Final

Geoarchaeological desktop and field assessments regarding pre- and post-settlement landscape evolution and stratigraphy of the City of Alexandria Waterfront Area, in support of the City of Alexandria Waterfront Implementation Project, Phase II Geotechnical Investigations

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Introduction

Landforms bordering river systems are generally prime and dynamic environments for human settlement and archaeological site formation. Context and preservation of any associated archaeological resources are often contingent upon the formation processes and relative ages of host landforms. Geoarchaeological investigations within alluvial settings focus on identification of principal landform formation processes and resulting components within a chronological framework.

The project area includes an urbanized section of waterfront in Old Town Alexandria bordered by the tidal Potomac River. The study area has been subjected to a continuous and sometimes dynamic range of landscape change throughout the ~15.5-14.0 ka period of human habitation in North America---the late Pleistocene through Holocene epochs---including the post-settlement period (post AD 1600) through modern times.

Long term these landform changes include the effects of post-glacial sea level rise that led to initial (early Holocene) formation of Chesapeake Bay, followed by the eventual upstream extension of tidal conditions within the Potomac Valley to the fall line above Washington D.C. Progressively rising sea levels within the tidal reach of the Potomac River and tributary estuaries reduced stream gradients and supported expanded accumulation of fine-grained alluvial estuary and marsh sediments that in reduced-energy environments (such as backwaters or drowned valleys) may eventually bury older previously extant (terrestrial) landscapes (Tibert et al 2012, Lothrop et al 2016, Cronin et al 2019).

Short-term and site-specific landform changes that followed the c.1749 establishment of Old Town Alexandria included relatively extensive and rapid borrowing and grading of extant upland terrace sediments, for redeposition across a relatively shallow river embayment (or cove) for purposes of land reclamation and wharf construction.

This geoarchaeological study was conducted in support of a Phase II Geotechnical investigation (MRCE 2022) conducted in support of a City of Alexandria Waterfront Implementation Project that may include relatively deep impacts within the footprint of the original Old Town port and waterfront. It aimed to sample and identify pertinent project landforms in regards to morphology, formation history and potential for inclusion of archaeological resources. This work initially included desktop review of map and archival resources and recent studies pertaining to geology, geomorphology, archaeology and historic development of the Old Town Alexandria project area, followed by field investigations. Field investigations included extraction of six solid-earth cores for review, evaluation and limited analyses.

Project Area Setting

The project area includes an urbanized section of waterfront located within the upper reaches of the tidal Potomac River, where a small colonial-era settlement was first platted as the Town of Alexandria in 1749. The town was platted on a remnant Pleistocene-age, upland landform that rose above (west) of a relatively broad, incurvate embayment—or cove---that demarcated the right bank of the river. High bank terrace remnants (subsequently graded) bounded the relatively shallow (~4~7 ft deep) embayment with 'headlands' at both its upstream extent (West's Point) and downstream extent (Port Lumley) (Shomette 1985, Shephard 2006). These uplands afforded some protection from prevalent winds and the embayment provided ready access to the principal deep-water (18-48' deep) channel of the Potomac River that lay just beyond (east) each headland.

Development here as a commercial town and deep-water port facility would prove prescient as by the late 18th century several local port facilities became less viable due to increased accumulations of fine-grained river alluvium (muds) within their tidal-affected portals (Callender et al 1984, Gottschalk 1945). Rapid increases in river siltation attributed to increased erosion-prone settlement and development activities within the greater drainage basin (deforestation, row cropping etc) resulted in significant increases in both the quantities and sediment contents of tributary streams (Callender et al 1984, Coleman and Bratton 2003, Cronin et al 2019, Shephard 2006, Tibert et al 2012).

Soon after the town was platted much of the embayment was filled or 'reclaimed' to extend the shoreline by progressive construction of wharf facilities to ensure reliable access to the primary deep-water river channel. Much of these reclamation efforts were accomplished in the latter half of the 18th c. with fills quarried from shore-proximal sections of upland terrace that were redeposited in the shallow bay waters extending east from the shore, often within cribbed, timber frameworks (Shephard 2006). These efforts eventually graded the near-shore landform features of the upland terrace (and associated irregularities in elevation, such as step terraces and/or bluffs) to elevations closer to those of the artificial extension, in effect capping much of the subaqueous embayment (floored primarily of fine-grained river alluvium) with variably stratified, redeposited elements of the terrestrial upland terrace (and any preexisting archaeological components contained within). Following initial reclamation efforts within the former embayment, subsequent commercial developments along the reclaimed waterfront (e.g., boat yards, railroads, coal yards, buildings) contributed more exotic fill sediments (such as brickbat, coal, etc) to the waterfront area.

Expanded narratives regarding the developmental history of the post-settlement waterfront area regarding initial landscape modification (upland grading and embayment filling) and subsequent commercial development are well-considered and documented in Shomette 1985, Knepper 1991, Shephard 2006, and Kreisa et al 2018.

Prefield review and Geoprobe (GP) location selection

Prefield investigations initially involved desktop review of map and archival resources and recent studies pertaining to geology, geomorphology, archaeology and historic development of the Old Town Alexandria project area. These investigations also included review of: 1) bore logs of both pre-existing and Phase I geotechnical borings located within the waterfront study area (compiled by Schnabel Engineering 2016); and 2) evaluations of a sample of the same Phase I borings by archaeologists (Kreisa et al 2018).

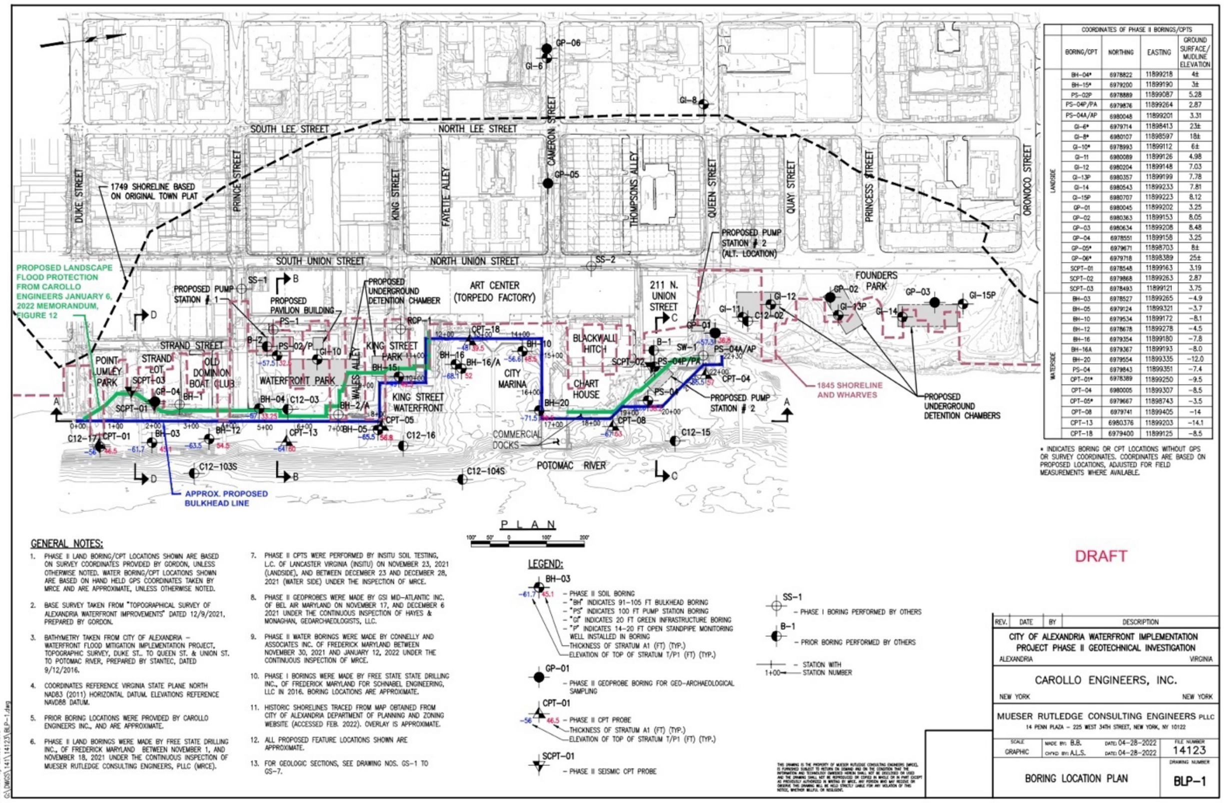

Figure E- 1: Preliminary Waterfront Project Plans with locations of Phase II (2022) geotechnical and geoprobe (GP) borings, locations of prior borings, and projections of both the 1749 and 1845 shorelines.

