Rehabilitation Alternative Environmental Effects

Prepared by:

HNTB Corporation

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Environmental Assessment

Magnolia Bridge Replacement

City of Seattle

Contents

1. Introduction 1-1

2. Description of Alternative..... 2-1

3. Additional Information and Analysis..... 3-1

3.1.1 Geology and Soils.....3.1-1
3.1.2 Air Quality 3.2-1
3.1.3 Water Quality (Groundwater).....3.3-1
3.1.4 Wildlife, Fisheries, and Vegetation 3.4-1
3.1.5 Noise 3.5-1
3.1.6 Hazardous Materials.....3.6-1
3.1.7 Land Use 3.7-1
3.1.8 Public Lands, Section 4(f).....3.8-1
3.1.9 Historic, Cultural, and Archaeological Resources.....3.9-1
3.1.10 Social, Economic, and Relocation 3.10-1
3.1.11 Environmental Justice.....3.11-1
3.1.12 Visual Quality.....3.12-1
3.1.13 Traffic & Transportation 3.13-1
3.1.14 Public Services and Utilities.....3.14-1

Appendix A – Geology and Soils Technical Memorandum

Appendix B – Groundwater Technical Memorandum

Appendix C – Hazardous Materials Technical Memorandum

List of Figures

Figure 1 Project Vicinity 1-2

Figure 2 Project Study Area 1-3

Figure 3 Rehabilitation Alternative 2-3

Figure 4 Bridge Cross Section at Location A (see Figure 3) 2-5

Figure 5 Bridge Cross Section with Ground Improvement at Location A (see Figure 3) 2-6

Figure 6 Bridge Cross Section at Location B (see Figure 3) 2-7

Figure 7 New Geotechnical Boring Locations 3.1-1

Figure 8 Location of Ground Improvement at Intertidal Area West of Pier 91 (view to the northeast from Smith Cove Park) 3.4-1

Figure 9 Validated Sites in the Rehabilitation Alternative Vicinity 3.6-2

Figure 10 View from Pier 91 Looking Northeast at the South Side of the Bridge 3.12-2

Figure 11 Proposed Cross Bracing between Bents 35 and 36, and 37 and 38 (South Side of Bridge) 3.12-2

List of Tables

Table 1 Discipline Reports Reviewed by WSDOT 1-1

Table 2 Rehabilitation Alternative Elements 2-2

Table 3 Intersection Carbon Monoxide (CO) Concentrations 3.2-1

Table 4 Predicted Design Year Leq Noise Levels (in dBA) 3.5-1

Table 5 Construction Cost (2004) 3.10-2

Table 6 Construction Durations (months) 3.13-3

1. Introduction

During the development of the Magnolia Bridge Replacement Project, the City of Seattle proposed four alternatives to be included in a NEPA EIS. These are the No Build, and Alternatives A, C, and D. Since that time, another alternative, the Rehabilitation Alternative, has been recommended for consideration. The City has already submitted the 14 discipline reports listed in Table 1 to WSDOT for review. WSDOT has approved 11 of these reports.

These discipline reports were prepared before the Rehabilitation Alternative was added to the project and only address the No Build Alternative and Alternatives A, C and D. This document was developed to provide information on and analysis of the Rehabilitation Alternative so that it can be included in the DEIS. Figure 1 and Figure 2 show the project vicinity and study area, respectively.

Table 1 Discipline Reports Reviewed by WSDOT

Discipline	Approval Date
1. Geology and Soils	February 2005
2. Air Quality	November 2004
3. Water Quality	April 2005
4. Wildlife, Fisheries, and Vegetation	December 2004
5. Noise	Not yet approved
6. Hazardous Materials	November 2004
7. Land Use	September 2004
8. Public Lands, Section 4(f)	Not yet approved
9. Historic, Cultural, and Archaeological Resources	Not yet approved
10. Social, Economic, and Relocation	February 2005
11. Environmental Justice	February 2005
12. Visual Quality	January 2005
13. Traffic & Transportation	January 2005
14. Public Services and Utilities	August 2004

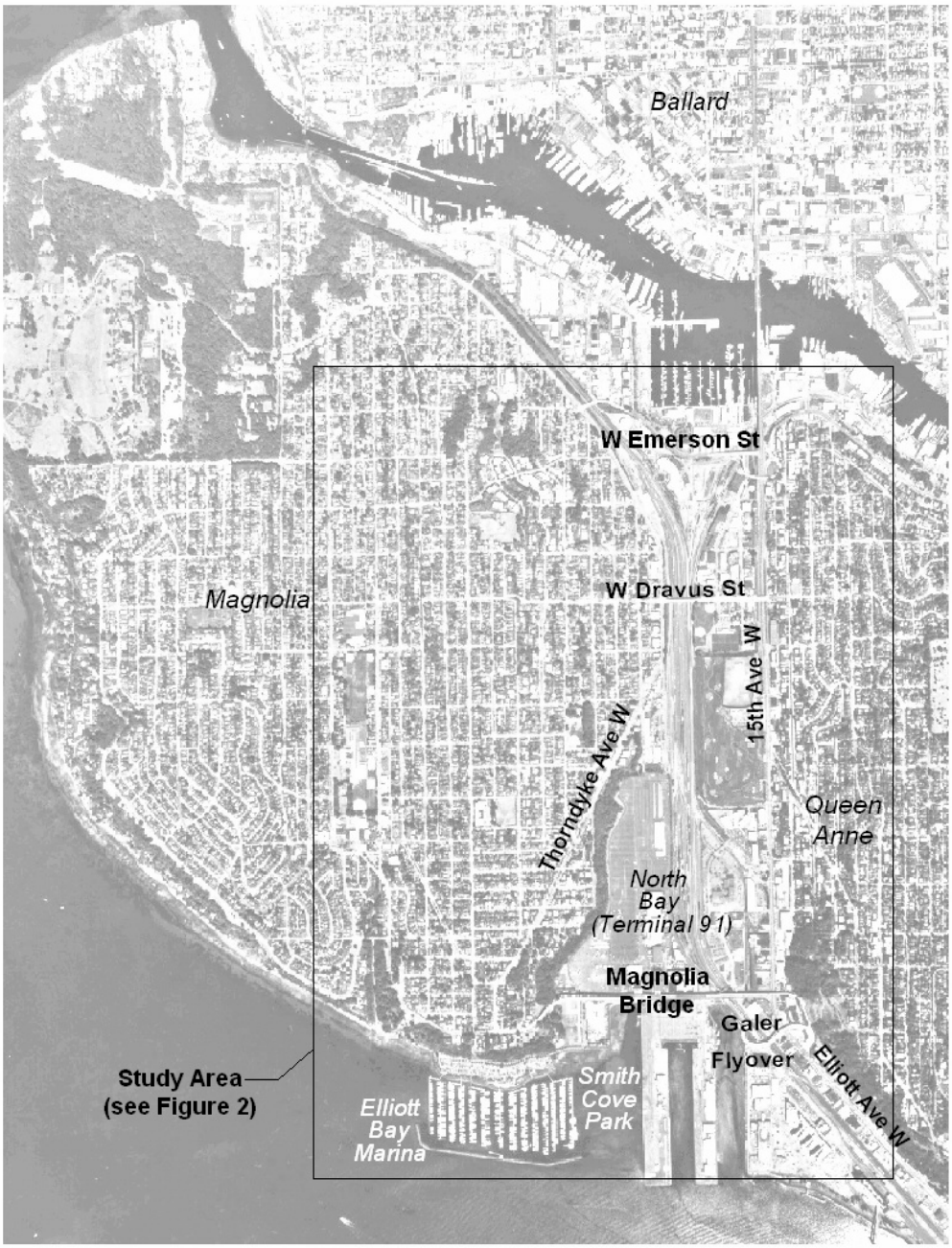

Figure 1 Project Vicinity

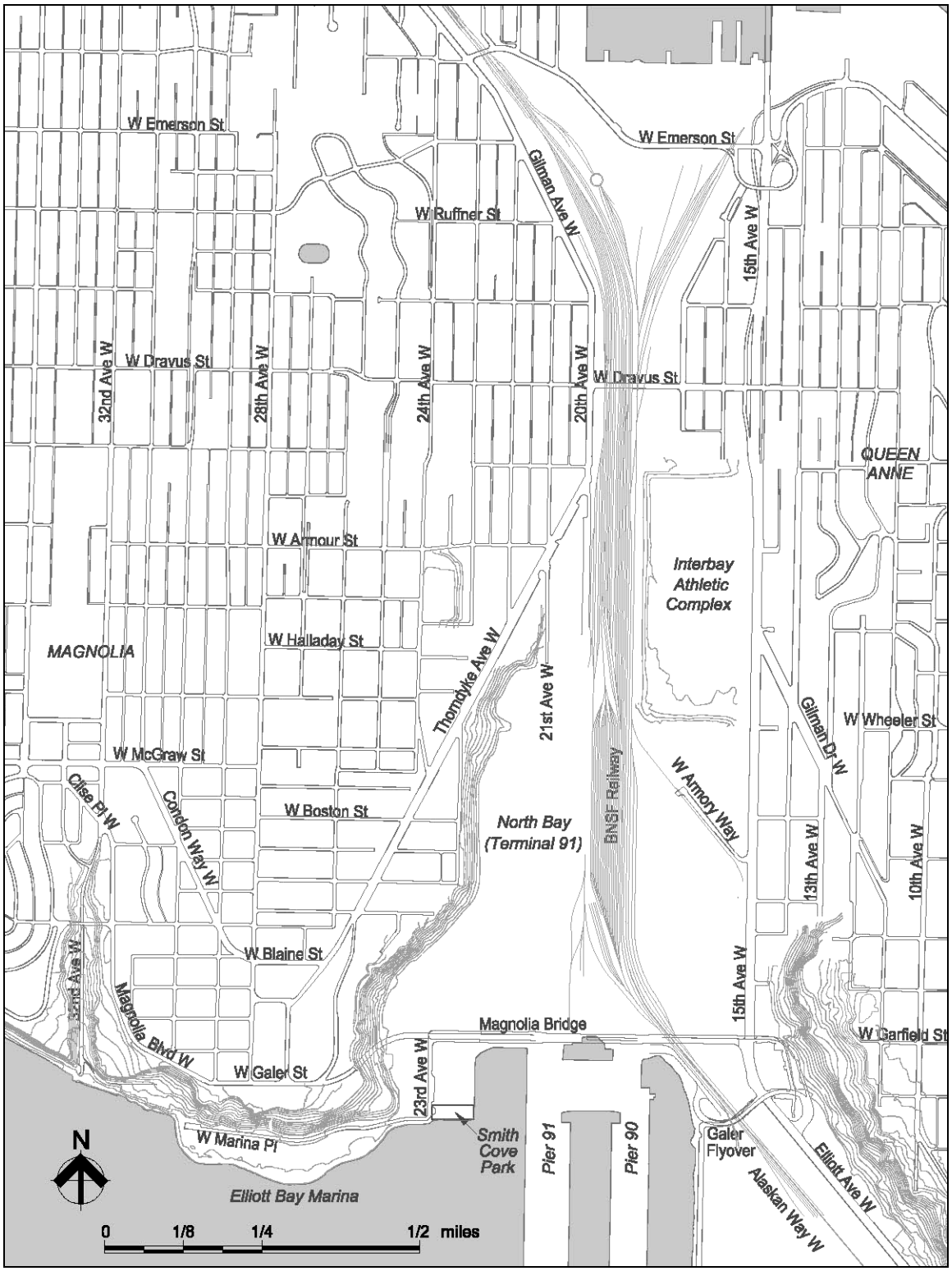

Figure 2 Project Study Area

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2. Description of Alternative

As part of an alignment study and NEPA Environmental Impact Statement process, the City of Seattle evaluated a number of alternatives for replacing the Magnolia Bridge. The alignment alternatives development and selection process is documented in the Alignment Study Report (revised September 2004). The process considered twenty-five alignment alternatives for the bridge replacement.

As a result of this work, four alternatives were selected to be included in the DEIS. They are: Alternatives A, C and D and the No Build Alternative. Since that time, the City has received feedback through its public process and wishes to include an additional alternative in the DEIS – the Rehabilitation Alternative.

A rehabilitation alternative was considered in 2001 and 2002 as the bridge replacement project was initially developed. It was rejected because it was deemed too costly. However, a revisiting of the initial 2001 and 2002 cost estimate for bridge replacement has shown a doubling of cost. This change has made the Rehabilitation Alternative a viable alternative for consideration in the DEIS.

The Rehabilitation Alternative would maintain the existing bridge alignment with the existing connections to 15th Avenue West at the east end and West Galer Street at the west end. Bridge rehabilitation would bring the structure up to current design standards. Table 2 and Figure 3**Error! Reference source not found.** show the elements of this alternative. Of the original structure built in 1929-1930, only the columns and foundations would remain between the BNSF Railway and Magnolia Bluff, and these would be strengthened to meet current standards. The existing ramps to and from the Elliott Bay Marina via 23rd Avenue West would be retained. The center ramps from the bridge to Terminal 91 would be removed. Terminal 91 access would remain at the East Gate with access from 15th Avenue West via the Galer Flyover structure and Alaskan Way West.

Similar to the build alternatives, the Rehabilitation Alternative would retain the same number of vehicle travel lanes as the existing bridge. Lane widths would meet WSDOT Local Agency Guideline (LAG) design standard widths of 12 feet for outside lanes and 11 feet for inside lanes. The number of vehicle travel lanes is as follows:

Westbound

- One lane from northbound 15th Avenue West on a grade-separated structure over 15th Avenue West
- One lane from southbound 15th Avenue West
- Two lanes from the BNSF Railway crossing to the west end of the bridge on Magnolia Bluff

Eastbound

- One lane from Magnolia Bluff to the 23rd Avenue West on-ramp
- Two lanes from the 23rd Avenue West on-ramp to 15th Avenue West (one lane right-only and one lane left and through at 15th Avenue West)

The Rehabilitation Alternative would have a sidewalk on the south side of the bridge structure. The LAG design standard minimum sidewalk width is five feet. A six-foot width may be possible on the Rehabilitation Alternative new bridge deck. The existing bridge stairway access to the ground would be retained near the current locations.

Table 2 Rehabilitation Alternative Elements

1.	15th Avenue W overpass	Retrofit the eastern 880 feet of this structure, which has 16 spans, for increased seismic capacity. Only the span over 15th Avenue W has been previously retrofitted.
2.	Ramp and structure west to 15th Avenue W to west side of railroad	The ramp and spans in this 873-foot long section would be removed and replaced with new structure. This would eliminate a design deficiency (inadequate stopping sight distance) where the railroad structure connects to the ramp to 15th Avenue W.
3.	Roadway deck and supporting crossbeams, west side of railroad to Magnolia Bluff	The existing superstructure in this 2,454-foot section would be replaced with pre-stressed slab spans. The seven concrete truss spans in this section would also be replaced. All crossbeams and column tops would be replaced.
4.	Center ramp to Terminal 91	The 529-foot center ramp located west of the railroad would be replaced with new foundations, columns, and deck.
5.	Railroad to center ramp and center ramp section to 23rd Avenue W ramps	Cross bracing would be provided between columns in the north-south (lateral) and east-west (longitudinal) directions.
6.	From marina ramps to west end of bridge	Columns would be encased in steel jackets to provide seismic capacity. Existing column bracing in the east-west (longitudinal) direction would be replaced.
7.	Timber pile foundations from railroad to west end of bridge	Grade beams and drilled shafts would be connected to existing column foundations to increase seismic capacity.
8.	Connection to Anthony's Seafood Distributing	This connection would be removed and not replaced when the bridge deck is replaced (item 3).
9.	Throughout	Ground around foundations would be treated by compaction grouting and stone columns to resist liquefaction during an earthquake.

Figures 4, 5, and 6 are cross sections that illustrate the type of replacement and retrofit improvements required. Figure 5 also shows the extent of ground improvement required west of the BNSF Railway where the depth to glacially compacted soil is about 100 feet.

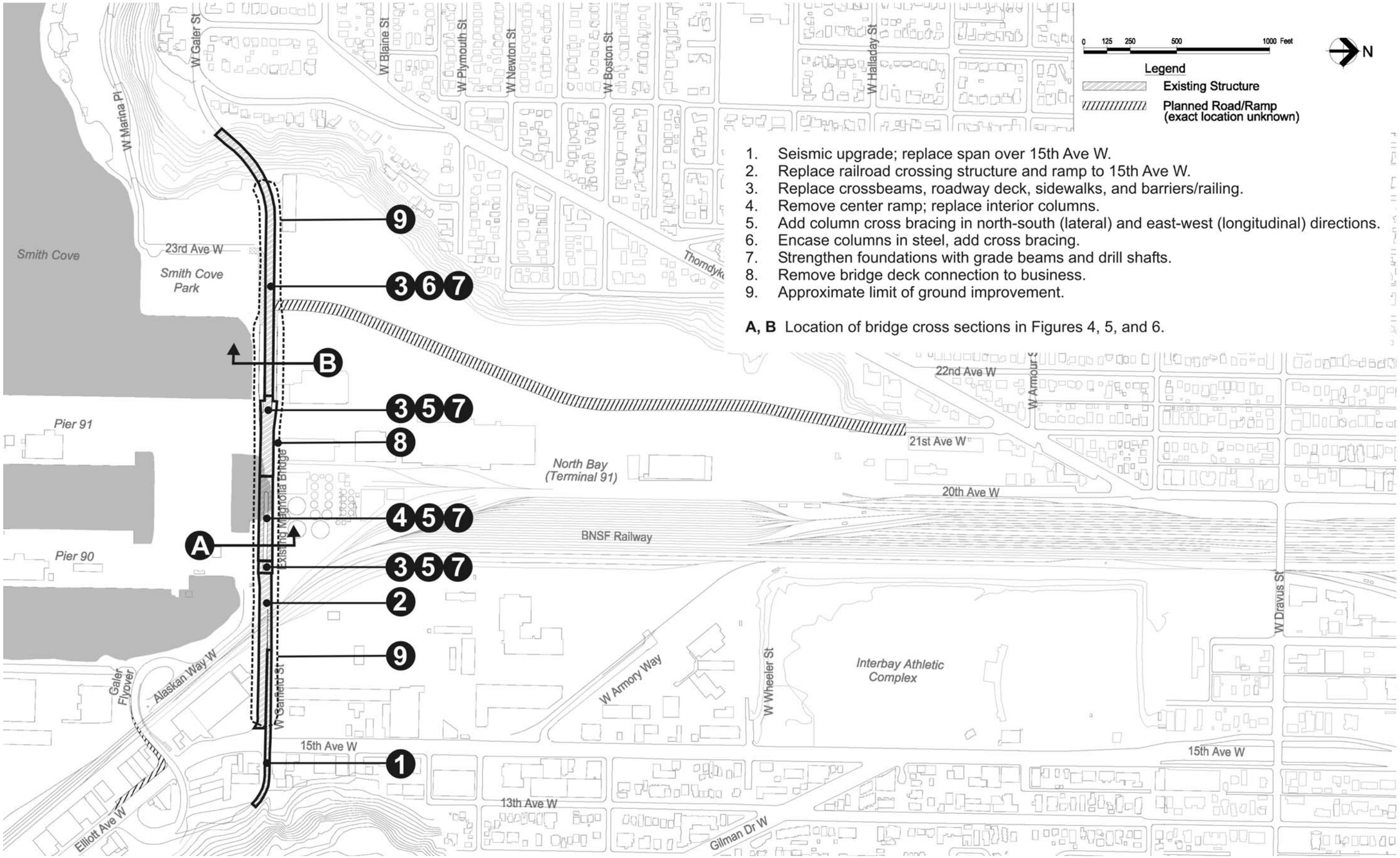

Figure 3 Rehabilitation Alternative

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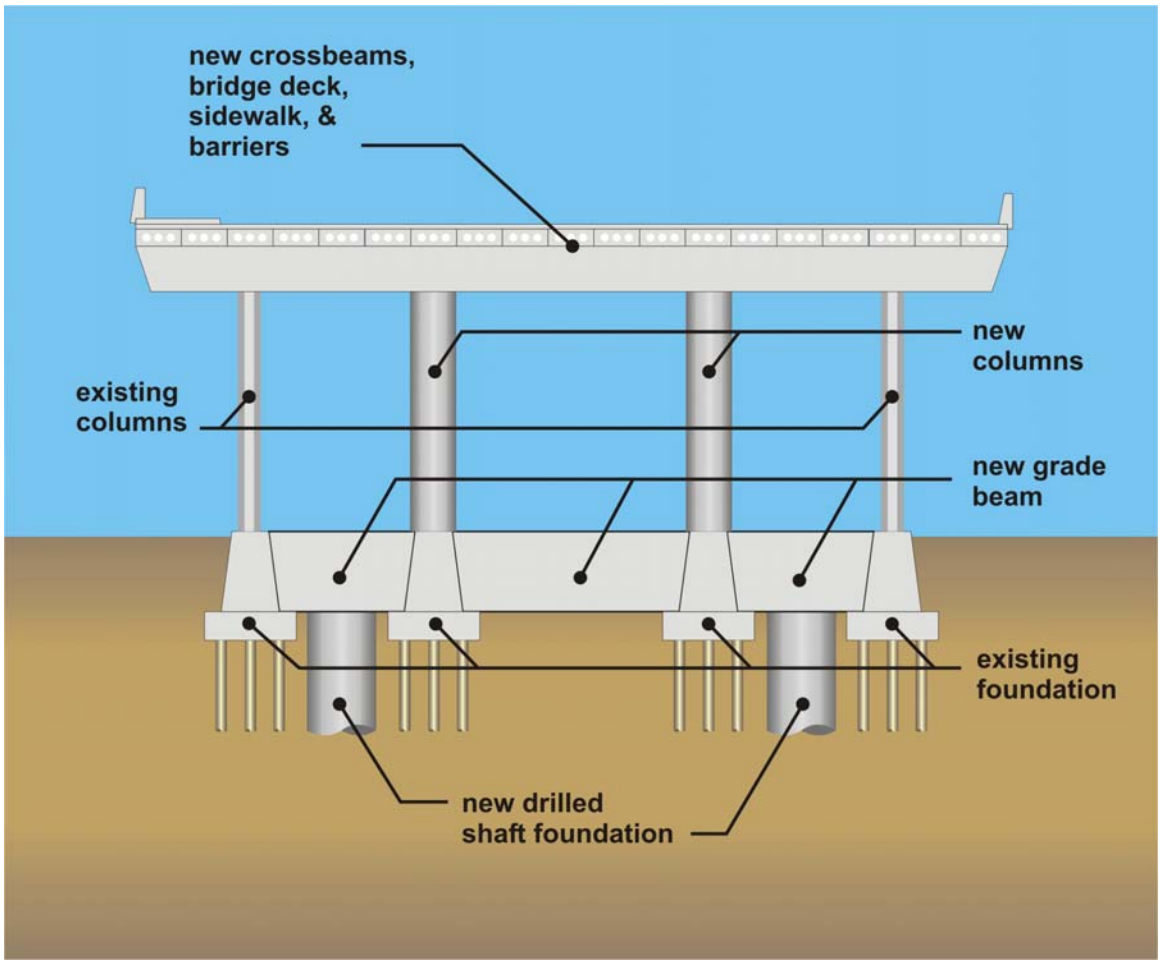

Figure 4 Bridge Cross Section at Location A (see Figure 3)

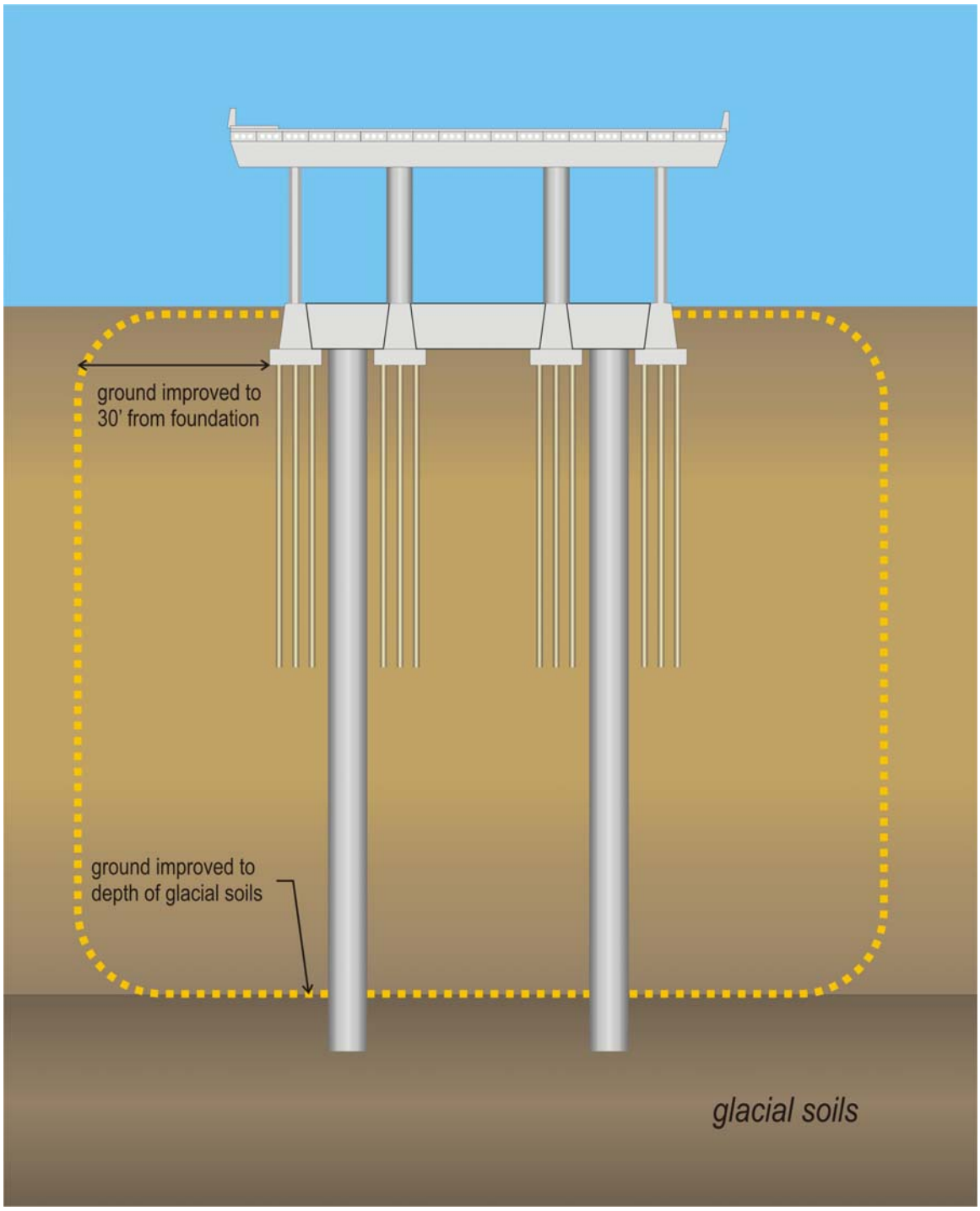

Figure 5 Bridge Cross Section with Ground Improvement at Location A (see Figure 3)

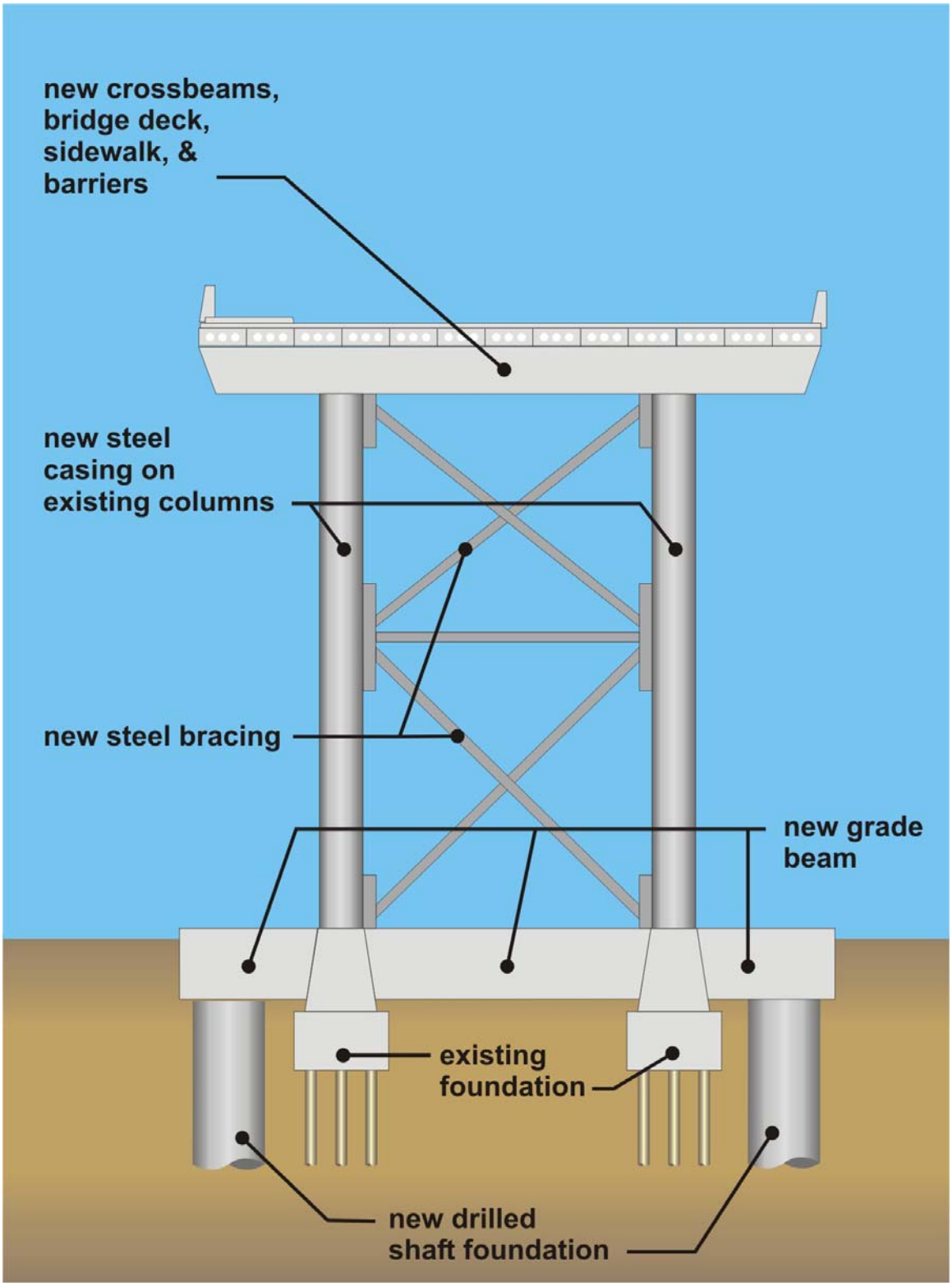

Figure 6 Bridge Cross Section at Location B (see Figure 3)

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3. Additional Information and Analysis

The following sections describe additional analyses and environmental impacts specific to the Rehabilitation Alternative. If the impacts of the Rehabilitation Alternative are the same as alternatives previously evaluated in the discipline reports listed in Table 1, the appropriate report is referenced.

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3.1 Geology and Soils

The Rehabilitation Alternative has similar subsurface soil, groundwater, and geologic conditions to Alternative A and the No Build. The impacts of Alternative A and No Build were evaluated in the Geology and Soils Discipline Report (February 2005). The discipline report summarizes impacts and mitigation measures on pages 93 through 97. Groundwater impacts are discussed in the Water Quality section of this memorandum.

Geologic data supplemental to Geology and Soils Discipline Report (February 2005) were obtained by drilling two additional borings in late June and early July, 2005. The boring locations are shown in Figure 7 and are near the center section of the bridge. Borings EB-1 and EB-2 were drilled to depths of 171 and 161 feet below ground surface, respectively. The two additional borings were evaluated for liquefaction potential. Based on this evaluation, potentially liquefiable and soil strength-reduced deposits could extend to approximate depths of 100 to 110 feet for the Rehabilitation Alternative. The Geology and Soils Technical Memorandum is included as Appendix A.

Figure 7 New Geotechnical Boring Locations

Many of the impacts described in the discipline report and in the Geology and Soils Technical Memorandum could be addressed by following established American Association of State Highway and Transportation Officials (AASHTO) criteria for proper design and/or standard construction practice.

Because of the depth of loose, soft, and potentially liquefiable soil as well as the anticipated bridge loads, the soil would be improved to maintain the integrity of the existing foundations and to provide improved capacities for new foundations. Ground improvement measures could include Earthquake Drains™, compaction grouting, cement deep soil mixing, and vibro-replacement (stone columns). The ground improvement type, area, and deep foundation design would take into account the current AASHTO seismic design criteria and the potential for liquefaction and lateral spreading. Because the design would account for site subsurface conditions, no soils- or geology-related direct impacts are anticipated for the Rehabilitation Alternative.

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3.2 Air Quality

The No Build and all build alternatives, including the Rehabilitation Alternative, would have the same opening year and design year traffic volume forecasts on study area roadways. As shown in Table 3, the three intersections evaluated for carbon monoxide (CO) concentrations would be well under NAAQS concentrations.

Table 3 Intersection Carbon Monoxide (CO) Concentrations in Parts per Million (ppm)

Location	NAAQS	2003	2010 Year of Opening	2030 Design Year
1-Hour Averaging Time				
Alaskan Way & Galer Flyover	35	1.8	1.9	1.6
15th Ave W SB ramps & W Dravus St	35	5.4	3.6	3.0
20th Ave W & W Dravus St	35	5.4	3.3	3.3
8-Hour Averaging Time				
Alaskan Way & Galer Flyover	9	1.4	1.7	1.3
15th Ave W SB ramps & W Dravus St	9	3.9	2.7	2.2
20th Ave W & W Dravus St	9	3.9	2.5	2.5

Notes: SB = southbound; NAAQS = National Ambient Air Quality Standards; CO = carbon monoxide
1-hour average ambient CO max = (CAL3QHC 1-hour max impact)+0.8 ppm background
8-hour average ambient CO max = (CAL3QHC 1-hour max impact)(0.7 persistence factor)+0.7 ppm background
Source: City of Seattle, Magnolia Bridge Replacement Air Quality Discipline Report, November 2004, Table 5, page 33

Rehabilitation Alternative construction impacts would be similar to those of Alternative A. Dust and particulate emissions during bridge demolition would be less than for the bridge replacement alternatives (A, C, and D) because the existing ramps to 23rd Avenue West, most of the bridge columns, and most of the 15th Avenue West overpass structure would be retained.

No supplemental analyses were done for the Rehabilitation Alternative. See the Air Quality Discipline Report (November 2004), for the detailed analysis.

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3.3 Water Quality (Groundwater)

Two additional borings were drilled and sampled to supplement the existing subsurface information (see Figure 7) presented in the Water Quality Discipline Report (April 2005). The borings were located in areas where geologic conditions, including the depths to soils not subject to earthquake-induced liquefaction, were not documented adequately by previous, shallower borings. Monitoring wells were not installed.

Impacts

Soil improvement activities for the Rehabilitation Alternative and the resulting soil densification could have two effects on the ability of shallow soils to transmit groundwater. Injected grout from compaction grouting could reduce the effective transmissive area of the soils and the related soil densification could reduce the hydraulic conductivity within the rehabilitation area. Reducing the area and the hydraulic conductivity of the shallow soils could result in a steepening of the hydraulic gradient through the rehabilitation area and could cause associated groundwater mounding of about 1 to 2 feet on the north side (upgradient) of the improved area. Figure 3 on page 2-3 shows the approximate area between the BNSF Railway and the toe of the Magnolia Bluff slope where ground improvement would be required. The improvement and resulting soil densification would be continuous in this area because of the short distances–30 to 60 feet–between the existing foundations and the need to densify soil within about 30 feet of the foundation (see Figure 5 on page 2-6). This is different from Alternatives A, C, and D where new bridge foundations would be 150 feet or further apart and ground improvement and soil densification would be localized around the foundations rather than continuous along the bridge.

Groundwater mounding would be highest on the west end of the site near the hillside, and lowest on the east side where groundwater would be able to flow around the improved zone through beach (sand and gravel) soils. Groundwater levels in some areas would be higher than the top of the ground improvement zone, assumed to extend downwards from 10 feet below the surface. Groundwater would be able to flow over the top of the improved zone in these areas and may have reduced mounding.

Since areas adjacent to the bridge site are contaminated, any magnitude of groundwater mounding could have the effect of mobilizing additional contaminants within previously unsaturated soil. It should be noted that some fill materials overlying the beach soils are unsaturated and may include relatively coarse-grained sand and gravel. When saturated, these soils could provide a pathway for rapid contaminant migration. A more detailed discussion of the potential impacts with regard to contamination is provided in the Hazardous Materials Technical Memorandum (Appendix C).

Due to the high pH of most grout types, however, groundwater pH may increase downgradient of the rehabilitation area.

Groundwater mounding of up to 2 feet should not cause surface ponding, since the water level is typically between 4 and 10 feet below ground surface. However,

mounding may flood existing utility vaults or corridors that are currently just above the water table.

