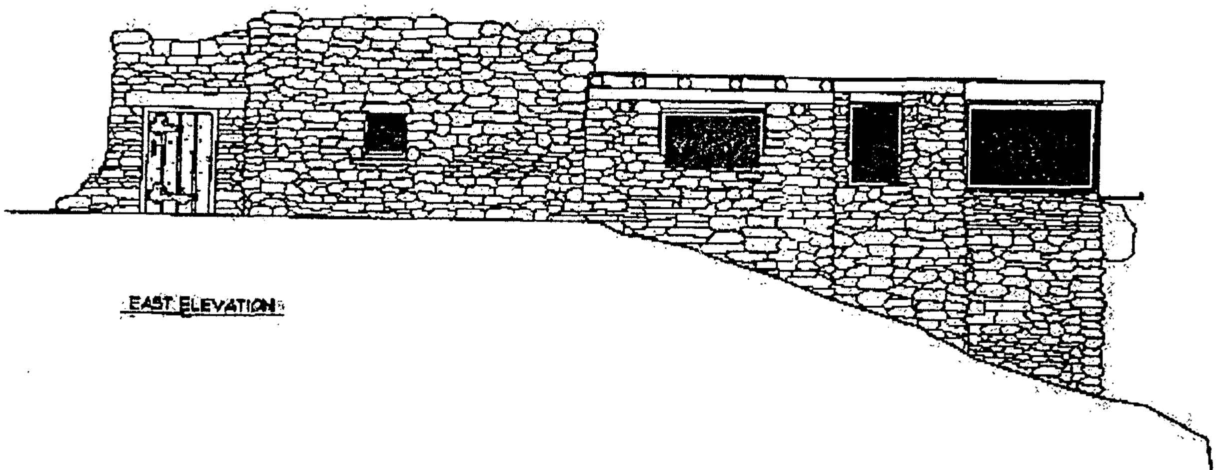
113/D-553
Grand Canyon

Yavapai Observation Station

Historic Structure Report



GRAND CANYON

National Park • Arizona

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Cover: East Elevation from HSR Drawings

Yavapai Observation Station
Historic Structure Report

prepared for the
National Park Service

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GRAND CANYON
National Park • Arizona

United States Department of the Interior

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I. Executive Summary and Administrative Data

Built in 1928 expressly for observing and understanding the geology of the Grand Canyon, the Yavapai Observation Station (also known as the Yavapai Point Museum) is a spectacularly designed example of the Park Service's pursuit of a singular and aesthetically appropriate architecture for the park system. Within the context of the development of the rustic style, the Yavapai Observation Station best exemplifies the National Park Service philosophy of melding the built environment into the natural landscape. Apart from this, the museum is significant for a wide range of reasons: The building, an excellent illustration of the characteristics of Pueblo architecture, is the work of a prominent architect, Herbert C. Maier, who was inspired by the ideology of architect Mary Colter: The warm golden-colored stone work exhibits a high level of craftsmanship. And, the building was among the earliest interpretive structures in the park system. Above all, the Yavapai Observation Station has long been a favorite of Grand Canyon visitors , a place at once welcoming and exciting, intimate and instructive **(see Appendix E, Historic Images)**.

Exhibiting indigenous materials and an intimate scale, the museum compares favorably with the architecture of the Grand Canyon Village, but it sits, somewhat isolated on a prominent point to the east, the area's best vantage point. Dramatically poised on the perimeter of the South Rim, the building's sensational siting on the canyon edge is integral to its design and expression. Flat-roofed and built low to the ground with battered stone walls, the one-story structure was designed to be particularly unobtrusive in its setting. The plane of the roof mimics the extreme flatness of the canyon rim and echoes the horizontal striations of the inner canyon, while the jagged outline of the observation terrace was shaped to conform almost exactly to the canyon rim. The original design's defining feature and function was the way in which the structure, from the interior, framed an expansive and specific panorama between the parapet wall below and exaggerated overhang above to maximize wide vistas and create an unparalleled viewing experience. The purpose of this design feature is not as effective as it was intended to be, as the cantilever roof has been cropped and tinted window panes installed, resulting in the building's most significant change and wholly altering the visitor experience. Given the numerous alterations to the building's interior and exterior, landscaping and road configuration, the Yavapai Observation Station retains a fairly high degree of historical and architectural integrity.

Though the building was constructed in 1928 as a museum and viewing platform, it has performed a unique function over time; the building itself acts as the interpretive feature perhaps even more than the exhibits it houses. Historical documents associated with the building reveal decades of debate and discussion about the content of the displays explaining the geology and geography of the Canyon, but more than exhibits, it is the structure itself that recounts the canyon's story. Constructed of local Kaibab limestone, the museum merges with the rim, opening the canyon to visitors and offering pivotal views, shade, shelter, and a place for contemplation.

The Yavapai Observation Station currently serves as a bookstore as much as a means for viewing the canyon. The building is not in a dilapidated state, but has been subject to treatment that has, over time, diminished its richness. Decisions related to maintenance, use, and landscaping have, in general, not been wholly destructive but have detracted from the building's original expression. Although the building today is commonly referred to as the Yavapai Observation Station, it does not, despite the presence of displays and exhibits, immediately convey a museum quality. Rather, the building's interior imparts a distinct sense of commerce.

In subtle ways, key aspects of Maier's design intent are no longer present. When constructed the open observation terrace exuded a feeling of outdoorsy ruggedness and elevated airiness over the canyon rim. The closeness, presence, and immediacy of the canyon's grandeur below the building's perch lent an almost daring quality to the visitor experience. The first-hand viewing experience of the canyon is no longer the focus. The principal goal of the planned work is to restore and preserve the structure to its original use as a geological interpretive facility. To encounter the Grand Canyon from the open-air perspective is integral to reviving the building's spirit and integrity.

The 1999 NPS task directive identified the parameters of the rehabilitation scheme for the Yavapai Point Museum with the principal goal as the return of the structure to its original integrity and purpose as a geological interpretive facility. Other design and construction work planned includes:

- the removal and replacement of the roofing system with new flashing, drains, and scuppers;
- repair and replacement of deteriorated vigas;
- tuckpointing to native stone masonry;
- repair to exterior doors including replacement hardware and weatherproofing;
- restoration and repair to windows and openings;
- repainting of interior and exterior trim and woodwork;
- restoration of original concrete floors and removal of carpets;
- upgrade of electrical, HVAC, and fire sprinkler systems;
- landscaping and signage; and,
- re-design and installation of interpretive / educational exhibits.

In addition to the task directive, users of the building and park administrators have expressed the need to upgrade mechanical, electrical, and telecommunications systems.

The information presented herein provides the basis for evaluating future alterations that may be proposed for the Yavapai Observation Station and will aid in the rehabilitation and stabilization of this significant park structure. As this building has been well-documented in the past for National Register eligibility and as a significant project within the portfolio of Herbert Maier, no significant new information regarding the architectural significance of the building has been found. The project team has developed a more thorough analysis of the structure's place within the context of rustic architecture and within the development of interpretive buildings within the Park System.

The document defines the elements that give the Yavapai Observation Station its architectural character and help convey its significance. The contents of this Historic Structure Report (HSR) are:

- a concise historic context associated with the building and its architect;
- a detailed chronology of building development including alterations and maintenance through time;
- a re-evaluation of the period of significance, historic integrity, and historic significance of the structure;
- an evaluation of building conditions;
- a list of character-defining features;
- updated existing conditions drawings; and
- plans that identify the primary, secondary and tertiary spaces of significance within the building.

The historical research portion of the report is based primarily on existing historical source material at the Grand Canyon National Park Archives and on other materials made available by NPS. Several NPS staff members of the Engineering and Maintenance divisions of the Grand Canyon National Park were consulted regarding the maintenance history of the building. Additional secondary research was conducted using materials within the libraries of the University of California at Berkeley, the library at the Grand Canyon National Park, the library at the San Francisco office of the National Park Service, at significant Bay Area research collections, and in the ARG library. The level of research requested for this report was "thorough" — one of three levels of investigation (exhaustive, thorough, and limited) as described by NPS Director's Order - 28. "Thorough" research is defined by DO-28 as follows:

> For historical studies this means research in selected published and documentary sources of known or presumed relevance that are readily accessible without extensive travel and that promise expeditious extraction of relevant data, interviewing all knowledgeable persons who are readily available, and presenting findings in no greater detail than required by the task directive.[1]

Administrative Data
Historic Name: Yavapai Observation Station or Trailside Museum
Common Name: Yavapai Point Museum
Park Structure Number: Building 110
Location: South Rim, Grand Canyon National Park, Coconino County, Arizona
USGS Map - Williams Quadrangle
UTM 339450 3991650

Cultural Resource Data

The Yavapai Observation Station was nominated to the National Register of Historic Places in 1990. The significance of the Yavapai Observation Station in relation to its role in the development of interpretive structures within the park system is such that its eligibility as a National Historic Landmark should be further studied.

The original drawings for this building are on microfiche at the NPS Denver Service Center. If there is not a copy of the drawings in the Grand Canyon National Park Archives at the South Rim, a copy should be placed with that collection. There are a number of historic photographs of this structure within the collection of the Park Archives. The Park Archives collection is an appropriate location for these items.

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II. Historical Background

Developmental History and Context

This section of the HSR outlines the people, events, and historic contexts associated with the structure. Historic contexts are broad patterns of historical development in a community or a region that may be represented by historical resources. Historic contexts can be identified through consideration of the history of individual properties or groupings of properties within the surrounding area. The establishment of historic contexts provides the foundation for decision-making concerning the planning, identification, evaluation, restoration, registration, and treatment of historic properties, based upon comparative significance. Historic contexts can be developed for all types of resources including, but not limited to, buildings, structures, objects, sites and historic districts. The methodology for developing contexts does not vary greatly with the different types of resources, and contexts may relate to any of the four National Register criteria. At the core of historic contexts is the premise that resources, properties, or happenings in history do not occur in a vacuum, but rather are part of larger trends or patterns.

The Canyon's First Inhabitants

Humans have known the Grand Canyon, the major chasm of the Colorado River and its tributaries, for thousands of years. Indigenous people have lived in the Grand Canyon for over 4000 years, with recent evidence suggesting people may have been utilizing the canyon as long as 10,000 years ago. Grand Canyon National Park is rich in cultural resources; the park records include 4,000 prehistoric and historic sites, based upon intensive survey of approximately 2.5% of the entire park. Estimates of archaeological resources within the park top 50,000 archaeological sites, prehistoric and historic, based upon the limited sample survey that currently exists.

For thousands of years, people moved in and out of Grand Canyon, leaving behind evidence of their passing. Thousands of dwellings, shelters, and agricultural terraces have been located, providing evidence of ancestral hunters, gatherers and farmers living on both rims and in the inner canyon. Campsites, rock art, house foundations, pottery, chipped stone, ground stone, and other artifacts remain to help tell the story of these people and their lives within the canyon over the last 10,000 years.

A single portion of a Folsum point provides the only evidence to date of Paleo-Indian hunters within Grand Canyon nearly 10,000 years ago. Although evidence for human occupation is limited, it is well documented that Archaic peoples began utilizing the Grand Canyon over 4000 years ago. Split-twig figurines, projectile points, campsites and rock art attest to archaic populations in and around the Grand Canyon from *ca.* 3500 B.C. to 1 A.D. Though limited, archaeological materials suggest near continuous occupations through the Archaic and Basketmaker (early A.D. to *ca.* A.D. 700) periods, moving directly into the Puebloan period occupations (*ca.* A.D. 800 - 1300). Groups identified as representing both the ancestral Puebloan peoples and Cohonina culture have been identified throughout the Canyon during those time periods, gradually giving way to contemporary peoples. The Hopi, Zuni, Southern Paiute, Havasupai, Hualapai and Navajo all left remains that have become part of the archaeological record. These same people continue to use the canyon today for traditional and religious reasons.

Grand Canyon has been home to various groups of people for thousands of years. These people, both native Americans and more recent Euro-Americans, have utilized the canyon as both a home and a place linked to traditional practices, values and beliefs. To the **Hopi** and **Zuni**, the Grand Canyon represents their place of origin into this world. For Hopi, it also represents the place where their spirits come to rest after death. Although the Anasazi (Hisatsinom), or ancestral Puebloan people, migrated from the canyon area, their descendants, the Hopi and Zuni, continue periodic visits.

For the **Pueblo** people, archaeological remains in the canyon provide evidence for their migration from their place of origin to their present homes. For the **Pai** people (Hualapai and Havasupai), the canyon and the river are the lands they have been entrusted to care for. The river represents the backbone. For the **Southern Paiute**, the canyon represents a place given to them from the Creator to protect and manage, including its water and natural resources. To the **Navajo** people, the Colorado River in Grand Canyon forms a protective boundary on the western border of Navajo land. Many of the tribes who claim ancestral ties to the Grand Canyon continue to use the park. Salt and hematite are collected from the locations along the river by all tribes, and certain plants are collected for traditional and medicinal purposes throughout the park. Pine nuts are still collected by Indians and non-Indians. One small group of Havasupai continues to live approximately one mile west of Grand Canyon Village in Supai Camp.

Most Havasupai today earn their living from tourism, ranching, and wage labor. Both spiritually and physically, the canyon remains of great importance to the local native peoples: it is a holy place, an object of pilgrimages, a symbol of legends, and a home place. Today, the reservations of the Hualapai, Havasupai, and Navajo tribes include parts of Grand Canyon National Park; the Paiute and Hopi reservations are nearby. Each of these tribes is linked to the history of the Canyon, from early times to present day involvement.[2]

European Exploration

During the early Spanish period, both the Hualapai and Havasupai were relatively unaffected. The first few Spanish soldiers and explorers to encounter the canyon were led by Garcia Lopez de Cardenas from Francisco Vasquez de Coronado's expedition of 1540-1542.[3] Cardenas and his men arrived at the South Rim of the Grand Canyon in late September of 1540 with the assistance of Hopi guides. Finding the land arid and difficult to traverse, the Spaniards left the canyon and its surrounding plateau lands to native tribes and were not seen again in the immediate area until the 1770s. More concerned with charting the New World and understanding the geography of the region, the Spanish they were awed by the canyon as a barrier, not for its scenic beauty, and focused instead on more easily-habitable regions.

American Westward Expansion

American trappers, fur traders, and frontiersmen scouted the area in the early nineteenth century, but tended to avoid the treacherous, unforgiving and still uncharted depths of the canyon. Like the Spanish before them, they saw it as an impediment to their hunting and trapping activities. In 1848, much of the territory was still unexplored. The course of the Colorado River had never been surveyed, nor did the canyon have an established name. In 1869, Major John Wesley Powell, a geologist and explorer from Illinois, organized several expeditions to charter the river that cut through the canyon. Powell's expedition appears to have been the first organized expedition of white men to successfully navigate the Colorado River and opened the way for further settlement.

Despite Powell's success, the American frontier came late. Rugged topography and a hot, arid climate deterred settlers. Consequently, those who came were mostly men without families in search of wealth: ranchers, settlers, and mining prospectors. These men arrived in Arizona in the 1870s in such huge numbers that the population quadrupled. Hundreds of mining claims were staked, but mining meant overcoming prohibitive difficulties: such as, lack of water; insufficient trails; packing out the ore on burros; and, finally, paltry deposits. Some mining prospectors saw that their trails and land had greater value in tourism than in mining. This realization coincided with escalating settlement of the Southwest and railroad expansion, particularly the Atlantic and Pacific Railroad, which pushed across northern Arizona.

Tourism Reaches the Canyon

While the extension of the railroad to northern Arizona made the canyon more accessible in the last quarter of the nineteenth century, it was not until 1901 that visitors could arrive directly to the South Rim by rail. Until then, hardy visitors withstood the laborious journey by horse-drawn stagecoach lines or wagons. In the early 1880s, Captain John Hance built the first hotel, in the form of a small cabin, on the canyon's rim near today's Grandview Point. Hance was a storyteller, tourist guide, trail builder, and miner who discovered that tourists were a source of greater profits than mining activities.

The arrival of rail service spawned the transformation of the small village into a more sophisticated resort under the aegis of a concessionaire, the Fred Harvey Company, which was allied with the Atchison, Topeka & Santa Fe Railway. Fred Harvey established resorts to accommodate rail travelers throughout the west. The Fred Harvey facilities at the South Rim ranged from the luxurious to the economical, from the sumptuous El Tovar Hotel (1905) to the Bright Angel tent cabins (no longer extant). The lodgings spawned other tourist-related businesses and structures, such as the Hopi House (1905), Verkamp's Canyon Souvenir Shop (1905), Mule Barns (1907), Rail Station building (1907), and the Lookout Studio (1914), creating a bustling arrival point for visitors.

An Appropriate Style of Architecture for the National Park System

From its inception in 1916, the National Park Service sought to define an appropriate architecture for buildings constructed within parks, some of the most scenic locations in the United States. The first directive issued by the new agency stressed that "particular attention must be devoted always to the harmonizing of these improvements with the landscape." [4] When the Grand Canyon officially became a National Park in 1919, the National Park Service Landscape Engineering Department teamed up with the Santa Fe Railroad and the Fred Harvey Company to plan development in the park. Concessionaires like the Fred Harvey Company had created structures in a variety of architectural styles, from buildings inspired by native construction techniques to those that evoked the imposing European chalet tradition. The early National Park Service architects and landscape architects, by contrast, pursued an architectural style that provided greater harmony with the natural surrounding and employed a generally smaller scale. The most influential and important designer working in the Grand Canyon prior to federal government stewardship was Mary Colter. Her collaboration with the NPS favorably influenced the architectural future of the natural landscape at the Grand Canyon.

Influence of M.E.J. Colter, Architect

Mary Elizabeth Jane Colter, architect and interior designer for the Fred Harvey Company and designer of many of the Grand Canyon Village buildings, forged her own unique expression, synthesizing Arts and Crafts ideals and indigenous architecture of the Southwest. Colter was not involved in the Yavapai Observation Station design; however, her influence is so directly read in the building's form and expression that a discussion of her oeuvre is merited here. Colter, a Minnesota native, received her architectural training in San Francisco in the 1880s. She was inspired by pueblo construction, Mesa Verde cliff dwellings and extant Hopi communities. Favoring indigenous-looking stone buildings, she became one of the foremost designers to seek harmonious solutions for inserting the built environment into the natural landscape. Colter's philosophy influenced the designs of the National Park Service and had far-reaching influence on subsequent development at the Grand Canyon. Her work at Hopi House (1905) Hermit's Rest (1914) Lookout House (1914) Phantom Ranch (1921) Desert View Watchtower (1932) and Bright Angel Lodge (1933-35), all substantially influenced design in the national parks for more than two decades. Colter worked closely with the National Park Service engineers and designers, including Charles Punchard and Daniel Hull who emulated Colter's architectural themes with regard to the use of wood and stone materials and the bold siting of structures **(see Appendix E, Figures 38-42)**. Colter's work fused cultural influences, including the Spanish colonial, a pioneer spirit, the Arts and Crafts, and Southwest settlement.

Grand Canyon Village and the General Plan

Ranging in date from the 1890s to the mid-1930s, the structures that comprise the Grand Canyon Village Historic District stretch along the South Rim extending from the canyon edge into the ravines and hills to the south. Rugged and rustic, the historic district retains a cohesive architectural character, consistent with the early twentieth century establishment of the park. The Grand Canyon Village was first established in the 1880s as a stop serviced by horse-drawn stagecoaches, and over time developed into a natural focal point for visitors. Shortly before the Grand Canyon officially became part of the United States Department of the Interior's National Park Service, a 1918 statement of policy of the National Park Service called for planning before design and construction.[5] Because the Grand Canyon Village had begun to grow organically at the end of the nineteenth century, the need for a general plan was especially pertinent. Beginning in 1918, the National Park Service hired landscape architects to plan and design park villages, campgrounds, road and trails, and facilities and to provide advice on issues affecting the scenery of the parks. The 1918 plan for the Grand Canyon Village attempted to impose order upon the village and to create a more pronounced town focal point, organized around a central civic space. Later Daniel Hull expanded upon the 1918 plan. In 1923, Hull spent two weeks at the Grand Canyon collaborating with Colter, drawing up schemes that met NPS requirements and were compatible with the existing concessionaire buildings. The plan entitled the Grand Canyon Village Area was adopted and implemented in 1924, calling for harmony between building and landscape and incorporating a variety of building types: public buildings around the village plaza, a post office, the Babbitt general store and a planned, but unrealized, museum. A museum was recommended as a high priority in the 1924 comprehensive plan for the village.

Although a museum would have worked well as a centrally-located visitor amenity within the Grand Canyon Village, the purpose of the Yavapai Observation Station as a means for observing and understanding the Grand Canyon geology meant that is had to be located at the canyon rim. Yavapai Point, to the east of the village, was chosen as the area's best vantage point, a somewhat isolated but prominent promontory with views on three sides.

Museums in the Parks

The need for park museums was first recognized in 1920, but it was several years before the park service found sources to fund construction. Eventually grant funding from the Laura Spelman Rockefeller Memorial Fund facilitated the construction of park museums and interpretive structures. Funding for the Yavapai Point Museum came from a $10,000 grant from the Memorial Fund given to the American Association of Museums (AAM). Herbert Maier was hired by the AAM to design museums for Yellowstone, Yosemite, and the Grand Canyon. Maier worked closely with Ansel Hall, park naturalist and later head of the Educational Division, and Carl Russell, the park service's museum expert. NPS landscape designers, particularly Thomas C. Vint, collaborated with Maier and prominent geologists and scholars in selecting the sites for the museums and reviewing designs.

Collaborative Efforts: The American Association of Museums and the NPS Educational Division

The Yavapai Observation Station was the first formal interpretive structure at the Grand Canyon. The plan for interpretation at Yavapai was the collaborative work of many influential scholars, scientists, curators, and researchers. The philosophy that united them was that innovative interpretation allowed the visitor to gain knowledge by observation and utilization of the displayed geological information. Among the most instrumental of these scholars were Hermon C. Bumpus, Carl Russell, and John C. Merriam, together with Ranger Ansel Hall and Edwin McKee, Park Naturalist and affiliate of the Carnegie Institute **(see Appendix E, Figure 9).**

Hermon C. Bumpus, first director of the American Museum of Natural History in New York, had strong ideas about park museums. He promoted a "focal point" lookout facility as best representing what park museums should be about:

> The controlling fact governing the development of educational work in the national parks is that within these reservations multitudes are brought directly in contact with striking examples of Nature's handicraft. To lead these people away from direct contact with Nature... is contrary to the spirit of the enterprise. The real museum is outside the walls of the building and the purpose of the museum work is to render the out-of-doors intelligible. It is out of this conception that a smaller specialized museum, the trailside museum, takes its origin. [6]

The AAM played an active role in museum development at the Grand Canyon National Park during the 1920s. Another grant from the Laura Spelman Rockefeller Memorial in 1926 funded the observation station and museum overlooking the Grand Canyon at Yavapai Point. Ansel Hall continued in AAM employ on the project, and John C. Merriam – formerly professor of paleontology at Berkeley, later president of the Carnegie Institution of Washington – spearheaded it for the park museum committee.

When the Rockefeller money ran out, funding to complete the project came from a variety of places. Merriam personally paid for one of the large windows (exactly which one is not discernible from park records) and got a $3,000 grant from the Carnegie Corporation of New York to finish the work. [7]

At the building's opening ceremony conducted by Park Superintendent M.R. Tillotson, John Merriam addressed the audience and acknowledged the collaborative effort of various organizations and scholars in establishing the museum. He explained the purpose of the building and how it would fit in with the general educational program at the Grand Canyon National Park.[8]

The Yavapai Observation Station represents the coordinated efforts of scholars, scientists, curators and researchers to fund the establishment of trailside museums and to carefully design their interpretive content. In a 1931 memo written by John Merriam regarding the use of Yavapai Station, he noted that in using Yavapai Station, "it is important to bear in mind that nearly ten years work has been given by a group of leading men of America to discover what of the multitude of things in the Canyon are of the greatest importance and might be of the greatest interest to the visitor."[9] The trailside museum building type illustrated the overriding belief that conservation of the natural environment was futile if it did not facilitate the public's use, understanding, and enjoyment of the parks.

Design for the Yavapai Point Museum

The Yavapai Point Museum, as it was originally known, was designed by Herbert C. Maier in the spring of 1927 and completed in July, 1928. **(see Appendix E, Figures 43, 44.)** This structure was a significant departure from Maier's rather traditionally-shaped Yosemite Museum and presented a vastly different design problem from that of Yellowstone. Drawing from the work of Mary Colter, Maier designed the new museum along distinctly indigenous lines, especially striking in its emulation of rustic native masonry techniques and the incorporation of native Pueblo patterns in the structure. Here he achieved variations of form, texture, and line which assimilated the character of the surrounding canyon; he experimented with the rough local rock as a material of beauty and interest. And although the use of flat roofs was generally discouraged in wilderness areas, Maier incorporated one "in keeping with the extreme flatness of the canyon rim and the precedent of Pueblo architecture." [10] For the Yavapai Point Museum, Maier has been credited with developing a "unique design of uncommon quality." [11]

Flat-roofed and built low to the ground with battered stone walls, the one-story pueblo-like structure was designed to be particularly unobtrusive in its setting **(see Appendix E, Figures 11, 15 and 16).** The flat roof mimics the extreme flatness of the canyon rim and echoes the terraced, horizontal striations of the peaks of the inner canyon. The large-roofed observation terrace was shaped to conform almost exactly to the canyon's rim. A defining feature and function of the design, though now altered, was the way in which the structure, from the interior, framed an expansive and specific panorama between the parapet wall below and exaggerated overhang above to create an unparalleled viewing experience and to maximize wide vistas. **(see Appendix E, Figures 5-8)**.

Maier not only designed the building but oversaw its construction, actively choosing the rocks to be quarried from the canyon and instructing the masons where each stone was to be laid. **(see Appendix E, Figures 1-4)**. In later years, when looking back at his completed works, Maier criticized his choice of rock sizes in the walls of the Yavapai Observation Station as having been too uniform and regular, not varied nor naturalistic enough.

Measuring approximately 3,000 square feet, the interior was initially laid out as two distinct spaces with different purposes, characteristics and light-reflecting qualities: the open-air viewing terrace and the exhibit room for focused, close-up study. The interior spaces, one open, light and airy, and the other closed, dark and cave-like, afforded a contrasting device that distinguished the two spaces and highlighted their distinct purposes of viewing vast distances and closely examining rock specimens. From inside the treatment of finishes on the observation terrace mimicked the canyon character: rough-hewn wall surfaces, the low rocky parapet and an east-west running load-bearing rock wall contributed to a feeling of outdoorsy ruggedness. The interior served to mirror the craggy interior of the canyon.

From the exterior, the two rooms read as separate volumes: the taller boxier exhibit room with small window openings and the flatter semi-circular observation deck, more generously punctuated. The exhibit room was accessed by a door in the chunky rock wall partitioning the spaces, and could be closed when unstaffed. By contrast, the terrace was never closed or locked and functioned more like a porch or deck, freely accessible to visitors at all hours.

The shapes of the two spaces also differed in plan **(see Appendix E, Figure 45)**. The unenclosed roofed observation terrace was originally configured to follow the irregular curving line of the canyon rim below. The semi-circular shape was divided into segments that directed visitors to view selected features of the canyon; its loose, free lines were meant to encourage spiritual contemplation. The sharply-delineated rectangular exhibit room, with straight lines and corners, was the area set aside for logical thinking and study. Perhaps Maier was trying to convey, in the plan of the building, something of the essence of the canyon and our intellectual relationship to it.

A singular and distinguishing building feature was the open terrace **(see Appendix E, Figures 13, 14)**. Though visually interesting, this element proved problematic as it allowed snow to enter and settle on the terrace floor. Window openings at the east, west and south elevations were small and deeply set in keeping with indigenous architecture. Other window openings contained modestly-sized panes since Maier felt glass was out of harmony with rock structures. [12]

Upon its completion, the Yavapai Observation Station was considered an immediate success and "attracted much favorable comment as to the manner in which it fit[s] in with the landscape features and appears to have grown as a continuation of the canyon walls."[13]

Yavapai Interior and Exhibits

As stated above, the interior was divided into two discrete spaces, the observation terrace and the exhibit room **(see Appendix E, Figures 18-20, and 32-35)**. The building was equipped with a large model of the Grand Canyon, samples of rock from the various formations, charts, maps, examples of fossil remains, and three high power telescopes. Viewing from the Yavapai was highly studied and controlled through the use of fixed telescopes and field glasses mounted on the parapet. Each parapet view was numbered and had a corresponding numbered exhibit with specimens such as fossils and rocks from that site in the room adjoining the terrace. The first descriptions of Yavapai Station specify that there were three telescopes. But shortly after construction, possibly as early as 1930, thirteen World War I battery commander telescopes and binoculars were loaned for use at Yavapai by the War Department. By 1944, they were dilapidated and nearly beyond repair, as was noted in a memo written by Park Naturalist Louis Shellbach to the Park Superintendent regarding the annual report on the condition of the telescopes. Shellbach suggested requesting replacements from the War Department, noting:

> Considering the length of time that they have been in constant daily use and the excellent service they have rendered the public, there cannot be the slightest doubt as to their value as interpretive mechanisms and as a means of service to the large number of visitors to the Grand Canyon National Park.[14]

At the time of its construction the facility was considered "well adapted for telling the story of the Grand Canyon, its formations, structure and relation to life forms on the earth."[15] In a 1931 memo written by John Merriam regarding the use of Yavapai Station, he noted that the "selection of [geologic] features of interest is of much advantage to the visitor, and it is desirable that opportunity be given the visitor to utilize the data as carefully as possible." [16]

Gardens

Museum gardens were a direct result of the park service's expanding interest in natural history, and parks began to hire resident naturalists to direct interpretive programs and select plantings. Unlike buildings which could be constructed in a single season, it took several seasons to establish life-zone gardens, collections of native wild plants. In the grounds surrounding the Yavapai Point Museum, the planting of an extensive garden of native wild plants was initiated upon completion of the building **(see Appendix E, Figures 24-26)**. By 1931, plants from the Canadian Zone of the North Rim and from the Lower Sonoran Zone within the canyon were flourishing in defined plots along tightly-curved paths studded with local boulders. The rest of the area was landscaped with plants from the Upper Sonoran Zone which is the natural habitat of the South Rim. Not only did the plantings serve an educational purpose, bringing together regional flora and continuing the informative exhibits from the interior, but the gardens and paths became an integral part of the building's design and expression.

Ancillary Structures

When the building was completed in 1928 it did not contain a restroom facility. A comfort station was added as an outbuilding at the time of the original construction. In 1959, the original comfort station was removed and replaced with a new separate building **(see Appendix E, Figure 27)**.

Herbert C. Maier, Architect

Architect Herbert C. Maier had a long career in Park Service construction and management, but began his association with the Park Service designing innovative museums. He eventually played a central role in promoting NPS design as the spokesman on the subject of parks structures.

Maier studied architecture at the University of California at Berkeley. In 1923, he worked for Ansel Hall and the Western Museum Laboratory at the University of California and then became the Executive Agent and Architect for the American Association of Museums. It was during this period that he designed the Yosemite, Grand Canyon, and Yellowstone museums for the National Park Service. Maier became District Officer for the National Park Service Emergency Conservation Work Program in 1933. He later became Associate Regional Director for the Southwest and then Western Regional Office of the National Park Service. Maier received the Distinguished Service Award in 1961 for his contributions to park architecture. Maier's buildings set the standards for NPS rustic architecture in national and state parks.

Maier's museums were unusual in that they incorporated elements common to the residential building type, the bungalow, including battered stonework, clipped gables, and low horizontal lines. However, he left many materials in a natural condition that reflected the scale and roughness of the surrounding landscape. His buildings responded to their sites in their low shapes and appropriately fit the contours of the site. Maier's buildings were perfect solutions for an architecture appropriate to the outdoors: informal through their use of natural materials and horizontal lines, but fused with a strength of design.[17]

Herbert Maier admired Mary Colter and had a special interest in her ability to position buildings on the edge of natural canyons, and to successfully blend native stone buildings with natural rock formations. Maier's respect for Colter's work and anthropological interest in the indigenous architecture of the Southwestern Native Americans is evident in his design of Yavapai.

In 1935, he addressed the conference of state park officials, instructing them in principles of site selection, harmonizing design, and other aspects of construction. Many of Maier's ideas were incorporated into the three-volume work *Park Structures and Facilities* edited by Ohio architect and advisor, Albert

H. Good, and published as a comprehensive statement of NPS design principles. Today, Maier's speech remains the definitive and most detailed explanation of park service design of the 1920s and '30s, illustrating practical and aesthetic principles that had evolved out of the formative years of NPS landscape design. In his speech, Maier outlined the basic tenets of park design, emphasizing schemes that were unique yet unified by principle. Experimentation was encouraged, as was innovation, refinement and above all, a steadfast search for sensible, simple, and pragmatic solutions. Maier defined six simple measures for making structures inconspicuous:

- screening – the siting of structures behind existing plant material or in a secluded nook in the terrain;
- the use of indigenous and native materials;
- adaptation of indigenous or frontier methods of construction;
- construction of buildings with low silhouettes and horizontal lines;
- avoidance of right angles and straight lines; and,
- elimination of the lines of demarcation between nature and built structures.

All six of these principles were fully and successfully incorporated into the design of the Yavapai Point Museum.

According to Linda Flint McClelland in *Building the National Parks*, Maier's greatest contribution to park design was his mastery of rockwork, assimilating both the landscape gardener's emphasis on naturalism, and the architect's vision of the material's construction potential. He recommended the use of naturalistic and natural rockwork to eliminate lines of demarcation:

> One of the principal phases of park development which may be an indicator of appreciation of good installations is the rockworking in general. The rock selected should first of all be proper in scale, that is the average size of the rocks employed should be sufficiently large to justify the use of masonry. In rockwork it is better, due to the scale of the nearby natural features, to oversize rather than undersize. Whether in retaining walls or in buildings, or bridges, it is usually better to employ rough rockwork or rubble, if properly done, than cut stone, and the weather faces of the rock should, of course, be exposed. Rock should be selected for its color, and for the lichens and mosses that abound on its surface as well as its hardness. [18]

Maier stressed the importance of all elevations in park buildings because the public would view and approach these buildings from various directions, a particular concern at the very exposed site of Yavapai Point.

Yavapai Design Altered

The Yavapai Observation Station's first change soon after construction **(see Appendix E, Figures 15, 21-22)**. In 1930, the parapet's straight roofline was altered to achieve a more serrated and naturalistic profile. The buidling remained as it was for two decades until 1953, when alterations were made to address persistent problems. The rehabilitation work was carried out by architect Kim Saunders. Difficulties with the building were varied. The open terrace observation deck allowed the elements to enter causing problems with heating and cooling. Snow drifted on the terrace, piled on the flat roof, and melted to form slippery pools on the concrete floor **(see Appendix E, Figure 28)**. The building was not usable year-round. Seating space on the observation terrace for lectures was insufficient **(see Appendix E, Figures 23, 31, and 35)**.

To remedy these issues changes were made to the building. The window openings were enclosed in glass to seal the building against the elements. The interior rock wall was removed and the floor plan re-configured to increase seating space. And the exaggerated overhanging roof was reduced to form a more uniform line and the parapet height was raised to accommodate the windows **(see Appendix E, Figure 36)**.

The original design's defining feature and function related to the way the structure's parapet wall and exaggerated overhang together framed an expansive and specific panorama. This device maximized wide vistas and created an unparalleled viewing experience. The alteration of this design feature resulted in the building's most significant change and wholly transformed the visitor experience. Additional works in 1978 further diminished the visitor experience, specifically, the replacement of the observation deck windows with polarized tinted glass, among other changes.

Post War Changes within the Park System and Plans for the Yavapai Interpretive Facility

After World War II, Americans increasingly took to the highways to explore the nation's points of interest and traveled domestically rather than internationally due to Post-War isolationism. With increased park usage and popularity, a rehabilitated infrastructure within the parks became necessary. Conrad L. Wirth, a landscape architect and planner who had led the Park Service's Civilian Conservation Corps (CCC) program, became director of the Park Service in December 1951. Facing a system with a deteriorating infrastructure overwhelmed by the postwar travel boom, Wirth responded with Mission 66, a ten-year financial program to upgrade facilities and park resources to coincide with the Service's fiftieth anniversary in 1966. A hallmark of the Mission 66 program was the park Visitor Center, a multiple-use facility with interpretive exhibits, audiovisual programs, and other public services. Fifty-six new visitor centers were open or under construction in national parks by 1960, the earliest of which was Grand Canyon National Park Visitor Center designed by Cecil Doty, completed in 1957.

Forming a part of the history of the Yavapai Point Museum was the 1960s plan to locate a Mission 66 Visitor Center at Yavapai Point, to "replace the small, outdated Yavapai Museum on the rim." [19] Tentatively titled the "Yavapai Interpretive Facility", a project construction proposal for a replacement building was a well developed concept and nearly became a reality. Plans for the proposed Yavapai facility were prepared by Cecil Doty, architect of the Grand Canyon South Rim Visitor Center. **(see Appendix E, Figures 46, 47)** It was thought that a new interpretive facility was needed to accommodate an increasing numbers of visitors, approximately 15,000 persons a day, and that the only solution was new construction on the same site, as opposed to expansion or alteration of the existing building. The proposed Yavapai Interpretive Facility was intended to provide restrooms, a lounge, a lobby, auditoriums, indoor viewing of the Canyon year-round, minimal office and storage space, and information services. The Construction Proposal went on to state:

> Yavapai Point and the facilities here discussed will be devoted to presenting the Grand Canyon Story of deposition, uplift and erosion, fossil records of life through the ages and the Colorado River and its role in the formation of Grand Canyon. Several interpretive approaches to understanding the Grand Canyon must be provided. Two auditoriums [providing nearly identical views of the Canyon and] capable of holding 200 and 400 people respectively and commanding spacious views of the complete stratigraphic sequence shown from rim to river in the Canyon walls are a must.[20]

It was anticipated that Cecil Doty's 1957 Visitor Center at the South Rim would continue to function as an interpretive facility addressing "secondary" themes of history, prehistory and biology and would continue to house the research library, scientific study collections, and the administrative offices of the Superintendent and staff, while the Yavapai Interpretive Facility would be the primary educational facility at the Grand Canyon.[21] The scale of the Mission 66 project proved to be excessive and a lack of funds prevented its construction.

III. Significance and Integrity Evaluation

Statement of Significance

The Yavapai Observation Station is a spectacularly designed example of the Park Service's pursuit of a singular and aesthetically appropriate architecture for the park system. Within the context of the development of rustic architecture, the Yavapai Observation Station best exemplifies the NPS philosophy of melding the built environment into the natural landscape. Additionally, the museum is significant for a wide range of reasons:

- the building is an excellent illustration of the characteristics of Pueblo architecture;
- it is the work of a prominent architect, Herbert C. Maier with influences from Mary Colter;
- the stone work exhibits a high level of craftsmanship; and,
- it was among the earliest interpretive structures in the park system.

The Yavapai Observation Station has played an important role in the evolution of NPS architecture and interpretative structures as the third of the national park museums. The preceding two were also built by Herbert C. Maier. The two preceding structures were both located in Yosemite, the Trailside Museum at Glacier Point Lookout (1924) and the Yosemite Museum (1925). The Yavapai Observation Station captures the essence of the Grand Canyon; it became a model for other interpretive structures in the parks in the way it reflects the special qualities of the place. In his 1938, three-volume edition of *Park & Recreation Structures,* Albert H. Good, an architectural consultant to the National Park Service noted:

> In its architecture the park museum not only offers great opportunity for capturing the spirit and character of an area or region, but it may be said to exist in no small measure for that purpose. Unless there is the flavor of the locality in the structure as well as in the material it houses, it has failed of its particular assignment.[22]

Period of Significance

The years 1928 through 1953 mark the period of architectural significance for the Yavapai Observation Station. Designed and built in 1928 by the park service, construction was considered complete by 1930, by which time the life-zone gardens had been planted and the straight-lines roof modified to reflect a more naturalistic appearance. The building's most important character-defining feature, the open viewing terrace under a deeply cantilevered roof, was altered in 1953, diminishing the architectural integrity and tinkering with the visitor experience. The roof was pulled back to follow a more regular curve and five single-pane windows installed along the elevated parapet. The 1953 campaign significantly affected the structure's architectural character so as to mark the end of the period of architectural significance. While they tell part of the structure's history, they in themselves are not considered historic.

The years 1928 through 1992 mark the period of significance for use as an interpretive facility. The use of the Yavapai Observation Station was modified in 1992 and has served primarily as a bookstore since then.

The Yavapai Observation Station is included on the NPS List of Classified Structures and was nominated to the National Register of Historic Places in 1990. The significance of the Yavapai Observation Station in relation to its role in the development of interpretive structures within the park system is such that it may be eligible as a National Historic Landmark.

National Register of Historic Places Boundary

The boundary of the Yavapai Observation Station historic property encompasses a perimeter 25 feet around the building. It also includes a corridor that follows the rim for 130 feet to the west (encompassing two log benches), 25 feet to the south and returns to the building perimeter. A second corridor follows the rim for 240 feet to the east (encompassing three log benches, the stone wall and vista point), 25 feet to the south and returns to the building perimeter.

Evaluation Of Integrity / Condition

Eligibility for the National Register hinges on both significance and historic and architectural integrity. Integrity is the authenticity of an historical resource's physical identity evidenced by the survival of characteristics that existed during the resources period of significance. Integrity involves several aspects including location, design, setting, materials, workmanship, feeling and association. These aspects closely relate to the resource's significance and must be primarily intact for eligibility. Integrity must also be judged with reference to the particular criteria under which a resource is eligible for inclusion in the National Register.

The Yavapai Observation Station is not in a dilapidated state, but the building has acquired certain features over time that detract from its richness, such as: tinted single-pane windows on the north elevation, visually heavy window frames, an interior altered in plan and function, excess and obsolete wiring visible on the exterior, accumulated equipment on the rooftop, uninspired landscaping, worn paving stones and steps, and weathered wood benches. Decisions related to maintenance have, in general, not been wholly destructive, but have had a somewhat detrimental effect over time. Overall the exterior of the Yavapai Observation Station retains a high level of integrity.

The location of the Yavapai Observation Station has remained unchanged since construction; the building sits in its original footprint and the surrounding natural environment is largely as it was at the time of construction. No other structures impinge on the building. The most significant exterior change to the building is the loss of the life-zone gardens and landscaping which has diminished the integrity of the setting. The installation of tinted single-pane windows, visually heavy window frames, and the removal of part of the roof overhang negatively impacted the building aesthetically and functionally.

The workmanship of the masonry of the original structure is intact and displays a high level of achievement. The building's materials, though aged, are in relatively good condition.

The structure retains significance as the embodiment of the work of various individuals. The building is significant as well for its role in the development of rustic park architecture and interpretive structures. Within the context of the development of the rustic style, the Yavapai Observation Station best exemplifies the National Park Service philosophy of melding the built environment into the natural landscape.

Character-Defining Features

Many of the character-defining features of the Yavapai Observation Station are typical of the Pueblo style. Elements of the design are taken from the geology of the Grand Canyon and indigenous building traditions. As stated above, clever visual devices were incorporated into the design by the architect. All these factors combine to make this a building of unique expression.

Exterior:

- canyon edge siting and screening
- a low silhouette and horizontal lines
- native Kaibab limestone walls, coursed rubble masonry color
- battered walls, buttressed corners
- flared out lower courses, splayed to avoid right angles and clean lines
- deeply raked joints in masonry
- jagged coursed stone parapet following the perimeter of a flat roof
- flat roof in keeping with flatness of rim
- indigenous method of construction
- projecting roof rafters, vigas, embedded into the stone
- whole peeled logs used as lintel over the doors and cornice above
- unpainted posts
- roughly-hewn stone window lintels and sills
- deeply-set windows, small window openings
- doors
- life-zone gardens (no longer extant)
- plantings meant to encroach upon the building to keep building as inconspicuous as possible

Interior:

- open-air terrace, now infilled with single-pane windows
- native stone walls
- four large peeled log support beams
- log rafters
- log purlins
- contour of the floor shaped to mimic the edge of the rim
- concrete floors scored to look like flagstone (no longer extant)
- load-bearing partition wall (no longer extant)

An analytical drawing identifying the primary and secondary spaces of significance within the building, as determined by areas that retain historic fabric and those that reflect alterations is included in **Appendix C**.

IV. Physical Description

Site

Situated on a prominent point on the South Rim of the Grand Canyon, the building's dramatic siting on the Canyon edge is integral to its design and expression **(see Appendix F, Figure 1)**. Flat-roofed and built low to the ground, the one-story stone structure was designed to be particularly unobtrusive in its Canyon rim setting. The structure is located two miles north of the South Entrance Station and half a mile east of the Grand Canyon Village.

Construction

The structure's walls and foundation are principally constructed in native Kaibab limestone boulders. The roof is tar and gravel. Wood is used throughout, in the timber beams, projecting rafters and carved doors rough cut wood siding, laid vertically around the entrances. There are four exterior doors to the building **(see Appendix F, Figures 2, 3)**.

Exterior General

The building is one story and irregularly shaped with a semi-circular observation terrace on the north side. Measuring approximately 40' x 65', the building has a low profile and a flat roof with parapet walls. The principal character-defining feature of the building's exterior is its battered walls and buttressed corners made of uniformly-sized limestone boulders which give the building a rich variation in form, texture, and line. Visually, the splayed lower courses of the building merge into the curbing, paving stones, and landscaping to blur the lines between the built fabric and the natural environment. Other typical Pueblo characteristics are protruding wood vigas on the exterior, small window openings, and timber doors.

West Elevation

The west and east elevations nearly mirror each other. The south-facing door at the west entrance leads directly into the main space of the interior. The interior spaces can be read from the exterior, the lower observation deck at the western half of the building and the former exhibit space toward the rear. Moving back from the rim, the part of the building that houses the exhibit room rises above the lower observation deck. Window treatments at the west elevation differ in accordance with the interior spaces they corresponded to, small openings for the exhibition space and larger openings for viewing. A metal catwalk, used as a service access, rings the west elevation below the window line **(see Appendix F, Figures 4-6)**.

East Elevation

One of two principal entrances, the east entrance leads into a foyer with two windows, one on the east wall and a larger one on the north wall. A steel-frame window and doorway separate the foyer from the observation room. The south wall of the foyer has a stone bench built into it. The east elevation has one small opening, now closed with a wood louver, toward the southern side of the building and three larger expanses of glass toward the canyon side. More pronounced at the east elevation are flared out lower courses of the stone walls; this corner treatment serves to mediate any sharp corners and soften the building's profiles **(see Appendix F, Figure 7)**.

North Elevation

The north elevation dramatically rises straight up from the line of the sheer canyon wall below it **(see Appendix F, Figure 8)**. The defining feature of this elevation are the five large picture windows which form the northern facade.

South Elevation

The south elevation is comprised of coursed rubble walls and introduces the building as an impenetrable fortress with four small window openings, two infilled with a wood louver and two with small panes of glass. All four windows have a solid stone lintel above and solid stone sill below. A regular row of protruding rafter ends punctuates the facade. Three of the buildings four doors are south facing.

Roof

The building's flat roof mimics the horizontality of the setting and the extreme flatness of the canyon rim and recalls the precedent of Pueblo architecture. It is of tar and gravel above the roofline. The parapet roofline does not follow a clean straight line but rather is a crenellated profile, in the manner of indigenous architecture. The roof framing members are round and rough-finished. A low brick chimney, a later addition in the southwest corner, does not rise above the parapet and is not visible from the ground below. Antennas and other equipment have been installedon the roof and can be seen from certain angles **(see Appendix F, Figure 9)**.

Interior

Though the interior was initially laid out as two distinct spaces with different purposes, characteristics and light-reflecting qualities, it is now perceived as one vast room measuring 3,000 square feet. Originally the interior spaces, one open-air, the other closed, dark and cave-like, afforded a contrasting device that distinguished the two spaces and highlighted their distinct purposes of viewing vast distances and closely examining rock specimens. At present, the feeling of the interior is quite changed from the original intent. The building no longer conveys a museum quality since the expansion of the bookstore in 1992. A series of large single-pane windows along the western wall give a sealed-in effect and the carpeted interior lies in place of a concrete floor, scored to look like stone. Rough-hewn wall surfaces and the rocky parapet have been smoothed over in stucco and concrete. The east and west walls of the observation room have corresponding windows that are hinged to open. The rear half of the interior space has solid wall surfaces, is primarily windowless and is filled with book displays and shelving selling books and videos. There are four timber columns in the interior **(see Appendix F, Figures 10-12)**.

More than half of the interior floor space is given over to a number of bookstore features: a cash register, check-out desk, free-standing laminated blonde wood book racks, plastic laminate display and shelving system, and fluorescent uplighters and under-soffit strips. The lighting is designed to highlight the abundance of articles for sale: books, framed photographs, videos, postcards and calendars, all fitting for a bookstore or giftshop. The building's interior imparts a distinct sense of commerce.

Basement

A small storage room is located below the westernmost part of the interior. Perhaps a misnomer to call it a basement, the ground level space occurs as part of the natural rock formation. The space is not accessible from the building interior but only from the cliffside. The "room" probably pre-dates the structure. It appears to be an old mine shaft opening. The door at the north side of the building has a door opening with a single-pane lite.

Landscaping

The landscaping appears rather untended. Although some of the rock outlines of the beds are evident, the life-zone garden has been virtually eliminated **(see Appendix F, Figures 13, 14).**

V. Conditions Assessment

Exterior

Exterior materials and features noted include stone, mortar, wood members, and paving. In general the condition of the stonework is good though there is evidence of biological growth and efflorescence. Given the nature of the use of native stone, it is not surprising that there is some minor cracking and loss of material. Further attention should be given to the boulders at the base of walls where some materials are missing. Exterior stones were originally laid with a mortar that was deeply raked to minimize the visual effect of the mortar. The joints may have been painted with mortar colored slightly darker than the stone. Some loss of mortar was noted. A general pattern of deterioration was noted at the exposed log ends due to weathering and insect infestation. Originally wood elements were probably unfinished or stained. Later painting of the wood elements has served to protect them. Some small window and door frames exhibit delamination and flaking paint surfaces. Exterior doors, originals and replacements, exhibit delamination and flaking paint surfaces. Paving stones are worn especially at building entrances and at the south elevation. Weather-stripping and thresholds at door openings are worn. Exterior wood benches are in fair to poor condition **(see Appendix F, Figures 15-17).**

Interior

As described above, the interior has been altered from its original condition and interior finishes are largely replacements. The condition of the original, scored concrete floor (designed to imitate flagstone paving) and extent to which original material remains after renovations undertaken in 1978 is not known. The existing wall shelving and sales desk in the exhibit room area obscure any remaining original finishes. Window openings have been altered and in-filled **(see Appendix F, Figure 18).**

Roof

The tar and gravel roof is in fair condition. Built-up roofing surfaces, excessive wiring, antennas, obsolete ducting have accumulated on the roof. The parapet shows evidence of mastic repairs along the base and cement repairs along the top of the parapet **(see Appendix F, Figure 19).** Roof flashing, drains, and scuppers are worn and in need of replacement. Should it be decided to remove glazing and leave window openings, further studies are required to assess structural issues.

VI. Chronology of Development and Use

This section summarizes the physical construction, modification, and use of the Yavapai Observation Station. It also includes information on any major maintenance and rehabilitation campaigns. The information presented is based on historical documentation with corroboration from first-hand observation and limited materials analysis. Changes to the building for which chronological documentation is not available are noted and explained at the end of the chronology.

Chronology of Use

The building was constructed in 1928 for use as an interpretive museum and viewing platform for the geology of the Grand Canyon. While is still serves as a space for public viewing, most of the exhibits were removed in the 1970s. The structure currently serves as a bookstore and viewing area.

Chronology of Development / Alterations

1924	Museum recommended for construction in comprehensive plan for the development of Grand Canyon Village.
1927	Design process initiated.
1928	Formal opening ceremony held July 19, 1928.
1930	Masonry added to parapet to alter straight roofline to more serrated profile. Installation of life zone gardens – native plants used for landscaping. Installation of gutter at north side of roof to prevent melted tar from dripping during summer months.
1933-34	Re-arrangement of zone garden. Area between road curb and museum paved with flagstone walks. Rim wall and Yavapai parking area wall installed by the CCC. Underground electric power line installed.
1940	Installation of lightning arresters at roof due to several previous lightning strikes.
1951	Maintenance records note that stone paths in zone gardens should be resurfaced, that the canyon viewing area (to the east of the building) should be paved, and that the rough stone flagging around the building needed replacement. It is not known exactly if or when this work was completed.
1953	Rehabilitation work completed during the winter months of 1953, designed by architect Kim Saunders, includes: • Enclosure of observation deck with five large single-pane picture windows. This work involves removing the top course of the rock guardrail wall at the north end of the observation deck and pouring a concrete cap over the remaining portion of the wall to support the steel frames for the plate glass windows. Due to the window installation, the cantilever roof at the north side was cut back.

- Reroofing.
- Installation of catwalk at north facade.
- Partial removal of interior partition rock wall.
- Installation of thermostat controlled hot air heating plant (used to circulate air during the summer as well).
- Installation of fuel oil storage tank on west side of building, enclosed within masonry wall, connected to the structure.

1954 Original, wood exhibit cases replaced with "standard" exhibit cases.

1959 Ancillary building added - comfort station.

1960 Original (1928) comfort station removed.

1966 New Yavapai interpretive facility, designed by Architect Cecil Doty, proposed for site (never executed).

1977 Interior drinking fountain removed.

1978 $200,000 renovation project. Work includes:

- Replacement of observation deck windows with polarized, tinted glass, new mullions.
- Installation of painted graphic panels below the windows.
- Reconstruction of interior partition wall in rough textured plaster.
- Door to work room from rear of exhibit room sealed to make an unbroken wall.
- Replacement of principal entrance doors, east and west facades.
- Installation of bronze metal thresholds and foot grilles with carpeted treads at doors.
- Construction of a steel-frame window and doorway to separate foyer from observation terrace.
- Original scored concrete floors grouted and covered with carpet.
- Installation of two television screens, supported on concrete stems rising from the floor, in the observation deck area.
- Removal of auditorium seating.

1983 New roof installed.

1992-93 Design and installation of fullsize bookstore, further diminishing the perception of the building as a museum.

1999 Antennas and dishes near the north edge of the roof installed for Y2K. Antennas to be relocated when building is rehabilitated.

Undated Alterations

- Mounted binoculars for viewing from interior parapet wall removed. It is unclear as to whether or not this was part of the 1953 works.

- Televisions removed from observation deck.
- Existing sales desk installed.
- Unbroken wall at south end of exhibit room removed.

VII. Treatment and Use

Introduction

This narrative discusses and analyzes the ultimate treatment and use of the structure as defined by the Grand Canyon National Park. Recommended treatment in general is to preserve the extant historic materials and features, but not to arbitrarily restore missing features unless they are highly characteristic and in need of treatment for other reasons, such as severe deterioration. Any proposed rehabilitation associated with new use will be carefully considered so that existing character-defining features of the site and buildings are maintained.

Through the years, the use of the Yavapai museum has deviated from its original purpose. Originally designed as an interpretive facility for the geology of the canyon, it now serves primarily as a bookstore for the Natural History Association and as a viewing area. There is little interpretive information, only that which keys the names of significant canyon features with the views one sees through the windows. It is the desire of the park to restore the building to its original use as an educational and interpretive facility. To meet these goals, the bookstore function will be removed from the building.

Exterior Rehabilitation

Exterior rehabilitation should be undertaken to restore all of the damaged exterior surfaces that contribute to and define the historic character of the building. Exterior elements that detract from the historic character, such as non-historic exterior doors, should be removed and replaced with elements more in keeping with the original design, as evidenced by historic drawings and photographs. In the case of excess roof equipment, antennas and the like should be obscured from view, either through relocation or reduced scale.

Other exterior work should be limited to maintenance and replacement, in kind, of deteriorated historic fabric. This work includes:

- Replacement of built-up roofing.
- Installation of new roof flashing, drains, and scuppers.
- Cleaning of exterior stonework with a restoration cleaner to remove biological growth and efflorescence.
- Minor stone repointing, taking care not to overpack the joints. Mortar mixture proportions should be verified with a sample of the existing mortar prior to any repointing work.
- Repair and replacement of log vigas. As much as possible, deteriorated log ends should receive dutchman repair instead of complete replacement. All log elements, both old and new, should be

treated with a boratic preservative prior to painting to deter future biological growth.

- All exterior wood elements should be repainted. Original drawings and photos indicate that all exterior log elements were unfinished. However, as these elements are currently painted, and it is not practical to leave them exposed for maintenance reasons, it is recommended that all exterior wood elements remain painted.

- Windows should have all delaminating and flaking paint surfaces sanded and scraped. All sash and frames should be repainted to match the original color. Windows should be repaired to operable condition. All hardware should be rehabilitated and replaced, in kind, where broken or missing.
- Historic, exterior doors should have all delaminating and flaking paint surfaces sanded and scraped. All doors and frames should be repainted to match the original color. All doors should be repaired to operable condition. All hardware should be rehabilitated and replaced, in kind, where broken or missing. The two exterior doors replaced during the 1978 renovation should be removed. Doors that replicate the original, 1928 doors should be installed in their place. All doors (old and new) should receive new weather-stripping and thresholds.

Interior Rehabilitation

The extent of interior rehabilitation will depend on the selected treatment alternative (discussed under "alternatives for treatment"). It is assumed that the design of all exhibits will be undertaken by the National Park Service. As the specific exhibit design is not an architectural issue, it is not discussed in this document. It is suggested that exhibit design reflect original exhibits housed in the building as evidenced in primary source documents within the park archives.

Interior rehabilitation measures common to all alternatives include the painting of interior wood elements and the installation of a new mechanical heating and cooling system (refer to the mechanical building assessment report in the **Appendix I** of this document). The interior carpeting should be removed. It is preferable to restore the original, scored concrete floor. However, portions of this floor were routed-out and grouted during the 1978 renovations and it is not known to what extent the original flooring remains. If necessary, a new topping slab may need to be installed. The existing wall shelving and sales desk in the exhibit room area should all be removed, and the walls restored to their original finishes. Historic photos of the space illustrate the original floor surfaces.

Additional measures needed to make the structure comply with current building codes are described under "requirements for treatment" below.

Requirements for Treatment

In concise terms, this text outlines applicable laws, regulations, and functional requirements. Specific attention is given to issues of handicapped accessibility, human safety, fire protection, energy conservation, and abatement of hazardous materials.

The rehabilitation design shall conform to NPS cultural resources policies and guidelines and will be reviewed for compliance with the GMP, NEPA, Section 106 of the NHPA, and all applicable codes and standards required by law and NPS policy. The building codes used for analysis include the 1997 Uniform Building Code (UBC), 1997 Uniform Code for Building Conservation (UCBC), and Uniform Federal Accessibility Standards.

The treatments recommended in this report will have effects on the cultural resource; however, it is intended that the treatments will result in benefits giving a higher level of preservation of the resource than is now provided. Some proposed work will include actions that could be considered to have negative effects. One of the most important design criteria, however, is that the modifications be designed to minimize these effects, both physically and visually. Those negative effects will be mitigated by providing an improved environment for the preservation of the building and the safety of its users. Further evaluation will be necessary when the recommendations are developed to a level of design detail specific enough to definitively identify specific building fabric impacts.

Accessibility

With the exception of buckling, irregular asphalt pavement along the accessible path of travel, the building meets all accessibility requirements. Exterior paving should be replaced to provide a smooth, code-compliant surface.

Human Safety (Egress)

Because the building is one story, without any ramps or stairs (the one set of stone steps at the south side of the building leads to an inoperable door), it meets most code-mandated egress requirements. The one exception is the height and swing direction of a few of the exit doors, issues that can be exempted with use of the UCBC (refer to the code analysis section of this document for further discussion).

Fire and Lightning Protection

The building is not equipped with a fire detection or sprinkler system. The installation of neither system is required by code, but it is NPS policy to sprinkle historic buildings when they are rehabilitated. According to NPS Director's Order 50B, section 12, article 12.2.A.6, " ... buildings undergoing renovation ... will have automatic sprinkler system protection and automatic fire detection". Depending on the degree of restoration of interior finishes, sprinkler pipes may be concealed above the ceiling or the use of a pressurized water tank or other type of automatic suppression may be considered. A dry pipe system is recommended due to the potential for pipe freezing. Due to the absence of an attic or soffit space, exposed pipes will have to be run throughout the building. The building has been hit by lightning several times. Due to this, six lighting rods are currently extant at the roof. All rods should be inspected and reinstalled once the building is reroofed.

Energy Conservation

The heating and cooling systems are currently inadequate. Originally an open air structure, the enclosure of the observation deck with glazing in 1953 eliminated a major source of natural ventilation. The glass enclosure allows the building interior to heat up significantly during warm, sunny weather and current ventilation is inadequate to exhaust the accumulated heat. This is further compounded by the absence of a partition wall between the observation deck and exhibit hall. When originally designed, the exhibition hall was enclosed on four sides by stone walls with small window openings. This most likely created a dark, cool environment. Now that the wall at the north side of the exhibition hall has been removed, heat that enters the glazed observation deck travels directly into this area of the building.

Solutions to this problem include both the installation of new mechanical systems and the possible rehabilitation of the spaces to their original 1928 configuration (refer to the "alternatives for treatment" section of this document).

In general, all of the utilities are aged and should be replaced. The existing 120/208V 3-phase service is adequate for the planned use. However, the load capacity will need to be reviewed when the air conditioning and other loads are more fully established. All light fixtures should be replaced with new energy efficient lighting systems where possible.

Abatement of Hazardous Materials

Asbestos-based elements and lead based paints are most likely found throughout the interior and exterior of the building. A Level I HAZMAT testing program is recommended for the entire building. All (e) magnetic ballasts should be assumed to contain PCB's and disposed of in accordance with all applicable rules and regulations.

Alternatives for Treatment

This section presents and evaluates alternative approaches to realization of the ultimate treatment. Alternatives are presented in both text and graphic form. Analysis addresses the adequacy of each solution in terms of impact on historic materials, effect on historic character, compliance with NPS policy, and other management objectives.

Three alternatives have been discussed for the future of this building:

- Maintenance Scheme: retain the current configuration.
- Partial Restoration: reconstruct the central rock wall separating the observation deck from the exhibition hall.
- Full Restoration: reconstruct the central rock wall separating the observation deck from the exhibition hall, remove the glazing at the observation deck to restore the open-air porch, and restore multi-paned window at the east elevation. Within the Full Restoration option there are two choices:

- to reconstruct the original cantilever roof at the deck's north side which would be structurally possible but costly; or,
- not to reconstruct the original cantilever roof.

Retaining the current configuration is, most likely, the least costly of the alternatives. The current building plan has been in place for nearly 47 years, while the original was only in place 25 years before the alterations took place. The changes to the plans were originally made to address very important issues: increased space that was needed for audience seating during lectures (the reason for the removal of the stone wall between the two spaces) and the desire to use the building year round (the reasoning behind the glass enclosure). Though these issues may not be as relevant to the building today (the building does not currently house lectures) they do represent educated and thoughtful decisions that reflect the history of the building's use.

Conversely, the alterations do detract from the original building plan. The structure is now perceived as one room, while it was originally designed to be two distinct spaces with different uses. As mentioned previously, the current configuration is most likely the cause of some of the summer cooling problems. While the building is now operable year-round due to the glass enclosure, the interior has, as a result, become much warmer during the summer months. Further, the winter weather issues that initially prevented the building from being operable year round could most likely be addressed with alternative means: radiant heat could be introduced in the concrete floor to melt incoming snow and ice, and the floor could be sloped to drain the melted snow out the north side of the building.

The removal of the windows would raise some safety issues; the low wall at the north side of the room would have to be made taller (42" - legal guardrail height) if the windows were removed. This could be accomplished by rebuilding a taller stone wall or adding a guardrail on top of the existing stone wall. As the original wall was lowered in 1953 when the windows were installed, rebuilding it to its original, taller height would be in keeping with a full restoration scheme. While it is true that immediately outside the building, such heights are not required for site walls immediately rimming the Canyon, it is reasonable to expect that, inside a structure, a greater level of safety should be provided for the occupants.

If it is decided to retain the glazing along the north elevation, one option that would more accurately match the openness of the original design would be to use butt glazing to avoid the vertical mullions. The mullions were added as part of the 1978 works and would not be considered historic as they are outside of the period of significance.

The exterior catwalk would most likely need to be removed as well. If the windows were removed, access to this catwalk would be entirely too easy (and dangerous) for the visiting public. If the windows were removed, the steel and glass storefront between the foyer and observation terrace (installed in 1978) could also be removed, further returning the plan to its original configuration.

Regardless of the treatment alternative pursued, it should be recognized that this structure may be eligible for National Historic Landmark designation. While the park may not be currently prepared to undertake a major restoration of the structure, the significance of the building warrants that the long term goal be to restore it to its original configuration and finishes. To that end, any changes or improvements made to the building before such restoration can be undertaken, should be reversible and pose no harm to the historic integrity of the structure.

VIII. Bibliography

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IX. Endnotes

1 Director's Order 28.

2 The information on native peoples of the Grand Canyon is taken from Michael F. Anderson's *Living at the Edge*, 1998.

3 Information on Spanish exploration of the canyon is summarized from Michael F. Anderson's *Living at the Edge*, 1998.

4 Tweed, Wm. C., Soulliere, Laura E., and Law, Henry G., *National Park Service Rustic Architecture: 1916-1942*, NPS Western Regional Office, 1977. p. 23.

5 McClelland, *Building the National Parks*, p. 291.

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7 Lewis, "Museum Curatorship in the National Park Service," p. 53. 20 Ibid., p.54.

8 "Museum at Grand Canyon", *Coconino Daily News*, 1931. (page and column reference unknown)

9 Merriam, John C. *Memo Regarding the Use of Yavapai Station*, 1931.

10 McClelland, *Building the National Parks*, p. 407.

11 NPS Rustic Architecture: 1916-1942, February, 1977 p. 55.

12 McClelland, *Building the National Parks*, p. 408.

13 "Museum at Grand Canyon", *Coconino Daily News*, 1931. (page and column reference unknown)

14 Shellbach, Louis. Memo for the Superintendent Regarding Conditionof the Telescopes at Yavapai Station, September 14, 1944.

15 ibid.

16 Merriam, John C. *Memo Regarding the Use of Yavapai Station*, 1931.

17 Soulliere, L. *Architecture in the Parks, National Historic Landmark Theme Study*, November, 1986. p. 6.

18 McClelland, *Building the National Parks*, pp. 398-399.

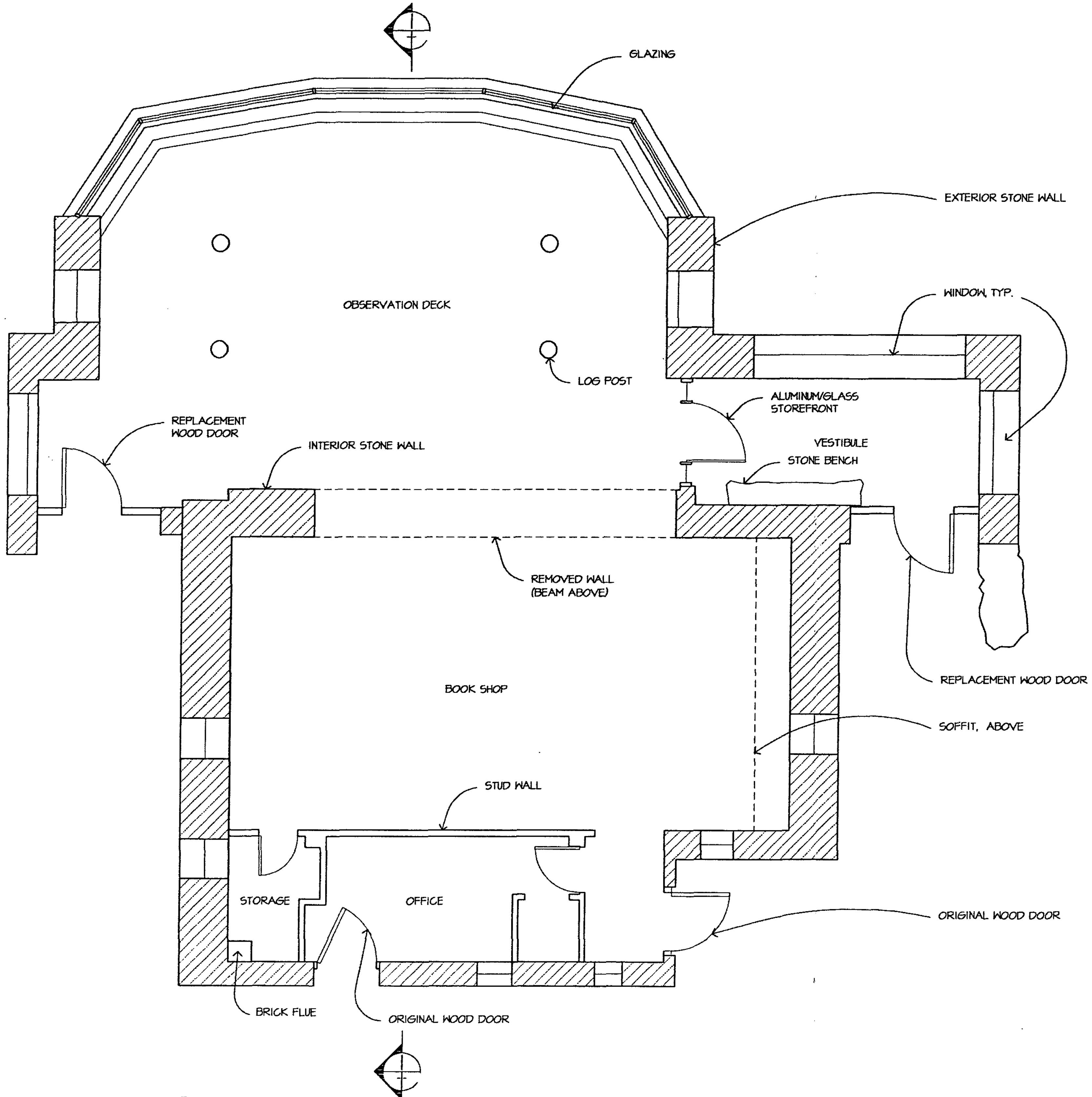
19 NPS, *Yavapai Interpretive Prospectus*, 1964.

20 *Project Construction Proposal for Yavapai Interpretive Facility*, document undated (but most likely to be circa 1966).

21 ibid.

22 Good, Albert H. *Park and Recreation Structures*, Volume II p. 171.

Appendix A. Existing Conditions Drawings of Plans, Elevations, and Section, by Architectural Resources Group, dated April 13, 2001.



