4.0 RESULTS OF INVESTIGATIONS

It is important to note that this report does not follow conventional practices of most technical archeological reports regarding the disclosure of site locations. No exact site locations are reported here, and photographs and other information that could lead to relocation of archeological remains are avoided. Even the site locations plotted on maps are generalized. This policy is meant to protect cultural remains from vandalism and unauthorized collection of artifacts. The policy is an acknowledgment of not only the scientific value of ancient archeological remains, but also of the cultural value of such resources to the heritage and traditions of contemporary indigenous groups and the interested public. This confidentiality is in keeping with federal statutory and regulatory guidelines and the administrative policies of the NPS that are meant to protect significant cultural resources.

4.1 Field Survey Results

The total of areas surveyed (1.16 km^2) covers only a small proportion (ca. 0.7%) of the entire watershed (166 km^2). The observed site density for the sampled area is 6.9sites/km^2. This density value is not likely to be representative of the entire watershed for several reasons. First, it is probable that the most culturally sensitive survey tracts were selected for examination. In particular, the sample is biased in favor of flat landforms and unfavorable to steep slopes of the valley walls. Although a probabilistic survey strategy is desirable, it is expensive and impractical in the densely wooded, steep slopes of the project area (for many reasons, it is also the case that a probabilistic sampling strategy does not assure a representative sample). The other major source of sample bias is caused by the obscuring effect of dense vegetation and other ground cover, which render subsurface and surface archeological remains invisible in the absence of extraordinary efforts to make them so.

Four previously unrecorded cultural resources were inventoried in the project area during implementation of the field surveys (Table 2). Two of these are documented as archeological sites (45WH631 and 45WH633) and the other two as isolated finds (IF-117 and IF-119). The following narrative provides a brief description of each of these cultural resources.

Table 2. Archeological Resources Inventoried in Survey

			Flaked Artifacts		Lithic Material Type		
Trinomial Site No.	Collection Type	Artifact Count	Formed Tools/ Diagnostics	Flakes and Shatter	Hozomeen Chert	Vitrophyre	Other
45WH631	Surface	75	1 Olcott biface; 1 side-notched point base	73	4	66	1 obsidian; 1 banded CCS; 1 Cache Ck. basalt; 1 metasediment; 1 Allenby Chert
45WH633	Surface	11	1 hammerstone	10	10	0	Unknown
IF 117	Surface	1	0	1	1	0	0
IF 119	Surface	0	0	-	0	0	Limonite
Totals		87	3	84	15	66	6

4.1.1 45WH631

The site is an open scatter of chipped stone on exposed mineral soil, located in a subalpine saddle at 1,587 m (5,200 ft) elevation. The site boundaries encompass an area ca. 400 m^2 (like so many high elevation sites, the actual site dimensions are likely to exceed the observed dimensions). The observed artifact assemblage totaled 75 flaked items, the majority consisting of whole and broken flakes. With 7 distinctive tool stone types represented in this assemblage, the site exhibits the greatest lithic material richness (diversity) of any in the watershed. Based on X-ray fluorescence analysis of 3 artifacts collected from the site surface, combined with visual assignment of other similar-appearing artifacts to the lithic category "vitrophyre", it is inferred that 88% of the assemblage is dominated by vitrophyre derived from Hannegan volcanics (see section 4.6).

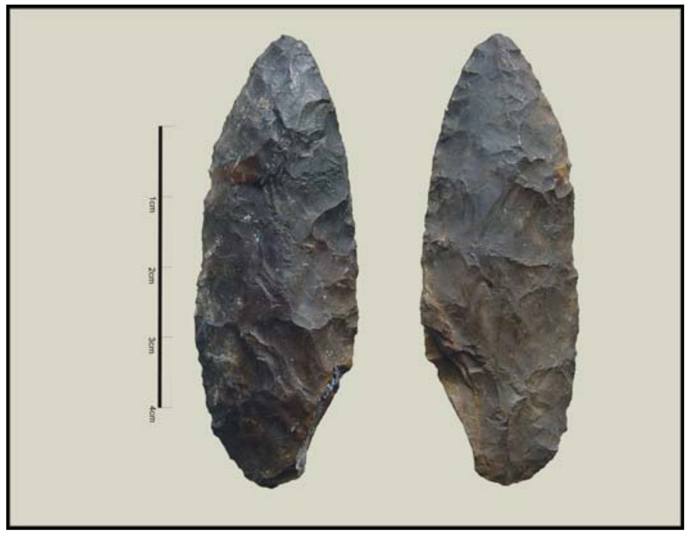

Figure 7. Olcott Series biface, 45WH631.

One early-style (Figure 7) and one late-style (Figure 8) projectile point are the only formed tools observed at the site. Table 3 shows metric attributes of the points. The early morphological point type belongs to the Olcott series, which is estimated to date between ca. 9,000 and 5,000 years ago; this estimated age range is derived from dated sites outside of the park because it has yet to be recovered from datable contexts within the park. For this reason, use of Olcott points as the sole dating technique is problematic, and it has been suggested that their use may extend even into the late period (Mierendorf et. al. 1998:352). The "point" was probably hafted in a socketed shaft and functioned as a spear point or a cutting knife, or both. It is made of a dark brown, fine-grained variety of chert, tentatively identified as "Allenby chert." Vivian (1989) describes the source location of this tool stone and its appearance in outcrops in the Similkameen River valley of southern British Columbia. Olcott series points occur in relatively high frequencies in the upper Skagit River valley at the eastern margin of the project area (the series is included within morphological Type 3 in Mierendorf et al. 1998:500-501). One of several Allenby chert reference specimens provided by Vivian and housed at the NPS curation facility in Marblemount closely matches this Olcott tool stone. Artifacts made of Allenby chert were also found in sites in the Ross Lake area and comprised <1% of the total of all lithic assemblages analyzed (Mierendorf et al. 1998). This Olcott series point may be the oldest (based on morphology and style) formed tool recorded in the subalpine of the park.

The late-style point consists of a basal (proximal) fragment of a small side-notched point. It is made of a black, fine-grained basalt that is visually-similar to Cache Creek basalt, which outcrops upstream of the Fraser River valley canyon (Rousseau 2000). Like Allenby chert, Cache Creek basalt is one of the exotic tool stones that occur in <1% of all upper Skagit River valley archeological assemblages. Identification of this material type as Cache Creek basalt is based on reference samples stored at the NPS curation facility in Marblemount. Points of this style (classed as morphological Type 15 in Mierendorf et al. 1998:514) are widespread in the upper Skagit River valley and elsewhere in the park and are associated with radiocarbon age estimates between ca. 600 and 300 years old. The point may have tipped an arrow shaft, but the neck width of 10.45 mm is intermediate between arrow point and dart point sample means (Mierendorf et al. 1998:353-355), so that either is a possibility. Based on these two time-sensitive point styles, use of this site may span the time between 9,000 and 300 years ago.

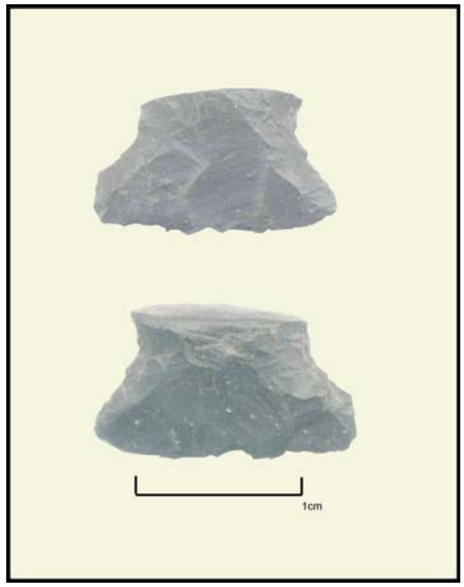

Figure 8. Distal end of Late-style projectile point, 45WH631.

A primary tephra (volcanic ash) sample was collected from the site to help estimate the date of occupation. The layer, ca. 1cm thick, is exposed in the side of several trail treads crossing the site. The tephra is encased within the intact soil A horizon that has developed under a subalpine tundra vegetation community. The sample was identified as layer "W" from Mount St. Helens, which was deposited following an eruption in A.D. 1482 (Mullineaux 1986). The presence of vitrophyre artifacts above and below this tephra indicates that the site was used by indigenous people both before and after this layer was deposited. It also indicates that buried, and presumably intact, artifact-bearing deposits at the site extend to a depth of at least ca. 6 cm below the ground surface.

4.1.2 45WH633

The site is an open scatter of chipped stone on exposed mineral soil, located on a small bedrock bench along the crest of a narrow, subalpine ridge at 1,280 m (4,200 ft) elevation. The site boundaries cover an area ca. 330 m^2 (as with 45WH631, the actual site dimensions are likely to exceed the observed dimensions). The observed artifact assemblage totaled 10 chipped stone artifacts, a hammerstone, and on-site outcrops of Hozomeen chert bedrock exhibiting hammer impact marks (conchoidal fracture scars) from quarrying of tool stone.

