Phase 1
Project No. RC1532, UPI #06-0150
*Index Galena Flood Repairs MP 6.4 to MP 6.9*
Route Feasibility Study
*Snohomish County, Washington*
March 30, 2009
Route Feasibility Study

Phase 1
Index Galena Flood Repairs
MP6.4 to MP 6.9

Prepared for.
Snohomish County Public Works
RC 1532, UPI # 06-0150

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Executive Summary

In November 2006, a major flood event on the North Fork Skykomish River caused multiple washouts of Index Galena Road. The most extensive of these were located between MP 6.4 and MP 6.9. Since that time the road has been closed at about MP 6.4 (its western end) and at MP 6.9 further upstream at the east end of the flood damage. Presently the only access to the area east of MP 6.4 is taking an extensive detour that is only seasonally available over Jack’s Pass.

Shortly after the flood damage occurred, Snohomish County Public Works determined that Index Galena Road should be repaired or relocated to reestablish roadway network connectivity. Index Galena Road is a two lane rural roadway originally built in 1911. Consequently, it does not meet current County Design Standards. The road has a posted speed limit of 35 MPH, and a functional classification of Major Collector Arterial (Rural). With this classification and carrying less than 400 vehicles per day, the current Snohomish County design standard requires Index Galena Road to have a minimum design speed of 50 MPH. This, in turn, calls for the following minimums: 11 foot lanes; 8 foot shoulders; and 80 foot right of way width.

In June 2008, Snohomish County entered into an agreement with a team led by H.W. Lochner, Inc. to study Index Galena Road and its surrounding area in the vicinity from just east of Trout Creek Bridge, approximately MP 6.0, to a logical tie-in east of MP 6.9. The study included a Route Feasibility Study, to develop options for restoring the roadway connectivity; a Channel Migration Study to delineate areas of recent, past and potentially future occupation by the river channel; and a Geotechnical Study to provide information and recommendations for roadway feasibility-level planning.

Fourteen alternatives were generated and were included in a high-level screening conducted by Snohomish County staff (design, environmental, right-of-way, river management and survey) and the consultant team. The alternatives were evaluated based on environmental criteria, design standard considerations, right-of-way impacts/needs and the ability to meet the projects purpose (to restore a through route that maintains essential travel on Index Galena Road in the North Fork Skykomish River corridor).

The alternatives chosen to be taken forward into the Design Report phase of the project are:

- **Alternative 1A – No Action:** This alternative is needed to comply with NEPA and SEPA requirements.
- **Alternative 2C – Reconstruct Elevated Road within Existing Alignment with deviations to design standards (large rock):** This alternative was chosen because it meets the project purpose and it would have lesser environmental impacts than the other alternatives utilizing the existing roadway alignment.
- **Alternative 3B – Relocation of the Roadway Benched in the toe of the Hillside within the CMZ (above the 100 year flood plain):** This alternative has reduced adverse environmental impacts as compared to the other alternatives.
- **Alternative 4B – Relocation upslope outside of Channel Migration Zone with design deviation:** This is the preferred alternative because it is located totally outside of the CMZ, and thereby has the least risk of future washouts and environmental impacts to the river.
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1 Introduction

1.1 Background

In November 2006, a major flood event on the North Fork Skykomish River caused extensive catastrophic damage to Index Galena Road. This major flood event resulted in multiple washouts along the Index Galena Road corridor, including two major washouts that lie between Milepost (MP) 6.4 and Milepost 6.9 that resulted in the road being permanently closed at MP 6.4 at its western end, just east of the Trout Creek Bridge, and at MP 6.9 further upstream at the east end of the flood damage. While much of the flood damage associated with the November 2006 flood event has been repaired in several locations, the major washout from MP 6.4 to MP 6.9 has resulted in Index-Galena Road no longer providing a through route to several destination points. An extensive detour over Jack’s Pass that is available only seasonally provides the only access for residents and other roadway users.

Prior to the November 2006 flood event, Index Galena Road served as the primary access road for several heavily used public hiking trails and campsites in the Mount Baker-Snoqualmie National Forest. It also provided access to private recreational properties and home sites. Index Galena Road also provided an alternate (back door) route to the Town of Skykomish via its intersection with U.S. Forest Service Road 65, which goes up and over Jack’s Pass and eventually becomes the Beckler River Road near the town of Skykomish. Shortly after the 2006 flood damage occurred, Snohomish County Public Works (SCPW) determined that the Index Galena Road should be repaired or relocated in order to reestablish roadway network connectivity. SCPW has coordinated with the Federal Highway Administration (FHWA) and the Washington State Department of Transportation (WSDOT) to secure Emergency Relief (ER) funding to study the feasibility of constructing repairs, and with the U.S. Forest Service on whose lands any relocated roadway would need to be constructed.

In June 2008, Snohomish County entered into an agreement with a team led by H. W. Lochner, Inc. to study Index Galena Road and its surrounding area in the vicinity of MP 6.4 to MP 6.9. Included in the scope of work for the agreement were the following:

- A Route Feasibility Study to develop viable options for restoring roadway connectivity in the vicinity of MP 6.4 to MP 6.9, while minimizing the environmental impacts from the roadway’s construction on both the surrounding land and the river.

- A Channel Migration Study of the North Fork Skykomish River to delineate areas of recent, past and potentially future occupation by the channel to help evaluate the risk of future washouts for the various alignments developed during the feasibility study.
A Geotechnical Study to provide conceptual geotechnical information and recommendations for feasibility-level planning.

This report is the culmination of the studies conducted.

1.2 Purpose of the Project

The purpose of the Route Feasibility study for Index Galena Road is to document the development, evaluation and selection of those alternatives which will be carried forward into the Design Report preliminary engineering phase of this project and those alternatives which were considered but rejected. The purpose of the project is to restore roadway connectivity to maintain essential travel. The need for this project resulted from river flooding in November 2006 which caused catastrophic roadway damage to Index Galena Road.

Figure 1.1 Project Vicinity Map
2 Site Conditions

2.1 Description of Site Conditions

Index Galena Road provides access to the Mount Baker-Snoqualmie National Forest, the Wild Sky Wilderness area and private property. It is the principal access to recreational areas within the National Forest and Wilderness Area. Index Galena Road was constructed in 1911 and served as a logging and mine to market road for copper mining, granite quarrying and logging. The road is located in the steep river valley of the North Fork of the Skykomish River. The study section of Index Galena Road is from milepost 6.0 to 7.3. This section of Index Galena Road is located on the east bank (left bank) of the North Fork Skykomish River within the river’s channel migration zone. A large section of road was lost during a major storm event of November 2006 where the river avulsed (formed a new channel separate from the existing mainstem) and formed a new side channel occupying the location of Index Galena Road between mile post 6.4 and 6.9. The present channel is a side channel that conveys a small volume of flow during summer low flows and provides a great deal of flood conveyance during higher flow conditions. Based upon observed conditions near the upstream end of the channel, it is possible that the mainstem channel will avulse into the side channel in the future. This would result in the river occupying the current roadway alignment and all remnants of roadway occupation would likely be swept away.

Index Galena Road is County Road Log Number. 54600 and is 14.145 miles long beginning with mile post 0.00 at the intersection of SR 2 (M.P. 35.70 on SR 2) and ending at Jacks Pass Road (USFS Road) at mile post 14.145 of Index Galena Road. The last traffic count for the subject section of Index Galena Road was conducted in August of 2005; traffic counts were taken at mile post 6.45. The average daily traffic based on those counts is 163 vehicles per day.

Index Galena road is a two lane rural highway with varying lane widths from 10 to 12 feet wide. Shoulder widths also vary from 1 foot to 6 foot wide. Index Galena Road has a posted speed limit of 35 MPH. Index Galena Road has a functional classification of Major Collector Arterial (Rural). As a major collector rural arterial with average daily traffic (ADT) of less than 400 vehicles the current Snohomish County design standard requires Index Galena Road to have as a minimum a 50 MPH design speed. This design speed specifies the following design criteria:

- 11 foot wide lane widths
- 8 foot wide shoulders
- Right-of-Way width of 80 feet

To use less than the standard roadway design and Right-of-Way widths outlined in table 3-030B of Snohomish County Engineering Design and Development Standards (EDDS) will require formal deviations by Snohomish County.
2.2 Geomorphic
The project site is located within a lower gradient basin area relative to upstream river reaches. This suggests that the project site would be within a depositional zone or at least within an area where significant temporary sediment storage occurs. As described in the channel migration zone study, the river is in a state of recovery from past human intervention and is occupying a wider area of the valley floor than in recent decades. The frequency of avulsion and other erosion-related events is expected to increase. It is expected that this trend will continue and the river will widen and occupy more of the valley floor through time. Therefore, it is believed that the future behavior of the North Fork Skykomish River will not resemble the behavior exhibited over the past several decades; management strategies should consider this behavioral change.

2.3 Geotechnical
The project is within the Northern Cascades geologic province on the northwest-facing slopes of the North Fork Skykomish River valley. The topography in the area is rugged, with steep slopes, high gradient tributary streams and high relief. Bedrock consists of granodiorite of the Index Batholith, which is hard, sound rock similar to granite. Erosion and deposition during multiple glaciations between 18,000 and 13,500 years ago sculpted and molded the present topographic terrain. After the glacier ice retreated, fluvial and mass wasting processes have reworked and incised the glacial deposits that filled the river valley. Soil deposits on the valley slopes and valley floor include:

**Alluvium** deposited by the North Fork of the Skykomish River and Trout Creek and consist of loose to medium dense, sandy gravel and sand. Alluvium typically has numerous cobbles and boulders and can contain logs and log jams.

**Alluvial fan** deposits formed from landslides and debris flows that originated in the steep slopes above the roadway and potential alternative alignments. The deposits consist of very loose to loose, poorly sorted sand and gravel with abundant silt lenses, cobbles, and boulders. The deposits can contain organic material, including logs.

**Marsh Deposits** formed in low-lying areas when runoff from the slopes was blocked by construction of Index Galena Road and natural river levees. These deposits typically consist of mostly saturated sand, silt and clay with abundant organic material.

**Colluvium** is soil that is deposited on slopes by mass wasting processes, including rockfall, soil creep and non-concentrated erosion caused by sheetwash and rain splash. Colluvium consists of heterogeneous clay, silt, sand, gravel, cobble and boulder deposits. It typically is present in a 5- to 20-foot thick layer overlying glacial recessional lacustrine deposits and bedrock. Colluvium includes talus and scree deposits that formed mostly from rockfall. Talus and scree deposits
consist of cobbles and bounders with a silty, sandy gravelly matrix. Boulders typically range from 5 to 10 feet in diameter and occasionally exceed 30 feet.

**Landslide deposits** and scars are present in the slopes above the valley floor. Landslide deposits are heterogeneous mixtures of angular to subangular gravel, cobbles and boulders with a sand, silt and clay matrix. The landslide scars are steep, marginally unstable areas that are subject to erosion.

**Glacial recessional lacustrine** deposits formed in lakes that formed along the margins of the continental glacier. During the last ice age, the continental glacier blocked drainage from the Skykomish Valley forming a lake. Runoff from the mountain streams laden with sediment deposited thin layers of normally consolidated clay and silt separated by laminations of fine sand. These deposits are present up to a few hundred feet above the North Fork Skykomish Valley floor.
3 Project Alternatives

Fourteen alternatives were generated during the course of the feasibility study’s development. These were considered as part of a high-level screening conducted by Snohomish County staff (design, environmental, right-of-way, geotechnical, river management and survey) and the Consultant team on February 4, 2009. The alternatives were evaluated based on five environmental criteria, design standard considerations, magnitude of potential right-of-way impacts and the ability to meet the project’s purpose to restore a through route that maintains essential travel on Index Galena Road in the North Fork Skykomish River corridor. A summary of the evaluation, showing how the alternatives scored, is presented in Appendix A and is discussed below.

