Volume
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of 5

FALLS CREEK DIVERSION REHABILITATION PROJECT
GEOTECHNICAL INFORMATION
CSKT 23-018

GEOTECHNICAL REPORT

BY
The Confederated Salish and Kootenai Tribes
Flathead Indian Reservation – Montana

This solicitation/specifications issued by the:

Confederated Salish and Kootenai Tribes

Natural Resources Department

P.O. Box 278

Pablo, Montana 59855

PHONE INQUIRIES
Regarding this solicitation/specifications should be made to the office listed below.
See also provision B.3 of the Instructions and Conditions to Bidders.

Confederated Salish and Kootenai Tribes
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CORRESPONDENCE
Regarding this solicitation/specifications should reference the solicitation/specifications number.

FALLS CREEK DIVERSION GEOTECHNICAL REPORT

for the Confederated Salish and Kootenai Tribes

May 20, 2021

WWC ENGINEERING

FALLS CREEK DIVERSION GEOTECHNICAL REPORT
FOR THE CONFEDERATED SALISH AND KOOTENAI TRIBES

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WWC ENGINEERING

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INTRODUCTION

WWC Engineering (WWC) has been contracted by the Confederated Salish and Kootenai Tribes (CSKT) to complete a geotechnical investigation for the replacement of irrigation infrastructure located in the Mission Mountains on the western portion of the Flathead Reservation, Montana. The project includes the replacement of an existing timber abutment bridge (Bridge) and cast-in-place concrete canal diversion structure (Falls Creek Diversion). The proposed structures are expected to consist of cast-in-place or pre-cast concrete water diversion/conveyance structures. The purpose of this geotechnical report is to provide information on soil characteristics, groundwater conditions, and design recommendations for the bearing capacity of the soils.

INVESTIGATION

SITE DESCRIPTION

The project is located along the CSKT Tabor Feeder canal and is accessed by a single lane gravel road that generally runs parallel to the canal. The project area is in mountainous terrain where the irrigation canal flows along the hillside. The canal intercepts upstream runoff and Falls Creek can be diverted into the irrigation system at the project site. The canal and roadway were constructed by excavating the canal prism and compacting the overburden downgrade to create the lower canal bank and access road. The Falls Creek Diversion is furnished with a wasteway gate that discharges back to the natural Falls Creek channel, where a bridge along the access road crosses the channel. The Bridge also accommodates flows that overtop the Falls Creek Diversion.

The Falls Creek Diversion structure appears to be constructed as slab-on-grade reinforced concrete on native soil at or near the elevation of the adjacent canal invert (4,138 ft). The bridge abutments have vertically driven steel rails with horizontally stacked wood timbers against the native backfill soils. The bridge deck consists of welded steel rails and reinforced concrete. The channel beneath the bridge is native gravels with lateral steel supports perpendicular to the channel flow line. The channel invert elevation beneath the bridge is approximately 4,134 ft.

GEOTECHNICAL INVESTIGATION

WWC performed an on-site geotechnical investigation on May 13, 2021. During the investigation two test pits were excavated and evaluated. The location of the test pits was selected as close as possible to the bridge and Falls Creek Diversion while limiting disturbance to the existing structures, roadway, and native vegetation. The first test pit (TP-1) was conducted in the grass area adjacent to the access road, approximately 20 feet west of the bridge and 20 feet south of the canal bank. The second test pit (TP-2) was conducted on the north edge of the roadway, approximately 20 feet east of the bridge. See Exhibit A for a map of test pit locations in relation to the existing structures.

Test pit excavation extended to depths below the existing/proposed structures to identify the underlying soil characteristics. TP–1 excavated depth was 12.5 feet and TP–2 excavated depth was 10 feet. Although both test pits were planned to be excavated to a depth of 12 feet, TP-2 was terminated at a shallower depth due to space constraints and difficulty removing large boulders from the hole. Elevations of the test pits and structures are as follows:

- TP–1 Ground Elevation: 4,144.0 ft
- TP–1 Bottom Elevation: 4,131.5 ft
- TP–2 Ground Elevation: 4,141.5 ft
- TP–2 Bottom Elevation: 4,131.5 ft
- Diversion Foundation Estimated Elevation: 4,138 ft
- Bridge Channel Flow Line Elevation: 4,134 ft

Representative samples were collected at each soil layer and were field classified in general accordance with the Visual-Manual Procedure (ASTM D2488). Appendix A contains a detailed test pit log. Photos of the investigation are included in Appendix B.

