Utility Board Agenda

For Meeting of November 29, 2016
7:00 PM to 9:00 PM
City Council Chambers, City Hall

Board Members:	Kwan Wong, Chairman, Tim O'Connell, Vice Chairman, Tom DeBoer, Susan Kaltenbach, Stephen Milton, William Pokorny and Brian Thomas
Council Liaison:	Council Member David Wisenteiner
Staff:	Jason Kintner, Public Works Director
	Chip Corder, Finance Director
	Francie Lake, Deputy Finance Director
	Patrick Yamashita, City Engineer
	Anne Tonella-Howe, Assistant City Engineer
	Brian McDaniel, Utilities Operations Manager
	Asea Sandine, Recording Secretary

Agenda topics

7:00 PM	King County North Mercer Interceptor Project Update	Anne Tonella-Howe
	Work Plan	All
Transmitted via Email:	Agenda	
	Work Plan	
Next Meeting:	To Be Determined	

Memorandum

CITY OF MERCER ISLAND, PUBLIC WORKS
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www.mercergov.org

To: Utility Board Members

Date: November 22, 2016

From: Anne Tonella-Howe, Assistant City Engineer

Re: King County North Mercer Interceptor Sewer Upgrade Project

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At your November 29th meeting the County's project team will be providing an update on their North Mercer Interceptor Sewer Upgrade Project. They have been working towards selection of a final alignment and will be able to answer questions on the steps they have taken and the information gathered to select the preferred alternative.

I have included a copy of their Final Alternatives Analysis Report (June 2016) to provide background information on the alternatives they have considered in their selection process. Any additional materials received from the County prior to Tuesday's meeting will be forwarded in a separate email.

King County
Department of
Natural Resources and Parks

North Mercer Island Interceptor and Enatai Interceptor Upgrade Project

Subtask 224—Alternatives Analysis Report

FINAL

TETRA TECH

June 2016

Subtask 224—Alternatives Analysis Report

June 2016

PREPARED FOR

King County
Department of Natural Resources and Parks
Wastewater Treatment Division
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ACRONYMS, ABBREVIATIONS AND TERMS

Acronym or Abbreviation	Definition
CCTV	Closed circuit TV
DNR	Department of Natural Resources (Washington State)
mgd	Million gallons per day
SEPA	State Environmental Policy Act
TDH	Total dynamic head
UFF	Uncertainty flow factor
WSDOT	Washington State Department of Transportation

EXECUTIVE SUMMARY

King County's North Mercer and Enatai Interceptors extend nearly 3 miles underground and underwater from northern Mercer Island to Bellevue. The interceptors' alignment begins at the North Mercer Pump Station on SE 22nd Street, enters Lake Washington near the south end of Luther Burbank Park, crosses the East Channel near the Interstate 90 bridge, follows the Enatai shoreline and the Mercer Slough, and ends at the Sweyolocken Pump Station. Two trunk sewers on Mercer Island (the East Trunk and the West Trunk) contribute significant flows to the interceptors; three sources in Bellevue contribute additional flow. Figure ES-1 shows the existing system.

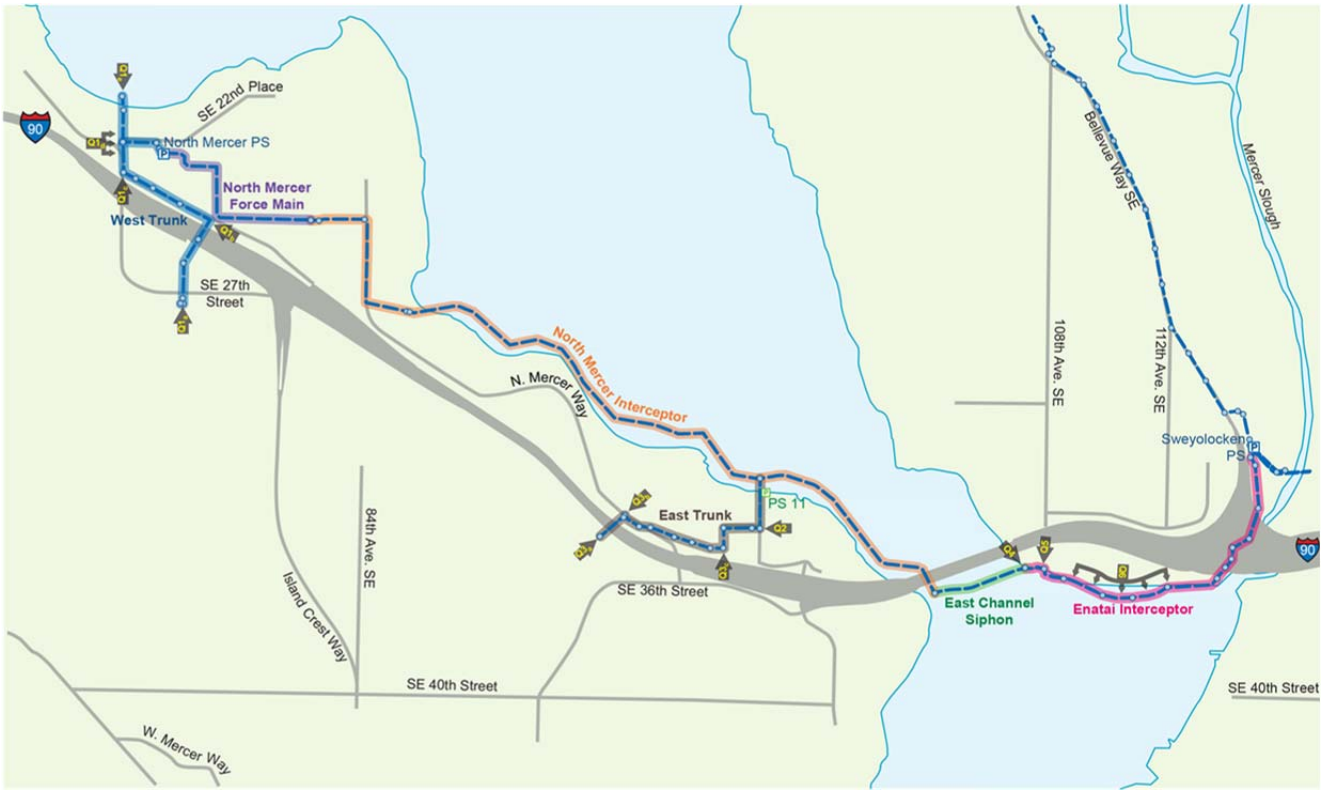

Figure ES-1. Existing North Mercer/Enatai Interceptor System

Some of the pipes that make up the North Mercer/Enatai system may be reaching the end of their useful lives, and future peak wastewater design flows are projected to exceed the system's existing capacity. The North Mercer Island Interceptor and Enatai Interceptor Upgrade Project is developing improvements to address these deficiencies. King County's 2012 *Preliminary Project Charter* for the project defined the objective as increasing the system capacity to convey projected peak wastewater flows through 2050 (the target date was changed to 2060 after release of the charter in 2014). The charter estimated that total project cost would be in the range of $41 million to $82 million and that construction would be completed in 2022.

The alternatives analysis report for the North Mercer Island Interceptor and Enatai Interceptor Upgrade Project summarizes work performed to evaluate improvement alternatives and identify a limited number of best apparent alternatives, including a single recommended alternative. The project team analyzed alternatives in three stages, as described in the following sections.

STAGE 1

Process

Stage 1 of the alternatives analysis consisted of the following steps:

- Evaluation criteria were developed in the following categories:
  - North Mercer Pump Station capacity and total dynamic head
  - Technical considerations
  - Constructability
  - Operation and maintenance
  - Permitting
  - Rights of way, easements and rights of entry
  - Environment
  - Community
  - Cost
- Multiple pipe segment options were identified for each of three project areas:
  - "A" segments are options for the system on Mercer Island (fifteen options were identified).
  - "B" segments are options for the system as it crosses the East Channel (nine options were identified).
  - "C" segments are options for the system in Bellevue (seven options were identified).
- Segment options were evaluated to eliminate fatal flaws (see Appendix A of the Alternatives Analysis report). Segments retained for consideration are listed in Table ES-1 and shown in Figure ES-2.
- Fifteen pipeline alignment alternatives for the full project length were created, each alternative including one of the segments for each project area, as listed in Table ES-2.
- A screening process evaluated the pipeline alternatives based on the established criteria.

Key Findings

Investigations performed in Stage 1 to develop pipeline alternatives led to the following key findings:

- **Existing Pipe Condition**—Due to the absence of pipe condition data, the preliminary scope statement in the Preliminary Project Charter made an initial project assumption of a new pipeline parallel to the existing pipeline, which would remain in service, and recommended that the pipe be inspected by this project to confirm its continued use. The project team decided to perform field condition assessment in Stage 2, prior to determining the use of the existing conveyance system.
- **Design Criteria**—Projected 2060 peak flow rates used for Stages 1 and 2 contain a 25-percent uncertainty flow factor (UFF), as directed by King County to account for uncertainties about future population and infiltration and inflow. The UFF increased the design flow from the previously projected 16.1 million gallons per day (mgd) to 20.1 mgd.

Table ES-1. Segment Options Retained for Consideration in Stage 1

Segment	Disposition
A1[a]	Force main from North Mercer Pump Station along N. Mercer Way to ~ 97th Avenue SE; gravity pipeline along North Mercer Way to East Channel
A4	Generally follows existing pipeline route from North Mercer Pump Station to existing force main discharge connection; gravity pipeline along Mercer shoreline to East Channel
A5-1[a]	Force main from North Mercer Pump Station to past segment midpoint; gravity pipeline along bike path on north side of I-90. Open cut to high point at the bike path, continue gravity to Mercer shoreline
A5-2[a]	Same as A5-1, but open cut portion along North Mercer Way
A10-1[b]	Divert flows at Manhole S-10, trenchless construction on SE 24th Street from 78th Avenue SE to 84th Avenue SE, trenchless construction south on 84th Avenue SE to meet grade at south end of Luther Burbank Park, then in lake
A10-2[b]	Same as A10-1, except trenchless construction from SE 24th Street / 78th Avenue SE directly to south end of Luther Burbank Park
B3[c]	Trenchless crossing of East Channel, south of I-90
B4[c]	Trenchless crossing of East Channel, north of I-90
B5	Trenchless crossing on north side of I-90, straight from west side of East Channel to Sweyolocken Pump Station
B6	Parallel the existing pipeline across East Channel, laying or trenching along bottom of lake.
C1	Trenchless crossing under Enatai from the vicinity of Enatai Beach Park to Sweyolocken Pump Station
C6	Gravity pipe parallel to existing pipeline along Enatai shoreline, through Mercer Slough, to Sweyolocken Pump Station

a. Segments A1, A5-1 and A5-2 were combined as A1/A5 for alternatives analysis due to significant similarities.
b. Segments A10-1 and A10-2 were combined as A10 for alternatives analysis due to significant similarities.
c. Segments B3 and B4 were combined as B3/B4 for alternatives analysis due to significant similarities.

Table ES-2. Description of Pipeline Alignment Alternatives

	Segments				Segments		
	Mercer Island	Each Channel	Bellevue		Mercer Island	Each Channel	Bellevue
Alternative 1	A1/A5	B3/B4	C1	Alternative 9	A4	B6	C1
Alternative 2	A1/A5	B3/B4	C6	Alternative 10	A4	B6	C6
Alternative 3	A1/A5	B5		Alternative 11	A10	B3/B4	C1
Alternative 4	A1/A5	B6	C1	Alternative 12	A10	B3/B4	C6
Alternative 5	A1/A5	B6	C6	Alternative 13	A10	B5	
Alternative 6	A4	B3/B4	C1	Alternative 14	A10	B6	C1
Alternative 7	A4	B3/B4	C6	Alternative 15	A10	B6	C6
Alternative 8	A4	B5					

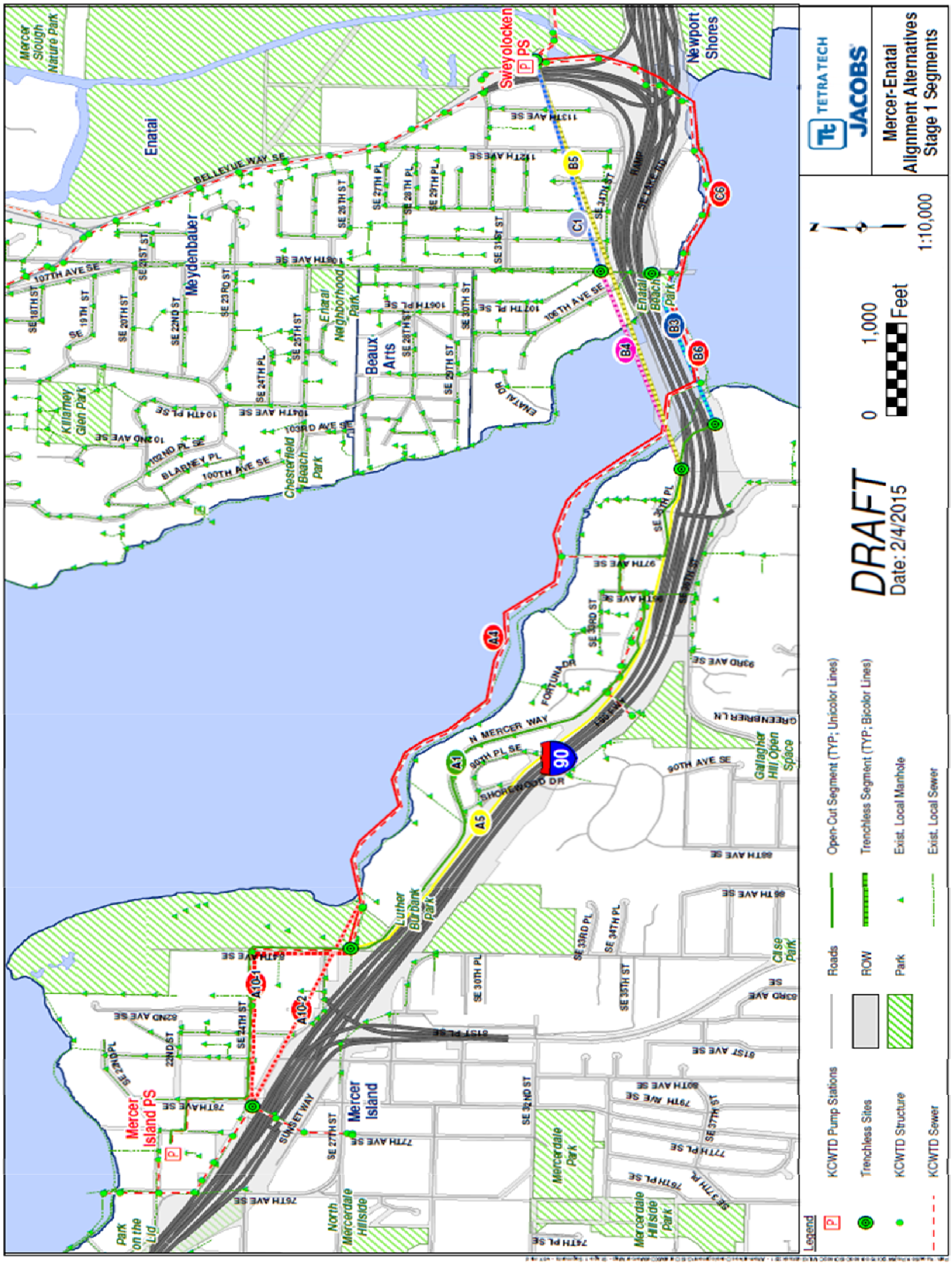

Figure ES-2. Segment Options Retained for Consideration in Stage 1

- **Hydraulics**—Based on a preliminary hydraulic analysis, alternatives were categorized into one of three hydraulically similar scenarios:

  - ***Upland Pipeline Option:*** Alternatives 1 through 5 include a long force main on Mercer Island, which would require improvements to the North Mercer Pump Station.
  - ***In-Water Option:*** Alternatives 6 through 10 include an in-water pipeline along the north side of Mercer Island. Hydraulics for these alternatives would closely match the existing system, with most of the in-water portion of the interceptor surcharged during most flow conditions.
  - ***Diversion Option:*** Due to the elevation of a gravity diversion to bypass the North Mercer Pump Station, Alternatives 11 through 15 work only with an in-water section along Mercer Island. For these alternatives, the entire interceptor would be surcharged from the diversion point to the East Channel.

- **Trenchless Construction**—The use of trenchless technologies was evaluated, and six segments involving trenchless construction were retained: A10-1, A10-2, B3, B4, B5 and C1.
- **North Mercer Pump Station**—Hydraulic assessment of the 15 alternatives indicated the following levels of requirements at the North Mercer Pump Station:

  - ***Alternatives 11 through 15:*** No increase in pump station capacity beyond the existing 8 mgd required; insignificant change in head
  - ***Alternatives 6 through 10:*** Requires an increase in pump station capacity to 13.1 mgd; moderate increase in head
  - ***Alternatives 1 through 5:*** Requires an increase in pump station capacity to 13.1 mgd; significant increase in head, possibly to the point of requiring two-stage pumping.

- **Geotechnical Conditions**—A review of existing geotechnical and environmental reports concluded that most potentially contaminated soil sites are more than 500 feet from the alignments and have a low potential to impact the project. However, two sites with documented petroleum contamination were identified at the existing North Mercer Pump Station. The project team developed a plan for four on-land geotechnical borings in Mercer Island and Bellevue, to occur in Stage 2.
- **Agency Input**:

  - The Washington State Department of Transportation was contacted to determine the feasibility of hanging pipe on the I-90 East Channel bridge. This option was eliminated because it would require costly seismic and structural investigation and might require a need for bride retrofits. The bridge design does not have a large factor of safety and structural design limits would need to be coordinated with Sound Transit's I-90 light rail design across the bridge.
  - Coordination meetings were held with Sound Transit to coordinate design and staging area with the proposed East Link light rail lines in the center roadway of I-90 and along Bellevue Way.
  - The City of Bellevue provided utility maps and GIS information for use in project development.
  - The City of Mercer Island provided utility maps and GIS information, discussed flow projections, and coordinated on upcoming geotechnical borings and information on infiltration and inflow.
  - The U.S. Army Corps of Engineers was contacted regarding requirements for alternatives that could impact waters of the United States.

Results

Through the Stage 1 evaluation, three of the 15 alternatives were eliminated from consideration:

- Alternative 2—Poor soils in the vicinity of Mercer Slough would have required pile-supported pipeline for Segment C6. Installation of piles near I-90 at this location poses a very high risk.

- Alternatives 3 and 8—High risk associated with long trenchless crossing for Segment B5; insufficient benefit relative to other alternatives including Segment B5 (Alternative 13).

The remaining 12 alternatives were carried forward for evaluation in Stage 2.

STAGE 2

Process

In Stage 2, the project team deleted the North Mercer Pump Station category of evaluation criteria, as the issues related to it were integrated into the other categories. All other Stage 1 categories of criteria were retained. A workshop on May 12, 2015 was held to establish a numerical weight for each category, indicating its relative importance. The Project Team identified major considerations in assigning weights to each category as follows (see Table 3-1):

- Operation and Maintenance.....Weight = 19
- Technical .....Weight = 16
- Cost.....Weight = 16
- Constructability .....Weight = 15
- Environment .....Weight = 11
- Permitting .....Weight = 10
- Rights of way, easements and rights of entry..... Weight = 8
- Community..... Weight = 5

Key Findings

Investigations performed in Stage 2 to further develop pipeline alternatives led to the following key findings:

- **Existing Pipe Condition**—To determine the feasibility of continuing to use the existing pipeline, the project team performed a pipeline condition assessment in Stage 1 through review of existing record documents, previous video inspections, sonar profiling, corrosion inspection reports, cathodic protection upgrades, and pipeline rehabilitation repair work. The project team determined that the upgrade project will not proceed on the project charter's assumption that the entire existing system can remain in service as a parallel pipeline. That assumption would require higher certainty that the pipeline is in suitable condition than is justified by available information. After construction of the new interceptors, the existing pipeline can be taken out of service so the County can inspect the entire line and determine an appropriate use for it.
- **Single vs. Dual Pipeline**—King County guidelines require force mains and siphons to have multiple barrels to accommodate both high and low flows and to allow pipeline inspection and maintenance. Since significant portions of several of the alternatives are force mains or siphons, this would require extensive lengths of dual systems. Based on an initial evaluation of costs and hydraulics associated with dual-pipe systems versus a single pipe, the project team determined that the maintenance and hydraulic benefits of dual pipes do not justify the increased costs and risk. Therefore it was initially determined that all alternatives would be evaluated as single-pipe systems. However, as the Project continued developing, with further consideration of low flow velocities in gravity and siphon systems, the decision was made to proceed with dual pipelines as discussed further in this Report.
- **Design Criteria**—When the single-pipe approach was selected over the dual-pipe approach, the County determined that the large pipe diameters required to convey design flows that include the UFF would be detrimental and result in inadequate scour velocities to transport solids at low flows. It was agreed that the UFF should not be incorporated in the design flow. This allows for a smaller pipeline, with better

velocities at low-flow conditions. The County also performed a statistical analysis and determined the percent of time flows would exceed the peak design flow was approximately 0.00003%. Thus it was determined that the operational issues associated with larger pipes did not support the use of the UFF. This decision was made at the end of Stage 2; its impacts were evaluated in Stage 3.

- **Hydraulics**—The Stage 1 preliminary hydraulic analysis was updated in Stage 2 to include the West Trunk, which was not analyzed in Stage 1.
- **Trenchless Construction**—The Stage 2 trenchless construction analysis advanced the trenchless design using the geotechnical field data collected in Stage 1 and a risk assessment workshop. The following is a summary of findings:

  - Segment A10—A single horizontal directional drilling (HDD) segment presents a slightly lower risk profile than microtunnel construction for this segment. Both options were carried forward.
  - Segment B3 and B4—The risk profiles are similar for trenchless construction north or south of the I-90 bridge. HDD construction across the East Channel presents a better risk profile than microtunnel construction.
  - Segment C1—In Stage 2, this segment was altered to allow the installation of conductor casing past two of the I-90 East Channel Bridge footings, to allow for a reduction of impacted wetland areas around the Sweyolocken Pump Station, and to provide greater separation between the proposed bore and the East Link project. The risk profile for this segment is less for HDD construction than for Direct Pipe, due to the ability for HDD to be redirected if obstructions are encountered.

- **Risk Assessment—**A workshop was held to identify risks associated with trenchless construction of single or dual pipelines.
- **North Mercer Pump Station**—The 12 remaining pipeline alternatives present different capacity and total dynamic head requirements for the North Mercer Pump Station. Concept-level pump station modifications and costs were added to the descriptions of the pipeline alternatives as follows:

  - Concept A (for Alternatives 11 – 15)—Bypass some flow around the North Mercer Pump Station and change the force main discharge point, reducing the pump station's flow and total head requirements.
  - Concept B (for Alternatives 6 – 10)—Increase flows to the North Mercer Pump Station and discharge at a similar location to the existing force main.
  - Concept C (for Alternatives 1 – 5)—Increase flows to the North Mercer Pump Station and discharge 4.5 times farther downstream; this raises the pump head significantly.

- **Geotechnical Conditions**—The four on-land geotechnical borings in Mercer Island and Bellevue were completed in Stage 2 and analyzed for use in the Stage 2 trenchless construction analysis described above.
- **Agency Input**:

  - The Washington State Department of Transportation notified the project team that the area of the I-90 bridge along Mercer Slough has no tolerance for settlement that could result from construction near the bridge piles. Construction along Mercer Slough and the bridge pier piles would pose a high construction risk. Poor soils offshore and through Mercer Slough could cause construction problems.
  - Sound Transit has two light rail Projects in the vicinity of the North Mercer /Enatai Project that will need to be coordinated; E130- East Link, Mercer Island segment and E320 – East Link, Bellevue segment. Coordination activities identified included the use of staging areas under the bridge approaches that both projects could use at the same time as the North Mercer /Enatai Project. Sound Transit plans to have the Bellevue segment (E320) in construction between 2016 and 2023 and the Mercer Island segment (E120) between 2019 and 2022.
  - The City of Bellevue reported that its Shoreline Master Program is being updated and includes policy language that highly discourages construction in environmentally sensitive areas, including the

Mercer Slough. Construction would affect the bike/walking path along Mercer Slough, requiring rerouting of bike traffic.

- The Enatai Beach Park is heavily used during the summer period (May-September). The Washington State Department of Transportation (WSDOT) owns a portion of the area beneath the bridge and Enatai park. The City stated that prior to any approval for use of park property requires a letter of intent on granting access by private owners before the permit is reviewed by the City (i.e. WSDOT letter of intent required for Enatai Park). They noted that the funding of parks establishes certain restrictions on the use of the park which should be identified during the planning stage.
- The City of Bellevue also provided input on park activities and construction coordination with businesses. It was noted that there are businesses that use the Enatai Beach Park, including vendor that leases canoes and kayaks, and the Pacific Science Center and City of Bellevue canoe program.
- The City of Mercer Island provided input on pipe laydown areas for trenchless construction, construction around key events and businesses that use the Mercer shore, and construction around key parking areas, wetland areas and Luther Burbank Park. It was noted that trenchless across East Channel could be done in the winter to minimize construction during the summer when park and trails are in heavy use. Pullback staging area north of the bridge would need to take into consideration water front access to shoreline homes. Trenchless for the A10 diversion option could use laydown area for pipe pull back along N. Mercer Way, which is wide enough to provide 2 lane traffic. The City also identified the option of pipe laydown area on the on-ramp on 76th Ave.

- **Enatai Shoreline/Mercer Slough Alignment**—Segment C6, includes a new gravity pipe parallel to the existing pipeline along the Enatai shoreline and then crossing through Mercer Slough. Disadvantages of this segment option were further assessed in Stage 2. A bathymetric survey confirmed that the lake bed outside the private boat docks is at too low an elevation for the proposed new pipeline to be installed at the required slope. Based on this and other identified constructability challenges in soft soils, the project team recommended that system alternatives including Segment C6 be eliminated.

Results

The removal of alternatives that include Segment C6 eliminated five of the 12 alternatives carried forward from Stage 1. The project team decided to proceed to Stage 3 with the seven remaining alternatives—1, 4, 6, 9, 11, 13 and 14—without conducting a criteria-based evaluation of the alternatives.

STAGE 3

Process

Stage 3 further developed the seven alternatives carried forward from Stage 2 and screened them through additional technical analysis and a criteria-based evaluation to identify three best apparent alternatives and a single recommended alternative.

All criteria categories and weighting from Stage 2 were retained for Stage 3. Ratings associated with criteria were made numerical by replacing Stage 1 and Stage 2 qualitative rating scales (low, medium, high) as follows:

- Assign numerical value of 7 to 9 for descriptions previously rated “low impact.”
- Assign numerical value of 4 to 6 for descriptions previously rated “medium impact.”
- Assign numerical value of 1 to 3 for descriptions previously rated “high impact.”

For the Stage 3 criteria evaluation, alternatives were assigned one score for each of the eight criteria categories. The weighting developed in Stage 2 was applied, and the scores were summed. Project team members and discipline leads developed rating scores for specific categories based on their expertise. The individual rating scores were used to calculate minimum, maximum, mean and median category rating scores.

Key Findings

Alternative development for Stage 3 consisted of two work components: the initial work component eliminated four alternatives, largely based on analyses of siphon operation in the new system; the final work component further screened the remaining alternatives based on additional analysis and the criteria-based evaluation.

Initial Work

Investigations performed in the initial work component of Stage 3 led to the following key findings:

- **Design Criteria**—Design criteria were updated as follows based on new analyses:
  - ***Minimum Flow Velocity Design Criteria:*** When flows are low, with resulting low velocities, the flow may not be able to keep solids suspended and transport them down the pipeline. The resulting accumulation of solids can present operational, maintenance, and hydraulic problems. Minimum flow velocity design criteria were established for summertime flows to prevent accumulation of solids at low flows: 2 feet per second for gravity pipes and force mains, and 3 feet per second for siphons. A siphon requires higher minimum velocity than a gravity pipe because of the need to flush solids through the rise portion on the siphon's downstream end.
  - ***Siphon Rise:*** The minimum flow velocity criterion for siphons is such that adequate flushing can be achieved provided that the amount of rise in the downstream siphon segment is not excessive.
  - ***Low-Flow Design Criteria:*** Based on 2010 summer flow monitoring data, the project team established low-flow design criteria for the Enatai Interceptor.
  - ***Uncertainty Flow Factor:*** Hydraulic modeling was updated in Stage 3 to remove the UFF (decided in Stage 2 as previously discussed) from the design flow.
- **East Channel Siphon Segments**—Trenchless Segments B3, B4 and B5 were found to have fatal flaws that ruled them out for further consideration:
  - They have a downstream rise of more than 100 feet, a significant rise that could make it difficult to provide adequate flushing.
  - They require trenchless construction of two pipelines across the East Channel, which poses significant construction challenges.

The removal of the alternatives that include B3, B4 and B5 trenchless segments eliminated four of the seven remaining Stage 3 alternatives, effectively screening the number of alternatives to three: Alternatives 4, 9 and 14. These are the best apparent alternatives for the project.

Final Evaluation of Best Apparent Alternatives

Investigations performed in the final work component of Stage 3 led to the following key findings:

- **Hydraulics**—Hydraulic modeling of the North Mercer Pump Station force main in Segment A1 and Segment A5 was carried out to better assess differences between the two:

- ***Force Main Segment A1:*** Hydraulic modeling of Segment A1 found that, due to its long distance and intermediate high points, the force main would not remain fully pressurized during low-flow conditions (single pump operation). Low-flow velocities would range from 0.1 to 1.4 feet per second.
- ***Force Main Segment A5:*** Hydraulic modeling of Segment A5 found that, because the elevation of the force main discharge is higher than it is for Segment A1, the force main would remain pressurized during all flow conditions. Low-flow velocities would range from 1.1 to 1.7 feet per second.
- ***Dual Force Main Evaluation:*** Due to the low velocities resulting from single pump operation, it was determined that dual pipes would be required for this force main.
- ***Surge Analysis:*** A force main surge analysis for the three remaining alternatives identified a need for surge tanks at the pump station and established locations for vacuum relief and air release valves. There were no major differences between the surge mitigation measures recommended for the force main options.

- **North Mercer Pump Station** —The following recommendations from a pump station condition assessment completed by King County for Stage 2 were incorporated into the North Mercer Pump Station capacity upgrade:

  - Replace pumps and motors (Recommendation EN6)
  - Rebuild/Replace the generator (Recommendation M5)
  - Replace chemical piping and valves for the odor control system (Recommendation M6).

- **Risk Assessment:**

  - ***Trenchless Risks:*** A trenchless risk workshop identified risks related to trenchless segments. Risks that were rated as having high probability or impact were quantified to establish the cost that could be incurred should that risk occur. Segment A10-2 (Microtunnel) was selected as the base case for A10 because it provides a gravity pipeline rather than an HDD siphon, with better hydraulic performance and reduced potential for sedimentation and odor generation, and because it affects fewer residential homeowners and reduces construction risk associated with the slope stabilization.
  - ***Project Risks:*** Project risks related to permitting, the environment and similar broad considerations were identified in a separate risk register. Alternative 14 was identified as having the highest risk because it includes two trenchless segments—A10 and C1. Alternatives 4 and 9 have similar risks.

- Cost Estimating—Capital and life-cycle costs were estimated for the best apparent alternatives as shown in Table ES-3

Table ES-3. Summary of Construction Cost and Life Cycle Costs

	Alternatives			
Description	Alternative 4 - A1	Alternative 4 - A5	Alternative 9	Alternative 14
Construction Cost	$22.8	$26.2	$26.0	$34.8
Life-Cycle Cost	$64.5	$66.2	$73.0	$92.0

a. Class 4 construction cost estimates were developed, including pump station modifications required for each alternative.
b. Life cycle cost indicates total anticipated present value cost per year through 2060, including capital cost, annual maintenance and chemical costs (labor and power costs), and expected equipment replacement.

Results

Alternative 4 had the highest rating score in the criteria evaluation as summarized in Table ES-4 and is the recommended alternative, as was confirmed by the project team at the Stage 3 workshop.

Table ES-4. Evaluation Scores for Evaluated Alternatives

	Weighted Minimum	Weighted Maximum	Weighted Mean	Weighted Median	Weighted Combined Score by Discipline Leads
Alternative 4	362	687	531	546	545
Alternative 9	286	518	400	404	415
Alternative 14	197	439	312	324	276

CAPITAL SYSTEM TEAM APPROVAL

On January 12, 2016, the results of the alternatives analysis and a comparison of the best apparent alternatives were presented to King County's Capital System Team, with the following recommendation for management approval:

- Implement Alternative 4, including upland open-cut via Mercer Island (routing to be finalized in predesign), open-cut across the East Channel and trenchless construction across Bellevue.
- Add scope and budget for necessary North Mercer Pump Station modifications required as part of the pipeline improvements.

The Capital System Team confirmed the recommendation. However, it was recognized that additional evaluation would be needed early in predesign to finalize:

- **LS 11upgrades with City of Mercer Island:** LS 11 upgrades will be required in order to route the localized and King County East Trunk flows via the upland corridor and avoid in-water construction along the Mercer Shore.
- **Mercer Island upland corridor route**: During Phase 1 – a generic corridor route was selected upland along Mercer Island. During early predesign, segment routes will be evaluated along the I-90 trail with an effort to minimize construction along N. Mercer Way. This analysis will address constructability considerations such as proximity to retaining walls, traffic disruptions, and utility relocations.
- **North Mercer Pump Station required modifications**: Modifications to the North Mercer Pump Station, whether required due to the pipeline upgrades, required per King County guidelines, or preferred by County operations staff, will be identified and incorporated into the project design to confirm the budget is adequate.

1. INTRODUCTION

1.1 PROJECT BACKGROUND AND PURPOSE

King County's North Mercer and Enatai Interceptors extend 14,000 feet underground and underwater from northern Mercer Island to Bellevue. The interceptors' alignment begins at the North Mercer Pump Station, enters Lake Washington near the south end of Luther Burbank Park, crosses the East Channel near the Interstate 90 bridge, follows the Mercer Slough, and ends at the Sweyolocken Pump Station. Two trunk sewers on Mercer Island (the East Trunk and the West Trunk) contribute significant flows to the interceptors, and three sources contribute additional flow in Bellevue. Figure 1-1 shows the existing system.

