

Geologic Resource Evaluation Scoping Summary Palo Alto Battlefield National Historic Site, Texas

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The Geologic Resource Evaluation (GRE) Program provides each of 270 identified natural area National Park System units with a geologic scoping meeting and summary (this document), a digital geologic map, and a geologic resource evaluation report. The purpose of scoping is to identify geologic mapping coverage and needs, distinctive geologic processes and features, resource management issues, and monitoring and research needs. Geologic scoping meetings generate an evaluation of the adequacy of existing geologic maps for resource management, provide an opportunity to discuss park-specific geologic management issues, and if possible include a site visit with local experts.

On April 23, 2008, the National Park Service held a GRE scoping meeting for Palo Alto Battlefield National Historic Site at the Amistad National Recreation Area visitor information center near Del Rio, Texas. Resource Manager Rolando Garza presented some background information about the setting of the national historic site and the U.S.-Mexican War. Andrea Croskrey (Geologic Resources Division) facilitated the assessment of map coverage, and Bruce Heise (Geologic Resources Division) led the discussion regarding geologic processes and features.

Participants at the meeting included NPS staff from Palo Alto Battlefield National Historic Site, Gulf Coast Network, and the Geologic Resources Division, as well as cooperators from the Texas Bureau of Economic Geology and Colorado State University (table 3).

Park and Geologic Setting

Authorized on November 10, 1978, with a boundary change on June 23, 1992, Palo Alto Battlefield National Historic Site covers 1,359 ha (3,357 ac). The site preserves the large battlefield where the first battle of the U.S.-Mexican War took place on May 8, 1846. The Battle of Palo Alto marks the beginning of two years of conflict between the nations. The site is located 13 km (8 mi) north of Brownsville, Texas, on a broad, flat prairie that is part of the Gulf Coastal Plain. Thirty thousand visitors annually tour the site, which commemorates the war, the battle, and its causes and consequences from the perspectives of both the United States and Mexico. Clays and silts of the Pleistocene Beaumont Formation and younger alluvium comprise the geologic foundation of the national historic site (Rolando Garza, Palo Alto National Historic Site, personal communication, April 23, 2008). Many landforms influenced the Battle of Palo Alto: Palo Alto pond, where the American forces paused to allow men and animals to drink and where the wagon train was stationed; Arista Hill located to the southeast; and the large marsh within the battlefield. Historical documents mention the hill and marsh as part of discussions of the battle (Caran et al. 2005). However, the Rio Grande resaca, which crisscrosses the Palo Alto prairie, is undoubtedly the most significant. The shallow ravines that comprise the resaca are former channels of the Rio Grande, left behind as the river shifted course along the low, coastal plain. Today, these ancient beds have been completely severed from the waterway that once filled them and remain dry for much of the year. Seasonal heavy rains occasionally pour into the ravines, creating pools of water that endure for days or months.

Geologic Mapping Plan for Palo Alto Battlefield National Historic Site

During the scoping meeting, Andrea Croskrey (Geologic Resources Division) showed some of the main features of the GRE Program's digital geologic maps, which reproduce all aspects of paper maps, including notes, legend, and cross sections, with the added benefit of being GIS compatible. The NPS GRE Geology-GIS Geodatabase Data Model incorporates the standards of digital map creation for the GRE Program and allows for rigorous quality control. Staff members digitize maps or convert digital data to the GRE digital geologic map model using ESRI ArcGIS software. Final digital geologic map products include data in

geodatabase and shapefile format, layer files complete with feature symbology, FGDC-compliant metadata, a Windows HelpFile that captures ancillary map data, and a map document that displays the map and provides a tool to directly access the HelpFile. Final products are posted at <http://science.nature.nps.gov/nrdata/>. The data model is available at <http://science.nature.nps.gov/im/inventory/geology/GeologyGISDataModel.cfm>.

When possible, the GRE Program provides large-scale (1:24,000) digital geologic map coverage for each park's area of interest, which is often composed of the 7.5-minute quadrangles that contain parklands (fig. 1). Maps of this scale (and larger) are useful to resource managers because they capture most geologic features of interest and are spatially accurate within 12 m (40 ft). The process of selecting maps for management begins with the identification of existing geologic maps in the vicinity of the park (table 1). Scoping session participants then discuss mapping needs and select appropriate source maps for the digital geologic data or, if necessary, develop a plan to obtain new mapping.

