Geochemical Identification of the Extramural Activity of Laundry Washing at Cantonment Burgwin, Taos, New Mexico

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ABSTRACT

During the occupation (1852–1860) of Cantonment Burgwin near Taos, New Mexico, the Army laundresses processed the soldiers' laundry using lye soap. Lye, or potash, contains phosphorus, an element that is relatively immobile when added to soils, as with discarded wash water. Archaeological excavation of Cantonment Burgwin's laundresses' quarters identified the footprint of their quarters. To locate the laundry washing area, chemical analysis was conducted on soil samples using the colorimetric method to determine the amount of phosphorus within each sample. The research conducted to geochemically identify the chemical signature of the extramural activity of laundry washing is summarized.

Historical Background

From 1802 to 1876 laundresses were the only officially recognized women in the U.S. Army. An 1802 Act of Congress assigned four laundresses per company (ca. 100 men) who were each issued a daily ration of meat, bread, and whiskey. Appointed by the company commander, the laundresses were generally placed in quarters—which could be tents, patched-together huts, or more substantial structures—that were set at a distance from the rest of the garrison in what was often termed Soap Suds Row (Stewart 1980:422). Laundresses' foremost duty was to launder the soldiers' clothes, but they often served as midwives, nurses, and part-time cooks and maids for officers (Stewart 1980:430). Each man was charged for his laundry, and the rates were determined by the post Council of Administration, with officers paying more than the enlisted men. When soap was scarce, as was the case in 1812 at Fort Wayne, the laundresses charged less if the soldiers provided the soap (Stewart 1980:424). Since the Revolutionary War, soap and candles were recognized as essentials in a U.S. Army soldier's rations (Koehler 1958).

Established in 1852, Cantonment Burgwin was a U.S. Army temporary fort located ca. 16 km (10 mi.) south of Taos, New Mexico, along the trail from Santa Fe to Fort Massachusetts in Colorado (Figure 1). Throughout the 1850s, Cantonment Burgwin fulfilled its military role by sending out expeditions that escorted supply wagons, recovered stolen cattle, and fought the raiding Utes and Jicarilla Apache. Originally constructed to hold one company of dragoons, the cantonment was later expanded to temporarily house two companies and, in 1857, it held as many as 236 men for several months (Wetherington 2006:395). As shown on an 1853 map of Cantonment Burgwin (Figure 2), the laundresses' quarters was a four-room structure set behind (east of) the main compound. The laundresses' water source, Rito de la Olla (Pot Creek), is located ca. 30 m (98 ft.) north of the former quarters. Based on the number of men housed at the garrison, it is estimated that between three and nine women worked on Cantonment Burgwin's Soap Suds Row during its occupation (Wetherington 2006:399).

As the region's major military engagements followed the Apache and Utes further north into the mountains and out of the Taos region, Cantonment Burgwin became less necessary and the post was closed in 1860. Over the ensuing years, the remains of the abandoned fort were salvaged by local people and some portions were burned to the extent that little physical evidence of its presence remained.

The archaeological investigation of Cantonment Burgwin (LA 88145, also known as TA-8) began in 1956 and continues to the present day (Kennedy 1967; Crass 1990; Whowell 1994; Wendorf 1996, 2007; Wetherington 2006; Thomas and Volanski 2014). The investigations have located and exposed the double-courtyard main fort compound, the commander's quarters, the officers' quarters, the hospital with associated doctor's quarters, the laundresses' quarters, and the quartermaster's store. Subsequently, the main fort and several of the buildings—but not the laundresses' quarters—were reconstructed on their original footprints.

