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Appendix A: Details on Construction of the NEHRP Site Class Map for Wood River Valley area, Blaine County, Idaho

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INTRODUCTION

This Appendix provides details on how the NEHRP Site Class Map for Wood River Valley, Blaine County, Idaho was produced. It is designed to be used with the NEHRP site class map.

Definition and Use of NEHRP Site Classes

The intensity of ground shaking during an earthquake varies according to the nature of near-surface materials. For example, shaking intensity is generally greater in areas underlain by unconsolidated materials than in areas underlain by firm bedrock. Engineers and architects incorporate site conditions into their designs to reduce damage from earthquakes.

In 1997, the National Earthquake Hazards Reduction Program (NEHRP) established procedures for placing building sites into classes based upon the geotechnical properties of near-surface materials. The site classes are shown in Map Table 1. For each NEHRP site class, coefficients adjust expected earthquake motions for local ground conditions. Earthquake ground motion parameters are produced by the U.S. Geological Survey for all parts of the United States and are available as national seismic hazard maps (http://earthquake.usgs.gov/hazards/products/).

NEHRP site classes are not shown on the national seismic hazard maps because local conditions are frequently too variable to accurately depict at the hazard map scale, and/or because the required geotechnical information is unavailable. Both NEHRP site classes and USGS national seismic hazard maps are incorporated into the International Building Code (IBC, 2012, p. 366-376).

WOOD RIVER Valley AREA

This map depicts NEHRP seismic site classes in the Wood River Valley. Hillslopes away from the valley bottom are, in general, not evaluated in order to concentrate on areas where human populations and infrastructure are greatest. Map users interested in estimating site classes for hillslopes may use the USGS Global Vs30 Map Server (http://earthquake.usgs.gov/hazards/apps/vs30/). This software uses topographic slope as a proxy for estimating shallow shear wave velocities.

HOW NEHRP SITE CLASSES WERE DETERMINED FOR THIS MAP

Profiles of shallow seismic shear wave velocity are used to estimate NEHRP site classes within the project area. Existing geological map information is used with the shear wave data to construct the NEHRP site class map.

Location of Shear Wave Velocity Surveys

Shear wave velocity (Vs) was measured at 51 sites in the study area using the Interferometric Multi-Channel Analysis of Surface Waves technique (Map Table 2; O'Connell and Turner, 2011; Fugro Consultants, Inc., 2013). Sites were selected with the following criteria:

1. Sites needed to be level enough to permit the placement of geophones and the active seismic source along an approximately 105 meter straight line. The line consists of a 92 meter geophone array and a seismic source operated 4-6 meters off each end.
2. Where possible, sites were distributed so as to sample each of the major landforms and surficial deposits present in the study area (i.e. a representative sample of each surficial geologic unit as shown on geologic maps);
3. Where possible, sites should be adjacent to critical infrastructure such as schools, hospitals, fire stations, courthouse, etc.
4. Sites were located on unconsolidated deposits and not on bedrock or pavement.
5. Property owner permission was required to access sites.

Calculation of Vs30 and Classification of Site Classes

Average shear wave velocities within 30 m (100 ft) of the ground surface are calculated for each measurement site using a standard equation (ASCE/SEI, 2010, Chapter 20, equation 20.4-1):

$$\bar{V}_s = \frac{\sum_{i=1}^{n} d_i}{\sum_{i=1}^{n} \frac{d_i}{V_{si}}}$$

where

$\bar{V}_s$ = average shear wave velocity in m/s (ft/s)
d_i = the thickness of any layer i between 0 and 30 m (100 ft)
V_{si} = the shear wave velocity in layer i in m/s (ft/s)
$\sum_{i=1}^{n} d_i = 30 \text{ m } (100 \text{ ft})$

Vs5 values (Map Table 2) are calculated to examine possible correlations with agricultural soil mapping. The measurement sites are classified according to Map Table 1.

Correlation of Vs30 in the Study Area

Vs30 values typically display spatial patterns related to characteristics of surficial earth materials and landforms. For this reason, it is possible to correlate Vs30 values across regions of limited extent on the basis of surficial geologic maps. A surficial geologic map of the Wood River area (Breckenridge and Othberg, 2006) is used for this purpose.

The basis for correlation of each geologic map unit with a site class is shown in Table A1. Histograms of Vs30 by geologic unit also clarified the correlation (Figure 1).

Several geologic units contained measurements of more than one class. For example, seven measurement sites underlain by Holocene alluvium of the Wood River (geologic map unit *Qam*) have Vs30 values in the C1 class. Three sites underlain by *Qam* have Vs30 values in the D2 and D3 classes. Polygons of unit Qam were assigned class C1 on the map based on the majority of Vs30 measurements. Where equal numbers of measurements fall into different classes, the higher velocity class was used. Individual measurement sites are color coded on the map by class to indicate the existence of intra-polygon variation in Vs30.

