RUSH CREEK HYDROELECTRIC SYSTEM, AGNEW LAKE DAM

HAER CA-166-F
HAER CA-166-F

June Lake vicinity
Mono County
California

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

Rush Creek Hydroelectric System, Agnew Lake Dam
HAER No. CA-166-F

Location: The Agnew Lake Dam is located approximately 3.3 air miles southeast of the approximate center of the town of June Lake in Mono County, California, and approximately 0.8 air miles southeast of the Rush Creek Powerhouse, which is situated on the west side of California State Route 158 (the June Lake Loop). The dam is located in the Inyo National Forest. From the Rush Creek Powerhouse, the dam site is accessible by an incline railroad, the Agnew Tram, which is controlled by the Southern California Edison Company. Public access to the dam site from the highway is provided by a foot/equestrian trail. There is no automobile access to the site.

The approximate center of the crest of the Agnew Lake Dam is located at UTM Zone 11S, easting 312208.00m, northing 4181102.00m. Distances and coordinates were obtained on November 6, 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: The Agnew Lake Dam is a reinforced concrete multiple-arch dam that is a component of the Rush Creek Hydroelectric System. The dam impounds a natural glacial lake, the Agnew Lake reservoir, which supplies water to the Rush Creek Powerhouse via pressure pipelines, or penstocks. The Agnew Lake Dam is one of three dams in the Rush Creek Hydroelectric System.

Significance: The Agnew Lake Dam, constructed in 1915-1916, is a contributing element of the Rush Creek Hydroelectric System historic district. It is significant for its position in the development of hydroelectric generation on the eastern slope of the Sierra Nevada and its nationally distinctive engineering characteristics. The district is significant under National Register of Historic Places Criterion A (broad patterns of history) and Criterion C (distinctive characteristics of period and type of engineering and construction that represent the work of a master). The Period of Significance for the district is 1915-1925.

Historian: Matthew Weintraub, Senior Architectural Historian
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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 Agnew Lake Dam recording project was undertaken by Galvin Preservation Associates Inc. (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. 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. James Sanderson (GPA) produced the large format photographs. The field team consisted of Andrea Galvin (GPA), James Sanderson (GPA), and Crystal West (SCE).

Researchers may also refer to:

- HAER No. CA-166-A, Rush Creek Hydroelectric System, Powerhouse Exciters (January 15, 1995)
- HAER No. CA-166-B, C, D, E, Rush Creek Hydroelectric Worker Cottages (Buildings 103, 104, 105, 108) (September 30, 1997)
- HAER No. CA-166-G, Rush Creek Hydroelectric System, Gem Lake Dam (January 14, 2013)
- HAER No. CA-166-H, Rush Creek Hydroelectric System, Rush Meadow Dam (January 14, 2013)

Part I. Historical Information

A. Physical History:

1. **Date of Construction:**
Construction of the Agnew Lake Dam occurred in 1915-1916.[1]

2. **Engineer:**
Lars R. Jorgensen, engineer, of San Francisco, designed the Agnew Lake Dam and supervised its construction. E. J. Waugh served as resident engineer, and L. B. Curtis served as field engineer. Charles Oscar Poole of the Nevada-California Power Company served as the chief engineer for the entire development.[2]

3. **Builder/Contractor/Supplier:**
The Duncan-Harrelson Company of San Francisco, contractors, constructed the Agnew Lake Dam, with F. O. Dolson serving as superintendent of construction.[3] Bear brand Portland cement was delivered to the site and mixed with local sand and rock to make concrete; lumber for forms was procured at the dam site.[4]

4. **Original Plans:**
Original construction plans for the Agnew Lake Dam are not found in the records of the Southern California Edison Company (SCE), which currently owns the dam. However, a paper published in the *Transactions of the American Society of Civil Engineers* during the early twentieth century, and written by Lars. R. Jorgensen, the engineer who designed the Agnew Lake Dam, describes the original design and construction of the dam. This paper, "Multiple-Arch Dams on Rush Creek, California," was published in 1917, shortly after the major work of building the dam was completed. It includes narrative description, drawings, and photographs of the two dams that were originally constructed in the Rush Creek Hydroelectric System, the Agnew Lake Dam and the Gem Lake Dam. Although Jorgensen's discussion focuses primarily on the larger of the two dams, the Gem Lake Dam, the design he describes and illustrates also applies to the Agnew Lake Dam.

   Jorgensen reported that the Agnew Lake Dam was 280' long at its crest and 30' high at its tallest point from grade.[5] His drawings show that the dam was built as a contiguous, linear series of reinforced concrete arches, inclined at 50 degrees to horizontal on the upstream side, with the crest located at an elevation of 8,495'. The span included seven arch segments that became designated as Arches No. 1

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[1] L. R. Jorgensen, "Multiple-Arch Dams on Rush Creek, California," Transactions of the American Society of Civil Engineers 81 (1917): 850.
[2] Jorgensen, "Multiple-Arch Dams," 881.
[3] Jorgensen, "Multiple-Arch Dams," 881.
[4] Jorgensen, "Multiple-Arch Dams," 879.
[5] Jorgensen, "Multiple-Arch Dams," 881.

to No. 7 from north to south. Each full arch segment was 40’ wide between the centers of the adjoining buttresses. The vertical distance between the crest and the toe of the dam varied along the span according to the uneven terrain within the incised stream channel. The dam’s maximum height from grade was 30’, at approximately Arches No. 5 and No. 6. The thickness of the arches increased consistently from 1.0’ at the crest to 1.85’ at a point 30’ below the crest.[6] At the downstream faces of the arches, the intrados transitioned from circular at the bases to elliptical at the tops.[7]

Concrete buttresses adjoined the arches, extending approximately 14’ back from the springing line of the arches to the downstream side at the crest of the dam. The tapered buttresses varied in thickness from 1.85’ at the crest to 2.75’ at a point 30’ below the crest. At Arches No. 3 through No. 7, braced horizontal steel struts were tied between the buttresses.[8]

Arches No. 5 and No. 6 were constructed with spillways. Each spillway consisted of a row of eight rectangular openings arranged symmetrically across the top of the arch just below the crest. The overflow openings were approximately 24” tall and 64” wide, with 8” wide columns separating the openings. The openings could be closed with loose flash-boards.[9] The outlet works consisted of a tilted concrete chamber with a row of iron bars situated at the upstream base of the dam between Arches No. 4 and No. 5, and connected to a 30” diameter pipe that passed through Arch No. 4.[10]

