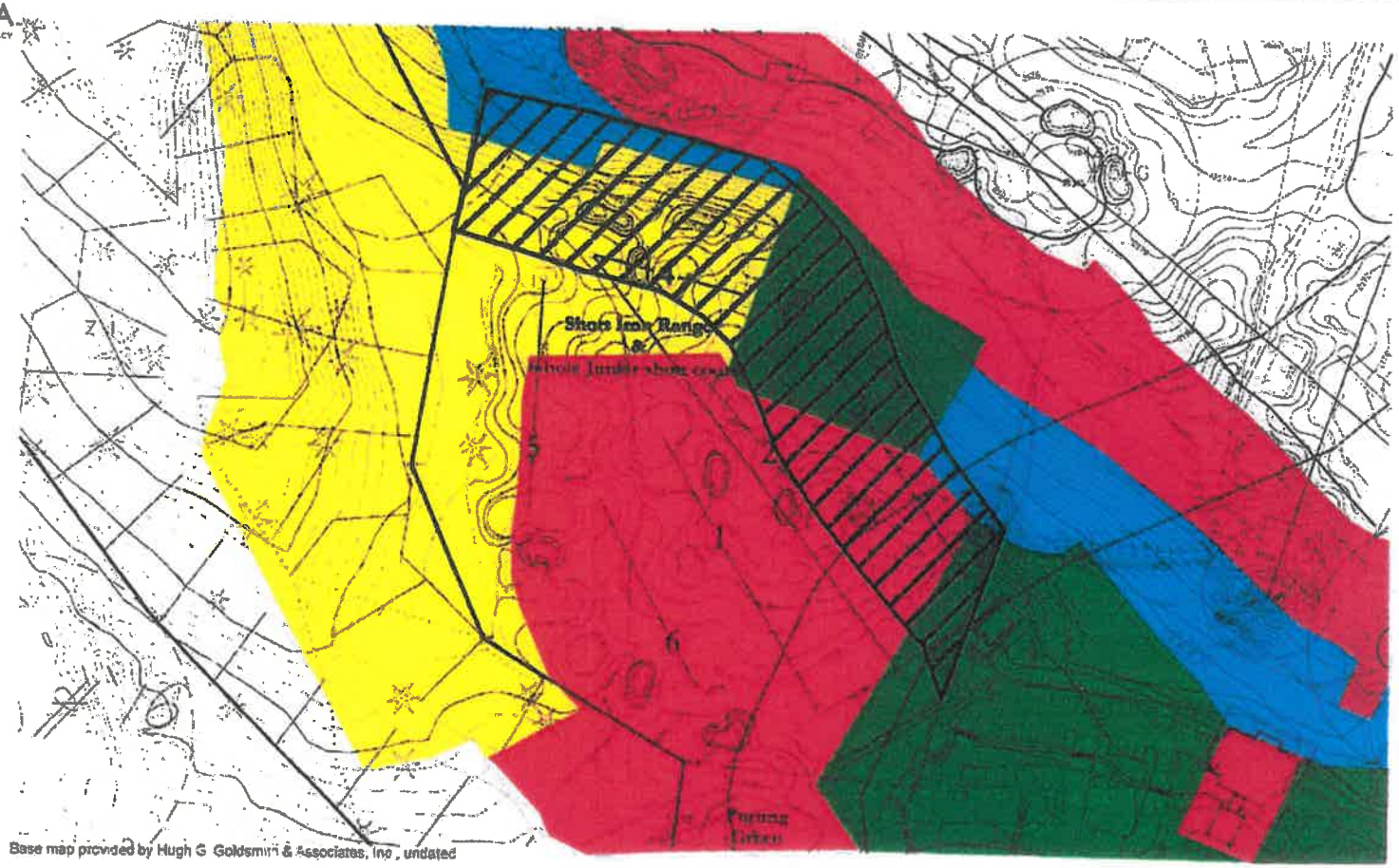
ICE File No. 0523-027 (Suncadia Phase 1, Short Iron Range Area)

BRB:01/12/07

SUNCADIA
RESORT · COMMUNITY · LEGACY



Explanation

High Risk Sinkhole Hazard Area - Underground mines are less than 50 feet below the ground surface. No buildings, roads or utilities unless underground mines are fully collapsed or are reclaimed by backfilling.

Declassified Coal Mine Area - No underground mines present. Unrestricted use of land for buildings, roads and utilities with regard to coal mine hazards.

Moderate Risk Sinkhole Hazard Area - Underground mines are 50 to 100 feet below the ground surface. No buildings unless underground mines are fully collapsed or are reclaimed by backfilling. Roads and utilities allowed provided that subsurface exploration is conducted to evaluate the strength of the overburden and develop mitigation, if appropriate.

Declassified Coal Mine Area with Mitigation - Buildings, roads and utilities are allowed. Mitigation for buildings should include the use of rigid foundations (conventional reinforced concrete spread footings) supporting a flexible superstructure (metal or wood-frame) and structurally reinforced slab-on-grade. No masonry-type construction other than fireplaces.

Proposed Rope Rider Ridge Residential Development Area

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Coal Mine Hazards Map - Figure 8

APPENDIX A

GROUND PROOFING PROGRAM

APPENDIX A
GROUND PROOFING PROGRAM

Subsurface conditions within the proposed Rope Rider Ridge residential development area were explored by drilling six test borings (Borings B-24 through B-29) to depths ranging from 56 to 99 feet between September 19 and 22, 2006 using truck-mounted air-rotary drilling equipment owned and operated by Holt Drilling, Inc. of Puyallup, Washington. These explorations were supplemented by borings completed for previous projects including Borings B-7 through B-9 in 2000, Borings B-12 through B-15 in 2004, and Borings B-18 through B-23 in September 2006. Borings B-12 and B-13 were drilled using track-mounted, mud-rotary drilling equipment. The remaining explorations were drilled using truck-mounted air-rotary drilling equipment.

The test borings for the current study were located by field measuring from survey points established for this study by Hugh G. Goldsmith & Associates, Inc. The locations of the test borings, including those from previous studies, are shown on the Abandoned Underground Coal Mine Map, Figure 6.

The test borings were continuously monitored by an engineering geologist from ICE who classified the soils or bedrock encountered, obtained representative soil and bedrock samples (when practical), observed ground water conditions (when possible) and prepared a detailed log of each exploration.

Representative samples were obtained at 5-foot depth intervals by screening drill cutting samples from the casing discharge. The drilling resistance was monitored to evaluate for the presence of voids that would indicate open mine workings. Drilling fluid circulation was also monitored as a loss of circulation may indicate voids in the bedrock.

Soils encountered in the test borings were visually classified in general accordance with the classification system described in Figure A-1. Bedrock was classified using standard geological methods. The test boring logs for the previous and current studies are presented in Figures A-2 through A-20.

The test boring logs are based on our interpretation of the field data and indicate the various types of soil and bedrock encountered. They also indicate the depths at which these soil and rock types or their characteristics change, although the change might actually be gradual. If the change occurred between samples in the test borings, it was interpreted.

Ground water conditions were observed when using air-rotary drilling methods. Ground water conditions were not evaluated when using mud-rotary drilling methods because of drilling fluids introduced into the test borings to convey drill cuttings.

Unified Soil Classification System

MAJOR DIVISIONS			Soil Classification and Generalized Group Description	
Coarse-Grained Soils	GRAVEL More than 50% of coarse fraction retained on the No. 4 sieve	CLEAN GRAVEL	GW	Well-graded gravels
			GP	Poorly-graded gravels
		GRAVEL WITH FINES	GM	Gravel and silt mixtures
			GC	Gravel and clay mixtures
	SAND More than 50% of coarse fraction passes the No. 4 sieve	CLEAN SAND	SW	Well-graded sand
			SP	Poorly-graded sand
		SAND WITH FINES	SM	Sand and silt mixtures
More than 50% retained on the No. 200 sieve			SC	Sand and clay mixtures
Fine-Grained Soils	SILT AND CLAY Liquid Limit less than 50	INORGANIC	ML	Low-plasticity silts
			CL	Low-plasticity clays
		ORGANIC	OL	Low plasicity organic silts and organic clays
	SILT AND CLAY Liquid Limit greater than 50	INORGANIC	MH	High-plasticity silts
			CH	High-plasticity clays
More than 50% passing the No. 200 sieve		ORGANIC	OH	High-plasticity organic silts and organic clays
Highly Organic Soils	Primarily organic matter with organic odor		PT	Peat

Notes: 1) Soil classification based on visual classification of soil is based on ASTM D2488-90.
2) Soil classification using laboratory tests is based on ASTM D2487-90.
3) Description of soil density or consistency is based on interpretation of blow count data and/or test data.

Soil Particle Size Definitions

Component	Size Range
Boulders	Coarser than 12 inch
Cobbles	3 inch to 12 inch
Gravel	3 inch to No. 4 (4.78 mm)
Coarse	3 inch to 3/4 inch
Fine	3/4 inch to No. 4 (4.78 mm)
Sand	No. 4 (4.78 mm) to No. 200 (0.074mm)
Coarse	No. 4 (4.78 mm) to No. 10 (2.0 mm)
Medium	No. 10 (2.0 mm) to No. 40 (0.42 mm)
Fine	No. 40 (0.42 mm) to No. 200 (0.074 mm)
Silt and Clay	Finer than No. 200 (0.074 mm)

Soil Moisture Modifiers

Soil Moisture	Description
Dry	Absence of moisture
Moist	Damp, but no visible water
Wet	Visible water

Key to Boring Log Symbols

Sampling Method	Boring Log Symbol	Description
Blows required to drive a 2.4 inch I.D. split-barrel sampler 12-inches or other indicated distance using a 300-pound hammer falling 30 inches.	34	Location of relatively undisturbed sample
	12	Location of disturbed sample
	21	Location of sample attempt with no recovery
Blows required to drive a 1.5-inch I.D. split barrel sampler (SPT - Standard Penetration Test) 12-inches or other indicated distance using a 140-pound hammer falling 30 inches.	14	Location of sample obtained in general accordance with Standard Penetration Test (ASTM D-1586) test procedures.
	30	Location of SPT sampling attempt with no recovery.
Pushed Sampler	P	Sampler pushed with the weight of the hammer or against weight of the drilling rig.
Grab Sample	G	Sample obtained from drill cuttings.

Note: The lines separating soil types on the logs represents approximate boundaries only. The actual boundaries may vary or be gradual.

Laboratory Tests

Test	Symbol
Density	DN
Grain Size	GS
Percent Fines	PF
Atterberg Limits	AL
Hydrometer Analysis	HA
Consolidation	CN
Compaction	CP
Permeability	PM
Unconfined Compression	UC
Unconsolidated Undrained TX	UU
Consolidated Undrained TX	CU
Consolidated Drained TX	CD
Chemical Analysis	CA

Boring B-7

BRB:10/23/06

Approximate Ground Surface Elevation: 2,242 feet

Logged by: KSK

Project Name: Suncadia Phase 1, Short Iron Range

ICE Project No. 0523-0275

Depth in Feet	Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
0	Brown fine to medium SAND with silt and fine gravel (outwash)		SP-SM				0
5							5
	Brown silty fine to medium SAND with occasional gravel (outwash)		SM				
10							10
	Brown silty fine to medium SAND (outwash)		SM			Soil grades to wet, but not saturated, at 13 feet	
15			SM				15
20			SM				20
	Brown silty fine SAND (outwash)		SM				
25							25
	Gray SILTSTONE (Roslyn formation)		Rock		Bedrock encountered at 27 feet	Becomes moist at 27 feet	
30							30
35			Rock				35
40			Rock				40
45			Rock				45
50			Rock				50

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Boring Log - Figure A-2

Boring B-7

BRB:10/23/06

Logged by: KSK

Project Name: Suncadia Phase I, Short Iron Range

ICE Project No. 0523-027

Depth in Feet	Soil/Rock Profile: Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
50	Gray SILTSTONE (Roslyn formation)		Rock				50
55			Rock				55
60			Rock				60
65			Rock				65
70			Rock				70
75	Brown SILTSTONE (Roslyn formation)		Rock				75
80	Brown SHALE (Roslyn formation)		Rock				80
85	Dark brown carbonaceous SHALE (Roslyn formation)		Rock		Top of BIG SEAM at 82.5 feet		85
90			Rock				90
95			Rock				95
100	Dark brown carbonaceous SHALE with thin layers of coal (Roslyn formation)		Rock				100

BRB:10/23/06

Boring B-7

Logged by: KSK

Project Name: Suncadia Phase 1, Short Iron Range

ICE Project No. 0523-027

Depth in Feet	Soil/Rock Profile: Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
100	Dark brown carbonaceous SHALE with thin layers of coal (Roslyn formation)		Rock		NO. 9 MINE (fully collapsed at 101 feet)		100
	Light gray SANDSTONE (Roslyn formation)						
105			Rock				105
	Boring completed at 105 feet on October 20, 2000						
110							110
115							115
120							120
125							125
130							130
135							135
140							140
145							145
150							150

Boring B-8

BRB:10/23/06

Approximate Ground Surface Elevation: 2,242 feet

Logged by: KSK

Project Name: Suncadia Phase 1, Short Iron Range

ICE Project No. 0523-027

Depth in Feet	Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
0	Brown silty fine sand (outwash)						0
5			SM				5
	Brown silty fine to medium sand with gravel (outwash)						
10			SM				10
	Brown fine to medium sand with silt and gravel (outwash)						
15			SP-SM				15
	Brown fine to coarse GRAVEL with sand and a trace of silt (outwash)						
20			GP/GW				20
	Brown fine to coarse GRAVEL with silt and sand (outwash)					Soil grades to wet, but not saturated, at 22 feet	
25			GP-GM				25
30			GP-GM				30
35			GP-GM				35
40			GP-GM				40
45	Gray SILTSTONE (Roslyn formation)		Rock		Bedrock encountered at 44 feet	Becomes moist at 44 feet	45
50			Rock				50

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Boring Log - Figure A-3

Boring B-8

BRB:10/23/06

Logged by: KSK

Project Name: Suncadia Phase 1, Short Iron Range

ICE Project No. 0523-027

Depth in Feet	Soil/Rock Profile: Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
50	Gray SILTSTONE (Roslyn formation)		Rock				50
	Brown SILTSTONE (Roslyn formation)						
55			Rock				55
60	Brown SHALE (Roslyn formation)		Rock				60
65			Rock				65
	Dark brown carbonaceous SHALE (Roslyn formation)				Top of BIG SEAM at 67.5 feet		
70			Rock				70
75			Rock				75
	Dark brown carbonaceous SHALE with thin layers of coal (Roslyn formation)		Rock				
80	Black COAL (Roslyn formation)						80
	Dark brown carbonaceous SHALE with thin layers of coal (Roslyn formation)						
85			Rock		NO. 9 MINE (fully collapsed at 86 feet)		85
	Light gray fine-grained SANDSTONE (Roslyn formation)						
90			Rock				90
	Boring completed at 90 feet on October 20, 2000						
95							95
100							100

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Boring Log - Figure A-3

Boring B-9

BRB:10/23/06

Approximate Ground Surface Elevation: 2,186 feet

Logged by: KSK

Project Name: Suncadia Phase 1, Short Iron Range

ICE Project No. 0523-027

Depth in Feet	Soil/Rock Profile: Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
0	Brown silty fine to medium SAND with gravel (outwash)						0
5	Brown fine to coarse GRAVEL with sand and cobbles (outwash)		SM				5
10			GP/GW				10
15			GP/GW				15
20	Dark brown carbonaceous SHALE (Roslyn formation)		Rock		Bedrock encountered at 19 feet	Soil grades to wet, but not saturated, at 18 feet Becomes moist at 19 feet	20
25	Dark brown carbonaceous SHALE with thin layers of coal (Roslyn formation)		Rock		Top of BIG SEAM at 22.5 feet		25
30	Brown SHALE (Roslyn formation)		Rock				30
35	Dark brown carbonaceous SHALE (Roslyn formation)		Rock				35
40	Black COAL (Roslyn formation) Dark brown carbonaceous SHALE with thin layersof coal (Roslyn formation)		Rock				40
45	Brown SHALE (Roslyn formation)		Rock				45
50	Light gray fine-grained SANDSTONE (Roslyn formation) Boring completed at 50 feet on October 20, 2000		Rock		NO. 9 MINE (fully collapsed at 46 feet)		50