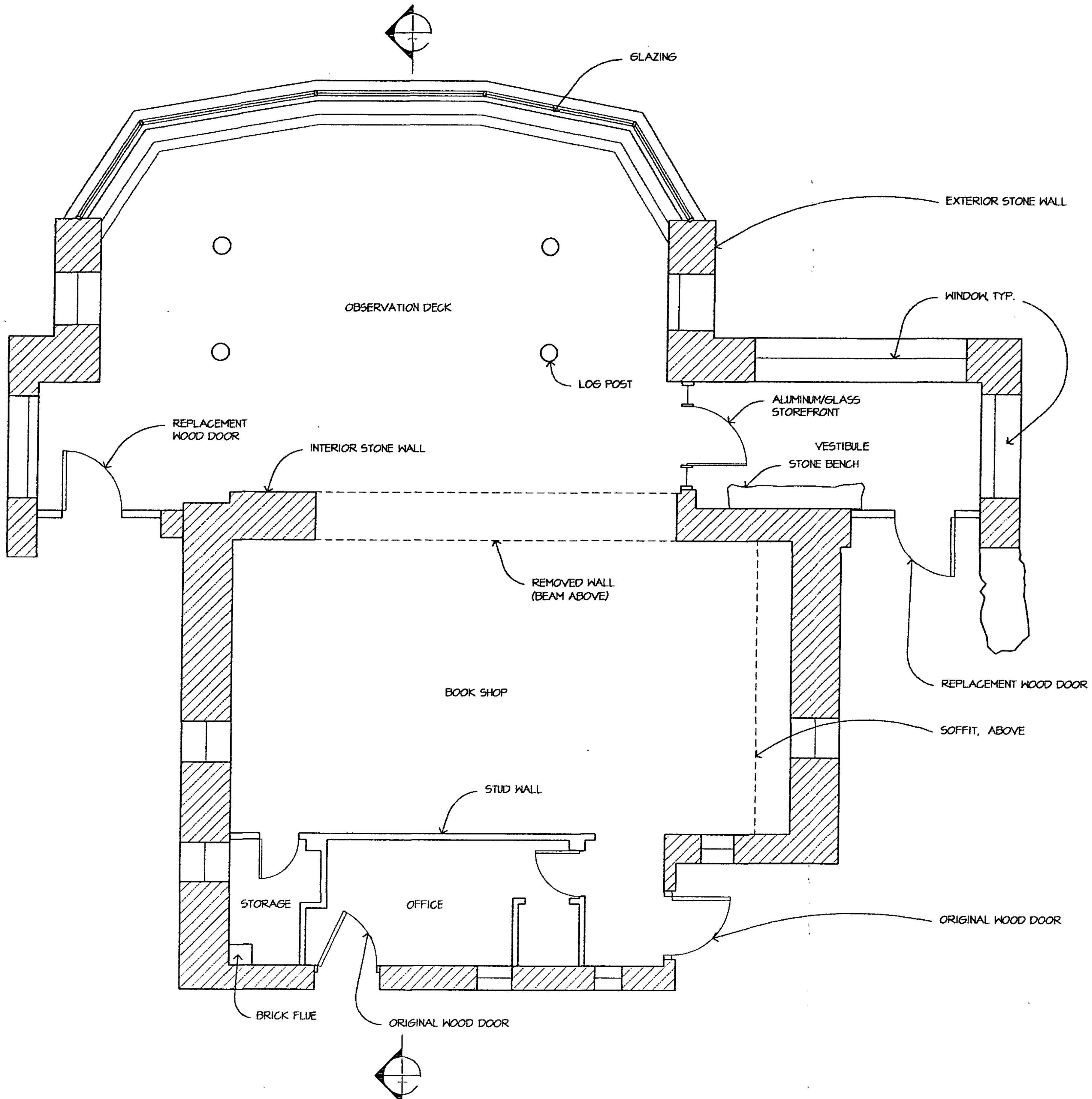
1 A-A- PLAN - EXISTING CONDITIONS
SCALE ⊘

SCALE ⊘ 4 0 4 8
1/4" = 1'-0"

PROJECT NORTH

DESIGNED: WH DRAWN: WH TECH. REVIEW: WH DATE: 4/13/2001	SUB SHEET NO.	TITLE OF SHEET YAVAPAI MUSEUM EXISTING CONDITIONS HSR GRAND CANYON NATIONAL PARK	DRAWING NO. PKG. NO. SHEET OF

ARCHITECTURAL RESOURCES GROUP



1 A-A- PLAN - EXISTING CONDITIONS
SCALE J

SCALE J 4 0 4 8
1/4" = 1'-0"

PROJECT NORTH

DESIGNED: WH	SUB SHEET NO.	TITLE OF SHEET	DRAWING NO.
DRAWN: WH		YAVAPAI MUSEUM EXISTING CONDITIONS HSR	PKG. NO. / SHEET -
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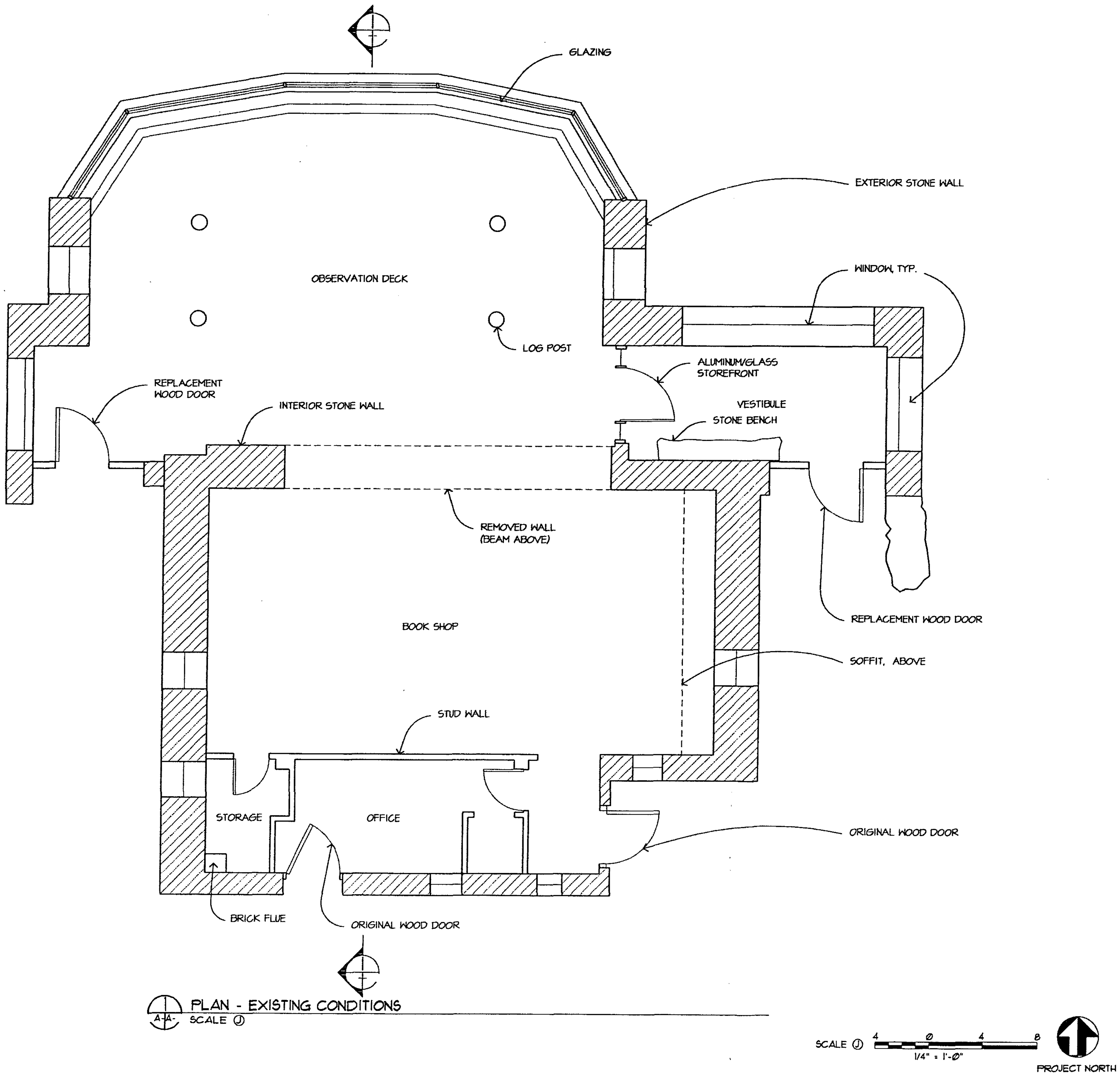

A-A- PLAN - EXISTING CONDITIONS
SCALE ①

DESIGNED: WH	SUB SHEET NO.	TITLE OF SHEET YAVAPAI MUSEUM EXISTING CONDITIONS HSR	DRAWING NO.
DRAWN: WH			PKG. NO. / SHEET
TECH. REVIEW: WH			
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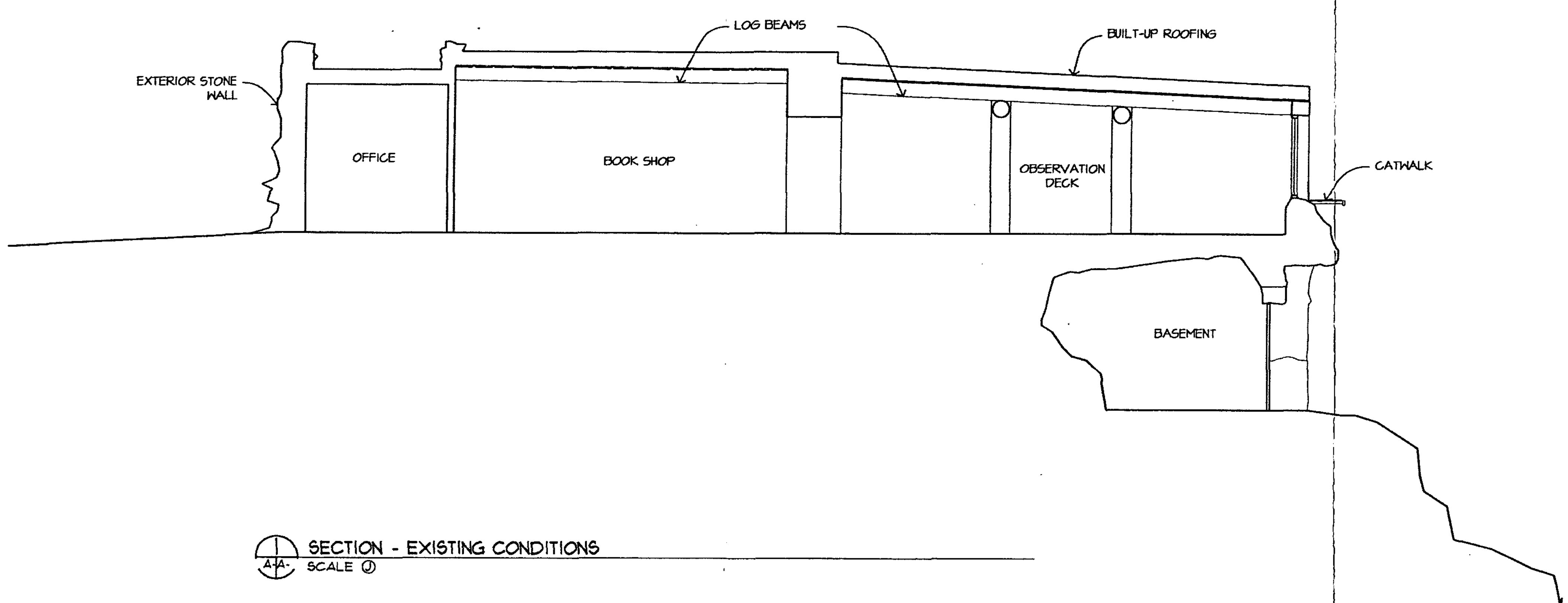

A-A- SECTION - EXISTING CONDITIONS
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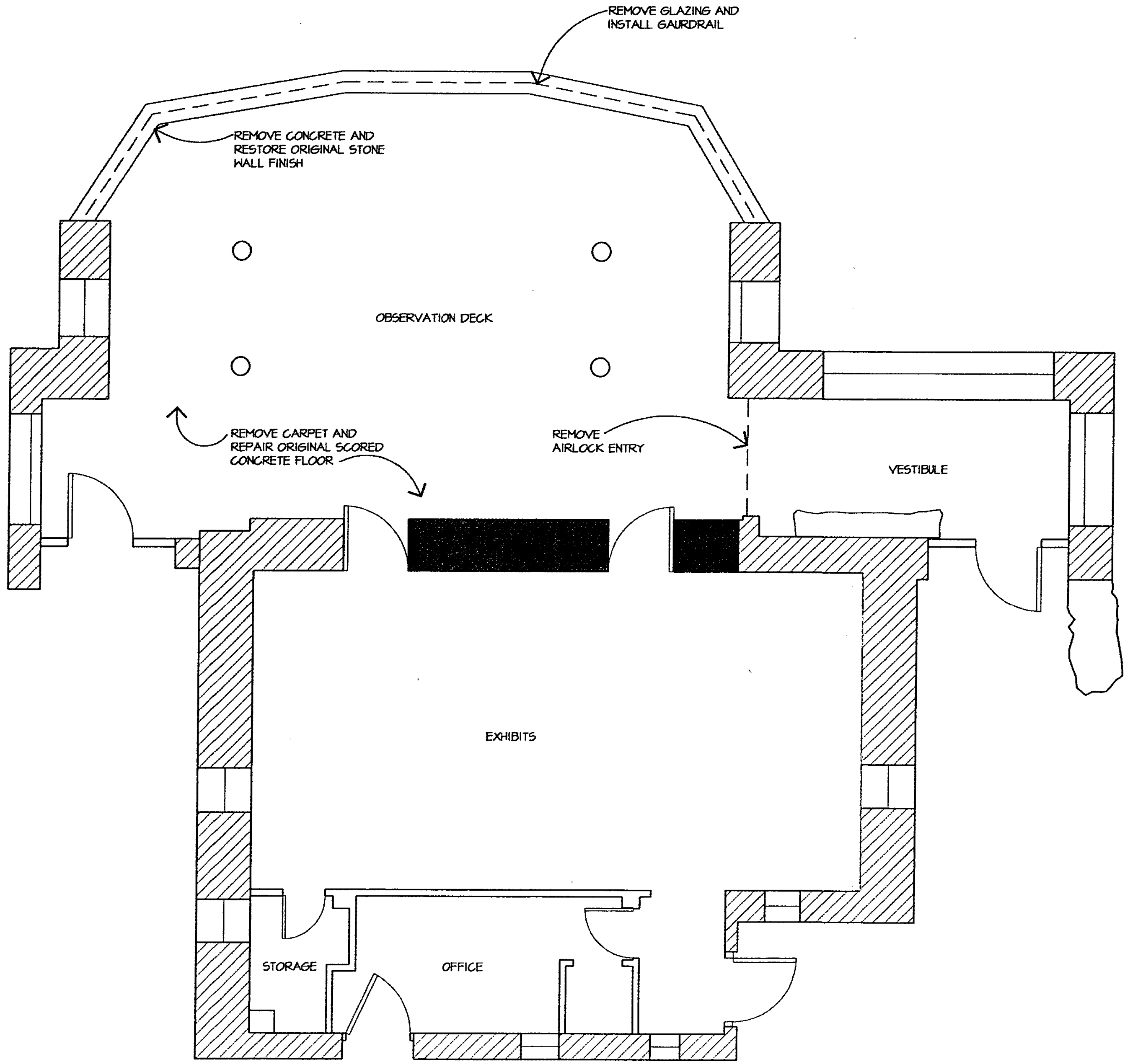
1/4" = 1'-0"

PROJECT NORTH

DESIGNED: WH DRAWN: WH TECH. REVIEW: WH DATE: 4/13/2001	SUB SHEET NO.	TITLE OF SHEET YAVAPAI MUSEUM EXISTING CONDITIONS HSR GRAND CANYON NATIONAL PARK	DRAWING NO. PKG. NO. SHEET - OF -

ARCHITECTURAL RESOURCES GROUP

Appendix B. Drawings Illustrating Alternative Treatments by Architectural Resources Group, dated April 13, 2001.



A-A- ALTERNATIVE #3 - RESTORATION
SCALE ①

DEVELOPMENT ALTERNATIVES #3 - RESTORATION:

RECONSTRUCT PORTION OF STONE PARTITION WALL BETWEEN OBSERVATION DECK & EXHIBITS

REMOVE GLAZING AT OBSERVATION DECK & INSTALL GUARDRAIL

REMOVE CONCRETE FINISH FROM NORTH WALL (AT OVERLOOK) AND RESTORE ORIGINAL STONE FINISHES AT INTERIOR

REMOVE GLAZING BETWEEN VESTIBULE AND OBSERVATION DECK

REMOVE CARPETING AND REINSTALL SCORED CONCRETE FLOOR

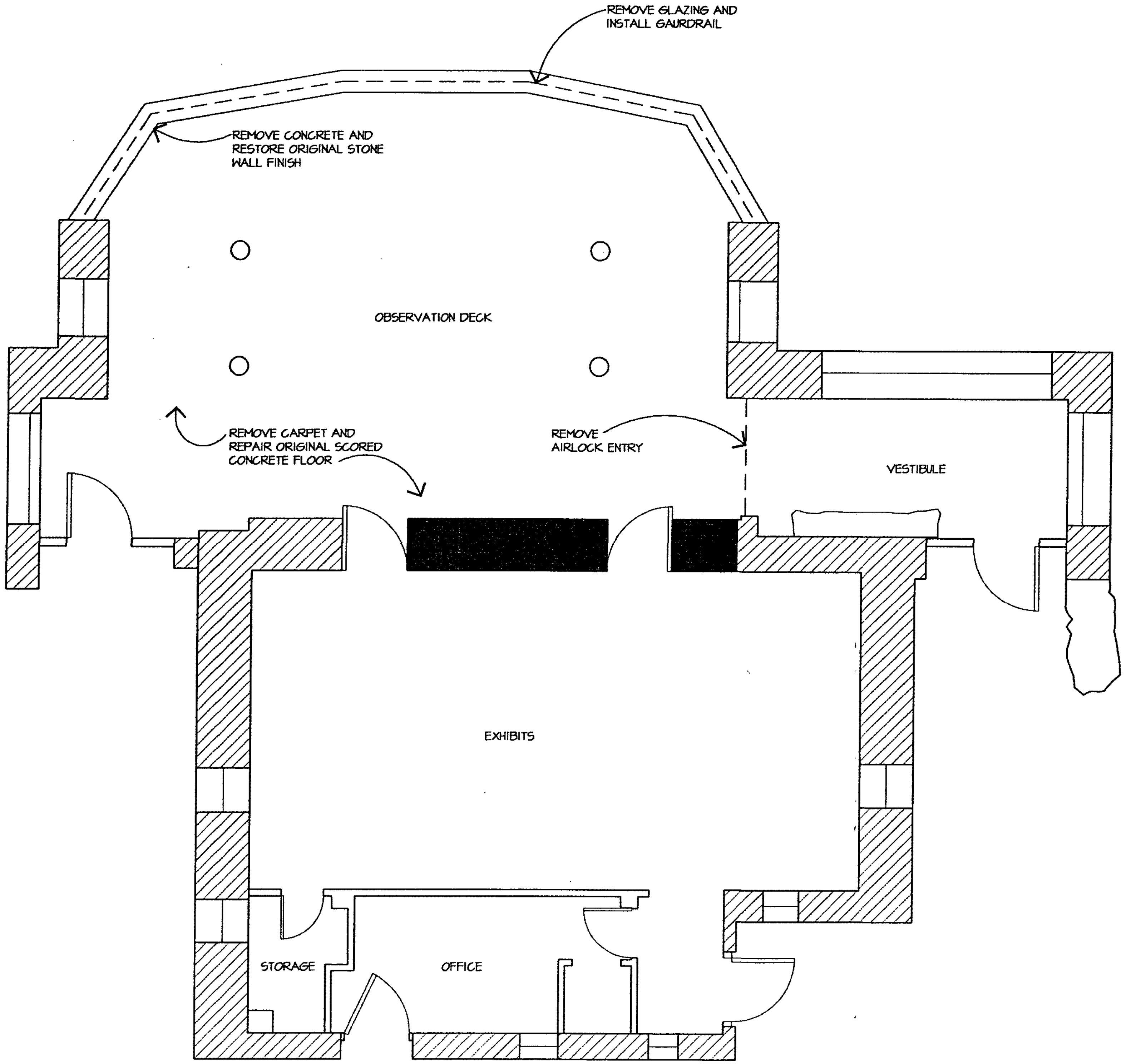
REHABILITATE MATERIALS AS NECESSARY

SCALE ① 4 0 4 8
1/4" = 1'-0"

PROJECT NORTH

DESIGNED: WH DRAWN: WH TECH. REVIEW: WH DATE: 4/13/2001	SUB SHEET NO.	TITLE OF SHEET YAVAPAI MUSEUM DEVELOPMENT ALTERNATIVE #3 HSR GRAND CANYON NATIONAL PARK	DRAWING NO. PKG. NO. SHEET OF

ARCHITECTURAL RESOURCES GROUP



DEVELOPMENT ALTERNATIVES #3 - RESTORATION:

RECONSTRUCT PORTION OF STONE PARTITION WALL BETWEEN OBSERVATION DECK & EXHIBITS

REMOVE GLAZING AT OBSERVATION DECK & INSTALL GUARDRAIL

REMOVE CONCRETE FINISH FROM NORTH WALL (AT OVERLOOK) AND RESTORE ORIGINAL STONE FINISHES AT INTERIOR

REMOVE GLAZING BETWEEN VESTIBULE AND OBSERVATION DECK

REMOVE CARPETING AND REINSTALL SCORED CONCRETE FLOOR

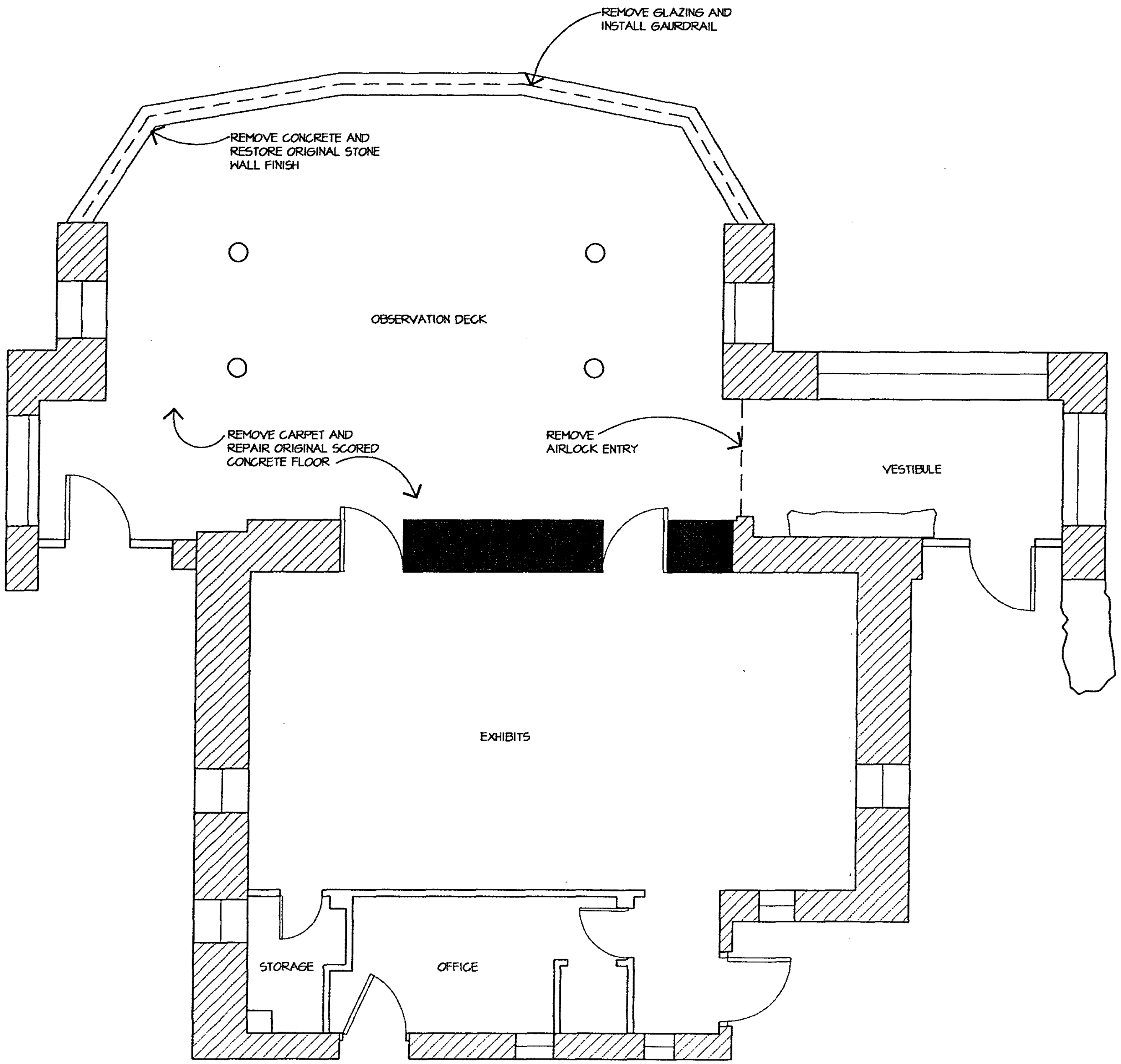
REHABILITATE MATERIALS AS NECESSARY

A-4- ALTERNATIVE #3 - RESTORATION
SCALE ①

SCALE ① 4 0 4 8
1/4" = 1'-0"

PROJECT NORTH

DESIGNED: WH DRAWN: WH TECH. REVIEW: WH DATE: 4/13/2001	SUB SHEET NO.	TITLE OF SHEET YAVAPAI MUSEUM DEVELOPMENT ALTERNATIVE #3 HSR GRAND CANYON NATIONAL PARK	DRAWING NO. PKG. NO. SHEET OF



DEVELOPMENT ALTERNATIVES #3 - RESTORATION:

RECONSTRUCT PORTION OF STONE PARTITION WALL BETWEEN OBSERVATION DECK & EXHIBITS

REMOVE GLAZING AT OBSERVATION DECK & INSTALL GUARDRAIL

REMOVE CONCRETE FINISH FROM NORTH WALL (AT OVERLOOK) AND RESTORE ORIGINAL STONE FINISHES AT INTERIOR

REMOVE GLAZING BETWEEN VESTIBULE AND OBSERVATION DECK

REMOVE CARPETING AND REINSTALL SCORED CONCRETE FLOOR

REHABILITATE MATERIALS AS NECESSARY

A-A- ALTERNATIVE #3 - RESTORATION
SCALE ①

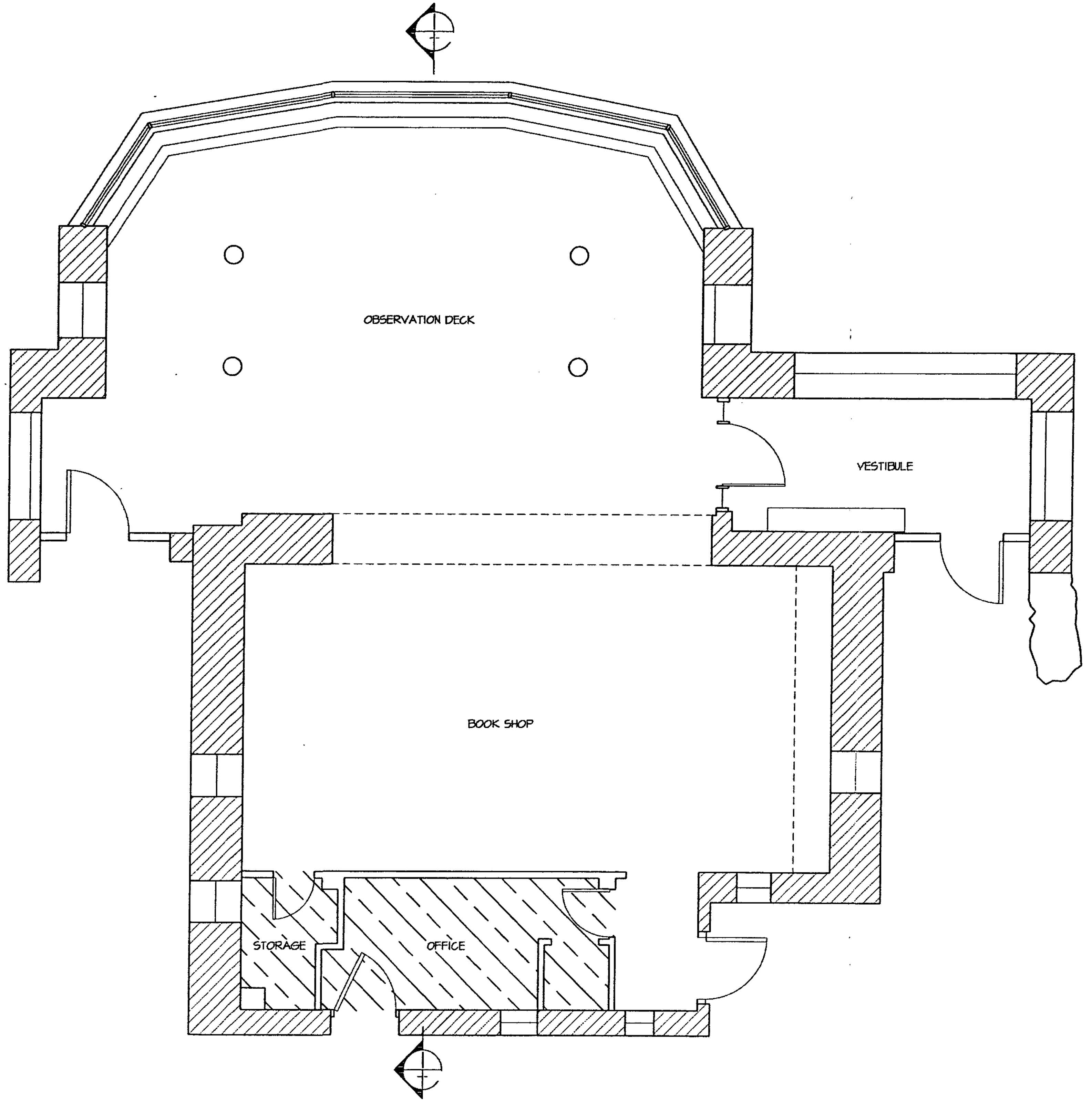
SCALE ① 4 0 4 8
1/4" = 1'-0"

PROJECT NORTH

ARCHITECTURAL RESOURCES GROUP

DESIGNED: WH DRAWN: WH TECH. REVIEW: WH DATE: 4/13/2001	SUB SHEET NO.	TITLE OF SHEET YAVAPAI MUSEUM DEVELOPMENT ALTERNATIVE #3 HSR GRAND CANYON NATIONAL PARK	DRAWING NO. PKG. NO. / SHEET - OF -

Appendix C. Plans Illustrating Primary and Secondary Spaces of Significance within the Building, dated April 13, 2001.



KEY:

PRIMARY SPACE

SECONDARY SPACE

PLAN - PRIMARY SPACES
A-A- SCALE ⓙ

SCALE ⓙ 4 0 4 8
1/4" = 1'-0"

PROJECT NORTH

DESIGNED: WH	SUB SHEET NO.	TITLE OF SHEET	DRAWING NO.
DRAWN: WH		YAVAPAI MUSEUM	PKG. NO.
TECH. REVIEW: WH		HSR	SHEET
DATE: 4/13/2001		GRAND CANYON NATIONAL PARK	OF

ARCHITECTURAL RESOURCES GROUP

Appendix D. Code Analysis.

Preliminary Code Analysis and Accessibility Evaluation

The following codes have been referenced for this analysis: the 1997 edition of the Uniform Building Code; the 1997 Uniform Mechanical Code; the 1996 Uniform Electrical Code; the 1994 Uniform Plumbing Code; and the 1997 Uniform Fire Code. The 1997 Uniform Code for Building Conservation (UCBC) has also been referenced to determine alternative code compliant solutions for historic buildings.

Although not a building code, the Americans with Disabilities Act (ADA) is a federal civil rights law that governs accessibility to buildings for the disabled. National Park Service (NPS) Director's Order 28 requires all historic structures to be made accessible to the highest degree for visitors and employees. Because the intent of the ADA is not necessarily addressed in the building code, a review of a project pursuant to ADA requirements is included in the following preliminary code analyses. The following standards have been referenced for this analysis: ADA Accessibility Guidelines for Buildings and Facilities (ADAAG), amended January 1998, and the Uniform Federal Accessibility Standards (UFAS). Where there is a discrepancy between ADAAG and UFAS, the NPS is required to follow the guidelines that provide equal or greater accessibility.

The classification of historic buildings as qualified historic buildings is typically an important step in the long-term preservation of historic character. Building codes, such as the UBC, prescribe solutions to conditions based on new construction models. When conformance with prevailing codes - such as the UBC - would adversely affect the historic character of a qualified historic building, the UCBC may be invoked as a means to preserve historic fabric and explore solutions that meet the intent, but not necessarily the letter, of the UBC.

As indicated above, the following code analysis is preliminary. To facilitate future design work, this code analysis attempts to cite all major ways in which the building does not comply with prevailing codes. If the UBC and UCBC suggest that a condition may remain subject to verification with the building official, the non-compliant condition is typically noted and qualified.

The classification of program elements (uses) are as follows:

1) Occupancy Classification: Chapter 10 of the UBC establishes the available number of occupants in the building, (a ratio referred to as occupant load) and Chapter 3 outlines occupancy requirements. The following matrix excludes square footages for service areas occupied or used by the occupants of the major rooms; these spaces include circulation (corridors and staircases), toilet rooms, and closets. The rooms discussed below are

shown on the building plans. Based on the table below, the total occupancy load for the exhibit space is 136 people. The total occupancy load for the office space is one person.

Area and Occupancy Matrix

ROOM(S)	AREA (SQ. FT)	USE	OCC. LOAD (SQ. FT / OCC.)	NO. OF OCCS.	OCCU-PANCY
exhibit	2041	exhibit	2041/15	136	A-3
office	124	office	124/100	1	B

Allowable Area / Height Matrix

BUILDING	OCCUPANCY	ACTUAL AREA	ALLOWED AREA (Type V-N Const.)	ALLOWED HEIGHT / (Type V-N Const.)	PERMITTED OR NOT IN BUILDING
Yavapai Museum	A-3	2823	6000	1	Permitted

2) Type of Construction: The existing construction is type V, non-rated, as defined in Chapter 6 of the UBC.

The following is a preliminary code analysis of the Yavapai Observation Station, addressing only major code issues that have a bearing on facility planning issues and including suggested resolutions to broad code issues:

UBC INCLUDING LIFE SAFETY/DISABLED ACCESS REQUIREMENTS	**RESOLUTION OF CODE ISSUES**
Exit doors should swing in direction of travel	Two doors do not swing in the direction of travel. UCBC 605.2 states that this requirement can be exempted for historic buildings.
An accessible route must be provided to an accessible entry	An accessible route is provided to three accessible entries. Paving along these routes is buckling and should be replaced.
According to UBC 1003.3.1.3, all exit doors must be a minimum of 36" wide and 6'-8" tall.	All exit doors are greater than 36" wide. Two of the exit doors are 6'-8" tall, and the third is 6'-3". As only two exit doors are required from this building, she shorter door will not be counted as an exit.

Appendix E. Historic Photographs of the Yavapai Observation Station in Chronological Order.

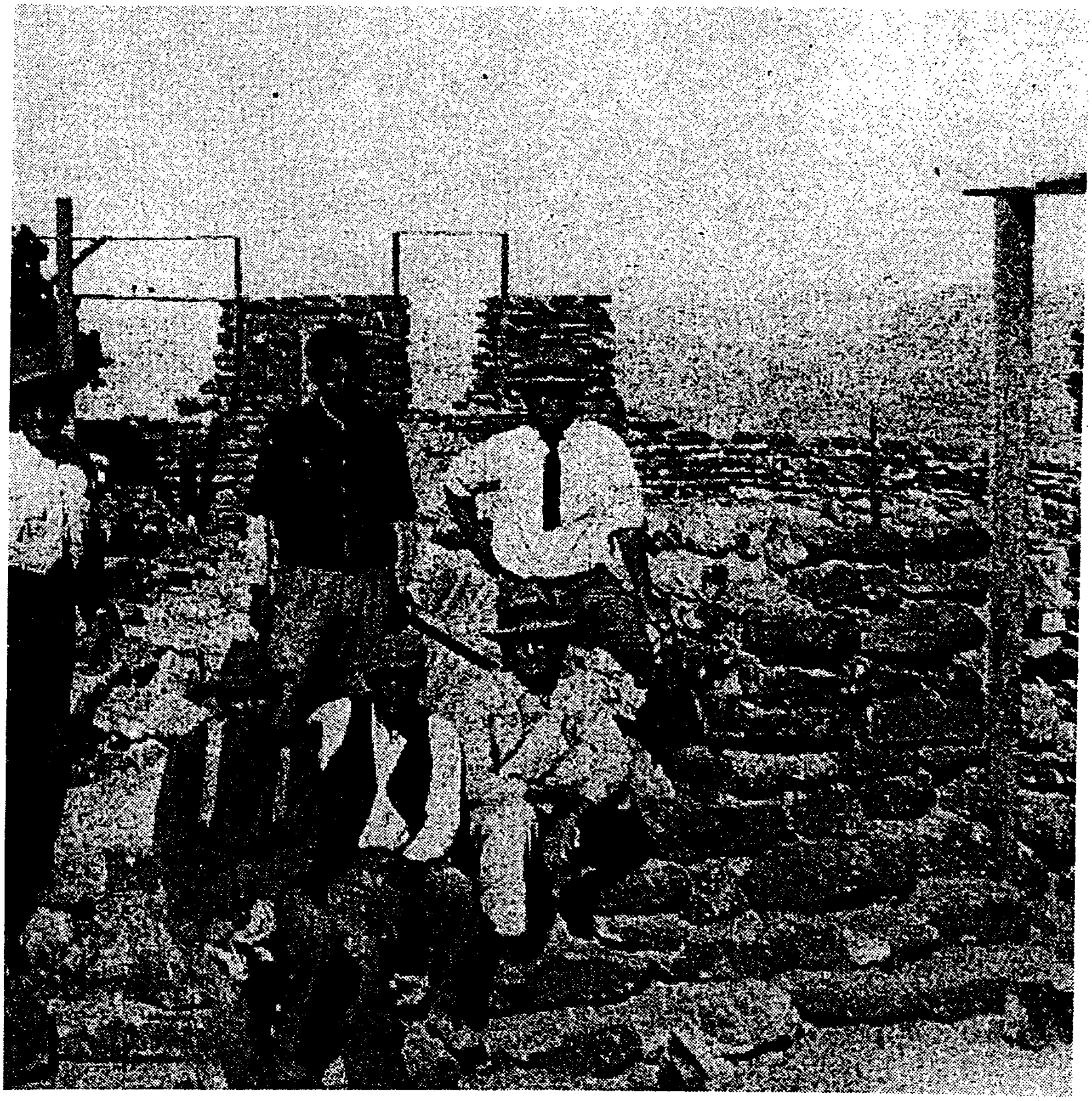


Figure 1. This photo depicts the construction crew in front of the Yavapai Observation Station during construction in 1928. The curve of the open terrace is discernible in the background and the local stones that form the walls are seen rising around the window openings. GCNPA Photo Number 16796.

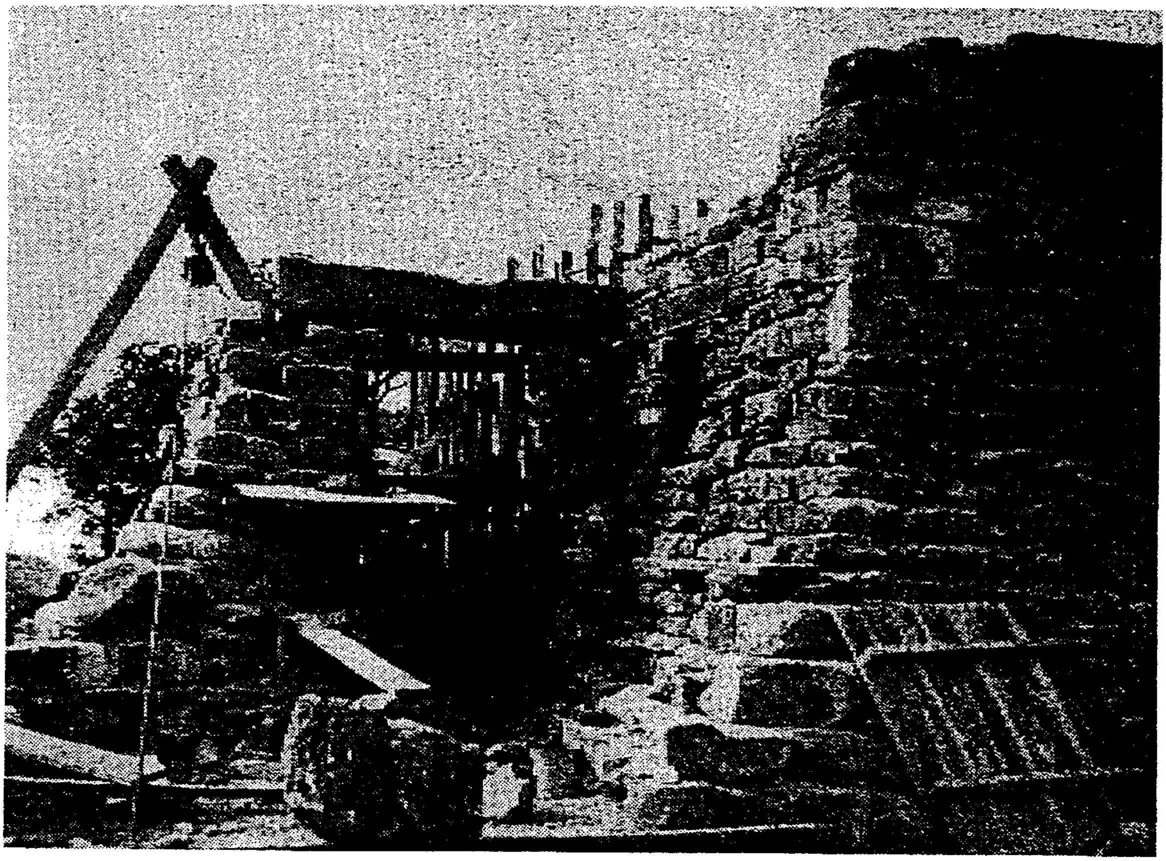


Figure 2. - The image shows the building under construction. The view is looking toward the rear room. Note lintel over opening. GCNPA Photo Number 16793a. Photo dated 1928.

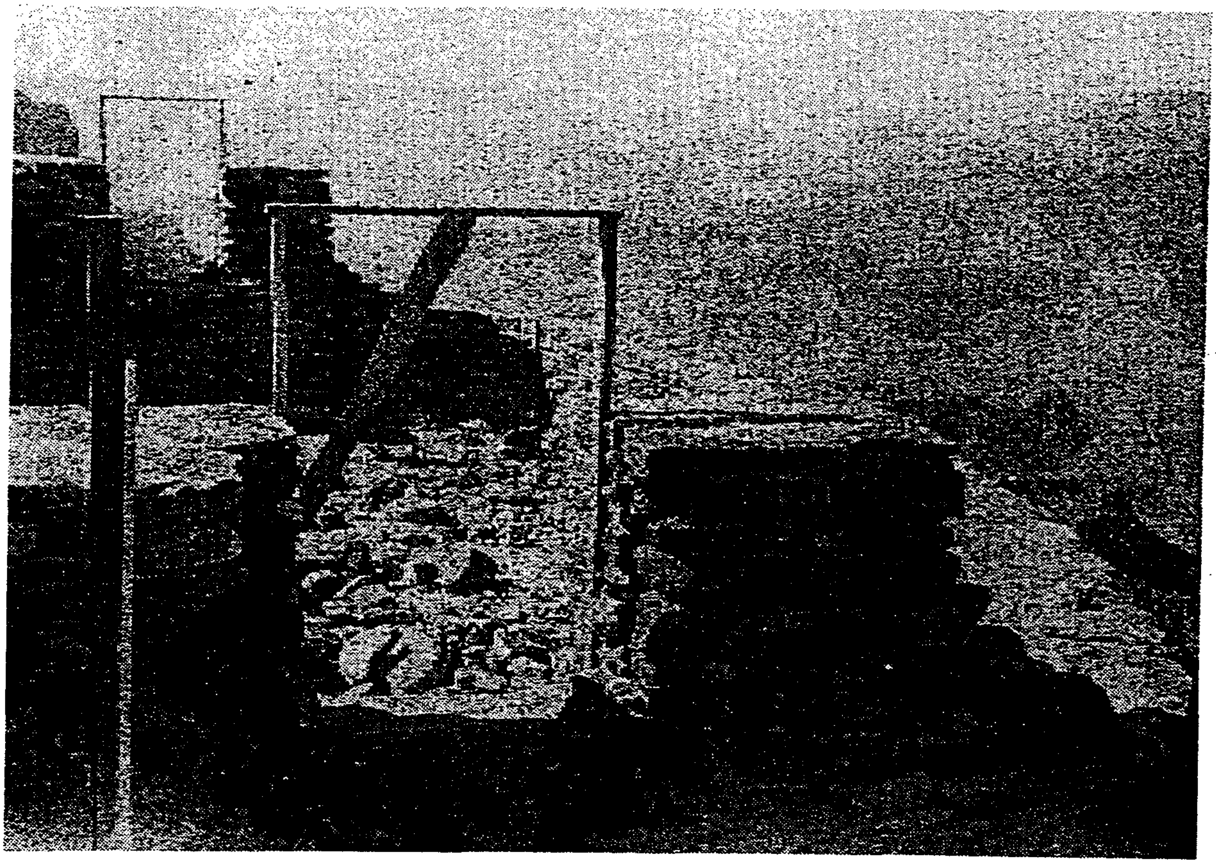


Figure 3. - The image shows the building under construction. The view is looking toward the west and into the space that will become the main observation deck at the Canyon rim. GCNPA Photo Number 16793b. Photo dated 1928.

Figure 4. - The image shows the east side of the building under construction. In the foreground is the ramp erected to take building stones to the top of the structure. GCNPA Photo Number 16794. Photo dated 1928.

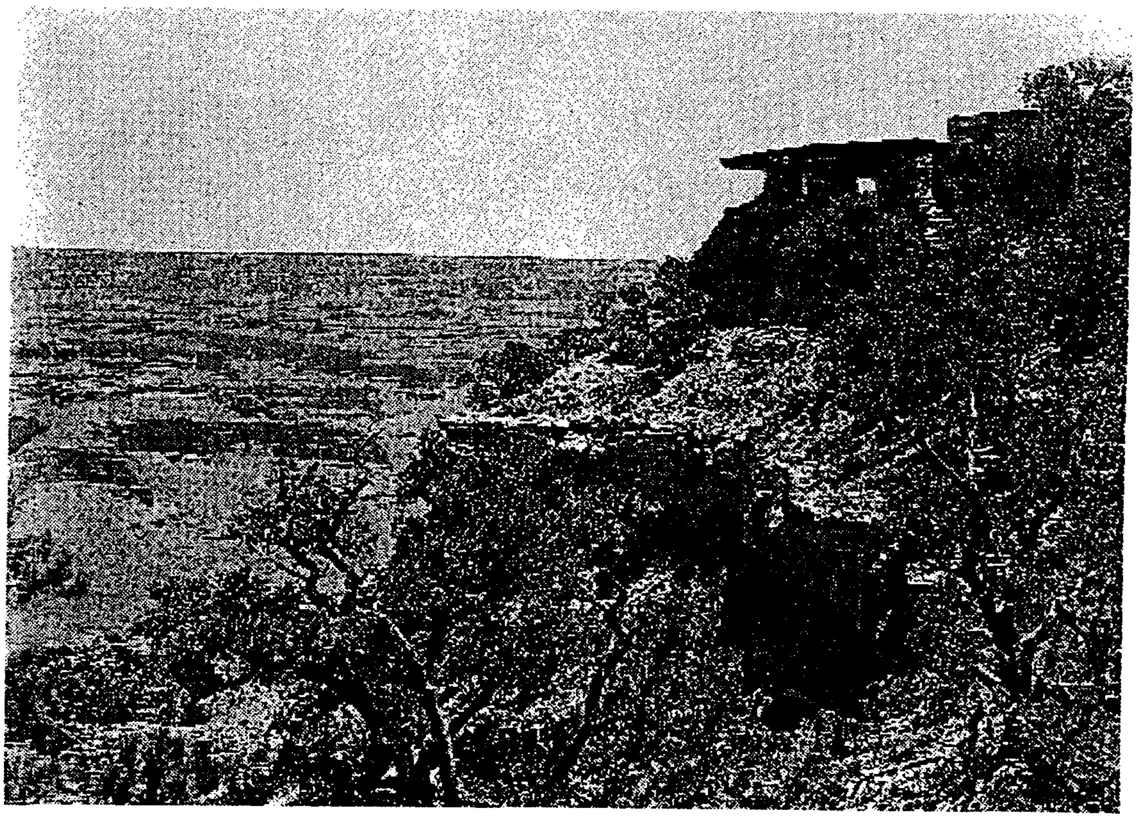


Figure 5. This photo shows the western elevation of the Yavapai Observation Station. The overhanging roof was a more dramatic defining feature before alteration. Photo dated June, 1929. Photographer George Grant. GCNPA Photo Number 9766.

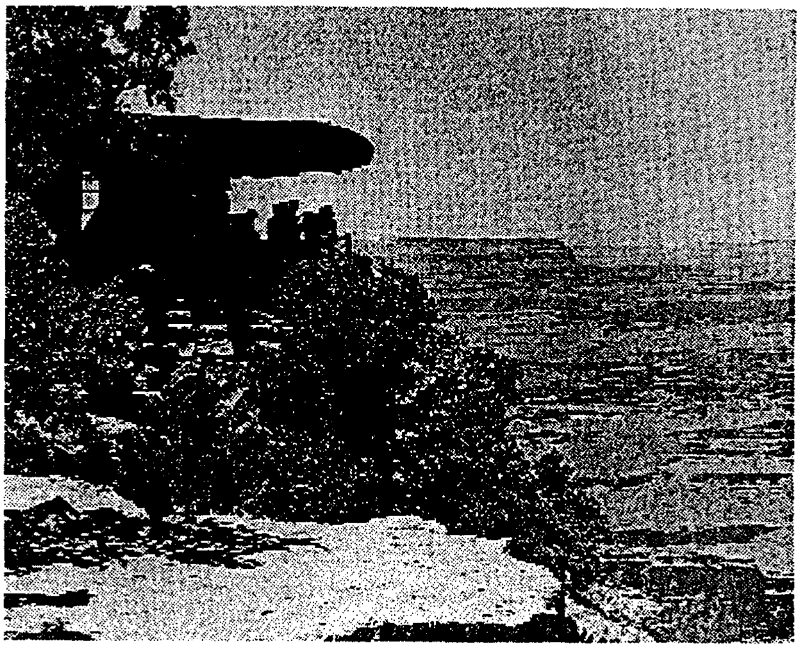


Figure 6. - The image shows figures on the open air deck of the Yavapai Observation Station. View is of the eastern side of the building. Note roof overhang at north side of the building in its original configuration before being cut back. GCNPA Photo Number 9765. Photo dated June 16, 1929.

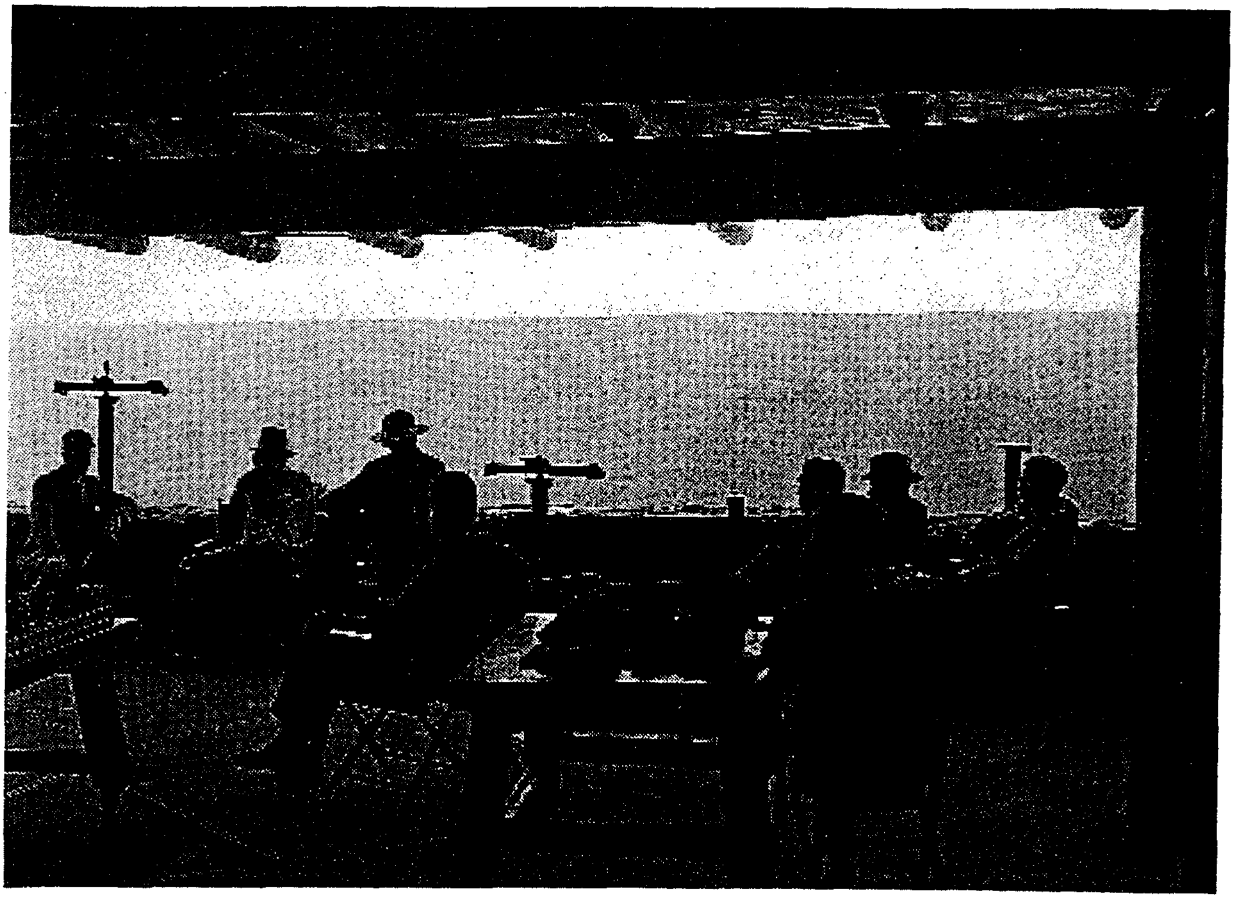


Figure 7. This photo depicts a lecture in progress. It is interesting to note that only three telescopes appear in the photo. Soon after this photo was taken, the park received an additional 13 WWI battery commander telescopes on loan from the War Department for use at the Yavapai Observation Station. Photo is dated June 16, 1929. GCNPA Photo Number 2820.

Figure 8. - The image shows the eastern side of the Yavapai Observation Station. GCNPA Photo Number 9770. Photo dated 1930.

Figure 9. - The image shows naturalist staff of the Grand Canyon National Park in front of the Yavapai Observation Station: (l-r) Dr. Fred Wright, Edwin McKee, Vernon Bailey, and Glen Sturdevant. Note rough stonework in the background that is characteristic of the building. GCNPA Photo Number 17577. Photo dated 1929.

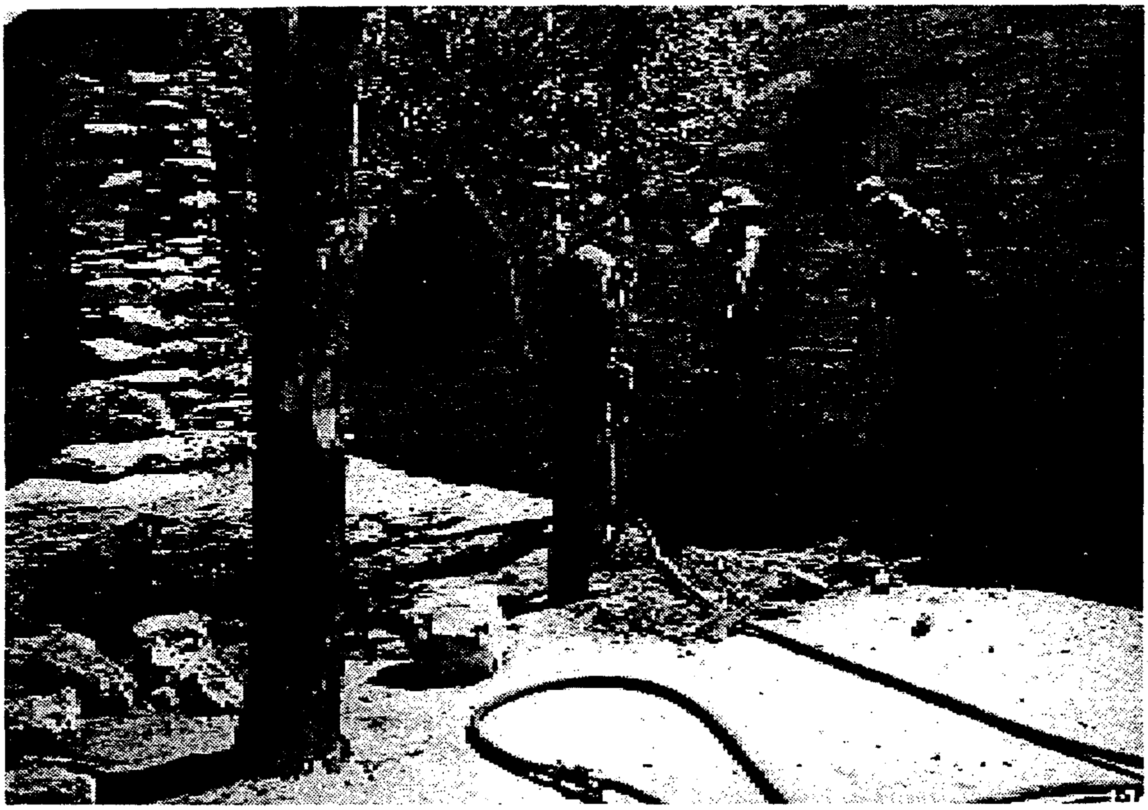


Figure 10. - The image shows the laying of conduit at the Yavapai Observation Station. GCNPA Photo Number 276. Photo dated c. 1930.

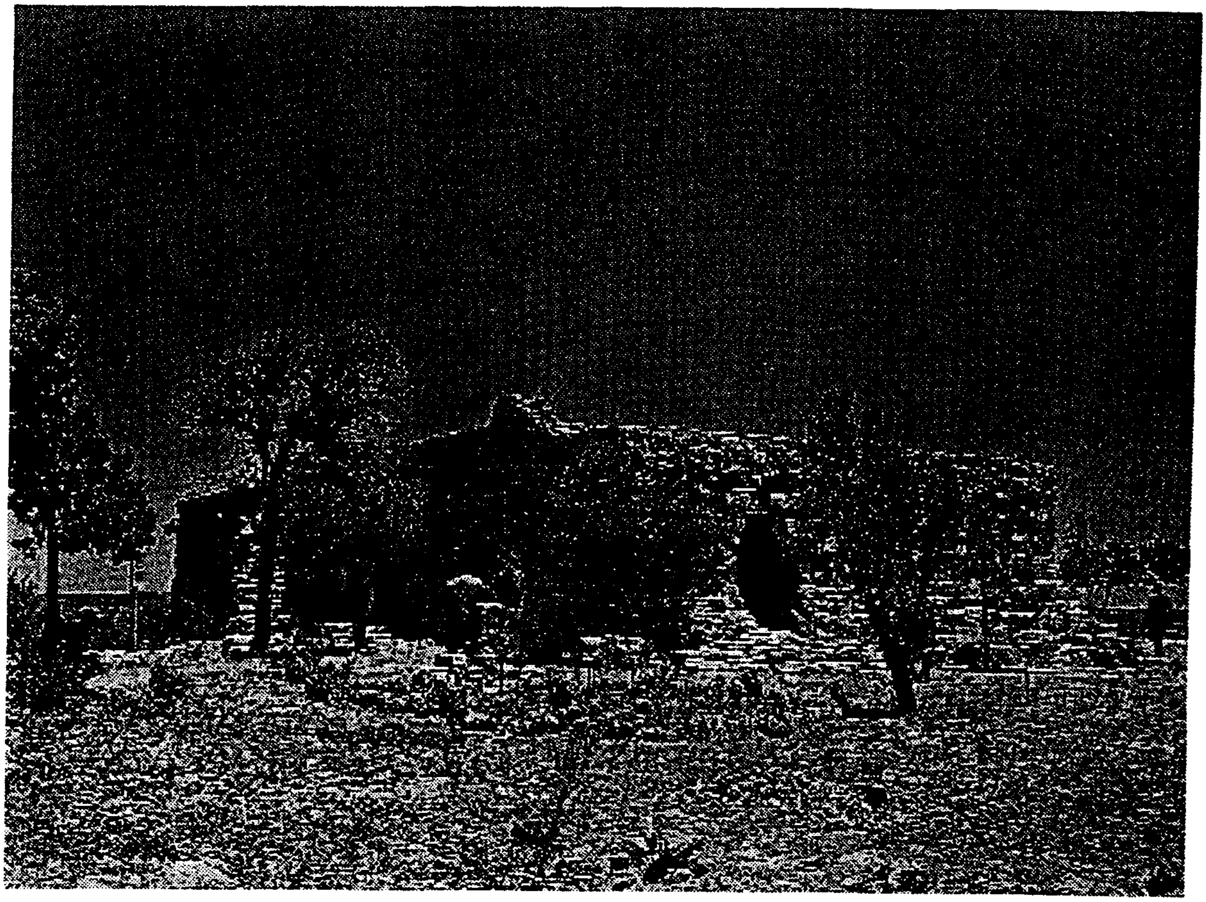


Figure 11. This photo shows the newly constructed Yavapai Observation Station. View is of the south and west elevations. Note people in the foreground at the water fountain which was later removed. Photo is dated June 24, 1929. GCNPA Photo Number 2821.

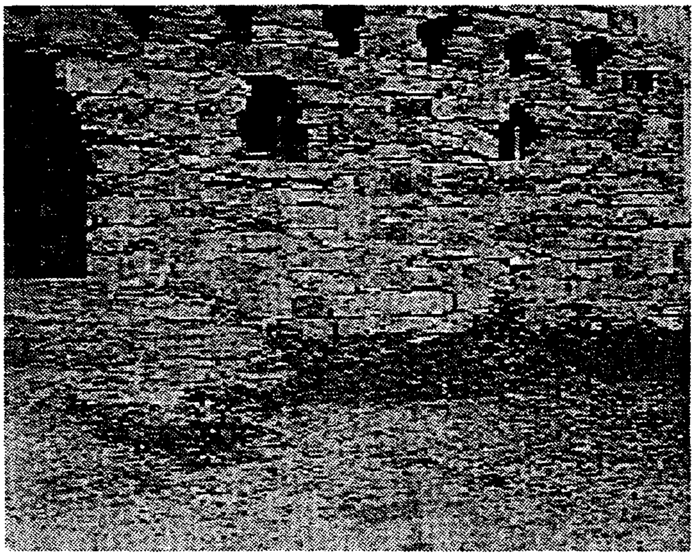


Figure 12. - Exterior view of the Yavapai Observation Station shortly after construction. GCNPA Photo Number 7169. Photo dated 1930.

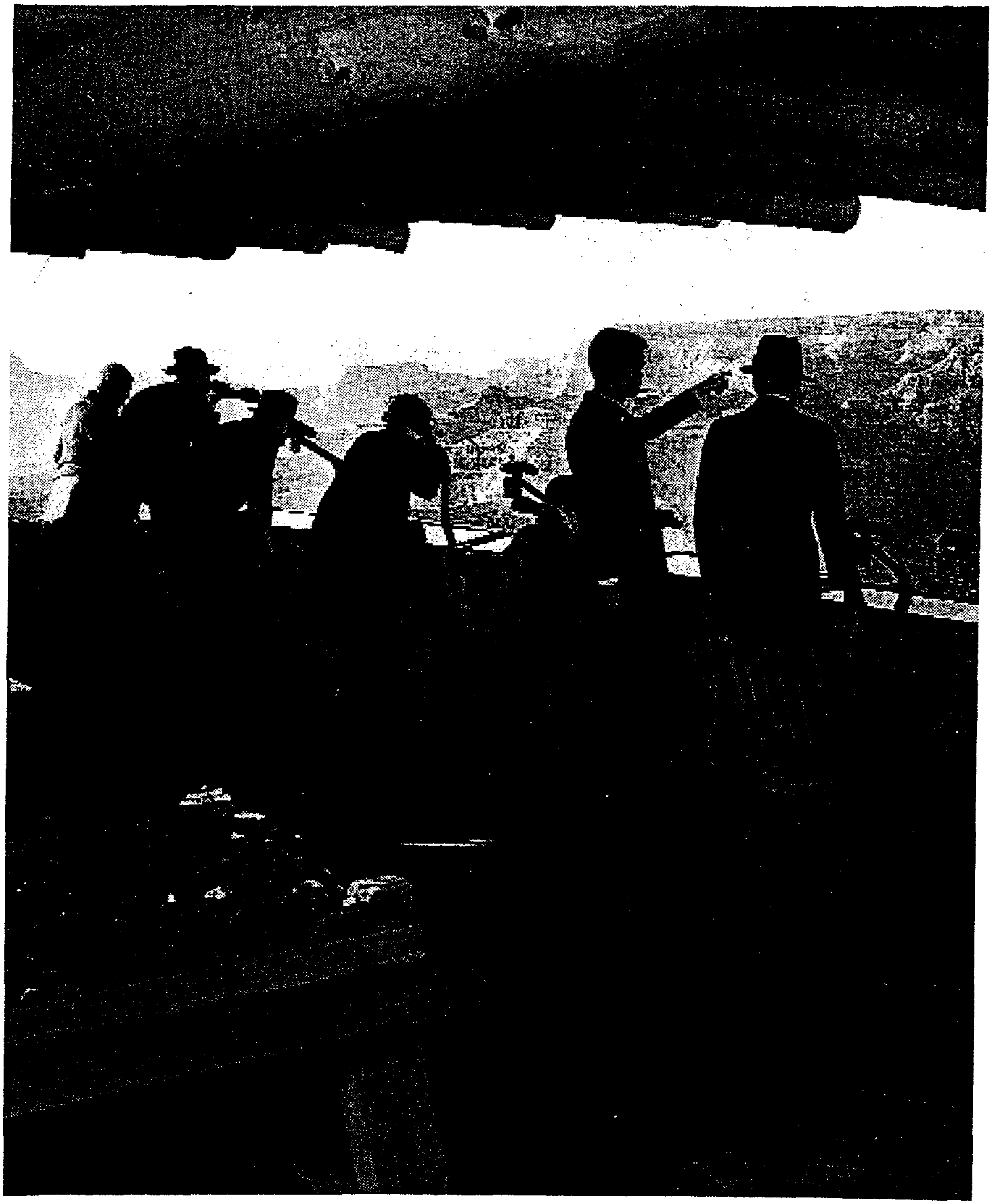


Figure 13. This photo shows park naturalist Edwin McKee (second from right) discussing the canyon with visitors on the open terrace of the Yavapai Observation Station. Photo dated 1930. GCNPA Photo Number 5829.

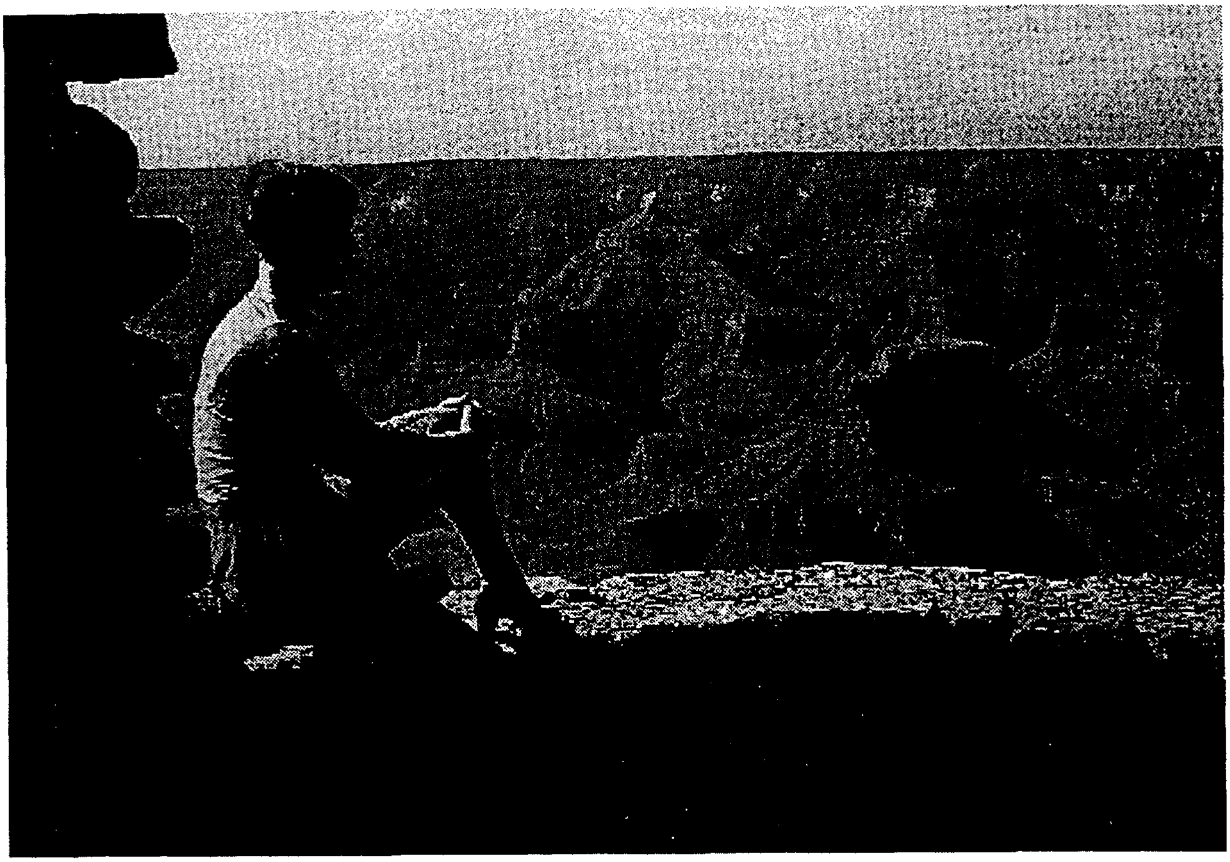


Figure 14. This photo depicts a visitor to the Yavapai Observation Station. She is experiencing the open- air terrace as was originally intended by Architect Herbert Maier. The photographer was George Grant and the photo is dated June 17, 1930. GCNPA Photo Number 12405.

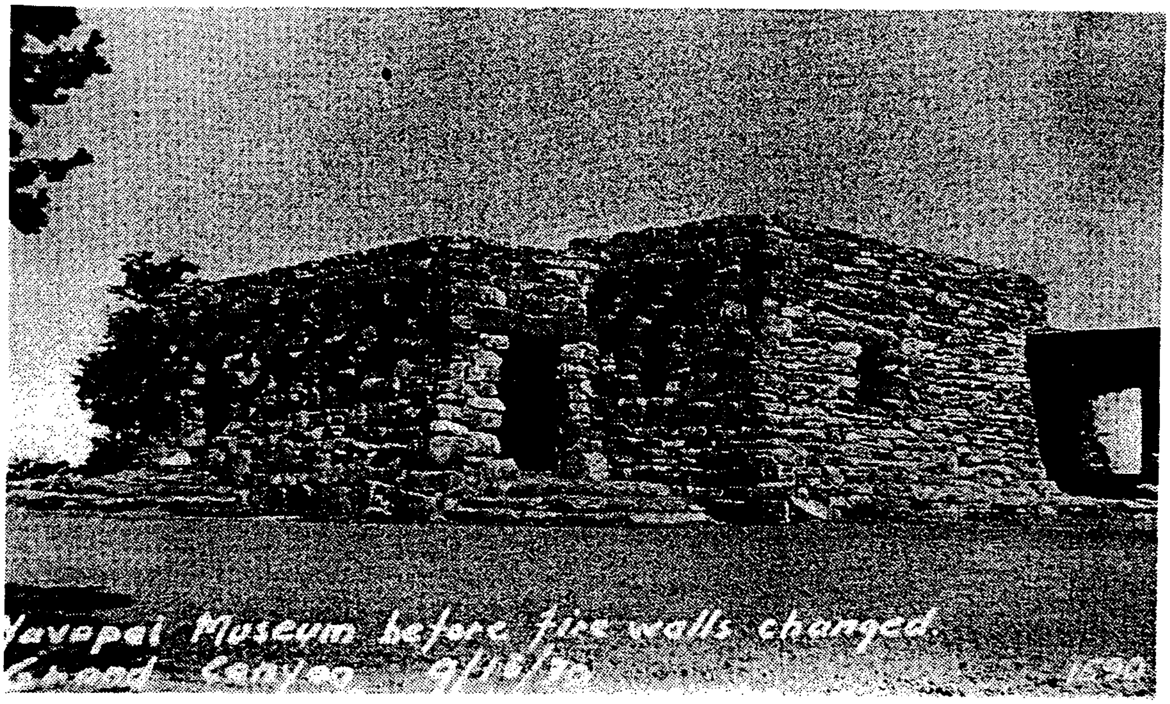


Figure 15. This photo shows the newly constructed Yavapai Observation Station before alterations to add a serrated line to the parapet. View is of the south and east elevations. The photo is dated September 13, 1930. GCNPA Photo Number 16791.

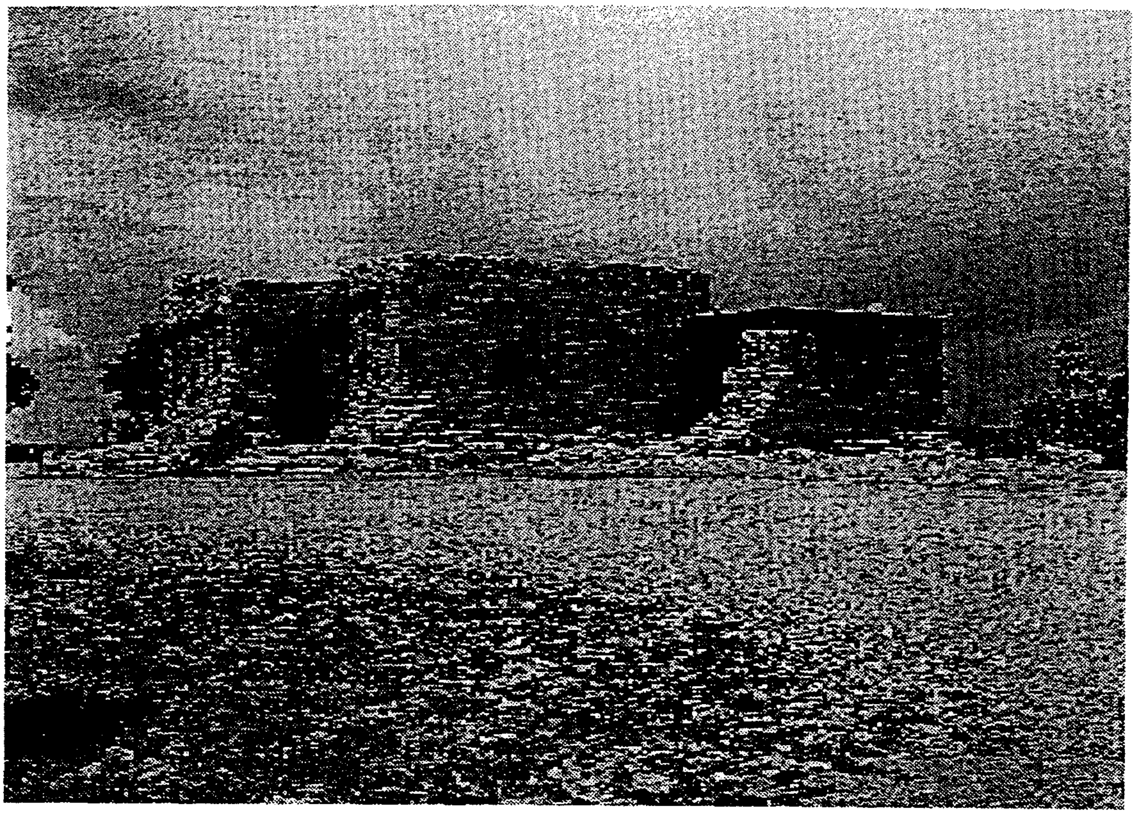


Figure 16. - The image shows view of the east elevation of the Yavapai Observation Station from the southeast. GCNPA Photo Number 9750. Photo dated July, 1930 by George Grant.

Figure 17. - The image shows view of the east elevation of the Yavapai Observation Station. Note the beginning of the rim wall, which was extended to the vista point in 1933. Photo dated July, 1930 by George Grant.

