CHILDS-IRVING HYDROELECTRIC PROJECT, HAER No. AZ-65-I
CHILDS SYSTEM: FLUME INTAKE AND FOREBAY
Forest Service Road 708/502
Camp Verde vicinity
Yavapai County
Arizona

Note: Elements of the Childs-Irving Hydroelectric Project are located in both Yavapai and Gila Counties. For shelving purposes at the Library of Congress; Yavapai County was selected as the official location for this project.

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Intermountain Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

CHILDS-IRVING HYDROELECTRIC PROJECT, CHILDS SYSTEM: FLUME INTAKE AND FOREBAY

HAER No. AZ-65-I

Location:	Childs Station No. 0+00. Forest Service Road 708/502, Camp Verde Vicinity, Yavapai County, Arizona. USGS Payson Quadrangle, UTM Coordinates: NAD 27 Zone 12 443230.4145E - 3806738.551N.
Date of Construction:	1908; 1916.
Engineer:	Iva Tutt; Francis S. Vielé; Raymond S. Masson.
Present Owner:	Arizona Public Service (improvements), P.O. Box 53933, M.S. 3190, Phoenix, AZ 85072-3933; U.S. Government, U.S.D.A. Forest Service (land).
Present Use:	Hydroelectric power generation (November 2004).
Significance:	The Flume Intake and Forebay contain features of the original Childs System and alterations with addition of the Irving System in 1915-1916. This complex structure directed and filtered water directly from Fossil Creek, or water leaving the Irving Powerhouse, into the beginning of the Childs flume system.
Historian:	James W. Steely, November 2004.

Project Information:

Between February and November 2004, Arizona Public Service (APS) and SWCA Environmental Consultants documented the hydroelectric complex, under guidance of the Historic American Engineering Record (HAER). Project managers Phil Smithers (APS) and Linda Martin (SWCA) coordinated historian Steely, photographer Jessica Maggio, and draftsman Hanson Todachine to complete the HAER documentation. Archives for the Childs-Irving Hydroelectric Project are at APS in Phoenix, Arizona.

Historic and Engineering Context:

The Childs-Irving Hydroelectric Project encompassed a unique water-pressure/electric-turbine system—according to engineering historians evaluating the historic complex since 1976—that 1) was constructed with great effort in an extremely remote landscape, 2) captured a natural water source and followed dramatic topography, 3) generated electric power in a remarkably simple and efficient manner, and 4) operated continuously for 95 years.

In addition to its individual significance nationwide, the Childs-Irving Hydroelectric Project is a classic part of Arizona history spanning the 20th century: remote low-grade mining operations sought reliable and less-expensive energy; a combination of investors, entrepreneurs and engineers modified a natural resource to supply the energy; cutting-edge technology entered a harsh and remote landscape; an isolated labor force merged those with skills learned far away with local residents, including Native Americans with traditional ties to the land; nearby communities soon offered an additional customer base; farmers and irrigation cooperatives became major consumers for their pumps and agricultural machinery; distant metropolitan areas boomed by tapping the energy source; and finally a conservative operational approach to investment and maintenance retained aging technology within a huge modern power grid for many, many years past a reasonable retirement.

Character Defining Attributes

Component/Feature No. 18 on National Register form. A small dam on Fossil Creek included a sluice gate and sluiceway cut into the dam's spillway at its lower end. At the lower end was a sandbox with an iron-bar grizzly and spill gate to admit water into the flume. When the Irving plant was built in 1915, the flume intake was modified to accept water diverted through the Irving Powerhouse. The accepting forebay with two spill gates incorporated the original intake ditch of the Childs flume to allow direct diversion of water from Fossil Creek when the Irving system is closed for repairs. One spill gate controlled water flowing into the Childs flume; the second gate allowed discharge of water from the forebay and back into Fossil Creek, to maintain the water level within the forebay or to divert water from the Childs flume when necessary. A part of the concrete flume discharge was replaced c. 1990 with metal. (Effland and Macnider 1991)

Bibliography

Arizona Public Service (APS) Archives

Historic photograph collection. Historic drawings collection. Historic documents collection. Available through appointment at: APS, P.O. Box 53933, M.S. 3190, Phoenix, Arizona 85072-3933, 602-371-7689.

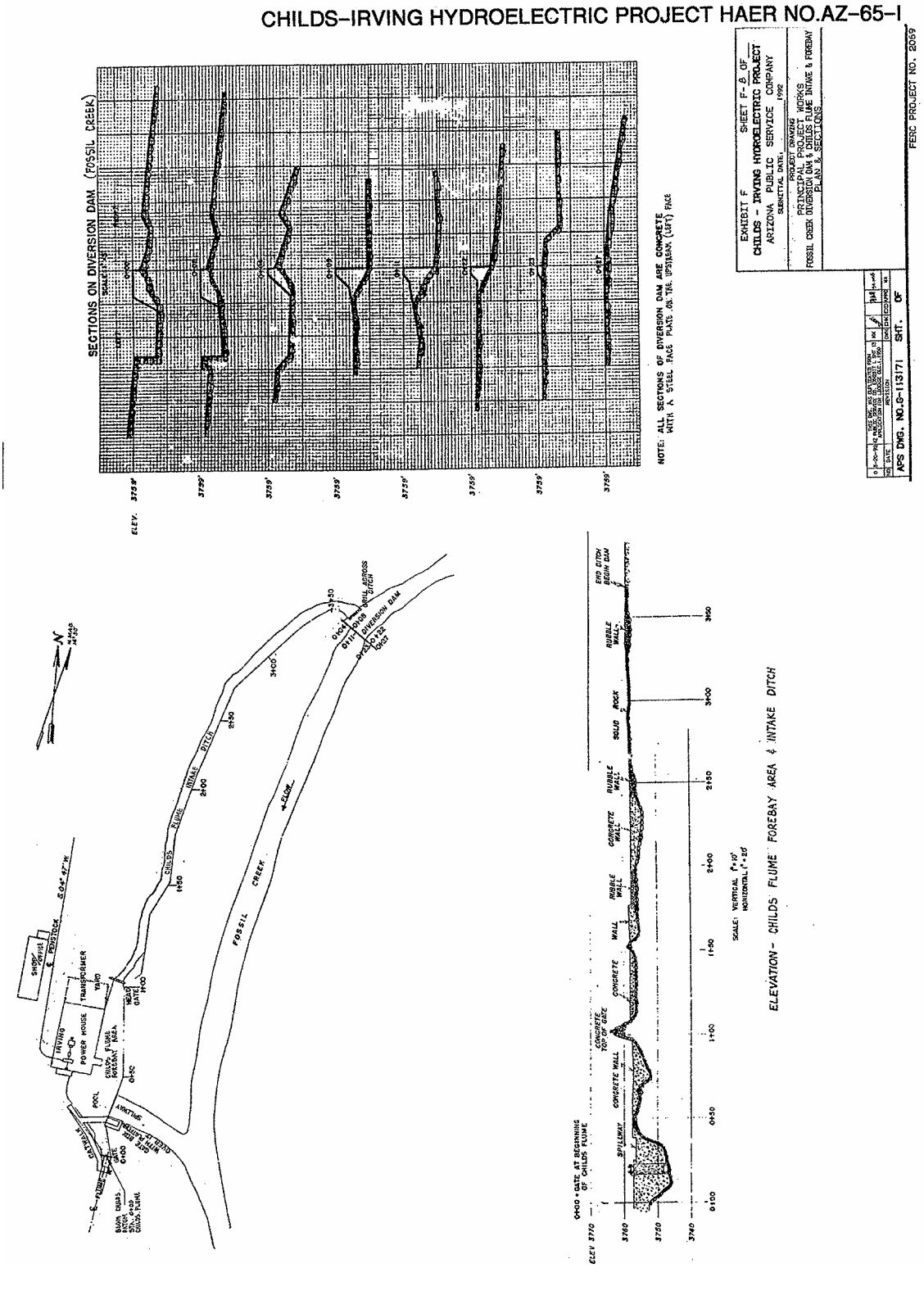
Effland, Richard W., Jr., and Barbara S. Macnider

1991 *Childs-Irving Hydroelectric Facilities.* National Register of Historic Places Registration Form. U.S. Department of the Interior, National Park Service. Washington, D.C.

Neal, Lynn, and Linda Martin

2003 *Childs/Irving Hydroelectric Decommissioning Project, Historic Properties Management Plan* (HPMP). Prepared for APS/Generation Engineering. SWCA Environmental Consultants. Flagstaff.

Drawing "Childs Flume Forebay Area & and Intake Ditch" c. 1916:



CHILDS-IRVING HYDROELECTRIC PROJECT, HAER No. AZ-65-J
CHILDS SYSTEM: CONCRETE FLUME
Forest Service Road 708/502
Camp Verde vicinity
Yavapai County
Arizona

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Intermountain Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

CHILDS-IRVING HYDROELECTRIC PROJECT, CHILDS SYSTEM: CONCRETE FLUME

HAER No. AZ-65-J

Location:	Childs Station No. 59+05. Forest Service Road 708/502, Camp Verde vicinity, Yavapai County, Arizona. USGS Payson Quadrangle, UTM Coordinates: NAD 27 Zone 12 443230.4145E - 3806738.551N.
Date of Construction:	1908.
Engineer:	Iva Tutt; Francis S. Vielé; Raymond S. Masson.
Present Owner:	Arizona Public Service (improvements), P.O. Box 53933, M.S. 3190, Phoenix, AZ 85072-3933; U.S. Government, U.S.D.A. Forest Service (land).
Present Use:	Hydroelectric power generation (November 2004).
Significance:	The Concrete Flume, cast in place for 1.6 miles, carried water along one of the less challenging geographic courses of the Childs System. The choice of concrete—instead of wood of metal, each with multiple joints—resulted in the unexpected efficiency of lower friction on flowing water.
Historian:	James W. Steely, November 2004.

Project Information:

Between February and November 2004, Arizona Public Service (APS) and SWCA Environmental Consultants documented the hydroelectric complex, under guidance of the Historic American Engineering Record (HAER). Project managers Phil Smithers (APS) and Linda Martin (SWCA) coordinated historian Steely, photographer Jessica Maggio, and draftsman Hanson Todachine to complete the HAER documentation. Archives for the Childs-Irving Hydroelectric Project are at APS in Phoenix, Arizona.

Historic and Engineering Context:

The Childs-Irving Hydroelectric Project encompassed a unique water-pressure/electric-turbine system—according to engineering historians evaluating the historic complex since 1976—that 1) was constructed with great effort in an extremely remote landscape, 2) captured a natural water source and followed dramatic topography, 3) generated electric power in a remarkably simple and efficient manner, and 4) operated continuously for 95 years.

In addition to its individual significance nationwide, the Childs-Irving Hydroelectric Project is a classic part of Arizona history spanning the 20th century: remote low-grade mining operations sought reliable and less-expensive energy; a combination of investors, entrepreneurs and engineers modified a natural resource to supply the energy; cutting-edge technology entered a harsh and remote landscape; an isolated labor force merged those with skills learned far away with local residents, including Native Americans with traditional ties to the land; nearby communities soon offered an additional customer base; farmers and irrigation cooperatives became major consumers for their pumps and agricultural machinery; distant metropolitan areas boomed by tapping the energy source; and finally a conservative operational approach to investment and maintenance retained aging technology within a huge modern power grid for many, many years past a reasonable retirement.

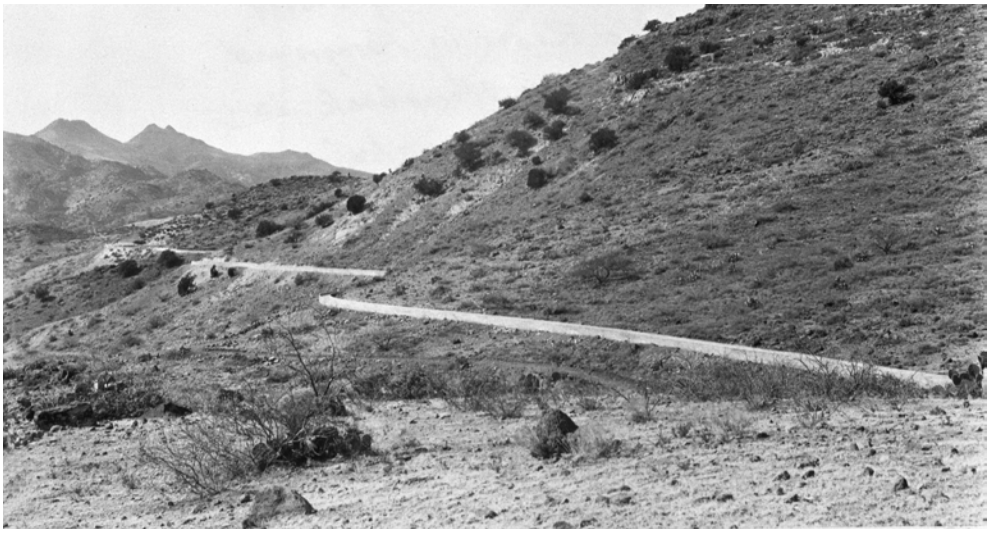
Character Defining Attributes

Component/Feature No. 19 on National Register form. The flume was constructed of concrete, reinforced with steel mesh and set on a bench excavated into the slopes above Fossil Creek. The concrete flume measured 6 feet across at the bottom and 3.5 feet high on the exterior, with a 6-inch base, and walls varied in thickness from 8 inches at bottom to 4 inches at top. Expansion joints were approximately 100 feet apart. Nearly 8800 feet of concrete flume was originally constructed with a gradient of 1 foot to 1000 feet. Parts of the concrete flume were replaced with metal flume; however, at least 75 percent of the original concrete flume still existed in 2004. Old flume components of flattened steel later served as covers for the flume. (Effland and Macnider 1991)

Bibliography

Effland, Richard W., Jr., and Barbara S. Macnider
1991 *Childs-Irving Hydroelectric Facilities.* National Register of Historic Places Registration Form. U.S. Department of the Interior, National Park Service. Washington, D.C.

Neal, Lynn, and Linda Martin
2003 *Childs/Irving Hydroelectric Decommissioning Project, Historic Properties Management Plan* (HPMP). Prepared for APS/Generation Engineering. SWCA Environmental Consultants. Flagstaff.



Above – concrete flume, 1910. APS Photo Library #186

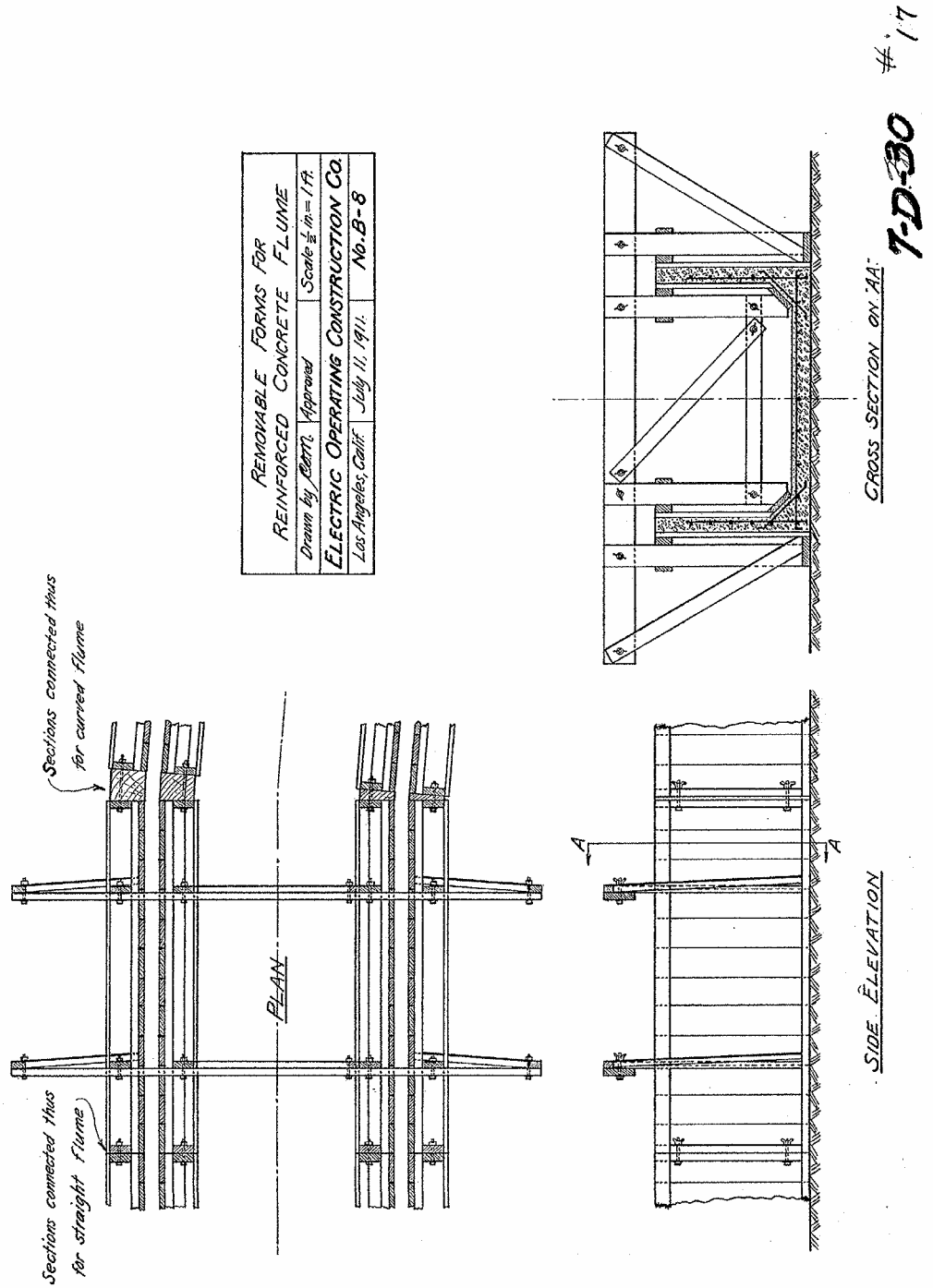
Left – concrete flume. APS Photo Library #201

