Attachment G

STRATUM GROUP
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April 12, 2024

Jeffrey Brubaker
Jbrubaker1966@gmail.com

Re: **Coal Mine Hazard and Subsidence Assessment**
Whatcom County Parcel 380224021143
2609 Patton St, Bellingham, WA 98225

Dear Jeffrey Brubaker:

This geologic hazard assessment was conducted to evaluate the risk of coal mine subsidence to the subject property and vicinity. It is our understanding that you are planning to construct an accessory dwelling unit as a second floor above an existing garage on the site. The subject property is mapped as an area with "moderate potential for subsidence" on the City of Bellingham City IQ Coal Mine Hazard Map. Furthermore, the subject property is underlain by historic coal mine workings according to maps produced by Tetra Tech (1984), and therefore meets the criteria for a potential coal mine hazard area per Bellingham Municipal Code 16.55.420D "Mine Hazard Areas".

However, it is our opinion that the probability of surface subsidence at the subject property is so low as to be negligible and does not warrant mitigation measures. Furthermore, the proposed development will not increase the risk of geologic hazards on or off site.

Our determination was based on the following factors:

1) There are no indicators of historic, recent or ongoing subsidence within 0.85 miles of the subject property.
2) The underlying mine workings are very deep; approximately 875 feet below the surface according to a report by Tetra Tech (1984).
3) The subject property is not located near the subcrop where sediments overlying mine workings could flow or be piped into subsurface void spaces.
4) The subject property is not located in the vicinity of any documented mine entrances or ventilation shafts.

This geologic hazard assessment included a review of subsurface mapping and subsidence reports by Tetra Tech (1984), review of airborne lidar imagery, review of aerial photography, a

site visit to observe surface conditions on the site and in the vicinity and our experience and research on mining subsidence.

UNDERLYING GEOLOGY AND COAL MINE WORKINGS

According to the Geologic Map of the Bellingham 1:100,000 Quadrangle, Washington (Lapen, 2000), the subject property is underlain by glacial outwash from the Sumas Stade of the Fraser Glaciation. Our site observations are not entirely consistent with the mapping. We observed medium stiff silt and fine sand with scattered pebbles and cobbles consistent with Sumas marine deltaic outwash.

Based on geologic mapping and other investigations we have conducted in the area, the Sumas glacial outwash is likely underlain by glaciomarine drift (Bellingham Drift). An interval of outwash sand (Deming Sand) has been recognized below the glaciomarine unit and another glacial marine drift (Kulshan Glaciomarine Drift) below the outwash with glacial till below the glaciomarine units (Easterbrook, 1976). These units have been recognized in numerous subsurface investigations in Bellingham where the depth to bedrock is deep.

Much of what is known about abandoned coal mines in Bellingham comes from a 1984 report by Tetra Tech for the United States Department of the Interior Office of Surface Mining. The report includes subsurface mapping from historical records and identification of possible coal mine hazard areas. The report also used geologic mapping and nearby boreholes to determine the depth to bedrock, orientation of the mined coal seam, location of the subcrop, and composition of surficial deposits.

According to Tetra Tech (1984), the subject project is underlain by the mine workings of the Bellingham #1 Mine at a depth of approximately 875 feet below the surface (Figure 1). The Bellingham #1 Coal Mine follows the geologic structure of a coal bed in the Eocene Chuckanut Formation. The bed is approximately 14 to 17 feet thick striking roughly to the southeast and dipping 8-10 degrees to the southwest. The tilted coal bed intersects the overlying surficial deposits (glacial deposits; Lapen, 2000) at depths between 150 and 300 feet, in a zone known as the subcrop.

The subcrop zone general follows the strike of the coal bed and trends NW-SE from the intersection of Northwest Avenue and McLeod in the northwest to the intersection of Meridian Street and Illinois Street in the southeast. According to the subsurface map produced by Tetra Tech (1984), the closest subcrop zone is located approximately 0.85 miles to the northeast of the subject property at its closest point (Figure 2).

