PanGEO
INCORPORATED
Geotechnical & Earthquake
Engineering Consultants

August 21, 2012
File No. 12-100

Mr. Kevin Brown, P.E.
Gray & Osborne, Inc.
3710 168th Street NE, Suite B210
Arlington, Washington 98223

Subject: **Draft Report**
Preliminary Geotechnical Evaluation
Gooseberry Point Pedestrian Improvements
Whatcom County, Washington

Dear Mr. Brown,

As requested, PanGEO Inc. completed a geotechnical engineering evaluation to support your feasibility and alternative analysis for the Gooseberry Point Pedestrian Improvement project in Whatcom County, Washington. Our work was performed in general accordance with our proposal dated June 18, 2012, which included conducting a site reconnaissance, reviewing available geologic and geotechnical data, and developing the conclusions and recommendations presented in this report.

SITE AND PROJECT DESCRIPTION

The project alignment is located along Haxton Way and Lummi View Drive, in the vicinity of the Lummi Ferry Terminal at Gooseberry Point in Whatcom County, Washington (see Figures 1 and 2). The project alignment begins at the intersection of Haxton Way and Balch Road at the north end and extends approximately southwest to the Gooseberry Point Ferry Terminal. At this point Haxton Way turns east and becomes Lummi View Drive. The alignment continues along Lummi Drive and ends at the intersection of Lummi View Drive and Mackenzie Road (see Figure 2). The entire alignment is approximately 1.76-mile long. The existing roadway within the project alignment consists of two travel lanes with narrow shoulders along most of the alignment. The general existing conditions along the alignment are shown in Plates 1 and 2 on the next page.

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Plate 1. Looking approximately southwest along Haxton Way near Southgate Street.

Plate 2. Looking approximately southeast along Lummi View Drive. The ferry terminal is located to the right side of this photo.

In general, between Balch Road (north end of the alignment) and the ferry terminal, the existing grade along the alignment generally slopes down from north to south. It appears that this portion of the roadway was constructed by cut along the east side of the roadway, and fill on the west side of the roadway. The site grade becomes relatively flat between the Emma Road and Mackenzie Road (south end of the alignment). The land use along the project alignment is mostly single-family residences on both sides of the roadway except at the ferry terminal where the terminal occupying the west side of the roadway and a parking lot occupying the east side of the roadway.

We understand that sidewalks are to be constructed along the project alignment. The locations, widths and types of sidewalk are yet to be determined at this time. The current phase of the project is to evaluate various alternatives, including a boardwalk, a pervious HMA walkway with curb, an impervious sidewalk with standard curb and gutter, a pervious sidewalk with standard curb and gutter, a separate pedestrian trail, and a combination of the above.

SITE GEOLOGY AND SUBSURFACE CONDIITONS

The subsurface conditions at the project site are inferred from a review of available geologic data and soil conditions in the project vicinity, and our observations of surficial soil along the alignment. Our review included the Geologic Map of the Bellingham 1:100,000 Quadrangle, Washington (Lapen, 2000), and a summary boring log completed by Material Testing and Consulting, Inc., which is located about 620 feet north Smokehouse Road and 8 feet west from the shoulder of Haxton Way. The geologic map of the project area is shown in Figure 3. The summary boring log is included in Appendix A at the end of this report.

According to Lapen (2000), the surficial geologic units mapped at the project site is Glaciomarine Drift, Everson Interstade deposits (Map Unit $Qgdm_e$). Glaciomarine Drift deposits ($Qgdm_e$) are described by Lapen as typically *moderately to poorly indurated, moderately to unsorted diamicton with lenses and discontinuous beds of moderately to well-sorted gravel, sand, silt, and clay*.

In summary, based on our review of the geologic map and previous boring, and our observations of surface soils at several location along the alignment, the near-surface subsurface conditions along the Haxton Way between Balch Road and Emma Road is anticipated to consist of medium dense to dense silty sand and medium stiff to stiff silt below the topsoil. The near-surface

subsurface conditions along the alignment between Emma Road to Mackenzie Road is anticipated to consist of loose to medium dense, sand and gravel with silt.