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Boring Log - Figure A-4

BRB:10/23/06

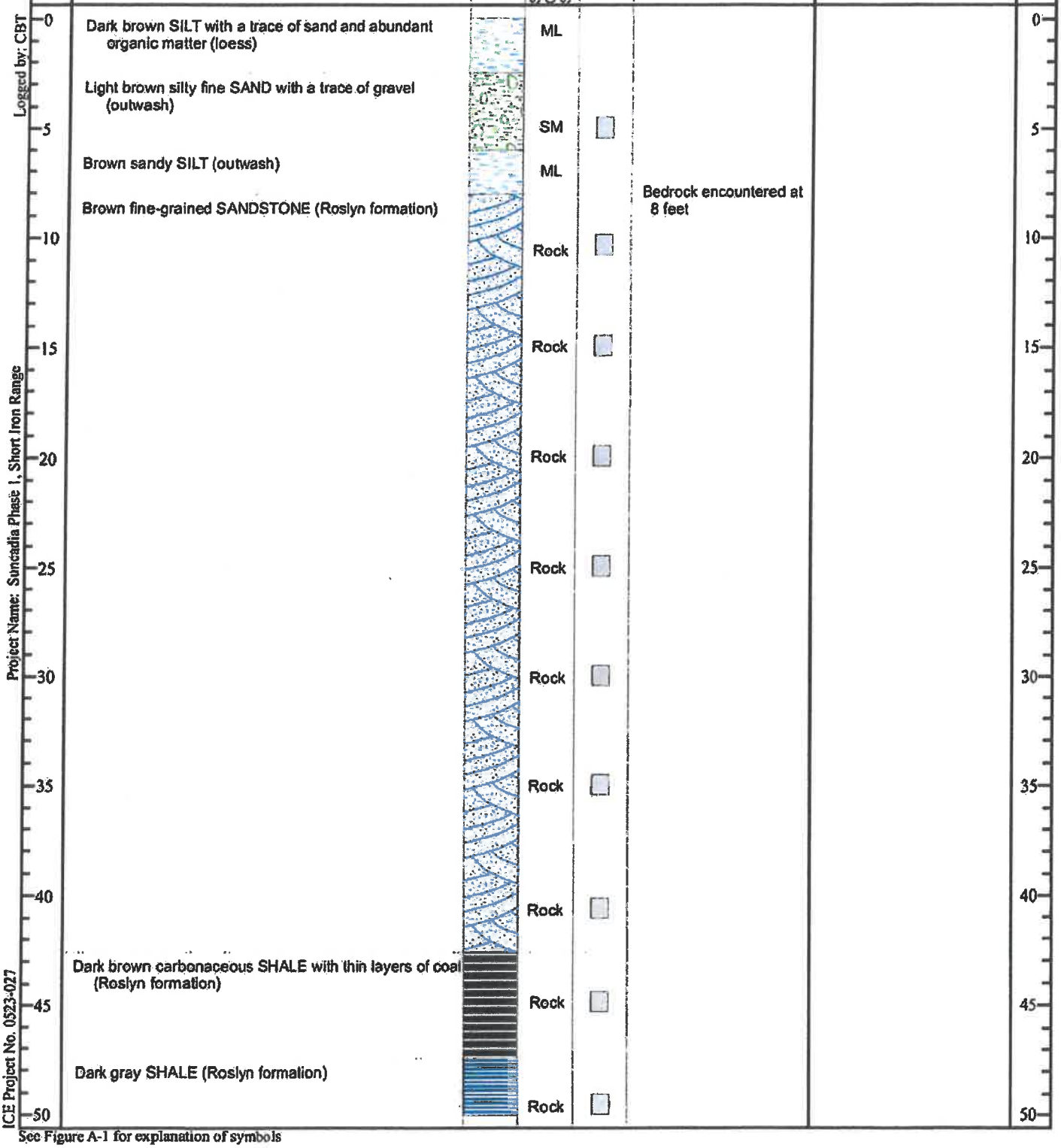
Boring B-12

Approximate Ground Surface Elevation: 2,261 feet

Logged by: CBT

Project Name: Suncadia Phase 1, Short Iron Range

ICE Project No. 0523-027



See Figure A-1 for explanation of symbols

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Boring Log - Figure A-5

Boring B-12

BRB: 10/23/06

Logged by: CBT

Project Name: Suncadia Phase 1, Short Iron Range

ICE Project No. 0523-027

Depth in Feet	Soil/Rock Profile: Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
50	Dark gray SHALE (Roslyn formation)		Rock				50
55			Rock				55
	Dark brown carbonaceous SHALE with thin layers of coal (Roslyn formation)						
60			Rock				60
	Dark gray SHALE (Roslyn formation)						
65			Rock				65
	Dark gray fine-grained SANDSTONE (Roslyn formation)						
70			Rock				70
	Dark brown carbonaceous SHALE with thin layers of coal (Roslyn formation)		Rock				
75							75
80			Rock				80
	Dark gray fine-grained SANDSTONE (Roslyn formation)						
85			Rock				85
90			Rock				90
	Dark gray SHALE (Roslyn formation)						
95			Rock				95
	Dark gray fine-grained SANDSTONE (Roslyn formation)						
100			Rock				100

See Figure A-1 for explanation of symbols

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Boring Log - Figure A-5

BRB:10/23/06

Boring B-12

Logged by: CBT

Project Name: Suncadia Phase 1, Short Iron Range

ICE Project No. 0523-027

Depth in Feet	Soil/Rock Profile: Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
100	Dark gray fine-grained SANDSTONE (Roslyn formation)		Rock				100
105			Rock				105
110			Rock				110
115			Rock				115
120			Rock				120
125			Rock				125
130			Rock				130
135			Rock				135
140			Rock				140
142	Black COAL (Roslyn formation)				Top of BIG SEAM at 142 feet		
145			Rock				145
150			Rock				150

See Figure A-1 for explanation of symbols

BRB:10/23/06

Boring B-12

Logged by: CBT

Project Name: Suncadia Phase 1, Short Iron Range

ICE Project No. 0523-027

Depth in Feet	Soil/Rock Profile: Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
150	Black COAL (Roslyn formation)		Rock		Complete loss of drilling fluid circulation at 152 feet		150
	MINE OPENING		Void		NO. 9 MINE (open from 152 - 155 feet - mined out; loose, caved rock from 155 - 157 feet)		
155	Dark brown carbonaceous SHALE and COAL (loose, caved rock)		Caved Rock		Drilling resistance indicates intact rock (not mined) at 157 feet		155
	Boring completed at 157 feet on November 8, 2004 because of loss of drilling fluid circulation						
160							160
165							165
170							170
175							175
180							180
185							185
190							190
195							195
200							200

See Figure A-1 for explanation of symbols

BRB:10/23/06

Boring B-13

Approximate Ground Surface Elevation: 2,280 feet

Logged by: CBT

Project Name: Suncadia Phase 1, Short Iron Range

ICE Project No. 0523-027

Depth in Feet	Soil/Rock Profile: Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
0	Dark brown SILT with a trace of sand and abundant organic matter		ML				0
	Light brown silty fine SAND with a trace of gravel (outwash)						
5			SM				5
	Brown fine-grained SANDSTONE (Roslyn formation)				Bedrock encountered at 7 feet		
10			Rock				10
15			Rock				15
20			Rock				20
	Gray and brown fine-grained SANDSTONE (Roslyn formation)						
25			Rock				25
	Light gray fine-grained SANDSTONE (Roslyn formation)						
30			Rock				30
35			Rock				35
	Gray fine-grained SANDSTONE (Roslyn formation)						
40			Rock				40
45			Rock				45
	Light brown, highly fractured, fine-grained SANDSTONE (Roslyn formation)				Open fractures and partial loss of drilling fluid circulation encountered from 46 to 52 feet		
50			Rock				50

See Figure A-1 for explanation of symbols

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Boring Log - Figure A-6

BRB:10/23/06

Boring B-13

Logged by: CBT

Project Name: Suncadia Phase 1, Short Iron Range

ICE Project No. 0523-027

Depth in Feet	Soil/Rock Profile: Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
50	Light brown, highly fractured, fine-grained SANDSTONE (Roslyn formation)		Rock		Open fractures and partial loss of drilling fluid circulation encountered from 46 to 52 feet		50
	Light gray fine-grained SANDSTONE (Roslyn formation)						
55			Rock				55
	Dark brown carbonaceous SHALE with thin layers of coal (Roslyn formation)						
60			Rock				60
	Dark gray SHALE (Roslyn formation)						
65			Rock				65
	Light gray fine-grained SANDSTONE (Roslyn formation)						
70			Rock				70
75			Rock				75
80			Rock				80
85			Rock				85
90			Rock				90
95			Rock				95
100			Rock				100

See Figure A-1 for explanation of symbols

BRB:10/23/06

Boring B-13

Logged by: CBT

Project Name: Suncadia Phase 1, Short Iron Range

ICE Project No. 0523-027

Depth in Feet	Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
100	Light gray fine-grained SANDSTONE (Roslyn formation) Dark gray fine-grained SANDSTONE (Roslyn formation)		Rock				100
105	Dark brown carbonaceous SHALE with thin layers of coal (Roslyn formation)		Rock				105
	Dark gray fine-grained SANDSTONE (Roslyn formation)						
110			Rock				110
115			Rock				115
120			Rock				120
125			Rock				125
130			Rock				130
135			Rock		Open fractures and partial loss of drilling fluid circulation encountered from 136 to 145 feet		135
140					No sample return at 140 feet because of complete loss of drilling fluid circulation		140
	Dark brown, highly fractured, carbonaceous SHALE with thin layers of coal				Top of BIG SEAM at 142 feet		
145			Rock		Partial drilling fluid circulation reestablished at 145 feet		145
150			Rock				150

See Figure A-1 for explanation of symbols

BRB:10/23/06

Boring B-13

Logged by: CBT

Project Name: Suncadia Phase 1, Short Iron Range

ICE Project No. 0523-027

Depth in Feet	Soil/Rock Profile: Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
150	Dark brown, highly fractured, carbonaceous SHALE with thin layers of coal (Roslyn formation)		Rock				150
155	Black, highly fractured, COAL and dark brown carbonaceous SHALE (Roslyn formation)		Caved Rock		Partial loss of drilling fluid circulation from 153.5 to 170 feet		155
160			Caved Rock				160
165	Black COAL (Roslyn formation)		Rock				165
	Light gray fine-grained SANDSTONE (Roslyn formaton)				NO. 9 MINE (fully collapsed at 167.5 feet)		
170	Boring completed at 170 feet on November 11, 2004		Rock				170
175							175
180							180
185							185
190							190
195							195
200							200

See Figure A-1 for explanation of symbols

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Boring Log - Figure A-6

Boring B-14

BRB:10/23/06

Approximate Ground Surface Elevation: 2,231 feet

Logged by: CBT

Project Name: Suncadia Phase 1, Short Iron Range

ICE Project No. 0523-005

Depth in Feet	Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
0	Brown silty fine SAND with occasional gravel (outwash)		SM				0
5	Brown silty fine to medium SAND with gravel (outwash)		SM				5
10			SM				10
	Brown SILT with a trace of sand (outwash)						
15			ML				15
	Gray SILTSTONE (Roslyn formation)				Bedrock encountered at 17 feet		
20			Rock				20
25			Rock				25
30	Brown SHALE (Roslyn formation)		Rock				30
35			Rock				35
	Dark brown carbonaceous SHALE with thin layers of coal		Rock		Top of BIG SEAM at 37 feet		
40	Black COAL		Rock				40
	Dark brown carbonaceous SHALE with thin layers of coal						
45			Rock				45
	Black COAL		Rock				
50	Dark brown carbonaceous SHALE with thin layers of coal		Rock				50

See Figure A-1 for explanation of symbols

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Boring Log - Figure A-7

BRB:10/23/06

Boring B-14

Logged by: CBT

Project Name: Suncadia Phase 1, Short Iron Range

ICE Project No. 0523-005

Depth in Feet	Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
50	Dark brown carbonaceous SHALE with thin layers of coal (Roslyn formation)		Rock				50
	Black COAL (Roslyn formation)		Rock				
55			Rock		BIG SEAM (Intact coal 52 - 58 feet - not mined)		55
	Light gray fine-grained SANDSTONE (Roslyn formation)						
60			Rock				60
65			Rock				65
70			Rock				70
75	Boring completed at 75 feet on October 20, 2004 No ground water observed at the time of drilling		Rock				75
80							80
85							85
90							90
95							95
100							100

See Figure A-1 for explanation of symbols

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Boring Log - Figure A-7

Boring B-15

BRB/CBT:10/23/06

Approximate Ground Surface Elevation: 2,233 feet

Logged by: CBT

Project Name: Suncadia Phase 1, Short Iron Range

ICE Project No. 0523-005

Depth in Feet	Soil/Rock Profile: Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
0	Dark brown SILT with a trace of sand and coal and brick fragments (mine rock fill)						0
	Gray fine to medium SAND with gravel and occasional cobbles (outwash)		SP				
5	Brown fine to medium SAND with a trace of silt and gravel (outwash)		SP				5
10			SP				10
	Light brown SILT with a trace of sand (outwash)						
15			ML				15
	Brown SILT with sand (outwash)		ML				
	Brown and gray silty fine SAND with a trace of gravel (outwash)						
20			SM				20
	Light gray SILTSTONE (Roslyn formation)				Bedrock encountered at 21 feet		
25			Rock				25
30			Rock				30
	Brown SHALE (Roslyn formation)						
35			Rock				35
	Dark brown carbonaceous SHALE with thin layers of coal (Roslyn formation)				Top of BIG SEAM at 39 feet		
40			Rock				40
45			Rock				45
50			Rock				50

See Figure A-1 for explanation of symbols

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Boring Log - Figure A-8

Boring B-15

BRB:10/23/06

Logged by: CBT

Project Name: Suncadia Phase 1, Short Iron Range

ICE Project No. 0523-005

Depth in Feet	Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
50	Dark brown carbonaceous SHALE with thin layers of coal (Roslyn formation)		Rock				50
55			Rock				55
	Black COAL (Roslyn formation)				NO. 9 MINE (intact coal from 56-63 feet - not mined)		
60			Rock				60
	Light gray fine-grained SANDSTONE (Roslyn formation)						
65			Rock				65
70			Rock				70
75			Rock				75
	Boring completed at 75 feet on October 21, 2004 No ground water observed at the time of drilling						
80							80
85							85
90							90
95							95
100							100

See Figure A-1 for explanation of symbols

BRB:20/23/06

Boring B-18

Approximate Ground Surface Elevation: 2,230 feet

Logged by: BLS

Project Name: Suncadia Phase 1, Short Iron Range

ICE File No. 0523-027

Depth in Feet	Soil/Rock Profile: Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
0	Brown silty fine to medium SAND with gravel and occasional cobbles (outwash)						0
5			SM				5
10			SM				10
15			SM			Ground water observed from 18 to 19 feet	15
20	Gray SILTSTONE (Roslyn formation)		Rock		Bedrock encountered at 19 feet		20
25			Rock				25
30			Rock				30
35			Rock				35
40			Rock				40
45			Rock				45
50			Rock				50

See Figure A-1 for explanation of symbols

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Boring Log - Figure A-9

BRB:10/23/06

Boring B-18

Logged by: BLS

Project Name: Suncadia Phase 1, Short Iron Range

ICE File No. 0523-027

Depth in Feet	Soil/Rock Profile: Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
50	Gray SILTSTONE (Roslyn formation)		Rock				50
55			Rock				55
60	Dark brown carbonaceous SHALE with thin layers of coal (Roslyn formation)		Rock		Top of BIG SEAM at 60 feet		60
65			Rock				65
70	MINE OPENING		Void		Complete loss of drilling fluid circulation at 70 feet		70
75			Void		NO. 9 MINE (open from 70-80 feet - mined out)		75
80	Boring completed at 80 feet on July 26, 2006		Void		Drilling resistance indicates intact rock (not mined) at 80 feet		80
85							85
90							90
95							95
100							100

