US Army Corps of Engineers®
Seattle District

SKAGIT COUNTY
Serving With Pride
WASHINGTON

Skagit River Flood Risk Management General Investigation

Skagit County, Washington

Draft Feasibility Report and Environmental Impact Statement

Appendix A – Plan Formulation

May 2014

1. Plan Formulation Appendix

This appendix contains supplemental details of the plan formulation process described in Section 3 of the main Draft FR/EIS document. Specifically, the following information describes how the PDT combined management measures into a preliminary array of alternatives, and subsequently evaluated and screened those alternatives to reach a focused array of alternatives. This appendix also describes the evaluation and screening of the focused array of alternatives to reach a final array of alternatives. Remaining evaluation of the final array to identify a TSP is included in Section 3 of the main Draft FR/EIS document.

1.1 Environmental Operating Principles

USACE developed the Environmental Operating Principles (EOP) below to ensure that USACE missions include totally integrated sustainable environmental practices. The EOP relate to the human environment and apply to all aspects of business and operations. For the purposes of this feasibility study, the PDT is conducting required NEPA analysis and documentation as a means to address principles of open and transparent processes, and evaluated alternatives against the P&G criteria and other project-specific criteria listed in Section 3 of the Draft FR/EIS to ensure the recommended plan is consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other federal planning requirements. In addition, USACE will continue to consider these principles throughout the feasibility-level design phase of the study and document how implementation of the recommended plan would be consistent with these EOP.

- Foster sustainability as a way of life throughout the organization.
- Proactively consider environmental consequences of all Corps activities and act accordingly.
- Create mutually supporting economic and environmentally sustainable solutions.
- Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the Corps, which may impact human and natural environments.
- Consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs.
- Leverage scientific, economic and social knowledge to understand the environmental context and effects of Corps actions in a collaborative manner.
- Employ an open, transparent process that respects views of individuals and groups interested in Corps activities.

1.2 Preliminary Array of Alternatives

Five preliminary alternatives were developed for the preliminary array of alternatives to reduce flood risk and life safety in the basin, based on the management measures carried forward following the screening of management measures.

- No Action Preliminary Alternative
- Non-Structural Preliminary Alternative:
- Joe Leary Slough Bypass Confined Channel or Overland Flow Preliminary Alternative
- Swinomish Bypass Confined Channel or Overland Flow Preliminary Alternative
- Urban Areas and Critical Infrastructure Protection Preliminary Alternative
- Levee Setback Preliminary Alternative

Preliminary alternatives were formulated to divert flood waters from the river system or improve conveyance of flood waters though the river system. All preliminary alternatives are conceptual level designs that were formulated using existing H&H data. Additional H&H analysis was conducted on the focused array of alternatives to determine the hydraulic effectiveness of the alternatives.

The rreliminary array of alternatives was presented to the public during April-June 2012. Comments received are documented in Appendix I of the Draft FR/EIS (Public Involvement).

1.2.1 No Action Alternative

Per USACE planning guidance, the No Action Alternative was evaluated. The No Action Alternative assumes that that no project would be implemented by either the Corps or by local interests to achieve flood risk management objectives. The NEPA-required No Action Alternative is synonymous with the USACE future without-project condition.

In general, flooding problems in the Skagit Basin will get worse if no action is taken. The No Action Alternative does not address the study objectives to reduce flood risk and life safety risk in the Skagit River Basin. The non-Federal sponsor predicts that there will be an increase in future population and there are numerous environmental challenges to maintenance of existing levees to comply with regulations which further renders the No Action Alternative ineffective. The No-Action Alternative will be used as a baseline against which to compare alternatives for plan formulation and will be used in evaluation of the range of alternatives during NEPA-required analysis.

1.2.2 Non-Structural Preliminary Alternative

The Non-Structural Preliminary Alternative does not involve construction of significant new infrastructure or structural modifications of existing infrastructure in the Skagit River Basin. Components of the Non-Structural Alternative include:

- Dam operational modifications of the Upper and Lower Baker Dam per Baker River Hydroelectric Project No. 2150 - Federal Energy Regulatory Commission (FERC) license Article 107 Flood Storage
- Debris management for river bridges during floods events. Various non-structural features would be implemented throughout the basin such as: education and outreach, evacuation routes, outlet structures in sea dikes installation of additional gauges, flood warning systems, real estate

acquisition, relocation of structures, elevation of structures, and flood proofing buildings. The type and extent of these features would be further refined during feasibility design analysis as the feasibility study progresses.

1.2.3 Joe Leary Slough Bypass Confined Channel or Overland Flow Preliminary Alternative

The Joe Leary Slough Bypass Confined Channel or Overland Flow Preliminary Alternative would divert flood waters from the Skagit River system upstream of the major urban areas either through a confined channel (bypass) or overland flow (Figure 1). This alternative does not include structural modification to river bridges or setback of levees in the urban areas.

Components of this alternative may include:

- Dam operational modifications of the Upper and Lower Baker Dam per Baker River Hydroelectric Project No. 2150 - FERC license Article 107 Flood Storage
- Joe Leary Slough Confined Channel or Overland Flow Bypass. The bypass will be dry except during floods of 4% ACE or greater.
- Sterling Levee
- Levees to protect Sedro-Woolley, Burlington and La Conner from induced flooding
- Debris management for river bridges during floods events.
- Various non-structural features would be implemented throughout the basin such as: education and outreach, evacuation routes, outlet structures in sea dikes installation of additional gauges, flood warning systems, real estate acquisition, relocation of structures, elevation of structures, and flood proofing buildings. The type and extent of these features would be further refined during feasibility design analysis as the feasibility study progresses.