Scoping participants agreed that the GRE Program should not use the *Geologic Atlas of Texas* (GAT) sheet maps (GMAP 72509) and the statewide geology shapefile (GMAP 74114) because of their small scale and mapped units. Instead, participants reviewed the *Environmental Geologic Atlas of the Texas Coastal Zone*. Nine plates (GMAPs 74934, 68689, 74928, 74929, 74930, 74931, 74925, 74926, and 74927) showing various themes cover the Brownsville-Harlingen area. Eddie Collins (Texas Bureau of Economic Geology [TBEG]) mentioned that the bureau could supply shapefiles of Plate 2: Environmental Geology (scale 1:125,000); Tom Tremblay (Texas Bureau of Economic Geology) is the "data steward"/contact person for this information. In addition to the area covered in the printed map (GMAP 68689), the shapefile also contains data for Mexico, which Brooks Anderson (?), a geologist in Mexico, could provide; Joe Brewton, one of the authors of the printed map, could provide data to the west. Park staff agreed that this data would be adequate for management, so GRE staff will convert the TBEG shapefile to the GRE geology geodatabase format for the quadrangles of interest: Los Fresnos, Laguna Vista, Port Isabel, East Brownsville, Palmito Hill, Mouth of the Rio Grande, Southmost, and Southmost Oe E (fig. 1).

On September 16, 2008, the GRE Program announced the completion of the digital geologic map for Palo Alto Battlefield National Historic Site. The digital map is available on the NPS Data Store at <http://science.nature.nps.gov/nrdata/quickoutput.cfm?type=ds&cat=geology&key=GRE&parkcode=PAAL>. As discussed during scoping, products from the Texas Bureau of Economic Geology provided source data (see table 1). The final map product includes localities of age dates from McCulloch Archeological Services (i.e., Appendix C in Caran et al. 2005). The digital map product—a 9.2 ArcMap document (.mxd)—has a HelpFile button that launches the GRE HelpFile. The GIS data are in the NPS 2.0 geodatabase data model and are available in ESRI 9.2 personal geodatabase and shapefile formats.

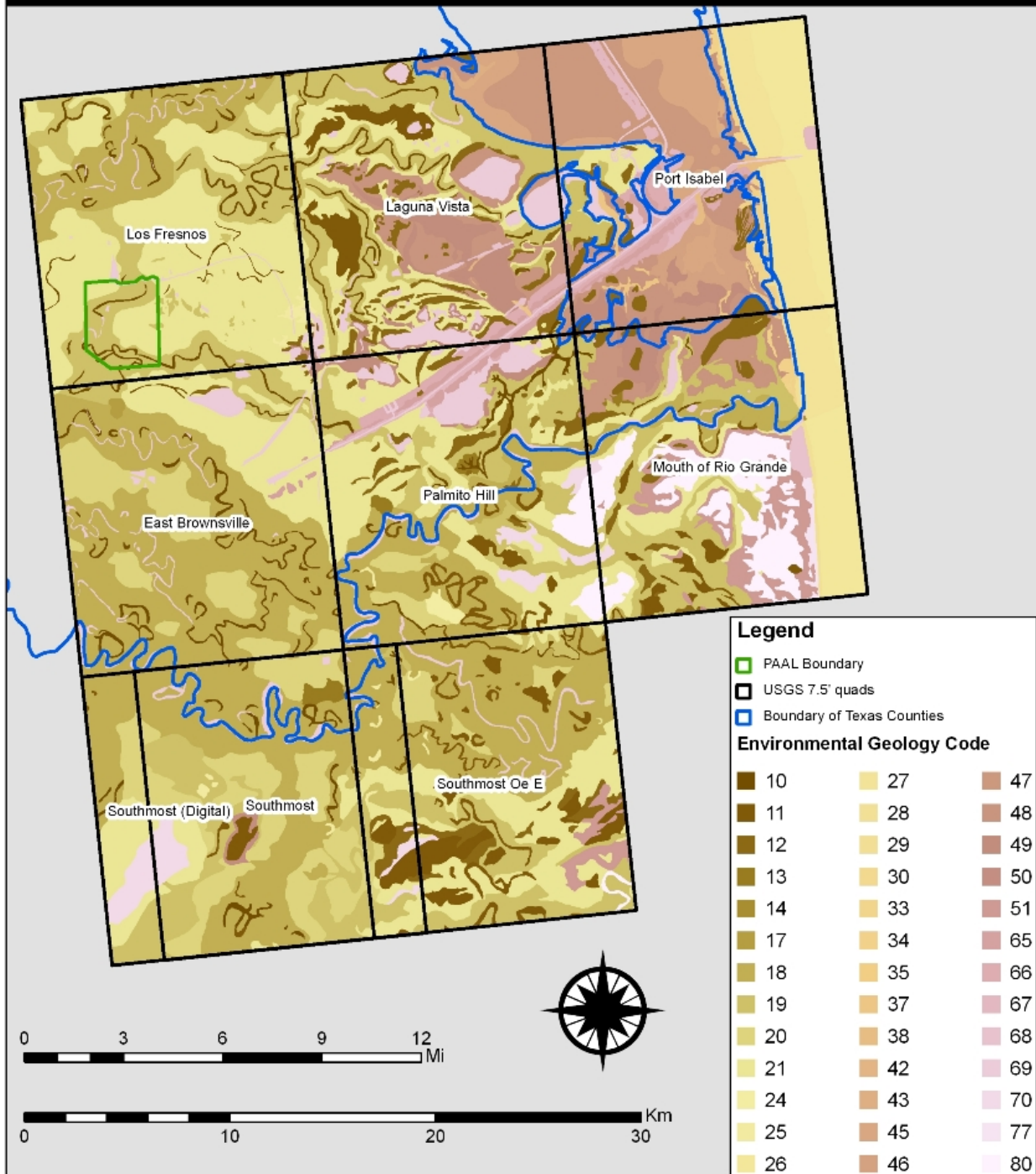
Table 1. Geologic Maps in the Vicinity of Palo Alto Battlefield National Historic Site