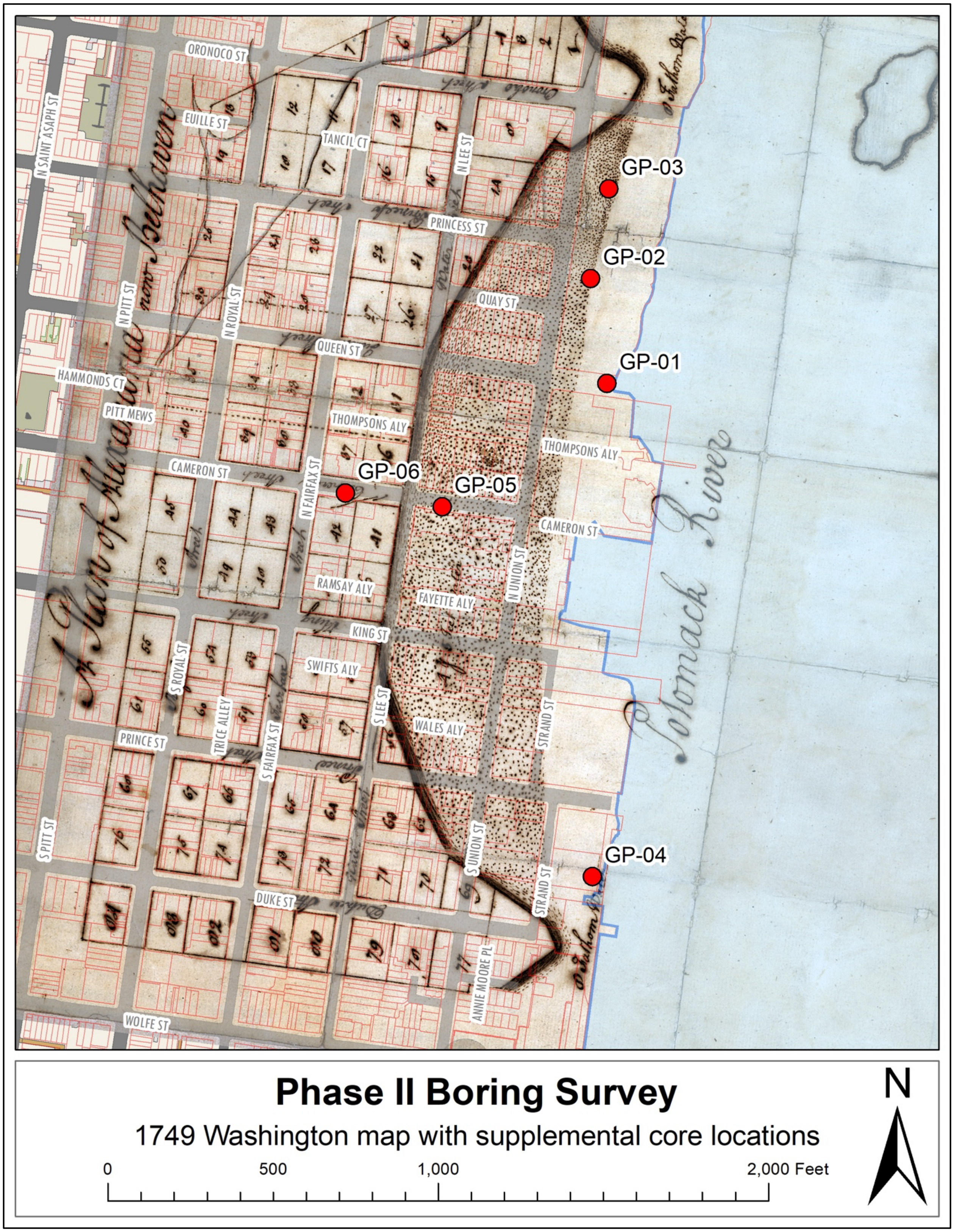

Figure E-2: 1749 Plat Map showing shoreline, shallow embayment and primary location of deep river channel (Washington 1749) with Phase II Geoprobe Test Locations.

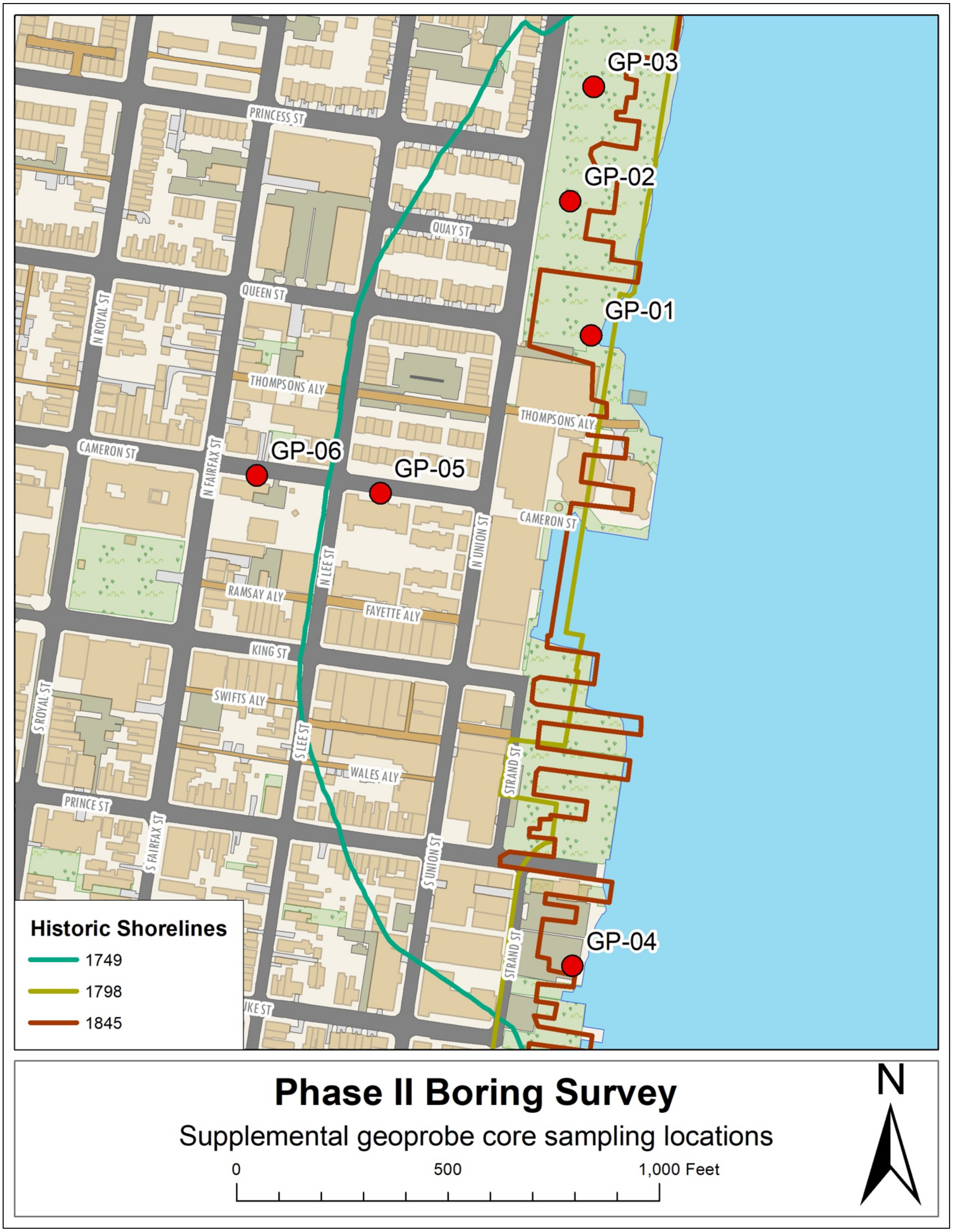

Figure E-3: Phase II Geoprobe Test Locations in relation to 1749 (Washington 1749), 1798 (Gilpin 1798) and 1845 (City of Alexandria 2009) shoreline locations.

Desktop review contributed to selection of six locations for supplemental geoarchaeological testing to sample specific landform components by extraction of continuous, solid-earth geoprobe (GP) cores (Figure E-1: Phase II Boring Location Plans). Locations were selected to both complement and expand upon data derived from previous Phase I geotechnical testing in support of the current Waterfront Implementation Project and investigate specific areas under consideration for deep disturbance (such as pump station areas, detention chamber areas and bulkheads). Locations were also selected to sample areas within the mapped extent of the mid-18th c embayment that included locations proximal to the primary deep river channel as well as locations nearer the upslope margins of the embayment (Figure E-2: 1749 Plat Map with Phase II Geoprobe Locations and Figure E-3: 1749, 1798 and 1845 Shoreline locations with Phase II Geoprobe Locations). All geoprobe (GP) locations were expected to provide pertinent information regarding pre- and post-settlement landscape topography and subsurface composition, and samples from reliable contexts for special analyses. These six GP locations and supporting rationale for selection include:

- GP-01: Co-located near proposed phase II Boring PS-04A/AP (and near prior phase I borings SW-1 and B-1), this location was chosen to provide a deep sample east of the mapped embayment where 1748 mapping indicated the river channel to approach 8 fathoms (48') in depth (Washington 1748 map in Shephard 2006), and 1842 bathymetric data indicate a 10' depth (Young et al 1857). Nearby phase I boring SW-1 had previously detailed potential undisturbed Holocene-age sediments (with inclusive organic material) from ~14 to >31 ft below mean sea level (bmsl).
- GP-02: Co-located near phase II borings GI-12 and GI-13P in Founders Park, NNW of GP-01, this previously untested location was chosen to provide bridging stratigraphic information between GP-01 and the northernmost margin of the pre-fill, c.1748 wetland embayment.
- GP-03: Located east of GP-02 and co-located near phase II borings GI-14 and GI-15P (and located just west of River Renew boring C12-13) this Founders Park location near Oronoco Street was chosen to provide stratigraphic information regarding the relatively shallow, c.1749 prefill wetland embayment and anticipated upland terrace margin in the vicinity of the north-bounding headland of West's Point.