The Groundwater Technical Memorandum is included as Appendix B.

Mitigation Measures

Groundwater Mounding

Construct an artificial bypass for groundwater through the rehabilitation zone, engineered in such a way to reduce groundwater mounding and maintain preconstruction water levels and groundwater flow directions.

Reduce the foundation rehabilitation area to reduce impacts on soil hydraulic conductivity and reduce the magnitude of mounding.

Contaminant Movement

Construct contaminant recovery trenches and/or treatment systems to collect newly mobilized contamination. Trenches and treatment systems may be necessary both upgradient and downgradient of the proposed rehabilitation area.

Mitigate mounding and changes in groundwater flow direction – additional information forthcoming.

Changes in Groundwater Flow Direction

Monitor water level and water quality at existing and new observation wells before, during, and after construction to evaluate changes in groundwater levels and flowpaths. Water levels can be used to evaluate changes in groundwater flow directions. Mitigation would be same as described for groundwater mounding.

Construction Impacts

There is a possibility that construction activities would encounter potentially contaminated soil and groundwater. These issues are discussed in both the Hazardous Material Discipline Report and Technical Memorandum.

3.4 Wildlife, Fisheries, and Vegetation

Rehabilitation Alternative operational impacts would be similar to Alternative A, as presented in the Wildlife, Fisheries, and Vegetation Discipline Report (December 2004). Bridge maintenance activities would be of longer duration than with the replacement alternatives because of the larger number of columns and more complex structure of the Rehabilitation Alternative. The Rehabilitation Alternative would also require more painting of steel bracing and column cladding.

The Rehabilitation Alternative would have similar construction impacts as Alternative A, but construction, except for some ground improvement compaction grouting, would be within the existing alignment and within existing rights of way and easements. There would not be any long-term forest removal for the Rehabilitation Alternative. Ground improvement, such as compaction grouting, would extend about 30 feet from existing bridge foundations, including the steel pile foundations of the ramps to 23rd Avenue W. Figure 3 and Figure 8 show where ground improvement would affect about 0.2-acre of intertidal area at the head of Smith Cove west of Pier 91.

Figure 8 Location of Ground Improvement at Intertidal Area West of Pier 91 (view to the northeast from Smith Cove Park)

Best Management Practices (BMPs) for construction would be implemented to minimize turbidity and water quality degradation during intertidal zone and in-water activities for ground improvement. Mitigation measures for the Rehabilitation Alternative would be the same as those described on pages 43 through 45 of the Discipline Report for Alternative A.

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3.5 Noise

The following discussion supplements the Noise Discipline Report (August 2005). The Rehabilitation Alternative was not modeled. Because it has the same horizontal and vertical alignments and traffic volume as the No Build Alternative, it would have the same operational noise levels at study area properties. Table 4 lists the modeled residential noise receptors where design year (2030) noise levels would exceed the Noise Abatement Criteria (NAC) of 66 dBA. These are residential properties along West Galer Street to the west of the Magnolia Bridge. The Noise Discipline Report concluded traffic management measures such as lower speed limits and restricting trucks would not be practical in this area for noise mitigation. Due to the number of driveway accesses and public road intersection, noise barriers would not be a feasible mitigation measure along West Galer Street.

Table 4 Predicted Design Year Leq Noise Levels (in dBA)

Receptor Number	No Build	A	C	D	Rehabili-tation	Source of Noise
3	70	70	70	68	70	W Galer St
4	71	71	71	70	71	W Galer St
5	70	70	70	70	70	W Galer St
6	70	70	70	69	70	W Galer St
10	70	71	69	67	70	W Galer St

Source: From Magnolia Bridge Replacement, Noise Discipline Report, August 2005, Table 3, pages 36 and 37.
Only receptors exceeding the Noise Abatement Criteria of 66 dBA are shown.

Construction noise impacts would be similar to Alternative A. However, the bridge would be closed to traffic for a longer period, 21 to 27 months, than Alternative A which has the longest closure period, 15 to 21 months, of the three replacement alternatives. Diverted traffic during bridge closure could increase noise levels for a short period of time along detour routes.

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3.6 Hazardous Materials

The following discussion supplements the Hazardous Materials Discipline Report (November 2004). A Hazardous Materials Technical Memorandum (October 2005) is provided as Appendix C.

Historic records for the project area along with agency environmental databases were reviewed to identify former and current land uses that could result in contamination of soil and/or groundwater along the alignment. Based on the review findings, 413 potentially contaminated properties were identified in the project area. Many of the properties were subsequently eliminated as potential concerns because they: (a) had been cleaned up and/or contamination is unlikely to migrate toward the project area, (b) were not listed on databases that indicate contamination is present, and/or (c) were considered a sufficient distance from the project area so as not to pose a risk.

After the initial screening, 35 validated sites were still considered to pose some risk to the project and were retained for further evaluation. These sites include metal manufacturers, junk and wrecking yards, auto repair shops, gasoline stations/bulk fuel distributors, dry cleaners, print shops, bulk fuel terminals, railroads, and other industrial sites. They also included properties adjacent to the project alignment that store or have stored heating oil. Each of the sites retained for further analysis was ranked as a low, moderate, or high risk to the project based on its proximity to the project alignment and the type of contaminants that may be present. Most of the sites are considered a low risk to the project because the potential contamination is considered "reasonably predictable" (as defined in the Washington State Department of Transportation [WSDOT] Environmental Procedures Manual), the property is not adjacent/near the alignment, and/or the property is located down-gradient of the project area. Seven properties are listed as posing a moderate risk due to: (a) their proximity to the project area and because potential contamination is not considered "reasonably predictable," and/or (b) the property is listed on a database indicating that contamination has been confirmed. One property, the Port of Seattle Terminal 91 tank farm, is identified as a moderate to high risk because it has a history of industrial activities, and has known or suspected contaminants that are not considered reasonably predictable. Most of the above ground tanks and buildings on this site were removed in summer 2005. The 21 properties shown in Figure 9 are included in the 35 validated sites.

Secondary and cumulative impacts discussed in the Hazardous Materials Discipline Report (November 2004) for Alternative A would apply for the Rehabilitation Alternative.

Figure 9 Validated Sites in the Rehabilitation Alternative Vicinity

The Rehabilitation Alternative, once constructed, has the potential to impact the groundwater regime. The most likely consequences included mounding of 1 to 2 feet of groundwater on north (upgradient) side of the rehabilitation area, and shifts in groundwater flow directions. If contaminants are present in soils that are currently above the high groundwater elevation, but that subsequently become saturated, contaminants could become mobilized that otherwise would have remained relatively stationary. Rises in groundwater elevations could also impact soils by increasing the smear zone containing contamination. Furthermore, shifts in groundwater flow gradients could spread contamination into areas not currently downgradient of contaminated site(s). This could adversely impact properties and create potential liabilities for cleanup that would not exist without the project.

Changes in groundwater elevations and shifts in flow gradients might impact the installed groundwater treatment system at the Port of Seattle's Terminal 91 tank farm (site #10). Remediation is ongoing at the site and includes product recovery. Based on the location of the Port's property, groundwater elevations could be increased at their site by the project. Depending on the construction and placement of the product recovery system, increases in groundwater elevations and shifts in flow directions might interfere with product recovery.

Preliminary Site Investigations (PSIs) are recommended for the right-of-ways at the Tsubota Steel and Pipe property (28), the Fred Arnold Truck Sales property (33), the Port of Seattle properties (9, 9A, and 10), the Metro Interbay Pump Station property (13), the Sammis Company property (15), the former service station at 1534 15th Avenue West (24), the SPCC property (25), the former Smith Cove Cleaners property (20), and the Builders Hardware Supply (22) property where grout injection and/or bridge foundation construction is proposed. Based on the findings of the PSIs, the amount of contamination encountered may be minimized by using driven piles instead of drilled shafts for bridge foundations.

3.7 Land Use

Operation impacts of the Rehabilitation Alternative would be similar to the No Build Alternative impacts discussed in the Land Use Discipline Report (September 2004). No new right of way would be required. The bridge would be operated in its existing rights of way, with easements from the Port of Seattle across Terminal 91 for bridge operation and maintenance access. For the 21 to 27 months of bridge closure during construction and with operation of the replacement bridge deck, the existing business access from the Magnolia Bridge deck to Anthony's Seafood Distributing truck loading would be eliminated. This would be a potential business displacement. This displacement is required for all build alternatives and would be mitigated by providing an alternative truck access to the building or relocating the business.

The Rehabilitation Alternative would have similar effects on the development of underused Port of Seattle property as the No Build Alternative since the existing ramps to 23rd Avenue West and bridge columns would remain. The existing ramps would occupy space along the waters edge and segregate the waterfront from the uplands area.

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3.8 Public Lands, Section 4(f)

The Rehabilitation Alternative would upgrade the existing bridge within its existing rights-of-ways and easements. Vehicle and non-motorized access to public lands in the project vicinity, including Smith Cove Park, would remain the same as with the No Build Alternative. See the Public Lands, Section 4(f) Discipline Report (September 2004) for detail.

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3.9 Historical, Cultural, and Archaeological Resources

The Rehabilitation Alternative would be constructed in the same alignment as the existing bridge. No additional studies were done to supplement the Historical, Cultural, and Archaeological Resources Discipline Report (August 2005). Most below ground construction for the Rehabilitation Alternative would occur in previously disturbed ground and in fill material placed at several times in the last 100 years. Some deep foundations ("drilled shafts") would be deeper than the fill and would extend through former Smith Cove to Salmon Bay valley margin areas where early Native American sites and Historic Period archaeological resources may be expected.

The Discipline Report discussions of affected environment, environmental consequences, and mitigation measures for the other build alternatives would also apply to the Rehabilitation Alternative.

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3.10 Social, Economic, and Relocation

No additional studies were done to supplement the Social, Economic, and Relocation Discipline Report (February 2005).

Operational Impacts

The Rehabilitation Alternative would be constructed within the same permanent rights of way and easements as the existing bridge. Project impacts, therefore, are similar to the No Build Alternative. No impacts related to community cohesion would occur. The Rehabilitation Alternative would not change neighborhood characteristics and would not separate or isolate any neighborhoods.

No specific adverse impacts on the "usual and accustomed areas" of local tribes have been identified for the Rehabilitation Alternative. The tribes will, however, have the opportunity to identify potential issues through formal Section 106 government-to-government consultation initiated by FHWA.

The Rehabilitation Alternative would not induce population growth in the study area. Without induced population growth, no increase in the demand for housing, recreation facilities, or community facilities, institutions, or services in the study area is expected. Furthermore, direct access to and from community facilities and general travel patterns and travel times near these facilities would not change in the future.

There would be no adverse impact on pedestrian, bicycle, and transit facilities. Non-motorized travel times would be similar to existing conditions.

The Rehabilitation Alternative would remove the existing vehicle connection between the bridge deck and the loading dock of Anthony's Seafood Distributing. From an economic standpoint, no environmental consequences would occur if this business were able to relocate within the Port of Seattle property and preserve its operational connections. The company manager indicates that Anthony's has a strong preference for remaining close to City Ice. If this business were relocated to other places within Seattle with access to cold storage and Port facilities for seaborne cargo, no loss of tax revenue to the City would be expected, and no impact on the region as a whole would be expected. In the unlikely event that relocation within Port property or within the City of Seattle is not possible, suitable facilities may be available in either Tacoma or Bellingham. Under this scenario, tax revenues generated by Anthony's Seafood Distributing would be lost to the City.

The Social, Economic, and Relocation Discipline Report contains estimates of economic output, labor income (wages), generated jobs, and state and local tax generation. These are based on an August 2004 estimate of construction costs that ranged between $77.5 million for Alternative C and $98.8 million for Alternative D with elevated intersection. Since the discipline report economic analysis was completed, the project cost estimates have been refined and subjected to a schedule and cost risk analysis. Table 5 shows the current (October 2005) range of project construction costs, without right of way, and without risk costs. The Rehabilitation Alternative has the highest cost and would have a corresponding greater effect on economic output, labor income (wages), generated jobs, and state and local tax generation than the bridge replacement alternatives.

Table 5 Construction Cost (2004)

Alternative	Construction Cost (2004 $millions)
A - Ramps	102.1
C	90.7
D - Ramps	102.7
Rehabilitation	121.6

Cost without right-of-way

Anthony's Seafood Distributing has approximately 12 to 15 full- and part-time employees, including nine minorities, which would be affected by potential relocation. See Environmental Justice, Section 3.11 of this memorandum, for a discussion of potential disproportionate and adverse impacts on minority and low-income populations.

Construction Impacts

During construction, the existing bridge and its access to southern Magnolia would need to be closed for periods of time. The Social, Economic, and Replacement Discipline Report estimated this closure period as 17 months for Alternative A, which had the longest closure period. The most current estimate for closure is 15 to 21 months for Alternative A. The Rehabilitation Alternative closure is estimated at 21 to 27 months.

3.11 Environmental Justice

The Rehabilitation Alternative would potentially impact one business, Anthony's Seafood Distributing, by removing the existing connection between the bridge deck, adjacent to the westbound lanes, and the business' loading dock. All other build alternatives (A, C, and D) would have this impact as well. This impact could be avoided by providing a replacement truck loading access to this business.

The City of Seattle and the Port of Seattle would work with Anthony's to find a suitable location in which to continue operations. The new location would need to be nearby current locations so that employee commutes would not be significantly affected. Also, any new structure(s) for displaced business would need to be completed prior to relocation so that disruption of business operations would be minimized and no loss of jobs would occur.

With the mitigation measures implemented for displaced business as described above, no adverse or disproportionate impacts on minority or low-income populations would occur under this alternative. The project would therefore meet the provisions of Executive Order 12898, as supported by Title VI of the Civil Rights Act.

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3.12 Visual Quality

The Rehabilitation Alternative would keep the bridge on its existing horizontal alignment. The vertical alignment would also remain the same except in the vicinity of the BNSF Railway crossing where the roadway would be slightly higher–by two feet or less–than the existing structure.

Compared to the No Build Alternative, the Rehabilitation Alternative would modify the bridge visually in several ways:

- The railroad crossing structure would be replaced by new, longer spans. With fewer columns, there would be increase visibility under the bridge.
- West of the railroad to the existing ramps to 23rd Avenue West, the existing center ramp would be removed and replaced with new bridge deck. This would remove the under-bridge visual barrier of the center ramp.
- At the first span west of the railroad, and between the west end of the existing center ramp and the existing ramps to 23rd Avenue West, cross bracing would be installed between every other pair of exterior columns. This east-west oriented bracing would create a physical barrier to circulation under the affected bridge spans, and some visual barrier as well.
- West of the railroad to Magnolia Bluff the existing bridge deck and supporting steel frames and concrete trusses would be removed and replaced by new precast, prestressed concrete slabs and new crossbeams. Even with new steel cross bracing between some column pairs, the overall appearance will be cleaner and less cluttered than the existing structure with the various retrofit frames and bracing.

Figure 10 shows the existing appearance of the south side of the bridge east of Pier 91. Only the existing columns would remain. Figure 11 shows proposed bridge rehabilitation elements for this section of the bridge.

Views from the structure would remain essentially unchanged from the No Build Alternative. Views toward the structure would not be significantly different from the No Build Alternative for surrounding neighborhoods on Magnolia Bluff and the west slope of Queen Anne Hill. See Figure 12 and accompanying text in the Visual Quality Discipline Report (January 2005) for a description of study area viewpoints. Only businesses in Terminal 91 or the public approaching from 23rd Avenue West would see the modifications to the supporting bridge structure.

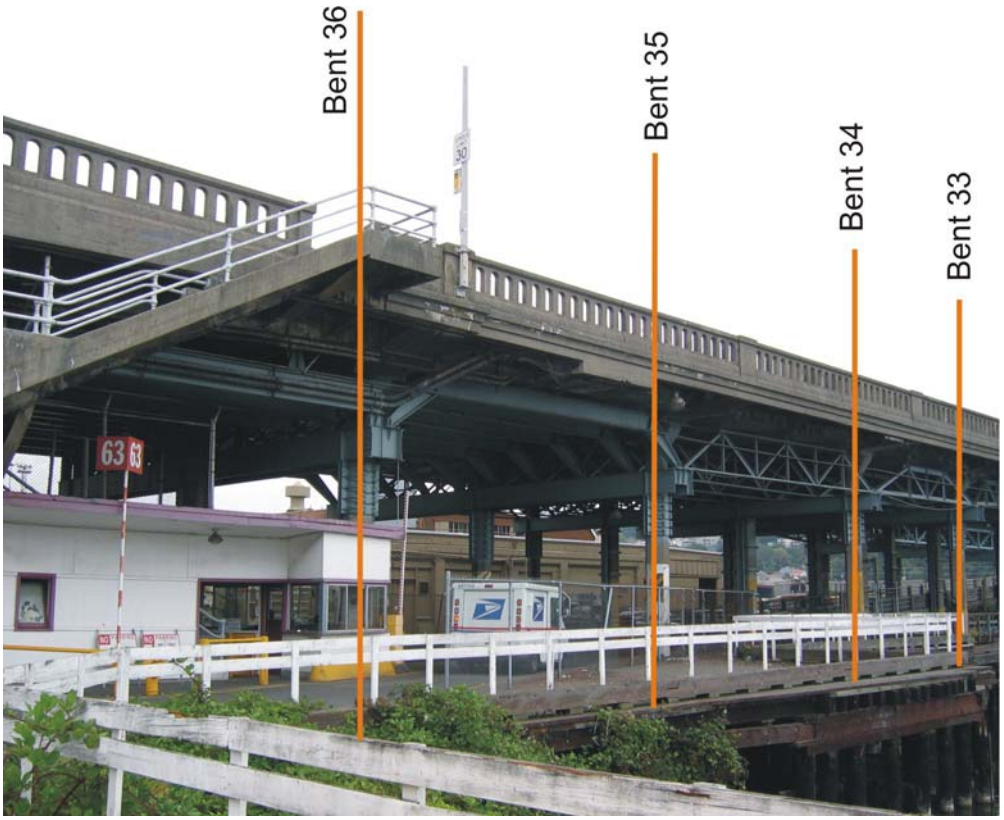

Figure 10 View from Pier 91 Looking Northeast at the South Side of the Bridge

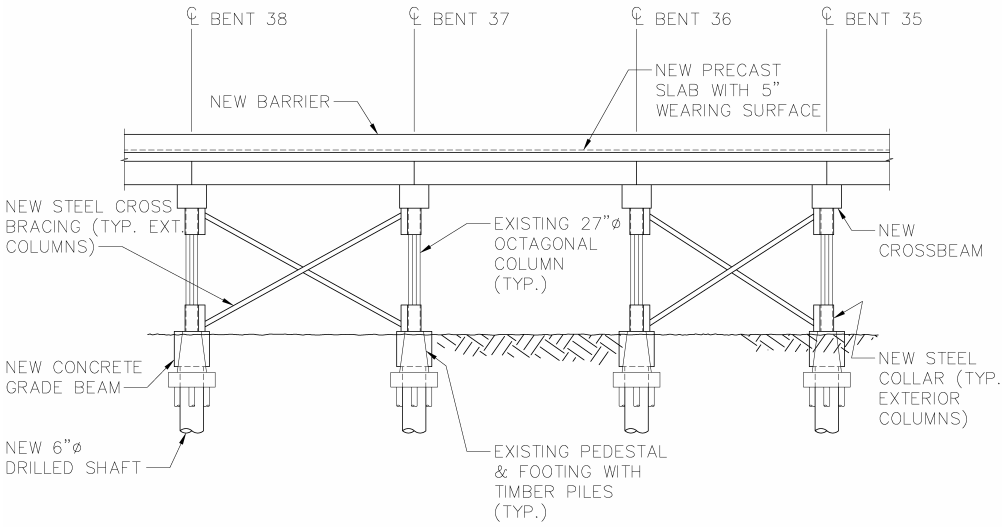

Figure 11 Proposed Cross Bracing between Bents 35 and 36, and 37 and 38 (South Side of Bridge)

3.13 Traffic & Transportation

Except as noted below, the Rehabilitation Alternative would have the same operational and construction impacts, and mitigation measures as Alternative A – Ramps as discussed in the Traffic and Transportation Discipline Report (January 2005).

Operational Impacts

The Rehabilitation Alternative would have the same design year daily and peak hour traffic forecasts, and would retain the existing connections on the east to 15th Avenue West/Elliot Avenue West and on the west to West Galer Street on Magnolia Bluff as the No Build and Alternatives A and D. The Rehabilitation Alternative would have the same operational impacts as Alternative A – Ramps.

Construction Impacts

Table 6 updates the estimated construction durations contained in Table 49 of the Traffic and Transportation Discipline Report (January 2005). Construction stage 2 would require bridge closure between the West Galer Avenue approach on Magnolia Bluff and the east approach from Elliot Avenue West. The Rehabilitation Alternative construction is located in the existing bridge alignment and would require the longest complete shutdown—an estimated six months longer than Alternative A

Construction impacts of the Rehabilitation Alternative during bridge shutdown (Stage 2 construction) would be similar to Alternative A, but of longer duration.

Table 6 Construction Durations (months)

Stage	Alternative A	Alternative C	Alternative D	Rehabili-tation
Mobilization	1	1	1	1
1. Initial construction with traffic maintained on existing bridge	24	24	24	12
2. Bridge closed to traffic to complete construction	15-21	12-18	6-12	21-27
3. Traffic on new structure(s) during demolition and cleanup	2	2	2	2
Total Construction Time	42-48	39-45	33-39	36-42

Mitigation of traffic impacts of bridge closure during constructions would be the same measures described in the Discipline Report for the other build alternatives: provision of access through the Port of Seattle Terminal 91 between the 21st Avenue West on the north side of Terminal 91 and Alaskan Way West near the Terminal 91 East Gate for access to 15th Avenue West via the Galer Flyover structure; and traffic control measures, including personnel, at the 15th Avenue W intersections with West Dravus Street to allow northbound to westbound double left turns in the PM peak period. Compared to the other build alternatives, the Rehabilitation Alternative

would have the highest bridge closure period traffic mitigation costs, and the greatest amount of closure period added vehicle travel time and user costs.

3.14 Public Services and Utilities

This section provides supplemental information to the Public Services and Utilities Discipline Report (August 2004).

Operational Impacts

Operation of the Rehabilitation Alternative would not create any new demand for public services or utilities. Emergency services using the rehabilitated Magnolia Bridge would operate similarly to the No Build Alternative.

Construction Impacts

Public Services

Construction impacts on public services would be similar to the bridge replacement Alternatives A, C, and D, but of a longer duration. The existing bridge and the access to southern Magnolia it provides would be closed for an estimated 21 to 27 months. That would be six months longer than the next longest closure of 15 to 21 months for Alternative A. The added travel time for vehicle trips between 15th Avenue W at West Galer Street and West Galer Street at Thorndyke Avenue West would be about eight minutes (under non-emergency conditions) using the West Dravus Street construction detour route. This could affect some emergency police, fire, and medical trips. See the Public Services and Utilities Discipline Report (August 2004) for the discussion of construction impacts for Alternative A, which would be similar to the construction impacts of the Rehabilitation Alternative.

Utilities

Utility systems within the study area are likely to be affected by construction of the new bridge and intersections under the Rehabilitation Alternative. The impacts would be similar to the Public Services and Utilities Discipline Report discussion for Alternative A. The Rehabilitation Alternative would place new grade beams at each existing foundation west of the BNSF Railway to Magnolia Bluff. This would create a greater quantity of excavation in areas with underground utilities for the Rehabilitation Alternative than for the bridge replacement alternatives.

Port of Seattle utilities would be affected by short-term shut-offs of service connections during construction of the main sections of the rehabilitated bridge, while public utilities would primarily be similarly affected at bridge connection points located at West Garfield Street and 15th Avenue West.

Construction of the Rehabilitation Alternative would result in the temporary relocation of utility service connections required to facilitate construction, as well as the permanent demolition and relocation of utility connections necessary to accommodate bridge rehabilitation construction. This process may result in unavoidable, temporary service interruptions. Such interruptions may have adverse economic impacts on utility customers, including local businesses whose operations are affected, and service providers, who are unable to bill because of inactivity. The type of impact is similar to the other build alternatives, but may be potentially of

greater extent because of the larger area of underground work for foundation strengthening and ground improvement. See the Public Services and Utilities Discipline Report, August 2004, discussion of Alternative A impacts on specific utility services.

No temporary service interruptions to sanitary sewer and drainage services would occur during construction of the Rehabilitation Alternative. No impacts on major utility infrastructure would occur during construction of Rehabilitation Alternative, and no permanent interruptions to utility services are anticipated as a result of Rehabilitation Alternative.

Mitigation Measures

Mitigation measures for the Rehabilitation Alternative would be the same as for the other build alternatives. See the Public Services and Utilities Discipline Report, August 2004.

Appendix A
Geology and Soils Technical Memorandum

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Technical Memorandum

Geology and Soils

Prepared by:

Shannon & Wilson, Inc.

November 2005

Seattle Department of Transportation
Agreement No. T01-34

Draft EA

Magnolia Bridge Replacement

City of Seattle

Contents

Contents i

Introduction 1

Description of Alternative 5

Methods 13

Affected Environment 15

Studies and Coordination 23

Studies 23

Data Sources 23

Major Assumptions 23

Impacts 25

Rehabilitation Alternative 25

Elevated Structure Foundations 25

Relationship Between Topography and Alignment Design 25

Mitigation Measures 27

Rehabilitation Alternative 27

Seismic Considerations 27

Construction Impacts 29

Rehabilitation Alternative 29

Impacts 29

Potential Soil and Groundwater Contamination 29

Summary of Findings 31

Affected Environment 31

Impacts and Mitigation Measures 31

Reference 33

Appendix A i

Contents iii

List of Figures

Figure 1 Project Vicinity 2
Figure 2 Project Study Area 3
Figure 3 Rehabilitation Alternative 7
Figure 4 Bridge Cross Section at Location A (see Figure 3) 9
Figure 5 Bridge Cross Section with Ground Improvement at Location A (see Figure 3) 10
Figure 6 Bridge Cross Section at Location B (see Figure 3) 11
Figure 7 Site and Exploration Plan, Rehabilitation Alternative (2 sheets) 17
Figure 8 Geologic Unit Explanations 19
Figure 9 Generalized Subsurface Profile, Rehabilitation Alternative (2 sheets) 21

Introduction

During the development of the Magnolia Bridge Replacement Project, the City of Seattle proposed four alternatives to be included in a NEPA EIS. These are the No Build, and Alternatives A, C, and D. Since that time, another alternative, the Rehabilitation Alternative has been recommended for consideration. The City has already submitted the 14 discipline reports listed below in Table 1 to WSDOT for review. WSDOT has approved 11 of these reports.

These discipline reports were prepared before the Rehabilitation Alternative was added to the project and only address the No Build Alternative and Alternatives A, C and D. This document was developed to provide information on and analysis of the Rehabilitation Alternative so that it can be included in the DEIS. Figure 1 and Figure 2 show the project vicinity and study area, respectively.

Table 1 Discipline Reports Reviewed by WSDOT

Discipline	Approval Date
1. Geology and Soils	February 2005
2. Air Quality	November 2004
3. Water Quality	April 2005
4. Wildlife, Fisheries, and Vegetation	December 2004
5. Noise	Not yet approved
6. Hazardous Materials	November 2004
7. Land Use	September 2004
8. Public Lands, Section 4(f)	Not yet approved
9. Historic, Cultural, and Archaeological Resources	Not yet approved
10. Social, Economic, and Relocation	February 2005
11. Environmental Justice	February 2005
12. Visual Quality	January 2005
13. Traffic & Transportation	January 2005
14. Public Services and Utilities	August 2004

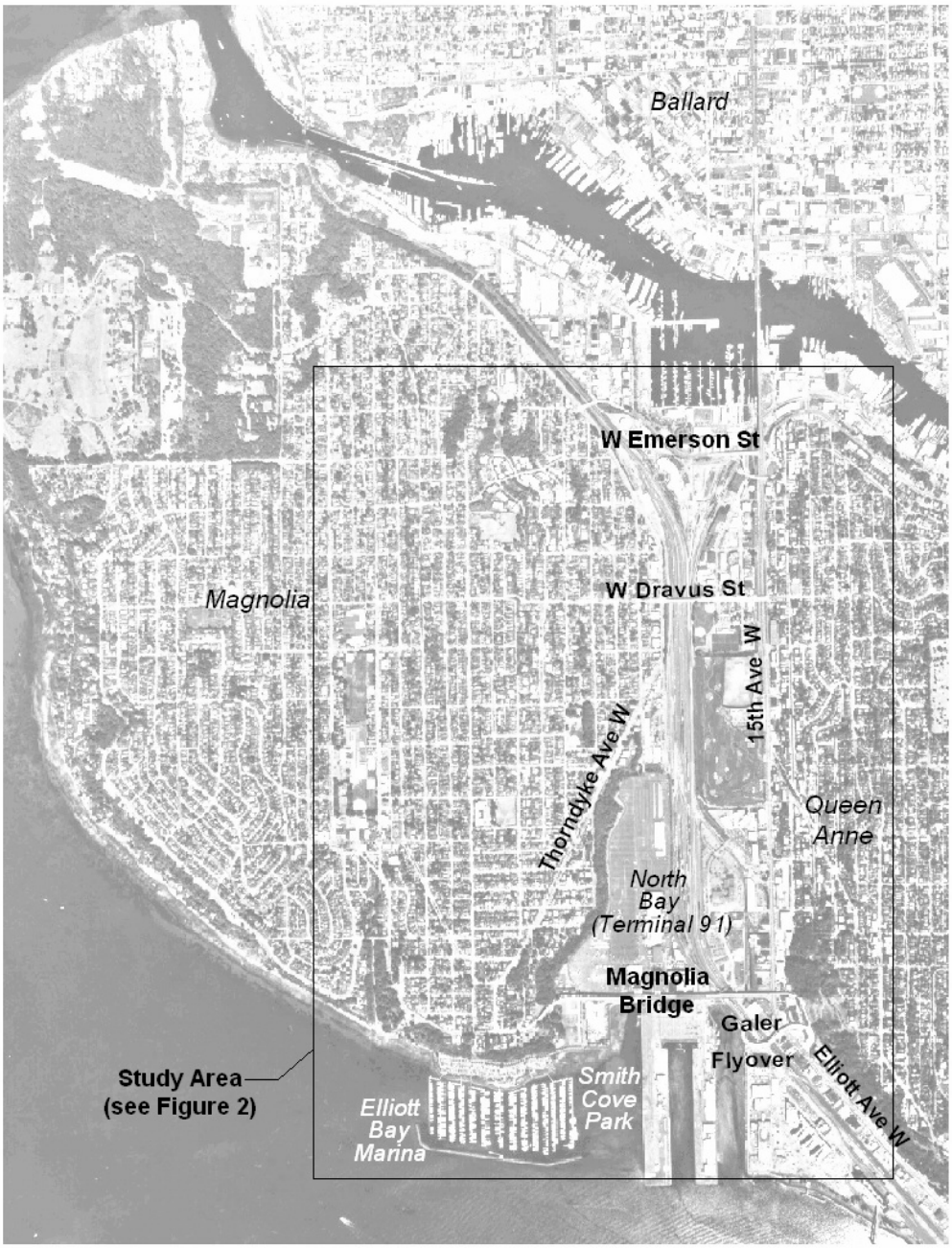

Figure 1 Project Vicinity

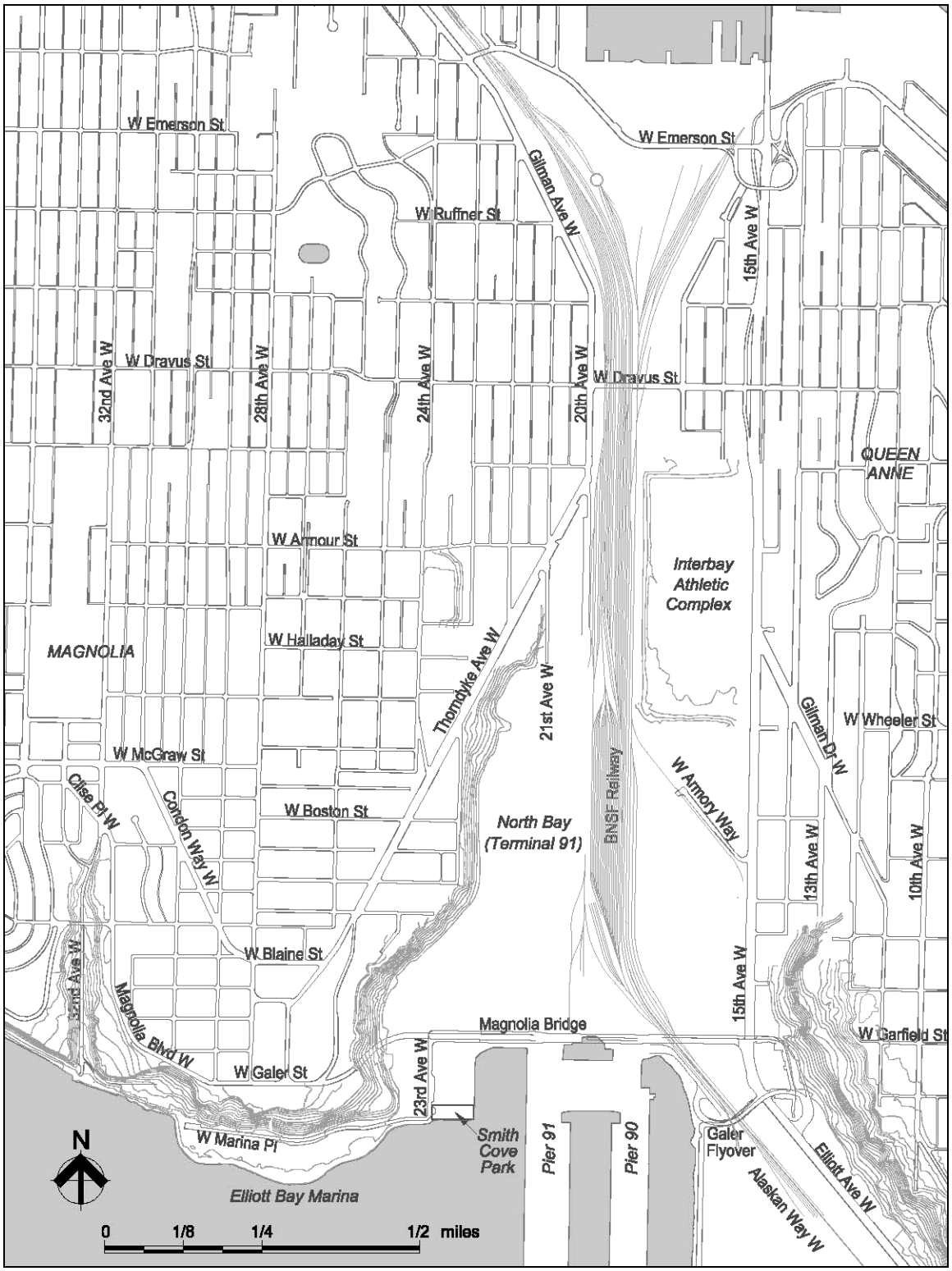

Figure 2 Project Study Area

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Description of Alternative

As part of an alignment study and NEPA Environmental Impact Statement process, the City of Seattle evaluated a number of alternatives for replacing the Magnolia Bridge. The alignment alternatives development and selection process is documented in the Alignment Study Report (revised September 2004). The process considered twenty-five alignment alternatives for the bridge replacement.

As a result of this work, four alternatives were selected to be included in the DEIS. They are: Alternatives A, C and D and the No Build Alternative. Since that time, the City has received feedback through its public process and wishes to include an additional alternative in the DEIS – the Rehabilitation Alternative.

A rehabilitation alternative was considered in 2001 and 2002 as the bridge replacement project was initially developed. It was rejected because it was deemed too costly. However, a revisiting of the initial 2001 and 2002 cost estimate for bridge replacement has shown a doubling of cost. This change has made the Rehabilitation Alternative a viable alternative for consideration in the DEIS.

The Rehabilitation Alternative would maintain the existing bridge alignment with the existing connections to 15th Avenue West at the east end and West Galer Street at the west end. Bridge rehabilitation would bring the structure up to current design standards. Table 2 and Figure 3**Error! Reference source not found.** show the elements of this alternative. Of the original structure built in 1929-1930, only the columns and foundations would remain between the BNSF Railway and Magnolia Bluff, and these would be strengthened to meet current standards. The existing ramps to and from the Elliott Bay Marina via 23rd Avenue West would be retained. The center ramps from the bridge to Terminal 91 would be removed. Terminal 91 access would remain at the East Gate with access from 15th Avenue West by the Galer Flyover structure and Alaskan Way West.