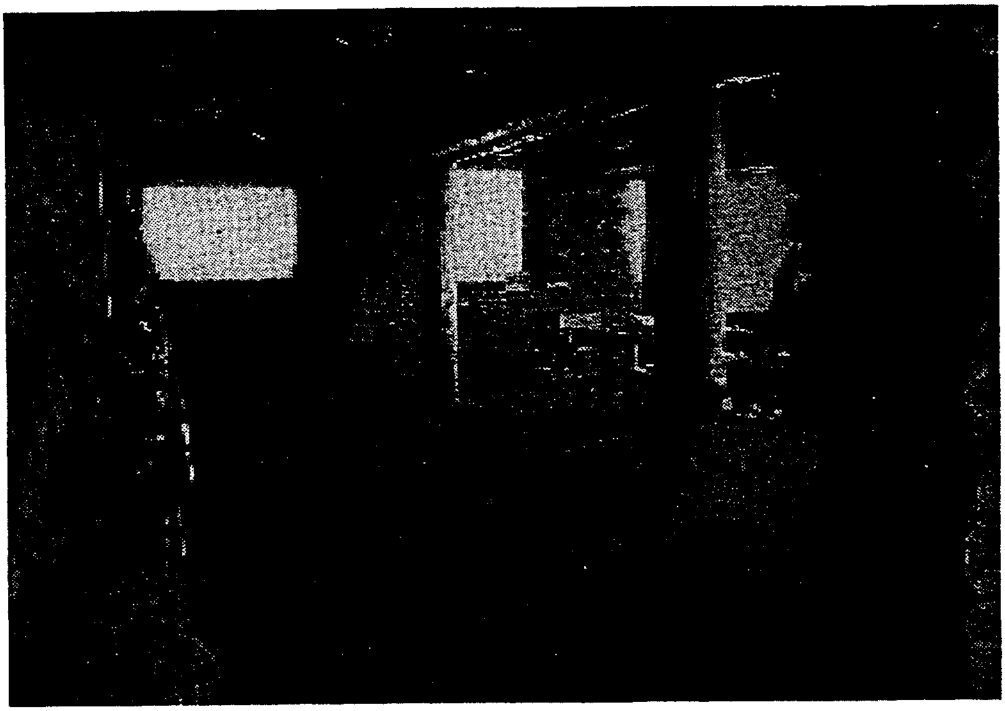


Figure 18. - The image shows the interior of the Yavapai Observation Station. GCNPA Photo Number 9748. Photo dated 1930.

Figure 19. - The image shows the interior of the Yavapai Observation Station. The view is looking north toward the parapet and mounted view descriptions and telescopes. Note flooring scored to imitate flagstone. GCNPA Photo Number 7154. Photo dated 1931.

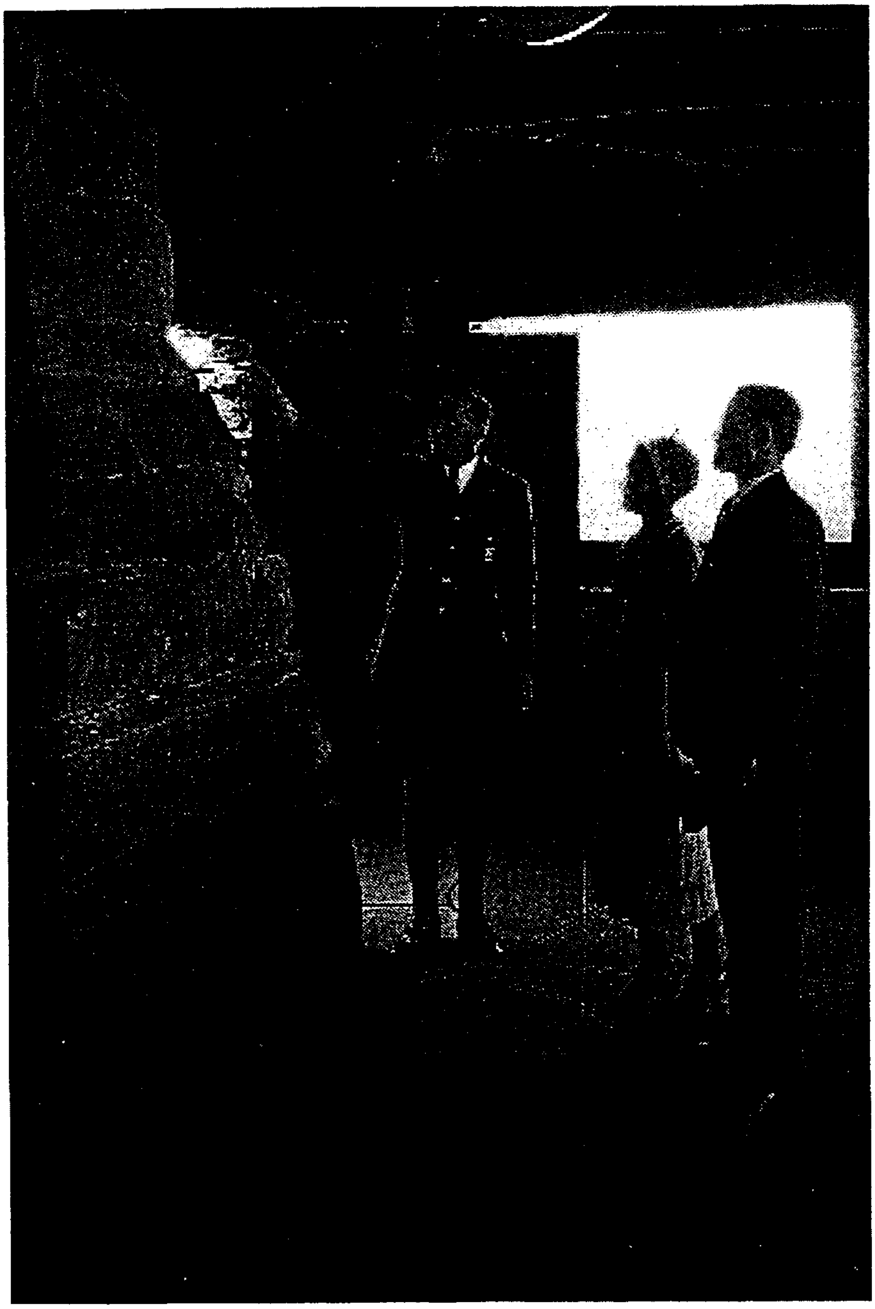


Figure 20. This photo shows Ranger Ralph Redburn and visitors in the interior of the Yavapai Observation Station. One of the prominent features of the interior was the rock wall that showed layers of canyon geology. Photo dated September, 1932. GCNPA Photo Number 5823.

Figure 21. - The image shows a caravan of autos, conducted by park naturalist Eddie McKee, lined up in front of the Yavapai Observation Station. Note distinctive craggy roofline as altered from the original. Note gravel road finish. GCNPA Photo Number 711. Photo dated September, 1932.

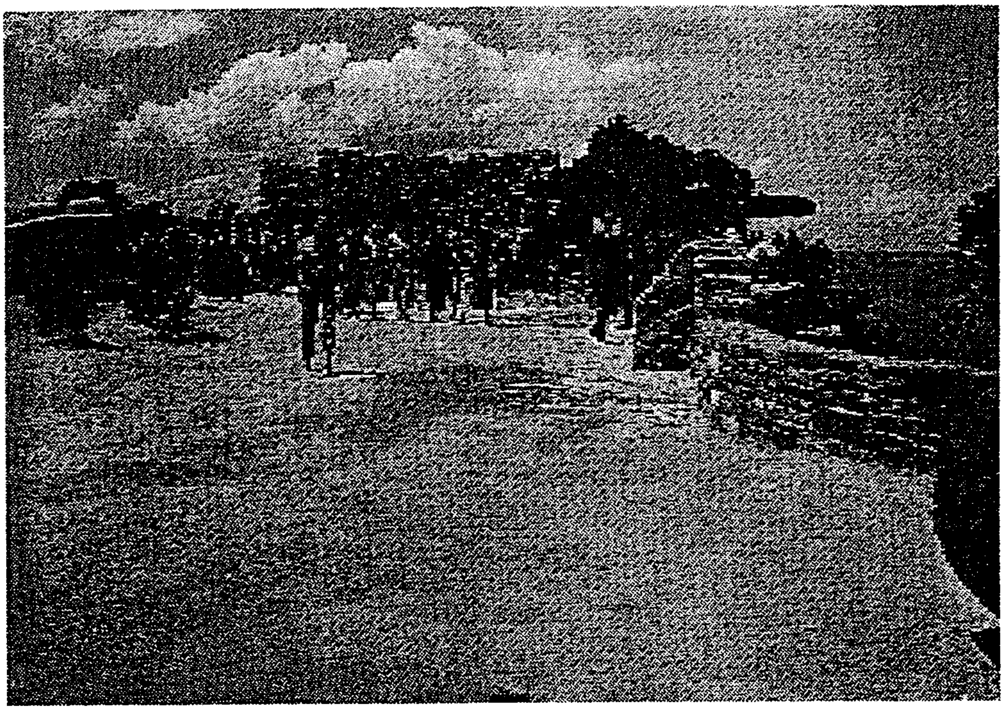


Figure 22. - The image shows park naturalist Eddie McKee in the foreground and the eastern side of the Yavapai Observation Station in the background. Note roof overhang at north side of the building in its original configuration before cropping. Note rough wall constructed to follow the rim. GCNPA Photo Number 9371. Photo dated September, 1932.

Figure 23. This photo shows Ranger Ralph Redburn addressing visitors on the open terrace of the Yavapai Observation Station. As seated visitors peer out into the canyon, it is evident why the parapet was originally kept so low. Photo dated September, 1932. GCNPA Photo Number 5825.

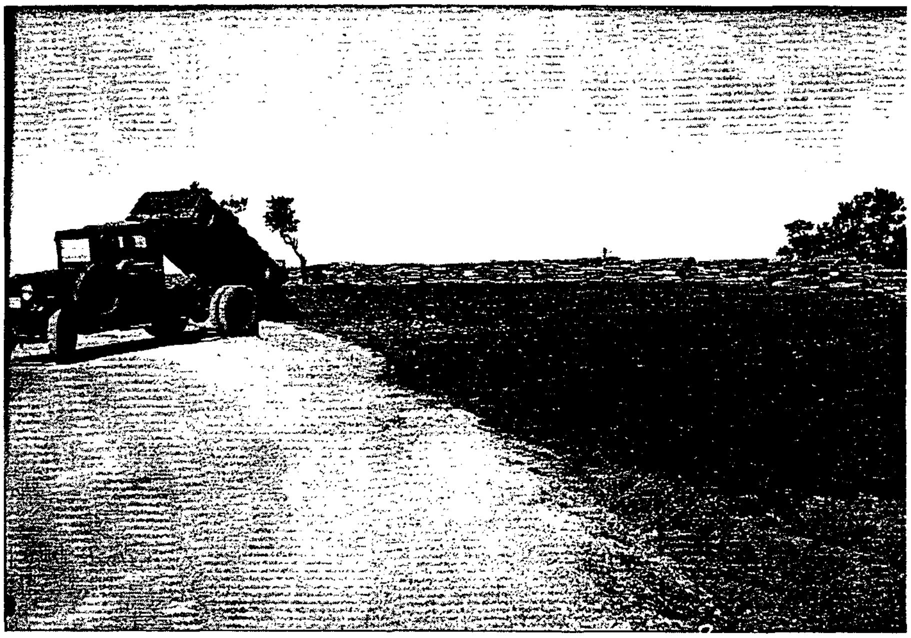


Figure 24. This photo shows landscaping in progress and the completion of the rock wall at the Yavapai Observation Station. Note curbing. Photo dated 1933. Photographer unknown.

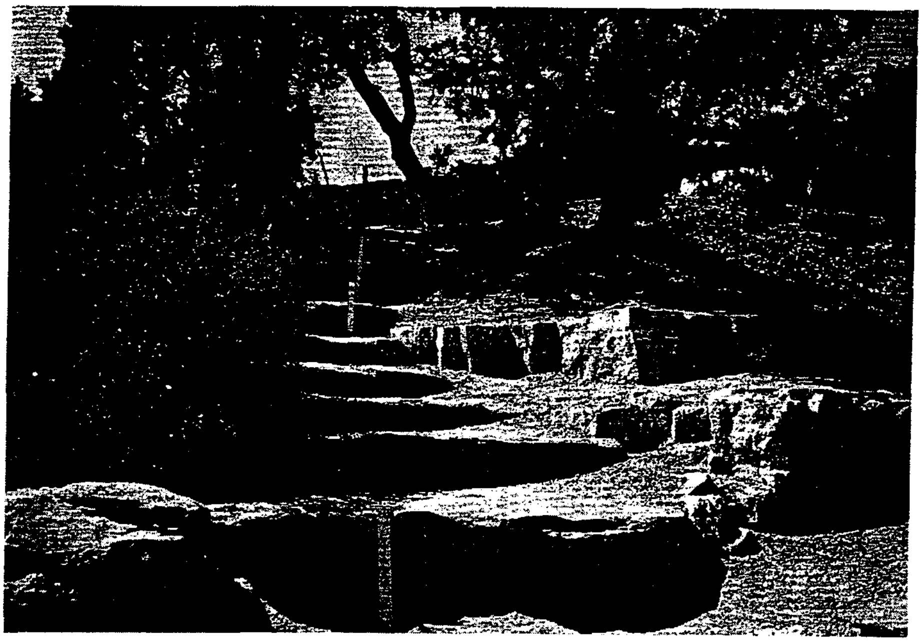


Figure 25. This photo shows new landscaping and the steps to vista point at the Yavapai Observation Station. Photo dated 1933. Photographer unknown.

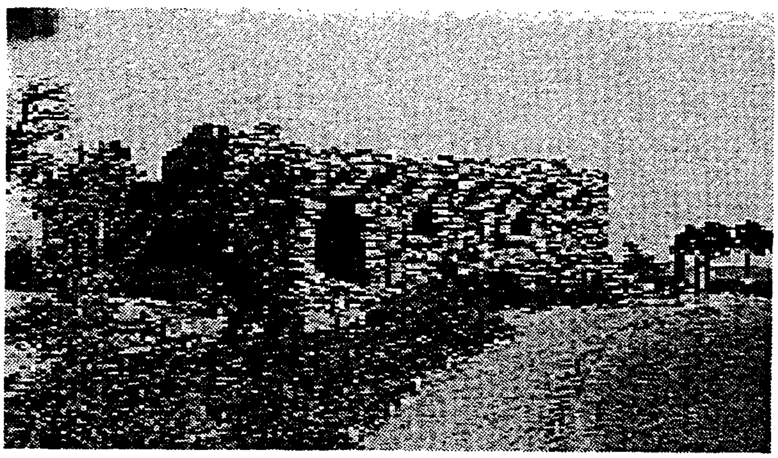


Figure 26. - The image shows the building after landscaping and the installation of curbing. The view is looking toward the north. GCNPA Photo Number 7225. Photo dated 1935.

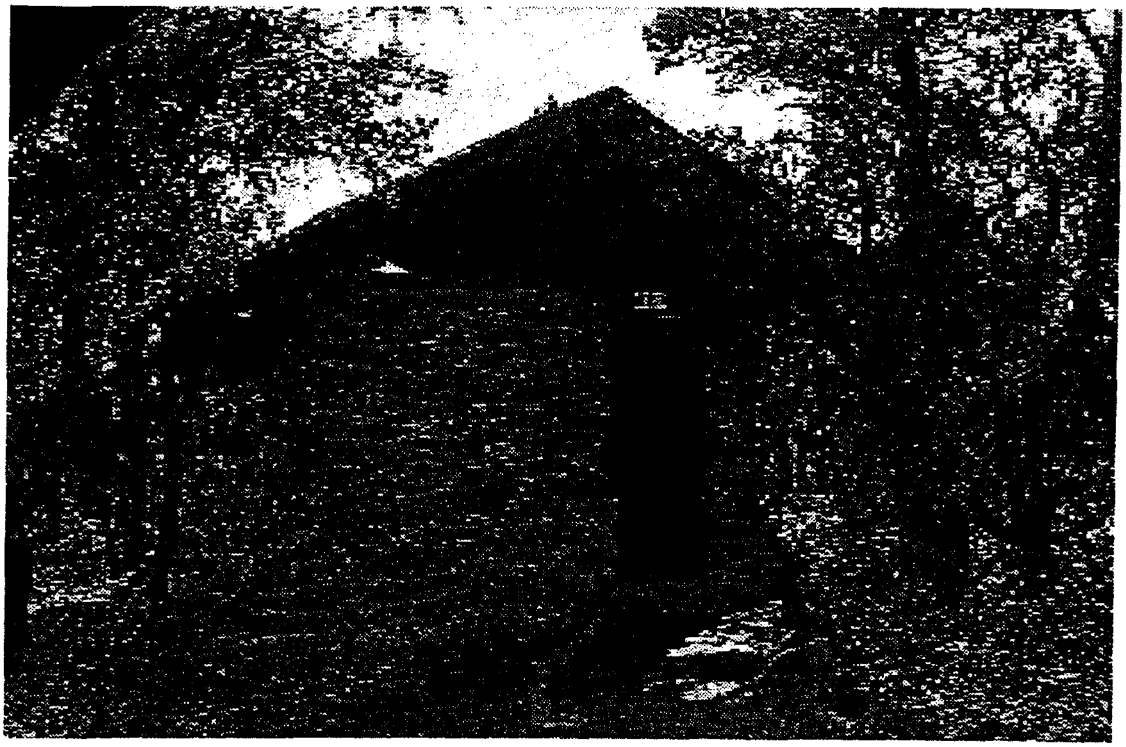


Figure 27. - The image shows the original comfort station made of rough-rock construction. The facility was built in 1928 and removed in 1960. GCNPA Photo Number 9734. Photo dated September, 1935.

Figure 28. This photo of the open terrace at the Yavapai Observation Station during a snowstorm shows snow piled on top of the parapet and telescopes. The ingress of snow was described as a recurring problem that prevented the building from staying open year-round. Photo dated is 1944. GCNPA Photo Number 7022.

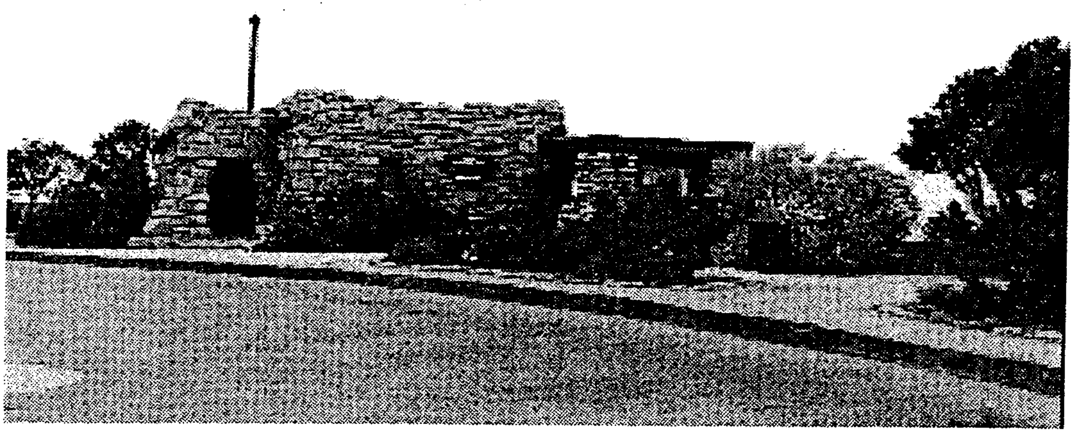


Figure 29. - The image shows a view of the eastern side of the building. Note curbing. Note flue which is no longer extant. GCNPA Photo Number 1753. Photo by J. M. Eden dated 1949.

Figure 30. - The image illustrates a view of the eastern side of the building. Parking lot was previously adjacent to the structure. GCNPA Photo Number 8473. Photo dated. 1952.

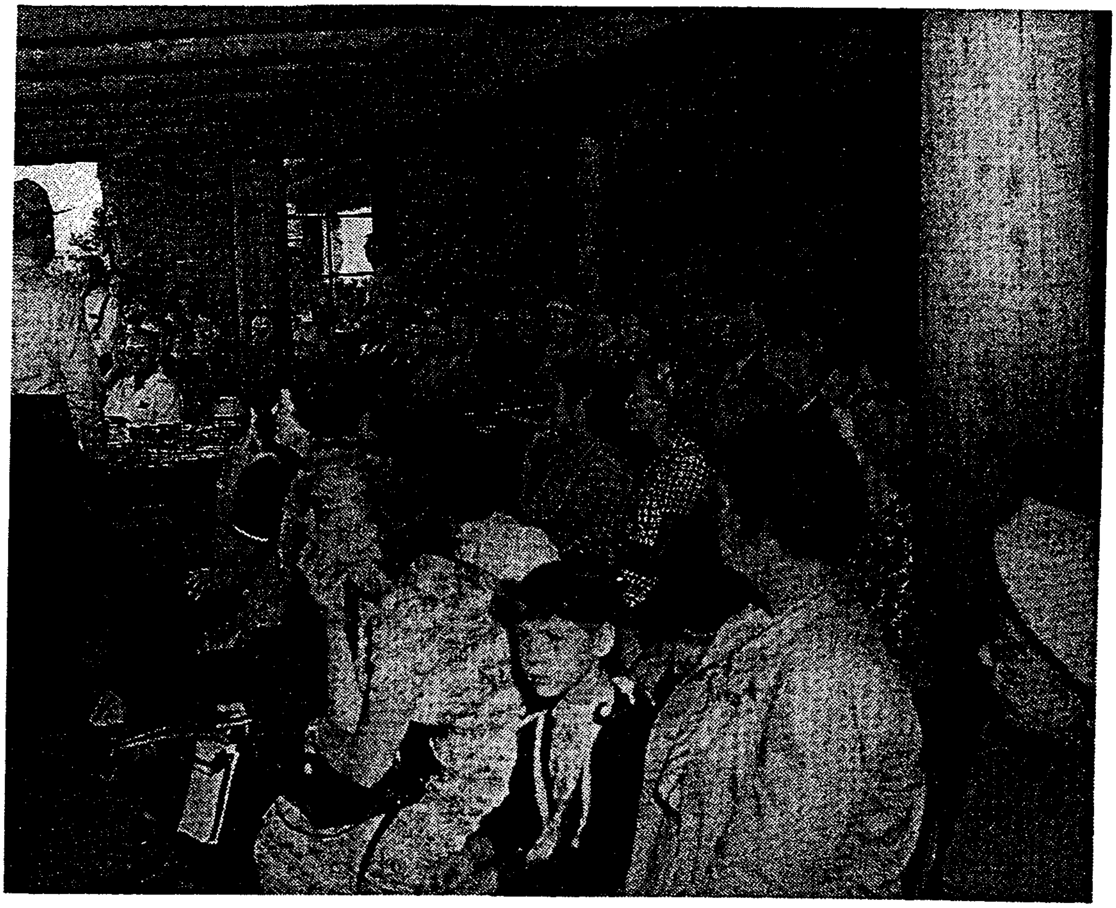


Figure 31. - Ranger lectures to a crowd of tourists on the deck of the Yavapai Observation Station. The image is indicative of the popularity of the Park in the post-war era. The building was more heavily used by traveling Americans than had originally been envisioned and resulted in crowding on the observation deck. GCNPA Photo Number 1610. Photo dated August, 1948.

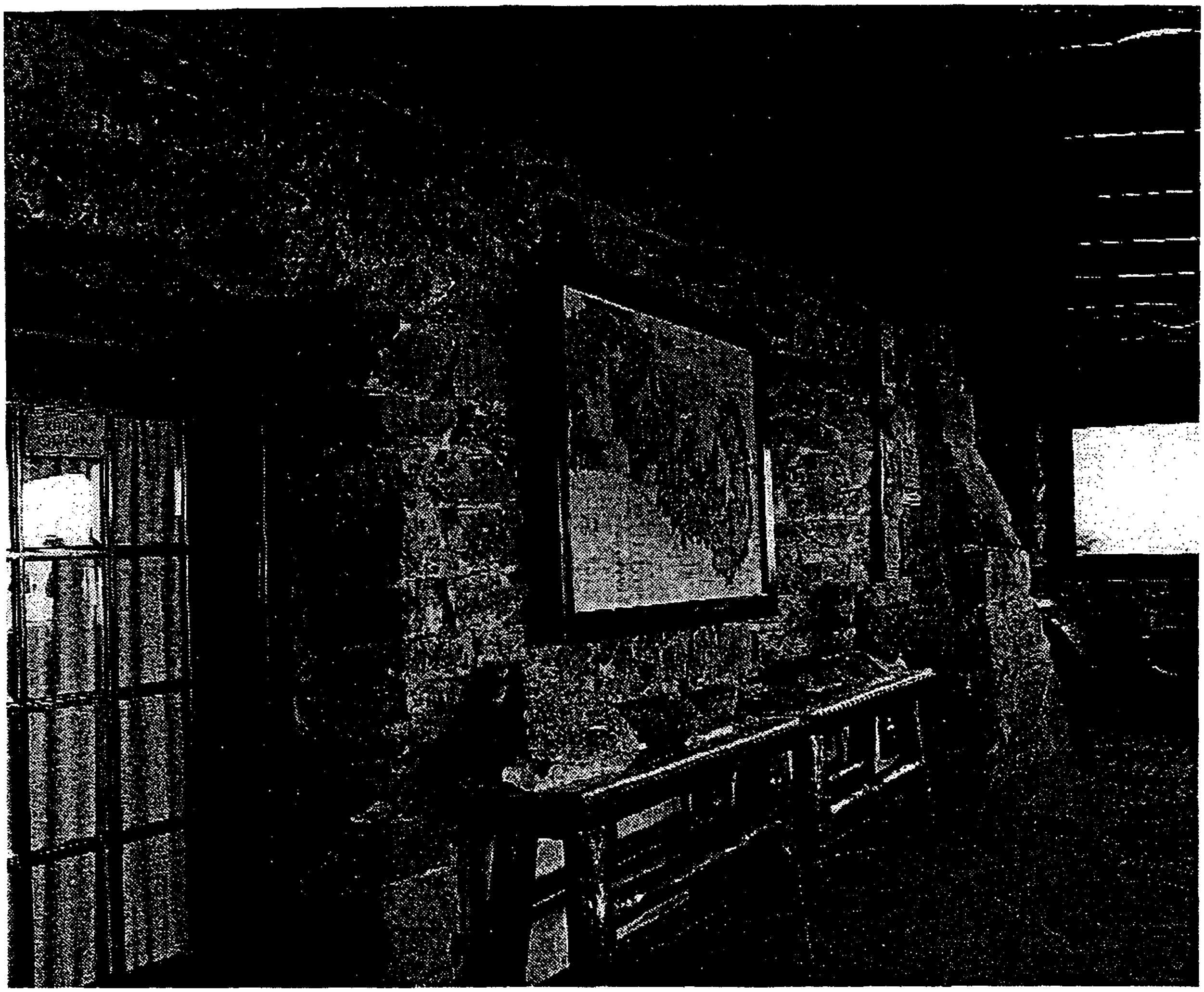


Figure 32. This photo shows the original interior rock wall that separated the exhibit room from the open terrace and the type of exhibits that were typical when the building first opened. The splayed wall near the west entrance was an exhibit of the geology of the canyon. The wall was removed in 1953. Photo is undated. GCNPA Photo Number 9744.

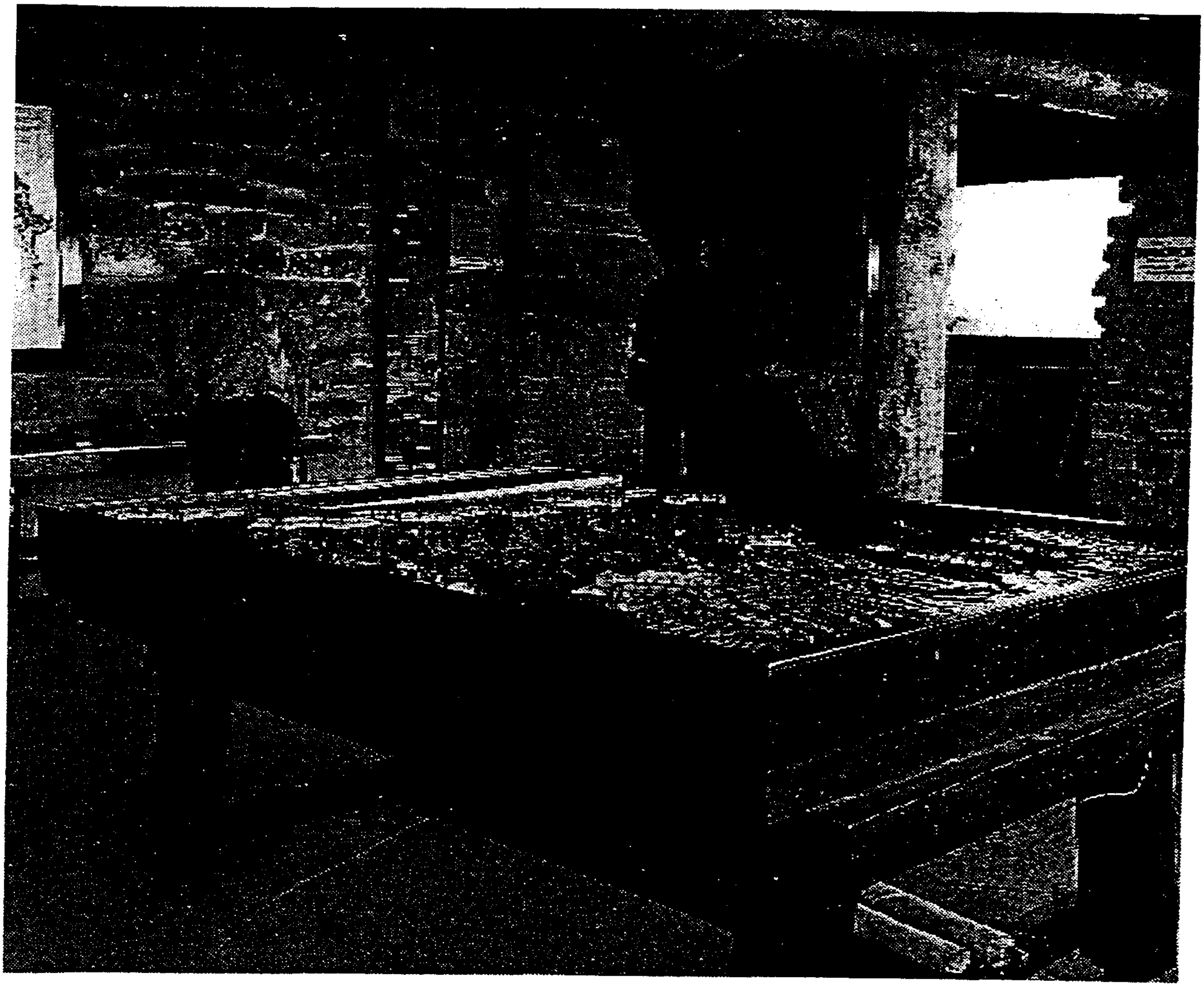


Figure 33. - The image shows the interior of the Yavapai Observation Station with a relief map of the Grand Canyon in the foreground and the rock wall in the background. Window at right faces west. GCNPA Photo Number 9743. Photo dated c. early 1950s shortly before the rock wall was removed.

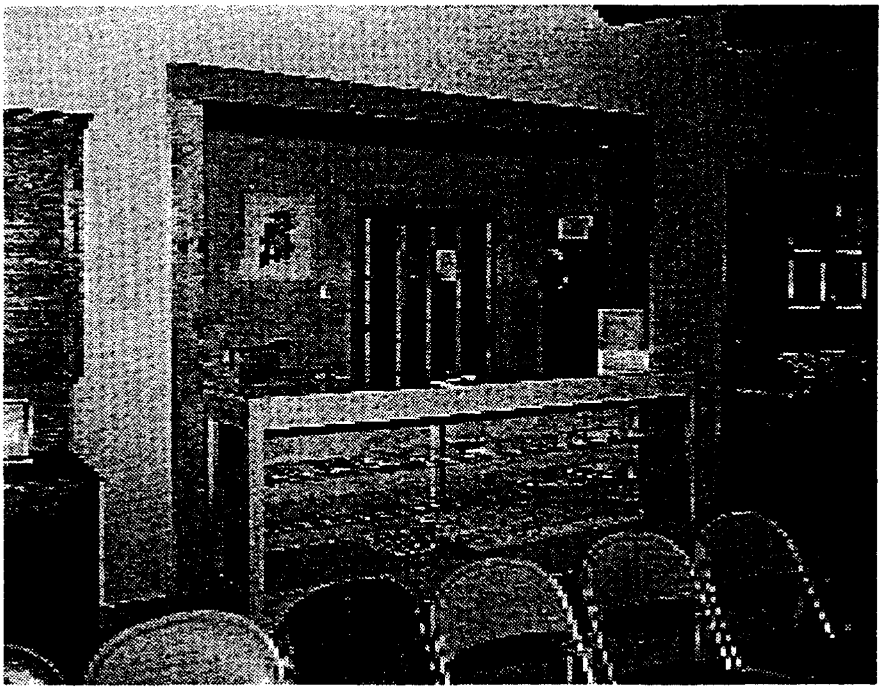


Figure 34. - The image shows the interior alteration to create a "sales booth" at the rear of the interior. Note north-south running logs in the ceiling remain. GCNPA Photo Number 2611. Photo dated 1953.

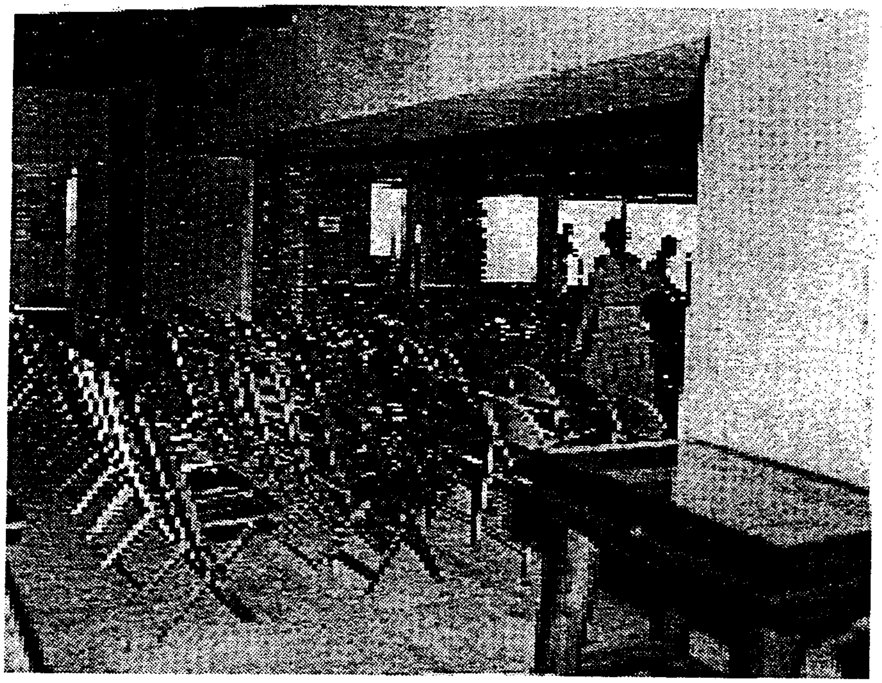


Figure 35. - The image shows the main support beam of the interior and the newly opened interior. Partition wall has recently been removed in this photograph. The view is looking toward the northwest. GCNPA Photo Number 2686. Photo by Steve Leding dated January, 1954.

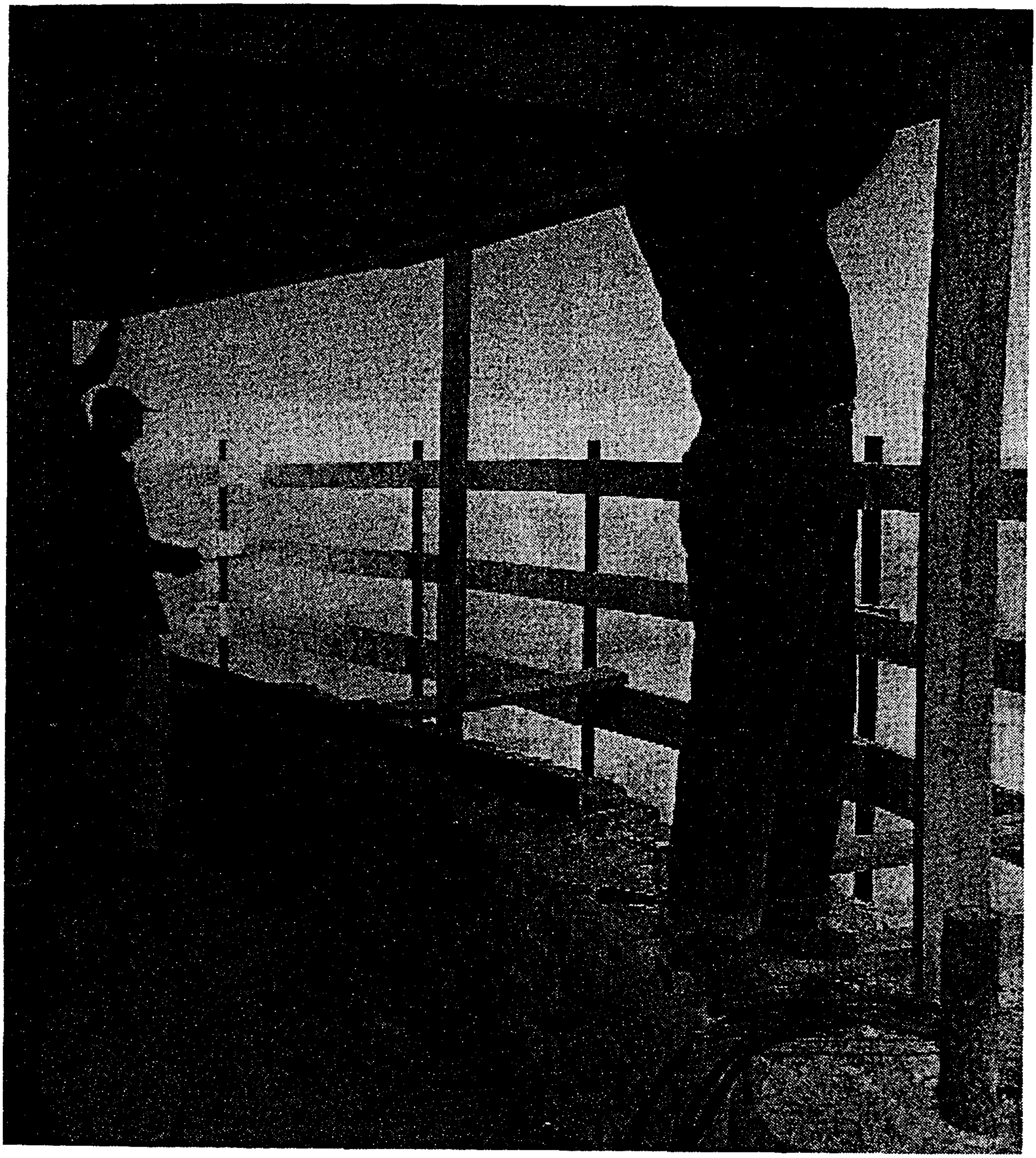


Figure 36. This photo depicts alterations in progress at the Yavapai Observation Station. The rehabilitation involved a reduction of the roof overhang, raising of the parapet, and installation of glass in the window openings. Photo is dated January 23, 1953. GCNPA Photo Number 2415.

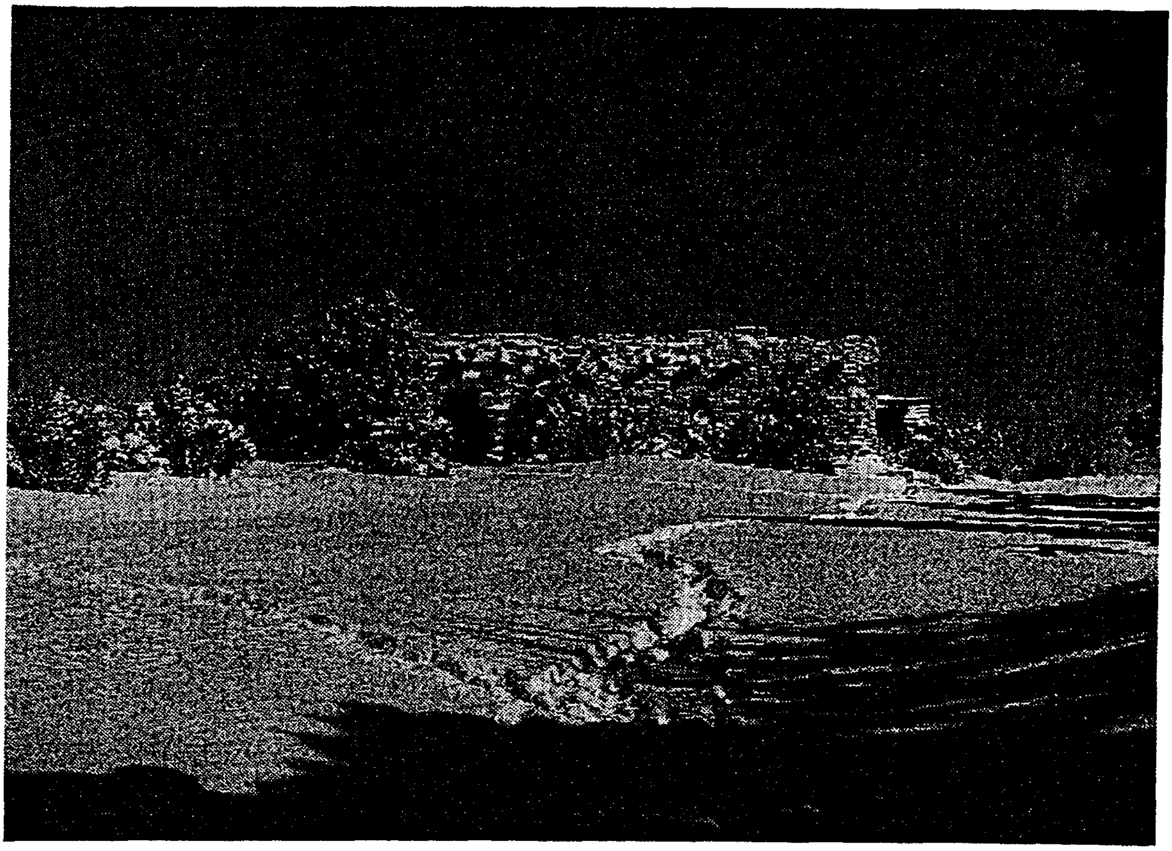


Figure 37. - The image shows the Yavapai Observation Station in a winterscape. Note paths to the building are blocked with snow. The view is looking north toward the south elevation. Note snow built up on exposed log ends. GCNPA Photo Number 3246. Photo dated January, 1957.

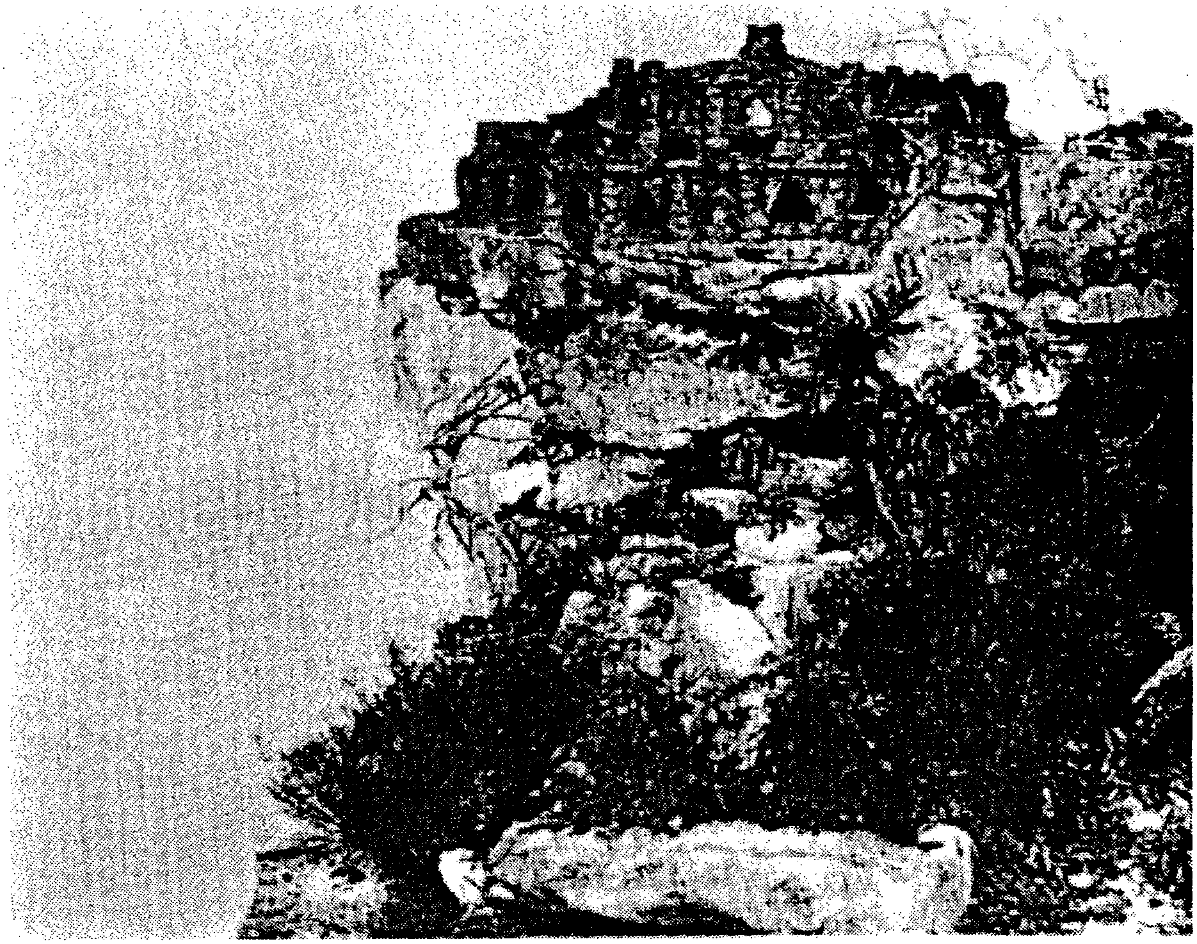


Figure 38. This image illustrates the clay model of Mary Colter's boldly sited Bright Angel Lodge at the canyon edge first planned in 1916. Colter's approach to siting and this image of a stone building merging with the canyon wall were highly influential on NPS architects, especially Herbert Maier, architect of the Yavapai Observation Station. Image from Grattan, Virginia. Mary Colter, Builder Upon the Red Earth. p. 83.

Figure 39. This image illustrates the exterior of Mary Colter's Hermit's Rest, 1914. Hermit's Rest was designed to look like a dwelling constructed with local materials by an untrained frontiersman. The exterior was meant to resemble a haphazard jumble and its roofline inspired the jagged profile at Yavapai. Image from Grattan, Virginia. Mary Colter, Builder Upon the Red Earth. p. 28

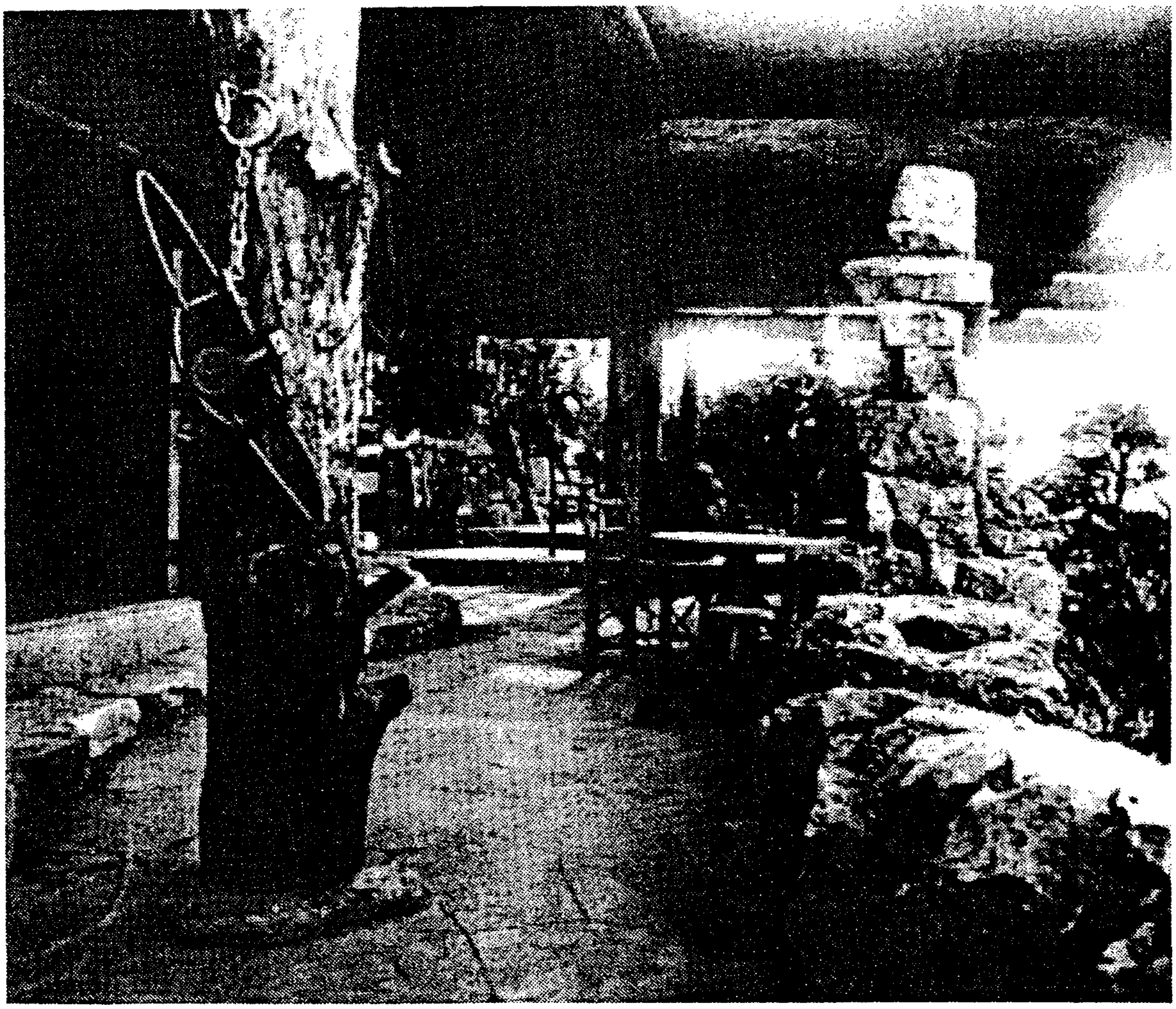


Figure 40. This image illustrates the covered porch of Mary Colter's Hermit's Rest. Located at the canyon rim, the building served as a refreshment stop for sightseers. Hermit's Rest opened 1914. The materials, scored floor, low stone wall following the canyon wall are among the similarities to the Yavapai Observation Station. Herbert Maier was an admirer of Mary Colter's work. Image from Grattan, Virginia. Mary Colter, Builder Upon the Red Earth. p. 29

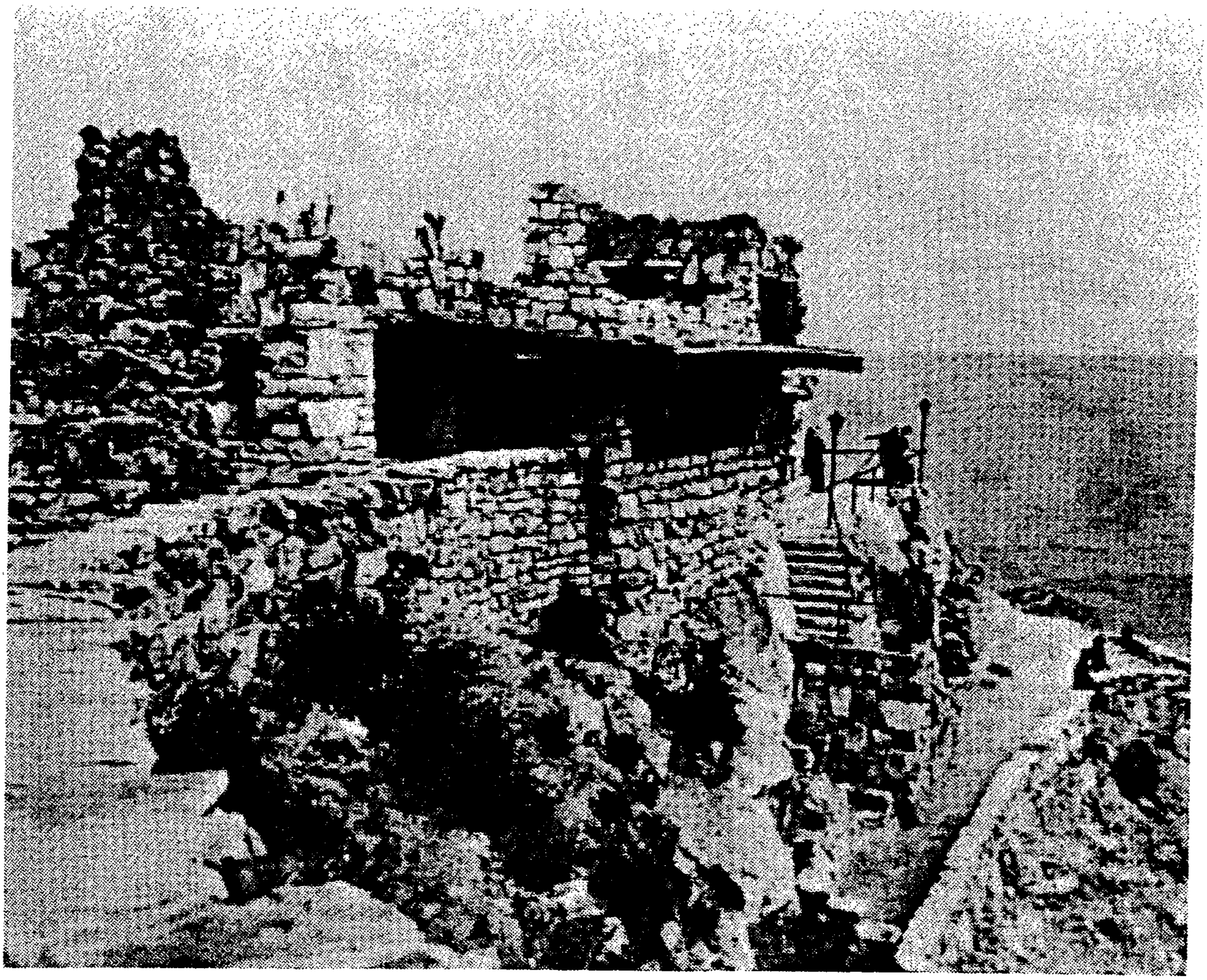


Figure 41. This photo shows The Lookout by Mary Colter in its original form. The photo was taken in 1914. The building epitomizes Colter's approach to siting and use of local stone as a building materials, a both ideas which were highly influential on NPS architects, especially Herbert Maier, architect of the Yavapai Observation Station. The building, now altered, exhibits the same jagged roofline, flat overhang, materials and merging with the surrounding landscape as Yavapai. Image from Grattan, Virginia. Mary Colter, Builder Upon the Red Earth. p. 33.

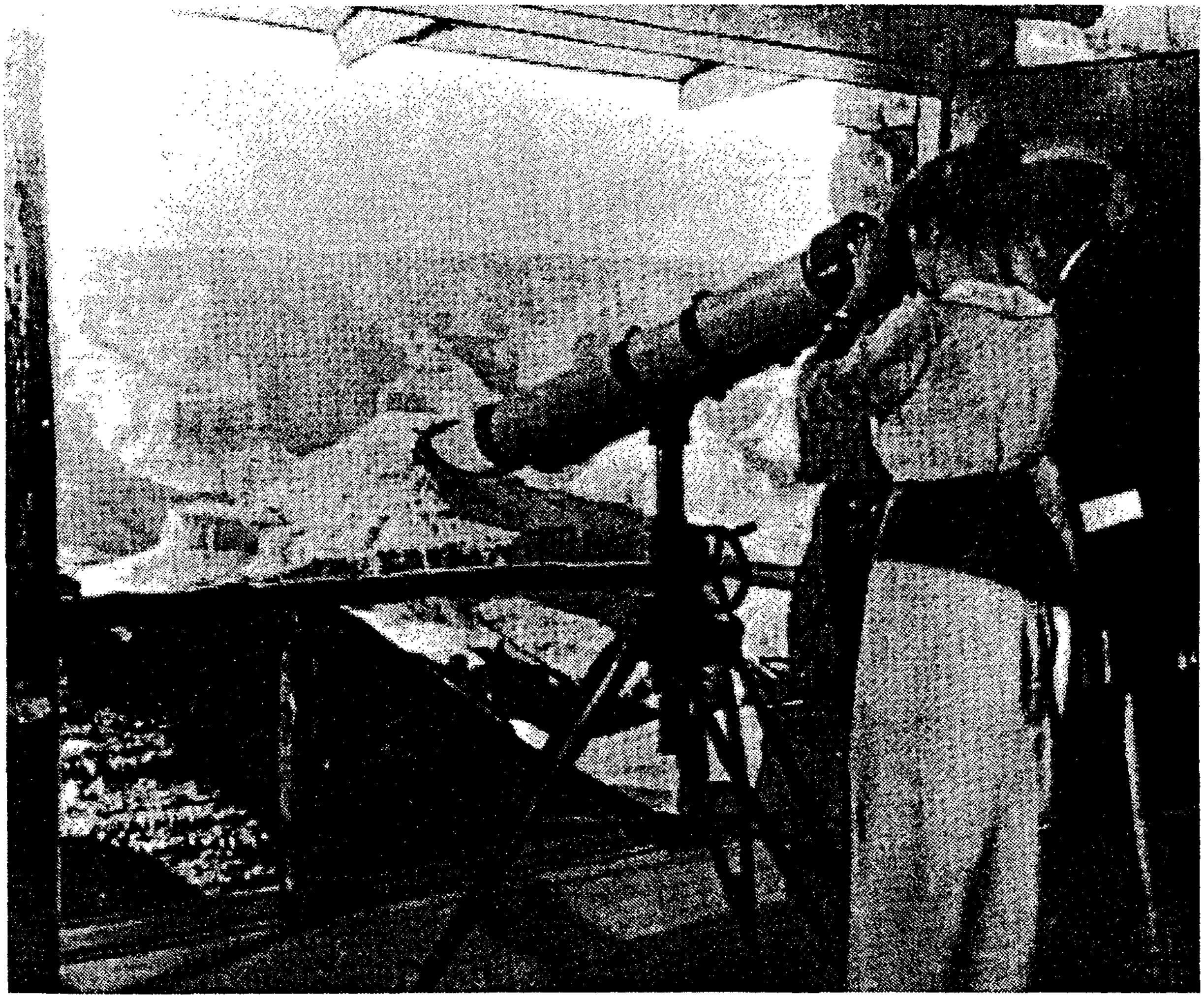


Figure 42. This image illustrates the interior of The Lookout by Architect Mary Colter and is dated circa 1914. The similarities in function, layout and materials to Yavapai are striking. Colter employed the overhang as a device to frame the vista and Maier appears to have borrowed this successful idea from her. Image from Grattan, Virginia. Mary Colter, Builder Upon the Red Earth. p. 34.

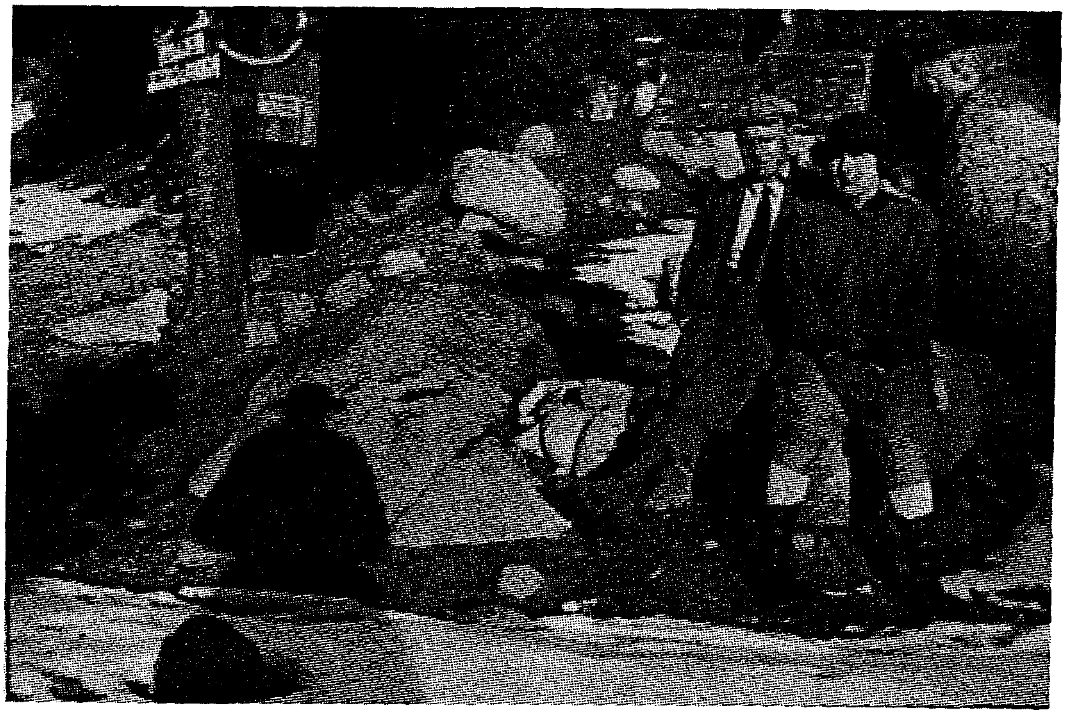


Figure 43. This image depicts Herbert C. Maier, architect of the Yavapai Observation Station, at the time of the building's construction. Photo dated 1928. Image from: Lewis, Ralph H. Museum Curatorship in the National Park Service, 1904-1982. Washington, D.C.: NPS, 1993.

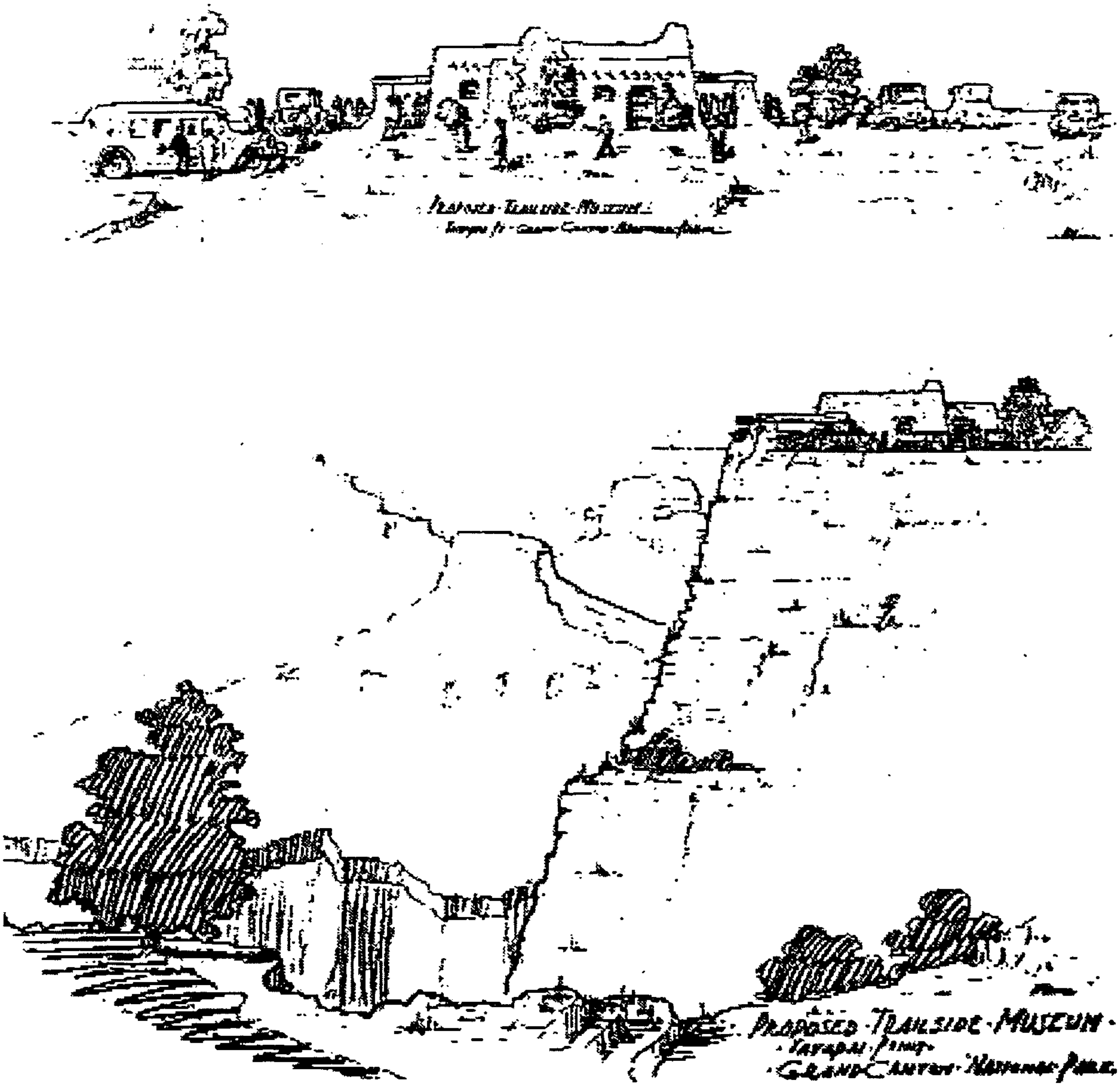


Figure 44. This image illustrates Herbert Maier's original schemes for the Yavapai Observation Station, dated 1927. Maier's primary concern with siting, the landscape and the way the building is perceived from a distance are evident in his drawings, as is the influence of Mary Colter. GCNP Archives.

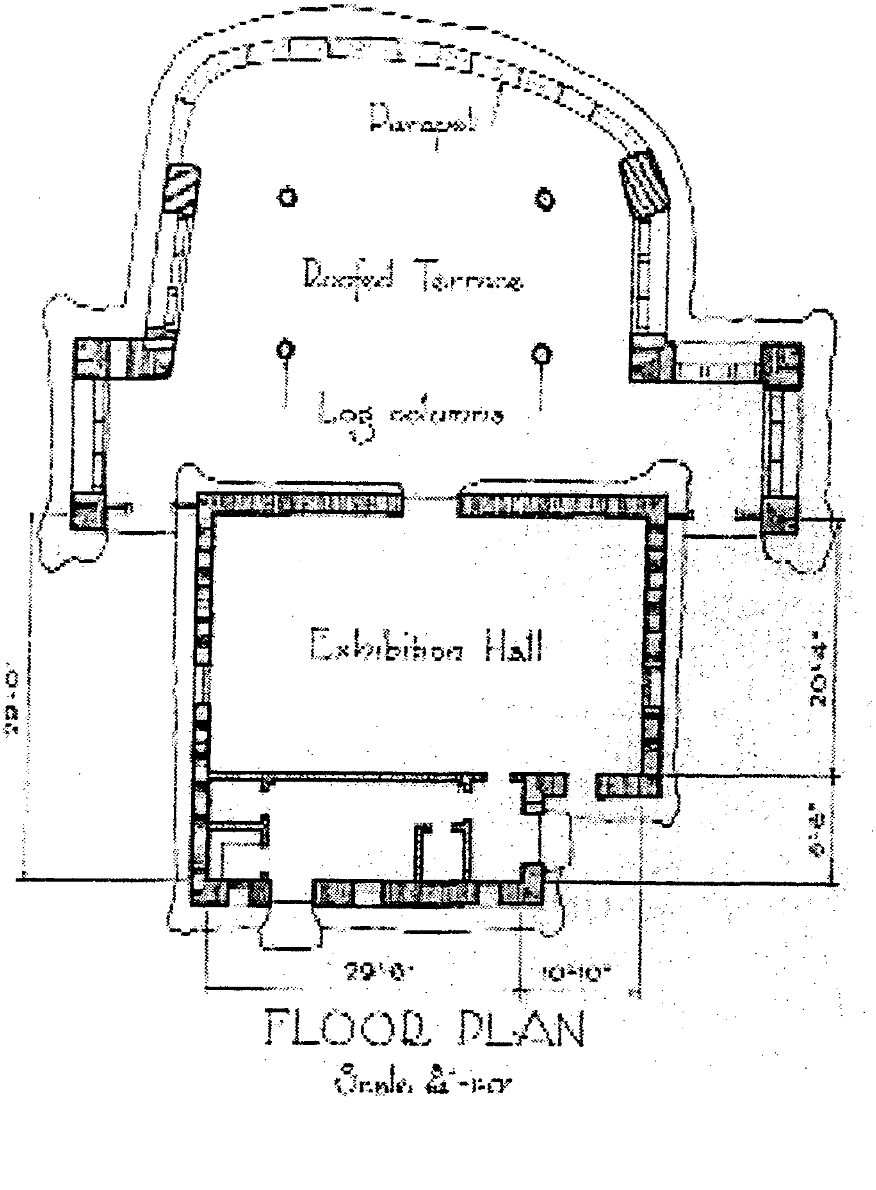


Figure 45. Floor plan of the Yavapai Observation Station by Herbert C. Maier, dated 1928. Note the irregular roofline along the northern side of the structure, later altered to form a more symmetrical line. In plan the Exhibition Hall reads as a square and regular box connected to the free-form viewing terrace. The two spaces had separate functions: one, open for viewing long vistas, and the other for close inspection of geological specimens. Image copied from __*Park and Recreation Structures*__*, by Alfred H. Good, 1935. p. 179.*

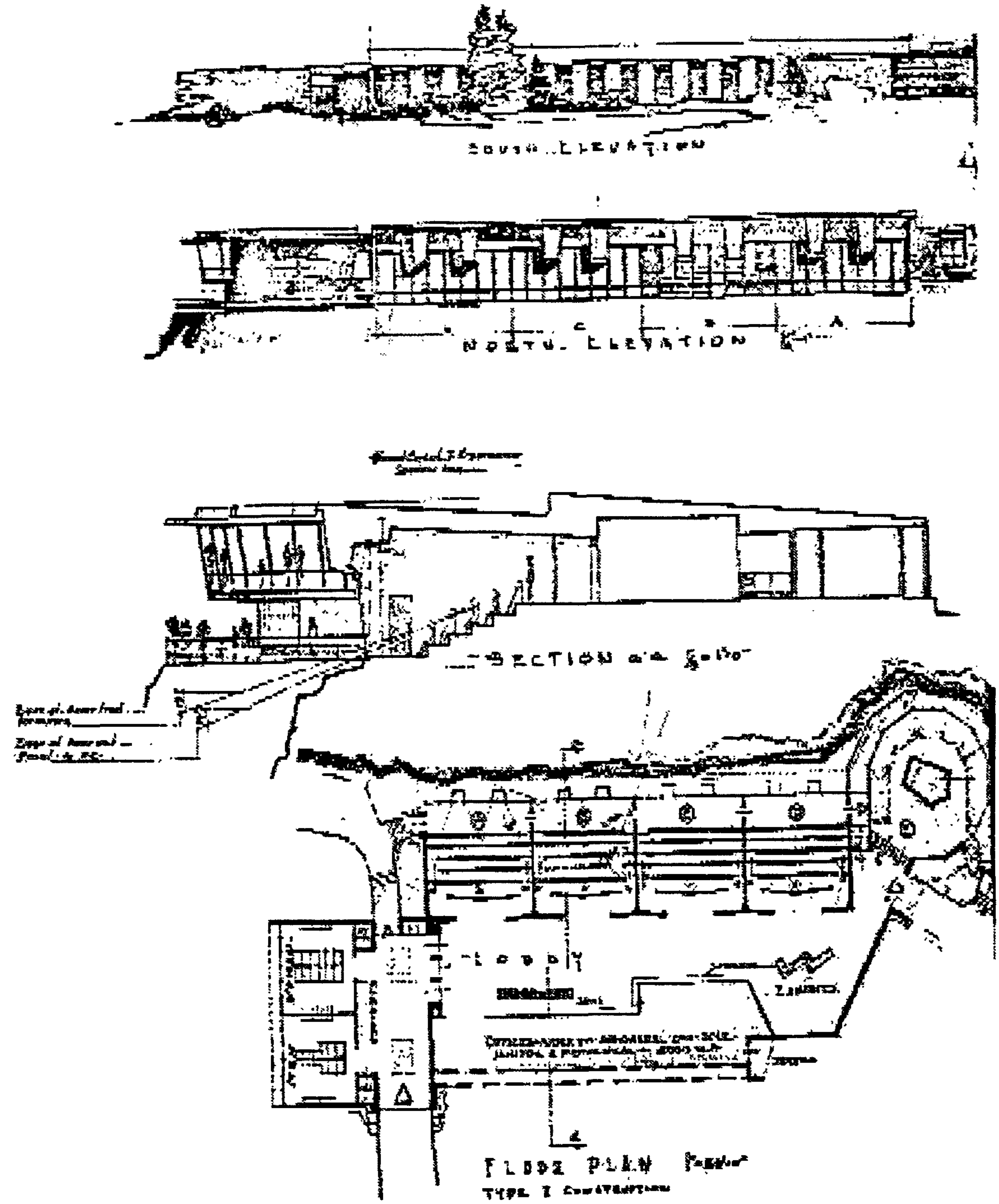


Figure 46. The image illustrates elevations, a section and a floor plan by Architect Cecil Doty for the proposed construction of the Yavapai Interpretive Facility, a Mission 66 facility, dated 1966. The proposed project was intended to be sited at Yavapai Point on the location of the existing Yavapai Observation Station, but was never realized. GCNP Archives.