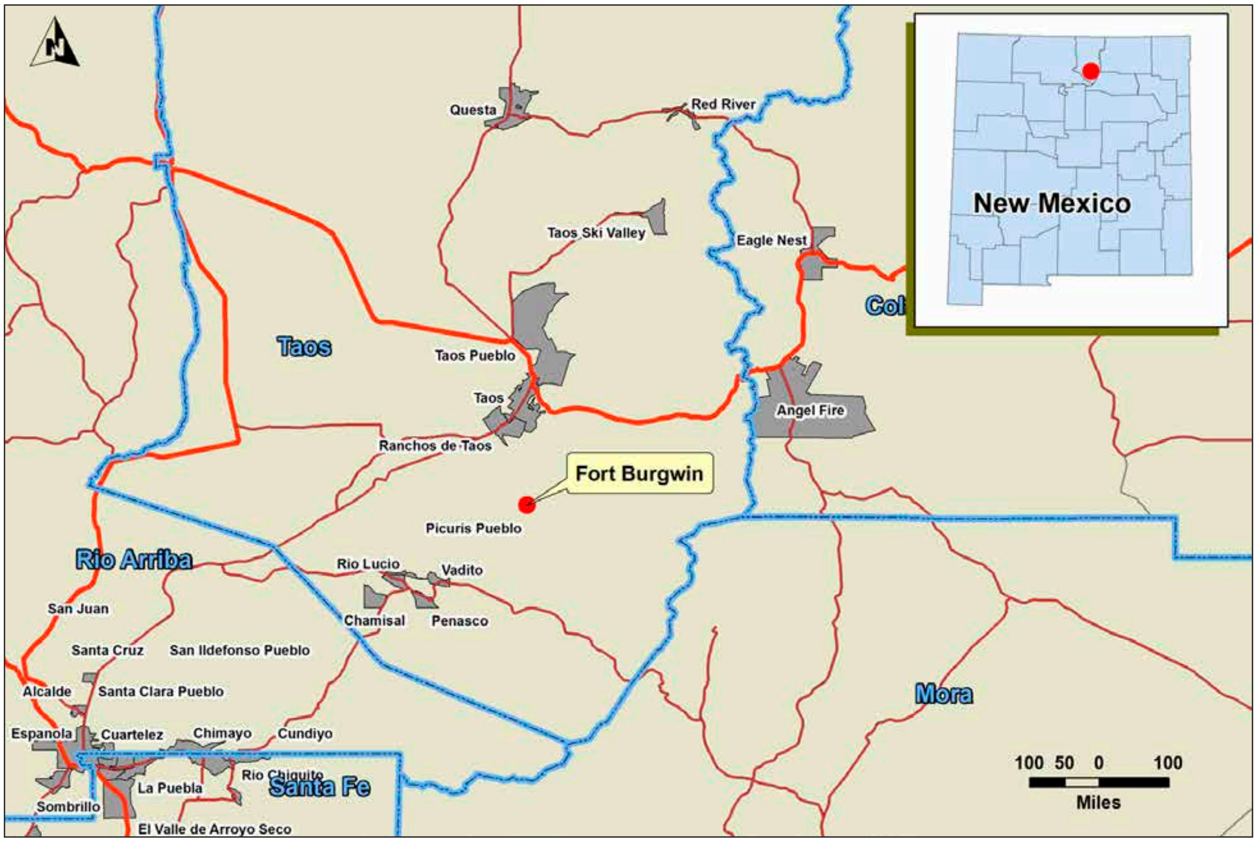

Figure 1. General location of Fort Burgwin, Taos, New Mexico. (Graphic by and courtesy of David Pedler, 2012.)

In 2009 Mercyhurst Archaeological Institute (MAI) revisited the portions of the laundresses' quarters that were initially exposed in 1967 (Kennedy 1967). The MAI investigation focused on relocating the building's footprint, determining the extent of intact remains, and recovering material culture associated with the women who occupied the structure. The investigations, which continued into the 2010 field season, exposed the remnants of the vertical logs that outlined the four-room structure, identified the two double-sided fireplaces, and recovered more than 6,500 artifacts. During the 2010 field season, soil cores were taken east of the laundresses' quarters to address the research objective of locating a potential extramural laundering activity area. Obvious prior disturbance in the form of a gravel road precluded testing west of the laundresses' quarters.