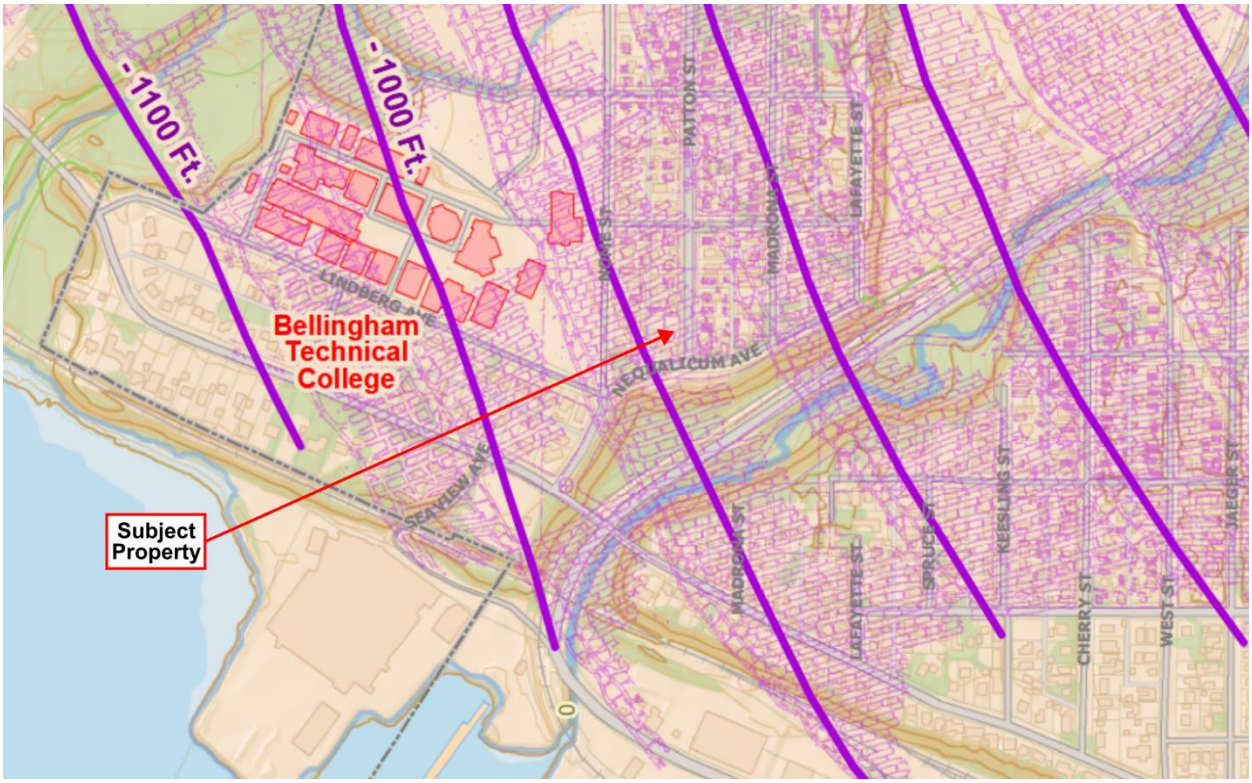

Figure 1. Annotated map of Bellingham #1 coal mine workings modified from Tetra Tech (1984). Bold dark purple lines represent 100-foot structure contours for the coal bed.

