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STOP 6. MT. WASHINGTON SLOPE
Leader: James V. Hamel, P.G.

MT. WASHINGTON SLOPE - DUQUESNE INCLINE TO SMITHFIELD STREET BRIDGE

The Mt. Washington Slope, across from the "Point" of Downtown Pittsburgh, will be viewed from the Corps of Engineers barge while we cruise the Monongahela and Ohio Rivers. The slope segment of interest here extends from the Duquesne Incline up the Monongahela River past the Fort Pitt Tunnel and Bridge to the Monongahela Incline and Smithfield Street Bridge at Station Square (Figure 59). The Monongahela Incline, which opened in 1870, is the oldest incline in the United States. The Monongahela Incline and the Duquesne Incline, which opened in 1877, are still used extensively by commuters and tourists. Both of these inclines are National Historic Landmarks as are the Smithfield Street Bridge constructed in 1883 and the former Pittsburgh and Lake Erie Railroad Station completed in 1901 at what is now Station Square.

The Mt. Washington Slope forms part of the famous Pittsburgh skyline. This slope extends from river level (normal pool elevation 710 ft [216.4 m], controlled by the Emsworth Dam 6 mi [9.6 km] down the Ohio River from the "Point") up to approximately elevation 1150 ft (350 m)

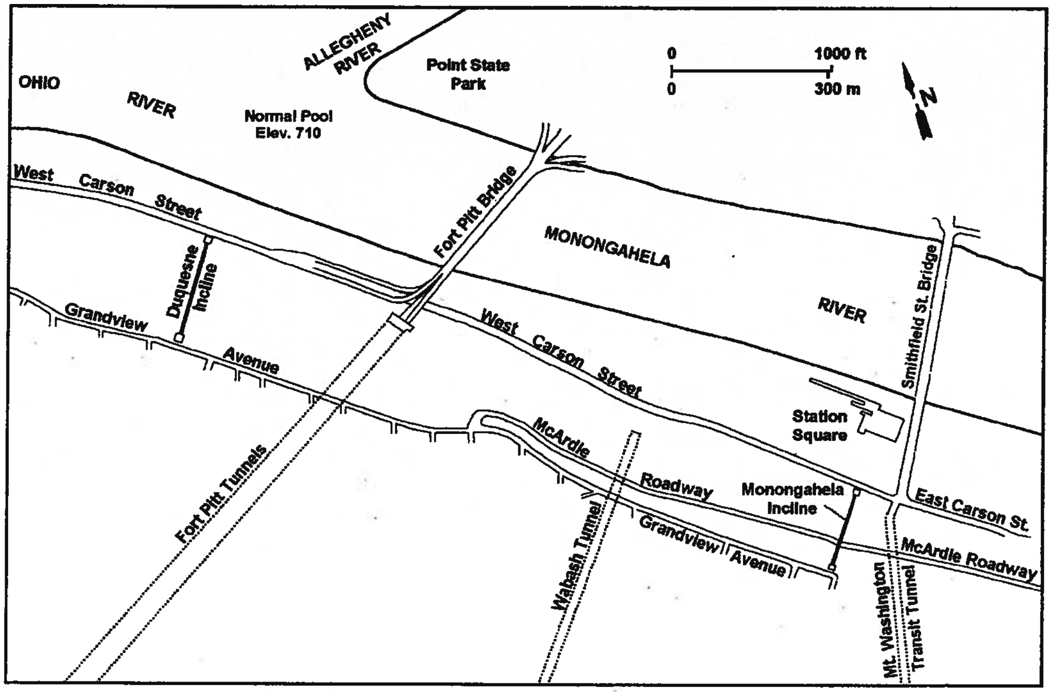

Figure 59. Map of Mt. Washington Slope - Duquesne Incline to Smithfield Street Bridge.

along Grandview Avenue (Figures 59-62). Rocks in the slope belong to the Pennsylvanian age Conemaugh and Monongahela Groups. These rocks are flat-lying with a dip of about 1% southerly or into the Mt. Washington Slope (Figure 61). The Ames Limestone at the top of the Lower Conemaugh Glenshaw Formation lies at nominal elevation 750 ft (229 m) while the Pittsburgh coal at the base of the overlying Monongahela Group lies at nominal elevation 1050 ft (320 m) (Figures 61 and 62). The first known mining of the Pittsburgh coal occurred on Mt. Washington, then known as Coal Hill, circa 1760 (Stop 1; Adams and oothers, 1980; Delano, 1985).