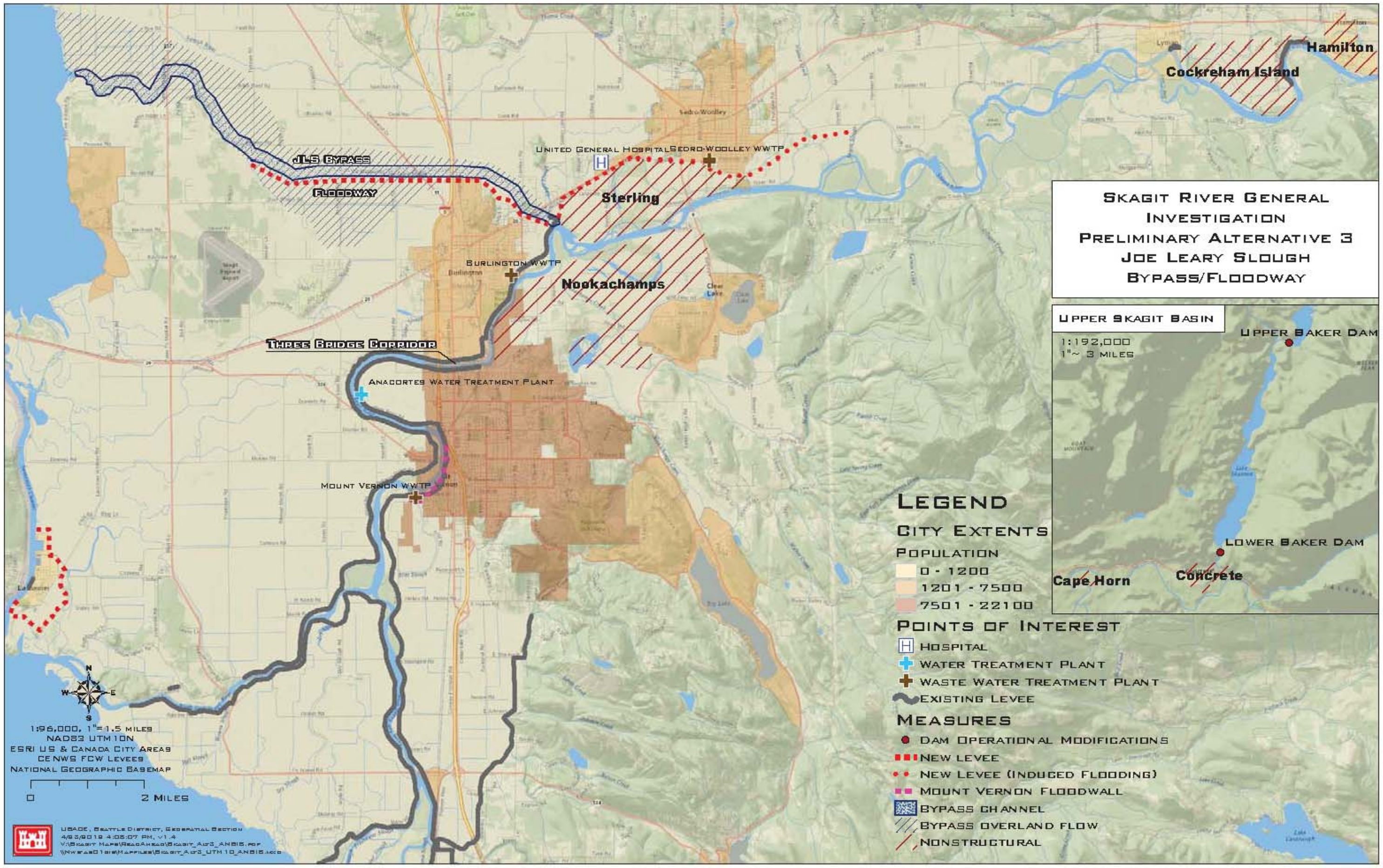

Figure 1. Joe Leary Slough Bypass Preliminary Alternative

1.2.4 Swinomish Bypass Confined Channel or Overland Flow Preliminary Alternative

The Swinomish Bypass Confined Channel or Overland Flow Preliminary Alternative would divert flood waters from the Skagit River system downstream of the urban areas either through a confined channel or overland flow. (Figure 2)

Components of this alternative include:

- Dam operational modifications of the Upper and Lower Baker Dam per Baker River Hydroelectric Project No. 2150 - FERC license Article 107 Flood Storage
- Swinomish Confined Channel or Overland Flow Bypass. The bypass will be dry except during floods of 4% ACE or greater.
- Structural modifications to the Burlington Northern Santa Fe railroad bridge and setback of levees in the urban areas, and potential modification to the Division Street Bridge if needed.
- Setback of existing right bank levees from Sterling to the Swinomish Bypass
- Sterling Levee
- Levees to protect Sedro-Woolley and La Conner from induced flooding
- Debris management for river bridges during floods events.
- Various non-structural features would be implemented throughout the basin such as: education and outreach, evacuation routes, outlet structures in sea dikes installation of additional gauges, flood warning systems, real estate acquisition, relocation of structures, elevation of structures, and flood proofing buildings. The type and extent of these features would be further refined during feasibility design analysis as the feasibility study progresses.

