

Appendix 4 - Nevan Carling, “Placing the Parsons House: The Cultural and Ecological Context of Constructing a Connecticut River Valley House”, 2026



Placing the Parsons House: The Cultural and Ecological Context for Constructing a Connecticut River Valley House

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Cover Photograph - Figure 1: The Nathaniel Parsons House in 1914 (D.A.R. Betty Allen Chapter Early Northampton (Springfield MA: F. A. Bassette Company: 1914), p. 16.)

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This essay was written as part of a larger historic structures report (HSR) commissioned by Historic Northampton, Inc. under the leadership of Myron O. Stachiw – architectural historian and buildings archaeologist. The objective of this research was to carefully examine and document the timber framing of the Nathaniel Parsons house to reveal the vernacular building traditions employed in the structure’s multiple phases. For this essay in particular, the structure’s earliest phase, dated to 1719 using dendrochronology, was investigated to place it within the larger historical and architectural context of the Connecticut River Valley and its distinctive building tradition developed during the late 17th – mid 18th centuries. Likewise, spurred on by an interest from Historic Northampton, Inc., this essay attempts to use the Parsons house as an example of the historic built environment to elucidate information about the historic natural environment from which the house was constructed.

Introduction:

The Nathaniel Parsons house (1719) in Northampton, Massachusetts is, in its earliest phase, a post-medieval structure with subsequent later 18th- and 19th century remodeling campaigns. Previous investigations established approximate chronologies of construction and alteration phases; however, these studies have not put the Parsons House within the wider context of the vernacular building tradition of the Connecticut River Valley (CTRV). The Valley's political and geographic isolation in the first century of New England's colonization produced a distinct socio-cultural environment which was in part expressed through a building tradition developed from the second half of the 17th century to the first half of the 18th century. Although there was a much wider range of house forms in this part than is present now in the CTRV¹, the few remaining houses of that date to this period largely represent the dwellings of the middling and upper classes of this society. These houses reveal the innovating made by the region's craftspeople upon the building forms characteristic of earlier regional English traditions to meet the demands of an emerging class of prosperous, craftspeople, and merchants. While this manner of building was short-lived and soon replaced by more fashionable and global Georgian architectural styles in the mid-18th century, these earlier houses are a rare and invaluable insight into an architectural tradition wholly belonging to the CTRV.

The first part of this essay focuses primarily on the Parsons house as built in 1719, as its form is characteristic of the distinctive vernacular building tradition which was developed and existed in the CTRV from the early 17th century until the mid-18th century. The Parsons house is a particularly interesting example of this building tradition, as it straddles the line between the general conservatism and traditionalism in the construction of the timber frame, while simultaneously setting a forward-looking architectural precedent that was being ushered in during the first half of the 18th century with its early use of cased and plastered interiors at the vernacular level. The second part of this essay looks at the Parsons house as it pertains to the historic environment around Northampton. While most house histories look exclusively at the social and cultural development embodied in the building, the reflection of the historic and natural environment within these buildings is seldom explored as part of the historical narrative.

¹ This includes one-room single-story structures, open-hall house plans, post-in-ground building, and more elaborate two-story structures with central chimneys and a second tier of rooms under rear lean-tos.

Placing the Parsons house within the broader context of the CTRV allows for a combined understanding of the social and ecological landscape experienced by the Parsons family.

Context in the Connecticut River Valley

To understand the way building traditions developed and were transmitted in the CTRV, it is important to discuss how the earliest towns were founded and divided among the first three generations of settlers. Bruce Daniels developed a theory for the formation of settlements in Connecticut (which can be broadly used in Massachusetts as well), broken into three definable periods, of which the first two are the most pertinent to placing the Parsons House in its full context. Period 1 (1635-1675) constituted the interval in which initial settlements along the coastline and major river valleys were founded. In the case of Northampton, settlement began in 1654 by settlers from Springfield, Massachusetts, many of whom were aligned very closely with the Pyncheon dynasty. Many towns settled in this period were founded as individual entities (corporations), which both isolated them and put them in direct competition with one another for the acquisition of fertile land and navigable ports.² However, Northampton's alignment with Springfield reinforced the kinship and economic relationships between it as a provincial town and Springfield as a nexus of control. In the case of the Parsons family, this can be seen with William Pyncheon's Northampton land grant to Cornet Joseph Parsons in 1654. Neighboring Hadley was founded in much the same way as Northampton, but its nexus of cultural control was Hartford, Connecticut instead.

Settlements along the Connecticut River were also prone to a certain level of societal isolation from one another because of the nature of their founding. In New England, groups of settlers fell into three broad types of companies: gentlemen's companies, where settlers were sponsored by wealthy proprietors who had relationships with these settling families in England, and whose motivation to emigrate may have had a more economic incentive such as William Pyncheon's settlement of Springfield, Massachusetts; clerical companies, in which companies are formed of familial and neighborhood groups bound together by a clerical figurehead such as Thomas Hooker's founding of Hartford, Connecticut; and finally, extended family companies, which either settled as individual groups, or comprised sub-groups of people who were part of a

²Daniels, B.C. *The Connecticut Town: Growth and Development, 1635–1790* (Middletown, CT: Wesleyan University Press 1979), p. 9-17.

larger gentleman's or clerical company, such as those at Windsor and Wethersfield in Connecticut, and Northampton and Hadley in Massachusetts.³ Although these towns were interlinked from the outset, either by waterways or economies, they operated with a relative independence from one another because of their alignments with the specific companies of which they were offshoots during the early settlements of these satellite towns.

The settlers of these early towns were not isolated by geographic immobility. On the contrary, people were highly mobile throughout this initial settlement period, not only between colonies/corporations, but also throughout the burgeoning Anglo-Atlantic world.⁴ As part of this mobility, certain societal members attained an accepted degree of permeability among these communities. This appears to have largely been achieved either through social status, or through trade competency, with one of the more notable groups known for itinerancy being members of the building trades.⁵ Therefore, the mobility and permeability of building tradespeople could have provided both the continuity and internal consistency of building aesthetics and methods of construction within the CTRV. Likewise, this kind of internal build consistency is similarly present in other regional architectural styles outside of the CTRV, although different construction and building aesthetic choices were employed in areas such as the Connecticut coast, Eastern Massachusetts, the former Plymouth Colony, coastal New Hampshire/Maine, and Rhode Island.

Period 2 (1686-1734) saw the beginning of new town formation through the separation from the original proprietorships of the earliest Connecticut River towns. In the context of Northampton, although the smaller parishes of Southampton, Easthampton, and Westhampton did not gain full independence until the end of the 18th century, they saw increased settlement

³ Thompson, R. *Mobility & Migration: East Anglian Founders of New England, 1629–1640* (Amherst, MA: University of Massachusetts Press 1994), p. 186.

⁴ Sweeney, K.M. 'From wilderness to Arcadian vale: material life in the Connecticut River Valley, 1635–1760', in Ward, G.W.R. and Hosley, W.N. Jr. (eds.) *The Great River: Art and Society of the Connecticut Valley, 1635–1820* (1985), p. 19.

⁵ Innes, S. *Labor in a New Land: Economy and Society in Seventeenth-Century Springfield* (Princeton, NJ: Princeton University Press 1983), p.95-96; Garrison, J.R. *Landscape and Material Life in Franklin County, Massachusetts, 1770–1860* (Knoxville, TN: University of Tennessee Press 1991), p. 1-13; & Sexton, J.C. *Craftsmen, Clients, and Buildings: The Domestic Architecture of Guilford, Connecticut, 1689–1789* (PhD thesis. Yale University 1999). Available at: <https://www.proquest.com/openview/e52fbcf22d5bd218dea74177e6203be3/1?pq-origsite=gscholar&cbl=18750&diss=y>, p. 32.

and development through this period, especially after the conclusion of King Philip's War (1678). This trend along the east/west division of the Connecticut River Valley, and along smaller tributary boundaries, would carry on through the 18th century. Parishes and smaller settlements of the larger original proprietorships would be broken off, either because of the inconveniences caused by crossing waterways or travelling large distances to attend meeting in the nexus of the original settlements ⁶ or the constraints on arable lands in the earliest settled towns.⁷ Although these new towns were suddenly independent, the cultural and kinship relationships established in the previous period of settlement still dominated relationship networks.⁸

Period 2, which encompassed the second and third generations of settlers, marked an important shift within the socio-economics of the CTRV as material wealth had time to accrue intergenerationally. The previous generation's work of town formation, land clearing, and the establishment of trades and basic facilities for processing raw materials provided the foundation for the next two generations to build new social, cultural, and economic structures within the colonial experience. In this way, the towns founded along the Connecticut River were able to commit to large-scale and capital-intense projects because most men in these communities could expect to own improved land acquired through purchase, grant, or inheritance of the previous generation's wealth.⁹ These factors, combined with the evening-out of populations and the resolution of political upheavals (The English Civil War (1642-51) in England and King Philip's War (1675-78) in New England, and the Dominion of New England (1686-1689) meant that by the end of the 17th century there was a building boom in the CTRV, now represented by the earliest extant structures in the region. Within this developmental context the CTRV emerged as

⁶ Daniels, B.C. *The Connecticut Town: Growth and Development, 1635–1790* (Middletown, CT: Wesleyan University Press 1979), p. 24.

⁷ Lewis, T.R. 'The landscape and environment of the Connecticut River Valley', in Ward, G.W.R. and Hosley, W.N. Jr. (eds.) *The Great River: Art and Society of the Connecticut Valley, 1635–1820* (1985), p. 9.

⁸ Sweeney, K.M. 'From wilderness to Arcadian vale: material life in the Connecticut River Valley, 1635–1760', in Ward, G.W.R. and Hosley, W.N. Jr. (eds.) *The Great River: Art and Society of the Connecticut Valley, 1635–1820* (1985), p. 21.

⁹ Main, J.T. *Society and Economy in Colonial Connecticut* (Princeton, NJ: Princeton University Press 1985), p. 68-69.

a distinct cultural region, populated and led by individuals with far-reaching kinship and economic relationships.

Connecticut River Valley House Typology

In this period, there was a much wider variety of buildings constructed than are extant now including: single-story buildings, end chimney building, open hall houses, sill on ground houses, post in ground houses, and hovels to name only the domestic structures.¹⁰ For the purposes of this study only a small subset of structures is being defined in this building culture. These buildings are two stories in height, have a central chimney, and are typically one room deep, although at the latter end of this period (1720-1750) the construction of two-story houses with integral rear lean-tos (commonly called saltboxes) began to appear¹¹. This is not to imply that the architectural and joinery features of these buildings are exclusive to this subset only, but rather through survival bias these structures are the remaining buildings that feature these defining characteristics. Therefore, in the Connecticut River Valley this vernacular building group can be broken into three types:

Type 1

The Type 1 house is outwardly the simplest structure among the three identifiable type-forms of housing in this group at large (Figure 2). These structures were usually constructed as one room deep, two stories in height, gable roofed, with one room set on either side of a central chimney base on a hall-and-parlor plan (Figure 3). The timber frame members of the structure are scribed flush to their outside faces resulting in no projecting tie beams nor jetties. Type 1 buildings are

¹⁰ See: Harper, R. K. “‘Their Houses are Ancient and Ordinary’: Archaeology and Connecticut’s Eighteenth-Century Domestic Architecture” (Historical Archaeology 46(4) 2012), p. 8-47; Harper, R.K., Harper, M.G. ,and Clouette, B. ‘Highways to history: the archaeology of Connecticut’s 18th-century lifeways’ (*Connecticut Department of Transportation and Federal Highway Administration* 2013). Available at: <https://portal.ct.gov/dot/-/media/dot/cultural-resources/highwaystohistorypdf.pdf?rev=cab4cf95805c47eb8222df98d6f3f1bf&hash=A4627AAD0269B3FD2189F6C6909E164E>; St. George, R.B. ‘Bawns and beliefs: architecture, commerce, and conversion in early New England’ (*Winterthur Portfolio*, 25(4), 1990), p. 241–287. DOI: <https://doi.org/10.1086/496502> ; Smith, J.T. ‘The Miles Standish house, Duxbury, Mass., and its British antecedents’ (*Vernacular Architecture*, 33(1), 2002), p. 57–66. DOI: <https://doi.org/10.1179/vea.2002.33.1.57>; Smith, A.Y. ‘A new look at early domestic architecture in Connecticut’ (*Connecticut History*, 46(1), 2007), p. 16–44. DOI: <https://doi.org/10.2307/44369757>; & Sweeney, K.M. ‘From wilderness to Arcadian vale: material life in the Connecticut River Valley, 1635–1760’, in Ward, G.W.R. and Hosley, W.N. Jr. (eds.) *The Great River: Art and Society of the Connecticut Valley, 1635–1820* (1985).

¹¹ Lewis, E. ‘New England Salt Boxes’ (*Vernacular Architecture*, 8(1), 1977), p. 838–840. doi: 10.1179/vea.1977.8.1.838.

also the most easily subsumed by later additions, given their simplicity in form, which may mean that they are less obvious to identify from outward observation alone which include the addition of saltboxes/lean-tos or extending the house to two-rooms-deep and reframing the roof system.

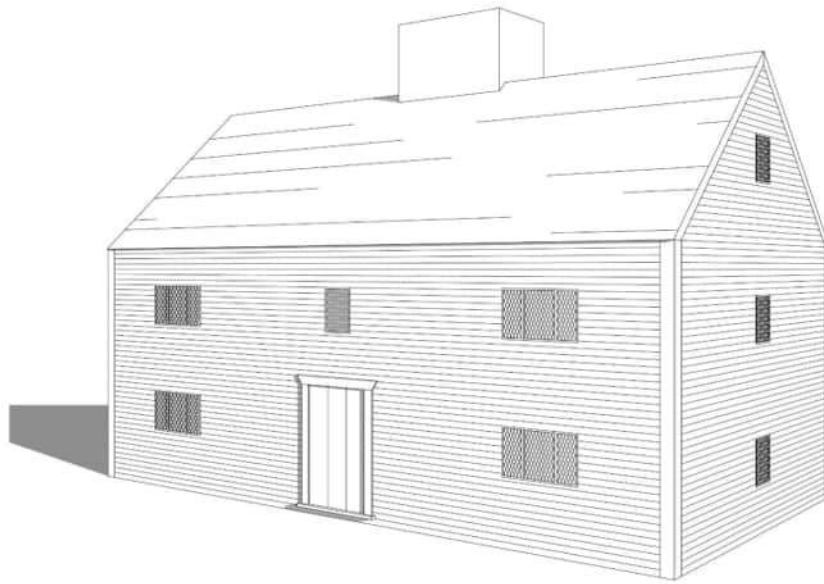


*Figure 2: Typical Type 1 house appearance based on the 1698 *d.*¹² Deacon John Goodwin house in East Hartford, CT. (Drawing by Nevan Carling.)*

¹² 1698 *d.* is the convention to show that a building has been dated using dendrochronology. *C.* refers to circa and represents a traditional/anecdotal date given to a building while *doc* refers to a documentary date given to a building.

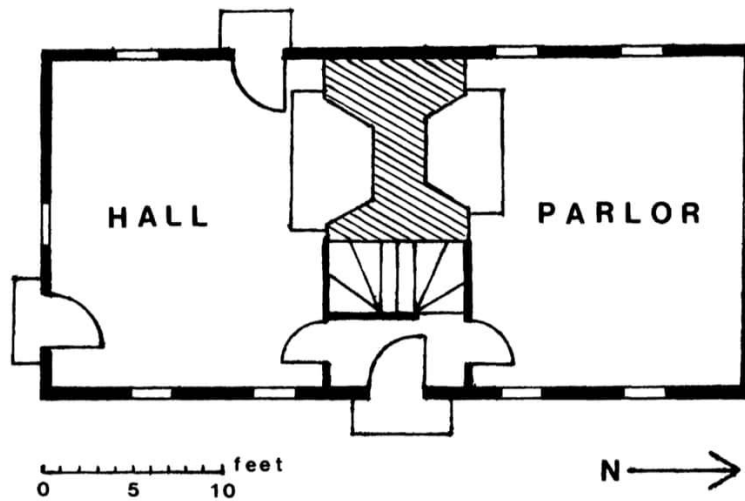


Figure 3: Hall-and-Parlor house plan

Type 2

The Type 2 house is slightly more embellished, with the use of a jettied gable tie beam as its defining outward characteristic and often a deepened front eave (Figure 4 & 5).

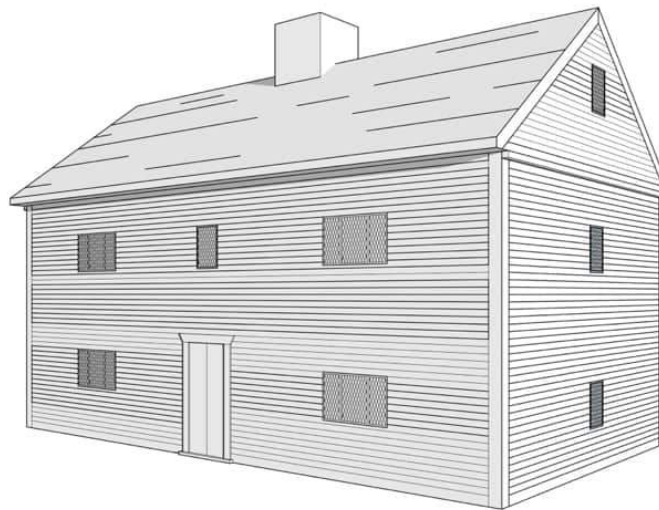


Figure 4: Typical Type 2 house appearance based on the 1720 c. Alan Homestead in Deerfield, MA. (Drawing by Nevan Carling.)



Figure 5: The. 1720 c. Samuel Moore house in South Windsor, CT (saltbox not original)¹³

Type 3

The Type 3 house is the most embellished form of this architectural tradition and features framed (Figure 6) or hewn jetties (

Figure 7) on the principal elevations of the building and have jettied gable tie beams.

¹³ Historic American Buildings Survey *Samuel Moore House, Station 48 - Main Street, East Windsor Hill, Hartford County, CT* (1933). Photograph. Retrieved from the Library of Congress, <www.loc.gov/item/ct0133/>.



Figure 6: The 1700 c. William Hill House formerly located in East Hartford, CT with a framed jetty. (Photograph by Nevan Carling.)



Figure 7: Buttolph-Williams House. 1712 c. in Wethersfield, CT with a hewn jetty.¹⁴

¹⁴ Syverson, L. Wethersfield, Connecticut - Buttolph-Williams House (1986). Available at: <https://www.flickr.com/photos/124651729@N04/42633774342>.

The Parsons in the Connecticut River Valley

It is clear that the Parsons family was a very well-connected kinship group in the CTRV from early on. Cornet Joseph Parsons' relationship to the Pynchon family and his important role in settling both Springfield and Northampton solidified the Parsons family's social, political, and economic stature for several generations. The first two generations of the Parsons family were very active in town and county affairs, as well as the development of local industries; Nathaniel Parsons' uncles and cousins had shares in and operated both saw and grist mills through the mid-17th century to the mid-18th century, had interests in the local iron works, and were active in real estate speculation.¹⁵ Somewhat in contrast, while Nathaniel was a member of the third generation and was born into a familial group with intergenerational wealth, his station was as a yeoman farmer who worked a modest amount of land inherited from his father. Regarding the house, it is probable that Nathaniel's brother Jonathan – a housewright – constructed the house erected in 1719, connecting Nathaniel to his broader kinship group both because the house was constructed by a family member and was built within an architectural tradition associated with the landed class in the CTRV. That being said, the house's interior remained largely unfinished until Nathaniel's death in 1738 and continued in that state through the 18th century during the ownership and occupation of the next two generation of Parsons (who remained yeoman farmers). Perhaps the construction of a two-story Type 1 house in 1719 was an expression of his inherited status and his expectations of future prosperity, which unfortunately never materialized.¹⁶

In the case of the Nathaniel Parsons house, it is important to recognize that Jonathan Parsons as a housewright had imbued him with a skill that further connected him with his community, both because of the pedigree in his name, as well as his ability to construct buildings. In this way, Jonathan's involvement with his brother's house carried a cultural connotation that was recognizable to people living in the CTRV in this period. Craftspeople, in providing their services, had the ability to move across the landscape and transmit these cultural ideas through construction projects. This thereby linked Nathaniel to a broader group of

¹⁵ *The Parsons Family: Volume 1. The English Ancestry and Descendants to the Sixth Generation of Cornet Joseph Parsons* (Baltimore, MD: Gateway Press, Inc., 2002), p.99.

¹⁶ See discussion of the evolution of the building in the section titled "History of Construction and Alterations" (pp. 60 – 149) of the Myron O. Stachiw, "Historic Structures Report, Nathaniel Parsons House", 2026.

politically influential people in this society even though he had a simpler house and sat at the lower end of the economic scale. Identities that may have divided communities across the Massachusetts and Connecticut colonies were instead supplanted by a regional cultural cohesion as it concerns the creation of a vernacular architectural style in the CTRV. This afforded Jonathan Parsons as a housewright a level of permeability throughout the region and Nathaniel some kind of social cachet by association. When Jonathan eventually moved from Northampton, MA to Granby/Suffield, CT in the lower CTRV - a contested area claimed by both colonies in this period – he brought with him the architectural knowledge of a recognized and respected building form across this geographic region. Jonathan Parsons then, as the most likely builder of Nathaniel’s house, represented a cultural communicator, one who was seen as an asset throughout the CTRV because of his ability to create and reiterate identity through his trade and as somebody who could have elevated Nathaniel’s social station through constructing his home.

English Scribing

To place the Parsons house in its full architectural and cultural context it is necessary to understand the logic underlying the house building process in the CTRV during the 17th and 18th centuries. While each of the three types of building in their outward appearance represent different social, economic, and temporal aspects of a CTRV building tradition, they all fundamentally share a similar timber framing logic and a set of construction rules familiar to the carpenter (see: Figure 8 for a diagram with each of the component parts labelled). The method of joinery used in the Parsons house is one example of many in the CTRV which demonstrates the formulae which governed the rules and logic builders used to create these structures and gave cultural meaning to the people who built them and lived in them.

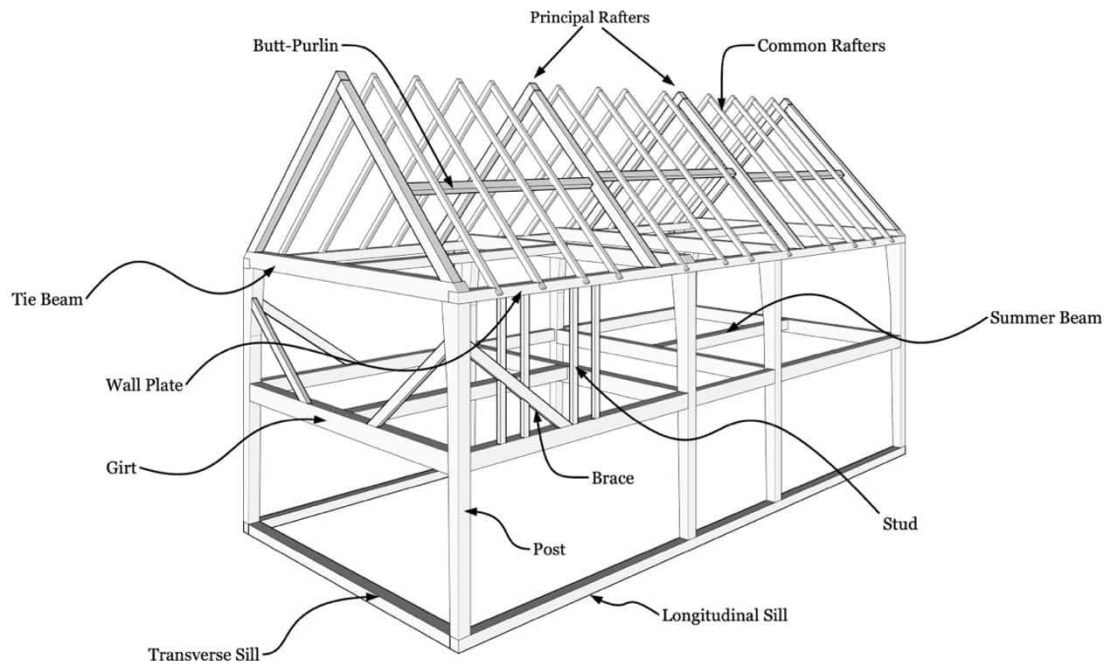


Figure 8: The 1719 d. Nathaniel Parsons house with component parts labelled. (Drawing by Nevan Carling.)

Scribing is the method by which the face of one framing member is traced onto the face of another so that they meet with one another perfectly when cut. The specific timber framing tradition that was brought to New England was a form of scribing known as ‘double-cut and tumbling’.¹⁷ In this method of scribing both the mortises and tenons of all primary framing members were pre-cut *before* they were scribed to each other, demonstrating that the housewright had a pre-established plan for where all the framing members would go. After all the mortises and tenons were cut, the carpenters would start by laying out the sill and floor system. This would set the dimensions of the building and create a level and plumb deck onto which the rest of the frame was scribed. Once the floor system was completed, the wall plates, tie beams, and roof system were scribed to each other, and the joinery re-cut to account for discrepancies in the shape of each individual timber. Then either the cross-frame or long-frame of the building was scribed, and finally the second story floor systems were scribed. In each one

¹⁷ Historically this was referred to as the ‘cut and try method.’

of these assemblies, timbers were given an identification mark (usually roman numerals) so that when the frame was raised each piece would be joined to its respective mate. Station marks - a type of fixed point - were scratched onto the framing members in this pre-assembly phase for later reference (Figure 9). For example, the placement of the two-foot mark on posts created a fixed reference point for scribing the location of the tie beam in the cross-frame assembly (Figure 10) and when scribing the wall-plate in the long-frame assembly (Figure 11).



Figure 9: Two-foot mark on the post of the 1722 d. Riley/Adams house formerly in Wethersfield, CT. (Photograph by Nevan Carling.)

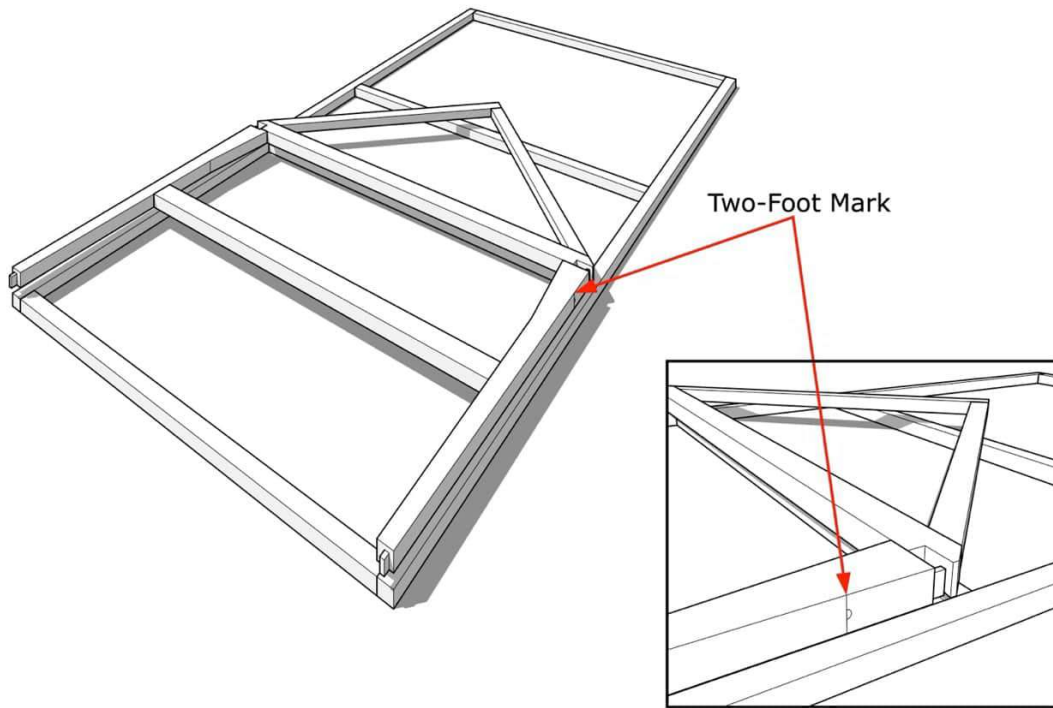


Figure 10: Cross frame assembly set on sill system for scribing. (Drawing by Nevan Carling.)

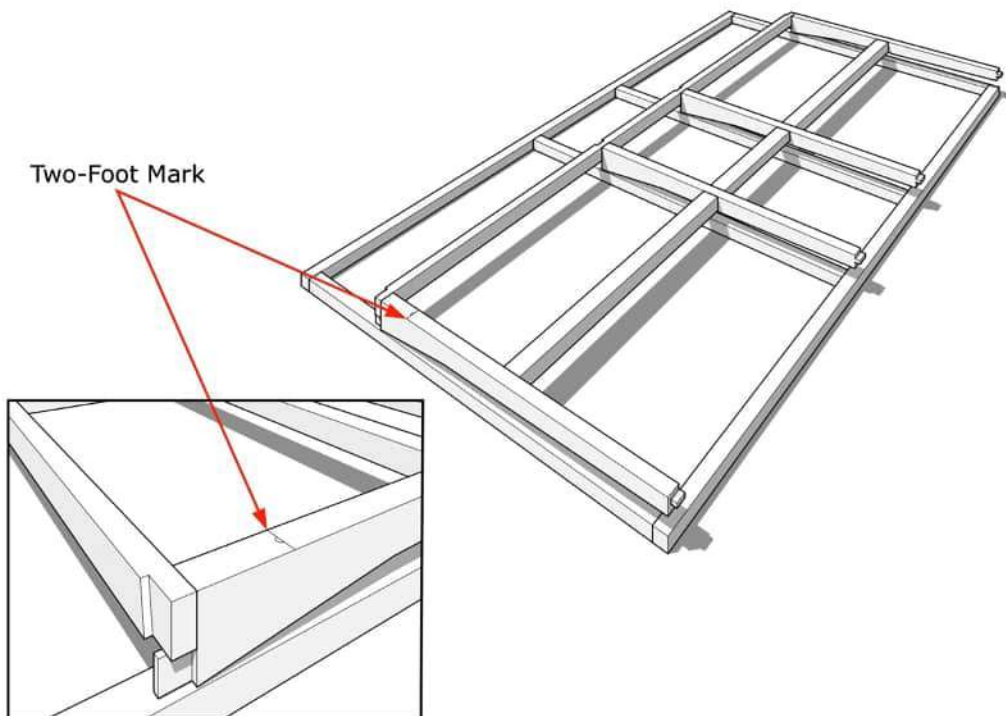


Figure 11: Long frame assembly set on sill system for scribing. (Drawing by Nevan Carling.)

Within this scribing tradition, every framing member was assigned a particular place in the frame; for example, each post in the building could not be swapped with another once they were scribed to a particular space. However, the mortises and tenons were initially cut before each member was scribed to its corresponding partners. This method of pre-cutting joinery, scribing each framing member to each other, and re-cutting the joinery to ensure an exact and unique fit within each joint.¹⁸ By working with this template, housewrights could essentially recreate the same building multiple times, even if the framing members were irregular and the joinery within was unique. Only through the repeated application of this building logic could a vernacular building tradition emerge in the CTRV, distinct from other areas of New England. While the outward appearance of a building was a form of cultural expression for the owner, the internal building logic was likewise an expression for the housewright of a distinct building culture.

Another defining aspect of the construction and joinery choices in the CTRV houses is that the teasle tenon and wall plate tenon on the jowl posts were first cut level (Figure 12). This CTRV jowled post assembly differs from other systems constructed around the same period in both Eastern and Western CT (Figure 13 & Figure 14) as well as in the Boston Bay and Eastern MA (Figure 15). Once the jowled posts joinery was cut, the carpenters could first go into a cross-frame assembly - where the tie beam and posts were scribed and fitted - or a long-wall assembly - where the wall plate and posts were scribed and fitted. Once their chosen assembly had been scribed and fitted, they would disassemble it in order to complete the other assembly. At this point, the teasle tenon or wall plate tenon, which were initially level, would be cut lower to accommodate both the wall plate and tie beam at this intersection (Figure 16). This secondary cut is a type of reduction. A reduction on the wall plate tenon implied that the cross-frame assembly was completed first, while a reduction on the teasle tenon implied that the long-frame assembly was completed first. Thus, it appears that the Parsons house went into a cross-frame assembly first because the scribed reduction in reference to the two-foot mark on the post was done at the wall plate tenon (Figure 17 & Figure 18).

¹⁸ It is unclear if buildings were historically cut and scribed on their building site, or if they were completed first in a framing yard and then moved to their building site. Given the timber used to build the Parsons house was unlikely locally sourced, there is a high probability that it was cut at a framing yard before being transported as a complete frame to its current site.

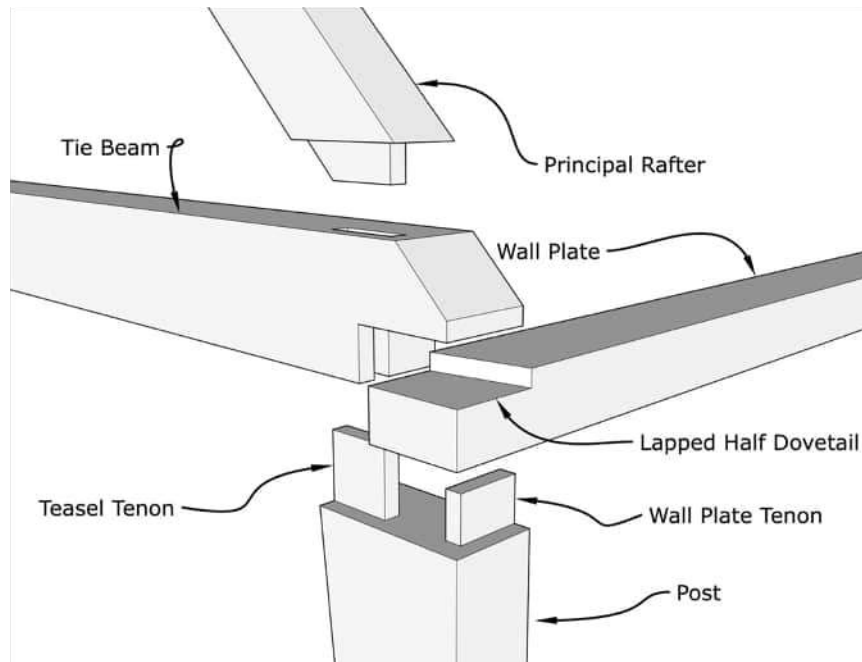


Figure 12: Jowled Post Assembly at the Parsons house showing level cut teasel and wall plate tenon. (Drawing by Nevan Carling.)

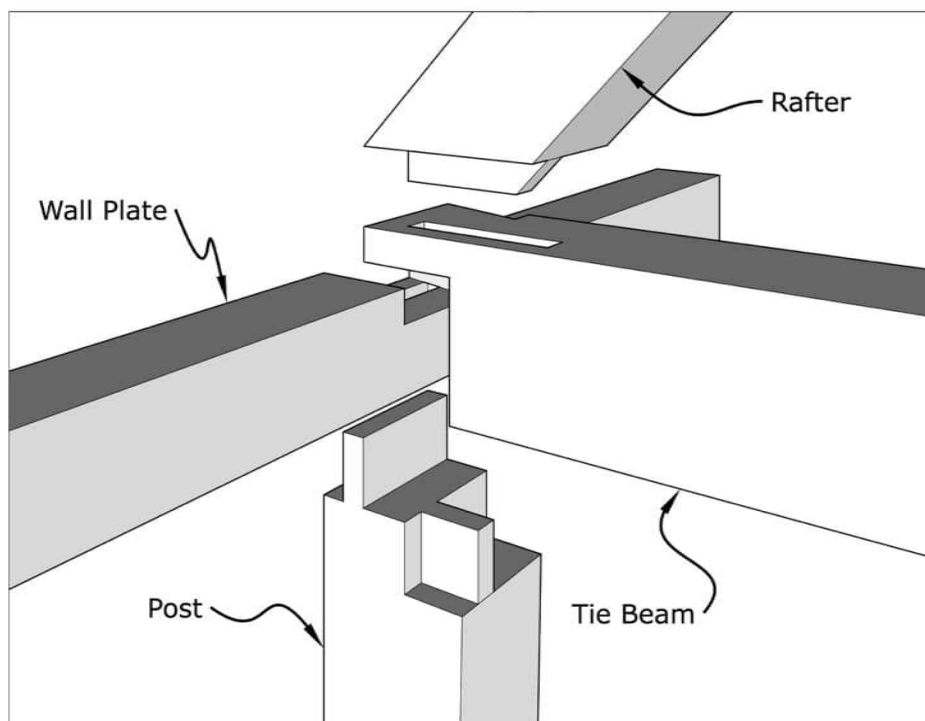


Figure 13: Jowled post assembly at Parish Hill 1700 c. in North Windham, CT. (Drawing by Nevan Carling.)

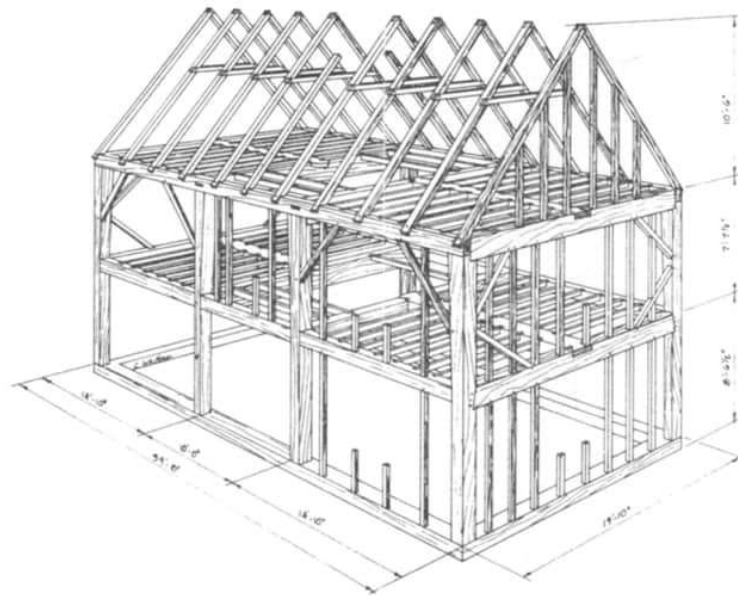


FIG. 14. JOHN WHEELER HOUSE, BRIDGEPORT, CT, CA. 1720. PERSPECTIVE OF HOUSE FRAME (PREPARATIONS FOR SHINGLE LATH NOT RENDERED). Drawing by Challenger Whitham and reproduced with his permission.

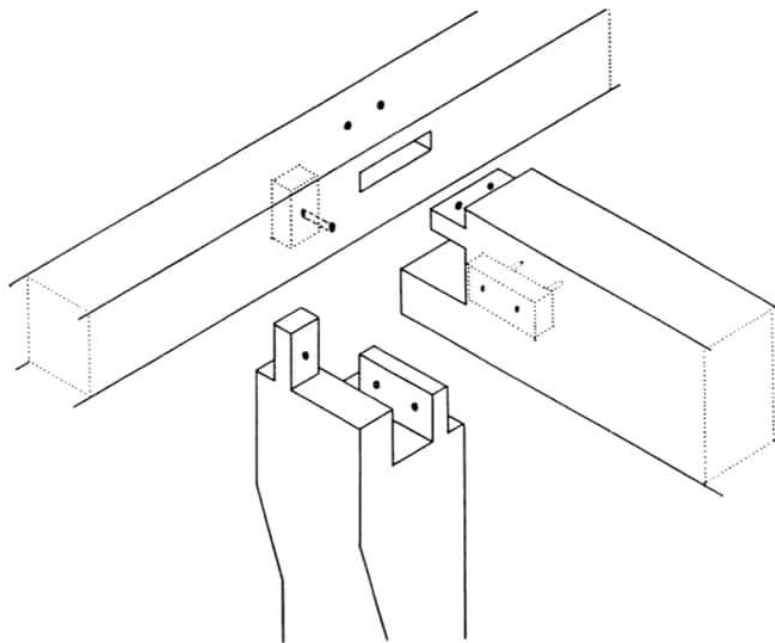


FIG. 11. JOHN WHEELER HOUSE, BRIDGEPORT, CT, CA. 1720. ASSEMBLY OF POSTHEAD, PLATE, AND "TIE BEAM." Drawing courtesy Department of the History of Art, Yale University.

Figure 14: Reverse assembly jowled post configuration¹⁹

¹⁹ Cummings, A.L. 'Connecticut and its building traditions' (*Connecticut History Review*, 35(1),1994), p. 192–233. Available at: <https://www.jstor.org/stable/44369385>.

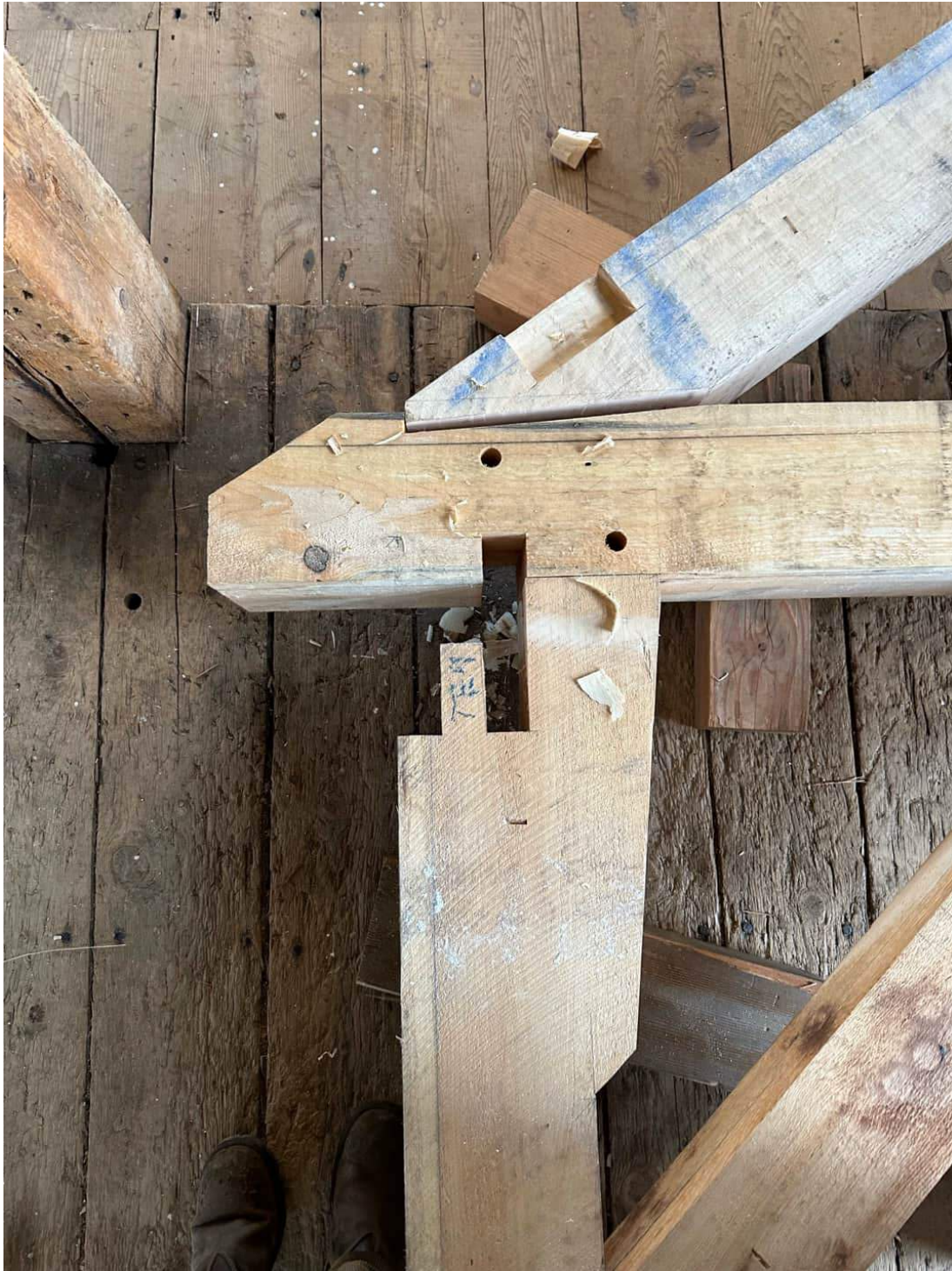


Figure 15: Standard assembly jowled post configuration typical of Eastern MA. (Photograph by Nevan Carling.)

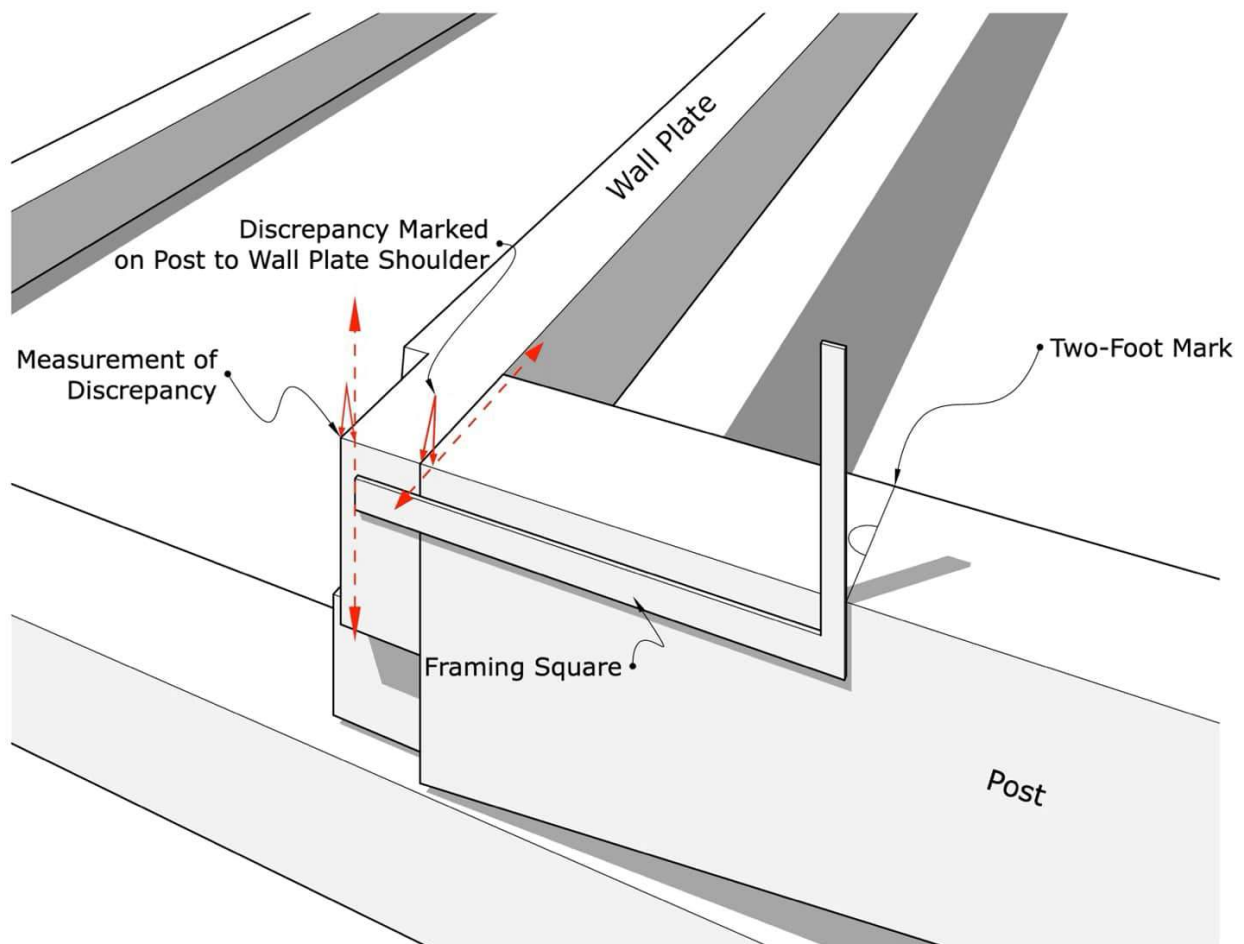


Figure 16: Scribing of reduction on the jowled post using the two-foot mark. (Drawing by Nevan Carling.)

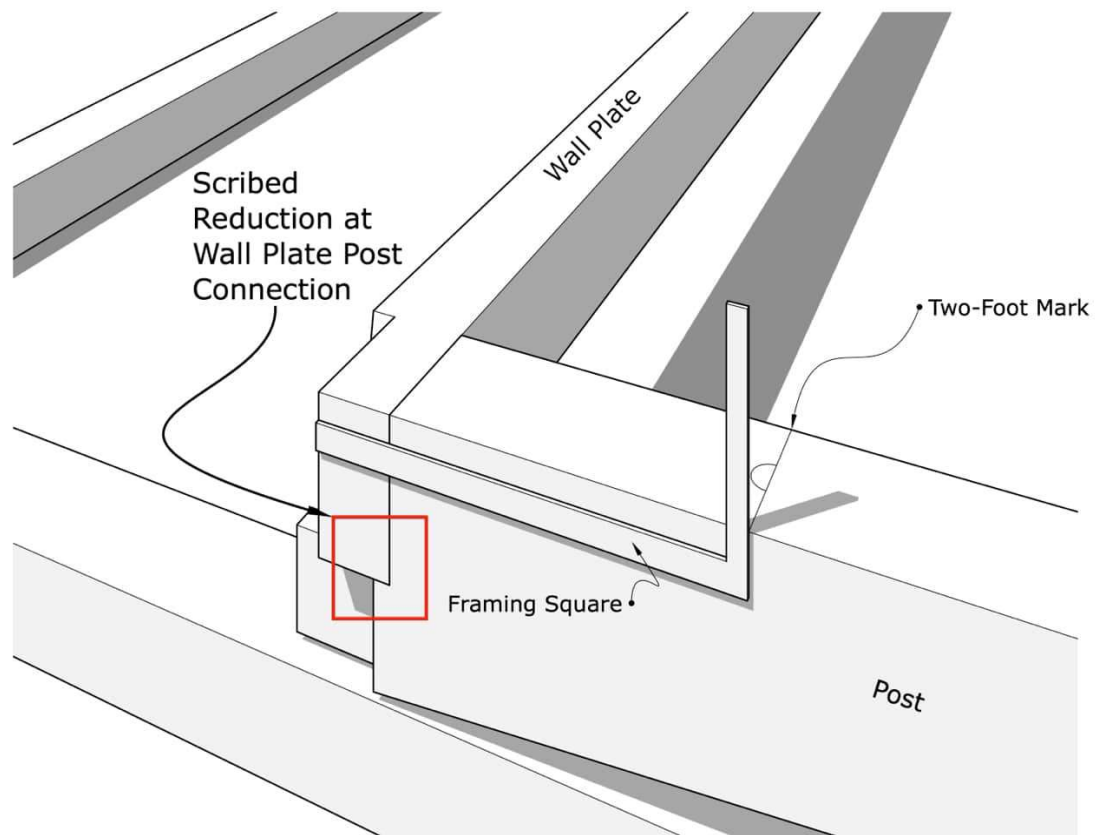


Figure 17: Reduction cut on jowled post. (Drawing by Nevan Carling.)

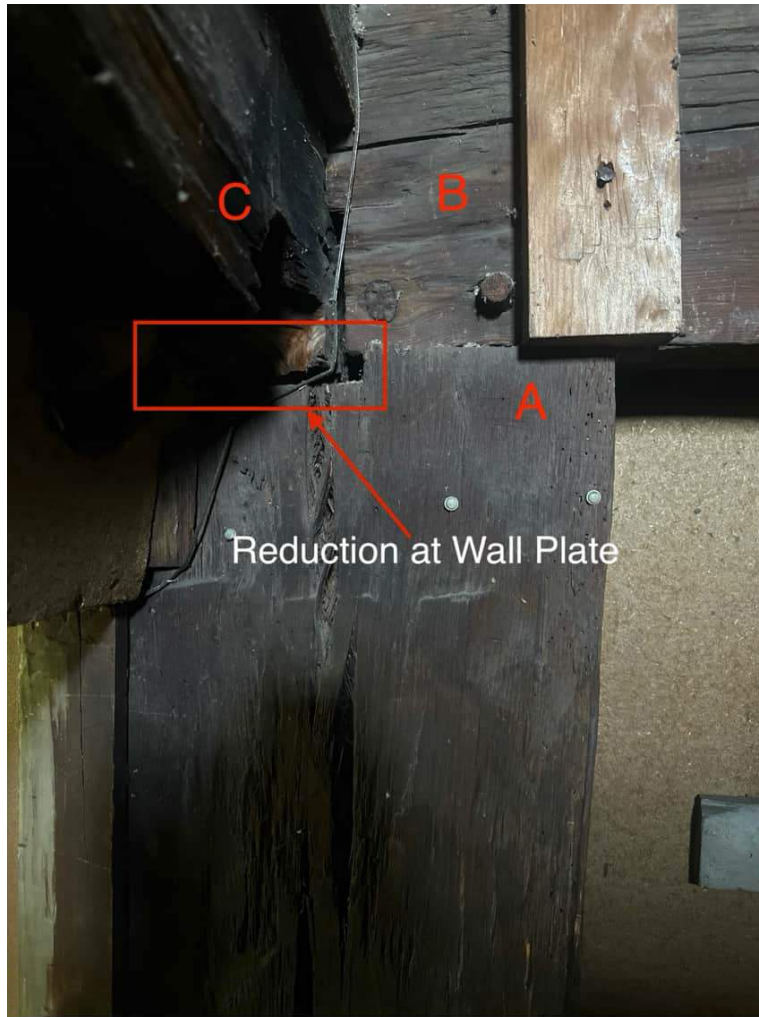


Figure 18: Jowled post assembly at the Parsons house A) Post, B) Tie Beam, C) Wall Plate. (Photograph by Nevan Carling.)

Part of this cultural choice was the legacy of certain building practices typical of East Anglia in the U.K. the region from which many of the original English colonists emigrated. The use of butt-purlin and clasp purlin roofs are a defining characteristic of East Anglian timber frames and an adherence to this particular building tradition was replicated in the CTRV. Although it is unclear exactly what roof system the Parsons house had, what can be surmised is that it had both principal rafters and common rafters as some reused timbers in the attic have mortises for butt purlins and have felling dates between 1715-18.²⁰ Similarly, it has been

²⁰ There are only two identified extant buildings in the CTRV with fully common rafter systems and one literary reference: the Deacon John Goodwin House 1698 *d.* (East Hartford, CT), the Deacon John Moore House c. 1665

observed in early CTRV buildings that roofs with principal and common rafters had butt purlins, further supporting the likelihood that this roof system was originally used at the Parsons house.²¹ However, the Parsons house is set apart from all other identified examples because it features housed bird mouth principal rafters in the chimney bay (Figure 19). Likewise, these rafters do not land on the inner two tie beams but rather land a few feet on either side of bays 1 and 3, which heretofore has not been observed in any other houses in the area (Figure 20).

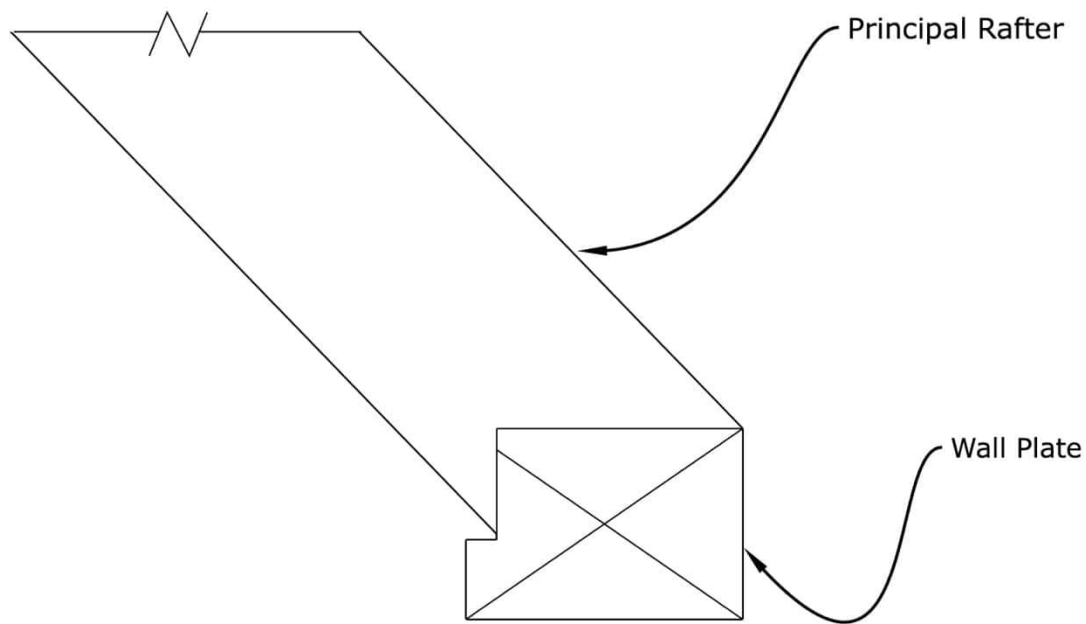


Figure 19: Cross section of housed birdsmouth joint. (Drawing by Nevan Carling.)

(Windsor, CT), and the Joseph Whiting House 1660's c. (Hartford, CT) respectively. In both the Goodwin and Moore houses it appears that fully common rafter roof systems only had collar ties and no purlins (see Appendix 1).

²¹ In the CTRV, it appears that butt-purlin roofs were replaced by principal purlin roofs with common rafters and ridge beams beginning in the mid 18th century (see: Silas Dean house in Wethersfield, CT for an early principal purlin roof and the Joseph Webb house in Wethersfield for a later and adapted butt purlin roof system), although conservative builders used the older butt purlin system until the turn of the 19th century.