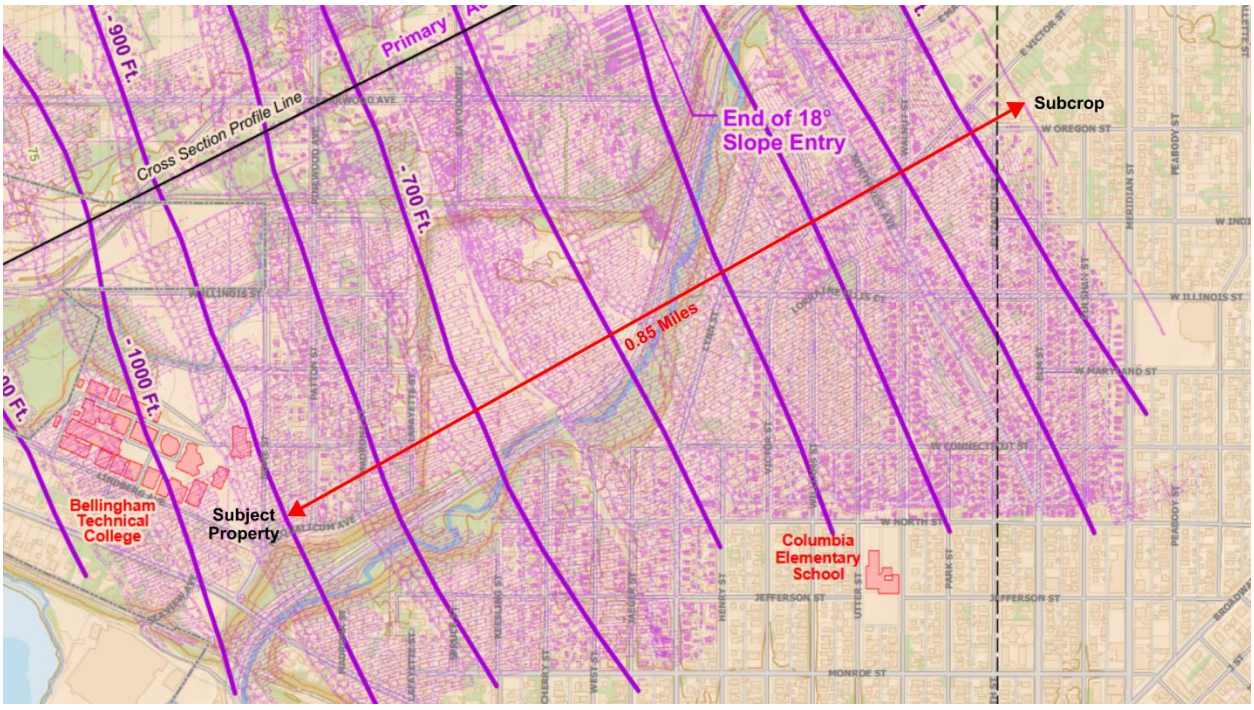

Figure 2. Annotated map of Bellingham #1 coal mine workings modified from Tetra Tech (1984). Bold dark purple lines represent 100-foot structure contours for the coal bed.

COAL MINE SUBSIDENCE HAZARD EVALUATION

In order to evaluate the risk of coal mine hazards to the subject property, we reviewed available records for any indication of historic, recent, or ongoing subsidence in the vicinity of the subject property. According the Tetra Tech (1984) report, the closest known subsidence occurred near the intersection of Maplewood Avenue and Walnut Street, approximately 0.65 miles away. Here, subsidence affected a 320 ft x 325 ft area in the early 1930s, causing significant damage to five homes.

The authors (Tetra Tech, 1984) speculated that the subsidence at this location and others was caused by flowage and piping of overlying sediments into coal mine rooms in the vicinity of the subcrop. Based on relationship between subcrop location and subsidence occurrence, they designated all areas overlying mine workings in the vicinity of the subcrop as at risk of flowage and consequent surface subsidence. Although the subject property overlies known mine workings, it is not in close proximity to the subcrop and therefore is not at risk of this type of subsidence.

In addition to flowage and piping near the subcrop, Tetra Tech (1984) believed that sediment flowage could occur if mine ceilings collapsed beneath the surficial deposits causing them to fill in the underlying void space. However, the mine workings are located 875 feet below the subject property. Therefore, any subsidence on the surface would be negligible because subsidence due to mine ceiling collapse would produce a cone of influence on the overlying sediments and distribute the subsidence over a large area on the surface. Even if a mine ceiling collapsed directly below the subject property, surface subsidence would be extremely minor and would be spread over a large area.

Tetra Tech (1984) also referenced reports from the 1930s that hypothesized that piping was caused by fluctuating groundwater levels and pressure gradients that cause piping of sediments into open mine rooms or ventilation shafts. The mine workings below the site are at a depth of 875 feet which is perpetually below the water table and therefore not subject to this type of piping.

