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Geologic Hazard Plan

Submitted with Form 2A Application for the Laramie Energy Laramie 0993-29-01 Well Site
NENE Section 29, T. 9 S., R. 93 W., 6th P.M.
Mesa County, Colorado

Prepared by:

GEI Consultants, Inc.
4601 DTC Boulevard, Suite 900
Denver, Colorado 80237

June 2023
GEI Project No. 2201944

Scott Yehl, P. G.
Senior Geologist

Christopher Slack, P.G., C.E.G.
Senior Engineering Geologist

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Attachments

Acronyms and Abbreviations

ECMC	Colorado Energy & Carbon Management Commission
CGS	Colorado Geological Survey
DWR	Colorado Division of Water Resources
EPA	Environmental Protection Agency
FWS	Fish and Wildlife Service
NRCS	Natural Resources Conservation Service
NAVD88	North American Vertical Datum of 1988
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
WSS	Web Soil Survey

1 Introduction

Laramie Energy, LLC retained GEI Consultants, Inc. to develop Geologic Hazards Maps and Plans for proposed drilling activities at the Laramie 0993-29-01 Well Site (Site) to address Colorado Energy & Carbon Management Commission (ECMC) requirements outlined in Rule 304.b.(7).I. Geologic Hazard Map and Rule 304.c.(21) Geologic Hazard Plan of ECMC's Operator Guidance Manual. The purpose of this document is to summarize and evaluate the identified geologic hazards present within a one (1) mile radius of the well pad through a desktop review of publicly available documents, data and literature on geologic conditions of the Site, as well as outlining mitigation measures for any hazards that are identified. Site specific geologic field mapping, or comprehensive desktop mapping using LiDAR and/or aerial imagery was not part of this scope.

2 Site Overview

The Site is in the NENE corner of Section 29, T. 9 S., R. 93 W., 6th P.M., in Mesa County, Colorado. The latitude and longitude coordinates are 39.254757°N and 107.784354°W. A location map is provided in Figure 1. It is our understanding that access to the site will be afforded by an existing lease road that extends south from highway 330, along Groundhog Gulch that leads to the proposed access road to be constructed.

2.1 Site Topography

A publicly available LiDAR dataset that includes the project area was collected by the USGS in 2016, as shown in Figure 2. Based on this dataset, the proposed well pad location is at an approximate elevation of 7,450 feet (NAVD88).

The pad is situated within a small tributary valley to Ground Hog Gulch. The western portion of the pad is adjacent to a localized ridge that is on the order of 75-feet higher than the pad. The topography in the immediate vicinity of the pad is gently sloping to the south. The local relief within a mile radius of the pad is approximately 1,000 feet.

2.2 Site Geology

A regional geologic map of the pad vicinity is provided in Figure 3. As shown on the USGS geologic map (Ellis, 1984) the location of the pad is interpreted to be situated on bedrock of the Wasatch Formation, at the margin of Quaternary alluvial deposits that are associated with the tributary valley. Subsequent surficial geologic mapping published by the Colorado Geological Survey (CGS) (Soule, 1988) interprets the pad to be located outside of and upslope of any mapped landslides (Figure 4). Soule (1988) delineates several other landslides within a 1-mile radius of the site, however, they do not impact the site.

The bedrock that the pad resides on is Late Paleocene to Early Eocene Wasatch Formation sedimentary bedrock. The Wasatch Formation is highly fossiliferous and primarily composed of claystone, siltstone, sandstone, and shale deposited in fluvial, paludal and lacustrine environments. The formation can be friable and is susceptible to slope failures, particularly under saturated conditions.

2.3 Site Hydrogeology

A site hydrogeology discussion is not included in this scope. Laramie Energy's wetlands evaluation is provided in a separate submittal for additional discussion and has not been reviewed by GEI.

3 Potential Geologic Hazards

This geologic assessment was performed to identify potential hazards within one (1) mile of the working pad surface, and was prepared in general accordance with ECMC Rules 304.b.(7).I. Geologic Hazard Map and 304.c.(21) Geologic Hazard Plan. The Geologic Hazard Maps prepared for the Site are based on information presented in the COGCC's online GIS database and contained in the CGS Open File 88-1 map titled *Surficial-Geologic and Landslide Map of Vega Reservoir and Vicinity, Mesa County, Colorado* (Soule, 1988). The Geologic Hazard Maps developed for this submittal are included as Figures 4, 5 and 6. No site-specific field mapping was performed as part of this assessment.

3.1 Avalanches

According to the Mesa County Hazard Mitigation Plan (Mesa County, 2020), less than 10 percent of the county is subject to avalanches. Most of these avalanches occur on the upper slopes of Grand Mesa. A comprehensive database showing existing avalanche areas, or relative avalanche hazard ratings in Mesa County was not identified for review in this assessment. However, based on preliminary review of aerial imagery and LiDAR, the Site is not located in a steeply sloping area or at the base of a clearing that would suggest active or youthful avalanche activity. Avalanches are considered to present a "low" risk to the Site.

3.2 Landslides

The CGS Landslide Inventory is a compilation database that includes published and unpublished mapping in the vicinity of the proposed well pad. The compilation database is presented at a scale of 1:24,000 (which is the highest available resolution). The locations of the CGS mapped landslides are shown in yellow polygons (undifferentiated) on Figure 4. Published landslide mapping (Soule, 1988), from which the CGS Landslide Inventory data are partially derived, is also shown on Figure 4.

