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ORCHARD MANAGEMENT PLAN

FOR

JOHN MUIR NATIONAL HISTORIC SITE

ORCHARD MANAGEMENT PLAN FOR JOHN MUIR NATIONAL HISTORIC SITE

HISTORICAL OVERVIEW

SIGNIFICANCE OF ORCHARDS

EXISTING CONDITIONS

ORCHARD TREATMENT

ORCHARD MANAGEMENT

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INTRODUCTION

SUMMARY AND PURPOSE OF THE ORCHARD MANAGEMENT PLAN

An Orchard Management Plan serves the National Park Service in documenting the history and significance of park orchards and providing guidance for day to day and long term management. To this end, this Orchard Management Plan for John Muir National Historic Site consists of a historical overview, a description of orchard significance, an analysis of existing conditions, and a delineation of management objectives for future management and treatment. Management objectives and recommended treatment actions are consistent with the *Secretary of the Interior's Standards for the Treatment of Historic Properties (1996)* and *Director's Order 28: Cultural Resource Management Guideline (1997)*. A calendar of work for orchard preservation maintenance activities and other practical information are also included.

The park's General Management Plan/Environmental Assessment (GMP/EA), updated in 1991 sets forth the basic management philosophy for the landscape, including the orchards. The report calls for the integration of newly acquired lands into the operations of the park and expansion of the park's visitor and protection use programs to include emphasis on the cultural and natural aspects of the added lands. Based on the recommendations of the GMP/EA, the Orchard Management Plan will prescribe a long range vision for the preservation of the park's orchards as cultural landscape features.

RELATIONSHIP TO THE CULTURAL LANDSCAPE REPORT

A Cultural Landscape Report (CLR) for John Muir National Historic Site was completed in 2005. This document describes the comprehensive history and significance of the park cultural landscape, analyses the existing conditions, and provides a treatment plan for all cultural landscape resources. The treatment plan directs physical work so that distinguishing characteristics and features that contribute to the significance of the property

are preserved. As such, the CLR has established the treatment philosophy, approach, guidelines and tasks with prioritization for the treatment of the park's cultural landscape, including the park orchards. In this plan, orchard management objectives, treatment actions and future preservation maintenance activities are prescribed solely for the park orchards, to provide greater specificity than the CLR, while nesting within and being consistent with its recommendations.

HISTORIC OVERVIEW

TYPICAL HISTORIC TREE FORM

EXAMPLES OF ORCHARD TREE FORM
BETWEEN 1880 AND 1945

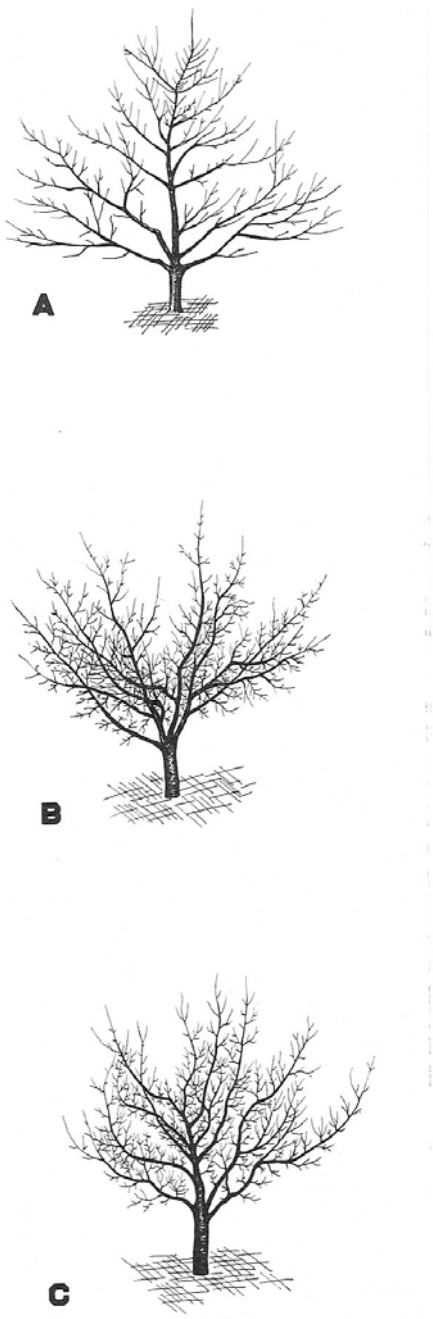


Figure x: Historic diagram showing three types of orchard tree scaffold used between 1880 and 1945 with a low-head (short trunk) **A**: *Central Leader*, **B**: *Open Bowl* (typical on Muir Ranch), **C**: *Modified Central Leader* (*Lowther, 1914)*.

HISTORICAL OVERVIEW

INTRODUCTION

Before John Muir was a renowned conservationist, author and Wilderness advocate, his principle livelihood was derived from orcharding. Muir raised his family on what had been his father-in-law's fruit ranch in the Alhambra Valley near Martinez, California, where he first assisted and then later took charge of growing pears, peaches, apricots, grapes, cherries and other fruits and nuts. Between 1853 when Muir's father-in-law, Dr. John Strentzel arrived in Martinez and Muir's death in 1914, the Alhambra Valley property was a patchwork of orchards, vineyards and pastures, laced together by farm roads, fence lines and creeks. The Strentzel-Muir fruit ranch was one of the most successful in the valley, and at its peak in the mid-1880s, covered 2,300 acres.

Much of the former agricultural scene in Alhambra Valley has been lost to suburban development since Muir's time, but the park still portrays a semblance of the earlier orchard history. Today, the John Muir National Historic Site encompasses approximately 336 acres of the original 2,300 acre Strentzel-Muir property. The park's cultural landscape resources, including the orchards, are spread over three park units: the House Unit (approximately 9 acres), the Gravesite Unit (1.3 acres) and Mt.Wanda Unit (326 acres).

Within the House Unit the two most dominant buildings of the former fruit ranch survive, the Muir House and the Martinez Adobe, the house that preceded Dr. Strentzel. The House Unit also retains orchard and vineyard spaces around the buildings, along with roads, paths and ornamental plantings. The Gravesite Unit contains the graves of Muir and the Strentzel families, along with a historic pear orchard that dates back to Dr. Strentzel's time. Mt. Wanda Unit is a predominantly natural upland of grasslands and forest where Muir and his family walked, though the lower slopes still bear some historic apricot and walnut trees and more than 120 olive trees, that

hint back to the time when orchards and vineyards appeared to march into the uplands from the valley floor.

Dr. John Strentzel was a Polish emigrant who earned a medical degree in Budapest and left Hungary for the United States in 1840. After marrying Louisiana Erwin of Texas in 1843, the Strentzels migrated to California in the Gold Rush of 1849. By the early 1850s, industrial mining had replaced the efforts of gold rush prospectors and new settlers like the Strentzels looked to other ventures. John Strentzel saw potential in California's sun-drenched climate for growing orchard fruits in the creek-fed foothills and valleys. After several ventures he arrived in Martinez in 1853, and perceived the Alhambra Valley as a very suitable location for orchards, due to its high sheltering hills and abundant creek water. He immediately purchased 20 acres to begin to realize his dream of a home surrounded by fruits and flowers.

While Dr. Strentzel was a medical doctor he chose to focus on orcharding. In this regard he was allied to a group of gentleman farmers in America in the 19th-century, who were professionally trained in other disciplines but were fascinated by the science and practice of fruit growing, or pomology. Gentleman farmers were well-versed in the early American horticultural literature of the time, and were connected with each other through societies and published works. Strentzel, like other gentleman farmers, took a somewhat experimental approach to pomology, growing a diverse array of fruit species and varieties, and attempting to expand the practice and profitability of orcharding in his region.

Strentzel's fruit fascination was set within the context of the “Golden Age of Pomology,” as the 19th-century in America is known. This was the time before science and technology entered the orchard but orcharding was becoming an acceptable means of making a living. It was also a time when newly-developed American fruit varieties, distinct from European varieties, were valued as part of the nation's identity, and each variety was cherished for its unique taste and appearance, rather like a work of art.

By the mid 19th-century, "every farmer [was] an amateur fruit grower and connoisseur," according to Andrew Jackson Downing, landscape gardener, architect, gentleman farmer and author, who published the widely-read *Fruits and Fruit Trees of America* in 1847. The nation's fascination with new and wonderful fruit varieties is evidenced in the new development of horticultural shows, societies, popular horticultural magazines, and the exponential growth in the number of fruit varieties offered in plant nursery catalogs between 1830 and 1880.

The Golden Age of Pomology fueled a rapid increase in the planting of orchards for commercial purposes, and the development of a nascent professional orchard industry throughout much of the country. California's first commercial orchard, a pear orchard, was established circa 1853 by W. M. Stockton, a pioneer who laid claim to an abandoned Spanish Mission orchard and grafted the stumps of old pear trees with his own scion wood. Dr. Strentzel and his brother Henry had no less enthusiasm when they began to plant the 20 acres in the Alhambra Valley that same year. They planted many species and varieties of fruit to learn which would grow best in a local climate of hot and dry summers and cool and wet winters. While their planting techniques were grounded in the writings of Downing and other experts of the time, *Dr. Strentzel's Time Book: Notes on Agriculture* reveals the Strentzels' adaptation to local conditions, such as low-heading the canopies of trees so that the low-borne branches shaded the orchard floor and protected trunks from sun-scald.

Dr. Strentzel first concentrated on growing European grape varieties, on stock imported from Europe. When disease wiped them out, he turned to hardier domestic grape rootstock. Strentzel grew the first Muscat grapes in California, as well as the Tokay, Catawaba, and Malaga varieties. He also produced the first raisins, which earned him recognition at the California State Fair in 1861. He also made wine, an art he had learned while working in a winery as a young man in Budapest.

During the first 25 years of his ranch ownership, Strentzel acquired more lands through purchase and litigation. He planted hundreds of acres of orchards, and successfully experimented with many varieties of fruits. By 1860 he was growing 50 different varieties of peaches. At the Contra Costa County Fair of 1861, Strentzel displayed 36 varieties of apples, 35 varieties of pears, four varieties of quinces, five varieties of plums and three varieties of grapes. That same year, the Strentzel orchards were also producing apricots, cherries, almonds, figs and olives. In a diary entry from 1869, Strentzel's wife Louisiana mentioned selling 375,000 pounds of produce, including grapes, peaches, mulberries, apples, oranges, lemons, cherries, plums, quince, pomegranates, olives, figs, pecans and walnuts. In the 1870s, Strentzel grew the area's first Navel oranges.

Strentzel's success mirrored the success of the California orchard industry. Within twenty years of the Gold Rush, California had a booming commercial orchard industry. California orchardists capitalized upon the completion of the transcontinental railroad in 1869. That year, the first commercial shipment of California apples and pears was made via rail to eastern and regional markets, rather than by ship around Cape Horn. During the 1870s and 1880s, the town of Martinez flourished as the county seat and trade center. The town became a major shipping port, based primarily on lucrative grain trade between California's Central Valley and international ports-of-call. The arrival of the Central Pacific Railroad to Martinez in 1877 provided for long-distance shipping of Alhambra Valley produce.

In addition to buying and developing city blocks and land parcels in Martinez, the Strentzels helped to establish the Alhambra Grange of the Patrons of Husbandry No. 231, in Martinez in 1874. The Grange's warehouses and 1900-foot long wharf provided for the storage and deep-water shipment of grain. The Grange supported the county's farmers working cooperatively to ship goods overseas without having to pay a middle-man. Strentzel also developed innovative growing and shipping techniques that allowed his fruit to sell for the best prices in San Francisco and other markets. He is credited with inventing a shipping technique using

carbonized bran to pack delicate fruits, and invented planting practices that became standard, such as planting table grape varieties on the valley floors, and wine grapes on the slopes.

Strentzel demonstrated the traits of a gentleman farmer in his didactic efforts to promote the expansion of orchard fruits in the region. He urged fellow farmers to plant vineyards and fruit trees, rather than focusing on lower-value grains, and extolled the benefits of fruit growing in his many articles for state and local scientific journals. The Strentzel orchards were frequently featured in the *Contra Costa Gazette* and the *Martinez Gazette*, and as an industry booster, Strentzel was known to give away vine and fruit tree cuttings for free. By 1875, the Alhambra Valley had become the cradle of fruit growing in Contra Costa County, with 40,000 apple, 20,000 peach, 10,000 pear, 1250 apricot, 3500 mulberry, 1,000 orange, 500 prune, 100 olive, and 50 lemon trees.

Strentzel continued to manage the fruit ranch until 1881. His emphasis was on experimentation and diversity, by growing a large number of varieties of many fruit species. Strentzel's interests typified the style of orcharding in the 19th-century, up until the 1880s. However, as John Muir arrived in the Alhambra Valley in 1877, American orchard fruit growing was starting to transition to a more rational, scientific period that would last until World War II. After marrying the Strentzel's daughter Louie in 1880, Muir entered into a financial partnership with his father-in-law. One year later, Muir took over management of the fruit ranch, and began to adapt growing methods to the modern method of orcharding.

RELATIONSHIP TO NATIONAL AND REGIONAL HISTORY

As the 1870s drew to a close, commercial orchards and farm orchards had been planted throughout the 48 contiguous states. Many thousands of true varieties of fruits were planted, with the greatest numbers of apple and peach being American varieties, and the majority of pear, cherry and plum being European. A gradual transition from growing seedling fruit trees to growing

true variety fruit trees had occurred over the previous 250-year history of fruit growing in America. Earlier, fruit trees had been grown from seed sown in the field rather than from grafted trees planted out, with the resultant seedling fruits being of no variety and typically not edible when raw. However, by the 1870s, most orchard fruits were grown for human consumption as fresh fruit from variety trees, vegetatively propagated by grafting a scion (aerial) variety to a seedling rootstock. Seedling fruit trees were still being sown in the newly settled West on homesteads, though even the most remote farm orchards were typically laid out with a handful of true varieties as well as seedlings, to provide some edible fresh fruit. Other commodities were replacing the use of seedling fruits for cider and livestock feed.

By the end of this period in the West, many newly claimed lands were immediately developed as commercial orchards. Orchards were laid out with relatively wide spacing between trees, typically a 30-feet grid for apple and pear, and 16-20 feet grid for peach, plum and cherry. The trees were grafted close to the ground, and were allowed to develop tall trunks. A typical orchard tree had a large, unpruned canopy, and would generally bear a good crop only once every other year. Dwarf apple and pear trees were available through the nursery trade, which had spread to every larger city in the country. However, dwarf trees were only found in the fruit gardens of the wealthy, distinct from farm orchards or commercial orchards. Ornamental plants such as rose, lilac, mock orange and spirea were not available from plant nurseries until the 1860s. Until this time, American horticulture was defined by the growing of fruits, and fruit trees were grown for their ornamental qualities as well as for their bounty.

By the 1880s, the threat from pests and diseases was formally realized, as insects and pathogens traveled West with migrating people, agricultural settlement and orchard trees. Pests that had been noted in the late 1700s in New York State had arrived in the West by the 1880s. Fireblight had decimated pear orchards in the Northeast, “Peach Yellows” had infected peach orchards of the East and South, and Codling moth and Apple scab

were blighting the apple orchards of Missouri, Kansas, Arkansas, Iowa, Mississippi and Texas.

The evolution of orchards during the 1880 to 1945 period was fueled by technological and scientific discovery, and led to the professional and commercial development of the orchard industry. Among the most important changes were transformations in the form, shape and layout of orchard trees, a dramatic reduction in the number of varieties grown and a dramatic reduction in the number of orchards. These transformations were influenced by the involvement of the Federal government in horticultural development through the creation of the United States Department of Agriculture (USDA).

The role of the Federal government in agricultural and horticultural development was institutionalized in 1887, when Congress approved appropriations for the establishment of an agricultural experiment station in every state. These federally-funded research centers would be associated with university or college campuses, where their first order of business would be pest and disease control for crop plants, including orchard trees. Gradually, the agricultural experiment stations would also take over the work of orchard fruit breeding and variety selection, and later still, would develop partnerships with growers' cooperatives to collaborate in field research. The primary mission of these Federal institutions was to increase the profitability of all forms of agriculture and horticulture. Their research efforts were therefore focused on increasing crop quality and yield, and all factors capable of enhancing or reducing yield. Bulletins published by the agricultural experiment stations would become the standard authority for new, valuable information, and through education and regulation, the USDA would take the leading role in building a professional industry of fruit growers.

Federal intervention in the development of the commercial orchard industry came at a time of the lowest orchard productivity in several decades. The 1880s was a decade of increasingly diminishing orchard yields due to rampant, untreated pest and disease infestations. Many small, independent farmers gave up orcharding, with the realization that a successful commercial

orchard enterprise required a greater investment of capital, skills and knowledge than they had at their disposal. The 1880s marked the beginning of the decline in the number of orchards throughout the country, a trend that continued until the end of World War II. The precursor of the trend was pest and disease infestations, though these were somewhat stabilized in the 1890s with the new use of topical pesticides. The trend continued, however, with increasing industrialization and urbanization. The prospect of greater prosperity led more and more farmers to give up their rural lifestyles in favor of industrial jobs in cities. Hired labor costs increased as farm labor shrank, with workers being pulled away by the magnetism of higher paid manufacturing jobs.

1910 census data reveal that 25% of the bearing fruit trees in the United States were lost during the first decade of the 20th-century, a decline from 200 million to 150 million trees (the number decreased to 100 million by 1930). By 1910, only half the farms in the United States had fruit trees, approximately 3 million farms, with an average of 40 trees or an acre of trees per farm. Editorial pleas in farmers' magazines were common in the years preceding World War I, asking workers to stay on farms as a matter of patriotism.

The loss of many thousands of orchards through farmers' migration to urban centers actually paralleled the specialization of the orchard industry, however. For although half the fruit trees in the country were lost during the first three decades of the 20th-century, the losses were mostly from smaller orchards of five acres or less, (approximately 200 trees for apple and pear orchards) or from farms where a range of crop plants had been grown. The orchards that remained were typically larger, more sophisticated operations. Orchard managers of the 20th-century would become referred to as "growers" rather than farmers, indicating a distancing from general agriculture. Many of the growers that kept their orchards were willing to incorporate new information on scientific management and specialize in growing orchard fruits alone. As a result, they soon began to increase the productivity of their trees.

Contrary to a general decline throughout the country, the Pacific Coast states added orchards and increased their numbers of fruit trees between the 1880s and World War II. The increases were due to the planting of newly settled lands as commercial orchards, which was buoyed by the development of transportation and irrigation systems throughout the West, and also by technological advancements in fruit canning. The invention of cold storage technology in the 1890s was a particular boost to the young western orchard industry, which depended on the lengthy haulage of fruits to eastern markets for economic viability (at the turn of the 20th-century, 90% of the U.S. population lived east of the Mississippi River). Refrigerated rail cars increased the quality of all western fruits arriving in eastern depots, though particularly peaches from California, which were more perishable than most orchard fruits.

Between the mid-19th-century and the turn of the 20th-century, orchard tree form was changed from a five-feet tall trunk to a less than three-feet tall trunk; tree shape was changed from an unpruned, natural state to either a central leader or an open bowl pruning style, and orchard layout was expanded to greater spacing. The layout of apple and pear orchards now ranged from 30 feet by 30 feet spacing to 40-50 feet by 40-50 feet, and for tighter-spaced fruits such as peach, plum and cherry, the layout was changed from a square to a rectangular arrangement. The layout changes were made for greater access for new machinery and equipment, and to increase the yield from mature trees.

The dramatic decrease in the number of varieties grown between the mid 19th-century and the turn of the 20th-century, was due to a process of selection for commercial fitness. Criteria for commercial fitness were refined during the period to incorporate all factors promoting high yields and durability of harvested fruit. As a result, the number of varieties of all orchard fruits grown was pared from many hundreds to tens. By World War II, most orchard fruit species were represented by just 10 widely grown commercial varieties. For most fruit species, the top 10 varieties were

dominated by one variety with the greatest commercial value and most widespread planting. For apple, Baldwin and Ben Davis were the most important commercial varieties in the early 20th-century, but by the late 1920s were rapidly superseded by McIntosh for Baldwin and Red Delicious for Ben Davis.

The development of Red Delicious in the 1920s had an enormous impact on apple growing, resulting in greater profitability for the industry, great fashionability of red apples, greater ubiquity of a single variety and further obsolescence of superseded varieties. For pear, the industry became dominated by Bartlett, and pear growing was intensified regionally, with New York and California becoming the greatest producers, and a significant growing region developing in the Pacific Northwest for Anjou and Bosc varieties.

Peach growing was ubiquitous with many local varieties remaining important, though Elberta became the most dominant and widely-grown variety. For cherry and plum, commercial growing became regionalized rather like pear. Sour cherry production became centered in the Upper Midwest, where Montmorency was the dominant variety, and sweet cherry production was taken over by the Pacific Northwest, where Bing was the most important variety. Plum growing was not dominated by a single variety, but specialization by certain regions occurred. The growing of Japanese and European plums became centered in the Pacific States, American variety plums were grown in the Midwest and South, and European variety plums were grown to a smaller extent in the eastern states.

Citrus and nut species were the only orchard fruits to have a net increase in the number of varieties grown during the 1880 to World War II period. Both industries were born and established during the period as a result of the development of American varieties, such as the Navel orange, Eureka lemon, Nonpareil almond and Hartley walnut, and breakthroughs in the horticultural techniques of propagation and transplanting tap rooted trees. The citrus and nut industries also became highly regionalized, with citrus becoming

HISTORIC OVERVIEW

TYPICAL HISTORIC TREE FORM

EXAMPLES OF ORCHARD TREE FORM BETWEEN 1880 AND 1945


Fig. 1. Arkansas Black Orchard of W. N. Yost, Meridian, Idaho, showing low-headed trees of unusual vigor. Trees 18 years old.

Figure x: Historic photo showing a low-headed (short trunk) apple tree, with open bowl scaffold, typical of the form of fruit trees on the Muir fruit ranch, during the period of significance *(Auchter, 1929)*.

Figure x: Historic photo showing low-headed orchard trees, typical between 1880 and 1945 (*Lowther, 1914)*.

centered in Florida and California, and nut growing becoming centered in Texas for pecans, California for almonds and English (Persian) walnuts, and the Pacific Northwest states for European filberts.

SITE HISTORY

As John Muir assumed responsibility for ranch operations in 1881, his orchards and vineyards were producing grapes, peaches, mulberries, apples, oranges, lemons, cherries, plums, quince, pomegranates, olives, figs, pecans and walnuts, as a result of his father-in-law's legacy. Many American and European varieties of the various fruits were grown, and growing methods were typical of those of the earlier 19th-century, with the exception of tree form. Strentzel had low-headed his trees and "head pruned" his grapes, to create a lower canopy which would shade the ground and the woody trunk and branches, to protect against sun scald. Muir adopted these methods, but began to conform to the national trend towards growing fewer varieties at wider spacing. He began focusing less on experimental varieties and more on proven ones, such as Bartlett pear and late season table grapes, such as Tokay, that commanded the highest prices. Muir grafted his father-in-law's 12-acre pear orchard near the family gravesite with Bartlett scion wood, to revitalize the seedling rootstock with the most popular commercial variety, and gradually replaced the 65 pear varieties Strentzel had grown on the ranch with Bartletts or Winter Nellis.

The first house used by the Strentzels, the Martinez Adobe, served as the ranch headquarters and was surrounded by a complex of barns, packing sheds, corrals and living quarters for hired laborers. A network of farm roads connected the various fields to the Strentzel House (later the Muir House) and adobe, and to the shipping facilities at the Martinez Wharf. Other orchard features included wells, windmills, cisterns, a woodshed and a seasonal pond (know as the fish pond).

Muir was no stranger to the business of farming; much of his youth was spent toiling in the family farms in Wisconsin. As the fruit ranch manager,

he supervised the work of up to 40 men, and labored alongside them to plant and harvest hundreds of tons of fruit. His keen senses of inventiveness and efficiency inspired him to improve ranch operations; among his inventions was a machine for planting grape vines in perfectly straight lines.

For the next decade, Muir toiled in the orchards, overseeing their replanting and redevelopment according to modern standards. New orchards were laid out with low-headed, full size trees, widely spaced to allow for full development of large tree canopies. Orchard floors were cover cropped with rye grass and legumes, which could be plowed under and tilled in the spring, then re-sown for the new growing season. The orchards and vineyards were flood irrigated when necessary, though mostly dryland orcharding was practiced, relying on natural precipitation and the water table in the valley floor. The low-headed fruit trees and vines had short trunks between 18 to 30 inches tall, and were winter-pruned into a central leader or open bowl style, to maximize light interception and crop yield.

Historic photographs from the 1880s show some of the orchards and vineyards in the vicinity of the Strentzel House. The earliest photograph is from 1883, just one year after the construction of the house. Close inspection reveals young fruit trees planted on the east side of the knoll beneath the house, which in later photographs can be identified as apple trees. A circa 1885 photograph shows the ranch property near the house divided into two spaces by Franklin Creek. On the east side of the creek, the east-west farm road separates a plum orchard on the south side from a row of quince on the north that borders the area known as the fish pond. On the west side of Franklin Creek, orchards of cherry or apricot are planted on the south side of the road, while grape and apricot are planted on the north. Though not visible in the photograph, the north side of the road had been lined with fig trees by this time. An 1887 photograph shows a peach orchard to the north and northwest of the house; plum and pear to the west and southwest, and Muscat, Tokay and Zinfandel grape vineyards to the south.