GMAP ¹	Citation	Format	Notes
72509	Texas Commission on Environmental Quality. 2004. <i>Geologic atlas of Texas</i> . Scale 1:250,000 scale. Austin, TX: Texas Commission on Environmental Quality.	Clipped, scanned, and georeferenced TIFs	Don't use
74114	Stoeser, D. B., G. N. Green, L. C. Morath, W. D. Heran, A. B. Wilson, D. W. Moore, and B. S. Van Gosen. 2005. <i>Preliminary integrated geologic map databases for the United States: Central states—Montana, Wyoming, Colorado, New Mexico, Kansas, Oklahoma, Texas, Missouri, Arkansas, and Louisiana</i> . Scale 1:100,000. Open-File Report OF-2005-1351. Reston, VA: U.S. Geological Survey.	Shapefiles	Don't use
74924	Brown, L. F., J. L. Brewton, T. J. Evans, J. H. McGowen, W. A. White, C. G. Groat, and W. L. Fisher. 1980. Physical properties [plate]. Scale 1:250,000. In <i>Environmental Geologic Atlas of the Texas Coastal Zone: Brownsville-Harlingen Area</i> . EA-3. Austin, TX: Bureau of Economic Geology.	Paper	Using 68689
68689	Brown, L. F., J. L. Brewton, T. J. Evans, J. H. McGowen, W. A. White, C. G. Groat, and W. L. Fisher. 1980. Environmental geology [plate]. Scale 1:250,000. In <i>Environmental Geologic Atlas of the Texas Coastal Zone: Brownsville-Harlingen Area</i> . EA-3. Austin, TX: Bureau of Economic Geology.	Shapefiles	Convert
74928	Brown, L. F., J. L. Brewton, T. J. Evans, J. H. McGowen, W. A. White, C. G. Groat, and W. L. Fisher. 1980. Active processes [plate]. Scale 1:250,000. In <i>Environmental Geologic Atlas of the Texas Coastal Zone: Brownsville-Harlingen Area</i> . EA-3. Austin, TX: Bureau of Economic Geology.	Paper	Using 68689
74929	Brown, L. F., J. L. Brewton, T. J. Evans, J. H. McGowen, W. A. White, C. G. Groat, and W. L. Fisher. 1980. Man-made features and water systems [plate]. Scale 1:250,000. In <i>Environmental Geologic Atlas of the Texas Coastal Zone: Brownsville-Harlingen Area</i> . EA-3. Austin, TX: Bureau of Economic Geology.	Paper	Using 68689
74930	Brown, L. F., J. L. Brewton, T. J. Evans, J. H. McGowen, W. A. White, C. G. Groat, and W. L. Fisher. 1980. Rainfall, discharge, and surface salinity [plate]. Scale 1:250,000. In <i>Environmental Geologic Atlas of the Texas Coastal Zone: Brownsville-Harlingen Area</i> . EA-3. Austin, TX: Bureau of Economic Geology.	Paper	Using 68689
74931	Brown, L. F., J. L. Brewton, T. J. Evans, J. H. McGowen, W. A. White, C. G. Groat, and W. L. Fisher. 1980. Topography and bathymetry [plate]. Scale 1:250,000. In <i>Environmental Geologic Atlas of the Texas Coastal Zone: Brownsville-Harlingen Area</i> . EA-3. Austin, TX: Bureau of Economic Geology.	Paper	Using 68689
74925	Brown, L. F., J. L. Brewton, T. J. Evans, J. H. McGowen, W. A. White, C. G. Groat, and W. L. Fisher. 1980. Environments and biologic assemblages [plate]. Scale 1:250,000. In <i>Environmental Geologic Atlas of the Texas Coastal Zone: Brownsville-Harlingen Area</i> . EA-3. Austin, TX: Bureau of Economic Geology.	Paper	Using 68689
74926	Brown, L. F., J. L. Brewton, T. J. Evans, J. H. McGowen, W. A. White, C. G. Groat, and W. L. Fisher. 1980. Current land use [plate]. Scale 1:250,000. In <i>Environmental Geologic Atlas of the Texas Coastal Zone: Brownsville-Harlingen Area</i> . EA-3. Austin, TX: Bureau of Economic Geology.	Paper	Using 68689
74927	Brown, L. F., J. L. Brewton, T. J. Evans, J. H. McGowen, W. A. White, C. G. Groat, and W. L. Fisher. 1980. Mineral and energy resources [plate]. Scale 1:250,000. In <i>Environmental Geologic Atlas of the Texas Coastal Zone: Brownsville-Harlingen Area</i> . EA-3. Austin, TX: Bureau of Economic Geology.	Paper	Using 68689
	Caran, S. C., S. D. McCulloch, and J. Jackson, with contributions by B. M. Albert, B. M. Winsborough, and Isotope Geochemistry Laboratory of the Illinois State Geological Survey. 2005. Report on a geoarchaeological investigation at the Palo Alto National Historic Site (41CF92), Cameron County, Texas. Order P73500-40016, Report 1, January 2005. San Marcos, TX: McCulloch Archaeological Services LLC.	Appendix C	Age-date localities