5. **Alterations and Additions:**
Since its original construction, minimal alterations to the Agnew Lake Dam have occurred as a result of maintenance and improvement projects. At an unknown time, it appears that a metal outflow box and a vertical steel blow-off pipe were constructed at the downstream side of Arch No. 4. According to a paper published in the *Transactions of the American Society of Civil Engineers* in 1926, the gunite coating was removed in 1925 and various water-proofing compounds were tested on the upstream face of the dam.[11] According to a historic resources inventory of the Rush Creek Hydroelectric System completed in 1988, gunite patching to the upstream face occurred in 1940, 1951, and 1955; new wire mesh and a full gunite coating were applied in 1957; and similar work was completed in 1968, and the upstream face was treated with a poly-sulfide paint seal.[12]

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[6] Jorgensen, “Multiple-Arch Dams,” 860 (Fig. 4), 861 (Fig. 5), 868 (Fig. 8).
[7] Jorgensen, “Multiple-Arch Dams,” 857.
[8] Jorgensen, “Multiple-Arch Dams,” 860 (Fig. 4), 861 (Fig. 5), 871 (Fig. 12).
[9] Jorgensen, “Multiple-Arch Dams,” 867 (Fig. 7), 870 (Fig. 10).
[10] Jorgensen, “Multiple-Arch Dams,” 867-868, 871 (Fig. 11).
[11] Fred O. Dolson and Walter L. Huber, “Multiple-Arch Dam at Gem Lake on Rush Creek, California,” Transactions of the American Society of Civil Engineers 89 (1926): 787.
[12] James C. Williams and Roger A. Hicks, Evaluation of the Historic Resources of the Lee Vining (FERC Project Number 1388) and Rush Creek (FERC Project Number 1389) Hydroelectric System, Mono County, California (Fair Oaks, California: Theodoratus Cultural Research, Inc., 1989), A-59.

According to plan drawings by SCE, a gunite coating was applied to the upstream face and gunite repairs were implemented in 1967. This work involved chipping out of the original concave profile of the crest line to allow for a gunite cap over the lip of the crest. At each arch, a 3" thick gunite coating was applied in a single continuous operation over a layer of welded wire fabric that was tied into the upstream face of the dam. The gunite coating was troweled smooth and Thiokol or equal waterproofing material was applied. Also, deteriorated concrete was removed from the downstream side of the dam and rebuilt with gunite.[13] A drawing from 1988, which was prepared for a plan compendium, indicates that a gunite coating with an average thickness of 5" was in place on the upstream face by that time.[14]

On August 1, 2012, the Southern California Edison Company was authorized to carry out physical improvements to the Agnew Lake Dam. Work on the dam began in September 2012 and was underway as of the production of this report in November 2012. The improvements included: installing a geomembrane liner on the upstream face of the dam to block current leaks and prevent future leaks; repairing deteriorated areas on the face of the dam by concrete filling and patchwork; grouting the foundation of the dam; and replacing the steel grids at the intake.[15]

B. Historical Context:

The Agnew Lake Dam and the Rush Creek Hydroelectric System, of which the dam is a part, were constructed during the early twentieth century, which was an era of growth and advancement for the hydroelectric generation industry. Spurred on by great commercial demand for electricity, various parties sought to capitalize on the tremendous potential of Rush Creek, and other watersheds of the Sierra Nevada, for power generation. Ultimately, it was the Pacific Power Corporation that began hydroelectric development of Rush Creek in 1915, led by James Stuart Cain, who initially acquired the rights to develop Rush Creek, and Delos Allen Chappell, president of the Nevada-California Power Company. Development proceeded under the Pacific Power Corporation, and later under the Nevada-California Power and Southern Sierras Power companies, all of which were controlled by the Nevada-California Electric Corporation.[16]

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[13] Southern California Edison Company, Gem Lake Dam and Agnew Lake Dam Maintenance (1966), Southern California Edison Company database (SCE Drawing No. 585927-3).

[14] Southern California Edison Company, Agnew Lake Dam Existing Plans, Elevations, and Sections (1988, revised 2008 and 2002), Southern California Edison Company database (SCE Drawing No. 5204741-0).

[15] State Water Resources Control Board, In the Matter of Water Quality Certification for the Southern California Edison Agnew Lake Dam Geomembrane Liner Installation and Dam Repairs Project (2012), 2-3, http://www.waterboards.ca.gov/waterrights/water_issues/programs/water_quality_cert/docs/lakeagnew/cert_lake_agnew.pdf.

[16] Valerie H. Diamond and Roger A. Hicks, Historic Overview of the Rush Creek and Lee Vining Creek Hydroelectric Projects (Fair Oaks, California: Theodoratus Cultural Research, Inc., 1988), 7-12.

In 1915, the Pacific Power Corporation commissioned the design and construction of two reinforced concrete multiple-arch dams to impound reservoirs on the Rush Creek system.[17] This was an important decision because, at the time, reinforced concrete multiple-arch dams were rare and controversial. "Compared with gravity, arch, and flat-slab buttress dams, the multiple arch concept occupied a minor – almost nonexistent – place in the world of hydraulic engineering at the start of the twentieth century."[18] Nonetheless, reinforced concrete multiple-arch dams generally represented a 30 to 40 percent savings in material costs over conventional gravity dams because they used far less cement.[19] According to Dolson and Huber in 1926, this was a key consideration in the decision to build reinforced concrete multiple-arch dams on Rush Creek, which was located in a very isolated location that made material costs exorbitant:

> Physical conditions governing the original construction of Gem Dam [and Agnew Lake Dam] had much to do with the selection of the multiple-arch type. Materials for an earth dam were not available. A masonry dam was thought, at the time, to have certain advantages over a rock-fill type. Because of the excessive cost of materials, the quantities required for a masonry dam of the gravity type had to be avoided. These considerations led to the selection of the multiple-arch type.[20]

Less than a decade earlier, in 1908-1909, the first reinforced concrete multiple-arch dam in the world was built at Hume Lake, California. This dam was designed by engineer John W. Eastwood, who championed the multiple-arch dam design as "The Ultimate Dam," due to its structural characteristics as well as its savings in construction costs over other types of dams. The multiple-arch dam design made development of water projects feasible that would otherwise have remained economically marginal or prohibitively expensive, such as the Rush Creek Hydroelectric System. Eastwood designed more than 60 hydraulic projects in his career throughout the western United States and Mexico, including multiple-arch dams, none of which ever failed or caused loss of life or substantial property loss.[21]