- GP-04: Co-located near proposed phase II probe SCPT-01 and borings BH-03, BH-12 and BH-13; this location was chosen to provide a deep sample near the south-bounding headland of Port Lumley just east of the mapped embayment where 1748 mapping indicated the river channel to approach 8 fathoms (48') in depth (Washington 1748) and 1842 bathymetric data indicated an approximate 30' depth (Young et al 1857). Nearby phase I boring BH-01 had previously detailed potential undisturbed Holocene-age sediments (with inclusive organic material) from ~15 to 55 ft below mean sea level (bmsl).
- GP-05: Located ~midway between Union St and Lee St, this location was chosen to provide bridging stratigraphic information linking previously recorded phase I boring SS-2 (on Union Street) with the c. 1748 westernmost margin of the pre-fill embayment near Lee Street (formerly Union Street). Bore SS-2 had had previously detailed potentially undisturbed Holocene-age sediments (with inclusive organic material) from ~4 to 20 ft below mean sea level (bmsl).
- GP-06: Co-located near phase II boring GI-06, west (uphill) of the c.1748 westernmost margin of the pre-fill embayment this location west of Lee Street was chosen to characterize the preexisting Pleistocene-age, upland terrace.

Field Investigations

Field evaluations included extraction of six GP cores during two field mobilizations: November 11, and December 06, 2021.

Cores were extracted with a Geoprobe 7822DT direct-push soil sampler capable of collecting continuous samples of unconsolidated materials in 5.0 ft (150 cm) sections encased within clear pvc liners. Cores ranged in depth from 20-60 ft deep. The upper 10 ft sections (through dense fills) were removed in 1.8 in (45 mm) diameter sections, followed by 1.5 in (35mm) diameter tooling through saturated sediments.

Following extraction each core was bisected, described, recorded and selectively sampled. The near-surface (0-10' sections) of several cores were recorded on site, while the majority were examined at an off-site location. Characteristics of core sediments included observations of lithology (texture), bedding, sorting, inclusions and the contacts (boundaries) between strata. Samples of inclusive organic materials were collected for lab analyses.

Detailed descriptions of each geoprobe core (GP) are found in Appx E-1.

Project Stratigraphy and Archaeological Potential

Project area stratigraphy was organized through identification of four principal allostratigraphic units (ASUs) distinguished on the basis of bounding discontinuities (NACSN 2005). Discontinuities represent interruptions in the depositional record and are often manifested as erosional breaks, or unconformities. Boundaries between ASU's are laterally traceable discontinuities. Subunits within each ASU may include significant variations in sediment type (lithology), environments of deposition, chronology, inclusions, pedology (soil weathering), and archaeological content.

Principal Allostratigraphic Units include:

- ASU-I: Allostratigraphic Unit I represents capping fill sediments of post-settlement age disturbed and/or deposited by human agency, sourced here primarily from terrestrial Old Town terrace (ASU-III) sediments (relic fluvial gravels, sands and alluvial fines) through quarrying efforts conducted to both grade upland terrace topography for settlement purposes and provide fills to reclaim the shallow river-fronting embayment for development that included wharf construction. Where redeposited in water it often appeared bedded. Inclusions noted here included charred and uncharred macro-organics (likely detrital), timbers, shell (oyster, small bivalve, snail), brick, coal and coal cinder; no prehistoric artifact components were identified. Inclusions were sometimes concentrated at sharp basal contacts with ASU-II or -III strata. Archaeological content may include artifacts derived from off-site fill sources (including both prehistoric and historic out-of-context components), as well as historic elements contemporaneous with ASU-I deposition (such as wharf components, coal-yard debris, etc.)

- ASU-II: Allostratigraphic Unit II represents fine-grained alluvial deposits of post-glacial (Holocene) age that accrued at and below sea levels with progressive rises in sea levels during steady expansion of estuarine conditions in the upper Potomac River valley. Deposition appears to have been primarily low-energy across terrace-margin tidal flats and marshes, yet potentially erosive in contact with underlying ASU-III (such as along sloped, relic terrace surfaces). ASU-II is comprised primarily of fine-grained, silt- and clay-dominated sediments with minor additions and limited interbeds of very fine sand, all of which maintain primary sedimentary bedforms (beds and laminates), and dark colors (gleyed hues and low values and chromas). It was noted to be saturated, minimally weathered, often anaerobic with occasional inclusions of well-preserved macro-organics (likely detrital). (No concentrations of macro-organic materials indicative of peat formation were noted in this study). ASU-II includes three subunits:

- ASU-IIa: silt and clay rich alluvial component of post-settlement age, often laminated, with inclusions (sometimes concentrated at basal contacts) that included uncharred and uncharred macro-organics (likely detrital), shell (oyster, small bivalve, snail), brick, coal and coal cinder; no prehistoric artifact components were identified. ASU-IIa archaeological content in primary contexts would expectedly be limited to post-settlement age elements (historic) associated with riverine/estuarine related activities (piers, boats, fishing nets etc).
- ASU-IIb: silt and clay rich alluvial component of pre-settlement age, often laminated, with inclusions noted here that included uncharred and uncharred macro-organics (few and likely detrital), and precipitates of iron phosphate (vivianite); no shell, brick, coal or coal cinder was noted, nor any evidence of prehistoric artifacts. ASU-IIb archaeological content in primary context would expectedly be limited to pre-settlement age elements (prehistoric) associated with riverine/estuarine related activities (dugouts, fishing nets, weirs etc).
- ASU-IIc: coarser-grained (sand-enriched) and relatively thin subunit noted in sharp (eroded?) contact with underlying ASU-III. ASU-IIc is comprised of both a higher content and broader range of sands (including gravels eroded from ASU-III context) before conformably fining up into IIb silts and clays, as likely characterized a prograding embayment along valley margins. Inclusions noted here only included uncharred and uncharred macro-organics (likely detrital). ASU-IIc archaeological content in primary context would expectedly be limited to pre-settlement age elements (prehistoric) associated with riverine/estuarine margin-related activities (fishing, cobble collection and lithic stone tool reduction etc) but context could be compromised by tidal wash in relatively shallow beach-like settings. Potential also exists for prehistoric artifacts in secondary context

(sourced from underlying eroded surface of ASU-III) to be included within ASU-IIc coarse-grained content.

- ASU-III: Allostratigraphic Unit III represents the Pleistocene-age, Old Town terrace that constitutes the principal river-flanking upland landform that hosts Old Town Alexandria and underlies the waterfront and river valley (Froelich et al 1978, Fleming 2015). The Old Town terrace is considered a construct of ancestral Potomac River as a series of repetitive, fining-up and deeply weathered alluvial sequences deposited during the late-Pleistocene (~150 ka-15 ka) comprised primarily of gravely sand grading up to sand with some sequence-capping silt and clay strata with occasional organic interbeds: terrace sediments are underlain by Cretaceous-age (>68 my) alluvial fines (primarily clays) of the Potomac Formation. Old Town terrace deposits range in elevation from a high of ~35 ft amsl uphill from the waterfront area to estimated depths of ~125 ft below the riverfront. Below Wilson Bridge it is inferred to include remnant channel-bed deposits (thalweg) of the deeply incised, pre-Holocene, Potomac River channel at ~100 ft bmsl (Ellman et al 2004). ASU-III archaeological content in primary contexts would expectedly be limited to the uppermost extents of this principal basal unit in surface and near-surface contexts. In extant upland settings west of the c 1748 waterfront archaeological contents in primary ASU-III contexts could include both pre- and post-settlement age elements (historic) in surface and near-surface contexts where not buried or truncated by ASU-I fills. In relic waterfront settings east of the c 1748 waterfront (within and below the reach of estuarine alluvial processes) archaeological content could potentially include pre-settlement age elements (prehistoric) in surface and near-surface ASU-III contexts where not truncated by ASU-IIb fills.

Project Chronology

Age determinations of project ASUs relied upon identification of gross temporal markers imbedded in cores, and supplemental radiocarbon analyses of imbedded macro-organics.

Temporal markers were not common, particularly in pre-settlement contexts. Other than macro-organics, temporally significant inclusions within cores of materials such as brick, coal, cinders and oyster were considered post-settlement markers, often noted together in or near eroded strata contacts. (Oyster shell was normally considered an anthropogenic addition, likely post settlement in age, and not indigenous/native to the upper extent of the Potomac River due to conditions of low salinity: see Haven 1976 and Callender et al 1984).

Pre-settlement temporal identifiers within alluvial fines---other than organics---were not evident in core samples. No prehistoric cultural materials (artifacts) were recovered from any GP core. However, in several cores (GP-01, GP-02 and GP-03) small (2-4 mm) soft nodules of an organic iron phosphate (vivianite) were noted in IIb strata. During initial examination of core sediments vivianite nodules were mistaken for inclusions of shell fragments (commonly found in post-settlement IIa sediments), but proved to be non-reactive to acid (a test that indicates carbonates). Left exposed to air for several hours these nodules oxidized to a striking blue color (vivianite forms in oxygen-poor environments (Rothe et al 2016)). Vivianite has been identified in deep, Pleistocene-age Potomac River alluvium noted ~ 6 river miles downstream in the Hybla Valley (Litwin et al 2013). Vivianite has also been documented (upriver) in relatively shallow dredge spoil deposits noted downstream of the Blue Plains sewage plant outflow (a source of concentrated Phosphorus-rich effluent) (Hearn et al 1983, Callender et al 1984) which casts doubts regarding assigning singular association with pre-settlement alluvium.