This area is generally thought to have been eroded to the ridgetop level of Mt. Washington (nominal elevation 1200 ft [365 m]) (Figures 59 and 61) by the end of Tertiary time (Johnson, 1929; Leighton, 1947; Wagner and others, 1970). Erosion of river channels in bedrock down to the Parker Strath, nominal elevation 900 ft (274 m), is generally thought to have occurred by the Illinoian period of Pleisttocene time when glacial outwash was deposited up to nominal elevation 1000 ft (305 m) (Figure 61). Further erosion of river channels in bedrock down to nominal elevation 660 ft (200 m)

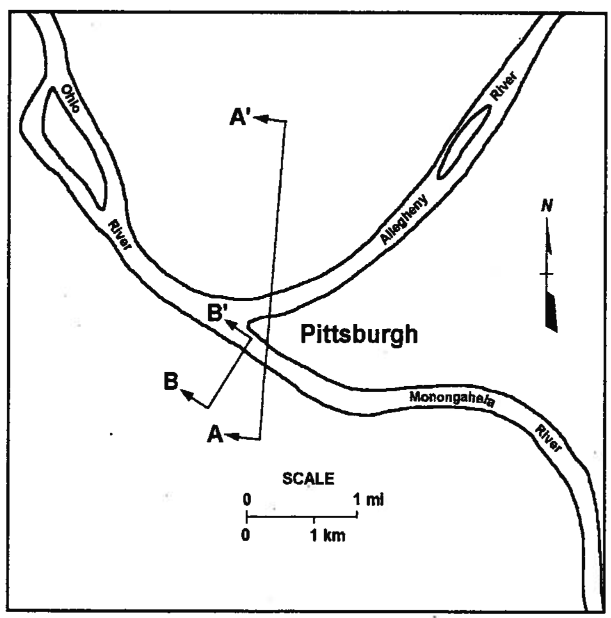

Figure 60. Map of Pittsburgh with cross-sections A – A' and B – B' (modified from Hamel, 1998).

