

Characterization of Geographical Aspects of the Landscape and
Environment in the Area of the Little Bighorn Battlefield, Montana

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Characterization of Geographical Aspects of the Landscape and Environment in the Area of the Little Bighorn Battlefield, Montana

John H. Sandy

Abstract: On June 24, 1876, a large military force of the United States Army 7th Cavalry converged on the lower Little Bighorn Valley in the Montana Territory, aiming to capture a large number of Native Americans. A major military battle ensued over the following two days. The landscape near the Little Bighorn Battlefield is both gentle and very rugged. The upland to the east of the Little Bighorn Valley is highly dissected by a complex drainage system, consisting of ravines, coulees, and ridges. Elevations from the valley floor to the upland change as much as 340 feet. The slope in parts of the upland is greater than 10 degrees, and in rugged areas of the bluffs and along some ravines and other erosional features in excess of 30 degrees. The Little Bighorn Valley itself is a gentle northward sloping plain, with the Little Bighorn River flowing to the east side of the valley adjacent to the upland. Local vegetation of the area is highly diverse, bearing a close relationship to the physiographic features, hydrology, and climate of this area. Certain characteristics of the Little Bighorn River and the bordering riparian zone add to the diversity of the landscape. A brief analysis suggests ways that elements of the landscape and environment affected the course of the battle.

Keywords: Little Bighorn Battlefield, physiography, weather, topography, vegetation, Montana, military history, Lakota Sioux, Northern Cheyenne, U.S. Army

HISTORICAL SIGNIFICANCE OF AREA

In 1876, Native Americans on the northern plains were in conflict with the United States government. The government wanted them to move to reservations, but they resisted. In response to the situation, the U.S. Army dispatched Lieutenant Colonel George A. Custer and others to locate and force them onto reservations. Feeling pressure from the army, several tribes gathered in the Little Bighorn Valley, Montana Territory, during late June. They assembled to protect themselves and to go about normal daily activities. Thus, the stage was set for the Battle of the Little Bighorn that occurred on June 25-26, 1876.

In the days immediately before the Battle of the Little Bighorn, Custer put his soldiers on a grueling march, perhaps hoping to reach the camp of the Native Americans before other military units could do so. The route followed began at the Yellowstone River Valley, went south up the valley of Rosebud Creek, and continued west over the Wolf Mountains, a low range of hills separating Rosebud Creek and the Little Bighorn Valley.

During the march west over the Wolf Mountains, the 7th Cavalry would pass through rugged terrain up Davis Creek, a tributary of Rosebud Creek, to reach the divide separating the valley of Rosebud Creek from the Little Bighorn Valley. After arriving at the divide separating the two valleys, the army moved westward downslope toward the Little Bighorn Valley. They followed

a tributary (later named Reno Creek) of the Little Bighorn River. Overall, the distance between the Rosebud and the Little Bighorn, as shown by GIS tools, is about 20.4 miles.

After locating the Native Americans in the Little Bighorn Valley, Custer divided his regiment into smaller battle units. One battalion of soldiers, under Captain Frederick Benteen, would go to the south to block any escape up the Little Bighorn Valley. A second battalion, led by Major Marcus Reno, would follow Reno Creek down from the divide and cross the Little Bighorn River in an area south of their camp and then attack the village. Custer would take a third battalion, five companies of soldiers, and move north along the upland east of the Little Bighorn Valley and, at a favorable place, cross the Little Bighorn River and attack from the flank or from a point at the north end of the encampment.

The Native Americans for their part were in position to sit on the plain of the Little Bighorn Valley, ready to take appropriate action as events unfolded. They were camped in a southeast-northwest direction across the plain. The site of their camp afforded excellent mobility and good visibility in all directions, including eastward toward the bluffs and other areas of the upland beyond the Little Bighorn River. The Native Americans, with many warriors in camp, and hundreds of fresh horses, were ready to engage. The army would go into battle with a solid force, although tired and exhausted after days of forced march.

Logistics are important in military campaigns. The soldiers of the 7th Cavalry were well supplied with armaments and ample provisions to sustain both horses and soldiers. For the soldiers, the weapons of choice were handguns and carbines. Many Native Americans had good armaments, too, even modern rifles of the time. In addition, traditional bows and arrows and hand-held weapons were available for use in battle.

The human side of events is often the main interest in this battle. However, as compelling, the battle tactics for both Native Americans and soldiers would play out under very difficult and unpredictable conditions. After a brief, unsuccessful attack in the valley of the Little Bighorn by Marcus Reno, the battle continued with soldiers led by Custer in an area of rugged terrain, further to the north and on the east side of the Little Bighorn Valley. As the battle progressed, the army would find that the rugged and diverse landscape was less than an ideal place to engage their adversary.

REVIEW OF LITERATURE

The Battle of the Little Bighorn is one the most studied military events in American history. Much of the interest in the battle is around the decisions and actions of Custer and other military participants in the conflict. Philbrick (2010) wrote an interesting narrative about movements of the 7th Cavalry on the days leading up to the battle and described details of the battle. Utley (1988), in a National Park Service handbook, gives readers essential background material and an account, supported with evidence, of what happened during the battle. Gray (1991) provided an in-depth account of troop movements and other aspects of the battle, including timelines, all described with thorough documentation. Sievers (1976) on the centennial anniversary of the Battle of the Little Bighorn prepared a major historiography on the literature of the Little Bighorn.

Other major books (Utley 1973; Stewart 1955; Vestal 1948) present well-research historical treatments of the era of conflict with the plains Native Americans. In varying degrees of detail, these three authors describe and analyze government policies, military campaigns, and the response of Native Americans among other topics. These works provide background material and place in context circumstances and actions that fueled the conflict, as well as particulars of the Battle of the Little Bighorn in 1876.