See Figure A-1 for explanation of symbols

Icicle Creek Engineers

Boring Log - Figure A-9

BRB:10/23/06

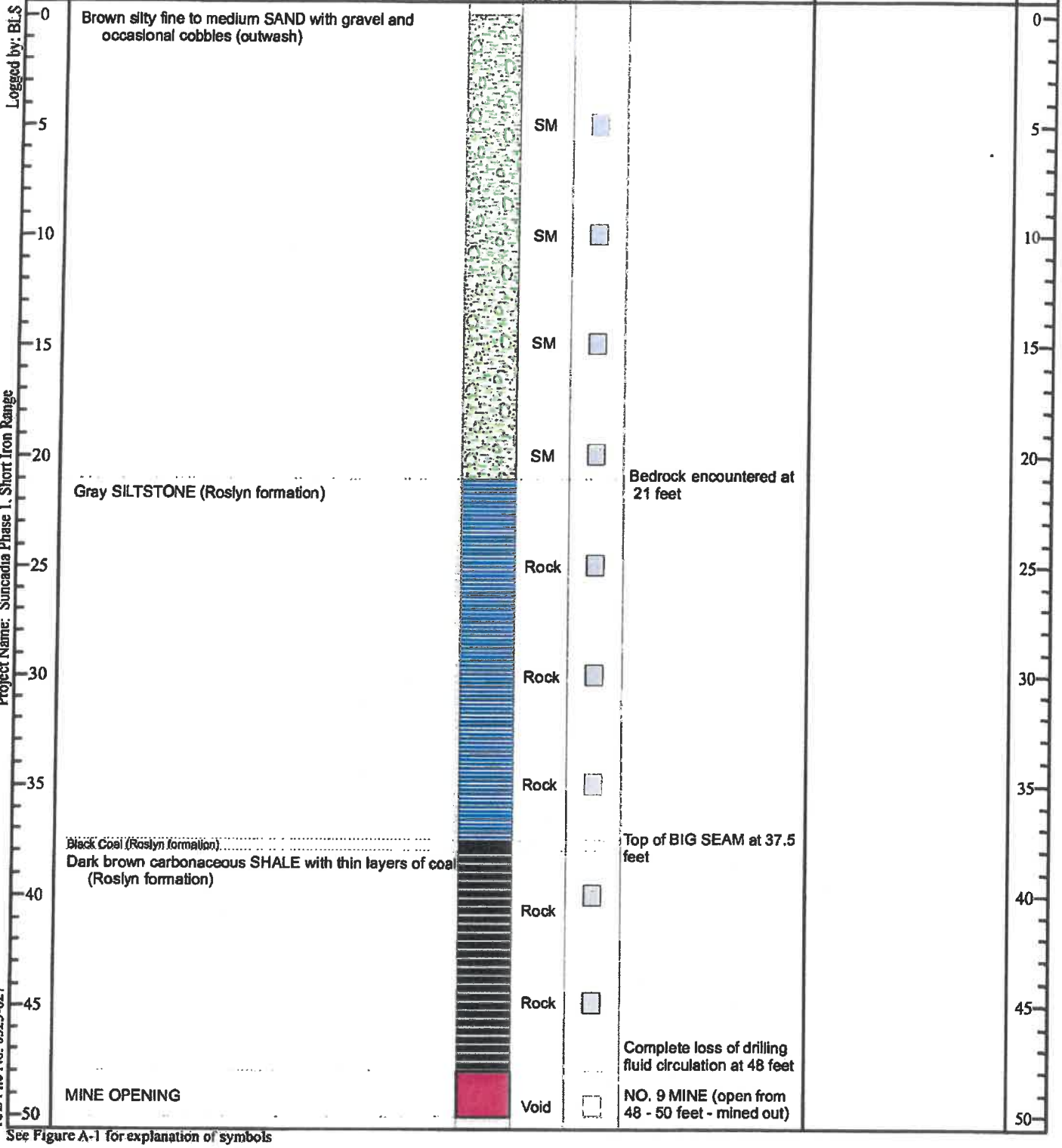
Boring B-19

Approximate Ground Surface Elevation: 2,232 feet

Logged by: BLS

Project Name: Suncadia Phase 1, Short Iron Range

ICE File No. 0523-027



See Figure A-1 for explanation of symbols

Icicle Creek Engineers

Boring Log - Figure A-10

Boring B-19

BRB:10/23/06

Logged by: BLS

Project Name: Suncadia Phase 1, Short Iron Range

ICE File No. 0523-027

Depth in Feet	Soil/Rock Profile: Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
50	Light gray fine-grained SANDSTONE? (based on drilling resistance - no sample recovery because of fluid circulation loss)		Rock		Drilling resistance indicates intact rock (not mined) at 50 feet		50
55			Rock				55
60	Boring completed at 60 feet on July 26, 2006		Rock				60
65							65
70							70
75							75
80							80
85							85
90							90
95							95
100							100

See Figure A-1 for explanation of symbols

Boring B-20

BRB:10/23/06

Approximate Ground Surface Elevation: 2,232 feet

Logged by: BLS

Project Name: Suncadia Phase 1, Short Iron Range

ICE File No. 0523-027

Depth in Feet	Soil/Rock Profile: Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
0	Brown silty fine to medium SAND with gravel and occasional cobbles (outwash)						0
5			SM				5
10			SM				10
15			SM				15
18	Gray SILTSTONE (Roslyn formation)				Bedrock encountered at 18 feet		
20			Rock				20
25			Rock				25
30			Rock				30
35			Rock				35
40			Rock				40
45			Rock				45
50			Rock				50

See Figure A-1 for explanation of symbols

Icicle Creek Engineers

Boring Log - Figure A-11

Boring B-20

BRB:10/23/06

Logged by: BLS

Project Name: Sumcadia Phase 1, Short Iron Range

ICE File No. 0523-027

Depth in Feet	Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
50	Gray SILTSTONE (Roslyn formation)		Rock				50
55			Rock				55
60			Rock				60
65			Rock				65
68	Dark brown carbonaceous SHALE with thin layers of coal (Roslyn formation)		Rock		Top of BIG SEAM at 68 feet		70
75			Rock				75
80			Rock				80
84	Light gray fine-grained SANDSTONE (Roslyn formation)		Rock		NO. 9 MINE (fully collapsed at 84 feet)		85
87	Boring completed at 87 feet on July 28, 2006						90
95							95
100							100

See Figure A-1 for explanation of symbols

Icicle Creek Engineers

Boring Log - Figure A-11

BRB:10/23/06

Boring B-21

Approximate Ground Surface Elevation: 2,237 feet

Logged by: BLS

Project Name: Suncadia Phase 1, Short Iron Range

ICE File No. 0523-027

Depth in Feet	Soil/Rock Profile: Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
0	Brown silty fine to medium SAND with gravel and occasional cobbles (outwash)						0
5			SM				5
10			SM				10
15			SM				15
20			SM				20
22.5	Gray SILTSTONE (Roslyn formation)				Bedrock encountered at 22.5 feet		
25			Rock				25
30			Rock				30
35			Rock				35
40			Rock				40
45			Rock				45
48.5	Dark brown carbonaceous SHALE with thin layers of coal (Roslyn formation)		Rock		Top of BIG SEAM at 48.5 feet		
50							50

See Figure A-1 for explanation of symbols

Boring B-21

BRB:10/23/06

Logged by: BLS

Project Name: Suncadia Phase 1, Short Iron Range

ICE File No. 0523-027

Depth in Feet	Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
50	Dark brown carbonaceous SHALE with thin layers of coal (Roslyn formation)		Rock				50
55	MINE OPENING		Rock		Complete loss of drilling fluid circulation at 55 feet		55
60			Void		NO. 9 MINE (open from 55 -66 feet - mined out)		60
65			Void		Drilling resistance indicates intact rock (not mined) at 66 feet		65
	Boring completed at 66 feet on July 27, 2006						
70							70
75							75
80							80
85							85
90							90
95							95
100							100

See Figure A-1 for explanation of symbols

BRB:10/23/06

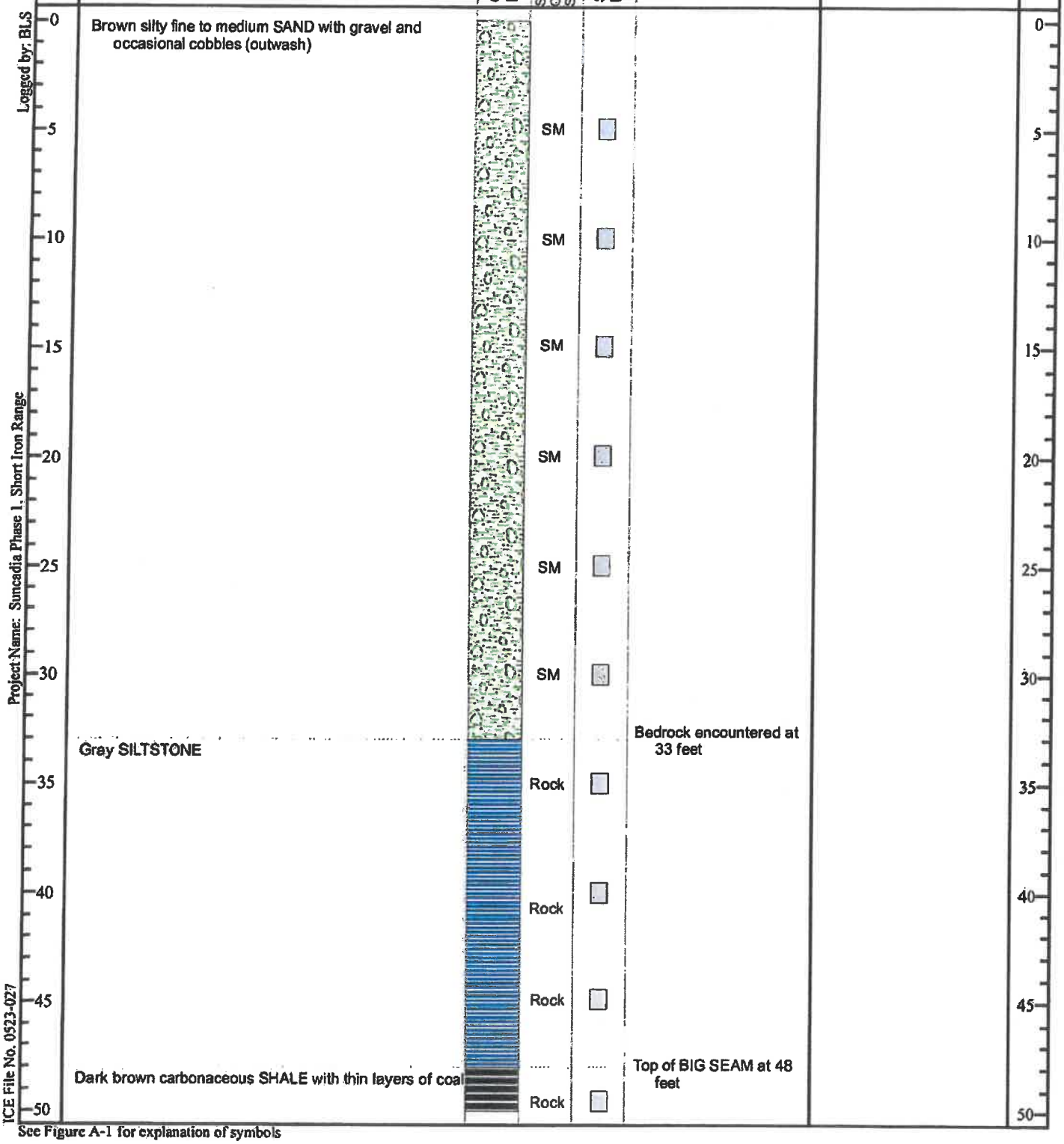
Boring B-22

Approximate Ground Surface Elevation: 2,235 feet

Logged by: BLS

Project Name: Suncadia Phase 1, Short Iron Range

ICE File No. 0523-027



See Figure A-1 for explanation of symbols

Icicle Creek Engineers

Boring Log - Figure A-13

Boring B-22

BRB: 10/23/06

Logged by: BLS

Project Name: Suncadia Phase 1, Short Iron Range

ICE File No. 0523-027

Depth in Feet	Soil/Rock Profile: Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
50	Dark brown carbonaceous SHALE with thin layers of coal (Roslyn formation)		Rock				50
55			Rock				55
60			Rock				60
65	Black COAL (Roslyn formation)		Rock		BIG SEAM (intact coal 63 -69 feet - not mined)		65
70	Light gray fine-grained SANDSTONE (Roslyn formation)		Rock				70
	Boring completed at 70 feet on July 27, 2006						
75							75
80							80
85							85
90							90
95							95
100							100

See Figure A-1 for explanation of symbols

BRB:10/23/06

Boring B-23

Approximate Ground Surface Elevation: 2,231 feet

Logged by: BLS

Project Name: Suncadia Phase 1, Short Iron Range

ICE File No. 0523-027

Depth in Feet	Soil/Rock Profile: Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
0	Brown silty fine to medium SAND with gravel and occasional cobbles (outwash)						0
5			SM				5
10			SM				10
15			SM				15
20			SM				20
22	Gray SILTSTONE (Roslyn formation)				Bedrock encountered at 22 feet		
25			Rock				25
30			Rock				30
35			Rock				35
40			Rock				40
45			Rock				45
50			Rock				50

See Figure A-1 for explanation of symbols

Icicle Creek Engineers

Boring Log - Figure A-14

Boring B-23

BRB:10/23/06

Logged by: BLS

Project Name: Suncadia Phase 1, Short Iron Range

ICE File No. 0523-027

Depth in Feet	Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
50	Gray SILTSTONE (Roslyn formation)		Rock				50
55			Rock				55
60			Rock				60
65			Rock				65
	Dark brown carbonaceous SHALE with thin layers of coal (Roslyn formation)				Top of BIG SEAM at 67 feet		
70			Rock				70
75			Rock				75
	MINE OPENING				Complete loss of drilling fluid circulation at 76 feet		
80			Void		NO. 9 MINE (open from 76 - 86.5 feet - mined out)		80
85			Void		Drilling resistance indicates intact rock (not mined) at 86.5 feet		85
	Boring completed at 86.5 feet on July 28, 2006						
90							90
95							95
100							100

See Figure A-1 for explanation of symbols

Icicle Creek Engineers

Boring Log - Figure A-14

JMS:10/14/06

Boring B-24

Approximate Ground Surface Elevation: 2,230 feet

Logged by: BRB

Project Name: Suncadia Phase 1, Short Iron Range

ICE File No. 0523-027

Depth in Feet	Soil/Rock Profile: Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
0	Brown silty GRAVEL with sand and cobbles (outwash)						0
5			GM				5
10			GM			Ground water observed at 9 feet	10
15			GM		Bedrock encountered at 16 feet		15
	Gray SILTSTONE (Roslyn formation)						
20	grades to brown at 20 feet		Rock				20
	grades to gray at 23 feet						
25	grades to brown at 26 feet		Rock				25
	grades to gray at 28 feet						
30	grades to brown at 32 feet		Rock				30
35	Dark brown carbonaceous SHALE (Roslyn formation)		Rock				35
	Black COAL (Roslyn formation)						
40	Gray SILTSTONE (Roslyn formation)		Rock				40
	Dark brown carbonaceous SHALE (Roslyn formation)				Top of BIG SEAM at 43 feet		
45	Black COAL (Roslyn formation)		Rock				45
	Dark brown carbonaceous SHALE (Roslyn formation)						
	Black COAL (Roslyn formation)						
50			Rock				50

See Figure A-1 for explanation of symbols

Icicle Creek Engineers

Boring Log - Figure A-15

JMS:10/14/06

Boring B-24

Logged by: BRB

Project Name: Suncadia Phase 1, Short Iron Range

ICE File No. 0523-027

Depth in Feet	Soil/Rock Profile: Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
50	Black COAL (Roslyn formation)		Rock				50
	MINE OPENING				Complete loss of drilling fluid circulation at 52.5 feet		
55			Void		NO. 9 MINE (open from 52.5-60 feet - mined out)		55
60	Boring completed at 60 feet on September 19, 2006		Void		Drilling resistance indicates intact rock (not mined) at 60 feet		60
	Ground water seepage observed at 9 feet						
65							65
70							70
75							75
80							80
85							85
90							90
95							95
100							100

See Figure A-1 for explanation of symbols

JMS:10/14/06

Boring B-25

Approximate Ground Surface Elevation: 2,238 feet

Logged by: BRB

Project Name: Suncadia Phase 1, Short Iron Range

ICE File No. 0523-027

Depth in Feet	Soil/Rock Profile: Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
0	Brown silty GRAVEL with sand and cobbles (outwash)						0
5			GM				5
10			GM				10
15			GM				15
20			GM			Soil grades to wet but not saturated at 20 feet	20
25			GM				25
30			GM				30
35			GM				35
40			GM				40
45	Gray SILTSTONE (Roslyn formation)		Rock		Bedrock encountered at 43 feet		45
50			Rock				50