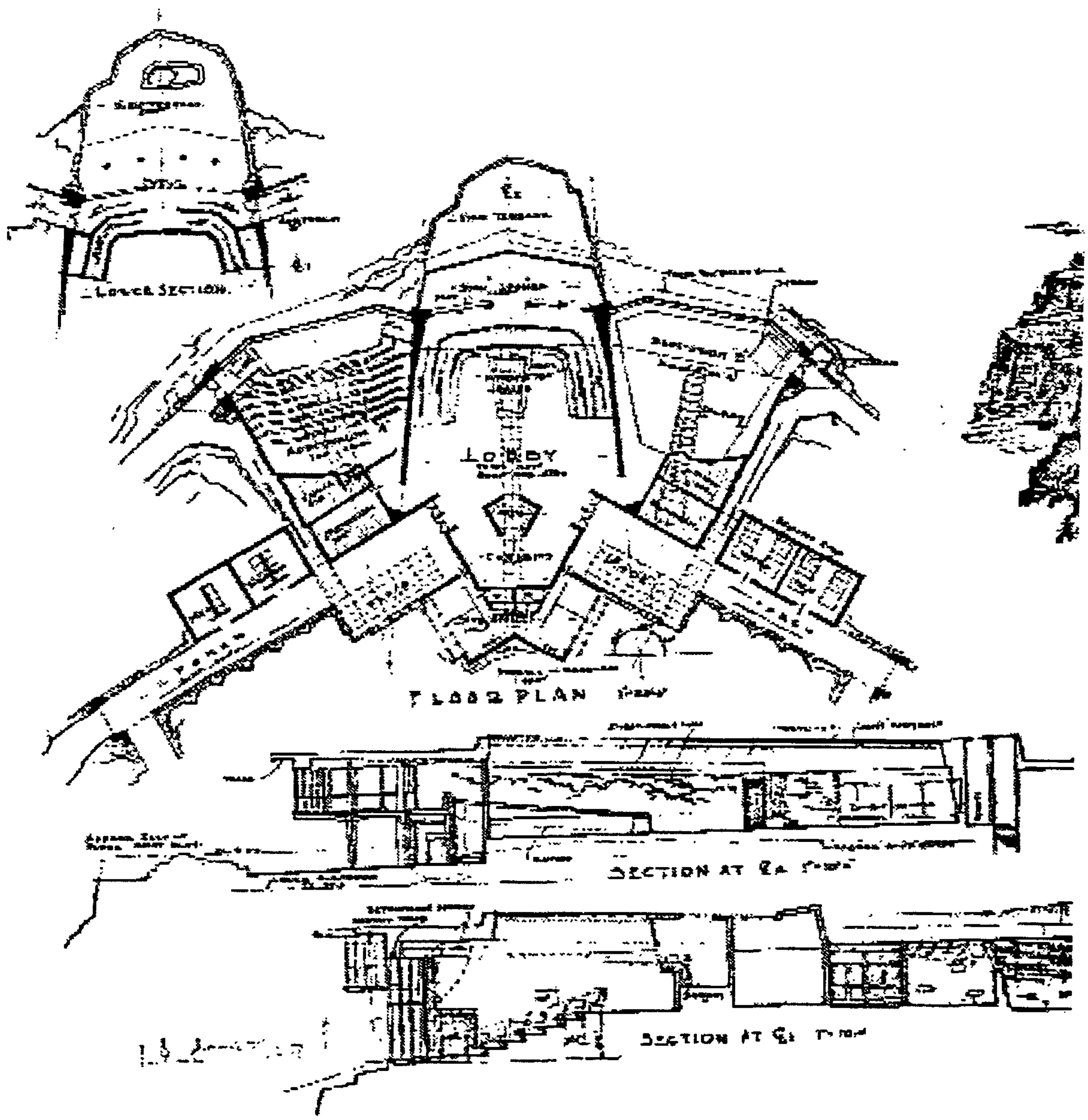


Figure 47. The image illustrates sections and floor plans by Architect Cecil Doty for the proposed construction of the Yavapai Interpretive Facility, a Mission 66 facility, dated 1966. The proposed project was intended to be sited at Yavapai Point on the location of the existing Yavapai Observation Station. Its construction would have required the demolition of the existing building. GCNP Archives.

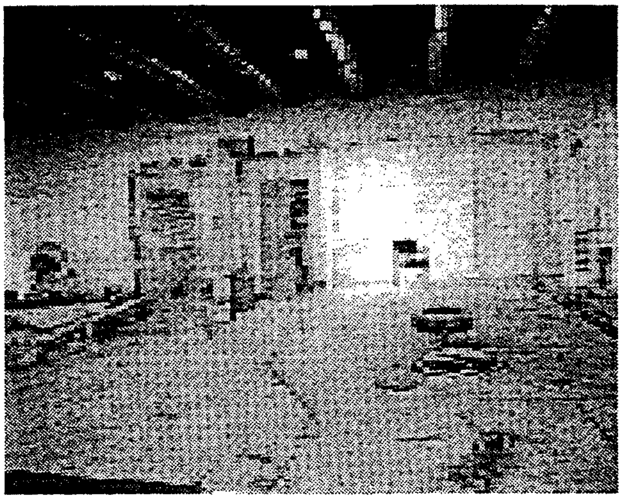


Figure 48. - Image shows the interior of the Yavapai Observation Station with alterations in progress. GCNPA Photo Number 10548. Photo dated 1978.

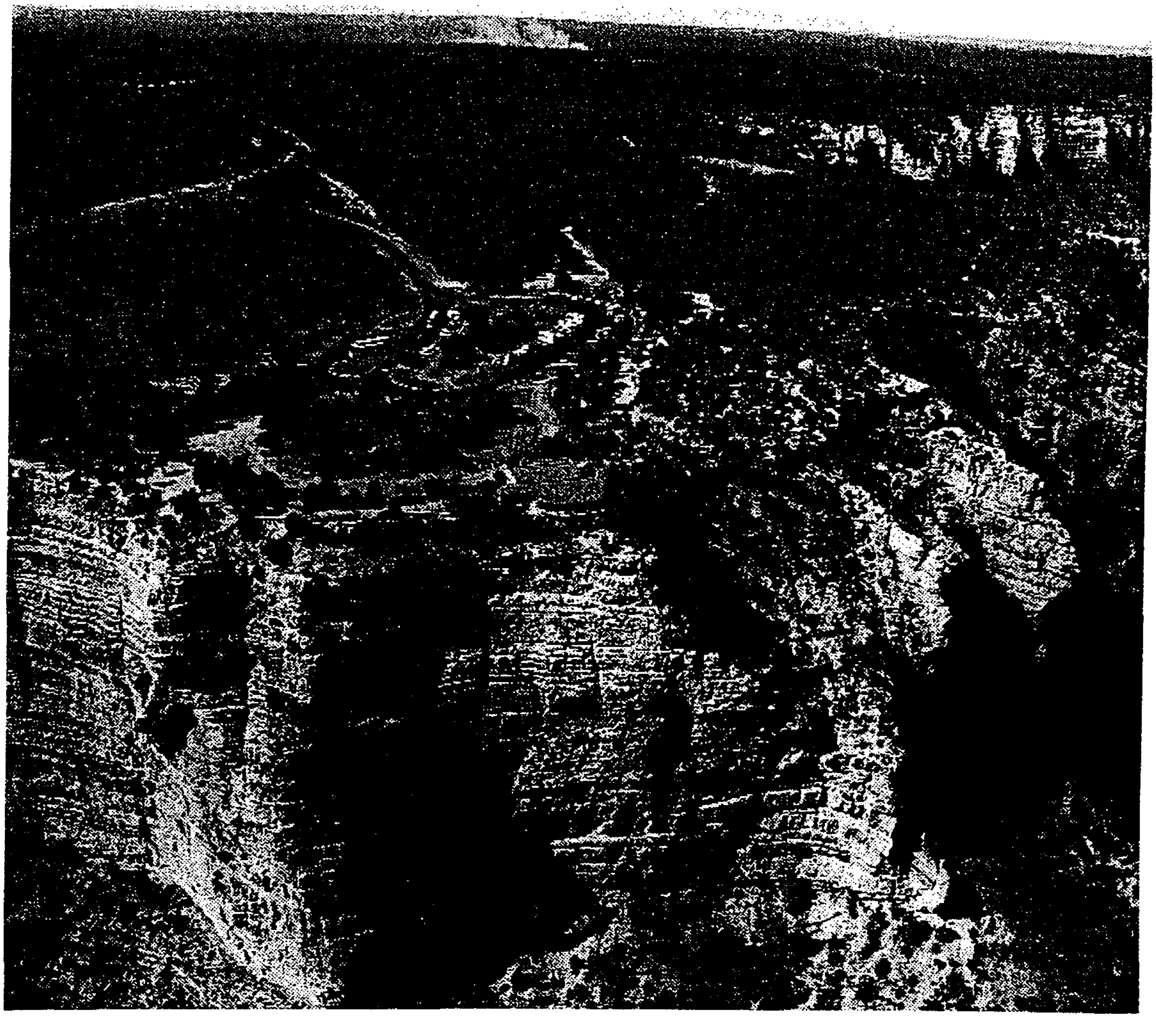


Figure 49. - The image illustrates an aerial view showing relationship to the Yavapai Observation Station to the rim of the canyon in the foreground and the extent of the parking lots in the background. GCNPA Photo Number 16477 dated 1980.

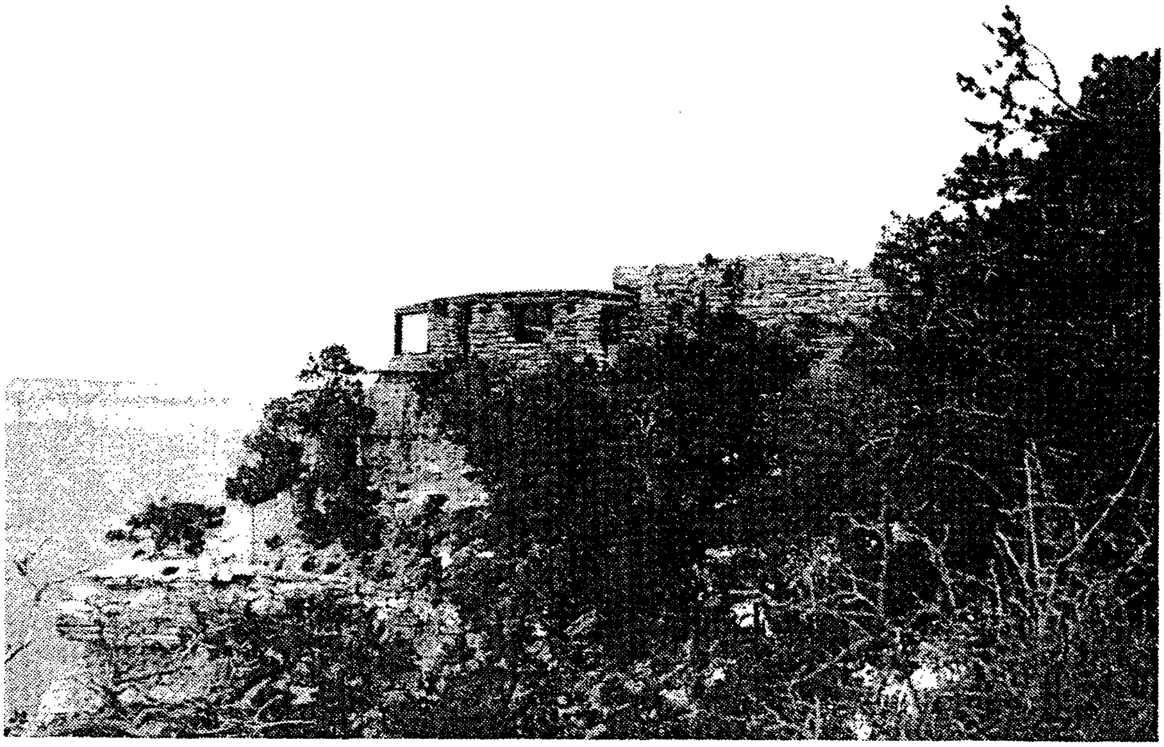


Figure 50. - The image shows the west elevation of the Yavapai Observation Station illustrating the building's existing profile and glazing. See Figure 5 for a historic view from the same angle that dramatizes the depth of the roof overhang as it was originally constructed. Photo provided by Paul Cloyd at NPS. Photo dated February, 1989 by Jacilee Wray.

Figure 51. - The image shows the east elevation of the Yavapai Observation Station. Photo dated February, 1989 by Jacilee Wray.

Figure 52. - The image shows the west/southwest elevation of the Yavapai Observation Station. Photo dated February, 1989 by Jacilee Wray.

Figure 53. - Grand Canyon National Park records states that the image depicts the "observation room foundation, storage room door and catwalk on the north elevation" of the Yavapai Observation Station. Photo dated February, 1989 by Jacilee Wray.

Figure 54. - The image shows the bench on the south wall in the east foyer of the Yavapai Observation Station. Photo dated January, 1990 by Jacilee Wray.

Figure 55. - The image shows the interior of the observation room of the Yavapai Observation Station. View is facing east to the foyer. Photo dated January, 1990 by Jacilee Wray.

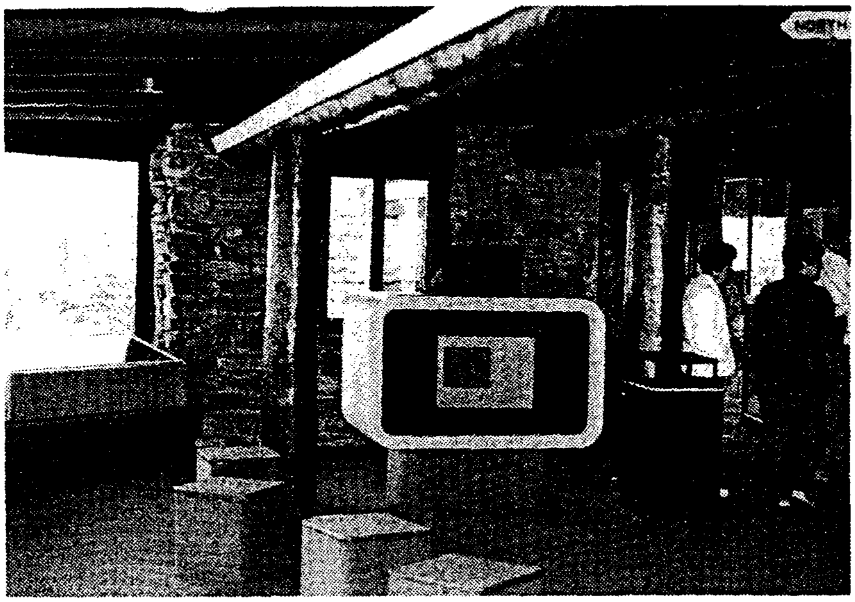


Figure 56. - The image shows the interior of the observation room of the Yavapai Observation Station. View is facing east to the foyer. Photo dated January, 1990 by Jacilee Wray.

Figure 57. - The image shows the exterior of the east window of the observation room of the Yavapai Observation Station. Note the addition of rock chinking. Photo dated February, 1989 by Jacilee Wray.

Figure 58. - The image shows the exterior of the north elevation of the Yavapai Observation Station from below the catwalk. Photo dated February, 1989 by Jacilee Wray.

Figure 59. - The image shows the Pinyon tree-well originally designed by Herbert Maier on south-west corner of the Yavapai Observation Station. Photo dated February, 1989 by Jacilee Wray.

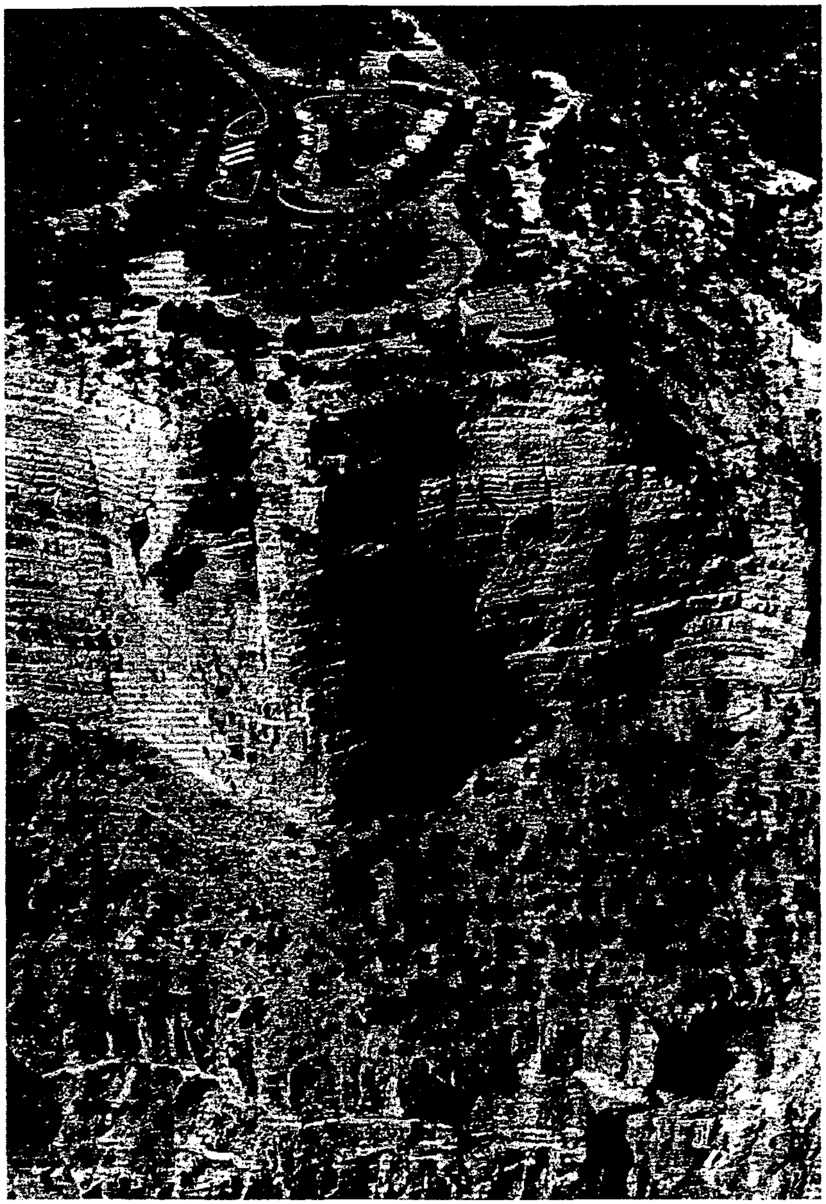


Figure 60. - The image illustrates an aerial view of the Yavapai Observation Station. Photo taken by Greg Probst dated May 1998.

Appendix F. Photographs of Existing Conditions.

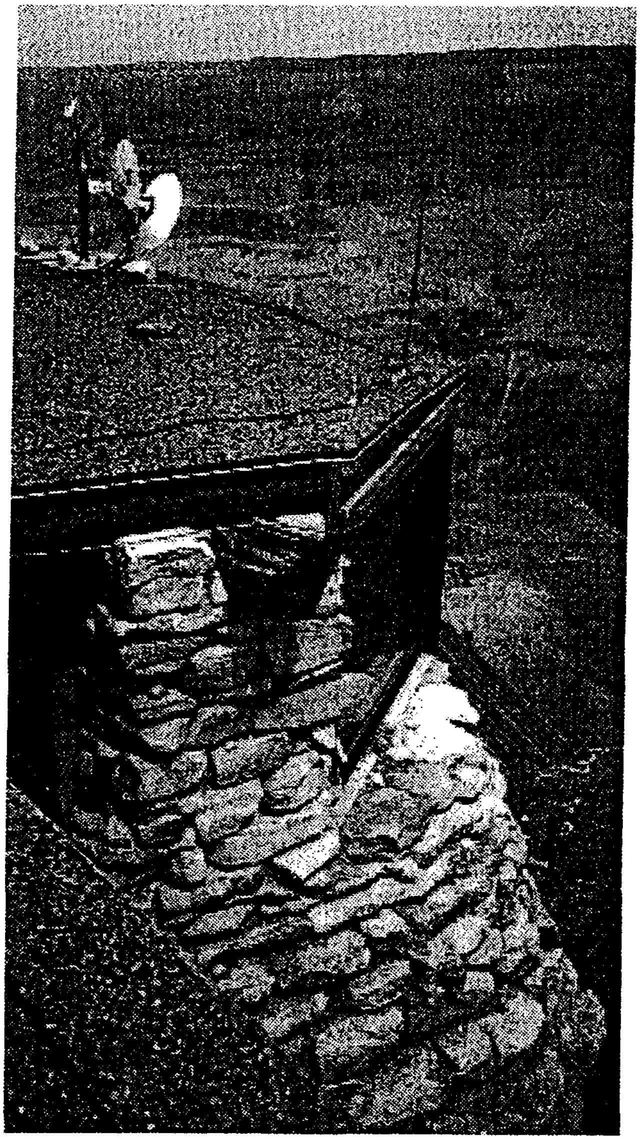


Figure 1. This image illustrates the unique relationship between the Yavapai building and the canyon below. Antennas and dishes on the roof were installed as part of Y2K compliance but are temporary and will be moved when the building is rehabilitated. View is looking down at the eastern corner of the north elevation. Photo dated May, 2000.

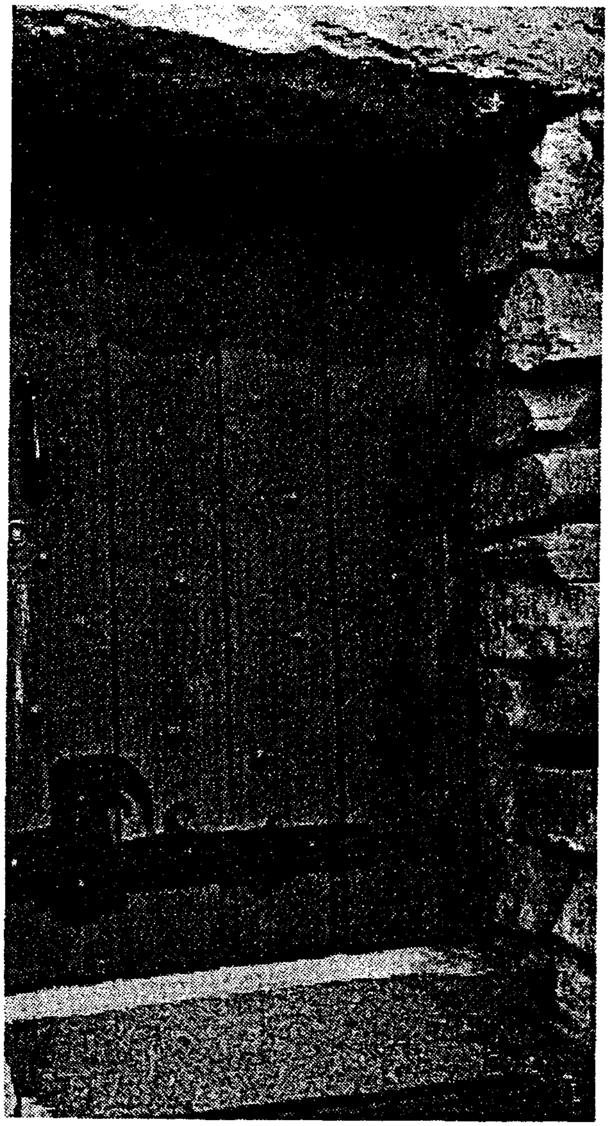


Figure 2. This image depicts the east-facing door just behind the south elevation. This door leads into the back of the shop, formerly the exhibit room. The strap hinge depicts a stylized eagle head. Rounded iron bolts are ornamental. There is no stair, rather the ground slopes up to the threshold. Photo dated May, 2000.

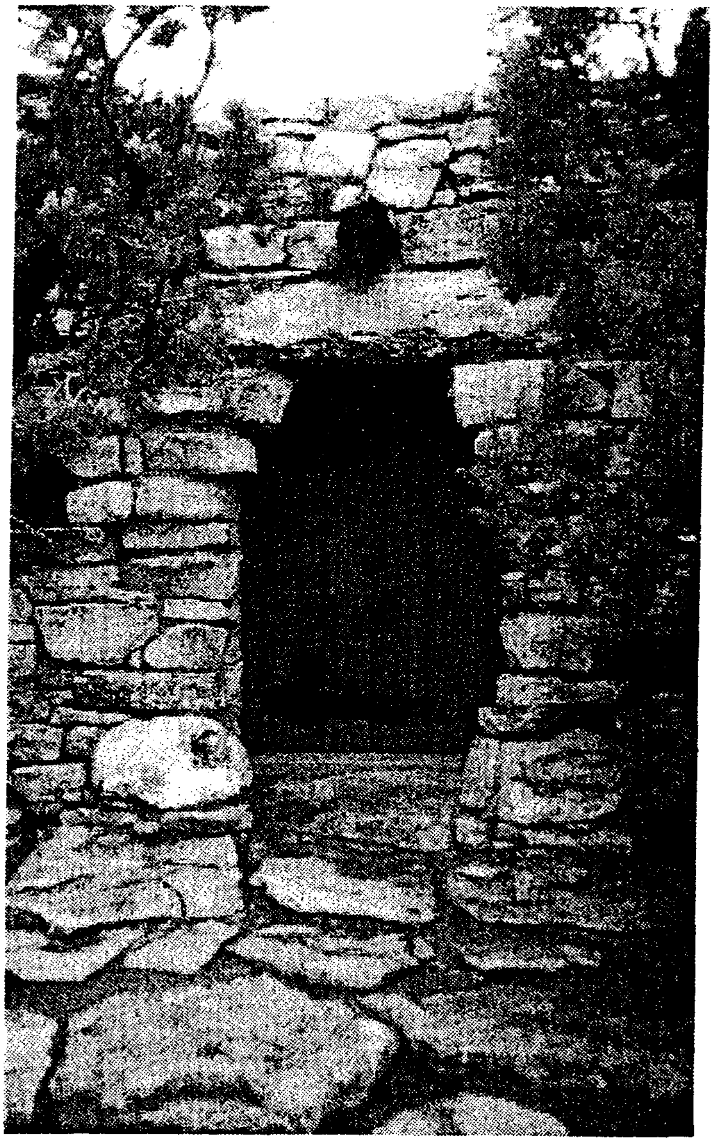


Figure 3. This image illustrates the entrance on the south side of the building. Photo dated May, 2000.

Figure 4. This image illustrates the west side of the Yavapai building. Photo dated May, 2000.

Figure 5. This image illustrates the western elevation of the Yavapai building. Photo dated May, 2000.

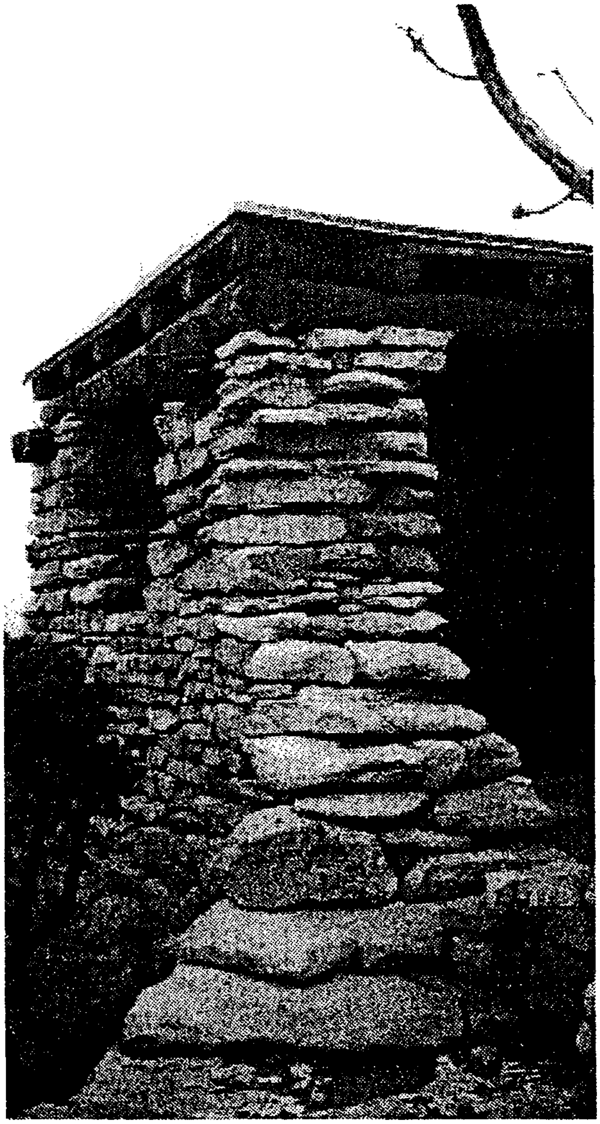


Figure 6. This image illustrates the native Kaibab stone at the corner pier and west elevation near the west entrance. Mortar was set so as to be invisible between the joints and stones were laid to look as if the pier was constructed without mortar. View is looking toward the north. Photo dated May, 2000.

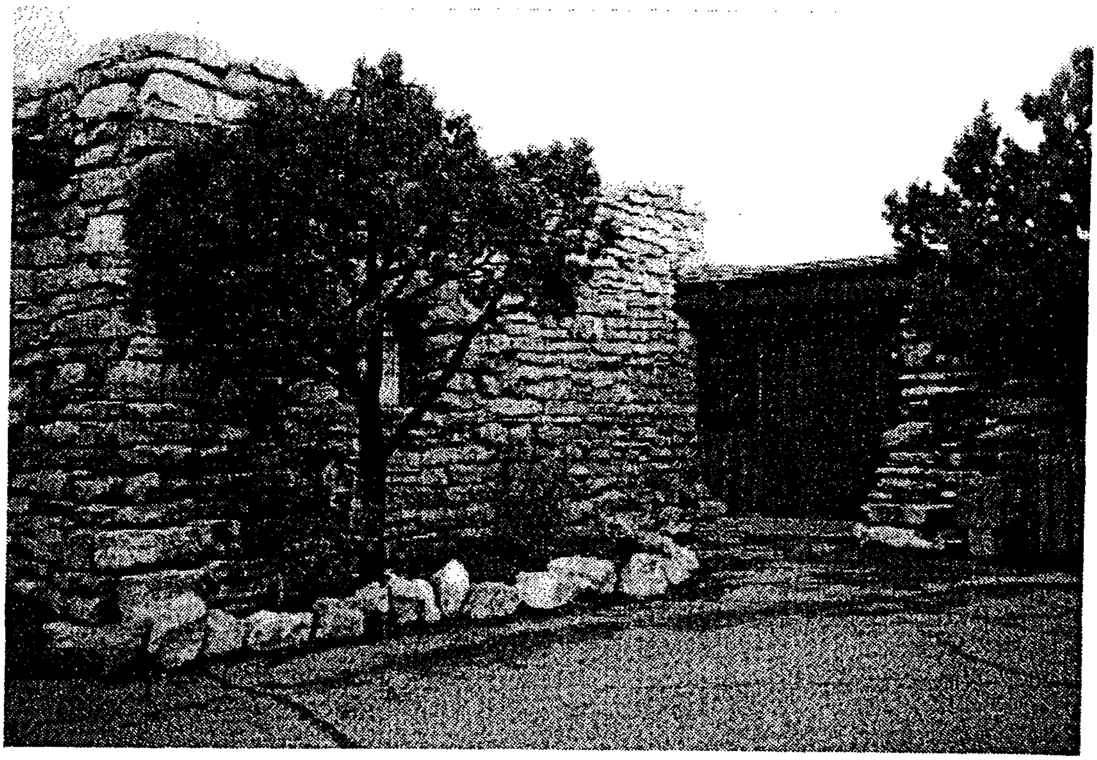


Figure 7. This image illustrates the east elevation of the Yavapai Observation Station. View is looking the northwest. Photo dated May, 2000.

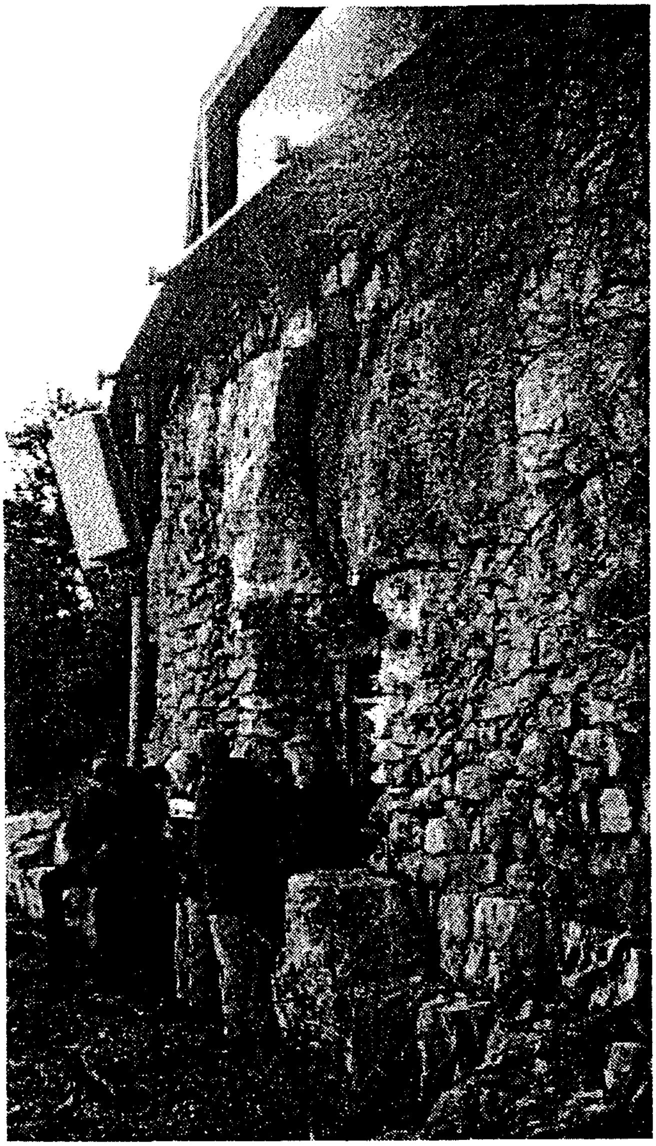


Figure 8. This image illustrates the lower northern side of the Yavapai exterior. Photo dated March, 2000.

Figure 9. This image illustrates typical conditions on the flat tar and gravel roof. In the foreground is the brick chimney below the parapet. View is looking to the southwest corner. Long view is looking southwest. Note paved rim trial and boulders along the walk. Photo dated May, 2000.

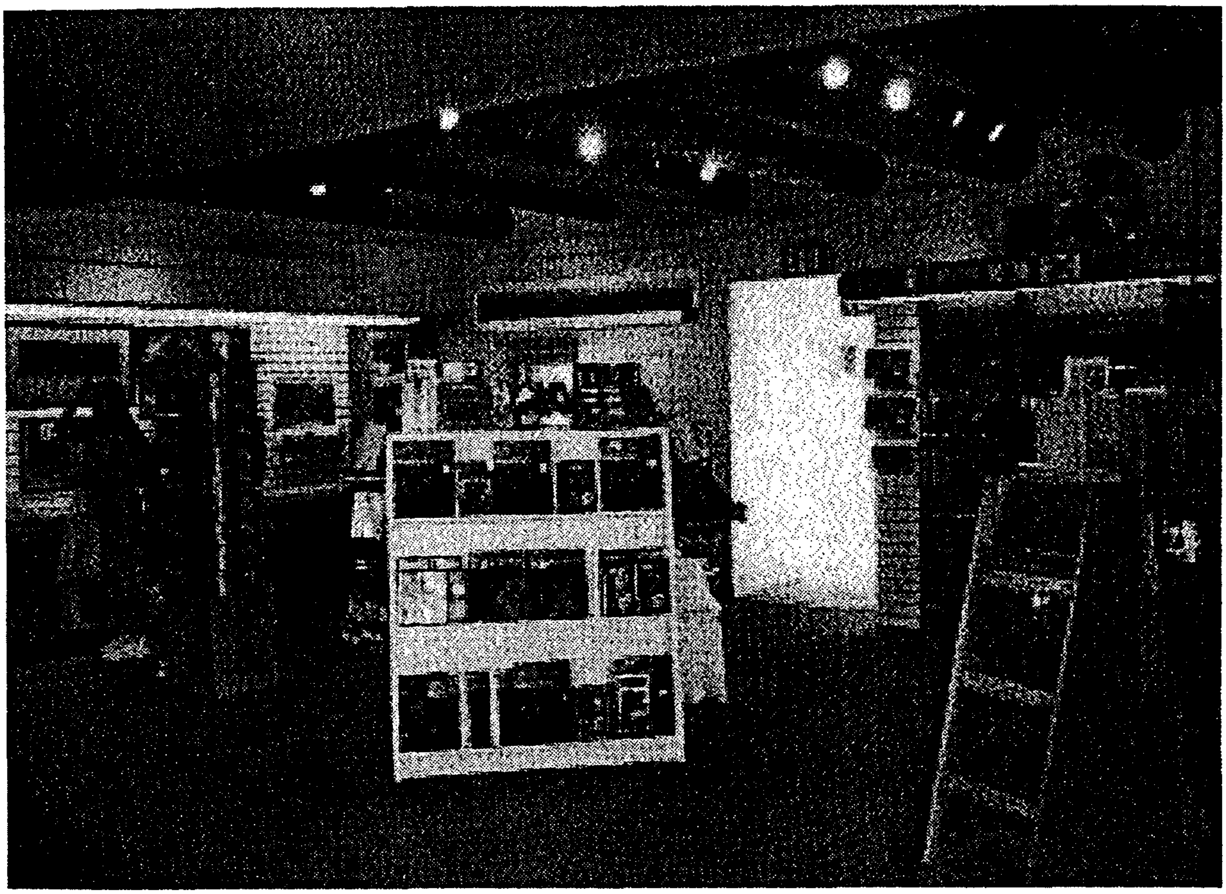


Figure 10. This image illustrates the interior toward the back of the Yavapai Observation Station. Much of the floor space is given over to the bookstore function: a cash register, check-out desk, free-standing laminated blonde wood book racks, plastic laminate display and shelving system, and fluorescent uplighters and under-soffit strips. Articles for sale are books, framed photographs, videos, postcards and calendars. With the exception of the ceiling rafters, very few original finishes or features are visible. Photo dated May, 2000.

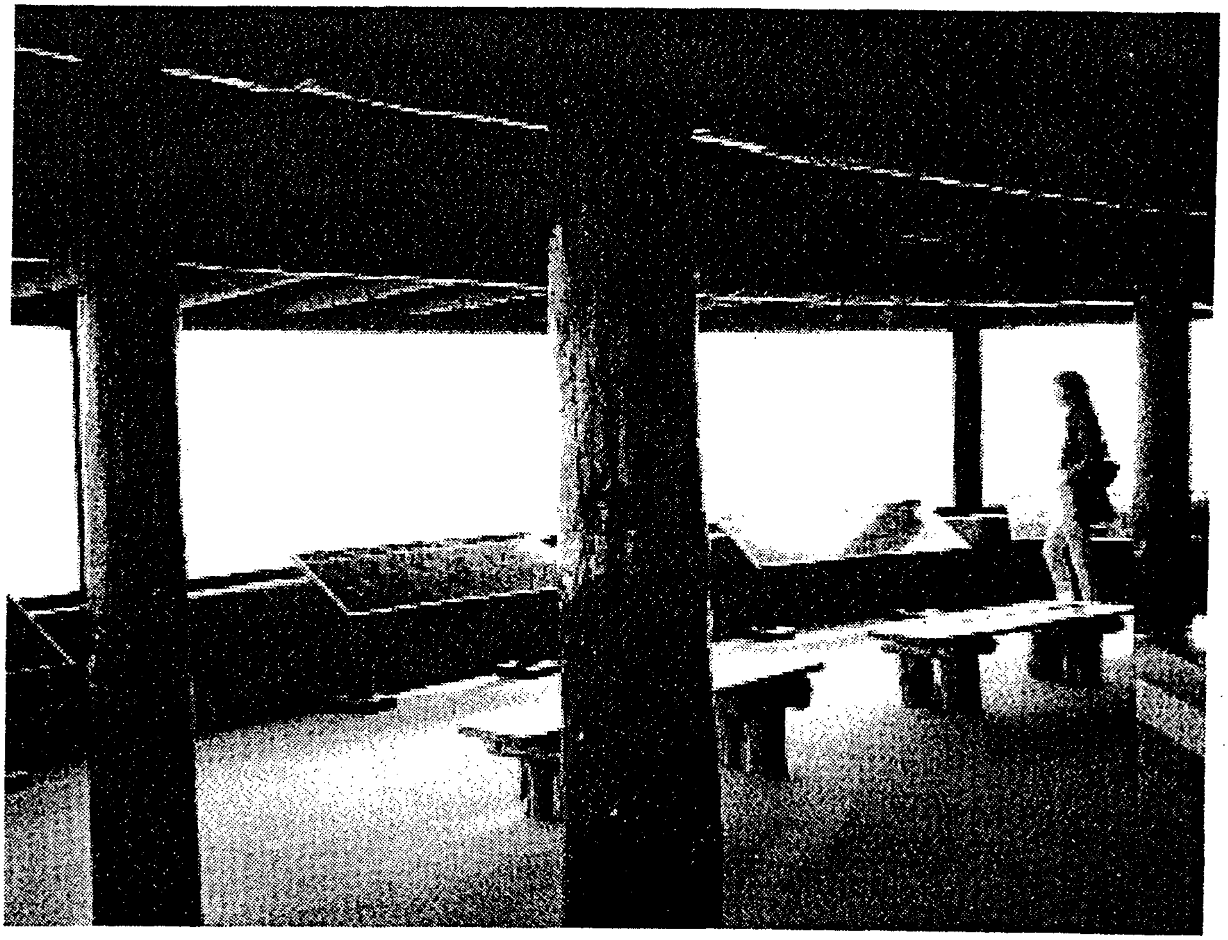


Figure 11. This image illustrates the northern side of the Yavapai interior. As opposed to the bookstore function of the back half of the interior, the north side of the interior provides space for viewing the canyon. The timber columns on the interior are original. Photo dated May, 2000.

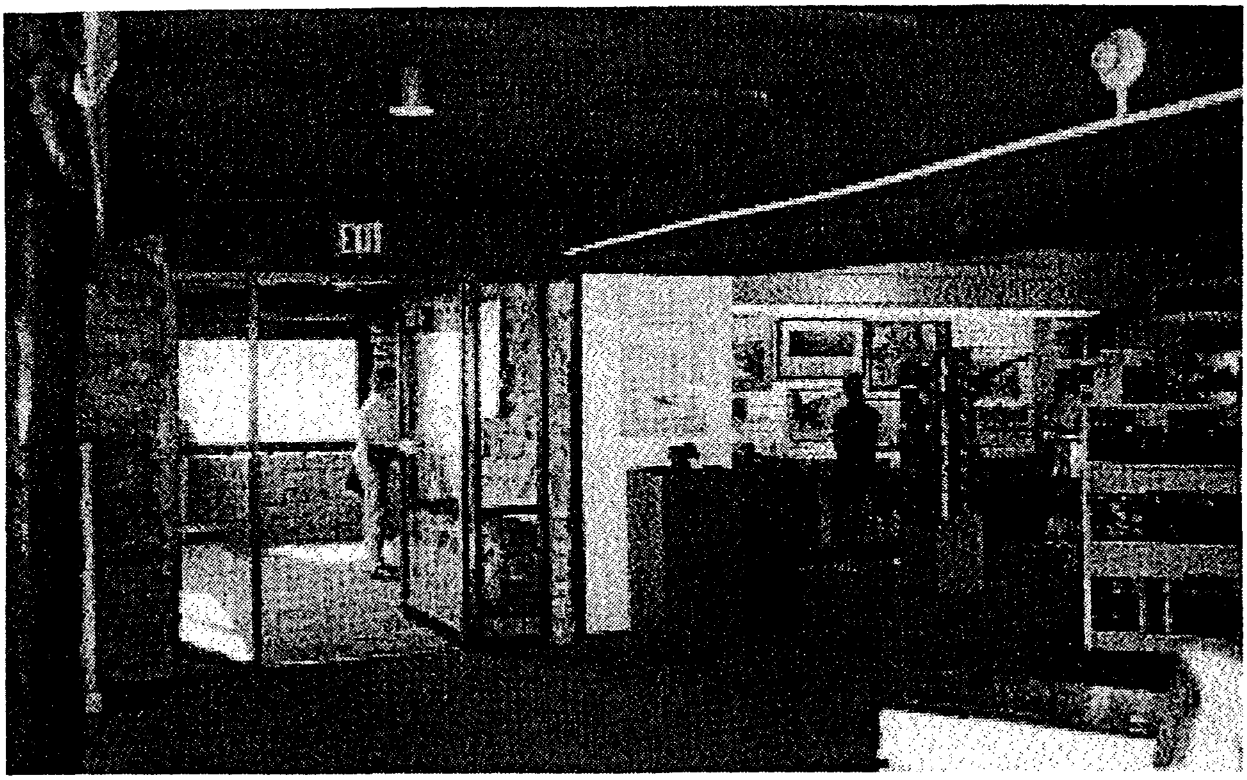


Figure 12. This image illustrates the eastern side of the Yavapai interior and the eastern entrance where glass doors have been installed. Photo dated May, 2000.

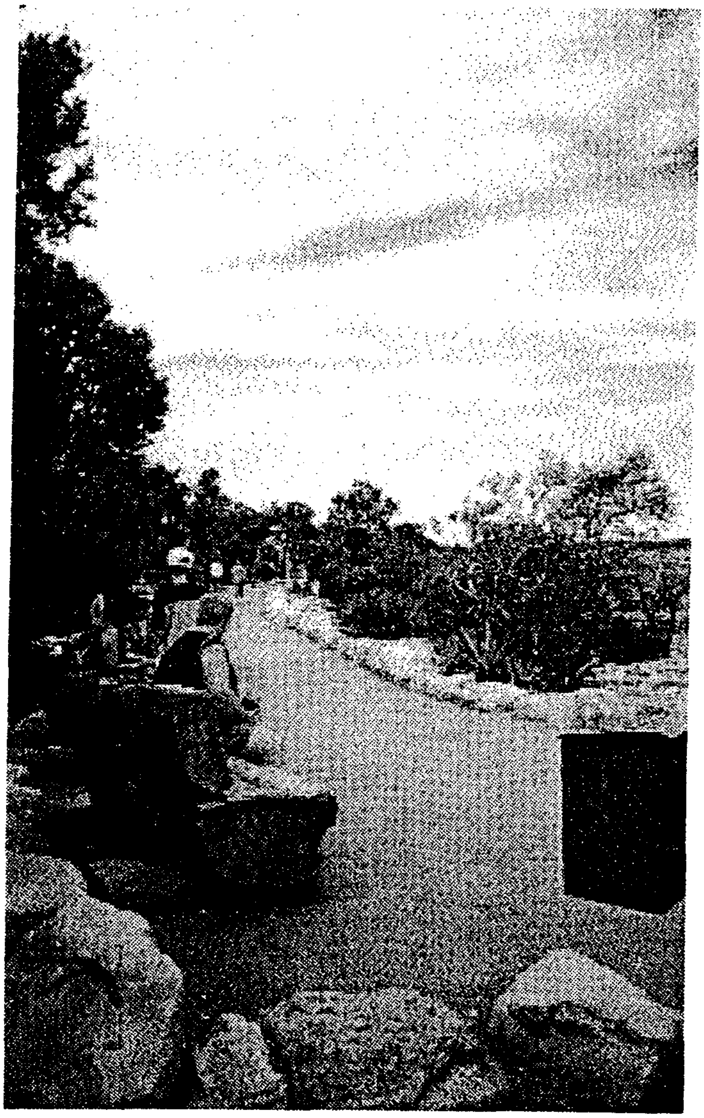


Figure 13. This image illustrates the landscaping and paving leading to the west side of the building. Benches are in poor condition. Photo dated May, 2000.

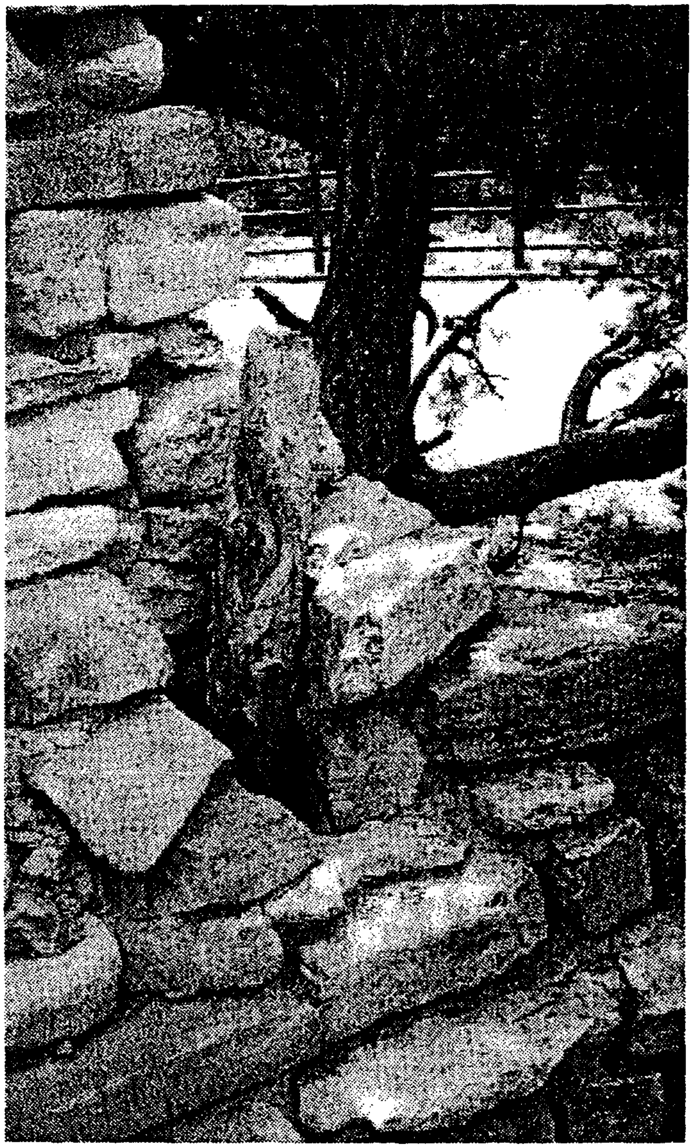


Figure 14. This image illustrates the tree well on the west side of the building, though the tree is no longer extant. Maier, ever sensitive to the surrounding landscape, incorporated this unplanned feature into the building during construction to accommodate an existing tree rather than cut it down. Photo dated May, 2000.

Figure 15. This detail image illustrates a fracture that runs the length of a boulder near a small window opening on the east elevation. The fracture may be the result of a natural cleft in the stone or it may be due to stresses on the rock. View is looking toward the north. Photo dated May, 2000.

Figure 16. This image illustrates a severely deteriorated log end on the south side of the building. Photo dated May, 2000.

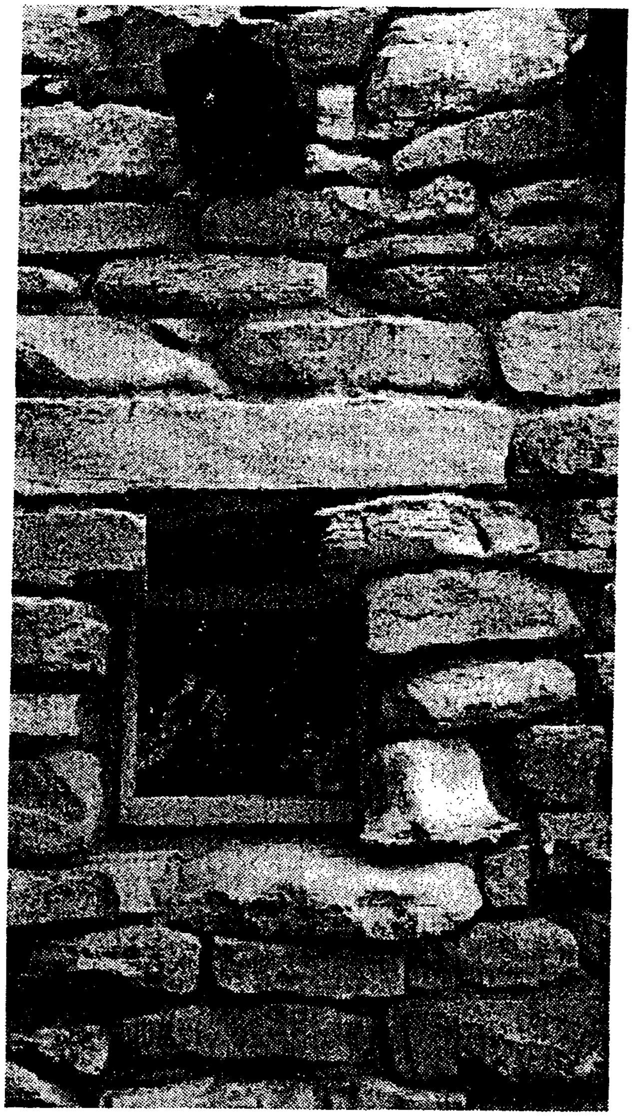


Figure 17. Detail shows window on the west elevation of the Yavapai exterior. Wood log end exhibits deterioration. Photo dated May, 2000.

Figure 18. This image illustrates the windows on the east side of the Yavapai interior, inside the foyer entrance. The windows were installed in 1979, replacing the 1953 glazing. The windows look to the north. Photo dated May, 2000.

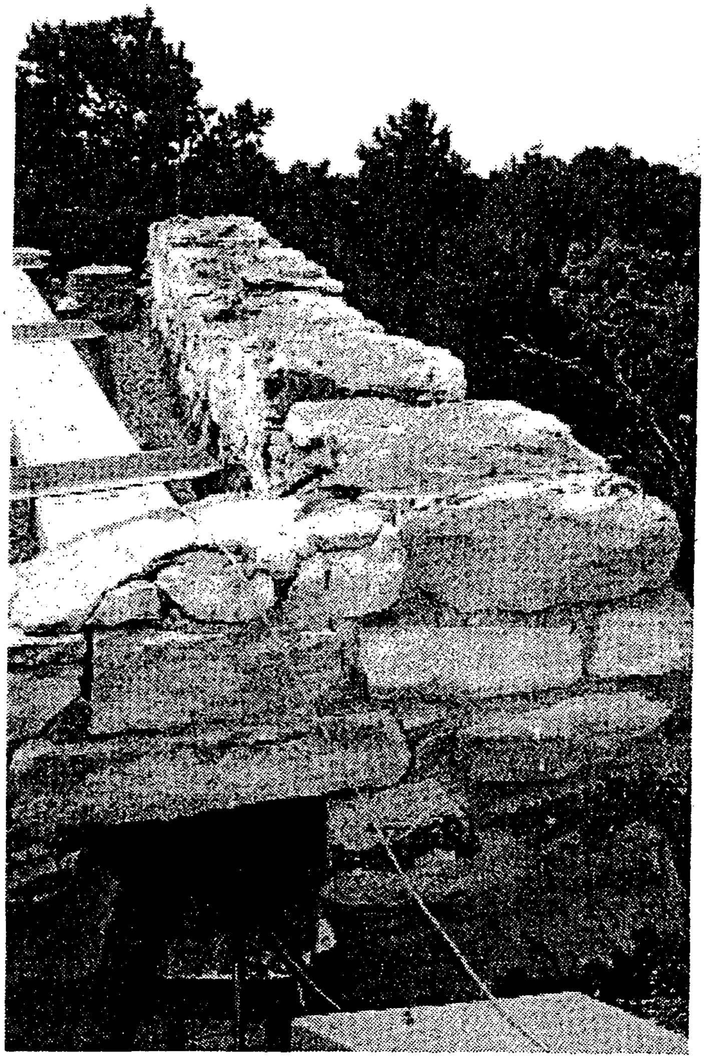


Figure 19. This image illustrates the parapet above the flat roof. Evidence of mastic repairs. View is looking south. Photo dated May, 2000.

Appendix G. Potential Seismic Hazard Assessment by Sato and Associates, dated October 1998.

Prepared for:

Denver Service Center
National Park Service
12795 West Alameda Parkway
Denver, CO 80225

RAPID VISUAL SCREENING OF BUILDINGS AT GRAND CANYON NATIONAL PARK FOR POTENTIAL SEISMIC HAZARDS

Prepared by:

J.F. Sato and Associates
5898 South Rapp Street
Littleton, CO 80120
Phone: (303) 797-1200
Fax: (303) 797-1187

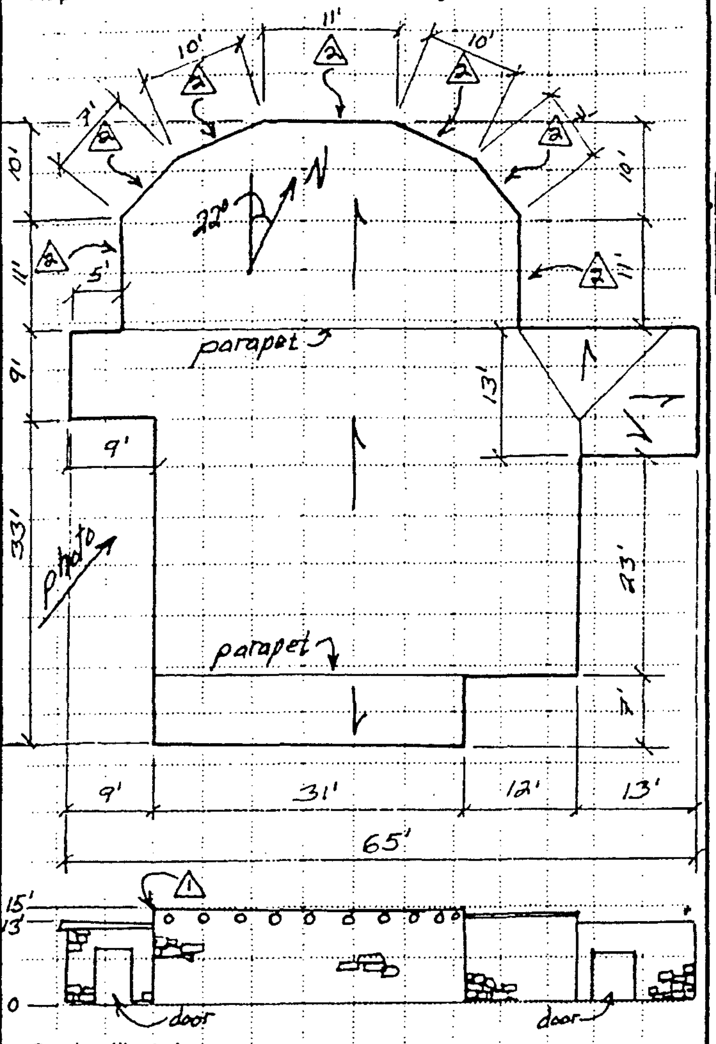
100% FINAL

October, 1998

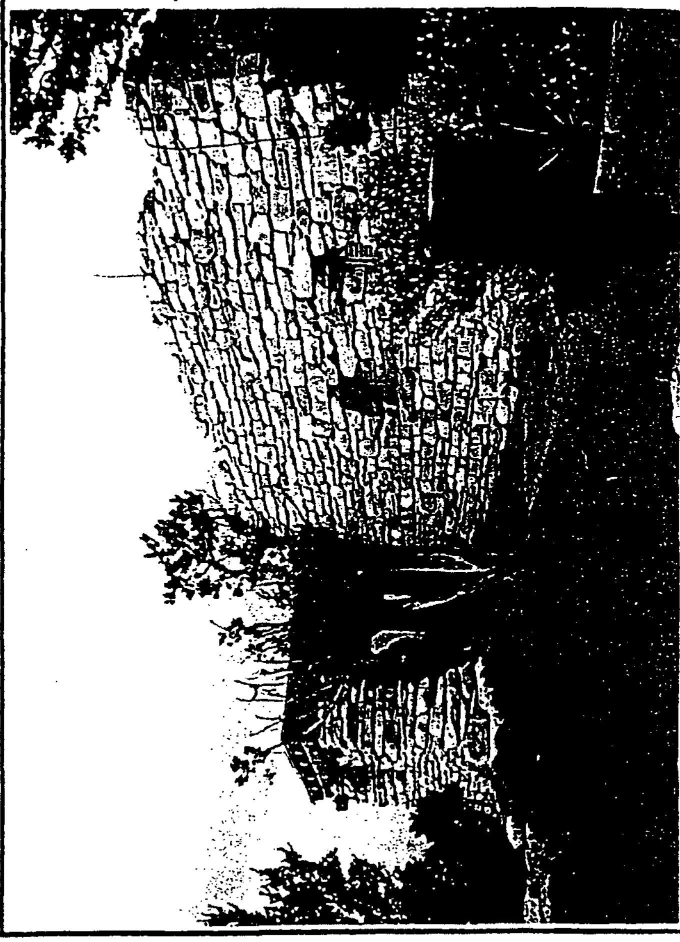
ATC-21/ (NEHRP Map Areas 1,2 Low)

Rapid Visual Screening of Seismically Hazardous Buildings

Address Yavapai Point
Grand Canyon, South Rim, AZ Zip 86023
Other Identifiers 1st Left after gas station on way to east entrance
No. Stories 1 Year Built 1928
Inspector Mark Wasinger Date 8-16-98
Total Floor Area (sq. ft) 2670
Building Name Yavapai Observation Station - Bldg #110
Use Visitor / Info Center / Observation station



Scale: 1"=20'



OCCUPANCY	No. Persons
Residential	0-10
Commercial	11-100
Office	100+
Industrial	
Pub. Assem.	
School	
Govt. Bldg.	
Emer. Serv.	
Historic Bldg.	

Non Structural Falling Hazard ☑ 1

DATA CONFIDENCE

* = Estimated, Subjective, or Unreliable Data

DNK = Do Not Know

STRUCTURAL SCORES AND MODIFIERS

BUILDING TYPE	W	S1 (MRF)	S2 (BR)	S3 (LM)	S4 (RC SW)	C1 (MRF)	C2 (SW)	C3/S5 (URM INF)	PC1 (TU)	PC2	RM	URM
Basic Score	8.5	3.5	2.5	6.5	4.5	4.0	4.0	3.0	3.5	2.5	4.0	2.5
High Rise	N/A	0	0	N/A	-0.5	-0.5	-0.5	-0.5	N/A	-1.0	-1.5	-0.5
Poor Condition	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Vert. Irregularity	-0.5	-0.5	-0.5	-0.5	-1.0	-1.0	-0.5	-1.0	-1.0	-1.0	-0.5	-1.0
Soft Story	-1.0	-2.0	-2.0	-1.0	-2.0	-2.0	-2.0	-1.0	-1.0	-1.0	-2.0	-1.0
Torsion	-1.0	-2.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
Plan Irregularity	-1.0	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-1.0	-1.0	-1.0	-1.0
Pounding	N/A	-0.5	-0.5	N/A	-0.5	-0.5	N/A	N/A	N/A	-0.5	N/A	N/A
Large Heavy Cladding	N/A	-2.0	N/A	N/A	N/A	-1.0	N/A	N/A	N/A	-1.0	N/A	N/A
Short Columns	N/A	N/A	N/A	N/A	N/A	-1.0	-1.0	-1.0	N/A	-1.0	N/A	N/A
Post Benchmark Year	+2.0	+2.0	+2.0	+2.0	+2.0	+2.0	+2.0	N/A	+2.0	+2.0	+2.0	N/A
SL2	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
SL3	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6
SL3 & 8 to 20 stories	N/A	-0.8	-0.8	N/A	-0.8	-0.8	-0.8	-0.8	N/A	-0.8	-0.8	-0.8

FINAL SCORE 0.5

COMMENTS

1 This portion of unreinforced stone wall could fall on people trying to flee the building during an earthquake

2 Large windows

Detailed Evaluation Required? YES NO

ATC19.OM
20086.01

Appendix H. National Register Nomination for the Yavapai Observation Station, dated April 13, 1990. (Due to document length, only the Statement of Significance is included.)

United States Department of the Interior
National Park Service

National Register of Historic Places Registration Form

This form is for use in nominating or requesting determinations of eligibility for individual properties or districts. See instructions in *Guidelines for Completing National Register Forms* (National Register Bulletin 16). Complete each item by marking "x" in the appropriate box or by entering the requested information. If an item does not apply to the property being documented, enter "N/A" for "not applicable." For functions, styles, materials, and areas of significance, enter only the categories and subcategories listed in the instructions. For additional space use continuation sheets (Form 10-900a). Type all entries.

1. Name of Property

historic name Yavapai Observation Station
other names/site number Yavapai Point Museum
LCS number 07661, see #9, Major Bibliographical References

2. Location

street & number Yavapai Point, Grand Canyon National Park ☐ not for publication
city, town Grand Canyon ☐ vicinity
state AZ code AZ county Coconino code AZ005 zip code 86023

3. Classification

Ownership of Property
- ☐ private
- ☐ public-local
- ☐ public-State
- ☒ public-Federal

Category of Property
- ☒ building(s)
- ☐ district
- ☐ site
- ☐ structure
- ☐ object

Number of Resources within Property

Contributing	Noncontributing	
1	1	buildings
		sites
7	1	structures
		objects
8	2	Total

Name of related multiple property listing:

Number of contributing resources previously listed in the National Register 0

4. State/Federal Agency Certification

As the designated authority under the National Historic Preservation Act of 1966, as amended, I hereby certify that this ☐ nomination ☐ request for determination of eligibility meets the documentation standards for registering properties in the National Register of Historic Places and meets the procedural and professional requirements set forth in 36 CFR Part 60. In my opinion, the property ☐ meets ☐ does not meet the National Register criteria. ☐ See continuation sheet.

Signature of certifying official Date

State or Federal agency and bureau

In my opinion, the property ☐ meets ☐ does not meet the National Register criteria. ☐ See continuation sheet.

Signature of commenting or other official Date

State or Federal agency and bureau

5. National Park Service Certification

I, hereby, certify that this property is:
- ☐ entered in the National Register.
  ☐ See continuation sheet.
- ☐ determined eligible for the National Register. ☐ See continuation sheet.
- ☐ determined not eligible for the National Register.
- ☐ removed from the National Register.
- ☐ other, (explain:)

Signature of the Keeper Date of Action

Statement of Significance

Certifying official has considered the significance of this property in relation to other properties:

☐ nationally ☐ statewide ☐ locally

Applicable National Register Criteria ☐ A ☐ B ☒ C ☐ D

Criteria Considerations (Exceptions) ☐ A ☐ B ☐ C ☐ D ☐ E ☐ F ☐ G

Areas of Significance (enter categories from instructions)	Period of Significance	Significant Dates
Architecture	1928 to present	1928
Other: NPS Interpretation		1953
		1978

Cultural Affiliation

Significant Person

Architect/Builder: Herbert C. Maier, Architect

State significance of property, and justify criteria, criteria considerations, and areas and periods of significance noted above.

Yavapai Point Museum is of national significance in National Park Service **architecture** and **interpretation**. The Yavapai Point Museum was designed by an architect who mastered designs that fit in with the wilderness setting of national parks. His work was the foundation and inspiration for architecture throughout the National Park Service and for CCC state park structures across the nation. Herbert Maier's work blended in with the landscape by using native materials and low unobtrusive forms. His idea was to study nature in situ, not "to bring the world in under one roof."[10] The observation station was built on the brink of the canyon rim, actually following its contour (see sketch). It remains a classic example of NPS rustic architecture, enhanced by incorporating the southwestern design elements that Mary Colter used in her architecture at the Grand Canyon.

The Yavapai Observation Station was one of the first formal interpretive structures in the National Park Service. The plan for interpretation at Yavapai was the work of many influential researchers and scholars. Their innovative interpretive philosophy was for the visitor to gain knowledge by observation, utilization of the displayed geological information and discovery. The structure was built on this particular point because so much of the important geological story of Grand Canyon may be seen from here. The Yavapai Observation Station became a model for interpretive structures in other parks.

ARCHITECTURE:

The Yavapai Observation Station was designed by **Herbert C. Maier**, who also supervised its construction. The Yavapai was built between September of 1927 and July of 1928, and was the third of Maier's National Park museums. The first two were in Yosemite; the Trailside Museum at Glacier Point Lookout built in 1924, and the Yosemite Museum built in 1925. Maier also designed three museums in Yellowstone in the late 1920s.

☒ See continuation sheet

[10] NPS Park Structures and Facilities, 1935, pg. 161

Maier's work on the Yavapai differed somewhat from his Yosemite work as the Yavapai was designed along "distinctly Indian lines."[11] The pueblo like features include; a masonry parapet around a flat roof, battered native limestone walls, buttressed corners, vigas, and tiny window openings.

The structure is a liaison with its setting on the edge of the Grand Canyon as the large observation terrace is shaped to conform almost exactly to the canyon rim. Maier chose the native rocks to be quarried from the canyon, as well as supervising where each stone was laid by his mason.[12] According to Maier's widow, he wanted his structures to blend with their surrounding, yet "he didn't want them to be diminutive. Nature is so grand you don't want to take little stones. So he'd get the biggest ones he could."[13] Maier was so attuned to the environmental setting he included a tree-well in the southwest corner of the building for a small pinyon growing there.

Maier studied architecture at the University of California at Berkeley. In 1923 he worked for Ansel Hall and the Western Museum Laboratory at the University of California and then became the Executive Agent and Architect for the American Association of Museums.[14] It was during this time that he designed the Yosemite, Grand Canyon, and Yellowstone museums.[15]

Maier became District Officer for the National Park Service Emergency Conservation Work Program in 1933. He later became Associate Regional Director for the Southwest and then Western Region of the National Park Service. Maier received the Distinguished Service Award in 1961 for his contributions to park architecture.

His work served as a teaching tool for Park Service architects in the work relief programs of the 1930s, as his style was appropriate for the wilderness setting of our parks. The 1935 publication Park Structures and Facilities, and the later 1938 edition, Park and Recreation Structures contain a majority

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[11] William C. Tweed, Laura E. Soulliere, Henry G. Law, National Park Service Rustic Architecture:1916-1942. National Park Service, 1977, p. 41.

[12] Interview with Susan Maier, conducted by Jacilee Wray, February 25, 1990. Grand Canyon National Park Oral History Files.

[13] Ibid.

[14] Interview with Herbert Maier, conducted by S. Herbert Evison, October 28, 1962. Harper's Ferry Center History Collection.

[15] Laura Soulliere Harrison, Architecture in the Parks: National Historic Landmark Theme Study. National Park Service, 1986.

of the structures that Herbert Maier had a hand in designing.[16] These publications set the standards for NPS rustic architecture seen in national and state parks today.

Maier's work was also the first to house the then new concept of interpretation.[17] Maier's philosophy of architecture fit in well with the value of a "natural" area. Maier said that "the exhibit rooms should afford an occasional vista into the nearby woodland so that the visitor may have a feeling of being in the midst of the subject matter that is being interpreted."

Maier felt that it was a shame to put any kind of a building in a national park, but if you had to, "it must spring up out of the ground,"[18] and that the "architecture of our park museums should, above everything else, reflect the outdoors.[19]

INTERPRETATION:

The Yavapai Observation Station is a type of trailside museum. The trailside museum can be accredited to **Hermon C. Bumpus**, chairman of the American Association of Museum's Committee on Outdoor Education. Bumpus believed that conservation was futile unless it was followed by a form of "public utilization and enjoyment."[20] The way to give the park visitor information was by "labeling" the landscape, so to speak, in "conveniently situated `interpreter houses'" which Bumpus termed "trailside museums."[21]

Bumpus and the American Association of Museums received funding from the Laura Spelman Rockefeller Foundation for museums in several national parks. The first was the Glacier Point Lookout Station at Yosemite National Park in 1924. Following this was the large Yosemite Museum, which was not a trailside museum. The Yavapai project was the second trailside museum in a national

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[16]Interview with Herbert Maier, conducted by S. Herbert Evison, October 28, 1962. Harper's Ferry Center History Collection.

[17]Ibid.

[18]Ibid.

[19]Ibid.

[20]Hermon Carey Bumpus Jr., Hermon Carey Bumpus: Yankee Naturalist. University of Minnesota Press, Minneapolis, 1947, p. 103.

[21]Ibid., pg. 104

park. It was designed as an observation station to call attention to the physical and historical geology of the Grand Canyon.

Yavapai Observation Station was one of the first settings for interpretation in the National Park Service located at the site of the phenomenon to be interpreted.[22] **John C. Merriam** had the "leading hand" in the interpretive aspects of the project according to Maier.[23] Merriam was the President of the Carnegie Institution and Chairman of the Committee on Educational Problems in National Parks which became the Advisory Board for the National Park Service.

Merriam's 1927 interpretive report for the Yavapai, "Suggestions Regarding Educational Program for Grand Canyon," is considered to be a classic example of interpretive planning. Merriam suggested telling the "main story" of the Grand Canyon by transmitting information to the visitor in a way that they could gain the most information in a short time.

Merriam wanted to develop opportunities for the visitor to learn the features of special interest on their own initiation. To accomplish this the observation station must "turn attention to the proper direction and yet leave the visitor the maximum opportunity for his own initiative and observation."[24] The Yavapai was to be an observatory where "interest might be stimulated better by pointing out the realities upon which the theory rests."[25]

Under Merriam's leadership leading scientists Dr. Herbert Gregory from the Geology Department at Yale University; D. Davis White, Senior Geologist for U.S.G.S.; Dr. Francois E. Matthes, USGS; and Dr. C.W. Gilmore, curator of Vertebrate Paleontology of the U.S. National Museum; as well as Herbert C. Maier, American Association of Museums; Ansel F. Hall, Senior Naturalist and Forester from the University of California at Berkeley; and Dr. Edwin D. McKee, then working for the Carnegie Institution of Washington, determined which geological features were the most outstanding and how they could be interpreted most effectively.

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[22] Interview with Herbert Maier, conducted by S. Herbert Evison, October 28, 1962. Harper's Ferry Center History Collection.

[23] Ibid., pg. 11.

[24] John C. Merriam, "Memorandum Regarding Use of Yavapai Station," no date. National Park Service microfiche files, Grand Canyon.

[25] John C. Merriam, "Notes on remarks by John C. Merriam in address to the Naturalist Staff of Crater Lake Park, Sinnott Memorial, August 6, 1932." National Park Service microfiche files, Grand Canyon.

The Yavapai Observation Station was designed to be a focal point for Grand Canyon's entire interpretive program, and all exhibits, lectures and field trips would relate to the orientation of the forces that created the canyon presented there[26] using photographs, charts, models, telescopes and fossil displays.

The Yavapai Observation Station was used as an example for other park museums, such as Crater Lake's Sinnott Memorial (termed a miniature Yavapai) built in 1931 and Olympic National Park's Hurricane Ridge Observation Station built in 1954.[27]

Herbert C. Maier was chosen by Bumpus to be the Executive Secretary of the Committee on Outdoor Education of the American Association of Museums, as well as their architect. The success of Maier's two Yosemite museums generated enthusiasm towards a movement to build a museum in every National Park.[28]

Maier felt that in constructing park museums "we must always keep in mind that our parks themselves are museums of natural history and the best museum structure is that one which functions most efficiently as an interpretive agent. They should never become mere repositories for curios and oddities."[29]

The Carnegie Institution engaged Edwin McKee to prepare a relief map for the observation station in 1927. McKee became the park naturalist at Grand Canyon from 1929 to 1940. McKee also constructed a geologic rock column at Yavapai illustrating the formations of the canyon. The column was built to the same relative thickness and position as the geology of the Grand Canyon. McKee quarried stones from the actual geologic strata to illustrate the concepts of "pages and chapters in the history of the earth."[30] This design was borrowed by Mary Colter in the construction of the Bright Angel lobby fireplace in 1935. In fact, McKee assisted Ms. Colter with geological authenticity of her

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[26]Ansel F. Hall, "Report on the Development of Yavapai Station: June 1930-July 1931," unpublished, 1931, pg. 44. National Park Service, Grand Canyon.

[27]National Park Service, "Interpretive History Yavapai Museum: Planning; General; 1920s to recent." National Park Service files, Grand Canyon.

[28]Linda Wendel Greene, Historic Resources Study - Yosemite: The Park and Its Resources, Vol. 2. National Park Service, 1987.

[29]National Park Service, Park Structures and Facilities. United States Department of Interior, Branch of Planning, 1935, p. 162.

[30]Edwin D. McKee, November 4, 1978, letter to Merle Stitt, Superintendent. National Park Service files. Grand Canyon.