Figure 3.1 is a cross-sectional representation of the project area divided into four environmental zones where particular alternatives are located in zones with differing natural feature.

Figure 3.1 Environmental Zones
3.1 Description of Alternatives

**Alternative 1A - No Action**
This alternative includes the construction of turn-arounds at the ends of the washed out roadway. It also assumes that the old pavement and other roadway debris would be removed from the river channel and that riparian areas along the former roadway would be restored. This alternative does not meet the primary purpose of the project, which is to restore roadway connectivity to maintain essential travel. It would be expected to have minimal environmental impact, primarily because of the removal of old pavement from the river channel. It also would not require any new Right-of-Way. This alternative will be carried forward to comply with NEPA and SEPA requirements to evaluate a no-action alternative.

**Alternative 1B - Do Absolutely Nothing**
This alternative assumes that nothing would be done at the end of the existing roadway where it is currently washed-out and that old pavement and other roadway debris would be left in the river channel. This alternative does not meet the primary purpose of the project to restore roadway connectivity to maintain essential travel. It would be expected to have moderate environmental impact, primarily from not removing the old roadway asphalt and other debris from the river channel that would adversely affect fish habitat, because it would not restore the adjacent riparian areas. This alternative would not require any new Right-of-Way. This alternative will not be carried forward because it has more environmental impacts than the No Action Alternative, does not meet the project purpose, does not meet County dead-end Standards and it is unlikely that regulatory agencies would allow the asphalt pavement to remain in the river.

**Alternative 2A - Reconstruct Roadway in Existing Alignment to Full Design Standards [Zone II]**
This alternative would reconstruct the roadway along the original alignment and rebuild to full County roadway design standards. It would be constructed within the existing roadway Right-of-Way that existed before the roadway was washed-out. During construction, the river channel would be permanently diverted back to its former channel. The roadway would also remain in the channel migration zone and would be within the 100-year floodplain. This alternative would meet the primary purpose of the project, which is to re-establish a through route along the river corridor; however, it would have significant environmental impacts associated with moving the river channel away from where it has recently migrated laterally. It would adversely impact fish habitat, wetland areas and adversely affect adjacent riparian areas. The roadway would be within the 100-year floodplain and would be at risk for being washed-out again due to its location within the channel migration zone. The new roadway would be designed to current County roadway design standards and may require new Right-of-Way. This alternative will not be carried forward because it has significant environmental impacts as compared to the other alternatives, especially to fish habitat, the free flowing character of the river and the roadway’s alignment in the channel migration zone.
Alternative 2B - Reconstruct Roadway within Existing Alignment with Deviations to Design Standards [Zone II]
This alternative would reconstruct the roadway along the original alignment and roadway grade with deviations to County standards. It would be constructed within the Right-of-Way that existed prior to the roadway wash out. During construction, the river channel would be permanently diverted back to its former channel. The roadway would remain in the channel migration zone and would be located within the 100-year floodplain. This alternative does meet the primary purpose of the project to re-establish a through route along the river corridor; however, it would have significant environmental impacts associated with moving the river channel back from where it has recently migrated laterally, and would adversely impact fish habitat, wetland areas and adjacent riparian areas. The reconstructed roadway would be located within the 100-year floodplain and would be at risk of being washed-out again due to its alignment within the channel migration zone. The new roadway would require deviations to current County roadway design standards but would not require new Right-of-Way. This alternative will not be carried forward because it has significant environmental impacts as compared to the other alternatives, especially to fish habitat, free flowing character of the river and the reconstructed roadway would remain in the channel migration zone.

Alternative 2C - Reconstruct Elevated Road within Existing Alignment with Deviations to Design Standards (Large Rock) [Zone II]
This alternative would reconstruct the roadway along the original alignment with deviations to County roadway design standards. It would be elevated above the 100-year floodplain, using large rocks for the roadway base that would potentially extend beyond the existing roadway Right-of-Way. During construction, the river would be permanently diverted back to its former channel. This alternative meets the primary purpose of the project to re-establish a through route along the river corridor but would have significant environmental impacts associated with moving the river channel away from where it has recently migrated laterally. This alternative would adversely impact fish habitat, wetland areas and adjacent riparian areas. The roadway would be elevated above the 100-year floodplain and would create a new “hard point” feature that would shift the channel migration zone. The new roadway would not meet current County roadway design standards and would require new roadway Right-of-Way. This alternative will be carried forward because it meets the project’s purpose, and would have reduced environmental impacts as compared to the other alternatives that would be constructed within the existing alignment. There would be impacts to fish habitat, the free flowing character of the river and the channel migration zone.

Alternative 2D - Reconstruct Road within Existing Alignment on Elevated Structure (Bridge) [Zone II]
This alternative would reconstruct the roadway along the original alignment and elevate the roadway above the 100-year floodplain on structural piers to meet current County roadway design standards. During construction, the river channel would be diverted out of the work area but after construction would be allowed to flow under the new roadway bridge. This alternative does meet the primary...
purpose of the project which is to re-establish a through route along the river corridor and would have moderate to substantial environmental impacts during construction associated with in-water work and moving the river channel and impacting in-stream fish habitat. It would have minimal impact to wildlife and wetlands and moderate impacts to adjacent riparian areas. The roadway would be above the 100-year floodplain and would not restrict the natural channel migration zone. The new roadway would be designed to current County roadway design standards and would not require new Right-of-Way. This alternative will not be carried forward because even though it meets the primary project purpose, environmental impacts would be expected to be substantial during construction, especially to fish habitat and the free flowing river course. In addition, this structural alternative is estimated to have exorbitant construction costs of greater than $100 million.

Alternative 3A - Relocation Landward of River and within 100-year Floodplain and Channel Migration Zone and use Remnant Section of Existing Road [Zone III]
This alternative would relocate washed out sections of the roadway outside of the current County easement area, and would be benched along the bottom of the adjacent landward hillside and would utilize the remnant sections of the old roadway to the extent possible. The remnant sections of the existing roadway would still remain in the river’s channel migration zone and within the 100-year floodplain. Bank protection will be provided along sections of the roadway that are located within the channel migration zone. Old roadway debris would be removed from the river channel. The new roadway would be improved to meet current County roadway design standards. Large sections of the new roadway would be located within the 100-year floodplain zone and the channel migration zone. The roadway would constrict the natural channel migration zone in places because new hard features would be constructed along the new alignment at the bottom of the hillside. This alternative does meet the primary purpose of the project to re-establish a through route along the river corridor, but would have significant environmental impacts, caused by impacts to the natural free flow of the river, and would adversely impact fish habitat, wetland areas and adjacent riparian areas. The new roadway would meet current County roadway design standards and would require acquisition of new Right-of-Way. This alternative will not be carried forward because it has significant environmental impacts as compared to the other relocation alternatives, especially with regard to fish habitat, wetlands, the free flowing character of the river course and would not restore riparian areas.

Alternative 3B - Relocation of the Roadway Benched in the toe of the Hillside partially within CMZ (above 100 year flood plain) [Zone III]
This alternative would relocate the roadway outside of the current County easement area and would bench a new alignment along the bottom of the adjacent hillside. It would be elevated above the 100-year floodplain and passive bank protection (installed out of water) would be provided along sections of the roadway, but would be located within the channel migration zone. Asphalt and other debris from the decommissioned section of road would be removed from the river channel and where intact roadway segments still exist. The new roadway would require County roadway design deviations to
adopted standards to minimize Right-of-Way acquisition impacts. This new roadway alignment would require installing new “passive” bank protection features that would be located within the natural channel migration zone. This alternative does meet the primary purpose of the project to re-establish a through route along the river corridor, but would have some environmental impacts and would alter the natural channel migration zone by adding bank protection where the new roadway would still be in the CMZ as mapped in the North Fork Skykomish Channel Migration Study River Mile 1.8 to 11.00. There would be unavoidable impacts to wetland areas, wildlife habitat and fish habitat. The natural free flow of the river would be impacted to some extent by locating portions of the roadway in the channel migration zone, but impacts would be substantially less than re-establishing the existing roadway alignment and other alternatives (structural piers for example) that would be located in the existing alignment. Adjacent riparian areas would be affected, but these impacts could potentially be offset by restoring riparian impacts associated with the existing roadway alignment. The new roadway would require design deviations from current County roadway design standards and would require new Right-of-Way, but potentially less than would be required by other alignments. This alternative will be carried forward because it has reduced environmental impacts as compared to the other alternatives, especially to wildlife habitat upslope from the existing roadway, wetland areas, the free flowing river and has potential to restore riparian areas associated with the existing roadway alignment.

**Alternative 4A - Relocation Upslope Outside of Channel Migration Zone-Full-Design Standards [Zone IV]**

This alternative would relocate the roadway outside of the channel migration zone and the current County Right-of-Way easement area. It would be benched along the hillside but outside of the Wild Sky Wilderness Area boundary. It would be elevated above the 100-year floodplain. Old roadway debris would be removed from the river channel. The new roadway would be design to meet current County roadway design standards. This alternative does meet the primary purpose of the project which is re-establish a through route along the river corridor and would have moderate to significant environmental impacts associated with moving the alignment onto steep slope areas, causing extensive impacts to seep wetland areas on the slopes, wildlife habitat and riparian area impacts. This alternative would require new Right-of-Way. This alternative will not be carried forward because it has slightly more environmental impacts as compared as compared to Alternative 4-B.

**Alternative 4B - Relocation upslope outside of Channel Migration Zone with Design Deviations [Zone IV]**

This alternative would relocate the roadway outside the channel migration zone and the current County Right-of-Way easement area. It would be benched along the hillside, but outside the Wild Sky Wilderness Area boundary. It would be elevated above the 100-year floodplain. Old roadway debris would be removed from the river channel. The new roadway would require design deviations to adopted County standards to minimize Right-of-Way impacts. This alternative does meet the primary purpose of the project to re-establish a through route along the river corridor and would have moderate
environmental impacts, caused by impacts to seep wetland areas on steep slopes and wildlife habitat. There would be minimal impacts to in-stream fish habitat, the natural free flow of the river and riparian area impacts would be minimized due to the upslope re-alignment. The new roadway would require design deviations from current County roadway design standards and would require new Right-of-Way. This alternative will be carried forward because it has somewhat reduced environmental impacts as compared to the other upslope alternative. There would be extensive clearing impacts that would affect upland wildlife habitat, and grading that would affect extensive seep wetland areas. Impacts to the free flowing character of the river would be minimized as would impacts to riparian areas.

**Alternative 5A - Relocation to North Side of River Outside of CMZ [Zone I]**
This alternative would relocate the highway to the north side of the river, potentially requiring new bridge structures across the river or substantially extending the roadway beyond current project limits in order to take advantage of existing bridge crossings. The new roadway would be located outside the channel migration zone to the extent practicable and old roadway debris would be removed from the river channel. This new roadway alignment would be constructed to meet current County roadway design standards, and would be located above the 100-year floodplain. This alternative does meet the primary purpose of the project to re-establish a through route along the river corridor, but would be expected to have significant environmental impacts, caused by significant adverse impacts to wildlife habitat, wetland areas, riparian areas and impacts to fish habitat. The new roadway would meet current County roadway design standards and would require extensive areas of new Right-of-Way. This alternative will not be carried forward because it has significant environmental impacts as compared to the other alternatives, especially to wildlife habitat and wetlands, and would require extensive Right-of-Way acquisition of private property in addition to U.S. Forest Service lands.