John Muir, his wife Louie and their daughter Helen moved into the Strentzel House in 1890, when Dr. Strentzel died. Muir's health had deteriorated from the years of hard work on the ranch, and with his wife's encouragement, Muir retired from its management. After selling or leasing some of his ranch lands and those inherited from his father-in-law, Muir raised sufficient funds to combine with the annual ranch profits to pursue writing and traveling for the last 15 years of his life. During this time, Muir passed on the responsibilities of ranch management to various family members. The types of fruits grown remained more or less the same as the ones Muir had planted, as these had proven profitable. Although immersed in travel and writing, Muir maintained his connection to the ranch through letters and occasional work in the orchards when he was in between projects and travel.

Management of the ranch in the 1890s by John Reid, Muir's brother-in-law, David Muir, Muir's brother, and A.B. Coleman, the husband of Muir's niece May, did not significantly change the types of fruits grown. Letters and journal entries from the period, the 1893 Contra Costa County Assessors Book, and historic photographs serve as confirmation. A circa 1898 photograph shows a plum orchard southwest of the knoll of the Muir House. Another late 1890s photograph shows a new planting of table grapes on the east side of Franklin Creek, south of the east-west farm road. The vineyard replaced most of the plum orchard in this area, with the exception of a few rows. A photograph circa 1905 shows mature apple trees on the east side of the house knoll, concentrated at the north and south ends. Another 1905 photograph shows a field with hay bales immediately east of the apple orchard on the house knoll.

With the death of John Muir in 1914, the lands of the Strentzel-Muir ranch passed to Muir's daughters, Wanda and Helen. Over time, the estate was sold and subdivided, and eventually, former orchards and vineyards gave way to new roads and residential subdivisions. The march of development in the Alhambra Valley, along with a growing consciousness to commemorate John Muir - as a conservationist, writer, and advocate for national parks and

national forests - set the stage for establishing the first part of the John Muir National Historic Site in 1964 – the House Unit.

While the land parcel that became the park's House Unit was formally recognized as a National Historic Landmark in 1962, many of the orchard and vineyard areas were in poor condition or had been entirely removed by 1964. The orchard space between the Martinez Adobe and Franklin Creek was mostly a grassy meadow with a few walnut, pecan and other fruit trees. The former grape vineyard between Franklin Creek and the Muir House was replanted with pear after 1914, and some of these trees were extant in 1964. However, only a scattering of fruit trees remained from the former peach orchard north and northwest of the house and the apple orchard on the east side of the house knoll. Quince still grew next to the pond, and fig trees lined the north side of the main farm road and served as the park's northwestern boundary.

Restoration of the orchards and vineyards were a high priority for the new park, due to the fruit ranch's association with Muir's life and livelihood. A 1965 Master Plan shows conceptual layouts for orchards along with general recommendations to clear remnant orchard trees and replant with new fruit trees. A 1968/69 "Historic Planting Plan" provides greater specificity, and recommends retaining some of the old fruit trees on the site, even though they did not date back to the time of Muir. New orange, lemon, apricot and pear trees were planted out around a mature walnut and two pecans trees in the area to the west side of Franklin Creek. The apricot varieties were Blenheim and Tilton, the pear varieties were Bartlett and Winter Nellis. On the east side of Franklin Creek, the Historic Planting Plan led to the planting out of three grape varieties: Muscat, Catawba and Tokay, as well as European plum and prune trees of varieties Coxe's, York, Crawford, Stump, and Coes Golden Drop. North and northwest of the Muir House, the orchard space was planted with almond, cherry and peach. The cherry varieties were Bing and Black Tartarian, the peach varieties were Muir, Crawford and Elberta. On the east side of the house knoll, three apple varieties were planted: Gravenstein, Yellow Newtown Pippin and Jonathan.

While no supporting documentation has been found, the Historic Planting Plan of 1968/69 appears to have been informed by historic photographs, diaries, letters and interviews. The plan calls for fruit species and varieties that were known to have been grown on the Strentzel-Muir Ranch during Muir's time, and in the approximate locations shown on the plan. The plan was implemented over a period of years. Ultimately, approximately 250 fruit trees and 200 grapevines were planted. Early on, the new plantings were threatened by diseases, including an oak root fungus in the grape vineyard that caused its complete removal and reinstallation. A severe winter in 1972/73 killed more than 150 trees and vines, and these were replaced by 1976, when the park's new General Management Plan described the orchards and vineyards as contributing to the historic scene. The grapevines were replanted in 1976 by John Hanna, Muir's grandson. Hanna used rootstock certified as "St. George" with Zinfandel, Flame Tokay and Golden Muscat varieties.

During the 1980s, the park's orchards were expanded beyond their historic footprint in Muir's time, into the fish pond space. A 1989 site inventory indicates a small pear orchard in the southwest of the pond space and many apricot trees in the more northerly part of the former pond. In addition, Japanese plums of the variety Santa Rosa were planted within the plum orchard west of the Muir House. A 1984 Orchard Management Plan authored by John Donahue, the park's resource manager, describes the challenges of maintaining the several hundred fruit trees and grapevines in light of the park's clay soils, dry summers, and abundant pest and disease problems. The plan identifies the need to maintain the park's orchards as part of the historic character of the site; however, greater emphasis is placed on fruit yields than on accurately depicting the historic character of the orchards during Muir's time. The 1984 plan provides contemporary horticultural information about planting, pruning, thinning, harvesting, soil fertility and integrated pest management (IPM), in order to promote fruit yields.

In 1986 the park received some funding to implement the IPM recommendations of the Orchard Management Plan, and establish systems to monitor pest populations in each orchard, along with disease resistant fruit varieties and biological controls for pests and diseases. The effort was further funded in 1988, and overall, nine insect pests were monitored and biologically controlled using IPM. In addition to projects generated by the Orchard Management Plan, the park's orchards received attention from local colleges and businesses. In 1984, the University of California – Berkeley conducted research in the vineyard to study the effects of cover crops on the dynamics of pest populations and on soil fertility relations. In 1986, the California Conservation Corps planted Washington Navel orange and Eureka lemon trees around the Martinez Adobe, and throughout the 1980s, local garden centers donated fruit trees and soil conditioners for orchard projects involving local school children.

In 1988, Congress enacted a law to expand the park boundaries to include the Gravesite and Mt. Wanda. The 1.3-acre parcel of the Gravesite Unit captured the Muir and Strentzel family graves, as well as the historic pear orchard that dated back to Dr. Strentzel and John Muir's tenures. The 326-acre Mt. Wanda parcel included upland grasslands and forest, as well as some old remnant fruit trees of apricot and walnut and an olive orchard. A 1991 GMP/EA directed the NPS to acquire these parcels. Acquisition of the Mt. Wanda Unit was completed in 1992, and in 2000, the NPS acquired the Gravesite property.

During the 1990s, several almond trees in the fish pond area began to decline and were removed, and new fruit trees of carob and white mulberry were planted in their place. Apricot and pear trees were also planted in the fish pond space at this time. Disease problems were found in the apricot trees near the pecans east of the Martinez Adobe and in a few walnut trees south of the adobe. A freeze in 1998 caused some of the lemon trees also near the adobe to die back to the ground. While some were lost, other lemon trees re-sprouted from the rootstock. Beginning in the mid-1990s, the park began hosting a group of volunteers associated with the Master Gardener program

run by the University of California Extension Service at Davis. As part of the required 50 hours of community service of the Master Gardener program, enrollees or recent graduates assist park staff in pruning and harvesting the orchards. By 2006, the park orchards were being sustained by the part time efforts of two maintenance staff, Master Gardeners and several maintenance volunteers.

CHARACTER OF ORCHARDS IN THE SIGNIFICANT PERIOD

The period of significance for the park extends from 1849 to 1914, which recognizes the construction of the Martinez Adobe in 1849 and John Muir's death in 1914. Within the period of significance is a narrower period of interpretation that begins in 1890, when Muir and his family moved into the Muir House (formerly the Strentzel House) and ends in 1914. The character of the orchards during the period of significance can be differentiated into two periods, the Strentzel period – 1851 to 1880 – when the orchards were owned and managed by Muir's father-in-law, Dr. John Strentzel, and the Muir period – 1881 to 1914 – when the orchards were influenced by John Muir's management or orchard business philosophy.

The Strentzel period is distinguished from the orchards of the Muir period primarily in the number of fruit species and varieties grown. As a gentleman farmer and pomologist, Dr. Strentzel experimented with a broad range of species and an even greater number of varieties, for their commercial value but also for their horticultural interest. For example, Strentzel grew fruit species with limited commercial value such as quince, which is not edible raw, and fruits with limited commercial demand, such as pomegranate and mulberry, due to his fascination with these fruits. Among many varieties, he grew 65 varieties of pear and 36 varieties of apple, even though half of these varieties had no commercial value at the time. Strentzel's fruit trees had a similar form to Muir's, however, as Strentzel was ahead of his time in low-heading his fruit trees and grapevines to create short trunks and low canopies, in order to provide sun scald protection.

The character of orchards in the Muir period is distinguished from the Strentzel period in a drastic reduction in the number of varieties grown and the incorporation of new scientific or modern methods not available during Strentzel's time. Muir honed the number of varieties grown on the fruit ranch to a handful of commercially valuable varieties of each species. Muir's approach was consistent with a drastic reduction in the number of fruit varieties grown in orchards throughout the United States, under the influence and ethos of the newly formed USDA, and the development of a professional orchard industry. Muir was a shrewd businessman rather than a pomologist, and followed the contemporary philosophy of selecting a few varieties based on criteria for commercial fitness, rather than beauty, taste or curiosity.

The adoption of these criteria was seen in horticultural bulletins and professional literature as early as the 1880s, and called for the following variety characteristics: abundant fruitfulness or productivity; youthfulness of fruit bearing; more compact size of tree; later blooming (i.e., avoiding frosts and later ripening); pest and disease tolerance or resistance, and commercial fitness of fruit, including the consistency of size, color, and taste of fruits, and tolerance to cold storage and shipping requirements. An example of the physical manifestation of this approach was the replacement of Strentzel's 65 varieties of pear with just two, Bartlett and Winter Nellis, two of the most commercially valuable varieties in the country by this time. Muir grew only a handful of apple, peach, plum and cherry varieties, and for orange and lemon, just the one most important variety of each.

The following table identifies the fruit species and varieties grown between 1881 and 1914 on the fruit ranch, under John Muir's influence. This information was derived from archival sources. Where the varieties of a species grown are unknown, varieties that were potentially grown are identified, based on the most important commercial varieties in California during this period.

Fruit Species and Varieties Grown on Fruit Ranch 1881 – 1914	
Species	**Fruit Variety**
Almond	Unknown – potentially 'Nonpareil'
Apple	'Alexander,' 'Gravenstein,' 'Jonathan,' 'Yellow Newtown Pippin'
Apricot	Unknown – potentially 'Blenheim,' 'Moorpark,' 'Tilton'
Cherry	'Bing,' 'Mayduke,' 'Royal Ann'
European pear	'Bartlett,' 'Winter Nellis'
European plum/ prune	'Coes Golden Drop,' 'Coxe's,' 'Crawford,' 'Stump,' 'York'
Fig	'Mission'
Japanese plum	'Santa Rosa,' 'Satsuma'
Grape	'Muscat,' 'Catawba,' 'Isabelle,' 'Malaga,' 'Rosa Peru,' 'Tokay,' 'Zinfandel'
Lemon	'Eureka'
Olive	Unknown – potentially 'Mission,' 'Manzanillo'
Orange	'Navel'
Peach	'Crawford,' 'Elberta'
Pecan	No variety
Pomegranate	Unknown – potentially 'Wonderful'
Quince	'Champion'
English Walnut (Persian)	Unknown – potentially 'Hartley'

Generally, the varieties grown by Muir represent the top-selling or most popular commercial varieties at the time. For most species, these varieties have remained the most popular, indicating that the late 19th- to early 20th-century was an important time in selecting varieties with commercial characteristics. This trend is different for apple, however, which underwent considerably more change after Muir's time. Between the mid-1920s and

World War II, the newly originated Red and Golden Delicious apple varieties that were distributed by the Stark Brothers Nursery began to dominate all apple orchards, a trend that persisted until the 1980s. The character of the orchards during the Muir period represents the modern period in fruit orchards before Red and Golden Delicious apple varieties were popularized, a very discrete period in which 19th-century apple varieties like Gravenstein and Yellow Newton Pippin were still dominant.

Other important characteristics of the orchards in the Muir period were tree form and spacing. Between 1880 and World War II, orchard trees in the United States were standard or full size trees, grafted to seedling rootstocks rather than clonal or dwarfing rootstocks. This meant orchard trees would attain their natural full size, rather than be retarded in vigor by a dwarfing rootstock. After World War II, clonal dwarfing rootstocks were introduced. Clonal dwarfing rootstocks are cloned or genetically identical and standardized rootstocks that reduce the vigor of the scion or aerial parts of the fruit tree. These rootstocks gradually influenced the intensification of orchards with smaller trees at tighter spacing. However in Muir's time, orchards were extensive rather than intensive, with wide tree spacing to accommodate the large canopies of the full-size trees. Orchardists of the time believed that only full-size trees were profitable, and that wide spacing led to maximum yields.

In addition to their full-size form, orchard trees were "low-headed" or pruned with low canopies and short trunks. The low-headed scaffold was created in the first one to two years of the tree's life, either in the nursery or during the first dormant season after planting out. The young whip or main stem of the fruit tree was cut off at 18 to 30 inches above the ground, and several axilliary buds were allowed to grow out from the tip of the cut stem, forming the low head of a canopy upon a short trunk. The low-headed scaffold was a modern form distinct from the scaffolds of fruit trees in the earlier 19th-century, that had tall trunks and high canopies. Orchardists low-headed their fruit trees to shade the tree trunk in order to prevent sun scald, but also to induce the tree to bear fruit earlier in its life (as early as five years old rather

than 12 years after planting), and to make the canopy more accessible for pruning, thinning, spraying and harvesting.

The following table provides a general summary of the character of fruit trees and vines during the Muir period.

Fruit Tree Characteristics in Muir Period				
Fruit Species	**Tree/Vine Form**	**Tree Spacing**	**Mature Height**	**Type of Rootstock**
Almond	Full size, low-headed, open bowl or central leader style	20 x 20 ft	15-20 ft	Seedling peach
Apple	Full size, low-headed, open bowl or central leader style	30 x 30 ft	30-35 ft	Seedling apple
Apricot	Full size, low-headed, open bowl or central leader style	20 x 20 ft	15-20 ft	Seedling peach
Cherry (Sweet)	Full size, low-headed, open bowl or central leader style	20 x 20 ft	25-30 ft	Seedling cherry
European pear	Full size, low-headed, open bowl or central leader style	30 x 30 ft	30-35 ft	Seedling pear
European plum/ prune	Full size, low-headed, open bowl style	15 x 20 ft	15-20 ft	Seedling quince
Fig (Common)	Full size, low-headed, open bowl style	15 x 15 ft	15-30 ft	Ungrafted – self-rooted
Japanese plum	Full size, low-headed, open bowl style	15 x 20 ft	15-20 ft	Seedling quince
Grape	Full size, low-headed, head pruned style	8 x 10 ft	2-3.5 ft	Seedling grape
Lemon	Full size, low-headed, open bowl style	20 x 20 ft	15-20 ft	Seedling lemon
Olive	Full size, low-headed, open	30 x 30 ft	20 ft	Seedling olive

	bowl style			
Orange	Full size, low-headed, open bowl style	30 x 30 ft	30-35 ft	Seedling orange
Pecan	Full size, low-headed, central leader style	40 x 40 ft	35-50 ft	Ungrafted – no rootstock
Pomegra-nate	Full size, low-headed, open bowl or central leader style	20 x 20 ft	20 ft	Seedling pomegranate
Quince	Full size, low-headed, open bowl style	15 x 20 ft	15-20 ft	Ungrafted – no rootstock
English Walnut (Persian)	Full size, low-headed, central leader style	40 x 40 ft	35-50 ft	Seedling Black walnut

During the Muir period, two pruning styles were typically used on low-headed fruit trees: the central leader (pyramidal) style and the open bowl (vase) style. The central leader style requires the leader or main vertical shoot be trained to develop a scaffold of well-spaced, nearly horizontal axilliary branches, rather like a ladder or the form of a coniferous tree. Horizontal branches intercept more sunlight than untrained branches, which increases blossoming and fruiting, and the crotches of horizontal branches can support more fruit weight. In the open bowl style, the central leader is removed and three to five axilliary shoots are allowed to radiate from the head of the trunk, rather like an inverted tripod or umbrella. A bowl-like scaffold is created with an open center, allowing sunlight to penetrate deep into the canopy.

One of the major advantages of the open bowl over the central leader style is greater control over the height of the tree, though an important disadvantage is the potential for a weaker system of more acute crotches for bearing fruit. Both styles were perceived to have strengths and weaknesses in Muir's time, and both were greatly favored over the "natural" or un-pruned style of 19th-century orchards, which bore less fruit and had a more unwieldy canopy. The central leader style may have been the most common, as it required less skill and less frequent pruning than the open bowl style. However, annual

winter pruning was needed to maintain both scaffold style, and summer pruning was performed periodically to remove suckers. Historic photographs appear to indicate that the majority of Muir's fruit trees were pruned in the open bowl style, rather than the central leader style.

Orchards in Muir's time were typically planted out in single variety blocks, with one variety planted over one acre or in repeating acre units. On a grid of 30 x 30 feet spacing (for apple, pear and orange), this meant 40 trees per acre would be of one variety, and the next acre would be all of another variety or the same variety again. Varieties were not mixed within rows or blocks in order to allow for efficient management. Trees of one variety would blossom, ripen fruit and need pruning all at the same time, and so orchard activities could be streamlined rather than staggered. For orchard varieties needing cross-pollination, pollinator varieties were planted every 100 feet within the orchard grid.

Another characteristic of orchards during Muir's time was "filler trees," a consequence of wide tree spacing that had become a norm. To compensate for the inefficient use of space during the early lives of widely planted apple and pear trees, "filler trees" were now added. The concept of filler trees was conceived in the early 20th-century as a way to optimize the use of land within the orchard in between the wide spacing of "permanent" trees. Filler trees were most commonly inserted within a square spacing of 40 feet, to form what was called a quincunx system. A filler tree of a youthful bearing, smaller variety was located at the center of a square of four trees, achieving a spacing of 28 ¼ feet. The yield from filler trees supplemented the grower's income until the permanent trees occupied their share of the space, a period of ten years or more. In theory, the filler trees were then removed. Filler trees could be of the same variety as the permanent trees but were more often a faster growing, younger-bearing variety, such as Wealthy, Wagener, Duchess or Missouri Pippin. Bartlett was used as a pear filler tree, as it is a naturally smaller and more youthful bearing pear variety.

Filler trees were regarded as having both advantages and disadvantages, and were not as common as single-aged orchard blocks of varieties in squares or rectangles. The advantages were early economic gains and beneficial services in cross pollination. The disadvantages were the limitation imposed on tractor access for cultivation and spraying, and their tendency to retard the growth of the permanent trees, when growers let them remain for too long. The decision to remove the filler tree was a hard call to make; the temptation was to leave them for "just another year."

Cultivation of the orchard floor was regarded as standard management practice during Muir's time. Where earlier orchards had been grazed by livestock to maintain a low groundcover, by the late 19th-century, livestock was excluded from the orchard due to the low-headed canopies, and the orchard floor was cultivated using a horse or mule-pulled plow and disc harrow. Leguminous cover crops were known to increase nitrogen fertility of soils, and alfalfa, buckwheat, clover, mustard, pea and vetch were commonly sown in spring, and plowed under the following late winter. Ryegrass was also used as a cover crop, which would be plowed, disked and re-sown in spring. Plowing and disking were known to aerate the soil, and discourage the establishment of perennial weed plants. Periodic horse-drawn disc mowing or hand scything of the grass was required, in order to maintain access to the trees. The Muir Ranch Journal makes reference to plowing within the orchards and mentions mustard as a ground cover.

Between 1881 and 1914, when Muir managed or influenced the management of the fruit ranch, the use of synthetic pesticides and fertilizers was popularized by the newly created USDA. Pests and diseases were so rampant by this time that the serious commercial orchardist engaged in pesticide use as standard practice. Horse-drawn spray equipment was used to douse large canopied trees with sulfur, arsenical and nicotine sprays for pests and diseases, and lime, sulfate and nitrate fertilizers were added to the soil during harrowing. Cheap and abundant composted manure was still frequently applied around the base of trees, though the greater potency of synthetic fertilizers was well recognized. The Muir's Ranch Journals makes

reference to spraying the grapes and other fruits with sulfur as a fungicide treatment.

SIGNIFICANCE OF PARK ORCHARDS

CONTRIBUTION TO THE NATIONAL HISTORIC LANDMARK AND NATIONAL REGISTER STATUS

The orchard areas of the park's House Unit were included within the boundary of the National Historic Landmark nomination of 1962 as the intervening lands between the Muir House and the Martinez Adobe. While the orchards were not specifically identified as contributing features, the nomination identified the importance of the landscape context for the house and adobe in conveying significance. A National Register nomination for the House Unit was accepted in 1966, and the nomination was revised and re-entered in 1978. The nomination identifies the significance of the House Unit under criterion A, for significance on a national level in association with the event of the conservation movement and on a state level for event of the development of regional agriculture. The nomination also identifies the significance of the House Unit under criterion B, for significance on a national level for its association with the life of John Muir and under criterion C, for significance on a state level for the distinct design styles of the Muir House and Martinez Adobe. The gravesite markers and granite enclosures were listed on the National Register in 1988.

The 2005 Cultural Landscape Report for John Muir National Historic Site (CLR) identifies additional findings on the significance of the park's cultural landscape resources, and specifically for the park orchards. The CLR identifies 'land use' as a significant landscape characteristic of the House, Gravesite and Mt. Wanda Units. Overall, the continued practice of orchard fruit growing at the House and Gravesite Units and on the lower slopes of Mt. Wanda is identified as a characteristic that contributes to the significance and historic integrity of the John Muir NHS cultural landscape. The CLR also identifies 'vegetation' as a significant landscape characteristic. The overall pattern of orchard, ornamental and native vegetation in the House, Gravesite and Mt. Wanda Units remain largely unchanged since Muir's time, and is a characteristic that contributes to the significance and integrity of the

John Muir NHS cultural landscape. In addition, the CLR identifies the orchard land use at the House Unit, and the orchard and fruit trees at the Gravesite and Mt. Wanda Units as contributing to the John Muir NHS cultural landscape integrity through the aspects of location, materials, workmanship and association. The CLR findings can be used to amend the National Register nomination to reflect the significance and integrity of the park's orchards.

RELATIONSHIP TO MUIR AND STRENTZEL

The orchards of the John Muir NHS cultural landscape are directly associated with the lives of John Muir and Dr. John Strentzel. Both Muir and Strentzel owned and managed the NHS cultural landscape as part of a fruit ranch during the period of significance, and orchards provided a livelihood for both men and their families. While Muir is renowned for his work as a conservationist and writer rather than as a commercial orchardist, orchard revenues and profits from orchard land transactions provided him with an income to support his travels and writing endeavors. Dr. Strentzel is renown on the state level for his work in the early development of commercial orchards in Northern California. Strentzel was the first orchardist to grow a number of fruit varieties in the region, and promoted commercial orcharding as an enterprise and the growing of certain varieties. He helped establish the supporting infrastructure for commercial orchards in Contra Costa County by creating the Alhambra Grange, and encouraged prospective growers through his horticultural writings and presentations.

Both Muir and Strentzel worked on the fruit ranch, grafting, planting and pruning fruit trees and harvesting fruit. Both men were knowledgeable horticulturists, though Muir's interest was primarily economic, whereas Strentzel's was more esoteric and experimental. The suitability of Contra Costa County for orcharding was the primary reason Strentzel acquired land parcels in the Alhambra Valley in the mid-19th century, and established a fruit ranch in the location that would become the home and ultimate resting place of John Muir.

While some individual fruit trees date to the period of significance, generally, the orchards in the House Unit do not date back to Muir's time, and do not accurately represent the historic character of Muir's orchards, as described in the previous chapter. However, as orchard *spaces* with their *land use* still functioning in orchard and vineyard cultivation, the orchards have an authentic relationship with Muir, as these spaces were used as orchards with similar species and varieties during his ranch tenure.

The pear orchard at the Gravesite Unit has existed since Muir and Strentzel's times, and is one of the oldest pear orchards in the national park system. Strentzel planted the seedling rootstock in this orchard and grafted an array of varieties onto the rootstock. After taking control of the fruit ranch, Muir removed Strentzel's varieties and regrafted the rootstock with scion wood of the commercial Bartlett variety. With the rootstock planted by Strentzel and scion wood grafted by Muir still extant, the Gravesite pear orchard is a remarkable cultural landscape feature associated with both men. The pear orchard is an excellent example of a late 19th-century commercial pear orchard, evidenced by the characteristic wide spacing, low-headed canopies, open bowl pruning style and a singular variety.

Some of the fruit trees on Mt. Wanda date back to Muir's time, when the lower slopes were planted with orchards and the upper slopes were conserved as a natural area. The historic apricot and walnut trees and historic olive orchard on Mt. Wanda are associated with the extent of Muir and Strentzel's former enterprise, as indicators of the scale of the 2300-acre fruit ranch property, its maximum size being under their joint ownership. In addition, the multi-acre olive orchard, with more than 120 historic olive trees dating back to Muir's time, is one of the largest and oldest olive orchards in the national park system.

