THESIS

AN ANALYSIS OF STONE CIRCLE SITE STRUCTURE ON THE PAWNEE NATIONAL GRASSLAND, WELD COUNTY, COLORADO

Submitted by

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ABSTRACT

AN ANALYSIS OF STONE CIRCLE SITE STRUCTURE ON THE PAWNEE NATIONAL GRASSLAND, WELD COUNTY, COLORADO

The purpose of this research is to create a context of stone circle site information on the Pawnee National Grassland that will contribute to the overall study of this valuable resource within Colorado, as well as throughout the Great Plains region. These data will provide a solid base for future research to be conducted on stone circles in Colorado. In order to better understand stone circle site structure, cluster analysis was utilized to expose patterns for three analyses which included overall site structure based on the landforms on which the site resides, stone circle gap direction as compared to overall site structure, and comparing prevailing wind directions and the portion of the stone circles with the highest stone counts.

To accomplish this, center points were collected with a GPS unit for each of the 249 stone circles recorded. Attributes were then documented including exterior diameters, circle definition, gap direction, stone counts per octant, and associated artifacts and features. To determine overall site structure, nearest neighbor analysis was run in ArcGIS 9.3 yielding a spatial pattern of clustered, dispersed, or random. Next, an attribute was included in the cluster analysis using the spatial autocorrelation test with the gap direction in degrees. This analysis also yielded a result of clustered, dispersed, or

random. Finally, for the wind direction analysis, rose diagrams were created to compare each stone circle feature with the prevailing wind directions.

The findings for the site structure based on landform types consisted of the lowland sites being random in pattern, or consisting of less than three features. The midland sites were dispersed, and the highland sites were clustered or random. When comparing overall site structure with the direction of the gap, the random and clustered sites had a random pattern for gap direction. The dispersed site, however, had a clustered pattern. The clusters consisted of three stone circles facing the same direction, though each cluster faced a different direction. Finally, the result for prevailing wind direction and the highest stone counts was inconclusive. Additional research is necessary to provide more conclusive interpretations of this analysis.

ACKNOWLEDGMENTS

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CHAPTER 1 – INTRODUCTION AND BACKGROUND

Stone circle sites are an underexplored archaeological resource in Colorado. Stone circles are often interpreted as the remains of tipis where the base of the tipi cover was lined with stones to hold it down (Malouf 1961:381). Figure 1 is a historic photograph from Banks and Snortland (1995:140) depicting an example of the type of structure often associated with stone circles.

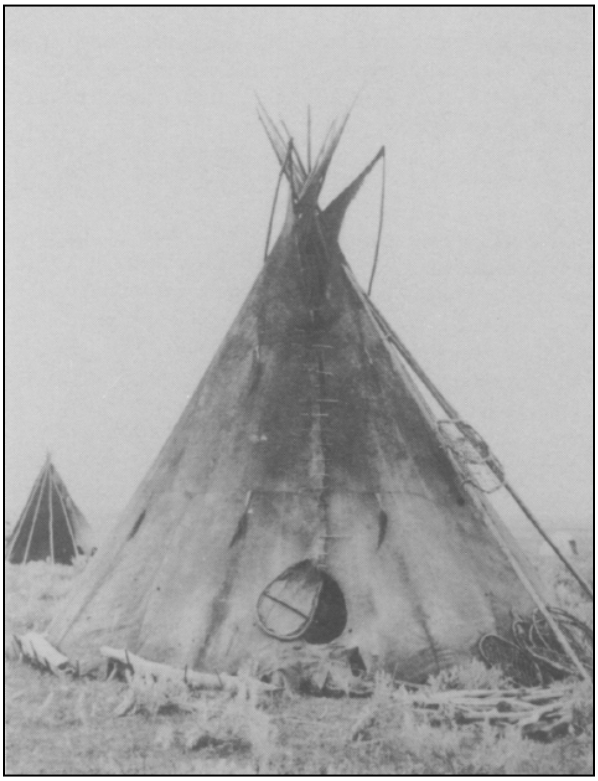

Figure 1 A historic photograph from Banks and Snortland (1995:140) of a tipi.

Once these structures were removed, the ring of stone from the base was all that remained. Figure 2 is an example of the archaeological remains of one of these structures.

Figure 2 Plan map of a complete stone circle found at site 5LR11622. Recorded by the Colorado State University Archaeological Field School.

Stone circles may provide a vast array of information including the seasonality of an occupation, whether or not there were multiple occupations of the area over time, and how people chose to live on various types of landforms. Site structure is studied by analyzing the distribution of artifacts, features, and environmental elements related to past human behavior (Feder 2010:34). Through this analysis, the layout, or organization, of the camp can be determined and interpreted.

Certain attributes of stone circles will provide important information when interpreting site structure, such as the direction of the gap in the stone circle and which quadrants of the stone circle have the most stones. The gap within a stone circle has been interpreted as the possible doorway location of the original structure, which is discussed in detail in Chapter 4 (Kehoe 1958:871). Within the archaeological record, this gap is a large break within the ring of stone, as depicted in Figure 3, in the southeast quadrant of the circle.

Figure 3 Plan map of a stone circle from 5LR11622 with a large gap. Recorded by the Colorado State University Archaeological Field School.

Another attribute that is important for interpreting site structure is the quadrant of the circle with the highest number of stones. This attribute has been interpreted as the direction of the prevailing winds at the time the structure was used, which will be discussed in detail in Chapter 5 (L. Davis 1983; W. Davis 1983; Quigg 1979). The highest number of stones is also visible in the archaeological record as depicted in Figure 4, where the highest number of stones can be seen in the southeast quadrant of the stone circle.

Stone circles are an important resource since they represent exactly where people of the past once lived, in the primary context. These features provide invaluable information about how a camp was set up, how many different occupations occurred in a particular area, and how the type of landform on which the site resides influenced the arrangement of the camp. In short, these features provide a glimpse into how people once lived.

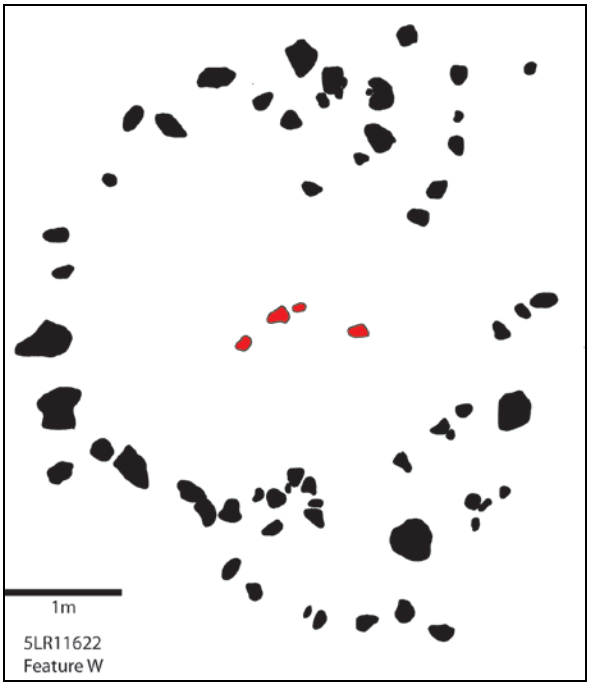

Figure 4 Plan map of a stone circle from site 5LR11622 with a higher concentration of stones in a quadrant. Recorded by the Colorado State University Archaeological Field School.

Landforms on which the sites reside can range from lowlands, such as basins, up to highlands, such as ridge tops. In eastern Colorado, there are often subtle differences between the different types of landforms where a basin may only be 10 feet lower than a midland formation, such as a bench. There may be subtle differences between the types of landforms, but they are an important factor in where people chose to set up camp. Additional details and definitions for each landform type will be addressed in Chapter 3. For this research, to establish how a site was explicitly arranged and why, cluster analysis will be used to determine the different types of camp layouts of stone circles, within sites and between them.

Purpose

The purposes of my research are, first, create a context of stone circle site information for the USDA Forest Service that will enhance our understanding of this valuable resource on the Pawnee National Grassland (PNG), in Weld County, Colorado. With these data, the Forest Service will be able to manage this important cultural resource more effectively. Second, this research is meant to establish whether cluster analysis can depict how sites were used by prehistoric peoples on the PNG. Third, this research will improve our knowledge of stone circle sites not only in Colorado, but throughout the Great Plains region as well.

With additional stone circle research in the plains of Colorado, a better understanding of site structure and land use can be developed. This will be beneficial to interpreting archaeology within this area, and throughout the Great Plains region. With the previous research available on stone circles in the northern plains, comparisons are possible with the stone circles observed in Colorado. These comparisons allow for a better understanding of the similarities and differences for these various areas. Continuing research in the underexplored areas of Colorado will allow for comparisons within Colorado, improving the analyses and interpretations that have already been made.

This research will be beneficial to archaeology since it will contribute to the existing data base for these and other housing types in the Great Plains and Rocky Mountains including pit houses, earth lodge villages, rock shelters, and wickiups. Together, these data will help to provide a more complete picture of how people have lived in the Great Plains throughout prehistory, and how past peoples made choices as to where to set up their camps. Furthermore, this research will be a strong foundation for

future research of stone circle sites in Northern Colorado allowing for further understanding of the past.

Cluster Analysis

To interpret the structure of the stone circle sites, a spatial analysis, in the form of a cluster analysis, will be used through GIS. Spatial analysis is a useful tool that can "reveal things that might otherwise be invisible – make what is implicit explicit" (Longley et al. 2005:316). Specifically, this research uses spatial autocorrelation which compares location and attributes of certain spatial objects (Longley et al. 2005:88). Cluster analysis will determine if the stone circles are in groups, or clusters, are evenly dispersed, or are in a random pattern, also based on specific attributes.

Previous research has proposed several hypotheses regarding certain attributes observed in stone circle site structures. These hypotheses will be used to see how effectively a cluster analysis will determine how peoples of the past were arranging sites. Cluster analysis is not new to tipi ring research, however, it is not widely used either. Day and Eighmy (1998) used an informal cluster analysis at the Biscuit Hill site (5WL1298) in Weld County, Colorado. Their informal analysis looked at the open spaces within and between what appeared to be clusters, for possible activity areas, and the direction of doorway gaps as a sign of a relationship between the rings within an apparent cluster, with the idea that the doorways would face the open space, or community area (Day and Eighmy 1998: 16). Their use of an informal cluster analysis was to depict more clearly how the site was structured, and for what function (Day and Eighmy 1998).

W. Davis (1983:75) also used a cluster analysis to look at multiple variables, such as the exterior diameters of the stone circles and the distribution of stones within the features, according to a hierarchy, to observe patterns and determine structural differences. The purpose of this analysis was to find patterns so that inferences about the differences in the data could be made with some statistical certainty (W. Davis 1983:77). The reason for using the cluster analysis was to expose similarities and differences within the data to better understand the function of stone circle sites overall (W. Davis 1983:78).

Both of these analyses depicted a valuable use for the cluster analysis technique when studying the function of stone circle sites. Day and Eighmy (1998:16), through their informal cluster analysis, were able to make hypotheses that would need further testing, but through the use of the cluster analysis, more questions about stone circle site structure were raised for additional research. W. Davis (1983:78) found through cluster analysis that the spacing of stones within a stone circle stayed constant even though the size of the circles were variable. In addition, cluster analysis depicted the morphological similarities within clusters including central rock concentrations, double courses of stones, and size of the stone circles (W. Davis 1983:78).

Research Questions

One purpose of this research is to analyze stone circle site structure on the PNG using a cluster analysis. To determine if cluster analysis is useful for understanding site structure of stone circle sites, three research questions were developed.

1. Does the spatial arrangement of features vary according to the type of landform?
    - Hypothesis: The stone circles located on highlands will be clustered while those located in midlands and lowlands will be dispersed or random. The sites on the highlands have less space to spread out down the edge and, therefore, will exhibit more clustering (Reher 1983). The sites in the midlands and lowlands will have more options for use of space and, therefore, will be more dispersed in site structure.
2. Does the gap direction of stone circles vary by the spatial arrangement?
    - Hypothesis: If the gap directions are based on wind direction, then they will likely vary within clustered and dispersed sites. With the wind coming from different directions during different seasons, variability would happen in areas that were used over multiple occupations. Both clustered and dispersed areas could have been used multiple times.
    - Hypothesis: If the gap directions are based on social influences, then they will likely face a central location. As noted by previous research (Day and Eighmy 1998; Oetelaar 2000), some sites may have had central social locations and the gaps tended to face that specific area for better interaction.
    - Hypothesis: If the gap directions are based on cultural ideals, then they will likely face the east, or rising sun. Previous research has observed (Banks and Snortland 1995; Hassrick 1964; Moore 1996; Oetelaar 2000) gaps facing all one direction, usually to the east. If this is the reason for

doorway placement, then cluster analysis will show a dispersed or clustered arrangement with the gaps.

3. Is there a correlation between prevailing wind direction and the direction with the highest stone count within a stone circle?
    - Hypothesis: The direction with the highest number of stones will also be the direction of the prevailing winds for each season. Also observed in previous research (L. Davis 1983; W. Davis 1983; Quigg 1979), stone counts tend to be correlated with prevailing wind direction and should be observed in this research.

A Brief History of Stone Circle Research

Stone circle research began in earnest in the Great Plains region during the 1950s and 1960s. Mulloy (1952; 1954) conducted research in Wyoming with one specific research project in the Shoshone Basin. From his research, Mulloy (1952:137) considered stone circles to be a resource of unknown purpose. This conclusion was based on the paucity of artifacts usually associated with the stone circles as well as the absence of hearths and packed floors. Without these types of archaeological remains, it was difficult for Mulloy to view stone circle sites as former habitation areas. Mulloy (1952:137) also noted that most stone circle sites were located in unprotected areas, and it was often difficult to decipher individual circles since most intersected one another.

The protection from the environment, and enemies, was seen as an important factor by Mulloy in campsite locations and, therefore, made it even more unlikely that stone circles were evidence for such activities. From this line of evidence, Mulloy

(1952:137; 1954:54) considered these circles to be possible relations of medicine wheels, suggesting a more ceremonial purpose to the stone circles. Mulloy (1952:137) noted, however, that medicine wheels usually had linear stone alignments within the center of the circle, whereas the other stone circles did not. This did not deter Mulloy from his interpretation of stone circles since he was merely suggesting they are relations of the more ceremonial medicine wheel.

Two years later, Mulloy (1954:53) documented stone circle sites within the Shoshone Basin of Wyoming, furthering his interpretation of these sites as being of unknown function. Mulloy (1954:53) took issue mainly with stone circles being referred to as "tipi rings", which automatically assumed the function of these sites. By using the term tipi ring, it was assumed that the stones within the circle were used to hold down the cover of the tipi at the edges of the base of the structure (Mulloy 1954:54). According to Mulloy (1954:54), there were too many stones observed within the circles than would have been needed for such a function, although he did not conduct research to determine what number of stones would be needed for this particular function. Artifacts, or the lack thereof, were also used as evidence for these sites not being for habitation. Mulloy (1954:54) asserted that had the circles been tipis, then there would have been a larger amount of artifacts to support any length of occupation, for the number of circles at the sites.

Mulloy (1954:54) also noted that the stone circles would not have had varying sizes throughout the sites, and there would have been wall gaps in the circles for the opening of the tipi, had the circles been used for habitation. Mulloy (1954:55) came to the conclusion that the stone circle sites were not for habitation, instead they were likely

of a more ceremonial function, and used for dancing or rituals. Wedel (1953:179) agreed with Mulloy that stone circles were likely ceremonial in nature given that these sites were "unassigned culturally" due to the paucity of diagnostic artifacts and features. Kehoe (1958:861), on the other hand, argued that there was sufficient evidence for determining function of stone circle sites, and that function was for habitation purposes.

Through ethnographic accounts, Kehoe (1958:861), while working in north central Montana and Alberta, was able to explain the purpose of stone circles, which he defined as the stones used to hold down the base of the tipi cover. The ethnographic accounts included those of early explorers and of Native Americans themselves. The explorers included Maximilian, Henry Hind, Washington Matthews, and J. N. Nicollet, all of which noted the use of stones to anchor the bases of the tipi structures (Kehoe 1958:861).

Native Americans interviewed by Kehoe also emphasized the use of stones as tipi anchors, to protect from the wind, and recalled that in the times before the horse was introduced to the Great Plains, people used dogs to carry materials around the country side (Kehoe 1958:868). According to an ethnographic account given by Bull Head of the North Piegan, the "dog people" only used stones to anchor the tipis while the "horse people" would use both stones and wooden pegs (Kehoe 1958:868). It was noted that wooden pegs were not used before the European contact era, due to a lack of tools such as an axe, to make and sharpen the pegs (Kehoe 1958:869). Kehoe (1958:870) introduced further evidence from ethnographic accounts, to strengthen his assertion of stone circles being part of habitation sites, from Adam White Man, a South Piegan, who recalled that cooking was only done inside the tipi during bad weather otherwise the

outdoor hearths were utilized. This explanation speaks to the lack of features within the stone circles that Mulloy used, partly, to interpret the rings as for only ceremonial purposes.

Additionally, through ethnographic accounts, Kehoe (1958:863) noted that, in the northern plains, stone circle sites were set up in coulees during the winter and moved to higher ground during the spring, to avoid flooding of the area. Not all sites, however, were located in ideal camping locations. Often, camp sites occurred wherever was possible and when necessary. Kehoe (1958:863) quoted Mae Williamson as stating that if the group was caught in a blizzard, for example, camp was set up wherever it was possible, which may have been a less than ideal location. Circumstances such as these make it difficult to predict where a stone circle site may be located, since they do not always follow a specific pattern.

A pattern mentioned by Kehoe (1958:862) was that of the size of the stone circles and temporal change. He asserted that the stone circles were smaller when people only had dogs to help haul materials from location to location, and became larger when the horse was introduced to the Great Plains, since horses were capable of hauling more material for larger tipis (Kehoe 1960:434). Kehoe (1958:861) used this interpretation to explain why the stone circles in his study area varied from 7 ft (about 2 m) to over 30 ft (over 9 m) in diameter.

While making his argument for stone circles as habitation sites, Kehoe (1958:872) utilized the term tipi ring for the stone circles he believed to be habitation versus those that were for ceremonial purposes. Although the term tipi ring has been used as a descriptor for these specific features, it may not be an accurate depiction of the structure

it once was associated with. Malouf (1961) noted multiple types of structures that have a stone circle associated with it. These structures included partial circles, single-course rings, multiple-course rings, circular walls, corrals and forts, and medicine wheels (Malouf 1961:382). Similar to Kehoe, Malouf (1961:382-3) noted that stone circle sites tended to be located in good camping locations and that not many artifacts were usually observed with the rings due to short-term occupations associated with the hunter-gatherer lifestyle. Malouf (1961:383) also observed larger artifact concentrations at stone circle sites that were associated with bison kill sites, since there would have likely been a longer occupation for such an event.

Kehoe (1960) interpreted stone circle diameter as an indication for multiple occupations of an area, believing the rings increased in size through time. Malouf (1961:382), however, saw partial stone circles as the same such indicator, since stones were likely robbed from an older ring to create a newer ring. The diameter of the stone circles became problematic for Malouf (1961:385) who observed rings ranging from 2 ft (less than a meter) to 80 ft (over 24 m), which would be far too large for a conical structure. Because of this, Malouf (1961:386) postulated that any stone circle over 30 ft (over 9 m) was probably not domestic, but rather ceremonial in function. Referring to stone circles as tipi rings was also problematic for Malouf. He noted that the Shoshoni constructed a circular lodge made of poles, willows, and brush that was covered with grass mats (Malouf 1961:386). Since other circular structures can have stone circles associated with them, the term tipi ring is too specific and “not always true” (Malouf 1961:388). Figure 5 is a drawing of a Winnebago campsite from 1634 with domed structures that also have a circular base (Treuer et al 2010:28).

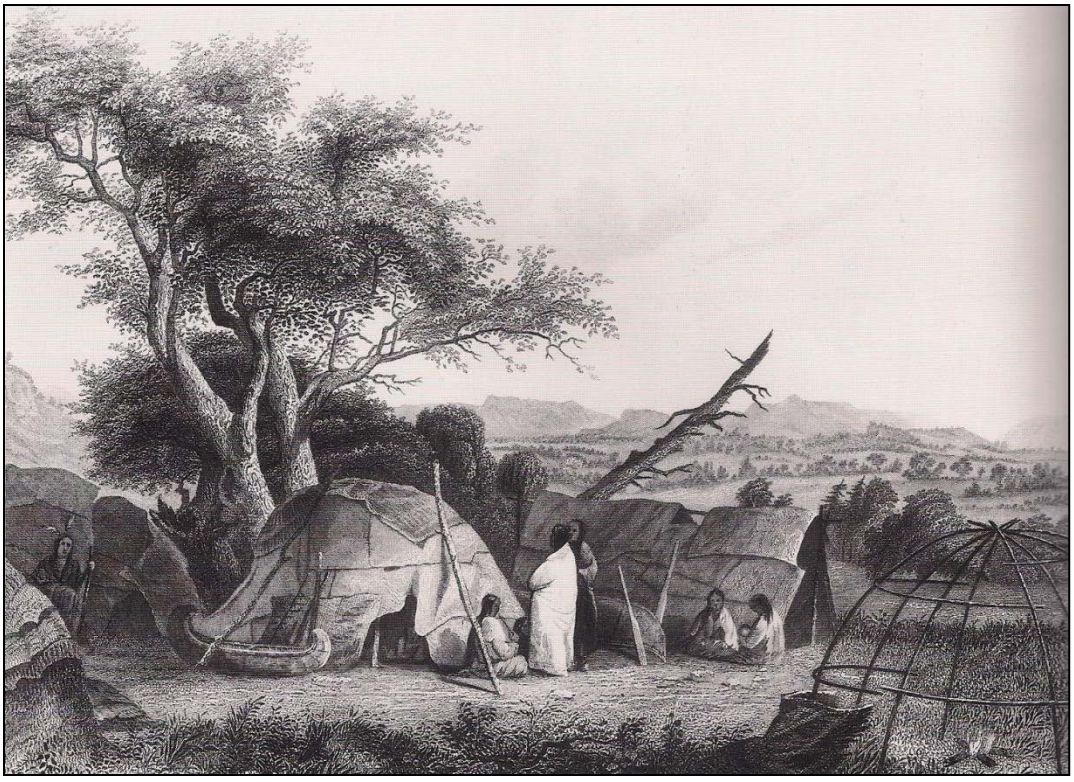

Figure 5 Drawing of a Winnebago campsite in 1634 showing domed structures that have circular bases. Picture from Treuer et al (2010:28).

Although they did not always agree, Mulloy, Kehoe, and Malouf set the ground work for stone circle research. Mulloy (1954) suggested much more research was needed to truly understand the meaning of stone circles. Kehoe and Malouf opened discourse, and provided evidence that stone circles were not all ceremonial in function, but were also the remains of habitation sites. Because of their initial research, archaeologists today are able to expand stone circle research throughout the Great Plains, for a better understanding of how the peoples of the past lived.

Stone Circle Research in Colorado

Stone circles have been researched in Colorado, though most of the site documentation available is in the form of site reports, providing little in the way of interpretation. This section reviews research and reports for Colorado State University alumni Amy Frederick's research, and sites 5BL876, 5LR110 5LR200, 5LR201, 5LR286, 5LR289, 5WL1298, the Keota Stone Circle district in Weld County, and 5WL2180 the West Stoneham Archaeological District. These sites and the sites recorded for the current research are shown in Figure 6. The sites summarized offer a sample of stone circle sites throughout northeast Colorado to provide a background of some of the previous work completed.

Amy Frederick's Master's Thesis

Frederick (2010:10) conducted research near the town of Grover, in Weld County Colorado, near the northern border where Wyoming and Nebraska meet. Within the study area there were four stone circle sites consisting of the Baugh Pasture Site, the Indian Overlook Site, the Rocky Point Site, and the Tower Butte Site. Below is a summary of each of these sites.

The Baugh Pasture Site

This site was located on a north-south trending butte and consisted of 28 stone circle features along with fire altered rock concentrations, and associated artifacts (Frederick 2010:73).

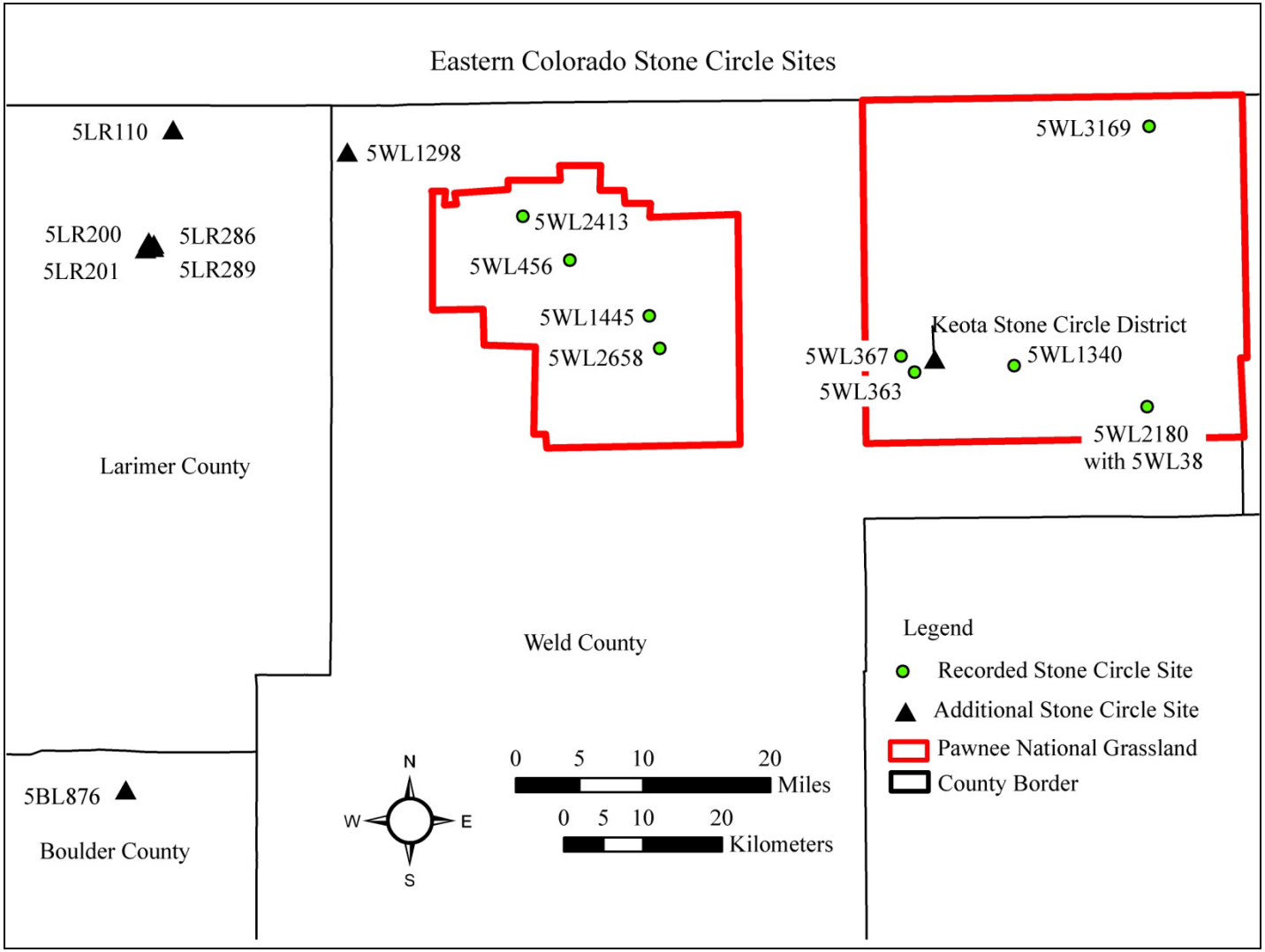

Figure 6 Stone circle sites in eastern Colorado along with the sites recorded for the current project.

The average diameter for the stone circles was 3.64 meters north-south by 3.52 meters east-west. The largest stone circle was 5 meters by 3.9 meters, and the smallest was 1.3 meters by 1 meter. No diagnostic artifacts were noted.

The Indian Overlook Site

The Indian Overlook Site was located on a butte and consisted of eight stone circles along with two fire altered rock concentrations and associated artifacts (Frederick 2010:87). Of the eight stone circles, one had three courses of stone stacked on top of each other, creating a short wall. This feature measured 2.65 meters by 3.14 meters by 45 centimeters high, and was made up of 85 stones (Frederick 2010:89). This feature also had associated ceramic sherds and two mid stage bifaces (Frederick 2010:89). The author interpreted this feature as a possible eagle trap. The additional seven stone circles had an average size of 4.89 meters by 4.63 meters with the largest circle at 5.6 meters in diameter, and the smallest circle at 4.06 meters by 4.8 meters (Frederick 2010:89). Frederick (2010:90) noted that the gap directions were mostly to the east for these stone circles. The landowner that located the site noted that more stone circles were present at one time, but are now buried (Frederick 2010:90).

The Rocky Point Site

This site was located on a butte and consisted of two stone circles along with one hearth and two fire altered rock concentrations (Frederick 2010:91). The largest stone circle was 3.7 meters by 4.6 meters, and the smallest circle was 2.7 meters by 3.6 meters (Frederick 2010:94). The associated artifact assemblage included 14 projectile points

with Middle Archaic, Late Archaic, Late Prehistoric, McKean, and Avonlea points (Frederick 2010:92).

The Tower Butte Site

The Tower Butte Site was located on a flat plain, under a sandstone overhang, and consisted of 49 stone circles along with 5 fire altered rock concentrations, a lithic scatter, and a historic dump (Frederick 2010:95). The average size of the stone circles was 3.3 meters by 3.27 meters with the largest circle at 5.1 meters by 4.2 meters, and the smallest at 1.1 meters by 1.2 meters (Frederick 2010:97). The artifact assemblage consisted of projectile points from the Early Archaic, Late Archaic, Protohistoric, and historic time periods (Frederick 2010:95).

Site 5BL876 – The Indian Mountain Site

The Indian Mountain Site is located in a clearing in the Dakota hogbacks, near Lyons, Colorado (Cassells and Farrington 1986:129). The site was excavated partly by high school students participating in an archaeological field school. The stone circles and the areas between them were excavated (Cassells and Farrington 1986:129). The site consisted of at least 10 stone circles that were separated into 3 areas (Cassells and Farrington 1986:129). The three areas consisted of Area 1 with seven stone circles, Area 2 with one stone circle, and Area 3 with two stone circles (Cassells and Farrington 1986:130). Of the 10 stone circles, 4 were excavated and 2 were sampled (Cassells and Farrington 1986:130).

Area 1 provided two dates from hearths within the rings. The first radiocarbon date was approximately AD 727 (1280 +/- 195 BP) and the second date was

approximately AD 845 (1120 +/- 200 BP) (Cassells and Farrington 1986:131-2). Area 3 only provided one date of 218 BC (2140 +/- 200 BP), from charcoal located inside Ring 4 (Cassells and Farrington 1986:132). The two stone circles (Ring 4 and Ring 5) within Area 3 had the most artifacts in the rings and the surrounding area, compared to any of the other two areas (Cassells and Farrington 1986:132). The artifacts included 1 projectile point tip, 1 scraper, 2 ceramic sherds, and 59 flakes (Cassells and Farrington 1986:132). The material types for the flakes were clustered in separate areas with Ring 4 having red quartzite, yellow chert in Ring 5 and white chert in an area outside both of the rings (Cassells and Farrington 1986:134). The authors interpreted this as being a campsite where a single knapper created each pile of the debitage.

The evidence of pottery at a site this far west, with such an early date (215 BC), was interpreted by the authors as either migrating groups coming from the east, or the vessel was traded from the east to the west (Cassells and Farrington 1986:138). The hypothesis of learned ceramic production was deemed not likely by the authors due to the small amount of sherds observed at the site (Cassells and Farrington 1986:138).

Site 5LR110

Site 5LR110 was located on an arroyo bank and consisted of at least 12 large stone circles ranging in size from 6.5 m to 10.0 m (Morris et al. 1983:53). No artifacts were observed at the site. The possible date of AD 1600 was determined by the interpretation that stone circles increased in size when the horse was introduced to the Great Plains (Morris et al. 1983:53). No radiocarbon dates were reported.

Site 5LR200 – The T-W Diamond Site

The T-W Diamond Site (5LR200) was located on a ridge top, in the ecotone boundary of the Rocky Mountain foothills and the eastern plains, 23 miles north of Fort Collins, Colorado (Flayharty and Morris 1974:161). Surface artifacts consisted of only potsherds, 1 core, 4 scrapers, and 14 flakes, leading the authors to conclude that the surface had likely been collected by looters (Flayharty and Morris 1974:162). The ridge altogether, not just the site area, had more tools than flakes, producing projectile points, bifacially flaked blades, and scrapers (Flayharty and Morris 1974:162). The authors interpreted the site to have been used for hunting, butchering, and collecting activities, based on the artifacts observed (Flayharty and Morris 1974:162).

Excavations of the site were conducted in 1971 as part of the Colorado State University Archaeological Field School. Excavations were kept within the stone circles and the immediately surrounding areas (Flayharty and Morris 1974:162). The site consisted of 47 stone circles that stretched along the ridge top for approximately a quarter mile, and according to the authors, had no apparent pattern to the site structure, although the site appears to have a slight linear distribution (Flayharty and Morris 1974:163). Of the 47 stone circles, 17 were excavated (Flayharty and Morris 1974:163). The diameters of the stone circles mostly ranged from 16 ft (4.9 m) to 18 ft (5.5 m) with no distinguishable wall gaps, or entry areas (Flayharty and Morris 1974:163). The authors noted that most of the rings had larger stones located in the northwest portion of the structure, which was also the side of the prevailing winds (Flayharty and Morris 1974:163).

Seven of the stone circles excavated had internal hearths, which were noted as being poorly defined by the authors (Flayharty and Morris 1974:163). Dates for the site ranged from AD 400 +/- 340 to AD 1170 +/- 220 (Flayharty and Morris 1974:163). Excavated artifacts included 139 pottery sherds, 30 projectile points and fragments, 14 of which were diagnostic, 7 scrapers and fragments, 1 biface, 1 spokeshave, 28 utilized flakes, 3 cores, 1 steatite pipe, and 1,027 flakes (Flayharty and Morris 1974:165-7).

Flayharty and Morris (1974:168) asserted that the pottery from the site was likely from one vessel broken into many pieces, providing evidence for a short occupation of the site. Initially, the authors thought the site was of one, short occupation due to the poorly defined hearths, no evidence of a midden, and, according to the authors, a paucity of artifacts, though the site does indeed yield a large amount of artifacts (Flayharty and Morris 1974:163;168). The interpretation of a single camp was also suggested due to a lack of partial stone circles or overlapping rings (Flayharty and Morris 1974:163). The range of radiocarbon dates for the site suggests otherwise.

Site 5LR201 – The Salt Box Site

Site 5LR201 exhibited multiple occupations beginning from at least the Middle Archaic (Morris et al. 1983:53). Artifacts included corner-notched and side-notched projectile points from the Middle Archaic, Late Archaic, Early Ceramic, and the Middle Ceramic periods (Morris et al. 1983:53). A small Middle Ceramic side-notched triangular projectile point was associated with the stone circles, but the author noted that Early Ceramic projectiles had been associated with stone circles in other research (Morris et al. 1983:53).

Site 5LR286

Site 5LR286 was located on top of a high ridge near the T-W-Diamond Site (Morris et al. 1983:55). The site consisted of six stone circles along with numerous flakes, two projectile points, and stone tool fragments (Morris et al. 1983:55). One of the projectile points recorded was possibly a Late Archaic point (Morris et al. 1983:55).

Site 5LR289 – The Killdeer Canyon Site

Site 5LR289 was located on the bottom of Killdeer Canyon consisting of 18 stone circles dating from 150 +/- 50 BP to 360 +/- 80 BP (approximately AD 1590 to 1800) (Morris 1989:238). Artifacts observed included triangular side-notched concave-based projectile points, plain pottery fragments, ground stone metate and mano fragments, and flakes (Morris 1989:238). According to Morris (1989:238), the stone circles resembled the T-W Diamond Site in size, and the artifacts were similar as well. The main differences were the geographic locations of the two sites and the plain versus incised pottery (Morris 1989:238). The site's function therefore, was also likely similar to that of T-W Diamond as a short occupation camp for hunting activities.

Site 5WL1298 – The Biscuit Hill Site

The Biscuit Hill Site was located in a broad, flat basin near Lone Tree Creek, in Weld County, Colorado (Day and Eighmy 1998:2). The site was surface recorded by the Colorado Archaeological Society in 1987 (Day and Eighmy 1998:2). The site was divided into a northern locus and a southern locus, and consisted of 78 stone circles that

were included in over 100 stone features at the site (Day and Eighmy 1998:4). The artifacts consisted of 1 reworked projectile point, 1 end scraper, 1 glass bead, and 14 flakes (Day and Eighmy 1998:4).

Interpretations of the site focused on site structure and feature attributes. No radiocarbon dates were collected. Day and Eighmy (1998:7) discussed multiple occupations at the site, but did not find evidence supporting such an interpretation. The authors noted that none of the stone circles were partial circles, or overlapping, and only two were touching, which was described as more of a lack of evidence for multiple occupations (Day and Eighmy 1998:7). The authors also looked at the size of the stone circles observing that there was no evidence for clustering of specific size classes within the site, noting the sizes were rather mixed throughout the site (Day and Eighmy 1998:7). Finally, the authors suggested the depth of the stones within each circle may be an indicator of relative age. The stones in the northern locus were embedded deeper than the stones in the southern locus, possibly suggesting the northern locus was from an older occupation (Day and Eighmy 1998:17). Day and Eighmy (1998:17) did not, however, believe that was the case, and suggested that geomophological processes may have been a more likely explanation for the differences in stone depth. Since no radiocarbon dates were collected from the site, a more concrete interpretation was not possible.

Keota Stone Circle District

The Keota Stone Circle District was originally recorded in the spring of 1978, and is located in Weld County Colorado near the town of Keota. The district consists of four stone circle sites including 5WL354, 5WL358, 5WL359, and 5WL360 (Halasi 1978).