Additional Bibliography

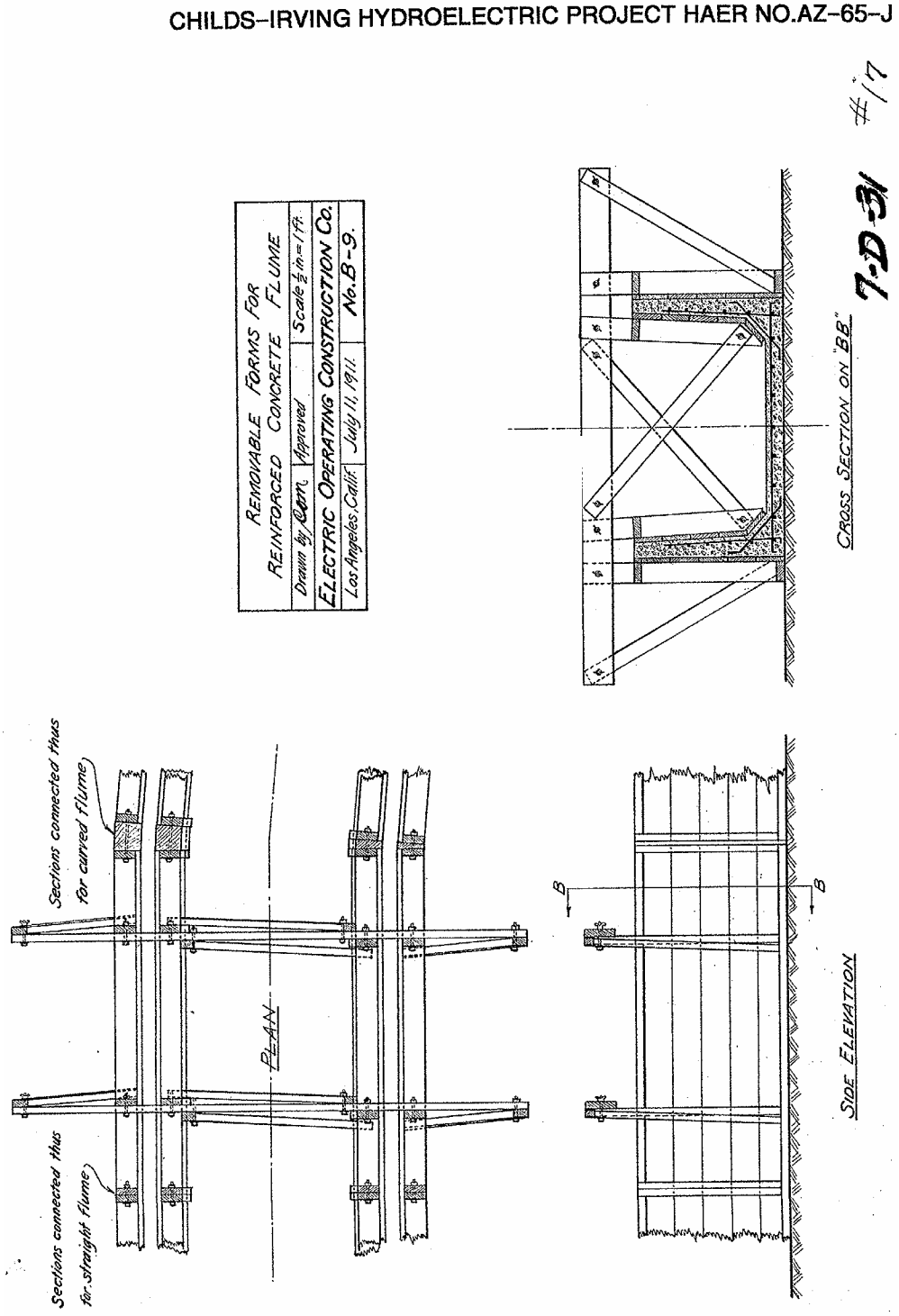
Arizona Public Service (APS) Archives
Historic photograph collection. Historic drawings collection. Historic documents collection. Available through appointment at: APS, P.O. Box 53933, M.S. 3190, Phoenix, Arizona 85072-3933, 602-371-7689.

Drawing "Removable Forms for Reinforced Concrete Flume No. B-8" 1911:

CHILDS–IRVING HYDROELECTRIC PROJECT HAER NO.AZ–65–J



Drawing "Removable Forms for Reinforced Concrete Flume No. B-9" 1911:



CHILDS-IRVING HYDROELECTRIC PROJECT, HAER No. AZ-65-K
CHILDS SYSTEM: FLUME TUNNEL #1
Forest Service Road 708/502
Camp Verde vicinity
Yavapai County
Arizona

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Intermountain Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

CHILDS-IRVING HYDROELECTRIC PROJECT,
CHILDS SYSTEM: FLUME TUNNEL #1

HAER No. AZ-65-K

Location:	Childs Station No. 25+03.9. Forest Service Road 708/502, Camp Verde vicinity, Yavapai County, Arizona. USGS Payson Quadrangle, UTM Coordinates: NAD 27 Zone 12 442533.8616E - 3806455.803N.
Date of Construction:	1908.
Engineer:	Iva Tutt; Francis S. Vielé; Raymond S. Masson.
Present Owner:	Arizona Public Service (improvements), P.O. Box 53933, M.S. 3190, Phoenix, AZ 85072-3933; U.S. Government, U.S.D.A. Forest Service (land).
Present Use:	Hydroelectric power generation (November 2004).
Significance:	The geography of Fossil Creek required a series of tunnels, judged to be less expensive and easier to maintain than continuous flume through this area.
Historian:	James W. Steely, November 2004.

Project Information:

Between February and November 2004, Arizona Public Service (APS) and SWCA Environmental Consultants documented the hydroelectric complex, under guidance of the Historic American Engineering Record (HAER). Project managers Phil Smithers (APS) and Linda Martin (SWCA) coordinated historian Steely, photographer Jessica Maggio, and draftsman Hanson Todachine to complete the HAER documentation. Archives for the Childs-Irving Hydroelectric Project are at APS in Phoenix, Arizona.

Historic and Engineering Context:

The Childs-Irving Hydroelectric Project encompassed a unique water-pressure/electric-turbine system—according to engineering historians evaluating the historic complex since 1976—that 1) was constructed with great effort in an extremely remote landscape, 2) captured a natural water source and followed dramatic topography, 3) generated electric power in a remarkably simple and efficient manner, and 4) operated continuously for 95 years.

In addition to its individual significance nationwide, the Childs-Irving Hydroelectric Project is a classic part of Arizona history spanning the 20th century: remote low-grade mining operations sought reliable and less-expensive energy; a combination of investors, entrepreneurs and engineers modified a natural resource to supply the energy; cutting-edge technology entered a harsh and remote landscape; an isolated labor force merged those with skills learned far away with local residents, including Native Americans with traditional ties to the land; nearby communities soon offered an additional customer base; farmers and irrigation cooperatives became major consumers for their pumps and agricultural machinery; distant metropolitan areas boomed by tapping the energy source; and finally a conservative operational approach to investment and maintenance retained aging technology within a huge modern power grid for many, many years past a reasonable retirement.

Character Defining Attributes

Component/Feature No. 22 on National Register form. This first tunnel in the Childs flume gravity system was 777 feet long and includes a timbered roof for 100 feet. The tunnel dimensions were 4 wide by 6 feet high. (Effland and Macnider 1991)

Bibliography

Effland, Richard W., Jr., and Barbara S. Macnider
1991 *Childs-Irving Hydroelectric Facilities.* National Register of Historic Places Registration Form. U.S. Department of the Interior, National Park Service. Washington, D.C.

Neal, Lynn, and Linda Martin
2003 *Childs/Irving Hydroelectric Decommissioning Project, Historic Properties Management Plan* (HPMP). Prepared for APS/Generation Engineering. SWCA Environmental Consultants. Flagstaff.

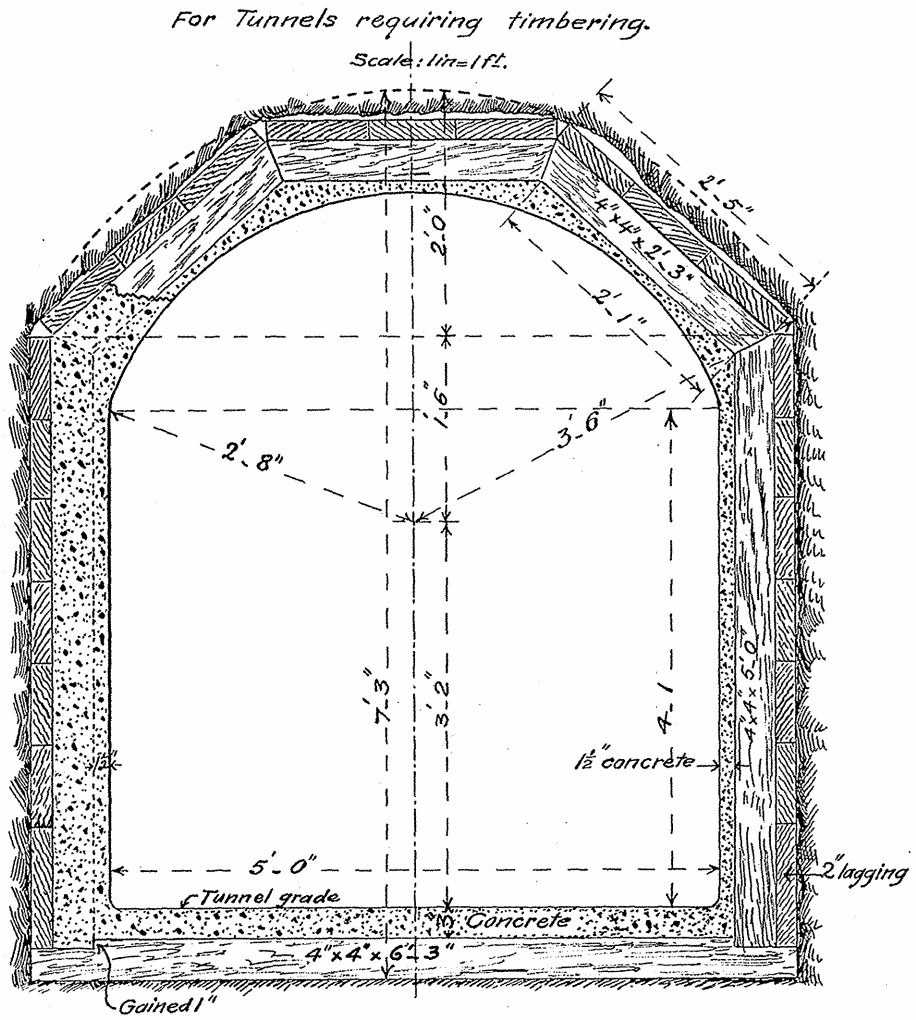
APS Photo Library #115

Additional Bibliography

Arizona Public Service (APS) Archives
Historic photograph collection. Historic drawings collection. Historic documents collection. Available through appointment at: APS, P.O. Box 53933, M.S. 3190, Phoenix, Arizona 85072-3933, 602-371-7689.

Drawing "For Tunnels requiring timbering" c. 1909:

CHILDS–IRVING HYDROELECTRIC PROJECT HAER NO.AZ–65–K



T-A-22
#204-4

CHILDS-IRVING HYDROELECTRIC PROJECT, HAER No. AZ-65-L
CHILDS SYSTEM: FLUME TUNNEL #2
Forest Service Road 708/502
Camp Verde vicinity
Yavapai County
Arizona

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Intermountain Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

CHILDS-IRVING HYDROELECTRIC PROJECT,
CHILDS SYSTEM: FLUME TUNNEL #2

HAER No. AZ-65-L

Location:	Childs Station No. 47+05. Forest Service Road 708/502, Camp Verde vicinity, Yavapai County, Arizona. USGS Payson Quadrangle, UTM Coordinates: NAD 27 Zone 12 441865.8465E - 3806253.599N.
Date of Construction:	1908.
Engineer:	Iva Tutt; Francis S. Vielé; Raymond S. Masson.
Present Owner:	Arizona Public Service (improvements), P.O. Box 53933, M.S. 3190, Phoenix, AZ 85072-3933; U.S. Government, U.S.D.A. Forest Service (land).
Present Use:	Hydroelectric power generation (November 2004).
Significance:	The geography of Fossil Creek required a series of tunnels, judged to be less expensive and easier to maintain than continuous flume through this area.
Historian:	James W. Steely, November 2004.

Project Information:

Between February and November 2004, Arizona Public Service (APS) and SWCA Environmental Consultants documented the hydroelectric complex, under guidance of the Historic American Engineering Record (HAER). Project managers Phil Smithers (APS) and Linda Martin (SWCA) coordinated historian Steely, photographer Jessica Maggio, and draftsman Hanson Todachine to complete the HAER documentation. Archives for the Childs-Irving Hydroelectric Project are at APS in Phoenix, Arizona.

Historic and Engineering Context:

The Childs-Irving Hydroelectric Project encompassed a unique water-pressure/electric-turbine system—according to engineering historians evaluating the historic complex since 1976—that 1) was constructed with great effort in an extremely remote landscape, 2) captured a natural water source and followed dramatic topography, 3) generated electric power in a remarkably simple and efficient manner, and 4) operated continuously for 95 years.

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Character Defining Attributes

Component/Feature No. 23 on National Register form. This gravity tunnel through sold rock was 1200 feet long, 4.5 feet wide by 5.5 feet high. (Effland and Macnider 1991)

Bibliography

Effland, Richard W., Jr., and Barbara S. Macnider
1991 *Childs-Irving Hydroelectric Facilities.* National Register of Historic Places Registration Form. U.S. Department of the Interior, National Park Service. Washington, D.C.

Neal, Lynn, and Linda Martin
2003 *Childs/Irving Hydroelectric Decommissioning Project, Historic Properties Management Plan* (HPMP). Prepared for APS/Generation Engineering. SWCA Environmental Consultants. Flagstaff.

CHILDS-IRVING HYDROELECTRIC PROJECT, HAER No. AZ-65-M
CHILDS SYSTEM:
SALLY MAY/PURPLE MOUNTAIN SIPHON INTAKE
Forest Service Road 708/502
Camp Verde vicinity
Yavapai County
Arizona

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Intermountain Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

CHILDS-IRVING HYDROELECTRIC PROJECT, CHILDS SYSTEM: SALLY MAY/PURPLE MOUNTAIN SIPHON INTAKE

HAER No. AZ-65-M

Location:	Childs Station No. 89+11.5. Forest Service Road 708/502, Camp Verde vicinity, Yavapai County, Arizona. USGS Payson Quadrangle, UTM Coordinates: NAD 27 Zone 12 440780.9739E - 3805975.126N.
Date of Construction:	1908.
Engineer:	Iva Tutt; Francis S. Vielé; Raymond S. Masson.
Present Owner:	Arizona Public Service (improvements), P.O. Box 53933, M.S. 3190, Phoenix, AZ 85072-3933; U.S. Government, U.S.D.A. Forest Service (land).
Present Use:	Hydroelectric power generation (November 2004).
Significance:	Sally May Wash presented a particularly challenging, and expensive, chasm to cross with Fossil Creek water coursing toward the Childs Powerhouse.
Historian:	James W. Steely, November 2004.

Project Information:

Between February and November 2004, Arizona Public Service (APS) and SWCA Environmental Consultants documented the hydroelectric complex, under guidance of the Historic American Engineering Record (HAER). Project managers Phil Smithers (APS) and Linda Martin (SWCA) coordinated historian Steely, photographer Jessica Maggio, and draftsman Hanson Todachine to complete the HAER documentation. Archives for the Childs-Irving Hydroelectric Project are at APS in Phoenix, Arizona.

Historic and Engineering Context:

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Character Defining Attributes

Component/Feature No.24 on National Register form. This entry into the Sally May/Purple Mountain Siphon had a concrete box with a sluice gate to divert water from the flume system. An iron bar grizzly at the box front prevented any large objects from entering the siphon. A corrugated steel shed, housing telephone and electrical circuits, was built over a part of the concrete box at an unrecorded date. (Effland and Macnider 1991)

Bibliography

Effland, Richard W., Jr., and Barbara S. Macnider
1991 *Childs-Irving Hydroelectric Facilities.* National Register of Historic Places Registration Form. U.S. Department of the Interior, National Park Service. Washington, D.C.

Neal, Lynn, and Linda Martin
2003 *Childs/Irving Hydroelectric Decommissioning Project, Historic Properties Management Plan* (HPMP). Prepared for APS/Generation Engineering. SWCA Environmental Consultants. Flagstaff.