In addition to the significance conveyed by the park's orchards as identified above, the park has the potential to more accurately represent another layer of orchard significance at the House Unit that is currently unrealized. Great

potential exists for the park to more accurately depict the appearance of the orchards in Muir's period of ownership and influence, as an example of commercial orcharding that belongs to the first half of the modern period in the history of American orchards, the period from 1880 to 1945. The first half of this period, from 1880 to 1914, shares the characteristics of low-headed, full-size trees, wide spacing and few varieties with the rest of the period. However, in the first half of the period, during Muir's time, the Red and Golden Delicious apple varieties were absent from the apple orchard. In the latter half of the period, after Muir's time, the newly originated Red and Golden Delicious varieties came to dominate apple orchards, to the extent that almost two thirds of all apples grown in the United States were of the two varieties. The park has the potential to accurately depict the discrete but significant period in the history of American orchards when the modern form was adopted, but 19th-century apple varieties were solely grown, as Red and Golden Delicious varieties had yet to be introduced.

RELATIONSHIP TO PRIMARY INTERPRETIVE THEMES

The park's 1996 Interpretive Prospectus identifies three primary themes:

1. *John Muir was a philosopher, writer, and spokesman for the emerging conservation movement in America.*

2. *Muir's conservation philosophy was intimately tied to his experiences in the wilds.*

3. *Muir's Martinez ranch gave him financial independence so he could pursue his interests; his happy home life provided emotional support to counterbalance a life of wandering and struggling in conservation causes.*

The park's historic and representative orchards and fruit trees are clearly related to the third interpretive theme that focuses on Muir's personal life. Orchards provided for Muir's income during the period of his greatest

conservation accomplishments, supporting his writing of numerous articles and books, traveling around the world, serving as first president of the Sierra Club, and being involved in the establishment of five national parks. However, beyond the relationship of the park's orchards with Muir's business acumen and financial independence, they also reveal the part of Muir that was a horticulturist and farmer. Muir not only knew the fruit ranch business, he also knew fruit tree culture, and personally performed all aspects of their cultivation. The orchards provide a window into this other, little-known facet of Muir - his knowledge and skills as a horticulturist - and therefore facilitate the broader interpretation of Muir's life and legacy.

EXISTING CONDITIONS

CONTRIBUTING AND NON-CONTRIBUTING ORCHARDS

INTRODUCTION

This section of the Orchard Management Plan deals with the existing conditions of all of the park's fruit trees. A condition description is provided for the fruit trees of the three park units, according to the nomenclature system described below. After each condition description, a statement of contributing (historic) or non-contributing (non-historic) status of the orchard or fruit trees is provided. *Contributing* orchards are those that date to the Strentzel or Muir periods. These fruit trees *contribute* to the significance and integrity of the John Muir NHS cultural landscape. *Non-contributing* orchards are those that were planted after the period of significance. These do not contribute to the significance and integrity of the cultural landscape, but may be *compatible*. Compatible but non-contributing orchards have an appearance that is consistent with the historic character of contributing fruit trees and the cultural landscape. *Incompatible* orchards or fruit trees are inconsistent with the historic character of contributing fruit trees or the cultural landscape. In summary, the JOMU fruit trees are identified as contributing or non-contributing. The non-contributing trees are further qualified as compatible or incompatible.

ORCHARD NOMENCLATURE

This Orchard Management Plan uses the same classification system for identifying orchards and other landscape features as the *Cultural Landscape Report for John Muir National Historic Site* (2005). The CLR divides the park into six character areas, four within the House Unit, and one each for the Gravesite and Mt. Wanda Units. The character areas are identified for management purposes, and are based on current park boundaries and landscape characteristics. These character areas are referenced in the *CLR*

Volume 2: Treatment, in the identification of specific treatment recommendations. The following list identifies the park's character areas.

John Muir NHS Cultural Landscape Character Areas:

House Unit
- Muir House and Knoll Area (MH)
- Agriculture Area (AG)
- Martinez Adobe Area (MA)
- Visitor Center Area (VC)

Gravesite Unit
- Gravesite Unit Area (GR)

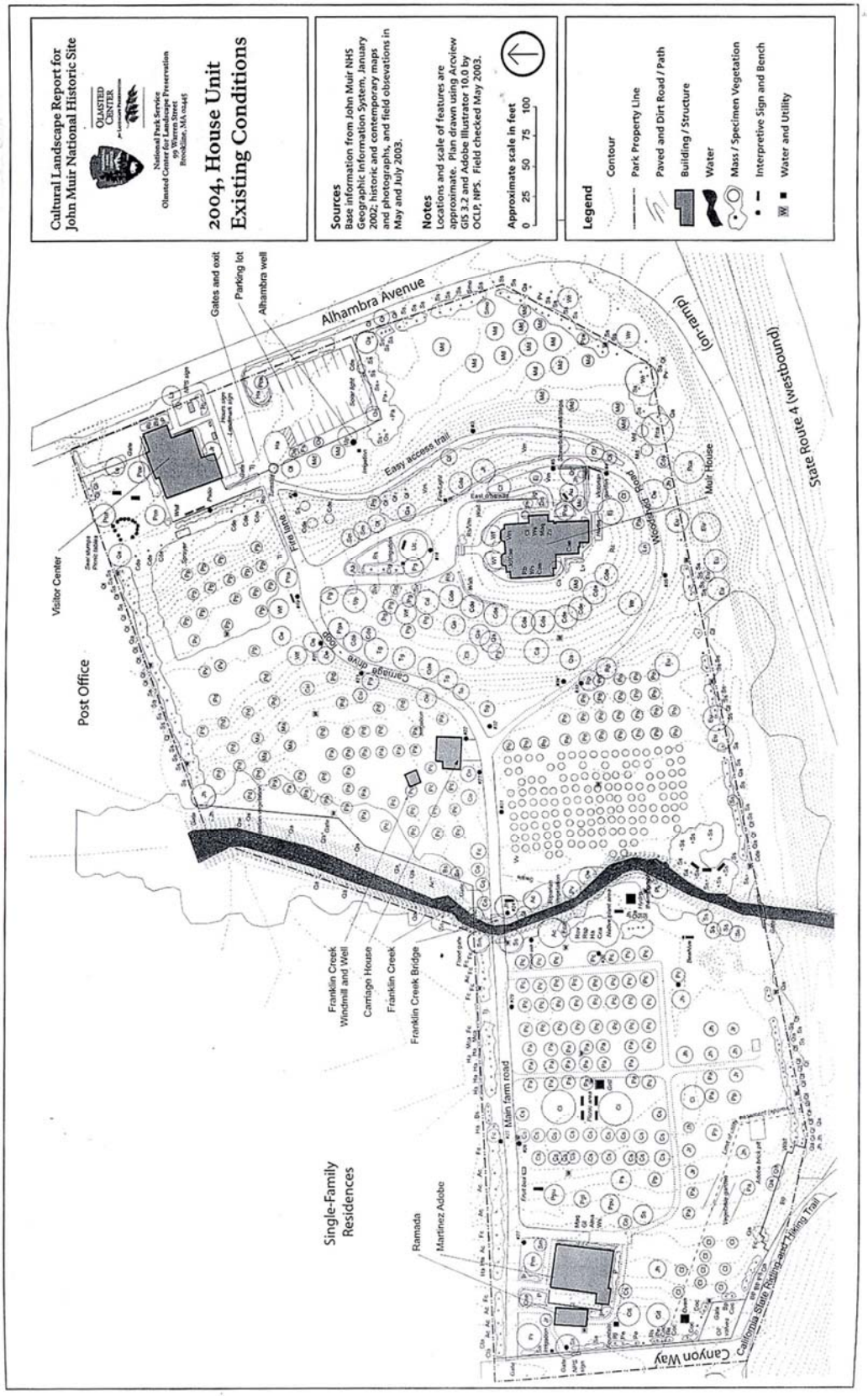
Mt. Wanda Unit
- Mt. Wanda Unit Area (WA)

The park's orchards and fruit trees are found within three of the six character areas: the Agriculture Area (AG) of the House Unit, the Gravesite Unit Area (GR) and in the Mt. Wanda Unit Area (WA).

Within the Agriculture Area of the House Unit, orchards are found within five "feature zones," as identified by the CLR. The feature zones are provided for management purposes and are used to reference specific treatment recommendations. The following list identifies the feature zones of the House Unit, Agriculture Area (AG):

House Unit, Agriculture Area Feature Zones:

- East Orchard
- North Orchard
- Fish Pond
- Middle Orchard
- West Orchard


Cultural Landscape Report for
John Muir National Historic Site
OLMSTED CENTER
National Park Service
Olmsted Center for Landscape Preservation
99 Warren Street
Brookline, MA 02445
2004, House Unit
Existing Conditions
Sources
Base information from John Muir NHS Geographic information System, January 2002; historic and contemporary maps and photographs, and field obsevations in May and July 2003.
Notes
Locations and scale of features are approximate. Plan drawn using Arcview GIS 3.2 and Adobe Illustrator 10.0 by OCLP, NPS. Field checked May 2003.
Approximate scale in feet
0 25 50 75 100
Legend
Contour
Park Property Line
Paved and Dirt Road / Path
Building / Structure
Water
Mass / Specimen Vegetation
Interpretive Sign and Bench
Water and Utility
Alhambra Avenue
Gates and exit
Parking lot
Alhambra well
Visitor Center
Post Office
Easy access trail
Fire lane
Carriage drive
Woodland road
Muir House
(on-ramp)
State Route 4 (westbound)
Franklin Creek
Windmill and Well
Carriage House
Franklin Creek
Franklin Creek Bridge
Main farm road
Single-Family
Residences
Ramada
Martinez Adobe
Canyon Way
California State Riding and Hiking Trail

ORCHARD EXISTING CONDITIONS

The following text describes the existing conditions of each orchard in each character area or feature zone and identifies their contributing or non-contributing status (refer to the CLR existing conditions site plan graphics for illustration).

AGRICULTURAL AREA, HOUSE UNIT

East Orchard

The East Orchard is located east of the Muir House knoll. It is composed of a small apple orchard generally located on a level area in the southern part of the space. An open field occupies most of the northern part of the space.

Apple - Condition Assessment

There are 14 living apple trees and 1 standing dead apple tree in the East Orchard. In addition, two living apple trees are located near the well on the east boundary near the parking area. Of the total 16 living apple trees, five or 33% are in fair condition and 11 or 66% are in poor condition. Approximately 11 of the trees were planted in the 1970s and five trees were planted in the 1990s. The apple varieties include Gravenstein, Jonathan, Yellow Newtown Pippin, Coxes Orange Pippin, Rhode Island Greening, Red Astrakhan, Esopus Spitzenburg, Swaar and Winesap. These are a mix of early, mid and late ripening varieties, and can cross pollinate each other.

The form of the trees is “high headed” rather than “low headed,” with trunks taller than three feet, an open-bowl pruning style and acutely ascending branch crotches. The apple canopies have been pruned up to allow room for the tractor or mower to pass under. All 16 apple trees have internodes (distance between axils) shorter than standard, full-size trees. The 11 older trees appear to be grafted onto semi standard rootstock, such as EM 111 or EM 106, and the younger trees appear to be grafted onto semi dwarf or dwarf

rootstock, such as EM 7 or EM 9. The older, semi standard trees are spaced on a 25 x 25 feet grid, the younger, semi dwarf trees are spaced approximately 20 feet apart. A sticky band of Tanglefoot has been applied to the trunk of each apple tree, to exclude crawling insect pests from the canopy. The trees are stressed and show indications of apple aphid and Codling moth damage, San Jose scale and sun-scald.

Apple Evaluation: *Non Contributing, Incompatible*

The 14 living apple trees in the East Orchard are non-contributing, i.e., non-historic trees, as they do not date to the period of significance. The apple trees are incompatible, as they are inconsistent with the historic character of apple trees in the significant period. They are high-headed with tall trunks rather than low-headed, and are grafted onto semi-standard or semi-dwarf, i.e., dwarfing rootstocks, rather than seedling apple rootstocks, which historically gave rise to full-size, standard trees.

North Orchard

The North Orchard is located north of the Muir House knoll, and is the first orchard visible to visitors entering the park. The North Orchard is on a hill with east and west facing slopes. The east-facing slope contains a peach orchard with a few cherry trees. The west-facing slope contains a mixed orchard of almond, mulberry, apricot and carob trees.

Peach – Condition Assessment

There are 17 living peach trees in the North Orchard. Of the 17 peach trees, three or 20 % are in fair condition and 14 or 80% are in poor condition. The peach trees were planted in the late 1960s, 1970s, 1980s, and in 1990. The peach varieties are Muir, Crawford, Elberta, and Fay Elberta, a modern strain of the Elberta variety. Peach can self-pollinate and does not require multiple varieties in order to achieve cross pollination.

The form of the peach trees is generally "low headed," with trunks less than 30" tall, and an open-bowl pruning style with acutely ascending branch crotches. The peach canopies have been pruned up to allow room for the tractor or mower to pass under. Despite their mature age, the trees are smaller than typical standard or full size peach trees, and appear to be grafted onto a dwarfing rootstock, such as the Lovell Peach Seedling. Eight Elberta trees, planted in 1984, are grafted onto the Nemeguard rootstock – a nematode resistant rootstock adapted to dry, sandy sites that in wet soils results in a stunted or dwarfed tree. The trees are spaced on a 20 x 20 feet grid. A band of Tanglefoot has been applied to the trunk of each peach tree, to exclude crawling insect pests from the canopy. The oldest peach trees bear the residue of white latex paint on their trunks. All of the trees are stressed and show indications of peach leaf curl, brown rot, chlorosis (probably from Nitrogen deficiency) and sun-scald, however, the trees that were formerly white-washed have less sun scald.

Peach Evaluation: *Non Contributing, Incompatible*

The 17 living peach trees in the North Orchard are non-contributing, i.e., non-historic trees, as they do not date to the period of significance. The peach trees are incompatible, as they are inconsistent with the historic character of peach trees in the significant period. They are grafted onto dwarfing rootstocks rather than seedling peach rootstock, which historically gave rise to full-size, standard trees.

Cherry – Condition Assessment

Three living sweet cherry trees are located at the north end of the peach trees in the North Orchard. Two or 66% of the cherry trees are in fair condition and one or 33% is in poor condition. The trees were planted in the 1980s and in 1990. The cherry varieties are Bing and Black Tartarian. Sweet cherries require cross pollination in order to bear fruit and the Black Tartarian and Bing varieties can cross pollinate each other. The form of the trees is generally "high-headed" rather than "low-headed," with trunks taller than

three feet, an open-bowl pruning style and acutely ascending branch crotches. The cherry canopies have been pruned up to allow room for the tractor or mower to pass under.

The trees have short internodes and therefore appear to be grafted onto a dwarfing rootstock such as Colt, rather than the vigorous Mazzard seedling rootstock. The three trees are spaced 20 to 25 feet apart. A band of Tanglefoot has been applied to the trunk of each cherry tree, to exclude crawling insect pests from the canopy. The trees are stressed and show indications of aphid damage, cytospora canker, bacterial canker and sun-scald.

Cherry Evaluation: *Non Contributing, Incompatible*

The three living cherry trees in the North Orchard are non-contributing, i.e., non-historic trees, as they do not date to the period of significance. The cherry trees are incompatible, as they are inconsistent with the historic character of cherry trees in the significant period. They are high-headed with tall trunks rather than low-headed, and are grafted onto dwarfing rootstocks rather than seedling cherry rootstocks, which historically gave rise to full-size, standard trees.

Almond – Condition Assessment

On the west-facing slope of the North Orchard, the peach trees give way to almond. Sixteen living almond and one standing dead almond tree are located here. Of the 16 living trees, four are almost dead. All 16 or 100% of the living almond trees are in poor condition. The trees were planted in the 1970s, 1980s and 1990s. The almond varieties are Nonpareil (planted in 1984 and 1996), Texas Mission (planted in 1980) and Neplus Ultra (planted in 1992). Almond trees require cross pollination and these varieties can cross pollinate each other.

The form of the almond trees is "high-headed" rather than "low-headed," with trunks taller than three feet, an open-bowl pruning style and acutely ascending branch crotches. The almond canopies have been pruned up to allow room for the tractor or mower to pass under. The 16 living almond trees are full size trees on seedling rootstocks (no dwarfing or clonal rootstocks are available for this species), and the trees are spaced at 25 x 25 feet apart. Almond trees are intolerant of wet soils and need good drainage and warm weather when flowering to thrive. The 16 almond trees are stressed, and show indications of Pacific Flathead borer damage, mites, bacterial canker disease and incompatible poorly drained soils.

Almond Evaluation: *Non Contributing, Incompatible*

The 16 living almond trees in the North Orchard are non-contributing, i.e., non-historic trees, as they do not date to the period of significance. The almond trees are incompatible, as they are inconsistent with the historic character of almond trees in the significant period. They are high-headed with tall trunks rather than low-headed, and are growing in a location historically used to grow peach trees.

White Mulberry – Condition Assessment

Four living White or Silkworm mulberry trees are located west of the almond in the North Orchard. Two or 50% of the mulberry trees are in good condition, two or 50% are in fair condition. The trees were planted in the 1990s. The trees are the straight species *Morus alba*, which has no commercial varieties, and the trees are ungrafted as they were grown from seed or rooted cuttings. The leaves of these trees provide food for silkworms where grown commercially in Southern Europe and in India, and the flowers are the primary ingredient of mulberry wine.

The form of the trees is "high headed" rather than "low headed," with trunks taller than three feet, a modified central leader pruning style and acutely ascending branch crotches. The mulberry canopies have been pruned up to

allow room for the tractor or mower to pass under. The mulberry are full sized trees, grown on their own roots, and will naturally achieve a very large size when mature, approximately 45 feet tall and 45 feet spread. The trees are spaced approximately 25 x 25 feet apart. Two of the trees are stressed and have thin canopies with yellowing foliage, possibly due to overcrowding by adjacent apricot trees and over-shading by native oak trees in the Franklin Creek riparian corridor.

Mulberry Evaluation: *Non Contributing, Incompatible*

The four living mulberry trees in the North Orchard are non-contributing, i.e., non-historic trees, as they do not date to the period of significance. The mulberry trees are incompatible, as they are inconsistent with the historic character of mulberry trees in the significant period. They are high-headed with tall trunks rather than low-headed and are growing in a location historically used to grow peach trees.

Apricot – Condition Assessment

Four living apricot trees are located at the far west-end of the North Orchard, near Franklin Creek, as delineated by the CLR feature zones. The apricot trees spread over into the delineated "Fish Pond" feature zone also, where another 19 living trees are located. As most of this apricot orchard is located in the Fish Pond rather than the North Orchard, the existing conditions of the apricot trees will be described in the next section, the Fish Pond zone, rather than in the North Orchard.

Fish Pond

The Fish Pond is the area referred to as a pond or fish pond during Muir's time. It is located north of the restored carriage house, near the North Orchard, and contains a reconstructed windmill and a restored Carriage House.

Apricot – Condition Assessment

As identified above, 19 living apricot trees are located in the Fish Pond and four trees are adjacent in the North Orchard. Of the total 23 apricot trees in this area, 17 or 75% are in fair condition and 6 or 25% are in poor condition. The trees were planted in the early 1990s. The varieties are Blenheim and Tilton, grafted to Marianna 2624 rootstock, a clonal rootstock that creates a smaller than standard apricot tree. Apricot is a self-fruitful species and does not require multiple varieties to perform cross pollination.

The form of the trees is "high headed" rather than "low headed," with trunks taller than three feet, an open bowl pruning style and acutely ascending branch crotches. The apricot canopies have been pruned up to allow room for the tractor or mower to pass under. The trees are spaced on an approximately 18 x 18 feet grid. The trees are stressed and show indications of fireblight, cytosporina, brown rot, over-shading by Franklin Creek oak trees, and sun-scald.

Apricot Evaluation: *Non Contributing, Incompatible*

The 19 living apricot trees in the Fish Pond are non-contributing, i.e., non-historic trees, as they do not date to the period of significance. The apricot trees are incompatible, as they are inconsistent with the historic character of apricot trees in the significant period. They are high-headed with tall trunks rather than low-headed, and are growing in a location historically used as a fish pond, which had no fruit trees.

Pear – Condition Assessment

Twelve living pear trees are located in the Fish Pond, south of the apricot trees. Ten or 85% of the trees are in fair condition, and two or 15% of the trees are in poor condition. The trees were planted in the early 1990s. The variety is Bartlett. European pear is self-unfruitful and each variety requires cross pollination by another variety. No information on a pollenizer variety

in the Fish Pond is available, and it may be assumed that the Fish Pond pears were planted without a pollenizer, relying on the several pear varieties in the West Orchard to pollinate these trees. However, at a distance of more than 100 feet, it is unlikely that effective cross pollination is occurring.

The form of the trees is "high headed" rather than "low headed," with trunks taller than three feet, an open bowl or modified central leader pruning style with acutely ascending branch crotches. The pear canopies have been pruned up to allow room for the tractor or mower to pass under. The pear trees are grafted to Winter Nellis seedling rootstock. This rootstock gives rise to a standard, full size tree, however, the growth of the trees appears to be stunted, probably by health stressors. The pear trees are spaced 20 x 20 feet apart. A band of Tanglefoot has been applied to the trunk of each pear tree, to exclude crawling insect pests from the canopy. The trees are stressed and show indications of aphid damage, fireblight, over-shading from Franklin Creek oaks and sun-scald.

Pear Evaluation: *Non Contributing, Incompatible*

The 12 living pear trees in the Fish Pond are non-contributing, i.e., non-historic trees, as they do not date to the period of significance. The pear trees are incompatible, as they are inconsistent with the historic character of pear trees in the significant period. They are high-headed with tall trunks rather than low-headed, and are growing in a location historically used as a fish pond, which had no fruit trees.

Quince – Condition Assessment

A row of five quince trees is located at the southern end of the Fish Pond, lining the edge of the main farm road. Four or 80% of the quince trees are in good condition, and one or 20% of the quince is in fair condition. The quince trees are historic and date back to John Muir's time, and even possibly to Dr. Strentzel. The variety is Champion. Quince is a self-fruitful species, and each variety can self pollinate to produce fruit.

Quince is a shrub-like multi-trunked tree and requires periodic thinning of the trunks to prevent overcrowding and control suckering from the rootstock. The variety is grafted onto a quince seedling rootstock. All of the five quince trees have overcrowded multi-trunks, with multiple suckers around the perimeter of the trunks. The trees have been allowed to develop a closed, tight-upright form, rather than an open, wide-spreading form. The trees are spaced approximately 20 feet apart, with a break in the middle of the row. While in generally good condition, the fruit quality is affected by Codling moth predation. Additionally, the one quince tree in fair condition is located near the Franklin Creek bridge, and is being over-shaded and over-crowded by a California buckeye, causing an asymmetrical and thinner canopy in this quince tree.

Quince Evaluation: *Contributing*

The five living quince trees at the southern end of the Fish Pond area are contributing trees, as they date to the period of significance in this location.

Middle Orchard

The middle orchard is located south of the Fish Pond and west of the Muir House knoll. The middle orchard consists of a plum orchard and further west, a vineyard.

Plum – Condition Assessment

The Middle Orchard contains a plum orchard of 24 living trees. Sixteen or 66% of the plum trees are in fair condition and eight or 33% are in poor condition. The east row of the plum orchard contains five Japanese plum trees *Prunus salicina*, and the west rows of the plum orchard contain 19 European plum trees *Prunus domestica*, also known as prune. The Japanese plum trees were planted in the 1980s and in 1990, and the European plum trees were planted in 1969 and in the early 1970s. The Japanese plum

varieties are Santa Rosa and Satsuma. The European plum varieties are French, Imperial, Sugar and Green Gage. The Japanese and European plum species are generally self-unfruitful, and each variety of each species requires another variety for cross pollination.

The form of the trees is "high headed" rather than "low headed," with trunks taller than three feet, an open bowl pruning style with acutely ascending branch crotches. The plum canopies have been pruned up to allow room for the tractor or mower to pass under. European plum trees attain a larger size at maturity than Japanese plum, and in the Middle Orchard, the European plum trees are larger than the Japanese. However, both species appear small or stunted, and in particular, the European plum trees are uncharacteristically small for their age. This may be due to health stressors or to the fact that the trees are grafted onto a clonal dwarfing rootstock such as Marianna 2624, rather than the seedling Myrobalan plum rootstock, which produces a standard full size tree for both European and Japanese plum. The plum trees are spaced approximately 15 x 18 feet apart. A band of Tanglefoot has been applied to the trunk of each plum tree, to exclude crawling insect pests from the canopy. The trees are stressed and show indications of plum aphid, San Jose scale, plum curculio and sun-scald.

Plum Evaluation: *Non Contributing, Incompatible*

The 24 living plum trees in the Middle Orchard are non-contributing, i.e., non-historic trees, as they do not date to the period of significance. The plum trees are incompatible, as they are inconsistent with the historic character of plum trees in the significant period. They are high-headed with tall trunks rather than low-headed, and are grafted onto dwarfing rootstocks, rather than seedling plum rootstock, which historically gave rise to full-size, standard trees.

Grape – Condition Assessment

There are 126 living grapevines in the Middle Orchard, and one dead grapevine. Approximately 63 or 50% of the grapevines are in good condition and 63 or 50% are in fair condition. The vines were planted in 1976, 1990 and 1998. The grape varieties are Zinfandel, Flame Tokay, Golden Muscat, and Muscat of Alexandria, which are table grape varieties rather than wine or juice varieties. All grape varieties are self-fruitful and do not require the presence of another variety for cross pollination.