Radiocarbon Analyses

Special lab analyses focused on acquiring radiocarbon age-estimates of select organic samples to provide a stronger chronologic component to stratigraphic interpretations of project landform components. Samples were chosen from a wide range of elevation points, often at what appeared to be potentially significant deposition breaks or transition points. Analyses of multiple samples (2-3) from the same core served to bracket time ranges of alluvial sequences.

A total of 10 uncharred, macro-organic samples were subjected to radiocarbon analyses (Table E-1). Prior to submission for dating each sample was subject to Taxonomic identification (Appx E-2). Radiocarbon lab results are included in Appx E-3.

Table E1: Accelerator mass spectroscopy (radiocarbon) analyses: age calibrations per Calib Rev8.2 (Stuiver and Reimer 1993), based on the intcal20.14c calibration dataset (Reimer et al 2020). *Cores GPC-x refer to Jones Point (Dutton 2021).*

ICA Lab #	Core-sample #	Depth bs (ft/m)	Depth bsl (ft/m)	^{14}C yr BP	2-sigma cal date range*	Median cal BC/AD	Median cal BP	Stratum (ASU)	Sample Type (uncharred)
14C-6408	GP-01-01	53.1/16.2	49.8/15.2	6600 ± 30	5567-5480 BC (75.1%)	5542 BC	7491 BP	IIc	Wood fiber
14C-6406	GP-01-04	37.7/11.5	34.4/10.5	4030 ± 30	2624-2470 BC (100%)	2533 BC	4482 BP	IIb	Wood fiber: Beech *Fagus americana*
14C-6405	GP-02-02	39.4/12.0	31.4/9.6	4820 ± 30	3590-3528 BC (61.1%)	3573 BC	5522 BP	IIc	Wood fiber: Chestnut *Castanea dentata,* and Oak *Quercus*
14C-6399	GP-03-03	9.8/3.0	1.3/0.4	170 ± 30	AD 1721-1814 (48.4%)	AD 1774	176 BP	I	Wood fragments; Pine *Pinus*
14C-6401	GP-03-04	20.0/6.1	11.5/3.5	210 ± 30	AD 1729-1808 (54.2%)	AD 1766	184 BP	I	Wood fibers: Oak *Quercus,* Pine *Pinus*
14C-6403	GP-03-07	26.9/8.2	18.4/5.6	3520 ± 30	1930-1749 BC (100%)	1833 BC	3782 BP	IIc	Coniferous bark or cambium
14C-6407	GP-04-01	34.1/10.4	30.8/9.4	200 ± 30	AD 1725-1811 (55.8%)	AD 1767	183 BP	IIa	Needle leaves: Pine *Pinus*
14C-6402	GP-04-02	47.2/14.4	43.9/13.4	6310 ± 30	5334-5214 BC (97.5%)	5266 BC	7215 BP	IIc	Wood fibers: deciduous
14C-6404	GP-05-02	17.1/5.2	9.1/2.8	970 ± 40	AD 1014-1164 (96.9%)	AD 1093	857 BP	IIc	Wood fiber: coniferous bark or cambium
14C-6400	GP-05-04	28.2/8.6	20.2/6.2	>42000	No *determinable* upper age limit due to small sample size, likely <60 ka		>42 ka	III	Wood fiber: Beech *Fagus americana*
14C-5791	*GPC1-1*	*16.4/5.0*	*13.1/4.0*	*3180 ± 40*	*1518-1389 BC (97.0%)*	*3404 BC*	*1455 BC*	*IIb*	*Wood fiber: Sycamore Platanus occidentalis*
14C-5792	*GPC1-2*	*12.5/3.8*	*9.2/2.8*	*2400 ± 40*	*568-393 BC (81.7%)*	*488 BC*	*2437 BP*	*IIb*	*Wood fiber: Hornbeam Carpinus caroliniana*
14C-5793	*GPC1-3*	*6.2/1.9*	*3.9/0.9*	*270+/-40*	*AD 1491-1604 (48.8%)*	*AD 1621*	*329 BP*	*IIb*	*Wood fiber: deciduous taxa*

(*highest probability %)

ASU/radiocarbon age associations

ASU-I: A pair of radiocarbon dates recovered from the base of post-settlement ASU-I fill sediments were acquired from core GP-03 located in the northern extent of the embayment in Founders Park (Table E-1). Pine and oak wood fibers imbedded within likely Old Town terrace-derived wharf fills (samples GP-03-03 and GP-03-04) provided age-estimates of median cal AD 1774/176 BP and AD 1766/184 BP, respectively. These age estimates are in agreement with accounts of late 18th c embayment reclamation/wharf construction efforts.

ASU-IIa: A single radiocarbon date representative of early deposition of post-settlement ASU-IIa fine-grained alluvium was acquired from GP-04 (Table E-1). Located in the southern extent of the embayment proximal to the deep river channel, core GP-04 provided a sample of pine needles (sample GP-04-01) from ~31' bmsl that provided an age-estimate of median cal AD 1767/183 BP. Approximately 23.5' of additional ASU-IIa sediments capped this sample (topped again with 10.5' of ASU-I fill). In this deep context the age estimate supports historical accounts of relatively high siltation rates attributed to the mid 18th c.

ASU-IIb: A single radiocarbon date recovered from pre-settlement, ASU-IIb fine-grained alluvium was acquired from core GP-01 located near the eastern edge of the embayment proximal to the deep river channel. Deciduous wood fibers (sample GP-01-04) imbedded ~34 ft bmsl just below contact with overlying post-settlement ASU-IIa sediments provided an age-estimate of median cal 2533 BC/4482 BP (Table E-1). ASU-IIc sample GP-01-01 (same core) collected below at ~50 ft bmsl near contact with ASU-III provided an age-estimate of median cal 5542 BC/7491 BP. These two age estimates bracket early- to mid-Holocene net accumulation of ~16 ft of sediment over ~3000 years.

ASU-IIc: Radiocarbon dates from IIc contexts were acquired from five geoprobe cores including a single core (GP-05) located near the western edge of the embayment proximal to the original foot slope of the upland Old Town terrace. At GP-05 coniferous wood fibers (sample GP-05-02) recovered from ~9' bmsl in possible eroded context with ASU-III provided an age-estimate of median cal AD 1093/857 BP (Table E-1). In this potential upland/embayment edge context the stratigraphic sequence is unclear, and may represent several different depositional environments involving erosion and redeposition of relic terrace sediments (e.g., unstable eroded shoreline, prograding alluvial fan, or possible root intrusion).

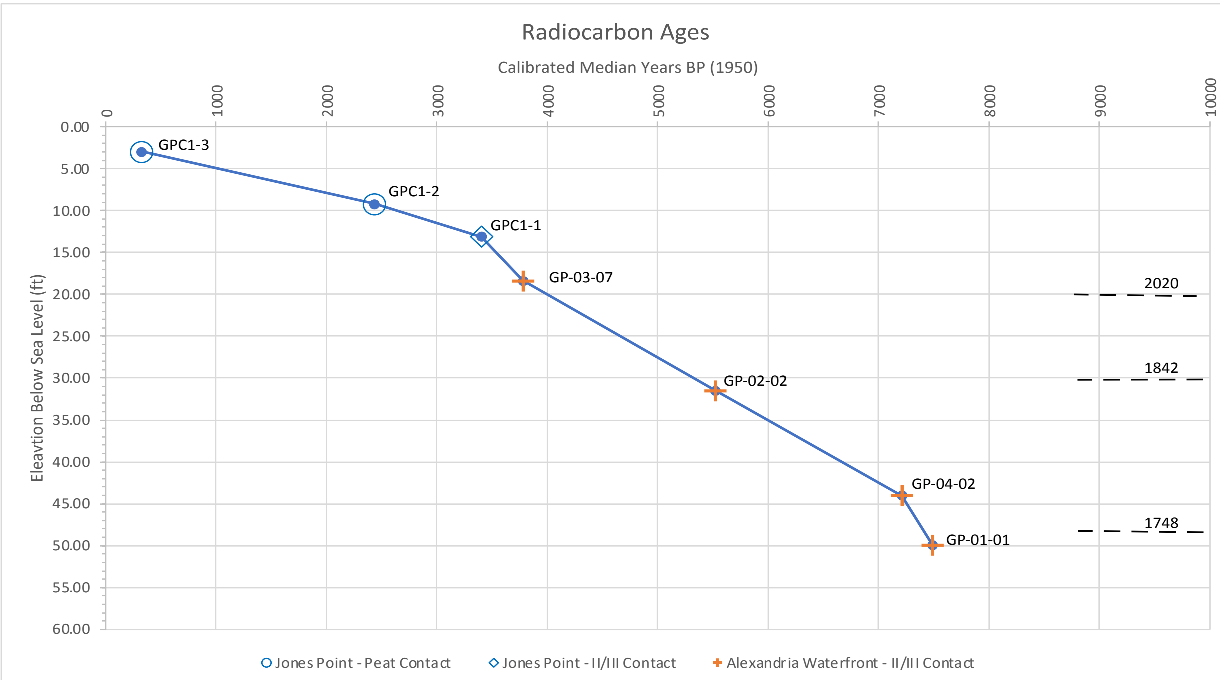

Figure E-4: Calibrated C14 ages versus depth (ft bmsl) of Stratigraphic Unit II/III contacts at Alexandria Waterfront (GP-01-01, GP-04-02, GP-02-02, GP-03-07 and Jones Point GPC1-1); and peat contacts at Jones Point (lower peat contact-GPC1-2 and uppermost peat extent (GPC1-3) as chronologic markers of regional sea level rise (see table E-1 for more detail). Dashed lines represent reported historic depths of Potomac River channel proximal to the Alexandria waterfront (OCS 2020, Young et al 1857, Washington 1748).