Similar to the build alternatives, the Rehabilitation Alternative would retain the same number of vehicle travel lanes as the existing bridge. Lane widths would meet WSDOT Local Agency Guideline (LAG) design standard widths of 12 feet for outside lanes and 11 feet for inside lanes. The number of vehicle travel lanes is as follows:

Westbound

- One lane from northbound 15th Avenue West on a grade-separated structure over 15th Avenue W
- One lane from southbound 15th Avenue West
- Two lanes from the BNSF Railway crossing to the west end of the bridge on Magnolia Bluff

Eastbound

- One lane from Magnolia Bluff to the 23rd Avenue West on-ramp
- Two lanes from the 23rd Avenue W on-ramp to 15th Avenue West (one lane right-only and one lane left and through at 15th Avenue West)

The Rehabilitation Alternative would have a sidewalk on the south side of the bridge structure. The LAG design standard minimum sidewalk width is five feet. A six-foot width may be possible on the Rehabilitation Alternative new bridge deck. The existing bridge stairway access to the ground would be retained near the current locations.

Table 2 Rehabilitation Alternative Elements

1.	15th Avenue W overpass	Retrofit the eastern 880 feet of this structure, which has 16 spans, for increased seismic capacity. Only the span over 15th Avenue W has been previously retrofitted.
2.	Ramp and structure west to 15th Avenue W to west side of railroad	The ramp and spans in this 873-foot long section would be removed and replaced with new structure. This would eliminate a design deficiency (inadequate stopping sight distance, where the railroad structure connects to the ramp to 15th Avenue W.)
3.	Roadway deck and supporting crossbeams, west side of railroad to Magnolia Bluff	The existing superstructure in this 2,454-foot section would be replaced with pre-stressed slab spans. The seven concrete truss spans in this section would also be replaced. All crossbeams and column tops would be replaced.
4.	Center ramp to Terminal 91	The 529-foot center ramp located west of the railroad would be replaced with new foundations, columns, and deck.
5.	Railroad to center ramp and center ramp section to 23rd Avenue W ramps	Cross bracing would be provided between columns in the north-south (lateral) and east-west (longitudinal) directions.
6.	From marina ramps to west end of bridge	Columns would be encased in steel jacket to provide seismic capacity. Existing column bracing in the east-west (longitudinal) direction would be replaced.
7.	Timber pile foundations from railroad to west end of bridge	Grade beams and drilled shafts would be connected to existing column foundations to increase seismic capacity.
8.	Connection to Anthony's Seafood Distributing	This connection would be removed and not replaced when the bridge deck is replaced (item 3).
9.	Throughout	Ground around foundations would be treated by compaction grouting and stone columns to resist liquefaction during an earthquake.

Figures 4, 5, and 6 are cross sections that illustrate the type of replacement and retrofit improvements required. Figure 5 also shows the extent of ground improvement required west of the BNSF Railway where the depth to glacially compacted soil is about 100 feet.

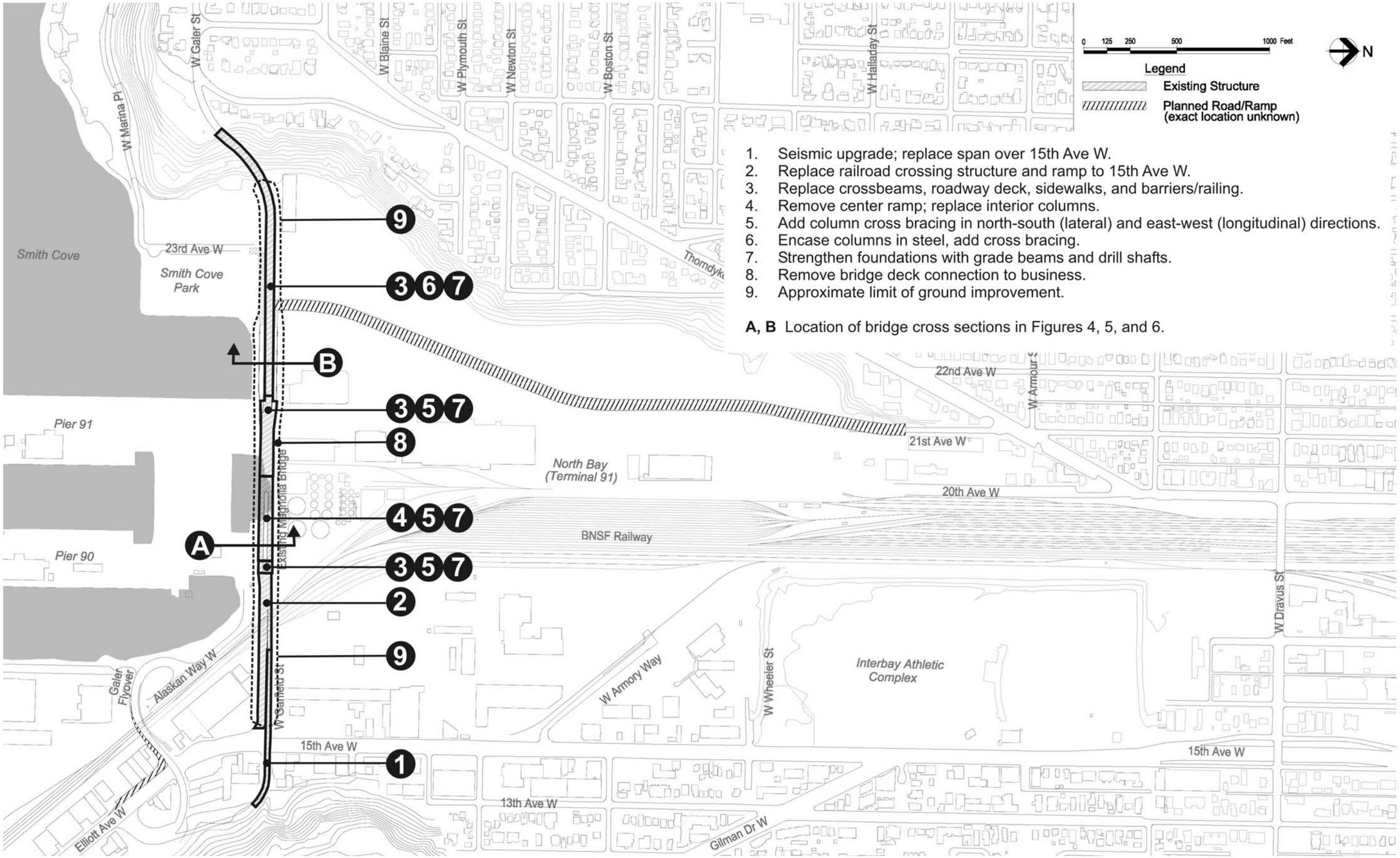

Figure 3 Rehabilitation Alternative

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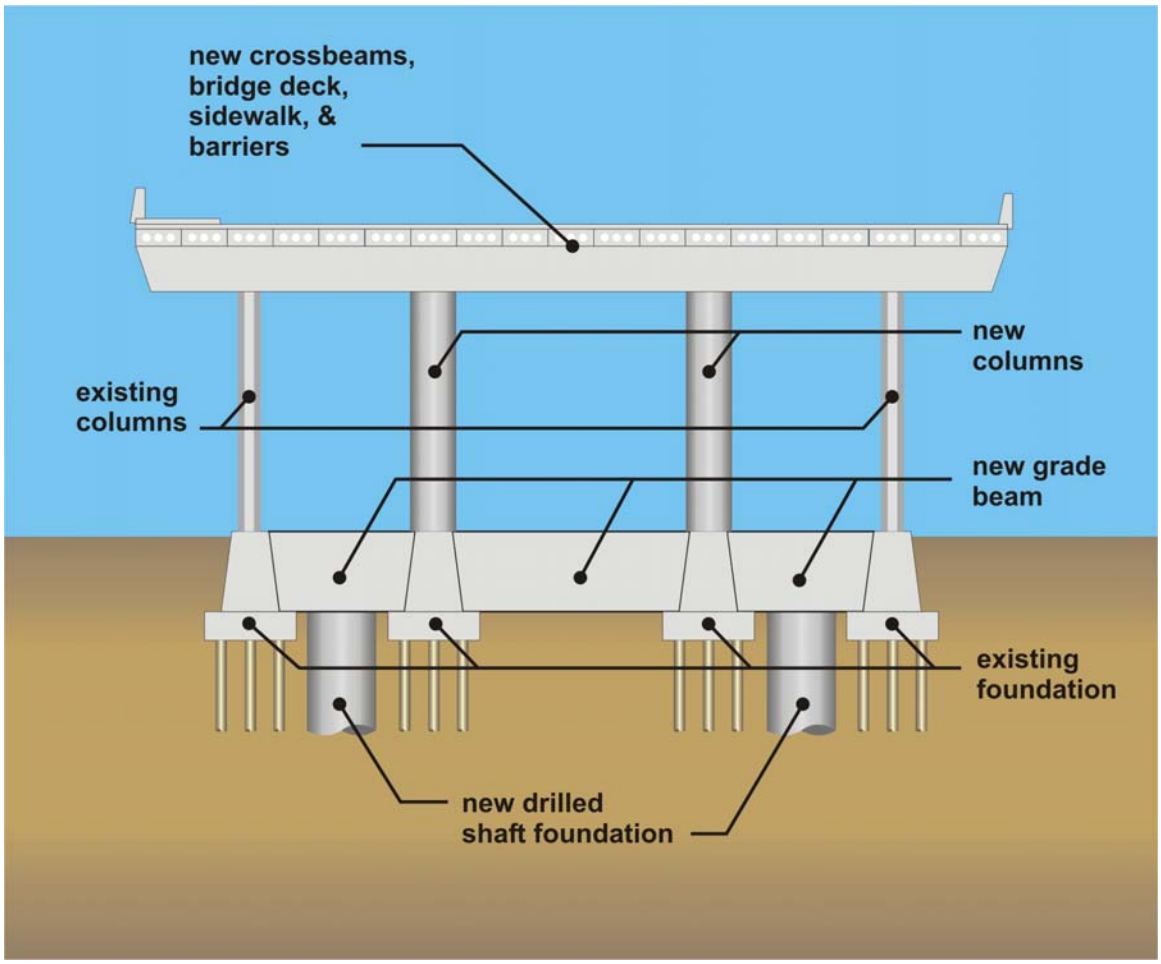

Figure 4 Bridge Cross Section at Location A (see Figure 3)

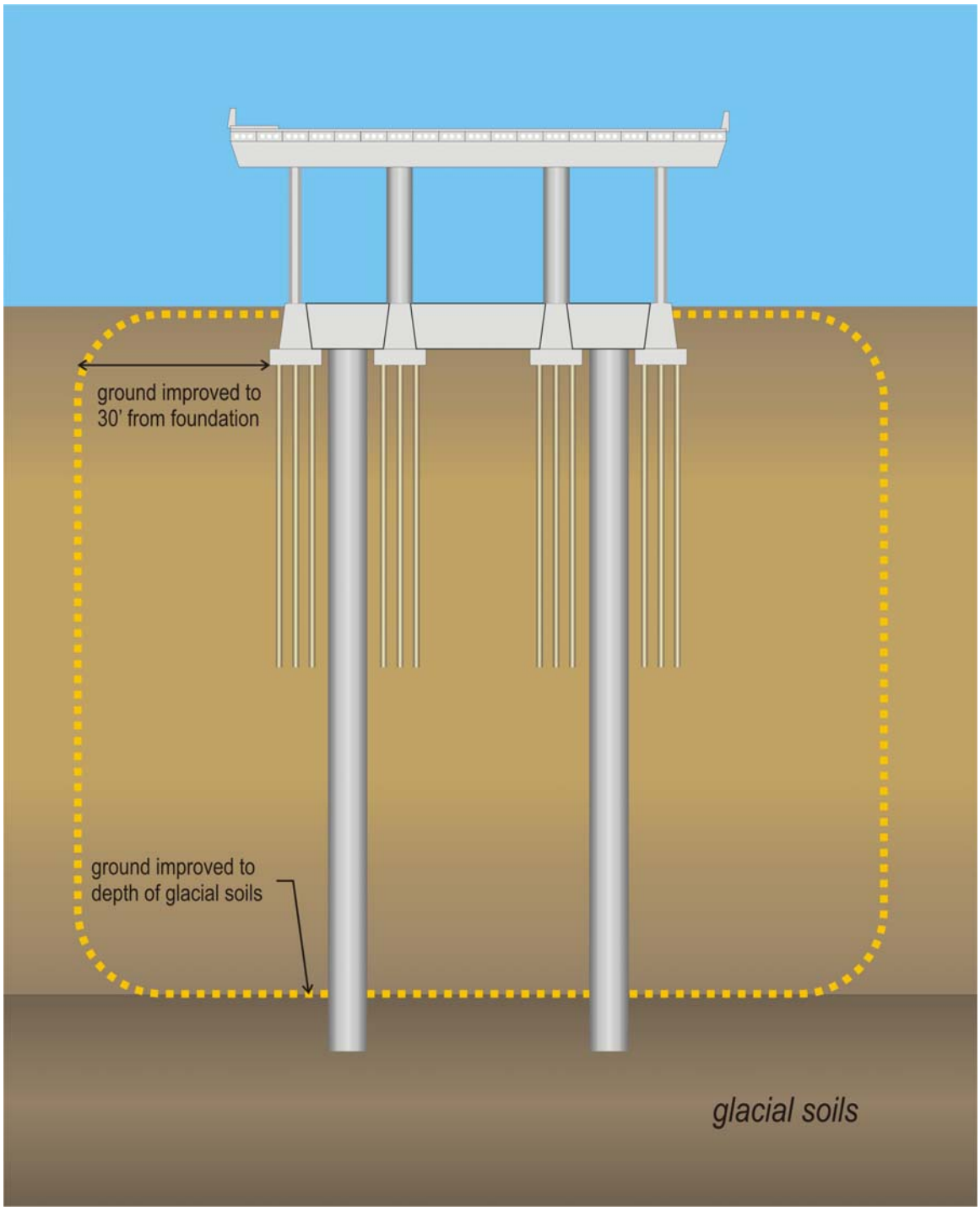

Figure 5 Bridge Cross Section with Ground Improvement at Location A (see Figure 3)

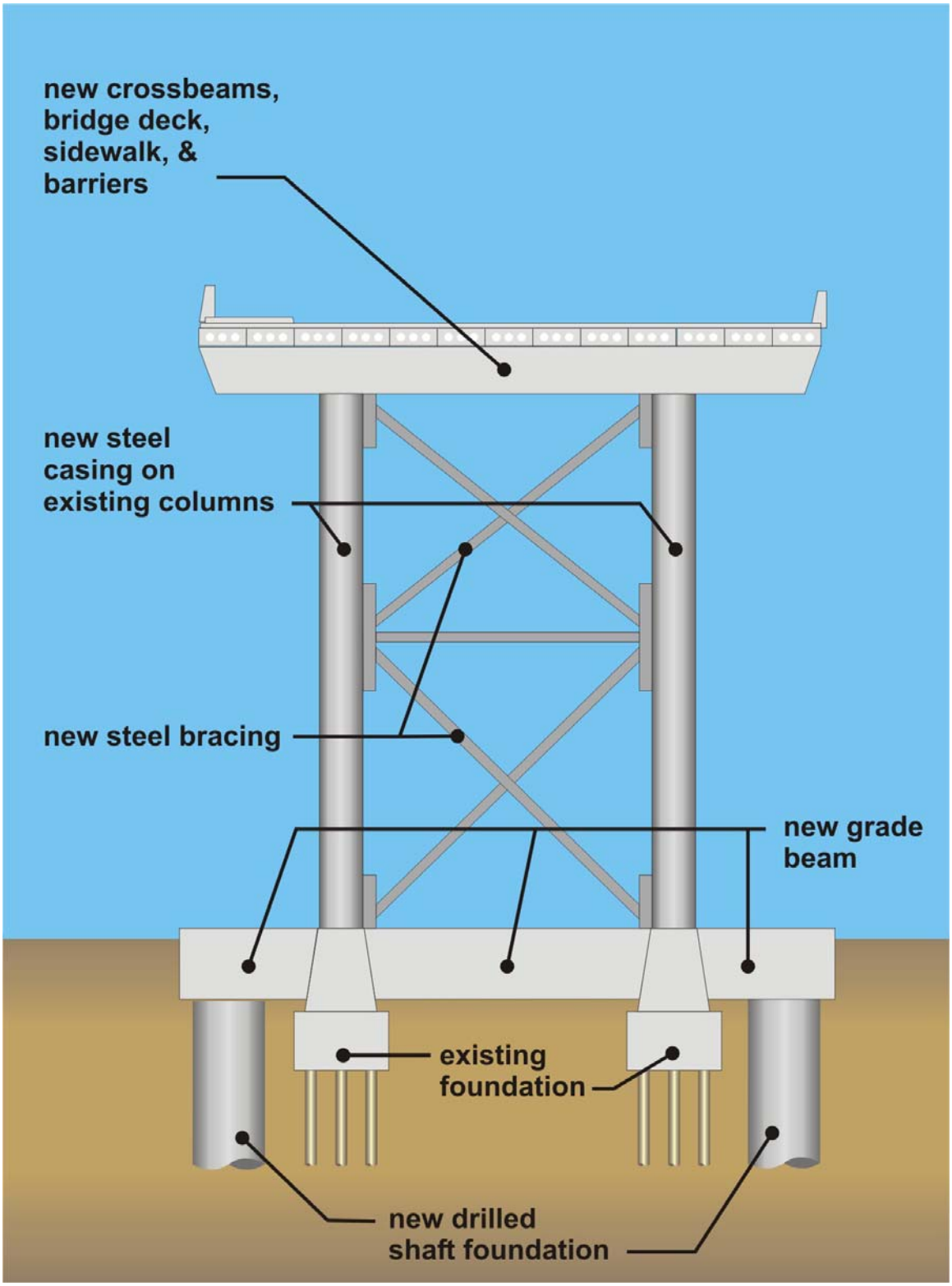

Figure 6 Bridge Cross Section at Location B (see Figure 3)

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Methods

The methods used to evaluate the Rehabilitation Alternative were the same as those discussed in the "Discipline Report, Geology and Soils" prepared by Shannon & Wilson, Inc. in February 2005 for the No Build Alternative and Alternatives A, C, and D. Two additional borings were drilled and sampled for the rehabilitation alternative.

Affected Environment

For a discussion of the Rehabilitation Alternative affected environment, refer to the discussion in the "Discipline Report, Geology and Soils" prepared by Shannon & Wilson, Inc. in February 2005 for the No Build Alternative and Alternatives A, C, and D. In particular, given the proximity of the two alternatives, the text and figures regarding Alternative A can be used as a reference for the Rehabilitation Alternative. The Alternative A plan view figures in the discipline report also depict the existing bridge alignment.

The Site and Exploration Plan, Geologic Unit Explanation, and Generalized Subsurface Profile for the Rehabilitation Alternative are presented on Figures 7 through 9, respectively. Figures 7 and 9 include the two additional borings, EB-1 and EB-2.

The two additional borings were evaluated for liquefaction potential. Based on this evaluation, potentially liquefiable and soil strength-reduced deposits could extend to approximate depths of 100 to 110 feet for the Rehabilitation Alternative.

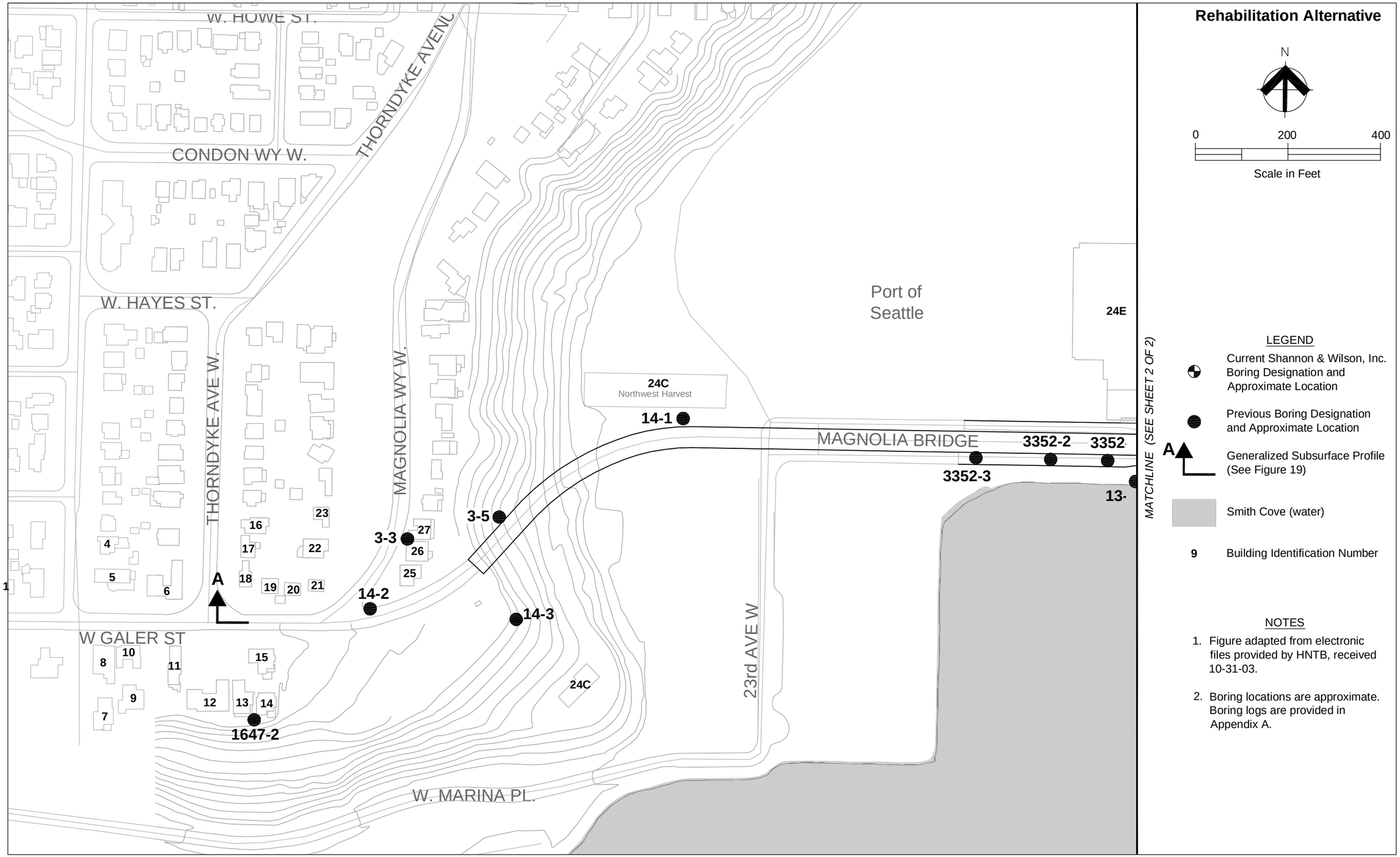

Figure 7, Sheet 1 of 2 - Site and Exploration Plan - Rehabilitation Alternative

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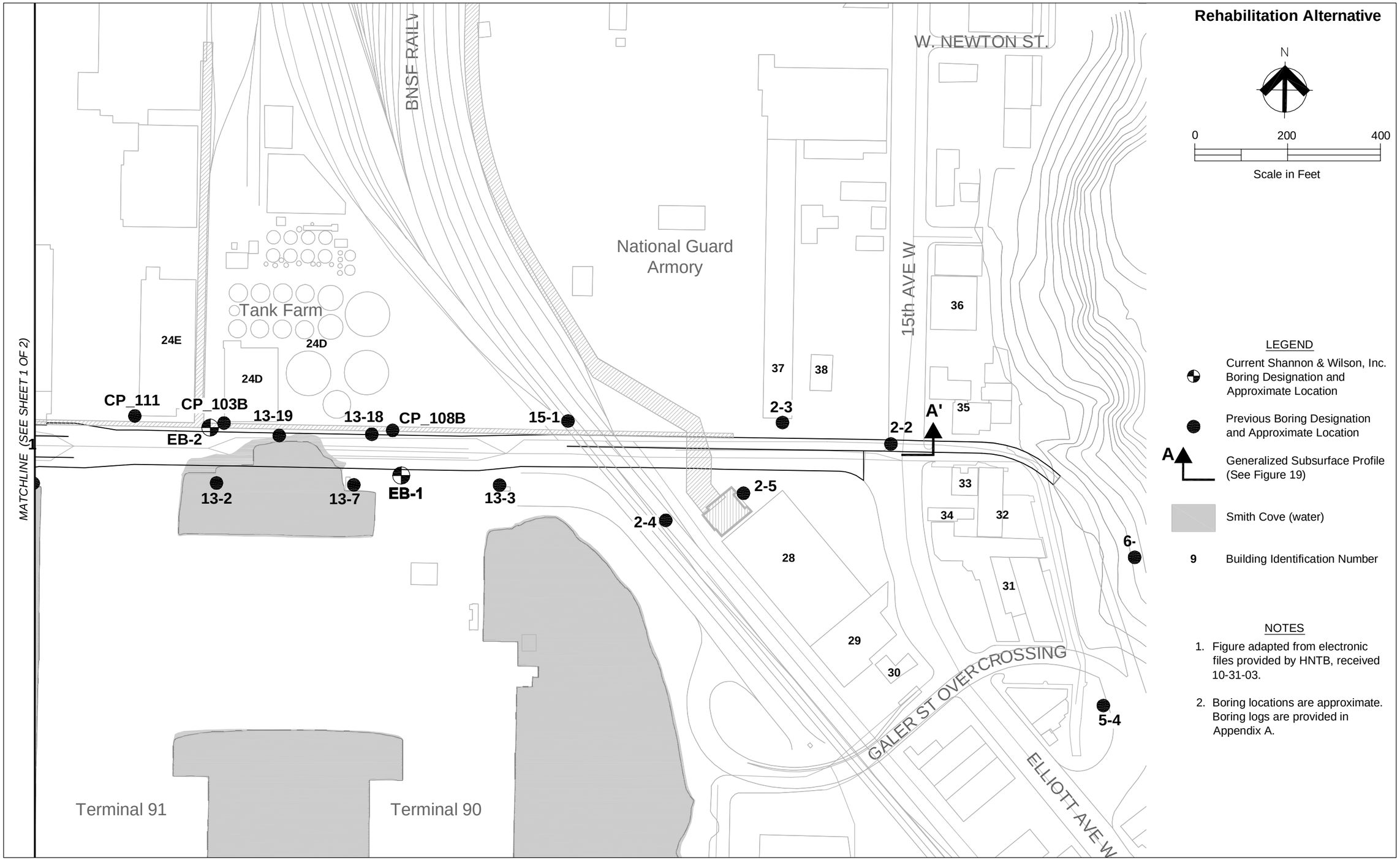

Figure 7, Sheet 2 of 2 - Site and Exploration Plan - Rehabilitation Alternative

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GEOLOGIC UNITS

HOLOCENE DEPOSITS

Hf FILL: Fill placed by humans, both engineered and nonengineered.
Various materials, including debris; cobbles and boulders common; commonly dense or stiff if engineered, but very loose to dense or very soft to stiff if nonengineered.

Hls LANDSLIDE DEPOSITS: Deposits of landslides, normally at and adjacent to the toe of slopes.
Disturbed, heterogeneous mixture of several soil types; loose or soft, with random dense or hard pockets.

He ESTUARINE DEPOSITS: Estuary deposits of intertidal zones associated with rivers and streams located along the present and former Puget Sound shoreline.
Clayey Silt, silty Clay, Silt, and fine Sand; very soft to very stiff or very loose to medium dense.

Hb BEACH DEPOSITS: Deposits along present and former shorelines of Puget Sound and tributary river mouths.
Silty Sand, sandy Gravel, Sand, scattered fine Gravel, organic and shell debris; loose to dense.

QUATERNARY VASHON DEPOSITS

Qvro RECESSIONAL OUTWASH DEPOSITS: Glaciofluvial sediment deposited as glacial ice retreated.
Clean to silty Sand, gravelly Sand, sandy Gravel; cobbles and boulders common; loose to very dense.

Qvt TILL: Lodgment till laid down along the base of the glacial ice.
Gravelly silty Sand, silty gravelly Sand ("hardpan"); cobbles and boulders common; very dense.

Qva ADVANCE OUTWASH: Glaciofluvial sediment deposited as the glacial ice advanced through the Puget Lowland.
Clean to silty Sand, gravelly Sand, sandy Gravel; dense to very dense.

Qvgl GLACIOLACUSTRINE DEPOSITS: Fine-grained glacial flour deposited in proglacial lake in Puget Lowland.
Silty clay, Clayey Silt, with interbeds of Silt and fine Sand; locally laminated; scattered organic fragments near base; hard or dense to very dense.

QUATERNARY PRE-VASHON DEPOSITS

Qpnl LACUSTRINE DEPOSITS: Fine-grained lake deposits in depressions, large and small.
Fine sandy Silt, silty fine Sand, clayey Silt; scattered to abundant fine organics; dense to very dense or very stiff to hard.

Qpnm MUDFLOW DEPOSITS: Distal deposits of mass movements such as landslides or lahars.
Stratified or irregular bodies of a heterogeneous mixture of Gravel, Sand, Silt, and Clay; pumice, obsidian and ash common; rare organics (charcoal); very stiff to hard or very dense.

Qpgt TILL: Lodgment till laid down along the base of the glacial ice
Gravelly silty Sand, silty gravelly Sand ("hardpan"); cobbles and boulders common; very dense.

Qpgo OUTWASH: Glaciofluvial sediment deposited as the glacial ice advanced through the Puget Lowland.
Clean to silty Sand, gravelly Sand, sandy Gravel; very dense.

Qpgl GLACIOLACUSTRINE DEPOSITS: Fine-grained glacial flour deposited in proglacial lake in Puget Lowland.
Silty Clay, clayey Silt, with interbeds of Silt and fine Sand; very stiff to hard or very dense.

NOMENCLATURE

GEOLOGIC AGE DESIGNATION		DEPOSITIONAL ENVIRONMENT, GEOLOGIC PROCESS, OR LITHOLOGY		
H = Holocene		f = fill ls = landslide	e = estuarine b = beach	Present
Q = Quaternary	v = Vashon	r = recessional	o = outwash at = ablation till	10,000 yrs BP *
		t = till (lodgment) a = advance outwash gl = glaciolacustrine		15,000 yrs BP *
	p = Pre-Vashon 6 or more glacial and interglacial episodes	n = nonglacial (interglacial)	l = lacustrine m = mudflow	
		g = glacial	l = lacustrine o = outwash m = marine t = till (lodgment)	2,000,000 yrs BP

* *These radiometric (C^{14}) dates are based on data in Central Puget Lowland. Equivalent calendar years before present are approximately 15,000 and 18,000 yrs BP. These dates may differ from onset and end of Vashon (late Pleistocene) glacial episode in other parts of the Puget Lowland.*

NOTES

1. The description of each geologic unit includes only general information regarding the environment of deposition and basic soil characteristics.
2. Each geologic unit has a two- to four-letter abbreviation composed of a leading capital letter signifying geologic age, followed by one or more lowercase letters indicating further breakdown of geologic age, depositional environment, or geologic process.
3. The nomenclature graphic was created to explain the distinctions among geologic deposits in the Central Puget Lowland for engineering purposes, e.g. engineering properties of geologic deposits. The actual geologic designations and dates, according to internationally accepted stratigraphic rules, may be slightly different.

LEGEND

Glacially Overridden Soil Units Below Line

Years BP — Radiocarbon Years Before Present (1950)

Figure 8 - Geologic Unit Explanation

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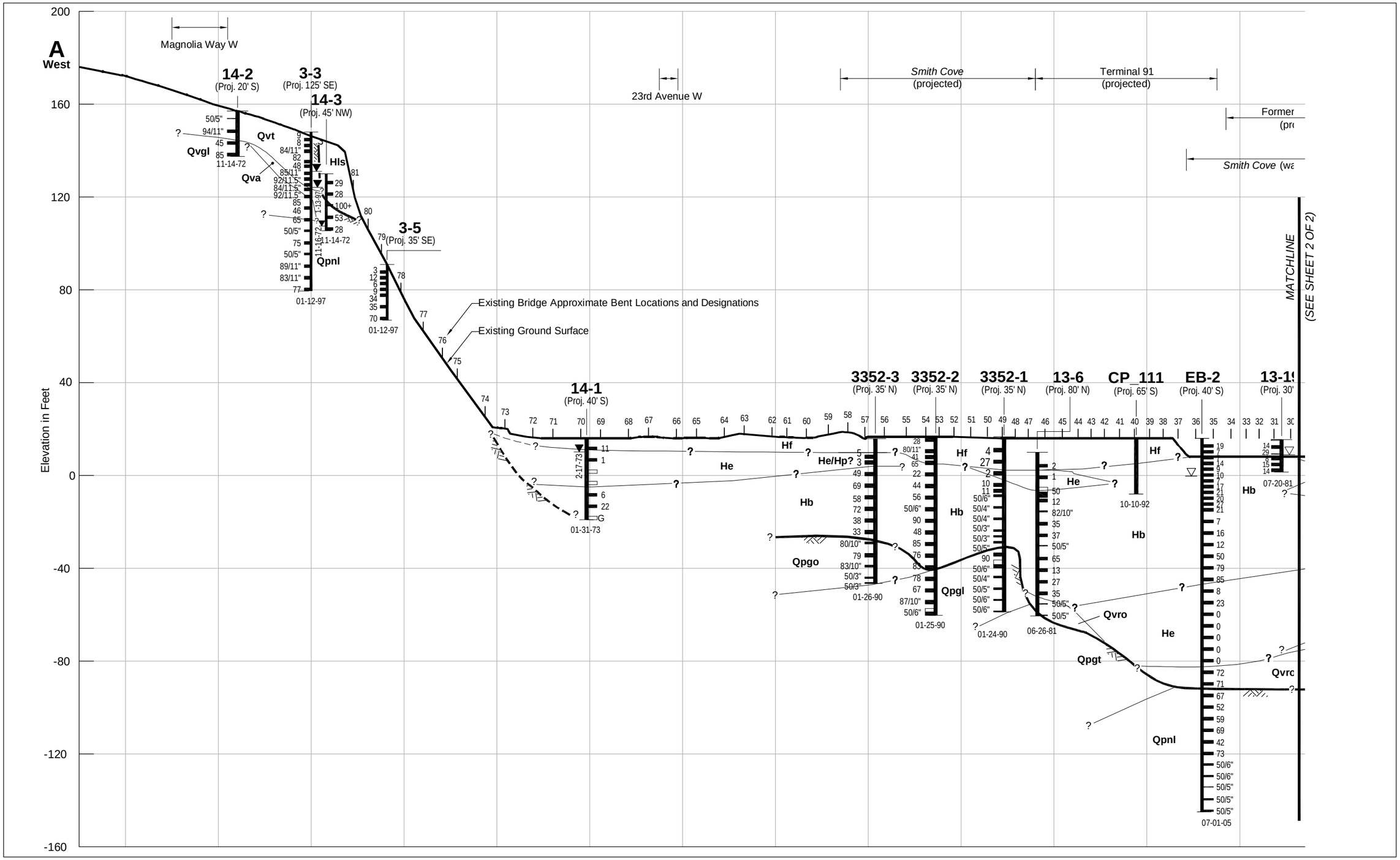

Figure 9, Sheet 1 of 2 - Generalized Subsurface Profile - Rehabilitation Alternative

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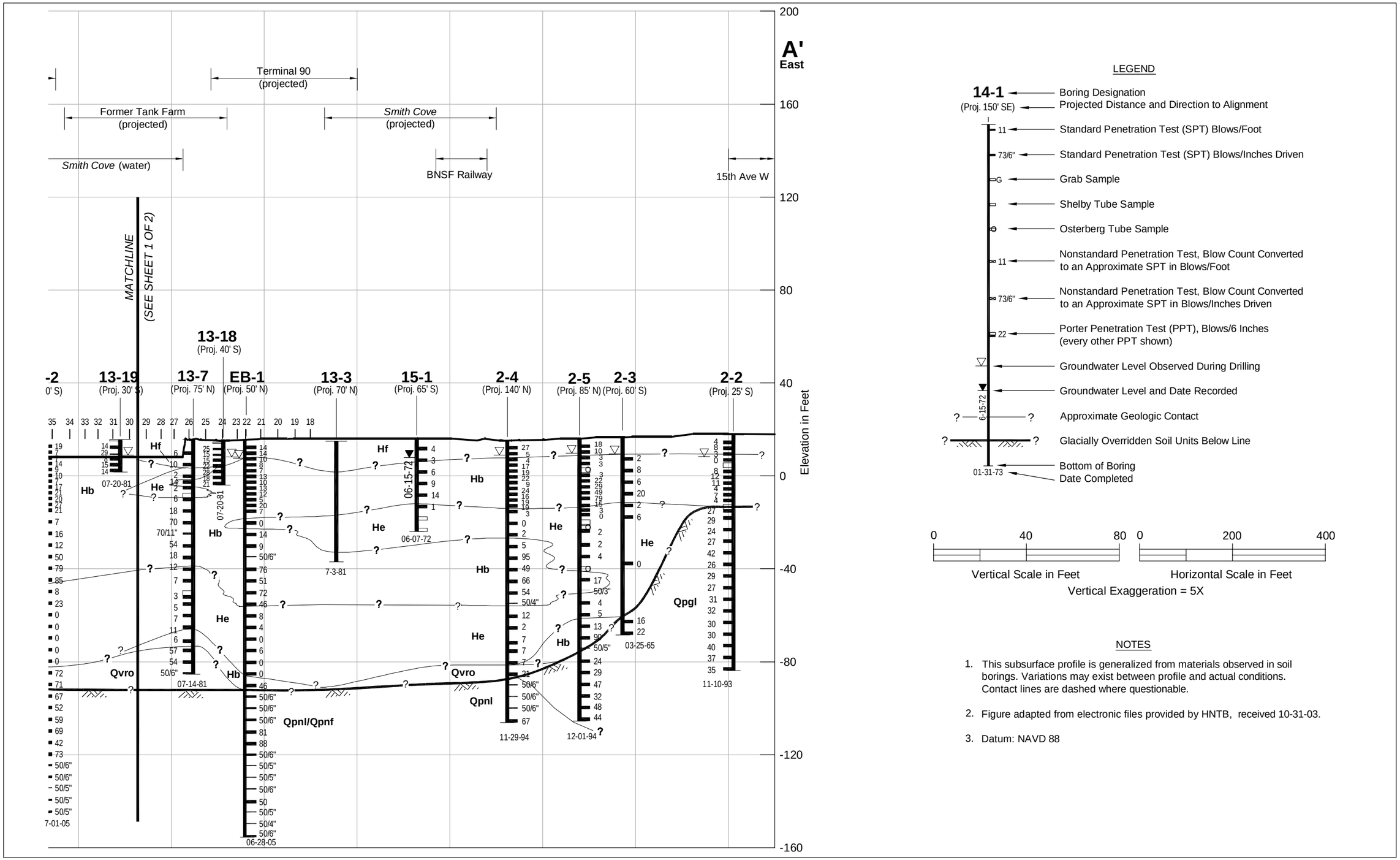

Figure 9, Sheet 2 of 2 - Generalized Subsurface Profile - Rehabilitation Alternative

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Studies and Coordination

Studies

Geologic data were obtained as described in the February 2005 Geology and Soils Discipline Report and by drilling two additional borings. The geologic evaluation of the Rehabilitation Alternative was performed based on this data and as described in the Geology and Soils Discipline Report.