The form of the grapevines is "head-pruned" rather than "trellised." The head-pruned vines have 18 to 24-inch tall trunks bearing four to five limbs in a star pattern. The varieties are grafted onto Rupestris St. George rootstock, a very vigorous clonal rootstock with resistance to drought, Phylloxera and some species of nematode. The vines are spaced approximately 10 x 10 feet apart. The vines show some stress and bear indications of powdery mildew, and Pierce's Disease, conducted by the blue-green sharpshooter leafhopper.

Grape Evaluation: *Non Contributing, Compatible*

The 126 living grapevines in the Middle Orchard are non-contributing, i.e., non-historic vines, as they do not date to the period of significance. The grapevines trees are compatible, however, as they are consistent with the historic character of vineyards in the significant period. They are high-pruned rather than trellised, and are of varieties used historically by Muir in this location.

West Orchard

The West Orchard is located west of Franklin Creek, and spans the area between the creek and the Martinez Adobe. The West Orchard contains pear, apricot, orange, lemon, pecan, English and Black walnut trees.

Pear – Condition Assessment

Thirty five living pear trees are located in the West Orchard. Twenty six or 75% of the trees are in fair condition, and nine or 25% of the trees are in poor condition. The trees were planted in 1967, 1970 and 1984. The varieties are Bartlett, Winter Nellis, Seckel and Comice, however, the vast majority of the trees are Bartlett. European pear is self-unfruitful and each variety requires cross pollination by another variety. Bartlett is an early variety that requires another early variety such as Seckel, for cross pollination. Comice is a later variety and will cross pollinate Winter Nellis.

The form of the trees is "high headed" rather than "low headed," with trunks taller than three feet, and a modified central leader pruning style with acutely ascending branch crotches. The pear canopies have been pruned up to allow room for the tractor or mower to pass under. The pear trees are grafted to Winter Nellis seedling rootstock. This rootstock gives rise to a standard, full size tree, however, the growth of the trees appears to be stunted, probably by health stressors. The pear trees are spaced approximately 20 x 20 feet apart. A band of Tanglefoot has been applied to the trunk of each pear tree, to exclude crawling insect pests from the canopy. The trees are stressed and show indications of aphid damage, fireblight, powdery mildew, pear scab, over-crowding from Franklin Creek oaks and sun-scald.

Pear Evaluation: *Non Contributing, Incompatible*

The 35 living pear trees in the West Orchard are non-contributing, i.e., non-historic trees, as they do not date to the period of significance. The pear trees are incompatible, as they are inconsistent with the historic character of pear trees in the significant period. They are high-headed with tall trunks rather than low-headed.

Apricot – Condition Assessment

There are a total of 21 living apricot trees in the West Orchard. Sixteen trees are located near the pecans, north of the small two-track road, and five are located south of the two-track road. Generally, all of the apricot trees in the

West Orchard (approximately 100%) are in good or almost good condition. The trees were planted in 1969 and 1984. The varieties are Blenheim and Tilton and are grafted to Marianna 2624 rootstock, a clonal rootstock that creates a smaller than standard apricot tree. Apricot is a self-fruitful species and does not require multiple varieties to perform cross pollination.

The form of the trees is generally "low headed," with trunks shorter than 30 inches, an open bowl pruning style and moderately ascending branch crotches. The apricot canopies have been pruned up to allow room for the tractor or mower to pass, however, their scaffolds are wider than most fruit tree scaffolds on the site. Most of the apricot trees in the West Orchard bear the residue of white latex paint on their trunks. The trees are spaced on an approximately 10 x 20 feet grid. While a number of the trees have lost lower limbs due to old age and over-shading by the pecan trees, the health of the trees is generally good. The formerly white washed trees have very little or no sun-scald. The trees show a low level of stress. Brown rot is present on the fruits.

Apricot Evaluation: *Non Contributing, Compatible*

The majority of the 21 living apricot trees in the West Orchard are non-contributing, i.e., non-historic trees, as they do not date to the period of significance. The oldest apricot trees are compatible, however, as they are consistent with the historic character of apricot orchards in the significant period. They are low-headed with short trunks and are white-washed, and are of varieties used historically by Muir in this location.

Orange – Condition Assessment

There are 17 orange trees in the West Orchard, east of the adobe. Seven or 65% are in fair condition, and four or 35% are in poor condition. The trees were planted in 1973 and 1986. The variety is Washington Navel. All of the orange trees are shorter than full-size standard trees, which can reach 25 feet when mature. Semi-dwarf or dwarf orange trees are created by grafting onto

the roots of the trifoliate orange, *Poncirus trifoliata*. Eleven of the total 17 orange trees are grafted onto semi-dwarf rootstock, such as the trifoliate orange Rubidoux stock, with an average height of eight feet. Six of the orange trees are grafted onto dwarf rootstock, such as the trifoliate orange Flying Dragon stock, with an average height of four feet. The Washington Navel is a seedless variety, not requiring pollination to set fruit.

The form of the trees is "low headed," with trunks shorter than 30 inches, and an open bowl pruning style with moderately ascending branch crotches. The orange canopies have not been pruned up to allow room for the tractor or mower to pass under and their scaffolds are wider than most fruit trees on the site. The trees are spaced on an approximately 20 x 25 feet grid. The trees are stressed by sun scald and appear chlorotic (yellow), due to a micronutrient deficiency, such as caused by lack of iron or zinc. The dwarf trees show considerable dieback, and may have a Phytophthora root infection.

Orange Evaluation: *Non Contributing, Incompatible*

The 17 living orange trees in the West Orchard are non-contributing, i.e., non-historic trees, as they do not date to the period of significance. The orange trees are incompatible, as they are inconsistent with the historic character of orange trees in the period of significance. While the orange trees are correctly low-headed, they are grafted to dwarfing rootstocks rather than seedling orange rootstocks, which historically gave rise to full-size, standard trees. In addition, this location was not used for citrus orchards in the significant period.

Lemon – Condition Assessment

There are nine living lemon trees in the West Orchard, located south of the adobe. Eight or 80% are in fair condition and one tree or 20% is in poor condition. The lemon trees were planted in 1974 and 1986. The variety is

Eureka. The Eureka lemon has apomictic seeds, not requiring pollination in order to set fruit.

The form of the trees is "low headed," with trunks shorter than 30 inches, and an open bowl pruning style with acutely ascending branch crotches. The lemon canopies have been pruned up to allow room for the tractor or mower to pass under. All of the lemon trees are shorter than full-size standard trees, which can reach 20 feet when mature. The lemon trees appear to be semi-dwarf as a result of grafting onto the trifoliate orange Rubidoux rootstock, with an average height of eight feet. The trees are spaced on an approximately 20 x 20 feet grid. The trees are stressed by sun-scald and appear chlorotic due to a micronutrient deficiency, such as caused by lack of iron or zinc.

Lemon Evaluation: *Non Contributing, Incompatible*

The nine living lemon trees in the West Orchard are non-contributing, i.e., non-historic trees, as they do not date to the period of significance. The lemon trees are incompatible, as they are inconsistent with the historic character of lemon trees in the significant period. While the lemon trees are correctly low-headed, they are grafted onto dwarfing rootstocks rather than seedling lemon rootstocks, which historically gave rise to full-size, standard trees. In addition, this location was not used for citrus orchards in the significant period.

Pecan – Condition Assessment

Three living pecan trees are located in the West Orchard. Three or 100% of the pecan trees are in good condition. These trees are sufficiently old to date back to Muir's time. The trees are of the straight species *Carya illinoensis.* As these trees are of no variety, they are ungrafted and are grown on their own roots. These graceful trees have tall straight trunks and are approximately 45 feet in height. They will continue to grow and may attain

70 feet in height and more than 50 feet in width over 150 years. The trees are located in a row and are spaced approximately 50 feet apart.

Pecan Evaluation: *Contributing*

The three living pecan trees in the West Orchard are contributing trees, as they date to the period of significance in this location.

English Walnut – Condition Assessment

Four living English walnut trees are located in the West Orchard, south of the two track road. One or 25% is in fair condition and three or 75% are in poor condition. The three trees in poor condition are almost dead. They were planted in the 1980s. The trees are of the varieties Payne, Hartley and Eureka. English walnut is self-unfruitful and two varieties must be present to achieve cross pollination.

The form of the trees is "low headed," with trunks generally shorter than 30 inches, and an open bowl pruning style with acutely ascending branch crotches. The English walnut canopies have been pruned in an acute, ascending pattern to allow room for the tractor or mower to pass under. All of the English walnut trees are grafted onto the rootstock of California Black or Hines walnut, *Juglans hindsii*, creating a full-size or standard tree. The trees are spaced approximately 20 feet apart. They are mixed together with apricot and Black walnut trees. The trees are stressed and show indications of Black line virus in the rootstock, with sprouting of the black walnut rootstock at the graft union, and Walnut blight in the tree canopies.

English Walnut Evaluation: *Non Contributing, Incompatible*

The four living English walnut trees in the West Orchard are non-contributing, i.e., non-historic trees, as they do not date to the period of significance. The English walnut trees are incompatible, as they are inconsistent with the historic character of English walnut orchards in the

significant period. The English walnut trees are correctly low-headed with short trunks, are correctly grafted onto seedling Black walnut rootstocks and are of varieties that were or could have been grown by Muir in the significant period. However, English walnut trees would not have been mixed in an orchard with different fruit species such as apricot during the significant period and the spacing would have been double the existing conditions. Mature English walnut trees are very large, and were grown in a solid block, at 40 feet spacing.

California Black/Hines Walnut – Condition Assessment

Eight living Black walnut trees are located in the West Orchard. All eight or 100% are in generally good condition. They were planted in the 1980s. The trees are of the straight species *Juglans hindsii*. They are of no variety and are therefore ungrafted, being grown on their own roots. Black walnut is self un-fruitful, and more than one tree must be present to achieve cross pollination and nut production. While the Black walnut has no commercial value due to its thick husk and small nutmeats, the nuts are edible. However, the tree is typically found in orchards as a source of rootstock for English walnut propagation, or for cross pollination.

The form of the trees is “high-headed” rather than “low-headed” with trunks generally taller than three feet, and an open bowl pruning style with moderately ascending branches. The Black walnut canopies have been pruned up to allow room for the tractor or mower to pass under. The trees are spaced approximately 25 x 25 feet apart. They appear to have a low level of stress.

California Black/Hines Walnut Evaluation: *Non Contributing, Incompatible*

The eight living Black walnut trees in the West Orchard are non-contributing, i.e., non-historic trees, as they do not date to the period of significance. The Black walnut trees are incompatible, as they are inconsistent with the historic character of Black walnut trees in the

significant period. The Black walnut trees are high-headed with tall trunks rather than low-headed, and are mixed in with apricot trees at tight spacing. Black walnut trees would not have been mixed in an orchard with different fruit species during the significant period and the spacing would have been double the existing conditions. Mature Black walnut trees are very large, and were planted at 40 feet spacing or greater.

Fig – Condition Assessment

Ten living fig trees and one standing dead fig tree are located in the West Orchard, lining the north side of the main farm road. The line of figs is interspersed with Toyon, Pacific wax myrtle, and California buckeye. A row of figs has existed in this location since Muir's time. Of the ten living fig trees, seven or 70% are in good condition and three or 30% are in poor condition. The trees are of the variety 'Mission.' The variety is considered the most dependable in California and is widely grown. The fruits have purple-black skin and strawberry-colored flesh. While the fig trees are a variety, they are ungrafted, as fig varieties root easily from air layering, and can be planted as ungrafted, rooted cuttings. In 1985, 13 historic fig trees in this location were air layered to produce clones. The 13 trees were removed in 1986, and replaced with the air-layered clones of the same variety in the same location. Air layering and subsequent planting was repeated in 1991, 1995 and 1999, with the goal of replacing in-kind the historic row of fig trees lining the north side of the main farm road.

Common fig is self fruitful with only female flowers, and does not require pollination in order to set fruit. The plant bears two crops per year, one in June, and one in September. The first crop, called the breba crop, is borne on last season's growth. The second crop is borne on new growth, and is the main crop. The tree can be pruned after the breba crop to control overall size and promote new growth for the main crop. The form of the ten fig trees is "low headed" or multi-trunked with low canopies, to facilitate harvesting of fruit. The trees are spaced between five and ten feet apart – too close for tree size. Common fig can attain 30 feet in height at maturity and should be

spaced at least 15 feet apart with pruning to control size. The three trees in poor condition have experienced gopher predation. Fig tree roots are a favorite food of gophers, which can easily kill a large tree. Planting a young tree into a large aviary wire basket can protect roots from gophers.

Fig Evaluation: *Non Contributing, Compatible*

The ten living fig trees in the West Orchard are non-contributing, i.e., non-historic trees, as they do not date to the period of significance. The fig trees are compatible, however, as they were directly propagated from historic trees, were planted in the same location, and are correctly low-headed with short trunks. The spacing of the trees is incorrectly tight, however, and should be 15 feet apart to be historically accurate, rather than 5 feet apart. If all of the above conditions had been followed, and the spacing had been accurate, the status of these trees would be contributing, rather than non-contributing, compatible.

GRAVESITE UNIT AREA

The following text describes the existing conditions of the pear orchard within the Gravesite Unit Area (GR) character area and evaluates historic integrity.

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Pear Orchard

Pear – Condition Assessment

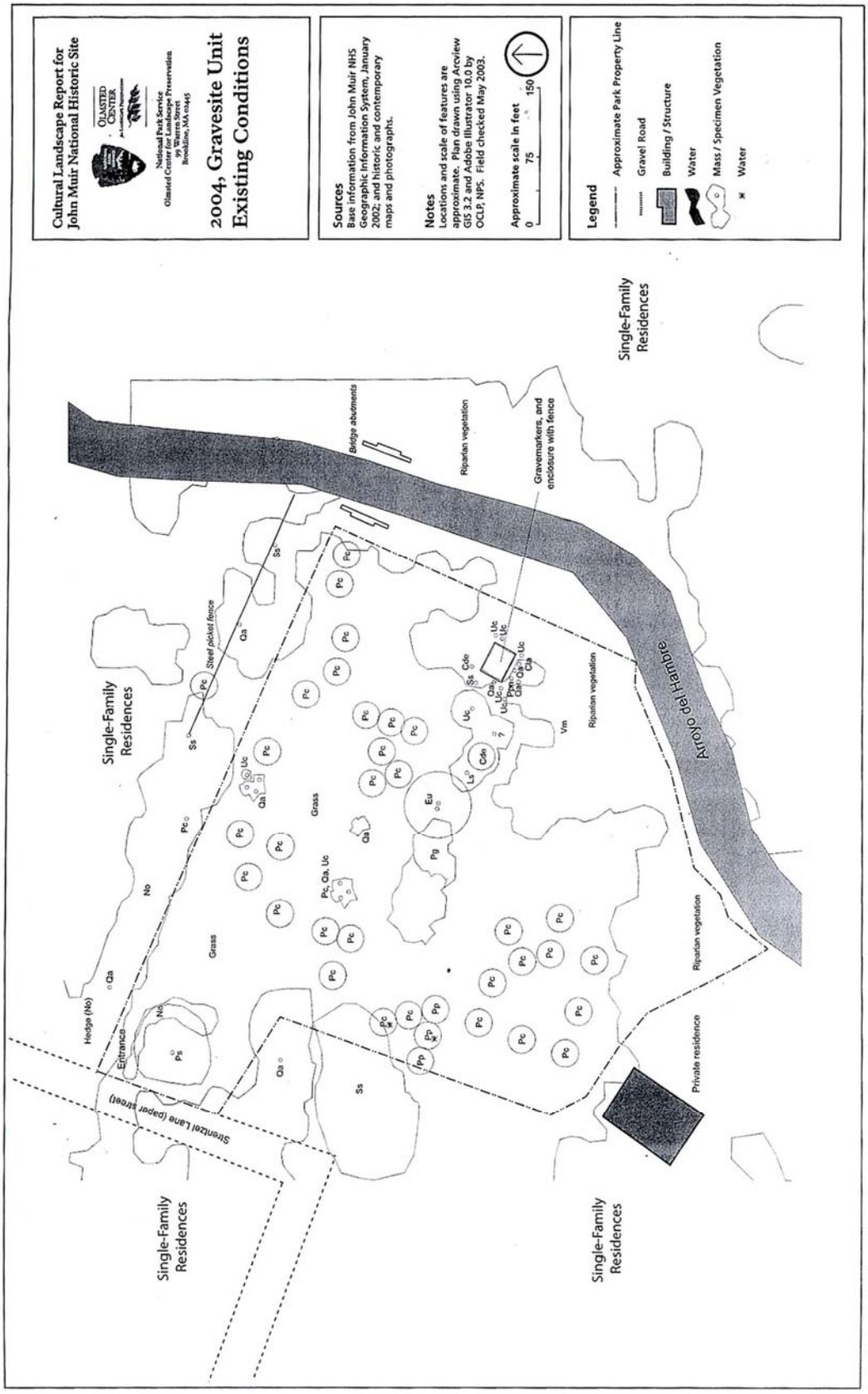
Eighteen living pear trees are located in the pear orchard at the Gravesite Unit. Twelve or 66% of the trees are in fair condition, and six or 33% of the trees are in poor condition. The tree rootstocks were planted by Dr. John Strentzel between 1853 and 1881. The tree scions were grafted by John Muir during the 1880s. The varieties are Bartlett and Winter Nellis, however, the majority of the trees are Bartlett. European pear is self-unfruitful and each variety requires cross pollination by another variety. Bartlett is an early

variety that requires another early variety for cross pollination. Winter Nellis is a late season variety that requires another late variety for pollination. Neither variety currently has a pollinator in the historic orchard. Fruit set occurs due to cross pollination by pollinator pear varieties in the surrounding residential neighborhood, typically within 100 feet from the historic trees. Approximately 14 additional historic pear trees can be found adjacent to the orchard in the surrounding private properties. These were formerly part of the Strentzel/Muir pear orchard but were excluded from the park unit when the boundary was established.

The form of the trees is "low headed," with trunks generally shorter than 30 inches, and an open bowl pruning style with acutely ascending branch crotches. The main trunk of each tree is approximately 24 to 30 inches in diameter at the base. Generally three to five main scaffold limbs were allowed to emanate from the head of the short trunk historically, however, in many cases one or more of the scaffold limbs has been lost over time, frequently leaving just two limbs behind. This gives the appearance of a tree with a double trunk. All of the pear canopies have a browse line about five to six feet from the ground. The pear trees are grafted to European pear seedling rootstock. This rootstock gives rise to a standard, full size tree. The pear trees are spaced approximately 30 x 20 feet apart. The trees are stressed and show indications of mower damage, powdery mildew, pear scab, over-crowding from volunteer trees and over-shading by a mixture of tree species around the site boundary. The trees have considerable die-back in their canopies, and suckering from the rootstocks. Each tree is in need of dead wood and sucker removal, and aeration in the root zone. Some trees are also in need of mechanical stabilization, due to interior rot within the trunk or scaffold limbs.

Pear Evaluation: *Contributing*

The 18 living pear trees at the Gravesite Unit are contributing trees, as they date to the period of significance in this location. The Gravesite orchard is one of the oldest pear orchards in the national park system.


Cultural Landscape Report for
John Muir National Historic Site
OLMSTED CENTER
National Park Service
Olmsted Center for Landscape Preservation
99 Warren Street
Brookline, MA 02445
2004, Gravesite Unit
Existing Conditions
Sources
Base information from John Muir NHS Geographic Information System, January 2002; and historic and contemporary maps and photographs.
Notes
Locations and scale of features are approximate. Plan drawn using ArcView GIS 3.2 and Adobe Illustrator 10.0 by OCLP, NPS. Field checked May 2003.
Approximate scale in feet
0
75
150
Legend
Approximate Park Property Line
Gravel Road
Building / Structure
Water
Mass / Specimen Vegetation
Water
Single-Family Residences
Single-Family Residences
Single-Family Residences
Single-Family Residences
Arroyo del Hambre
Bridge abutments
Riparian vegetation
Gravemarkers, and enclosure with fence
Steel picket fence
Riparian vegetation
Riparian vegetation
Riparian vegetation
Grass
Grass
Hedge (No)
Entrance
Private residence
Stentzel Lane (paper street)
Pc
Ss
Qa
No
Uc
Eu
Pg
Pp
Vm
Cde
Ls
Pc, Qa, Uc

MT. WANDA UNIT AREA

The following paragraphs describe the existing conditions of the olive orchard and other fruit trees within the Mt. Wanda Unit Area (WA) character area and their contributing or non-contributing status.

Olive Orchard

Olive – Condition Assessment

More than 120 living olive trees are located in the olive orchard on the southeast end of the Mt. Wanda Unit. Approximately 66% of the trees are in good condition, and 33% are in fair condition. At least ten rows with at least twelve trees per row are located on or near the crest of a hill. A graft union is clearly evident at the base of the largest tree trunks, indicating the presence of at least one grafted variety in the orchard. The variety is probably 'Mission' and/or 'Manzanillo.' The 'Mission' variety was derived from a selection from a Spanish Mission in the 1830s and became widely distributed in California in the 19th-century. The Manzanillo variety was introduced into California in 1874 from Seville, Spain, and became the most widely grown and commercially suitable cultivar in the state before the turn of the 20th-century. Varieties of the Mediterranean olive, *Olea europea*, are not abundantly self-fruitful. While olive trees of a single variety can self pollinate, more abundant fruit set occurs when more than one variety is present for cross pollination. Pollination in olives is performed by wind.

The form of the trees is "low headed," with trunks generally shorter than 30 inches, and an open bowl pruning style with wide ascending branch crotches. The main trunk of each tree is generally 30 to 36 inches in diameter at the base, indicating the trees probably date to the late 19th- or early 20th-century, coinciding with John Muir's ownership of the Mt. Wanda property. Generally five main scaffold limbs were allowed to emanate from the head of each short trunk historically, and in most cases, each tree still has excellent

form, with minimal loss of scaffold limbs. The olive trees are grafted to Mediterranean olive seedling rootstock. This rootstock gives rise to a standard, full size tree. The olive trees are spaced approximately 30 x 30 feet apart, and on the steeper slopes, the rows of trees are clearly terraced. The terraces are retained by sloping earth banks, permitting the gradient of the orchard floor to be shallower within the rows, for easier access to the trees. In addition, a loop access road with a terraced prism is evident within the orchard, historically used for hauling equipment and harvested fruit.

Generally, the condition of the trees is good. The terminal ends of the lower branches of each canopy have died, due to over-shading by the huge canopy that has grown above. Many trees are more than 30 feet tall. Some trees have dead limbs and some are overcrowded by volunteering native upland trees. Most trees would benefit from some canopy reduction to permit more light entry, and deadwood removal. Native upland trees within the olive grid should be removed to prevent overcrowding. Olive trees can live for more than 500 years.

Olive Evaluation: *Contributing*

The 120+ living olive trees on Mt. Wanda are contributing trees, as they date to the period of significance in this location. The Mt. Wanda olive orchard is one of the oldest and largest olive orchards in the national park system.

Apricot Trees Above Strain Ranch

Apricot – Condition Assessment

Three living and approximately 16 dead apricot trees are located on the slope of Mt. Wanda above the Strain Ranch. Two of the living trees are in fair condition (66%), and one is in severely poor condition, and will die within the next couple of years. Some of the dead trees are still standing, but most have fallen and are lying in place on the grassy slope. The living and dead apricot trees have trunks sized 12 to 18” in diameter at the base, indicating

the trees date prior to World War II, and possibly to the 1920s. It is likely these trees are replacements of fruit trees planted on the Mt. Wanda slopes by Strentzel or Muir, and are associated with the operations of the Strain Ranch. It is assumed that these trees are a commercial variety common in the area before World War II, such as Moorpark, Blenheim or Tilton. The scion would have been grafted to seedling apricot rootstock, giving rise to a full size, standard tree.

The form of the trees is generally "low headed," with trunks shorter than 30 inches, an open bowl pruning style and wide ascending branch crotches. These trees have a relatively poor scaffold form, and appear to have not received much scaffold training in their early years. This suggests that these trees were part of a very large planting historically, and/or that the fruits were grown primarily for drying, rather than for the fresh market. The three living apricot trees have moderate to severe die-back of the canopy, and have lost scaffold limbs, leaving only one or two remaining trunks. A browse line is evident five to six feet from the ground. The trees have sun-scald, are water-stressed, and are in moderate to severe decline. Germplasm should be removed from these trees for genetic conservation before the remaining three trees die.

Apricot Evaluation: *Non Contributing, Compatible*

The three living apricot trees on Mt. Wanda above the Strain Ranch are non-contributing, i.e., non-historic trees, as they do not date to the period of significance. The apricot trees are compatible, however, as they are consistent with the historic character of apricot trees in the significant period. The variety, form, spacing and location of these trees are consistent with apricot trees in the significant period.

Walnut Trees Near Franklin Canyon Way/ BNSF Railroad

Mixed English and Black Walnut – Condition Assessment

Six walnut trees are located in the Mt. Wanda unit near the Maintenance Facility on Franklin Canyon Way and just below the Burlington Northern Santa Fe Railroad. These trees are located beside a drainage ditch that appears to be the terminus of a natural drainage swale. A higher water table in this area has benefited these trees that appear to have received little attention since their initial grafting. Of the six trees, five are English walnut, *Juglans regia* and one is a California Black or Hines walnut, *Juglans hindsii.* Three of the English walnut trees are located in a line, suggesting a formal geometry to the planting historically, and that these tree may be the remains of a larger walnut orchard in this area. The trunks are generally sized between 32 and 36" in diameter, suggesting the trees date prior to World War II, and probably to the 1930s.