**Alternative 5B - Two-way Single Lane with Pull Outs in New Alignment [Zone IV]**
This alternative would relocate the roadway as a two-way, single lane roadway with passing areas outside the current County Right-of-Way easement area and would be benched along the hillside, elevated above the 100-year floodplain and outside the channel migration zone. Old roadway debris would be removed from the river channel. The new roadway would require design deviations to adopted County roadway design standards to achieve the minimization of Right-of-Way acquisition impacts that would be associated with a one-lane roadway. The reduced, narrowed roadway cross-section would potentially reduce impacts to the natural environment compared to a two-lane roadway, but the reduction may not be substantial given the need for roadway cuts and fills to establish a drivable roadway profile on the steep terrain. This alternative does meet the primary purpose of the project to re-establish a through route along the corridor but it would require significant design deviations that may not be approved by state and federal agencies for funding. While potentially reducing impacts on the natural environment, this alternative would still have significant impacts to seep wetlands areas and wildlife habitat. Riparian area impacts could potentially be reduced with this alternative. The new
roadway would require design deviations from current County design standards and would require new Right-of-Way. This alternative will not be carried forward because it does not comply with minimum County Roadway Standards and would have significant environmental impacts.

**Alternative 5C – Pedestrian and Bicycle Trail (only) [Zone III]**
This alternative would provide a pedestrian and bicycle trail along the project area reach of the river outside the current County Right-of-Way easement area and constructed above the 100-year floodplain. Old roadway debris would be removed from the river channel and vehicle turn-arounds would be constructed at the road closure locations. New Right-of-Way would be required for the pedestrian and bicycle trail. This alternative does not meet the primary purpose of the project to re-establish a through route along the river corridor and would be expected to have low to moderate environmental impacts to wetland areas, wildlife habitat and riparian areas. This alternative will not be carried forward because it does not meet the primary project purpose.

**Alternative 5D – Purchase all Private Property and Close Road at Trout Creek Bridge**
This alternative would purchase the private property along the section of the County roadway that is located east of the washed out area (MP 6.4), instead of providing vehicle access to these properties. All property purchases will be voluntary. This alternative does not meet the primary purpose of the project to re-establish a through route along the river corridor. This alternative will not be carried forward because it does not meet the primary project purpose and need. This alternative could potentially be combined with the No Action Alternative 1A to reduce property access impacts.

### 4 Alternative Analysis

#### 4.1 Evaluation Criteria
Evaluation criteria and a ranking factor approach were developed for this project to analyze the selected alternatives based on further analysis and review. The criteria was used by the project team to assess and evaluate fourteen alternatives in a workshop comprised of the Snohomish County Public Works and Consultant project team including design, right-of-way, environmental and river specialists.

The criteria are divided into three categories: Natural Environment, Right-of-Way and, Supports Project Purpose. The Natural Environment category includes factors that evaluate:

1. Fisheries Resources
2. Wildlife Habitat
3. Restoration of Riparian Area
4. Wetland Impacts
5. Impact to free flow of the North Fork of the Skykomish River

The Right-of-Way category considered two primary issues, whether or not additional or new Right-of-Way easement acquisition was required and the extent of acquisition that would be required if
acquisition was needed. Any additional easement area would need to be acquired from the United States Forest Service. Right-of-Way acquisition from private property owners was not considered.

Supports Project Purpose was the last evaluation criteria category that was considered. This category consisted of the following principal project objectives:

1. Re-establishment of through route for vehicular traffic
2. Minimize impact to the natural environment
3. Reduce roadway conflicts with the channel migration zone of the North Fork Skykomish River and elevate the road above the 100 year flood elevation
4. Do not encroach on the Wild Sky Wilderness Area boundary
5. Improve the Riparian Area within the project limits

Each category is divided into various factors with specific attributes that are used to rate the alternatives with a range of Least Impact to Greatest Adverse Impact. The criteria and ranking factors are outlined in Appendix A.

4.2 Summary of Analysis

Fourteen alternatives where considered for a high-level screening by Snohomish County staff and the project team on February 4, 2009. The purpose of this project is to re-establish a through highway along the Index Galena corridor to maintain essential travel. The alternatives were evaluated based on five environmental criteria, as well as if each alternative meets County design standards, magnitude of Right-of-Way impacts and the ability of the alternative to meet the project purpose. A summary of the evaluation, showing how the alternatives scored, is presented in Appendix A and discussed below.

The meeting goals were to:

1. Come up with one score for each category for each alternative
2. Evaluate the alternatives to determine which should be carried forward

Each alternative is discussed in this section with commentary on the score provided as necessary.

Alternative 1-A: No Action

- Fisheries resources (Adverse Impact Minimized): this option would be building hammerheads and removing roadway debris, including the asphalt that is in the river from the road that is washed away
- Wildlife habitat (Least Impact): this score was assigned because compared to Alternative 1-B, it should be less impactful
- Restoration of riparian area (Adverse Impact Minimized)
- Impacts to free flowing river (Least Impact): removing the decommissioned roadway asphalt
- Meets design standards (n/a)
- Right-of-Way (Least Impact) this alternative provides no impact to Right-of-Way
Meets basic objectives of project (Greatest Adverse Impacts): it was agreed that this alternative has no merit in meeting the objectives

Alternative 1-B: Do Absolutely Nothing
- Fisheries resources (Adverse Impact): doing absolutely nothing is more impactful than actually removing the debris
- Wildlife habitat (Adverse Impact Minimized): leaving the asphalt is adverse to the wildlife habitat
- Restoration of riparian area (Greater Adverse Impacts)
- Wetland impacts (Adverse Impact Minimized): doing nothing may potentially leave things in the wetlands
- Impacts to free flowing river (Adverse Impact Minimized)
- Meets design standards (n/a)
- Right-of-Way (Least Impact)
- Meets basic objective of project (Greatest Adverse Impacts)

Alternative 2-A: Reconstruct Roadway in Existing Alignment to Full Design Standards
- Fisheries resources (Greatest Adverse Impacts)
- Wildlife habitat (Adverse Impact Minimized)
- Restoration of riparian area (Greater Adverse Impacts)
- Wetland impacts (Adverse Impact): the existing roadway has wetlands. The County standards would require widening the road substantially.
- Impacts to free flowing river (Greater Adverse Impacts)
- Meets design standards (Least Impact)
- Right-of-Way (Least Impact)
- Meets basic objective of project (Greater Adverse Impacts)

Alternative 2-B: Reconstruct Roadway within Existing Alignment with Deviations to Design Standards
- Fisheries resources (Greatest Adverse Impacts)
- Wildlife habitat (Adverse Impact Minimized)
- Restoration of riparian area (Greater Adverse Impacts)
- Wetland impacts (Adverse Impacts)
- Impacts to free flowing river (Greater Adverse Impacts)
- Meets design standards (Adverse Impact Minimized)
- Right-of-Way (Least Impact)
- Meets basic objective of project (Greater Adverse Impacts)

Alternative 2-C: Reconstruct Elevated Road within Existing Alignment with Deviations to Design Standards (Large Rock)
- Fisheries resources (Greatest Adverse Impacts)
- Wildlife habitat (Adverse Impact Minimized)
- Restoration of riparian area (Greater Adverse Impacts)
• Wetland impacts (Greater Adverse Impacts): elevating the roadway with slopes will be more impactful
• Impacts to free flowing river (Greatest Adverse Impacts)
• Meets design standards (Adverse Impact Minimized)
• Right-of-Way (Adverse Impact Minimized)
• Meets basic objective of project (Adverse Impacts): the rock base will create a new channel migration zone, making the road above flood elevation

**Alternative 2-D: Reconstruct Road within Existing Alignment on Elevated Structure (Bridge)**

• Fisheries resources (Greater Adverse Impacts): with this option, piers would be built to allow the river to migrate and stay migrated rather than forcing the river back. There will be impacts to fish during construction and past construction
• Wildlife habitat (Least Impact): with the elevated road, it must be 3 feet above the 100-year flood, so wildlife could go underneath, and there is no real impact.
• Restoration of riparian area (Adverse Impacts)
• Wetland impacts (Adverse Impact Minimized)
• Impacts to free flowing river (Adverse Impact Minimized)
• Meets design standards (Least Impact)
• Right-of-Way (Least Impact)
• Meets basic objective of project (Adverse Impact Minimized)

**Alternative 3-A: Relocation Landward of River and within 100-year Floodplain and Channel Migration Zone and use Remnant Section of Existing Road**

• Fisheries resources (Greater Adverse Impacts): this option benches the road into the hillside. It is still in the channel migration zone, less old growth is affected, possible embankment and rock will be in the river. This will come down to the existing roadway and use what is already there
• Wildlife habitat (Greater Adverse Impacts): benching into the hillside would be taking out habitat. There is still uncertainty of how many acres would be removed using this alternative
• Restoration of riparian area (Greater Adverse Impacts)
• Wetland impacts (Greatest Adverse Impacts)
• Impacts to free flowing river (Adverse Impacts)
• Meets design standards (Least Impact)
• Right-of-Way (Adverse Impact Minimized)
• Meets basic objective of project (Adverse Impact Minimized): reestabishes the channel migration zone, connects the roadway up and would last 20 years

**Alternative 3-B: Relocation of the Roadway Benched in the toe of the Hillside Significant Portion within CMZ (above 100 year Flood Plain)**

• Fisheries resources (Adverse Impacts)
• Wildlife habitat (Greater Adverse Impacts)
• Restoration of riparian area (Greater Adverse Impacts)
• Wetland impacts (Greatest Adverse Impacts)
• Impacts to free flowing river (Adverse Impacts)
• Meets design standards (Adverse Impact Minimized)
• Right-of-Way (Adverse Impact Minimized)
• Meets basic objective of project (Adverse Impact Minimized): reestablishes the channel migration zone, connects the roadway up and would last 20 years

**Alternative 4-A: Relocation Upslope Outside of Channel Migration Zone-Full-Design Standards**

• Fisheries resources (Adverse Impact Minimized): this is using all County standards
• Wildlife habitat (Greater Adverse Impacts): This alternative likely has more take, but it still needs to be determined if this alternative has greater impact than Alternatives 3A and 3B
• Restoration of riparian area (Adverse Impacts)
• Wetland impacts (Greatest Adverse Impacts)
• Impacts to free flowing river (Least Impact)
• Meets design standards (Least Impact)
• Right-of-Way (Adverse Impacts)
• Meets basic objective of project (Least Impact): outside of the channel migration zone; meets all criteria; does not affecting anything

**Alternative 4-B: Relocation Upslope Outside of Channel Migration Zone with Design Deviations**

• Fisheries resources (Least Impact): this uses less impacts than Alternative 4-A, because it is going to minimum FHWA requirements
• Wildlife habitat (Greater Adverse Impacts)
• Restoration of riparian area (Adverse Impacts)
• Wetland impacts (Greatest Adverse Impacts)
• Impacts to free flowing river (Least Impact)
• Meets design standards (Adverse Impact Minimized)
• Right-of-Way (Adverse Impacts)
• Meets basic objective of project (Least Impact)

**Alternative 5-A: Relocate to North Side of River outside of the CMZ**

• Fisheries resources (Adverse Impacts): this option would require a bridge, meaning the new corridor would have more impact on fish than using the area that already has impacts. The impact to the fish is ultimately unknown
• Wildlife habitat (Greatest Adverse Impacts)
• Restoration of riparian area (Greatest Adverse Impacts)
• Wetland impacts (Greatest Adverse Impacts): assuming wetlands exist on the north side of the river
• Impacts to free flowing river (Least Impact)
• Meets design standards (Least Impact)
• Right-of-Way (Greatest Adverse Impacts)
Route Feasibility Study for Index Galena M.P. 6.4 to 6.9 Flood Repairs