From deep within the footprint of the buried relic embayment, radiocarbon dates were acquired from each of four cores (GP-01 through GP-04) sourced from ASU-IIc strata situated in basal contacts with ASU III at different elevations relative to modern sea level (Table E-1). These loci are postulated to represent possible transition contexts (inflection points) representing progressive sea level rise and the transition to tidal estuary influenced sedimentation. Figure E-4 plots these radiocarbon age values with depth, in addition to three additional dated inflection points from a sequence of a peat-bearing estuarine marsh sediments recovered from a core extracted at nearby Jones Point [a tidal marsh locus near the mouth of Hunting Creek that provides a basal II/III contact date and a pair of subsequent dates that bracket initial and final accumulation of a stable peat deposit in IIb contexts (Dutton 2021: Core GPC-1)]. Together these seven values provide indications of minimal age by depth of initial *sustained* tidal influence in this area, and are in general agreement with regional composite sets of Chesapeake Bay data regarding sea-level rise, backflooding of principal river systems and estuary formation (Tibert et al 2012, Lothrop et al 2016, Cronin et al 2019). These data have applicability regarding the chronology and elevation of sea-level rise and inundation of low-altitude riverine landforms throughout the upper tidal extent of the Potomac River.

ASU-III: A single late-Pleistocene, radiocarbon-age estimate was acquired (ASU-III) (late-Pleistocene, Old Town terrace) from ~20 ft bmsl in GP-05 located where the western edge of the embayment would expectedly be in relatively shallow and close proximity to the upland Old Town terrace. Deciduous wood fiber (sample GP-05-04) imbedded within a possible backswamp deposit (flood splay?) provided a >42ky minimal age-estimate (Table: E-1). This date falls within the expected age-range of the Old Town terrace (Fleming 2015).

Summary and Recommendations

The stratigraphic framework applied here serves to organize three principal landform components in the project area that vary by relative age, formation history, morphology and potential for inclusion and preservation of associated archaeological components. All three principal components were identified in the first five of six geoprobe tests located within the footprint of the waterfront study area, a relic embayment buried by historic fills. (The last of the sequence (GP-06) is an upland outlier represented by principal component ASU-III with a thin topcover of ASU-I).

The oldest principal component (ASU-III) represents a foundational Pleistocene-age landform incised along its eastern extent by the Potomac River valley and progressively buried along its lower flanks by Holocene-age (post-glacial) alluvial sedimentation sustained and primarily controlled by continuous sea level rise. Its terrestrial landform components (above sea level) have likely provided near-surface contexts for settlement and potential archaeological site formation throughout much of prehistory, as it presently does in upland settings above and upslope of the riverfront. The chronological data assembled here (Figure E4) provides a temporal framework for landscape inundation over time, and by extension, a date-range for potential site formation on previously extant landscapes of similar relative elevations in presently inundated settings. However, both the low number of tests conducted in this study area and the small physical size of cored samples limit what may be determined regarding presence/absence and context of buried archaeology at the upper contact of ASU-III. The upper boundary of ASU-III ranged from 18-55 ft below surface in the five geoprobe tests located within the footprint of the waterfront study area.

The younger principal alluvial component (ASU-II) represents fine-grained alluvial deposits of post-glacial (Holocene) age that accrued at and below sea level with progressive rises in sea levels during steady expansion of estuarine conditions in the upper Potomac River valley. ASU-II was identified in five geoprobe tests located within the relic embayment footprint of the waterfront study area (GP-01 through GP-05). Deposition appears to have been primarily low-energy across terrace-margin tidal flats and marshes, yet potentially erosive in initial contact with underlying ASU-III (such as along sloped, relic terrace surfaces). The chronological and morphological data assembled here differentiates pre-settlement (prehistoric) subunits IIc and IIb from post-settlement (historic) subunit IIa. No characteristics indicative of weathered terrestrial surfaces were noted, indicating that sub-aqueous environments of deposition prevailed. ASU-II archaeological content in primary contexts would expectedly be limited to cultural materials (artifacts) associated with riverine/estuarine related activities (such as transportation or fishing) embedded within saturated (anaerobic) alluvium that exhibits high potential for preservation of organic materials. The upper boundary of pre-settlement subunit ASU-IIc ranged from 8 ft below surface in GP-05 and 26-51ft below surface in GP-01 through GP-04. The upper boundary of pre-settlement subunit ASU-IIb ranged from 16-38 ft below surface in GP-01 through GP-03. The upper boundary of post-settlement subunit ASU-IIa ranged from 10-12' below surface in GP-04 and GP-03.

The youngest principal component (ASU-I) represents capping fill sediments of post-settlement age disturbed and/or deposited by human agency, sourced primarily from local Old Town terrace (ASU-III). ASU-I archaeological components of pre-settlement (historic) origin would exist in disturbed secondary contexts; post-settlement (prehistoric) components could reside in both primary and secondary contexts. ASU-I ranged in depth below surface from 8-18 ft within the footprint of the waterfront study area (GP-01 through GP-05), and ~1 ft in the upland terrace location of GP-06.

Archaeological Site Discovery Recommendations

Discovery and evaluation of archaeological sites in alluvial settings are often contingent upon the preservation conditions of host landforms, and the investigative techniques employed.

In this current phase of investigations within the footprint of the relic embayment, the limited number of relatively narrow-diameter cores (geoprobe tests GP-01 through GP-05) proved useful for near-continuous sediment sampling (where not obstructed), but limited in regards to providing adequate sample size to evaluate strata for archaeological components. This could be remedied by examination of larger diameter cores---or preferably—broad exposures (both vertical and horizonal) provided by open excavations.

However, excavations within the subject area are likely to be hampered by several factors revealed by recent testing. First, the area is capped with 8-18 ft of mixed lithology and mixed component ASU-I which has potential to obstruct core and trench excavation efforts; and second, the maximum depth to water table (sea level) noted in geoprobe tests is ~8 ft below surface which compromises the viability of open excavations (without ameliorating efforts such as shoring and dewatering). Additional evaluations of any proposed project impact may need to employ a variety of techniques depending upon the vertical range of anticipated disturbances.

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APPX E-1: Geoprobe Core Descriptions

Test: **Geoarchaeology Test GP-01**

Date: **11/17/21**

Elevation: **3.25'/1.0m** **Lat/Long: 6980045/1189920**

Elevation 1842: **-10'/-3m (appx), (embayment margin near river channel)**

Elevation 1748: **"river" (~8 fathoms/48'/14.6m)**

Depth of capping surface fills (ASU-I): 11.8ft/3.6m below surface.

Depth bs (feet)	Depth bs (meter)	Stratum	Description
0.0- 5.0	0.0-1.5	I	Mixed FILL; building debris, brickbat etc; abrupt lower boundary @ water table
5.0-11.2	1.5-3.4	I	Black (2.5Y2.5/1) COAL SAND (with mixed sand and pebbles), very friable; brown silty sand slurry in center of section; petroleum (?) odor; abrupt lower boundary
11.2-11.8	3.4-3.6	I	Black (2.5Y2.5/1) silty fine sand and mixed sand; bedded; friable abrupt and eroded lower boundary
11.8-13.1	3.6-4.0	IIa	Very dark gray (2.5Y3/1) to black 2.5Y2.5/1 clayey silt with olive gray (5Y4/2) very fine sand laminae that include ~4 mm bivalve shell; few macro-organics, sticky, firm.
13.1-15.0	4.0-4.6		(No Recovery) Bark plug (pine-like) in core bit
15.0-24.3	4.6-7.4	IIa	Very dark gray (2.5Y3/1) to black (2.5Y2.5/1) and dark gray (5Y4/1) clayey silt and silty clay with olive gray (5Y4/2) very fine sand laminae that include few 1-2 mm fragments of shell; few macro-organics; sticky, firm; abrupt lower contact with IIb marked by a 15mm thick bed of crushed platy COAL and CINDER.
24.3-37.8	7.4-11.5	IIa	Dark gray (2.5Y4/1) silt; laminated, very few organics noted; few shell fragments* and oyster* noted between 9.3-11.5 mbs; sticky, firm, clear lower boundary.
37.8-38.1	11.5-11.6	IIb	Very dark gray (2.5Y3/1) mixed (very fine to coarse) sandy silt; bedded, friable; clear lower boundary. Wood fragment (GP01-04) recovered from 11.5 mbs (10.5 mbsl) provided a radiocarbon age estimate of 4030+/-30 BP (median cal 2533 BC, 4482 BP), (ICA-14C6406).
38.1-51.2	11.6-15.6	IIb	Very dark gray (5Y-2.5Y3/1) very fine sandy silt fining up to clayey silt; laminated, sticky, firm; few macro-organics* noted between 12.6-15.0 mbs; very few very fine (1-3mm) white nodular inclusions noted between 14.4-15.2 mbs (non-reactive to acid, turned blue upon rapid oxidation, possible iron phosphate 'vivianite'); no shell noted, clear lower boundary with IIc.