"rim to rim" fireplace.[31] McKee's rock column and relief map were removed during the interior renovation of Yavapai in 1978 to McKee's great disappointment.

McKee saw the observation station as a tool for introducing the great and inspirational aspects of the canyon. He called the Yavapai the "key to the Grand Canyon."[32] McKee said it is "not intended to be a museum where collections of specimens and exhibits not related to the features selected as most significant to the story would be displayed."[33] The Yavapai was designed to be an observatory of the Grand Canyon.

The Yavapai Observation Station was one of the first truly interpretive structures in the National Park Service. Some of the most renown people in their fields worked very hard to make it a place where knowledge could be gained by seeing the natural wonders of the Grand Canyon and bringing the geologic story together with the beauty of observation. It can be put into the best perspective by quoting Dr. John C. Merriam: "Yavapai is a particular point of view and an instrument for obtaining this view."[34]

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[31] Letter to Edwin McKee, from Mary E. J. Colter, April 1, 1935, Bright Angel Lodge History File, Park Library, Grand Canyon.

[32] Edwin D. McKee, November 4, 1978, letter to Merle Stitt, National Park Service files, Grand Canyon.

[33] Ibid.

[34] John C. Merriam, September 24, 1935, letter to Edwin Mckee. National Park Service microfiche files, Grand Canyon.

Appendix I. Consultant Reports.

Flack + Kurtz Inc.

Yavapai Museum
Grand Canyon National Park, Arizona

BUILDING ASSESSMENT REPORT

Prepared for:
Architectural Resources Group
Pier 9, The Embarcadero
San Francisco, CA 94111

Prepared by
Flack+Kurtz Inc.
A WSP Group Company
343 Sansome Street
San Francisco, California 94104

November 7, 2000

TABLE OF CONTENTS

I. INTRODUCTION

A. GENERAL

The Yavapai Museum is located on the South Rim of Grand Canyon National Park. The site elevation is approximately 7,000 feet above sea level.

The Yavapai Museum was originally constructed in 1928 for the purpose of providing an observation area to better understand the geology of the Grand Canyon. Its current use is still as an observation area. However, a bookstore has since been added. The plan is to renovate and restore the building to its original use as an observation platform and museum.

This report provides a basic assessment of the building's HVAC, plumbing, fire protection and electrical systems. The report is based on a review of available building drawings and a walk through of the building on May 15th and 16th, 2000 by Flack + Kurtz. The estimation of the future viability of existing systems is based solely on field observations. The walk through was limited to the observation of visible equipment only. Equipment was not tested or operated for functionality, nor were hidden areas exposed or inspected.

Recommendations related to code issues are based on the current versions of the Uniform Building, Electrical, Fire, Mechanical, and Plumbing codes.

II. HEATING, VENTILATING AND AIR CONDITIONING

A. GENERAL DESCRIPTION

In general the heating system equipment seemed to be in good working order and has been fairly well maintained over its operational lifetime. The plans of the existing conditions appear to be reasonably accurate with only a few deviations and undocumented changes.

B. AIR CONDITIONING SYSTEM

1. Existing Conditions

The entire building is heated by electric radiant convectors mounted on walls or beams near the ceiling. The convectors are approximately 3 inches wide and are several feet long. Several of the convectors are grouped together in zones and controlled by wall mounted thermostats.

There are currently no provisions for outside air or cooling for the space. However, there are small ceiling registers that are capped which may have been used at one time to provide some outside air and cooling for the space. Two gravity relief vents are located on the roof.

2. Recommendations

If the observation area is to opened up to the outdoors, it could be possible to re-use the electric radiators in order to provide some heating on the open terrace. If the remainder of the building becomes a museum or display area we would recommend adding a small roof mounted air cooled heat pump which would provide heating, cooling and minimum outside air requirements for the occupied space.

III. PLUMBING

A. DOMESTIC WATER SYSTEM

1. Existing Conditions

There is a ¾ inch domestic water service entering the building serving a single sink. No other plumbing serves this building.

2. Recommendations

Modify the current sink installation, which is draining into a bucket, and connect to a sanitary line with required venting. Also verify source of domestic water and ensure it is operational.

B. FIRE PROTECTION SYSTEM

1. Existing Conditions

There currently is no fire protection in the building

2. Recommendations

Provide a new 4 inch fire service and sprinkler protection of the building with a wet fire sprinkler system. Also, provide a fire department connection on the exterior of the building for the fire department to connect to in the event of a fire.

C. SANITARY AND STORM SYSTEM

1. Existing Conditions

There currently is no sanitary service to this building. The storm water is collected on the roof and directed to perimeter scuppers where it falls away from the building.

2. Recommendations

If a sink and/or toilet is added a sanitary line will need to be installed. The roof drainage system appears to be in good condition from a functional standpoint and recommend it stay in place.

IV. ELECTRICAL

A. ELECTRIC SERVICE

1. Existing Conditions

Electrical service to the building is provided by APS at 120/208V, 1-phase, 3-wire. The service disconnect is a 3P-150A circuit breaker which in turn feeds a 150A main panel.

2. Recommendations

The existing service equipment appears to be in fair condition but is a candidate for replacement due to its age. Recommend replacement.

The existing service capacity is adequate for the planned renovation. However, the load capacity will be reviewed when the air conditioning and museum loads are more fully established.

B. POWER DISTRIBUTION

1. Existing Conditions

A single panelboard for lighting and receptacle circuits is located in the building. Service to the panelboard is via overhead conduit routing. The panelboard is rated at 120/208V, 1-phase.

2. Recommendations

All existing panelboards should be replaced with new panels during the renovation phase.

C. LIGHTING AND RECEPTACLES

1. Existing Conditions

Lighting consists mainly of surface mounted track light fixtures and incandescent downlights.

Recessed wall mounted receptacles and telephone outlets are located at various points to satisfy current equipment locations.

2. Recommendations

Light fixtures should be replaced with new energy efficient lighting systems where possible. Magnetic ballasts should be assumed to contain PCB's and disposed of in accordance with all applicable rules and regulations

D. FIRE ALARM SYSTEM

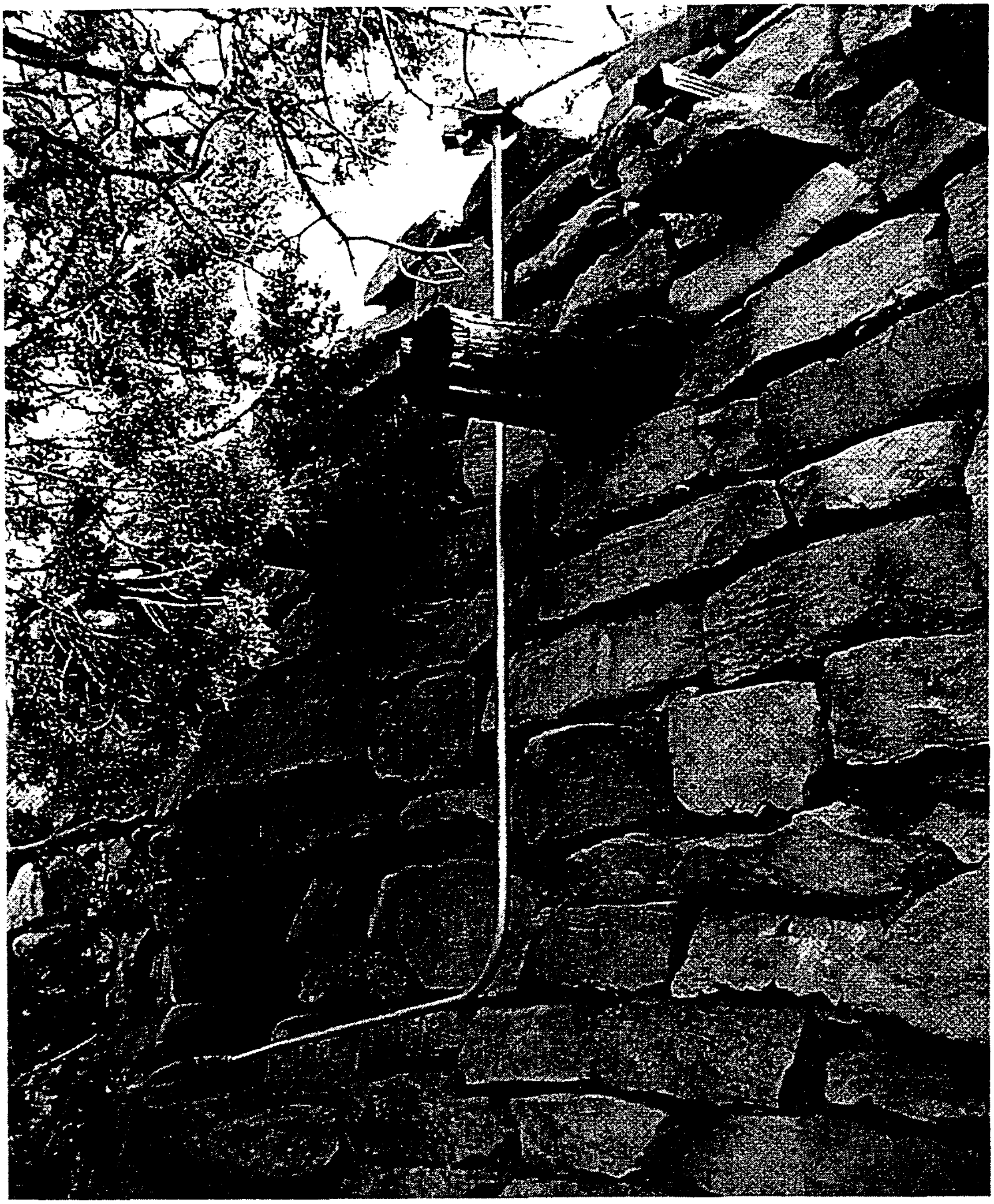
1. Existing Conditions

There is no fire alarm signaling system currently installed. Smoke detectors are installed with local annunciation.

2. Recommendations

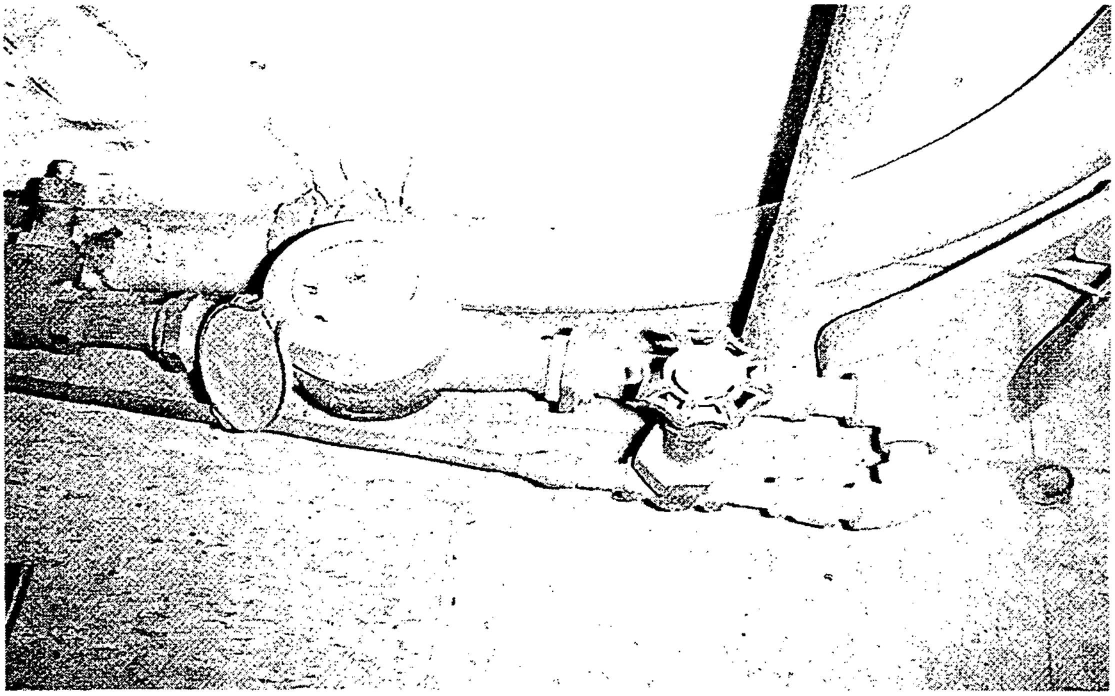
The current occupancy use group does not require a full fire alarm signaling system. However, it is recommended to add ADA visual strobe devices to meet the requirements of the Americans with Disabilities Act of 1990 (ADA). ADA xenon strobes should be located 80" above finished floor or 6" below ceiling, whichever is lower. Strobes would located in all common areas including break rooms, lobbies and restrooms. A fire alarm panel will need to be provided in order to power the strobe devices. A remote dialer should be provided to communicate with an off-site monitoring station.

V. SITE PHOTOS



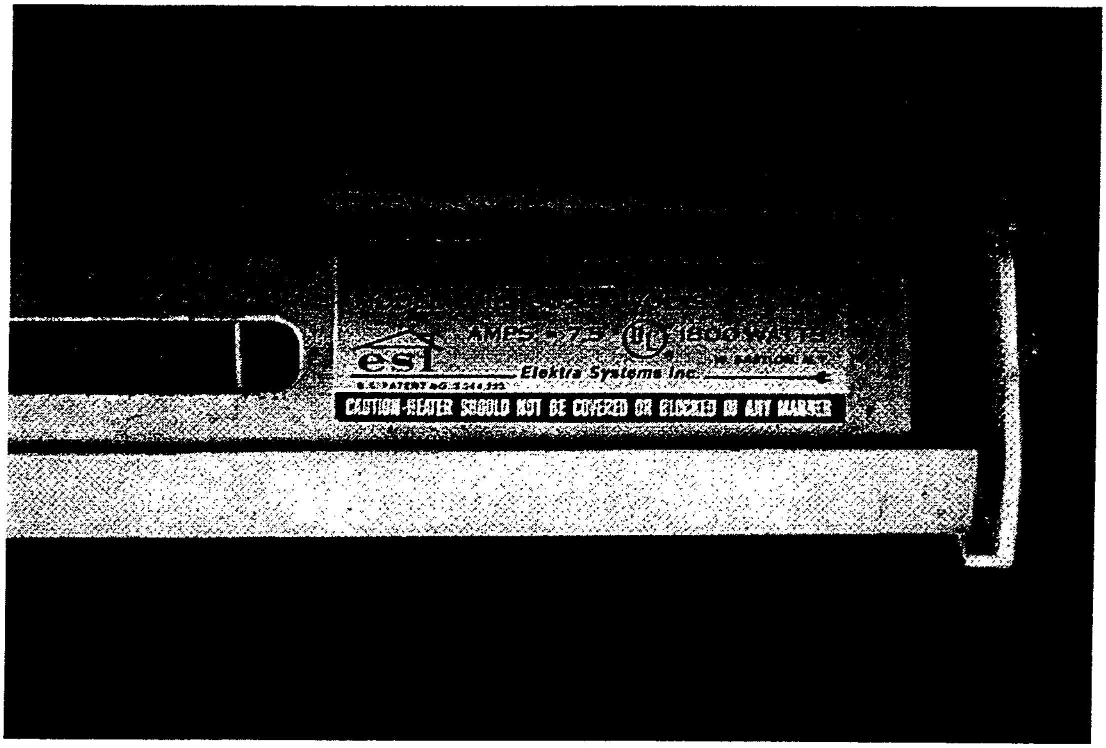
1: Conduit on Exterior Wall and Scupper

2: Electrical Panels

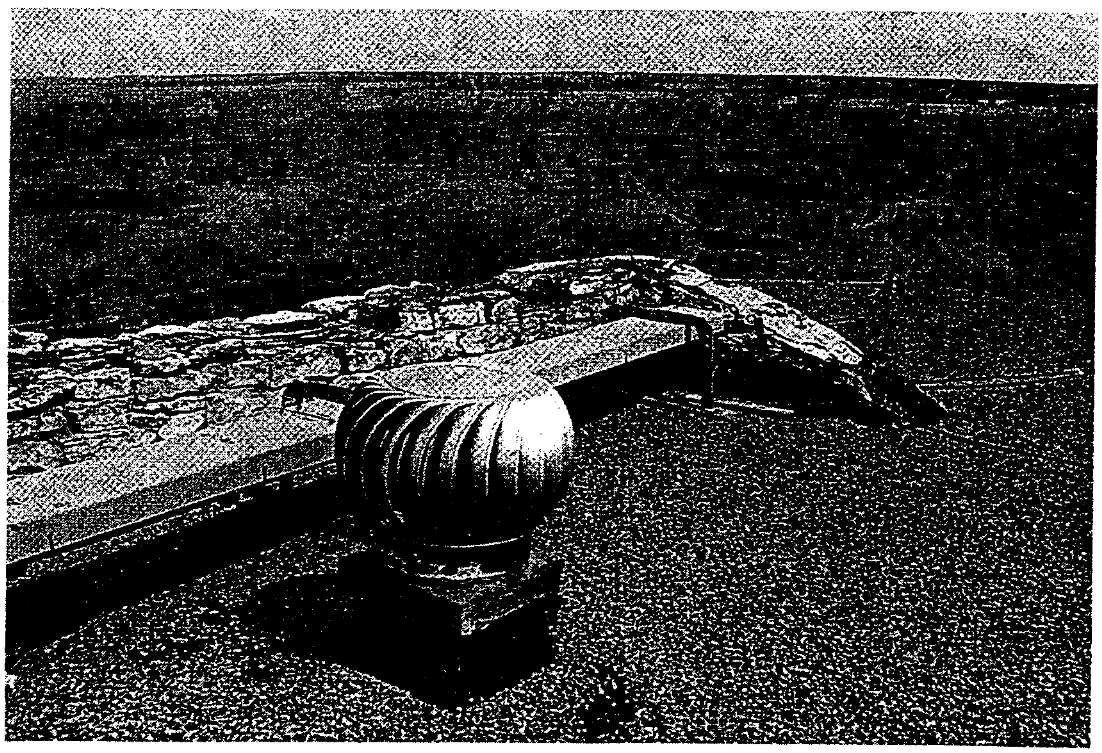


3: Domestic Water Line

4: Smoke Detector



5. Electric Radiator Nameplate



6: Roof Vent

Yavapai Museum

Existing Conditions

The Yavapai Museum was built in approximately 1928. The building is a single story structure with a small storage room, accessible only from the cliff side, below the main floor. The roof is flat with a tar and gravel topping. A portion of an interior bearing wall was removed in 1953 and replaced with a beam and column support system. The available drawings of the building depict only a very limited portion of the structural system.

The storage room appears to occur in a natural pocket in the rock face of the cliff. Rather than infilling the pocket in the rock below, the main floor was framed above the pocket and the space was closed off with a door at the exterior. The remainder of the main floor is a concrete slab-on-grade.

The building consists of mortared, solid stone masonry bearing walls at the perimeter and one interior, solid stone masonry bearing wall, which originally separated the open-air observation deck from interior space. The stone appears to have been quarried, with relatively large individual pieces. Over the smaller window and door openings, longer, single-piece stones were placed as lintels. The walls at the cliff edge appear to have been constructed on top of the existing rock, which acts as the foundation of the building. In several locations around the perimeter, stones are noticeably missing from the walls. These gaps occur primarily near the base of the walls.

At some time after the observation deck was enclosed, the original door opening in the interior stone masonry wall was enlarged to create a 24-foot clear span opening. The wall support was replaced with two parallel beams and two sets of columns at each end. Although the beams and columns are architecturally enclosed, an available drawing shows two 6x8 wood columns at 12" on center at each end. The columns support two beams, side by side. The drawing shows options of either built-up 4-2x14 wood beams or W14x30 steel beams.

Four round timber columns, approximately 12", in rough diameter, provide roof support in the observation deck area. There appear to be two square concrete columns, supporting a concrete beam, in the partition wall between the gift shop and park service office space. The concrete columns seem to be a later addition to the building, although the time period of the installation and their purpose is not readily discernable.

The roof framing members, as well as the large window lintel members, are round timbers. All round timber members in the building are rough finished. Where the timbers bear directly on the stone masonry walls, most rest in partial grout beds and usually protrude through the thickness of the wall. Where timbers bear on other timbers, the upper timbers are usually either notched or rest in wood bearing cradles. At the roof corner conditions, where members meet at 45-degree angles, nailed connections are visible. The timber joists support straight sheathing at the roof.

At the large window opening adjacent to the east entrance, it appears that two timber sections that partially support the timber header are missing. The header still bears directly on the stone wall and is not in any danger of falling out.

In the observation deck area, the timber beams and columns support cantilevered timber joists, which extend to the edge of the deck. Four 3" diameter pipe columns, at 12 feet on center, were added in 1953 at the cantilevered roof edge. It is not known whether these pipes were intended to provide support for the enclosing window wall being added, or if support of the roof edge was needed.

At some unknown time, a brick chimney was added in the southwest interior corner of the building. It is not currently being used. Above the roofline, the brick has deteriorated and partially broken off.

A metal-grated service balcony is supported by pipe sections cantilevered from the stone masonry wall at the outer edge of the observation deck. The connection of the pipes to the building is unknown.

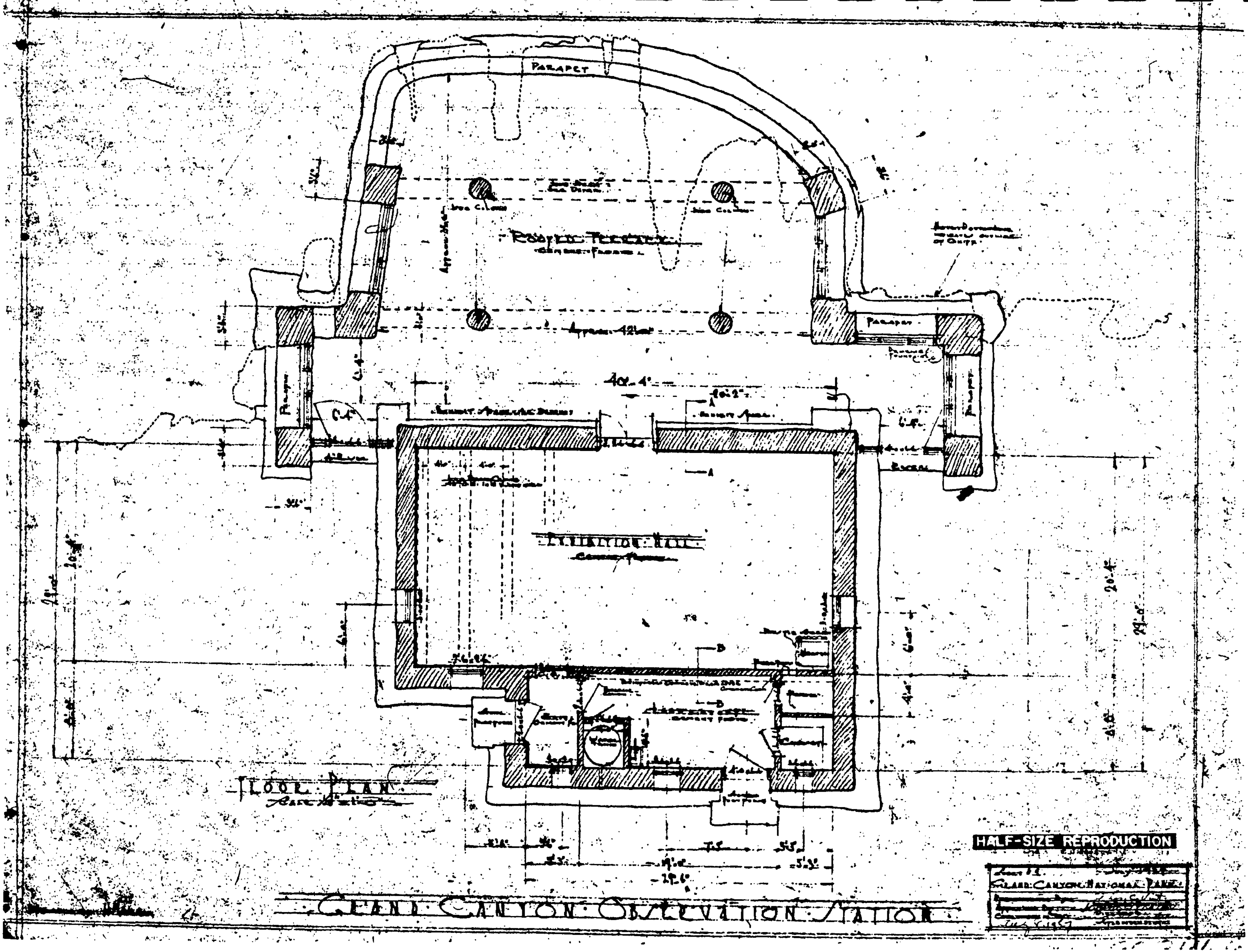
Recommendations

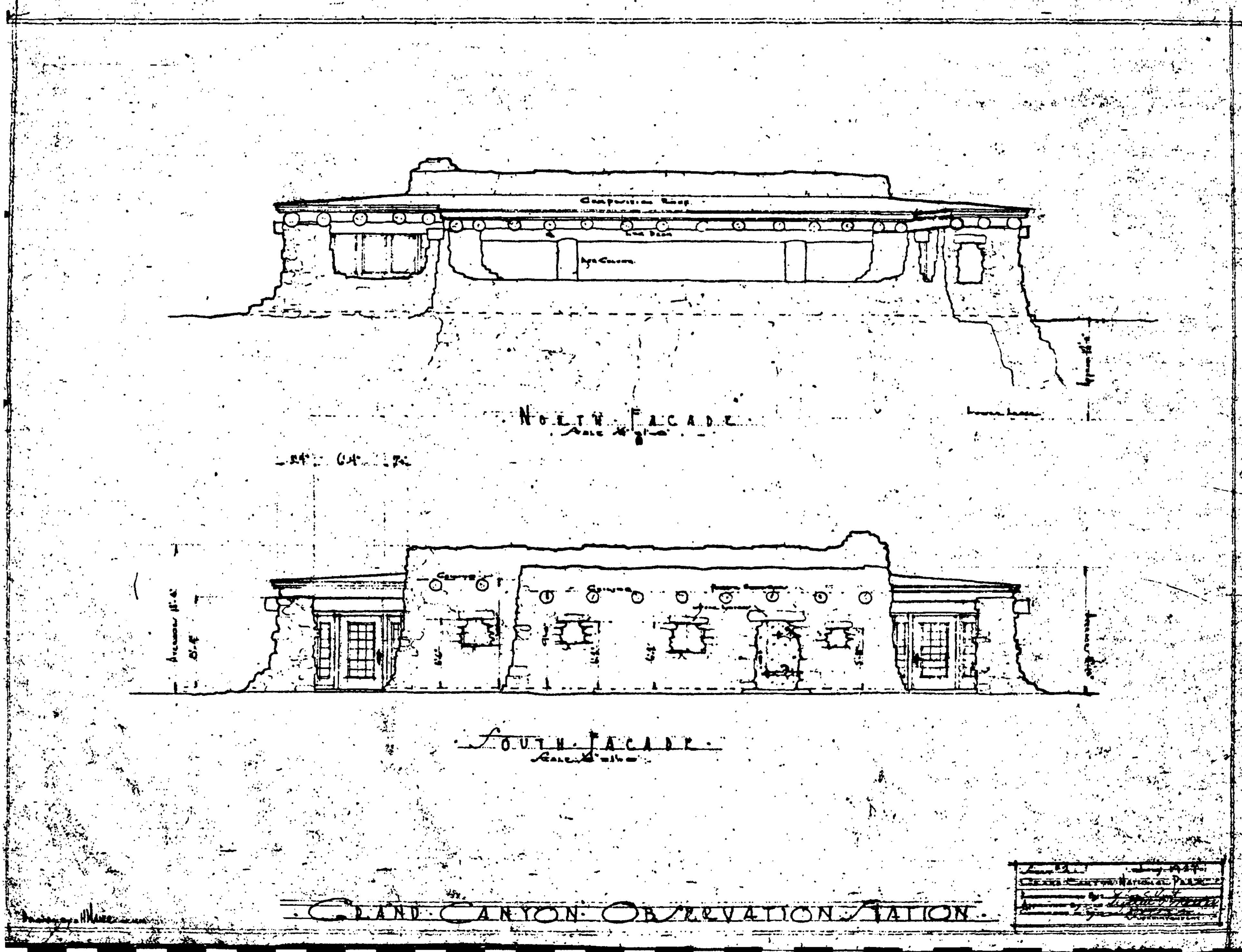
Based on its age, construction, and historic status, the Yavapai Museum would fall under the provisions of the Uniform Code for Building Conservation. Because the building is in seismic zone 2B, and since no change in occupancy has occurred, the structure does not require strengthening for seismic loads. The building must comply with the Building Code requirements for floor live loads though. Since most of the floor is on grade, the museum appears to comply with the code, although the floor framing over the lower storage room is unknown.

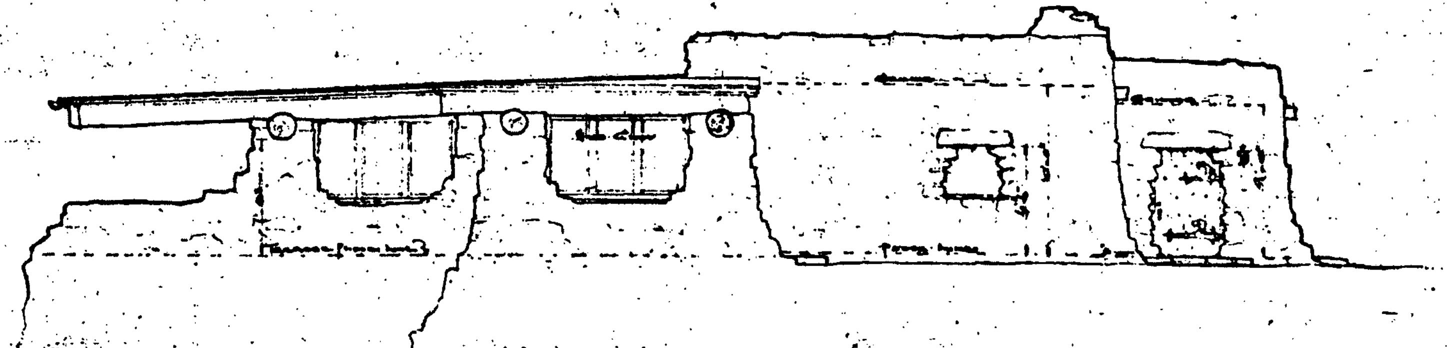
The structure is in very good condition, considering its age and the building materials used. Replacements should be made where stones have been removed from the walls, grouting the replacement stones securely in place. Missing timber members around the large windows should also be replaced. All wood-to-wood connections should be verified as having nailed connection detailing. If renovation work is undertaken, the in-place detailing of the enlarged opening at the interior stone masonry wall should be investigated and verified as adequate. Because there are no signs of potential failure or damage, it is assumed that the details shown in procured construction drawings are sufficient for the existing conditions.

In 1998, an ATC-21 Rapid Visual Screening assessment was completed for the Yavapai Museum. The assessment identified the parapet in the southwest corner of the building as a potential falling hazard. The existing parapet is constructed from full-wall width stones, mortared together, with a mortar cap. The maximum parapet height is approximately 12 inches high. Due to the width of the stones, and the mortar cap tying the stones together, the parapet presents a very low-risk for a falling hazard. The short height of the parapet would not allow sufficient room to add a typical parapet bracing system. The parapet could be simply removed above the roof line. However, instead of attempting to brace or remove the stones, any gaps between stones could be fully filled with mortar and the mortar cap could be patched or replaced. This repair would tie the full-width stones together, serving to reduce any falling hazard, while preserving the historic appearance of the building.

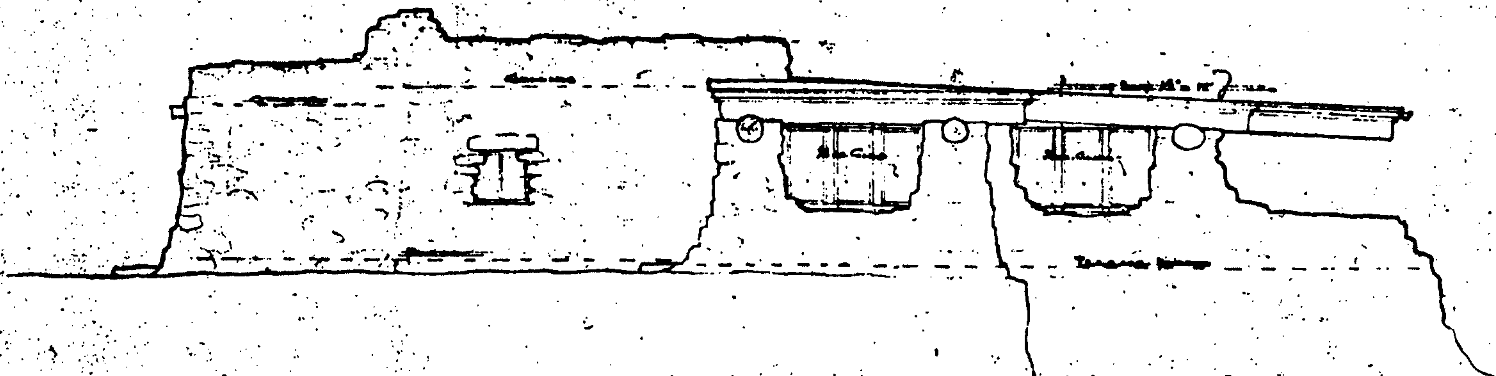
Appendix J. Copies of Original Drawings of Grand Canyon Observation Station by Herbert Maier, dated July, 1927.


PARAPET
ROOFED TERRACE
EXHIBITION HALL
Parapet
40'-4"
20'-4"
29'-0"
HALF-SIZE REPRODUCTION
FLOOR PLAN
GRAND CANYON OBSERVATION STATION
GRAND CANYON NATIONAL PARK


NORTH FACADE
SOUTH FACADE
GRAND CANYON OBSERVATION STATION



West Facade



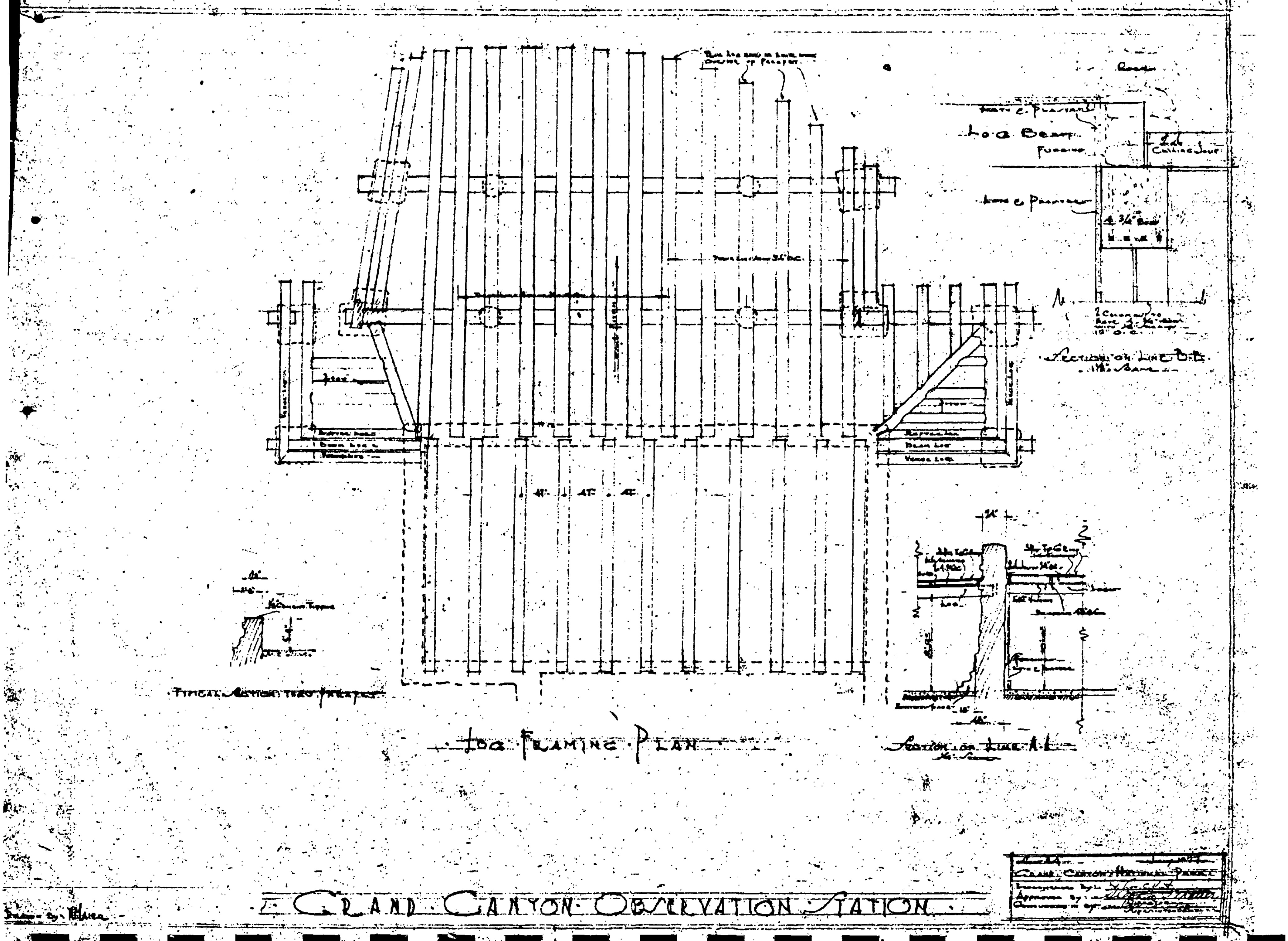
East Elevation

Sheet #3 — July 1927

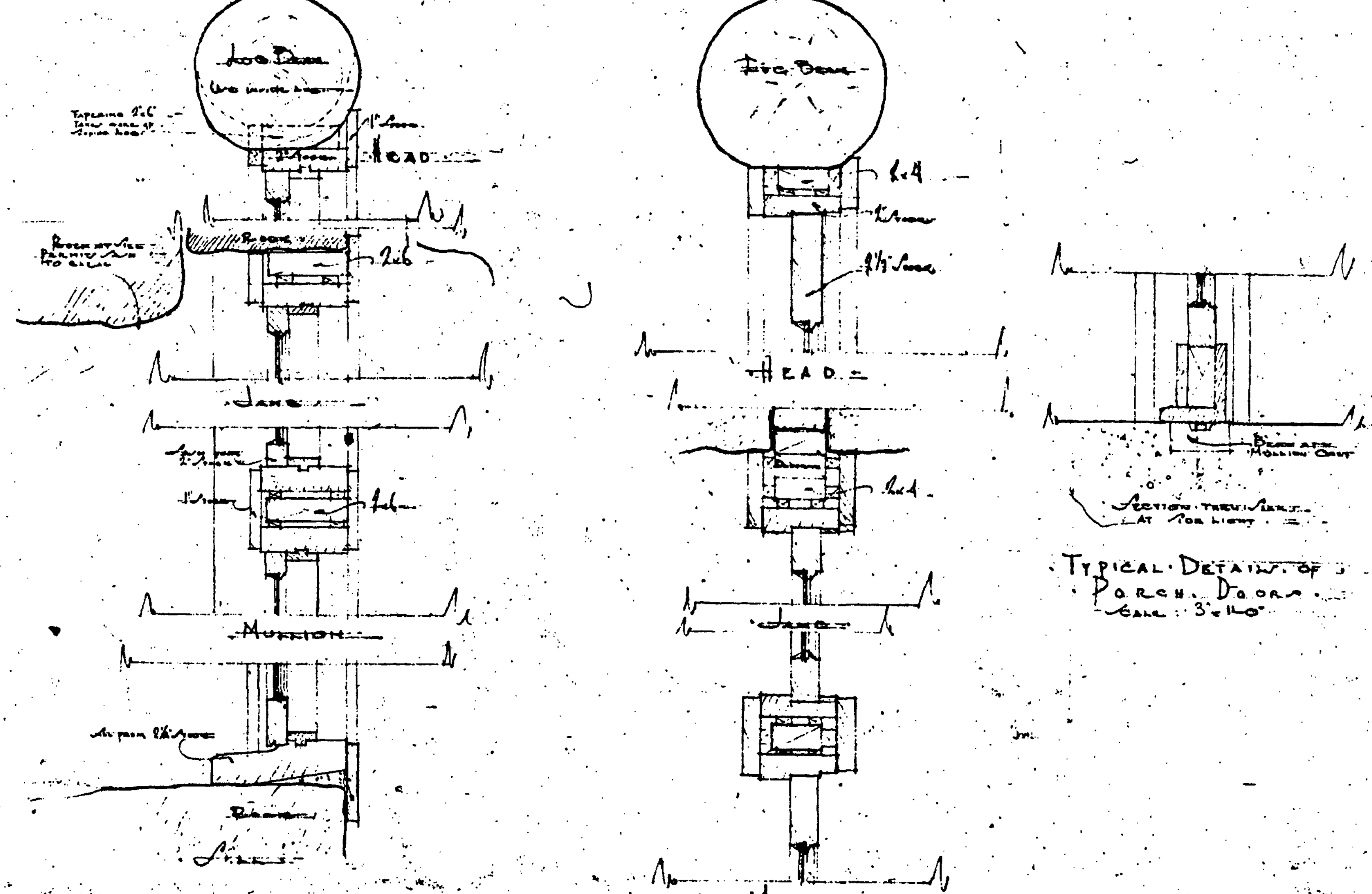
Grand Canyon National Park

Approved By:

Grand Canyon Observation Station



GRAND CANYON OBSERVATION STATION



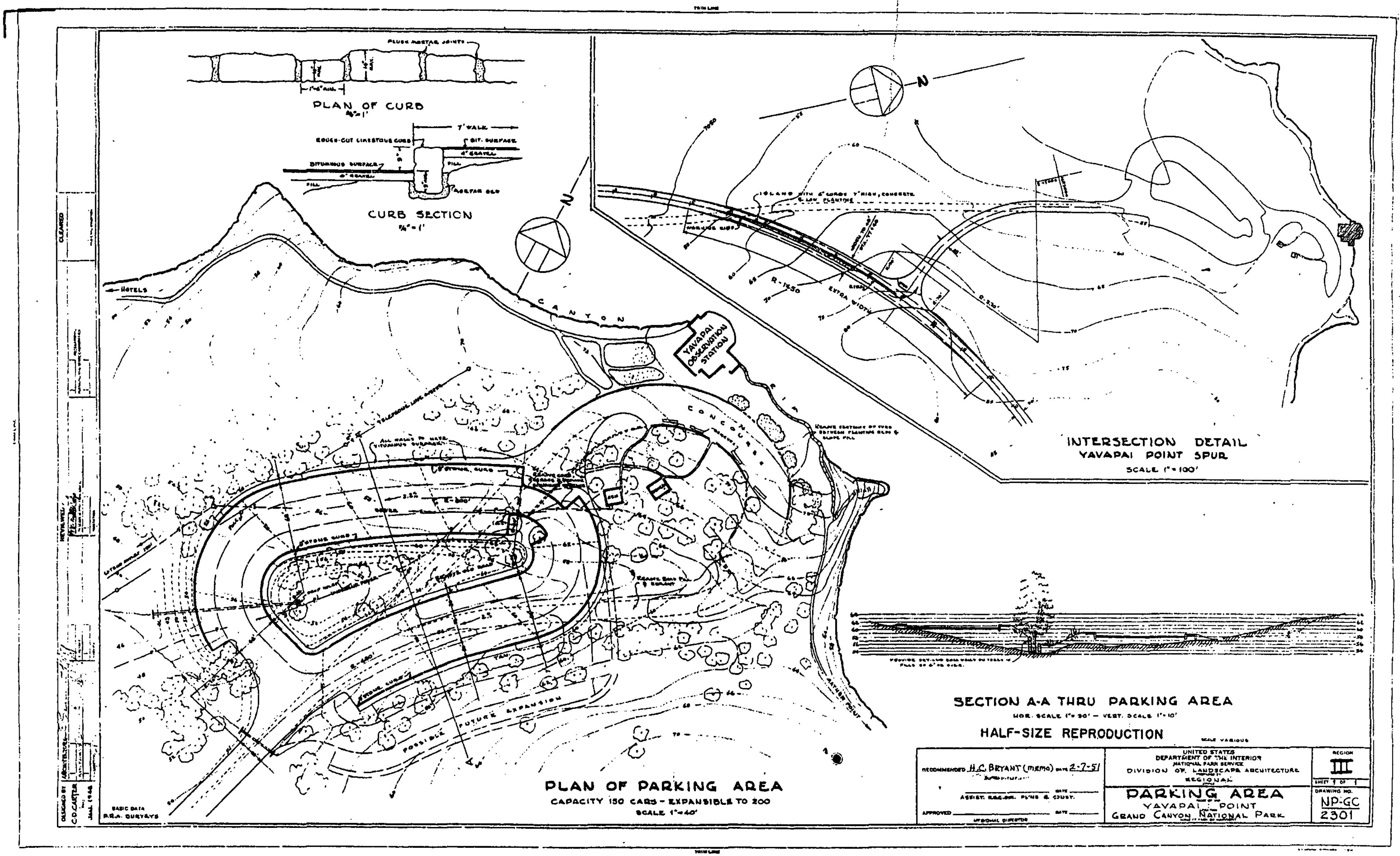
Typical Detail of Porch Casement Window
Scale 3"=1'0"

Typical Detail of Porch Doors
Scale 3"=1'0"

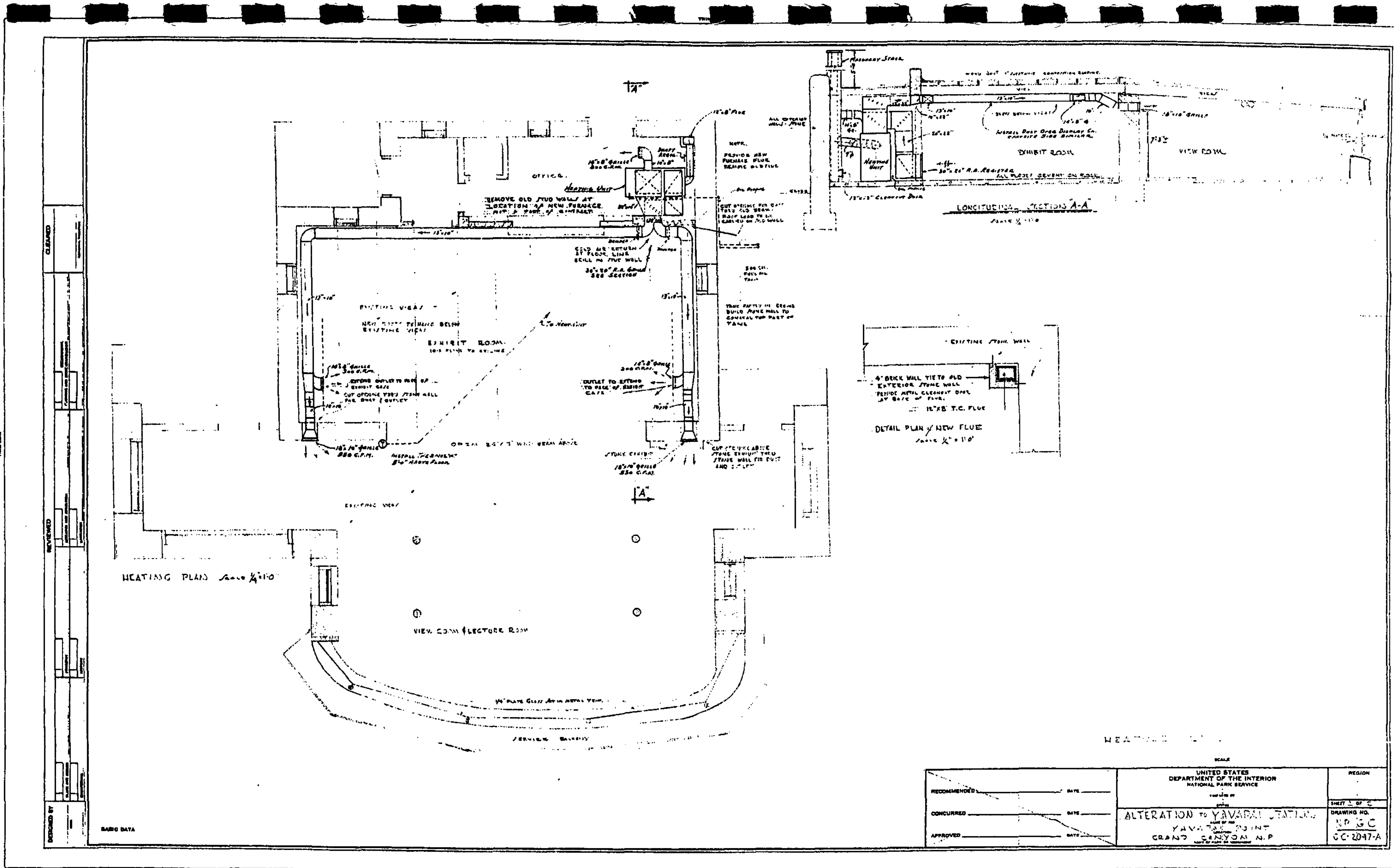
Grand Canyon Observation Station

Grand Canyon National Park

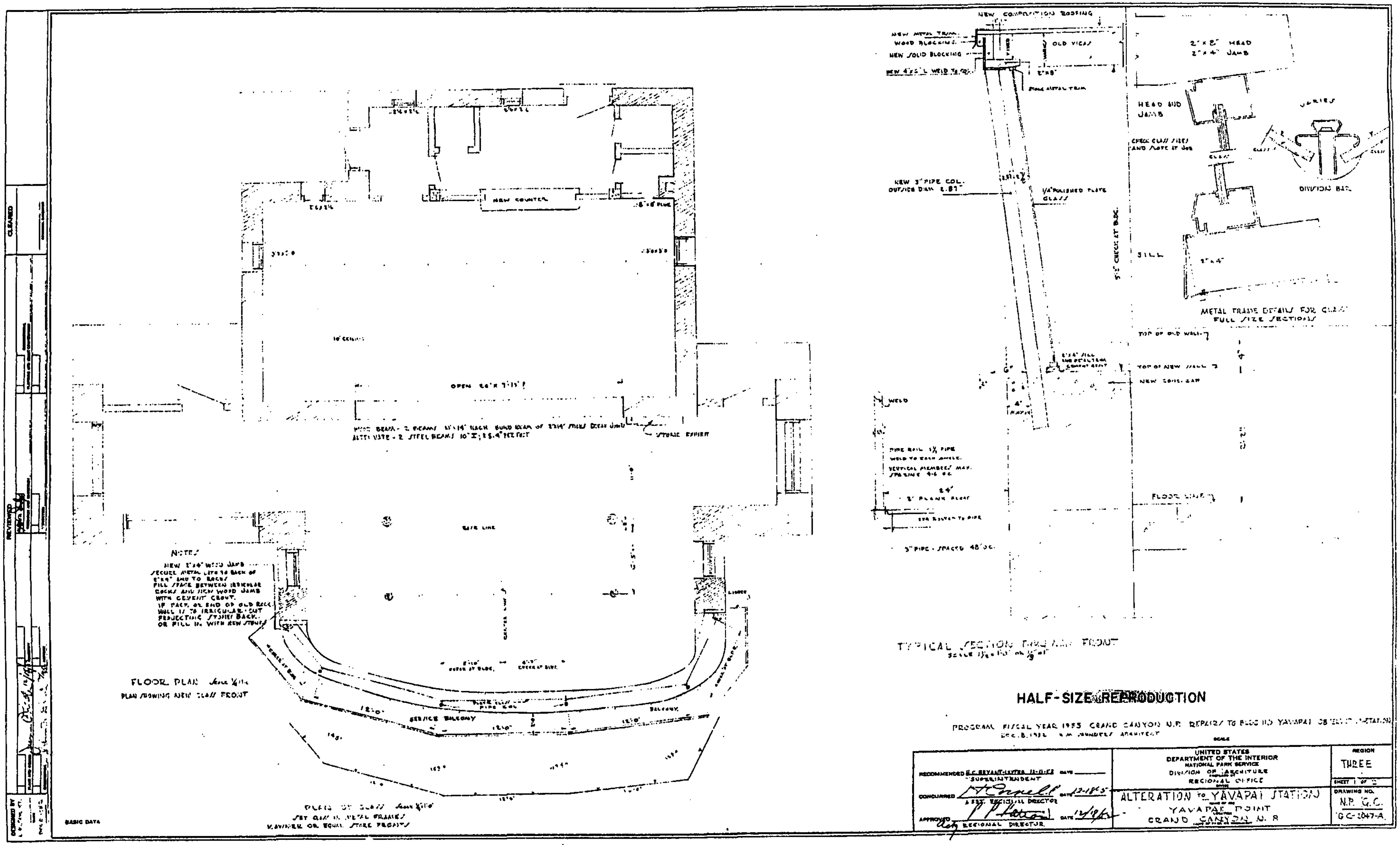
Appendix K. Plan of Parking Area, Section A-A thru Parking Area at Yavapai Point by National Park Service Division of Landscape Architecture, dated February 7, 1951.


PLAN OF CURB
CURB SECTION
INTERSECTION DETAIL
YAVAPAI POINT SPUR
SCALE 1"=100'
YAVAPAI OBSERVATION STATION
HOTELS
CANYON
RIM
CONCOURSE
POSSIBLE FUTURE EXPANSION
SECTION A-A THRU PARKING AREA
HALF-SIZE REPRODUCTION
PLAN OF PARKING AREA
CAPACITY 150 CARS - EXPANSIBLE TO 200
SCALE 1"=40'
RECOMMENDED H.C. BRYANT (memo) DATE 2-7-51
APPROVED
UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
DIVISION OF LANDSCAPE ARCHITECTURE
REGIONAL
PARKING AREA
YAVAPAI POINT
GRAND CANYON NATIONAL PARK
REGION
III
DRAWING NO.
NP-GC
2301
DESIGNED BY C.D. CARTER
BASIC DATA
P.R.A. SURVEYS

Appendix L. Alteration to Yavapai Station designed by K.M. Saunders, dated December 8, 1952.



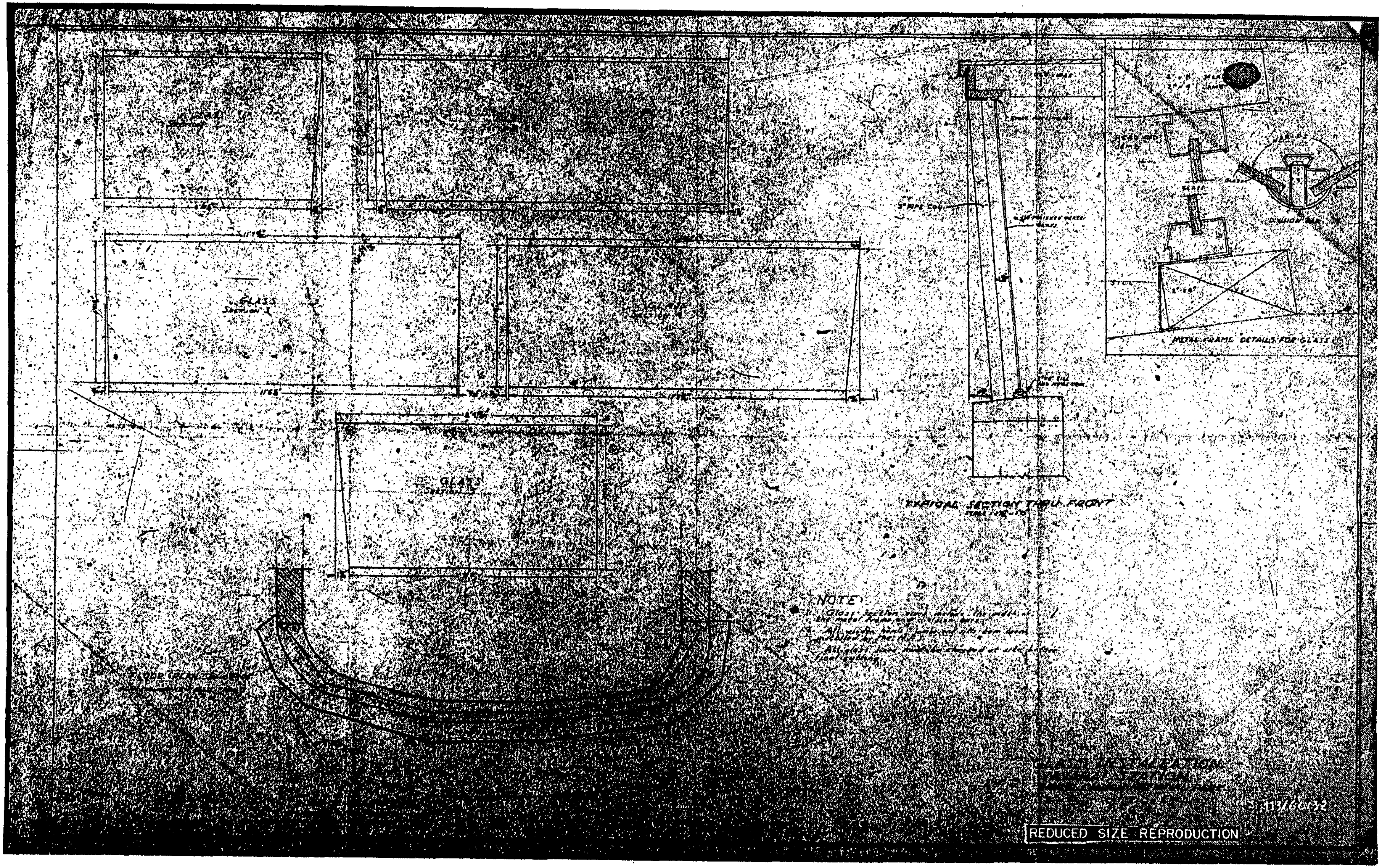
OFFICE
HEATING UNIT
REMOVE OLD STUD WALLS AT LOCATION OF NEW FURNACE
EXISTING VIEW
EXHIBIT ROOM
OPEN
EXISTING VIEW
VIEW ROOM & LECTURE ROOM
HEATING PLAN
LONGITUDINAL SECTION "A-A"
EXHIBIT ROOM
VIEW ROOM
4" BRICK WALL TIE TO OLD EXTERIOR STONE WALL
DETAIL PLAN of NEW FLUE
SCALE
UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
REGION
RECOMMENDED
DATE
CONCURRED
DATE
APPROVED
DATE
SHEET 1 OF 2
DRAWING NO.
ALTERATION TO YAVAPAI STATION
YAVAPAI POINT
GRAND CANYON N.P
NP GC
GC-2047-A
BASIC DATA



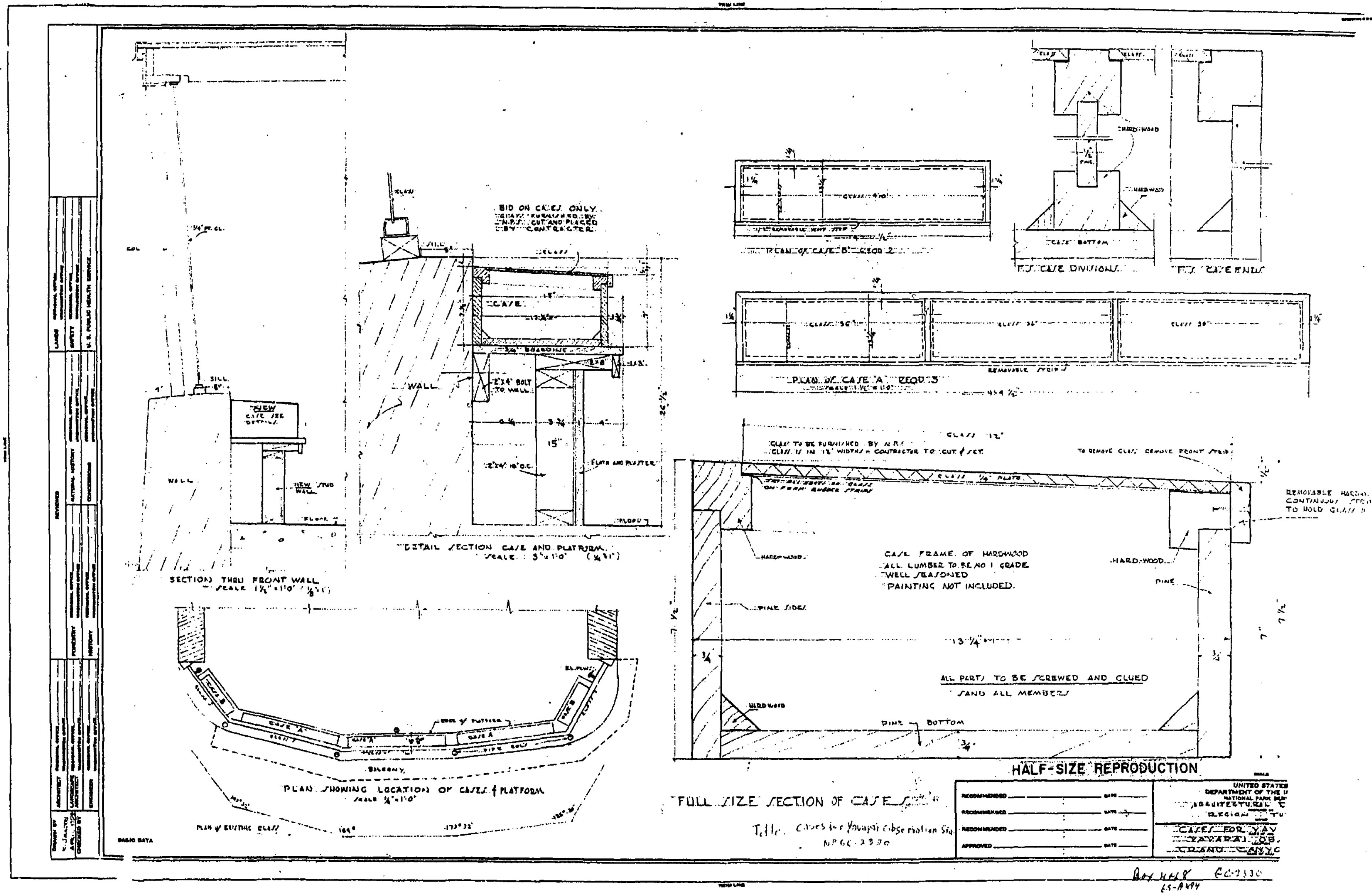
HALF-SIZE REPRODUCTION

PROGRAM FISCAL YEAR 1953 GRAND CANYON N.P. REPAIRS TO BLDG NO YAVAPAI OBSERVATION STATION

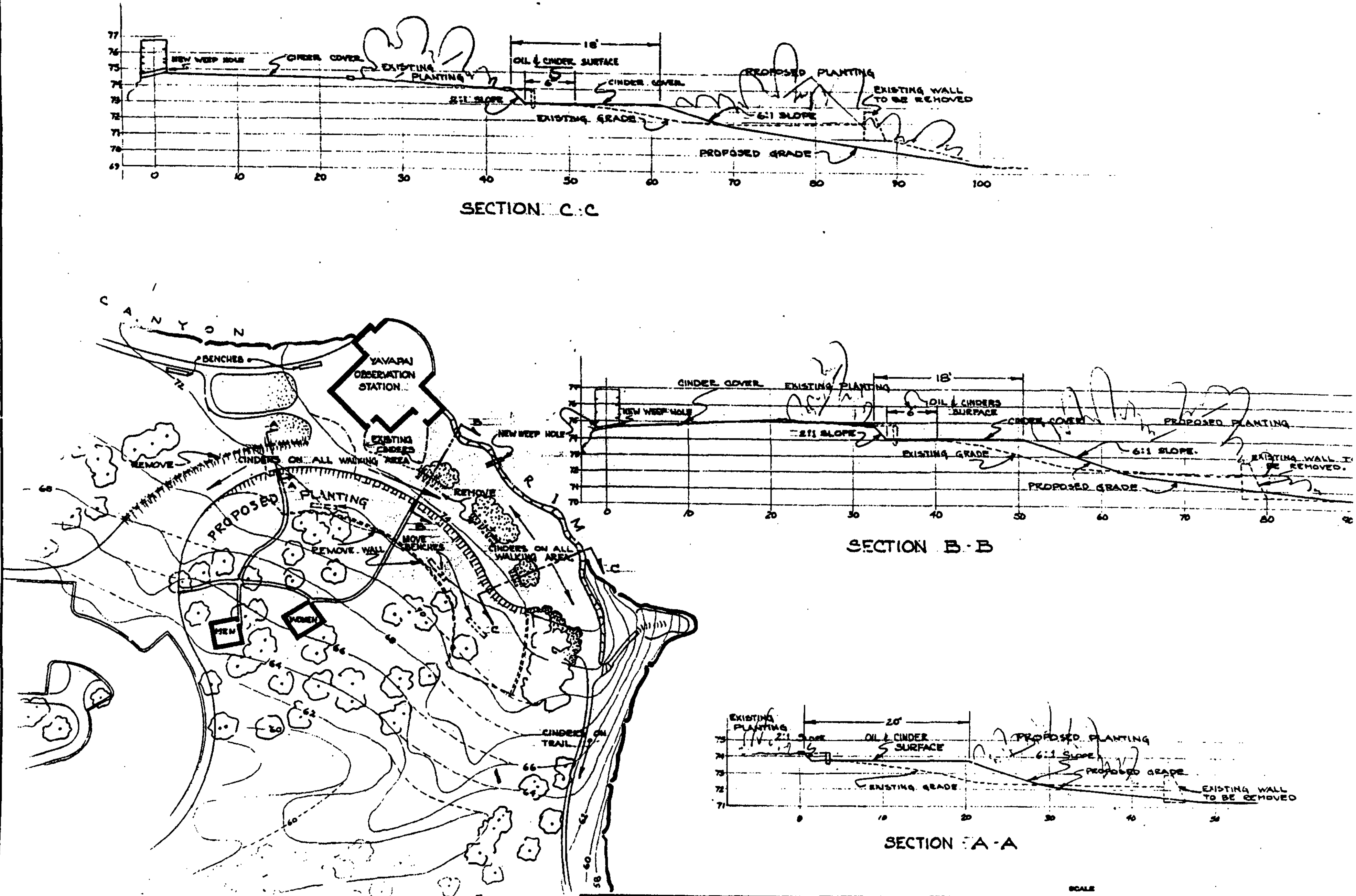
RECOMMENDED ... SUPERINTENDENT DATE	UNITED STATES DEPARTMENT OF THE INTERIOR NATIONAL PARK SERVICE DIVISION OF ARCHITECTURE REGIONAL OFFICE	REGION THREE
CONCURRED ... ASST. REGIONAL DIRECTOR DATE 12-18-5	ALTERATION TO YAVAPAI STATION	SHEET 1 OF 2
APPROVED ... Acting REGIONAL DIRECTOR DATE 12/18/	YAVAPAI POINT GRAND CANYON N.P.	DRAWING NO. N.P. G.C. GC-3047-A


GLASS
GLASS
METAL FRAME DETAILS FOR GLASS
TYPICAL SECTION THRU FRONT
NOTE
113/66/32
REDUCED SIZE REPRODUCTION

Appendix M. Cases for Yavapai Observation Station drawn by K.M. Saunders, dated April, 1954.


SECTION THRU FRONT WALL
NEW CASE SEE DETAIL
NEW STUD WALL
WALL
SILL
BID ON CASES ONLY
BY CONTRACTOR
CASE
3/4" BOARDING
2"x4" BOLT TO WALL
2"x4" 16" O.C.
LATH AND PLASTER
FLOOR
15"
DETAIL SECTION CASE AND PLATFORM
PLAN OF CASE "B" REQ'D 2
F.S. CASE DIVISIONS
F.S. CASE ENDS
HARDWOOD
CASE BOTTOM
PLAN OF CASE "A" REQ'D 3
REMOVABLE STRIP
CASE "A"
CASE "B"
BALCONY
PLAN SHOWING LOCATION OF CASES & PLATFORM
PLAN of EXISTING GLASS
GLASS TO BE FURNISHED BY N.P.S.
GLASS 12"
TO REMOVE GLASS REMOVE FRONT STRIP
REMOVABLE HARDWOOD CONTINUOUS STRIP TO HOLD GLASS
CASE FRAME OF HARDWOOD
ALL LUMBER TO BE NO 1 GRADE
WELL SEASONED
PAINTING NOT INCLUDED
HARDWOOD
HARD-WOOD
PINE
PINE SIDES
13 1/4"
ALL PARTS TO BE SCREWED AND GLUED
SAND ALL MEMBERS
PINE BOTTOM
HALF-SIZE REPRODUCTION
FULL SIZE SECTION OF CASE
Title: Cases for Yavapai Observation Sta.
NP GC-2330
RECOMMENDED
APPROVED
UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
ARCHITECTURAL
CASES FOR YAVAPAI OBS.
GRAND CANYON
Box 4418 GC-2330

Appendix N. Proposed Reconstruction of Observation Area at Yavapai by National Park Service Branch of Landscape Architecture, dated July 8, 1954.



BASIC DATA

CHECKED BY: LANDSCAPE ARCHITECT | ENGINEER | FORESTRY | HISTORY | NATURAL HISTORY | CONCESSIONS | SAFETY | U.S. PUBLIC HEALTH SERVICE

RECOMMENDED	DATE
RECOMMENDED	DATE
RECOMMENDED	DATE
APPROVED	DATE

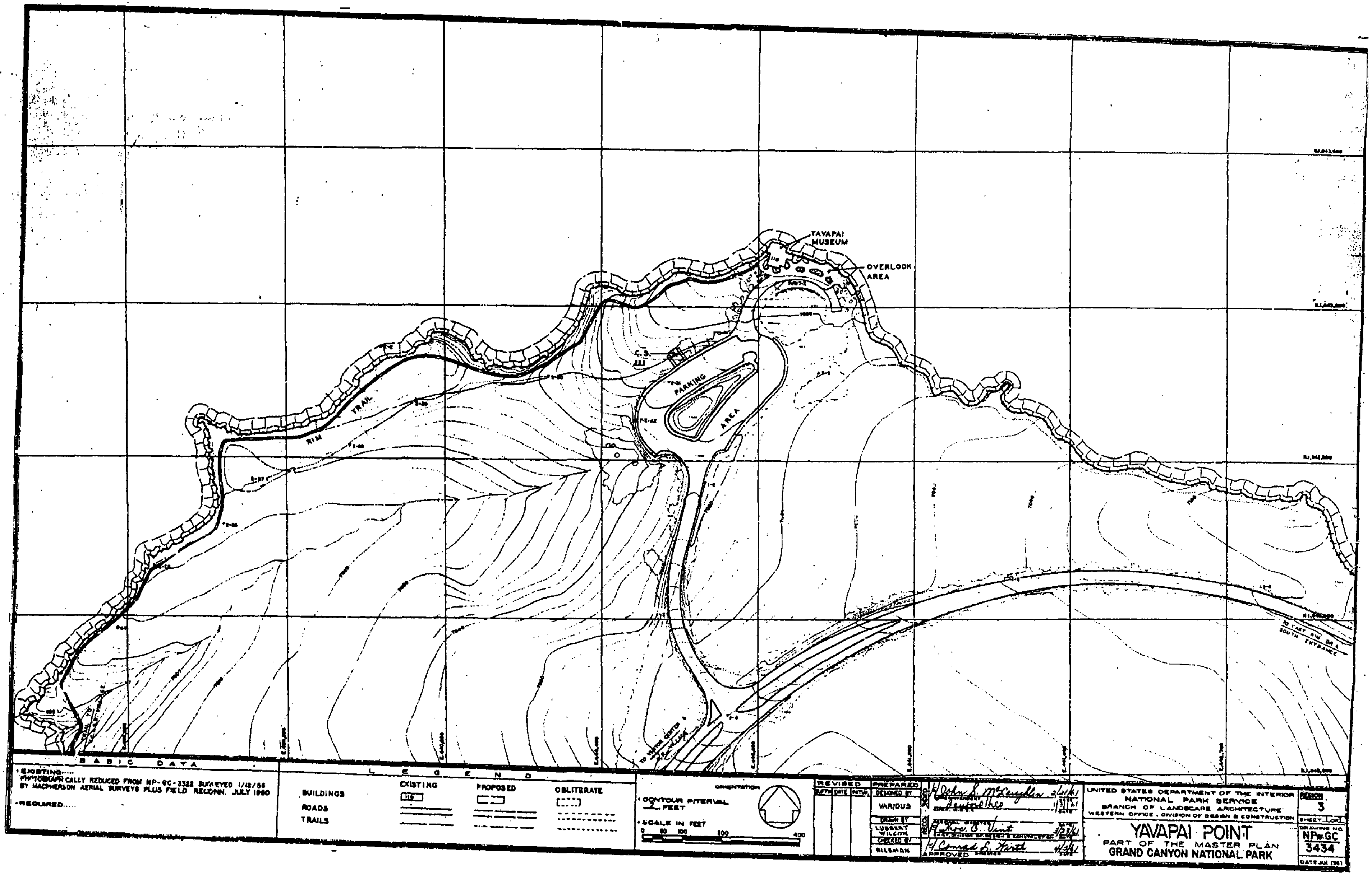
SCALE

UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
DIVISION OF LANDSCAPE ARCHITECTURE
REGIONAL

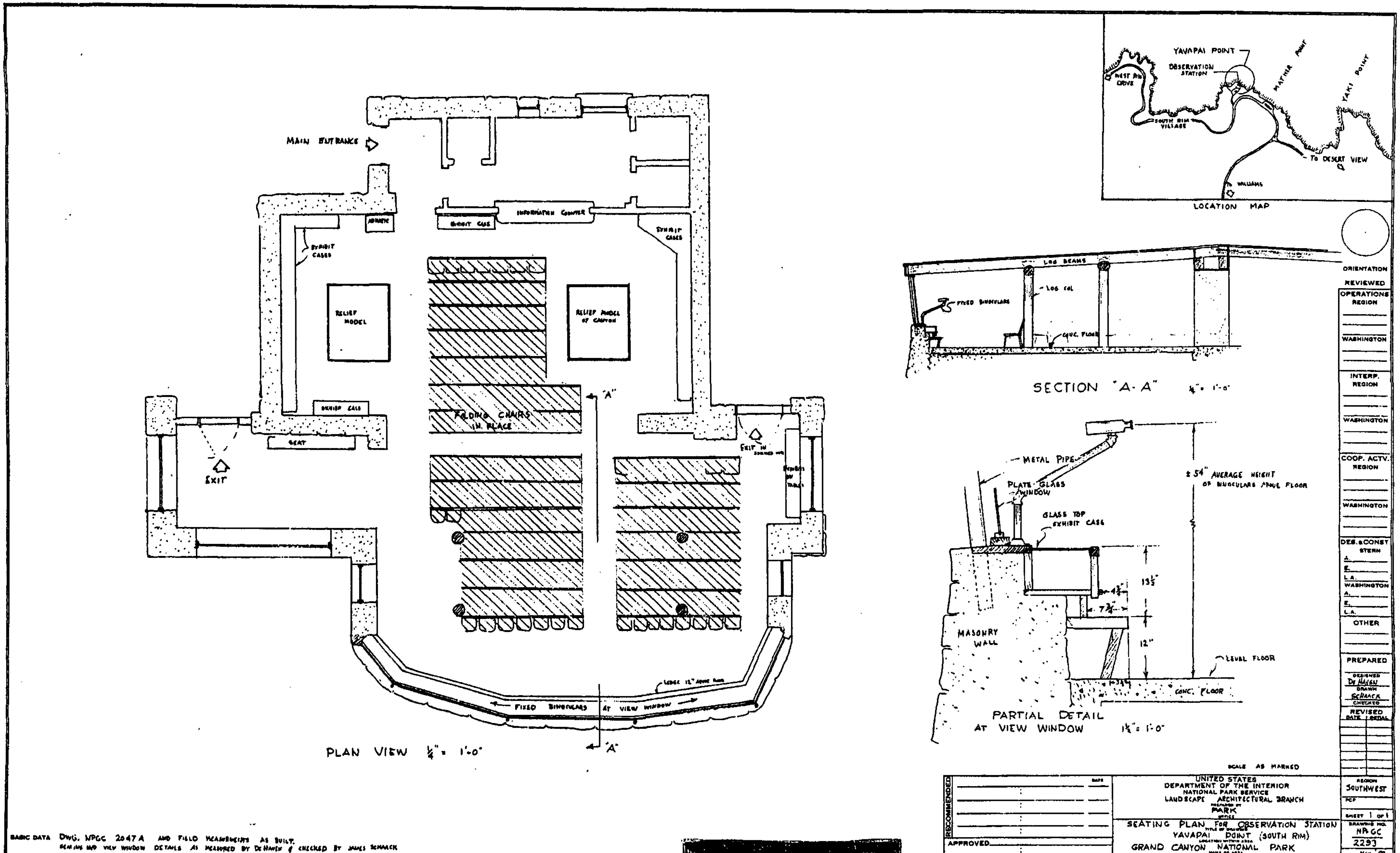
OBSERVATION AREA
PROPOSED RECONSTRUCTION AT YAVAPAI
GRAND CANYON NATIONAL PARK

REGION THREE
PCP NO.
SHEET OF
DRAWING NO. NP-GC 2263
DATE 7/8/54

Appendix O. Topographical Drawing by National Park Service Branch of Landscape Architecture, dated January, 1961.