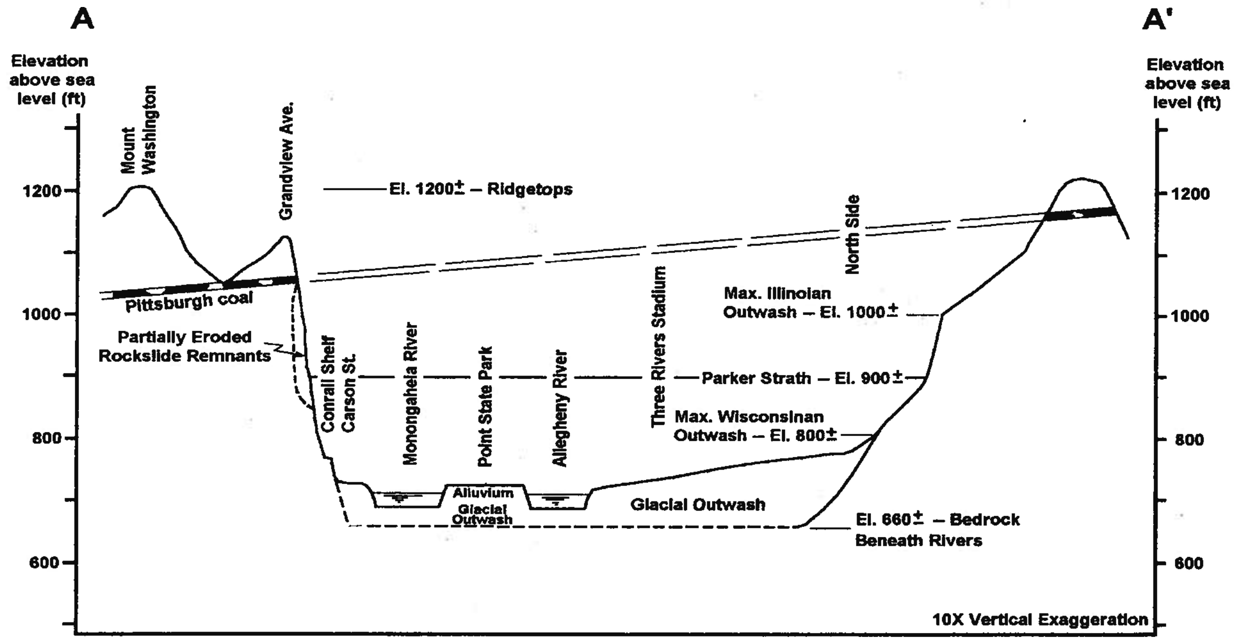

Figure 61. Cross-section A – A' (modified slightly from Hamel, 1998). See Figure 60 for location.

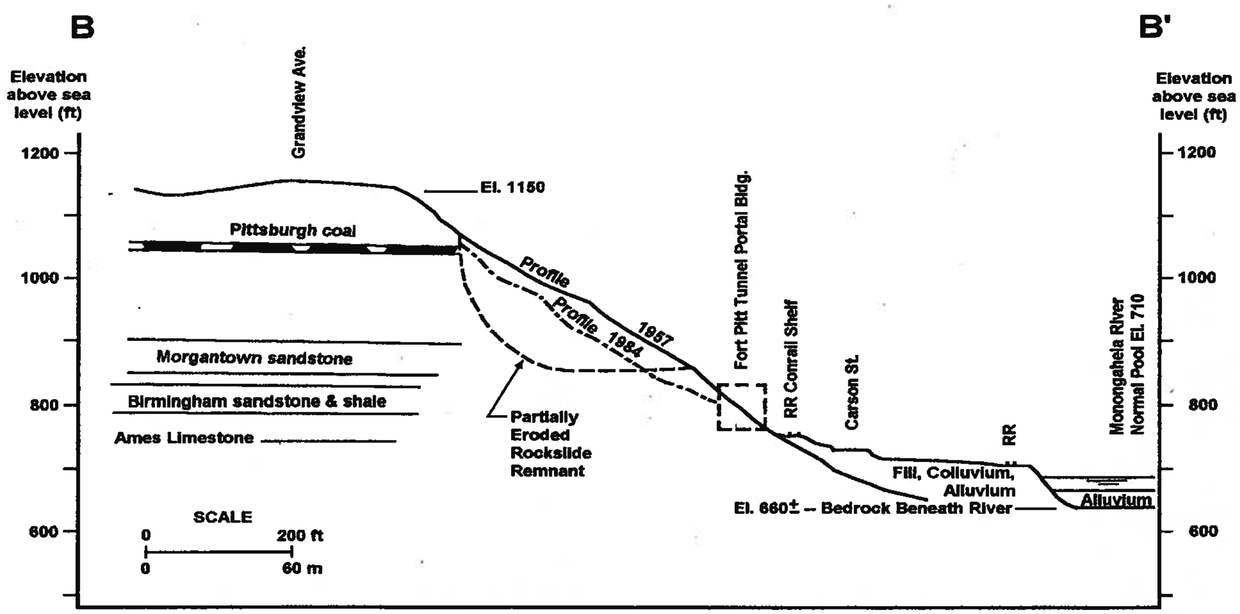

Figure 62. Cross-section B – B' (modified slightly from Hamel, 1998). See Figure 60 for location.