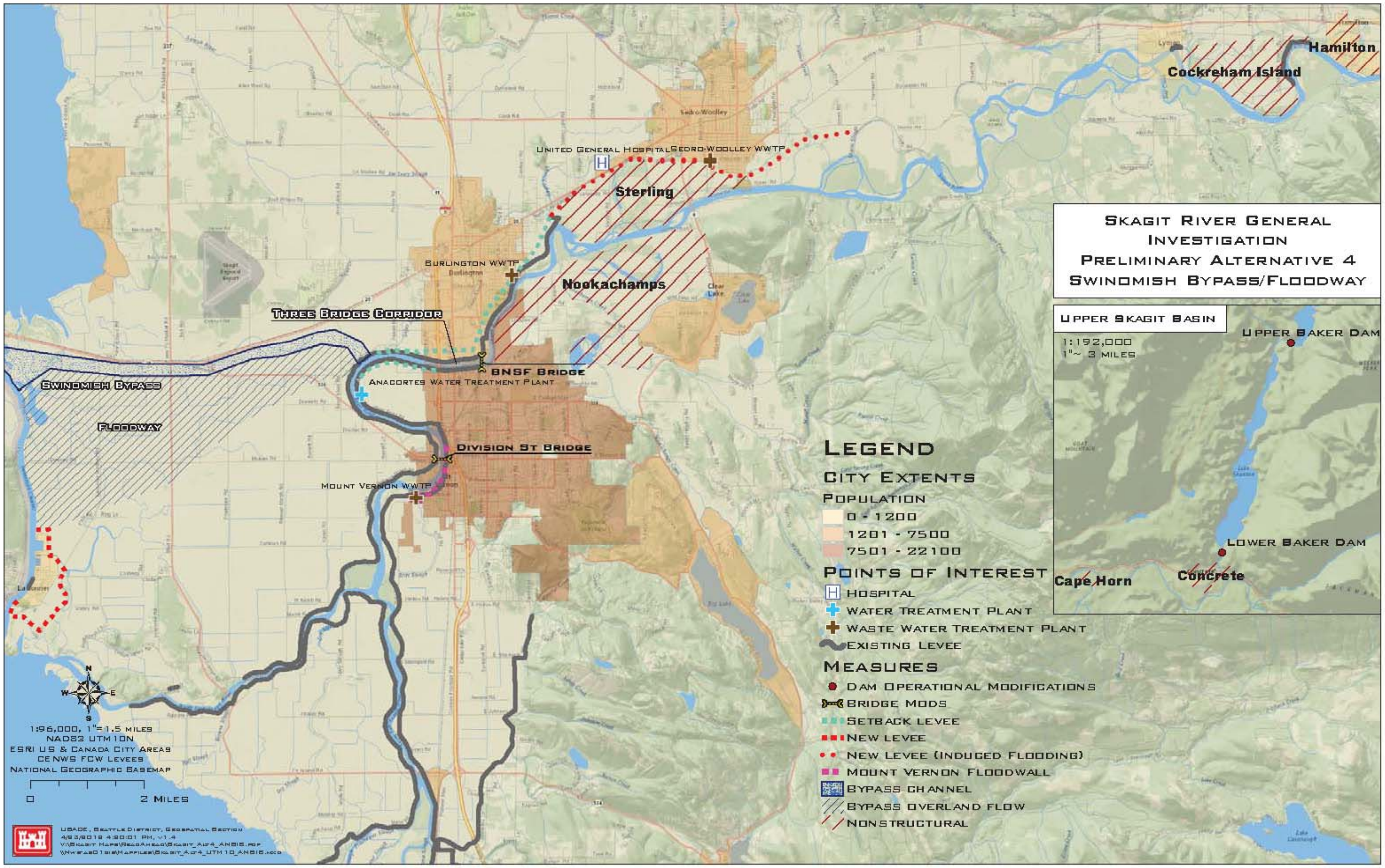

Figure 2. Swinomish Bypass Preliminary Alternative

1.2.5 **Urban Areas and Critical Infrastructure Protection Preliminary Alternative**

This alternative focuses on providing flood risk reduction for urban areas, such as the cities of Sedro-Woolley, Burlington, and Mount Vernon; and critical infrastructure, such as waste water treatment plants and hospitals in the Skagit River Basin (Figure 3).This alternative prioritizes flood risk reduction for areas with the potential for high economic and infrastructure damages during a large flood event. This alternative does not include structural modification to river bridges or setback levees in the urban areas.

Components of this alternative include:

- Dam operational modifications of the Upper and Lower Baker Dam per Baker River Hydroelectric Project No. 2150 - FERC license Article 107 Flood Storage
- Levees/ring dikes around the urban centers of Burlington, Mount Vernon and La Conner
- Ring dikes around critical infrastructure such as the Sedro-Woolley Waste Water Treatment Plant, the United General Hospital. Debris management for river bridges during floods events.
- Various non-structural features would be implemented throughout the basin such as: education and outreach, evacuation routes, outlet structures in sea dikes installation of additional gauges, flood warning systems, real estate acquisition, relocation of structures, elevation of structures, and flood proofing buildings. The type and extent of these features would be further refined during feasibility design analysis as the feasibility study progresses.