TAVAPAI MUSEUM
OVERLOOK AREA
RIM TRAIL
PARKING AREA
C. S.
TO VISITOR CENTER & VILLAGE
TO EAST RIM DR. & SOUTH ENTRANCE
BASIC DATA
EXISTING.....
PHOTOGRAPHICALLY REDUCED FROM NP-GC-3322 SURVEYED 1/12/56
BY MACPHERSON AERIAL SURVEYS PLUS FIELD RECONN. JULY 1960
REQUIRED.....
LEGEND
EXISTING
PROPOSED
OBLITERATE
BUILDINGS
ROADS
TRAILS
ORIENTATION
CONTOUR INTERVAL 2 FEET
SCALE IN FEET
0 50 100 200 400
REVISED
PREPARED
DESIGNED BY
VARIOUS
DRAWN BY
LUBBERT WILCOX
CHECKED BY
RILEMAN
RECD.
/s/ John S. McLaughlin 3/21/61
/s/ Thos. C. Vint 3/23/61
/s/ Conrad L. Wirth 4/3/61
APPROVED
UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
BRANCH OF LANDSCAPE ARCHITECTURE
WESTERN OFFICE, DIVISION OF DESIGN & CONSTRUCTION
YAVAPAI POINT
PART OF THE MASTER PLAN
GRAND CANYON NATIONAL PARK
REGION 3
SHEET 1 OF 1
DRAWING NO.
NP-GC
3434
DATE JAN 1961

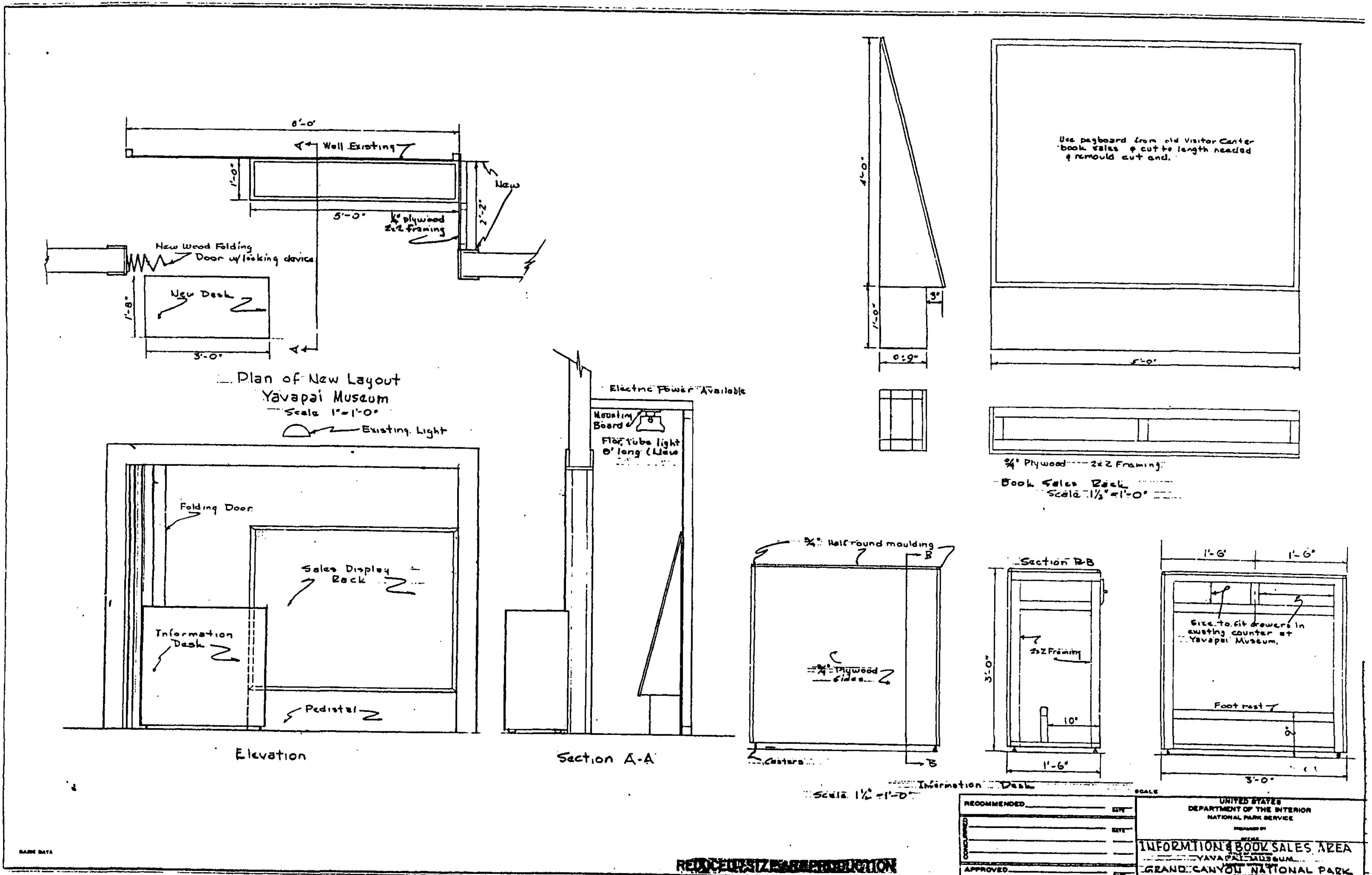
Appendix P. Proposed Seating Plan for Observation Station at Yavapai Point by National Park Service Landscape Architectural Branch, dated May, 1963.



BASIC DATA DWG. NPGC 2047A AND FIELD MEASUREMENTS AS BUILT. SEATING AND VIEW WINDOW DETAILS AS MEASURED BY DE HAVEN & CHECKED BY JAMES SCHAACK

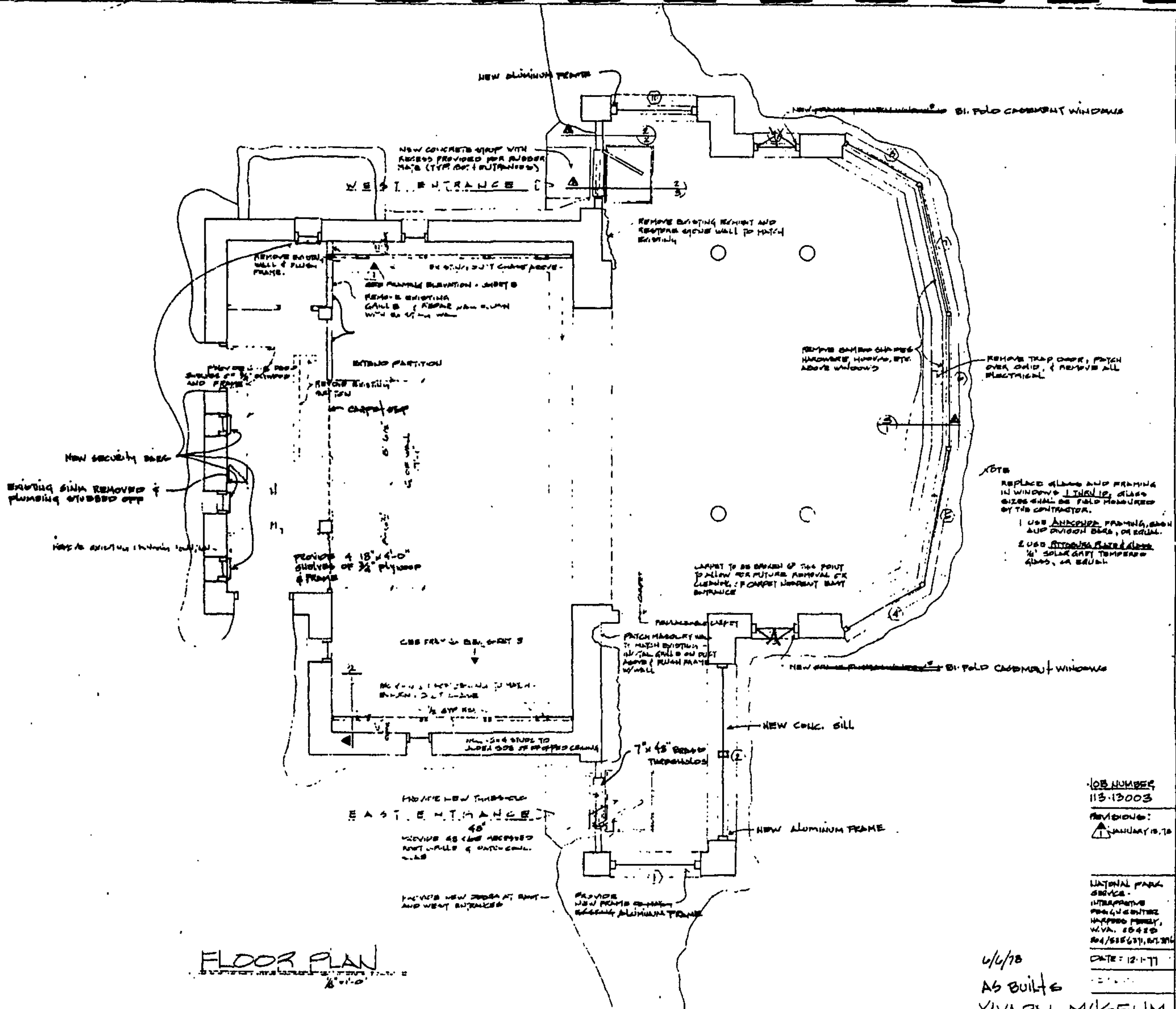
1-20-?

Appendix Q. Plan of New Layout Information and Book Sales Area at Yavapai Museum by National Park Service, filed February 2, 1974.



8'-0"
Wall Existing
New
1'-0"
5'-0"
2'-2"
¾" Plywood 2x2 Framing
New Wood Folding Door w/locking device
New Desk
1'-8"
3'-0"
Plan of New Layout
Yavapai Museum
Scale 1"=1'-0"
Existing Light
Folding Door
Sales Display Rack
Information Desk
Pedistal
Elevation
Electric Power Available
Mounting Board
Flor. tube light 8' long (New
Section A-A
4'-0"
1'-0"
9"
0'-9"
Use pegboard from old Visitor Center book sales & cut to length needed & remould cut end.
5'-0"
¾" Plywood 2x2 Framing
Book Sales Rack
Scale 1½"=1'-0"
¾" Half round moulding
B
¾" Plywood Sides
Casters
Section B-B
3'-0"
2x2 Framing
10"
1'-6"
1'-6"
1'-6"
Size to fit drawers in existing counter at Yavapai Museum.
Foot rest
3'-0"
Information Desk
Scale 1½"=1'-0"
RECOMMENDED
APPROVED
UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
INFORMTION & BOOK SALES AREA
YAVAPAI MUSEUM
GRAND CANYON NATIONAL PARK
REDUCED SIZE REPRODUCTION

Appendix R. Window Glass Replacement and General Upgrade Drawings by National Park Service Interpretive Design Center, Harper's Ferry West Virginia, dated December 1, 1977 and As Built Drawings (various details), Sheets 6-10, dated June 6, 1978.



JOB NUMBER
113-13003

REVISIONS:
1 JANUARY 18, 78

NATIONAL PARK SERVICE -
INTERPRETIVE DESIGN CENTER
HARPERS FERRY, W.VA.

DATE: 12-1-77

6/6/78
AS BUILTS

YAVAPAI MUSEUM
GRAND CANYON NATIONAL PARK - EASTRIM
GRAND CANYON, ARIZONA

1
OF 10

REDUCED SIZE REPRODUCTION

INTERIOR & EXTERIOR PAINTING SCHEDULE

KEY	SURFACE	FINISHES	REMARKS
(A)	CEILINGS, EXPOSED LOG JOISTS & BEAMS, EXPOSED WALL SURFACES, DUCTS, DROPPED WALL SECTIONS	N7634 'MILLCREST' FLAT WALL PAINT	TWO(2) BRUSH APPLIED COATS · SEE NOTE 1
(B)	BUILDING COLUMNS (WOOD), WINDOW SASH & TRIM - WOOD AND FERROUS METALS ONLY, MISC. WOOD TRIM THROUGHOUT	N7634 'MILLCREST' LO-LUSTRE OIL BASE	TWO(2) BRUSH APPLIED COATS · SEE NOTE 1
N.I.C.	NEW DOORS - ALL EDGES & FACES	'WATERLOX' HEAVY BODY FINISH COAT	FOUR(4) BRUSH APPLIED COATS · SEE NOTE 2.
(C)	ALL EXTERIOR WOOD AND METAL TRIM, SIDING, FASCIAS, PLATFORMS, WINDOWS, DOORS & MISC. TRIM	D4607 'BAYLEAF' LO-LUSTRE OIL BASE	TWO(2) BRUSH APPLIED COATS · SEE NOTE 3.

PAINTING NOTES

1. MISCELLANEOUS SURFACE PREPARATION REQUIRED WITH HAND SANDING, PATCHING AS NECESSARY, AND SMOOTHING OF SURFACES. FINISHED PAINTING SHALL BE FREE OF RUNS AND APPLIED TO PROVIDE UNIFORM COVERING & COVERAGE.
2. SURFACE SANDING BETWEEN COATS REQUIRED. FIRST TWO COATS SHALL BE 'TRANSPARENT' SEALER WITH LAST TWO COATS 'HEAVY BODY FINISH COAT'
3. MISCELLANEOUS SURFACE PREPARATION REQUIRED WHERE EXISTING FINISH HAS PEELED OR OTHERWISE BEEN DAMAGED, SPOT PRIME WILL BE REQUIRED. FINISHING COATS SHALL BE APPLIED TO PROVIDE UNIFORM FINISH.
4. PROTECTION TO EXISTING STONE WORK SHALL BE PROVIDED.

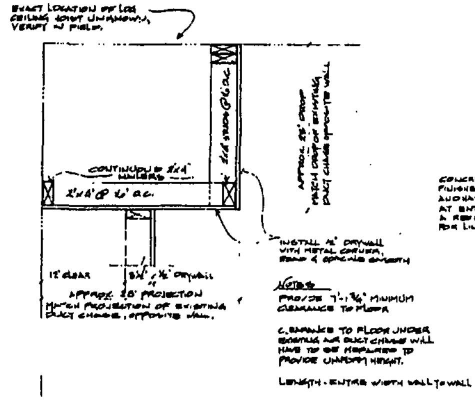
OPAQUE PAINTS AS MANUFACTURED BY:
PITTSBURG PAINT COMPANY
PITTSBURG, PENN.

TRANSPARENT FINISH AS MANUFACTURED BY:
WATERLOX CHEMICAL & COATINGS CORP.
1808 MEDEN AVE, CLEVELAND, OHIO, 44105

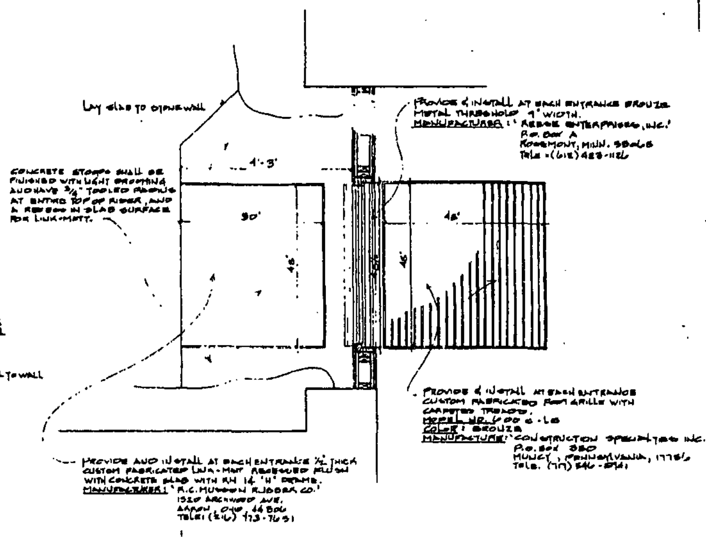
REMOVALS

1. PATCHING REQUIRED FOLLOWING REMOVALS, SHALL BE OF LIKE AND MATCHING TO SURROUNDING FINISHES, ETC.
2. BEFORE REMOVALS AS INDICATED, BRACING SHALL BE INSTALLED TO CARRY EXISTING SUPERSTRUCTURE AND PROTECTING EXISTING ADJOINING WORK.
3. ITEMS OF WORK TO BE REMOVED.
   a) SECTION OF EXISTING PARTITION AS INDICATED.
   b) EXISTING GEOLOGICAL EXHIBIT NEAR WEST ENTRANCE.
   c) CONCRETE FLOOR SLAB AS REQUIRED FOR NEW WORK.
   d) EXISTING DRINKING FOUNTAIN WITH SUPPLY & DRAIN.
   e) EXISTING ELECTRICAL CIRCUITRY - BACK TO EXISTING PANEL - INCLUDING ALL CONDUITS, SPEAKER WIRES, & SPEAKER MOUNTS

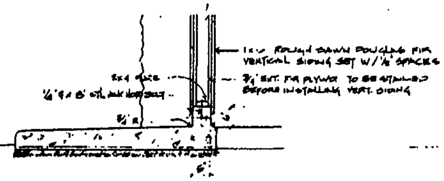
NOTE:
JURISDICTION AND APPROVAL(S) FOR SITE & BUILDING MODIFICATIONS SHALL BE ADMINISTERED BY CHIEF OF PRODUCTION, DIVISION OF EXHIBIT PLANNING AND DESIGN, HARPERS FERRY CENTER, HARPERS FERRY, W. VA.



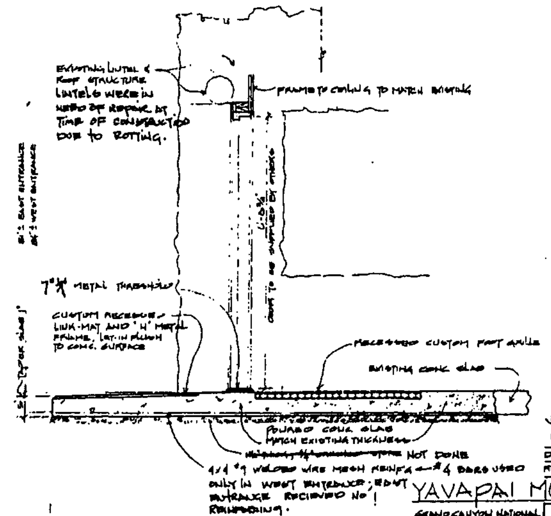
2/1 FALSE DUCT CHASE-SECTION
SCALE · 1/2"=1'-0"



EAST/WEST ENTRANCE PLANS (TYPICAL)
SCALE · 3/4"=1'-0"



2/2 SECTION
SCALE · 3/4"=1'-0"

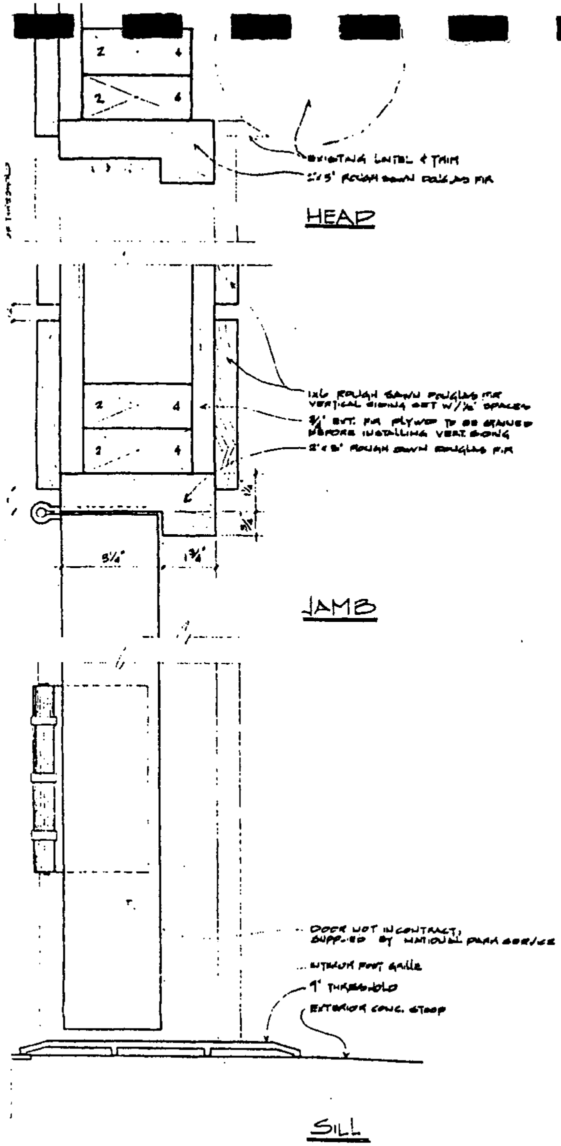


2/3 SECTION
SCALE · 3/4"=1'-0"

JOB NUMBER 118-13003
DATE: 12-1-77
REVISIONS

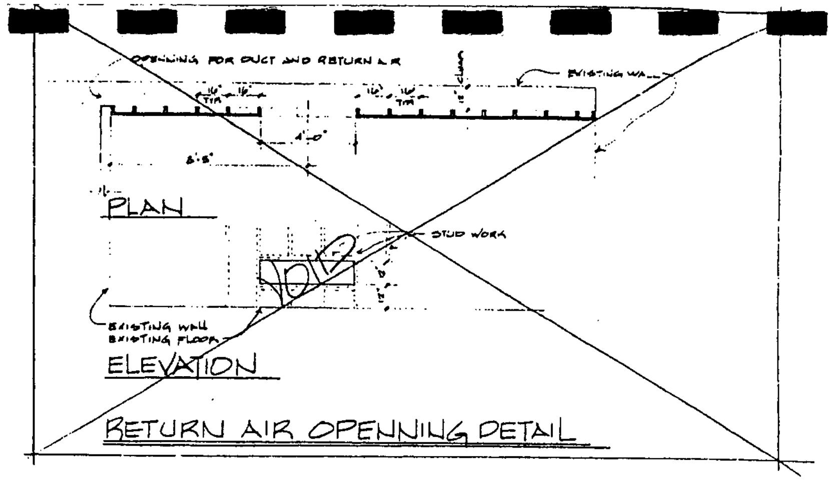
YAVAPAI MUSEUM
GRAND CANYON NATIONAL PARK, SOUTH RIM
GRAND CANYON, ARIZONA
6/6/78
AS BUILTS

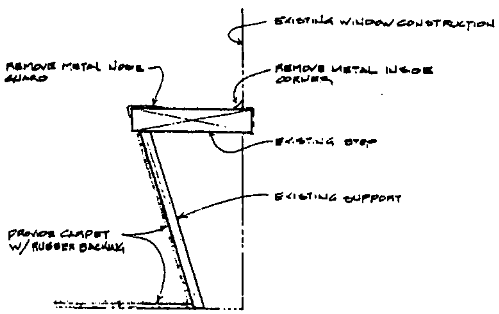
2 OF 10



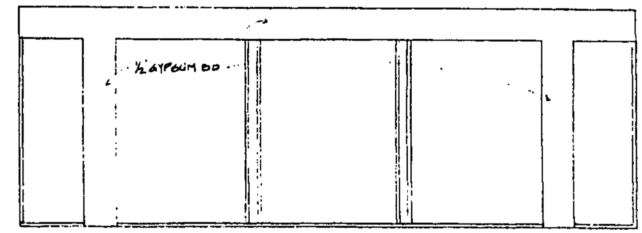
FR[redacted]SP[redacted]ICA[redacted]S

1. JAMBS SHALL BE FABRICATED WITH CLEAR SELECT ROUGH-CUT DOUGLAS FIR.
2. FINISHES:
   a) ALL TRIM AND JAMB SHALL BE PRIMED & FINISHED WITH TWO (2) COATS OF FINISH PAINT - (EXTERIOR FINISH 'C' - INTERIOR FINISH 'B' - REFER TO FINISH SCHEDULE
   b) SEALER FINISH SHALL BE:
      'WATERLOX TRANSPARENT.'
      MANUFACTURED BY;
      WATERLOX DIVISION, EMPIRE VARNISH CO.
      CLEVELAND OHIO
   c) APPLICATION SHALL BE FREELY APPLIED TO OBTAIN DEEP PENETRATION TO ALL SURFACES, FRONT, BACK AND ALL EDGES WITH MINIMUM 24 HOUR DRYING TIME BETWEEN COATS. LIGHT HAND SANDING BETWEEN COATS ARE REQUIRED

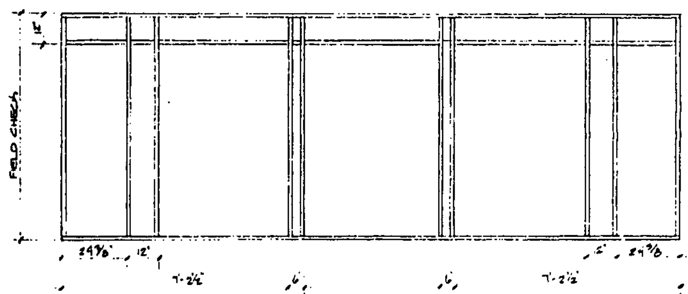




3/1 EXISTING STEP DETAIL
3"=1'-0"



ELEVATION SHOWING GYP. BD. APPLICATION



FRAMING ELEVATION
1/2"=1'-0"

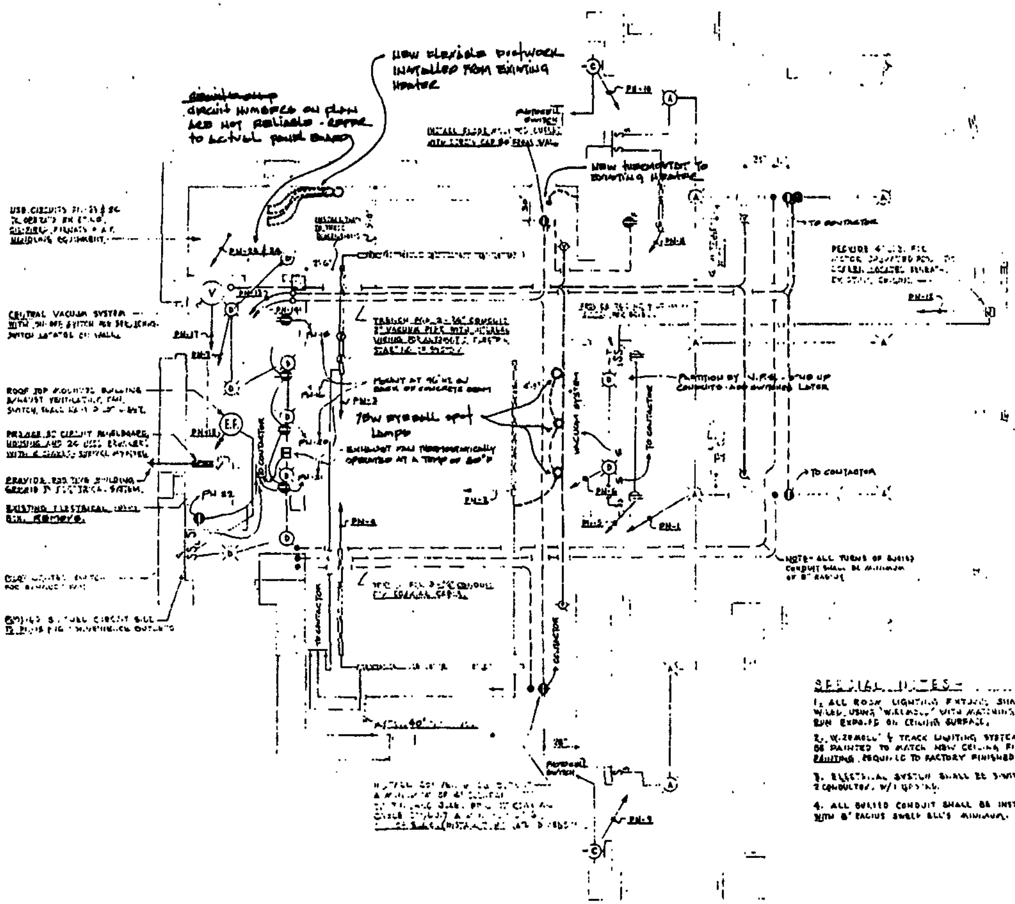
113
13002

REVISIONS:
1 JANUARY 3, 78

DATE: 12-1-77

YAVAPAI MUSEUM

3
OF 7



ELECTRICAL PLAN

ELECTRICAL SPECIFICATIONS

1. ALL ELECTRICAL WORK SHALL BE ACCOMPLISHED IN STRICT ACCORDANCE TO THE 'NATIONAL ELECTRIC CODE' MINIMUM STANDARDS, AND TO THE LATEST REVISION (S) THEREOF.
2. ALL INSTALLED ELECTRICAL OPERATING EQUIPMENT AND ... FIXTURES SHALL CARRY THE 'UNDERWRITERS LABORATORIES' APPROVAL ... AND BE CLEARLY LABELED AS BEING SO APPROVED.
3. [illegible]

ELECTRICAL LEGEND

- 32 BREAKER PANELBOARD WITH METAL ... HOUSING - SURFACE ... - 4 SPARES (20A AMP)
- EXISTING MAIN SERVICE PANEL - CONNECT TO NEW MAIN ...
- STANDARD ... OUTLETS - EITHER WALL MTD. ... AS INDICATED.
- STANDARD CONVENIENCE OUTLETS
- FLUSH ... CONVENIENCE OUTLET ... WITH DUST AND DIRT COVER.
- S — SINGLE POLE SWITCH.
- S_3 — THREE-WAY SWITCH.
- S_L — [illegible]
- [illegible]
- [illegible]
- ... VACUUM HOSE CONNECTORS WITH AUTOMATIC SYSTEM ... SWITCH IN FACE.
- ... AREA LIGHTING FIXTURES (SEE FIXTURE SCHEDULE ... 19).
- ... LIGHTING - PORCELAIN FIXTURE WITH STANDARD BOX - SURFACE MOUNTED.
- [illegible]
- TRACK ... FIXTURES ... LAMPS (SEE FIXTURE SCHEDULE - SHT. ... 19).
- TRACK ... FIXTURE ... (SEE FIXTURE SCHEDULE ... 19).
- ... P.V.C. ... SLAB FOR CONDUCTORS ...
- ... P.V.C. ... CABLE INSTALL ...
- [illegible]
- S — ... SWITCH ... PROJECTOR ...

SPECIAL NOTES -

1. ALL ROOM LIGHTING FIXTURES SHALL BE WIRED USING 'WIREMOLD' WITH MATCHING COMPONENTS RUN EXPOSED ON CEILING SURFACE.
2. 'WIREMOLD' & TRACK LIGHTING SYSTEMS SHALL BE PAINTED TO MATCH NEW CEILING FINISH. NO PAINTING REQUIRED TO FACTORY FINISHED FIXTURES.
3. ELECTRICAL SYSTEM SHALL BE 3-WIRE SYSTEM, 2 CONDUCTOR, W/1 GROUND.
4. ALL BURIED CONDUIT SHALL BE INSTALLED WITH 8' RADIUS SWEEP ELL'S MINIMUM.

EQUIPMENT LEGEND

- V — CENTRAL VACUUM SYSTEM - (SEE LISTING ... 19).
- E.F. — CEILING EXHAUST FAN - (SEE LIST ... 19).

ELECTRICAL REMOVALS

1. ELECTRICAL CONTRACTOR SHALL REMOVE ALL EXISTING CIRCUITS, BOXES, FIXTURES AND EXPOSED WIRING IN IT'S ENTIRETY, BACK TO MAIN DISTRIBUTION PANEL WHICH SHALL BE USED FOR NEW WORK.
2. EXISTING ELECTRICAL WORK THAT IS BURIED WITHIN STRUCTURE SHALL BE DISCONNECTED AND LEFT IN PLACE.
3. DISPOSAL OF REMOVED ITEMS SHALL BE UNDER THE SUPERVISION OF PARK MAINTENANCE SUPERVISOR.

JOB NUMBER
113-13003

DATE: 12-1-77

REVISIONS.

YAVAPAI MUSEUM

6/6/78
AS BUILTS

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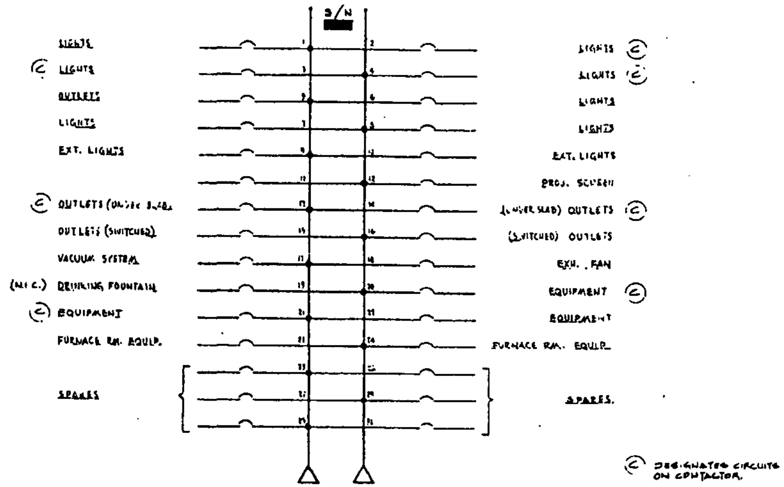


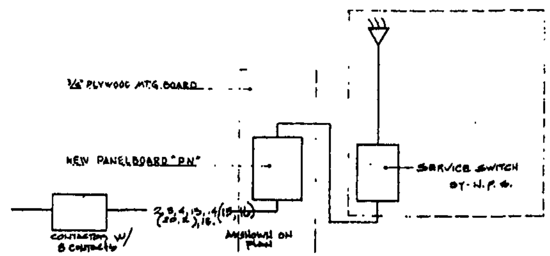
Ⓒ DESIGNATES CIRCUITS ON CONTACTOR.

LIGHTING PANELBOARD "DN"

NEW, 30 CIRCUIT PANELBOARD, RATED 120/240 V., 1 PHASE, 3 WIRE, S/N WITH TOP MOUNTED LUGS. PANELBOARD WILL HAVE BOLTED BREAKERS, 150 AMP. MAINS, AND BE SUITABLE FOR SURFACE MOUNTING. BRANCH BREAKERS WILL BE AS FOLLOWS:

30 – SINGLE POLE – 20 AT

PANELBOARD WILL BE 'SQUARE D' OR EQUAL MTG. ON 3/4" THICK MTG. BOARD 42" OFF OF FLOOR, AND HAVE HINGED DOOR WITH KEY LOCK AND TYPED DIRECTORY AFFIXED TO INTERIOR SIZE [illegible]



ONE LINE DIAGRAM
120/240 V., 1 ϕ, 3 WIRE SERVICE

LIGHTING FIXTURE SCHEDULE

Ⓐ	'MULTI-GROOVE', 150 W PAR 38 – SURFACE MOUNTING TYPE – BRONZE TONE STOCK & MF'R. NO. 7075 (9 REQUIRED).
Ⓑ	'MULTI-GROOVE DOWNLIGHT', 150 W. PAR 38 – TRACK MOUNTED ON 4'-0" LENGTH STOCK & MF'R. NO. 7661 (3 REQUIRED).
Ⓒ	'WALL BRACKETS' 6½" DIA. × 11" H. – SURFACE MOUNTED AT 60" TO ℄ OF FIX. HT. STOCK & MF'R. NO. 6611 BRONZE TONE (8 REQUIRED).
Ⓓ	STANDARD PORCELAIN FIXTURE NO IDENTITY NO. (9 REQUIRED).
Ⓔ	'LIFELITE MULTI-GROOVE', 75 W R30 – TRACK MTD. ON STEM MTD. TRACK – BLACK MATTE STOCK & MF'R. NO. 7110 (32 REQUIRED).

FIXTURE MOUNTING NOTES: FOR TRACK [illegible] UNITS (E) TRACK SHALL BE MOUNTED WITH [illegible]

MANUFACTURER: [illegible]
[illegible]
JERSEY CITY, NEW JERSEY [illegible]2

EQUIPMENT SCHEDULE

EXHAUST FAN

PROVIDE AND INSTALL CENTRIFUGAL BELT DRIVE FAN AND HOUSING, WITH PREFABRICATED CURB FOR FLAT ROOF INSTALLATION. LOCATED AS INDICATED ON SHT. NO. 14.

SPECIFICATIONS:
SIZE: 10"
H.P.: 1/3 HP – SINGLE PHASE MOTOR
RPM: 880
SWITCH: SINGLE POLE WITH RED INDICATING LIGHT.

MF'R. IDENTIFICATION:
MODEL W, NO. WCD 10

MANUFACTURER: 'DOHERTY-SILENTAIRE CO.'
BATON ROUGE, LOUISIANA 70821
TELE: (504) 383-6112

CENTRAL VACUUM SYSTEM

PROVIDE AND INSTALL REMOTE OPERATED VACUUM SYSTEM AS LOCATED ON SHT. NO. 14, EQUIPPED WITH WAND, MISCELLANEOUS SUCTION HEADS WITH BRUSH FILLERS, AND 30'-0" MINIMUM FLEXIBLE HOSE.

INSTALLATION SHALL BE IN STRICT ACCORDANCE TO MANUFACTURER'S RECOMMENDATIONS AND INSTRUCTIONS.

MF'R. IDENTIFICATION:
MODEL NO. P225 (115 VOLT)

MANUFACTURER: 'VACU-MAID, INC.'
P.O. DRAWER 1708
PONCA CITY, OKLAHOMA 74601
TELE: (405) 762-2457

USED DIFFERENT MODEL & MAKE - CHECK W/ PARK

DRINKING FOUNTAIN

PROVIDE AND INSTALL FREE STANDING DRINKING FOUNTAIN AS INDICATED ON SHT. NO. 14, SPECIALLY EQUIPPED WITH FLEXIBLE STRIP HEATING ELEMENT FOR WINTER PROTECTION.

MF'R. IDENTIFICATION:
MODEL NO. 6887.

MANUFACTURER: 'HALSEY TAYLOR DIVISION'
KING-SEELY THERMOS CO.
1554 THOMAS ROAD
WARREN, OHIO 44481
TELE: (216) 394-1911

N. I. C.

JOB NUMBER 113-13003
DATE: 12-1-77
REVISIONS

YAVAPAI MUSEUM

6/6/78
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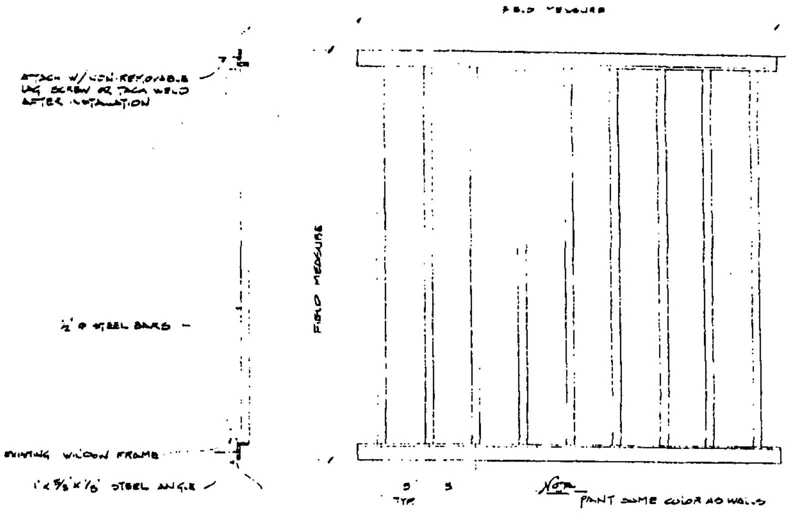
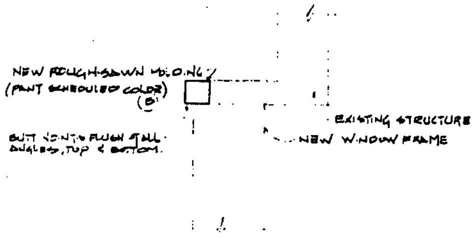
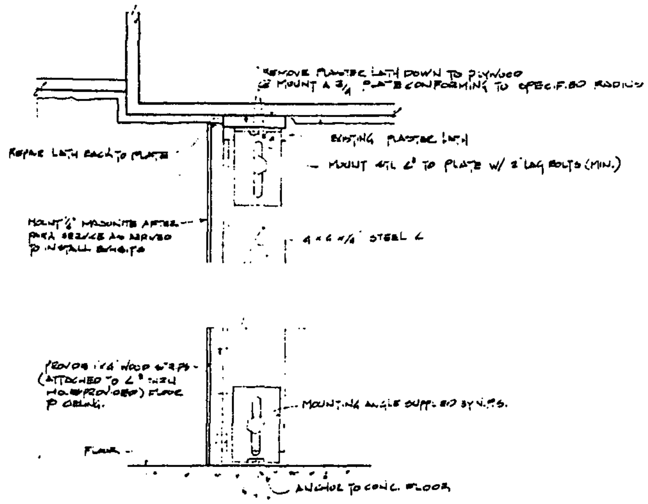
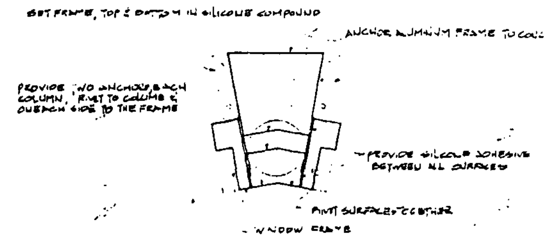
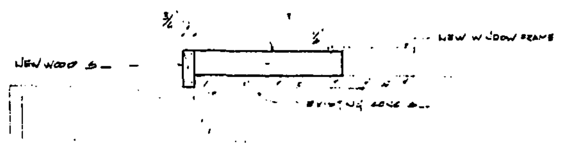


SECURITY BARS
3"=1'-0"









NEW FRAMING WINDOWS 4,5,6,7,&8.
3"=1'-0"

CIRCULAR EXHIBIT ALGLE MOUNTING DETAIL
3"=1'-0"

SECTION @ WINDOW COLUMNS
3"=1'-0"

FEB 4 1975

113
13002

YAVAPAI MUSEUM
LOCAL DETAILS

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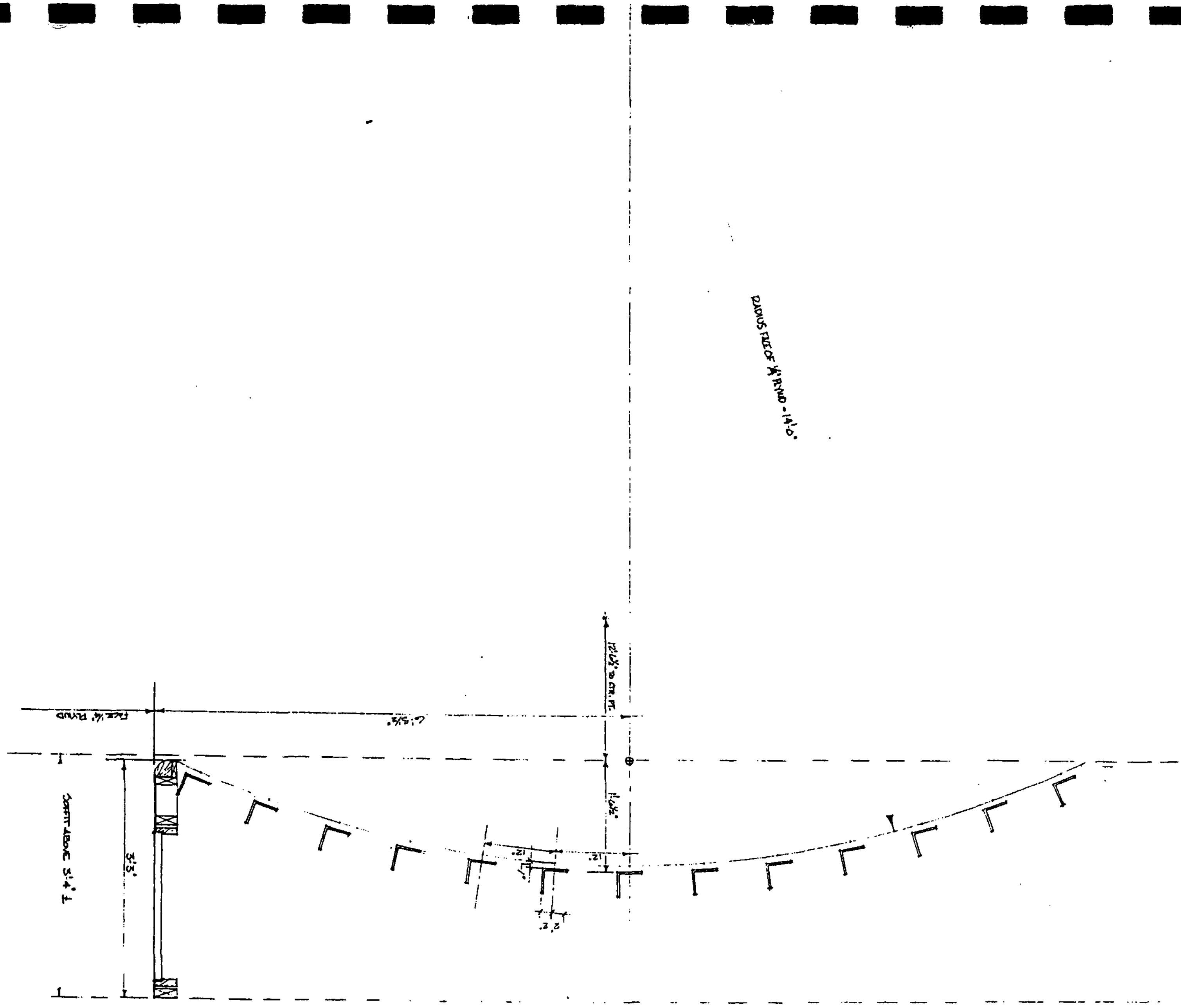
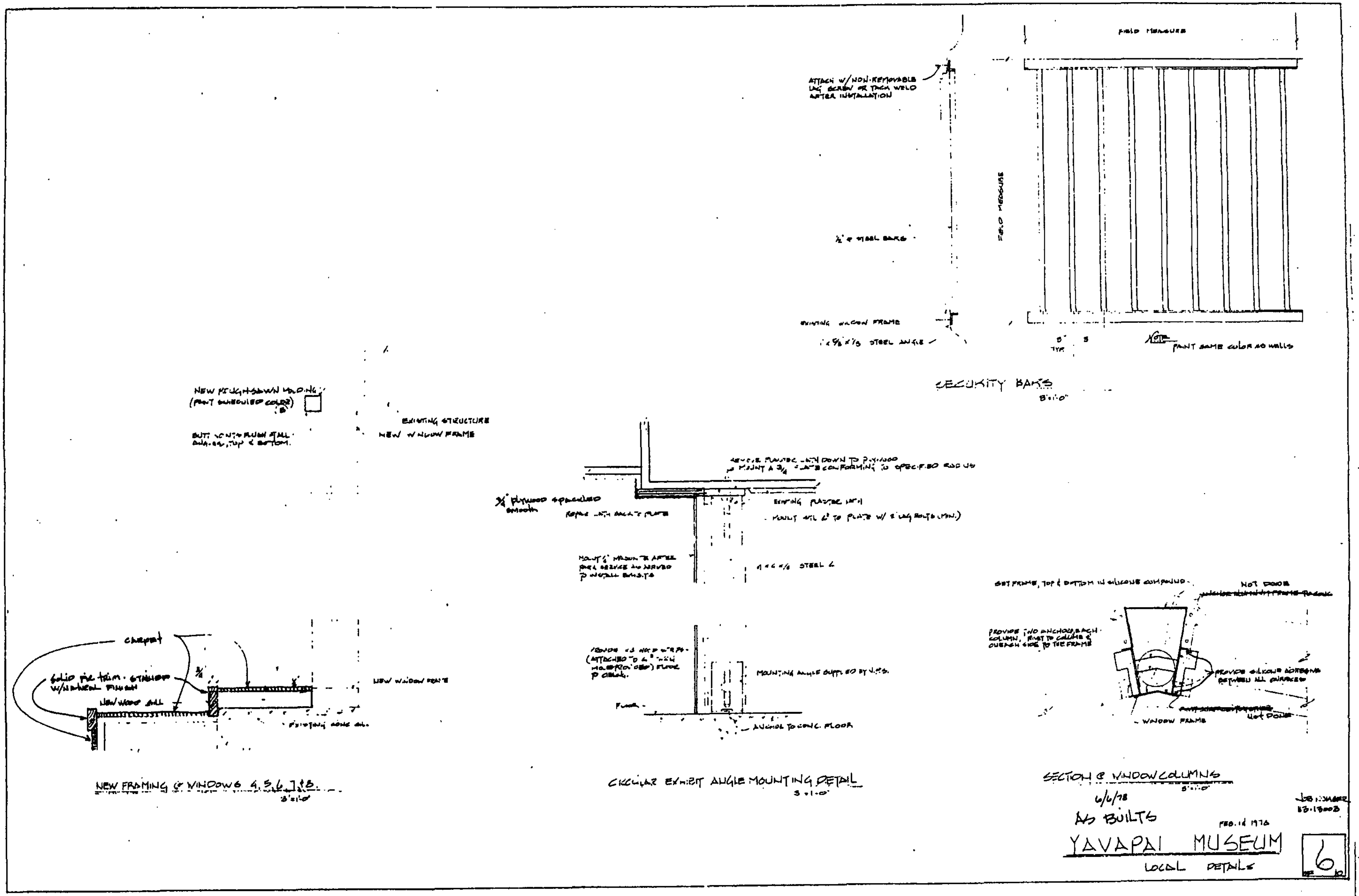
OF 7

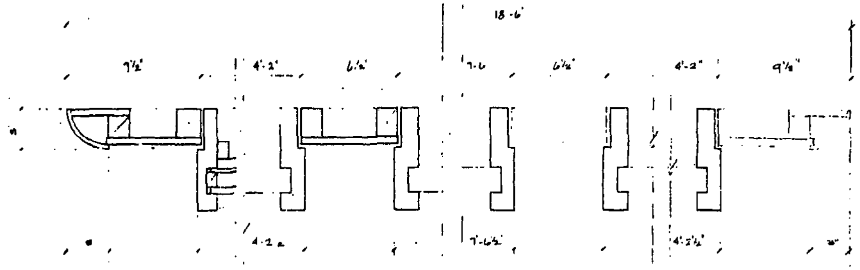


113
13002

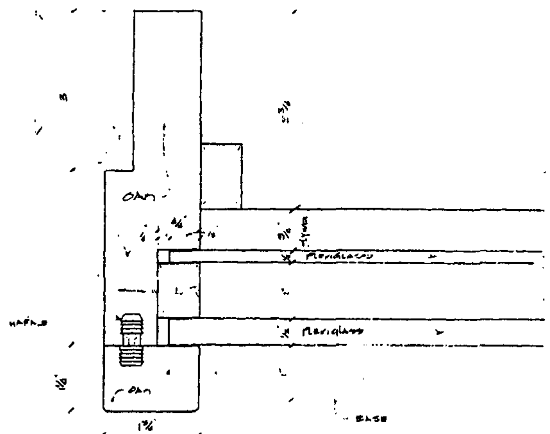
7

OF 7


FIELD MEASURE
ATTACH W/ NON-REMOVABLE LAG SCREW OR TACK WELD AFTER INSTALLATION
EXISTING WINDOW FRAME
NOTE PAINT SAME COLOR AS WALLS
SECURITY BARS
EXISTING STRUCTURE
NEW WINDOW FRAME
carpet
NEW WOOD SILL
NEW WINDOW FRAME
NEW FRAMING @ WINDOWS 4,5,6,7 & 8
FLOOR
ANCHOR TO CONC. FLOOR
CIRCULAR EXHIBIT ANGLE MOUNTING DETAIL
NOT DONE
WINDOW FRAME
SECTION @ WINDOW COLUMNS
6/6/78
AS BUILTS
FEB. 14 1978
YAVAPAI MUSEUM
LOCAL DETAILS
6



PLAN/SECTION · EXHIBITS 5·A, 5·B & 5·C
SCALE · ¾" = 1'-0"



SECTION · EXHBIT · 5·2
FULL SCALE

SHOP DRAWING FOR FIBER optics EXHIBIT
on SOUTH WALL.

JOB NUMBER
113·13003

4/4/78
AS BUILTS

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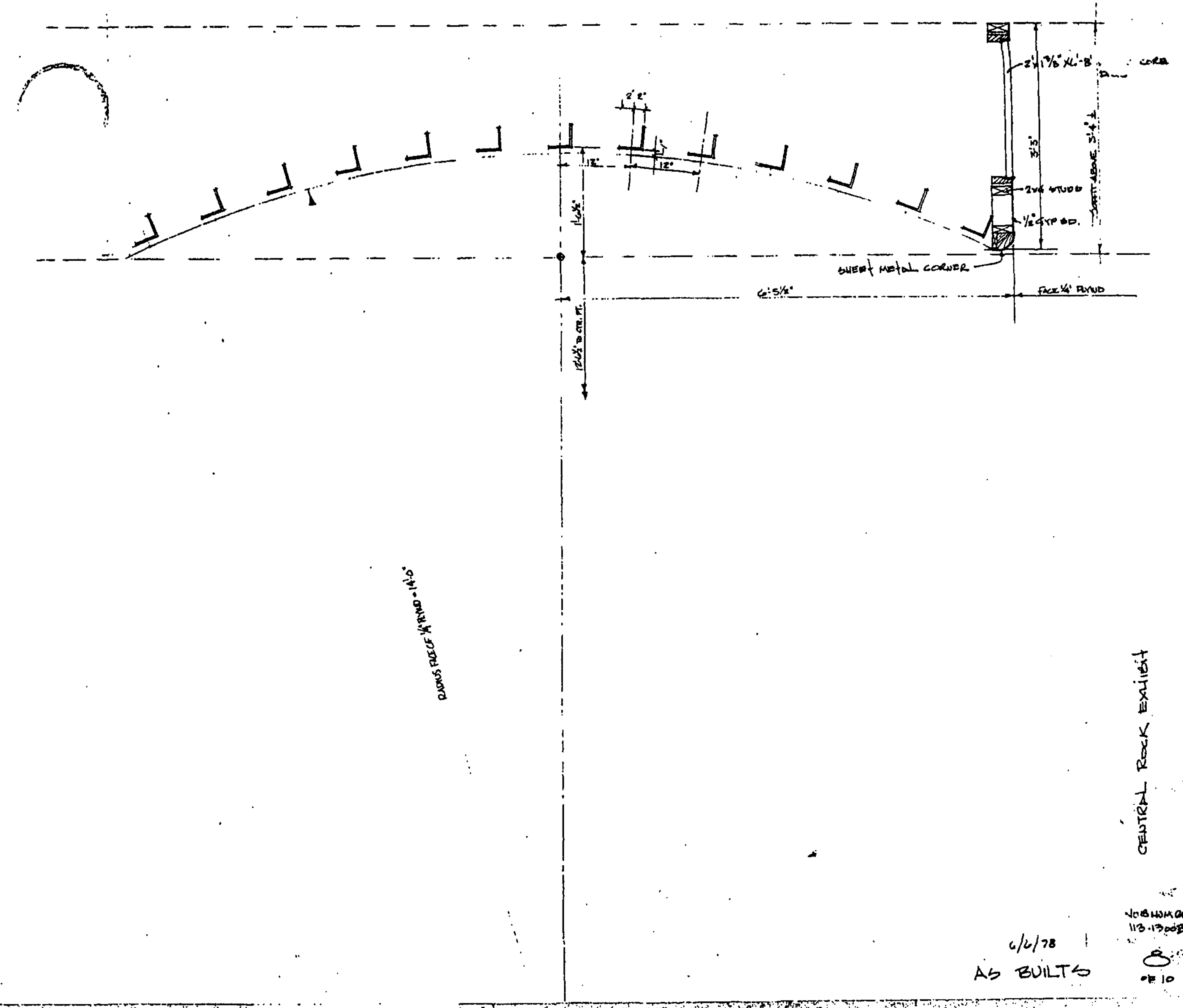
OF 10

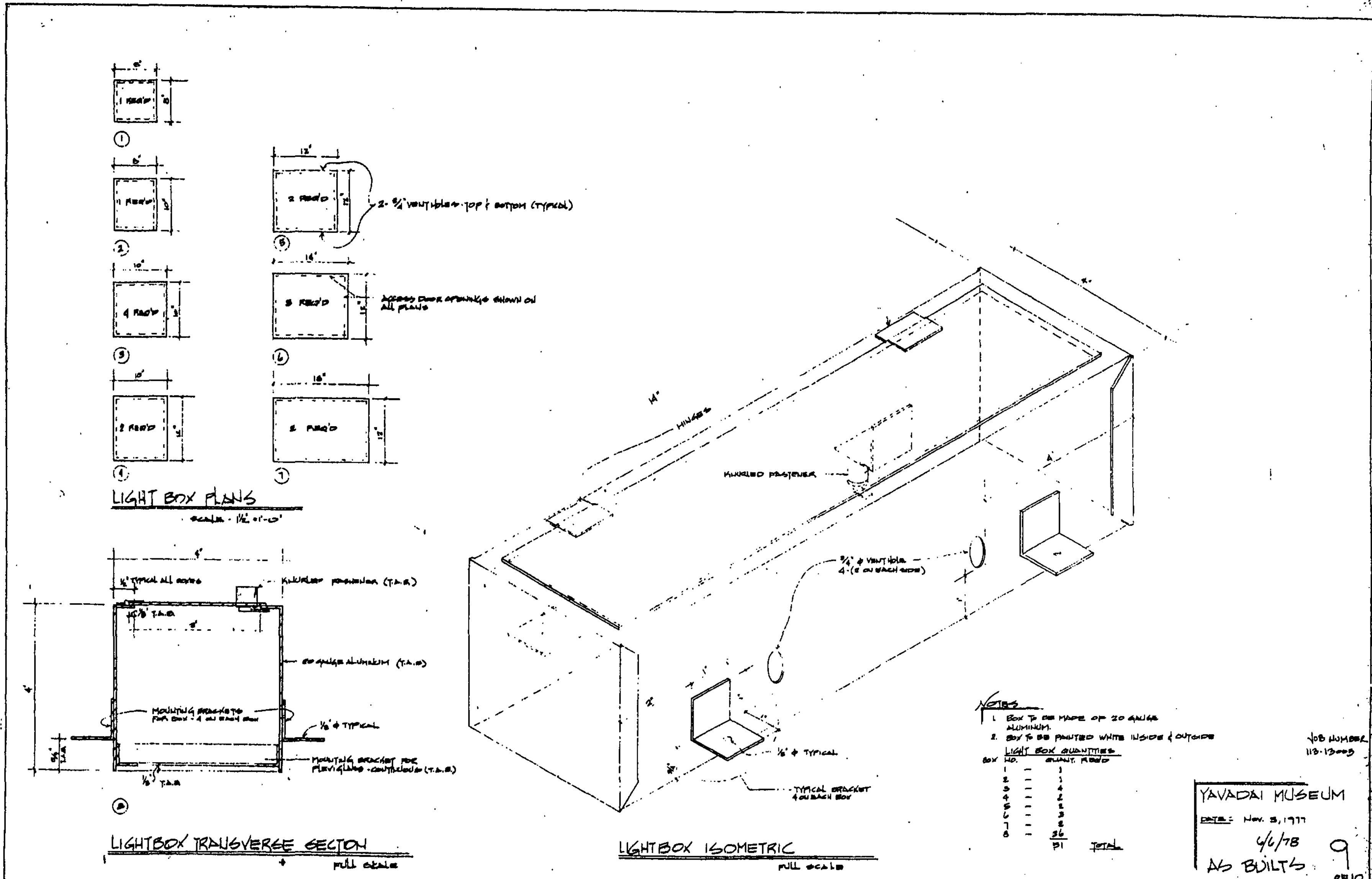


CENTRAL ROCK EXHIBIT

JOB NUMBER
113-13008

6/6/78
AS BUILTS

8
OF 10


LIGHT BOX PLANS
SCALE - 1½" = 1'-0"
1 REQ'D
2 REQ'D
4 REQ'D
3 REQ'D
2 - ¾" VENT HOLES - TOP & BOTTOM (TYPICAL)
ACCESS DOOR OPENINGS SHOWN ON ALL PLANS
LIGHTBOX TRANSVERSE SECTION
FULL SCALE
½" TYPICAL ALL BOXES
KNURLED FASTENER (T.A.B.)
20 GAUGE ALUMINUM (T.A.B.)
MOUNTING BRACKETS FOR BOX - 4 ON EACH BOX
⅛" ⌀ TYPICAL
MOUNTING BRACKET FOR PLEXIGLASS - CONTINUOUS (T.A.B.)
⅛" T.A.B.
LIGHTBOX ISOMETRIC
FULL SCALE
HINGES
KNURLED FASTENER
¾" ⌀ VENT HOLE
4 - (2 ON EACH SIDE)
⅛" ⌀ TYPICAL
TYPICAL BRACKET
4 ON EACH BOX
NOTES
1. BOX TO BE MADE OF 20 GAUGE ALUMINUM.
2. BOX TO BE PAINTED WHITE INSIDE & OUTSIDE
LIGHT BOX QUANTITIES
BOX NO. — QUANT. REQ'D
1 — 1
2 — 1
3 — 4
4 — 2
5 — 2
6 — 3
7 — 2
8 — 36
51 TOTAL
JOB NUMBER
113-13005
YAVADAI MUSEUM
DATE: Nov. 3, 1977
6/6/78
AS BUILTS
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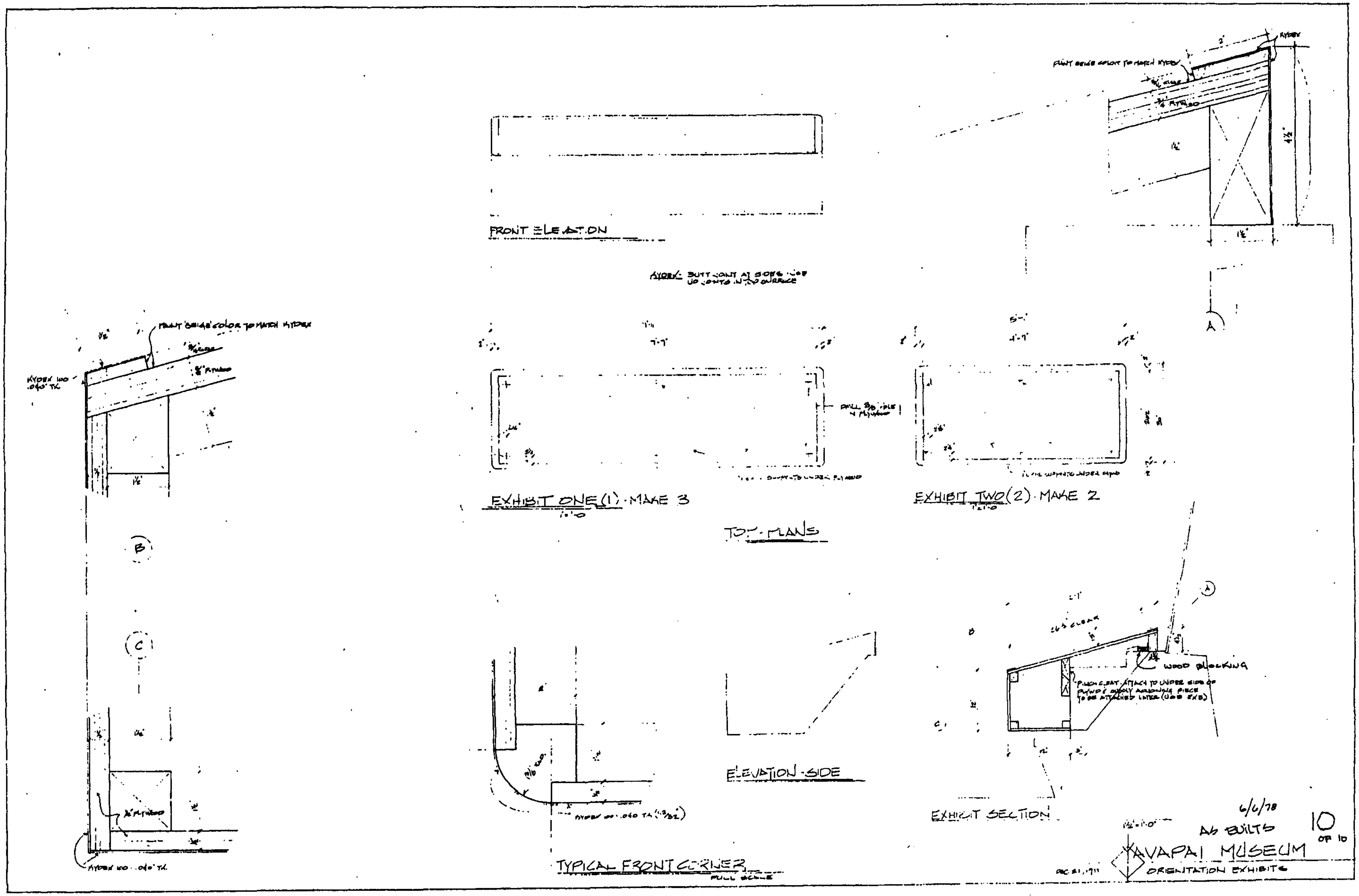
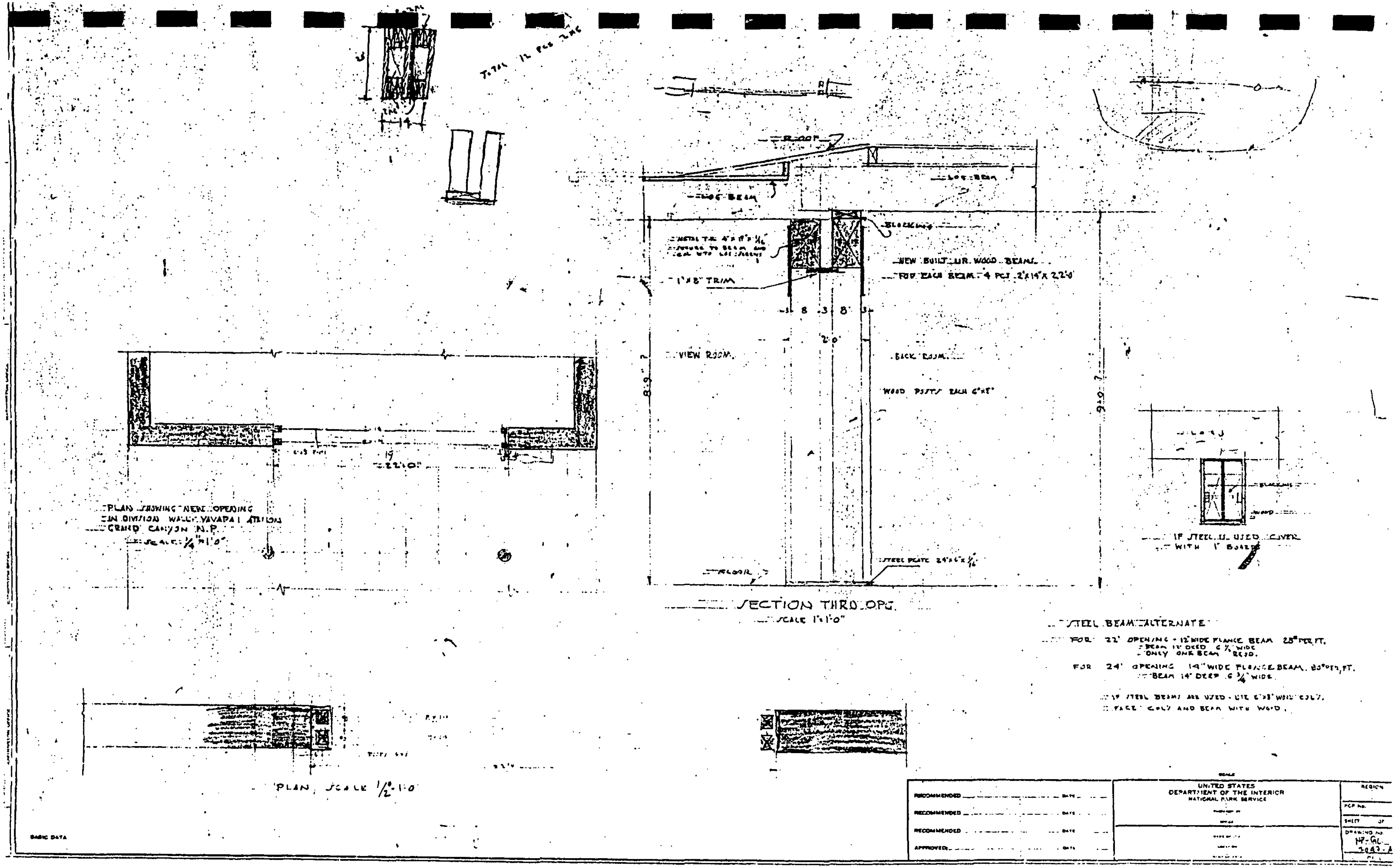
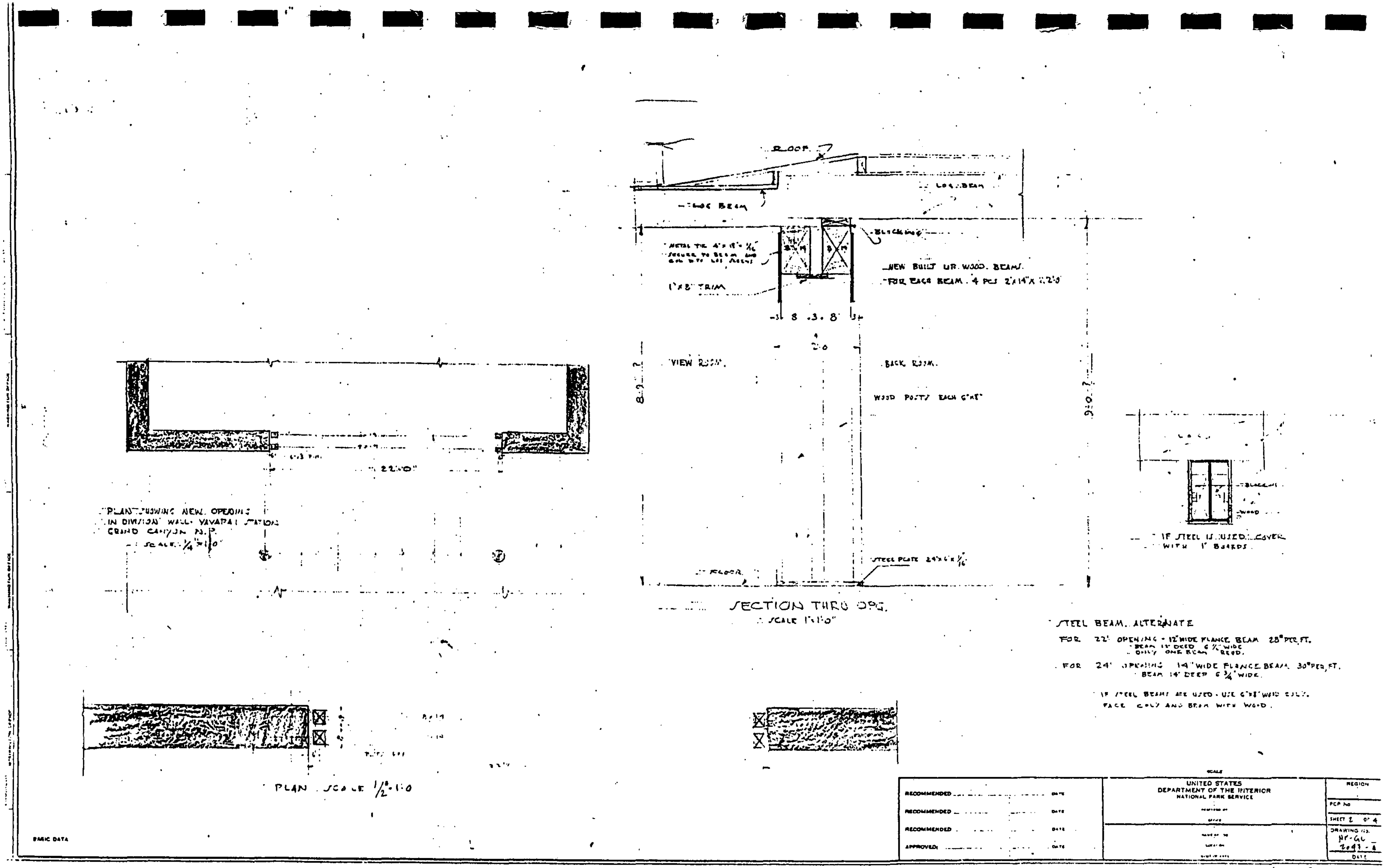
OF 10


FRONT ELEVATION
PAINT BEIGE COLOR TO MATCH KYDEX
KYDEX 100 · .040" TK
EXHIBIT ONE (1) · MAKE 3
EXHIBIT TWO (2) · MAKE 2
TOP PLANS
A
B
C
TYPICAL FRONT CORNER
FULL SCALE
ELEVATION · SIDE
WOOD BLOCKING
EXHIBIT SECTION
6/6/78
AS BUILTS
10
OF 10
YAVAPAI MUSEUM
ORIENTATION EXHIBITS

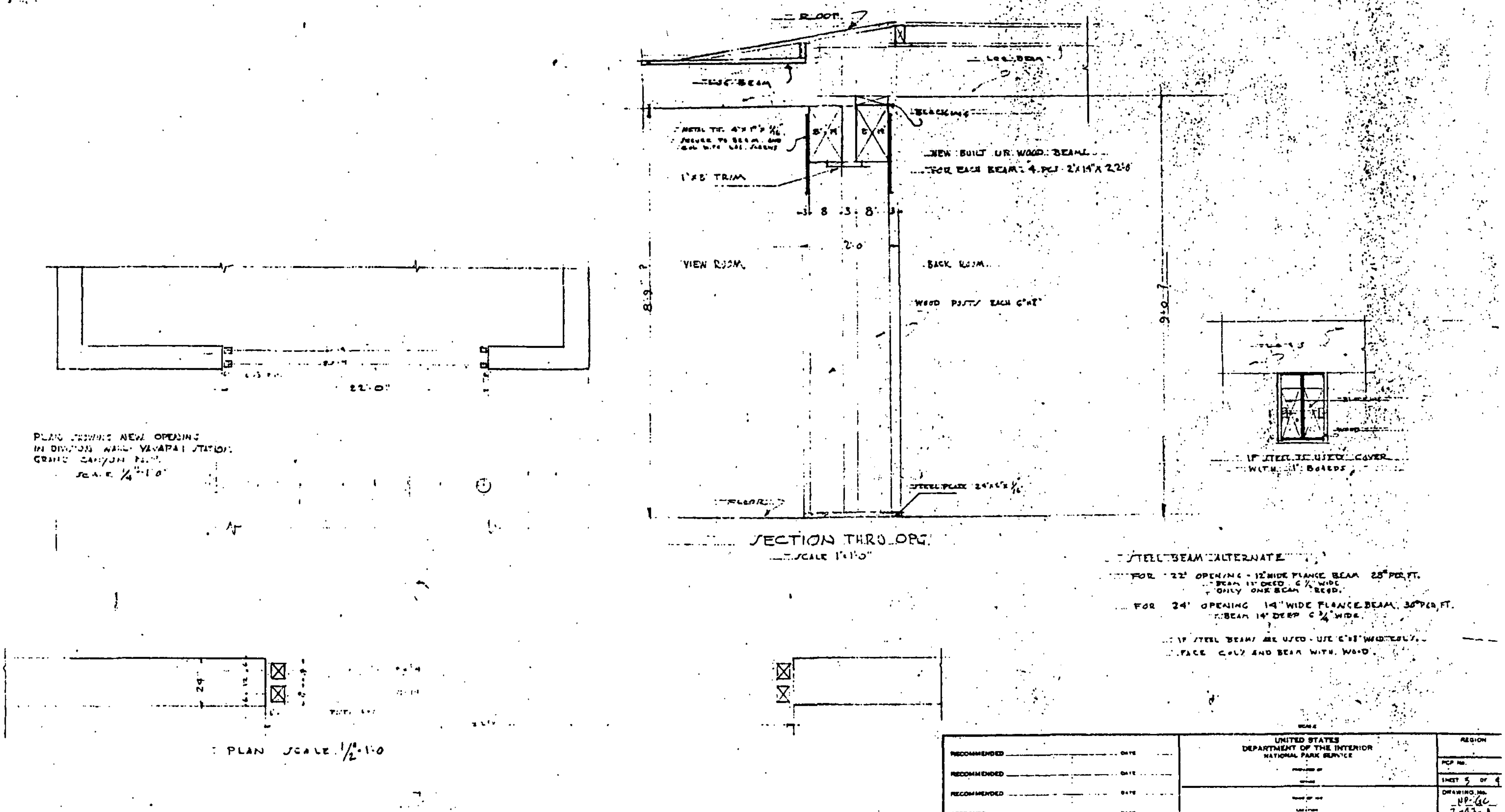
Appendix T. Plan Showing New Opening in Division Wall at Yavapai Station, National Park Service, undated.