(Figures 61 and 62) is generally considered to have occurred in Late Illinoian time. During the later Wisconsinan period, little, if any, additional bedrock erosion of river channels is thought to have occurred. Extensive Wisconsinan outwash was deposited and reworked in the Pittsburgh area, with remnants existing up to nominal elevation 800 ft (244 m) (Figure 61).

Further information on the fascinating history of Pittsburgh's rivers during Pleistocene time is given by Leverett (1902, 1934), Wagner and others (1970), Adams and others (1980), Jacobson and others (1988), Harper (1997), and Hamel (1998) (also, see p. 28). It should be noted that the chronology of river erosion and deposition in the Pittsburgh area is not well constrained and some events may, in fact, have occurred earlier than generally believed. Additional details of this chronology are yet to be discovered through meticulous geologic field work, combined with the latest laboratory dating techniques, at key areas like the Mt. Washington Slope.

As Pittsburgh grew over the past two centuries, extensive development occurred in flatter areas along the toe and top of the Mt. Washington Slope. Of particular importance was initial railroad construction along the slope toe ca. 1850, as the railroads extended westward, and railroad expansion further into the slope toe ca. 1900, as Pittsburgh industries grew (Conrail Shelf, Figures 61 and 62). The slope itself, with a height of 300 to 400 ft (90 to 120 m) and an overall inclination of 1.5H:1V (34°) with some steeper segments, remained, for the most part, undeveloped. This lack of development on the slope resulted from generally difficult access as well as geotechnical problems, mainly slope instability. Numerous landslides and rockfalls have come down onto the railroad over the past 150 years.

Until the 1990s, the Mt. Washington Slope received little attention from geologists and engineers, other than that related to construction and rehabilitation of several tunnels through the ridge in the 19^{th} and 20^{th} centuries, construction of McArdle Roadway up the slope from the Liberty Bridge in the 1920s, and re-construction of McArdle Roadway in the 1980s. Ackenheil (1958, 1959, and 1987) described rock slides and their treatment at the North Portal of the Fort Pitt Tunnel (Figures 59 and 62). Voytko and others (1987) described stabilization measures for the rock slope at the North Portal of the Mt. Washington Transit Tunnel southwest of the Smithfield Street Bridge at Station Square (Figure 59). I have not yet found any publications on the Wabash Railroad Tunnel or McArdle Roadway (Figure 59). Ackenheil (1954) tabulated some historic landslides and rockfalls along Mt. Washington and Ackenheil (1958) provided additional historical information on slope instability along the railroad.

Geologic and engineering attention was focused on the Mt. Washington Slope in the 1990s when a busway was proposed to be constructed along the slope toe on the Conrail Shelf (Hamel and others, 1998a and 1998b). Preliminary geotechnical investigations for the busway from 1991 to 1993 identified significant rockfall hazards. Detailed geotechnical investigations during 1994 and 1995 developed further information on slope geology and landslide and rockfall hazards, and produced designs for hazard reduction measures. Construction of these measures (which included cable lashing, scaling, rockbolts, and buttresses along the Mt. Washington Slope) began in late 1996 and was terminated prior to completion in early 1997 when the busway project was cut back as a result of cost and political considerations. There are some indications that this project may re-activate in the 21^{st} century.

The 1994-1995 busway slope investigations included review of technical literature and historical records as well as analysis of historical (vertical) aerial photographs and low-level oblique aerial photographs taken for this project. The Mt. Washington Slope was virtually

