

BISHOP CREEK HYDROELECTRIC SYSTEM, PLANT 2,
POWERHOUSE NO. 2

Bishop Creek
Bishop vicinity
Inyo County
California

HAER CA-145-2-B
HAER CA-145-W

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

FIELD RECORDS

HISTORIC AMERICAN ENGINEERING RECORD

National Park Service
U.S. Department of the Interior
1849 C Street NW
Washington, DC 20240-0001

HISTORIC AMERICAN ENGINEERING RECORD

Bishop Creek Hydroelectric System, Plant 2, Powerhouse No. 2 Bishop Creek, Bishop vicinity, Inyo County, California HAER No. CA-145-2-B

- Location:** The Bishop Creek Hydroelectric Powerhouse No. 2 (Powerhouse No. 2) is located on the southeast side of California State Route 168 in Inyo County, California. From the intersection of California State Route 168 (West Line Road) and U.S. Route 395 (Three Flags Highway) in the Town of Bishop, California, Powerhouse No. 2 is located approximately 13.29 miles southwest on California State Route 168 and 0.40 miles south on Big Trees Road and Forest Service Road 8S03.
- The approximate center of Powerhouse No. 2 is located at UTM Zone 11S, easting 360483.00m, northing 4126370.00m. Distances and coordinates were obtained on January 17, 2012, by plotting location using Google Earth. The coordinate datum is World Geodetic System 1984.
- Present Owner:** Southern California Edison Company
P.O. Box 800
Rosemead, California 91770
- Present Use:** Powerhouse No. 2 is a hydroelectric power generating facility that uses high-head impulse water wheels to generate electricity for transmission to distant customers, as it was originally designed and constructed to do. Powerhouse No. 2 is one in a chain of five similar power generating facilities located in the Bishop Creek system.
- Significance:** Powerhouse No. 2, a reinforced concrete industrial building constructed in 1908 and 1927 by the Nevada-California Power Company, is a significant resource by virtue of its position in the historic Bishop Creek Hydroelectric System and its expression of the Mission Revival architectural style.
- The Bishop Creek Hydroelectric System Historic District is significant for its position in the expansion of hydroelectric power generation technology, its role in the development of eastern California, and its contribution to the development of long-distance power transmission and distribution. The System is significant under National Register of Historic Places criterion A (broad patterns of history) and C (distinctive characteristics of period and type of engineering and construction). The Period of Significance for the

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Bishop Creek Hydroelectric System is identified as 1905-1938.

Historian:

Matthew Weintraub, Senior Architectural Historian
Galvin Preservation Associates
231 California Street
El Segundo, CA 90245

Project Information:

The Historic American Engineering Record (HAER) is a long-range program that documents and interprets historically significant engineering sites and structures throughout the United States. HAER is part of Heritage Documentation Programs (Richard O'Connor, Manager), a division of the National Park Service (NPS), United States Department of the Interior. The Powerhouse No. 2 recording project was undertaken by Galvin Preservation Associates (GPA) for the Southern California Edison Company (SCE) in cooperation with Justine Christianson, HAER Historian (NPS). SCE initiated the project with the intention of making a donation to NPS. As recommended by Justine Christianson (NPS), the report describes how water flows in and out of the powerhouse to produce electricity, and a vital component of the report documents changes in operating machinery that have occurred over time. Archaeologist Crystal West (SCE) oversaw the project and provided access to the site. Historian Andrea Galvin (GPA) served as project leader. Architectural Historian Matthew Weintraub (GPA) served as the project historian. Jeff McCarthy, Supervisor of Operations (SCE), and Keith Inderbieten, Hydro System Operator (SCE), provided research assistance. Stephen Schafer produced the large format photographs. The field team consisted of Andrea Galvin (GPA), Matthew Weintraub (GPA), Crystal West (SCE), Neil Sliger (SCE), Stephen Schafer (photographer) and David Sanchez (photographer assistant).

Researchers can be directed to also see:

HAER No. CA-145-2, Bishop Creek Hydroelectric System, Plant 2;
HAER No. CA-145-2-A, Bishop Creek Hydroelectric System, Plant 2, Lake Sabrina Dam; and
HAER No. Ca-145-2-C, Bishop Creek Hydroelectric System, Plant 2, Transformer House.

PART I. HISTORICAL INFORMATION

A. Physical History of Building:

The physical history of Powerhouse No. 2 was determined by reviewing original construction drawings including architectural elevations,¹ a floor plan,² a roof plan,³ and machine foundation plans.⁴ Also, drawings for alterations and additions to Powerhouse No. 2 which occurred after its original construction were reviewed.⁵ These plans were retained by the power companies that successively owned and operated the plant (currently SCE). In addition, articles describing construction and operation of the powerhouse which originally appeared in the trade journals *Journal of Electricity Power and Gas*⁶ and *Electrical World*⁷ and reprinted by SCE were reviewed. They included a series of articles written by Charles O. Poole, who served as chief engineer of the Nevada-California Power Company. The building itself provided physical evidence of its history and development via field inspection,⁸ as did historical photographs and contemporary drawings in the possession of SCE. Further information was found in previously completed HAER documentation⁹ and evaluations of eligibility for listing in the National Register of Historic Places.¹⁰ These sources provided thorough and detailed information regarding the historic design, construction, improvement and operation of the building.

Overview

Powerhouse No. 2 was constructed in 1908 by the Nevada-California Power Company. It was the third of five powerhouses to be established in the Bishop Creek system (preceded

¹ Nevada-California Power Company (NCPC), "East Elevation of Power House, Southeasterly End Elevation of Power House No. 2," Sheet 1 of 6, approved March 1908; NCPC, "South Side Elevation of Power House No.2," Sheet 2 of 6, approved March 1908.

² NCPC, "Floor Plan of Power House No. 2," Sheet 3 of 6, approved March 1908.

³ NCPC, "Roof Details of Power House No. 2," Sheet 5 of 6, approved March 1908.

⁴ NCPC "General Foundation Plan for Power House No. 2," approved May 12, 1908.

⁵ NCPC "Floor & Foundation Plan, Operating & Bus Room Addition," approved February 11, 1927, redrawn on June 24, 1966 and revised on April 13, 1967.

⁶ Rudolph W. Van Norden, "System of Nevada-California Power Company and the Southern Sierras Power Company. Part 1 – Power Plants," *Properties and Power Developments of the Nevada-California Power Company and the Southern Sierras Power Company*. Reprinted from the *Journal of Electricity Power and Gas*, Volume XXXI, Numbers 1-2, July 5-12, 1913, p. 1-20.

⁷ C. O. Poole, "Hydraulic and electric features of stations No. 2 and No. 3 of the Nevada-California Power Company – Tailrace water of former discharges directly into intake of latter," *Power Development and Transmission Systems of The Nevada-California Power Company and the Southern Sierras Power Company*, 1915, p. 19-26. Reprinted from *Electrical World*, New York, 1914.

⁸ Field inspections were conducted on October 19 and December 7, 2011.

⁹ Thomas T. Taylor, "Bishop Creek Hydroelectric System," HAER No. CA-145, Historic American Engineering Record, National Park Service, U.S. Department of the Interior, 1994, p. 12-13.

¹⁰ Robert Clerico and Ana Beth Koval, "An Architectural and Historical Evaluation of Structures Associated with the Bishop Creek Hydroelectric Power System, Inyo County, California," Southern California Edison Company, December 1986, p. 24-29; Valerie Diamond, Stephan G. Helmich, and Robert A. Hicks, "Evaluation of the Historic Resources of the Bishop Creek Hydroelectric System," Southern California Edison Company, July 1988, p. A-161-165.

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by No. 4 and No. 5), and it is the highest powerhouse at an elevation of 7,999 feet. Powerhouse No. 2 was constructed as a single-story reinforced concrete industrial building in the Mission Revival architectural style. It contains a large rectangular room that houses three rotating generators driven by impulse water wheels, installed in 1908 and 1911. In 1913, the water wheel-driven generators operated with a combined capacity of 6,000 kilowatts (kw). The power company constructed a complementary wing addition to the powerhouse in 1927. Currently, Powerhouse No. 2 continues to operate as a hydroelectric powerhouse in the Bishop Creek system. The power plant is situated on the northwest bank of Bishop Creek in the upper reaches of Bishop Creek Canyon. The plant originally consisted of the powerhouse (extant), a matching transformer house (extant), four residence cottages (not extant), and two outbuildings (extant).