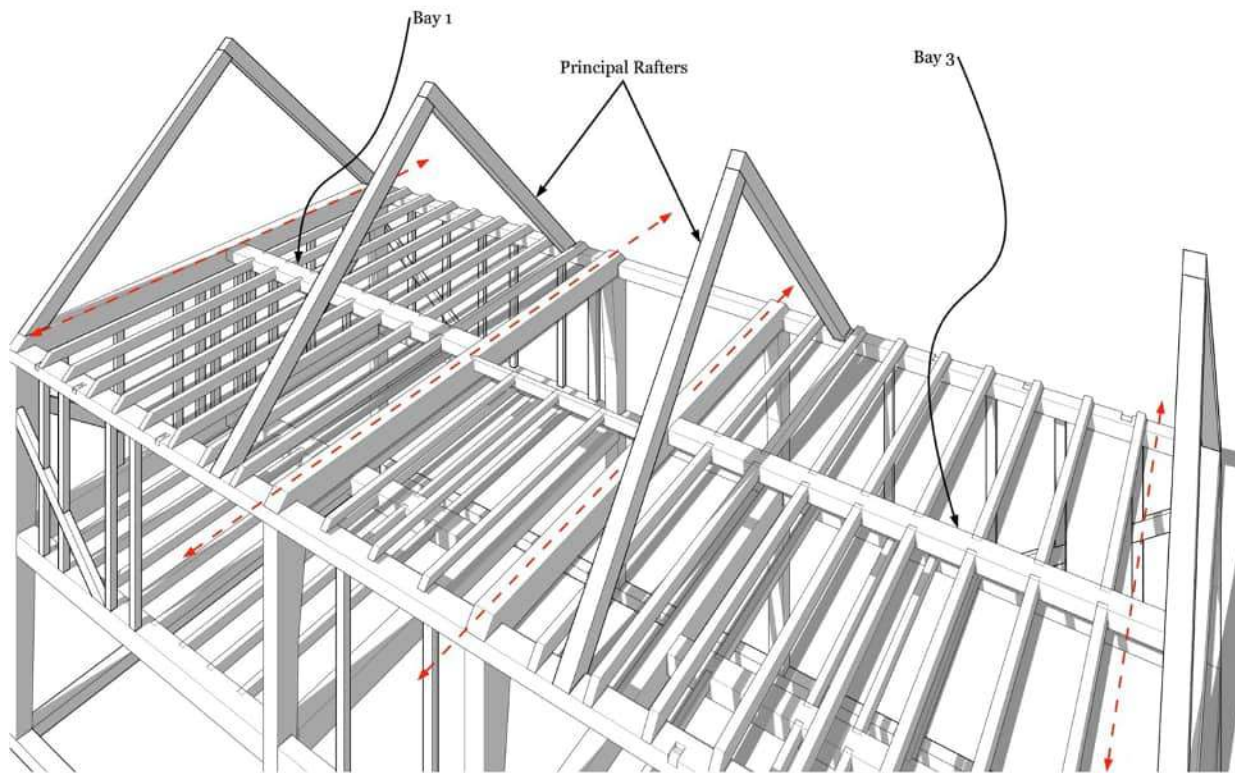


Figure 20: Location of inner principal rafters and bays – dashed red lines indicate bay extremities. (Drawing by Nevan Carling.)

Conclusion:

The vernacular building tradition created in the 17th - and 18th centuries in the CTRV was a recognizable symbolic language that could express both the social and cultural inclinations of a client and also express the shared knowledge and practice between carpenters/housewrights. For the socially aspirational or established alike, having a house constructed in this manner was significant because it related both the owner and the builder to a larger group of people, and maybe more importantly, to a shared sense of community and society in the CTRV. The rapid differentiation of joinery techniques from English precedents and from their early colonial counterparts had meaning for both carpenters and clients. The vernacular building tradition of the CTRV, formed by its unique colonial experience, marked a conscious departure from some historic English building practices, while simultaneously retaining aspects that tied these buildings to an idea of Englishness.

The Embodied Ecological Landscape in the Parsons House

Another aspect of the Parsons house as an historic timber-framed building is its reflection of and relationship to the specific ecological landscape in which it was constructed. This includes the tree speciation in the frame, their ages and basal diameters, the mechanics of timber and material conversion, and the types of natural material-based finishes used in the structure. Together, these provide a glimpse into both the natural landscape from which timbers and other natural materials were harvested, as well as the impact of the burgeoning agricultural landscape and the extractive activities underway at the turn of the 18th century in the CTRV.

Constructing the Parsons House:

The relationship between timber conversion and the types of labor involved in material processing is important to understand when looking at historic timber buildings. The processes have a direct connection to the forested landscape as well as early industrial operations in the colonial landscape.

Methods of Timber Conversion:

There are three methods by which timber was converted historically:

- I- Splitting (cleaving), for shingles, clapboards, and laths. It has been observed that some scantlings like braces, studs, and girts were also split (
- II-
- III- Figure 21).



Figure 21: Cleaving an ash log with wedges. (Photograph by Nevan Carling.)

- IV- Hewing or converting the timber from round to square with an axe, for primary framing timbers. It has been seen that scantlings like braces, studs, and girts were also hewn (Figure 22).



Figure 22: Nevan Carling and Patrick Taylor hewing a timber. (Photograph courtesy of Robert Ryan.)

- V- Sawing, which can either be done by a two-person team or mechanically by a water-powered sawmill, was typically employed to cut scantlings and boards (
- VI- Figure 23).



Figure 23: Will Lisak and Peter Maslan trestle sawing. (Photograph courtesy of Robert Ryan.)

Types of Timber Conversion

The way timber was converted is an indicator of both the historic woodland landscape as well as the cultural practices that are distinctive to vernacular buildings traditions. In the CTRV, and New England as a whole, by far the most common building system used was timber framing - specifically box framing. Other timber building traditions the coexisted in this period were log building and earth-fast building.

For this paper, as per the Timber Framer's Guild, timber is defined as: (bold is author's addition) "large squared or otherwise shaped piece of wood ready for fashioning as one member of a structure **and used as a primary framing member in a timber framed assembly**".

Scantling is defined as "any small piece of wood **used as secondary framing members in a timber framed assembly.**"

For timber framed buildings trees are first converted from round logs to square timbers which are the basic stock required to construct a timber framed building. Trees were converted square in three main ways:

- I- Boxing, where the heart of the tree is kept in the center of the timber (Figure 24).



Figure 24: Cross section of a boxed heart timber. (Photograph courtesy of Joe Thompson.)

- I- Halving, where a larger tree is hewn into a bulk and is split in half to get two smaller timbers (Figure 25).



Figure 25: Cross section of a halved timber. (Photograph courtesy of Joe Thompson.)

- II- Quartering, where, usually by sawing, a larger hewn bulk is converted into four smaller timbers (Figure 26)

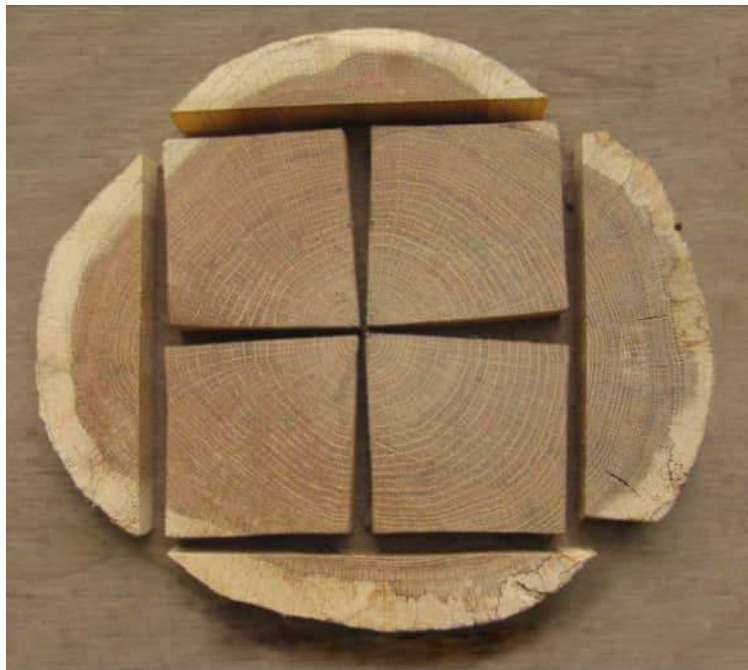


Figure 26: Cross section of a quartered timber. (Photograph courtesy of Joe Thompson.)

Sawing was also a fundamental process for creating smaller timbers as well as scantlings and boards. Trees can be sawn in three ways: through-and-through sawing where the timber is cut tangentially along the grain to produce boards or bulks; quarter sawing; and rift sawing (Figure 27).

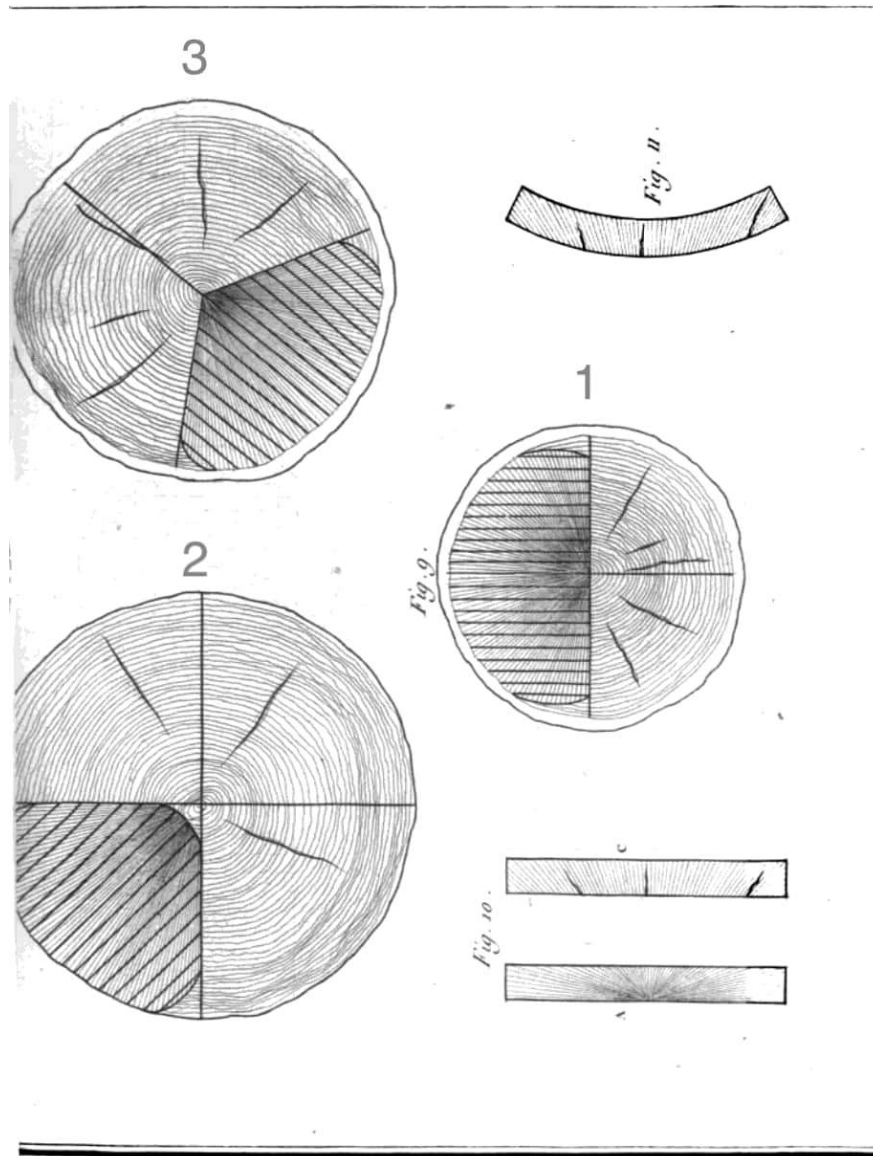


Figure 27: Different methods of sawing timber 1) through-and-through, 2) Quarter Sawing, 3) Rift Sawing²²

²² Hassenfratz, J. H. (1804) *Traité de l'art du Charpentier*. Paris, France. Didot.

The choice to use sawn timbers in a timber frame largely seems to have been an economically driven choice dependent upon the accessibility to a local sawmill, whether that was motivated by convenience, affordability, and seasonality. Where sawn timbers were available, they were used over hewn timbers. However, it was not typical for sawmills in this period to have carriages longer than sixteen feet, which would exclude sawing logs long enough for pieces such as posts, wall plates, sills, and tie beams. Similarly, moving large logs to and from a sawmill was difficult and expensive, so hewing remained an economically competitive way to convert trees to timber.

Tree Speciation and Dendrochronology

Two foundational studies underpin research into understanding the relationship between historic timber frames and historic forests/forestry practices. Oliver Rackham pioneered this study with his initial work on Grundle House.²³ More recently, Peter Varlow's updated study on Coppard's Bridge took Rackham's original thesis and expanded it.²⁴ However, because these studies were conducted in England as an attempt to understand the agroforestry practices during the Middle Ages, they fundamentally seek different answers about forestry management and the historic landscape than a similar study of New England's forests in this period might yield. In short, through coppicing and other forestry management techniques, English carpenters grew and selected for trees of specific sizes to be different structural members in a timber frame. This tradition was emulated in New England with adaptations to the new forests of America and now pose new questions for understanding the relationship between forests and buildings:

- 1- How do the size of trees selected for timber conversion correspond to a certain age range in this historic forested landscape of New England?
- 2- How do historic timber frames represent the remnants of earlier Native American agroforestry practices?
- 3- Were the trees selected for timber framing selected because of workability or were they selected because of the percentage of the forested landscape they made up?

²³ Rackham, O. 'Grundle House: On the Quantities of Timber in Certain East Anglian Buildings in Relation to Local Supplies' (*Vernacular Architecture*, 3(1), 1972), p. 3–8. doi: 10.1179/vea.1972.3.1.3

²⁴ Varlow, P. 'From Trees To Timbers: A Comparative Study Of Timber Quantities In Houses' (*Vernacular Architecture*, 46(1), 2015), p. 66–81. doi: 10.1080/03055477.2015.1123416.

- 4- Are the tree species found in historic homes accurate to the speciation of trees found in the immediate locality?

A dendrochronological campaign was undertaken at the Parsons house in 2024-25²⁵ during the preparation of the historic structures report. This report enabled some observations to be made about both the age and species of the trees used in the house frame, as well as the relationship between the methods of conversion and tree basal diameter, age, and speciation. For this analysis, Oliver Rackham's timber tree class chart is reproduced below.

Class 0	Class 1	Class 2	Class 3	Class 4
4 ½ - 6	6 ½ - 8 ½	9 – 12 ½	13 – 17 ½	18 – 25 ½

The two species of oak represented in the Parsons House are white oak (*Quercus alba*) and red oak (*Quercus rubra*). From visual inspection, all the posts in the building are class 3 boxed heart hewn oak. This is corroborated in part by the dendrochronology where the northeast chimney post and northwest corner post were both white oak, aged 68 and 94 years old respectively. Likewise, the scantlings in the building (studs, joists, and braces) are mechanically sawn through and through oak. It is assumed that the sawn scantling is sourced from class 4 trees (or larger), as there is very limited usefulness in class 4 trees for boxed heart hewn material. The rest of the boxed heart hewn primary framing timbers in the Parsons house are pitch pine (*Pinus resinosa*). Of the dated timbers in the building, seven framing members, the girts and reused butt purlins, are class 2 with a mean age of 64 years. Five timbers - the wall plates, summer beams, and tie beams - are class 3 with a mean age of 80 years.

From this preliminary survey of the dated timbers in the building, a few observations can be gleaned. Firstly, none of the dated timbers in the building are particularly old. The oldest dated timber in the building is a class 3 pitch pine summer beam at 97 years old, representing a tree that began growing in 1621 before widespread European intervention in the region. However, by the time the tree was 40 years old, European colonists had already begun to fundamentally change the landscape from the ecosystem in which it began growing. In contrast,

²⁵ Flynt, W. *A Dendrochronology of Select Timbers from the Nathaniel Parsons House, Northampton, MA*. (Unpublished report, Deerfield, MA, 2024): Historic Deerfield, Inc.

the youngest dated tree is a class 2 presumed butt purlin at 37 years old and represents a tree that began growing in a landscape in fluctuation. Secondly, what is clear from the mean ages of the dated trees is that there is not a great age difference between class 3 and 4 pitch pines in the landscape and clearly tree selection for conversion was determined by basal diameter. Therefore, the trees in the Parsons House are representative of a narrow age and basal diameter range and do not necessarily reflect other aspects of the forested landscape in the region. Lastly, these trees are illustrative of a pivotal moment in the history of North America because they began growing at a time when the landscape was fundamentally changing as a result of European colonization.

What is also evident in the timbers in the first phase of Parsons house is that they are indicative of the Pitch Pine – Oak Forest/Woodland type. An essential part of this forest ecology is fire. Without it, less fire-tolerant species would succeed this forest type. The frequency of fire in this landscape also has a relationship to the density of pitch pine with more frequent fire leading to more pitch pine.²⁶ The closest place where this forest type exists today is the Montague Plains Wildlife Management Area. This makes it clear that the forest(s) that provided the timber for the Parsons House were part of the Native American managed landscape and represents a landscape and cultural practices (such as controlled burning) that were both more common and important historically.

As for the later phases of construction at the Parsons house, a loose narrative of the changing ecology of the CTRV can be created. Starting with the saltbox-kitchen addition, while the timbers used to construct the framing are largely still pitch pine and oak, they are of substantially poor quality and fast grown or reused timbers from earlier structures. This would imply that the resources available to builders during this phase of construction were constrained likely by the ongoing deforestation in the period. The large serially-laid pine sheathing boards in the ground-floor, rear pile rooms of the kitchen also tell an interesting story. They are clearly from one exceptionally large pine tree that was through-and-through sawn, but the speculative origin of this tree remains unclear. It could have been a large pine that grew in an open setting, allowing for the tree to grow rapidly in girth, but not necessarily in height which may lend itself to how relatively short the boards are. Likewise, the tree could have been imported from forests

²⁶ Natural Heritage & Endangered Species Program, Massachusetts *Pitch Pine -Oak Forest/Woodland* (Westborough, MA: Massachusetts Division of Fish and Wildlife, 2016). Available at: <https://www.mass.gov/doc/pitch-pine-oak-forestwoodland-0/download>

further upriver where they still yielded pines of this size. Whatever the case may be, this tree was sought out because of its size and reserved for use as a finished interior, demonstrating that the value of timber and boards in this period was still connected to their size.

As the house continued to be expanded with additions, another noticeable change in the construction material and construction method is apparent. Firstly, much more softwood was being used in the frames of both the second-story addition 1816 *d.*, west wing 1822 *d.*, and north kitchen ell 1830 *.doc.* While oak and pitch pine were still used for short framing members, white pine (*Pinus strobus*) was used for timbers that had to be long, such as the ridgepoles in the kitchen ell and roof system of the main house. This could imply that longer trees were being sourced from farther afield. The Connecticut River has always been a means of transportation, and with the opening of the South Hadley Canal in 1795, the impetus for continued long distance trade of goods and materials was increased in the area. The method of construction in these buildings also changed from scribe rule to square rule. In the square rule system of construction, buildings can be pre-cut with no need for pre-assembly. This could further suggest that these buildings and additions were not being manufactured hyper-locally (on-site) but could be premade elsewhere.

All in all, the chronological development of buildings at the Parsons house requires further research to fully contextualize them as byproducts of the changing landscape. Scientific methods like dendro-provenancing could further hone an understanding of the regions or forests from which the trees were harvested. Likewise, broader research in the area could be undertaken to establish a timeline of deforestation in the region and locate the possible forest reserves used for construction material in the area around Northampton. Other aspects of the forested landscape could also be explored through looking more closely at the materials used in the house, such as the possibility of discovering colonial agro-forestry practices including coppicing and pitch pine forest management. Lastly, a full-scale study of the timbers in the building similar to the studies conducted by Rackham and Varlow could be undertaken to quantify the number of trees required for constructing a house like the one built for Nathaniel Parsons²⁷.

²⁷ Due to both the limitations of not having access to all the framing in the house as well as the time demands of such a novel study, this project must be shelved until more of the structure is revealed.

Other Aspects of the Forested Landscape in the Parsons House:

Other aspects of the forested and ecological landscape in the Parsons house include the earliest split lath in the 1719 structure. As was traditional in England, split laths usually came from class 0 trees and could be indicative of either the establishment of early coppices in the area or the continued clearing of small undergrowth trees. The laths in the Parsons House provided a matrix for early plaster, probably an earth-lime plaster. This plaster was made of natural materials including clay, straw/grasses, cow hair, and lime (calcium carbonate). The use of lime in the plaster raises questions about how this lime was acquired, as there were no nearby local sources of limestone. The limestone had to either be imported from elsewhere, which would create an area of further study to understand the movement of building materials in the colonial landscape, or was created by burning shells. These shells would have been gathered locally from the landscape or even from Native American middens and could be representative of local freshwater mollusk populations or demonstrate how far saltwater mollusks were transported as a staple food supply. Lastly, the prevalence of sawn material marks one of the last changes in the landscape as part of the colonial process: industrialization. To power the sawmills (and other mills) in the area, waterways that once flowed naturally were dammed and controlled, fundamentally changing natural processes including flood events, fish spawning, and erosion cycles.

Conclusion:

The Parsons House is not only important because of its age or survival, but also because it is a record and physical tether to a landscape and peoples that we in the present do not have direct access to anymore. Being a house is only one cultural form of a building and is often the only way historians interact with historic structures. However, by interpreting the structure's individual parts, a vast array of interactions and meanings can be uncovered. Today, it is rare to walk through a forest whose trees began growing at the beginning of the 17th century; A tour through the Parsons House is a unique opportunity to walk through such a woodland landscape. The Parsons House is a time capsule of Native American forestry practices, of change and deforestation, and of mechanization and early industrial processes.

Appendix 1: Explanation of Purlin Roof Systems

Although a variety of roof systems were developed in New England beginning in the 17th century, they can be broken down into two fundamental types: where board sheathing was applied to the rafters vertically, and where it was applied horizontally. Figure 28 shows a principal rafter and common purlin roof system a circa. 1780's barn in Buckland, MA. This roof system appears have been adopted very early in the 17th century and continued to be the most common roof system in Eastern Massachusetts, New Hampshire, and Maine through early 19th century.

Figure 29 shows an early and rare roof system found in the CTRV where there are no purlins or principal rafters, but rather only common rafters with collars to restrain the roof thrust (see also: Figure 14). Thus far, only two extant examples of this roof system exist in the CTRV. Lastly, by the mid-18th century, purlins supported by posts began to become a more standard assembly. Figure 30 shows the transitional roof frame in the Joseph Webb house in Wethersfield, CT in which jowled posts with no tie beams nor teasel tenons are used as purlin posts to create the gambrel, however, butt purlins were still used in the lower section of the roof demonstrating how traditional joinery assemblies in the CTRV continued even as the buildings were fundamentally changing.

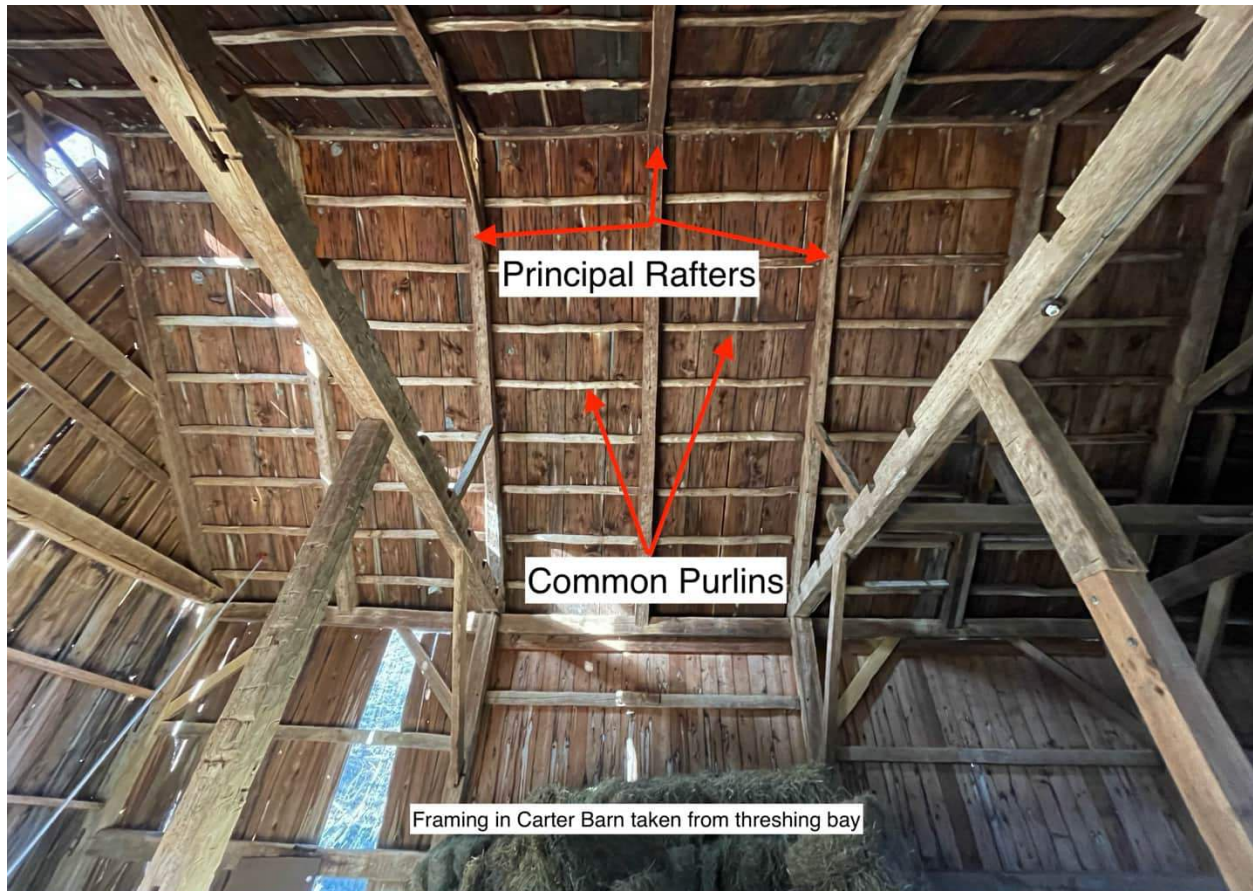


Figure 28: Principal rafter and common purlin roof system at the Carter barn 1780 c. in Buckland, MA. (Photograph by Nevan Carling.)



Figure 29: Common rafter and collar roof system of the John Moore house 1666 c. in South Windsor, CT. (Photograph by Nevan Carling.)

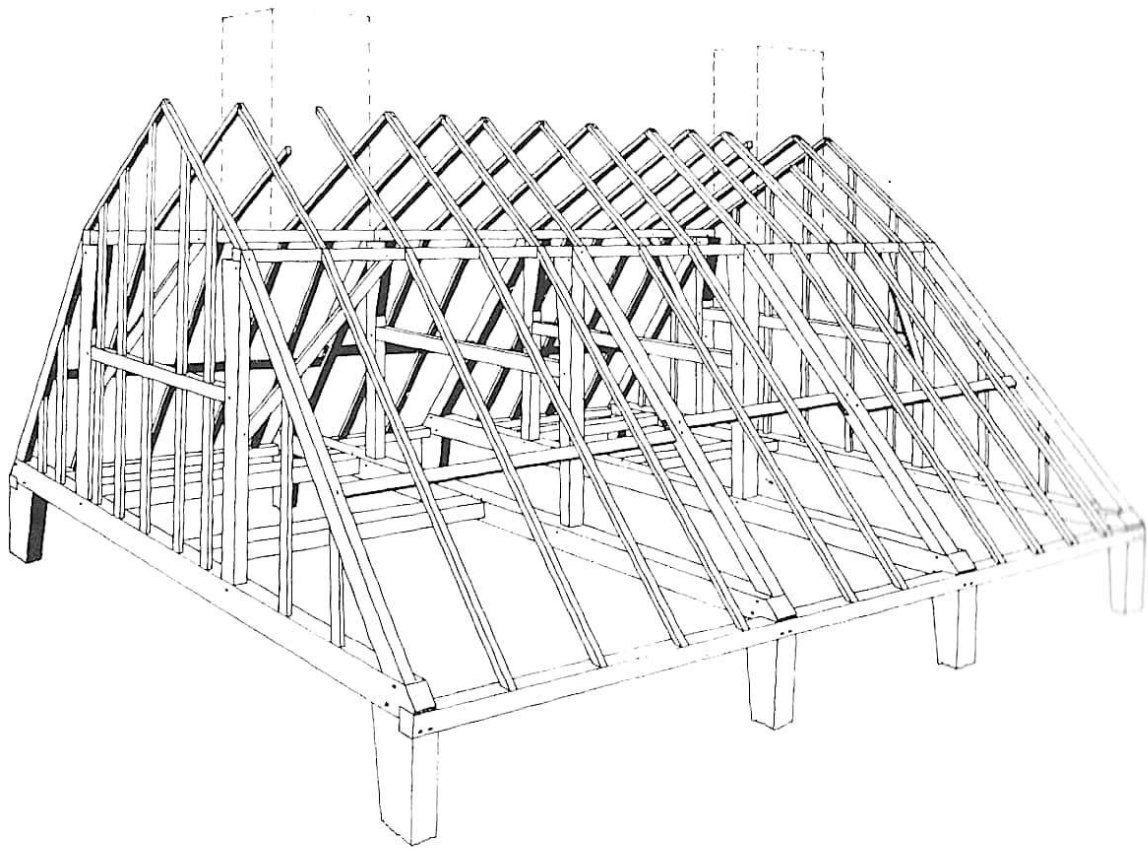


Fig. 2. Roof frame of Joseph Webb's house, made by Judah Wright, 1752. (Drawing by Robert St. George, based on field-work by Robert St. George, R. Trent, and Kevin Sweeney, November 1984.)

Figure 30: Transitional purlin roof frame at the Webb House 1752 c. in Wethersfield, CT.²⁸

²⁸ St. George, R.B. "Artifacts of regional consciousness in the Connecticut River Valley, 1700-1780", p. 341 in: St. George, R.B., *Material Life in America, 1600-1800* (Boston: Northeastern University, 1988).

Appendix 2: Other Comparable Examples in the CTRV

The two extant examples of type 1 houses that this author has surveyed include:



Figure 31: Deacon John Goodwin House 1698 d. (Photograph by Nevan Carling.)

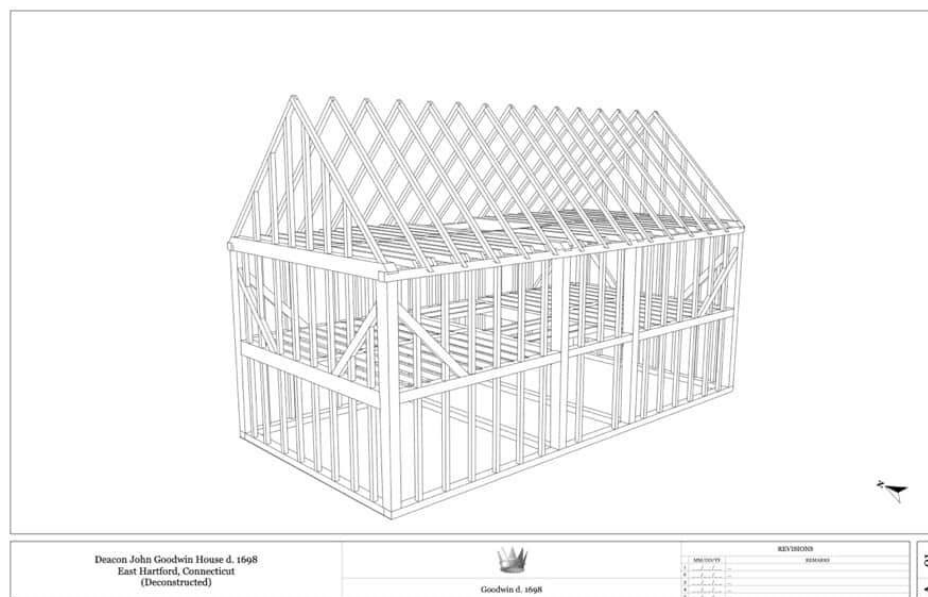


Figure 32: John Goodwin house 1698 d. framing. (Drawing by Nevan Carling.)



Figure 33: Daniel/Noah Webster house 1747 d. West Hartford, CT. (Photograph courtesy of Wikimedia Commons.)

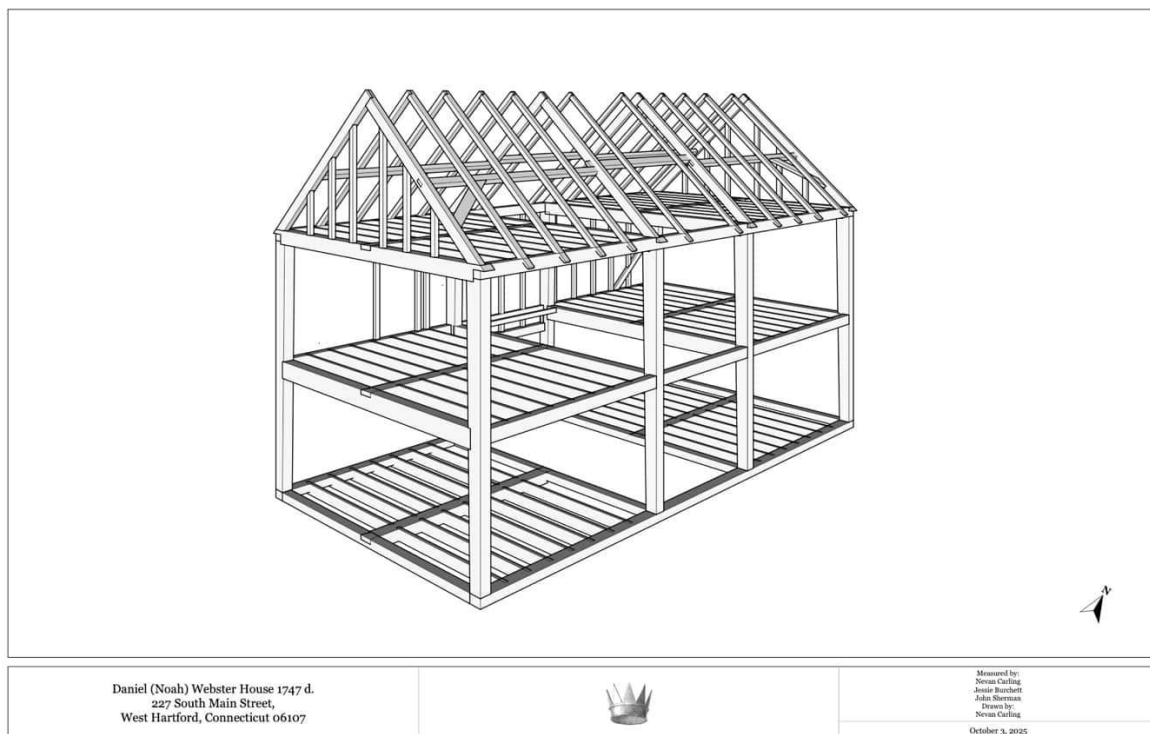


Figure 34: Daniel/Noah Webster house 1747 d. framing. (Drawing by Nevan Carling.)

Houses that have traditionally early dates and have a Type 1 appearance from the outside include:



Figure 35: Samuel Porter house 1730 c. East Windsor, CT –saltbox later addition. (Photograph by Nevan Carling.)



Figure 36: Return Strong house 1720-40 c. Windsor, CT. (Photograph courtesy of the Windsor Historical Society.)



Figure 37: Unattributed house early 18th century 867 Taintor Street, Suffield, CT. (Image courtesy of Google Maps.)



Figure 38: Ebenezer Clark House 1730 c. 197 Elm Street, Northampton, MA. (Image courtesy of Google Maps.)



Figure 39: Clapp House 1713 c. 148 South Street, Northampton, MA. (Photograph courtesy of Historic Northampton.)



Figure 40: Unattributed house early 18th century 208 South Street, Northampton, MA. (Image courtesy of Google Maps.)

The 3 houses in Northampton and the 1 house in Suffield shown above should be investigated for their similarities or differences in construction to the Parsons House.

**Appendix 5 – A Dendrochronology Study of Select Framing Timbers from the Nathaniel
Parsons House, Northampton, MA”, 2024**

A Dendrochronology Study of Select Framing Timbers from the Nathaniel Parsons House, Northampton, Massachusetts



William A. Flynt
November, 2024

A Dendrochronology Study of Select Framing Timbers from the Nathaniel Parsons House, Northampton, Massachusetts

Introduction

On July 29th, 2024, a selection of timbers were cored by William Flynt and Eric Gradoia from the Nathaniel Parsons house located on the grounds of Historic Northampton in Northampton Massachusetts for the purposes of conducting a dendrochronology study. A second trip to the site occurred on October 22nd to check a few of the previous sampling sites and to take additional samples from the second floor, phase 1 chamber ceiling joists. All samples were mounted, sanded, measured, and analyzed by the author back in Dummerston, Vermont. It should also be noted that sample data collected by the author in 2003 from the phase 1 framing within the attic space (NP-01-11) has been incorporated into this report.

Background

Dendrochronology, or the study of tree ring growth patterns to date the age of archeological timbers, was initially developed in the 1920's by Andrew E. Douglass using long-lived Ponderosa pines in the Southwest United States. An astronomer by training, Douglass was interested in historical sun spot activity and its relationship to earth's climate. He surmised that by looking at yearly growth ring sequences in long-lived trees growing in an arid environment where moisture is key, he might be able to ascertain yearly variations in climate attributable to sunspot activity. (Baillie, 1982). To push the tree ring database back past the age of living trees, samples were taken from roof poles in Pueblo ruins that turned out to eventually overlap the living tree data. Besides fulfilling his research needs, this work revealed the feasibility of dating archeological structures.

In the 1980's the advent of computer programs to collate data, run comparative analyses, and compile master chronologies enabled unknown samples to be compared to known masters with a high degree of accuracy in more temperate climates. Pioneering work in Eastern Massachusetts focusing on Oak (Krusic and Cook 2001, Miles, Worthington and Grady 2002, 2003, 2005) and in the Connecticut River valley initially concentrating on Pitch pine (Krusic 2001, Flynt 2004) and expanding into oak, chestnut, hemlock, spruce, and white pine, has revealed the suitability of using dendrochronology as a mainstream research tool for analyzing and establishing construction timber felling dates in the Northeast, a region heretofore considered too variable climatically to provide reliable results. It should be pointed out that this science is now one more tool in building archaeologists extensive analytical toolbox that allows them to study historic structure construction details with ever greater precision.

Over the past 20 years conducting such studies of historic structures throughout New England and eastern New York state, the author has been able to develop numerous site and regional dated masters for all of the species noted above. These are constantly being updated as additional material is dated and added to the appropriate masters to further enhance the chances of successfully dating future projects. As well, additional New

England dated chronologies for some of these species, available online at the International Tree-Ring Databank, are also used as needed.

It should be remembered that trees were usually felled in the winter months with frame preparation occurring shortly thereafter, so the earliest a frame could be raised would be in the year following the felling date delineated in a dendrochronology study such as this.

Procedures

In procuring samples suitable for dendrochronology research, the analyst must be on the lookout for timbers, framing, and boards that exhibit several parameters. First, a bark, or waney, edge must be present if one wishes to establish with certainty the last year of growth. Second, there needs to be a sufficient number of rings in a sample to span several distinctive climactic variations that register as patterns of wide and narrow rings. Ideally, having 100 or more years of growth is best, but more often than not, samples will range from 50 to 100+ years. While it is feasible to get dates on young samples (50-60 rings), spurious results are possible and thus must be reviewed carefully both with longer-lived samples from the same structure as well as with what documentary and stylistic research uncovers. Third, enough samples need to be obtained (10-15 per building episode is usually reasonable) to allow for comparison and the fact that often some will not align for one reason or another. It is also critical that an assessment be made of the building frame to ascertain that the members from which samples are extracted were not reused or inserted at a later date, or, if so, are duly noted. Fourth, all samples must be labeled and entered into a log book that notes the position of each sampled timber within the structure, its species, whether or not it has wane, and any other information pertinent to the sample. In labeling the samples the following code was employed, NP (Northampton, Parsons). The numbers that follow simply refer to the sequence in which the samples were taken. In the case of the second round of sampling, letters (A-G) had to be used in lieu of numbers as these samples came from the phase 1 section of the house which was limited to sample numbering 1-19.

Samples were extracted using a custom coring bit, chucked into a 20 volt, 1/2" battery-powered drill, that creates a 9/16" hole out of which is obtained a 3/8" core. The core samples were glued into custom wood mounts (oriented so as to be looking down, or up, the tree when viewed through the microscope) and sanded using successively finer grit paper (150-600 grit) both on a bench top belt sander and by hand sanding to create a mirror-smooth finish. All samples were then viewed under an Amscope 7.5-45X binocular microscope fitted with cross hairs in one eyepiece to count and mark the number of rings per sample. This was followed with a careful visual review, again under magnification, in an attempt to determine if site-specific growth patterns could be ascertained in order to help cross date the samples. Each sample was then placed under the microscope on a Velmex UniSlide Encoder stage calibrated to read to the nearest micron (.001mm). Measuring begins at the outer, or last year of growth ring (LYOG), established as 1000, and proceeds to the center of the sample or first year of growth, as measured (FYOG). It should be noted that not all cores reach the center of the tree, thus the first year of growth does not necessarily reflect when the tree began to grow. At the

junction of each growth ring, the analyst registers the interface electronically, which sends the measurement to the computer via a VMO Digital Readout.

In all of the work in this study, the measuring program MEASURE J2X was used to compile each sample's raw data files. The program transforms the ring widths into a series of indices that relate each ring's growth to its neighbors, thus standardizing the climate-related influences on a year-to-year basis (Krusic 2001). Thus trees from a similar location but growing at different rates should exhibit similar indices. With the raw data in hand, using the program COFECHA (Holmes, 1983) the samples from this site can be compared with each other to determine if all were cut at the same time or within the span of several years or more. The hope is that a floating chronology can be developed revealing the felling relationship between some, if not all of the samples within each species found in the structure. The samples are also compared against one or more dated regional master chronologies or site masters of the same species to determine the exact year or years when the samples in question were felled. As strong samples are uncovered, these are added to a fledgling site master and the raw data is again run against this site master to see if additional samples align.

With COFECHA samples are broken down into ring groups of 50 years that are then compared to either the other undated samples (to create a floating site master) or with various dated masters (to determine a calendar year match). The 50-year ring groups in an individual sample are lagged a certain number of years (in this study lags of 10 and 25 years were used) to provide an overlap of data within the groupings. The results are displayed in a series of ways, with Part 8 "Date Adjustment for Best Fit Matches for Counted or Unknown Series" composed of columns with the "best fit" being in column #1, the next "best fit" in column #2 and so on out 11 columns. The "add" number is the number to be added to the last year of growth (1000) to provide the year date of felling, while the "corr" number relates to how well the "add" meshes with the master. A correlation coefficient of .3281 is considered the threshold of significance for 50-year ring groups. Higher correlation values (preferably over .40) accompanying consistent "add" numbers in the first column usually reveal reliable results for longer-lived samples. It should be noted that samples exhibiting short ring counts (less than 60) are more prone to display spurious results. In the example below, consistent "add" numbers with strong correlations appearing in the first column for samples DLBH-07 and 08 reveal each samples' true date of felling ($1000+784$ and $782 = 1784$ and 1782 respectively). Sample DLBH-09 does not show consistently strong correlation with any particular date. Note that the lag used in this example is 10 years.

SERIES	COUNTED SEGMENT	CORR		CORR		CORR		CORR		CORR		CORR		CORR		CORR					
		ADD	# 1	ADD	# 2	ADD	# 3	ADD	# 4	ADD	# 5	ADD	# 6	ADD	# 7	ADD	# 8	ADD	# 9	ADD	# 10
DLBH-07	937- 986	784	.51	712	.47	729	.37	713	.37	847	.33	846	.31	728	.30	813	.29	800	.29	763	.28
DLBH-07	947- 996	784	.54	712	.45	760	.33	816	.31	729	.31	800	.29	713	.29	671	.29	847	.26	808	.25
DLBH-07	951-1000	784	.41	760	.35	712	.35	661	.31	787	.30	800	.29	774	.29	729	.27	808	.26	832	.25
DLBH-08	929- 978	782	.44	746	.42	793	.33	760	.32	705	.32	840	.31	858	.30	689	.30	824	.28	685	.26
DLBH-08	939- 988	782	.61	746	.37	689	.34	840	.30	725	.29	708	.27	723	.27	806	.27	684	.25	724	.25
DLBH-08	949- 998	782	.69	669	.47	840	.41	722	.32	806	.28	708	.27	700	.26	683	.25	723	.25	720	.24
DLBH-08	951-1000	782	.69	669	.38	840	.38	722	.34	757	.29	700	.28	730	.25	659	.24	838	.23	723	.23
DLBH-09	932- 981	713	.52	785	.35	848	.35	744	.35	729	.32	863	.31	846	.28	849	.26	693	.26	714	.25
DLBH-09	942- 991	846	.38	713	.36	785	.33	848	.33	729	.29	727	.29	790	.29	693	.28	761	.28	705	.27
DLBH-09	951-1000	799	.43	783	.39	731	.30	689	.30	808	.29	767	.27	756	.26	790	.25	814	.24	846	.24

Once samples from a site are firmly dated and grouped into a site master, Part 2 "Correlations with Master Series of all Segments as Dated and Measured" and Part 3 "Segments Correlating Low, or Higher, at other than Dated Position" of COFECHA can be viewed to see how well each sample correlates with the others in the group and where weak areas within the ring counts are located for further scrutiny.

Results- See Figure 1, Appendix A, Appendix B

A total of 64 samples were extracted from timbers in five different phases of construction, namely the original 2 over 2 front portion of the house, the raised rear pile and the associated new roof, the West wing, the leanto kitchen, and the kitchen ell. Of the 64 samples, only 36 had adequate ring counts, and some just barely, to make analysis feasible. The samples were identified as a mix of pitch pine, oak, white pine, hemlock, and in two cases, maple. As mentioned earlier, sample data from a 2003 sampling session where 10 pitch pine and one oak sample were collected, identified as NP-01 through NP-11 (from the Phase 1 attic) has been added to the sample data collected most recently.

It should be pointed out that while it might seem as though there are missing samples within the sample numbering system, this is not the case. As sampling moved from one section to the next, the numbering was bumped up to the next "decade" to leave room for additional samples, if needed, from previous sections. This is noted in Figure 1.

The following analysis will look at each species separately with the first series of tests attempting to develop floating chronologies for each species present in the building to ascertain the felling relationship between samples. Were they all felled the same year, or over a period of years? With this information in hand, the next series of tests will compare the raw sample data to local/regional dated master chronologies for the species in question, with the expectation that consistent calendar dates will be revealed for each sample's last year of growth.

Pitch pine

A majority of the samples were revealed to be pitch pine, a species commonly found in early Connecticut River Valley of Massachusetts buildings. The attempt to create a floating master resulted in two floating masters, as the earliest phase 1 material did not align well with shorter-lived pitch pine found in the later phases of construction. This is not surprising as the ring overlaps are most likely not sufficient, if they overlap at all, to provide meaningful correlations. Chart 1A reveals how the Phase 1 framing samples, accessed from the main attic, align with each other. NP-05, 07, 08, 09, 17, 18, A, D, and G, all have the same last year of growth, as do the two short-lived samples NP-01 and 02 (although with fairly weak correlation coefficients), while NP-04, 05, and 10 were felled the previous year. While NP-12 and NP-B signal having been felled two years previous, it should be noted that NP-12 has a partial last ring which was not measured so in reality it was felled the previous growing season, rather than 2 years earlier. NP-13 weakly suggests having a last growth ring in line with the others aligned at 0. While NP-38 is a rafter in the later roof framing system, it has clear evidence in the form of nail holes, revealing it is reused

Also of interest is NP-36 suggesting possibly coming down 18 year earlier and NP-40 having possibly been felled 17 years earlier. Knowing where these samples were taken (replacement roof rafters) makes one wary of these results. Considering these samples are relatively short-lived, it may be that the results are spurious, especially when compared to the results of the second pitch pine floating master to be discussed next. Finally, NP-49A seemingly indicates having been felled one year earlier. This post should be examined closely to see if evidence survives indicating a previous use. Chart 1B reveals how the phase 1 floating master 50-year ring groups correlate with each other where they overlap. Overall the correlation coefficients are respectable, indicating that the alignments are correct.

The second floating master focused on the pitch pine in the later phases of construction. Chart 2A reveals NP-36 and 43 having been felled the same year, NP-40 came down 2 years later, NP-42 and 71 have last measured rings 3 years later, and NP-44 has a last ring 5 years earlier. None of the earlier Phase 1 material aligned with these later samples. Chart 2B once again reveals decent correlation coefficients where each samples' 50-year ring groups overlap suggesting these alignments are correct.

The next series of tests compared the Parsons house pitch pine to several regional pitch pine masters. Working with a Deerfield pitch pine master, as seen on Chart 3, Phase 1 samples NP-04, 06, and 10 align well with 1717, NP-05, 07, 08, 09, 17, 18, D, G, and 38 align with varying strength with 1718, and NP-12 aligns with 1716, all in agreement with the results seen on Chart 1A. As well, NP-49A's suggests an alignment with 1717 (in agreement with Chart 1A results) and NP-71 seemingly aligns with a date of 1778 (though 1815 is also lurking within the results as well), though in both cases the correlation coefficients are not overly strong. Knowing the location of these last few samples in the structure, it may well be that these dates are spurious, or perhaps they are reused material. The fact that the Deerfield pitch pine master data is heavily weighted to the 17th and 18th centuries with less data relating to the first half of the 19th century may also be contributing to the later samples not aligning as strongly with potentially later dates.

The next test compared these samples to a Northampton area pitch pine master (that includes the phase 1 Parsons house samples obtained in 2003). Not surprisingly, Chart 4 reveals NP-01 through 10 aligning strongly with specific dates due to the fact that these samples are included in the master. As for the samples collected during this project, NP-12 aligns well with 1716 as does NP-B, NP-17 and 18, and to a lesser extent NP-A and NP-D associate with 1718, while short-lived NP-26 aligns best with 1815, as does NP-33 and 71. NP-03, a short-lived sample collected from one of the later purlin posts in 2003, also aligns with 1815. While NP-38 shows good strength for 1718, both 1807 and 1819 reveal decent alignments as well in columns 2 and 3. Knowing this sample is reused, the 1718 date is likely correct, especially since it aligns well with the other early samples, as noted in Chart 1A and fails to align with the later pitch pine floating master. NP-40 seemingly wants to align with 1701 but here too, dates of 1713 and 1814 also reveal themselves, though weaker. NP-49A once again aligns relatively well with a date of 1717, suggesting it too, could be reused material. All in all, due to the relatively short

ring counts for all the pitch pine associated with the later phases of construction, none of these dates can be deemed absolutely accurate. The fact that other than NP-12's alignment with 1716 and NP-17,18, A, D, and 38 aligning well in agreement with the floating master depicted on Chart 1A, the others do not all align well with the floating master illustrated on Chart 2A which throws some confusion into the mix.

While short-lived, sample NP-60 was measured due to the fact that it is one of the few samples extracted from the former one story leanto. It is worth noting that a date of 1767 appears in this test with a decent correlation coefficient of .55. Although this one short sample is not sufficient to date this portion of the structure, it should be kept in mind when conducting documentary research.

Working with the various tests, a Parsons house pitch pine site master was created, as displayed on Charts 5A and 5B.

Oak

Ten samples turned out to be oak, a mix of red and white, from various construction phases of the house. As with the pitch pine, success at creating a floating master was mixed in that small groups of samples could be aligned, but the group as a whole could not be aligned. In part this was due to relatively short-lived samples that did not have sufficient ring overlap to convincingly align. As well it could be that the material may have been sourced from a variety of woodlots that were subjected to varying growing conditions. Chart 6 reveals samples NP-53 and 55 having the same last year of growth while NP-28 has a last growth ring 5 years earlier and NP-58 has a last growth ring two years later. Chart 7 illustrates NP-28 and 49 having the same last year of growth (though with relatively weak 50-year ring group overlap correlation coefficients) while Chart 8 indicates samples NP-39 and 41 have the same last measured year. It should be noted that with both NP-39 and 41, some of the outermost rings were lost during coring due to the fragile nature of the waney edge.

When the oak samples were run against a Connecticut River Valley of Massachusetts oak master, most of the samples seemingly align well with specific dates, as seen on Chart 9. NP-11 aligns well with 1716, and NP -14 aligns well with 1717 in its later years of growth but weakens in its earlier years of growth. Both samples were extracted from Phase 1 framing members. NP-39 and 41, both reused principal rafters repurposed as ceiling joists in the raised rear pile, align with a date of 1715, though, as mentioned above, these two samples lost a bit of the waney edge during coring, thus the actual felling date is several years later. Sample NP-61, the reused chimney post on the north wall of the rear pile kitchen, aligns well with a date of 1725. The remaining samples, all extracted from later alterations to the house, align well with 19th century dates. NP-28 and 49 associate with 1814 while NP-53 and 55 align with 1819. The agreement between these dates and the various floating oak masters would indicate the dating is accurate. When these samples are assigned the dates indicated on Chart 9, their 50-year ring overlaps do not exhibit strong correlation coefficients. This could suggest that the material was being sourced from different areas during different building episodes.

White pine

While many of the white pine timbers sampled turned out to have too few rings for analysis, three were measured (one, NP-63, is a bit under the minimum ring count but was included anyway) in the hope that they might date and help strengthen the results from other species analysis. No alignment between the three samples could be found when the samples were compared to NP-21.

The samples were next tested against a Deerfield white pine master, as seen at the top of Chart 10. NP-21 aligns relatively well with 1814 while NP-63 may well align with 1820 (the correlation coefficient of .48 is decent) though the short ring count makes one wary of assigning too much significance to this result. Within the data for NP-19, a nailer for lath in the west parlor ceiling, no conclusive results are noted, however, it is interesting to see a date of 1713 in both rows, though with a marginal correlation coefficients in its latter years of growth.

Hemlock

Only one sample identified as hemlock, a north side rafter in the main attic later roof frame. Testing this against a Connecticut River Valley of Massachusetts historic hemlock master, as seen on the lower portion of Chart 10, reveals a date of 1813 for the last full growth ring. As this sample has a partial last ring that was not measured, its true felling date would be during the 1814 growing season.

Discussion

While the number of samples obtained from the various phases of construction was seemingly ample, the large proportion that turned out to be too short-lived was a bit frustrating. In spite of this factor, enough samples did provide dates to enable a more focused examination of the written record for verification. In spite of being in close proximity to a number of dated masters, especially in regards to pitch pine, it was surprising to find that other than the phase 1 material, the later material did not date all that well.

It is clear that most of the material felled for construction of the house, no matter which phase, was relatively short lived which would seemingly indicate that either old growth trees were already felled for other purposes (in relation to phase 1 construction) or they were too large to be deemed useful for framing this structure. With the abundant use of forests for firewood and construction, it is not surprising to see, especially in the early 19th century portions of the house, very fast grown material such as white pine, showing up with insufficient ring counts to allow for analysis.

Throughout the structure the species used for framing could all be found growing in the region and were most likely sourced from nearby. The fact that several samples turned out to be maple, while unusual, is also not altogether surprising as the use of non-traditional species for one or two timbers within an otherwise typical frame (that is, pine, hemlock, and oak) can be found in other valley houses. An occasional poplar, birch, or elm timber have been identified in local structures during such studies. It should also be noted that the general shift from oak and pitch pine in 18th century valley framing to

more prolific use of white pine (and often hemlock) in 19th century valley framing is certainly in evidence in the Parsons house.

In reviewing the results from this study, both the original samples extracted in 2003 along with the additional samples obtained from phase 1 during this project confirm an initial construction date of 1719 at the earliest using timbers felled no later than 1718. While it was thought the phase 1 second floor ceiling joists might have been installed a generation or two after the phase 1 portion was constructed, as has been found in several early houses in Deerfield, a second round of sampling determined this was not the case as the joists have felling dates in line with the main framing members.

The early leanto could not be firmly dated due to a lack of suitable material to sample. Sample NP-61, while dating to 1725, was a reused framing member from an unknown source. As noted earlier, NP-60, while very short-lived, did align with a decent correlation coefficient, to 1767. It could be accurate, or it could be spurious, but it would be well worth exploring the documentary record around this time period to see if any corroborating evidence can be found.

The raising of the early leanto to create a full two story, double pile house was fabricated using material felled primarily in 1814 and 1815. It should be noted that samples NP-26 and 33 are missing the latewood of their last growth ring, but these rings were measured anyway, thus they came down during the growing season of 1815, and could well have been used during an 1815/16 construction project. While many samples from this phase of construction did not date, the fact that those that did represented several species helps to strengthen the validity of the date.

Very few of the rafters in the present roof provided conclusive dates. While a few suggested dates in the early 19th century, two, NP-38 and 40, seemingly want to align with 1718 and 1701 respectfully. A review of the two rafters during the second round of sampling did reveal nail hole evidence on NP-38 revealing it is, in fact, reused, while the rafter from which NP-40 was extracted had no evidence of reuse and looked just like the other later rafters. It is suspected that the NP -40 results are spurious. It is fortunate that other framing related to this expansion dated consistently.

Amongst the attic north side ceiling joists are several clearly reused principal rafters. Two were sampled with both revealing an early 18th century date (1715) though the loss of the last few rings at the waney edge due to decay would indicate a felling date several years later. These may, or may not, be parts of the original roof frame dismantled at the time the leanto was raised to a full two stories.

The west wing proved to be a challenge as of the nine samples extracted, four were too short-lived. Of the remaining, two, NP-53 and 55, aligned with a date of 1819. Both had a small amount of new growth at the waney edge which was not measured, thus these two samples were felled in the early spring of 1820. In the basement of the west wing, sample NP-58 aligned well with a date of 1821 which pushes the earliest framing date to 1822. Having only three dated samples is less than the desired number to pinpoint a

construction date, but these results do narrow down the expansion to the first half of the 1820's.

Due to the lack of suitable framing members, only four samples could be extracted from the east kitchen ell. Three came from the chimney base and one from the ridgepole. The ridgepole sample was too short-lived leaving just the three from the chimney base. While NP-71 aligns weakly with 1778, and a bit less so with 1815, when compared to the Deerfield pitch pine master, it aligns with much greater strength with 1815 when compared to the Northampton area pitch pine master. As this sample has a bit of new growth at the waney edge that was not measured, it actually was felled in the spring/summer of 1816. The strong correlation coefficients associated with this date in this test would indicate the date is correct. As with the west wing, this lone sample is not sufficient to firmly establish when the east kitchen ell was constructed, though clearly no earlier than 1816 (for the chimney, at least).

With this information in hand, a review of the documentary records around the time periods noted will hopefully reveal corroborating evidence for how this structure evolved.