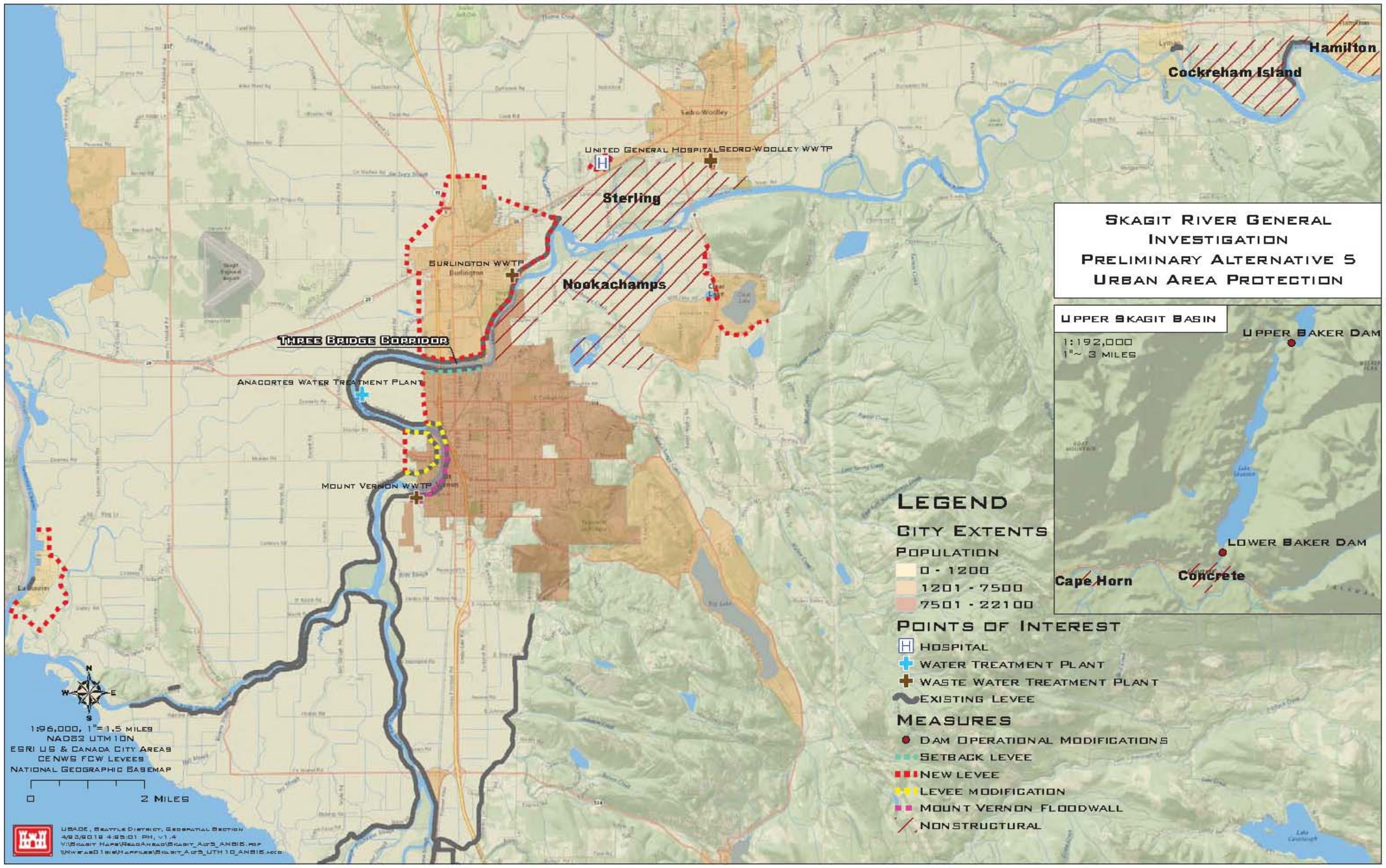

Figure 3. Urban Area Protection Preliminary Alternative

1.2.6 Setback Entire Levee System Preliminary Alternative

The Setback Entire Levee System Alternative (Figure X) increases conveyance of floodwaters though the river system and contains floodwaters within the river system by setting back the entire levee system, modifying river bridge structures, and constructing a West Mount Vernon Bypass. Components of this alternative include:

- Dam operational modifications of the Upper and Lower Baker Dam per Baker River Hydroelectric Project No. 2150 - FERC license Article 107 Flood Storage
- Setback the entire Skagit River levee system
- Structural modifications to the Burlington Northern Santa Fe railroad bridge, setback of levees in the Three Bridge Corridor, and potential modification to the Division Street Bridge if needed.
- West Mount Vernon Bypass. The bypass will be dry except during floods of 4% ACE or greater.
- Fir Island Bypass. The bypass will be dry except during floods of 4% ACE or greater.
- Sterling levee
- Levees to protect Sedro-Woolley as needed to reduce flood risk from induced flooding caused by the Sterling levee. Debris management for river bridges during floods events.
- Various non-structural features would be implemented throughout the basin such as: education and outreach, evacuation routes, outlet structures in sea dikes installation of additional gauges, flood warning systems, real estate acquisition, relocation of structures, elevation of structures, and flood proofing buildings. The type and extent of these features would be further refined during feasibility design analysis as the feasibility study progresses.