Bibliography

Arizona Public Service (APS) Archives
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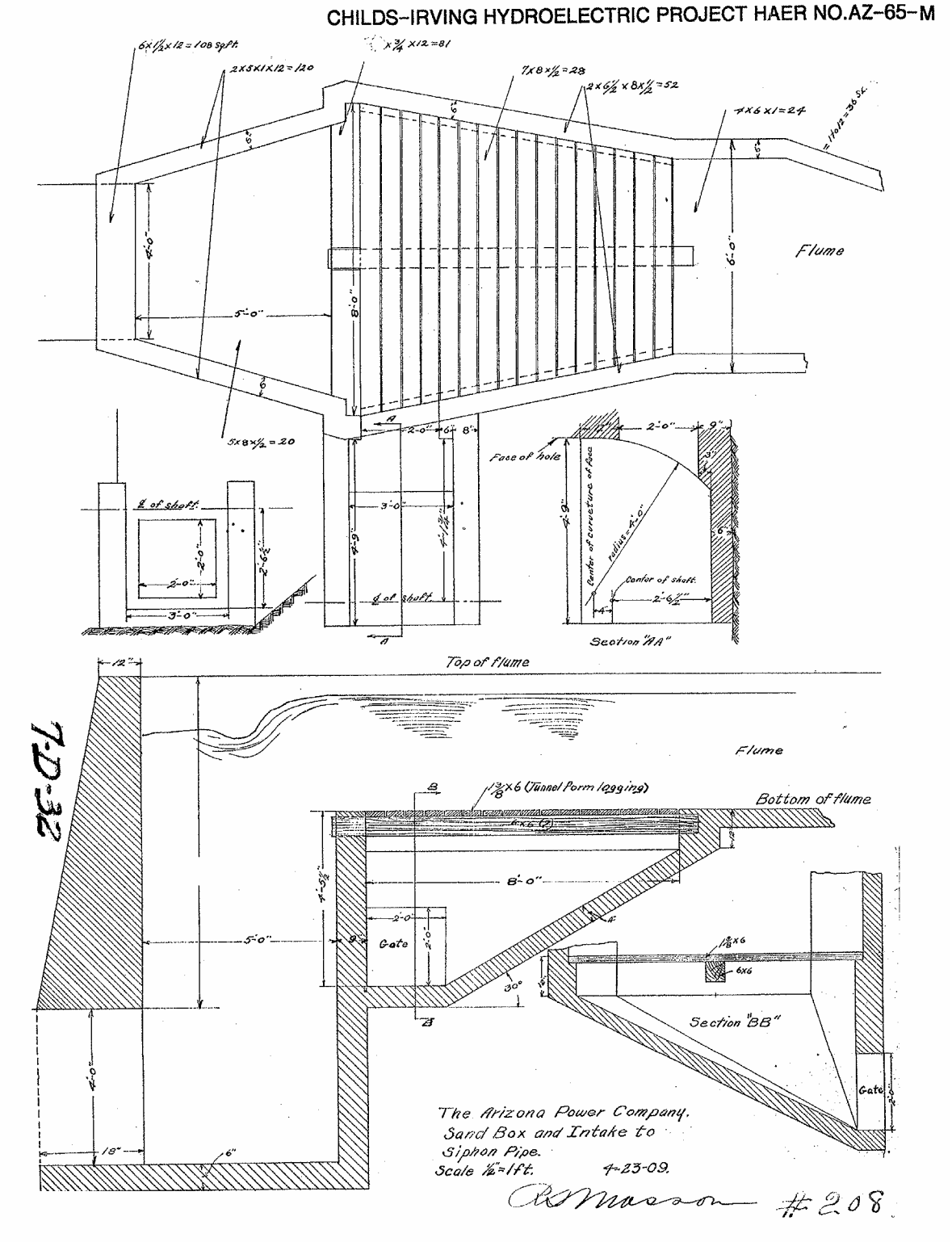
Effland, Richard W., Jr., and Barbara S. Macnider
1991 *Childs-Irving Hydroelectric Facilities.* National Register of Historic Places Registration Form. U.S. Department of the Interior, National Park Service. Washington, D.C.

Neal, Lynn, and Linda Martin
2003 *Childs/Irving Hydroelectric Decommissioning Project, Historic Properties Management Plan* (HPMP). Prepared for APS/Generation Engineering. SWCA Environmental Consultants. Flagstaff.

Drawing "Sand Box and Intake to Siphon Pipe" 1909:



CHILDS-IRVING HYDROELECTRIC PROJECT, HAER No. AZ-65-N
CHILDS SYSTEM:
SALLY MAY/PURPLE MOUNTAIN SIPHON
Forest Service Road 708/502
Camp Verde vicinity
Yavapai County
Arizona

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Intermountain Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

CHILDS-IRVING HYDROELECTRIC PROJECT, CHILDS SYSTEM: SALLY MAY/PURPLE MOUNTAIN SIPHON

HAER No. AZ-65-N

Location:	Childs Station No. 89+11.5. Forest Service Road 708/502, Camp Verde vicinity, Yavapai County, Arizona. USGS Payson Quadrangle, UTM Coordinates: NAD 27 Zone 12 440102.6399E - 3805447.963N.
Dates of Construction:	1908; 1920.
Engineer:	Iva Tutt; Francis S. Vielé; Raymond S. Masson.
Present Owner:	Arizona Public Service (improvements), P.O. Box 53933, M.S. 3190, Phoenix, AZ 85072-3933; U.S. Government, U.S.D.A. Forest Service (land).
Present Use:	Hydroelectric power generation (November 2004).
Significance:	Sally May Wash presented a particularly challenging, and expensive, chasm to cross with Fossil Creek water coursing toward the Childs Powerhouse. The siphon route was modified at the west end about 1920, due to unstable ground conditions along the original route.
Historian:	James W. Steely, November 2004.

Project Information:

Between February and November 2004, Arizona Public Service (APS) and SWCA Environmental Consultants documented the hydroelectric complex, under guidance of the Historic American Engineering Record (HAER). Project managers Phil Smithers (APS) and Linda Martin (SWCA) coordinated historian Steely, photographer Jessica Maggio, and draftsman Hanson Todachine to complete the HAER documentation. Archives for the Childs-Irving Hydroelectric Project are at APS in Phoenix, Arizona.

Historic and Engineering Context:

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Character Defining Attributes

Component/Feature No.25 on National Register form. The inverted siphon was 6952.3 feet in length, intake elevation at 3745.318 feet. Water droped 335.69 feet in the pipe to a low point of 3409.628 feet, and rose to 3735.848 feet for a total elevation change of –9.47 feet along a hydraulic grade line of 0.0028 feet. Four-inch air relief valves were spaced along the pipe to permit egress and ingress of air pressure, preventing collapse of the siphon pipe during a sudden removal of water from the system. The pipe was coated with graphite paint to prevent corrosion. Pipe thickness through the 6952.3-foot siphon ranged from 3/16 inch to 1/4 inch. (Effland and Macnider 1991)

Bibliography

Effland, Richard W., Jr., and Barbara S. Macnider
1991 *Childs-Irving Hydroelectric Facilities.* National Register of Historic Places Registration Form. U.S. Department of the Interior, National Park Service. Washington, D.C.

Neal, Lynn, and Linda Martin
2003 *Childs/Irving Hydroelectric Decommissioning Project, Historic Properties Management Plan* (HPMP). Prepared for APS/Generation Engineering. SWCA Environmental Consultants. Flagstaff.

APS Photo Library #188

Additional Bibliography

Arizona Public Service (APS) Archives
Historic photograph collection. Historic drawings collection. Historic documents collection. Available through appointment at: APS, P.O. Box 53933, M.S. 3190, Phoenix, Arizona 85072-3933, 602-371-7689.

CHILDS-IRVING HYDROELECTRIC PROJECT, HAER No. AZ-65-O
CHILDS SYSTEM: FLUME BRIDGE #2
Forest Service Road 708/502
Camp Verde vicinity
Yavapai County
Arizona

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Intermountain Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

CHILDS-IRVING HYDROELECTRIC PROJECT,
CHILDS SYSTEM: FLUME BRIDGE #2

HAER No. AZ-65-O

Location:	Childs Station No. 108+51. Forest Service Road 708/502, Camp Verde vicinity, Yavapai County, Arizona. USGS Payson Quadrangle, UTM Coordinates: NAD 27 Zone 12 440343.8254E - 3805660.334N.
Date of Construction:	1908.
Engineer:	Iva Tutt; Francis S. Vielé; Raymond S. Masson.
Present Owner:	Arizona Public Service (improvements), P.O. Box 53933, M.S. 3190, Phoenix, AZ 85072-3933; U.S. Government, U.S.D.A. Forest Service (land).
Present Use:	Hydroelectric power generation (November 2004).
Significance:	A dramatic change in topography below Sally May Wash required a series of bridges as trestles to convey water across a series of small but deep washes.
Historian:	James W. Steely, November 2004.

Project Information:

Between February and November 2004, Arizona Public Service (APS) and SWCA Environmental Consultants documented the hydroelectric complex, under guidance of the Historic American Engineering Record (HAER). Project managers Phil Smithers (APS) and Linda Martin (SWCA) coordinated historian Steely, photographer Jessica Maggio, and draftsman Hanson Todachine to complete the HAER documentation. Archives for the Childs-Irving Hydroelectric Project are at APS in Phoenix, Arizona.

Historic and Engineering Context:

The Childs-Irving Hydroelectric Project encompassed a unique water-pressure/electric-turbine system—according to engineering historians evaluating the historic complex since 1976—that 1) was constructed with great effort in an extremely remote landscape, 2) captured a natural water source and followed dramatic topography, 3) generated electric power in a remarkably simple and efficient manner, and 4) operated continuously for 95 years.

In addition to its individual significance nationwide, the Childs-Irving Hydroelectric Project is a classic part of Arizona history spanning the 20th century: remote low-grade mining operations sought reliable and less-expensive energy; a combination of investors, entrepreneurs and engineers modified a natural resource to supply the energy; cutting-edge technology entered a harsh and remote landscape; an isolated labor force merged those with skills learned far away with local residents, including Native Americans with traditional ties to the land; nearby communities soon offered an additional customer base; farmers and irrigation cooperatives became major consumers for their pumps and agricultural machinery; distant metropolitan areas boomed by tapping the energy source; and finally a conservative operational approach to investment and maintenance retained aging technology within a huge modern power grid for many, many years past a reasonable retirement.

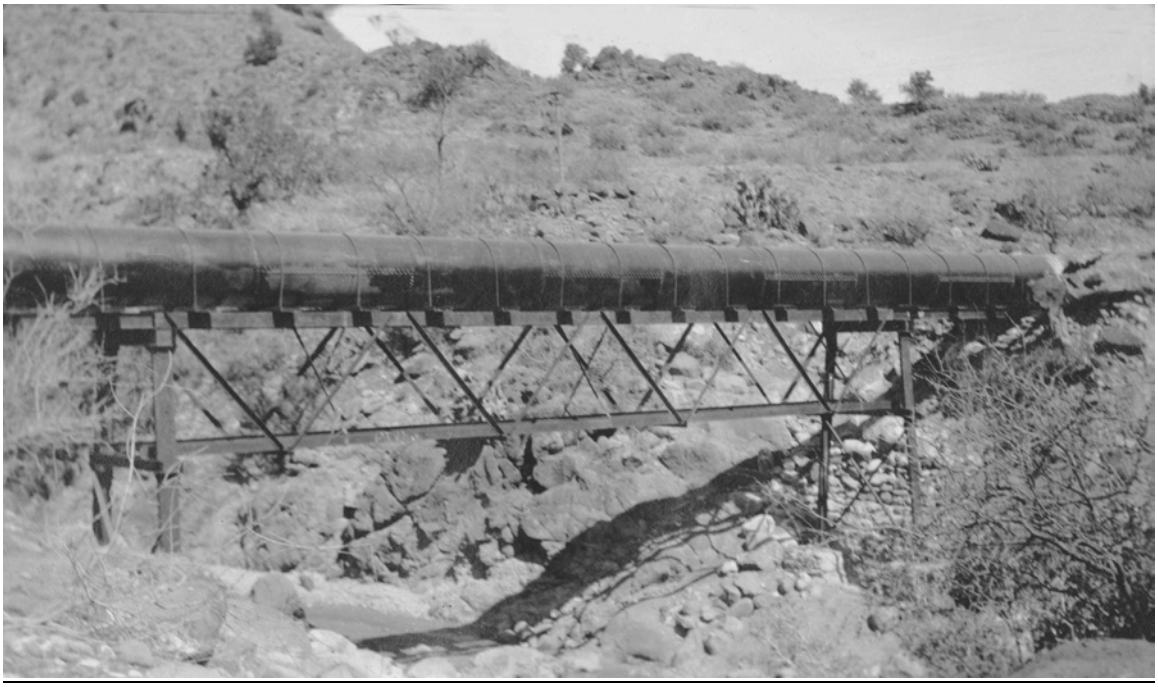
Character Defining Attributes

Component/Feature No.26 on National Register form. This steel bridge, originally bridge #1 on the Childs system before adding the Irving system, supported the Sally May Siphon pipe across Boulder Canyon. Siphon bridges were constructed with trestle foundations to support the siphon pipe across washes. (Effland and Macnider 1991)

Bibliography

Effland, Richard W., Jr., and Barbara S. Macnider
1991 *Childs-Irving Hydroelectric Facilities.* National Register of Historic Places Registration Form. U.S. Department of the Interior, National Park Service. Washington, D.C.

Neal, Lynn, and Linda Martin
2003 *Childs/Irving Hydroelectric Decommissioning Project, Historic Properties Management Plan* (HPMP). Prepared for APS/Generation Engineering. SWCA Environmental Consultants. Flagstaff.

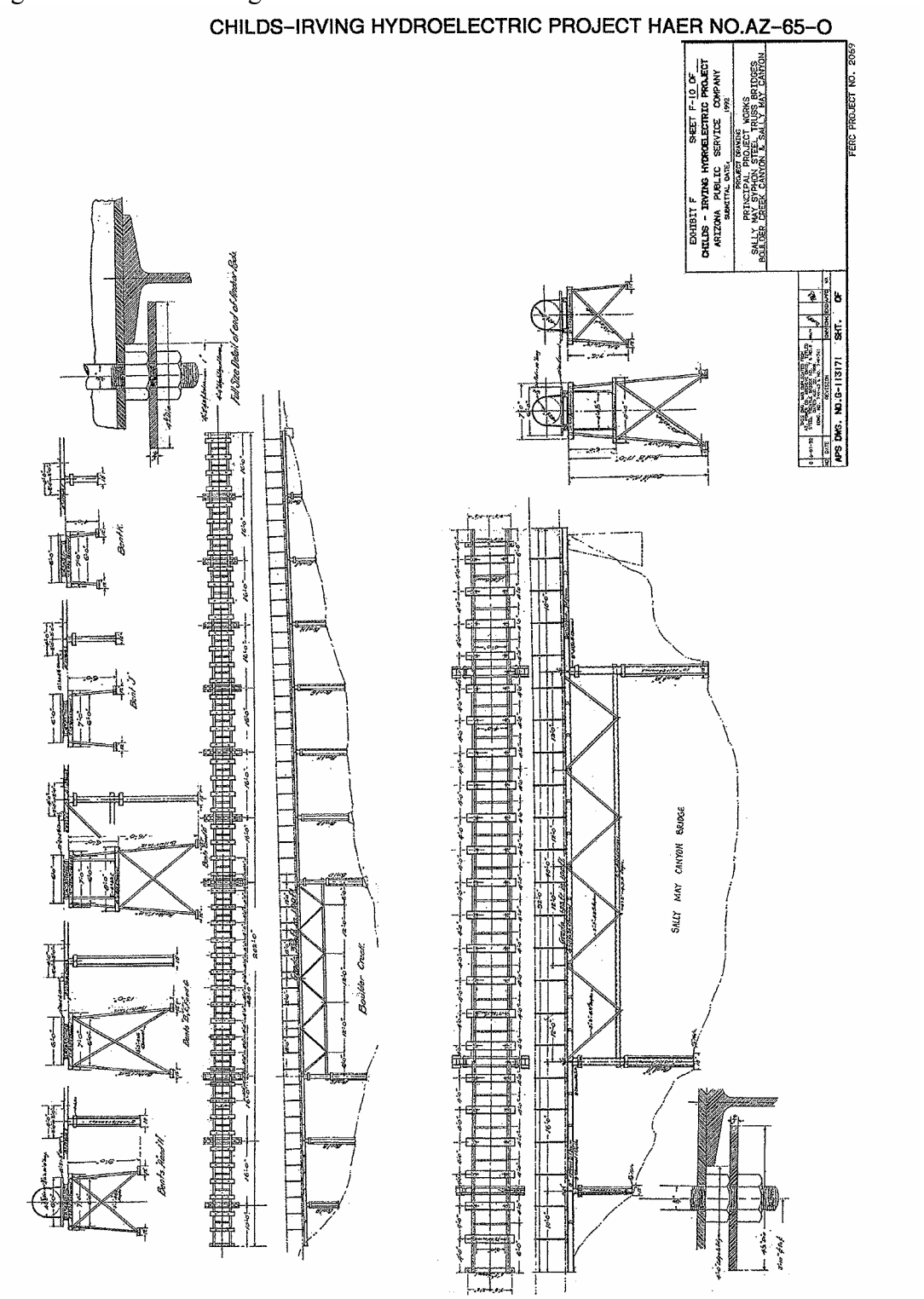


Example of steel bridge. APS Photo Library #82

Additional Bibliography

Arizona Public Service (APS) Archives
Historic photograph collection. Historic drawings collection. Historic documents collection. Available through appointment at: APS, P.O. Box 53933, M.S. 3190, Phoenix, Arizona 85072-3933, 602-371-7689.