Table 3. Projectile Point Metric Data, 45WH631

Oject Name	Catalog Number	Length (mm)	Width (mm)	Thickness (mm)
Olcott series biface	NOCA 22185	65.5	22.86	9.66
Side-notched biface[1]	NOCA 11963	9.3	16.16	4.1

[1]Neck width of biface is 10.45 mm

Most of artifacts of the category "shatter" are made of the most common variety of Hozomeen chert, which is characterized by a microcrystalline, dark gray groundmass, complexly mottled with white, macro crystalline quartz veins. Also present in the assemblage is the sub-variety of Hozomeen chert informally named "Little Beaver gray", a finer-grained microcrystalline tool stone recognized by its homogeneous, medium gray groundmass and near-absence of macro crystalline quartz veins (Mierendorf 1993). The shatter exhibits clear remnant flake scars; several of these pieces retain the tabular shape and weathered cortex of the "ribbon" beds of chert observed on local outcrops.

Most of the site area is covered by a carpet of moss (Figure 9). In several places where we removed the moss cover, we observed that more of the chert beds had been hammered, which left impact scars (negative flake scars, equivalent to partial conchoidal fractures). Such "hammered" bedrock constitutes a type of site feature that appears to be common in several other sites in the upper Skagit River valley where chert was removed from bedrock as the first stage in the procurement of tool stone. (Mierendorf 1993). It is almost certain that removal of more of the obscuring moss carpet would reveal additional artifacts and areas of hammered chert bedrock.

Figure 9. General Area of 45WH633, showing moss-covered Hozomeen chert bedrock (backpack on ground provides scale).

This site is another case of the large class of "quarry" sites that have been recorded in the upper Skagit River valley (Mierendorf 1993; Mierendorf et al. 1998; Franck 1999). Such quarries are the locations where artifact and feature assemblages indicate that indigenous people procured and then initially reduced nodules of chert from bedrock outcrops. Although there is no evidence yet for a quantitative estimate of site age, it appears to belong to a pre-contact time period.

4.1.3 IF 117

This isolated artifact of chipped stone was found at the surface of exposed mineral soil, located on a side-slope several meters below a small bedrock bench at 1,463 m (4,800 ft) elevation, on the same narrow ridge as 45WH633. This flat bench is at the top of a bald, rocky cliff supporting mostly moss, brush, and small tree islands (which are beginning to form krummholz). Only restricted areas of mineral soil are visible. On the bench is a small (<1 m high and several m long) but prominent outcrop of Hozomeen chert displaying a striking pattern of ribbon layering (Figure 10).

The one observed artifact is a primary decortication flake made of dark gray Hozomeen chert. The ventral surface reveals an interior that is glossy and relatively free of inclusions and impurities, qualities that are sought after in good tool stone. The dorsal surface is dull brown and weathered, much like the weathering on the adjacent bedrock. The flake is inferred to mark the procurement of Hozomeen chert from another bedrock source. As in the case of 45WH633, removal of obscuring moss and ground-cover would most probably reveal additional artifacts of chert.

4.1.4 IF 119

This is the location of a mineral deposit with the potential to have cultural significance as a resource collecting area. The deposit has formed as part of the shoreline of a subalpine cirque lake at 1,770 m (5,600 ft) elevation. Here, a reddish-brown bog iron forms as a chemical precipitate along a series of groundwater seeps flowing from the base of a cliff along the lake shore. As the groundwater passes through granodiorite in the mountain above the lake, it leaches iron from crystals of pyrite (iron sulfide) and deposits the iron as limonite (Tabor and Haugerud 1999). This mineral deposit comprises a constructional landform at the east side of the lake outlet and along the lake's eastern shoreline. This landform covers an area of several thousand square meters, and although the depth of the deposit is unknown, it appears to comprise a large volume. This is the only mineral deposit of this type I am aware of in the park. Limonite is one of a class of chemically similar iron oxide compounds, some of which were highly valued by indigenous populations for their use in pigmentation. Stó:lō people, for example, used red mineral pigments to paint masks and in guardian spirit ceremonies (Smith 1988:144).

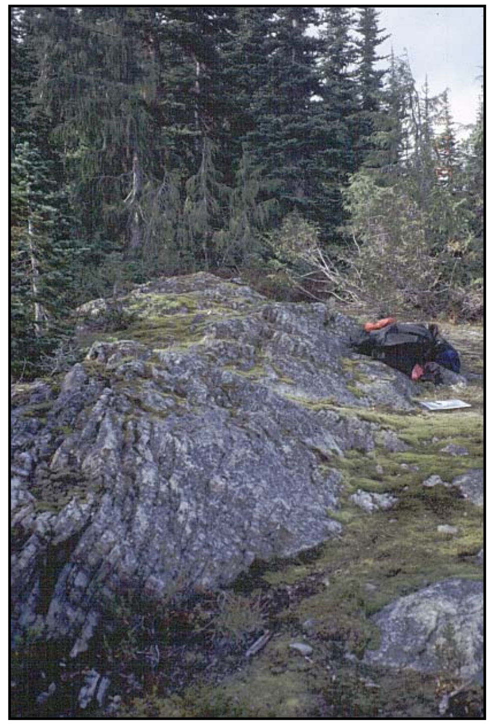

Figure 10. Ribbon bedding of Hozomeen chert at IF 117.

A total assemblage of 87 artifacts was observed at these four archeological resources (Table 2). Eighty-six percent of these were observed at 45WH631. Seventy-six percent of these are comprised of vitrophyre, 17% are Hozomeen chert, and the remainder is of other tool stone categories. The abundance of vitrophyre and Hozomeen chert in the assemblage is not surprising, considering the close proximity of the sites to the geologic sources of these materials. The most abundant morphological artifact categories in this inventory are shatter and flake.

The presence of the two stone points from 45WH631 may be evidence of hunting, but they also represent a tool type that was common whenever travel through the mountains was required. The primary flaking debris and hammerstone at 45WH633 and IF 117 are consequents of quarrying, the set of activities involving the procurement and initial shaping of Hozomeen chert nodules removed directly from bedrock outcrops. Based on chronological assignment of Olcott series biface, it is inferred that indigenous groups utilized the Little Beaver subalpine terrain over a time span as great as ca. 8,000 years.

These simple inferences contribute importantly to our understanding of the northern Cascades high country. They revise conventional ideas about the nature and extent of indigenous adaptations to the high country, chronologically extending the indigenous presence well into the mid-Holocene, a time-span encompassing considerable climatic and ecological variation. The empirical basis for these inferences is limited, however, by the small sample of archeological remains, and to the sample bias introduced by vegetation-obscured surfaces, unsupplemented by controlled excavation data. Another limitation in these data stems from the fact that projectile point morphology is, most often, an imprecise technique for dating archeological assemblages.

Given these concerns, it would be helpful if additional data were available to extend our coverage of the Little Beaver archeological assemblages. Fortunately, this can be accomplished by expanding the geographic scale of the archeological analysis. This is accomplished by including the four archeological resources described above within the larger aggregate sample of all known archeological remains inventoried in the Little Beaver watershed prior to implementation of the SEEC-funded survey. This aggregate sample is constructed by compiling the results of unpublished site inventory records, excavation and research data, and small compliance surveys conducted over nearly two decades of archeological work in or near the project area. The following section describes the archeological patterns and relationships revealed in this larger, aggregate sample of data.

4.1.5 Aggregate Sample of All Little Beaver Archeological Sites

Tables 4 and 5 summarize descriptive site assemblage data and environmental characteristics for all eight archeological sites and the three isolated archeological remains recorded in the Little Beaver watershed. Figures 11 and 12 plot the spatial distribution of these sites in the watershed. These aggregated assemblage data reveal several general trends. All except one of the sites is "open", meaning they area unsheltered and, therefore, exposed to the natural effects of weathering. Nearly half of the sites are on ridges and those that are not are spread across diverse landform categories, such as steep slope, saddle, landslide, river terrace, and cirque lake. About half of the sites are in the subalpine, with all sites ranging in elevation between 500 and 1,756 m in elevation. Although all of the sites are assigned to a pre-contact time period, only two have age estimates, both indicating an indigenous presence in the watershed since the mid- to early-Holocene. The main activities inferred to have occurred at the sites include gathering (procurement) of Hozomeen chert, initial stages of tool manufacture (chert and vitrophyre reduction), with some evidence to suggest the extraction and processing of other resources, including some type of mammal (bone fragments were too small to specify the animal's size or taxonomic identity). Figure 11 plots approximate site locations along vertical and horizontal axes, showing that indigenous use spanned the geographic limits of the watershed.

Table 4. Inventory of Archeological Sites in the Little Beaver Watershed

Trinomial Site No.	Field Site No.	Cultural Resource Type	Landform Type	Age Estimate	Inferred Activity
45WH220	FS 6	Open Lithic Remain	Bedrock Bench	6540-1360 BP [1]	Lithic Procurement/Reduction
45WH446*	FS 129	Open Lithic Remain	Steep Slope	Pre-contact	Lithic Procurement/Reduction
45WH447*	FS 130	Open Lithic Remain	Ridgecrest Bench	Pre-contact	Lithic Procurement/Reduction
45WH463	FS 194	Open Lithic Remain	Saddle	Pre-contact	Lithic Reduction
45WH515	FS 233	Open Lithic Remain	Ridgecrest Bench	Pre-contact	Lithic Reduction
45WH552	FS 270	Rock Shelter/Lithic Remain/Hearth	Landslide	Pre-contact	Lithic Reduction/Resource Processing
45WH631	FS 283	Open Lithic Remain	Saddle	9,000-300 BP [2]	Lithic Reduction
45WH633	FS 280	Open Lithic Remain	Ridgecrest Bench	Pre-contact	Lithic Procurement/Reduction
N/A	IF 93	Open Lithic Remain	River Terrace	Pre-contact	Resource Extraction/Processing
N/A	IF 117	Open Lithic Remain	Ridgecrest Bench	Pre-contact	Lithic Procurement/Lithic Reduction
N/A	IF 119	Open, Mineral Deposit	Glacial Cirque	Pre-contact	Mineral Extraction

*Sites reported and described in Mierendorf, 1993.