¹GMAP numbers are unique identification codes used in the GRE database.

Proposed Geologic Map Source for PAAL GRE Geologic Geodatabase

Palo Alto Battlefield National Historic Site, Texas



Geologic Resource Evaluation Team
Inventory and Monitoring Program

May 5, 2008
Geologic Resources Division
National Park Service

Figure 1. Area of Interest for Palo Alto National Historic Site. See table 2 for code descriptions.

Table 2. Environmental Geologic Units

Code	Description
10	Abandoned channel and course, mud-filled, locally some freshwater marsh cover (Pleistocene and Holocene-Modern)
11	Coastal lake or pond, mud-filled, occasionally flooded (Pleistocene and Holocene-Modern)
12	Clay-sand dunes (locally called gabilans), eolian, accretionary, active, local sparse grass, wind-tidal flat or playa source common (Modern)
13	Clay-sand dune complexes, eolian, inactive, grass- or brush-covered (Holocene-Modern)
14	Sand sheets, strong relict grain of base-leveled dunes, grass-covered
17	Levee and local crevasse splay deposits, silt, and sand, sparsely grass-covered
18	Meander belt sands and silt, sparsely grass- and shrub-covered, inactive, including some small, active point bars
19	Distributary sands and silts, including levee and crevasse splay deposits
20	Flood basin, overbank mud and silt, abandoned channels, within entrenched valley
21	Flood basin, overbank mud and silt, abandoned channels, within entrenched valley grading into interdistributary mud with small abandoned channels, clay-sand dunes, and lacustrine facies
24	Marsh, fresh- to brackish water, mud and local sand substrate, fills abandoned channel courses
25	Marsh, fresh-water, mud and local sand substrate
26	Shelf mud and sand, shell, mottles
27	Shoreface, sand and muddy sand, burrowed
28	Beach, sand and shell
29	Fore-island dune ridge, sand
30	Sand flats and/or coppice sand-dune fields, wind-shadow dunes common, active
33	Washover distributary channel, sand, active
34	Washover fan, sand, subaerial, vegetated
35	Washover distal fan, sand, subaerial, barren, active
37	Tidal channel, sand, active
38	Inlet-related shoal, sand, in passes
42	Bay- or lagoon-margin sand or shell berms, accretionary, sub-aerial, relict depositional grain, vegetated
43	Bay- or lagoon-margin sand or shell and mud, normally bare sand, may be locally covered by sparse marine grass, occasionally emergent
45	Grass flat, muddy sand with shell, normal to hypersaline
46	Bay and lagoon sand, muddy, local sparse marine grass
47	Bay and lagoon mud, mottled, some mixed shell
48	Wind-tidal flat, sand and mud, firm, locally upper flat rarely flooded
49	Wind-tidal flat, sand and mud, extensive algal mats, alternately emergent-submergent
50	Wind-tidal flat, sand and mud, algal-bound mats, depressed relief, wet and soft, locally upper flat rarely flooded
51	Transitional zone, wind-tidal flat to eolian sand sheet, wind deflation, concentrated clay-sand dunes, sand (tidal flats and clay-sand dunes south of Port Mansfield mapped independently)
65	Spoil heap or mound, subaerial
66	Reworked spoil, subaerial
67	Spoil, subaqueous
68	Made land
69	Water
70	Saline pond or lake, with algal mat cover, ephemeral
77	Backbeach, coppice dunes, some wind deflation flats covered by shells
80	Lagoon floor, clay