The CGS also includes a mapped landslide in their data base that includes a large area north of the Laramie 0993-29-01 well pad. It is important to note that this landslide is compiled from an unsourced publication mapped at a scale of 1:250,000 and included in a separate database from the higher resolution 1:24,000 database that the CGS maintains. The approximate extent of the landslide is labeled Landslide A on Figure 4. Review of the LiDAR in comparison to the limit of Landslide A indicates the mapped limits are quite crude. Moreover, the mapped extent is north and outside of the drainage basin of the well pad and would pose no hazard to the site if it even existed.

There are several recent landslides within a half mile of the well pad that are evident in the LiDAR. The potential runout of these slides shown on Figure 4 are highly unlikely to directly impact the well pad, however, it is possible progression of these slides could hinder access along nearby lease roads.

It is worth noting the western side of the well pad is immediately adjacent to an isolated ridge that has a local relief of approximately 75-feet above the pad. This slope adjacent to the well pad is in excess of 25-degrees in places. Within the site area slopes of this steepness can be prone to landslides. This is demonstrated by a nearly 400-feet long recent landslide that is emanating from the same ridge immediately west of the well pad (Figure 4). During development of the well pad, disturbances and oversteepening of the hillslope adjacent to the well pad should be avoided. Due to the proximity to the adjacent hillslope there is a “low to moderate” level of risk.

3.3 Rockfalls

The Mesa County Hazard Mitigation Plan indicates that the Site is not located within a rockfall hazard zone (Mesa County, 2020). Review of aerial imagery indicates there are several rock outcrops near the pad, however, they appear to have low relief and not to be susceptible to failures impacting the pad. Rockfall is considered to present a “very low” level of risk to the Site.

3.4 Seismic Effects

The Site is not located near any known faults. The closest identified faults based on information on the CGS Earthquake and Fault Map Server are a group of unnamed faults along the Grand Hogback Monocline near Glenwood Springs, which are approximately 25 miles from the Site (Morgan and Fitzgerald, 2022). The nearest historical earthquakes in the CGS database are at least 11 miles from the Site. As such, fault surface rupture hazards are considered to present a “very low” level of risk to the Site. A seismically induced landslide from a regional earthquake is possible but considered to present a “low” level of risk to the Site.

3.5 Radioactivity

Radioactive hazards are characterized by the presence of radon. According to the Environmental Protection Agency (EPA, 2019) Map of Radon Zones, Mesa County is listed as a Zone 1 county, which indicates high levels of predicted average indoor radon screening levels. However, workers will spend the entirety of their shifts outside and will not be exposed to radon, if present. Therefore, radon is considered to present a "very low" level of risk to the Site.

3.6 Ground Subsidence and Collapsible Soils

Ground subsidence is the sinking or settling of the ground surface due to collapse of subsurface mines, sinkhole development, or loss of soil structure. According to information in the ECMC GIS database, there are no mining operations within one (1) mile radius of the Site which could lead to subsidence (ECMC, 2022). Bedrock at the Site does not include formations that are considered conducive to natural sinkhole development due to the lack of limestone and karst features. Additionally, according to the CGS there are no collapsible soils mapped within the one (1) mile radius of the Site (CGS, 2022). Ground subsidence and collapsible soils are considered to present a very low potential hazard to the Site.

3.7 Corrosive Soils

Risk of corrosion pertains to the potential soil-induced electrochemical or chemical action that corrodes or weakens uncoated steel or concrete. The rate of corrosion of these materials is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. Based on these attributes, the Web Soil Survey (WSS) categorizes soils as having either "low", "moderate", or "high" risk of corrosion to steel or concrete.

The WSS (Web Soil Survey) database classifies soils at the Site as having "moderate" to "high" risk for soil-induced corrosion or weakening of uncoated steel, and "low risk" for the corrosion or weaking of concrete. The risk classifications for steel and concrete in the Site's one-mile radius are presented in Figures 5 and 6, respectively.

4 Potential Mitigation Measures for Identified Geologic Hazards

4.1 Landslides

Existing published mapping shows that the Laramie 0993-29-01 well pad is outside of any published mapped landslides, or existing landslides that GEI interpreted from desktop review of the LiDAR. However, as described in Section 3.2, the steepness of the hillside adjacent to the well pad (to the west) can be susceptible to slope failures in

the region. If the hillside were to destabilize it could runout on the pad resulting in significant disruptions to oil and gas operations. Slope instability could be induced by high precipitation events or sustained rainy periods, and any oversteepening of the slope from grading or erosion. The susceptibility of slope movement is also dependent on the local condition of the underlying Wasatch formation. As such, GEI included best management plan (BMP) considerations to address landslide potential in Section 4.4 below.

4.2 Corrosive Soils

The WSS (Web Soil Survey) database classifies soils at the Site as being at the border of “moderate” to “high” risk for soil-induced corrosion or weakening of uncoated steel, and “low risk” for the corrosion or weaking of concrete. To mitigate this hazard, it is recommended that the subsurface well pipes should be coated and incorporate sacrificial anodes. Cased wells should be encased in concrete.