[1] Age range based on three radiocarbon dates.

[2] Age range based on diagnostic projectile point and primary tephra layer.

Table 5. Artifact inventory, All Archeological Resources in Little Beaver Watershed

Trinomial Site No.	Collection Type	Artifact Count	Formed Tools/ Diagnostics	Tool Stone Type: Hozomeen Chert	Tool Stone Type: Vitrophyre	Tool Stone Type: Other	MNT
45WH220	Test Excavation						-
	TU1: Lv. 1	165	0	156	0	9 metasediment	-
	TU1: Lv. 2	137	1 biface fragment (H)	135	0	2 metasediment	-
	TU1: Lv. 3	30	0	30	0	0	-
	TU1:Lv. 4	7	0	7	0	0	-
	TU1: Lv 2,3,4,:wall cleanings	3	0	3	0	0	-
	TU1: Lv. 5	1	0	1	0	0	-
	TU2: Lv. 1	73	0	68	0	5 metasediment	-
	TU2: Lv. 2	159	1 biface fragment (H), 1 bedrock corner (H)	158	0	1 metasediment	-
	TU2: Lv. 3	146	0	146	0	0	-
	TU2: Lv. 4	38	0	38	0	0	-
	TU2: Lv. 5	5	0	5	0	0	-
	TU2: Lv. 6	1	0	1	0	0	-
	Excavation Subtotal	765	2	748	0	17	-
45WH220	Surface	74	1 blade (H); 1 unifacial scraper (H)	72	0	1 metasediment; 1 obsidian; 1 bone fragment	3
45WH446	Surface	405	0	405	0	0	0
45WH447	Surface	9	0	9	0	0	0
45WH463	Surface	10	0	0	10	0	1
45WH515	Surface	13	0	0	13	0	1
45WH552	Surface	5	0	0	0	1 metasediment; 4 bone	1
45WH631	Surface	75	1 lanceolate biface (Olcott style); 1 side-notched point base	4	66	1 obsidian; 1 banded CCS; 1 Cache Ck. basalt; 1 metasediment; 1 Allenby Chert	7
45WH633	Surface	11	1 hammerstone	10	0	1 granite	1
IF 93	Surface	1	1 biface (M)	0	0	1 metasediment	1
IF 117	Surface	1	0	1	0	0	0
IF 119	Surface	0	0	0	0	Limonite	0
	Surface Subtotal	604	7	501	89	10	15
	Grand Total	1,369					

The combined artifact count for all sites is 1,369 (Table 5), but slightly more than half of these (765 items) were recovered from the excavation of two 1x1 m test units at site 45WH220 (excavation results are described in section 4.4). Not counting the excavated assemblage, the total of 604 artifacts observed on the surface of all sites far exceeds the sample of 87 artifacts described in Table 2. Noticeable in Table 5 is the low proportion of stone tools relative to other flaked stone categories, which consist mostly of flake and shatter. This observation is consistent with a geographically broader pattern identified in the adjacent Skagit River valley (Mierendorf 1993; Mierendorf et al. 1998). The abundance of flaking debris is a consequence of stone procurement and reduction in a landscape where tool-quality stone must be selected from a larger, heterogeneous body of inferior (non-tool stone) lithic material. Consequently, at the source locations of tool stone materials, the process of extracting tool stone nodules, cleaning them, assuring their quality, and fashioning them into portable shapes, results in a large number of waste flakes and flake fragments. Collectively, such deposits are lumped together as “primary quarrying debris”. This quarrying debris is so abundant that it tends to quantitatively or statistically drown out any finished tool forms that may be present. Further numerical disparity between tool and quarrying debris category frequencies is an outcome of the fact that the shaping of tools into their finished forms tends to be done at locations distant from the sources of the tool stone, so that few completed tools are ever discarded at quarries (this tendency was strongly expressed at 45WH224). It is not surprising, then, that a total of only three formed tools are reported in Table 2 and only eight are reported in Table 3.

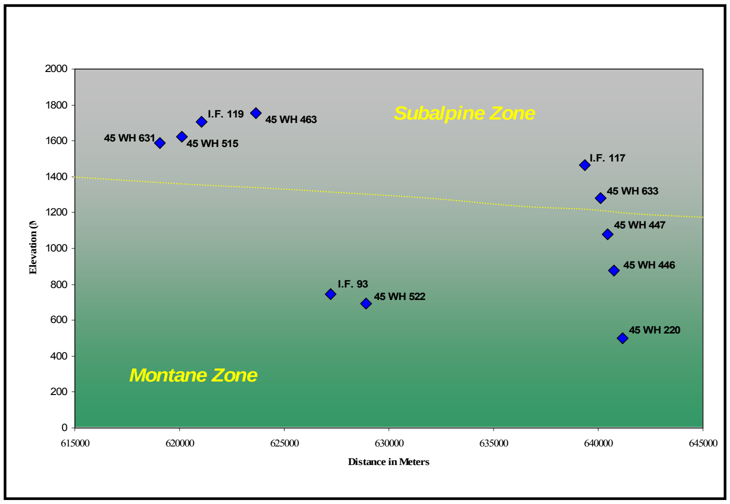

Figure 11. All Little Beaver archeological resources plotted against elevation and east-west distance in meters.

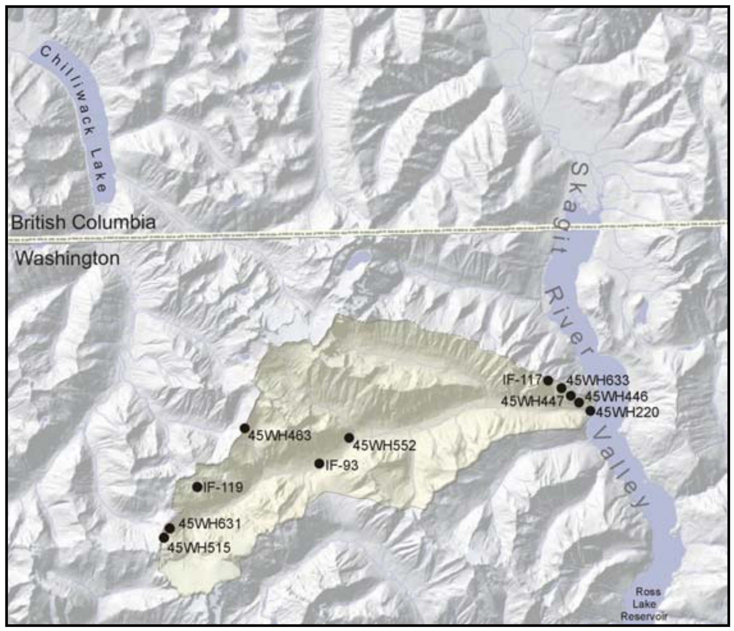

Figure 12. Map of all archeological resources inventoried in Little Beaver watershed.

4.2 Tool Stone Sources

Techniques that are used to accurately identify the variety of lithic materials used for tool stone and to locate the sources where they naturally occur contribute data that is crucial for understanding indigenous use of the project area. The linkage between artifacts and the sources of the materials they are made of—the "source-to-artifact-correlation"—is useful because it is influenced by several cultural and natural factors of interest, including trade, social relationships, band subsistence, demography, mountain geography, bedrock geology, and glacial history. It is seldom easy, however, to accurately identify tool stone sources, and the degree of success depends on many factors. It is fortunate for the present study that positive results have been achieved in characterizing and locating tool stone sources in the mountains surrounding the project area. Based on earlier studies, we can now outline the geographic distribution of several naturally-occurring stone materials utilized by indigenous people in this part of the northern Cascades. East of the project area, Hozomeen chert and metasediment are the two locally available lithic types that dominate archeological assemblages in the upper Skagit River valley (Mierendorf et al. 1998). To the west, vitrophyre derived from the Hannegan volcanic rocks dominates archeological assemblages in the upper Chilliwack River valley (Mierendorf 1987 and 1999). That these two types dominate the Little Beaver aggregate assemblage is consistent with the close proximity of these lithic types in the adjacent watersheds.

Table 6 shows the proportion of the seven distinct tool stone types in the sample (n = 598) of flaked stone artifacts from all Little Beaver watershed sites (does not include artifacts excavated from 45WH220). Hozomeen chert comprises 83% of the sample, and 15% is made of Hannegan volcanics vitrophyre. Allenby chert, basalt, exotic obsidian, metasediment, and chalcedony comprise the remaining 2%. Non-local types were often transported long distances, and are as important as local types for understanding pre-contact cultures.