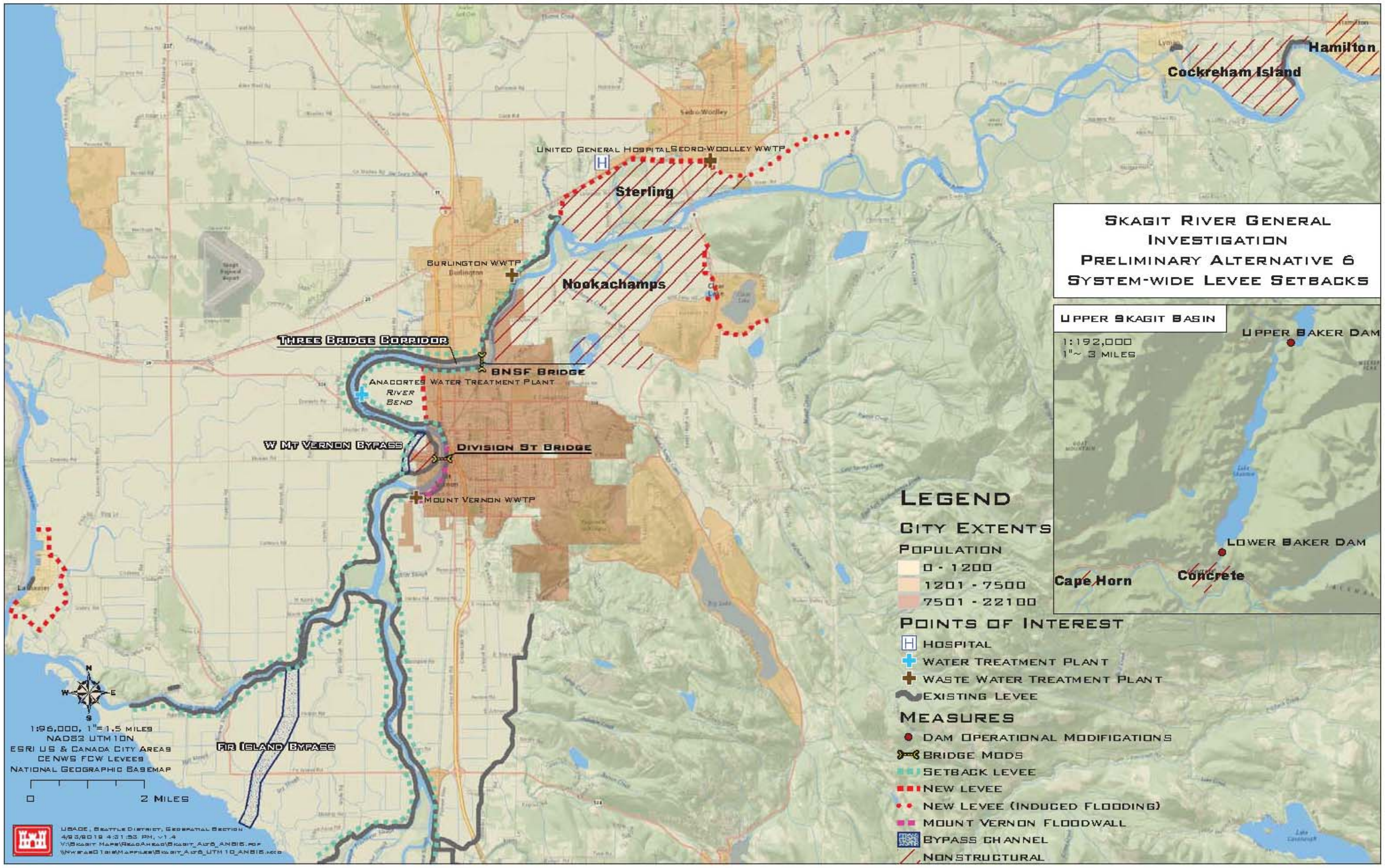

Figure 4. Entire Levee System Setback Preliminary Alternative

1.3 Evaluation and Screening of Preliminary Array of Alternatives

The following criteria were used to evaluate the preliminary array of alternatives:

- Does the alternative address the objective of reducing flood damages?
- Does the alternative address the objective of reducing life safety risk?
- Does the alternative minimize adverse impacts to environmental and cultural resources?
- Is the alternative cost effective (based on preliminary evaluation of costs and professional judgment)?

Screening Criteria:

- Preliminary alternatives that do not address the objective of reducing flood damages will not be carried forward.
- Preliminary alternatives that do not address the study objective of reducing life safety risk will not be carried forward.
- Preliminary alternatives that address the first two criteria and minimize adverse impacts to environmental and cultural resources will be carried forward.
- Preliminary alternatives that address the first two criteria and are cost effective will be carried forward.

Table 1 below outlines the evaluation of the preliminary array of alternatives per the criteria listed above.

Table 1. Evaluation of Preliminary Array of Alternatives

Preliminary Alternative	Does the alternative address the objective of reducing flood damages?	Does the alternative address the objective of reducing life safety risk?	Does the alternative minimize adverse impacts to environmental, agricultural and cultural resources?	Is the alternative cost effective (based on preliminary evaluation of costs and professional judgment)?
No Action	No	No	Not Applicable (N/A)	N/A
Entire non-structural	Yes, but not significantly	Yes, but not significantly	This alternative has smallest footprint	This alternative only provides limited flood risk management.
Setback Entire Levee System	Yes. Maximizes the flood capacity of the existing channel.	Yes	Setting back of levees would increase the width of the riparian corridor, allow for more refuge habitat during flood events, providing potential environmental benefits. If bypasses are not designed for fish passage then damage and/or entrainment is possible. Levee setbacks may remove agricultural farmland out of production. Working in previously undisturbed areas would increase the likelihood of encountering hazardous materials or archaeological sites.	- West Mount Vernon Bypass may involve relocation of numerous homes and businesses and may adversely impact the West Mount Vernon urban growth area. - Levee setback may require large number of modifications to existing utilities and roads. - Levee setbacks may involve significant real estate acquisition and costs, particularly in urban areas - Setbacks would require a large quantity of soil and other materials, as existing levee material could not be utilized as a component of constructing new levees.
Joe Leary Slough	Yes. This alternative removes water upstream of the Three Bridge Corridor.	Yes	The Joe Leary Bypass follows the path of the natural hydraulic condition under existing conditions at the Three Bridge Corridor during a flood event. High risk of fish entrainment in the bypass channels. Fish screens to prevent entrainment are impracticable. Routing of floodwaters through the Joe Leary Bypass or Floodway may change sedimentation and erosion patterns and salinity in Padilla Bay, adversely affecting eelgrass beds, fish, and benthic communities. The Joe Leary Bypass or Floodway crosses	Construction of the Joe Leary confined channel or overland flow may involve significant real estate acquisition and costs. Construction of the Joe Leary Bypass/floodway may require modifications to Interstate 5 and Burlington Northern Santa Fe railroad, local roadways, and utilities Construction of the Joe Leary Bypass may eliminate the need to modify the Three Bridge Corridor to increase conveyance of floodwaters through the Skagit River system. Routing of floodwaters through the Joe Leary Bypass or Floodway may require additional