4.3 Contingency Plan

Laramie Energy has submitted several action plans which cover safety issues that could arise at the Site, including geologic hazards. These plans include the Laramie 0993-29-01 Oil and Gas Development Plan (OGDP) Emergency Response Plan, the Spill Prevention Control and Countermeasure Plan: Western Colorado Facilities, the North Vega Stormwater Management Plan, the Stormwater Management Plan, and the Laramie Energy Flowline Management Plan. These documents provide details regarding best management practices for the Site and guidance in the event of a hazard occurrence and should be updated frequently and referenced if a relevant incident occurs at the well pad.

4.4 Site Specific BMPs

Site-specific BMPs for the Laramie Energy Laramie 0993-29-01 Well Pad include the following considerations:

- Laramie should avoid cutting into and grading the slope west of the pad. This could lead to over-steepening the slope and an increased likelihood of a slope failure impacting the well pad.
- Constructing and maintaining adequate surface drainage around the perimeter of the well pad.
- Design-level geotechnical plans and drawings for ground improvements that specify the type, depth, and extent of sub-excavation and replacement fill. Fill slopes should be placed, moisture conditioned, and compacted to 95% of the maximum dry density according to ASTM D698 or AASHTO T99 to reduce the

potential for instability at the well pad, and the well pad surface should be sloped to avoid ponding water.

- Performing periodic seasonal monitoring of the hillslope west of the pad to detect any incipient slope movement or erosion that could be mitigated before impacting the pad.
- Additional improvements of the drill pad construction using materials such as Soilcrete®, plastic, rubber and/or oak mats under the drill rig subsurface, should be considered to better support the drilling rig loads.

5 Conclusions and Summary

The geologic hazards at the site include potential slope movements from the hillside to the west and corrosive soils. The most effective way to reduce the risk of a slope failure from the slope west of the well pad, is by avoiding any earthwork that could over-steepen the slope or moving the pad footprint further from the toe of the slope. The potential for these hazards to impact operations at the site can also be reduced through frequent monitoring by operators and employing engineering controls such as drainage provisions, shallow excavated slopes, compacting fill materials, and using corrosion protection.

To safely develop this Site, Laramie Energy should follow the practices listed in this plan, follow BMPs incorporated into their standard operating procedures for the site, have draft plans and drawings of site work reviewed by an engineer, and carry out periodic inspections to monitor any changes in ground condition at the site and the area surrounding the well pad, particularly following periods of increased precipitation.

6 Certification

I certify that I am a Professional Geologist, having met the educational requirements and professional work experience required by C.R.S. § 23-41-208(b). I certify that the Geologic Hazard Plan described herein is, to the best of my knowledge, accurate and complete.

Signature:_____ Date:__6-5-2023____

Christopher Slack, P.G., C.E.G CA (PG 8994, CEG 2638)

Christopher Slack's professional resume is provided in Attachment B.

7 Limitation of Liability

In the performance of its professional services, GEI Consultants, Inc., its employees, and its agents comply with the standards of care and skill ordinarily exercised by

members of our profession practicing in similar localities. The observations and recommendations made in this report are based on a desktop data review of existing information, unanticipated site conditions cannot be fully disclosed using this approach. Accordingly, this screening level report may not provide all the information needed to fully assess the hazard risk at this site. No warranty, either express or implied, is made or intended in connection with the work performed by us or by the furnishing of oral or written reports or findings. In the event conclusions or recommendations based on these data are made by others, such conclusions and recommendations are not our responsibility unless we have been given an opportunity to review and concur with such conclusions or recommendations in writing.

8 References

Colorado Division of Water Resources (DWR) (2022). Groundwater Water Levels Database. Website accessed June 2023 via: https://dwr.state.co.us/Tools/GroundWater/WaterLevels?submitButton=Submit&SelectedGeoValue=countyDiv&SelectedCountyId=39&SelectedPublicationAreaName=All&SelectedAquiferName=All

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Morgan, Matthew L., and F. Scot Fitzgerald (2019). "ON-001 Colorado Earthquake and Fault Map." Earthquake, (scale variable) online map. Golden, CO: Colorado Geological Survey. July 1, 2019. Website accessed June 2023 via: https://cgsarcimage.mines.edu/ON-001/