All of these sites are located in a draw, south of an east-west trending rock outcropping (Halasi 1978).

According to the report and site forms, site 5WL354 consists of 63 stone circles split between two concentrations within the draw (Halasi 1978:17). The associated artifacts were dated by Halasi (1978:17) based on artifacts to the Late Preceramic. Site 5WL358 consisted of 14 stone circles and 2 stone alignments, along with an associated lithic scatter dated by Halasi (1978:18) based on artifacts to the Middle Preceramic. Site 5WL359 consisted of two stone circles and one fire cracked rock concentration (Halasi 1978:18-19). Finally, site 5WL360 consisted of 76 stone circles and partial stone circles along with 2 rectangular stone alignments (Halasi 1978:19). Together, these sites make up the District.

Site 5WL2180 – West Stoneham Archaeological District

The West Stoneham Archaeological District is located on a rare landform for eastern Colorado (Brunswig 2003:51). The area consists of playa basins surrounded by large rock outcroppings which create a protective shelter from the elements (Brunswig 2003:52). Water is available in a temporary form from the playa basins and standing water that accumulates in the rock outcrops after rain and snow (Brunswig 2003:52). For more permanent sources of water, the South Pawnee Creek is locate 3.6 kilometers to the north and the South Platte River is located 36 kilometers to the southeast (Brunswig 2003:52).

John Wood's Dissertation – 1967

Wood (1967) recorded seven sites at the West Stoneham Archaeological District for his dissertation including one stone circle site and six rock shelter sites. The stone circle site was 5WL38, the Hatch Site, located in the western portion of the basin, on the east side of the north-south-trending rock outcroppings and estimated to have approximately 12 stone circles (Wood 1967:386). Wood (1967:386) noted that the site had been heavily collected prior to recordation, along with two holes dug into the middle of two stone circles by pot hunters. Excavation of two of the stone circles yielded a date of approximately AD 1790 (less than 160 BP) from the hearth in Feature 1, that was associated with artifacts from stratum II, and the earliest occupation noted in stratum IV (Wood 1967:392). Feature 2 also had a shallow hearth with bison bone associated with it (Wood 1967:395). Artifacts observed included a projectile point fragment, a ground stone slab located in the hearth of Feature 1, and 132 pottery sherds (Wood 1967). The majority of the pottery was located in stratum IV (Wood 1967:415). The site was interpreted as a hunting camp with a possible reuse of the site due to the close proximity of the stone circles (Wood 1967:417).

Robert Brunswig's Dissertation – 1996

According to Brunswig (1996:93), the West Stoneham Archaeological District was located in "a relatively rare landform on the Colorado Piedmont, a discrete series of rock outcrop ridge lines encircling a series of interconnected, east to west trending, playa basin valleys." The University of Northern Colorado conducted 5 field schools at the district, collecting 13 radiocarbon dates for 5 sites, along with projectile point typologies

for dates (Brunswig 1996:116). In total, 18 of the sites were dated by Brunswig either through projectile point typologies or radiocarbon dates (Brunswig 1996:267).

For his research, Brunswig (1996) was concerned with the sites dating from the Late Archaic to the Middle Ceramic time periods. Only the sites falling into these time periods were included in his dissertation, therefore, only the stone circle sites from those periods will be summarized here.

Late Archaic

Site 5WL1840 was located in the southwestern portion of the playa basin consisting of 37 stone circles (Brunswig 1996:286). Brunswig (1996:286) stated that the artifacts observed at the site included two corner-notched projectile points which placed the site in the Late Archaic time period, but no specific details about these tools were provided.

Site 5WL1844 was located 30 m north of site 5WL1840 and consisted of 14 stone circles (Brunswig 1996:287). The artifacts included one corner-notched projectile point, also placing the site in the Late Archaic time period, but no specific details were provided for this projectile point (Brunswig 1996:287).

The last of the Late Archaic time period sites was 5WL1857, which was located on a south facing slope along the east-west-trending rock outcrop in the northeastern most portion of the basin (Brunswig 1996:287). The site consisted of two stone circles and "an upper biface fragment having typological traits comparable with other regional Late Archaic specimens" (Brunswig 1996:287). No additional details about these tools were provided by the author.

Early Ceramic

Site 5WL1849 was located on the north-south-trending rock outcrop in the northwestern most portion of the playa basin (Brunswig 1996:331). The site consisted of one circular rock wall feature measuring 20-30 cm high and 4 m in diameter (Brunswig 1996:332). Artifacts placed the site in the Early and Middle Ceramic and also in the prehistoric or early historic time periods, along with radiocarbon dates of 700 +/- 70 BP and 1170 +/- 70 BP (approximately AD 780 to 1250) (Brunswig 1996:332).

Site 5WL2002 was located north of the east-west-trending rock outcrop in the northeast portion of the playa basin (Brunswig 1996:336). The site consisted of one stone circle yielding 93 flakes during excavations (Brunswig 1996:336). Based on a "diagnostic, hafted biface" the site was dated to the Early Ceramic (Brunswig 1996:337). No additional details were provided about the biface.

Site 5LW38, the Hatch Site, was also excavated by Brunswig (1996:347) yielding a radiocarbon date of 880 +/- 50 BP, placing the range of dates from 917 to 690 BP (AD 1033 to 1260). Additional pottery was observed during excavations by Brunswig (1996:352) and was interpreted as being from the Middle Ceramic time period. Other artifacts observed included 1 drill tip, 2 biface fragments, 2 retouch flakes, 1 leaf-shaped, corner-notched projectile point, 1 side-notched, flat based projectile point, 2 knives and 86 faunal fragments (Brunswig 1996).

Site 5WL1994 was located on a hilltop in the northeastern most portion of West Stoneham consisting of 14 small stone circles (Brunswig 1996:359). The dates for this

site were determined by two “hafted bifaces” dated to the Early Ceramic time periods, but no specific details about these tools were provided (Brunswig 1996: 359).

Site 5WL2131 was located within the playa basin at the western portion consisting of an undetermined number of small stone circles in a linear arrangement (Brunswig 1996:360). The date for the site was based on a small triangular, corner-notched projectile point to the Early Ceramic (Brunswig 1996:360). No additional details about the projectile point were provided.

Brunswig (1996:372) asserted that 20 percent of the stone circle sites were from the Early Ceramic and 17 percent were from the Middle Ceramic, although it was not mentioned which sites were from each period. According to Brunswig (1996:373), West Stoneham had a 2,500 year occupation span from 3350 – 880 BP (approximately 1400 BC to AD 1070) with a 400 year time gap from 1920 – 1510 BP (approximately AD 30 to AD 440).

The West Stoneham Archaeological District consisted of multiple stone circles along with lithic scatters and rock shelters. These cultural resources ranged in date from the Late Archaic to historic times, based on radiocarbon dates and projectile point typologies. The landform at West Stoneham is rare for eastern Colorado, making it an important resource to study.

Research in Colorado has produced stone circle sites ranging from at least the Late Archaic to historic times. These sites range in size with small sites of a few stone circles to over 70 stone circles observed. The sites are located in lowlands and on ridge tops. Some have very few artifacts while others have many. Having such diverse stone

circle sites in Colorado increases the need for additional research to gain a better understanding of how people were living throughout the past.

Summary of Chapters

The following chapters attempt to answer the questions set forth earlier in this chapter. Chapter 2 addresses the methods used for this research for in the field and in the lab, and the definitions of terms used for this project. Chapter 3 is an analysis and discussion of stone circle site structure and the type of landforms on which the sites reside. Chapter 4 is an analysis and discussion of stone circle site structure in relation to the direction the gap is facing in the ring of stone. Chapter 5 is an analysis and discussion of individual stone circle structure in relation to prevailing wind directions. Chapter 6 is the conclusion with a final summary of the research along with some suggestions for future directions of stone circle research.

CHAPTER 2 – METHODS

This research was conducted on the Pawnee National Grassland (PNG) in Weld County, Colorado. The sites recorded were selected from previously recorded sites that could be relocated. Some sites that had been recorded in the 1940s could not be relocated due to a lack of location information. The sites that were recorded include the West Stoneham Archaeological District (5WL2180), along with eight additional sites located throughout the Grassland (5WL363, 5WL367, 5WL456, 5WL1340, 5WL1445, 5WL2413, 5WL2658, and 5WL3169) (Figure 7).

Definitions of a Site and a District

Defining an archaeological site is not a simple concept. In order to understand the definition of a site for the current research, an examination of various ways to record the archaeological record is necessary. Since this research was conducted on the PNG, cultural resource management regulations for defining a site will be examined followed by the concept of "siteless" archaeology which allows for better interpretation of the entire archaeological record. The current project uses a combination of both of these concepts for defining a site, and is explained below.

Archaeological Sites

The term "site" can have many different definitions to many different archaeologists. A site is used as a unit of analysis for interpretation as well as for

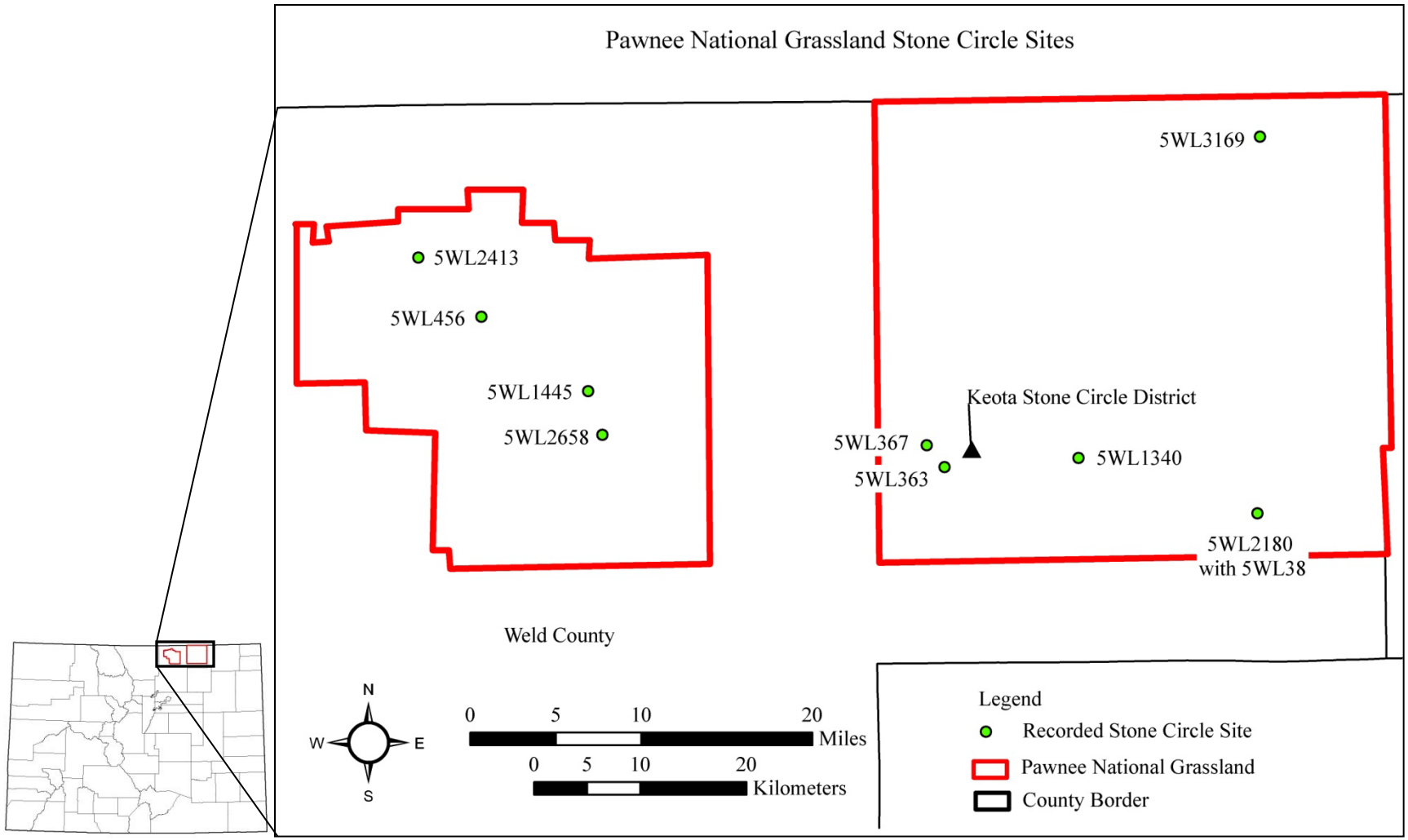

Figure 7 East and west portions of the PNG. The dots depict stone circle sites.

management purposes through Section 106 of the National Historic Preservation Act (NHPA) of 1966. Any Federal agency managing Federal lands, such as the Forest Service, are required to comply with Section 106 in order to protect historic properties on their lands, such as the PNG (Seifert et al 1997:1). Section 301(5) of the NHPA defines historic properties as follows:

> "Historic property" or "historic resource" means any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion on the National Register, including artifacts, records, and material remains related to such a property or resource [ACHP 2009].

This definition for historic properties only refers to the cultural resources that are significant enough, or eligible, for listing on the National Register of Historic Places (NRHP) (King 2008:372). This definition, therefore, does not address any cultural resources that are not eligible for listing on the National Register. The National Parks Service (NPS), which manages the NRHP, defines a site as:

> … the location of a significant event, a prehistoric or historic occupation or activity, or a building or structure, whether standing, ruined, or vanished, where the location itself possesses historic, cultural, or archaeological value regardless of the value of any existing structure [NPS 1995:5].

This definition of a site does include cultural resources that are not eligible for listing to the NRHP, but does not specifically address what a site is. The complexity of defining the boundary of a site, considering many sites are buried, is usually the cause for this vagueness (Seifert et al 1997:30). According to Seifert et al (1997:5), it is up to the archaeologist recording the site to justify what the boundary of the site is and, therefore, what constitutes a site. Since

archaeology varies greatly from state to state, this vague definition allows for each archaeologist to determine what is significant and how best to protect and/or interpret the cultural resources they are managing. For example, the boundary justification for a prehistoric habitation site would include the extent of surface, and if possible buried, archaeological evidence (artifacts, features etc.) along with topographic features that limit the use of the spatial area (NPS 1997:32). Once a site boundary is created, it is not set in stone. Other archaeologist may alter the boundary as needed given that natural and cultural transformations are continuously changing the archaeological record.

The NPS has provided guidelines for how best to determine a site boundary, but the system is not perfect. Since every archaeologist is creating their own definition of a site, there is no good way to compare data from, or interpretations about, sites. Site boundaries are still necessary for the management side of archaeology in order to best protect the cultural resources and, therefore, will not be going away anytime soon.

Archaeological Districts

Archaeological districts are another aspect of managing sites. The NPS defines a district as being a "unified entity" of various cultural materials such as sites, buildings, features, and artifacts that are interrelated within a concentration or continuous formation throughout a spatial area (NPS 1995:5). Since a district can represent one activity, several activities, or include several sites, it is once

again left up to the recording archaeologist to justify the boundary, and determine what constitutes a district (NPS 1995:5; Seifert et al 1997:30).

The NPS (1997:33) provides an example for the boundary justification of a contiguous archaeological district as the clustering of sites and the restriction of topographic features. This boundary definition for a district is quite similar to that of a site boundary, which is basically the clustering of features and artifacts that are confined to a topographic area. Why, then, would an archaeological district not be considered one large archaeological site instead of a clustering of sites?

"Siteless" Archaeology

The concept of "siteless" archaeology has many names including distributional archaeology and landscape archaeology. According to Ebert (1992:6), a site is not something that can be defined, but must be in order to evaluate it. One problem with grouping concentrations of archaeological materials into a single unit, such as a site, is that areas are often reused over time, making it difficult to associate specific artifacts with specific events or activities (Ebert 1992:10). Another issue with creating sites is how landscapes are used within a single system of human activity (Ebert 1992:11). Dunnell (1992:26) concurs stating that even for management purposes, the site concept removes portions of the archaeological record. Dunnell (1992:29) asserts that if sites are not units of formation then they cannot be used as units of observation. Along those lines, Ebert (1992:11) suggests that many aspects of this system interact, including the archaeological record, mobility of people, and the environment. For

example, two “sites” could actually be part of one event with one site being the habitation area and the other site being the location of the hunt. Both of these sites are from a single time, but have different locations and different archaeological materials. As suggested by Ebert (1992:11), these two sites would not be sites at all, but rather they would be parts of a single system of human activity.

According to Ebert (1992:48), sites are generally defined as “spatially discrete locus of cultural material that can be interpreted.” The concern with this definition is that sites exist both in the past and in the present. The site is both the location of the past behavior and the location of the archaeological record that exists today (Ebert 1992:47-8). Interpretation of the archaeological record as it exists today is not an accurate portrayal of what actually occurred in the past. Dunnell (1992:26-9) agrees noting that a site is a contemporary notion created by archaeologists, that cannot be used as an empirical unit of analysis. The “siteless” approach removes the arbitrary boundaries placed around the archaeological material, and, therefore, allows for interpretation of the archaeological record, since it is not always clustered everywhere within the system and cannot always be placed into individual sites (Ebert 1992:53).

The concept of distributional archaeology relies on the importance of scale since activities in the past are all part of a single system (Ebert 1992:72-3). Stafford and Hajic (1992:140) assert that the structure of the archaeological record varies from a large scale to a small scale. For example, a hunter-gatherer group will first decide on an area based on where the game are for hunting, or the

large scale, and then choose the specific camping location based on the availability of other resources and the specific terrain, or the small scale (Stafford and Hajic 1992:140). When the archaeological record is arbitrarily placed into single units, with no uniformity of how and why the boundaries were determined, interpretations between those sites become impossible (Ebert 1992:157). According to Ebert (1992:246), distributional archaeology is not spatially restricted and, therefore, allows for interpretation and analysis of the archaeological record throughout the system. The concept of "siteless" archaeology is ideal for site analysis and interpretation. For site management purposes, however, "siteless" archaeology is not practical.

Definition of a Site Revisited

Since the notion of a site is not an ideal practice for interpretation of the archaeological record and "siteless" archaeology is not practical for cultural resource management, but these two concepts can be used together to a certain degree. For the purposes of this research, the Forest Service's definition of a site was used, which is defined as 15 or more artifacts or any number of artifacts in association with a historic or prehistoric feature for the total extent of the cultural material. The sites included in this research were all previously recorded and the previous boundaries and feature numbers were used, when possible. Any additional features observed were added to the site accordingly. This definition of a site, and keeping the previous site information consistent, allows for a better use of this research by the Forest Service for management purposes. In terms of the analysis and interpretation of these sites, the purpose of this research is to understand individual site structure. The concentrations of stone circles are

the unit on analysis and not the entire system of archaeological material that is inevitably associated with them. To analyze the habitation portion of the system is the goal, and therefore, interpreting individual concentrations of stone circles is sufficient to meet this goal.

The difficulty with using the previous site boundary information was apparent at 5WL2180, the West Stoneham Archaeological District. Site boundaries had been established during previous recordings of the area, with each type of resource receiving a separate site boundary and number. This means that stone circles had separate boundaries from other stone circles and separate boundaries from the lithic scatters and rock shelters also located at the district. Problems occurred when site boundaries for rock shelters and lithic scatters overlapped with those of the stone circles, and each other (Figure 8).

In the case of sites 5WL1840, 5WL1844, and 5WL1991, all of which are located at the western portion of the basin, on the basin floor. The problem was that the stone circles separated into these three sites in fact made a linear distribution of continuous features that are being referred to in this research as Concentration A (Figure 9).
In this instance, the use of individual site boundaries is impractical for management and analysis purposes. For this research, the West Stoneham Archaeological District is being considered one site, 5WL2180, with concentrations of stone circles separated by landform type. Concentration A is the linear grouping of stone circles on the basin floor and Concentration B is the grouping located on the bench to the north of the basin. The remaining stone circles are scattered throughout the area in smaller groups, on various landform types (Figure 10).

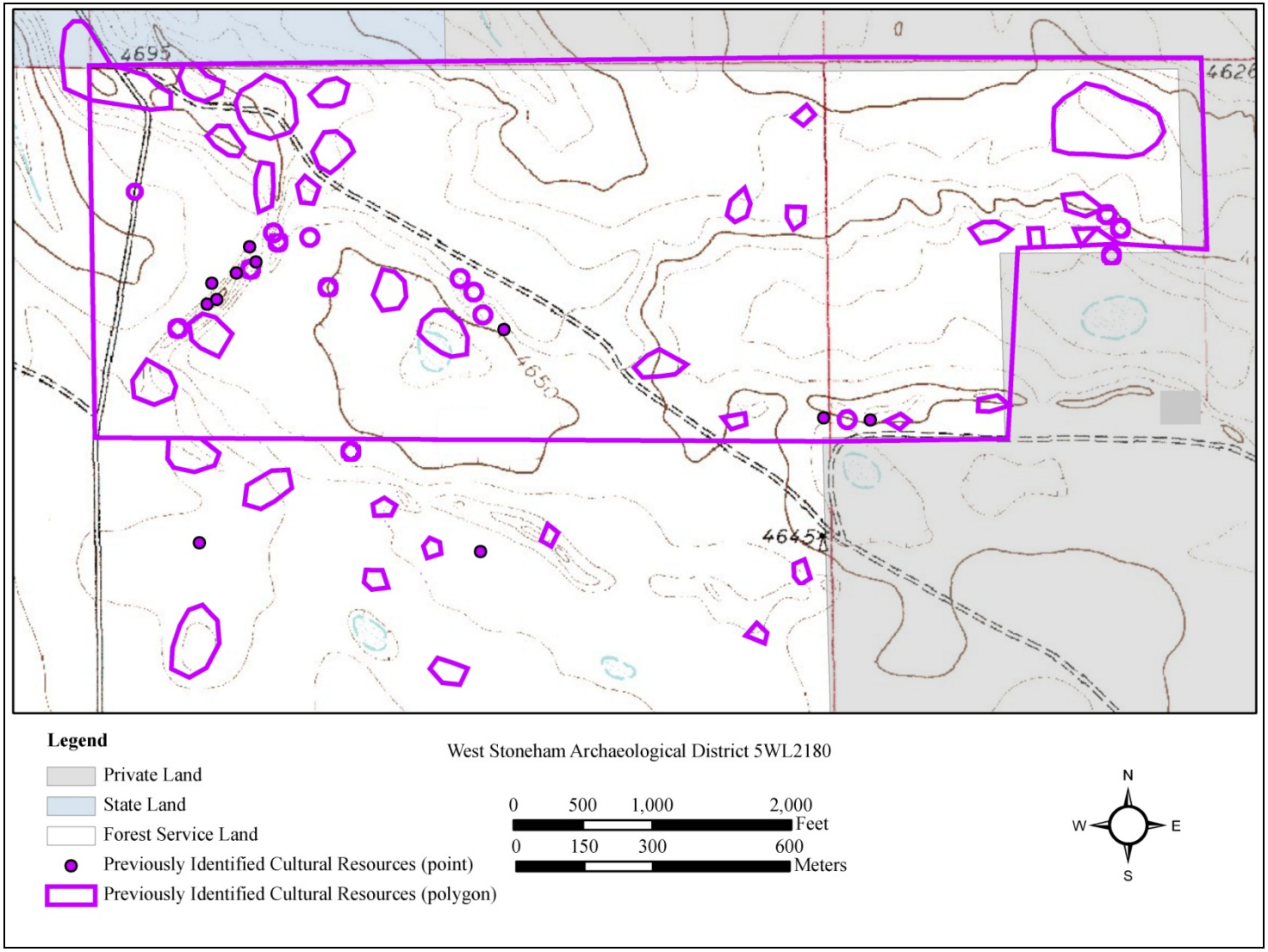

Figure 8 West Stoneham Archaeological District with previously recorded sites.

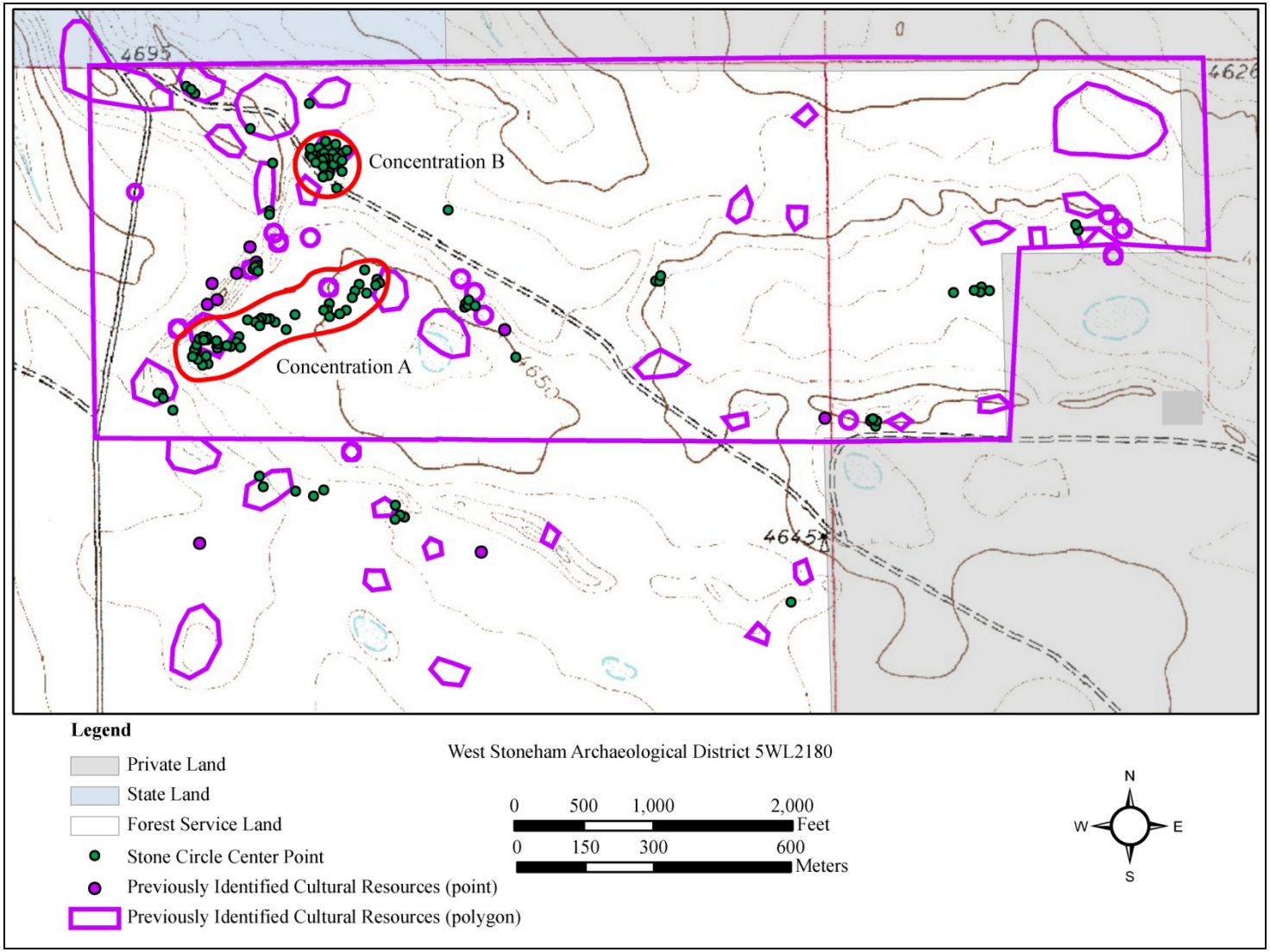

Figure 9 West Stoneham Archaeological District with previously recorded sites and newly recorded stone circles.

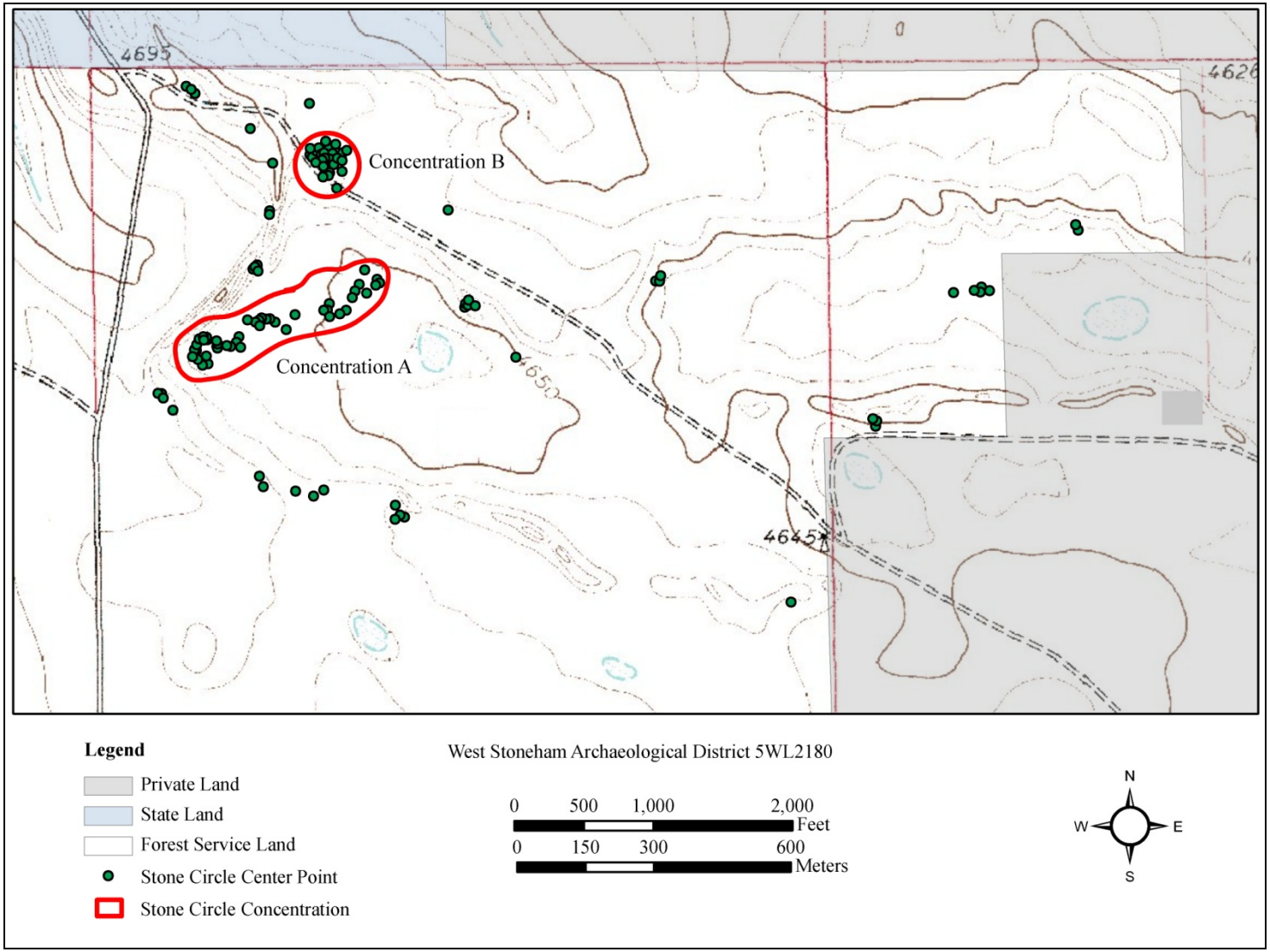

Figure 10 West Stoneham Archaeological District stone circle locations.

These concentrations may be considered by some as separate sites, but the concern with making these concentrations sites is that this basin was used multiple times throughout history and assigning separate boundaries assumes separate occupations when in fact the stones circles within each concentration, as well as between concentrations, are likely from different occupations. The West Stoneham environment is quite different from the majority of the PNG and was likely used as an entire landscape throughout history and, therefore, cannot be divided into individual sites, and hence, it is an appropriate district. Since three sites have already been combined into one large concentration, it does not make sense to create a new site that will be changed in the future when more stone circles are exposed and others are concealed by the changing environment. Considering the entire district as a single site allows for a unit to be managed by the Forest Service and allows for a better analysis of what may have been occurring in this unusual landscape.

Data Collection

Data collection occurred during the summer and fall of 2010 and spring of 2011 using a Trimble GeoXT to collect geographic positioning data. A center point was collected for each stone circle and post-corrected for better accuracy. Multiple attributes were recorded for each stone circle, including the interior and exterior diameters, stone counts for eight sectors (octants) within each circle, gap direction, circle completeness, and circle definition.

The two measurements for each stone circle were taken along the north-south axis and the east-west axis. The interior measurement was taken from the innermost

alignment of stones creating the circular geometric shape. Any stones within the interior of the circle, not part of the geometric shape of the feature, were noted but not included in the measurement. The exterior measurement was taken from the outermost stones associated with the circular geometric shape. In the case of areas where many stones were naturally scattered around, for example near a rock outcropping, then the outer most stone was determined by similar level of sodding in the ground with the other stones in the circle, and no further than 1 meter from the main circular geometric shape. It is possible that stones further than 1 meter out were associated with the feature, but this was meant to provide a good representation of the overall exterior measurement of the feature.

The classification for a gap was taken from the Recordation Standards and Evaluation Guidelines for Stone Circle Sites: Planning Bulletin No. 22, from the Montana State Historic Preservation Office (MSHPO 2002). A wall gap was classified as "a void between stones, which exceeds roughly 50 cm and is less than 90 degrees of the stone circle" (MSHPO 2002:6). Since this research only deals with the surface expression of the stone circles, it is possible that stones were buried where a gap appeared to be on the surface. To attempt to mitigate this possibility, a pin flag was used to probe the area of the gap to determine if any stones were buried just below the surface. If no stones were struck by the pin flag, then it was determined that the gap was indeed a break in the stone alignment. It is still possible buried stones existed, but this reduced the possibility of the occurrence.

The definition of the circle was also taken into consideration when determining if a gap was present. The definition of the circle refers to how closely spaced the stones are from each other, within the stone circle (MSHPO 2002:6). Good definition, therefore,

required the stones to be close together, while poor definition had many small gaps throughout, and moderate definition had some distance between the stones, but the feature still had an obvious geometric shape (MSHPO 2002:6). For the purposes of the gap direction and site structure analysis, only stone circles containing wall gaps with good or moderate definition were used. Stone circles with poor definition were either considered complete stone circles with poor definition or partial stone circles.

Once a gap was observed within a stone circle, the compass direction was recorded while standing at the center point of the circle aiming at the middle of the gap. The direction was recorded in degrees. A complete stone circle was defined as any feature that had at least ¾ of the circle present, given that the ¼ of the circle missing was considered to be a wall gap. Any feature with less than ¾ of a circle was considered to be partial. For a complete stone circle, the gap direction was recorded as "none," and for a partial stone circle the gap direction was recorded as "partial." For a partial stone circle, the portions of the circle that were missing were also noted by general cardinal direction(s).

For each stone circle, the stones were counted per octant for sites 5WL2180 and 5WL2413. The stone circles were divided into eight wedges with strings going from the center point and following compass directions including north, northeast, east, southeast, south, southwest, west, and northwest. If a stone evenly split two of the wedges, the stone was placed in the wedge to the right. As noted above, this research is of surface expressions of the stone circles only, and, therefore, is only a representative sample of the stones associated with each feature, and not an exact count. It is quite likely that there

are buried stones, but not in such a number to greatly alter the structure of the stone circle that is visible on the surface.

Cluster Analysis

Spatial analysis, in the form of cluster analysis, was used through GIS, using ESRI ArcGIS 9.3, to interpret the structure of the stone circle sites. More specifically, this research uses nearest neighbor and spatial autocorrelation analyses. Nearest neighbor analysis compares the locational similarities of specified features (Longley et al. 2005:100). The spatial autocorrelation analysis compares location and attributes of certain spatial objects (Longley et al. 2005:88). According to Longley et al. (2005:88), features have a positive spatial autocorrelation when the location and attributes are similar, and a negative correlation is observed when the location of the features are close, but the attributes are quite dissimilar. Zero autocorrelation is observed when there is no relationship between location and attribute. Cluster analysis will determine if the stone circles are in groups, or clusters, are evenly dispersed, or are in a random pattern, based on location or a specific attribute. For this analysis, the extent of the features, or points, was the extent for the clustering tests.

CHAPTER 3 – LANDFORM AND SITE STRUCTURE

The purpose of this chapter is to examine site structure of each stone circle site recorded on the PNG in relation to the type of landform on which they each reside. Stone circle sites have been observed on various landform types for various reasons. These sites have been noted on lowlands up to highlands (L. Davis 1983; Gragson 1983; Hovde 1983; Malouf 1961; Morris 1983) for many reasons including distance to water (Malouf 1961), extreme weather conditions (Kehoe 1958; Malouf 1961), and protection from prevailing winds (L. Davis 1983). Site structure and various topographic features have been analyzed by Banks and Snortland (1995) and Reher (1983). These past interpretations will be compared to the data collected for this project.

Methods

Field – Data Collection

For this chapter, a center point was collected with a Trimble GeoXT GPS unit. The center of the circle was determined by the point where half of the north-south interior diameter for each circle met with half of the east-west interior diameter. The center points of each circle were put into a separate layer for each site, and each layer was used for the nearest neighbor analysis separately. This means that the extent of the analysis was based on the extent of the stone circle center points. The scale for each analysis, therefore, was at the site level only, since running the nearest neighbor analysis for the

entire PNG would automatically put each site as a cluster. The concept for this chapter is to determine each individual site's spatial patterning, and not the overall pattern of stone circles in the area.

Based on previous research examining stone circle site landform types, discussed below (Gragson 1983), the types of landforms for this research were separated into three categories: lowlands, midlands, and highlands. Though there are subtle differences between the landform types on the PNG there is enough variability to be able to separate them into three groups. These groups may not be as drastic as compared to Montana landforms, but they will aid in interpreting site structure. To begin with, the lowlands are defined as areas that are the lowest point on the landscape, and surrounded by higher landforms, such as a ridge or bench, and include basins, valley floors, and the floors of drainages (Figure 11).

Figure 11 Example of a lowland landform showing the basin at the West Stoneham Archaeological District.