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FIGURE 1

NATHANIEL PARSONS HOUSE, NORTHAMPTON, MASSACHUSETTS

SAMPLE	AGE	FYOG	LYOG	WANE	SPECIES	LOCATION
PHASE 1						
NP-01	46	1673	1718w	Y	PIRI	S.ROOF PURLIN POST,W.OF CHIMNEY, REUSED?
NP-02	37	1682	1718w	Y	PIRI	N.ROOF PURLIN POST,W.OF CHIMNEY, REUSED?
NP-03	46	1768	1815w	Y	PIRI	N.ROOF PURLIN POST,E.OF CHIMNEY
NP-04	87	1631	1717	Y	PIRI	ORIGINAL HOUSE,NORTH PLATE
NP-05	66	1653	1718	Y	PIRI	EAST CHIMNEY GIRT
NP-06	81	1637	1717	Y	PIRI	WEST CHIMNEY GIRT
NP-07	71	1648	1718	Y	PIRI	EAST END ATTIC TIE GIRT
NP-08	97	1622	1718	Y	PIRI	EAST CHAMBER SUMMER BEAM
NP-09	76	1643	1718	Y	PIRI	WEST CHAMBER SUMMER BEAM
NP-10	71	1647	1717	Y	PIRI	2ND FLOOR N.GIRT BETWEEN CHIMNEY POSTS
NP-11	68	1649	1716	Y	QUAL	NORTHEAST CHIMNEY POST
NP-12	72	1645	1716*	Y	PIRI	WEST END ATTIC TIE BEAM
NP-13	94	1619	1712w	Y	PIRI	ATTIC,1ST JOIST E.OF E.CHIMNEY GIRT
NP-14	94	1624	1717*	Y	QUAL	NORTHWEST CORNER POST
NP-15	15	TOO	SHORT	Y	PIRI	NORTH SILL
NP-16	40	TOO	SHORT	Y	PIRI	W.CELLAR,N-S TIMBER ON EAST WALL
NP-17	73	1646	1718	Y	PIRI	W.CHAMBER,W.WALL GIRT UNDER FLOOR
NP-18	75	1644	1718	Y	PIRI	W.CHAMBER,W.CHIMNEY GIRT UNDER FLOOR
NP-19	59	942	1000	Y	PIST	W.PARLOR,W.WALL CEILING LATH NAILER, AFFIXED TO NP-17
MAIN ATTIC						
NP-A	66	1653	1718	Y	PIRI	E.CHAMBER,3RD N SIDE JOIST FROM E.END
NP-B	52	1665	1716	Y	PIRI	E.CHAMBER,1ST N.SIDE JOIST FROM E.END
NP-C	120	881	1000	Y	PIRI	E.CHAMBER,1ST S.SIDE JOIST FROM CHIMNEY GIRT
NP-D	76	1643	1718	Y	PIRI	E.CHAMBER,4TH N.SIDE JOIST FROM E.END
NP-E	31	TOO	SHORT	Y	QURU	W.CHAMBER,6TH N.SIDE JOIST FROM W.END
NP-F	113	888	1000	Y	PIRI	W.CHAMBER,1ST S.SIDE JOIST FROM CHINMEY GIRT
NP-G	56	1663	1718	Y	PIRI	W.CHAMBER,1ST S.SIDE JOIST FROM W.END
NP-20	30	TOO	SHORT	Y	PIST	SOUTHEAST PURLIN POST
NP-21	71	1744	1814	Y	PIST	SOUTHEAST PURLIN
NP-22	20	TOO	SHORT	Y	PIST	SOUTHWEST PURLIN POST
NP-23	34	TOO	SHORT	Y	PIST	SOUTHWEST PURLIN
NP-24	39	TOO	SHORT	Y	PIST	NORTHWEST PURLIN POST
NP-25	30	TOO	SHORT	Y	PIST	NORTHWEST PURLIN
NP-26	47	1769	1815	Y	PIRI	NORTHEAST PURLIN POST
NP-27	36	TOO	SHORT	Y	PIST	NORTHEAST PURLIN
NP-28	69	1746	1814	Y	QURU	NORTHWEST PURLIN BRACE
NP-29	45	TOO	SHORT	Y	PIRI	SOUTH CHIMNEY PURLIN POST
NORTH BAY ADDITION ATTIC						
NP-30	27	TOO	SHORT	Y	PIST	NORTHWEST TIE BEAM
NP-31	42	TOO	SHORT	Y	PIST	NORTHEAST TIE BEAM
NP-32	24	TOO	SHORT	Y	PIST	NORTHWEST "CHIMNEY" TIE BEAM
NP-33	56	1760	1815	Y	PIRI	NORTHEAST "CHIMNEY" TIE BEAM
NP-34	118	1696	1813*	Y	TCSA	NORTHEAST RAFTER
NP-35	32	TOO	SHORT	Y	PIRI	1ST JOIST FROM WEST END
NP-36	74	927	1000	Y	PIRI	N.SIDE RAFTER,6TH FROM W.GABLE
NP-37	30	TOO	SHORT	Y	PIRI	2ND JOIST FROM WEST END
NP-38	62	1657	1718	Y	PIRI	S.SIDE RAFTER,8TH FROM W. GABLE, REUSED
NP-39	64	1652	1715**	N	QUAL	5TH JOIST FROM WEST END, REUSED
NP-40	62	939	1000	Y	PIRI	S.SIDE RAFTER,6TH FROM E.GABLE
NP-41	60	1656	1715**	Y	QUAL	7TH JOIST FROM WEST END, REUSED
NP-42	69	932	1000	Y	PIRI	S.SIDE RAFTER,3RD FROM E. GABLE
NP-43	75	926	1000	Y	PIRI	SOUTHEAST END RAFTER
NP-44	68	933	1000	Y	PIRI	1ST JOIST FROM EAST END
NP-45	45	TOO	SHORT	Y	PIRI	8TH JOIST FROM WEST END
NP-46	43	TOO	SHORT	Y	PIST	WEST RIDGE POLE

FIGURE 1 continued

NATHANIEL PARSONS HOUSE, NORTHAMPTON, MASSACHUSETTS

SAMPLE	AGE	FYOG	LYOG	WANE	SPECIES	LOCATION
NORTH BAY ADDITION ATTIC						
NP-47	29	TOO SHORT		Y	PIST	EAST RIDGE POLE
NP-48	91	NOT MEASURED^		Y	ACRU	S.SIDE,W.CHIMNEY PURLIN POST BRACE
NP-49	65	1750	1814	Y	QURU	N.SIDE 2ND FLOOR STUD,2ND FROM NE POST
NP-49A	58	943	1000	Y	PIRI	2ND FLOOR POST ABOVE BACK STAIRS
WEST WING						
NP-50	37	TOO SHORT		Y	QURU	SOUTHWEST RAFTER
NP-51	39	TOO SHORT		Y	QURU	WEST GABLE CENTER STUD
NP-52	60	941	1000	Y	PIRI	SOUTH E-W ATTIC GIRT
NP-53	64	1756	1819*	Y	QURU	S.SIDE,4TH RAFTER FROM W.GABLE
NP-54	40	TOO SHORT		Y	PIST	NORTH MAIN E-W ATTIC GIRT
WEST WING						
NP-55	51	1769	1819*	Y	QURU	S.SIDE RAFTER,5TH FROM W.GABLE
NP-56	74	NOT MEASURED^		Y	ACSH	N.SIDE,6TH RAFTER FROM W.GABLE
NP-57	32+	BAD BREAK		Y	QURU	NORTH SILL IN BASEMENT
NP-58	75	1747	1821	Y	QURU	N-S CENTRAL FIRST FLOOR GIRT
NP-59 NO SAMPLE						
LEANTO KITCHEN						
NP-60	43	958	1000	Y	PIRI	NORTH PLATE
NP-61	84	1642	1725	Y	QUAL	WEST CHIMNEY POST, REUSED
NP-62	29	TOO SHORT		Y	PIRI	CEILING GIRT ATTACHED TO NP-61
NP-63	49	952	1000*	Y	PIST	NORTH SILL
NP-64	42	TOO SHORT		Y	QURU	SOUTH SILL
NP-65	39	TOO SHORT		Y	QURU	2ND JOIST FROM WEST WALL
NP-66 NO SAMPLE						
NP-67 NO SAMPLE						
NP-68 NO SAMPLE						
NP-69 NO SAMPLE						
KITCHEN ELL						
NP-70	26	TOO SHORT		Y	PIST	RIDGE POLE
NP-71	70	1746	1815**	Y	PIRI	CHIMNEY BASE TIMBER, 3RD FROM N.SIDE
NP-72	60	941	1000	Y	PIRI	CHIMNEY BASE TIMBER,1ST ON S.SIDE
NP-73	60	941	1000	Y	PIRI	CHIMNEY BASE TIMBER, 2ND FROM S.SIDE

FYOG = FIRST YEAR OF GROWTH, AS MEASURED

LYOG = LAST YEAR OF GROWTH, AS MEASURED

PIRI = PITCH PNE

QUAL = WHITE OAK

PIST = WHITE PINE

QURU = RED OAK

TCSA = HEMLOCK

ACRU = RED MAPLE

ACSH = SUGAR MAPLE

^ = THESE SAMPLES WERE NOT MEASURED DUE TO LACK OF DATED MASTERS

* = PARTIAL LAST RING, NOT MEASURED. TREE FELLED FOLLOWING SPRING

** = SEVERAL RINGS MISSING AT WANE DUE TO LOSS DURING CORING

w = WEAK

CHART 1A

PART 8: DATE ADJUSTMENT FOR BEST MATCHES FOR COUNTED OR UNKNOWN SERIES

Tucson-Mendoza-Hamburg-Lamont Proglib

NP PITCH PINE VS NP PITCH PINE (PHASE 1) ALIGNED
50-YEAR SEGMENTS LAGGED 10 YEARS

SERIES	COUNTED SEGMENT	CORR ADD # 1	CORR ADD # 2	CORR ADD # 3	CORR ADD # 4	CORR ADD # 5	CORR ADD # 6	CORR ADD # 7	CORR ADD # 8	CORR ADD # 9	CORR ADD #10	CORR ADD #11
NP-01	955-1000	0 .47	-51 .34	-34 .32	-22 .28	-48 .27	-23 .26	-36 .23	-46 .21	-10 .21	-21 .21	-16 .18
NP-02	964-1000	0 .35	-51 .35	-1 .30	-23 .27	-27 .23	-39 .21	-5 .20	-15 .17	-10 .16	-52 .15	-53 .14
NP-03	955-1000	-28 .30	-17 .27	-23 .25	-45 .22	-29 .20	-7 .19	-32 .18	-42 .17	-47 .16	-21 .16	-5 .15
NP-04	914- 963	-1 .73	23 .34	-4 .34	25 .23	21 .23	11 .23	37 .21	29 .20	13 .18	-3 .16	17 .16
NP-04	924- 973	-1 .72	21 .33	-13 .25	-3 .24	23 .21	25 .20	9 .18	13 .18	3 .17	17 .16	5 .16
NP-04	934- 983	-1 .70	-13 .32	9 .26	5 .22	13 .19	-25 .18	-5 .18	17 .18	-7 .17	-26 .12	11 .11
NP-04	944- 993	-1 .65	-13 .44	-31 .23	-25 .22	3 .20	-29 .13	-39 .12	-5 .12	-7 .11	-26 .11	-19 .09
NP-04	951-1000	-1 .59	-13 .41	-5 .28	-29 .22	-27 .15	-39 .14	-25 .14	-44 .14	-30 .12	-26 .10	-6 .09
NP-05	935- 984	0 .73	-17 .41	6 .22	-4 .16	-10 .16	-18 .15	-6 .10	12 .09	-30 .09	16 .09	-21 .09
NP-05	945- 994	0 .73	-21 .38	-38 .23	-10 .23	-39 .20	-34 .18	-35 .13	-4 .12	-24 .11	1 .11	-37 .10
NP-05	951-1000	0 .80	-38 .29	-39 .25	-21 .22	-34 .18	-17 .18	-24 .17	-10 .16	-4 .16	-23 .15	-36 .15
NP-06	920- 969	-1 .68	1 .33	24 .25	27 .23	15 .23	3 .21	-14 .20	-11 .19	5 .19	10 .16	29 .15
NP-06	930- 979	-1 .75	1 .25	-12 .25	-14 .24	15 .19	3 .16	-26 .15	10 .12	21 .11	-25 .10	5 .10
NP-06	940- 989	-1 .71	1 .16	-2 .15	-26 .14	3 .14	-12 .13	-35 .13	-29 .12	-14 .12	-36 .11	-24 .11
NP-06	950- 999	-1 .71	-29 .34	-18 .23	-14 .21	-35 .17	-40 .16	-17 .15	-23 .13	-36 .11	-31 .11	-13 .11
NP-06	951-1000	-1 .62	-29 .30	-14 .20	-35 .20	-36 .19	-38 .19	-2 .17	-40 .14	-18 .14	-17 .13	0 .12
NP-07	930- 979	-23 .39	0 .38	14 .32	16 .20	-25 .20	-24 .18	-26 .18	-22 .17	2 .15	-16 .13	1 .12
NP-07	940- 989	0 .54	-25 .27	-22 .24	-16 .23	-23 .21	-5 .16	-26 .15	2 .12	-29 .11	1 .11	-35 .10
NP-07	950- 999	0 .70	-17 .25	-23 .22	-22 .20	-24 .19	-1 .19	-39 .17	-5 .14	-36 .14	-38 .13	-4 .13
NP-07	951-1000	0 .71	-38 .25	-17 .23	-24 .22	-36 .20	-23 .20	-22 .17	-1 .15	-26 .15	-39 .10	-4 .07
NP-08	904- 953	0 .75	25 .31	3 .26	18 .22	36 .21	30 .21	27 .15	2 .13	21 .11	13 .10	43 .10
NP-08	914- 963	0 .77	25 .25	27 .21	18 .20	2 .18	36 .17	-3 .17	30 .16	3 .14	21 .12	14 .12
NP-08	924- 973	0 .77	-18 .32	21 .26	25 .17	-3 .17	12 .17	-20 .16	6 .15	4 .10	18 .09	-6 .09
NP-08	934- 983	0 .74	-18 .32	-11 .22	12 .19	16 .19	-24 .16	-27 .13	-12 .10	-14 .10	-20 .09	4 .08
NP-08	944- 993	0 .73	-38 .27	-24 .25	-12 .18	-13 .17	-11 .17	-36 .17	-39 .16	4 .15	-6 .13	-25 .09
NP-08	951-1000	0 .72	-38 .33	-22 .26	-12 .22	-36 .19	-13 .18	-11 .16	-24 .15	-39 .15	-27 .12	-4 .11
NP-09	925- 974	0 .73	2 .21	-17 .20	22 .19	4 .17	6 .17	18 .12	-6 .12	26 .11	-15 .09	-16 .08
NP-09	935- 984	0 .74	-17 .28	4 .25	-30 .22	6 .16	-24 .15	2 .15	-4 .14	-21 .13	-6 .13	-10 .11
NP-09	945- 994	0 .73	4 .33	-21 .33	-24 .18	-17 .18	-34 .18	-12 .14	5 .12	-39 .11	-28 .11	-6 .10
NP-09	951-1000	0 .78	-24 .27	-22 .20	-17 .20	-21 .18	-34 .17	-23 .17	-12 .16	-39 .12	-28 .12	-38 .11
NP-10	930- 979	-1 .75	21 .24	-23 .19	-26 .18	-17 .15	11 .15	-5 .14	15 .14	16 .12	-14 .12	-10 .10
NP-10	940- 989	-1 .71	-5 .18	-31 .15	-26 .15	-19 .15	-17 .12	-36 .11	11 .11	-6 .10	8 .10	5 .10
NP-10	950- 999	-1 .72	-23 .24	-17 .22	-29 .21	-5 .18	-40 .17	-31 .16	-39 .15	-22 .13	0 .13	-46 .11
NP-10	951-1000	-1 .70	-23 .23	-17 .22	-29 .20	-40 .17	0 .15	-31 .14	-5 .13	-22 .12	-39 .12	-46 .11
NP-12	929- 978	-2 .63	-16 .27	-20 .21	4 .20	10 .19	-14 .17	-23 .14	-18 .13	19 .11	14 .11	22 .10
NP-12	939- 988	-2 .70	-14 .27	10 .21	-29 .20	-32 .17	-6 .17	4 .14	-27 .12	-30 .11	3 .10	8 .08
NP-12	949- 998	-2 .69	-6 .22	-36 .21	-27 .19	-24 .17	-45 .17	-38 .15	-23 .15	-14 .14	2 .13	-18 .11
NP-12	951-1000	-2 .71	-6 .21	-24 .21	-36 .18	-14 .17	-45 .16	-38 .16	-23 .15	-47 .14	-40 .14	-25 .14
NP-13	907- 956	24 .47	8 .28	-1 .25	14 .22	10 .22	12 .21	38 .19	33 .15	34 .14	26 .13	36 .12
NP-13	917- 966	24 .48	10 .26	12 .25	14 .21	8 .21	0 .20	34 .19	33 .16	-1 .15	-13 .14	-4 .12
NP-13	927- 976	0 .39	10 .36	-6 .34	24 .33	-4 .26	-16 .21	14 .20	-14 .19	12 .19	8 .12	-12 .09
NP-13	937- 986	0 .37	10 .37	-6 .36	12 .24	-4 .22	-18 .19	-28 .18	-12 .18	-24 .18	14 .17	-27 .17
NP-13	947- 996	0 .39	-6 .35	-28 .27	-16 .21	-38 .21	-4 .20	-25 .18	-43 .16	-40 .16	-14 .15	-18 .13
NP-13	951-1000	-28 .36	-6 .34	0 .33	-38 .32	-25 .27	-16 .24	-41 .21	-44 .18	-4 .16	-43 .15	-14 .13
NP-17	928- 977	0 .47	-17 .29	-16 .19	8 .16	-15 .16	-12 .15	-14 .14	22 .13	18 .13	10 .11	6 .10
NP-17	938- 987	0 .44	-15 .27	-34 .26	-12 .25	-28 .20	-9 .16	-25 .15	6 .14	12 .11	13 .10	-30 .10
NP-17	948- 997	0 .53	-28 .33	-22 .21	-43 .20	-35 .18	-24 .18	-9 .18	-17 .17	-12 .12	-4 .10	-34 .09
NP-17	951-1000	0 .57	-22 .25	-28 .22	-17 .21	-43 .20	-24 .19	-9 .15	-34 .14	-12 .13	-4 .12	-47 .10
NP-18	926- 975	0 .55	15 .27	13 .23	-3 .22	-17 .19	-15 .16	11 .12	-10 .11	-13 .08	-12 .07	10 .06
NP-18	936- 985	0 .58	-24 .34	13 .29	-27 .22	15 .21	-12 .21	-25 .19	-30 .18	-10 .16	-22 .13	3 .13
NP-18	946- 995	0 .56	-25 .27	-23 .26	-37 .23	4 .22	-12 .22	-27 .21	-24 .21	-1 .20	-38 .19	-39 .15
NP-18	951-1000	0 .55	-23 .36	-25 .32	-1 .25	-37 .24	-38 .22	-35 .20	-12 .20	-24 .20	-13 .13	-39 .12
NP-A	935- 984	0 .53	-25 .21	1 .19	14 .18	12 .16	-24 .16	-11 .14	10 .14	-18 .14	-16 .11	-12 .10
NP-A	945- 994	0 .53	-16 .25	-36 .20	-25 .18	-14 .12	-13 .12	-38 .11	3 .10	-41 .09	1 .09	-27 .08
NP-A	951-1000	0 .46	-16 .34	-28 .31	-25 .18	-38 .17	-29 .17	-13 .17	-47 .15	-22 .14	-41 .11	-11 .10
NP-B	949- 998	-2 .61	-41 .24	-8 .24	-40 .23	-18 .23	-38 .18	-20 .17	-27 .16	-30 .13	-15 .13	2 .12
NP-B	951-1000	-2 .60	-40 .31	-18 .31	-27 .24	-8 .20	-41 .17	-14 .14	-20 .13	-30 .13	-6 .13	-34 .12
NP-C	881- 930	27 .33	65 .31	28 .29	66 .26	30 .24	49 .21	64 .21	29 .19	54 .17	53 .16	38 .14
NP-C	891- 940	14 .34	38 .30	49 .26	37 .26	13 .21	28 .18	53 .17	27 .16	54 .15	50 .15	26 .13
NP-C	901- 950	38 .30	12 .29	49 .28	14 .24	37 .22	15 .21	13 .20	28 .16	31 .15	26 .12	10 .11
NP-C	911- 960	23 .34	13 .30	38 .24	-5 .22	37 .20	17 .15	2 .13	1 .13	-1 .13	11 .12	-7 .09
NP-C	921- 970	23 .31	2 .30	-1 .27	-5 .25	-11 .18	-7 .18	-17 .17	11 .16	13 .15	7 .14	-14 .12
NP-C	931- 980	-1 .35	-7 .29	9 .23	-17 .21	11 .18	-23 .17	-26 .15	-25 .15	-15 .14	-5 .13	7 .12
NP-C	941- 990	-7 .36	-1 .34	-37 .32	-19 .32	-17 .25	-28 .23	9 .16	-13 .15	6 .14	-22 .13	-26 .13
NP-C	951-1000	-1 .36	-7 .32	-17 .29	-23 .27	-26 .27	-37 .25	-28 .20	-19 .19	-40 .17	-45 .16	-13 .16
NP-D	925- 974	0 .49	-13 .43	12 .26	23 .25	24 .22	-4 .17	-15 .17	11 .17	22 .14	2 .14	-6 .13
NP-D	935- 984	0 .57	12 .29	-30 .29	-15 .29	-13 .24	-26 .23	-6 .22	-28 .22	-27 .19	-4 .18	-2 .17
NP-D	945- 994	0 .61	-30 .30	-6 .29	-39 .29	-26 .27	-4 .24	-28 .17	-12 .14	6 .13	-15 .10	-27 .10
NP-D	951-1000	0 .65	-26 .31	-39 .29	-4 .26	-6 .20	-12 .19	-32 .18	-30 .18	-22 .18	-16 .13	-43 .12

CHART 1A continued

SERIES	COUNTED SEGMENT	CORR ADD # 1	CORR ADD # 2	CORR ADD # 3	CORR ADD # 4	CORR ADD # 5	CORR ADD # 6	CORR ADD # 7	CORR ADD # 8	CORR ADD # 9	CORR ADD # 10	CORR ADD # 11
NP-F	888- 937	16 .33	20 .22	46 .22	29 .17	50 .16	35 .15	63 .15	33 .15	34 .14	23 .13	57 .13
NP-F	898- 947	16 .33	41 .28	37 .23	25 .22	20 .22	46 .20	21 .17	35 .16	36 .16	18 .15	45 .15
NP-F	908- 957	37 .31	20 .25	25 .23	35 .22	21 .22	41 .19	-1 .17	16 .15	34 .15	-2 .14	-4 .14
NP-F	918- 967	-14 .29	-2 .27	20 .25	25 .21	23 .18	10 .17	9 .16	21 .15	-4 .15	-3 .10	19 .06
NP-F	928- 977	-16 .48	20 .38	-2 .32	-14 .30	10 .26	-18 .21	21 .18	-3 .18	8 .16	4 .15	9 .14
NP-F	938- 987	-16 .45	-2 .43	-14 .26	10 .25	-28 .23	-18 .22	-31 .20	-32 .18	-12 .18	7 .12	-3 .12
NP-F	948- 997	-2 .26	-14 .26	-28 .19	3 .17	-24 .16	-12 .16	0 .15	-35 .15	-26 .12	-39 .12	-13 .12
NP-F	951-1000	-2 .29	-14 .25	-24 .24	0 .24	-38 .18	-12 .16	-23 .16	-26 .13	-40 .13	-35 .13	-32 .12
NP-G	945- 994	0 .45	-6 .22	-26 .22	-30 .17	-10 .16	-1 .16	-18 .15	6 .13	-27 .13	-39 .13	4 .11
NP-G	951-1000	0 .49	-22 .22	-18 .19	-1 .19	-24 .16	-26 .15	-7 .13	-36 .13	-10 .12	-32 .12	-30 .11
NP-26	954-1000	-29 .24	-17 .23	-28 .21	-44 .20	-7 .20	-46 .17	-47 .17	-10 .16	0 .15	-43 .14	-31 .11
NP-33	945- 994	-4 .25	-10 .24	-29 .24	-27 .23	-40 .20	6 .19	0 .15	-16 .14	-2 .13	-28 .13	-31 .13
NP-33	951-1000	0 .31	-29 .25	-4 .22	-32 .22	-40 .21	-16 .17	-10 .15	-42 .13	-46 .13	-43 .13	-22 .12
NP-36	927- 976	-13 .26	20 .24	-8 .23	22 .17	4 .17	-5 .16	-2 .16	21 .12	-11 .12	9 .12	17 .12
NP-36	937- 986	-18 .40	-16 .38	-32 .26	-5 .26	-6 .20	-2 .19	4 .19	-7 .16	9 .13	-20 .13	-29 .13
NP-36	947- 996	-18 .40	-12 .24	-30 .23	4 .22	-7 .22	-6 .20	-2 .18	-16 .17	-22 .16	-34 .14	-5 .13
NP-36	951-1000	-18 .37	-12 .24	-2 .22	-7 .21	-22 .19	-6 .17	-16 .17	-30 .15	-20 .15	-41 .13	-34 .11
NP-38	939- 988	0 .66	-24 .28	12 .24	-21 .22	4 .19	-26 .19	-15 .19	-25 .15	-27 .13	-12 .13	-6 .11
NP-38	949- 998	0 .71	-39 .43	-36 .28	-23 .26	-22 .23	-12 .17	-45 .14	-21 .13	-43 .11	-26 .11	-42 .10
NP-38	951-1000	0 .76	-39 .33	-36 .30	-38 .22	-22 .19	-15 .15	-26 .15	-32 .15	-12 .14	-23 .13	-25 .11
NP-40	939- 988	-17 .52	-5 .36	-30 .25	11 .22	-32 .20	-15 .17	7 .17	-1 .14	-19 .14	-13 .13	0 .12
NP-40	949- 998	-17 .49	-5 .32	-41 .28	-1 .24	-38 .17	-15 .17	-19 .14	-29 .12	-30 .12	0 .12	-13 .11
NP-40	951-1000	-17 .47	-5 .32	-1 .25	-41 .24	-15 .15	-29 .14	-30 .12	-13 .12	-19 .11	0 .10	-28 .10
NP-42	932- 981	-4 .41	-8 .27	-10 .21	-2 .20	-16 .19	14 .19	-26 .18	-20 .15	-23 .14	-5 .12	18 .11
NP-42	942- 991	-16 .37	-4 .33	-5 .25	-14 .24	-2 .22	-29 .19	-8 .17	-10 .16	-32 .13	-20 .07	-38 .07
NP-42	951-1000	-16 .25	-2 .25	-14 .22	-40 .19	-5 .17	-8 .16	-4 .16	-37 .16	-10 .16	-1 .13	-39 .11
NP-43	926- 975	-13 .29	17 .23	-15 .19	-8 .18	-2 .17	-7 .16	23 .13	9 .13	7 .11	20 .10	-5 .10
NP-43	936- 985	-7 .37	-32 .26	-26 .21	-13 .21	11 .18	-25 .16	-28 .14	-11 .13	-9 .13	-2 .12	-19 .10
NP-43	946- 995	-7 .37	-11 .36	-32 .20	-41 .18	-2 .16	-12 .13	-8 .11	-5 .09	-28 .09	-18 .09	-29 .08
NP-43	951-1000	-7 .37	-11 .34	-2 .26	-41 .16	-29 .16	-12 .13	-40 .12	-37 .11	-43 .11	-24 .10	-18 .10
NP-44	933- 982	4 .28	-18 .27	-13 .26	14 .25	15 .19	18 .14	-20 .13	-8 .11	12 .10	-12 .10	17 .09
NP-44	943- 992	-21 .38	4 .28	-24 .27	-37 .25	-12 .24	-38 .18	-8 .17	-34 .17	-36 .14	-18 .14	-39 .13
NP-44	951-1000	-38 .33	-25 .30	-24 .22	-2 .21	-36 .20	-35 .20	-8 .20	-12 .16	-9 .12	-21 .09	-19 .08
NP49A	943- 992	-1 .41	-5 .32	-16 .21	-36 .21	-11 .19	-30 .13	-29 .10	-6 .09	-37 .09	-38 .09	-2 .09
NP49A	951-1000	-1 .53	-5 .39	-11 .25	-26 .23	-37 .21	-22 .19	-40 .16	-33 .15	-6 .13	-43 .11	-28 .10
NP-52	941- 990	2 .27	4 .24	-10 .21	-17 .19	-12 .17	-13 .17	-37 .16	-11 .15	-36 .14	-1 .12	0 .11
NP-52	951-1000	-12 .28	-34 .27	-28 .21	-26 .15	-10 .15	-17 .14	-13 .14	-4 .12	-11 .12	-40 .11	-38 .11
NP-60	958-1000	-38 .38	-25 .30	-27 .26	-9 .24	-16 .19	-49 .15	-52 .15	0 .14	-21 .14	-36 .13	-8 .13
NP-71	931- 980	-4 .38	-16 .26	-10 .24	8 .24	-14 .23	-3 .23	-2 .23	2 .22	12 .21	-13 .20	20 .14
NP-71	941- 990	-16 .38	-4 .36	-2 .28	8 .27	-28 .26	2 .23	-3 .20	-10 .14	-14 .14	-15 .12	0 .09
NP-71	951-1000	-16 .43	-28 .36	-40 .33	-4 .32	-3 .25	-15 .20	-32 .19	-2 .18	-31 .12	-27 .11	-10 .11
NP-72	941- 990	-35 .21	0 .20	-30 .19	10 .19	-14 .18	-29 .18	-8 .17	8 .16	-20 .16	-17 .15	4 .14
NP-72	951-1000	-1 .27	-23 .21	-26 .21	-35 .19	-29 .19	-38 .18	-37 .17	-44 .15	-2 .15	0 .14	-14 .14
NP-73	941- 990	10 .31	-16 .28	-36 .26	2 .22	-12 .21	-24 .20	6 .20	-6 .18	-35 .15	-10 .14	-22 .13
NP-73	951-1000	-24 .38	-22 .25	-36 .20	-35 .20	-6 .19	-10 .16	-2 .14	-28 .14	-19 .14	-16 .14	-1 .12

CHART 1B

PART 2: CORRELATIONS WITH NP PITCH PINE FLOATING MASTER SERIES OF ALL SEGMENTS AS ALIGNED AND MEASURED

32-YEAR CUBIC SPLINE FILTER; CORRELATIONS OF 50-YEAR SEGMENTS LAGGED 10 YEARS

0SEQ		SERIES		INTERVAL		CORRELATION UNDER 0.3281;										CORRELATION HIGHER AT OTHER POSITION										0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0.3281;		0	
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NP PITCH PINE VS NP PITCH PINE (LATER PHASES) ALIGNED
50-YEAR SEGMENTS LAGGED 10 YEARS

SERIES	COUNTED SEGMENT	CORR ADD # 1	CORR ADD # 2	CORR ADD # 3	CORR ADD # 4	CORR ADD # 5	CORR ADD # 6	CORR ADD # 7	CORR ADD # 8	CORR ADD # 9	CORR ADD #10	CORR ADD #11
NP-01	955-1000	-17 .43	-3 .34	-18 .25	-4 .22	-11 .13	-20 .13	3 .11	-28 .09	-9 .09	-23 .08	-5 .07
NP-02	964-1000	-18 .43	-16 .31	-3 .27	-20 .25	-32 .20	-8 .16	2 .15	-33 .15	-12 .15	-19 .14	-38 .14
NP-03	955-1000	-10 .38	1 .24	3 .16	-22 .15	-21 .14	-27 .12	-13 .10	-2 .09	-5 .08	-11 .08	-25 .08
NP-04	914- 963	12 .30	28 .27	18 .21	40 .20	22 .15	31 .13	30 .13	32 .08	29 .07	36 .07	27 .06
NP-04	924- 973	6 .34	10 .30	28 .28	18 .24	2 .20	30 .19	12 .19	16 .10	4 .09	29 .06	21 .04
NP-04	934- 983	6 .43	18 .22	1 .21	10 .19	0 .16	2 .16	-6 .09	-2 .09	4 .08	14 .05	7 .04
NP-04	944- 993	6 .45	-18 .24	-6 .23	0 .18	2 .16	10 .16	1 .14	-10 .14	-2 .11	-9 .09	-8 .09
NP-04	951-1000	-24 .27	-6 .27	1 .22	-21 .21	-23 .19	-22 .18	-10 .14	-8 .09	2 .08	-18 .07	-25 .05
NP-05	935- 984	5 .24	19 .23	7 .18	2 .17	-9 .15	13 .14	8 .12	6 .06	-5 .05	-7 .03	14 .01
NP-05	945- 994	-19 .32	7 .17	3 .14	-8 .13	2 .12	-17 .11	1 .10	-9 .09	5 .08	-3 .08	-2 .04
NP-05	951-1000	-19 .35	-20 .26	-17 .22	2 .19	-3 .17	3 .17	-22 .17	1 .14	-23 .10	-5 .07	-11 .07
NP-06	920- 969	18 .32	32 .28	10 .21	17 .16	7 .16	30 .15	6 .15	31 .14	12 .14	34 .13	23 .12
NP-06	930- 979	18 .26	19 .26	4 .25	6 .24	17 .20	10 .20	5 .20	12 .18	3 .10	23 .10	11 .09
NP-06	940- 989	-10 .32	4 .31	5 .27	6 .27	12 .19	10 .18	-11 .12	-13 .12	3 .09	11 .07	-9 .06
NP-06	950- 999	-10 .25	4 .23	-21 .18	-24 .18	-12 .14	2 .13	-16 .13	-5 .12	-20 .12	-11 .11	-22 .09
NP-06	951-1000	-12 .24	-20 .20	-10 .19	-5 .16	2 .15	-21 .14	-13 .13	-24 .11	-6 .09	-22 .08	-11 .07
NP-07	930- 979	5 .29	8 .24	17 .20	3 .19	-3 .17	19 .13	18 .08	11 .07	6 .07	21 .07	16 .07
NP-07	940- 989	-12 .26	-9 .25	5 .25	7 .23	3 .23	-3 .17	8 .15	-14 .12	6 .09	4 .08	11 .04
NP-07	950- 999	-17 .27	-3 .23	-11 .22	3 .18	-10 .14	-5 .13	-4 .13	-12 .12	4 .10	2 .09	-16 .08
NP-07	951-1000	-12 .23	-3 .22	-17 .21	-11 .16	-5 .14	-19 .14	-25 .12	2 .12	-4 .11	3 .10	-20 .10
NP-08	904- 953	32 .30	26 .18	34 .16	47 .15	40 .13	41 .12	43 .12	31 .06	35 .04	48 .03	49 .03
NP-08	914- 963	13 .30	32 .19	34 .17	40 .16	19 .16	26 .14	16 .10	15 .06	33 .06	20 .06	35 .04
NP-08	924- 973	7 .33	19 .27	8 .16	4 .09	24 .07	13 .06	23 .06	6 .06	20 .05	2 .05	16 .05
NP-08	934- 983	-5 .30	19 .28	7 .27	5 .19	18 .13	11 .11	12 .11	6 .08	8 .08	2 .07	-7 .06
NP-08	944- 993	7 .32	-5 .17	-9 .16	-8 .15	5 .14	-18 .12	-17 .11	-7 .10	-1 .06	6 .05	2 .02
NP-08	951-1000	-20 .24	-9 .24	-17 .21	-3 .18	-25 .16	-19 .15	-23 .15	-22 .13	-5 .13	2 .11	-8 .06
NP-09	925- 974	7 .35	19 .20	20 .19	9 .16	8 .11	13 .11	11 .10	28 .09	29 .06	18 .06	24 .03
NP-09	935- 984	7 .41	19 .30	-9 .22	8 .18	5 .13	13 .10	6 .09	9 .07	11 .06	-5 .05	12 .02
NP-09	945- 994	7 .38	-17 .20	-15 .19	-13 .15	-19 .14	2 .12	-9 .11	8 .10	6 .09	-5 .09	-14 .05
NP-09	951-1000	-17 .31	-19 .23	2 .18	-5 .17	-12 .11	-13 .11	-4 .09	-20 .08	-11 .07	-3 .06	-15 .05
NP-10	930- 979	6 .43	3 .26	18 .23	23 .17	1 .15	12 .15	22 .10	19 .06	16 .05	11 .03	-2 .03
NP-10	940- 989	6 .35	-10 .24	3 .22	-12 .19	-13 .17	4 .16	-14 .14	-11 .13	5 .11	1 .09	7 .05
NP-10	950- 999	-12 .28	-11 .25	-10 .24	3 .20	-20 .14	-24 .14	4 .13	-18 .13	2 .10	1 .09	-4 .08
NP-10	951-1000	-12 .32	-11 .24	-10 .22	-20 .20	3 .17	-18 .14	-24 .12	2 .11	1 .09	-13 .08	-4 .08
NP-12	929- 978	5 .44	-3 .33	17 .22	16 .15	10 .14	2 .12	11 .11	9 .07	25 .06	3 .01	14 .01
NP-12	939- 988	5 .43	-11 .12	-7 .10	-9 .10	2 .09	-4 .09	-6 .09	3 .08	-3 .07	10 .07	11 .07
NP-12	949- 998	5 .29	-11 .23	-10 .19	-5 .13	-13 .11	-17 .08	1 .08	2 .07	-19 .06	-7 .05	-20 .04
NP-12	951-1000	-11 .26	-25 .19	-19 .16	-5 .15	-10 .14	-13 .13	1 .11	2 .09	-12 .09	-17 .07	-20 .07
NP-13	907- 956	43 .31	44 .25	45 .21	30 .15	21 .13	29 .12	19 .11	31 .11	36 .10	40 .09	41 .07
NP-13	917- 966	15 .38	29 .26	16 .25	31 .15	14 .14	30 .12	17 .11	13 .11	36 .10	21 .09	37 .09
NP-13	927- 976	15 .24	1 .24	16 .22	7 .19	13 .16	14 .11	2 .10	21 .09	18 .09	-1 .08	17 .07
NP-13	937- 986	1 .25	-5 .22	15 .21	16 .19	14 .18	7 .15	5 .14	-7 .13	2 .12	-9 .12	13 .11
NP-13	947- 996	-5 .22	-9 .19	3 .18	-11 .17	2 .14	1 .12	5 .12	-18 .09	6 .08	-12 .07	-3 .07
NP-13	951-1000	-23 .40	-25 .25	-9 .22	-12 .16	-5 .13	-6 .13	2 .12	3 .12	-3 .11	-20 .11	1 .10
NP-17	928- 977	7 .28	-1 .22	15 .20	24 .16	25 .13	16 .13	17 .13	19 .11	11 .10	-2 .09	12 .09
NP-17	938- 987	7 .36	15 .23	16 .13	-2 .12	1 .11	-4 .10	11 .09	-9 .07	-5 .06	8 .04	-8 .03
NP-17	948- 997	2 .23	-17 .21	-4 .19	-11 .14	-21 .14	-5 .13	-20 .13	-12 .07	-22 .06	-19 .04	-9 .04
NP-17	951-1000	2 .23	-17 .19	-20 .17	-5 .16	-4 .14	-12 .12	-21 .10	-11 .07	-19 .06	-22 .05	-3 .05
NP-18	926- 975	17 .34	16 .25	8 .21	5 .19	19 .18	18 .16	7 .14	2 .11	6 .09	20 .07	3 .07
NP-18	936- 985	17 .32	4 .31	18 .30	-4 .22	-9 .21	5 .21	16 .14	-5 .14	7 .10	2 .08	11 .06
NP-18	946- 995	-5 .29	4 .22	-11 .18	-8 .16	-19 .14	2 .12	-20 .10	-16 .10	6 .08	5 .08	-17 .08
NP-18	951-1000	-5 .28	-19 .25	-11 .22	-17 .18	2 .18	-20 .17	-18 .14	-4 .14	-12 .10	-6 .08	-22 .06
NP-A	935- 984	-8 .28	7 .27	-5 .25	6 .18	-7 .18	5 .17	-9 .17	19 .16	11 .14	13 .06	3 .06
NP-A	945- 994	-9 .31	6 .28	7 .21	5 .21	-5 .18	-8 .18	-10 .17	-7 .16	-18 .10	3 .09	-11 .07
NP-A	951-1000	-9 .40	-23 .24	-10 .19	3 .17	-21 .13	-8 .12	-20 .11	-5 .10	-6 .09	-18 .08	-25 .07
NP-B	949- 998	0 .38	-1 .26	4 .22	1 .17	-7 .17	5 .15	-13 .15	-11 .13	3 .11	-10 .11	-8 .08
NP-B	951-1000	0 .37	-25 .30	-1 .25	-11 .23	1 .20	3 .19	-7 .12	-8 .11	-13 .11	-10 .07	-21 .06
NP-C	881- 930	45 .41	56 .32	69 .21	71 .17	55 .16	68 .16	73 .15	72 .14	54 .12	57 .12	60 .11
NP-C	891- 940	56 .31	45 .30	57 .25	55 .20	46 .17	40 .12	35 .08	54 .07	60 .06	39 .05	42 .03
NP-C	901- 950	27 .22	45 .21	44 .16	41 .12	25 .11	47 .08	43 .06	46 .06	26 .03	32 .03	40 .03
NP-C	911- 960	42 .25	15 .19	20 .15	30 .11	33 .11	36 .09	28 .08	18 .05	35 .05	21 .04	34 .03
NP-C	921- 970	15 .30	14 .28	12 .20	30 .16	20 .16	6 .14	28 .14	33 .10	9 .09	18 .06	21 .05
NP-C	931- 980	14 .21	6 .20	0 .19	12 .17	20 .15	3 .12	5 .09	15 .09	9 .07	17 .06	18 .04
NP-C	941- 990	-6 .29	0 .21	-12 .20	-11 .17	12 .16	4 .14	1 .13	-9 .13	13 .11	-8 .06	6 .06
NP-C	951-1000	-24 .36	-12 .19	-6 .17	-10 .16	-15 .12	-19 .10	0 .09	1 .09	-11 .09	2 .07	-18 .06
NP-D	925- 974	19 .25	29 .21	7 .21	18 .21	1 .17	2 .16	27 .16	13 .12	15 .10	26 .10	28 .09
NP-D	935- 984	7 .31	1 .26	19 .21	0 .15	3 .14	-7 .13	-2 .10	4 .09	15 .09	6 .07	2 .07
NP-D	945- 994	1 .37	7 .29	-17 .20	-19 .20	-8 .19	2 .16	0 .14	-15 .12	3 .11	5 .10	-14 .08
NP-D	951-1000	1 .31	-20 .25	-17 .23	-19 .20	-8 .16	-23 .15	2 .12	-15 .12	0 .12	3 .11	-9 .09

CHART 2A continued

SERIES	COUNTED SEGMENT	CORR										
		ADD # 1	ADD # 2	ADD # 3	ADD # 4	ADD # 5	ADD # 6	ADD # 7	ADD # 8	ADD # 9	ADD #10	ADD #11
NP-F	888- 937	52 .22	48 .22	57 .21	42 .20	51 .18	40 .16	56 .15	53 .14	45 .11	60 .09	59 .06
NP-F	898- 947	56 .31	42 .27	29 .23	28 .22	44 .20	32 .12	43 .11	52 .10	53 .10	45 .07	51 .05
NP-F	908- 957	42 .34	28 .30	27 .28	43 .28	26 .23	29 .15	44 .15	41 .12	32 .07	25 .06	24 .05
NP-F	918- 967	27 .30	28 .30	26 .24	12 .21	15 .14	14 .14	9 .13	29 .13	11 .05	17 .05	32 .04
NP-F	928- 977	26 .22	1 .18	-1 .16	15 .15	12 .10	4 .09	17 .08	16 .07	3 .05	6 .04	11 .04
NP-F	938- 987	-5 .31	0 .21	-10 .19	1 .19	3 .18	-8 .16	-7 .14	2 .08	10 .08	9 .07	15 .02
NP-F	948- 997	-21 .25	-9 .25	-19 .19	-17 .15	0 .15	-22 .14	-16 .13	2 .13	-11 .12	1 .12	-8 .10
NP-F	951-1000	-19 .23	-9 .22	-21 .21	-17 .15	-1 .13	2 .13	0 .12	1 .12	-11 .12	-20 .11	-22 .11
NP-G	945- 994	-19 .32	1 .28	-15 .22	-17 .17	4 .17	7 .13	-14 .13	-11 .12	3 .11	-18 .06	-7 .02
NP-G	951-1000	-19 .35	1 .32	-17 .28	-20 .18	-11 .18	-14 .08	-15 .06	-16 .05	3 .05	-18 .05	-5 .04
NP-26	954-1000	-5 .25	-10 .25	-21 .24	-12 .20	-4 .15	-3 .15	3 .11	-9 .11	-13 .09	-18 .06	-22 .05
NP-33	945- 994	1 .33	3 .33	2 .27	-14 .17	-5 .15	-13 .12	4 .11	9 .10	-11 .07	0 .04	-18 .02
NP-33	951-1000	1 .32	-20 .29	2 .29	3 .25	-21 .20	-5 .14	-13 .09	0 .07	-12 .06	-3 .05	-14 .05
NP-36	927- 976	0 .79	12 .20	11 .19	2 .16	20 .12	3 .12	26 .08	24 .07	-1 .06	22 .04	21 .03
NP-36	937- 986	0 .65	-1 .25	-11 .22	6 .16	-9 .16	15 .11	1 .11	13 .11	12 .08	11 .06	8 .06
NP-36	947- 996	0 .63	-1 .37	1 .30	-15 .18	-11 .15	6 .13	-16 .10	-19 .09	-9 .07	-21 .06	-20 .05
NP-36	951-1000	0 .63	-1 .34	1 .27	-11 .25	-15 .14	-22 .13	-19 .10	-16 .10	-21 .06	-9 .05	-14 .01
NP-38	939- 988	7 .36	-13 .28	-8 .26	-5 .23	4 .22	-11 .18	5 .10	-10 .09	-4 .08	6 .06	-9 .05
NP-38	949- 998	-17 .23	4 .18	-5 .18	-11 .18	-4 .16	-16 .16	-9 .16	5 .14	-10 .13	-8 .13	-13 .12
NP-38	951-1000	-19 .22	-17 .18	-9 .18	-5 .16	-8 .10	-16 .08	-4 .07	-20 .07	-13 .07	-10 .06	2 .06
NP-40	939- 988	2 .79	3 .20	-6 .19	-10 .18	10 .10	-11 .10	-12 .10	-9 .08	-4 .07	14 .07	-13 .04
NP-40	949- 998	2 .70	-12 .32	-10 .25	3 .25	-6 .23	1 .19	-13 .19	-22 .16	-11 .15	-14 .05	-23 .03
NP-40	951-1000	2 .70	3 .30	-12 .27	-10 .25	-6 .22	-11 .22	1 .21	-13 .17	-22 .15	-14 .09	-23 .02
NP-42	932- 981	3 .78	2 .22	0 .20	19 .20	17 .14	18 .09	-5 .09	11 .08	6 .06	4 .00	15 .00
NP-42	942- 991	3 .74	2 .32	-13 .17	-9 .16	4 .16	-5 .12	-14 .10	-3 .07	1 .04	11 .01	-12 .01
NP-42	951-1000	3 .66	2 .35	-13 .20	-5 .12	-25 .11	1 .11	-9 .10	-17 .09	-19 .07	-12 .07	-4 .06
NP-43	926- 975	0 .89	3 .22	22 .14	8 .10	14 .10	20 .09	24 .09	15 .08	9 .06	16 .04	28 .04
NP-43	936- 985	0 .79	15 .21	-2 .14	-10 .14	9 .12	14 .10	3 .08	-3 .07	6 .05	13 .04	1 .03
NP-43	946- 995	0 .61	-20 .27	1 .22	8 .16	-1 .15	-5 .13	-6 .13	2 .09	-15 .08	-19 .07	-4 .06
NP-43	951-1000	0 .62	-5 .26	1 .21	-21 .20	-20 .20	-19 .17	-6 .15	-1 .12	-4 .09	-18 .08	-22 .07
NP-44	933- 982	-5 .76	6 .22	15 .19	-3 .15	-2 .14	0 .13	17 .11	21 .11	-6 .09	7 .08	14 .06
NP-44	943- 992	-5 .64	-6 .15	-8 .14	6 .11	-2 .11	7 .09	-4 .09	-17 .08	-1 .08	-3 .07	-16 .06
NP-44	951-1000	-5 .59	-6 .27	-14 .19	-1 .17	-22 .15	-25 .15	-4 .15	-13 .12	-19 .10	-7 .07	-20 .03
NP49A	943- 992	-10 .29	5 .26	3 .22	1 .21	4 .13	6 .11	-4 .11	2 .09	-5 .08	-15 .07	9 .04
NP49A	951-1000	-10 .28	-20 .23	-9 .22	-18 .21	3 .21	-25 .21	-4 .16	-24 .15	1 .11	2 .09	0 .08
NP-52	941- 990	-7 .33	7 .32	6 .26	-9 .22	9 .20	-8 .20	1 .18	8 .15	-5 .14	-15 .09	-6 .06
NP-52	951-1000	-8 .27	-9 .24	-7 .22	1 .21	-21 .15	-6 .15	-15 .11	-10 .09	-24 .07	-5 .05	-19 .05
NP-60	958-1000	-8 .34	-23 .27	-7 .26	-30 .22	-20 .21	-5 .20	-31 .19	-19 .18	-3 .14	-27 .12	-18 .10
NP-71	931- 980	3 .75	4 .25	9 .12	0 .11	19 .10	12 .09	17 .09	18 .08	15 .08	20 .05	21 .05
NP-71	941- 990	3 .72	4 .33	-13 .23	-11 .21	-9 .19	2 .19	-8 .10	-5 .07	-12 .06	9 .04	-10 .02
NP-71	951-1000	3 .70	-9 .28	-25 .21	2 .19	-21 .14	-11 .14	-12 .14	-8 .13	-13 .12	-15 .12	-24 .07
NP-72	941- 990	-10 .40	-7 .33	-1 .26	5 .19	6 .19	10 .14	2 .12	-12 .09	11 .08	3 .05	-2 .04
NP-72	951-1000	-18 .34	-19 .34	-10 .30	-11 .23	-22 .16	-2 .11	-3 .11	3 .09	-13 .09	-23 .08	-1 .03
NP-73	941- 990	7 .26	-5 .21	8 .20	-10 .14	-9 .12	5 .12	-8 .10	-13 .07	3 .06	1 .06	-1 .05
NP-73	951-1000	-21 .25	-17 .20	-16 .18	0 .14	-9 .12	-18 .12	-10 .11	-11 .10	-5 .09	-19 .08	-1 .08

CHART 28

PART 2: CORRELATIONS WITH NP PITCH PINE (LATER) MASTER SERIES OF ALL SEGMENTS AS ALIGNED AND MEASURED

32-YEAR CUBIC SPLINE FILTER; CORRELATIONS OF 50-YEAR SEGMENTS LAGGED 10 YEARS

[illegible]

CHART 3

PART 8: DATE ADJUSTMENT FOR BEST MATCHES FOR COUNTED OR UNKNOWN SERIES

Tucson-Mendoza-Hamburg-Lamont Proglib

NP PITCH PINE VS DEERFIELD PITCH PINE MASTER
50-YEAR SEGMENTS LAGGED 10 YEARS

SERIES	COUNTED SEGMENT	CORR ADD # 1	CORR ADD # 2	CORR ADD # 3	CORR ADD # 4	CORR ADD # 5	CORR ADD # 6	CORR ADD # 7	CORR ADD # 8	CORR ADD # 9	CORR ADD #10	CORR ADD #11
NP-01	955-1000	603 .41	667 .38	720 .37	772 .36	718 .33	794 .32	639 .32	732 .30	809 .30	745 .28	785 .26
NP-02	964-1000	804 .59	828 .49	619 .43	718 .42	574 .36	709 .33	853 .32	814 .32	812 .31	833 .29	600 .29
NP-03	955-1000	815 .47	749 .45	625 .43	606 .35	726 .35	660 .35	695 .34	577 .34	671 .33	834 .30	641 .29
NP-04	914- 963	842 .54	887 .53	830 .44	713 .39	793 .35	717 .34	854 .34	701 .34	795 .32	667 .29	619 .28
NP-04	924- 973	717 .55	842 .47	830 .43	793 .39	875 .34	795 .33	779 .31	656 .30	711 .29	735 .29	753 .28
NP-04	934- 983	717 .56	842 .43	830 .42	663 .42	687 .36	779 .36	594 .33	793 .31	753 .29	727 .26	832 .26
NP-04	944- 993	717 .47	663 .37	687 .36	731 .34	769 .34	779 .33	594 .29	705 .29	729 .28	735 .27	824 .27
NP-04	951-1000	779 .44	675 .40	775 .39	717 .37	753 .35	705 .33	713 .32	830 .31	727 .28	731 .28	769 .27
NP-05	935- 984	718 .67	690 .37	634 .33	760 .33	635 .32	595 .32	636 .30	614 .30	756 .29	813 .28	697 .27
NP-05	945- 994	718 .67	595 .34	680 .32	697 .32	792 .32	805 .31	659 .29	598 .29	760 .25	676 .25	854 .24
NP-05	951-1000	718 .67	595 .38	792 .33	680 .32	805 .29	826 .29	771 .26	659 .26	789 .26	684 .25	766 .24
NP-06	920- 969	717 .63	795 .42	771 .38	832 .36	700 .34	759 .33	747 .30	818 .30	613 .29	704 .27	842 .27
NP-06	930- 979	717 .64	596 .38	663 .36	769 .36	795 .34	598 .34	793 .32	742 .32	639 .29	700 .29	863 .28
NP-06	940- 989	717 .64	742 .40	795 .38	598 .31	663 .28	597 .27	652 .27	596 .26	793 .26	861 .26	632 .25
NP-06	950- 999	717 .57	742 .46	583 .33	795 .30	700 .30	853 .28	775 .28	706 .27	658 .27	625 .27	704 .27
NP-06	951-1000	717 .57	742 .47	583 .37	853 .34	795 .31	658 .28	706 .28	793 .27	740 .27	618 .26	769 .26
NP-07	930- 979	819 .47	794 .40	732 .38	682 .37	598 .36	770 .35	772 .31	600 .30	702 .30	664 .29	788 .29
NP-07	940- 989	744 .44	819 .36	718 .35	598 .35	862 .34	600 .33	603 .33	833 .32	831 .32	766 .31	713 .29
NP-07	950- 999	718 .44	819 .38	603 .37	714 .35	742 .32	684 .31	766 .29	583 .28	654 .28	833 .27	646 .26
NP-07	951-1000	718 .47	819 .34	742 .33	583 .33	654 .32	603 .31	842 .30	676 .28	684 .28	646 .27	771 .27
NP-08	904- 953	689 .45	654 .40	748 .38	795 .37	655 .36	705 .31	743 .31	718 .27	698 .26	817 .24	784 .24
NP-08	914- 963	689 .46	634 .43	654 .41	705 .36	718 .33	797 .30	748 .30	843 .29	669 .29	655 .28	819 .26
NP-08	924- 973	718 .49	669 .36	843 .35	766 .35	819 .31	730 .31	743 .31	634 .30	648 .30	705 .29	633 .28
NP-08	934- 983	718 .44	669 .33	819 .31	730 .28	817 .27	766 .27	743 .27	634 .26	676 .26	705 .26	801 .25
NP-08	944- 993	718 .51	770 .32	730 .32	613 .29	612 .29	676 .29	653 .26	807 .26	705 .26	805 .26	806 .25
NP-08	951-1000	718 .39	758 .31	805 .31	680 .30	676 .30	780 .30	807 .30	732 .28	759 .27	825 .27	705 .26
NP-09	925- 974	718 .70	864 .35	657 .35	843 .35	690 .34	794 .33	606 .33	798 .31	770 .30	714 .28	655 .27
NP-09	935- 984	718 .77	690 .35	843 .33	657 .32	866 .32	714 .31	864 .29	664 .29	831 .28	760 .27	807 .27
NP-09	945- 994	718 .70	807 .33	714 .31	771 .31	809 .29	831 .29	676 .28	842 .27	648 .27	584 .26	749 .26
NP-09	951-1000	718 .71	771 .34	842 .31	595 .30	666 .27	584 .27	770 .26	807 .26	736 .24	603 .24	853 .23
NP-10	930- 979	717 .63	596 .31	634 .28	652 .27	747 .27	765 .26	663 .25	688 .25	863 .25	699 .24	649 .24
NP-10	940- 989	717 .62	775 .45	765 .35	649 .30	791 .28	634 .27	597 .26	842 .26	647 .25	616 .25	740 .25
NP-10	950- 999	717 .55	583 .48	765 .43	791 .39	576 .34	775 .33	743 .27	649 .27	689 .26	597 .24	854 .23
NP-10	951-1000	717 .55	583 .49	765 .42	791 .41	576 .34	775 .29	597 .26	689 .25	743 .24	649 .24	812 .24
NP-12	929- 978	651 .45	716 .43	632 .41	841 .37	764 .29	687 .28	746 .28	631 .27	722 .27	871 .27	774 .27
NP-12	939- 988	716 .58	686 .43	632 .43	651 .42	774 .38	841 .37	640 .35	764 .35	695 .30	852 .29	780 .29
NP-12	949- 998	716 .57	841 .42	651 .37	678 .36	790 .35	632 .34	774 .31	795 .28	695 .27	610 .26	742 .26
NP-12	951-1000	716 .53	841 .37	790 .36	651 .36	678 .33	695 .31	640 .31	764 .30	741 .28	632 .28	742 .27
NP-13	907- 956	742 .39	841 .35	804 .33	876 .32	887 .30	704 .29	726 .29	714 .26	890 .26	780 .26	700 .25
NP-13	917- 966	742 .44	672 .36	841 .33	804 .32	887 .30	714 .30	700 .30	817 .27	730 .26	609 .25	860 .24
NP-13	927- 976	712 .40	742 .38	766 .36	860 .35	876 .34	672 .31	714 .29	817 .27	700 .26	843 .26	872 .25
NP-13	937- 986	742 .40	766 .38	712 .34	860 .33	608 .32	672 .32	730 .28	788 .28	839 .27	768 .27	667 .27
NP-13	947- 996	766 .45	742 .38	608 .34	672 .34	837 .29	676 .29	817 .27	592 .26	726 .26	700 .25	780 .24
NP-13	951-1000	766 .45	608 .41	672 .33	742 .29	837 .27	799 .26	728 .26	591 .25	788 .25	780 .25	817 .25
NP-17	928- 977	718 .42	843 .35	653 .33	690 .32	873 .31	778 .31	754 .30	637 .30	698 .30	606 .29	779 .28
NP-17	938- 987	718 .39	690 .39	653 .35	597 .32	688 .31	608 .31	754 .29	785 .28	748 .27	822 .26	776 .26
NP-17	948- 997	690 .44	776 .37	653 .36	718 .32	754 .27	683 .27	785 .26	638 .26	732 .26	770 .25	714 .24
NP-17	951-1000	690 .37	776 .35	718 .32	653 .30	785 .28	696 .27	608 .26	610 .26	673 .25	577 .24	638 .24
NP-18	926- 975	718 .60	769 .35	733 .35	863 .34	756 .31	818 .31	843 .30	852 .29	612 .28	690 .27	668 .27
NP-18	936- 985	718 .55	769 .38	612 .33	733 .29	807 .28	747 .28	688 .27	818 .27	653 .27	806 .26	770 .26
NP-18	946- 995	718 .51	780 .38	612 .35	769 .32	747 .32	743 .31	630 .30	805 .29	597 .27	650 .26	782 .25
NP-18	951-1000	718 .54	780 .36	743 .32	782 .31	747 .30	693 .29	805 .29	597 .28	769 .28	630 .27	612 .27
NP-A	935- 984	664 .41	837 .34	742 .33	718 .33	732 .31	719 .31	770 .30	867 .27	748 .27	608 .26	806 .26
NP-A	945- 994	676 .33	837 .30	817 .29	719 .29	584 .28	849 .27	664 .27	608 .25	742 .25	672 .24	653 .24
NP-A	951-1000	743 .35	766 .34	838 .33	837 .33	732 .32	584 .31	719 .29	780 .29	744 .28	757 .27	672 .26
NP-B	949- 998	758 .42	716 .38	790 .34	635 .32	582 .31	778 .31	764 .30	835 .28	846 .28	815 .28	593 .26
NP-B	951-1000	790 .39	758 .39	778 .35	764 .35	716 .34	635 .31	582 .30	835 .29	815 .29	752 .29	730 .27
NP-C	881- 930	717 .41	682 .40	823 .39	681 .37	702 .37	663 .30	683 .30	901 .30	856 .28	782 .28	772 .25
NP-C	891- 940	663 .36	635 .34	901 .33	717 .32	869 .31	856 .31	832 .30	857 .28	891 .28	900 .28	880 .27
NP-C	901- 950	808 .39	663 .38	797 .38	869 .38	717 .34	883 .30	880 .29	635 .28	845 .28	891 .27	767 .26
NP-C	911- 960	756 .33	886 .32	891 .31	720 .30	711 .30	803 .30	703 .29	663 .29	713 .28	772 .28	866 .27
NP-C	921- 970	720 .39	713 .37	845 .35	650 .34	803 .31	767 .30	756 .29	711 .29	643 .26	842 .26	609 .26
NP-C	931- 980	711 .35	805 .31	650 .31	741 .29	663 .28	816 .27	612 .27	670 .27	671 .26	845 .26	850 .25
NP-C	941- 990	711 .38	671 .35	805 .32	859 .31	836 .31	826 .30	699 .30	741 .29	650 .28	631 .28	663 .27
NP-C	951-1000	743 .38	650 .35	765 .32	675 .32	607 .28	711 .28	731 .27	631 .27	836 .26	826 .26	779 .26
NP-D	925- 974	804 .39	829 .39	676 .38	688 .34	716 .31	756 .31	766 .29	712 .29	782 .28	718 .28	608 .27
NP-D	935- 984	718 .49	688 .45	676 .36	804 .32	642 .29	831 .28	766 .27	817 .27	595 .27	621 .27	862 .26
NP-D	945- 994	718 .49	803 .43	712 .33	595 .31	766 .30	754 .27	593 .26	776 .26	836 .25	741 .24	688 .24
NP-D	951-1000	718 .46	803 .35	744 .33	754 .32	766 .31	776 .28	805 .28	791 .26	595 .26	577 .26	792 .25