Laundering

Prior to the advent of modern washing machines, laundering required hard physical labor that involved hauling water, chopping wood for fires to heat the water, filling the laundry tubs, and hanging them over the fire (Army Laundresses 2008). Soap, obviously, was an essential element in the laundering operation, and in the 19th century soap was made of lye and fats and produced via saponification. Prior to modern synthetic chemicals, the necessary fatty acids were obtained from rendered oils and fats found in foodstuffs. The alkali was derived from seeping water through wood, bone, or bracken ashes to create a strong alkali known as lye or potash (sodium hydroxide [$NaOH$] or, historically, potassium hydroxide [KOH]). The two ingredients were boiled together until the brown, jelly-like, soft soap was formed. Hard soap was created by adding common salt at the end of the boiling process, which produced a hard layer that floated to the top (Ellis and Ellis 2013). Generally, soft soap was stored in a tub or smaller vessel and was ladled out when needed. Hard soap, on the other hand, was formed in a mold and then cut into individual bars.

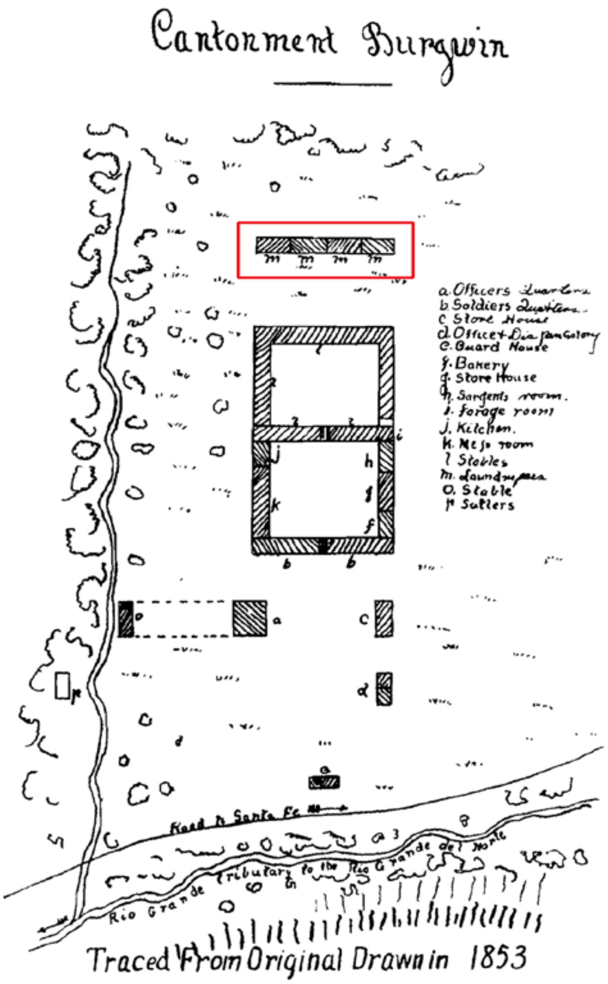

Figure 2. Map of Cantonment Burgwin (1853) showing laundresses' quarters outlined in red (modified from Wendorf 2007, by David Pedler, 2012).

One of the elements found in wood ash is phosphorus, which played a key role in this research. When the laundresses discarded tubs of soapy water after washing, the residues would have leached into the ground. Studies have shown that once phosphorus is added to soils, it is relatively immobile and does not disperse far from the area of deposition (Lawrie 1999:76; Misarti et al. 2011:1453), nor does time affect the phosphorus signature's strength for at least 4,500 years (Misarti et al. 2011:1453).