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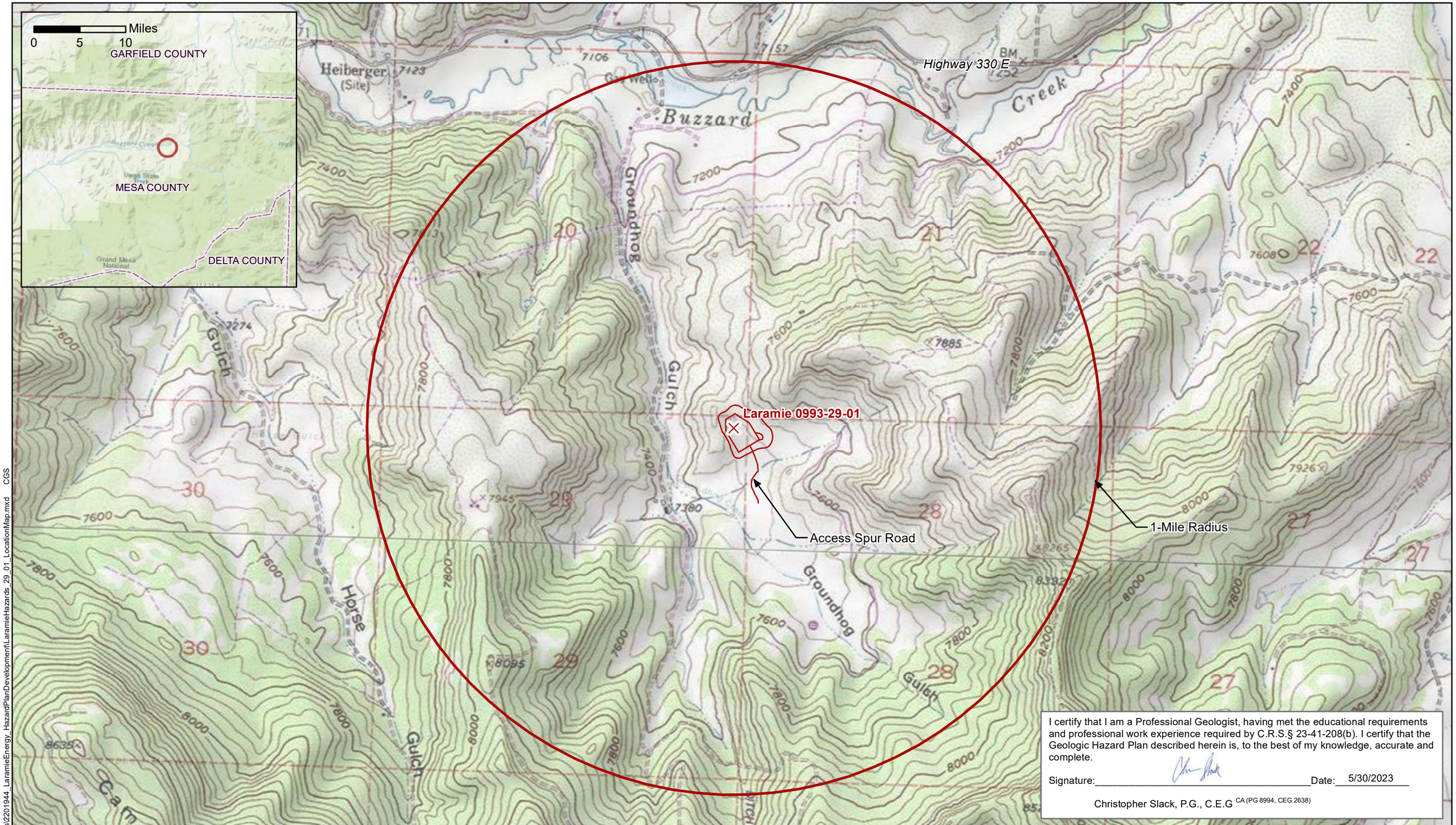
Soule, James M. (1988). Surficial Geological and Landslide Map of Vega Reservoir and Vicinity, Mesa County, Colorado. Colorado Geological Survey Open File Report 88-1. 1 plate.

United States Geological Survey (USGS) (1984). Geologic Map and Cross Sections of the Carbondale 30' x 60' Quadrangle, West-Central Colorado.

Attachment A – Figures



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Signature:_____ Date: 5/30/2023

Christopher Slack, P.G., C.E.G CA (PG 8994, CEG 2638)

0 0.25 0.5 1 Miles

N E S W

Laramie 0993-29-01
Geologic Hazard Plan
NENE, Section 29, T.9 S., R 93 W., 6th P.M.