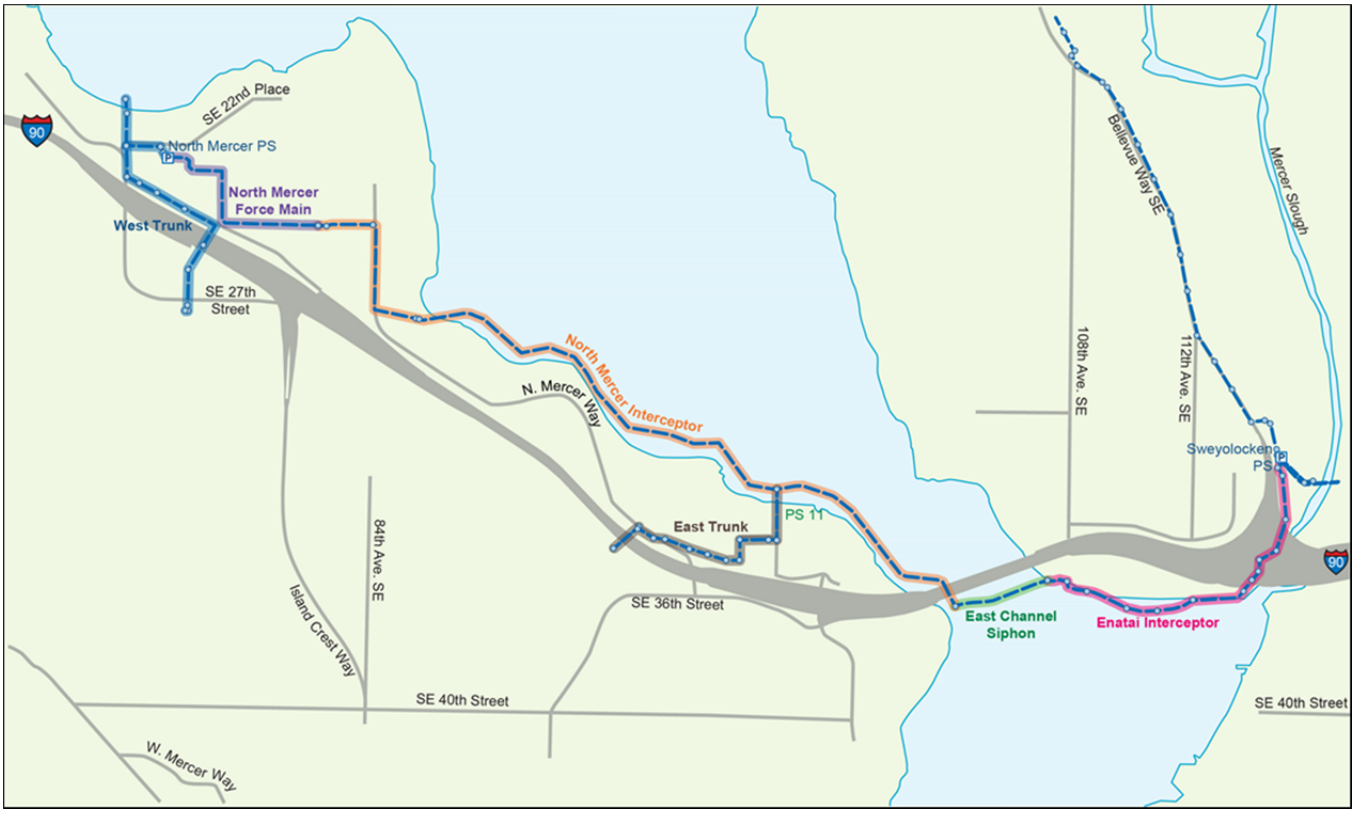

Figure 1-1. Existing North Mercer/Enatai Interceptor System

The North Mercer Pump Station serves north Mercer Island. Most flow to the pump station is from the downtown business area. Wastewater flows to the station through gravity sewers. Currently, the North Mercer Pump Station receives flows from the West Trunk, which collects and conveys local residential flows as well as flows from the commercial area of downtown Mercer Island.

Some of the pipes that make up the North Mercer/Enatai system may be reaching the end of their useful lives, and future peak wastewater design flows are projected to exceed the system's existing capacity. The North Mercer

Island Interceptor and Enatai Interceptor Upgrade Project is developing system improvements to handle peak flows through 2060. It is being conducted in three phases:

- Phase 1—Alternatives Analysis
- Phase 2—Preliminary design
- Phase 3—Design and construction.

This report summarizes the work completed in the alternatives analysis under Phase 1. Preliminary design under Phase 2 will begin upon final acceptance of the best apparent alternative identified through the alternatives analysis process.

1.2 ALTERNATIVES ANALYSIS APPROACH

The Tetra Tech project team analyzed project alternatives in a multi-stage process to identify a limited number of best apparent alternatives, including one recommended alternative. The alternatives analysis approach was adapted as appropriate throughout Phase 1 to address new information that was developed as the work proceeded. The initial plan was to conduct the alternatives analysis in four stages, reducing the number of alternatives from 15 or more to 12 (Stage 1), and then to six (Stage 2), and then to two to four (Stage 3), and finally to one best apparent alternative (Stage 4). Under that initial plan, each stage of the process included work to develop project alternatives, work to develop an appropriate evaluation methodology, and work to apply the methodology to the alternatives, iteratively reducing the number of alternatives under consideration. Figure 1-2 shows the schematic plan for the initial approach.

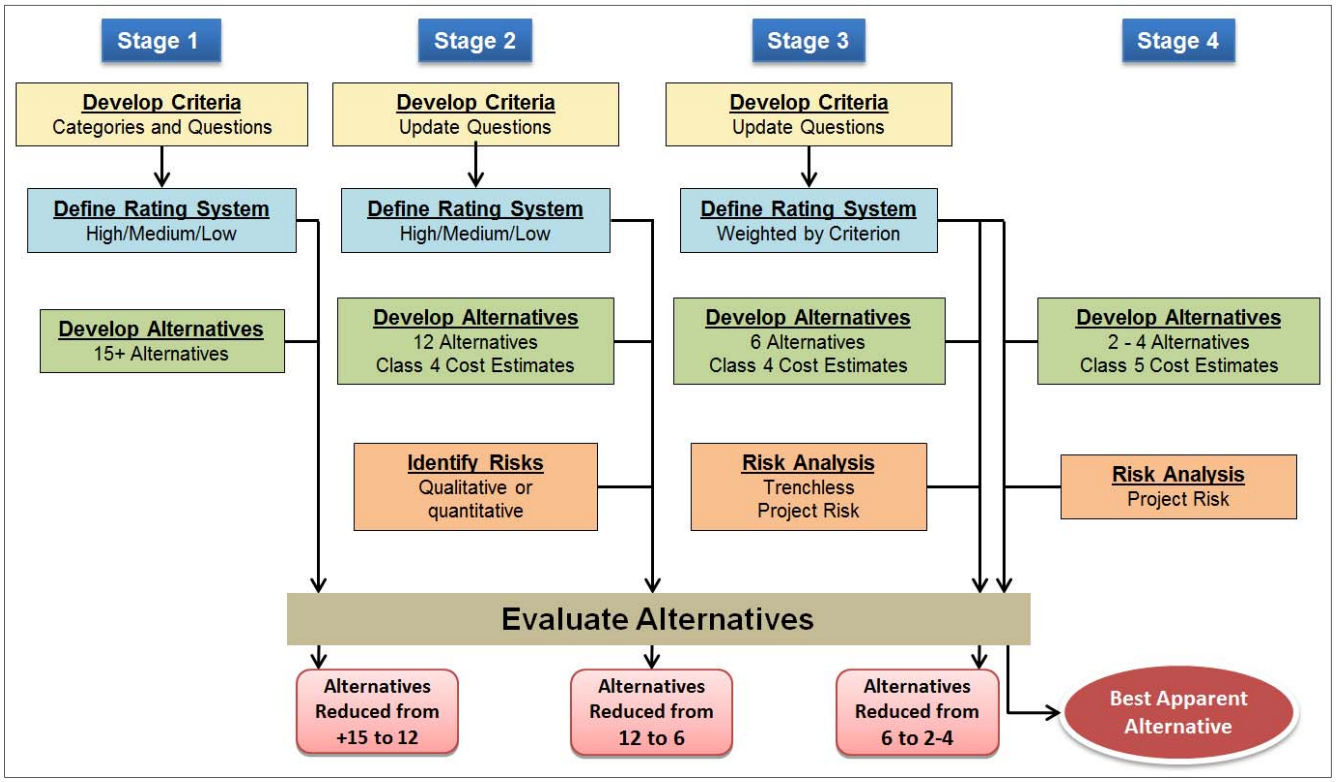

Figure 1-2. Original Four-Stage Alternative Analysis Process

As the analysis proceeded, incremental findings warranted revisions to the approach. In particular, new information about constructability eliminated some alternatives without a full criteria-based evaluation in Stage 3, so the work originally planned for Stages 2 and 3 was combined into a single effort. The final approach as conducted is shown schematically on Figure 1-3.

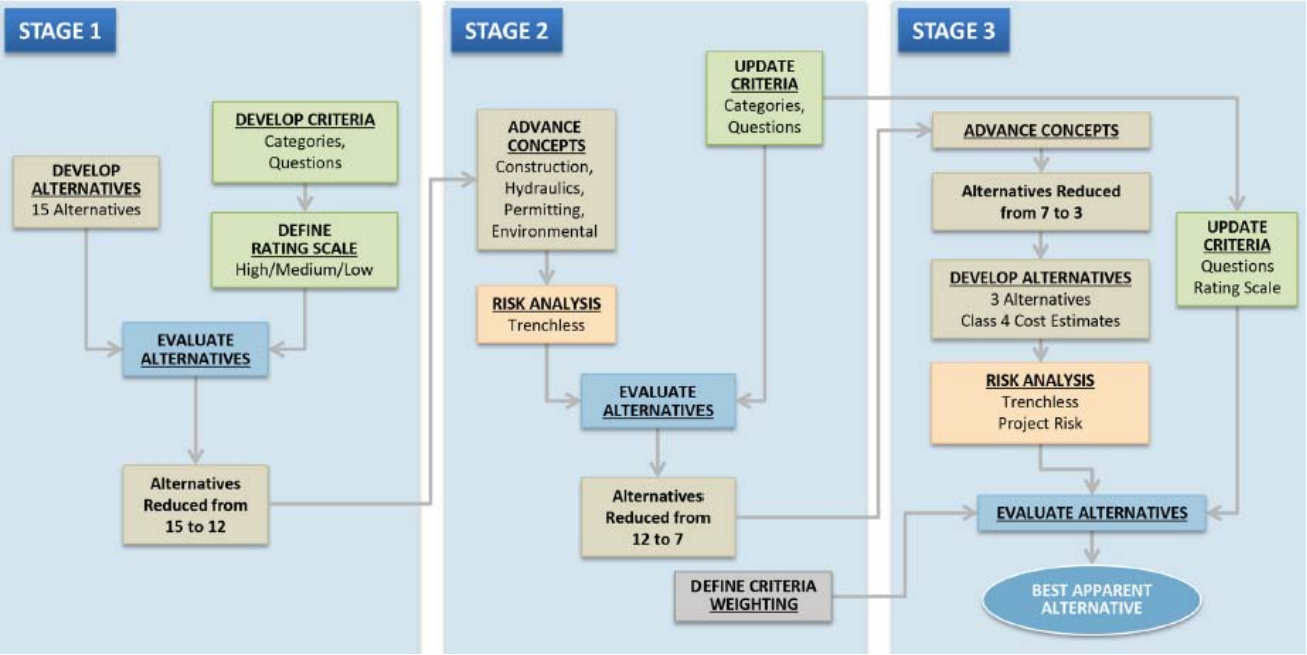

Figure 1-3. Final Three-Stage Alternative Analysis Process

1.3 PRELIMINARY PROJECT CHARTER

King County's *Preliminary Project Charter* (December 17, 2012) for the North Mercer Island Interceptor and Enatai Interceptor Upgrade Project outlined project needs, initial project assumptions and estimated costs. The project objective was defined as increasing the capacity of the North Mercer Island/Enatai portion of the regional wastewater system in order to convey the projected peak wastewater flows through 2050 (the target date was changed to 2060 after release of the charter). The preliminary project charter's assumptions included the following project elements to provide a basis for starting the project and to prepare initial estimates for the project cost and schedule, with the understanding that the information will change after the project begins:

- Continue to convey wastewater in the existing interceptors at their capacities.
- Construct a parallel line for the North Mercer Island Interceptor, East Channel Siphon, and Enatai Interceptor to convey the remaining projected flows through 2050.
- Retain the existing North Mercer Pump Station force main.
- Use the following construction methods:

  - Open-cut construction on Mercer Island, with the exception of jack-and-bore construction at the intersection of North Mercer Way and SE 35th Street
  - Horizontal directional drilling (HDD) for the East Channel crossing
  - Microtunneling for the section in the Mercer Slough.

The initial project schedule estimate in the charter is as follows:

- Phase 1—Alternatives analysis: through January 2016

- Phase 2—Predesign: 2016-2017
- Phase 3—Final design: 2017-2019
- Phase 3—Construction: 2019-2022.

The charter estimated that total project cost would be in the range of $41 million to $82 million. The cost estimate did not include construction of improvements at the North Mercer Pump Station. However, it did indicate that a hydraulic analysis of the North Mercer Pump Station was warranted in the alternatives analysis phase due to the hydraulic interdependence of the pumps and pipeline.

1.4 PREVIOUS STUDIES AND DOCUMENTS

The project team received numerous reference documents for the North Mercer Island Interceptor and Enatai Interceptor Upgrade Project from King County and other agencies. A log and description summary of those files is included in the Basis of Design Report for this project.

2. STAGE 1

In Stage 1 of the alternatives analysis, sets of segment options were developed for each of three geographic portions of the project: Mercer Island, the East Channel, and the Enatai neighborhood of Bellevue. An initial analysis of the three areas by the project team and King County led to numerous segment options being removed from consideration. The remaining segments were then combined into 15 alternatives, which were evaluated at the end of Stage 1. Through that evaluation, three of the fifteen alternatives were eliminated from consideration.

The first stage consisted of the following steps:

- Evaluation criteria development: Evaluation criteria were developed, along with a procedure for applying the criteria to rate project alternatives.
- Segment development: Multiple pipe segment options were identified for each of three project areas:
  - "A" segments are options for the improved system on Mercer Island, from the North Mercer Pump Station to the East Channel.
  - "B" segments are options for the improved system as it crosses the East Channel.
  - "C" segments are options for the improved system in Bellevue, from the East Channel to the Sweyolocken Pump Station.
- Segment screening: Each segment option was evaluated to eliminate any that had fatal flaws.
- Pipeline alternatives development: Pipeline alignment alternatives for the full project length were created, each representing a combination of one of the remaining segments for each project area.
- Pipeline alternatives screening: Pipeline alternatives were evaluated based on the established criteria.

2.1 EVALUATION CRITERIA DEVELOPMENT

Evaluation criteria to screen the preliminary alternatives were developed and then refined at a workshop on September 8, 2014. The sections below describe the general approach.

2.1.1 Categories, Criteria, Questions and Ratings

The criteria development began with establishing broad categories of issues that are important for this project. Although the Preliminary Project Charter did not include North Mercer Pump Station upgrades, the project team included a criterion regarding the pump station capacity required for each alternative and each alternative's potential impact on total dynamic head (TDH), as indicators for whether the existing North Mercer Pump Station would need to be modified. The resulting categories of criteria were as follows:

- North Mercer Pump Station capacity and TDH
- Technical considerations
- Constructability
- Operation and maintenance
- Permitting
- Rights of way, easements and rights of entry

- Environment
- Community
- Cost

Specific criteria were identified within each of these categories. For each criterion, one or more questions were defined, with three possible answers for each question. These questions were designed to help the reviewer to focus on established criteria when evaluating among alternatives. Each alternative was rated as low, medium, or high for each criterion depending on the selected answer. The evaluation criteria matrix (see Appendix B) provides a full list of screening criteria and questions and the corresponding high, medium, and low rating descriptions.

Not all questions were used in Stage 1. Because of the limited level of development of the alternatives at this time, some questions could not be answered or could not draw meaningful distinctions among alternatives. Those questions were tabled until Stages 2 or 3, when further development of the alternatives allowed for better application of the criteria. Development of questions for the cost criteria also was tabled in Stage 1, as the Stage 1 evaluation was qualitative rather than quantitative.

2.1.2 U.S. Army Corps of Engineers Screening Criteria

The U.S. Army Corps of Engineers requires a permit for projects that could impact waters of the United States (as defined under the federal Clean Water Act). Under federal guidelines, the Corps may not issue this permit for a project if a practicable alternative exists that would have less adverse impact on an aquatic ecosystem. "Practicable" is defined as available and capable of being done after taking into consideration cost, existing technology, and logistics (40 CFR 230.3(q)). Logistics encompasses elements such as hydraulic performance, maintenance, accessibility, strong stakeholder opposition and constructability. To address this, the evaluation criteria questions for this project integrated cost, existing technology, and logistics as screening criteria.

2.1.3 Sustainability/Equity and Social Justice

Sustainability criteria were identified to address whether construction and operation of an alternative are likely to positively or negatively affect sustainability. For these questions, a note on the Alternatives Evaluation Criteria Matrix was provided indicating whether the sustainability impact would be environmental, social, economic or operational. King County has defined 14 "determinants of equity," which represent ideal conditions for people to live, work and recreate. To ensure equal access to these determinants to all residents, the project team will review major project elements to assess how they can affect these determinants of equity and whether they will increase or restrict access to the determinants. The affected determinants and sustainability evaluation is noted in the sustainability technical memorandum in Appendix C.

2.2 SEGMENT DEVELOPMENT

Figure 2-1 and Table 2-1 indicate the initial segment options developed: 15 options for Area A, nine options for Area B, and seven options for Area C. Initial segments were developed by considering all possible pipeline construction methods identified for each area. This included options such as continuous trenchless construction from the North Mercer Pump Station to the Sweyolocken Pump Station. East Channel options included trenchless construction north or south of the I-90 bridge, open-cut construction, and suspension of the pipeline from the I-90 bridge. In general, stationing provided in Table 2-1 represents the distance downstream of the North Mercer Pump Station (see the plan and profile figures submitted in Stage 1 for segment alignment stationing).

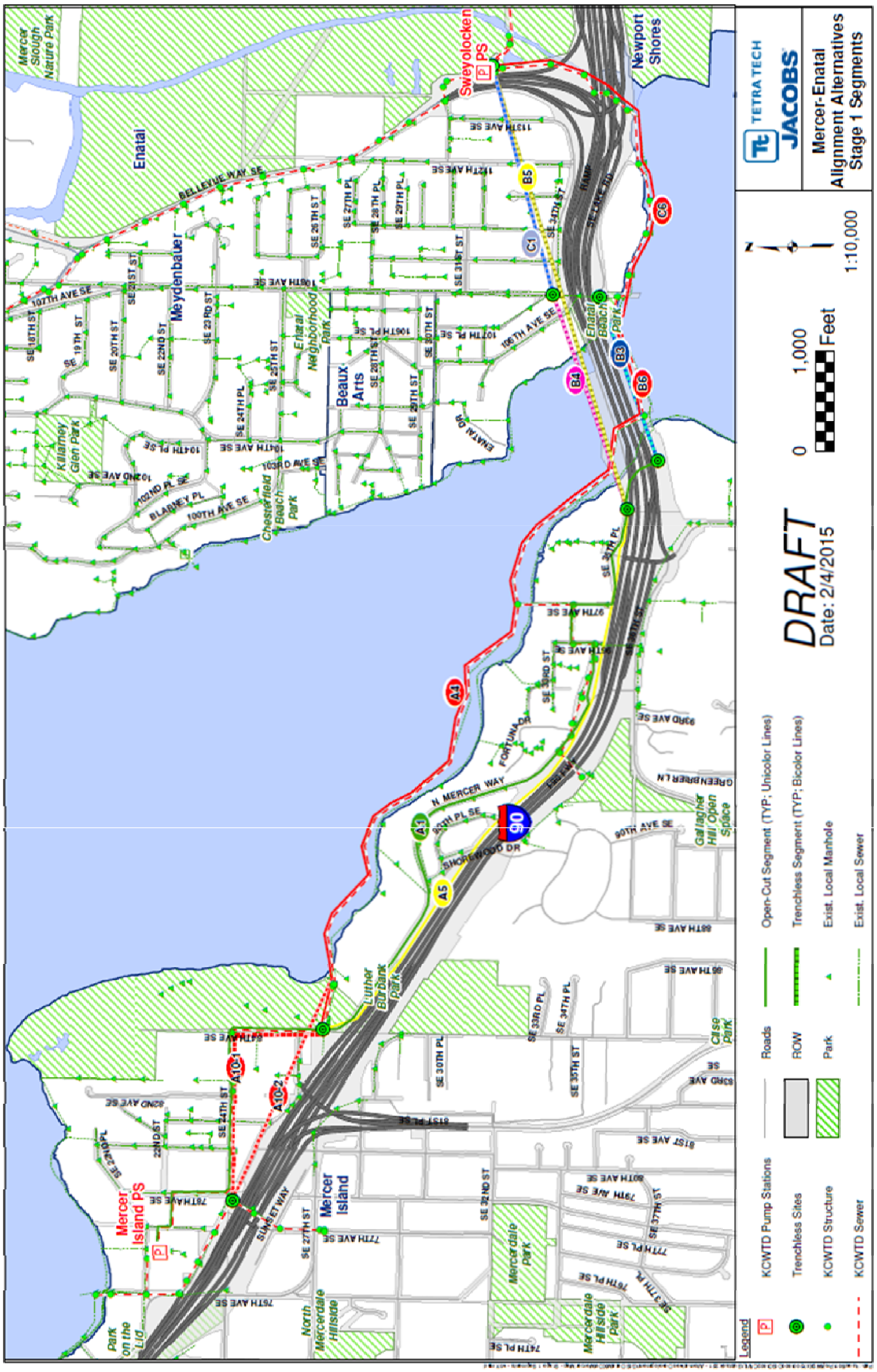

Figure 2-1. Initial Segment Options for the North Mercer/Enatai Project

Table 2-1. Description of Initial Segment Alignment Options

Segment	Description
A Segments	
A1	Force main from North Mercer Pump Station along N. Mercer Way to ~ 97th Ave SE; gravity pipeline along North Mercer Way to East Channel
A2	Force main from North Mercer Pump Station south of I-90 along 84th Avenue SE to SE 36th Street (4,500 feet of force main); trenchless under hillside and open-cut/trenchless along south side of I-90 to East Channel
A3	Force main from North Mercer Pump Station south of I-90 along 77th Avenue SE to SE 36th Street in local streets and under Island Crest Way; trenchless under hillside and open-cut/trenchless along south side of I-90 to East Channel
A4	Generally follows existing pipeline route from North Mercer Pump Station to existing force main discharge connection; gravity pipeline along Mercer shoreline to East Channel
A4-1	Same as A4, but with pipe laid on bottom
A5	Force main from North Mercer Pump Station to past midpoint of A5; gravity pipeline along bike path on north side of I-90. Trenchless required due to high point along the bike path.
A5-1	Same as A5 along bike path on north side of I-90, but with open cut to high point at the bike path
A5-2	Same as A5-1, but open-cut a portion along North Mercer Way
A5-3	Same as A5, but with trenchless from Station 40 to Station 107
A6	Force main from North Mercer Pump Station to high point near Station 70; trenchless across I-90 along 84th Avenue. Gravity along the south side of I-90 by open cut or trenchless construction
A7	Storage at North Mercer Pump Station to limit or delay required pump station upgrades and pipe upgrades
A8	Tunnel all the way from North Mercer Pump Station to Sweyolocken Pump Station
A9	Horizontal directional drill (HDD) from North Mercer Pump Station to East Trunk connection or Mercer Shore
A10-1	Divert flows at Manhole S-10, trenchless on SE 24th Street from 78th Avenue SE to 84th Avenue SE, trenchless south on 84th Avenue SE to meet grade at south end of Luther Burbank Park, then A4 profile in lake
A10-2	Same as A10-1, except trenchless directly from SE 24th Street / 78th Avenue SE to south end of Luther Burbank Park
B Segments	
B1	Curving trenchless from west side of East Channel to Sweyolocken Pump Station, south of I-90 and along south side of Bellevue shoreline and Mercer Slough
B2	Trenchless from west side of East Channel to Enatai Beach park vicinity, on south side of I-90 (this segment intended to fit with Segments A2 and A3)
B3	Trenchless crossing of East Channel, south of I-90 (similar to B2)
B4	Trenchless crossing of East Channel, north of I-90
B5	Trenchless crossing on north side of I-90, straight from west side of East Channel to Sweyolocken Pump Station
B6	Parallel the existing pipeline across East Channel, laying or trenching along bottom of lake.
B7	Long HDD crossing starting at 97th Avenue SE on Mercer Island and crossing under Lake Washington, under the Enatai hillside, and ending at Sweyolocken Pump Station
B8	Trenchless crossing of East Channel, diagonal across I-90
B9	Pipe hung from I-90 bridge across East Channel
C Segments	
C1	Trenchless crossing under Enatai from the vicinity of Enatai Beach Park to Sweyolocken Pump Station
C2	Curving trenchless along south side of I-90, eastbound off-ramp to Bellevue Way, to Sweyolocken Pump Station
C2-1	Same alignment as C2, but open cut
C3	Open-cut along SE 34th Street and 113th Avenue SE (north of I-90), trenchless under Bellevue Way, to Sweyolocken Pump Station
C4	Trenchless along north side of I-90 / SE 34th Street, under Bellevue Way, to Sweyolocken Pump Station
C5	Open cut via 108th Ave SE, SE 31st Street, 110th Ave SE, and SE 30th Street, followed by a trenchless crossing under Bellevue Way to Sweyolocken Pump Station
C6	Gravity pipe parallel to existing pipeline along Enatai shoreline, through Mercer Slough, to Sweyolocken Pump Station

2.3 SEGMENT SCREENING

The project team used criteria categories to consider the following for each segment option:

- Technical—Hydraulic performance, complexity
- Constructability—High risk and whether construction methods are innovative or unproven
- Geotechnical—Areas of gravel, loose soils and high groundwater along trenchless segments
- Community—Construction disturbance to community, including traffic disruptions and bike path closures
- Environmental—Potential environmental effects
- Permitting—Not permittable
- Operations—Requirements for operation and maintenance and the ease of inspection of pipeline.
- Cost—Cost prohibitive
- ROW—Coordination with City of Bellevue, City of Mercer Island, or the Washington State Department of Transportation (WSDOT) for staging area in park areas.

The full segment disposition matrix, provided in Appendix A, lists advantages, disadvantages, impacts on tributary flow, disposition (moved forward or not) and justification. Table 2-2 and Figure 2-1 summarizes the segment disposition resulting from the screening. Generally, segments were eliminated from further consideration for the following reasons:

- Technical—Substantial TDH or otherwise unacceptable hydraulic performance
- Constructability—Difficulties associated with trenchless construction
- Cost-effectiveness—Prohibitive cost
- Permitting—Permitting complexities.

2.4 PRELIMINARY PIPELINE ALTERNATIVES

All possible combinations of the screened segments were identified as preliminary pipeline alternatives for the full project from the North Mercer Pump Station to the Sweyolocken Pump Station. At a focused technical meeting held on August 8, 2014, these were further reduced to 24 alternatives (combinations of four A segments, three B segments, and two C segments) by eliminating segments with any of the following characteristics where were characterized as “fatal flaws”:

- Prohibitive cost
- Excessive force main lengths and detention times
- Excessive trenchless challenges
- Not permittable
- Insufficient benefit compared to similar segment (coupled with high cost and risk)
- Construction complexity (e.g., unsuitable soil conditions)
- Significant TDH increase at the North Mercer Pump Station

Table 2-2. Disposition of Initial Segment Alignment Options

Segment	Disposition	Justification/Comment
A Segments		
A1	Moved forward	Combined with A5-1 for alternatives analysis due to significant similarities.
A2	Not moved forward	Significant TDH resulting in higher pumping costs with a high risk trenchless segment. The trenchless construction would be greater than 200 feet deep and challenging. The force main is approximately three times longer in order to pump the flows past the high point across I-90.
A3	Not moved forward	Similar to A2—Substantial TDH. Trenchless challenges.
A4	Moved forward	
A4-1	Not moved forward	U.S. Army Corps of Engineers will not accept if there is a feasible option to bury the pipe on the same alignment.
A5	Not moved forward	Insufficient benefit with trenchless (high cost and risk) compared to A5-1 and A5-2 alternatives.
A5-1	Moved forward	Renamed to A5. Combined with A1 for alternatives analysis due to significant similarities.
A5-2	Moved forward	Renamed to A5. Combined with A1 for alternatives analysis due to significant similarities.
A5-3	Not moved forward	High risk and cost associated with trenchless.
A6	Not moved forward	High construction costs and greater lengths.
A7	Not moved forward	Storage discarded by King County
A8	Not moved forward	Cost prohibitive—estimated $100 million with tunneling costs approximately $8000 per lf High constructability risk with trenchless construction and environmental permitting. The elevation at the North Mercer Pump Station is lower than Sweyolocken Pump Station and this option would still require pumping to lift the flows up to Sweyolocken Pump Station. The risk profile for tunneling at this diameter is substantial.
A9	Not moved forward	Unacceptable hydraulic performance
A10-1	Moved forward	Combined with A10-2 for alternatives analysis due to significant similarities.
A10-2	Moved forward	Combined with A10-1 for alternatives analysis due to significant similarities.
B Segments		
B1	Not moved forward	Complex trenchless in unsuitable soil. Complex Washington State Department of Transportation (WSDOT) permitting.
B2	Not moved forward	Similar to B3. Would connect to A segment options south of I-90 that are not moved forward.
B3	Moved forward	Combined with B4 for alternatives analysis due to significant similarities.
B4	Moved forward	Combined with B3 for alternatives analysis due to significant similarities.
B5	Moved forward	
B6	Moved forward	
B7	Not moved forward	No benefit in comparison to B5 and high environmental associated with access pit in water and cost risks
B8	Not moved forward	High risk with permitting process and technical feasibility of routing the pipe through bridge piles.
B9	Not moved forward	Complex seismic evaluation, potential cost impact for seismic improvements, and overall agency coordination. Long force main and high TDH required.
C Segments		
C1	Moved forward	
C2	Not moved forward	Complex trenchless in unsuitable soil conditions. Complex WSDOT permitting.
C2-1	Not moved forward	Complexity of construction in unsuitable soils, significant potential conflicts under I-90. Complex WSDOT permitting.
C3	Not moved forward	Excessively long force main. This would create a pressurized system that would need to rely on the existing pipeline in order to provide means for carrying flows from the East Trunk and Bellevue flows, and for draining the pipeline for access and inspection
C4	Not moved forward	Complex trenchless in unsuitable soil conditions. Trenchless construction risk associated with achieving the tight steering curve both horizontally and vertically. Complex WSDOT permitting.
C5	Not moved forward	Insufficient benefit in comparison to C3.
C6	Moved forward	

The alternatives then were further reduced to the 15 listed in Table 2-3, based on the following:

- Segments A1 and A5 were consolidated. Both segments use open-cut construction and have similar hydraulic impact, differing only in using an alignment along North Mercer Way (A1) or the bike path adjoining I-90 (A5). This difference did not warrant separate evaluation at this early level of design. Final open-cut alignment in Mercer Island would be defined in Predesign, if an alternative with this segment would move forward.
- Segments B3 and B4 were consolidated. Both are trenchless segments across East Channel, one to the south of I-90 (B3) and one to the north (B4). Later analysis in Stage 2 would identify a preferred side for trenchless construction based on available staging area, layout area and pit construction.
- Segments A10-1 and A10-2 were consolidated. These trenchless Mercer Island diversion segments use similar construction, differing only in using different pipeline routing from SE 24th Street to Luther Burbank Park. This difference did not warrant separate evaluation at this early level of design.
- Based on contact with Washington State Department of Transportation (WSDOT) staff, Segment B9, which included hanging pipe on the I-90 bridge, was determined to be infeasible, eliminating the two pipeline alternatives that included this segment.

Table 2-3. Description of Pipeline Alignment Alternatives

	Mercer Island Segment	Each Channel Segment	Bellevue Segment	General Description
Alternative 1	A1/A5	B3/B4	C1	In-land (N Mercer Way/ bike path) open-cut, trenchless under E Channel and Bellevue
Alternative 2	A1/A5	B3/B4	C6	In-land (N Mercer Way/ bike path) open-cut, trenchless under E Channel, open-trench at Bellevue
Alternative 3	A1/A5	B5		In-land (N Mercer Way/ bike path) open-cut, one trenchless section under E Channel and Bellevue
Alternative 4	A1/A5	B6	C1	In-land (N Mercer Way/ bike path) open-cut, in-water across E Channel, trenchless under Bellevue
Alternative 5	A1/A5	B6	C6	In-land (N Mercer Way/ bike path) open-cut, in-water across E Channel and along Bellevue
Alternative 6	A4	B3/B4	C1	In-land on Mercer Island (similar to existing) trenchless under E Channel and Bellevue
Alternative 7	A4	B3/B4	C6	In-land on Mercer Island (similar to existing), trenchless under E Channel, open-trench at Bellevue
Alternative 8	A4	B5		In-land on Mercer Island (similar to existing), one trenchless section under E Channel and Bellevue
Alternative 9	A4	B6	C1	In-land on Mercer Island (similar to existing), in-water across E Channel, trenchless under Bellevue
Alternative 10	A4	B6	C6	In-land on Mercer Island (similar to existing), in-water across E Channel and along Bellevue
Alternative 11	A10	B3/B4	C1	Diversion option (similar to A4 on Mercer Island), trenchless under E Channel and Bellevue
Alternative 12	A10	B3/B4	C6	Diversion option (similar to A4 on Mercer Island), trenchless under E Channel, open-trench at Bellevue
Alternative 13	A10	B5		Diversion option (similar to A4 on Mercer Island), one trenchless section under E Channel and Bellevue
Alternative 14	A10	B6	C1	Diversion option (similar to A4 on Mercer Island), in-water across E Channel, trenchless under Bellevue
Alternative 15	A10	B6	C6	Diversion option (similar to A4 on Mercer Island), in-water across E Channel and along Bellevue

2.5 INVESTIGATIONS TO DEVELOP PIPELINE ALTERNATIVES

2.5.1 Design Flow Analysis

Design flows used for Stage 1 were analyzed and confirmed against King County developed design flows.

- King County developed the draft *Design Flow Criteria for the North Mercer Island Interceptor and Enatai Interceptor Upgrade Project* and presented projected design flows.
- The project team compared the estimating criteria and methodologies used in that report to projected design flows developed from information (i.e. population and zoning data) used by the cities of Bellevue and Mercer Island.
- Design flows between King County and Project Team were comparable.
- Design flows used for Stage 1 hydraulic calculations were taken from *Updated Design Flow Criteria for the North Mercer Island Interceptor and Enatai Interceptor Upgrade Project* (King County, September 2014).

As presented in *Design Flow Analysis Technical Memorandum* (August 22, 2014), which was reviewed and accepted by the County modeling team, the analysis concluded the following:

- Existing development and growth projections used by King County are comparable to both cities' projections. The project study area boundary matches the Mercer Island and Bellevue area.
- The distribution of wastewater flows to the major system components is comparable to that of both cities.
- The County dry-weather flow criteria differ slightly from those of the two cities.
- The County's base flow (with peaking factor) estimates are lower than Mercer Island's but similar to Bellevue's.
- King County infiltration and inflow (I/I) estimates are higher than the cities' estimates, to account for sewer degradation.

Table 2-4 summarizes the estimates of 2060, 20-year peak flows. These peak flow rates, used during Stages 1 and 2, contain a 25-percent contingency—the uncertainty flow factor (UFF)—as directed by King County. The County established this factor to account for uncertainties in population projections and uncertainty about how I/I could increase over time, given the potential for higher than anticipated flows due to climate change. The UFF increased the total system design flow from 16.1 million gallons per day (mgd) to 20.1 mgd.

Table 2-4. Peak Flow Rates

Tributary Flow	Source	2060, 20-Year Peak Flow[a] (million gallons/day)	
		Local Contribution	Cumulative Interceptor Total Flow
Q1	North Mercer Pump Station	13.13	13.1
Q2	Mercer Island Pump Station 11	4.25	17.4
Q3	East Trunk		
Q4	Bellevue Lake Line	2.75	20.1
Q5	Bellevue 108th Avenue		
Q6	Enatai Homes		

a. Flow rates contain 25% UFF

2.5.2 Hydraulic Analysis

Preliminary hydraulic grade lines were determined for Stage 1 by an analysis using the Hazen-Williams equation to calculate major hydraulic losses through the pipe segments, with the following key design assumptions:

- Hydraulic analysis based on a single new pipe to convey the projected design flows. Dual piping configurations (either use of the existing and new pipe or dual new pipes) were not hydraulically considered.
- Peak flows included the 25-percent UFF.
- Maximum flow velocity was assumed to be 8 feet per second (fps) in force mains and 5 fps in all other pipes.
- Conveyance system boundary conditions were identified as follows:

    - Sweyolocken Pump Station—This location is the downstream end of the project and sets the starting gradeline for the hydraulic analysis.
    - Bellevue Lake Line—This location is an inflow point to the Enatai Interceptor for which the County identified a limiting surcharge elevation.
    - Enatai Homes—This location is where numerous homes along the Enatai shoreline connect directly to the Enatai Interceptor; identified a limiting surcharge elevation
    - Bellevue 108th Avenue NE—This is a location where a new interceptor could collect flows from the local gravity system; identified a limiting surcharge elevation
    - East Trunk—This location is associated with the East Trunk limiting surcharge elevation identified in the County memorandum.
    - Diversion Alternative (West Trunk under I-90)—This location addresses conditions related to the potential bypass of flows upstream of the North Mercer Pump Station; identified a limiting surcharge elevation

Based on the hydraulic analysis, alternatives were categorized into one of three hydraulically similar scenarios:

- Upland Pipeline Option—Alternatives 1 through 5 all include a long force main on Mercer Island that parallels the north side of I-90. The length of the new force main would require improvements to the North Mercer Pump Station. This would result in a steep portion of gravity sewer down to the Mercer Island shoreline for connection to the East Channel segment. For these alternatives, only the East Channel and Enatai portions of the new interceptor would likely be surcharged. Flows from the East Trunk would continue through a rehabilitated portion of the existing North Mercer Island Interceptor to the west side of the East Channel or require routing through the new conveyance system.
- In-Water Option—Alternatives 6 through 10 include an in-water pipeline along the north side of Mercer Island that would replace the existing interceptor and carry East Trunk flows. Hydraulics for this option would closely match the existing system, with most of the in-water portion of the interceptor surcharged during most flow conditions.
- Diversion Option—Due to the elevation of a gravity diversion to bypass the North Mercer Pump Station, the diversion option (Alternatives 11 through 15) works only with an in-water section along Mercer Island, similar to Alternatives 6 through 10. For these alternatives, it is likely that the entire interceptor would be surcharged from the point of the diversion to the East Channel crossing.