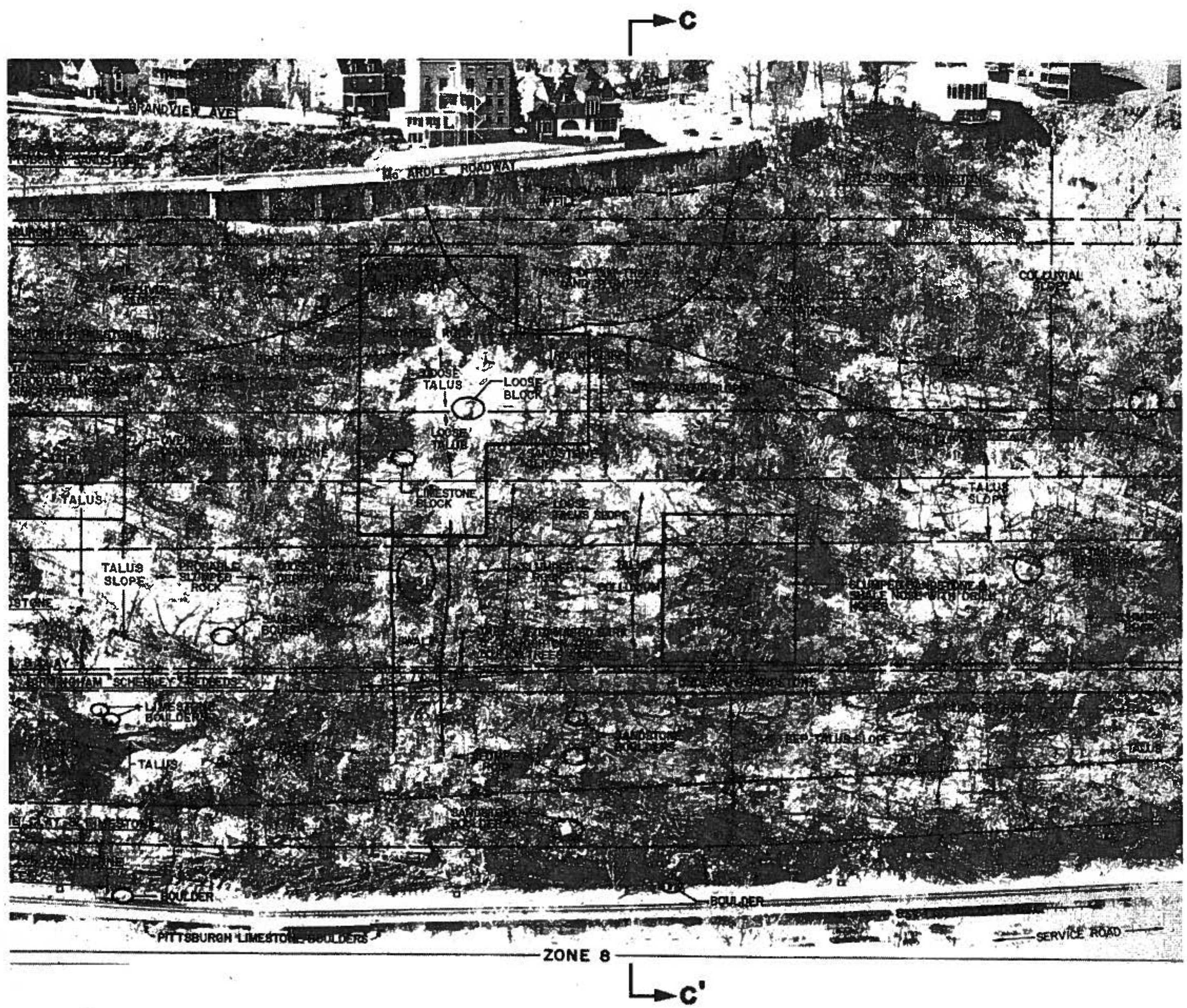

Figure 63. Aerial mosaic strip with cross-section C – C' (modified from Hamel and others, 1998b).

inaccessible to drill rigs and environmental and safety concerns essentially precluded drilling there. Field work consisted mainly of reconnaissance and mapping on large-sale (1:360) oblique aerial mosaics (Figures 63 and 64).