- Meets basic objective of project (Adverse Impact Minimized)

**Alternative 5-B: Construct Single Lane Road with Pullouts on the New Alignment**
- Fisheries resources (Least Impact)
- Wildlife habitat (Greater Adverse Impacts)
- Restoration of riparian area (Greatest Adverse Impacts)
- Wetland impacts (Greatest Adverse Impacts)
- Impacts to free flowing river (Least Impact)
- Meets design standards (Greatest Adverse Impacts)
- Right-of-Way (Adverse Impacts)
- Meets basic objective of project (Adverse Impact Minimized)

**Alternative 5C: Pedestrian and Bicycle Trail (only)**
- Fisheries resources (Least Impact): this would provide a 10-foot gravel path
- Wildlife habitat (Adverse Impact Minimized)
- Restoration of riparian area (Adverse Impact Minimized)
- Wetland impacts (Adverse Impact Minimized): the path could possible meander and avoid any wetlands
- Impacts to free flowing river (Least Impact)
- Meets design standards (score n/a)
- Right-of-Way (Greater Adverse Impacts)
- Meets basic objective of project (Greatest Adverse Impacts)

**Alternative 5D: Purchase all Private Property and Close Road at Trout Creek Bridge**
- Fisheries resources (Least Impact)
- Wildlife habitat (Least Impact)
- Restoration of riparian area (Least Impact)
- Wetland impacts (Least Impact)
- Impacts to free flowing river (Least Impact)
- Meets design standards (score n/a)
- Right-of-Way (Greatest Adverse Impacts): this option would not condemn. It would entail a voluntary buy-out, depending on how much money is given to the County
- Meets basic objective of project (Greatest Adverse Impacts)

**4.3 Preferred Alternatives For Further Evaluation:**
As a result of the Alternative Evaluation Workshop convened on February 4th, 2009, the alternatives have been selected for further evaluation by Snohomish County Public Works. A summary of the alternatives below evaluated with their requirements and intent is shown in Appendix A.

- 1A: No Action combined with 5-E: Buyout private properties
- 2C: Reconstruct Elevated Road within Existing Alignment with deviations to design standards (large rock)
• 3B: Relocation of the Roadway Benched in the toe of the Hillside partially within CMZ using design deviations
• 4B: Relocate Roadway outside of CMZ using design deviations

**Figure 4.3.1 Composite Conceptual Roadway Cross-sections Alts 2C, 3B, and 4B**

### 4.4 Planning Level Opinion of Cost

A planning level opinion of cost was prepared for Alternative 2C: Reconstruct Elevated Road within Existing Alignment with deviations to design standards (large rock): Alternative 3B: Relocate the Roadway Benched into the base of the hillside partially outside the CMZ: and Alternative 4B: Relocation upslope outside of Channel Migration Zone with design deviations. The purpose of these opinions of cost is to provide a basis for estimating probable future construction funds needed for project implementation. The planning level estimate has combined the project’s major quantity items into a unit price opinion of probable cost. The opinion of cost was prepared using WSDOT historical cost data from 2008. It is the opinion of the author that the estimates presented are conservative. It is felt that the constructions costs can be reduced substantially during the Design Report phase with refinements to the preferred alignment. Two of the items driving up the opinions of cost are retaining walls and bridges. Sufficient data was not gathered in this phase of the project to determine the type size and location of walls and bridges. Consequently the estimator assumed tie-back soldier pile walls as the type of wall for the estimate, and assumed the use of bridges to span intermittent streams. Both of these assumptions are conservative. The opinion of probable costs was developed in 2009 dollars.
Exclusions to this opinion of probable cost are escalation of future cost, environmental mitigation, and easement costs associated with acquisition of right of way/easement from the U.S. Forest Service to realign the road.

<table>
<thead>
<tr>
<th>Alignment</th>
<th>Estimate (2009 Dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alternative 2C</strong> – Reconstruct Elevated Road within Existing Alignment with deviations to design standards (large rock).</td>
<td>$21,860,000</td>
</tr>
<tr>
<td><strong>Alternative 3B</strong> - Relocate the Roadway Benched into the base of the hillside partially outside the CMZ</td>
<td>$9,842,000</td>
</tr>
<tr>
<td><strong>Alternative 4B</strong> - 4B Relocation upslope outside of Channel Migration Zone with design deviations</td>
<td>$15,030,000</td>
</tr>
</tbody>
</table>

5. Geomorphic and Hydrodynamic Summary

The North Fork Skykomish River (NFS) is a steeply sloped, high relief basin that flows from bedrock-lined canyons in the high Cascades to the confluence with the South Fork Skykomish, which is located downstream from the town of Index. The upper valley is steep and confined in bedrock through a significant length of river. The project site is lower gradient and many areas are unconfined. Deposition of wood and sediment transported from upstream is more likely to occur through these reaches, likely creating logjams and large gravel bar areas.

The project site is bounded along the left river bank by two ancient alluvial fans, the Trout Creek fan on the downstream end (near MP 6) and an unnamed fan upstream (near MP 7.5). These fans represent hard points in the river where channel migration has not occurred in the historic record and field observations suggest that the river is not likely to migrate through these areas as the composition of the materials composing each fan is very large relative to materials being transported by the river. Between these fans, the floodplain materials are composed of alluvium and highly erodible. The existing roadway was placed on alluvium materials from approximately MP 6.2 to MP 7.3.

Human impacts to the system (logging and channel clearing) in the 1960s and 1970s resulted in a straightened channel with increased hydraulic energy. The river is currently in a stage of recovery—wood and sediment are being stored, creating logjams and splitting the mainstem river into multiple channels. Logjams and multiple channel configurations reduce hydraulic energy and promote the deposition of additional wood and sediment. In this way, a feedback loop is created where logjams, sediment deposition and split flow conditions leads to more logjams, sediment deposition, and split flow conditions. Therefore, it is expected the river will expand its active channel width and will occupy a broader range of the valley floor in the next 50 years than it has occupied in the last 50 years. Logjam accumulation and extensive gravel bar development has occurred in the project reach and is at least partially responsible for causing the development of the side channel that washed out the roadway.
Channel migration through this reach was characterized as avulsive, meaning that it is common for the river channel to abruptly move laterally from one location to another, sometimes translating the river from one side of the river valley to the other. Evidence of this type of activity is common in the historic record and this type of process is what is responsible for the existing washout. It is expected that these channel movement processes will continue is the future and that the active river channel is likely to occupy an increased width of the valley bottom in comparison to the river’s occupation area over the past several decades.

The projected Channel Migration Zone (CMZ) occupies nearly the entire valley bottom through this reach and most of the CMZ is delineated into the “high hazard zone” where it is likely that channel occupation will occur over the course of the next 50 years. This is primarily because of the character of channel migration, expected future morphology of the river given increased wood and sediment storage and the erodability of existing floodplain materials. This places the current roadway alignment within the high risk area of the CMZ from MP 6.2 to MP 7.3.

The hydraulic model results indicate that the 100-year flood inundates nearly the entire valley floor. In addition, much of the existing roadway in the project reach is within the 100 year floodplain including the two washout areas. No major tributary inputs or sediment sources are found within the left bank along the project reach.

**Alternative 3A - Relocation Landward of River and within 100-year Floodplain and Channel Migration Zone and use Remnant Section of Existing Road**

A significant portion of the alignment for Alternative 3-B is located within the Channel Migration Zone. Most of the portion of the alignment within the Channel Migration Zone is within the high risk CMZ. This alignment is outside the 100-year floodplain through the relocation extent.

**Alternative 4B - Relocation upslope outside of Channel Migration Zone with Design Deviations** The alignment for Alternative 4-B is located outside the CMZ for its entire extent. This alignment traverses bedrock between the ancient alluvial fans both upstream and downstream. This alignment is also outside the 100-year floodplain.

Note: it is important to note that the extent of the CMZ is based upon evaluation of existing data and site observation. No subsurface testing was conducted to help place the extent of the CMZ. In some locations, we have placed the CMZ extent based upon data suggesting that bedrock is located in areas, although no bedrock was confirmed through subsurface testing.

**6. Geotechnical Summary**

A planning level geotechnical study was performed to provide information related to geologic hazards and geotechnical design issues that could affect alternative selection. Geologic hazards include: rockfall,
landsides and seismic hazards. Geotechnical design issues that could affect alternative selection include earthwork to make cuts and fills necessary for a new roadway and bridge foundations.

**Rockfall**

Rockfall will occur from natural outcrops and from cuts made into bedrock and the bouldery colluvium. Natural rockfall could affect all alternatives under consideration; however, the risk should decrease with distance from cliffs. Therefore, all of the Alternative 2 alignments would have somewhat less risk and Alternative 4B would have the greatest risk. The likelihood of natural rockfall impacting the roadway is relatively low. Although infrequent, natural rockfall can include boulders larger than 20 feet in diameter.

Rockfall that occurs from cuts made into bedrock and bouldery colluvium has a greater likelihood of affecting the Alternative 4B and with somewhat lower likelihood of affecting Alternative 3B. Rockfall likely from cuts probably would be less than a few feet in diameter. Rockfall mitigation, such as roadway ditches, rockfall catchment fences and mesh or wire rope drapes can substantially reduce rockfall; however, these measures can be costly.

**Landslides**

Several landslides on the hillside along the proposed roadway corridor were mapped during the site reconnaissance. Two landslide types we observed include debris flows and slumps. Debris flows are rapidly moving rock fragments, soil and water that form a viscous fluid. Debris flows originate in the steep uplands. After triggering with a small landslide or log dam break, a debris flow typically follows an existing stream channel scouring it and accumulating more debris. In steep areas, debris flow velocity can exceed 20 miles per hour. Near the valley floor the debris flow loses energy and deposits boulders, cobbles, gravel and sand.

Slumps are landslides in which soil fails a short distance down the slope, typically with a rotational component to the movement. There are 50- to 100-foot-wide slumps present in areas where lateral support was reduced by bank erosion of underlying lacustrine beds or old timber road construction.

All of the Alternative 2 alignments should have a low risk of being affected by landslide hazards. Debris flow channels and deposits, and landslide scars are present near both Alternative 3B and 4B. Alternative 4B has a higher risk of damage from rapidly moving debris flows because it is mostly on steep slopes. Alternative 3B has a higher risk of debris flow deposits burying the roadway and from slumps that could form in the glacial lacustrine deposits. Approximately 1,700 feet of the Alternative 3B alignment is underlain by recessional lacustrine deposits.

Debris flow hazards can be mitigated with flexible debris flow barriers, armored roadway crossings and bridges or oversized culverts that are above likely debris flows. Slumps that form in glacial lacustrine deposits can be mitigated by avoiding placement of fills on slopes, placing fills to buttress the toes of existing slopes and making cuts no steeper than existing, stable slopes underlain by lacustrine deposits.
Cuts and Fills

Alternative 2D would require approach embankments for bridges. These embankments may require liquefaction mitigation because of the underlying loose, saturated alluvium. Liquefaction mitigation can be costly. The roadway and bridge approach embankments would require erosion protection measures such as rip rap and/or lower impact approaches.

Alternative 3B alignment crosses slopes ranging from 20 to 30 degrees that would require cuts and fills approximately 20 feet high. Embankment fills likely would extend down to the valley floor and in several places would be within the CMZ. Embankments within the CMZ would require erosion protection measures. Approximately 1,700 feet of the proposed Alternative 3B alignment is underlain by recessional lacustrine deposits. These deposits can be unstable when subject to loads from fills or when steep cuts are made. Therefore, fills should extend to the valley floor so they buttress and improve stability of the glacial lacustrine deposits. Cuts should not be steeper than existing, stable slopes.