Site Geomorphology and Soils

Located within the Sangre de Cristo Mountains, Cantonment Burgwin was constructed at the confluence of Rio Grande del Ranchos and Pot Creek at an elevation of 7,415 ft. Since that time, the confluence has migrated ca. 1.6 km (1 mi.) downstream of the Rio Grande del Ranchos. The laundresses' quarters are situated on a nearly level first terrace of Pot Creek. As described in the soil survey of Taos County (Hacker 1982), the soils expressed on the site are Cumulic Haplaquolls, which are poorly drained and found on level to gently sloping soils adjacent to streams at elevations of 7,000–8,000 ft. Formed in mixed alluvium, these soils are stratified gravelly sandy loam, gravelly loam, and gravelly sandy clay loam to a depth of 60 in. or more. The content of gravel and cobblestones ranges between 15% and 50%. The permeability is moderate to moderately rapid and runoff is slow (Hacker 1982:16–17).

To expose the natural stratigraphy of the terrace, a 1 × 1-m unit at E1010, N1000 was excavated during the 2010 investigation of the laundresses' quarters. Excavated to a depth of 1.8 m (6 ft.), the unit identified the following strata: A horizon (0–40 cm), E horizon (40–64 cm), Bw horizon (64–80 cm), C horizon of glacial outwash (80–135 cm), 2C horizon of slackwater deposits (135–155 cm), and 3C horizon of glacial outwash (155–180 cm). The A horizon showed no evidence of plowing.

Phosphorus and Soil Analysis

The element phosphorus, 15P, is a multivalent nonmetal of the nitrogen group that is generally found in an oxidized state as inorganic phosphate rock. Essential for life, inorganic phosphorus is obtained from the soil by plants and, in turn, the decay of dead plants and animals produces organic phosphorus (Cornforth 2008:1). Agriculturalists have long recognized the importance of enhancing plant production by introducing phosphorus through phosphate fertilizers. Their interest in assessing the phosphorus level of soils led to the development of a number of phosphate testing methodologies.

The colorimetric method for determining phosphate in water was first developed by Murphy and Riley (1962). This method utilizes antimony in a solution that will turn an intense blue color depending on the amount of phosphorus present. A spectrophotometer is then used to measure the optical density (or absorbance) of the blue solution. Some 30 years later, Tiessen and Moir (1993) utilized the colorimetric method to determine the amount of phosphorus in soil samples. Additional methods for detecting the amount of inorganic phosphate in soil samples were developed, including mass spectrometry and inductively coupled plasma spectrometry. (For comparisons of the three methods, see Pierzynski et al. [2010] and Sobeck and Ebeling [2007].)

Analyzing the elements in soils is a well-established practice in archaeology. Recognizing that human activities such as food preparation and discard, hearth use, burials, and manure accumulation and discard impact the elements in soils, researchers have used phosphorus testing to identify activity areas and site organization (Lawrie 1999; Vizcaíno and Cañabate 1999; Sullivan and Kealhofer 2004; Wilson et al. 2008; Misarti et al. 2011). The Cantonment Burgwin research extends the use of phosphorus testing to identifying laundry processing locales.

Analytical Methodology

During the 2010 season, MAI field personnel systematically collected soil cores via a 3¼-in. hand auger (Figure 3). At each sample location, single samples were taken from each of the three arbitrary 10-cm levels (labeled A–C) spanning the depth of 0–30 cm below ground surface, where possible. Occasionally natural obstructions (e.g., large rocks) at a given surface location or within a coring hole prevented the extraction of the entire core and/or all three levels. In total, 297 core samples were recovered from 99 sample locations. To produce a manageable and statistically representative sample size for this study, a 35% sample was randomly selected from the 99 sample locations. From 35 sample locations, 105 samples were selected for chemical analysis.

This study employed the colorimetric phosphorus test method outlined by Tiessen and Moir (1993:75–76) to determine the phosphorous concentration of the soil samples. The data were digitized using Microsoft Excel, and the mass equivalents of the samples' absorbance values were calculated using the following equation: $y = 0.0143x - 0.086$, where y represents the absorbance value and x represents mass (in µg) of phosphorus in the solution. For a complete description of the analytical procedures, see Thomas and Volanski (2014).