Data Sources

Data sources were the same as those used for the February 2005 discipline report. The two additional borings were drilled and sampled to supplement the existing subsurface information. The borings were located in areas where geologic conditions were not documented adequately. Monitoring wells were not installed. The locations of recent field explorations are shown on Figure 7. The boring locations were not surveyed, but were measured from existing features and plotted on the site topographic map provided by HNTB. After plotting the approximate boring locations, we estimated the boring elevations in terms of North American Vertical Datum, 1988 (NAVD88).

Major Assumptions

Major assumptions are the same as those used for the February 2005 Geology and Soils report.

Rehabilitation Alternative

The Rehabilitation Alternative has similar subsurface soil, groundwater, and geologic conditions to Alternative A. The impacts are described in the February 2005 Geology and Soils Discipline Report. Only those impacts that are specific to the Rehabilitation Alternative are discussed below. Groundwater impacts are discussed in the October 2005 Groundwater technical memorandum.

Many of the impacts described in the discipline report and in this technical memorandum could be addressed by following established American Association of State Highway and Transportation Officials (AASHTO) criteria for proper design and/or standard construction practice. The following paragraphs state if the impact that is described could be addressed by proper design and/or standard construction practice. Only those impacts that would use nonstandard construction practices are included in the subsequent mitigation section of this memorandum.

Elevated Structure Foundations

Because of the depth of loose, soft, and potentially liquefiable soil as well as the anticipated bridge loads, the soil would be improved to maintain the integrity of the existing foundations and to provide improved capacities for new foundations. The ground improvement type, area, and deep foundation design would take into account the current AASHTO seismic design criteria and the potential for liquefaction and lateral spreading. Because the design would account for site subsurface conditions, no soils- or geology-related direct impacts are anticipated for the Rehabilitation Alternative.

Relationship Between Topography and Alignment Design

HNTB to provide cut and fill volumes – Shannon & Wilson will address this in a later version of the technical memorandum.

Rehabilitation Alternative

All the impacts could be mitigated as presented in the February 2005 discipline report. Only those impacts that are specific to the Rehabilitation Alternative are discussed below.

Only those impacts that would use nonstandard construction practices to mitigate are included in this section. Although nonstandard, these construction procedures are not uncommon, given current seismic design criteria and earthquake engineering technology. Impacts that could be addressed by design and/or standard construction procedures are described in the Impacts section. The Rehabilitation Alternative has similar subsurface soil, groundwater, and geologic conditions to Alternative A.

Seismic Considerations

The project features should be designed considering the seismicity of the site and the project seismic design criteria. The seismic design criteria would be used to determine depths of liquefaction at various locations along the alignment. Estimates of lateral spreading would also be developed. Liquefaction (and its associated effects such as lateral spreading and foundation damage) could be mitigated using ground improvements such as Earthquake Drains™, compaction grouting, cement deep soil mixing, and vibro-replacement (stone columns). In the rehabilitation portion of the alignment from Bent 18 west to the base of Magnolia Bluff, compaction grouting would be the preferred method of ground improvement. Compaction grouting would not disturb the existing foundations during construction. East of Bent 18, in the rebuild portion of the alignment, the existing foundations will not be reused and therefore do not need to be protected.

Groundwater mitigation measures due to ground improvements, etc., are discussed in the October 2005 Groundwater technical memorandum.

Rehabilitation Alternative

Construction impacts and mitigation measures were presented in the February 2005 Geology and Soils Discipline Report. Only those construction impacts that are specific to the Rehabilitation Alternative are discussed below. There are no mitigation measures specific to the Rehabilitation Alternative.

Impacts

Potential Soil and Groundwater Contamination

There is a possibility that construction activities would encounter potentially contaminated soil and groundwater. These issues are discussed in the Hazardous Material Discipline Report and Technical Memorandum, the Water Quality Discipline Report, and the Groundwater Technical Memorandum.

Summary of Findings

This Geology and Soils Technical Memorandum along with the February 2005 discipline report describes the geologic conditions present along the Rehabilitation Alternative, discusses the geotechnically-related operational and construction impacts and recommended mitigations for the Magnolia Bridge Replacement Project. Subsurface data used to assess these issues was presented in the discipline report; the two additional borings for the Rehabilitation Alternative are presented in Appendix A.

Affected Environment

The affected environment is summarized in the February 2005 discipline report.

Impacts and Mitigation Measures

Soil- and geology-related operational and construction impacts and recommended mitigation measures were developed based on the project area geology, known subsurface conditions, and the Rehabilitation Alternative alignment. The Rehabilitation Alternative has similar subsurface soil, groundwater, and geologic conditions to Alternative A; therefore, the impacts and mitigation measure costs for these alternatives would be similar. A discussion and a summary matrix of the impacts and mitigation measures were included in the February 2005 discipline report.

Reference

Shannon & Wilson, Inc. 2005. *Discipline Report, Geology and Soils*. Report by Shannon & Wilson, Inc., Seattle, Wash., project no. 21-1-09759-008, for Seattle Department of Transportation, Seattle, Wash., February.

Appendix A

Contents

Figure A-1	Soil Classification and Log Key (2 sheets)
Figure A-2	Log of Boring EB-1 (2 sheets)
Figure A-3	Log of Boring EB-2 (2 sheets)

Shannon & Wilson, Inc. (S&W), uses a soil classification system modified from the Unified Soil Classification System (USCS). Elements of the USCS and other definitions are provided on this and the following page. Soil descriptions are based on visual-manual procedures (ASTM D 2488-93) unless otherwise noted.

S&W CLASSIFICATION OF SOIL CONSTITUENTS

- MAJOR constituents compose more than 50 percent, by weight, of the soil. Major consituents are capitalized (i.e., SAND).
- Minor constituents compose 12 to 50 percent of the soil and precede the major constituents (i.e., silty SAND). Minor constituents preceded by "slightly" compose 5 to 12 percent of the soil (i.e., slightly silty SAND).
- Trace constituents compose 0 to 5 percent of the soil (i.e., slightly silty SAND, trace of gravel).

MOISTURE CONTENT DEFINITIONS

Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, from below water table

ABBREVIATIONS

ATD	At Time of Drilling
Elev.	Elevation
ft	feet
FeO	Iron Oxide
MgO	Magnesium Oxide
HSA	Hollow Stem Auger
ID	Inside Diameter
in	inches
lbs	pounds
Mon.	Monument cover
N	Blows for last two 6-inch increments
NA	Not applicable or not available
NP	Non plastic
OD	Outside diameter
OVA	Organic vapor analyzer
PID	Photo-ionization detector
ppm	parts per million
PVC	Polyvinyl Chloride
SS	Split spoon sampler
SPT	Standard penetration test
USC	Unified soil classification
WLI	Water level indicator

GRAIN SIZE DEFINITION

DESCRIPTION	SIEVE NUMBER AND/OR SIZE
FINES	< #200 (0.08 mm)
SAND*	
- Fine	#200 to #40 (0.08 to 0.4 mm)
- Medium	#40 to #10 (0.4 to 2 mm)
- Coarse	#10 to #4 (2 to 5 mm)
GRAVEL*	
- Fine	#4 to 3/4 inch (5 to 19 mm)
- Coarse	3/4 to 3 inches (19 to 76 mm)
COBBLES	3 to 12 inches (76 to 305 mm)
BOULDERS	> 12 inches (305 mm)

* Unless otherwise noted, sand and gravel, when present, range from fine to coarse in grain size.

RELATIVE DENSITY / CONSISTENCY

COARSE-GRAINED SOILS		FINE-GRAINED SOILS	
N, SPT, BLOWS/FT.	RELATIVE DENSITY	N, SPT, BLOWS/FT.	RELATIVE CONSISTENCY
0 - 4	Very loose	Under 2	Very soft
4 - 10	Loose	2 - 4	Soft
10 - 30	Medium dense	4 - 8	Medium stiff
30 - 50	Dense	8 - 15	Stiff
Over 50	Very dense	15 - 30	Very stiff
		Over 30	Hard

WELL AND OTHER SYMBOLS

Bent. Cement Grout	Surface Cement Seal
Bentonite Grout	Asphalt or Cap
Bentonite Chips	Slough
Silica Sand	Bedrock
PVC Screen	
Vibrating Wire	

Magnolia Bridge Replacement
Seattle, Washington

SOIL CLASSIFICATION AND LOG KEY

October 2005 21-1-09759-008

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-1
Sheet 1 of 2

BORING_CLASS1 21-09759.GPJ SWNEW.GDT 10/4/05

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)
(From ASTM D 2487-98 & 2488-93)

MAJOR DIVISIONS			GROUP/GRAPHIC SYMBOL		TYPICAL DESCRIPTION
COARSE-GRAINED SOILS *(more than 50% retained on No. 200 sieve)*	Gravels *(more than 50% of coarse fraction retained on No. 4 sieve)*	Clean Gravels *(less than 5% fines)*	GW		Well-graded gravels, gravels, gravel/sand mixtures, little or no fines
			GP		Poorly graded gravels, gravel-sand mixtures, little or no fines
		Gravels with Fines *(more than 12% fines)*	GM		Silty gravels, gravel-sand-silt mixtures
			GC		Clayey gravels, gravel-sand-clay mixtures
	Sands *(50% or more of coarse fraction passes the No. 4 sieve)*	Clean Sands *(less than 5% fines)*	SW		Well-graded sands, gravelly sands, little or no fines
			SP		Poorly graded sand, gravelly sands, little or no fines
		Sands with Fines *(more than 12% fines)*	SM		Silty sands, sand-silt mixtures
			SC		Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS *(50% or more passes the No. 200 sieve)*	Silts and Clays *(liquid limit less than 50)*	Inorganic	ML		Inorganic silts of low to medium plasticity, rock flour, sandy silts, gravelly silts, or clayey silts with slight plasticity
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
		Organic	OL		Organic silts and organic silty clays of low plasticity
	Silts and Clays *(liquid limit 50 or more)*	Inorganic	MH		Inorganic silts, micaceous or diatomaceous fine sands or silty soils, elastic silt
			CH		Inorganic clays or medium to high plasticity, sandy fat clay, or gravelly fat clay
		Organic	OH		Organic clays of medium to high plasticity, organic silts
HIGHLY-ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor		PT		Peat, humus, swamp soils with high organic content (see ASTM D 4427)

NOTE: No. 4 size = 5 mm; No. 200 size = 0.075 mm

NOTES

1. Dual symbols *(symbols separated by a hyphen, i.e., SP-SM, slightly silty fine SAND)* are used for soils with between 5% and 12% fines or when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart.

2. Borderline symbols *(symbols separated by a slash, i.e., CL/ML, silty CLAY/clayey SILT; GW/SW, sandy GRAVEL/gravelly SAND)* indicate that the soil may fall into one of two possible basic groups.

Magnolia Bridge Replacement
Seattle, Washington

SOIL CLASSIFICATION AND LOG KEY

October 2005 | 21-1-09759-008

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-1
Sheet 2 of 2

BORING_CLASS2 21-09759.GPJ SWNEW.GDT 10/4/05

SOIL DESCRIPTION

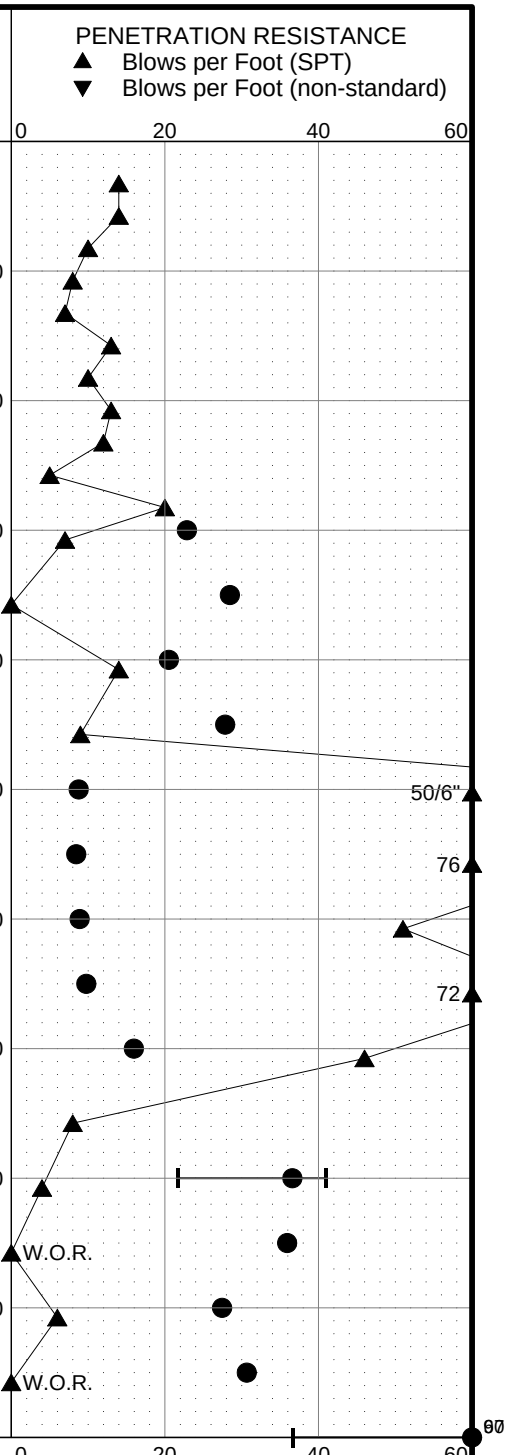
Surface Elevation: Approx. 16.0 Ft. NAVD88

Description	Depth, Ft.
ASPHALT.	0.3
Base course GRAVEL.	1.3
Medium dense, light brown to brown, fine SAND, trace of silt; moist; (Fill, HF) SP.	8.0
Loose to medium dense, dark gray, slightly gravelly, silty SAND; wet; scattered shells, wood, and plant fragments; heavy sheen and strong petroleum odor; (Hb) SM.	35.3
Very loose, gray, fine sandy SILT, trace of gravel and clay; moist to wet; abundant shells and wood fibers; no sheen, no odor; (He) ML.	37.5
Medium dense to loose, dark olive-gray, silty, slightly gravelly to gravelly SAND, trace of clay; moist to wet; scattered shells and wood debris, scattered clayey silt clasts, slight organic odor, no sheen; (Hb) SM.	47.5
Very dense, gray, slightly silty, gravelly SAND; wet; scattered gravel seams, organic odor; (Hb) SP-SM/GP-GM.	70.0
Dense, dark olive-gray, silty, sandy GRAVEL, trace of clay; wet; (Hb) GM.	73.0
Very soft to medium stiff, gray-brown, fine sandy, silty CLAY; moist; blocky texture; scattered shells, occasional to scattered wood debris, scattered laminated seams of fine sand, locally slightly gravelly at bottom; (He) CL/ML.	98.0

CONTINUED NEXT SHEET

Samples	PID, ppm
1	0.6
2	2.1
3	20.6
4	147.9
5	16.4
6	6.8
7	6.6
8	18
9	22.4
10	13.1
11	16.5
12	14.1
13	0.8
14	1.2
15	1.2
16	4.3
17	6
18	15.8
19	10.1
20	12.2
21 *	
22	8.1
23	2
24	1.6
25	2.3

Ground Water: During Drilling



LEGEND

* Sample Not Recovered

Standard Penetration Test

Ground Water Level ATD

NOTES

1. The boring was performed using HSA and Rotary Combined drilling methods.
2. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
3. The discussion in the text of this report is necessary for a proper understanding of the nature of the subsurface materials.
4. Groundwater level, if indicated above, is for the date specified and may vary.
5. Refer to KEY for explanation of symbols, codes and definitions.
6. USCS designation is based on visual-manual classification and selected lab testing.

Magnolia Bridge Replacement
Seattle, Washington

LOG OF BORING EB-1

October 2005 | 21-1-09759-008

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-2
Sheet 1 of 2

MASTER LOG2 21-09759.GPJ SHAN WIL.GDT 10/4/05 Log: MET Rev: LMM Typ: EET

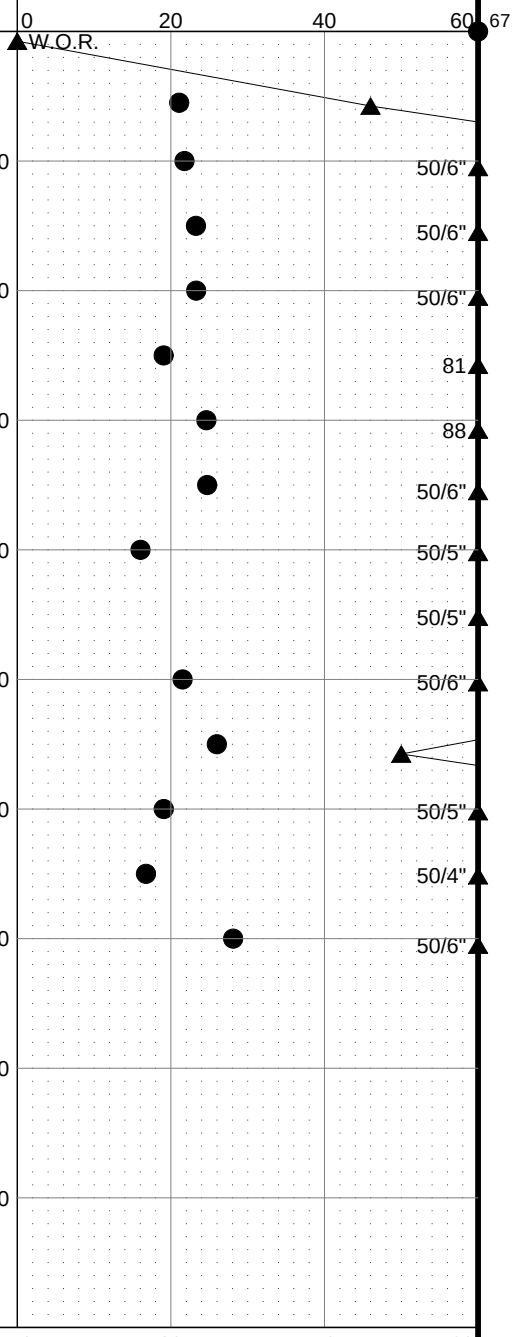
SOIL DESCRIPTION

Surface Elevation: Approx. 16.0 Ft. NAVD88

Soil Description	Depth, Ft.	PID, ppm	Samples
Very soft, olive-gray, silty CLAY; moist; massive; (He) CH.	103.0	1.6	26
Stiff, dark brown to black, slightly silty PEAT, trace of fine sand; (Hp) PT.	105.5	4.4	27
Dense, gray, silty, fine SAND; moist; scattered peat seams; (Hb) SM.	107.5	1.2	28
Very dense, dark gray, slightly silty, fine to medium SAND, trace of gravel; (Qpnf) SP-SM.		1.5	29
Very dense, dark gray, silty, fine to medium SAND; wet; massive to bedded; (Qpnf) SM.	118.0	1.7	30
		0.1	31
		0.1	32
		0.1	33
Very dense, dark gray, silty, gravelly SAND; wet; massive; (Qpnf) SM.	138.0	0.1	34
			35
			36
Very dense, dark gray, slightly clayey, silty, fine SAND; wet; bedded, abundant wood fragments; (Qpnl) SM.	154.0		37
Very dense, gray, silghtly silty to silty, fine to medium SAND, trace of gravel; wet; (Qpnf) SM/SP-SM.	157.5		38
			39
Hard, gray, clayey SILT, trace of fine sand; moist; (Qpnl) ML.	167.5		40
BOTTOM OF BORING COMPLETED 6/28/2005	171.0		

Ground Water

PENETRATION RESISTANCE
▲ Blows per Foot (SPT)
▼ Blows per Foot (non-standard)



LEGEND

* Sample Not Recovered
Standard Penetration Test
Ground Water Level ATD

● % Water Content
Plastic Limit ├─●─┤ Liquid Limit
Natural Water Content

NOTES

1. The boring was performed using HSA and Rotary Combined drilling methods.
2. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
3. The discussion in the text of this report is necessary for a proper understanding of the nature of the subsurface materials.
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Magnolia Bridge Replacement
Seattle, Washington

LOG OF BORING EB-1

October 2005 | 21-1-09759-008

SHANNON & WILSON, INC.
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FIG. A-2
Sheet 2 of 2

MASTER LOG2 21-09759.GPJ SHAN WIL.GDT 10/4/05 Log: MET Rev: LMM Typ: EET

ROD (%) Recovery (%)

SOIL DESCRIPTION

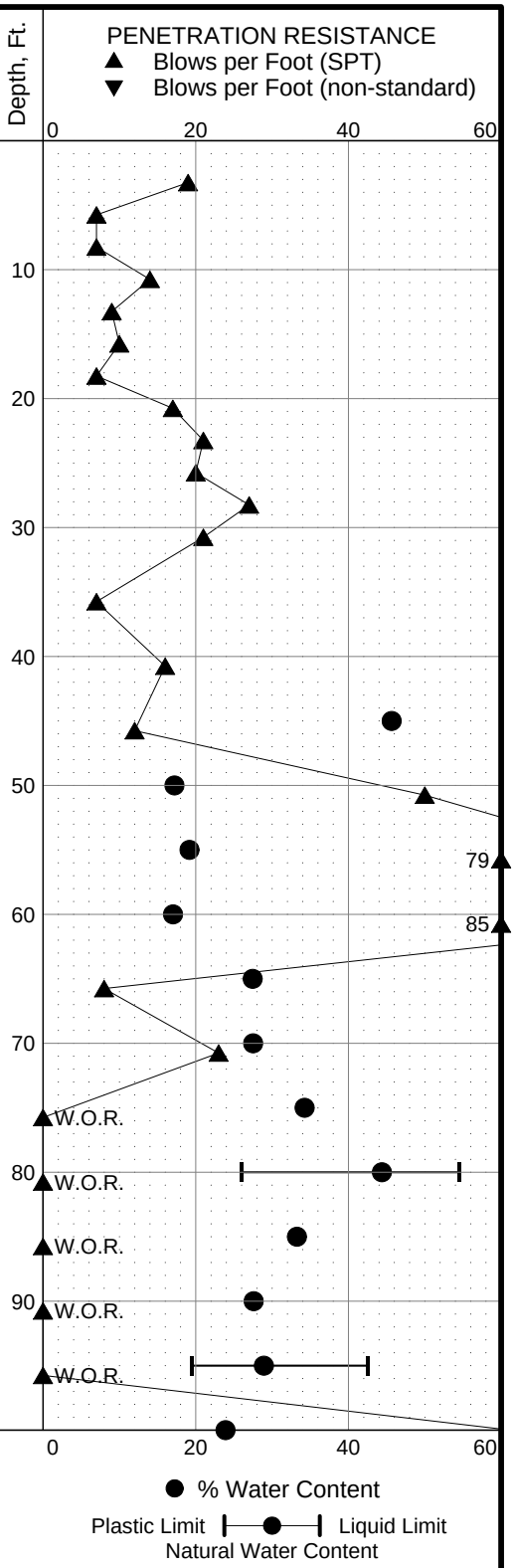
Surface Elevation: Approx. 16.0 Ft. NAVD88

Description	Depth, Ft.
ASPHALT.	0.3
Angular GRAVEL base course; GP.	1.3
Medium dense, brown, fine to medium SAND, trace of silt; moist; scattered shell fragments; (Hf) SP.	8.3
Loose to medium dense, brown and dark gray, slightly fine gravelly, silty SAND; wet; scattered shells, moderate to heavy sheen, moderate to strong odor; sheen, odor, and silt content decreasing with depth; (Hb) SM.	19.5
Medium dense, gray, slightly silty, fine to gravelly SAND; wet; scattered shells, moderate odor and sheen; (Hb) SP-SM.	22.0
Loose to medium dense, dark gray, silty SAND, trace of gravel; moist to wet; scattered to abundant shells and wood debris, slight to moderate odor and sheen, organic odor near 45.0 feet; (Hb) SM.	50.5
Very dense, brownish-gray, slightly silty to silty, gravelly SAND; wet; scattered shells and wood debris; (Hb) SP-SM.	52.5
Very dense, dark gray, trace to slightly silty, fine to medium SAND; wet; scattered wood debris, scattered shells; (Hb) SP/ SP-SM.	62.5
Loose, gray-brown, silty, fine to medium SAND, trace of clay; wet; abundant organic debris (wood), scattered shells, strong organic odor; (He) SM.	67.5
Medium dense, gray-brown, silty, fine SAND; wet; scattered wood debris, scattered shells; (He) SM.	72.5
Very soft, gray-brown, slightly fine sandy, silty CLAY; moist; scattered wood debris and shells; (He) CH.	95.0
Very soft, green-gray, silty CLAY, trace of sand and gravel; wet; abundant fractured	97.5

CONTINUED NEXT SHEET

Samples	PID, ppm
1	0.3
2	0.2
3	4.7
4	338.6
5	35
6	37.2
7	52
8	12.8
9	22.4
10	13.4
11	1.7
12	3.7
13	0.6
14	25.9
15	1.4
16	2.4
17	9.3
18	8
19	1.2
20	5.6
21	2
22	2.6
23	3.1
24	4.1
25	3

Ground Water: During Drilling



LEGEND

* Sample Not Recovered

Standard Penetration Test

Ground Water Level ATD

NOTES

1. The boring was performed using HSA and Rotary Combined drilling methods.
2. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
3. The discussion in the text of this report is necessary for a proper understanding of the nature of the subsurface materials.
4. Groundwater level, if indicated above, is for the date specified and may vary.
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6. USCS designation is based on visual-manual classification and selected lab testing.

Magnolia Bridge Replacement
Seattle, Washington

LOG OF BORING EB-2

October 2005 | 21-1-09759-008

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-3
Sheet 1 of 2

MASTER LOG2 21-09759.GPJ SHAN WIL.GDT 10/4/05 Log: MET Rev: LMM Typ: EET

SOIL DESCRIPTION

Surface Elevation: Approx. 16.0 Ft. NAVD88

clay clasts; (Hls) CL/CH.

Very dense, slightly silty, fine to medium SAND; moist; scattered organics, scattered seams and layers of silt; (Qvro) SM/SP-SM.

108.0

Hard, gray, silty CLAY, trace of fine sand; moist; abundant sheared and slickensided seams, scattered fine organic fragments; (Qpnl/Qpgl) CH.

135.0

Hard, gray, trace to slightly sandy, silty CLAY, trace of gravel; wet; abundant pumice and angular andesite; (Qpnl) CH.

148.0

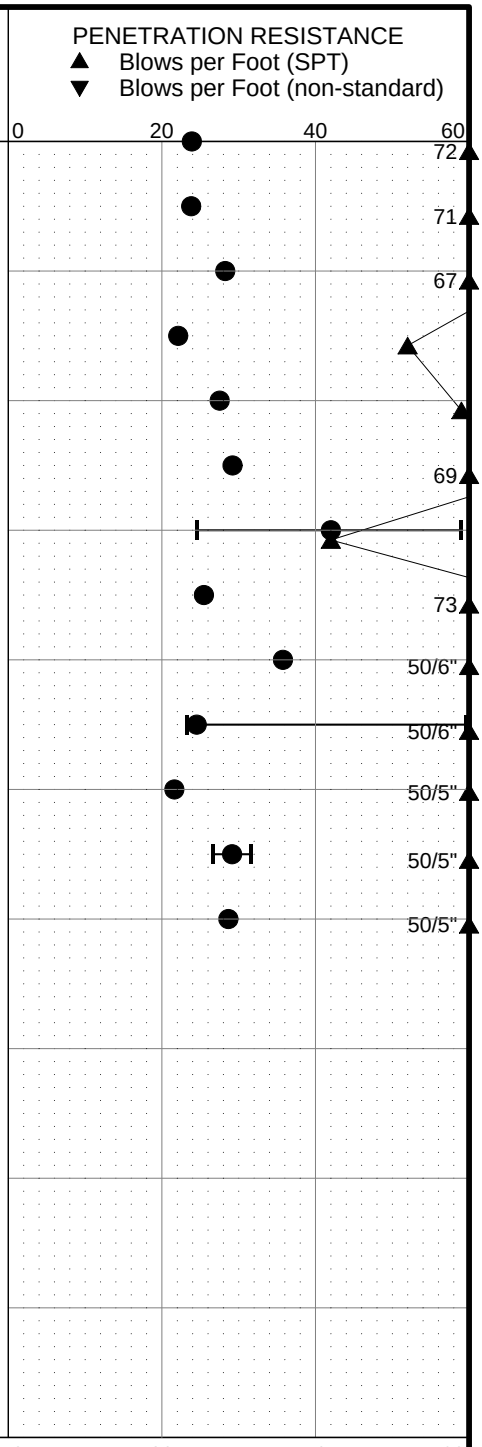
Hard, gray, slightly clayey to clayey SILT, trace of fine sand; wet; massive; scattered very fine organic fragments; (Qpnl) ML.

160.9

BOTTOM OF BORING
COMPLETED 7/1/2005

Depth, Ft.	PID, ppm	Samples
	5.4	26
	2.3	27
	0.9	28
		29
		30
		31
		32
		33
		34
		35
		36
		37
		38

Ground Water



LEGEND

* Sample Not Recovered

Standard Penetration Test

Ground Water Level ATD

● % Water Content

Plastic Limit ⊢●⊣ Liquid Limit

Natural Water Content

NOTES

1. The boring was performed using HSA and Rotary Combined drilling methods.
2. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
3. The discussion in the text of this report is necessary for a proper understanding of the nature of the subsurface materials.
4. Groundwater level, if indicated above, is for the date specified and may vary.
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Magnolia Bridge Replacement
Seattle, Washington

LOG OF BORING EB-2

October 2005 21-1-09759-008

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-3
Sheet 2 of 2

MASTER LOG2 21-09759.GPJ SHAN WIL.GDT 10/4/05 Log: MET Rev: LMM Typ: EET

Appendix B
Groundwater Technical Memorandum

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Technical Memorandum

Groundwater

Prepared by:

Shannon & Wilson, Inc.

November 2005

Seattle Department of Transportation
Agreement No. T01-34

Draft EA

Magnolia Bridge Replacement

City of Seattle

Contents

Contents i

Introduction 1

Description of Alternative 5

Methods 13

Affected Environment 15

Studies and Coordination 23

- **Studies** 23
- **Data Sources** 23
- **Major Assumptions** 23

Impacts 25

- **Rehabilitation Alternative** 25
  - Ground Improvement 25

Mitigation Measures 27

- **Rehabilitation Alternative** 27
  - Groundwater Mounding 27
  - Contaminant Movement 27
  - Changes in Groundwater Flow Direction 27

Construction Impacts 29

- **Rehabilitation Alternative** 29
  - Impacts 29
    - Potential Soil and Groundwater Contamination 29
    - Other 29

Summary of Findings 31

- **Affected Environment** 31
- **Impacts and Mitigation Measures** 31

Reference 33

Appendix A ..... A-i

Contents ..... A-iii

List of Figures

Figure 1 Project Vicinity 2
Figure 2 Project Study Area 3
Figure 3 Rehabilitation Alternative 7
Figure 4 Bridge Cross Section at Location A (see Figure 3) 9
Figure 5 Bridge Cross Section with Ground Improvement at Location A (see Figure 3) 10
Figure 6 Bridge Cross Section at Location B (see Figure 3) 11

Figure 7 Site and Exploration Plan, Rehabilitation Alternative (2 sheets) 17
Figure 8 Geologic Unit Explanations 19
Figure 9 Generalized Subsurface Profile, Rehabilitation Alternative (2 sheets) 21

Introduction

During the development of the Magnolia Bridge Replacement Project, the City of Seattle proposed four alternatives to be included in a NEPA EIS. These are the No Build, and Alternatives A, C, and D. Since that time, another alternative, the Rehabilitation Alternative has been recommended for consideration. The City has already submitted the 14 discipline reports listed below in Table 1 to WSDOT for review. WSDOT has approved 11 of these reports.

These discipline reports were prepared before the Rehabilitation Alternative was added to the project and only address the No Build Alternative and Alternatives A, C and D. This document was developed to provide information on and analysis of the Rehabilitation Alternative so that it can be included in the DEIS. Figure 1 and Figure 2 show the project vicinity and study area, respectively.