See Figure A-1 for explanation of symbols

Icicle Creek Engineers

Boring Log - Figure A-16

Boring B-25

JMS:10/14/06

Logged by: BRB

Project Name: Suncadia Phase 1, Short Iron Range

ICE File No. 0523-027

Depth in Feet	Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
50	Gray SILTSTONE (Roslyn formation)		Rock				50
55			Rock				55
60	grades to brown at 60 feet		Rock				60
65			Rock				65
70	Dark brown carbonaceous SHALE with thin layers of coal (Roslyn formation)		Rock		Top of BIG SEAM at 70 feet		70
75			Rock				75
80	Black COAL (Roslyn formation)		Rock				80
85	Light gray fine-grained SANDSTONE (Roslyn formation)		Rock		NO. 9 MINE (fully collapsed at 85 feet)		85
	Boring completed at 87 feet on September 19, 2006 Ground water seepage observed at the time of drilling						
90							90
95							95
100							100

See Figure A-1 for explanation of symbols

JMS:10/14/06

Boring B-26

Approximate Ground Surface Elevation: 2,242 feet

Logged by: BRB

Project Name: Suncadia Phase 1, Short Iron Range

ICE File No. 0523-027

Depth in Feet	Soil/Rock Profile: Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
0	Brown silty fine SAND (outwash)		SM				0
	Brown silty GRAVEL with sand and cobbles (outwash)						
5			GM				5
10			GM				10
15			GM				15
20			GM				20
25			GM				25
30			GM			Soil grades to wet but not saturated at 30 feet	30
35			GM				35
40			GM				40
	Gray SILTSTONE (Roslyn formation)				Bedrock encountered at 43 feet		
45			Rock				45
50			Rock				50

See Figure A-1 for explanation of symbols

Icicle Creek Engineers

Boring Log - Figure A-17

Boring B-26

JMS:10/14/06

Logged by: BRB

Project Name: Suncadia Phase 1, Short Iron Range

ICE File No. 0523-027

Depth in Feet	Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
50	Gray SILTSTONE (Roslyn formation)		Rock				50
55			Rock				55
60			Rock				60
	grades to brown at 64 feet						
65			Rock				65
	grades to gray at 69.5 feet						
70	grades to brown at 71 feet		Rock				70
75			Rock				75
	Dark brown carbonaceous SHALE (Roslyn formation)				Top of BIG SEAM at 79 feet		
80	Light brown SILTSTONE (Roslyn formation)		Rock				80
	Dark brown carbonaceous SHALE with thin layers of coal (Roslyn formation)						
85			Rock				85
90			Rock				90
95	Black COAL (Roslyn formation)		Rock				95
	Gray SILTSTONE (Roslyn formation)				NO. 9 MINE (fully collapsed at 97 feet)		
100	Boring completed at 99 feet on September 20, 2006 No ground water observed at the time of drilling						100

See Figure A-1 for explanation of symbols

Icicle Creek Engineers

Boring Log - Figure A-17

JMS:09/29/06

Boring B-27

Approximate Ground Surface Elevation: 2,230 feet

Logged by: JMS

Project Name: Suncadia Phase 1, Short Iron Range

ICE File No. 0523-027

Depth in Feet	Soil/Rock Profile: Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
0	Brown silty GRAVEL with sand and cobbles (outwash)						0
5			GM				5
10			GM				10
15			GM				15
20			GM				20
25			GM				25
30			GM			Soil grades to wet but not saturated at 30 feet	30
35			GM				35
40	Brown silty SAND (outwash)		SM				40
45	Gray SILTSTONE (Roslyn formation)		Rock		Bedrock encountered at 45 feet		45
50			Rock				50

See Figure A-1 for explanation of symbols

Icicle Creek Engineers

Boring Log - Figure A-18

Boring B-27

JMS:9/29/06

Logged by: JMS

Project Name: Suncadia Phase 1, Short Iron Range

ICE File No. 0523-027

Depth in Feet	Soil/Rock Profile: Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
50	Gray SILTSTONE (Roslyn formation)		Rock				50
55			Rock				55
60			Rock				60
	Dark brown carbonaceous SHALE with thin layers of coal (Roslyn formation)				Top of BIG SEAM at 62 feet		
65	Gray SILTSTONE (Roslyn formation)		Rock				65
	Black COAL (Roslyn formation)						
	Gray SILTSTONE (Roslyn formation)						
	Dark brown carbonaceous SHALE with thin layers of coal (Roslyn formation)						
70	Gray SILTSTONE (Roslyn formation)		Rock				70
	Dark brown carbonaceous SHALE with thin layers of coal (Roslyn formation)						
75	Black COAL (Roslyn formation)		Rock				75
					NO. 9 MINE (fully collapsed at 78 feet)		
	Light gray fine-grained SANDSTONE (Roslyn formation)						
80			Rock				80
85			Rock				85
	Boring completed at 87 feet on September 21, 2006						
	No ground water observed at the time of drilling						
90							90
95							95
100							100

See Figure A-1 for explanation of symbols

Icicle Creek Engineers

Boring Log - Figure A-18

JMS:09/29/06

Boring B-28

Approximate Ground Surface Elevation: 2,218 feet

Logged by: JMS

Project Name: Suncadia Phase 1, Short Iron Range

ICE File No. 0523-027

Depth in Feet	Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
0	Brown silty GRAVEL with sand and cobbles (outwash)						0
5			GM			Soil grades to wet but not saturated at 6 feet	5
10			GM				10
	Brow silty SAND (outwash)						
15			SM				15
20	Gray SILTSTONE (Roslyn formation)		Rock		Bedrock encountered at 19 feet		20
25			Rock				25
30			Rock				30
	grades to brown at 32 feet						
	grades to gray at 34 feet						
35			Rock				35
	Dark brown carbonaceous SHALE with thin layers of light brown siltstone (Roslyn formation)				Top of BIG SEAM at 36 feet		
40	Black COAL (Roslyn formation)		Rock				40
	Dark brown carbonaceous SHALE with thin layers of black coal (Roslyn formation)						
	Light brown SILTSTONE with thin layers of dark brown carbonaceous shale (Roslyn formation)						
45	Black COAL (Roslyn formation)		Rock				45
	Dark brown carbonaceous SHALE with layers of light brown SILTSTONE (Roslyn formation)						
50	Black COAL (Roslyn formation)		Rock		NO. 9 MINE (intact coal from 49-55 feet - not mined)		50

See Figure A-1 for explanation of symbols

Icicle Creek Engineers

Boring Log - Figure A-19

Boring B-28

JMS:9/29/06

Logged by: JMS

Project Name: Suncadia Phase 1, Short Iron Range

ICE File No. 0523-027

Depth in Feet	Soil/Rock Profile: Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
50	Black COAL (Roslyn formation)		Rock				50
	Dark brown carbonaceous SHALE (Roslyn formation)				NO. 9 MINE (intact coal from 49-55 feet - not mined)		
55	Light gray fine-grained SANDSTONE (Roslyn formation)		Rock				55
	Boring completed at 56 feet on September 22, 2006						
	No ground water observed at the time of drilling						
60							60
65							65
70							70
75							75
80							80
85							85
90							90
95							95
100							100

See Figure A-1 for explanation of symbols

Icicle Creek Engineers

Boring Log - Figure A-19

JMS:10/18/06

Boring B-29

Approximate Ground Surface Elevation: 2,218 feet

Logged by: JMS

Project Name: Suncadia Phase 1, Short Iron Range

ICE File No. 0523-027

Depth in Feet	Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
0	Brown silty GRAVEL with sand and cobbles (outwash)						0
5			GM				5
10			GM			Soil grades to wet but not saturated at 10 feet	10
	Brown silty SAND (outwash)		SM				
15	Brown silty GRAVEL with sand and cobbles (outwash)		GM				15
	Gray GRAVEL (outwash)		GW				
20	Brown silty GRAVEL with sand and cobbles (outwash)		GM				20
	Gray SILTSTONE (Roslyn formation)				Bedrock encountered at 21 feet		
	grades to brown at 23 feet						
	grades to gray at 24 feet						
25			Rock				25
	grades to brown at 29 feet						
30			Rock				30
35			Rock				35
	grades to gray at 36 feet						
	grades to brown at 37 feet						
	Dark brown carbonaceous SHALE				Top of BIG SEAM at 37.5 feet		
40	Black COAL		Rock				40
	Gray SILTSTONE (Roslyn formation)						
	Dark brown carbonaceous SHALE						
45	Black COAL		Rock				45
	Dark brown carbonaceous SHALE						
	Black COAL						
50			Rock				50

See Figure A-1 for explanation of symbols

Icicle Creek Engineers

Boring Log - Figure A-20

JMS:10/18/06

Boring B-29

Logged by: JMS

Project Name: Suncadia Phase 1, Short Iron Range

ICE File No. 0523-027

Depth in Feet	Soil/Rock Profile: Description	Graphic Log	Soil Classification Symbol	Sample Location	Comments	Ground Water Observations	Depth in Feet
50	Black COAL		Rock				50
55	Light gray fine-grained SANDSTONE		Rock		No. 9 MINE (intact coal from 47-55 feet - not mined)		55
	Boring completed at 57 feet on September 22, 2006 No ground water observed at the time of drilling						
60							60
65							65
70							70
75							75
80							80
85							85
90							90
95							95
100							100

See Figure A-1 for explanation of symbols

Northern, Inc.

Consulting Engineers Environmental Scientists Geologists
Construction Materials Testing Geophysical Services

COAL MINE HAZARDS ASSESSMENT & GEOTECHNICAL EVALUATION REPORT

WINEMAKER'S CABINS AT SWIFTWATER CELLARS
301 ROPE RIDER DRIVE
CLE ELUM, KITTITAS COUNTY, WASHINGTON

GNN PROJECT NO. 217-871

DECEMBER 2017

Prepared for

SWIFTWATER CUSTOM HOMES
SWIFTWATER CELLARS PROPERTIES, LLC
PO BOX 492, ROSLYN, WA 98941

Prepared by

GN NORTHERN, INC.
CONSULTING GEOTECHNICAL ENGINEERS
YAKIMA, WASHINGTON
(509) 248-9798

At GN Northern our mission is to serve our clients in the most efficient, cost effective way using the best resources and tools available while maintaining professionalism on every level. Our philosophy is to satisfy our clients through hard work, dedication and extraordinary efforts from all of our valued employees working as an extension of the design and construction team.

December 4, 2017 **GNN Project No. 217-871**

Swiftwater Custom Homes
Swiftwater Cellars Properties, LLC
PO Box 492
Roslyn, WA 98941

Attention: Jeff Hansell

Subject: Coal Mine Hazards Assessment & Geotechnical Evaluation Report
Winemaker's Cabins at Swiftwater Cellars
301 Rope Rider Drive, Cle Elum, Kittitas, Washington

Dear Mr. Hansell,

As requested, GN Northern (GNN) has completed a geotechnical site investigation and coal mine hazards assessment for the above referenced residential and mixed-use development to be constructed at 301 Rope Rider Drive within the Suncadia Resort community near Cle Elum, Kittitas County, Washington.

Based on the findings of our subsurface study, we conclude that some portions of the site are unsuitable/unbuildable for the proposed construction as planned due to the risk of surface subsidence and sinkholes from potential mine collapse. However, provided that our geotechnical recommendations presented in this report are followed during the design and construction phases, the remaining areas are suitable for the proposed development.

This report describes in detail the results of our investigation, summarizes our findings and presents our recommendations regarding mitigation of the identified mine hazards as well as earthwork, and the design and construction of foundations for the proposed development. It is important that GN Northern provide consultation during the design phase, as well as field compaction testing and geotechnical monitoring services during the construction phase to review and monitor the implementation of the geotechnical recommendations.

If you have any questions regarding this report, please contact us at 509-248-9798.

Respectfully submitted,
GN Northern, Inc.

M. Yousuf Memon, EIT
Staff Geotechnical Engineer

Karl A. Harmon, LEG, PE
Senior Geologist/Engineer

Expires 08/02/2019

Karl A. Harmon

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TABLES

APPENDICES

INTRODUCTION

Project Description

This Coal Mine Hazards Assessment and Geotechnical Evaluation Report has been prepared for the ±5.8-acre site of the proposed Winemaker's Cabins at Swiftwater Cellars development to be located at 301 Rope Rider Drive in the Suncadia area near Cle Elum, Kittitas County, Washington (see Figure 1). The project area is underlain by portions of the abandoned Roslyn No.9 Mine, and was classified in Icicle Creek Engineers (ICE) Coal Mine Hazard Assessment Report dated February 2008 as a 'sinkhole hazard area' due to the presence of open and partially collapsed mine shafts. We understand that ICE's hazard classification was based on subsurface exploration at various locations across the project site and vicinity. It is noteworthy that the boundaries of the currently proposed project (as depicted on the Preliminary Plat prepared by JUB Engineers, dated 8/7/2017) are drawn to generally site the new development outside of areas delineated by ICE as 'high risk sinkhole hazard area'.

Proposed Development

Based on the information provided, we understand that a residential development is planned northwest of the existing Swiftwater Cellars Winery/Restaurant, and a mixed-use development is proposed to the east of the existing winery. Based on the preliminary plan set prepared by JUB Engineers, Inc. (JUB), the residential development includes 15 single-family custom home lots (Lots 1-15) and 4 multi-family lots with duplexes (Lots 15-19) in an area northwest of the existing winery, hereby designated as 'Area 1', and a two-story pool/gym building along with 6 two-story attached rental units east of the existing winery, hereby designated as 'Area 2'. To provide access to Area 1, a new roadway is proposed on the west, extending from Rope Rider Drive near the western end of the existing parking lot, terminating at Lot 1 in the northwestern-most portion of the proposed development. Access to Area 2 is proposed through a new driveway from Rope Rider Drive. Site improvements will also include construction of associated utilities and infrastructure.

Based on the proposed grading plans prepared by JUB, we understand that single-family Lots 8-15 will be graded with two benches for future development of daylight-basement homes. Site grading is planned with cut and fill slopes with a 2H:1V gradient. The tallest fill slope is proposed in Area 1 on the north side of Lot 2 with a maximum height of approximately 23 feet. The tallest cut slope

is proposed in Area 2 near the proposed carports with a maximum height of approximately 12 feet. Retaining walls are proposed within Area 2.

Although loading criteria for the future proposed structures was not provided to us at the time of this report, based on our work with similar projects, we assume that new structures will be founded on shallow spread type foundations. Additionally, we expect wall loads to be on the order of 3,000 plf and maximum column loads to be less than 80 kips. If loading conditions are greater than those described herein please contact our office for potential re-analysis. Settlement tolerances for the structures are assumed to be limited to 1 inch, with differential settlement limited to ½ inch.

Purpose and Scope of Services

The purpose of our services was to evaluate the surface and subsurface soil and bedrock conditions for potential coal mine hazards as they relate to the proposed development, and provide professional opinions regarding the suitability of the subsurface materials along with recommendations for geotechnical design parameters, bearing capacity for the proposed construction, and mitigation of any existing coal mine hazards. Our evaluation was completed in general accordance with our *Proposal for Geotechnical Services* dated August 18, 2017; notice to proceed was provided by Mr. Hansell on September 19, 2017 in the form of a signed copy of the proposal. The scope of work included the following:

- A detailed reconnaissance of the site;
- Subsurface exploration by excavating nine (9) exploratory test-pits and five (5) exploratory borings;
- A microgravity survey of selected areas of the project site;
- Laboratory testing of selected soil samples obtained from exploratory borings and test-pits;
- A review of selected published technical literature pertaining to the site and previous geotechnical/geologic reports prepared for the project;
- Review of selected available historic aerial photos, USGS topographic maps, and published WA DNR mine maps of the project site and vicinity;
- A geologic/engineering analysis and evaluation of the acquired data from the exploration and testing programs;
- Stability analyses of existing and proposed site slopes;
- A summary of our findings and recommendations.