CHART 3 continued

SERIES	COUNTED SEGMENT	CORR		CORR		CORR		CORR		CORR		CORR		CORR		CORR		CORR		CORR			
		ADD	# 1	ADD	# 2	ADD	# 3	ADD	# 4	ADD	# 5	ADD	# 6	ADD	# 7	ADD	# 8	ADD	# 9	ADD	# 10	ADD	# 11
NP-F	888- 937	714	.52	734	.44	671	.41	673	.31	815	.28	831	.28	694	.27	764	.27	817	.26	641	.26	669	.26
NP-F	898- 947	671	.39	734	.37	673	.36	714	.33	817	.33	781	.30	759	.28	900	.26	844	.26	839	.26	688	.26
NP-F	908- 957	817	.39	753	.32	671	.31	621	.29	618	.29	673	.28	755	.28	734	.28	698	.27	684	.26	781	.26
NP-F	918- 967	817	.42	673	.37	658	.35	873	.34	878	.31	618	.30	621	.30	815	.30	779	.29	698	.29	858	.28
NP-F	928- 977	817	.39	673	.37	779	.36	790	.35	764	.35	698	.34	768	.33	801	.32	658	.32	700	.31	754	.30
NP-F	938- 987	815	.42	778	.39	764	.38	803	.36	621	.36	790	.33	849	.33	754	.33	732	.32	827	.31	622	.31
NP-F	948- 997	815	.47	803	.40	622	.37	825	.36	596	.33	827	.30	662	.30	641	.29	834	.27	629	.27	742	.26
NP-F	951-1000	815	.39	803	.39	596	.36	742	.31	827	.29	834	.28	825	.28	641	.27	813	.26	795	.26	769	.24
NP-G	945- 994	718	.40	712	.39	770	.36	858	.32	813	.32	734	.29	599	.29	776	.28	596	.24	740	.23	807	.23
NP-G	951-1000	718	.41	813	.36	577	.36	770	.30	734	.29	576	.28	599	.25	747	.25	807	.25	836	.24	744	.24
NP-26	954-1000	749	.48	608	.38	625	.36	824	.35	815	.34	836	.33	778	.30	589	.30	661	.28	803	.28	577	.27
NP-33	945- 994	778	.40	596	.39	661	.38	815	.35	632	.31	803	.31	678	.27	641	.24	738	.24	625	.23	740	.23
NP-33	951-1000	678	.37	778	.33	577	.33	596	.31	661	.31	814	.28	802	.28	824	.28	826	.27	740	.26	803	.26
NP-36	927- 976	835	.41	824	.38	740	.35	811	.35	761	.33	855	.32	661	.31	727	.27	846	.26	869	.24	620	.24
NP-36	937- 986	846	.42	789	.37	700	.36	635	.36	646	.35	620	.35	811	.35	698	.34	801	.34	607	.32	858	.32
NP-36	947- 996	846	.40	813	.39	736	.38	635	.37	801	.36	700	.36	835	.33	825	.32	789	.30	758	.30	620	.29
NP-36	951-1000	813	.41	801	.39	846	.39	635	.37	835	.34	736	.33	700	.32	825	.30	670	.30	789	.29	698	.29
NP-38	939- 988	718	.54	770	.50	819	.39	653	.36	690	.32	745	.32	748	.30	807	.29	612	.27	809	.27	792	.25
NP-38	949- 998	718	.51	770	.50	792	.43	653	.39	807	.35	744	.32	819	.31	743	.30	754	.29	612	.28	584	.28
NP-38	951-1000	718	.52	792	.41	770	.37	653	.34	807	.34	817	.30	842	.30	754	.29	776	.29	642	.28	612	.26
NP-40	939- 988	701	.39	838	.38	804	.34	688	.32	826	.32	713	.32	631	.30	675	.29	672	.29	597	.29	595	.28
NP-40	949- 998	595	.44	701	.40	675	.31	713	.30	741	.29	814	.28	802	.27	631	.27	660	.27	663	.26	826	.26
NP-40	951-1000	595	.44	701	.43	660	.31	713	.31	741	.30	631	.29	675	.29	584	.26	765	.26	673	.25	826	.25
NP-42	932- 981	632	.39	740	.30	714	.30	676	.29	689	.28	704	.28	756	.27	660	.26	668	.26	835	.26	702	.26
NP-42	942- 991	689	.36	596	.33	598	.32	778	.31	632	.30	702	.30	740	.29	676	.26	714	.26	686	.25	803	.24
NP-42	951-1000	598	.42	778	.35	596	.32	803	.31	815	.28	595	.27	689	.27	597	.26	832	.25	632	.24	765	.23
NP-43	926- 975	811	.45	610	.36	824	.33	783	.31	646	.30	869	.30	629	.30	758	.28	690	.28	835	.27	855	.26
NP-43	936- 985	590	.36	824	.35	811	.34	646	.34	820	.33	629	.33	783	.30	610	.27	762	.26	767	.26	789	.25
NP-43	946- 995	707	.40	825	.29	783	.28	731	.28	595	.28	754	.28	608	.27	815	.27	628	.26	711	.24	826	.24
NP-43	951-1000	707	.39	594	.29	825	.29	628	.29	731	.28	595	.26	752	.25	802	.25	783	.25	608	.24	635	.24
NP-44	933- 982	806	.46	722	.35	748	.34	732	.32	753	.32	786	.31	652	.29	784	.27	680	.27	817	.27	864	.26
NP-44	943- 992	806	.39	758	.39	753	.35	784	.34	652	.32	736	.31	693	.31	748	.30	818	.29	722	.29	819	.28
NP-44	951-1000	676	.35	693	.35	593	.33	652	.33	852	.33	758	.32	588	.32	822	.27	615	.27	853	.26	747	.24
NP49A	943- 992	717	.39	675	.33	806	.30	837	.29	637	.27	598	.27	652	.27	740	.27	765	.27	849	.25	707	.25
NP49A	951-1000	717	.47	806	.34	837	.32	597	.31	765	.31	836	.31	598	.30	713	.30	637	.30	707	.29	596	.28
NP-52	941- 990	784	.45	602	.40	665	.34	745	.32	821	.32	850	.31	652	.30	744	.28	722	.27	807	.26	755	.25
NP-52	951-1000	821	.42	744	.39	602	.38	684	.37	850	.35	784	.34	621	.32	675	.31	690	.30	702	.29	830	.28
NP-60	958-1000	839	.46	767	.46	651	.42	626	.39	851	.38	818	.38	838	.38	817	.36	756	.35	676	.33	663	.32
NP-71	931- 980	778	.41	827	.39	740	.38	756	.35	815	.31	610	.31	805	.30	661	.29	814	.28	720	.28	860	.27
NP-71	941- 990	778	.51	661	.41	815	.39	827	.37	756	.36	861	.36	740	.36	720	.35	673	.34	690	.31	714	.31
NP-71	951-1000	815	.45	778	.45	690	.40	673	.39	661	.36	597	.33	720	.32	702	.31	686	.28	581	.28	848	.28
NP-72	941- 990	688	.45	663	.40	680	.40	788	.39	600	.37	817	.34	676	.34	813	.33	804	.32	859	.32	751	.31
NP-72	951-1000	825	.40	813	.35	663	.35	688	.32	717	.31	784	.30	718	.30	575	.29	780	.29	695	.29	652	.29
NP-73	941- 990	690	.39	678	.35	819	.32	665	.32	807	.32	742	.32	790	.31	861	.31	706	.30	795	.29	602	.28
NP-73	951-1000	690	.37	782	.36	815	.35	720	.33	678	.32	719	.32	742	.32	665	.31	636	.29	836	.28	795	.28

CHART 4

PART 8: DATE ADJUSTMENT FOR BEST MATCHES FOR COUNTED OR UNKNOWN SERIES

Tucson-Mendoza-Hamburg-Lamont ProgLib

NP PITCH PINE VS NORTHAMPTON AREA PITCH PINE MASTER (NP PHASE 1 SAMPLES 1-10 INCLUDED)
50-YEAR SEGMENTS LAGGED 10 YEARS

SERIES	COUNTED SEGMENT	CORR ADD # 1	CORR ADD # 2	CORR ADD # 3	CORR ADD # 4	CORR ADD # 5	CORR ADD # 6	CORR ADD # 7	CORR ADD # 8	CORR ADD # 9	CORR ADD #10	CORR ADD #11
NP-01	955-1000	718 .51	809 .37	831 .36	684 .33	783 .33	667 .30	732 .28	745 .27	794 .27	696 .27	682 .26
NP-02	964-1000	718 .49	754 .43	804 .40	828 .38	812 .35	826 .32	719 .31	780 .29	667 .28	778 .28	691 .26
NP-03	955-1000	815 .44	813 .39	749 .32	834 .30	724 .29	695 .28	841 .27	740 .27	802 .27	832 .24	673 .24
NP-04	914- 963	717 .69	842 .60	830 .45	854 .42	793 .36	714 .33	876 .32	866 .28	818 .27	741 .24	867 .24
NP-04	924- 973	717 .66	842 .51	830 .46	854 .36	793 .31	818 .29	782 .28	868 .26	832 .25	739 .24	852 .24
NP-04	934- 983	717 .61	842 .44	830 .43	854 .30	812 .30	816 .28	832 .27	785 .27	727 .26	806 .25	782 .23
NP-04	944- 993	717 .63	842 .33	705 .31	824 .31	782 .31	830 .30	763 .29	816 .29	687 .26	802 .24	692 .23
NP-04	951-1000	717 .55	705 .40	713 .32	775 .28	816 .28	766 .27	806 .26	779 .25	830 .25	744 .25	841 .24
NP-05	935- 984	718 .69	778 .40	701 .37	813 .26	794 .24	826 .23	853 .22	807 .21	819 .21	735 .20	831 .20
NP-05	945- 994	718 .73	792 .31	794 .31	679 .28	825 .28	805 .27	815 .26	697 .26	842 .21	735 .21	759 .21
NP-05	951-1000	718 .81	679 .32	792 .29	771 .27	825 .26	759 .26	842 .24	794 .22	809 .22	783 .21	680 .20
NP-06	920- 969	717 .66	733 .36	832 .32	818 .31	728 .30	876 .29	808 .29	742 .29	719 .28	842 .27	771 .27
NP-06	930- 979	717 .70	793 .42	747 .33	863 .31	733 .26	832 .24	742 .24	834 .23	704 .23	769 .22	852 .22
NP-06	940- 989	717 .66	793 .42	747 .34	733 .25	742 .25	832 .24	795 .23	746 .21	835 .20	841 .19	775 .19
NP-06	950- 999	717 .64	793 .33	775 .30	841 .26	740 .25	689 .24	742 .24	766 .23	747 .22	790 .21	785 .20
NP-06	951-1000	717 .60	793 .40	740 .28	742 .26	769 .26	747 .25	845 .25	835 .24	790 .23	689 .22	683 .21
NP-07	930- 979	718 .57	794 .39	819 .38	807 .35	732 .35	695 .35	775 .33	847 .29	808 .28	766 .28	865 .28
NP-07	940- 989	718 .65	807 .35	831 .35	819 .32	744 .30	775 .29	817 .28	748 .28	799 .25	702 .24	773 .23
NP-07	950- 999	718 .70	819 .42	771 .37	809 .30	841 .30	831 .29	701 .26	745 .24	747 .24	829 .23	679 .22
NP-07	951-1000	718 .68	819 .40	771 .39	745 .29	831 .28	747 .27	809 .26	682 .24	841 .24	759 .24	781 .23
NP-08	904- 953	718 .77	797 .39	743 .33	795 .30	770 .30	819 .28	769 .28	887 .28	721 .28	810 .26	736 .23
NP-08	914- 963	718 .78	797 .40	770 .35	819 .34	743 .30	757 .28	810 .28	769 .26	795 .26	870 .23	868 .22
NP-08	924- 973	718 .76	819 .42	700 .35	777 .31	843 .30	863 .24	830 .24	739 .24	795 .22	810 .21	743 .20
NP-08	934- 983	718 .70	819 .37	700 .36	753 .25	748 .25	825 .24	807 .23	794 .22	806 .20	705 .19	842 .18
NP-08	944- 993	718 .66	807 .36	825 .32	705 .31	783 .30	734 .28	851 .28	680 .28	735 .27	793 .26	819 .25
NP-08	951-1000	718 .63	825 .35	696 .30	680 .30	705 .29	793 .29	819 .29	781 .26	783 .25	740 .25	842 .25
NP-09	925- 974	718 .64	807 .38	864 .33	798 .30	843 .29	819 .28	794 .28	871 .28	809 .24	831 .24	855 .22
NP-09	935- 984	718 .69	807 .30	831 .27	819 .27	701 .26	843 .26	722 .23	853 .23	688 .22	693 .21	809 .21
NP-09	945- 994	718 .68	722 .30	697 .29	807 .28	783 .28	798 .25	745 .24	776 .23	831 .22	749 .22	723 .21
NP-09	951-1000	718 .76	771 .34	783 .34	745 .32	831 .26	722 .25	723 .25	842 .22	807 .22	819 .22	889 .20
NP-10	930- 979	717 .70	863 .34	768 .33	713 .30	854 .29	814 .26	793 .25	812 .25	747 .25	733 .24	692 .23
NP-10	940- 989	717 .72	775 .47	699 .29	854 .29	847 .29	713 .25	812 .24	742 .23	791 .22	831 .21	744 .19
NP-10	950- 999	717 .68	778 .30	775 .29	812 .28	831 .27	791 .26	743 .25	678 .24	699 .24	701 .23	828 .22
NP-10	951-1000	717 .67	791 .29	812 .28	778 .28	699 .28	831 .27	775 .26	828 .25	743 .24	678 .23	742 .22
NP-12	929- 978	716 .50	767 .38	775 .36	817 .31	698 .30	780 .29	702 .28	861 .28	841 .26	827 .23	811 .22
NP-12	939- 988	716 .53	774 .29	817 .29	841 .28	811 .27	712 .25	849 .25	786 .24	827 .24	704 .24	792 .23
NP-12	949- 998	716 .56	841 .33	712 .27	747 .26	673 .25	682 .24	811 .24	792 .22	742 .22	786 .22	774 .22
NP-12	951-1000	716 .58	811 .28	841 .28	712 .27	792 .24	783 .22	673 .22	817 .22	694 .22	747 .22	725 .21
NP-13	907- 956	742 .44	887 .30	726 .29	839 .28	843 .26	817 .24	717 .24	793 .24	728 .24	870 .23	730 .23
NP-13	917- 966	742 .48	817 .35	728 .31	730 .27	726 .26	804 .25	755 .25	756 .25	843 .24	839 .24	827 .23
NP-13	927- 976	712 .39	728 .39	742 .36	817 .35	843 .30	839 .27	827 .26	714 .26	801 .25	755 .25	863 .24
NP-13	937- 986	712 .44	817 .38	728 .37	742 .32	825 .31	843 .30	700 .28	827 .28	839 .27	849 .26	755 .23
NP-13	947- 996	817 .45	712 .40	779 .28	843 .26	718 .26	839 .25	690 .25	837 .25	751 .24	700 .24	801 .24
NP-13	951-1000	817 .48	712 .38	839 .33	690 .33	779 .29	777 .26	728 .26	751 .25	680 .25	801 .25	718 .24
NP-17	928- 977	718 .44	855 .37	769 .33	754 .33	853 .32	779 .32	778 .30	843 .29	783 .27	851 .26	781 .26
NP-17	938- 987	718 .39	783 .37	785 .37	706 .31	754 .28	853 .28	684 .27	855 .26	761 .26	843 .24	831 .24
NP-17	948- 997	718 .49	690 .32	754 .29	803 .29	750 .28	779 .28	709 .26	836 .25	827 .24	785 .23	842 .22
NP-17	951-1000	718 .50	779 .34	750 .30	803 .29	709 .27	783 .25	745 .24	842 .22	690 .22	754 .21	696 .20
NP-18	926- 975	718 .44	819 .35	807 .31	843 .29	746 .28	715 .26	818 .25	733 .24	792 .23	794 .23	832 .23
NP-18	936- 985	718 .44	807 .42	731 .31	819 .28	806 .27	792 .26	706 .26	780 .24	747 .24	818 .23	746 .23
NP-18	946- 995	718 .48	780 .39	792 .30	807 .30	846 .29	806 .27	830 .27	747 .26	693 .26	819 .25	842 .25
NP-18	951-1000	718 .53	780 .40	792 .36	782 .33	693 .29	695 .27	830 .26	794 .26	842 .25	807 .25	683 .22
NP-A	935- 984	718 .41	783 .33	748 .29	817 .28	846 .25	700 .25	779 .24	793 .24	732 .24	825 .24	837 .23
NP-A	945- 994	817 .41	718 .38	747 .30	750 .26	779 .26	836 .24	846 .23	849 .23	700 .23	783 .21	784 .20
NP-A	951-1000	817 .41	718 .40	820 .31	690 .28	732 .26	766 .25	779 .25	760 .24	689 .24	731 .24	836 .23
NP-B	949- 998	716 .49	815 .42	758 .35	698 .34	847 .33	762 .31	781 .28	802 .27	710 .26	844 .25	677 .22
NP-B	951-1000	716 .52	815 .45	758 .33	698 .32	802 .27	762 .26	678 .26	781 .24	710 .23	700 .23	730 .22
NP-C	881- 930	810 .40	783 .38	823 .37	856 .35	843 .34	767 .29	782 .27	901 .27	746 .25	745 .24	784 .23
NP-C	891- 940	856 .35	869 .33	901 .33	857 .33	767 .31	732 .31	880 .30	883 .29	891 .28	832 .28	810 .27
NP-C	901- 950	832 .32	883 .31	880 .31	856 .30	767 .29	797 .27	869 .26	808 .26	730 .25	809 .25	857 .24
NP-C	911- 960	803 .32	832 .30	756 .29	731 .27	856 .27	772 .27	808 .25	713 .25	741 .24	866 .24	857 .23
NP-C	921- 970	866 .34	803 .33	800 .31	845 .28	842 .27	741 .26	713 .25	826 .24	756 .24	707 .24	838 .23
NP-C	931- 980	800 .39	711 .31	816 .31	741 .29	842 .28	862 .26	826 .26	695 .26	792 .26	805 .25	850 .25
NP-C	941- 990	699 .42	711 .41	800 .40	816 .35	681 .31	826 .28	824 .25	836 .23	776 .22	803 .22	845 .21
NP-C	951-1000	816 .40	711 .39	695 .35	800 .32	699 .29	826 .29	743 .26	766 .25	782 .25	717 .23	803 .23
NP-D	925- 974	705 .40	855 .34	829 .31	756 .31	741 .30	841 .29	857 .28	842 .27	742 .26	817 .26	728 .25
NP-D	935- 984	718 .35	841 .31	712 .28	831 .27	744 .27	855 .26	769 .25	804 .25	817 .25	688 .25	791 .24
NP-D	945- 994	718 .46	803 .44	791 .32	679 .28	815 .28	825 .27	740 .25	757 .25	712 .25	739 .25	829 .24
NP-D	951-1000	718 .52	803 .43	791 .32	679 .30	831 .27	825 .26	815 .25	714 .24	807 .24	702 .23	813 .23

CHART 4 continued

SERIES	COUNTED SEGMENT	CORR ADD # 1	CORR ADD # 2	CORR ADD # 3	CORR ADD # 4	CORR ADD # 5	CORR ADD # 6	CORR ADD # 7	CORR ADD # 8	CORR ADD # 9	CORR ADD #10	CORR ADD #11
NP-F	888- 937	734 .35	786 .30	738 .29	844 .29	815 .29	810 .26	818 .23	846 .22	866 .22	900 .22	889 .20
NP-F	898- 947	815 .35	755 .32	734 .32	739 .30	759 .28	786 .27	738 .26	768 .24	743 .24	844 .24	814 .23
NP-F	908- 957	755 .36	739 .34	738 .33	815 .32	817 .30	781 .27	768 .27	743 .26	839 .25	786 .25	753 .25
NP-F	918- 967	815 .39	755 .37	716 .32	781 .31	817 .31	878 .30	839 .30	873 .30	741 .29	738 .27	852 .27
NP-F	928- 977	702 .50	716 .36	781 .34	754 .33	738 .32	817 .32	741 .28	839 .27	764 .27	815 .26	829 .24
NP-F	938- 987	702 .52	716 .45	815 .39	803 .31	801 .29	790 .29	738 .29	767 .28	781 .27	791 .24	690 .24
NP-F	948- 997	803 .39	813 .30	790 .25	690 .24	815 .24	791 .24	793 .24	704 .22	779 .20	721 .20	825 .20
NP-F	951-1000	803 .38	813 .34	793 .32	745 .28	790 .26	779 .26	791 .25	781 .25	769 .24	845 .23	721 .21
NP-G	945- 994	813 .36	770 .35	739 .31	807 .29	740 .28	743 .27	776 .26	718 .26	842 .23	847 .23	791 .23
NP-G	951-1000	813 .39	718 .35	842 .28	770 .26	696 .26	740 .26	739 .25	807 .25	803 .23	771 .21	791 .20
NP-26	954-1000	815 .40	824 .38	725 .37	752 .28	803 .26	766 .26	749 .26	825 .25	778 .25	802 .25	790 .24
NP-33	945- 994	815 .43	740 .34	730 .32	844 .31	803 .26	714 .26	841 .25	790 .25	778 .24	813 .22	831 .22
NP-33	951-1000	740 .37	815 .36	790 .30	813 .29	791 .28	841 .25	803 .25	778 .25	689 .25	800 .24	718 .24
NP-36	927- 976	811 .53	824 .39	855 .38	789 .33	835 .32	787 .30	710 .28	814 .25	783 .25	856 .24	740 .23
NP-36	937- 986	787 .43	789 .43	811 .42	801 .36	686 .34	700 .33	702 .29	853 .27	855 .26	713 .26	763 .24
NP-36	947- 996	813 .38	700 .36	801 .35	787 .31	835 .31	789 .30	846 .28	814 .26	736 .26	711 .24	688 .23
NP-36	951-1000	813 .38	801 .37	700 .34	835 .31	814 .28	811 .25	789 .24	711 .23	769 .21	736 .21	787 .21
NP-38	939- 988	718 .54	807 .47	819 .40	776 .37	730 .27	770 .25	792 .22	779 .22	757 .22	694 .22	733 .21
NP-38	949- 998	718 .63	807 .44	819 .39	679 .39	779 .30	792 .30	682 .30	794 .27	829 .25	744 .24	817 .22
NP-38	951-1000	718 .63	807 .39	779 .34	819 .32	682 .32	817 .31	679 .30	783 .27	792 .27	842 .25	813 .23
NP-40	939- 988	701 .49	713 .36	814 .34	838 .32	826 .31	731 .29	792 .28	756 .28	772 .28	688 .27	804 .26
NP-40	949- 998	701 .46	713 .32	814 .32	731 .31	802 .26	790 .25	752 .24	725 .22	846 .22	699 .22	826 .22
NP-40	951-1000	701 .44	713 .33	814 .30	731 .29	752 .27	790 .26	802 .26	725 .22	826 .22	792 .22	838 .21
NP-42	932- 981	714 .32	789 .30	765 .29	793 .29	713 .29	814 .26	740 .26	859 .26	710 .26	861 .23	847 .22
NP-42	942- 991	713 .36	815 .34	702 .34	740 .30	714 .28	831 .27	778 .26	765 .26	805 .26	704 .21	760 .20
NP-42	951-1000	815 .37	778 .34	713 .25	791 .24	681 .24	702 .23	740 .23	704 .22	739 .21	757 .20	765 .20
NP-43	926- 975	811 .48	824 .37	735 .30	855 .29	814 .26	787 .26	710 .26	770 .24	835 .23	705 .23	862 .23
NP-43	936- 985	824 .39	811 .36	762 .36	711 .32	686 .30	757 .25	787 .25	735 .24	848 .24	789 .23	820 .21
NP-43	946- 995	711 .43	707 .34	770 .32	796 .31	824 .28	737 .25	814 .23	736 .22	791 .22	825 .22	677 .21
NP-43	951-1000	711 .39	770 .39	707 .35	757 .31	716 .26	796 .24	694 .23	752 .23	840 .22	736 .22	814 .21
NP-44	933- 982	806 .44	784 .37	705 .35	753 .30	830 .25	809 .24	732 .24	798 .23	786 .23	819 .23	700 .23
NP-44	943- 992	753 .39	798 .38	697 .32	736 .31	806 .29	681 .28	758 .27	732 .26	850 .25	786 .25	784 .25
NP-44	951-1000	839 .43	680 .36	693 .34	798 .29	734 .28	716 .26	753 .25	758 .24	735 .24	817 .23	807 .22
NP49A	943- 992	717 .40	713 .28	825 .26	766 .25	740 .24	847 .23	849 .22	831 .22	767 .21	736 .20	716 .19
NP49A	951-1000	717 .52	713 .33	802 .27	778 .24	831 .24	793 .23	806 .22	766 .22	844 .21	692 .21	744 .21
NP-52	941- 990	819 .32	782 .30	821 .29	744 .28	784 .27	745 .27	708 .27	850 .26	730 .26	847 .23	736 .22
NP-52	951-1000	821 .43	744 .33	731 .31	819 .30	736 .27	830 .26	706 .23	701 .23	797 .22	722 .22	815 .22
NP-60	958-1000	767 .55	817 .40	680 .40	691 .37	839 .36	732 .36	804 .31	805 .29	780 .28	807 .28	818 .27
NP-71	931- 980	815 .49	791 .35	803 .33	714 .33	702 .31	827 .30	805 .28	790 .26	715 .24	781 .22	716 .21
NP-71	941- 990	815 .56	702 .44	791 .43	827 .33	714 .31	803 .31	778 .29	716 .28	726 .27	805 .27	690 .26
NP-71	951-1000	815 .63	702 .45	791 .43	714 .33	690 .30	778 .29	715 .28	805 .26	678 .26	716 .25	686 .24
NP-72	941- 990	817 .38	813 .37	760 .31	700 .31	854 .30	688 .30	825 .30	683 .30	740 .29	788 .28	751 .27
NP-72	951-1000	692 .36	780 .34	825 .29	743 .28	793 .28	683 .27	717 .27	813 .25	740 .24	792 .24	751 .23
NP-73	941- 990	819 .43	702 .37	694 .29	807 .28	795 .27	742 .27	753 .26	706 .26	682 .25	790 .25	782 .24
NP-73	951-1000	694 .47	782 .32	770 .31	795 .30	720 .29	742 .26	791 .24	737 .24	746 .23	819 .23	793 .23

CHART 5A

PART 2: CORRELATIONS WITH NP PITCH PINE MASTER SERIES OF ALL SEGMENTS AS DATED AND MEASURED

32-YEAR CUBIC SPLINE FILTER; CORRELATIONS OF 50-YEAR SEGMENTS LAGGED 10 YEARS

		FLAGS: __A = CORRELATION UNDER 0.3281; __B = CORRELATION HIGHER AT OTHER POSITION																					
0SEQ	SERIES	INTERVAL	1620	1630	1640	1650	1660	1670	1680	1690	1700	1710	1720	1730	1740	1750	1760	1770	1780	1790	1800	1810	FLAGS/ TOTAL
			1669	1679	1689	1699	1709	1719	1729	1739	1749	1759	1769	1779	1789	1799	1809	1819	1829	1839	1849	1859	
+	1 NP-01	1673-1718	=	=	=	=	=	.49	=	=	=	=	=	=	=	=	=	=	=	=	=	=	0/ 1
	2 NP-02	1682-1718	=	=	=	=	=	=	.41	=	=	=	=	=	=	=	=	=	=	=	=	=	0/ 1
+	3 NP-03	1770-1815	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	.45	=	=	=	=	0/ 1
+	4 NP-04	1631-1717	=	.47	.59	.60	.57	.45	=	=	=	=	=	=	=	=	=	=	=	=	=	=	0/ 5
+	5 NP-05	1653-1718	=	=	=	.69	.67	.77	=	=	=	=	=	=	=	=	=	=	=	=	=	=	0/ 3
+	6 NP-06	1637-1717	=	.55	.58	.65	.65	.50	=	=	=	=	=	=	=	=	=	=	=	=	=	=	0/ 5
+	7 NP-07	1648-1718	=	=	.21	.28	.46	.64	=	=	=	=	=	=	=	=	=	=	=	=	=	=	2/ 4
+	8 NP-08	1631-1718	=	.47	<u>A</u> .64	<u>A</u> .58	.66	.63	=	=	=	=	=	=	=	=	=	=	=	=	=	=	0/ 5
+	9 NP-09	1643-1718	=	=	.68	.67	.65	.74	=	=	=	=	=	=	=	=	=	=	=	=	=	=	0/ 4
+	10 NP-10	1647-1717	=	=	.66	.69	.63	.64	=	=	=	=	=	=	=	=	=	=	=	=	=	=	0/ 4
+	11 NP-12	1645-1716	=	=	.54	.51	.68	.69	=	=	=	=	=	=	=	=	=	=	=	=	=	=	0/ 4
+	12 NP-17	1646-1718	=	=	.39	.37	.35	.50	=	=	=	=	=	=	=	=	=	=	=	=	=	=	0/ 4
+	13 NP-18	1644-1718	=	=	.53	.54	.53	.52	=	=	=	=	=	=	=	=	=	=	=	=	=	=	0/ 4
+	14 NP-A	1653-1718	=	=	=	.42	.37	.34	=	=	=	=	=	=	=	=	=	=	=	=	=	=	0/ 3
+	15 NP-B	1665-1716	=	=	=	=	.52	.49	=	=	=	=	=	=	=	=	=	=	=	=	=	=	0/ 2
+	16 NP-D	1643-1718	=	=	.31	.45	.52	.59	=	=	=	=	=	=	=	=	=	=	=	=	=	=	1/ 4
+	17 NP-G	1663-1718	=	=	<u>A</u> .42	.47	.47	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	0/ 2
+	18 NP-26	1769-1815	=	=	=	=	=	=	=	=	=	=	=	=	=	=	.50	=	=	=	=	=	0/ 1
+	19 NP-33	1760-1815	=	=	=	=	=	=	=	=	=	=	=	=	=	=	.54	.49	=	=	=	=	0/ 2
+	20 NP-38	1657-1718	=	=	=	.65	.65	.75	=	=	=	=	=	=	=	=	=	=	=	=	=	=	0/ 3
+	21 NP-40	1753-1814	=	=	=	=	=	=	=	=	=	=	=	=	=	.70	.63	.61	=	=	=	=	0/ 3
+	22 NP-42	1747-1815	=	=	=	=	=	=	=	=	=	=	=	=	.60	.59	.56	.45	=	=	=	=	0/ 4
+	23 NP49A	1660-1717	=	=	=	=	.40	.55	=	=	=	=	=	=	=	=	=	=	=	=	=	=	0/ 2
+	24 NP-71	1746-1815	=	=	=	=	=	=	=	=	=	=	=	.62	.63	.62	.53	=	=	=	=	=	0/ 4

NP PITCH PINE VS NP PITCH PINE DATED
50-YEAR SEGMENTS LAGGED 10 YEARS

SERIES	COUNTED SEGMENT	CORR ADD # 1	CORR ADD # 2	CORR ADD # 3	CORR ADD # 4	CORR ADD # 5	CORR ADD # 6	CORR ADD # 7	CORR ADD # 8	CORR ADD # 9	CORR ADD #10	CORR ADD #11
NP-01	955-1000	718 .57	809 .40	795 .39	667 .35	684 .31	670 .28	696 .28	720 .26	695 .26	682 .25	694 .21
NP-02	964-1000	718 .49	804 .38	667 .36	809 .33	760 .33	719 .28	717 .27	691 .26	793 .26	768 .24	802 .24
NP-03	955-1000	815 .62	740 .36	724 .32	690 .30	782 .29	747 .27	701 .25	711 .25	695 .23	673 .23	689 .22
NP-04	914- 963	717 .71	824 .38	741 .36	714 .35	818 .35	810 .33	842 .28	743 .26	830 .26	794 .26	739 .25
NP-04	924- 973	717 .68	830 .46	818 .40	842 .37	824 .35	777 .33	810 .31	739 .31	802 .28	794 .25	705 .24
NP-04	934- 983	717 .67	830 .39	818 .36	802 .32	705 .30	739 .29	727 .28	767 .25	763 .25	788 .25	826 .23
NP-04	944- 993	717 .59	705 .41	818 .38	806 .30	794 .29	727 .28	802 .28	788 .27	776 .25	739 .23	764 .23
NP-04	951-1000	717 .52	705 .39	818 .38	806 .30	727 .25	744 .25	802 .25	689 .24	776 .24	806 .24	767 .24
NP-05	935- 984	718 .73	701 .43	789 .33	831 .29	756 .28	819 .26	825 .26	740 .25	817 .25	801 .25	786 .22
NP-05	945- 994	718 .74	697 .37	789 .28	680 .25	780 .24	793 .24	756 .23	740 .22	786 .21	730 .21	679 .20
NP-05	951-1000	718 .80	793 .36	680 .31	780 .26	751 .26	679 .24	740 .22	730 .22	697 .21	815 .20	808 .20
NP-06	920- 969	717 .67	830 .36	719 .35	788 .28	742 .26	802 .26	846 .26	796 .26	755 .26	704 .23	785 .23
NP-06	930- 979	717 .74	830 .39	788 .30	704 .28	802 .27	719 .27	706 .25	755 .23	832 .22	740 .22	742 .21
NP-06	940- 989	717 .69	788 .30	802 .29	740 .25	733 .25	824 .23	772 .21	817 .20	755 .19	816 .19	746 .19
NP-06	950- 999	717 .65	689 .38	740 .29	772 .27	775 .27	704 .26	757 .25	739 .25	815 .23	788 .22	700 .21
NP-06	951-1000	717 .57	757 .37	689 .33	751 .30	740 .30	704 .25	772 .24	739 .23	808 .22	807 .21	775 .20
NP-07	930- 979	695 .40	718 .38	803 .32	732 .32	766 .28	820 .26	789 .26	770 .25	743 .24	817 .24	831 .24
NP-07	940- 989	718 .55	789 .32	744 .30	803 .30	693 .27	817 .25	734 .25	819 .24	696 .23	766 .23	753 .23
NP-07	950- 999	718 .72	695 .24	759 .24	809 .23	767 .23	768 .23	815 .23	701 .22	717 .22	793 .21	751 .20
NP-07	951-1000	718 .72	751 .35	793 .32	680 .26	768 .22	695 .22	808 .21	682 .21	809 .21	757 .21	767 .20
NP-08	904- 953	718 .75	770 .33	769 .33	795 .30	828 .29	844 .29	743 .28	825 .28	721 .27	861 .24	775 .24
NP-08	914- 963	718 .76	770 .37	795 .30	769 .30	811 .28	819 .28	825 .25	844 .25	757 .25	775 .24	743 .22
NP-08	924- 973	718 .76	819 .38	789 .31	700 .31	739 .30	831 .30	777 .29	786 .28	754 .28	770 .27	807 .24
NP-08	934- 983	718 .71	789 .33	700 .31	831 .30	819 .30	807 .29	707 .24	757 .21	739 .21	803 .20	734 .20
NP-08	944- 993	718 .70	819 .39	789 .32	740 .30	807 .30	680 .28	730 .28	734 .27	694 .25	757 .23	795 .20
NP-08	951-1000	718 .70	680 .33	740 .32	795 .27	803 .27	793 .25	706 .25	734 .23	781 .22	760 .21	696 .21
NP-09	925- 974	718 .73	819 .33	789 .32	831 .31	756 .29	780 .27	795 .25	754 .22	701 .21	720 .20	807 .20
NP-09	935- 984	718 .73	789 .38	831 .36	819 .35	722 .29	701 .29	803 .28	740 .23	756 .23	688 .21	786 .19
NP-09	945- 994	718 .72	722 .36	697 .35	789 .32	819 .28	756 .23	740 .22	772 .22	797 .21	769 .21	694 .20
NP-09	951-1000	718 .78	694 .28	722 .28	808 .26	793 .26	740 .23	765 .22	768 .22	807 .21	795 .20	772 .20
NP-10	930- 979	717 .74	818 .43	785 .36	788 .27	830 .26	739 .25	749 .23	768 .23	824 .19	792 .19	751 .19
NP-10	940- 989	717 .71	788 .33	739 .24	802 .24	818 .22	772 .22	756 .21	785 .20	792 .19	816 .19	769 .18
NP-10	950- 999	717 .72	739 .35	766 .34	751 .28	792 .27	802 .27	689 .24	701 .21	800 .21	772 .21	816 .20
NP-10	951-1000	717 .70	739 .35	766 .33	751 .31	802 .27	792 .26	689 .24	701 .21	772 .20	772 .20	695 .19
NP-12	929- 978	716 .63	817 .41	775 .40	787 .34	772 .29	702 .27	750 .26	781 .25	767 .24	808 .24	829 .24
NP-12	939- 988	716 .69	787 .42	775 .36	817 .35	778 .31	704 .29	750 .27	808 .24	823 .24	781 .23	689 .22
NP-12	949- 998	716 .72	750 .36	778 .33	787 .31	817 .28	775 .26	781 .23	682 .22	766 .21	712 .20	691 .18
NP-12	951-1000	716 .73	750 .36	778 .35	775 .23	766 .22	787 .22	781 .22	704 .21	694 .19	682 .19	807 .18
NP-13	907- 956	742 .45	827 .36	797 .34	807 .31	843 .29	794 .28	717 .27	726 .27	813 .26	855 .23	728 .23
NP-13	917- 966	742 .45	827 .37	841 .37	843 .33	728 .29	813 .28	797 .27	807 .25	730 .23	752 .22	726 .21
NP-13	927- 976	728 .39	718 .38	827 .34	742 .31	712 .30	807 .30	797 .28	813 .28	783 .28	774 .28	819 .27
NP-13	937- 986	728 .40	764 .37	718 .35	742 .32	712 .32	752 .31	813 .31	807 .30	827 .29	797 .28	774 .26
NP-13	947- 996	718 .37	752 .31	728 .31	712 .29	690 .27	764 .27	742 .25	819 .22	693 .20	680 .20	783 .20
NP-13	951-1000	690 .36	728 .35	680 .31	712 .30	718 .30	693 .29	764 .24	741 .23	702 .22	677 .22	752 .20
NP-17	928- 977	718 .46	827 .39	754 .37	778 .28	701 .28	777 .27	803 .27	819 .27	770 .26	769 .23	811 .23
NP-17	938- 987	827 .45	718 .44	777 .33	765 .30	703 .28	780 .27	819 .26	786 .25	684 .25	706 .24	754 .24
NP-17	948- 997	718 .50	690 .37	765 .30	768 .28	771 .26	803 .25	786 .24	780 .24	777 .23	807 .23	808 .22
NP-17	951-1000	718 .54	765 .36	768 .31	771 .30	690 .27	751 .26	808 .24	793 .23	777 .22	803 .22	675 .21
NP-18	926- 975	718 .58	786 .32	780 .32	733 .29	831 .25	744 .25	819 .24	789 .23	783 .22	715 .21	731 .21
NP-18	936- 985	718 .61	780 .38	694 .35	731 .31	789 .25	691 .24	830 .24	706 .24	767 .24	816 .24	744 .23
NP-18	946- 995	718 .60	780 .40	807 .29	731 .26	693 .25	691 .25	706 .25	733 .24	695 .24	681 .23	694 .23
NP-18	951-1000	718 .57	780 .41	695 .33	693 .33	807 .31	731 .28	717 .26	681 .25	680 .23	694 .21	706 .21
NP-A	935- 984	718 .51	807 .34	774 .25	742 .25	819 .24	693 .24	748 .23	804 .23	789 .23	818 .20	817 .20
NP-A	945- 994	718 .49	764 .35	761 .25	741 .25	702 .23	807 .22	789 .22	774 .21	818 .21	742 .21	693 .20
NP-A	951-1000	718 .43	764 .37	690 .34	741 .32	702 .31	803 .28	761 .27	758 .26	755 .25	752 .23	705 .22
NP-B	949- 998	716 .60	762 .39	750 .31	802 .27	756 .25	817 .25	753 .24	787 .23	677 .23	678 .23	700 .21
NP-B	951-1000	716 .57	762 .38	678 .31	750 .29	700 .29	756 .25	691 .25	753 .24	815 .22	802 .22	787 .21
NP-C	881- 930	857 .41	783 .34	745 .32	746 .29	824 .29	782 .26	818 .26	748 .25	767 .24	885 .23	784 .23
NP-C	891- 940	818 .35	732 .35	756 .33	869 .30	857 .28	767 .27	806 .26	755 .24	805 .23	783 .22	824 .22
NP-C	901- 950	806 .44	756 .33	809 .32	824 .30	730 .29	803 .29	767 .28	782 .28	818 .25	771 .25	732 .25
NP-C	911- 960	812 .36	806 .35	741 .33	818 .31	756 .31	731 .27	767 .26	842 .26	826 .24	817 .23	713 .21
NP-C	921- 970	818 .36	812 .34	806 .31	824 .30	720 .30	741 .30	785 .29	826 .29	842 .29	800 .27	717 .26
NP-C	931- 980	806 .38	717 .33	818 .33	741 .31	826 .28	711 .27	800 .27	812 .27	788 .27	727 .24	824 .24
NP-C	941- 990	711 .35	806 .34	699 .34	717 .33	681 .31	812 .30	788 .29	763 .29	800 .27	767 .27	741 .26
NP-C	951-1000	717 .35	763 .30	711 .29	692 .29	788 .28	701 .26	782 .24	681 .23	806 .23	690 .23	741 .23
NP-D	925- 974	718 .50	705 .44	756 .41	831 .39	789 .36	780 .33	741 .28	730 .25	742 .22	830 .22	795 .20
NP-D	935- 984	718 .58	789 .39	756 .33	768 .33	831 .33	703 .33	688 .30	730 .27	712 .24	780 .24	705 .24
NP-D	945- 994	718 .61	789 .41	712 .34	688 .31	679 .30	740 .28	739 .28	795 .28	692 .27	730 .26	714 .25
NP-D	951-1000	718 .65	789 .33	679 .31	692 .30	730 .28	795 .27	714 .25	712 .24	740 .23	803 .23	739 .22

CHART 5B continued

SERIES	COUNTED SEGMENT	CORR		CORR		CORR		CORR		CORR		CORR		CORR		CORR		CORR		CORR		CORR	
		ADD	# 1	ADD	# 2	ADD	# 3	ADD	# 4	ADD	# 5	ADD	# 6	ADD	# 7	ADD	# 8	ADD	# 9	ADD	#10	ADD	#11
NP-F	888- 937	854	.34	734	.31	860	.28	786	.26	810	.26	738	.24	844	.23	814	.23	868	.20	811	.20	863	.19
NP-F	898- 947	856	.38	854	.38	734	.31	868	.28	759	.28	738	.23	791	.23	755	.23	743	.22	840	.22	763	.20
NP-F	908- 957	854	.43	856	.32	755	.31	738	.28	753	.27	840	.26	743	.23	739	.22	759	.21	779	.20	839	.20
NP-F	918- 967	840	.37	704	.30	738	.27	755	.26	716	.26	787	.23	779	.23	839	.22	754	.22	743	.22	741	.21
NP-F	928- 977	702	.48	754	.42	738	.39	704	.31	716	.31	781	.28	728	.26	829	.25	787	.25	772	.24	726	.23
NP-F	938- 987	702	.48	738	.41	716	.40	787	.39	754	.37	815	.30	704	.27	805	.25	690	.24	728	.23	763	.23
NP-F	948- 997	754	.42	787	.37	803	.32	751	.30	738	.27	796	.27	704	.26	690	.24	716	.22	771	.22	815	.20
NP-F	951-1000	751	.41	754	.40	787	.30	803	.29	716	.27	793	.27	704	.26	738	.25	771	.24	795	.22	694	.21
NP-G	945- 994	718	.47	740	.30	785	.28	813	.27	739	.25	712	.25	734	.23	807	.22	768	.21	692	.19	793	.19
NP-G	951-1000	718	.52	771	.31	750	.28	793	.28	795	.28	739	.26	785	.25	813	.25	740	.24	767	.24	751	.23
NP-26	954-1000	815	.65	740	.37	750	.35	791	.33	725	.31	808	.27	782	.26	689	.26	690	.23	800	.23	711	.23
NP-33	945- 994	815	.66	740	.39	782	.37	779	.32	730	.28	714	.26	689	.24	739	.24	807	.23	758	.21	691	.21
NP-33	951-1000	815	.63	740	.38	779	.33	718	.31	782	.27	689	.26	714	.24	678	.22	702	.20	724	.20	730	.20
NP-36	927- 976	812	.45	784	.30	762	.26	815	.26	781	.26	761	.26	824	.26	738	.25	705	.24	710	.23	775	.23
NP-36	937- 986	700	.40	702	.37	811	.34	803	.31	762	.30	738	.29	781	.29	812	.28	686	.26	713	.24	722	.24
NP-36	947- 996	813	.42	700	.41	781	.36	811	.34	738	.30	711	.25	762	.25	722	.24	688	.23	769	.21	736	.20
NP-36	951-1000	813	.41	700	.38	781	.33	811	.30	738	.29	769	.26	749	.25	722	.25	716	.22	711	.22	762	.21
NP-38	939- 988	718	.72	819	.35	807	.32	694	.29	768	.28	801	.28	804	.27	774	.27	816	.26	771	.25	745	.24
NP-38	949- 998	718	.76	679	.42	768	.32	807	.31	682	.29	780	.26	695	.25	754	.25	730	.23	816	.23	771	.22
NP-38	951-1000	718	.79	679	.33	768	.32	682	.30	754	.29	793	.28	807	.25	771	.23	780	.22	680	.22	751	.21
NP-40	939- 988	814	.85	701	.54	713	.36	737	.30	802	.26	773	.26	688	.26	752	.24	740	.23	731	.23	686	.21
NP-40	949- 998	814	.79	701	.50	800	.31	802	.31	713	.28	773	.28	677	.28	756	.26	731	.23	717	.21	786	.21
NP-40	951-1000	814	.79	701	.47	802	.29	713	.29	773	.28	756	.26	800	.26	677	.24	764	.24	717	.23	786	.23
NP-42	932- 981	815	.79	714	.42	765	.35	787	.31	740	.28	710	.26	773	.25	781	.24	803	.23	753	.22	782	.22
NP-42	942- 991	815	.75	766	.43	702	.39	787	.36	740	.31	714	.31	799	.29	772	.28	753	.27	713	.27	781	.27
NP-42	951-1000	815	.67	766	.48	740	.31	702	.27	799	.27	772	.25	716	.24	704	.22	779	.22	787	.21	752	.20
NP-43	926- 975	812	.66	782	.30	705	.27	770	.26	815	.26	735	.24	829	.20	703	.20	806	.18	836	.18	710	.18
NP-43	936- 985	812	.62	711	.36	762	.34	818	.27	779	.27	686	.26	735	.25	782	.24	815	.23	729	.22	692	.22
NP-43	946- 995	711	.39	707	.37	820	.34	729	.31	782	.27	812	.24	779	.24	778	.22	796	.22	716	.21	750	.19
NP-43	951-1000	711	.35	749	.35	707	.33	782	.31	716	.30	729	.28	778	.26	779	.25	807	.21	752	.21	812	.21
NP-44	933- 982	807	.41	748	.28	722	.28	705	.27	700	.26	732	.26	777	.25	798	.24	818	.23	753	.22	787	.22
NP-44	943- 992	697	.39	807	.37	748	.33	732	.31	798	.31	694	.28	819	.27	765	.27	722	.26	733	.26	759	.26
NP-44	951-1000	680	.34	765	.34	748	.33	807	.30	693	.29	744	.29	798	.27	733	.25	776	.24	806	.23	732	.23
NP49A	943- 992	717	.49	758	.32	713	.32	767	.28	702	.26	740	.23	736	.22	788	.22	682	.20	707	.20	782	.20
NP49A	951-1000	717	.61	713	.37	803	.33	767	.33	792	.31	707	.23	692	.23	681	.22	815	.20	735	.19	782	.18
NP-52	941- 990	821	.46	819	.41	785	.39	776	.36	720	.27	730	.25	722	.23	744	.23	700	.23	791	.22	755	.21
NP-52	951-1000	785	.40	776	.34	706	.29	744	.29	797	.27	684	.27	720	.26	730	.26	722	.24	777	.22	804	.21
NP-60	958-1000	773	.41	765	.36	731	.34	680	.34	691	.30	732	.29	693	.29	809	.27	789	.26	762	.26	806	.25
NP-71	931- 980	815	.81	714	.42	773	.36	702	.29	803	.27	726	.27	779	.26	791	.26	829	.26	715	.25	782	.25
NP-71	941- 990	815	.78	702	.41	714	.39	773	.34	740	.30	779	.30	726	.30	765	.28	690	.28	791	.27	716	.26
NP-71	951-1000	815	.73	702	.46	690	.37	773	.35	678	.33	714	.32	740	.27	791	.25	755	.24	788	.24	726	.24
NP-72	941- 990	802	.42	760	.40	817	.38	752	.35	805	.31	740	.29	793	.26	768	.22	756	.22	683	.21	751	.21
NP-72	951-1000	766	.40	760	.38	752	.33	793	.32	717	.30	802	.30	740	.24	794	.23	801	.22	744	.22	692	.21
NP-73	941- 990	819	.42	787	.38	770	.35	728	.31	779	.30	702	.29	682	.26	753	.26	754	.25	803	.24	737	.23
NP-73	951-1000	770	.38	694	.37	779	.33	803	.30	746	.28	795	.27	728	.27	767	.27	737	.26	720	.25	696	.22

CHART 6

PART 2: CORRELATIONS WITH NP OAK MASTER SERIES OF ALL SEGMENTS AS ALIGNED AND MEASURED

32-YEAR CUBIC SPLINE FILTER; CORRELATIONS OF 50-YEAR SEGMENTS LAGGED 10 YEARS																									
FLAGS: __A = CORRELATION UNDER 0.3281; __B = CORRELATION HIGHER AT OTHER POSITION																									
0SEQ	SERIES	INTERVAL	920	930	940	950	960	970	980	990	1000	1010	1020	1030	1040	1050	1060	1070	1080	1090	1100	1110	FLAGS/		
			969	979	989	999	1009	1019	1029	1039	1049	1059	1069	1079	1089	1099	1109	1119	1129	1139	1149	1159	TOTAL		
==	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====		
	1 NP-28	928- 995	.23	.33	.42	.54	=	=	=	=															
+			__A																				1/	4	
	2 NP-53	937-1000	=	.44	.48	.51	.51	=	=	=															
+																								0/	4
	3 NP-55	950-1000	=	=	=	.61	.58	=	=	=															
+																								0/	2
	4 NP-58	928-1000	.28	.35	.37	.45	.44	=	=	=															
+			__A																					1/	5

PART 8: DATE ADJUSTMENT FOR BEST MATCHES FOR COUNTED OR UNKNOWN SERIES

Tucson-Mendoza-Hamburg-Lamont ProgLib

NP OAK VS NP OAK ALIGNED

50-YEAR SEGMENTS LAGGED 10 YEARS

SERIES	COUNTED SEGMENT	CORR ADD # 1	CORR ADD # 2	CORR ADD # 3	CORR ADD # 4	CORR ADD # 5	CORR ADD # 6	CORR ADD # 7	CORR ADD # 8	CORR ADD # 9	CORR ADD #10	CORR ADD #11
NP-11	933-982	-1.30	-5.28	13.26	9.14	17.14	1.12	-3.12	15.11	-4.08	14.07	-6.06
NP-11	943-992	-1.25	-2.23	-5.22	-3.14	-7.14	10.12	-6.07	-15.06	9.05	-9.04	-4.04
NP-11	951-1000	-21.32	-5.26	-1.22	-9.19	-3.18	-23.16	-2.16	-7.14	-17.13	-19.09	-15.08
NP-14	907-956	26.23	27.19	28.19	40.16	21.16	24.15	20.14	32.12	25.11	39.11	42.06
NP-14	917-966	24.35	36.22	28.14	13.13	20.12	10.12	12.11	35.09	32.07	31.06	21.06
NP-14	927-976	24.33	10.27	4.17	16.14	13.12	8.09	21.09	17.07	12.06	18.05	20.02
NP-14	937-986	-2.30	10.29	-3.24	-6.22	13.18	16.10	15.10	9.06	-4.06	8.03	11.03
NP-14	947-996	-6.22	-3.21	-18.16	-2.15	-1.12	-17.06	-5.05	-9.05	-14.03	-4.01	-7.01
NP-14	951-1000	-6.21	-1.15	-24.15	-3.15	-2.13	-14.13	-9.10	-18.09	-7.01	-17.01	-11.00
NP-28	932-981	-5.53	18.31	21.17	8.12	5.12	10.12	3.08	6.07	2.06	4.05	9.03
NP-28	942-991	-5.64	-12.21	3.17	2.17	11.15	-14.13	6.11	10.10	8.07	-13.05	4.05
NP-28	951-1000	-5.74	-21.20	-19.19	2.10	-13.09	-12.07	-20.06	-18.05	-14.04	-3.03	-17.02
NP-39	937-986	-8.26	-5.26	12.22	11.16	-3.15	15.14	13.14	9.13	6.12	-7.11	-4.06
NP-39	947-996	-3.31	-5.26	-8.21	-11.19	-17.18	-16.13	-13.12	-4.11	-10.07	6.06	3.06
NP-39	951-1000	-24.32	-8.28	-3.28	-23.17	-11.16	-5.15	-13.14	-17.13	-4.10	-16.09	-10.08
NP-41	941-990	11.32	-3.21	-2.18	-4.16	6.14	0.11	-10.08	-13.06	-5.05	12.03	9.03
NP-41	951-1000	-3.26	-2.21	-22.15	-24.15	-4.14	-17.14	-18.11	0.10	-23.08	-13.07	-10.06
NP-49	936-985	-5.37	10.19	9.18	-8.18	11.16	-6.16	1.09	8.07	12.03	3.02	17.02
NP-49	946-995	-13.24	-5.24	-18.23	-6.22	-12.17	-10.15	-8.13	-14.11	-11.11	2.11	-16.09
NP-49	951-1000	-13.25	-18.25	-10.24	-5.23	-14.17	-16.17	-11.16	-24.13	-6.13	2.11	-12.10
NP-53	937-986	0.73	16.41	8.24	14.24	-2.11	5.05	1.03	9.03	3.02	-10.01	2-.01
NP-53	947-996	0.74	-16.25	-18.22	-2.15	-19.10	-17.10	-14.07	-3.07	1.05	-5.04	-8.03
NP-53	951-1000	0.75	-16.30	-18.28	-23.23	-2.20	-19.17	-17.11	1.10	-14.10	-3.08	-5.01
NP-55	950-999	0.78	-14.28	2.21	-20.20	-16.17	-23.16	-22.13	3.09	-8.09	-18.06	-2.05
NP-55	951-1000	0.77	-14.24	2.21	-16.18	-20.18	-23.17	-22.16	-8.08	-15.08	-18.07	-24.05
NP-58	926-975	2.79	22.27	20.19	25.13	6.12	14.11	4.10	16.09	17.06	15.05	13.05
NP-58	936-985	2.75	6.16	0.15	4.14	17.10	-6.10	16.07	14.07	-9.06	-2.04	13.03
NP-58	946-995	2.72	-14.41	-6.18	5.14	-17.11	6.10	-18.07	-1.06	4.05	-9.04	0.02
NP-58	951-1000	2.74	-14.41	-21.29	-6.23	-17.15	-22.14	-1.10	-9.05	-3.03	-24.03	-12.02
NP-61	917-966	30.26	21.16	17.15	22.12	19.12	16.09	36.09	31.08	32.03	27.03	11.02
NP-61	927-976	21.37	7.29	8.27	5.23	1.16	19.16	3.14	23.13	6.08	24.05	16.03
NP-61	937-986	7.37	8.31	5.27	3.18	-10.14	16.06	-5.05	6.04	4.03	-7.03	-6.02
NP-61	947-996	-18.32	5.26	-8.20	-19.18	-20.13	4.11	-6.09	-7.09	-10.08	-4.08	-16.07
NP-61	951-1000	-18.30	-20.19	-21.19	-8.15	-4.13	-7.13	-16.13	-10.11	-22.08	-2.05	-6.03