Table 6. Tool Stone Types by Site in the Little Beaver Watershed

Trinomial Site No.	Hozomeen Chert	Vitrophyre	Metasediment	Allenby Chert	Cache Cr. Basalt	Obsidian	C.C.S.[2]	Totals	Ratio V/T	Ratio H/T
45WH220	71	-	1	-	-	1	-	73	0.00	0.97
45WH446[1]	405	-	-	-	-	-	-	405	0.00	1.00
45WH447[1]	9	-	-	-	-	-	-	9	0.00	1.00
45WH463	-	10	-	-	-	-	-	10	1.00	0.00
45WH515	-	13	-	-	-	-	-	13	1.00	0.00
45WH552	-	-	1	-	-	-	-	1	0.00	0.00
45WH631	4	66	1	1	1	1	1	75	0.88	0.05
45WH633	10	-	-	-	-	-	-	10	0.00	1.00
IF 93	-	-	1	-	-	-	-	1	0.00	0.00
IF 117	1	-	-	-	-	-	-	1	0.00	1.00
Totals	500	89	4	1	1	2	1	598	-	-
Percent	83	15	1	0.2	0.2	0.4	0.2	100	-	-

[1]Sites reported and described in Mierendorf (1993)

[2] Lithic material exhibited alternate bands of chalcedony and chert

A variety of techniques are used to identify tool stone types, but for several reasons, these cannot be applied uniformly to all materials in all localities. This is because the chemical or mineral composition of the material dictates the appropriate analytic technique. Materials of glassy composition, for example, (especially obsidian and vitrophyre) are identified most accurately by chemical characterization using the XRF technique. XRF does not work for crystalline materials like chert and metasediment, which can be characterized by using yet other quantitative techniques. A limitation of the XRF technique is that the artifacts must be at least 1.5 mm thick.

Due to the wide variety of lithic types and the generally high cost of laboratory analysis, not all tool stone types recovered in the project area can be identified with equal levels of confidence. Some identifications are made with a high degree of confidence, while others are made at lower confidence levels. In order to address this problem, I have ranked the seven identified tool stone types in the aggregate archeological assemblage into one of three confidence levels, as shown in Table 7. Four criteria are used to rank the types. The criteria are, 1) presence of a macroscopic description or availability of comparative reference specimens, 2) presence of a petrographic analysis, 3) a chemical characterization or other equivalent quantitative analysis, and 4) description of a material's natural geographic distribution and source locations. The confidence level of an identification is ranked 1 or "low" if it is based on only one of the four criteria; it is ranked 2 or "moderate" if based on two criteria; and it is 3 or "high" if based on three or more criteria. Depending on environmental factors and the nature of the archeological remains in question, any number of other criteria might be considered in assigning confidence levels, but these four are sufficient for this project area.

Table 7. Tool Stone Identification Confidence Levels for Little Beaver Site Sample

Level	Macro Desc/Ref	Petrographic Analysis	XRF	Lithic Landscape	Confidence	Lithic Raw Material Type
1	X	-		-	Low	Cache Cr. Basalt
1	X	-		-	Low	Metasediment
1	X	-		-	Low	Banded CCS
2	X	-		X	Moderate	Allenby Chert
2	X	-		X	Moderate	Exotic Obsidian
3	X	X		X	High	Hozomeen Chert
3	X	-	X	X	High	Copper Ridge Vitrophyre

The first criterion requires that there be a detailed description of the physical properties, including texture, color, grain-size, and other major physical properties of the tool stone or that representative comparative samples are available to categorize tool stone types during analyses. The second criterion requires a petrographic description of the stone to assist in identification or analysis of comparative type specimens. The third criterion entails some type of chemical characterization technique (such as XRF analysis of vitrophyre) that identifies a "fingerprint" for any particular tool stone type. The fourth criterion necessitates an understanding of the local bedrock geology sufficient to identify all available tool stone sources and their geographic distribution. Knowing the geography of tool stone is critical for making artifact-to-source correlations and requires an ability to spatially define and map the extent of separate "lithic provinces" or "lithic landscapes" as they are referred to in tool stone sourcing studies (see Mierendorf 1993:81). However, the difficulties inherent in finding, defining, and mapping tool stone geography requires a long and direct involvement with complex landscapes, especially in the northern Cascades, before this degree of knowledge is acquired.

Hozomeen chert and Hannegan volcanics vitrophyre (Figure 13) are the only tool stone types in Table 7 identifiable to a high level of confidence; both meet three of the four criteria. For Hozomeen chert, a macroscopic description, semi-quantitative petrographic analyses, and a description of its geographic distribution, including several recorded bedrock quarries, have been published (Mierendorf 1993, Mierendorf et al. 1998). In the case of Hannegan volcanics vitrophyre, macroscopic description, x-ray fluorescence of ca. 120 samples from bedrock outcrops and of artifacts, and geographic distribution have been reported and published in technical reports and professional presentations. Field description of source outcrops and their associated quarry assemblages have been reported in Mierendorf (1987 and 1999) and Mierendorf and Skinner (1997). Skinner (1999a, 1999b, 1999c, and 2003), and Skinner and Davis (1996) report the XRF data on source samples and artifacts collected by the author. Maps of the major rock formations from whence the tool stone sources derive are published by Staatz et al. (1972), Tabor and Haugerud (1999), and Tabor et al. (2003).

Figure 13. Photographs of dominant tool stone types in project area. upper, Hozomeen chert, Little Beaver gray variety; center, Hozomeen chert, common dk. gray variety; bottom, Hannegan Volcanics vitrophyre, from Copper Ridge.

The level 1 ranking shown in Table 7 for basalt and metasediment reveals that petrologically-distinct types are difficult to separate on the basis of macroscopic descriptions and comparison between reference specimens and unknowns. Both types are usually black to dark gray, opaque, and fine-grained in field-examined specimens. Although these types ought to reveal distinctive mineral compositions, individual artifacts often require laboratory analysis due to field limitations, such as surface weathering and soil adhesions on artifact surfaces, small crystal sizes of diagnostic crystals in rock matrix, and the small size of many artifacts. The cost of performing petrographic analysis on large samples of archeological specimens is prohibitive. Further research will be required before a shift is possible to a higher confidence level in identifying and discriminating basalt and metasediment tool stone in the northern Cascades. The results of petrographic analysis of several samples from the upper Skagit Valley, compared with a "field" identification of the same samples (Cache Cr. basalt and metasediment) revealed the difficultly in distinguishing these types in hand specimens (Mierendorf et. al. 1998).

Both Allenby chert and exotic obsidian tool stone types are imported to the project area from distant sources. The geography of Allenby chert is described in Vivian (1989), and reference samples provided by Vivian to the author were used to assign artifacts to this tool stone type. The level 2 ranking reflects that fact that there is great variation in hand-specimen samples of these cherts and no petrographic or chemical data are available to characterize or fingerprint the material. The exotic obsidian artifacts from the project area are too thin (<1.5 mm) for XRF analysis, but they exhibit visual characteristics that are similar to other samples from the upper Skagit River valley that correlated with obsidian sources in central Oregon and northern California based on XRF analyses (Mierendorf et al. 1998).

The local dominance of Hozomeen chert reflects its abundance in bedrock formations at the extreme eastern portion of the watershed and that primary reduction at local bedrock quarries deposited a large amount of flaking debris. This is consistent with results reported for the adjacent Skagit River valley, where this lithic type was quarried and procured from numerous local sources (Mierendorf et al. 1998:Table 9.12, p. 78). All sites in Table 6 that are dominated by Hozomeen chert are located at the eastern margin of the watershed.

Hannegan vitrophyre does not occur naturally in the Little Beaver, but it dominates site assemblages at the extreme western margin of the watershed (45WH463, -515, -and 631). This tool stone has yet to be identified in the upper Skagit River valley or in the eastern portion of the project area (although vitrophyre artifacts were recovered from the upper Skagit sites, they apparently are derived from other sources whose locations currently remain unknown [Mierendorf 1997, Mierendorf et al. 1998:360-368]). The presence of vitrophyre tool stone is consistent with the knowledge that sources of this material, associated with pre-contact age quarries, are located only ca. 9 km northwest of the Little Beaver watershed. Only one site, 45WH631, contains artifacts of both Hozomeen chert and vitrophyre. Accordingly, although Hannegan vitrophyre cannot be shown, at present, to have been utilized by inhabitants in the upper Skagit River valley, it was used by those who visited the divide between the Chilliwack and Little Beaver watersheds.

This geographic disparity in the use of these two tool stone types shows quantitatively in Table 6 in the last two columns on the right-hand side. The first of these columns lists the ratio of vitrophyre artifacts to the total number of artifacts in each site (V/T); the second column shows the ratio of Hozomeen chert to the total number (H/T). A ratio of 1 means all of the artifacts are of the type; a ratio of 0 means none are of that type. Note that with the exception of 45WH631, virtually every site exhibits a ratio of 1 or 0 (45WH220 is <1 due to the minor presence of two other tool stone types).

Although ranked at lower confidence levels of identification, the remaining lithic types convey useful information. The presence of metasediment in sites throughout the watershed is not unexpected, given this type's abundance in bedrock of the northern Cascades. The four remaining tool stone types are certain to be exotic in origin, and therefore indicate that the people who utilized the project area carried with them tools made of materials that were traded or procured from distant sources. Assuming the identifications are correct, these exotic source locations are on the order of 100 km (Allenby chert), 240 km (Cache Cr. basalt), and 600 km (Oregon/California obsidians) distant. Finally, it may be noteworthy that 45WH631 is unique among all sites in the watershed for having all seven lithic types represented in its assemblage. This information suggests that indigenous groups who used the northern Cascades interior in the pre-contact past had access to high quality tool stone for the tools they carried with them into the mountains. These conclusions are consistent with the results of tool stone identification and sourcing evidence from the upper Skagit River valley (Mierendorf et al. 1998) and from other widely separated valleys in the North Cascades National Park Service Complex.