The midlands are defined as areas that are above lower landforms, such as a basin or drainage, but below a higher landform, such as a ridge. The midland landforms include low terraces and benches (Figure 12).

Figure 12 Example of a midland landform showing a bench at the West Stoneham Archaeological District. The basin is in the foreground and a rock outcrop in the opposite direction, out of the frame.

The highlands are defined as areas that are higher than all nearby surrounding landforms without any taller landforms surrounding it. The highlands include ridge tops, bluffs, and high terraces (Figure 13).

These categories were used for the ease of comparison between sites, but they do lose some of the detail about site location. Since this analysis is concerned with overall patterns of site structure and general landform type, this level of detail is sufficient.

Figure 13 Example of a highland landform showing a ridgeline on the PNG.

Lab – Data Analysis

The data were incorporated into maps using ESRI's ArcGIS 9.3 software. Each center point collected for the stone circle was added to a site map along with the respective feature number (See Appendix I). The structure of each site was determined by using the spatial statistics toolbox in ArcGIS for nearest neighbor analysis. Nearest neighbor analysis was used to understand the overall spatial patterning (clustered, dispersed, or random) within each site or concentration. For each site, a graphic produced in ArcGIS 9 displaying the results of the analysis is included and consists of the p value and Z score for each of the site structures. A directional distribution analysis was also completed using ArcGIS to determine if any of the sites exhibited a linear spatial arrangement in addition to the clustered, dispersed, or random patterns.

Previous Research

The variation of stone circle site locations was observed by Kehoe (1958:863) through ethnographic research noting that a group may get caught in a blizzard and need to set up camp anywhere, many times in places that would not normally be used for camping. Kehoe (1958:863) asserted that stone circle sites were most often found along the edges of ridges and buttes, but occasionally these sites were observed in less conventional locations such as river bottoms, stream terraces, and on gradual slopes of ridges. According to Kehoe (1958), this variation was attributed to not always being able to pick the best camping locations, but taking what was available.

Malouf (1961:385) noted that stone circle site locations were influenced by both circumstances as well as the environment, allowing for these sites to be located almost anywhere. Malouf (1961:381) observed stone circle sites on three types of landforms: low terraces/low passes/valleys, ridges or saddles, and on stream terraces. At Elk Mountain, stone circle sites were noted at high elevations in clusters of four or five circles, mostly on ridges instead of in drainages, with springs hundreds of meters away (Malouf 1961:385). This location was interpreted as a warmer weather occupation where the camp was located above the leftover winter snow remains, and was removed from the springs so not to scare away the game (Malouf 1961:385). Lone Tree Creek had a different arrangement of stone circle sites with only a few pairs of stone circles located along the creek, and clusters of 12 to 50 located at the mouth of the canyon (Malouf 1961:385). Malouf (1961:385) noted that the stone circles were only located where the water was at the surface and not any of the places where the water was below the ground. There were no stone circles observed away from the creek, or on the hill crests, nor the

intermittent streams nearby (Malouf 1961:385). Of the 60 miles along the creek, the clusters of stone circles were only located where the creek was at the surface (Malouf 1961:385).

Many stone circle sites are located on higher grounds and have been noted by archaeologists time and again. Morris (1983:48) stated that high bluffs and tributary drainages above floodplains tended to have many of the stone circle sites. Similar to Malouf's observation of the high elevation stone circle sites, Morris also noted the campsites being removed from the water sources nearby. These locations at first seem unlikely due to the long distance to water sources when camping on top of a ridge, but if the camps were during the winter month's then snowmelt could be used for water (Morris 1983:48).

Also similar to Malouf, Gragson (1983:143) had three types of landforms utilized in Montana, including lowlands, midlands, and uplands. The lowlands included alluvial fans, canyon floors, deltas, draws, floodplains, and valley floors. The midlands included hillsides mountain sides, ridges, spurs, terraces, saddles, and benches. Finally, the uplands consisted of buttes, hilltops, mesas, and rolling uplands (Gragson 1983:145). Gragson (1983:143) asserted that the number of stone circle sites varied by the type of landform with 8.0% of the sites in the lowlands, 74.3% in the midlands, and 17.8% in the uplands. Gragson (1983:143) interpreted this variation as being due to seasonal occupations and movements throughout the area.

As noted by Kehoe and Malouf, stone circle site locations often were influenced by environmental factors. L. Davis (1983:240) observed that stone circles at the Pilgrim site in Montana were located within a basin that provided protection from prevailing

winds on the western side of the site. There were two aspects of the environment at play here, with the first being the landform which provided protection from the second environmental factor, the wind. Hovde (1983:29), however, noted that the stone circles at the Hermosa site in South Dakota were located on top of a terrace, with no protection from the wind. No interpretation was provided for why this site was located on this particular landform.

Banks and Snortland (1995:128) looked at approximately 450 photographs of historic tipi village sites, ranging in dates from the 1850s to 1954, with the majority of the images coming from the 1870s to the 1900s. From these images, the authors were able to glean some information about how the peoples of the past were setting up their camps. The authors observed four camp types within these pictures including group camps, clustered camps, circular camps, and linear camps (Banks and Snortland 1995:128). The group camp had a random spatial pattern of less than 30 tipis and an average number of 5.4. The majority, 60.5%, had 4 or less tipis at the camp (Banks and Snortland 1995:130). These camps were associated with specialized activities and the most common type of camp seen in the photographs (Banks and Snortland 1995:130). The cluster camps were of an irregular arrangement with clustered groups usually associated with aggregations of 7 to 100 tipis with the average number at 27.3 (Banks and Snortland 1995:130). The circular camps were associated with ceremonial events having an average of 39.3 tipis at the sites (Banks and Snortland 1995:130). The linear sites were set up in one or more straight lines and were difficult to assess since the entire site was rarely seen in the photographs. The average camp size, however, was 20.5 tipis and was noted to be a newer phenomenon (Banks and Snortland 1995:130).

In addition to the different types of site structures, Banks and Snortland (1995:137) also noted that stone circle sites were found within four topographic settings including uplands, valleys, rivers, and woodlands. Of these landform settings, 63.2% (n=201) of the sites were located on the uplands, followed by 19.2% (n=61) on the woodlands, 10.1% (n=32) by rivers, and 7.5% (n=24) in valleys (Banks and Snortland 1995:139). According to Banks and Snortland (1995:139), the uplands exhibited all of the site structure types with clustered, groups, linear, and circular while the woodlands had slightly more group camps, and the valleys had more circular and linear camps.

Site structure and local setting was examined by Reher (1983) using seven stone circle sites in Wyoming. These sites, in general, exhibited clustered site structures, but no statistical application was used to determine if the sites were indeed clustered. According to Reher (1983:212), multiple occupations of a site complicate the understanding of site structure since clusters within a site are likely comprised of more than one occupation. Areas that are desirable camping locations will be reused throughout time. Reher (1983:210) also observed that sites on upland landforms, such as ridges and bluffs, often followed the edges in what he referred to as edge compression, where the site structure was restricted to the edge of the landform in order to benefit from upslope wind currents during the summer months. Coupling this with multiple occupations and the site structure becomes difficult to differentiate.

Finally, Oetelaar (2004:134) interpreted small clustered site structures as groupings, three to seven stone circles, of related households, if evidence is present to suggest the cluster of stone circles are contemporary. With large clustered camps, Oetelaar (2004:135) noted the clusters represented many households coming together as

an aggregation. Again, evidence that each cluster is a contemporary relation, would need to be present. Oetelaar (2004:136-7) also noted that it is difficult to distinguish a clustered area from one that was used for multiple occupations and one that had multiple households at one time. Absolute dating techniques would need to be employed, if possible, to make such a distinction (Oetelaar 2004:137). The previous research noted above is summarized in Table 1.

Table 1 Summary of stone circles and landforms previous research.

Author(s)	Date	Area/Site	Summary
Banks and Snortland	1995	Examined 450 historic photographs of tipi village sites from the 1850s to 1954	Observed four camp types: group camp, clustered camp, circular camp, and linear camp located on uplands, valleys, rivers, or woodlands.
L. Davis	1983	Pilgrim Site, Montana	Stone circles were located in a basin, protected from prevailing winds.
Gragson	1983	Montana	8.0% of sites on lowlands, 74.3% of sites on midlands, 17.8% of sites on uplands. Interpreted as being due to seasonal occupations of the area.
Hovde	1983	Hermosa Site, South Dakota	Stone circles were located on a terrace, with no protection from the wind
Kehoe	1958	Ethnographic accounts	Tipi camps often set up where ever available due to extenuating circumstances.
Malouf	1961	Elk Mountain, Wyoming	High elevation site on ridge, away from water to not scare game
Malouf	1961	Lone Tree Creek, Wyoming	Sites along creek located only where the water was at the surface. Majority of stone circles at canyon mouth
Oetelaar	2004	Canada	Small clusters were related households. Large clusters were many households together or evidence for multiple occupations.
Reher	1983	Wyoming	Sites on uplands had "edge compression" influencing site structure.

Results

Of the 10 stone circle sites and concentrations recorded on the PNG, 5 are located on lowland landforms, 2 are located on midland landforms, and 3 are located on highland landforms. Each site and concentration is discussed in detail below.

Site 5WL1340

Site 5WL1340 is located on a low terrace, south of an east-west trending rock outcropping, and north of an ephemeral drainage. The site consists of 13 stone circles in an area measuring approximately 75 meters in length. The site structure is dispersed ($p<0.01$) with less than 1% chance the site structure is a random pattern (Figure 14).

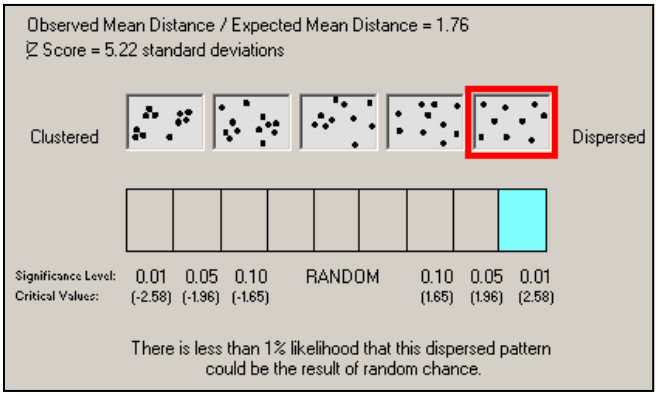

Figure 14 Site 5WL1340 nearest neighbor analysis from ESRI ArcGIS 9.3.

Site 5WL1445

Site 5WL1445 is located on top of a northwest-southeast trending ridgeline following the edge along the northeast facing side of the landform. The site consists of 15 stone circles in an area measuring approximately 600 meters in length. The site is clustered ($p<0.01$) with a less than 1% chance the pattern is a random pattern (Figure 15).

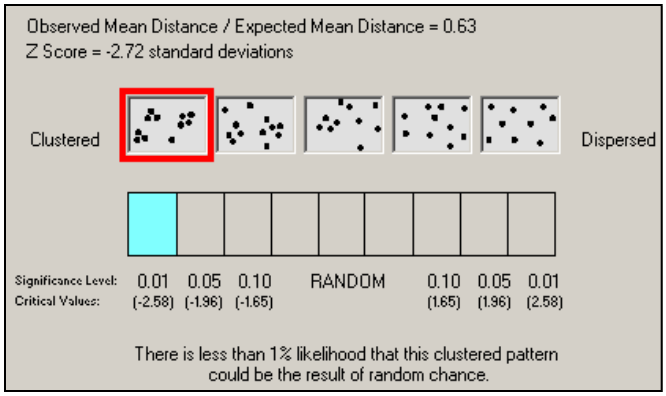

Figure 15 Site 5WL1445 nearest neighbor analysis from ESRI ArcGIS 9.3.

Site 5WL1445 has a linear distribution of the stone circles as well as a clustered site structure (Figure 16). The linear distribution follows along the northwest-southeast trending pattern of the ridgeline.

Site 5WL2180

Site 5WL2180 is the West Stoneham Archaeological District consisting of 119 stone circles along with lithic scatters, rock shelters, and historic artifact scatters. The site area is restricted to Forest Service lands and extends for 1.5 miles east to west and half a mile north to south. The stone circles are scattered throughout the district area, but there are two notable concentrations of stone circles on distinct landforms. These concentrations have been labeled A and B for the purposes of this analysis and only the concentrations were used (Discussed in Chapter 2).

Concentration A

Site 5WL2180, Concentration A is located in a basin, east of a northeast-southwest trending rock outcropping and north of a northwest-southeast trending rock outcropping. North of the concentration is a low terrace where Concentration B resides. Due east of Concentration A is a dry playa. The concentration consists of 46 stones

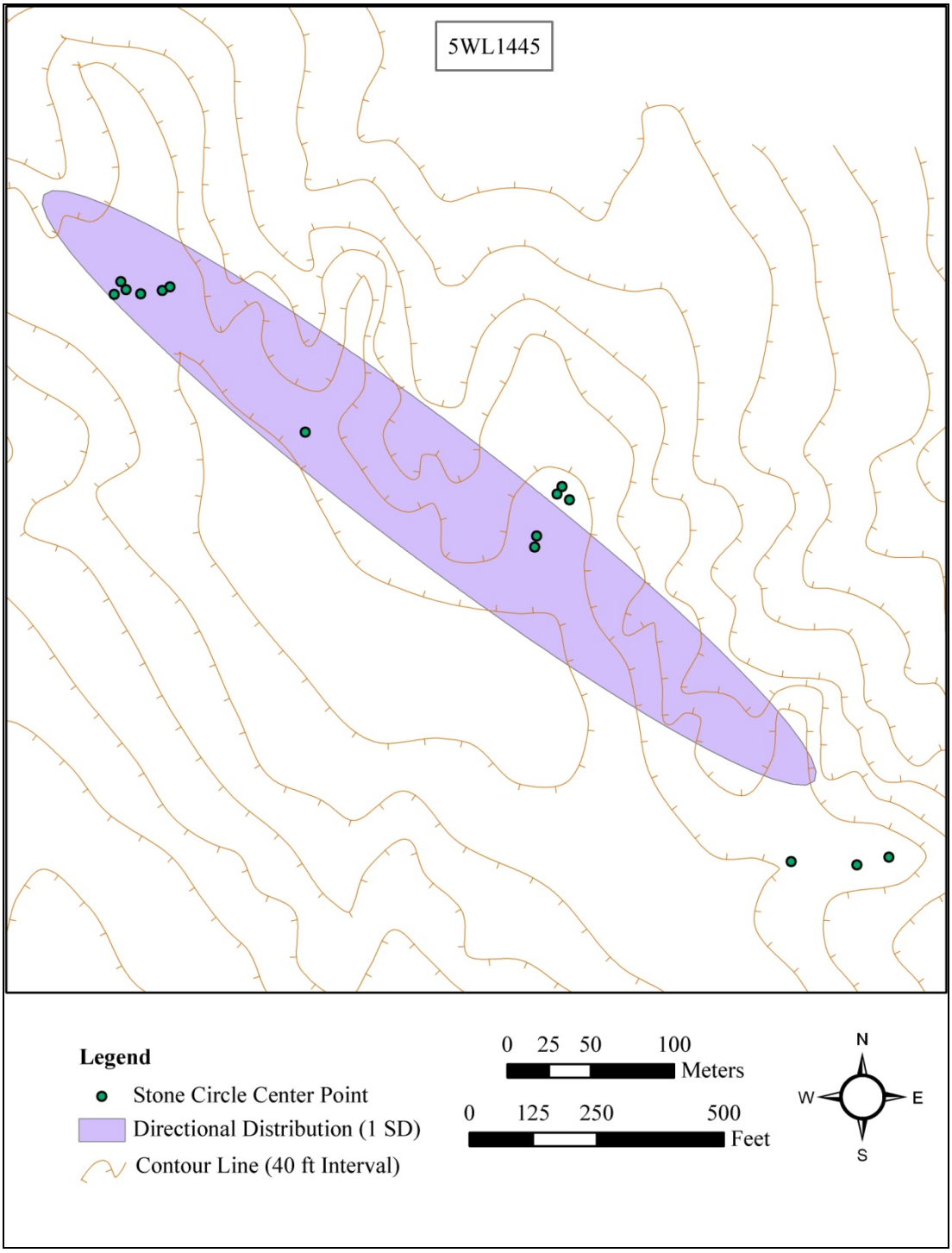

Figure 16 Site 5WL1445 directional distribution map showing a linear pattern.

circles stretching for approximately 400 meters. The site structure is a random pattern (Figure 17).

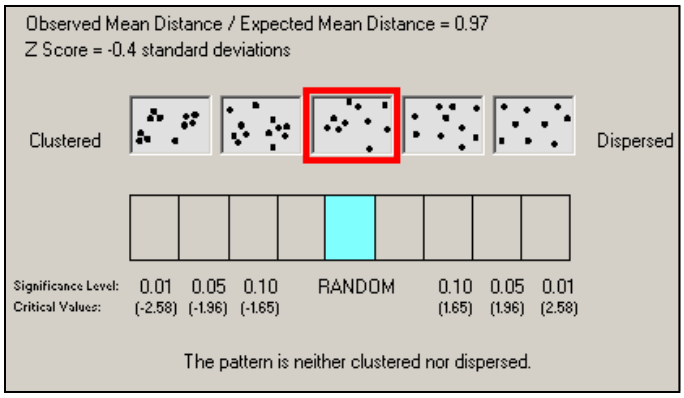

Figure 17 Site 5WL2180, Concentration A, nearest neighbor analysis from ESRI ArcGIS 9.3.

Site 5WL2180, Concentration A has a linear distribution of stone circles even though the site structure is a random pattern. The linear distribution follows an east-northeast-west-southwest line (Figure 18).

Concentration B

Site 5WL2180, Concentration B is located on a low terrace bench within the main basin at the West Stoneham Archaeological District, east of a north-south trending rock outcropping. The dry playa is located southeast of the site, down in the basin. The concentration consists of 26 stone circles in an area approximately 100 meters in length.The site structure is dispersed ($p<0.01$) with a less than 1% chance the pattern is random (Figure 19).

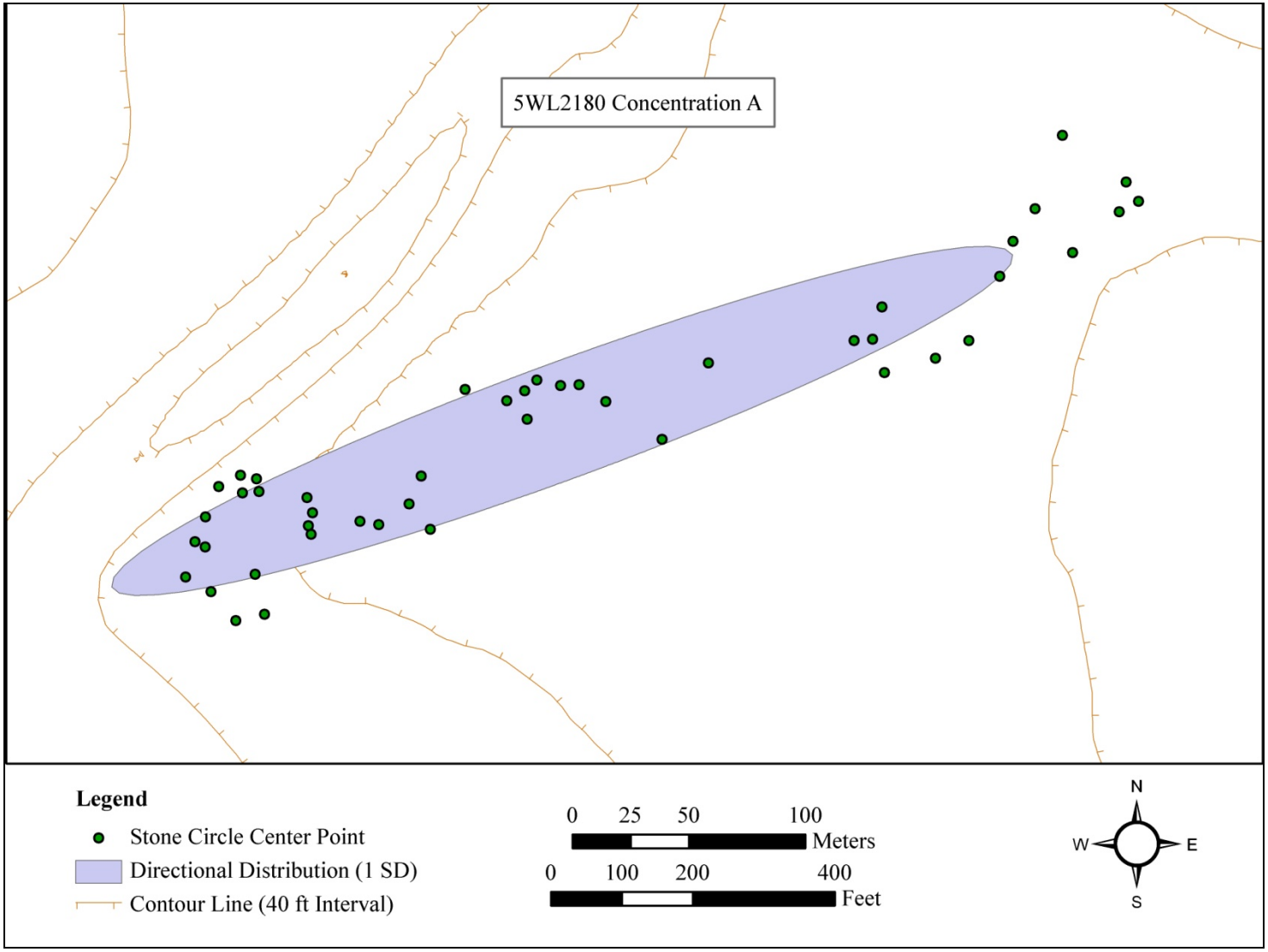

Figure 18 Site 5WL2180, Concentration A, directional distribution map showing linear patterning.

Figure 19 Site 5WL2180, Concentration B, nearest neighbor analysis from ESRI ArcGIS 9.3.

Site 5WL2413

Site 5WL2413 is located on a ridgeline curving from the northwest to the south, overlooking the rolling plains to the west. The site consists of 30 stone circles in an area approximately 450 meters in length. The site structure is slightly clustered ($p<0.05$) with a less than 5% chance the pattern is random (Figure 20).

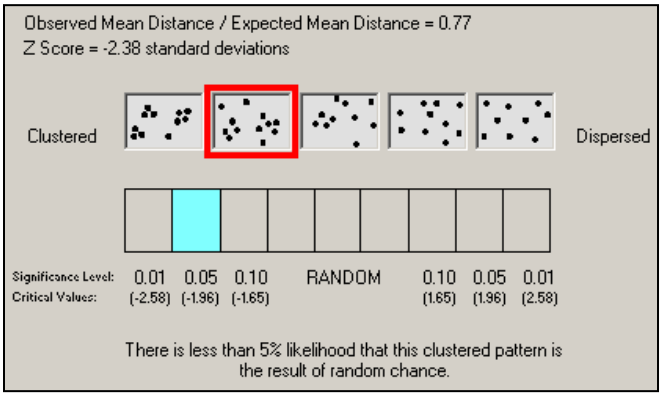

Figure 20 Site 5WL2413 nearest neighbor analysis from ESRI ArcGIS 9.3.

Site 5WL2658

Site 5WL2658 is located on the floor of a broad, flat ephemeral drainage, north of an east-west trending ridgeline. The site consists of 28 stone circles in an area approximately 200 meters in length. The site structure is random (Figure 21).

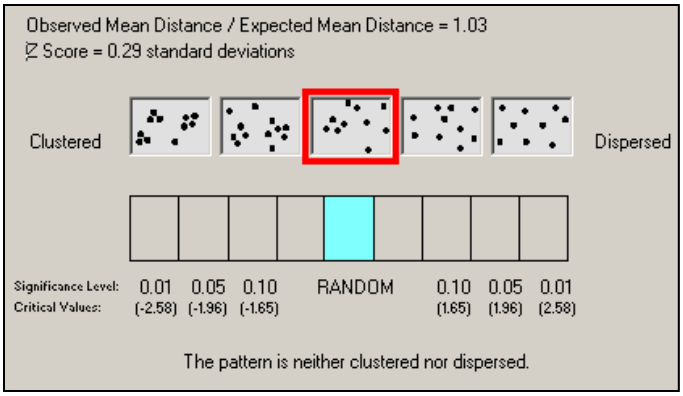

Figure 21 Site 5WL2658 nearest neighbor analysis from ESRI ArcGIS 9.3.

Site 5WL3169

Site 5WL3169 is located on a ridgeline, overlooking the rolling plains to the southwest. The site consists of 39 stone circles in an area approximately 150 meters in length. The site structure is random (Figure 22).

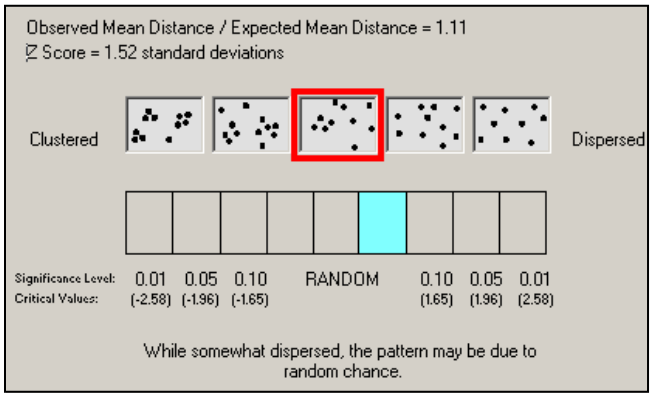

Figure 22 Site 5WL3169 nearest neighbor analysis from ESRI ArcGIS 9.3.

A summary of the stone circle site structures and landform types is provided in Table 2 for each of the sites and concentrations recorded.

Table 2 Summary of stone circle site structure and landform data.

Site	Landform	Structure	Number of Stone Circles
5WL363	Lowland	None	1
5WL367	Lowland	None	1
5WL456	Lowland	None	3

Site	Landform	Structure	Number of Stone Circles
5WL1340	Midland	Dispersed	13
5WL1445	Highland	Clustered and Linear	15
5WL2180 Concentration A	Lowland	Random and Linear	46
5WL2180 Concentration B	Midland	Dispersed	26
5WL2413	Highland	Clustered	30
5WL2658	Lowland	Random	28
5WL3169	Highland	Random	39

Discussion

A total of 249 stone circles, divided between 9 sites, were recorded for this analysis. Looking strictly at the 10 sites and concentrations, and the landforms on which they reside, 50% (n=5) are on lowland landforms, 20% (n=2) are on midland landforms, and 30% (n=3) are on highland landforms. Of the individual stone circles, 37.3% (n=93) are located on lowland landforms, 28.5% (n=71) are located on midland landforms, and 34.1% (n=85) are located on highland landforms. Even though the majority of stone circle sites are located on lowland landforms, the individual stone circles are almost evenly divided between the highland landforms and the lowland landforms.

When looking at the size of the site and the landforms there does not appear to be a significant pattern. The lowlands have sites with 28 and 46 stone circles, the midlands have sites with 13 and 26 stone circles, and the highlands have sites with 15, 30, and 39 stone circles. The overall size of the sites is evenly distributed throughout each of the landform types.

Comparing these results to those observed by Gragson (1983) in Montana, variability between landform types is apparent, but with different results. Gragson (1983)

found that midland landforms had significantly more stone circle sites than the other two landform types. The opposite is being observed on the PNG. The midland landforms have the least amount of sites and the least amount of individual stone circles. Gragson (1983) also found that the lowland landforms had by far the least amount of sites in Montana, whereas on the PNG the lowlands had the most sites and the most individual stone circles. Gragson's (1983) interpretation of this level of variability being attributed to seasonal movements is likely applicable to the PNG as well. The variation between sites being located on lowlands versus midlands may be due to the different environments present in Montana and the PNG.

Montana is located within the glaciated portion of the Great Plains, where stones have been deposited by glacial movements from the past, and therefore, stones are located almost continuously throughout the area (Trimble 1980). The PNG is located within the unglaciated region of the Great Plains and does not have stones in much of the area. Stones can be found in areas where rock outcroppings are present and near incised topography where rocks have been exposed. Since there are limitations to where stone circle sites can be located on the PNG, there are also limitations to the types of landforms in which the sites may reside.

The high number of stone circles on lowland landforms is due, in large part, to site 5WL2180, the West Stoneham Archaeological District, which has two large basins surrounded by rock outcroppings. With 60 of the stone circles at 5WL2180 located in the basins, the lower lands were ideal either for protection from the prevailing winds, as noted by L. Davis (1983), or for staying hidden from game, as noted by Malouf (1961). The midlands at 5WL2180 were also greatly utilized with 58 stone circles on these

landform types. The rest of the PNG, however, did not exhibit much use of midland landforms with only one other site, 5WL1340, being located on the midlands. This may be due to the midlands on the PNG not possessing many stones, or the protection needed from these landforms may not be as great on the PNG, as in other parts of the Great Plains. This is likely due to the more subtle differences in landform types on the PNG as well.

The highlands are well utilized on the PNG with 85 total stone circles located on these landform types, only 1 of which is located at 5WL2180. As noted by Hovde (1983), the highlands do not afford the protection from the prevailing winds that the lowlands do, and are often well removed from water sources, as noted by Malouf (1961). According to Morris (1983), these site locations are not impossible since snow is often available during the winter months. On the PNG, the highlands tend to be within the most incised areas with exposed rock readily available, likely explaining the greater number of stone circles on these landform types.

As Table 3 depicts, for the lowland landforms, two sites have a random spatial pattern and three have less than three stone circles at the site. The three sites with three or less stone circles include 5WL363 with one stone circle, 5WL367 with one stone circle, and 5WL456 with three stone circles. The two sites located on midland landforms have a dispersed spatial pattern, while none of the highland sites are dispersed. Two of the highland sites are clustered and one is of a random spatial pattern. Two of the sites have a linear distribution of stone circles, 5WL1445 on a highland landform and 5WL2180, Concentration A, on a lowland landform.

Table 3 Total stone circles by site structure and landform type.

PNG	Clustered	Dispersed	Random	Less Than 3	Total
Lowlands	0	0	2	3	5
Midlands	0	2	0	0	2
Highlands	2	0	1	0	3
Total	2	2	3	3	10

The cluster analysis revealed that the highlands had the only clustered sites as well as one random pattern site. Two sites were clustered, and one of those sites also had a linear distribution. As noted by Reher (1983), with the concept of edge compression, the site structure following the ridgeline limits the available space to set up camp, even though the entire ridge top may be vast. The length of the ridgeline allows for more options for camping spots, and would then allow for more clustering in order for the best areas along the edge to be completely utilized. Whether the clusters are from one occupation or multiple occupations, cannot readily be determined with the data at hand. If the clusters are from one occupation, where the residents wanted to stay along the ridge edge and, therefore, needed to spread down the ridgeline to accommodate the camp size, then these clusters may represent family groupings, as observed by Oetelaar (2004:134). If the clusters are from multiple occupations where the new residents did not want to set up camp in a previous camp location, then they may have moved down the ridge to the next untouched spot. Given that many stone circle sites recorded for this analysis exhibit evidence for reuse of stones from older circles to make newer circles, this may not necessarily be the case. It is possible that multiple occupations of the site created the clustered pattern when a linear camp, like those described by Banks and Snortland (1995), was spread out down the ridge line, multiple times, making clusters of old and new stone circles. Since the clustered sites had partial stone circles, it is likely that the

areas had been reused over time. Additional evidence however, in the form of absolute dates, would need to be collected in order to make such an interpretation of the site structure.

The clustered site with the linear distribution, 5WL1445, does not seem to fit the definition proposed by Banks and Snortland (1995) for the linear camp. Site 5WL1445 has small clusters of stone circles located on finger ridges that happen to be in a line stretching down the edge of the ridge. The stone circles are not in a line themselves, and, therefore, are not what was being described for the linear camp. The linear distribution is evidence for Reher's (1983) edge compression concept, depicting how the stone circles follow the linear line of the ridge's edge instead of spreading out onto the available space of the interior portion of the ridge top.

The linear distribution of site 5WL2180, Concentration A also does not fit the definition of a linear camp, proposed by Banks and Snortland (1995). The site structure of Concentration A is random, but the stone circles are not forming one or more lines within the basin. As with 5WL1445, the stone circles are stretching the length of the landform, which in this case the basin, in a linear distribution that also coincides with the direction of the rock outcropping providing protection to the west, and the slope within the basin curving to the northeast. The linear distribution within the basin is interesting, depicting the use of the best camping spots on this particular landform type as far as wind protection, the playa to the east of the concentration, and the slope are concerned.

The two midland sites were dispersed, and the midlands were the only landform type with dispersed sites. Given the more restricted nature of the midland landforms than the lowlands, less space is available for camp selection, requiring for the structures to be

arranged more evenly spaced between each other. Especially in both of the cases on the PNG, the midland landforms on which the sites reside had rock outcroppings as protection from prevailing winds, making the specific location where the stone circles were observed the best camping locations. Going beyond where the stone circles were observed would have exposed the structure to the winds, and also placed the structures on unfavorable slopes. Determining multiple occupations versus one occupation has the same difficulties as with the clustered sites. Without absolute dates for each stone circle, determining if the site structure was of one camp or because it was the best place to camp time and again, is difficult to determine. Since both sites had partial stone circles, it is likely that these areas had been reused.

Stone circle sites are located on all of the landform types throughout the PNG, at least all the landforms with rocks available to make the rings of stone. Given the different environment of the PNG, compared to other portions of the Great Plains with stone circle sites, different results were observed for landform types on which the sites reside. In Montana, the majority of sites were located on the midland landforms, whereas on the PNG most sites were on the lowlands, and the most individual stone circles were also located on the lowlands, followed closely by the highlands.

The structure of these sites is what makes the landform type important for interpretation and analysis of stone circle sites. Since the only clustered sites were on the highlands and the only dispersed sites were on the midlands, landforms played a part in how the sites were structured. The nature of the site structures cannot be conclusive without obtaining absolute dates for each of the stone circles at each site, in order to know whether multiple occupations were indeed occurring, or if the sites were from a

single occupation. The cluster analysis does, however, provide some detail for the study of why sites were structured the way they were, and how the type of landform influences site structure.

CHAPTER 4 – GAP DIRECTION AND SITE STRUCTURE

The purpose of this chapter is to compare stone circle data, collected from the PNG in Weld County, Colorado, to the existing literature to determine if any patterns can be seen, and any interpretations made, regarding stone circle site structure and gap direction. From this comparison, it will be determined if a cluster analysis is useful in depicting site structure based on an attribute, such as gap direction. The gaps sometimes seen in the rings of stone have been interpreted as probable doorways for the structure when the tipi covering was not present under the door opening (Kehoe 1958:871). Throughout stone circle research, many observations have been made about the direction these gaps may face. Some researchers have noted that the gap will always face the east, or rising sun, as a cultural belief (Banks and Snortland 1995; Hassrick 1964; Moore 1996; Oetelaar 2000) while others assert that the gap will face away from the prevailing winds (Banks and Snortland 1995; Davis 1983; Day and Eighmy 1998). Social factors have also been taken into account when interpreting gap directions including having the gap face the center of a group encampment or social area (Day and Eighmy 1998; Oetelaar 2000). These past interpretations will be compared to the data collected for this question.

Methods

Field – Data Collection

For this question, the author recorded and evaluated two sites, 5WL2413 and 5WL2180 which was separated into two main concentrations, A and B, based on their

location on different landforms. Each of these is different in that they are located on different types of landforms. The two concentrations are located at the West Stoneham Archaeological District, 5WL2180, and are both located within a basin. Concentration A is on the basin floor at the west end, while Concentration B resides on a low bench at the northwest end of the basin. Site 5WL2413 is located on a ridge top, following the edge and finger ridges, at the northwest corner of the PNG. These sites also vary in the number of stone circles present with 46 stone circles at Concentration A, 26 stone circles at Concentration B, and 30 stone circles at 5WL2413, for a total of 102 stone circles observed for this question.

Lab – Data Analysis

As noted in Chapter 3, the spatial patterning of each site was determined through ArcGIS 9.3. For the purposes of this chapter, those data were used as the control for when the analysis was run again using the gap directions for 5WL2413 and 5WL2180, Concentrations A and B. The spatial patterning for the gap direction was conducted by using the spatial autocorrelation (Moran's I) tool in ArcGIS. This tool allows for an attribute with a numeric value to be analyzed for spatial patterning. Again, this analysis was to determine if the gap direction for the stone circles were clustered, dispersed, or random, within the site structure. The extent for this analysis was based on the extent of the features, or points, for each site. Finally, basic statistics were calculated for each site and displayed graphically, and included in this report for comparison purposes between sites.

Previous research

The direction the gap is facing within a stone circle has been interpreted in varying ways. Most researchers view the gap within a stone circle as the opening for the doorway of tipis. Some tipis, however, had material below the doorway and therefore did not leave a gap in the stone ring, lining the base of the material (Kehoe 1983:336). For tipis that had the doorway extending to the ground, a gap in the stone circle would be needed in order to enter and exit the tipi easily, so as not to trip over the cover or stones. For the purposes of this research, a gap in the stone circle is being interpreted as the direction of the doorway for the structure.

Some researchers have considered the gap direction as a cultural ideal where the doorway would always face one direction, toward the east or the rising sun. To get a better idea of how tipi village sites were structured, as noted in Chapter 3, Banks and Snortland (1995:128) looked at approximately 450 photographs of historic tipi village sites, ranging in dates from the 1850s to 1954, with the majority of the images coming from the 1870s to the 1900s. From these images, the authors were able to glean some information about how the peoples of the past were setting up their camps. One of the attributes the authors considered was the direction the doorways were facing in the photographs. The results were that 69.7% of the photographs showed all of the doorways facing the same direction within the camp, and 12% had most of the doorways facing the same direction. Altogether, 81.7% of the stone circles had all or most of the doorways facing the same direction within a camp. The remaining 13.7% had the doorways facing random directions (Banks and Snortland 1995:139). Although the cardinal direction the doorways were facing could not be determined from the photographs, the authors

suggested that this could be evidence of either the doorways always facing east, the rising sun, or away from the prevailing winds (Banks and Snortland 1995:139).