51.2-54.5	15.6-16.6	IIc	Very dark gray (2.5Y4/1) to gray (2.5Y5/1) silty very fine sand, fining up, bedded and laminated; Si-rich pebbles noted at eroded basal contact with III. Wood fibers* (sample GP01-01: unidentified) recovered from 16.2 mbs (15.2 mbsl) provided a radiocarbon age estimate of 6600+/-30 BP (median cal 5542 BC, 7491 BP), (ICA 14C6408).
54.5-60.0	16.6-18.3	III	Greenish gray (10Y5/2-10Y6/1) silty sand; with olive brown (2.5Y4/3-4/4) redox laminae below17.5 mbs; no shell or organics noted; slightly sticky and wet.

Test: **Geoarchaeology Test GP-02**

Date: **12/06/21**

Elevation: **3.25'/1.0m** **Lat/Long: 6980363/11899153**

Elevation 1842: **~ 8'/2.4m (reclaimed)**

Elevation 1748: **<-5'/-1.5m (embayment)**

Depth of capping surface fills (ASU-I): 18.1ft/5.5m below surface.

Depth bs (feet)	Depth bs (meter)	Stratum	Description
0.0-6.2	0.0-1.9	I	High-terrace sourced fill (basement spoil?), clay-rich strong brown 5YR-7.5YR4/4 with common redox mottles) with mixed sand, gravel and coal cinder.
6.2-8.2	1.9-2.5	I	Mixed Fill; dominated by black (2.5Y2.5/1) coal (with mixed sand and pebbles), friable.
8.2-9.8	2.5-3.0	I	High-terrace sourced fill (basement spoil?), clay-rich strong brown 5YR-7.5YR4/4 with common redox mottles) with mixed sand and gravel.
9.8-11.5	3.0-3.5	I	Fill: silty mixed sand with crushed red brick, wood and broken chert-like pebbles.
11.5-14.8	3.5-4.5		(No Recovery) brick plug (fragment) in core bit
14.8-18.1	4.5-5.5	I	Fill: Brown (10YR4/3) silty sand with crushed shell and crushed red brick.
18.1-20.0	5.5-6.1		(No Recovery) pebble plug in core bit
20.0-25.3	6.1-7.7	IIb	Black (5Y2.5/1) silty clay coarsening up to clayey silt; massive, slightly sticky to sticky, firm; no detrital macro-organics or shell noted; very few very fine (1-3mm) white nodular inclusions* noted between ~6.1-8.1 mbs (non-reactive to acid, turned blue upon rapid oxidation, possible iron phosphate 'vivianite'); clear lower boundary.
25.3-26.2	7.7-8.0	IIb	Black (2.5Y2.5/1) very fine sandy silt and silty very fine sand; bedded, friable; clear lower boundary. Single snail shell noted at 7.8 mbs.
26.2-37.4	8.0-11.4	IIb	Black (2.5Y2.5/1) very fine sandy silt fining up to clayey silt and silty clay; laminated, sticky to slightly sticky, firm; no detrital shell or macro-organics noted, but very fine root hairs were noted between 9-10 mbs; single small quartz pebble noted at 10.4 and 10.9 mbs; clear lower boundary with IIc.
37.4-41.4	11.4-12.6	IIc	Very dark gray (5Y3/1) Si-rich pebbles in silty mixed sand fining up to silty very fine-to-fine sand with occasional pea gravel; fining up again to silty very fine sand; bedded and laminated; friable, eroded basal contact with III. No shell noted. Woody fibers* (sample GP02-02: American Chestnut-*Castanea dentata* and Oak-*Quercus)* recovered

			from 12.0 mbs (9.6 mbsl) provided a radiocarbon age estimate of 4820+/-30 BP (median cal 3573 BC, 5522 BP), (ICA 14C6405).
41.4-43.3	12.6-13.2	III	Greenish gray (5GY5/1) very dense clayey silt grading up to laminated dark gray (N4/) silt with common dark yellowish brown (10YR4/6) Fe oxidation stains along laminates; no inclusions, clear lower boundary
43.3-45.0	13.2-13.7		(No Recovery) clayey silt plug in core bit
45.0-50.0	13.7-15.2	III	Gray (10YR7/1) silt with occasional strong brown (7.5YR5/6) redox mottles, interspersed with 5-8 cm thick, highly oxidized red (10R4/6) silt bands* (with possibly higher sand content); no pebble, shell or organic inclusions; sticky, wet, firm.

Test: **Geoarchaeology Test GP-03**

Date: **12/06/21**

Elevation: **8.48'/2.58m** **Lat/Long: 6980634/11899208**

Elevation 1842: **~ 8'/2.4m (reclaimed)**

Elevation 1748: **<-5'/-1.5m (embayment)**

Depth of capping surface fills (ASU-I): 16.4ft/5.0m below surface.

Depth bs (feet)	Depth bs (meter)	Stratum	Description
0.0-3.9	0.0-1.2	I	High-terrace sourced fill (basement spoil?), clay-rich strong brown 5YR-7.5YR4/4 with common redox mottles) with mixed sand, gravel and coal cinder.
3.9-7.9	1.2-2.4	I	Mixed Fill; dominated by black (2.5Y2.5/1) coal sand, cinder, sand and pea gravel (with occasional brick fragment and shell), friable; abrupt lower contact (truncated?) at water table.
7.9-9.2	2.4-2.8	I	Brown (10YR4/3) silty very fine-medium sand with 1-2 mm strong brown 7.5YR5/8) silt drapes; bedding trends downslope; includes very few, fine inclusions of charcoal; clear lower contact marked by cherty pebbles and oyster shell fragments.
9.2-9.8	2.8-3.0	I	Brown (10YR4/3) very fine sandy silt (loam); with inclusions of wood*; dense.
9.8-11.2	3.0-3.4	I	Brown (10YR4/3) silty very fine to medium sand with few fine (4-6mm) prominent inclusions of soft shell fragments; poorly sorted; abrupt lower contact.
11.2-12.8	3.4-3.9	I	Brown (10YR4/3) silty very fine sand, bedded with silty laminates that coarsen up to silty medium sand with Si-rich pea gravel (includes cherty pebbles with white weathered patina, including jasper); inclusions include charcoal and wood. Wood fragments (sample GP03-03: Southern Yellow Pine-*Pinus)* recovered from 3.0 mbs (0.4 mbsl) provided a radiocarbon age estimate of 170+/-30 BP (median cal AD 1774, 176 BP), (ICA 14C6399).
12-8-15.1	3.9-4.6		(No Recovery)
15.1-15.7	4.6-4.8	I	Very dark gray (5Y3/1) very fine sand; abrupt lower contact.
15.7-16.4	4.8-5.0	I	Dark grayish brown (2.5Y4/2) silty fine sand with pine-like bark fragments, broken greenstone pebble, and wood.
16.4-20.0	5.0-6.1		(No Recovery, wood in core bit)
20.0-20.3	6.1-6.2	I	Wood in dark gray (5YR3/1) very fine silty sand; friable; abrupt and eroded? lower contact. Wood fibers (sample GP03-04: Southern Yellow Pine *Pinus* and Red Oak *Quercus)* recovered from 6.1 mbs (3.5 mbsl) provided a radiocarbon age estimate of 210+/-30 BP (median cal AD 1766, 184 BP) (ICA 14C6401).

20.3-23.6	6.2-7.2	IIb	Very dark gray (5Y3/1) very fine sandy silt; laminated, with rare pebble inclusion; very few very fine charcoal inclusions; friable to firm; no detrital macro-organics or shell noted; very few very fine (1-3mm) white inclusions noted between ~6.1-7.2 mbs (non-reactive to acid, turn blue upon rapid oxidation, possible iron phosphate 'vivianite'); slightly sticky to sticky, clear lower boundary.
23.6-24.9	7.2-7.6		(No Recovery)
24.9-26.2	7.6-8.0	IIb	Very dark gray (5Y3/1) very fine sandy silt, laminated; with single pebble inclusion and single fibrous wood*; friable; slightly sticky to sticky, clear lower boundary.
26.2-28.2	8.0-8.6	IIc	Olive gray (5Y4/2) silty medium sand grading up to very dark gray (5Y3/1) silty fine sand with pebbles (matrix supported) throughout; detrital macro-organics noted (wood and bark); friable. A single sample of coniferous bark or cambium (sample GP03-07) recovered from 8.2-8.3 mbs provided a radiocarbon age estimate of 3520+/-30 BP (median cal 1833 BC, 3782 BP), (ICA 14C6403).
28.2-29.8	8.6-9.1		(No Recovery)
29.8-31.2	9.1-9.5	III	Olive gray (5Y4/1) silty mixed sand with single line of pebbles at 9.3 mbs and concentration of pebbles at 9.4-9.5 mbs; friable.
31.2-33.8	9.5-10.3	III	Dark greenish gray (5GY4/1 and 10Y4/1) mixed pebbles in silty mixed sand that fines up to pebbly silty very fine to medium sand, capped by poorly sorted but crudely bedded silty mixed sand with pea gravel (all gravel is Si-rich); all friable to very friable.

Test: **Geoarchaeology Test GP-04**

Date: **12/06/21**

Elevation: **3.25'/1.0m** **Lat/Long:** **6978551/11899158**

Elevation 1842: **-30'/-10m (appx), (river channel)**

Elevation 1748: **"river" (~8 fathoms/48'/14.6m)**

Depth of capping surface fills (ASU-I): 10.5ft/3.2m below surface.