Alternative 4B crosses slopes ranging from 35 to 45 degrees along the south section of the proposed alignment, approximately 70 to 80 percent of the alignment. Slopes to the north become shallower to approximately 20 to 30 degrees. Much of the roadway construction will require large cuts and fills. To reduce the sizes of cuts and fills, large retaining walls likely will be needed. To reduce risks from rockfall, mitigation measures such as rockfall catchment fences and mesh drapes could be required for many of the cut slopes. Cut and fill heights along this alternative could be more than 40 feet high.

Excavations in granodiorite along Alternative 3B and 4B will require drilling and blasting. Conventional earthwork equipment likely will be able to excavate most soil; however, large boulders will require drilling and blasting. Scrapers probably will not be practical. Excavations made in glacial lacustrine soil likely will not be suitable for reuse because the silt and clay is moisture sensitive and would be difficult or impractical to compact. Bouldery colluvium, alluvium and landslide deposits likely will require processing to remove cobbles and boulders larger than 6 inches before the soil could be reused. Boulders and cobbles could be crushed and then reused on site, or could be used for large rock fills.

Bridge Foundations

Rebuilding the Index Galena Road along Alternative 2D would require one or more bridges to cross washed out sections of the road. Bridges may also be necessary along the Alternative 4B to cross ephemeral streams or debris flow hazards. It is unlikely that Alternative 3B will require bridges. If bridges are required for Alternative 4B, the foundation conditions should be favorable with shallow bedrock. Foundation for bridges along Alternative 2D could require deep foundations in alluvium that provides moderate to low capacity and is subject to scour. Deep foundations probably would be deep shafts, because of the likely presence of large boulders.
Seismic Hazards

The project area lies approximately 30 miles northeast from the Seattle Fault Zone, the nearest known active fault; therefore, risk posed by fault-induced surface rupture along each of the three alternatives is low. Earthquakes could trigger rockfall and landslides, which would have hazards similar to the discussions above.

For design of structures, the estimated subsurface conditions along Alternative 2D are best characterized as Site Class D due to the thick deposits of alluvium that likely underlie the alignment. Subsurface conditions along the southern half of Alternative 3B are best characterized as Site Class B because of relatively shallow bedrock. The northern half is underlain by thick deposits of lacustrine, colluvial and alluvial fan deposits which are best characterized as Site Class D. Alternative 4B is underlain by relatively shallow bedrock (Site Class B) for approximately two-thirds of the proposed alignment, with the last third underlain by thick soil deposits (Site Class D).

<table>
<thead>
<tr>
<th>Site Class</th>
<th>Soil Type and Profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Hard rock with measured shear wave velocity; average shear wave velocity for the upper 100 feet of the soil profile (Vs) is greater than 5,000 ft/sec</td>
</tr>
<tr>
<td>B</td>
<td>Rock with Vs between 2,500 ft/sec and 5,000 ft/sec</td>
</tr>
<tr>
<td>C</td>
<td>Very dense soil and rock with Vs between 1,200 ft/sec and 2,500 ft/sec, or with Standard Penetration Test (SPT) blow counts greater than 50 blows/ft</td>
</tr>
<tr>
<td>D</td>
<td>Stiff soil with Vs between 600 ft/sec and 1,200 ft/sec, or SPT blow counts between 15 and 50 blows/ft</td>
</tr>
<tr>
<td>E</td>
<td>Soil profile with Vs less than 600 ft/sec, or SPT blow counts less than 15 blows/ft</td>
</tr>
<tr>
<td>F</td>
<td>Soil requiring site-specific evaluations, such as:</td>
</tr>
<tr>
<td></td>
<td>• Peats or highly organic clays</td>
</tr>
<tr>
<td></td>
<td>• Very high plasticity clays</td>
</tr>
<tr>
<td></td>
<td>• Very thick soft/medium stiff clays</td>
</tr>
</tbody>
</table>

7 Project Alternatives-Environmental Considerations

Fourteen alternatives were generated during the course of the feasibility study’s development. These alternatives underwent a high-level screening by Snohomish County staff (design, environmental, right-of-way, geotechnical, river management, survey) and the Consultant team on February 4, 2009. The alternatives were evaluated based on five environmental criteria, design standard considerations, magnitude of potential right-of-way impacts, and the ability to meet the project’s purpose and need to restore a through route that maintains essential travel on Index Galena Road.
Permits and Approvals Required

All alternatives would involve in-water work to some degree. In water work would be associated with re-establishing the damaged roadway in the existing alignment or removing the existing roadway if an alignment is chosen that would move the roadway landward of the existing alignment. It is expected that all alternatives would have some affect on wetlands. Due to in-water work and wetland impacts, all alternatives would require an Army Corps of Engineers (ACOE) Section 404 permit. Section 410 Water Quality Certification is required when Section 404 permits are issued by the ACOE.

The road will be located on U.S. Forest Service (USFS) land therefore an easement would be required from the USFS.

Section 7 Endangered Species Act (ESA) consultation would be associated with the federal funding, federal permits and easement. The Federal Highway Administration (FHWA) would be the lead federal agency due to the project’s federal funding. The USFS would be the cooperating agency. FHWA would consult with the service agencies National Marine Fisheries (NMFS) and the United States Fish and Wildlife Service (USFWS). A Biological Assessment would be required to document effects on listed ESA species in the project area.

All alignments would also require Hydraulic Project Approval (HPA) from the Washington Department of Fish and Wildlife. HPA conditions typically require mitigation for impacts such as vegetation clearing, in water, and adjacent riparian impacts. HPA approval also conditions project permits with timing restrictions. Alternatives that minimize in-water work would typically have less stringent conditions.

Due to proximity to the river, all alternatives would also require a Snohomish County Shoreline Substantial Development Permit and Flood hazard Permit from Snohomish County Planning and Development Services. Submittal for permit approval will require preparation of supporting documents that document effects to critical areas, the floodplain, the channel migration zone, and steep slopes. Clearing and Grading Approval would be required from Snohomish County.

A Forest Practices Permit and/or U.S. Forest Service approval would be needed for timber harvest in new alignments with extensive forest clearing.

Section 106 National Historic Preservation Act (NHPA) review would be associated with the project due to its federal nexus of federal funding, work on U.S. Forest Service federal land, and the ACOE permits. Section 106 NHPA would take into account potential effects on historic and archaeological sites. If a determination is made that there are adverse effects to such sites, adverse effects would need to be resolved in consultation with the State Historic Preservation Officer (SHPO) and the federal agencies for Section 106 compliance. The Washington State Department of Transportation (WSDOT) Highways and Local Programs staff would assist Snohomish County in the Section 106 consultation process.
State Environmental Policy Act (SEPA) review will be required prior to a decision by Snohomish County to proceed with final design and construction of a selected alignment alternative. National Environmental Policy Act (NEPA) review would need to occur prior to a decision by the Federal Highway Administration to approve funding for a project. WSDOT Highways and Local Programs staff would provide guidance and coordinate NEPA review with the U.S. Forest Service and assist Snohomish County in the NEPA process.

A brief summary of the environmental issues associated with alternatives scored is presented below.

### 7.1 Environmental Issues Associated with Alternatives

**Alternative 1A - No Action**

This alternative includes the construction of turn-arounds at the ends of the washed out roadway. It also assumes that the old pavement and other roadway debris would be removed from the river channel and that riparian areas along the former roadway would be restored. This alternative would be expected to have the least environmental impact because minimal vegetation clearing and grading would be needed to accommodate the construction of turn-arounds and long expanses of second-growth forest would not need to be cleared to accommodate construction of a restored roadway. Though in-water work would be needed to remove the asphalt that remains in place from the existing roadway alignment, impacts associated with this work would be short term and the areas would eventually be restored as natural re-vegetation occurs and natural river processes re-establish themselves in the former roadway area.

**Alternative 1B - Do Absolutely Nothing**

This alternative assumes that nothing would be done at the end of the existing roadway where it is currently washed-out and that old pavement and other roadway debris would be left in the river channel. This alternative would maintain an altered environment by not removing the old roadway asphalt and other debris from the river channel that would continue to adversely affect fish habitat. Adjacent riparian areas would not be expected to restore themselves as long as asphalt impervious areas remain in the abandoned roadway alignment.

**Alternative 2A - Reconstruct Roadway in Existing Alignment to Full Design Standards**

This alternative would reconstruct the road along the original alignment and grade to full County roadway design standards. It would be constructed within the existing roadway Right-of-Way that existed before the roadway was washed-out. This alternative would maintain existing adverse effects to the environment by moving the river channel out of the road. The roadway would remain in the channel migration zone and the 100-year floodplain, which would require long term maintenance to address future erosion risks associated with the river’s lateral migration and flood events. Continued maintenance of the existing alignment would adversely impact in-stream fish habitat, and adjacent riparian and wetland areas.
**Alternative 2B - Reconstruct Roadway within Existing Alignment with deviations to design standards**

This alternative would reconstruct the roadway along the original alignment and roadway grade with deviations to County standards. It would be constructed within the existing Right-of-Way easement that has been damaged as part of the roadway wash out. Similar to Alternative 2A, the river channel would be moved to allow the road to be reconstructed. The roadway would remain in the channel migration zone and would be located within the 100-year floodplain. This alternative’s impact would be associated with moving the river channel back from where it has recently migrated laterally, and would adversely impact in-stream fish habitat, wetland areas, and adjacent riparian areas. The reconstructed roadway would be located within the 100-year floodplain and would be at risk of being washed-out again due to its alignment within the channel migration zone. It is anticipated that this alternative would minimize impacts by reducing the footprint of Alternative 2A, but that long term maintenance to address future erosion events associated with the river’s lateral migration and flood events would be similar to Alternative 2A. The continued maintenance of the existing alignment would adversely impact in-stream fish habitat, and adjacent riparian and wetland areas. This alternative would also continue to have long term effects to the free flowing character of the river which would not be favorable for salmon recovery on North Fork Skykomish River.

**Alternative 2C - Reconstruct Elevated Road within Existing Alignment with deviations to design standards (large rock)**

This alternative would reconstruct the roadway along the original alignment with deviations to County roadway design standards. It would be elevated above the 100-year floodplain, using large rocks for the roadway base that would potentially extend beyond the existing roadway Right-of-Way and would likely mean more vegetation clearing is needed to facilitate rock placement. As in Alternatives 2A and 2B, the river would be moved from where it has recently migrated laterally onto the road. It is anticipated that this more hardened approach would minimize long term maintenance by reducing the future erosion risks associated with the river’s lateral migration and flood events. The hardened bank design and continued maintenance of the existing alignment would adversely impact in-stream fish habitat, and adjacent riparian and wetland areas. This alternative’s more hardened approach would be expected to have greater long term effects to the free flowing character of the river which would not be favorable for salmon recovery on North Fork Skykomish River.

**Alternative 2D - Reconstruct Road within Existing Alignment on Elevated Structure (bridge)**

This alternative would reconstruct the roadway along the original alignment but would be elevated structurally above the 100-year floodplain on piers to meet current County roadway design standards. During construction, the river channel would be isolated from the active work area causing extensive temporary impacts that would impact in-stream fish habitat. After construction the river would be allowed to migrate laterally under the new roadway. This design could potentially reduce impacts to wildlife using the river corridor for passage between upper and lower elevation areas, and the
permanent footprint of impacts to in-stream areas and wetlands would be reduced compared to an at-grade roadway.