It is not possible to completely rule out piping into an unknown ventilation shaft that is not apparent at the surface or mapped. Therefore, we must partially rely on surficial evidence and records of previous subsidence. Our review of lidar and field observations revealed no indicators of previous, recent, or ongoing subsidence at the subject property or in the vicinity. We are also not aware of any recent subsidence issues related to the Bellingham #1 Coal Mine.

Although we cannot completely rule out the possibility of subsidence related to sediment piping or flowage into an unknown ventilation shaft, it is our professional opinion that the risk of surface subsidence at the subject property is so low as to be negligible and does not warrant mitigation. Furthermore, the proposed construction will not increase the risk of surface subsidence on or off site.

BELLINGHAM MINE HAZARD AREA CODE REQUIREMENTS

In this section, we address all code language that pertains to mine hazards in Bellingham to assure compliance with critical areas regulation.

16.55.420 Designation of specific hazard areas. D. Mine Hazard Areas. Mine hazard areas are those areas underlain by or affected by mine workings such as adits, gangways, tunnels, drifts, or airshafts, and those areas of probable sink holes, gas releases, or subsidence due to mine workings. Specific areas of known and suspected historical mining activity and hazards include:

> *1. Areas depicted as coal mine hazard areas within the Geologic Hazard Areas Map Folio, Bellingham, Washington, 1991. [Ord. 2016-02-005 § 28; Ord. 2010-08-050; Ord. 2008-04-037; Ord. 2005-11-092].*

Based on our review of subsurface maps produced by Tetra Tech (1984), it is our professional opinion that the subject property is underlain by known mine workings and therefore meets the criteria for a mine hazard area per BMC 16.55.420.D.

16.55.430 Additional requirements for geologically hazardous areas.

A. Prepared by a Qualified Professional. A critical areas report for a geologically hazardous area shall be prepared by a qualified professional, in accordance with BMC 16.55.510.

Geoffrey Malick is a Licensed Engineering Geologist in the State of Washington.

B. Area Addressed in Critical Area Report. The following areas shall be addressed in a critical area report for geologically hazardous areas:

> *1. The project area of the proposed activity; and*
> *2. All geologically hazardous areas within zone or distance of potential significant influence as determined by a professional engineer/geologist.*

Our discussion of the coal mine subsidence hazards in the previous sections addresses the project area. Based on our evaluation, it is our professional opinion that there are no nearby hazardous areas that could influence the subject property. The subcrop and all documented areas of subsidence are located 0.85 and 1.05 miles away respectively.

C. Geological Hazards Assessment. A critical area report for a geologically hazardous area shall contain an assessment of geological hazards including the following site- and proposal-related information at a minimum:

> *1. Site and Construction Plans. The report shall include a copy of the site plans for the proposal showing:*
>
> > *a. The type and extent of geologic hazard areas, any other critical areas, and buffers on, adjacent to, or within a zone or distance of potential significant influence as determined by a professional engineer/geologist;*

> *b. Proposed development, including the location of existing and proposed structures, fill, storage of materials, and drainage facilities, with dimensions indicating distances to the floodplain, if available;*
> *c. The topography, as determined by a professional engineer or geologist, of the project area and all hazard areas addressed in the report; and*
> *d. Clearing limits.*

Our attached site plan includes the type and extent of known geologic hazards. The property is essentially level and no significant topography exists on the property. No clearing is planned for this project.

> *Assessment of Geological Characteristics. The report shall include an assessment of the geologic characteristics of the soils, sediments, and/or rock of the project area and potentially affected adjacent properties, and a review of the site history regarding landslides, erosion, and prior grading. Soils analysis shall be accomplished in accordance with accepted classification systems in use in the region. The assessment shall include, but not be limited to:*
> *a. A description of the surface and subsurface geology, hydrology, soils, and vegetation found in the project area and in all hazard areas addressed in the report;*

The surface and subsurface geology is described in the underlying geology and coal mine workings section of this report.