Black and English walnut are moderate to fast-growing trees, and could easily attain 32" in diameter in 75 years, in the presence of ground water. The spacing of the trees is extremely tight, at 10 to 15 feet apart, rather than 40 feet, indicating that these trees were not grown for commercial production. These English walnut trees are grafted to California Black walnut rootstocks, giving rise to a full size, standard tree. The variety of the English walnut scions is unknown. The presence of both English walnut and Black walnut trees is probably to promote cross-pollination. The trees are in fair condition (100%).

The five English walnut trees have an unusual form with graft unions located very high on their trunks, generally four to six feet high and in one case, approximately eight feet above the ground. Most graft unions on fruit and nut trees before World War II were located within several inches from the ground. In the case of these English walnut trees, it means the scions would have been grafted onto relatively tall Black walnut trees that were probably growing in this location, rather than brought in from a nursery as grafted stock. The reason for the exceptionally high graft unions is unknown, but may relate to the opportunistic use of Black walnut trees for rootstock that were already growing here, or the desire to elevate the graft union above wet soil conditions to avoid diseases such as Black Line virus. Another reason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Sources
Base information from John Muir NHS Geographic Information System, January 2002; and historic and contemporary maps and photographs.
Notes
Locations and scale of features are approximate. Plan drawn using Arcview GIS 3.2 and Adobe Illustrator 10.0 by OCLP, NPS. Field checked May 2003.
Approximate scale in feet
0 50 100 150 200
Legend
Contour
Park Property Line
Paved Road, Gravel Road, Trail
Building / Structure
Water
Mass Vegetation
Tour Sign, Other Sign
Bench
Single-Family Residences
Alhambra Avenue
Alhambra Valley Road
Strentzel Lane
Strain Ranch
Single-Family Residences
Park 'n' ride lot
BNSF trestle
Alhambra Avenue
Main fire road
State Route 4
Cal. Riding and Hiking Trail and Tunnel
(Access to House Unit)
Franklin Canyon Way
BNSF tracks
Open lands
Open lands

may be the desire to elevate the precious English walnut fruits above the browse-height of deer and other grazing animals. Whatever the reason, the trees present a strange form, with stout California Black walnut trunks giving way to silver-gray English walnut trunks at four to six feet from the ground.

The six walnut trees have an open-bowl form, with acutely ascending branch crotches, due to the tight spacing of the trees. Beyond the formation of the high-headed, open-bowl scaffold historically, these trees received little pruning, with the majority of scaffold limbs being allowed to soar to 15 to 20 feet in length. Overall tree height is 30 to 35 feet. Despite their lack of attention, the trees are in relatively good condition, with some die-back of the canopies and limb death due to overcrowding and over-shading by reforesting native tree species. The tight spacing and unkempt form of the trees may suggest the trees were grown as a nursery, to supply stock for orchard plantings elsewhere.

Mixed Walnut Evaluation: *Non Contributing, Incompatible*

The six living walnut trees near the Maintenance Facility on Franklin Canyon Road are non-contributing, i.e., non-historic trees, as they do not date to the period of significance. The walnut trees are incompatible, as they are inconsistent with the historic character of walnut orchards in the significant period. The strange form of these trees with their high graft unions and tight spacing at 10 feet apart is inconsistent with horticultural practices used by Muir or Strentzel. However, these are 75 year-old trees, and are associated with the subsequent use of the land after Muir's time. While these trees do not contribute to the significance and integrity of the John Muir NHS cultural landscape, they have old germplasm which may be used as a source of replacement stock for walnut trees in the NHS cultural landscape.

SUMMARY OF HISTORIC AND NON-HISTORIC CHARACTER

The following table provides a summary of the contributing (historic) or non-contributing (non-historic) status of the park's existing fruit trees, described in the preceding narrative. Refer to the text above for explanation of status.

Summary Table of Contributing (Historic) and Non-Contributing (Non-Historic) Status of Existing Fruit Trees

Landscape Character Area	Orchard	Fruit Trees	Historic Status: Contributing/ Non-contributing	Non-contributing: Compatible/ Incompatible
House Unit Agriculture Area (AG)	East Orchard	Apple	Non-contributing	Incompatible
	North Orchard	Peach	Non-contributing	Incompatible
		Cherry	Non-contributing	Incompatible
		Almond	Non-contributing	Incompatible
		White Mulberry	Non-contributing	Incompatible
	Fish Pond	Apricot	Non-contributing	Incompatible
		Pear	Non-contributing	Incompatible
		Quince	Contributing	N/A
	Middle Orchard	Plum	Non-contributing	Incompatible
		Grape	Non-contributing	Compatible
	West Orchard	Pear	Non-contributing	Incompatible
		Apricot	Non-contributing	Compatible
		Orange	Non-contributing	Incompatible
		Lemon	Non-contributing	Incompatible
		Pecan	Contributing	N/A
		English Walnut	Non-contributing	Incompatible
		Black Walnut	Non-contributing	Incompatible
		Fig	Non-contributing	Compatible
Gravesite Unit Area (GR)	Pear Orchard	Pear	Contributing	N/A
Mt. Wanda Unit Area (WA)	Olive Orchard	Olive	Contributing	N/A
	Apricot/Strain Ranch	Apricot	Non-contributing	Compatible
	Walnut/BNSF Railroad	Walnut	Non-contributing	Incompatible

EXISTING CONDITIONS

HISTORIC FRUIT TREES

EXAMPLES OF CONTRIBUTING FRUIT TREES

Figure x: Contemporary photo showing historic quince trees in the House Unit Agricultural Area *(PWR, 2005)*.

Figure x: Contemporary photo showing historic pear trees at the Gravesite Unit *(PWR 2005)*.

Figure x: Contemporary photo showing historic olive trees at the Mt. Wanda Unit *(PWR 2005)*.

EXISTING CONDITIONS

NON-HISTORIC FRUIT TREES

EXAMPLES OF INCOMPATIBLE, NON-CONTRIBUTING FRUIT TREES

Figure x: Contemporary photo showing incompatible non-contributing pear trees in the House Unit Agricultural Area, with high heads (tall trunks) and acutely ascending branches (limbed up canopies) *(PWR, 2005).*

Figure x: Contemporary photo showing incompatible, non-contributing European plum trees in the House Unit Agricultural Area with high heads and limbed up and acutely ascending branches *PWR, 2005)*

SUMMARY OF ORCHARD HEALTH PROBLEMS

The following table provides a summary of the predominant health problems in each orchard, including pests, diseases and environmental issues. It also indicates the principal health stressors that weaken the orchard's natural resistance and increase susceptibility to health problems. This information summarizes the preceding existing conditions narrative.

Summary Table of Orchard Health Problems and Stressors

Landscape Character Area	Orchard	Fruit Trees	Predominant Health Problems	Principal Health Stressors
House Unit Agriculture Area (AG)	East Orchard	Apple	Apple Aphid Codling Moth San Jose Scale	Sun scald Short-lived - dwarfing rootstock Lack of water
	North Orchard	Peach	Peach Leaf Curl Brown Rot Chlorosis	Sun scald Short-lived - dwarfing rootstock Nitrogen deficiency Lack of water
		Cherry	Aphid Cytospora Canker Bacterial Canker	Sun Scald Lack of water
		Almond	Pacific Flathead Borer Mites Bacterial Canker	Poor drainage
		White Mulberry	Chlorosis Defoliation	Over-crowding Over-shading
	Fish Pond	Apricot	Fireblight Cytosporina Brown Rot	Sun scald Over-shading Lack of water
		Pear	Aphid Fireblight	Sun scald Over-shading Lack of water
		Quince	Codling Moth	Over-crowding in crown Over-shading

	Middle Orchard	Plum	Plum Aphid San Jose Scale Plum Curculio	Sun scald Short-lived - dwarfing rootstock Lack of water
		Grape	Powdery mildew Pierce's Disease (Blue-Green Sharpshooter)	Over-shading Lack of water
	West Orchard	Pear	Aphid Fireblight Powdery Mildew Pear Scab	Sun scald Over-crowding
		Apricot	Brown Rot	Over-shading
		Orange	Chlorosis Phytophthora	Short-lived - dwarfing rootstock Iron or zinc deficiency Cold winter temperatures
		Lemon	Chlorosis	Short-lived - dwarfing rootstock Iron or zinc deficiency Cold winter temperatures
		Pecan	None identified	None identified
		English Walnut	Black Line Virus Walnut Blight	Over-crowding
		Black Walnut	None identified	None identified
		Fig	Die-back	Gophers Over-crowding
Gravesite Unit Area (GR)	Pear Orchard	Pear	Powdery Mildew Pear Scab Die-back	Old age Mower damage Over-shading Over-crowding Root suckering
Mt. Wanda Unit Area (WA)	Olive Orchard	Olive	Lower Canopy Die-back Olive Fruit Fly unconfirmed	Over-shading Over-crowding
	Apricot/Strain Ranch	Apricot	Severe Canopy Die-back	Old age Sun scald Lack of water
	Walnut/BNSF Railroad	Walnut	Canopy Die-back	Over-crowding Over-shading

EXISTING CONDITIONS

STRESSORS

EXAMPLES OF CURRENT HEALTH STRESSORS ON FRUIT TREES

SUN SCALD

Figure x: Contemporary photo showing sun scald on the trunk of a European plum tree in the House Unit Agricultural Area. Sun scald is caused through inadequate shading of the tree trunk due to inappropriate pruning style – which has lifted tree canopy *(PWR, 2005)*.

OVERCROWDING

Figure x: Contemporary photo showing the problem of overcrowding in fig trees in the House Unit Agricultural Area. Overcrowding is a health stressor, causing over-competition between trees for resources and poor health status *(PWR, 2005)*.

LACK OF WATER

Figure x: Contemporary photo showing the problem of lack of water in fruit trees in the House Unit Agricultural Area. An inefficient irrigation system currently does not allow for adequate irrigation, leading to severe stress *(PWR, 2005)*.

HEALTH STRESSORS

In general, the condition of the John Muir NHS cultural landscape fruit trees ranges from fair to poor. Regardless of age, most trees have pests, diseases or environmental problems, which in many cases are beyond the threshold of the trees' abilities to endure. Fruit trees can tolerate some pest and disease predation and infection, and some sub-optimal environmental conditions up to a point of threshold. However, in the presence of health stressors over sustained periods, the threshold point is lowered, weakening resistance and causing the tree to succumb to infestation and die. The table above indicates that almost all of the John Muir NHS fruit trees are suffering from health stressors in addition to pests and diseases. In the absence of stressors, each tree could potentially endure some predation or infection. In most cases, however, the condition of the trees is being adversely affected by the intensity of the underlying stressors.

It is very difficult, if not impossible, to treat pests and diseases without addressing the underlying health stressors. Health stressors create an adverse cultural environment, and challenge the tree's physiological processes dealing with growth, reproduction and fruit development. As can be seen in the table above, some common health stressors occur throughout the John Muir NHS orchards. These stressors and their underlying causes will be discussed below. Some of these stressors cannot be addressed in the short-term, as they are inextricably related to factors that cannot be quickly altered or reversed, such as pruned scaffold or park operations. However, over the long-term, each health stressor must be addressed and managed in order to implement the *John Muir NHS Cultural Landscape Report Treatment Plan*. Successful implementation of the CLR treatment plan is contingent amount minimizing these health stressors and therefore establishing an appropriate cultural environment for new fruit trees.

Sun Scald

Sun Scald is a common health stressor among the younger fruit trees of the House Unit Agricultural Area, and is one of the fundamental causes of pest and disease problems. Sun scald is a serious condition caused by direct contact of sunlight on tree bark, typically with the unprotected tree trunk. Exposure to sunlight for just a few days in duration will cause young, thin bark to excessively dry out and split, and then peel away and girdle the conductive tissues beneath the bark. Evidence of sun scald is seen in scars on the south and west sides of damaged trunks. The effect on the tree is stunted growth, die-back of the canopy and even death, when ringing or girdling of the entire circumference of the conductive tissue occurs. However, more often the stress caused by sun scald leaves trees less resistant and therefore more vulnerable to a secondary level of attack by pest and disease predation and infection.

Sun scald is a particularly common problem throughout the younger trees of the House Unit Agricultural Area, as the scaffolds of these trees have been headed-high and limbed up, i.e., the trees have been pruned with a tall trunk and steeply ascending branches. This historically inaccurate pruning style exposes each tall trunk to the sun's rays, as the high canopy provides little shading. Historically, Strentzel and Muir's fruit trees were low-headed with short trunks, to induce the trees to bear younger, to ease cultural operations, and to shade each tree trunk from the damaging effects of the sun. In addition, young tree trunks were white-washed with dilute latex paint to provide a layer of sun protection. Sun protection is generally absent from the younger trees of the House Unit, and sun scald has clearly damaged many tree trunks. Unfortunately, the younger trees are now too old to have their scaffolds modified in order to lower their canopies and shade their trunks. White wash can be applied at the end of wet weather, but the existing scald damage cannot be reversed. It is critical therefore that new trees planted during the implementation of the CLR Treatment Plan have historically accurate scaffolds and receive white wash when young. This is addressed in the Calendar of Work chapter.

Short Life Span/Dwarfing Rootstock

Many younger fruit trees of the House Unit Agricultural Area are in decline due to shortness of natural life span. These trees have stopped making net growth and have entered a mortality spiral, which through a process of decline, will ultimately lead to death. The short life span is induced by the presence of a dwarfing rootstock. Trees grafted to semi-standard, semi-dwarf or dwarf rootstocks have a more compressed life cycle than full size or standard trees on seedling rootstocks used historically.

A dwarfing rootstock is less vigorous than a seedling rootstock and retards the vegetative development of the scion or aerial part of the tree. This induces earlier sexual reproduction, causing the dwarf tree to flower and fruit in its second to fifth year rather than the tenth to twelfth year, as with full size trees. Earlier reproduction also means earlier death, leading to an average 30-year life span rather than an 80 to 150-year life span of full-size, standard trees. After entering the mortality spiral the tree becomes susceptible to the attack of pests and diseases that are generally the cause of death. The stressor of a short natural life span is irreversible and can only be addressed by avoiding historically inaccurate, dwarfing rootstocks. New trees planted through the implementation of the CLR Treatment Plan should be grafted onto historically accurate, seedling rootstocks, creating full size trees with long natural life spans.

Over-Crowding

Over-crowding of fruit trees is a common health stressor in the younger fruit trees of the House Unit Agricultural Area, where it is caused by too tight spacing of trees. However, overcrowding is also stressing the historic pear trees at the Gravesite Unit Area and the historic olives of the Mt. Wanda Unit Area, due to in-fill of the orchard grid by colonizing native tree species. Over-crowded fruit trees are forced to be more competitive with each other for light, water and nutrients. This can lead to unequal or unbalanced growth of the tree canopy, leaning of the tree trunk, or die back in parts of the

canopy. More seriously, the stress of over-crowding can lower a tree's resistance to pest and disease attack.

Generally, the fruit trees in the orchards of the House Unit Agricultural Area are planted too close to each other, with historically inaccurate, tight spacing in the grid. Historically, full size trees were planted with wide spacing, on average 30 feet apart for apple and pear trees, 40 feet for nut trees and 20 feet for plum and apricot, to provide adequate room for full development. In principle, over-crowding is relieved by selectively removing alternate trees. In practice, however, many of the trees in the House Unit are now insidiously affected by pest and disease problems, and would be unlikely to recover in the absence of over-crowding. The over-crowded historic pear trees at the Gravesite and the historic olives on Mt. Wanda however, should be relieved by the removal of in-filling native tree species. Removal of oak and other species that interrupt the spaces in the orchard grid will help perpetuate the longevity of trees.

Over-Shading

Over-shading is a health stressor similar to over-crowding. This is caused by taller canopies in the vicinity of the orchard casting shadows over fruit tree canopies for sustained periods each day. Like over-crowded fruit trees, over-shaded trees become misshapen with asymmetrical canopies and leaning trunks. They produce very little fruit. Over-shaded trees are usually associated with windbreaks or buffer plantings allowed to become too tall beside orchards, or with orchards planted too close to windbreaks or buffers.

At John Muir NHS, over-shading at the House Unit is predominantly caused by the tall native riparian vegetation along Franklin Creek, or by the tall buffer plantings of Redwood around the perimeter. The deep shade cast by the riparian trees and the perimeter Redwoods is stressing the health of the fruit trees in their vicinity. The stress of over-shading has lowered these trees resistance to pest and disease attack. In principle, over-shading is relieved by selectively removing, limbing-up or thinning tall canopies in the

vicinity of the orchard, and shade removal may benefit some fruit trees here. In practice, however, many of the trees in the House Unit are now insidiously affected by pest and disease problems, and would be unlikely to recover in the absence of over-shading. Full light exposure of canopies is a fundamental cultural requirement of healthy fruit trees. The conditions leading to over-shading need to be eliminated or managed in order to successfully implement the CLR Treatment Plan, when new trees are planted.

Lack of Water

Lack of water is a common stressor in areas of the House Unit where the water table is lower. This is seen particularly on the slopes of the East and North Orchards, but also in the Middle Orchard. The West Orchard appears to be served with a higher water table, and less water stress is evident here. In drought conditions, tree root hairs die, compromising a tree's ability to take up nutrients and water. In addition, the park's clay soil has a heavy, compactable texture that is easily waterlogged but difficult to re-hydrate after drying. Historically, the water table of the Alhambra Valley was higher, due to the free-flowing nature of streams and creeks, and the lack of impermeable surfaces and storm sewer systems on the valley floor. Strentzel and Muir probably used the Fish Pond to divert water from Franklin Creek to flood irrigate the orchards when necessary. Today, the cultural landscape is droughted by a drier climate, channelization of creeks, and impermeable surface development of the valley floor. Adequate irrigation is needed for the establishment and maintenance of all young fruit trees in the park's orchards.

At the House Unit, supplemental water is supplied through irrigation by overhead sprinklers. However, the duration and frequency of irrigation is insufficient to prevent the drying out of the soil. The unit's irrigation system is limited by inadequate coverage of sprinklers and inefficient timing and method of application. The system is inefficient because irrigation delivered by overhead sprinklers during the heat of the day is lost to evaporation. The

large water droplets delivered by overhead sprinklers cause damage by panning or compacting the clay soil and by spraying directly at tree trunks. The stress caused by lack of water has contributed to the pest and disease problems through the House Unit orchards. The irrigation system within the unit is inadequate to support the orchards. Successful implementation of the CLR Treatment Plan will require installation of an efficient irrigation system that is designed to serve the quantity, density and species of fruit trees in the House Unit, along with the soil type.

PESTS AND DISEASES

Numerous pests and diseases are found throughout the park's orchards, causing severe health problems. These pests or diseases are not unusual however, but are common in orchards and are likely found throughout the Alhambra Valley and Contra Costa County. In organically managed orchards, pests and diseases are kept in check through the creation of a healthy cultural environment that minimizes health stressors. Significant health stressors identified in the section above are the underlying cause of the pest and disease problems in the park's orchards. Many of these problems are too insidious to correct in the existing trees, as they have exceeded thresholds manageable through Integrated Pest Management (IPM). New trees planted through the implementation of the CLR Treatment Plan must be managed to prevent the development of health stressors, and therefore resist the infestation of pests and diseases. A discussion of pest and disease management goals is provided in the Management chapter and IPM practices for pests and diseases are included in the Calendar of Work.

EXISTING CONDITIONS

MANAGEMENT ISSUES

PROBLEMATIC USE OF TRACTOR FOR MOWING

Figure x: Contemporary photo showing mowing of the House Unit Agricultural Area using a tractor, which has led to the high-heading (tall trunk form) of fruit trees and limbing up- resulting in a non-historic tree form, and lack of sun protection for tree trunks *(PWR, 2005)*

APPROPRIATE USE OF RIDER MOWER

Figure x: Contemporary photo showing the appropriate use of a rider mower to maintain the ground cover in the House Unit Agricultural Area. This piece of equipment is appropriately scaled for maneuver between fruit trees and vines, without high-heading/limbing up trees *(PWR, 2005)*.

LACK OF MULCHING AROUND TREES

Figure x: Contemporary photo showing the problem in not mulching around tree bases – leading to the laborious practice of week whacking. Mulching avoids need for weed whacking and nourishes trees *(PWR, 2005)*.

ORCHARD TREATMENT

MANAGEMENT OBJECTIVES

LONG TERM PLANNING OBJECTIVES

The management objectives for the John Muir NHS orchards are derived from the park's General Management Plan and Environmental Assessment (GMP/EA), updated in 1991 and the Cultural Landscape Report (CLR), completed in 2005. These long term planning documents define the objectives for the park and the cultural landscape that integrate the significance and integrity of the park's resources, the existing conditions, the interpretive goals and visitor use and experience.

The GMP/EA outlines the following management objectives for the park's cultural landscape and orchards:

- *All existing historic plantings will be retained (those prior to 1915);*

- *Representative orchards and vineyards will be maintained, and special protection should be given to trees planted by Muir or Strentzel; and*

- *The grounds will aid in re-creating the historic scene and will speak indirectly of Muir's involvement in commercial orchards and vineyards as well as his interest in native plants.*

The CLR provides the following general objective for the park's cultural landscape:

- *The park should be managed to improve the condition of landscape features and historic character so that the site's rich history can be interpreted and understood.*

Consistent with the GMP and CLR, this Orchard Management Plan identifies these additional management objectives for the park's orchards:

- *The orchards should be managed to more accurately depict the characteristics of John Muir's orchards during the period of significance, so that the National Historic Landmark property and the cultural landscape in general have greater authenticity and integrity.*

- *The orchards should be managed for overall landscape character, rather than high fruit yields and/or quality fruit production. Fruit production is desirable for interpretation, but should not attempt to meet contemporary standards for edible consumption.*

CLR TREATMENT GUIDELINES FOR PARK ORCHARDS

The CLR identifies "rehabilitation" as the primary treatment for the park's cultural landscape. Rehabilitation is the only one of four preservation treatments defined by the *Secretary of the Interior's Standards* that makes possible compatible alterations or additions for contemporary needs. Specifically, rehabilitation recommends some changes to a cultural landscape to allow for contemporary uses while retaining the landscape's historic character. A cultural landscapes characteristics and historic features are protected and maintained as they are in the treatment "preservation," but due to a greater amount of deterioration of historic features or number of missing or non-contributing features, repair and replacement is required. The standards allow for the replacement of deteriorated, missing or incompatible features with traditional or compatible substitute materials.

Rehabilitation consists of the following spectrum of activities: *retain and preserve historic features and materials; protect, maintain and repair historic features and materials; replace deteriorated and missing historic features, and potential compatible alterations and additions for contemporary use*.

The CLR provides the following rehabilitation guidelines for the park's orchards:

Retain and preserve historic features and materials:

Retain and preserve orchard land uses, historic orchard spaces, and contributing orchards and fruit trees.

Protect and maintain historic features:

Protect contributing orchards and fruit trees from health stressors and deterioration, maintain by cyclic actions designed to perpetuate historically accurate or compatible tree species, varieties, tree type, tree form and spacing.

Repair historic features:

Repair through non-destructive means, with the least degree of intervention possible. If necessary, replace contributing orchards and/or fruit trees in-kind, with the same genetic stock or same species and variety, tree type, tree form and spacing.

Replace deteriorated historic features:

Replace in-kind contributing orchards and/or fruit trees that have deteriorated beyond repair (beyond point of rejuvenation) with the same genetic stock or same species and variety, tree type, tree form and spacing.

Replace missing and incompatible features:

Replace missing or incompatible fruit trees when the historic identity of the fruit tree is known, and replace with historically accurate tree species, variety, tree type, form and spacing.

CLR GENERAL TREATMENT RECOMMENDATIONS FOR ORCHARDS

The following general recommendations for the park's orchards are outlined in the CLR treatment plan.