However, despite their utility and economic advantages, multiple-arch dams were not widely accepted because they departed from traditional dam-building methods and principles. They belonged to the category of carefully engineered "structural dams," whose strengths were not visually obvious. Most engineers and the general public preferred the simpler designs of "massive dams," which conveyed strength and mass through their visual characteristics.[22] According to Donald C. Jackson, who authored a text on Eastwood and the development of multiple-arch dams, this dichotomy between

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[17] Diamond and Hicks, Historic Overview, 13, 19.
[18] Donald C. Jackson, Building the Ultimate Dam: John S. Eastwood and the Control of Water in the West (Lawrence, Kansas: University Press of Kansas, 1995), 34.
[19] Jackson, Building the Ultimate Dam, 3.
[20] Dolson and Huber, "Multiple-Arch Dam," 714-715.
[21] Jackson, Building the Ultimate Dam, 2-3, 12.
[22] Jackson, Building the Ultimate Dam, 18-21.

massive dams and structural dams lay at the root of the deep-seated reluctance of the general public and many professionals to accept multiple-arch dams:

> While massive dams are simple to conceptualize, they make profligate use of construction materials. In contrast, structural dams require relatively small amounts of material, but can present more sophisticated problems in design and construction... Historians must appreciate the conflict between the massive and structural traditions in order to come to grips with many of the controversies that attended dam building during the early twentieth century.[23]

Engineer Lars R. Jorgensen of San Francisco, who was commissioned by the Pacific Power Corporation to design the two original dams in the Rush Creek system, was a proponent of reinforced concrete multiple-arch dams. Jorgensen, an established theoretician on arch dams, was aware of Eastwood's work. Jorgensen proceeded to design the Agnew Lake Dam and the Gem Lake Dam as reinforced concrete multiple-arch dams that were similar to Eastwood's dam at Hume Lake. Jorgensen used an identical design for both dams, which originally differed from each other only in span length and in details. Jorgensen introduced elliptical shapes at the tops of the arches for greater strength, and he included hooped steel reinforcement, which allowed him to patent the dam design.[24]

Within a few years of construction, deterioration occurred on the downstream face of the Gem Lake Dam, which was the larger of the two dams. The deterioration was apparently caused by water penetrating the concrete and freezing during the extremely cold winters.[25] However, this problem did not occur on the lesser of the two dams, the Agnew Lake Dam. According to Jorgensen:

> The Agnew Lake Dam, built of practically the same material on the same stream [as the Gem Lake Dam], but 500 ft. lower in elevation, is still in first-class condition. The water level in this reservoir, however, is not appreciably lowered during the cold season, and snowdrifts protect the down-stream face to a great extent from the extreme cold weather.[26]

Although the problem with the Gem Lake Dam was not structural, ultimately caused minor damage, and was successfully remedied by the addition of gravity sections that insulated the thin concrete arches, the problem fueled the controversy over the suitability of reinforced concrete multiple-arch dams. The deterioration of Gem Lake Dam was discussed extensively at meetings and in publications of the American Society of Civil Engineers, and it ultimately contributed to the downfall of the multiple-arch dam

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[23] Jackson, Building the Ultimate Dam, 20-21.
[24] Williams and Hicks, Evaluation, A-67-68.
[25] Williams and Hicks, Evaluation, A-69.
[26] J. Y. Jewett et al., Discussion of "Multiple-Arch Dam at Gem Lake on Rush Creek, California," by Fred O. Dolson and Walter L. Huber, Transactions of the American Society of Civil Engineers 89 (1926): 741.

movement in the United States.[27] According to Jackson, the legacy of multiple-arch dams such as those found on Rush Creek is mixed:

> Consequently, in terms of performance, they can be considered a success worthy of his [Eastwood's] claims. In another sense, however, multiple arch dams represent a profound failure, since they never achieved great influence in the development of America's water resources. Although approximately fifty multiple arch dams were built in the United States in the first part of the twentieth century, this number pales in comparison to hundreds of earthen and concrete gravity dams built during the same period; by 1945 the technology had almost completely disappeared from the design lexicon of American dam engineers.
>
> Thus, the history of Eastwood and the multiple arch dam encompasses both success and failure, depending on the context of analysis. For historians, this dichotomy is significant because it offers insight into important aspects of western water development that might be overlooked in analyses of more traditionally "successful" or prominent technologies. Eastwood's hopes of deploying "The Ultimate Dam" throughout the arid region provided chimerical, but his accomplishments and frustrations survive as touchstones for those seeking to comprehend the modern West's hydraulic infrastructure.[28]

Part II: Structural/Design Information

A. General Description:

The Agnew Lake Dam is a linear, reinforced concrete multiple-arch structure. The crest is 278' long and located at 8,498.9' in elevation. The dam is comprised of five full arches adjoined by buttresses, and two partial arches at the ends, which are designated from north to south as Arches No. 1 to No. 7. In plan view, the multiple-arch dam has a reeded, scalloped profile.[29] The arches are tilted at 50 degrees to the horizontal, with the intrados open to the downstream side.[30] The maximum height of the dam above grade is 30', and the maximum height from the crest to the lowest point in the foundation is 34'.[31] Metal pipe handrails are installed along a runway atop the crest. A geomembrane layer covers the upstream face of the dam.

The arches are circular at the bases and transition to elliptical at the tops. Each full arch segment is 40' wide between the centers of the adjoining buttresses. The arches vary in thickness from 1.4' at the crest (which appears to include the thickness of the gunite coating) to 1.85' at a point 30' below the crest. The tapered buttresses are 1.85' wide at

[27] Williams and Hicks, Evaluation, A-69.
[28] Jackson, Building the Ultimate Dam, 12.
[29] Southern California Edison Company, Agnew Lake Dam Existing Plans.
[30] Jorgensen, "Multiple-Arch Dams," 860 (Fig. 4).
[31] Williams and Hicks, Evaluation, A-58.

the crest and 2.75’ wide at a point 30’ below the crest. Along the span from Arches No. 3 to No. 7, 12” by 18” steel-reinforced concrete struts extend horizontally between the buttresses, 10’ below the crest. At Arch No. 7, which is a partial arch, the horizontal bracing is anchored to the south canyon wall.[32] At Arch No. 2, a diagonal strut braces the northernmost buttress and anchors to the canyon floor.

