RECLAMATION

Managing Water in the West

Proposed Bumping Dam Modifications – Summary of Geophysical Surveys

Rich Markiewicz
Geophysicist
Technical Service Center, Denver

U.S. Department of the Interior
Bureau of Reclamation

Seismic Refraction Surveys

- Used to delineate top of bedrock configuration.
- Seismic velocities tell us something about the subsurface materials properties.
- Excavation conditions can *sometimes* be predicted with refraction surveys.

Seismic Refraction Surveys

What is seismic survey?

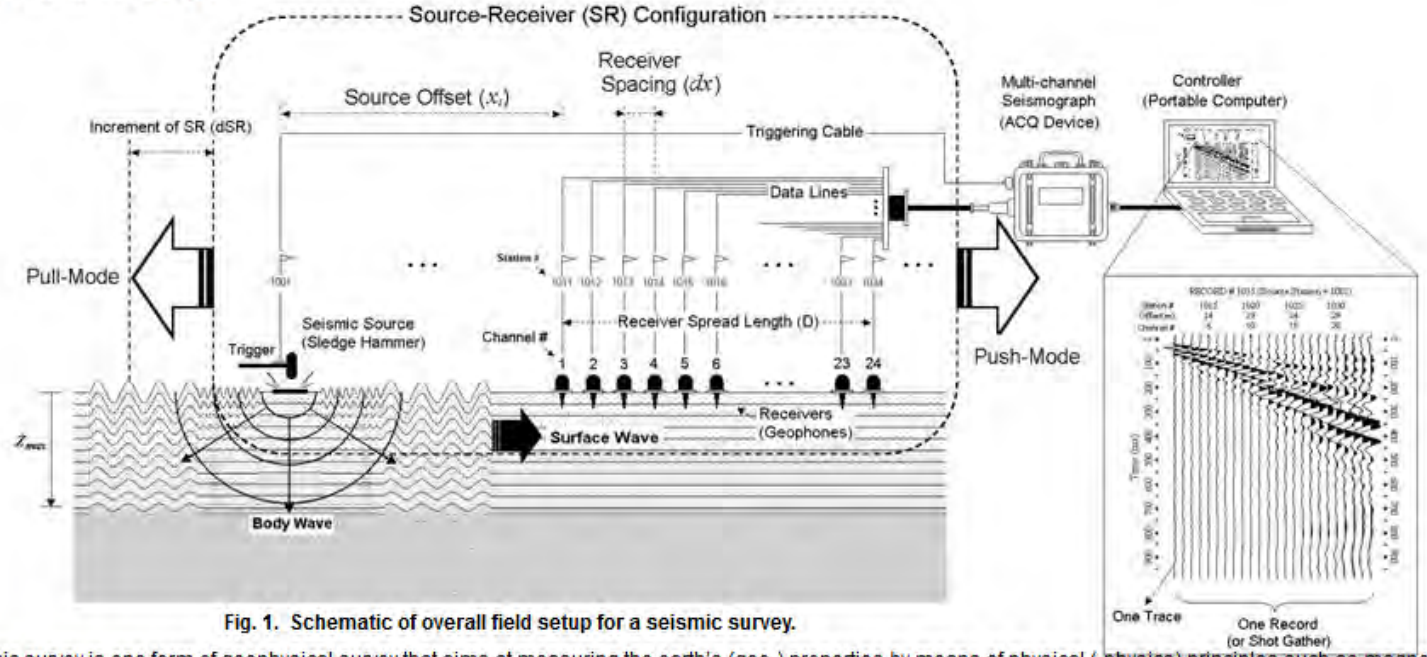


Fig. 1. Schematic of overall field setup for a seismic survey.

The seismic survey is one form of geophysical survey that aims at measuring the earth's (geo-) properties by means of physical (-physics) principles such as magnetic, electric, gravitational, thermal, and elastic theories. It is based on the theory of elasticity and therefore tries to deduce elastic properties of materials by measuring their response to elastic disturbances called seismic (or elastic) waves.

What Are Seismic Waves?

A seismic source-such as sledgehammer-is used to generate seismic waves, sensed by receivers deployed along a preset geometry (called receiver array), and then recorded by a digital device called seismograph (**Fig. 1**). Based on a typical propagation mechanism used in a seismic survey, seismic waves are grouped primarily into direct, reflected, refracted, and surface waves (**Fig. 2**).