Depth bs (feet)	Depth bs (meter)	Stratum	Description
0.0- 0.8	0.0-0.25	I	Concrete; white/gray.
0.8-2.6	0.25-0.8	I	Black (10YR2/1) mixed sand (with clayey sand and pebbles) and dark yellowish brown (10YR4/4) sand with brickbat and furnace cinder, friable to loose consistency.
2.6-3.0	0.8-0.9	I	Very dark gray (7.5YR3/1) muddy silty fine sand and pebbles; loose; saturated, with sticks.
3.0-4.9	0.9-1.5		(No Recovery)
4.9-6.2	1.5-1.9	I	Dark brown (7.5YR3/1) mixed sand and pebbles, with wood inclusions, wet and loose.
6.2-6.6	1.9-2.0	I	Wood (log/pier?)
6.6-7.2	2.0-2.2	I	Dark brown (7.5YR3/1) mixed sand and pebbles, with wood inclusions, wet and loose.
7.2-8.2	2.2-2.5	I	Wood (log/pier?)
8.2-9.8	2.5-3.0		(No Recovery) Solid wood plug in core bit
9.8-10.5	3.0-3.2	I	Shell, cinder and coal hash.
10.5-29.2	3.2-8.9	IIa	Dark grayish brown (2.5Y4/2) to dark gray (2.5Y4/1) clayey silt; massive; with minor (<1%) small inclusions of oyster shell*, brick fragments*, snail, wood, bark, coal dust and coal* throughout, with same inclusions (less snail) plus minor mixed sand noted in the basal 30 cm; sticky, firm; clear lower contact.
29.2-39.7	8.9-12.1	IIa	Dark gray (2.5Y4/1) clayey silt and silty clay; laminated; few shell* fragments and macro-organics* noted between 10.4-12.1 mbs; sticky, firm, clear lower boundary. Pine needles (sample GP04-01: *Pinus*) recovered from 10.45 mbs (9.4 mbsl) provided a radiocarbon age estimate of 200+/-30 BP (median cal AD 1767, 183 BP) (ICA 14C6407).
39.7-47.6	12.1-14.5	IIc	Black (2.5Y2.5/1) to gray (2.5Y5/1) silty very fine sand, laminated with one interbed of washed-out very fine sand from 13.6-13.85 mbs; upper 40 cm includes (overall coarser) silty very fine to fine sand with inclusions of coarse sand. Macro organics (wood*) noted with laminated sands; very friable, slurry at base (precluded additional coring). Wood fibers (sample GP04-02: nondiagnostic deciduous) recovered from 14.4 mbs (13.4 mbsl) provided a radiocarbon age estimate of 6310+/-30 BP (median cal 5266 BC, 7215 BP), (ICA 14C6402).
47.6-50.0	14.5-15.2	III?	(No Recovery) Wet sand slurry?

Test: **Geoarchaeology Test GP-05**

Date: **11/17/21**

Elevation: **8.0’/2.4m** **Lat/Long: 6979671/11898703**

Elevation 1842: **~ 8’/2.4m (reclaimed)**

Elevation 1748: **<-5’/-1.5m (embayment)**

Depth of capping surface fills (ASU-I): 7.9ft/2.4m below surface.

Depth bs (feet)	Depth bs (meter)	Stratum	Description
0.0-1.3	0.0-0.40	I	Asphalt over Concrete
1.3-5.4	0.4-1.65	I	Strong brown (7.5YR4/6) clay-rich basement-like spoil (redeposited B-horizon); with few large distinct Manganese sheet precipitates along ped surfaces; firm. Abrupt lower contact at a line of pebbles.
5.4-7.9	1.65-2.4	I	Dark gray (10YR4/1) and dark grayish brown (10YR4/2) silty very fine sand; bedded, friable; with an interbed of oyster-shell hash with brick fragments between 2.0-2.15 mbs; friable.
7.9—9.8	2.4-3.0		(No Recovery)
9.8-13.4	3.0-4.1	IIc	Dark gray (10YR4/1) and dark grayish brown (10YR4/2) silty very fine sand and very fine sandy silt; bedded, friable; with a silt-rich interbed with few, medium and distinct charcoal inclusions of between 3.4-3.6 mbs, single pebble at 4.0 mbs; friable.
13.4-15.1	4.1-4.6		(No Recovery)
15.1-18.0	4.6-5.5	IIc	Dark brown (2.5Y4/1) silty very fine micaceous sand; bedded and laminated; with an interbed of very dark grayish brown (10YR3/2) silty sand (and one pebble) and wood fragment “hash” with few, medium and distinct charcoal inclusions between 5.2-5.3 mbs; friable; base of stratum included pebbles in an abrupt (eroded) lower contact. Woody fibers (sample GP05-02: coniferous bark/cambium) recovered from 5.2 mbs (2.8 mbsl) provided a radiocarbon age estimate of 970+/-30 BP (median cal AD 1083, 857 BP), (ICA 14C6404).
18.0-21.6	5.5-6.6	II/III?	Very dark gray (5Y3/1) ranging up to gray (N5/) with olive (5Y4/3) redox staining in bedded silty very fine micaceous sand; bedded and laminated, with macro-organic (wood <25 mm) inclusions* near base, friable; clear lower boundary.
21.6-22.6	6.6-6.9	III	Very dark gray (5Y3/1) very fine sandy silt; laminated with inclusions of woody organic matter, friable; gradual lower boundary.

22.6-27.9	6.9-8.5	III	Dark gray (5Y4/1) grading up to dark grayish brown (2.5Y4/2) silty very fine micaceous sand, laminated; few distinct charcoal inclusions noted at 8.2-8.3 mbs; friable; clear lower boundary.
27.9-30.0	8.5-9.1	III	Very dark grayish brown (2.5Y3/2) silty very fine sand, bedded and capped with 0.2 m thick bed of silty very fine to medium sand with wood and leaf inclusions*; friable. Woody fibers (sample GP05-04: wood fibers-possible American Beech *Fagus americana*) recovered from 8.6 mbs (6.2 mbsl) provided a radiocarbon age estimate of >42,000 BP (ICA 14C6400).

Test: **Geoarchaeology Test GP-06**

Date: **11/17/21**

Elevation: **25.0'/7.6m** **Lat/Long: 6979718/11898389**

Elevation 1842: **(upland, ~25')**

Elevation 1748: **(upland, ~25')**

Depth of capping surface fills (ASU-I): 1.10ft/0.35m below surface.

Depth bs (feet)	Depth bs (meter)	Stratum	Description
0.0-1.1	0.0-0.35	I	Asphalt over pebbly concrete over cinder in very dark gray (5YR3/1) silty mixed sand.
1.1-4.1	0.35-1.25	III	Reddish brown (5YR4/4) very fine sandy loam with lams of very fine-fine sand, coarsening up to brown (7.5YR4/4) coarse-fine sandy loam and loamy very fine sand; bedded, compact and friable.
4.1-4.9	1.25-1.50		(No Recovery)
4.9-6.1	1.5-1.85	III	Reddish brown (5YR4/4) very fine sandy clayey silt (sandy loam) with laminates of very fine-fine sand, abrupt lower contact at a line of black (5YR2.5/1) Mn (?) cemented coarse sand and pea gravel.
6.1-6.9	1.85-2.10	III	Brown (7.5YR4/4) very fine sandy clayey silt (sandy loam) with laminates of yellowish red (5YR4/6) oxidized iron and dark reddish brown soft manganese concretions; abrupt lower boundary.
6.9-7.7	2.10-2.35	III	Brown (7.5YR4/4) silty very fine quartz sand.
7.7-9.8	2.35-3.00		(No Recovery)
9.8-11.3	3.0-3.45	III	Reddish brown (5YR4/4) very fine sandy clayey silt (sandy loam); massive with dark reddish brown redox mottle; abrupt lower contact at a line of black (5YR2.5/1) Mn (?) cemented coarse sand and pea gravel.
11.3-13.1	3.45-4.00	III	Light brown (7.5YR6/3) silty very fine quartz sand with brown (7.5YR5/4) silty laminates; friable with abrupt (and eroded?) lower contact marked by 10 cm of crushed (by core bit) white quartz gravel.
13.1-14.8	4.0-4.5		(No Recovery)
14.8-16.0	4.5-4.9	Potomac Fm.	Reddish brown (5YR5/4) very fine sandy clay with yellowish red (5YR5/8) redox mottles and dark reddish brown Mn staining in laminates; very firm, clear lower boundary.
16.0-20.0	4.9-6.1	Potomac Fm.	Strong brown (7.5Y5/6) silty very fine-fine sand fining up to reddish brown (5YR5/3) very fine sandy clay; mid stratum laminates are reddish gray (5YR5/2) with yellowish red (5YR5/6-5/8) redox mottles; laminated, friable to firm.

Appx E-2: Taxonomic Identifications of Wood Remains

Taxonomic Identification of Wood Remains Geoarchaeological Field Investigations in support of the City of Alexandria Waterfront Flood Mitigation Implementation Project

For: Daniel R. Hayes, Geoarchaeologist
By: Justine McKnight, Archeobotanical Consultant

April 8, 2022

Ten samples of sediment containing organic material were submitted from recent geomorphological investigations on the Potomac River waterfront within the City of Alexandria, Virginia in support of an upcoming flood mitigation implementation project. This collection of samples derives from sediment cores secured from floodplain terrain from a depth of as much as 50 feet. Samples were submitted in vinyl bags and foil packets and ranged in moisture content from dry to very wet. Samples were individually air-dried prior to analysis, and sample weights reflect dry condition. Upon initial examination samples appeared to contain plant materials in an uncarbonized state, along with varying amount of sediment.