2.5.3 Trenchless Construction

A Stage 1 analysis of trenchless technologies evaluated factors such as trenchless length, compatibility with geotechnical conditions, need for conductor casings and intersect drilling and ability to handle potential obstructions along the bore path. Findings are presented in the *Stage 1 Trenchless Construction Analysis*

Technical Memorandum (Staheli Trenchless Consultants, October 2014). At the end of Stage 1, six segments involving trenchless construction were still under consideration:

- Segment A10-1—A microtunnel or open-shield pipe jack between Manhole S10 and Luther Burbank Park, in two segments along SE 24th Street and 84th Avenue SE.
- Segment A10-2—Trenchless (via horizontal directional drill (HDD) or microtunnel) in a straight line between Manhole S10 and Luther Burbank Park.
- Segment B3—An HDD beneath the East Channel between the Mercer Island Boat Launch and Enatai Beach Park, on the south side of the I-90 Bridge.
- Segment B4—An HDD beneath the East Channel between the Mercer Island Boat Launch and Enatai Beach Park, on the north side of the I-90 Bridge.
- Segment B5—An HDD beneath the East Channel and the Enatai neighborhood, between the Mercer Island Boat Launch and Sweyolocken Pump Station.
- Segment C1—An HDD beneath the Enatai neighborhood between Enatai Beach Park and Sweyolocken Pump Station.

2.5.4 Pump Station Concepts and Condition Assessment

In Stage 1, the North Mercer Pump Station criterion was developed to evaluate alternatives based on rating levels of high, medium and low associated with flow and TDH capacity increases to the North Mercer Pump Station.

Pump Station Concepts

The hydraulic profiles developed for the 15 remaining alternatives indicated the following levels of requirements at the North Mercer Pump Station:

- Alternatives 11 through 15 - No increase in flow capacity beyond the existing 8 mgd, and insignificant reduction in head
- Alternatives 6 through 10 - An increase in flow capacity to 13.1 mgd, with a moderate increase in head due to increased flows.
- Alternatives 1 through 5 - An increase in flow capacity to 13.1 mgd and a significantly higher head capacity, possibly to the point of two-stage pumping.

North Mercer Pump Station Condition Assessment

During Stage 1, King County's operations group was preparing to conduct a pump station condition assessment to develop a recommendation of pump station modifications required to maintain existing operating conditions for the next six years. The recommendation would be presented in Stage 2. The project team met with King County operations and maintenance staff on October 7, 2014, to discuss the North Mercer Pump Station. It was agreed that any improvements at the North Mercer Pump Station required to implement the pipeline alternatives would also reflect the recommendations of the condition assessment.

2.5.5 Pipe Condition Assessment

Due to the absence of pipe condition data, the preliminary scope statement in the Preliminary Project Charter made an initial project assumption of a new pipeline parallel to the existing pipeline, which would remain in service, and recommended that the existing pipe be inspected by this project to confirm its continued use. To determine the feasibility of continuing to use the existing pipeline, the project team performed a pipeline condition assessment in Stage 1 through review of existing record documents and past studies. Records reviewed included previous video inspections, sonar profiling, corrosion inspection reports and evaluations that led to

previous system repairs and replacements, cathodic protection upgrades, and pipeline rehabilitation work. Key findings were as follows:

- North Mercer Island Interceptor (Upland)—Approximately 2,000 feet of pipe was replaced in 2007 as part of an emergency repair.
- North Mercer Island Interceptor (Lake Line)—Pipe has not been inspected or assessed, due to lack of access to the pipeline.
- North Mercer Island Trunk (East)—This line has been inspected by video.
- East Channel Siphon—Pipe condition assessment data is available from a 1999 corrosion inspection and a 2001 cathodic protection study.
- Enatai Interceptor—Sonar profiling of the interceptor has been performed (except for the portion connecting to the Sweyolocken Pump Station) and part of the interceptor has been rehabilitated to address hydrogen sulfide damage by relining with cured in place pipe.

Because the Enatai Interceptor was the only portion of the existing conveyance system anticipated to remain in service, the *Subtask 302 – Pipeline Condition Assessment Report* (Tetra Tech, 2015) concluded with the recommendation to rehabilitate the existing reinforced concrete pipe to prevent further hydrogen sulfide damage.

2.5.6 Geotechnical Investigation

A review was conducted of existing geotechnical data and environmental data resource reports for locations within 200 to 500 feet of the alternative pipeline alignments. Results are summarized in *Geotechnical Survey of Existing Conditions Report* (Shannon & Wilson, 2014). The following data sources were reviewed:

- Shannon & Wilson job files
- Washington Department of Natural Resources (DNR) subsurface geology information system
- DNR Washington Interactive Geologic Maps
- A 1983 report on historical changes in Lake Washington (Chrzastowski, 1983).

Most potentially contaminated sites were found to be more than 500 feet from the alignments and are considered to have a low potential to impact the project. However, two sites with documented petroleum contamination were identified at the existing North Mercer Pump Station.

To evaluate surface geology, surface features and subsurface soil and groundwater conditions along the alternative pipeline alignments, the Project Team developed a geotechnical boring plan to complete four on-land geotechnical borings in Mercer Island and Bellevue. Permits, community information flyers and boring plans were developed in Stage 1 for preparation of the field work to occur in Stage 2.

2.5.7 Agency Contact

The following agencies were contacted in Stage 1 to solicit input regarding the segments and alternatives under consideration:

- WSDOT was contacted to determine the feasibility of hanging pipe on the I-90 East Channel bridge (Segment B9). Discussions indicated that required investigation of seismic risk and structural design for this option could be costly. If studies indicated risks of structural impacts on the bridge or its piers, then costly mitigation could be required. This information led to the elimination of this option.
- Sound Transit will be constructing light rail lines in the center roadway of I-90 and north along Bellevue Way, which will be known as East Link. King County met with Sound Transit and WSDOT to coordinate project construction in Mercer Island and Bellevue.

- The project team met with City of Bellevue staff to present the project and the alternatives analysis process. The City provided utility maps and GIS information for use in the development of project base maps and flow projections.
- The project team met with City of Mercer Island staff to present the project and the alternatives analysis process. The City provided utility maps and GIS information, discussed flow projections, and coordinated on upcoming geotechnical borings and I/I information.
- The U.S. Army Corps of Engineers was contacted to outline the requirements for documentation and evaluation process for alternatives that could impact waters of the United States (as defined under the federal Clean Water Act).

2.6 ALTERNATIVES SCREENING PROCESS

The 15 alternatives were evaluated using the Stage 1 evaluation criteria and questions. Given the preliminary level of development of the Stage 1 alternatives, this evaluation was qualitative, using a system that assigned ratings of low, moderate or high impact. The ratings were modified in response to King County and project team feedback. For each question being used at this stage, the best answer was selected from those presented in the evaluation criteria matrix. Comments on the matrix were compiled into a unified document. Then, the project team assigned each alternative a single rating for each broad category, based on the ratings for individual answers within that category.

The Stage 1 Alternatives Evaluation Workshop was held on November 20, 2014 to finalize the rating process and reach consensus on the three alternatives to be removed. At the end of the Stage 1 alternatives evaluation workshop, 12 alternatives remained from the 15 evaluated, as summarized in Table 2-5. Table 2-6 lists the three eliminated alternatives and the justification for removing them.

Table 2-5. Summary Description of Alternatives Carried Forward from Stage 1

	Segments Included in Alternative[a]							
	Mercer Island			East Channel			Bellevue	
	A1/A5	A4	A10	B3/B4	B5	B6	C1	C6
Alternative 1	X			X			X	
Alternative 4	X					X	X	
Alternative 5	X					X		X
Alternative 6		X		X			X	
Alternative 7		X		X				X
Alternative 9		X				X	X	
Alternative 10		X				X		X
Alternative 11			X	X			X	
Alternative 12			X	X				X
Alternative 13			X		X			
Alternative 14			X			X	X	
Alternative 15			X			X		X

a. See Table 2-1 and Table 2-3 for description of segments.

Table 2-6. Preliminary Alternatives Not Advanced to Stage 2

Description	Explanation for Not Carrying Forward
Alternative 2	Poor soils in vicinity of Mercer Slough would have required pile-supported pipeline associated with Segment C6. Installation of piles in vicinity of WSDOT bridge also very high risk.
Alternative 3	High risk associated with long trenchless crossing for Segment B5; insufficient benefit relative to other alternative including Segment B5
Alternative 8	High risk associated with long trenchless crossing for Segment B5; insufficient benefit relative to other alternative including Segment B5

3. STAGE 2

The remaining Stage 1 alternatives and the Stage 1 matrix of evaluation criteria were the starting point for Stage 2. The initial work plan for Stage 2 was as follows:

- Further develop the 12 remaining alternatives.
- Update the criteria categories and questions based on updated design information.
- Replace the high-medium-low rating scale with a numerical scale.
- Define numerical weighting to indicate the relative importance of each criterion (weight the criteria categories).
- Use this updated information for a second-round evaluation to reduce the number of alternatives to six.

3.1 STAGE 2 CRITERIA UPDATE

3.1.1 Categories and Questions

Project team members reviewed the full Stage 1 evaluation matrix in light of the most current information about the project. The team deleted the North Mercer Pump Station category, as the issues related to it were integrated into the other categories. This change allowed alternatives to better be evaluated as unified systems including both pumping and pipeline conveyance. All other Stage 1 categories of criteria were retained.

Changes also were made to the wording of criteria, questions, and rating descriptions, in order to best address current project understanding. Questions that did not draw meaningful distinctions among the alternatives at the Stage 2 level of development were tabled for later use in Stage 3.

3.1.2 Criteria Weighting

A workshop was held on May 12, 2015 to establish the numerical weight for each category to define the relative importance of the criteria. Final weighting for the eight categories was determined as follows:

- Individual team members provided weights for each of the eight categories, with the sum equaling 100.
- Averages of the weights by category were presented at the workshop.
- The project team discussed each final weighting, modified several and documented justification for assigning the final weight to the specific category.
- Consensus was reached by the project team, and the final weighting was set.

Table 3-1 shows the final weighting assignments and major consideration for each criteria weighting.

Table 3-1. Final Stage 2 Criteria Weighting

Category	Final Weight	Considerations
Technical	16	• Hydraulic considerations • Complexity of design
Constructability	15	• Risks during construction • Large number of risk elements • Differences in construction methods (open-cut, trenchless, in-water) • Some trenchless options go under homes • Trenchless segments are relatively simple
Operation and Maintenance	19	• Addresses accessibility and long-term maintenance • Need to consider difference between no access and limited access • Potential for sediment accumulation
Permitting	10	• Addresses regulations and mitigation elements • Permitting complexity • Number and type of permits required for project to proceed
Rights of way, easements and rights of entry	8	• Subterranean easements necessary for trenchless crossings • Right of way/easement coordination split between Mercer Island and Bellevue • Number and complexity of surface easements and use permits
Environment	11	• Tribal and cultural considerations • Project area contains sensitive resources (fish and wildlife) • Environment approach: avoidance, minimization, mitigation
Community	5	• Community coordination related to the pipeline is temporary and related to construction • Community coordination related to permanent construction (i.e., odor control or North Mercer Pump Station modifications) would be similar among alternatives, thus not a differentiator • None of the alternatives have a long-term effect on community character that would justify additional weighting • Community concerns about environmentally sensitive areas and land use issues are captured in weighting for other sections • Community concerns about operations are covered in other sections • Community concerns about construction will be covered in contract specifications addressing noise, glare, vibration, and traffic
Cost	16	• Includes project, risk, and lifecycle costs
TOTAL	100	

3.2 EXISTING PIPE CONDITION ASSESSMENT

The Preliminary Project Charter included an initial assumption that the existing system could remain in place to continue to carry its current capacity of flow, with new facilities as parallel pipelines to accommodate additional flows. Reusing the existing North Mercer/Enatai interceptor system would require verification that the system is in suitable condition for ongoing use or can be effectively rehabilitated as needed. Not all of the existing piping has been inspected.

An adequate assessment of pipe condition required more information than the available data reviewed in Stage 1. A workshop on Dec 16, 2014, identified suitable pipe condition assessment techniques that could be used to acquire needed additional information. Techniques identified as feasible are summarized in Table 3-2.

The workshop analyzed suitable condition assessment techniques for each portion of the North Mercer/Enatai interceptor system without existing condition assessment. It was assumed at this stage of the evaluation that the force main will be replaced as part of this project; this would be verified based on actual condition assessment results. Table 3-3 summarizes the findings of this assessment.

Table 3-2. Pipe Condition Assessment Techniques—Description and Access Requirements

Test	Description	Access Requirements
Ultrasonic	Non-destructive pipe wall evaluation	Exterior access to pipe
Sonar	Interior submerged evaluation	Pipe access for equipment
Pipe Coupons	Wall sample cut from pipe for laboratory evaluation	Exterior access to pipe
Soil Test	Laboratory characterization of soil samples around pipe	Access to soil around pipe
Potential Test	Evaluation of continuity between pipe segments and electrical potential between pipe and soil	Exterior access to pipe
Pit Gage	Determination of extent of exterior pipe wall pitting	Exterior access to pipe
Radiography	Non-destructive unsubmerged pipe wall evaluation	Exterior access to pipe
CCTV	Interior unsubmerged pipe video	Pipe access for equipment

Table 3-3. Criteria for Selecting Pipe Condition Assessment Techniques

North Mercer Interceptor			East Channel Siphon	Enatai Interceptor
North Mercer Pump Station Force Main	Submerged Trunk			
	Upstream of East Trunk	Downstream of East Trunk		
Can Pipe Be Rehabilitated with Slipline or Cast-in-place Pipe, Without a Condition Assessment?				
YES	YES	YES	YES	YES
Condition Assessment Technique Options				
• Ultrasonic • Coupons • Soil Test • Potential Test • Pit Gage • Radiography • Partial CCTV	• Ultrasonic • Coupons • Soil Test • Potential Test • Pit Gage • Sonar • Radiography	• Ultrasonic • Coupons • Soil Test • Potential Test • Pit Gage • Sonar • Radiography	• Not required; use existing data	• CCTV • Sonar • Pile Evaluation
Confidence Level of Results				
LOW	LOW	LOW	N/A	HIGH
Permits Required				
Street Use Permit	• Corps Nationwide Permit 404/10 • Ecology 401 and Coastal zone management • Washington Department of Fish and Wildlife Hydraulic project approval • City Shoreline Exemption • DNR Right of Entry only • King County SEPA (in house)	• Corps Nationwide Permit 404/10 • Ecology 401 and Coastal zone management • Washington Department of Fish and Wildlife Hydraulic project approval • City Shoreline Exemption • DNR Right of Entry only • King County SEPA (in house)	N/A	None
Is Condition Assessment Feasible?				
YES	NO	NO	N/A	YES - CCTV
Recommendation				
Partial CCTV of the downstream piping that can be drained back would provide assessment of some pipe.	Condition assessment not recommended due to high cost and effort and low level of confidence.	Condition assessment not recommended due to high cost and effort and low level of confidence.	Existing data is sufficient to evaluate condition of siphon.	Sonar is costly compared to CCTV with similar confidence level of results. CCTV is recommended.

CCTV = Closed circuit TV; DNR = Washington Department of Natural Resources; SEPA = State Environmental Policy Act

Key conclusions are as follows:

- Enatai Interceptor—CCTV and sonar are suitable assessment techniques. Both require equipment access to the pipe interior. Sonar has the advantage of being able to be performed in submerged conditions, but would be more expensive. CCTV was selected, to be performed by County staff outside surcharged areas.
- East Channel Siphon—Currently available condition assessment data is sufficient to determine the integrity of the pipe; no additional assessment is required.
- North Mercer Island Interceptor (Submerged Interceptor)—Available techniques would require divers and potentially destructive testing of the pipe. Such testing would be at point locations and would provide assessment data only for that specific spot on the pipe. The data provided would have a low confidence level because it might not represent the entire pipe. Acquiring permits would take at least three months, and timing restrictions in the fish window would be imposed on the work. In addition, previous studies have indicated a potential of rupture in the existing line. For these reasons, the project team decided not to perform condition assessment on the submerged portions of the existing North Mercer Interceptor.
- North Mercer Pump Station Force Main—Condition assessment data would have a low confidence level. CCTV would provide good results but the force main would need to be drained. The downstream end of the force main could be drained and taken out of service for about 30 minutes, allowing for partial CCTV. This approach was selected, to be performed by County staff as part of Stage 3.

Because the project team decided not to proceed with field pipe condition assessment of the existing North Mercer Interceptor downstream of the force main, it was determined that the upgrade project will not proceed on the charter's assumption that the entire existing system can remain in service as a parallel pipeline. That assumption would require higher certainty that the pipeline is in suitable condition than is justified by available information. The project decision at this Stage and with the information available was that the existing pipe could not be relied upon as a second pipeline. However, after construction of the new interceptors, the existing line will be taken out of service and the County will inspect the entire existing pipeline and determine the appropriate use of the existing pipe.

3.3 SINGLE VS. DUAL PIPELINE

King County guidelines require force mains and siphons to have multiple barrels to accommodate both high and low flows and to allow pipeline inspection and maintenance. Since significant portions of several of the alternatives are force mains or siphons, this would require extensive lengths of dual systems. A comparison was made between single and dual pipeline systems in early 2015 in order to identify the costs and benefits of using dual pipelines to manage flow velocities and enhance maintenance.

The Stage 2 assessment considered the feasibility of building complete new dual-pipe segments, including the trenchless and open-cut portions of the project. In Stage 2, a single force main was assumed for all alternatives. The trenchless analysis assumed that double-barrel siphons would be constructed as two independent HDD installations, due to the required pipeline diameter and the added project risk of installing multiple large-diameter barrels in one pull. The following HDD arrangements were considered:

- Segment A10-2—Two vertically stacked HDD bores
- Segments B3 and B4—Two vertically stacked HDD bores
- Segment B5—Two HDD bores that are vertically stacked at the Mercer Island Boat Launch and widen to be horizontally separated at Sweyolocken Pump Station
- Segment C1—Two HDD bores that are vertically stacked at Enatai Beach Park and widen to be horizontally separated at Sweyolocken Pump Station.

The project team developed Class 5 cost estimate comparisons for single and dual pipelines on two alternatives: Alternative 4, which was chosen to represent upland open-cut options on Mercer Island; and Alternative 14, which was chosen to represent trenchless options on Mercer Island (related to the diversion option). Both use in-water open-cut construction across the East Channel and a trenchless siphon across Bellevue for the Enatai segment. Trenchless construction of the dual siphons across Bellevue would use HDD or the proprietary Direct Pipe technology. Both technologies have a cost versus risk profile that would need to be evaluated.

The estimates are shown in Table 3-4 and Table 3-5. The cost analysis demonstrated the following:

- Choosing the dual pipeline approach for Alternative 4 would increase construction cost by about $12.5 million, most of it related to trenchless construction of Segment C1 in Bellevue. The cost increase associated with dual pipelines for the 10,300 feet of force main is about $1 million; this would be reduced if the force main length were decreased.
- Choosing the dual pipeline approach for Alternative 14 would increase construction cost by about $15.5 million, with most of the increase related to trenchless Segments A10 (Mercer Island Diversion) and C1 (Bellevue).

Table 3-4. Single vs. Dual Cost Analysis—Alternative 4

Segments	Alternative 4 (Single)	Alternative 4 (Dual)
North Mercer—Open Cut	$5,300,000	$6,400,000
East Channel—HDD	$2,900,000	$4,900,000
Enatai—HDD	$8,200,000	$13,900,000
Construction Subtotal	*$16,400,000*	*$25,200,000*
Design Contingency (@ 30%)	$4,920,000	$7,560,000
Construction Contingency (@ 10%)	$2,130,000	$3,280,000
Total Construction w/ Contingencies	$23,500,000	$36,000,000

Table 3-5. Single vs. Dual Cost Analysis—Alternative 14

Segments	Alternative 14 (Single)	Alternative 14 (Dual)
North Mercer—HDD & Open Cut	$18,100,000	$21,200,000
East Channel—HDD	$2,900,000	$4,900,000
Enatai—HDD	$8,200,000	$13,900,000
Construction Subtotal	*$29,200,000*	*$40,000,000*
Design Contingency (@ 30%)	$8,760,000 (@ 30%)	$12,000,000 (@ 30%)
Construction Contingency (@ 10%)	$3,780,000 (@ 10%)	$5,200,000 (@ 10%)
Total Construction w/ Contingencies	$41,700,000	$57,200,000

Based on the evaluation of costs, hydraulics and flow velocities associated with these dual-pipe systems versus a single pipe, the project team determined at a meeting with County staff on May 5, 2015 that the maintenance and hydraulic benefits of dual pipes do not justify the increased costs and risk. Therefore it was determined that all alternatives would be evaluated as single-pipe systems.

3.3.1 Removal of Uncertainty Flow Factor

In a single pipe system, making the pipe larger to convey higher peak flows would result in lower velocities during average flow conditions. When the single-pipe approach was selected over the dual-pipe approach, the County determined that the large pipe diameters required to convey peak flows with the UFF would be detrimental to flow velocities during the predominant average flow conditions. In addition, it was agreed that the

cost and operational issues do not support the use of the UFF. The team reached consensus that the 25-percent UFF should not be incorporated in the design flow for this project. This allows for a smaller pipeline, with better velocities at low-flow conditions. Because the decision to omit the UFF was made at the end of Stage 2, the hydraulic impacts of that decision were evaluated in Stage 3.

3.4 OTHER INVESTIGATIONS TO DEVELOP PIPELINE ALTERNATIVES

In Stage 2, the project team further advanced the design of alternatives, performed additional field investigation and met with agencies to solicit further input. This work identified fatal flaws associated with some alternatives. The work and findings are described below.

3.4.1 Hydraulic Analysis

The Stage 1 preliminary hydraulic analysis of grade lines, velocities, and pipe sizes was updated in Stage 2 to include the West Trunk pipeline section at the upstream end of the project, which was not analyzed in Stage 1. Hydraulic analysis also was conducted as part of the dual-pipe assessments described above.

3.4.2 Trenchless Construction

Trenchless Construction Analysis Based on Geotechnical Findings

The Stage 2 trenchless construction analysis advanced the trenchless design using the geotechnical field data collected in Stage 1. The following is a summary of findings for each trenchless segment still under consideration for Stage 2:

- Segment A10-1—No substantial changes to this segment were made since Stage 1. The geotechnical investigation confirmed the proposed alignment to be within hard or dense to very dense glaciolacustrine deposits with low hydraulic conductivity (Shannon & Wilson, 2015). It was determined that open-shield pipe jacking and microtunneling could both be feasible.
- Segment A10-2—The only substantial change to this segment made since Stage 1 was elimination of an on-grade HDD alternative because grade deviations are likely to exceed acceptable tolerances. Due to the elevation difference between the entry and exit of the siphon, the HDD would begin at the Luther Burbank Park south parking lot. This would decrease the chance of creating a highly pressurized borehole, which could result in hydrofracture along the alignment. Project-specific geotechnical borings showed the proposed alignment to be within hard or dense to very dense glaciolacustrine deposits consisting of sandy silt and fat clay (Shannon & Wilson, 2015). These soils will be relatively stable for borehole construction, making the HDD construction feasible
- Segment B3, B4 and B5—No substantial changes to these segments were made since Stage 1. Geotechnical boring data was not taken for the East Channel.
- Segment C1—In Stage 2, this segment was altered in two major ways. First, the entry angle of the bore was shallowed to allow the installation of conductor casing past two of the I-90 East Channel Bridge footings. Second, the alignment of the bore was modified near the Sweyolocken Pump Station to allow for equipment laydown in the boat launch parking area. This change allows for substantial reduction of impacted wetland areas around the Sweyolocken Pump Station, while increasing the separation between the proposed bore and the support columns to be constructed as part of Sound Transit's East Link project.

Trenchless Risk Assessment

The *Stage 2 Trenchless Risk Register* (Staheli Trenchless Consultants, 2015) was developed to compare trenchless options, including single and dual systems. The register provided a qualitative approach to describing risks

associated with each trenchless segment. A trenchless risk workshop on July 26, 2014 assessed the following potential risks for each alternative:

- The length, diameter or size of the pipeline classifies the construction as cutting edge (this increases the risk and cost, and limits the bidder pool).
- Challenging geotechnical conditions are present.
- Microtunneling machine becomes stuck.
- Obstruction (e.g., a boulder) is encountered.
- Borehole collapses during pullback.
- Construction footprint requires difficult permitting and high easement costs.
- Elevation difference between entry and exit increases the potential for hydrofracture or borehole collapse.
- Construction results in environmental impacts on shoreline or wetlands.
- Staging area cannot be obtained for layout and assembly area for pipe pullback.
- Private property or infrastructure settlement damage occurs.

The following was concluded from the workshop:

- Segment A10—A single HDD segment presents a slightly lower risk profile than microtunnel construction for this segment. Both trenchless options were carried forward.
- Segment B3 and B4—The risk profiles are similar for trenchless construction north or south of the I-90 bridge. HDD construction across the East Channel presents a better risk profile than microtunnel construction.
- Segment C1—The risk profile is less for HDD construction than for Direct Pipe, due to the ability for HDD to be redirected if obstructions are encountered. However, Direct Pipe will be further evaluated in predesign if hydraulic and operation and maintenance benefits outweigh the associated costs and risks.

3.4.3 Pump Station Concepts

Pump Station Modification Concepts

Because it was found in Stage 1 that the North Mercer Pump Station capacity and TDH requirements vary among the pipeline alternatives, the project team decided in Stage 2 to add the development of basic pump station concepts to the scope of work. Adding conceptual-level pump station definitions and costs allowed a more comprehensive comparison of overall conveyance system needs. It was intended to inform the selection of an inexpensive pipeline alternative that would require an expensive pump station upgrade not considered in the selection process. Three pump station concepts were developed:

- Concept A—Bypass some flow around the North Mercer Pump Station and change the force main discharge point, reducing its flow and total head requirements.
- Concept B—Increase flows to the North Mercer Pump Station and discharge at a similar location to the existing force main.
- Concept C—Increase flows to the North Mercer Pump Station and discharge 4.5 times farther downstream; this raises the pump head significantly.

The three pump station concepts are further described in the technical memorandum *North Mercer Pump Station, Development of Concepts* (Jacobs, 2015).

Pump Station Condition Assessment

The County completed its pump station condition assessment and summarized the findings in *North Mercer Island Pump Station Condition Assessment – Draft Final* (December 2014). The following recommendations

from the condition assessment were included in the pump station concept development to integrate with the pipeline alternatives:

- Recommendation EN6—Replace pumps and motors for energy savings purposes. For pipeline alternatives in which the existing pumps can be reused, implementation is assumed to be in 2029, the presumed end of the useful life of the existing equipment.
- Recommendation M5—Rebuild the generator in the initial construction of any pipeline alternative. Replace the generator in 2029.
- Recommendation M6—Replace chemical piping and valves associated with the odor control system.
- Additional essential items that are relatively low in cost will be completed.

3.4.4 Geotechnical Investigation

Shannon & Wilson completed the four on-land geotechnical borings in Mercer Island and Bellevue:

- Borings NME-1 and NME-4 were drilled to evaluate soil and groundwater conditions for the Enatai Beach and Enatai hill crossings. The borings were drilled and sampled to a depth of approximately 30 feet below the lowest point of the proposed HDD crossing of the East Channel (Segment B3/B4).
- Borings NME-5 and NME-6 were drilled to evaluate the subsurface conditions along the trenchless flow diversion alignment on Mercer Island (Segment A10). These borings were drilled and sampled to a depth of about 30 feet below the proposed invert elevation of the deep siphon diversion.

The geotechnical borings were analyzed for use in the Stage 2 trenchless construction analysis. Boring logs were developed to represent the subsurface conditions that would be encountered along the pipeline alignments. Other information shown in the boring logs includes the most recent groundwater level measurement, ground surface elevation, types and depths of sampling. The results of the upland geotechnical borings are presented in the *Preliminary Geotechnical Assessment* by Shannon and Wilson (December 2015).

3.4.5 Agency Contact

Coordination with agencies continued as alternatives design progressed in Stage 2. This coordination provided the following information for use in the alternatives analysis:

- The Washington State Department of Transportation notified the project team that the area of the I-90 bridge along Mercer Slough has no tolerance for settlement that could result from construction near the bridge piles. Construction along Mercer Slough and the bridge pier piles would pose a high construction risk. Poor soils offshore and through Mercer Slough could cause construction problems.
- Sound Transit has two light rail projects in the vicinity of the North Mercer /Enatai Project that will need to be coordinated; E130- East Link, Mercer Island segment and E320 – East Link, Bellevue segment. Coordination activities identified included the use of staging areas under the bridge approaches that both projects could use at the same time as the North Mercer /Enatai Project. Sound Transit plans to have the Bellevue segment (E320) in construction between 2016 and 2023 and the Mercer Island segment (E120) between 2019 and 2022.
- The City of Bellevue reported that its Shoreline Master Program is being updated and includes policy language that highly discourages construction in environmentally sensitive areas, including the Mercer Slough. Construction would affect the bike/walking path along Mercer Slough, requiring rerouting of bike traffic.
- The Enatai Beach Park is heavily used during the summer period (May-September). WSDOT owns a portion of the area beneath the bridge and Enatai park. The City stated that prior to any approval for use of park property requires a letter of intent on granting access by private owners before the permit is reviewed by the

City (i.e. WSDOT letter of intent required for Enatai Park). They noted that the funding of parks establishes certain restrictions on the use of the park which should be identified during the planning stage.

- The City of Bellevue also provided input on park activities and construction coordination with businesses. It was noted that there are businesses that use the Enatai Beach Park, including vendor that leases canoes and kayaks, and the Pacific Science Center and City of Bellevue canoe program.
- The City of Mercer Island provided input on pipe laydown areas for trenchless construction, construction around key events and businesses that use the Mercer shore, and construction around key parking areas, wetland areas and Luther Burbank Park. It was noted that trenchless across East Channel could be done in the winter to minimize construction during the summer when park and trails are in heavy use. Pullback staging area north of the bridge would need to take into consideration water front access to shoreline homes. Trenchless for the A10 diversion option could use laydown area for pipe pull back along N. Mercer Way, which is wide enough to provide 2 lane traffic. The City also identified the option of pipe laydown area on the on-ramp on 76th Ave.

3.4.6 Assessment of Enatai Shoreline/Mercer Slough Alignment

One of the Bellevue segments carried forward to Stage 2 was Segment C6, which includes a new gravity pipe parallel to the existing pipeline along the Enatai shoreline and then crossing through Mercer Slough. This segment offers the advantages of a gravity pipeline. The in-water open-cut pipeline along the Enatai shoreline would provide better hydraulic conditions and fewer operation and maintenance requirements than a siphon pipe option across Bellevue. Open-cut construction, even in-water, would improve flexibility for addressing obstructions during construction from existing boulders, piles or utilities. Such obstructions also would be less likely with the in-water alignment than along trenchless alignments. However, disadvantages of this segment option were further investigated in Stage 2.

A survey of the lake bed elevation (a bathymetric survey) was performed along the proposed route of the Enatai shoreline alignment. The survey was taken to a minimum of 100 feet offshore from the private boat docks that line the shoreline in this area. The bathymetric survey confirmed that the lake bed outside the private boat docks is at too low an elevation for the proposed new pipeline to be installed at the required slope. This means that the pipeline would have to be installed in one of the following three ways, all of which have fatal flaws:

- The pipeline could be built outside the docks on piles to provide the required slope, but this would not provide adequate protection of the pipe from boat anchors or barge spuds.
- The pipeline could be built outside the docks and graded with fill to provide required slope, but the amount of fill required in the lake could have enough potential impact to prevent the issuance of permits needed for the project.
- The pipeline could be built closer to shore where higher lake bed elevation would allow it to be buried with adequate cover, but this would require the pipeline to cross below private boat docks, which would be expensive, including potential costs associated with having to upgrade docks to current standards.

In addition to the fatal flaws based on the new bathymetry information, the following challenges would need to be addressed for any alternative that includes Segment C6:

- Construction through Mercer Slough would require the pipe to be pile-supported there, which would have potential impacts on the I-90 bridge pilings across the slough.
- Pending new City of Bellevue policies would discourage open-cut pipeline construction in Mercer Slough.
- There is potential to encounter obstructions in Mercer Slough from past bridge construction.
- Work on this alignment would have a higher risk of cultural resource discovery along the shoreline and greater disturbance of sensitive habitat.

- Limited staging area would be available for work under the I-90 bridge.

Given the fatal flaws and other considerations described above, the project team recommended that system alternatives including Segment C6 be eliminated.

3.5 ALTERNATIVES SCREENING PROCESS

The removal of alternatives that include Segment C6 eliminated five of the 12 initial Stage 2 alternatives. This effectively screened the number of alternatives from 12 to seven. The project team decided to proceed to Stage 3 with the seven remaining alternatives without holding the Stage 2 Alternatives Evaluation Workshop. Table 3-6 lists the alternatives officially carried forward. It should be noted that in anticipation of the deletion of several other segments (B3/B4 and B5), most of the Stage 2 deliverable documents describe only three remaining alternatives. Officially the elimination of these segments occurred during Stage 3.

Table 3-6. Summary Description of Alternatives to Be Carried Forward to Stage 3

	Segments Included in Alternative[a]							
	Mercer Island			East Channel			Bellevue	
	A1/A5	A4	A10	B3/B4	B5	B6	C1	C6
Alternative 1	X			X			X	
Alternative 4	X					X	X	
Alternative 6		X		X			X	
Alternative 9		X				X	X	
Alternative 11			X	X			X	
Alternative 13			X		X			
Alternative 14			X			X	X	

a. See Table 2-1 for description of segments.

4. STAGE 3

Stage 3 further developed the seven alternatives carried forward from Stage 2 and screened them through additional technical analysis and a criteria-based evaluation process to identify three best apparent alternatives and a single recommended alternative. The evaluation criteria were also refined prior to the screening based on the further development of the alternatives.

4.1 UPDATED DESIGN CRITERIA

4.1.1 Minimum Flow Velocity Design Criteria

Part of the Stage 3 analysis focused on pipeline performance during low flows. When flows are low, with resulting low velocities, the flow may not be able to keep solids suspended and transport them down the pipeline. The resulting accumulation of solids can present operational, maintenance, and/or hydraulic problems.

For gravity pipes and siphons, minimum flow velocities need to be established to ensure adequate solids suspension. A siphon requires higher minimum velocity than a gravity pipe because of the need to flush solids through the rise portion on the siphon's downstream end. The following minimum flow velocity design criteria were established for gravity pipes and siphons:

- Gravity systems shall maintain a minimum velocity of 2 fps at summer peak flows.
- Inverted siphons shall maintain a minimum velocity of 3 fps at summer peak flows. This can be accomplished with a dual pipe system in which one pipe is smaller and carries all the flow during low-flow periods—a smaller pipe results in higher velocities for a given amount of flow.