Hassrick (1964) depicted the life of the Sioux during historic times, from the 1830s to the 1870s, through documentation and ethnographic research. The author looked at many variables of everyday life for the Sioux, often describing the structure of their camps. Hassrick (1964:153) asserts that once a campsite was chosen and the proper ceremonies were performed, the women began setting up the tipis with each doorway facing to the east. From this account, it appears that the doorways were traditionally set up to the east as a cultural ideal of the group. Given that, it is also possible that environmental factors, in addition to cultural ideals, could have influenced this site structure.

Moore (1996:36) described the procedures used by the Cheyenne to construct a tipi which was noted as still being used in modern times. In this description, Moore (1996:37) noted that the doorway faced to the southeast once the tipi was set up. Moore (1996:39) continued to explain the need for this positioning was to move air through the door, or from under the cover, to push the smoke up and out the top of the structure. The author did not indicate if this position for the doorway was a seasonal method or only the typical procedure for construction. The doorway facing the east has been viewed as a ceremonial indicator as well. Oetelaar (2000:37) suggested that structures for ceremonial purposes had the doorway facing the east, while the non-ceremonial structure doorway orientations were determined by social or environmental factors.

Environmental factors include the direction of prevailing wind. L. Davis (1983:263) observed at the Pilgrim site in Montana that none of the stone circles

excavated had a wall gap within the ring of stone that was associated with the flow of the debris excavated from the inside of the circle. This flow of debris was interpreted as an indication for the direction of where the doorway would have been. Recordation of the few interior features within the stone circles tended to be in the eastern most portion of the ring, and was interpreted as allowing for the structure to be supported against westerly or southwesterly winds (L. Davis 1983:263). Artifacts were also observed in the eastern portions of the stone circles providing more evidence for the author's assertion that the doorway was likely to the east, away from the wind (L. Davis 1983:264). According to L. Davis (1983:264), some exceptions were noted with flake scatters going to the north, south and west and one doorway likely opening to the south; however, the majority of the evidence indicated an easterly orientation. The author did not interpret these eastern doorway orientations as being a cultural or ceremonial indicator, but only viewed them as being evidence for orientation away from the prevailing wind.

Research at the Biscuit Hill site in Weld County, Colorado also observed stone circle gap directions opposite of the prevailing wind (Day and Eighmy 1998:14). Day and Eighmy (1998:14) asserted that the doorway was likely placed opposite the prevailing winds in order to establish a "good internal draft" throughout the tipi. The authors noted that, during the coldest parts of the year at the Biscuit Hill site, the wind was blowing from the northwest. The least number of the stone circles observed had a gap facing the north or northwest, with the majority of the gaps facing the northeast and the southwest (Day and Eighmy 1998:16). All of the octants recorded by Day and Eighmy (1998:16) had at least one gap indicating variability likely due to environmental factors.

Along with the notion of doorways facing away from the prevailing winds, Day and Eighmy (1998:16) also suggest that the doorway orientation may have been due to social factors, such as facing the doors into a social center or common area of the site. At the Biscuit Hill site, three groups of stone circles were observed to have gaps facing a central area or feature (Day and Eighmy 1998:16). Oetelaar (2000:37) also asserts that stone circles that have been placed in a large circle, or circle camp, had the gaps facing the center of the circle, which allowed for better interaction. Oetelaar (2000:37) does note, however, that during the winter months the gaps tended to face downwind. As quoted by Banks and Snortland (1995:128), Gilbert Wilson interviewed a Hidatsa woman in 1924 about how tipi village sites were arranged. He noted that when the wind was calm, the doorways of the tipis would face the center of the large circle camp, suggesting further that when environmental conditions allow, social factors may play a role in stone circle site structure (Banks and Snortland 1995:128). The previous research described above is summarized in Table 4.

Table 4 Summary of the stone circle gap direction previous research.

Author(s)	Date	Area/Site	Summary
Banks and Snortland	1995	Examined 450 historic photographs of tipi village sites from the 1850s to 1954	Observed 82% of the photographs with most or all of the doorways facing one direction. Interpreted as either facing east or away from the prevailing winds.
L. Davis	1983	Pilgrim Site, Montana	Excavated stone circles found artifact scatters were not correlated with gap directions. Observed the artifacts mostly concentrated in the eastern portion of the circles. Interpreted as doorways facing away from the prevailing winds.

Author(s)	Date	Area/Site	Summary
Day and Eighmy	1998	Biscuit Hill Site, Colorado	Observed doorways positioned away from prevailing winds and toward a central social area.
Hassrick	1964	Sioux culture from the 1830s to 1870s	Observed the doorways facing east.
Moore	1996	Cheyenne tipi construction	Observed the doorways facing southeast.
Oetelaar	2000	Canada	Structures of ceremonial purposes had east facing doorways. Non-ceremonial structures had doorways determined by environmental factors. Also noted doorways facing a social center of a circle camp site.

Results

Site 5WL2180

Concentration A

Concentration A is located in the West Stoneham Archaeological District on the west side of the basin floor. Large rock outcroppings line the western side of the site, and a dried up playa is located to the east. Concentration A has 46 stone circles stretching for approximately 400 m. The nearest neighbor analysis determined that Concentration A had a random site structure providing no distinguishable spatial patterning of the stone circles within the site area. However, the site does exhibit a linear spatial pattern, as noted in the previous chapter.

Of the 46 stone circles in Concentration A, 41% (n=19) were complete, 20% (n=9) were partial circles, and 39% (n=18) had a distinguishable wall gap (Figure 23). The number of stone circles with a gap is mostly evenly distributed among the four

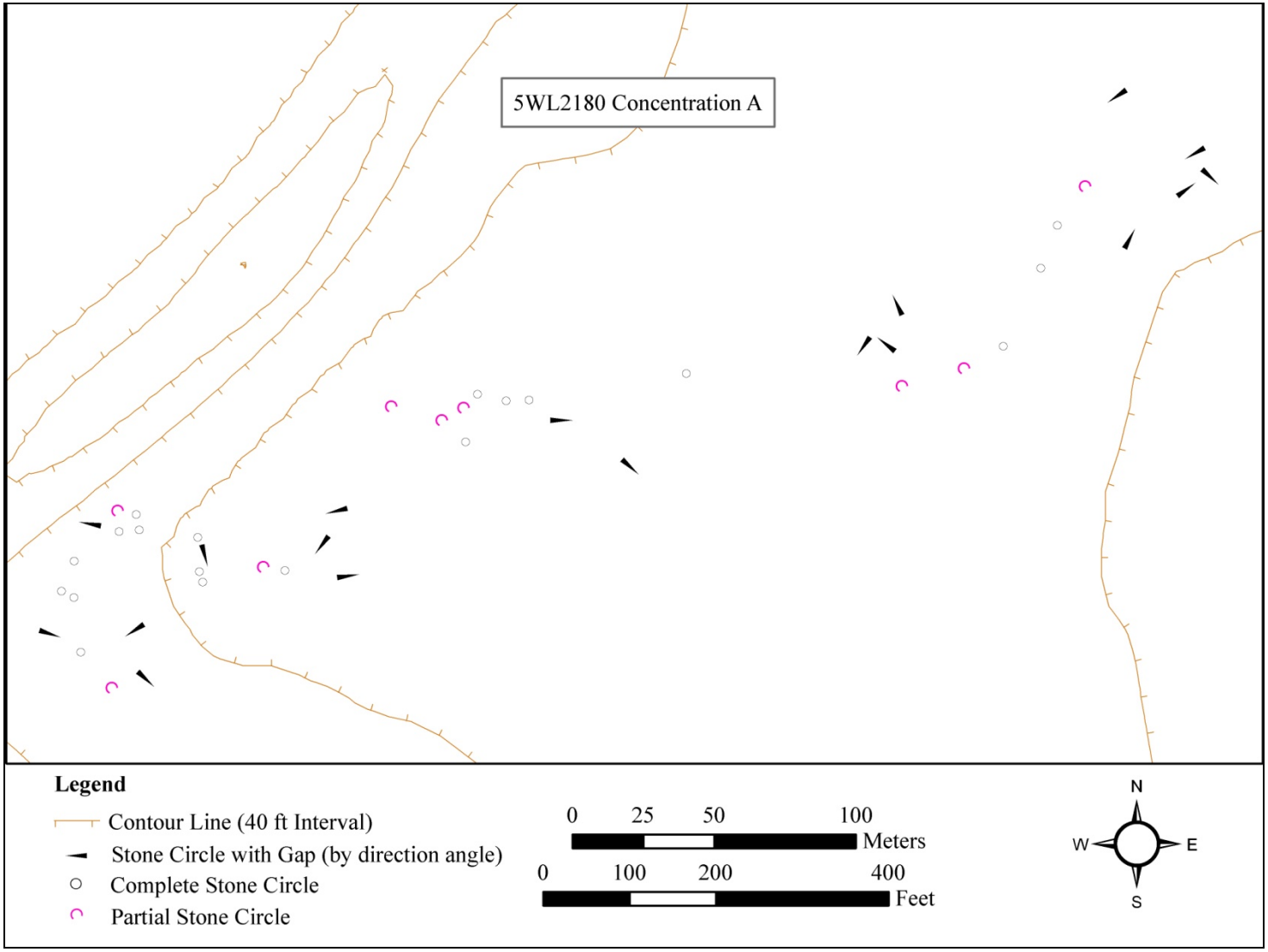

Figure 23 Site 5WL2180, Concentration A, site structure with stone circle completeness and gap direction.

quadrants with the northeast, southeast, and northwest at 22% (n=4) each, and the southwest only slightly higher at 33% (n=6).

Figure 23 depicts the site structure according to the completeness of each of the stone circles and the direction of each of the wall gaps. Looking only at the stone circles with a distinguishable wall gap, the spatial autocorrelation (Moran's I) analysis also determined these structures to have a random spatial pattern. At the southern portion of the site is a large circle of stone circles comprised of 59% (n=10) complete stone circles, 12% (n=2) partial stone circles, and 29% (n=5) stone circles with a distinguishable gap. Of the five stone circles with a gap, one is facing west, one is facing south, two are facing southeast, and one is facing southwest, with none of the gaps facing the center of the large circle.

Concentration B

Concentration B is also located at the West Stoneham Archaeological District however this site is situated on a bench above the basin, but still surrounded by the rock outcroppings to the west and the playa located to the southeast. Concentration B has 26 stone circles within an approximately 100 m area. The nearest neighbor analysis determined this site to be dispersed indicating, with less than 1% possibility that the spatial pattern of the site is by random chance. Of the 26 stone circles at the site, 38% (n=10) were complete, 12% (n=3) were partial stone circles, and 50% (n=13) had a distinguishable gap (Figure 24). The number of stone circles with a gap is distributed among the four quadrants, with 38% (n=5) in the northeast quadrant, 8% (n=1) located in the southeast quadrant, 31% (n=4) located in the southwest quadrant, and 23% (n=3) located in the northwest quadrant.

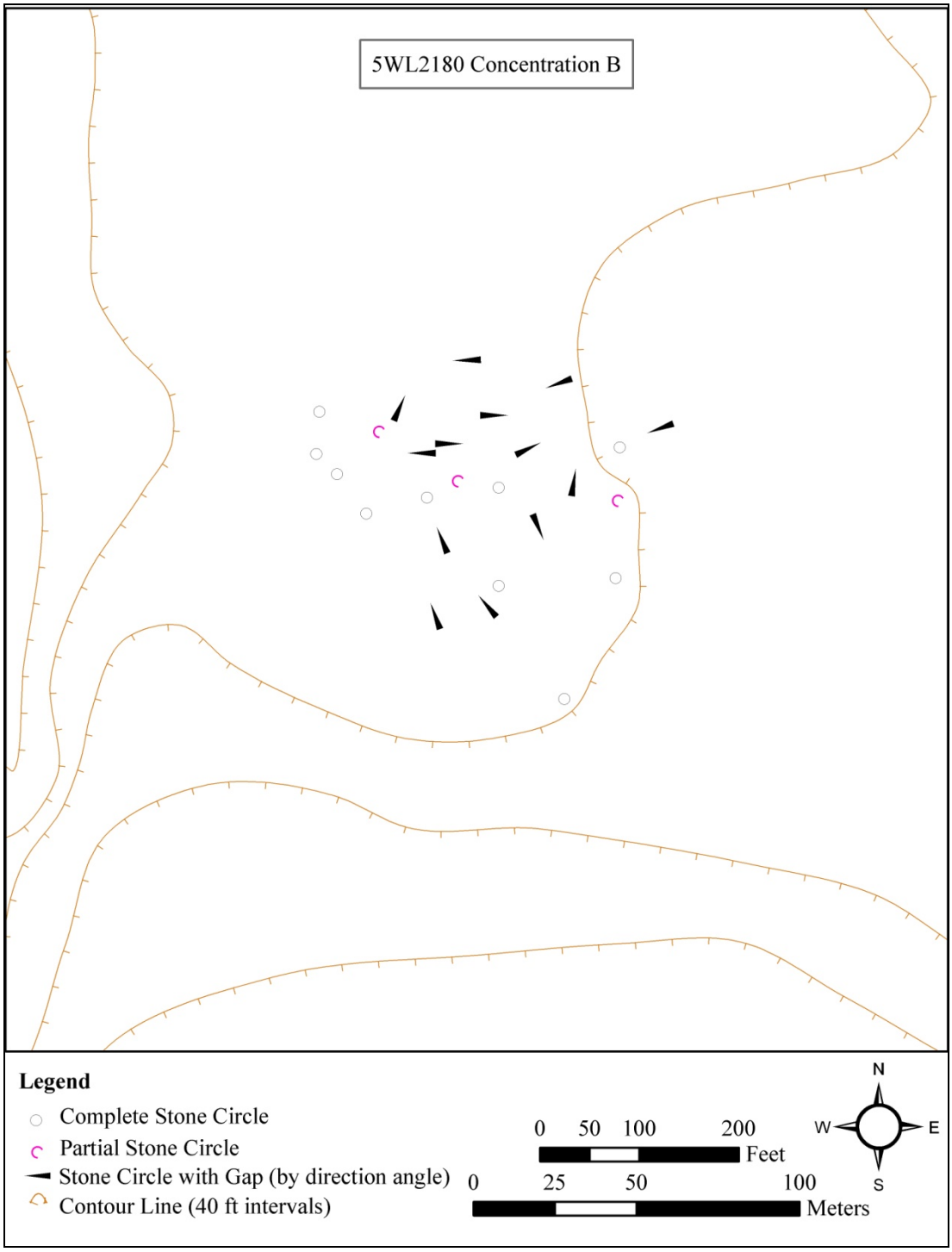

Figure 24 Site 5WL2180, Concentration B, site structure with stone circle completeness and gap direction.

Figure 24 depicts the site structure according to the completeness of each of the stone circles and the direction of each of the wall gaps. Looking only at the stone circles with a distinguishable wall gap, the spatial autocorrelation (Moran's I) analysis determined these structures to have a moderately clustered pattern, with a 5% to 10% possibility of the pattern being from random chance. It does appear that some of the stone circles in the northeast portion of the site are facing a central location which will be discussed further below.

Site 5WL2413

Site 5WL2413 is located in the northwest portion of the PNG on top of a ridge following the edge and finger ridges. 5WL2413 has 30 stone circles within an approximately 450 m area. The nearest neighbor analysis determined this site to have a clustered spatial pattern, with a less than 5% possibility of the pattern being random chance. Of the 30 stone circles, 43% (n=13) were complete, 20% (n=6) were partial stone circles, and 37% (n=11) had a distinguishable gap (Figure 24). The number of stone circles with a gap are distributed among the four quadrants with 9% (n=1) in the northeast, 45% (n=5) in the southeast, 18% (n=2) in the southwest, and 27% (n=3) in the northwest quadrants of the stone circles.

Figure 25 depicts the site structure according to the completeness of each of the stone circles and the direction of each of the wall gaps. Looking only at the stone circles with a distinguishable wall gap, the spatial autocorrelation (Moran's I) analysis determined these structures to have a random spatial pattern. None of the gaps are facing a central portion of the site.

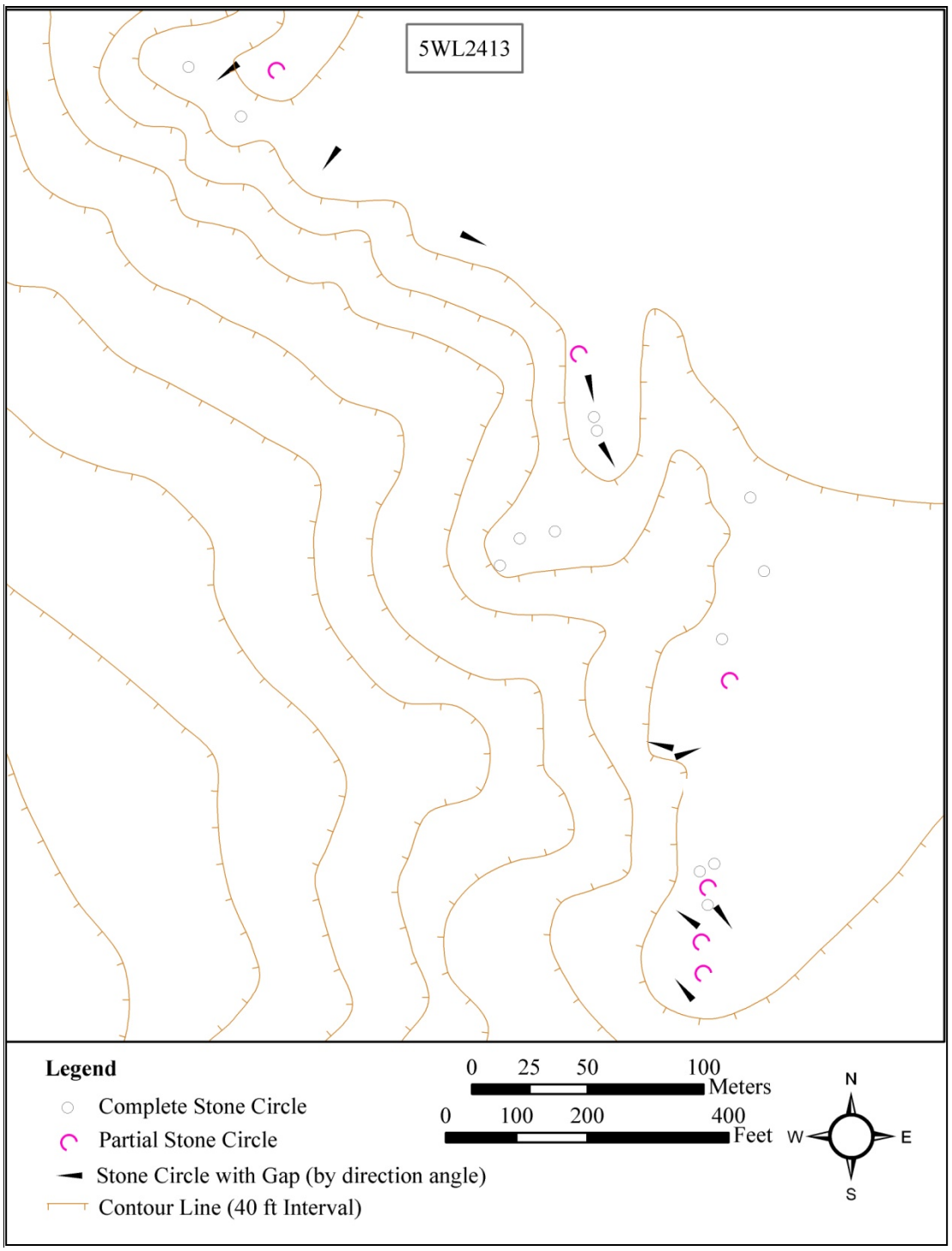

Figure 25 Site 5WL2413 site structure with stone circle completeness and gap direction.

Discussion

Comparing the three sites based on stone circle completeness, there is little difference between them. As shown in Figure 26, the sites are similar in the relative number of complete stone circles, partial stone circles, and stone circles with a gap. The main difference between the sites is that Site 5WL2180, Concentration B has relatively more gaps than the other sites.

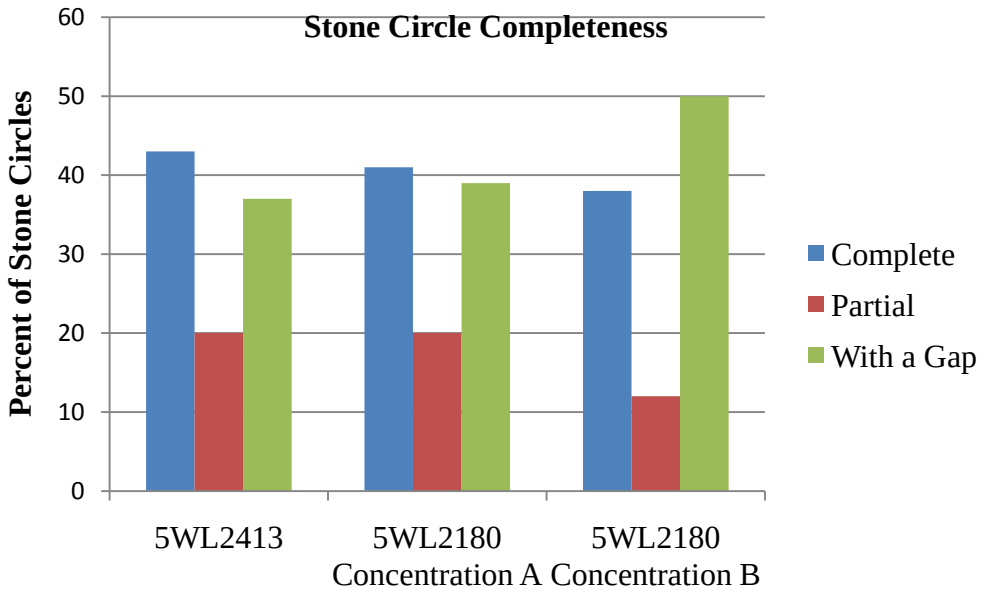

Figure 26 Stone circle completeness by site and concentration**.**

There is some variability in the number of gaps per eastern versus western quarters, with site 5WL2180, Concentration A and Concentration B, showing slightly more gaps in the western quarters than the eastern quarters (Figure 27). The quarter with the most gaps for Concentration B, however, is the northeast quarter. The quarter with the most gaps for site 5WL2413 is the southeast quarter and for 5WL2180, Concentration A, is the northwest quarter.

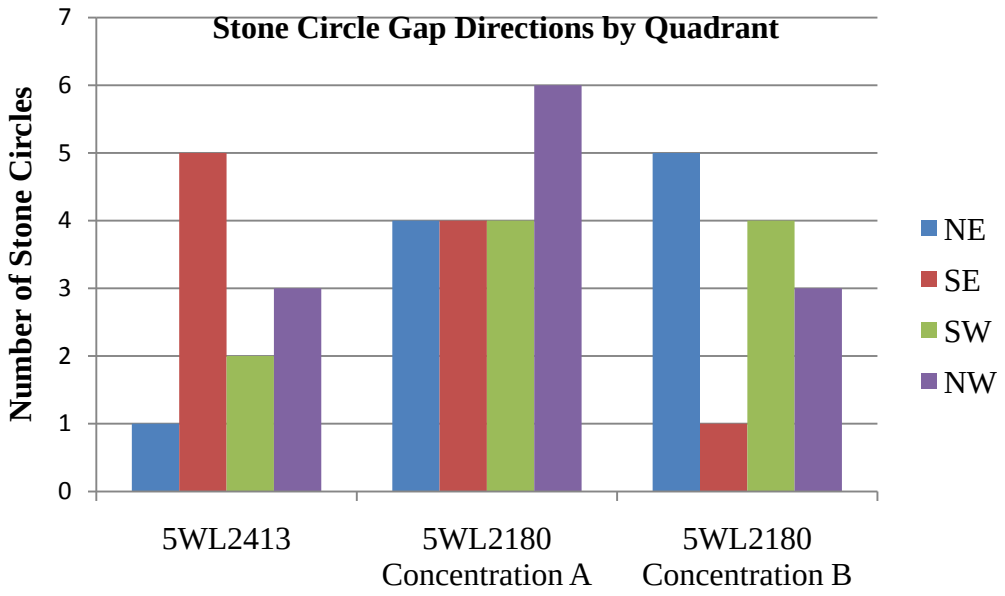

Figure 27 Chart of the stone circle gap directions for each of the sites analyzed.

From these data, it is clear that not all of the stone circles have gaps facing toward the east, or rising sun. This lends to the notion that these gaps are likely facing away from the prevailing winds which change direction throughout the year.

According to McNoldy (2010), the Fort Collins, Colorado weather station indicated that the prevailing winds are from the north-northwest during the late fall through the early spring, and from the south-southeast during the late spring through the early fall, with the strongest winds during the winter and spring months. Chapter 5 will examine wind directions further.

Given the distribution of gaps in all four quarters of the circles at each site, prevailing wind is likely an explanation for gap direction. Since there are seasonal differences of wind directions, then it would be expected that the varying direction of the gaps would be an indicator of different seasons of occupation. If this is the case, these

areas would have been used for multiple occupations, throughout time, during different seasons.

Another environmental factor, likely impacting the gap direction, may have been the rock outcroppings on the west side of site 5WL2180, Concentrations A and B. This protection from the northwesterly winds may have allowed for more gaps to be located in the western quarters of the stone circles year round. Site 5WL2413, located on the ridge top, was not afforded the same protection, and had a slightly higher number of gaps in the eastern quarters of the stone circles, with slightly more possible winter occupation stone circles than summer occupation. With site 5WL2180, the large rock outcropping providing protection from the northwesterly wind may blur this line of evidence. For Concentrations A and B during the winter months, with prevailing northwesterly winds, could have gaps facing any direction, whereas the summer months would have less protection from the prevailing southeasterly winds.

Concentration A, located on the basin floor, has an even distribution of gap directions with the most protection from prevailing winds of any direction. Concentration B, located on the low bench, has protection from northwesterly winds, but not from any other direction. The gap directions for Concentration B are inconclusive for seasonal occupation since the majority of the gaps face the northeast and southwest, neither of which are prevailing wind directions. Having said all that, it must be taken into account that there are many stone circles at each site that were complete, where the doorway location could not be determined. These stone circles may have demonstrated much different patterns than those with a gap in the circle.

Most notably is the large circle of stone circles at 5WL2180 Concentration A where 12 of the 17 features were complete. Even though the five stone circles that had gaps did not face the center of the large circle, this is not conclusive evidence for the actual structure of the large circle. The complete stone circles may have had doorways that faced the center of the circle for better social interaction. The stone circles with gaps may have been from separate occupations.

Banks and Snortland (1995) observed that the vast majority of doorways faced the same way in historical photographs, regardless of cardinal direction. This may provide information important to interpreting a site for multiple occupations. None of the three sites had all of the gaps going in the same direction. In fact, none of the sites even had a majority going one way. Given this, and the aforementioned observations from historical photographs, there are likely multiple occupations occurring at each of the three sites recorded. Banks and Snortland (1995) noted that 14% of the photographs depicted sites with random doorway orientations. These sites, however, with that low of a percentage, seem to be more of an anomaly than a regular occurrence. If the sites recorded for this analysis were of single occupations than it would be expected to have observed at least one site with all, or the majority, of the gaps facing one direction.

The cluster analysis using spatial autocorrelation (Moran's I) depicted the spatial patterning of each site, with regards to the gap directions. The analysis indicated that sites 5WL2180 Concentration A and 5WL2413 resulted in random patterns concerning gap direction, even though the overall patterns for these sites were random and clustered respectively. This random pattern explicitly details the relationship the features have

with each other. It has been established that not all of the gaps were facing the same direction, and this random pattern indicates that as well.

Site 5WL2180, Concentration B, however, had an overall site structure that was dispersed, and spatial autocorrelation indicated the gap directions were moderately clustered. Of the stone circles with gaps, nine were grouped into three separate clusters of three stone circles each (Figure 28).

The first cluster, located in the northern portion of the site, has gaps facing southwest. The second cluster, in the middle of the site, has gaps facing east-northeast, and the third cluster, in the southern portion of the site, has gaps facing northwest. These clusters may indicate three separate occupations of small groups of people. Cluster 2 may also have been a winter occupation with gaps facing away from the prevailing northwesterly winds. Cluster 3 may have represented a summer occupation since the gaps were facing northwest, away from the prevailing southeasterly winds. Cluster 1 may have been an early fall occupation when the prevailing winds were mostly from the east.

There is a grouping of stone circles in the northeast portion of the concentration that appears to be facing a central location (Figure 29). Though this is not statistically significant through cluster analysis, this pattern may be even more evidence for multiple occupations of the area, with one group having the structures all facing a social center. This is not, however, likely to be an overall explanation of site structure, but may be an explanation for a particular group from one occupation of the concentration.

From the data recorded, it is likely the gap directions for the stone circles at the three sites were based on environmental factors, such as wind direction, more so than

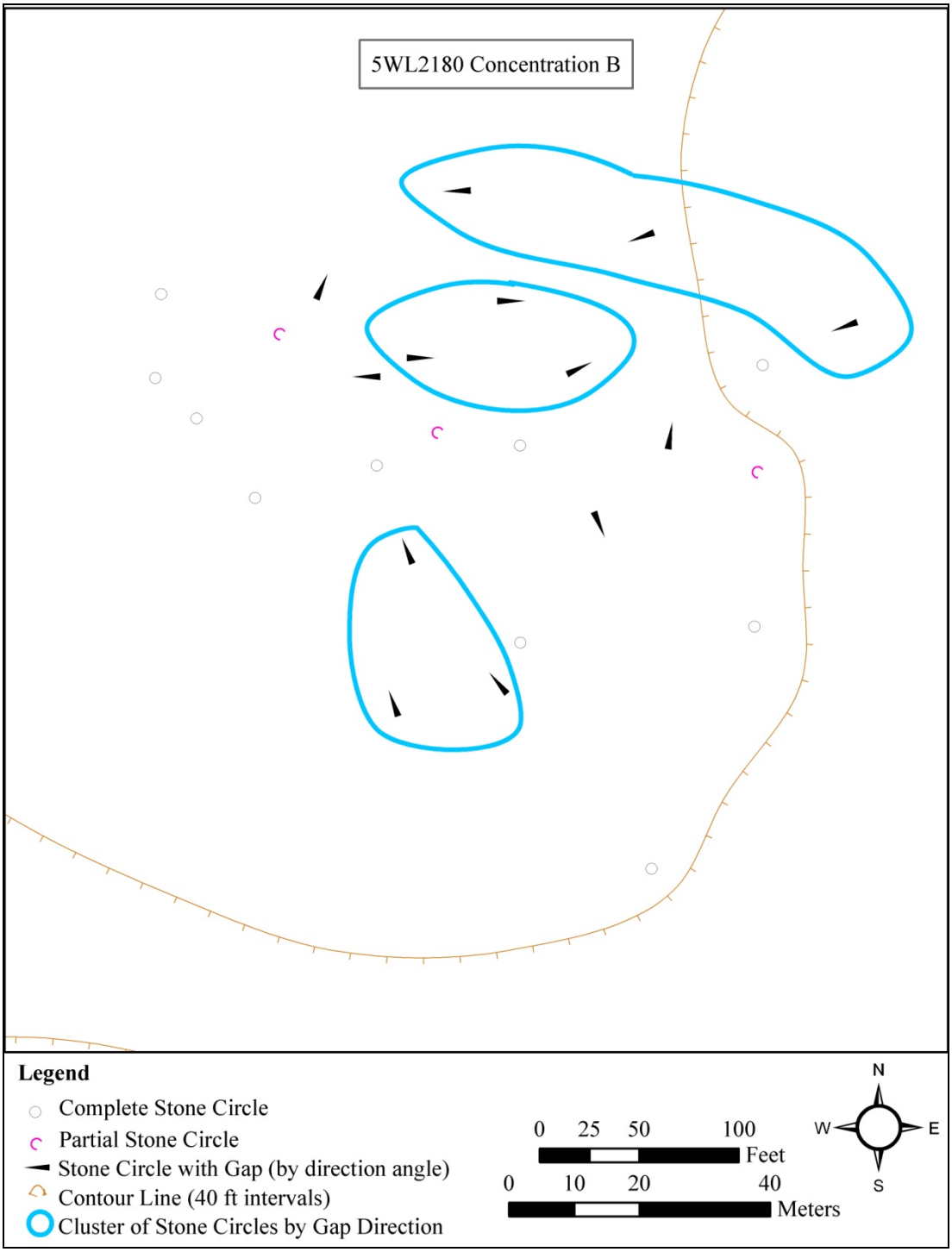

Figure 28 Site 5WL2180, Concentration B, gap direction clusters..

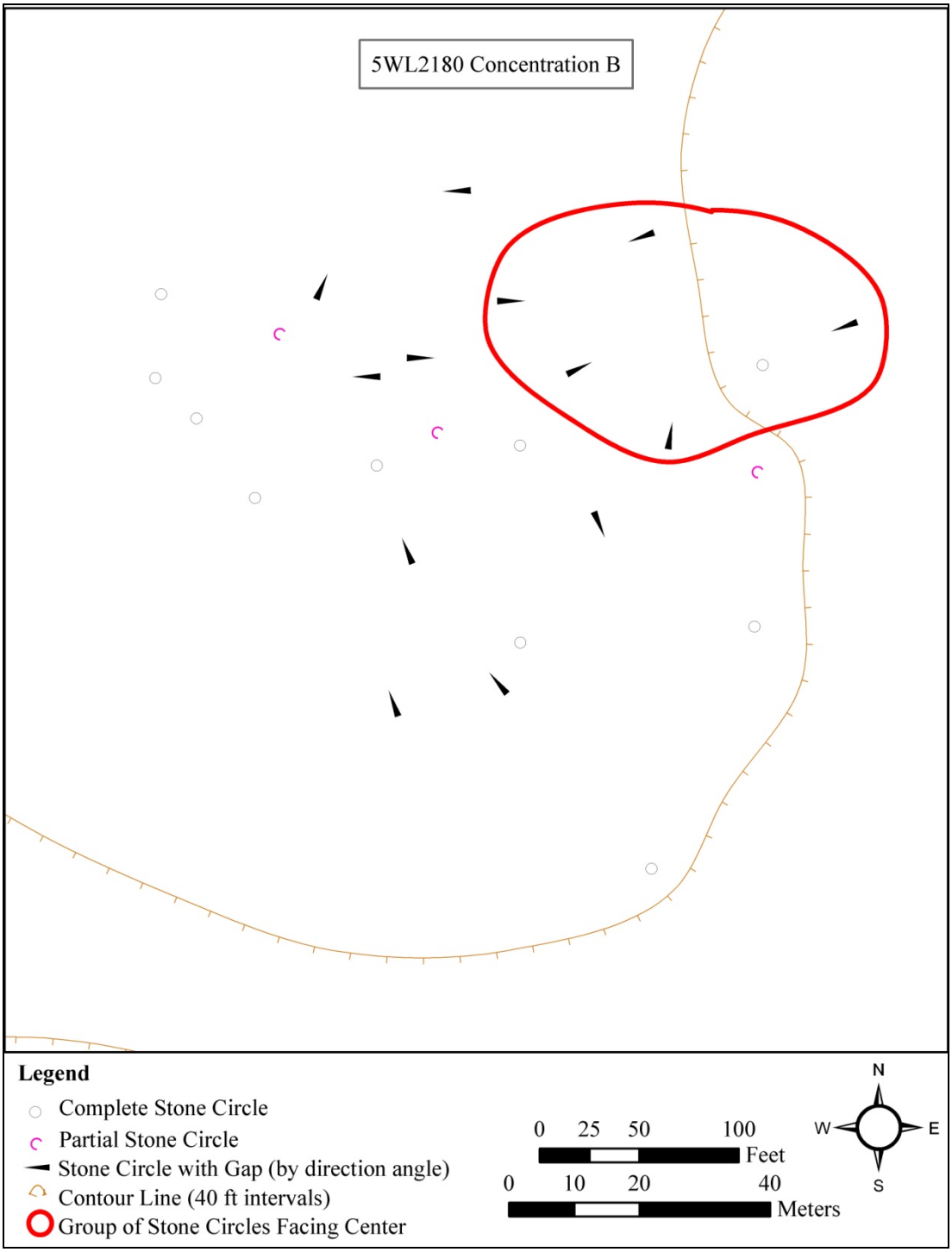

Figure 29 Site 5WL2180, Concentration B possible group of stone circles facing a social center.

cultural ideals or social factors. Because it was so random, more data are needed to make more conclusive interpretations about the significance of gap direction and seasonality and multiple occupations of the sites. Excavations of multiple stone circles would provide valuable information about possible doorway locations for the complete circles. Also, gap directions may slightly change when the stone circles are excavated since buried stones might be revealed where a gap appears on the surface. Radiocarbon dates would allow for a better understanding of the use and reuse of these sites over time.

The cluster analysis has proven useful in depicting some clusters at site 5WL2180 Concentration B, but it did not notice the possible small clusters of stone circles by gap direction at sites 5WL2413 and 5WL2180 Concentration A. As depicted in Figures 30 and 31, small clusters of two stone circles each are likely significant to understanding the overall site structure, even though these clusters may not be statistically significant. From this result, it appears it is necessary to visually interpret the site along with the cluster analysis for a better understanding of site structure.

Some data, in the form of radiocarbon dates, have been collected previously by Brunswig (1995; 1996) for the West Stoneham Archaeological District. According to Brunswig (1996:373), the area had been reused for approximately 2,500 years from the Late Archaic to the Middle Ceramic periods. Additional data have shown the District being occupied through prehistoric and historic times (Brunswig 1996:332). In his dissertation, Brunswig (1996:286) reported that site 5WL2180, Concentration A was likely dated to the Late Archaic based on two diagnostic biface tools, although the exact location of these tools is presently unknown, and no additional details about these two tools was provided.