> *b. A detailed overview of the field investigations, published data, and references; data and conclusions from past assessments of the site; and site-specific measurements, test, investigations, or studies that support the identification of geologically hazardous areas; and*

We did not observe any evidence of any previous, ongoing, or incipient surface subsidence on the subject property or vicinity. The only published data on coal mine subsidence hazards in Bellingham is the Tetra Tech (1984) report which we summarize in the "coal mine subsidence hazard evaluation" section of this report.

> *c. A description of the vulnerability of the site to seismic and other geologic events.*
> *i. Analysis of Proposal. The report shall contain a hazards analysis including a detailed description of the project, its relationship to the geologic hazard(s), and its potential impact upon the hazard area, the subject property, and affected adjacent properties.*
> *ii. Minimum Buffer and Building Setback. The report shall make a recommendation for the minimum no-disturbance buffer and minimum building setback from any geologic hazard based upon the geotechnical analysis.*

This geologic hazard evaluation includes a discussion of the potential for subsidence due to underlying coal mine working and the site's close proximity to the coal mine subcrop. Setbacks are not applicable for coal mine hazards of this type because if subsidence were to take place, it

will likely not substantially impact the property or would be associated with an unidentified ventilation shaft.

> d. *Incorporation of Previous Study. Where a valid critical areas report has been prepared, and where the proposed land use activity and surrounding site conditions are unchanged, said report may be incorporated into the required critical area report, if deemed still valid and appropriate by a professional engineer or geologist. The applicant shall submit a hazards assessment detailing any changed environmental conditions associated with the site based on best professional judgment of the engineer/geologist.*

There are no previous reports or studies for this property.

> *e. Mitigation of Long-Term Impacts. When hazard mitigation is required, the mitigation plan shall specifically address how the activity maintains or reduces the preexisting level of risk to the site and adjacent properties on a long-term basis (equal to or exceeding the projected life span of the activity or occupation). Proposed mitigation techniques shall be considered to provide long-term hazard reduction only if they do not require regular maintenance or other actions to maintain their function. Mitigation may also be required to avoid any increase in risk above the preexisting conditions following abandonment of the activity. [Ord. 2005-11-092].*

No mitigation is required for this site due to the very low risk for subsidence.

16.55.440 Additional technical information requirements for specific hazards
C. Mine Hazard Areas. In addition to the basic report requirements, a critical area report for a mine hazard critical area shall also meet the following requirements:

> *1. Site Plan. The site plan shall delineate the following found within a zone or distance of potential significant influence as determined by a professional engineer/geologist:*
> *a. The existence of mines, including all significant mine features, such as mine entries, portals, adits, mine shafts, air shafts, and timber shafts;*
> *b. The location of any nearby mines that may impact or be affected by the proposed activities;*
> *c. The location of any known sinkholes, significant surface depressions, trough subsidence features, coal mine spoil piles, and other mine-related surface features; and*
> *d. The location of any prior site improvements that have been carried out to mitigate abandoned coal mine features.*

Our attached site plan includes all of the above requirements that are relevant to the subject property.

> *2. Hazards Analysis. The hazards analysis shall include a discussion of the potential for subsidence on the site and classify all mine hazards areas within a zone or distance of potential significant influence as determined by a professional engineer/geologist, as either low, moderate, or severe. The hazards analysis shall include a mitigation plan containing recommendations for mitigation of the potential for future trough subsidence, as appropriate, for the specific proposed alteration and recommendations for additional study, reports, and development standards if warranted.*

Our discussion in the "coal mine subsidence hazard section of this report" includes classification of all known coal mine hazards affecting the subject property including the horizontal and vertical distances to known coal mine rooms as well as the estimated subcrop zone location. No mitigation plan is included because of the very low potential for subsidence at the subject property.

16.55.450 Performance standards-General requirements
A. Alterations of geologically hazardous areas or associated buffers may only occur for activities that:

> *1. Will not increase the threat of the geological hazard to adjacent properties beyond predevelopment conditions;*

The proposed ADU above the existing garage will not increase the threat or risk of geological hazards on or offsite.

> *2. Will not adversely impact other critical areas;*

The proposed ADU above the garage will not adversely impact any other critical area.