There are three major types of seismic surveys: refraction, reflection, and surface-wave, depending on the specific type of waves being utilized. Each type of seismic survey utilizes a specific type of wave (for example, reflected waves for reflection survey) and its specific arrival pattern on a multichannel record (**Fig. 3**). Seismic waves for the survey can be generated in two ways: actively or passively. They can be generated actively by using an impact source like a sledgehammer or passively by natural (for example, tidal motion and thunder) and cultural (for example, traffic) activities. Most of the seismic

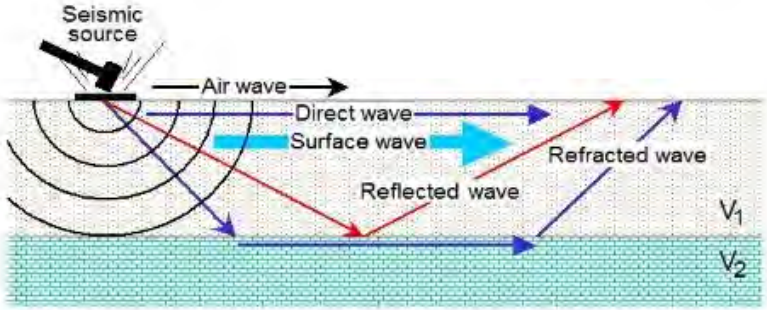


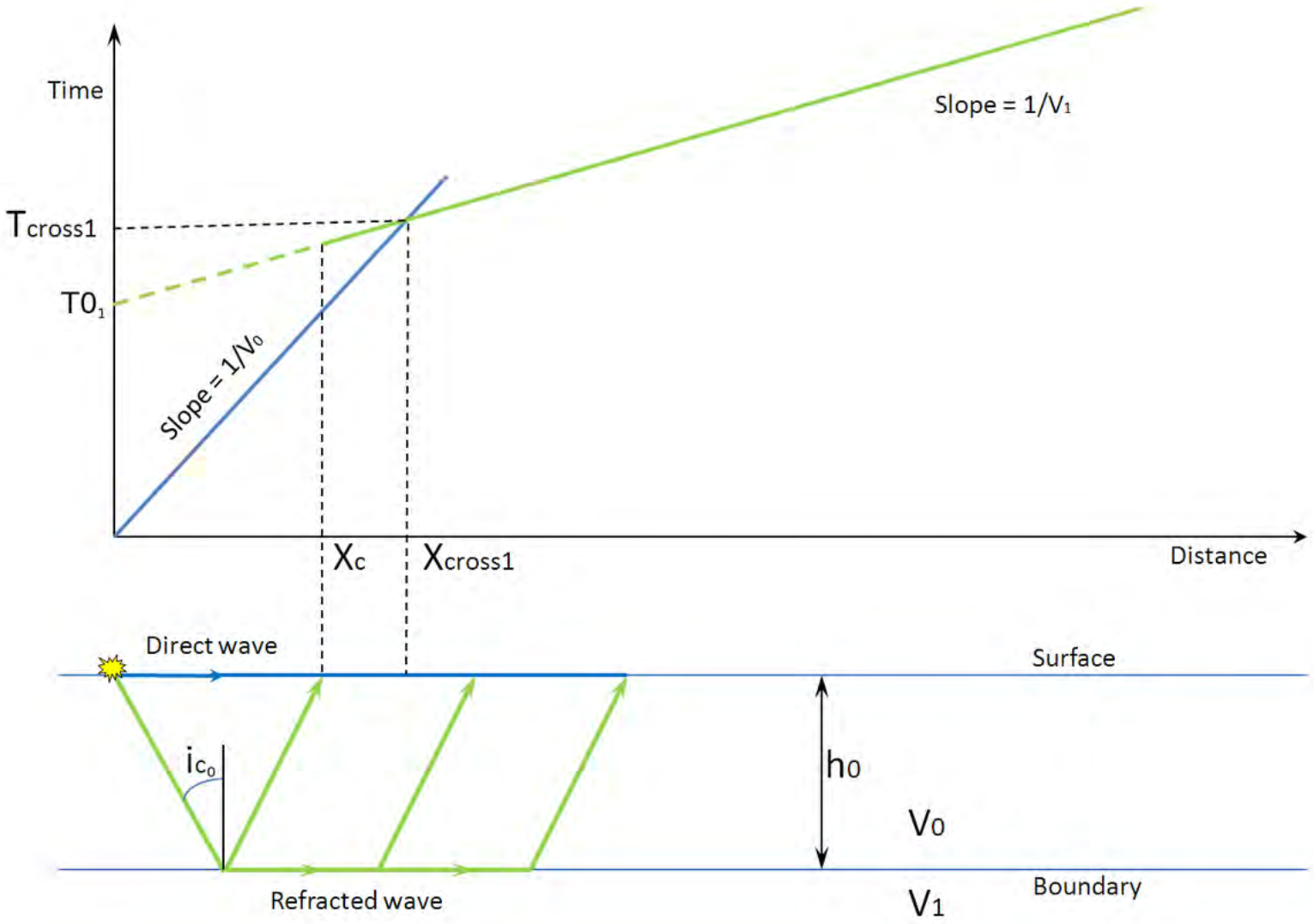
Fig. 2. Major types of seismic waves based on propagation characteristics.