In 1913, the *Journal of Electricity Power and Gas* provided this general description of Powerhouse No. 2, which was constructed five years previously:

No. 2 powerhouse, in its design, represents a style of construction and finish characteristic of all of the plants [in the Bishop Creek system] with the exception of No. 5. The building is of reinforced concrete. There are four columns on each longitudinal side of this construction, these extend inside of the walls and support the crane rails, also of concrete, and extend without the walls to give a buttress effect. The end walls have two buttressed columns and the walls are carried to the gables, which are finished above the roof in a simple style of the Spanish renaissance. The roof is supported on [four] Fink steel trusses, the purlins being "I" beams spaces rather closer than usual and carrying a steel Spanish tile roof. The powerhouse layout is very simple and consists of three main generating units placed with their shafts in a line lengthwise with the building... The generators are mounted in pits and there are but two bearings [on each unit], the water wheels being overhung. One of these machines installed at a later date than the others is of a slightly different type...The two earlier units are driven by single runner Pelton water wheels, each equipped with needle deflecting nozzles controlled by hand operated worm-gear handles...The third unit is driven by a Doble wheel, also equipped with needle main and auxiliary nozzles...Placed in front of two of the main units and with their shafts in line are the two exciter units...The switchboard is placed at the middle of one side of the building facing the main units...The transformers are housed in a separate building of similar construction to that of the power house.¹¹

¹¹ Van Norden, "System of Nevada-California Power Company," p. 8. Whereas this source indicates that the roof was supported by three Fink steel trusses, original plans and field inspection indicates that the powerhouse was constructed with and retains four trusses. This discrepancy should be noted.

1. Date of Construction:

Construction of Powerhouse No. 2 occurred in 1908, based on architectural drawings dated March 1908 and foundation plans dated May 1908. As stated in 1914 by Charles O. Poole, chief engineer of the Nevada-California Power Company, "The plant was constructed in 1908 and has been in continuous use ever since, excepting the twenty days when the steel Y failed."¹² A small addition (north wing) to the main building was constructed in 1927, as indicated by a floor and foundation plan for the addition dated February 1927.

2. Architect/Engineer:

The engineers of the original construction of Powerhouse No. 2 were (R. G.) Manifold & (Charles O.) Poole of Los Angeles, as listed on construction drawings dated 1908. Poole served as chief engineer of the Nevada Power, Mining and Milling Company, later the Nevada-California Power Company. The top sheet of construction drawings included the notation "by Paul H. Ehlers," who was probably the draftsman and possibly an architect. Other architects and/or engineers are not known.

3. Builder/Contractor/Supplier:

The builder of Powerhouse No. 2 was the Engineering-Contracting Co., as listed on the top sheet of construction drawings dated 1908. According to the construction drawing for the addition dated 1928, all plumbing and fixtures in the north wing addition were installed by the power company. Other builders, contractors and material suppliers are not known.

4. Original Plans:

The powerhouse was designed as rectangular in plan with exterior wall-to-wall dimensions of 36'8" x 80'8" and height of 29'0". It was constructed of concrete reinforced with "new style" corrugated metal bars and finished in stucco. The powerhouse was built three bays wide and five bays long as defined by regularly spaced columns that extended to the interior. The concrete columns, or "pilasters", were spaced 12'0" center-to-center at the building ends (east and west walls) and 16'0" center-to-center at the long sides (north and south walls). Between the columns were suspended curtain walls 4" thick. Columns were squared and terminated in well-defined drainage slopes. Columns located at corners and long sides were buttressed and columns at ends were flat. The powerhouse roof was a moderately pitched gable supported on four Fink steel trusses and sheathed in interlocking, barrel-shaped pressed metal "tiles" that measured 21-1/4" long (23-1/4" long at eaves). The gable roof measured 9'4" in height from eaves to ridge, and 39'6" in width between the eaves, which extended 8" beyond the side walls. End walls terminated in three-level stepped parapets with square-profile coping that obscured the gable ends.

¹² Poole, "Hydraulic and electric features of stations No. 2 and No. 3," p. 21.

The building contained two large entrances in the first bays of the long sides (counting from east to west) with side-hinged swinging double-leaf metal doors with central latches, which allowed for large machinery to be moved in and out of the building. A third entrance with a similar, smaller single-leaf door was located in the fifth bay of the north side.¹³ The building was fenestrated in a regular pattern with a large rectangular window in each of the end bays (three windows total on each end wall) and paired windows in side wall bays that were not filled by doors. Windows were identical wood sash 16-light-over-4-light. Each gable end contained a large circular louvered vent. At the east end, the primary façade was distinguished by raised lettering that read: NEVADA-CALIFORNIA POWER COMPANY, located above the circular vent; and POWER HOUSE NO. 2 located below the circular vent. The individual block letters were approximately 9" tall, 6" wide, and cast of cement mortar and cemented into positions on the façade.

The powerhouse was built with a complex concrete substructure over aggregate rock base 10'0" feet deep that was designed to house impulse wheel-driven generators. The foundation was topped by a floor slab 16" thick. At the interior, the generator room that occupied the structure measured 36'0" x 80'0". It was open in plan. The generator room housed three water-wheel/generator assemblies situated at the center of the room and related equipment such as valves, pumps, governors, exciters, and switchboard panels. The interior long walls contained recessed bays formed by the post-and-beam construction and filled by curtain-wall panels. The building was open vertically through the trusses. A 20-ton overhead traveling crane furnished by the Cyclops Iron Works of San Francisco spanned the width of the room. The rolling crane ran on rails mounted on concrete beams that formed parallel ledges along the long side walls 4'6" below the level of the trusses.

5. Alterations and Additions:

In July 1988, as part of an evaluation of the powerhouse's eligibility for nomination to the National Register of Historic Places, the following conclusion was reached regarding the condition of the powerhouse with respect to alterations and additions:

The powerhouse, which has been modified, retains its architectural integrity. The wing housing the operating and bus room was constructed in 1927 in the same style as the original building... [I]t appears that numerous windows and doors have been replaced over the years; however, dimensions of the openings remained

¹³ The third entrance is not shown in original construction drawings or in available historical photographs. It is inferred to original and/or historic based on field inspection.

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consistent. One exception is the central door on the front façade; it appears originally to have been a window identical to those remaining on the front façade.¹⁴

The wing containing the operating (switchboard) room and bus room, built in 1927, was constructed adjacent to the third and fourth bays on the north side of the powerhouse. The rectangular-in-plan addition projected approximately 34'0" from the east side of the powerhouse and it was 19'6" wide. The addition included: a gabled roof clad in pressed metal Spanish tiles; a Mission-style three-level stepped parapet at the north end; squared concrete columns spaced 14'0" end-to-end at the longer north wall, 7'5" end-to-end at the short walls, and buttressed at corners; and concrete curtain walls 4" thick; which complemented the original powerhouse. Construction of the addition involved removal of the original curtain wall and column from the fourth bay of the powerhouse, as well as removal of the switchboard from its location in front of the fourth bay. In 1938, the pair of windows located in the third bay of the north wall of the powerhouse, originally on the building's exterior and enclosed by the bus room addition, were removed and filled with concrete wall 4" thick concrete to match the existing wall.

The addition was built to house a switchboard room that extended into the main generator room from the fourth bay of the north wall as a five-sided, two-door, steel-framed office bay. At the back of the switchboard room, where the new switchboard was installed, a cable trench was installed, 16" wide, 11" deep, and running the length of the room. The remainder of the addition was partitioned into: a battery room located in the northwest corner; an internally partitioned U-shaped bus room located in the eastern part; and a small lavatory located behind the switchboard room between the battery and bus rooms.

Other structural and/or material changes have occurred. Sometime before approximately 1927, center-pivot metal covers replaced louvered vents in the round windows at gable ends. In 1927, steel windows replaced original wood sashes in original openings. Sometime after approximately 1927, a single-light metal door with transom replaced the central window on the front (east) wall; and later, the transom was removed and the opening was filled. At unknown times, the following changes also occurred: two gabled rooftop monitors with vented sides were constructed at the center of the ridge; corrugated metal roll-up doors replaced double-leaf metal doors in the large service openings; at the interior, a small rectangular, roofless concrete block partition was constructed in the southwest corner of the generating room, possibly originally to house batteries; and the original overhead traveling crane furnished by Cyclops Iron Works of San Francisco was replaced with a Northern Crane model.

¹⁴ Clerico and Koval, "An Architectural and Historical Evaluation," p. 27.