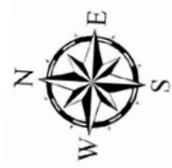
As for the physical aspects of the landscape near the Little Bighorn, studies by academic and government scientists report basic scientific information. In recognition of the historical significance of the battle, the United States Geological Survey (1908) prepared a topographic map of the area, based on a survey completed in 1891. Moulder et al. (1960) described in detail the geology and groundwater resources of the lower Little Bighorn River Valley. Under contract from the National Park Service, Simonson (2001) conducted a systematic survey of the vascular plants of the battlefield, adding to work done earlier. More recently, the National Park Service (2011) published an inventory of the geologic resources of the battlefield drawing from pre-existing data and information. Rice et al. (2012) developed a detailed classification of plants of the Little Bighorn Battlefield National Monument and prepared a map of plant distribution. Of special importance to this paper, Smoak (2015) wrote a technical report about the battlefield as it may have appeared as a natural landscape in 1876, including plants and animals present at that time.

METHODOLOGY

To characterize the landscape of the land in the area of the Little Bighorn Battlefield, this study draws primarily on information from primary sources and Geographic Information Systems. Technical reports and datasets of the U.S. Geological Survey, the National Park Service, and the U.S. National Weather Service were widely used. Historical information and weather data from the U.S. Army were valuable for background information. The *Plant Fact Sheet* series prepared by the Natural Resources Conservation Service, United States Department of Agriculture, provided essential reference data on specific plants. Topographic maps at the scale of 1:2400, published by the U.S. Geological Survey in 1967, provided details about the topography in the area of the Little Bighorn Battlefield. The topographic map for Crow Agency, Montana, was an important source of data in this study. This sheet shows the Little Bighorn Battlefield and surrounding land in detail. Google Earth Pro provided data visualization and a mechanism to measure relationships of physical features on the landscape. ArcGIS (Esri) was a primary tool for collecting detailed topographic data, data analysis, and reporting of the same.

PHYSIOGRAPHIC AREAS

The landscape in the area of the Little Bighorn Battlefield consists of two major physiographic areas, the Little Bighorn Valley and the adjacent upland (Figure 1). These areas, in more detail, include the plain of the Little Bighorn Valley, the Little Bighorn River, riparian zones bordering the Little Bighorn River, the bluff region east of the Little Bighorn River, the upland east of the Little Bighorn Valley, and the ravines and coulees carved in the upland. All areas have special and prominent features/characteristics.



Latitude & Longitude N45°30'00" - N45°35'00" and W107°22'30" - W107°27'30"
Scale: Approx. 1 mile

FIGURE 1 Shaded relief map of landscape in the area of Little Bighorn Battlefield. Little Bighorn valley and river at bottom and dissected upland at top of illustration. Downstream flow of the river is southeast to northwest, from right to left in this illustration. Source: Courtesy National Park Service, U.S. Department of the Interior.

Due to the how geomorphic processes changed the landscape over millions of years, differences in topography are very apparent from one area to another. Changes in slope, elevation, and other details of topography occur often over short distances. Further, the variability of the landscape contributes to an abundance of plant communities distributed in special ways. The characteristics of the landscape played a significant role in events/activities leading up to the battle and ultimately had a major impact on the outcome of the fighting.

LITTLE BIGHORN VALLEY AND LITTLE BIGHORN RIVER

Considered separately and together, the Little Bighorn Valley and the Little Bighorn River are crucial elements of any discussion of the Battle of the Little Bighorn. The Little Bighorn Valley in the area of the Little Bighorn Battlefield is an extensive plain. In width, the plain at its more northern part has a width of about .98 miles, and further upstream the valley floor broadens to about 1.30 miles. In another segment, even further upstream, the width of the valley floor measures about 1.50 miles. Elevation of the plain decreases modestly moving downstream, south to north from 3,134 feet to 3,060 feet, over a distance of about 5.5 miles.

The Little Bighorn River is a tributary stream of the Bighorn River, which is itself a tributary of the Yellowstone River. The Little Bighorn River originates in the Bighorn Mountains. The width of the river varies with location and streamflow. Data from selected years recorded by the U.S.G.S. (Table 1) near Hardin, Montana, shows width ranging from 41 to 106 feet in late June near the lower end of the river’s course. The depth of the river in late June is consistently less than three feet. Data recorded at the same location show discharge in late June, averaged over six different years, is about 348 cubic feet per second (U.S. Geological Survey 2016).

Hydrology of Little Bighorn River near Hardin, Montana						
Characteristics of Stream	Date of Measurement					
	25 June 1981	25 June 1986	24 June 1988	30 June 2005	28 June 2012	02 July 2014
Channel width (feet)	66.0	106	41.0	83.0	89.0	94.3
Channel area (square feet)	136	148	45.7	122	135	205
Average Channel depth (feet)	2.06	1.40	1.11	1.47	1.52	2.17
Streamflow (cubic feet per sec.)	482	392	122	275	232	587

TABLE 1 Characteristics of Little Bighorn River at monitoring station about 20 miles downstream from Garryowen, Montana. Data from the years 1981, 1986, 1988, 2005, 2012, and 2014. Source: Data obtained from dataset for USGS 06294000 Little Bighorn River near Hardin MT.

Daily variations in stream flow are interesting, as well. Lundquist and Cayan (2002, 601) noted that diurnal stream discharge varies depending on the season. In May, on a daily basis, the Little Bighorn River tends to rise steeply and decline gradually due to melting snows. The river’s maximum discharge occurs at about midnight. By July, the pattern has shifted to steep declines and gradual rises, with daily maximum discharge coming about 12 hours later or at mid-day. Hence, the water discharge in the river in late June is greatest at mid-day, but decreases as the

afternoon and day continues. Precipitation over a short period affects daily stream flow as well. Importantly, on June 26, 1876, about one-tenth inch of rain fell over the south-central Montana Territory, likely adding runoff to the lower Little Bighorn River.