Spillways are located in Arches No. 4 and No. 5. Each spillway is comprised of eight rectangular openings, each approximately 5’ wide and 2’ high, arranged in a horizontal row just below the crest of the dam, at 8,495.88’ in elevation. The inlet works is a concrete chamber built against the base of the upstream face, between Arches No. 4 and No. 5, at an elevation of 8,470’. The sloping upstream face of the chamber is approximately 16’ wide and over 20’ long. The opening of the chamber is covered with a steel grate that is approximately 13’ wide and over 17’ long. The chamber is connected to a 30” diameter, steel outlet pipe that passes through the base of the dam at Arch No. 4.[33] On the downstream side of Arch No. 4, the pipeline, which runs to the powerhouse, is connected to a metal outflow box and a tall metal blow-off tube.

1. **Character:**
   The Agnew Lake Dam exhibits the historic character of an early twentieth century, reinforced concrete multiple-arch dam. It displays the form, scale, materials, and craftsmanship of its original and historic construction. The dam continues to operate as originally designed. While some minor physical repairs and improvements have occurred over time, they generally augment rather than diminish the historic character of the dam, by allowing it to continue to function according to its basic structural design.

2. **Condition of Fabric:**
   The Agnew Lake Dam is in good condition. With the benefit of frequent maintenance and repair, the original structure has remained sound and generally intact. Over time, alterations to fabric have generally been limited to the repair and replacement of deteriorated concrete on the surface of the downstream face, and several cycles of removal and replacement of sprayed concrete and/or gunite coatings on the upstream face. A dam repair and improvement project was underway at the time that this report was produced. It included installation of a geomembrane liner over the upstream face of the dam to block current leaks and prevent future leaks, which is expected to extend the effective life span of the structure by 30 years.[34] None of these alterations negatively affects the soundness or intactness of the historic structure and its design.

B. Construction:
Between May and December 1915, workers established a supply chain to the remote Rush Creek area and cleared construction sites. In May 1916, workers began actual

[32] Southern California Edison Company, Agnew Lake Dam Existing Plans.
[33] Southern California Edison Company, Agnew Lake Dam Existing Plans.
[34] State Water Resources Control Board, In the Matter of Water Quality Certification, 2.

construction of the Agnew Lake Dam and other facilities.[35] The shipping of materials from their points of origin, across the difficult terrain of the eastern Sierras, to the construction site of the Agnew Lake Dam at approximately 8,500' in elevation, presented great challenges.[36] In 1926, Dolson and Huber described how these transportation challenges were overcome:

> All materials necessary for its construction except lumber, which could be cut locally, and rock, must be moved long distances and under difficult conditions. Cement had to be shipped from the place of manufacture by broad-gauge railroad 336 miles, transhipped [sic] to a narrow-gauge railroad, and hauled 84 miles farther; then hauled over a sandy desert road, using engines or motor trucks of the caterpillar type, for 70 miles, to the power-house below the dam. Here, it was reloaded on tram cars and raised more than 1250 ft. vertically on a 4826-ft. tramway to Agnew Lake...[37]

Due to the high costs and difficulty of transporting building materials to the isolated construction site, local materials were used in the construction of the Agnew Lake Dam, except for the steel used for reinforcement and the Bear brand Portland cement used for mixing concrete, which were shipped. According to Jorgensen, local building materials were found, prepared, conveyed, and used in the following ways:

> The building material for the dam was found near-by. The sand was taken from the shore of the natural lake. The rock had to be hauled a short distance on a tramway, from the outlet tunnel dump (limestone), and later from a large rockslide (granite) about 2500 ft. away. All available materials in the neighborhood, especially the different sand deposits, were tested before any particular material was selected for construction. As the sand deposit along the shore of the Gem Lake Dam was good, it was used. This sand was first pumped, and later shoveled, from the lake, and transported to a storage pile near the mixing plant. This lake sand, which contained 3½% of clay and 1% of dirt, was mixed with the sand from the rock crusher (all particles being less than ¼ in. in diameter) in the proportion of about three-fourths of lake sand to one-fourth of crushed rock sand. This gave a very good combination, both as to strength and water tightness.
>
> A 1:2:4 mix [of cement to sand to rock] was adopted for the arches and struts, and a 1:2½:5 mix for the buttresses. The actual proportions, however, were sometimes changed, but 1½ bbl. of cement for the arches, and 1¼ bbl. for the buttresses were used always. The rock was crushed in a gyratory crusher, and separated into three sizes through a revolving screen having 1½, ¾, and ¼-in. meshes. The rejects from the screen went

[35] Diamond and Hicks, Historic Overview, 13-19.
[36] Williams and Hicks, Evaluation, A-68.
[37] Dolson and Huber, "Multiple-Arch Dam," 714.

> into a jaw crusher, the jaws of which were set to give a maximum size of 2 in.
>
> The distribution of the concrete to the different arches and buttresses was done with two-wheeled push carts and short chutes.
>
> The reinforcement placed in the dam consisted of high-carbon steel bars, either corrugated or twisted.
>
> The trees standing on the reservoir site were cut down, sawed into lumber in a mill and erected on the ground by the contractors, and used for the forms.
>
> A 1:2 plaster coat of cement mortar ¼ in. thick at the crest, and increasing to ¾ in. thick 80 ft. below, was put on the up-stream face with a cement gun.
>
> The contract price was $22 per cu. yd., including cement, forms, plastering the up-stream face, and all tools and materials except the reinforcing steel, which was paid for as an extra at the rate of $110 per ton in place. The excavation, of which there was only a limited quantity, was also paid for as an extra.[38]

The Agnew Lake Dam structure was completed during the construction season of 1916, which ended in December. The concrete coating was finished in June 1917.[39]

C. Operation:

The Agnew Lake Dam captures a watershed area of 1.65 square miles.[40] It impounds a reservoir, Agnew Lake at 8,499' in elevation, with a storage capacity of 810 acre-feet.[41] The reservoir is used as a water supply to produce power in the Rush Creek Hydroelectric System. Via the pressure pipeline, or penstock, water is conveyed from the reservoir a total linear distance of 4,855'. The upper portion of the pipeline is a lap welded, 30" diameter steel pipe that runs downhill from the reservoir for a linear distance of 575', to the Agnew Junction. From the Agnew Junction, two parallel, 30" diameter welded steel penstocks convey water an additional linear distance of 3,552' to another parallel pair of pipes, 28" in diameter, which run the final linear distance of 728' to the powerhouse.[42] The decrease in elevation from the head of the penstock (8,467.18' in elevation as measured from the bottom of the pipe at Agnew Lake) to the nozzle of the powerhouse

[38] Jorgensen, "Multiple-Arch Dams," 868, 879-880.
[39] Diamond and Hicks, Historic Overview, 19-20.
[40] Diamond and Hicks, Historic Overview, 19.
[41] Southern California Edison Company, Southern California Edison Hydro Generation Division (Draft) (Rosemead, California: Southern California Edison Company, 1994), 15.
[42] Southern California Edison Company, Gem Lake and Dam, Project 1389 (1980), Southern California Edison Company database (SCE Drawing No. 5161820).