Preliminary Alternative	Does the alternative address the objective of reducing flood damages?	Does the alternative address the objective of reducing life safety risk?	Does the alternative minimize adverse impacts to environmental, agricultural and cultural resources?	Is the alternative cost effective (based on preliminary evaluation of costs and professional judgment)?
			through miles of farmland. Runoff entering the bypass may contain high levels of agricultural runoff resulting in adverse water quality impacts to Padilla Bay. The Joe Leary Bypass or Floodway may remove agricultural farmland out of production and cause erosion to agricultural lands Working in previously undisturbed areas would increase the likelihood of encountering hazardous materials or archaeological sites.	infrastructure for drainage of farmland along the Bypass. A large gate structure of uncertain design would be required at the mouth of Joe Leary slough. Significant armoring of the mouth would be required to prevent scour Large and complex screens could be required to prevent fish from being pushed into the bypass. Construction and operation of this would have significant costs. A large number of drainage culverts and gates would be required at the outlet of Joe Leary Slough into Padilla Bay.
Swinomish Bypass	Yes	Yes	The Swinomish Bypass or Overland Flow may introduce sediment into the Swinomish Channel (Federal navigation project). High risk of fish entrainment in the bypass channels. Fish screens to prevent entrainment are impracticable. Increased volume of flood waters into Swinomish Channel may adversely affect sedimentation patterns in the Channel. Routing of floodwaters through the Swinomish Bypass or Floodway may adversely impact salinity levels in the Swinomish Channel. The Swinomish Bypass or Floodway may remove	The Swinomish Bypass would require a large number of modifications to existing utilities, pipelines, and roads. The Swinomish Bypass or Floodway may involve significant real estate acquisition and costs. Routing of floodwaters through the Swinomish Bypass may require additional infrastructure for drainage of farmland along the Bypass Removal of floodwaters from the Skagit system through the Swinomish Bypass/Floodway may eliminate the need to set back levees downstream of Mount Vernon.

Preliminary Alternative	Does the alternative address the objective of reducing flood damages?	Does the alternative address the objective of reducing life safety risk?	Does the alternative minimize adverse impacts to environmental, agricultural and cultural resources?	Is the alternative cost effective (based on preliminary evaluation of costs and professional judgment)?
			agricultural farmland out of production and cause erosion to agricultural lands. Working in previously undisturbed areas would increase the likelihood of encountering hazardous materials or archaeological sites.	A large gate structure of uncertain design would be required at the mouth of the Swinomish Bypass. Significant armoring of the mouth would be required to prevent scour Large and complex screens could be required to prevent fish from being pushed into the bypass. Construction and operation of this would have significant costs. A large number of drainage culverts and gates would be required at the outlet of Swinomish Bypass into the Swinomish Channel.
Urban Areas and Critical Infrastructure	Yes. Flood risk reduction would be limited to the urban centers.	No. Ring dikes increase the residual life safety risk. This alternative would require evacuation routes and procedures out of areas enclosed by levees to provide an additional level of safety for residents	This alternative may induce flooding on agricultural lands.	This alternative only provides benefits to urban areas.

1.3.1 Screening of Preliminary Array of Alternatives

Table 2 below outlines the screening process of the preliminary array of alternatives

Table 2. Screening Process for Preliminary Array of Alternatives

Preliminary Alternative	Bring forward into Focused Array of Alternatives?	Rationale
No Action Alternative	Yes	No Action Plan will be retained to serve as the basis against which all other alternative plans are evaluated. This plan is also required by NEPA to be included among the plans in the final array of alternatives.
Non-Structural and Dam Storage Only Alternative	No*	This alternative does not provide comprehensive flood risk reduction for the Basin. See note below
Setback Entire Levee System	Yes	This alternative addresses study objectives
Joe Leary Slough Bypass	Yes	This alternative addresses study objectives
Swinomish Bypass	Yes	This alternative addresses study objectives
Urban Areas and Critical Infrastructure Protection Alternative	No	This alternative does not provide flood risk reduction for rural areas and has high residual life safety risk for residents within the urban ring levees

* The Non-Structural and Dam Storage Alternative did not provide comprehensive flood risk reduction in the study area; however, it does provide some benefits. Therefore, all alternatives in the focused array of alternatives incorporate elements of the Non-structural and Dam Storage Only Alternative.

1.4 Focused Array of Alternatives

Per the screening process of the Preliminary Array of Alternatives, the Focused Array of Alternatives for the study is:

- No Action Alternative
- Joe Leary Slough Bypass Confined Channel or Overland Flow Alternative (JLS Bypass Alternative)
- Swinomish Bypass Confined Channel or Overland Flow Alternative (Swinomish Bypass Alternative)
- System-wide Levee Setbacks

1.4.1 Evaluation of Bypass Alternatives

Preliminary evaluation of the Bypass Alternatives revealed that the bypass alignment through agricultural lands and routing of floodwaters through the bypass would likely restrict or adversely impact existing agricultural activities within the bypass footprint. The Bypass Alternatives would also likely adversely impact fisheries by flushing fish through the bypass during flood events and leaving fish stranded in the bypass when floodwaters receded. A preliminary analysis of fish screens show them to be impracticable due to the massive size that would be required and the large amount of debris that would accumulate on them..