(from ParkSeismic.com)

RECLAMATION

Simple Refraction Model

Two Horizontal Layers. [edit]



(from Wikipedia.com)

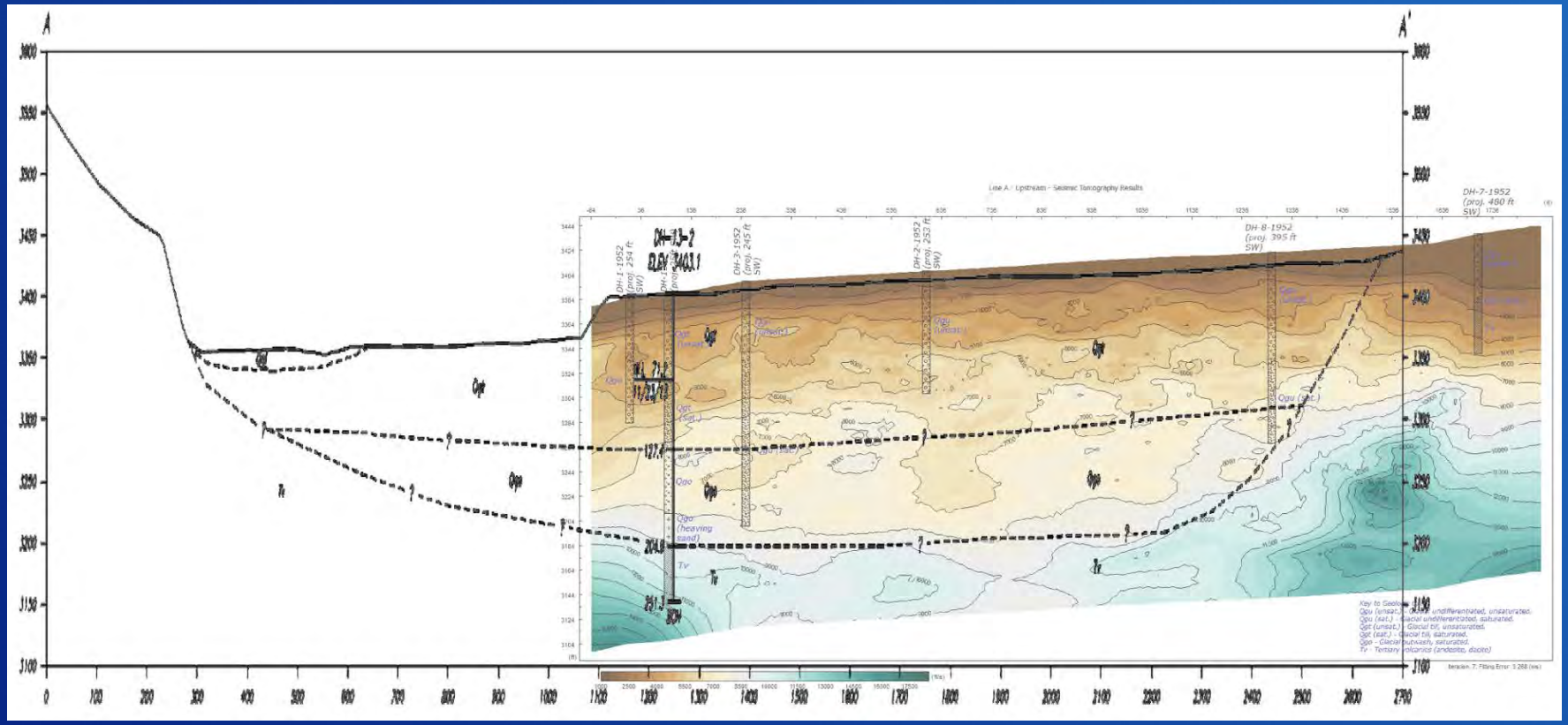
RECLAMATION

Seismic Refraction Field Equipment

Seismic survey targets

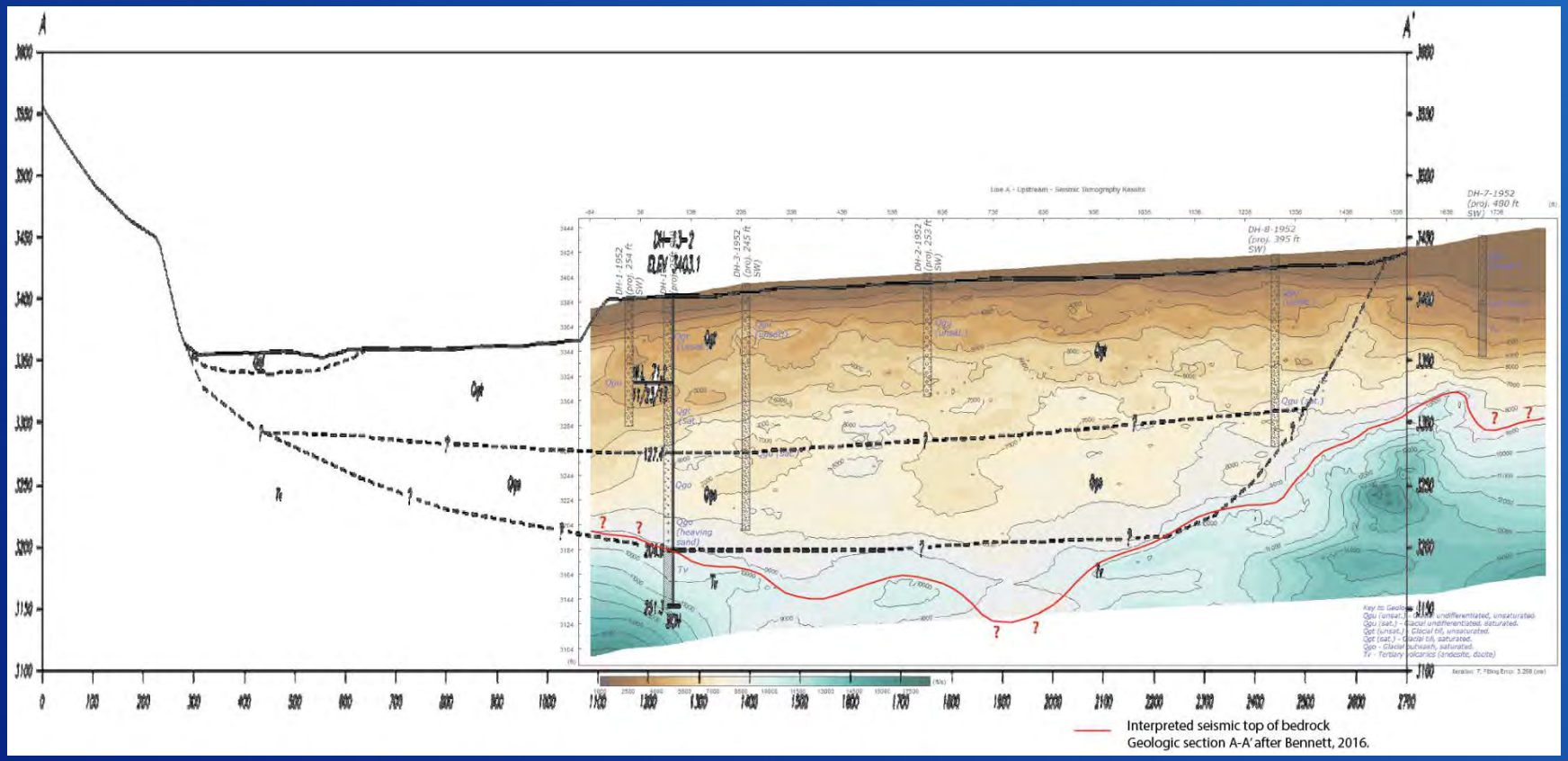
- Top of Bedrock configuration – refraction survey results are often combined with drilling results to form a cross-section of the site.
- Excavation Conditions estimate - There is a rough correlation between seismic velocity and excavation conditions. The actual conditions are also equipment-dependent.