Results

The colorimetric testing for phosphorous in the soil samples successfully demonstrates that a direct correlation exists between optical density (or absorbance) and phosphorus concentration: the darker the blue, the greater amount of phosphorus in the solution (Murphy and Riley 1962; Tiessen and Moir 1993). The absorbance readings range from a low of 0.003 to a high of 0.180. The highest concentrations of phosphorus in the project area soils were identified in the uppermost 0–10-cm arbitrary level (Level A), which exhibits absorbance values that range between 0.016 and 0.180 (Figure 4). With the exception of a few outliers, the highest absorbance values in Level A are located in the west-central portion of the project area. Containing considerably less phosphorus than those from Level A, soil samples from the 10–20-cm arbitrary level (Level B) exhibit absorbance values that range between 0.004 and 0.096 (Figure 4). Like Level A, the highest absorbance values for Level B are located in the west-central portion of the sampled area. The lowest concentrations of phosphorus were identified in the lowermost 20–30-cm arbitrary level (Level C), which exhibits absorbance values that range from 0.003 to 0.099 (Figure 4). With the exception of one outlier, and as with Levels A and B, the highest absorbance values for Level C are located in the western center of the sampled area. At each level, however, there is broad conformity between the absorbance values and the color of the solution.

Of the mass values calculated for phosphorus concentration among the samples, Sample 24 (E1010, N1015) contains the highest amount of phosphorus—18.6 µg/ml—in Level A. The highest phosphorus concentration was detected in Samples 10 (E1008, N1019), 24 (E1010, N1015), and 27 (E1010, N1021) (Figure 4; Table 1). The lowest phosphorus concentration was detected in Sample 91 (E1018, N1017), Level C, which exhibits a phosphorus concentration of 6.2 µg/ml.

Discussion

This project identified elevated levels of phosphorous in soils derived from an area behind (east of) the laundresses' quarters. Not unexpectedly, the soil phosphorus concentration for Level A (0–10 cm) was either elevated or