This report contains the following:

- Discussions on subsurface soil, bedrock and groundwater conditions;
- Discussions on regional and local geologic conditions;
- Discussions on historic coal mining activities and related hazards;
- Graphic and tabulated results of laboratory tests and field studies;
- Suitability of onsite soils for placement as engineered fill;
- Recommendations for mitigation of identified mine hazards;
- Recommendations regarding site development and grading criteria including cut and fill slope construction;
- Recommendations for geotechnical design parameters and allowable bearing capacity for the proposed commercial and residential construction.

METHODS OF EXPLORATION AND TESTING

Technical Literature and Aerial Photo Review

A review of selected information pertaining to the site and surrounding area was performed that included published technical literature, mine maps, geologic maps, aerial photographs and previous geotechnical and geologic reports prepared for the project site and vicinity. The review was performed to identify typical geotechnical and geologic constraints that may affect the proposed development, including soil and bedrock conditions, groundwater, slopes, drainage, erosion, and mine/sinkhole related hazards.

Field Reconnaissance

An initial site reconnaissance of the subject property was performed on September 21, 2017 to develop the exploration plan and determine drill rig access to certain locations of the site. Additional detailed reconnaissance was conducted in conjunction with our subsurface exploration on October 3rd and October 10th through 12th, 2017 to observe the on-site surficial geologic and geotechnical conditions and to confirm the data obtained from our technical literature review.

Field Exploration

To investigate shallow soil conditions, a total of nine (9) test-pits were completed on October 3rd; seven (7) test-pits in Area 1 and two (2) in Area 2. Test-pits TP-1, TP-8 and TP-9 were excavated using a Hitachi Zaxis 50U and TP-2 through TP-7 were excavated with a John Deere 135G

excavator provided by the client to depths ranging from approximately 7.5 to 14.0 feet below existing grade (BGS). To evaluate the subsurface bedrock and coal conditions, exploratory borings were drilled using a track-mounted Terra Sonic TSi 150 Compact Crawler drill rig operated by Holt Services to depths of approximately 54 to 90 feet BGS between October 10th and 12th. A utility clearance was obtained prior to the field exploration.

The exploratory borings and test-pits were logged by a GNN geotechnical engineer. Selected representative soil/rock samples were recovered from the test-pits and borings, sealed in containers, and returned to our laboratory for further analyses. Upon completion, the borings were backfilled in general accordance with Washington State guidelines, and test-pits were loosely backfilled with the excavated soils. The exploratory test locations are shown on *Site & Exploration Map* (Figure 2, Appendix I).

The soils observed during our field exploration were classified according to the Unified Soil Classification System (USCS), utilizing the field classification procedures as outlined in ASTM D2488. A copy of the USCS Classification Chart is included in Appendix II. Photographs of the site and exploration are presented in Appendix IV following this report. Depths referred to in this report are relative to the existing ground surface elevation at the time of our investigation. The surface and subsurface conditions described in this report are as observed at the time of our field investigation.

Laboratory Testing

Representative samples of the native soil obtained during our subsurface exploration were selected for testing to determine the index properties of the soils in general accordance with ASTM procedures. The following laboratory tests were performed:

Table 1: Laboratory Tests Performed

Test	To determine
Particle Size Distribution (ASTM D6913)	Soil classification based on proportion of sand, silt, and clay-sized particles
Natural Moisture Content (ASTM D2216)	Soil moisture content indicative of in-situ condition at the time samples were taken

Results of the laboratory tests are included on the boring and test-pit logs, and are also presented in graphic form in Appendix III attached to the end of the report.

Microgravity Survey

To further evaluate and confirm the locations and extent of voids and open mine tunnels, a microgravity survey was completed by Global Geophysics of Redmond, Washington at the site to locate the low density zones. The gravimeter instrument used for micro-gravity survey measures the earth's gravitational acceleration. After corrections are made to the gravity measurements for latitude, elevation, tide, drift, regional trend, and terrain at each station, the gravity values represent an excess or deficiency in mass of the subsurface geology. Encompass Surveying of Cle Elum performed survey of each gravity test stake to collect location survey data. The gravity survey report (dated November 13, 2017) is presented in Appendix VI.

DISCUSSION

Site Conditions

The site of the proposed development is located on the east and northwest sides of the existing Swiftwater Cellars Winery/Restaurant located at 301 Rope Rider Drive, in the Suncadia area near Cle Elum. The ~5.8-acre project site currently lies within a single 8.5-acre parcel identified as Parcel# 21909 / Map# 20-15-20058-0162 by the Kittitas County Assessor. The site is generally situated within the SW ¼ of Section 20, Township 20 North, Range 15 East, Willamette Baseline and Meridian.

The ~4.6-acre Area 1 is situated northwest of the existing winery, generally surrounding the east and north sides of Rope Rider Golf Park practice area. Proposed development in this area extends from Rope Rider Drive to the south, paralleling a northeast facing hillside overlooking the Rope Rider Golf Course, terminating to the northwest near existing residences. Surface conditions across majority of the undeveloped Area 1 include apparent historically re-graded areas with little to no vegetation cover, with selected areas along the existing slope and towards the northwestern end consisting of a dense cover of mature trees and brush. An area of stockpiled soils was observed in the central portion of the development site near proposed Lots 7 and 8. An existing ski pull rope tow system with an associated shed building is located on proposed Lots 16 & 17. Site elevations within the project boundaries range from ±2,245' in the northwestern portion to ±2,215' near the lowest portion of the descending hillside to the northeast.

The ~1.2-acre Area 2 is located east of the existing winery, with Rope Rider Drive to the south and the Rope Rider Golf Course to the north. An existing maintenance shop/yard area is located east of Area 2. Surface conditions across this entire undeveloped area include a dense cover of mature trees and brush. To provide for access into the site, a trail was cleared of vegetation/brush extending from the existing golf cart path to the north. Site elevations within the project boundaries range from ±2,210' near the northwestern corner to ±2,170' near the southeastern corner.

Geologic Setting

The site is located on the eastern flanks of the Cascade Mountains within the Cle Elum River valley just upstream from the confluence with the Yakima River. The Cascade Range physiographic province consists of an active volcanic arc superimposed atop Paleozoic to Tertiary bedrock. Eocene to present tectonic uplift of the Cascades has resulted due to the collision of oceanic and continental crust along Cascadia subduction zone off the western coast of Washington. Localized geologic conditions at the project site are generally characterized by Pleistocene glacial outwash deposits atop Miocene sedimentary bedrock of the Roslyn Formation.

While modified near the surface from past mining, logging, and grading activities, the overlying materials in the project vicinity generally consist of a mix of silt, sand, gravel, & cobble sized sediments identified as glacial outwash. The underlying Roslyn Formation typically consists of interbedded sedimentary rocks including siltstone, sandstone, shale, and coal.

Underground Coal Mines

Based on a review of available information including previous site investigations and published mine maps of the area, the proposed site is located atop an area of historic coal mines. More specifically, we understand that Roslyn No. 9 Mine was worked within the Big Seam of the Roslyn Formation at depths of approximately 36 to 97 feet BGS within the project area. Thickness of the commercially valuable coal at the bottom of the Big Seam is known to be approximately 5 to 8 feet. The coal from Roslyn No. 9 Mine directly under the project area was mined from 1962 to 1963. The deeper Roslyn Seam is about 200 feet below the Big Seam.

Soil/Bedrock Conditions

Our understanding of the soil/bedrock conditions at the project site was developed from our site-specific exploration, and review of borings logs previously completed by ICE in the project vicinity. Near-surface soils at the site were explored by means of test-pit excavations, while deeper substrata were investigated through drilling boreholes. Boring and test-pit logs provided in Appendix II include detailed descriptions of the soils/rock encountered. In general, the subsurface geologic setting at the project site (Area 1 and Area 2) typically consists of Quaternary glacial outwash deposits [Outwash] overlying the local Tertiary sedimentary bedrock [Roslyn Formation].

Outwash (Area 1): The Outwash materials in Area 1 consist primarily of subangular to subrounded gravels/cobbles identified as Silty Sandy Gravels (GP-GM), Silty Gravel with Sand (GM), and Gravelly Silty Sand (SM). Deeper substratum of the Outwash unit included some layers of silty/clayey soils. Depth of the Outwash soil overburden was noted to range from approximately 13 to 50 feet BGS, with the thickest deposits towards the northwestern portion of Area 1. These predominantly gravelly soils were generally noted to be 'medium dense' to 'dense', increasing in relative density with depth. In-place moisture of these soils ranged from dry to moist, with some moist to wet soils at deeper elevations. Unique to test-pit TP-1, a thin layer of imported crushed gravel was observed at the surface along with some decomposed organics noted at approximately 3.5 to 4 feet BGS. Some apparent fill soils were also encountered in boring B-1 and test-pit TP-6 in the upper approximately 2 to 3 feet in the northwestern portion of the site.

Outwash (Area 2): The Outwash materials in Area 2 consist of consolidated fine-grained deposits classified as Sandy Silt (ML) and Silty Sand (SM) with varying amounts of gravels. These silty/sandy soils were observed to be 'medium dense' to 'dense' and some cementation of the soil was also noted. Deeper Outwash materials encountered in boring B-5 included relatively stiff Sandy Clay (CL) and Silty Clay with Sand (CL-ML) soil units. In-place moisture of these soils ranged from dry to moist.

Roslyn Formation: The observed stratigraphy of the Roslyn Formation bedrock was relatively consistent across Areas 1 and 2. The bedrock profile generally consists of poorly indurated siltstone atop carbonaceous shale underlain by coal, overlying a unit of sandstone. The thicknesses of the siltstone and carbonaceous shale layers were noted to range from approximately 10-36 feet

and 11-27 feet, respectively. The carbonaceous shale unit was observed to include coal-rich seams with increasing depth, ultimately transitioning to coal at the bottom. Highly pulverized core sample recovery of the shale and coal materials indicated possible mine collapse conditions as seen in borings B-1 and B-2. An approximately 7-foot tall void was encountered in boring B-3, suggesting presence of an open mine tunnel/drift at approximately 50 feet BGS.

NRCS Soil Survey

Although somewhat altered by previous grading activities, the soil survey map of the vicinity prepared by the Natural Resources Conservation Service (NRCS) indicates soils in the vicinity of the project site are primarily mapped as variants of *Roslyn ashy sandy loam* and *Dystroxerepts*. The typical soil profile is described to consist of *ashy sandy loam* grading to *very gravelly sandy loam*. The landform setting is identified as terraces and escarpments, and parent materials are described as glacial drift/outwash with a mantle of loess and volcanic ash. According to the NRCS, these soil units generally consists of *well drained* materials with a capacity of the most limiting layer to transmit water (Ksat) identified as *moderately high* to *high* (0.57 to 1.98 in/hr). Refer to the NRCS Soil Survey Map in Appendix VII for more details.

Groundwater

Static groundwater was not encountered in any of the borings or test-pits during exploration. Based on *USGS Hydrogeologic Framework and Groundwater/Surface-Water Interactions of the Upper Yakima River Basin, Kittitas County, Central Washington*, water-levels near the project area are anticipated to be at approximate elevation 2,050'. Based on this data and the existing site elevations, groundwater at the project site is believed to be greater than 100 feet BGS.

Minor localized and seasonal perched groundwater conditions may occur beneath the site above the underlying less permeable bedrock layers as seen in TP-5 and several of the borings completed by GNN and ICE. Perched groundwater layers may fluctuate with precipitation, irrigation, drainage, and site grading, therefore, the absence of detected groundwater may not represent a permanent condition. Nevertheless, based on the currently available information, groundwater is not expected to be a significant factor in design or construction at this site.

Seismic Design Parameters

To estimate the mapped maximum credible earthquake (MCE) spectral response accelerations with 5 percent damping at short periods (S_S) and at the 1-second period (S_1), the site's latitude and longitude coordinates were entered into the USGS Earthquake Ground Motion Application which computes values based on smoothing and averaging of the spectral response acceleration contour map data included in the IBC (International Code Council, 2015). Based on the findings of our subsurface investigation, a site class 'C' may be used for seismic design purposes (see Appendix VIII) as per the 2015 IBC. Site Class 'C' corresponds to 'very dense soil and soft rock'. The following site-specific design values may be used:

Table 2: IBC Design Response Spectra Parameters

Seismic Design Parameter	Value (unit)
S_S	0.699 (g)
S_1	0.275 (g)
F_a	1.120 (unitless)
F_v	1.524 (unitless)
SM_S	0.783 (g)
SM_1	0.419 (g)
SD_S	0.522 (g)
SD_1	0.279 (g)

S_S = MCE spectral response acceleration at short periods
S_1 = MCE spectral response acceleration at 1-second period
F_a = Site coefficient for short periods
F_v = Site coefficient for 1-second period
SM_S = MCE spectral response acceleration at short periods as adjusted for site effects
SM_1 = MCE spectral response acceleration at 1-second period as adjusted for site effects
SD_S = Design spectral response acceleration at short periods
SD_1 = Design spectral response acceleration at 1-second period

COAL MINE HAZARDS

According to Kittitas County Code, Title 17A - Critical Areas, Chapter 17A.06 - Geologically Hazardous Areas, "*mine hazard areas*" are defined as geologically hazardous areas, directly underlain by, adjacent to, or affected by abandoned mine workings such as adits, tunnels, ducts or air shafts with the potential for creating large underground voids susceptible to collapse.

Portions of the project site are underlain by various abandoned coal mine workings of the No. 9 Mine. The subsurface coal deposits include the deeper Roslyn Seam, situated approximately 200 feet below the upper Big Seam. The relatively shallow Big Seam is generally characterized as an

approximately 20- to 25-foot thick layer of interbedded carbonaceous shale and coal. Mining operations to extract the coal from an approximately 5- to 8-foot thick layer at the bottom of the Big Seam beneath the project site vicinity apparently occurred between 1962 and 1963.

The previously mined drifts and galleries of the Big Seam beneath the project site are known to include areas that have remained open (void) and others that have collapsed. The collapsed portions occurred either from natural stress/strain over time (short-term and/or long-term) or intentionally by the miners following the coal extraction.

The existing mine conditions beneath the proposed development, particularly the areas that remain as open voids, represent a significant hazard and risk for surface disturbance and subsidence. Without appropriate mitigations, areas developed above the potentially unstable open mine works will be subject to a risk of associated ground subsidence, including property/structural damage and potential life safety concerns.

According to Kittitas County Code, Section 17A.06.030, "*Siting of structures on known mine hazard areas should be avoided*". While selected jurisdictions within Washington State that have experienced historic mining operations/activities have developed regulatory critical areas ordinances that require an evaluation and assessment of the risk from mine hazards, as of the date of this report Kittitas County has not adopted ordinances for a formal mine hazard/risk classification or rating criteria.

A site-specific assessment and evaluation of the areas encompassing the currently proposed site layout plan consisted of a careful review of existing available data, maps and reports, additional site exploration including borings and geophysical microgravity surveys. Based on the aforementioned, GNN prepared Coal Mine Hazards Maps (Figures 3 and 4) for the currently proposed site layout, presenting the following three (3) classifications for land use and development considering mine hazard/risk posed by the noted subsurface mine conditions, along with recommendations for building development restrictions and mitigations, as listed below:

- ***"Declassified" No Significant Mine Hazard - Buildable Areas***: No underground mines are present within 100 feet below ground surface. Proposed buildings and infrastructure development may be constructed as recommended in this geotechnical engineering report.

- ***Low Mine Hazard - Buildable Areas with Mitigation***: Fully collapsed underground mines are less than 100 feet below the ground surface. Proposed buildings and infrastructure development must be constructed with appropriate mitigations and structural enhancements as recommended in this geotechnical engineering report.

- ***Moderate to Severe Mine Hazard - Unbuildable Areas***: Open and/or partially collapsed underground mines are less than 100 feet below the ground surface. No buildings, roads or utilities should be constructed unless underground mines are fully collapsed or are reclaimed by backfilling. The owner/develop must understand and accept the risk of property/structural damage, and the risk of personal injury shall be minimized or eliminated through effective mitigation for structures constructed on ground that has a potential for subsidence and development of sinkholes resulting from mine collapse.

SLOPE STABILITY ANALYSIS

Slope stability analyses were conducted on selected existing slopes, as well as proposed reconfigured cut and fill slopes for the project. Slope stability section lines are shown on Figures 2A and 2B. The analyses were conducted using generalized geologic cross-section models developed from the existing site topography, and data obtained from our subsurface exploration. Outputs of our slope stability analyses are attached in Appendix V.