(7,244.63’ in elevation) is approximately 1,222.55’. Water delivered from the reservoir to the powerhouse through the penstock drives impulse-driven water wheels that are mounted in the foundation of the powerhouse, which in turn move the direct-connected revolving generators that produce electricity for long-distance transmission to customers.

Water is also released from the reservoir as required to maintain the minimum instream flows that are conditioned in Federal Energy Regulatory Commission (FERC) License No. 1389. Water is released from the reservoir by passing through the intake chamber at the base of the dam and into a 30” diameter steel outlet pipe. The outlet conduit is controlled by two manually operated gave valves. A steel grid over the intake prevents debris from entering the pipe.[43] In addition, spillways are located near the middle of the span to provide emergency water release in the event that it becomes necessary.

D. Site Information:

The Agnew Lake Dam spans Rush Creek canyon and abuts its granitic walls. The dam is aligned along a generally north-south axis. Immediately to the southwest lies Agnew Lake reservoir at the former site of a natural glacial lake. At the north abutment of the Agnew Lake Dam, a concrete pad supports a wood-frame storage building. Past the north abutment on the upstream side of the dam, an incline railroad terminates at a metal tram hoist house that was constructed in 1953 on the bank of the reservoir. Downstream from the dam, several other buildings and structures are located on the canyon floor a short distance away.

The Rush Creek Powerhouse and California State Route 158 (the June Lake Loop) are located approximately three-quarters of a mile downstream from the Agnew Lake Dam. The Agnew Tram, an incline railroad, crosses the canyon floor between the powerhouse and the Agnew Lake Dam on an S-shaped route. Access to the dam site is also provided by trails that run along the sides of the canyon and around the shorelines of its reservoirs. The Gem Lake Dam and reservoir are found approximately three-quarters of a mile further upstream to the southwest.

[43] State Water Resources Control Board, In the Matter of Water Quality Certification, 1.

Part III: Sources of Information

A. Primary Sources:

Dolson, Fred O., and Walter L. Huber. "Multiple-Arch Dam at Gem Lake on Rush Creek, California." Transactions of the American Society of Civil Engineers 89 (1926): 713-736. Located at the Linda Hall Library, Kansas City, Missouri.

Jewett, J. Y., L. R. Jorgensen, Walter H. Wheeler, C. A. P. Turner, Thomas H. Wiggin, C. H. Howell, E. W. Lane, E. J. Waugh, Alfred D. Flinn, Luigi Luiggi, Thaddeus Merriman, M. M. O'Shaughnessy, J. B. Lippincott, Oren Reed, B. F. Jakobsen, J. D. Galloway, I. Oesterblom, B. C. Collier, Fred A. Noetzli, F. W. Scheidenhelm, Charles W. Comstock, George W. Howson, and Fred O. Dolson and Walter L. Huber. Discussion of "Multiple-Arch Dam at Gem Lake on Rush Creek, California," by Fred O. Dolson and Walter L. Huber. Transactions of the American Society of Civil Engineers 89 (1926): 737-783. Located at the Linda Hall Library, Kansas City, Missouri.

Jorgensen, L. R. "Multiple-Arch Dams on Rush Creek, California." Transactions of the American Society of Civil Engineers 81 (1917): 850-881. Located at the Linda Hall Library, Kansas City, Missouri.

Drawings provided by Southern California Edison Company:

Southern California Edison Company. Agnew Dam. 1995. Southern California Edison Company database (SCE Drawing No. 5146732-0).

_________. Agnew Lake Dam Existing Plans, Elevations, and Sections. 1988, revised 2008 and 2002. Southern California Edison Company database (SCE Drawing No. 5204741-0).

_________. Agnew Lake Reservoir. Not dated. Southern California Edison Company database (SCE Drawing No. 2209090-1).

_________. Gem Lake and Dam, Project 1389. 1980. Southern California Edison Company database (SCE Drawing No. 5161820).

_________. Gem Lake Dam and Agnew Lake Dam Maintenance. 1966. Southern California Edison Company database (SCE Drawing No. 585927-3).

_________. Rush Creek Powerhouse, Agnew, Gem & Rush Meadow Reservoirs Overview and Area Map. 2003. Southern California Edison Company database (SCE Drawing No. 5305821-0).

_________. Security Features, Agnew & Gem Reservoirs. 2003. Southern California Edison Company database (SCE Drawing No. 245975-0).

Southern Sierras Power Co. Spillway & Outlet Features, Agnew Lake Dam. 1934. Southern California Edison Company database (SCE Drawing No. 214696-0).

B. Secondary Sources:

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Williams, James C., and Roger A. Hicks. Evaluation of the Historic Resources of the Lee Vining (FERC Project Number 1388) and Rush Creek (FERC Project Number 1389) Hydroelectric System, Mono County, California. Fair Oaks, California: Theodoratus Cultural Research, Inc., 1989. Prepared for the Southern California Edison Company, Rosemead, California. Located at the Southern California Edison Company, Bishop, California.