Each sample was individually weighed and its general description was recorded. Where possible, each sample was passed through a clean 2 millimeter geologic sieve to isolate plant materials for identification. The less-than 2 millimeter fractions were scanned under low magnification (10X to 40X) for the remains of seeds (none were encountered). The greater-than- or-equal-to 2 millimeter fraction was examined under low magnification and vegetative material was isolated from sediment for identification. Identification of plant tissue relies upon patterns in minute morphology and their measurement following standard procedures (Fritz and Nesbitt 2014; Pearsall 2000). Taxonomic identification was attempted under low magnification (10X to 40X) with the aid of standard texts (Edlin 1969; Panshin and deZeeuw 1980) and by comparison to modern plant specimens from a reference collection representative of the flora of Northern Virginia (USDA 2022). Results are presented by sample number in Table 01.

GP-01-01
Sample GP-01-01 was composed of wood fibers in a matrix of abundant sediment and including the remains of insect pupae. Dry weight of the sample was 3.51 grams. Woody material was scant, and a total of only 0.06 grams of clean root material was present within the sample.

GP-01-04
Sample GP-01-04 consisted of scant woody fibers in abundant sediment. The weight of sample totaled 9.85 grams. The wood compared favorably to American beech (*Fagus americana*).

GP-02-02
Sample GP-02-02 was composed of woody fibers in an abundant sediment matrix (3.28 grams). American chestnut (*Castanea dentata*) and oak (*Quercus*) were identified.

GP-03-03
Sample GP-03-03 contained three fragments (0.13 grams) of clean wood identified as pine (*Pinus*), of the southern yellow pine group. These pines of the Southern and Eastern United States cannot be separated on the basis of minute wood structure (Panshin and deZeeuw 1970:456-457). The southern pine group includes the following species: longleaf pine (*Pinus palustris*), shortleaf pine (*Pinus echinata*), loblolly pine (*Pinus taeda*), slash pine (*Pinus elliottii*), pitch pine (*Pinus rigida*), Virginia pine (*Pinus virginiana*), and pond pine (*Pinus serotina*).

GP-03-04
Sample GP-03-04 was made up of woody fibers in a scant quantity of sediment. Dry sample weight was 8.25 grams. Wood fibers were identified as red oak (*Quercus*) (6.84 grams) and southern yellow pine (*Pinus*). This group of pines cannot be separated on the basis of minute wood structure (Panshin and deZeeuw 1970:456-457). The southern pine group includes the following species: longleaf pine (*Pinus palustris*), shortleaf pine (*Pinus echinata*), loblolly pine (*Pinus taeda*), slash pine (*Pinus elliottii*), pitch pine (*Pinus rigida*), Virginia pine (*Pinus virginiana*), and pond pine (*Pinus serotina*).

GP-03-07
Sample GP-03-07 weighed 1.02 grams and consisted of a single fragment of coniferous bark or cambium material.

GP-04-01
Sample GP-04-01 was composed of needle leaves in abundant sediment. The leaves were isolated from the soil matrix, and 0.18 grams of clean material was recovered. The needles are coniferous and compare favorably with pine (*Pinus*).

Plate 01: Coniferous needle leaves from Sample 04-01. Scale = 1 millimeter grid

GP-04x-02
Sample GP-04x-02 contained wood fibers with adherent sediment. Sample weight totaled 0.46 grams. Wood fibers were compressed and non-diagnostic and were classified as a deciduous type.

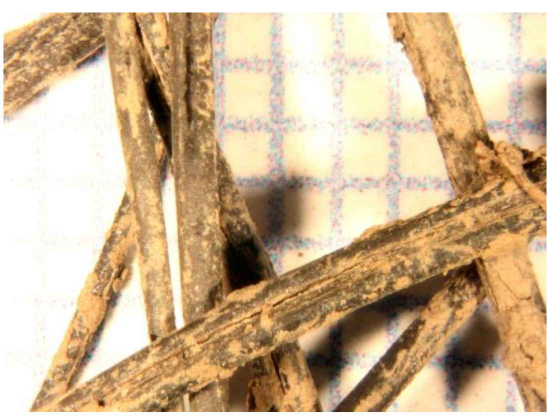

Plate 01: Coniferous needle leaves from Sample 04-01. Scale = 1 millimeter grid

GP-04x-02

Sample GP-04x-02 contained wood fibers with adherent sediment. Sample weight totaled 0.46 grams. Wood fibers were compressed and non-diagnostic and were classified as a deciduous type.

GP-05-02

Sample GP-05-02 consisted of woody fibers in a matrix of abundant sediment. Sample weight was 6.78 grams. Woody material was identified as coniferous bark or cambium.

GP-05-04

Sample GP-05-04 contained woody fibers and organic conglomerate material in a matrix of sediment. A single wood fragment compared favorably American beech (*Fagus americana*).

Table 01: Identification of carbon samples submitted from the Geoarchaeological Field Investigations in support of the City of Alexandria Waterfront Flood Mitigation Implementation Project

Sample Number	**GP-01-01**	**GP-01-04**	**GP-02-02**	**GP-03-03**	**GP-03-04**	**GP-03-07**	**GP-04-01**	**GP-04x-02**	**GP-05-02**	**GP-05-04**
Description	wood fibers in abundant sediment, insect remains	scant wood fibers in abundant sediment	wood fibers in abundant sediment	3 fragments clean wood fibers	wood fibers in scant sediment	wood fibers	needle leaves in abundant sediment	wood fibers with sediment	wood fibers in abundant sediment	wood fibers, organic conglomerate, sediment
Total Sample Weight (grams)	3.51	9.85	3.28	0.13	8.25	1.02	2.25	0.46	6.78	4.84
Unburned Woody Tissue	x	x	x	x	x	x		x	x	x
Castanea dentata (American chestnut)			x							
cf. Fagus americana (beech)		x								x
Pinus sp. (southern hard pine group)				x	x					
Quercus sp. (red oak group)					x					
Quercus sp. (oak)			x							
bark/cambium, coniferous						x			x	
root material, woody	x									
deciduous woody taxa								x		
Needle leaves, coniferous, cf. *Pinus sp.* (pine)							x			

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USDA, NRCS
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Appx E-3: ICA Radiocarbon Lab Report

International Chemical Analysis Inc.
10001 Lewis Dr. Suite A-100
Damascus, MD 20871

Sample Report

Submitter Name: Daniel Hayes
Company Name: Hayes & Monaghan Geoarchaeologists, LLC
Address: 125 Bennington Road Charlottesville, VA 22901
Date Received: April 11, 2022
Date Reported: May 09, 2022

ICA ID	Submitter ID	Material Type	Pretreatment	Conventional Age	Calibrated Age
14C-6399	GP-03-03	Wood	AAA	170 +/- 30 BP	Cal 1650 - 1700 AD (17.4%) Cal 1720 - 1820 AD (46.4%) Cal 1830 - 1890 AD (12.2%) Cal 1900 - ….. AD (19.5%)
14C-6400	GP-05-04	Wood	AAA	>42000 BP	
14C-6401	GP-03-04	Wood	AAA	210 +/- 30 BP	Cal 1640 - 1690 AD (30.8%) Cal 1720 - 1810 AD (53.6%) Cal 1920 - …… AD (11.1%)
14C-6402	GP-04x-02	Wood	AAA	6310 +/- 30 BP	Cal 5360 - 5210 BC
14C-6403	GP-03-07	Wood	AAA	3520 +/- 30 BP	Cal 1940 - 1740 BC
14C-6404	GP-05-02	Wood	AAA	970 +/- 40 BP	Cal 990 - 1170 AD
14C-6405	GP-02-02	Wood	AAA	4820 +/- 30 BP	Cal 3850 - 3520 BC
14C-6406	GP-01-04	Wood	AAA	4030 +/- 30 BP	Cal 2630 - 2460 BC
14C-6407	GP-04-01	Wood	AAA	200 +/- 30 BP	Cal 1640 - 1700 AD (26.3%) Cal 1720 - 1820 AD (54.8%) Cal 1910 - ……. AD (14.4%)
14C-6408	GP-01-01	Wood	AAA	6600 +/- 30 BP	Cal 5620 - 5580 BC (23.7%) Cal 5570 - 5470 BC (71.7%)

International Chemical Analysis Inc.
10001 Lewis Dr. Suite A-100
Damascus, MD 20872

QC Report

Submitter Name: Daniel Hayes
Company Name: Hayes & Monaghan Geoarchaeologists, LLC
Address: 125 Bennington Road Charlottesville, VA 22901

Date Submitted	April 11, 2022	Date Reported	May 09, 2022
QC 1 Sample ID	**IAEA C7**	QC 2 Sample ID	**IAEA C5**
QC Expected Value	49.53 +/- 0.70 pMC	QC Expected Value	23.05 +/- 0.70 pMC
QC Measured Value	50.08 +/- 0.20 pMC	QC Measured Value	23.20 +/- 0.20 pMC
Pass?	**YES**	Pass?	**YES**

- pMC = Percent Modern Carbon.
- IAEA = International Atomic Energy Agency.

- Calibrated ages are attained using INTCAL20.
- Unless otherwise stated, the error reported is one standard deviation.
- Conventional ages are given in BP (BP=Before Present, 1950 AD), and have been corrected for natural isotope fractionation.