Seismic refraction section, A-A’ (upstream)



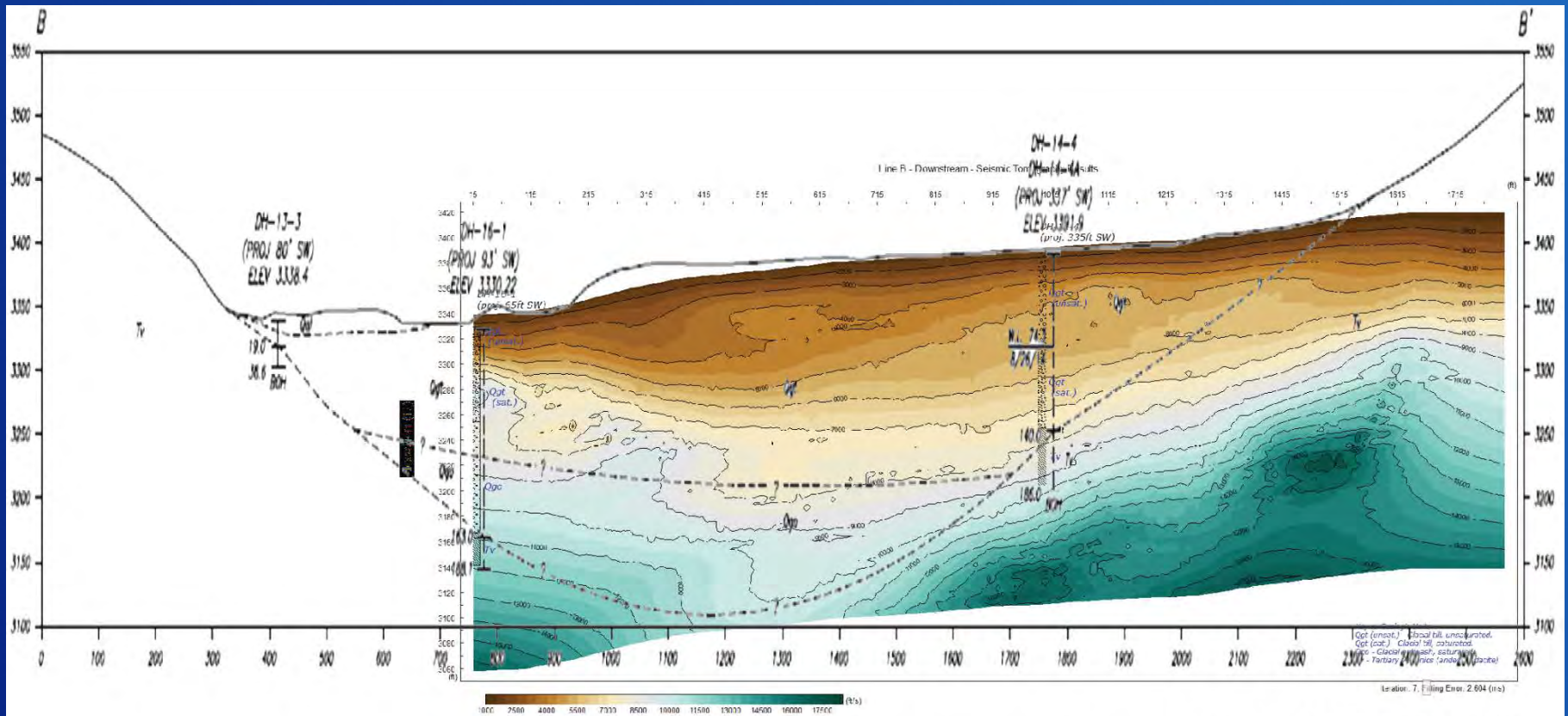
RECLAMATION

Seismic refraction section, A-A’ (upstream) with interpretation