4.1.2 Siphon Rise

The established minimum flow velocity criterion for siphons is such that adequate flushing can be achieved provided that the amount of rise in the downstream siphon segment is not excessive. This relates to the duration for which sufficient velocity exists to move solids past the rise.

4.1.3 Low-Flow Design Criteria

Low-flow design criteria for the project were evaluated through a review of Enatai Interceptor summer flow monitoring data from 2009-2011. Based on the flow monitoring data, the project team established the following low-flow design criteria for the Enatai Interceptor:

- Average Dry-Weather Flow = 1.48 mgd
- Summer Daily Design Flow = 2.0 mgd.

4.1.4 Removal of Uncertainty Flow Factor

The project hydraulic modeling was updated in Stage 3 to remove the UFF. The updated modeling found that the removal of the UFF did not have a significant effect on low-flow velocity as it was partially offset by an adjustment of the assumed pipe roughness.

4.2 SCREENING OF SIPHON SEGMENTS

As part of the analysis of low-flow performance, all siphon segments in the Stage 3 alternatives were reviewed. Table 4-1 shows the vertical rise of the downstream portion of each of these segments. The siphon sections on Mercer Island and in Bellevue are not expected to present flow velocity problems. However, two of the three East Channel siphon segments have a downstream rise of more than 100 feet. Therefore, an additional assessment of the remaining East Channel segments was made.

Table 4-1. Rise of Siphon Segments

	Existing East Channel	Mercer Island A10-2 (HDD)	East Channel B3/B4	East Channel B5	East Channel B6	Bellevue C1
Rise of Downstream Portion of Siphon	35 feet	46 feet	102 feet	135 feet	43 feet	46 feet

Despite the prior decision to use a single pipe system, several team members expressed concern about low summer velocities and sedimentation. The project team used the new low-flow design criteria to model low-flow velocities for single and dual pipeline systems for the East Channel siphon segments. Flow velocities based on the updated average dry-weather flow and summer daily design flows were as follows:

- Single pipe: 0.48 to 0.64 fps
- Dual pipes (in the smaller-diameter low-flow pipe): 2.4 to 3.0 fps

Mercer Island

In Stage 2, the existing N. Mercer Interceptor downstream of the East Trunk was to be rehabbed and used to convey the East Trunk Flows similar to current flow path and out via the East Channel. However, the existing N. Mercer Interceptor downstream of the East Trunk does not meet the established minimum velocity criterion. Therefore, Alternative 4 was revised to include replacement of the City's Pump Station 11 in order to pump all East Trunk flows, as well as Mercer Island lake line flows currently flowing to PS11, to the new upland interceptor adjacent to I-90. A preliminary assessment of the existing pump station indicates that diverting all East Trunk flows and increasing the length and discharge elevation of the PS11 force main, as required to pump to the new interceptor, would require doubling the static head on the station and a threefold increase in the peak capacity of the station. Given the large increase in static head and peak capacity, it is anticipated a larger station would be constructed adjacent to the existing station on the Mercer Island shoreline.

East Channel

The peak summer velocity of 0.64 fps for a single-pipe system does not meet the established minimum velocity criterion, so a siphon across the East Channel would require dual pipes, with one of the two pipes a smaller low-flow pipe, to meet the velocity criterion. For open-cut Segment B6, this configuration meets all criteria and is an acceptable option. Its downstream siphon rise of 46 feet is similar to that of the 35-foot rise in the existing East Channel crossing.

Trenchless Segments B3, B4 and B5 all were found to have fatal flaws that ruled them out for further consideration:

- These segments have a downstream rise of more than 100 feet and have significantly more rise than other options.
- These segments require trenchless construction of two pipelines across the East Channel (assumed to be installed by HDD), which poses significant construction challenges:

- If the two pipes are installed in a single bore, it would require a bore diameter larger than has been previously used for this type of installation.
- If the two pipes are installed in separate bores, the construction would face space constraints relative to private property and proximity to WSDOT's East Channel bridge footings. The cost of the dual HDD pipes in separate bores across the East Channel would be essentially doubled.

Bellevue

In Stage 2, the existing Enatai Interceptor was to be rehabbed and used to convey localized City of Bellevue flows similar to current flow path and out to Sweyolocken. Flows from the East Channel siphon outlet will route low flows via the rehabbed Enatai Interceptor and high flows via the HDD pipeline to Sweyolocken.

4.3 FURTHER DEVELOPMENT OF SCREENED ALTERNATIVES

The removal of the alternatives that include B3, B4 and B5 trenchless segments eliminated four of the seven remaining Stage 3 alternatives, effectively screening the number of alternatives to three. The project team advanced the development of the three remaining alternatives and proceeded with them to the Stage 3 Alternatives Evaluation Workshop. Table 4-2 lists the alternatives carried forward.

Table 4-2. Summary Description of Alternatives Carried Forward to Stage 3 Evaluation Workshop

	Segments Included in Alternative[a]							
	Mercer Island			East Channel			Bellevue	
	A1/A5	A4	A10	B3/B4	B5	B6	C1	C6
Alternative 4	X					X	X	
Alternative 9		X				X	X	
Alternative 14			X			X	X	

a. See Table 2-1 and Table 2-3 for description of segments.

4.3.1 Force Main Hydraulic Modeling

Alternative 4 includes a new longer force main segment from the North Mercer Pump Station. Prior to Stage 3, two segment options for this force main (Segment A1 and Segment A5) were treated as equivalent. For the Stage 3 analysis, hydraulic modeling of the two options was carried out to better assess differences between the two. Low-flow velocities also were evaluated for Segments A4 and A10.

Force Main Segment A1

Segment A1 is the longer of the two force main segment options, at 10,850 feet. This 24-inch force main contains two intermediate high points before discharging in the vicinity of the East Trunk. Hydraulic modeling found that, due to the long distance and intermediate high points, the force main will not remain fully pressurized during low-flow conditions (single pump operation). Low flows will be pumped to the first high point, in the vicinity of the existing force main discharge, and then flow by gravity through two siphon segments before reaching the force main discharge point. Low-flow velocities through a single pipe along these two siphon segments will range from 0.1 to 1.4 fps, with the lower velocities occurring when pumps are not in operation.

Force Main Segment A5

Segment A5 is 7,100 feet long and contains one intermediate high point. Hydraulic modeling found that, because the elevation of the force main discharge is higher than it is for Segment A1, the force main will remain pressurized during all flow conditions. Velocities during pump operation are expected to range between 1.1 and 1.7 fps in the single 24-inch force main.

Force Main Segment A4

For the Alternative 9 force main (Segment A4), velocities ranged from 1.4 to 2.2 fps during single pump operation.

Force Main Segment A10

For the Alternative 14 force main (Segment A10), velocities ranged from 1.7 to 3.0 fps during single pump operation.

Dual Force Main Evaluation

Due to the low velocities resulting from single pump operation, as well as the County's requirements for two force mains, it was determined that dual force main pipes would be required to meet the velocity criteria set for siphon segments discussed previously. Because this decision was made at a project team meeting on October 20, 2015, shortly before the conclusion of Stage 3, it was not reflected in any of the Stage 3 documents. Dual force mains will however be implemented during the Predesign phase. A more detailed discussion on the dual force main evaluation can be found in the *Dual Force Main Memo* (Tetra Tech, 2015) submitted with the Stage 3 deliverable package.

Surge Analysis

A surge analysis for the force main options associated with the three remaining alternatives identified a need for surge tanks at the North Mercer Pump Station and established locations for vacuum relief and air release valves (Flow Science, October 2015). There were no major differences between the surge mitigation measures recommended for the force main options. Surge tanks able to store 150 to 200 cubic feet were recommended at the North Mercer Pump Station. Four-inch vacuum relief valves were identified at high points and grade breaks along the force main.

4.3.2 Risk Assessment

Trenchless Risks

A second trenchless risk workshop was held in August 2015 to assess risks associated with trenchless construction. The trenchless risks associated with Segment C1 were not assessed in detail because they would be common to all three remaining alternatives. The trenchless risk register identified risks related to specific trenchless segments as follows:

- Segment A10-1, a single microtunneled gravity pipe in the rights of way of SE 24th Street and 84th Avenue—The microtunneling would require three pits, with an intermediate shaft approximately 70 feet deep and located along a steep slope, requiring slope stabilization. The microtunnel alignment would eliminate the siphon, providing a gravity pipeline with ease of maintenance.
- Segment A10-2 (Microtunnel), a single microtunnel pipeline generally following North Mercer Way—The trenchless risks for microtunneling Segment A10-2 would be the same as those for Segment A10-1. The only difference would be the pipeline alignment. This alignment would be similar to that of the HDD option for Segment A10-2, but would provide gravity flow from Manhole S10 to Luther Burbank Park. The intermediate shaft would be located along North Mercer Way, adjacent to condominiums. During predesign, this alignment would be further reviewed to determine if the entire alignment and shaft can be maintained in the right of way.
- Segment A10-2 (HDD), dual HDD pipelines generally following North Mercer Way—Dual pipelines would be required for Segment A10-2 (HDD) to ensure that minimum flow velocity criteria are met. A

dual HDD pipeline would require separate boreholes for the low- and high-flow pipes, vertically stacked, or a larger single borehole than has previously been drilled (54-inch diameter) for dual carrier pipes.

The trenchless risk workshop qualitatively rated the probability of each risk and the potential impact of each risk as high, medium or low. Risks that were rated as having high probability or impact were quantified to establish the cost that could be incurred should that risk occur. Mitigation measures for addressing those risks, either in design or construction, were identified. Key conclusions were as follows:

- Alternative 14 has the highest risk profile and associated costs because it includes two trenchless segments—A10 and C1.
- Segments A10-1 and A10-2 (Microtunnel) have higher risks associated with encountering differing site conditions or a machine getting stuck.
- Segment A10-2 (HDD) has a lower risk profile and cost than the microtunnel option.
- Segment A10-2 (Microtunnel) was selected as the base case for A10 for the following reasons:
  - Microtunneling provides a gravity pipeline rather than an HDD siphon, with better hydraulic performance and reduced potential for sedimentation and odor generation.
  - The A10-2 alignment affects fewer residential homeowners and reduces construction risk associated with the slope stabilization required for construction along the A10-1 alignment.

The trenchless risks (see Appendix D) were integrated into the project risks and total project risk costs were identified.

Project Risks

The trenchless risk register did not identify risks to the overall project related to permitting, the environment or similar broad considerations. These project risks were identified in a separate project risk register and organized by the previously-identified evaluation criteria categories. Their probability and impact were rated as high, medium or low, and costs were estimated for those risks rated with a high probability or impact. The project risks accounted for the following potential design variations:

- Alternative 4 force main alignment risk—Opposition to construction of the force main along North Mercer Way could result in construction along the adjoining bike path instead, with similar high constructability risks. This alignment would require replacing the North Mercer Pump Station pumps with pumps having higher flow and head capacity, adding $3 million capital cost to the project risk for Alternative 4.
- For this alternative 4, the City of Mercer Island Pump Station 11 will need to be upgraded in order to maintain adequate flushing velocities in the system and maintain an upland alignment along Mercer Island. However, if coordination with the City of Mercer Island and permitting are not successful, additional open-cut in-water construction would be required along the Mercer shore, downstream of LS 11, resulting in a reduced construction cost with increased environmental mitigation.

Key conclusions were as follows:

- Alternative 14 has the highest risk profile and associated costs because it includes two trenchless segments—A10 and C1.
- Alternatives 4 and 9 have similar risk costs. However, potential variations in alignment for Alternative 4 would modify its project risk cost.

The project risk matrix is included in Appendix E.

4.3.3 Cost Estimating

Cost estimates were developed for the best apparent alternatives as shown in Table 4-3. The design status of the alternatives is considered to be conceptual (10% design), calling for a Class 4 estimate as defined by the Association for the Advancement of Cost Engineering International. The accuracy range for Class 4 estimates is minus 20 percent to plus 30 percent. The assumptions used for the cost estimates can be found in *Stage Three Alternatives Analysis 10% Design Level Estimate of Probable Cost* (P&M Services, 2015).

Table 4-3. Estimate of Probable Construction Cost for Evaluated Alternatives

	Alternative 4 (A1 option)	Alternative 9	Alternative 14
Conveyance	$34,430,000	$39,659,000	$53,623,000
North Mercer Pump Station Improvements	$1,287,634	$1,173,000	$971,000
Total Estimate of Probable Construction Costs	$35,717,634	$40,832,000	$54,594,000

Alternative 4 demonstrated the lowest construction costs, assuming modifications to the City of Mercer Island Pump Station 11 and construction of the force main along North Mercer Way. However, the costs associated with two possible variations of Alternative 4 were also developed, as shown in Table 4-4. Alternative 4 with the combination of variants would result in either similar or slightly less cost than Alternative 9. Alternative 14 had the highest costs, associated with its trenchless construction segments.

Table 4-4. Estimate of Probable Construction Cost for Alternative 4 Variants

	Hybrid In-Water Open-Cut in Mercer Island	Bike Path Alignment
Conveyance	$33,503,000	$33,503,000
North Mercer Pump Station Improvements	$1,288,000	$4,812,000
Total Estimate of Probable Construction Costs	$34,791,000	$38,315,000

Life Cycle Costs

Once total construction costs (capital costs) had been determined, those costs were entered into the County's life cycle cost model in order to compare alternatives based upon total life cycle costs. Information used to determine life cycle costs included existing North Mercer Pump Station power usage costs as well as annual labor and parts costs. For the purposes of determining annual costs for these items, existing quantities were scaled up or down depending on the ratio of existing average flow rates versus the anticipated average flow rate for each alternative. Life cycle costs also included costs for 2029 pump and generator improvements which were not included in the construction costs described previously, except for the A-5 variation which requires pump replacement to occur simultaneously with the installation of the new force main. Table 4-5 provides a summary of the information used in the calculation of life cycles costs as well as the resulting net costs. The *Stage 3 – Life Cycle Cost Summary Memo* (Tetra Tech, 2015) provides greater detail on how quantities used in the life cycle cost model were determined.

Table 4-5. Summary of Construction and Life Cycle Costs (in millions)

	Alternatives			
Description	Alt 4 - A1	Alt 4 - A5	Alt 9	Alt 14
Construction Cost	$22.8	$26.2	$26.0	$34.8
Life-Cycle Cost	$64.5	$66.2	$73.0	$92.0

4.4 STAGE 3 CRITERIA UPDATE

All criteria categories from Stage 2 were retained for Stage 3. The project team reviewed the criteria matrix in light of the most current design information about the alternatives. Revisions were made to the wording of criteria, questions, and rating descriptions, in order to best address current project understandings. Some questions were removed or added, as summarized in Table 4-6 and Table 4-7. The ratings associated with the criteria questions were made numerical by replacing the Stage 1 and Stage 2 qualitative rating scales as follows:

- Assign numerical value of 7 to 9 for descriptions previously rated "low."
- Assign numerical value of 4 to 6 for descriptions previously rated "medium."
- Assign numerical value of 1 to 3 for descriptions previously rated "high."

Table 4-6. Criteria Questions Removed in Stage 3

Questions Removed	Justification
Category: Constructability	
Will construction of the alternative encounter high groundwater and result in extensive dewatering systems?	All three alternatives will include work in the Luther Burbank Park area where groundwater levels may be high. Not a differentiator among alternatives based on findings.
Are there construction risks associated with substantial steep slopes?	Substantial steep slopes are not a differentiator among the three alternatives at this stage.
What is the planned construction schedule/duration? Does alternative meet project schedule?	Project schedules are not being developed for the three alternatives. However, community criteria question rates the alternatives based on duration of construction in each area.
Will the pump station construction have sufficient space for continuous operation, laydown area, and construction activity?	The pump station design is not part of this evaluation. However at this level of conceptual design for the pump station, there is sufficient space for operation, laydown and construction for all three concepts.
Is design geotechnical evaluation required to evaluate potential effects on existing facilities (buildings, bridges, etc.) adjacent to the work during construction?	This is not a differentiator, as the construction method across East Channel and Enatai, where work would occur adjacent to existing facilities, will be similar among the three alternatives.
Will construction of the alternative encounter contaminated soils?	There is insufficient information at this stage to evaluate the alternatives based on the potential of encountering contaminated soils.
Will construction of the alternative encounter contaminated groundwater?	There is insufficient information at this stage to evaluate the alternatives based on the potential of encountering contaminated groundwater.
Category: Operation and Maintenance	
What is the level of maintenance required for inspection and cleaning?	Level of maintenance is not a differentiator among the three alternatives.
How many mechanical/ instrumentation components are required?	The three alternatives include basic weir structures and mechanical/instrumentation components.
How difficult will it be to service equipment at the pump station, especially in deep structures such as the wet well, pump room and motor room?	The pump station is not part of the alternatives evaluation. In addition, servicing of equipment is not a differentiator among the three alternatives.
Do the facilities require interaction with other agencies for maintenance access?	There are not facilities that require interaction with agencies in order to access for maintenance among the three alternatives.
Category: Rights of way, easements and rights of entry	
How many rights of entry will be needed?	Rights of entry have not been identified for any of the three alternatives at this phase.
Alternative requires private land acquisition or relocation?	Acquisition or relocation is not required for any of the three alternatives at this phase.

Questions Removed	Justification
Category: Community	
Is facility compatible with existing and proposed land use and community and neighborhood plans?	The conveyance pipeline is routed to similar land use and community and neighborhood plans for all three alternatives; thus, this is not a differentiator at this stage.
Category: Cost	
Compared to other alternatives, are operational costs for training, energy, staffing, and external agency costs greater, the same or lower?	This is not a differentiator among the alternatives. The operational costs for training, energy, staffing and external agency are similar for the three pipeline projects.
How does the cost of land and land development compare with other alternatives?	This is not a differentiator among the alternatives. The cost of land and land development not applicable as there is no acquisition.
Are there extra costs imposed by external agencies and/or stakeholders resulting from their design standards or durability requirements?	There are not external agency costs identified among the alternatives based on input solicited by the agencies at this stage.

Table 4-7. Criteria Questions Added in Stage 3

Category	Questions Added	Justification
Community	Will construction occur in public access areas, including parks and beaches? What is the estimated construction duration for each area?	This question evaluates the alternatives based on the duration of construction in specific areas, which differ among the alternatives.
Costs	Are the project risk costs relatively close to one another (i.e., project risk cost is not a differentiating factor in selecting an alternative), or is there a high degree of variability in cost between the alternatives?	Project risks costs have been developed in Stage 3 and are be included as a question to compare the total project risk costs between the three alternatives.

4.5 FINAL ALTERNATIVES EVALUATION

The Stage 3 alternatives evaluation workshop rated the remaining alternatives based on the criteria questions in the criteria matrix. The alternatives evaluation matrix summarized the key elements of the Best Apparent Alternatives for each criteria category (see Appendix F). Each alternative was assigned one score for each of the eight criteria categories. The weighting developed in Stage 2 was applied, and the scores were summed. Individual Project Team members developed rating scores for their respective categories and were sent to the discipline leads. Discipline leads developed rating scores for their respective categories, while taking into consideration the ratings from the project team members.

The individual rating scores were also used to calculate the minimum, maximum, mean and median category rating score using the individual rating score. In general, a higher score indicates a better rating for the given alternative. The scores were presented in the Stage 3 Alternatives Evaluation Workshop held on November 19, 2015. The calculated rating scores demonstrated that Alternative 4 resulted in the highest rating score as summarized in Table 4-8. The project team discussed and reached consensus on rating scores at the workshop.

Table 4-8. Evaluation Scores for Evaluated Alternatives

	Weighted Minimum	Weighted Maximum	Weighted Mean	Weighted Median	Weighted Combined Score by Discipline Leads
Alternative 4	362	687	531	546	545
Alternative 9	286	518	400	404	415
Alternative 14	197	439	312	324	276

Alternative 4 received the highest weighted combined score and is the recommended best apparent alternative. Table 4-9 provides a breakdown of the 545 weighted combined scores by category.

Table 4-9. Final Weighting Category Rating Scores

Category	Weighted Combined Score by Discipline Leads	Justification Alternative 4 selected over Alternative 9 and 14
Technical	64	• Alt 4 has the LS 11 replacement that lowers the score. • Alt 14 requires less flow and TDH requirements at the North Mercer Pump Station. • For North Mercer Pump Station operation, Alt 14 is the most reliable, while Alt 9 is a little more reliable than Alt 4. • Alt 9 requires 4 pumps at the North Mercer Pump Station as currently designed so it's more space constrained. • Alt 14 received lower score due to complicated drop structure at flow diversion.
Constructability	120	• Alt 9 and 14, in-water construction is riskier than land construction. • Microtunneling risks for Alt 14 are even higher than other alternatives. • Alt 9 and 14 have soft ground concerns in Luther Burbank Park which do not apply to Alt 4. • Alt 4 force main can be shallow, easier to change alignment in field to accommodate utilities if needed. Gravity would be more challenging, especially along the bike path.
Operation and Maintenance	95	• Upland access is ideal, therefore Alt 4 was ranked the highest. • Dual force mains will allow bypassing for inspection and maintenance.
Permitting	50	• Alt 4, less complex federal and state permits as a result of less in-water construction. • Less risk for NGO and/or tribal opposition as a result of less in-water construction for Alt 4. • Less mitigation required along Mercer Island for Alt 4. • Mercer Island permitting complexity resulted in lower rating for Alt 4. • Special use permit may be required by City of Bellevue for use of Enatai Beach Park.
ROW /Easements	32	• Alt 9 avoids the potential easements for bike path, although it does affect Luther Burbank Park. Alt 9 was rated higher because of fewer potential easements required. • Alt 4 requires more involvement and coordination with WSDOT. • Alt 9 and 14 avoids boat launch coordination with City of Mercer Island police boat and dock.
Environment	55	• Alt 4 avoids in-water works and impacts associated impacts to Lake Washington fish, wildlife, and wetlands. • Alt 9 and 14 contain an area in Luther Burbank Park near shoreline has higher potential to contain cultural resources. • All alternatives would have similar potential for encountering petroleum contamination in soils at the North Mercer Pump Station.
Community Involvement	16.5	• Alt 9 and 14 requires going through Luther Burbank Park for a portion of the alignment. Alt 4 parallels Luther Burbank Park, potentially on park property, but it does not require a significant structure in the park. • Alt 14 avoids traffic impacts near community center, although it does impact condos due to location of microtunneling pit and odor control. Also impacts Luther Burbank Park. • Alt 9 and 14 could potentially affect waterfront areas although both avoid impacts to N. Mercer Way. • Alt 4 is problematic due to N. Mercer way, need to qualify the tree impact which could be a community issue. • Permanent community impacts are related to odor control facilities. • All alternatives could potentially get credit for improvements by removing red ivy at the North Mercer Pump Station. • Alt 4 could get a credit for improving bike path.
Cost	112	• Alt 14 had highest construction costs, life cycle costs, and project risk costs.
Total	545	

5. CAPITAL SYSTEM TEAM APPROVAL

On January 12, 2016, the results of the alternatives analysis and a comparison of the best apparent alternatives were presented to King County's Capital System Team, with the following recommendation for management approval:

- Implement Alternative 4, including upland open-cut via Mercer Island (routing along the I-90 trail to be finalized in predesign), open-cut across the East Channel and trenchless construction across Bellevue.
- Add scope and budget for necessary North Mercer Pump Station modifications required as part of the pipeline improvements.

The Capital System Team approved the recommendation.

5.1 NEXT STEPS

Next steps will include the following:

- Finalize upland open-cut alignment in Mercer Island along the I-90 trail. Tasks include obtaining feedback from bicycle and Mercer Island neighborhood groups, evaluation of WSDOT retaining walls along the north side of I-90 (e.g., locations of tiebacks), evaluation of constructability along narrow portions of the bike path, confirmation of existing utilities and further evaluation of North Mercer Pump Station and Mercer Island Lift Station 11 requirements.
- Local Agency Coordination with City of Mercer Island, Sound Transit and WSDOT. During predesign, these PS11 modifications will continue to be discussed and coordinated with the City of Mercer Island. Coordination with Sound Transit is ongoing for design purposes, construction staging and scheduling, and community involvement. Applicable portions of the project design will need to comply with WSDOT standards.
- Conveyance of East Trunk Flows. Further evaluation is needed of the advantages and disadvantages of Mercer Island Pump Station 11 concepts (and associated modifications to the East Trunk) with King County and the City of Mercer Island. This will require discussions with Mercer Island regarding costs of the required improvements, operation of Pump Station 11, and local flows into the East Trunk.
- The condition of the Enatai Interceptor's existing pipe and piles needs to be assessed in order to further evaluate the feasibility of rehabilitating the Enatai Interceptor to meet project goals for design life and hydraulic capacity. If the condition of the piles is too deteriorated, it may be necessary to design facilities to pump flow to the new interceptor from the homes that currently connect directly to the Enatai Interceptor and from the Bellevue Lakeline.
- A more in-depth evaluation of velocities, the number of pipes, and flow splitting structures will be necessary to refine the selected alternative.

REFERENCES

Chrzastowski, Michael J. 1983. Historical Changes to Lake Washington and Route of the Lake Washington Ship Canal, King County, Washington. U.S. Geological Survey Water-Resources Investigations Report 81-1182.

Flow Science, Inc. 2015. North Mercer Island & Enatai Interceptor Upgrades Pump Station Force Main Alternatives Pressure Surge Analysis. October 2015.

Appendix A. Segment Disposition Matrix

CONTRACT PHASE 1 – ALTERNATIVES ANALYSIS
SEGMENT DISPOSITION MATRIX
STAGE 1

Segments	Alignments	Description	Pros	Cons	Tributary Flow Impacts	Justification for Not Moving Forward
A Segments **Generally the North Mercer Area**	A1	FM from NMPS to existing FM discharge connection. "Gravity" along NM way to East Channel.	Opportunity for new smaller FM with existing Interceptor to provide capacity. Better access with pipe in road not in water. Easiest in constructability compared to other A segments. Short term "rolling area" impact with construction of approximately 12,000 lineal feet of piping (min 1 year of construction) rather than a long term impact in a fixed area. Suitable soil in area (till and fill) Majority of construction within the ROW	Needs increased capacity at North Mercer PS from 8 mgd to 10.5 mgd or 13.2 mgd (w/ 25% UFF) Additional TDH required relative to the existing system (high pumping impacts, high energy costs). Longer force main than existing system/A4 (~10,700 ft vs. ~2300 ft) Mini siphons through the system; additional air valves with potential to address odor control. Increased operation & maintenance with air valves. Variable grade lines cause pressurized system requiring sealed manholes. High community impact with alignment along residential and arterial streets. High impact (even though short term), blocking driveways and dead-end roads. Potential for staging area impact in Luther Burbank Park. Potential impact to the bike path at the Mercer Shore	Majority of East Trunk flows could be connected. Local connections north of alignment & downstream of FM discharge could not be connected.	Moves forward. Combined with A5-1 for Alternatives Analysis due to significant similarities.
	A2	FM from NMPS, south of I-90 along 84th Ave SE to SE 36th ST (~ 4500 lineal feet of FM). Trenchless under hillside, and open-cut/trenchless along south side of I-90 to East Channel.		Needs increased capacity at North Mercer PS from 8 mgd to 10.5 mgd or 13.2 mgd (w/ 25% UFF) Additional TDH required relative to the existing system (high pumping impacts, high energy costs). High trenchless risk from Sta 75 to 100, due to ravines and height differential. High trenchless risk across I-90 due to	Local connections north of alignment & downstream of FM discharge could not be connected.	Substantial TDH. Trenchless challenges.

Segments	Alignments	Description	Pros	Cons	Tributary Flow Impacts	Justification for Not Moving Forward
				potential height differential of 160 feet. Deep shafts, 30 to 40 feet. Higher costs compared to A1 and A5 (north options) due to trenchless construction and greater length.		
	A3	FM from NMPS, south of I-90 along 77th Ave SE to SE 36th ST via local streets and under Island Crest Way. Trenchless under hillside, and open-cut/trenchless along south side of I-90 to East Channel.		Needs increased capacity at North Mercer PS from 8 mgd to 10.5 mgd or 13.2 mgd (w/ 25% UFF) Additional TDH required relative to the existing system (high pumping impacts, high energy costs). High trenchless risk from Sta 75 to 100, due to ravines and height differential. Impact to major business areas (restaurants, gas station) Higher costs compared to A1 and A5 (north options) due to trenchless construction and greater length. I-90 crossing increases difficulty and risk.	Local connections north of alignment & downstream of FM discharge could not be connected.	Substantial TDH. Trenchless challenges.
	A4	Generally follows existing pipeline route from NMPS to existing FM discharge connection. Gravity along Mercer shoreline to East Channel.	Pipeline follows shoreline and may have limited slope. Good constructability. Good connectivity to existing tributaries. Limited traffic / public impact. No trenchless construction risk. Very good hydraulics.	Needs increased capacity at North Mercer PS from 8 mgd to 10.5 mgd or 13.2 mgd (w/ 25% UFF) Similar TDH required as for the existing system (medium pumping impact, medium energy costs). High water impact, permits. Long schedule (potentially 2 seasons for in-water construction) High environmental impacts. Long length difficult access for O&M.	Allows connection of East Trunk and MI PS 11.	Moves forward.
	A4-1	A4, but with pipe laid on bottom.	Similar to A4 except as noted. Simplified construction relative to A4. Good connectivity to existing tributaries? Less traffic impact Exposed pipe is more visible for inspection purposes.	Similar to A4 except as noted. Greater risk of pipe damage (vs. A4). Increased impact on environment, fish (vs. A4). Expected significant permitting challenges.	Same as A4.	ACOE won't accept if there is a feasible option to bury the pipe on the same alignment.
	A5	FM from NMPS to past midpoint of A5. "Gravity" along Bike Path Route, along Bike Path route on north side of I-90, on north side of I-90.	Opportunity for new smaller FM with existing interceptor to provide capacity. Better access with pipe in road, not in water.	Needs increased capacity at North Mercer PS from 8 mgd to 10.5 mgd or 13.2 mgd (w/ 25% UFF) Additional TDH required relative to the	Majority of East Trunk flows (COMI) could be connected. Local connections north of	Insufficient benefit with trenchless (high cost and risk) compared to A5-1 and

Segments	Alignments	Description	Pros	Cons	Tributary Flow Impacts	Justification for Not Moving Forward
		Trenchless required due to high point at Sta 65+00 (about 40 feet depth).	Easiest in constructability compared to other A segments. Short term rolling area impact rather than a long term. Suitable soil in area is till and fill. Generally follows grades Less potential for utility conflicts with open cut in bike path.	existing system (high pumping impacts, high energy costs). Longer force main than existing system/A4 Mini siphons through the system; additional air valves with potential to address odor control. Increased operation & maintenance with air valves. Variable grade lines cause pressurized system with sealed manholes. Potential for staging area impact in Park. Major impact to the bike path. High community impact to bikers and pedestrian. Higher costs compared to A1 due to trenchless segment.	alignment & downstream of existing FM Discharge could not be connected.	A5-2 alternatives.
	A5-1	A5, along Bike Path route on north side of I-90, but with open cut to high point about Sta 65 to elevation ~140.	Eliminates trenchless segment in A5 (lower cost, lower risk) New high point at Sta 65+00 may be better option than having much longer force main for alternatives that include C3 segment (high point in Bellevue).	Needs increased capacity at North Mercer PS from 8 mgd to 10.5 mgd or 13.2 mgd (w/ 25% UFF) Additional TDH required relative to the existing system (high pumping impacts, high energy costs). Longer force main than existing system/A4 (~6500 ft vs. ~2300 ft)	Generally similar to A-5.	Moves forward. Renamed to A-5. Combined with A1for Alternatives Analysis due to significant similarities.
	A5-2	Same as A5-1, but open-cut North Mercer Way from about Sta 55 to Sta 70 (“bump”).	Eliminates new high point that is part of A5-1, and trenchless segment that is part of A-5. Generally similar to A-5.	Needs increased capacity at North Mercer PS from 8 mgd to 10.5 mgd or 13.2 mgd (w/ 25% UFF) Additional TDH required relative to the existing system (high pumping impacts, high energy costs). Longer force main than existing system/A4 (~10,700 ft vs. ~2300 ft) or A5-1. Generally similar to A5-1.	Generally similar to A-5.	
	A5-3	A5, but with trenchless from Sta 40 to 107.	Better hydraulics than other A5 options.	Needs increased capacity at North Mercer PS from 8 mgd to 10.5 mgd or 13.2 mgd (w/ 25% UFF) Similar TDH required as for the existing system (medium pumping impact, medium energy costs).	East Trunk flows could not be connected.	High risk and cost associated with trenchless does not outweigh pros compared to other A segements.

Segment Disposition Matrix

Segments	Alignments	Description	Pros	Cons	Tributary Flow Impacts	Justification for Not Moving Forward
				Very long, expensive, technically difficult HDD/trenchless segment.		
	A6	FM from NMPS to high point near Sta 70. Trenchless across I-90 along 84th Ave. Gravity along the south side of I-90 either via open cut or trenchless construction.	Avoids most roads, follows south side of I-90 alignment, lower on hill than A2 and A3. Requires fewer trenchless segments, as compared to A2 and A3.	Needs increased capacity at North Mercer PS from 8 mgd to 10.5 mgd or 13.2 mgd (w/ 25% UFF) Additional TDH required relative to the existing system (high pumping impacts, high energy costs). Longer force main than existing system/A4 (~7000 ft vs. ~2300 ft) High environmental impact due to construction through trees and park. Higher costs compared to A1 and A5 (north options) due to I-90 trenchless crossing and greater length.	Majority of East Trunk flows (COMI) could be connected. Local connections north of alignment & downstream of existing FM Discharge (including MI PS 11) could not be connected.	High construction costs and greater lengths does not outweigh pros compared to other A segements.
	A7	Provide storage at NMPS to limit or delay required PS upgrades and pipe upgrades.				Discarded by King County
	A8	Tunnel all the way from NMPS to Sweyolocken.	Very low community and traffic impact. May eliminate NMPS.	Technically infeasible without intermediate shafts in the water. Long length without access for O&M. Very high cost and risk.	Does not allow connection of any tributary flows.	Cost prohibitive – estimated $100 mil.
	A9	HDD from NMPS to East Trunk connection or Mercer Shore.	May eliminate NMPS.	Long length without access for O&M. Wet well at NMPS is lower than East Trunk connection along Mercer shoreline.	Allows connection of East Trunk and MI PS 11.	Hydraulics of this segment was a fatal flaw, as flow would go backwards from East Trunk connection to NMPS.
	A10-1	Divert flows at MH S-10, trenchless on SE 24th St from 78th Ave SE to 84th Ave SE, trenchless south on 84th Ave SE to meet grade at south end of Luther Burbank Park, then A4 profile in lake.	Limits or eliminates required NMPS Upgrade (which one is pending further study). Reduced TDH required relative to the existing system (low pumping impacts, low energy costs). Shorter force main than existing system/ A4 (~1300 ft vs. ~2300 ft) Good constructability in lake. Good connectivity to existing tributaries. Limited traffic / public impact in lake. Very good hydraulics.	Deep shaft at 24st St/84th Ave to connect two trenchless segments. Difficult staging area for trenchless. High water impact, permits. Long schedule (potentially 2 seasons for in-water construction). Long length difficult access for O&M.	Allows connection of East Trunk and MI PS 11.	Moves forward. Combined with A10-2 for Alternatives Analysis due to significant similarities.
	A10-2	Same as A10-1, except trenchless directly from SE24th St / 78th Ave SE to south end	Same as A10-1 except as noted.	Same as A10-1 except as noted.	Same as A10-1.	Moves forward.