Data in Table 1, while important, likely are not an absolute surrogate for hydrology of the Little Bighorn River more than a century ago. Hamlet & al. (2005, 4545) referenced recent studies showing that in the second half of the twentieth century areas in the western part of the United States experienced a decrease in snow-water equivalents, earlier spring snowmelt, and earlier peak flow in streams, due to climate warming and other factors. This suggests that stream flows of the Little Bighorn River during historical times, in late June, may have differed from and exceeded levels documented in contemporary periods.

Indeed, the research findings by Hamlet and others on the impact of environmental changes on stream hydrology in the West are consistent with a first-hand historical account on the depth of the Little Bighorn River. Granville Stuart wrote, “four years after the battle, the river was fifty to sixty yards wide, about three feet deep, very swift” (Stewart 1955, 307). Stuart’s report indicates a greater depth for the river in 1880 than data from the U.S.G.S. shown in Table 1.

In many areas along its course, the Little Bighorn River meanders as it flows downstream. In some meanders, the river cuts into the valley floor, creating abrupt and steep banks at sides of the channel. Generally, the Little Bighorn River has a comparatively narrow channel and crossing is not too difficult. However, since beds of stream channels are seldom consistent, this may affect crossing. As a military matter, the Little Bighorn River was a barrier to movement in either direction.

For the Native Americans, the plain of the Little Bighorn Valley allowed ease of movement, especially during early phases of the battle. A mounted warrior riding a horse at full gallop (25 to 30 miles per hour), could travel up and down the valley in a short amount of time. In tactical terms, the Native Americans could direct action at the right time and place as appropriate to counter the Cavalry.

SLOPE OVER LITTLE BIGHORN BATTLEFIELD

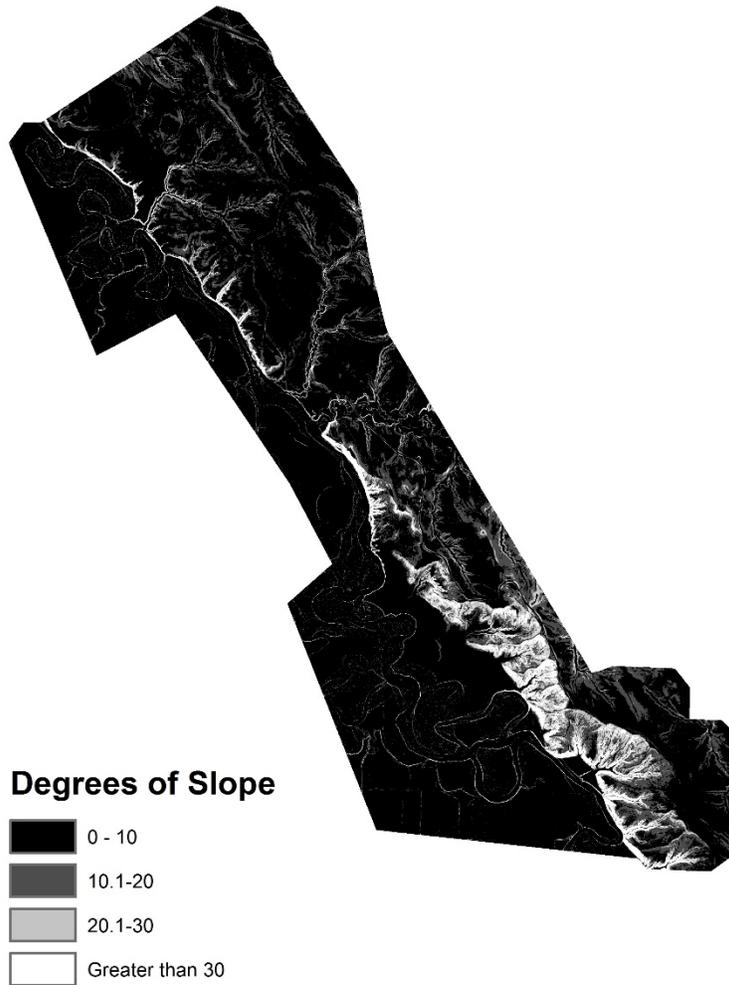
The rise or fall of the land surface, commonly referred to as slope, is a way to characterize landforms. In the area of the Little Bighorn Battlefield, slope is a major feature of the landscape. Slope varies in relation to the degree of erosion and the pattern of the drainage system.

Due to proximity to the Little Bighorn River, much of the upland area of the battlefield area is highly dissected and very rugged. Significant slope is the common characteristic of the upland. Greater slope occurs in areas of major dissection along the sides of coulees and ravines and at the line of bluffs adjacent to the Little Bighorn Valley. On the plain of the Little Bighorn Valley, slope is minor.

Along ridges on the upland, the elevation may be mostly level in one direction, but then fall in opposite directions. An example is a long, mostly level, narrow ridge that extends from northwest to southeast for a distance of about two-thirds of a mile, beginning at the north end of

the battlefield near the battlefield's historical marker. The elevation of the land decreases on both sides of this ridge, giving rise to slight slope.

Slope of the Little Bighorn Battlefield



Latitude & Longitude N45°30'00" - N45°35'00" and W107°22'30" - W107°27'30"

Scale: Approx. 1 mile 

FIGURE 2 Average slope of the land in the area of the Little Bighorn Battlefield. Source: Data from U.S.G.S. digital elevation model (DEM), with resolution of one meter. Degrees of slope computed with ArcGIS from Esri.

In the map shown by Figure 2, analysis of U.S.G.S data gives a visual representation of the slope over the entire area. As calculated by ArcGIS (Esri), slope is depicted in continuous values ranging from 0 – 81.07 degrees, with 0 being no slope and 81.07 representing the greatest slope in the study area. Slope averages 7.27 degrees over the entire battlefield.