RECLAMATION

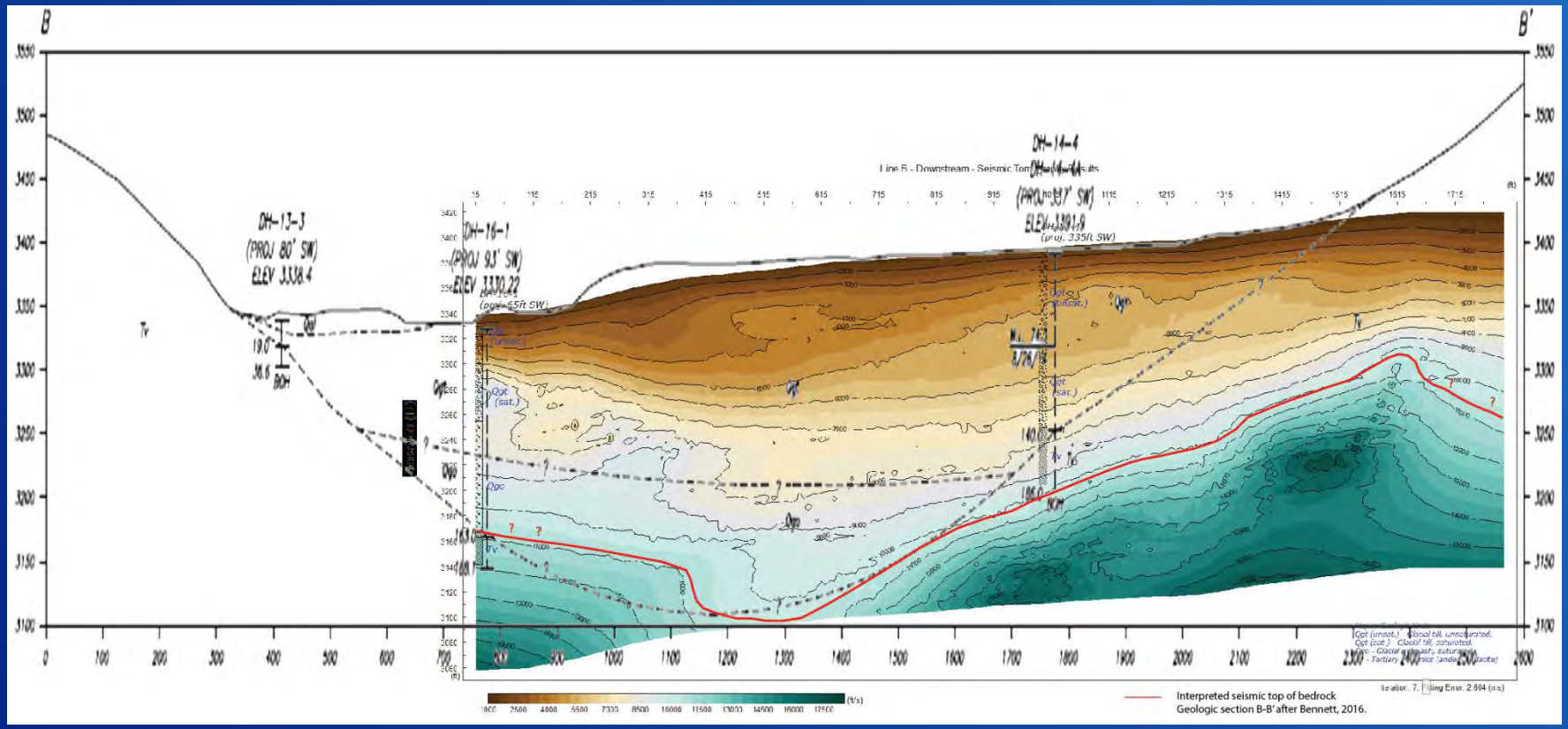
Seismic refraction section, B-B' (downstream)



Geologic Sections B-B' (downstream) after Bennett (2016).