CHART 7

PART 2: CORRELATIONS WITH NP-28,49 OAK MASTER SERIES OF ALL SEGMENTS AS ALIGNED AND MEASURED

32-YEAR CUBIC SPLINE FILTER; CORRELATIONS OF 50-YEAR SEGMENTS LAGGED 10 YEARS

		FLAGS: __A = CORRELATION UNDER 0.3281; __B = CORRELATION HIGHER AT OTHER POSITION																					
0SEQ	SERIES	INTERVAL	930	940	950	960	970	980	990	1000	1010	1020	1030	1040	1050	1060	1070	1080	1090	1100	1110	1120	FLAGS/
			979	989	999	1009	1019	1029	1039	1049	1059	1069	1079	1089	1099	1109	1119	1129	1139	1149	1159	1169	TOTAL
	1 NP-28	936-1000	.44	.42	.39	.36	=	=	=														0/ 4
+	2 NP-49	936-1000	.44	.42	.39	.36	=	=	=														0/ 4
+																							

PART 8: DATE ADJUSTMENT FOR BEST MATCHES FOR COUNTED OR UNKNOWN SERIES

Tucson-Mendoza-Hamburg-Lamont ProgLib

NP OAK VS NP-28,49 ALIGNED
50-YEAR SEGMENTS LAGGED 10 YEARS

SERIES	COUNTED SEGMENT	CORR ADD # 1	CORR ADD # 2	CORR ADD # 3	CORR ADD # 4	CORR ADD # 5	CORR ADD # 6	CORR ADD # 7	CORR ADD # 8	CORR ADD # 9	CORR ADD #10	CORR ADD #11
NP-11	933- 982	4 .28	7 .17	3 .17	11 .16	9 .13	15 .11	8 .10	5 .08	13 .07	12 .06	14 .05
NP-11	943- 992	-9 .28	4 .25	7 .18	3 .17	8 .14	6 .07	5 .04	-7 .02	-5 .01	-10 .03	-4 .06
NP-11	951-1000	-9 .27	-16 .20	-13 .14	-14 .12	-15 .12	-7 .07	-12 .06	-17 .03	-18 .02	-10 .00	-4 .04
NP-14	907- 956	29 .26	31 .23	26 .22	33 .16	44 .15	32 .13	40 .11	30 .06	35 .06	34 .04	27 .02
NP-14	917- 966	29 .30	26 .24	33 .19	30 .14	18 .14	32 .10	27 .07	22 .07	23 .03	17 .03	28 .01
NP-14	927- 976	6 .19	22 .16	5 .15	18 .14	9 .12	7 .11	14 .06	23 .03	10 .03	13 .01	21 .05
NP-14	937- 986	6 .26	2 .18	3 .18	10 .16	14 .13	11 .09	5 .08	-1 .05	0 .05	7 .01	4 .00
NP-14	947- 996	2 .15	-12 .13	3 .12	-14 .11	-13 .11	0 .09	4 .08	-10 .07	-4 .05	-1 .01	-9 .01
NP-14	951-1000	-14 .14	-12 .13	-13 .13	-18 .12	-19 .09	-1 .09	-10 .09	0 .05	-4 .04	-9 .03	-6 .01
NP-28	932- 981	0 .83	13 .12	1 .12	15 .10	2 .03	19 .00	3 .00	9 .01	8 .02	7 .06	11 .06
NP-28	942- 991	0 .84	-7 .18	-6 .09	-1 .07	1 .05	-2 .05	-4 .03	3 .03	8 .01	-9 .01	-3 .00
NP-28	951-1000	0 .86	-7 .16	-6 .10	-3 .06	-8 .05	-16 .03	-15 .02	-2 .01	-1 .00	-13 .01	-10 .03
NP-39	937- 986	1 .24	8 .22	7 .18	2 .13	9 .08	-5 .08	0 .07	12 .06	3 .03	4 .02	11 .00
NP-39	947- 996	2 .27	1 .26	-12 .19	-11 .16	-8 .16	-5 .12	0 .08	-10 .06	3 .05	-3 .01	4 .01
NP-39	951-1000	-18 .26	-8 .17	-11 .17	-12 .15	-5 .13	0 .06	-16 .03	-10 .00	-9 .02	-19 .02	-3 .03
NP-41	941- 990	-8 .25	8 .24	-5 .14	1 .12	-7 .12	6 .11	2 .09	-9 .08	9 .07	3 .06	5 .00
NP-41	951-1000	-8 .29	-12 .27	-5 .12	-11 .12	-7 .11	-10 .10	-18 .04	-17 .00	-4 .00	-13 .01	-16 .05
NP-49	936- 985	0 .85	4 .18	6 .11	13 .06	1 .06	-1 .03	8 .01	-4 .01	15 .01	7 .01	-2 .02
NP-49	946- 995	0 .82	-13 .18	2 .10	4 .08	-1 .08	1 .03	-8 .00	-3 .02	-6 .03	-5 .04	-4 .04
NP-49	951-1000	0 .79	-13 .19	-19 .11	-15 .03	-1 .03	-8 .02	-6 .01	-16 .01	-5 .01	-17 .01	-2 .02
NP-53	937- 986	5 .30	13 .24	14 .16	11 .15	6 .14	-4 .13	-5 .09	-2 .09	-3 .05	8 .04	0 .01
NP-53	947- 996	-11 .23	-9 .20	-8 .16	-13 .15	-10 .13	-4 .12	-2 .12	-5 .08	-3 .07	0 .06	-1 .04
NP-53	951-1000	-8 .20	-13 .18	-10 .16	-11 .15	-9 .15	-4 .12	-5 .11	-2 .09	0 .03	-17 .03	-18 .02
NP-55	950- 999	-10 .26	-18 .22	-8 .18	-2 .16	-9 .14	-3 .12	-6 .05	-17 .05	-5 .04	-12 .02	-11 .00
NP-55	951-1000	-10 .27	-18 .23	-2 .18	-8 .16	-9 .13	-3 .11	-19 .09	-17 .08	-12 .06	-6 .06	-11 .01
NP-58	926- 975	14 .33	7 .26	20 .17	10 .16	8 .14	12 .12	18 .10	16 .10	21 .04	11 .01	19 .03
NP-58	936- 985	14 .31	7 .26	10 .18	12 .16	-4 .13	-3 .11	-1 .10	15 .08	13 .08	11 .01	4 .01
NP-58	946- 995	-9 .25	-4 .21	-1 .16	-8 .15	-3 .08	-5 .05	-12 .01	-2 .03	-7 .04	4 .06	-11 .06
NP-58	951-1000	-16 .31	-9 .28	-4 .22	-1 .21	-8 .13	-3 .08	-19 .04	-12 .02	-5 .00	-17 .01	-2 .03
NP-61	917- 966	19 .23	26 .16	21 .09	22 .09	27 .09	17 .08	30 .04	33 .01	34 .02	25 .04	16 .05
NP-61	927- 976	13 .36	19 .20	20 .14	14 .12	6 .07	8 .06	21 .06	12 .03	24 .01	17 .00	18 .01
NP-61	937- 986	13 .41	-5 .20	12 .13	3 .11	-2 .08	-4 .08	14 .05	2 .03	0 .02	8 .02	6 .02
NP-61	947- 996	-15 .16	-13 .16	-5 .13	0 .11	-2 .10	-14 .09	-4 .07	3 .06	-3 .05	2 .05	-1 .04
NP-61	951-1000	-17 .25	-15 .24	-2 .20	-19 .16	-13 .15	-16 .14	-5 .11	-10 .06	0 .05	-4 .04	-3 .00

CHART 8

PART 2: CORRELATIONS WITH NP-39,41 OAK MASTER SERIES OF ALL SEGMENTS AS ALIGNED AND MEASURED

32-YEAR CUBIC SPLINE FILTER; CORRELATIONS OF 50-YEAR SEGMENTS LAGGED 10 YEARS

FLAGS: _A = CORRELATION UNDER 0.3281; _B = CORRELATION HIGHER AT OTHER POSITION

0SEQ SERIES	INTERVAL	930	940	950	960	970	980	990	1000	1010	1020	1030	1040	1050	1060	1070	1080	1090	1100	1110	1120	FLAGS/TOTAL
		979	989	999	1009	1019	1029	1039	1049	1059	1069	1079	1089	1099	1109	1119	1129	1139	1149	1159	1169	
1 NP-39	941-1000	=	.55	.59	.61	=	=	=														0/ 3
+ 2 NP-41	941-1000	=	.55	.59	.61	=	=	=														0/ 3

PART 8: DATE ADJUSTMENT FOR BEST MATCHES FOR COUNTED OR UNKNOWN SERIES

Tucson-Mendoza-Hamburg-Lamont ProgLib

NP OAK VS NP-39,41 ALIGNED
50-YEAR SEGMENTS LAGGED 10 YEARS

SERIES	COUNTED SEGMENT	CORR ADD # 1	CORR ADD # 2	CORR ADD # 3	CORR ADD # 4	CORR ADD # 5	CORR ADD # 6	CORR ADD # 7	CORR ADD # 8	CORR ADD # 9	CORR ADD #10	CORR ADD #11
NP-11	933- 982	4 .17	16 .09	18 .05	13 .03	12 .03	9 .01	15 .00	11-.02	7-.02	17-.04	5-.05
NP-11	943- 992	3 .36	2 .32	1 .31	-4 .16	-5 .15	4 .14	7 .01	-1 .00	-2-.02	5-.05	6-.13
NP-11	951-1000	-4 .18	-5 .09	-13 .04	-2 .02	-12 .01	-1 .00	0-.09	-8-.13	-10-.14	-6-.15	-11-.16
NP-14	907- 956	34 .17	33 .17	44 .10	36 .07	35 .07	38 .07	39 .06	43 .03	30 .02	32-.05	42-.07
NP-14	917- 966	21 .20	28 .17	34 .13	30 .12	24 .04	25 .02	26 .02	27 .00	31-.01	33-.05	23-.05
NP-14	927- 976	21 .21	10 .14	17 .12	24 .08	13 .07	18 .07	11 .01	23-.01	19-.06	22-.07	16-.07
NP-14	937- 986	4 .32	2 .23	13 .10	10 .05	1 .00	7-.02	14-.04	12-.05	5-.06	6-.06	3-.07
NP-14	947- 996	4 .36	-2 .31	2 .21	-1 .17	-9 .13	-10 .12	-3 .05	1 .04	-4 .02	-8-.04	-7-.05
NP-14	951-1000	-2 .22	-9 .16	-1 .08	-8 .08	-3 .03	-4 .03	-10 .03	-7 .01	-13-.07	-14-.08	0-.09
NP-28	932- 981	11 .30	10 .21	12 .12	9 .11	5 .09	8 .09	18 .05	13-.01	7-.05	16-.08	19-.11
NP-28	942- 991	-1 .17	8 .17	5 .15	-2 .15	9-.01	-3-.04	1-.04	3-.04	-4-.08	2-.11	6-.12
NP-28	951-1000	-2 .26	-8 .23	-1 .16	-9 .15	-11 .13	-12 .05	-14 .02	-3 .01	-10-.02	-5-.05	-7-.05
NP-39	937- 986	0 .93	14 .09	1 .07	6 .05	12 .05	8 .02	13 .01	2-.05	7-.06	11-.08	3-.08
NP-39	947- 996	0 .91	-1 .10	-2 .09	2 .05	1 .04	-3-.01	-6-.02	-8-.05	-5-.07	-9-.08	3-.09
NP-39	951-1000	0 .92	-1 .08	-2 .04	-14 .03	-6 .02	-3-.02	-12-.03	-11-.04	-8-.05	-7-.05	-13-.06
NP-41	941- 990	0 .84	1 .13	-1 .08	2 .07	-2 .00	4-.01	6-.03	3-.03	5-.04	9-.06	8-.10
NP-41	951-1000	0 .87	-14 .14	-11 .04	-6 .04	-1 .03	-9 .02	-2 .02	-12-.01	-13-.03	-8-.07	-3-.14
NP-49	936- 985	12 .27	8 .25	5 .10	11 .05	14 .00	10-.02	9-.09	7-.09	1-.10	13-.14	4-.14
NP-49	946- 995	-8 .24	-1 .17	-3 .17	-2 .16	-5 .12	5 .11	-4 .10	0 .08	-7 .06	-6 .04	-9-.15
NP-49	951-1000	-8 .28	-1 .16	-3 .14	-5 .13	-2 .12	-7 .09	-6 .08	-4 .07	-10 .04	0 .04	-12 .01
NP-53	937- 986	13 .32	8 .27	5 .19	3 .12	11 .08	7 .07	1-.01	6-.01	4-.07	10-.08	9-.09
NP-53	947- 996	3 .23	-1 .12	-9 .11	-3 .10	-10 .08	-6 .04	1 .01	0-.02	4-.08	2-.14	-8-.14
NP-53	951-1000	-11 .34	-12 .31	-9 .14	-1 .10	-3 .09	-14 .06	0 .02	-10 .02	-13 .01	-6-.01	-8-.08
NP-55	950- 999	-11 .22	-13 .21	-12 .17	-9 .16	-10 .07	-6 .02	0 .01	-1-.06	-4-.07	-3-.08	-7-.10
NP-55	951-1000	-11 .22	-9 .20	-13 .19	-12 .13	-10 .09	-14 .05	0 .05	-6 .03	-7-.06	-4-.08	-1-.08
NP-58	926- 975	25 .21	19 .21	13 .13	24 .10	11-.02	17-.03	18-.05	12-.05	21-.06	15-.09	22-.10
NP-58	936- 985	5 .21	13 .19	6 .19	7 .18	8 .07	12 .07	4 .05	9 .03	2 .02	11 .01	10-.02
NP-58	946- 995	-9 .22	5 .21	2 .11	-4 .08	4 .08	-7 .03	-6-.05	3-.07	1-.09	-1-.10	-5-.11
NP-58	951-1000	-11 .32	-12 .26	-9 .24	-13 .21	-4 .09	-10 .05	-7-.01	-6-.05	-1-.07	0-.08	-14-.12
NP-61	917- 966	24 .39	32 .16	25 .16	30 .14	26 .08	34 .06	27-.01	29-.01	23-.05	33-.09	31-.10
NP-61	927- 976	24 .40	12 .37	10 .17	11 .15	13 .13	18 .10	14 .03	23-.03	16-.07	19-.11	21-.13
NP-61	937- 986	12 .39	11 .27	13 .18	10 .16	14 .10	5 .06	6 .04	1 .03	4 .03	8-.05	3-.06
NP-61	947- 996	-5 .24	-10 .21	-8 .18	1 .15	-6 .04	-7 .02	-1 .00	-3-.01	3-.02	4-.05	-9-.05
NP-61	951-1000	-5 .25	-10 .22	-8 .16	-7 .08	-11 .05	-9 .04	-1 .03	-6 .02	-13 .01	-3-.03	-12-.08

CHART 9

PART 8: DATE ADJUSTMENT FOR BEST MATCHES FOR COUNTED OR UNKNOWN SERIES

Tucson-Mendoza-Hamburg-Lamont ProgLib

NP OAK VS CONNECTICUT RIVER VALLEY OF MASSACHUSETTS OAK MASTER
 50-YEAR SEGMENTS LAGGED 10 YEARS

SERIES	COUNTED SEGMENT	CORR ADD # 1	CORR ADD # 2	CORR ADD # 3	CORR ADD # 4	CORR ADD # 5	CORR ADD # 6	CORR ADD # 7	CORR ADD # 8	CORR ADD # 9	CORR ADD #10	CORR ADD #11
NP-11	933- 982	716 .57	740 .37	848 .35	850 .34	855 .34	662 .33	798 .32	773 .31	694 .30	738 .30	794 .29
NP-11	943- 992	716 .62	798 .44	677 .35	848 .33	832 .33	738 .32	697 .31	855 .28	662 .28	717 .27	666 .26
NP-11	951-1000	716 .62	717 .38	677 .35	798 .34	802 .34	697 .33	775 .30	662 .29	834 .29	750 .27	852 .27
NP-14	907- 956	787 .49	843 .37	749 .36	687 .33	765 .32	659 .30	692 .29	734 .29	799 .29	786 .26	771 .26
NP-14	917- 966	843 .39	703 .33	717 .33	816 .32	688 .32	692 .30	821 .27	813 .25	878 .24	795 .24	687 .23
NP-14	927- 976	688 .39	843 .38	717 .34	816 .30	813 .29	739 .29	676 .27	719 .27	743 .26	703 .26	791 .25
NP-14	937- 986	717 .53	697 .34	851 .33	719 .33	775 .33	813 .30	641 .30	676 .29	661 .27	849 .27	843 .27
NP-14	947- 996	717 .48	775 .40	719 .38	641 .32	697 .32	813 .31	852 .30	691 .30	789 .29	676 .28	816 .27
NP-14	951-1000	717 .47	641 .35	719 .35	617 .33	775 .32	695 .31	789 .30	813 .30	691 .30	754 .30	673 .29
NP-28	932- 981	814 .51	798 .39	863 .34	841 .31	690 .28	875 .28	787 .28	843 .27	652 .26	822 .26	651 .24
NP-28	942- 991	814 .56	845 .37	798 .37	651 .36	807 .33	863 .28	690 .27	784 .26	682 .23	822 .23	785 .23
NP-28	951-1000	814 .57	651 .42	746 .34	713 .33	845 .32	784 .32	762 .28	620 .28	852 .26	630 .25	775 .25
NP-39	937- 986	713 .42	715 .40	853 .34	659 .34	698 .32	642 .29	682 .28	785 .26	732 .25	661 .25	870 .24
NP-39	947- 996	715 .46	713 .39	734 .33	698 .33	661 .32	748 .30	642 .30	795 .27	659 .26	682 .23	853 .23
NP-39	951-1000	715 .47	713 .36	748 .34	661 .34	698 .29	830 .29	793 .28	795 .28	642 .26	659 .26	682 .25
NP-41	941- 990	715 .45	642 .38	659 .36	830 .35	698 .33	643 .31	850 .30	853 .29	735 .29	681 .29	631 .26
NP-41	951-1000	715 .51	678 .39	850 .35	830 .35	642 .33	817 .32	643 .31	682 .30	698 .27	659 .27	848 .26
NP-49	936- 985	814 .50	690 .41	768 .35	790 .32	743 .28	642 .27	686 .25	862 .24	670 .24	712 .23	755 .23
NP-49	946- 995	814 .41	743 .39	690 .35	790 .35	829 .34	862 .33	731 .30	764 .26	686 .26	732 .25	658 .25
NP-49	951-1000	814 .45	743 .44	790 .37	829 .37	746 .35	712 .34	731 .33	727 .32	618 .30	690 .30	844 .28
NP-53	937- 986	819 .36	672 .35	803 .34	687 .34	790 .33	828 .31	718 .31	759 .30	661 .29	835 .27	804 .25
NP-53	947- 996	718 .46	819 .42	803 .31	661 .31	687 .31	759 .30	723 .30	701 .29	702 .28	633 .27	629 .25
NP-53	951-1000	819 .44	718 .43	701 .35	803 .35	702 .32	704 .31	633 .29	617 .28	681 .27	751 .27	629 .24
NP-55	950- 999	819 .45	835 .39	718 .33	681 .32	687 .30	633 .29	664 .29	853 .27	754 .26	857 .26	701 .26
NP-55	951-1000	819 .41	835 .40	718 .34	633 .31	754 .30	804 .27	687 .27	857 .26	751 .25	806 .25	725 .24
NP-58	926- 975	821 .50	747 .40	723 .33	739 .30	773 .27	819 .26	669 .26	685 .26	687 .26	794 .25	724 .25
NP-58	936- 985	821 .51	724 .43	782 .36	859 .35	723 .32	700 .30	665 .28	630 .28	805 .27	757 .25	739 .25
NP-58	946- 995	821 .57	859 .43	650 .43	805 .39	782 .36	666 .35	723 .32	839 .32	854 .29	700 .29	686 .27
NP-58	951-1000	821 .56	650 .48	666 .41	805 .41	723 .39	854 .38	782 .34	649 .30	839 .29	700 .29	753 .28
NP-61	917- 966	739 .45	725 .44	799 .38	882 .35	880 .34	871 .29	833 .28	696 .28	849 .27	801 .27	685 .27
NP-61	927- 976	725 .52	739 .37	688 .35	728 .32	878 .32	750 .32	772 .29	857 .29	685 .29	860 .29	785 .29
NP-61	937- 986	725 .50	772 .43	727 .40	858 .36	739 .34	688 .34	749 .33	738 .33	785 .32	761 .30	857 .29
NP-61	947- 996	725 .50	727 .39	726 .38	785 .36	772 .35	738 .33	739 .32	623 .31	811 .31	858 .29	797 .28
NP-61	951-1000	725 .48	727 .44	797 .32	726 .31	739 .31	623 .30	785 .30	772 .29	738 .29	688 .28	809 .27

CHART 10

PART 8: DATE ADJUSTMENT FOR BEST MATCHES FOR COUNTED OR UNKNOWN SERIES

Tucson-Mendoza-Hamburg-Lamont ProgLib

NP WHITE PINE VS DEERFIELD WHITE PINE MASTER-REFINED
50-YEAR SEGMENTS LAGGED 10 YEARS

SERIES	COUNTED SEGMENT	CORR ADD # 1	CORR ADD # 2	CORR ADD # 3	CORR ADD # 4	CORR ADD # 5	CORR ADD # 6	CORR ADD # 7	CORR ADD # 8	CORR ADD # 9	CORR ADD #10	CORR ADD #11
NP-19	942- 991	713 .42	743 .34	678 .34	752 .30	808 .30	730 .29	819 .29	869 .29	788 .29	745 .29	681 .28
NP-19	951-1000	661 .43	730 .43	808 .35	659 .34	710 .33	678 .33	700 .31	839 .29	690 .29	713 .28	752 .28
NP-21	930- 979	814 .41	736 .38	877 .35	714 .31	797 .30	758 .27	795 .25	706 .24	702 .24	882 .24	863 .24
NP-21	940- 989	814 .61	782 .38	736 .36	667 .35	719 .35	706 .32	673 .31	815 .27	780 .27	781 .26	758 .26
NP-21	950- 999	706 .48	814 .48	831 .36	725 .36	673 .34	782 .33	780 .29	868 .29	758 .28	744 .27	705 .27
NP-21	951-1000	814 .48	706 .43	831 .36	780 .34	725 .33	782 .33	673 .33	868 .29	704 .27	705 .27	736 .26
NP-63	952-1000	820 .48	860 .39	804 .39	810 .36	763 .35	701 .35	787 .33	829 .32	762 .31	770 .31	819 .30

PART 8: DATE ADJUSTMENT FOR BEST MATCHES FOR COUNTED OR UNKNOWN SERIES

Tucson-Mendoza-Hamburg-Lamont ProgLib

NP HEMLOCK VS CONNECTICUT RIVER VALLEY OF MASSACHUSETTS HISTORIC HEMLOCK MASTER
50-YEAR SEGMENTS LAGGED 25 YEARS

SERIES	COUNTED SEGMENT	CORR ADD # 1	CORR ADD # 2	CORR ADD # 3	CORR ADD # 4	CORR ADD # 5	CORR ADD # 6	CORR ADD # 7	CORR ADD # 8	CORR ADD # 9	CORR ADD #10	CORR ADD #11
NP-34	883- 932	813 .49	765 .34	851 .34	717 .31	703 .28	827 .27	907 .25	718 .24	924 .24	753 .24	763 .24
NP-34	908- 957	813 .47	734 .36	703 .35	713 .29	751 .28	851 .28	749 .27	903 .25	717 .25	907 .24	692 .23
NP-34	933- 982	813 .43	886 .39	808 .36	758 .36	700 .34	783 .34	869 .30	838 .29	728 .29	695 .28	730 .26
NP-34	951-1000	700 .51	813 .49	750 .39	828 .37	775 .32	838 .31	794 .30	789 .28	871 .28	808 .27	722 .26

Appendix A

Sample location descriptions compiled by Myron Stachiw during sampling session 7/29/2024

Parsons House
Historic Northampton
Dendrochronology samples taken July 29, 2024

William A. Flynt
Eric Gradoia

List prepared by Myron O. Stachiw

Phase 1 - Original two-story, single pile, center-chimney house

- NP-12 - Garret - Tie beam in west gable end at its north end (EG)
- NP-13 - Garret - Joist - 1st joist to east of east chimney girt (WF)
- NP-14 - Garret - - Post - Northwest corner post of house, taken from west wing garret (EG)
- NP-15 - East Cellar - North sill from just east of doorway from Rm 102 to 109 (EG)
- NP-16 - West cellar beneath Rm 112 - large N-S hewn pine timber atop east wall of cellar (EG)

Phase 3 - Rear pile raised to two full stories, new roof

- NP-20 - Garret - South roof slope, purlin post at east gable end (WF)
- NP-21 - Garret - South roof slope, east purlin, near 2nd purlin post from the east gable end (WF)
- NP-22 - Garret - South roof slope, purlin post at west gable end (EG)
- NP-23 - Garret - South roof slope, west purlin, near west gable end (EG)
- NP-24 - Garret - North roof slope, purlin post at west gable end (EG)
- NP-25 - Garret - North roof slope, purlin near west gable end and purlin post (EG)
- NP-26 - Garret - North roof slope, purlin post at east gable end (WF)
- NP-27 - Garret - North roof slope, purlin at east gable end (WF)
- NP-28 - Garret - North roof slope, purlin post brace at west gable end (EG)
- NP-29 - Garret - South roof slope, purlin post just east of chimney (EG)
- NP-30 - Garret - rear pile (north bay), tie beam #1 in west gable end (EG)
- NP-31 - Garret - rear pile (north bay), tie beam #4 in east gable end (WF)
- NP-32 - Garret - rear pile (north bay), tie beam #2, 2nd east of west gable end (EG)
- NP-33 - Garret - rear pile (north bay), tie beam #3, 3rd east of west gable end (WF)
- NP-34 - Garret - North roof slope, rafter min east gable end (WF)
- NP-35 - Garret - rear pile (north bay), joist #1, first joist east of west gable end (EG)
- NP-36 - Garret - North roof slope, 6th rafter from west gable end (WF)
- NP-37 - Garret - rear pile (north bay), joist #2, 2nd joist east of west gable end (EG)
- NP-38 - Garret - South roof slope, rafter #8 from West gable end (WF)
- NP-39 - Garret - rear pile (north bay), joist #5, 5th joist east of west gable end (reused rafter with purlin pockets) (EG)
- NP-40 - Garret - South roof slope, 6th rafter from east gable end (WF)
- NP-41 - Garret - rear pile (north bay), joist #7, first joist east of west gable end (reused rafter with purlin pockets) (EG)
- NP-42 - Garret - South roof slope, 3rd rafter from east gable end (WF)
- NP-43 - Garret - South roof slope, 1st rafter in east gable end (WF)
- NP-44 - Garret - rear pile (north bay), joist #13, last joist east of west gable end, 1st joist from east gable end (WF)

- NP-45 - Garret – rear pile (north bay), 8th joist east of west gable end (reused rafter with purlin pockets) (EG)
- NP-46 – Garret, west ridge pole, ~4 ft. from west gable end (WF)
- NP-47 - Garret, east ridge pole, ~3 ft. from east gable end (WF)
- NP-48 - Garret, South roof slope, brace to purlin post immediately west of the chimney (EG)
- NP-49 – Stud in the North wall of the raised rear wall of the rear pile of the house, accessed from the garret of the kitchen ell – 2nd stud from the NE corner post of the raised rear pile (WF)
- NP-49A – Post inserted above the rear plate of the Phase 2 rear lean-to raising the rear pile to 2 stories, accessed from the kitchen ell garret, post located immediately west of the opening in the north wall of the rear staircase to the 2nd floor of the house from Rm 104 (WF)

West Wing (Phase 4)

- NP-50 –Garret - South roof slope, rafter in West gable end (WF)
- NP-51- Garret - West gable end, central stud behind chimney (3rd stud of 5 in west gable end) (WF)
- NP-52 – Garret – large E-W joist, 1st North of South plate (EG)
- NP-53 – Garret – South roof slope, 4th rafter from West gable end (WF)
- NP-54 – Garret - large E-W joist, 1st South of North plate (EG)
- NP-55 – Garret – North roof slope, 5th rafter from West gable end (WF)
- NP- 56 - Garret – North roof slope, 6th rafter from West gable end (WF)
- NP-57 – ground floor framing, North sill (WF)
- NP-58 - ground floor framing, N-S beam east of the fireplace hearth and chimney on the west wall of the west wing (WF)

Phase 2 – One-story rear lean-to

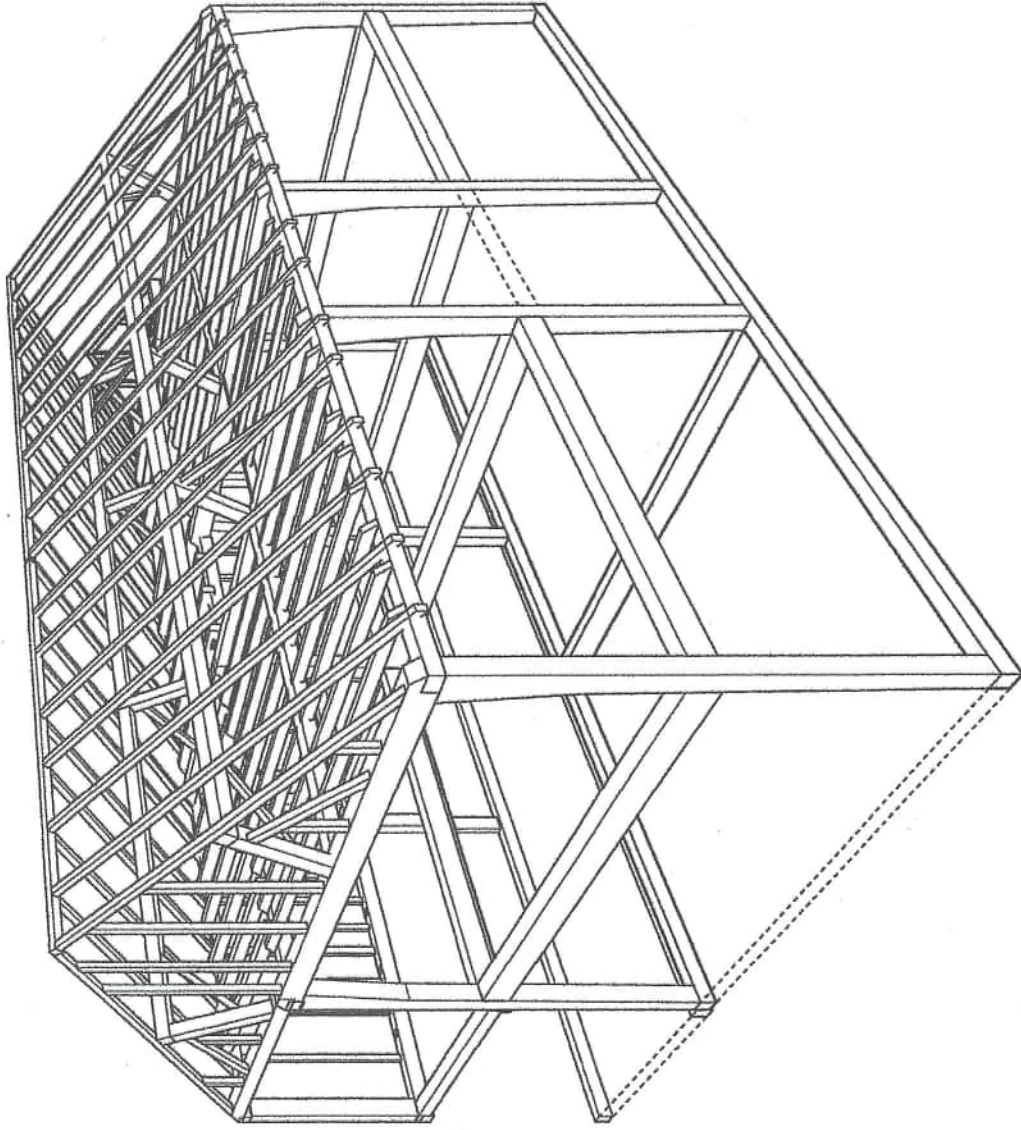
- NP-60 – North plate of the lean-to, north upper edge, accessed through the opening in the north wall of the rear staircase to the second floor from Rm 104 (EG)
- NP-61 – Post in the North wall of Rm 109 just east of doorway – reused oak post, partially cut away on its lower half, inner face (EG)
- NP-62 – N-S tie beam/girt in ceiling situated just to east of post (sample NP-61) – sample too short (EG)
- NP-63 – North sill of the lean-to, accessed from the cellar below the rear kitchen ell (reused former plate) (EG)
- NP-64 – South sill of lean-to from the East cellar (EG)
- NP-65 – 2nd round log joist from the west end of the rear lean-to (accessed in the stairwell from Rm 109 to the west cellar (EG)

Rear Kitchen ell (Phase 4)

- NP-70 – Garret – ridge pole (WF)
- NP-71 – Cellar, timber platform supporting kitchen chimney mass, 3rd timber from the North (WF)
- NP-72 - Cellar, timber platform supporting kitchen chimney mass, 1st timber from the South (EG)
- NP-73 - Cellar, timber platform supporting kitchen chimney mass, 2nd timber from the South (EG)

Appendix B

Sample locations delineated on Parsons house framing plans compiled by Nevan Carling,
Little King Timber Works, LLC



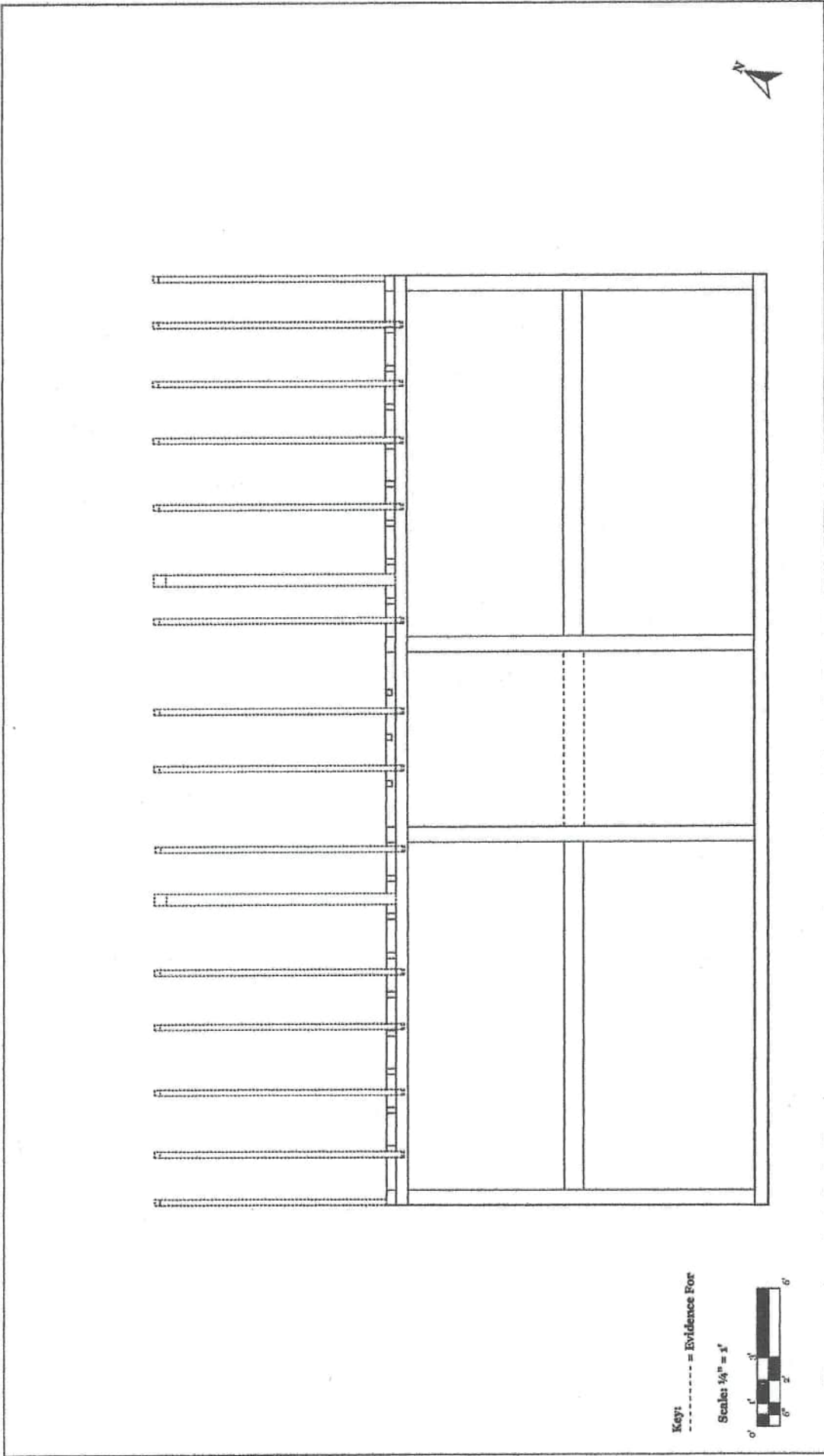
*Studs, joists, and braces only included
where measured



Joseph Parsons House C.17 19
Northampton, Massachusetts

Drawn By: Nevan Carling
Little King Timber works, LLC

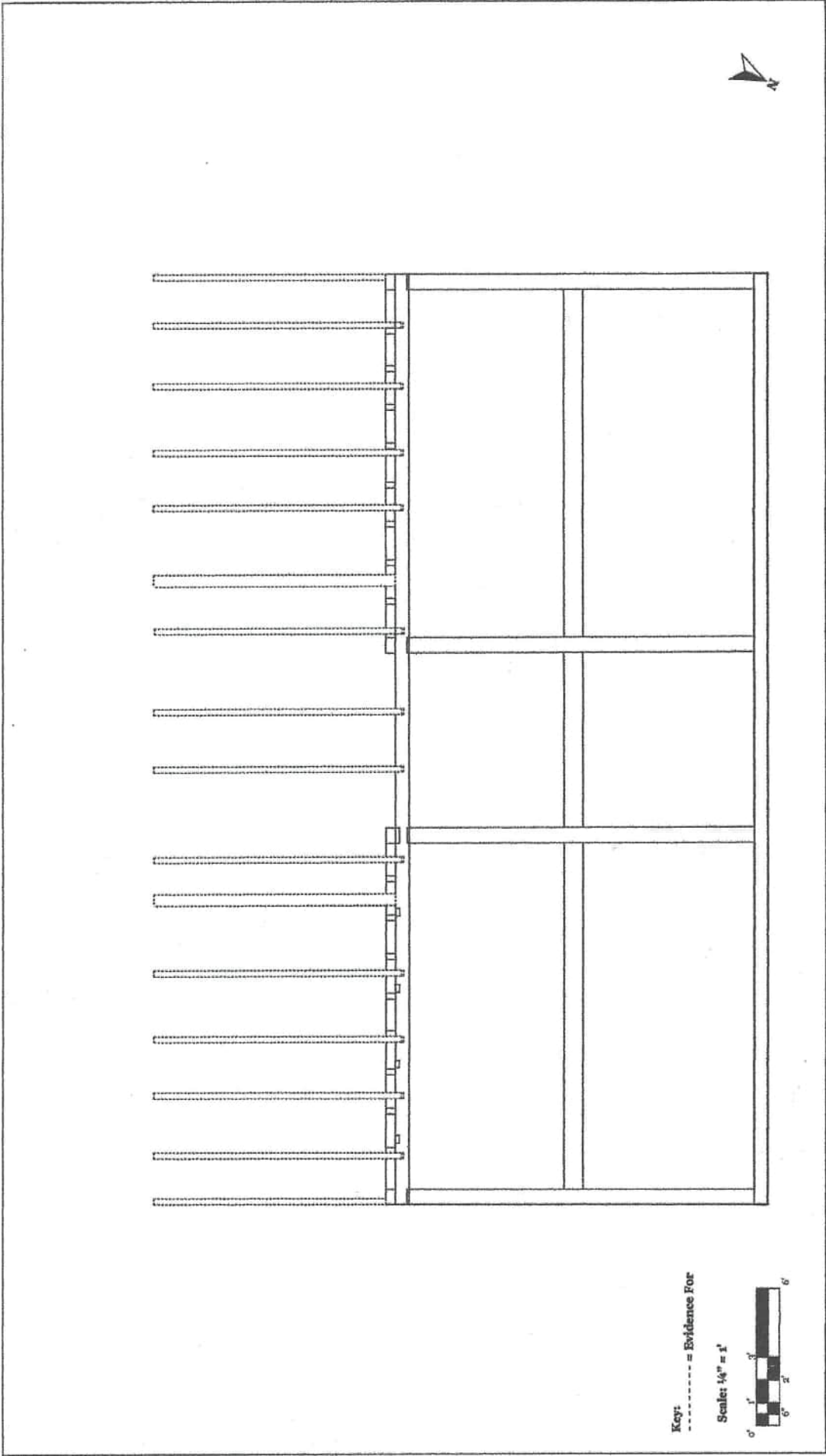
July 21, 2024



REVISIONS		REMARKS
1	MM/DD/YY	1. Special Survey Study and Tools Added on South Section Viewed from Outside
2	12/12/24	2. Special Survey Study and Tools Added on South Section Viewed from Outside
3	12/12/24	3. Special Survey Study and Tools Added on South Section Viewed from Outside
4	12/12/24	4. Special Survey Study and Tools Added on South Section Viewed from Outside
5	12/12/24	5. Special Survey Study and Tools Added on South Section Viewed from Outside



Joseph Parsons House C. 1719
Northampton, Massachusetts

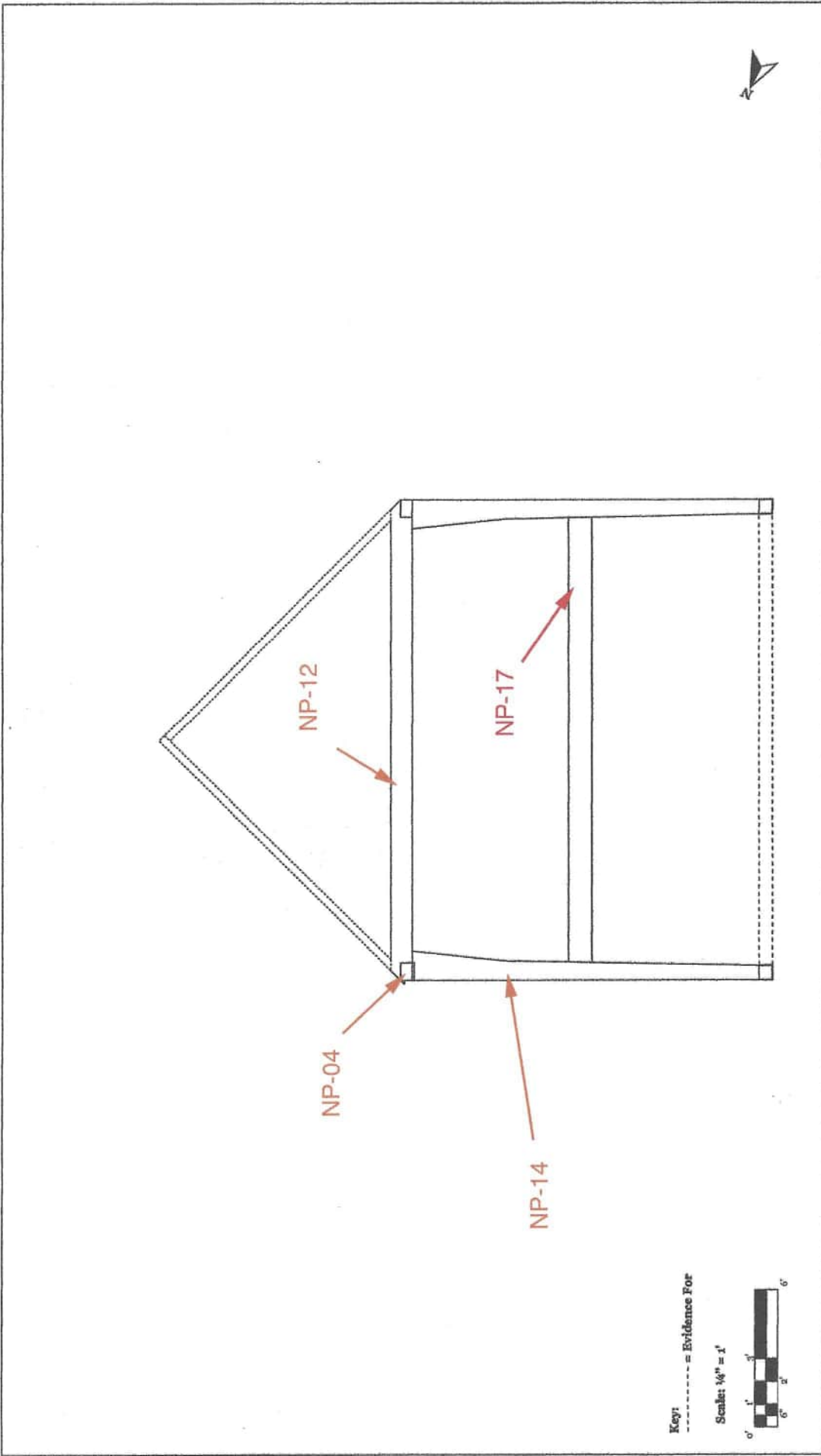


Key: ----- = Evidence For

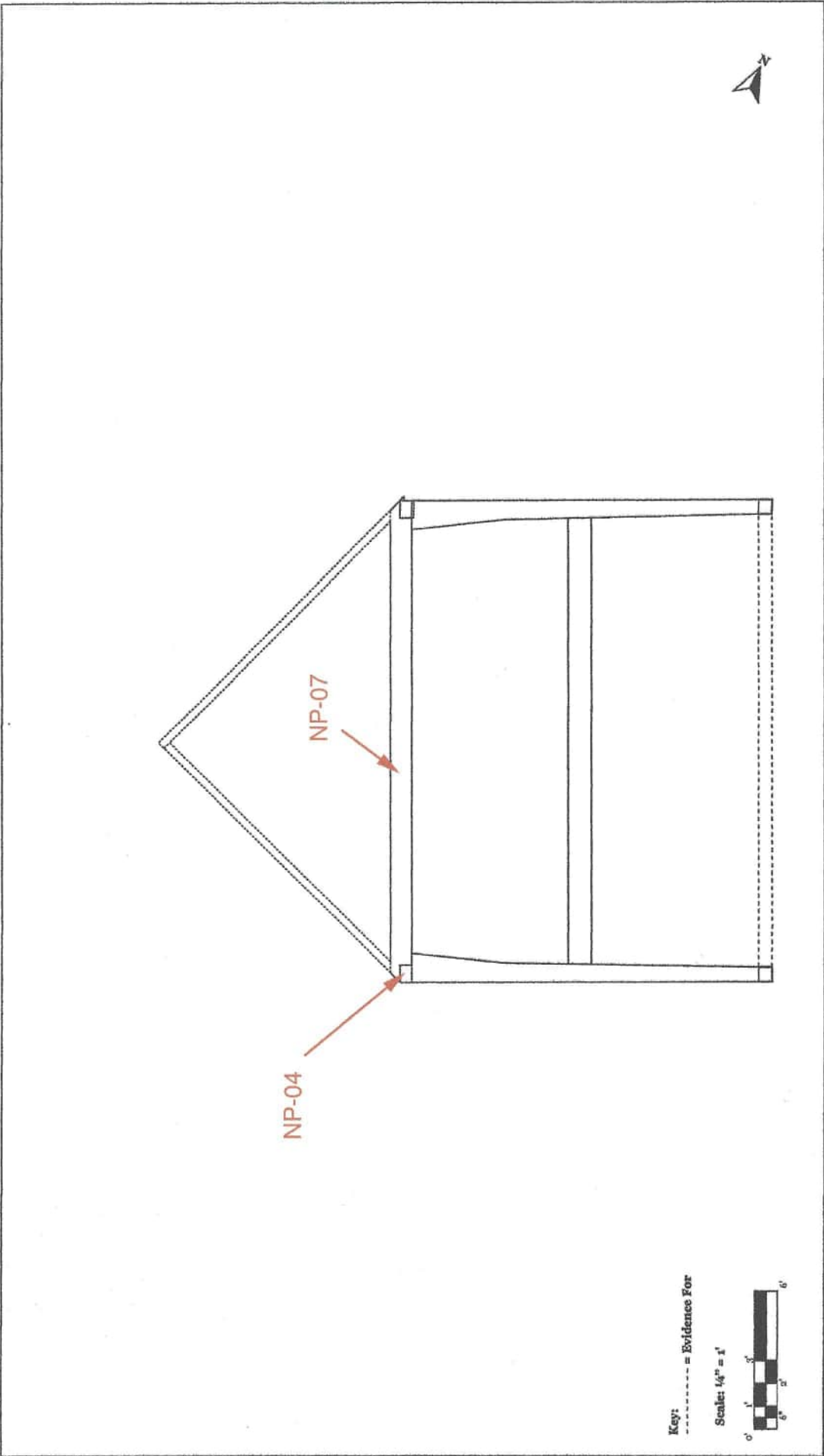
Scale: 1/4" = 1'



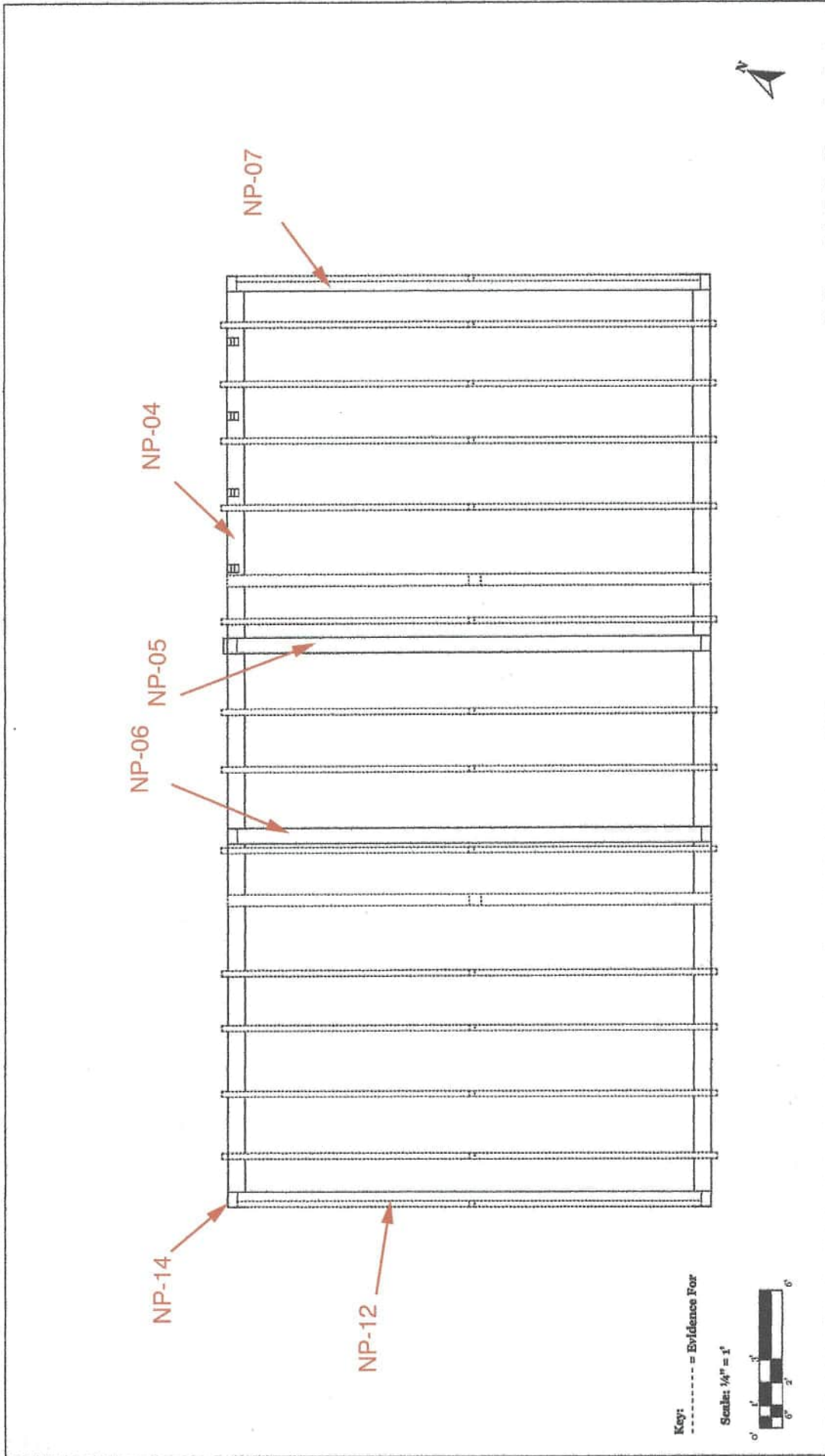
Section of North Elevation Viewed from Outside (Phase I)			Joseph Parsons House C. 1719 Northampton, Massachusetts		A	
			REVISIONS		REMARKS	
			MM/DD/YY		17/07/74	
			1		Pg Second Story Study and Plans Added on North Section Viewed from Outside	
			2			
			3			
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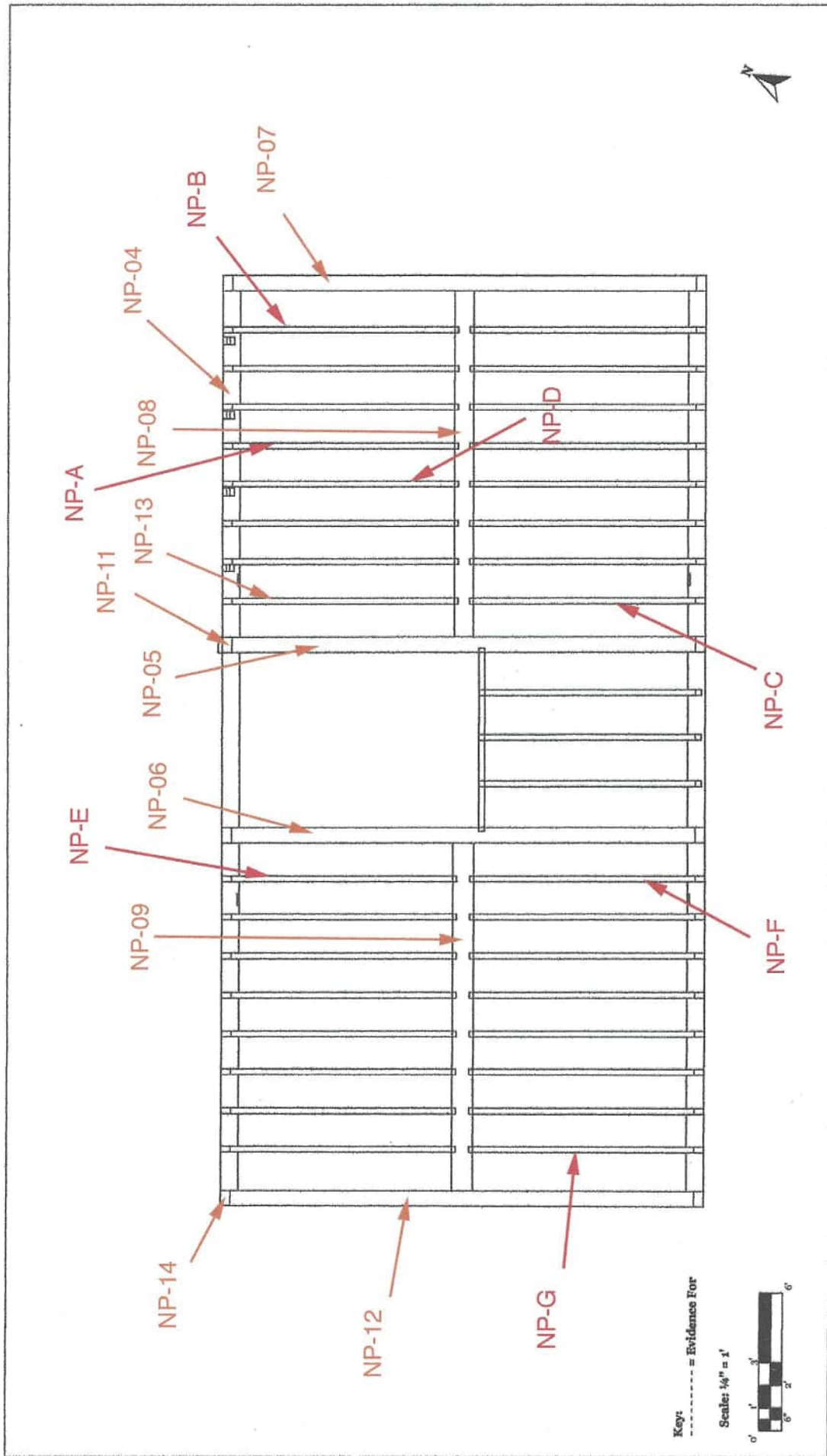
West Gable Viewed from Outside (Phase I)		Joseph Parsons House C. 1719 Northampton, Massachusetts		A	
				03	
REVISIONS		REMARKS			
NO.	DATE	BY	REVISION		
1	12/07/14		Per Second Story Study and Plans Added on North Section Viewed from Outside		
2					
3					
4					
5					



East Gable Viewed from Outside (Phase I)		Joseph Parsons House C. 1719 Northampton, Massachusetts		A	04
REVISIONS		DATE	BY	REMARKS	
1	17/07/2014	17/07/2014	17/07/2014	17/07/2014	17/07/2014
2	17/07/2014	17/07/2014	17/07/2014	17/07/2014	17/07/2014
3	17/07/2014	17/07/2014	17/07/2014	17/07/2014	17/07/2014
4	17/07/2014	17/07/2014	17/07/2014	17/07/2014	17/07/2014
5	17/07/2014	17/07/2014	17/07/2014	17/07/2014	17/07/2014