B. Historical Context:

The following historical context was included in previously completed documentation which established the eligibility of the Bishop Creek Hydroelectric System for listing in the National Register of Historic Places.¹⁵

The turn of the twentieth century saw a dramatic change in technological history. The production of cheap, dependable hydroelectric power, and the ability to transport the power over great distances, was perfected at this time. In short order, drainages with sufficient flow for hydroelectric power generation began to be developed. By 1923, the only suitable streams draining the east slope of the Sierra Nevada which were not being used for electricity production were the Carson and Walker river systems. The first hydroelectric power generation along Bishop Creek was a small plant operated by the Bishop Light and Power Company. The facility was reported to be a half mile west of the Standard Flouring Mills (present site of Plant 6) and two and a half miles from the town of Bishop. The plant consisted of a Stanley polyphase generator (capable of 150 horsepower) driven by a 48-inch Pelton wheel. The power was generated for local use.

Through the efforts of Loren B. Curtis, an engineer, and Charles M. Hobbs, a banker and financier, the Nevada Power, Mining and Milling Company was incorporated on December 24, 1904. The first facility built by the Nevada Power, Mining and Milling Company was put into operation in September, 1905, supplying hydroelectric power to the mining communities of Tonopah and Goldfield, Nevada. Executives of the power company had purchased controlling interest in the locally operated facilities in Tonopah and Goldfield, so that, when production began, there was a market ready for their product. The original transmission line extended east across Owens valley, the White Mountains, Fishlake Valley, and the Silver Peak Range to the town of Silver Peak in Clayton Valley. Here the line split, diverging northeast to Tonopah and due east to Goldfield. The line distance from Bishop Creek to Goldfield was 95 miles, and that to Tonopah was 118 miles. This was a new record for long distance transmission. On January 5, 1907, the Nevada-California Power Company, successor to the Nevada power, Mining and Milling Company, was incorporated; most of the original corporate officers remained with the new company.

Between 1905 and 1913, four more generating plants were placed on line, in tandem along Bishop Creek, and additional generators were placed in existing plants. As a result of this additional power generation, the "Tower Line" from Bishop to San Bernardino was completed in 1912 and put into operation, again creating a new record for long distance transmission (239 miles). The directors of the Nevada Power, Mining and Milling Company were well aware of the vicissitudes of the boom-bust mining industry and took steps to secure a more constant market for their product. In 1911, the Southern Sierra Power Company was incorporated with the main purpose of creating and servicing

¹⁵ Clerico and Koval, "An Architectural and Historical Evaluation," p. 5-12.

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the power needs of southeast California. From then until 1918, several smaller power companies were purchased by the new company. The development of southern California's Imperial Valley corresponds directly with Bishop Creek's production of cheap, reliable electricity.

By the end of 1913, the Bishop Creek system was essentially complete with all five plants operating. In descending order down the drainage, the Bishop Creek facility then consisted of:

Power Plant 2: Three Westinghouse generators, each capable of 2,000 kw of power (total output of 6,000 kw). Units 1 and 2 were driven by Pelton wheels and unit 3 by a Doble wheel.

Power Plant 3: Three Crocker-Wheeler generators, each capable of 2,250 kw of power (total output of 6,750 kw). All three units were direct connected to Henry impulse wheels.

Power Plant 4: Five generating units consisting of: two National Electric Company, 750 kw, generators connected to Pelton wheels; one Bullock, 1,500 kw, generator driven by a Pelton wheel; one Allis-Chalmers, 1,500 kw, connected to a Pelton wheel; and one Allis-Chalmers, 1,500 kw, machine driven by a Doble wheel (total output of 6,000 kw).

Power Plant 5: Two generating units, one of which was a 1,500 kw, Allis-Chalmers machine driven by a Doble wheel and the other a 1,850 kw unit connected to a Pelton-Francis wheel (total output of 3,350 kw).

Power Plant 6: A single generator capable of 2,250 kw driven by a Pelton-Doble wheel.

It is interesting to note that Power Plant 1 was to have been built at the present site of Intake No. 2, but the plant was never built due to the vulnerability of the site to avalanches. The plant number designators were not adjusted accordingly, so that there is no Power Plant 1, nor has there ever been.

In 1936, the Nevada-California Electric Corporation again was reorganized to become an operating company. The corporation became California Electric Power Co. and continued to operate under this name until 1964, when the company known as Calectric was subsumed by Southern California Edison Company. Since 1964, as a result of acquisition through merger consolidation, Southern California Edison (SCE) has owned and operated the Bishop Creek plants.

PART II: SITE INFORMATION

A. General Description of Building:

The following description of Powerhouse No. 2 incorporates information included in previously completed HAER documentation¹⁶ and evaluations of eligibility for listing in the National Register of Historic Places.¹⁷ This information was verified and new information was gathered via field inspection to inform the building description.¹⁸

Overview

Powerhouse No. 2 is a one-story, reinforced concrete industrial building resting on a deep concrete foundation and topped by a metal gable roof. It was designed and constructed in the Mission Revival architectural style with stepped parapets at end walls. A small addition resulted in an L-shaped plan. The main volume houses three hydroelectric power generation units which are mounted in the concrete foundation and driven by impulse water wheels.

Exterior

Powerhouse No. 2 is a one-story, rectangular-in-plan, reinforced concrete building resting on a deep concrete foundation. A tan, rough-textured stucco covers the exterior. Structural pilasters subdivide the walls into panels. The original structure is three bays wide and five bays long; the north wing is two by two. A wing extends off-center from bays three and four on the north façade. The exterior pilasters are flat at end walls and buttressed at corners and side walls. All pilaster tops have well-defined drainage slopes. The building is covered by a medium-pitched cross-gabled roof sheathed with pressed sheet metal which simulates American Spanish clay tile regularly laid. The transition from the roof to the side walls is accomplished with very simple, square-in-section, sheet metal cornices. Two rooftop monitors with gabled roofs provide ventilation to the older structure.

The three end walls, which conceal the gable ends, culminate in symmetrical, three-tiered, stepped parapets, finished with square-in-section concrete coping. End walls of the original structure have large circular vent openings with center-pivot metal covers. The eastern façade is labeled in raised block letters: NEVADA-CALIFORNIA POWER COMPANY; and POWER HOUSE NO. 2. A flagpole is located on the eastern façade. Most bays on long walls contain pairs of 6-light-over-6-light-over-3-light, wire-glass, metal-framed windows inset; most bays on short walls contain single windows. Typical windows have fixed upper and lower sections and hinged middle sections. Other openings contain 6-light-over-3-light metal windows with the 3-light section hinged. Most operable window openings have security grates. Windows have plain, stuccoed surrounds and projecting lugsills. Entrances to the building include: a one-light metal

¹⁶ Taylor, "Bishop Creek Hydroelectric System," p. 12-13.

¹⁷ Clerico and Koval, "An Architectural and Historical Evaluation," p. 24-29; Diamond, Helmich, and Hicks, "Evaluation of the Historic Resources," p. A-161-165.

¹⁸ Field inspections were conducted on October 19 and December 7, 2011.

door with a shallow projecting stuccoed hood located at the center of the east end of the powerhouse; a plain metal door located at the east wall of the north wing; and large metal roll-up doors behind hinged security gates at the east corners of the long walls of the powerhouse.

Interior

The main rectangle of the building is open in plan, except for a five-sided windowed operators office protruding from the fourth bay of the north wall into the generator room. The floor is poured concrete with areas of metal foundation plates bolted into place. Three sets of water-wheel/generator assemblies are mounted in pits at the center of the room, with their axis of spin aligned horizontally along the east-west centerline of the building. The generator room also contains water valves and governors on the south side of the building, and other support equipment around the periphery. A roofless concrete block partition occupies the southwest corner of the powerhouse. Walls are finished in smooth stucco and subdivided into bays by structural pilasters that extend from the exterior to the interior. The bays along the long walls contain additional internal structural divisions. Most bays contain large rectangular metal-framed windows. An overhead traveling crane is mounted on rails supported by a post-and-beam system that is integrated into the structural system of the long walls. The generator room is open vertically through the Fink steel trusses and the underside of the pressed metal roof sheathing is exposed.

The five-sided operators office is enclosed with 12-light, fixed, steel-framed panels with wire glass and accessed by two single 6-light metal doors. The office contains a desk in the windowed bay and a switchboard at the back of the room, which extends into the addition. The office also contains contemporary computer equipment. The office serves as a connection to other rooms in the partitioned north wing including: a battery room in the northwest corner; a bus room containing circuit breakers in the eastern portion; and a small lavatory between the battery room and bus room.