Drawing "…Steel Truss Bridges" 1992:



CHILDS-IRVING HYDROELECTRIC PROJECT, HAER No. AZ-65-P
CHILDS SYSTEM: FLUME BRIDGE #3
Forest Service Road 708/502
Camp Verde vicinity
Yavapai County
Arizona

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Intermountain Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

CHILDS-IRVING HYDROELECTRIC PROJECT,
CHILDS SYSTEM: FLUME BRIDGE #3

HAER No. AZ-65-P

Location:	Childs Station No. 131+43. Forest Service Road 708/502, Camp Verde vicinity, Yavapai County, Arizona. USGS Payson Quadrangle, UTM Coordinates: NAD 27 Zone 12 439703.1767E - 3805182.875N.
Date of Construction:	1908.
Engineer:	Iva Tutt; Francis S. Vielé; Raymond S. Masson.
Present Owner:	Arizona Public Service (improvements), P.O. Box 53933, M.S. 3190, Phoenix, AZ 85072-3933; U.S. Government, U.S.D.A. Forest Service (land).
Present Use:	Hydroelectric power generation (November 2004).
Significance:	A dramatic change in topography below Sally May Wash required a series of bridges as trestles to convey water across a series of small but deep washes.
Historian:	James W. Steely, November 2004.

Project Information:

Between February and November 2004, Arizona Public Service (APS) and SWCA Environmental Consultants documented the hydroelectric complex, under guidance of the Historic American Engineering Record (HAER). Project managers Phil Smithers (APS) and Linda Martin (SWCA) coordinated historian Steely, photographer Jessica Maggio, and draftsman Hanson Todachine to complete the HAER documentation. Archives for the Childs-Irving Hydroelectric Project are at APS in Phoenix, Arizona.

Historic and Engineering Context:

The Childs-Irving Hydroelectric Project encompassed a unique water-pressure/electric-turbine system—according to engineering historians evaluating the historic complex since 1976—that 1) was constructed with great effort in an extremely remote landscape, 2) captured a natural water source and followed dramatic topography, 3) generated electric power in a remarkably simple and efficient manner, and 4) operated continuously for 95 years.

In addition to its individual significance nationwide, the Childs-Irving Hydroelectric Project is a classic part of Arizona history spanning the 20th century: remote low-grade mining operations sought reliable and less-expensive energy; a combination of investors, entrepreneurs and engineers modified a natural resource to supply the energy; cutting-edge technology entered a harsh and remote landscape; an isolated labor force merged those with skills learned far away with local residents, including Native Americans with traditional ties to the land; nearby communities soon offered an additional customer base; farmers and irrigation cooperatives became major consumers for their pumps and agricultural machinery; distant metropolitan areas boomed by tapping the energy source; and finally a conservative operational approach to investment and maintenance retained aging technology within a huge modern power grid for many, many years past a reasonable retirement.

Character Defining Attributes

Component/Feature No.27 on National Register form. This steel trestle, originally Childs bridge #2 before the addition of the Irving system, carried the siphon across Sally May Wash. (Effland and Macnider 1991)

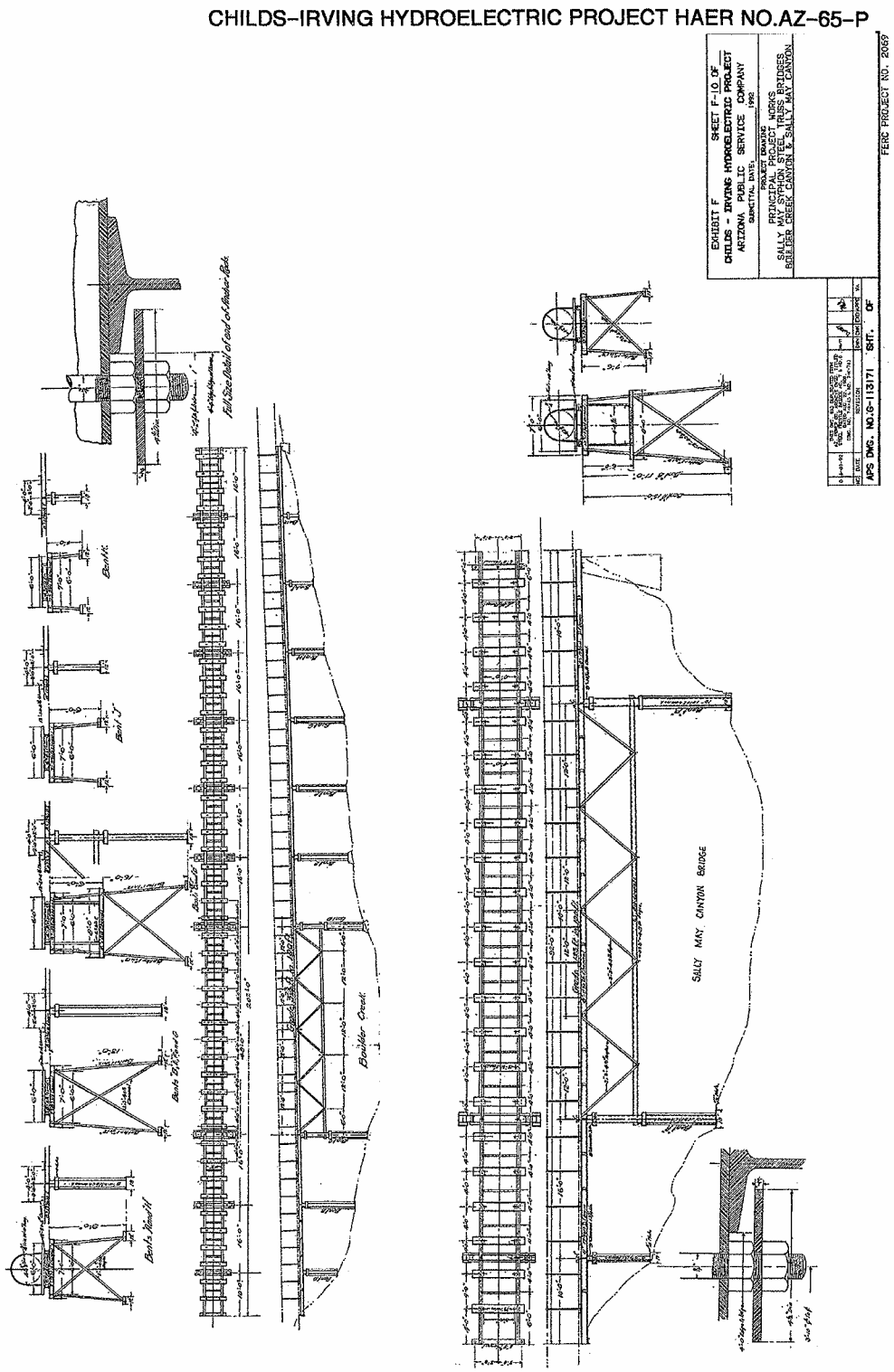
Bibliography

Arizona Public Service (APS) Archives
Historic photograph collection. Historic drawings collection. Historic documents collection. Available through appointment at: APS, P.O. Box 53933, M.S. 3190, Phoenix, Arizona 85072-3933, 602-371-7689.

Effland, Richard W., Jr., and Barbara S. Macnider
1991 *Childs-Irving Hydroelectric Facilities.* National Register of Historic Places Registration Form. U.S. Department of the Interior, National Park Service. Washington, D.C.

Neal, Lynn, and Linda Martin
2003 *Childs/Irving Hydroelectric Decommissioning Project, Historic Properties Management Plan* (HPMP). Prepared for APS/Generation Engineering. SWCA Environmental Consultants. Flagstaff.

Drawing "…Steel Truss Bridges" 1992:



CHILDS-IRVING HYDROELECTRIC PROJECT, HAER No. AZ-65-Q
CHILDS SYSTEM: FLUME BRIDGE #4
Forest Service Road 708/502
Camp Verde vicinity
Yavapai County
Arizona

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Intermountain Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

CHILDS-IRVING HYDROELECTRIC PROJECT,
CHILDS SYSTEM: FLUME BRIDGE #4

HAER No. AZ-65-Q

Location:	Childs Station No. 139+63. Forest Service Road 708/502, Camp Verde vicinity, Yavapai County, Arizona. USGS Payson Quadrangle, UTM Coordinates: NAD 27 Zone 12 439449.9321E - 3805051.838N.
Date of Construction:	1908.
Engineer:	Iva Tutt; Francis S. Vielé; Raymond S. Masson.
Present Owner:	Arizona Public Service (improvements), P.O. Box 53933, M.S. 3190, Phoenix, AZ 85072-3933; U.S. Government, U.S.D.A. Forest Service (land).
Present Use:	Hydroelectric power generation (November 2004).
Significance:	A dramatic change in topography below Sally May Wash required a series of bridges as trestles to convey water across a series of small but deep washes.
Historian:	James W. Steely, November 2004.

Project Information:

Between February and November 2004, Arizona Public Service (APS) and SWCA Environmental Consultants documented the hydroelectric complex, under guidance of the Historic American Engineering Record (HAER). Project managers Phil Smithers (APS) and Linda Martin (SWCA) coordinated historian Steely, photographer Jessica Maggio, and draftsman Hanson Todachine to complete the HAER documentation. Archives for the Childs-Irving Hydroelectric Project are at APS in Phoenix, Arizona.

Historic and Engineering Context:

The Childs-Irving Hydroelectric Project encompassed a unique water-pressure/electric-turbine system—according to engineering historians evaluating the historic complex since 1976—that 1) was constructed with great effort in an extremely remote landscape, 2) captured a natural water source and followed dramatic topography, 3) generated electric power in a remarkably simple and efficient manner, and 4) operated continuously for 95 years.

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Character Defining Attributes

Component/Feature No.28 on National Register form. This steel trestle, originally Childs Bridge #3 before the addition of the Irving system, carried the siphon across a minor wash. (Effland and Macnider 1991)

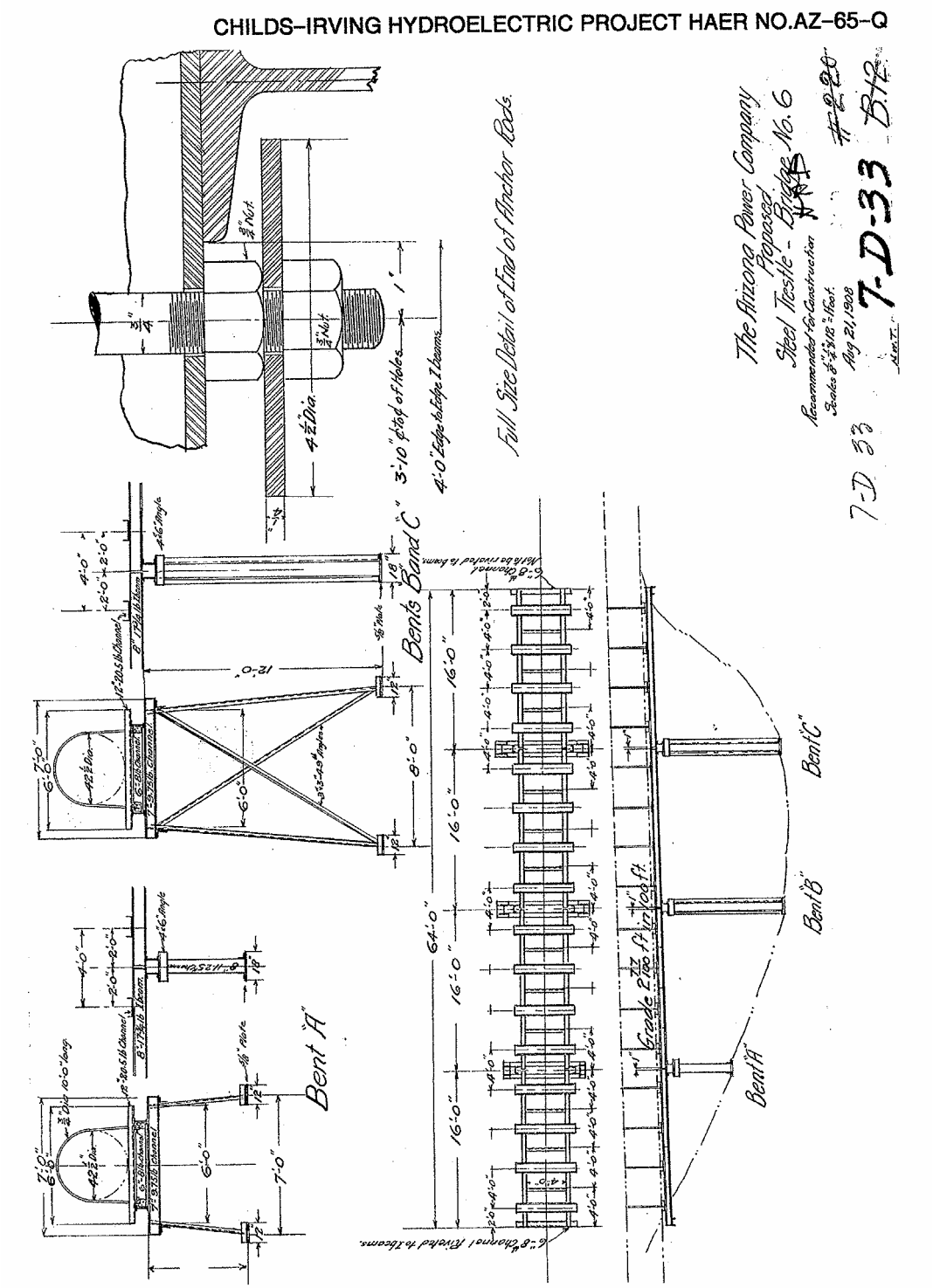
Bibliography

Arizona Public Service (APS) Archives
Historic photograph collection. Historic drawings collection. Historic documents collection. Available through appointment at: APS, P.O. Box 53933, M.S. 3190, Phoenix, Arizona 85072-3933, 602-371-7689.

Effland, Richard W., Jr., and Barbara S. Macnider
1991 *Childs-Irving Hydroelectric Facilities.* National Register of Historic Places Registration Form. U.S. Department of the Interior, National Park Service. Washington, D.C.

Neal, Lynn, and Linda Martin
2003 *Childs/Irving Hydroelectric Decommissioning Project, Historic Properties Management Plan* (HPMP). Prepared for APS/Generation Engineering. SWCA Environmental Consultants. Flagstaff.

Drawing "Proposed Steel Trestle – Bridge No. 6" 1908:



CHILDS-IRVING HYDROELECTRIC PROJECT, HAER No. AZ-65-R
CHILDS SYSTEM:
SALLY MAY/PURPLE MOUNTAIN SIPHON DISCHARGE
Forest Service Road 708/502
Camp Verde vicinity
Yavapai County
Arizona

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Intermountain Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

CHILDS-IRVING HYDROELECTRIC PROJECT, CHILDS SYSTEM: SALLY MAY/PURPLE MOUNTAIN SIPHON DISCHARGE

HAER No. AZ-65-R

Location:	Childs Station No. 158+63.8. Forest Service Road 708/502, Camp Verde vicinity, Yavapai County, Arizona. USGS Payson Quadrangle, UTM Coordinates: NAD 27 Zone 12 439097.1984E - 3805027.739N.
Dates of Construction:	1908; 1920.
Engineer:	Iva Tutt; Francis S. Vielé; Raymond S. Masson.
Present Owner:	Arizona Public Service (improvements), P.O. Box 53933, M.S. 3190, Phoenix, AZ 85072-3933; U.S. Government, U.S.D.A. Forest Service (land).
Present Use:	Hydroelectric power generation (November 2004).
Significance:	The route of the siphon was modified about 1920, between engineering stations 153+78.8 and 158+63.8. Originally the west end of the siphon included a bridge (original # 4) across a steep wash; the siphon then traversed a steep slope to hook up with Tunnel # 3. However, after several cases of undermining of the siphon pipe on this slope, operators decided to reroute the siphon around the slope.
Historian:	James W. Steely, November 2004.

Project Information:

Between February and November 2004, Arizona Public Service (APS) and SWCA Environmental Consultants documented the hydroelectric complex, under guidance of the Historic American Engineering Record (HAER). Project managers Phil Smithers (APS) and Linda Martin (SWCA) coordinated historian Steely, photographer Jessica Maggio, and draftsman Hanson Todachine to complete the HAER documentation. Archives for the Childs-Irving Hydroelectric Project are at APS in Phoenix, Arizona.

Historic and Engineering Context:

The Childs-Irving Hydroelectric Project encompassed a unique water-pressure/electric-turbine system—according to engineering historians evaluating the historic complex since 1976—that 1) was constructed with great effort in an extremely remote landscape, 2) captured a natural water source and followed dramatic topography, 3) generated electric power in a remarkably simple and efficient manner, and 4) operated continuously for 95 years.

In addition to its individual significance nationwide, the Childs-Irving Hydroelectric Project is a classic part of Arizona history spanning the 20th century: remote low-grade mining operations sought reliable and less-expensive energy; a combination of investors, entrepreneurs and engineers modified a natural resource to supply the energy; cutting-edge technology entered a harsh and remote landscape; an isolated labor force merged those with skills learned far away with local residents, including Native Americans with traditional ties to the land; nearby communities soon offered an additional customer base; farmers and irrigation cooperatives became major consumers for their pumps and agricultural machinery; distant metropolitan areas boomed by tapping the energy source; and finally a conservative operational approach to investment and maintenance retained aging technology within a huge modern power grid for many, many years past a reasonable retirement.

Character Defining Attributes

Component/Feature No.29 on National Register form. This west extreme of the siphon was a concrete box, part of an adjustment of the siphon about 1920 to solve undermining problems with the siphon near its discharge. This reroute and modification included a steel flume that ran between the end of the siphon and tunnel #3, and a corrugated metal shed nearby. (Effland and Macnider 1991)

Bibliography

Effland, Richard W., Jr., and Barbara S. Macnider
1991 *Childs-Irving Hydroelectric Facilities.* National Register of Historic Places Registration Form. U.S. Department of the Interior, National Park Service. Washington, D.C.

Neal, Lynn, and Linda Martin
2003 *Childs/Irving Hydroelectric Decommissioning Project, Historic Properties Management Plan* (HPMP). Prepared for APS/Generation Engineering. SWCA Environmental Consultants. Flagstaff.