Soil Lithology

The soils encountered in both test pits were consistent and uniform. Except for the upper topsoil depth, the soil underlying the topsoil and extending to the bottom of each test pit was a single classification. The soil profiles from the test pits are summarized below:

TP-01: Approximately 0.5 foot of topsoil overlies a moist dark brown well graded and weathered gravel. The gravel contained fine to coarse grained sands and boulders that were up to 48 inches in diameter. These soils were present throughout the entire test pit depth, which terminated at 12.5 feet below the ground surface. No groundwater was present. Organics were found from a depth of 0.5 to 4 feet and appeared to be the roots from the adjacent tree and possibly timber from the original construction project.

TP-02: Approximately 0.5 foot of topsoil overlies a moist dark brown well graded and weathered gravel. The gravel contained fine to coarse grained sands and boulders that were up to 48 inches in diameter. These soils were present throughout the entire test pit depth, which terminated at 10 feet below the ground surface. No groundwater was present. Organics were found from a depth of 0.5 to 3 feet and appeared to be the roots from the adjacent tree and possibly timber from the original construction project.

Groundwater

Groundwater was not encountered in the test pits during the investigation. Semi-saturated soils indicate groundwater may be at an elevation just beyond the depth of the test pit. It is reasonable to assume the soil moisture is a result of seepage from the canal or Falls Creek. The groundwater level likely fluctuates seasonally and may be a construction concern. The groundwater conditions that were encountered may only be applicable for the date of the investigation and likely vary for different times of the year.

Laboratory Testing

Given the nature of the project, anticipated shallow foundations, and the apparent soil conditions, further laboratory testing and laboratory classification in addition to visual classifications was not conducted.

RECOMMENDATIONS

PROPOSED CONSTRUCTION

The proposed bridge replacement is expected to be a precast concrete box culvert, precast bridge with shallow footing abutments, or an open bottom culvert with strip footing abutments. Each of these alternatives will have a similar span and depth as the existing bridge, but the size may be slightly modified based on the hydraulic analysis. The diversion is expected to be replaced with either precast or cast-in-place concrete with a geometry similar to the existing structure. Both structures will be located in the same place as the existing structure and are expected to be founded on structural fill placed on compacted, in-situ soil.

Bridge Foundation

Bridge Abutments: WWC suggests constructing the proposed bridge abutments with reinforced concrete spread footings founding on compacted structural fill. The bottom of footing elevation should be set below the scour zone of the channel. Footings should be constructed on an 18-inch-deep layer of compacted structural backfill meeting the specifications as described in the Structural Fill section of this report.

Culverts: WWC suggests founding precast box culverts on 18 inches of compacted structural backfill meeting the specifications, as described in the Structural Fill section of this report. Cut-off walls should be used and set to a depth below the scour depth of the channel.

Diversion Foundation

WWC suggests the structure be either precast or cast-in-place slab-on-grade. The structure should be placed on 18 inches of compacted structural backfill meeting the specifications, as described in the Structural Fill section of this report.

Uncontrolled Fill

Existing native soils are suitable as fill material and may be used as backfill with the following limitations. Rocks and boulders with a diameter greater than 6-inches shall not be located within two feet of precast or cast-in-place concrete. All organics should be removed from backfill material and exposed subgrades. In the event debris, deleterious materials, unsuitable, or loose backfill material is encountered, the material must be removed and replaced with suitable compacted backfill. Should construction occur in colder temperatures, appropriate winter construction techniques must be used. Fill must not be placed on top of frozen soils, and all deleterious materials must be completely removed. Fill may contain large rocks if large rocks are not placed next to each other and voids are filled in with fine soils.

STRUCTURAL FILL

The proposed foundations should be founded on a structural fill layer consisting of two 9-inch lifts (18-inches total) of structural backfill meeting the gradation provided in Table 1. The structural fill's footprint should extend horizontally past all foundation dimensions by 12 inches in each direction.

Table 1. Structural Backfill Gradation (MPWSS 3-Inch Minus Sub Base Course)

SIEVE SIZE	PERCENT PASSING
3-inch	100
No. 4	25 – 60
No. 40	10 – 30
No. 200	2 - 10

Structural fill and subgrade should be compacted to a standard relative compaction (ASTM D698) of at least 98 percent. Provided the compaction of the subgrade soils are met, an allowable bearing capacity of 2,000 pounds per square foot (psf) can be used for bridge and diversion design. A modulus of subgrade reaction, k_s of 100 pounds per square inch per inch (psi/in) of deflection can be used for reinforcement design.