Forming a line along the middle of the generator room are found the three power generation units with original water wheel housings, original generator housings and rotors, and original shaft mountings. The wheel housings are semicircular, made of riveted cast iron, and bolted to the floor over the operating water wheels. The generator housings are donut-shaped with open interiors, also made of cast iron, and suspended around the stator cores and rotors. The power generation units are numbered from east to west as: No. 1; No. 2; and No. 3. At Units No. 1 and No. 2, the original rounded metal wheel housings, which are bolted and riveted, are intact with raised lettering at the bases that reads: PELTON WATER WHEEL CO, SF, NY, 1908. Also, stylized metal nameplates affixed to the surface of the wheel housings read: THE PELTON WATER WHEEL CO., HYDRAULIC ENGINEERS, SAN FRANCISCO, NEW YORK, USA. Similarly, the original rounded metal wheel housing is intact on Unit No. 3, with raised lettering at the sides that reads: DOBLE. All three generators retain their original rotors and metal housings with raised lettering at the sides that reads: WESTINGHOUSE. The

generator housings also display stylized metal nameplates bolted to the surfaces that read: WESTINGHOUSE A.C. GENERATOR; and include original machine specifications and patent numbers.

1. Character:

In 1913, the *Journal of Electricity Power and Gas* stated that Power Plant 2 was “a most ideal example of pure Western practice of its time.”¹⁹ This description remains true nearly a century later. Powerhouse No. 2 is an embodiment of an early twentieth century industrial building designed in the Mission Revival architectural style, as is the accompanying Transformer House. It retains the significant majority of exterior features and materials that convey its historic architectural character, including (but not limited to) stucco-clad concrete walls and buttressed columns, stepped end parapets, Spanish metal tile roof, and integrated signage. The powerhouse also retains the significant majority of interior features that convey its historic character, including (but not limited to) an open linear floor plan, centrally located water wheel/generator assemblies, perimeter walls with recessed bays, natural lighting provided by large windows, open truss roof system, and the control room.²⁰ The overall design of the powerhouse is very well intact, in part due to the historic addition that was completed in style with the original. Minor changes that have occurred include window replacement,²¹ door replacement, and installation of a new entrance. Powerhouse No. 2 continues to operate and it serves as a superb example of an early twentieth century California hydroelectric power plant.

2. Condition of Fabric:

Powerhouse No. 2 is in good physical condition. The concrete walls are intact and the exterior stucco facing does not contain noticeable cracks or damage, with few attachments and/or piercings. The pressed metal roof is intact. Likewise, the interior is in good condition. The stucco-clad perimeter walls and concrete foundation are intact, as is the historic internal addition to the generator room, the office bay. Windows and doors are operable. The only visible damage consists of chipped corners on the concrete parapet coping of the north end wall (north wing).

B. Site Layout:

The terrain surrounding Powerhouse No. 2 consists of steep canyon walls covered with natural vegetation. The plant is located on a graded level area on the west bank of Bishop Creek. To the west, topography rises sharply towards Big Trees Campground Road,

¹⁹ Van Norden, “System of Nevada-California Power Company,” p. 4.

²⁰ Construction of the control room in 1927 occurred during the identified Period of Significance for the Bishop Creek system, 1905-1938. The control room is significant and contributing because it is characteristic of operational improvements that occurred in the Bishop Creek system during the early twentieth century.

²¹ Installation of steel-sash windows in 1927 occurred during the identified Period of Significance for the Bishop Creek system, 1905-1938. Steel-sash windows are significant and contributing because they are characteristic of material and functional improvements that occurred in the Bishop Creek system during the early twentieth century.

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California State Route 168, and a distant ridge from which Penstock No. 2 approaches the plant. To the east, the terrain slopes down to nearby Intake No. 3 and Bishop Creek, then rises steeply at the opposite valley wall. The powerhouse and the transformer house are arranged in an L-shaped configuration. The powerhouse stands with its long axis running east-west and its wing extending to the north. The transformer house is found to the north of the powerhouse with its primary axis oriented north-south. Metal car rails set in pavement run between service openings of the two buildings which are separated by a distance of 50 feet. North of the transformer house, a terraced pad contains transformers and chain-link perimeter fencing. Originally, the power plant complex included a powerhouse (extant), a transformer house (extant), four residence cottages (not extant), and two outbuildings (extant). The two accessory buildings, a garage and shed, are located to the south of the powerhouse in isolated locations. The cottages were removed in 1977. Extensive stone retaining walls remain at the west side of the site. Also, the original highway (California State Route 168) followed the northwest bank of Bishop Creek directly past all the powerhouse sites including Plant 2 (apparently along the route of the current Big Trees Campground Road). The new highway, which bypasses the powerhouses, was constructed to the northwest in 1965-1966.

PART III: OPERATIONS AND PROCESS

A. Operation:

This section describes the process that creates hydroelectric power at Powerhouse No. 2, in the context of Plant 2 and the chain of power plants that comprise the Bishop Creek Hydroelectric System. This section is divided into two subsections: (1) Basic Components of Hydroelectric Systems, which provides a general background for understanding the operations of hydroelectric plants; and (2) Operation of Plant 2, which describes how water moves through the power plant in order to drive turbines and generate electricity that is transmitted long distances.

Basic Components of Hydroelectric Systems

In a hydroelectric power generating unit, the force of moving water is used to spin a turbine (or “water wheel”). A turbine is connected via a shaft to a rotor, the moving part of an electric generator. The movement of the turbine spins the rotor within the generator and sweeps coils of wire past the generator’s stationary coil, or stator, which produces electricity. Once electricity is produced, transformers raise the voltage to allow transmission over long distances through power lines.²²

The following explanation of hydroelectric systems was included in a previously completed evaluation of eligibility for listing in the National Register of Historic Places.²³

There are two basic types of hydroelectric systems. The first of these, low-head hydro, uses a large volume or mass of water from relatively low dams in order to turn the angled surfaces of screw-shaped turbines. The other type, high-head hydro, uses streams with relatively low volume flows, where water is diverted away from the natural stream course and elevated by artificially reduced fall far above the natural stream through a man-made canal or pipeline. At some point downstream the water is directed downslope where it achieves a very high pressure. The water at the base of the slope is directed against a bucketed wheel which receives an energy impulse by its impact.

The basic features of a high-head hydro system, of which the Bishop Creek Hydroelectric System is an example, are outlined below.

1. Water from a stream channel is separated from the natural stream using a diversion dam, headgates, screens and a spillway. The headgate regulates the flow of water, while the screens prevent debris from entering the water conduit. The reservoir behind the intake dam acts as the principal regulator of the water flow, allowing excess water to escape into the natural water channel. The dam,

²² U.S. Department of the Interior, Bureau of Reclamation Power Resources Office, “Reclamation: Managing Power in the West – Hydroelectric Power,” July 2005, unpaginated. Found at <http://www.usbr.gov/power/edu/pamphlet.pdf>, accessed on January 30, 2012.

²³ Diamond, Helmich, and Hicks, “Evaluation of the Historic Resources,” p. 10-11.

headgate, and regulating and cleaning apparatus are all known collectively as the *intake*.

2. Following intake, water is conducted by flumes or canal systems, pipes, tunnels or siphons (pipes in the case of Bishop Creek). The length of the system varies greatly, depending on the area's topography and amount of water-pressure desired. Sluices and sandboxes are usually built into the system to allow sand and gravel, which could clog or damage the downstream equipment, to settle out of the water. *Flowlines* generally incorporate pressure-relief valves, installed at regular intervals along their length. These open and permit outside air to enter the line to prevent the line from collapsing should there be an accidental break in the pipe. A large vacuum would normally be formed by the sudden acceleration of water through a break, which could easily destroy either wood or steel pipe.
3. At the end of the canal system, a pipe is installed as nearly vertical as conditions will allow providing the water pressure needed to operate the water wheel(s). This pressure pipe is known as a *penstock*. At the top of this pipe is a small reservoir, expansion tank or standpipe (standpipe in the case of Bishop Creek) which helps to regulate and smooth the flow of water within the penstock.
4. A *powerhouse* is located at the bottom of the penstock. This consists of a building within which is housed the power generation and distribution equipment. The machinery within the building includes water wheels, generators, batteries and exciters. Exciters provide direct current to energize the electromagnets within the larger alternating current generator(s). The powerhouse also includes the distribution equipment used to initiate transmission of electricity. This equipment consists of switches, circuit breakers and related controls which are connected to a nearby transformer. The transformer increases voltage so that power can be transmitted over long distances. The powerhouse also contains a variety of other apparatus used in the operation of the system. This often includes a small generating unit to operate the powerhouse lights and equipment, as well as telephone links with other system components. Other buildings associated with the operation of the hydro system are usually located in close proximity to the powerhouse(s). These may include such facilities as administrative headquarters, garages, housing for system personnel, equipment storage sheds, pump houses, and machine shops.
5. Where there is more than one power-generating source, it is not uncommon for there to be a *control station* where the transmission of energy may be monitored and regulated. If electrical generating facilities are close by, many functions may be automated or operated from a centralized control point; the control station may serve this additional function.