Table 2 shows average slope, by area, over the entire battlefield. When analyzed in detail, slope data in the range of 30.52 – 81.07 (greater slope) accounts for 455,257 square meters, or 3.04% of the total area. Lower levels of slope in the range of 0 - 10 degrees are found throughout the area. Slope from 10.1 - 20 degrees is also common. In more heavily eroded areas, such as near coulees and ravines, slope can reach from 20.1 – 30 degrees or greater. In bluff areas, adjacent to and east of the Little Bighorn River, slope is mostly more than 30 degrees. At the south end of the battlefield, slope in excess of 30 degrees is pervasive and extends a significant distance back into the upland.

Area of slope Little Bighorn Battlefield	
Average slope	Area represented
0 – 10 degrees	74.7%
10.1 – 20 degrees	13.6%
20.1 – 30 degrees	4.4%
Greater than 30 degrees	3.04%

TABLE 2 Area represented by varying degrees of slope over the Little Bighorn Battlefield.

Slope is a factor in ease and speed of movement for both men on foot and mounted cavalry. At the Battle of the Little Bighorn, the army had traveled a long distance on the days leading up to June 25, the first day of the battle. As such, men and horses alike were at less than optimum strength, and movement over rugged, sloping terrain on the upland east of the Little Bighorn River presented considerable difficulty. In the area of Medicine Tail Coulee and Deep Coulee, gradual slope along stream channels added to the challenge. Areas of steep slope, along the line of bluffs, were even more difficult to navigate and likely avoided by battle participants. In essence, slope in the bluff region was a major factor that limited possibilities for movement, particularly in an east-west direction, along the western margin of the battlefield.

ELEVATION OF THE LAND

The elevation of the land east of the Little Bighorn Valley rises precipitously, beginning at the point where the valley floor meets steep bluffs. Beyond the bluffs, the land continues to rise to the east into an area of rugged uplands. Measured at selected intervals from north to south across the battlefield, differences in elevations rise in the north from 3,056 feet at the valley floor to about 3,300 feet at a distance of 1,141 yards east from the point at which the valley floor meets the bluffs. This represents an increase in elevation of 219 feet. Further south, elevations change from 3,100 feet at the valley floor to as high as 3,413 feet (at Weir Point) at a distance of 600 yards east from the point at which the valley floor abuts the bluffs. The increase in elevation in this area is 313 feet.

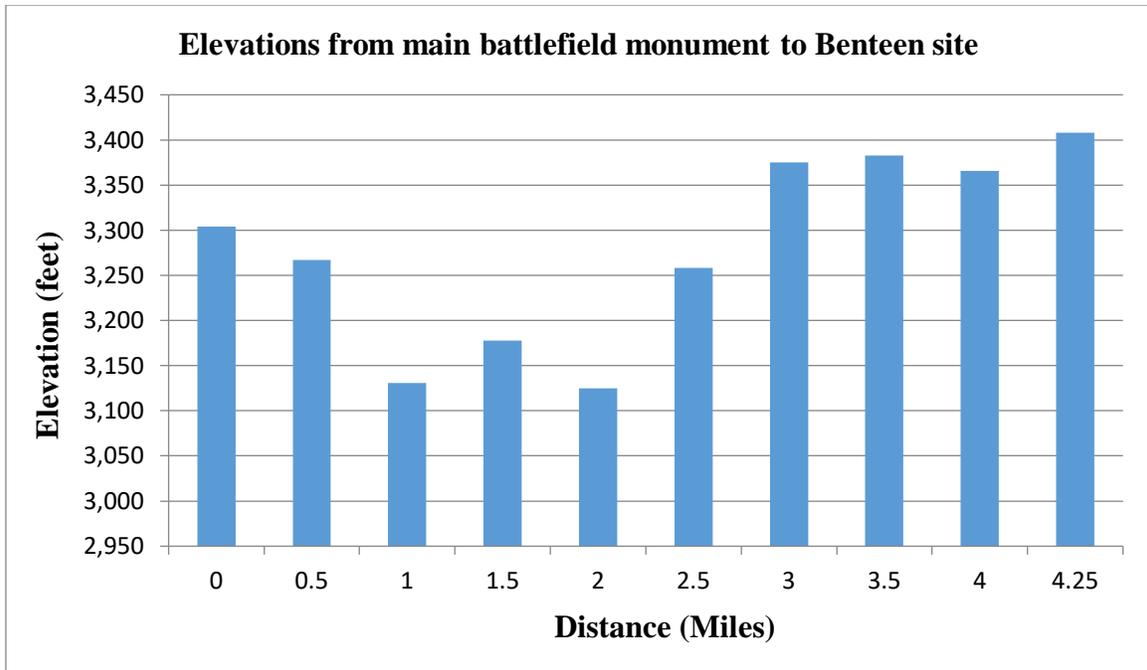


FIGURE 3. Data showing elevations (in feet) across the battlefield on the upland measured along a straight line, northwest to southeast, at one-half mile intervals beginning at the main battlefield monument and ending at Benteen site, a total distance of 4.25 miles.

The elevation level of about 3,290 feet in the northern part of the battlefield extends in a northwest-southeast direction over a distance of about .62 miles. Approaching the southern part of the battlefield, elevations rise to 3,400 feet, and the upland continues at or slightly above this elevation over a distance of about 367 yards. Figure 3 shows that elevations decrease and then increase from northwest to southeast across the battlefield.