Table 1 Discipline Reports Reviewed by WSDOT

Discipline	Approval Date
1. Geology and Soils	February 2005
2. Air Quality	November 2004
3. Water Quality	April 2005
4. Wildlife, Fisheries, and Vegetation	December 2004
5. Noise	Not yet approved
6. Hazardous Materials	November 2004
7. Land Use	September 2004
8. Public Lands, Section 4(f)	Not yet approved
9. Historic, Cultural, and Archaeological Resources	Not yet approved
10. Social, Economic, and Relocation	February 2005
11. Environmental Justice	February 2005
12. Visual Quality	January 2005
13. Traffic & Transportation	January 2005
14. Public Services and Utilities	August 2004

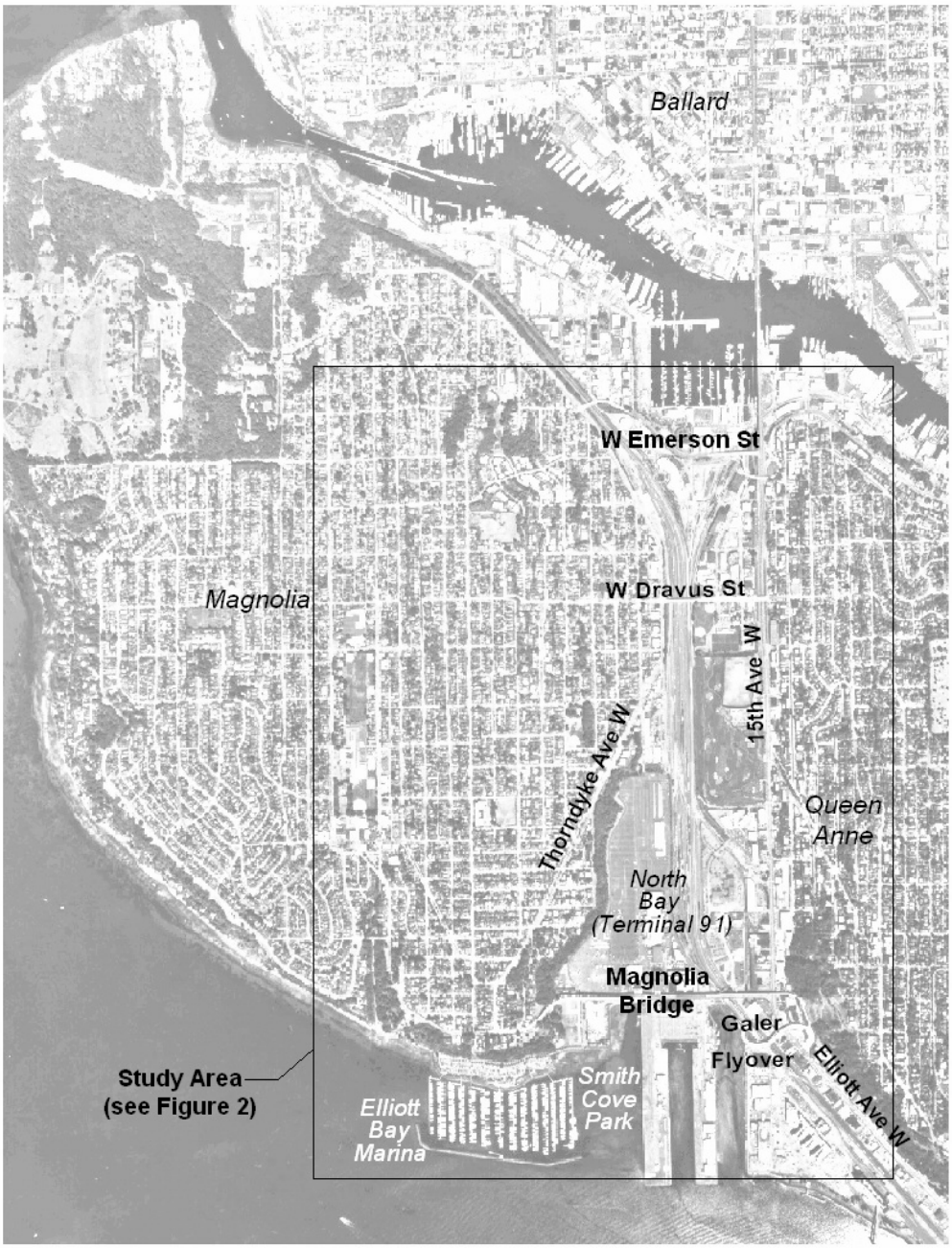

Figure 1 Project Vicinity

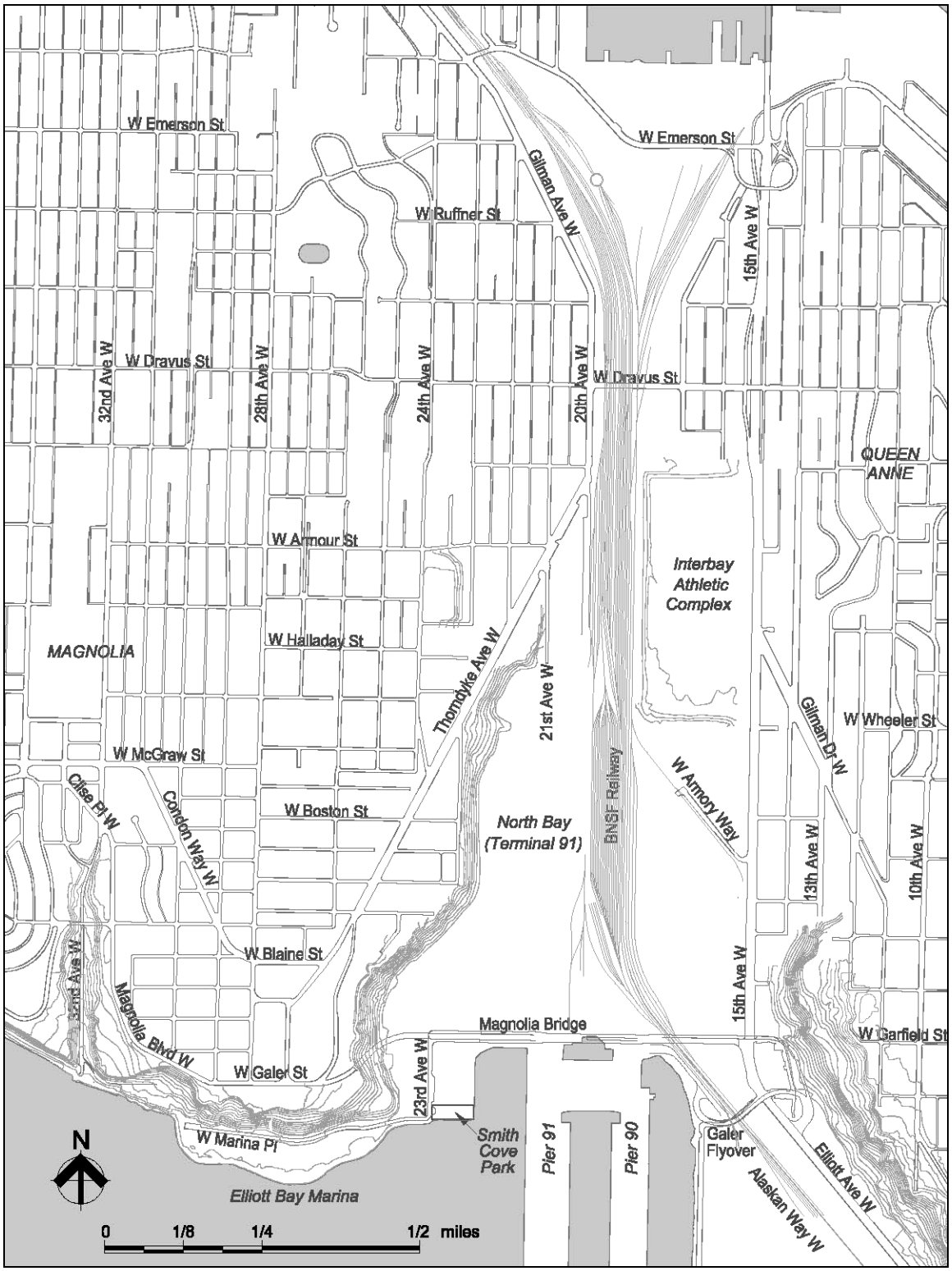

Figure 2 Project Study Area

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Description of Alternative

As part of an alignment study and NEPA Environmental Impact Statement process, the City of Seattle evaluated a number of alternatives for replacing the Magnolia Bridge. The alignment alternatives development and selection process is documented in the Alignment Study Report (revised September 2004). The process considered twenty-five alignment alternatives for the bridge replacement.

As a result of this work, four alternatives were selected to be included in the DEIS. They are: Alternatives A, C and D and the No Build Alternative. Since that time, the City has received feedback through its public process and wishes to include an additional alternative in the DEIS – the Rehabilitation Alternative.

A rehabilitation alternative was considered in 2001 and 2002 as the bridge replacement project was initially developed. It was rejected because it was deemed too costly. However, a revisiting of the initial 2001 and 2002 cost estimate for bridge replacement has shown a doubling of cost. This change has made the Rehabilitation Alternative a viable alternative for consideration in the DEIS.

The Rehabilitation Alternative would maintain the existing bridge alignment with the existing connections to 15th Avenue West at the east end and West Galer Street at the west end. Bridge rehabilitation would bring the structure up to current design standards. Table 2 and Figure 3**Error! Reference source not found.** show the elements of this alternative. Of the original structure built in 1929-1930, only the columns and foundations would remain between the BNSF Railway and Magnolia Bluff, and these would be strengthened to meet current standards. The existing ramps to and from the Elliott Bay Marina via 23rd Avenue West would be retained. The center ramps from the bridge to Terminal 91 would be removed. Terminal 91 access would remain at the East Gate with access from 15th Avenue West by the Galer Flyover structure and Alaskan Way West.

Similar to the build alternatives, the Rehabilitation Alternative would retain the same number of vehicle travel lanes as the existing bridge. Lane widths would meet WSDOT Local Agency Guideline (LAG) design standard widths of 12 feet for outside lanes and 11 feet for inside lanes. The number of vehicle travel lanes is as follows:

Westbound

- One lane from northbound 15th Avenue West on a grade-separated structure over 15th Avenue W
- One lane from southbound 15th Avenue West
- Two lanes from the BNSF Railway crossing to the west end of the bridge on Magnolia Bluff

Eastbound

- One lane from Magnolia Bluff to the 23rd Avenue West on-ramp
- Two lanes from the 23rd Avenue W on-ramp to 15th Avenue West (one lane right-only and one lane left and through at 15th Avenue West)

The Rehabilitation Alternative would have a sidewalk on the south side of the bridge structure. The LAG design standard minimum sidewalk width is five feet. A six-foot width may be possible on the Rehabilitation Alternative new bridge deck. The existing bridge stairway access to the ground would be retained near the current locations.

Table 2 Rehabilitation Alternative Elements

1.	15th Avenue W overpass	Retrofit the eastern 880 feet of this structure, which has 16 spans, for increased seismic capacity. Only the span over 15th Avenue W has been previously retrofitted.
2.	Ramp and structure west to 15th Avenue W to west side of railroad	The ramp and spans in this 873-foot long section would be removed and replaced with new structure. This would eliminate a design deficiency (inadequate stopping sight distance, where the railroad structure connects to the ramp to 15th Avenue W.)
3.	Roadway deck and supporting crossbeams, west side of railroad to Magnolia Bluff	The existing superstructure in this 2,454-foot section would be replaced with pre-stressed slab spans. The seven concrete truss spans in this section would also be replaced. All crossbeams and column tops would be replaced.
4.	Center ramp to Terminal 91	The 529-foot center ramp located west of the railroad would be replaced with new foundations, columns, and deck.
5.	Railroad to center ramp and center ramp section to 23rd Avenue W ramps	Cross bracing would be provided between columns in the north-south (lateral) and east-west (longitudinal) directions.
6.	From marina ramps to west end of bridge	Columns would be encased in steel jacket to provide seismic capacity. Existing column bracing in the east-west (longitudinal) direction would be replaced.
7.	Timber pile foundations from railroad to west end of bridge	Grade beams and drilled shafts would be connected to existing column foundations to increase seismic capacity.
8.	Connection to Anthony's Seafood Distributing	This connection would be removed and not replaced when the bridge deck is replaced (item 3).
9.	Throughout	Ground around foundations would be treated by compaction grouting and stone columns to resist liquefaction during an earthquake.

Figures 4, 5, and 6 are cross sections that illustrate the type of replacement and retrofit improvements required. Figure 5 also shows the extent of ground improvement required west of the BNSF Railway where the depth to glacially compacted soil is about 100 feet.

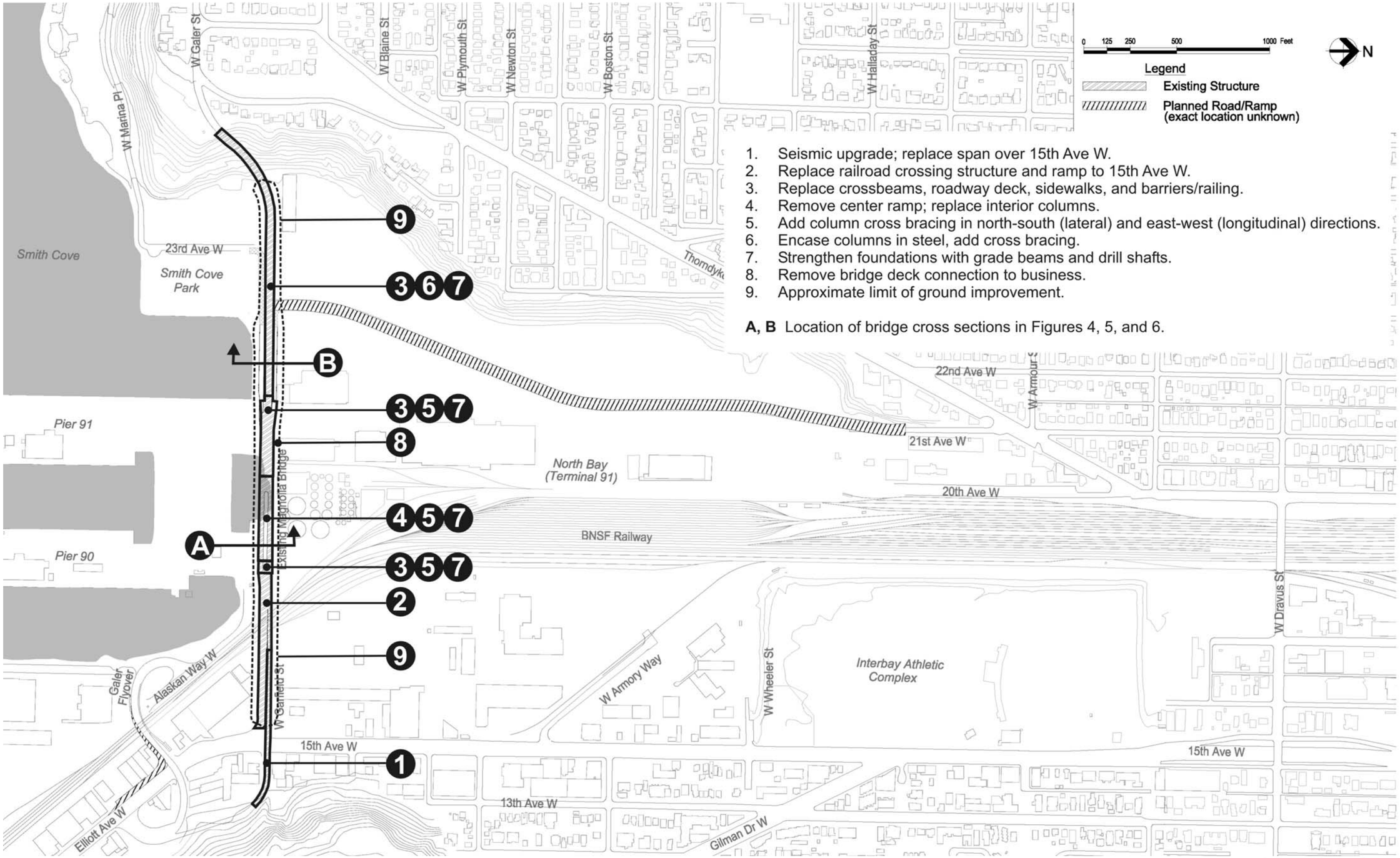

Figure 3 Rehabilitation Alternative

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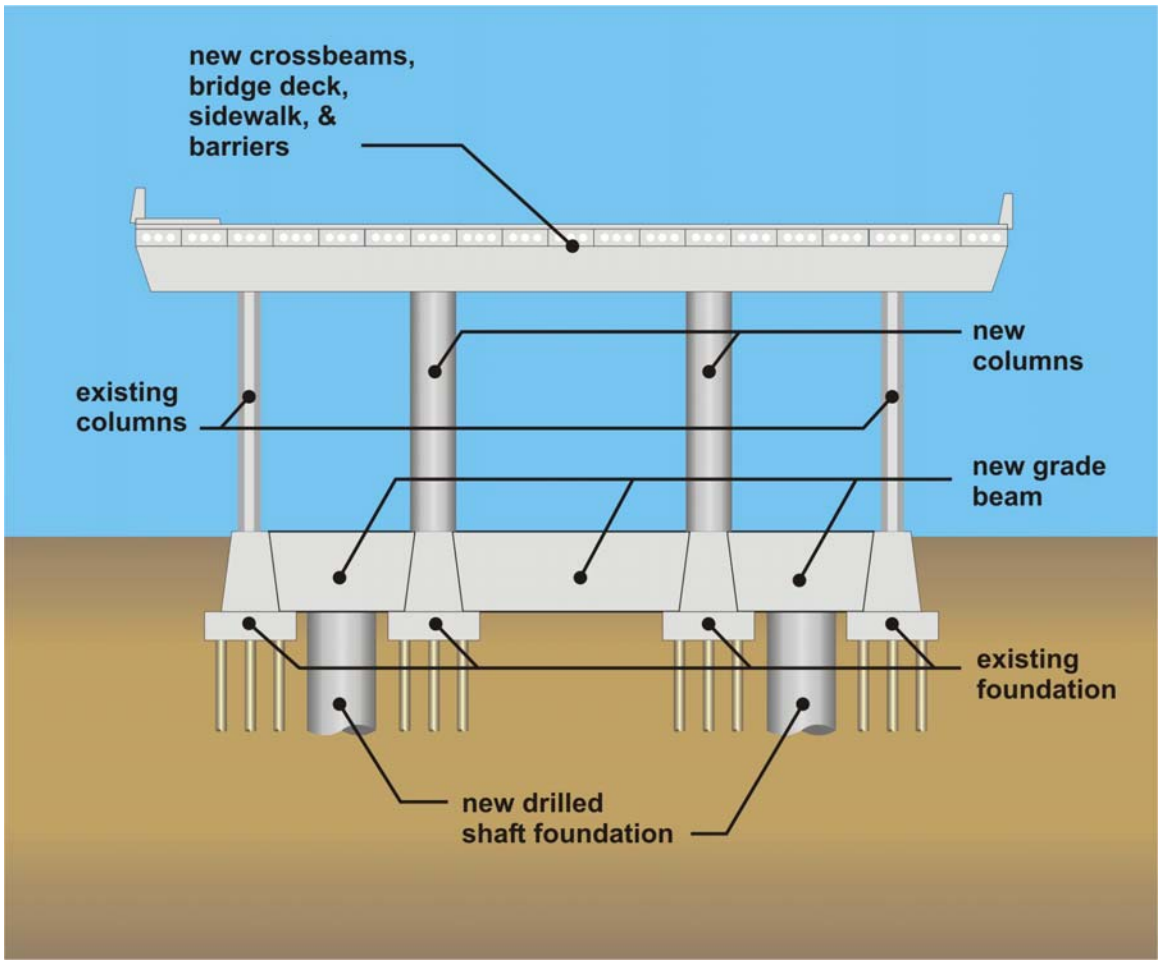

Figure 4 Bridge Cross Section at Location A (see Figure 3)

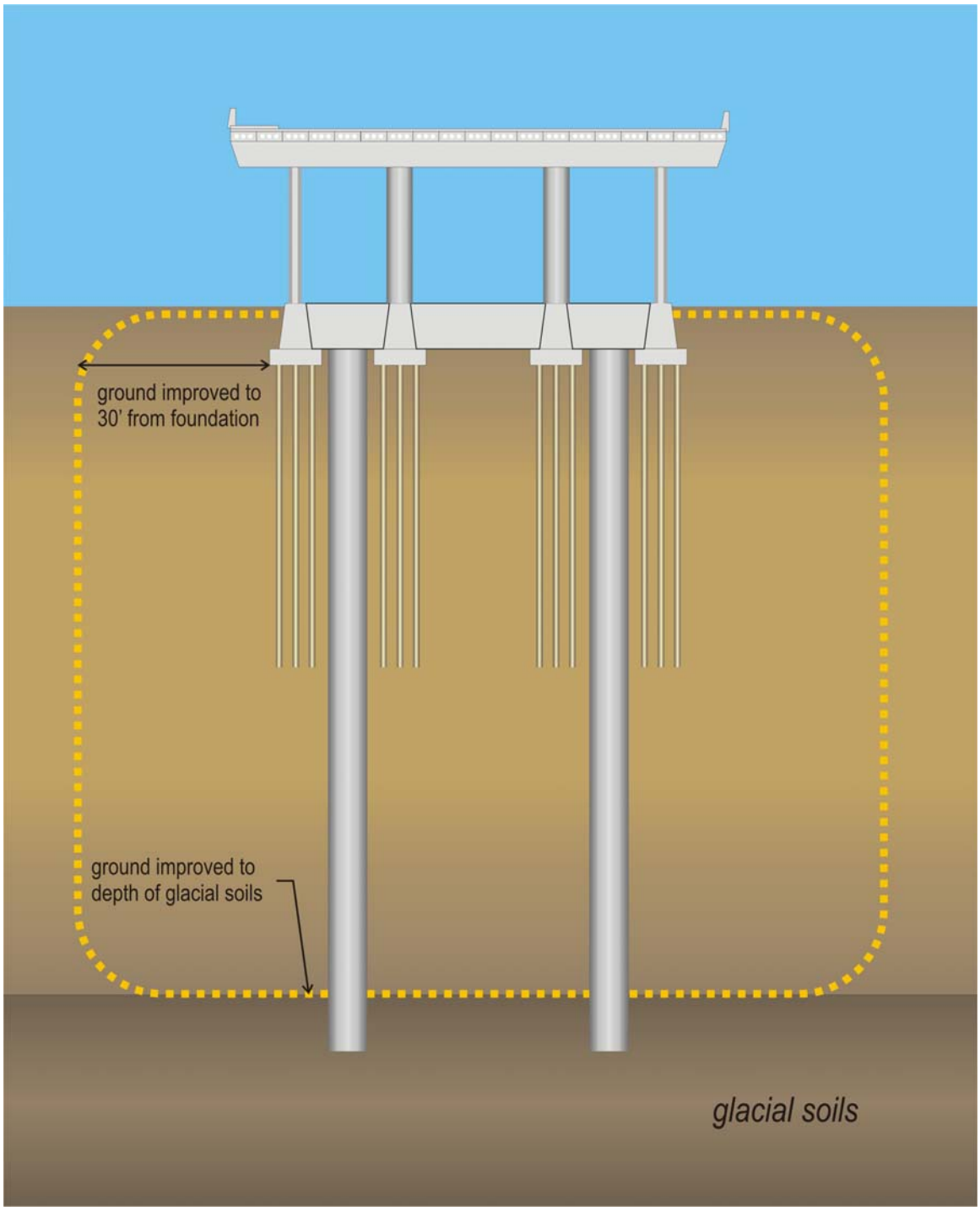

Figure 5 Bridge Cross Section with Ground Improvement at Location A (see Figure 3)

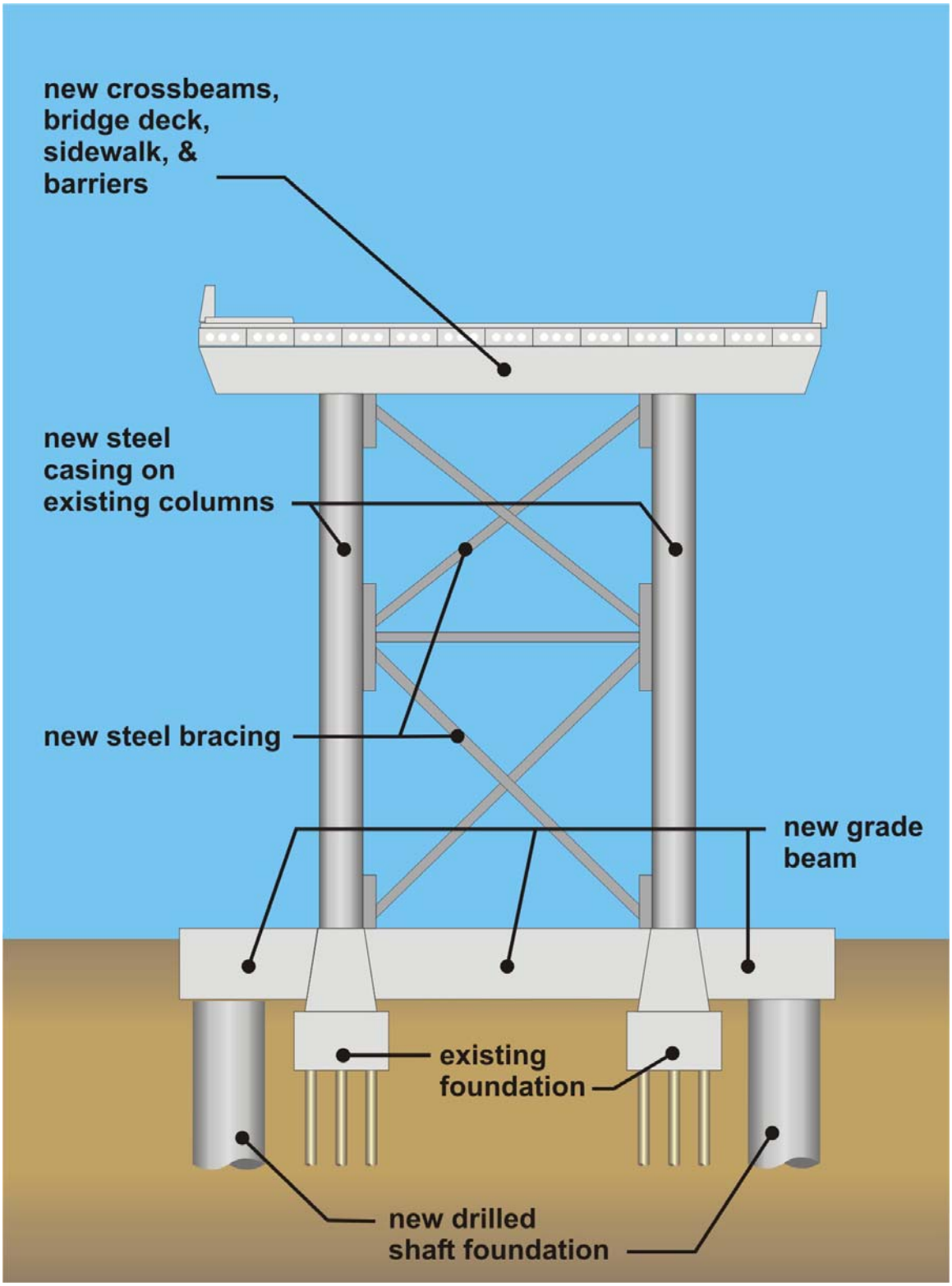

Figure 6 Bridge Cross Section at Location B (see Figure 3)

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Methods

The methods used to evaluate the Rehabilitation Alternative were the same as those discussed in the "Discipline Report, Water Quality" prepared by KPFF Consulting Engineers and Shannon & Wilson, Inc. in February 2005 for the No Build Alternative and Alternatives A, C, and D. Two additional borings were drilled and sampled for the rehabilitation alternative.

Affected Environment

For a discussion of the Rehabilitation Alternative affected environment, refer to the discussion in the "Discipline Report, Water Quality" prepared by KPFF Consulting Engineers and Shannon & Wilson, Inc. in February 2005 for the No Build Alternative and Alternatives A, C, and D. In particular, given the proximity of the two alternatives, the text and figures regarding Alternative A can be used as a reference for the Rehabilitation Alternative. The Alternative A plan view figures in the discipline report also depict the existing bridge alignment.

The Site and Exploration Plan, Geologic Unit Explanation, and Generalized Subsurface Profile for the Rehabilitation Alternative are presented on Figures 7 through 9, respectively. Figures 7 and 9 include the two additional borings, EB-1 and EB-2.

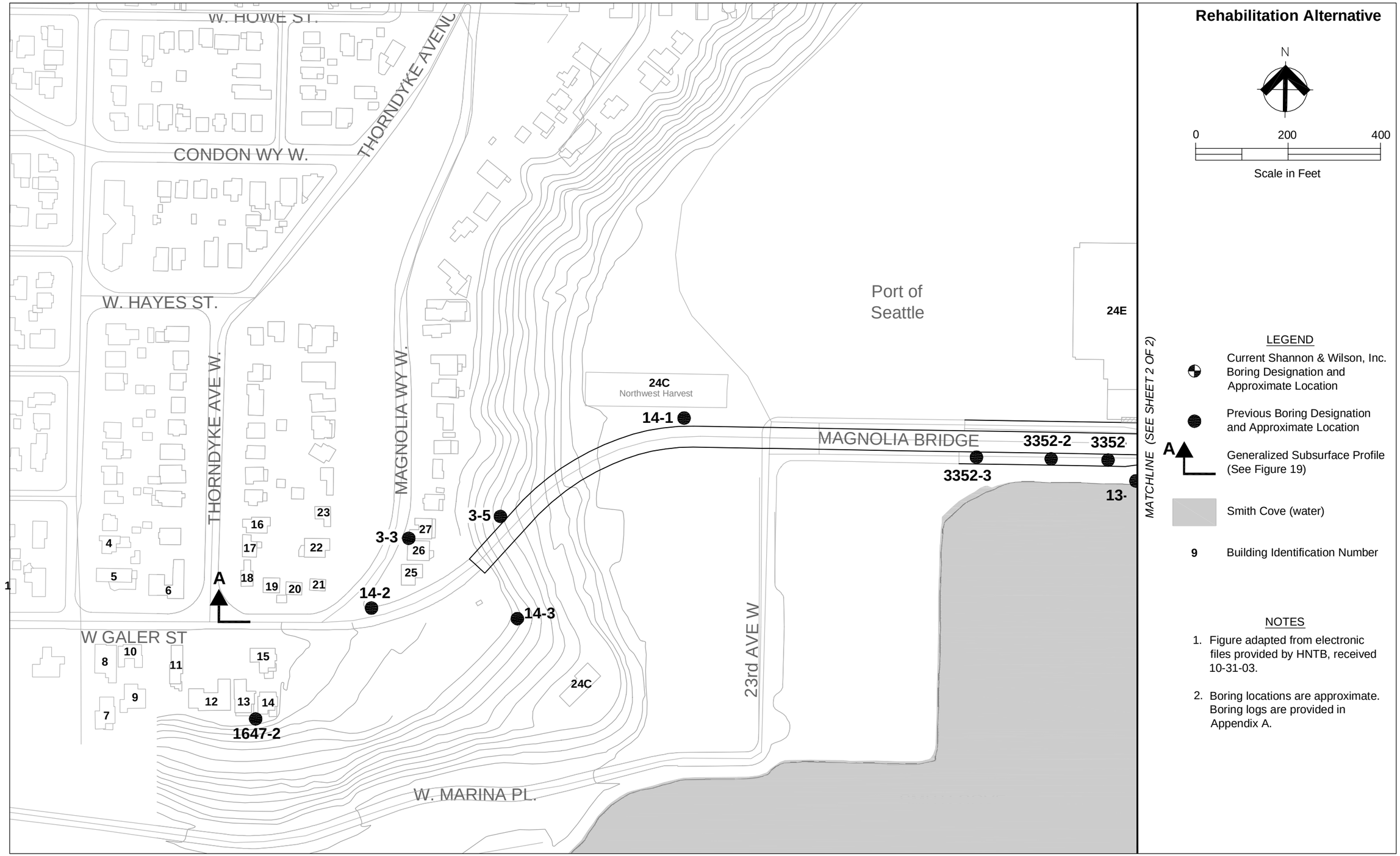

Figure 7, Sheet 1 of 2 - Site and Exploration Plan - Rehabilitation Alternative

File: J:\211\09759-008\Technical Memorandum 11-05\21-1-09759-008 Site Plan.dwg Date: 11-11-2005 Author: SAC

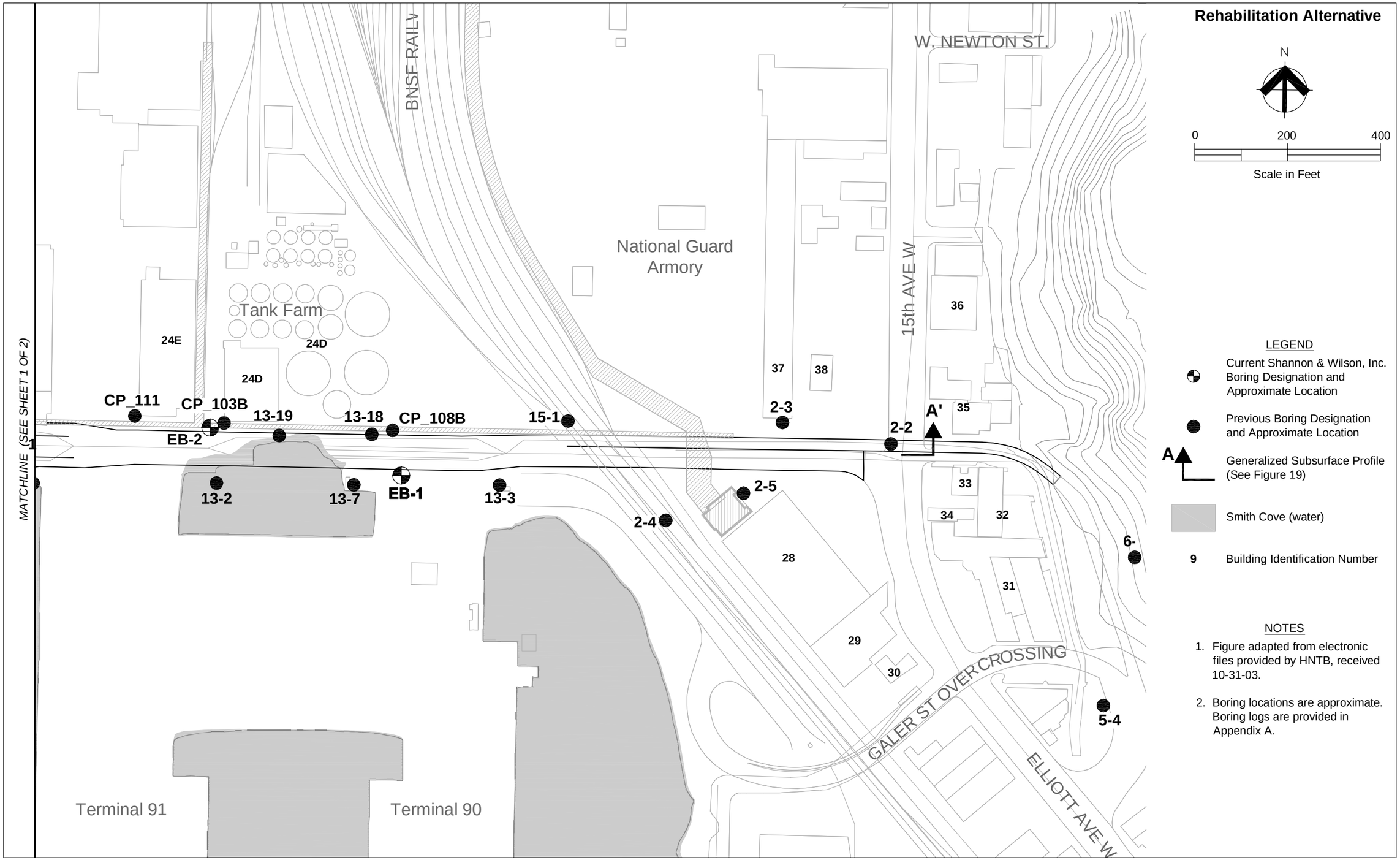

Figure 7, Sheet 2 of 2 - Site and Exploration Plan - Rehabilitation Alternative

File: J:\211\09759-008\Technical Memorandum 11-05\21-1-09759-008 Site Plan.dwg Date: 11-11-2005 Author: SAC

GEOLOGIC UNITS

HOLOCENE DEPOSITS

Hf FILL: Fill placed by humans, both engineered and nonengineered.
Various materials, including debris; cobbles and boulders common; commonly dense or stiff if engineered, but very loose to dense or very soft to stiff if nonengineered.

Hls LANDSLIDE DEPOSITS: Deposits of landslides, normally at and adjacent to the toe of slopes.
Disturbed, heterogeneous mixture of several soil types; loose or soft, with random dense or hard pockets.

He ESTUARINE DEPOSITS: Estuary deposits of intertidal zones associated with rivers and streams located along the present and former Puget Sound shoreline.
Clayey Silt, silty Clay, Silt, and fine Sand; very soft to very stiff or very loose to medium dense.

Hb BEACH DEPOSITS: Deposits along present and former shorelines of Puget Sound and tributary river mouths.
Silty Sand, sandy Gravel, Sand, scattered fine Gravel, organic and shell debris; loose to dense.

QUATERNARY VASHON DEPOSITS

Qvro RECESSIONAL OUTWASH DEPOSITS: Glaciofluvial sediment deposited as glacial ice retreated.
Clean to silty Sand, gravelly Sand, sandy Gravel; cobbles and boulders common; loose to very dense.

Qvt TILL: Lodgment till laid down along the base of the glacial ice.
Gravelly silty Sand, silty gravelly Sand ("hardpan"); cobbles and boulders common; very dense.

Qva ADVANCE OUTWASH: Glaciofluvial sediment deposited as the glacial ice advanced through the Puget Lowland.
Clean to silty Sand, gravelly Sand, sandy Gravel; dense to very dense.

Qvgl GLACIOLACUSTRINE DEPOSITS: Fine-grained glacial flour deposited in proglacial lake in Puget Lowland.
Silty clay, Clayey Silt, with interbeds of Silt and fine Sand; locally laminated; scattered organic fragments near base; hard or dense to very dense.

QUATERNARY PRE-VASHON DEPOSITS

Qpnl LACUSTRINE DEPOSITS: Fine-grained lake deposits in depressions, large and small.
Fine sandy Silt, silty fine Sand, clayey Silt; scattered to abundant fine organics; dense to very dense or very stiff to hard.

Qpnm MUDFLOW DEPOSITS: Distal deposits of mass movements such as landslides or lahars.
Stratified or irregular bodies of a heterogeneous mixture of Gravel, Sand, Silt, and Clay; pumice, obsidian and ash common; rare organics (charcoal); very stiff to hard or very dense.

Qpgt TILL: Lodgment till laid down along the base of the glacial ice
Gravelly silty Sand, silty gravelly Sand ("hardpan"); cobbles and boulders common; very dense.

Qpgo OUTWASH: Glaciofluvial sediment deposited as the glacial ice advanced through the Puget Lowland.
Clean to silty Sand, gravelly Sand, sandy Gravel; very dense.

Qpgl GLACIOLACUSTRINE DEPOSITS: Fine-grained glacial flour deposited in proglacial lake in Puget Lowland.
Silty Clay, clayey Silt, with interbeds of Silt and fine Sand; very stiff to hard or very dense.