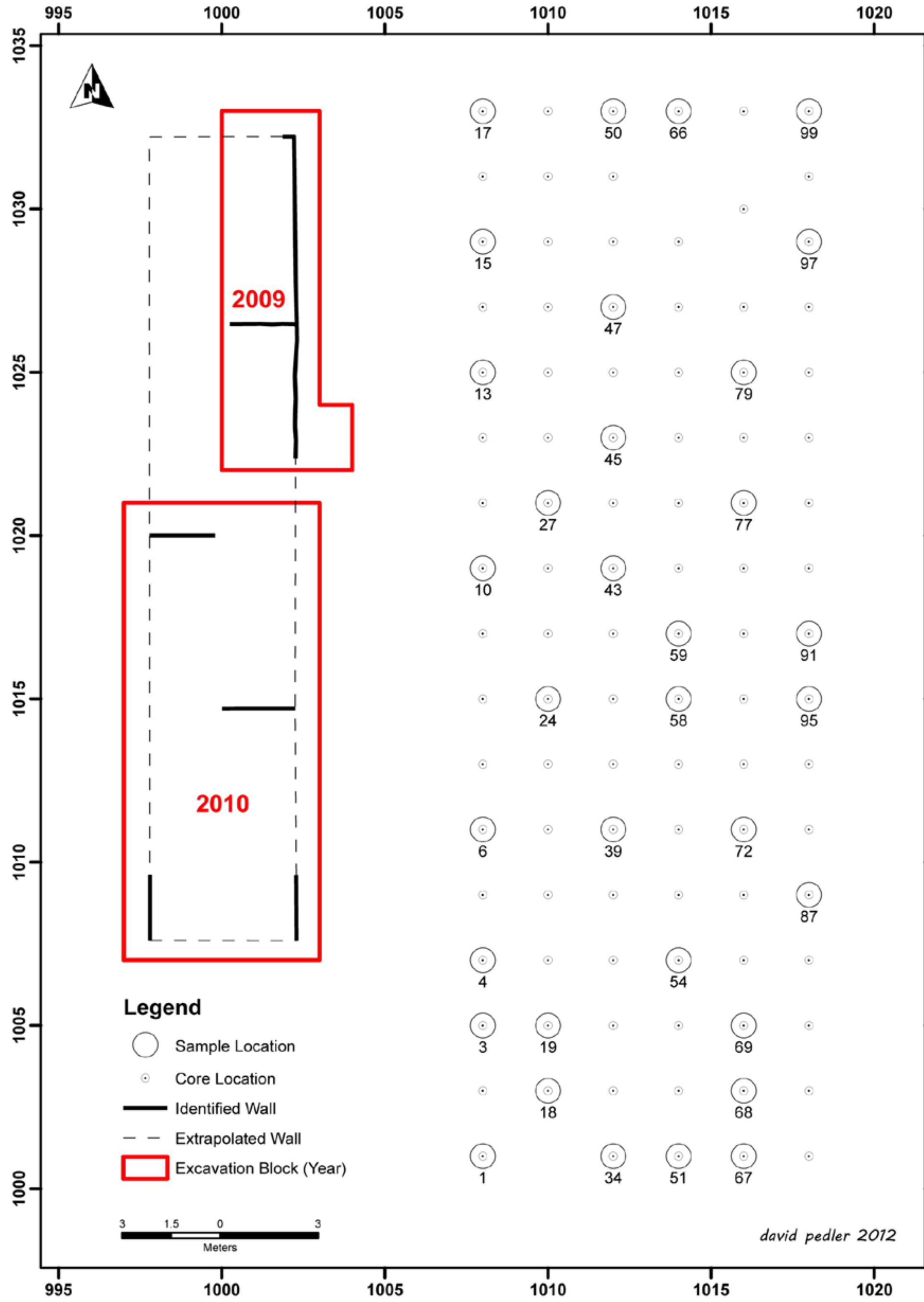

Figure 3. Locations of cores and samples in relation to excavation blocks and identified features. (Graphic by and courtesy of David Pedler, 2012.)

Level A (0–10 cm)

Grid		Easting					
		1008	1010	1012	1014	1016	1018
Northing	1033	0.058		0.067	0.068		0.068
	1031						
	1029	0.080					0.019
	1027			0.016			
	1025	0.080				0.028	0.078
	1023			0.062			
	1021		0.118			0.061	
	1019	0.114		0.078			
	1017				0.087		0.060
	1015		0.180		0.018		0.054
	1013						
	1011	0.113		0.043		0.074	
	1009						0.012
	1007	0.046			0.016		
	1005	0.045	0.016			0.048	
	1003		0.051			0.040	
	1001	0.100		0.153	0.048	0.037	

Level B (10–20 cm)

Grid		Easting					
		1008	1010	1012	1014	1016	1018
Northing	1033	0.059		0.046	0.043		0.068
	1031						
	1029	0.072					0.004
	1027			0.010			
	1025	0.060				0.025	0.057
	1023			0.071			
	1021		0.096			0.051	
	1019	0.090		0.034			
	1017				0.068		0.012
	1015		0.090		0.015		0.035
	1013						
	1011	0.086		0.006		0.028	
	1009						0.061
	1007	0.020			0.048		
	1005	0.047	0.044			0.051	
	1003		0.037			0.051	
	1001	0.036		0.056	0.007	0.045	

Level C (20–30 cm)

Grid		Easting					
		1008	1010	1012	1014	1016	1018
Northing	1033	0.046		0.021	0.022		0.048
	1031						
	1029	0.068					0.036
	1027			0.009			
	1025	0.055				0.040	0.052
	1023			0.006			
	1021		0.078			0.076	
	1019	0.099		0.052			
	1017				0.024		0.003
	1015		0.086		0.026		0.057
	1013						
	1011	0.075		0.013		0.019	
	1009						0.006
	1007	0.021			0.022		
	1005	0.029	0.023			0.048	
	1003		0.029			0.072	
	1001	0.030		0.072	0.010	0.005	

Figure 4. Absorbance values recorded for samples from Levels A (0–10 cm), B (10–20 cm), and C (20–30 cm). (Graphic by and courtesy of David Pedler, 2012.)