CHILDS-IRVING HYDROELECTRIC PROJECT, HAER No. AZ-65-S
CHILDS SYSTEM: STEEL FLUME ON TRESTLES
Forest Service Road 708/502
Camp Verde vicinity
Yavapai County
Arizona

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Intermountain Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

CHILDS-IRVING HYDROELECTRIC PROJECT, CHILDS SYSTEM: STEEL FLUME ON TRESTLES

HAER No. AZ-65-S

Location:	Childs Station No. 158+83. Forest Service Road 708/502, Camp Verde vicinity, Yavapai County, Arizona. USGS Payson Quadrangle, UTM Coordinates: NAD 27 Zone 12 439008.2613E - 3804975.022N.
Dates of Construction:	1908; 1920.
Engineer:	Iva Tutt; Francis S. Vielé; Raymond S. Masson.
Present Owner:	Arizona Public Service (improvements), P.O. Box 53933, M.S. 3190, Phoenix, AZ 85072-3933; U.S. Government, U.S.D.A. Forest Service (land).
Present Use:	Hydroelectric power generation (November 2004).
Significance:	This is the only section in the Childs System that functioned with a steel flume on steel trestles, and was part of the siphon reroute completed about 1920.
Historian:	James W. Steely, November 2004.

Project Information:

Between February and November 2004, Arizona Public Service (APS) and SWCA Environmental Consultants documented the hydroelectric complex, under guidance of the Historic American Engineering Record (HAER). Project managers Phil Smithers (APS) and Linda Martin (SWCA) coordinated historian Steely, photographer Jessica Maggio, and draftsman Hanson Todachine to complete the HAER documentation. Archives for the Childs-Irving Hydroelectric Project are at APS in Phoenix, Arizona.

Historic and Engineering Context:

The Childs-Irving Hydroelectric Project encompassed a unique water-pressure/electric-turbine system—according to engineering historians evaluating the historic complex since 1976—that 1) was constructed with great effort in an extremely remote landscape, 2) captured a natural water source and followed dramatic topography, 3) generated electric power in a remarkably simple and efficient manner, and 4) operated continuously for 95 years.

In addition to its individual significance nationwide, the Childs-Irving Hydroelectric Project is a classic part of Arizona history spanning the 20th century: remote low-grade mining operations sought reliable and less-expensive energy; a combination of investors, entrepreneurs and engineers modified a natural resource to supply the energy; cutting-edge technology entered a harsh and remote landscape; an isolated labor force merged those with skills learned far away with local residents, including Native Americans with traditional ties to the land; nearby communities soon offered an additional customer base; farmers and irrigation cooperatives became major consumers for their pumps and agricultural machinery; distant metropolitan areas boomed by tapping the energy source; and finally a conservative operational approach to investment and maintenance retained aging technology within a huge modern power grid for many, many years past a reasonable retirement.

Character Defining Attributes

Component/Feature No.30 on National Register form. The section was 866 feet long between the siphon discharge and tunnel #3, constructed of 120-inch semicircular Hess-type steel flume sections including a 60 foot steel truss bridge structure, similar to that used on the Irving system. (Effland and Macnider 1991)

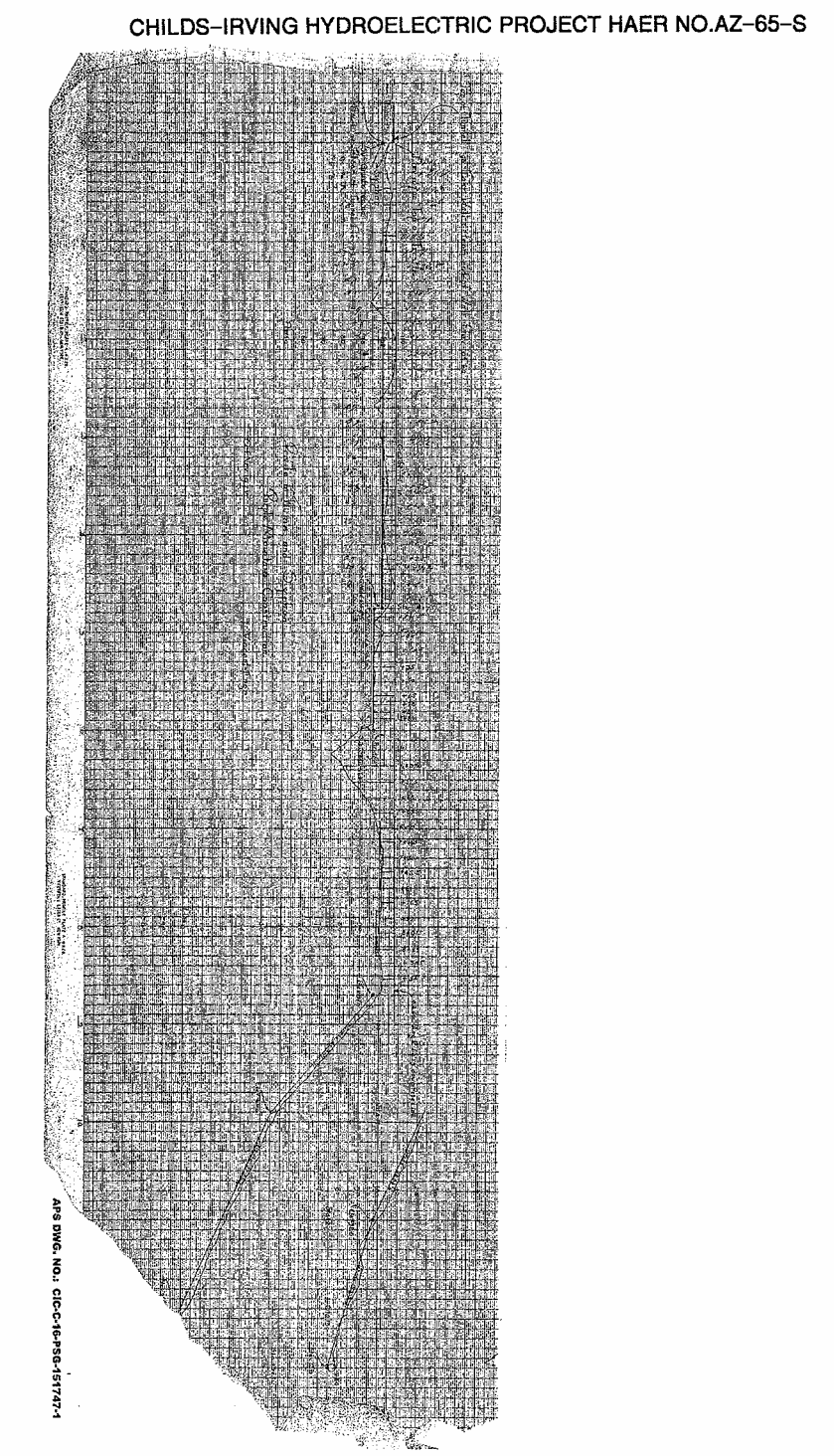
Bibliography

Arizona Public Service (APS) Archives
Historic photograph collection. Historic drawings collection. Historic documents collection. Available through appointment at: APS, P.O. Box 53933, M.S. 3190, Phoenix, Arizona 85072-3933, 602-371-7689.

Effland, Richard W., Jr., and Barbara S. Macnider
1991 *Childs-Irving Hydroelectric Facilities.* National Register of Historic Places Registration Form. U.S. Department of the Interior, National Park Service. Washington, D.C.

Neal, Lynn, and Linda Martin
2003 *Childs/Irving Hydroelectric Decommissioning Project, Historic Properties Management Plan* (HPMP). Prepared for APS/Generation Engineering. SWCA Environmental Consultants. Flagstaff.

Drawing “Standard Profile Plate A” circa 1930:



CHILDS-IRVING HYDROELECTRIC PROJECT, HAER No. AZ-65-T
CHILDS SYSTEM: FLUME TUNNEL #3
Forest Service Road 708/502
Camp Verde vicinity
Yavapai County
Arizona

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Intermountain Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

CHILDS-IRVING HYDROELECTRIC PROJECT,
CHILDS SYSTEM: FLUME TUNNEL #3

HAER No. AZ-65-T

Location:	Childs Station No. 167+29.8. Forest Service Road 708/502, Camp Verde vicinity, Yavapai County, Arizona. USGS Payson Quadrangle, UTM Coordinates: NAD 27 Zone 12 438856.0131E - 3804621.07N.
Date of Construction:	1908.
Engineer:	Iva Tutt; Francis S. Vielé; Raymond S. Masson.
Present Owner:	Arizona Public Service (improvements), P.O. Box 53933, M.S. 3190, Phoenix, AZ 85072-3933; U.S. Government, U.S.D.A. Forest Service (land).
Present Use:	Hydroelectric power generation (November 2004).
Significance:	The geography of Fossil Creek required a series of tunnels, judged to be less expensive and easier to maintain than continuous flume through this area.
Historian:	James W. Steely, November 2004.

Project Information:

Between February and November 2004, Arizona Public Service (APS) and SWCA Environmental Consultants documented the hydroelectric complex, under guidance of the Historic American Engineering Record (HAER). Project managers Phil Smithers (APS) and Linda Martin (SWCA) coordinated historian Steely, photographer Jessica Maggio, and draftsman Hanson Todachine to complete the HAER documentation. Archives for the Childs-Irving Hydroelectric Project are at APS in Phoenix, Arizona.

Historic and Engineering Context:

The Childs-Irving Hydroelectric Project encompassed a unique water-pressure/electric-turbine system—according to engineering historians evaluating the historic complex since 1976—that 1) was constructed with great effort in an extremely remote landscape, 2) captured a natural water source and followed dramatic topography, 3) generated electric power in a remarkably simple and efficient manner, and 4) operated continuously for 95 years.

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Character Defining Attributes

Component/Feature No.31 on National Register form. This tunnel was 600 feet in length, 4 feet wide and 6 feet high, partially timbered and roofed. (Effland and Macnider 1991)

Bibliography

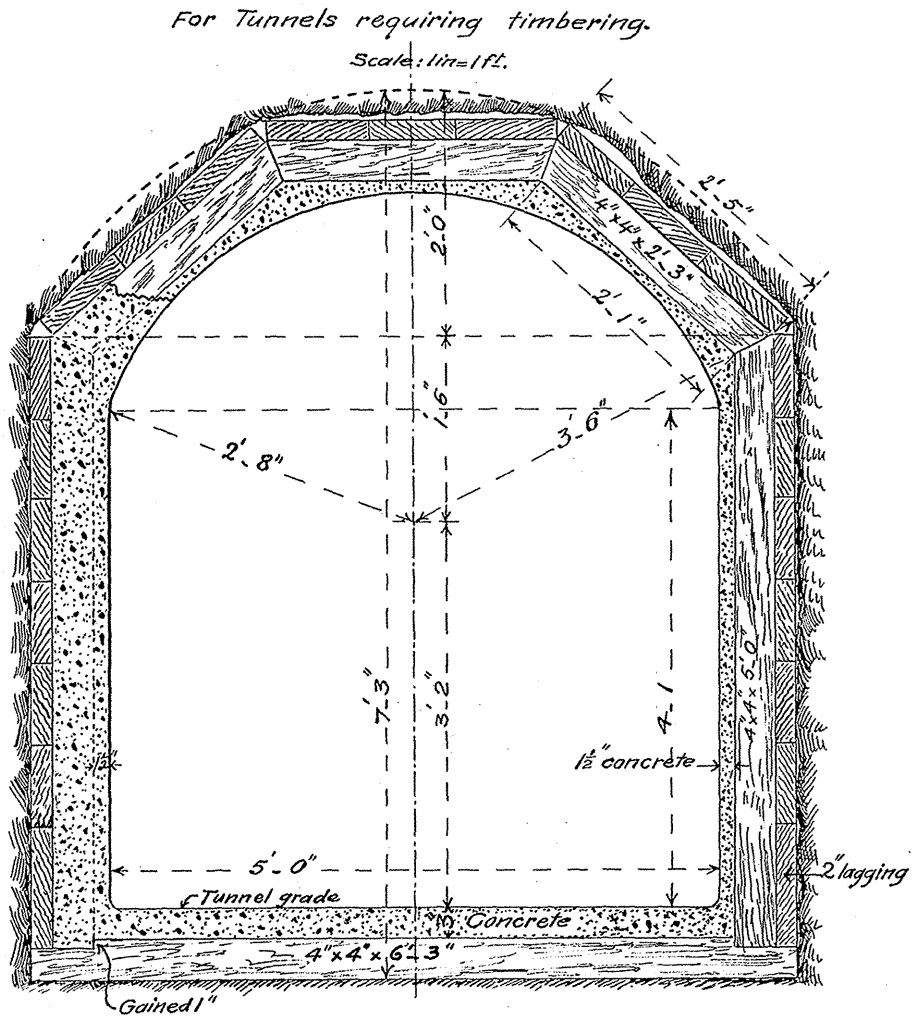
Arizona Public Service (APS) Archives
Historic photograph collection. Historic drawings collection. Historic documents collection. Available through appointment at: APS, P.O. Box 53933, M.S. 3190, Phoenix, Arizona 85072-3933, 602-371-7689.

Effland, Richard W., Jr., and Barbara S. Macnider
1991 *Childs-Irving Hydroelectric Facilities.* National Register of Historic Places Registration Form. U.S. Department of the Interior, National Park Service. Washington, D.C.

Neal, Lynn, and Linda Martin
2003 *Childs/Irving Hydroelectric Decommissioning Project, Historic Properties Management Plan* (HPMP). Prepared for APS/Generation Engineering. SWCA Environmental Consultants. Flagstaff.

Drawing "For Tunnels requiring timbering" circa 1908:

CHILDS–IRVING HYDROELECTRIC PROJECT HAER NO.AZ–65–T



APS DWG. NO.: CIC-C-21-PBS-151896-2

T-A-22
#204-4

CHILDS-IRVING HYDROELECTRIC PROJECT, HAER No. AZ-65-U
CHILDS SYSTEM: FLUME BRIDGE #5
Forest Service Road 708/502
Camp Verde vicinity
Yavapai County
Arizona

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Intermountain Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

CHILDS-IRVING HYDROELECTRIC PROJECT,
CHILDS SYSTEM: FLUME BRIDGE #5

HAER No. AZ-65-U

Location:	Childs Station No. 173+29.8. Forest Service Road 708/502, Camp Verde vicinity, Yavapai County, Arizona. USGS Payson Quadrangle, UTM Coordinates: NAD 27 Zone 12 438985.6503E - 3804404.18N.
DateS of Construction:	1908; 1920.
Engineer:	Iva Tutt; Francis S. Vielé; Raymond S. Masson.
Present Owner:	Arizona Public Service (improvements), P.O. Box 53933, M.S. 3190, Phoenix, AZ 85072-3933; U.S. Government, U.S.D.A. Forest Service (land).
Present Use:	Hydroelectric power generation (November 2004).
Significance:	This originally was a wood flume bridge that crossed a steep unnamed wash, replaced by metal pipe about 1920, and connected Tunnel # 3 with concrete flume.
Historian:	James W. Steely, November 2004.

Project Information:

Between February and November 2004, Arizona Public Service (APS) and SWCA Environmental Consultants documented the hydroelectric complex, under guidance of the Historic American Engineering Record (HAER). Project managers Phil Smithers (APS) and Linda Martin (SWCA) coordinated historian Steely, photographer Jessica Maggio, and draftsman Hanson Todachine to complete the HAER documentation. Archives for the Childs-Irving Hydroelectric Project are at APS in Phoenix, Arizona.