6. *Transmission lines* carry power to users. Normally a step-down transformer is used near the point-of-use to reduce the voltage to normal house currents.

Operation of Power Plant 2

At Plant 2, the static head (or vertical drop in elevation from intake to water wheel) ranges from 928 to 951 feet, depending on the water level of Intake No.2, with an effective head of 875 feet. The waters from all three forks (south, middle, and north) of Bishop Creek are collected in Intake No.2, an equalizing pond located upstream of the plant. Water is transferred from the intake by Flowline No. 2, a metal pipeline (originally a redwood stave pipe). The flowline runs along the crest of a moraine located to the west of Powerhouse No. 2. In addition, water from Birch and McGee creeks is delivered via a flume that intersects the flowline between Intake No.2 and Power Plant 2. The water is conveyed from the flowline to the powerhouse via Penstock No. 2, a metal pipeline that begins at the height of the flowline and descends steeply from the west, thereby using gravity to deliver water at substantial velocity to the plant. The penstock approaches Powerhouse No. 2 below grade, running just south of and parallel to the south side of the powerhouse. There, it splits into three separate feeder pipes that enter the powerhouse foundation on the south side, with each pipe directed to one of three water wheels located within the powerhouse.

Three feeder pipes from Penstock No. 2 enter the substructure at an angle of approximately 45 degrees to the south wall. The pipes pass through control pits located along the south side of the generator room. These control pits contain the machinery that regulates the flow of water from the penstock feeder pipes to the impulse water wheels, including governors (which can be used to control the positioning of the power needle and/or the stream deflector), gate valves, penstock nozzles and power needles, stream deflectors, and the controlling mechanisms (originally hand wheels). At Units No. 1 and No. 2 (numbered east to west), which were designed for single-nozzle use, the control pits are four feet deep (as measured from the floor line) and the ell-shaped floor openings measure approximately 9'3" x 11'8-1/2" at the long sides. At Unit No. 3, which was designed to house a primary nozzle and an auxiliary nozzle, the control pit is seven feet deep and the irregularly shaped floor opening measures approximately 7'9" x 13'6 1/2". The control pits are covered by bolted metal foundation plates that provide flooring.

In the concrete floor of the powerhouse, three power generation units consisting of impulse water wheels and direct-connected generators are shaft-mounted with their common axis of spin aligned horizontally and parallel to the centerline of the building. The impulse wheels are mounted in pits located in front of the control pits, from which extremely high-velocity jets of water are directed at the wheels. Rounded metal casings are bolted to the concrete floor over the water wheels. At Units No. 1 and No. 2, which originally housed identical Pelton-manufactured wheels (installed in 1908), the wheel pits are 7'6" deep directly beneath the centers of the wheels and the floor openings measure 4'8" x 10'5". At Unit No. 3, which originally housed a Doble-manufactured wheel installed after the other units (1911), the wheel pit is 7'0" deep at its shallowest point and

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the floor opening measures 3'10-½" x 9'0". The wheel pits slope gradually down to the north and into tailrace channels within the substructure.

Each water wheel drives a Westinghouse-manufactured rotating generator, which is shaft-mounted in tandem with the turbine. The generators are hung over open rectangular pits located parallel to and centered with the wheel pits. The wheel pits and generator pits are separated by low concrete partitions. At Units No. 1 and No. 2, the generator pits are 6'0" deep, the floor openings measure 5'10" x 12'0", and the shafts measured 13'11-½" in length. At Unit No. 3, the generator pit is 5'3-1/8" deep, the floor opening measures 5'11" x 9'10", and the shaft measures approximately 10'11" in length. Shaft bearings and housings are bolted to the concrete foundation to either side of each generator with bolts that run 7'0" deep into the concrete foundation. The centerline of the wheels, generators, and shafts is located 16'11" from the south wall and 20'7" from the north wall of the building. Within each unit, the center-to-center distance between wheel and generator is 8'11".

Currently, Powerhouse No. 2 operates with solid-state exciter units which consist of non-moving electrical machinery housed within metal cabinets. The exciters are used to produce direct current that is used to energize electromagnets within the main power generation units. Originally, the powerhouse contained a pair of water-driven exciters with impulse wheel/generator assemblies similar to those found at the main power generation units but smaller. They were located in front of the second and third bays of the north wall. Water reached the impulse wheels of the exciters from a dedicated penstock feeder pipe that entered the substructure at the south wall, passed between Units No. 2 and No. 3, and split into a "Y" with branching pipes that terminated at the impulse wheels. The exciter wheel pits were 3'0" deep at their shallowest points and sloped downward to the north to a depth of 5'0". The exciter wheel pits drained into tailrace channels to the north.

Within the foundation, three separate tailrace channels run northward from the water wheel pits of the main generating units and exit the north side of the substructure. These tailrace channels are 56" wide and are contained within concrete side walls 15" thick. Previously, two smaller channels ran from the water-driven exciters (not extant) and converged in a reverse "Y" as a single tailrace channel 24" wide. Water that passes through the plant is conveyed by the separate tailrace channels that originate at the water wheels into the primary tailrace channel located below grade to the north of the powerhouse. The main tailrace exits the plant to the east through a square concrete opening that spills into nearby Intake No. 3.

B. Machines

This section provides an inventory of extant machinery within Powerhouse No. 2, including descriptions of purposes, manufacturer names and dates of installation (as available), and information regarding changed and removed machinery (as available). This section is divided into several subsections beginning with a general description of

the power generation units, followed by detailed descriptions of individual machines and sets of machines. The individual machinery is described in the following order: turbines (water wheels); generators; governors; exciters; and additional machinery.

Power Generation Units

Units No. 1 and No. 2 (installed 1908) are identical, while Unit No. 3 (installed 1911) varies from the other two in its hydraulics. The water wheels at Units No. 1 and No. 2 were equipped with standard single nozzles, whereas Unit No. 3 was furnished with a primary nozzle and an auxiliary nozzle. In 1914, Charles O. Poole, chief engineer of the Nevada-California Power Company, described the original power generation machinery for *Electrical World*:

There are three 2000-kw generating units in this power house, with an overload capacity of 25 per cent. All of the electrical apparatus in this station is of Westinghouse make. Two of the units are driven by Pelton wheels, with Pelton governors operating the needles, and the stream deflectors. The control is so arranged that the needle and deflector can be operated with the governor, or the deflector alone can be instantly attached to the governor and the needle regulated and set to any position by hand. The last-name method is made use of at this plant most of the time, as the load is nearly constant, the governing being taken care of at one of the other plants. The third unit is provided with a Doble wheel and an auxiliary type nozzle. The wheel is controlled by a Lombard-Doble directly connected governor so arranged that when the main needle is closed to any appreciable extent during the cycle of regulation the auxiliary nozzle opens correspondingly and slowly closes by means of a cataract cylinder on the stem of the auxiliary needle... The generators are wound for 2200 volts, three-phase, sixty cycles, and operate at 300 r.p.m.²⁴

Turbines (Water Wheels)

Originally, Units No. 1 and No. 2 were driven by single-hung Pelton-manufactured water wheels. During the mid-twentieth century, the original water wheels on both units were replaced with newer cast iron Pelton-manufactured wheels. This occurred on Unit No. 1 in 1952 and on Unit No. 2 in 1950. These newer Pelton water wheels operated at 300 rpm (rotations per minute) consistent with original specifications for the units and they also maintained the original number of buckets per wheel (17). Furthermore, in 2009, the newer Pelton water wheel in Unit No. 2 was replaced with a new stainless steel Canyon Hydro-manufactured water wheel (21 buckets) that is 94" in diameter. In 1950, the original Doble-manufactured water wheel at Unit No. 3 was replaced with a newer cast iron Pelton-manufactured water wheel, which operated at 300 rpm consistent with original specifications for the unit, and which maintained the original number of buckets

²⁴ Poole, "Hydraulic and electric features of stations No. 2 and No. 3," p. 19-21.

(18). Unit No. 3 retains its dual needle operation with a primary nozzle and an auxiliary nozzle. All of the water wheel replacements occurred within the original cast iron machine housings and mountings which are extant.

Generators

Similarly, the original generators furnished by Westinghouse were upgraded over time. They are revolving field, alternating current generators that operate at 300 rpm (in tandem with direct-connected water wheels). As originally designed, the generators were rated at 2,000 kw and delivered three-phase current at 2,200 volts. After service in 1959, the generators at Units No. 1 and No. 2 were upgraded for an output capacity of 2,500 kw each; and the generator at Unit No. 3 had an output capacity of 2,320 kw after service in 1958. These generator upgrades retained the original rotors and the original generator housings which are extant.