4.3 Minimum Number of Tools (MNT)

The seven "formed tools/diagnostics" inventoried in Table 5 are likely to comprise only a subset of the larger assemblage of tools that were used and discarded at the sites reported here. It is often the case that tools used at any site are retained and used again at other, far-removed locations. Although "unseen," such tools can leave evidence of their presence in the form of re-sharpening flakes or broken and discarded fragments. For this reason, the raw count of tools and diagnostics shown in Table 5 is likely to under-represent the actual number of tools that were used at these sites. Shott (2000) has compiled and reviewed techniques previously used by archeologists to address this problem of under-representation. The techniques are similar to those used by archeologists to infer the number of whole pots represented by many pot fragments or the minimum number of animals inferred from an assemblage of animal bone fragments. In the case of flaked lithic remains, several pooled criteria, when applied to a lithic assemblage, can lead to an inference of the minimum number of tools (MNT) represented in a lithic archeological assemblage.

Criteria applied to lithic artifact assemblages for this purpose include tool stone type, whether any of the artifacts fit together, tool dimensions and morphology, manufacturing technology, or any other empirical observations that indicate the incompatibility of different objects. Incompatible objects are those that can be eliminated as once having been part of the same tool or artifact. Using this procedure, a small tool fragment is equivalent to a complete tool in that they both count as 1, as long as they are shown to be incompatible. Even a small resharpening flake, if it is made of a tool stone that does not match any other material at the site, counts as one tool. Any number of separate tool fragments, should they fit together (hence are compatible), count as one tool, no more.

Table 5 shows the MNT for the Little Beaver sites in the far right column. Note that flaking debris representing primary reduction of lithic material at a quarry is not counted as a tool (such as at 45WH446 and 45WH447), unless one of the above criteria unambiguously indicates the presence of a tool (such as the hammerstone at 45WH633). However, the presence of exotic, Hannegan vitrophyre flaking debris (non-local and non-quarrying) at 45WH515 and 45WH631 counted as one in each case; this is because, at a minimum, at least one nodule or core was transported to each site and flaked there. In the absence of a refitting analysis at these two sites, there is no evidence to indicate incompatibility of the flaking debris, so I conclude that no more than one flake core was reduced at each site.

The total of 15 MNT shown in Table 5 is twice the number indicated by the raw count of tools. Most of this disparity is from 45WH631's assemblage, which has a raw count of two tools but a MNT of eight. The significantly larger MNT count is inferred from the presence of incompatible flakes made of several distinct tool stone types. This suggests that the raw count of tools in Little Beaver's aggregate archeological assemblage, and particularly at site 45WH631, under-represents the extent of actual tool use. This is because tools were used and probably resharpened at 45WH631 that were then carried on to other locations. No other site in the current Little Beaver sample of sites displays this amount of tool stone richness (diversity).

4.4 Results of Excavation at 45WH220

4.4.1 Test Units

This section describes the results of the excavation of two 1X1 m test units in site 45WH220. These results do not constitute a final and complete report of the excavation; instead they describe the cultural remains recovered in the test units and relate these to the other site assemblages from the Little Beaver watershed. By combining the watershed's site surface data (survey results) with subsurface data (excavation results), a more complete picture of indigenous use of the area is achieved.

The excavation data from 45WH220 is critical for estimating the time span of human occupation of the valley with far more accuracy than is possible from using surface data alone. There are two primary reasons for this. First, no other site in the watershed has been excavated; consequently, the 45WH220 excavated assemblage is the only one with unambiguous spatial and contextual association of artifacts, soils, and radiocarbon-dated charcoal samples. The second reason is that artifacts excavated from intact (undisturbed) site deposits will usually reveal meaningful associations among soil horizons and weathering zones, geologic layers, including volcanic ashes, and anthropogenic deposits. These associations provide the data necessary to infer local and regional climatic and environmental influences, as well as to investigate on-site subsistence and settlement activities, leading to inferences about site function.

Both test units (TU1 and TU2) were oriented to true north and were placed 10 cm apart, but TU2 was off-set 30 cm south of TU1. This particular positioning of the test units was controlled by several factors, including a confined space within the walls of the wooden shelter and by the presence of bedrock exposed at the ground. As excavation proceeded through the first two levels, it quickly became obvious that the northern half of each test unit was comprised of the top of a bedrock ledge of Hozomeen chert. As a result, the majority of the excavated soils came from the southern half of each unit, immediately adjacent to the ledge. The excavation levels were dominated by a sandy silt matrix encasing abundant granules, pebbles, and cobbles, and flaked stone debitage. Glaciers deposited most of this matrix, which is the parent material within which several natural soil horizons have developed.

No pre-contact age, anthropogenic features were recognized in the test units or elsewhere on-site.

4.4.2 Artifacts Recovered by Test Unit and Level

Table 5 inventories artifacts, including diagnostics and formed tools, recovered by level from each test unit. Only two formed tools/diagnostics were found in the excavated assemblage. Both are fragmentary bifaces that were broken mid-section and both were made of Hozomeen chert. Both are also stage III bifaces, which means that the pattern of flake scars and other morphological characteristics indicate that they had reached an intermediate stage of tool manufacture at the time that they broke and were discarded. Note that each biface was recovered from level two (ca. 10-20 cm below ground surface), but in separate test units, and each is associated with a high density of flaking debris. Also from level 2 of TU2, note the diagnostic item identified in the table as "bedrock corner." This morphologically unique category reflects the intentional removal of chert fragments from bedrock formations. "Bedrock corner" is thus diagnostic of a quarrying technique (first recognized at 45WH224, see Mierendorf, 1993:p. E-4) wherein indigenous quarry workers selectively exploited outside corners or other protuberances in the bedrock by directly applying a great percussive force with a hammerstone. This quarry technique provides an efficient way to remove workable chert fragments from bedrock formations, and it results in morphologically distinctive bedrock corner fragments among the quarrying debris. The corner fragment from TU2 is composed of a tool stone-quality, local sub-variety of Hozomeen chert referred to as "Little Beaver gray" due to its apparent restriction to the lower (eastern) Little Beaver Cr. valley; the direction of flake removals shown by the flake scars and the presence of outcrop cortex preserved on the remnant corner faces reveals a characteristic "pyramid" shape. This shape results from the intersection of the two joining bedrock surfaces, with the third face formed by the irregular fracture plane created where the piece became detached from the bedrock mass. Outcrops of this chert variety are abundant across 45WH220, and the presence of this artifact category in the flaking debris supports the claim that bedrock was quarried on-site.

A total of 765 artifacts were excavated from both test units, which is more than double the total number of artifacts inventoried from the surface of all sites in the watershed (n=604). The tool stone type column in Table 5 shows that virtually all artifacts are made from Hozomeen chert, but for 17 pieces of flaked metasediment. The great abundance of flaking debris and the absence of complete tool forms is consistent with excavation results at Desolation chert quarry (45WH224), where a large assemblage of flaking debris was characterized the primary reduction of Hozomeen chert from bedrock formations and from naturally-occurring nodules (Mierendorf 1993). Both sites (45WH220 and -224) reveal the co-occurrence of abundant primary flaking debris and chert bedrock (usually displaying hammerstone impact marks). Although a quantitative lithic analysis of flaking debris from 45WH220 has not been performed, a qualitative examination of the entire assemblage indicates that biface thinning flakes are abundant. The presence of biface thinning flakes in direct association with early-stage biface fragments, and the absence of evidence for finished tool manufacture, together support the conclusion that the site inhabitants used the locally procured Hozomeen chert for the production of mid-stage bifaces.

Several additional tools, although they were recovered from the surface rather than from excavation, contribute additional useful site information. The blade listed in Table 5 is described morphologically as a mid-section fragment of a Hozomeen chert flake that is trapezoidal in cross-section, and on the dorsal surface exhibits two parallel ridges formed by the removal of three linear flakes. The blade is thin (0.2 cm) and exhibits a transverse fracture at both ends, which has reduced its length to 1.2 cm. The width of the blade is also 1.2 cm. Linear flakes that look like blades are sometimes unintentionally created as a by-product of other technologies, and such flakes are typically triangular in cross-section. The trapezoidal cross-section of this flake, however, may indicate an on-site blade technology. This conclusion is consistent with the results of the Ross Lake archeological project, where the use of microblade technology and microblades are documented at several sites in the upper Skagit Valley (Mierendorf et al. 1998).

The unifacial scraper listed in Table 5 is a thick, broken flake of high tool stone-quality Hozomeen chert. The scraper edge exhibits a consecutive series of short, parallel flake scars on the dorsal surface of the distal flake margin. The scraper edge is continuous across both straight and excurvate segments of the acute-angled margin. The high points on this edge are noticeably smoothed and rounded, indicating that the tool was used against a relatively soft material. Although there is uncertainly as to whether or not the "scraper" was used in other ways, such as for cutting, its presence on-site is evidence that other domestic activities, apart from stone procurement and quarry reduction, were conducted at 45WH220.