Backfill and Lateral Loads

Backfill against the exterior concrete walls may consist of native gravels (<6" dia.) or the structural backfill listed in Table 1. Backfill should be placed in 9-inch (maximum) loose lifts, and each lift should be compacted to a standard relative compaction of at least 95 percent. Care should be taken not to over-compact the backfill or use large equipment within 5 feet of the wall to minimize excessive lateral wall loading.

Excavation Slopes

For excavations, the site soils meet the Occupational Safety & Health Administration's (OSHA) 29 CFR Part 1926 requirements for a Type C soil. The steepest unsupported slope within a Type C soil is limited to 1.5H:1V.

SEISMIC CONSIDERATIONS

The Project area is located on the boundary of the Northern Intermountain Seismic Belt, which is a relatively active seismic zone. According to ASCE 7-16 and Risk Category I, Seismic coefficients are presented in Table 2. The seismic coefficients data sheet is included in Appendix C.

Table 2. Seismic Coefficients

PARAMETER	COEFFICIENT
Risk Category	I
Seismic Design Category	D
Mapped Spectral Response Acceleration Parameter, S_S for 0.2 second	0.701
Mapped Spectral Response Acceleration Parameter, S_1 for 1.0 second	0.230
Adjusted Maximum Considered Earthquake Spectral Response Acceleration Parameter, S_{MS}	0.869
Adjusted Maximum Considered Earthquake Spectral Response Acceleration Parameter, S_{M1}	See ASCE 7-16, Section 11.4.8
Design Spectral Response Acceleration Parameter, S_{DS}	0.579
Design Spectral Response Acceleration Parameter, S_{D1}	See ASCE 7-16, Section 11.4.8

SHRINK/SWELL CHARACTERISTICS

The volume change potential of the native subgrade soils is considered low based on the non-plastic soils. No additional measures to reduce shrink/swell are necessary.

EARTHWORK TESTING

WWC recommends that a qualified inspector perform compaction testing for subgrade, structural fill, base course, and backfill. Table 3 lists the suggested minimum compaction testing frequency.

Table 3. Compaction Testing Frequency

LOCATION	FREQUENCY
Beneath Bridge Footings	1 test per 25 linear feet of footing per lift
Beneath Diversion Slab/Box Culvert	1 test per 400 square feet per lift
Concrete Wall Backfill	1 test per 50 linear feet per lift

Table 4 summarizes the material compaction specifications. Compaction testing should be performed on subgrade, structural fill, base course, and backfill.

Table 4. Required Relative Compaction

LOCATION REQUIRED	RELATIVE COMPACTION STANDARD
Beneath Bridge Footings	98% ASTM D698
Beneath Diversion Slab/Box Culvert	98% ASTM D698
Concrete Wall Backfill	95% ASTM D698

Concrete testing frequency should be performed in accordance with project specifications and/or inspecting engineers' requirements.

BASIS OF RECOMMENDATIONS

The analyses and recommendations submitted in this report are based upon the test pits dug during the subsurface investigation. Often, variations occur within the subgrade, the nature and extent of which do not become evident until additional exploration or construction is conducted. WWC recommends that, during earthmoving operations, a qualified geotechnical engineer be present to evaluate the foundation soils to verify their resemblance to those encountered during the site investigation. WWC should be alerted if during excavation soil conditions appear inconsistent with this soil investigation.

REVIEW OF DESIGN

This report is based on WWC's understanding of the proposed project. If the location or design changes, please consult WWC to verify that these recommendations are still applicable.