In addition to agricultural and fishery impacts, there were concerns that high velocities associated with the Swinomish Bypass and Joe Leary Slough Bypass Alternative could potentially alter sedimentation patterns in the receiving waters of the Swinomish Channel and Padilla Bay respectively. The Swinomish Channel is a Federal navigation project and undergoes maintenance dredging. The introduction of high flows into the channel could exacerbate erosion along the banks of the channel, increase volume of O&M dredging material, and potentially changed the sediment composition of O&M dredge material. With the Joe Leary Slough Bypass alternative, there was concern that high velocities could potentially alter fresh water flows and sedimentation in Padilla Bay, a National Estuarine Research Reserve.

In order to assess the rough order magnitude of these potential impacts, three design configurations were created for both the Joe Leary Slough and Swinomish Bypass Alternatives, a wide confined channel (2000 ft), narrow confined channel (1000 ft) configuration, and an overland flow design configuration.

1.4.1.1 Evaluation Criteria for the Wide Confined Channel, Narrow Confined Channel, and Overland Flow Design Configurations

The following evaluation criteria were used to evaluate the Bypass Alternatives design configurations:

- Order of magnitude of velocity of floodwaters moving through the bypasses. High velocities of flood water have a greater potential causing increased erosion on lands within the bypass.
- Potential for increased sedimentation into receiving bodies of water. (Padilla Bay for Joe Leary Bypass, Swinomish Channel for the Swinomish Channel Bypass)
- Number of acres of agricultural lands impacted by bypass footprint.
- Potential real estate costs associated with bypass footprint
- Potential impacts to critical basin infrastructure within the bypass footprint
- Potential level of support from the sponsor and public for the bypass alignment and footprint

1.4.1.2 Overland Flow Design Configuration vs. Existing Condition:

On the surface, the overland flow design configuration and existing condition appear similar. However, there are critical differences between the existing condition and the overland flow design configuration:

- The overland flow design configuration changes the flood hydrology, requires construction of associated infrastructure and requires procurement of real estate. Both the Joe Leary Bypass and the Swinomish Channel Overland Flow Designs were formulated to capture and divert flood discharges in excess of the mainstem channel capacity in the 4% ACE event. This is different than the existing condition where flooding occurs in a 4-5% ACE event.
- The overland flow design configuration requires conduction of a single controlled intake at the entrance of the bypass, would require comprehensive system for drainage of floodwaters, result in

increased inundation depths and velocities from existing conditions. Since overland flow design alters the existing condition in the floodplain during flood events; implementation of the alternative requires flowage easements or other real estate requirements which are not required in the existing condition.

1.4.1.3 Determination of Channel Width for Bypass Alternatives

All three design configurations were designed to provide equal level of flood risk management; therefore evaluation of potential impacts was used to screen the design configurations. Hydraulic modeling was conducted to evaluate each of the three design configurations per the following evaluation criteria:

- Evaluation Criteria: Order of magnitude of velocity of floodwaters moving through the channel.*
- Evaluation Criteria: Potential for erosion of agricultural lands *
- Evaluation Criteria: Potential for increased sedimentation into receiving bodies of water.*
- Evaluation Criteria: Number of acres of agricultural lands impacted
- Evaluation Criteria: Potential real estate costs
- Evaluation Criteria: Potential impacts to critical basin infrastructure
- Evaluation Criteria: Potential level of support from the sponsor and public

* The underlying assumption is that higher velocities are likely to result in the highest potential for erosion of agricultural lands and increases sedimentation into receiving bodies of water.

The hydraulic modeling of the three design configurations for each alternative indicated the overland flow configuration had the lowest flood velocities while the narrow confined configuration had the highest. Narrow confined was screened out first since it had the highest velocities therefore, the highest potential for erosion and sedimentation impacts. Overland flow design configuration was screened out given that the unconfined nature of the floodwaters, it would be extremely difficult to contain potential infrastructure damage and impacts to agricultural lands as floodwaters spread out over an unconfined area. In addition, overland flow designs have the highest associated real estate costs, highest agricultural acreage impacts, and it is likely that more mitigation would be required compared to the other design configurations. Therefore, wide confined configuration was the remaining design configuration and carried forward into the final array of alternatives for both bypass alternatives as shown in the table below. This design configuration minimizes erosion, minimizes sedimentation issues, provides containment of potential flood damages, limits real estate costs, limits impacts to critical basin infrastructure, and is likely to have a greater level of support from the sponsor and public.