NEW BUILT UP WOOD BEAMS
FOR EACH BEAM 4 PCS 2"x14"x 22'0"
BLOCKING
LOG BEAM
1"x8" TRIM
8 3 8 3
2'0"
VIEW ROOM
BACK ROOM
WOOD POSTS EACH 6"x8"
8'-9"
9'-0"
FLOOR
SECTION THRU OPG.
SCALE 1"=1'-0"
PLAN SHOWING NEW OPENING
IN DIVISION WALL, YAVAPAI STATION
GRAND CANYON N.P.
SCALE 1/4"=1'-0"
22'-0"
PLAN, SCALE 1/2"=1'-0"
IF STEEL IS USED COVER WITH 1" BOARDS
STEEL BEAM ALTERNATE
FOR 22' OPENING - 12" WIDE FLANGE BEAM 25# PER FT.
BEAM 12" DEEP 6 1/2" WIDE
ONLY ONE BEAM REQD.
FOR 24' OPENING 14" WIDE FLANGE BEAM, 30# PER FT.
BEAM 14" DEEP 6 3/4" WIDE.
UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
RECOMMENDED DATE
RECOMMENDED DATE
RECOMMENDED DATE
APPROVED DATE
REGION
PCP No.
SHEET OF
DRAWING No.
NP-GC-
3043-A
BASIC DATA

1-20-01



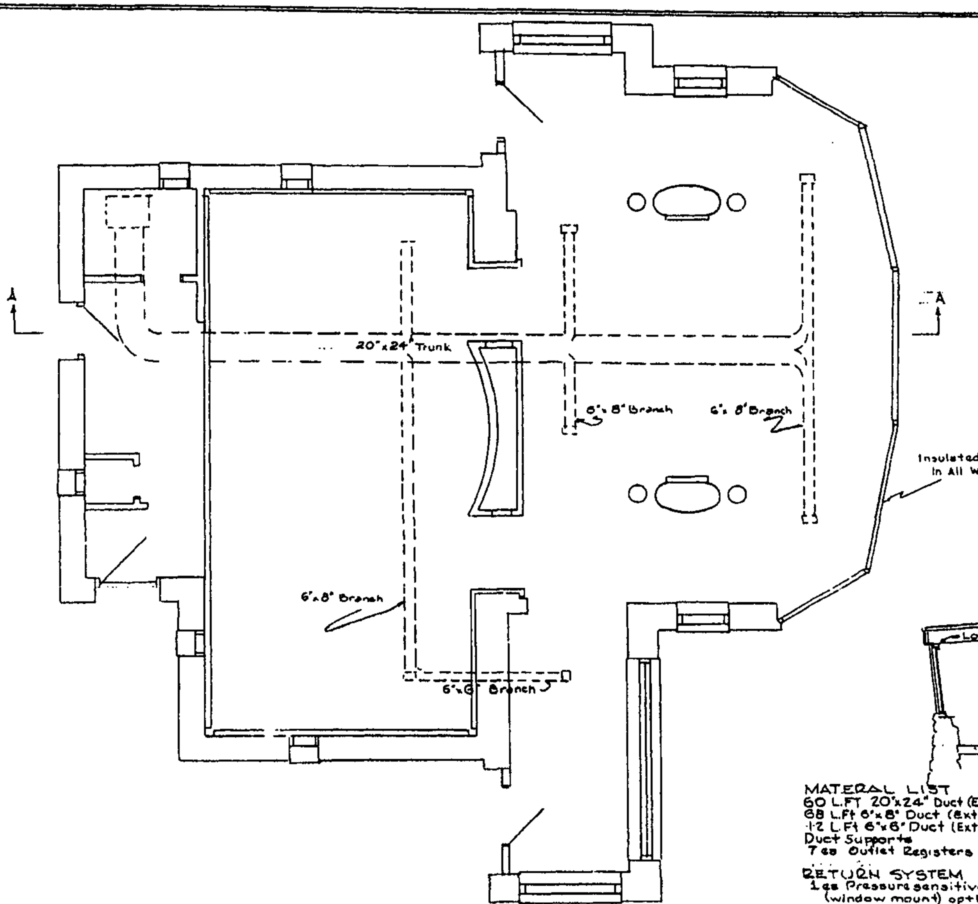
ROOF
HIGH BEAM
LOW BEAM
BLOCKING
NEW BUILT UP WOOD BEAMS
FOR EACH BEAM, 4 PCS 2"x14"x 22'0"
1"x8" TRIM
VIEW ROOM
BACK ROOM
WOOD POSTS EACH 6"x8"
STEEL PLATE
FLOOR
SECTION THRU OPG.
SCALE 1"=1'0"
PLAN SHOWING NEW OPENING
IN DIVISION WALL - YAVAPAI STATION
GRAND CANYON N.P.
SCALE 1/4"=1'0"
22'0"
IF STEEL IS USED COVER WITH 1" BOARDS
STEEL BEAM ALTERNATE
FOR 22' OPENING - 12" WIDE FLANGE BEAM 28# PER FT.
FOR 24' OPENING 14" WIDE FLANGE BEAM 30# PER FT.
BEAM 14" DEEP 6 3/4" WIDE.
PLAN SCALE 1/2"=1'0"
BASIC DATA
RECOMMENDED
RECOMMENDED
RECOMMENDED
APPROVED
DATE
UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
REGION
SHEET 2 OF 4
DRAWING NO.
1-20-0



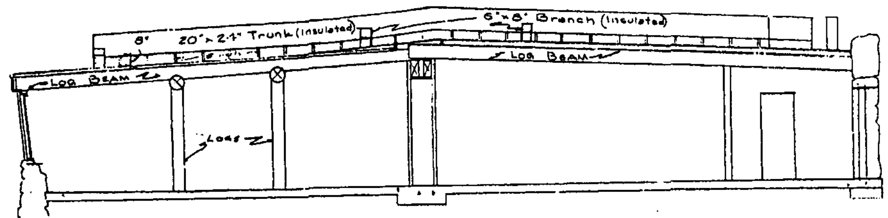
RECOMMENDED ______ DATE ______	UNITED STATES DEPARTMENT OF THE INTERIOR NATIONAL PARK SERVICE	REGION
RECOMMENDED ______ DATE ______		PCP No.
RECOMMENDED ______ DATE ______		SHEET 5 OF 9
APPROVED ______ DATE ______		DRAWING No. NP-GC 2047-A
		DATE

1-20-0

Appendix S. Floor Plan of Heat Duct Remodeling for Yavapai Museum by National Park Service Denver Service Center, dated December, 1979.



YAPAPAI MUSEUM FLOOR PLAN
SCALE 1/4" = 1'-0"



SECTION A-A 1/4" = 1'-0"

MATERAL LIST
60 L.FT 20"x24" Duct (Exterior)
68 L.Ft 6"x8" Duct (Exterior)
12 L.Ft 6"x6" Duct (Exterior)
Duct Supports
7 ea Outlet Registers

RETURN SYSTEM
1 ea Pressure sensitive louver set (window mount) optional.
4 ea 6"x18" Registers
1 ea 6"x6" Registers

All Duct is horizontal measurements only allow for vertical duct at each register and at plenum.
All duct roof mounted on support system and sufficiently insulated.

REDUCED SIZE REPRODUCTION

UNITED STATES DEPARTMENT OF THE INTERIOR NATIONAL PARK SERVICE DENVER SERVICE CENTER	PREPARED F.N DESIGNED EJC DRAWN WC CHECKED DATE 12/79	TITLE OF DRAWING: HEAT DUCT REMODELING FOR YAVAPAI MUSEUM LOCATION WITHIN PARK: YAVAPAI POINT NAME OF PARK: GRAND CANYON NATIONAL PARK REGION: WESTERN COUNTY: COCONINO STATE: ARIZONA	DRAWING NO. 113 / 60371 PCIP PKG. SHEET 1 OF

BASIC DATA

Appendix U. Seismic Rehabilitation, Yavapai Observation Station by J.F. Sato Associates, dated July, 2001

Prepared for:

Denver Service Center
National Park Service
12795 West Alameda Parkway
Denver, CO 80225

SEISMIC REHABILITATION:

YAVAPAI POINT MUSEUM

GRAND CANYON NATIONAL PARK

Prepared by:

J.F. Sato and Associates
5898 South Rapp Street
Littleton, CO 80120
Phone: (303) 797-1200
Fax: (303) 797-1187

Job # 0125
FINAL

July, 2001

Executive Summary:

Originally constructed in 1928, the Yavapai Observation Station has undergone at least two major renovations (in 1953 and 1978) as well as a name change, to become the present Yavapai Point Museum. This structure remains the Park's main interpretive center, and attracts visitors by the thousand with its displays, bookstore, and, of course, the view.

The Museum is a single story unreinforced stone masonry structure perched at the very rim of the Canyon. This portion of northern Arizona is a region of moderate seismicity. This fact, combined with the historically poor performance of unreinforced masonry structures during seismic events, and the high occupancy of this building, is cause for concern. This report has been prepared to address this concern by evaluating this structure for seismic hazards and suggesting retrofit work where appropriate.

This building is in generally excellent condition, and only two apparent deficiencies were found. It should be noted that invasive investigation was specifically prohibited in this evaluation, and such investigation may prove these deficiencies to be non-existent:

1) Positive ties could not be verified between the log columns and the foundation, and between the log columns and the log beams.

2) The building is located at a site that may be at risk of sliding, fracturing, or collapsing in a major quake.

This report recommends that these items be verified. In particular, the condition of the underlying strata (item 2) should be assessed by a qualified Geological/Geotechnical Engineer. If positive connections cannot be found at the log columns (item 1), details are included in this report for a simple, inexpensive retrofit.

It is anticipated that the work proposed by these recommendations will cost approximately $5,600.

The evaluation of this structure, and the recommendations presented, address only the life safety performance of the building during an earthquake with a 10% chance of occurrence in 50 years. They are not intended to assure the survival of the structure itself, nor the performance of the structure in a so-called "maximum credible earthquake," nor are concerns unrelated to seismic performance addressed.

Further renovations, both structural and non-structural, have been recommended in the Yavapai Point Museum Historic Structure Report, Architectural Resources Group, November 2000. The reader should refer to that document for further information.

SEISMIC REHABILITATION:
YAVAPAI POINT MUSEUM
GRAND CANYON NATIONAL PARK

TABLE OF CONTENTS

Introduction:

The Grand Canyon exposes a billion years of geologic history, the Park encompasses several ecologic zones throughout its varied elevations, it was the site of early human habitation, and later exploration and rediscovery. The area has a rich history, but for most of the Park's five million annual visitors...

It's all about the view!

And one of the finest views around, easily accessible from Grand Canyon Village, is at Yavapai Point. To bring a little comfort to the viewing, and provide housing for interpretive displays, the Yavapai Observation Station was constructed at this location in 1928.

This structure has been renovated numerous times throughout the last 73 years, and now bears the name Yavapai Point Museum, but it remains the Park's main interpretive center. It attracts visitors by the thousand with its displays, bookstore, and, of course, the view. Unfortunately, there is a hidden danger here. Although northern Arizona is not the hotbed of seismic activity that coastal California is, it does have its share of earthquakes, and unreinforced masonry structures such as the Yavapai Point Museum often perform poorly in seismic events.

The high occupancy of a potentially dangerous building, as well as impending possible renovation and restoration, has made it appropriate that this structure be evaluated for seismic hazards to determine the required rehabilitation measures. With that in mind, this report has been prepared to evaluate the potential earthquake related risk to human life, and to recommend retrofits to mitigate those hazards, per the guidelines set forth by the Federal Emergency Management Agency (FEMA) in their report 273, the NEHRP Guidelines for the Seismic Rehabilitation of Buildings, October 1997

The Park Service selected a Rehabilitation Objective consisting of providing a Life Safety performance level (3-C) for ground motion equivalent to a Basic Safety Earthquake 1 (BSE-1), as defined in FEMA 273. That report provides two alternative analysis procedures which may be used to determine the required retrofits: The Simplified Method and the Systematic Method. For unreinforced stone masonry structures with flexible diaphragms (such as the Yavapai Point Museum), FEMA 273 recommends the use of the Simplified Rehabilitation approach described in Chapter 10. That chapter presents the Simplified Method for use on a selected group of simple buildings being rehabilitated to the Life Safety performance level and ground motions described in FEMA 178, the NEHRP Handbook for the Seismic Evaluation of Existing Buildings, June 1992. To complicate matters, FEMA 178 was revised and republished as FEMA 310, the Handbook for the Seismic Evaluation of Building -- A Prestandard, January 1998. The reader is encouraged to refer to note 1 of Appendix B for an in-depth explanation of the process followed, but in general: An evaluation based on FEMA 310 was performed, deficiencies were identified, and retrofits to correct those deficiencies were developed.

While reviewing this report, it is important to bear in mind that the emphasis of the Life Safety performance level is to reduce the life safety risks to occupants of the building by meeting a minimum performance objective of a low "risk for life-threatening injury and entrapment," not survival of the structure itself. The American Society of Civil Engineers recognized that many existing structures were not designed to meet modern earthquake codes, and that the cost of the retrofits required to meet such codes would, in many cases, exceed the replacement cost of the structure. For this reason, the philosophy was adopted that the risk of catastrophic failures which could result in serious injury or death should be minimized, but that the risk of the structure itself being unusable after a major seismic event is acceptable. FEMA 310 itself includes in its definition of life safety performance level: "Building performance that includes significant damage to both structural and nonstructural components during a design earthquake..."

This report delineates the rehabilitation needed for this structure to meet the requirements of Executive Order 12941, which requires Federal agencies to evaluate and mitigate seismic hazards in their owned and leased buildings.

Building Description:

The Yavapai Point Museum is a single story unreinforced stone masonry structure of approximately 2,700 square feet perched on the very rim of the Grand Canyon. The original (1928) configuration of the structure consisted of basically three rooms: At the south was a small Laboratory room. Just north of that was a larger Exhibition Hall. North of that, and separated by a masonry wall with a single doorway, was the Roofed Terrace, originally open at the north for viewing the canyon. In 1953 the Terrace roof was trimmed slightly, and windows were installed to enclose the space. Also during this remodel, the majority of the wall between the Exhibition Hall and the (former) Terrace was removed to create a single large space. Further renovations in 1978 modified the entryways, replaced the windows, and set the building layout basically as it is today. The southernmost portion of the building contains a small office and an entry foyer for the main space. A bookshop occupies the former Exhibition Hall area, which remains open to the former Terrace. South facing entry doors both north and south of the Exhibition Hall open to the Terrace area, directly at the west, and though a foyer at the east. Although the terms may not designate the current uses, for consistency throughout this report, the three main areas of this structure will be referred to as the *Office*, *Exhibition Hall*, and *Terrace*. See photographs, Figures 1 & 2, and Plan and Elevation, Figures 3 & 4.

In addition, there is a small space below the structure built into a cavity in the face of the canyon wall that may, from time to time, be referred to as the *Basement*. Structurally, this area is not a part of the building, but may be considered a weakness in the strata underlying the foundation. This is discussed further in the Foundation and Geologic Checklist and 12 of Appendix B.

This building was in use at the time of the site visit. The nature of the construction, architectural finishes, bookstore racks, and interpretive displays limited access to portions of the structure. In addition, in order to keep the building in operation, and because of the historic nature of this museum, the Park Service prohibited "invasive" investigation. As such, the details of some elements of the existing structure have been assumed based upon the available sheets of the as-built, construction, and renovation drawings, as well as historic data and information regarding typical construction practices in the Canyon area.

Roof:

All portions of the roof are flat, or nearly so. The roof over the Office is believed to consists of built up tar and gravel roofing over 3/8" plywood, over 1 x 10 straight sheathing, supported by 2 x 6 joists. The joists span from the masonry bearing wall at the south to a beam in the wall between the Office and Exhibition Hall. A plaster and lath ceiling is attached to the underside of the joists.

The roof over the Exhibition Hall appears to consist of built up tar and gravel roofing over 3/8" plywood, over 1 x 10 straight sheathing over 2 x 4 purlins, over a 1 x 10 plank ceiling. The ceiling and purlins are supported on ~12" diameter log rafters ("vigas") which span from beam to beam or bearing wall to bearing wall, depending on location.

The roof of the Terrace consists of built up tar and gravel roofing over 3/8" plywood over 1 x 10 straight sheathing. The sheathing is supported by vigas spanning from the beam between the Exhibition Hall and Terrace, over two column supported log beams, and cantilevering out to the curved north wall. In the original configuration, there was no north wall, so it is reasonable to assume the vigas still act as a cantilevers, and are not supported by the more recently installed window framing. See Roof Framing Plan, Figure 5.

Foundation & Ground Floor:

The building foundation appears to consist of grouted stone masonry walls bearing directly on the native stone of the canyon rim. The stone masonry walls are tapered, and slightly thicker at the base than the top. The ground floor is an unreinforced concrete slab-on-grade.

Aligned with the north wall of the building, is the canyon edge. In areas it has been patched or improved with stone masonry to support the curved north side of the building. A portion of this masonry work encloses the "Basement," which has a single door opening on the north side, see Figure 4.

Very little deterioration of the foundation is anticipated based on observations of the concrete composing the floor slab and the exposed portions of the masonry walls. No signs of settlement or foundation distress were evident. A few stones are missing from the walls near the base. The stone composing the canyon rim at this location is fractured, there is at least one cave below the structure, and significant masonry "improvements" to the canyon walls directly below the building.

Note that no excavations or geotechnical borings were performed. Evaluation of the foundation condition was limited to visual observation of the exposed structure and a search for evidence of settlement in foundations or connected elements. Partial original plans were available for this structure, but the foundation was not well detailed.

Walls:

Walls consist of native Kaibab limestone laid in a primarily coursed, but occasionally random ashlar pattern and cemented together with deeply raked mortar of an undetermined composition. Walls are approximately 24" thick; stone masonry columns at the Terrace are approximately 36" thick. Very close to the base, and at building corners, the walls flare to form buttresses. However, since this detail occurs only quite close to the ground, its contribution to the building mass may be neglected. The buttresses do add some moment capacity at the base of the walls, however, neglecting this contribution should not make the evaluation overly conservative. A few small window and door opening exist in the walls of the Office and Exhibition Hall area. These openings are typically spanned by stone lintels. No distress is evident at any of these locations.

Historical Significance:

The low roof line of this building, combined with the coursed native stone mimicking the striations of the canyons geology, create a structure that seems a part of the landscape. The building, originally designed by Herbert Maier, exemplifies Park Service Rustic Architecture, with additional elements reflecting the native architecture of the Southwest. The curved north wall, following the rim of the canyon, is a further unique aspect of this building. The structure was nominated to the National Register of Historic Places in 1990.

The historic nature of this structure limits both the thoroughness of the evaluation and the nature of any acceptable retrofits. In many cases, preserving the historic fabric of a structure may prevent incorporation of a complete rehabilitation, forcing adoption of what FEMA 273 terms "Limited Objectives." FEMA 310, at least in its commentary, recognized these difficulties. While Section 2.2 states, "Unreinforced masonry bearing wall buildings . . . shall have destructive tests conducted," the commentary of Section 1.1 notes, "Testing that damages the historic character of the building generally is not acceptable. In addition, an appropriate level of performance for historic structures needs to be chosen that is acceptable to the local jurisdiction."

Lateral System:

This one story structure has basically one concentration of mass above the ground level consisting of the roof, complete with roofing, framing, and supported snow. Additional mass is contained in the stone shear walls themselves. This mass is distributed (vertically) throughout the structure. In a seismic event, displacement of the ground results in a lateral acceleration of the building, including the walls, roof, and any supported snow. The acceleration of this mass results in a lateral force which must be reacted to the ground.

In this structure, the lateral force is carried as shear in the roof to the supporting masonry walls, where it is carried in shear and cantilever bending to the foundation. Where no wall exists, such as along the north windows, the shear load must be carried by the diaphragm (acting as a cantilever) in one direction only, with the appropriate reactions transferred to various wall elements. The walls themselves, being thick, short, and heavy, are able to carry some out-of-plane loads directly to the foundation as bending in cantilever beams. Unreinforced masonry tends to behave in a stiff and brittle fashion, thus little damping or energy dissipation occurs in the walls themselves. Therefore, the walls react a force close to the full directly supported mass multiplied by the ground acceleration (in accordance with Newton's famous F = m x a).

Building Evaluation:

As mentioned in the introduction, this structure was evaluated and rehabilitation recommendations developed based on FEMA 273, the NEHRP Guidelines for the Seismic Rehabilitation of Buildings, October 1997, and its references to FEMA 178, the NEHRP Handbook for the Seismic Evaluation of Existing Buildings, June 1992, which was superceded by FEMA 310, the Handbook for the Seismic Evaluation of Building -- A Prestandard, January 1998. (Again, refer to note 1 of Appendix B for an in-depth explanation of the process followed.)

The balance of this report will follow closely to the format of FEMA 310. Copies of various forms from that report have been included where appropriate. A Tier 1 evaluation is not allowed for Unreinforced Masonry Bearing Wall Structures With Flexible Diaphragms, therefore, an evaluation in accordance with the Special Procedure of Section 4.2.6 of FEMA 310 has been carried out. Tier 1 evaluations using the Geologic Site Hazards and Foundation and the Basic Nonstructural checklists remain applicable for the entire structure.

Flag notes appearing on the included forms, in calculations, and other places, refer to detailed discussions and/or calculations contained in Appendix B of this report. Information used for this evaluation was collected during a visit to the building March 2001; various sheets of the original blueprints dated 1927; a few sheets of renovation drawings dated 1952; and a few sheets of renovation drawings dated 1977. None of these drawing sets was complete, and much of the information was illegible. In addition, further information was gleaned from the Transcontinental Geophysical Survey (35°-39° N) Geologic Map from 112° W Longitude to the Coast of California, Miscellaneous Geologic Investigations Map I-532-C, Carlson and Willden, U.S. Geologic Survey, 1968; the Encyclopedia Britannica; and verbal information provided by Park personnel.

The Yavapai Point Museum was occupied and in use at the time the field investigation was performed. At the explicit direction of the National Park Service, no destructive investigation or material testing was performed. Assumed material strengths have been used in this evaluation. It should be noted that this is not in conformance with FEMA 310, Section 2.2, which reads: "Unreinforced masonry bearing wall buildings with flexible diaphragms using Tier 2 Special Procedures of Section 4.2.6 shall have destructive tests conducted to determine average bed-joint shear strength, v_{te}, and the strength of the anchors." In addition, no excavations or geotechnical borings were performed. Invasive investigation (e.g: Cutting holes in walls and ceilings to observe the structure) was not performed, instead, inaccessible structural details were assumed based on extrapolation of accessible structure, available drawings, and common building practices.

Summary of Evaluation Information:

BUILDING DATA

Year Built:	1928
Significant Modifications:	1953, 1978
Date of Site Visit:	March 2001
Area:	2,700 sq. ft.

CONSTRUCTION AND STRENGTH DATA 4

Office Roof:	3/8" Plywood & 1" str. sheathing over 2x6 rafters, plaster & lath ceiling.	975	lbs/ft
Exh. Hall Roof:	3/8" Plywood & 1" str. sheathing, 2x4 purlins, 1" str. sheathing over vigas.	1,275	lbs/ft
Terrace Roof:	3/8" Plywood & 1" str. sheathing over vigas (log rafters).	975	lbs/ft
Ground Floors:	Concrete Slab on grade.		
Exterior Walls:	Ashlar stone masonry.	10	psi

SEISMIC PARAMETERS 5

Mapped Short Period Ground Acceleration (S_s):	0.308 g	
Mapped 1.0 Second Ground Acceleration (S_1):	0.083 g	
Building Seismic Coefficient (S_a):	0.205 g	
Soils Class:	B	
Site Coefficients	Fa = 1.0	Fv = 1.0
Region of Seismicity	Moderate	

LOADS 7 & 8

Dead Loads:		
Office Roof:	20.5	psf
Exhibition Hall Roof:	18.9	psf
Terrace Roof:	15.9	psf
Limestone Ashlar Masonry Walls	150	pcf
Live Loads:		
Roof Design Snow Load:	29	psf
Seismic Design Snow Load	0	psf

Unreinforced Masonry Evaluation:

FEMA 310 does not provide a checklist or a Tier 1 evaluation for Unreinforced Masonry Bearing Wall Buildings with Flexible Diaphragms, but rather requires a Tier 2 evaluation be completed following the Special Procedure of Section 4.2.6. A careful review of that Section uncovered a number of discrepancies the reader should be aware of. These are discussed in detail in 2 and 3 . A Subsection by Subsection summary of the evaluation process outlined in Section 4.2.6, with the modifications discussed in 2 and 3 , appears below. In-depth calculations or other information required to complete each subsection are included in Appendix B under the indicated flag note.

FEMA 310 SUBSECTION	ANALYSIS RESULTS
4.2.6.1, Applicability:	**This structure meets the stated applicability requirements.**
4.2.6.2, Cross Walls:	There are no cross walls in this building, nor would they be appropriate given the geometry of this structure. Diaphragm capacity will be checked based on the existing building geometry. **This section is not applicable.**
4.2.6.3, Diaphragms:	As explained in 3, there are inconsistencies in the Demand Capacity Ratio analysis method of FEMA 310 that make it unreliable. By calculating the out-of-plane cantilever capacity of the walls (see 7), the actual loads in the diaphragms were calculated and found to be well below the actual capacity of the existing structure (see 9). **Existing diaphragms are adequate.**
4.2.6.4, Shear Walls:	Both the shear and bending loads, including out-of-plane effects, were calculated for the critical shear walls in 9, and found to be far below the capacities calculated in 7. **Existing Shear walls are adequate.**
4.2.6.5, Out-of-Plane:	Calculations in 7 and 9 show the out-of-plane loads to be far below the capacities of the masonry walls. **Walls have adequate out-of-plane capacity.**
4.2.6.6, Connections:	This section, as written in FEMA 310, is not strictly applicable to this structure. However, the roof to wall connections are important, and are discussed at length in 10. **The existing roof to wall connections are adequate.**
4.2.6.7, Open Fronts:	This building effectively meets the requirements of this section using moment resistant columns rather than cross walls. Calculations in 9 show the masonry columns to have sufficient weak axis strength to react loads generated in the cantilever portion of the diaphragm extending out to the observation windows. **Sufficient capacity exists to support the open front.**

By omitting a checklist for Unreinforced Masonry Structures with Flexible Diaphragms, FEMA 310 misses some potentially significant items. Two of the evaluation statements from Section 3.7.16, the General Basic Structural Checklist, are important in this structure:

ASSESSMENT	FEMA 310 EVALUATION STATEMENT
Non-Conforming 11	WOOD POSTS: There shall be a positive connection of wood posts to the foundation.
Non-Conforming 11	GIRDER/COLUMN CONNECTIONS: There shall be a positive connection between the girder and the column support.

Foundation and Geologic Checklist Evaluation:

A reproduction of the Geologic Site Hazards And Foundations Checklist from Chapter 3 of FEMA 310 follows, comments or related information as they pertain to each question are included in Appendix B of this report under the appropriate flag note.

3.8 Geologic Site Hazards And Foundations Checklist

This Geologic Site Hazards and Foundations Checklist shall be completed when required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked compliant (C), non-compliant (NC), or not applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this Handbook, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 evaluation procedure; the section numbers in parentheses following each evaluation statement correspond to Tier 2 evaluation procedures.

Geologic Site Hazards

The following statements shall be completed for buildings in regions of high or moderate seismicity.

C NC N/A LIQUEFACTION: Liquefaction susceptible, saturated, loose granular soils that could jeopardize the building's seismic performance shall not exist in the foundation soils at depths within 50 feet under the building for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.7.1.1)

12 C NC N/A SLOPE FAILURE: The building site shall be sufficiently remote from potential earthquake-induced slope failures or rockfalls to be unaffected by such failures or shall be capable of accommodating any predicted movements without failure. (Tier 2: Sec. 4.7.1.2)

12 C NC N/A SURFACE FAULT RUPTURE: Surface fault rupture and surface displacement at the building site is not anticipated. (Tier 2: Sec. 4.7.1.3)

Condition of Foundations

The following statement shall be completed for all Tier 1 building evaluations.

C NC N/A FOUNDATION PERFORMANCE: There shall be no evidence of excessive foundation movement such as settlement or heave that would affect the integrity or strength of the structure. (Tier 2: Sec. 4.7.2.1)

The following statement shall be completed for buildings in regions of high or moderate seismicity being evaluated to the Immediate Occupancy Performance Level.

C NC N/A DETERIORATION: There shall not be evidence that foundation elements have deteriorated due to corrosion, sulfate attack, material breakdown, or other reasons in a manner that would affect the integrity or strength of the structure. (Tier 2: Sec. 4.7.2.2)

Capacity of Foundations

The following statement shall be completed for all Tier 1 building evaluations.

C NC N/A POLE FOUNDATIONS: Pole foundations shall have a minimum embedment depth of 4 ft. for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.7.3.1)

Nonstructural Checklist Evaluation:

A reproduction of the Basic Nonstructural Component Checklist from Chapter 3 of FEMA 310 follow, comments or related information as they pertain to each question are included in Appendix B of this report under the appropriate flag note.

3.9.1 Basic Nonstructural Component Checklist

This Basic Nonstructural Component Checklist shall be completed when required by Table 3-2.

Each of the evaluation statements on this checklist shall be marked compliant (C), non-compliant (NC), or not applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this Handbook, while non-compliant statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 evaluation procedure; the section numbers in parentheses following each evaluation statement correspond to Tier 2 evaluation procedures.

Partitions

C NC N/A UNREINFORCED MASONRY: Unreinforced masonry or hollow clay tile partitions shall be braced at a spacing of equal to or less than 10 feet in regions of low and moderate seismicity and 6 feet in regions of high seismicity. (Tier 2: Sec. 4.8.1.1)

Ceiling Systems

C NC N/A INTEGRATED CEILINGS: Integrated suspended ceilings at exits and corridors or weighing more than 2 lb/ft^2 shall be laterally restrained with a minimum of 4 diagonal wires or rigid members attached to the structure above at a spacing of equal to or less than 12 ft. (Tier 2: Sec. 4.8.2.1)

C NC N/A LAY-IN TILES: Lay-in tiles used in ceiling panels located at exitways and corridors shall be secured with clips. (Tier 2: Sec. 4.8.2.2)

C NC N/A SUPPORT: The integrated suspended ceiling system shall not be used to laterally support the tops of gypsum board, masonry, or hollow clay tile partitions. (Tier 2: Sec. 4.8.2.3)

C NC N/A SUSPENDED LATH AND PLASTER: Ceilings consisting of suspended lath and plaster or gypsum board shall be attached for each 10 square feet of area. (Tier 2: Sec. 4.8.2.4)

Light Fixtures

C NC N/A INDEPENDENT SUPPORT: Light fixtures in suspended grid ceilings shall be supported independently of the ceiling suspension system by a minimum of two wires at diagonally opposite corners of the fixtures. (Tier 2: Sec. 4.8.3.1)

C NC N/A EMERGENCY LIGHTING: Emergency lighting shall be anchored or braced to prevent falling or swaying during an earthquake. (Tier 2: Sec. 4.8.3.2)

Cladding and Glazing

C NC N/A CLADDING ANCHORS: Cladding components weighing more than 10 psf shall be anchored to the exterior wall framing at a spacing equal to or less than 6 ft. for Life Safety and 4 ft. for Immediate Occupancy. (Tier 2: Sec. 4.8.4.1)

C NC N/A CLADDING ISOLATION: For moment frame buildings of steel or concrete, panel connections shall be detailed to accommodate a drift ratio of 0.02 for Life Safety and 0.01 for Immediate Occupancy. (Tier 2: Sec. 4.8.4.2)

C NC N/A MULITSTORY PANELS: For multistory panels attached at each floor level, the panels and connections shall be able to accommodate a drift ratio of 0.02 for Life Safety and 0.01 for Immediate Occupancy. (Tier 2: Sec. 4.8.4.3)

C NC N/A BEARING CONNECTIONS: Where bearing connections are required, there shall be a minimum of two bearing connections for each wall panel. (Tier 2: Sec. 4.8.4.4)

C NC N/A INSERTS: Where inserts are used in concrete connections, the inserts shall be anchored to reinforcing steel. (Tier 2: Sec. 4.8.4.5)

C NC N/A PANEL CONNECTIONS: Exterior cladding panels shall be anchored with a minimum of 2 connections for each wall panel for Life Safety and 4 connections for Immediate Occupancy. (Tier 2: Sec. 4.8.4.6)

C NC N/A DETERIORATION: There shall be no evidence of deterioration or corroding in any of the connection elements. (Tier 2: Sec. 4.8.4.7)

C NC N/A DAMAGE: There shall be no damage to exterior wall cladding. (Tier 2: Sec. 4.8.4.8)

13 C NC N/A GLAZING: Glazing in curtain walls and individual panes over 16 square feet in area, located up to a height of 10 feet above an exterior walking surface, shall be laminated annealed or heat strengthened safety glass that will remain in the frame when cracked. (Tier 2: Sec. 4.8.4.9)

Masonry Veneer

C NC N/A SHELF ANGLES: Masonry veneer shall be supported by shelf angles or other elements at each floor above the first floor. (Tier 2: Sec. 4.8.5.1)

C NC N/A TIES: Masonry veneer shall be connected to the back-up with corrosion-resistant ties. The ties shall have a spacing of equal to or less than 36" for Life Safety and 24" for Immediate Occupancy with a minimum of one tie for every 2-2/3 square feet. (Tier 2: Sec. 4.8.5.2)

C NC N/A WEAKENED PLANES: Masonry veneer shall be anchored to the back-up at locations of flashing. (Tier 2: Sec. 4.8.5.3)

Parapets, Cornices, Ornamentation and Appendages

C NC N/A URM PARAPETS: There shall be no laterally unsupported unreinforced masonry parapets or cornices above the highest anchorage level with height-to-thickness ratios greater than 1.5 in regions of high seismicity and 2.5 in regions of moderate or low seismicity. (Tier 2: Sec. 4.8.8.1)

C NC N/A CANOPIES: Canopies located at building exits shall be anchored at a spacing 10 feet for Life Safety and 6 feet for Immediate Occupancy. (Tier 2: Sec. 4.8.8.2)

Masonry Chimneys

C NC N/A URM: No unreinforced masonry chimney shall extend above the roof surface more than twice the least dimension of the chimney. (Tier 2: Sec. 4.8.9.1)

C NC N/A MASONRY: Masonry chimneys shall be anchored to the floor and roof. (Tier 2: Sec. 4.8.9.2)

Stairs

C NC N/A URM WALLS: Walls around stair enclosures shall not consist of unbraced hollow clay tile or unreinforced masonry. (Tier 2: Sec. 4.8.10.1)

C NC N/A STAIR DETAILS: In moment frame structures, the connection between the stairs and the structure shall not rely on shallow anchors in concrete. Alternatively, the stair details shall be capable of accommodating the drift calculated using the Quick Check Procedure of Section 3.5.3.1 without inducing tension in the anchors. (Tier 2: Sec. 4.8.10.2)

Building Contents and Furnishing

C NC N/A TALL NARROW CONTENTS: Contents with a height-to-depth ratio greater than 3 for Immediate Occupancy and 4 for Life Safety shall be anchored to the floor slab or adjacent walls. (Tier 2: Sec. 4.8.11.1)

Mechanical and Electrical Equipment

C NC N/A EMERGENCY POWER: Equipment used as part of an emergency power system shall be mounted to maintain continued operation after an earthquake. (Tier 2: Sec. 4.8.12.1)

C NC N/A HEAVY EQUIPMENT: Equipment weighing over 20 lb that is attached to ceilings, walls, or other supports 4 ft. above the floor level shall be braced. (Tier 2: Sec. 4.8.12.2)

Piping

C NC N/A FIRE SUPPRESSION PIPING: Fire suppression piping shall be anchored and braced in accordance with *NFPA-13* (NFPA, 1996). This statement need not be evaluated for buildings in regions of moderate seismicity being evaluated to the Life Safety Performance Level. (Tier 2: Sec. 4.8.13.1)

C NC N/A FLEXIBLE COUPLINGS: Fluid, gas and fire suppression piping shall have flexible couplings. This statement need not be evaluated for buildings in regions of moderate seismicity being evaluated to the Life Safety Performance Level. (Tier 2: Sec. 4.8.13.2)

Hazardous Materials Storage and Distribution

C NC N/A TOXIC SUBSTANCES: Toxic and hazardous substances stored in breakable containers shall be restrained from falling by latched doors, shelf lips, wires, or other methods. (Tier 2: Sec. 4.8.15.1)

Summary of Deficiencies:

The evaluation process of FEMA 310 showed very few deficiencies in this structure related to its expected life safety performance in a design seismic event. The two items worthy of note are:

1) Positive ties could not be verified between the log columns and the foundation, and between the log columns and the log beams. A failure here could result in one or more of the columns moving out of their proper location, leading to a partial roof collapse.

2) The building is located at a site that may be at risk of sliding, fracturing, or collapsing in a major quake. Should a portion of the underlying canyon rim slough in a major earthquake, the building, its occupants, and anyone in the vicinity would be in great danger.

It should be noted that the deficiencies identified are based on a "BSE-1 Earthquake", defined in FEMA 273 as ground motion which has a 10% probability of being exceeded in 50 years. Since the structure is regularly occupied, and frequently crowded, this is a high enough possibility of occurrence to warrant concern.

Recommendations:

For the most part, the Yavapai Point Museum can be expected to perform well in a seismic event. However, further investigation should be undertaken with regard to the two deficiencies noted. The results of such investigation may serve to provide further assurance of the safety of building occupants, or may identify corrective actions which need to be taken.

At the same time, the historic nature of this structure should be recognized, and an effort made not to significantly alter the historic fabric and outward appearance of the structure. With this in mind, invasive investigation and retrofits should be made as minimally intrusive as possible.

Column Connections:

As explained in $\triangle$11, the connections at the top and bottom of the log columns could not be verified. Typical construction practice would suggest there are steel alignment pins or bolts in the ends of the columns, however, this could not be confirmed. It may be possible to remove a portion of the carpet and determine whether restraint is provided at the base of the column. Similarly, it may be possible to drill a small exploratory hole, or to use a feeler gauge or metal detector to probe for connecting elements between the log beams and the columns.

If such investigations cannot be performed, or if they reveal no positive connections, restraints such as those shown in Figure 19 should be installed.

It is anticipated that this retrofit could be accomplished by Park personnel. The total cost of this work should be minimal, and is estimated at no more than $600.

Geotechnical Investigation and Assessment:

As noted in 12, there are significant concerns with the integrity of the rock strata forming the canyon rim below this structure. It is recommended that a qualified geotechnical engineer be retained to assess the site. As a minimum, this investigation should include boring a hole or removing some of the canyon wall masonry to determine the existence, extent, and condition of the large void shown on the original floor plan (Figure 18). Long term monitoring of some cracks may be required.

Based on our experience, a fee on the order of $5,000 can be anticipated for this investigation.

Total Cost:

The total cost of the recommended geotechnical investigation and possible seismic retrofit of the log columns for this structure is approximately $5,600.

This figure represents the cost of only the items noted above. It is possible the geotechnical engineer will have further suggestions for subgrade stabilization that may considerably increase this figure. In addition, if other renovations (as discussed below) are accomplished at the same time, the total cost will increase.

Other Work:

It is our understanding that the Park Service is considering a major renovation of this structure. Undertaking any required seismic retrofit work at the same time is a very good idea. However, bear in mind that other structural repair and preservation work is required in addition to the seismic work addressed by this report.

The reader is directed to the Yavapai Point Museum Historic Structure Report, prepared by Architectural Resources Group, November 6, 2000. That report mentions quite a bit of required work including, but not limited to:

- Replacement of built-up roofing.
- Installation of new flashing, drains, and scuppers.
- Minor stone repointing.
- Repair and replacement of log vigas, where required.
- Painting of all exterior wood.

If this work is undertaken, the opportunity to observe and record the concealed structure, and verify the assumptions made in this report, should not be missed. In particular, when the existing roofing is removed, it may be advisable to arrange a site visit by a structural engineer to assess the condition of the previously concealed elements.

Appendix A

Figures

1) Elevation Looking Northeast
2) Elevation Looking Northwest
3) Plan of Building
4) North Elevation of Building
5) Roof Framing Plan
6) Map: 0.2 Second Spectral Response Ground Motion
7) Map: 1.0 Second Spectral Response Ground Motion
8) Allowable Height-to-Thickness Ratios
9) Strength Values for Existing Materials
10) Strength Values of New Materials Used in Conjunction with Existing Construction
11) Lateral Loading Diagram
12) Critical Connection from Exterior
13) Critical Connection from Interior
14) Beam / Column Connection
15) Basement Crack and Canyon Wall Improvements
16) Basement Crack
17) Crack in Strata Below Structure
18) Original Floor Plan Showing Voids
19) Column Connection Retrofit

ELEVATION LOOKING NORTHEAST

FIG. 1 YAVAPAI POINT MUSEUM

ELEVATION LOOKING NORTHWEST

FIG. 2 YAVAPAI POINT MUSEUM

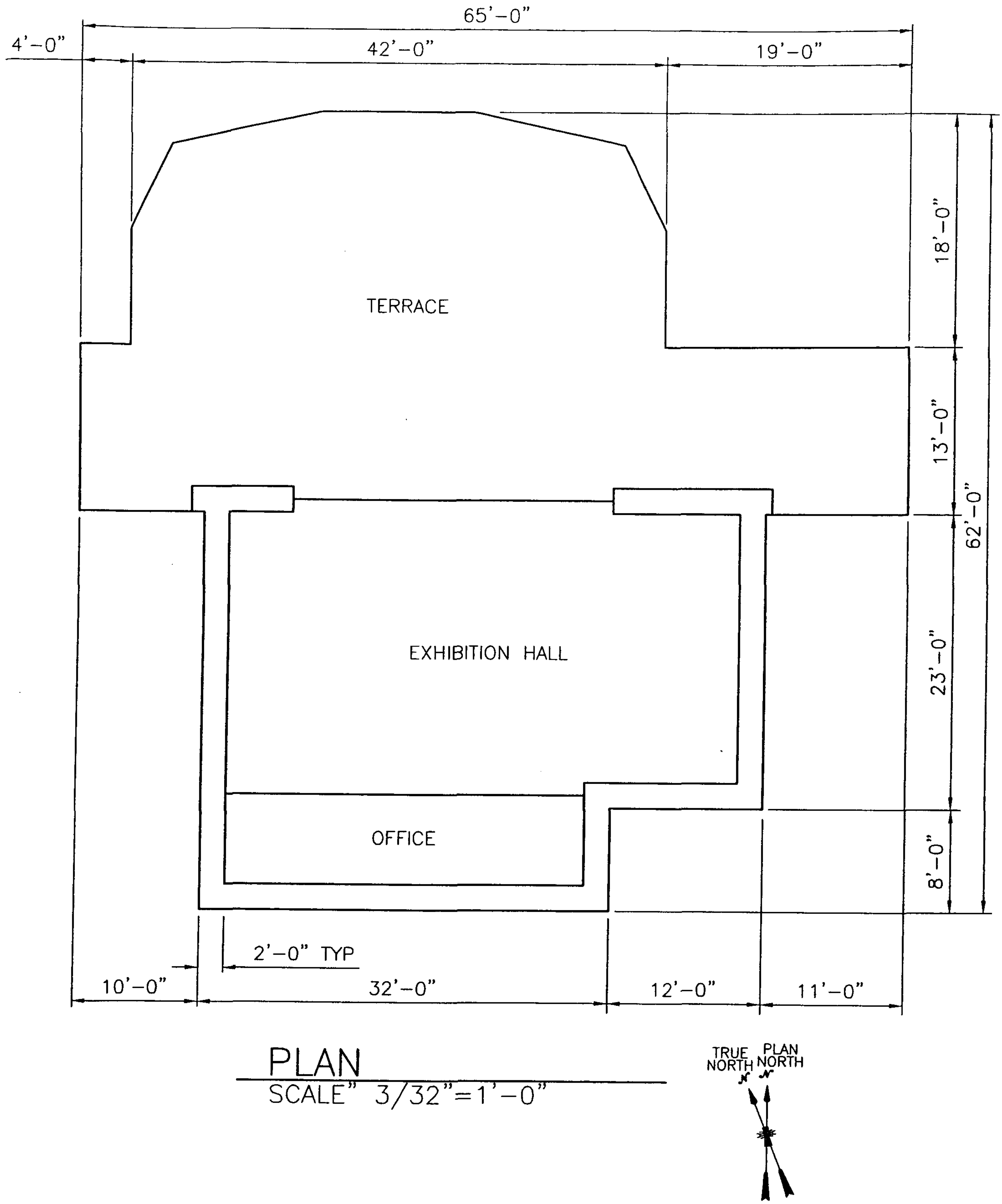
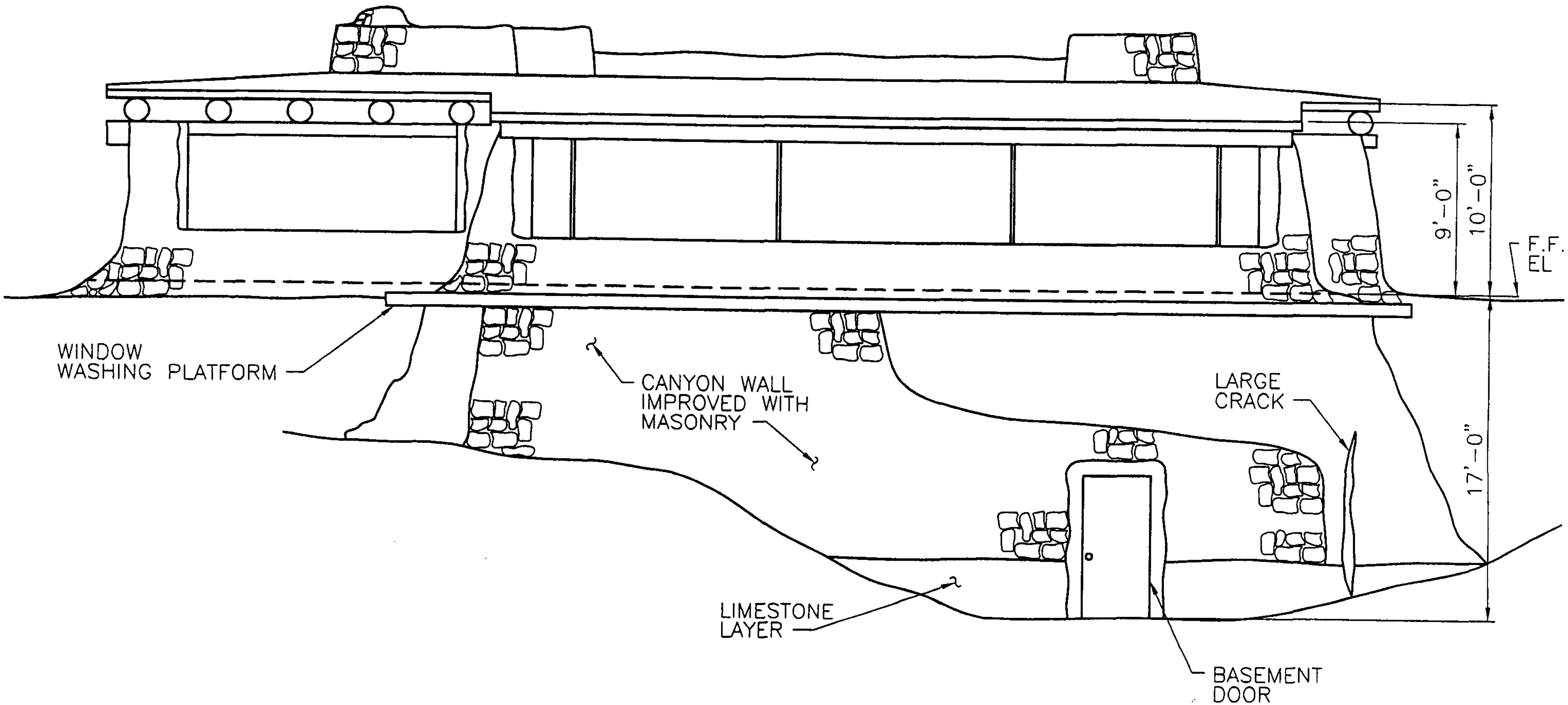
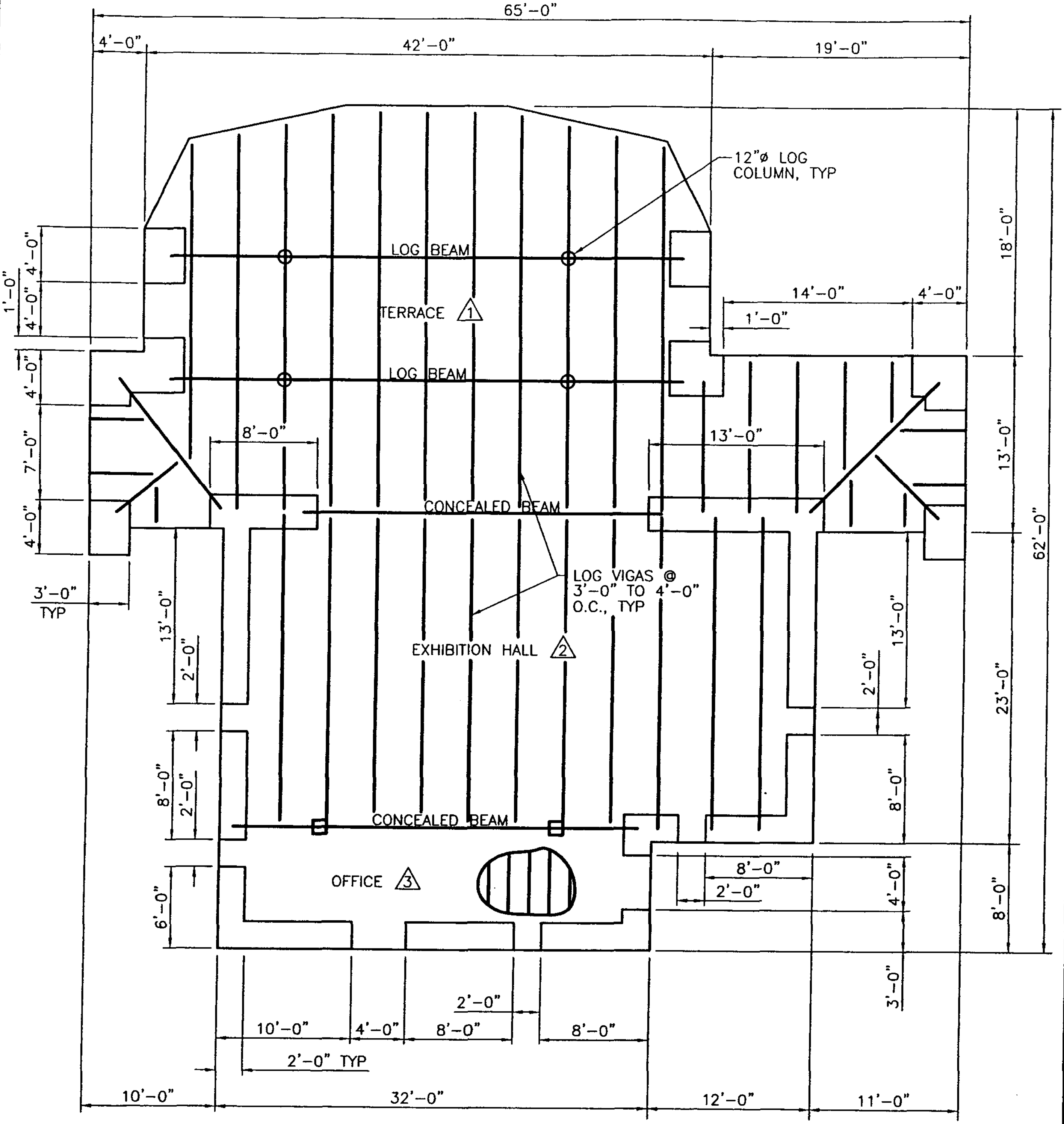


FIG. 3 YAVAPAI POINT MUSEUM



NORTH ELEVATION
SCALE" 1/8"=1'–0"

FIG. 4 YAVAPAI POINT MUSEUM



ROOF FRAMING PLAN

SCALE: 3/32"=1'-0"

1. 3/8" PLYWOOD, 1" STRAIGHT SHEATHING, VIGAS, (LOG RAFTERS).
2. 3/8" PLYWOOD, 1" STRAIGHT SHEATHING, 2x4 PURLINS, 1" STRAIGHT SHEATHING, VIGAS.
3. 3/8" PLYWOOD, 1" STRAIGHT SHEATHING, 2x6 JOISTS, PLASTER & LATH CEILING.

FIG. 5 YAVAPAI POINT MUSEUM

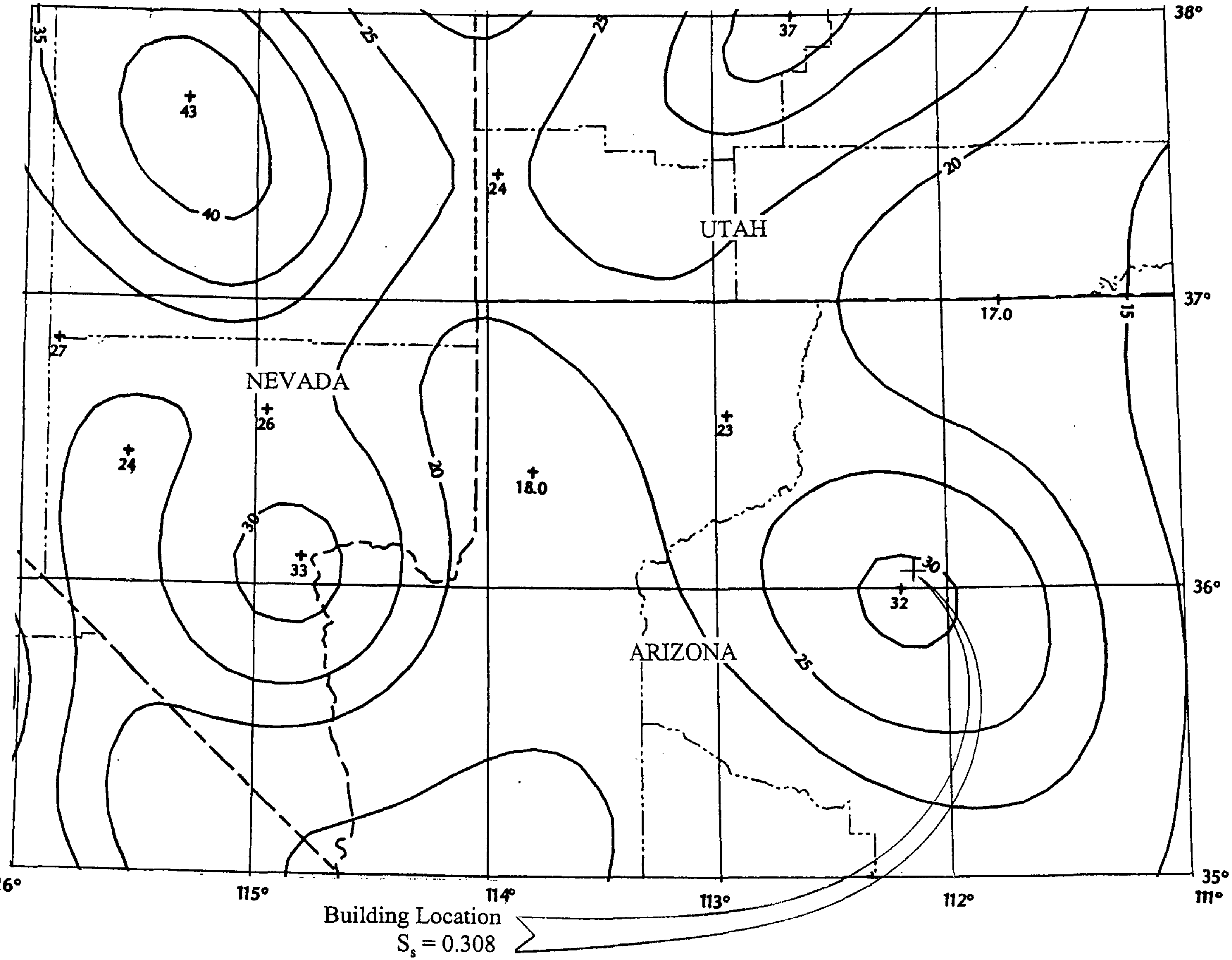


Fig 6: CONTOUR MAP FOR 0.2 SECOND SPECTRAL RESPONSE GROUND MOTION (Ss)

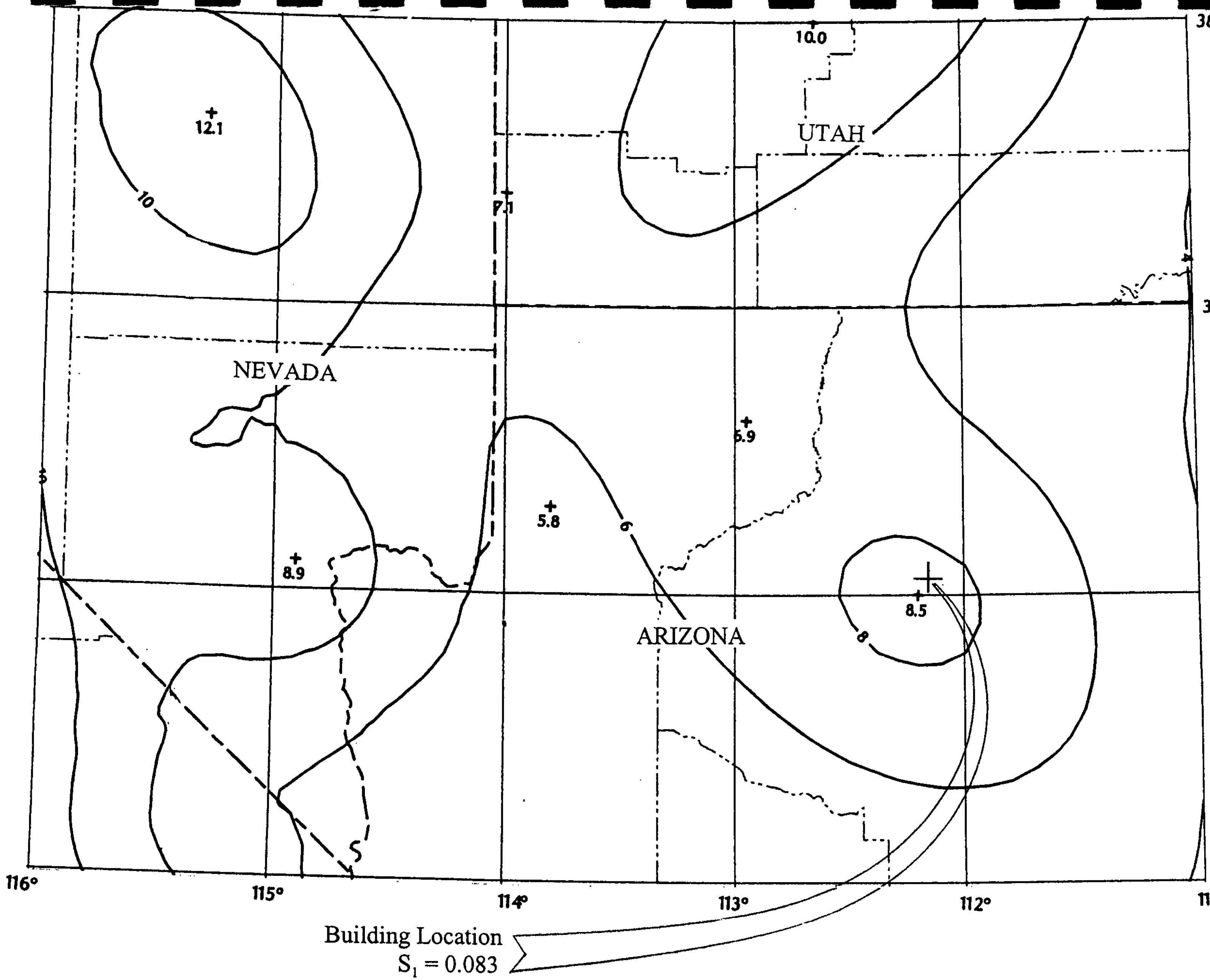


Fig 7: CONTOUR MAP FOR 1.0 SECOND SPECTRAL RESPONSE GROUND MOTION (Ss)

Wall Type	Regions of Moderate Seismicity	Regions of High Seismicity	
		A	B
Top story of multi-story building	14	14	9
First story of multi-story building	18	16	15
All other conditions	16	16	13

FEMA 310 Table 4-2

Fig. 8: ALLOWABLE HEIGHT-TO-THICKNESS RATIOS FOR URM WALLS

Existing Materials or Configuration of Materials [a]		Strength Values
Horizontal Diaphragms [d]	Roofs with straight sheathing and roofing applied directly to the sheathing	300 lb/ft for seismic shear
	Roofs with diagonal sheathing and roofing applied directly to the sheathing	750 lb/ft for seismic shear
	Floors with straight tongue-and-groove sheathing	300 lb/ft for seismic shear
	Floors with straight sheathing and finished wood flooring with board edges offset or perpendicular	1,500 lb/ft for seismic shear
	Floors with diagonal sheathing and finished wood flooring	1,800 lb/ft for seismic shear
	Metal deck with minimal welding [e]	1,800 lb/ft for seismic shear
	Metal deck welded for seismic resistance [f]	3,000 lb/ft for seismic shear
Crosswalls [b,d]	Plaster on wood or metal lath	600 lb/ft/side for seismic shear
	Plaster on gypsum lath	550 lb/ft for seismic shear
	Gypsum wall board, unblocked edges	200 lb/ft for seismic shear
	Gypsum wall board, blocked edges	400 lb/ft for seismic shear
Existing Footing, Wood Framing, Structural Steel, Reinforcing Steel	Plain concrete footings	f'_c = 1,500 psi unless otherwise shown by tests [c]
	Douglas fir wood	Allowable stress same as for DF No. 1 [c]
	Reinforcing steel	F_y = 40,000 lb/in.^{2} maximum [c]
	Structural steel	F_y = 33,000 lb/in.^{2} maximum [c]

[a] Material must be sound and in good condition.

[b] Shear values of these materials may be combined except the total combined value should not exceed 900 lb/ft.

[c] Allowable stresses given may be increased for seismic loads as specified in the 1988 *NEHRP Recommended Provisions*.

[d] No increase in stress is allowed.

[e] Minimum 22-gage steel deck with welds to supports satisfying the standards of the Steel Deck Institute.

[f] Minimum 22-gage steel deck with 3/4ϕ plug welds at an average spacing not exceeding 8 inches and with sidelap welds appropriate for the deck span.