**Alternative 3A - Relocation landward of river and within 100-year floodplain and Channel Migration Zone and use remnant section of existing road**

This alternative would relocate washed out sections of the highway outside of the current County easement area, and would be benched along the bottom of the adjacent landward hillside and would utilize the remnant sections of the old roadway to the extent possible. The remnant sections of the existing roadway would still remain in the river’s channel migration zone and within the 100-year floodplain. Bank protection would be provided along sections of the roadway that are located within the channel migration zone. The new roadway would be improved to meet current County roadway design standards, and some sections of the new roadway would be located within the 100-year floodplain zone and the channel migration zone. Portions of the reconstructed roadway would shift the channel migration zone because constructed hard features would be placed along the new alignment at the bottom of the hillside. This alternative would continue to adversely affect the natural free flow of the river, but would reduce the levels of adverse impacts to fish habitat, wetland areas, and adjacent riparian areas relative to other alternatives that keep the roadway in the existing alignment.

**Alternative 3B - Relocation of the Roadway Benched in the toe of the Hillside partially within CMZ (above 100 year flood plain)**

This alternative would relocate the roadway outside of the current County easement area and would bench a new alignment along the bottom of the adjacent hillside. It would be elevated above the 100-year floodplain and areas of passive bank protection (installed landward of the ordinary high water mark) would be provided along sections of the roadway but would be located within the channel migration zone. This alternative would pursue County roadway design deviations to adopted standards to minimize Right-of-Way acquisition impacts. This alternative would alter the natural channel migration zone by adding bank protection where the new roadway would still be in the CMZ but the level of CMZ impacts would be reduced compared to other alternatives that maintain the existing roadway alignment. There would be unavoidable impacts to wetland areas, wildlife habitat, and potentially to in-stream fish habitat, but the extent of impacts to in-stream fish habitat and some of these resources could potentially be reduced. The natural free flow of the river would be impacted to some extent by locating portions of the roadway in the channel migration zone, but impacts would be substantially less than re-establishing the existing roadway alignment. Adjacent riparian areas would be affected but these impacts could potentially be offset by restoring riparian impacts associated with the existing roadway alignment. Impacts to wildlife habitat could be substantially less than other upslope alternatives that would impact wildlife habitat upslope from the existing roadway.

**Alternative 4A - Relocation upslope outside of Channel Migration Zone-Full-Design Standards**
This alternative would relocate the roadway outside of the channel migration zone and the current County Right-of-Way easement area. It would be benched in cuts and fills along the hillside upslope from the existing roadway alignment but down slope from and outside of the Wild Sky Wilderness Area boundary. It would be elevated above the 100-year floodplain. This alignment would have minimal impacts to the river and adjacent riparian area. This alignment would have moderate to substantial environmental impacts associated with clearing and grading that would be required to move the alignment onto steep slope areas. Clearing and grading would cause extensive impacts to seep wetland areas on the slopes and wildlife habitat. Riparian area impacts would not be close to the river for the most part except where the roadway alignment would match into the existing alignment. There would be several stream crossings of non-fish-bearing streams.

**Alternative 4B - Relocation upslope outside of Channel Migration Zone with design deviations**

This alternative would relocate the roadway outside the channel migration zone and the current County Right-of-Way easement area similar to Alternative 4A. However, Alternative 4B would incorporate design deviations to adopted County standards that minimize Right-of-Way impacts and consequently would be expected to reduce the project footprint so that environmental impacts identified for Alternative 4A would also be reduced. As with 4A, environmental impacts associated with clearing and grading would disturb non-fish-bearing streams, seep wetland areas on steep slopes and wildlife habitat. This upslope alternative would be expected to have less impact than Alternative 4A to in-stream fish habitat, the natural free flow of the river, and riparian areas.

**Alternative 5A - Relocation to north side of river outside of CMZ**

This alternative would relocate the roadway to the north side of the river, potentially requiring new bridge structures across the river or substantially extending the roadway beyond current project limits in order to take advantage of existing bridge crossings. This new roadway alignment would meet current County roadway design standards, and would be located above the 100-year floodplain. This alternative would be expected to have substantial environmental impacts associated with constructing a new roadway in an area that does not currently have a continuous through route. There would be adverse impacts to wildlife habitat, wetland areas, riparian areas, and impacts to fish habitat.

**Alternative 5B - Two-way Single Lane with pull outs in New Alignment**

This alternative would relocate the roadway as a two-way, single lane roadway with passing areas outside the current County Right-of-Way easement area and would be benched along the hillside, elevated above the 100-year floodplain and outside the channel migration zone. The reduced narrowed roadway alignment would likely have substantially reduced environmental impacts due to its smaller footprint. Despite reduced impacts to the natural environment, substantial impacts would remain for slope seep wetland areas and wildlife habitat. Riparian area impacts could potentially be reduced with this alternative.
Alternative 5C – Pedestrian and Bicycle Trail (only)
This alternative would provide a pedestrian and bicycle trail along the project area reach of the river outside the current County Right-of-Way easement area and elevated above the 100-year floodplain. This alternative would be expected to have low to moderate environmental impacts to wetland areas, wildlife habitat, and riparian areas.

Alternative 5D – Purchase all Private Property and Close Road at Trout Creek Bridge
This alternative would purchase the private property along the section of the county roadway that is located east of the washed out area (MP 6.4) instead of providing vehicle access to these properties. Environmental impacts would be expected to be minimal and short term and would be primarily associated with removing existing asphalt and other debris from the river.

8 Recommendation
During the alternative evaluation phase 14 alternatives were examined for the flood repairs to Index Galena Road between mile post 6.0 and 7.3. Alternative 4B (Relocation upslope outside of Channel Migration Zone with Design Deviations) emerged as the best alternative to repair the flood damage to Index Galena Road and meet the project goals. This alternative is the most promising of the alternatives in that it would be outside of the channel migration zone and above the 100 year floodplain. In addition this Alternative 4B has reduced riparian environmental impacts as compared to the other alternatives.

Alternative 4B:

- Meets the project’s purpose and need to restore a through route that maintains essential travel on Index Galena Road.
- Removes the existing roadway asphalt and other associated roadway elements for the abandoned portion of the existing roadway.
- Requires design deviations from current County roadway standards. The roadway will be designed and constructed to closely conform to the roadway section of the remaining portions of Index Galena Road. Building the roadway to closely conform to the existing roadway will significantly reduce the roadway footprint and its impact to the surrounding environment.
- Has moderate to substantial short term environmental impacts during construction.
- Has minimal adverse impact to adjacent riparian areas, but these impacts could potentially be offset by restoring riparian impacts associated with the existing roadway alignment.
- Has reduced environmental impacts as compared to the other alternatives. Specifically it would have reduced impacts to fish habitat, wetland areas and the free flowing river.
- Has the potential to restore riparian areas associated with the existing roadway alignment.
- Requires new Right-of-Way easement for USFS.
Listed below are additional factors to evaluate Alternative 4B during the Design Report phase to minimize environmental impacts and construction cost:

- Avoid large cuts by adjusting the proposed alignment down slope
- Avoid costly bridging of intermittent stream by the proposed alignment down slope
- Require design deviations from current County roadway standards. The roadway will be designed and constructed to closely conform to the roadway geometric section of the remaining upstream and downstream portions of Index Galena Road. Building the roadway to closely conform to the existing roadway will significantly reduce the roadway footprint and its impact surrounding environment

In summary, Alternative 4B fulfills the purpose of the project to restore a through route that maintains essential travel, has reduced environmental impacts when compared to other alternatives and is expected to have lower construction costs relative to the other alternatives. The preferred alternative is shown in the companion Supplement to this document.
APPENDIX A

PROJECT ALTERNATIVE EVALUATION

1. COMPOSITE SCORE CARD OF ALTERNATIVES EVALUATED

2. ALTERNATIVE EVALUATION CRITERIA
## Composite Score Card of Alternatives Evaluated for the Index Galena Flood Repairs from M.P. 6.0 to 7.3

<table>
<thead>
<tr>
<th>Alternative No.</th>
<th>Alt 1-A</th>
<th>Alt 1-B</th>
<th>Alt 2-A</th>
<th>Alt 2-B</th>
<th>Alt 2-C</th>
<th>Alt 2-D</th>
<th>Alt 3-A</th>
<th>Alt 3-B</th>
<th>Alt 4-A</th>
<th>Alt 4-B</th>
<th>Alt 5-A</th>
<th>Alt 5-B</th>
<th>Alt 5-C</th>
<th>Alt 5-D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative Description</td>
<td>No Action</td>
<td>Do Absolutely Nothing</td>
<td>Reconstruct road on original alignment and grade to full County design standards</td>
<td>Reconstruct road on original alignment and grade using minimum FHWA design standards</td>
<td>Reconstruct elevated roadway using large rock</td>
<td>Construct elevated roadway on piers within existing easement</td>
<td>Relocate washed out sections of roadway outside of County Easement within CMZ, utilize remnant sections of former County Road</td>
<td>Relocate new section of outside of County easement within CMZ</td>
<td>Relocate roadway outside of CMZ using the most optimum Snohomish County design criteria</td>
<td>Relocate the roadway outside of the CMZ using reduced Snohomish County Standards by using FHWA minimums</td>
<td>Relocate section of road to north side of river outside of CMZ</td>
<td>Construct single lane road with pullouts on new alignment</td>
<td>Provide only pedestrian and bike access</td>
<td>Buy out all private properties that need access past M.P. 6.4 and do not reconstruction the roadway or pedestrian and bicycle trail</td>
</tr>
</tbody>
</table>

### Natural Environment

| Fisheries resources | ●● | ● | ○ | ○ | ○ | ○ | ○ | ○ | ●● | N/A | N/A | N/A | N/A | N/A |
| Wildlife habitat | ●●● | ●● | ●● | ●● | ●● | ●● | ●● | ●● | ●● | ●● | ●● | ●● | ●● | ●● |
| Restoration of Riparian Area | ●● | ● | ○ | ○ | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Wetland Impacts | ●●● | ●● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Impacts to Free Flowing River | ●●● | ●● | ○ | ○ | ○ | ○ | ● | ● | ● | ● | ● | ● | ● | ● |

### Design

| Meets design standards | N/A | N/A | ●●● | ●● | ●● | ●● | ●● | ●● | ●● | ●● | ○ | N/A | N/A | N/A |

### Right of Way

| Right of Way | ●●● | ●●● | ●●● | ●●● | ●●● | ●●● | ●●● | ●●● | ●●● | ●●● | ●● | ○ | ● | ○ |

| Meets basic objective of project | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

### Legend

- Least Impact = ●●●
- Adverse Impact Minimized = ●●
- Adverse Impacts = ●
- Greater Adverse Impacts = ●●
- Greatest Adverse Impacts = ○
- Not Applicable = N/A
## ALTERNATIVE EVALUATION CRITERIA:

<table>
<thead>
<tr>
<th>NATURAL ENVIRONMENT</th>
<th>Least Impact</th>
<th>Adverse Impact Minimized</th>
<th>Adverse Impacts</th>
<th>Greater Adverse Impacts</th>
<th>Greatest Adverse Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fisheries resources</td>
<td>Minimally impacts to river, riparian forest or restriction to river's CMZ. Impacts limits to removing roadway debris from the river and installing riparian restoration and/or stream habitat enhancements.</td>
<td>More than 0.01 acre of riparian vegetation clearing, minor or no increase in riparian coverage following project.</td>
<td>Minor impacts to river (associated with work below OHWM during fish-free work windows); impacts to river migration reduced by relocation of road. Habitat enhancement provided by roadway debris removal and riparian restoration or stream habitat enhancements.</td>
<td>Some impacts to river (greater work below OHWM during fish-free work windows); impacts to river migration are NOT reduced by partial relocation of road. Revegetations are buried in footprint of existing road.</td>
<td>Extensive work below OHWM for longer periods of time during critical seasons for fish such as spawning, or when eggs are in gravel. Hardened structures used to protect road in CMZ with extensive adverse impacts to stream habitat.</td>
</tr>
<tr>
<td>Wildlife habitat</td>
<td>Minimally adverse impacts to existing wildlife habitat and enhances wildlife habitat in the project area.</td>
<td>Less than 0.01 acre of riparian vegetation clearing, minor or no increase in riparian coverage following project.</td>
<td>Less than 0.5 acre of riparian vegetation clearing, minor decrease in riparian coverage following project.</td>
<td>Less than 1.0 acre of riparian vegetation clearing, minor decrease in riparian coverage following project.</td>
<td>More than 1.0 acre of riparian vegetation clearing, significant (&gt;1.0 acre) decrease in riparian coverage following project.</td>
</tr>
<tr>
<td>Restoration of Riparian Area</td>
<td>No removal of riparian vegetation. Increased riparian vegetation coverage following project completion.</td>
<td>No adverse impacts to existing wetlands in the project area.</td>
<td>Buffers of wetlands are affected in the project area. Wetlands are directly affected by the project. Wetlands cannot be mitigated in same drainage basin.</td>
<td>Wetlands are directly affected by the project. Wetlands cannot be mitigated in same drainage basin.</td>
<td>Extensive bank protection is required and active. Energy dissipation structures are needed.</td>
</tr>
<tr>
<td>Wetland Impacts</td>
<td>No adverse impacts to existing wetlands and the project creates or enhances wetlands in the project area.</td>
<td>No adverse impacts to existing wetlands in the project area.</td>
<td>Buffers of wetlands are affected in the project area. Wetlands are directly affected by the project. Wetlands cannot be mitigated in same drainage basin.</td>
<td>Wetlands are directly affected by the project. Wetlands cannot be mitigated in same drainage basin.</td>
<td>Extensive bank protection is required and active. Energy dissipation structures are needed.</td>
</tr>
<tr>
<td>Impacts to Free Flowing River</td>
<td>The road is completely relocated out of CMZ. Location of bank protection: Road is out of the CMZ and needs no form of bank protection.</td>
<td>80% of the new road is out of the CMZ. Location of bank protection: All of the bank protection is located above the OHWM and the new roadway is in a passive state.</td>
<td>Less than 50% of the new road is located within the CMZ. Bank protection is needed and less than 50% is located below the OHWM.</td>
<td>More than 50% of the new road is within the CMZ. Bank protection is needed and more than 50% is located below the OHWM. A portion of bank protection is active.</td>
<td>Extensive bank protection is required and active. Energy dissipation structures are needed.</td>
</tr>
</tbody>
</table>

### DESIGN
- Meets design standards
- Meets all current design standards

### RIGHT OF WAY acquisition
- No Right of Way required
- Right of Way required

### SUPPORTS PROJECT PURPOSE
- Meets basic objectives of project – Re-establish through route to maintain essential travel while minimizing environmental impacts and improve the environment by reducing Index Galena Road impacts to river functions within the project limits.
- The roadway is 100% out of the river’s CMZ and above the 100 year flood elevation and all old roadway material can be removed and the roadway link is reestablished.
- The roadway is 100% out of the river’s CMZ and relocated above the 100 year flood elevation and over 50% of the old roadway material can be removed and the roadway link is reestablished.
- The roadway is 100% out of the river’s CMZ and relocated above the 100 year flood elevation and over 50% of the old roadway material can be removed and the roadway link is reestablished.
- The roadway is 100% out of the river’s CMZ and relocated above the 100 year flood elevation and over 50% of the old roadway material can be removed and the roadway link is reestablished.
- The roadway is 100% out of the river’s CMZ and relocated above the 100 year flood elevation and over 50% of the old roadway material can be removed and the roadway link is reestablished.
APPENDIX B

OPINION OF PROBABLE COST

1. ALTERNATIVE 2C - Reconstruct Road within Existing Alignment on Elevated Structure (bridge)

2. ALTERNATIVE 3B - Relocation of the Roadway Benched in the toe of the Hillside partially within CMZ

3. ALTERNATIVE 4B - Relocation upslope outside of Channel Migration Zone with design deviations
# PLANNING LEVEL OPINION OF COST SUMMARY

**Project Description:** Index Galena Road - Alternative 2C  
**Client:** Snohomish County  
**Date:** 3/19/2009  
**Date of Cost Index:** 2009  
**Calculation By/Entered By:** MAS  
**Checked By:** RAM

## Channel Migration & Route Feasibility Study

<table>
<thead>
<tr>
<th>ITEM NO.</th>
<th>STD ITEM NUMBER</th>
<th>DESCRIPTION</th>
<th>ESTIMATED QUANTITY</th>
<th>UNIT</th>
<th>ESTIMATED UNIT COST</th>
<th>TOTAL COST</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SECTION 1: PREPARATION</strong></td>
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<td></td>
<td></td>
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<tr>
<td>0002</td>
<td>MOBILIZATION (10%)</td>
<td>1</td>
<td>LS</td>
<td>$139,000.00</td>
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<tr>
<td>0025</td>
<td>CLEARING AND GRUBBING</td>
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<tr>
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<tr>
<td>0050</td>
<td>REMOVAL STRUCTURES &amp; OBSTRUCTIONS</td>
<td>1</td>
<td>LS</td>
<td>$10,000.00</td>
<td>$10,000</td>
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| **SECTION 2: GRADING** | | | | | | |
| 1075 | HEAVY LOOSE RIPRAP | 421,000 | TON | $25.00 | $10,525,000 |
| | EMBANKMENT COMPACTION & PLACEMENT OF RIPRAP | 230,000 | CY | $2.00 | $460,000 |

| **SECTION 4: DRAINAGE** | | | | | | |
| 1320 | PLAIN ST. CULV. PIPE. 0.109 IN. TH. 18 IN. DIA. | 320 | LF | $25.00 | $8,000 |
| 1323 | PLAIN ST. CULV. PIPE. 0.109 IN. TH. 36 IN. DIA. | 800 | LF | $125.00 | $100,000 |

| **SECTION 9: SURFACING** | | | | | | |
| 5100 | CRUSHED SURFACING BASE COURSE | 26,000 | TON | $20.00 | $520,000 |

| **SECTION 14: SURFACING** | | | | | | |
| 5767 | HMA CL. 1/2 IN. PG 64 - 22 | 7,500 | TON | $90.00 | $675,000 |

| **SECTION 17: EROSION CONTROL AND PLANTING** | | | | | | |
| 6373 | SILT FENCE | 6820 | LF | $5.00 | $34,100 |
| 6468 | STABILIZED CONSTRUCTION ENTRANCE | 160 | SY | $25.00 | $4,000 |
| 6474 | SEEDING, MULCHING & FERTILIZING | 8.9 | ACRE | $20,000.00 | $177,000 |
| | TEMPORARY WATER POLLUTION & EROSION CONTROL (1%) | 1 | LS | $136,000.00 | $136,000 |

| **SECTION 18: TRAFFIC** | | | | | | |
| 6749 | BEAM GUARD RAIL TYPE 1 - 11 FT. LONG POST | 12,800 | LF | $28.00 | $358,400 |
| 6737 | BEAM GUARDRAIL BULL NOSE TERMINAL | 4 | EA | $6,590.00 | $26,360 |
| 6849 | PAINTED SKIP WIDE LINE | 6,400 | LF | $1.10 | $7,040 |
| 6817 | PAINTED WIDE LINE | 12,800 | LF | $3.10 | $39,680 |
| 6873 | OTHER TEMPORARY TRAFFIC CONTROL | 1 | LS | $2,500.00 | $2,500 |

| **SECTION 19: OTHER ITEMS** | | | | | | |
| | BANK PROTECTION | 1 | LS | $500,000.00 | $500,000 |
| | TEMPORARY RIVER DIVERSION | 1 | LS | $225,000.00 | $225,000 |
| | LARGE WOODY DEBRIS | 1 | LS | $125,000.00 | $125,000 |
| 7736 | SPCC PLAN | 1 | LS | $2,500.00 | $2,500 |

**CONSTRUCTION SUBTOTAL** | $14,012,940 |

**OTHER ADDITIVES**

- CONTINGENCIES 20% OF CONSTRUCTION COST | $2,802,588 |
- PE 15% | $2,922,329 |
- CE 15% | $2,922,329 |

**SUBTOTAL** | $7,647,246 |

**TOTAL** | $21,860,186 |

---

No Right of Way Included  
No environmental mitigation Included  
No wetland mitigation Included  

The above opinion of cost is a planning level estimate only. It is based on best available information and scope at the time, not on the results of a detailed engineering study, and is supplied as a budgeting guide only. H.W. Lochner, Inc. does not guarantee or warrant the accuracy of this planning level estimate.
## Channel Migration & Route Feasibility Study

### PLANNING LEVEL COST ESTIMATE

<table>
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<tr>
<th>ITEM NO.</th>
<th>STD ITEM NUMBER</th>
<th>DESCRIPTION</th>
<th>QUANTITY</th>
<th>UNIT</th>
<th>TOTAL COST</th>
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</thead>
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<tr>
<td>0002</td>
<td>MOBILIZATION (10%)</td>
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<td>$570,000.00</td>
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<td>0025</td>
<td>CLEARING AND GRUBBING</td>
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<td>ACRE</td>
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<td>$106,800</td>
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<td>0044</td>
<td>STRIPPING INCL. HAUL</td>
<td>15,000</td>
<td>CY</td>
<td>$1,000</td>
<td>$15,000</td>
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<tr>
<td>0120</td>
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<td>8,500</td>
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<td>1</td>
<td>LS</td>
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### SECTION 2: GRADING

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<th>ITEM NO.</th>
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<th>UNIT</th>
<th>TOTAL COST</th>
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<tbody>
<tr>
<td>0310</td>
<td>ROADWAY EXCAVATION INCL. HAUL (on site)</td>
<td>82,000</td>
<td>CY</td>
<td>$10,000</td>
<td>$820,000</td>
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<tr>
<td>0300</td>
<td>Roadway Excavation (real line)</td>
<td>64,500</td>
<td>CY</td>
<td>$5,35</td>
<td>$345,075</td>
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<tr>
<td>1030</td>
<td>DITCH EXCAVATION INCL. HAUL</td>
<td>3,100</td>
<td>CY</td>
<td>$12,50</td>
<td>$39,750</td>
</tr>
<tr>
<td>1086</td>
<td>QUARRY SPALLS</td>
<td>600</td>
<td>TON</td>
<td>$35,00</td>
<td>$21,000</td>
</tr>
<tr>
<td>1138</td>
<td>HALF ROUND PLAIN ST. CULV PIPE 0.064 IN. TH. 30 IN. DIAM.</td>
<td>450</td>
<td>LF</td>
<td>$40,00</td>
<td>$18,000</td>
</tr>
<tr>
<td>1320</td>
<td>PLAIN ST. CULV PIPE 0.109 IN. TH. 18 IN. DIAM.</td>
<td>200</td>
<td>LF</td>
<td>$12,50</td>
<td>$2,500</td>
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<tr>
<td>1323</td>
<td>PLAIN ST. CULV PIPE 0.109 IN. TH. 36 IN. DIAM.</td>
<td>160</td>
<td>LF</td>
<td>$125,00</td>
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### SECTION 4: DRAINAGE