NOMENCLATURE

GEOLOGIC AGE DESIGNATION		DEPOSITIONAL ENVIRONMENT, GEOLOGIC PROCESS, OR LITHOLOGY		
H = Holocene		f = fill ls = landslide	e = estuarine b = beach	Present
Q = Quaternary	v = Vashon	r = recessional	o = outwash at = ablation till	10,000 yrs BP *
		t = till (lodgment) a = advance outwash gl = glaciolacustrine		
	p = Pre-Vashon 6 or more glacial and interglacial episodes	n = nonglacial (interglacial)	l = lacustrine m = mudflow	15,000 yrs BP *
		g = glacial	l = lacustrine o = outwash m = marine t = till (lodgment)	2,000,000 yrs BP

* *These radiometric (C^{14}) dates are based on data in Central Puget Lowland. Equivalent calendar years before present are approximately 15,000 and 18,000 yrs BP. These dates may differ from onset and end of Vashon (late Pleistocene) glacial episode in other parts of the Puget Lowland.*

NOTES

1. The description of each geologic unit includes only general information regarding the environment of deposition and basic soil characteristics.
2. Each geologic unit has a two- to four-letter abbreviation composed of a leading capital letter signifying geologic age, followed by one or more lowercase letters indicating further breakdown of geologic age, depositional environment, or geologic process.
3. The nomenclature graphic was created to explain the distinctions among geologic deposits in the Central Puget Lowland for engineering purposes, e.g. engineering properties of geologic deposits. The actual geologic designations and dates, according to internationally accepted stratigraphic rules, may be slightly different.

LEGEND

Glacially Overridden Soil Units Below Line

Years BP — Radiocarbon Years Before Present (1950)

Figure 8 - Geologic Unit Explanation

File: J:\211\09759-008\Technical Memorandum 11-05\21-1-09759-008 Legend.dwg Date: 11-11-2005 Author: SAC

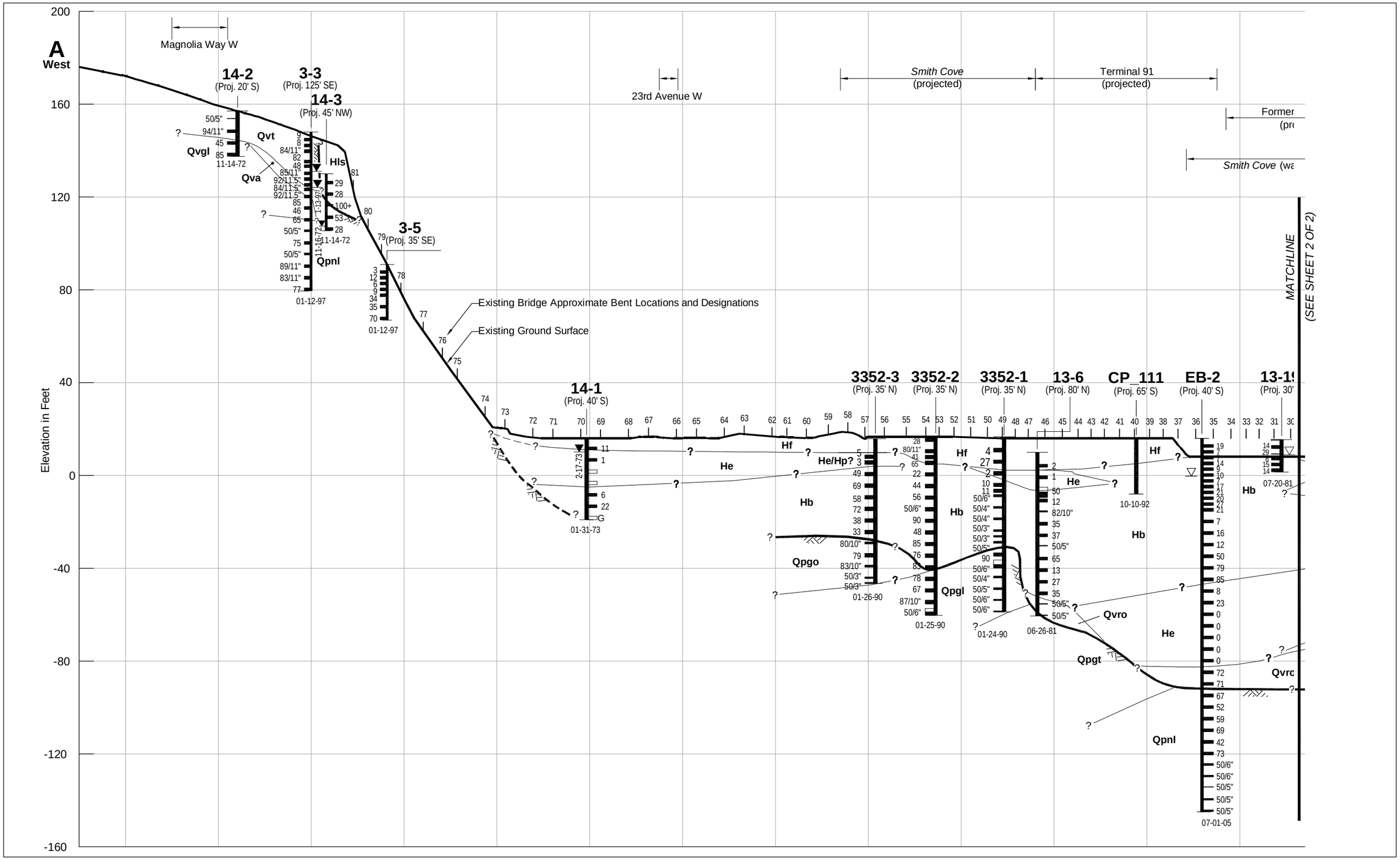

Figure 9, Sheet 1 of 2 - Generalized Subsurface Profile - Rehabilitation Alternative

File: J:\211\09759-008\Technical Memorandum 11-05\21-1-09759-008 Profile.dwg Date: 11-11-2005 Author: SAC

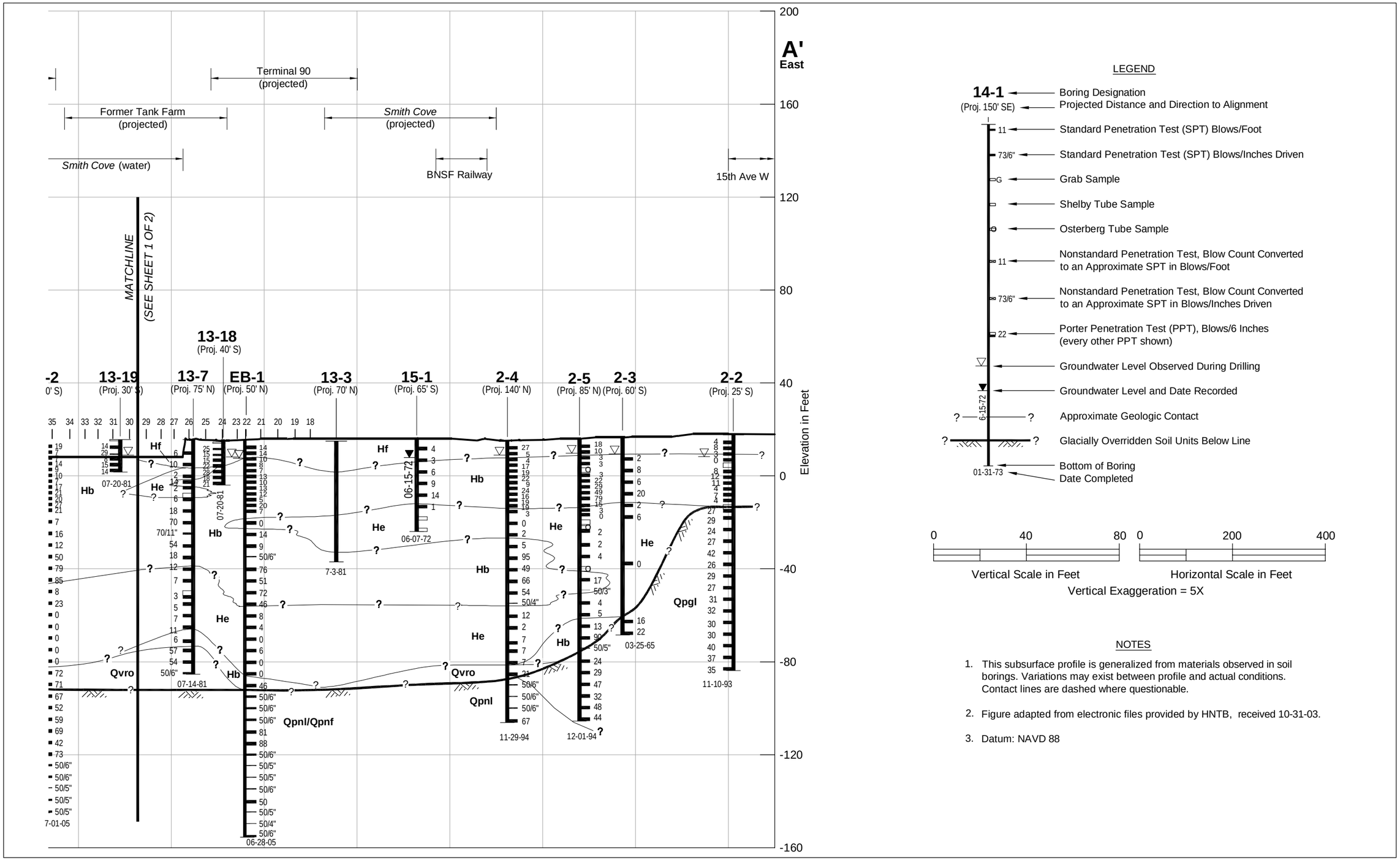

Figure 9, Sheet 2 of 2 - Generalized Subsurface Profile - Rehabilitation Alternative

File: J:\211\09759-008\Technical Memorandum 11-05\21-1-09759-008 Profile.dwg Date: 11-11-2005 Author: SAC

Studies and Coordination

Studies

Groundwater data were obtained as described in the February 2005 Water Quality Discipline Report and by drilling two additional borings. The groundwater evaluation of the Rehabilitation Alternative was performed based on this data and as described in the Water Quality Discipline Report. In addition, a groundwater conceptual model was completed to evaluate changes in groundwater flow and groundwater levels.

Data Sources

Data sources were the same as those used for the February 2005 discipline report. The two additional borings were drilled and sampled to supplement the existing subsurface information. The borings were located in areas where geologic conditions were not documented adequately. Monitoring wells were not installed. The locations of recent field explorations are shown on Figure 7. The boring locations were not surveyed but were measured from existing features and plotted on the site topographic map provided by HNTB. After plotting the approximate boring locations, their elevations, in terms of North American Vertical Datum 1988 (NAVD88), were estimated.

Major Assumptions

Major assumptions are the same as those used for the February 2005 Water Quality report.

Rehabilitation Alternative

The Rehabilitation Alternative has similar subsurface soil, groundwater, and geologic conditions to Alternative A. Only those impacts that are specific to the Rehabilitation Alternative are discussed below. Contamination impacts are also discussed in the October 2005 Hazardous Materials technical memorandum.

Ground Improvement

Soil improvement activities and the resulting soil densification could have two effects on the ability of shallow soils to transmit groundwater. Injected grout from compaction grouting could reduce the effective transmissive area of the soils and the related soil densification could reduce the hydraulic conductivity within the rehabilitation area. Reducing the area and the hydraulic conductivity of the shallow soils could result in a steepening of the hydraulic gradient through the rehabilitation area and could cause associated groundwater mounding.

Assuming a 5 percent reduction in area as a result of compaction grouting and a reduction in the soil hydraulic conductivity by a factor of 2 to 4 from soil densification, groundwater analyses indicate the potential for about 1 to 2 feet of groundwater mounding on the upgradient side of the rehabilitation area. The mounding would be highest at the west end of the site where compaction grouting intercepts Hb soils and Hb soils are truncated by the hillside. Mounding would diminish to the east where groundwater is able to preferentially flow around the rehabilitation area within the Hb soils. It should be noted that the groundwater levels are higher than the top of the rehabilitation zone (assuming it extends up to 10 feet below ground surface) in some areas; groundwater flow will “overtop” the densified soils and grout in those areas. This may have the effect of reducing the magnitude of mounding in those areas.

Any magnitude of groundwater mounding could have the effect of mobilizing additional contaminants within previously unsaturated soil. It should be noted that some Hf materials overlying the Hb soils are unsaturated and may include relatively coarse-grained sand and gravel. When saturated, these soils could provide a pathway for rapid contaminant migration. A more detailed discussion of the potential impacts with regard to contamination is provided in the Hazardous Materials technical memorandum.

Due to the high pH of most grout types, groundwater pH may increase downgradient of the rehabilitation area.

Groundwater mounding of up to 2 feet should not cause surface ponding, since the water level is typically between 4 and 10 feet below ground surface. However, mounding may flood existing utility vaults or corridors that are currently just above the water table.

Rehabilitation Alternative

All the impacts could be mitigated as presented in the February 2005 discipline report. Only those impacts that are specific to the Rehabilitation Alternative are discussed below.

Groundwater Mounding

Construct an artificial bypass for groundwater through the rehabilitation zone, engineered in such a way to reduce groundwater mounding and maintain pre-construction water levels and groundwater flow directions.

Construct a drainage trench along the upgradient of the rehabilitation zone to readily move groundwater to the edge of the rehabilitation zone.

Reduce the foundation rehabilitation area to reduce impacts on soil hydraulic conductivity and reduce the magnitude of mounding.

Contaminant Movement

Construct contaminant recovery trenches and/or treatment systems to collect newly mobilized contamination. Trenches and treatment systems may be necessary both upgradient and downgradient of the proposed rehabilitation area.

Mitigate mounding and changes in groundwater flow direction as indicated.

Changes in Groundwater Flow Direction

Monitor water level and water quality at existing and new observation wells before, during, and after construction to evaluate changes in groundwater levels and flowpaths. Water levels can be used to evaluate changes in groundwater flow directions.

Rehabilitation Alternative

Construction impacts and mitigation measures were presented in the February 2005 Water Quality Discipline Report. Only those construction impacts that are specific to the Rehabilitation Alternative are discussed below.

Impacts

Potential Soil and Groundwater Contamination

There is a possibility that construction activities would encounter potentially contaminated soil and groundwater. These issues are discussed in both the Hazardous Material Discipline Report and Technical Memorandum.

Other

Short-term changes in groundwater levels and flow direction may occur prior to implementation of mitigation measures.

Summary of Findings

This Groundwater Technical Memorandum along with the February 2005 Water Quality discipline report describes the groundwater conditions present along the Rehabilitation Alternative, and discusses the groundwater-related operational and construction impacts and recommended mitigations for the Magnolia Bridge Replacement Project. Subsurface data used to assess these issues were presented in the discipline report; the two additional borings for the Rehabilitation Alternative are presented in Appendix A.

Affected Environment

The affected environment is summarized in the February 2005 discipline report.

Impacts and Mitigation Measures

Groundwater-related operational and construction impacts and recommended mitigation measures were developed based on the project area geology, known subsurface conditions, and the Rehabilitation Alternative alignment.

Potential impacts of the Rehabilitation Alternative alignment include groundwater mounding, changes in groundwater flow direction, and changes to groundwater quality. Groundwater mounding should not cause surface ponding; however mounding may flood existing utility vaults or corridors that are currently just above the water table. Changes in groundwater flow direction could impact groundwater quality. Changes to groundwater quality are described in the Hazardous Material Discipline Report and Technical Memorandum.

Table 2 summarizes anticipated groundwater impacts and measures that can be taken to minimize those impacts.

Table 2
Summary Matrix for Rehabilitation Alternative – Groundwater

Impact Type	Impacts	Mitigation Measures
Construction Impacts	Contaminated soil and/or groundwater, may be encountered. See Hazardous Material Discipline Report and Technical Memorandum.	See Hazardous Material Discipline Report and Technical Memorandum.
	Short-term changes in groundwater levels and flow direction may occur prior to implementation of mitigation measures.	No mitigation proposed.
Operation Impacts	None.	No mitigation proposed.
Secondary Impacts	Contamination may be spread to soil and groundwater as a result of construction. For example, new contamination migration pathways may be created as a result of compaction grouting, and by construction of underground utility corridors. The rehabilitation area may cause changes in groundwater elevations and shifts in flow directions.	See Hazardous Material Discipline Report and Technical Memorandum.
	Groundwater mounding may occur resulting in flooded existing utility vaults or corridors that are currently just above the water table.	Provide mitigation measures to reduce groundwater mounding. Mitigation measures may include providing a pathway for groundwater to readily move through or around the area of ground improvement.

Source: Shannon & Wilson, Inc., 2005

Reference

KPFF Consulting Engineers and Shannon & Wilson, Inc. 2005. *Discipline Report, Water Quality*. Report by KPFF Consulting Engineers and Shannon & Wilson, Inc., Seattle, Wash., for Seattle Department of Transportation, Seattle, Wash., February.

Appendix A

Contents

Figure A-1	Soil Classification and Log Key (2 sheets)
Figure A-2	Log of Boring EB-1 (2 sheets)
Figure A-3	Log of Boring EB-2 (2 sheets)

Shannon & Wilson, Inc. (S&W), uses a soil classification system modified from the Unified Soil Classification System (USCS). Elements of the USCS and other definitions are provided on this and the following page. Soil descriptions are based on visual-manual procedures (ASTM D 2488-93) unless otherwise noted.

S&W CLASSIFICATION OF SOIL CONSTITUENTS

- MAJOR constituents compose more than 50 percent, by weight, of the soil. Major consituents are capitalized (i.e., SAND).
- Minor constituents compose 12 to 50 percent of the soil and precede the major constituents (i.e., silty SAND). Minor constituents preceded by "slightly" compose 5 to 12 percent of the soil (i.e., slightly silty SAND).
- Trace constituents compose 0 to 5 percent of the soil (i.e., slightly silty SAND, trace of gravel).

MOISTURE CONTENT DEFINITIONS

Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, from below water table

ABBREVIATIONS

ATD	At Time of Drilling
Elev.	Elevation
ft	feet
FeO	Iron Oxide
MgO	Magnesium Oxide
HSA	Hollow Stem Auger
ID	Inside Diameter
in	inches
lbs	pounds
Mon.	Monument cover
N	Blows for last two 6-inch increments
NA	Not applicable or not available
NP	Non plastic
OD	Outside diameter
OVA	Organic vapor analyzer
PID	Photo-ionization detector
ppm	parts per million
PVC	Polyvinyl Chloride
SS	Split spoon sampler
SPT	Standard penetration test
USC	Unified soil classification
WLI	Water level indicator

GRAIN SIZE DEFINITION

DESCRIPTION	SIEVE NUMBER AND/OR SIZE
FINES	< #200 (0.08 mm)
SAND*	
- Fine	#200 to #40 (0.08 to 0.4 mm)
- Medium	#40 to #10 (0.4 to 2 mm)
- Coarse	#10 to #4 (2 to 5 mm)
GRAVEL*	
- Fine	#4 to 3/4 inch (5 to 19 mm)
- Coarse	3/4 to 3 inches (19 to 76 mm)
COBBLES	3 to 12 inches (76 to 305 mm)
BOULDERS	> 12 inches (305 mm)

* Unless otherwise noted, sand and gravel, when present, range from fine to coarse in grain size.

RELATIVE DENSITY / CONSISTENCY

COARSE-GRAINED SOILS		FINE-GRAINED SOILS	
N, SPT, BLOWS/FT.	RELATIVE DENSITY	N, SPT, BLOWS/FT.	RELATIVE CONSISTENCY
0 - 4	Very loose	Under 2	Very soft
4 - 10	Loose	2 - 4	Soft
10 - 30	Medium dense	4 - 8	Medium stiff
30 - 50	Dense	8 - 15	Stiff
Over 50	Very dense	15 - 30	Very stiff
		Over 30	Hard

WELL AND OTHER SYMBOLS

Bent. Cement Grout	Surface Cement Seal
Bentonite Grout	Asphalt or Cap
Bentonite Chips	Slough
Silica Sand	Bedrock
PVC Screen	
Vibrating Wire	

Magnolia Bridge Replacement
Seattle, Washington

SOIL CLASSIFICATION AND LOG KEY

October 2005 21-1-09759-008

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FIG. A-1
Sheet 1 of 2

BORING_CLASS1 21-09759.GPJ SWNEW.GDT 10/4/05

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)
(From ASTM D 2487-98 & 2488-93)

MAJOR DIVISIONS			GROUP/GRAPHIC SYMBOL		TYPICAL DESCRIPTION
COARSE-GRAINED SOILS *(more than 50% retained on No. 200 sieve)*	Gravels *(more than 50% of coarse fraction retained on No. 4 sieve)*	Clean Gravels *(less than 5% fines)*	GW		Well-graded gravels, gravels, gravel/sand mixtures, little or no fines
			GP		Poorly graded gravels, gravel-sand mixtures, little or no fines
		Gravels with Fines *(more than 12% fines)*	GM		Silty gravels, gravel-sand-silt mixtures
			GC		Clayey gravels, gravel-sand-clay mixtures
	Sands *(50% or more of coarse fraction passes the No. 4 sieve)*	Clean Sands *(less than 5% fines)*	SW		Well-graded sands, gravelly sands, little or no fines
			SP		Poorly graded sand, gravelly sands, little or no fines
		Sands with Fines *(more than 12% fines)*	SM		Silty sands, sand-silt mixtures
			SC		Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS *(50% or more passes the No. 200 sieve)*	Silts and Clays *(liquid limit less than 50)*	Inorganic	ML		Inorganic silts of low to medium plasticity, rock flour, sandy silts, gravelly silts, or clayey silts with slight plasticity
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
		Organic	OL		Organic silts and organic silty clays of low plasticity
	Silts and Clays *(liquid limit 50 or more)*	Inorganic	MH		Inorganic silts, micaceous or diatomaceous fine sands or silty soils, elastic silt
			CH		Inorganic clays or medium to high plasticity, sandy fat clay, or gravelly fat clay
		Organic	OH		Organic clays of medium to high plasticity, organic silts
HIGHLY-ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor		PT		Peat, humus, swamp soils with high organic content (see ASTM D 4427)

NOTE: No. 4 size = 5 mm; No. 200 size = 0.075 mm

NOTES

1. Dual symbols *(symbols separated by a hyphen, i.e., SP-SM, slightly silty fine SAND)* are used for soils with between 5% and 12% fines or when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart.

2. Borderline symbols *(symbols separated by a slash, i.e., CL/ML, silty CLAY/clayey SILT; GW/SW, sandy GRAVEL/gravelly SAND)* indicate that the soil may fall into one of two possible basic groups.

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SOIL CLASSIFICATION AND LOG KEY

October 2005 | 21-1-09759-008

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FIG. A-1
Sheet 2 of 2

BORING_CLASS2 21-09759.GPJ SWNEW.GDT 10/4/05

SOIL DESCRIPTION

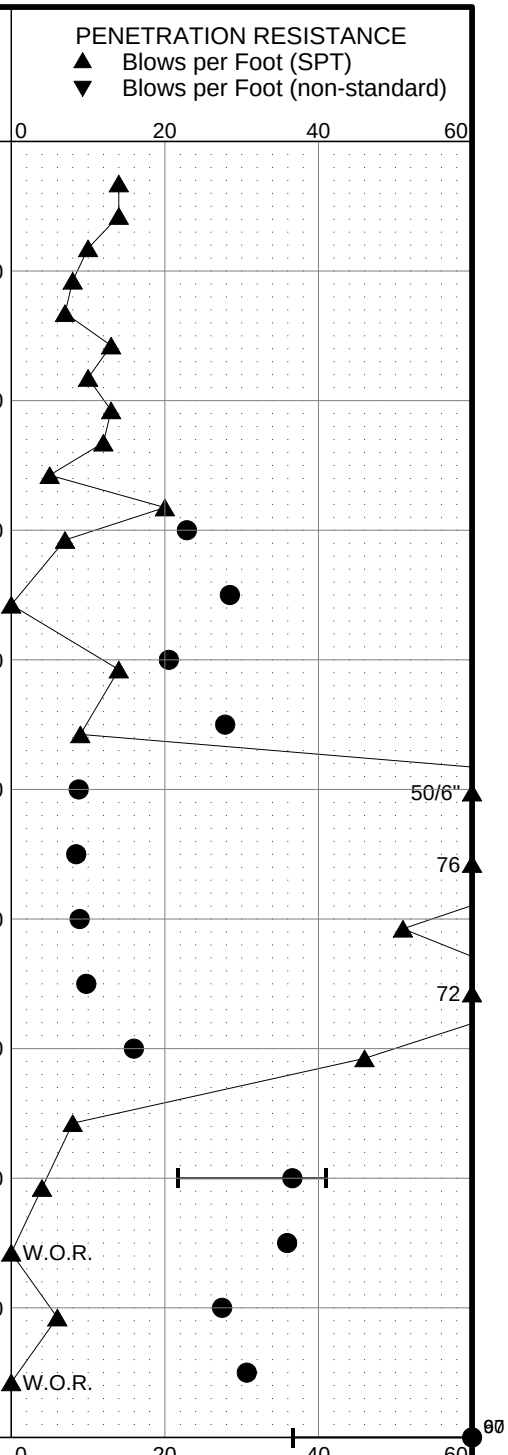
Surface Elevation: Approx. 16.0 Ft. NAVD88

Description	Depth, Ft.
ASPHALT.	0.3
Base course GRAVEL.	1.3
Medium dense, light brown to brown, fine SAND, trace of silt; moist; (Fill, HF) SP.	8.0
Loose to medium dense, dark gray, slightly gravelly, silty SAND; wet; scattered shells, wood, and plant fragments; heavy sheen and strong petroleum odor; (Hb) SM.	35.3
Very loose, gray, fine sandy SILT, trace of gravel and clay; moist to wet; abundant shells and wood fibers; no sheen, no odor; (He) ML.	37.5
Medium dense to loose, dark olive-gray, silty, slightly gravelly to gravelly SAND, trace of clay; moist to wet; scattered shells and wood debris, scattered clayey silt clasts, slight organic odor, no sheen; (Hb) SM.	47.5
Very dense, gray, slightly silty, gravelly SAND; wet; scattered gravel seams, organic odor; (Hb) SP-SM/GP-GM.	70.0
Dense, dark olive-gray, silty, sandy GRAVEL, trace of clay; wet; (Hb) GM.	73.0
Very soft to medium stiff, gray-brown, fine sandy, silty CLAY; moist; blocky texture; scattered shells, occasional to scattered wood debris, scattered laminated seams of fine sand, locally slightly gravelly at bottom; (He) CL/ML.	98.0

CONTINUED NEXT SHEET

Samples	PID, ppm
1	0.6
2	2.1
3	20.6
4	147.9
5	16.4
6	6.8
7	6.6
8	18
9	22.4
10	13.1
11	16.5
12	14.1
13	0.8
14	1.2
15	1.2
16	4.3
17	6
18	15.8
19	10.1
20	12.2
21 *	
22	8.1
23	2
24	1.6
25	2.3

Ground Water: During Drilling



LEGEND

* Sample Not Recovered

Standard Penetration Test

Ground Water Level ATD

NOTES

1. The boring was performed using HSA and Rotary Combined drilling methods.
2. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
3. The discussion in the text of this report is necessary for a proper understanding of the nature of the subsurface materials.
4. Groundwater level, if indicated above, is for the date specified and may vary.
5. Refer to KEY for explanation of symbols, codes and definitions.
6. USCS designation is based on visual-manual classification and selected lab testing.

Magnolia Bridge Replacement
Seattle, Washington

LOG OF BORING EB-1

October 2005 | 21-1-09759-008

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FIG. A-2
Sheet 1 of 2

MASTER LOG2 21-09759.GPJ SHAN WIL.GDT 10/4/05 Log: MET Rev: LMM Typ: EET

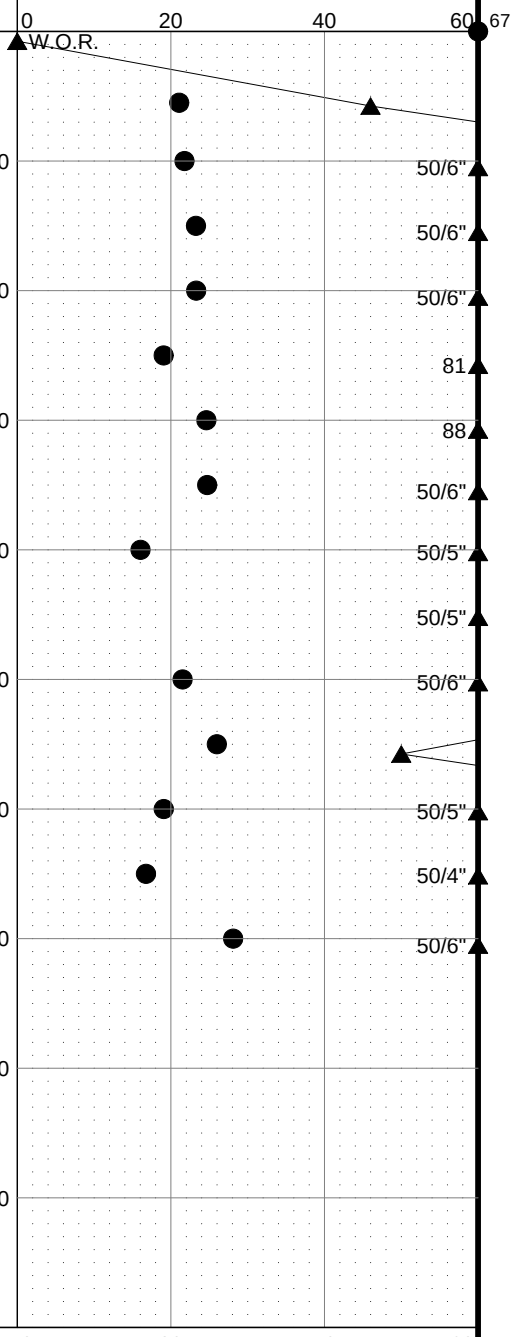
SOIL DESCRIPTION

Surface Elevation: Approx. 16.0 Ft. NAVD88

Soil Description	Depth, Ft.	PID, ppm	Samples
Very soft, olive-gray, silty CLAY; moist; massive; (He) CH.	103.0	1.6	26
Stiff, dark brown to black, slightly silty PEAT, trace of fine sand; (Hp) PT.	105.5	4.4	27
Dense, gray, silty, fine SAND; moist; scattered peat seams; (Hb) SM.	107.5	1.2	28
Very dense, dark gray, slightly silty, fine to medium SAND, trace of gravel; (Qpnf) SP-SM.		1.5	29
Very dense, dark gray, silty, fine to medium SAND; wet; massive to bedded; (Qpnf) SM.	118.0	1.7	30
		0.1	31
		0.1	32
		0.1	33
Very dense, dark gray, silty, gravelly SAND; wet; massive; (Qpnf) SM.	138.0	0.1	34
			35
			36
Very dense, dark gray, slightly clayey, silty, fine SAND; wet; bedded, abundant wood fragments; (Qpnl) SM.	154.0		37
Very dense, gray, silghtly silty to silty, fine to medium SAND, trace of gravel; wet; (Qpnf) SM/SP-SM.	157.5		38
			39
Hard, gray, clayey SILT, trace of fine sand; moist; (Qpnl) ML.	167.5		40
BOTTOM OF BORING COMPLETED 6/28/2005	171.0		

Ground Water

PENETRATION RESISTANCE
▲ Blows per Foot (SPT)
▼ Blows per Foot (non-standard)



LEGEND

* Sample Not Recovered
Standard Penetration Test
Ground Water Level ATD

● % Water Content
Plastic Limit ├─●─┤ Liquid Limit
Natural Water Content

NOTES

1. The boring was performed using HSA and Rotary Combined drilling methods.
2. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
3. The discussion in the text of this report is necessary for a proper understanding of the nature of the subsurface materials.
4. Groundwater level, if indicated above, is for the date specified and may vary.
5. Refer to KEY for explanation of symbols, codes and definitions.
6. USCS designation is based on visual-manual classification and selected lab testing.

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Seattle, Washington

LOG OF BORING EB-1

October 2005 | 21-1-09759-008

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FIG. A-2
Sheet 2 of 2

MASTER LOG2 21-09759.GPJ SHAN WIL.GDT 10/4/05 Log: MET Rev: LMM Typ: EET

ROD (%) Recovery (%)

SOIL DESCRIPTION

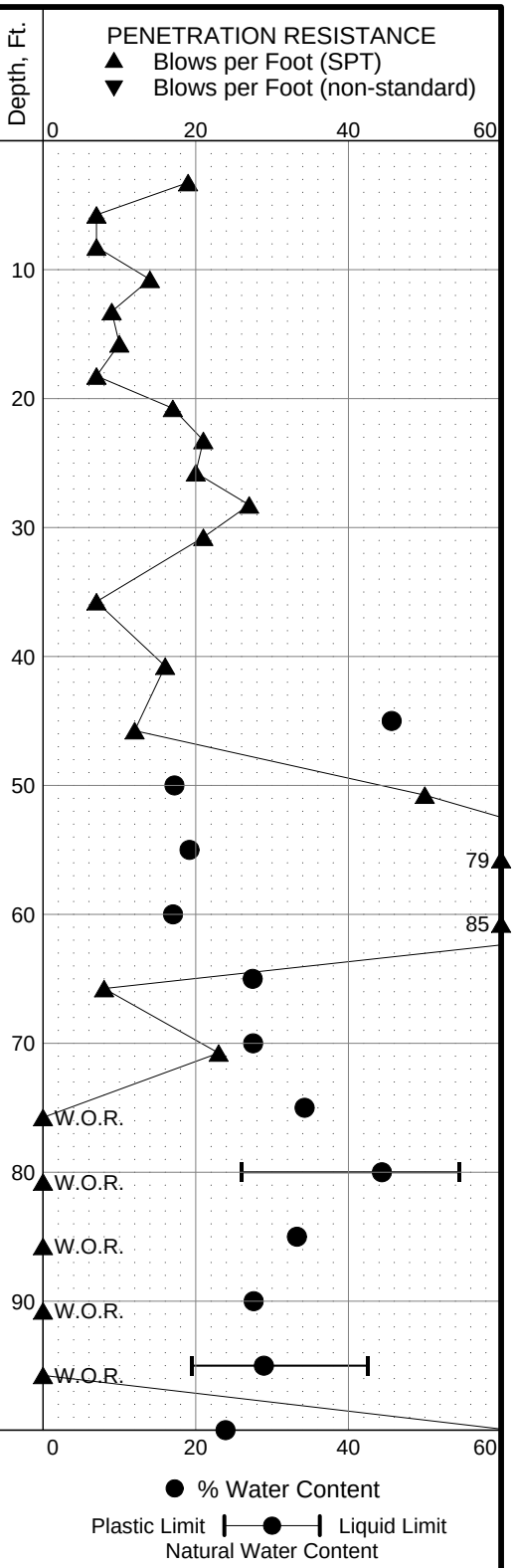
Surface Elevation: Approx. 16.0 Ft. NAVD88

Description	Depth, Ft.
ASPHALT.	0.3
Angular GRAVEL base course; GP.	1.3
Medium dense, brown, fine to medium SAND, trace of silt; moist; scattered shell fragments; (Hf) SP.	8.3
Loose to medium dense, brown and dark gray, slightly fine gravelly, silty SAND; wet; scattered shells, moderate to heavy sheen, moderate to strong odor; sheen, odor, and silt content decreasing with depth; (Hb) SM.	19.5
Medium dense, gray, slightly silty, fine to gravelly SAND; wet; scattered shells, moderate odor and sheen; (Hb) SP-SM.	22.0
Loose to medium dense, dark gray, silty SAND, trace of gravel; moist to wet; scattered to abundant shells and wood debris, slight to moderate odor and sheen, organic odor near 45.0 feet; (Hb) SM.	50.5
Very dense, brownish-gray, slightly silty to silty, gravelly SAND; wet; scattered shells and wood debris; (Hb) SP-SM.	52.5
Very dense, dark gray, trace to slightly silty, fine to medium SAND; wet; scattered wood debris, scattered shells; (Hb) SP/ SP-SM.	62.5
Loose, gray-brown, silty, fine to medium SAND, trace of clay; wet; abundant organic debris (wood), scattered shells, strong organic odor; (He) SM.	67.5
Medium dense, gray-brown, silty, fine SAND; wet; scattered wood debris, scattered shells; (He) SM.	72.5
Very soft, gray-brown, slightly fine sandy, silty CLAY; moist; scattered wood debris and shells; (He) CH.	95.0
Very soft, green-gray, silty CLAY, trace of sand and gravel; wet; abundant fractured	97.5

CONTINUED NEXT SHEET

Samples	PID, ppm
1	0.3
2	0.2
3	4.7
4	338.6
5	35
6	37.2
7	52
8	12.8
9	22.4
10	13.4
11	1.7
12	3.7
13	0.6
14	25.9
15	1.4
16	2.4
17	9.3
18	8
19	1.2
20	5.6
21	2
22	2.6
23	3.1
24	4.1
25	3

Ground Water: During Drilling



LEGEND

* Sample Not Recovered

Standard Penetration Test

Ground Water Level ATD

NOTES

1. The boring was performed using HSA and Rotary Combined drilling methods.
2. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
3. The discussion in the text of this report is necessary for a proper understanding of the nature of the subsurface materials.
4. Groundwater level, if indicated above, is for the date specified and may vary.
5. Refer to KEY for explanation of symbols, codes and definitions.
6. USCS designation is based on visual-manual classification and selected lab testing.