Geologic Features and Processes and Related Management Issues

The scoping session for Palo Alto Battlefield National Historic Site provided the opportunity to discuss management-related geologic issues and develop a list of geologic features and processes, which will be further explained in the final GRE report. During scoping, participants did not prioritize the issues, but discussion made it clear that fluvial features and process have high management significance. This is discussed first, followed alphabetically by other features and processes at the national historic site.

Fluvial Features and Processes and Surface Water

Resacas—remains of the 500-year-old channel abandoned by the Rio Grande—cut across Palo Alto Battlefield National Historic Site. In some parts of the country these abandoned bends are called oxbows; along the Rio Grande and in other parts of the Southwest, they are called resacas, from the Spanish word “resacar” meaning “to redraw” or “to retake.” Initially these abandoned bends form lakes but over time fill with sediment. About 30 cm (12 in) of sediment has accumulated since the battle in 1846. Resacas enhance the beauty of the area and provide habitat for birds and other animals. Woody plants colonize these areas.

Palo Alto Battlefield National Historic Site has several natural resacas that hold pools of water after heavy rains but are dry at other times of the year. A geoarchaeological investigation documents the importance of resacas to the Battle of Palo Alto (Caran et al. 2005). Today, resacas serve as stock ponds. Also many communities in the Rio Grande Valley pump water into resacas to keep them filled year-round for storage and transport of drinking and irrigation water.

In 1846 the battlefield was situated on a coastal sand flat, with many more marshes than today and a number of small ponds that are no longer in existence. Park staff has a GIS layer of excavated tanks and ponds. The one remaining “natural lake”—Tule Chica—is ephemeral. In 1916 a ditch constructed for flood control drained the lakes on the north side of the national historic site.

Climate Change

Losing Ground: Western National Parks Endangered by Climate Disruption states, “A climate disrupted by human activities poses such sweeping threats to the scenery, natural and cultural resources, and wildlife of the West’s national parks that it dwarfs all previous risks to these American treasures (Saunders et al. 2006). The authors contend that “a disrupted climate is the single greatest threat to ever face western national parks.” Because of the potential disruption that climate change could cause to park resources, including geologic features and processes, the GRE Program has begun to include a discussion of the effects of climate change to park resources during scoping meetings. One impact that may affect the resources at Palo Alto is a change in drought cycles.

Past changes in climate are significant for interpreting the Palo Alto landscape. The Battle of Palo Alto occurred just at the end of a fluctuating climatic period known as the Little Ice Age. Haecker and Mauck (1997) note heavy rains just before the battle, which may be a reflection of variable climate at the time. Recent climate data indicate an average monthly rainfall in May of about 5.6 cm (2.2 in), with the heaviest rains in September (13.2 cm [5.2 in]). According to the National Weather Service, May 1846 experienced especially heavy rains (Weaver 1999).