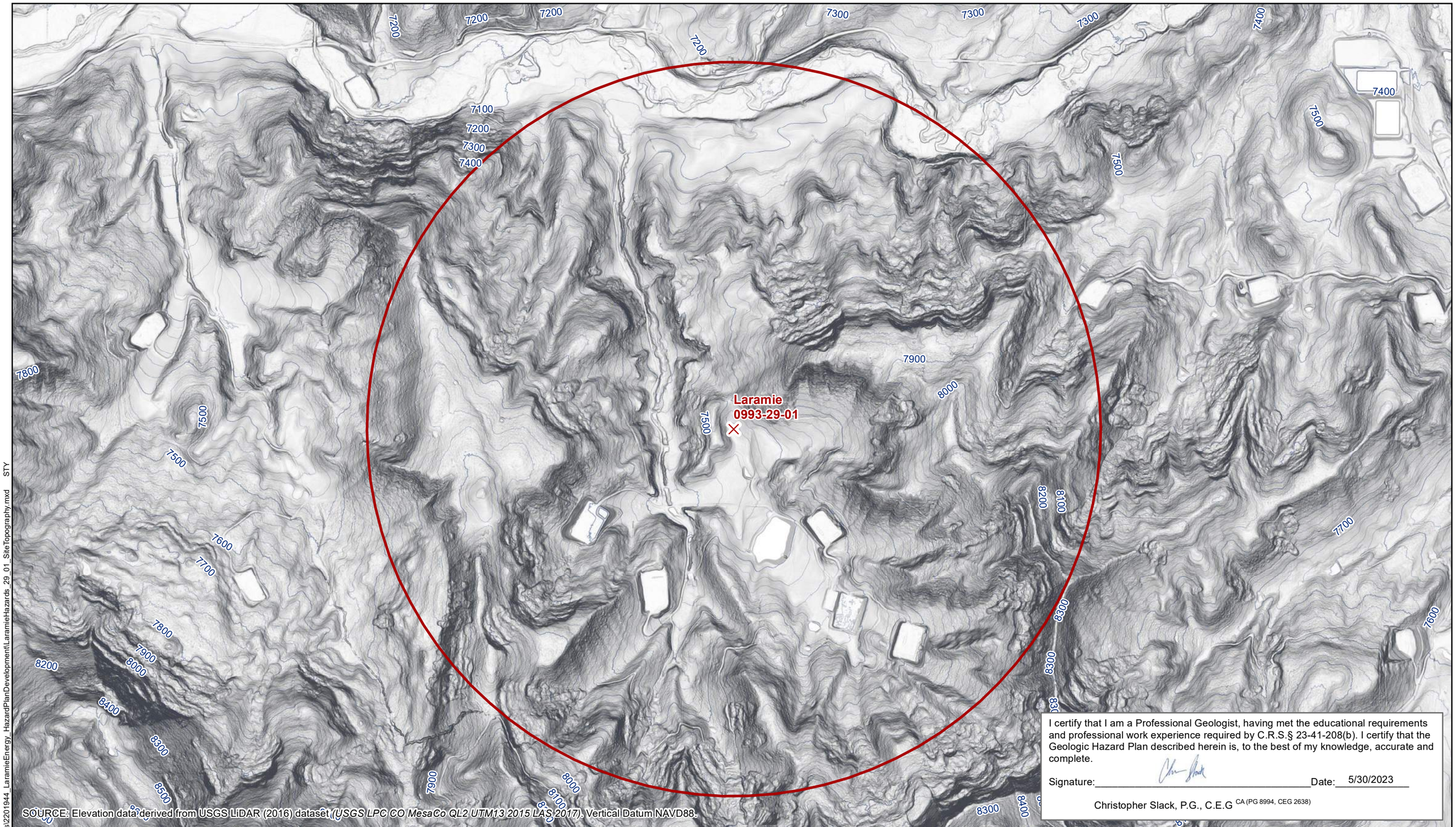
Laramie Energy, LLC

GEI Consultants

LARAMIE 0993-29-01
WELL PAD LOCATION AND VICINITY

June 2022 Figure 1

30-May-2023 Z:\Projects\2201944_LaramieEnergy_HazardPlanDevelopment\LaramieHazards_29_01_LocationMap.mxd CGS



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Christopher Slack, P.G., C.E.G CA (PG 8994, CEG 2638)

0 0.25 0.5 1 Miles

N W E S

Laramie 0993-29-01
Geologic Hazard Plan
NENE, Section 29, T.9 S., R 93 W., 6th P.M.