Magnolia Bridge Replacement
Seattle, Washington

LOG OF BORING EB-2

October 2005 | 21-1-09759-008

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-3
Sheet 1 of 2

MASTER LOG2 21-09759.GPJ SHAN WIL.GDT 10/4/05 Log: MET Rev: LMM Typ: EET

SOIL DESCRIPTION

Surface Elevation: Approx. 16.0 Ft. NAVD88

clay clasts; (Hls) CL/CH.

Very dense, slightly silty, fine to medium SAND; moist; scattered organics, scattered seams and layers of silt; (Qvro) SM/SP-SM.

108.0

Hard, gray, silty CLAY, trace of fine sand; moist; abundant sheared and slickensided seams, scattered fine organic fragments; (Qpnl/Qpgl) CH.

135.0

Hard, gray, trace to slightly sandy, silty CLAY, trace of gravel; wet; abundant pumice and angular andesite; (Qpnl) CH.

148.0

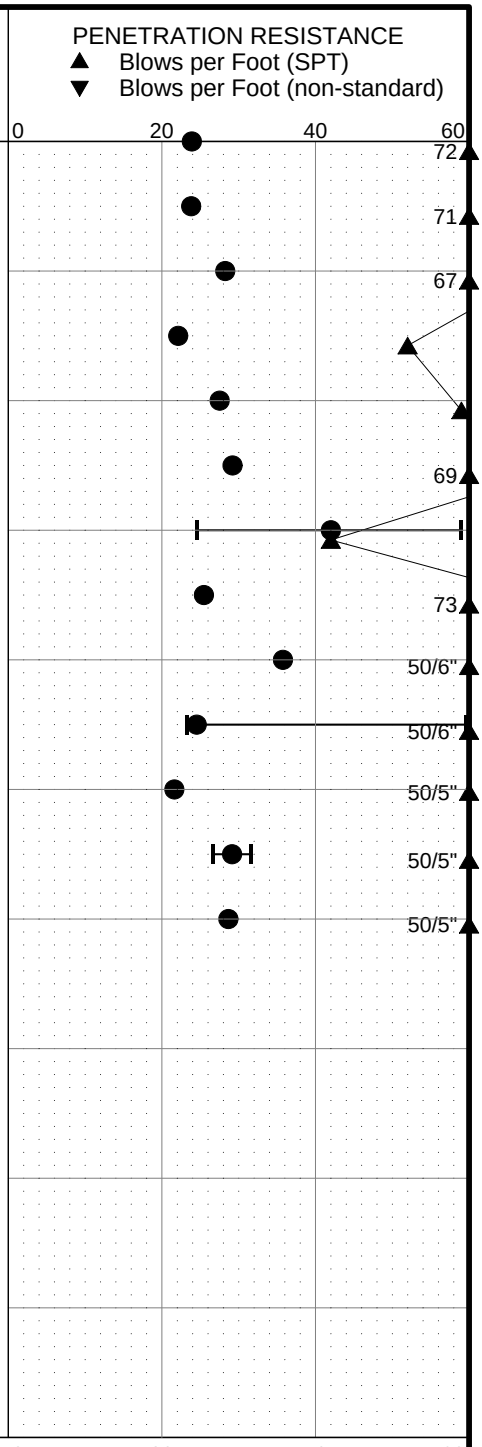
Hard, gray, slightly clayey to clayey SILT, trace of fine sand; wet; massive; scattered very fine organic fragments; (Qpnl) ML.

160.9

BOTTOM OF BORING
COMPLETED 7/1/2005

Depth, Ft.	PID, ppm	Samples
	5.4	26
	2.3	27
	0.9	28
		29
		30
		31
		32
		33
		34
		35
		36
		37
		38

Ground Water



LEGEND

* Sample Not Recovered

Standard Penetration Test

Ground Water Level ATD

● % Water Content

Plastic Limit ⊢●⊣ Liquid Limit

Natural Water Content

NOTES

1. The boring was performed using HSA and Rotary Combined drilling methods.
2. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
3. The discussion in the text of this report is necessary for a proper understanding of the nature of the subsurface materials.
4. Groundwater level, if indicated above, is for the date specified and may vary.
5. Refer to KEY for explanation of symbols, codes and definitions.
6. USCS designation is based on visual-manual classification and selected lab testing.

Magnolia Bridge Replacement
Seattle, Washington

LOG OF BORING EB-2

October 2005 21-1-09759-008

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-3
Sheet 2 of 2

MASTER LOG2 21-09759.GPJ SHAN WIL.GDT 10/4/05 Log: MET Rev: LMM Typ: EET

Appendix C
Hazardous Materials Technical Memorandum

Technical Memorandum

Hazardous Materials

Prepared by:

Shannon & Wilson, Inc.

November 2005

Seattle Department of Transportation
Agreement No. T01-34

Draft EA

Magnolia Bridge Replacement

City of Seattle

Contents

Contents i

Introduction 1

Description of Alternative 5

Methods, Studies and Coordination 13

Affected Environment 15

Validated Sites 15

Impacts 25

Rehabilitation Alternative 25

Potential Property Acquisition 25
Construction Impacts 25
Operation Impacts 25
Secondary and Cumulative Impacts 25
Recommendations for Further Investigations 26

Mitigation Measures 27

Rehabilitation Alternative 27

Summary of Findings 29

Affected Environment 29

Environmental Consequences 29

References 33

List of Tables

Table 1 Discipline Reports Reviewed by WSDOT 1
Table 2 Rehabilitation Alternative Elements 6
Table 3 Validated Sites for Rehabilitation Alternative (2 sheets) 22
Table 4 Summary Matrix for Rehabilitation Alternative – Hazardous Materials..... 30

List of Figures

Figure 1 Project Vicinity..... 2
Figure 2 Project Study Area 3
Figure 3 Rehabilitation Alternative 7
Figure 4 Bridge Cross Section at Location A (see Figure 3) 9
Figure 5 Bridge Cross Section with Ground Improvement at Location A (see Figure 3)..... 10
Figure 6 Bridge Cross Section at Location B (see Figure 3) 11
Figure 7 Validated Sites – Rehabilitation Alternative (2 sheets) 17

Introduction

During the development of the Magnolia Bridge Replacement Project, the City of Seattle proposed four alternatives to be included in a NEPA EIS. These are the No Build, and Alternatives A, C, and D. Since that time, another alternative, the Rehabilitation Alternative has been recommended for consideration. The City has already submitted the 14 discipline reports listed below in Table 1 to WSDOT for review. WSDOT has approved 11 of these reports.

These discipline reports were prepared before the Rehabilitation Alternative was added to the project and only address the No Build Alternative and Alternatives A, C and D. This document was developed to provide information on and analysis of the Rehabilitation Alternative so that it can be included in the DEIS. Figure 1 and Figure 2 show the project vicinity and study area, respectively.

Table 1 Discipline Reports Reviewed by WSDOT

Discipline	Approval Date
1. Geology and Soils	February 2005
2. Air Quality	November 2004
3. Water Quality	April 2005
4. Wildlife, Fisheries, and Vegetation	December 2004
5. Noise	Not yet approved
6. Hazardous Materials	November 2004
7. Land Use	September 2004
8. Public Lands, Section 4(f)	Not yet approved
9. Historic, Cultural, and Archaeological Resources	Not yet approved
10. Social, Economic, and Relocation	February 2005
11. Environmental Justice	February 2005
12. Visual Quality	January 2005
13. Traffic & Transportation	January 2005
14. Public Services and Utilities	August 2004

This addendum addresses changes to the hazardous materials discipline report related to the addition of an alternative for rehabilitating the Magnolia Bridge foundations by performing ground improvements (Rehabilitation Alternative). The original study was conducted to identify areas where current or past property uses may have resulted in contamination, and to assess the potential environmental impact on the project. A full discussion of impacts and mitigation was presented in the Draft EIS, Hazardous Materials Discipline Report (Shannon & Wilson, 2004), which can be referenced for original text, tables, and exhibits relating to hazardous materials.

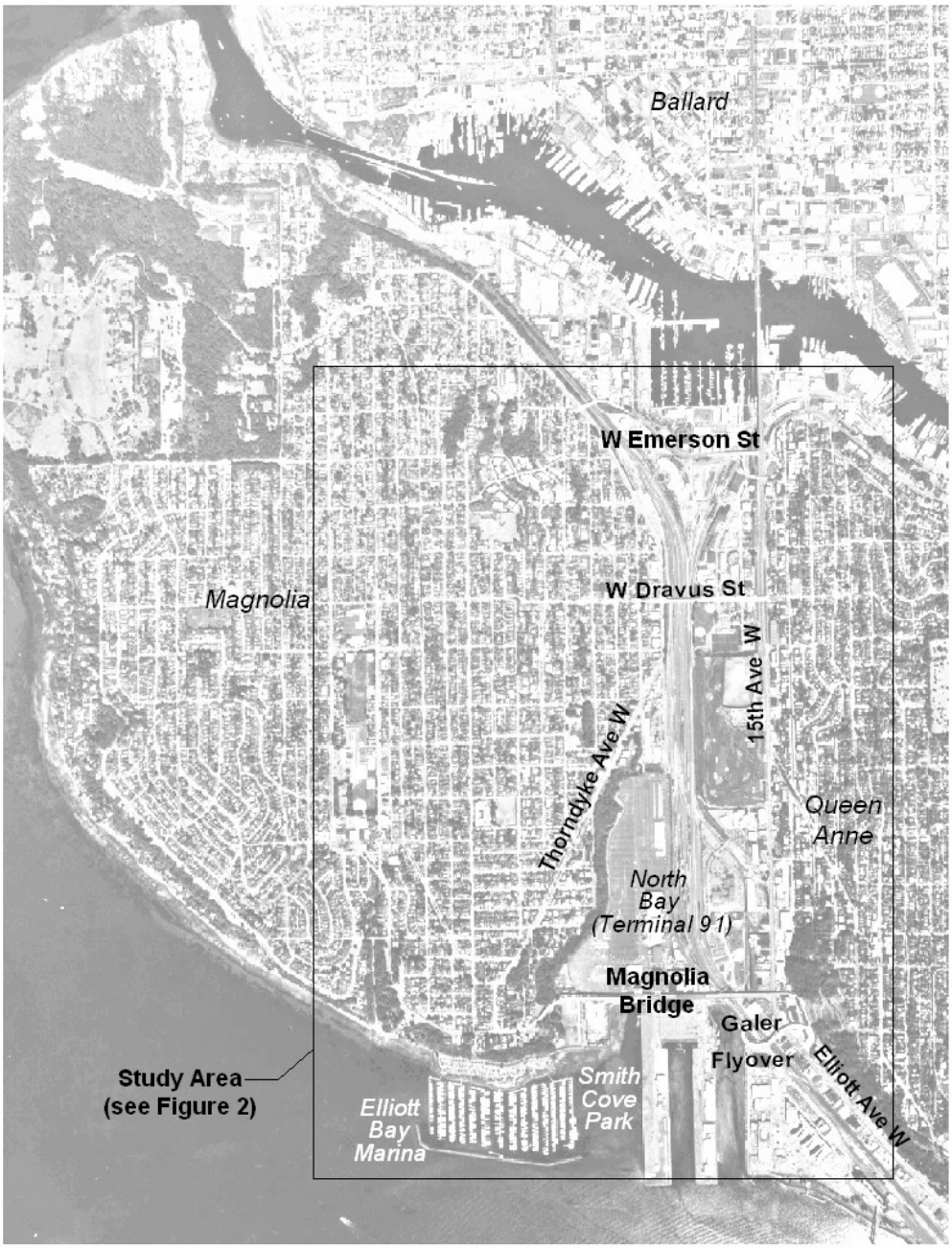


Figure 1 Project Vicinity

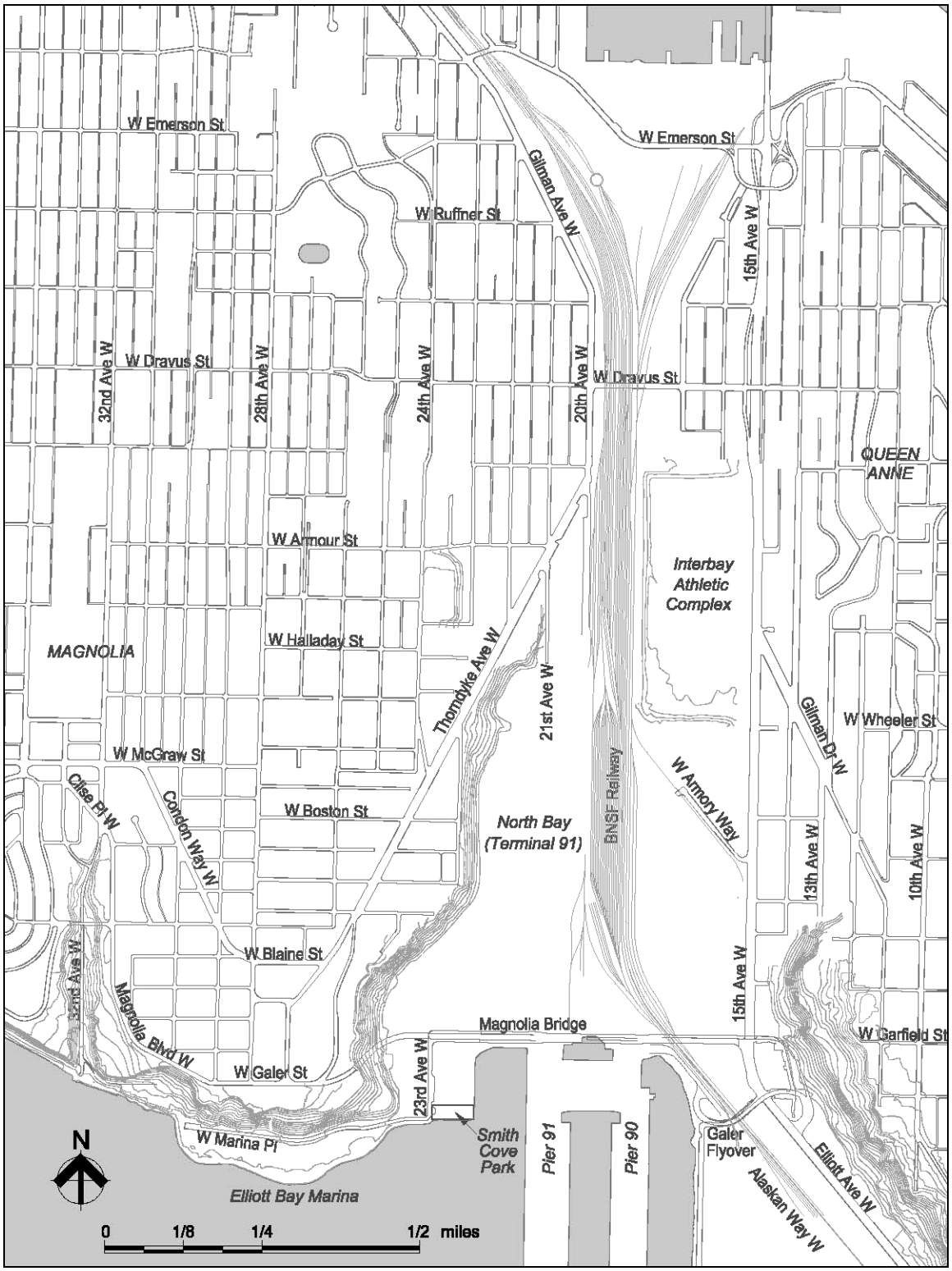


Figure 2 Project Study Area

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Description of Alternative

As part of an alignment study and NEPA Environmental Impact Statement process, the City of Seattle evaluated a number of alternatives for replacing the Magnolia Bridge. The alignment alternatives development and selection process is documented in the Alignment Study Report (revised September 2004). The process considered twenty-five alignment alternatives for the bridge replacement.

As a result of this work, four alternatives were selected to be included in the DEIS. They are: Alternatives A, C and D and the No Build Alternative. Since that time, the City has received feedback through its public process and wishes to include an additional alternative in the DEIS – the Rehabilitation Alternative.

A rehabilitation alternative was considered in 2001 and 2002 as the bridge replacement project was initially developed. It was rejected because it was deemed too costly. However, a revisiting of the initial 2001 and 2002 cost estimate for bridge replacement has shown a doubling of cost. This change has made the Rehabilitation Alternative a viable alternative for consideration in the DEIS.

The Rehabilitation Alternative would maintain the existing bridge alignment with the existing connections to 15th Avenue West at the east end and West Galer Street at the west end. Bridge rehabilitation would bring the structure up to current design standards. Table 2 and Figure 3**Error! Reference source not found.** show the elements of this alternative. Of the original structure built in 1929-1930, only the columns and foundations would remain between the BNSF Railway and Magnolia Bluff, and these would be strengthened to meet current standards. The existing ramps to and from the Elliott Bay Marina via 23rd Avenue West would be retained. The center ramps from the bridge to Terminal 91 would be removed. Terminal 91 access would remain at the East Gate with access from 15th Avenue West by the Galer Flyover structure and Alaskan Way West.

Similar to the build alternatives, the Rehabilitation Alternative would retain the same number of vehicle travel lanes as the existing bridge. Lane widths would meet WSDOT Local Agency Guideline (LAG) design standard widths of 12 feet for outside lanes and 11 feet for inside lanes. The number of vehicle travel lanes is as follows:

Westbound

- One lane from northbound 15th Avenue West on a grade-separated structure over 15th Avenue W
- One lane from southbound 15th Avenue West
- Two lanes from the BNSF Railway crossing to the west end of the bridge on Magnolia Bluff

Eastbound

- One lane from Magnolia Bluff to the 23rd Avenue West on-ramp
- Two lanes from the 23rd Avenue W on-ramp to 15th Avenue West (one lane right-only and one lane left and through at 15th Avenue West)

The Rehabilitation Alternative would have a sidewalk on the south side of the bridge structure. The LAG design standard minimum sidewalk width is five feet. A six-foot width may be possible on the Rehabilitation Alternative new bridge deck. The existing bridge stairway access to the ground would be retained near the current locations.

Table 2 Rehabilitation Alternative Elements

1.	15th Avenue W overpass	Retrofit the eastern 880 feet of this structure, which has 16 spans, for increased seismic capacity. Only the span over 15th Avenue W has been previously retrofitted.
2.	Ramp and structure west to 15th Avenue W to west side of railroad	The ramp and spans in this 873-foot long section would be removed and replaced with new structure. This would eliminate a design deficiency (inadequate stopping sight distance, where the railroad structure connects to the ramp to 15th Avenue W.)
3.	Roadway deck and supporting crossbeams, west side of railroad to Magnolia Bluff	The existing superstructure in this 2,454-foot section would be replaced with pre-stressed slab spans. The seven concrete truss spans in this section would also be replaced. All crossbeams and column tops would be replaced.
4.	Center ramp to Terminal 91	The 529-foot center ramp located west of the railroad would be replaced with new foundations, columns, and deck.
5.	Railroad to center ramp and center ramp section to 23rd Avenue W ramps	Cross bracing would be provided between columns in the north-south (lateral) and east-west (longitudinal) directions.
6.	From marina ramps to west end of bridge	Columns would be encased in steel jacket to provide seismic capacity. Existing column bracing in the east-west (longitudinal) direction would be replaced.
7.	Timber pile foundations from railroad to west end of bridge	Grade beams and drilled shafts would be connected to existing column foundations to increase seismic capacity.
8.	Connection to Anthony's Seafood Distributing	This connection would be removed and not replaced when the bridge deck is replaced (item 3).
9.	Throughout	Ground around foundations would be treated by compaction grouting and stone columns to resist liquefaction during an earthquake.

Figures 4, 5, and 6 are cross sections that illustrate the type of replacement and retrofit improvements required. Figure 5 also shows the extent of ground improvement required west of the BNSF Railway where the depth to glacially compacted soil is about 100 feet.

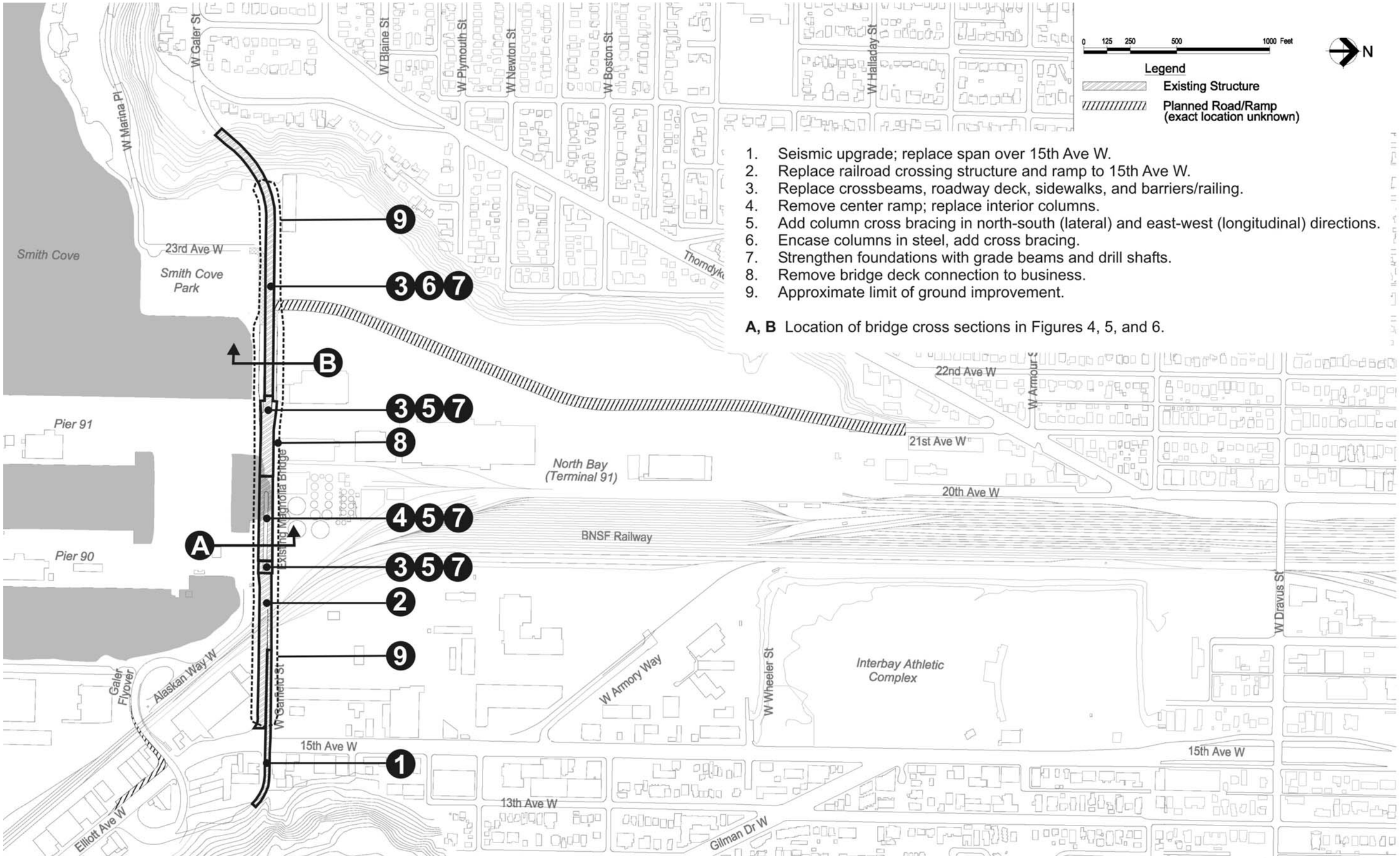

Figure 3 Rehabilitation Alternative

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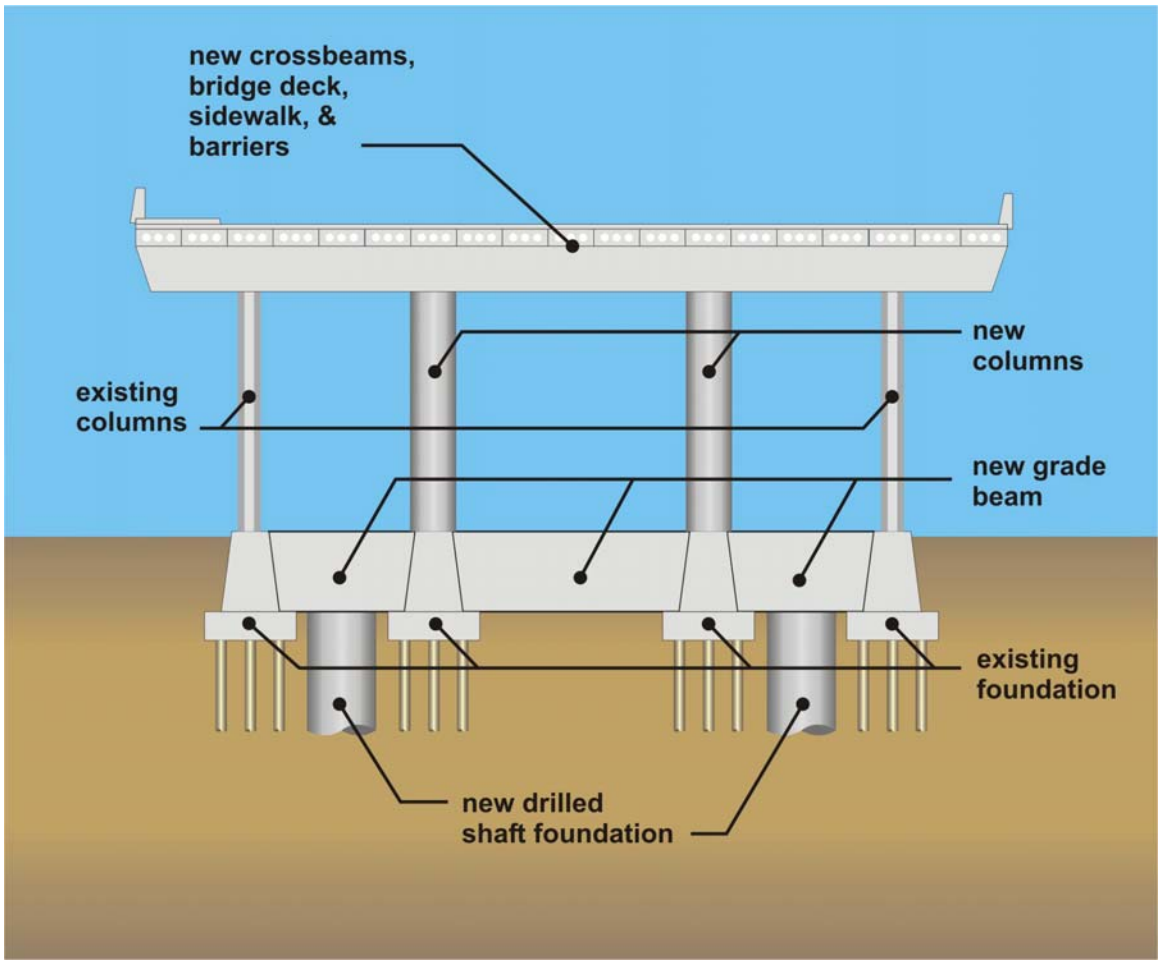

Figure 4 Bridge Cross Section at Location A (see Figure 3)

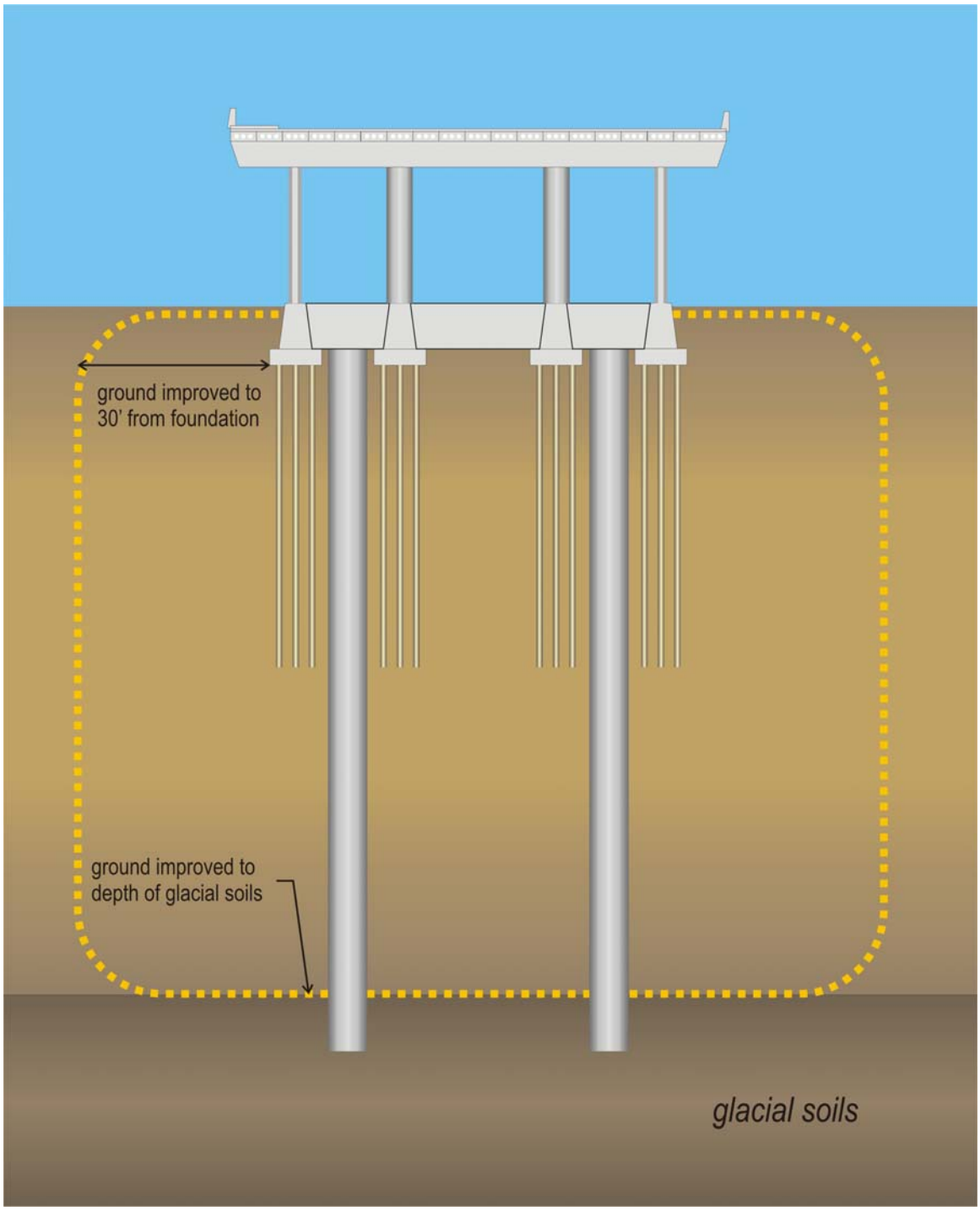

Figure 5 Bridge Cross Section with Ground Improvement at Location A (see Figure 3)

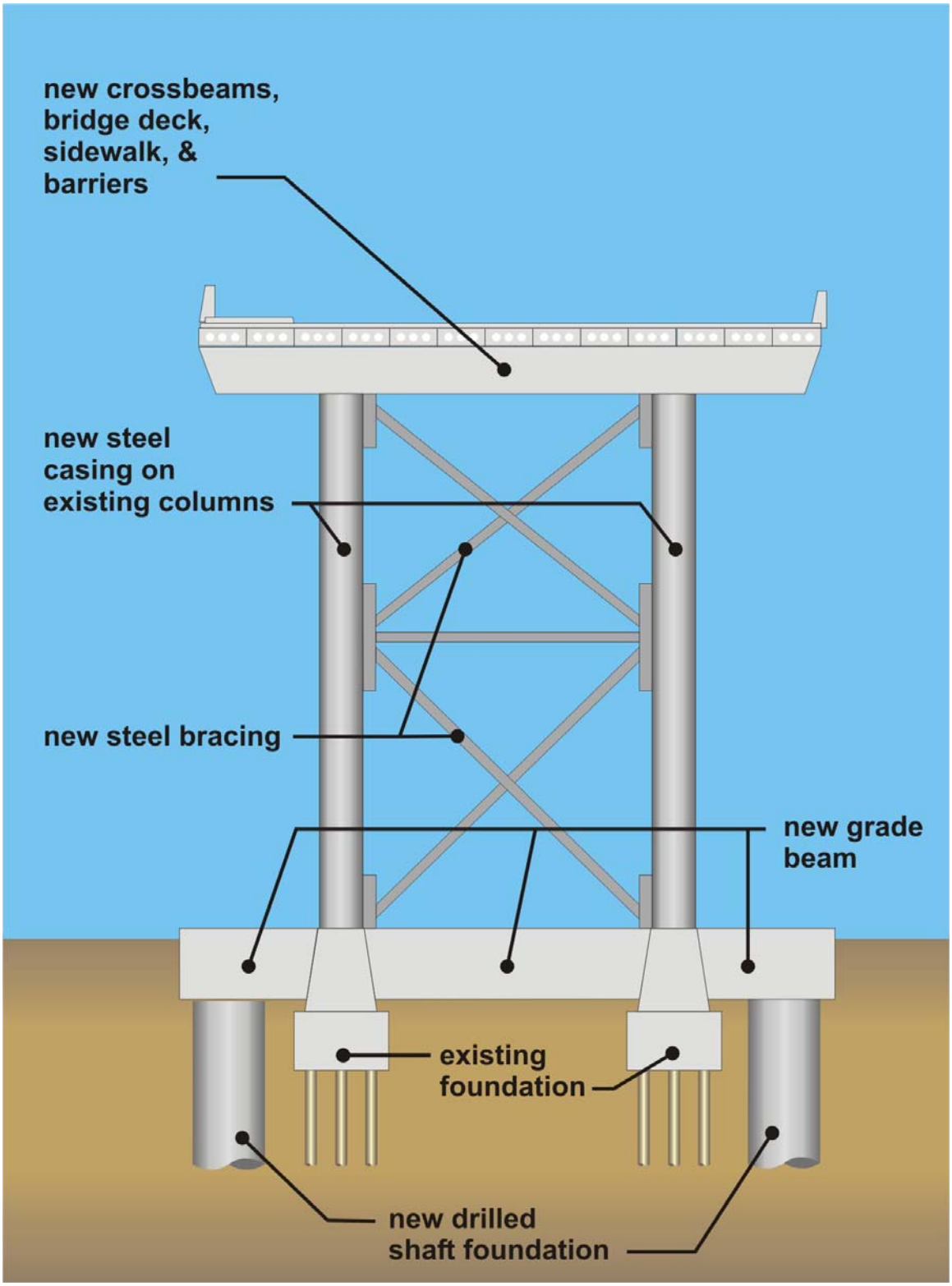

Figure 6 Bridge Cross Section at Location B (see Figure 3)

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Methods, Studies and Coordination

The methodology and resources used for identifying contaminated and potentially contaminated sites and for classifying sites as “validated” was described in the original report (Shannon & Wilson 2004). Sites are considered “validated” either because current or historic practices at the site have been associated with hazardous waste use or storage, or they have a history of contamination that has a potential to affect the proposed project.

Validated Sites

The method for assessing the risk associated with each validated property is the same as in the November 2004 Hazardous Materials Discipline Report; however, the risks posed for the Rehabilitation Alternative are somewhat different since construction will be confined to the existing right-of-way. Table 3 summarizes information about validated sites that pose some risk for the Rehabilitation Alternative. Additional information regarding each of these properties is included in the Hazardous Materials Discipline Report (Shannon & Wilson 2004).

Each validated property described in the following paragraphs is located adjacent to the alignment or would potentially be modified for the project. Because of their proximity to the alignment, these properties have a higher potential to affect the project than sites located further away. The potential risk to the project for each of these properties was characterized as low, moderate, or high depending on whether contamination was known to be present, if remediation of suspected contaminants is reasonably predictable, and/or whether earthwork is anticipated in the property vicinity. Locations of validated properties are shown in Figure 1.

Low-risk properties include sites where remediation of contamination, if present, would be reasonably predictable.

Moderate-risk properties include sites that are classified as substantially contaminated under FHWA guidelines, but SDOT is not anticipated to acquire the property and/or contamination is only suspected, and sites classified as reasonably predictable that SDOT is anticipating would be modified.

High-risk properties include sites classified as substantially contaminated under FHWA guidelines on which earthwork would occur.

Six **Residences with Oil Heat (1 through 6)** are or were located adjacent to the existing alignment. These properties are considered to be low risk to the project because heating oil is not particularly mobile when released to subsurface soil, and petroleum contamination, if present, is considered “reasonably predictable.”

The **Port of Seattle Property (9 and 9A)** occupies several parcels north of West Galer Street, to the east of Magnolia Way West and Thorndyke Avenue West, south of West Wheeler Street, and west of the Terminal 91 tank farm. This property has a history of site uses including freight staging, military supply, and ship fueling. Based on a photograph from the Seattle Museum of History and Industry, a tank farm was formerly located adjacent to the Magnolia Bridge (9A on Figure 1).