The obsidian flake fragment noted in Table 5 is too small for XRF analysis, but simply its presence on-site indicates that another tool form, made from a unique tool stone type compared with all other artifacts from the site, was used at this location. Based on these surface artifacts, combined with the excavated assemblage, it is concluded that site 45WH220 served as an important source of tool-making chert, and as a place where domestic activities were conducted. These activities are consistent with short-term or seasonal camping episodes.

4.4.3 Test Unit Stratigraphy

During excavation, the irregular conformation of the bedrock ledge that covered the northern half of the test units and the abundance of glacial cobbles made it difficult to maintain uniform walls and level floors. As excavation proceeded, it became clear that TU1 had sustained extensive post-occupation disturbance, while TU2 presented a relatively undisturbed sedimentary matrix. For this reason, only the stratigraphy of TU2 is described in this section.

A schematic diagram of the stratigraphy exposed in the southern half of TU2 is shown in Figure 14. Depicted are the vertical and horizontal extent of excavation levels 1 through 5, the bedrock formation exposed in the test unit, and the locations of the three radiocarbon-dated charcoal samples discussed in section 4.4.5 below.

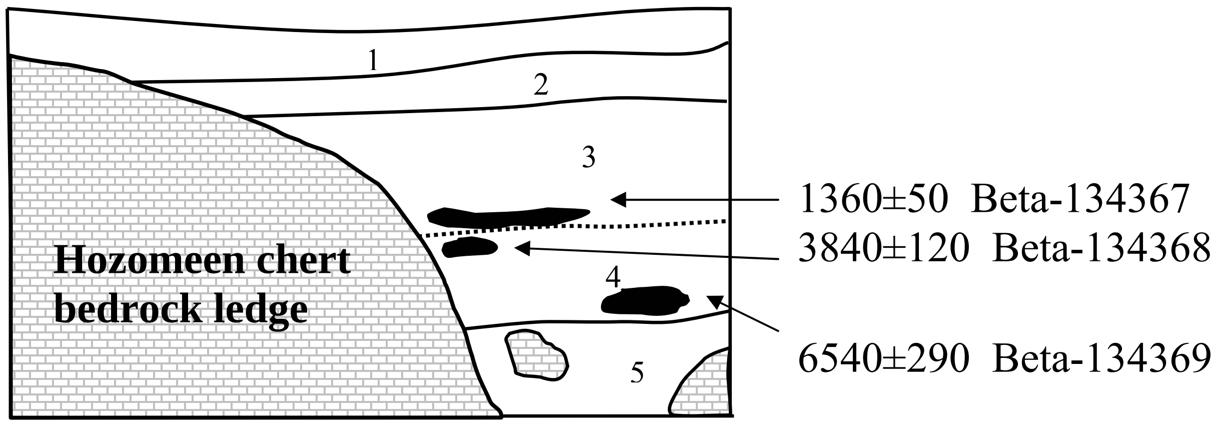

Figure 14. Test unit 2, 45WH220, description of soils and sediments by excavation level (for scale, TU is 1 m wide).

Table 8 provides a detailed description of the soil and sedimentary properties observed in the excavation levels, the artifact categories found in each level, the degree of disturbance, and notes regarding the possible origin of the deposit. The first two levels contained historic artifacts mixed with pre-contact age lithic artifacts, indicating that modern use of the landform for recreational activities has resulted in mixing of the upper site deposits; this recent anthropogenic influence is designated the “Ap” soil horizon in level 1. Level 2 is a mix of the disturbed Ap soil horizon above, mingled with subsurface, pre-contact age B horizon (subsoil) sediments from below. Level 2 is more silt-enriched than any other soil horizon. Levels 3 and 4 contain only flaked lithic artifacts and together these two levels encompass most of the weathered, iron-rich soil B horizon, along with high densities of flaking debris and soil charcoal. This charcoal appears to be anthropogenic in origin. Soil charcoal in level 3 dated 1,360±50 radiocarbon years old; soil charcoal in level 4 dated 3,840±120 and 6,540±290 radiocarbon years old (see section 4.4.5). The frequency of artifacts decreased abruptly in the level 5 matrix, and the test unit was terminated on the top of compact and rocky glacial till.

Generally, the finest (silt dominated) sediments are near the top, and the coarsest (rockiest) sediments are at the test unit bottom. It would be useful if the source of this silt could be known, but this is presently not possible. The site is positioned so far above the Little Beaver Creek and Skagit River flood plains that it would be impossible for flood events to deposit over bank silts on the site. Another source for this silt may be volcanic ash derived from Cascade volcano eruptions. Although the site sediments are likely to contain dispersed or redeposited volcanic silts, discrete layers of volcanic ash were not observed. Another possibility is for the silt to be a type of loess, which is the term applied to deposits of wind-blown silt. Loess typically forms downwind of major silt accumulations, including glacial outwash trains and glacial lake deposits, such as the kind that filled Puget Sound and the lower Skagit valley during the melting of the Puget glacier lobe, between ca. 13,000 and 10,000 years ago. Silt can also become windblown during arid climatic intervals, such as when droughts cause a decrease in vegetative cover resulting in wind erosion of soil.

Whatever the explanation, the co-occurrence of a silt-enriched, weathered soil B horizon with a high density of primary reduction flaking debris, is most consistent with the results of test excavations at several test units at Desolation chert quarry (Mierendorf 1993: see especially the results from TUs 1, 2, 7, 8, 9, 11 at 45WH224). If the age estimates derived from the soil charcoal are free of errors, it suggests that silty parent materials continued to accumulate in the soils at 45WH220 throughout the middle and late Holocene. During this same time span, indigenous groups repeatedly visited the site to exploit its readily-available outcrops of chert, and in the process, deposited dense quarrying debris and charcoal within the soil matrix. Clearly the soil characteristics observed in TUs 1 and 2 are explained only by a combination of anthropogenic and non-anthropogenic causes.

Table 8. Description of Test Unit 2 Deposits by Excavation Level, 45WH220

Excavation Level	Soil Symbol[1]	Description of Excavated Deposits
1: 0-10 cm	Ap	Brown (10YR5/3), pebbly silt, mixed with scattered charcoal fragments; topsoil eroded away; deposits mixed with historic artifacts made of glass, metal, plastic, nylon, including .22 bullet casings, coins dating no earlier than 1976, and nylon rope. Contains high density of Hozomeen chert flaking debris. The top of level is the ground surface under the shelter prior to excavation.
2: 10-26 cm	Ap/B	Light yellowish-brown (10YR6/4) silt, with some angular and subangular pebbles; recent historic artifacts of glass, metal, plastic, and fiber. High density of Hozomeen chert flaking debris. Level is disturbed by historic mixing, particularly near the bedrock ledge. The characteristics of both Levels 1and 2 are a product of modern tent camping and campfire use for decades, and of construction and maintenance of the wooden structure.
3: 20-30 cm	Bo1	Yellowish-brown (10YR5/4), gravelly silt; gravels are angular and subangular clasts of Hozomeen chert from adjacent bedrock, supported in the silt matrix; the soil zone of maximum weathering, and color appears to be imparted by formation of iron oxide coatings on soil particles and artifacts; absence of historic artifacts; one tight pocket of charcoal collected from ***in situ*** submitted for radiocarbon dating. Moderate density of Hozomeen chert flaking debris. This Level is an intact remnant of an old, weathered, and relatively stable soil that has formed in place on one of the largest expanses of flat land atop a bedrock formation of ribbon chert of the Hozomeen group of rocks. **Dated sample lab number is Beta-134367.**
4: 30-40 cm	Bo2	Yellowish-brown (10YR5/4), gravelly silt; exhibits same pedological characteristics as level 3; gravels are angular and subangular clasts of mixed lithology, including igneous (granitic) and metasedimentary types, including Hozomeen chert; gravels increase in density at bottom of level; collected from ***in situ*** two concentrations of charcoal; the lowest was wedged between cobbles, near bottom of the level and appears to have been intact a long time; bottom of level is at the top of glacial till. **Dated sample lab numbers Beta-134368 and Beta-134369**.
5: 40-50 cm, 50-60 cm	C	Very pale brown (10YR7/3), poorly sorted, silty gravel; the brown silt of levels 3 and 4 forms the silty matrix at top of level, grading to compact glacial till at the bottom; large clasts in the till show a variety of igneous and weakly and strongly metamorphosed rock types; some rocks coated with clayey, weathered surfaces.

[1]Master soil horizon nomenclature according to Schoeneberger et al. 1998.

4.4.4 Local and Regional Context of Excavation Results

When compared with the 36 archeological sites test excavated in the adjacent Upper Skagit River valley, both the artifact assemblage and environmental setting of 45WH220 is most similar to those of 45WH224. Both sites reflect quarrying of bedrock and the manufacture of "blanks", the equivalent of "refined raw material" in that the raw rock was cleaned of imperfections and made portable. At both of these sites, the absence of finished tools made from the on-site chert bedrock means that final manufacturing was completed elsewhere. Sites 45WH220 and portions of 45WH224 are located on flat, rocky, valley-marginal landforms covered by a half-meter or so of post-glacial loess. At both, dense flaking debris is dispersed throughout the soil matrix, but most noticeably in the reddened, iron oxide-rich zone that forms the present soil B horizon. Both locations also offer good solar exposure, a local climatic factor important in the selection of even short-term mountain encampments (Mierendorf 1986). Overall however, the artifact assemblages speak to task-specific activities centered around collecting chert and reducing it into generic biface forms.