RECLAMATION

Seismic refraction section, B-B’ (downstream) with interpretation



RECLAMATION

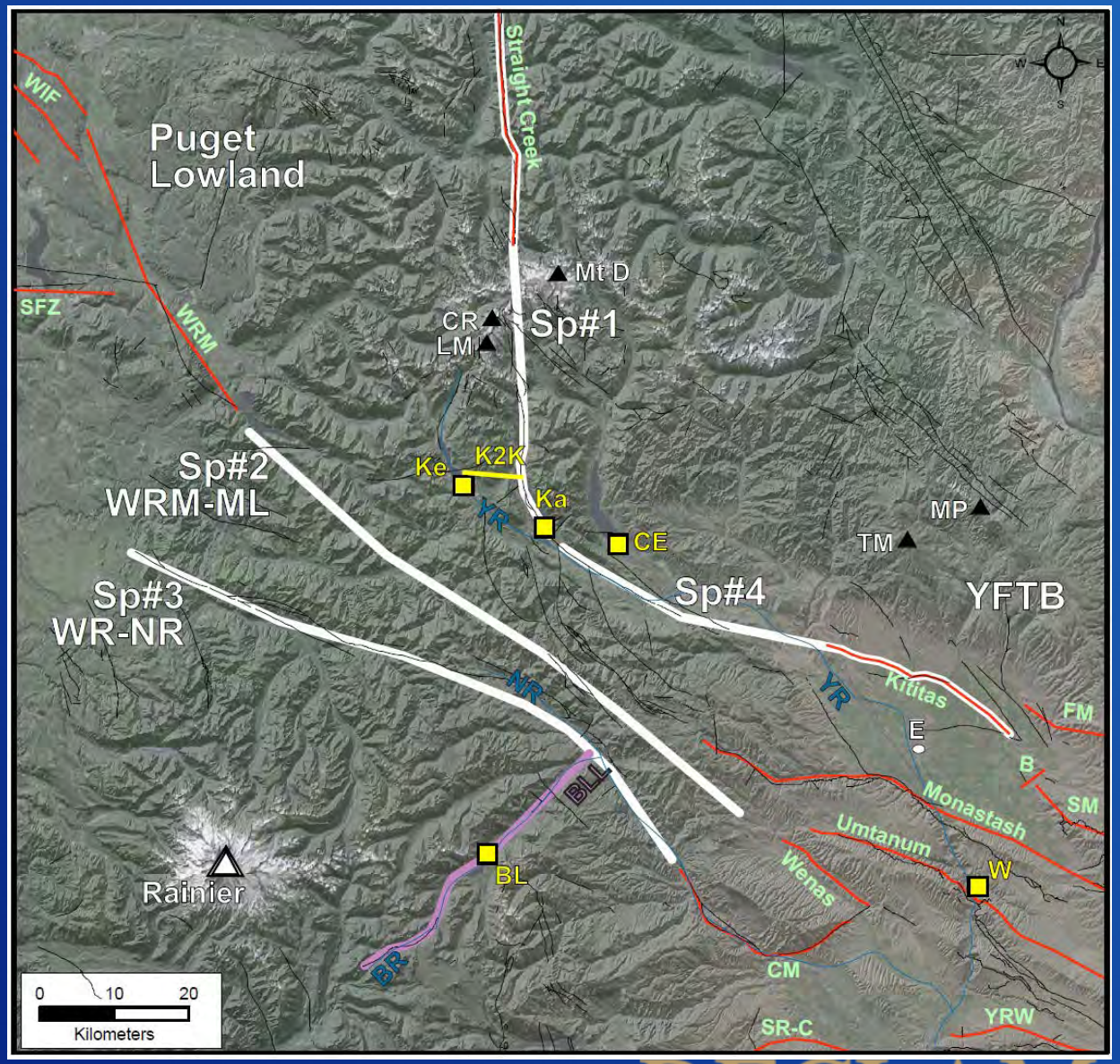
Summary

- Seismic refraction and borehole geologic logs suggest that maximum depths to top of bedrock are roughly 160-210 feet at both the A (upstream) and B (downstream) sites.
- These data also suggest that there is an appreciable difference in expected excavation effort, and cost savings, with the B site requiring less excavation work.

Summary (cont'd)

- Seismic and borehole results to date on the right (southeast) side of the B site are somewhat sparse. Further explorations would be required to more confidently assess geologic and engineering conditions on the right side.

Regional Geology



From Redwine, USBR, 2014

RECLAMATION

RECLAMATION