Groundwater is not anticipated to be present within upper 10 feet of the ground surface in the higher elevation areas between Balch Road and approximately Emma Road. However, perched groundwater seepage may be present in localized areas on the upper slope (east) side of the roadway in the wet seasons. Groundwater level in the flat areas between Emma Road and Mackenzie Road will likely fluctuate with the tide levels in the Lummi Bay. It should be noted that groundwater elevations and seepage rates are likely to vary depending on the season, local subsurface conditions, and other factors. Groundwater levels and seepage rates are normally highest during the winter and early spring.

GEOTECHNICAL CONSIDERATIONS

SIDEWALK SUBGRADE SUPPORT

Based on the anticipated subsurface conditions along the project alignment, it is our opinion that the native soil along the project alignment will provide adequate support for the concrete sidewalks, asphalt sidewalks, or footings for boardwalk, provided the topsoil or surficial unsuitable soils are removed. In our opinion, a leveling course consists of at least 4 inches of crushed surfacing top course, compacted to a dense condition, will need to be placed directly below the concrete or asphalt sidewalks to provide a level and firm uniform support for the section between Balch Road and Emma Road. The leveling course may need to be increased to 8 inches for the section between Emma Road and Mackenzie Road to provide a stable support for the sidewalks.

Some loose fill may be present along the west side of the roadway. As a result, some over-excavation and re-compaction of existing soils may be needed in order to provide a firm subgrade for supporting the proposed sidewalk.

INFILTRATION CHARACTERISTICS OF ON-SITE SOILS

In our opinion, the Glaciomarine Drift deposits along the alignment between Balch Road and approximately Emma Road have limited infiltration capability and significant infiltration of surface water is likely not feasible. The relatively clean sand and gravel soil anticipated between Emma Road and Mackenzie Road is considered to have moderate infiltration capability, and we

believe that infiltration of surface water is feasible. We recommend that field explorations be conducted during the design stage of the project to evaluate and characterize the infiltration rates of the site soils along the alignment.

PERMANENT CUT SLOPE

If a sidewalk will be constructed on the east (upslope) side of the roadway and at approximately the same elevation as the roadway, an excavation in to the hill side will be needed. Based on our field observations, the slope on the east side of the roadway is very gentle, probably less than 15 to 20 percent. Assuming the cut extends about 10 feet into the toe of the slope, the excavation depth is likely on the order of 2-foot deep. If space if available, a permanent 2H:1V slope cut is considered appropriate from the geotechnical engineering perspective. If space is not available, a retaining wall will be needed to retain the cut.

RETAINING WALLS

Short retaining walls may be needed to facilitate the construction of the proposed sidewalk for the following scenarios: (1) a wall to retain fill on the west side (downslope side) of the roadway for an at-grade sidewalk along the west side of the roadway; (2) a wall to retain cut on the east side (upslope side) of the roadway for an at-grade sidewalk along the east side of the roadway; and (3) a wall to retain fill on the east side (upslope side) of the roadway for an elevated sidewalk along the east side of the roadway. Conventional wall types such as cast-in-place concrete walls and gravity walls (e.g. Ultra Blocks, gabion baskets, or equivalent) are considered appropriate for the envisaged cuts and fills.

From the engineering perspective, construction of walls for the above three scenarios are feasible. However, wall construction on the downslope side of the roadway is likely more challenging than on the upslope side of the roadway because of (1) potential presence of loose fill on the downslope side of the roadway, and (2) taller walls on the downslope slope side of the roadway due to steeper slope. Taller walls will also make it more difficult to accommodate the existing driveways that would cross path with the sidewalk.

TRAIL ALONG UPSLOPE SIDE OF ROADWAY

We understand that a separate pedestrian trial option is also being considered along the upslope side of the roadway. The trail will be located approximately 10 feet from the roadway shoulder.

In our opinion, the trail is feasible from a geotechnical standpoint. The trail may be constructed with balanced cut and fill method. However, short retaining walls may be needed at localized areas if space is not available for sloped cuts and fills on the both sides of the trail.

BOARDWALK

An elevated boardwalk is also being considered as an option. A boardwalk is feasible from a geotechnical engineering standpoint. However, it should be noted that it may be very challenging and difficult to accommodate the existing and future driveways that would cross the boardwalk, and may even be cost-prohibitive.