LOCATION OF THE LITTLE BIGHORN RIVER RELATIVE TO THE BLUFFS

The course of the Little Bighorn River in this area is of special interest (Table 3). The entire channel runs on the east side of the Little Bighorn Valley, near the bluffs and the upland. The bluffs are almost continuous, except for occasional coulees and numerous short ravines entering the valley floor. Large breaks in the bluffs are few. For over one-half the distance, the river's channel is immediately adjacent to the bluffs and upland. Data from GIS mapping shows the river is near the bluffs for 3.1 miles of the total distance the river passes on the west side of the battlefield. The distance from where the river moves away from bluffs and the upland is slightly less at about 2.4 miles

Line of bluffs on east side of Little Bighorn Valley covers a distance of about 5.5 miles adjacent to the Little Bighorn Battlefield

North

South

Distance (in yards) measured, from north to south, along the line of bluffs where the channel of Little Bighorn River is near or away from the bluffs.

-A-	-N-	-A-	-N-	-A-	-N-	-A-	-N-	-A-	-N-	-A-	-N-	-A-	-N-	-A-
210	579	147	283	41	1,266	747*	1,425	1,629	233	257	1,123	479	541	705

TABLE 3 Data shows the distances, measured in yards, that the line of bluffs, from north to south, is located near or away from the Little Bighorn River. The letter “N” represents distances where the river is near the bluffs. The letter “A” represents distances where the river is away from the bluffs. The asterisk (*) designates a major break in the bluffs occurring where Deep Coulee and Medicine Tail Coulee join the Little Bighorn Valley. Reference map: U.S.G.S. 7.5 minute topographic map of Crow Agency, Montana, 1967.

In areas where the river channel moves away from the bluffs, distances from the river to the bluffs vary considerably. The distance that the river meanders away from the bluffs ranges from about 330 yards to about 1,000 yards at maximum. At the south end of the battlefield, the Little Bighorn River moves away from the bluffs over a large area with exact distances depending on variations in the depth of stream meanders. West of Weir Point the river channel is about 933 yards away from the bluffs. The topography where the Little Bighorn River meanders away from the bluffs is fairly level similar to the plain of the Little Bighorn Valley.

A small break in the bluffs occurs at Deep Ravine at the north end of the battlefield, with a width of about 30 yards at the valley floor. Near here, the river meanders back from the bluffs. In the area of Deep Coulee and Medicine Tail Coulee, a major break in the bluffs covers a distance of about 635 yards. The bluffs are highly eroded by stream action from the upland. Both coulees extend far into the upland. The river remains close to the line of bluffs. Another wide break in the bluffs, about 933 yards, occurs where Reno Creek meets the valley floor at the south end of the battlefield.

The location of the Little Bighorn River channel relative to the bluffs has changed slightly since 1891 (Martin et al. 2013, 3). On an overlay prepared by the National Park Service, some major meanders are further away from the bluffs in the year 1891 than shown on recent aerial photography of the area. Nevertheless, the river’s channel is consistently on the east side of the valley and always relatively close to the bluffs.

Both the Little Bighorn River and the bluffs were natural barriers to the movement of men and horses on the western margin of the battlefield. Perhaps most significantly, where the river abuts the bluffs, both barriers are in close proximity. Even in areas where the river meanders away from the bluffs, crossing the Little Bighorn River is likely a challenge. Of the two groups of

combatants, the soldiers faced the greater burden from these obstacles in the initial stage of the conflict since as attackers they would have to consider geographical aspects of both the bluffs and the river. Meanwhile, the Native Americans could easily defend or counter-attack from positions on the plain of the valley west of the Little Bighorn River.

WEATHER IN THE MONTANA TERRITORY IN LATE JUNE 1876

Weather data from the National Weather Service and other sources is useful for understanding conditions in the area of the lower Little Bighorn Valley. In broad measure, weather conditions for a locality are a result of seasonal variations, movement of air masses, and diurnal shifts. Weather data for Billings Logan International Station, some 59 miles northwest of the Little Bighorn Battlefield, for June 25, 1945-1952 (eight-year period), show high temperatures on average of 69.8 degrees and low temperature on average of 50.8 degrees, with relatively low humidity and mean average wind speeds of 11.7 miles per hour (Yankee Publishing 2016).

Some historical weather data exists for June 1876. In the late 1800s, the U.S. Army collected daily weather data at Ft. Benton, Montana Territory, a location on the upper Missouri River some 285 miles northwest of the Little Bighorn Battlefield (Table 4). Weather logs from late June 1876 show that military personnel recorded daytime temperatures at 6:00 AM; 3:00 PM; and 9:00 PM (Westcott 2016). For a five-day period in 1876, the average 3:00 pm temperature at Ft. Benton was 72.6 degrees.

Historical weather data archived at the State Historical Society of North Dakota show weather patterns during this period, as well. Of particular interest, the U.S. Weather Service at Bismarck, North Dakota, reported daytime high temperatures of 80, 71, 75, and 67 degrees for June 25, 26, 27, 28, 1876 (Greg Wysk, e-mail message to author, May 19, 2016).

Daily temperatures, Ft. Benton, Montana Territory, in late June 1876			
	6:00 AM	3:00 PM	9:00 PM
June 22	59	71	62
June 23	66	80	72
June 24	60	77	65
June 25	60	68	59
June 26	51	67	60

TABLE 4 Data showing temperatures in degrees Fahrenheit at various times of the day for the period June 22-26, 1876, recorded at Ft. Benton, Montana Territory, by military personnel on duty at the fort.

The historical weather data indicate two air masses moving over the northern Great Plains in late June 1876 (David Bernhardt, e-mail message to author, April 3, 2017). Bernhardt’s analysis of the data suggests a dry cold front moved over Montana Territory on June 23, followed by a stronger front late on June 24 or early on June 25. The second front produced a wide area of rainfall on June 26, with recorded amounts of about one-tenth of an inch at Ft. Ellis (in modern-day Gallatin County) and Camp Baker (in modern-day Meagher County). The second air mass likely passed over south-central Montana (335 miles west of Bismarck) and the Little Bighorn

Battlefield during the evening on June 25 or early in the day on June 26. The 3:00 PM declining temperatures at Ft. Benton from June 23 and the drop in temperatures at Bismarck after June 25 supports this interpretation of the shift in weather conditions.