Appendix A: Images

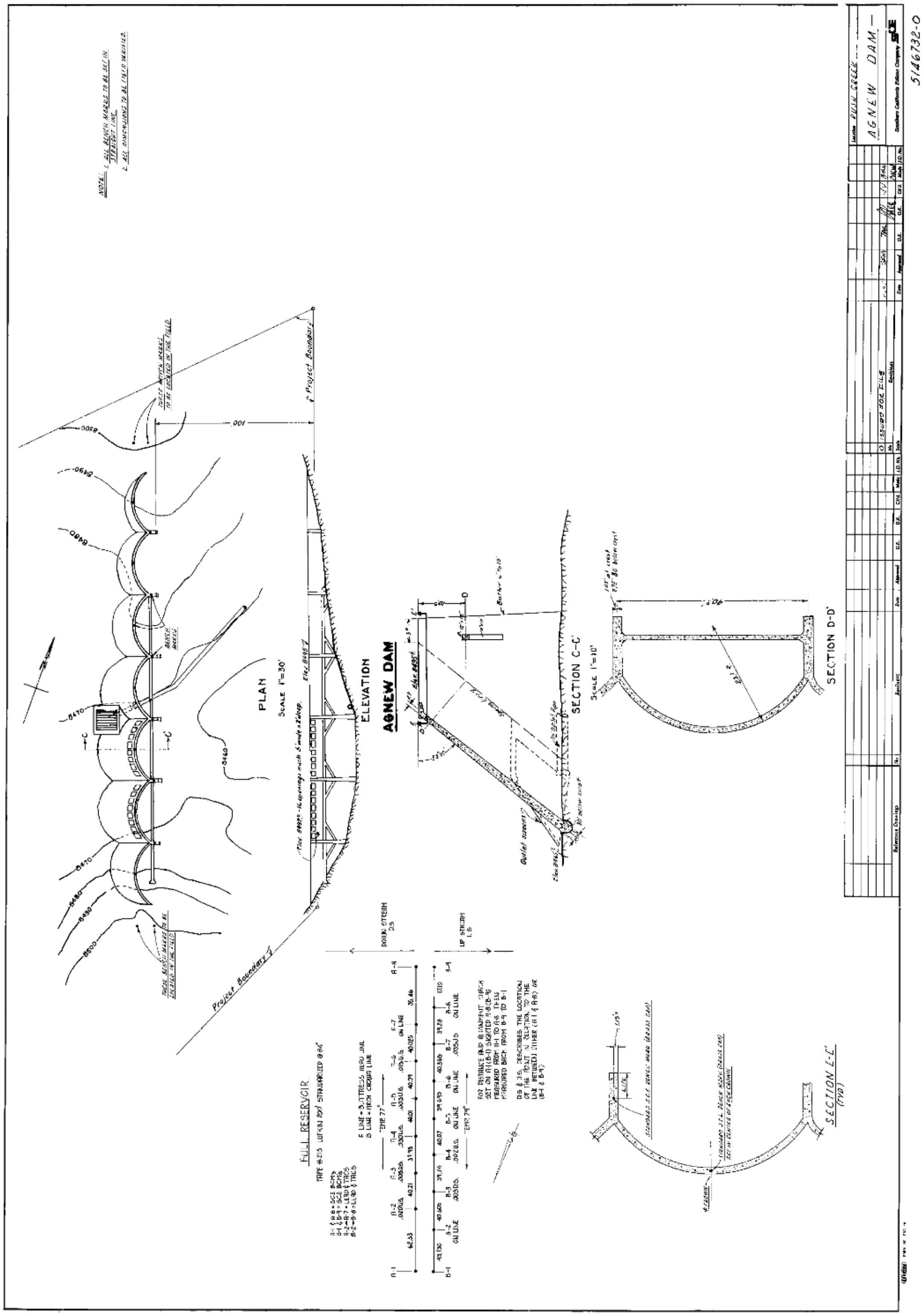

Figure 1: Southern California Edison Company, Agnew Dam (1995), Southern California Edison Company database (SCE Drawing No. 5146732-0).

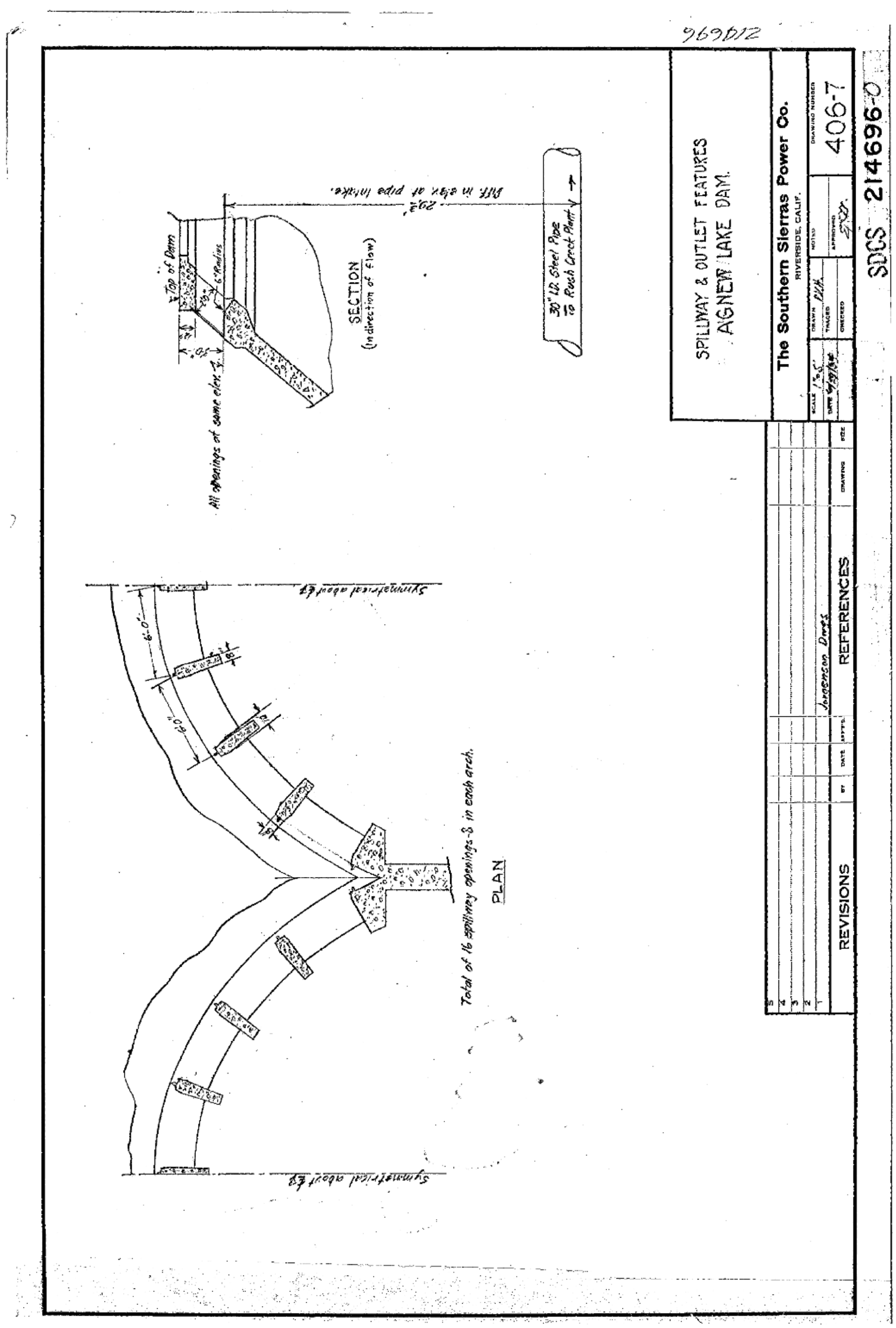

Figure 2: Southern Sierras Power Co., Spillway & Outlet Features, Agnew Lake Dam (1934), Southern California Edison Company database (SCE Drawing No. 214696-0).