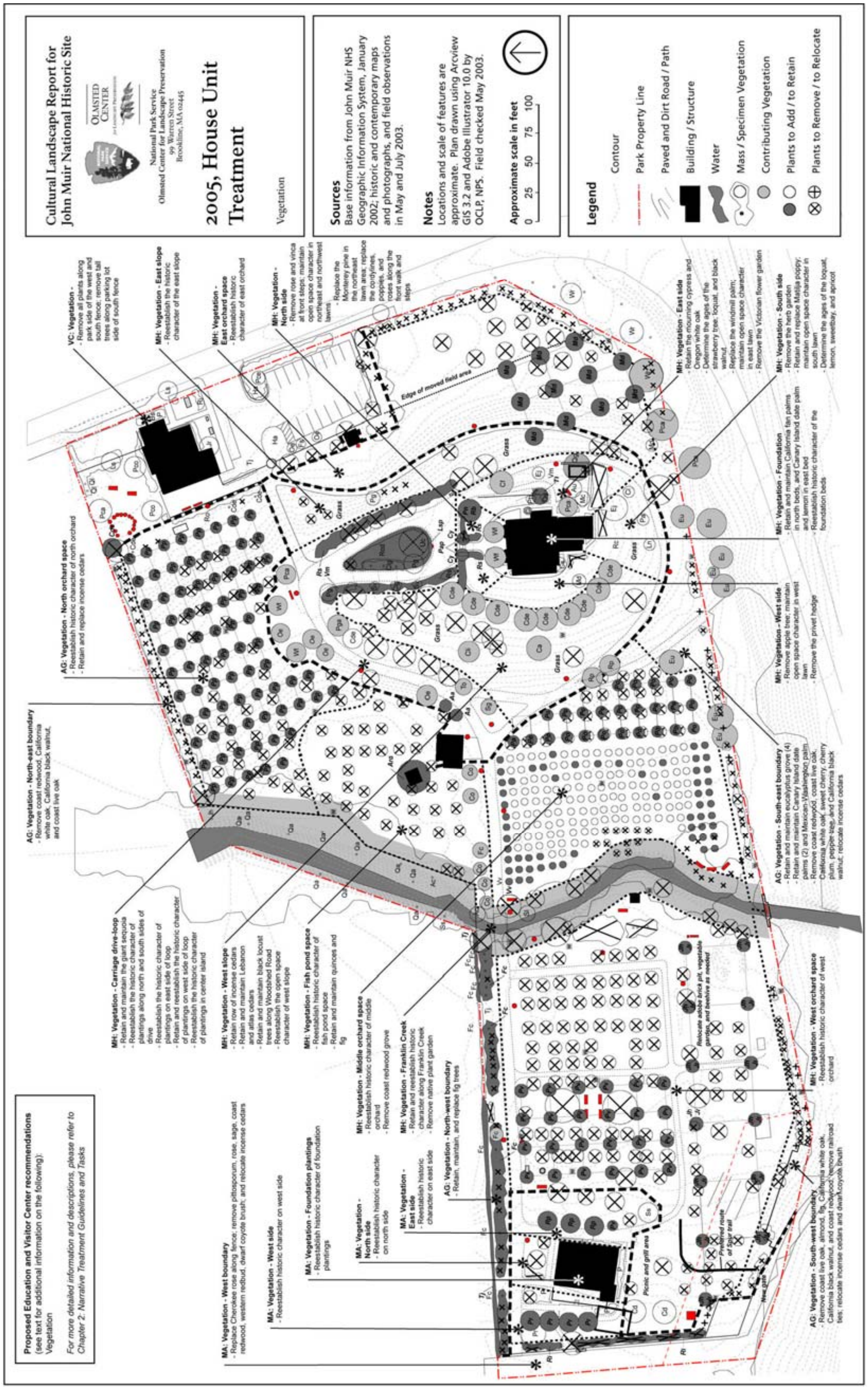
- *The highest treatment priority for the park cultural landscape is to ensure that all historic plant materials are stabilized and strategies are in place for their replacement, should loss occur.*

- *Replacements of all contributing fruit trees should be available when the original trees die or are in hazardous condition. Propagation is needed for the historic orchard trees. Orchard trees should be grafted onto the appropriate rootstock. The germplasm of historic orchard trees can also be conserved at repositories as living collections or by cryogenic conservation (tissue incubated in sub-zero conditions).*

- *Wherever feasible, non-historic vegetation should be removed if it conflicts with the re-establishment of historic character.*

- *Orchard cover crops should be considered to reestablish historic character.*

- *In keeping with late nineteenth and early twentieth-century orcharding practices, the number of varieties in the orchards should be few in number. Trees should be low-headed and the trees should be trained in either an open bowl (vase)or central leader (pyramidal) style. Trees should be full size rather than semi standard, semi-dwarf or dwarf.*


Cultural Landscape Report for
John Muir National Historic Site
National Park Service
Olmsted Center for Landscape Preservation
99 Warren Street
Brookline, MA 02445
2005, House Unit
Treatment
Vegetation
Sources
Base information from John Muir NHS Geographic Information System, January 2002; historic and contemporary maps and photographs, and field observations in May and July 2003.
Notes
Locations and scale of features are approximate. Plan drawn using Arcview GIS 3.2 and Adobe Illustrator 10.0 by OCLP, NPS. Field checked May 2003.
Approximate scale in feet
0 25 50 75 100
Legend
Contour
Park Property Line
Paved and Dirt Road / Path
Building / Structure
Water
Mass / Specimen Vegetation
Contributing Vegetation
Plants to Add / to Retain
Plants to Remove / to Relocate
Proposed Education and Visitor Center recommendations
Grass
Edge of mowed field area

CLR TREATMENT PLAN BY PARK UNIT AND CHARACTER AREA

The Rehabilitation Treatment Plan provided by the John Muir NHS Cultural Landscape Report is organized by park units and cultural landscape character areas. This Orchard Management Plan uses the same nomenclature system to identify park orchards and their associated treatment tasks. The nomenclature system is outlined at the beginning of the Existing Conditions chapter. The following text provides a summary of treatment tasks prescribed by the CLR for each orchard (refer to the treatment plan graphics for illustration).

AGRICULTURAL AREA, HOUSE UNIT

At the end of the period of significance, distinctive blocks of fruit trees and grape vines covered the fertile flatlands and lower slopes of the Alhambra Valley like a patchwork quilt. The orchards and vineyards were typically laid out in single-variety blocks of one species of fruit. Each block had neat rows with its own spacing. The agricultural area around the Muir House and Martinez Adobe was no exception, and featured row upon row of cherries, apricots, lemons, oranges, plums, peaches, apples, pears, walnuts and pecans. Orchard blocks filled every available space, pushing up against the edges of Franklin Creek, the fish pond space, the farm roads and lanes. The following treatment tasks aim to recover the historic character of the Agricultural Area.

East Orchard (CLR ref "AG VEGETATION – EAST ORCHARD SPACE")

Re-establish the historic character of the East Orchard.

The apple trees that comprise the East Orchard are non-contributing and incompatible with the cultural landscape (see "Existing Conditions" chapter for more details). Historic photographs show that the flat field area of the East Orchard was planted in hay or other grain crops, while apples were planted on the house knoll's east slope.

- Remove all of the existing apple trees, and seed the area with a cover crop to restore the historic open character of this former silage field.

- Plant historically accurate apple trees on the east slope of the house knoll, as indicated on the CLR Treatment Plan, at 30 x 30 feet spacing, and stake the trees for the first two years after planting.

- Use apple varieties known to be grown by Muir: 'Alexander,' 'Gravenstein,' 'Jonathan,' and 'Yellow Newtown Pippin.' The varieties (scions) should be grafted to apple seedling rootstocks, with a low graft union (located within a couple of inches from the ground after planting).

- Low-head the tree trunks by cutting off the main stem or whip less than 30" from the ground in the first year. Prune the head into an open-bowl form, with three to five scaffold branches in the second year.

- Create a minimum 8-foot diameter mulched circle at the base of each new apple tree after planting. Use composted, nutritional mulch.

- Remove the existing Vinca ground cover in this area. Seed a cover- crop of perennial rye grass under the new apple trees (outside of the mulched areas).

- Provide a minimum of 1" depth of water per week for each new apple tree during the dry seasons.

North Orchard (CLR ref "AG VEGETATION – NORTH ORCHARD SPACE")

Re-establish the historic character of the North Orchard.

The fruit trees that comprise the North Orchard are non-contributing and incompatible with the cultural landscape (see "Existing Conditions" chapter

for more details). According to photographs from c.1887 to c.1905, peaches and apples were planted in this space. The trees were arranged in a grid that was oriented off the Muir Homestead's northeast fenceline, which is a now a boundary line of the park. The cherry, white mulberry, almond and carob have no historic precedent in the area.

- Remove all of the existing fruit trees, including the peach, cherry, carob, almond, white mulberry and apricot and replace with all peach trees, as indicated in the CLR Treatment Plan.

- Plant historically accurate peach trees throughout the North Orchard, at 15 x 20 feet spacing and stake the trees for the first two years after planting.

- Use peach varieties known to be grown by Muir: 'Crawford' and 'Elberta.' The varieties (scions) should be grafted to peach seedling rootstocks, with a low graft union (located within a couple of inches from the ground after planting).

- Low-head the tree trunks by cutting off the main stem or whip less than 30" from the ground in the first year. Prune the head into an open-bowl form, with three to five scaffold branches in the second year.

- Create a minimum 8-foot diameter mulched circle at the base of each new peach tree. Use composted, nutritional mulch.

- Seed a cover-crop of perennial rye grass under the new peach trees (outside of the mulched areas).

- Allow for maintenance access by leaving a minimum ten-foot wide space unplanted along the north and west sides of the orchard, parallel to the boundary fences.

- To avoid damaging new peach trees on the east end, the park may wish to postpone replanting the peach orchard until the proposed Education and Visitor Center is constructed.

- Provide a minimum of 1" depth of water per week for each new peach tree during the dry seasons.

Fish Pond (CLR ref "AG VEGETATION – FISH POND SPACE")

Re-establish the historic character of the Fish Pond.

The fruit trees in the Fish Pond space are non-contributing and incompatible with the cultural landscape (see "Existing Conditions" chapter for more details). Historic photographs show the fish pond as a low-lying, open area, which functioned as a dry pond that occasionally filled with water after heavy rains. The Franklin Creek Windmill and Well was located in the center of the space. No fruit trees were present in the area.

- The existing pear, apricot and almond trees in the Fish Pond space should be removed, to re-establish the open character of the space.

- Prepare the soil as a seed bed and sow a native short grass, such as the short grasses along Franklin Creek, to cover the floor of the Fish Pond space. The bowl-shaped earthform of the fish pond should be revealed.

- Retain the historic quince trees at the south end of the Fish Pond space, lining the main farm road. Preserve the trees through cyclic preservation maintenance.

Middle Orchard (CLR ref "AG VEGETATION – MIDDLE ORCHARD")

Re-establish the historic character of the Middle Orchard.

The grapevines and plum trees that comprise the Middle Orchard are not historically significant, as they do not date to the period of significance. The plum trees are incompatible with the cultural landscape but the grapevines however, are compatible (see "Existing Conditions" chapter for more details). Historic photographs indicate that grapevines and plum trees were planted in this location by the 1890s, with grapes filling the western two-thirds up to the edge of the main farm road and Franklin Creek, and plums filling the eastern one-third. The existing layout of two-thirds grapevines and one-third plum trees should be retained to re-establish the historic condition.

- Remove all of the existing plum trees in the Middle Orchard, as these are severely deteriorated, and replace with historically accurate plum trees, as indicated on the Treatment Plan.

- Plant historically accurate plum trees at the east end of the Middle Orchard, at 15 x 20 feet spacing and stake the trees for the first two years after planting.

- Use plum varieties known to be grown by Muir: for European plum (prune) use 'Coes Golden Drop,' 'Coxe's,' 'Crawford,' 'Stump' and 'York.' For Japanese plum use 'Santa Rosa' and 'Satsuma.' The varieties (scions) should be grafted to plum seedling rootstocks, with a low graft union (located within a couple of inches from the ground after planting).

- Low-head the tree trunks by cutting off the main stem or whip less than 30" from the ground in the first year. Prune the head into an open-bowl form, with three to five scaffold branches in the second year.

- Create a minimum 8-foot diameter mulched circle at the base of each new plum tree. Use composted, nutritional mulch.

- Seed a cover-crop of perennial rye grass under the new plum trees (outside of the mulched areas).

- Allow space for re-establishment of the southeast farm road as indicated in the CLR Treatment Plan. Retain a minimum 10-feet wide access route along the south edge of the Middle Orchard.

- Retain the existing grapevines through cyclic preservation maintenance.

- Replant missing or dead grapevines as indicated on the Treatment Plan with historically accurate grapevines, at 10 x 10 feet spacing. Use varieties grown by Muir, such as the ones being used: 'Zinfandel,' 'Flame Tokay,' 'Golden Muscat' and 'Muscat of Alexandria,' or others: 'Isabelle,' 'Catawba,' 'Malaga' or 'Rosa Peru.' The varieties (scions) should be grafted to grape seedling rootstocks or to Rupestris St. George rootstock, with a low graft union (located within a couple of inches from the ground after planting).

- Plant new grapevines near Franklin Creek as indicated on the Treatment Plan. Minimize damage to vines from high water events by planting vines with their crowns slightly above grade.

- Head prune the grapevines by cutting off the main stem or whip less than 24" from the ground in the first year. Prune the head into an umbrella form, with four to five limbs in a star pattern in the second year. Stake the main trunk for the first two years.

- Retain a minimum 10-feet wide access route along the south and west edge of the Middle Orchard.

- Provide a minimum of 1" depth of water per week for each new plum tree or grapevine during the dry seasons.

West Orchard (CLR ref "AG VEGETATION – WEST ORCHARD")

Re-establish the historic character of the West Orchard.

The apricot, orange, lemon, walnut, and pear trees in the West Orchard are non-contributing and in general, are incompatible with the cultural landscape. The pecan trees date to Muir's time, and contribute to the significance of the cultural landscape (see "Existing Conditions" for more details). Unlike the other orchards of the House Unit, reliable evidence of the layout of the West Orchard is unknown. Therefore, the CLR Treatment Plan calls for the depiction of a typical early 20th-century orchard in this area, and the simplification of the number of species from seven, to four – cherry, Black walnut, English walnut and pear. While there is less evidence that pear was historically grown in this area, the pear was Muir's most important fruit crop, and from an interpretive standpoint, should be present at the House Unit. The West Orchard, more than any other at the House Unit, is a logical place to plant pear trees.

- All of the existing fruit and nut trees in the West Orchard should be removed, as indicated in the CLR Treatment Plan.

- Remove the historic pecan trees, as they are over-scaled for the desired character of the West Orchard. A new orchard cannot be established in the shade cast by the pecan trees, and the pecans block the historic view between the Martinez Adobe and the Muir House. Before removal, the germplasm of the pecan trees should be sent to the USDA National Plant Germplasm Repository in Texas for cryogenic conservation.

- Plant historically typical fruit trees in three main blocks, two blocks in the north section and one in the south section, as indicated on the Treatment Plan. The north section is the area bounded on the north by the north farm road, on the east by Franklin Creek, on the south by the farm lane, and on the west by the driveway that fronts the Martinez

Adobe. On the east half of the north section, plant historically typical pear trees. On the west half of the north section, plant historically typical cherry trees. In the south section, (bounded on the north by the farm lane, on the east by Franklin Creek, on the south by the park boundary, and on the west by the oil valve fence) plant historically typical English and Black walnut trees.

- Plant historically typical pear trees on the east half of the north section of the West Orchard at 30 x 30 feet spacing, and stake the trees for the first two years after planting.

- Use pear varieties known to be grown by Muir: 'Bartlett' and 'Winter Nellis.' The varieties (scions) should be derived as scionwood (dormant shoots) from the historic pear trees at the Gravesite Unit and be grafted to pear seedling rootstocks, with a low graft union (located within a couple of inches from the ground after planting).

- Plant historically typical cherry trees on the west half of the north section of the West Orchard at 25 x 25 feet spacing and stake for the first two years after planting.

- Use cherry varieties known to be grown by Muir: 'Bing,' 'Mayduke' and 'Royal Ann.' The varieties (scions) should be grafted to cherry seedling rootstocks, with a low graft union (located within a couple of inches from the ground after planting).

- Plant historically typical English and Black walnut trees in the south section of the West Orchard at 50 x 50 feet spacing, and stake for the first two years after planting.

- Use the English walnut variety probably grown by Muir: 'Hartley,' or from scionwood (dormant shoots) taken from the old English walnut trees near the BNSF railroad in the Mt. Wanda Unit. The English walnut

variety (scions) should be grafted to Black walnut seedling rootstock, with a low graft union (located within a couple of inches from the ground after planting). The Black walnut trees are of the straight species *Juglans hindsii*, and are therefore ungrafted, grown on their own roots.

- Low-head the tree trunks of all pear, cherry and walnut trees by cutting off the main stem or whip less than 30" from the ground in the first year. Prune the head into an open-bowl form, with three to five scaffold branches in the second year.

- Create a minimum 8-foot diameter mulched circle at the base of each new tree. Use composted, nutritional mulch.

- Seed a cover-crop of perennial rye grass under the new pear, cherry and walnut trees (outside of the mulched areas).

- Provide a minimum of 1" depth of water per week for each new pear, cherry or walnut tree during the dry seasons.

- Retain the existing network of farm lanes for access.

- Retain the fig trees along the north side of the main farm road and gradually increase the spacing to 15 feet apart. This should be done by selective removal of trees, or in-filling gaps by air layering from the existing trees, and new planting within the row, as indicated in the CLR Treatment Plan.

GRAVESITE UNIT (GR)

Pear Orchard (CLR ref "GR VEGETATION")

Re-establish the historic character of the Pear Orchard.

The pear orchard at the Gravesite dates to the time of Muir and Strentzel, and contributes to the significance of the cultural landscape. The trees are in fair to poor condition, and the legibility of the grid of the orchard has diminished through loss of trees and in-fill by non-orchard trees.

- Protect, retain, stabilize and preserve the 18 historic pear trees extant within the pear orchard.

- Stabilize the trees through the following actions:

  Remove dead wood and rootstock suckers from the trees, using a trained arborist;

  Remove non-orchard trees from the orchard grid;

  Aerate the root zone (within the canopy dripline) of each tree using a mechanical aerator or pitchfork;

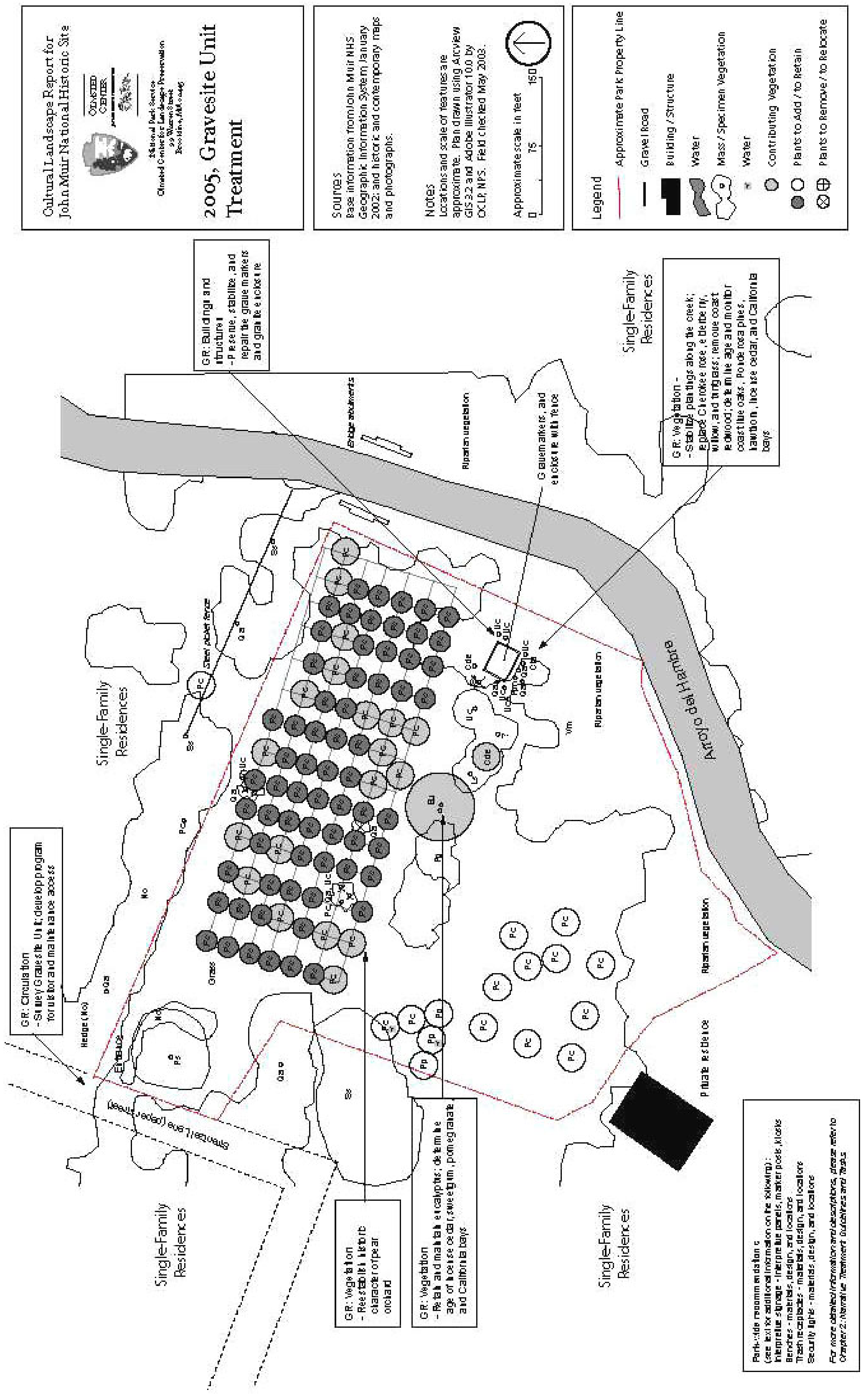
  Create a minimum 8-foot diameter mulched circle at the base of each new tree. Use composted, nutritional mulch;

  Collect and send live shoots from the canopies of the historic pear trees to the National Plant Germplasm Repository in Corvallis, Oregon for conservation.

- Propagate replacement pear trees and extra trees to fill in gaps in the orchard grid, as indicated in the CLR Treatment Plan. Derive scionwood (dormant shoots) for propagation from the historic pear trees. The scions should be grafted onto seedling pear rootstocks with a low graft union (located within a couple of inches from the ground after planting).

- Replace missing trees by planting with newly propagated pear trees at 30 x 20 feet spacing, as indicated in the CLR Treatment Plan. Stake the new trees for the first two years after planting.

- Low-head the new pear tree trunks by cutting off the main stem or whip less than 30” from the ground in the first year. Prune the head into an open-bowl form, with three to five scaffold branches in the second year.


Cultural Landscape Report for
John Muir National Historic Site
National Park Service
Olmsted Center for Landscape Preservation
2005, Gravesite Unit
Treatment
Sources
Base information from John Muir NHS Geographic Information System January 2002; and historic and contemporary maps and photographs.
Notes
Locations and scale of features are approximate. Plan drawn using Arcview GIS 3.2 and Adobe Illustrator 10.0 by OCLP, NPS. Field checked May 2003.
Approximate scale in feet
0
75
150
Legend
Approximate Park Property Line
Gravel Road
Building / Structure
Water
Mass / Specimen Vegetation
Water
Contributing Vegetation
Plants to Add / to Retain
Plants to Remove / to Relocate
Single-Family Residences
Single-Family Residences
Single-Family Residences
Single-Family Residences
Arroyo del Hambre
Riparian vegetation
Private residence
Grass
Entrance
Hedge (Ho)
Steel picket fence
Gravemarkers, and enclosure with fence
GR: Buildings and structures
- Preserve, stabilize, and repair the grave markers and granite enclosure
GR: Vegetation -
- Stabilize plantings along the creek; replace Cherokee rose, elderberry, willow, and turfgrass; remove coast redwood; determine age and monitor coast live oaks, Ponderosa pines, hawthorn, incense cedar, and California bays
GR: Circulation
- Survey Gravesite Unit; develop program for visitor and maintenance access
GR: Vegetation
- Reestablish historic character of pear orchard
GR: Vegetation
- Retain and maintain eucalyptus; determine age of incense cedar, sweetgum, pomegranate, and California bays
Park-wide recommendations
For more detailed information and descriptions, please refer to Chapter 2: Narrative Treatment Guidelines and Tasks

- Create a minimum 8-foot diameter mulched circle at the base of each new tree. Use composted, nutritional mulch.

- Cultivate the orchard floor to receive a seed cover-crop of perennial rye grass (outside of the mulched areas).

- Provide a minimum of 1" depth of water per week for each tree during the dry seasons, using a drip system fed by a water tank (refilled from a truck bladder), or other off-line system, such as manual delivery from a hose fed by a truck bladder, or by individual perforated tree bladders that wrap around the base of each tree

MT. WANDA UNIT (WA)

Olive Orchard (CLR ref "WA VEGETATION")

Preserve the historic character of the Olive Orchard.

- Retain, stabilize and preserve the historic olive orchard through cyclic preservation maintenance;

- Stabilize and maintain the 120+ historic olive trees (with a trunk diameter larger than 24") by removing dead wood and thinning canopies to permit more light to the orchard floor. Use a trained arborist for pruning services;

- Remove non-olive trees that have colonized the orchard;

- Remove young, seedling olive trees on the margins of the orchard or outside of the orchard grid, that are smaller than 24" in diameter;

- Collect and send live shoots from the canopies of the historic olive trees to the National Plant Germplasm Repository at Winters or Davis, California for conservation.

Apricot Trees above Strain Ranch (CLR ref "WA VEGETATION")

Retain and conserve the germplasm of the apricot trees.

The apricot trees on Mt. Wanda do not contribute to the significance of the cultural landscape as they do not date to the significant period. However, the trees are compatible with the type, style and spacing of fruit trees grown by Muir on Mt. Wanda. Historically, the lower slopes of Mt. Wanda were full of fruit orchards, and the park may decide to re-establish apricot orchards in the area, as part of future plans for the Strain Ranch. However, this will require propagation of historically typical trees, watering newly planted trees, and providing browse protection. The GMP and CLR provide no management objectives for the re-establishment of orchards near the Strain Ranch on Mt. Wanda. In lieu of a long-range plan for the Strain Ranch area, the following treatment tasks should be implemented.

- Retain and stabilize the three living apricot trees above the Strain Ranch on Mt. Wanda, by removing dead wood;

- Collect and send live shoots from the canopies of the apricot trees to the National Plant Germplasm Repository at Davis, California for conservation;

- If long-term plans for the Strain Ranch include the re-establishment of apricot trees on the lower slopes of Mt. Wanda, the conserved germplasm should be used to propagate historically typical apricot trees for the area.