In our opinion, the boardwalk may be supported on shallow foundations. Foundation cost may likely be higher for the boardwalk constructed on the downslope side of the roadway than on the upper slope side of the roadway, due to potential presence of fill on the west side of the roadway. Foundation soil over-excavation and backfilling with structural fill may be needed for the boardwalk located in the flat areas in the vicinity of the ferry terminal. In addition, if an elevated boardwalk is planned between the roadway and shoreline, east of the terminal, a deep foundation system, such as driven pin piles, may be needed to support the boardwalk.

GENERAL EARTHWORK

Earthwork for the proposed pedestrian improvements will include removing surface vegetation, excavating to the design grade, and preparing subgrade. For planning purposes, temporary excavations may be sloped 1H:1V or flatter.

Structural fill will likely be needed for the project. Structural fill should consist of WSDOT Gravel Borrow (WSDOT 9-03.14(1)) or approved equivalent. The leveling course material should consist of WSDOT CSBC (crushed surfacing base course, WSDOT 9-03.9(3)). The Gravel Borrow and CSBC should be compacted to at least 95 percent maximum density, determined using ASTM D 1557 (Modified Proctor).

CLOSURE

We trust that this letter meets your needs at this time. Should you have any questions regarding this letter, please call (206) 262-0370.

Sincerely,

DRAFT *DRAFT*

H. Michael Xue, P.E.
Senior Geotechnical Engineer

Siew L. Tan, P.E.
Principal Geotechnical Engineer

Attachment:

Figure 1 – Vicinity Map

Figure 2 – Site and Alignment Map

Figure 3 – Geology Map

Appendix A - Previous Summary Boring Log

REFERENCES

Lapen, Thomas J., 2000. *Geologic Map of the Bellingham 1:100,000 Quadrangle, Washington, Washington State Department of Natural Resources.*

Material Testing and Consulting, 2012, *Summary Log of Boring B-5, Haxton Way Signs project* (provided by Whatcom County Public Works Department).

WSDOT, 2012. *Standard Specifications for Road, Bridges, and Municipal Construction*.

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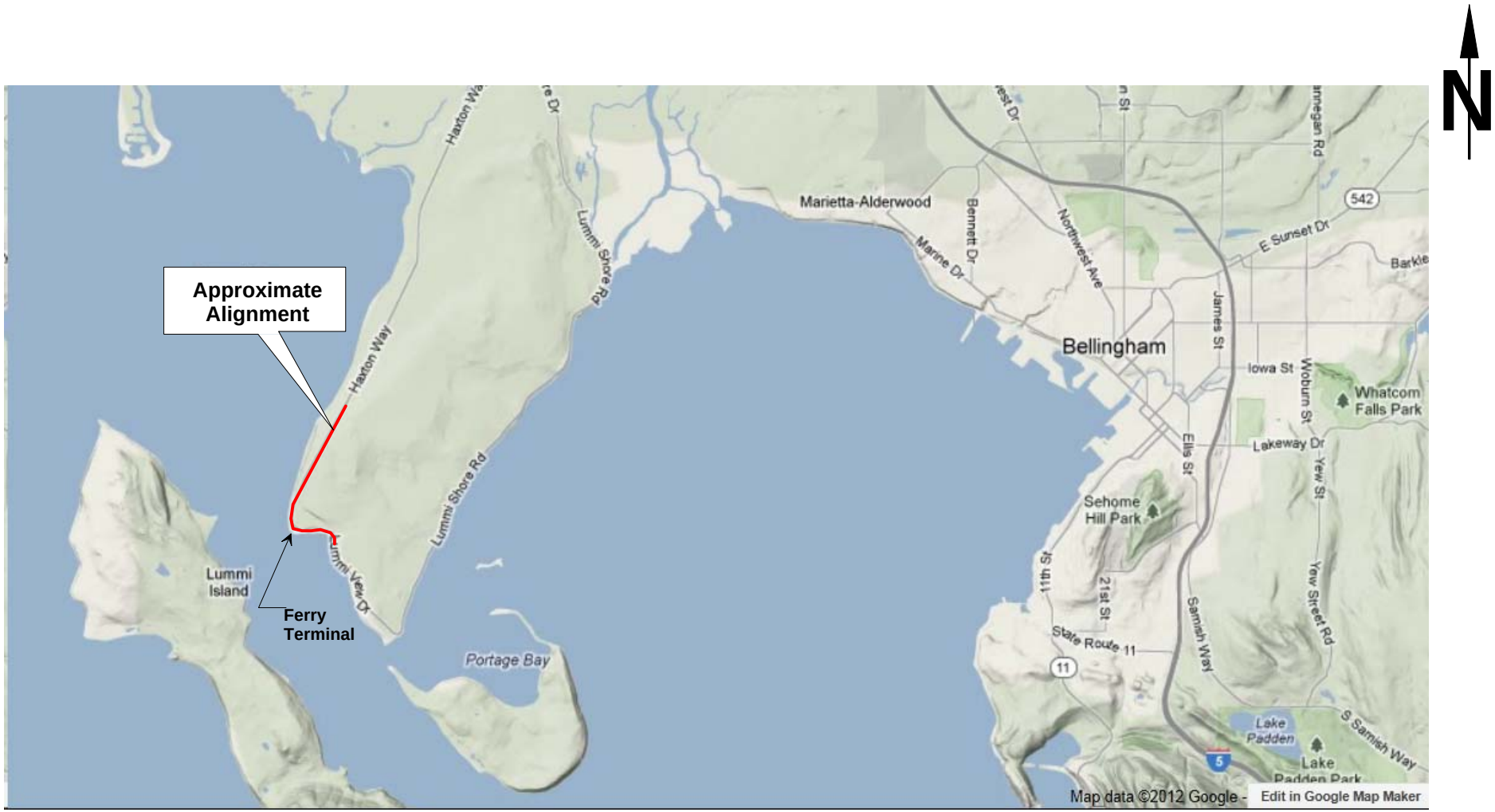