Segments	Alignments	Description	Pros	Cons	Tributary Flow Impacts	Justification for Not Moving Forward
		of Luther Burbank Park.				Combined with A10-1 for Alternatives Analysis due to significant similarities.
B Segments **Generally the East Channel Area**	B1	Curving trenchless from west side of East Channel to Sweyolocken PS, south of I-90 and along south side of Bellevue shoreline and Mercer Slough.	Low community impacts. Low ROW impacts (both public and private)	Very soft soils (peat). Trenchless option would need to be below at least 30 feet deep. Complex WSDOT permitting. Complex trenchless - difficult to steer in peat, very long trenchless length, very long conductor casing. Long length without access for O&M. Staging area impacts boat launch on west side of East Channel. Potential obstructions under I-90 (slough area), existing drill shafts. Higher monitoring requirements due to ongoing existing WSDOT bridge settlement. Corrosive peat soils. Difficult steering. High water table. Coordinate with existing utilities on south side. Potential bike path impacts. Requires short trench across shoreline to connect to in-water A segments.	Bellevue/Enatai tributary flows could not be connected.	Complex trenchless in unsuitable soil. Complex WSDOT permitting.
	B2	Trenchless from west side of East Channel to Enatai Beach park vicinity, on south side of I-90. (This segment intended to fit with Segments A2 and A3.)	Staging area available on the South side. Simpler crossing – good stable soil conditions (in glacial soils), straight bore geometry alignment. Successful history of trenchless construction in existing soil conditions. Potential to use access road/lane south of I-90. Easiest connection to Bellevue flows.	Requires crossing I-90 twice compared to the north side alignments. Close to existing utilities in the Channel (water, gas, power). Staging area impact community further inland from Mercer Shore. Potential high mitigation costs related to staging in Enatai Beach Park. Requires trench across shoreline to connect to in-water A segments and Bellevue flows.	Bellevue tributary flows could be intercepted (depending on downstream segment).	Similar to B3 option; B2 option was to connect to A segment options south of I-90 that are currently proposed to be eliminated from further consideration.
	B3	Trenchless crossing of East Channel, south of I-90. (Similar to B2)	Simpler crossing – good stable soil conditions (in glacial soils), straight bore alignment.	Requires crossing I-90 twice compared to the north side alignments.	Bellevue tributary flows could be connected (depending on downstream	Moves forward. Combined with B4 for

Segment Disposition Matrix

Segments	Alignments	Description	Pros	Cons	Tributary Flow Impacts	Justification for Not Moving Forward
			Successful history of trenchless construction in existing soil conditions. Potential to use access road/lane south of I-90. Staging area on west side of crossing less constrained (vs. B4)	Close to existing utilities in the Channel (water, gas, power). Staging area impacts boat launch at Mercer Shore and Enatai Beach Park. Potential high mitigation costs related to staging in Enatai Beach Park. Requires short trench across shoreline to connect to in-water A segments and Bellevue Tributary flows.	segment)	Alternatives Analysis due to significant similarities.
	B4	Trenchless crossing of East Channel, north of I-90.	Similar to B3 except as noted. Avoids crossing I-90 twice (vs. B3). Minimizes impact to Enatai Beach Park (vs. B3) Avoids existing south side utilities in water.	Similar to B3 except as noted. Smaller staging area than B3.	Bellevue tributary flows could be connected. (depending on downstream segment).	Moves forward. Combined with B3 for Alternatives Analysis due to significant similarities.
	B5	Trenchless crossing on north side of I-90, from west side of East Channel on straight alignment to Sweyolocken PS.	Feasible crossing – good stable soil conditions (in glacial soils), straight bore geometry alignment. Successful history of trenchless construction in existing soil conditions.	Long length without access for O&M. Riskier than B4 and B3 (shorter segments). Higher costs than B3 or B4. Private easements acquisition required at significant depth. Likely requires an intersect due to length (~4,300). Requires short trench across shoreline to connect to in-water A segments.	Bellevue tributary flows could not be connected. Enatai flows could not be connected.	Moves forward.
	B6	Parallel the existing pipeline across East Channel, laying or trenching along bottom of lake.	Less risk than trenchless construction. Less cost than trenchless construction. Less length required than trenchless construction. Can access pipeline under East Channel as compared to trenchless B segments.	Environmental/Permitting impacts – adhere to fish windows for construction could extend construction schedule. Impact to boat traffic.	Bellevue tributary flows could be connected. (depending on downstream segment).	Moves forward.
	B7	Long HDD crossing, starting at 97th Ave SE on Mercer shoreline, under Enatai hillside, and ending at Sweyolocken PS.	Feasible crossing – good stable soil conditions (in glacial soils), straight bore geometry alignment. Successful history of trenchless construction in existing soil conditions. Reduces A4 length. Reduces WSDOT permitting	Long length without access for O&M. Riskier than B4 and B3 (shorter segments) Higher costs than B3 or B4. Private easements acquisition required at significant depth. Higher environmental risk with potential	Bellevue / Enatai flows could not be connected.	No benefit in comparison to B5 and high environmental and cost risks

Segments	Alignments	Description	Pros	Cons	Tributary Flow Impacts	Justification for Not Moving Forward
				of losing mud in the water. Longer length than B5. Higher trenchless cost due to platform / barge work in the water. Likely requires an intersect due to length (~5,300)		
	B8	Trenchless crossing of East Channel, diagonal across I-90.	Minimizes impact to Enatai Beach Park (vs. B3). Staging area on west side of crossing less constrained (vs. B4).	Complexity with avoiding piles and zone of influence in a diagonal crossing. Complex WSDOT Permitting; structural coordination for bridge foundations. Potentially more difficult pipe laydown area due to diagonal crossing. Requires short trench across shoreline to connect to in-water A segments.	Bellevue tributary flows could be connected (depending on downstream segment).	Insufficient benefits in comparison to B3/B4 and B5
	B9	Hang pipe on I-90 Bridge across East Channel	Can access pipe easier as compared to other B segments.	WSDOT permitting may be difficult or not possible to obtain. Only works with A5-1 due to hydraulics. Expected requirement to provide seismic evaluation and upgrades to bridge. Extensive coordination with WSDOT and Sound Transit regarding use of bridge. Requires short trench across shoreline to connect to in-water A segments.	Prevents connection of East Trunk flows to A segments. Bellevue tributary flows could be connected. (depending on downstream segment).	Complex seismic evaluation, potential cost impacts for seismic improvements, and overall agency coordination. Long forcemain required.
C Segments **Generally the Bellevue / Enatai Area**	C1	Straight shot from east end of B4 to Sweyolocken	Less risk, cost than trenchless B5 segment.	Creates intermediate high point / air valve between B3 and C1 segments. Higher cost, higher risk and open-cut C segments.	May allow Bellevue 108th Ave connection. Prevents Bellevue lake line and Enatai connections. May allow East Mercer Trunk flows to connect to new system (pending).	Moves forward.
	C2	Trenchless along south side of I-90, eastbound off-ramp to Bellevue Way, to Sweyolocken PS.	Low community impacts. Low ROW impacts (both public and private)	Very soft soils (peat). Trenchless option would need to be below at least 30 feet. Extensive WSDOT permitting process that would extend project schedule. Complex trenchless - difficult to steer a tight compound curve (both vertically and horizontally), long length, long conductor casing required for peat in Mercer Slough area.	Bellevue tributary flows could be connected (pending confirmation of entry/exit geometry). Enatai flows could not be connected.	Complex trenchless in unsuitable soil conditions. Complex WSDOT permitting.

Segments	Alignments	Description	Pros	Cons	Tributary Flow Impacts	Justification for Not Moving Forward
				Providing access manholes for deep trenchless pipe not feasible. Staging area impact boat launch at Mercer Shore. Potential obstructions under I-90, existing drill shafts. Higher settling monitoring requirements due to ongoing existing WSDOT bridge settlement. Corrosive peat soils. High water table Coordinate with existing utilities on south side of I-90. Potential bike path impacts.		
	C2-1	Same alignment as C2, but open cut.	Better hydraulics than C3. Less risk than trenchless C options. Less environmental impacts than C6.	Difficult open-cut construction through Mercer Slough area. Peat soils will require pile supported pipeline. Creates intermediate high point / air valve along C2-1 segment. Bike path impacts.	Does not allow connection of Bellevue or Enatai flows.	Complexity of construction in unsuitable soils, significant potential conflicts under I-90. Complex WSDOT permitting.
	C3	Open-cut along SE 34th ST and 113th Ave SE (north of I-90), trenchless under Bellevue Way, to Sweyolocken PS.	Balanced E&SJ - open cut balanced on both sides. Limited to no trenchless construction.	Short term impact to community, roads. Potential conflicts with tiebacks near retaining wall along I-90. Potential impact to bike path. Requires air valves. Creates new FM 17,000 feet long.	Backwater from high point elevation will prevent connection of East Trunk, Bellevue, and Enatai flows.	Excessively long forcemain
	C4	Trenchless along north side of I-90 / SE 34th ST, under Bellevue Way, to Sweyolocken PS.	Good stable soil conditions (in glacial soils). Successful history of trenchless construction in existing soil conditions. Low community impact	Complex trenchless - difficult to steer a tight compound curve (both vertically and horizontally). Geometry likely to be more like C1. Easements likely required for trenchless under private properties. Skewed crossing of WSDOT ROW (~600 feet). Lengthy conductor casing in slough area.	Bellevue tributary flows could be connected if deep shaft provided. Enatai flows could not be connected.	Complex trenchless in unsuitable soil conditions. Complex WSDOT permitting.
	C5	Open cut/trenchless, up 108th, SE 31st, SE 30th St, and Sweyolocken.	Limited to no trenchless construction.	Highest community impacts (traffic, neighborhood disruption) of C segments.	Backwater from high point elevation prevents	Insufficient benefit in comparison to C3.

Segments	Alignments	Description	Pros	Cons	Tributary Flow Impacts	Justification for Not Moving Forward
				Very deep profile requires numerous trenchless segments. (C3 is better open-cut option).	connection of East Trunk and all Bellevue tributaries. Alignment prevents connection of Enatai homes.	
	C6	Gravity pipe parallel to existing pipeline along Enatai shoreline, through Mercer Slough, to Sweyolocken PS.	Very good hydraulics; allows connection of Bellevue / Enatai flows.	Poor soils – pile support would be required. Environmental/permitting impacts. Potential bike path impacts. Complex WSDOT permitting. Poor constructability due to poor soils, work under existing bridge, and potential obstructions from past bridge construction. Long length difficult access for O&M.	Allows connection of Bellevue Lake Line, 108th St, and Enatai homes.	Moves forward.

Appendix B. Evaluation Criteria Matrix

North Mercer Island Interceptor and Enatai Interceptor Upgrade

SELECTION CRITERIA MATRIX – FINAL

Category		Criteria	Questions	Numeric Rating Scale			
				Scale: 7 -9	**Scale: 4 - 6**	**Scale 1 - 3**	**Comments**
TECHNICAL							
		Technical Complexity					
		The purpose of this question is to evaluate the level of complexity to manage flows in the conveyance system – including dual pipeline systems.	T1. In this alternative, does flow management require flow splitting structures? *– Operational Sustainability*	Simple or no special structures needed, similar to existing system.	Structures required, including flow diversion structures with overflow weirs. Mechanical gates are not required.	Structures required, including flow diversion structures with overflow weirs/and or mechanical gates.	
		The purpose of this question is to determine if modifications to the local systems are required.	T2. Does the alternative require modifications to the localized Mercer Island or Bellevue conveyance systems (piping or lift stations)? *--Operational, Economic Sustainability*	Does not require piping or pumping modifications of localized Mercer Island or Bellevue system.	Minimal piping modifications adjacent to the new pipelines required to convey local flows to the County's conveyance system.	Extensive piping and/or lift station modifications required to convey local flows to the County's conveyance system.	
		The purpose of this question is to rate the alternatives if rehab/relining is required to the existing County Interceptors.	T3. Are modifications to the existing King County North Mercer Island Interceptor and Enatai Interceptor required? *--Economic Sustainability*	No, existing interceptors will be decommissioned. Modifications not required.	Yes, rehab/relining of the Existing North Mercer Island or Enatai Interceptor required.	Yes, rehab/relining or replacement of the Existing North Mercer Island and Enatai Interceptor required.	Rehab/relining is required for portions of the existing pipeline that will be used to convey localized flows.
		The purpose of this question is to address need the for modifying the existing County pump station for the proposed alternatives.	T4. Does the North Mercer Pump Station require capacity (flow and/or head) related modifications? *--Operational, Environmental, Social Sustainability*	Pumping capacity upgrade is not required. Pump station capacity remains the same due to less flow to Pump Station.	Pumping upgrade is required to meet increased flow capacity. Moderate additional head capacity required. Upgrade modifications can be deferred until 2029.	Pumping capacity upgrade is required to meet increased flow capacity. Substantial additional head capacity required. Upgrade modifications can potentially be required as part of the pipeline project.	
		The purpose of this question is to rate the relative risk of pressure surge/drop on the modified force main and pump station based on the three pump station concepts.	T5. Do modifications result in risks of force main damaging due to potential changes in pressure resulting from hydraulic transients? Is mitigation required to reduce hydraulic transients?	Potential surge pressures represent a lesser risk of damaging force main(s) as existing. Mitigation for addressing hydraulic transients not required.	Potential surge pressures represent a similar risk of damaging force main(s) as existing. Mitigation required and consists of air/vac valves and surge tanks with footprint available along conveyance alignment.	Potential surge pressures represent a greater risk of damaging force main(s) as existing. Mitigation required and consists of air/vac valves and surge tanks with limited footprint (at pump station site) and along conveyance alignment.	

North Mercer Island Interceptor and Enatai Interceptor Upgrade

SELECTION CRITERIA MATRIX – FINAL

Category		Criteria	Questions	Numeric Rating Scale			
				Scale: 7 -9	**Scale: 4 - 6**	**Scale 1 - 3**	**Comments**
CONSTRUCTABILITY							
		Constructability/ Implementation Schedule					
		The purpose of this question is to rate based on constructability of upland open –cut .	C 1. Are the site conditions appropriate for constructability of upland <u>open-cut</u> pipeline and associated structures where proposed? --*Economic, Environmental Sustainability*	Open-cut is relatively shallow (6 ft or less)	Open-cut moderate depth 6-20 feet in depth.	Open cut deep trenches. (20 ft or greater)	
		The purpose of this question is to rate based on constructability of in-water open –cut.	C 2. Are the site conditions appropriate for constructability of in-water <u>open-cut</u> pipeline and associated structures where proposed? --*Economic, Environmental Sustainability*	There is only one segment for the entire conveyance system requiring in-water open-cut construction.	There are two or more segments for the entire conveyance system requiring in-water open-cut construction. In-water construction is outside of existing docks.	There are two or more segments for the entire conveyance system requiring in-water open-cut construction, or in-water construction is required under existing docks.	
		The purpose of this question is to rate based on constructability of trenchless –and whether alternative is "pushing the envelope" with respect to trenchless technology and if staging area is available.	C 3. Are conditions appropriate for constructability of <u>trenchless</u> pipeline and associated structures where proposed? Is adequate staging area available? --*Economic, Environmental, Social Sustainability*	Typical trenchless construction. Site is not constrained. Adequate area for access, pipe pull-back laying, and staging and operation of equipment can be accommodated.	Trenchless construction at upper end of typical pipe diameter and/or length for trenchless method. Site may be constrained, but access and staging are adequate for construction sequencing.	Trenchless construction exceeds typical pipe diameter and/or length for trenchless method. Site is constrained, requiring careful construction sequencing, with several move-in, move-out stages to accommodate construction by other agencies (Sound Transit, WSDOT).	
		2. Coordination with other Projects *The purpose of this question is to rate based on level of coordination required with agencies that go beyond and require extensive studies and calculations.*	C 4. What level of coordination with Sound Transit and WSDOT or other agencies is required?	Coordination is required but not complicated. Agencies (Sound transit, WSDOT) have clear project scope and project schedule to facilitate coordination.	Agency coordination effort required, including studies and calculations. Sound Transit and WSDOT project scope is still in early stage, but is clearly defined.	High level of effort coordination required during design, including studies, calculations and design modifications to agency facilities. Sound Transit and WSDOT project scope is still in early stage, not clearly defined.	
		The purpose of this question is to rate based on the level of coordination with existing utilities	C 5. Are existing utilities within the proximity of the pipeline construction zone that will require temporary reroute or replacement ? Do utilities require extensive coordination with agencies, MOA? --*Economic Sustainability*	There are no major utilities over or within the influence of the excavations or dewatering during construction. Existing utility requires minor rerouting of water and power lines. Limited to no coordination required with utility agencies.	There are major and minor utilities that cross over or are within the influence of the excavations or dewatering, but can be supported or appropriately shored to limit settlement. Dewatering induced settlements are negligible. Utility coordination, and permits required for input during design and construction (ie PSE).	There are numerous major and/or minor utilities that cross over or are within the influence of the excavations or dewatering that will require relocation, underpinning, the use of tight robust shoring, and/or recharge wells to limit settlement. Existing utility requires agency coordination, including MOA and utility applications with fees.	

North Mercer Island Interceptor and Enatai Interceptor Upgrade

SELECTION CRITERIA MATRIX – FINAL

Category		Criteria	Questions	Numeric Rating Scale			
				Scale: 7 -9	**Scale: 4 - 6**	**Scale 1 - 3**	**Comments**
		3. Soils, Sediments and Groundwater					
		The purpose of this question is to rate based on the presence of soft soils and the applicability of trenchless method to anticipated geotechnical conditions.	C 6. Will construction of the alternative encounter peat/soft soils that will need to be addressed in the design and construction of the foundation of the pipeline and related facilities? Are geotechnical conditions appropriate for constructability of trenchless pipeline and associated structures where proposed? *--Economic, Environmental Sustainability*	It is unlikely that the alternative will encounter soft soils that will require pile support, deep foundations, or ground modification to limit settlement of the pipeline and related facilities. Anticipated geotechnical conditions are favorable for trenchless method.	It is likely that soft soils will be encountered that may require pile support, some over-excavation, and limited replacement of foundation soils to limit settlement of the pipeline and related facilities. Anticipated geotechnical conditions are somewhat to moderately unfavorable for trenchless method.	It is certain that soft soils will be encountered that will require pile support, deep foundations, or ground modification to limit settlement of the pipeline and related facilities. Anticipated geotechnical conditions are moderately unfavorable to unfeasible for trenchless method.	
OPERATION AND MAINTENANCE							
		1. Operation					
		The purpose of this question is to rate based on potential for odor generation based on multiple odor release points along the pipeline project.	OM 1. Potential for odor generation due to long detention times requires multiple odor control systems? *-- Social Sustainability*	There are no additional air release points along the alignment. Similar to existing conditions.	Proposed improvements introduce new odor release points with one new air release point along the alignment.	Proposed improvements introduce multiple odor release points (air release points along the alignment).	
		2. Maintenance					
		The purpose of this question is to rate based on ease of access as well as safety.	OM 2. Are facility components accessible and safe for inspection, maintenance and cleaning? Is there permanent access and staging for County maintenance vehicles (chemical, vactor and boom trucks). Are traffic control, special procedures, specialized personnel or special equipment required? *– Operational Sustainability*	The facility components are accessible for routine and non–routine operations. Alternative does not have right of way access requirements, in water access or require confined space entry. Permanent access available for County maintenance vehicles. No traffic control or specialized procedures/personnel are required during operations and maintenance.	The facility components are accessible for routine O&M. However, right of way access requirements or confined space entry for non-routine operation and/or maintenance procedures are required. Limited access is available for County maintenance vehicles. Traffic control procedures are required during non-routine operations and maintenance procedures. Specialized procedures are required for manway access in the water for pipeline inspection.	The facility components have restricted access for routine O&M. Right of way access requirements, special in-water access or confined space entry required during routine operation and/or maintenance procedures. Access is not available for County maintenance vehicles. Traffic control procedures are required during routine operations and maintenance procedures. Manway access in the water for pipeline inspection not feasible.	
PERMITTING							
		The purpose of these questions is to rate the alternatives based on the complexity of obtaining the required permits.	P 1. **Consistency with Shoreline Master Program (SMP).** Consider whether alternative is consistent with City of Mercer Island and City of Bellevue SMP. For instance, the City of Bellevue's updated SMP states that conveyance must be out of the water. *-- Environmental Sustainability*	All segments consistent with SMP of both Mercer Island and Bellevue	Minor inconsistency with SMP of either Mercer Island or Bellevue.	Substantial inconsistency with SMP of either Mercer Island or Bellevue.	All alternatives will need to obtain 404 (Corps permit), 401 (Ecology permit), HPA (WDFW permit), SSDP (Cities of Mercer Island and Bellevue permits), DNR easement, and work within Corps in-water work windows.

North Mercer Island Interceptor and Enatai Interceptor Upgrade

SELECTION CRITERIA MATRIX – FINAL

Category		Criteria	Questions	Numeric Rating Scale			
				Scale: 7 -9	**Scale: 4 - 6**	**Scale 1 - 3**	**Comments**
			P 2. **Type of Corps permit required.** Nationwide Permit or Individual Permit.	Falls under Nationwide Permit 12 (Utility Line activities).	Requires a more complex nationwide permit (i.e., Individual 401 certification). - OR – Requires a less complex individual permit.	Requires a more complex individual permit.	
			P 3. **Duration to acquire land use permits (Mercer Island, Bellevue)**. Estimated length of time to obtain permits.	Less time than average.	Average time.	Extensive negotiations required with cities.	
ROW/EASEMENTS/ RIGHT OF ENTRY							
		Property Rights Acquisition					
		The purpose of this question is to rate based on easements needed.	ROW 1. How many permanent/construction easements will be needed?	0-5 easements needed.	6-10 easements needed.	More than 10 easements needed.	
		The purpose of this question is to rate based on ROW needed.	ROW 2. What ROW agreements will be needed?	No apparent coordination conflicts.	Minor coordination conflicts but can be worked out.	Major conflicts for coordination or restrictions imposed.	
ENVIRONMENT							
		Cultural Resources	E 1. **Will construction occur in areas that have been identified as "high probability" for archaeological resources?** -- *Social Sustainability*	The project does not require ground disturbance in Mercer Slough or Luther Burbank shoreline.	The project requires ground disturbance in with Mercer Slough <u>OR</u> Luther Burbank shoreline.	The project requires ground disturbance in both Mercer Slough <u>AND</u> Luther Burbank shoreline	Based on a high-level survey from King County archaeologist, Mercer Slough and South Luther Burbank Park shoreline are the two known areas with potential overlap with alternatives.
		Tribal Fishery	E 2. **Work in proximity to tribal fishery.** Consider timing/duration of in-water work and proximity to tribal fishery and potential mitigation. *Environmental, Social Sustainability*	Limited amount of in-water work.	Moderate amount of in-water work.	Extensive in-water work.	
		Fish and Wildlife	E 3. Will construction or operation of the alternative adversely affect fish and wildlife or their habitat? -- *Determinant of Equity: Healthy Built and Natural Environment* -- *Environmental Sustainability*	Construction and operation of the alternative will not adversely affect, or will beneficially affect, fish and wildlife and/or their habitat. No Effect Letter anticipated for ESA Section 7 compliance.	Construction and/or operation of the alternative may affect but are not likely to adversely affect fish and wildlife or their habitat. Informal consultation anticipated for ESA Section 7 compliance.	Construction and/or operation of the alternative is likely to adversely affect fish and wildlife and/or their habitat and require compensatory mitigation. Formal consultation anticipated for ESA Section 7 compliance.	
		Mitigation	**E 4. Extent of required mitigation.** Based on the extent of mitigation habitat disturbance, consider amount of structure within mitigation area, temporary vs permanent coordination, terrestrial (wetlands) vs aquatic (shoreline). *-Environmental Sustainability*	No mitigation or limited mitigation.	Moderate mitigation.	Extensive mitigation .	

North Mercer Island Interceptor and Enatai Interceptor Upgrade

SELECTION CRITERIA MATRIX – FINAL

Category		Criteria	Questions	Numeric Rating Scale			
				Scale: 7 -9	**Scale: 4 - 6**	**Scale 1 - 3**	**Comments**
COMMUNITY							
		Construction locations	CI 1. Will construction occur in public access areas, including parks and beaches? What is the estimated construction duration for each area? -- *Determinant of Equity: Access to Parks and Natural Resources* -- *Social Sustainability*	**Location** Project located on site with no public access, or public access can be maintained during construction. **Duration** Project is short duration or constructed outside main user season.	**Location** Project located in public access area; access may be reduced, but some access can be maintained during construction. **Duration** Duration may be up to six months in each construction staging area.	**Location** Project located in public access area. Construction results in unavoidable area closures. **Duration** Project lasts one year or more in each construction staging area.	Areas are defined as Mercer Island, East Channel and Bellevue.
		Transportation	CI 2. Will construction affect bike and pedestrian trails, bus routes, commuter parking, and/or roadways? -- *Determinant of Equity: Access to Safe and Efficient Transportation* -- *Social Sustainability*	Project located on site where access can be maintained during construction. Project is short duration or constructed outside main user season. Bus routes are minimally affected, and commuter parking can be accommodated. Restoration requirements may improve existing conditions.	Project located in an area where access may be reduced, but some access can be maintained during construction. Affected roadways and trails will require careful attention to traffic control during a moderate duration project. Bus service can be maintained, but may have temporary stops or detours. Commuter parking can be accommodated, but at a different location.	Project lasts one year or more, located in heavy-use roadway, or trail, with unavoidable area closures, resulting in detours. Bus service in the area cannot be maintained, and commuter parking is temporarily unavailable.	
		Construction effects on neighbors and area users	CI 3. What will neighbors and area users experience during construction? -- *Determinant of Equity: Strong and Vibrant Neighborhoods* -- *Social Sustainability*	Reasonable measures can be implemented to meet or exceed requirements for construction site controls to reduce vibration, noise and light to surrounding properties. The construction method requires truck traffic but can be staged to avoid heavy traffic or access disruptions. Worker parking can be accommodated on site or in the area with little effect on neighbors.	High levels of construction activity can be constrained during normal working hours. Construction noise and glare reaching nearby properties can be reduced or buffered with reasonable measures to ensure compliance with local ordinances. Construction traffic includes some periods of heavy truck traffic or large equipment deliveries, but work can be scheduled to provide advanced notice to neighbors and users. Worker parking can't be accommodated on site, but will not affect the area.	The construction method requires 24-hour work, or long working hours at high activity levels, and may require temporary accommodations to be available if needed or required by permit. There is insufficient room or other obstacles to buffer noise or reduce light reaching surrounding properties. High-level construction traffic is expected for extended periods, and either special measures will be needed to maintain traffic flow or traffic disruptions can't be avoided. Worker parking will affect the surrounding area unless special measures are implemented.	
COST							
		1. Project Costs					
			C1. Are the Construction Costs relatively close to one another (i.e. cost is not a differentiating factor in selecting an alternative), or is there a high degree of variability in Cost between the alternatives?	Alternative has the lowest Construction Cost, or the Project Cost is tightly grouped near the lowest cost alternative relative to the expected accuracy of the estimate.	Alternative has a Construction Cost that is moderately higher than the low cost alternative, and lower than the high cost alternative, relative to the expected accuracy of the estimate.	Alternative has the highest Construction Cost and/or is exceedingly higher than the next lowest cost alternative, relative to the expected accuracy of the estimate.	

North Mercer Island Interceptor and Enatai Interceptor Upgrade SELECTION CRITERIA MATRIX – FINAL							
Category		**Criteria**	**Questions**	**Numeric Rating Scale**			
				Scale: 7 -9	**Scale: 4 - 6**	**Scale 1 - 3**	**Comments**
			C2. Are the Life-Cycle Costs relatively close to one another (i.e. life-cycle cost is not a differentiating factor in selecting an alternative), or is there a high degree of variability in Life-Cycle Cost between the alternatives? -- *Economic and Environmental Sustainability*	Alternative has the lowest Life-Cycle Cost, or the Life-Cycle Cost is tightly grouped near the lowest cost alternative relative to the expected accuracy of the estimate. No added operational energy use	Alternative has a Life-Cycle Cost that is higher than the low cost alternative, and lower than the high cost alternative, relative to the expected accuracy of the estimate. Moderate added operational energy use (0 – 100,000 kWh/year)	Alternative has the highest Life-Cycle Cost . High added operational energy use (> 100,000 kWh/year	
			C3. Are the Project Risk Costs relatively close to one another (i.e. project risk cost is not a differentiating factor in selecting an alternative), or is there a high degree of variability in Cost between the alternatives?	Alternative has the lowest Project Risk Cost, or the Project Cost is tightly grouped near the lowest project risk cost alternative.	Alternative has a Project Risk Cost that is moderately higher than the low project risk cost alternative, and lower than the high project risk cost alternative.	Alternative has the highest Project Risk Cost and/or is exceedingly higher than the next lowest project risk cost alternative.	

Subtask 224—Alternatives Analysis Report

Appendix C. Sustainability Technical Memorandum

ALTERNATIVES ANALYSIS / GATE 2
SUSTAINABILITY / EQUITY AND SOCIAL JUSTICE MEMO

June 1st, 2016

INTRODUCTION

The North Mercer Island Interceptor and Enatai Interceptor Upgrade (North Mercer / Enatai) project is nearing completion of Phase 1 (alternatives analysis) and preparing for Gate 2 and Phase 2 (predesign). For the alternatives analysis, the project team developed a number of alternatives and a list of criteria against which each alternative was evaluated. This evaluation is being conducted in workshops over the course of three stages. Alternatives scoring relatively low by the evaluation criteria or found to have fatal flaws were eliminated. With two stages completed, three alternatives remain to be evaluated in the Stage 3 Alternatives Evaluation Workshop on November 19, 2015.

KING COUNTY SUSTAINABILITY REQUIREMENTS

The following King County requirements affect the evaluation of project alternatives:

- King County's Green Building Ordinance (GBO, Ordinance #17709, adopted December 2013), requires all LEED-eligible County construction projects to use the LEED rating system for evaluating alternatives. For other projects, the ordinance allows the use of department-established Sustainable Infrastructure Scorecards or an alternate sustainability rating system.
- The County's Strategic Climate Action Plan requires that by 2020 all County construction projects achieve a Platinum level under LEED, the Sustainable Infrastructure Scorecard, or the Envision rating system developed by the Institute for Sustainable Infrastructure and Harvard University for rating the community, environmental and economic benefits of infrastructure projects.

Wastewater Treatment Division (WTD) staff determined that the North Mercer / Enatai project is not LEED-eligible. As an alternative, Sustainability and Equity and Social Justice (ESJ) staff received approval from WTD management to apply the Envision rating system to the project on a pilot-testing basis (see Attachment A). The North Mercer / Enatai project is one of three WTD projects piloting the Envision system. County sustainability staff will also use WTD's Sustainable Infrastructure Scorecard to address GBO requirements.

Sustainability considerations are addressed in the criteria evaluations for this project, though they are not required during the alternatives analysis phase and no reporting is required at Gate 2. Sustainability evaluations will be more fully implemented during predesign and final design. The County's sustainability lead will document the process and results annually in the GBO Annual Report.

EQUITY AND SOCIAL JUSTICE EXPECTATIONS

King County Ordinance #16948 (October 2010) establishes principles and approaches for the County to conduct its business in fair and just ways. As an ESJ pilot project for WTD, the North Mercer / Enatai project is to incorporate ESJ strategies where they are feasible and reasonable. Like the sustainability principles, ESJ principles are addressed in the alternative evaluation criteria and will be applied more completely in the predesign and final design phase. The project team's ESJ lead will monitor and report progress on ESJ principles to WTD management on a quarterly basis.

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INCORPORATION OF ENVISION INTO THE ALTERNATIVES ANALYSIS

Sustainability and ESJ principles are addressed in the alternatives analysis by being included in the evaluation criteria definitions. WTD's sustainability and ESJ leads participated in team meetings and gave targeted presentations about how these principles apply to the evaluation criteria and the advantages and disadvantages for each alternative (see Table 1). The sustainability lead presented a summary of the Envision rating system. The ESJ lead guided the project team through a review of the determinants of equity applicable to elements of the project alternatives (see Attachment B). The sustainability and ESJ leads also participated in document development and review. Each of these steps helped inform the project team's evaluation of alternatives and the application of scores for alternative selection.

INCORPORATION OF ENERGY EFFICIENCY INTO THE ALTERNATIVES ANALYSIS

This project is evaluating pipelines that function primarily by gravity. However, the project alternatives have energy requirements associated with the static head on force mains and dynamic head, which varies with force main length. Variations among the alternatives were converted to electrical energy consumed and then to cost based on power cost and rate schedules. Energy use costs are included in the life cycle cost estimate for each alternative. Therefore, energy requirements are included in the alternatives rating system and inform part of the selection of alternatives.

HIGH-LEVEL SUSTAINABILITY/ESJ PLAN FOR PREDESIGN (PRE-GATE 3)

Sustainability and ESJ are expected to be implemented more thoroughly during the predesign phase of the project leading to Gate 3. The expected activities are currently being incorporated into the evolving scope of work for predesign. Planned activities and associated deliverables include the following:

- Conduct a sustainability / ESJ workshop (an eco-charrette) early in the predesign phase.
- Incorporate strategies identified as most applicable at the workshop into the evolving design concept:
  - Prioritize strategies that address both sustainability and ESJ.
  - Seek ways to use the project's "2% for sustainability" allocation.
- Continue to conduct energy analyses consistent with King County Energy Efficiency Ordinance #16927.
- Complete the Envision checklist at the 30-percent level near the end of predesign.
- Complete the 30-percent Sustainable Infrastructure Scorecard.
- Complete an assessment of expected construction and demolition waste, and develop a plan to address the following 2015 Strategic Climate Action Plan target: 85% construction and demolition waste diversion by 2025.