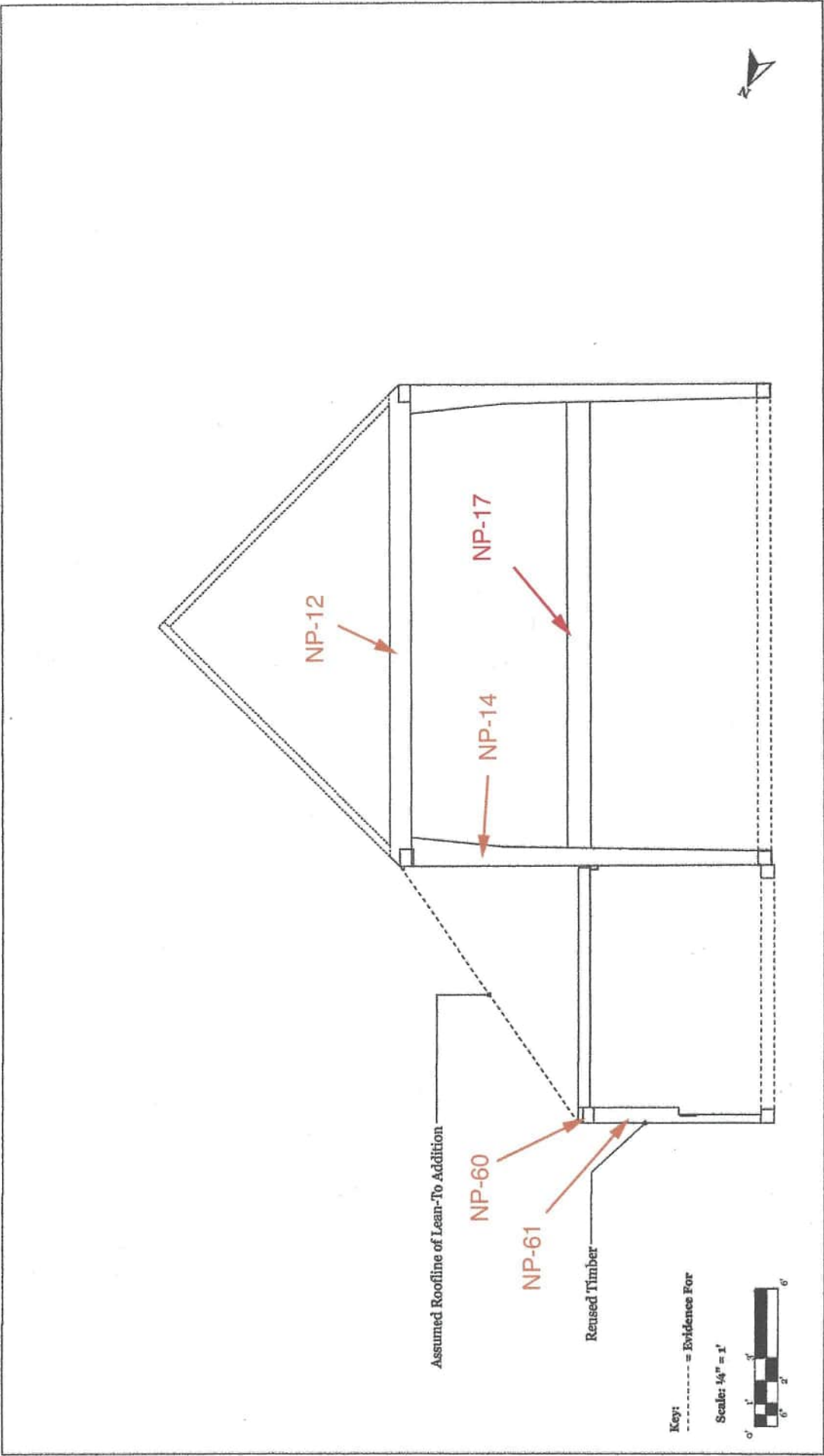


Birdseye Attic Framing without Joists and Summers (Phase I)				Joseph Parsons House C. 1719 Northampton, Massachusetts		A
REVISIONS						50
		DATE/TITLE	REMARKS			
1	17	10/1/14	Fig Second Storey Stairs and Posts Added on North Section Viewed from Outside			
2	18	10/1/14				
3	19	10/1/14				
4	20	10/1/14				
5	21	10/1/14				
6	22	10/1/14				
7	23	10/1/14				
8	24	10/1/14				
9	25	10/1/14				



REVISIONS	
NO.	REMARKS
1	17/07/24
2	17/07/24
3	17/07/24
4	17/07/24
5	17/07/24

Joseph Parsons House C. 1719 Northampton, Massachusetts	
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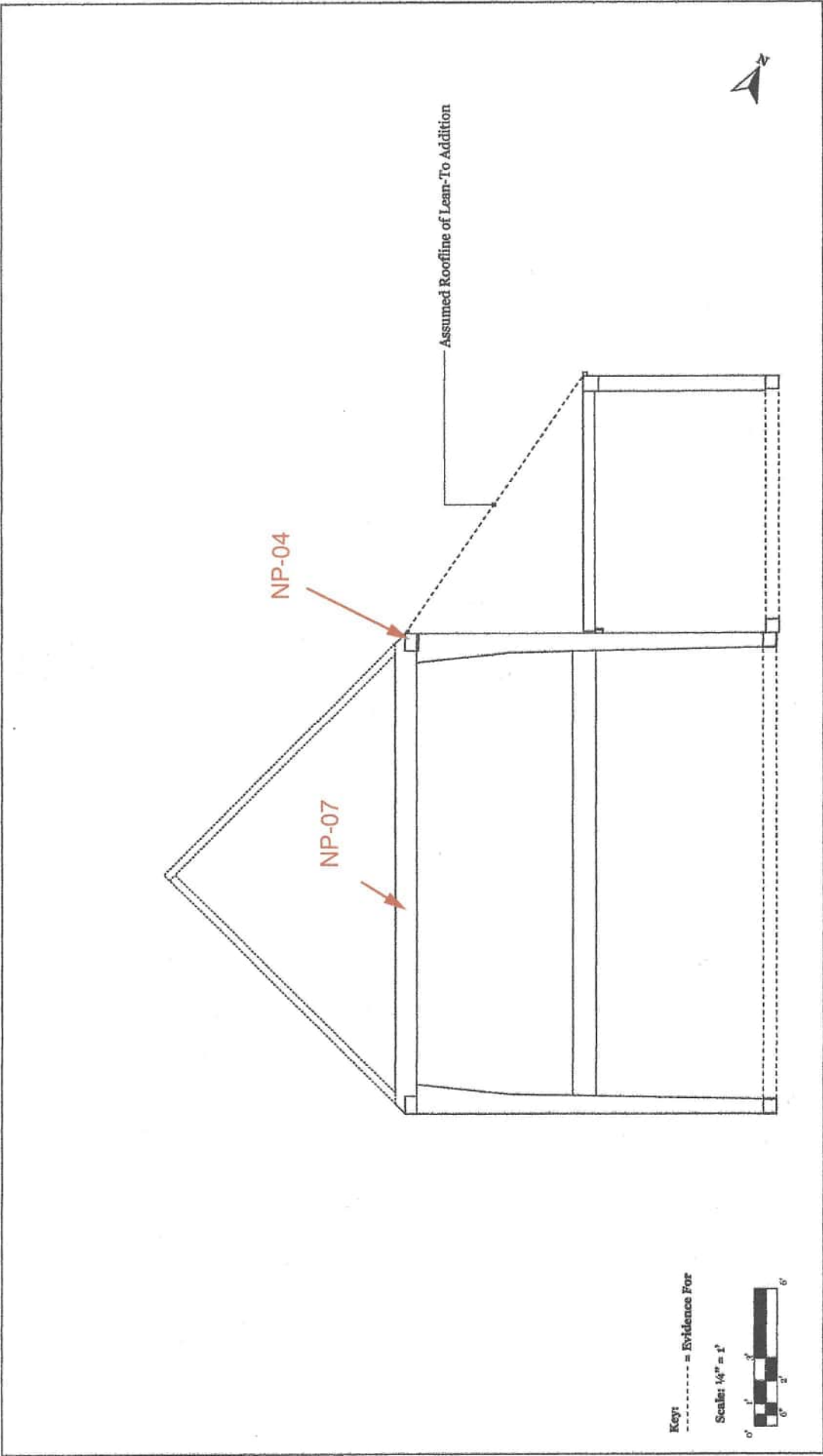


REVISIONS		
MM/DD/YY	DESCRIPTION	BY
12/17/2014	Final Drawing	...
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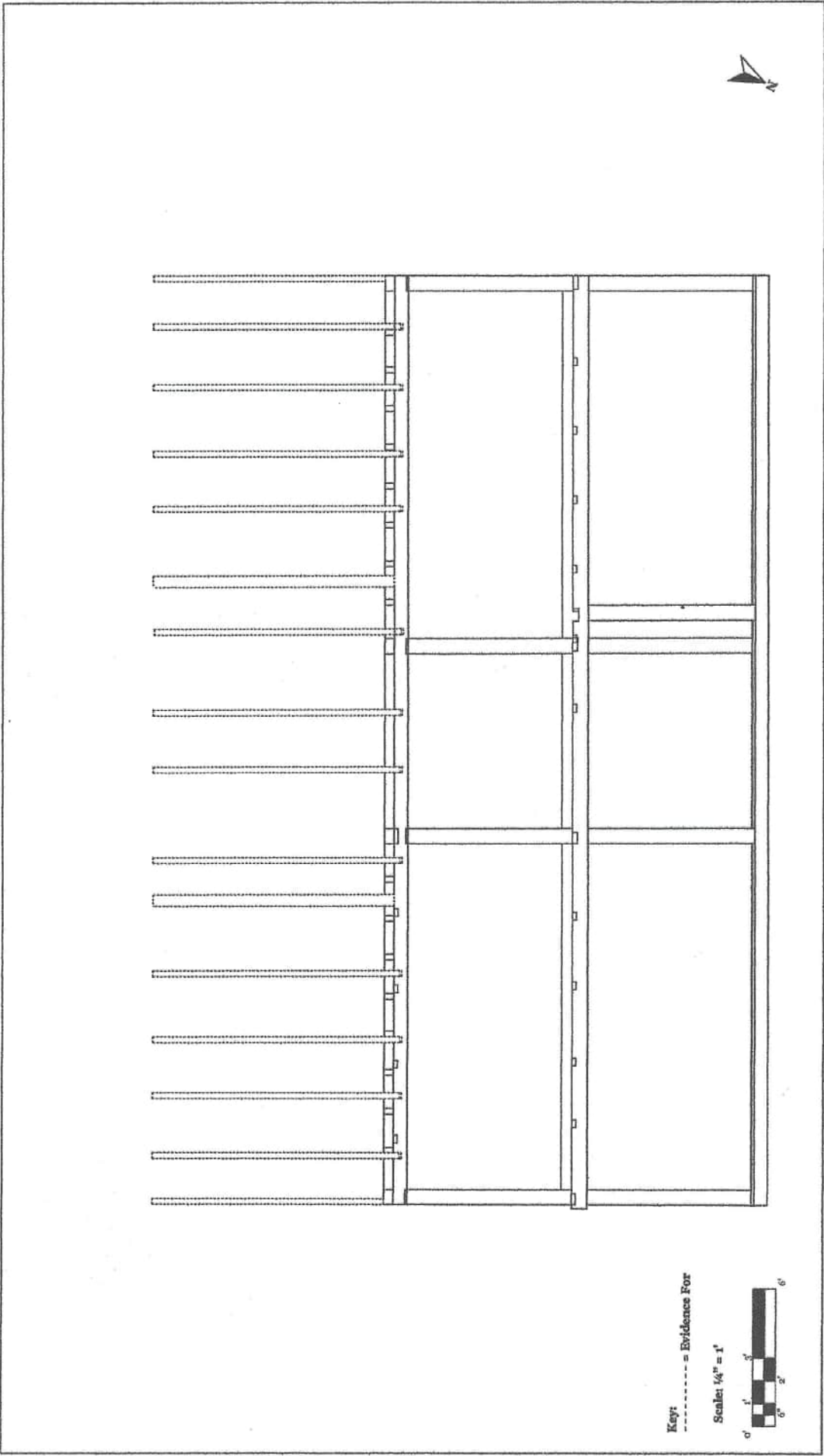


Joseph Parsons House C. 1719
Northampton, Massachusetts

West Gable Viewed from Outside
(Phase II)



80		A	
East Gable Viewed from Outside (Phase II)		Joseph Parsons House C. 1719 Northampton, Massachusetts	
REVISIONS		REMARKS	
1	ML/DP/PP	17/10/24	1) Second Story Stairs and Porch Added on North Section Viewed from Outside
2			
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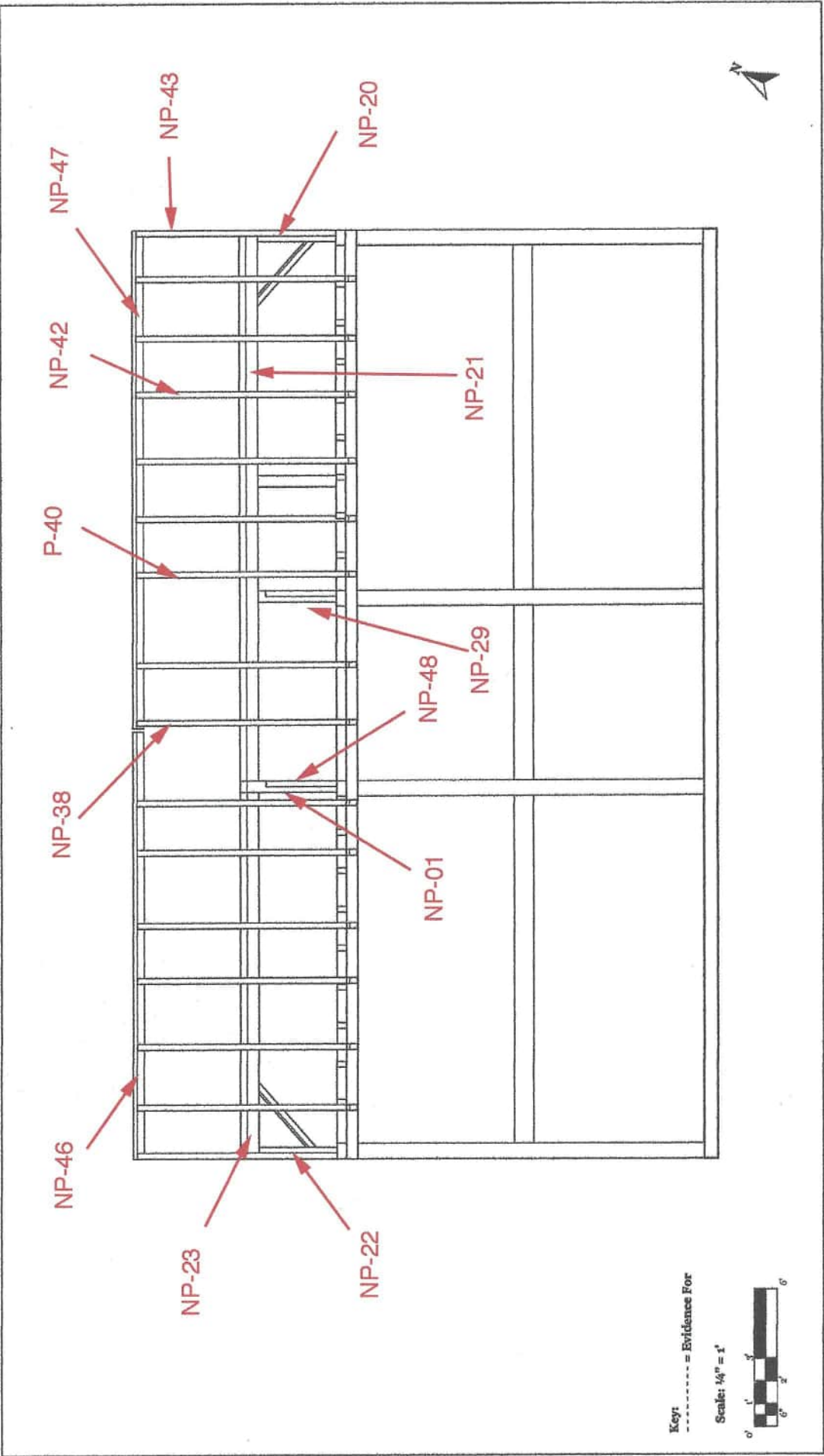


Key: ----- = Evidence For

Scale: 1/8" = 1'



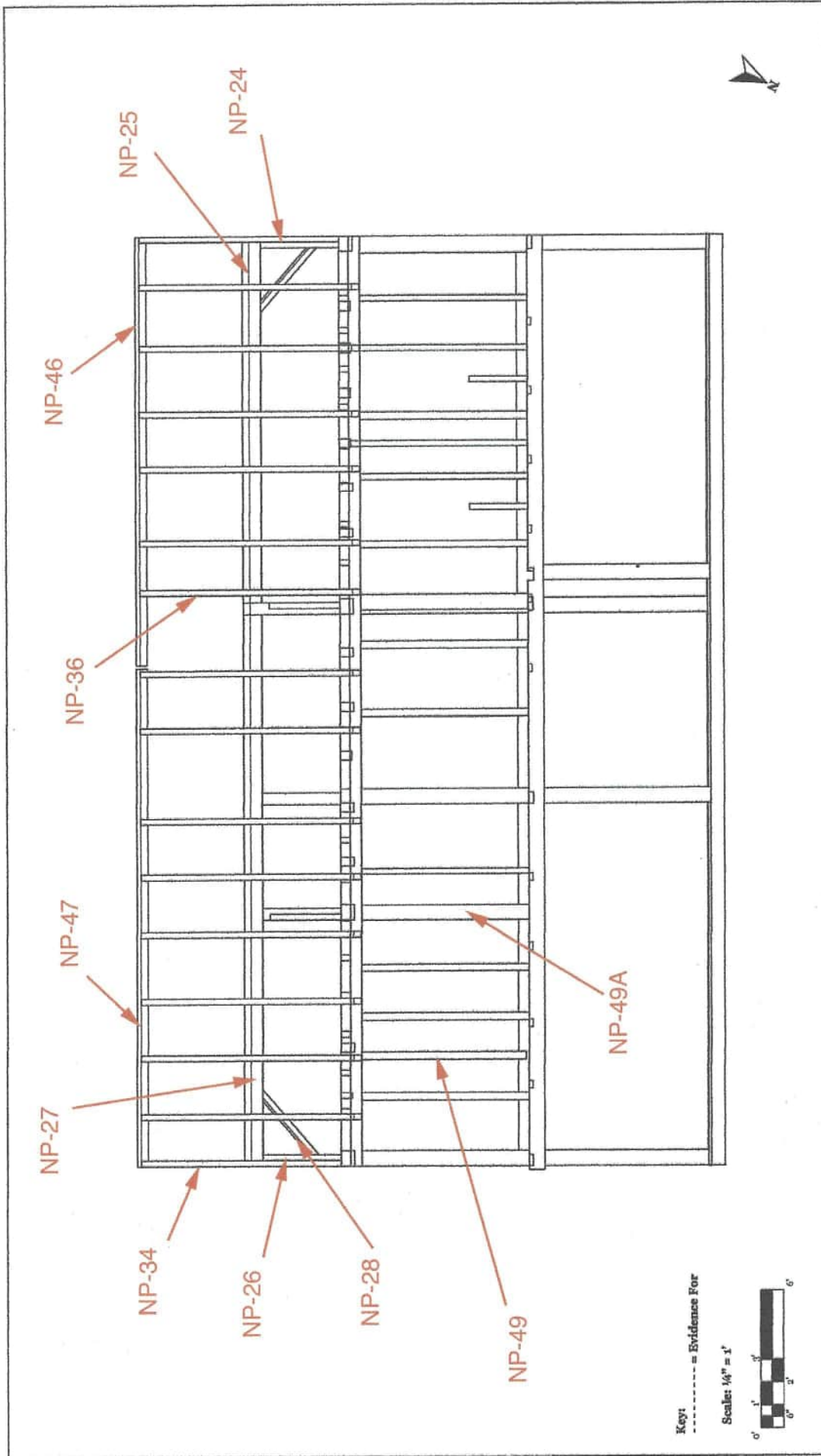
Section of North Elevation Viewed from Outside (Phase II)		Joseph Parsons House C. 1719 Northampton, Massachusetts		A	
REVISIONS		REMARKS		60	
NO.	DATE	BY	REVISIONS		
1	12/17/24	PH	Second floor gable and Porch Added on North Section Viewed from Outside		
2					
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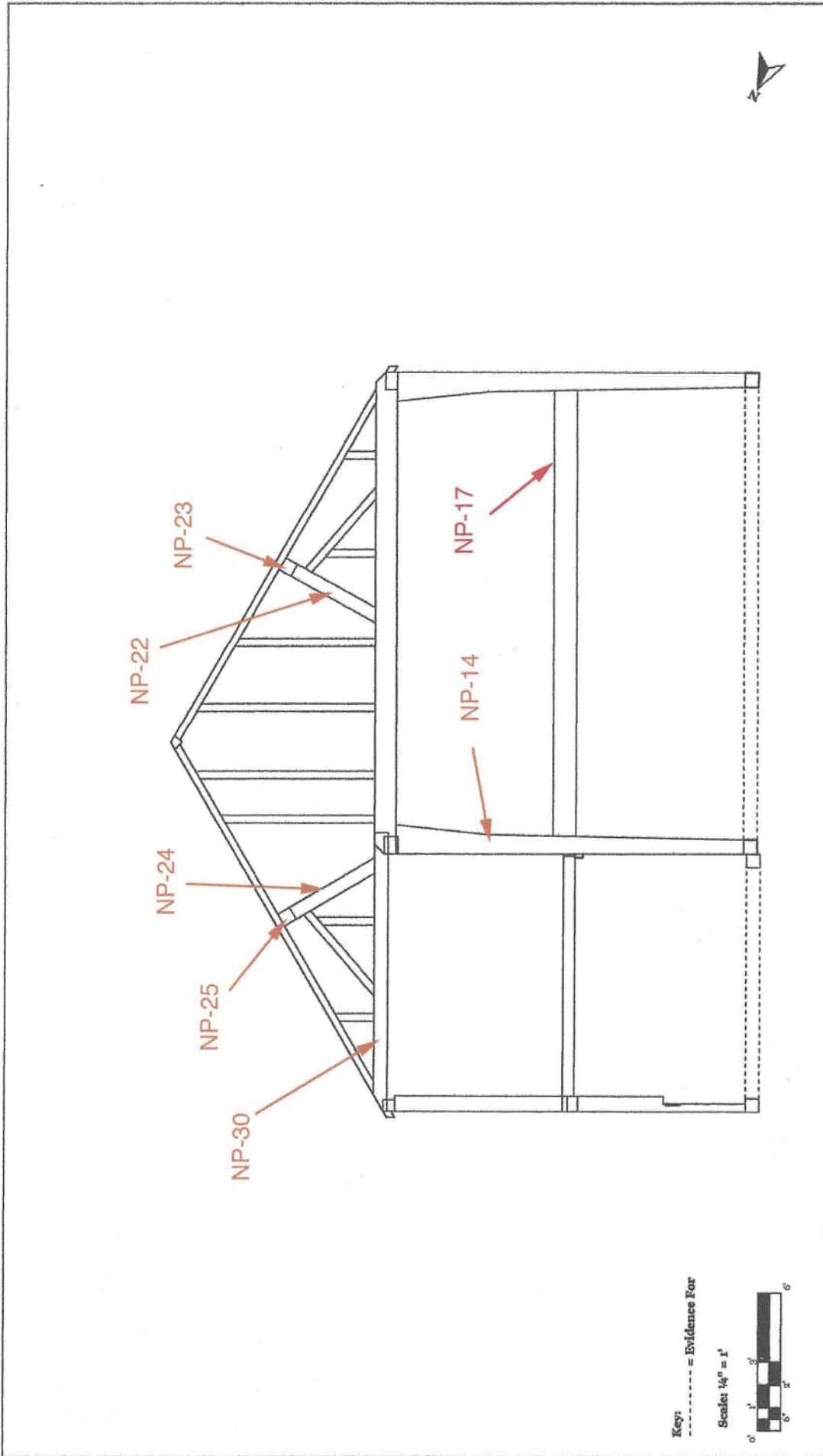
REVISIONS		REMARKS
NO.	DATE	DESCRIPTION
1	12/12/24	Final Second Story Study and Points Added on North Section Viewed from Outside
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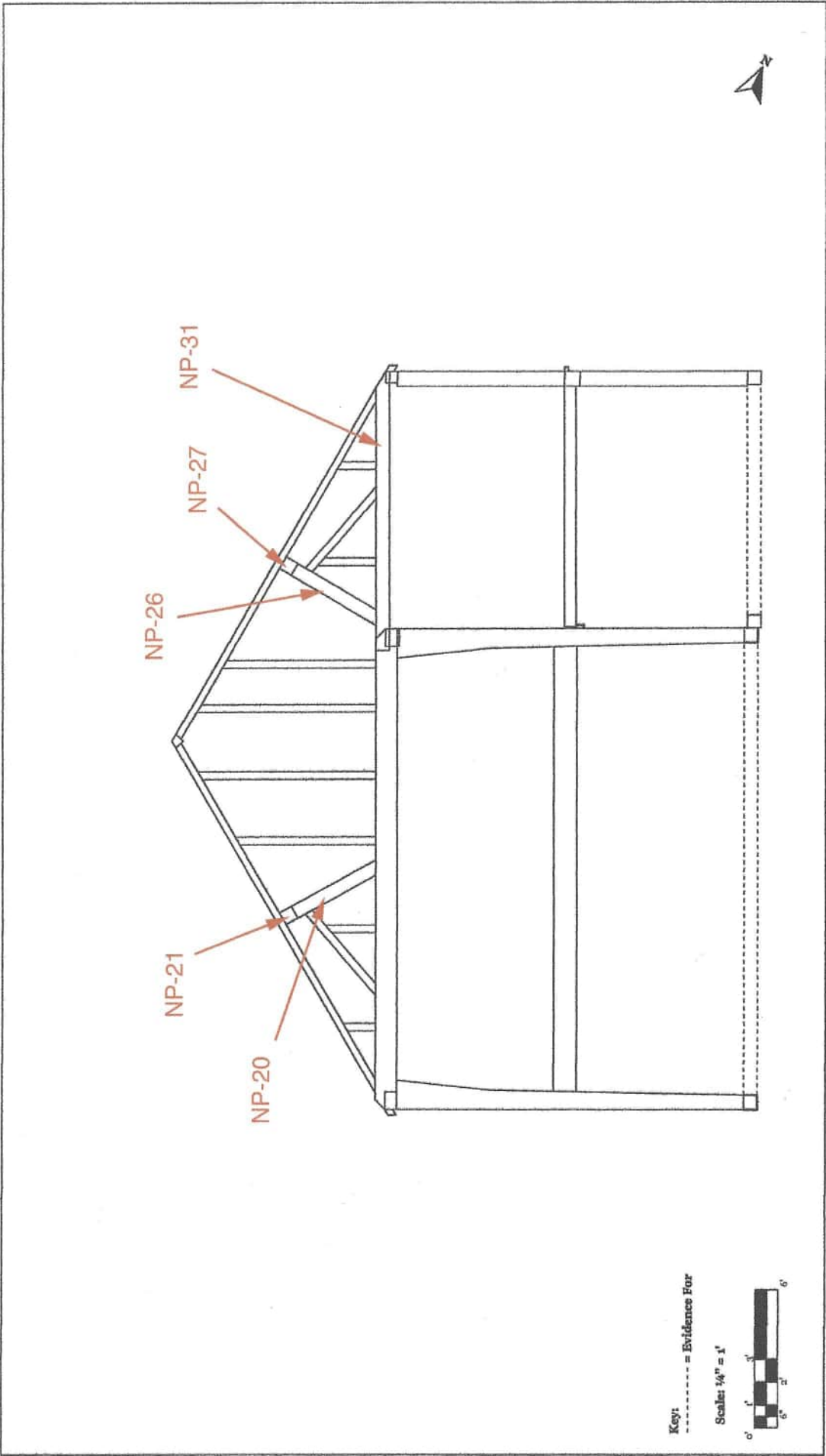
Joseph Parsons House C. 1719
Northampton, Massachusetts



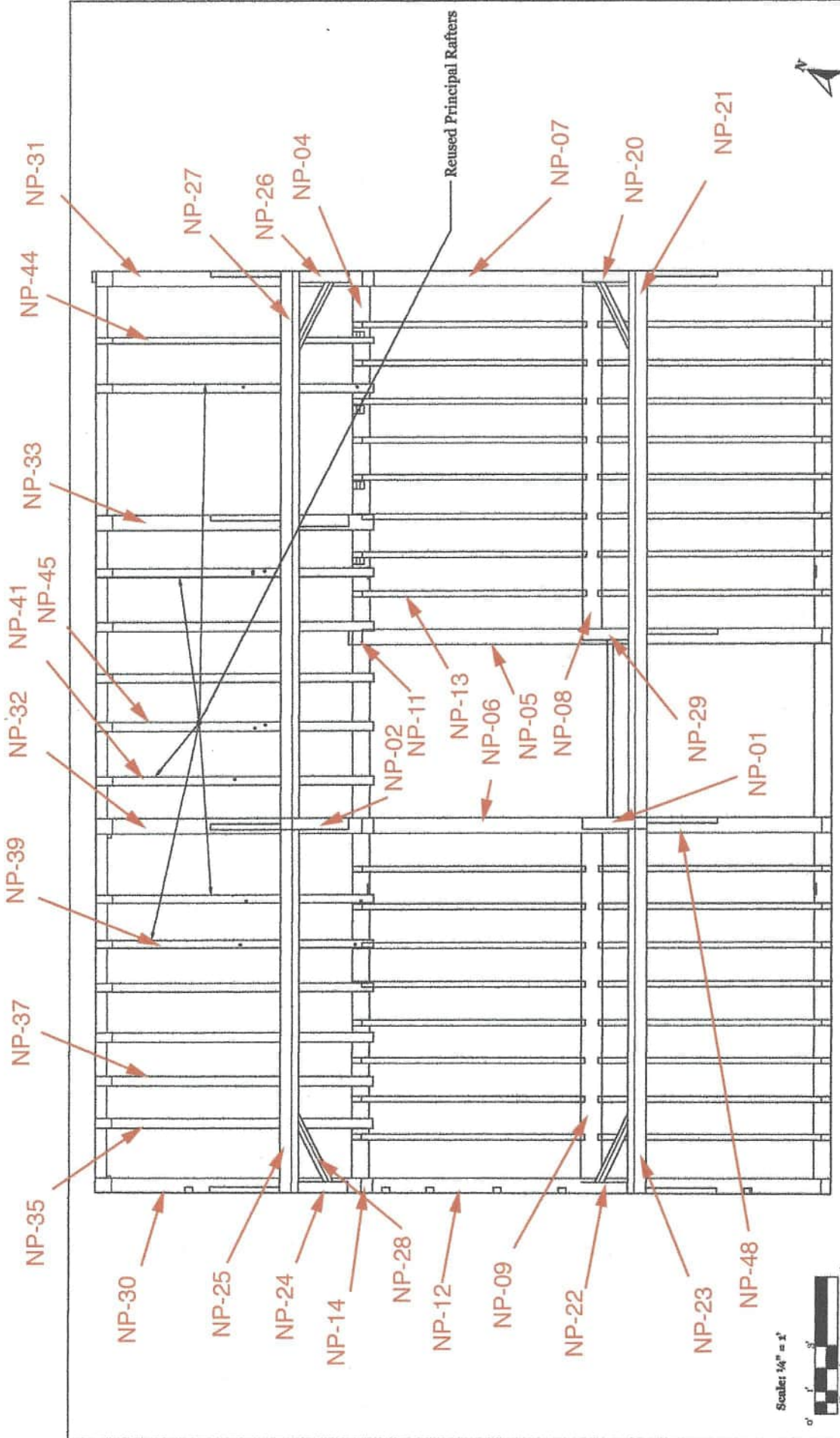
Section of North Elevation Viewed from Outside (Phase III)		Joseph Parsons House C. 1719 Northampton, Massachusetts		A	
REVISIONS		REMARKS		11	
1	MM/10/11	P1 Second Story Study and Details Added on North Section Viewed from Outside			
2	12/17/14				
3					
4					
5					



A		12	
West Gable Viewed from Outside (Phase III)		REVISIONS	
		DATE	REMARKS
Joseph Parsons House C. 1719 Northampton, Massachusetts		1	17/07/04
		2	18/07/04
		3	18/07/04
		4	18/07/04
		5	18/07/04
		18 Second Story Study and Plans Added on North Section Viewed from Outside	



A		13	
East Gable Viewed from Outside (Phase III)		Joseph Parsons House C. 1719 Northampton, Massachusetts	
NO.	DATE	REVISIONS	REMARKS
1	12/12/74		1st Second Story Study and Photo Added on North Section Viewed from Outside
2	1/10/75		
3	1/10/75		
4	1/10/75		
5	1/10/75		
6	1/10/75		
7	1/10/75		
8	1/10/75		
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12	1/10/75		
13	1/10/75		
14	1/10/75		
15	1/10/75		

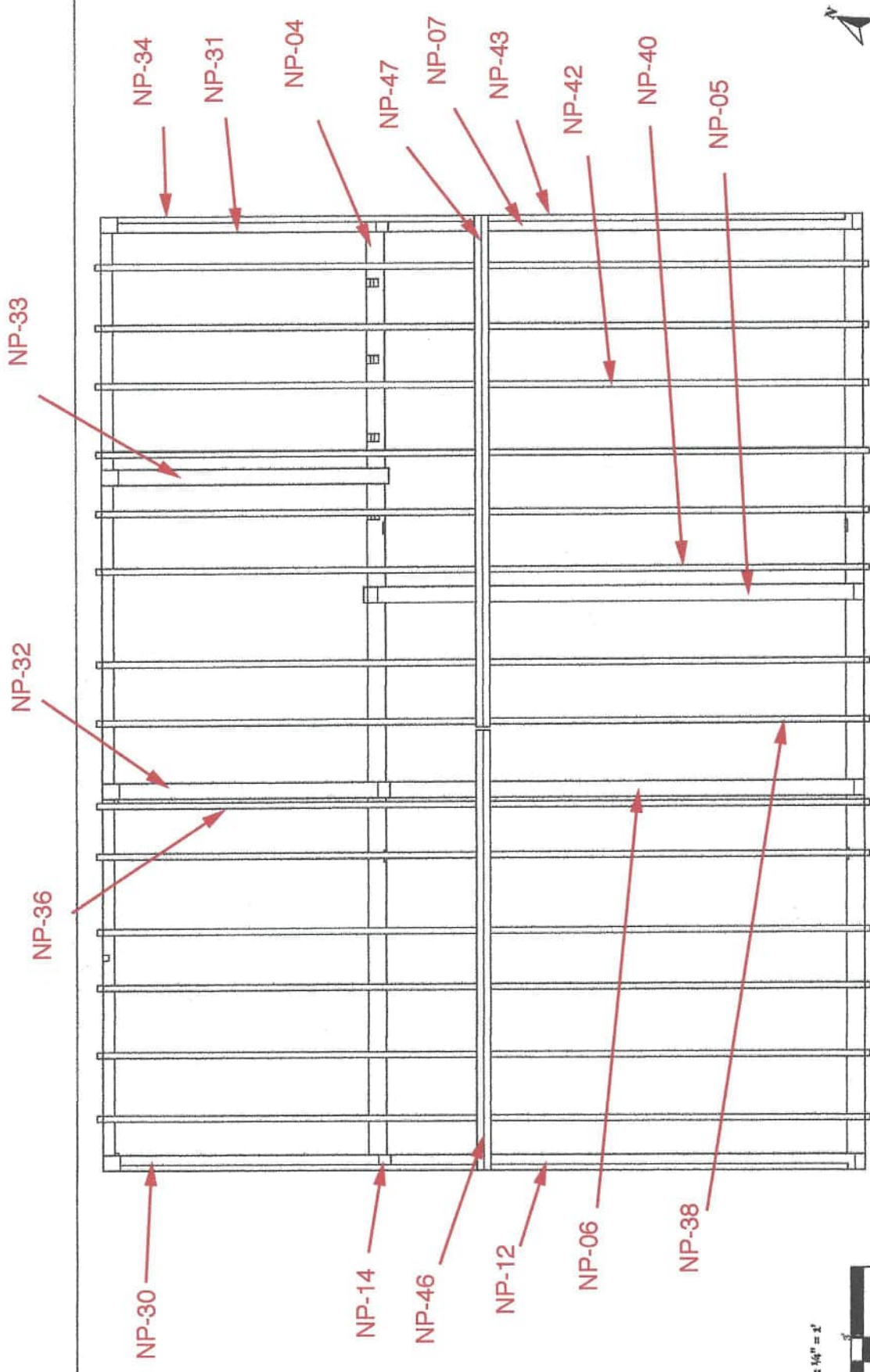


REVISIONS		REMARKS
1	MM/DVV	17/07/2014
2	MM/DVV	17/07/2014
3	MM/DVV	17/07/2014
4	MM/DVV	17/07/2014
5	MM/DVV	17/07/2014



Joseph Parsons House C. 1719
Northampton, Massachusetts

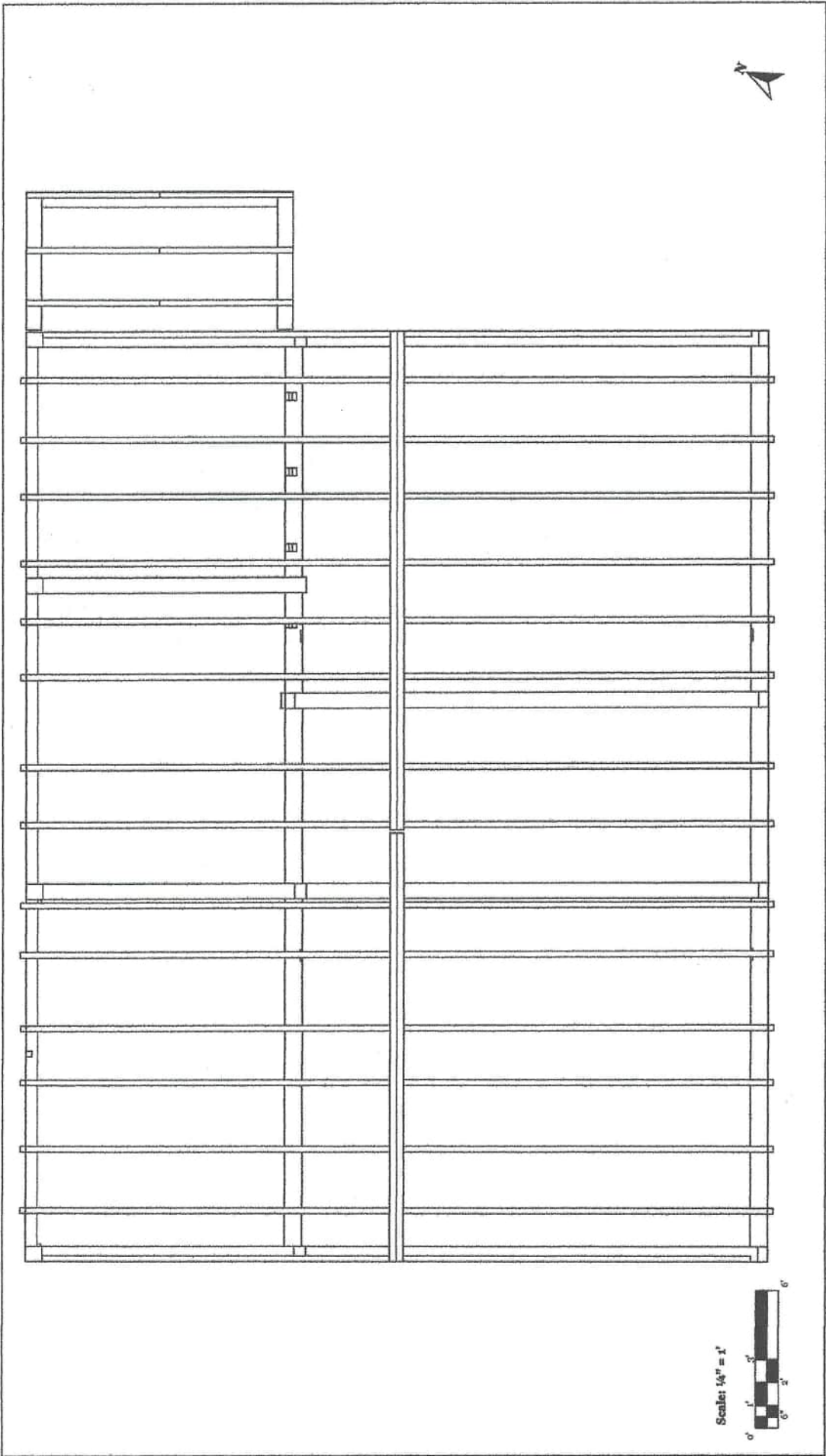
Birdseye Attic Framing with Joists, Summers, and Purlin Framing
(Phase III)



Scale: 1/4" = 1'



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Joseph Parsons House C. 1719 Northampton, Massachusetts			REVISIONS
			REMARKS
			1: 17 / 07 / 24
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			6: 17 / 07 / 24
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Birdseye Attic Framing without Joists, Summers, and Purlin Framing (Phase IV)	
	
Joseph Parsons House C. 1719 Northampton, Massachusetts	
REVISIONS	
NO./DATE	REMARKS
1 17/07/24	1st Second Story Study and Purlin Added on North Section Viewed from Outside
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**Appendix 6 - C14 Dating Report of grasses in Rm 112 plaster– Beta Analytic
Laboratory, Miami, Florida, 2025**



ISO/IEC 17025:2017-Accredited Testing Laboratory

Beta Analytic, LLC
4985 SW 74th Court
Miami, FL 33155 USA
Tel: (305) 667-5167
info@betalabservices.com

August 5, 2025

Myron O. Stachiw
18 Doctor Pike Road P.O. Box 193
East Woodstock, CT 06244-0193
USA

Dear Colleague,

Enclosed is the radiocarbon dating result for the sample recently sent to us. As usual, specifics of the analysis are listed on the report with the result and calibration data is provided where applicable. The Conventional Radiocarbon Age has been corrected for total fractionation effects and where applicable, calibration was performed using 2020 calibration databases (cited on the graph pages).

The web directory containing the table of results and PDF download also contains pictures, a cvs spreadsheet download option and a quality assurance report containing expected vs. measured values for 3-5 working standards analyzed simultaneously with your samples.

The reported result is accredited to ISO/IEC 17025:2017 Testing Accreditation PJLA #59423 standards and all pretreatments and chemistry were performed here in our laboratories and counted in our own accelerators here in Miami. Since Beta is not a teaching laboratory, only graduates trained to strict protocols of the ISO/IEC 17025:2017 Testing Accreditation PJLA #59423 program participated in the analysis.

As always Conventional Radiocarbon Ages and sigmas are rounded to the nearest 10 years per the conventions of the 1977 International Radiocarbon Conference. When counting statistics produce sigmas lower than ± 30 years, a conservative ± 30 BP is cited for the result unless otherwise requested. The reported $\delta^{13}C$ was measured separately in an IRMS (isotope ratio mass spectrometer). It is NOT the AMS $\delta^{13}C$ which would include fractionation effects from natural, chemistry and AMS induced sources.

When interpreting the result, please consider any communications you may have had with us regarding the sample. As always, your inquiries are most welcome. If you have any questions or would like further details of the analysis, please do not hesitate to contact us.

Thank you for prepaying the analysis. As always, if you have any questions or would like to discuss the results, don't hesitate to contact us.

Sincerely,


Digital signature on file

Mr. Ron Hatfield
Laboratory Management Group / President



ISO/IEC 17025:2017-Accredited Testing Laboratory

Beta Analytic, LLC
4985 SW 74th Court
Miami, FL 33155 USA
Tel: (305) 667-5167
info@betalabservices.com

REPORT OF RADIOCARBON DATING ANALYSIS

Submitter

Received Date **July 21, 2025**

Company **Myron O. Stachiw**

Report Date **August 5, 2025**

Laboratory Number **Beta-762474**

Sample Code **Sample #1**

To validate report, scan this QR code on a mobile device or go to <https://verify.betalabservices.com> and enter the requested information.



Conventional Radiocarbon Age **100 +/- 30 BP**

Ratio of Stable Isotopes **IRMS $\delta^{13}C$: -24.44 $\pm$ 0/00**

95.4% Probability Calibrated Range(s)

(68.1%)	1802 - 1928 cal AD	(148 - 22 cal BP)
(25.7%)	1684 - 1735 cal AD	(266 - 215 cal BP)
(0.8%)	1952 - 1955 cal AD	(-2 - -5 cal BP)
(0.5%)	1756 - 1760 cal AD	(194 - 190 cal BP)
(0.3%)	1934 - 1937 cal AD	(16 - 13 cal BP)

Submitter Material **Plant**

Pretreatment **(Plant material): acid/alkali/acid**

Analyzed Material **Plant material**

Analysis Service **AMS-Standard Delivery**

Percent Modern Carbon **98.76 +/- 0.37 pMC**

Fraction Modern Carbon **0.9876 +/- 0.0037**

$\delta^{14}C$ **-12.37 +/- 3.68 o/oo**

$\Delta^{14}C$ **-21.29 +/- 3.68 o/oo (1950:2025)**

Measured Radiocarbon Age **(without $\delta^{13}C$ correction): 90 +/- 30 BP**

Calibration **BetaCal 5.0: High Probability Density Range Method: INTCAL20 + NHZ2**

Results are ISO/IEC-17025 accredited. All work was done at Beta in-house NEC accelerator mass spectrometers and 4 Thermo IRMSs. The "Conventional Radiocarbon Age" was calculated using the Libby half-life (5568 years), is corrected for total isotopic fraction and was used for calendar calibration where applicable. The Age is rounded to the nearest 10 years and is reported as radiocarbon years before present (BP), "present" = AD 1950. Results greater than the modern reference are reported as percent modern carbon (pMC). The modern reference standard was 95% the ^{14}C signature of NIST SRM-4990C (oxalic acid). Quoted errors are 1-sigma counting statistics. Calculated sigmas less than 30BP on the Conventional Radiocarbon Age are conservatively rounded up to 30. $\delta^{13}C$ values are on the material itself (not the AMS $\delta^{13}C$). $\delta^{13}C$ and $\delta^{15}N$ values are relative to VPDB. References for calendar calibrations are cited at the bottom of calibration graph pages.

BetaCal 5.0
Calibration of Radiocarbon Age to Calendar Years
(High Probability Density Range Method: INTCAL20 + NHZ2)

(Variables: $\delta^{13}C = -24.4$ o/oo)

Beta-Laboratory Number 762474

Conventional Radiocarbon Age (BP) 100 +/- 30 BP

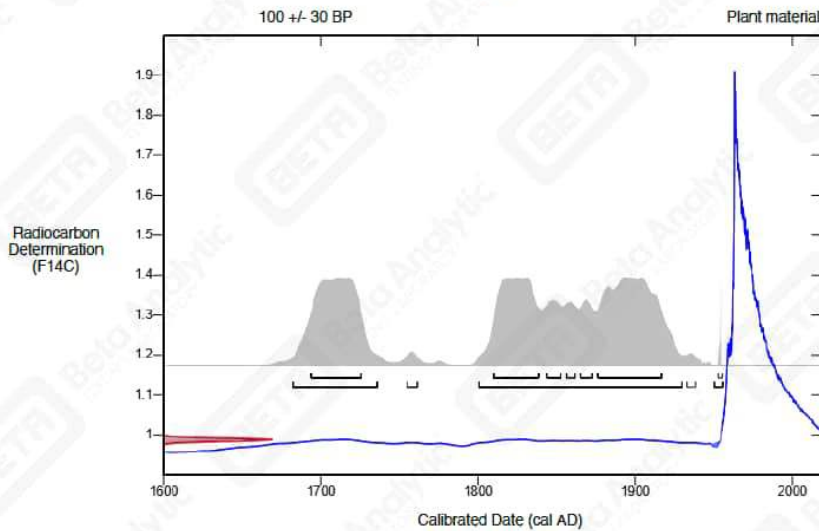
95.4% Probability Calibrated Range(s)

(68.1%)	1802 - 1928 cal AD	(148 - 22 cal BP)
(25.7%)	1684 - 1735 cal AD	(266 - 215 cal BP)
(0.8%)	1952 - 1955 cal AD	(-2 - 5 cal BP)
(0.5%)	1756 - 1760 cal AD	(194 - 190 cal BP)
(0.3%)	1934 - 1937 cal AD	(16 - 13 cal BP)

68.2% Probability Calibrated Range(s)

(24.4%)	1878 - 1916 cal AD	(72 - 34 cal BP)
(19.8%)	1695 - 1725 cal AD	(255 - 225 cal BP)
(17.4%)	1811 - 1837 cal AD	(139 - 113 cal BP)
(3.1%)	1845 - 1851 cal AD	(105 - 99 cal BP)
(2.2%)	1867 - 1871 cal AD	(83 - 79 cal BP)
(1.1%)	1858 - 1860 cal AD	(92 - 90 cal BP)
(0.2%)	1954 - 1954 cal AD	(-4 - -4 cal BP)

Sample #1



Database Used

INTCAL20 + NHZ2

References

References to Probability Method

Bronk Ramsey, C. (2009). Bayesian analysis of radiocarbon dates. Radiocarbon, 51(1), 337-360.

References to Database INTCAL20 + NHZ2

Hua, et al., 2022, Radiocarbon 64(4): 723-745.

Reimer, et al., 2020, Radiocarbon 62(4): 725-757.

Quality Assurance Report

This report provides the results of reference materials used to validate radiocarbon analyses prior to reporting. Known-value reference materials were analyzed quasi-simultaneously with the unknowns. Results are reported as expected values vs measured values. Reported values are calculated relative to NIST SRM-4990C and corrected for isotopic fractionation. Results are reported using the direct analytical measure percent modern carbon (pMC) with one relative standard deviation. Agreement between expected and measured values is taken as being within 2 sigma agreement (error x 2) to account for total laboratory error.

Report Date August 5, 2025

Submitter

QA MEASUREMENTS

Reference 1

Expected Value 0.44 +/- 0.04 pMC

Measured Value 0.43 +/- 0.05 pMC

Agreement Accepted

Reference 2

Expected Value 95.86 +/- 0.37 pMC

Measured Value 95.86 +/- 0.24 pMC

Agreement Accepted

Reference 3

Expected Value 110.69 +/- 0.40 pMC

Measured Value 110.75 +/- 0.28 pMC

Agreement Accepted

Comment All measurements passed acceptance tests.

Validation


Digital signature on file

Date August 5, 2025

Appendix 7 - Historic Northampton Nathaniel Parsons House Maintenance/Repairs Record, 1911 – 2019

Appendix 7 - Historic Northampton Nathaniel Parsons House Maintenance/Repairs Record, 1911 – 2019

1911	• Additional gas lights installed in the house • (1912) coal furnace in the house	A.V. Bliss (B2F5: A. Md.19.29) (B2F5: A. Md.19.30) (Parsons Hs archives)
1913	• 1 bedroom and house exterior repainted	A.V. Bliss (B2F5: A. Md.19.31)
1914	• Repair to roof and clapboards	A.V. Bliss (B2F5: A. Md.19.32)
1918	• Stove fires in Parsons House	A.V. Bliss (B2F5: A. Md.19.34)
1919	• Ceiling in Dining Room repaired	A.V. Bliss (B2F5: A. Md.19.35)
1936	• Dining Room redecorated	A.V. Bliss (B2F5: A. Mdd.19.36)
1937	• New Parlor carpet installed • Repair ceiling in Dining Room	A.V. Bliss (B2F5: A. Md.19.36)
1939/1940	• Paint and wallpaper in “Frances Room”	A.V. Bliss (B2F5: A. Md.19.37)
1940	• Repaint exterior of house	A.V. Bliss (B2F5: A. MD.19.37)
Early 20 th c.	• c.1930s electrical wiring installed (knob and tube) • back porch added; replaced earlier lean-to shed attached to back of house and west wing	Nancy Rexford, “Architectural Development of Parsons House”, Mss., Historic Northampton, 1983
1950	York Oil burner installed	Addendum to Rexford Notes, “History of Repairs to Parsons House since 1941”, 10/31/90; “Information gathered from Ephemera File: NHS “Annual Reports Maintenance
Pre-1951	Insulation blown into floor of house attic	Rexford Notes, “History of Repairs to Parsons House since 1941”, 1976
September 1951	Insulation blown into all exterior walls in main house and into walls and ceiling of the office wing (now Rm 111).	Rexford Notes, “History of Repairs to Parsons House since 1941”, 1976
Spring 1953	P-9 Dining Room (now Rm 102) – Plaster over the fireplace was bulging; when removed found a larger fireplace and oven behind; replastered then painted and papered the room P-5 Kitchen (now Rm 109 in former rear lean-to) – Decision to restore the room. • Beaverboard ceiling removed, revealed plaster and split lath of “apre-1840 type”. • Removed lath and plaster to reveal joists and beams, some of which were rotten and replaced. ○ New ceiling floor boards, coarsely hand-planed were • Paint was scraped and sanded off the walls and floor • Removed boards from wall above mantel, revealing chimney ○ Bricks 8x2-2.5 inches, chinked with mud or clay, not mortar ○ Revealed another oven facing the dining room (Rm 102) about 1 foot from the corner post facing the dining room behind the present china cupboard; most bricks	Rexford Notes, “History of Repairs to Parsons House since 1941”, 1976 Nancy Rexford, “Architectural Development of Parsons House”, Mss., Historic Northampton, 1983 Historic Northampton Institutional Records Series VI: Properties and Facilities Box 33 Folder 1

	caved in [approximately 1 foot of oven dome at its east or front end and flue was dismantled when the cupboard was constructed in early 19th and the present mantelpiece was installed – MOS] • Beams cased with new boards P-12 Parlor chamber (now Rm 210) • The plaster over the mantel was bulging and pushing the mantel out; they feared the chimney was damaged but found to be fine when plaster removed. Wall was replastered, woodwork painted and wallpaper applied to the walls • Floor scraped and scrubbed, sandpapered and oiled P-13,14 (now Rms 202, 203) • Papered and painted the rooms • Floor scrubbed, sandpapered and oiled	
1953	Electrical work in “restored” kitchen (now Rm 109)	Addendum to Rexford Notes, “History of Repairs to Parsons House since 1941”, 10/31/90 tfk “Information gathered from Ephemera File: NHS “Annual Reports Maintenance
1955	Electrical work (no location given)	Addendum to Rexford Notes, “History of Repairs to Parsons House since 1941”, 10/31/90 tfk “Information gathered from Ephemera File: NHS “Annual Reports Maintenance
1957	One door weather-stripped (no location given)	Addendum to Rexford Notes, “History of Repairs to Parsons House since 1941”, 10/31/90 tfk “Information gathered from Ephemera File: NHS “Annual Reports Maintenance
1958	Everhot tankless water heater installed, copper water piping	Addendum to Rexford Notes, “History of Repairs to Parsons House since 1941”, 10/31/90 tfk “Information gathered from Ephemera File: NHS “Annual Reports Maintenance
September 1966	House painted and roof stripped and replaced	Rexford Notes, “History of Repairs to Parsons House since 1941”, 1976 CAP ASSESSMENT BUILDINGS AND COLLECTIONS Historic Northampton 46 Bridge Street

		Northampton, MA 01060-2406 September 2020 (10-5-20rev)
1969	Sprinkler system put in; removed 1982.	Rexford Notes, "History of Repairs to Parsons House since 1941", 1976
1970	Front room (parlor, now Rm 112) restored to 1780 period	CAP ASSESSMENT BUILDINGS AND COLLECTIONS Historic Northampton 46 Bridge Street Northampton, MA 01060-2406 September 2020 (10-5-20rev)
1971	Library and workroom created in rear space	CAP ASSESSMENT BUILDINGS AND COLLECTIONS Historic Northampton 46 Bridge Street Northampton, MA 01060-2406 September 2020 (10-5-20rev)
1972/3	Security system installed	CAP ASSESSMENT BUILDINGS AND COLLECTIONS Historic Northampton 46 Bridge Street Northampton, MA 01060-2406 September 2020 (10-5-20rev)
1973	Window sashes with small panes replaced existing window sash on front of house, west wing (now Rms 102, 112, 111, 201, 202, 210) "Heater" (Furnace) Purchased from Foster-Farrar, installed in cellar beneath Rm 105; chimney repaired Front porch removed Basement cement floor and stairs installed beneath Rm 105	Rexford Notes, "History of Repairs to Parsons House since 1941", 1976 Addendum to Rexford Notes, "History of Repairs to Parsons House since 1941", 10/31/90 tfk "Information gathered from Ephemera File: NHS "Annual Reports Maintenance CAP ASSESSMENT BUILDINGS AND COLLECTIONS Historic Northampton 46 Bridge Street Northampton, MA 01060-2406 September 2020 (10-5-20rev)
1975, Summer	Work done on sills and foundations • Brick foundation set under the office (now Rm 111) • Sills and posts along the front of the house were replaced where rotten • Cellar under Parlor (now Rm 112) ○ Electric heater installed	Rexford Notes, "History of Repairs to Parsons House since 1941", 1976 Addendum to Rexford Notes, "History of Repairs to Parsons House since 1941", 10/31/90 tfk

1975, Summer	○ Bulkhead eliminated, sills replaced, 4 rolls of insulation Bulkhead into west basement (under now Rm 112) eliminated	“Information gathered from Ephemera File: NHS “Annual Reports Maintenance
1975-76	• replacement of Parson Hs sills and elimination of 2 cellar windows; rebuild foundation of office wing; jack and reset porch; replaced cornice trim; new gutters; repair shutters; new sash in office; replace porch screens; insulate office closets; remove and replace kitchen floor for plumbing; rebuild window well; insulate cellar and office chimney; build window covers	Historic Northampton Institutional Records Series VI: Properties and Facilities Box 33, Folder F8
1976, November	• Kitchen floor (now Rms 109/110) was removed and replaced to put plumbing under it to supply heat to the office (now Rm 111) • Chimney in Office (Rm 111) insulated • Cellar was insulated as much as possible • Old coal bin removed ○ [above 2 entries likely refer to cellar under west Parlor - Rm 112 – MOS]	Rexford Notes, “History of Repairs to Parsons House since 1941”, 1976
1976	Office (now Rm 111) • 5 sheets “insulation” for office closets • Insulation for cellar, outside wall, and copper tubing for heat to Office • Wire zoned hot water heating installed • Heat ducts to Director’s office and 2nd floor installed	Addendum to Rexford Notes, “History of Repairs to Parsons House since 1941”, 10/31/90 tfk “Information gathered from Ephemera File: NHS “Annual Reports Maintenance
1979	Insulation for dirt floor in “full front basement” installed (under Rm 112)	
1975-1982	Electrical and lighting upgrades	CAP ASSESSMENT BUILDINGS AND COLLECTIONS Historic Northampton 46 Bridge Street Northampton, MA 01060-2406 September 2020 (10-5-20rev)
1980	• Patching of plaster on ground floor and second floor • Chimneys repaired	Historic Northampton Institutional Records Series VI: Properties and Facilities Box 33, Folder F8
1981	• New gas pipes from street to meter • Changed steam system to forced hot water • Removed sprinkler pipes	Addendum to Rexford Notes, “History of Repairs to Parsons House since 1941”, 10/31/90 tfk “Information gathered from Ephemera File: NHS “Annual Reports Maintenance
1981		

	- Stair in former lean-to kitchen now (Rm 109) was removed and moved about 3 feet to the east, returned to what was likely its original location. This required removing the early 20th c. bathroom installed in this location and relocating it to the east side of the new stairway built to the residents' apartment on the second floor, along with a new closet on the east side of the new stairs along the west wall of what is now Rm 104. - Doorway in north wall of Rm 109 to residents' living room (the former early 19th c. kitchen in the rear kitchen wing, now Rm 105) was closed	Nancy Rexford, "Architectural Development of Parsons House", Mss., Historic Northampton, 1983
1981-1982	- Cellar under Rms 102, 103, 104 fully excavated, sills and floor framing replaced (but old joists retained in -place; as result, the floor was leveled. - Leveling also done to fireplace hearth in Rm 102. - The mantelpiece on the west wall of Rm 102 was removed and also leveled to the new floor surface, plaster on wall around mantelpiece patched. - Follows 1979 survey by architect Roger Clarke). - Entry to stairs to west cellar recreated in original location in west wall of Rm 102; closing-in of former closet under the stairs in the north wall of front entry, plastering and some new woodwork, on new doorway to stairs in west wall of Rm 102 - Renovations to house and rear apartment -replace sink and cabinet in kitchen; Hall, bath and cellar stairs, stairs to upstairs- east wall of staircase moved to east into back bedroom about 6 ft - frame and install stairs, bathroom (in Rm 103); Foundation with cellar under east room of house (16 x 32 x 8 ft deep) and foyer and stairwell. Install block foundation, etc. Replace approx. 20 floor joists and 20' sill; sheetrock dining room ceiling. Full cellar under rear section of building, block fndn, concrete floor under rear lean-to area	NHS newsletter, # _____ CAP ASSESSMENT BUILDINGS AND COLLECTIONS Historic Northampton 46 Bridge Street Northampton, MA 01060-2406 September 2020 (10-5-20rev) Historic Northampton Institutional Records Series VI: Properties and Facilities Box 33, Folder F8
1982	- Insulation applied in residents' kitchen - Radiator added to apartment kitchen - Ten new windows installed - All old steam heating pipes and radiators removed, new hot water heating system installed - Old sprinkler system discontinued, pipes removed. - New bathroom installed in resident' apartment - New Electrical 1975-1982	Addendum to Rexford Notes, "History of Repairs to Parsons House since 1941", 10/31/90 tfk "Information gathered from Ephemera File: NHS "Annual Reports Maintenance Addendum "Information on Houses owned or managed by NHS" to Addendum to Rexford Notes, "History of Repairs to Parsons House since 1941", 10/31/90 tfk

	New 1/3 basement and Foundation 1981 (under now Rm 102)	“Information gathered from Ephemera File: NHS “Annual Reports Maintenance Nancy Rexford, “Architectural Development of Parsons House”, Mss., Historic Northampton, 1983
1982	- Paint on woodwork in dining room (now Rm 102) burned off and sanded - New wallpaper in second floor rooms (now Rms 202 and 210), hall (2nd floor landing now 201), bathroom, 102, apartment - Back bedroom (now Rm 203 received new ceiling replacing beaverboard which was applied to hide old damaged plaster - Plaster repairs also made in front bedroom and hall (now Rms 202 and 201) - Gypsum board installed on -wall of front -entry (Rm 101)	“The Weathervane”, Northampton Historical Society Newsletter, October 1982, Vol. 7, No. 1, p.2, ”Progress Report on Parsons House Historic Northampton Institutional Records Series VI: Properties and Facilities Box 33, Folder F8
1983	- Front porch and concrete slab removed. This version of the porch was likely a repair made during period of ownership of Anne Catherine Bliss (replacement of turned posts by plain, hollow square posts) of an earlier (late 19th c.) porch - Smaller stone slab for doorstep installed - Victorian 4-paned window sash, installed sometime before 1882, were removed and replaced with small-paned sash	Nancy Rexford, “Architectural Development of Parsons House”, Mss, Historic Northampton, 1983
1984	- Burst radiator repaired - Water damage on ceiling of Rm 102 from leaking radiator required replacement of plaster ceiling with wallboard and new plaster	Addendum to Rexford Notes, “History of Repairs to Parsons House since 1941”, 10/31/90 tfk “Information gathered from Ephemera File: NHS “Annual Reports Maintenance Historic Northampton Institutional Records Series VI: Properties and Facilities Box 33, Folder F8
1985	Exterior painting	Historic Northampton Institutional Records Series VI: Properties and Facilities Box 33, Folder F8
1989, July	Walls of parlor (now Rm 112) and dining room (now 102) painted	Penciled addendum to Rexford Notes, “History of Repairs to Parsons House since 1941”, 1976

1989	Bathtub removed in residents' apartment, replaced with shower stall	Addendum to Rexford Notes, "History of Repairs to Parsons House since 1941", 10/31/90 tfk "Information gathered from Ephemera File: NHS "Annual Reports Maintenance
1992	John Leeke conducted conditions assessment of Parsons House	Historic Northampton Institutional Records Series VI: Properties and Facilities Box 33, Folder F8
1999	Covers added to basement windows	CAP ASSESSMENT BUILDINGS AND COLLECTIONS Historic Northampton 46 Bridge Street Northampton, MA 01060-2406 September 2020 (10-5-20rev)
2005	Rear porch removed	CAP ASSESSMENT BUILDINGS AND COLLECTIONS Historic Northampton 46 Bridge Street Northampton, MA 01060-2406 September 2020 (10-5-20rev)
2011	Renovations: new roof, exterior painting, new door; shutters removed	CAP ASSESSMENT BUILDINGS AND COLLECTIONS Historic Northampton 46 Bridge Street Northampton, MA 01060-2406 September 2020 (10-5-20rev)
2014-2015	Renovation Work (Community Preservation Act funded): - Archeology adjacent to basement area where work scheduled. - Basement cleanout (paint cans, shutters, old wooden exhibit platforms). - Asbestos abatement. - Structural repairs at north wall basement. - Furnace replaced. - Improperly installed insulation removed. - Basement converted to collections storage.	CAP ASSESSMENT BUILDINGS AND COLLECTIONS Historic Northampton 46 Bridge Street Northampton, MA 01060-2406 September 2020 (10-5-20rev)
2015	Kris Thomson contractor – excavated and constructed new basement and bulkhead under rear pile (former rear lean-to), replaced rotting sill and lower 4' of post, augmented joists	CAP ASSESSMENT BUILDINGS AND COLLECTIONS Historic Northampton 46 Bridge Street Northampton, MA 01060-2406 September 2020 (10-5-20rev)

2016	• Mud room and attached shed removed, revealing cistern • Removal of all knob and tube electrical wiring	CAP ASSESSMENT BUILDINGS AND COLLECTIONS Historic Northampton 46 Bridge Street Northampton, MA 01060-2406 September 2020 (10-5-20rev)
2017	• Exterior painting • New gutters installed • Installation of climate-monitoring devices and software • New security system installed	CAP ASSESSMENT BUILDINGS AND COLLECTIONS Historic Northampton 46 Bridge Street Northampton, MA 01060-2406 September 2020 (10-5-20rev)
2019	• New LED lighting installed in 2nd floor spaces	CAP ASSESSMENT BUILDINGS AND COLLECTIONS Historic Northampton 46 Bridge Street Northampton, MA 01060-2406 September 2020 (10-5-20rev)

Appendix 8 - Structural Engineering Report, Elizabeth Acly, Cirrus Structural Engineering, Columbia, CT, 2026.