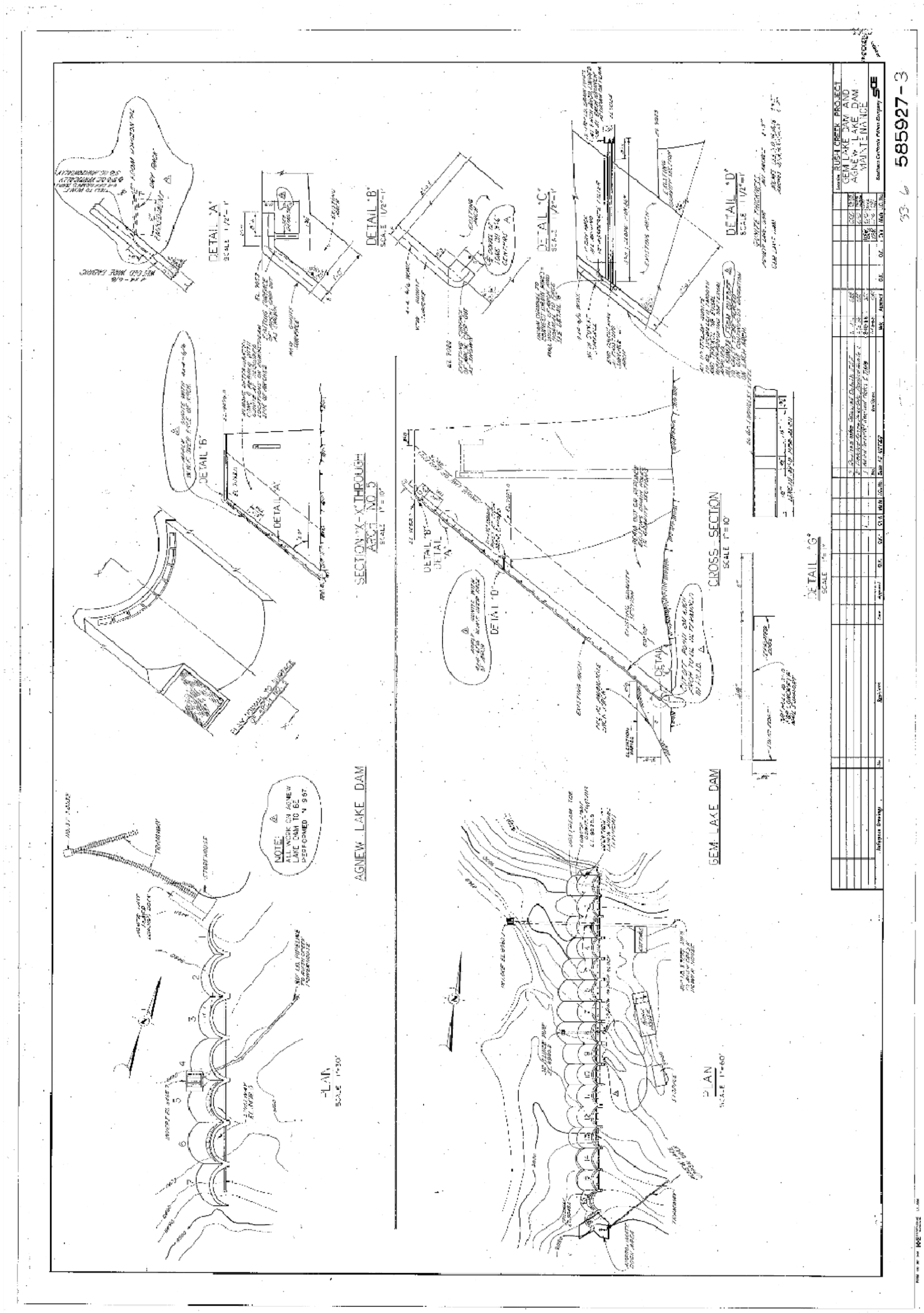

Figure 3: Southern California Edison Company, Gem Lake Dam and Agnew Lake Dam Maintenance (1966), Southern California Edison Company database (SCE Drawing No. 585927-3).