Table 1. Alternatives Sustainability and ESJ Evaluation

	Pros	Cons
Alternative 4: Mercer Island Upland Route with Lift Station 11 Upgrade; Lake Bottom Crossing of East Channel with Upland Connection; Trenchless Enatai Alignment	• Shortest duration of impacts to Luther Burbank Park and the Community Center • Infrastructure coordination– working with Mercer Island to upgrade Pump Station 11 • Limited in-water work • No impact to wetlands in Luther Burbank Park • Opportunity to do restoration along 84th Avenue • Opportunity to make drainage improvements as part of permit conditions • Easier access for maintenance and inspection	• Traffic effects on North Mercer Way • More effect on cyclists, many of whom currently use North Mercer Way • Higher energy use at the North Mercer Pump Station
Alternative 9: Mercer Island Lake Bottom Route; Lake Bottom Crossing of East Channel with In-Water Connection; Trenchless Enatai Alignment	• Limited traffic effects • Opportunity to do restoration along 84th Avenue • Less energy use at the North Mercer Pump Station	• Increased access effects on Luther Burbank Park and the Community Center • Primarily in-water work • Effects on wetlands in Luther Burbank Park • Keeping an operational pipe in the lake: o Limited access for maintenance and inspection
Alternative 14: Mercer Island Trenchless Diversion and Lake Bottom Route; Lake Bottom Crossing of East Channel with In-Water Connection; Trenchless Enatai Alignment	• Least amount of energy use at the North Mercer Pump Station • Reduced traffic temporary impacts on North Mercer Way	• Neighborhood impacts by Luther Burbank Park: o Noise, vibration from trenchless construction o Potential temporary resident accommodations o Trenchless pits • Access impacts on Luther Burbank Park and the Community Center • Traffic effects on the neighborhood by Luther Burbank: o If HDD, pullback to shut down an I-90 on-ramp o Assembling pipeline temporarily on streets • Primarily in-water work • Keeping an operational pipe in the lake: o Limited access for maintenance and inspection

Attachment A: Envision Credit List

ENVISION™
CREDIT LIST

QUALITY OF LIFE
13 Credits

1 PURPOSE

QL1.1 Improve Community Quality of Life
QL1.2 Stimulate Sustainable Growth & Development
QL1.3 Develop Local Skills & Capabilities

2 WELLBEING

QL2.1 Enhance Public Health & Safety
QL2.2 Minimize Noise and Vibration
QL2.3 Minimize Light Pollution
QL2.4 Improve Community Mobility & Access
QL2.5 Encourage Alternative Modes of Transportation
QL2.6 Improve Site Accessibility, Safety & Wayfinding

3 COMMUNITY

QL3.1 Preserve Historic & Cultural Resources
QL3.2 Preserve Views & Local Character
QL3.3 Enhance Public Space

QL0.0 Innovate or Exceed Credit Requirements

LEADERSHIP
10 Credits

1 COLLABORATION

LD1.1 Provide Effective Leadership & Commitment
LD1.2 Establish A Sustainability Management System
LD1.3 Foster Collaboration & Teamwork
LD1.4 Provide for Stakeholder Involvement

2 MANAGEMENT

LD2.1 Pursue By-Product Synergy Opportunities
LD2.2 Improve Infrastructure Integration

3 PLANNING

LD3.1 Plan For Long-Term Monitoring & Maintenance
LD3.2 Address Conflicting Regulations & Policies
LD3.3 Extend Useful Life

LD0.0 Innovate or Exceed Credit Requirements

RESOURCE ALLOCATION
14 Credits

1 MATERIALS

RA1.1 Reduce Net Embodied Energy
RA1.2 Support Sustainable Procurement Practices
RA1.3 Use Recycled Materials
RA1.4 Use Regional Materials
RA1.5 Divert Waste From Landfills
RA1.6 Reduce Excavated Materials Taken Off Site
RA1.7 Provide For Deconstruction & Recycling

2 ENERGY

RA2.1 Reduce Energy Consumption
RA2.2 Use Renewable Energy
RA2.3 Commission & Monitor Energy Systems

3 WATER

RA3.1 Protect Fresh Water Availability
RA3.2 Reduce Potable Water Consumption
RA3.3 Monitor Water Systems

RA0.0 Innovate or Exceed Credit Requirements

NATURAL WORLD
15 Credits

1 SITING

NW1.1 Preserve Prime Habitat
NW1.2 Protect Wetlands & Surface Water
NW1.3 Preserve Prime Farmland
NW1.4 Avoid Adverse Geology
NW1.5 Preserve Floodplain Functions
NW1.6 Avoid Unsuitable Development on Steep Slopes
NW1.7 Preserve Greenfields

2 LAND+WATER

NW2.1 Manage Stormwater
NW2.2 Reduce Pesticide & Fertilizer Impacts
NW2.3 Prevent Surface & Groundwater Contamination

3 BIODIVERSITY

NW3.1 Preserve Species Biodiversity
NW3.2 Control Invasive Species
NW3.3 Restore Disturbed Soils
NW3.4 Maintain Wetland & Surface Water Functions

NW0.0 Innovate or Exceed Credit Requirements

CLIMATE AND RISK
8 Credits

1 EMISSIONS

CR1.1 Reduce Greenhouse Gas Emissions
CR1.2 Reduce Air Pollutant Emissions

2 RESILIENCE

CR2.1 Assess Climate Threat
CR2.2 Avoid Traps & Vulnerabilities
CR2.3 Prepare For Long-Term Adaptability
CR2.4 Prepare For Short-Term Hazards
CR2.5 Manage Heat Island Effects

CR0.0 Innovate or Exceed Credit Requirements

Institute For Sustainable Infrastructure
1275 K Street, NW, Suite 750
Washington, DC 20005

Attachment B: Determinants of Equity

King County Determinants of Equity

Highlighting = Applies to NM/E Project

Early Childhood Development
Early childhood development that supports nurturing relationships, high-quality affordable child care and early learning opportunities that promote optimal early childhood development and school readiness for all children.

Quality Education
Education that is high quality and culturally appropriate and allows each student to reach his or her full learning and career potential.

Family Wage Jobs and Job Training
Job training and jobs that provide all residents with the knowledge and skills to compete in a diverse workforce and with the ability to make sufficient income for the purchase of basic necessities to support them and their families.

Access to Health and Human Services
Health and human services that are high quality, affordable and culturally appropriate and support the optimal wellbeing of all people.

Access to Affordable, Healthy, Local Food
Food systems that support local food production and provide access to affordable, healthy and culturally appropriate foods for all people.

Access to Parks and Natural Resources
Parks and natural resources that provide access for all people to safe, clean and quality outdoor spaces, facilities and activities that appeal to the interests of all communities.

Healthy Built and Natural Environments
Healthy built and natural environments for all people that include mixes of land use that support jobs, housing, amenities and services, trees and forest canopy, clean air, water, soil and sediment.

Access to Safe and Efficient Transportation
Transportation that provides everyone with safe, efficient, affordable, convenient and reliable mobility options including public transit, walking, car-pooling and biking.

Community Economic Development
Community economic development that supports local ownership of assets, including homes and businesses, and assures fair access for all to business development and retention opportunities.

Strong, Vibrant Neighborhoods
Neighborhoods that support all communities and individuals through strong social networks, trust among neighbors and the ability to work together to achieve common goals that improve the quality of life for everyone in the neighborhood.

Affordable, Safe, Quality Housing
Housing for all people that is safe, affordable, high quality and healthy.

Community and Public Safety
Community and public safety that includes services such as fire, police, emergency medical services and code enforcement that are responsive to all residents so that everyone feels safe to live, work and play in any neighborhood of King County.

Equitable Law and Justice System
A law and justice system that provides equitable access and fair treatment for all.

Appendix D. Trenchless Risk Matrix

NORTH MERCER ISLAND INTERCEPTOR AND ENATAI INTERCEPTOR UPGRADE PROJECT RISK REGISTER

			Segment A10-2 (Two HDD bores) *Risk Cost is Doubled*									
Risk Identification		**General Risk Description**	**Features Specific to the Trenchless Segment**	**Impact should risk occur**	**Risk Type**		**Risk Qualification**		**Risk Quantification**			**Risk Mitigation / Response**
Risk #					Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
x.x	*Example Risk*				*T*	*C*	*H>35; M-10-35; L<10*	*L<500K; M-500K to 1.0M; H >1M*	*%*	*$*		
1.0	**HDD Risks**											
1.1	Geotechnical conditions unfavorable to HDD	For any HDD, open-graded gravel, cobbles, and boulders are challenging.	The A10-2 bore is anticipated to be within stiff, glaciolacustrine soil (stiff to hard clays).	1. Open-graded gravel/cobbles: may require grouting. 2. Boulders: may require steering corrections resulting in borehole deviations.	T	C	L	L	5%	$250,000	$12,500	Grouting could be specified. Additional work area/easements could be acquired to account for a deviation in bore geometry
1.2	Borehole instability	For any HDD, an unstable bore occurs when the drilling mud is unable to keep the borehole walls from collapsing. When the borehole collapses, the excavated material is not properly removed and the bore is not adequately prepared for pullback.	The A10-2 bore has an elevation difference between entry and exit.	Product pipe may become stuck in borehole during pullback.	T	C	L	H	5%	$2,000,000	$100,000	Significant geotechnical investigation could be performed to identify any zones of unstable soils. Grouting could be specified for zones where unstable soils exist.
1.3	Hydrofracture	For any HDD, hydrofracture occurs when underground drilling pressures become higher than the overlying confining pressure of the soil, resulting in the escape of drilling mud to the surface.	Due to the change in elevation for the A10-2 bore, a packer will likely be used at the lower end with a pressure measuring device. This packer will allow drainage of the borehole fluid to relieve pressure. Hydrofracture will likely occur at the downstream end of the bore near completion of the pilot and subsequent reaming passes.	Drilling fluid release to the surface.	T	C	M	L	10%	$300,000	$30,000	Specify conductor casings at the entry and exit locations to protect against hydrofracture at any shallow locations.
1.4	Difficult steering/accuracy of drill	To effectively steer a pilot bore, the soil must have sufficient strength to allow steering reaction.	The A10-2 bore is anticipated to be within consistently stiff glaciolacustrine material that will likely have good steering response and unlikely have any boulders	Bore may not be within required tolerances. Re-drill may be required by the driller.	T	C	L	L	5%	$200,000	$10,000	Perform more borings to ensure that soft soils will not be encountered on the HDD alignment.
1.5	Constrained work area adds cost and schedule to project.	For any HDD, constrained work areas decrease production and can increases cost if the site is so constrained that specialty equipment is required.	Layout is not particularly constrained.	Production is decreased.	T	C	L	L	5%	$200,000	$10,000	Acquire more easement to allow the HDD contractor adequate space for equipment and pipe layout.
1.6	Damage to bridge infrastructure	With any HDD, the primary concern for damage to property is settlement above the bore which may lead to damage of nearby infrastructure.	The A10-2 bore is beneath private homes but is very deep. Being under homes can cause damage due to any vibrations.	Construction may damage homes or claims from homeowners.	T	C	L	M	5%	$500,000	$25,000	Design bore to minimize the number of houses under which it traverses.

NORTH MERCER ISLAND INTERCEPTOR AND ENATAI INTERCEPTOR UPGRADE PROJECT RISK REGISTER

			Segment A10-2 (Two HDD bores) *Risk Cost is Doubled*									
Risk Identification		**General Risk Description**	**Features Specific to the Trenchless Segment**	**Impact should risk occur**	**Risk Type**		**Risk Qualification**		**Risk Quantification**			**Risk Mitigation / Response**
Risk #					Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
1.7	Encountering Differing Site Conditions (DSC)	For any trenchless project, it is possible that the geotechnical conditions encountered will be different and more adverse than those presented in the contract documents. This may result in a Change Order or Claim.	The A10-2 bore is anticipated to be within consistently stiff glaciolacustrine material, but boulders and cobbles are always a risk in glacial soils.	Higher projects costs and possible legal fees.	T	C	L	H	5%	$2,000,000	$100,000	Perform a thorough geotechnical investigation so that the contractor can make an educated evaluation of the soil conditions with the information provided in the contract documents.
1.8	Impacting the Shoreline	With any HDD, if the bore profile (particularly the entry and exit points) are close to a water body/shoreline, the potential for shoreline impacts increases.	N/A - not near shoreline.									
1.9	Bore Encounters Utilities	With any HDD, the Pilot Bore or Reaming Pass could encounter an existing Utility during drilling	The A10-2 bore runs through a congested neighborhood with the possibility of utilities in close proximity of the bore.	Depending on type of utility encountered, damage to utility, escape of material in the utility pipe (water, sewer, gas, etc.). Danger to health and safety.	T	C	M	L	15%	$250,000	$37,500	Perform a thorough search for all utilities in the area of the bore during design. Require contractor to locate and pothole any utilities within a specified distance of the bore during construction.
1.10	Small Bidder Pool	For any HDD, the technical complexity of the bore (bore geometry, site features, laydown area, contract features, and risk allocation) can result in lack of bidder response or the need for a very sophisticated contractor.	Bore is not particularly complicated.	Only one bidder responds with a very high price. County accepts price or has to rebid the project.	T	C	M	H	15%	$4,000,000	$600,000	Simplify the bore during design to the extent possible. Focus on risk sharing elements when producing the contract documents to encourage Contractors to bid. Assume packaged with C1 for now. (adjust at project risk assessment for Alt 14 which has C1 AND dual HDD)
									Total Risk Cost		**$1,250,000**	
									Total Risk Cost (HH, HM, MH, LH)		**$1,000,000**	

NORTH MERCER ISLAND INTERCEPTOR AND ENATAI INTERCEPTOR UPGRADE PROJECT RISK REGISTER

			Segment A10-2 (Microtunnel)									
Risk Identification		**General Risk Description**	**Features Specific to the Trenchless Segment**	**Impact should risk occur**	**Risk Type**		**Risk Qualification**		**Risk Quantification**			**Risk Mitigation / Response**
Risk #					Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
x.x	*Example Risk*				*T*	*C*	*H>35; M-10-35; L<10*	*L<500K; M-500K to 1.0M; H >1M*	*%*	*$*		
2.0	**Microtunnel Risks**											
2.1	Geotechnical conditions unfavorable to microtunneling	For any microtunnel, open-graded gravel, cobbles, and boulders can be challenging.	The A10-2 microtunnel is anticipated to be within stiff, glaciolacustrine soil (stiff to hard clays).	Gravel/cobbles/boulders can stop forward progress, requiring tunnel rescue shaft.	T	C	L	H	10%	$1,500,000	$150,000	Open shield pipe jacking may be considered to allow obstruction removal. A tunnel rescue shaft could be included as a bid item in order to establish costs up-front.
2.2	Machine stuck due to high face pressures forces in combination with high frictional forces, leading to high jacking forces.	For any microtunnel, long drive lengths, unfavorable soil, and poor construction practices can lead to high jacking forces.	The A10-2 microtunnel will be within stiff clays that can plug/clog the face of a microtunneling machine resulting in the blockage of soil from getting into the slurry circuit.	Tunnel access shaft required to clean out face of machine. Continued jacking may be possible.	T	C	M	H	30%	$1,000,000	$300,000	Open shield pipe jacking may be considered. A tunnel rescue shaft could be included as a bid item in order to establish costs up-front.
2.3	Line and grade deviation outside of tolerances or beyond the laser path to the machine target.	For any microtunnel, encountering mixed face conditions, soft soils, or boulders can cause line and grade deviations.	The A10-2 microtunnel is anticipated to be within soil conditions that are favorable to maintaining line and grade without significant deviations.	Access shaft to dig up the machine.	T	C	L	H	5%	$1,500,000	$75,000	A tunnel rescue shaft could be included as a bid item in order to establish costs up-front.
2.4	Encountering Differing Site Conditions (DSC)	For any trenchless project, it is possible that the geotechnical conditions encountered will be different and more adverse than those presented in the contract documents. This may result in a Change Order or Claim.	There is always a potential to encounter DSCs on microtunneling projects, which may be valid or result in a claim. The Puget Sound area has a history of a high rate of Claims on microtunneling projects	Higher projects costs and possible legal fees.	T	C	M	H	30%	$3,000,000	$900,000	Perform a thorough geotechnical investigation so that the contractor can make an educated evaluation of the soil conditions with the information provided in the contract documents.
2.5	Constrained work area adds cost and schedule to project.	For any microtunnel, constrained work areas decrease production and can increases cost if the site is so constrained that specialty equipment is required.	The A10-2 microtunnel is constrained near MH S10 but not very constrained elsewhere.	Production is decreased in a significantly constrained space.	T	C	M	L	20%	$250,000	$50,000	Acquire more easement and/or full road closures to allow the Contractor adequate space for equipment and pipe layout.
2.6	Damage above the microtunnel due to sink holes.	Any microtunnel can result in sink holes developing above the crown of the tunnel due to improper tunnel machine operation. This can damage roads or facilities above the alignment.	The A10-2 microtunnel is anticipated to be within favorable soils which will likely arch over any over-excavation by tunneling long enough to apply contact grout. The alignment passes below private homes.	Roads, utilities, or homes above the alignment are damaged.	T	C	M	L	15%	$200,000	$30,000	Revise alignment to avoid passing beneath homes. Sink holes would be filled with CDF. Roads and utilities would be repaired; road closures would be required.
2.7	Machine breakdown or failure while underground.	For any microtunnel, there is the risk of a catastrophic machine breakdown during tunneling.	The A10-2 microtunnel will be significantly deep should recovery shafts be needed.	Construction of a rescue shaft, repair of the machine, conversion of a rescue shaft to a jacking shaft, relaunch, continue jacking.	T	C	L	H	5%	$3,000,000	$150,000	A tunnel rescue shaft could be included as a bid item in order to establish costs up-front.

NORTH MERCER ISLAND INTERCEPTOR AND ENATAI INTERCEPTOR UPGRADE PROJECT RISK REGISTER

			Segment A10-2 (Microtunnel)									
Risk Identification		**General Risk Description**	**Features Specific to the Trenchless Segment**	**Impact should risk occur**	**Risk Type**		**Risk Qualification**		**Risk Quantification**			**Risk Mitigation / Response**
Risk #					Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
2.8	Small Bidder Pool	For any microtunnel, the technical complexity of the project can result in lack of bidder response or the need for a very sophisticated contractor.	Although deep, the A10-2 microtunnel is within commonly performed length and diameter.	Only one bidder responds with a very high price. County accepts price or has to rebid the project.	T	C	L	H	5%	$2,000,000	$100,000	Focus on risk sharing elements when producing the contract documents to encourage Contractors to bid.
									Total Risk Cost		**$1,755,000**	
									Total Risk Cost (HH, HM, MH, LH)		**$1,675,000**	

NORTH MERCER ISLAND INTERCEPTOR AND ENATAI INTERCEPTOR UPGRADE PROJECT RISK REGISTER

			Segment A10-1 (Microtunnel)									
Risk Identification		**General Risk Description**	**Features Specific to the Trenchless Segment**	**Impact should risk occur**	**Risk Type**		**Risk Qualification**		**Risk Quantification**			**Risk Mitigation / Response**
Risk #					Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
x.x	*Example Risk*				*T*	*C*	*H>35; M-10-35; L<10*	*L<500K; M-500K to 1.0M; H >1M*	*%*	*$*		
2.0	**Microtunnel Risks**											
2.1	Geotechnical conditions unfavorable to microtunneling	For any microtunnel, open-graded gravel, cobbles, and boulders can be challenging.	The A10-1 microtunnel is anticipated to be within stiff, glaciolacustrine soil (stiff to hard clays).	Gravel/cobbles/boulders can stop forward progress, requiring tunnel rescue shaft.	T	C	L	H	10%	$1,500,000	$150,000	Open shield pipe jacking may be considered to allow obstruction removal. A tunnel rescue shaft could be included as a bid item in order to establish costs up-front.
2.2	Machine stuck due to high face pressures forces in combination with high frictional forces, leading to high jacking forces.	For any microtunnel, long drive lengths, unfavorable soil, and poor construction practices can lead to high jacking forces.	The A10-1 microtunnel will be within stiff clays that can plug/clog the face of a microtunneling machine resulting in the blockage of soil from getting into the slurry circuit.	Tunnel access shaft required to clean out face of machine. Continued jacking may be possible.	T	C	M	H	30%	$1,000,000	$300,000	Open shield pipe jacking may be considered. A tunnel rescue shaft could be included as a bid item in order to establish costs up-front.
2.3	Line and grade deviation outside of tolerances or beyond the laser path to the machine target.	For any microtunnel, encountering mixed face conditions, soft soils, or boulders can cause line and grade deviations.	The A10-1 microtunnel is anticipated to be within soil conditions that are favorable to maintaining line and grade without significant deviations.	Access shaft to dig up the machine.	T	C	L	H	5%	$1,500,000	$75,000	A tunnel rescue shaft could be included as a bid item in order to establish costs up-front.
2.4	Encountering Differing Site Conditions (DSC)	For any trenchless project, it is possible that the geotechnical conditions encountered will be different and more adverse than those presented in the contract documents. This may result in a Change Order or Claim.	There is always a potential to encounter DSCs on microtunneling projects, which may be valid or result in a claim. The Puget Sound area has a history of a high rate of Claims on microtunneling projects	Higher projects costs and possible legal fees.	T	C	M	H	30%	$3,000,000	$900,000	Perform a thorough geotechnical investigation so that the contractor can make an educated evaluation of the soil conditions with the information provided in the contract documents.
2.5	Constrained work area adds cost and schedule to project.	For any microtunnel, constrained work areas decrease production and can increases cost if the site is so constrained that specialty equipment is required.	The A10-1 microtunnel will utilize very constrained work sites in a residential neighborhood.	Production is decreased in a significantly constrained space.	T	C	H	L	50%	$250,000	$125,000	Acquire more easement and/or full road closures to allow the Contractor adequate space for equipment and pipe layout.
2.6	Damage above the microtunnel due to sink holes.	Any microtunnel can result in sink holes developing above the crown of the tunnel due to improper tunnel machine operation. This can damage roads or facilities above the alignment.	The A10-1 microtunnel is anticipated to be within favorable soils which will likely arch over any over-excavation by tunneling long enough to apply contact grout. The alignment stays within public ROW.	Roads or utilities above the alignment are damaged.	T	C	M	L	20%	$200,000	$40,000	Sink holes would be filled with CDF. Roads and utilities would be repaired; road closures would be required.
2.7	Machine breakdown or failure while underground.	For any microtunnel, there is the risk of a catastrophic machine breakdown during tunneling.	The A10-1 microtunnel will be significantly deep should recovery shafts be needed.	Construction of a rescue shaft, repair of the machine, conversion of a rescue shaft to a jacking shaft, relaunch, continue jacking.	T	C	L	H	5%	$3,000,000	$150,000	A tunnel rescue shaft could be included as a bid item in order to establish costs up-front.

NORTH MERCER ISLAND INTERCEPTOR AND ENATAI INTERCEPTOR UPGRADE PROJECT RISK REGISTER

			Segment A10-1 (Microtunnel)									
Risk Identification		**General Risk Description**	**Features Specific to the Trenchless Segment**	**Impact should risk occur**	**Risk Type**		**Risk Qualification**		**Risk Quantification**			**Risk Mitigation / Response**
Risk #					Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
2.8	Small Bidder Pool	For any microtunnel, the technical complexity of the project can result in lack of bidder response or the need for a very sophisticated contractor.	Although deep, the A10-1 microtunnel is within commonly performed length and diameter.	Only one bidder responds with a very high price. County accepts price or has to rebid the project.	T	C	L	H	10%	$2,000,000	$200,000	Focus on risk sharing elements when producing the contract documents to encourage Contractors to bid.
									Total Risk Cost		**$1,940,000**	
									Total Risk Cost (HH, HM, MH, LH)		**$1,775,000**	

NORTH MERCER ISLAND INTERCEPTOR AND ENATAI INTERCEPTOR UPGRADE PROJECT RISK REGISTER

			Segment C1									
Risk Identification		**General Risk Description**	**Features Specific to the Trenchless Segment**	**Impact should risk occur**	**Risk Type**		**Risk Qualification**		**Risk Quantification**			**Risk Mitigation / Response**
Risk #					Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
x.x	*Example Risk*				*T*	*C*	*H>35; M-10-35; L<10*	*L<500K; M-500K to 1.0M; H >1M*	*%*	*$*		
1.0	**HDD Risks**											
1.1	Geotechnical conditions unfavorable to HDD	For any HDD, open-graded gravel, cobbles, and boulders are challenging.	The C1 HDD is likely to be in glacial soils that always have some potential for gravel, cobbles, and boulders.	1. Open-graded gravel/cobbles: may require grouting. 2. Boulders: may require steering corrections resulting in borehole deviations.	T	C	M	L	20%	$250,000	$50,000	Grouting could be specified. Additional work area/easements could be acquired to account for a deviation in bore geometry
1.2	Borehole instability	For any HDD, an unstable bore occurs when the drilling mud is unable to keep the borehole walls from collapsing. When the borehole collapses, the excavated material is not properly removed and the bore is not adequately prepared for pullback.	For C1, some soil along the HDD borepath may be unstable but it is unlikely to be prohibitive to drilling.	1. Additional drilling materials (grout or loss circulation materials) may be required. 2. Product pipe may become stuck in borehole during pullback.	T	C	L	H	5%	$2,000,000	$100,000	Significant geotechnical investigation could be performed to identify any zones of unstable soils. Grouting could be specified for zones where unstable soils exist.
1.3	Hydrofracture	For any HDD, hydrofracture occurs when underground drilling pressures become higher than the overlying confining pressure of the soil, resulting in the escape of drilling mud to the surface.	The C1 bore is very deep with high confining pressures to protect against hydrofracture.	Drilling fluid release to the surface.	T	C	L	L	2%	$300,000	$6,000	Specify conductor casings at the entry and exit locations to protect against hydrofracture at any shallow locations.
1.4	Difficult steering/accuracy of drill	To effectively steer a pilot bore, the soil must have sufficient strength to allow steering reaction.	The C1 bore is in glacial soils that typically provide enough stability to allow steering.	Bore may not be within design tolerances/easements. Re-drill may be required.	T	C	L	L	5%	$200,000	$10,000	Perform more borings to ensure that soft soils will not be encountered on the HDD alignment.
1.5	Constrained work area adds cost and schedule to project.	For any HDD, constrained work areas decrease production and can increases cost if the site is so constrained that specialty equipment is required.	The C1 bore work area is adjacent to the I-90 bridge and very constrained on the west side of the bore (east side of the Channel).	Production is decreased.	T	C	L	L	10%	$200,000	$20,000	Acquire more easement to allow the HDD contractor adequate space for equipment and pipe layout.
1.6	Damage to bridge infrastructure	With any HDD, the primary concern for damage to property is settlement above the bore which may lead to damage of nearby infrastructure.	The west side of the C1 bore is in close proximity to I-90 bridge piers and traverses beneath the abutment. In addition, the bore is beneath private homes; however, the bore is very deep beneath the homes.	Settlement of bridge piers.	T	C	L	H	2%	$2,000,000	$40,000	Acquire private easement that allows moving the HDD away from the I-90 bridge. Design bore to minimize the number of houses under which it traverses.

NORTH MERCER ISLAND INTERCEPTOR AND ENATAI INTERCEPTOR UPGRADE PROJECT RISK REGISTER

			Segment C1									
Risk Identification		**General Risk Description**	**Features Specific to the Trenchless Segment**	**Impact should risk occur**	**Risk Type**		**Risk Qualification**		**Risk Quantification**			**Risk Mitigation / Response**
Risk #					Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
1.7	Encountering Differing Site Conditions (DSC)	For any trenchless project, it is possible that the geotechnical conditions encountered will be different and more adverse than those presented in the contract documents. This may result in a Change Order or Claim.	The C1 bore is in glacial soils that often vary significantly over very short distances. As a result it is often difficult to represent these soils accurately in the contract documents.	Higher projects costs and possible costs of claims/law suits.	T	C	L	H	10%	$2,000,000	$200,000	Perform a thorough geotechnical investigation so that the contractor can make an educated evaluation of the soil conditions with the information provided in the contract documents.
1.8	Impacting the Shoreline	With any HDD, if the bore profile (particularly the entry and exit points) are close to a water body/shoreline, the potential for shoreline impacts increases.	For the C1 bore, the entry/exit point is 50 to 60 feet from the waterline at the east side of the East Channel.	Escape of drilling fluid to the shoreline and into the East Channel	T	C	H	M	80%	$500,000	$400,000	Specify positive controls to prevent damage to the shoreline or inadvertent returns. Require the contractor to design, implement, and construct drilling fluid containment measures when drilling near the shoreline (through the specifications)
1.9	Bore Encounters Utilities	With any HDD, the Pilot Bore or Reaming Pass could encounter an existing Utility during drilling	The C1 bore should not encounter utilities near the I-90 bridge but may be in close proximity to utilities near the Sweylocken Pump Station	Depending on type of utility encountered, damage to utility, escape of material flowing within the utility (water, sewer, storm, gas, etc.). Danger to health and safety.	T	C	M	L	15%	$250,000	$37,500	Perform a thorough search for all utilities in the area of the bore during design. Require contractor to locate and pothole any utilities within a specified distance of the bore during construction.
1.10	Small Bidder Pool	For any HDD, the technical complexity of the bore (bore geometry, site features, laydown area, contract features, and risk allocation) can result in lack of bidder response or the need for a very sophisticated contractor.	Although the C1 bore is not considered extremely large in diameter or long in bore length, this bore is too complex for a mid-size contractor, as it will require the intersect method, and the use of large drill rigs. There are typically a limited number of larger drillers who bid complex jobs (3 or 4 max).	Only one bidder responds with a very high price. County accepts price or has to rebid the project.	T	C	H	H	50%	$4,000,000	$2,000,000	Simplify the bore during design to the extent possible. Focus on risk sharing elements when producing the contract documents to encourage Contractors to bid. Potential floating NTP date?
									Total Risk Cost		**$2,863,500**	
									Total Risk Cost (HH, HM, MH, LH)		**$2,740,000**	

Appendix E. Project Risk Matrix

Stage 3 Remaining Alternatives		
Alternative 4	**Alternative 9**	**Alternative 14**
A1 - upland along N. Mercer Way, PS 11 upgrades	A4 - in water	A10-2 - Microtunnel
B6 - in water	B6 - in water	B6 - in water
C1 - trenchless	C1 - trenchless	C1 - trenchless

Risk Categories			
Technical	**$ (200,000)**	**$ 850,000**	**$ 850,000**
Trenchless Risks	**$ 2,740,000**	**$ 2,740,000**	**$ 4,415,000**
Constructability	**$ 835,000**	**$ 560,000**	**$ 1,367,500**
Operations and Maintenance	**$ -**	**$ 250,000**	**$ 250,000**
Permitting	**$ -**	**$ -**	**$ -**
ROW/Easements	**$ 150,000**	**$ 150,000**	**$ 250,000**
Environment	**$ -**	**$ -**	**$ -**
Community	**$ 1,460,000**	**$ 310,000**	**$ 380,000**
Cost	**$ 500,000**	**$ 750,000**	**$ 750,000**
Total Project Risk Cost	**$ 5,485,000**	**$ 5,610,000**	**$ 8,262,500**

Alternative 4

Risk Identification		Risk Type		Risk Qualification		Risk Quantification			Risk Mitigation / Response
Risk #		Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
x.x	*Example Risk*	*T*	*C*	*H>35; M-10-35; L<10*	*L<500K; M-500K to 1.0M; H >1M*	*%*	*$*		
1.0	**Technical**								
T1	Complex hydraulic assumptions (e.g., average dry weather flows, peak flows), conditions (siphons), and analysis leads to system hydraulic issues (ie overflows, sediment accumulation)	T	C	L	H	5%	$5,000,000	$250,000	Sensitivity analysis using the dynamic hydraulic model. CFD model during design to evaluate solids movement in system (ie siphons)
T2	Bellevue flows must be rerouted to Sweyolocken due to one or more of the following risks: - Existing Enatai Interceptor piles/caps will not last until design year 2060 and cannot be rehabilitated to provide reliable service through 2060 - Enatai pipe cannot be rehabilitated to provide reliable service through 2060 - Enatai Interceptor is not recommended to be kept in service in the existing location due to risks of unstable flowing soils and future pipe breakage	T	C	L	H	2%	5000000	$100,000	1) Pile condition assessment during predesign. 2) Redirect Bellevue flows to C1 segment via pumping (for HDD trenchless option). 3) Direct Pipe trenchless method to allow for gravity flow and addition of low flow pipe in steel casing.
T3	Current bathymetric survey is insufficient and results in readjusting alignment of in-water open-cut pipeline and additional hydraulic analysis.	T	C	L	L				1) Add bathymetric survey to predesign.
T4	Design criteria, standards, codes and/or criteria change during design and/or construction and leads to project budget and schedule overruns.	T	B	M	L				
T5	Inadequate or incorrect existing data (ie asbuilts) leads to incorrect design assumptions	T	B	M	L				1) Identify critrical data and groundtruth to confirm.

Alternative 4

Risk Identification		Risk Type		Risk Qualification		Risk Quantification			Risk Mitigation / Response
Risk #		Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
T6	Poor condition of existing Enatai Interceptor or undocumented conditions (ie joint seperation or pile conditions) leads to challenges with rehabilitation during design.	T	B	L	H	5%	$5,000,000	$250,000	Change order to change product requirements or means and methods of project implementation.
T7	Subsurface (underground or underwater) contamination or utility/physical conflicts found during design causes remediation response or alignment adjustment.	T	B	M	M				
T8	Upgrade of PS 11 is not viable due to hydraulic issues identified during predesign and/or coordination with COMI.	O	B	H	M	40%	$ (2,000,000)	$ (800,000)	**Design variant for Alternative 4, hybrid- with open-cut along N. Mercer Way and in-water open-cut starting at 97th Ave SE.**
TR1	Borehole instability	T	C	L	H	5%	$2,000,000	$100,000	Significant geotechnical investigation could be performed to identify any zones of unstable soils. Grouting could be specified for zones where unstable soils exist.
TR2	Damage to bridge infrastructure	T	C	L	H	2%	$2,000,000	$40,000	Acquire private easement that allows moving the HDD away from the I-90 bridge. Design bore to minimize the number of houses under which it traverses.
TR3	Encountering Differing Site Conditions (DSC)	T	C	M	H	10%	$2,000,000	$200,000	Perform a thorough geotechnical investigation so that the contractor can make an educated evaluation of the soil conditions with the information provided in the contract documents.
TR4	Discharge of drilling fluid to Lake Washington	T	C	H	M	80%	$500,000	$400,000	Specify positive controls to prevent damage to the shoreline or inadvertent returns. Require the contractor to design, implement, and construct drilling fluid containment measures when drilling near the shoreline (through the specifications)

		Alternative 4							
Risk Identification		**Risk Type**		**Risk Qualification**		**Risk Quantification**			**Risk Mitigation / Response**
Risk #		Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
TR5	Small Bidder Pool	T	C	H	H	50%	$4,000,000	$2,000,000	Simplify the bore during design to the extent possible. Focus on risk sharing elements when producing the contract documents to encourage Contractors to bid. Potential floating NTP date?
TR6	Geotechnical conditions unfavorable to microtunneling along Segment A10-2, and causes re-alignment to Segment A10-1								
TR7	Machine stuck due to high face pressures forces in combination with high frictional forces, leading to high jacking forces.								
TR8	Line and grade deviation outside of tolerances or beyond the laser path to the machine target.								
TR9	Encountering Differing Site Conditions (DSC)								
TR10	Machine breakdown or failure while underground.								
TR11	Small Bidder Pool								

Alternative 4

Risk Identification		Risk Type		Risk Qualification		Risk Quantification			Risk Mitigation / Response
Risk #		Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
2.0	**Constructability**								
CM1	Unanticipated contaminated soil and/or groundwater discovered during construction.	T	B	L	L				
CM2	Abandoned buried structures, abandoned creosote-contaminated piles, submerged/buried logs, and fill debris that was not anticipated is encountered during excavation; and must be removed. This could occur in open-cut excavation for pipeline, structures including Sweyolocken area, along N. Mercer Way in-water.	T	B	M	L				
CM3	Damage to public or private property. This includes damage to docks for HDD work or in-water lakeline work, or rehab work. This also includes excessive ground losses during HDD and microtunneling which leads to ground surface settlements that damage overlying buildings, residences, roadways, and utilities.	T	B	M	M				
CM4	Control of groundwater difficult and causes pipeline and structures installation to stop and result in delays and additional costs during construction.	T	B	L	L				
CM5	Construction dewatering during excavation and/or vibration may result in localized ground settlement. Results in damage to existing structures or facilities and require additional settlement and vibration monitoring during construction.	T	B	L	M				
CM6	Unidentified utility can lead to rerouting of pipeline alignment, delay in construction requiring input/approval of utility owner and adds additional construction cost for rerouting utilities.	T	B	H	M	60%	$750,000	$450,000	

		Alternative 4							
Risk Identification		**Risk Type**		**Risk Qualification**		**Risk Quantification**			**Risk Mitigation / Response**
Risk #		Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
CM7	Construction staging and construction affect bus service / transit center and City parking areas (ie Luther Burbank, park and rides) requiring mitigation (ie tempoary parking) during design.	T	B	M	L				
CM8	Businesses disruption due to construction. Waterfront businesses (ie kayaking, Pacific Science Center etc) cannot operate due to construction in the area.	T	C	L	M				
CM9	Additional Odor Control systems are required than initially developed during alternatives analysis and requires additional footprint for odor control systems in design, additional permits, and/or coordination with agencies.	T	C	H	M	40%	$500,000	$200,000	Provide additional odor control system along conveyance system to address potential odors of concern.
CM10	Construction deviations in line-and-grade of the pipeline or other construction elements causes hydraulic or other operational problems.	T	B	L	M				
CM11	Deviations from construction contract in construction footprint, duration, and allowed impact levels results in community complaints to jurisdiction and County management and electeds.	T	B	H	L	35%	$100,000	$35,000	Deviations from construction contract in construction footprint, duration, and allowed impact levels results in community complaints to jurisdiction and County management and electeds.
CM12	Differing site conditions during in-water construction causes additional contractor delays and costs	T	C	M	H	10%	$1,500,000	$150,000	
3.0	**Operations and Maintenance**								
OM1	Complex inspection access points do not function as well as planned or cumbersome for O&M use due to surcharged system.	T	B	M	M				

Alternative 4

Risk Identification		Risk Type		Risk Qualification		Risk Quantification			Risk Mitigation / Response
Risk #		Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
4.0	**Permitting**								
P1	SEPA and/or permits appealed.	T	B	L	M				Early coordination with cities and public to ensure they accept the project approach. If SEPA determination is contested, would need to produce additional documentation.
P2	Contractor does not acquire all required permits.	T	B	L	M				Early coordination with agencies to ensure they accept the project approach. More documentation for East Channel Crossing
P3	In water construction or rehab work triggers additional permitting and environmental approvals.	T	B	L	M				Document cut and cover option for in-water open cut.
P4	In-water construction takes longer than expected, requiring demobilization and remobilization (ie have to wait until next fish window.	T	B	L	L				Build construction schedule that reflects permitting constraints (Regulatory fish windows and tribal fishing considerations).
P5	Permit violations result in substantial project delay.	T	B	L	M				
P6	Corps requires additional analysis/justification for in-water construction.	T	B	L	L				Provide effective alternatives analysis documentation showing there is no practicable alternative to proposed in-water work.
5.0	**ROW/Easements/ROE**								
R1	Condemnation required for easements and "Possession & Use" not granted, resulting in delayed bidding and start of construction.	T	B	L	H	10%	$1,000,000	$ 100,000.00	Mitigate

Alternative 4

Risk Identification		Risk Type		Risk Qualification		Risk Quantification			Risk Mitigation / Response
Risk #		Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
R2	Alignment changed, after start of acquisitions, due to political pressures, and causes re-work and schedule delays.	T	B	L	H	5%	$1,000,000	$ 50,000.00	Mitigate
R3	Underground pipeline construction alignment deviates outside of the acquired right-of-way and requires easement modification.	T	B	L	L				Accept
R4	Constraints tied to funding at one or more park sites will limit time or footprint for construction, or require partial or complete park replacement for exceedences.	T	B	L	L				
6.0	**Environment**								
E1	Archaeological resources found during construction result in construction delay.	T	B	M	L				Sweyolocken area and Luther Burbank Park shoreline identified as high probability areas.
E2	Mitigation measures to replace wetlands/vegetation (ie trees) are underestimated during design can result in extensive restoration measures including tree replacment at a higher ratio (2:1) and vegetations study.	T	B	L	L				Thorough environmental reports upfront to quantify all resources.
E3	BMP failures - failure to meet conditions in the BMP	T	B	M	L				
7.0	**Community**								

		Alternative 4							
Risk Identification		**Risk Type**		**Risk Qualification**		**Risk Quantification**			**Risk Mitigation / Response**
Risk #		Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
CO1	Community opposition forces us to change the project. Private property owners oppose trenchless options to jurisdiction and project must be changed. This may be due to perceived construction risks, subterranean easements, impacts on traffic and access for park and community center for variant in 84th/24th.	T	B	M	M				Avoid: conduct extensive community outreach during pre-design phase to reach all affected people and organizations and ensure they understand the purpose of and need for the project. One-on-ones with waterfront property owners. ROW/permitting staff work proactively with property owners and jursidiction. Community Relations team works with community stakeholders to understand benefits and reasonable solutions for concerns.