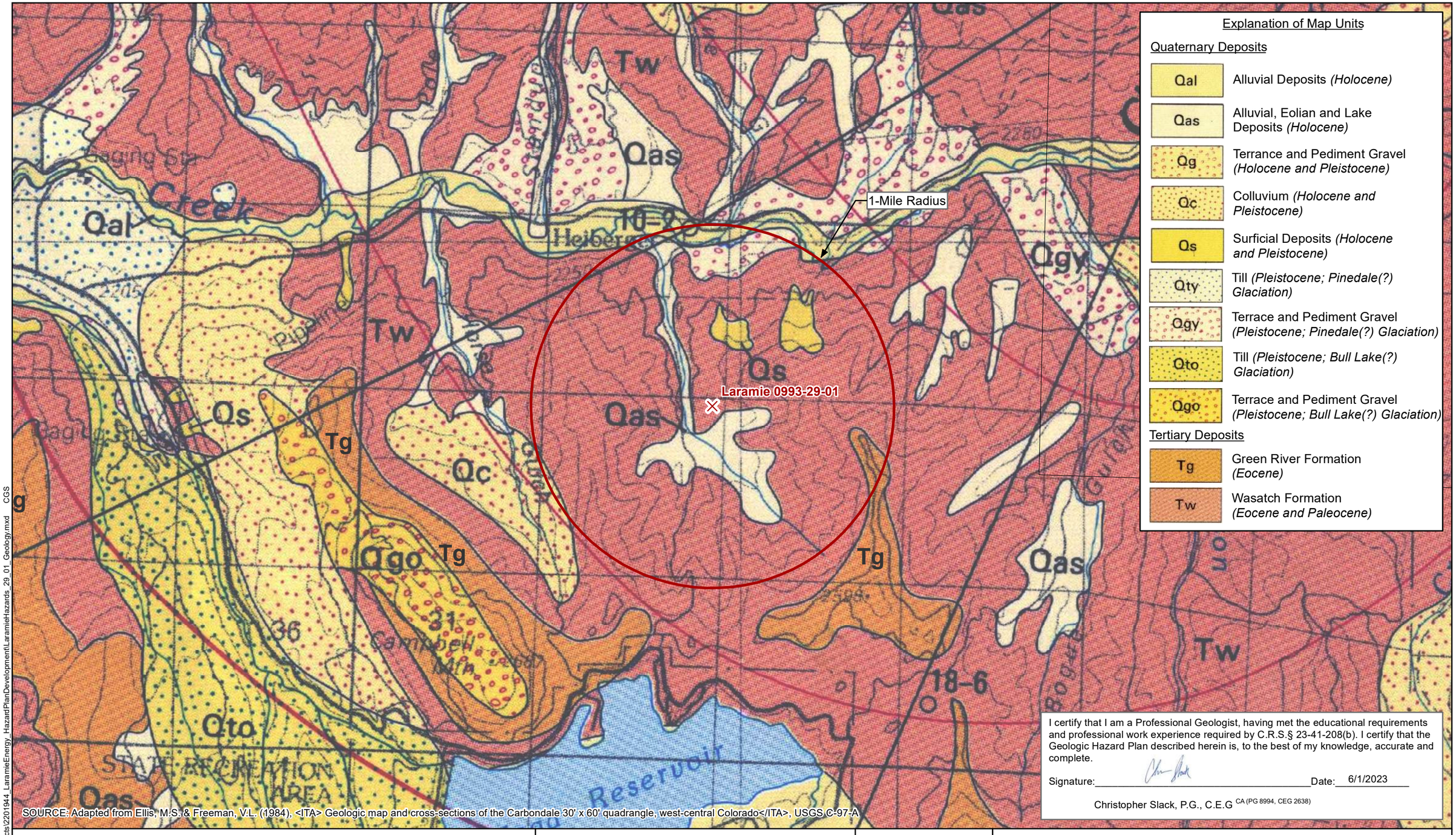
Laramie Energy, LLC

GEI Consultants

LARAMIE 0993-29-01
SITE TOPOGRAPHY

June 2023 Figure 2

30-May-2023 Z:\Projects\22201944_LaramieEnergy_HazardPlanDevelopment\LaramieHazards_29_01_SiteTopography.mxd STY



SOURCE: Adapted from Ellis, M.S. & Freeman, V.L. (1984), <ITA> Geologic map and cross-sections of the Carbondale 30' x 60' quadrangle, west-central Colorado</ITA>, USGS C-97-A

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Signature: _____ Date: 6/1/2023

Christopher Slack, P.G., C.E.G [CA (PG 8994, CEG 2638)]

0 0.5 1 2 Miles

N W E S

Laramie 0993-29-01
Geologic Hazard Plan
NENE, Section 29, T.9 S., R 93 W., 6th P.M.

Laramie Energy, LLC

GEI Consultants

LARAMIE 0993-29-01 GEOLOGIC MAP

June 2023 Figure 3

01-Jun-2023 Z:\Projects\2201944_LaramieEnergy_HazardPlanDevelopment\LaramieHazards_29_01_Geology.mxd CGS

Landslide A see text for discussion

Laramie 0993-29-01

Access Spur Road

Map Explanation

GEI Mapped Landslides

CGS Landslide Inventory; Landslides from 24k Maps

Soule (1988) Explanation

Als - Modern Landslides

yls - Young Landslides

ls - Old Landslides

ols - Ancient Landslides

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Signature: _____ Date: 5/31/2023

Christopher Slack, P.G., C.E.G CA (PG 8994, CEG 2638)

SOURCE: CGS Landslide Inventory; Soule (1988) OF-88-01 *Surficial-Geologic and Landslide Map of Vega Reservoir and Vicinity, Mesa County, Colorado*

0 0.25 0.5 1 Miles

N W E S

Laramie 0993-29-01
Geologic Hazard Plan
NENE, Section 29, T.9 S., R 93 W., 6th P.M.

Laramie Energy, LLC

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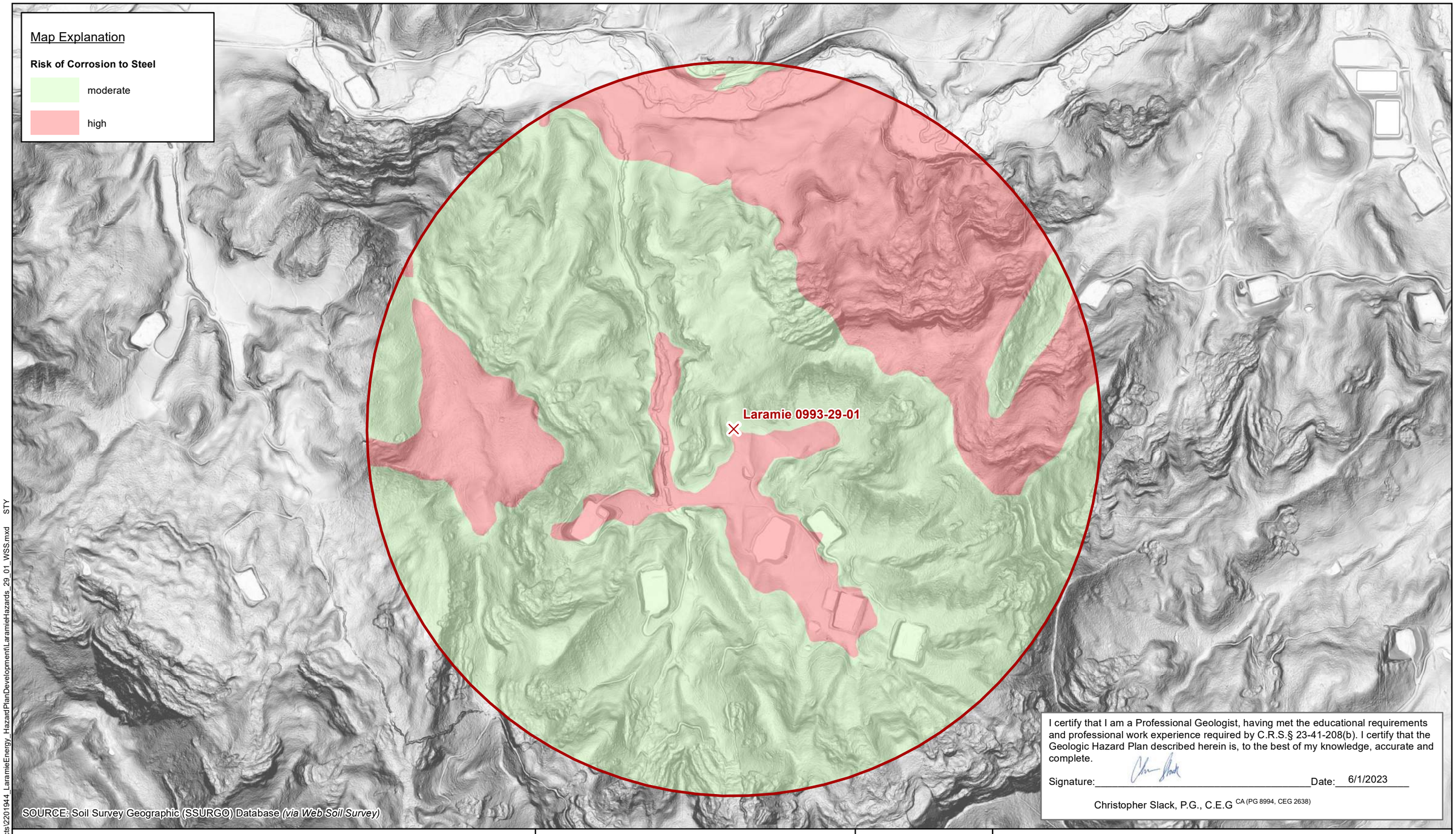
LARAMIE 0993-29-01
LANDSLIDE HAZARD MAP