Such quarries are one part of a broader, valley-wide pattern of a well-developed biface production technology in the Upper Skagit. The technology developed in response to the presence of a locally abundant chert, extracted in bulk by indigenous populations for millennia (Mierendorf et al. 1998). The Hozomeen chert was mined and collected from bedrock outcrops and from the gravels deposited in alluvial fans, glacial till, flood plains, and river gravels. As described here, this quarrying technology signifies a local montane-oriented, industrial-level of indigenous quarrying unlike any other reported in western Washington or the southern Northwest Coast.

4.4.5 Radiocarbon Age Estimates

Dating of charred plant remains is a precise and reliable way to estimate the age of pre-contact period sites and the human activities they reflect. One of the noteworthy discoveries from the excavation of TU 2 at 45WH220 was the presence of discrete pockets of charred wood fragments in the silty and somewhat rocky, weathered subsoil. These concentrations appeared strikingly different from the many small, dispersed charcoal fragments observed throughout the soil matrix. Much of this dispersed charcoal is the result of natural forest fires. Three of the charcoal samples collected during excavation of TU2 met the field criteria used to assess a sample's potential reliability. The criteria are that 1) the sample is intact and is recovered from in situ, 2) it is in direct physical association with artifacts, and 3) that it lacks any evidence of matrix disturbance, mixing, large root penetration, or intact tree or root burning.

The three samples were collected from *in situ* in the unit floor during excavation (none of the samples was recovered from the screen). At the time of collection samples were placed in labeled, zip-lock plastic bags. Samples were cleaned, weighed, and packaged for shipment at the park's archeological lab in Marblemount.

The age estimates obtained from the samples are shown in Table 9 along with the sample provenience, the depths below the ground surface, and the conventional and calibrated ages.

Table 9. Radiocarbon Age Estimates From Site 45WH220[1]

Sample Lab. Number	Test Unit	Excavation Level	Depth Below Unit Datum	Conventional Radiocarbon Age[2]	Calibrated Age[3]
Beta-134367	2	3	26-27 cm	1360±50	1335-1185
Beta-134368	2	4	30-31 cm	3840±120	4540-3895
Beta-134369	2	4	38-39 cm	6540±290	7945-6760

[1]All ages reported here are conventional dates on charcoal, excavated from in direct association with lithic artifacts

[2]Age in radiocarbon years before present after C13/C12 adjustment

[3]Calibrated date at two Sigma (95% confidence interval), using tree ring calibration curve to estimate age in calendar years

Figure 14 and Table 9 show the provenience of the samples in TU2 (Table 8 describes the soil and sedimentary context of each sample). The sample depth and age columns in Table 9 reveal that the sample ages increase with increasing depth below ground surface. This is the spatial relationship expected if the charcoal is in original (i.e. undisturbed) depositional context. The table also shows the conventional radiocarbon ages corrected for error by calibrating them to calendar years. These age estimates reveal that people began to use the site as early as 8,000 to 6,700 years ago. The physical remains associated with each sample, described below, leads to other inferences from the radiocarbon dates.

Beta-134367 (1,360±50), the uppermost sample, appeared as a concentration covering an area ca. 25 cm x 8 cm in the top of level 3, immediately next to a sloping face of Hozomeen chert bedrock. The sample co-occurred with abundant flaking debris, and angular nodules of Hozomeen chert from the surrounding soil matrix which appear to have been anthropogenically detached from the bedrock outcrop. This is the largest of the three samples (6.6 g dry weight before pretreatment).

Beta-134368 (3,840±120) was recovered in the top of level 4, 1-2 cm below the northern extent of Beta-134367 and immediately adjacent to the sloping face of bedrock, and in direct association with abundant Hozomeen chert flaking debris. The submitted sample weighed 2.4 g dry, before pretreatment.

Beta-134369 (6,540±290) was collected from an area about 10 cm in diameter, where it formed a tight pocket wedged among a grouping of rocks. Of the three, this sample was farthest removed from the bedrock face. It also was in direct association with a high density of flaking debris. This was also the smallest sample (1.4 g dry weight before pretreatment) and it required extended counting time for a reliable age estimate (the small sample size accounts for the wide standard deviation).

In order to formulate reliable inferences from these dates, it is necessary to know the origin of the charred woody fragments. Were these concentrations the result of human activity or is the charcoal's presence an outcome of natural, soil-forming processes as influenced by forest and shrub plant communities? A clear pattern of association with dense flaking debris and with charred woody fragments occurring in well-defined concentrations could support the case for an anthropogenic origin to the charcoal. At the same time, a natural origin cannot be ruled out, given that the presence of forest fire-created charcoal in soil profiles of coastal temperate forests of the region is well-demonstrated (Gavin 2001, Gavin et al. 2003). Assuming the dated charcoal samples at 45WH220 are anthropogenic in origin, there is still the problem of the inbuilt error in the dates. This error is the time that lapses between the death of the organism (in this case, trees or shrubs) and the occurrence of the event being dated (anthropogenic burning, such as in a campfire). This means that woody tissue that died a century before being burned in a fire will yield a radiocarbon date 100 years older than the event being dated (campfire burning). Although the anthropogenic origin of the charcoal samples cannot be demonstrated conclusively, their occurrence in association with abundant artifacts and as discrete concentrations of charred fragments is indicative of human activity.

For comparison, there are no other radiocarbon-dated archeological sites in the Little Beaver watershed, but a series of sites was dated in the adjacent upper Skagit River valley, within the Ross Lake drawdown zone. Many of the drawdown dates correlate with the youngest date from 45WH220, 1,360 years ago, which falls in a time period when indigenous groups made extensive seasonal use of the Skagit valley. But none of the dated Ross Lake sites have radiocarbon age estimates that correlate with the two earlier dates from 45WH220. The one site that does correlate, however, is Desolation Chert Quarry (45WH224). This site closely resembles 45WH220 in terms of artifact classes present, artifact abundance, radiocarbon age estimates, and geologic characteristics. This quarry is located several km to the southeast and across the valley from 45WH220.

The correlation between these two sites is seen clearly in the comparison of excavation levels 3 and 4 of Test Unit 2 at 45WH220 with Stratum 3 (excavation levels 4 through 8) of Test Unit 2 at 45WH224. At the latter site, a small concentration of charcoal was found encased in brown, weathered silts and in direct association with a high density of Hozomeen chert flaking debris. The charcoal was excavated from *in situ* from 80 cm below ground surface and was dated at 4470±200 years old (WSU-3813) (Mierendorf 1993:45, D-4). This date falls between the two older dates from 45WH220.

Based on the near-equivalency of artifact assemblages, age, and geologic context, the archeological excavation data from 45WH220 upholds two conclusions formed more than a decade ago, based on data from 45WH224, that 1) indigenous inhabitants began to utilize local rock outcrops to procure and initially reduce Hozomeen chert at least by the mid-Holocene, and 2) that flaking debris resulting from this activity is preserved in a weathered subsurface soil horizon in direct association with datable soil charcoal of probable anthropogenic origin. These results, in turn, support the assertion of the upper Skagit Valley as a Northwest Coast tool stone source for many millennia.

4.5 Electron-microprobe Identification of Tephra (Volcanic Ash) Sample

One primary tephra sample was collected from 45WH631 and submitted for identification to Dr. Franklin J. Foit, Jr., at the Department of Geology, Washington State University. The sample (NOCA 22171) closely matches the chemistry (0.99 similarity coefficient) of Mount St. Helen's W, a chemically-distinctive tephra deposited from an A.D. 1480 eruption (Mullineaux 1986, Yamaguchi 1983). This layer has been chemically identified previously at other archeological sites in the park, including at 45WH484 on Copper Ridge to the west (Mierendorf 1999) and from several sites in the Ross Lake vicinity to the east (Mierendorf et al. 1998). The ash from this event must have blanketed the watershed immediately following the eruption.

This volcanic ash sample was removed from 4 cm below the ground surface, from within a well-defined, black soil A-horizon formed under a subalpine meadow community. The tephra layer outcrops at several locations inside the site boundaries, but it was sampled at the place where it appeared to be a primary deposit (meaning the layer is undisturbed and in the original location of its deposition). The primary tephra was observed here to form a continuous layer of very light-gray silt, ca. 1 cm thick, aligned parallel to the ground surface, but beneath the dense root zone of the meadow vegetation (which is dominated by heather, huckleberry, and *Luetkea*.. At one location on-site, flakes of vitrophyre were observed both above and below this ash, indicating use of the site both before and after ca. A.D. 1480. This finding is consistent with the results of the test excavations at 45WH484, where a high density of vitrophyre flaking debris also was found both above and below a primary layer of St. Helens W tephra (Mierendorf 1999). This also indicates that indigenous use of 45WH631 was contemporaneous with the use of 45WH484, which is located close to one of several vitrophyre quarries.