Walnut Trees Near Franklin Canyon Way/ BNSF Railroad (CLR ref "WA VEGETATION")

Retain and conserve the germplasm of the walnut trees.

The six living walnut trees near the Maintenance Facility on Franklin Canyon Road are non-contributing, i.e., non-historic trees, as they do not date to the period of significance. The walnut trees are incompatible, as they are inconsistent with the historic character of walnut orchards in the significant period. However, these trees are probably 75 years old, and can provide germplasm for the re-establishment of a walnut planting in the West Orchard of the House Unit.

- Retain and stabilize the six living walnut trees near the BNSF railroad by removing dead wood and by removing over-crowding and over-shading nearby forest trees;

- Collect and send live shoots from the canopies of the English and black walnut trees to the National Plant Germplasm Repository at Davis, California for conservation;

- Use the conserved germplasm or scionwood (dormant shoots) taken from the English walnut trees to propagate historically typical walnut trees for the West Orchard of the House Unit. New Black walnut trees for the West Orchard can be propagated from seed or rooted cuttings, rather than by grafting. Seeds or cuttings may be taken from the BNSF railroad Black walnut.

PHASING OF ORCHARD TREATMENT

The Cultural Landscape Report Treatment Plan calls for a large amount of change to the park's orchards, particularly at the House and Gravesite Units. In essence, the plan calls for preservation of contributing (historic) fruit trees and removal and replacement of non-contributing (non-historic) fruit trees with historically accurate or typical replacements. Implementation of the plan will vastly change the character of the park's cultural landscape, by

increasing the number and stature of the fruit trees, with low-headed, large canopies that tower overhead. The visitor experience will be enriched by the greater historical accuracy and character of the fruit trees, which will appear distinct from contemporary orchard plantings in the region and throughout the nation.

As the CLR Treatment Plan calls for considerable change, a phasing plan is needed. Phasing will reduce the visual impact of tree removal and replacement, will provide for continuity in interpretation and park operations, and will enable the park to be more competitive in competing for funding for discrete projects. Phasing of implementation of the CLR Treatment Plan is based on the following park priorities:

- Acquisition of funding;
- Interaction with other projects, such as construction of a new Visitor Center;
- Installation of an irrigation system for all orchard areas of the House Unit;
- Visitor experience;
- Current state of deterioration of existing orchards;
- Operational issues, such as staffing, equipment, materials and volunteer coordination.

However, the following phasing plan is recommended from a cultural landscape preservation perspective.

PHASE ONE

Implement CLR Treatment Plan for House Unit North Orchard and Fish Pond Space:

Remove all of the fruit trees in the North Orchard and Fish Pond Space; install a subterranean irrigation in the North Orchard; replant the North

Orchard with historically accurate peach trees. Hold off planting the eastern-most row of peach trees until the new Visitor Center is built.

Justification: the North Orchard is the first part of the cultural landscape seen by visitors as they arrive. The North Orchard is currently in poor condition, and presents a degraded appearance to visitors. Implementation of this phase is contingent upon installation of a new irrigation system.

PHASE TWO

Implement CLR Treatment Plan for Gravesite Unit Pear Orchard:

Retain, preserve and replace-in-kind the historic pear trees of the Gravesite Unit; propagate historically accurate new pear trees and fill in the gaps in the grip with new tree plantings; irrigate with off-line system such as a drip system from a water tank, or hand-water with hose and truck bladder.

Justification: the Gravesite pear orchard is one of the oldest pear orchards in the national park system, is directly associated with Muir and Strentzel, and is the historic setting for the Muir family graves. While the Gravesite is currently under-utilized by visitors and under-staffed, the significance of the site demands high prioritization of treatment.

PHASE THREE

Implement CLR Treatment Plan for Mt. Wanda Olive Orchard and Germplasm Conservation for BNSF Railroad Walnut and Strain Ranch Apricot Trees:

Retain, preserve and protect the historic olive orchard on Mt. Wanda, conserve germplasm, remove in-filling native trees, and remove naturalizing olive trees outside the historic orchard grid. Conserve the germplasm of BNSF railroad walnut trees and of the apricot trees above the Strain Ranch.

Justification: the Mt. Wanda olive orchard is one of the oldest and largest historic olive orchards in the national park system, dating to Muir's time. The olive orchard requires minimal maintenance, but the significance of the orchard demands high prioritization of treatment and germplasm conservation. In addition, naturalizing olive trees are potentially invasive exotic plants, and should be controlled. The germplasm of the walnut and apricot trees in the Mt. Wanda unit should be conserved, to preserve these old genotypes, and to support future propagation efforts.

PHASE FOUR

Implement CLR Treatment Plan for House Unit East Orchard:

Remove all of the apple trees in the East Orchard and convert the flat field area to hay; install a subterranean irrigation zone on the east slope of the House Knoll, and plant historically accurate apple trees on the slope.

Justification: the East Orchard is the second part of the cultural landscape seen by visitors as they approach the Muir House, and is the last area seen as visitors leave. All visitors see the East Orchard, whereas not all visitors venture further into the site to experience other orchards. The East Orchard is in relatively poor condition, and presents a historically inaccurate and degraded appearance. Implementation of this phase is contingent upon installation of a new irrigation system zone.

PHASE FIVE

Implement CLR Treatment Plan for House Unit Middle Orchard:

Remove all of the plum trees in the Middle Orchard; install a subterranean irrigation system zone, and plant historically accurate plum trees in the same area. Replace missing grapevines in the vineyard area. Extend the irrigation system into the vineyard as a drip system laid out along the columns of vines

(perpendicular to the main farm road) with subterranean lines interconnecting columns, for equipment access and grass maintenance.

Justification: the Middle Orchard plum trees are in poor condition, and present a degraded, historically inaccurate appearance to visitors. The Middle Orchard is visible from the Muir House, and "links" the landscape experience for visitors between the Muir House and the Martinez Adobe. Implementation of this phase is contingent upon installation of a new irrigation system zone.

PHASE SIX

Implement CLR Treatment Plan for House Unit West Orchard:

Remove all of the fruit trees in the West Orchard; install a subterranean irrigation system zone, and plant historically typical pear, cherry and walnut trees.

Justification: the West Orchard trees vary in condition and historical accuracy, and present a confusing array of orchard trees and configurations. The West Orchard lacks the cohesion it had historically as an area, and with the other orchards of the park. Visitors pass through the West Orchard en route to the Martinez Adobe, and it is used by visitors for group activities including picnicking. As visitors may spend more time in the West Orchard than any other orchard in the park, it is important to elevate the West Orchard as a priority for treatment. Implementation of this phase is contingent upon the installation of a new irrigation system zone.

PHASE SEVEN

Implement Remainder of CLR Treatment Plan:

Stabilize BNSF railroad walnut trees and apricot trees above Strain Ranch.

Justification: the BNSF railroad walnut trees and the Strain Ranch apricot trees are not historic, and therefore should receive the lowest prioritization for phasing treatment. Their germplasm conservation should receive relatively high prioritization however, as this can be used to support the propagation of new trees for the park.

ORCHARD MANAGEMENT

ORCHARD PRESERVATION MAINTENANCE ACTIVITIES

PROPAGATION

Objectives

The goal of propagation is to create new or replacement trees for the park's historic orchards, using the existing historic fruit trees as source material (germplasm) to the greatest extent possible. Vegetative propagation is a method of genetic cloning, and is therefore a way to conserve historic germplasm over time. It is desirable to conserve historic germplasm through custom-propagation efforts rather than purchase "ready-made" fruit trees from a vendor, to preserve the historic integrity of the park's orchards. While the varieties of the historic fruit trees in the park are not rare, these varieties have been altered through horticultural breeding by the industry since Muir's time. Many strains or altered versions of varieties have been created over time, to improve the commercial characteristics of the original variety. To some extent, the more common varieties such as Bartlett pear and Elberta peach have been altered most through the creation of strains. Propagation by taking cuttings from the historic trees preserves the significance and integrity of the park's historic orchards, through germplasm conservation.

Propagation Services

If germplasm is not available for propagation from historic trees within the park for a particular variety, several sources can be used to obtain appropriate germplasm. The National Plant Germplasm Repository (NPGR) system has the largest historic fruit and nut variety germplasm collection in the nation, and is the preferred source. The NPGR in Geneva, New York is a source for historic apple variety germplasm, the NPGR in Davis, California is a source for historic stone fruit germplasm (plum, cherry, peach, apricot, olive) and

the NPGR in Corvallis, Oregon is a source for historic pear variety germplasm. An Agreement can be developed with the NPGR for propagation services, using germplasm from the Repository. Alternatively, a qualified commercial nursery vendor can provide custom-propagation services for replacement trees. Typically, these services can be provided as a simplified purchase.

When procuring propagation services, the vendor should have demonstrated expertise with historic orchard fruit varieties and access to seedling rootstocks, rather than clonal dwarfing rootstocks. When ordering, it is important to specify the following:

- The desired number of propagated trees - specify up to 30% extra to allow for some mortality after planting;
- The scion variety (scion cuttings can be provided by the park or derived from NPGR);
- The type of rootstock – in all cases, the type needed for the JOMU NHS cultural landscape will be seedling rootstock (e.g., seedling apple, seedling pear, seedling peach, etc.., not clonal dwarfing rootstock);
- The height of the graft union – this should be specified as "low," so that when the tree is planted, the graft union will be just above the ground, depicting historic conditions;
- Desired length of cultivation – specified as one or two years. The specified delivery date should be as close as possible to the time of planting.

Propagated trees can be provided in six inch to one gallon-sized containers, as bareroot trees in February, or balled and burlapped (B&B). Propagated trees can be ready for delivery in one year, or may be held for two years before delivery and planting. New containerized trees to be held for two years should be potted in one gallon minimum-sized containers. After delivery, young trees should be kept well-watered until planting.

PLANTING

Appropriately-propagated fruit trees should be planted during the dormant season, between late fall and early spring. At the time of planting, the soil should not be frozen or waterlogged, but be workable with a shovel. New tree locations should be marked prior to planting, either with a stake or vegetable-based paint sprayed on the ground. In the park's House Unit, new tree planting should follow only after the installation of a subterranean irrigation system, the preparation of the orchard floor as a seed bed for a cover crop of perennial rye, and preparedness to immediately spread an eight-foot circle of mulch around each new tree. The use of micro-emitter heads rather than pop-up sprinklers is recommended for the irrigation system. Micro-emitter heads are located at ground level and emit a fine mist spray, thus avoiding inundation and conserving water. Micro-emitters can be paired on either side of each tree, inside but near the perimeter of the mulched circle (i.e., not in the mowed-zone of the rye-grass cover crop, where the emitters can sustain damage).

For large plantings (such as those required by various phases of the CLR Treatment Plan), hole digging can be expedited using a mechanical soil auger. For smaller scale plantings, holes can be dug by hand shovel. Holes should be at least one and-a-half times the size of the tree root system, to ensure that roots can be spread out in the hole, without bending or "jay rooting." The hole should be just deep enough to accommodate the whole root system, but not cover the tree trunk with any more soil than it was already covered in the container. The graft union should be positioned just above the level of the soil, in order to prevent the scion (aerial parts above the union) from rooting.

When planting new fruit trees, broken roots should be removed using a sterile knife. Roots should be spread out in the hole, and backfilled with a mixture of conserved and new topsoil. After filling the hole, the soil should be lightly tamped, and a low, soil berm hand-formed around the perimeter of

the planting hole, to create a shallow watering basin around the tree. All branches within 16 inches of the ground should be removed using pruning shears. A two-inch depth of nutritional mulch should be spread around the tree, up to eight feet in diameter, or a minimum of three feet in diameter, in order to eliminate competing vegetation and discourage rodents. Mulch should not touch the tree trunk. Trees should be thoroughly watered at planting, and then be given a minimum of one inch-depth of water per week through the dry seasons.

At planting, trees should be double-staked, to protect them against wind-throw. Six-feet tall tree stakes should be driven at least one foot into the ground, and one stake should be located on either the windward or leeward side of the tree. Loosely installed rubberized tree ties are the preferred material for securing the trees to the stakes. Tree stakes should be maintained for up to two years after planting, and then removed. Failing to remove tree stakes will retard the thickening of tree trunks, and result in structurally weak trees.

SUN SCALD PROTECTION

All new fruit trees should receive sun scald protection immediately after planting. Sun scald is a serious health stressor and a major cause of young fruit tree mortality. The trunks of young fruit trees should be protected by painting with white-wash. White wash is a 50% solution of white latex paint in water. The full height of exposure of the trunk should be painted in preferably cool (less than 70 degrees Fahrenheit) and dry weather conditions. Over time, the white wash will be degraded by ultraviolet light, and should be re-applied during appropriate weather conditions to maintain an opaque coat. Sun scald protection should be provided until the fruit tree has developed mature bark (a minimum of five years). Various commercial fabrics for sun scald protection are also available. These products are wrapped around the trunk and must be loosened as the tree grows to avoid retarding development. Whitewash is the recommended historically accurate

method of protection, however, and is the more flexible and easily maintained over time.

PRUNING

Objectives

Annual pruning of the park's fruit trees is needed to perpetuate the historic character of the orchards and promote the health and longevity of the trees. During the period of significance, Muir and his laborers performed annual pruning of the fruit trees. Pruning was used to create a productive framework or scaffold of branches, to stimulate fruit wood production, to remove diseased wood, to thin fruit, and to manage the size of each tree. While the same objectives apply today, it is important to use the low-headed scaffold and open bowl form used by Muir in the historic period, rather than contemporary standards for tree form. The low-headed, open-bowl scaffold is developed in the young tree during the first several years after planting. More details are provided under "Pruning Young Trees."

Timing

Pruning is performed in winter, and typically between January and March. It should be done after leaf fall and before bud break, except for pear and apricot trees, which may be pruned later in spring, to avoid Cytosporina infection or to remove Fireblight infection, respectively. More pruning details are provided under individual species. Root suckers or aerial water sprouts may be removed in summer. Dead or diseased wood should be removed as it appears.

Equipment

Hand shears can cut stems up to one half inch in diameter, and are useful for pruning young, non-bearing fruit trees. Loppers are needed to prune branches up to one inch in diameter. Pole loppers are useful for reaching up to one-inch branches at the top of tree canopies. A tree-pruning saw is

required for cuts larger than one inch in diameter. Easily maneuvered tripod tree ladders are needed for saw cuts high in the canopy. The use of chain saws should be avoided to the greatest extent possible, to avoid excessive pruning and the removal of scaffold limbs.

Removal of Debris

All debris pruned from fruit trees should be removed from the orchard, to avoid disease transmission. Debris may be disposed of as solid waste, be burned or chipped and composted to form nutritional mulch. However, complete composting is a requisite for the prevention of pest and disease transmission in mulch. Complete composting is achieved by wind-rowing organic material to a maximum height of three feet, and seasonal turning of the material (a front-end loader can be used) to dissipate interior heat.

Pruning Young Trees – Scaffold Development

The main framework or "scaffold" of a fruit tree is developed during the dormant season, in the first several years after planting. The scaffold refers to the system of the trunk and main structural branches, and for the John Muir NHS cultural landscape, the scaffold should be "low-headed" with an open-bowl form. The low-headed scaffold was the form of most fruit trees used in America between 1880 and 1945. The open-bowl pruning style was the style typically used on the Muir fruit ranch.

The region on the trunk where most of the main framework branches are borne is called the "head" of the tree. The "head" maintains its position as the tree grows, i.e., it does not extend higher as branches grow in diameter. The lower surface of each growing branch becomes lower to the ground as it expands, and the upper surface become further from the ground. However, the center of each branch remains at its original height relative to the trunk and ground level as when it was originally formed. A low-headed tree is created by cutting off the central leader (the main stem) of a young whip 30 inches from the ground immediately after planting. Three to five well-

spaced lateral buds near the top end of the cut whip are allowed to grow out, however, no lateral bud should be less than 24 inches above the ground. The three to five lateral buds should radiate around the trunk like the spokes of a wheel, and be at least two inches apart in height, in order to make room for the adequate spacing of five lateral branches.

Over the next two to three winters, a low-headed, open-bowl scaffold is formed by rubbing off excess lower buds on the trunk, and pruning off lateral branches growing into the center. Eventually, the resultant scaffold will appear as an inverted umbrella of 18 to 30 inches in height with three to five spokes (lateral branches) oriented outwards. Once the low head is established, the open bowl scaffold is retained and further developed by winter pruning of secondary and tertiary branches. Laterals growing into the open bowl are removed, and laterals growing to the outside are thinned for good spacing, to avoid shading of one branch by one above. Laterals are also headed back to an outside bud to stimulate spreading of the scaffold when these buds grow out as shoots. All pruning cuts are made immediately outside of the collar or abscission zone of the branch, or immediately above a lateral bud, to avoid leaving a stub. More information on pruning cuts can be found in "Pruning Mature Trees."

Pruning Mature Trees – Scaffold Maintenance

After initial scaffold development in the early years after planting, winter pruning should be performed annually to maintain the tree scaffold. Without pruning, the historical form of the tree and character of the orchard will be lost. In addition to perpetuating the scaffold, winter pruning serves to remove dead and diseased wood, thin fruit-wood while stimulating new fruit-wood production, and increase fruit quality by opening up the tree canopy to more light and air penetration.

If winter pruning is performed annually, the hierarchy of branch sizes in each tree will vary gradually from the primary scaffold limbs to the secondary and tertiary lateral branches as an even spectrum of diminishing size. This is the

desirable condition. If annual pruning is not performed for a period of years and then resumed, the hierarchy of branching will be uneven, as large outer limbs are pruned and give rise to tiny, terminal branches. The undesirable appearance is of large, stubby limbs bearing wispy terminal branches. The need to remove large limbs due to a cessation in pruning opens up the upper canopy to a lot more sunlight, and can result in sun scald to the upper branches. Removal of large limbs also results in the growth of water sprouts or suckers; these are vertical, non-fruiting shoots that drain a tree's energy resources. Regular winter pruning avoids the need to remove large, over-grown limbs, and maintains a balanced branching hierarchy, with a sun-scald protective canopy.

To maintain an even-branching hierarchy as described above, winter pruning in mature trees is performed on the secondary and tertiary branches, not on the primary scaffold branches (unless a scaffold branch is dead or diseased). A combination of two pruning methods is used to maintain the open-bowl form and a balanced canopy: heading back and thinning out. Heading back targets the secondary branches (those borne from the primary scaffold branches), whereas thinning out targets tertiary branches (those borne last, or from the secondary branches). As heading back removes secondary branches, it also removes the tertiary branches borne from those branches, and results in the reduction in the size of the canopy (rather like removing the fingers of a glove at the knuckles). Thinning out removes tertiary and younger branches, and results in the opening up of the tree canopy (rather like removing every-other finger on a glove). As a general rule, no more than 30% of a tree canopy should be removed in any one winter pruning, and a mature tree should not be headed back more than five feet. Annual winter pruning will avoid the need for long limb removal and severe canopy reduction.

Heading back and thinning out are performed in the dormant season to maintain a balanced open-bowl tree canopy, with spreading, well-spaced branches. Well-spaced branches do not cross, touch, closely parallel, or shade one another. A well-spaced canopy can be viewed from below,

looking up into the canopy, and find no branches occupying the same vertical or horizontal location. Each secondary and tertiary branch has its own space. A spreading canopy is formed by heading back, or shortening a branch to the point of an outside-oriented bud (rather than an inside bud). Each year, more thinning out is performed than heading back and the goal is to only need to make many small cuts (i.e., thinning only the small, new growth) equally over the entire canopy, to stimulate balanced growth.

Pruning Apple Trees

Follow the general pruning guidance provided above for young and mature fruit trees. Apple trees bear blossoms and fruit on last year's or older wood, on short branches called spurs. At the time of winter pruning, the short spurs will be clearly evident along the tertiary branches. Removing tertiary branches to thin out the canopy will also remove fruit spurs. Fruit yield will be reduced by removing tertiary branches, or by removing individual fruit spurs along tertiary branches. Winter pruning is one form of fruit thinning that is desirable to prevent heavy bearing of trees. Heavy bearing is undesirable, as it taxes the energy resources of apple trees and can result in limb breakage due to heavy weight. Once formed, the same apple fruit spurs can continue to bear fruit for more than a decade.

After winter pruning, when dormancy breaks, blossom buds will open on the remaining fruit spurs. Shortly afterwards, vegetative buds will break along the tertiary branches, or at the tips of fruit spurs. These will grow out to form new shoots, approximately 10-20 inches long in young trees, and 6-10 inches long in healthy old trees. The new shoots will develop fruit spurs during the growing season. To maintain the size of the mature canopy, remove these new shoots from the last season's growth during winter pruning. For younger trees, new shoots can be partially headed back or thinned, to stimulate a fuller canopy with more fruit spurs. Water sprouts or suckers can be removed in winter or summer.

Pruning Pear Trees

Less pruning is needed for pear trees than apple, as new growth is less prolific. Pruning should be just sufficient to maintain the scaffold form and size of the mature canopy. Heavily pruned pear trees bear more water sprouts, which along with soft new growth, are sources for Fireblight infection. While it is preferable to prune pear trees during the dormant season, if Fireblight infection occurs, infected shoots should be pruned off immediately, or "winter" pruning can be performed at the end of the rainy season in spring. Pruning shears should be sanitized between cuts using a solution of 10% bleach in water. The Fireblight bacterium enters the fruit tree through the blossoms, and can be isolated from the tree by pruning off infected shoots six inches below the level of infection. Infected shoots have wilted, scorched-looking leaves. Short shoots and fruit spurs borne directly on the trunk or at the base of scaffold branches should also be removed, to eliminate possible Fireblight infection through these points, which could girdle the tree. Pear trees bear fruit on last year's and older spurs, like apple. The same spurs can continue to produce pears for more than a decade. While fruit thinning can be performed by early season pruning, most pear thinning should be done after fruit set, to avoid excessive pruning cuts.

Pruning Peach Trees

Peach trees bear fruit on last year's wood, but the wood will only have one crop of peaches, i.e., bear for only one year. Relatively heavy winter pruning of peaches is needed to stimulate the production of new fruit-wood for the next year's crop. In other words, it is necessary to sacrifice some fruit by pruning off last year's wood in this dormant season, in order to get more fruit the year after this one. Some heading back and thinning out of peach trees should be performed annually in winter. Avoid summer pruning to protect against sun scald.

Pruning Plum Trees

Japanese plum trees are more vigorous and heavy-bearing than European plum trees, and require more heading back and thinning out each winter.

Japanese plum trees are more lateral spreading in form than European plum trees, which are more vertical. Plum trees bear fruit on last year's fruit spurs, which remain viable for five years or more. Regular light pruning of the European plum and prune encourages the even distribution of fruit throughout the tree.

Pruning Apricot Trees

Apricot trees bear fruit on last year's fruit spurs, or last year's tertiary branches, rather like plum trees. However, apricot fruit spurs are more short-lived than plum, and so heavier pruning is needed to stimulate new wood and new spur production. In addition, the terminal shoots of apricot trees tend to become long and willowy unless they are headed back to desirable lateral secondary or tertiary branches. If the fungal disease Cytosporina is prevalent in the apricot orchard, prune in the dry season rather than in winter, to avoid spread of infection. Remove all wood with cankers of Brown Rot or Cytosporina as soon as they appear.

Pruning Cherry Trees

Cherry trees should be pruned only lightly. In the early years, cherry trees should be thinned just enough to remove crossing limbs and headed back to outside buds to encourage a more spreading habit. Fruit is borne on long-lived fruit spurs that remain viable for more than ten years. The cherry tree branches very little as it gets older, and it is therefore unnecessary to thin out to admit light and air. A very light heading back of the canopy will stimulate replacement fruit wood.

Pruning Quince Trees

Quince bears fruit at the terminal ends of new shoots, rather than on last year's wood. Annual winter pruning should both head back and thin out the canopy. This multi-trunked tree has a tendency to become vertical and over-crowded in the center, and will produce very little fruit without some heading

back to outside buds each winter. The center of the tree should be kept open by thinning out old interior branches as low to the ground as can be reached. Heading back the remaining branches to an outside bud will encourage a more outward spreading form, a lighter interior, and more abundant fruit.

Pruning Fig Trees

Fig trees only bear fruit on one or two-year old wood, and so wood should be renewed, in order to get much fruit. Fig trees should be moderately headed back and thinned out to stimulate new wood production, and to control the height of the tree. Pruning may be done in winter or spring.

Pruning Walnut Trees

Walnut trees bear fruit on only one year-old wood, and so wood should be renewed, in order to produce many nuts. Walnut trees should be headed back and thinned out annually in winter to stimulate new wood production, and to control the height of the tree.

ORCHARD GROUNDS MAINTENANCE

Cover Cropping and Mowing

The majority of orchard floor grounds maintenance involves mowing the rye-grass cover crop throughout. While there is no definitive evidence for the use of rye-grass on the Muir fruit ranch during the historic period, rye-grass was a well-accepted cover crop during Muir's time. Cover crops were used on the fruit ranch to nourish the soil and prevent soil erosion. The Nitrogen-fixing legume mustard was one cover crop named in the park's archival record. Perennial rye, *Lolium perenne* is a compatible cover crop for the orchards of the John Muir NHS cultural landscape. While it does not nourish the soil like leguminous plants, perennial rye will prevent soil erosion, out-compete perennial weeds, avoid the need for soil cultivation during wet and dry conditions by tractor-pulled equipment and serve as a durable ground

cover for staff and visitor access. If no cover crop is used, orchard soil will gradually become devoid of organic matter, moisture will not be absorbed or held, and soil will puddle in winter and bake and crack in summer. Exposed orchard soils are washed away in heavy rains. Under these conditions, fruit tree growth is retarded, foliage becomes yellow, and smaller, poor quality fruits result. Consequently, the role of the cover crop is significant.