<table>
<thead>
<tr>
<th>ITEM NO.</th>
<th>STD ITEM NUMBER</th>
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<th>UNIT</th>
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</thead>
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<tr>
<td>1093</td>
<td>DITCH EXCAVATION Incl. Haul</td>
<td>800</td>
<td>CY</td>
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<td>1094</td>
<td>STRUCTURE EXCAVATION CLASS A INCL. HAUL</td>
<td>300</td>
<td>CY</td>
<td>$155,00</td>
<td>$465,000</td>
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### SECTION 7: EROSION CONTROL AND PLANTING

<table>
<thead>
<tr>
<th>ITEM NO.</th>
<th>STD ITEM NUMBER</th>
<th>DESCRIPTION</th>
<th>QUANTITY</th>
<th>UNIT</th>
<th>TOTAL COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>6446</td>
<td>SEEDING, MULCHING &amp; FERTILIZING</td>
<td>8.9</td>
<td>ACRE</td>
<td>$2,000.00</td>
<td>$17,760</td>
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<tr>
<td>6418</td>
<td>Silt fence</td>
<td>180</td>
<td>SY</td>
<td>$50,00</td>
<td>$4,000</td>
</tr>
</tbody>
</table>

### SECTION 9: SURFACING

<table>
<thead>
<tr>
<th>ITEM NO.</th>
<th>STD ITEM NUMBER</th>
<th>DESCRIPTION</th>
<th>QUANTITY</th>
<th>UNIT</th>
<th>TOTAL COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>5767</td>
<td>HMA CL. 1/2 IN. PG 64 - 22</td>
<td>8,200</td>
<td>TON</td>
<td>$50,00</td>
<td>$738,000</td>
</tr>
</tbody>
</table>

### CONSTRUCTION SUBTOTAL

$6,308,611

### OTHER ADDITIVES

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>TOTAL COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTINGENCIES 20% OF CONSTRUCTION COST</td>
<td>$1,261,722</td>
</tr>
<tr>
<td>PE 15%</td>
<td>$1,135,550</td>
</tr>
</tbody>
</table>

### TOTAL

$9,841,433

---

The above opinion of cost is a planning level estimate only. It is based on best available information and scope at the time, not on the results of a detailed engineering study, and is supplied as a budgeting guide only. H.W. Lochner, Inc. does not guarantee or warrant the accuracy of this planning level estimate.
# PLANNING LEVEL OPINION OF COST SUMMARY

**Project Description:** Index Galena Road - Alternative 4B  
**Corridor Section:** Channel Migration & Route Feasibility Study  
**Client:** Snohomish County  
**Date:** 3/19/2009  
**Date of Cost Index:** 2009  
**Calculating Firm/Entered By:** MAS  
**Checked By:** RAM

## Channel Migration & Route Feasibility Study

### ESTIMATED UNIT COST

<table>
<thead>
<tr>
<th>ITEM NO.</th>
<th>DESCRIPTION</th>
<th>ESTIMATED QUANTITY</th>
<th>UNIT</th>
<th>ESTIMATED UNIT COST</th>
<th>TOTAL COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>0002</td>
<td>MOBILIZATION (10%)</td>
<td>1</td>
<td>LS</td>
<td>$875,000.00</td>
<td>$875,000</td>
</tr>
<tr>
<td>0025</td>
<td>CLEARING AND GRUBBING</td>
<td>21.0</td>
<td>ACRE</td>
<td>$8,500.00</td>
<td>$178,500</td>
</tr>
<tr>
<td>0044</td>
<td>STRIPPING INCL. HAUL</td>
<td>15,000</td>
<td>CY</td>
<td>$1,000.00</td>
<td>$15,000</td>
</tr>
<tr>
<td>0120</td>
<td>REMOVING ASPHALT CONC. PAVEMENT</td>
<td>8,900</td>
<td>SY</td>
<td>$10,000.00</td>
<td>$89,000</td>
</tr>
<tr>
<td>0050</td>
<td>REMOVAL STRUCTURES &amp; OBSTRUCTIONS</td>
<td>1</td>
<td>LS</td>
<td>$10,000.00</td>
<td>$10,000</td>
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</tbody>
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### SECTION 2: GRADING

<table>
<thead>
<tr>
<th>ITEM NO.</th>
<th>DESCRIPTION</th>
<th>ESTIMATED QUANTITY</th>
<th>UNIT</th>
<th>ESTIMATED UNIT COST</th>
<th>TOTAL COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>0310</td>
<td>ROADWAY EXCAVATION INCL. HAUL (on site)</td>
<td>72,000</td>
<td>CY</td>
<td>$10,000.00</td>
<td>$720,000</td>
</tr>
<tr>
<td>0300</td>
<td>Roadway Excavation (neat line)</td>
<td>76,000</td>
<td>CY</td>
<td>$7,000.00</td>
<td>$532,000</td>
</tr>
<tr>
<td>1320</td>
<td>PLAIN ST. CULV. PIPE. 0.190 IN. TH. 18 IN. DIAM.</td>
<td>320</td>
<td>LF</td>
<td>$7,000.00</td>
<td>$2,240,000</td>
</tr>
<tr>
<td>1323</td>
<td>PLAIN ST. CULV. PIPE. 0.109 IN. TH. 36 IN. DIAM.</td>
<td>240</td>
<td>LF</td>
<td>$125.00</td>
<td>$30,000</td>
</tr>
<tr>
<td>2461</td>
<td>ST. STR PLATE PIPE ARCH 12 GAUGE 15 FT. 10 IN. SPAN</td>
<td>120</td>
<td>LF</td>
<td>$900.00</td>
<td>$108,000</td>
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### SECTION 4: DRAINAGE

<table>
<thead>
<tr>
<th>ITEM NO.</th>
<th>DESCRIPTION</th>
<th>ESTIMATED QUANTITY</th>
<th>UNIT</th>
<th>ESTIMATED UNIT COST</th>
<th>TOTAL COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>1030</td>
<td>DITCH EXCAVATION INCL. HAUL</td>
<td>3,600</td>
<td>CY</td>
<td>$12.50</td>
<td>$45,000</td>
</tr>
<tr>
<td>1086</td>
<td>QUARRY SPALLS</td>
<td>1,200</td>
<td>TON</td>
<td>$35.00</td>
<td>$42,000</td>
</tr>
<tr>
<td>1138</td>
<td>HALF ROUND PLAIN ST. CULV PIPE 8.644 IN. TH. 30 IN. DIAM.</td>
<td>650</td>
<td>LF</td>
<td>$40.00</td>
<td>$26,000</td>
</tr>
<tr>
<td>1320</td>
<td>PLAIN ST. CULV. PIPE. 0.109 IN. TH. 18 IN. DIAM.</td>
<td>320</td>
<td>LF</td>
<td>$25.00</td>
<td>$8,000</td>
</tr>
<tr>
<td>1323</td>
<td>PLAIN ST. CULV. PIPE. 0.109 IN. TH. 36 IN. DIAM.</td>
<td>240</td>
<td>LF</td>
<td>$125.00</td>
<td>$30,000</td>
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### SECTION 6: STRUCTURE

<table>
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<tr>
<th>ITEM NO.</th>
<th>DESCRIPTION</th>
<th>ESTIMATED QUANTITY</th>
<th>UNIT</th>
<th>ESTIMATED UNIT COST</th>
<th>TOTAL COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>4006</td>
<td>STRUCTURE EXCAVATION CLASS A INCL. HAUL</td>
<td>2400</td>
<td>CY</td>
<td>$20.00</td>
<td>$48,000</td>
</tr>
<tr>
<td>4007</td>
<td>BRIDGE - REINFORCED CONCRETE FLAT SLAB</td>
<td>4000</td>
<td>SF</td>
<td>$155.00</td>
<td>$620,000</td>
</tr>
<tr>
<td>4008</td>
<td>RETAINING WALLS (510M PIP TUBE/D)</td>
<td>13,300</td>
<td>SF</td>
<td>$160.00</td>
<td>$2,160,000</td>
</tr>
<tr>
<td>4009</td>
<td>REINFORCED CONCRETE RETAINING WALL</td>
<td>13,300</td>
<td>SF</td>
<td>$75.00</td>
<td>$1,012,500</td>
</tr>
<tr>
<td>4011</td>
<td>SE WALL - WELDED WIRE</td>
<td>18,800</td>
<td>SF</td>
<td>$30.00</td>
<td>$564,000</td>
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</table>

### SECTION 8: SURFACING

<table>
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<tr>
<th>ITEM NO.</th>
<th>DESCRIPTION</th>
<th>ESTIMATED QUANTITY</th>
<th>UNIT</th>
<th>ESTIMATED UNIT COST</th>
<th>TOTAL COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>4090</td>
<td>CRUSHED SURFACING BASE COURSE</td>
<td>17,400</td>
<td>TON</td>
<td>$20.00</td>
<td>$348,000</td>
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</tbody>
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### SECTION 16: TRAFFIC

<table>
<thead>
<tr>
<th>ITEM NO.</th>
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<th>ESTIMATED QUANTITY</th>
<th>UNIT</th>
<th>ESTIMATED UNIT COST</th>
<th>TOTAL COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>6749</td>
<td>BEAM GUARD RAIL TYPE 1, 11 FT. LONG POST</td>
<td>7,800</td>
<td>LF</td>
<td>$28.00</td>
<td>$218,400</td>
</tr>
<tr>
<td>6757</td>
<td>BEAM GUARD RAIL BULL NOSE TERMINAL</td>
<td>6</td>
<td>EA</td>
<td>$650.00</td>
<td>$3,900</td>
</tr>
<tr>
<td>6776</td>
<td>PRECAST CONC. BARRIER</td>
<td>2,120</td>
<td>LF</td>
<td>$35.00</td>
<td>$74,200</td>
</tr>
<tr>
<td>6849</td>
<td>PAINTED SKIP WIDE LINE</td>
<td>8,000</td>
<td>LF</td>
<td>$1.10</td>
<td>$8,800</td>
</tr>
<tr>
<td>6917</td>
<td>PAINTED WIDE LINE</td>
<td>16,000</td>
<td>LF</td>
<td>$3.10</td>
<td>$49,600</td>
</tr>
<tr>
<td>6973</td>
<td>OTHER TEMPORARY TRAFFIC CONTOL</td>
<td>1</td>
<td>LS</td>
<td>$2,500.00</td>
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### SECTION 19: OTHER ITEMS

<table>
<thead>
<tr>
<th>ITEM NO.</th>
<th>DESCRIPTION</th>
<th>ESTIMATED QUANTITY</th>
<th>UNIT</th>
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</thead>
<tbody>
<tr>
<td>7736</td>
<td>SPDC PLAN</td>
<td>1</td>
<td>LS</td>
<td>$2,500.00</td>
<td>$2,500</td>
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</table>

### CONSTRUCTION SUBTOTAL

$9,634,500

### OTHER ADDITIVES

- CONTINGENCIES 20% OF CONSTRUCTION COST | $1,926,900
- PE 15% | $1,734,210
- CE 15% | $1,734,210

### SUBTOTAL

$5,395,320

### TOTAL

$15,029,820

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No Right of Way Included  
No environmental mitigation Included  
No wetland mitigation Included

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APPENDIX C

PLAN and PROFILE

1. ALTERNATIVE 3B – Plan View
2. ALTERNATIVE 3B – Profile
3. ALTERNATIVE 4B – Plan View
4. ALTERNATIVE 4B – Profile
Route Feasibility Study for Index Galena M.P. 6.4 to 6.9 Flood Repairs

Snohomish County Public Works
RC 1532, UPI# 06-0150
Appendix C
Route Feasibility Study for Index Galena M.P. 6.4 to 6.9 Flood Repairs

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