Governors

Originally, Pelton governors with self-contained oil tanks, operated by 3 horsepower (hp), 300 rpm General Electric induction motors, controlled the nozzle mechanisms at Units No. 1 and No. 2. At Unit No. 3, the nozzle mechanism was controlled by a Lombard-Doble type "Q" governor, with oil furnished by a Lombard automatic oil pump driven through a Morse chain by a 5 hp, 900 rpm General Electric motor. In approximately 1931, the original governor and oil pump at Unit No. 3 was replaced by a Woodward governor. Woodward governors with distinctive bell-shaped heads and stylized meters are extant on all three units. It is not known if replacement of all three original governors occurred at the same time. On the metal housing of the Woodward governor on Unit No. 3, painted notations indicate that "NEW BRNG" (new bearing) was installed in "2-85" (February 1985) and "3-04" (March 2004).

Exciters

Originally, the powerhouse contained two water-driven exciters that provided the direct current initially needed to energize the electromagnets within the larger generators. The original exciters operated as independent generating units with impulse turbines. The exciters, including impulse water wheels, housings, and generators, were located with their shafts in line along the north wall of the powerhouse. The original exciter machinery was described in the *Journal of Electricity Power and Gas* in 1913:

The generators in both cases are Westinghouse, 100 kw., 6-pole d.c. machines, operating at 580 r.p.m., and delivering current at 125 volts. The waterwheels are Pelton single overhung runners with hand operated needle nozzles and cast iron housings. One of the units has a Westinghouse 140 h.p., 2,200 volt induction motor placed between the water wheel and the generator, there being one bearing between the water wheel and the motor

and another at the far side of the generator. With the first unit the two generator bearings furnish the only shaft support.²⁵

In 1968, new Allis Chalmers exciters delivering current at 125 volts were installed on all three units; and in 1995, new Basler Electric exciters delivering current at 125 volts were installed on all three units. These solid-state exciter units are extant. Directly adjacent to each unit on the east side, an exciter transformer cabinet (presumed Allis Chalmers) is positioned to the south, and a Basler Electric static exciter cabinet is positioned to the north. The two original water-driven exciters were removed from their location along the north wall of the powerhouse, and the pit was covered with metal foundation plates. The area is currently empty.

Additional Machinery

Other notable details of operating machinery within the powerhouse include: removal of the original Westinghouse five-panel switchboard with underground cables from in front of the fourth bay along the north wall and installation of a new switchboard within the switchboard (operations) room that was constructed in its place in 1927; installation of cooling water filter equipment within a roofless concrete block enclosure at the southwest corner of the building; installation of an air compressor at the west end of the building; installation of an oil pump in the northeast corner of the building; and installation of various electrical conduits, panels, and boxes along perimeter walls and on machinery housings, which support electronic sensors, controls, and automation. The dates of the latter alterations are not known.

C. Technology:

This section describes the technology of impulse turbines, also known as Pelton wheels, which are used to create hydroelectric power at Powerhouse No. 2.

Impulse Turbines (Pelton Wheels)

The “Pelton” or impulse wheel, the prime converter used for generating electrical energy on the Bishop Creek System, was designed and perfected in northern California during the last quarter of the nineteenth century (1872-1890). The Pelton wheel was named for its inventor Lester Allan Pelton who was based in California. All impulse water wheels are basically variations on the earliest Pelton concept, although impulse water wheels in the Bishop Creek System were also manufactured by the Doble, Henry, and Worthington companies as well as the Pelton company. With the application of a technology which evolved from the water monitor used in hydraulic mining, impulse wheels are driven by extremely high-velocity jets of water playing on buckets at the periphery of a high-strength iron or steel wheel. These wheels depend not on the mass of water falling the distance of the diameter of the wheel but on the velocity of the impacting jet of water. Impulse water wheels are especially well suited to high-head (high-pressure) but relatively low-volume water power resources. These wheels are also adaptable to streams

²⁵ Van Norden, “System of Nevada-California Power Company,” p. 8.

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with highly variable flow regimes. Current-day Pelton wheels, which are considered over 80-percent efficient, have bucket shapes which are slightly revised from those used originally on Bishop Creek – an improvement which increases the efficiency of energy transfer by a small percentage.²⁶

The operation of an impulse turbine involves precise control over the high-velocity stream of water that strikes the wheel's buckets. This is accomplished by adjusting the position of a "power needle" that is located at the end of a penstock "nozzle" and that can variously restrict or permit water passage. Water passing through the end nozzle and past the power needle is directed with a "stream deflector" to strike the buckets at the proper angle for the desired rotation. Some impulse wheels are fitted with multiple nozzles and power needles, in which water under high pressure is directed against the wheel at multiple locations at the same time, which provides greater control and efficient use of water. After turning with the wheel, the water in the buckets falls to the bottom of the wheel housing and flows out. A typical impulse wheel turns the flow of water approximately 170 degrees from the point it receives the water pulse to the point that it drops the water into the tailrace.²⁷

In the Bishop Creek system, which is typified by high-head, low-volume conditions, 12 of the 14 power generation units contained within four of its five powerhouses are driven by impulse turbines. Impulse turbines are installed in the three highest powerhouses at Plants 2, 3, and 4 and in the lowest powerhouse at Plant 6, which utilizes a dual-wheel, four-nozzle configuration with its single power generation unit in order to compensate for the low-head conditions found at the lower reaches of Bishop Creek. Other impulse turbines in the Bishop Creek system are configured with single nozzles, with the exceptions of Unit No. 2 at Plant 2 and Unit No. 5 at Plant 4, which operate with primary and auxiliary nozzles that provide greater control. The only powerhouse in the Bishop Creek system that does not use impulse wheels is located at Plant 5 which contains two units with reaction turbines.

²⁶ Diamond, Helmich, and Hicks, "Evaluation of the Historic Resources," p. 11-12.

²⁷ U.S. Department of the Interior, "Reclamation: Managing Power in the West – Hydroelectric Power," unpaginated.

PART IV: SOURCES OF INFORMATION

A. Primary Sources:

Clerico, Robert and Ana Beth Koval. "An Architectural and Historical Evaluation of Structures Associated with the Bishop Creek Hydroelectric Power System, Inyo County, California." Prepared for Southern California Edison Company, Rosemead, CA: Intermountain Research, December 1986. Located in SCE company archives at 4000 Bishop Creek Road, Bishop, California.

Diamond, Valerie, Stephen G. Helmich, and Robert A. Hicks. "Evaluation of the Historic Resources of the Bishop Creek Hydroelectric System." Prepared for Southern California Edison Company, Rosemead, CA: Theodoratus Cultural Research, Inc., July 1988. Located in SCE company archives at 4000 Bishop Creek Road, Bishop, California.

Myers, William A. *Iron Men and Copper Wires: A Centennial History of the Southern California Edison Company*. Glendale, California: Trans-Anglo Books, 1986.

Poole, C. O. "Hydraulic and electric features of stations No. 2 and No. 3 of the Nevada-California Power Company – Tailrace water of former discharges directly into intake of latter." Pages 19-26 in *Power Development and Transmission Systems of The Nevada-California Power Company and the Southern Sierras Power Company*. Reprinted in 1915 from *Electrical World*, New York, 1914. Located in SCE company archives at 4000 Bishop Creek Road, Bishop, California.

_____. "Hydroelectric Development on Bishop Creek, Cal." Pages 3 -7 in *Power Development and Transmission Systems of The Nevada-California Power Company and the Southern Sierras Power Company*. Reprinted in 1915 from *Electrical World*, New York, 1914. Located in SCE company archives at 4000 Bishop Creek Road, Bishop, California.

Southern California Edison Company. Eastern_Hydro_Facilities_Data. Microsoft Excel databases transmitted on October 19, 2011. Located in SCE company archives at 4000 Bishop Creek Road, Bishop, California.

_____. "Southern California Edison Hydro Generation Division." October 25, 1983. Appended April 26, 1988 and October 11, 1990. Located in SCE company archives at 4000 Bishop Creek Road, Bishop, California.

Taylor, Thomas T. "Bishop Creek Hydroelectric System." HAER No. CA-145. Historic American Engineering Record, National Park Service, U.S. Department of the Interior, 1994.