4.6 X-Ray Fluorescence (XRF) of Vitrophyre

Three artifacts from 45WH631 and one from 45WH515 were analyzed, and all four were identified as coming from Copper Ridge geochemical source B (detailed results are shown in Appendix A-2). This source is one of nine separate vitrophyre dikes, associated with the Hannegan volcanics that were mapped in the park by the author between 1986 and 1998. In the nine outcrops, four geochemical sources could be discriminated, but with high intrasource variation. Copper Ridge geochemical source B is the best defined of the four,

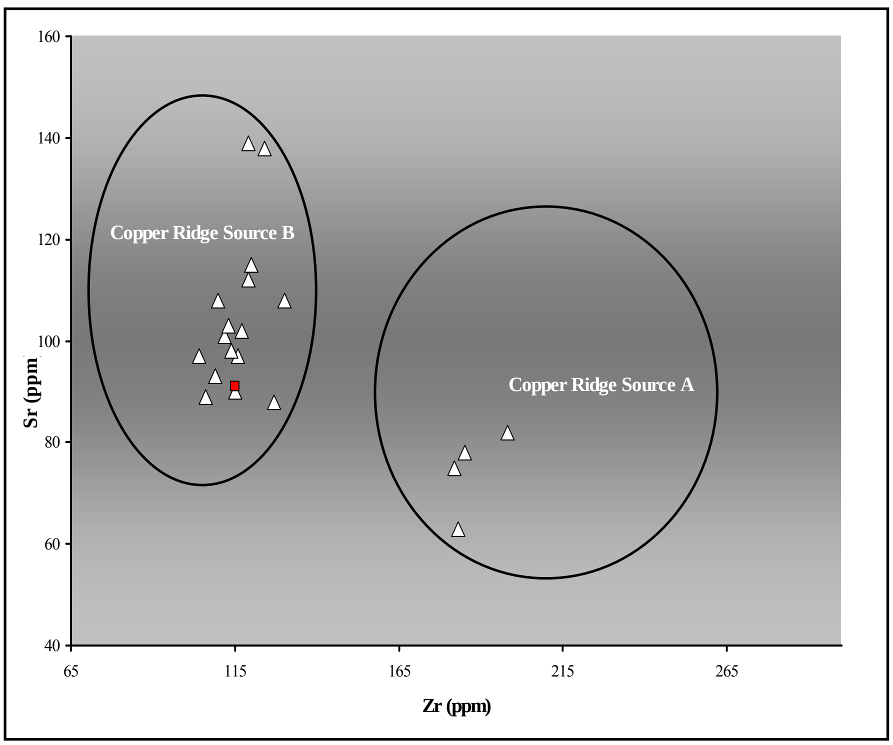

Figure 15. Scatter plot of Strontium (Sr) vs. Zirconium (Zr) in part per million, of all artifacts in Appendix A-2. Black lines circumscribe the plotted values from 67 vitrophyre source samples from nine outcrops used to define geochemical sources A and B on Copper Ridge (Skinner 1999b:Fig. 3, p.8). Triangles are artifacts, the red square represents a geologic sample (see appendix A-2).

but the others (A, C, and D) exhibit wider variation in trace element composition.

Figure 15 plots the results shown in Appendix A-2, using Strontium and Zirconium (in parts per million) as diagnostic trace elements (following Skinner 1999a and 1999b). The ellipses in Figure 15 outline the areas defined by the scatter plot of 67 geologic source samples published in Skinner and Davis (1996) and Skinner (1999a and 1999b). Note that four artifacts are correlated with Copper Ridge source A, but these are derived from a site located to the southwest of the project area.

Figure 16 maps the locations of sources A and B on Copper Ridge. The outcrops consist of veins or dikes of mostly black vitrophyre derived from volcanic activity associated with formation of the Hannegan caldera (Tabor and Haugerud 1999, Tabor et. al. 2003). The dikes intrude into the older and lighter-colored granitic rocks of the Chilliwack Composite Batholith. In some cases the dikes have weathered and eroded to the degree that no dike structure is visible, resulting in the formation of vitrophyre nodules in scree deposits below outcrops.

Geochemical source A is comprised of eight separate dikes located along the southern extent of Copper Ridge. The vitrophyre outcrops exhibit wide variation in tool stone quality. The majority of each outcrop generally consists of stone that is marginal, at best, for tool use. Nevertheless, a small portion of some outcrops consists of glassy, tool stone-quality vitrophyre. Wherever these latter outcrops occur, they are associated with nearby quarrying sites dominated by primary flaking debris.

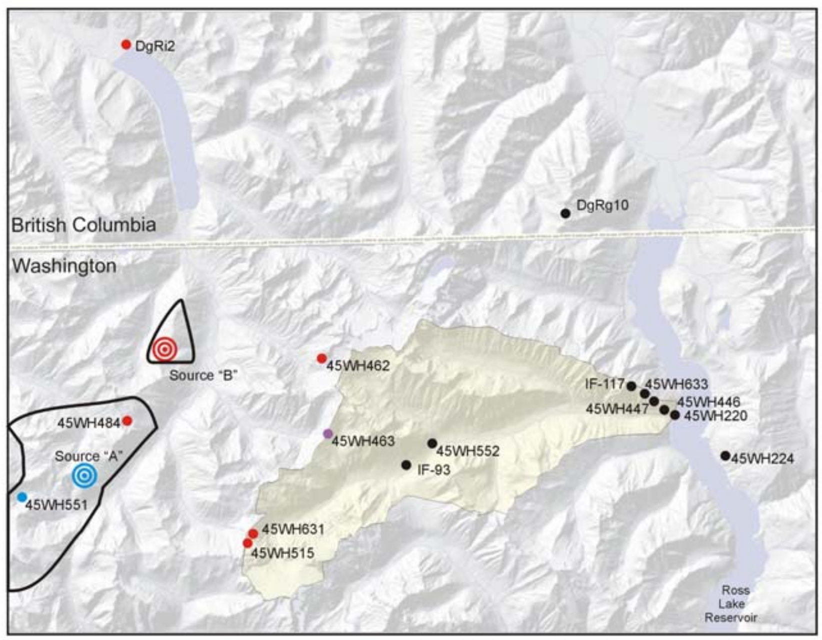

Figure 16. Map showing Little Beaver watershed sites with artifacts correlated to vitrophyre tool stone source locations; red dots denote artifacts from Source B; blue dots denote artifacts from Source A; purple dot no data; black dots denote sites lacking vitrophyre.

The geochemical source identified by XRF as "Copper Ridge Variety B" occurs as a single outcrop that has eroded from the side of an unnamed summit on northern Copper Ridge. Although quite glassy, this outcrop is highly fractured and weathered, resulting in an abundance of small (<4cm), rounded nodules. This outcrop is also associated with primary flaking debris.

In addition to these two geochemical sources, Figure 16 shows archeological sites in the project area vicinity, color-matched to the geochemical source of the site's vitrophyre artifacts. Artifacts made from source B are found in two sites at the head of the Little Beaver watershed, at the lower end of Chilliwack Lake, at one site just west of the Little Beaver watershed (45WH462) and on Copper Ridge (several other sites on Copper Ridge, not plotted in Figure 16, also contain artifacts geochemically sourced to B). To date, artifacts made from Hannegan volcanic rocks have not been identified in the upper Skagit River valley, and their only occurrence in the Little Beaver watershed is along the divide that separates Little Beaver from the Chilliwack. The map shows that all vitrophyre artifacts from along this divide are geochemically correlated with Copper Ridge source B (the only exception is that vitrophyre artifacts from 45WH463 have yet to be collected for sourcing). Two artifacts made from Copper Ridge source B were found in site DgRi-2 at the northern end of Chilliwack Lake, a distance of 12 km from its outcrop location (analysis of these artifacts and the geologic specimen was made possible through a loan to the author by Dave Schaepe). A single geologic specimen, although not visibly modified, could have been transported by people to DgRi-1, located near to DgRi-2, and it too is correlated with source B. All eight artifacts analyzed from 45WH462, which is located in a deep cirque bowl on the Chilliwack side of the ridge separating it from the Little Beaver watershed, correlated with source B. Artifacts from 45WH551 shown in Figure 16, which sits in a subalpine basin below the southern end of Copper Ridge, were mostly vitrophyre from source A (one of these five samples shown in Appendix A-2 is from source B). Due to the geochemical variation in the eight outcrops that define this source, the artifacts linked to source A could have come from any of these outcrops. Given that 45WH551 is the most proximate site to the source A outcrops, dominance of this source within the artifact sample makes intuitive sense. The presence of one artifact correlated to source B at this site, combined with the other artifact-to-source correlations, indicates that artifacts from source B are widely-distributed in the upper Chilliwack and upper Little Beaver watersheds.

Figure 17. Outcrop ii, Copper Ridge geochemical source B.

The fact that the locations of sources A and B are approximately equally distant from the upper Little Beaver-Chilliwack divide might suggest that tool stone from both sources should have an equal probability of being transported to the divide. The source-to-artifact data from the sample of artifacts analyzed for this project reveals that only vitrophyre from source B was brought to the upper Little Beaver. Any number of ad hoc inferences could be invoked to explain this distribution of source B tool stone, including that there was a preference for source B. But the current state of knowledge is limited by small sample sizes and a large deficit in survey data covering a broad area of northern Cascades. Much of the mountainous terrain that exposes the Hannegan volcanic rocks is administered by agencies other than the NPS and has not been surveyed for tool stone sources. Surveys notwithstanding, there are likely to be other volcanic tool stone sources remaining undiscovered. In spite of these limitations, the methodologies and analytic tools are in place to investigate millennial patterns in the movement of tool stone as these relates to indigenous adaptations to high elevation terrain of western North America.