16 February 2026

Laurie Sanders and Elizabeth Sharpe
Historic Northampton
46 Bridge Street
Northampton, MA 01060

Reference: Parsons House - Structural Conditions Assessment

Dear Laurie and Betty:

It is a pleasure to present the findings from our Structural Conditions Assessment of the Nathaniel Parsons House located on the Historic Northampton Campus in Northampton, Massachusetts in the following report. This project and report are part of Myron Stachiw's overall updated 'Historic Structures Report (HSR)' study.

General Description

We visited the site on 21/January and 25/March/2025 to perform a structural survey of the building. For the purposes of this report, the front elevation of the house with the main entrance facing Bridge Street is considered south, with Bridge Street assumed to run east-west.

The Nathaniel Parsons House is a contributing resource in the Parson-Shepherd-Damon Houses National Historic District, designated in 2001.



View of the Parsons House from the southeast

Building and Structural Description

Myron Stachiw's concurrent building archeology work being documented into an updated HSR identifies the following chronology of building evolution:

1719 – Original Phase 1 framed house with small lean-to

1800 – Expansion of Lean-to on north side*

1816 – Addition of second floor above Lean-to to create full 2-pile, 2-story building, renovations to 'Federalize' the house*

1822 – Addition of East (jut-by) and West Wings*

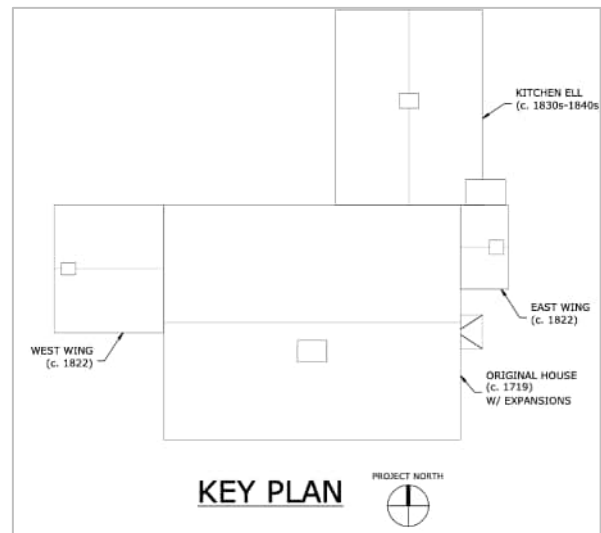
1830s-1840s – Addition of Kitchen Ell (North)*

1981-82 – Cellar / first floor framing replacement below east side of house

* circa

The updated HSR also includes a Maintenance Chronology document that lists all known work on the building to date.

The following describes the structural framing and support systems in each section of the building, *for graphic representation see accompanying framing plans in the appendix of the report.*



Foundations and Basement

- *Original House with Expansions (c. 1719 to c. 1816).* The building originally had a basement below the west side with only a crawlspace below the east side and lean-to. Based on the outline of the stone foundation in the 1979 existing conditions drawings, the basement section appears to have originally enclosed both the current lean-to and front vestibule stairs (only the width of the stairs). In 1981-82, a full basement was dug below the east side including the east portion of the lean-to, connecting the front stair to the Kitchen Ell at the basement level. At this time the stone foundations on the east side were replaced with contemporary block masonry walls with a concrete slab floor. In 2015, the west end of the lean-to was excavated and a new basement and bulkhead constructed. The 'new' basement is roughly 24" below the original basement.



Basement at the east block, looking south and north respectively

The basement walls of the west block are constructed of rubble stone masonry except for the brick infill at the south end of the east wall and concrete block infill (ca. 1975) at the former bulkhead opening at the south end of the west wall. The basement ends about 30" inside the south wall of the house creating an unusual strip of crawlspace between the outer wall footing and basement wall.



Left: West block looking north to stair below lean-to; Right: Lean-to looking south

- *East and West Wings (c. 1822).* Both East and West Wings were constructed over a crawlspace. The foundation of the East Wing was replaced with shallow concrete block walls in the 1981-82 work and is open to the main basement but separated by screens. The exterior of the West Wing foundation walls were reported to have been constructed / replaced in 1975 with brick masonry. The West Wing crawlspace was not accessible during our visit.
- *Kitchen Ell (c. 1830s-40s).* The Kitchen Ell sits over its full original basement with whitewashed brick masonry foundation walls. A concrete slab floor was poured in 1973.

Chimney Masses and Stairs

- *Original House with Expansions (c. 1719 to c. 1816).* A large chimney mass is located at the center of the building. The base is constructed of rubble fieldstone like the foundations and appears to have been extended to the north when the lean-to was expanded. During the 1981-82 work, it appears that the north, east and south sides of the chimney base were underpinned with concrete and concrete block masonry to accommodate the new (lower) basement. The chimney mass is constructed of brick masonry at the living levels and extends to a brick chimney mass above the roof.



West (original rubble stone) and east (1981-82 CMU underpinning) side of main chimney mass base respectively

- *East and West Wings (c. 1822)*. Both East and West wings were built with chimney masses on their exterior end walls. It appears that the chimney mass in the East Wing was underpinned with the adjacent basement work in 1981-82. Both chimneys are brick masonry above the roof.
- *Kitchen Ell (c. 1830s-40s)*. The chimney mass of the Kitchen Ell sits on a typical early 19th century brick pier and heavy timber platform deck that appears to sit on a solid concrete footing likely constructed with the 1973 floor slab. As with the other three, the Kitchen Ell chimney is brick masonry above the roof and has a bluestone cover.



Kitchen Ell chimney mass base from the north

First Floor Framing

- *Original House with Expansions (c. 1719 to c. 1816)*. On the west side of the house, the joist framing runs north south and is supported by a central east-west beam as well as one at the north end of the joists. The south (front) foundation wall in this section is inboard of the building wall above, which sits on what looks to be a shallow stone foundation with a concrete cap on it. Shorter north-south joists run between the south basement wall and shallow foundation below the upper walls. The framing on the east side originally ran east-west spanning between the exterior wall and chimney mass. The work in 1981-82 included sistering of joists between the originals and a north-south spanning built-up dimensional lumber beam supported by steel columns. Similarly, the front vestibule joists that span east-west and the east portion of the lean-to joists that span north-south were both augmented by intermediate lumber joists in 1981-82.

In 2015 the basement under the west end of the lean-to was added, at which time maintenance suggests that a deteriorated sill was replaced, lower 4' of a post repaired (presumably the northwest post), and joists were augmented. A stair servicing the west basement is present at the west side of the lean-to with framing joists truncated for the floor opening. The lean-to framing steps down in elevation relative to the front east and west rooms.

- *East and West Wings (c. 1822)*. Framing for the East Wing was replaced with dimensional lumber joists in the 1981-82 work and runs north-south. Framing for the West Wing was not observed.
- *Kitchen Ell (c. 1830s-40s)*. Joists in the Kitchen Ell span east-west and are supported down the middle of the building by a north-south beam spanning between foundation walls and the chimney mass. Maintenance logs show cellar stairs being added in 1973, at which time the floor looks like it may have been reframed.

Second Floor Framing

- *Original House with Expansions (c. 1719 to c. 1816).* The east and west rooms are framed with north-south spanning joists onto a central east-west spanning summer beam. The lean-to is framed with north-south spanning joists with some augmentation. The lean-to framing steps down in elevation relative to the front east and west rooms.
- *East Wing (c. 1822).* Framing for the East Wing was not observed. *Note that the West Wing is a single story and does not have second floor framing.*
- *Kitchen Ell (c. 1830s-40s).* *Note that the Kitchen Ell is a single story and does not have second floor framing.*

Attic and Roof Framing

- *Original House with Expansions (c. 1719 to c. 1816).* The Original House roof was reconstructed to top a full two-story structure in its most recent expansion. It appears likely that the attic framing for the original single pile structure remains and was expanded over the lean-to, and some parts of the older roof framing were reused in the new one. The reconstructed roof is framed with common rafters supported at their midspan by a longitudinal timber purlin. The purlin is supported by timber struts at the gable ends and chimney girts. A 5-sided ridge pole connects the rafters at the peak of the gable.
- *East and West Wings (c. 1822).* Except for the north slope of the East Wing (jut-by), both wings have gable roofs parallel to but in different planes to the Original House roof. Framing for the East Wing roof was not observed. The West Wing is framed with two parallel chimney girts running east-west with board nailers running north-south to support the plaster ceiling (no joists).



Original House roof framing showing 5-sided ridge pole; common rafters and central purlin



West Wing exterior; roof framing, looking west

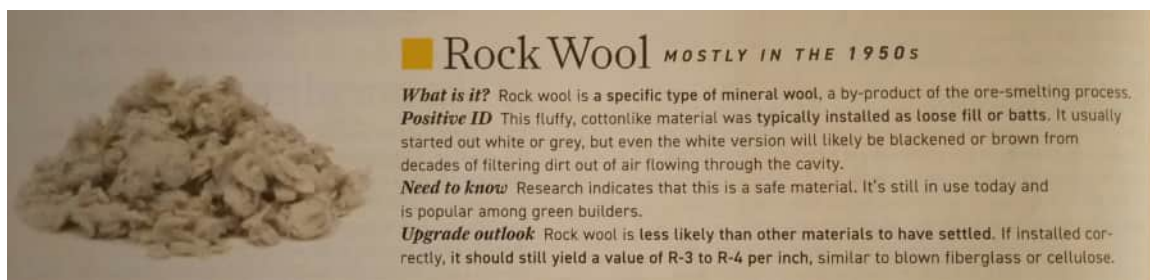
- *Kitchen Ell (c. 1830s-40s).* Framing for the Kitchen Ell was not observed.

Wall Framing

- *Original House with Expansions (c. 1719 to c. 1816).* Wall framing for the south / front wall of the main house is framed with studs. Wall framing type for other areas was not observed.
- *East and West Wings (c. 1822).* Wall framing type for the East and West Wings is not known.
- *Kitchen Ell (c. 1830s-40s).* Wall framing type for the Kitchen Ell is not known.

Building Envelope Components and Site

- *Roofing.* The building is roofed with asphalt shingles. Maintenance records suggest that the roof was stripped and replaced in 1966, and a new roof installed in 2011.
- *Roof Drainage.* Roof drainage components consist of half-round gutters at the eaves of the gable roofs connecting to downspouts in the corners. Downspouts discharge in a combination of ways from directly on-grade to leaders and below-grade piping. According to maintenance records, gutters were installed in 1975-6 and then in 2017 (likely a replacement).
- *Wall and Attic Insulation.* Maintenance records state that blown insulation was installed in the attic pre-1951, and in all exterior walls in the main house in September 1951. Based on the appearance and date, it is likely that the insulation is rock wool.



Description of rock wool insulation from Old House Journal, February 2026

- *Site.* The Parsons House is located on the spacious 2.5 acre Historic Northampton campus on the north side of Bridge Street and shared with three other buildings. The grade around Parsons House gently pitches to the north at a slope of roughly 16" to 24" over the width of the building.

Load Analysis of Floor Framing

A load analysis was performed on the floor framing to determine its capacity relative to code-prescribed live loads. Historic Northampton is currently exploring campus-wide space needs and is exploring multiple options for future use of the Parsons House. Our understanding of considered future uses:

- Maintain the building as museum exhibit rooms. Loads would include residential furnishings and small tour groups.
- Museum collections storage (as it is currently used).

Based on the code-prescribed uses noted above, the most relevant use categories relative to live load requirements are Residential (40 psf live load for "public" level rooms) and Office (50 psf live load) for museum-use rooms, although specifics of museum storage would have to be better understood to verify.

The existing first and second floor framing in the Original House can support 40 psf live load. The second floor of the lean-to is more lightly framed and limited to 4-5 people (or light storage) per room, and currently has visible deflection under current loads. Both future museum exhibit rooms and museum collections storage can be accommodated; however, limitations may be required for occupancy and type of storage on a room-by-room basis, particularly at the lean-to, and should be verified by the preservation structural engineer on the team as specific programmatic use is being developed.

Noted Structural Conditions and Recommendations

The following conditions were observed during the site investigation and subsequent analysis and are accompanied by *recommendations for repair or treatment*.

1. Settlement in West Room of Main House (Room 112) at Hearth. A significant downward pitch or compression below the floor is evident along the chimney (east) side of the west room. Myron Stachiw, in his concurrent HSR update field work, found evidence that suggests that movement in this area has been longstanding, and that some settlement had already occurred prior to the 1816 renovation that "Federalized" the building.



Deflection at hearth in west room, from north and south respectively

In the basement on the south side of the chimney mass, two different defects were observed. Vertical cracks in the masonry at the west end are present and suggest a downward or outward movement of the west side of the chimney mass base. Additionally, mud-colored drips are visible adjacent to the stair suggesting a water ingress issue that is leaching clay mortar out of the chimney mass masonry.



South wall of chimney base, red arrows indicate cracks and water staining

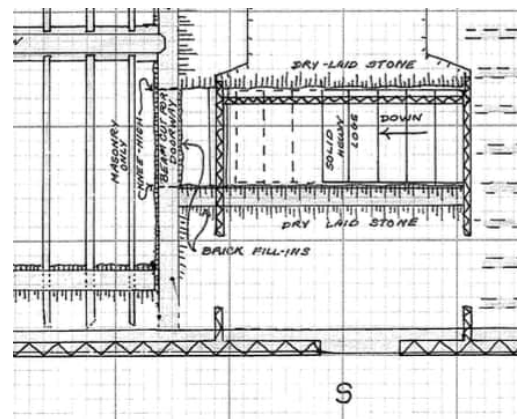
On the west side of the chimney base (in the west basement) a bulge and cracking in the wall are evident, as is a prominent dip in the chimney girt just above it that attaches to the floor framing and is the direct connection to the deflected deck above. The dip is adjacent to a deep notch in the girt (thought to be cut out for head room prior to the wall below being infilled with brick) which may have weakened the beam's overall stiffness.



West wall of chimney base showing bulge and compressed chimney girt

The observations noted above suggest a shifting of the west end of the masonry chimney base. The chimney base is likely constructed of dry-laid stone on the interior; therefore, any introduction of water ingress (say from an open flue above) or change of support (say during the process of excavation and underpinning the north, east and sides) might cause stones to shift and put increased pressure on the west wall. Further investigation is recommended to determine if water is getting into the flues, perhaps by using a drone to check the chimney cap. It would also be beneficial to perform supplementary structural investigation to learn more about existing concealed condition as follows:

- Review documents from 1981/82 work to determine if CMU block along the chimney mass is underpinning the existing chimney mass or constructed alongside it to serve as a buttress. If documentation not available, consider performing exploratory openings.
- Expose and review: a) the space below the basement landing to view the geometry and condition of the underpinning on that location (below the cracks in the brick; and b) the drywall concealing the connection between the brick separator wall and CMU exterior south basement wall.



Left: Brick infill wall between west (higher / original) basement and east lower basement, note CMU underpinning below brick and along south wall of the chimney mass; Right: Excerpt from 1979 Rexford drawing showing narrow basement below front vestibule prior to underpinning and constructing full east basement in 1981/82.

- Expose and review the geometry and condition of the concealed masonry near the southwest corner of the chimney mass at the first floor.
- Explore the possibility of removing the base of any of the first floor fire boxes (if not historic) to better understand the construction of the chimney base below.

Further study would help identify root cause and movement over time. This may be a long-standing issue; however, it is currently unclear if is ongoing or amplified by the 1981/82 underpinning. *Once root cause is more closely determined, remediation might include installing a tension collar or belt around the base of the chimney to restrain the stone in place. If water is getting into the flues and causing damage, the chimney should be capped using a detail that allows ventilation. These solutions and the best type of contractor to remediate them should be specified by a qualified preservation consultant.*

We also observed a framing connection defect where a short length of sub-floor connects to the basement stair header just to the south of the chimney mass. The existing blocking that is intended to provide a bearing surface for the decking has shifted leaving a gap under the end of the now unsupported sub-floor. The shifted blocking is directly below the loose baseboard in this area. *This issue is easily remediated by installing blocking or shims that provide full contact bearing between the header and subfloor and ensuring that the paneling is well fastened.*



East wall panel from above west and below east respectively



Directly below east wall panel from east showing gaps in 2 different views

2. 'Settlement' in South Wall of West Block of Main House (Room 112). A deflection of the floor structure at the south wall of the west block is present. The base trim on the exterior was removed to inspect the sills in this area. The removal provided an opportunity to inspect the short joists that span between the inset basement wall and shallow south foundation wall, as well as both sills and the top of the south foundation wall.

Maintenance logs note that part of the front sill was replaced in 1975. Removal of the siding confirmed a newer replacement sill at the west end along with unfilled CMU block below it, and replacement short joists between the basement wall and outer foundation. Photos from the crawlspace reveal that the CMU "foundation" and sill above have settled and rotated inward, perhaps from unequal pressure from the higher exterior grade. The movement is significant enough that the short joists are no longer supported by the sill. A later nailer on the outside of the sill may be helping to support wall studs. The 'sill' above the south basement wall appears decayed, the extent of which is unclear, as does the post base to the west of the entry vestibule. *The west end of the south wall needs a holistic repair campaign including outer foundation wall repairs (likely replacement), inner sill repairs or replacement, support / connection augmentation between the outer sill and joists and wall studs, and a potential timber dutchman repair at the base of the post.*



Condition of south wall of west block. Top: After trim removal; Bottom Left: Replacement sill condition above grade; Bottom Right: View of shifting CMU foundation and sill.



View of decayed inner sill and suspended short joist end (not bearing on outer sill), respectively.

3. Southwest Corner Post. Saturation of the structure at the southwest corner of the main house due to an ineffectively draining downspout has caused water ingress into the basement and decay in the corner sill and post. *It is recommended that the malfunctioning downspout is remediated, and that timber repairs be performed on the decayed timbers in the form of traditional timber frame repair such as dutchman.*



Left: Southwest corner inside basement showing salts from water ingress and dark staining suggestive of mold (note CMU bulkhead infill); Right: Southwest corner on exterior showing deteriorated sill and post base.

4. Former Repair in East Block of Main House (Room 102), First Floor. During prior repair work, presumably during the 1981-82 east block framing augmentation, the heavily deteriorated portion of the original north sill of the house, adjacent to the later lean-to, was lightly sistered but not replaced. This area is below the threshold of the door at the step-up between the lean-to and east room. Without the full sill, there is little support for the wall studs or for nailing of floor and trim. Maintenance logs reference floor leveling work in the 1981-82 project; settlement patterns prior to leveling can be seen when comparing new and existing framing in this location. *We recommend that an infill timber in the size of the former joist be slipped into the void of the former sill and secured via the sister to allow for a structural member to properly support this area. Alternatively, a full timber replacement sill can be installed in this location if desired.*





Top: Looking down at door threshold without trim; Bottom Left: Looking east to end of abandoned timber; Bottom Right: Looking west at augmented framing from below.

5. First Floor Chimney Mass / Hearth Support in Kitchen Ell (Room 004). The heavy timber “deck” upon which the chimney mass and hearth above the basement is built, has some areas of wood deterioration, particularly in one of the timbers. Water ingress from the chimney landing on the hearth, either past or current, is a possible root cause of the deterioration and should be investigated. A more recent brick chimney was installed below the deck, likely to create an exhaust route for newer mechanical equipment in the basement. The smaller chimney is built up to the bottom of the deck and it is unclear how the timbers were treated at the flue opening. *The chimney cap could be checked by using a drone. The deteriorated timber should be checked with a drill and thin drill bit to determine how deep the deterioration goes, and to better identify if repairing in place with a wood consolidate approach would work, or if a timber replacement is necessary.*



Deteriorated timber platform supporting Kitchen Ell chimney mass above

6. Second Floor Framing Lean-To North Wall (above Room 109). The second floor of the lean-to is lightly framed (see Load section above) and shows a history of movement and repairs, specifically a pattern of outward movement of the second floor wall plate and subsequent loss of bearing of joist ends onto the wall plate. Maintenance logs suggest that the north sill was replaced in this area (due to deterioration) in 2015, in conjunction with the construction of the new basement below, a condition that would plausibly have caused the wall movement and joist bearing loss described above. *We recommend that joist ends be reinforced with joist hangers that can be concealed behind the beam trim (which had*

been removed at the time of our visits). During the design for the hangers, existing and proposed connections at both ends of the joists should be checked to confirm that the second floor north wall plate is adequately tied into the frame. Additional concealed joist hangers can be added if needed.



Second floor joists framing into the north wall plate with diminished bearing visible after removal of trim board.

7. Second Floor Framing at Lean-To Stair Infill (above Room 109). The former stair opening was infilled, presumably in 2015, at the east end of Room 109, an area that also experienced movement of the outer wall and deflection of the floor framing above due to the shifting wall plate from the sill below deteriorating as noted in Item 6 above. The infill floor joists use modern engineered lumber and contemporary fasteners, presumably to meet building code strength requirements, in a way that does not meet the Secretary of the Interior's Standards for the Treatment of Historic Properties (SOIS). An engineered lumber ledger, which seems to have replaced an historic timber version, appears to be inadequately fastened to the historic material behind it. We also identified an adjacent joist with a substantial notch removed from it thus reducing its capacity. *Framing in this area should be evaluated in conjunction with the determination of uses and proposed finishes on both floors. Framing deficiencies as identified above will likely need to be remediated to accommodate proposed live loads. If the floor framing in this area will be exposed from Room 105 (as it currently is), the infill should be reframed to be in better alignment with the SOIS.*



Infill framing at former stair opening looking north and south respectively



Top: Ledger at south side of infill, overview and east end (not fastened) respectively; Bottom Left: Central portion of south ledger; Bottom Right: Notch in joist from former waste pipe



Left: Second floor door threshold above stair infill showing floor deflection; Right: Overall view of lean-to framing showing sag

8. South Sill Deterioration, East Side. Upon exposure, the west end of the east block of the south sill, adjacent to the entry vestibule is showing deterioration and biological growth as is the base of the post to the east of the vestibule. *Damaged sill lengths and post base should be replaced in like kind with a naturally rot resistant species of timber, such as white oak. New timber components should be positively fastened with traditional timber repair techniques such as half lap at the sill and a dutchman at the post. The entry stairs may need to be removed to access the west end of the deterioration. The stair should be reset with a slight pitch to the south to help direct rainwater away from the structure.*



Exposed south sill, east block overall



Deteriorated portion of the south sill and post

9. Southeast Corner Post Deterioration. Upon exposure of the sill, photographs inside the wall cavity in the southwest corner identified the post base being cut, presumably due to deterioration, but not augmented with a replacement post base. *We recommend that the southeast post base be supplemented using a post base dutchman to give the post full bearing on the sill as intended.*



Southeast corner post base from exterior and from wall cavity respectively

10. Cable Ties at Attic. Two cables were observed in the attic space over the north lean-to end of the Original House. It is likely that the cables were installed to provide tension and positive tie-in to resist the wall moving out due to the former sill deterioration or even foundation settlement, both addressed in 2015 repairs. It is likely that the condition is no longer active; *therefore, no action beyond occasional observation is currently required.*



Cable ties over lean-to in attic

11. Spray Foam. Spray foam insulation has been extensively applied within the basement, particularly along the building perimeter, where it fully encases the interior faces of the sill framing. While likely intended to improve thermal performance or mitigate perceived moisture issues, this application prevents the wood from drying to the interior and can trap moisture against framing members that are already vulnerable to exterior moisture exposure. Over time, this condition can accelerate concealed deterioration of sills and adjacent framing. *We recommend that removal of the spray foam be considered in conjunction with other planned work in the basement (such as sill repair or replacement), and that efforts be made to better understand and address the underlying sources of moisture that the insulation was attempting to manage, rather than relying on impermeable materials to mask those conditions.*



Multiple generations of spray foam insulation apparent in the basement, particularly along the perimeters of the building

12. Exterior Moisture Management. The building has experienced intermittent basement leaking, likely due to a combination of site drainage and rainwater management issues. Several gutters and downspouts appear to discharge immediately adjacent to the foundation walls, allowing water to migrate toward and into the basement. In addition, site grading slopes toward the building in localized areas. In some locations, grade has built up along the perimeter and is in direct contact with wood siding, increasing the susceptibility of sills and concealed framing to moisture damage and insect activity. *We recommend a holistic evaluation of site drainage to identify areas where regrading and improved downspout discharge would most effectively reduce moisture exposure at the foundation and lower wall framing.*

Summary of Findings

The following summarizes the identified structural conditions and is arranged in three priority levels as defined below.

Priority 1 – Most urgent; potential for instability or material loss due to exposure;

Priority 2 – High return value work to extend longevity of the structure;

Priority 3 – Recommended treatments with less urgency.

Priority 1

- Item 1* – Further study and stabilization of chimney base settlement
- Item 2* – Restoration of sills on south wall, west end
- Item 3* – Repair southwest corner post and sill

Priority 2

- Item 4* – Infill framing at joist adjacent to lean-to, east side
- Item 5* – Replace / stabilize timbers in platform for Kitchen Ell chimney mass
- Item 6 – Provide positive tie-in connection for north wall at lean-to second floor framing, augment support for joists where bearing has been compromised
- Item 8 – Repair South Sill, east end including post base
- Item 9* – Supplement southeast corner post for full bearing
- Item 12 – Identify locations of deficiencies in roof drainage components, sloping of site toward building, and grade in contact with clapboards. Prepare a holistic plan and remediate.

Priority 3

- Item 7 – Reframe stair infill at Lean-to in more historically appropriate way, address deficiencies
- Item 10* – Cable ties at attic, monitor
- Item 11 – Spray foam, consider removing as part of other planned work

Note building envelope materials are not included in this list but should be considered in holistic approach to area-by-area work.

** Denotes items that are primarily structural in nature and can be addressed independently of holistic future use, finish restoration concepts and accessibility concepts.*

Overall considerations – accessibility and energy upgrades in a historic building

The Parsons House faces a common, yet manageable, challenge to the stewardship of most historic buildings: improving safety, accessibility, comfort and operating efficiency while retaining character-defining features and as much historic fabric as feasible. The recommended approach is to treat accessibility and energy upgrades as integrated building-systems interventions, not isolated “add-ons”, and to evaluate each proposed measure for: a) impact on historic materials and features; b) durability and moisture performance; and c) reversibility/repairability.

When viewed through a life-cycle lens, preserving and repairing historic materials, even where they do not meet modern thermal performance expectations, often results in a lower overall environmental impact than replacement, due to the significant embodied energy already invested in existing construction and the avoided impacts of demolition, disposal and new material production. Where modern code requirements create tension with preservation goals, the International Existing Building Code (IEBC) provides pathways, including the Historic Buildings provisions, to achieve compliant outcomes without unnecessary loss of historic fabric, provided the design team documents significance, constraints and the rationale for selected alternatives.

Accessibility considerations. Providing an accessible entrance and an accessible path of travel at the first floor should be approached as an early, organizing design decision rather than a later accommodation. For historic buildings of this era, the selection of *which* entrance to make accessible often has the greatest impact on historic fabric, circulation patterns, and structural interventions. The preferred approach is to identify an entrance that minimizes alteration of character-defining features, primary elevations, and historic stair configurations, while allowing a clear, intuitive route into principal public spaces. Once the entrance is established, the first-floor path of travel, including door widths, floor level changes, and access to toilet facilities, should be evaluated as a continuous system so that isolated interventions do not trigger cascading structural modifications (such as cutting historic framing or altering load paths). Where full compliance presents challenges, the International Existing Building Code (IEBC), including its provisions for historic buildings, allows for alternative methods that balance accessibility goals with preservation of historic fabric, provided constraints and rationale are clearly documented. Early coordination between accessibility planning, structural assessment, and program layout is strongly recommended to avoid unnecessary loss of historic material and to support durable, defensible solutions.

At this site, a primary accessibility challenge is the vertical relationship between the exterior grade and the first-floor level, which currently requires a step up from grade and is not wheelchair accessible. Complicating this condition, the Lean-to and Kitchen Ell portions of the building step down relative to the street-facing sections, creating changes in floor elevation within the first-floor plan. Establishing an accessible entrance and a continuous, usable path of travel will therefore require careful consideration of both exterior approaches and interior transitions between these areas. Where feasible, gently sloped exterior walkways (with slopes of less than 5 percent) may offer a preferable alternative to ramps, as they do not require handrails and can be integrated more subtly into the landscape and historic setting. Thoughtful grading, alignment with existing circulation patterns, and discreet detailing, such as bridge or platform transitions at changes in elevation, can help achieve accessibility goals while minimizing visual and physical impacts to the historic fabric. We have developed a drawing showing the first floor exterior doors accessibility considerations and included it in the appendix.

Energy upgrades and thermal performance. Energy improvements in historic buildings should be guided by a measured, incremental approach that recognizes the inherent performance characteristics of early construction and prioritizes durability over prescriptive R-values. As outlined in the National Park Service’s *Preservation Brief 3: Improving Energy Efficiency in*

Historic Buildings, the first step should be a professional energy audit to establish a baseline of current performance, identify primary sources of heat loss and air leakage, and inform cost-effective decision-making. Initial “low-hanging fruit” typically includes controlling bulk water ingress (if any), reducing air infiltration (particularly at the attic, basement, and interstitial bypasses), adding or upgrading attic insulation where it has minimal impact on historic fabric, improving mechanical system efficiency and controls, and enhancing the performance of existing windows through repair, weatherstripping, and compatible storm windows rather than replacement. More intensive upgrades, such as wall insulation, insulating masonry assemblies, or creating conditioned attics or crawlspaces, should be considered only after these measures are addressed and only with a clear understanding of existing moisture behavior and drying pathways. In early wood-frame, insulating without an integrated moisture strategy can increase condensation risk, reduce drying potential, and accelerate deterioration of historic materials. For this reason, any higher-impact energy measures should be evaluated on a case-by-case basis, coordinated with planned repairs, and reviewed for long-term compatibility with the building’s historic construction and intended use.

Next Steps

Under the “Site and Buildings” section of the 2020 CAP, the final of three recommendations (following completion of an HSR) states: *Given the significance of the building, future work should be guided by a team expert in historic preservation and will likely include an architect, structural engineer, mechanical engineer, and exhibit/lighting designer.*

Our experience with historic buildings in museum settings suggests that a phased, step-by-step approach is often necessary. These structures not only provide shelter for artifacts and exhibits but are themselves part of the collection and interpretive experience. As such, planning work must move through a multi-factorial process of study and design development to address programmatic needs, code requirements, environmental performance, and the interpretation and treatment of historic fabric in accordance with an established preservation philosophy and period of interpretation. The observations identified in this Conditions Assessment establish a framework for structural and building envelope work within a broader restoration effort. To translate these findings into shovel-ready construction documents, they must advance through a more detailed process of investigation, design and specification. In some cases, this will require targeted “pre-design” exploration to better understand underlying conditions. Ideally, even if implemented in phases, this work proceeds under the umbrella of a comprehensive master plan that articulates programming goals, accessibility strategies, preservation philosophy and interpretive direction.

We would be delighted to partner with Historic Northampton as part of a comprehensive interdisciplinary team to advance this vision. As noted by the asterisk in the Summary of Findings section, certain structural and building envelope conditions are independent of programmatic decisions or interior interpretation and may be prioritized ahead of, or in parallel to, larger planning efforts. We would be pleased to assist with the next steps of targeted investigation (where warranted) and the development of design and specification documents to responsibly move those areas forward.

Limitations of Report

The analysis and recommendations in this report are based on data gathered from limited field observations, which primarily involve a visual assessment of exposed elements. If discrepancies, unforeseen conditions, or issues more extensive than initially anticipated arise in the field, it will be necessary to re-evaluate the recommendations outlined in this report.

The information provided here is not suitable for construction and is intended for planning and budgeting purposes only.

Closing

It has been a pleasure to perform this study. If you have any questions regarding this report, please do not hesitate to contact this office.

Respectfully Yours,

Cirrus Structural Engineering, LLC

A handwritten signature in black ink, appearing to read 'E. Acly', written over a light blue rectangular background.

Elizabeth Acly, PE
Principal

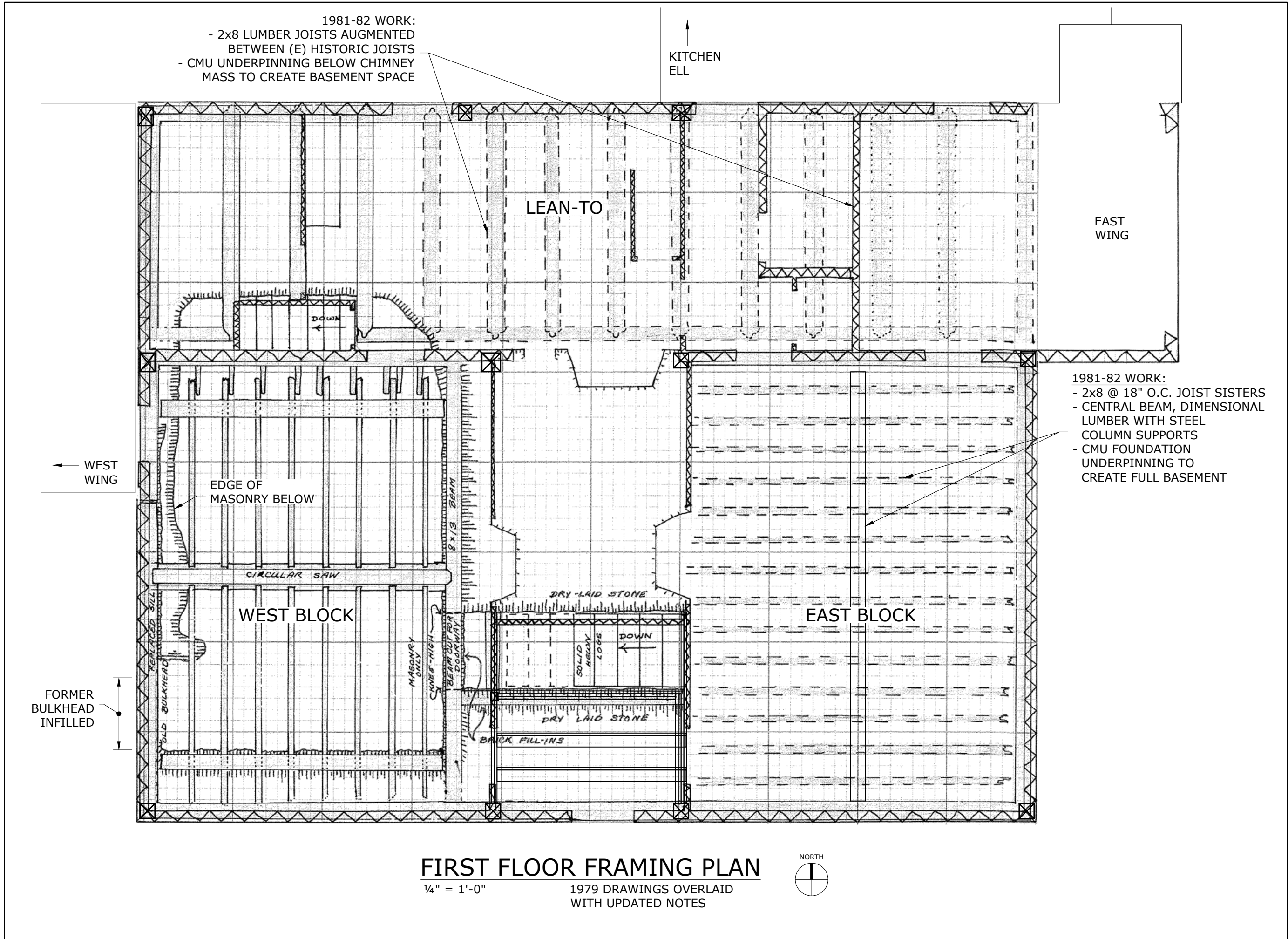
Appendices:

Annotated Framing Drawings

Key Plan defining room number designations

Parsons House Accessibility Options Drawing

National Park Service's Preservation Brief 3: Improving Energy Efficiency in Historic Buildings



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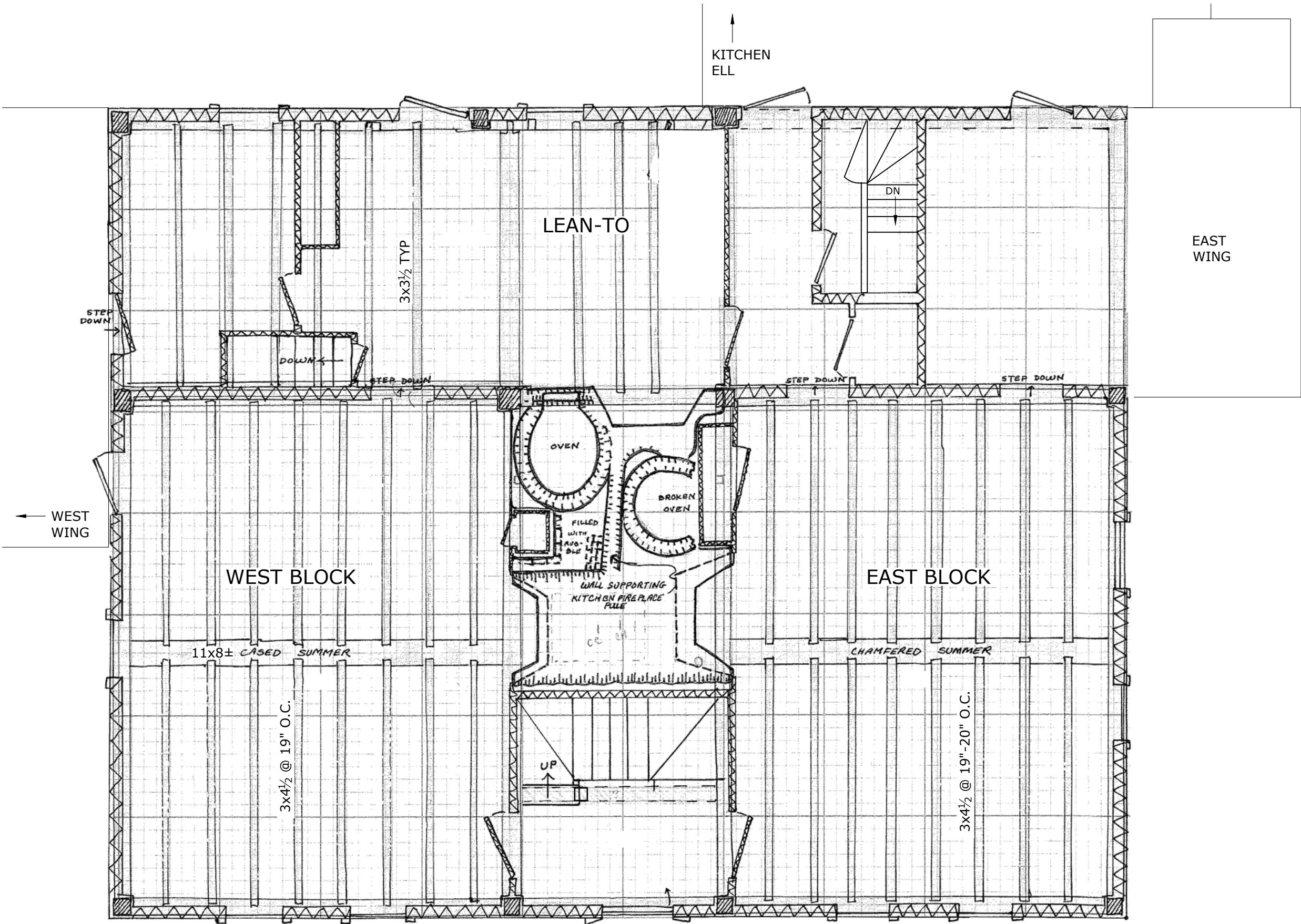
Parsons House
Structural Conditions Assessment

ADDRESS:

46 Bridge Street
Northampton, MA 01060

REVISIONS		
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Date of Issue:	
January 27, 2026	
Drawing Title:	
EXISTING FRAMING PLANS	
Scale:	
As Noted @ 11x17	
Drawing No:	
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SECOND FLOOR FRAMING PLAN

1/4" = 1'-0"

1979 DRAWINGS OVERLAID
WITH UPDATED NOTES



Parsons House Structural Conditions Assessment

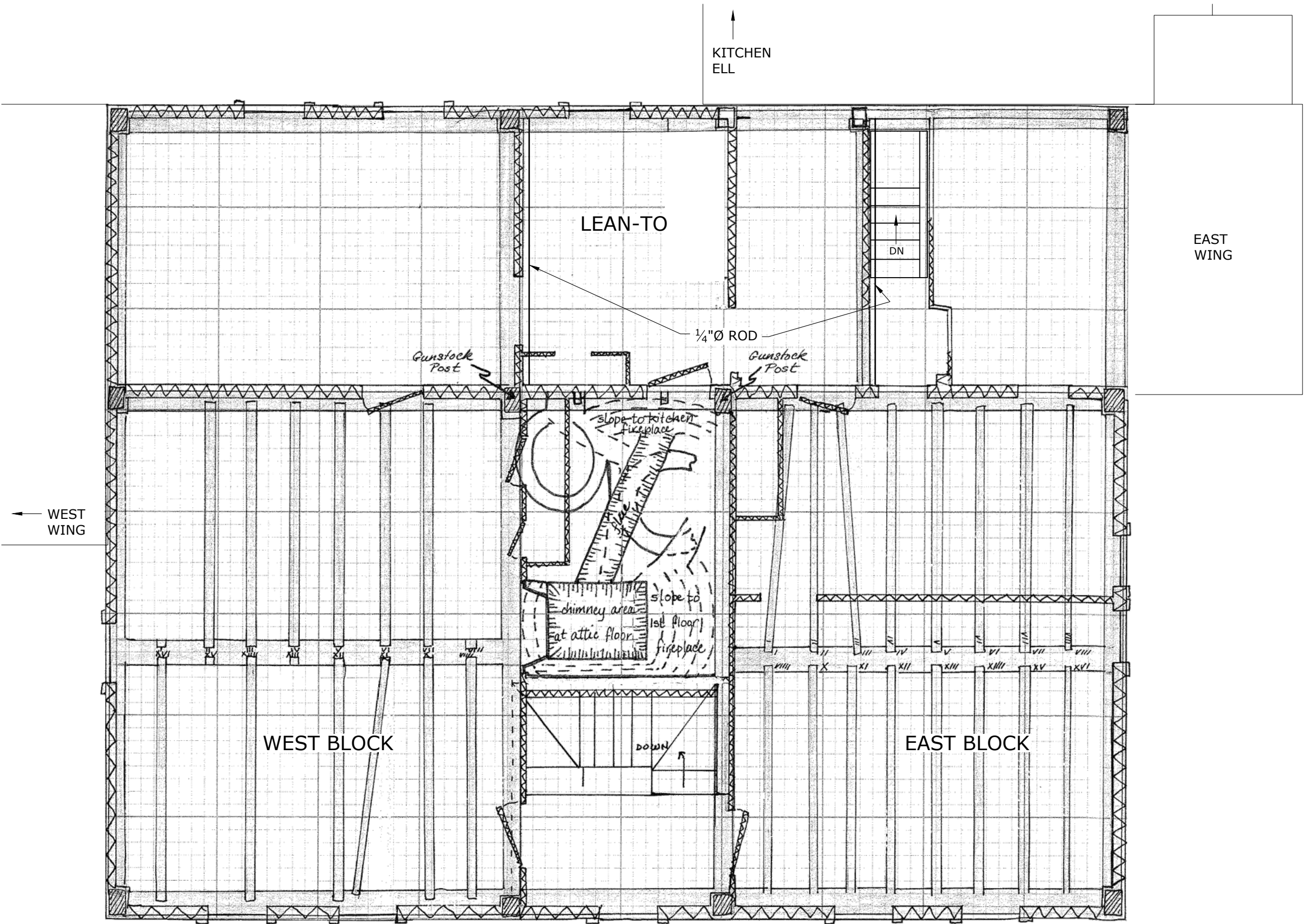
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ATTIC FRAMING PLAN

1/4" = 1'-0" 1979 DRAWINGS OVERLAID
WITH UPDATED NOTES



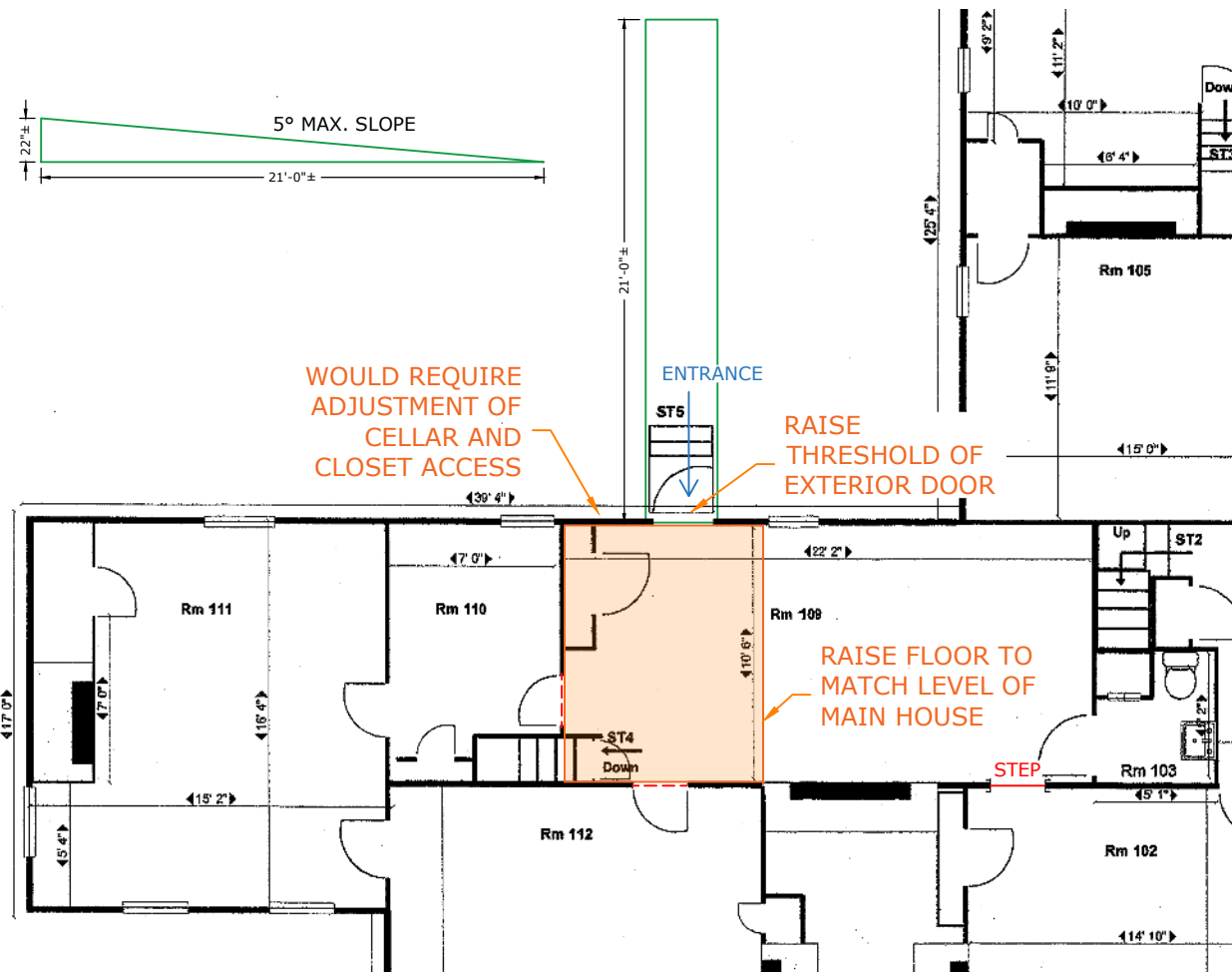
Parsons House
Structural Conditions Assessment

46 Bridge Street
Northampton, MA 01060

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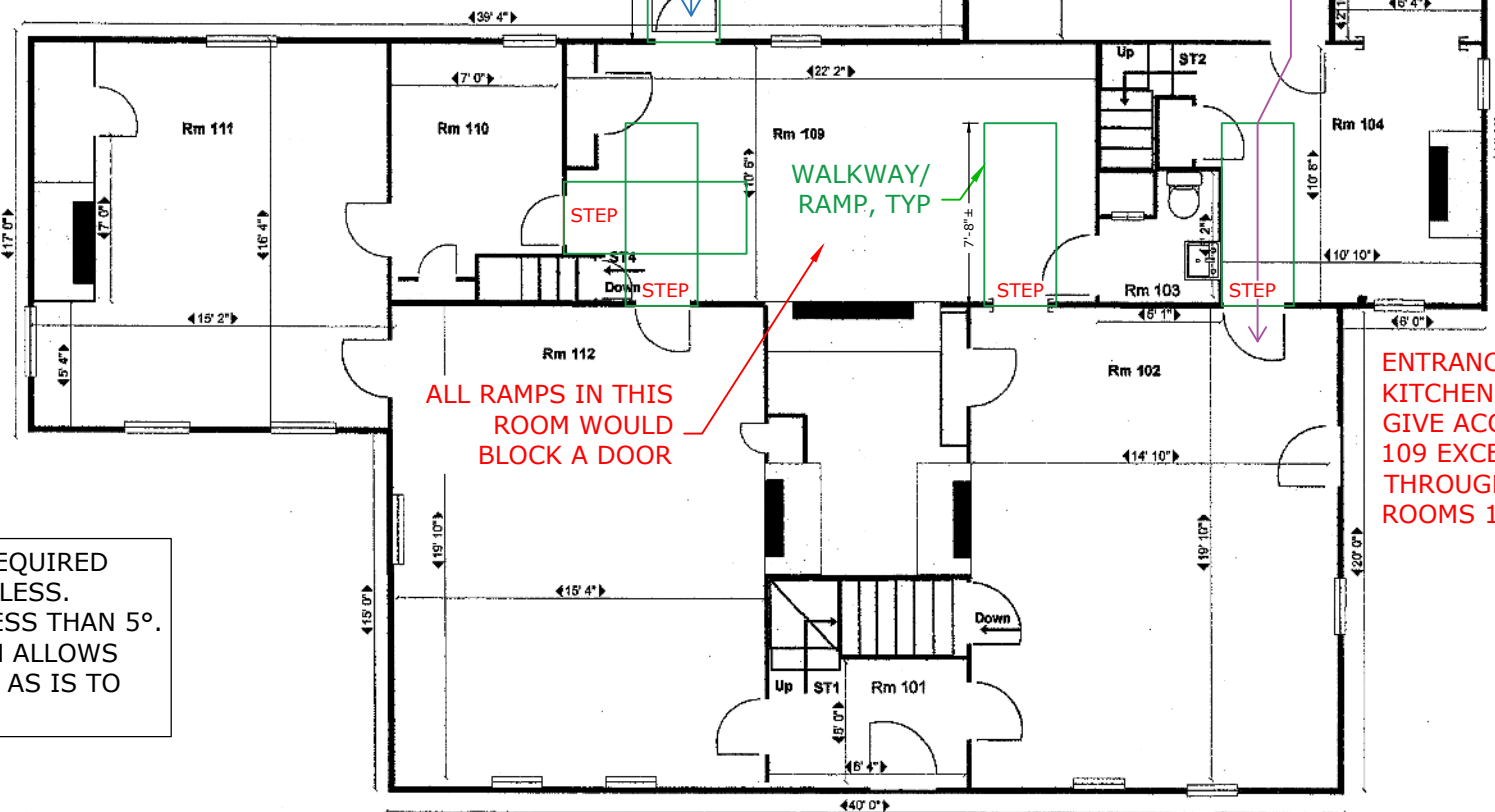
ADDITIONAL OPTION (PARTIAL PLAN)



WALKWAY/RAMP SAMPLES

HANDRAILS ARE NOT REQUIRED FOR A SLOPE OF 5° OR LESS. THESE SAMPLES ARE LESS THAN 5°. THE "BRIDGE" PORTION ALLOWS THE GRADE TO REMAIN AS IS TO PROTECT SILLS.