> *3. Are designed so that the hazard to the project is eliminated or mitigated to a level equal to or less than predevelopment conditions; and*
> *4. Are certified as safe as designed and under anticipated conditions by a qualified engineer or geologist, licensed in the state of Washington.*

No mitigation or specific designs are required due to the low potential for subsidence.

B. Essential public facilities shall not be sited within geologically hazardous areas unless there is no other practical alternative. [Ord. 2005-11-092].

The project involves construction of an ADU as a second floor above an existing garage.

16.55.460. Performance standards-specific hazards
C. Mine Hazard Areas. Activities proposed to be located in mine hazard areas shall meet the standards of Performance standards – General requirements (BMC 16.55.450) and the specific following requirements:

> *1. Alterations. Alterations of a mine hazard area and/or buffer are allowed, as follows:*

a. All alterations are permitted within a mine hazard area with a low potential for subsidence.
b. Within a mine hazard area with a moderate potential for subsidence and at coal mine byproduct stockpiles, all alterations are permitted subject to a mitigation plan to minimize risk of structural damage using appropriate criteria to evaluate the proposed use, as recommended in the hazard analysis.
c. Within a mine hazard area with a severe potential for subsidence, no structural activities shall be permitted without an effective settlement mitigation strategy.

It is our professional opinion that there is a very low potential for subsidence at the subject property. Therefore, all proposed alterations are permitted in accordance with BMC 16.55.460.C.

2. Subdivisions. The division of land in mine hazard areas and associated buffers is subject to the following:
a. Land that is located within 200 feet of a mine hazard area with a severe potential for subsidence may not be subdivided. Land that is located partially within a mine hazard area may be divided; provided, that each resulting lot has sufficient buildable area that is 200 feet away from the mine hazard area with a severe potential for subsidence. Land that is located within a mine hazard area with a low or moderate potential for subsidence may be subdivided.
b. Access roads and utilities may be permitted within 200 feet of a mine hazard area with a moderate or severe potential for subsidence if the city determines that no other feasible alternative exists.

No subdivision is proposed for the subject property.

3. Reclamation Activities. For all reclamation activities, including grading, filling, and stockpile removal, as-built drawings shall be submitted to the city in a format specified by the director. [Ord. 2016-02-005 § 30; Ord. 2010-08-050; Ord. 2005-11-092].

No reclamation activities are needed or proposed on the subject property.

CONCLUSIONS

Based on our investigation of possible coal mine hazards on the subject property, it is our professional opinion that the risk of subsidence is so low as to be negligible. Because of the very low risk, no mitigation plans or efforts are required for this project.

Stratum Group appreciates the opportunity to be of service to you. Should you have any questions regarding this report please contact our office at (360) 714-9409.

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Sincerely yours,

Stratum Group

Geoff Malick, L.E.G., M.Sc.
Licensed Engineering Geologist

State of Washington
Engineering Geologist
20120197
Licensed Geologist
Geoffrey Malick

Site plan showing the subject property and the distance to the nearest known zone of historic subsidence and the closest location underlain by the subcrop.

Statement of Limitation and Indemnity

This document has been prepared by Stratum Group for the exclusive use and benefit of the client. No other party is entitled to rely on any of the conclusions, data, opinions, or any other information contained in this document. This document represents Stratum Group's best professional judgment based on the information available at the time of its completion and as appropriate for the project scope of work. It is not possible to fully anticipate all future risks or future site evolution. Services performed in developing the content of this document have been conducted in a manner consistent with that level and skill ordinarily exercised by members of the geology profession currently practicing under similar conditions.

The client shall understand that the subject property includes geologic hazard areas, and the client has elected to develop and/or reside at this location. The client shall accept that there are inherent risks associated with geologic hazard areas and assume sole responsibility for its future consequences, both as detailed herein and unknown. The client shall accept that is not possible to entirely eliminate all risk associated with geologic hazards. Stratum Group Inc, its staff and owners, shall be indemnified and held harmless from the consequences of development and residence at the subject property. Furthermore, no warranty, expressed or implied, is made.