PATTERNS OF NEHRP SITE CLASSES IN THE WOOD RIVER VALLEY

The Wood River Valley is underlain predominantly by gravel and sand deposited by the Big Wood River, debris flows, snow avalanches, and landslides (Breckenridge and Othberg, 2006; Bartolino and Adkins, 2012). Units of Holocene and Pleistocene age generally classify as site class C1 with Vs30 values between 490-360 m/s. However, significant variation over short distances occurs in unit Qam and Qag2. This may indicate the local presence of unmapped made ground or young stream deposits composed of muck or peat. In general, sites with Vs30 between 360-240 m/s (site classes D3 and D2) are Holocene in age. For example, the slowest site (BL-28; 253 m/s) is located within Holocene sidestream alluvium (geologic unit Qas). Made ground sites are also among the slowest Vs30 values. These are tailings of the Minnie Moore mine (BL-1-1; 291 m/s), and an upland site (BL-38; 279 m/s) tentatively correlated with the Independence Mill Prospect (see the Idaho Geological Survey Abandoned Mine Lands database at http://www.idahogeology.org/Services/MinesAndMinerals/Search/Details.asp?SequenceNumber=HA0288). Site BL-45 has an exceptionally high VS30 value of 1018 m/s and is tentatively interpreted as a resistant lithology within the Eocene Challis Volcanics concealed beneath thin alluvium.

FURTHER INFORMATION

Details of the seismic survey performed for this project are given in the final report by Fugro Consultants, Inc., 2013. The report is distributed online with the site class map and this appendix at www.idahogeology.org.

Previous studies of NEHRP site classes in Idaho are described by Phillips and others, 2010; Phillips and Welhan, 2011; Phillips, 2011; and Fugro William Lettis & Associates, Inc., 2012.

Additional information about Idaho earthquakes and seismic hazards is described in *Putting Down Roots in Earthquake County: Your Handbook for Earthquakes in Idaho* (available for free download at www.idahogeology.org).

LIMITATIONS ON THE USE OF THIS MAP

This map is based on the correlation of Vs30 measurements between widely separated localities. Site-specific geotechnical investigations are required to determine actual ground conditions for specific building sites. This map is intended to be used at a scale of 1:50,000. As with all maps, users should not apply this map, either digitally or on paper, to more detailed scales.

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Table A1. Assignments of NEHRP Site Classes to Geologic Units of Breckenridge and Othberg (2006).

Map Unit	Name	Age	Landscape Position	NEHRP Site Class	Basis of Assignment
m	Made ground	Holocene	Valley bottom	D2	Measurement
Qac	Alluvium and colluvium	Holocene	Valley bottom	C3	Measurement
Qad	Alluvial-fan and debris-flow	Holocene	Valley bottom	D3	Measurement
Qaf	Alluvial-fan	Holocene and late Pleistocene	Valley bottom	D3	Correlated with Qad
Qag1	Gravel terrace 1 Big Wood River	Holocene and late Pleistocene	Valley bottom	C1	Measurement
Qag2	Gravel terrace 2 Big Wood River	late Pleistocene	Valley bottom	C1	Measurement
Qag3	Gravel terrace 3 Big Wood River	pre-late Pleistocene	Valley bottom	C1	Age between Qag2 (D3+C1) and Qag4 (C1+C2)
Qag4	Older gravel deposits	Pleistocene and Pliocene	Valley bottom	C2	Measurement
Qagc	Gravel depiosits in colluvium	Pleistocene and Pliocene	Valley bottom	C2	Correlated with Qag4
Qags	Gravel deposits of sidestreams, undivided	Pleistocene	Valley bottom	C2	Measurement
Qags1	Gravel deposits of sidestreams 1	Holocene and late Pleistocene	Valley bottom	D2	Measurement
Qags2	Gravel deposits of sidestreams 2	late Pleistocene	Valley bottom	C1	Measurement
Qags3	Gravel deposits of sidestreams 3	pre-late Pleistocene	Valley bottom	C3	Middle Pleistocene age suggests Stiff Soil
Qagsu	Gravel deposits of unglaciated sidestreams, undivided	Holocene and late Pleistocene	Valley bottom	C1	Measurement
Qagsu2	Gravel deposits of unglaciated sidestreams, undivided	Pleistocene	Valley bottom	C1	Correlated with Qag2
Qam	Alluvium of mainstreams	Holocene	Valley bottom	C1	Measurement