The slope stability analyses were conducted by a two-dimensional limit equilibrium stability analysis of selected trial failure surfaces using the computer program *SLIDE*. Potential circular-arc failure surfaces were evaluated using the Spencer method. The computer program searched for critical potential failure surfaces with low computed factors of safety. The computed factor of safety (FS) against slope failure is simply the ratio of total resisting forces or moments (strength of the slope) to the total driving forces or moments for planar or circular failure surfaces respectively. A slope with a factor of safety of 1.0 is in equilibrium, indicating that the disturbing forces driving the slope down are equal to its strength to resist failure. Slope failure results when the strength of the slope is overcome by gravity.

The stability of the slopes have been analyzed under both static and seismic conditions. Our analysis used the pseudostatic method which modifies the limit equilibrium method by

incorporating a horizontal static seismic force to simulate the potential inertial forces generated from earthquake ground accelerations. For slope stability analyses under seismic loading, a pseudostatic seismic coefficient, kh (horizontal component), expressed in terms of acceleration (units of g), is typically estimated as a percentage of the horizontal peak ground acceleration (PGA). PGA for this site was calculated with a 975-year return interval (RI) using the USGS PSH Deaggregation tool for a 5% probability of exceedance in 50 years. For our analyses, we have selected a value of kh = 0.113g, approximately half of the design PGA of 0.226g.

The selection of unit weight and shear strength parameters for the various earth materials were based on judgment and data obtained during our field investigation, laboratory testing, review of previous studies, research and previous experience with similar materials in similar geotechnical and geologic settings. Engineering and geologic judgment must be applied to the estimated shear strength parameters in order to consider lateral and vertical variations in the subsurface conditions, such as degree of cementation, fracturing, planes of weakness, and gradational characteristics. The following geotechnical strength parameters were used in our stability calculations:

Table 3: Estimated Strength Parameters

Site Location	Material	Shear Strength Parameters		Unit Weight (pcf)
		Friction Angle: ϕ	Cohesion: c (psf)	
Area 1	Native Gravelly Outwash	34	10	135
	Compacted Onsite Fill	35	20	140
Area 2	Native Silty/Sandy Outwash	32	50	125

The factors of safety against slope failure, using the shear strength data as described above, were computed for existing and proposed site slopes as summarized below:

Table 4: Calculated Factors of Safety

Site Location	Analyzed Condition	Slope Section	Factor of Safety	
			Static	Seismic
Area 1	Proposed Fill	A-A'	1.52	1.17
	Existing	B-B'	1.55	1.20
	Proposed Fill	C-C'	1.69	1.32
Area 2	Proposed Cut	D-D'	1.81	1.41
	Existing	E-E'	3.18	2.20

GN Northern recommends that any existing or reconfigured slopes should meet or be designed and constructed to meet a minimum factor of safety of 1.5 for the static condition and 1.1 under seismic loading. Our analyses indicate that the existing native (undisturbed) site slopes, as well as proposed cut and fill slopes, meet or exceed minimum safety factors. We recommend that all proposed cut and fill slopes at the project site shall be constructed in accordance with the recommendations (*Graded Slope Construction*) of this report.

FINDINGS AND CONCLUSIONS

The following is a summary of our findings, conclusions and professional opinions based on the data obtained from a review of selected technical literature and the site evaluation:

- ***Based on our current understanding of the proposed development and subsurface conditions encountered, from a geologic and geotechnical perspective, it is our professional opinion that some portions of the site (as planned) are currently unsuitable (identified as 'Unbuildable' on Figures 3 and 4) for the proposed development due to the significant risk of ground subsidence resulting from remaining subterranean mine works. The remaining proposed development areas (identified as 'Buildable' on Figures 3 and 4) are suitable for development provided the recommendations in this report are followed in the design and construction of this project. Unbuildable areas require special mitigation measures through engineering design recommendations, followed by confirmation with insitu testing as described below to mitigate threats to human health, public safety, and property.***

Coal Mine Hazards and Mitigation:

- The primary geologic hazard and site constraint for the proposed project is the risk of catastrophic surface subsidence and associated structural damage above the old coal mine works resulting from potential collapse related to unmitigated mine openings. Engineered design and careful construction measures as recommended within this report can mitigate these geologic mine hazard constraints and increase stability and safety for the proposed development.
- Based on our assessment and evaluation of the currently proposed site layout, which consisted of a careful review of available data and maps, along with additional site exploration including

borings, and microgravity surveys, GNN prepared Coal Mine Hazards Maps (Figures 3 and 4) depicting 'Declassified/Buildable' and 'Unbuildable' areas.

- The owner/developer must understand and accept the risk of property/structural damage and potential life safety concerns for structures constructed on unmitigated ground that has a potential for subsidence and development of sinkholes resulting from mine collapse.
- Unless underground mines are fully collapsed or are reclaimed by backfilling, development must be restricted within areas located above existing open and/or partially collapsed underground mines that are less than 100 feet below the ground surface (refer to Figures 3 and 4 for 'Non-Buildable' areas).
- Development within areas located above fully collapsed underground mines that are less than 100 feet below the ground surface must be constructed with appropriate mitigations and structural enhancements. The structural engineer should consider the use of rigid foundation systems supporting a flexible superstructure and structurally reinforced slab-on-grade.
- To provide for access to Lots 1 through 9, planning and construction of infrastructure improvements, including the proposed roadway and utilities spanning across the mapped 'Unbuildable' area will require the use of a 'bridge' design concept supported on competent ground on either side. The structural engineer shall be consulted for additional options for bridging over the 'Unbuildable' area.
- We recommend performing additional site-specific explorations (borings) and microgravity surveys within the 'Unbuildable' areas to better define the areal extent of the delineated coal mine hazard areas.
- An acceptable option for mitigation of open mine hazards includes drilling multiple access holes from the surface and backfilling the noted voids with concrete slurry. Appropriate backfilling will allow for reclassification of the 'Unbuildable' areas to 'Buildable'. A geophysical survey shall be performed post-backfilling to confirm that the open mine areas have been appropriately remediated. A qualified specialty contractor familiar with this type of work shall be employed.

Geotechnical Constraints and Mitigation:

- The subsurface geologic setting at the project site typically consists of Quaternary glacial outwash deposits [Outwash] overlying the local Tertiary sedimentary bedrock [Roslyn Formation]. The Outwash materials in Area 1 consist primarily of gravels/cobbles, while the Outwash materials in Area 2 consist of consolidated fine-grained soils. The stratigraphy of the Roslyn Formation bedrock generally consists of poorly indurated siltstone atop carbonaceous shale underlain by coal, overlying a unit of sandstone.
- The upper native soils [Outwash] were generally found to be 'medium dense' to 'dense' and are considered to be suitable for support of structures, fill and hardscape, provided that the subgrade is appropriately moisture conditioning and recompacted along with placement of engineered fill material.
- Development on sloping ground can pose a risk related to global and local stability of site slopes. Site development will require appropriate design and construction of project slopes as well as drainage/erosion control measures to mitigate the noted constraints.
- Remedial site grading will be necessary to appropriately mitigate the existing surface conditions and to develop appropriate cut/fill slopes and provide uniform competent support for future structures and infrastructure improvements.
- Proposed building layouts across native sloping areas will require a cut-fill transitions beneath the building footprint. Foundations supported on variably thick cuts and fills, and variable support conditions will result in a significant risk for differential settlement.
- To provide a uniform bearing support and minimize the potential for differential settlement, all foundation elements should bear completely a relatively uniform thick mat of structural engineered fill. No foundation elements shall rest partially on the fill and partially on cut.
- The native outwash soils may be suitable for use as engineered fill and utility trench backfill, provided it is free of significant organic or deleterious matter, and rocks greater than 3 inches.
- Excavation of the on-site soils can be accomplished with most types of conventional heavy-duty earth excavation equipment.

- Adherence to the grading and structural recommendations in this report should reduce the potential hazard of slope failure, erosion and settlement problems.
- Our analyses indicate that the existing native (undisturbed) site slopes, as well as proposed cut and fill slopes, meet or exceed minimum safety factors. We recommend that all proposed cut and fill slopes at the project site shall be constructed in accordance with the recommendations (*Graded Slope Construction*) of this report.
- Groundwater was not encountered in any of the borings or test-pits during exploration. Minor localized and seasonal perched groundwater conditions may occur beneath the site above the underlying less permeable bedrock layers as seen in TP-5 and several of the borings. Based on available data, static groundwater at the project site is believed to be greater than 100 feet BGS.
- Deeper excavations for basements and/or utilities along Lots 6 to 11 in Area 1 may encounter wet soil conditions or possible localized perched groundwater conditions.
- A site class 'C' may be used for seismic design purposes. The *minimum* seismic design should comply with the *2015 International Building Code* (IBC) and ASCE 07-10, *Minimum Design Loads for Buildings and Other Structures*.
- Site grading, stripping, excavation, placement of fill, setbacks, drainage, terracing, and erosion control measures shall conform to the provisions of Appendix J, *Grading*, of 2015 IBC. Any deviations or revision incorporated into the final design shall be approved by the Geotechnical Engineer of Record and local building jurisdiction.
- Appropriate slope set-backs should be incorporated in the final planning and design of the project. Slopes setbacks shall adhere to 2015 IBC, Section 1808.7 *Foundations on or Adjacent to Slopes*.

GEOTECHNICAL RECOMMENDATIONS

The recommendations presented in this report are predicated upon a program of appropriate monitoring and testing of the site grading activities by a representative of our Geotechnical-Engineer-of-Record (GER). The following sections are intended to reduce the potential earthwork related risks at this site.

Site Development – Grading

The project GER or a representative of the GER should observe site clearing, grading, and the bottoms of excavations before placing fills. Local variations in soil conditions may warrant increasing the depth of over-excavation and recompaction. Seasonal weather conditions may adversely affect grading operations. To improve compaction efforts and prevent potential pumping and unstable ground conditions, we suggest performing site grading during dryer periods of the year.

Soil conditions shall be evaluated by in-place density testing, visual evaluation, probing, and proof-rolling of the imported fill and re-compacted on-site soil as it is prepared to check for compliance with recommendations of this report. A moisture-density curve shall be established in accordance with the ASTM D1557 method for all onsite soils and imported fill materials used as structural fill.

Clearing and Grubbing

At the start of site grading, areas of proposed improvements should be cleared of existing vegetation, large roots, non-engineered fill, construction debris, trash, and abandoned underground utilities. The surface should be stripped of organic growth and removed from the construction area. Additional clearing and excavation efforts will be required in both Areas 1 and 2 to sufficiently chase-out the deeper buried roots of the mature trees. Areas disturbed during clearing should be properly backfilled and compacted with suitable fill soils placed as engineered fill. Additionally, the following mitigation measures shall be implemented for Area 1:

- Existing stockpiles of fill soils shall be completely removed from Lots 7 and 8.
- Existing structures associated with the ski pull system (rope tow) shall be completely removed from Lots 16 and 17.

- Existing fill materials and silty sand soils with decomposed organics, as noted in TP-1, shall be over-excavated from the building footprint of Lots 16 to 19 to expose the native gravelly stratum.

Building Pad & Foundation Subgrade Preparation

Based on our review of the preliminary grading plan, we understand that the development will include both cut and fill to create level building pads. The proposed layout of buildings situated on existing sloping and uneven ground conditions will likely result in areas with variably thick fills, variably deep cuts, as well as cut-fill transitions through the building footprints. Structures founded on transitional conditions with varying depths of cuts and fills are prone to differential settlement.

To improve bearing capacity and reduce the potential for differential settlement from static loading, onsite soils within the building pad footprint should be over-excavated and re-compacted to minimize total and differential settlement. Remedial grading will require over-excavation and replacement with a relatively uniform thick section of compacted engineered fill. The entire building pad shall be over-excavated to a minimum depth of 1-foot below existing grade or bottom of proposed footing elevation, whichever is greater. Due to the cut-fill transition across the final grade, additional overexcavation within the cut side and structural engineered fill placement should be completed with horizontal benches, such that the differential between the maximum and minimum thickness of engineered fills beneath common foundation elements shall not exceed 15% (for example: if the maximum fill thickness is 10-feet, then the minimum fill thickness should be no less than 8.5 feet). The over-ex shall include a minimum lateral offset of 3-feet on all sides.

A representative of the GER shall inspect the bottom of the over-excavation to confirm a suitable subgrade condition. For Area 1, suitable subgrade is considered as the relatively dense native gravelly soil, whereas the native relatively dense silty/sandy soils are considered as a suitable subgrade for Area 2. After confirmation of an approved subgrade, the exposed soils shall be moisture-conditioned to near-optimum and proof compacted to a dense and non-yielding condition and/or 95% of the maximum dry density per ASTM D1557. The over-excavation shall be backfilled with suitable onsite soils placed as engineered fill. Allowance shall be made for placement of a minimum 12-inch layer of imported crushed rock structural fill material. All

foundations shall be supported with a minimum 12-inch layer of imported crushed rock structural fill material compacted to 95% of the maximum dry density as determined by ASTM D1557.

Imported Crushed Rock Structural Fill

Imported structural fill shall consist of well-graded, crushed aggregate material meeting the grading and quality requirements of *2016 Washington State Department of Transportation (WSDOT) Standard Specifications* section 9-03.9(3) (1¼-inch minus Base Course Material) presented in the table below:

Table 5: WSDOT Standard Spec. 9-03.9(3) (1¼" minus Base Course)

Sieve Size	Percent Passing (by Weight)
1¼ Inch Square	99 - 100
1 Inch Square	80 - 100
5/8 Inch Square	50 – 80
U.S. No. 4	25 - 45
U.S. No. 40	3 – 18
U.S. No. 200	Less than 7.5

A fifty (50) pound sample of each imported fill material shall be collected by GNN personnel prior to placement to ensure proper gradation and establish a moisture-density relationship (proctor curve).

Re-Use of Onsite & Imported Soils as Engineered Fill

The native outwash soils may be suitable for use as engineered fill and utility trench backfill, provided it is free of significant organic or deleterious matter, and rocks greater than 3 inches. The onsite soil should be placed in maximum 8-inch lifts (loose) and compacted to at least 95% relative compaction (ASTM D1557). Compaction of the onsite soils should be performed within a range of ±2% of optimum moisture to achieve the proper degree of compaction. Compaction should be verified by quality control testing.

If needed, imported fill soils should be non-expansive, granular soils meeting the USCS classifications of SM, SP-SM, or SW-SM with a maximum rock size of 3 inches, minimum 70% passing the No. 4 sieve, and 5 to 15% passing the No. 200 sieve. The GER should evaluate the import fill soils before hauling to the site. However, because of the potential variations within the borrow source, import fill soil will not be prequalified by GNN. The imported fill should be

placed in lifts no greater than 8 inches in loose thickness and compacted to at least 95% of the maximum dry density (ASTM D1557) near optimum moisture content.

Temporary Excavation and Utility Trenches

Temporary excavations should be made in accordance with requirements of Chapter 296-155, Part N of the WAC. Temporary excavations within silty/sandy soil should be kept moist (but not saturated) to reduce the potential of caving or sloughing. Where excavations over 4 feet deep are planned, lateral bracing or appropriate cut slopes of 1.5H:1V or flatter should be provided. No surcharge loads from stockpiled soils or construction materials and equipment should be allowed within a horizontal distance measured from the top of the excavation slope and equal to the depth of the excavation unless appropriate shoring is provided.

In accordance with the standards of WAC Chapter 296-155, Part N, and the general soil information obtained during our field exploration, classification of the near-surface on-site soils will likely be characterized as Type C. Actual classification of site specific soil types as they pertain to excavating, trenching, and shoring safety should be based on real-time observations and determinations of exposed soils by the Competent Person (as defined by OSHA 29 CFR 1926.32(f)) in the field during grading and trenching operations.

Utility Trenches: Backfill of utilities within roads or public right-of-ways should be placed in conformance with the requirements of the governing agency (water district, public works department, etc.). Utility trench backfill within private property should be placed in conformance with the provisions of this report. In general, service lines extending inside of property may be backfilled with native soils compacted to at least 95% of the maximum dry density as determined by ASTM D1557 method above the pipe zone elevation. Sufficient backfill should be placed over the utility before compacting with heavy compactors to prevent damage. Backfill operations should be observed and tested to monitor compliance with these recommendations.