During proceedings at the Reno Court of Inquiry in 1879, military officers were queried about weather conditions. Major Reno said, referring to June 25, "It was very warm. The sun was shining brightly" (Graham 1933, 585). First Lieutenant Wallace, testified, "I know the next day was cloudy and rainy" (41). When the first-hand accounts of the weather in late June 1876 are balanced with a scientific study of historical data from the same period, a better understanding is likely possible. The analysis by David Bernhardt, a scientist with the National Weather Service, is significant in this regard.

VEGETATION OF THE AREA

Landscape conditions affect the kinds and distribution of plant life in the area of the Little Bighorn Battlefield. Varying topographies, hydrological characteristics, and other factors result in a mosaic of vegetation over the battlefield area. Five areas are of special interest when describing the vegetation of this region: Little Bighorn Valley plain, the riparian zones adjacent to the Little Bighorn River, the bluffs east of the Little Bighorn River, the upland area east of the Little Bighorn Valley, and the ravines and coulees that dissect the upland (Table 5).

The plain of the Little Bighorn Valley is a grassland, covered by Western Wheatgrass and Bluebunch Wheatgrass. This is an open landscape, where great visibility and easy movement are characteristic. Abundant sustenance for herbivores benefitted the large herd of horses accompanying the various tribes camped in the Little Bighorn Valley in the early summer of 1876.

The area along the banks of the Little Bighorn River is a riparian zone in ecological classification. Availability of ample water allows trees and other vegetation to grow in abundance. Major tree species are the Eastern Cottonwood and Green Ash. Cottonwood grow 80 to 100 feet in height, with a diameter of three to four feet and have a significant canopy. Green Ash reach about 50 feet in height. Coyote Willow, with a height of about 40 feet, and other species of willow, thrive in wet soils near the river. Whereas vegetation on the plain, bluffs, and uplands consists mostly of grasses and shrubs, the riparian zone presents a large contrast and is a healthy forest ecosystem. Due to density and characteristics of woody biomass and foliage, the riparian zone is a place of refuge, and visibility is limited, as is the case in any woodland.

The riparian zone covers a significant amount of land. Areas with vegetation are common on both sides of the river channel. Vegetation is particularly extensive in areas where the channel of the river bends in large and deep meanders. In a meander near the mouth of Deep Ravine, U.S.G.S. topographic maps show about 24 acres covered with vegetation, for example. More to the south, another extensive area of vegetation, about 22 acres, occurs on the east side of the river in a large meander near the site of Reno's battle on the plain.

Major landscape areas and plants common in each area		
Area	Type of Vegetation	Plants
Plain of Little Bighorn Valley	Grasses	-Western Wheatgrass (1-3 feet.) -Green Needlegrass (18-36 inches) -Bluebunch Wheatgrass (1.5-4 feet.)
Riparian Zones near Little Bighorn River	Trees	-Eastern Cottonwood (80-100 feet.) -Green Ash (50 feet.) -Peachleaf Willow (40 feet.) -Boxelder (20 feet.)
	Shrubs	-Coyote Willow (23 feet.) -Silver Buffaloberry (6-20 feet.) -Choke Cherry (30 feet.) -Silver Sage (20-59 inches)
Bluffs on east side of Little Bighorn Valley	Miscellaneous	Mostly barren without much vegetation
Ravines and coulees that dissect the bluffs and the uplands	Grasses	-Western Wheatgrass (1-3 feet.) -Bluebunch Wheatgrass (1.5-4 feet.)
	Trees	-Rocky Mountain Juniper (35 feet.) -Green Ash (50 feet.) -Boxelder (20 feet.)
	Shrubs	-Western Snowberry (20 feet.) -Choke Cherry (30 feet.) -Silver Sagebrush (3 feet.) -Black Greasewood (3-10 feet.)
Upland east of Little Bighorn Valley	Grasses	-Western Wheatgrass (1-3 feet.) -Needle-and-Thread Grass (1-4 feet) -Bluebunch Wheatgrass (1.5-4 feet) -Green Needlegrass (18-36 inches) -Crested Wheatgrass* (1-3 feet.)
	Shrubs	-Big Sagebrush (2-13 feet.) -Skunkbush (8 feet.)

TABLE 5 Some common plants found in the area of the Little Bighorn Battlefield. Height of plants given in a range or at maximum. Source: Identification and distribution of plants from *Vegetation Classification and Mapping Project Report, Little Bighorn Battlefield National Monument*, National Park Service, U.S. Department of the Interior. Height of plants from *Plant Fact Sheet* series prepared by the Natural Resources Conservation Service, United States Department of Agriculture. *Note: Crested Wheatgrass was introduced in western areas of the U.S. at a later period and not present in 1876.

The bluffs along the east side of the Little Bighorn valley rise precipitously often as much as 100 feet in a relatively short distance from the valley floor. Due to the degree of slope, lack of moisture, and general orientation along a north-south axis, with considerable exposure to wind and sun, the bluffs region is essentially an arid desert. Vegetation is absent or sparse.

Like the valley of the Little Bighorn, the upland to the east is mainly grassland and a variety of grasses flourish. Western Wheatgrass and Bluebunch Wheatgrass cover large areas. The grasses grow from one to three feet and about four feet tall, respectively. Big Sagebrush was common in historical times as well. By late June, grasses are usually at maximum height, and shrubs display abundant and large leaves.

In ravines and coulees, medium-height woody shrubs, such as Western Snowberry and Choke Cherry, find suitable conditions. Various grasses fill in the surrounding landscape. Trees become more common in some tributaries as elevation decreases and moisture improves near the valley floor.