June 2023

Figure 4

31-May-2023 Z:\Projects\2201944_LaramieEnergy_HazardPlanDevelopment\LaramieHazards_29_01_GeologicHazardMap.mxd CGS



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N W E S

Laramie 0993-29-01
Geologic Hazard Plan
NENE, Section 29, T.9 S., R 93 W., 6th P.M.

Laramie Energy, LLC

GEI Consultants

LARAMIE 0993-29-01
RISK OF CORROSION TO STEEL

June 2023 Figure 5

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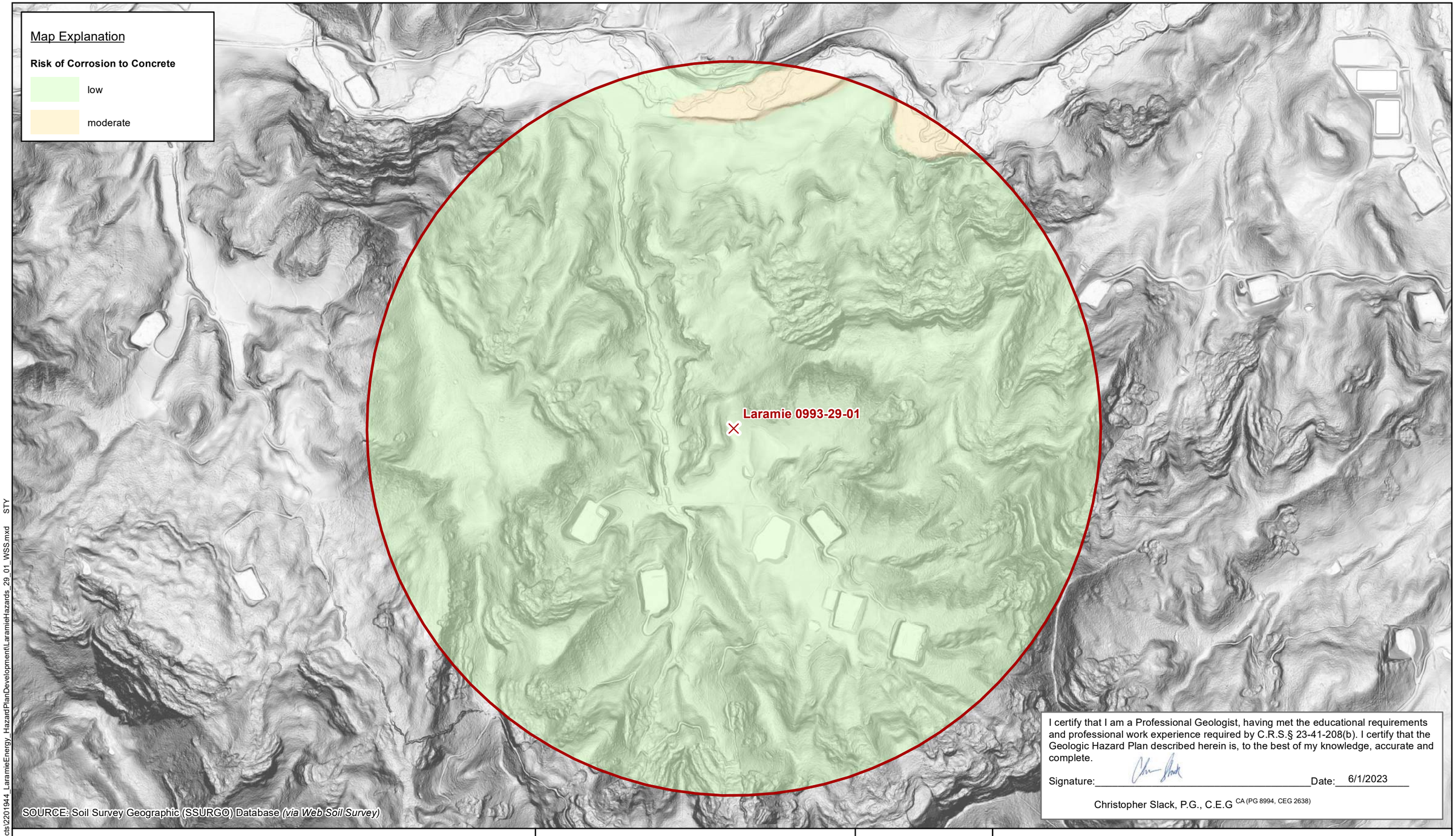