Table 3. Evaluation of the Focused Array of Alternatives

Evaluation Criteria	**Narrow Confined Channel**	**Wide Confined Channel**	**Overland Flow**
Order of magnitude of velocity of floodwaters moving through the channel	Highest velocities of floodwaters moving through the channel.	Next highest velocities of floodwaters moving through the channel	Lowest Velocity
Potential for erosion of agricultural lands	Highest velocities of floodwaters associated with this design are likely to result in the highest potential for erosion of agricultural lands.	This design is likely to have lower potential for erosion of agricultural lands than the Narrow Confined but likely to have higher potential impacts than the unconfined channel.	Lowest velocities of floodwaters associated with this design are likely to result in the lowest potential for erosion of agricultural lands.
Potential for increased sedimentation into receiving bodies of water. (Padilla Bay for Joe Leary Bypass, Swinomish Channel for the Swinomish Channel Bypass)	Highest velocities floodwaters associated with this design are likely to result in increased sedimentation to the receiving bodies of water.	This design is likely to have lower rate of sedimentation than the Narrow Confined but likely to have higher potential impacts than the unconfined channel.	Lowest velocities of floodwaters associated with this design are likely to result in the lowest increases of sedimentation into the receiving body of water.
Screening Point: The Narrow Confined Channel was screened out at this point. This design has the highest potential for erosion of agricultural lands and potential increase of sedimentation compared to the other channel configurations.			
Number of acres of agricultural lands impacted. • Evaluation Assumption: PDT assumed that all lands within the bypass footprint would be subject to impacts such as land-use restrictions, flood easements or total take. • Assumed that impacts to agricultural practices (real estate taking or land use restrictions) would lead to great net loss of agricultural lands. (Per input from Skagit County. Basin needs critical mass of farmland and farm activities to sustain agricultural economy).		Agricultural impacts associated with this design are less than the overland flow design. Impacts to agricultural lands are confined to the footprint of the levees and the 2,000ft bypass corridor.	This design has the highest potential impacts to agricultural lands. Inundation area is the entire northern floodplain; therefore there are widespread impacts to agricultural lands.
Potential real estate costs		Real estate costs for this design are	The overland flow designs have

• Evaluation Assumption: PDT assumed that all lands within the bypass footprint would be subject to impacts such as land-use restrictions, flood easements or total take.		less than the un-confined design. Real estate impacts are largely limited to the footprint of the levees and the 2,000ft bypass corridor.	inundation areas that encompass broad swaths of the floodplain; therefore the overland flow designs have the highest associated real estate costs.
Potential impacts to critical basin infrastructure such as: • I-5, BNSF railroad, water and petroleum pipelines (Joe Leary Alternative Only) • Existing agricultural infrastructure (Both Joe Leary and the Swinomish Channel Bypass Alternative)		Potential impacts to basin infrastructure are limited to discreet points within the 2,000ft bypass corridor.	The unconfined nature of the inundation area associated with the overland flow designs will are highly likely to require multiple and/or large scale mitigation actions that will likely be more costly than the impacts associated with the wide confined design.
Potential level of support from the sponsor and public		This design has less impacts to agricultural lands than the unconfined alternative and is more likely to be supported by the public than the overland flow alternative.	The potential large scale impacts to agricultural lands associated with the overland flow designs is likely to generate strong opposition from the public. • Basin needs a critical mass of farm land to support current industry such as production of seed. • There are few or no options for replacement of lands or relocations of farms within the Skagit River Basin
Screening Point: The overland flow design was screened out from further consideration. This design has potential to have greater impacts to agricultural lands and real estate costs. It is also likely to face strong opposition from the public. As a result evaluation and comparison, the wide confined channels configuration for both bypass alternatives were carried forward to the final array of alternatives.			

1.4.2 Reformulation of the System-wide Levee Setbacks into the Comprehensive Urban Levee Improvement Alternative

During evaluation of the focused array of alternatives, the Levee System Alternative was reformulated into the Comprehensive Urban Levee Improvement (CULI) Alternative. The CULI Alternative involves raising approximately 9.2 miles of existing urban levees 3 to 5 feet, constructing 2 miles of new levee to the east and north of Burlington, and constructing a mile of new levee in Riverbend. There are no large-scale levee setbacks associated with the CULI alternative. The Levee Setback Alternative was revised based on hydraulic analysis of the alternative. In summary, in order for the levee setbacks to be effective for Burlington and Mount Vernon, the levees setbacks had to extend upstream to these cities. It was also determined that those levee setbacks would not be adequate to protect Burlington from upstream spill at Sterling and other measures would be needed as well.

The initial Levee Setback Alternative, as presented in the preliminary array of alternatives, called for setback of the entire levee system. The hydraulic analysis evaluated setback combinations, starting with the downstream levees. The initial setback levee combination was along the North and South Forks only. This would not have the desired reductions in water surface elevation in the urban areas, so the modeled setbacks were extended upstream to Mount Vernon. This still would not provide the desired reductions in Burlington, so they were extended farther upstream. This was continued until the levees setbacks extended all the way to the BNSF Bridge.

In addition to the levee setbacks, levee improvements would have been necessary upstream of the BNSF Bridge, existing levees that were not set back would have needed to be raised, and the Mount Vernon bypass would have been required. Costs of these levee setbacks and modification of existing levees would likely be high due to construction costs, real estate costs, and likely require relocation of utilities. At this point it became apparent that the potential flood risk reduction associated with levee setbacks would likely not be cost effective. Therefore, this alternative was reformulated into the less complex Comprehensive Urban Levee Improvement (CULI) Alternative.

Subsequent hydraulic modeling of the CULI Alternative determined that flood risk in urban areas can be reduced solely with modification to existing urban levees and are not dependent on setback of levees at Fir Island to achieve the benefit needed for the urban areas. Levee setbacks at Fir Island have the greatest benefit for Fir Island; however, Fir Island is not an urban area and has mostly agricultural land use. Setback levees to protect Fir Island do not accomplish the project goal of reducing the flood risk in the urban areas and are not included in the CULI Alternative.

1.5 Final Array of Alternatives

Based on the process conducted above, the PDT identified the following alternatives that were then considered for selection as the TSP.

- No Action
- Comprehensive Urban Levee Improvement (CULI)

- Joe Leary Slough Bypass Wide Confined Channel
- Swinomish Bypass Wide Confined Channel

These four alternatives were developed to an equal level of conceptual level design for evaluation and comparison to determine the TSP. Details of the evaluation and comparsion of the Final Array to determine the TSP is included in Section 3 of the main Draft FR/EIS Report.