Subgrade Protection

The degree to which construction grading problems develop is expected to be dependent, in part, on the time of year that construction proceeds and the precautions which are taken by the contractor to protect the subgrade. The onsite fine-grained soils currently present on site may be considered to be moisture and disturbance sensitive due to their fines content and may become

unstable (pumping) if allowed to increase in moisture content and are disturbed (rutted) by construction traffic if wet. If necessary, the construction access road shall be covered with a layer of ballast or quarry spalls during wet weather conditions. The soils are also susceptible to erosion in the presence of moving water. The soils shall be stabilized to minimize the potential of erosion into the foundation excavation. The site shall be graded to prevent water from ponding within construction areas and/or flowing into excavations. Accumulated water must be removed immediately along with any unstable soil. Foundation concrete shall be placed and excavations backfilled as soon as possible to protect the bearing grade. We further recommend that soils that become unstable are to be either:

- Removed and replaced with structural compacted gravel fill, or
- Mechanically stabilized with a coarse crushed aggregate (possibly underlain with a geotextile) and compacted into the subgrade.

Wet Weather Conditions

The project site soils may be sensitive to moisture during handling and compaction particularly with regard to the native soils within Area 2. Proceeding with site earthwork operations using these soils during wet weather could add project costs and/or delays. The stability of exposed soils may rapidly deteriorate due to a change in moisture content. Therefore, if at all possible, complete site clearing, preparation, and earthwork during periods of warm, dry weather when soil moisture can be controlled by aeration. During or subsequent to wet weather, drying or compacting the on-site soils will be difficult. It may be necessary to amend the on-site soils or import granular materials for use as structural fill.

If earthwork takes place in wet weather or wet conditions, the following recommendations should be followed:

- Fill material should consist of clean, granular soil, and not more than 3 percent fines (by weight) should pass the No. 200 sieve. Fines should be non-plastic. These soils would have to be imported to the site.

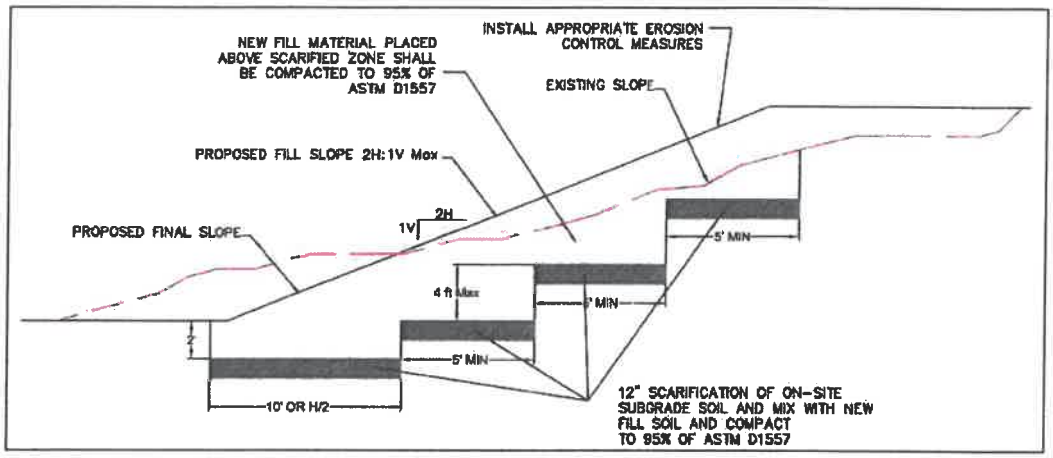
- Earthwork should be accomplished in small sections and carried through to completion to reduce exposure to wet weather. Soils that becomes too wet for compaction should be removed and replaced with clean, granular material.
- The construction area ground surface should be sloped and sealed to reduce water infiltration, to promote rapid runoff, and to prevent water ponding.
- To prevent soil disturbance, the size or type of equipment may have to be limited.
- Work areas and stockpiles should be covered with plastic. Straw bales, straw wattles, geotextile silt fences, and/or other measures should be used as appropriate to control soil erosion.

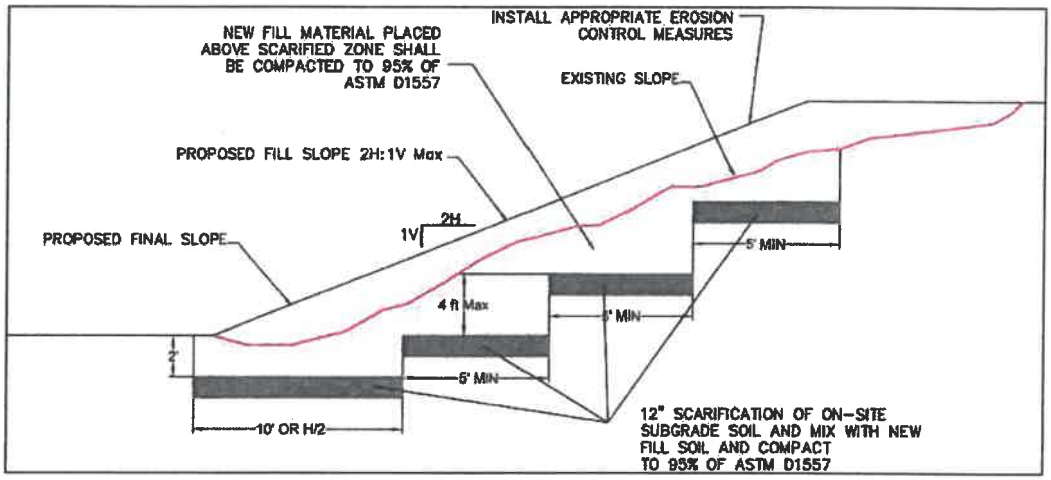
Excavation and fill placement should be observed on a full-time basis by a representative of GER to determine that unsuitable materials are removed and that suitable compaction and site drainage is achieved.

Graded Slope Construction

Development on sloping ground poses an inherent risk related to global and local stability of site slopes. In order to mitigate the potential hazards of erosion and slope instability, site development will require careful design and construction including proper drainage/erosion control measures.

All reconfigured slopes should be overfilled and trimmed back to competent material. A representative of the GER should observe all construction cuts to inspect for adverse geologic conditions and make appropriate recommendations based on the exposed conditions. Grading details for proper slope construction are shown below:


INSTALL APPROPRIATE EROSION CONTROL MEASURES
NEW FILL MATERIAL PLACED ABOVE SCARIFIED ZONE SHALL BE COMPACTED TO 95% OF ASTM D1557
EXISTING SLOPE
PROPOSED FILL SLOPE 2H:1V Max
PROPOSED FINAL SLOPE
1V
2H
5' MIN
4 ft Max
3' MIN
2'
5' MIN
10' OR H/2
12" SCARIFICATION OF ON-SITE SUBGRADE SOIL AND MIX WITH NEW FILL SOIL AND COMPACT TO 95% OF ASTM D1557


INSTALL APPROPRIATE EROSION CONTROL MEASURES
NEW FILL MATERIAL PLACED ABOVE SCARIFIED ZONE SHALL BE COMPACTED TO 95% OF ASTM D1557
EXISTING SLOPE
PROPOSED FILL SLOPE 2H:1V Max
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1V
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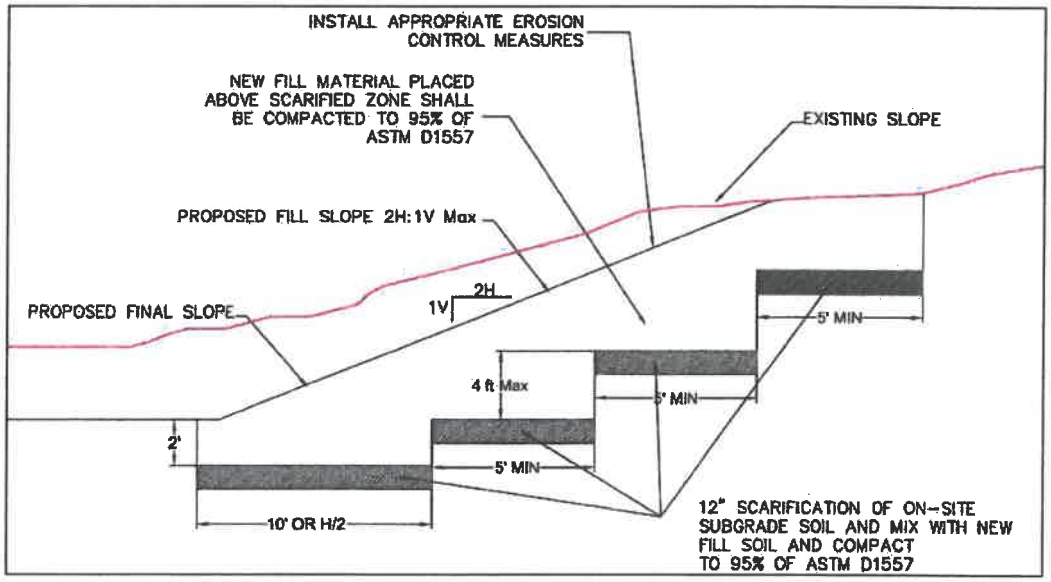
INSTALL APPROPRIATE EROSION CONTROL MEASURES
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EXISTING SLOPE
PROPOSED FILL SLOPE 2H:1V Max
PROPOSED FINAL SLOPE
1V
2H
5' MIN
4 ft Max
5' MIN
2'
5' MIN
10' OR H/2
12" SCARIFICATION OF ON-SITE SUBGRADE SOIL AND MIX WITH NEW FILL SOIL AND COMPACT TO 95% OF ASTM D1557

BMPs to control erosion on all graded slopes will be required. Landscaping should take into consideration the engineering characteristics of the slopes, especially with regards to the surficial stability of the slopes.

Fill Slopes (2H:1V Maximum Gradient)

Fill slopes should be overfilled and trimmed back to uniformly compacted material. The final slope surface should be track-walked or grid rolled to improve the slope's resistance to erosion.

Where fill slopes or stabilization fill slopes are to be constructed on natural slopes steeper than 5V:1H, the fill should be keyed and benched into firm natural soil. Keyways for all slopes, greater than 5 feet in height, should be cut into firm natural soil. This helps ensure a good bond between the existing native soil and new fill, and to eliminate a plane of weakness at the interface. Benching dimensions into existing native slopes shall be a minimum 5 feet horizontal and maximum 4 feet vertical from the lowest adjacent soil grade. Before engineered fill is placed, the key should be observed by a representative of the GER, to observe compliance with the above recommendations. It is recommended that the GER, or their representatives, be present during the fill construction to observe compliance with the above recommendations.

Compacted fill slopes shall be overbuilt and cut back to grade, exposing the firm, compacted fill inner core. The actual amount of overbuilding should vary as field conditions dictate. The degree of overbuilding should be increased until the desired compacted slope surface condition is achieved. Care should be taken by the contractor to provide thorough mechanical compaction to the outer edge of the overbuilt slope surface. Fill placement should proceed in thin lifts (8-10 inch loose thickness, depending upon compaction equipment). Each lift should be moisture-conditioned and thoroughly compacted. The desired moisture condition should be maintained during the period between successive lifts, and each lift should be tested to ascertain that desired compaction is being achieved.

At intervals not exceeding 4 feet in vertical slope height or the capability of available equipment, whichever is less, fill slopes should be thoroughly back-rolled utilizing conventional equipment. Care should be taken to maintain the desired moisture conditions as needed prior to back-rolling. Upon achieving final grade, the slopes should again be moisture

conditioned and thoroughly back-rolled. The use of a side boom roller may be necessary as well as vibratory methods. Without delay, the slopes should then be grid-rolled to achieve a relatively smooth surface and uniformly compact condition. Slope construction procedures shall be monitored, and moisture and density tests shall be taken at regular intervals.

Cut Slopes (2H:1H Maximum Gradient)

We recommend reconstruction of the proposed cut-slope faces by keying and benching into native soils, along with replacement with engineered fill. A key shall be constructed at the toe of the proposed cut slope, 24-inches deep, with horizontal dimensions of 10 feet of H/2 (where H is the finished height of the slope). Benching dimensions into native cut slopes shall be a minimum 5 feet horizontal and maximum 4 feet vertical from the lowest adjacent soil grade. The exposed native surface of the overcut bench should be scarified, moisture conditioned, and recompacted to a dense and non-yielding surface prior to replacement with engineered fill. The reconstructed cut slope faces shall be overbuilt and cut back to grade, exposing the firm and compacted surface. The GER, or their representatives, should monitor cut slopes during construction, to check for adverse geologic features exposed within the cut face.

A representative of the GER, should monitor cut slopes during construction, to check for adverse geologic features exposed within the cut face. Although not anticipated, slopes may require a shallower gradient or reconstruction as buttressed slopes if adverse geologic conditions and/or unsuitable trash and debris are exposed during construction.

Slope Maintenance and Erosion Protection

Some building sites may require appropriate setbacks from adjacent ascending or descending slopes in accordance with 2015 IBC Section 1808.7. Proper slope protection and maintenance will help minimize slope erosion and improve the stability of the project slopes. The project soils are prone to erosion and will require appropriate BMP protection and maintenance. Positive drainage should be provided at the tops of all slopes to divert runoff away from the face. Swales constructed in native soils should be lined with suitable no-erosive material. Erosion protection should be provided, especially where concentrated runoff is anticipated. A qualified Landscape Architect should provide recommendations for slope planting. As the exposed site soils are susceptible to erosion, it is required that erosion control measures, such as planting, erosion control blankets or

fabrics, sprayed tackifiers, or some combination of these, be utilized on all slopes within the project. Landscaping should take into consideration the engineering characteristics of the slopes, especially with regards to the surficial stability.

The need for and design of surface runoff/drainage control and erosion protection measures is within the purview of the design civil engineer. In general, erosion should be mitigated with best management practices (BMPs) consisting of proper drainage design including collecting and disposal (conveyance) of water to approved points of discharge in a non-erosive manner. Appropriate project design, construction, and maintenance will be necessary to mitigate the site erosion concerns.

Foundation Bearing Support Zone and Allowable Bearing Capacity

Foundations supported on structural engineered fill prepared as discussed above (*Building Pad & Foundation Subgrade Preparation* section) may be proportioned for an allowable soil bearing capacity of 2,000 psf. These values may be increased by up to one-third (33%) for short-term (transient) loading events. We estimate the total settlement for footings to be less than 1 inch, with differential settlement less than half that magnitude.

To conform to the local building codes, we recommended extending all exterior footings at least 24 inches below the adjacent exterior finished grade for frost protection. Interior footings may be supported at nominal depths below the floor. All footings shall be protected against weather and water damage during and after construction and must be supported on suitable bearing materials as described above.

Lateral forces on the foundation from wind and seismic loading would be resisted by friction at the base of foundations and passive earth pressure against the buried portions. A one-third (33%) increase in these values may be used for short duration wind and seismic lads. We recommend a passive earth pressure in compacted structural backfill of 275 pcf. This lateral foundation resistance values includes a factor of safety of 1.5. We recommend using a coefficient of friction of 0.45 between the cast-in-place concrete and compacted crushed rock. An appropriate factor of safety should be used to calculate sliding resistance at the base of footings

Slope Setbacks

In accordance with IBC 2015 Section 1808.7 *Foundations on or Adjacent to Slopes*, "footings on or adjacent to slope surfaces shall be founded in firm material with embedment and setback from the slope surface sufficient to provide vertical and lateral support for the footing without detrimental settlement. Where the slope is steeper than 1 unit vertical in 1 unit horizontal, the required set back shall be measured from an imaginary plane 45 degrees to the horizontal, projected upward from the toe of the slope." The long term performance of the structure near slopes is dependent on the protection of slopes from erosion or over steepening by cutting into the toe of the slope. Lots should be maintained to prevent erosion or undermining the toe. If the slopes will be modified from their constructed configuration, we recommend using properly designed retaining walls. Based on the existing site conditions, we anticipate cut and fill grading will be required to develop level building pad sites.

Retaining Walls

Based on the preliminary grading plans, we understand that retaining walls are proposed within Area 2. Retaining walls allowed to deflect may be designed for an active equivalent fluid pressure of 40 psf per foot of depth (psf/foot), while retaining walls restrained from movement (basement walls) may be designed using an at-rest equivalent fluid pressure of 60 psf/foot. The earth pressures presented herein assume that no surcharge loads exist, the backfill is level, the walls are backfilled with granular material and include a footing drain, and will not develop hydrostatic pressures. The project structural engineer should be responsible for the design of structural elements such as basement walls and footing considering the actual structural loading conditions in conjunction with the geotechnical parameters provided in the report.