MINIMUM DOOR WIDTH REQUIREMENT FOR ACCESSIBILITY IS 32". EXISTING DOORS ARE APPROXIMATELY 30" - 32" AND ADJUSTMENT MAY NEED TO BE CONSIDERED.



ACCESSIBILITY OPTIONS



BACKGROUND DRAWINGS BY BILL HOLLOWAY, SMARTDRAW, 8/25/2020



Parsons House
Structural Conditions Assessment

NAME:

ADDRESS:
46 Bridge Street
Northampton, MA 01060

REVISIONS		
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Date of Issue:	
January 27, 2026	
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As Noted @ 11x17	
Drawing No:	
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3 PRESERVATION BRIEFS

Improving Energy Efficiency in Historic Buildings

Jo Ellen Hensley and Antonio Aguilar



National Park Service
U.S. Department of the Interior

Technical Preservation Services



The concept of energy conservation in buildings is not new. Throughout history building owners have dealt with changing fuel supplies and the need for efficient use of these fuels. Gone are the days of the cheap and abundant energy of the 1950's. Today with energy resources being depleted and the concern over the effect of greenhouse gases on climate change, owners of historic buildings are seeking ways to make their buildings more energy efficient. These concerns are key components of sustainability — a term that generally refers to the ability to maintain the environmental, social, and economic needs for human existence. The topic of sustainable or “green” building practices is too broad to cover in this brief. Rather, this preservation brief is intended to help property owners, preservation professionals, and stewards of historic buildings make informed decisions when considering energy efficiency improvements to historic buildings.

Sound energy improvement measures must take into consideration not only potential energy savings, but also the protection of the historic property's materials and features. This guidance is provided in accordance with the Secretary of the Interior's Standards for Rehabilitation to ensure that the architectural integrity of the historic property is preserved. Achieving a successful retrofit project must balance the goals of energy efficiency with the least impact to the historic building. Planning must entail a holistic approach that considers the entire building envelope, its systems and components, its site and environment, and a careful evaluation of the effects of the measures undertaken. Treatments common to new construction need to be evaluated carefully before implementing them in historic buildings in order to avoid inappropriate alteration of important architectural features and irreparable damage to historic building materials. This brief targets primarily small-to medium-size historic buildings, both residential and commercial. However, the general decision-making principles outlined here apply to buildings of any size and complexity.

Inherent Energy Efficient Features of Historic Buildings

Before implementing any energy conservation measures, the existing energy-efficient characteristics of a historic building should be assessed. Buildings are more than the sum of their individual components. The design, materials, type of construction, size, shape, site orientation, surrounding landscape, and climate all play a role in how buildings perform. Historic building construction methods and materials often maximized natural sources of heat, light and ventilation to respond to local climatic conditions. The key to a successful rehabilitation project is to understand and identify the existing energy-efficient aspects of the historic building and how they function, as well as to understand and identify its character-defining features to ensure they are preserved. Whether rehabilitated for a new or continuing use, it is important to utilize the historic building's inherent sustainable qualities as they were intended to ensure that they function effectively together with any new treatments added to further improve energy efficiency.

Windows, courtyards, and light wells

Operable windows, interior courtyards, clerestories, skylights, rooftop ventilators, cupolas, and other features that provide natural ventilation and light can reduce energy consumption. Whenever these devices can be used to provide natural ventilation and light, they save energy by reducing the need to use mechanical systems and interior artificial lighting.

Historically, builders dealt with the potential heat loss and gain from windows in a variety of ways depending on the climate. In cold climates where winter heat loss from buildings was the primary consideration before mechanical systems were introduced, windows were limited to those necessary for adequate light and ventilation. In historic buildings where the ratio of glass



Fig. 1. A decorative, stained glass skylight allows natural daylight into the interior.

to wall is less than 20%, the potential heat loss through the windows is likely minimal; consequently, they are more energy efficient than most recent construction. In hot climates, numerous windows provided valuable ventilation, while features such as wide roof overhangs, awnings, interior or exterior shutters, venetian blinds, shades, curtains and drapes significantly reduced heat gain through the windows. Historic windows can play an important role in the efficient operation of a building and should be retained.



Fig. 2. Upper and lower shutters control daylight and provide privacy.

New architectural styles, beginning with the International Style of the 1920's, brought about an increase in the percentage of glazing in the total building envelope. By the 1950's, with the advent of the glass curtain wall, glazing constituted nearly 100% of a building's exterior walls in many buildings. While many early modern buildings continued to use operable windows as a way to provide natural ventilation, greater reliance on mechanical heating and air conditioning systems eventually reduced the function of exterior glazing to providing light only, particularly in commercial, office, and institutional buildings.



Fig. 3. Stone walls with substantial mass have high thermal inertia.

Walls

Thick masonry walls typical of the late-nineteenth and early-twentieth centuries have inherent thermal characteristics that keep the buildings cooler in the summer and warmer in the winter. Walls with substantial mass have the advantage of high thermal inertia, which reduces the rate of heat transfer through the wall. For instance, a wall with high thermal inertia, subjected to solar radiation for an hour, will absorb the heat at its outside surface, but slowly transfer it to the interior over a period as long as six hours. Conversely, a wall having the equivalent thermal resistance (R-value), but a substantially lower thermal inertia, will transfer the heat in perhaps as little as two hours. Heavy masonry walls also reduce the need for summer cooling. High thermal inertia is the reason many older public and commercial buildings without air conditioning still feel cool during the summer. The heat from the midday sun does not penetrate the buildings until late afternoon and evening, when it is less likely to be occupied or when exterior temperatures have fallen. Heavy masonry walls are also effective in moderating internal temperatures in the winter by dampening the overall peaks of heat gain and loss resulting in a flatter and more tolerable daily cycle. In areas that require cooling during the day and heating at night, masonry walls can help spread out excess heat gain from the day to cover some of the needed heating for the evening and night hours.

Roofs

Roof construction and design in historic buildings, particularly vernacular buildings, are strongly

influenced by the conditions of the local climate. Wide overhangs that sometimes extend to create porches minimize the heat gain from the sun in warmer climates, while steep, sloping roofs with minimal or no overhang prevail in colder climates to allow for shedding snow and increasing beneficial solar heat gain through the windows. Materials and color also influence the thermal performance of roofs. Metal and light colored roofs, for example, reflect sunlight and thereby reduce the heat gain from solar radiation.

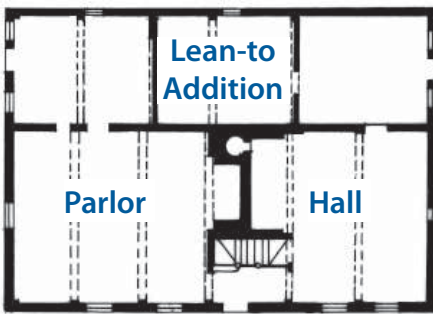


Fig. 4. A typical New England saltbox features a steeply sloping roof to shed snow and a floor plan organized around a central chimney to conserve heat.

Floor Plans

The floor plan of many historic buildings, particularly traditional vernacular ones, was also designed to respond to the local climate. In cold climates, rooms with low ceilings were clustered around central chimneys to share the heat, while small windows with interior shutters reduced drafts and heat loss. In warmer climates, wide central halls with tall ceilings, breezeways, and large porches all maximized air circulation.

Landscape

Site orientation was another factor considered especially in the location of a historic building on its property. In cold climates, buildings were oriented against northern winds while buildings in warm climates were sited to take advantage of prevailing breezes. Evergreen trees planted on the north side of buildings shielded from winter winds; deciduous trees planted to the south provided summer shade and maximum sun in the winter.



Fig. 5. The side porches of this house in Charleston, SC, shade the large windows and provide outdoor living spaces that take advantage of sea breezes.

Energy Audit

Before implementing any measures to improve the thermal performance of a historic building, an energy audit should be undertaken to evaluate the current energy use of the building and identify deficiencies in the building envelope or mechanical systems. In some areas, the local utility company may offer a free simple audit, however a more in-depth audit should be obtained from a professional energy auditor. The goal of the audit is to establish a baseline of building performance data to serve as a reference point when evaluating the effectiveness of future energy improvements. It is important to hire an independent auditor who does not have financial interests in the results, such as a product vendor.

An energy auditor first documents the current energy use patterns in the building to establish an energy use history. This initial step includes obtaining the billing history from the local utility company over a one- or two-year period, as well as documenting the number of building occupants, how the building is used, and the type of fuel consumed. The location of any existing insulation is recorded and the approximate R-value of various components of the building envelope including walls, ceilings, floors, doors, windows and skylights is calculated. The building envelope is inspected to identify areas of air infiltration and air loss. The type and age of mechanical systems and major appliances are also recorded.

Tools such as a blower door test or infrared thermography are useful to identify specific areas of infiltration, lack of insulation and thermal bridging. Mechanical depressurization along with infrared thermography is extremely useful in identifying locations of air leakage and heat loss followed by the use of tracer smoke to isolate specific air leaks. These tests are often challenging to perform on buildings and must be undertaken by experienced professionals to avoid

misleading or inaccurate results. There are professional standards for audits, those of the Building Performance Institute (BPI) being the most widely used.

The energy auditor then produces a detailed report that documents the findings of the audit and includes specific recommendations for upgrades such as air sealing, adding insulation, general repairs, lighting, and improvements to or replacement of mechanical systems or major appliances. Cost estimates are provided for each of the improvements including the cost of implementation, potential operating cost savings, and, importantly, the anticipated payback period. Armed with this information, historic building owners can start to make informed decisions on how to improve the performance of their buildings. Usually the auditor finds a few locations where there is major air leakage; large “holes” that are unique to a particular building and require equipment to find them. These anomalies are often invisible to the people who use the building on a regular basis. It is important to retest the performance of the building following the implementation of any upgrades undertaken as a result of an energy audit to ensure that the upgrades are performing as expected.

Prioritizing Energy Upgrades

When implementing energy upgrades, efforts should be concentrated on improvements that will provide the most payback for the money expended and the least compromise to the historic character of the building. Some upgrades recommended in energy audits may not be introduced into a historic building feasibly without damaging historic fabric or altering the appearance of significant features. Removing historic siding and replacing it with new siding to introduce insulation

into the wall cavity of a frame building or replacing repairable historic windows are examples of treatments that should not be undertaken on historic buildings.

A common misconception is that replacing windows alone will result in major energy savings. This argument, often used to sell replacement windows, is simply not true. Although it varies from building to building, the U.S. Department of Energy (DOE) has documented that air loss attributable to windows in most buildings is only about 10% of the total air loss. Studies have shown that window replacement does not pay for itself in energy savings in a reasonable length of time. Moreover, there are ways to improve the performance of historic windows that do not require their replacement. In addition, historic windows can usually be repaired and are, thus, sustainable, while most new windows cannot be repaired, or even recycled, and may wind up in landfills.

When considering energy upgrades, it is imperative to get a clear picture of what an improvement will cost initially and how long it will take to pay back the cost in energy savings. Therefore, the life cycle cost of the improvement must be considered as well as its impact on historic fabric. Reducing infiltration around existing windows and doors, sealing penetrations in the building envelope, and adding insulation — particularly in the attic where it has little impact on historic fabric — can result in significant improvements at relatively little cost. Updating mechanical systems or changing the way in which they are operated can also be cost-effective interventions. For example, installing a more efficient mechanical system alone may pay for itself in ten years.



Fig. 6. (left) A blower door is used to depressurize a building by exhausting air at a rate that allows pressure gages and tracer smoke to measure the amount and location of air leakage. Photo: Robert Cagnetta, Heritage Restoration, Inc.



Fig. 7. (center and right) The left thermal image shows the walls of this building before insulating. After insulation was added, the cooler and, thus darker exterior walls evidence how much the heat loss has been reduced. Photos: EYP Architecture & Engineering.

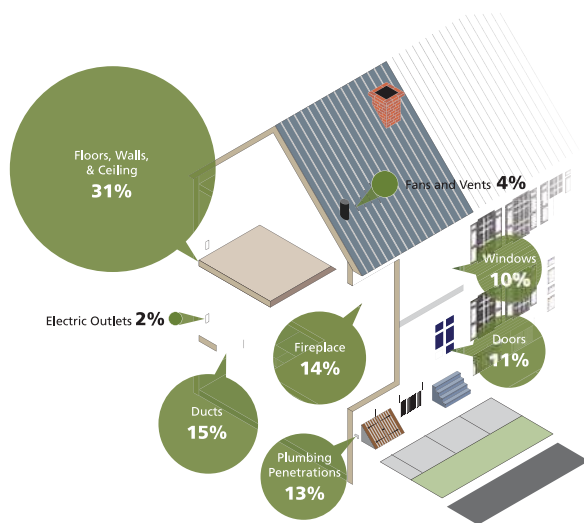


Fig. 8. Where Air Escapes From a House (by percentage) – Image based on data from Energy Savers, U.S. Department of Energy. Illustration: Blank Space LLC.

Actions to Improve Energy Efficiency

Reducing energy demands for heating and cooling may be accomplished in two steps. First, implement operational changes and upgrades to mechanical systems and major appliances — measures that do not require making alterations or adding new materials — to ensure that a building functions as efficiently as possible. After all these measures have been implemented, corrective work or treatments, such as weatherization, that require other alterations to the building may be considered.

Residential Energy Use Intensity by Age

Year Built	KBtu/sq ft/yr
Prior to 1950	74.5
1950 to 1969	66.0
1970 to 1979	59.4
1980 to 1989	51.9
1990 to 1999	48.2
2000 to 2005	44.7

Source: Residential Energy Consumption Survey, 2005

Establishing Realistic Goals

Energy consumption data gathered by the U.S. Energy Information Administration (see chart) shows that residential buildings built before 1950 (the largest percentage of historic building stock) are about 30 to 40 percent less energy efficient than buildings built after 2000. Using this as a baseline, a 30 to 40 percent upgrade of a historic building's energy performance can be a realistic goal. A 40 percent increase in energy efficiency would of course be a more achievable goal for buildings that have had minimal upgrades since their

original construction, i.e., added insulation, tightening of the exterior envelope, or more efficient mechanical equipment. On the other hand, achieving “net zero” energy goals as it is currently done with some new construction can be a much more difficult challenge to achieve in a historic retrofit. Attempting to reach such a goal with a historic building would most likely result in significant alterations and loss of historic materials. [The data for commercial buildings documents that buildings in 2003 used approximately the same energy as they did before 1920, after reaching their peak in the 1980's.]

Operational Changes

One of the greatest effects on energy use is user behavior. Once an energy audit has established a baseline for the current energy use in a building, operational changes should be identified to control how and when the building is used to minimize the use of energy-consuming equipment. These changes can range from simple measures such as regular cleaning and maintenance of mechanical equipment to installing sophisticated controls that cycle equipment on and off in specified intervals for maximum performance. The following changes are recommended to reduce heating and cooling costs.

- Install programmable thermostats.
- Close off rooms that are not in use and adjust the temperature in those rooms.
- Do not condition rooms that do not need to be conditioned, thereby reducing the thermal envelope.
- Use insulated shades and curtains to control heat gain and loss through windows.
- Use operable windows, shutters, awnings and vents as originally intended to control temperature and ventilation.
- Take advantage of natural light.
- Install compact fluorescent lights (CFL) and light-emitting diode (LED) lights.
- Install motion sensors and timers for lighting and local ventilation, such as bathroom exhaust fans.
- Reduce “phantom” electricity loads by turning equipment off when not in use.
- Clean and service mechanical equipment regularly.

These measures should be undertaken first to save energy in any existing building and are particularly appropriate for historic buildings because they do not require alterations to historic materials.

Upgrading Equipment and Appliances

In addition to maximizing the energy efficiency of existing building systems, substantial savings can be achieved through upgrading equipment and appliances. One should still weigh the operational savings against the initial cost of the new equipment, particularly if the existing equipment is not near the end of its life.

Calculator aids that take into account the efficiency of both the existing and new equipment are available



Fig. 9. An energy auditor tests the efficiency of a boiler.

online to assist in determining the payback. Advance planning will allow time to find the most efficient unit, as well as to investigate the availability of any state and federal energy credits. As energy prices continue to rise and technology advances, options such as the installation of a solar hot water heater or geothermal ground source or water source heat pumps are becoming more economically feasible. Recommendations for upgrading equipment and appliances include:

- Upgrade the heating system. It is important to install new furnaces that utilize outside combustion air to reduce air drawn into the building through uncontrolled infiltration. [All furnaces and boilers are now measured by their annual fuel utilization efficiency or AFUE.] Heating equipment is now more efficient and gas furnaces that used to have a 60% (AFUE) rating can now operate at as much as 90 to 97% efficiency.
- Upgrade the air conditioning system.
- Replace the water heater. High-efficiency water heaters use far less energy than earlier models, and high-efficiency tankless water heaters heat water on demand and offer even greater savings. Point of use water heat can also reduce costs and water consumption by reducing the time it takes to draw hot water.
- Upgrade appliances. Energy Star appliances, particularly refrigerators, washing machines and dishwashers can all reduce electricity use and additional indoor heating loads.

Upgrading Building Components

In addition to operational and mechanical upgrades, it can be possible to upgrade many building components in a manner that will not jeopardize the historic character of the building and can be accomplished at a reasonable cost. The goal of these upgrades is to improve the thermal performance of the building, resulting in even greater energy savings. Retrofit measures to historic buildings should be limited to those that achieve at least reasonable energy savings, at reasonable costs, with the least impact on the character of the building.

The following list includes the most common measures proposed to improve the thermal performance of an existing building; some measures are highly recommended for historic buildings, but others are less beneficial, and can even be harmful to a historic building.

Requires Minimal Alteration

- Reduce air leakage.
- Add attic insulation.
- Install storm windows.
- Insulate basements and crawlspaces.
- Seal and insulate ducts and pipes.
- Weather strip doors and add storm doors.
- Add awnings and shading devices where appropriate.

Requires More Alteration

- Add interior vestibules.
- Replace windows.
- Add insulation to wood-frame walls.
- Add insulation to masonry walls.
- Install cool roofs and green roofs.

The treatments listed first have less potential to negatively impact the historic fabric of a building. They tend to be less intrusive, are often reversible, and offer the highest potential for energy savings. Undertaking any of the treatments in the second group, however, may pose technical problems and damage to historic building materials and architectural features. Their installation costs may also outweigh the anticipated energy savings and must be evaluated on a case-by-case basis with advice from professionals experienced in historic preservation and building performance.

Requires Minimal Alteration

Reduce air leakage. Reducing air leakage (infiltration and exfiltration) should be the first priority of a preservation retrofit plan. Leakage of air into a building can account for 5 to 40 percent of space-conditioning costs, which can be one of the largest operational costs for buildings.¹ In addition, unwanted air leakage into and out of the building can lead to occupant comfort issues resulting from drafts. Air infiltration can be especially problematic in historic buildings because it is closely linked to increased moisture movement into building systems.

Air flow into and out of buildings is driven by three primary forces: wind pressure, mechanical pressure and the stack effect. Cold outside air that infiltrates the building through big holes, as well as through loose windows, doors, and cracks in the outer shell of the building, causes the heating system to work harder and consume more energy. In a multi-story building, cold air that enters the building at lower levels, including the basement or crawlspace, will travel up through the building and exit out leaky windows, gaps around windows and the attic as a result of temperature and pressure differential. This pattern of air movement

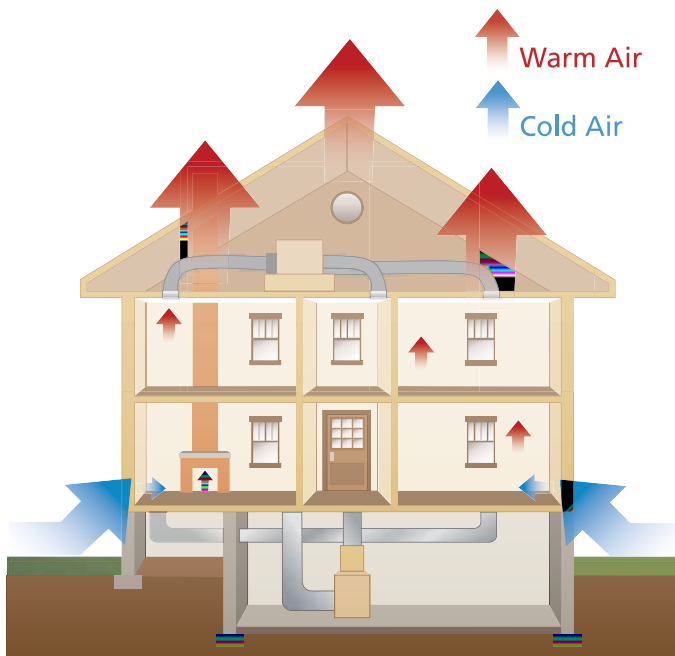


Fig. 10. The pattern of air movement referred to as the "stack effect". Illustration: Blank Space LLC.

is called the "stack effect." Not only is valuable conditioned air lost, but damaging moisture may also enter the wall cavities and attic spaces. To stop the stack effect, the top and bottom of the exterior walls, inter-floor bypasses, and any existing chases or shafts must be sealed, or "draft proofed." The use of spray foam sealants in basement and attic cracks is a particularly useful technique for reducing air infiltration.

Adding weatherstripping to doors and windows, sealing open cracks and joints at the base of walls and around windows and doors, sealing off recessed lighting fixtures from above, and sealing the intersection of walls and attic, will substantially reduce air leakage. When using exterior caulk to seal the intersection of siding and doors or windows, do not caulk the underside of clapboards or below windows to allow any liquid water to escape. When infiltration and, consequently, exfiltration are reduced, mechanical ventilation may be necessary to meet occupants' requirements for fresh air.

Add attic or roof insulation. Heat loss and gain caused by increased interior/exterior temperature differentials primarily due to the stack effect and solar radiation are greatest at the top of a building. Therefore, reducing heat transfer through the roof or attic should be one of the highest priorities in reducing energy consumption. Adding insulation in unoccupied, unfinished attics is not only very effective from an energy-savings perspective, but it is also generally simple to install and causes minimal disruption to historic materials. The U.S. Department of Energy (DOE) provides a recommended R-value chart based on climate zones to help determine the optimal amount of insulation that should be installed in a particular project. Local codes may also have specific insulation requirements. Insulating trap or access doors should not be overlooked. Even though they may be

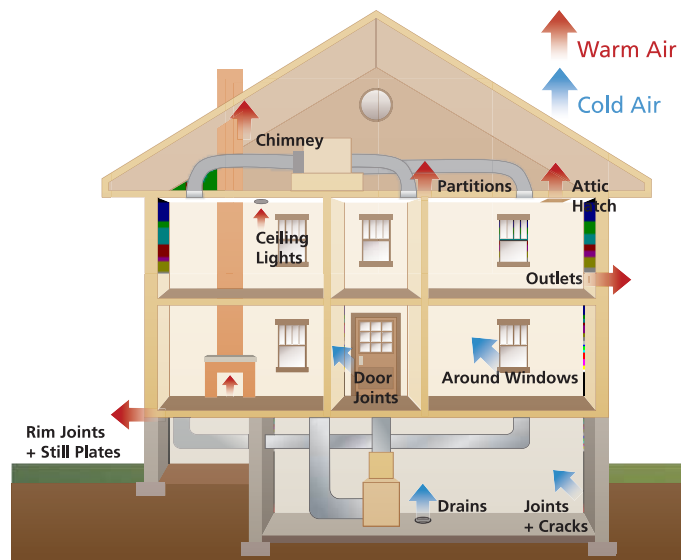


Fig. 11. Air infiltration and exfiltration. Illustration: Blank Space LLC.

small, attic doors can be responsible for substantial heat loss and should be addressed as part of any attic insulation project.

DOE Climate Zone Map

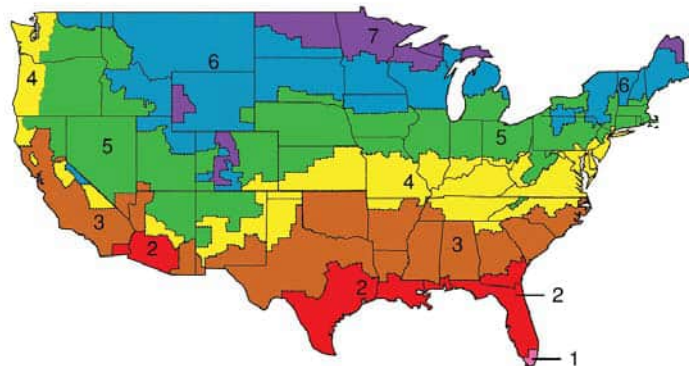


Fig. 12. Recommended energy improvements vary widely based on climate. The information contained in this document is based primarily on the available data for the Northeast and Mid-Atlantic regions.

In unfinished and unheated attics, the insulation material is typically placed between the floor joists using blown-in, batt, or rigid foam insulation. When using fiberglass batts faced with a vapor retarder, the vapor retarder should be face down towards the heated interior. However, the use of a vapor retarder is not necessary in attic applications. If additional batt insulation is being added over existing insulation that is near or above the top of the joists, new un-faced batts should be placed perpendicular to the old ones to cover the top of the joists and reduce thermal bridging through the frame members. In low-pitched roofs, or where installing batt insulation is difficult, a more complete coverage of the attic floor may be achieved by using blown-in insulation. Unfinished attics must be properly ventilated to allow excess heat to escape.

Radiant barriers may be used in attics to reduce thermal radiation across the air space between the roof deck and the attic floor in order to reduce summer heat gain. They are most beneficial in reducing cooling loads in hot climates and consist of a highly reflective sheet or coating, usually aluminum, applied to one or both sides of a flexible material. They are effective only when the foil surface faces an air space, and as long as the surface remains shiny – that is, free from dirt, dust, condensation and oxidation. Radiant barriers should not be installed directly over insulation on the attic floor, as they can act as vapor retarders and trap moisture in the insulation unless they are perforated. Their placement should be ventilated on both sides.

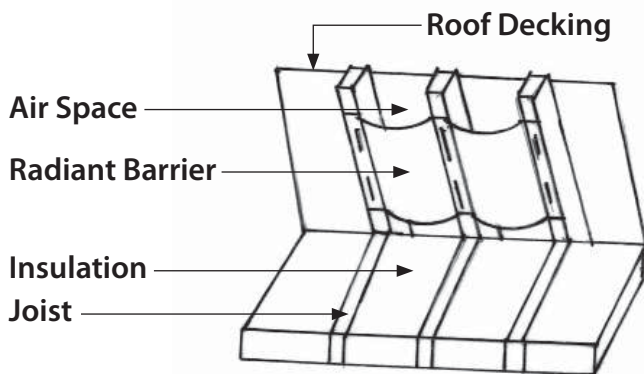


Fig. 13. Sample installation of a radiant barrier.

Insulating the underside of the roof rather than the attic floor increases the volume of the thermal envelope of the building, thus making this treatment inherently less energy efficient. However, when mechanical equipment and/or ductwork are housed in an attic space, placing the insulation under the roof and treating the attic as a conditioned space is strongly recommended. This treatment allows the equipment to operate more efficiently and can prevent moisture-related problems caused by condensation on the mechanical equipment.

When insulation is placed under the roof, all vents in the attic and the intersection between the walls and roof rafters must be sealed. Rigid foam or batt insulation placed between the roof rafters is a common method of insulating the underside of a roof. Open cell spray foam (.5lb/cuft) may sometimes be applied under the roof deck only when there are no gaps in the sheathing which could allow the foam to expand under slates or shingles, preventing the re-use of the roofing material. Also, if roof leaks do occur, they may go undetected until after major damage occurs. Consideration must also be given to the irreversibility of this procedure because the foam enters the pores of the wood. It may be more advisable to install a breathable layer of material that will allow for future removal without leaving a residue.

When total roof replacement is required because of deterioration, installing rigid foam insulation on top of the roof deck before laying the new roofing material

can be simple and effective, particularly on low-pitched or flat roofs. However, the added thickness of the roof caused by installing rigid foam can alter the appearance of projecting eaves, dormers, and other features. If this application would significantly alter the appearance of these features, consider other methods.

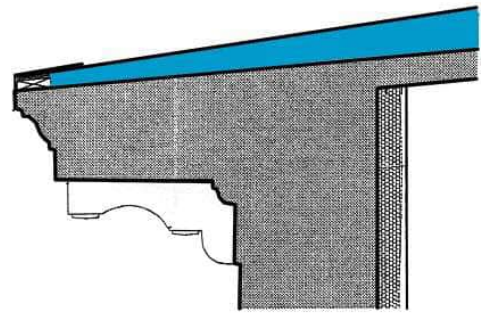


Fig. 14. Sample installation of rigid foam insulation, tapered at the edge to avoid altering the appearance of the roof.

Install storm windows. The addition of metal or wood exterior or interior storm windows may be advisable to increase the thermal performance of the windows in ways that weatherstripping and caulking cannot address. A single-glazed storm window may only increase a single-pane window's thermal resistance to R2, however, that is twice as good as a single-glazed window alone. It will make a noticeable contribution to the comfort level of the building occupant, with the added benefit of protecting the historic window from weathering. Using clear, non-tinted, low-e glass in the storm window can further increase the thermal performance of the window assembly without the loss of historic fabric. Studies have shown that the performance of a traditional wood window with the addition of a storm window can approach that of a double-glazed replacement window.² Some storm windows are available with insulated low-e glass, offering even higher thermal performance without the loss of the historic window. Furthermore, a storm window avoids the problem of irreparable seal failure on insulated glass units (IGUs) used in modern replacement windows. While the lifespan of the IGU depends both on the quality of the seal and other factors, it is unreasonable to expect more than 25 years. Once the seal fails, the sash itself will usually need to be entirely replaced.

By providing an additional insulating air space and adding a barrier to infiltration, storm windows improve comfort and reduce the potential for condensation on the glass. To be effective and compatible, storm windows must be tight fitting; include a sealing gasket around the glass; align with the meeting rail of the primary sash; match the color of the sash; and be caulked around the frame to reduce infiltration without interfering with any weep holes.

Whether a storm window or the historic window itself, the interior window must be the tighter of the two units to avoid condensation between the windows that can

occur in a cold climate that requires indoor heating. Condensation is a particular concern if it collects on the historic window, as can easily happen with a loose-fitting, storm window. While interior storm windows can be as thermally effective as exterior storm windows, appropriate gaskets must be used to ensure that damage-causing condensation does not form on the inside face of the historic window. Opening or removing the interior storm windows during non-heating months also helps to avoid the negative effects of moisture build-up.



Fig. 15. Original steel windows were retained and made operable during the rehabilitation of this historic mill complex. Insulated sliding windows were added on the interior to improve energy efficiency.



For large, steel industrial windows, the addition of interior, insulated sliding glass windows that align with the primary vertical mullions has proven to be a successful treatment that allows the primary window to remain operable.

Insulate basements and crawlspaces. The first step in addressing the insulation of basements and crawl spaces is to decide if they are to be part of the conditioned space and, therefore, within the thermal envelope of the building. If these areas are kept outside the thermal envelope of the building and treated as unconditioned areas, insulating between the floor joists on the underside of the subfloor is generally recommended. Alternatively, rigid foam insulation installed over the bottom of the floor joists on the basement or crawlspace side may also be used. All gaps between the unconditioned and conditioned areas of the building, including the band joists, should be air sealed to prevent air infiltration into the upper levels of the building.

If the crawlspace contains mechanical equipment, or if high levels of moist air enter the crawlspace through vents during the summer months, it is advisable to include the crawlspace within the thermal boundary of the building. As in attics, water vapor can condense on ducts and other equipment located in unconditioned basements and crawlspaces. In the past, building codes routinely required that crawlspaces be treated as non-

conditioned spaces and be ventilated. However, this has not proven to be a best practice in all cases. Ventilation through crawlspace vents does not keep the space dry during humid summers. All vents should be sealed and access doors weather-stripped. Rigid foam insulation installed on the interior face of the wall is recommended for basement and crawlspace foundation walls, only after all drainage issues have been addressed. Special attention should be given to ensure that all the joints between the insulation boards are sealed.

A moisture barrier on exposed dirt in a crawlspace is strongly recommended to prevent ground moisture from entering the building envelope. Whenever feasible, pouring a concrete slab over a moisture barrier in crawlspaces or basements with exposed dirt floors should be considered.

Seal and insulate ducts and pipes. A surprisingly enormous amount of energy is wasted when heated or cooled air escapes from supply ducts or when hot attic air leaks into air conditioning return ducts. Based on data collected in energy audits, as much as 35 percent of the conditioned air in an average central air conditioning system may escape from the ducts.³ Care must be taken to completely seal all connections in the duct system and adequately insulate the ducts, especially in unconditioned spaces. This loss of energy is another reason to treat attics, basements and crawlspaces as conditioned spaces. Ducts located in unconditioned spaces should be insulated based on the recommendations for the appropriate climate zone. Hot water pipes and water heaters should be insulated in unconditioned spaces to retain heat, and all water pipes insulated to prevent freezing in cold climates.

Weather strip doors and add storm doors. Historic wood doors are often significant features and should always be retained, rather than replaced. While an insulated replacement door may have a higher R-value, doors represent a small area of the total building envelope, and the difference in energy savings after replacement would be insignificant. The doors and frames should, however, have proper maintenance including regular painting, and the addition or renewal of weatherstripping. Storm doors can improve the thermal performance of the historic door in cold climates and may be especially recommended for a door with glazing. The design of the storm door should be compatible with the character of the historic door. A fully glazed storm door with a frame that matches the color of a historic door is often an appropriate choice because it allows for the historic door to remain visible. Storm doors are recommended primarily for residential buildings. They are not appropriate for commercial or industrial buildings. These buildings never had storm doors, because the doors were opened frequently or remained open for long periods. It may also not be appropriate to install a storm door on a highly significant entrance door. In some instances,

the addition of a storm door could add significant heat gain on certain exposures or in hot climates, which could degrade the material or finish of the historic door.

Add awnings and shading devices. Awnings and other shading devices can provide a considerable reduction of heat gain through windows and storefronts. Keeping existing awnings, or replacing them if previously removed, is a relatively easy way to enhance the energy performance of a building. Awnings should only be installed when they are compatible with the building type and character. In building types that did not have awnings historically, interior shades, blinds or shutters should be considered instead.

A wide range of shades, blinds and shutters is available for use in all types of buildings to control heat gain or loss through windows, as well as lighting levels. When properly installed, shades are a simple and cost-effective means of saving energy. Some shade fabrics block only a portion of the light coming in — allowing the use of natural light — while others block all or most of the light. The light-colored or reflective side of the shades should face the window to reduce heat gain. Quilted roller shades feature several layers of fiber batting and sealed edges, and these shades act as both insulation and an air barrier. They control air infiltration more effectively than other soft window treatments. Pleated or cellular shades provide dead air spaces within the cells to add insulation value. These shades, however, do not measurably control air infiltration.

Retractable awnings and interior shades should be kept lowered during the summer to prevent unwanted heat gain, but raised in the winter to take advantage of the heat gain. Interior shades, especially those that have some insulation value, should be lowered at night during the winter months.

Light shelves are architectural devices designed to maximize daylight coming through windows by reflecting it deeper into the building. These horizontal elements are usually mounted on the interior above head height in buildings with high ceilings. Although they can provide energy savings, they are not compatible with most historic buildings. In general, light shelves are most likely to be appropriate in some industrial or modernist-style buildings, or where the historic integrity of interior spaces has been lost and they can be installed without being visible from the exterior.

Requires More Alteration

Add interior vestibules. Vestibules that create a secondary air space or “air lock” are effective in reducing air infiltration when the exterior door is open. Exterior and interior vestibules are common architectural features of many historic buildings and should be retained wherever they exist. Adding an interior vestibule may also be appropriate in some historic buildings. For example, new glazed interior vestibules may be compatible changes to historic commercial and industrial buildings. New exterior vestibules will usually result in too great a change to the character of primary entrances, but may be acceptable in very limited instances, such as at rear entrances. Even in such instances, new vestibules should be compatible with the architectural character of the historic building.

Replace windows. Windows are character-defining features of most historic buildings. As discussed previously, the replacement of a historic window with a modern insulated unit is not usually a cost-effective choice. Historic wood windows have a much longer service life than replacement insulated windows, which cannot be easily repaired. Therefore, the sustainable choice is to repair historic windows and upgrade their thermal performance. However, if the historic windows are deteriorated beyond repair, if repair is impractical because of poor design or material performance, or if repair is economically infeasible, then replacement windows may be installed that match the historic windows in size, design, number of panes, muntin profile, color, reflective qualities of the glass, and the same relationship to the window opening.

Other options should also be considered before undertaking complete window replacement. If only the sash is severely deteriorated and the frame is repairable, then only the sash may need to be replaced. If the limited lifespan of insulated glass is not a concern, the new sash can be made to accommodate double glazing.



Fig. 16. Historic vestibules retain conditioned air in the living spaces.

Where the sashes are sound, but improved thermal performance without the use of a storm window is desired, some windows may be retrofitted with insulated glass. If the existing sash is of sufficient thickness, it may be routed to accept insulated, clear low-e glass without extensive loss of historic material or historic character. When insulated glass is added in a new or retrofitted sash, any weights will have to be modified to accommodate the significant extra weight.

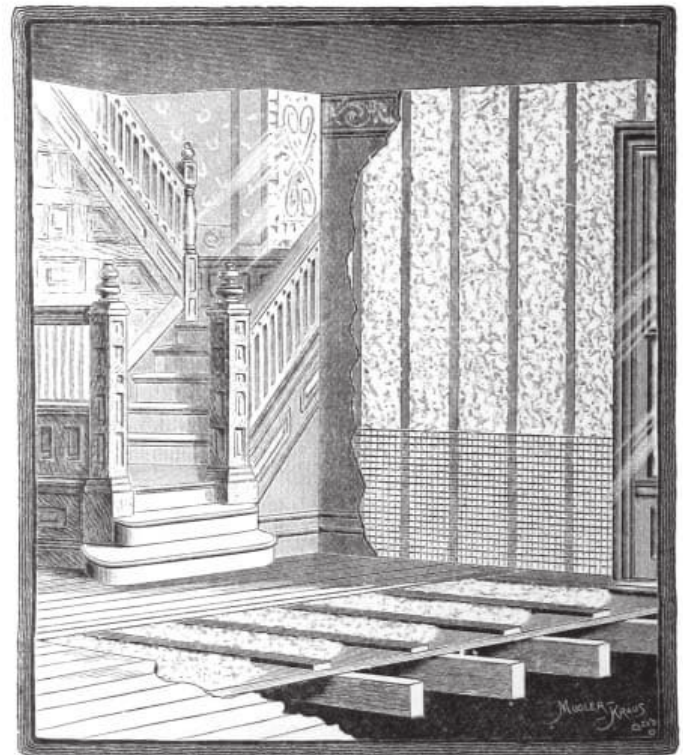
Wall Insulation

Adding wall insulation must be evaluated as part of the overall goal to improve the thermal efficiency of a building and should only be considered after the installation of attic and basement insulation. Can this goal be achieved without the use of wall insulation? Can insulation be added without causing significant loss of historic materials or accelerated deterioration of the wall assembly? Will it be cost effective? These are basic questions that must be answered before a decision is made to insulate the walls and may require professional evaluation.

Add insulation to wood-frame walls. Wood is particularly susceptible to damage from high moisture levels; therefore, addressing existing moisture problems before the addition of insulation is essential. Un-insulated historic wood buildings have a higher rate of air infiltration than modern buildings; while this makes older buildings less efficient thermally, it helps dissipate the unwanted moisture and thus keeps building assemblies dry. Climate, building geometry, the condition of the building materials, construction details, and many other factors make it difficult to assess the impact that adding insulation will have on reducing the air flow and, hence, the drying rate in a particular building. For this reason, predicting the impact of adding insulation to wood-frame walls is difficult.

Insulation Installed in the Wall Cavity: When sheathing is part of the wall assembly, and after any moisture-related problems have been addressed, adding insulation to the interior cavity of a wood-frame wall may be considered. Adding insulation in a wall where there is no sheathing between the siding and studs is more problematic, however, because moisture entering the wall cavity through cracks and joints by wind-driven rain or capillary action will wet the insulation in contact with the back of the siding.

Installing **blown-in insulation**, either dense-packed cellulose or fiberglass, into the wall cavity causes the least amount of damage to historic materials and finishes when there is access to the cavity walls, and it is therefore a common method of insulating wood-frame walls in existing buildings. In most cases, blowing insulation material into the wall cavity requires access through the exterior or interior wall surfaces. When historic plaster, wood paneling, or other interior historic decorative elements are present, accessing the



AN INTERIOR

Showing Mineral Wool in Floor, and Walls behind Wire Lath.

Fig. 17. Illustration of insulation from the 1889 trade catalog "The Uses of Mineral Wool in Architecture, Car Building and Steam Engineering". Collection Centre Canadien d'Architecture/Canadian Centre for Architecture, Montreal, Canada.

cavity from the exterior is recommended by removing individual siding boards at the top of each wall cavity. In this manner the boards can be reinstalled without unsightly drill holes on the exterior. If the plaster is deteriorated and will require repair, then the wall cavity may be accessed from the interior through holes drilled through non-decorative plaster.

Of the materials available, dense-packed cellulose fiber is most commonly used. Its R-value, ability to absorb and diffuse moisture, impediment to air flow, relatively simple installation, and low cost make it a popular choice. Cellulose insulation from most manufacturers is available in at least two grades that are characterized by the type of fire retardant added to the insulation. The fire retardants are usually: (1) a mix of ammonium sulfate and boric acid or (2) boric acid only (termed "borate only"). The recommended type of cellulose insulation for historic buildings is the "borate only" grade, as cellulose treated with sulfates reacts with moisture in the air and forms sulfuric acid which corrodes many metals.

Optimum conditions for installing insulation inside the wall cavity occur in buildings where either the exterior materials or interior finishes have been lost, or where the materials are deteriorated beyond repair and total replacement is necessary. However, wholesale removal of historic materials either on the exterior or interior face of a historic wall to facilitate insulation is

not recommended. Even when the exterior materials, such as wood siding, could potentially be reinstalled, this method, no matter how carefully executed, usually results in damage to, and loss of historic materials.



Fig. 18. Dense-packed cellulose insulation is being blown in through holes drilled in the sheathing. Once the operation has been completed, the shingles will be reinstalled. Photo: Edward Minch.

If the wall cavity is open, the opportunity to properly install **batt insulation** is available. A tight fit between the insulation and the adjacent building components is critical to the performance of the insulation. Batt insulation must be cut to the exact length of the cavity. A batt that is too short creates air spaces above and beneath the batt, allowing convection. A batt that is too long will bunch up, creating air pockets. Air pockets and convection currents significantly reduce the thermal performance of insulation. Each wall cavity should be completely filled. Unfaced, friction-fit batt insulation fluffed to fill the entire wall cavity is recommended. Any air gaps between the insulation and the framing or other assembly components must be avoided. Batts should be split around wiring, pipes, ducts and other elements in the wall rather than be pushed or compressed around obstacles.

When adding insulation to the sidewalls, the band joist area between floors in multi-story, platform-framed buildings should be included in the sidewall insulation retrofit. The R-value of the insulation installed in the band joist area should be at least equal to the R-value of

Band Joist

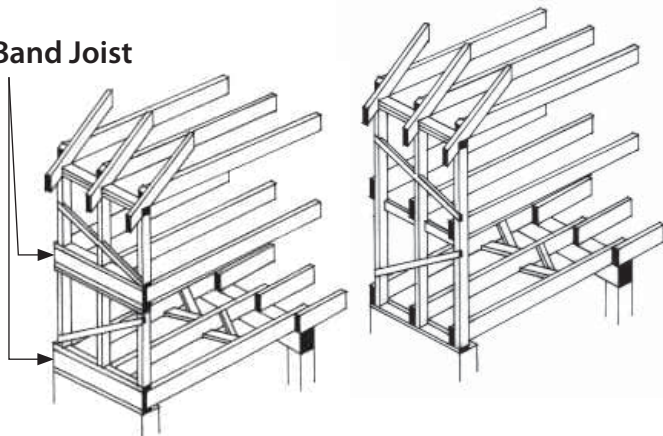


Fig. 19. Platform framing (left) and Balloon framing (right).

the insulation in the adjacent wall cavities. In balloon-framed buildings, the wall cavity is continuous between floors except where fire stops have been inserted.

The use of **spray foam or foamed-in-place insulation** would appear to have great potential for application in historic wood-frame buildings due to their ability to flow into wall cavities and around irregular obstacles. Their high R-value and function as an air barrier make them a tempting choice. However, their use presents several problems. The injected material bonds tightly to historic materials making its removal difficult, especially if it is encased in an existing wall. The pressure caused by the expansion rate of these foams within a wall can also damage historic material, including breaking the plaster keys or cracking existing plaster finishes.

Insulation Installed on Either Side of the Wall: Batt, rigid foam board, and spray foam insulation are commonly added to the interior face of walls in existing buildings by furring-out the walls to accommodate the additional thickness. However, this often requires the destruction or alteration of important architectural features, such as cornices, base boards, and window trim, and the removal or covering of plaster or other historic wall finishes. Insulation installed in this manner is only recommended in buildings where interior spaces and features lack architectural distinction or have lost significance due to previous alterations.



Fig. 20. The walls have been furred out inappropriately around the historic window trim creating an appearance the interior never had historically.

Adding rigid foam insulation to the exterior face of wood-frame buildings, while common practice in new construction, is never an appropriate treatment for historic buildings. Exterior installation of the foam boards requires removal of the existing siding and trim to install one or more layers of polyisocyanurate or polystyrene foam panels. Depending on the amount of insulation added for the particular climate, the wall thickness may be dramatically increased by moving

What about moisture?

The issue of moisture in insulated assemblies is the subject of much debate. While there is no conclusive way to predict all moisture problems, especially in historic buildings, experts seem to agree on a few basic tenants. Exterior materials in insulated buildings become colder in the winter and stay wet longer following a rain event. While the wetness may not pose a problem for robust materials, it may speed the deterioration of some building materials, and lead to more frequent maintenance such as repainting of wood or repointing of masonry. Summer moisture problems are most commonly associated with excessive indoor cooling and the use of interior wall finishes that act as vapor retarders (paint buildup or vinyl wall coverings). Good air-sealing at the ceiling plane usually controls moisture in insulated attics.

Most problems are caused by poor moisture management, poor detailing which does not allow the building to shed water, or inadequate drainage. Therefore, a thorough assessment of the building's ability to keep out unwanted moisture must be done before adding new insulation materials. Refer to Preservation Brief #39: *Holding the Line: Controlling Unwanted Moisture in Historic Buildings* for more information. Because of all the uncertainties associated with insulating walls, brick walls in particular, it may be advisable to hire a professional consultant who specializes in the many factors that affect the behavior of moisture in a building and can apply this expertise to the unique characteristics of a particular structure. Sophisticated tools such as computer modeling are useful to predict the performance of building assemblies, but they require interpretation by a skilled practitioner and the results are only as good as the data entered. It is important to remember, there are no reliable prescriptive measures to prevent moisture problems.⁴

Vapor Retarders (Barriers): Vapor retardants are commonly used in modern construction to manage the diffusion of moisture into wall cavities and attics. For vapor retardants to work properly, however, they must be continuous, which makes their installation difficult in existing buildings, and therefore generally not recommended. Even in new construction, installation of vapor retardants is not always indicated. Formerly, the recommended treatment was to install a vapor retardant toward the heated side of the wall (toward the interior space in cold climates and toward the exterior in hot climates). DOE now recommends that if moisture moves both to the interior and exterior of a building for significant parts of the year, it is better not to use a vapor retarder at all.⁵

the siding as much as 4 inches out from the sheathing. Even if the historic siding and trim could be removed and reapplied without significant damage, the historic relationship of windows to walls, walls to eaves, and eaves to roof would be altered, which would compromise the architectural integrity and appearance of the historic building.

Solid Masonry Walls: As with frame buildings, installing insulation on the interior walls of a historic masonry structure should be avoided when it would involve covering or removing important architectural features and finishes, or when the added thickness would significantly alter the historic character of the interior. The addition of insulation on solid masonry walls in cold climates results in a decreased drying rate, an increased frequency of freeze-thaw cycles, and prolonged periods of warmer and colder temperatures of the masonry. These changes can have a direct effect on the durability of materials.



Fig. 21. The interior face of a brick masonry wall shows damage that resulted from the installation of a vapor retardant (foil facing) and thermal insulation. Photo: Simpson Gumpertz & Heger.

Depending on the type of masonry, exterior masonry walls can absorb a significant amount of water when it rains. Masonry walls dry both toward the exterior and the interior. When insulation is added to the interior side of a masonry wall, the insulation material reduces the drying rate of the wall toward the interior, causing the wall to stay wet for longer periods of time. Depending on the local climate, this could result in damage to the historic masonry, damage to interior finishes, and deterioration of wood or steel structural components

imbedded in the wall. Masonry walls of buildings that are heated during the winter benefit from the transfer of heat from the inside to the outside face of the walls. This thermal transfer protects the exterior face of the wall by reducing the possibility of water freezing in the outer layers of the wall, particularly in cold and wet climates. The addition of insulation on the interior of the wall not only prolongs the drying rate of the exterior masonry wall, but keeps it colder as well, thereby increasing the potential for damage due to freeze-thaw cycles.⁶

Extreme swings in temperature may also have negative effects on a historic masonry wall. The addition of insulation materials to a historic masonry wall decreases its ability to transfer heat; thus, walls tend to stay warm or cold for longer periods of time. In addition, walls exposed to prolonged solar radiation during winter months can also be subject to higher swings in surface temperature during the day. Deleterious effects due to stress caused by expansion and contraction of the building assembly components can result.

Buildings with masonry materials of higher porosity, such as those built with low-fired brick, or certain soft stones, are particularly susceptible to freeze-thaw cycles and must be carefully evaluated prior to adding insulation. Inspection of the masonry in areas that are not heated such as parapets, exposed wing walls, or other parts of the building is particularly important. A noticeable difference in the amount of spalling or sanding of the masonry in these areas could predict that the same type of deterioration will occur throughout the building after the walls are insulated. Brick that was fired at lower temperatures was often used on the inside face of the wall or on secondary elevations. Even masonry walls faced with more robust materials such as granite may have brick, rubble, mortar or other less durable materials as backing.

Spray foams are being used for insulation in many masonry buildings. Their ability to be applied over irregular surfaces, provide good air tightness, and continuity at intersections between, walls, ceilings, floors and window perimeters makes them well suited for use in existing buildings. However, the long-term effects of adding either open- or closed-cell foams to insulate historic masonry walls as well as performance of these products have not been adequately documented. Use of foam insulation in buildings with poor quality masonry or uncontrolled rising damp problems should be avoided.

Periodic monitoring of the condition of insulated masonry walls is strongly recommended regardless of the insulation material added.

Install cool roofs and green roofs: Cool roofs and vegetated “green roofs” help to reduce the heat gain from the roof, thereby cooling the building and its environment. Cool roofs include reflective metal roofs,

light-colored or white roofs, and fiberglass shingles that have a coating of reflective crystals. All of these roofing materials reflect the sun’s radiation away from the building, which lessens heat gain, resulting in a reduction of the cooling load. Cool roofs are generally not practical in northern climates where buildings benefit from the added heat gain of a dark-colored roof during colder months. Cool and green roofs are appropriate for use on historic buildings only when they are compatible with their architectural character, such as flat roofs with no visibility. A white-colored roof that is readily visible is not appropriate for historic metal roofs that were traditionally painted a dark color, such as green or iron oxide red. A white reflective roof is most suitable on flat roofed historic buildings. If a historic building has a slate roof, for example, removing the slate to install a metal roof is not a compatible treatment. It is never appropriate to remove a historic roof if the material is in good or repairable condition to install a cool roof. However, if the roof has previously been changed to an asphalt shingle roof, fiberglass shingles with special reflective granules may be an appropriate replacement.



Fig. 22. Installation of both cool and green roofs in an urban environment.

A green roof consists of a thin layer of vegetation planted over a waterproofing system or in trays installed on top of an existing flat or slightly sloped roof. Green roofs are primarily beneficial in urban contexts to reduce the heat island effect in cities and to control storm water run-off. A green roof also reduces the cooling load of the building and helps cool the surrounding urban environment, filters air, collects and filters storm water, and can provide urban amenities, including vegetable gardens, for building occupants. The impact of increased

structural loads, added moisture, and potential for leaks must be considered before installing a green roof. A green roof is compatible on a historic building only if the plantings are not visible above the roofline as seen from below.

Alternative Energy Sources

Although not the focus of this publication, alternative energy sources are dealt with in more detail in *The Secretary of the Interior's Standards for Rehabilitation & Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings* and other NPS publications.

Devices that utilize solar, geothermal, wind and other sources of energy to help reduce consumption of fossil fuel-generated energy can often be successfully incorporated in historic building retrofits. However, if the alterations or costs required to install these devices do not make their installation economically feasible, buying power generated off site from renewable sources may also be a good alternative. The use of most alternative energy strategies should be pursued only after all other upgrades have been implemented to make the building more energy efficient because their initial installation cost is usually high.

Solar Energy: Man has sought to harness the power of solar energy to heat, cool, and illuminate buildings throughout history. Construction techniques and design strategies that utilize building materials and components to collect, store, and release heat from the sun are described as “passive solar design.” As previously discussed, many historic buildings include passive solar features that should be retained and may be enhanced. Compatible additions to historic buildings also offer opportunities to incorporate passive solar features. Active solar devices, such as solar heat collectors and photovoltaic systems, can be added to historic buildings to decrease reliance on grid-source fossil-fuel powered electricity. Incorporating active solar devices in existing buildings is becoming more common as solar collector technology advances. Adding this technology to historic buildings, however, must be done in a manner that has a minimal impact on historic roofing materials and preserves their character by placing them in locations with limited or no visibility, i.e., on flat roofs at a low angle or on a secondary roof slope.

Solar collectors used to heat water can be relatively simple. More complex solar collectors heat a fluid or air that is then pumped through the system to heat or cool interior spaces. Photovoltaic panels (PV) transform solar radiation into electricity. The greatest potential for the use of PV panels in historic buildings is on buildings with large flat roofs, high parapets, or roof configurations that allow solar panels to be installed without being prominently visible. The feasibility of installing solar devices in small commercial and residential buildings will depend on installation costs, conventional energy rates, and available incentives, all of

which will vary with time and location. The same factors apply to the use of solar collectors for heating water, but smaller installations may meet a building's need and the technology has a considerable track record.



Fig. 23. Solar collectors installed in a compatible manner on low sloping sawtooth monitors. Top Photo: Neil Mishalov, Berkeley, CA.

Geothermal Energy: The use of the earth's heat is another source of readily-accessible clean energy. The most common systems that utilize this form of energy are geothermal heat pumps, also known as geo-exchange, earth-coupled, ground-source, or water-source heat pumps. Introduced in the late 1940s, geothermal heat pumps rely on heat from the constant temperature of the earth, unlike most other heat pumps which use the outside air temperature as the exchange medium. This makes geothermal heat pumps more efficient than conventional heat pumps because they do not require an electric back-up heat source during prolonged periods of cold weather.

There are many reasons that geothermal heat pumps are well suited for use in historic buildings. They can reduce the amount of energy consumption and emissions considerably, compared to the air exchange systems or electric resistance heating of conventional HVAC systems. They require less equipment space, have fewer moving parts, provide better zone space conditioning, and maintain better internal humidity levels. Geothermal heat pumps are also quieter because they do not require external air compressors. Despite higher installation costs, geothermal systems offer long-term operational savings and adaptability that may make them a worthwhile investment in some historic buildings.

Wind Energy: For historic properties in rural areas, where wind power has been utilized historically, installation of a wind mill or turbine may be suitable to the historic setting and cost effective. Before choosing to install wind-powered equipment, the potential benefit and the impact on the historic character of the building, the site and surrounding historic district must be analyzed. In order for the turbines to work effectively, average wind speeds of 10 mph or higher are necessary. This technology may not be practical in more densely-populated areas sheltered from winds or regions where winds are not consistent. In cities with tall buildings, there is potential for installing relatively small rooftop turbines that are not visible from the ground. However, because of the initial cost and size of some turbines, it is generally more practical to purchase wind power from an off-site wind farm through the local utility company.

Summary

With careful planning, the energy efficiency of historic buildings can be optimized without negatively impacting their historic character and integrity. Measuring the energy performance of buildings after improvements are completed must not be overlooked, as it is the only way to verify that the treatments have had the intended effect. Ongoing monitoring of buildings and their components after alterations to historic building assemblies are completed can prevent irreparable damage to historic materials. This, along with regular maintenance, can ensure the long-term preservation of our historic built environment and the sustainable use of our resources.

End Notes

¹ John Krigger and Chris Dorsi, "Air Leakage," in *Residential Energy: Cost Savings and Comfort for Existing Buildings*. Helena, Montana: Saturn Resource Management, 2004, p. 73.

² *Measured Winter Performance of Storm Windows*. A 2002 study done by Lawrence Berkeley National Labs.

³ *Midwest Weatherization Best Practices Field Guide*. Prepared for the U.S. Department of Energy Weatherization Assistance Program, May 2007, p. 157.

⁴ Adapted from comments provided by William B. Rose, Research Architect, University of Illinois, April 2011.

⁵ U.S. Department of Energy, *Insulation Fact Sheet*, DOE/CE-0180, 2008, p.14.

⁶ Bradford S. Carpenter, P.E., LEED AP et al., *The Designer's Dilemma: Modern Performance Expectations and Historic Masonry Walls* (paper presented at the RCI 2010 Symposium on Building Envelope Technology, San Antonio, Texas).

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This publication has been prepared pursuant to the National Historic Preservation Act of 1966, as amended, which directs the Secretary of the Interior to develop and make available information concerning historic properties. Additional information about the programs of Technical Preservation Services is available on the website at www.nps.gov/tps. Comments about this publication should be addressed to: Charles E. Fisher, Technical Preservation Publications Program Manager, Technical Preservation Services, National Park Service, 1201 Eye Street, NW, 6th Floor, Washington, DC 20005. This publication is not copyrighted and can be reproduced without penalty. Normal procedures for credit to the authors and the National Park Service are appreciated. The photographs used in this publication may not be used to illustrate other publications without permission of the owners. *Cover photograph: Farmhouse with energy efficient historic storm windows.*