Historic and Engineering Context:

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Character Defining Attributes

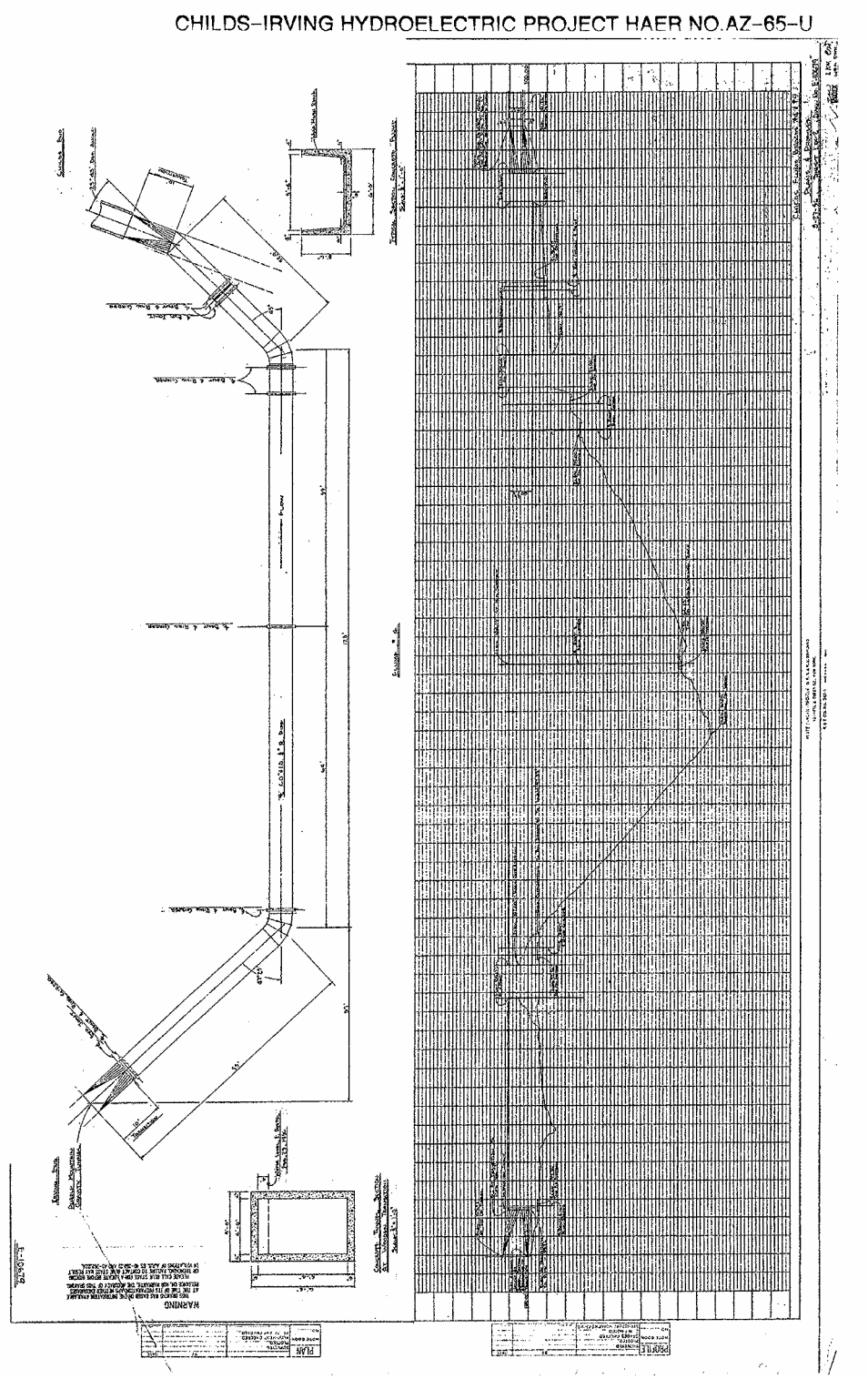
Component/Feature No.32 on National Register form. This 211 foot 60-inch diameter steel pipe bridge was installed about 1920 to replace the original wooden flume bridge that crossed a steep unnamed wash to connect tunnel #3 with concrete flume. (Effland and Macnider 1991)

Bibliography

Effland, Richard W., Jr., and Barbara S. Macnider
1991 *Childs-Irving Hydroelectric Facilities.* National Register of Historic Places Registration Form. U.S. Department of the Interior, National Park Service. Washington, D.C.

Neal, Lynn, and Linda Martin
2003 *Childs/Irving Hydroelectric Decommissioning Project, Historic Properties Management Plan* (HPMP). Prepared for APS/Generation Engineering. SWCA Environmental Consultants. Flagstaff.

Drawing "Childs Flume Bridges #4 and #5" 1956:



CHILDS-IRVING HYDROELECTRIC PROJECT, HAER No. AZ-65-V
CHILDS SYSTEM: FLUME TUNNEL #4
Forest Service Road 708/502
Camp Verde vicinity
Yavapai County
Arizona

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Intermountain Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

CHILDS-IRVING HYDROELECTRIC PROJECT, CHILDS SYSTEM: FLUME TUNNEL #4

HAER No. AZ-65-V

Location:	Childs Station No. 190+87. Forest Service Road 708/502, Camp Verde vicinity, Yavapai County, Arizona. USGS Payson Quadrangle, UTM Coordinates: NAD 27 Zone 12 439019.2694E - 3804100.087N.
Date of Construction:	1908.
Engineer:	Iva Tutt; Francis S. Vielé; Raymond S. Masson.
Present Owner:	Arizona Public Service (improvements), P.O. Box 53933, M.S. 3190, Phoenix, AZ 85072-3933; U.S. Government, U.S.D.A. Forest Service (land).
Present Use:	Hydroelectric power generation (November 2004).
Significance:	The geography of Fossil Creek required a series of tunnels, judged to be less expensive and easier to maintain than continuous flume through this area.
Historian:	James W. Steely, November 2004.

Project Information:

Between February and November 2004, Arizona Public Service (APS) and SWCA Environmental Consultants documented the hydroelectric complex, under guidance of the Historic American Engineering Record (HAER). Project managers Phil Smithers (APS) and Linda Martin (SWCA) coordinated historian Steely, photographer Jessica Maggio, and draftsman Hanson Todachine to complete the HAER documentation. Archives for the Childs-Irving Hydroelectric Project are at APS in Phoenix, Arizona.

Historic and Engineering Context:

The Childs-Irving Hydroelectric Project encompassed a unique water-pressure/electric-turbine system—according to engineering historians evaluating the historic complex since 1976—that 1) was constructed with great effort in an extremely remote landscape, 2) captured a natural water source and followed dramatic topography, 3) generated electric power in a remarkably simple and efficient manner, and 4) operated continuously for 95 years.

In addition to its individual significance nationwide, the Childs-Irving Hydroelectric Project is a classic part of Arizona history spanning the 20th century: remote low-grade mining operations sought reliable and less-expensive energy; a combination of investors, entrepreneurs and engineers modified a natural resource to supply the energy; cutting-edge technology entered a harsh and remote landscape; an isolated labor force merged those with skills learned far away with local residents, including Native Americans with traditional ties to the land; nearby communities soon offered an additional customer base; farmers and irrigation cooperatives became major consumers for their pumps and agricultural machinery; distant metropolitan areas boomed by tapping the energy source; and finally a conservative operational approach to investment and maintenance retained aging technology within a huge modern power grid for many, many years past a reasonable retirement.

Character Defining Attributes

Component/Feature No.33 on National Register form. This gravity tunnel was 726 feet long and measures 4.5 feet wide and 5.5 feet high. (Effland and Macnider 1991)

Bibliography

Arizona Public Service (APS) Archives
Historic photograph collection. Historic drawings collection. Historic documents collection. Available through appointment at: APS, P.O. Box 53933, M.S. 3190, Phoenix, Arizona 85072-3933, 602-371-7689.

Effland, Richard W., Jr., and Barbara S. Macnider
1991 *Childs-Irving Hydroelectric Facilities.* National Register of Historic Places Registration Form. U.S. Department of the Interior, National Park Service. Washington, D.C.

Neal, Lynn, and Linda Martin
2003 *Childs/Irving Hydroelectric Decommissioning Project, Historic Properties Management Plan* (HPMP). Prepared for APS/Generation Engineering. SWCA Environmental Consultants. Flagstaff.

CHILDS-IRVING HYDROELECTRIC PROJECT, HAER No. AZ-65-W
CHILDS SYSTEM: FLUME TUNNEL #5
Forest Service Road 708/502
Camp Verde vicinity
Yavapai County
Arizona

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Intermountain Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

CHILDS-IRVING HYDROELECTRIC PROJECT,
CHILDS SYSTEM: FLUME TUNNEL #5

HAER No. AZ-65-W

Location:	Childs Station No. 206+58.6. Forest Service Road 708/502, Camp Verde vicinity, Yavapai County, Arizona. USGS Payson Quadrangle, UTM Coordinates: NAD 27 Zone 12 438969.7254E - 3803765.938N.
Date of Construction:	1908.
Engineer:	Iva Tutt; Francis S. Vielé; Raymond S. Masson.
Present Owner:	Arizona Public Service (improvements), P.O. Box 53933, M.S. 3190, Phoenix, AZ 85072-3933; U.S. Government, U.S.D.A. Forest Service (land).
Present Use:	Hydroelectric power generation (November 2004).
Significance:	The geography of Fossil Creek required a series of tunnels, judged to be less expensive and easier to maintain than continuous flume through this area.
Historian:	James W. Steely, November 2004.

Project Information:

Between February and November 2004, Arizona Public Service (APS) and SWCA Environmental Consultants documented the hydroelectric complex, under guidance of the Historic American Engineering Record (HAER). Project managers Phil Smithers (APS) and Linda Martin (SWCA) coordinated historian Steely, photographer Jessica Maggio, and draftsman Hanson Todachine to complete the HAER documentation. Archives for the Childs-Irving Hydroelectric Project are at APS in Phoenix, Arizona.

Historic and Engineering Context:

The Childs-Irving Hydroelectric Project encompassed a unique water-pressure/electric-turbine system—according to engineering historians evaluating the historic complex since 1976—that 1) was constructed with great effort in an extremely remote landscape, 2) captured a natural water source and followed dramatic topography, 3) generated electric power in a remarkably simple and efficient manner, and 4) operated continuously for 95 years.

In addition to its individual significance nationwide, the Childs-Irving Hydroelectric Project is a classic part of Arizona history spanning the 20th century: remote low-grade mining operations sought reliable and less-expensive energy; a combination of investors, entrepreneurs and engineers modified a natural resource to supply the energy; cutting-edge technology entered a harsh and remote landscape; an isolated labor force merged those with skills learned far away with local residents, including Native Americans with traditional ties to the land; nearby communities soon offered an additional customer base; farmers and irrigation cooperatives became major consumers for their pumps and agricultural machinery; distant metropolitan areas boomed by tapping the energy source; and finally a conservative operational approach to investment and maintenance retained aging technology within a huge modern power grid for many, many years past a reasonable retirement.

Character Defining Attributes

Component/Feature No.35 on National Register form. This gravity tunnel was 200 feet long, with concrete slabs placed over sections of concrete flume, running under Childs Road (FS 502). (Effland and Macnider 1991)

Bibliography

Effland, Richard W., Jr., and Barbara S. Macnider
1991 *Childs-Irving Hydroelectric Facilities.* National Register of Historic Places Registration Form. U.S. Department of the Interior, National Park Service. Washington, D.C.

Neal, Lynn, and Linda Martin
2003 *Childs/Irving Hydroelectric Decommissioning Project, Historic Properties Management Plan* (HPMP). Prepared for APS/Generation Engineering. SWCA Environmental Consultants. Flagstaff.

CHILDS-IRVING HYDROELECTRIC PROJECT, HAER No. AZ-65-X
CHILDS SYSTEM: FLUME TUNNEL #6
Forest Service Road 708/502
Camp Verde vicinity
Yavapai County
Arizona

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Intermountain Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

CHILDS-IRVING HYDROELECTRIC PROJECT,
CHILDS SYSTEM: FLUME TUNNEL #6

HAER No. AZ-65-X

Location:	Childs Station No. 228+16.1. Forest Service Road 708/502, Camp Verde vicinity, Yavapai County, Arizona. USGS Payson Quadrangle, UTM Coordinates: NAD 27 Zone 12 438898.9339E - 3803126.976N.
Date of Construction:	1908.
Engineer:	Iva Tutt; Francis S. Vielé; Raymond S. Masson.
Present Owner:	Arizona Public Service (improvements), P.O. Box 53933, M.S. 3190, Phoenix, AZ 85072-3933; U.S. Government, U.S.D.A. Forest Service (land).
Present Use:	Hydroelectric power generation (November 2004).
Significance:	The geography of Fossil Creek required a series of tunnels, judged to be less expensive and easier to maintain than continuous flume through this area.
Historian:	James W. Steely, November 2004.

Project Information:

Between February and November 2004, Arizona Public Service (APS) and SWCA Environmental Consultants documented the hydroelectric complex, under guidance of the Historic American Engineering Record (HAER). Project managers Phil Smithers (APS) and Linda Martin (SWCA) coordinated historian Steely, photographer Jessica Maggio, and draftsman Hanson Todachine to complete the HAER documentation. Archives for the Childs-Irving Hydroelectric Project are at APS in Phoenix, Arizona.

Historic and Engineering Context:

The Childs-Irving Hydroelectric Project encompassed a unique water-pressure/electric-turbine system—according to engineering historians evaluating the historic complex since 1976—that 1) was constructed with great effort in an extremely remote landscape, 2) captured a natural water source and followed dramatic topography, 3) generated electric power in a remarkably simple and efficient manner, and 4) operated continuously for 95 years.

In addition to its individual significance nationwide, the Childs-Irving Hydroelectric Project is a classic part of Arizona history spanning the 20th century: remote low-grade mining operations sought reliable and less-expensive energy; a combination of investors, entrepreneurs and engineers modified a natural resource to supply the energy; cutting-edge technology entered a harsh and remote landscape; an isolated labor force merged those with skills learned far away with local residents, including Native Americans with traditional ties to the land; nearby communities soon offered an additional customer base; farmers and irrigation cooperatives became major consumers for their pumps and agricultural machinery; distant metropolitan areas boomed by tapping the energy source; and finally a conservative operational approach to investment and maintenance retained aging technology within a huge modern power grid for many, many years past a reasonable retirement.

Character Defining Attributes

Component/Feature No.36 on National Register form. This gravity tunnel was 521.3 feet long and measured 3 feet wide and 8 feet high. (Effland and Macnider 1991)

Bibliography

Arizona Public Service (APS) Archives
Historic photograph collection. Historic drawings collection. Historic documents collection. Available through appointment at: APS, P.O. Box 53933, M.S. 3190, Phoenix, Arizona 85072-3933, 602-371-7689.

Effland, Richard W., Jr., and Barbara S. Macnider
1991 *Childs-Irving Hydroelectric Facilities.* National Register of Historic Places Registration Form. U.S. Department of the Interior, National Park Service. Washington, D.C.

Neal, Lynn, and Linda Martin
2003 *Childs/Irving Hydroelectric Decommissioning Project, Historic Properties Management Plan* (HPMP). Prepared for APS/Generation Engineering. SWCA Environmental Consultants. Flagstaff.

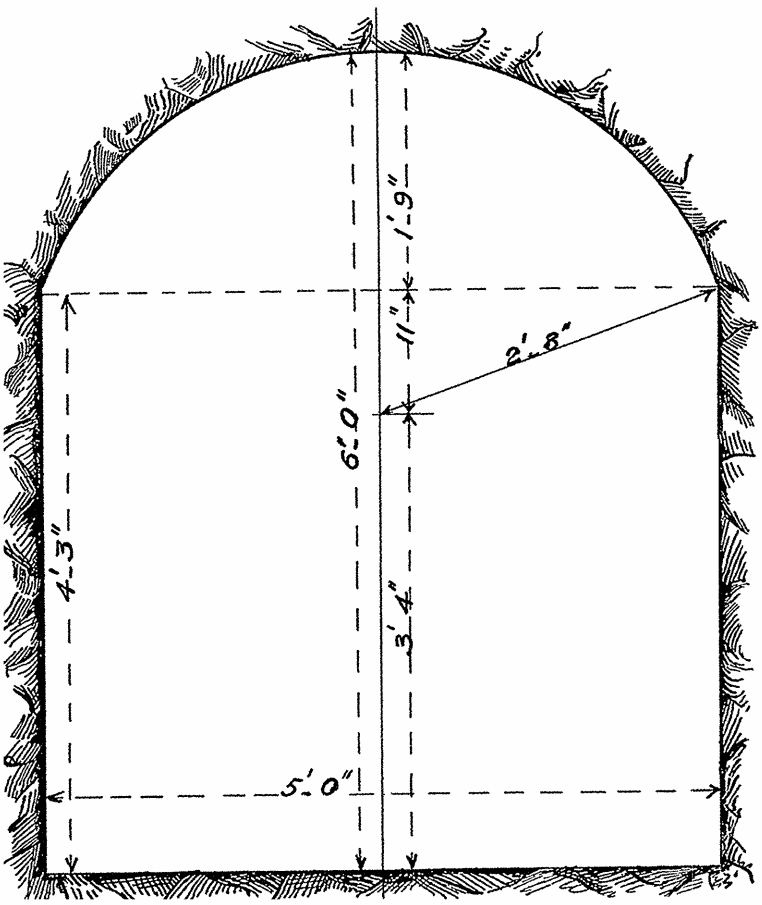
Drawing "Arizona Power Co Cross Section No 1…." circa 1908:

CHILDS–IRVING HYDROELECTRIC PROJECT HAER NO.AZ–65– X

ARIZONA POWER Co

Cross Section No 1.

For tunnels not requiring timbering or lining.



APS DWG. NO.: CIC-C-06-PFS-151901-1

#204-2

CHILDS-IRVING HYDROELECTRIC PROJECT, HAER No. AZ-65-Y
CHILDS SYSTEM: STEHR LAKE AND DAMS
Forest Service Road 708/502
Camp Verde vicinity
Yavapai County
Arizona

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Intermountain Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

CHILDS-IRVING HYDROELECTRIC PROJECT, CHILDS SYSTEM: STEHR LAKE AND DAMS

HAER No. AZ-65-Y

Location:	Childs Station No. 237+52. Forest Service Road 708/502, Camp Verde vicinity, Yavapai County, Arizona. USGS Payson Quadrangle, UTM Coordinates: Inlet Dam: NAD 27 Zone 12 438891.907E - 3802826.195N. Outlet Dam: NAD 27 Zone 12 438525.0426E - 3802444.077N.
Date of Construction:	1908.
Engineer:	Iva Tutt; Francis S. Vielé; Raymond S. Masson.
Present Owner:	Arizona Public Service (improvements), P.O. Box 53933, M.S. 3190, Phoenix, AZ 85072-3933; U.S. Government, U.S.D.A. Forest Service (land).
Present Use:	Hydroelectric power generation (November 2004).
Significance:	Stehr Lake was constructed to provide a reservoir of water to allow the Childs Power Plant to continue to generate power during a flume outage on the Childs system. The reservoir also served as a settling pond for silt in the Fossil Creek water. The presence of an ancient lake bed made construction of this system possible, providing a substantial basin for the reservoir between two containment dams.
Historian:	James W. Steely, November 2004.

Project Information:

Between February and November 2004, Arizona Public Service (APS) and SWCA Environmental Consultants documented the hydroelectric complex, under guidance of the Historic American Engineering Record (HAER). Project managers Phil Smithers (APS) and Linda Martin (SWCA) coordinated historian Steely, photographer Jessica Maggio, and draftsman Hanson Todachine to complete the HAER documentation. Archives for the Childs-Irving Hydroelectric Project are at APS in Phoenix, Arizona.