Slab-on-Grade Floors

We recommend placing a minimum 6-inch layer of crushed aggregate fill beneath all building floor slabs atop the re-constructed building pad as recommendation in the *Building Pad & Foundation Subgrade Preparation* section. The material shall meet *WSDOT Specification* section 9-03.9 (3), "Crushed Surfacing Top Course", with less than 5% passing the No. 200 sieve (fines). The crushed rock material shall be compacted to at least 95% of the maximum dry density as determined by the ASTM D1557 method. Assuming a minimum crushed rock thickness of 6

inches placed on improved subgrade, we recommend using a subgrade modulus of 180 pci (pounds per square inch per inch).

Slab thickness and reinforcement of slabs-on-grade are contingent on the recommendations of the structural engineer or architect. Concrete slabs and flatwork should be a minimum of 4 inches thick (actual, not nominal). We suggest reinforcing the concrete slabs to resist potential cracking. Concrete floor slabs may either be monolithically placed with the foundations or doweled after footing placement. The thickness and reinforcing given are not intended to supersede any structural requirements provided by the structural engineer.

Control joints should be provided in all concrete slabs-on-grade at a maximum spacing of 36 times the slab thickness (12 feet maximum on-center, each way) as recommended by American Concrete Institute (ACI) guidelines. All joints should form approximately square patterns to reduce the potential for randomly oriented shrinkage cracks. Construction joints in the slabs should be tooled at the time of the concrete placement or saw cut (¼ of slab depth) as soon as practical but not more than 8 hours from concrete placement. Construction (cold) joints should consist of thickened butt joints with ½-inch dowels at 18-inches on center or a thickened keyed-joint to resist vertical deflection at the joint. These procedures will reduce the potential for randomly oriented cracks, but may not prevent them from occurring.

A vapor retarder (15-mil polyethylene liner) shall be used in all areas receiving resilient flooring/VCT to prevent moisture migration through the slab. The slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder. We recommend measuring the slab moisture vapor emission rate and relative humidity prior to placing the VCT flooring. Concrete floor slabs shall be tested for relative humidity in concrete per ASTM F2170-11 when the building has been properly conditioned. Manufacturer's guidelines shall be adhered to in performing the slab moisture test. The architect shall determine the need and use of a vapor retarder.

Swimming Pool

The design and construction criteria presented below should be observed for the swimming pool. The construction details should be considered when preparing the project documents. The pool should be designed and constructed to withstand differential movement without cracking. We anticipate that excavation for the pool may extend into clayey soils. Therefore, we recommend that a representative of GNN shall inspect the excavation bottom and determine the need for additional sampling and testing in real-time, if necessary.

The swimming pool subgrade shall consist of a non-expansive, impervious material that is dense and/or compacted to 95% of the maximum dry density at or above optimum moisture content. An impervious membrane, such as sprayed on rubberized asphalt or PVC, may be provided on the walls of the excavation to help prevent moisture from migrating into the fine-grained material.

A minimum 12-inch free-draining gravel layer shall be placed beneath the deck and pool. The drainage layer under the pool should slope to a drain line or collection point from which water can be removed by pumping or gravity drainage. The drainage layer under the deck should slope to a perimeter drain or be connected to the under pool layer by free-draining backfill. The drains should consist of perforated plastic pipe surrounded by a minimum of 12 inches of free-draining granular material. The free-draining granular material should consist of minus 2-inch aggregate with less than 3% passing the No. 200 sieve and less than 50% passing the No. 4 sieve.

Flexible Pavement

Pavement analyses are based on *1993 AASHTO Guide for Design of Pavement Structures*. The following table presents recommended light-duty and heavy-duty pavement sections for this project:

Table 6: Recommended Pavement Sections

Traffic	Asphalt Thickness (inches)	Crushed Aggregate Base Course (inches)
Heavy Duty†	4	10.0*
Standard Duty ††	2.5	6.0

†Heavy duty applies to pavements subjected to heavy truck traffic and delivery trucks
††Standard duty applies to general parking areas
*The upper 2 inches of crushed rock should be Top Course material placed over the Base Course layer

The pavement design recommendations assume that the subgrade and placement of fills be prepared in accordance with the recommendations of this report. The upper 12 inches beneath the pavement surface shall be moisture conditioned to near optimum, re-compacted and proof-rolled to a dense and non-yielding surface, and/or compacted to a minimum 95% of the maximum dry density as determined by ASTM D1557. The asphalt paving materials should be compacted to a minimum 92% of the maximum theoretical specific gravity (Rice's density). Pavement design recommendations assume proper drainage and construction monitoring and are based on AASHTO Design parameters for a 20-year design period. However, continual flexible maintenance along with major rehabilitation after about 8 to 10 years may be expected to obtain a 20-year service life.

Upon completion of required stripping and removal of topsoil and fine grained soils with organics, we recommend that the entire pavement subgrade should be scarified to a minimum depth of 12 inches, moisture conditioned and re-compacted to a dense and non-yielding surface with appropriate heavy compaction equipment. If a weak subgrade area (soft and yielding soil) is noticed during densification or proof-rolling, that area shall be over-excavated an additional 12 inches and repaired with compacted on-site soils or imported granular structural fill. Depending on the time of year earthwork begins, anticipate moisture conditioning to facilitate compaction. The base course rock must be placed as structural fill in uniform, horizontal lifts and each 6-inch lift must be compacted to at least 95% of the maximum dry density as determined by ASTM D1557 method. We recommend that proper surface and subsurface drainage measures must be incorporated in the parking lot design. Crushed aggregate base course material shall conform to *2016 WSDOT Standard Specifications* section 9-03.9(3), Crushed Surfacing Base Course.

Surface Drainage

With respect to surface water drainage, we recommend that the ground surface be sloped to drain away from the structure. Final exterior site grades shall promote free and positive drainage from the building areas. Water shall not be allowed to pond or to collect adjacent to foundations or within the immediate building area. We recommend that a gradient of at least 5% for a minimum distance of 10 feet from the building perimeter be provided, except in paved locations. In paved areas, a minimum gradient of 1% should be provided unless provisions are included for collection/disposal of surface water adjacent to the structure. Catch basins, drainage swales, or other drainage facilities should be aptly located. All surface water such as that coming from roof

downspouts and catch basins be collected in tight drain lines and carried to a suitable discharge point, such as a storm drain system. Surface water and downspout water should not discharge into a perforated or slotted subdrain, nor should such water discharge onto the ground surface adjacent to the building. Cleanouts should be provided at convenient locations along all drain lines.

REFERENCES

City of Black Diamond, Coal Mine Hazard Areas – Information Sheet, http://www.ci.blackdiamond.wa.us/Depts/CommDev/building/forms/Coal%20Mine%20Hazard%20Handout.pdf

Icicle Creek Engineers, Inc., February 8, 2007, Report, Geologic Engineering Services, Coal Mine Hazard Assessment, Ground Proofing Program, Suncadia Phase 1, Proposed Rope Rider Ridge Residential Development Area, Kittitas County, Washington, Project No. 0523-027.

JUB Engineers, Inc., August, 2017, Preliminary Plat, Winemaker's Cabins at Swiftwater Cellars, plan set, Sheet Numbers 1 – 5.

King County, Part Two – Critical Areas, Coal Mine Hazard Areas, http://www.kingcounty.gov/~/media/depts/permitting-environmental-review/dper/ documents/cao/manual/II-CoalMine.ashx

Kittitas County, Kittitas County Code, Title 17A Critical Areas, https://www.co.kittitas.wa.us/boc/countycode/title17a.aspx

Northwestern Improvement Company, 1963, Map of Roslyn No. 9 Mine, Roslyn, Washington, scale 1:1,200.

United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), Web Soil Survey, online mapping service, http://websoilsurvey.sc.egov.usda.gov/.

United States Geological Survey, Earthquake Hazards Program, Unified Hazard Tool (on-line), https://earthquake.usgs.gov/hazards/interactive/

United States Geological Survey, Hydrogeologic Framework and Groundwater/Surface-Water Interactions of the Upper Yakima River Basin, Kittitas County, Central Washington.

Washington State Department of Natural Resources (DNR), Washington Division of Geology and Earth Resources, November 1980, Geology and Energy Resources of the Roslyn-Cle Elum Area, Kittitas County, Washington, Open File Report OF-80-1.

Washington State Department of Natural Resources (DNR), Washington Division of Geology and Earth Resources, on-line mapping tool, https://fortress.wa.gov/dnr/protectiongis/geology/

ADDITIONAL SERVICES

GNN recommends that the Client should maintain an adequate program of geotechnical consultation, construction monitoring, and soils testing during the final design and construction phases to monitor compliance with GNN's geotechnical recommendations. Maintaining GNN as the geotechnical consultant from beginning to end of the project will provide continuity of services. If GN Northern, Inc. is not retained by the owner/developer and/or the contractor to provide the recommended geotechnical inspections/observations and testing services, the geotechnical engineering firm or testing/inspection firm providing tests and observations shall assume the role and responsibilities of Geotechnical Engineer-of-Record.

GNN can provide construction monitoring and testing as additional services. The costs of these services are not included in our present fee arrangement, but can be obtained from our office. The recommended construction monitoring and testing includes, but is not necessarily limited to, the following:

- Consultation during the design stages of the project.
- Review of the grading and drainage plans to monitor compliance and proper implementation of the recommendations in GNN's Report.
- Observation and quality control testing during site preparation, grading, and placement of engineered fill as required by the local building ordinances.
- Geotechnical engineering consultation as needed during construction

LIMITATIONS OF THIS REPORT

This COAL MINE HAZARDS ASSESSMENT & GEOTECHNICAL EVALUATION REPORT ("Report") was prepared for the exclusive use of the Client. GN Northern, Inc.'s (GNN) findings, conclusions and recommendations in this Report are based on selected points of field exploration, laboratory testing, and GNN's understanding of the proposed project at the time the Report is prepared. Furthermore, GNN's findings and recommendations are based on the assumption that soil, rock and/or groundwater conditions do not vary significantly from those found at specific exploratory locations at the project site. Variations in soil, bedrock and/or groundwater conditions could exist between and beyond the exploration points. The nature and extent of these variations may not become evident until during or after construction. Variations in soil, bedrock and groundwater may require additional studies, consultation, and revisions to GNN's recommendations in the Report.

This Report's findings are valid as of the issued date of this Report. However, changes in conditions of the subject property or adjoining properties can occur due to passage of time, natural processes, or works of man. In addition, applicable building standards/codes may change over time. Accordingly, findings, conclusions, and recommendations of this Report may be invalidated, wholly or partially, by changes outside of GNN's control. Therefore, this Report is subject to review and shall not be relied upon after a period of one (1) year from the issued date of the Report.

In the event that any changes in the nature, design, or location of structures are planned, the findings, conclusions and recommendations contained in this Report shall not be considered valid unless the changes are reviewed by GNN and the findings, conclusions, and recommendations of this Report are modified or verified in writing.

This Report is issued with the understanding that the owner or the owner's representative has the responsibility to bring the findings, conclusions, and recommendations contained herein to the attention of the architect and design professional(s) for the project so that they are incorporated into the plans and construction specifications, and any follow-up addendum for the project. The owner or the owner's representative also has the responsibility to verify that the general contractor and all subcontractors follow such recommendations during construction. It is further understood

that the owner or the owner's representative is responsible for submittal of this Report to the appropriate governing agencies. The foregoing notwithstanding, no party other than the Client shall have any right to rely on this Report and GNN shall have no liability to any third party who claims injury due to reliance upon this Report, which is prepared exclusively for Client's use and reliance.

GNN has provided geotechnical services in accordance with generally accepted geotechnical engineering practices in this locality at this time. GNN expressly disclaims all warranties and guarantees, express or implied.

Client shall provide GNN an opportunity for to review the final design and specifications so that earthwork, drainage and foundation recommendations may be properly interpreted and implemented in the design and specifications. If GNN is not accorded the review opportunity, GNN shall have no responsibility for misinterpretation of GNN's recommendations.

Although GNN can provide environmental assessment and investigation services for an additional cost, the current scope of GNN's services does not include an environmental assessment or an investigation for the presence or absence of wetlands, hazardous or toxic materials in the soil, surface water, groundwater, or air on, below, or adjacent to the subject property.

APPENDICES

Appendix I
FIGURES

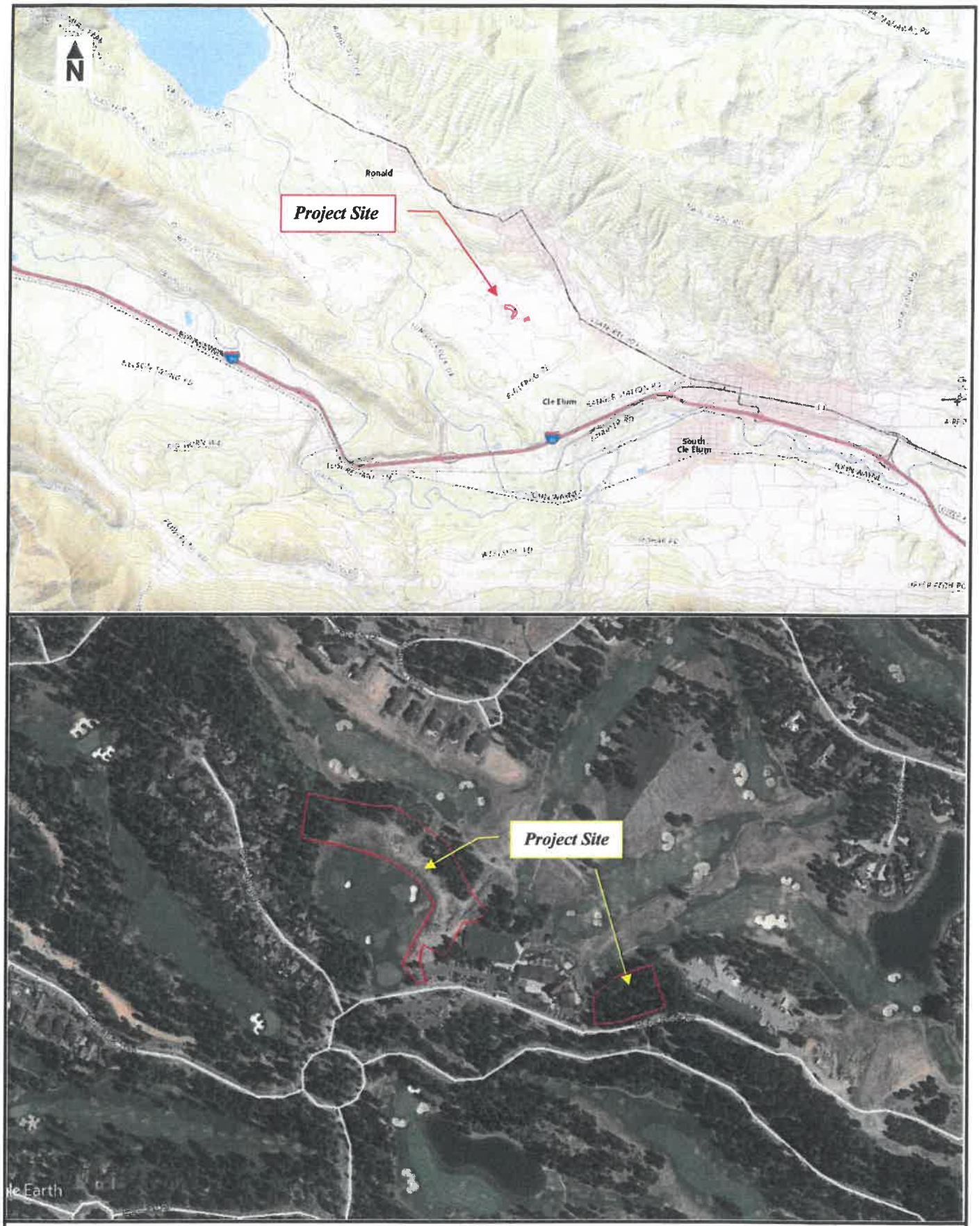

FIGURE 1: SITE VICINITY MAP **PROJECT NO. 217-871**