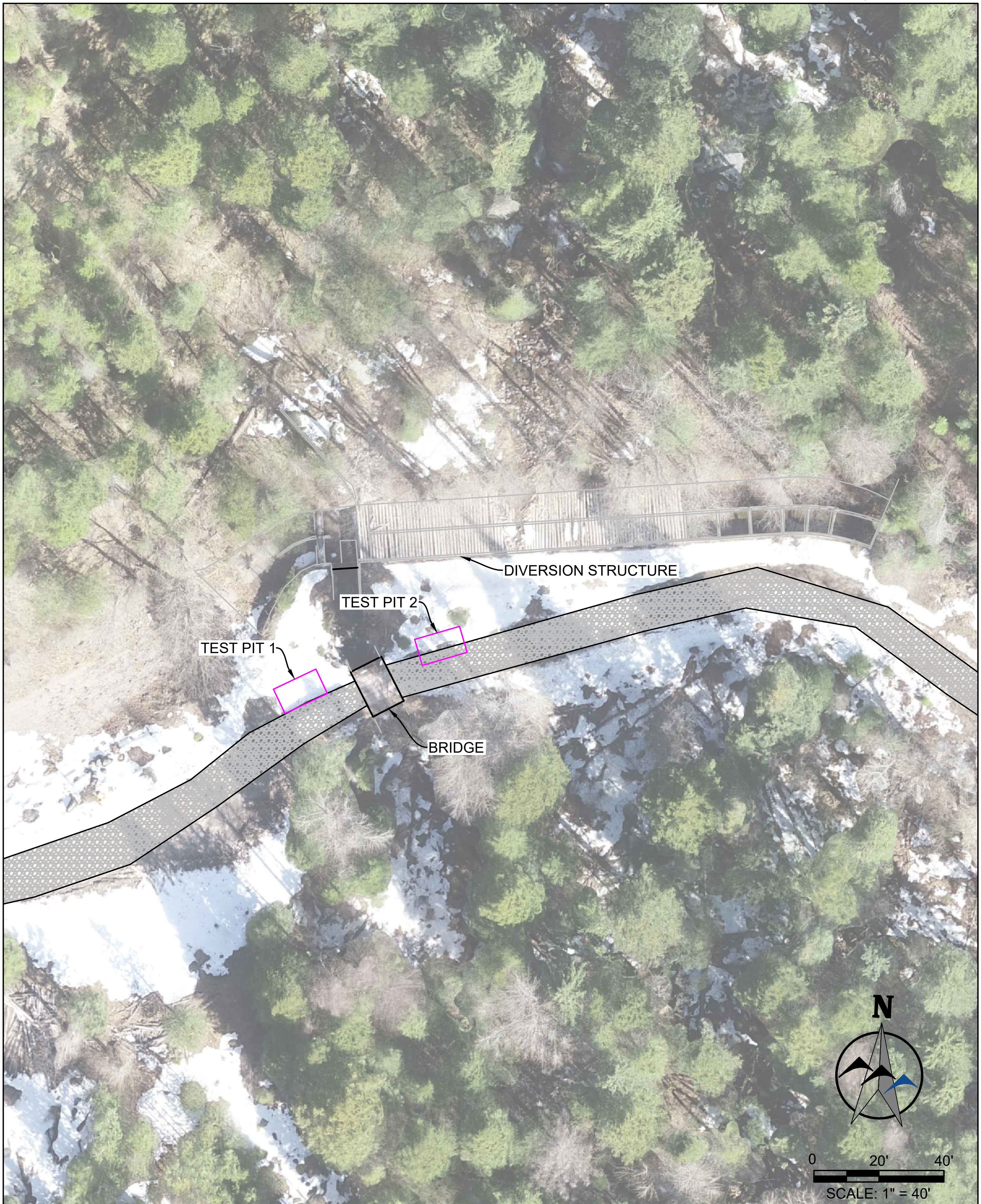
USE OF REPORT

This report is for the exclusive use of CSKT and their design team. In the absence of WWC's written approval, WWC makes no representation and assumes no responsibility to other parties regarding this report. The data, analyses, and recommendations may not be appropriate for other structures or purposes. Other parties contemplating other structures or purposes should contact WWC.

Level of Care

Services performed by WWC Engineering personnel for this project have been conducted with the level of care and skill ordinarily exercised by members of the profession currently practicing in this area under similar budget and time restraints. No warranty, expressed or implied, is made.

EXHIBITS



FALLS CREEK DIVERSION REHABILITATION

TEST PIT LOCATIONS

LAKE COUNTY, MT

PREPARED FOR

CONFEDERATED SALISH AND KOOTENAI TRIBES

P.O. BOX 278
PABLO, MT 59855

DESIGNED BY: DP
DRAWN BY: MJS
CHECKED BY: DP
DATE: 5/20/21

PREPARED BY

WWC ENGINEERING

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EXHIBIT

A

APPENDIX A
TEST PITS

WWC Engineering

GEOTECHNICAL ENGINEERING AND SOILS

LOG OF TEST PIT		TEST PIT # 1		Page 1 of 2	
PROJECT:	Falls Creek	**OPERATOR:**	CSKT Road Dept.	**DATE:**	May 13, 2021
CLIENT/LOCATION:	CSKT West of Bridge	**RIG:**	Excavator	**START:**	
FACILITY:	Bridge Abutment	**BIT(S):**	NA	**FINISH:**	
GROUND ELEVATION:	4144				
COORDINATES:		**FLUID:**	NA	**TOTAL DEPTH:**	12.5’
N:	**E:**				
SURVEYED:	Ground Topo	**LOG BY:**	Scott Dunkelberger	**HOLE DIAMETER:**	Bucket