Alternative 4

Risk Identification		Risk Type		Risk Qualification		Risk Quantification			Risk Mitigation / Response
Risk #		Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
CO2	Community opposition forces us to change the project alignment during design. Commuters, community members, jurisdictions, bicyclists protest due to traffic impacts in North Mercer Way	T	B, O	H	H	40%	$3,000,000	$1,200,000	Avoid: conduct extensive community outreach during pre-design phase to reach all affected people and organizations and ensure they understand the purpose of and need for the project. Meet with cyclist advocacy groups (Cascade), Friends of LB Park **<u>Design variant for Alternative 4,</u> Option 1A - with FM routed along bike path, resulting in pump station upgrades to be implemented as part of the project. Mitigation oppurtunity to improve bike path.**
CO3	Community opposition forces us to change the project alignment during design. Property owners, park users, and/or groups oppose work in Luther Burbank Park, wetlands and/or waterway.	T	B	L	L				Avoid: conduct extensive community outreach during pre-design phase to reach all affected people and organizations and ensure they understand the purpose of and need for the project. Meet with cyclist advocacy groups (Cascade), Friends of LB Park

		Alternative 4							
Risk Identification		**Risk Type**		**Risk Qualification**		**Risk Quantification**			**Risk Mitigation / Response**
Risk #		Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
CO2	Changing options or alignments with little or no public outreach compromises trust with Cities of MI and Bellevue and the affected community, resulting in project opposition and requiring additional outreach.	T	C	H	L	50%	$100,000	$50,000	Avoid: ensure community relations team is engaged in and kept informed of all project decisions. Manage expectations with public and jurisdiction, so people understand if things change with little notice. Meet with cyclist advocacy groups (Cascade), Friends of LB Park
CO3	Community/jurisdictions advocate for additional scope and/or mitigation than called for in project charter or environmental review.	T	C	H	M	60%	$250,000	$150,000	Avoid: surface community concerns early (during pre-design), so they can be considered, addressed, and reported back to community members well before it becomes more costly to address. Meet with cyclist advocacy groups (Cascade), Friends of LB Park
CO4	Community/jurisdictions advocate for additional process (CAG, design workshops, examining other alternatives proposed by the community or jurisdiction).	T	B,S	H	L	60%	$100,000	$60,000	Avoid: carefully document process from alternatives analysis through final design, including input from public and how we considered and addressed that input in project decision-making. Make extensive effort to identify and reach all potentially affected parties early in the process. Meet with cyclist advocacy groups (Cascade), Friends of LB Park
8.0	**Cost**								

		Alternative 4							
Risk Identification		**Risk Type**		**Risk Qualification**		**Risk Quantification**			**Risk Mitigation / Response**
Risk #		Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
C1	Project complexity, County budget/cashflow restrictions, and/or project changes causes re-bid or project budget to be exceeded beyond approved limit.	T	B	L	H	5%	$5,000,000	$250,000	
C2	Increase of material costs at time of construction due to limited availability (ie fly ash for concrete) or escalating petroleum prices (HDPE pipe & FPVC pipes) results in construction costs during construction than in the original bid opening price.	T	C	L	M				
C3	Limited qualified competitive bidders for contract due to specialized construction techniques (in-water and trenchless)	T	B	L	H	5%	$5,000,000	$250,000	
							Total Risk Cost	**$5,485,000**	

		Alternatives 9							
Risk Identification		**Risk Type**		**Risk Qualification**		**Risk Quantification**			**Risk Mitigation / Response**
Risk #		Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
x.x	*Example Risk*	*T*	*C*	*H>35; M-10-35; L<10*	*L<500K; M-500K to 1.0M; H >1M*	*%*	*$*		
1.0	**Technical**								
T1	Complex hydraulic assumptions (e.g., average dry weather flows, peak flows), conditions (siphons), and analysis leads to system hydraulic issues (ie overflows, sediment accumulation)	T	C	L	H	5%	$10,000,000	$500,000	
T2	Bellevue flows must be rerouted to Sweyolocken due to one or more of the following risks: - Existing Enatai Interceptor piles/caps will not last until design year 2060 and cannot be rehabilitated to provide reliable service through 2060 - Enatai pipe cannot be rehabilitated to provide reliable service through 2060 - Enatai Interceptor is not recommended to be kept in service in the existing location due to risks of unstable flowing soils and future pipe breakage	T	C	L	H	2%	5000000	$100,000	
T3	Current bathymetric survey is insufficient and results in readjusting alignment of in-water open-cut pipeline and additional hydraulic analysis.	T	C	M	L				
T4	Design criteria, standards, codes and/or criteria change during design and/or construction and leads to project budget and schedule overruns.	T	B	M	L				
T5	Inadequate or incorrect existing data (ie asbuilts) leads to incorrect design assumptions	T	B	L	L				

Alternatives 9

Risk Identification		Risk Type		Risk Qualification		Risk Quantification			Risk Mitigation / Response
Risk #		Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
T6	Poor condition of existing Enatai Interceptor or undocumented conditions (ie joint seperation or pile conditions) leads to challenges with rehabilitation during design.	T	B	L	H	5%	$5,000,000	$250,000	
T7	Subsurface (underground or underwater) contamination or utility/physical conflicts found during design causes remediation response or alignment adjustment.	T	B	M	M				
T8	Upgrade of PS 11 is not viable due to hydraulic issues identified during predesign and/or coordination with COMI.								
TR1	Borehole instability	T	C	L	H	5%	$2,000,000	$100,000	Significant geotechnical investigation could be performed to identify any zones of unstable soils. Grouting could be specified for zones where unstable soils exist.
TR2	Damage to bridge infrastructure	T	C	L	H	2%	$2,000,000	$40,000	Acquire private easement that allows moving the HDD away from the I-90 bridge. Design bore to minimize the number of houses under which it traverses.
TR3	Encountering Differing Site Conditions (DSC)	T	C	M	H	10%	$2,000,000	$200,000	Perform a thorough geotechnical investigation so that the contractor can make an educated evaluation of the soil conditions with the information provided in the contract documents.
TR4	Discharge of drilling fluid to Lake Washington	T	C	H	M	80%	$500,000	$400,000	Specify positive controls to prevent damage to the shoreline or inadvertent returns. Require the contractor to design, implement, and construct drilling fluid containment measures when drilling near the shoreline (through the specifications)

		Alternatives 9							
Risk Identification		**Risk Type**		**Risk Qualification**		**Risk Quantification**			**Risk Mitigation / Response**
Risk #		Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
TR5	Small Bidder Pool	T	C	H	H	50%	$4,000,000	$2,000,000	Simplify the bore during design to the extent possible. Focus on risk sharing elements when producing the contract documents to encourage Contractors to bid. Potential floating NTP date?
TR6	Geotechnical conditions unfavorable to microtunneling along Segment A10-2, and causes re-alignment to Segment A10-1								
TR7	Machine stuck due to high face pressures forces in combination with high frictional forces, leading to high jacking forces.								
TR8	Line and grade deviation outside of tolerances or beyond the laser path to the machine target.								
TR9	Encountering Differing Site Conditions (DSC)								
TR10	Machine breakdown or failure while underground.								
TR11	Small Bidder Pool								

		Alternatives 9							
Risk Identification		**Risk Type**		**Risk Qualification**		**Risk Quantification**			**Risk Mitigation / Response**
Risk #		Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
2.0	**Constructability**								
CM1	Unanticipated contaminated soil and/or groundwater discovered during construction.	T	B	L	L				
CM2	Abandoned buried structures, abandoned creosote-contaminated piles, submerged/buried logs, and fill debris that was not anticipated is encountered during excavation; and must be removed. This could occur in open-cut excavation for pipeline, structures including Sweyolocken area, along N. Mercer Way in-water.	T	B	M	L				
CM3	Damage to public or private property. This includes damage to docks for HDD work or in-water lakeline work, or rehab work. This also includes excessive ground losses during HDD and microtunneling which leads to ground surface settlements that damage overlying buildings, residences, roadways, and utilities.	T	B	M	M				
CM4	Control of groundwater difficult and causes pipeline and structures installation to stop and result in delays and additional costs during construction.	T	B	L	M				
CM5	Construction dewatering during excavation and/or vibration may result in localized ground settlement. Results in damage to existing structures or facilities and require additional settlement and vibration monitoring during construction.	T	B	L	H	5%	$1,000,000	$50,000	
CM6	Unidentified utility can lead to rerouting of pipeline alignment, delay in construction requiring input/approval of utility owner and adds additional construction cost for rerouting utilities.	T	B	M	H	10%	$1,000,000	$100,000	

		Alternatives 9							
Risk Identification		**Risk Type**		**Risk Qualification**		**Risk Quantification**			**Risk Mitigation / Response**
Risk #		Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
CM7	Construction staging and construction affect bus service / transit center and City parking areas (ie Luther Burbank, park and rides) requiring mitigation (ie tempoary parking) during design.	T	B	M	L				
CM8	Businesses disruption due to construction. Waterfront businesses (ie kayaking, Pacific Science Center etc) cannot operate due to construction in the area.	T	C	L	M				
CM9	Additional Odor Control systems are required than initially developed during alternatives analysis and requires additional footprint for odor control systems in design, additional permits, and/or coordination with agencies.	T	C	L	M				
CM10	Construction deviations in line-and-grade of the pipeline or other construction elements causes hydraulic or other operational problems.	T	B	L	M				
CM11	Deviations from construction contract in construction footprint, duration, and allowed impact levels results in community complaints to jurisdiction and County management and electeds.	T	B	H	L	35%	$100,000	$35,000	Deviations from construction contract in construction footprint, duration, and allowed impact levels results in community complaints to jurisdiction and County management and elects.
CM12	Differing site conditions during in-water construction causes additional contractor delays and costs	T	C	M	H	25%	$1,500,000	$375,000	
3.0	**Operations and Maintenance**								
OM1	Complex inspection access points do not function as well as planned or cumbersome for O&M use due to surcharged system.	T	B	H	M	50%	$500,000	$250,000	

		Alternatives 9							
Risk Identification		**Risk Type**		**Risk Qualification**		**Risk Quantification**			**Risk Mitigation / Response**
Risk #		Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
4.0	**Permitting**								
P1	SEPA and/or permits appealed.	T	B	L	M				Early coordination with cities and public to ensure they accept the project approach. If SEPA determination is contested, would need to produce additional documentation.
P2	Contractor does not acquire all required permits.	T	B	M	M				Early coordination with agencies to ensure they accept the project approach. More documentation for East Channel Crossing
P3	In water construction or rehab work triggers additional permitting and environmental approvals.	T	B	M	M				
P4	In-water construction takes longer than expected, requiring demobilization and remobilization (ie have to wait until next fish window.	T	B	M	M				Negotiate fish windows that will meet construction timing requirements. If construction does take longer, would need to get permits extended with all agencies.
P5	Permit violations result in substantial project delay.	T	B	M	M				
P6	Corps requires additional analysis/justification for in-water construction.	T	B	M	M				Provide effective alternatives analysis documentation showing there is no practicable alternative to proposed in-water work.
5.0	**ROW/Easements/ROE**								
R1	Condemnation required for easements and "Possession & Use" not granted, resulting in delayed bidding and start of construction.	T	B	L	H	10%	$1,000,000	$ 100,000	Mitigate

		Alternatives 9							
Risk Identification		**Risk Type**		**Risk Qualification**		**Risk Quantification**			**Risk Mitigation / Response**
Risk #		Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
R2	Alignment changed, after start of acquisitions, due to political pressures, and causes re-work and schedule delays.	T	B	L	H	5%	$1,000,000	$ 50,000	Mitigate
R3	Underground pipeline construction alignment deviates outside of the acquired right-of-way and requires easement modification.	T	N/A	L	L				Accept
R4	Constraints tied to funding at one or more park sites will limit time or footprint for construction, or require partial or complete park replacement for exceedences.	T	B	L	L				
6.0	**Environment**								
E1	Archaeological resources found during construction result in construction delay.	T	B	M	L				Sweyolocken area and Luther Burbank Park shoreline identified as high probability areas.
E2	Mitigation measures to replace wetlands/vegetation (ie trees) are underestimated during design can result in extensive restoration measures including tree replacment at a higher ratio (2:1) and vegetations study.	T	B	M	L				Thorough environmental reports upfront to quantify all resources.
E3	BMP failures - failure to meet conditions in the BMP	T	B	M	M				
7.0	**Community**								

		Alternatives 9							
Risk Identification		**Risk Type**		**Risk Qualification**		**Risk Quantification**			**Risk Mitigation / Response**
Risk #		Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
CO1	Community opposition forces us to change the project. Private property owners oppose trenchless options to jurisdiction and project must be changed. This may be due to perceived construction risks, subterranean easements, impacts on traffic and access for park and community center for variant in 84th/24th.	T	B	M	M				Avoid: conduct extensive community outreach during pre-design phase to reach all affected people and organizations and ensure they understand the purpose of and need for the project. One-on-ones with waterfront property owners. ROW/permitting staff work proactively with property owners and jursidiction. Community Relations team works with community stakeholders to understand benefits and reasonable solutions for concerns.

		Alternatives 9							
Risk Identification		**Risk Type**		**Risk Qualification**		**Risk Quantification**			**Risk Mitigation / Response**
Risk #		Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
CO2	Community opposition forces us to change the project alignment during design. Commuters, community members, jurisdictions, bicyclists protest due to traffic impacts in North Mercer Way	T	B	L	L				Mitigate: Project team works with jurisdiction to establish permit conditions that reduce traffic impacts. **Based on community input, risk for this is low probability for upland variant (bike path), even if route involves some work on North Mercer Way.**
CO3	Community opposition forces us to change the project alignment during design. Property owners, park users, and/or groups oppose work in Luther Burbank Park, wetlands and/or waterway.	T	B	M	H	60%	$100,000	$ 60,000	Avoid: conduct extensive community outreach during pre-design phase to reach all affected people and organizations and ensure they understand the purpose of and need for the project. One-on-ones with waterfront property owners.

		Alternatives 9							
Risk Identification		**Risk Type**		**Risk Qualification**		**Risk Quantification**			**Risk Mitigation / Response**
Risk #		Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
CO2	Changing options or alignments with little or no public outreach compromises trust with Cities of MI and Bellevue and the affected community, resulting in project opposition and requiring additional outreach.	T	C	H	L	50%	$100,000	$ 50,000	Avoid: ensure community relations team is engaged in and kept informed of all project decisions. Manage expectations with public and jurisdiction, so people understand if things change with little notice. Meet regularly with Friends of LB Park, one-on-ones with waterfront property owners.
CO3	Community/jurisdictions advocate for additional scope and/or mitigation than called for in project charter or environmental review.	T	C	H	L	60%	$250,000	$ 150,000	Avoid: surface community concerns early (during pre-design), so they can be considered, addressed, and reported back to community members well before it becomes more costly to addresss. One-on-ones with waterfront property owners.
CO4	Community/jurisdictions advocate for additional process (CAG, design workshops, examining other alternatives proposed by the community or jurisdiction).	T	B	H	L	50%	$100,000	$ 50,000	Avoid: carefully document process from alternatives analysis through final design, including input from public and how we considered and addressed that input in project decision-making. Make extensive effort to identify and reach all potentially affected parties early in the process. One-on-ones with waterfront property owners.
8.0	**Cost**								

		Alternatives 9							
Risk Identification		**Risk Type**		**Risk Qualification**		**Risk Quantification**			**Risk Mitigation / Response**
Risk #		Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
C1	Project complexity, County budget/cashflow restrictions, and/or project changes causes re-bid or project budget to be exceeded beyond approved limit.	T	B	M	H	10%	$5,000,000	$500,000	
C2	Increase of material costs at time of construction due to limited availability (ie fly ash for concrete) or escalating petroleum prices (HDPE pipe & FPVC pipes) results in construction costs during construction than in the original bid opening price.	T	C	L	M				
C3	Limited qualified competitive bidders for contract due to specialized construction techniques (in-water and trenchless)	T	B	L	H	5%	$5,000,000	$250,000	
						Total Risk Cost		**$5,610,000**	

Alternative 14

Risk Identification		Risk Type		Risk Qualification		Risk Quantification			Risk Mitigation / Response
Risk #		Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
x.x	*Example Risk*	*T*	*C*	*H>35; M-10-35; L<10*	*L<500K; M-500K to 1.0M; H >1M*	*%*	*$*		
1.0	**Technical**								
T1	Complex hydraulic assumptions (e.g., average dry weather flows, peak flows), conditions (siphons), and analysis leads to system hydraulic issues (ie overflows, sediment accumulation)	T	C	L	H	5%	$10,000,000	$500,000	
T2	Bellevue flows must be rerouted to Sweyolocken due to one or more of the following risks: - Existing Enatai Interceptor piles/caps will not last until design year 2060 and cannot be rehabilitated to provide reliable service through 2060 - Enatai pipe cannot be rehabilitated to provide reliable service through 2060 - Enatai Interceptor is not recommended to be kept in service in the existing location due to risks of unstable flowing soils and future pipe breakage	T	C	L	H	2%	5000000	$100,000	
T3	Current bathymetric survey is insufficient and results in readjusting alignment of in-water open-cut pipeline and additional hydraulic analysis.	T	C	M	L				
T4	Design criteria, standards, codes and/or criteria change during design and/or construction and leads to project budget and schedule overruns.	T	B	M	L				
T5	Inadequate or incorrect existing data (ie asbuilts) leads to incorrect design assumptions	T	B	L	L				

Alternative 14

Risk Identification		Risk Type		Risk Qualification		Risk Quantification			Risk Mitigation / Response
Risk #		Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
T6	Poor condition of existing Enatai Interceptor or undocumented conditions (ie joint seperation or pile conditions) leads to challenges with rehabilitation during design.	T	B	L	H	5%	$5,000,000	$250,000	
T7	Subsurface (underground or underwater) contamination or utility/physical conflicts found during design causes remediation response or alignment adjustment.	T	B	M	M				
T8	Upgrade of PS 11 is not viable due to hydraulic issues identified during predesign and/or coordination with COMI.								
TR1	Borehole instability	T	C	L	H	5%	$2,000,000	$100,000	Significant geotechnical investigation could be performed to identify any zones of unstable soils. Grouting could be specified for zones where unstable soils exist.
TR2	Damage to bridge infrastructure	T	C	L	H	2%	$2,000,000	$40,000	Acquire private easement that allows moving the HDD away from the I-90 bridge. Design bore to minimize the number of houses under which it traverses.
TR3	Encountering Differing Site Conditions (DSC)	T	C	M	H	10%	$2,000,000	$200,000	Perform a thorough geotechnical investigation so that the contractor can make an educated evaluation of the soil conditions with the information provided in the contract documents.
TR4	Discharge of drilling fluid to Lake Washington	T	C	H	M	80%	$500,000	$400,000	Specify positive controls to prevent damage to the shoreline or inadvertent returns. Require the contractor to design, implement, and construct drilling fluid containment measures when drilling near the shoreline (through the specifications)

Alternative 14

Risk Identification		Risk Type		Risk Qualification		Risk Quantification			Risk Mitigation / Response
Risk #		Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
TR5	Small Bidder Pool	T	C	H	H	50%	$4,000,000	$2,000,000	Simplify the bore during design to the extent possible. Focus on risk sharing elements when producing the contract documents to encourage Contractors to bid. Potential floating NTP date?
TR6	Geotechnical conditions unfavorable to microtunneling along Segment A10-2, and causes re-alignment to Segment A10-1	T	C	L	H	10%	$1,500,000	$150,000	Open shield pipe jacking may be considered to allow obstruction removal. A tunnel rescue shaft could be included as a bid item in order to establish costs up-front. **Variant (10-1): New alignment is required along SE 24 and 84th Ave for better geological conditions**
TR7	Machine stuck due to high face pressures forces in combination with high frictional forces, leading to high jacking forces.	T	C	M	H	30%	$1,000,000	$300,000	Open shield pipe jacking may be considered. A tunnel rescue shaft could be included as a bid item in order to establish costs up-front.
TR8	Line and grade deviation outside of tolerances or beyond the laser path to the machine target.	T	C	L	H	5%	$1,500,000	$75,000	A tunnel rescue shaft could be included as a bid item in order to establish costs up-front.
TR9	Encountering Differing Site Conditions (DSC)	T	C	M	H	30%	$3,000,000	$900,000	Perform a thorough geotechnical investigation so that the contractor can make an educated evaluation of the soil conditions with the information provided in the contract documents.
TR10	Machine breakdown or failure while underground.	T	C	L	H	5%	$3,000,000	$150,000	A tunnel rescue shaft could be included as a bid item in order to establish costs up-front.
TR11	Small Bidder Pool	T	C	L	H	5%	$2,000,000	$100,000	Focus on risk sharing elements when producing the contract documents to encourage Contractors to bid.

Alternative 14

Risk Identification		Risk Type		Risk Qualification		Risk Quantification			Risk Mitigation / Response
Risk #		Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
2.0	**Constructability**								
CM1	Unanticipated contaminated soil and/or groundwater discovered during construction.	T	B	L	L				
CM2	Abandoned buried structures, abandoned creosote-contaminated piles, submerged/buried logs, and fill debris that was not anticipated is encountered during excavation; and must be removed. This could occur in open-cut excavation for pipeline, structures including Sweyolocken area, along N. Mercer Way in-water.	T	B	M	L				
CM3	Damage to public or private property. This includes damage to docks for HDD work or in-water lakeline work, or rehab work. This also includes excessive ground losses during HDD and microtunneling which leads to ground surface settlements that damage overlying buildings, residences, roadways, and utilities.	T	B	M	M				
CM4	Control of groundwater difficult and causes pipeline and structures installation to stop and result in delays and additional costs during construction.	T	B	L	M				
CM5	Construction dewatering during excavation and/or vibration may result in localized ground settlement. Results in damage to existing structures or facilities and require additional settlement and vibration monitoring during construction.	T	B	L	H	5%	$1,000,000	$50,000	
CM6	Unidentified utility can lead to rerouting of pipeline alignment, delay in construction requiring input/approval of utility owner and adds additional construction cost for rerouting utilities.	T	B	M	H	10%	$7,500,000	$750,000	

Alternative 14

Risk Identification		Risk Type		Risk Qualification		Risk Quantification			Risk Mitigation / Response
Risk #		Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
CM7	Construction staging and construction affect bus service / transit center and City parking areas (ie Luther Burbank, park and rides) requiring mitigation (ie tempoary parking) during design.	T	B	H	M	35%	$450,000	$157,500	
CM8	Businesses disruption due to construction. Waterfront businesses (ie kayaking, Pacific Science Center etc) cannot operate due to construction in the area.	T	C	L	M				
CM9	Additional Odor Control systems are required than initially developed during alternatives analysis and requires additional footprint for odor control systems in design, additional permits, and/or coordination with agencies.	T	C	L	M				
CM10	Construction deviations in line-and-grade of the pipeline or other construction elements causes hydraulic or other operational problems.	**T**	B	L	M				
CM11	Deviations from construction contract in construction footprint, duration, and allowed impact levels results in community complaints to jurisdiction and County management and electeds.	T	B	H	L	35%	$100,000	$35,000	
CM12	Differing site conditions during in-water construction causes additional contractor delays and costs	T	C	M	H	25%	$1,500,000	$375,000	
3.0	**Operations and Maintenance**								
OM1	Complex inspection access points do not function as well as planned or cumbersome for O&M use due to surcharged system.	T	B	H	M	50%	$500,000	$250,000	

Alternative 14

Risk Identification		Risk Type		Risk Qualification		Risk Quantification			Risk Mitigation / Response
Risk #		Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
4.0	**Permitting**								
P1	SEPA and/or permits appealed.	T	B	L	M				Early coordination with cities and public to ensure they accept the project approach. If SEPA determination is contested, would need to produce additional documentation.
P2	Contractor does not acquire all required permits.	T	B	M	M				Early coordination with agencies to ensure they accept the project approach. More documentation for East Channel Crossing
P3	In water construction or rehab work triggers additional permitting and environmental approvals.	T	B	M	M				
P4	In-water construction takes longer than expected, requiring demobilization and remobilization (ie have to wait until next fish window.	T	B	M	M				Negotiate fish windows that will meet construction timing requirements. If construction does take longer, would need to get permits extended with all agencies.
P5	Permit violations result in substantial project delay.	T	B	M	M				
P6	Corps requires additional analysis/justification for in-water construction.	T	B	M	M				Provide effective alternatives analysis documentation showing there is no practicable alternative to proposed in-water work.
5.0	**ROW/Easements/ROE**								
R1	Condemnation required for easements and "Possession & Use" not granted, resulting in delayed bidding and start of construction.	T	B	L	H	20%	$1,000,000	$ 200,000	Mitigate

Alternative 14

Risk Identification		Risk Type		Risk Qualification		Risk Quantification			Risk Mitigation / Response
Risk #		Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
R2	Alignment changed, after start of acquisitions, due to political pressures, and causes re-work and schedule delays.	T	B	L	H	5%	$1,000,000	$ 50,000	Mitigate
R3	Underground pipeline construction alignment deviates outside of the acquired right-of-way and requires easement modification.	T	N/A	L	L				
R4	Constraints tied to funding at one or more park sites will limit time or footprint for construction, or require partial or complete park replacement for exceedences.	T	B	L	L				
6.0	**Environment**								
E1	Archaeological resources found during construction result in construction delay.	T	B	M	L				Sweyolocken area and Luther Burbank Park shoreline identified as high probability areas.
E2	Mitigation measures to replace wetlands/vegetation (ie trees) are underestimated during design can result in extensive restoration measures including tree replacment at a higher ratio (2:1) and vegetations study.	T	B	M	L				Thorough environmental reports upfront to quantify all resources.
E3	BMP failures - failure to meet conditions in the BMP	T	B	M	M				
7.0	**Community**								

Alternative 14

Risk Identification		Risk Type		Risk Qualification		Risk Quantification			Risk Mitigation / Response
Risk #		Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
CO1	Community opposition forces us to change the project. Private property owners oppose trenchless options to jurisdiction and project must be changed. This may be due to perceived construction risks, subterranean easements, impacts on traffic and access for park and community center for variant in 84th/24th.	T	B	H	H	60%	$100,000	$ 60,000	Avoid: conduct extensive community outreach during pre-design phase to reach all affected people and organizations and ensure they understand the purpose of and need for the project. Meet with cyclist advocacy groups (Cascade), Friends of LB Park regarding trenchless in Mercer Island. ROW/permitting staff work proactively with property owners and jursidiction. Community Relations team works with community stakeholders to understand benefits and reasonable solutions for concerns. Project team works closely with waterfront homeowners whose dock access will be affected during work.

		Alternative 14							
Risk Identification		**Risk Type**		**Risk Qualification**		**Risk Quantification**			**Risk Mitigation / Response**
Risk #		Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
CO2	Community opposition forces us to change the project alignment during design. Commuters, community members, jurisdictions, bicyclists protest due to traffic impacts in North Mercer Way	T	B	L	L				Mitigate: Project team works with jurisdiction to establish permit conditions that reduce traffic impacts. **Based on community input, risk for this is low probability for upland variant (bike path), even if route involves some work on North Mercer Way.**
CO3	Community opposition forces us to change the project alignment during design. Property owners, park users, and/or groups oppose work in Luther Burbank Park, wetlands and/or waterway.	T	B	M	H	60%	$100,000	$ 60,000	Provide briefings for agencies and jurisdiction on recommendation for this alignment early in design. Project team works with agencies and jurisdiction on restoration/mitigation strategy for affected areas, and community relations conveys to concerned citizens. Project team works closely with waterfront homeowners whose dock access will be affected during work. Robust level of work with public prior to environmental review to address questions and concerns.

		Alternative 14							
Risk Identification		**Risk Type**		**Risk Qualification**		**Risk Quantification**			**Risk Mitigation / Response**
Risk #		Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
CO2	Changing options or alignments with little or no public outreach compromises trust with Cities of MI and Bellevue and the affected community, resulting in project opposition and requiring additional outreach.	T	C	H	L	50%	$100,000	$ 50,000	Avoid: ensure entire project team is engaged in and kept informed of all potential project changes and project decisions. Manage expectations with public, property owners and jurisdiction. If major alignment change occurs, team develops and implements strategic outreach plan to provide reasoning and work with jurisdiction, agencies, and stakeholders.
CO3	Community/jurisdictions advocate for additional scope and/or mitigation than called for in project charter or environmental review.	T	C	H	H	60%	$250,000	$ 150,000	Community relations provides team with community concerns early (during pre-design), so they can be considered, addressed, and reported back to community members. Community relations manages expectations about environmental review process and mitigation constraints. Project team and WTD management to work with jurisdiction and agencies to define appropriate mitigation.
CO4	Community/jurisdictions advocate for additional process (CAG, design workshops, examining other alternatives proposed by the community or jurisdiction).	T	B	H	L	60%	$100,000	$ 60,000	Project teams to provide briefings for internal management, elected officials, and agencies. Conduct robust public outreach during design phase to avoid community perception of non-responsiveness or lack of availability. Convey community concerns to team and report back to community in a timely fashion.
8.0	**Cost**								

		Alternative 14							
Risk Identification		**Risk Type**		**Risk Qualification**		**Risk Quantification**			**Risk Mitigation / Response**
Risk #		Threat(T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Prob	Impact	Probability	Impact Costs	Risk Cost	Description (Accept, Avoid, Transfer, Mitigate)
C1	Project complexity, County budget/cashflow restrictions, and/or project changes causes re-bid or project budget to be exceeded beyond approved limit.	T	B	M	H	10%	$5,000,000	$500,000	
C2	Increase of material costs at time of construction due to limited availability (ie fly ash for concrete) or escalating petroleum prices (HDPE pipe & FPVC pipes) results in construction costs during construction than in the original bid opening price.	T	C	L	M				
C3	Limited qualified competitive bidders for contract due to specialized construction techniques (in-water and trenchless)	T	B	L	H	5%	$5,000,000	$250,000	
						Total Risk Cost		**$8,262,500**	

Appendix F. Alternatives Evaluation Matrix

North Mercer Island Interceptor and Enatai Interceptor Upgrade Project — Stage 3 Alternatives Evaluation Matrix

		4	9	14
ALTERNATIVE		4	9	14
MERCER ISLAND		A1 (upland w/PS 11 replacement)	A4 (lake bottom)	A10-2 (trenchless diversion & lake bottom)
EAST CHANNEL		B6u (upland connection; lake bottom)	B6w (in-water connection; lake bottom)	B6w (in-water connection; lake bottom)
ENATAI		C1 (trenchless)	C1 (trenchless)	C1 (trenchless)
SUMMARY	Total New Pipeline	18,261 LF	16,737 LF	16,628 LF
	Single Pipe Force Main, On Land (Note: dual FM to be incorporated in predesign based on 10/20/15 decision)	11,637 LF (Segment A1, Connection C08)	3,000 LF (Segment A4)	1,897 LF (Segment A10-2)
	New North Mercer PS Force Main Discharge Invert Elevation	173' (Segment A1)	212' (Segment A4)	181' (Segment A10-2)
	New North Mercer PS Force Main Intermediate High Point Invert Elevations	212' and 184' (Segment A1)	None	None
	Dual Pipe, Trenchless (Microtunnel)	None	None	2,014 LF (Segment A10-2)
	Single Pipe Open-Cut Gravity Sewer, On Land	1,898 LF (Segment A1, Connection C11, Connection C05, Segment C1)	1,226 LF (Segment A4, Connection C01, Connection C05, Segment C1)	781 LF (Connection C06, Connection C01, Connection C05, Segment C1)
	Dual Pipe Open-Cut, On Land	434 LF (Segment A1, Segment B6u)	1,740 LF (Segment A4, Connection C01, Segment B6w)	1,165 LF (Segment A10-2, Connection C01, Segment B6w)
	Dual Pipe Open-Cut, In Water	1,382 LF (Segment B6u)	7,861 LF (Segment A4, Connection C01, Segment B6w)	7,861 LF (Segment A10-2, Connection C01, Segment B6w)
	Single Pipe, Trenchless (HDD)	2910 LF (Segment C1)	2910 LF (Segment C1)	2910 LF (Segment C1)
	Rehabilitation	CIPP Enatai Interceptor (up to 3,961 LF)	CIPP Enatai Interceptor (up to 3,961 LF)	CIPP Enatai Interceptor (up to 3,961 LF)
	Special Structures	2 weir structures	3 weir structures	3 weir structures
	North Mercer Pump Station	Install three (3) 150 hp pumps and associated electrical equipment by 2029. Modify suction piping and wetwell. Install new surge tanks.	Install four (4) 150 hp pumps and associated electrical equipment by 2029. Modify suction piping and wetwell. Install new surge tanks.	Install new surge tanks.