This field work along the Mt. Washington Slope revealed many of the slope failure types and processes of Varnes (1978). Rockfalls and rock topples are ubiquitous. Some of these failures are related to lateral rock spreads, rock slides, and rock slumps associated with valley stress relief (Ferguson, 1967; Ferguson and Hamel, 1981; Hamel, 1998). Debris slumps, debris slides, and slump-earthflows, all colluvial slope failures typical of the region (Hamel and Hamel, 1985; Hamel and Ferguson, 1999), are common along the Mt. Washington Slope. Debris slides, debris flows, and debris avalanches, which involve movement of colluvium and/or talus down chutes or ravines, are also common there (Hamel and others, 1998b).

The most significant geologic finding along the Mt. Washington Slope was the previously hypothesized (Hamel and Adams, 1981; Hamel and Hamel, 1985; Hamel and Ferguson, 1999), but hitherto relatively undocumented presence of numerous remnants of deep-seated, slump and translational landslides in bedrock. Slumped rock masses are recognized in the field by the appreciable dip of their beds back into the slope (Figure 65). Field recognition of translational rock slides is more difficult.

These rock slides are believed to have occurred during Pleistocene time when the rivers were actively eroding their valleys and climatic and hydrogeologic conditions were much more

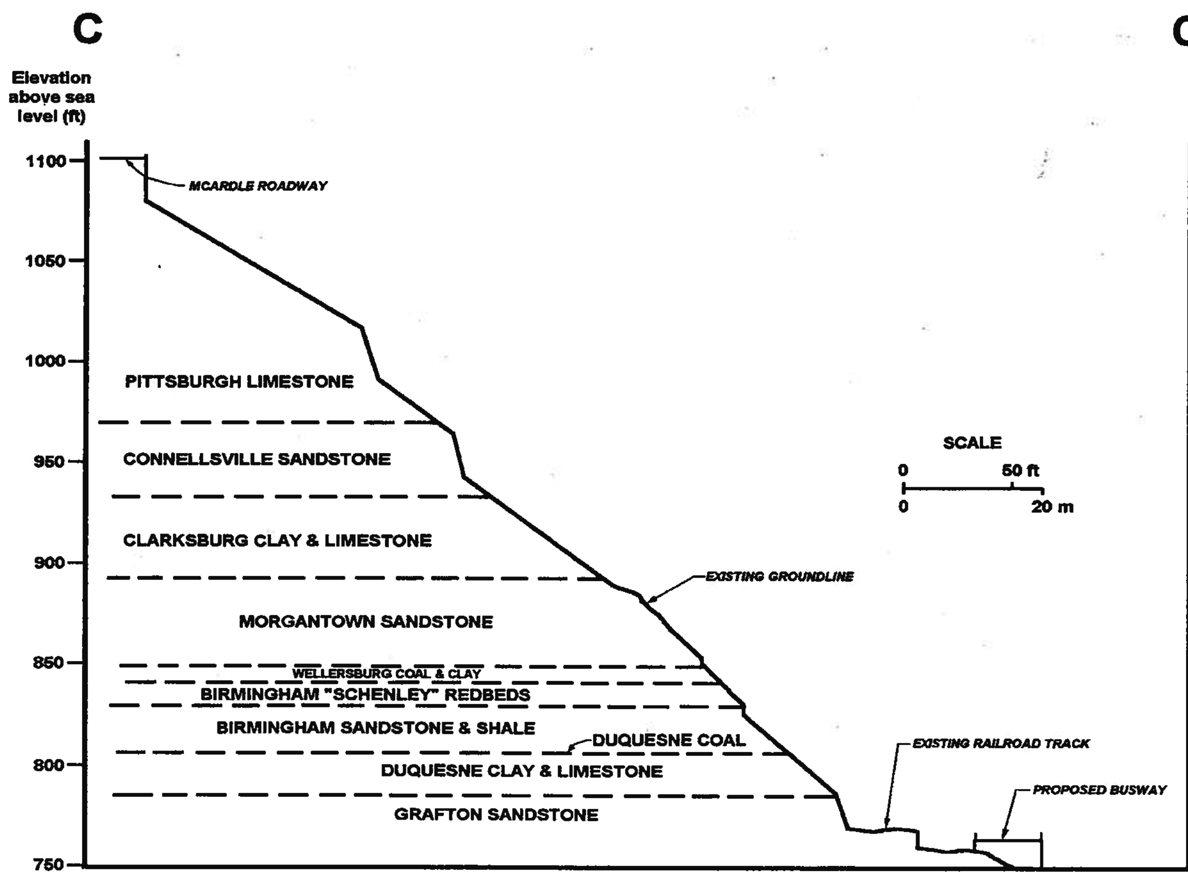

Figure 64. Cross-section C – C' (modified from Hamel and others, 1998b). See Figure 63 for location.