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Christopher Slack, P.G., C.E.G CA (PG 8994, CEG 2638)

0 0.25 0.5 1 Miles

N W E S

Laramie 0993-29-01
Geologic Hazard Plan
NENE, Section 29, T.9 S., R 93 W., 6th P.M.

Laramie Energy, LLC

GEI Consultants

LARAMIE 0993-29-01
RISK OF CORROSION TO CONCRETE

June 2023 Figure 6

01-Jun-2023 Z:\Projects\2201944_LaramieEnergy_HazardPlanDevelopment\LaramieHazards_29_01_WSS.mxd STY

Attachment B – Professional Resume

Christopher Slack, P.G. C.E.G.
Senior Engineering Geologist

GEI Consultants, Inc.
6915 S. Macadam Ave. Suite 130
Portland, Oregon 97219

PROFESSIONAL BIOGRAPHY

Christopher Slack currently holds a position as a Senior Engineering Geologist at GEI Consultants in Portland, OR, USA. He is part of a geosciences department that interacts across disciplines with geotechnical and civil engineering teams to develop scopes of work, conduct site investigations, interpret data, generate conclusions, and provide recommendations. Mr. Slack articulates geologic and geotechnical data to a varied audience and clientele. Throughout each phase of a project, he provides up-to-date observations from the geohazards team to the engineering design team. Mr. Slack's projects have involved characterizing site stratigraphy, soils analyses, geomorphology, and geology for seismic hazard analysis, slope stability analysis, surface fault rupture, seismic shaking, liquefaction, and soils hazards. His client industry needs have included: nuclear, oil and gas, hydro power, and water conveyance infrastructure.

EDUCTATION

M.S., Environmental Systems: Geology, Humboldt State University, Arcata, CA, 2009

B.S., Environmental Geology, minor Marine Studies, Northeastern University, Boston, MA, 2004

PROFFESIONAL EXPERIENCE

GEI Consultants, Inc. (GEI), Senior Engineering Geologist, 2016 to Present

AMEC Geomatrix, Inc. (GMX), Staff to Senior Geologist, 2008 to 2016

Busch Geotechnical Consultants (BGC), Arcata, CA, Field Assistant, 2006 to 2008

Boston Water and Sewer Commission (BWSC), Boston, MA, Intern (field tech.), 2002

McPhail Geotechnical Consultants (MGC), Cambridge, MA, Intern (field tech.), 2001

CERTIFICATIONS

Certified Engineering Geologist (CA) #2638, 2015

Certified Engineering Geologist (OR) #E2634, 2019

Licensed Engineering Geologist (WA) #21031244, 2021

Professional Geologist (CA) #8994, 2012

Registered Geologist (OR) #2634, 2018

Society of Professional Rope Access Technicians (SPRAT) Level 1, 2015

OSHA 40-Hour HAZWOPER Training, 2008

BEST MANAGEMENT PRACTICES

Laramie will implement the following best management practices to mitigate geologic hazards:

- The pad design incorporates compacted fill along the western slope of the pad with the exception of a minor 1.7 foot cut at one corner of the location. All grading that will occur in the form of this minor cut and cutting the slope north northwest of the pad will be minimal and at 2:1 horizontal: vertical. This existing slope to the NNW is shallow compared to the slope directly west.

- Laramie will maintain adequate surface drainage to minimize potential slope failures. Storm water will be concentrated to Working Pad Surface perimeters where water will be directed alongside pad berm openings that lead off the pad to sediment traps. Rock armored channels from the openings within the sediment traps will direct flow to designated construction ditches that have rock checks to dissipate flow and eliminate erosion. Laramie's stormwater management efforts may include additional engineering measures such as the installation of culverts and/or flexpipe to divert water flow away from surface locations as needed. Flexpipe will be utilized in certain areas to carry flow over disturbed soils to where they will tie into said construction ditches with riprap to eradicate erosion and/or channeling. For the production phase, a V-ditch and berm will be installed along the perimeter of the Production Pad Surface perimeter to convey water away from the production pad. Laramie will construct and maintain stormwater and erosion control features, implementing the SWMP, to minimize erosion, the transport of sediment offsite, and site degradation.

- Compaction of fill slopes will equal or exceed that of the excavated cut and will be achieved by moisture conditioning and demonstrated by testing with nuclear gauge or sand cone test methods.

- Laramie personnel will visually inspect the area daily during the course of construction daily and weekly during normal/production operations. Additional inspections by qualified personnel will take place in the early spring and after major precipitation events. If slope movements, slumping, cracking, etc. are observed, operations will be halted until the same are remediated.

- Laramie will utilize structural rig mats beneath the rig substructure to maximize rig stability.