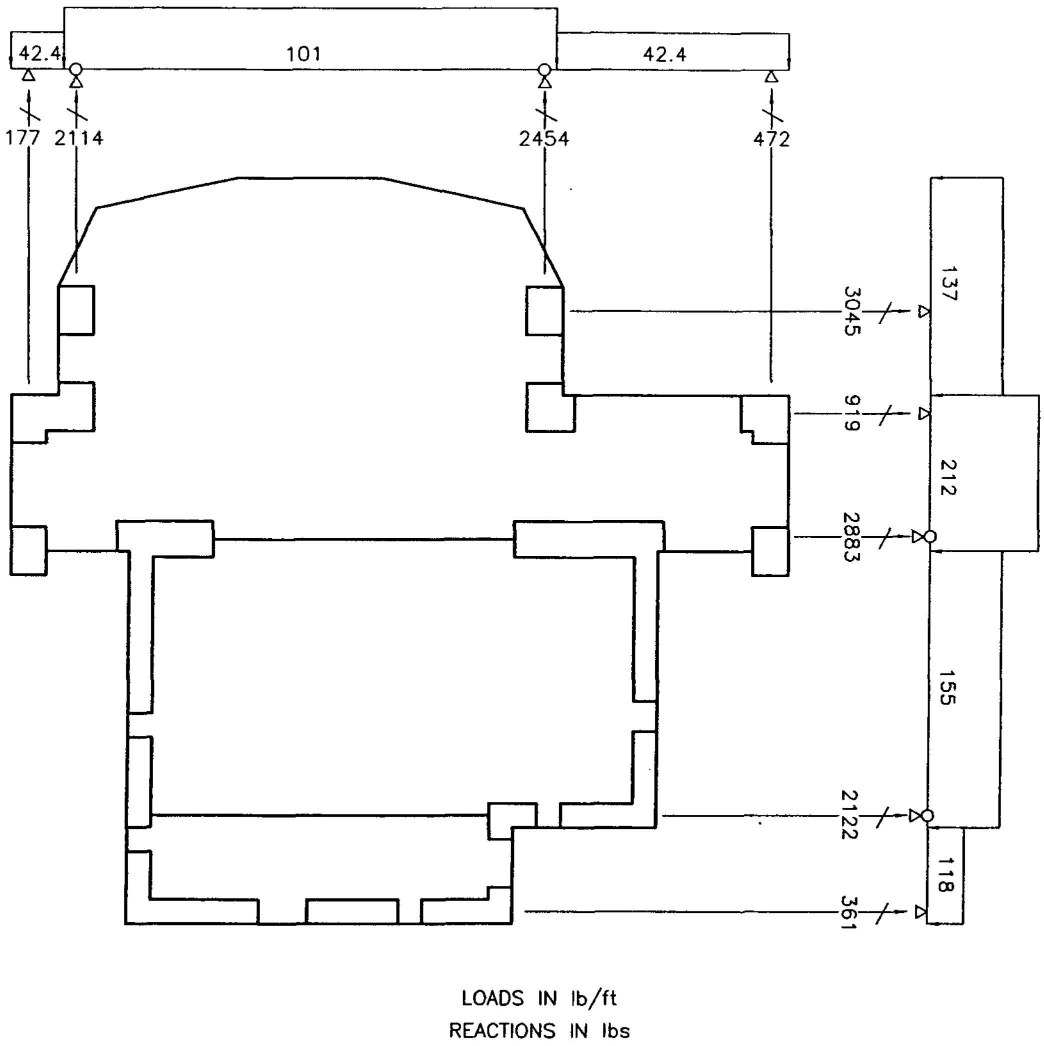
FEMA 178 Table C6.1.1a

Fig. 9: STRENGTH VALUES FOR EXISTING MATERIALS

New Materials or Configurations of Materials		Useable Values [c,d]
Horizontal Diaphragms	Plywood sheathing applied directly over existing straight sheathing with ends of plywood sheets bearing on joists or rafters and edges of plywood located on center of individual sheathing boards.	675 lb/ft
Cross Walls	Plywood sheathing applied directly over wood studs; no value should be given to plywood applied over existing plaster or wood sheathing.	The value specified in the 1988 *NEHRP Recommended Provisions*
	Drywall or plaster applied directly over wood studs	The value specified in the 1988 *NEHRP Recommended Provisions*
	Drywall or plaster applied to sheathing over existing wood studs.	50 percent of the value specified in the 1988 *NEHRP Recommended Provisions* [e]
Tension Bolts	Bolts extending entirely through unreinforced masonry wall secured with bearing plates on far side of a three-wythe minimum wall with at least 30 square inches of area. [b,c]	5,400 lb/bolt 2,700 lb for two-wythe walls
Shear Bolts	Bolts embedded a minimum of 8 inches into unreinforced masonry walls; bolts should be centered on 2-1/2 inch diameter holes with dry-pack or nonshrink grout around the circumference of the bolt.	The value for plain masonry specified for solid masonry in the 1988 *NEHRP Recommended Provisions*; no value larger than those given for 3/4 inch bolts should be used.
Combined Tension and Shear Bolts	Through Bolts--Bolts meeting the requirements for shear and for tension bolts. [a,b,c]	Tension--same as for tension bolts Shear--same as for shear bolts
	Embedded Bolts--Bolts extending to the exterior face of the wall with a 2-1/2 inch round plate under the head and drilled at an angle of 22-1/2 degrees to the horizontal; installed as specified for shear bolts. [a,b,c]	Tension--3,600 lb/bolt Shear--same as for shear bolts
Infilled Walls	Reinforced masonry infilled openings in existing unreinforced masonry walls; provide keys or dowels to match reinforcing.	Same as values specified for unreinforced masonry walls
Reinforced Masonry	Masonry piers and walls reinforced per the 1988 *NEHRP Recommended Provisions*.	The value specified in the 1988 *NEHRP Recommended Provisions*
Reinforced Concrete	Concrete footings, walls, and piers reinforced as specified in the 1988 *NEHRP Recommended Provisions* and designed for tributary loads.	The value specified in the 1988 *NEHRP Recommended Provisions*

FEMA 178 Table C6.1.1B

Fig. 10: STRENGTH VALUES FOR NEW MATERIALS
USED IN CONJUNCTION WITH EXISTING CONSTRUCTION



LATERAL LOADING DIAGRAM

SCALE" 1/16"=1'-0"

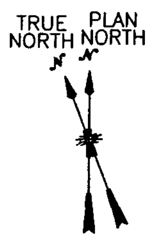
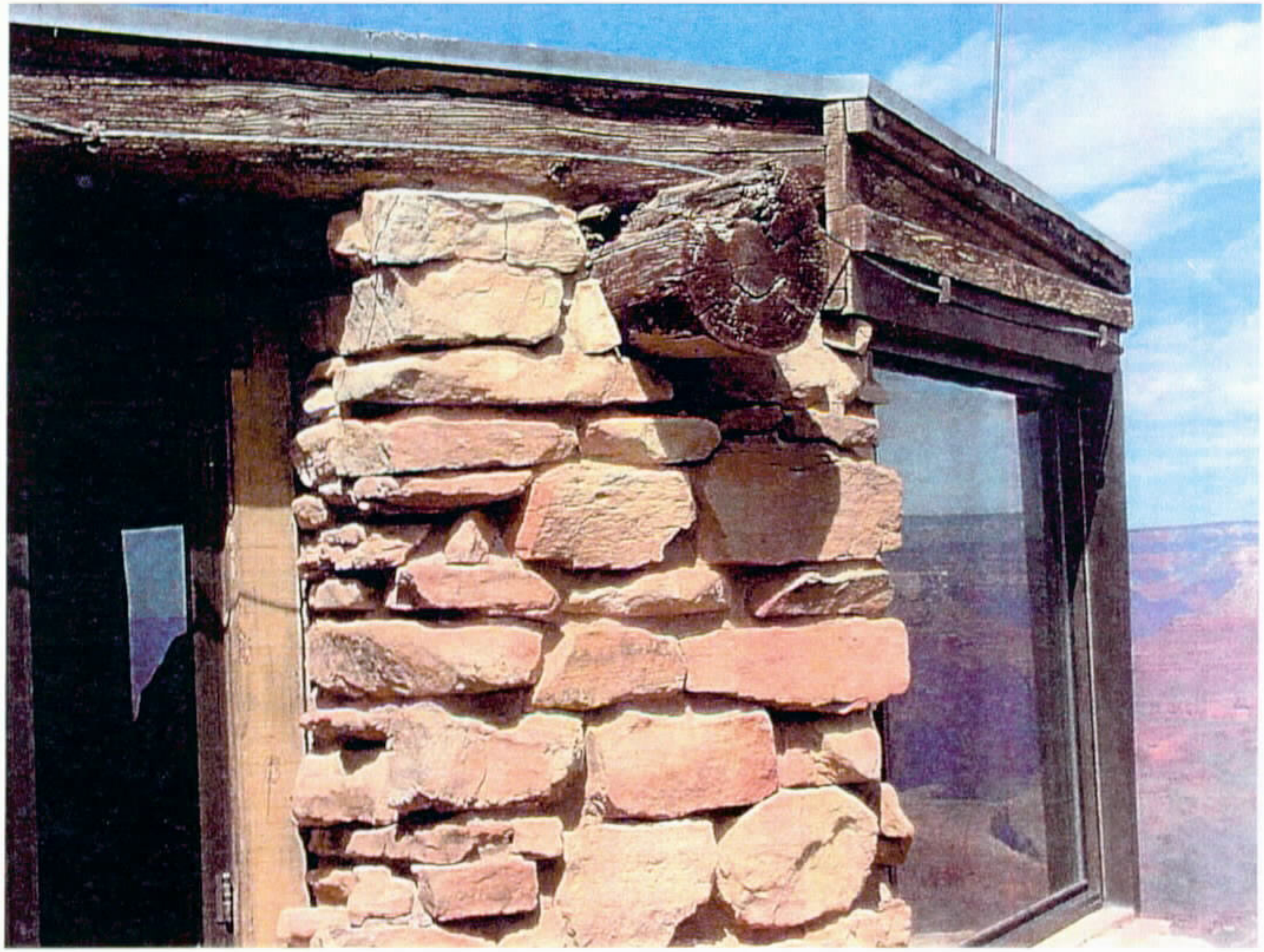


FIG. 11 YAVAPAI POINT MUSEUM

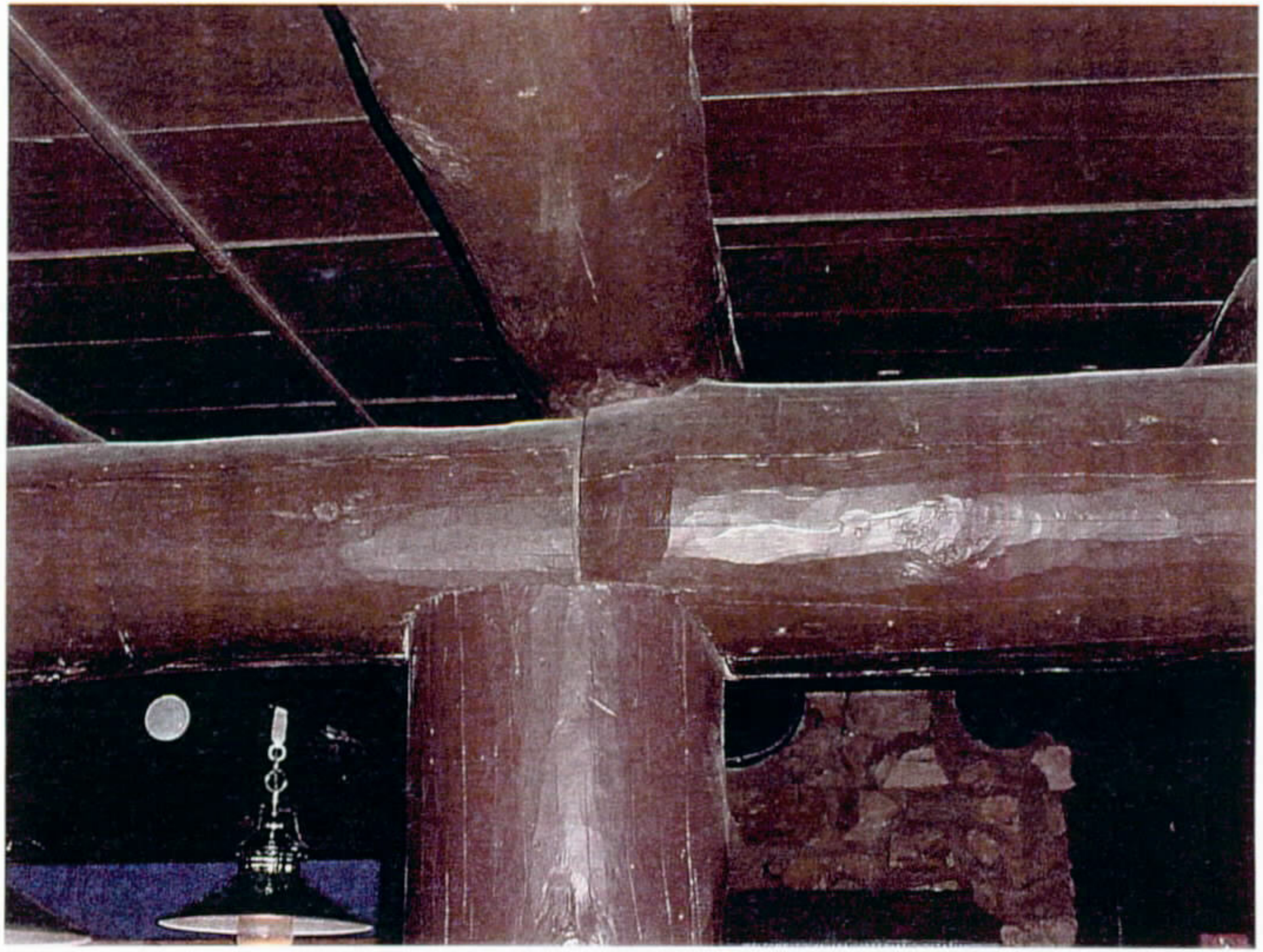


CRITICAL CONNECTION FROM EXTERIOR

FIG. 12 YAVAPAI POINT MUSEUM

CRITICAL CONNECTION FROM INTERIOR

FIG. 13 YAVAPAI POINT MUSEUM



BEAM / COLUMN CONNECTION

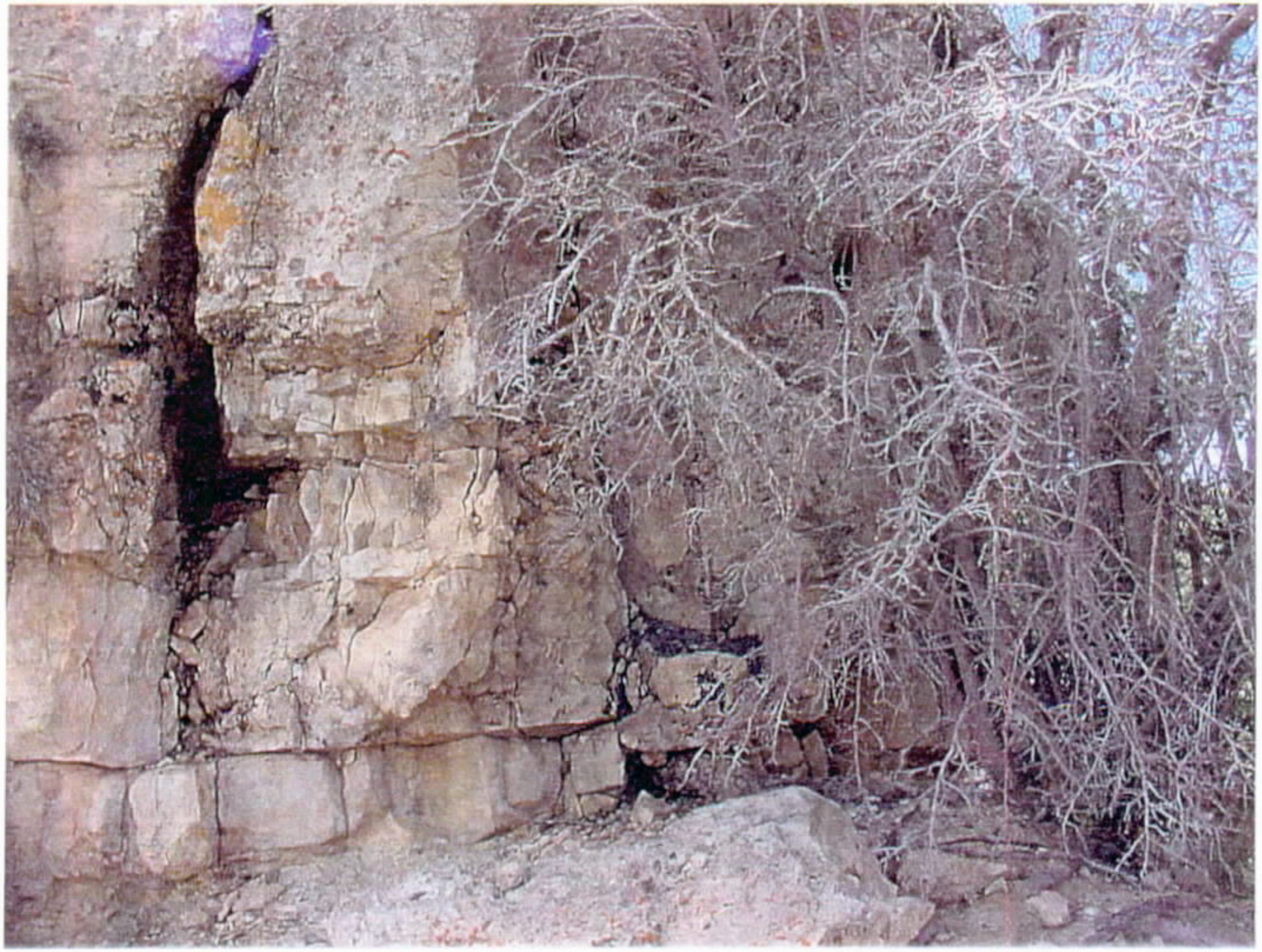
FIG. 14 YAVAPAI POINT MUSEUM

BASEMENT, SHOWING CRACK AND MASONRY REPAIRS TO CANYON WALL

FIG. 15 YAVAPAI POINT MUSEUM

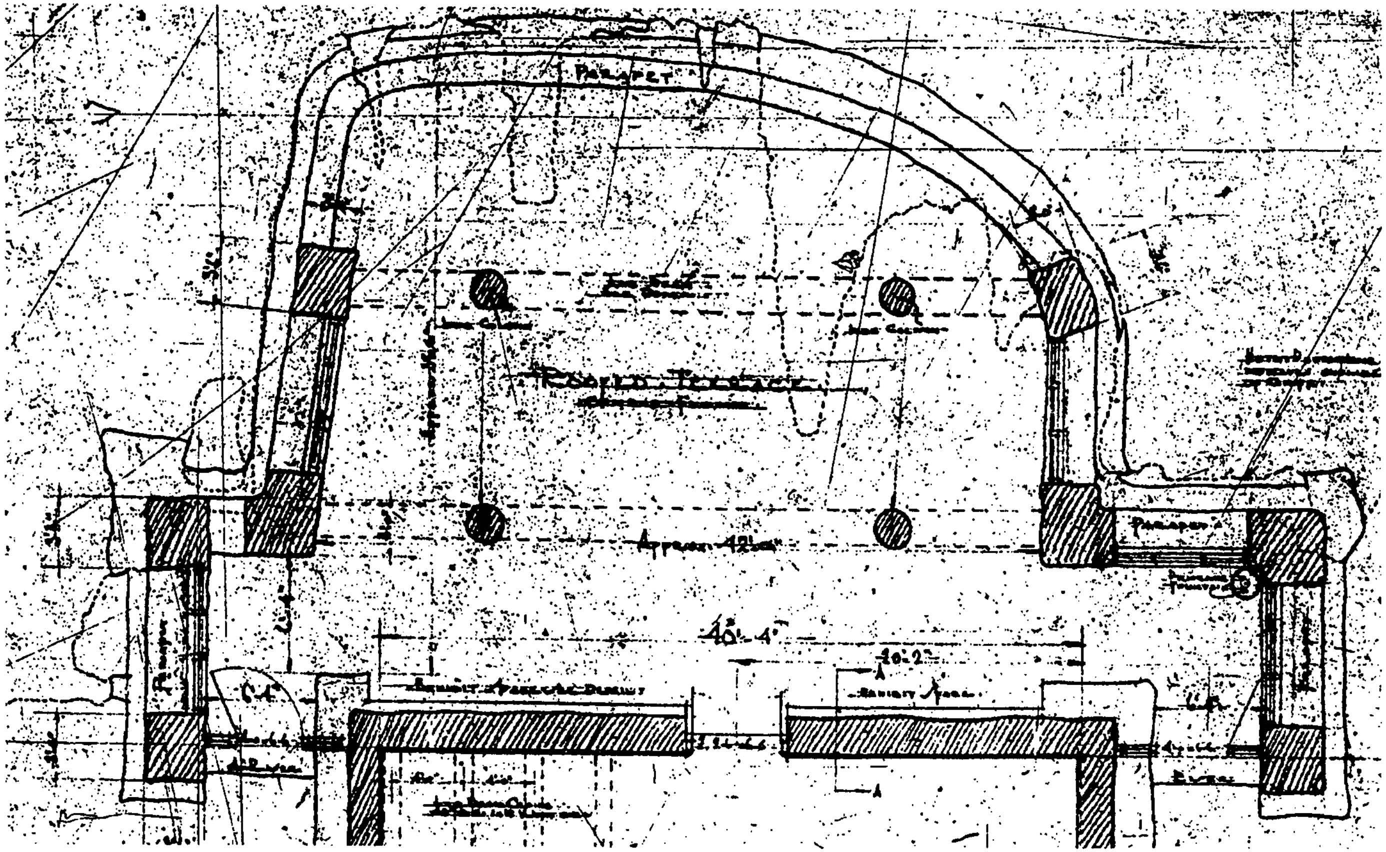
BASEMENT, SHOWING CONTINUING CRACK AND WOODEN WEDGES

FIG. 16 YAVAPAI POINT MUSEUM



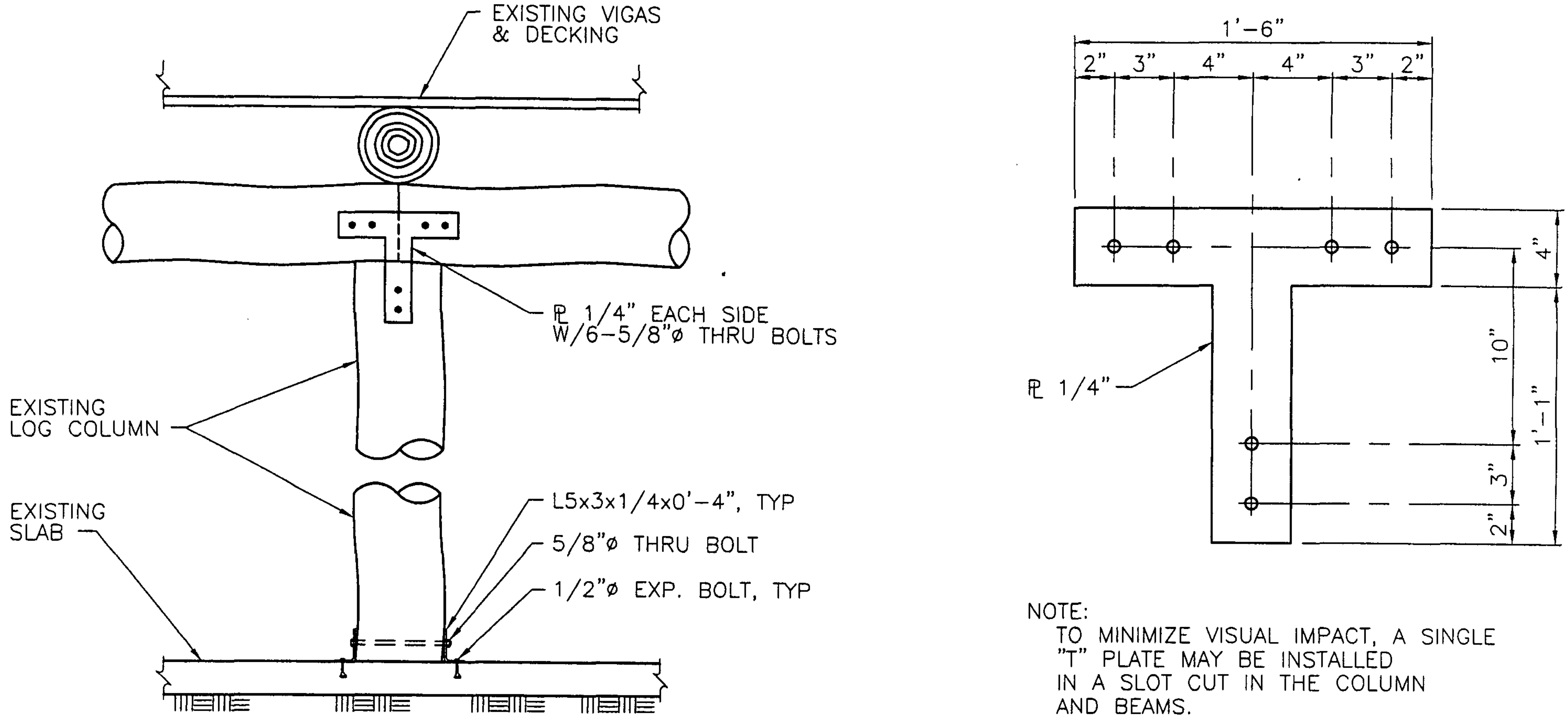
LARGE CRACK IN STRATA BELOW STRUCTURE

FIG. 17 YAVAPAI POINT MUSEUM



PORTION OF ORIGINAL FLOORPLAN SHOWING VOIDS BELOW STRUCTURE

FIG. 18 YAVAPAI POINT MUSEUM



COLUMN CONNECTION RETROFIT

SCALES: 1/2"=1'-0"
1 1/2"=1'-0"

FIG. 19 YAVAPAI POINT MUSEUM

Appendix B

Flag Notes / Calculations

1. Explanation of Analysis Procedure
2. Review of, Commentary on, and Modifications to FEMA 310, Section 4.2.6
3. Comments on Demand Capacity Ratios and "Actual" Diaphragm Loads
4. Calculation of Diaphragm and Shear Wall Strengths
5. Calculation of Seismic Coefficients
6. Comments on Site Geology
7. Calculation of Out-of-Plane Wall Loads and Capacities
8. Calculation of Roof Loads
9. Calculation of Diaphragm and Shear Wall Loads
10. Comments on Roof to Wall Connections
11. Comments on Wood Column Connections
12. Comments on Slope Failure and Surface Fault Rupture
13. Comments on Glazing

△1 Explanation of Analysis Procedure:

Anyone carefully following the calculations in this report will find the references to various Codes, Guidelines, Handbooks, and analysis procedures to be somewhat convoluted. It is hoped that this section will provide an explanation of the procedures used, and a road map to the various references.

The original Request for Proposal from the Park Service requested that a recommended rehabilitation solution be developed for the Yavapai Point Museum using the "latest building seismic rehabilitation documents (ASCE/FEMA 273 Pre-standard)." FEMA 273 is the Federal Emergency Management Agency report number 273, entitled National Earthquake Hazard Reduction Program Guidelines for the Seismic Rehabilitation of Buildings, and published October 1997. In that report, Chapter 7 addresses the "systematic rehabilitation" of masonry structures, but specifically states: "Stone . . . masonry is not covered in this chapter."

For this reason, it was specifically agreed in JFSA's Proposal that we would perform an evaluation based on the "simplified method" described in Chapter 10 of FEMA 273. This procedure is summarized in Section 2.8.1 of FEMA 273 as, "A complete evaluation of the building is performed in accordance with FEMA 178." FEMA 178 is entitled National Earthquake Hazard Reduction Program Handbook for the Seismic Evaluation of Existing Buildings, and was published June 1992. Appendix C of FEMA 178 addresses the evaluation of Unreinforced Masonry Buildings.

However, FEMA 273, Section 10.1 notes that "FEMA 178 is currently under revision (October, 1997) and the revised version will be available soon." FEMA 178, Section 1.3 itself states, ". . . this handbook reflects the present state of the art and . . . new knowledge gained as a result of research or damage investigations following future earthquakes may alter the recommendations presented." FEMA 273 further notes, ". . . new national earthquake hazard maps were developed in 1996 by the United States Geologic Survey. . . ." (Note that the publication date of FEMA 178 is 1992). The revision to FEMA 178 was published as FEMA 310, entitled Handbook for the Seismic Evaluation of Buildings -- A Prestandard, January 1998. FEMA 310 adopted the analysis method used in FEMA 273 (which is substantially different than that used in FEMA 178) for all structures *except Unreinforced Masonry buildings*, for which it includes Section 4.2.6 "Special Procedures," which are substantially the same as Appendix C of FEMA 178. Two important advantages of FEMA 310 (over FEMA 178), are that it includes the new USGS earthquake hazard maps based on the Open File Report 97-130 (1997), and that the Evaluation Checklists have been updated to incorporate lessons learned during recent earthquakes. The unfortunate thing about FEMA 310, is that it appears a few errors were introduced into the equations of Section 4.2.6 when the terminology was updated from Appendix C of FEMA 178.

The maps of USGS Open File Report 97-130 are a significant improvement upon the maps used by FEMA 178. The source of the FEMA 178 maps is not clear, but they appear to come from at least as far back as 1988, the publication date of the National Earthquake Hazard Reduction Program Recommended Provisions for the Development of Seismic Regulations for New Buildings, which is frequently referenced by FEMA 178. The new maps have three important advantages over the older maps: First, they are at a larger scale, and show contours at much more frequent intervals.

1 Continued:

Second, they show a local area of higher seismic risk centered very near the location of the Yavapai Point Museum. And third, the 1997 map set includes 3 separate maps, one for the Maximum Considered Earthquake, one for ground motion with a 2% chance of exceedance in 50 years, and one for ground motion with a 10% chance of exceedance in 50 years. JFSA's proposal stated that we would perform the evaluation for a Life Safety performance level for a BSE-1 earthquake, defined in FEMA 273 as the ground motion with a 10% chance of exceedance in 50 years. To do this, the evaluation must be based on the new maps, and the seismic coefficient calculated by the procedure outlined in FEMA 310. To assure this produces reasonable values, approximate seismic coefficients were calculated three ways and compared:

Analysis Procedure	Ground Motion	Approximate Seismic Coefficient	
FEMA 178	1988 (or earlier) maps:	0.11	
FEMA 310	**1997 10% chance in 50 years:**	**0.21**	< Value used in this analysis
FEMA 310	1997 2% chance in 50 years:	0.47	

The evaluation and analysis processes of FEMA 310 were followed when possible, as the evaluation checklists have been revised to incorporate lessons learned from recent earthquakes, and the analysis procedure contains the appropriate equations for use with the new maps.

However, as noted above, a few errors appear to have been incorporated when the nomenclature of the equations of FEMA 178 Appendix C were modified to become the special procedure Section 4.2.6 of FEMA 310. These equations are corrected as outlined in 2 for use in this report.

Finally, both FEMA 310, Section 4.2.6 and FEMA 178, Appendix C calculate a diaphragm "Demand Capacity Ratio" (DCR), and base certain acceptance criteria on further calculations using the DCR value. There are a few points of this analysis (discussed in detail in 3) that appear illogical. Rather than blindly accepting this criteria, we have analyzed the structure using a procedure following the load from source to ground as described in 3. This is used in conformance with Section 2.9.3 of FEMA 273: "Nothing in the Guidelines should be interpreted as preventing the use of any alternative analysis procedure that is rational and based on fundamental principles of engineering mechanics and dynamics." Section 1.3 of FEMA 178: "Nothing in this handbook should be construed as preventing an engineer from making a properly substantiated evaluation using other procedures." And Section 1.1 of FEMA 310: "This Handbook does not preclude a building from being evaluated by other well-established procedures based on rational methods of analysis in accordance with principles of mechanics. . . ."

We feel that the analysis contained herein presents a logical, and internally self-consistent, evaluation of this unreinforced stone masonry structure using the latest available probabilistic earthquake ground motion and generally accepted linear static analysis procedure.

Review of, Commentary on, and Modifications to FEMA 310, Section 4.2.6:

An extensive review of Section 4.2.6, "Special Procedure" for Unreinforced Masonry Structures with Flexible Diaphragms of the Federal Emergency Management Agency (FEMA) report 310, Handbook for the Seismic Evaluation of Buildings -- A Prestandard, published in January 1998 appears to indicate some inconsistencies. This report is a revision of the FEMA report 178, NEHRP Handbook for the Seismic Evaluation of Existing Buildings, published June 1992, and, in particular, the provisions for unreinforced masonry were taken directly from Appendix C of this previous report. The procedures in FEMA 178, in turn, were taken from the Uniform Code for Building Conservation, and originally (it is believed) from the Los Angeles City code.

It should be noted that while extensive commentaries were provided in other Sections of FEMA report 310, none was included in Section 4.2.6. Similarly, FEMA 178 provides no commentary or logical reasoning supporting the provisions of Appendix C. However, the NEHRP Recommended Provisions for Seismic Regulations for New Buildings, 1994, provides commentary and cites research in support of the body of FEMA 178, excluding Appendix C. Based on this, and further arguments to be presented below, we propose that where disparities exist preference be given to the other provisions of FEMA report 310 over Section 4.2.6.

Equation 4-21 (FEMA 310) and C-11 (FEMA 178):

The first equation to be reviewed is equation 4-21 from FEMA 310:

$$F_{wx} = S_{D1} \text{ x } (W_{wx} + 0.5 \text{ x } W_d) \qquad \text{4-21}$$

In this equation W_{wx} represents the weight of one wall, and 0.5 x W_d represents the weight of 1/2 of the diaphragm. For purposes of clarity we shall discuss only a one story structure such that "diaphragm" and "roof" may be used interchangeably, and subscripts referring to the story under consideration can only have one value. The upshot is this equation says the lateral shear in the walls is equal to the mass times S_{D1}. This appears immediately inappropriate for two reasons:

1) S_{D1} is not a seismic coefficient, it is merely the mapped 1.0 second Spectral Response Acceleration multiplied by a factor to account for site geology and by 2/3 for use in existing buildings (as opposed to new construction). The seismic coefficient, S_a, which corresponds to the accelerations felt by a *structure*, rather than the ground, is given in equation 3-4 as S_{D1}/T. This is supported by research by Seed, Ugas, and Lysmer in 1976 and quoted in the 1994 NEHRP Recommended Provisions for Seismic Regulations for New Buildings.

2) The second discrepancy is that, in general, unreinforced masonry structures are low, wide, stiff structures with a very high natural frequency, which is to say: a very short period. One would anticipate the forces generated in such structures to be governed by the short period spectral response acceleration. This is again supported by equation 3-4, which limits the seismic coefficient, S_a, to S_{ds} for short period structures.

2 Continued:

Based on the above, it appears appropriate to replace S_{D1} with S_a, such that equation 4-21 reads:

$$F_{wx} = S_a \times (W_{wx} + 0.5 \times W_d) \qquad \text{4-21 (revised)}$$

Equations 4-22 through 4-25 should be modified similarly.

Similar arguments can be made regarding C-11 through C-15 of FEMA 178. In these equations the Effective Peak Velocity-Related Acceleration Coefficient A_v should be replaced with the Seismic Coefficient C_s as calculated in equations 2-4 or 2-5, to give:

$$F_{wx} = C_s \times (W_{wx} + W_d / 2) \qquad \text{C-11 (revised)}$$

It is worth noting an inconsistency between FEMA 310 and FEMA 178 that lends further credibility to the concept of revising these equations. Comparing the unmodified equations in each we see:

$$F_{wx} = S_{D1} \times (W_{wx} + 0.5 \times W_d) \qquad \text{4-21 (FEMA 310)}$$
$$F_{wx} = A_v \times (W_{wx} + W_d / 2) \qquad \text{C-11 (FEMA 178)}$$

The only difference between these equations is the use of S_{D1} in place of A_v by FEMA 310. However, this is a significant difference, these two factors are not the same. S_{D1} is the mapped 1.0 second Spectral Response Acceleration modified to account for site geology, whereas A_v is the mapped Peak Velocity Related Acceleration Coefficient with no modification for site geology. Experiences in San Francisco's Marina District during the 1989 Loma Prieta earthquake made it abundantly clear that site specific geology cannot be neglected.

Equation 4-15 (FEMA 310) and C-5 (FEMA 178):

The next equation to be reviewed is equation 4-15 from FEMA 310:

$$DCR = 2.5 \times S_{D1} \times W_d / \Sigma v_d \times D \qquad \text{4-15}$$

In this equation W_d represents the mass of the diaphragm while $\Sigma v_d \times D$ represents the strength, or "capacity" of the diaphragm. To determine the "Demand to Capacity Ratio" the numerator of this equation must represent the "demand," or lateral force. This, of course, would be the mass (W_d) multiplied by a seismic coefficient.

As argued with equation 4-21 above, S_{D1} is not a seismic coefficient, and, for most unreinforced masonry structures, is not the governing Spectral Response Acceleration. As such, it should be replaced with S_a.

$\triangle$2 Continued:

In addition, the 2.5 factor is inappropriate, and should be 1.0, giving the equation:

$$DCR = S_a \times W_d / \Sigma v_d \times D \qquad \text{4-15 (revised)}$$

The explanation for eliminating the 2.5 coefficient is rather long, but since it incorrectly increases design loads by 250% it is important:

Referring to FEMA 178 equation C-5 we find exactly the same equation with A_v in the place of S_{D1}. If C_s were simply substituted for A_v while leaving the 2.5 factor in place the equation would appear to give 2.5 x Lateral Load / Diaphragm Capacity as the Demand Capacity Ratio, which does not make apparent sense. Recalling, however, that the fundamental period of most unreinforced masonry structures is quite short, and therefore generally governed by A_a, one might try substituting the Peak Acceleration Coefficient, A_a, for A_v in equation C-5 giving:

$$DCR = 2.5 \times A_a \times W_d / \Sigma v_d \times D \qquad \text{C-5 (revised)}$$

This equation makes sense. The reader may notice that we have used an Acceleration Coefficient rather than a Seismic Coefficient in this equation, in apparent contradiction to the arguments we presented above. However, a review of equation C-5 explains that 2.5 x A_a may be considered to be the seismic coefficient:

$$C_s = 0.85 \times (2.5 \times A_a / R) \qquad \text{2-5}$$

Since the element under consideration is the diaphragm, the R factor for the balance of the building may not apply ($R = 1.0$), and in any case, for unreinforced masonry construction, R is quite low ($R = 1.25$ in Table 2.4.3.1). Further, the 0.85 factor is a reduction for existing structures from the limiting value of equation 4-3 of the 1988 NEHRP Recommended Provisions. Removing both of these factors gives:

$$C_s \approx 2.5 \times A_a$$

Thus equation C-5 (revised) above is approximately correct, and substituting A_v for A_a would be an easy mistake to make in typesetting.

It appears that equation C-5 was simply copied from FEMA 178 to equation 4-15 of FEMA 310 and A_v modified to S_{D1} to agree with the new terminology. However, if the term in equation C-5 should have been A_a, and been replaced by S_a, the 2.5 factor should have been removed since it was incorporated into the 1997 maps of S_s. (This is easily verified by comparing the same region on the FEMA 178 and USGS 1997 maps. This reveals, in general (though much more detail and many more contours are included on the 1997 maps) that $S_s \approx 2.5 \times A_a$. (Note that this comparison should be made in areas of relatively uniform ground motion, as the improved resolution of the 1997 maps leads to significant local variations in areas of high ground motion gradients.) Using S_a in equation 4-15 of FEMA 310 rather than S_s has the additional advantages of including the site specific geology factor (F_a) and the 2/3 reduction for existing structures.

2 Continued:

Equation 4-19 (FEMA 310) and C-9 (FEMA 178)

The final equation to be reviewed is equation 4-19 from FEMA 310:

$$V_d = 1.5 \text{ x } S_{D1} \text{ x } C_p \text{ x } W_d \qquad 4\text{-}19$$

This equation is a calculation of the required capacity of the shear connectors between the diaphragm and the shear wall. It is obvious that this value should be related to the load in the diaphragm itself. In fact it is: The load in the diaphragm is given by the numerator of equation 4-15:

$$= 2.5 \text{ x } S_{D1} \text{ x } W_d \qquad \text{Numerator of 4-15}$$

And equation 4-19 is simply 60% (to account for any accidental eccentricity) of this total load applied to one shear wall, multiplied by a factor which, presumably, accounts for energy dissipation in different types of diaphragms.

Clearly, the same modifications made to equation 4-15 must be made to equation 4-19 to maintain consistency. This results in:

$$V_d = 0.6 \text{ x } S_a \text{ x } C_p \text{ x } W_d \qquad 4\text{-}19 \text{ (revised)}$$

A similar modification would be made to FEMA 178 equation C-9, giving:

$$V = 1.5 \text{ x } A_a \text{ x } C_p \text{ x } W_d \qquad 4\text{-}19$$

Material Strengths:

A final note should be made regarding the commentary at the beginning of Chapter 4 of FEMA 310. There it states: "The procedures for evaluating potential deficiencies have been completely revised from FEMA 178. . . . The lateral forces related to each of these approaches is radically different and cannot be directly compared."

As we have seen above, this is not the case with the provisions for unreinforced masonry. The formulas and procedure have been taken directly from Appendix C of FEMA 178 with modifications of terminology only. Review of selected points on the maps (in regions of relatively uniform ground motion) show:

$$A_v \text{ (FEMA 178)} \approx S_1 \text{ (USGS 1997)}$$

$$2.5 \text{ x } A_a \text{ (FEMA 178)} \approx S_s \text{ (USGS 1997)}$$

Thus similar, if not identical seismic coefficients are calculated.

2 Continued:

Bearing out this observation is footnote 1 of table 4-5 of FEMA 310. This table provides "m - factors", or material strength modification factors for use with the loads calculated under FEMA 310's new procedures. However, footnote 1, for unreinforced masonry structures, states: "Applicable to buildings with rigid diaphragms; for flexible diaphragms see Special Procedures."

Based on these considerations, the Strength Values for Existing Materials given in table C6.1.1 of FEMA 178 will be used for analysis based on Section 4.2.6 of FEMA 310.

Conclusions:

- Equation 4-21 of FEMA 310 should be revised to:

  $$F_{wx} = S_a \text{ x } (W_{wx} + 0.5 \text{ x } W_d) \qquad \text{4-21 (revised)}$$

  Equations 4-22 through 4-25 should be similarly revised as required.

- Equation 4-15 of FEMA 310 should be revised to:

  $$DCR = S_a \text{ x } W_d / \Sigma v_d \text{ x } D \qquad \text{4-15 (revised)}$$

  Equations 4-16 through 4-18 should be similarly revised as required.

- Equation 4-19 of FEMA 310 should be revised to:

  $$V_d = 0.6 \text{ x } S_a \text{ x } C_p \text{ x } W_d \qquad \text{4-19 (revised)}$$

- Material strengths from Tables C6.1.1a and C6.1.1b of FEMA 178 should be used with analysis based on Section 4.2.6 of FEMA 310

3 Comments on Demand Capacity Ratios and "Actual" Diaphragm Loads:

The Federal Emergency Management Agency (FEMA) report 310, Handbook for the Seismic Evaluation of Buildings -- A Prestandard, published in January 1998, as well as FEMA report 178, NEHRP Handbook for the Seismic Evaluation of Existing Buildings, published June 1992, the Uniform Code for Building Conservation, 1997, and other sources, spend a considerable amount of effort calculating a Demand to Capacity Ratio (DCR) for diaphragms of unreinforced masonry structures. This DCR is then compared with a graph similar to Figure A (below) to determine acceptability. Oddly, Figure A permits the DCR to far exceed 1.0.

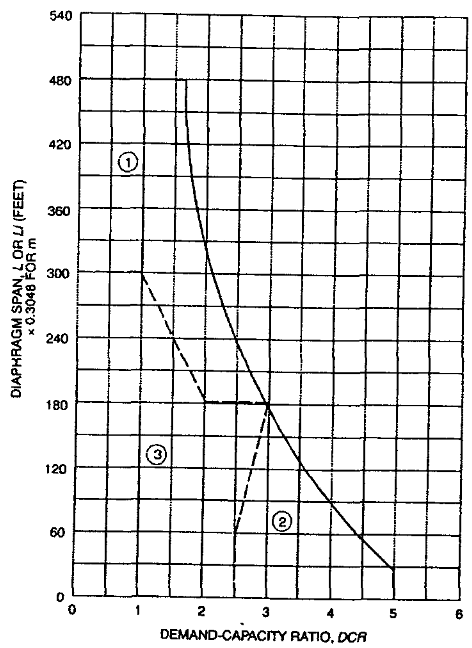


Figure A: FEMA 310, Figure 4-1.

Why a Demand Capacity Ratio in excess of 1.0 should be permissible is unclear. None of the references researched explained this point. Simplistic logic would suggest that if the demand exceeds the capacity (DCR > 1.0) failure would result. The fact identical DCR allowable curves appear in various sources suggests empirical evidence exists to support the curve. It may be that transverse bending strength and out-of-plane shear strength of masonry walls, which are neglected throughout the calculations, although they are obviously nonzero, allow transfer of loads through the walls perpendicular to the direction of earthquake motion. Qualitatively, these considerations would result in a curve of the shape given in Figure A: Very long walls would have no appreciable capacity due to bending or shear in the horizontal direction, but would have a strength due to out-of-plane shear and bending in the vertical direction. This strength would be fixed by the allowable slenderness ratio of the wall. Thus, as the wall becomes longer in the horizontal direction, the allowable DCR curve would asymptotically approach a value greater than 1.0. On the other hand, as the wall becomes shorter in the horizontal direction, transverse bending and shear can carry more and more load until, in the limit, when the distance between the endwalls is zero, the diaphragm is required to carry no load at all. Thus, the allowable DCR curve would approach infinity as the building width approached zero. The curve given in Figure A appears to follow this trend, with the unreasonable extremes of infinitely wide and infinitely narrow buildings truncated.

The problem with blindly accepting the DCR criteria presented in FEMA 310 occurs later on, in considering the shear wall strengths. Two equations are given for this value: First (equation 4-21), gives the force in the shear wall as equal to the sum of half the tributary weight of the diaphragm plus the self weight of the shear wall multiplied by a seismic coefficient. The maximum value is limited by equation 4-22, which gives a force equal to the self weight of the shear wall multiplied by a seismic coefficient plus the load which could be applied by the maximum capacity of the diaphragm.

3 Continued:

When the DCR significantly exceeds 1.0, the second equation will always control. This makes sense, after all, the load applied by the diaphragm cannot be greater than the capacity of the diaphragm. However, consider a structure with a DCR in excess of 1.0, but still within the acceptable region of Figure A, whose shear walls have a capacity slightly greater than the load calculated by equation 4-22 (that is: The load generated by the walls plus the maximum load that can be applied by the diaphragm). By the criteria of FEMA 310, this would be an acceptable structure, and could be expected to perform adequately during an earthquake. Now consider: If one were to nail a sheet of plywood to the roof, increasing the strength of the diaphragm, the limiting value of equation 4-22 would increase, the structure could no longer be considered adequate, and failure of the shear walls would be anticipated. Yet no new load has been introduced to the structure! Clearly, if out-of-plane wall strength made the original structure adequate (as hypothesized above), the improvement of the diaphragm would not destroy this capacity and make the structure weaker.

Obviously, a more in-depth investigation of the actual structural capacities is required.

For the purpose of this evaluation, horizontal bending of the walls perpendicular to the ground motion will be neglected, but vertical bending of those walls will not be. FEMA 310 gives some empirical values which make an estimate of this strength possible. Table 4-2, reprinted here as Figure 8, gives empirical values for the allowable slenderness of unreinforced masonry walls. Using these values, a bending capacity can be calculated assuming the wall to have a fixed base and a pinned connection at the diaphragm. (Note that the same numeric value for moment is obtained assuming a pinned base and pinned diaphragm connection, but tension stresses are reduced in bending at the base by the self weight of the wall. Thus this is the "more conservative" assumption, as it results in lower allowable tensile stresses.) With consideration given to the self weight of the wall, the tension stress generated by this bending can be calculated. For any wall with a slenderness ratio less than the limiting value, an allowable base moment can be calculated which results in the same tensile stresses. This moment may be relied upon to reduce the demand on the diaphragm. Following these calculations, the reaction required at the diaphragm is an actual demand, and may not exceed the capacity of the diaphragm without failure. Similarly, connections and shear walls must be capable of reacting this load.

It is worth noting that Section 4.2.5 of FEMA 310 uses exactly this procedure to calculate out-of-plane forces in walls, at diaphragm connections, and in diaphragms themselves. Further, Section 4.2.5 uses χS_{DS} as the seismic coefficient for these calculations. The value of χ is given as 0.4 for life safety, and then multiplied by 2 for flexible diaphragms, giving a seismic coefficient of 0.8 x S_{DS}. This is in excellent agreement with the seismic coefficient S_a = 1.0 x S_{DS} which has been used heretofore in this evaluation based on the discussion in 2 The difference between the 1.0 factor and the 0.8 factor can be explained as an effort to compensate for the use of modification factors for inelastic displacements which exceed 1.0 (FEMA 310, Table 3-4) used for materials other than unreinforced masonry to which Section 4.2.5 may apply (Section 4.2.5 is generally applicable to the analysis procedure of FEMA 310, and not specific to the "Special Procedure" of Section 4.2.6.) Even in the worst case, the use of 1.0 x S_a would simply include a slight conservativism.

4 Calculation of Diaphragm and Shear Wall Strengths:

As noted in 2, the *Strength Values for Existing Materials*, FEMA 178, Table C6.1.1a and *Strength Values for New Materials Used in Conjunction with Existing Construction*, FEMA 178, Table C6.1.1b, herein reproduced as Figures 9 and 10, will be used for this analysis.

Applying these values to the observed and assumed construction of the Yavapai Point Museum gives the following diaphragm strengths:

Office Roof: 3/8" Plywood over 1" Straight Sheathing
675 lb/ft + 300 lb/ft = 975 lb/ft

Exhibition Hall Roof: 3/8 ply over 1" Str. Sheathing above 1" Str. Sheathing
675 lb/ft + 300 lb/ft + 300 lb/ft = 1275 lb/ft

Terrace Roof: 3/8" Plywood over 1" Straight Sheathing
675 lb/ft + 300 lb/ft = 975 lb/ft

The strength of the stone masonry walls is more difficult to estimate. Section 5.4.1 of FEMA 178 suggests a maximum "quick check" shear stress of 10 psi in solid brick masonry. It does not specifically address stone masonry. FEMA 310 does not provide any guidelines or acceptable stress level, and simply states in Section 2.2, "Unreinforced masonry bearing wall buildings . . . shall have destructive tests conducted to determine the average bed-joint shear strength . . . ." A discussion with Mike Schuller of Atkinson-Noland and Associates in Boulder Colorado, a company specializing in in-situ testing of masonry structures, indicated that the strength of high quality masonry may greatly exceed 10 psi. In particular, random Ashlar lay-ups, which provide interlock between stones, may easily have shear strengths of 40 psi, and can exceed 100 psi.

For initial evaluation, without conducting testing, a shear strength of 10 psi has been assumed, representing a reliable minimum strength.

5 Calculation of Seismic Coefficients, YAVAPAI POINT MUSEUM:
The seismic coefficient Sa is calculated from equation 3-4 of FEMA 310.

$hn := 9.5$	Average height from ground to center of mass at roof level (ft).		
$Ct := 0.020$	Coefficient for "all other framing systems," (including masonry bearing walls).		
$T := Ct \cdot hn^{\frac{3}{4}}$	$T = 0.108$	Fundamental period (s), FEMA 310 Eqn. 3-7.	
$Ss := 0.308$	0.2 Second Spectral Response Acceleration, Figure 6.		
$S1 := 0.083$	1 Second Spectral Response Acceleration, Figure 7.		
$Fv := 1.0$	Long period site coefficient for Site Class B. See 6		
$Fa := 1.0$	Short period site coefficient for Site Class B. See 6		
$SD1 := \frac{2}{3} \cdot Fv \cdot S1$	$SD1 = 0.055$	FEMA 310 Eqn. 3-5.	
$SDs := \frac{2}{3} \cdot Fa \cdot Ss$	$SDs = 0.205$	FEMA 310 Eqn. 3-6.	
$Sa_0 := \frac{SD1}{T}$	$Sa_0 = 0.511$		
$Sa_1 := SDs$	$Sa_1 = 0.205$		
$Sa := \min(Sa)$	$Sa = 0.205$	FEMA 310 Eqn. 3-4	

SDs greater than 0.167 but less than 0.50 constitutes a region of **MODERATE SEISMICITY** in accordance with Table 2-1 of FEMA 310.

6 No geotechnical borings were performed. The building is situated at the south rim of the Grand Canyon. The area is composed of Permian sedimentary rocks, primarily Kaibab Limestone. Testing was not performed to measure wave propagation speeds, however, it has been assumed that this strata can be classified as soil Class B: Rock with 2,500 ft/sec $\leq \grave{v}_s \leq$ 5,000 ft/sec.

Tables 3-5 and 3-6 of FEMA 310 show F_v and F_s (respectively) to be 1.0 for all values of S_s for Site Classification B.

7 Calculate Out-of-Plane Wall Loads, Capacities, and Reaction at Diaphragm, YAVAPAI POINT MUSEUM:

The out-of-plane strength of the unreinforced masonry walls is calculated based on empirical allowable slenderness ratios as explained in 3. "Excess" capacity in walls with a slenderness ratio less than the empirically allowable value is used to support lateral wall loads as a cantilever from the ground. Where walls have some excess capacity, but not enough to act completely as a cantilever, the minimum diaphragm reaction required to prevent wall collapse (as a "propped cantilever") may be calculated.

The Yavapia Point Museum is located in a region of "Moderate" seismicity. FEMA 310, Table 4-2, reproduced here as Figure 8, gives an allowable wall slenderness ratio of 16.

$r := 16$	Allowable slenderness ratio.
$Sa := 0.205$	Seismic coefficient. See 5.
$\gamma := 150$	Density of limestone ashlar masonry (pcf).

2' thick walls at Office and Exhibition Hall:

Find allowable bending & tension stress:

$tw := 2$		Actual wall thickness (ft).
$hwa := r \cdot tw$	$hwa = 32$	Allowable max wall height based on allowable slenderness ratio (ft).
$Pwa := tw \cdot hwa \cdot \gamma$	$Pwa = 9600$	Weight of max allowable wall (lbs/ft)
$w := tw \cdot \gamma \cdot Sa$	$w = 61.5$	Lateral distributed load (lbs/ft^2)
$ma := \dfrac{w \cdot hwa^2}{8}$	$ma = 7872$	Allowable moment at base of wall (ft-lbs/ft)
$\sigma a := \dfrac{\left(\dfrac{6 \cdot ma}{tw^2} - \dfrac{Pwa}{tw}\right)}{144}$	$\sigma a = 48.667$	Allowable tensile stress at base of wall (psi).

Find moment capacity of actual wall:

$hw := 10$		Actual wall height to roof diaphragm (ft).
$Pw := tw \cdot hw \cdot \gamma$	$Pw = 3000$	Actual wall weight (lbs/ft).
$m := \left(\dfrac{Pw}{tw} + \sigma a \cdot 144\right) \cdot \dfrac{tw^2}{6}$	$m = 5672$	Allowable moment at base of actual wall (ft-lbs/ft).

Find base moment and shear of actual wall as cantilever:

$mc := \dfrac{w \cdot hw^2}{2}$	$mc = 3075$	Actual moment as cantilever (ft-lbs/ft).
$vc := \dfrac{w \cdot hw}{tw \cdot 144}$	$vc = 2.135$	Actual shear stress as cantilever (psi).

The actual moment (3,075 ft-lbs/ft) is less than the allowable moment (5,672 ft-lbs/ft) and the actual shear stress (2 psi) is less than the allowable shear stress (10 psi), thus the *Exhibition Hall* and *Office* walls can act as cantilever beams and require no support at the diaphragm.

$\triangle$7 Continued:

3' thick walls and columns at Terrace:

Find allowable bending & tension stress:

$tw := 3$		Actual wall thickness (ft).
$hwa := r \cdot tw$	$hwa = 48$	Allowable max wall height based on allowable slenderness ratio (ft).
$Pwa := tw \cdot hwa \cdot \gamma$	$Pwa = 21600$	Weight of max allowable wall (lbs/ft)
$w := tw \cdot \gamma \cdot Sa$	$w = 92.3$	Lateral distributed load (lbs/ft^2)
$ma := \dfrac{w \cdot hwa^2}{8}$	$ma = 26568$	Allowable moment at base of wall (ft-lbs/ft)
$\sigma a := \dfrac{\left(\dfrac{6 \cdot ma}{tw^2} - \dfrac{Pwa}{tw}\right)}{144}$	$\sigma a = 73$	Allowable tensile stress at base of wall (psi).

Find moment capacity of actual wall:

$hw := 7$		Actual wall height to bottom of beams / top of masonry (ft).
$Pw := tw \cdot hw \cdot \gamma$	$Pw = 3150$	Actual wall weight (lbs/ft).
$m := \left(\dfrac{Pw}{tw} + \sigma a \cdot 144\right) \cdot \dfrac{tw^2}{6}$	$m = 17343$	Allowable moment at base of actual wall (ft-lbs/ft).

Find base moment and shear of actual wall as cantilever:

$mc := \dfrac{w \cdot hw^2}{2}$	$mc = 2260$	Actual moment as cantilever (ft-lbs/ft).
$vc := \dfrac{w \cdot hw}{tw \cdot 144}$	$vc = 1.5$	Actual shear stress as cantilever (psi).

The actual moment (2,260 ft-lbs/ft) is less than the allowable moment (17,343 ft-lbs/ft) and the actual shear stress (2 psi) is less than the allowable shear stress (10 psi), thus the Terrace walls and columns can act as cantilever beams and require no support at the diaphragm.

8 Calculation of Roof Loads, YAVAPAI POINT MUSEUM:

Calculate Masses:

Snow Loads:

$Pg := 48$	Ground snow load (psf) for South Rim per Park Engineer.
$I := 1.0$	UBC Tab. A-16-B for standard occupancy.
$Ce := 0.6$	UBC Tab. A-16-A for standard open terrain.
$Pf := Ce \cdot I \cdot Pg$	UBC 40-1-1.
$Pf = 28.8$	Roof Snow Load (psf).

FEMA 310, Section 4.2.4.2 specifies an **effective snow load of 0.0 psf** when the design snow load is 30 psf or less. This reflects the low probability of having a significant snow load during a seismic event.

Office Roof Loads:

Tar & Gravel Roof	6.0 psf
3/8" Plywood	1.1 psf
1" Str. Sheathing	2.3 psf
2" x 6" @ 24"	1.1 psf
Plaster & Lath Ceiling	8.0 psf
Miscellaneous	2.0 psf
TOTAL	20.5 psf

Office Roof Area:

$Aor := 9 \cdot 28$	$Aor = 252$	Roof area (sq. ft.)
$Wor := Aor \cdot 20.5$	$Wor = 5166$	**Total Office Roof Load (lbs):**

Exhibition Hall Roof Loads:

Tar & Gravel Roof	6.0 psf
3/8" Plywood	1.1 psf
1" Str. Sheathing	2.3 psf
2" x 4" @ 24"	0.7 psf
1" Str. Sheathing	2.3 psf
Vigas at 3'-6"	5.5 psf
Miscellaneous	1.0 psf
TOTAL	18.9 psf

Exhibition Hall Roof Area:

$Aer := 1 \cdot 28 + 21 \cdot 40$	$Aer = 868$	Roof area (sq. ft.)
$Wer := Aer \cdot 18.9$	$Wer = 16405$	**Total Exhibition Hall Roof Load (lbs):**

8 Continued:

Terrace Roof Loads:

Tar & Gravel Roof	6.0 psf
3/8" Plywood	1.1 psf
1" Str. Sheathing	2.3 psf
Vigas at 3'-6"	5.5 psf
Miscellaneous	1.0 psf
TOTAL	15.9 psf

Terrace Roof Area:

$Atr := 13 \cdot 65 + 18 \cdot 42 - 60$ $\quad Atr = 1541$ Roof area (sq. ft.)

$Wtr := Atr \cdot 18.9$ $\quad Wtr = 29125$ **Total Terrace Roof Load (lbs):**

9 Calculate Diaphragm and Shear Wall Loads, YAVAPAI POINT MUSEUM:

Since the walls and masonry columns have been shown in 7 to be capable of reacting their lateral out-of-plane loads to the ground as cantilevers, the only loads in the diaphragm are those that originate there.

$Sa := 0.205$ Seismic coefficient, see 5.

North - South ground motion:

Due to the long diaphragm span, and the absence of continuous shear walls, it is evident that the Terrace area will be critical for this loading.

$wtr := 15.9$ Terrace roof unit weight (psf).

The roof diaphragms are modeled as lateral beams. The applied loading is equal to the roof unit weight times the seismic coefficient times the width of the roof. Figure 11 shows the assumed loading and support conditions.

$w1 := wtr \cdot Sa \cdot 13$ $w1 = 42.4$ Diaphragm lateral load (lbs/ft).

$w2 := wtr \cdot Sa \cdot 31$ $w2 = 101$ Diaphragm lateral load (lbs/ft).

Beameval was used to calculate the shears and reactions developed by this loading, (see 9a).

The maximum reaction, 2,454 lbs shared by two masonry columns, is not the critical condition for wall loading. That occurs during East-West ground motion (see below).

Maximum shear, 1970 lbs, occurs at the edge of the viewing area roof. Here the diaphragm depth is approximately 20 feet.

$V := 1970$ Max. diaphragm shear load, see 9a , (lbs).

$v := \frac{V}{20}$ $v = 98.5$ Max diaphragm shear stress (lbs/ft).

The maximum diaphragm shear stress, 99 lbs/ft, is well below the allowable diaphragm shear stress, 975 lbs/ft, (see 4). Thus the diaphragm is adequate.

East - West ground motion:

$wer := 18.9$ Exhibition Hall roof unit weight (psf).

$wor := 20.5$ Office roof unit weight (psf).

The roof diaphragms are modeled as lateral beams. The applied loading is equal to the roof unit weight times the seismic coefficient times the width of the roof. Figure 11 shows the assumed loading and support conditions.

$w1 := wtr \cdot Sa \cdot 42$ $w1 = 137$ Diaphragm lateral load (lbs/ft).

$w2 := wtr \cdot Sa \cdot 65$ $w2 = 212$ Diaphragm lateral load (lbs/ft).

$w3 := wer \cdot Sa \cdot 40$ $w3 = 155$ Diaphragm lateral load (lbs/ft).

$w4 := wor \cdot Sa \cdot 28$ $w4 = 118$ Diaphragm lateral load (lbs/ft).

9 Continued:

Beameval was used to calculate the shears and reactions developed by this loading, (see 9b).

Maximum shear in the Terrace roof, 1,506 lbs, occurs just north of the north most supports where the diaphragm is 42 feet deep..

$V := 1506$ — Max. diaphragm shear load, see 9b, (lbs).

$v := \frac{V}{42}$ $\quad v = 35.857$ — Max diaphragm shear stress (lbs/ft).

Maximum shear in the Exhibition Hall roof, 1,837 lbs, occurs just south of the north wall where the diaphragm is 40 feet deep..

$V := 1837$ — Max. diaphragm shear load, see 9b, (lbs).

$v := \frac{V}{40}$ $\quad v = 45.925$ — Max diaphragm shear stress (lbs/ft).

The maximum diaphragm shear stresses are well below the allowable diaphragm shear stresses (see 4). Thus the diaphragms are adequate.

The maximum reaction occurs at the north most supports where 3,045 labs is reacted by two masonry columns. As all other reactions are lower, and all other shear walls are longer, these are obviously the critical "shear walls" in this structure.

These columns are roughly 4' wide and 3' deep. With this loading they are being loaded in their weak direction. This loading adds to the "out-of-plane" loading calculated in 7.

$P := \frac{3045}{2}$ $\quad P = 1522.5$ — Load on one column from diaphragm (lbs).

$hw := 7$ — Height of column from base to bearing of log beam (ft).

$w := 4$ — Width of column perpendicular to loading (ft).

$m := 17343$ — Allowable moment at base of column (ft-lbs/ft), see 7.

$mc := 2260$ — Moment at base due to self weight inertial loads (ft-lbs/ft), see 7.

$M := (m - mc) \cdot w$ $\quad M = 60332$ — Total remaining moment capacity of column (ft-lbs).

$Md := P \cdot hw$ $\quad Md = 10658$ — Total base moment resulting from diaphragm load (ft-lbs).

$vc := 1.5$ — Shear in column due to self weight inertial loads (psi), see 7.

$v := 1.5 + \frac{P}{36 \cdot 48}$ $\quad v = 2.381$ — Total shear stress in column (psi).

The maximum column bending moment, 10,658 ft-lbs, is well below the allowable value of 60,332 ft-lbs. In addition, the column shear stress, 2.4 psi, is below the allowable shear stress, 10 psi. Therefore, the column is adequate as a shear wall. As this column was identified as the critical shear wall in this structure, all other shear walls may be assumed to be adequate.

9a

April 11, 2001
10:31 am

North - South loading

LENGTH = 65

MODULUS OF ELASTICITY = 10000000

MOMENT OF INERTIA = 1.0000

SUPPORTS:

SUPPORT			FLEXIBILITY COEFFICIENT		FORCED	
Name	Type	Location	Vertical	Rotational	Deflection	Slope
Rs01	Simple	1.5000		______		______
Rs02	Simple	5.5000		______		______
Rs03	Simple	44.5000		______		______
Rs04	Simple	63.5000		______		______

HINGES:

Name	Location	Rotation Stiffness
Hg01	5.5000	
Hg02	44.5000	

UNIFORM LOADS:

Name	Start Location	End Location	Load
Uf01	0.0000	4.0000	42.4000
Uf02	4.0000	46.0000	101.0000
Uf03	46.0000	65.0000	42.4000

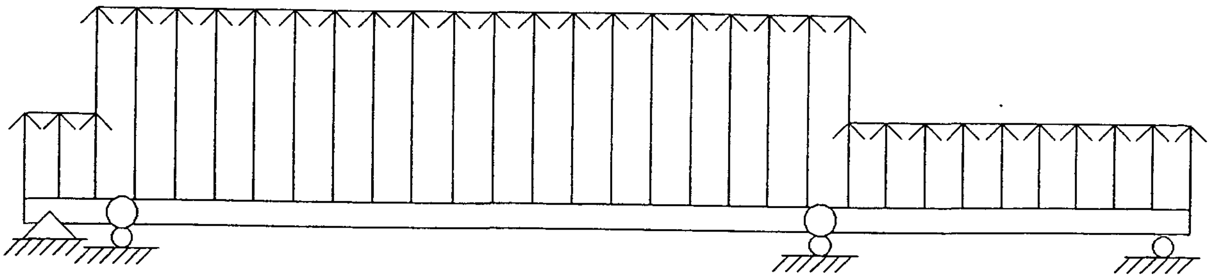
REACTIONS:

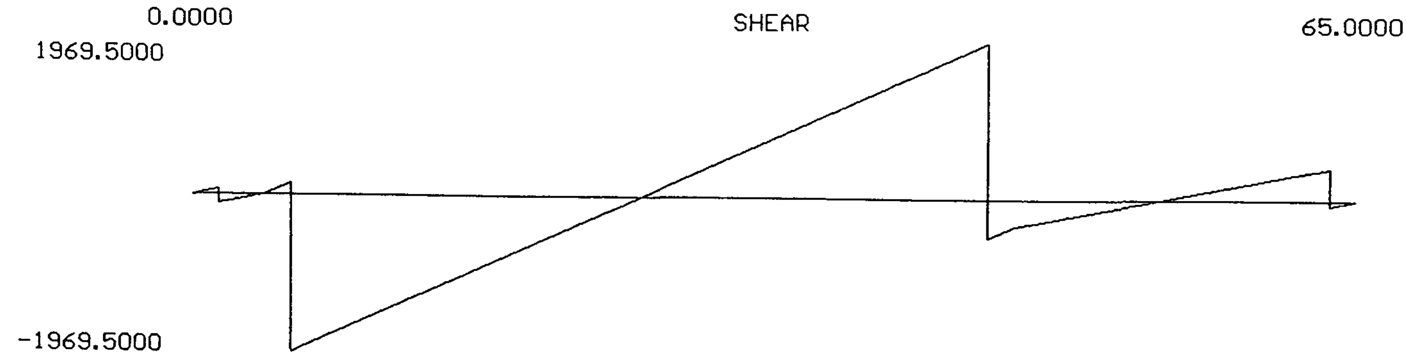
Name	Location	Vertical	Moment
Rs01	1.5000	-176.8062	______
Rs02	5.5000	-2113.7938	______
Rs03	44.5000	-2454.2197	______
Rs04	63.5000	-472.3803	______

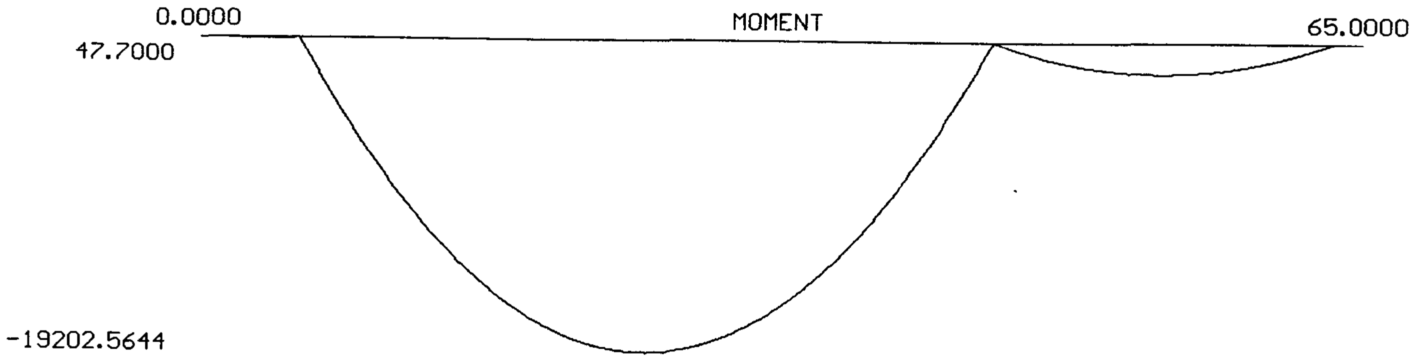
9a Continued:

North - South loading (cont)

April 11, 2001
10:31 am







9b

April 11, 2001
10:32 am

East - West loading

LENGTH = 61

MODULUS OF ELASTICITY = 10000000

MOMENT OF INERTIA = 1.0000

SUPPORTS:

SUPPORT			FLEXIBILITY COEFFICIENT		FORCED	
Name	Type	Location	Vertical	Rotational	Deflection	Slope
Rs01	Simple	11.0000		___		___
Rs02	Simple	20.0000		___		___
Rs03	Simple	30.0000		___		___
Rs04	Simple	53.0000		___		___
Rs05	Simple	61.0000		___		___

HINGES:

Name	Location	Rotation Stiffness
Hg01	30.0000	
Hg02	53.0000	

UNIFORM LOADS:

Name	Start Location	End Location	Load
Uf01	0.0000	18.0000	137.0000
Uf02	18.0000	31.0000	212.0000
Uf03	31.0000	52.0000	155.0000
Uf04	52.0000	60.0000	118.0000

9b Continued:

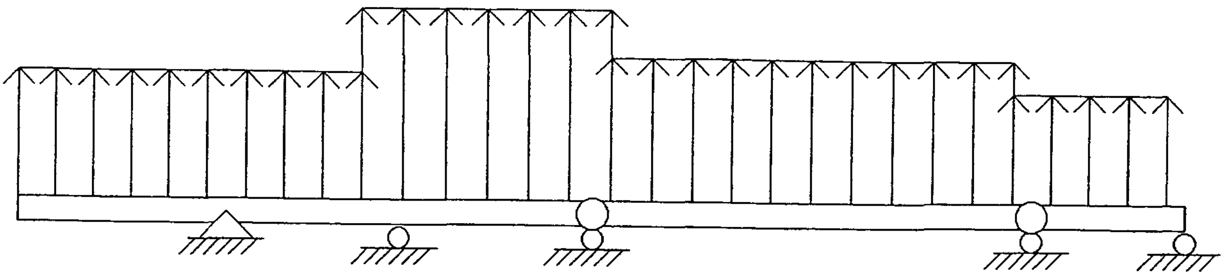
April 11, 2001
10:32 am

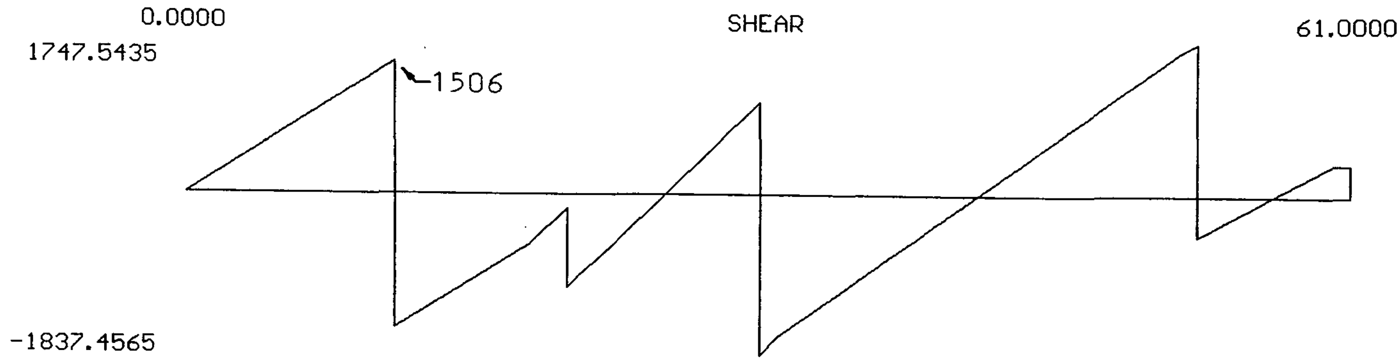
East - West loading (cont)

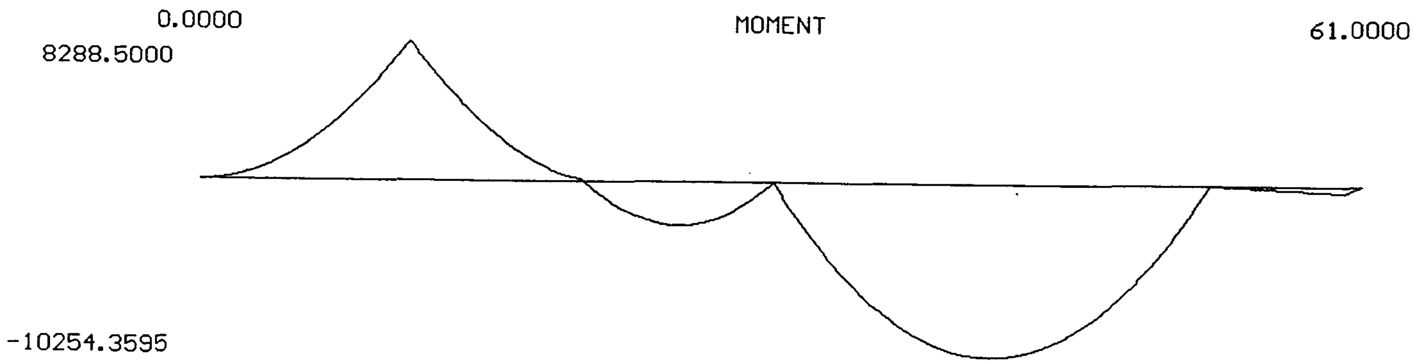
REACTIONS:

Name	Location	Vertical	Moment
Rs01	11.0000	-3045.0144	________
Rs02	20.0000	-919.4727	________
Rs03	30.0000	-2882.9695	________
Rs04	53.0000	-2212.1685	________
Rs05	61.0000	-361.3750	________

9b Continued:







10 Roof to Wall Connections:

If any connecting elements (bolts, straps, etc.) exist, they were not visible during the site visit. The available portions of existing drawings did not include any information relating to the connection of the roof diaphragm or vigas to the masonry walls. As such, this discussion is necessarily more qualitative than quantitative.

Flag note 9 identified the critical wall elements as the north most masonry columns. This is also the location of the critical connections. Here the most load is transferred over the least distance. For that reason, emphasis is placed on assessing these connections, with the assumption that all other connections will be less critical, and more likely to perform adequately during an earthquake.

Figures 12 and 13 show the connection at the northeast column from the outside and inside of the building, respectively.

Movement of the roof relative to the column in the north-south direction would require the main beam to shear through the top of the column. The area of the failure surface would be approximately 12" x 36" = 432 sq. in. At a shear strength of 10 psi, this would equate to a load of 4,320 lbs, far in excess of the applied reaction of 2,454 / 2 = 1,227 lbs (see Figure 11).

The capacity of the connection in the east-west direction is harder to judge. The vigas above, as well as the main beam, are all socketed into the masonry to some extent, and appear to comprise a joint of significant strength. Allowables, or a coefficient of friction for wood in masonry are not available, but some simplistic calculations can be performed:

The applied load (see Figure 11) is 3,045 / 2 = 1,523 lbs.

Assuming ½ the surface of the embedded beam is in contact with the masonry gives a shear surface of π x 6" x 36" = 679 sq. in.

This would require a minimum masonry to wood bond of 2.2 psi.

This stress, as an average over the surface of the log, seems very low, and is likely an acceptable value. In addition, friction, and the socketing of the vigas at the top of the column will provide additional resistance.

Finally, and perhaps most importantly, the analysis to this point has been using a static procedure for the calculation of loads. While convenient, one should never lose sight of the fact earthquakes are a dynamic event. When large forces are generated, it is only for the briefest of times. Considering this adds confidence to the adequacy of these connections: The bearing lengths are very long. The entire roof structure would have to shift three feet or more to lose vertical support from the masonry column.

10 Continued:

Given the relatively low amplitude of the anticipated ground motion in this region, and the criteria of a Life Safety performance level, it is felt that the existing roof to wall connections are adequate.

A comment should be added regarding the criteria in FEMA 310. Section 4.2.6.6 in fact addresses the anchorage of the walls to the diaphragm. As we have seen, the walls of this structure are self supporting, and require no support by the diaphragm, thus the criteria of this section is inapplicable. The calculations above, and those of 9 follow the actual loads generated in the roof diaphragm, through connections, to their reaction in wall elements. As such, these calculations supplant those of Section 4.2.6.3.6 of FEMA 310, which addresses transfer of shear forces from the diaphragm to the walls.

11 Wood Column Connections:

Although they may exist, positive connections between the log columns and the foundation, and between the columns and the beams, could not be verified with the limited investigation permitted. This condition occurs at four log columns in the Terrace area of the building. Unlike the roof to wall connections, the bearing length at the column to beam connections is very short (see Figure 14), and without positive connection, the possibility exists of the roof beams moving off the column and losing support.

12 Slope Failure and Surface Fault Rupture:

The typical meaning of the slope failure evaluation statement as intended by FEMA 310 is whether the structure is in danger of being hit by a landslide. The Yavapai Point Museum is free from this concern, however, it is in danger of being *part* of a landslide. Similarly, the surface fault rupture statement is intended to address natural geologic faults -- while there is a small fault running through Grand Canyon Village, the far more serious concern is the abandoned mine and natural cracks in the strata over which this building was constructed.

The Grand Canyon is nine miles wide and 4,500 feet deep near the Yavapai Point Museum. In geologic terms, The erosion of another few feet of the south rim, which will completely consume this building, is inevitable. In human terms, the question is whether this occurrence is likely to happen in the near future.

Before discounting the possibility of such an event as vanishingly unlikely, recall the rockfall from the face of Glacier Point in Yosemite National Park on November 16, 1998. In this case, no rockfall had been recorded in historic times, despite the occupation of nearby Curry Village since 1899. The rocks above had been exposed and weathering for over 1 million years, and all at once, an estimated 19,900 cubic feet, or 3.5 million pounds of rock exfoliated from the face and plummeted to the valley floor. Admittedly, the weathering and erosion process in the Yosemite Valley is entirely different than that at the Grand Canyon, this example is included only to emphasize that geologic events sometimes do occur on a human time scale.

Several potential weaknesses are present in the strata underlying the Yavapai Point Museum:

1) At the "basement," which various sources indicate to be the opening of an abandoned mine, a large crack is visible in the face of the rock above the entry (Figure 15). This crack extends deep into the rock below the structure (Figure 16). Wooden wedges have been driven into the crack for unknown reasons, it may have been in an effort to stabilize the ceiling of the basement and prevent the periodic fall of small stones.

2) A large natural crack exists in the strata west of the basement (Figure 17).

3) The original floor plan (Figure 18) indicates an opening or crack, even larger than the basement, below the northeast corner of the structure. This area has been "improved" with masonry work (Figures 4 & 15), but it was impossible to determine whether the void was filled, or the mouth of the opening simply "bricked up" with stone masonry.

13 Glazing:

During the 1953 renovation, the Terrace was enclosed with large plate glass windows. In the 1978 renovation, these windows were replaced with the large lights of polarized glass that remain in place to this day. It is unknown whether these lights are tempered in conformance with FEMA 310's evaluation statement. However, the geometry of this building is such that these panes of glass do not pose a significant hazard. To reduce reflection and allow a superior view of the canyon, the windows are tilted slightly outward at the top. Should the glass crack and fall from it's frame during an earthquake, the broken glass would fall into the canyon, away from visitors. Thus the existing windows pose little risk to building occupants.

As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

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