Since peak annual precipitation occurs in late spring, two inches in May and three inches in June, on the plains of Montana (Conway 1974, 100), soil moisture is adequate. Further, in riparian areas, soil moisture improves with run-off from melting snow at higher elevations. In late June, the abundance of vegetation across the Little Bighorn region is remarkable, considering the aridity of this region. Due to greater availability of water, grasses, shrubs, and trees have grown considerably and added significant foliage. Plant life benefits as well from relatively cool late spring temperatures, in contrast to the months that follow when the weather turns hot and dry.

In contemporary time, vegetation in this area, as is the case with hydrology and topography, likely varies somewhat from that present in the late nineteenth century. This is evident from historic photos of the battlefield (Lee Moorhouse photographs, PH036, 1901) that show vegetation in the valley and on the upland as it existed a few years after the battle. Shifts in climate, forces of erosion, and other factors consistently drive changes in the landscape over many years.

The types and distribution of vegetation in an area can influence military actions and decisions. In the case of the Battle of the Little Bighorn, the presence of vegetation or, in a few areas lack thereof, affected visibility, concealment, and movement. The specific role that vegetation played for either side is mostly conjectural. Nevertheless, while advancing on soldiers under Custer's command on the uplands, some Native Americans likely sought to minimize exposure to gunfire by using sagebrush, other shrubs, and grasses for concealment and cover. In some situations, vegetation served as a place of refuge. For example, woodlands along the banks of the Little Bighorn River provided cover and protection for soldiers under Major Reno's command during retreat following an initial and unsuccessful engagement with warriors in the valley.

CONCLUSION

Many scholars have written important and highly informative papers and books about the human aspects of the Battle of the Little Bighorn. In narratives put forth, the land where the battle took place receives less attention. Important details are not included, likely because this part of the story is not of great interest to readers. However, scientists working for or on behalf of various federal agencies, such as the U.S. Geological Survey and the U.S. National Park Service, have as part of their broader missions filled in the gap with well-researched technical literature on all aspects of the physical and plant geography of south-central Montana and the Little Bighorn

Battlefield in particular. The results of this study confirm that the land in vicinity of the Little Bighorn Battlefield is a very complex environment, with a variety of physical landscapes in close proximity to one another. Added to this, the ecological conditions vary with the type of landscape, often with distinctive plant communities found in the plain, riparian zones, bluffs, rugged ravines and coulees, and the upland. In a short distance, riparian woodlands transition to barren slopes, then to rugged topography with mixed vegetation and an upland where grasses are dominant. Changes in slope and elevation of the land adds to the complexity of the landscape. When viewed from any perspective, elements of the landscape and environment played a major role in the events that played out on June 25-26, 1876, when the U.S. Army 7th Cavalry and Native American tribes led by Crazy Horse, Gall, and other chiefs fought for supremacy on the battlefield.

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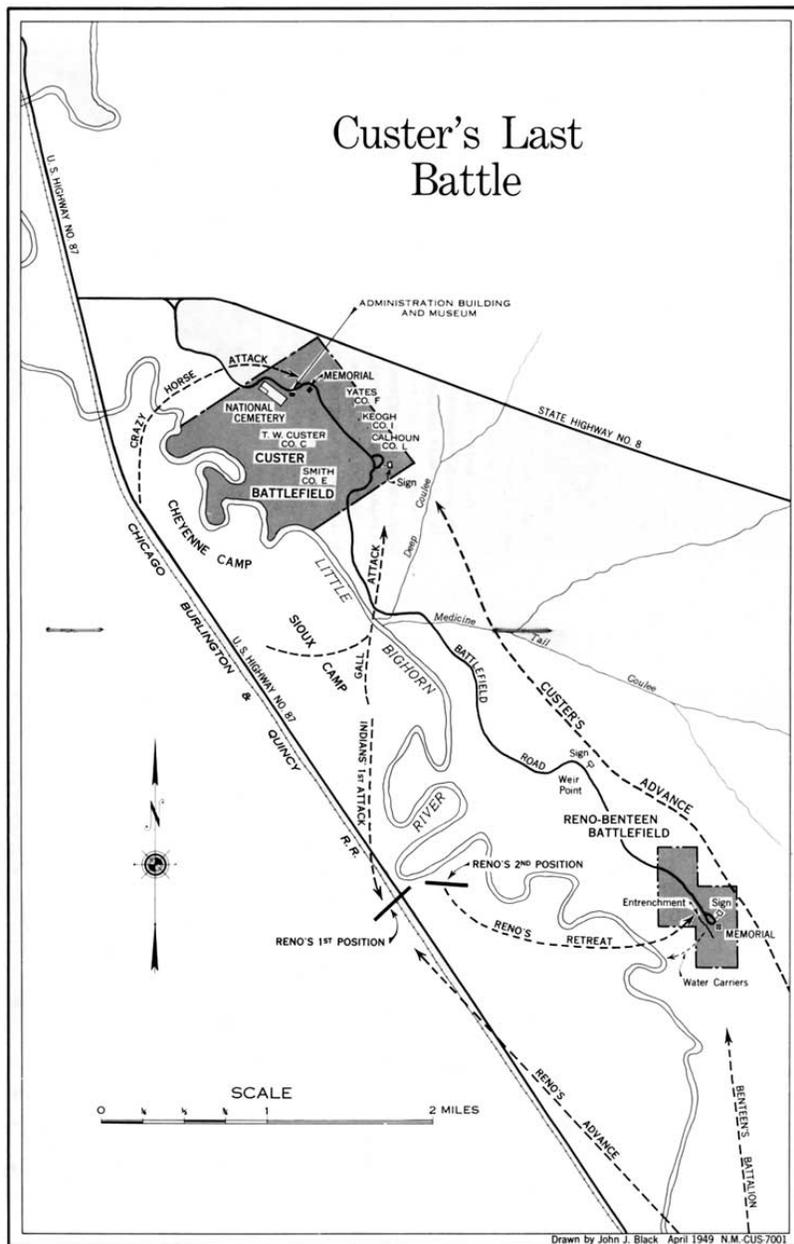
REFERENCES