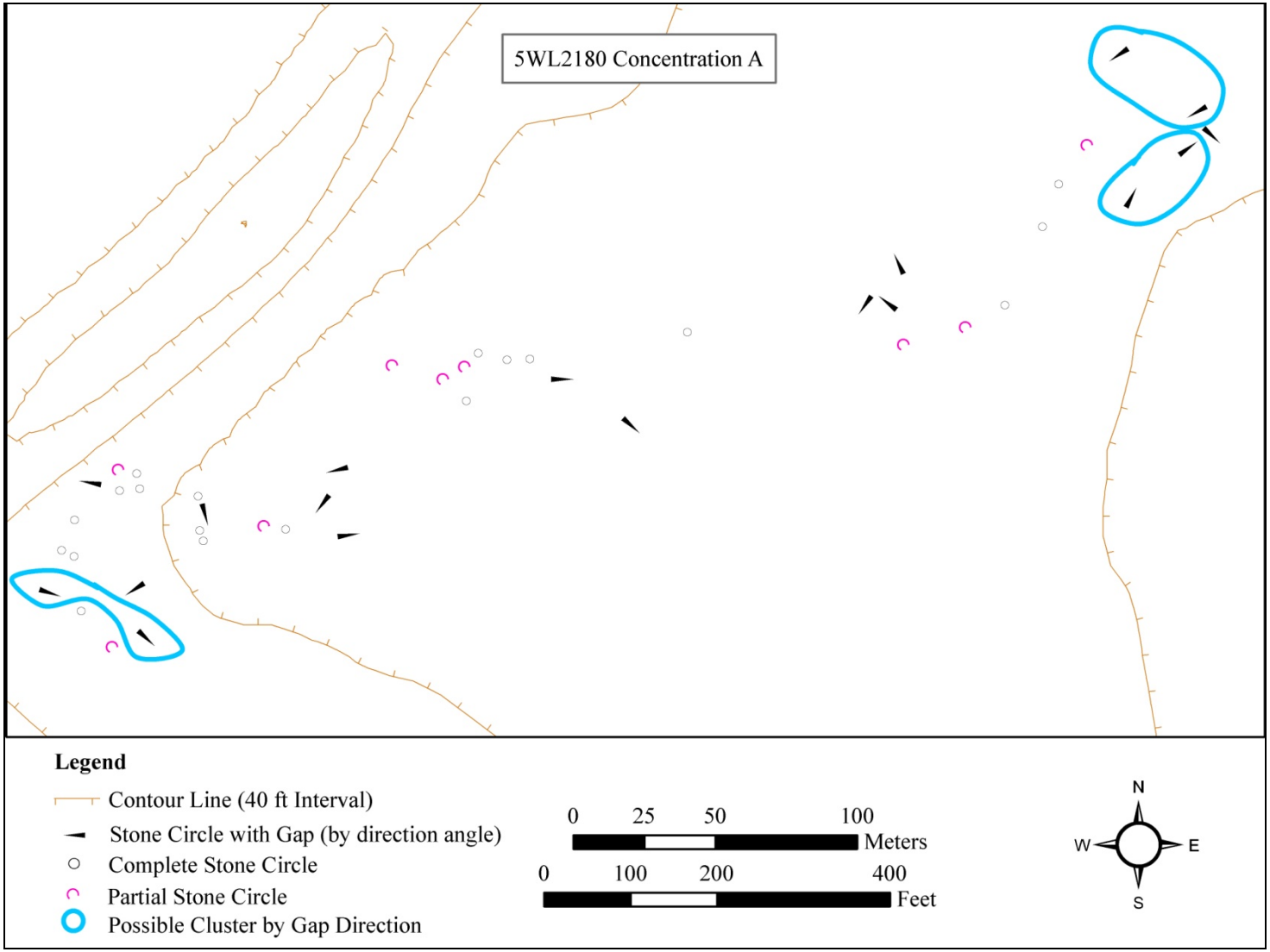

Figure 30 Possible clusters at site 5WL2180 Concentration A.

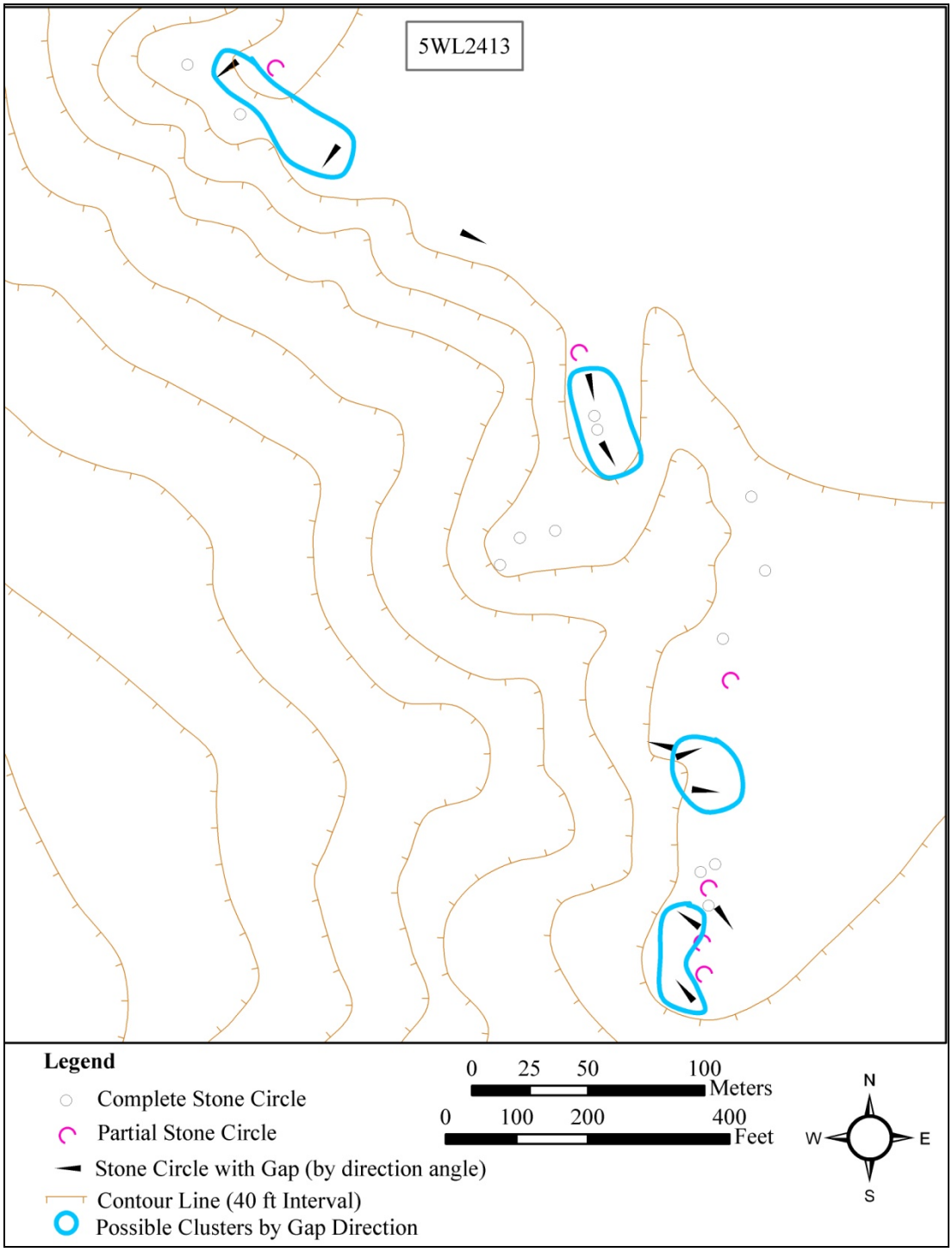

Figure 31 Possible clusters at site 5WL2413.

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No radiocarbon dates, however, were obtained for this concentration. Site 5WL2180, Concentration B, was radiocarbon dated to the mid-1800s based on one carbon sample from the largest stone circle at the site (Brunswig 1995:8). These data are a good starting point, but more are needed.

Additional dates, however, would provide a clearer picture of what was truly occurring at these sites. Even though a more in-depth level of analysis is not possible at this time, the cluster analysis proves useful for making some interpretations about site structure as it relates to a specific attribute. The cluster analysis, however, is not perfect. Given that there appear to be multiple small clusters of stone circles with the same gap direction at sites 5WL2413 and 5WL2180 Concentration A that cluster analysis did not observe, indicates the necessity for a more visual analysis of the sites in addition to cluster analysis. Both of these methods together provide a better understanding of overall site structure.

CHAPTER 5 – WIND DIRECTION AND FEATURE STRUCTURE

The purpose of this chapter is to examine the possible impact wind directions had on stone circle structures in relation to stone counts and gap directions. It has been asserted that more stones were placed on the prevailing wind side of the stone circles to secure the structure (L. Davis 1983:264-5; W. Davis 1983:73; Quigg 1979:263). Day and Eighmy (1998:14) observed that the structure of the stone circles exhibited more stones in the portion of the ring facing the prevailing winds at the Biscuit Hill site in Weld County, Colorado. Flayharty and Morris (1974:163) also observed greater numbers of stones on the prevailing wind sides of the stone circles at the T-W Diamond site in Larimer County, Colorado.

Stone count was not the only consideration when it came to wind direction. Finnigan (1982:43) created an equation to determine how much weight was needed in rocks to hold down the structure's cover, in various wind velocities. Finnigan (1982:43) observed that there needed to be an increase in weight on the windward side of the stone circle. The number of stones in the ring was not the only variable. The size of the stones and the amount of stones available were also important (Finnigan 1982:45). This analysis will compare rose diagrams of stone counts by octants of the stone circles, to rose diagrams of wind directions, by month for the region, with current wind data from Fort Collins, Colorado. The patterns observed will then be compared to observations made in the previous literature.

Methods

Field – Data Collection

For this analysis, the stone counts per octant of each stone circle were recorded for sites 5WL2413, located on a ridge top, and 5WL2180, Concentration A, located in a basin. These sites were chosen for this analysis based on their different landforms. As noted in Chapter 2, the stone counts were obtained by creating eight wedges with strings following cardinal directions, based on the center point of each circle (Figure 32).

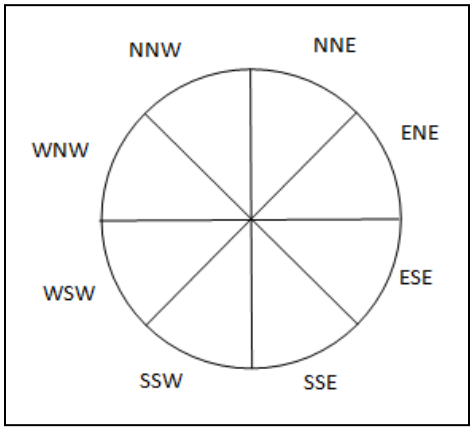

Figure 32 Example of octants used for stone counts.

The analysis of the stone counts ultimately pertained to site 5WL2413 since the stone counts at 5WL2180, Concentration A were too small to depict any patterns. This issue will be discussed in detail below. In addition to the stone counts, if a gap was noted for the stone circles, the direction of the gap was included to the analysis of the wind direction and feature arrangement.

Lab – Data Analysis

Rose diagrams were created using Microsoft Excel for each of the complete stone circles at site 5WL2413 (See Appendix III). The wind direction data was obtained from

Colorado State University's Colorado Climate Center (McNoldy 2010). The wind direction data is the average percentage of wind directions from 2005 through 2009, and was also put into rose diagrams using Excel. It is understood that these data are of the current wind patterns in northeastern Colorado, and do not exactly portray the wind patterns of the past. These data are strictly for general comparison purposes to obtain an idea of what prevailing wind patterns of the past may have resembled. It is also understood that the wind patterns of Fort Collins, Colorado are not identical to those at site 5WL2413, which is located north of Ault, Colorado. However, it is the overall pattern of the region that is being analyzed and, therefore, likely not extremely different from wind patterns on the PNG, to make generalized comparisons.

Previous Research

Many archaeologists have observed more stones located on the prevailing wind side of the stone circle. Quigg (1979:262) excavated 41 stone circles out of 323, spread out between 18 sites in Alberta. Of these excavated stone circles, four had more stones on the prevailing wind side. For the sample of stone circles excavated this only represented 10% of the stone circles exhibiting this feature structure. It was noted at the T-W Diamond site in Colorado that there were more stones in the northwest portion of the stone circles (Flayharty and Morris 1974:163; Morris 1983:49). The northwestern side was interpreted as the windward side for that site. An exact number of circles with this attribute were not noted, only that many of the stone circles exhibited this structure (Morris 1979:163). The size of stones was noted as ranging from "fist size" to small boulders of 20 to 30 pounds (Flayharty and Morris 1974:163; Morris 1979:163).

W. Davis (1983:73) asserted that more stones would be needed during the winter months and times of stronger winds, in order to anchor the outer cover or inner linings of the tipi. According to W. Davis (1983:73), ridge top sites would require more stones to protect against the prevailing winds than sites that were sheltered in the lowlands would need. Day and Eighmy (1998:14) recorded stone counts per octant for the stone circles at the Biscuit Hill site in Weld County, Colorado. It was asserted that the prevailing wind in the winter was from the northwest and there were slightly more stones within the northern octant, than any of the other octants (Day and Eighmy 1998:14). Even though the site is located in a broad, flat basin, some variability in stone counts was observed (Day and Eighmy 1998:1).

Brumley (1983:177) observed 88 stone circles in southeastern Alberta also noting the increase of stone counts in the direction of prevailing winds. The interpretation for this practice was not limited to the directional winds. Brumley (1983:177) noted that other factors influenced stone placement including using fewer stones on the portion of the cover that was raised up during warmer weather to allow for better ventilation. The lower stone counts in the southwest and west portions of the circle were seen as places where the cover was lifted in the direction of the prevailing winds for ventilation while the lower stone counts in the southeast were interpreted as the location of the doorway (Brumley 1983:177).

At the Pilgrim site in Montana, Aaberg (1983:299) set up a wind-monitoring station and recorded wind direction and frequency data for a year. Rose diagrams were created for the wind directions and for the distribution of stone weights by direction for each of the excavated stone circles (Aaberg 1983:299). The results of this analysis were

that the prevailing winds for the site came from the southwest and the most stone weights also tended to occur in the southwest quadrant. An observation was made for the autumn wind directions which came from the east and northwest, but the stone weights did not reflect that pattern (Aaberg 1983:299). The same observation was made for the winter wind directions not showing a correlation with the stone weights (Aaberg 1983:299). Due to these observations, a spring occupation was suggested (Aaberg 1983:301). The spring interpretation for site use was further discussed by the bones of a grouse associated with the site. The grouse was determined to have been killed in the spring months of May or June (Aaberg 1983:301).

Also from the Pilgrim site in Montana, L. Davis (1983:264) noted the largest number of stones, as well as the heaviest weights of stones were used within the south, southwest, west, and northwest portions of the stone circles. This was interpreted as depicting the wind directions of the past. Finnigan (1982 and 1985) considered stone weight as well as stone count when analyzing feature and site structure. At site Dg-Ok-1, three features were observed (Finnigan 1985:5). To analyze these features, wind direction data for the area were compared with the stone counts for the features (Finnigan 1985:10). According to Finnigan (1985:10), the feature 1 stone counts did not coincide with the wind directions for the area. Feature 2, however, had the most stones in the west and northwest portions of the circle, which was similar to the wind directions for July and interpreted as being a possible summer occupation (Finnigan 1985:10). Even though that interpretation was suggested, Finnigan (1985:10) did not feel that stone counts were a useful interpretation tool for determining seasonality of a site.

At site EdOp-1 in Alberta, Finnigan (1982) analyzed wind velocity versus the weight of the stones within each feature. According to Finnigan (1982:60), the amount of weight required to hold down the tipi cover was dependent on the inside diameter of the stone circle and the maximum wind speed. At the site, five of the stone circles were anchored against approximately the same wind speed (Finnigan 1982:100). Although Finnigan (1982:145) did not attribute this similarity to seasonality, he did assert the possibility of these five stone circles being of a summer occupation.

Many observations have been made about stone counts and stone circle structure. It is still undecided whether or not these data can provide evidence for seasonality, or wind direction, or both, of stone circle sites. The data, however, have been used for gaining a better understanding of stone circle site structure. The previous research described above is summarized in Table 5.

Table 5 Summary of prevailing wind directions and stone counts previous research.

Author(s)	Date	Area/Site	Summary
Aaberg	1983	Pilgrim Site, Montana	Used rose diagrams to compare wind directions and stone weight. Observed a correlation between prevailing wind direction and the most stone weight distribution.
Brumley	1983	Alberta	Observed 88 stone circles, noted an increase in stones in the direction of the prevailing winds. Lower stone counts may have been where cover was raised for ventilation.
L. Davis	1983	Pilgrim Site, Montana	Heaviest weights of stone in the south, southwest, west, and northwest, which were the seasonal prevailing wind directions.
W. Davis	1983	Shoshoni, Wyoming	More stones needed during the winter months. Uplands require more stones than lowlands, to protect against the wind

Author(s)	Date	Area/Site	Summary
Day and Eighmy	1998	Biscuit Hill Site, Colorado	Most stones in the northern portion of the stone circles, which is the direction of the prevailing winds.
Finnigan	1982	Ed-Op-1, Alberta	Observed wind velocity and stone weight of stones. Weight of stones needed dependent of diameter of stone circle and wind speed. Five stone circles were anchored against approximately the same wind speed.
Finnigan	1985	Dg-Ok-1, Saskatchewan	Compared wind direction data to stone counts. One stone circle had a correlation to prevailing wind direction and the most stone counts.
Morris	1979 & 1983	T-W Diamond Site, Colorado	The prevailing wind side, the northwest portion of the stone circles, had more stones
Quigg	1979	Alberta	Excavated 41 stone circles, 4 had more stones on the prevailing wind side of the stone circle

Results

The current average wind patterns in Fort Collins, Colorado, from 2005-2009, indicate that the prevailing winds are mostly from the north-northwest late October to early May and from the south-southeast from late May to early October (See Appendix III for all rose diagrams). The months of May and October appear to be transitional months, where the winds begin to change directions. From these data, it appears that the prevailing winds are only coming from the southeast for a short period of time, mainly the summer months. These data are strictly averages to be generalized across a region and not intended to show exact wind directions per month.

Site 5WL2413

Site 5WL2413 consisted of 11 complete stone circles with gaps, 13 complete stone circles without gaps, and 6 partial stone circles. As depicted in Figure 33, the 24 complete stone circles had the most stones observed for each octant with 25% (n=6) in both the north-northeast and south-southwest, 17% (n=4) in the west-northwest, 12.5% (n=3) in both the west-southwest and south-southeast, 8% (n=2) in the east-southeast, and neither the east-northeast nor the north-northwest had the most stones in any of the stone circles.

Spatial autocorrelation analysis yielded a result of a random pattern for the directions of the highest stone counts for each feature. Looking at the map (Figure 33), however, there appears to be five small clusters of two features each that have the highest stone counts in the same direction. This will be discussed in further below.

The stone circles with gaps do not necessarily have the most stones in the octant opposite of the gap direction. The most stones were observed in the south-southwest and west-northwest with 30% (n=3) each. The north-northeast had 20% (n=2), the east-southeast had 10% (n=1), and 10% (n=1) had an even distribution of stones. The remaining octants did not have the majority of stones for any of the stone circles with gaps (Figure 34).

The gap directions were observed with 40% (n=4) in the southeast, 30% (n=3) in the northwest, 20% (n=2) in the southwest, and 10% (n=1) in the northeast. Features with the most stones located within 90 degrees or less from the gap included features 1, 9, 22, and 30. Features with the most stones within 90 degrees and 135 degrees from the gap were features 4, 10, 25, and 32.

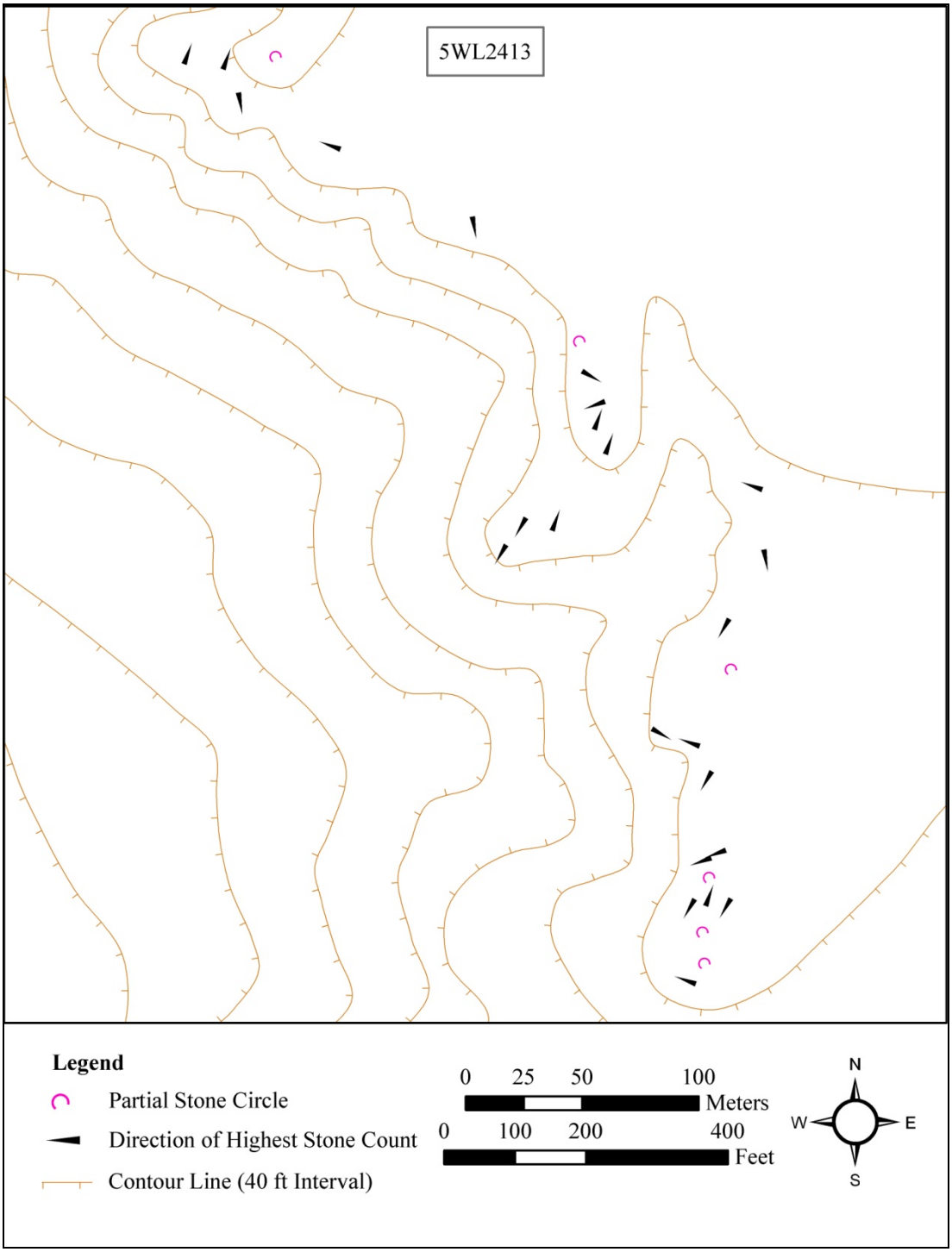

Figure 33 Map of the direction of the highest stone counts at 5WL2413.

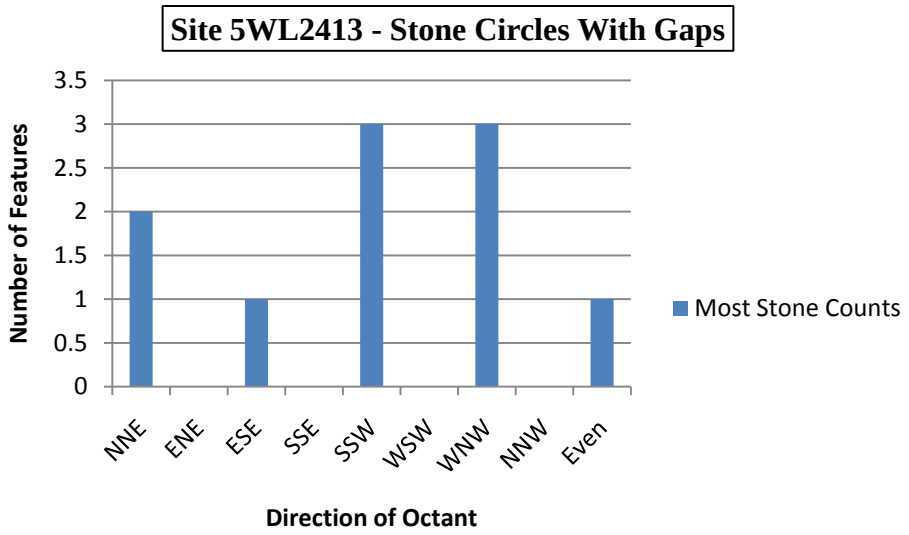

Figure 34 Chart of the most stone counts per octant for stone circles with a gap at site 5WL2413.

Feature 11 was the only one with the most stones 180 degrees from the gap which is facing west-northwest. Feature 19 is more difficult to classify since four of the octants have nearly the same number of stones. The gap is facing south-southeast and the most stones are located directly next to the gap in the east-southeast and south-southwest, and also opposite the gap in the north-northwest and north-northeast.

The complete stone circles, without a gap, observed the most stones in the north-northeast in 31% (n=4) of the stone circles, 23% (n=3) in the south-southwest and west-southwest, 15% (n=2) in the south-southeast, and 8% (n=1) west-northwest.

Features 7, 14, and 33 have interesting rose diagrams indicating that gaps may be present, though not recorded. This may be the case for feature 7 where only two stones were recorded in the north-northwest. The rest of the feature was noted as having a moderate definition with the majority of stones located in the southern portion of the circle. This may be due to the need to redefine what a gap is in order to allow for occasions where a couple stones are located within the gap opening.

There is a different story for features 14 and 33. Each of these features has a poor definition exhibiting many small gaps throughout the circles. Feature 14 has a total of 69 stones, mostly in the western portions of the circle, and feature 33 has 57 stones evenly distributed. The average stone count for the site is 98.6 with a maximum count of 166 stones. Even though 57 and 69 stones seem like a large amount, they are relatively low for this site, which gives these stone circles their poor definition. The stones located at site 5WL2413 are small, averaging in size around 10 cm. Because of this, more stones are necessary in order to achieve the needed weight to anchor the structure's cover.

Discussion

Originally site 5WL2180, Concentration A was going to be included in this analysis. Once the rose diagrams were made, it became apparent that the small amount of stones per stone circle was not enough to exhibit patterns in the arrangement of each feature. There simply was not enough variability between the octants. The average total stone count for stone circles at Concentration A was 35 stones with an average stone size of 20 cm. Given the large stone size, fewer stones were needed to anchor the structure. Also considering the location of Concentration A within the basin, fewer stones were needed since the rock outcroppings provided a natural windbreak, as noted by W. Davis (1983). Site 5WL2180 has much larger stones available than 5WL2413, therefore, less stones were needed for each stone circle. This is good evidence for the weight of the stones playing a large part in stone circle structure since larger stones will provide more weight, and need fewer stones to make the circle anchoring the cover. The location within the basin also requires less stones and weight since the rock outcroppings protect

the structures from prevailing winds naturally. The structures on the ridge top at 5WL2413 were not afforded protection from the wind, and had smaller stones to work with. The features were much more different on the ridge top than in the basin, with more stones needed to achieve the weight needed to anchor the tipi.

It was noted during recording of the features at site 5WL2180 that some of the larger stones were placed in specific portions of the stone circles as possible protection from the prevailing winds. This is inconclusive since the stones were mostly buried in the ground, and since this was strictly a surface recording, it is not possible at this time to know the exact size and weight of the stones used, and their placement within the circle. It would be useful to determine if at 5WL2180 larger stones were being used in the prevailing wind direction, in lieu of more stones to anchor the cover, as was observed by L. Davis (1983) and Aaberg (1983) at the Pilgrim Site in Montana.

Site 5WL2413 revealed more stones in certain portions of the stone circles, as noted by archaeologists from previous research (Day and Eighmy 1989; Flayharty and Morris 1974; Morris 1983; Quigg 1979), but not necessarily in the prevailing wind direction. The south-southwest octant had the most stones, at the most stone circles (n=6). The north-northeast and west-northwest had the most stones at five stone circles each. The current prevailing wind directions for the region are from the north-northwest in the colder weather months and from the south-southeast in the warmer weather months. Since these are general wind directions for the region, and are from current wind data, they may not match up exactly to the wind patterns for site 5WL2413 from the past. Assuming that the wind would still be roughly from the north or northwest in the winter and from the south or southeast in the summer, then the stone circles with the most stones

in the south-southwest may have been summer occupations and the stone circles with the most stones in the north-northeast and west-northwest may have been of winter occupations, using more stones against the prevailing winds. As noted by Finnigan (1982), this is not necessarily the best indicator for seasonality of a site, but it is a possible explanation for why there would be more stones in one portion of the stone circle than others. More data are needed to make a more conclusive interpretation.

Something that was not observed in the previous research was the stone counts in relation to the gap direction. What was found at 5WL2413 was that more stones tended to be located near the gap, sometimes on either side of the gap, or within a more or less right angle of the gap. There was only one stone circle that had the most stones 180 degrees from the gap direction. This may have something to do with the structure of a tipi that has the doorway opening extending all the way to the ground. More stones may be necessary near the gap to secure the structure since the cover does not make a complete circle around the ground, and instead has a wedge of material missing for the doorway opening. This missing wedge would, therefore, make the structure weaker at this point. Anchoring the structure more securely near the gap may have been more important than anchoring against the prevailing wind. This is most apparent with the majority of gap directions facing the southeast, and the most stones counted in the south-southwest. This observation may explain the octants that have the most stones that are not facing the prevailing wind directions. These octants may have more to do with the proximity to the gap direction. This is merely a hypothesis of what may be occurring here. Since this is a sample of one site, it would be useful to compare the same analysis at additional sites to determine if this is a common occurrence or exclusive to 5WL2413.

The cluster analysis determined that the site is of a random pattern when looking at the direction of the highest stone counts. It appears, however, that there may be small clusters not detected by the analysis, as seen before with the gap direction cluster analysis results. When comparing the highest stone count possible clusters with the gap direction possible clusters, there does not appear to be any similarities (Figure 35). There is some overlap between the clusters, but none of the clusters between the two separate analyses are the same.

Since this is the second time the cluster analysis did not pick up on these possible small clusters, it appears this method of detecting site structure is not perfect, and it is important to use our ability to visualize patterns manually. By doing this, the maps and cluster analysis become good tools for the interpretation instead of the ultimate result of the interpretation.

The overall trend for stone counts at site 5WL2413 is to be located near the prevailing wind direction of the stone circle, which was to be expected. What was not expected was the stone circles with a gap showing more stones either next to the gap or within a roughly 90 degree angle from the gap. The expectation was for the most stones in the circle to be located in the opposite direction, roughly 180 degrees, from the gap with the assumption that the doorway would be set up opposite the prevailing winds. With only one of the stone circles with a gap to have the most stones opposite the gap direction, this obviously was not the case. It is still likely that the gap was set up opposite the prevailing winds with 40% of the gaps facing southeast and 30% facing northwest. The majority of stones being located near these gaps change the interpretation for the structure. It appears the direction the wind was blowing for the structures with a gap is

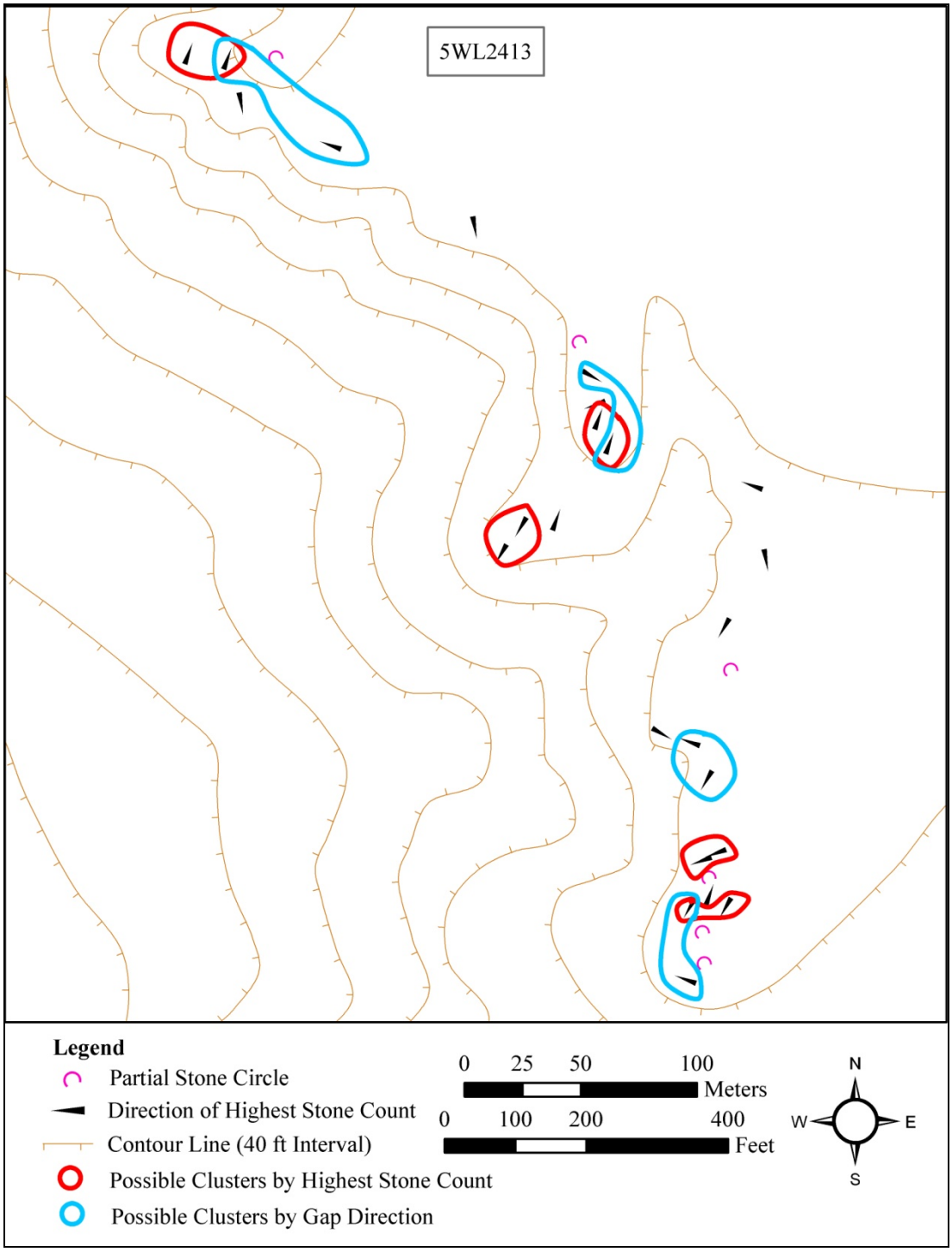

Figure 35 Possible clusters by highest stone counts and gap directions at 5WL2413.

more likely to be opposite from the gap then it is to be opposite from the most stones. The stone circles without a gap may have a completely different interpretation, but more data are needed to conclude on feature arrangement. Due to these results, it does not appear seasonality can be determined from stone circle arrangement as far as stone counts are concerned.

CHAPTER 6 – CONCLUSION

This chapter will summarize all of the results and discussions discussed above starting with the research questions and how effective cluster analysis is in determining site structure, followed by a summary of the different landform types and the site structures associated with them. Finally, some suggestions for future research are discussed with the hopes that stone circles research will continue in Colorado.

Research Questions Revisited

One purpose of this research was to analyze stone circle site structure on the PNG using cluster analysis. Some conclusions on the effectiveness of cluster analysis along with the results of the three research questions are discussed below.

The results for each of the three research questions are as follows:

1. Does the spatial arrangement of features vary according to the type of landform?
    - Hypothesis: The stone circles located on highlands will be clustered while those located in midlands and lowlands will be dispersed or random. The sites on the highlands have less space to spread out down the edge and, therefore, will exhibit more clustering (Reher 1983). The sites in the midlands and lowlands will have more options for use of space and, therefore, will be more dispersed in site structure.
    - Results: The results were as expected with the highland sites clustered, the midland sites were dispersed, and the lowland sites were random. The

highland sites did have less space with Rehers's (1983) concept of edge compression limiting the space available to camp.

2. Does the gap direction of stone circles vary by the spatial arrangement?
    - Hypothesis: If the gap directions are based on wind direction, then they will likely vary within clustered and dispersed sites. With the wind coming from different directions during different seasons, variability would happen in areas that were used over multiple occupations. Both clustered and dispersed areas could have been used multiple times.
    - Results: The gaps exhibit a random spatial pattern at the clustered and random patterned sites. The gaps were clustered at the dispersed site, but the three clusters each faced a different direction. It is likely that wind is a factor in deciding which direction to face the gap of a stone circle.
    - Hypothesis: If the gap directions are based on social influences, then they will likely face a central location. As noted by previous research (Day and Eighmy 1998; Oetelaar 2000), some sites may have had central social locations and the gaps tended to face that specific area for better interaction.
    - Results: None of the gaps faced a central location of any of the sites analyzed. It is not likely that social factors influenced the direction of the gaps in the stone circles.
    - Hypothesis: If the gap directions are based on cultural ideals, then they will likely face the east, or rising sun. Previous research has observed (Banks and Snortland 1995; Hassrick 1964; Moore 1996; Oetelaar 2000),

gaps facing all one direction, usually to the east. If this is the reason for doorway placement, then the cluster analysis will show a dispersed or clustered arrangement with the gaps.

- Results: A few of the gaps did face east, but the majority did not. Given the random pattern of the gaps and the observation of gaps facing toward all four quadrants of the circle, it is not likely that the gaps were arranged to meet a cultural ideal such as facing the rising sun.

3. Is there a correlation between prevailing wind direction and the direction with the highest stone count within a stone circle?
    - Hypothesis: The direction with the highest number of stones will also be the direction of the prevailing winds for each season. Also observed in previous research (L. Davis 1983; W. Davis 1983; Quigg 1979), stone counts tend to be correlated with prevailing wind direction and should be observed in this research.
    - Results: To a degree, the highest stone counts did correlate with the direction of the prevailing winds. There were portions of the stone circles that had the highest stone counts but did not face the prevailing winds. It is likely that the highest stone counts were used to brace against the prevailing winds. It was also observed that the highest stone counts helped to strengthen the structure at the gap, which was likely the weakest point of the circle. This was an unexpected result.