More nutritional cover crops than rye-grass can be used, such as alfalfa, buckwheat, clover, vetch, mustard and pea, however, these must be tilled-in annually during the winter, and re-sown in early spring. In addition, these leguminous cover crops present other operational challenges. They provide less weed suppression than rye-grass, present a potential for bee (and other insect pollinator) interactions with visitors, create a potential for soil erosion during the tilling process, and pose a potential for mechanical damage of fruit trees during tractor tilling. A perennial rye cover crop can be established in the fall and maintained at less than six inches in height with periodic mowing by a rider mower, rather than a tractor-pulled mower. Use of the tractor in the orchards is to be avoided, especially upon implementation of the CLR Treatment Plan, as this equipment is not compatible with the historically accurate low-headed form of the fruit trees. Perennial rye-grass does not need to be tilled under, and can be more easily maintained than other cover crops. Weekly mowing by the rider mower may be needed during the March to June grass growing season.

The rye grass cover crop is established by preparing a seed bed throughout the orchard floor. A seed bed is prepared by disking and tilling-in the existing ground cover in early October, then sowing perennial rye seed (either in October or March). Immediately after sowing, mulched circles can be established or re-established around the base of each fruit tree. The rye-grass cover crop should be maintained in conjunction with the mulch. Eight-foot diameter mulched circles around each fruit tree will exclude direct competition from the rye-grass, and avoid the need for weed-whacking around tree trunks. Mulch can be imported or created on-site from organic

debris accumulated during mowing, pruning, and the collection of dropped fruit (culls).

Mulching

Nutritional mulch, rather than bark mulch is the recommended material for mulching fruit trees. Mulching with nutritional mulch or compost is the most valuable cultural component of Integrated Pest Management in the John Muir NHS cultural landscape. Mulching with nutritional mulch combines all of the benefits of mulch with all of the benefits of compost. While mulch suppresses weeds and retains moisture, compost increases the microbial activity in the root zone of fruit trees and stimulates ecologically balanced soil. Tree health is promoted by ecologically balanced soil, as soil pathogens are controlled by beneficial micro-organisms, and pH balance, nutrients and soil texture are maintained.

Nutritional mulch can be imported as compost mixed with bark mulch, or created on-site through a composting operation. Compost can be prepared in as little as three weeks with daily turning of the pile (this can be done using a front-end loader). The length of the production cycle is extended by a greater interval between turnings. In addition to regular turning, organic material should be chipped to begin the compost pile, and the maintenance of approximately 50% moisture content is recommended. As the nutritional mulch is so valuable to the health of the fruit trees, and so important in reducing grounds maintenance needs, a designated park lead for mulch production is recommended. A two to three-inch thick layer of mulch in an eight-foot diameter circle should be maintained around the base of each fruit tree, through annual re-applications, as needed.

Culls

Young fruit trees grafted to seedling rootstocks will take at least five years to start bearing fruit. However, as soon as the first crop is borne, culls will also appear. Wind-fallen or aborted fruit lying beneath fruit trees are known as

"drops" or "culls." Culls are eaten by deer or other mammals, when present. However, in their absence, culls will accumulate and provide a source of nourishment for pest and disease organisms. Maintenance of orchard hygiene through the removal of culls is an important part of Integrated Pest Management. This labor-intensive activity is best done by hand with a rake, rather than with machinery. Culls are dropped throughout the fruiting season, and periodic collection should be staged, in order to prevent accumulation. This valuable activity may be performed by volunteer work parties. Culls are an excellent source of organic debris for composting into nutritional mulch.

Aerating

Aeration of the orchard floor allows more oxygen, water and nutrients to permeate to fruit tree roots, by re-introducing air spaces into the soil. Historically, aeration was performed by tilling-in the cover crop. As rye-grass is a "no-till" cover crop, periodic aeration is necessary. Aeration is needed when compaction of the orchard floor has occurred. This may result from the use of machinery or from frequent staff or visitor circulation. Maintaining an eight-foot diameter mulched circle around the base of each fruit tree should prevent compaction and avoid the need for aeration in the root zone. However, compaction of the rye-grass aisles between tree rows may occur and should be relieved periodically. In the most severe cases of compaction, where the orchard floor has puddled or is water-logged, aeration may be performed annually. In general, aeration of the orchard floor should be performed every five years at a minimum.

A pedestrian-operated mechanical aerator rather than a tractor-pulled aerator is recommended, to avoid damaging tree roots. The aerating tines should be set to a six-inch depth. As the aerator is guided through the rye-grass areas of the orchard floor, six-inch plugs of sod are pulled out, to leave behind thousands of holes. The holes will soon reduce in size, and the plugs will naturally decompose. The mulched areas around trees should be avoided with the mechanical aerator. If aeration is needed within the eight-foot

mulched zone, hand aeration with a pitchfork is recommended, to prevent large root damage.

FRUIT THINNING

As soon as the first fruits appear in five year-old trees, fruit thinning is needed to prevent over-production in one season. Over-production can cause the breakage of limbs under the considerable weight of fruit in the canopy and can cause the draining of energy resources. The energy-consuming effect of a bumper crop can lead some species into a biennial-bearing cycle with fruit production only in alternate years. Quality fruit production is an interpretive goal that is secondary in importance to historic orchard preservation maintenance, and so the primary value of thinning is to reduce weight to protect canopies and to balance tree energies to maintain health. A positive byproduct of thinning is the increase in size and quality of fruits, and the compression of the ripening of the entire tree's fruit into a shorter period. Thinning also reduces the effort required in harvesting.

Some species require more thinning than others, to avoid an excessively large crop. Apple, peach and pear trees should be thinned to one fruit every six inches of fruit wood. Apricot and plum trees can be thinned to one fruit every three inches. Cherry and nut trees require no thinning (as thinning is performed by squirrels and birds). Fruit thinning is performed a minimum of two weeks after fruit set (after blossoming, pollination and fertilization have occurred), and most efficiently after "June drop," the natural shedding of fruit by trees in June. The swollen primordial fruit is best removed by hand, by grasping the fruit stem with the thumb and forefinger and "pushing" the fruit off the stem with the other fingers. This avoids breaking off the fruit spurs. Where fruits are borne in clusters on a single spur, fruits should be thinned to one fruit per spur. Typically the center fruit is left on the spur (called the "king" fruit), as this is the most well positioned. Well-thinned fruits can develop without touching each other. Where more fruit is borne on one side of a tree canopy than the other, thinning is used to evenly distribute

the weight of the fruit throughout the canopy. Thinning may be performed several times during fruit development, if needed.

FRUIT HARVESTING

Fruit harvesting is a labor-intensive activity that spans from May to November in the John Muir NHS orchards. (This assumes that after the implementation of the CLR Treatment Plan, no citrus fruits will remain in the cultural landscape. These fruits are currently harvested in the winter months.) Upon implementation of the CLR Treatment Plan, the park's orchards will consist of the following orchard species: apple, apricot, cherry, fig, olive, pear, peach, plum (European and Japanese), quince and walnut (Black and English). At least a five-year interval after planting should be expected, before the first fruit appears in new trees.

The following table indicates the locations of fruit species, after implementation of the CLR Treatment Plan, and their period of fruit ripening:

Summary Table of Orchard Harvest Periods
(after implementation of CLR Treatment Plan)

Landscape Character Area	Orchard	Fruit Trees	General Harvest Period
House Unit Agriculture Area (AG)	East Orchard	Apple	July to October
	North Orchard	Peach	May to September
	Fish Pond (edge)	Quince	October to November
	Middle Orchard	Grape	August to October
		Plum	June to September
	West Orchard	Apricot	May to June
		Cherry	May to July
		Pear	July to September
		English Walnut	August to November
		Black Walnut	August to November
		Fig	August to October
Gravesite	Pear Orchard	Pear	July to September

Unit Area (GR)			
Mt. Wanda Unit Area (WA)	Olive Orchard	Olive	October to November

Implementation of the CLR Treatment Plan will result in the replacement of much of the House Unit's orchards with more historically accurate fruit trees. These trees will be grafted onto seedling rootstocks, and as a result, the trees will be able to develop a full size, posing greater challenges for access in fruit harvesting. The greater difficulty in maintaining and harvesting full-size fruit trees led to the adoption of clonal dwarfing rootstocks after World War II, and the loss of full-size trees. While greater challenges exist with full-size trees, their rarity today underscores the importance of historical accuracy in preserving the integrity of the John Muir NHS cultural landscape, and providing unique interpretive opportunities.

Harvesting fruit from full-size fruit trees makes the use of tree ladders a requisite. Tree ladders are tripod, or three-legged ladders which are light, strong and well-balanced. The tripod ladder has a flared based for stability, and may taper to a point at the top, or remain open. The tapered-top tripod ladder is more easily maneuvered between tree branches. At least two sizes of ladder should be able for harvesting shorter and taller tree species. Peach, plum, apricot, fig and quince trees may be harvested with a 10 to 12 feet-tall tripod ladder, or a tall step ladder. Taller species such as apple, pear, cherry, walnut and olive will need a taller tripod ladder. Tripod ladders up to 22 feet-tall can be handled by a single person. Harvesters should receive safety training on the use of ladders, and wear personal protective equipment, such as hat, gloves, boots, and use a picker's pail or basket. Large containers should be avoided, as these become too heavy to carry safely down the ladder.

In general, all fruits should be harvested before they are completely ripe, as they will develop brown flesh if ripened on the tree or deteriorate rapidly

after picking. Skin color, fruit firmness and seed color are classic indicators of ripeness, however ripening of each species is sequential, requiring at least two harvests per tree. (Generally, fruits become ripe from the top to the lower branches of the tree.) Horticultural experience is needed to judge timing. Expertise comes with the ability to recognize the later stages of ripening and know when to pick a species. Some species can be picked earlier in ripening, such as apple, pear and plum, and will finish ripening in the fruit bowl. In fact pear must not be left to ripen on the tree, or the flesh will rapidly deteriorate. Apricot, peach and cherry should be left to a later moment before fully ripe, in order to attain fuller flavor and sweetness. When harvesting, care should be taken to not rip the fruit from the spur or branch, as this will tear out the stem and rupture the fruit. A slightly upward twisting movement separates the fruit stem from the tree, and leaves the stem attached to the fruit. Prunes, olives and walnuts can be harvested from tarps laid on the ground after shaking the tree with padded poles.

PEST CONTROL

Pest control is addressed by the 2001 NPS Management Policies, where pests are defined as living organisms that interfere with the management objectives of a park or site within a park (4.4.5.1, 2001). Management Policies permit the NPS to control native pests to preserve, maintain or restore the historical integrity of cultural resources, and to conduct integrated pest management (IPM) to reduce risks to the public, park resources and the environment from pest management strategies (4.4.5.2, 2001). Like all parks, John Muir NHS is required to use an IPM approach to address pest issues. The IPM process, prescribed in Director's Order #77-7, is defined as *"..a decision-making process that coordinates knowledge of pest biology, the environment and available technology to prevent unacceptable levels of pest damage, by cost-effective means, while posing the least risk to people, resources and the environment."* In the case of the John Muir NHS cultural landscape, the orchard environment can be managed to prevent unacceptable levels of pest damage. As the primary management objective in maintaining the orchards is to preserve the cultural landscape for the experience of park visitors, "an

unacceptable level of pest damage" can be defined as a level of damage that has an impact on orchard tree health. This is related to, but distinguishable from pest damage that has an impact on fruit quality and yield.

As noted in the "Existing Conditions" chapter, the orchards of the House Unit contain a large number of insect pests and pathogenic micro-organisms that are contributing to poor tree health. Some of these pests are native, and all are commonly-occurring throughout the geographic area. They can have a limited negative impact on orchard health when cultural conditions are good. However, sub-optimal cultural conditions have generated several health stressors that are compromising the existing orchards' ability to naturally resist pests and diseases. Removing health stressors and improving cultural conditions will greatly improve tree health status, without eliminating pests and disease organisms. Healthy fruit trees can co-exist with some level of predation from their environment.

Upon implementation of the CLR Treatment Plan, the majority of the House Unit fruit trees will be replanted with more accurate replacements, and the Gravesite Unit pear orchard will be supplemented with new trees. The cultural conditions for the new trees should incorporate the recommendations of this chapter "Orchard Preservation Maintenance Activities." Following these recommendations will prevent exposure to the current health stressors of sun scald, short life span, over-crowding, over-shading and lack of water. This can be accomplished by white-washing trees, using seedling rootstock, using recommended tree spacing, removing shading over-story canopies, and using an automatic subterranean irrigation system with correctly positioned micro-emitters. In addition, the use of nutritional mulch around all trees, a rye-grass cover crop of the orchard floor with periodic aeration and good orchard hygiene, will create excellent cultural conditions for the replanted orchards. All of these actions will stimulate and sustain the health of orchard trees, and therefore provide the foundation of integrated pest management.

While it is beyond the scope of this plan to prescribe an Integrated Pest Management Plan for the park's orchards, it can outline the following

concepts as a philosophical approach. Pests that attack fruit trees can be grouped into the following categories:

- Pests that are life-threatening;
- Pests that retard growth and development;
- Pests that reduce fruit quality and yield.

While almost any pest can be become life-threatening when a particular level of damage is exceeded, some pests are extremely unlikely to be life threatening (e.g., Apple Scab) and others can quickly be life-threatening (e.g., Anthracnose). While some pests target the photosynthetic (energy-synthesizing) capacity of the tree and therefore stunt growth (e.g., Powdery Mildew), others target just the fruits and pose no threat to life or growth (e.g., Apple Maggot). It is important to understand pest targets, and the importance of pest damage at particular times in the lifecycle of fruit trees. As a general pattern, young trees are more susceptible to life-threatening and growth retarding pests than mature, well-established trees, and mature trees are more affected by fruit-targeting pests. When these concepts are weighed against the park's management objective to preserve the cultural landscape, it follows that the "real" pests in this case, are those that compromise the park's ability to maintain the park's orchards, not those that do damage to orchard fruit. Consequently, the integrated pest management process should focus primarily on protection from the first two kinds of pests: life-threatening and growth retarding, particularly in the early life of newly planted trees.

As indicated, implementing all of the cultural recommendations in this chapter will provide substantial protection for life-threatening and growth-retarding pests. The nature of the protection provided is from damage exceeding a threshold that affects the health status of the whole tree, rather than protection from predation by the pest. The orchards should be monitored with a bi-weekly walk-through and records kept of pest presence and damage level, as the basis for decisions to take specific evasive action. All the while cultural conditions are good, acceptable levels of pest damage

are unlikely to be exceeded. However, in the first five years after planting new trees, supplementary protection is recommended through an "organic" spray program.

An "organic" spray program is most efficiently implemented by a private contractor, selected through a competitive bidding process. The program involves the application of dormant oil and copper mixture, lime sulfur, and insecticidal soap, to protect young trees and vines against the majority of pests.

- Dormant oil and copper mixture – should be applied three times during the dormant season to all species accept walnuts. The first application should be in November (after leaf fall), in January (in a dry period) and in March (at bud break). This will protect against the majority of bacterial and fungal diseases.

- Lime sulfur –should be applied in April (during blossom time) to provide a barrier against Powdery Mildew and Scab pathogens. Spraying should be repeated up to three times if the weather is wet, as rain will wash off the lime sulfur coat. Grapevines may be sprayed every six weeks during the growing season to protect against mildew.

- Insecticidal soap – should be applied in May and July (in temperatures of less than 70 degrees Fahrenheit) to kill aphids and other insect pests on foliage, as needed.

Further protection can be provided by banding trees with Tanglefoot to exclude crawling insects from the canopy, particularly ants. Fireblight and Cytosporina diseases can be eliminated by pruning infected limbs six inches below the level of infection with sterile pruning shears. Pruning is also an effective means of removing aphid and tent caterpillars. Clippings should be disposed or composted.

When monitoring indicates that pest damage is adversely affecting the health of fruit trees, specific evasive action may be taken beyond implementing the recommended cultural conditions, "organic" spray program, sanitary pruning and banding. Specific evasive action includes the use of biological controls, such as natural predators, trapping, disrupting, or treating pests with certified pesticides. The use of certified pesticides must be approved by the park or region's IPM Specialist. Typically, the escalation of a pest population to an unacceptable level damage will not occur unless the cultural conditions become unbalanced. Cultural conditions should be examined and addressed as specific evasive action is taken, in order to achieve sustainable protection.

The table on the following page contains a calendar of orchard preservation maintenance activities.

CALENDAR OF WORK

Calendar of Orchard Preservation Maintenance Activities													
Landscape Character Area/ Orchard	**Fruit Trees**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
House Unit/ Agriculture Area (AG East Orchard	Apple	Prune Oil spray	Prune	Prune Oil spray	Thin fruit Lime sulfur spray	Water Thin fruit Soap spray	Water	Water Soap spray Harvest	Harvest	Harvest	Harvest	Harvest Oil spray	Prune
North Orchard	Peach	Prune Oil spray	Prune	Prune Oil spray	Thin fruit Lime sulfur spray	Thin fruit Water Soap spray	Water	Water Soap spray Harvest	Water Harvest	Water			Prune
Fish Pond (edge)	Quince	Prune Oil spray	Prune	Prune Oil spray	Thin fruit Lime sulfur spray	Thin fruit Soap spray		Water Soap spray	Water	Harvest	Harvest		Prune
Middle Orchard	Grape	Prune Oil spray	Prune	Prune Oil spray	Thin fruit Lime sulfur spray	Thin fruit Soap spray		Soap spray					Prune
	Plum	Prune Oil spray	Prune	Prune Oil spray	Thin fruit Lime sulfur spray	Thin fruit Soap spray	Water	Water Soap spray Harvest	Water Harvest				Prune
West Orchard	Apricot	Oil spray		Oil spray	Thin fruit Prune Lime sulfur spray	Water Soap spray Harvest	Water Harvest	Water Soap spray	Water	Water Prune			
	Cherry	Prune Oil spray	Prune	Prune Oil spray	Lime sulfur spray	Soap spray Harvest	Water Harvest	Water Soap spray	Water				Prune
	Pear	Oil spray		Oil spray	Thin fruit Prune Lime sulfur spray	Thin fruit Water Soap spray	Water	Water Soap spray Harvest	Water Harvest	Water			

	English Walnut	Prune	Prune	Prune	Lime sulfur spray		Water	Water	Water Harvest	Harvest	Harvest	Harvest	Prune
	Black Walnut	Prune	Prune	Prune	Lime sulfur spray		Water	Water	Water Harvest	Harvest	Harvest	Harvest	Prune
	Fig	Prune Oil spray	Prune	Prune Oil spray		Soap spray	Water	Water	Water Harvest	Harvest	Harvest		Prune
Gravesite Unit Area (GR) Pear Orchard	Pear	Oil spray		Oil spray	Thin fruit Prune Lime sulfur spray	Thin fruit Water Soap spray	Water	Water Soap spray Harvest	Water Harvest	Water			
Mt. Wanda Unit Area (WA) Olive Orchard	Olive	Prune Oil spray	Prune	Prune Oil spray									Prune
All Units/ All Areas	Grounds maintenance	Mulch	Monitor	Monitor Mow	Monitor Mow	Monitor Mow	Monitor Mow	Monitor Mow	Monitor Mow	Monitor Mow	Monitor Mow	Monitor Mow	Mow

MONITORING AND RECORD KEEPING

MONITORING

Cyclic monitoring and record keeping is a foundation for integrated pest management, along with providing good cultural conditions for the park's orchards. Monitoring is a labor-intensive task that must be factored into the calendar of orchard preservation maintenance activities, just like pruning, watering and harvesting. A bi-monthly inspection of each orchard in the park is recommended between February and November. This means half the park's orchards will receive monitoring during any week within these months. Observations of tree health problems, stressors, pest damage, or other deficiencies, should be recorded on a spreadsheet. Also included is information about specific pest populations derived from monitoring traps. Monitoring traps recommended for use in the park's orchards are the following:

- Yellow sticky traps – hung within the orchards at a rate of 16 traps/acre
- Codling Moth pheromone traps – hung in the apple, pear and apricot orchards at a rate of 2/orchard
- Peach Borer pheromone traps – hung in the peach orchard at a rate of 2/orchard
- Tanglefoot sticky band – spread around the trunk of each fruit tree

Monitoring traps must be replaced or replenished with pheromone according to the manufacturer's directions. Maintenance of the traps should be considered part of monitoring activities. Pest population information should be recorded and tracked for each trap in each orchard.

RECORD KEEPING

Two sets of records should be kept for orchard preservation maintenance over time, however, the content of these sets will overlap. One set is a horticultural record, based on the record unit of one tree. This record is the most detailed, tracking the maintenance and health history of each tree. The other set is input into the Facility Management Software System, where each orchard can be recorded as a either an asset or a feature. In FMSS, condition, deficiencies and work orders with cost estimates are tracked for the asset or feature. As individual trees are not likely to be tracked in FMSS as features, this results in a more generic level of recording than the horticultural record, which tracks the individual tree. The horticultural record is described below.

The horticultural record is a MS Access spreadsheet (which can be tied to a GIS system), organized by individual tree and activities and problems associated with the tree. A unique field identification number is needed to differentiate each feature effectively, and track a tree's history over time. As the CLR Treatment Plan is implemented and accurate replacement trees are planted, unique identification numbers should be assigned to each tree.

The following, three-part number system is recommended for orchard tree identification numbers.

The first part should indicate the tree's location such as:

House Unit Agriculture Area	(AG)
East Orchard	(EO)
North Orchard	(NO)
Fish Pond	(FP)
Middle Orchard	(MO)
West Orchard	(WO)
Gravesite Unit Area	(GR)
Pear Orchard	(PO)

Mt. Wanda Unit Area	(WA)
Olive Orchard	(OO)

The second part should indicate the tree species, such as:

Apple	(Ap)
Apricot	(At)
Cherry	(Ch)
Fig	(Fi)
Grape	(Gr)
Peach	(Pe)
Pear	(Pr)
Plum	(Pl)
Quince	(Qu)
Walnut-Black	(Wb)
Walnut-English	(We)

The third part should indicate the specific tree in sequential or chronological order within its location, such as 001, 002., 003.,004., 005., 006., etc..

For example, a three part unique identification number for a peach tree in the House Unit might be: "AG-Pe-001." A pear tree at the Gravesite Unit may have the number: "GR-Pr-005." An olive tree in Mt. Wanda Unit may have the number "WA-OO-102." Upon implementation of the CLR Treatment Plan, all numbered trees should be entered into a park GIS, and trees should be field identified with a stake, located near the base of the tree (the cardinal location of each stake should be consistent throughout the park's orchards.)

An alternative numbering system is to use the FMSS asset or feature number for each orchard as the root of the number, then add a unique identification number for each tree. Either way, identifying each tree with a unique identification number is at the heart of the record keeping system. The

following table provides an example of how the MS Access spreadsheet can be organized for the horticultural record:

John Muir NHS Cultural Landscape Orchards
Horticultural Record (Example)

Tree ID	Planted	Pruned	Irrigate	Fruit Thin	Oil Spray	Lime Sulfur spray	Insecticidal Soap Spray	Harvest	Fertile Mulch	Trap Data	Condition Deficiency	Action Taken

As the MS Access spreadsheet is populated with data, it provides the "attribute" data for a GIS database. The GIS database is built by associating each unique tree ID number with spatial data, such as UTM coordinates. Once the GIS database is built, the MS Access spreadsheet (horticultural record) can be linked to GIS maps and the park intranet. One click on the tree ID number could display a map of the tree within the orchard. The map could display trees with particular activity needs on a particular week, or trees with condition problems. Certain data sets from the MS Access spreadsheet (horticultural record) could be displayed for visitors on the park intranet site as an "orchard news report." These data can be copied into FMSS, to satisfy reporting requirements.

The following page provides an example spreadsheet of the horticultural record, tracking one apple tree and one peach tree for the period 2008 – 2012.

John Muir NHS Cultural Landscape Orchards
Horticultural Record (Example)

Tree ID	Planted	Pruned	Irrigated	Fruit Thinned	Oil Spray	Lime Sulfur spray	Insecticidal Soap Spray	Harvested	Fertile Mulched	Trap Data	Cond-tion/ Deficiency	Action Taken
AG-Ap-01	11/2009	12/2009 1/2011 2/2012	5-7/2010 5-7/2011 5-8/2012	N/A	11/2009 1/2010 3/2010 11/2010 1/2011 3/2011 11/2011 1/2012 3/2012	4/2010 5/2011 4/2012	5/2010 5/2011 5/2012	N/A	11/2009 11/2010 11/2011 11/2012	No trap in tree	5/2012 Good. Tree bent	5/2012 Stake replaced
AG-Pe-34	11/2008	12/2008 12/2009 1/2011 1/2012	5-9/2009 5-9/2010 5-9/2011 5-9/2012	N/A	11/2008 1/2009 3/2009 11/2009 1/2010 3/2010 11/2011 1/2011 3/2011 11/2011 1/2012 3/2012	4/2009 5/2010 4/2011 4/2012	5/2009 5/2010 5/2011 5/2012	N/A	11/2008 11/2009 11/2010 11/2011 11/2012	5/2011 Peach borer – low levels	Good. Some Peach Leaf Curl	None

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