Qas	Alluvium of sidestreams	Holocene	Valley bottom	D2	Measurement
Qcd	Colluvium from diorite	Holocene and Pleistocene	Hillslope	not evaluated	Hillslope unit
Qcg	Colluvium from granite	Holocene and Pleistocene	Hillslope	not evaluated	Hillslope unit
Qcm	Colluvium from metasedimentary rocks	Holocene and Pleistocene	Hillslope	not evaluated	Hillslope unit
Qcv	Colluvium from volcanic rocks	Holocene and Pleistocene	Hillslope	not evaluated	Hillslope unit
Qcvb	Colluvium from volcanic breccias, tuffs and sedimentary rocks	Holocene and Pleistocene	Hillslope	not evaluated	Hillslope unit
Qcw	Colluvium from sedimentary rocks	Holocene and Pleistocene	Hillslope	not evaluated	Hillslope unit
Qdf	Debris flow deposits	Holocene	Hillslope	not evaluated	Hillslope unit
Qgt	Glacial deposits, undivided	Pleistocene	Hillslope	not evaluated	Hillslope unit
Qgt1	Neoglacial deposits, undivided	Holocene	Hillslope	not evaluated	Hillslope unit
Qgt2	Till of late Pleistocene glaciation	late Pleistocene	Hillslope	not evaluated	Hillslope unit
Qgt3	Till of pre-late Pleistocene glaciation	middle Pleistocene	Hillslope	not evaluated	Hillslope unit
Qls	Landslides	Holocene and Pleistocene	Hillslope	not evaluated	Hillslope unit
Qlsd	Landslides-area of deposit	Holocene and Pleistocene	Hillslope	not evaluated	Hillslope unit
Qlsh	Landslides-headwall area	Holocene and Pleistocene	Hillslope	not evaluated	Hillslope unit
Qt	Talus	Holocene	Hillslope	not evaluated	Hillslope unit

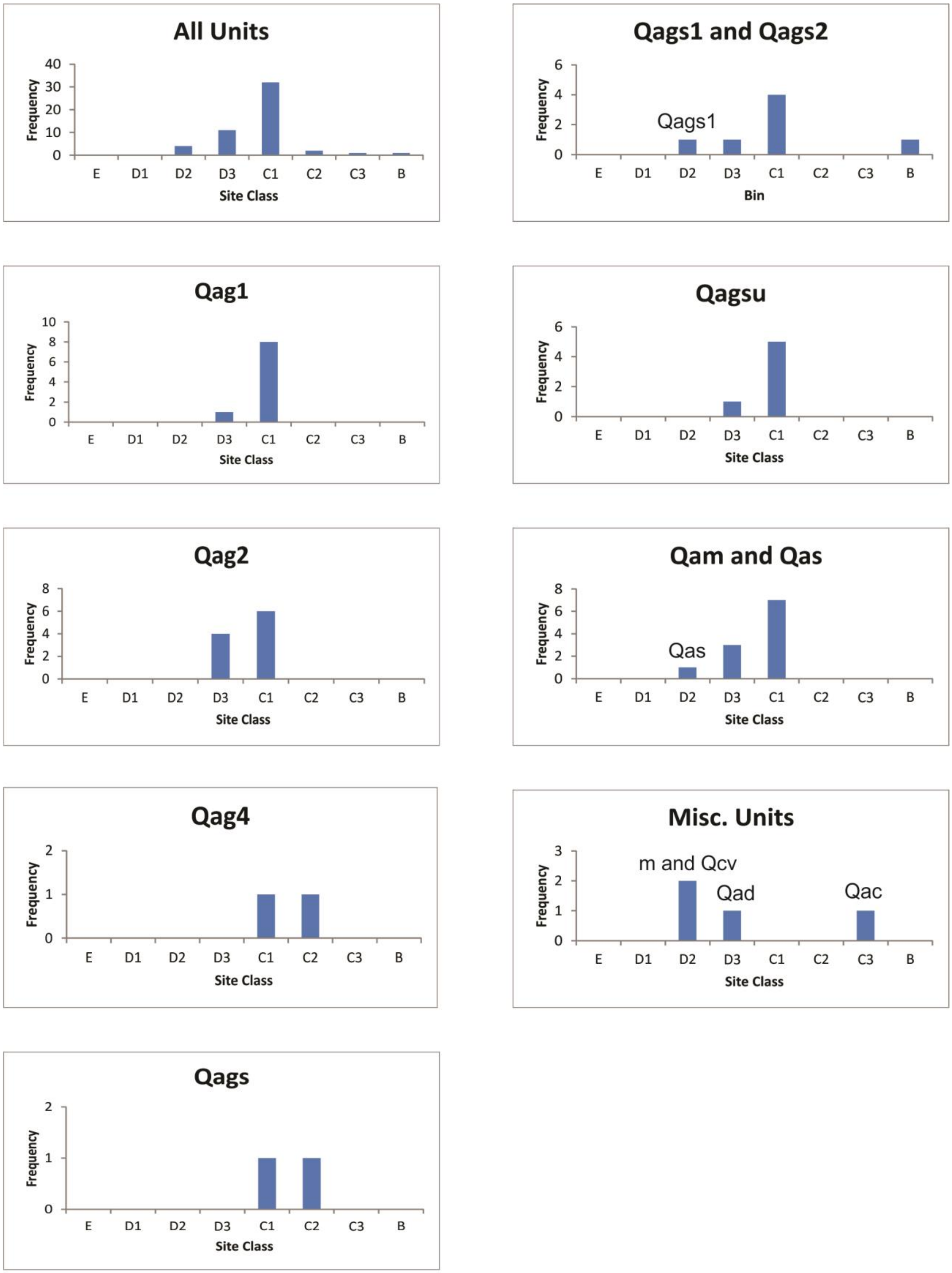

Figure 1. Histograms of Vs30 values for geologic units at measurement sites.