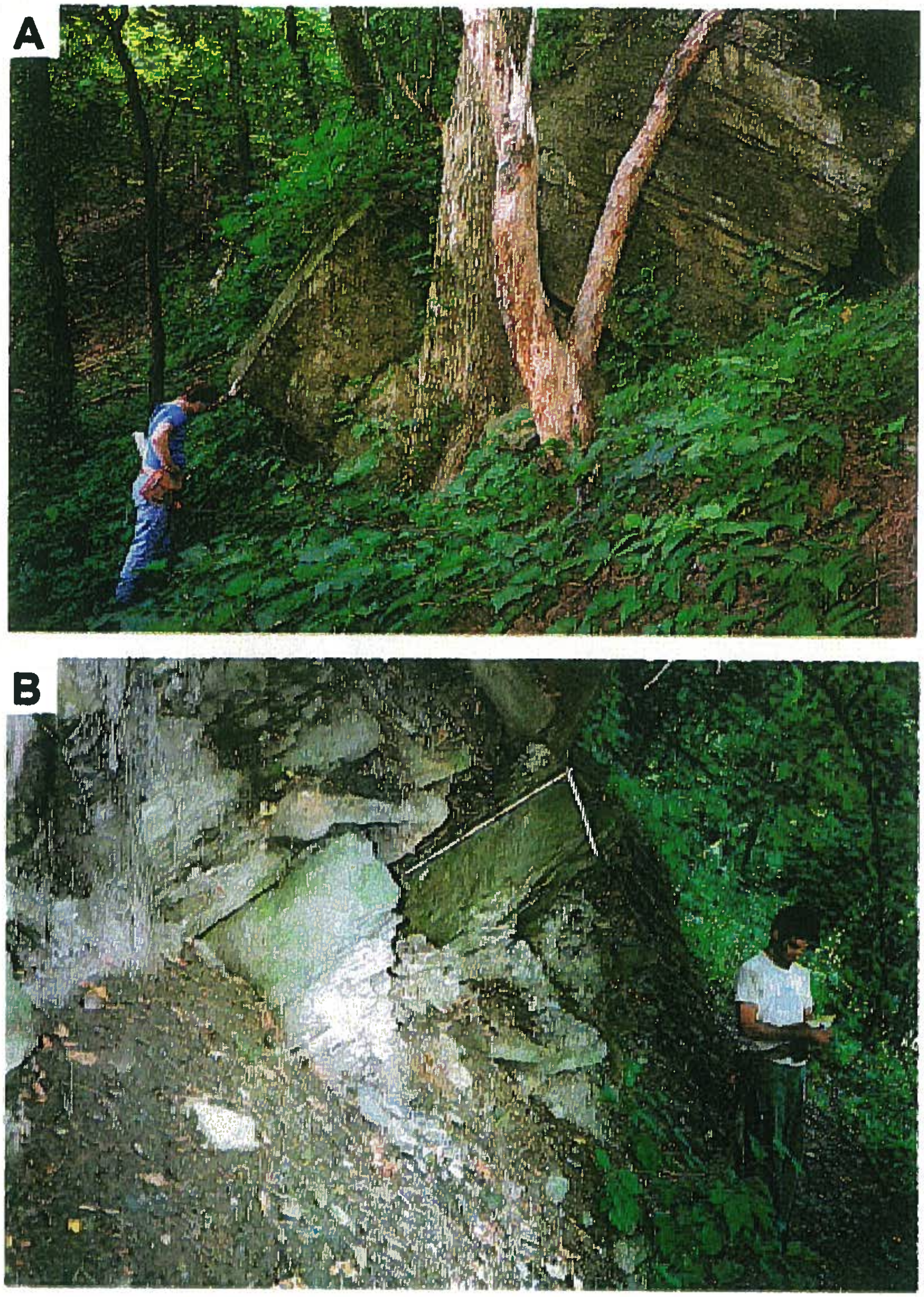

Figure 65. A. Slumped Morgantown sandstone blocks on slope 500 ft (150 m) upriver from Duquesne Incline (July 21, 1994). B. Slumped sandstone (30° dip into slope along 3-ft segment of 3 X 1-ft rule) in Pittsburgh limestone unit on slope 1000 ft (300 m) upriver from Fort Pitt Tunnel (July 28, 1995).

severe than at present (Hamel, 1998). Portions of these rock slide masses were eroded during later Pleistocene time and additional portions were excavated during the two major phases of railroad construction ca. 1850 and 1900.

The Pleistocene rock slide remnants, along with the numerous colluvial landslide features along the Mt. Washington Slope, are considered to be at least marginally stable under presently prevailing climatic, fluvial, and hydrogeologic conditions as long as they are not disturbed by construction activities. Loosened rocks from the rock slide remnants will continue to fall and/or slide onto the railroad along the slope toe, however, as they have for the past 150 years (Ruppen, 1999).

Discovery and documentation of numerous, deep-seated rock slide remnants along the Mt. Washington Slope lead to review of previously noted but seemingly rare and widely scattered rock slides in the region (Hamel, 1998). These rock slides have significant geologic implications regarding the Pleistocene history of the region, specifically processes of valley formation and colluvial slope development. They also have significant engineering implications relative to continuing rockfall and rock slide problems along transportation corridors, e.g., the Conrail Shelf, and future construction activities, particularly along slopes like the Mt. Washington Slope, which comprise much of the open space remaining in the Greater Pittsburgh area (Hamel, 1998).