Historic and Engineering Context:

The Childs-Irving Hydroelectric Project encompassed a unique water-pressure/electric-turbine system—according to engineering historians evaluating the historic complex since 1976—that 1) was constructed with great effort in an extremely remote landscape, 2) captured a natural water source and followed dramatic topography, 3) generated electric power in a remarkably simple and efficient manner, and 4) operated continuously for 95 years.

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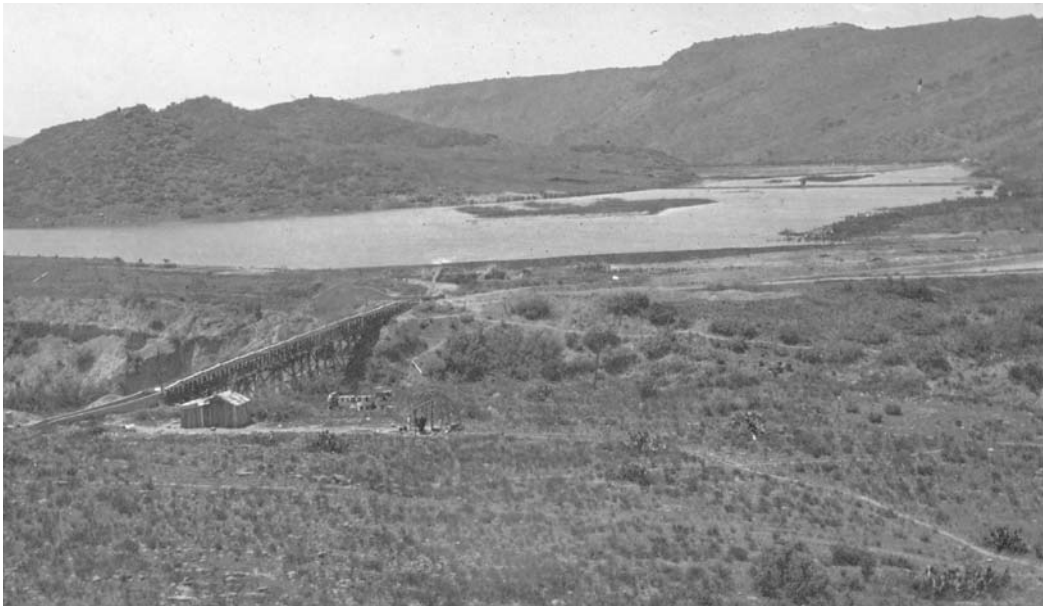
Character Defining Attributes

Component/Feature No.38 on National Register form. Stehr Lake was formed upon a natural depression near Fossil Creek canyon through construction of two earthen dams at each end of the depression: Upper Stehr Lake Dam, forming the reservoir's north containment, and Lower Stehr Lake Dam, roughly south. The reservoir covered 27.5 acres to a maximum depth of 13.3 feet for a maximum capacity of 287 acre-feet of reservoir. (Effland and Macnider 1991).



APS Photo Library #111

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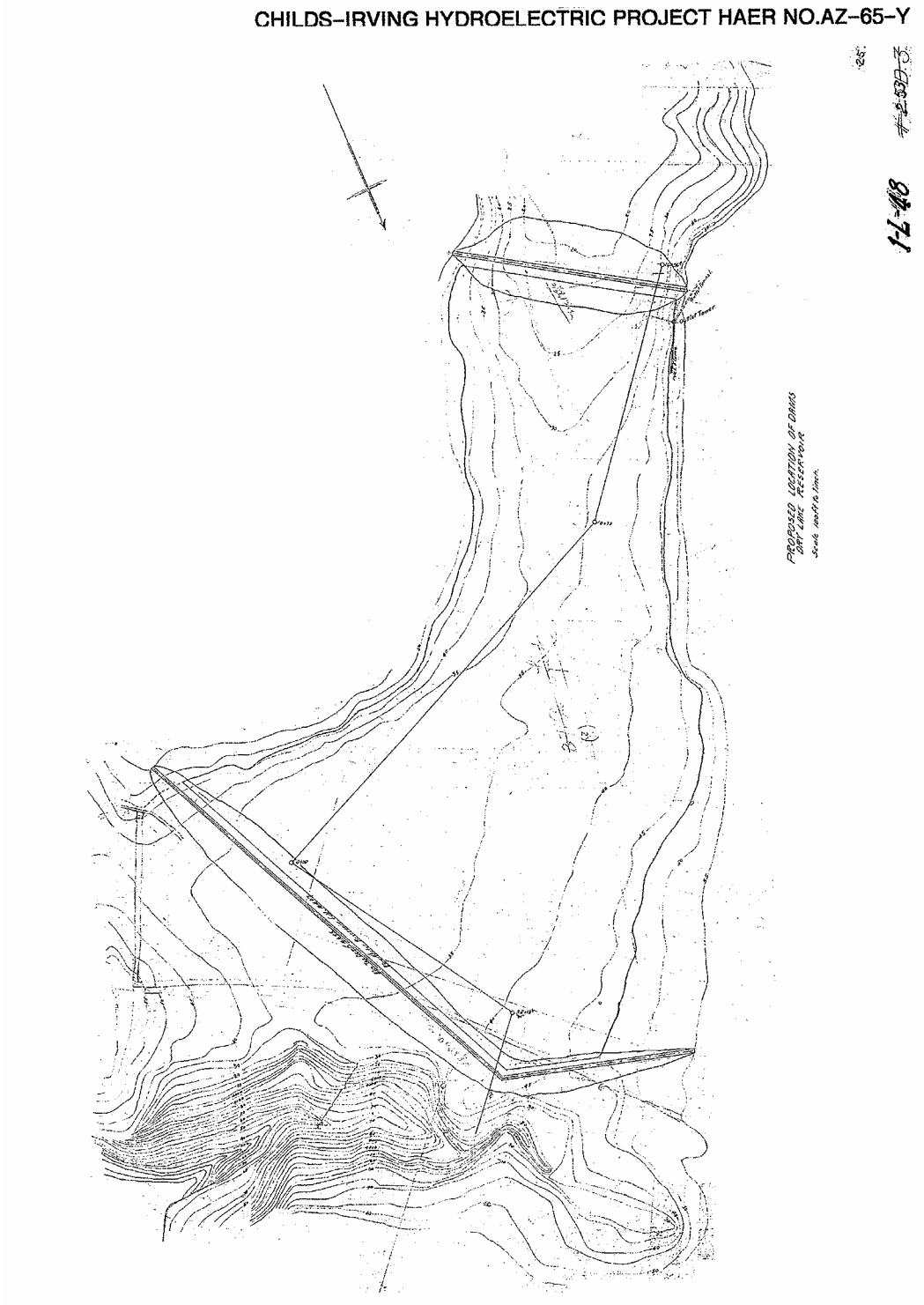
Arizona Public Service (APS) Archives
Historic photograph collection. Historic drawings collection. Historic documents collection. Available through appointment at: APS, P.O. Box 53933, M.S. 3190, Phoenix, Arizona 85072-3933, 602-371-7689.

Effland, Richard W., Jr., and Barbara S. Macnider
1991 *Childs-Irving Hydroelectric Facilities.* National Register of Historic Places Registration Form. U.S. Department of the Interior, National Park Service. Washington, D.C.

Neal, Lynn, and Linda Martin
2003 *Childs/Irving Hydroelectric Decommissioning Project, Historic Properties Management Plan* (HPMP). Prepared for APS/Generation Engineering. SWCA Environmental Consultants. Flagstaff.

Drawing "Proposed Location of Dams" circa 1908:



CHILDS-IRVING HYDROELECTRIC PROJECT, HAER No. AZ-65-Z
CHILDS SYSTEM: PRESSURE TUNNEL INTAKE
Forest Service Road 708/502
Camp Verde vicinity
Yavapai County
Arizona

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Intermountain Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

CHILDS-IRVING HYDROELECTRIC PROJECT,
CHILDS SYSTEM: PRESSURE TUNNEL INTAKE

HAER No. AZ-65-Z

Location:	Childs Station No. 237+52. Forest Service Road 708/502, Camp Verde vicinity, Yavapai County, Arizona. USGS Payson Quadrangle, UTM Coordinates: NAD 27 Zone 12 438473.7216E - 3802506.967N.
Dates of Construction:	1908-1909.
Engineer:	Iva Tutt; Francis S. Vielé; Raymond S. Masson.
Present Owner:	Arizona Public Service (improvements), P.O. Box 53933, M.S. 3190, Phoenix, AZ 85072-3933; U.S. Government, U.S.D.A. Forest Service (land).
Present Use:	Hydroelectric power generation (November 2004).
Significance:	Water enters the pressure tunnel (Flume Tunnel # 7) to begin its fall and production of static head for the Childs Powerhouse.
Historian:	James W. Steely, November 2004.

Project Information:

Between February and November 2004, Arizona Public Service (APS) and SWCA Environmental Consultants documented the hydroelectric complex, under guidance of the Historic American Engineering Record (HAER). Project managers Phil Smithers (APS) and Linda Martin (SWCA) coordinated historian Steely, photographer Jessica Maggio, and draftsman Hanson Todachine to complete the HAER documentation. Archives for the Childs-Irving Hydroelectric Project are at APS in Phoenix, Arizona.

Historic and Engineering Context:

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In addition to its individual significance nationwide, the Childs-Irving Hydroelectric Project is a classic part of Arizona history spanning the 20th century: remote low-grade mining operations sought reliable and less-expensive energy; a combination of investors, entrepreneurs and engineers modified a natural resource to supply the energy; cutting-edge technology entered a harsh and remote landscape; an isolated labor force merged those with skills learned far away with local residents, including Native Americans with traditional ties to the land; nearby communities soon offered an additional customer base; farmers and irrigation cooperatives became major consumers for their pumps and agricultural machinery; distant metropolitan areas boomed by tapping the energy source; and finally a conservative operational approach to investment and maintenance retained aging technology within a huge modern power grid for many, many years past a reasonable retirement.

Character Defining Attributes

Component/Feature No.39 on National Register form. From the southwestern corner of Stehr Lake, water flowed into the concrete and rubble intake structure and then into Flume (pressure) Tunnel #7. An automatic gate at the bottom of the intake structure allowed excess water beyond tunnel capacity to reenter the reservoir. (Effland and Macnider 1991)

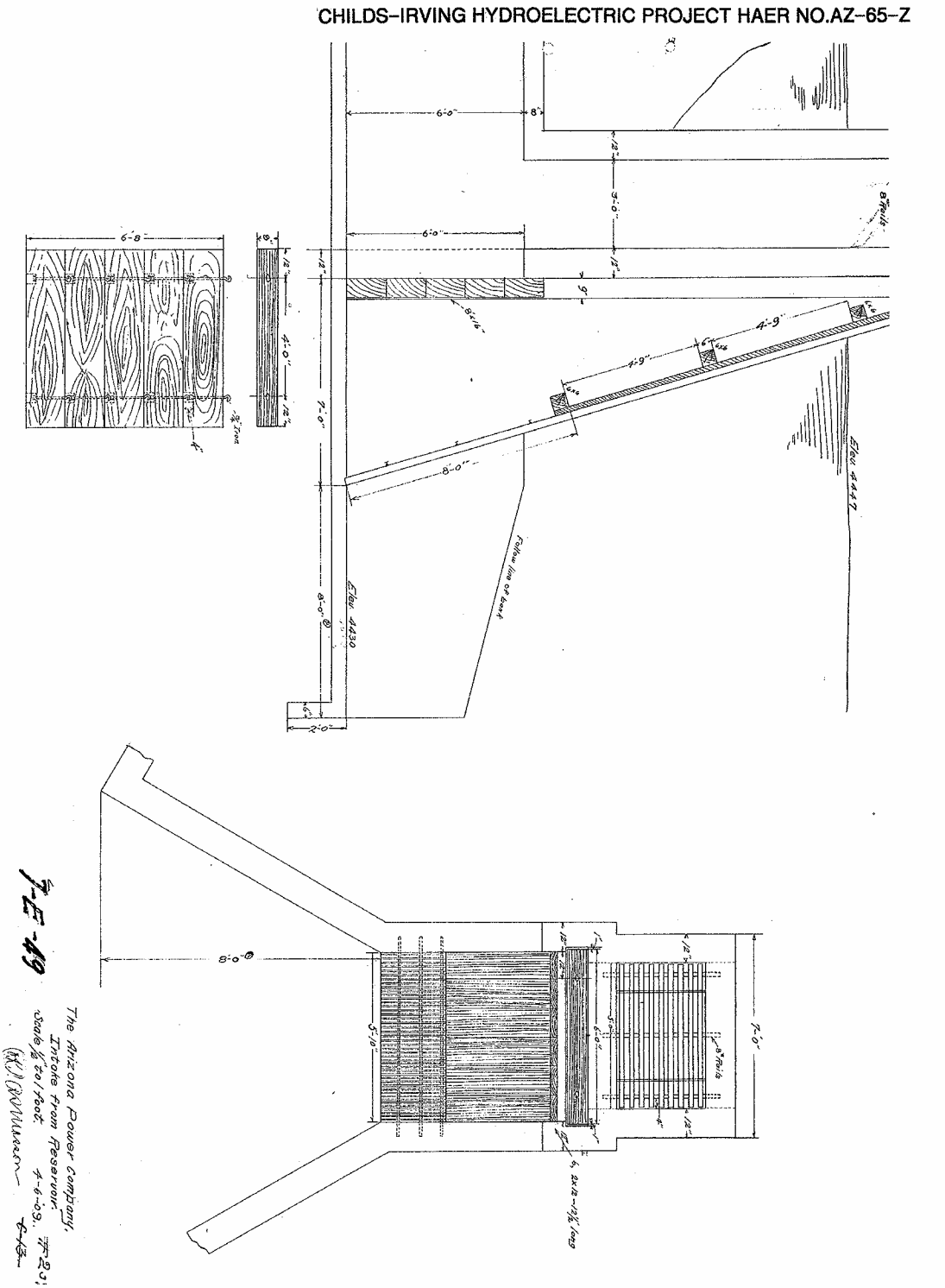
Bibliography

Arizona Public Service (APS) Archives
Historic photograph collection. Historic drawings collection. Historic documents collection. Available through appointment at: APS, P.O. Box 53933, M.S. 3190, Phoenix, Arizona 85072-3933, 602-371-7689.

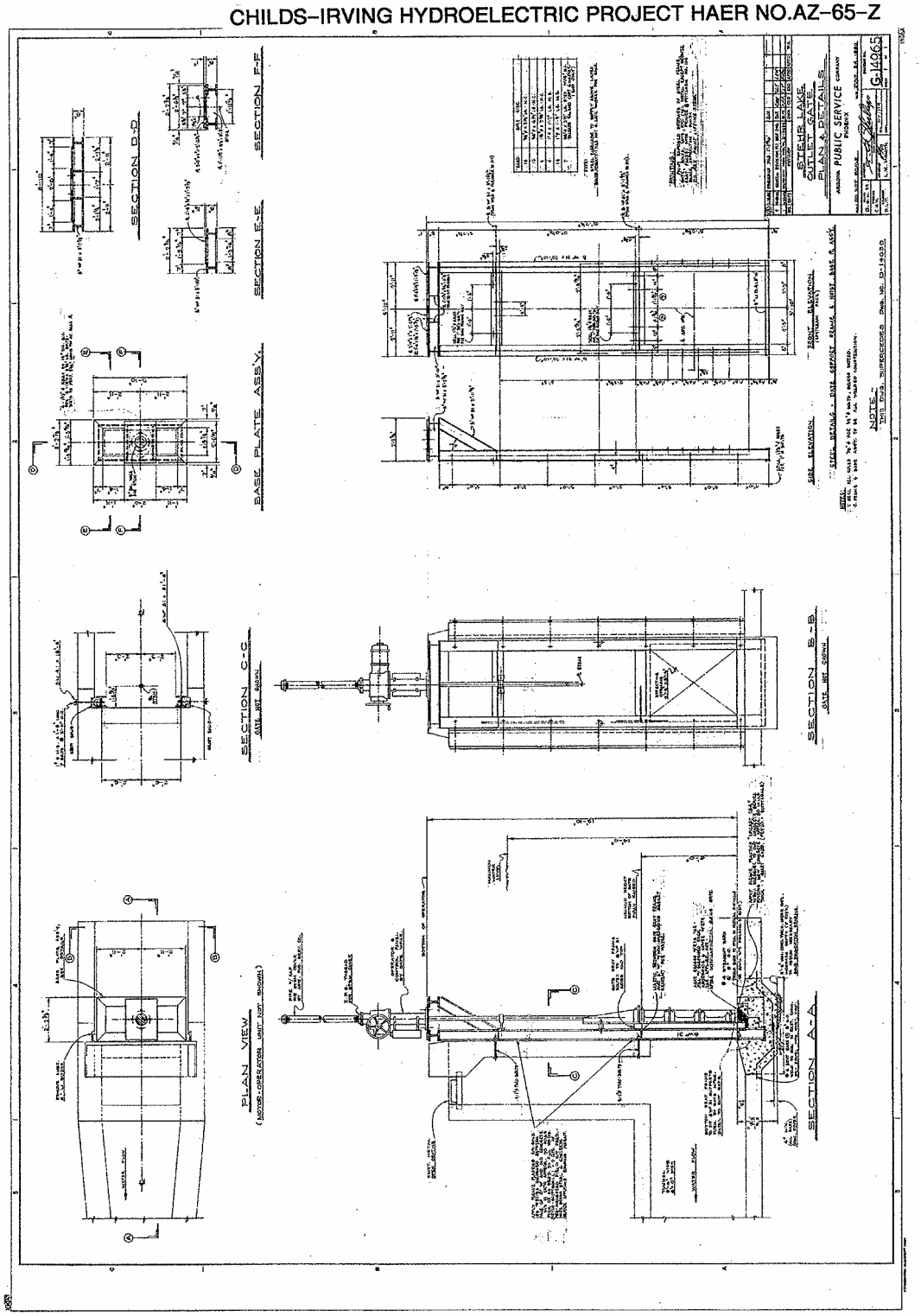
Effland, Richard W., Jr., and Barbara S. Macnider
1991 *Childs-Irving Hydroelectric Facilities.* National Register of Historic Places Registration Form. U.S. Department of the Interior, National Park Service. Washington, D.C.