Table 1. Highest mass values calculated from phosphorus colorimetric data.

Level	Phosphorus Concentrations (µg/ml) by Sample		
	Sample 10	Sample 24	Sample 27
A (0–10 cm)	13.9	18.6	14.2
B (10–20 cm)	12.3	12	12.7
C (20–30 cm)	12.9	12	11.4

slightly elevated (with absorbance values > 0.050) across much of the project area. These values occur in 21 (60%) of the 35 sample locations. This widespread, high incidence of phosphorus in Level A is undoubtedly attributable to the presence of decayed plant material, plant roots, and rhizosphere organisms.

Despite this masking effect, the discrete area of elevated soil phosphorous concentration becomes more readily apparent relative to depth below ground surface. Its highest visibility is in the lowermost Level C (20–30 cm), where the soil's elevated phosphorus concentration is restricted to a triangular area measuring ca. 72 m^2 (Figure 5). The presence of elevated phosphorus concentrations indicates that this area could have served as a location for laundering activities. Phosphorus would have been added to the soil by both the lye soap used in the laundry and as a by-product of wood fires that heated the wash water. The central portion of the area with elevated phosphorus concentrations is defined by three samples (10, 24, and 27 [Figure 5]). Consistently high concentrations of phosphorus were detected in all three levels of these samples (Table 1).

The area of elevated phosphorous concentrations is located ca. 6 m behind the laundresses' quarters and ca. 30 m from Pot Creek. Notably, the soil phosphorus concentrations gradually decline to the north and more abruptly to the east and south.

The implications of this study are threefold. First, the results show that phosphorus solution leached to a depth of at least 30 cm below the ground surface. The phosphorus-rich wash water apparently infiltrated into the ground to this lower level. At this depth, it is unlikely that the phosphorus presence reflects decayed plant materials or fertilizers, especially when compared to the surrounding soil samples. The depth also decreases the likelihood that plowing or other relatively shallow disturbances would have eradicated the phosphorus signature. Consequently, the probability of locating an extramural activity that produces phosphorus, such as laundry processing, is noticeably improved.

Second, the identification of a phosphorus distribution pattern directly contributes to our knowledge about the laundresses' activities at Cantonment Burgwin. As suggested by the findings, the laundresses were conducting their washing tasks closer to their living quarters than to the water source. This choice suggests that there were ad-