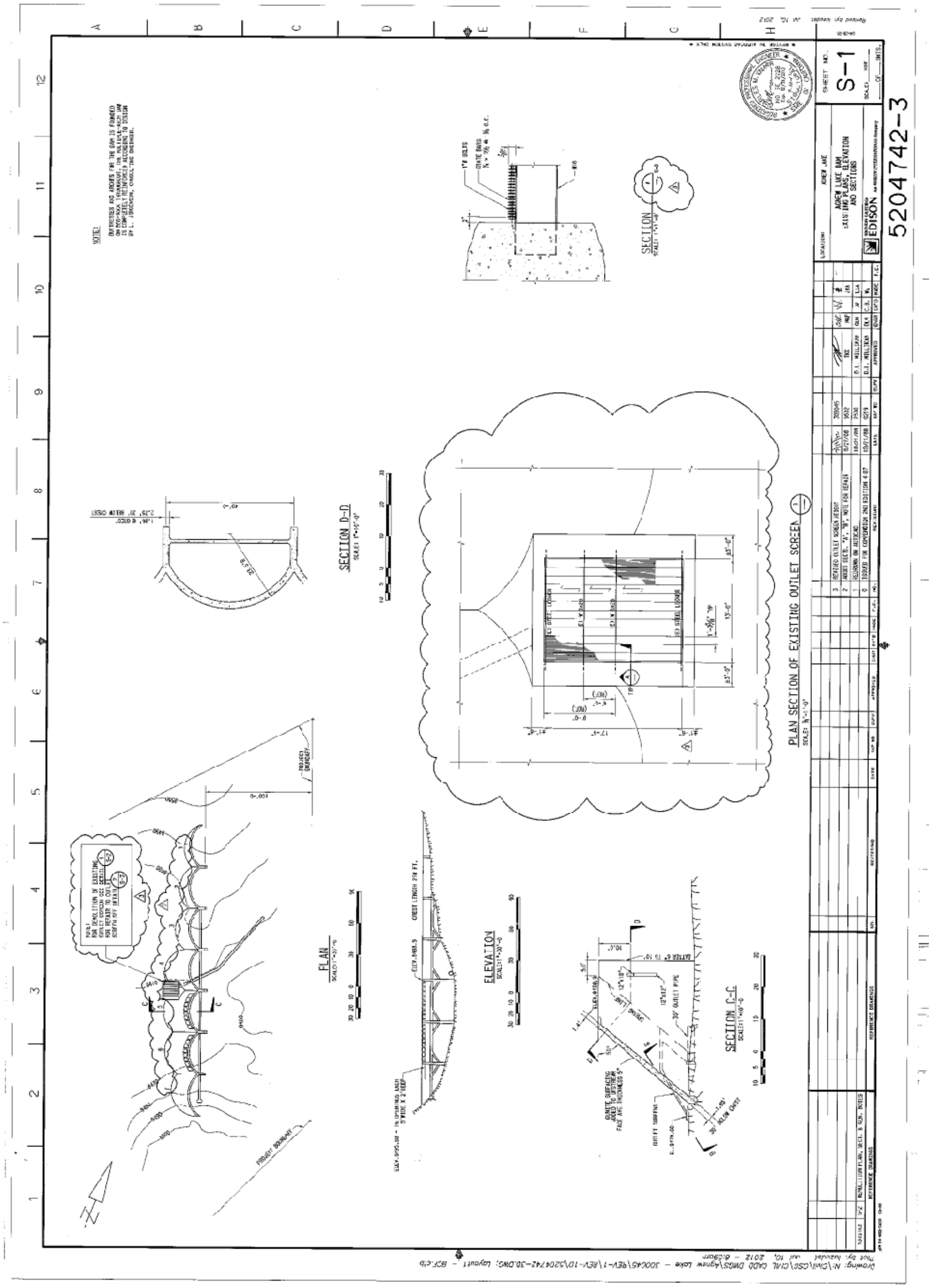

Figure 4: Southern California Edison Company, Agnew Lake Dam Existing Plans, Elevations, and Sections (1988, revised 2008 and 2002), Southern California Edison Company database (SCE Drawing No. 5204741-0).

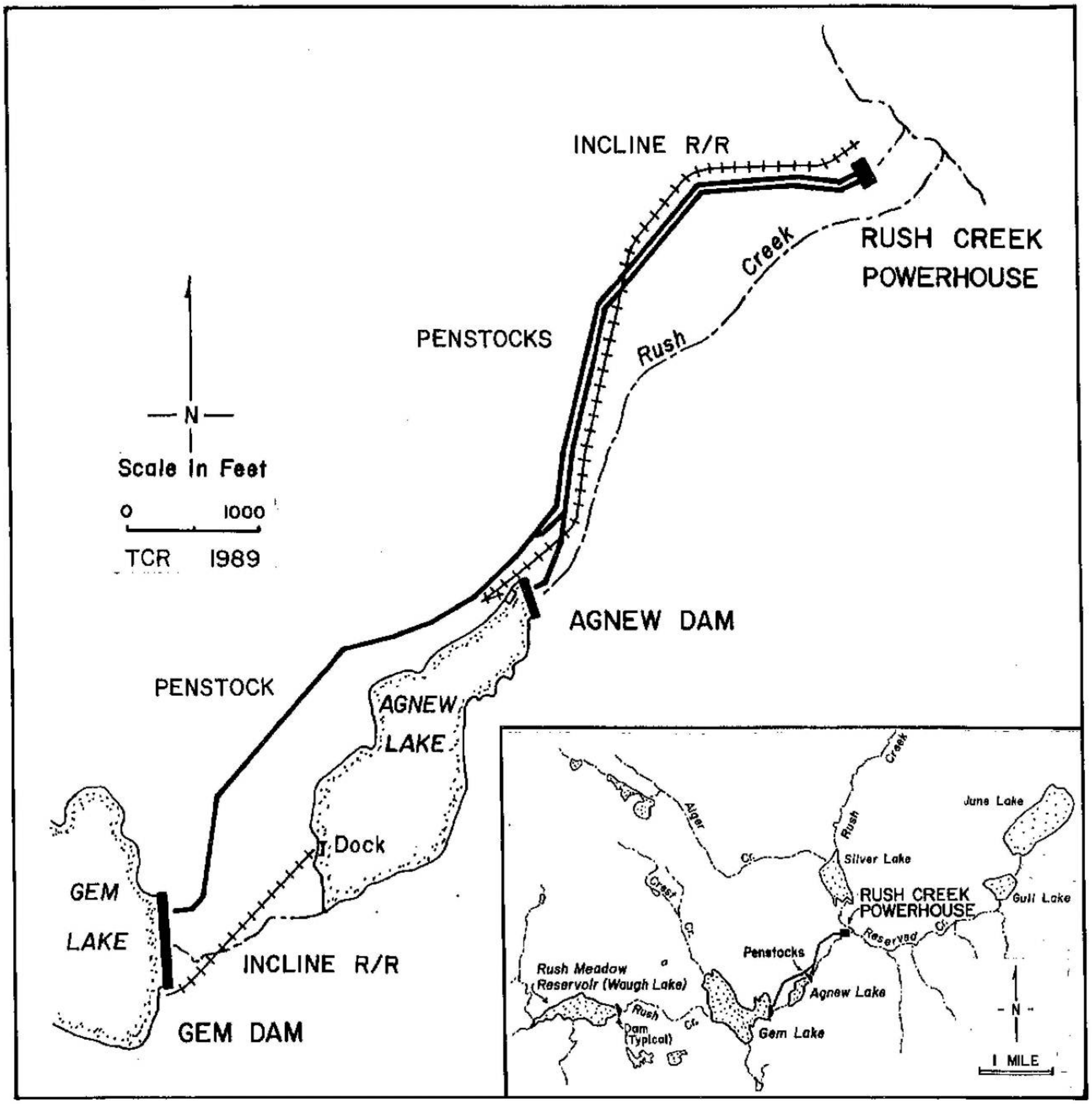

Figure 5: Map of the Rush Creek Hydroelectric System. James C. Williams and Roger A. Hicks, Evaluation of the Historic Resources of the Lee Vining (FERC Project Number 1388) and Rush Creek (FERC Project Number 1389) Hydroelectric System, Mono County, California (Fair Oaks, California: Theodoratus Cultural Research, Inc., 1989), 11.