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U.S. Department of the Interior, Bureau of Reclamation Power Resources Office. "Reclamation: Managing Power in the West – Hydroelectric Power," July 2005, unpaginated. Found at <http://www.usbr.gov/power/edu/pamphlet.pdf>, accessed on January 30, 2012.

Van Norden, Rudolph W. "System of Nevada-California Power Company and the Southern Sierras Power Company. Part 1 – Power Plants." Pages 1-20 in *Properties and Power Developments of the Nevada-California Power Company and the Southern Sierras Power Company*. Reprint from the *Journal of Electricity Power and Gas*. Volume XXXI. Numbers 1-2. July 5-12, 1913, by Technical Publishing Company (San Francisco). Located in SCE company archives at 4000 Bishop Creek Road, Bishop, California.

Drawings available from Southern California Edison Company (located in SCE company archives at 4000 Bishop Creek Road, Bishop, California):

Nevada-California Power Company. "East Elevation of Power House, Southeasterly End Elevation of Power House No. 2." March 1908, Sheet 1 of 6, SCE Drawing No. 434407-0.

_____. "Elevations of Foundation Plan for Power House No. 2." May 12, 1908, SCE Drawing No. 570865-1.

_____. "Floor & Foundation Plan, Operating & Bus Room Addition." February 11, 1927; redrawn on June 24, 1966 and revised on April 13, 1967. SCE Drawing No. 435847-4.

_____. "Floor Plan of Power House No. 2." March 1908, Sheet 3 of 6, SCE Drawing No. 434409-0.

_____. "Foundation Plan, No. 3 Unit, Power Plant No. 2." March 31, 1910, SCE Drawing No. 570870-1.

_____. "Foundation Plan, Unit No. 1, Power House No. 2." May 27, 1908, SCE Drawing No. 570868-0.

_____. "General Foundation Plan for Power House No. 2." March 1908, SCE Drawing No. 570866-1.

_____. "Roof Details of Power House No. 2." March 1908, Sheet 5 of 6, SCE Drawing No. 434411-0.

_____. "Security Features for Power House No. 2 on Bishop Creek." November 13, 2003, SCE Drawing No. 245969-0.

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_____. “Sketch Showing Elimination of Windows in Wall Between Generator Room and Bus Room, Power House No. 2.” April 13, 1938, SCE Drawing No. 124241-0.

_____. “South Side Elevation of Power House No.2.” March 1908, Sheet 2 of 6, SCE Drawing No. 434408-0.

B. Secondary Sources:

Poole, C. O. “Hydraulic and electric features of stations Nos. 4 and 5 of the Nevada-California Power Company – Static head at the former station, 1100ft.” Pages 27-31 in *Power Development and Transmission Systems of The Nevada-California Power Company and the Southern Sierras Power Company*. Reprinted in 1915 from *Electrical World*, New York 1914. Located in SCE company archives at 4000 Bishop Creek Road, Bishop, California.

_____. “Power house and equipment of station No. 6 of the Nevada-California Power Company – All water leaving station used for irrigation purposes.” Pages 32-34 in *Power Development and Transmission Systems of The Nevada-California Power Company and the Southern Sierras Power Company*. Reprinted in 1915 from *Electrical World*, New York, 1914. Located in SCE company archives at 4000 Bishop Creek Road, Bishop, California.

White, David R. M. “Management Plan for Historic and Archaeological Resources Associated with the Historic and Archaeological Preservation Plan for the Bishop Creek Hydroelectric Project (FERC Project 1394), Inyo County, California.” Prepared for the Southern California Edison Company, Rosemead, California: March 1989. Located in SCE company archives at 4000 Bishop Creek Road, Bishop, California.

C. Likely Sources Not Yet Investigated:

An inquiry was made to The Huntington Library, Arts Collections, and Botanical Gardens (The Huntington) located in San Marino, California, regarding the availability of construction drawings for Bishop Creek plants that may be stored in the Southern California Edison Records, 1848-1989 (SCE Records). According to The Huntington personnel and finding aids, the SCE Records do not contain indexed construction drawings. However, a vast volume of materials is indexed in the SCE Records in a variety of categories that include: Administrative Records; Department/Division Records; Financial Records; Generation, Distribution, and Transmission Records; Project Records; Research Files; Topical Records; and Oversize Materials. These materials could potentially yield additional information related to the historical development of Bishop Creek power plants. This information could be gathered by conducting a thorough review of materials indexed in the SCE Records.

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In addition, the Huntington maintains a Digital Library that includes a Southern California Edison Photographs and Negatives Collection (SCE Photograph Collection). This SCE Photograph Collection contains numerous historical photographic images of SCE facilities that could potentially yield additional information related to the historical development of Bishop Creek power plants. This information could be gathered by conducting a thorough review of photographic images indexed in the SCE Photograph Collection.

Other potential sources of information that could be investigated include current and former power company employees, who may have knowledge of the historical development of Bishop Creek power plants which may not be contained in available documents, drawings, or other materials. This information could be gathered by contacting and conducting interviews with individuals who potentially have this knowledge.

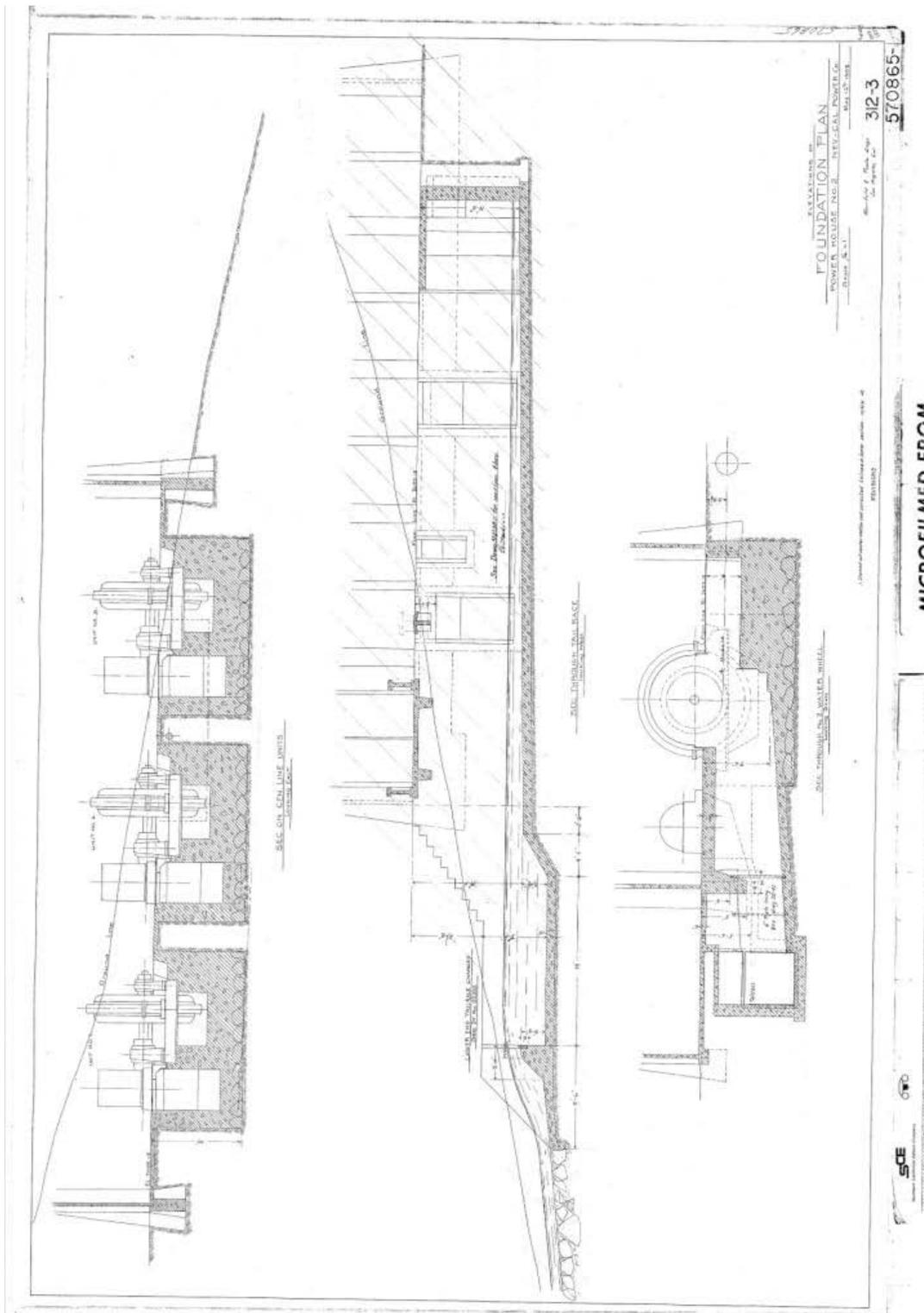


Figure 3: Nevada-California Power Company, "Elevations of Foundation Plan for Power House No. 2," May 12, 1908. SCE Drawing No. 570865-1.