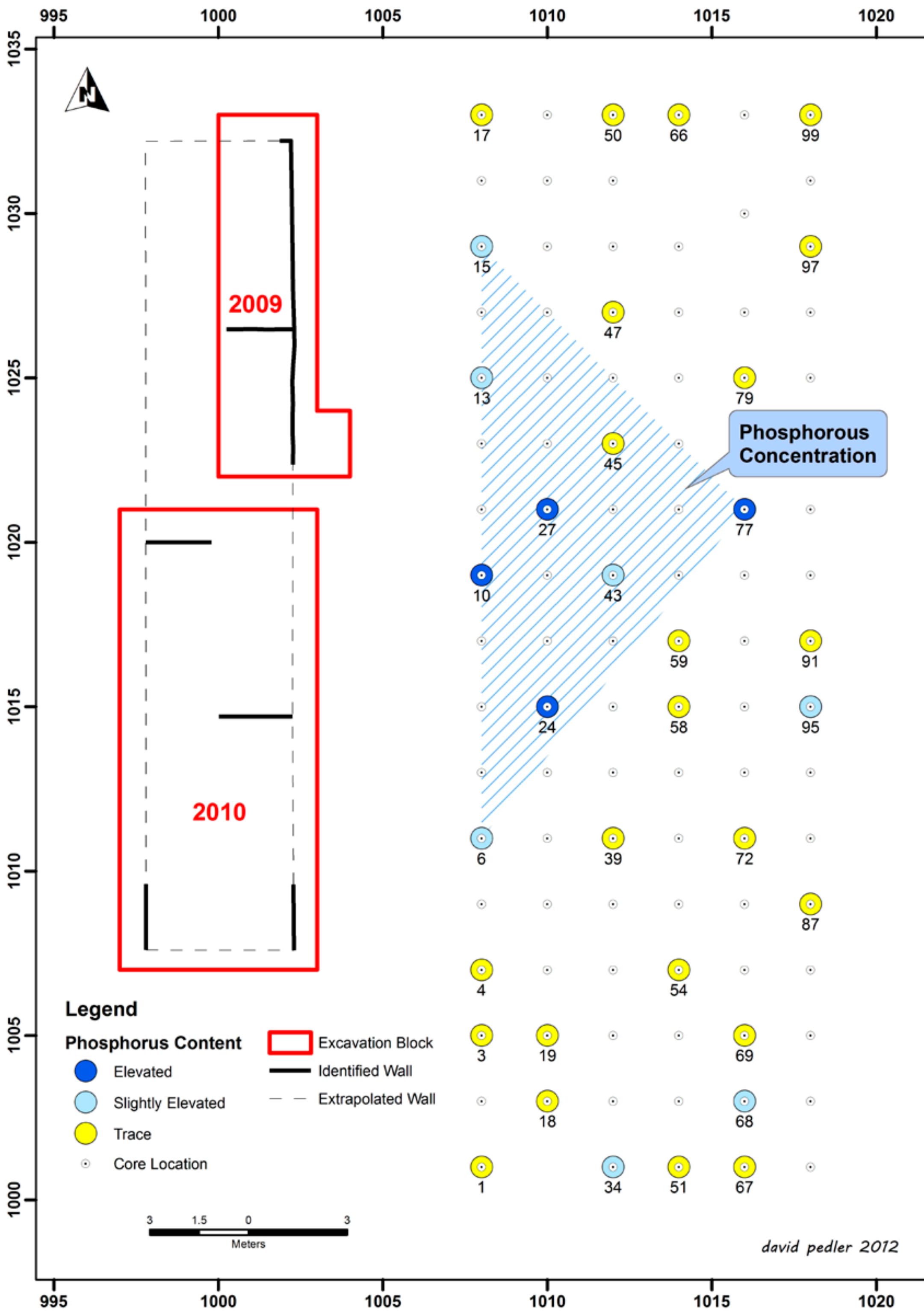

Figure 5. Distribution of soil samples from Level C (20–30 cm), showing relative phosphorus levels and the apparent phosphorous concentration. (Graphic by and courtesy of David Pedler, 2012.)

ditional considerations other than the distance necessary to lug water. Possibly, the hostile region required a closer proximity to the fort complex for safety. Conversely, it may have been a simple logistic decision where transporting the laundry equipment and clothing was more difficult than hauling water.

Finally, this study has expanded the use of phosphorus detection to geochemically identify human activity areas. Previous studies used phosphorus in defining middens and hearths, kitchen areas, food storage, and animal pens (Vizcaíno and Cañabate 1999; Sullivan and Kealhofer 2004; Wilson et al. 2008). Clearly, laundresses that washed with lye soap also left a phosphorus signature in the soil. Phosphorus testing applied to other 19th-century military sites may help to refine research questions for similar archaeological investigations. Higher phosphorus patterns on a site could alert excavators to the location of a laundresses quarters or wash area. In any case, this study illustrates how a relatively simple chemical detection test can help define and illuminate a mundane but critical class of behaviors on the western frontier.

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