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VICINITY MAP

Project No.	Figure No.
12-100	1

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SITE ALIGNMENT MAP

Project No.	Figure No.
12-100	2

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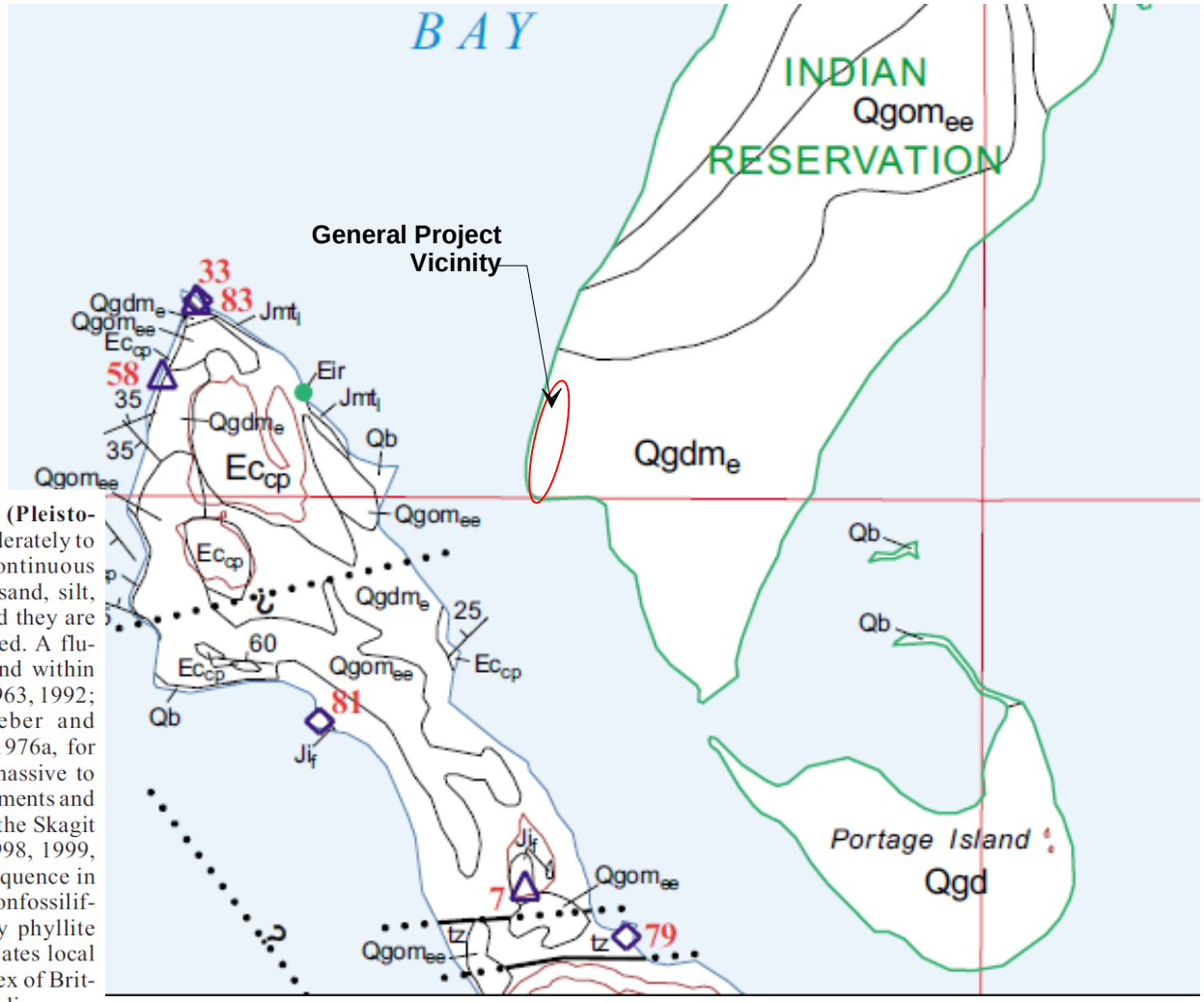