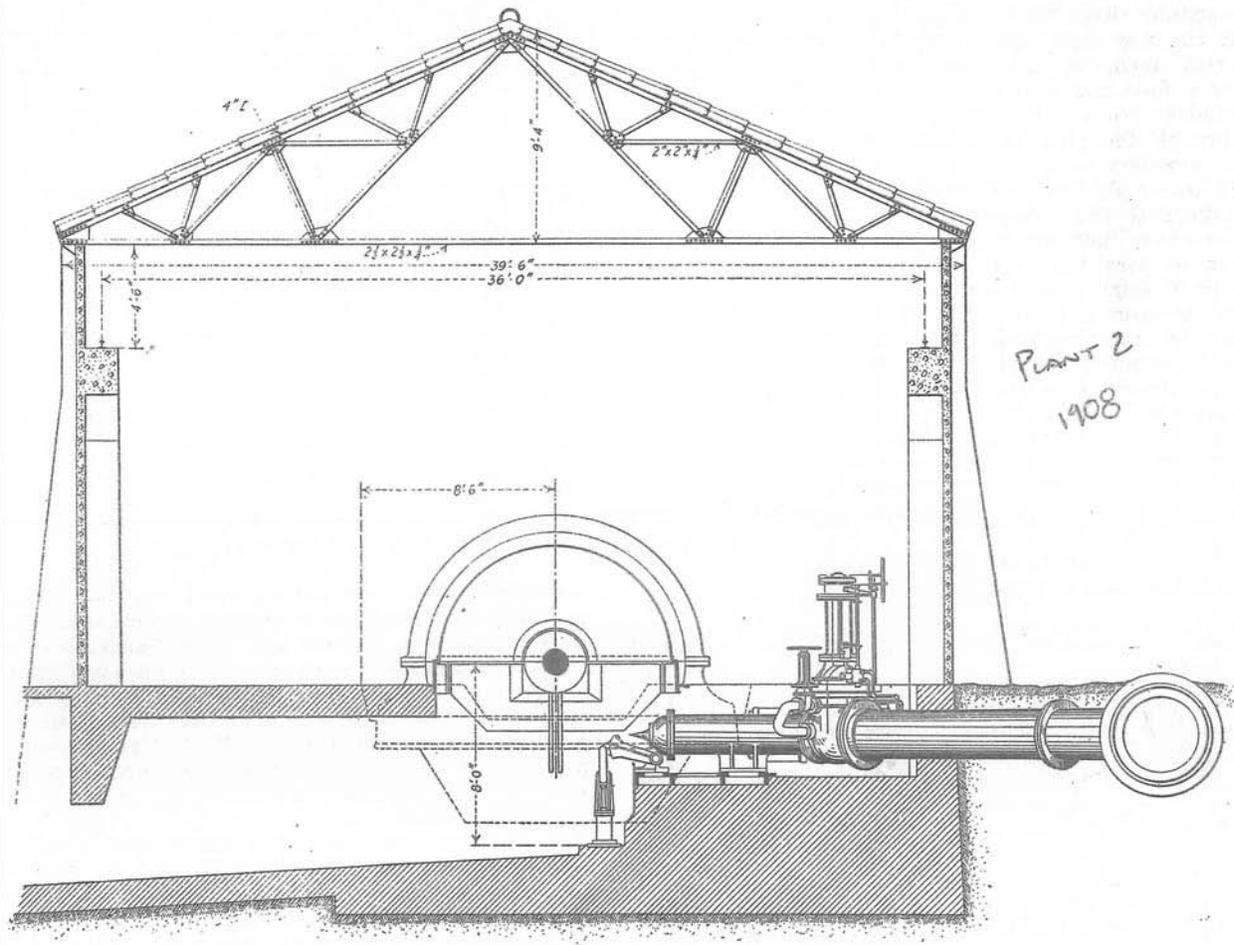


Figure 4: Section elevation of Powerhouse No. 2 through an impulse wheel unit. Poole, C. O., "Hydraulic and electric features of stations Nos. 4 and 5 of the Nevada-California Power Company – Static head at the former station, 1100ft," *Power Development and Transmission Systems of The Nevada-California Power Company and the Southern Sierras Power Company*, 1915, Figure 24, p. 21; reprinted from *Electrical World*, New York, 1914.

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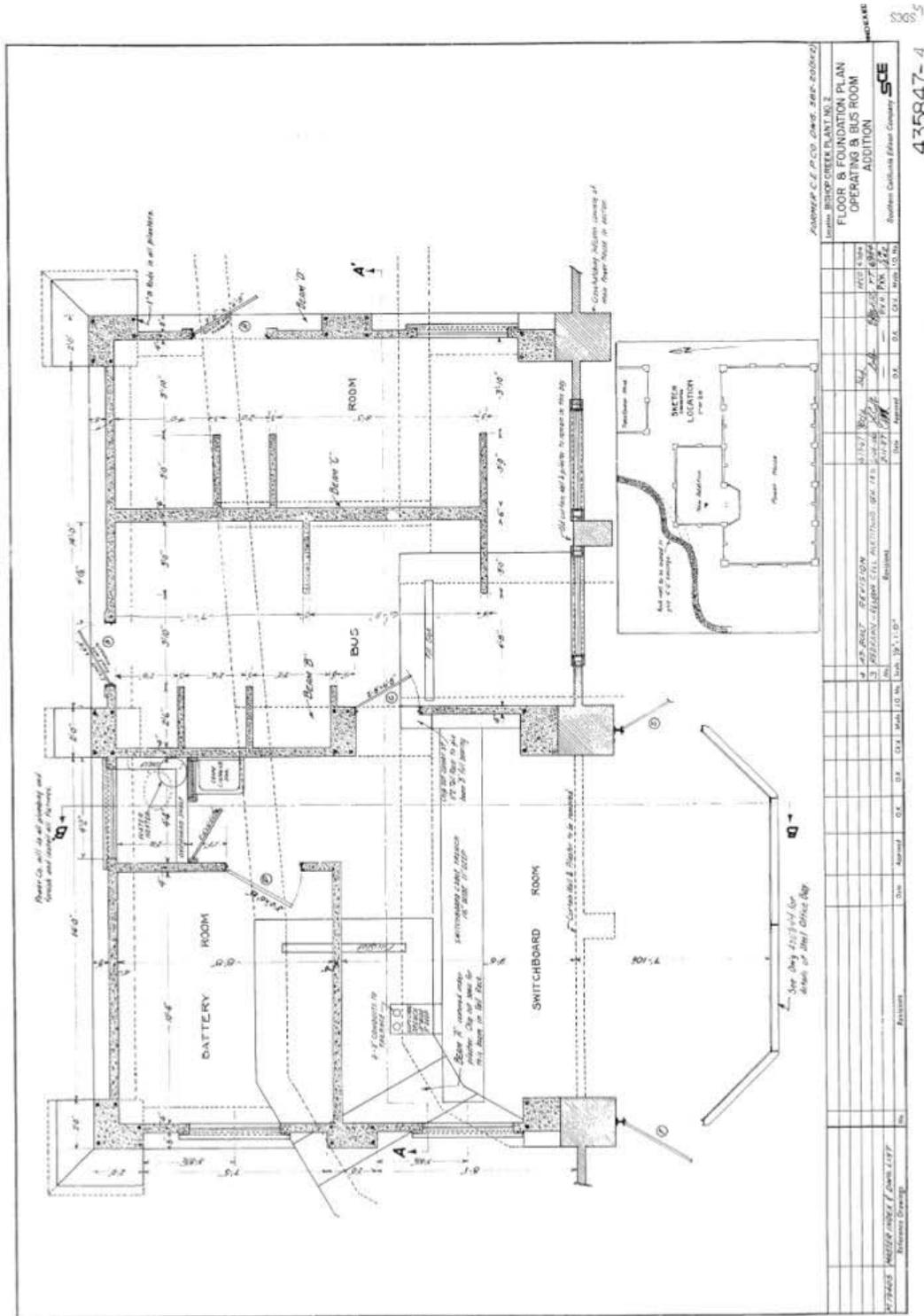


Figure 5: Nevada-California Power Company, “Floor & Foundation Plan, Operating & Bus Room Addition,” February 11, 1927; redrawn on June 24, 1966 and revised on April 13, 1967. SCE Drawing No. 435847-4.