Coastal Features and Processes

Palo Alto Battlefield National Historic Site is situated 18 km (11 mi) inland but is only 3 m (10 ft) above sea level. “Hills” at the site rise to less than 5 m (15 ft) above sea level. Coastal grasses and highly saline soils characterize the battlefield. Hurricane-related waters inundated the landscape in 1898, 1933, and 1967 (Hurricane Buelah). In the event of a hurricane, enhanced rainfall and a possible storm surge could affect the national historic site. Park staff thinks that hurricane-related flood water inside the visitor center is highly probable. Park managers are working on a hurricane response plan but as of April 2008, they had not completed it (Rolando Garza, Palo Alto Battlefield National Historic Site, e-mail communication, April 29, 2008).

Disturbed Lands

Disturbed lands are those park lands where the natural conditions and processes have been directly impacted by mining, development (e.g., facilities, roads, dams, abandoned campgrounds, and user trails), agricultural practices (e.g., farming, grazing, timber harvest, and abandoned irrigation ditches), overuse, or inappropriate use. The NPS Disturbed Lands Restoration Program, administered by the Geologic Resources Division, usually does not consider lands disturbed by natural phenomena (e.g., landslides, earthquakes, floods, hurricanes, tornadoes, and fires) for restoration unless influenced by human activities.

Participants of GRE scoping identified some disturbances at Palo Alto Battlefield National Historic Site, primarily from past agricultural activities. Much of the land within the site’s legislative boundary is private, and grazing still occurs on some non-federal portions. Ultimately the management plan is to restore the landscape to conditions existing between 1846 and 1848. This would include a woody buffer along the

highway and filling livestock tanks (vintage 1920–1960). A vegetation management plan (in process) will help with restoration.

Eolian Features and Processes

Desiccated, cracking clay-rich soils at Palo Alto produce ample source material for wind erosion, particularly on hilltops. Barren areas on the east side of the site are prime candidates for blowouts.

Oil and Gas Exploration and Development

Mentioned during scoping and documented in a letter, L3025(PAAL), the Texas Gas Service Company is requesting approval to access a pipeline that runs through Palo Alto Battlefield National Historic Site. The request is to conduct vegetative maintenance along the corridor to facilitate inspections. As of July 2008, the company was preparing a proposal for NPS review and approval.

Some seismic testing has occurred in the vicinity of the site as a result of favorable conditions for gas exploration; however, operations within the legislative boundary could only be conducted if there is a demonstrated outstanding nonfederal mineral right, and such operations would be subject to the NPS regulations at 36 C.F.R. Part 9 Subpart B, which govern nonfederal oil and gas rights.

Paleontological Resources

Fossils are not known from Palo Alto, and no paleontological specimens are stored in the park's museum collection; therefore, Kenworthy et al. (2007) concludes that the future for fossil discovery is limited as a result of the vegetated prairie landscape and underlying geology. Nevertheless the authors suggest that “an initial field investigation of any deep ravines or gullies might expose Pleistocene sediments, however, most are probably Holocene in age.” As a case in point, a geoarchaeological investigation of the Palo Alto resaca unearthed faunal material, including burrows of fiddler crabs (*Uca subcylindrica*) and occasionally snail shells (*Rabdotus* sp. and cf. *Gyranulus* sp.) (Caran et al. 2005). In addition, investigators recovered and described an extensive floral (pollen) record, which yielded radiocarbon ages ranging from 5,300–300 years before present (Caran et al. 2005).

During scoping, park staff mentioned the discovery of mastodon remains at the mouth of the Rio Grande. Hay (1924) documents this find as an “elephant [mammoth or mastodon] molar which had been found near Brownsville.”

Seismic Features and Processes

Palo Alto Battlefield National Historic Site is seismically quiet, though growth faults form in sediments of the coastal plain. Faulting does not appear to be impacting park infrastructure, however.

Unique Geologic Resources

Unique geologic resources include natural features mentioned in a unit's enabling legislation, features of widespread geologic importance, geologic resources of interest to visitors, and geologic features worthy of interpretation. The GRE Program also considers type localities and age dates as unique geologic resources. At Palo Alto Battlefield, unique features include carbon-14 dates of geoarchaeological landforms, which are significant for interpreting the battlefield site. GRE staff included point locations of radiocarbon dates from Caran et al. (2005) in the GRE geodatabase. Ric Page (U.S. Geological Survey) mentioned that the soils in the vicinity of Palo Alto (to the south) have elevated uranium levels, which may be considered unique.

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Table 3. GRE Scoping Cooperators for Palo Alto Battlefield National Historic Site

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