- Conway, H. M., and L. L. Liston, eds. 1974. *The weather handbook: a summary of weather Statistics for selected cities throughout the United States and around the world.* Atlanta, Ga.: Conway Research.
- Graham, W. A., comp. 1933. *Proceedings of a court of inquiry in the case of Major Marcus A. Reno concerning his conduct at the Battle of the Little Bighorn River, June 25-26, 1876.* Washington D.C.: Office of the Judge Advocate General.
http://www.loc.gov/rr/frd/Military_Law/pdf/Reno-court-of-inquiry.pdf.
- Gray, J. S. 1991. *Custer's last campaign: Mitch Boyer and the Little Bighorn reconstructed.* Lincoln, Nebr.: University of Nebraska Press.
- Hamlet, A. F., P. W. Mote, M. P. Clark, and D. P. Lettenmaier. 2005. Effects of temperature and precipitation variability on snowpack trends in the western United States. *Journal of Climate* 18: 4545-4561. Accessed April 25, 2017. doi:10.1175/JCLI3538.1
- Lee Moorhouse photographs. PH036. 1901. University of Oregon. Libraries. Special Collections & University Archives.
<http://oregondigital.org/sets/lee-moorhouse/oregondigital:df711g98m>. Accessed May 1, 2017.
- Lundquist, J. D., and D. R. Cayan. 2002. Seasonal and spatial patterns in diurnal cycles in streamflow in the western United States. *Journal of Hydrometeorology* 3: 591-603. Accessed April 25, 2017. doi: 10.1175/1525-7541(2002)003<0591:SASPID>2.0.CO;2
- Martin, M. J., J. Wagner, J. Cummings, and M. Britten. 2013. *Proper functioning condition assessment of the Little Bighorn River Little Bighorn Battlefield National Monument, Montana.* Ft. Collins, Colo.: National Park Service.
<https://irma.nps.gov/DataStore/DownloadFile/481564>.

- Moulder, E. A., M. F. Klug, D. A. Morris, and F. A. Swenson. 1960. *Geology and ground-water resources of the lower Little Bighorn River valley Big Horn County, Montana*. Washington, D.C.: Government Printing Office.
<https://pubs.usgs.gov/wsp/1487/report.pdf>.
- National Park Service. 2011. *Little Bighorn National Monument geologic resources inventory report*. Denver: National Park Service.
<https://www.nps.gov/libi/learn/nature/upload/LIBI-2011-Geologic-Resources-Inventory-Report.pdf>.
- Philbrick, N. 2010. *The last stand: Custer, Sitting Bull and the Battle of the Little Bighorn*. New York: Viking.
- Rice, P. M., E. W. Schweiger, W. Gustafson, C. Lea, D. Manier, D. Shorrock, B. Frakes, and L. O'Gan. 2012. *Vegetation classification and mapping project report, Little Bighorn Battlefield National Monument*. Fort Collins, Colo.: National Park Service.
<https://www1.usgs.gov/vip/libi/libirpt.pdf>.
- Sievers, M. A. 1976. The literature of the Little Bighorn: a centennial historiography. *Arizona and the West* 18: 149-176.
- Simonson, S. 2001. *A systematic survey of Little Bighorn Battlefield National Monument*. Fort Collins, Colo.: Natural Resource Ecology laboratory, Colorado State University.
https://science.nature.nps.gov/im/units/romn/inventory/LIBI/Simonson_2001_Systematic_Survey.pdf.
- Smoak, G. E. 2015. *An environmental history of Little Bighorn Battlefield National Monument*. Ft. Collins, Colo.: Public Lands History Center, Colorado State University.
<https://www.nps.gov/libi/learn/nature/upload/Environmental-History-Report-draft-October-2015-1.pdf>.
- Stewart, E. I. 1955. *Custer's luck*. Norman, Okla.: University of Oklahoma Press.
- U.S. Geological Survey. 1908. "Montana Custer Battlefield."
http://www.lib.utexas.edu/maps/topo/montana/txu-pclmaps-topo-mt-custer_battlefield-1891.jpg.
- U.S. Geological Survey. 2016. "Streamflow measurements for the nation USGS 06294000 Little Bighorn River near Hardin, MT." Accessed April 24.
http://waterdata.usgs.gov/nwis/measurements?site_no=06294000&format=html_table_expanded.
- Utley, R. M. 1973. *Frontier regulars: the United States Army and the Indian, 1866-1891*. Lincoln, Nebr.: University of Nebraska Press.
- Utley, R. M. 1988. *Custer Battlefield: a history and guide to the Battle of Little Bighorn: Custer Battlefield National Monument, Montana*. Washington, D.C.: U.S. Dept. of the Interior.
- Vestal, S. 1948. *Warpath and council fire: the plains Indians' struggle for survival in war and in diplomacy, 1851-1891*. New York: Random House
- Westcott, N. E. 2016. *Montana-Ft. Benton data, historical weather, 1862-1881*. Excel file. Urbana-Champaign, Ill.: Climate and Atmospheric Science Section, Illinois State Water Survey, Prairie Research Institute.
- Yankee Publishing. 2016. "Weather history for Billings, MT." Accessed October 20.
<https://www.almanac.com/weather/history/MT/Billings/2008-06-26>.

APPENDIX

ILLUSTRATION OF LITTLE BIGHORN BATTLEFIELD



Latitude & Longitude N45°30'00" - N45°35'00" and W107°22'30" - W107°27'30"

Area of Custer Battlefield illustrated by John J. Black. From: *Custer Battlefield: National Monument*, NPS Historical Handbook Series No. 1, 1949. Area renamed Little Bighorn Battlefield National Monument in 1991. Courtesy of National Park Service.

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