North Mercer Island Interceptor and Enatai Interceptor Upgrade Project — Stage 3 Alternatives Evaluation Matrix

ALTERNATIVE	4	9	14
MERCER ISLAND	A1 (upland w/PS 11 replacement)	A4 (lake bottom)	A10-2 (trenchless diversion & lake bottom)
EAST CHANNEL	B6u (upland connection; lake bottom)	B6w (in-water connection; lake bottom)	B6w (in-water connection; lake bottom)
ENATAI	C1 (trenchless)	C1 (trenchless)	C1 (trenchless)
DESCRIPTION	Mercer Island: Segment A1: Upland, open-cut pipeline from North Mercer PS to the Mercer shore near the I-90 bridge, mainly following North Mercer Way (segment A1). Segment A1 includes 10,854 LF of force main, 1,073 LF of gravity sewer to Special Structure WS01, and 267 LF of dual pipeline to the East Channel. North Mercer Pump Station: Station modifications are required to increase capacity to meet the projected need in 2029. Surge tanks required based on new force main alignment. East Channel: Segment B6u (upland connection): Replace existing interceptor (siphon) with 1,382 LF new in-water dual pipeline from the Mercer Island shore just north of the I-90 bridge to the Enatai shore just north of the I-90 bridge and 167 LF on-land dual pipeline to Special Structure WS02. New in-water interceptor to be placed in a shallow trench along the lake bottom. Enatai: Segment C1: 2,910 LF HDD crossing from the vicinity of the Enatai shore just north of the I-90 bridge to the vicinity of Sweyolocken PS, followed by 180 LF of open-cut gravity pipeline to connect at Sweyolocken. Rehab Requirements: • R02: CIPP Exist Enatai Interceptor: up to 3,961 LF (exact rehab limits TBD) Connections: • C11: Gravity connection between the existing East Trunk (pipe reach R208G-26 to R08G-20) and Mercer Island PS 11. Could be anywhere between 10 LF and 200 LF, depending on exact PS 11 and East Trunk locations and PS	Mercer Island: Segment A4: New interceptor alignment is from North Mercer PS to the Mercer Island shore in Luther Burbank Park, and then in-water to the Segment A4/A10 connection point in the East Channel. New interceptor to include a 3,000 LF force main, 480 LF of gravity sewer, 1,160 LF of dual pipeline to the Mercer Island shore, and 6,315 LF of in-water open-cut dual pipeline to the Segment A4/A10 connection point in the East Channel. In-water portion to be placed in a shallow trench along the lake bottom outside the Inner Harbor Line, at least 20’ from docks, and up to 450’ from shore (as required by Lake Washington bathymetry). North Mercer Pump Station: Same as Alternative 4. East Channel: Segment B6w (in-water connection): Replace existing interceptor (siphon) with 1,307 LF new in-water dual pipeline from A4/A10 connection point in the East Channel to the Enatai shore and 167 LF on-land dual pipeline to Special Structure WS02. New in-water interceptor to be placed in a shallow trench along the lake bottom. Enatai: Segment C1: Same As Alternative 4. Rehab Requirements: • R02: Same as Alternative 4. Connections: • C01: Connect exist East Trunk MH R208G-26 (where Pump Station 11 flows enter KC system) to new interceptor. Requires 673 LF of new pipeline: 21 LF gravity sewer on	Mercer Island: Segment A10-2: New interceptor alignment is a force main (1,897 LF) from North Mercer PS to Special Structure WS05, then a 2,014 LF microtunnel (or possibly a similar-length HDD) of dual carrier pipes straight to the south parking lot of Luther Burbank Park, 585 LF of dual pipeline to the Mercer Island Shore, and 6,315 LF of in-water open-cut dual pipeline to the Segment A4/A10 connection point in the East Channel. In-water portion to be placed in a shallow trench along the lake bottom outside the Inner Harbor Line, at least 20’ from docks, and up to 450’ from shore (as required by Lake Washington bathymetry). North Mercer Pump Station: No modifications required due to capacity. Surge tanks required based on new force main alignment. East Channel: Segment B6w (in-water connection): Same as Alternative 9 Enatai: Segment C1: Same as Alternative 4. Rehab Requirements: • R02: Same as Alternative 4. Connections: • C06: Connect exist MH S10 (in the middle of North Mercer Way) by gravity to new diversion structure near the north edge of North Mercer Way (WS05). Requires 35 LF of 40’ deep trench. • C01: Same as Alternative 9.

ALTERNATIVE	4	9	14
MERCER ISLAND	A1 (upland w/PS 11 replacement)	A4 (lake bottom)	A10-2 (trenchless diversion & lake bottom)
EAST CHANNEL	B6u (upland connection; lake bottom)	B6w (in-water connection; lake bottom)	B6w (in-water connection; lake bottom)
ENATAI	C1 (trenchless)	C1 (trenchless)	C1 (trenchless)
	11 inlet invert. Assumed length is 100 LF for summary purposes. • C08: New 783 LF force main from Mercer Island PS 11 to new interceptor. Connection to new interceptor to be made in the vicinity of the I-90 bike path and 97th Ave SE. • C05: Connection between the start of the new Enatai HDD (segment C1) and the existing Enatai Interceptor. 545 LF of single pipeline buried 11 '- 22' deep that will divert Mercer Island low flows into the existing Enatai Interceptor. Special Structures: • WS01: Weir Structure (Flow-Split) on land near the Mercer Island shore in the vicinity of the East Channel. 6'x6' cast-in-place concrete structure 6' deep, located in the road on SE 35th Pl. Flows in are from the gravity sewer portion of segment A1, flows out are to the dual pipeline portion of segment A1. • WS02: Weir Structure (Flow-Split) on land near the Enatai shore in the vicinity of the East Channel. 8'x8' cast-in-place concrete structure 16' deep, located near the north edge of Enatai Beach Park. Flows in are from segment B6u (upland connection), flows out are to Connection C05 and Segment C1.	land to special structure WS04, 413 LF dual pipeline on land, and 239 LF dual in-water pipeline. In-water pipeline to be placed in a shallow trench along the lake bottom. • C05: Same as Alternative 4. Special Structures: • WS03: Weir Structure (Flow-Split) on Mercer Island near the intersection of SE 24th St and 84th Ave SE. 6'x6' cast-in-place concrete structure 13' deep, located in the road. Flows in are from the gravity-sewer part of Segment A4, flows out are to the dual pipeline part of Segment A4. • WS04: Weir Structure (Flow-Split) on Mercer Island near the intersection of 97th Ave SE and SE 34th St. 6'x6' cast-in-place concrete structure 13' deep, located along the edge of the road. Flows in are from the gravity sewer part of Connection C01, flows out are to the dual pipeline part of Connection C01. • WS02: Weir Structure (Flow-Split) on land near the Enatai shore in the vicinity of the East Channel. 8'x8' cast-in-place concrete structure 16' deep, located in the grassy area near the north edge of Enatai Beach Park. Flows in are from segment B6w (in-water connection), flows out are to Connection C05 and Segment C1.	• C05: Same as Alternative 4. Special Structures: • WS05: Weir/Drop Structure (Flow-Split) on Mercer Island near the intersection of 77th Ave SE and North Mercer Way. 6'x6' cast-in-place concrete structure 38' deep, located near the edge of the road. Flows in are from the force main part of segment A10-2 and from Connection C06, flows out are to the microtunnel or HDD part of segment A10-2. • WS04: Same as Alternative 9. • WS02: Same as Alternative 9.
TECHNICAL • Technical Complexity	T1. Flow Management • Two Weir Structures (flow-split) required: WS01, WS02 T2. Modify Localized Conveyance • Mercer Island: Modifications to the local conveyance system are required. A new gravity connection (Connection C11) will be constructed between the East Trunk and Mercer Island PS 11 in	T1. Flow Management • Three Weir Structures (flow-split) required: WS03, WS04, WS02. T2. Modify Localized Conveyance • Mercer Island: Potentially minor piping modifications in the vicinity of exist MH R208G-26 as needed to accommodate Connection C01 and special structure WS04.	T1. Flow Management • Three Weir Structures (flow-split) required: WS05, WS04, WS02 T2. Modify Localized Conveyance • Mercer Island : Potentially minor piping modifications in the vicinity of exist MH R208G-26 as needed to accommodate Connection C01 and special structure WS04, and minor piping modifications in

ALTERNATIVE	4	9	14
MERCER ISLAND	A1 (upland w/PS 11 replacement)	A4 (lake bottom)	A10-2 (trenchless diversion & lake bottom)
EAST CHANNEL	B6u (upland connection; lake bottom)	B6w (in-water connection; lake bottom)	B6w (in-water connection; lake bottom)
ENATAI	C1 (trenchless)	C1 (trenchless)	C1 (trenchless)
	the vicinity of PS 11 such that the East Trunk discharges to PS 11. The existing PS 11 force main will be abandoned, minor piping modifications may be required in the vicinity of exist MH R208-26, and a new force main will be constructed from PS 11 to the new interceptor (see description of Connection C08 above). PS 11 will require upgrades in order to meet increased head and flow requirements. • Bellevue: Potentially minor piping modifications in the vicinity of exist MH RO8-01A as needed to accommodate Connection C05. T3. Modify the Exist King County Pipelines • Mercer Island: Modifications to the Existing Interceptor are not required. Modifications to the East Trunk are required in the vicinity of Mercer Island PS 11 and exist MH R208-26 as described above under "Modify Localized Conveyance." It's possible that some East Trunk flows can be diverted to the new interceptor and a portion of the East Trunk abandoned; this possibility will be further studied in the predesign phase. Modifications to the West Trunk are not required. • Bellevue: Rehab R02 is required. T4. North Mercer Pump Station Modifications (Concept C) • Upgrades are required to meet increased flow capacity. The projected need for additional capacity will be in 2029. • Needs increased capacity at PS from 8 mgd to 10.5 mgd. • A1: Install three (3) new 150 hp pumps and associated equipment in 2029. • A1: Suction piping and wetwell modifications will be required when new pumps are installed. This work will require a temporary pumping station. • A1: For this force main alignment the discharge elevation is below multiple intermediate high points. This results in conditions where the entire force will not always be full and portions upstream of the intermediate high points will act like as gravity syphons. T5. Hydraulic Transient Mitigation • A1: 200 ft3 surge tank at PS • A1: 4-inch vacuum relief valve at each of STA 11+84, STA 11+43 (~3000 ft downstream of PS), and STA 45+98 (~9260 ft downstream of PS)	• Bellevue: Same as Alt 4. T3. Modify the Exist King County Pipelines • Mercer Island: Modifications not required • Bellevue: Same as Alt 4. T4. North Mercer Pump Station Modifications (Concept B) • Upgrades are required to meet increased flow capacity. The projected need for additional capacity will be in 2029. • Needs increased capacity at PS from 8 mgd to 10.5 mgd. Install four (4) new 150 hp pumps and associated equipment in 2029. • Suction piping and wetwell modifications will be required when new pumps are installed. This work will require a temporary pumping station. T5. Hydraulic Transient Mitigation • 200 ft3 surge tank at PS (roughly 4' dia and 16 ft long/tall) • 4-inch vacuum relief valve at STA 11+84	the vicinity of exist MH S10 in order to accommodate connection C06 and special structure WS05. • Bellevue: Same as Alt 4. T3. Modify the Exist King County Pipelines • Mercer Island: Modifications to the West Trunk are required in the vicinity of exist MH S10 as needed to accommodate connection C06. • Bellevue: Same as Alt 4. T4. North Mercer Pump Station Modifications (Concept A) • Diversion will reduce flows to North Mercer so that capacity upgrade is not required. However, existing pumps will need replacement in 2029 due to end of useful life of pumps. • The existing three (3) 125 hp pumps can deliver a station capacity of 8 mgd which is greater than the 7 mgd maximum flow projection for 2060. • New force main to diversion location (WS05) will reduce static head while maintaining acceptable velocities. • No temporary pumping station required. T5. Hydraulic Transient Mitigation • 150 ft3 surge tank at PS (roughly 4' dia and 12 ft long/tall) • 4-inch vacuum relief valve at each of STA 11+84 and STA 11+43

North Mercer Island Interceptor and Enatai Interceptor Upgrade Project — Stage 3 Alternatives Evaluation Matrix

ALTERNATIVE	4	9	14
MERCER ISLAND	A1 (upland w/PS 11 replacement)	A4 (lake bottom)	A10-2 (trenchless diversion & lake bottom)
EAST CHANNEL	B6u (upland connection; lake bottom)	B6w (in-water connection; lake bottom)	B6w (in-water connection; lake bottom)
ENATAI	C1 (trenchless)	C1 (trenchless)	C1 (trenchless)
CONSTRUCTABILITY • Constructability • Coordination with Other Projects • Soils	<u>C1. Upland Open Cut</u> • Primarily shallow open cut (6 – 10 feet typ depth) along Mercer Island for approx. 12,200 feet <u>C2. In-water Open Cut</u> • No in-water work along Mercer Island • Requires 1,382 LF of in-water work across East Channel • Will require in-water work to rehab/reline Enatai Interceptor <u>C3. Trenchless</u> • C1: Length and diameter are constructible. Adequate staging area and construction layout but constrained right at WSDOT bridge columns. Earthwork required to make connection to Enatai Interceptor. • Rehabilitation: Length of runs and diameter are constructible. Some access points are constrained but adequate for necessary work. Earthwork is not required. • C1: Adequate staging area and construction layout. <u>C4. Level of Coordination with Agencies</u> • Coordinate PS 11 upgrades with COMI. • Coordinate trenchless construction and staging area with WSDOT and COB along Enatai Park area and I-90 bridge. • Coordinate construction staging with Sound Transit in Enatai Park area and in Mercer Island Boat Launch area <u>C5. Existing Utilities</u> • Requires increased coordination with utilities located along N. Mercer Way. <u>C6. Geotechnical (Soils)</u> Mercer Island: • The soils along the alignment are favorable for open cut construction and are considered to be favorable foundation soils for pipelines and manhole structures.	<u>C1. Upland Open Cut</u> • Primarily shallow open cut (6 – 10 feet typ depth) along Mercer Island for approx. 4600 feet <u>C2. In-water Open Cut</u> • Requires 7,861 LF of in-water work along Mercer Island and East Channel • Will require in-water work to rehab/reline Enatai Interceptor <u>C3. Trenchless</u> • Same as Alternative 4. • Rehabilitation: Same as Alternative 4. <u>C4. Level of Coordination with Agencies</u> • Coordinate trenchless construction and staging area with WSDOT and COB along Enatai Park area and I-90 bridge. • Same as Alt. 4 <u>C5. Existing Utilities</u> • Less coordination of utilities associated with in-water open cut segments. <u>C6. Geotechnical (Soils)</u> Mercer Island: • Along the upland portion of the alignment, the geotechnical soils are as described for Alternative 4. • In Luther Burbank Park, up to 10 feet of soft lake and peat deposits will be encountered and may require overexcavation to remove unsuitable foundation soils. • For the in-water alignment, the soils are favorable for open cut construction using a barge-mounted excavator or dredge equipment and the soils are considered to be acceptable to very good foundation soils.	<u>C1. Upland Open Cut</u> • Primarily shallow open cut (6 – 10 feet typ depth) along Mercer Island for approx. 1900 feet • Connection pipeline from exist MH S10 to new diversion structure requires 35 LF of 40' deep trench. <u>C2. In-water Open Cut</u> • Same as Alt. 9 <u>C3. Trenchless</u> • A10-1/2 (MT): Length of drives and diameter are constructible. Constrained staging area at condo building and in N Mercer Way. • C1: Same as Alternative 4. • Rehabilitation: Same as Alternative 4. • C1: Adequate staging area and construction layout. <u>C4. Level of Coordination with Agencies</u> • Coordinate trenchless construction and staging area with WSDOT and COB along Enatai Park area and I-90 bridge • Same as Alt. 4. <u>C5. Existing Utilities</u> • Less coordination of utilities associated with in-water open cut segments and trenchless segment. <u>C6. Geotechnical (Soils)</u> Mercer Island: • The geotechnical soils for the upland and in-water alignments on Mercer Island are as described in Alternative 4 and 9. • The soils along the trenchless section consist of very dense or very stiff to hard glaciolacustrine deposits consisting of nonplastic to low-plasticity silts and lean to fat clays with groundwater levels are at about 10 to 30 feet below ground surface. • The glaciolacustrine deposits will contain cobbles and

ALTERNATIVE	4	9	14
MERCER ISLAND	A1 (upland w/PS 11 replacement)	A4 (lake bottom)	A10-2 (trenchless diversion & lake bottom)
EAST CHANNEL	B6u (upland connection; lake bottom)	B6w (in-water connection; lake bottom)	B6w (in-water connection; lake bottom)
ENATAI	C1 (trenchless)	C1 (trenchless)	C1 (trenchless)
	East Channel: • The soils are favorable for open cut construction using a barge-mounted excavator or dredge equipment and the soils are considered to be very good foundation soils. Enatai: • The majority of the HDD alignment will encounter glacial outwash and glaciolacustrine deposits, which are favorable soil conditions for HDD construction. Cobbles and boulders are common in these soils, but HDD bores can be redirected around obstructions. • Near the Sweyolocken Pump Station, soft recessional outwash soils will be encountered above the glacial soils and are susceptible to squeezing and may require a conductor casing to stabilize the ground during construction. • Because of the depth and the existence of a relatively thick mantle of till-like deposits at the surface, settlements are anticipated to be negligible.	East Channel: • The geotechnical conditions are as described for Alternative 4. Enatai: • The geotechnical conditions are as described for Alternative 4.	boulders. If a boulder is encountered that cannot be broken and excavated by the closed face microtunnel machine; a rescue shaft may be required to clear the boulder. • Ground losses and surface settlements from microtunneling are anticipated to be minimal. East Channel: • The geotechnical conditions are as described for Alternative 4. Enatai: • The geotechnical conditions are as described for Alternative 4.
OPERATION AND MAINTENANCE • Operation • Maintenance	<u>OM1. Odor Generation</u> • Potential of odor release at three locations: 1) FM discharge structure – longer detention times in FM can result in release of H2S- provide passive odor control 2) Odor potential at Enatai Beach Park area at siphon inlet structure of "parked" C1 pipeline – provide active odor control system. 3) Odor release at Sweyolocken siphon outlet structure during initial first flush of C1 pipeline. Evaluate potential of using existing PS OCU system. • Three air/vac valves required on longer FM for surge protection and at intermediate high points. <u>OM2. Accessibility</u> • Mercer Island portion is within public ROW, but only 1000' (A1) is easily accessible within gravity portions of system. • Long forcemain onland will have access points.	<u>OM1. Odor Generation</u> • Potential of odor release at three locations: 1) FM discharge structure –detention times in FM similar to existing and treated with passive carbon system. 2) Same as Alt. 4. 3) Same as Alt. 4. • One air/vac valve required on FM. <u>OM2. Accessibility</u> • Most of new system is difficult to access since it is in-water/surcharged or a siphon under the East Channel, and is inaccessible under Enatai	<u>OM1. Odor Generation</u> • Potential of odor release at three locations: 1) FM discharge /S10 Drop structure – 40 foot deep structure could release high levels of H2S during turbulence related to drop. Provide active odor control system. 2) Same as Alt. 4. 3) Same as Alt. 4. • One air/vac valve required on FM. <u>OM2. Accessibility</u> • Deep flow diversion would have difficult access. • Entire length of new interceptor (including diversion) surcharged • Most of new system is difficult to access since it is in-

ALTERNATIVE	4	9	14
MERCER ISLAND	A1 (upland w/PS 11 replacement)	A4 (lake bottom)	A10-2 (trenchless diversion & lake bottom)
EAST CHANNEL	B6u (upland connection; lake bottom)	B6w (in-water connection; lake bottom)	B6w (in-water connection; lake bottom)
ENATAI	C1 (trenchless)	C1 (trenchless)	C1 (trenchless)
	• New system under the East Channel is difficult to access and inaccessible under Enatai		water/surcharged or a siphon under the East Channel, and is inaccessible under Enatai
PERMITTING • Environmental Permits • Construction Permits	<u>P1. Shoreline Master Program Consistency</u> • Consistent with city SMPs • Will require Shoreline Substantial Development Permit (SSDP) for HDD staging areas and in-water work in Bellevue and Mercer Island • May require Conditional Use Permit (CUP) for work 200' inland from Ordinary High Water Mark in Mercer Island • Will require Shoreline CUP for Bellevue <u>P2. Corps Permit Type</u> • Will require in-water work permits (Corps, Ecology and WDFW) – more timing restrictions in the water south of I-90 • Likely Individual Water Quality Certification for work in Lake WA <u>P3. Land Use Permits</u> • City street closure construction permits challenging • Standard CUP in areas outside of shoreline environment for Bellevue	<u>P1. Shoreline Master Program Consistency</u> • Same as Alternative 4. <u>P2. Corps Permit Type</u> • If Alternative 4 (or other upland alternative) is determined to be practicable, Corps will not issue a permit for in-water alternative. • Will require in-water work permits (Corps ,Ecology and WDFW) – more timing restrictions in the water south of I-90 • Expanded critical area project area due to work in Luther Burbank Park • Likely Individual Water Quality Certification for work in Lake WA and Luther Burbank Wetlands <u>P3. Land Use Permits</u> • City street closure construction permits challenging • Standard CUP in areas outside of shoreline environment for Bellevue May take longer to obtain permits in Mercer Island due to more extensive work in critical areas and shoreline	<u>P1. Shoreline Master Program Consistency</u> • Same as Alternative 4. <u>P2. Corps Permit Type</u> Same as Alt 9 <u>P3. Land Use Permits</u> Same as Alt 9
ROW / EASEMENTS / RIGHT OF ENTRY • Property Rights Acquisition	<u>ROW 1. Easements</u> • Five (5) Open-cut Easements from private properties on Mercer Island are currently listed as "contingent" and may be required depending on location of existing utilities and final design refinements. • 22 Subterranean Easements are required through Enatai, but this is not a differentiator among the alternatives.	<u>ROW 1. Easements</u> • No private Easements required on Mercer Island. • All Subterranean Easements in Enatai same as Alt 4.	<u>ROW 1. Easements</u> • Five (5) subterranean easements required from private properties on Mercer Island for microtunnel passage. Two (2) additional easements are listed as "contingent", but likely due to proximity to microtunnel center line, offset of 2.2' and 2.6', respectively. • One of the required easements is from a Condominium Association ("Mercer Isle") owned property with 89 residential

ALTERNATIVE	4	9	14
MERCER ISLAND	A1 (upland w/PS 11 replacement)	A4 (lake bottom)	A10-2 (trenchless diversion & lake bottom)
EAST CHANNEL	B6u (upland connection; lake bottom)	B6w (in-water connection; lake bottom)	B6w (in-water connection; lake bottom)
ENATAI	C1 (trenchless)	C1 (trenchless)	C1 (trenchless)
	• Three (3) additional Subterranean Easements in Enatai are listed as "contingent" and may be required due to proximity to HDD center line, offset 8.7', 5.8' and 1', respectively. ROW 2. ROW Agreements • Agreements needed with City of Mercer Island for 1) Luther Burbank Park (effects vary, Alt 4 is easiest) and 2) 97th Ave SE street end at Lake Washington for PS 11 upgrades. • Coordination with City of Mercer Island needed for access to Mercer Island (Police) Boat Launch. • WSDOT Agreements needed for landings at east channel crossing, particularly the MI side. • New ROW agreement needed with DNR for east channel crossing north of I-90 bridge. • ROW agreement with City of Bellevue needed for Enatai Beach Park and Mercer Slough.	ROW 2. ROW Agreements • Agreements with City of Mercer Island, but more difficult to obtain due to effect on Luther Burbank Park. • WSDOT Agreement needed for landing at Enatai side of east channel crossing. • DNR Agreement same as Alt 4. • City of Bellevue Agreements same as Alt 4.	owners, potentially complicated negotiations in obtaining owner concurrence. • All Subterranean Easements in Enatai same as Alt 4. ROW 2. ROW Agreements • ROW Agreement needed with Sound Transit for microtunnel passage. • Agreements needed with City of Mercer Island for 1) microtunnel pit and Open-cut at Luther Burbank Park (most difficult of Alts). • WSDOT Agreement needed for landing at Enatai side of east channel crossing. Same as Alt 9. • DNR Agreement same as Alt 4. • City of Bellevue Agreements same as Alt 4.
ENVIRONMENT • Cultural Resources • Tribal Fishery • Fish and Wildlife • Mitigation	E1. Cultural Resources No ground disturbance to Luther Burbank shoreline. Excavation required near Sweyolocken and possibly in/adjacent to Mercer Slough. E2. Tribal Fishery Moderate amount of in-water work in Lake Washington E3. Fish and Wildlife In-water construction likely to adversely affect fish and habitat in Lake WA because of extent and duration E4. Mitigation Moderate mitigation requirements for impacts along East Channel; mitigation also potentially required for impacts to Mercer Slough	E1. Cultural Resources Limited ground disturbance to Luther Burbank shoreline. Excavation required near Sweyolocken and possibly in/adjacent to Mercer Slough. E2. Tribal Fishery Extensive amount of in-water work in Lake Washington E3. Fish and Wildlife More likely to adversely affect fish and habitat in Lake WA due to longer length of in-water work, as compared to Alt. 4. Excavation through wetlands may be required in Luther Burbank Park E4. Mitigation Extensive mitigation for impacts in Luther Burbank Park, Mercer Island shoreline, and East Channel; mitigation also potentially required for impacts to Mercer Slough	E1. Cultural Resources Same as Alt 9 E2. Tribal Fishery Same as Alt 9 E3. Fish and Wildlife Same as Alt 9 E4. Mitigation Same as Alt 9
COMMUNITY • Potential Community Effects	CI 1. Construction Location and Duration **Moderate** disruptions at Luther Burbank Park, Enatai Beach Park, and Mercer Island Boat Launch for up to six months at each construction staging area. CI 2. Transportation **High** level of disruption to traffic on N. Mercer Way. Potential for	CI 1. Construction Location and Duration **High** level of disruption at Luther Burbank Park, due to open cut through the park. Potential impacts to public art in Luther Burbank Park. **Moderate** disruptions at Enatai Beach Park and Mercer Island Boat Launch, same as Alt. 4. CI 2. Transportation **Moderate** level of disruption to neighbors on NE 24th and Mercer	CI 1. Construction Location and Duration **High** level of disruption (higher than Alt. 9) at Luther Burbank Park, due to open cut through the park and microtunnel pit. Potential impacts to public art in Luther Burbank Park. **Moderate** disruptions at Enatai Beach Park and Mercer Island Boat Launch, same as Alt. 4. CI 2. Transportation **Moderate** level of disruption to neighbors on NE 24th and Mercer

ALTERNATIVE	4	9	14
MERCER ISLAND	A1 (upland w/PS 11 replacement)	A4 (lake bottom)	A10-2 (trenchless diversion & lake bottom)
EAST CHANNEL	B6u (upland connection; lake bottom)	B6w (in-water connection; lake bottom)	B6w (in-water connection; lake bottom)
ENATAI	C1 (trenchless)	C1 (trenchless)	C1 (trenchless)
	detoured bus routes, temporary relocation of bus stops, and reduced access to commuter parking. Disruption to neighbors on NE 24th and Mercer Island Community Center users. Boat traffic in East Channel may be temporarily limited. CI 3. Construction Effects on Neighbors and Area Users **Moderate to high** disruptions to area neighbors and users. Construction activity can be constrained to normal working hours. Potential noise and glare can be reduced with reasonable measures.	Island Community Center users. Potential for detoured bus routes, temporary relocation of bus stops, and reduced access to commuter parking. Boat traffic in East Channel may be temporarily limited. CI 3. Construction Effects on Neighbors and Area Users **Moderate to high** disruptions to area neighbors and users. Construction activity can be constrained to normal working hours. Potential noise and glare can be reduced with reasonable measures. Truck traffic will be less than Alt. 4. In-water work causes temporary disruptions for waterfront property owners.	Island Community Center users. Potential for detoured bus routes, temporary relocation of bus stops, and reduced access to commuter parking. Boat traffic in East Channel may be temporarily limited. CI 3. Construction Effects on Neighbors and Area Users **Moderate** disruptions to area neighbors and users. Construction activity can be constrained to normal working hours. Potential noise and glare can be reduced with reasonable measures. Truck traffic will be similar to Alt. 4 due to microtunnel crossing. In-water work causes temporary disruptions for waterfront property owners.
COST • Construction Cost • Life-Cycle Cost • Risk Cost	Construction Cost: $35,717,634 Life-Cycle Cost: $64,515,000 (WTD Rate) Risk Cost: $5,485,000	Construction Cost: $40,832,000 Life-Cycle Cost: $72,991,000 (WTD Rate) Risk Cost: $5,610,000	Construction Cost: $54,594,000 Life-Cycle Cost: $91,959,000 (WTD Rate) Risk Cost: $8,202,500

VARIANT		Alternative 4 Variant: 4/A5	Alternative 4 Variant: 4/A1h	Alternative 14 Variant: 14/A10-1
MERCER ISLAND		A5 (upland)	A1h & A4h (upland & lake bottom)	A10-1 (trenchless & lake bottom)
EAST CHANNEL		B6u (upland connection; lake bottom)	B6w (in-water connection; lake bottom)	B6w (in-water connection; lake bottom)
ENATAI		C1 (trenchless)	C1 (trenchless)	C1 (trenchless)
SUMMARY	Total New Pipeline	17,315 LF	17,948 LF	Not Available
	Single Pipe Force Main, On Land	7,940 LF (Segment A5, Connection C08)	7,268 LF (Segment A1h)	About 1,880 LF
	New North Mercer PS Force Main Discharge Invert Elevation	237’ (Segment A5)	182.5’ (Segment A1h)	About 180’
	New North Mercer PS Force Main Intermediate High Point Invert Elevations	212’ (Segment A5)	212’ (Segment A1h)	None
	Dual Pipe, Trenchless (Microtunnel)	None	None	About 2,600 LF
	Single Pipe Open-Cut Gravity Sewer, On Land	4,649 LF (Segment A5, Connection C11, Connection C05, Segment C1)	3,984 LF (Segment A1h, Connection C09, Connection C10, Connection C05, Segment C1)	Not Available
	Dual Pipe Open-Cut, On Land	434 LF (Segment A5, Segment B6u)	580 LF (Segment A1h, Segment B6w)	Not Available
	Dual Pipe Open-Cut, In Water	1,382 LF (Segment B6u)	3,206 LF (Segment A4h, Segment B6u)	Not Available
	Single Pipe, Trenchless (HDD)	2910 LF (Segment C1)	2910 LF (Segment C1)	2910 LF (Segment C1)
	Rehabilitation	CIPP Enatai Interceptor (up to 3,961 LF)	CIPP Enatai Interceptor (up to 3,961 LF)	CIPP Enatai Interceptor (up to 3,961 LF)
	Special Structures	2 weir structures	2 weir structures	3 weir structures
	North Mercer Pump Station	Install three (3) 200 hp pumps and associated electrical equipment (required for new force main). Modify suction piping and wetwell. Install new surge tanks.	Similar to Alternative 4.	Install new surge tanks (same as Alternative 14).

VARIANT	Alternative 4 Variant: 4/A5	Alternative 4 Variant: 4/A1h	Alternative 14 Variant: 14/A10-1
MERCER ISLAND	A5 (upland)	A1h & A4h (upland & lake bottom)	A10-1 (trenchless & lake bottom)
EAST CHANNEL	B6u (upland connection; lake bottom)	B6w (in-water connection; lake bottom)	B6w (in-water connection; lake bottom)
ENATAI	C1 (trenchless)	C1 (trenchless)	C1 (trenchless)
DESCRIPTION	Mercer Island: Segment A5: Upland, open-cut pipeline from North Mercer PS to the Mercer shore near the I-90 bridge, mainly following the bike path adjoining I-90 (segment A5). Segment A5 includes 7,131 LF force main, 3,824 LF of gravity sewer to Special Structure WS01, and 267 LF of dual pipeline to the East Channel. North Mercer Pump Station: Station modifications are required to increase capacity and meet the hydraulic requirements of the new force main. Surge tanks required based on new force main alignment. East Cannel: Segment B6u (upland connection): Same as Alternative 4. Enatai: Segment C1: Same as Alternative 4. Rehab Requirements: • R02: Same as Alternative 4. Connections: • C11: Same as Alternative 4. • C08: New 809 LF force main from Mercer Island PS 11 to new interceptor. Connection to new interceptor to be made in the vicinity of the I-90 bike path and 97th Ave SE. • C05: Same as Alternative 4.	Mercer Island: Segments A1h & A4h: Upland, open-cut pipeline from North Mercer PS to the Mercer Island shore at the end of 97th Ave SE via North Mercer Way and then in-water to the Segment A4/A10 connection point in the East Channel. Segment A1h includes a 7,268 LF force main, 3,233 LF of gravity sewer to Special Structure WS04, and 413 LF dual pipeline on land to the Mercer Island shore at the end of 97th Ave SE. Segment A4h includes 1,899 LF of in-water open-cut dual pipeline from the Mercer Island shore at the end of 97th Ave SE to the Segment A4/A10 connection point in the East Channel. In-water portion to be placed in a shallow trench along the lake bottom outside the Inner Harbor Line, at least 20’ from docks, and up to 450’ from shore (as required by Lake Washington bathymetry). North Mercer Pump Station: Similar to Alternative 4. East Cannel: Segment B6w (in-water connection): same as Alternative 9 Enatai: Segment C1: Same as Alternative 4. Rehab Requirements: • R02: Same as Alternative 4. Connections: • C09: Connect exist East Trunk MH RO8C-02 to new interceptor. Requires 11 LF of new gravity sewer. Allows East Trunk to be abandoned between RO8C-02 and RO8C-08. • C10: Connect exist East Trunk MH R08C-08 to new interceptor. Requires 15 LF of gravity sewer. Allows East Trunk to be abandoned between RO8C-08 and R208G-20. • C05: Same as Alternative 4.	Mercer Island: Segment A10-1: New interceptor alignment is a force main (about 1,880 LF) from North Mercer PS to Special Structure WS05, then a microtunnel (About 2,600 LF) consisting of dual carrier pipes to the south parking lot of Luther Burbank Park via SE 24th St and 84th Ave SE, 585 LF of dual pipeline to the Mercer Island Shore, and 6,315 LF of in-water open-cut dual pipeline to the Segment A4/A10 connection point in the East Channel. In-water portion to be placed in a shallow trench along the lake bottom outside the Inner Harbor Line, at least 20’ from docks, and up to 450’ from shore (as required by Lake Washington bathymetry). North Mercer Pump Station: Same as Alternative 14. East Channel: Segment B6w (in-water connection): Same as Alternative 9 Enatai: Segment C1: Same as Alternative 4. Rehab Requirements: • R02: Same as Alternative 4. Connections: • C06: Similar to Alternative 14; length may be slightly different. • C01: Same as Alternative 9.

North Mercer Island Interceptor and Enatai Interceptor Upgrade Project — Stage 3 Alternatives Variant Summaries and Descriptions

VARIANT	Alternative 4 Variant: 4/A5	Alternative 4 Variant: 4/A1h	Alternative 14 Variant: 14/A10-1
MERCER ISLAND	A5 (upland)	A1h & A4h (upland & lake bottom)	A10-1 (trenchless & lake bottom)
EAST CHANNEL	B6u (upland connection; lake bottom)	B6w (in-water connection; lake bottom)	B6w (in-water connection; lake bottom)
ENATAI	C1 (trenchless)	C1 (trenchless)	C1 (trenchless)
	Special Structures: • WS01: Weir Structure (Flow-Split) on land near the Mercer Island shore in the vicinity of the East Channel. 6'x6' cast-in-place concrete structure 6' deep, located in the road on SE 35th Pl. Flows in are from the gravity sewer portion of segment A5, flows out are to the dual pipeline portion of segment A5. • WS02: Same as Alternative 4.	Special Structures: • WS04: Weir Structure (Flow-Split) on Mercer Island near the intersection of 97th Ave SE and SE 34th St. 6'x6' cast-in-place concrete structure 13' deep, located along the edge of the road. Flows in are from the gravity sewer part of Segment A1h, flows out are to the dual pipeline part of Segment A1h. • WS02: Same as Alternative 9.	Special Structures: • WS05: Similar to Alternative 14; location may be slightly different. • WS04: Same as Alternative 9. • WS02: Same as Alternative 9.

Utility Board
2016 Work Plan

Meeting Date	Agenda Item
January 12	Cancelled
February 9	2016 Work Plan (Jason)
March 8	Conservation & Sustainability Update (Ross)
April 12	Water Response CIP Update (Anne & Jason)
May 10	2016 Project Updates (All)
June 14	Board Elections Utility CIP Preview (All)
July 12	Cross Connection Program Update (Brian McDaniel) Water System Plan Update (Rona Lin)
August 9	Recess
September 13	Sewer Budget & Rates (Francie) Stormwater Budget & Rates (Francie)
October 11	Water Budget & Rates (Francie) EMS Rates (Francie)
November 29	KC North Mercer Interceptor Project Update
December 13	Recess

General Sewer Plan Update (Anne)
Shorewood Water System (Yamashita & McDaniel)
Solid Waste Service (Kintner)
Stormwater & NPDES Program Update (Patrick & Brian Hartvigson)