Large parking areas for semi-tractor trailers and Port of Seattle support buildings currently occupy the property. Based on the history of site uses, there is the potential for petroleum, metals, munitions, and solvent contamination to be present in the soil and/or groundwater at this site. Due to the size and variety of potential contaminants, this site would be classified as “substantially contaminated.” The site is considered a moderate risk for the Rehabilitation Alternative.

The **Port of Seattle Terminal 91 (10)** tank farm site is located adjacent to and north of the existing Magnolia Bridge. Until recently, this 4-acre site was used as a bulk fuel storage facility. The site was in use as early as 1925 and has in the past been an oil refinery, a waste oil reclamation facility, and a generator, storer, and marketer of used oil fuel and hazardous waste fuel. The site is listed on Ecology's Underground Storage Tank (UST), Leaking UST (LUST), Confirmed and Suspected Contaminated Sites List (CSCSL), and Independent Cleanup Sites (WA ICR) databases. According to files reviewed at Ecology, the soil and groundwater at this site historically has been contaminated with volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), gasoline-, diesel-, and oil-range petroleum hydrocarbons, metals (arsenic, chromium, lead, mercury, and zinc), and polychlorinated biphenyls (PCBs). During the last sampling event on record at Ecology, gasoline-, diesel-, and oil-range hydrocarbons; VOCs; arsenic; chromium; lead; and zinc were detected in the groundwater, although only gasoline-range hydrocarbons exceeded the MTCA Method A cleanup level. Additionally, light non-aqueous phase liquid (LNAPL) was present in 8 of the 29 groundwater monitoring wells on the property. The Port is under an agreed order to clean up the site. Remediation is ongoing and includes passive LNAPL product recovery. However, the results of groundwater sampling indicate that impacted soil and groundwater extend beyond the boundaries of the monitoring network. The general groundwater gradient at the property appears to be south-southwest, toward the current Magnolia Bridge. Due to the size, complexity, and variety of chemicals at this site, it would be considered "substantially contaminated." This property is a moderate to high risk to the project because of the potential for contamination from this site to have migrated into the construction zone (right-of-way).

The **Burlington Northern Santa Fe Railroad (BNSF) property (11)** runs north-south, perpendicular to the existing Magnolia Bridge and is situated between Elliott Ave, the National Guard Armory, and the Interbay Landfill on the east; and the Port of Seattle Terminal 91 property and 20th Avenue West on the west. A number of potential concerns are associated with railroads. Petroleum hydrocarbon contamination from wheel greasing is common, as is polycyclic aromatic hydrocarbons (PAHs) contamination from preservatives leaching out of railroad ties. In addition, accidental releases from tank cars may have occurred. Petroleum hydrocarbon and PAHs contamination are considered "reasonably predictable;" the property is considered a low risk to the project.

The **Port of Seattle Terminal 90 property (12)** is located adjacent to and south of the existing Magnolia Bridge. This site appears on Ecology's WA ICR, CSCSL, and VCP lists. According to Ecology files, a bunker oil pipeline spill of unknown quantity occurred at this terminal in 1999. Contaminated soil was excavated from the area around the pipeline to remove the contamination. Groundwater was not encountered, but was estimated to be at approximately 6 to 9 feet below the ground surface (bgs). It is unknown if the contaminants migrated to the groundwater. Oil was not detected in samples collected from the northern boundary of the excavation, nearest the current Magnolia Bridge.

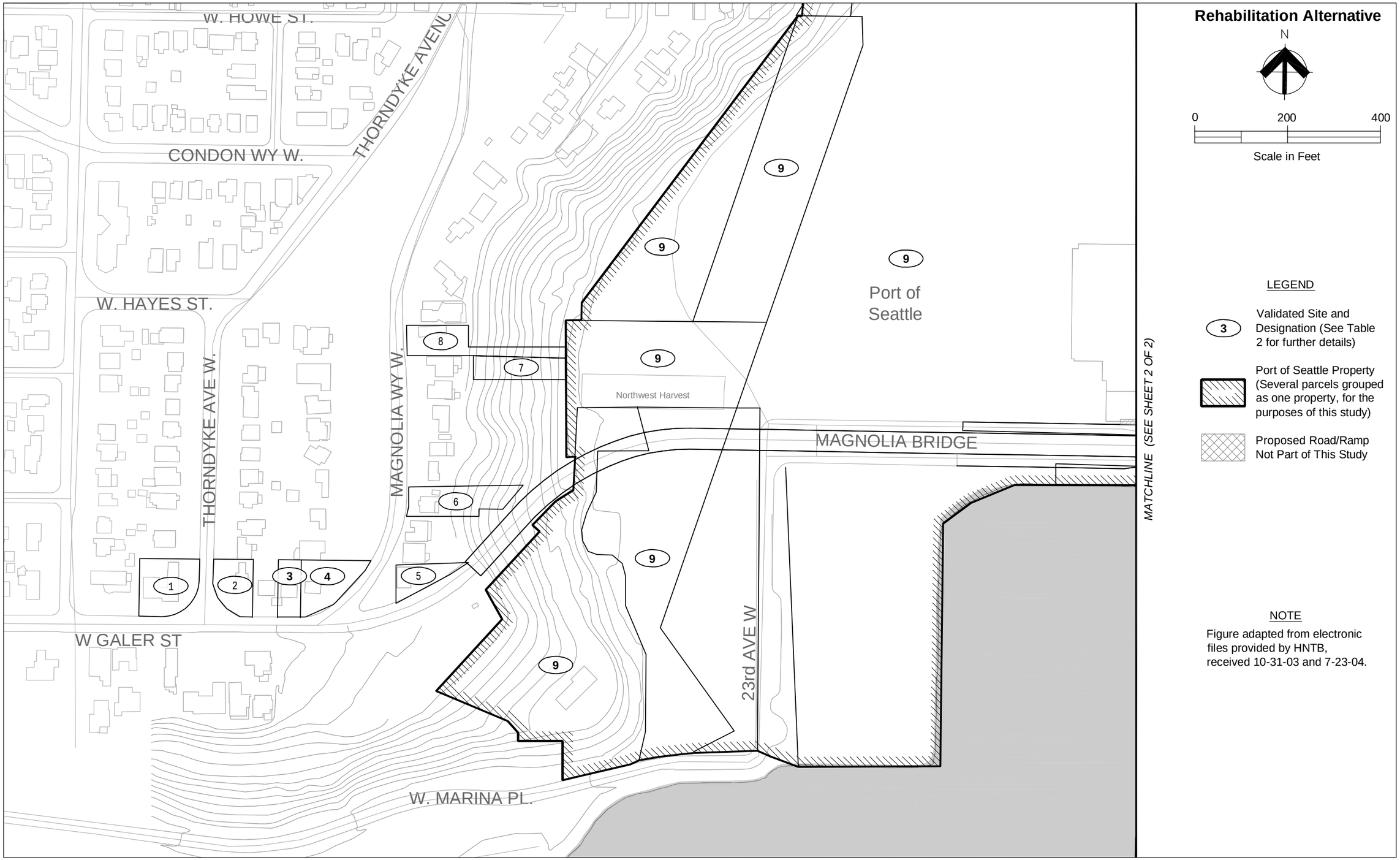

Figure 7, Sheet 1 of 2 - Validated Sites - Rehabilitation Alternative

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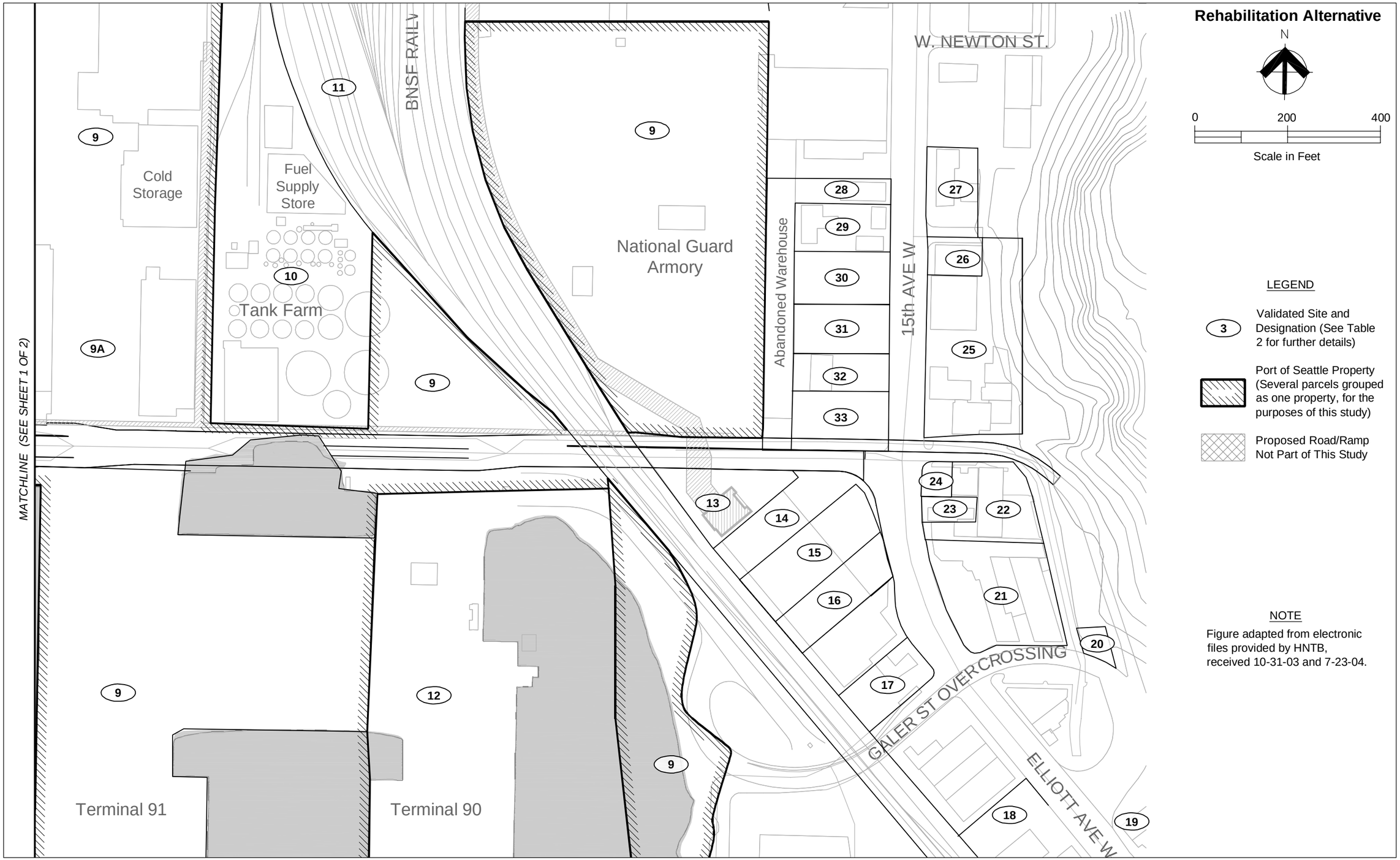

Figure 7, Sheet 2 of 2 - Validated Sites - Rehabilitation Alternative

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According to archive records, Pier 90 was also the site of a vacuum fumigation plant that was constructed in 1913. It is unknown what hazardous materials were used at this plant; however, they may have included arsenic and/or cyanide. Since this plant was in operation well before many environmental regulations were promulgated, there is the potential for unreported releases from this site to have occurred in the past that could have contaminated the site soil and/or groundwater. Because potential contamination at the site may include arsenic, cyanide, or other hazardous materials used in fumigation, this site would be considered "substantially contaminated." Although the site is immediately adjacent to the alignment, the areas of potential contamination are at least 500 feet south, so this property is considered a moderate risk to the project.

The **Metro Interbay Pump Station (13)** is located at 1523 West Garfield, adjacent to and south of the current Magnolia Bridge. The site is listed on Ecology's UST and LUST databases. According to Ecology files, two 750-gallon USTs, one motor oil UST, and one waste oil UST were removed from the property in 1990. Approximately 15 tons of PCS were removed in 1990, and 750 cubic yards of PCS were removed from the site in 1992 and disposed at a landfill. Samples from the excavation had concentrations of diesel-range petroleum hydrocarbons below the current MTCA Method A cleanup level of 2,000 parts per million (ppm). Groundwater was not encountered during site activities. The site is "reported cleaned up" by Ecology because all PCS was reportedly removed from the site; however, the site has not been given a "No Further Action" status and site soil and/or groundwater may still be contaminated with petroleum hydrocarbons. Additionally, an exempt 111 – 1,000-gallon bunker C fuel UST is still present at the site. Since petroleum hydrocarbon contamination is considered "reasonably predictable," this site is considered a low risk to the project.

The Vacant Commercial Land property (14) is located at the intersection of Elliott Avenue West and West Garfield Street. This property is adjacent to and south of the project alignment and was formerly occupied by Richfield Oil Corporation. Based on a historical photograph from the historical tax assessor records, many 55-gallon drums were present on this property. Because bulk amounts of petroleum may have been stored on this property, this property is considered "substantially contaminated." Based on its location adjacent to the alignment, it is considered a moderate risk to the project.

The **Sammis Company Property (Elliott Industrial Park) (15)** is located at 1519, 1523, 1535 and 1541 to 1545 15th Avenue West, adjacent to, and south of the current Magnolia Bridge. The site appears on the WA ICR, VCP, and CSCSL databases and is currently undergoing independent remedial action. According to Ecology files, this property was occupied by the Richfield Oil Corporation, a bulk petroleum tank farm containing ASTs from 1927 to 1965. Other site uses have included a gasoline station and an automobile wrecking yard. Petroleum contamination was detected in soil to a depth of 5 feet bgs, and in groundwater at levels above MTCA cleanup standards. Other contaminants found in soil above MTCA cleanup standards included methylene chloride (possibly a lab contaminant) and PAHs. There have been up to 15 groundwater monitoring wells onsite, but 11 were closed in agreement with Ecology. During the four most recent groundwater monitoring events, elevated concentrations of gasoline, diesel, oil and benzene above MTCA Method A cleanup standards were detected in samples from a well located in an existing building in the middle-northern portion of the site. VOCs

above cleanup levels were also detected in this sample. Groundwater is located at approximately 9 to 10.5 feet bgs, and the gradient is generally toward the west-northwest. This property also has suspect surface water contamination (halogenated VOCs, total petroleum hydrocarbons [TPH], and non halogenated solvents). Based on the elevated levels of contaminants in the groundwater and soil, and the former use of the property as a bulk fuel storage facility, it is considered "substantially contaminated" and a moderate risk to the project.

Smith Cove Cleaners (20) occupied the property at 1422 West Galer, adjacent to the east end of the alignment, until approximately 1944. After that, a steel products manufacturer occupied the property until approximately 1961, followed by a number of small businesses. Due to the potential for dry cleaning solvents to have been used and/or stored at this property, it is considered "substantially contaminated." Because it is a relatively small site, it is considered a moderate risk to the project.

The **Winkler NW, Inc. property (22)** is located adjacent to, and south of, the current bridge at 1401 to 1409 West Garfield Avenue and 1524 15th Avenue West. Former site occupants included a Shell service station, a separate auto service garage, and Fentron Steel and Iron Works, Inc. The site is currently occupied by Builder's Hardware. Based on the historical site uses, the potential exists for this site to be contaminated with petroleum, metals, and solvents. Metals and solvents are not considered "reasonably predictable," so this site would be considered "substantially contaminated." Due to the size of this site, and because it is adjacent to the alignment, it is considered a moderate risk to the project.

The **Lighthouse Uniforms property (23)** is located at 1532 15th Avenue West, approximately 100 feet south of the current bridge. This building was constructed in 1956 and was initially occupied by a dry cleaners. The site is currently a retail uniform store, and it is unknown when the dry cleaners ceased operation. Additionally, this site appears on Ecology's UST list. According to the EDR report, three unleaded gasoline USTs have been removed from this site. Due to the potential for dry cleaning solvents to have been used and/or stored at this property, it is considered "substantially contaminated." Because it is a relatively small site, it is considered a moderate risk to the project.

The **property located at 1534 15th Avenue West (24)** was occupied by a gasoline service station from approximately 1938 to 1951. The property is adjacent to the current Magnolia Bridge. No evidence of the former gasoline station is now present. The property is considered low risk because petroleum contamination, if present, is considered "reasonably predictable."

The **SPCC (formerly Rudd Paint and Varnish Co.) site (25)** is adjacent to, and north of, the alignment. This site, consisting of an entire city block located at 1602 to 1630 15th Avenue West, appears on Ecology's CSCSL, LUST, WA ICR and VCP databases. According to Ecology files, seven USTs were removed from this property in 1991, and another twelve USTs were removed in 1999. These USTs formerly were used to store raw materials for manufacturing paints, including a lacquer thinner blend, toluene, mineral spirits, acetone, ethyl alcohol, ethylbenzene, butyl alcohol, methyl alcohol, methyl isobutyl ketone, naphtha, tolusol 20, trichloroethane, and n-butyl acetate. Confirmation soil and groundwater samples collected following the 1991 removals indicated that the soil and groundwater were contaminated with a number of chemicals, including ethylbenzene, xylenes, and 1,1,1-trichloroethane, at levels that exceeded the MTCA Method A criteria at the

time. Contaminated soil was over-excavated, and 500 pounds of oxygen release compound (ORC) was injected into monitoring wells at the site to remediate the groundwater. During the most recent monitoring event conducted in March 2002, trichloroethylene and toluene were detected in the site groundwater at levels that exceeded the MTCA Method A cleanup levels, but were below the site-specific Method C cleanup levels of 39.8 ug/l and 3,500 ug/l, respectively. The depth to groundwater measured at the property is approximately 6 to 13 feet bgs, and the general groundwater gradient appears to be to the west/northwest. Because this site is contaminated with VOCs, including the solvent trichloroethylene, it is considered "substantially contaminated," and because of its proximity to the alignment, it poses a moderate risk to the project.

The **Tsubota Steel and Pipe site (28)** occupies an entire block. This property extends from West Garfield Street to approximately West Howe Street, and is located between 15th Avenue West and the Port of Seattle properties. Tsubota Steel and Pipe Co. have owned the properties on this block since approximately 1956. However, the northernmost parcels in this block changed ownership in 2001. Some of the parcels located within the Tsubota property are also listed as separate properties; these properties are listed as numbers 29 through 33 (Figure 1). The northern and western portions of this site are currently occupied by a number of vacant buildings. This property is listed on Ecology's UST, LUST, and WA ICR databases. According to Ecology files, two gasoline USTs were removed from the north end of the property at 1837 15th Avenue, and two more were removed from the southern end of the property at 1601 15th Avenue in 1990. The results of confirmation sampling at these locations indicated that the soil and groundwater were contaminated with petroleum products. The most recent sampling event for which results were available at Ecology occurred in February 1998. The results of this sampling indicate that the groundwater on the northern end of the site was contaminated with benzene at a maximum concentration of 1,280 micrograms per liter (ug/L). This concentration exceeds Ecology's MTCA Method A cleanup criteria of 5 ug/L. The groundwater gradient at the site is reportedly to the west, and depth to groundwater is approximately 0.5 to 1.5 feet bgs.

Since petroleum contamination is considered "reasonably predictable" by WSDOT and the contaminated portion of this site is located approximately 800 feet north of the proposed alignment, this property is considered a low risk to the project.

The **Fred Arnold Truck Sales property located at 1601 15th Avenue West (33)** has been occupied by a used car lot since about 1980. The property is adjacent to the current Magnolia Bridge. Because auto repairs may be conducted at the site, the potential exists for petroleum, solvent, and metal contamination to be present. However, the property is considered low risk because petroleum contamination, if present, is considered "reasonably predictable." It should be noted that this property is also part of the **Tsubota Steel and Pipe (28)** site discussed previously.

Table 3 Validated Sites for Rehabilitation Alternative (Page 1 of 2)

Site No.	Site Name	EDR#	Site Address	Approximate Distance From Project Area	Regulatory List/Concern	Contamination Known or Potential	Reasonably Predictable / Substantially Contaminated
1	Single Family Residence	N/A	2700 W. Galer St.	Adjacent north+F28	Residential heating oil UST	Potential	Reasonably Predictable
2	Single Family Residence	N/A	1502 Thorndyke Ave	Adjacent north	Residential heating oil UST	Potential	Reasonably Predictable
3	Single Family Residence	N/A	2608 W. Galer St.	Adjacent north	Residential heating oil UST	Potential	Reasonably Predictable
4	Single Family Residence	N/A	2600 W. Galer St.	Adjacent north	Residential heating oil UST	Potential	Reasonably Predictable
5	Single Family Residence	N/A	1500 Magnolia Way	Adjacent north	Residential heating oil UST	Potential	Reasonably Predictable
6	Single Family Residence	N/A	1524 Magnolia Way W	Adjacent north	Oil Burner	Potential	Reasonably Predictable
7	Vacant, Residential	N/A	None	200 feet north	Oil Burner	Potential	Reasonably Predictable
8	Single Family Residence	N/A	1556 Magnolia Way W	300 feet north	Oil Burner	Potential	Reasonably Predictable
9	Port of Seattle	N/A	2001 W. Garfield	Adjacent north and south	History of industrial uses	Potential	Substantially Contaminated
9A	Port of Seattle	N/A	2001 W. Garfield	Adjacent north	Former tank farm	Potential	Substantially Contaminated
10	Port of Seattle, Terminal 91	20		Adjacent north	Tank farm and former waste oil reclamation facility, CSCSL, UST, LUST, WA ICR	Known	Substantially Contaminated
11	Burlington Northern Santa Fe Railroad	N/A	2201 W. Armory Way	On alignment	Railroad	Potential	Reasonably Predictable
12	Port of Seattle, Terminal 90	20		Adjacent south	Former fumigation plant, WA ICR, CSCSL, VCP	Known	Substantially Contaminated
13	Metro Interbay Pump Station	20	1523 W. Garfield	Adjacent south	UST, LUST	Potential	Reasonably Predictable
14	Vacant Commercial Land	N/A	Elliott Ave. W. and W. Garfield St.	Adjacent south	Richfield Oil Corp warehouse, many 55-gallon drums in old tax assessor photograph	Potential	Substantially Contaminated
15	Sammis Company	20	1519 - 1545 15th Ave	Adjacent south	CSCSL, UST	Known	Substantially Contaminated
16	Duplex Property	N/A	1517 15th Ave	300 feet south	Former service station, auto-wrecker, and used car sales lot	Potential	Reasonably Predictable
17	Precision Motorworks	N/A	1501 Elliott Ave & 1555 Galer	400 feet south	Former oil and gas wholesalers and gas station	Potential	Reasonably Predictable
18	The Pennzoil Co.	N/A	1451 Elliott Ave	450 feet south	Former oil wholesaler	Potential	Reasonably Predictable
19	SDOT Garage	N/A	1450 Elliott Ave	300 feet south	Auto garage/service center	Potential	Reasonably Predictable
20	Former Smith Cove Cleaners	N/A	1422 W. Galer	Adjacent south	Former dry cleaners	Potential	Reasonably Predictable
21	Properties located at 1504 and 1506 15th Avenue W.	N/A	1504 - 1506 15th Ave	300 feet south	Former service station and machine shop	Potential	Reasonably Predictable

Table 3 Validated Sites for Rehabilitation Alternative (Page 2 of 2)

Site No.	Site Name	EDR#	Site Address	Approximate Distance From Project Area	Regulatory List/Concern	Contamination Known or Potential	Reasonably Predictable / Substantially Contaminated
22	Builders Hardware Supply	N/A	1401-1409 W. Garfield & 1524 15th Ave	Adjacent south	Former service station and industrial property	Potential	Substantially Contaminated
23	Lighthouse Uniforms	20	1532 15th Ave	100 feet south	UST, Former dry cleaners	Potential	Substantially Contaminated
24	Property located at 1534 15th Avenue W.	N/A	1534 15th Ave	Adjacent south	Former service station	Potential	Reasonably Predictable
25	SPCC (formerly Rudd paint)	20	1602 - 1630 15th Ave	Adjacent north	CSCSL, UST, LUST, WA ICR	Known	Substantially Contaminated
26	EZ Mini Storage	20	1634 15th Ave	500 feet north	UST, Former "insect powder" manufacturer	Potential	Substantially Contaminated
27	Car Wash Enterprises/ Circle K Store 5516	N/A	1800 15th Ave	800 feet north	Former service station	Known	Reasonably Predictable
28	Tsubota Steel and Pipe	20	1805 - 1827 15th Ave	Adjacent to 800 feet north	UST, LUST, WA ICR	Known	Reasonably Predictable
29	Joseph Smith Estate	20	1641 - 1801 15th Ave	250 feet north	1938 - 1941: Smith Cove Fuel Co. and gas station. 1941 to ??: Expert Radiator Service; Referred to as Joe Smith's property in Ecology database	Known	Substantially Contaminated
30	Triad Interbay LLC	20	1631 15th Ave	150 feet north	Former Smith Cove Auto Wrecking Yard and Olympic Iron and Steel	Potential	Reasonably Predictable
31	Commercial Storage Yard	N/A	1621 15th Ave. W.	200 feet north	Former used car lot	Potential	Reasonably Predictable
32	Evergreen Trailways Garage	25	1617 15th Ave	50 feet north	UST, Truck and bus maintenance garage	Potential	Reasonably Predictable
33	Fred Arnold Truck Sales	N/A	1601 15th Ave	Adjacent north	Former used car lot	Known	Reasonably Predictable
34	National Guard Armory	N/A	1600 Armory Way	900 feet north	Probably munitions and fuel storage	Potential	Substantially Contaminated
35	Interbay Old Landill	13	2501 15th Ave. W.	2,500 feet north	CSCSL - Interbay Landfill, former service station	Known	Substantially Contaminated

Rehabilitation Alternative

Potential Property Acquisition

No property acquisition is anticipated for the Rehabilitation Alternative.

Construction Impacts

Construction impacts discussed in the Hazardous Materials Discipline Report (Shannon & Wilson 2004) for Alternative A would apply for the Rehabilitation Alternative. However, there would be less potential for worker exposure to subsurface contamination, if present, since there would be fewer excavations and potentially no drill cuttings if driven piles are used for bridge support. Excavation for pile/shaft caps would still be required in the eastern area of the project, with the potential for encountering contaminated soil and/or groundwater. If contaminated soil and/or groundwater is encountered during construction, it would be necessary to assess the regulatory classification of the soil/groundwater and the most cost-effective remediation strategy and disposal options.

Operation Impacts

Operation impacts discussed in the Hazardous Materials Discipline Report (Shannon & Wilson 2004) for Alternative A would apply for the Rehabilitation Alternative.

Secondary and Cumulative Impacts

Secondary and cumulative impacts discussed in the Hazardous Materials Discipline Report (Shannon & Wilson 2004) for Alternative A would apply for the Rehabilitation Alternative.

As discussed in the Groundwater Technical Memorandum, the Rehabilitation Alternative, once constructed, has the potential to impact the groundwater regime. The most likely consequences included mounding of groundwater on upgradient side(s) of the rehabilitation area, and shifts in groundwater flow directions. If contaminants are present in soils that are currently above the high groundwater elevation (vadose zone), but that subsequently become saturated, contaminants could become mobilized that otherwise would have remained relatively stationary. Rises in groundwater elevations could also impact soils by increasing the smear zone containing contamination. Furthermore, shifts in groundwater flow gradients could spread contamination into areas not currently downgradient of contaminated site(s). This could adversely impact properties and create potential liabilities for cleanup that would not exist without the project.

Changes in groundwater elevations and shifts in flow gradients might impact the installed groundwater treatment system at the **Port of Seattle's Terminal 91 tank farm (10)**. Remediation is ongoing at the site and includes passive LNAPL product recovery. Based on the location of the Port's property, groundwater elevations could be increased at their site by the project. Depending on the construction and placement of the product recovery system, increases in groundwater elevations and shifts in flow directions might interfere with product recovery.

Another site where subsurface contamination is known to exist might be impacted by changes in the groundwater regime resulting from construction of the Rehabilitation Alternative. The **Tsubota Steel and Pipe site (28)** is located north of the eastern portion of the existing bridge. The results of sampling during UST removals at several locations at this site indicated that soil and groundwater were contaminated with petroleum products. The existing groundwater gradient at the site is reportedly toward the west, and depth to groundwater is approximately 0.5 to 1.5 feet bgs. Based on the shallow depth to groundwater, mounding, should it occur, might cause groundwater to pond at the ground surface. Refer to the Groundwater Technical Memorandum for further discussion of this issue.

Recommendations for Further Investigations

Preliminary Site Investigations (PSIs) are recommended for the right-of-ways at the **Tsubota Steel and Pipe property (28)**, the **Fred Arnold Truck Sales property (33)**, the **Port of Seattle properties (9, 9A, and 10)**, the **Metro Interbay Pump Station property (13)**, the **Sammis Company property (15)**, the **former service station at 1534 15th Avenue West (24)**, the **SPCC property (25)**, the **former Smith Cove Cleaners property (20),** and the **Builders Hardware Supply (22)** property where grout injection and/or bridge foundation construction is proposed. These properties have been identified as known or potentially contaminated sites that are immediately adjacent to the construction limits and may have impacted the right-of-way. The PSIs would include soil and/or groundwater sampling in the ground improvement areas at regular intervals to the maximum depth of the proposed grouting.

Samples taken from the right-of-way adjacent to the Tsubota property would be analyzed for petroleum and VOCs. Samples taken adjacent to the Fred Arnold Truck Sales property would be analyzed for petroleum, solvents, and metals.

Based on existing data for the Port of Seattle Terminal 91 tank farm site (10) and historical uses, samples taken on the adjacent right-of-way for sites 9, 9A, and 10 should be analyzed for VOCs; SVOCs; gasoline-, diesel-, and oil-range petroleum hydrocarbons; total metals (arsenic, chromium, lead, mercury, and zinc); and PCBs.

Samples from the right-of-way adjacent to the Metro Interbay Pump Station would be analyzed for petroleum hydrocarbons. At the Sammis Company property, samples would be analyzed for petroleum hydrocarbons, metals, VOCs, solvents, and PAHs. At the former service station property (1534 15th Avenue West) samples would be analyzed for petroleum hydrocarbons and lead. At the SPCC property, samples would be analyzed for VOCs. At the former Smith Cove Cleaners property, samples would be analyzed for VOCs. At the Builders Hardware Supply (former service station) property, samples would be analyzed for petroleum, solvents, and metals.

Rehabilitation Alternative

The Rehabilitation Alternative does not require the acquisition of new easements, property, or structures. The anticipated work in the ground improvement area does not require soil excavation, generation of soil cuttings from drilling, or groundwater extraction. However, it is anticipated that soil will be excavated, and dewatering may be required, in the eastern project area where the bridge structure will be replaced.

To minimize the potential for encountering contamination during construction, we recommend that PSIs be performed in areas where ground improvements and construction are anticipated. It may be possible to modify the construction areas to avoid "hot spots." If such areas cannot be avoided, knowing in advance that contamination may be encountered will make it possible to institute appropriate worker protections and equipment decontamination procedures.

To reduce the impact of potential groundwater mounding upgradient of the rehabilitation area, it may be possible to design the grouting program to take place only in the general areas of the bents. The objective would be to reduce the cross-sectional area of decreased soil hydraulic conductivity, thereby reducing the magnitude of mounding.

Water level and water quality monitoring at existing and new observation wells before, during, and after construction may be needed to evaluate changes in groundwater levels, flowpaths and contaminant transport. Water levels can be used to evaluate changes in groundwater flow directions.

Based on the findings of the groundwater monitoring, contaminant recovery trenches and/or treatment systems may be needed to collect newly mobilized contamination. Trenches and treatment systems may be necessary both upgradient and downgradient of the proposed rehabilitation area. Modification of the Port of Seattle's Terminal 91 tank farm product recovery system may be needed.

Summary of Findings

Affected Environment

The purposes of this technical memorandum are to identify areas along the proposed Magnolia Bridge Rehabilitation Alternative where current or past property uses may have resulted in contamination, and to assess the potential environmental impact of those conditions on the project.

Historic records for the project area along with agency environmental databases were reviewed to identify former and current land uses that could result in contamination of soil and/or groundwater along the alignment. Based on the review findings, 413 potentially contaminated properties were identified in the project area. Many of the properties were subsequently eliminated as potential concerns because they: (a) had been cleaned up and/or contamination is unlikely to migrate toward the project area, (b) were not listed on databases that indicate contamination is present, and/or (c) were considered a sufficient distance from the project area so as not to pose a risk.

Environmental Consequences

After the initial screening, 35 validated sites were still considered to pose some risk to the project and were retained for further evaluation. These sites include metal manufacturers, junk and wrecking yards, auto repair shops, gasoline stations/bulk fuel distributors, dry cleaners, print shops, bulk fuel terminals, railroads, and other industrial sites. They also included properties adjacent to the project alignment that store or have stored heating oil. Each of the sites retained for further analysis was ranked as a low, moderate, or high risk to the project based on its proximity to the project alignment and the type of contaminants that may be present. Most of the sites are considered a low risk to the project because the potential contamination is considered “reasonably predictable” (as defined in the Washington State Department of Transportation [WSDOT] Environmental Procedures Manual), the property is not adjacent/near the alignment, and/or the property is located downgradient of the project area. Seven properties are listed as posing a moderate risk due to: (a) their proximity to the project area and because potential contamination is not considered “reasonably predictable,” and/or (b) the property is listed on a database indicating that contamination has been confirmed. One property, the Port of Seattle Terminal 91 property, is identified as a high risk because it has a history of industrial activities, and has known or suspected contaminants that are not considered reasonably predictable.

Table 4 summarizes anticipated hazardous materials impacts and measures that can be taken to minimize those impacts.

Table 4
Summary Matrix for Rehabilitation Alternative – Hazardous Materials

Impact Type	Impacts	Mitigation Measures
Construction Impacts	Contaminated soil and/or groundwater, resulting from contaminant migration from off-site properties and/or historic properties located in the vicinity of the alignment, may be encountered during construction.	Perform PSIs in potentially contaminated area where construction is proposed to determine the location and extent of contamination, if present. Minimize the amount of contamination encountered by using driven piles instead of drilled shafts for bridge foundations. Analyze contaminated soil and/or groundwater encountered to assess the regulatory classification of the soil/groundwater and the most cost-effective remediation strategy.
	Construction activities may generate hazardous wastes, which could be introduced to the environment.	Spill Prevention, Control, and Countermeasure (SPCC) plans, erosion and sedimentation control plans, and plans for handling and disposal of known and anticipated contamination would be developed that prescribe procedures, including best management practices, for use during construction.
	Workers and public could be exposed to hazardous materials.	Individuals on site would be apprised of the possibility of encountering known or predicted contaminants and the locations of potentially contaminated areas. A site-specific Health & Safety Plan that describes monitoring requirements, and the use of personal protective equipment, would be necessary. Workers would be trained in recognizing potential contamination and reporting procedures. Contractors who are likely to encounter known or unknown contamination would be required to demonstrate their ability to identify these situations and respond quickly to avoid contaminant migration to public areas.
Operation Impacts	Vehicle accidents could result in spills of hazardous materials.	Stormwater and water quality treatment facilities would be constructed to collect and retain pollutants from traffic operations. These facilities would decrease the potential for off-site migration of contaminants.
Secondary Impacts	Contamination may be spread to soil and groundwater as a result of construction. For example, new contamination migration pathways may be created as a result of compaction grouting, and by construction of underground utility corridors. The rehabilitation area may cause changes in groundwater elevations and shifts in flow directions.	Construction planning would include development of SPCC plans, erosion and sedimentation control plans, and plans for handling and disposal of known and anticipated contamination. The plans would prescribe procedures, including best management practices, to minimize potential secondary impacts. Performing PSIs in the right-of-way may help to identify contaminated areas, and provide an opportunity for remediation to be conducted, thereby reducing the potential for negative impacts from changes in groundwater flow regime. Design ground improvement program to minimize potential groundwater mounding, if possible.
	Contamination that otherwise would remain in place and potentially migrate may be discovered and may be cleaned up faster because of the project.	No mitigation proposed.
	Removing potential hazardous material release sources, such as USTs, before a release occurs may prevent contamination.	No mitigation proposed.

Impact Type	Impacts	Mitigation Measures
	Contaminated materials may be uncovered, allowing more direct exposure to the public.	Construction planning would include development of SPCC plans, erosion and sedimentation control plans, and plans for handling and disposal of known and anticipated contamination. Contractors who are likely to encounter contamination would be required to demonstrate their ability to identify these situations and respond quickly to avoid contaminant migration to public areas.
Cumulative Impacts	There would likely be fewer contaminated sites in the project vicinity due to cleanup activities associated with the project.	No mitigation proposed.

Source: Shannon & Wilson, Inc., 2005

References

Shannon & Wilson, Inc. November 2004. *Discipline Report Hazardous Materials, Draft EIS Magnolia Bridge Replacement, City of Seattle.*

Washington State Department of Transportation (WSDOT). 2003. *Environmental Procedures Manual.* M31-11. Web Page: http://www.wsdot.wa.gov/fasc/EngineeringPublications/Manuals/EPM/EPM.htm