Cluster analysis proved useful in understanding site structure as it relates to the type of landform on which the sites reside. Cluster analysis was able to produce patterns

for analysis, and assisted in better understanding stone circle site structure. Secondly, cluster analysis was useful, for the most part, in determining site structure as it related to gap directions. The use came more in the form of what it did not find. The random patterns for gap direction assigned to 5WL2413 and 5WL2180, Concentration A, showed that the gap directions were quite variable at both sites, disproving the ideas that gaps will always face the rising sun or a social center. Even with the random patterns, the gaps were not facing a central location of the sites. The clustered gap directions at Concentration B likely depict multiple occupations of small groups. Without the cluster analysis, these patterns would have been less explicit.

Where the cluster analysis fell short was for the gap direction analysis at sites 5WL2180 Concentration A and 5WL2413, both of which had multiple, possible small clusters of two stone circles each. Though these clusters are not statistically significant according to cluster analysis, they are quite useful in interpreting overall site structure.

The final conclusion on whether or not cluster analysis can determine site structure is both yes and no. It was able to determine overall site structure based on the geographic position of each feature, and it was able to determine site structure based on an attribute, but to a limited extent. Visual analysis of the sites is still an important part of analyzing site structure. Both of these methods together provide a clearer picture of how people of the past were living.

Site Structure

This research was able to provide a better understanding of stone circle site structure on the PNG. There were specific characteristics pertaining to each of the

landform types, lowlands, midlands, and highlands. The environment seems to play a large role in site structure from the type of landform on which the sites reside to the prevailing winds. A summary of the site structure interpretation is as follows.

Lowlands

The lowland sites had a random pattern which may be indicative of this landform type. With the lower landforms there was more protection from environmental factors, such as the wind, and often more options of where to set up camp. Since these sites were not restricted to environmental factors as much as the other types, more variability in site structure was to be expected. The linear distribution of the stone circles within the basin at 5WL2180 seemed to be influenced by the landform, however, as the line followed the contour of the basin, and the direction of the slope off the rock outcropping. The feature structure for the lowlands also tended to use less stones to make the circles. At 5WL2180, Concentration A, fewer stones were used, likely due to the natural protection from the prevailing winds afforded by the rock outcroppings. Another factor in the lower stone counts was the larger stones available within the basin. More weight provided by the stones meant needing to use less of them.

The direction the gaps were facing within the lowlands was also considered random. Again, the protection from the prevailing winds allowed for more variability of gap direction since the wind was less of a concern. Even though the wind was not much of a concern, there still was no evidence of more social or cultural factors influencing gap directions. None of the gaps were facing a social center of the site and given the random pattern, the gaps were not all facing east, or the rising sun.

The lowlands also had the three sites that had three or less stone circles. With small groups, protection from wind may have been just as important as protection from other people. Being in the lowlands may have provided a good hiding place as well as being removed from environmental factors.

Midlands

The midland sites, both located near rock outcroppings, had the dispersed site structures. Since the midland areas had less space to choose from in order to still have the protection needed from the rock outcrops, the site structure became more evenly spaced than the lowland sites which had more options. Even if the sites had multiple occupations, there was still only so much space to choose from, and if it was not desirable to use an older stone circle, than moving to the next available space would create a dispersed site structure. The midlands, however, had the only clustered pattern for gap direction, at least according to cluster analysis. This was likely evidence for multiple occupations of three small groups. The gaps in each cluster were facing different directions possibly depicting the different seasons each cluster was being used. The stone counts were not analyzed for either of the midland sites, but it was noted that the stones for each site were larger, and fewer were used to make the individual stone circles. This similarity with the lowland sites may have the same explanation. With some protection from the rock outcroppings from the wind would require less stones and the larger stones mean more weight and, therefore, less stones needed to hold down the cover. The midlands share some similarities with the lowlands in the aspect of natural protection

from environmental factors, but the midlands had less space to use, changing the structure of these sites.

Highlands

The highlands had two clustered and one random site. The clustered pattern may be attributed to the concept of edge compression asserted by Reher (1983). The desire to stay along the edge of the ridge greatly reduced the amount of space to choose from to set up camp. The use of the finger ridges along the edge may have contributed to the clustered pattern since the natural spacing of these extensions to the landform would automatically group the stone circles. The linear distribution of stone circles at 5WL2413 exhibits this idea of edge compression, depicting how the features followed the linear angle of the edge, instead of straying off onto the broad, open space of the rest of the ridge top.

The gap directions for 5WL2413 were random, according to cluster analysis, possibly signifying that the clusters at the site were not an indication of single occupations. It would be expected that stone circles of an occupation would have similar individual structures. Since that is not the case, there were likely multiple occupations, during different seasons, at the site that spread out along the ridgeline, utilizing as much of the edge as possible. Having said that, there do appear to be small clusters by gap direction and by stone count direction that cluster analysis did not observe. These possible clusters may be additional proof of multiple occupations with small groups of people.

The stone counts on the ridge top were quite different from the other landform types. The stones were smaller than the other sites which meant more stones were needed to achieve the necessary weight to effectively hold down the cover of the structure. Coupling that with the lack of protection from the prevailing winds, and the stone counts for the features at the site were high. It was expected that more stones would be observed in the portions of the circle that faced the prevailing wind directions. This was seen for the most part with 33% of the most stones facing south and 21% facing north-northeast. Since the prevailing winds came from the north and south in the winter and summer respectively, this pattern was expected. The observation of the most stones being in the other octants may have to do with different wind patterns during the past than what is seen today. The most surprising result was that most of the stones in a feature with a gap were located near the gap, instead of opposite the gap. This structural aspect may have to do with the gap for the doorway creating a weakness in the structure, and the stones were used to make it stronger. As a result, strengthening the structure became more important than bracing against the prevailing winds.

The observations about site structure are intriguing but inconclusive. More data are needed in order to gain a true understanding of site structure for stone circles sites on the PNG. The sample size of nine sites is too small to make any sort of statement about site structure and past behavior. This is a good start, but much more could still be done.

Future Directions

One purpose of this research was to examine site structure of stone circle sites to gain a better understanding of how the peoples of the past utilized the PNG and in the

Great Plains region as a whole. Much more work could be done to get more information, and in turn, enhance interpretations of past behavior. To start with, this research was limited to recording the surface expression of the sites. In a perfect world, excavations of every stone circle would provide a plethora of data that would greatly enhance our knowledge of the past. Through excavations, the true arrangement of each feature would be revealed, and the exact location of gaps would be known. The weights and measurements of each stone could then be taken, and a total count of stones within the circles could be recorded. With these data, a comparison could be made between sites such as 5WL2413, on the ridge top with smaller stones, and site 5WL2180, the West Stoneham Archaeological District located in the basin with larger stones. Looking at the different site structures when it comes to stone size and weight would provide a better understanding the role of feature arrangement has when analyzing overall site structure. The current research was limited since many of the stones were buried, and measurements of the rocks would be of what was visible. An analysis of how the landform type influences feature arrangement on the PNG could be performed with the exact size and weight of the stones present, if excavations were conducted.

Excavations would also provide additional information about artifacts and other features associated with the stone circles. These data would be especially useful for understanding the direction of the doorway. Similar to L. Davis (1983) at the Pilgrim site in Montana, artifact distribution within the stone circles and outside them would depict where activities were taking place. Determining the location of activity areas depicts site structure, and comparing those data to the individual stone circle structures would provide a broader picture of past human behavior. It would be interesting to compare

artifact distributions to clusters of stone circles versus more dispersed stone circles. This would provide evidence needed to understand multiple occupations of a site.

Other data that would be useful to collect would be the exact wind directions for each site being analyzed. Comparable to research by Aaberg (1983), if wind directions could be recorded at each site, a more accurate analysis could be performed for understanding gap direction, and the portion of the circle with the most stone counts and/or weight. These data would not be perfect since they are still recording current wind directions, but at least the data would be from the exact location the stone circles being observed.

The stone weights and exact numbers would make for an interesting comparison between landform types. It was already noted by W. Davis (1983) that stone count would vary based on landform type. Taking this further and comparing the stone size and weight and landform type would provide a better understanding of how the different types of landforms were being utilized and how the landforms influenced site structure and feature structure.

The type of landform associated with the stone circle sites could also be analyzed in the terms of distance to water, as observed by Malouf (1961), where some sites were deliberately set up away from water so to not scare away the game. A comparison of landform type and distance to water would provide a better understanding of the overall use of the area. Finally, obtaining absolute dates for the stone circles would provide strong evidence for multiple occupations of sites and whether site structure and feature structure varied throughout time. It is rather difficult to get radiocarbon dates for each stone circle since most do not have an associated hearth feature or other feature that

would yield carbon for dating. Other techniques such as thermoluminescence dating (Oetelaar 2004:137) and optically stimulated luminescence dating can provide absolute dates for stone circles without the need for charcoal samples.

With additional stone circle research in the plains of Colorado, a better understanding of site structure and land use can be developed. This will be beneficial to interpreting archaeology within this area and throughout the Great Plains region. With enumerable previous research on stone circles in the northern plains, comparisons were possible with the stone circles observed in Colorado. These comparisons allowed for a better understanding of the similarities and differences for these various areas. Continuing this research in the underexplored areas of Colorado will allow for comparisons within Colorado, improving the analyses and interpretations that have already been made.

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APPENDIX I

SITE MAPS

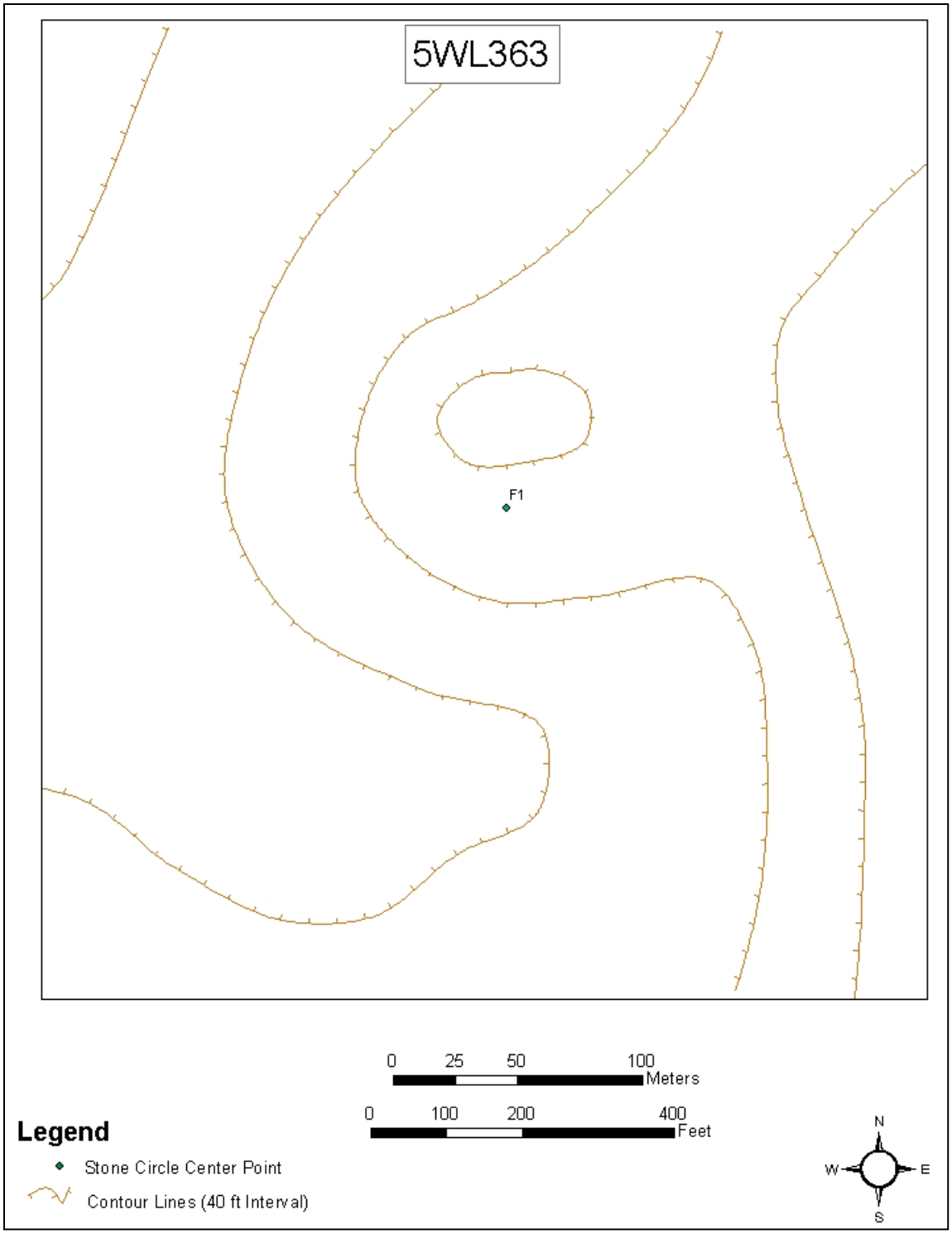

Figure 36 Site 5WL363 map of stone circle center points.

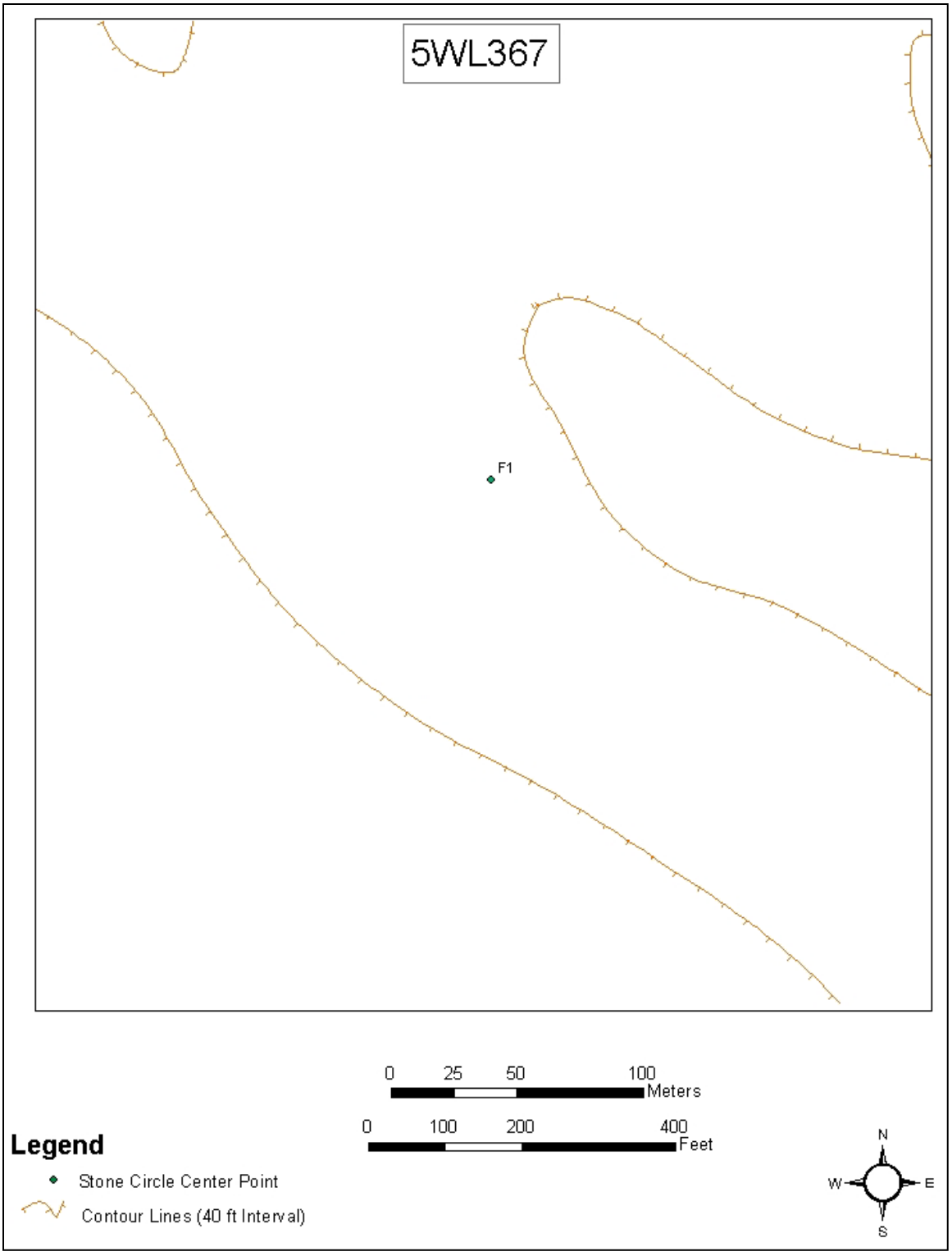

Figure 37 Site 5WL367 map of stone circle center points.

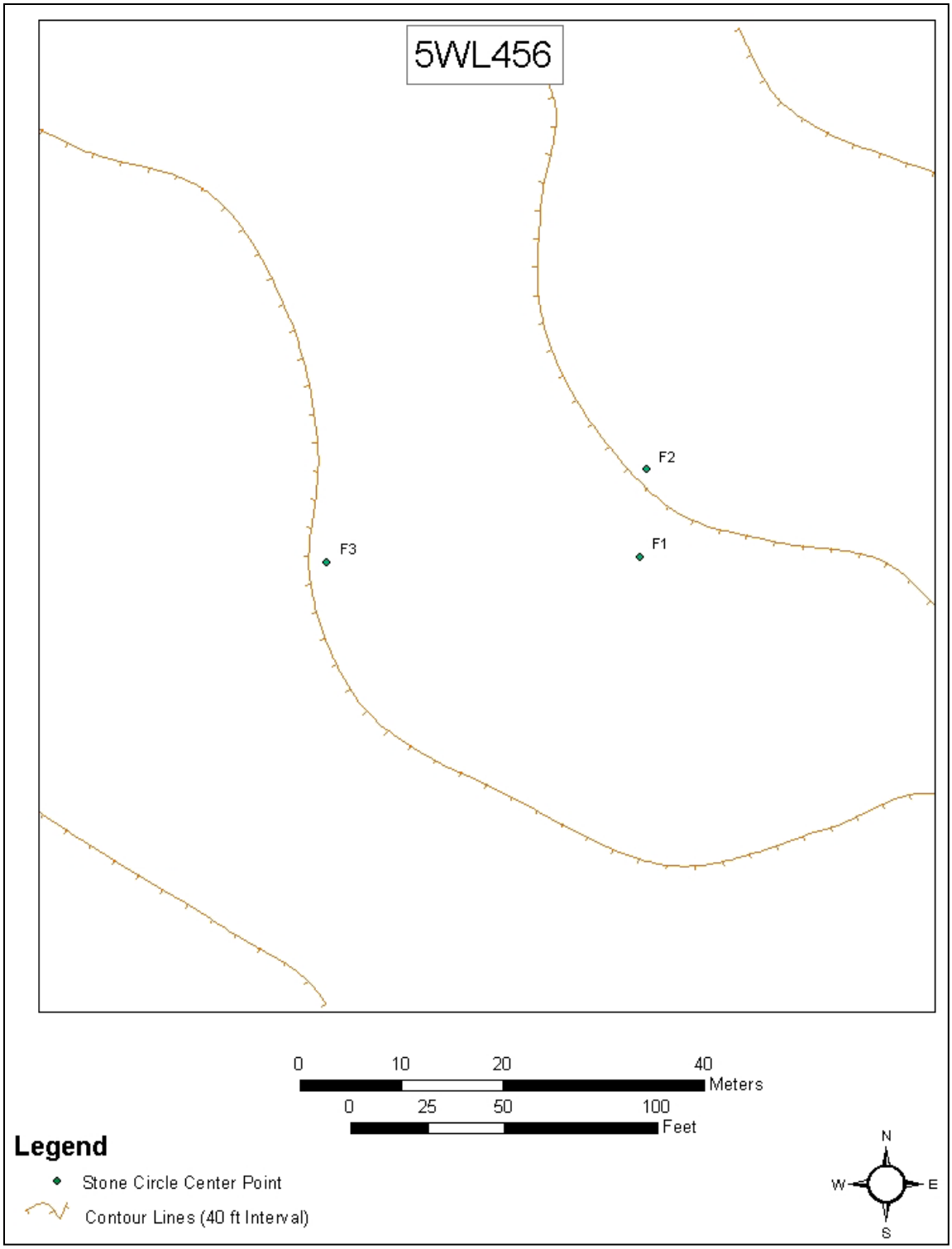

Figure 38 Site 5WL456 map of stone circle center points.

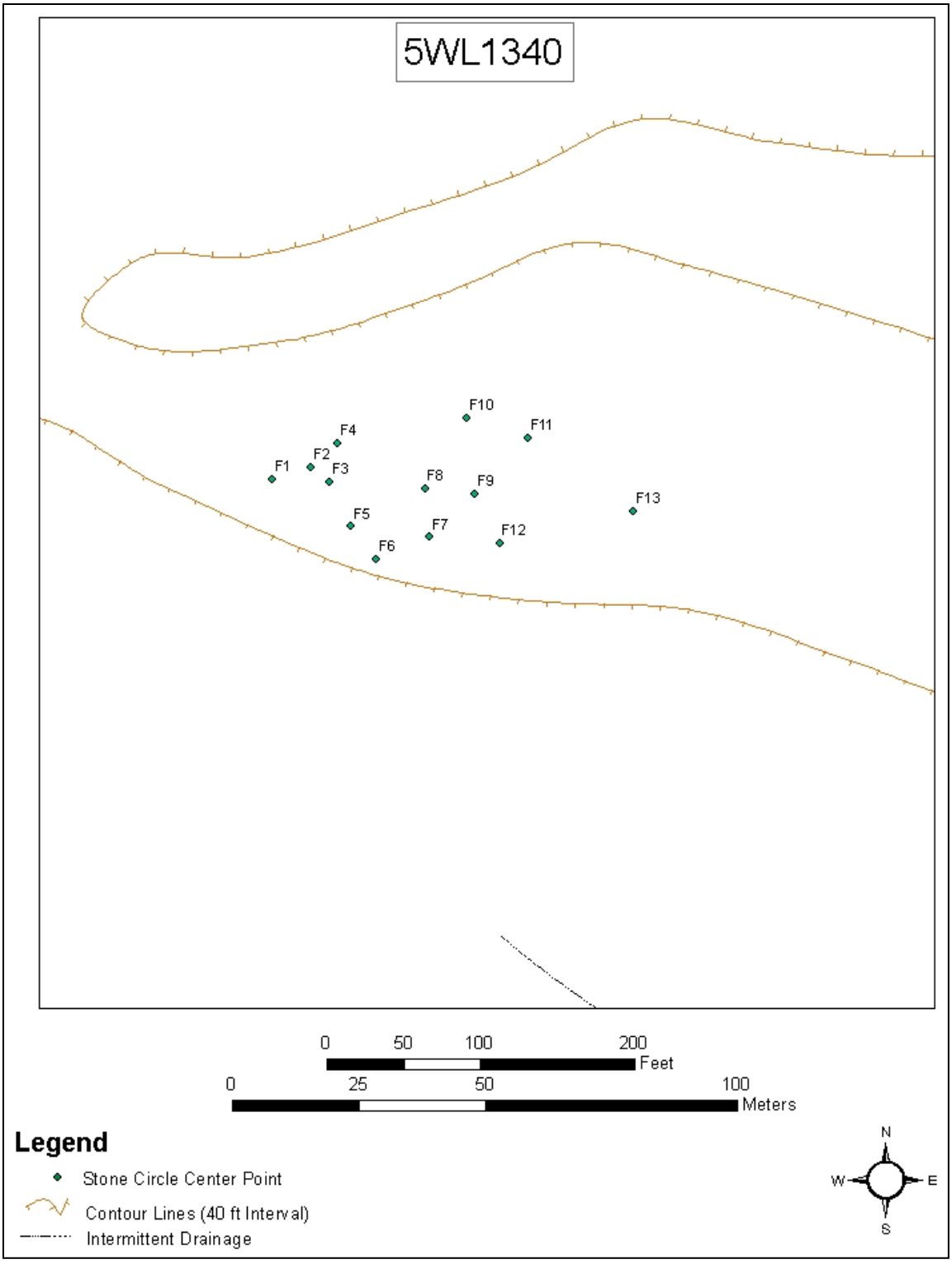

Figure 39 Site 5WL1340 map of stone circle center points.

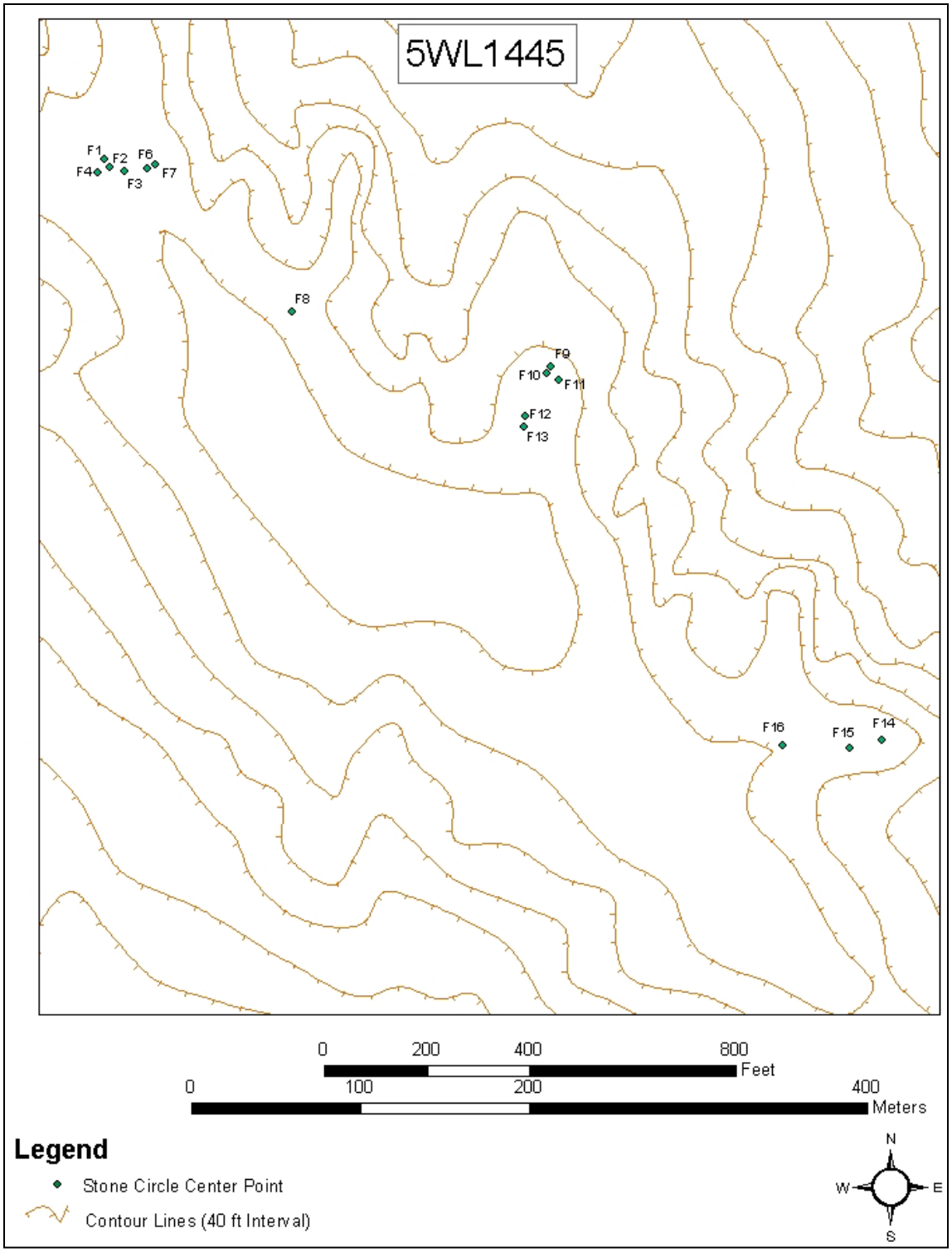

Figure 40 Site 5WL1445 map of stone circle center points.

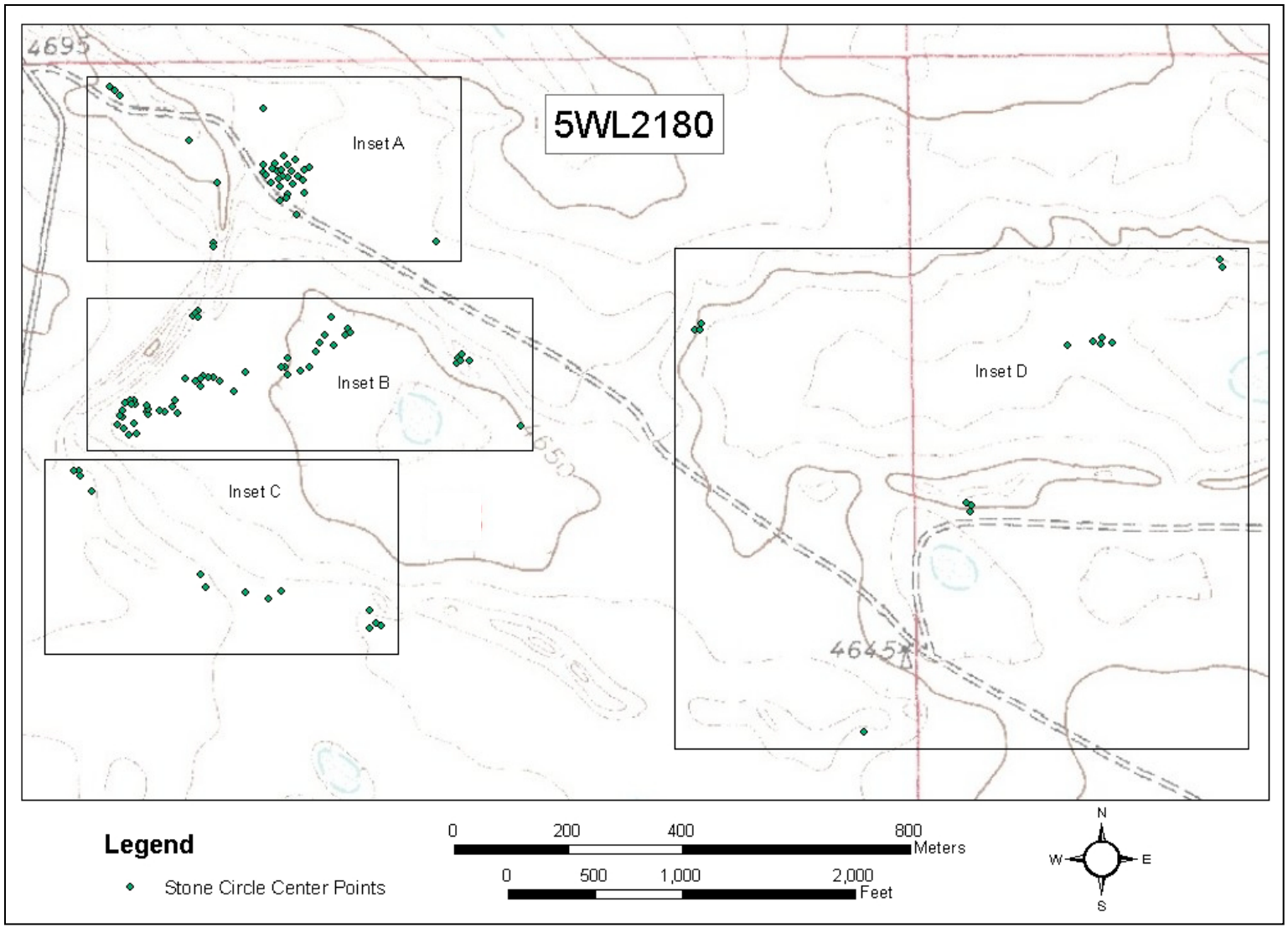

Figure 41 Site 5WL2180 map of stone circle center points.

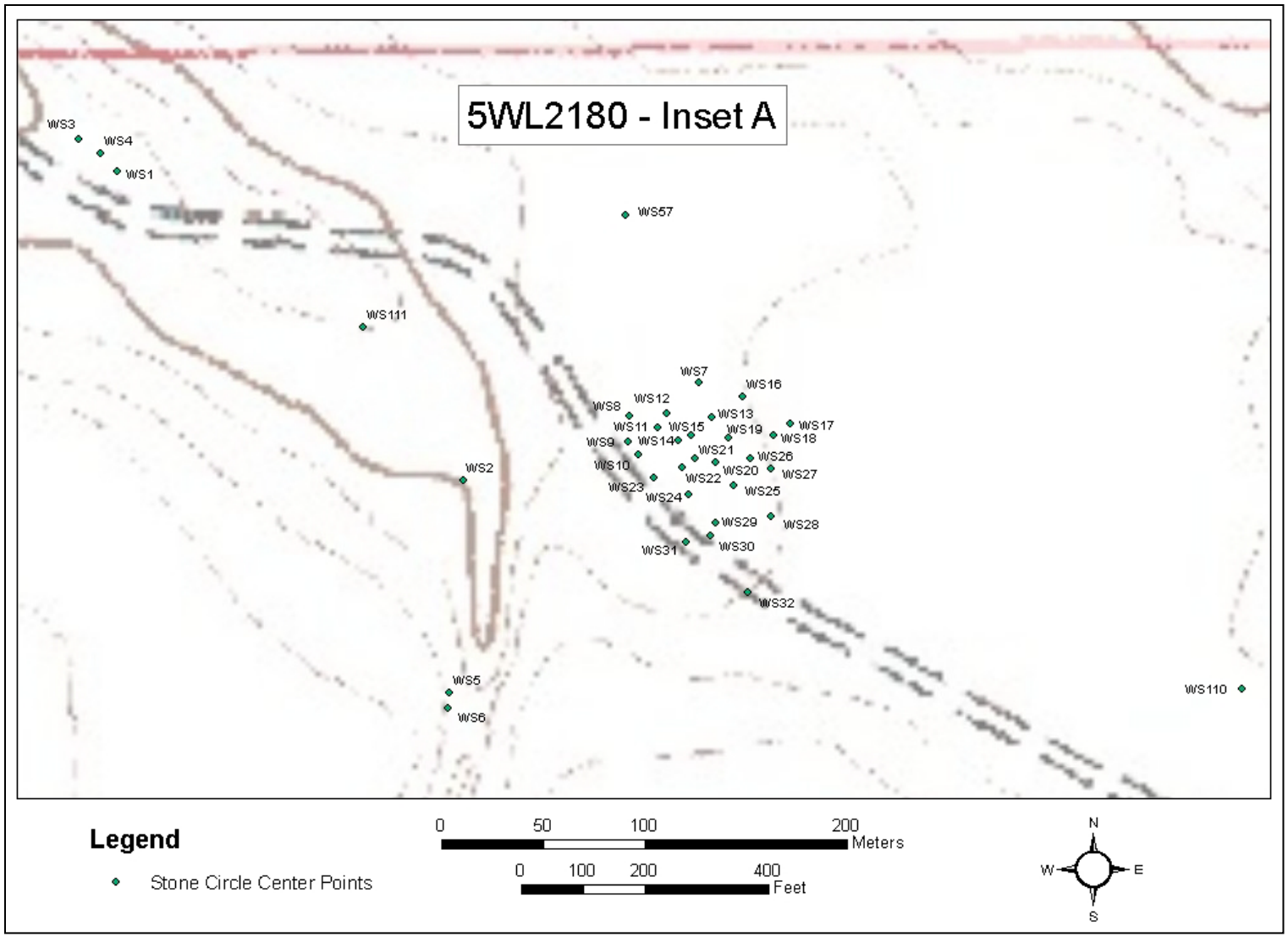

Figure 42 Site 5WL2180 map of stone circle center points, inset A.

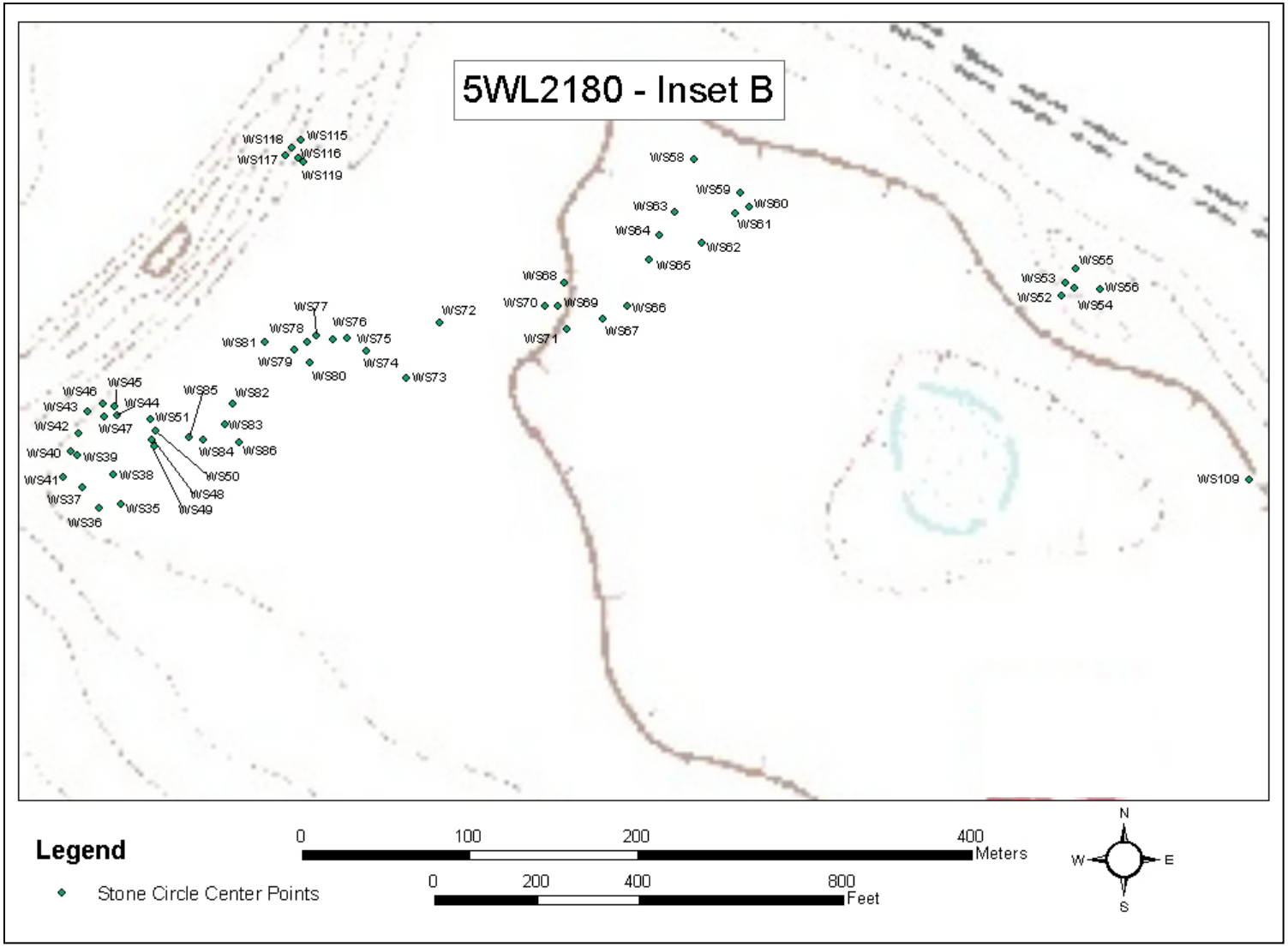

Figure 43 Site 5WL2180 map of stone circle center points, inset B.