The 1994-1995 busway slope investigation, which included the Mt. Washington Slope, was performed by Michael Baker, Jr., Inc. for the Port Authority of Allegheny County under FTA Project PA-03-0227. The work was financed in part through a grant from the US Department of Transportation, Federal Transit Administration, under the Urban Mass Transportation Act of 1964, as amended. John D. Lasko, Christopher A. Ruppen, and Donald V. Gaffney (all Professional Geologists) of Michael Baker, Jr., Inc., contributed substantially to this work for which the writer served as a consultant.

0.6	0.20	Pass under the Fort Pitt Bridge.
0.2	0.00	Confluence of the Monongahela River and Allegheny River to form the Ohio River.
0.3	0.30	The oddly shaped gray building to the **right** with the submarine USS Requin in front of it is the Carnegie Science Center. Next to it downstream are docked Voyager and Discovery, two surplus naval vessels that serve as Pittsburgh's floating classrooms. Pittsburgh Voyager takes groups of school children and their teachers on the water during the school year to teach them about the biology, chemistry, geology, and engineering of Pittsburgh rivers.
0.4	0.70	Pass under the West End Bridge. There used to be a salt works on the south shore to the **left** where Saw Mill Run drains into the river (Figure 66).
0.8	1.50	Upstream end of Brunot Island on the **left**. The island was named for the Brunot family who once lived there. Brunot Island is a six-unit, oil-fired, electric-generation facility. Formerly a coal-fired plant, it was converted by Duquesne Light Company in 1972. It has a demonstrated net capacity of 234 megawatts. Orion Power, a Baltimore-based corporation, recently acquired Brunot Island from Duquesne Light and plans to refurbish the facility, converting the old oil-fired plant to an efficient, environmentally preferred combined-cycle power plant fueled with natural gas. Orion Power expects to begin construction in November 2000, with full commercial operation

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