Qgdm$_e$ **Glaciomarine drift, Everson Interstade (Pleistocene)**—Moderately to poorly indurated, moderately to unsorted diamicton with lenses and discontinuous beds of moderately to well-sorted gravel, sand, silt, and clay. Dropstone content is variable, and they are commonly polished, striated, and (or) faceted. A fluvial interbed occurs in the Deming area and within bluffs near Bellingham Bay (Easterbrook, 1963, 1992; Easterbrook, oral commun., 2000; Weber and Kovanen, 2000). (See Easterbrook, 1963, 1976a, for details on the Deming Sand.) Bedding is massive to poorly stratified (planar beds) in marine sediments and locally cross-bedded in sandy interbeds. In the Skagit River valley area, Dragovich and others (1998, 1999, 2000) observed an overall upward-fining sequence in glaciomarine drift. The unit varies from nonfossiliferous to highly fossiliferous and is locally phyllite and vein-quartz rich. Provenance data indicates local sources as well as the Coast Plutonic Complex of British Columbia. Color is gray to blue-gray to olive-gray to brown, depending upon oxidation state. Thickness ranges from a few meters to as much as 90 m.

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GEOLOGY MAP

Project No.	Figure No.
12-100	3

APPENDIX A

PREVIOUS SUMMARY BORING LOG

Materials Testing and Consulting, Inc. 2126 E. Bakerview Road Bellingham, Washington 98226	Log of Boring B- 5 (Page 1 of 1)
Haxton Way Signs Project No.: 10W033-14 Geotechnical Site Investigation Bellingham, WA	Date Started : 06/04/12 Date Completed : 06/04/12 Sampling Method : Standard Penetration Split Spoon Location : 620 Feet North of Smokehouse Road, 8 Feet from West Shoulder Logged By : Meghan Hallam

Depth in Feet	USCS	GRAPHIC	DESCRIPTION	Samples	Inches Recovered	Percent Moisture	% Finer # 200 Sieve	Blow Count	Blow Count Graph (0 20 40 60 80)
0	SM		SILTY SAND with gravel and organics, loose, moist. BROWN						
	ML		SILT with sand and some gravel, orange mottling throughout, loose, moist. BROWN					10	
5									
	SP		SAND with gravel and some silt, orange mottling observed from 9.2' BPG to depth explored, very dense, moist. BROWN 0.2' thick layer of SILTY SAND with organics at 9.0' BPG.					56	
10								67	
15			T.D. 14.0' Boring terminated at requested depth of 14.0' BPG.						

06-19-2012 F:\GEOTECH PROJECTS\2012\Haxton Way Signs\Boring Logs\Haxton Way B-5.bor