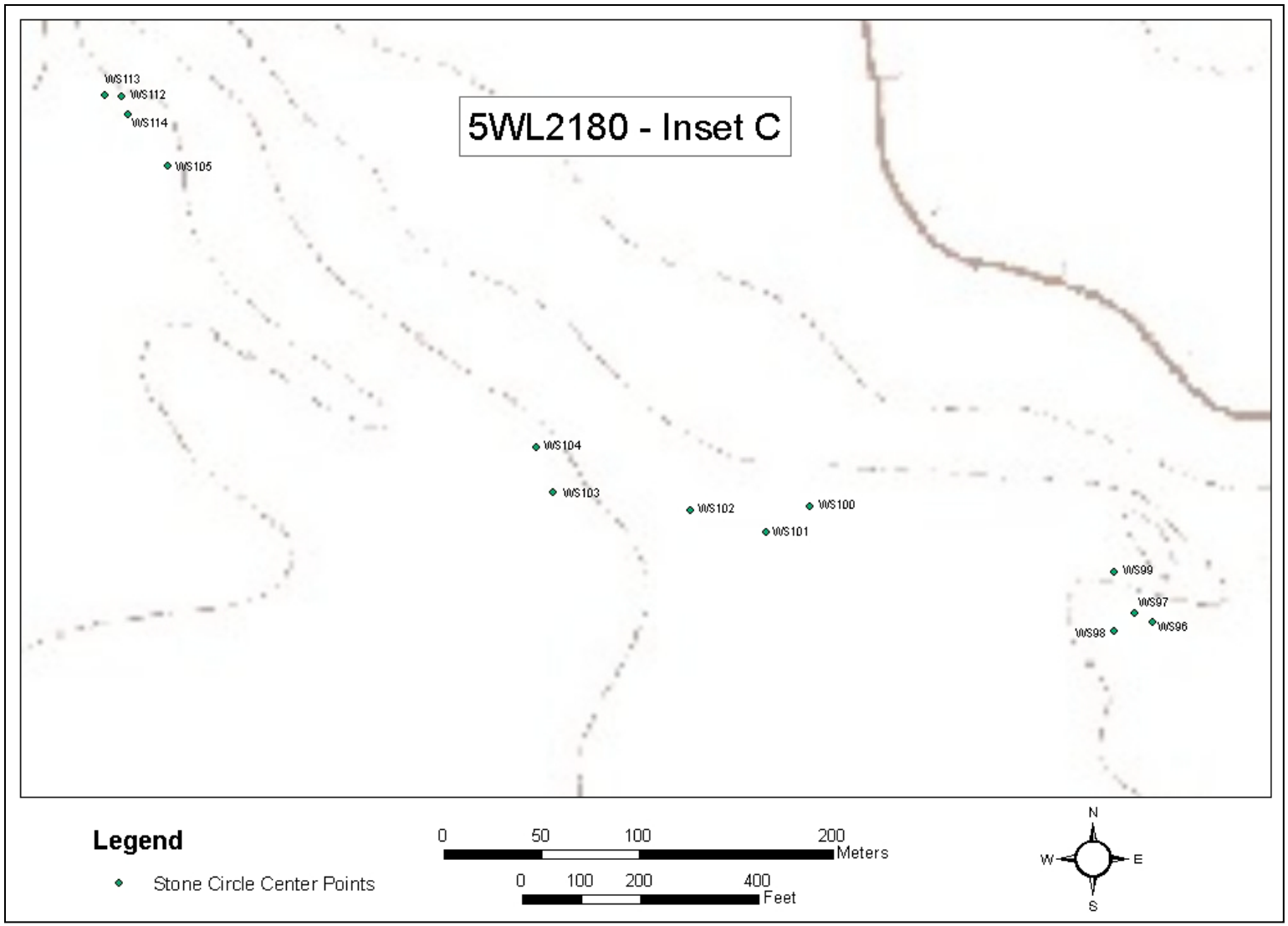

Figure 44 Site 5WL2180 map of stone circle center points, inset C.

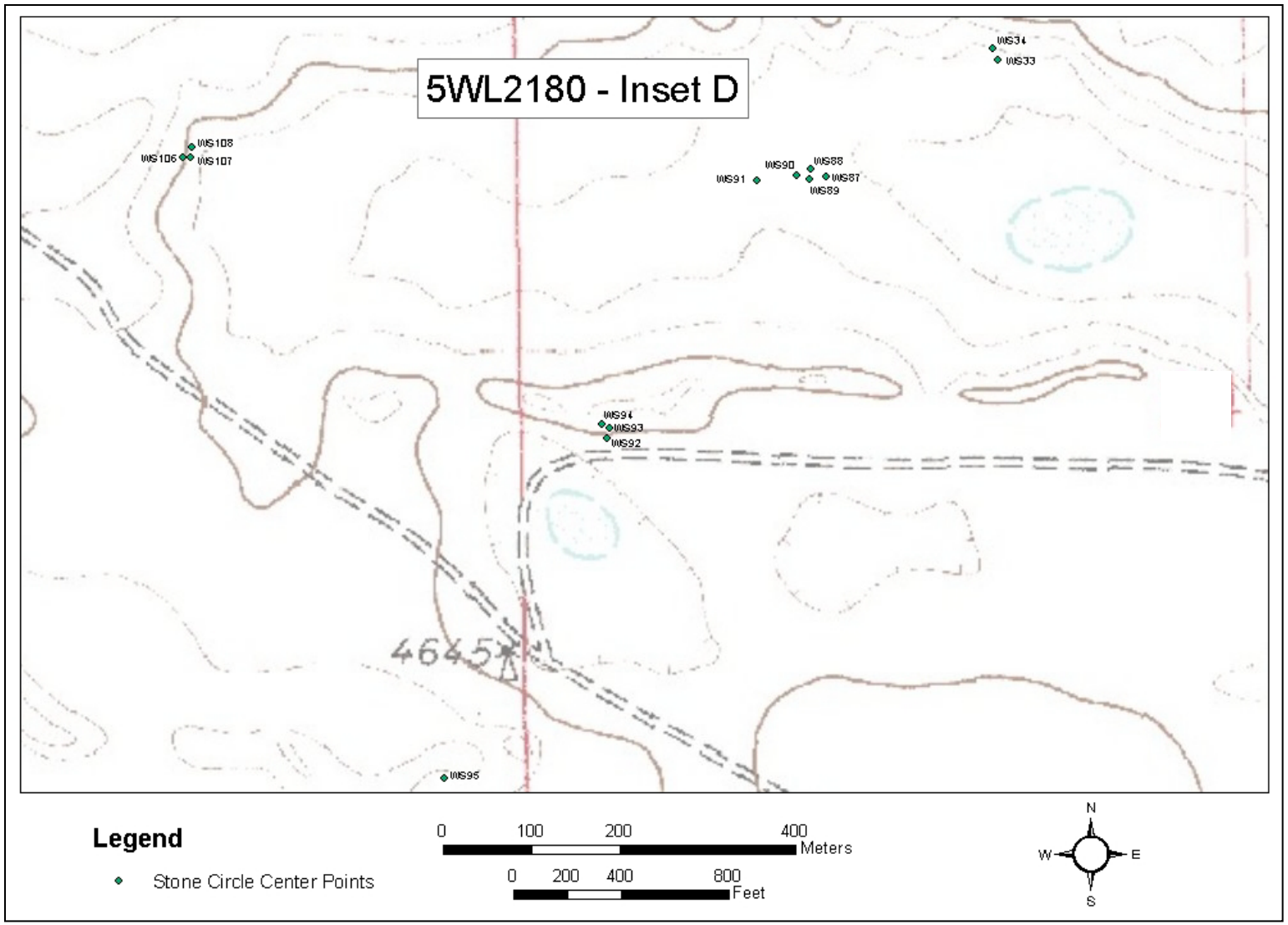

Figure 45 Site 5WL2180 map of stone circle center points, inset D.

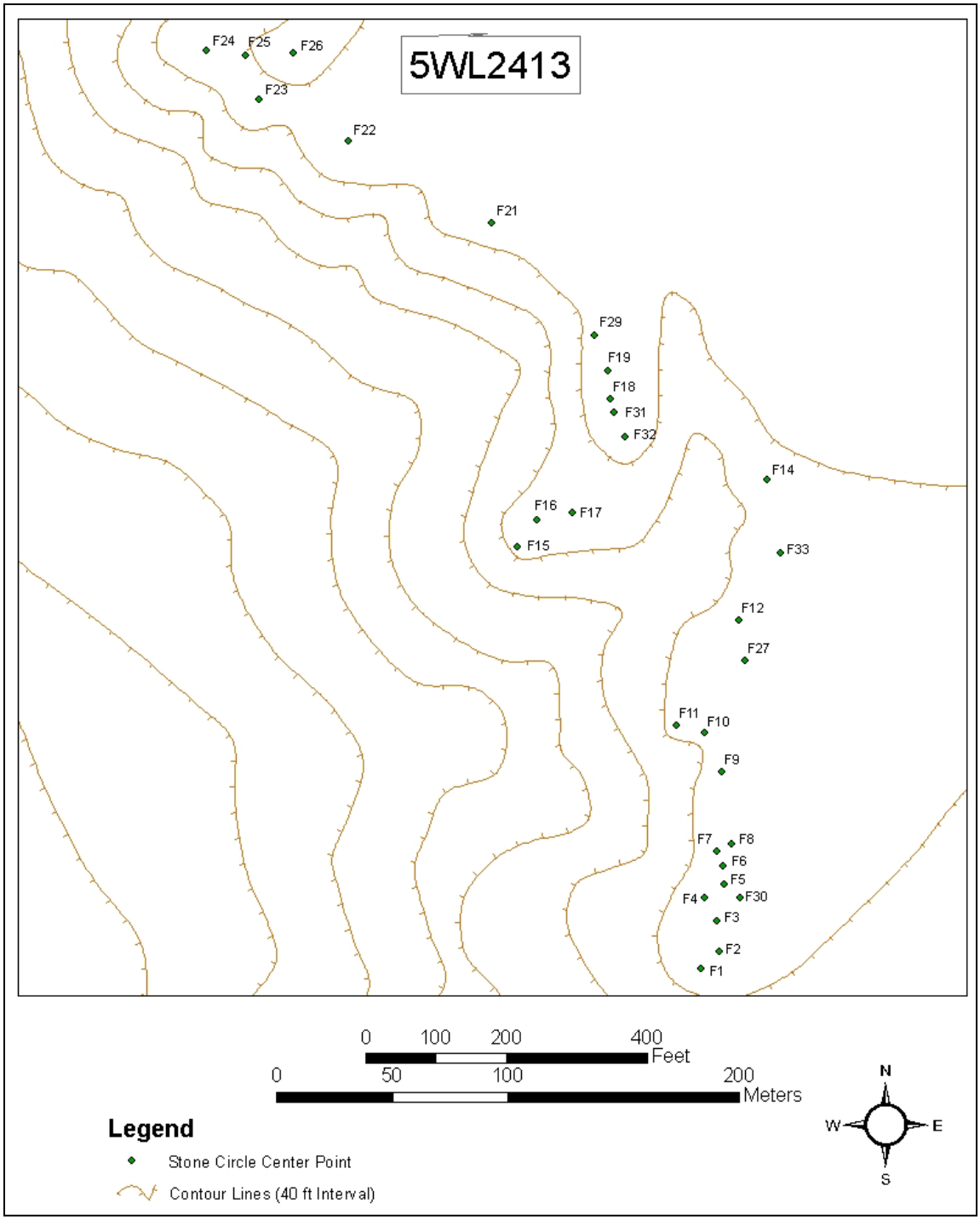

Figure 46 Site 5WL2413 map of stone circle center points.

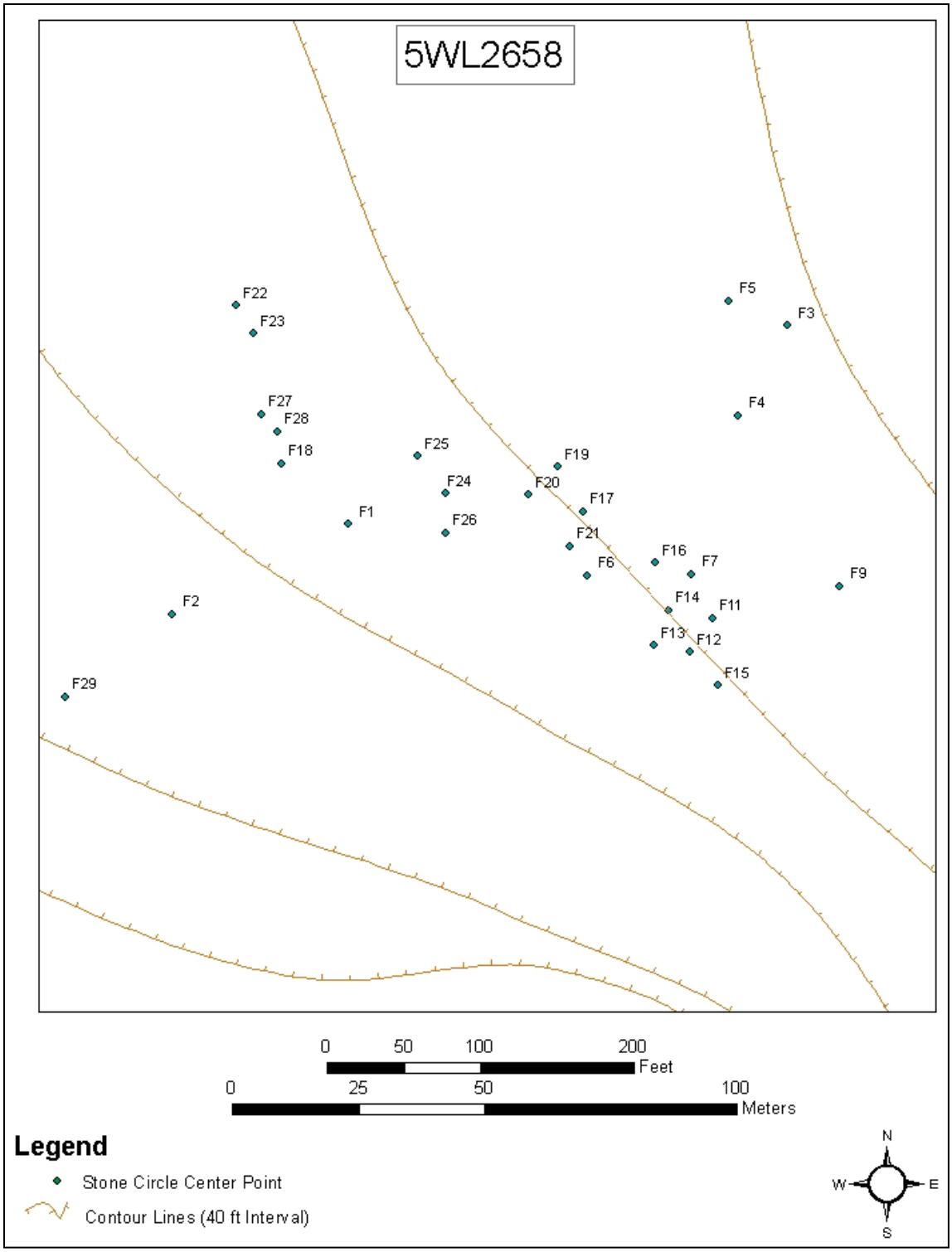

Figure 47 Site 5WL2658 map of stone circle center points.

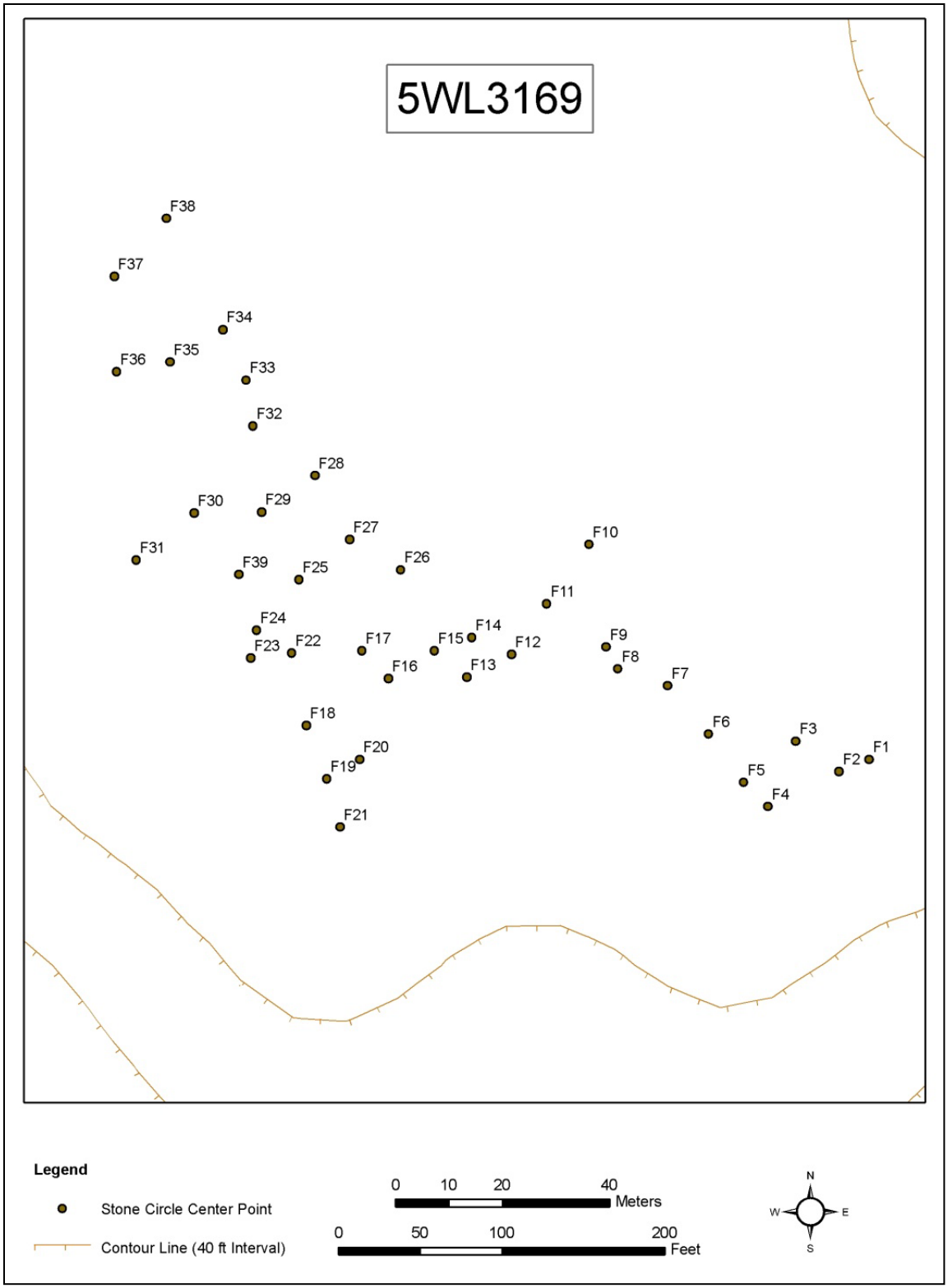

Figure 48 Site 5WL3169 map of stone circle center points.

APPENDIX II

TABLES OF STONE CIRCLE DATA BY SITE

Table 6 Site 5WL363 stone circle data.

Feature Number	Exterior Diameter N-S	E-W	Circle Completeness	Circle Definition	Wall Gap Present/ Absent	Wall Gap Direction (Degrees)	Artifacts	Associated Features
1	500 cm	500 cm	Complete	Moderate	Absent	N/A	None	None

Table 7 Site 5WL367 stone circle data.

Feature Number	Exterior Diameter N-S	E-W	Circle Completeness	Circle Definition	Wall Gap Present/ Absent	Wall Gap Direction (Degrees)	Artifacts	Associated Features
1	500 cm	500 cm	Complete	Moderate	Absent	N/A	None	None

Table 8 Site 5WL456 stone circle data.

Feature Number	Exterior Diameter N-S	E-W	Circle Completeness	Circle Definition	Wall Gap Present/ Absent	Wall Gap Direction (Degrees)	Artifacts	Associated Features
1	430 cm	450 cm	Complete	Moderate	Absent	N/A	None	None
2	300 cm	N/A	Partial	West half missing	N/A	N/A	None	None
3	350 cm	N/A	Partial	East half missing	N/A	N/A	None	None

Table 9 Site 5WL1340 stone circle data.

Feature Number	Exterior Diameter N-S	E-W	Circle Completeness	Circle Definition	Wall Gap Present/ Absent	Wall Gap Direction (degrees)	Artifacts	Associated Features
1	630 cm	490 cm	Complete	Moderate	Absent	N/A	None	None
2	550 cm	580 cm	Complete	Moderate	Absent	N/A	None	None
3	410 cm	500 cm	Complete	Moderate	Absent	N/A	None	None
4	590 cm	660 cm	Complete	Moderate	Absent	N/A	None	None
5	590 cm	560 cm	Complete	Moderate	Absent	N/A	None	None
6	690 cm	680 cm	Complete	Moderate	Absent	N/A	None	None
7	690 cm	620 cm	Complete	Good	Absent	N/A	None	None
8	540 cm	600 cm	Complete	Moderate	Absent	N/A	None	None
9	560 cm	600 cm	Complete	Good	Present	230	None	None
10	490 cm	N/A	Partial	East half missing	N/A	N/A	None	None
11	N/A	500 cm	Partial	North half missing	N/A	N/A	None	None
12	690 cm	750 cm	Complete	Moderate	Absent	N/A	None	None
13	530 cm	570 cm	Complete	Moderate	Absent	N/A	None	None

Table 10 Site 5WL1445 stone circle data.

Feature Number	Exterior Diameter N-S	E-W	Circle Completeness	Circle Definition	Wall Gap Present/ Absent	Wall Gap Direction (degrees)	Artifacts	Associated Features
1	263 cm	N/A	Partial	East half missing	N/A	N/A	None	None
2	270 cm	N/A	Partial	East half missing	N/A	N/A	None	None
3	375 cm	N/A	Partial	East half missing	N/A	N/A	None	None
4	380 cm	N/A	Partial	East half missing	N/A	N/A	None	None
6	430 cm	460 cm	Complete	Heavily sodded - could not be determined	Unknown	N/A	None	None
7	180 cm	N/A	Partial	East half missing	N/A	N/A	None	None
8	510 cm	500 cm	Complete	Good	Absent	N/A	None	None
9	410 cm	520 cm	Complete	Moderate	Absent	N/A	None	None
10	400 cm	N/A	Partial	East half missing	N/A	N/A	None	None
11	540 cm	N/A	Partial	East half missing	N/A	N/A	None	None
12	280 cm	N/A	Partial	West half missing	N/A	N/A	None	None
13	245 cm	N/A	Partial	West half missing	N/A	N/A	None	None
14	310 cm	440 cm	Complete	Heavily sodded - could not be determined	Unknown	N/A	None	None
15	450 cm	420 cm	Complete	Poor - Heavily disturbed	Absent	N/A	None	None
16	490 cm	470 cm	Complete	Moderate	Present	270	None	None

Table 11 Site 5WL2180 stone circle data.

Feature Number	Exterior Diameter N-S	E-W	Circle Completeness	Circle Definition	Wall Gap Present/ Absent	Wall Gap Direction (Degrees)	Artifacts	Associated Features
WS1	630 cm	605 cm	Complete	Good	Present	194	1 noncortical tan chert flake; 4 noncortical red-orange chert flakes	Center Depression 50x50 cm
WS2	285 cm	330 cm	Complete	Good	Present	128	None	None
WS3	580 cm	550 cm	Complete	Good	Present	236	5 non cortical red-orange chert flakes; 1 red chert reduced core; 1 cortical red chert flake	Center Depression 60x65 cm
WS4	425 cm	435 cm	Complete	Good	Absent	N/A	2 noncortical red chert flakes; 2 noncortical tan chert flakes	None
WS5	380 cm	205 cm	Complete	Moderate	Present	142	None	None
WS6	645 cm	575 cm	Complete	Good	Present	44	None	Interior rock clusters: North 90x60 cm 10 stones; East 70x45 cm 5 stones
WS7	610 cm	595 cm	Complete	Good	Present	268	None	None
WS8	595 cm	585 cm	Complete	Good	Absent	N/A	None	Center depression 90x125 cm with 3

Feature Number	Exterior Diameter N-S	E-W	Circle Completeness	Circle Definition	Wall Gap Present/ Absent	Wall Gap Direction (Degrees)	Artifacts	Associated Features
								stones
WS9	590 cm	465 cm	Complete	Good	Absent	N/A	1 cortical tan quartzite flake	Center depression 80x60 cm
WS10	555 cm	605 cm	Complete	Good	Absent	N/A	1 cortical tan quartzite flake; 1 cortical purple and white chert flake; 1 noncortical tan chert flake; 1 cortical tan and red chert flake.	Center depression 70x50 cm
WS11	N/A	500 cm	Partial	South half missing	N/A	N/A	None	Interior Depression 120x70 cm
WS12	640 cm	565 cm	Complete	Moderate	Present	24	None	Interior Depression lined with 5 stones, 140x105 cm
WS13	750 cm	610 cm	Complete	Good	Present	90	1 noncortical red-orange chert flake	Central depression 100x110 cm
WS14	760 cm	800 cm	Complete	Good	Present	270	None	Interior rock lined depression 210x160 cm, 16 stones
WS15	440 cm	455 cm	Complete	Moderate	Present	90	None	Interior Depression 70x65 cm at the gap
WS16	640 cm	615 cm	Complete	Good	Present	250	None	Interior Depression 80x90 cm

Feature Number	Exterior Diameter N-S	E-W	Circle Completeness	Circle Definition	Wall Gap Present/ Absent	Wall Gap Direction (Degrees)	Artifacts	Associated Features
WS17	685 cm	680 cm	Complete	Moderate	Present	250	1 cortical tan quartzite flake	Interior Depression 70x80 cm
WS18	690 cm	725 cm	Complete	Moderate	Absent	N/A	None	Interior Depression 120x80 cm
WS19	530 cm	655 cm	Complete	Good	Present	64	None	None
WS20	530 cm	435 cm	Complete	Good	Absent	N/A	None	None
WS21	N/A	460 cm	Partial	South half missing	N/A	N/A	1 noncortical white chert flake	None
WS22	535 cm	540 cm	Complete	Good	Absent	N/A	None	Interior Depression 110x80 cm
WS23	505 cm	515 cm	Complete	Good	Absent	N/A	None	Interior Depression 110x75 cm
WS24	545 cm	470 cm	Complete	Good	Present	338	None	Interior Depression 80x80 cm
WS25	650 cm	620 cm	Complete	Good	Present	157	None	None
WS26	470 cm	540 cm	Complete	Good	Present	9	None	None
WS27	380 cm	475 cm	Complete	Good	Present	225	None	Interior Depression 120x60 cm
WS28	570 cm	550 cm	Complete	Good	Absent	N/A	None	None
WS29	680 cm	675 cm	Complete	Good	Absent	N/A	1 noncortical tan quartzite flake	None
WS30	470 cm	465 cm	Complete	Moderate	Present	320	None	None
WS31	615 cm	500 cm	Complete	Good	Present	340	1 noncortical tan chert flake	None
WS32	430 cm	330 cm	Complete	Moderate	Absent	N/A	1 cortical dark brown chert flake	None

Feature Number	Exterior Diameter N-S	E-W	Circle Completeness	Circle Definition	Wall Gap Present/ Absent	Wall Gap Direction (Degrees)	Artifacts	Associated Features
WS33	545 cm	490 cm	Complete	Good	Absent	N/A	None	Interior Depression
WS34	485 cm	555 cm	Complete	Good	Present	296	None	Interior Depression
WS35	455 cm	470 cm	Complete	Good	Present	133	None	None
WS36	N/A	325 cm	Partial	South half missing	N/A	N/A	None	None
WS37	485 cm	495 cm	Complete	Moderate	Absent	N/A	1 noncortical orange chert flake	Central rock cluster 100x75 cm, 7 stones
WS38	560 cm	500 cm	Complete	Moderate	Present	237	1 noncortical amber quartzite flake	None
WS39	370 cm	400 cm	Complete	Moderate	Absent	N/A	1 noncortical light brown chert flake; 1 non cortical tan and orange quartzite flake	None
WS40	410 cm	460 cm	Complete	Good	Absent	N/A	None	None
WS41	570 cm	450 cm	Complete	Good	Present	108	None	Central rock cluster 105x50 cm, 4 stones
WS42	380 cm	410 cm	Complete	Moderate	Absent	N/A	None	None
WS43	490 cm	565 cm	Complete	Moderate	Present	280	1 noncortical tan quartzite flake	Central rock lined depression 65x55 cm, 5 stones
WS44	500 cm	540 cm	Complete	Poor	Absent	N/A	None	None

Feature Number	Exterior Diameter N-S	E-W	Circle Completeness	Circle Definition	Wall Gap Present/ Absent	Wall Gap Direction (Degrees)	Artifacts	Associated Features
WS45	445 cm	575 cm	Complete	Moderate	Absent	N/A	1 cortical tan and red chert flake	None
WS46	405 cm	N/A	Partial	West half missing	N/A	N/A	None	None
WS47	445 cm	420 cm	Complete	Moderate	Absent	N/A	1 cortical red-brown chert flake	None
WS48	540 cm	480 cm	Complete	Moderate	Absent	N/A	1 noncortical purple chert flake	None
WS49	500 cm	465 cm	Complete	Moderate	Absent	N/A	1 noncortical brown chalcedony flake	None
WS50	285 cm	315 cm	Complete	Moderate	Present	165	1 cortical pink chert flake; 2 cortical tan quartzite flake;	None
WS51	465 cm	495 cm	Complete	Moderate	Absent	N/A	None	None
WS52	470 cm	455 cm	Complete	Moderate	Present	320	1 noncortical tan quartzite flake; 1 cortical tan quartzite flake	None
WS53	500 cm	525 cm	Complete	Moderate	Present	236	None	None
WS54	405 cm	485 cm	Partial	East half missing	N/A	N/A	None	None
WS55	610 cm	615 cm	Complete	Good	Present	160	1 noncortical tan quartzite flake	None
WS56	460 cm	440 cm	Complete	Moderate	Present	135	None	Interior depression

Feature Number	Exterior Diameter N-S	E-W	Circle Completeness	Circle Definition	Wall Gap Present/ Absent	Wall Gap Direction (Degrees)	Artifacts	Associated Features
								60x50 cm
WS57	525 cm	490 cm	Complete	Moderate	Present	106	None	None
WS58	620 cm	610 cm	Complete	Poor	Absent	N/A	None	None
WS59	630 cm	515 cm	Complete	Moderate	Present	240	1 noncortical brown chert flake	None
WS60	530 cm	485 cm	Complete	Good	Present	133	1 noncortical purple chalcedony flake	None
WS61	475 cm	525 cm	Complete	Moderate	Present	54	1 cortical orange chert flake; 1 cortical tan quartzite flake; 1 noncortical tan quartzite flake	None
WS62	450 cm	475 cm	Complete	Moderate	Present	28	1 cortical red quartzite flake; 2 cortical brown chert flakes; 2 noncortical tan quartzite flakes	None
WS63	N/A	500 cm	Partial	South half missing	N/A	N/A	1 noncortical gray quartzite flake	None
WS64	515 cm	515 cm	Complete	Good	Absent	N/A	1 noncortical pink chert flake	None
WS65	565 cm	615 cm	Complete	Good	Absent	N/A	None	None

Feature Number	Exterior Diameter N-S	E-W	Circle Completeness	Circle Definition	Wall Gap Present/ Absent	Wall Gap Direction (Degrees)	Artifacts	Associated Features
WS66	660 cm	620 cm	Complete	Good	Absent	N/A	None	None
WS67	N/A	445 cm	Partial	South half missing	N/A	N/A	None	None
WS68	540 cm	655 cm	Complete	Good	Present	335	None	None
WS69	520 cm	575 cm	Complete	Moderate	Present	308	None	None
WS70	485 cm	455 cm	Complete	Moderate	Present	215	None	None
WS71	465 cm	N/A	Partial	East half missing	N/A	N/A	1 noncortical white chalcedony flake; 1 noncortical brown-tan-orange mottled chert flake	None
WS72	650 cm	615 cm	Complete	Moderate	Absent	N/A	1 noncortical tan quartzite flake	
WS73	620 cm	600 cm	Complete	Moderate	Present	132	None	None
WS74	490 cm	538 cm	Complete	Moderate	Present	90	None	None
WS75	560 cm	580 cm	Complete	Moderate	Absent	N/A	1 noncortical tan and red quartzite flake	None
WS76	540 cm	655 cm	Complete	Moderate	Absent	N/A	None	None
WS77	545 cm	560 cm	Complete	Moderate	Absent	N/A	2 noncortical tan quartzite flakes	None
WS78	710 cm	N/A	Partial	West half missing	N/A	N/A	1 noncortical red chert flake	None

Feature Number	Exterior Diameter N-S	E-W	Circle Completeness	Circle Definition	Wall Gap Present/ Absent	Wall Gap Direction (Degrees)	Artifacts	Associated Features
WS79	535 cm	N/A	Partial	West half missing	N/A	N/A	None	None
WS80	450 cm	400 cm	Complete	Moderate	Absent	N/A	2 noncortical tan quartzite flakes	None
WS81	575 cm	500 cm	Complete	Poor	Absent	N/A	1 noncortical tan chert flake; 1 noncortical tan quartzite flake	None
WS82	480 cm	610 cm	Complete	Moderate	Present	256	None	None
WS83	600 cm	545 cm	Complete	Moderate	Present	217	None	None
WS84	590 cm	605 cm	Complete	Poor	Absent	N/A	1 noncortical tan and red chert flake	None
WS85	N/A	615 cm	Partial	North half missing	N/A	N/A	None	None
WS86	480 cm	540 cm	Complete	Good	Present	82	None	None
WS87	570 cm	460 cm	Complete	Moderate	Present	270	None	None
WS88	670 cm	N/A	Partial	North half missing	N/A	N/A	None	None
WS89	550 cm	760 cm	Complete	Moderate	Present	295	None	None
WS90	600 cm	670 cm	Complete	Good	Absent	N/A	None	None
WS91	N/A	525 cm	Partial	North half missing	N/A	N/A	None	None
WS92	560 cm	550 cm	Complete	Good	Present	150	None	None
WS93	490 cm	490 cm	Complete	Good	Present	224	None	None

Feature Number	Exterior Diameter N-S	E-W	Circle Completeness	Circle Definition	Wall Gap Present/ Absent	Wall Gap Direction (Degrees)	Artifacts	Associated Features
WS94	545 cm	N/A	Partial	East half missing	N/A	N/A	None	None
WS95	615 cm	740 cm	Complete	Good	Absent	N/A	None	Interior rock cluster, 5 stones, 170x50 cm
WS96	665 cm	640 cm	Complete	Good	Absent	N/A	None	None
WS97	760 cm	740 cm	Complete	Good	Absent	N/A	None	None
WS98	660 cm	685 cm	Complete	Good	Present	146	1 cortical red and tan quartzite flake; 3 noncortical red and tan chert flakes; 4 noncortical tan quartzite flakes; 1 cortical red and tan chert flake; 2 noncortical tan chert flakes	None
WS99	560 cm	635 cm	Complete	Good	Absent	N/A	None	None
WS100	610 cm	570 cm	Complete	Good	Present	135	None	None
WS101	440 cm	570 cm	Complete	Poor	Absent	N/A	None	None
WS102	560 cm	N/A	Partial	East half missing	N/A	N/A	None	None
WS103	580 cm	660 cm	Complete	Good	Absent	N/A	None	None
WS104	490 cm	500 cm	Complete	Good	Present	225	None	None

Feature Number	Exterior Diameter N-S	E-W	Circle Completeness	Circle Definition	Wall Gap Present/ Absent	Wall Gap Direction (Degrees)	Artifacts	Associated Features
WS105	N/A	460 cm	Partial	North half missing	N/A	N/A	None	None
WS106	590 cm	560 cm	Complete	Good	Present	338	None	None
WS107	490 cm	440 cm	Complete	Good	Present	32	None	None
WS108	540 cm	540 cm	Complete	Good	Present	78	None	None
WS109	N/A	540 cm	Partial	South half missing	N/A	N/A	None	None
WS110	470 cm	455 cm	Complete	Good	Present	156	None	None
WS111	N/A	325 cm	Partial	South half missing	N/A	N/A	None	None
WS112	485 cm	N/A	Partial	West half missing	N/A	N/A	None	None
WS113	460 cm	N/A	Partial	East half missing	N/A	N/A	None	None
WS114	510 cm	N/A	Partial	South half missing	N/A	N/A	None	None
WS115	480 cm	480 cm	Complete	Good	Present	20	None	None
WS116	420 cm	500 cm	Complete	Good	Present	90	None	None
WS117	550 cm	485 cm	Complete	Good	Present	190	None	None
WS118	590 cm	530 cm	Complete	Good	Absent	N/A	None	None
WS119	460 cm	415 cm	Complete	Good	Absent	N/A	None	None

Table 12 Site 5WL2413 stone circle data.