DEPTH		DESCRIPTION OF MATERIALS (ASTM D2488)	ASTM D2487 SYMBOL	TEST, SAMPLES, OR NOTES
From	**To**			
0	0.5’	Topsoil		
0.5’	12.5’	Moist Dark Brown Well Graded Weathered GRAVEL with Fine Sands and Boulders Gravel size ranged from 1/8” to 12”, Boulders 12” to 48”		SAMPLES @ 3’ & 12’

ABBREVIATIONS

SWL – Static Water Level
ST – Shelby Tube Sample
GS – Geochemical Sample
O - Petroleum Odor

DBS – Disturbed Bulk Sample
REF – Refusal
SPT – Standard Penetration Test with Split Barrel Sample (ASTM D-1586)

CAL – California Tube Sample
ZP – Ziplock Bag Sample
LA – Laboratory Analysis
PID – Instrument Response

WWC Engineering

GEOTECHNICAL ENGINEERING AND SOILS

LOG OF TEST PIT	TEST PIT # 2	Page 2 of 2
PROJECT: Falls Creek	**OPERATOR:** CSKT Road Dept.	**DATE:** May 13, 2021
CLIENT/LOCATION: CSKT East of Bridge	**RIG:** Excavator	**START:**
FACILITY: Bridge Abutment **GROUND ELEVATION:** 4141.5’	**BIT(S):** NA	**FINISH:**
COORDINATES: **N:** **E:**	**FLUID:** NA	**TOTAL DEPTH:** 10’
SURVEYED: Ground Topo	**LOG BY:** Scott Dunkelberger	**HOLE DIAMETER:** Bucket

DEPTH		DESCRIPTION OF MATERIALS (ASTM D2488)	ASTM D2487 SYMBOL	TEST, SAMPLES, OR NOTES
From	To			
0	0.5’	Topsoil		
0.5’	10’	Moist Dark Brown Well Graded Weathered GRAVEL with Fine Sands and Boulders Gravel size ranged from 1/8” to 12”, Boulders 12” to 48”		SAMPLES @ 4’ & 10’

ABBREVIATIONS

SWL – Static Water Level
ST – Shelby Tube Sample
GS – Geochemical Sample
O - Petroleum Odor

DBS – Disturbed Bulk Sample
REF – Refusal
SPT – Standard Penetration Test with Split Barrel Sample (ASTM D-1586)

CAL – California Tube Sample
ZP – Ziplock Bag Sample
LA – Laboratory Analysis
PID – Instrument Response

APPENDIX B

PHOTOS


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APPENDIX C

SEISMIC DATA

ATC Hazards by Location

Search Information

Coordinates:	47.3199306, -114.0939979
Elevation:	2943 ft
Timestamp:	2021-05-18T22:40:10.909Z
Hazard Type:	Seismic
Reference Document:	ASCE7-16
Risk Category:	I
Site Class:	D-default

Basic Parameters

Name	Value	Description
S_S	0.701	MCE_R ground motion (period=0.2s)
S_1	0.23	MCE_R ground motion (period=1.0s)
S_{MS}	0.869	Site-modified spectral acceleration value
S_{M1}	* null	Site-modified spectral acceleration value
S_{DS}	0.579	Numeric seismic design value at 0.2s SA
S_{D1}	* null	Numeric seismic design value at 1.0s SA

* See Section 11.4.8

Additional Information

Name	Value	Description
SDC	* null	Seismic design category
F_a	1.239	Site amplification factor at 0.2s
F_v	* null	Site amplification factor at 1.0s
CR_S	0.911	Coefficient of risk (0.2s)
CR_1	0.927	Coefficient of risk (1.0s)
PGA	0.304	MCE_G peak ground acceleration
F_{PGA}	1.296	Site amplification factor at PGA
PGA_M	0.394	Site modified peak ground acceleration

T_L	6	Long-period transition period (s)
SsRT	0.701	Probabilistic risk-targeted ground motion (0.2s)
SsUH	0.77	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
SsD	3.173	Factored deterministic acceleration value (0.2s)
S1RT	0.23	Probabilistic risk-targeted ground motion (1.0s)
S1UH	0.248	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
S1D	1.273	Factored deterministic acceleration value (1.0s)
PGAd	1.269	Factored deterministic acceleration value (PGA)

* See Section 11.4.8

The results indicated here DO NOT reflect any state or local amendments to the values or any delineation lines made during the building code adoption process. Users should confirm any output obtained from this tool with the local Authority Having Jurisdiction before proceeding with design.

Disclaimer

Hazard loads are provided by the U.S. Geological Survey Seismic Design Web Services.

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