Feature Number	Exterior Diameter N-S	E-W	Circle Completeness	Circle Definition	Wall Gap Present/ Absent	Wall Gap Direction (degrees)	Artifacts	Associated Features
1	425 cm	425 cm	Complete	Moderate	Present	320	Tan quartzite reduced core	Central hearth, 145x110 cm, 22 stones
2	N/A	290 cm	Partial	North half missing	N/A	N/A	None	None
3	370 cm	320 cm	Partial	NNE and SSE missing	N/A	N/A	None	None
4	530 cm	475 cm	Complete	Moderate	Present	306	None	None
5	615 cm	640 cm	Complete	Good	Absent	N/A	None	None
6	445 cm	N/A	Partial	East half missing	N/A	N/A	None	None
7	395 cm	400 cm	Complete	Moderate	Absent	N/A	None	Central rock cluster, 55x80 cm, 7 stones
8	510 cm	520 cm	Complete	Good	Absent	N/A	None	Central hearth, 130x85 cm, 11 stones
9	555 cm	510 cm	Complete	Moderate	Present	96	None	None
10	565 cm	450 cm	Complete	Good	Present	70	None	hearth, 117x106 cm, 21 stones
11	570 cm	620 cm	Complete	Moderate	Present	284	None	None
12	750 cm	750 cm	Complete	Moderate	Absent	N/A	None	Central dispersed rock cluster, 226x173 cm, 16 stones

Feature Number	Exterior Diameter N-S	E-W	Circle Completeness	Circle Definition	Wall Gap Present/ Absent	Wall Gap Direction (degrees)	Artifacts	Associated Features
14	685 cm	785 cm	Complete	Poor	Absent	N/A	None	Rock cluster in NNE, 130x145 cm, 25 stones; Dispersed central rock cluster, 150x150 cm, 9 stones
15	550 cm	540 cm	Complete	Moderate	Absent	N/A	None	None
16	585 cm	525 cm	Complete	Moderate	Absent	N/A	None	None
17	595 cm	600 cm	Complete	Moderate	Absent	N/A	None	None
18	460 cm	510 cm	Complete	Moderate	Absent	N/A	None	None
19	420 cm	425 cm	Complete	Good	Present	168	None	None
20	Not Relocated							
21	400 cm	485 cm	Complete	Moderate	Present	156	None	Central depression 50x50 cm; Rock cluster 85x60 cm, 10 stones
22	390 cm	515 cm	Complete	Good	Present	216	Size 3, secondary, brown chalcedony modified flake	None
23	615 cm	615 cm	Complete	Good	Absent	N/A	None	None
24	585 cm	595 cm	Complete	Good	Absent	N/A	None	None
25	550 cm	465 cm	Complete	Good	Present	232	None	None

Feature Number	Exterior Diameter N-S	E-W	Circle Completeness	Circle Definition	Wall Gap Present/ Absent	Wall Gap Direction (degrees)	Artifacts	Associated Features
26	455 cm	N/A	Partial	East half missing	N/A	N/A	None	Rock cluster, 72x61 cm, 6 stones
27	560 cm	N/A	Partial	East and West quarters missing	N/A	N/A	Tan quartzite core 12x8 cm	None
29	505 cm	N/A	Partial	West half missing	N/A	N/A	None	None
30	665 cm	500 cm	Complete	Good	Present	144	None	None
31	550 cm	530 cm	Complete	Poor	Absent	N/A	None	None
32	715 cm	660 cm	Complete	Moderate	Present	150	None	Depression in NNE, 70x70 cm
33	495cm	580 cm	Complete	Poor	Absent	N/A	None	None

Table 13 Site 5WL2658 stone circle data.

Feature Number	Exterior Diameter N-S	E-W	Circle Completeness	Circle Definition	Wall Gap Present/ Absent	Wall Gap Direction (degrees)	Artifacts	Associated Features
1	465 cm	450 cm	Complete	Poor	Absent	N/A	None	None
2	620 cm	580 cm	Complete	Poor	Absent	N/A	None	None
3	400 cm	490 cm	Complete	Moderate	Absent	N/A	None	None
4	450 cm	410 cm	Complete	Poor	Absent	N/A	None	None
5	590 cm	500 cm	Complete	Moderate	Present	225	None	None
6	N/A	410 cm	Partial	North half missing	N/A	N/A	None	None

Feature Number	Exterior Diameter N-S	E-W	Circle Completeness	Circle Definition	Wall Gap Present/ Absent	Wall Gap Direction (degrees)	Artifacts	Associated Features
7	510 cm	490 cm	Complete	Moderate	Absent	N/A	Tan quartzite, corner-notched projectile point fragment	None
8	Not Relocated							
9	610 cm	620 cm	Complete	Good	Absent	N/A	None	None
11	510 cm	560 cm	Complete	Moderate	Absent	N/A	None	None
12	520 cm	470 cm	Complete	Poor	Absent	N/A	None	None
13	420 cm	500 cm	Complete	Good	Absent	N/A	None	None
14	500 cm	500 cm	Complete	Moderate	Absent	N/A	None	None
15	N/A	420 cm	Partial	South half missing	N/A	N/A	None	None
16	580 cm	520 cm	Complete	Poor	Absent	N/A	None	None
17	380 cm	470 cm	Complete	Poor	Absent	N/A	None	None
18	450 cm	580 cm	Complete	Poor	Absent	N/A	None	None
19	N/A	400 cm	Partial	North half missing	N/A	N/A	None	None
20	550 cm	575 cm	Complete	Good	Absent	N/A	None	None
21	360 cm	400 cm	Complete	Moderate	Absent	N/A	None	None
22	350 cm	N/A	Partial	East half missing	N/A	N/A	None	None
23	480 cm	580 cm	Complete	Poor	Absent	N/A	None	None
24	510 cm	680 cm	Complete	Good	Absent	N/A	None	None
25	N/A	350 cm	Partial	North half missing	N/A	N/A	None	None
26	610 cm	640 cm	Complete	Good	Absent	N/A	None	None
27	400 cm	N/A	Partial	East half missing	N/A	N/A	None	None
28	520 cm	600 cm	Complete	Poor	Absent	N/A	None	None

Feature Number	Exterior Diameter N-S	E-W	Circle Completeness	Circle Definition	Wall Gap Present/ Absent	Wall Gap Direction (degrees)	Artifacts	Associated Features
29	N/A	720 cm	Partial	South half missing	N/A	N/A	None	None

Table 14 Site 5WL3169 stone circle data.

Feature Number	Exterior Diameter N-S	E-W	Circle Completeness	Circle Definition	Wall Gap Present/ Absent	Wall Gap Direction (degrees)	Artifacts	Associated Features
1	505 cm	400 cm	Complete	Poor	Absent	N/A	None	None
2	310 cm	390 cm	Complete	Moderate	Absent	N/A	None	None
3	450 cm	465 cm	Complete	Moderate	Absent	N/A	None	None
4	460 cm	495 cm	Complete	Good	Absent	N/A	None	Outside rock cluster 180 cm by 215 cm with 23 stones on the north side of circle
5	445 cm	445 cm	Complete	Moderate	Absent	N/A	None	None
6	500 cm	615 cm	Complete	Good	Absent	N/A	None	None
7	390 cm	400 cm	Complete	Moderate	Absent	N/A	None	None
8	360 cm	430 cm	Complete	Good	Absent	N/A	None	None
9	350 cm	255 cm	Complete	Good	Absent	N/A	None	None
10	495 cm	440 cm	Complete	Poor	Absent	N/A	None	None
11	500 cm	530 cm	Complete	Good	Absent	N/A	None	None
12	360 cm	330 cm	Complete	Poor	Absent	N/A	None	None
13	530 cm	510 cm	Complete	Moderate	Absent	N/A	None	None

Feature Number	Exterior Diameter N-S	E-W	Circle Completeness	Circle Definition	Wall Gap Present/ Absent	Wall Gap Direction (degrees)	Artifacts	Associated Features
14	410 cm	485 cm	Complete	Moderate	Absent	N/A	None	None
15	390 cm	396 cm	Complete	Poor	Absent	N/A	None	None
16	515 cm	565 cm	Complete	Moderate	Absent	N/A	None	None
17	430 cm	460 cm	Complete	Moderate	Absent	N/A	None	None
18	490 cm	465 cm	Complete	Moderate	Absent	N/A	None	None
19	400 cm	420 cm	Complete	Good	Absent	N/A	None	None
20	395 cm	400 cm	Complete	Good	Absent	N/A	None	None
21	475 cm	490 cm	Complete	Good	Absent	N/A	None	None
22	465 cm	470 cm	Complete	Poor	Absent	N/A	None	None
23	485 cm	460 cm	Complete	Good	Absent	N/A	None	None
24	500 cm	495 cm	Complete	Moderate	Absent	N/A	None	None
25	440 cm	385 cm	Complete	Moderate	Absent	N/A	None	None
26	660 cm	585 cm	Complete	Moderate	Absent	N/A	None	None
27	450 cm	450 cm	Complete	Good	Absent	N/A	None	None
28	430 cm	450 cm	Complete	Good	Absent	N/A	None	None
29	455 cm	540 cm	Complete	Good	Absent	N/A	None	None
30	500 cm	520 cm	Complete	Good	Absent	N/A	None	None
31	705 cm	N/A	Partial	East half missing	N/A	N/A	None	None
32	425 cm	445 cm	Complete	Moderate	Present	80	None	None
33	505 cm	570 cm	Complete	Moderate	Absent	N/A	None	None
34	410 cm	490 cm	Complete	Moderate	Absent	N/A	None	Non
35	640 cm	645 cm	Complete	Moderate	Absent	N/A	None	Large rock cluster 260 cm by 160 cm in the southwest

Feature Number	Exterior Diameter N-S	E-W	Circle Completeness	Circle Definition	Wall Gap Present/ Absent	Wall Gap Direction (degrees)	Artifacts	Associated Features
								quadrant
36	355 cm	390 cm	Complete	Moderate	Absent	N/A	None	None
37	620 cm	540 cm	Complete	Good	Absent	N/A	None	None
38	530 cm	510 cm	Complete	Good	Absent	N/A	None	None
39	490 cm	530 cm	Complete	Good	Absent	N/A	None	None

APPENDIX III

ROSE DIAGRAMS

Fort Collins, Colorado Average Wind Direction (%) From 2005-2009, by Month
(McNoldy 2010)

January

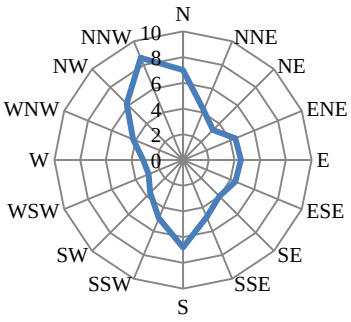

Figure 49 Fort Collins January wind directions.

February

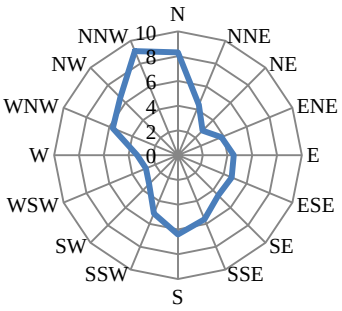

Figure 50 Fort Collins February wind directions.

March

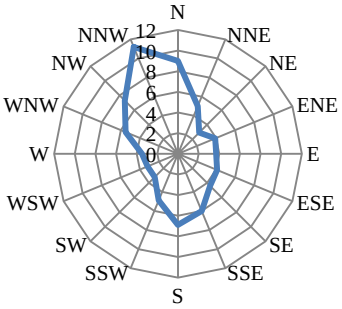

Figure 51 Fort Collins March wind directions.

April

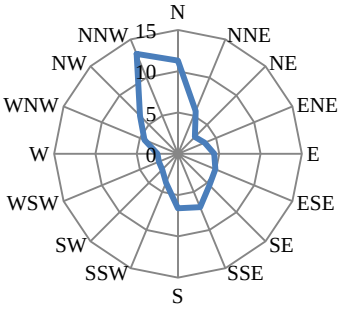

Figure 52 Fort Collins April wind directions.

May

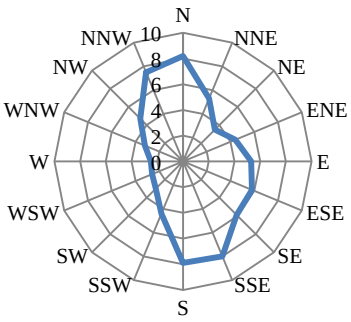

Figure 53 Fort Collins May wind directions.

June

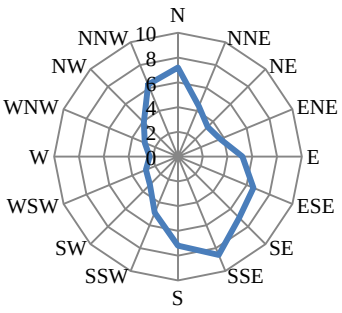

Figure 54 Fort Collins June wind directions.

July

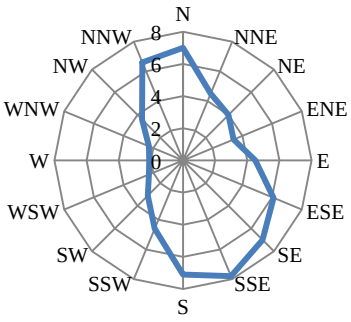

Figure 55 Fort Collins July wind directions.

August

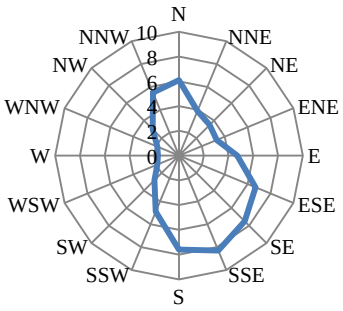

Figure 56 Fort Collins August wind directions.

September

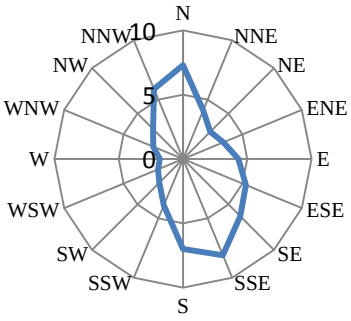

Figure 57 Fort Collins September wind directions.

October

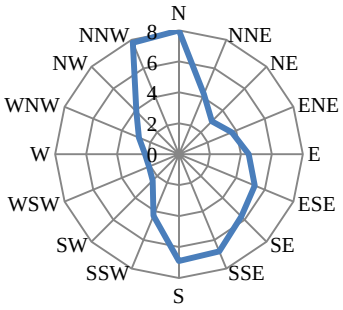

Figure 58 Fort Collins October wind directions.

November

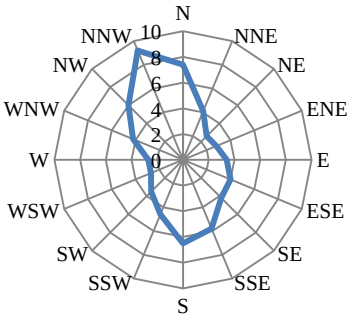

Figure 59 Fort Collins November wind directions.

December

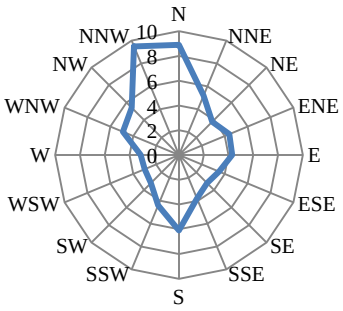

Figure 60 Fort Collins December wind directions.

Site 5WL2413 – Stone Counts per Sector

Stone Circles with a Gap (arrow indicates gap direction)

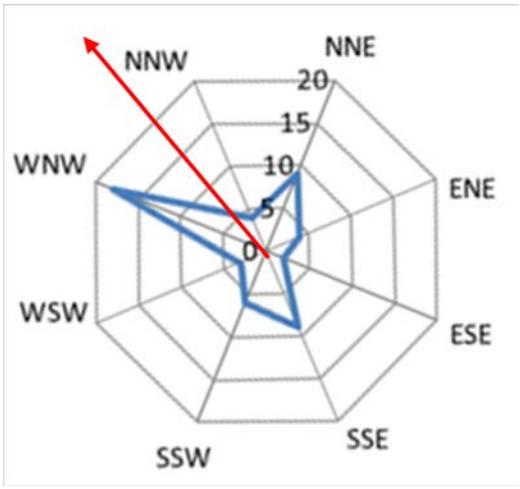

Figure 61 Site 5WL2413 Feature 1 rose diagram.

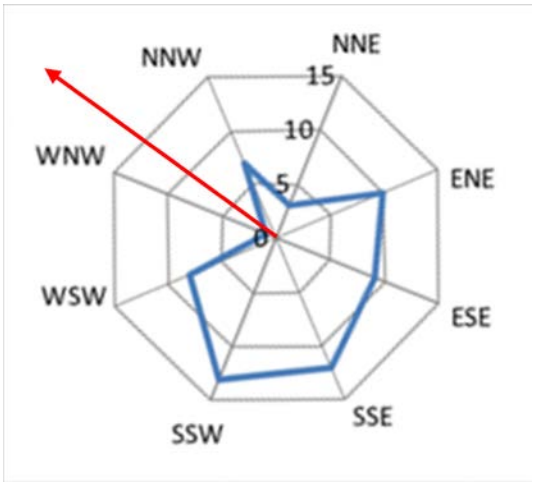

Figure 62 Site 5WL2413 Feature 4 rose diagram.

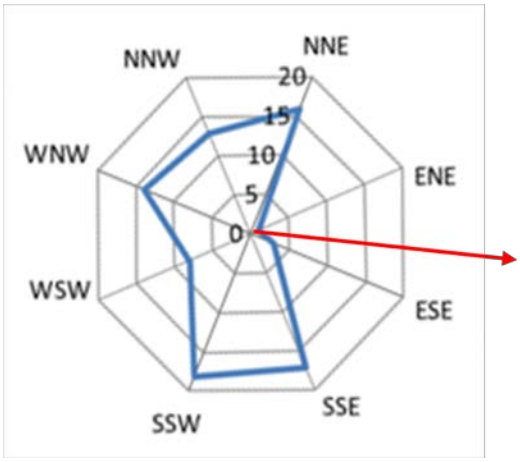

Figure 63 Site 5WL2413 Feature 9 rose diagram.

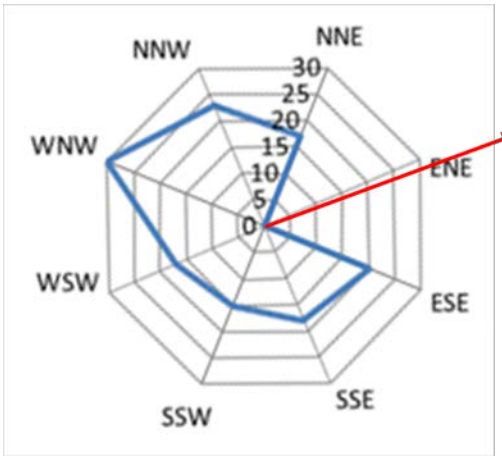

Figure 64 Site 5WL2413 Feature 10 rose diagram.

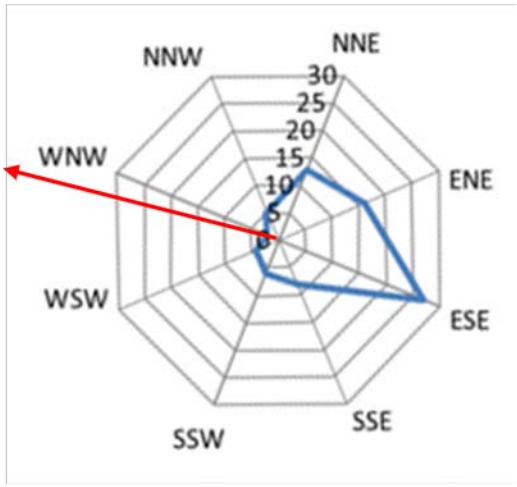

Figure 65 Site 5WL2413 Feature 11 rose diagram.

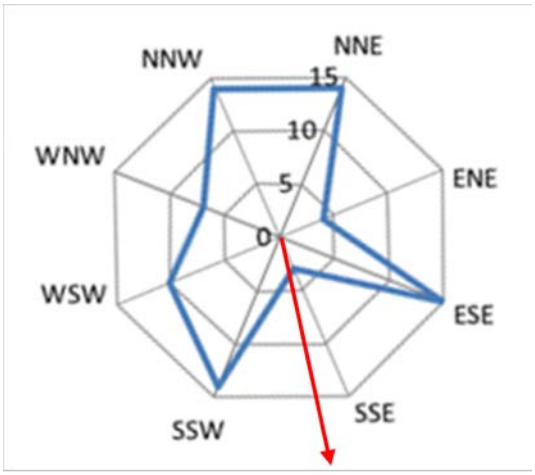

Figure 66 Site 5WL2413 Feature 19 rose diagram.

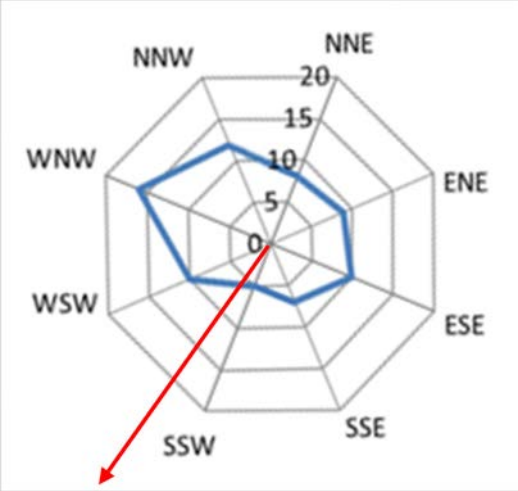

Figure 67 Site 5WL2413 Feature 22 rose diagram.

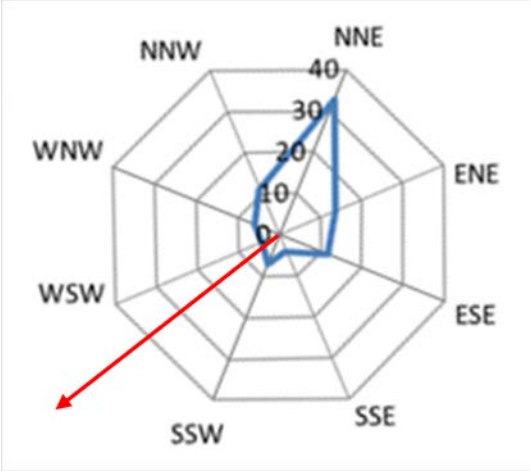

Figure 68 Site 5WL2413 Feature 25 rose diagram.

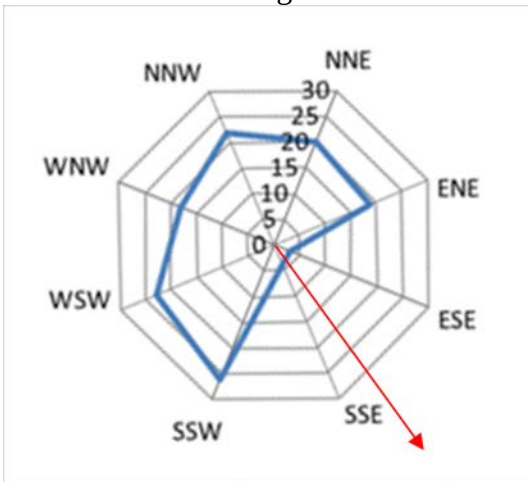

Figure 69 Site 5WL2413 Feature 30 rose diagram.

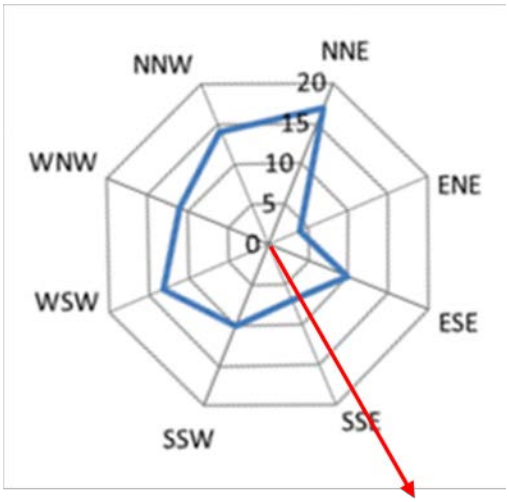

Figure 70 Site 5WL2413 Feature 32 rose diagram.

Complete Stone Circles

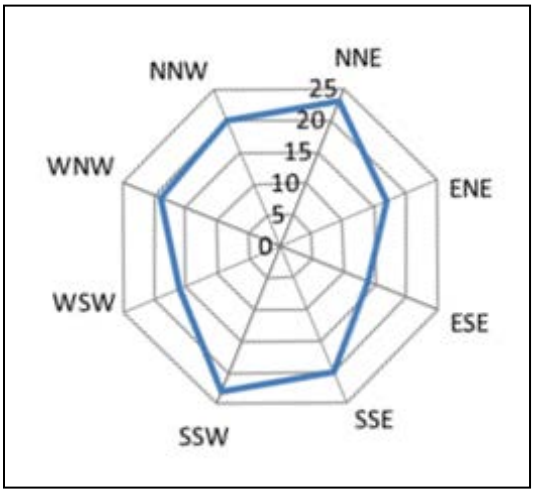

Figure 71 Site 5WL2413 Feature 5 rose diagram.

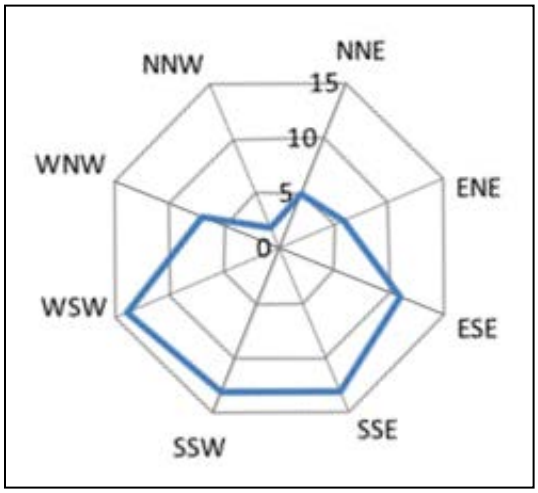

Figure 72 Site 5WL2413 Feature 7 rose diagram.

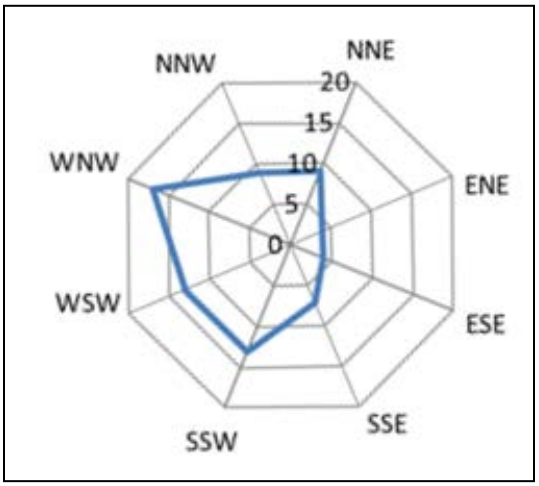

Figure 73 Site 5WL2413 Feature 8 rose diagram.

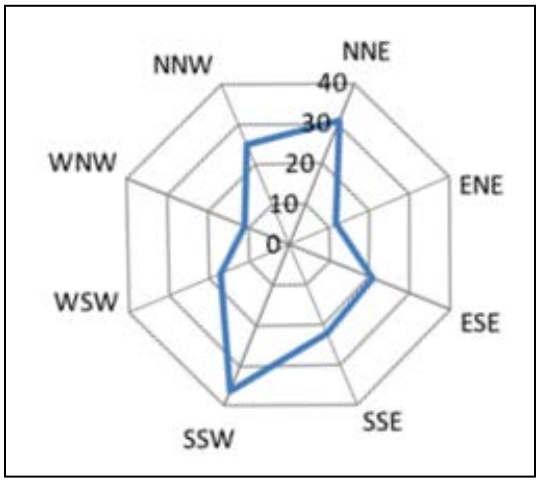

Figure 74 Site 5WL2413 Feature 12 rose diagram.

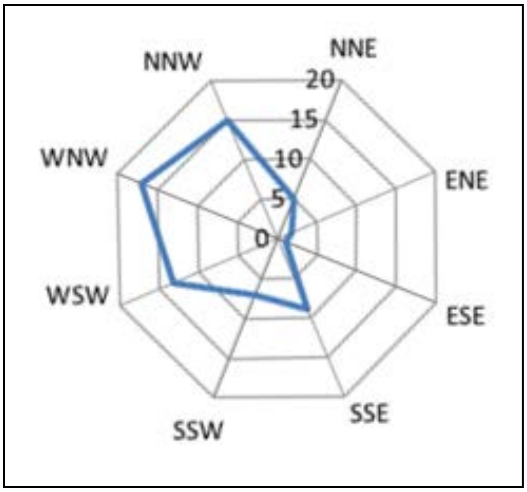

Figure 75 Site 5WL2413 Feature 14 rose diagram.

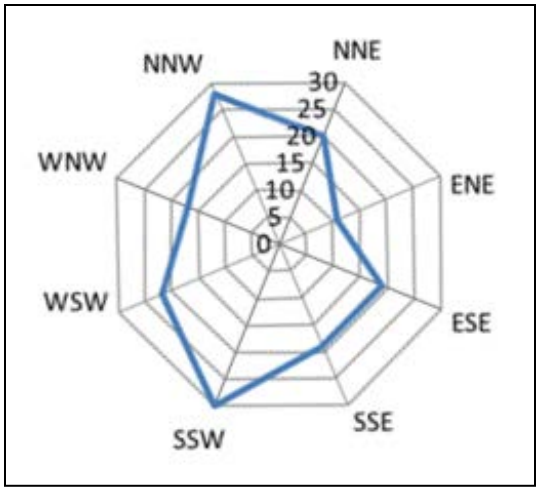

Figure 76 Site 5WL2413 Feature 15 rose diagram.

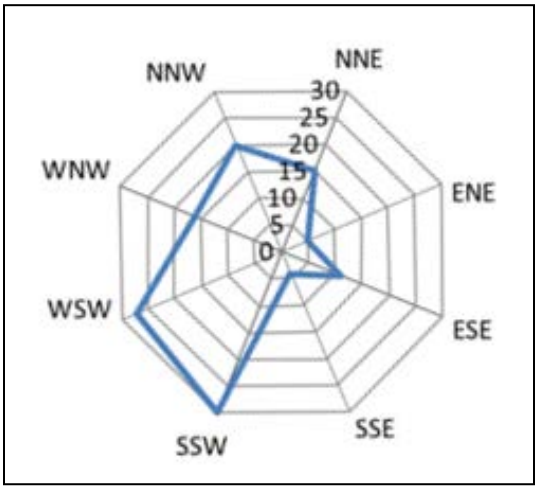

Figure 77 Site 5WL2413 Feature 16 rose diagram.

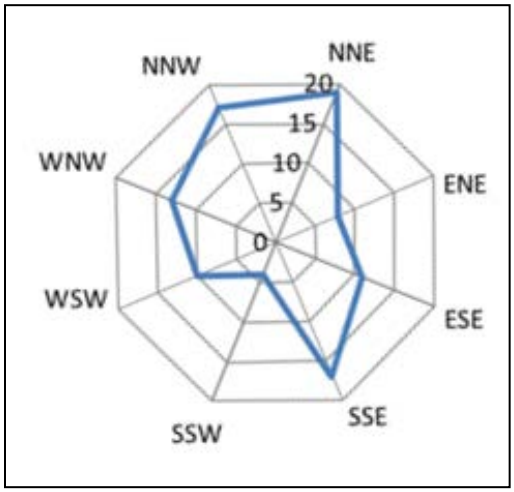

Figure 78 Site 5WL2413 Feature 17 rose diagram.

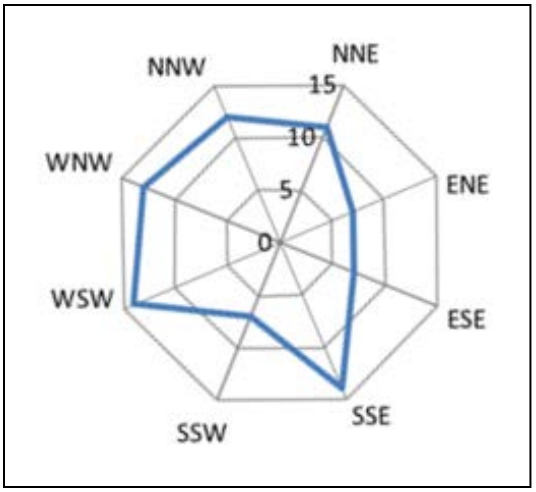

Figure 79 Site 5WL2413 Feature 18 rose diagram.

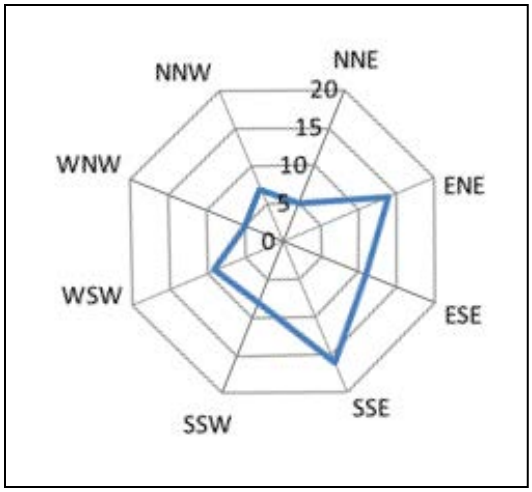

Figure 80 Site 5WL2413 Feature 21 rose diagram.

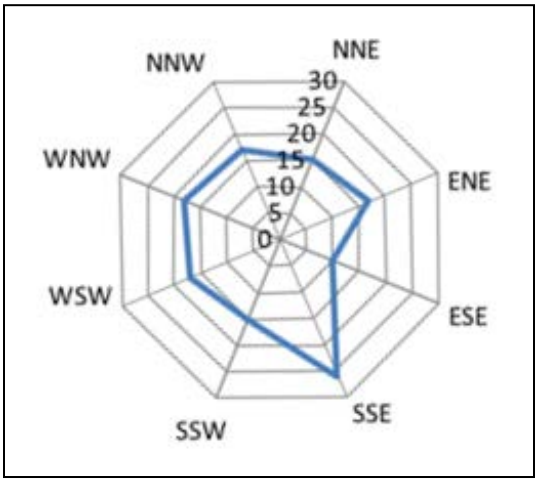

Figure 81 Site 5WL2413 Feature 23 rose diagram.

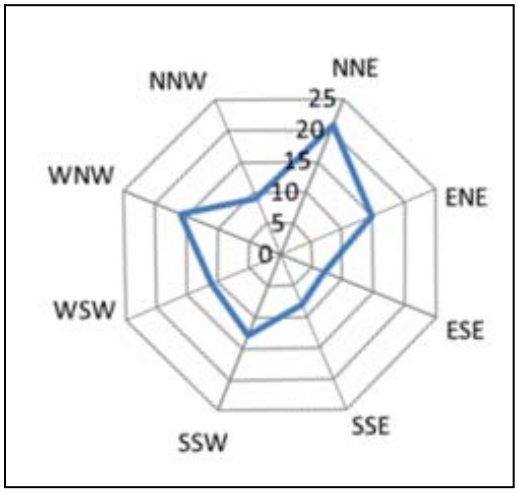

Figure 82 Site 5WL2413 Feature 24 rose diagram.

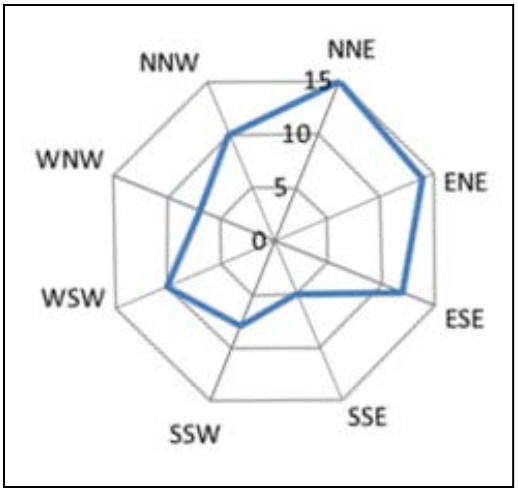

Figure 83 Site 5WL2413 Feature 31 rose diagram.

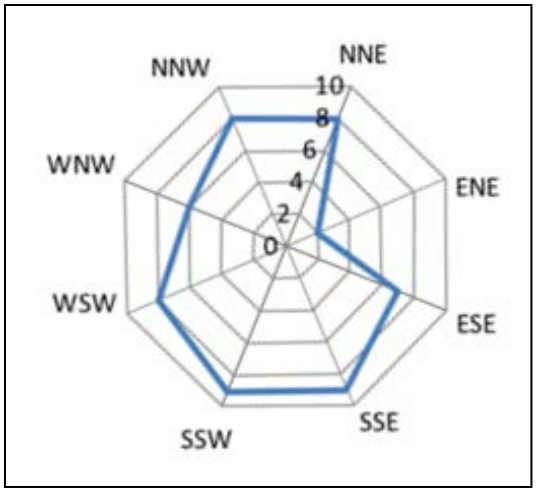

Figure 84 Site 5WL2413 Feature 33 rose diagram.