Neal, Lynn, and Linda Martin
2003 *Childs/Irving Hydroelectric Decommissioning Project, Historic Properties Management Plan* (HPMP). Prepared for APS/Generation Engineering. SWCA Environmental Consultants. Flagstaff.

Drawing "Intake from Reservoir" 1909:



Drawing “Stehr Lake Outlet Gate” 1960:



CHILDS-IRVING HYDROELECTRIC PROJECT, HAER No. AZ-65-AA
CHILDS SYSTEM: FLUME (PRESSURE) TUNNEL #7
Forest Service Road 708/502
Camp Verde vicinity
Yavapai County
Arizona

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Intermountain Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

CHILDS-IRVING HYDROELECTRIC PROJECT, CHILDS SYSTEM: FLUME (PRESSURE) TUNNEL #7

HAER No. AZ-65-AA

Location:	Childs Station No. 254+45.5. Forest Service Road 708/502, Camp Verde vicinity, Yavapai County, Arizona. USGS Payson Quadrangle, UTM Coordinates: NAD 27 Zone 12 438141.2648E - 3802076.229N.
Date of Construction:	1908.
Engineer:	Iva Tutt; Francis S. Vielé; Raymond S. Masson.
Present Owner:	Arizona Public Service (improvements), P.O. Box 53933, M.S. 3190, Phoenix, AZ 85072-3933; U.S. Government, U.S.D.A. Forest Service (land).
Present Use:	Hydroelectric power generation (November 2004).
Significance:	The pressure tunnel shortcuts water from Stehr Lake and away from the Fossil Creek canyon under "Ikes Backbone" ridge, initiating its fall and buildup of static head on the course to Childs Powerhouse.
Historian:	James W. Steely, November 2004.

Project Information:

Between February and November 2004, Arizona Public Service (APS) and SWCA Environmental Consultants documented the hydroelectric complex, under guidance of the Historic American Engineering Record (HAER). Project managers Phil Smithers (APS) and Linda Martin (SWCA) coordinated historian Steely, photographer Jessica Maggio, and draftsman Hanson Todachine to complete the HAER documentation. Archives for the Childs-Irving Hydroelectric Project are at APS in Phoenix, Arizona.

Historic and Engineering Context:

The Childs-Irving Hydroelectric Project encompassed a unique water-pressure/electric-turbine system—according to engineering historians evaluating the historic complex since 1976—that 1) was constructed with great effort in an extremely remote landscape, 2) captured a natural water source and followed dramatic topography, 3) generated electric power in a remarkably simple and efficient manner, and 4) operated continuously for 95 years.

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Character Defining Attributes

Component/Feature No.40 on National Register form. The only pressure-type tunnel in the Childs-Irving Hydroelectric Project was 4888.5 feet long, 3.5 feet wide and 6 feet high with a hydraulic grade of 0.001 feet. The tunnel cut through Ikes Backbone, a ridge that separates the higher Fossil Creek Canyon at Stehr Lake from the Verde River Valley. It was excavated in four sections with three or four adits for access during construction. At its west end was a release gate that allowed water to exit the system, and access to the tunnel for cleaning and repair; partial buckling of the tunnel in 1941 required significant repairs. (Effland and Macnider 1991)

Bibliography

Arizona Public Service (APS) Archives

Historic photograph collection. Historic drawings collection. Historic documents collection. Available through appointment at: APS, P.O. Box 53933, M.S. 3190, Phoenix, Arizona 85072-3933, 602-371-7689.

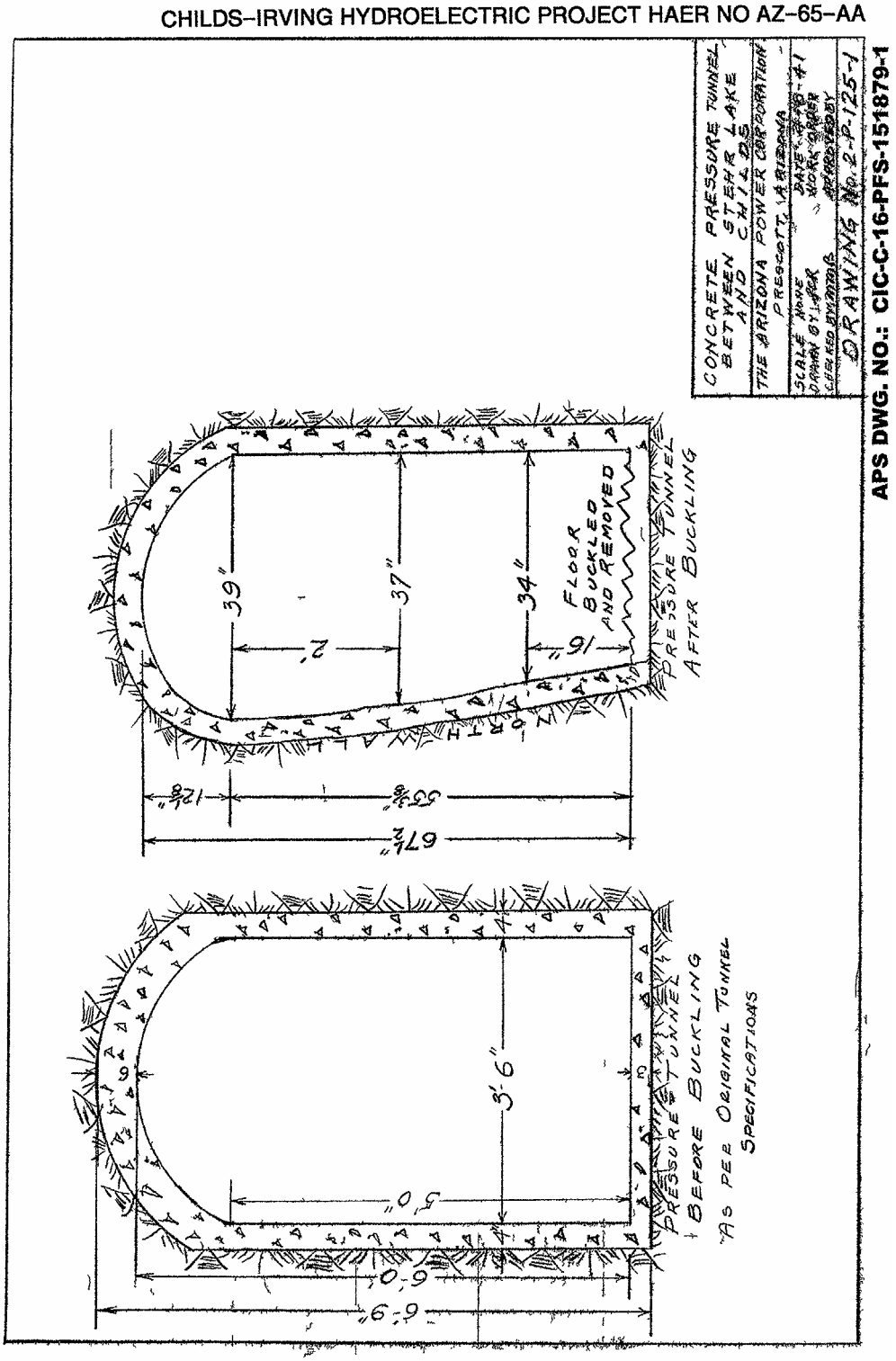
Effland, Richard W., Jr., and Barbara S. Macnider

1991 *Childs-Irving Hydroelectric Facilities.* National Register of Historic Places Registration Form. U.S. Department of the Interior, National Park Service. Washington, D.C.

Neal, Lynn, and Linda Martin

2003 *Childs/Irving Hydroelectric Decommissioning Project, Historic Properties Management Plan* (HPMP). Prepared for APS/Generation Engineering. SWCA Environmental Consultants. Flagstaff.

Drawing "Concrete Pressure Tunnel…" 1941:



CHILDS-IRVING HYDROELECTRIC PROJECT, HAER No. AZ-65-BB
CHILDS SYSTEM: REINFORCED CONCRETE PIPE
Forest Service Road 708/502
Camp Verde vicinity
Yavapai County
Arizona

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Intermountain Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

CHILDS-IRVING HYDROELECTRIC PROJECT, CHILDS SYSTEM: REINFORCED CONCRETE PIPE

HAER No. AZ-65-BB

Location:	Childs Station No. 303+34. Forest Service Road 708/502, Camp Verde vicinity, Yavapai County, Arizona. USGS Payson Quadrangle, UTM Coordinates: NAD 27 Zone 12 437374.2923E - 3801419.643N.
Date of Construction:	1908.
Engineer:	Iva Tutt; Francis S. Vielé; Raymond S. Masson.
Present Owner:	Arizona Public Service (improvements), P.O. Box 53933, M.S. 3190, Phoenix, AZ 85072-3933; U.S. Government, U.S.D.A. Forest Service (land).
Present Use:	Hydroelectric power generation (November 2004).
Significance:	This concrete pipe was cast in place on site in 4-to-6-foot approximate lengths. It connects water from the Pressure Tunnel with the Stand Pipe as part of the accumulation of static head on the course to Childs Powerhouse.
Historian:	James W. Steely, November 2004.

Project Information:

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Character Defining Attributes

Component/Feature No.41 on National Register form. This reinforced concrete pipe was 1393.6 feet long, 48 inches in diameter, and connected the pressure tunnel to the Stand Pipe. The pipe ran along the western slope of Ikes Backbone, on a stone bench or in trenches, at a hydraulic grade of 3 feet per 1000 feet, 0.0026 feet. (Effland and Macnider 1991)

Bibliography

Arizona Public Service (APS) Archives
Historic photograph collection. Historic drawings collection. Historic documents collection. Available through appointment at: APS, P.O. Box 53933, M.S. 3190, Phoenix, Arizona 85072-3933, 602-371-7689.

Effland, Richard W., Jr., and Barbara S. Macnider
1991 *Childs-Irving Hydroelectric Facilities.* National Register of Historic Places Registration Form. U.S. Department of the Interior, National Park Service. Washington, D.C.

Neal, Lynn, and Linda Martin
2003 *Childs/Irving Hydroelectric Decommissioning Project, Historic Properties Management Plan* (HPMP). Prepared for APS/Generation Engineering. SWCA Environmental Consultants. Flagstaff.

APS Photo Library #166

CHILDS-IRVING HYDROELECTRIC PROJECT, HAER No. AZ-65-CC
CHILDS SYSTEM: STAND PIPE (SURGE TANK)
Forest Service Road 708/502
Camp Verde vicinity
Yavapai County
Arizona

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Intermountain Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

CHILDS-IRVING HYDROELECTRIC PROJECT,
CHILDS SYSTEM: STAND PIPE (SURGE TANK)

HAER No. AZ-65-CC

Location:	Childs Station No. 317+27.6. Forest Service Road 708/502, Camp Verde vicinity, Yavapai County, Arizona. USGS Payson Quadrangle, UTM Coordinates: NAD 27 Zone 12 437196.4353E - 3801102.3N.
Date of Construction:	1908.
Engineer:	Iva Tutt; Francis S. Vielé; Raymond S. Masson.
Present Owner:	Arizona Public Service (improvements), P.O. Box 53933, M.S. 3190, Phoenix, AZ 85072-3933; U.S. Government, U.S.D.A. Forest Service (land).
Present Use:	Hydroelectric power generation (November 2004).
Significance:	The Stand Pipe (Surge Tank) was at the head of the penstock pipe, allowing inflowing water to back up and retain water in the Pressure Tunnel and Penstock pipes system when Childs Powerhouse gates were closed for repairs.
Historian:	James W. Steely, November 2004.

Project Information:

Between February and November 2004, Arizona Public Service (APS) and SWCA Environmental Consultants documented the hydroelectric complex, under guidance of the Historic American Engineering Record (HAER). Project managers Phil Smithers (APS) and Linda Martin (SWCA) coordinated historian Steely, photographer Jessica Maggio, and draftsman Hanson Todachine to complete the HAER documentation. Archives for the Childs-Irving Hydroelectric Project are at APS in Phoenix, Arizona.

Historic and Engineering Context:

The Childs-Irving Hydroelectric Project encompassed a unique water-pressure/electric-turbine system—according to engineering historians evaluating the historic complex since 1976—that 1) was constructed with great effort in an extremely remote landscape, 2) captured a natural water source and followed dramatic topography, 3) generated electric power in a remarkably simple and efficient manner, and 4) operated continuously for 95 years.

In addition to its individual significance nationwide, the Childs-Irving Hydroelectric Project is a classic part of Arizona history spanning the 20th century: remote low-grade mining operations sought reliable and less-expensive energy; a combination of investors, entrepreneurs and engineers modified a natural resource to supply the energy; cutting-edge technology entered a harsh and remote landscape; an isolated labor force merged those with skills learned far away with local residents, including Native Americans with traditional ties to the land; nearby communities soon offered an additional customer base; farmers and irrigation cooperatives became major consumers for their pumps and agricultural machinery; distant metropolitan areas boomed by tapping the energy source; and finally a conservative operational approach to investment and maintenance retained aging technology within a huge modern power grid for many, many years past a reasonable retirement.

Character Defining Attributes

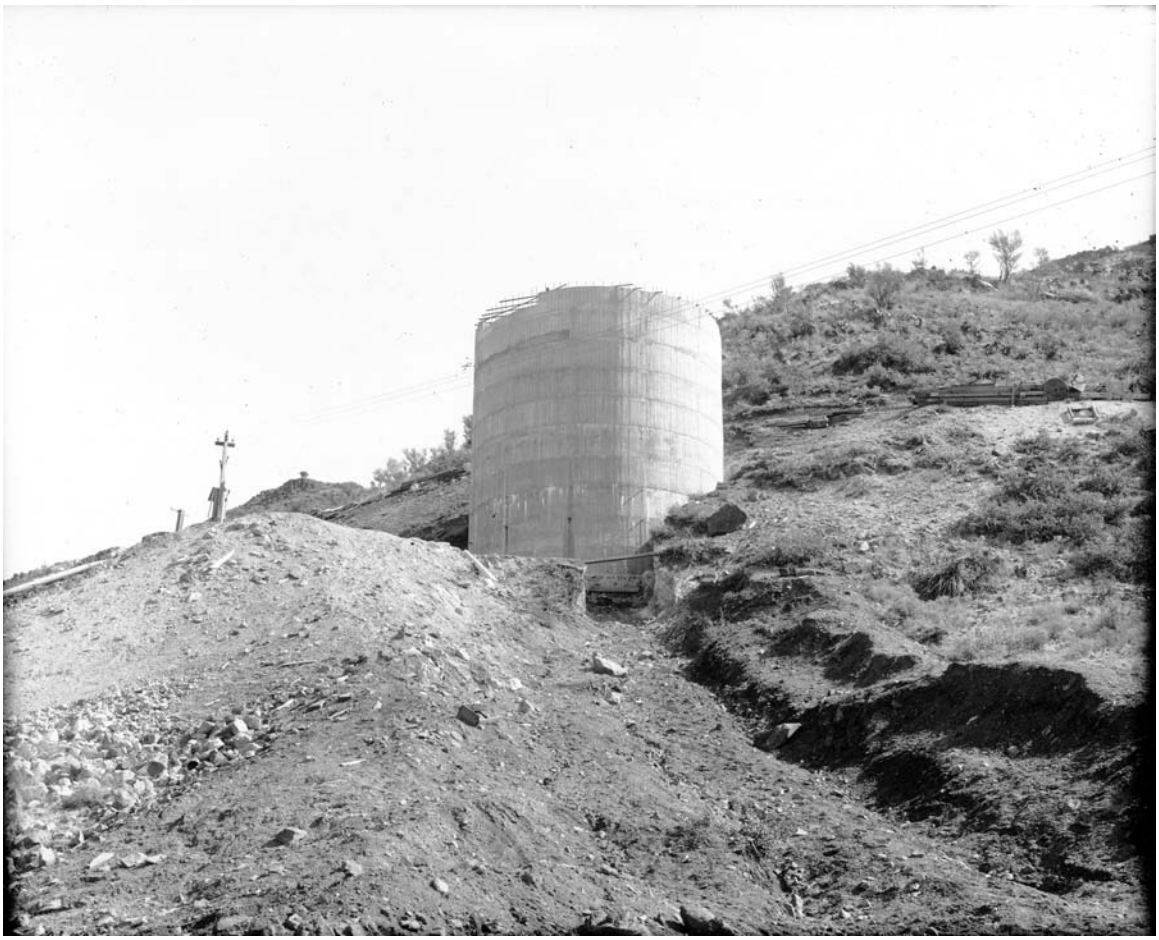
Component/Feature No.43 on National Register form. The reinforced concrete stand pipe, or surge tank, was 36 feet tall and 30 feet in diameter (Effland and Macnider 1991). The foundation or base of the tank had an internal trench connecting the water flow from the reinforced concrete pipe and the penstock piping (APS).

Bibliography

Arizona Public Service (APS) Archives
Historic photograph collection. Historic drawings collection. Historic documents collection. Available through appointment at: APS, P.O. Box 53933, M.S. 3190, Phoenix, Arizona 85072-3933, 602-371-7689.

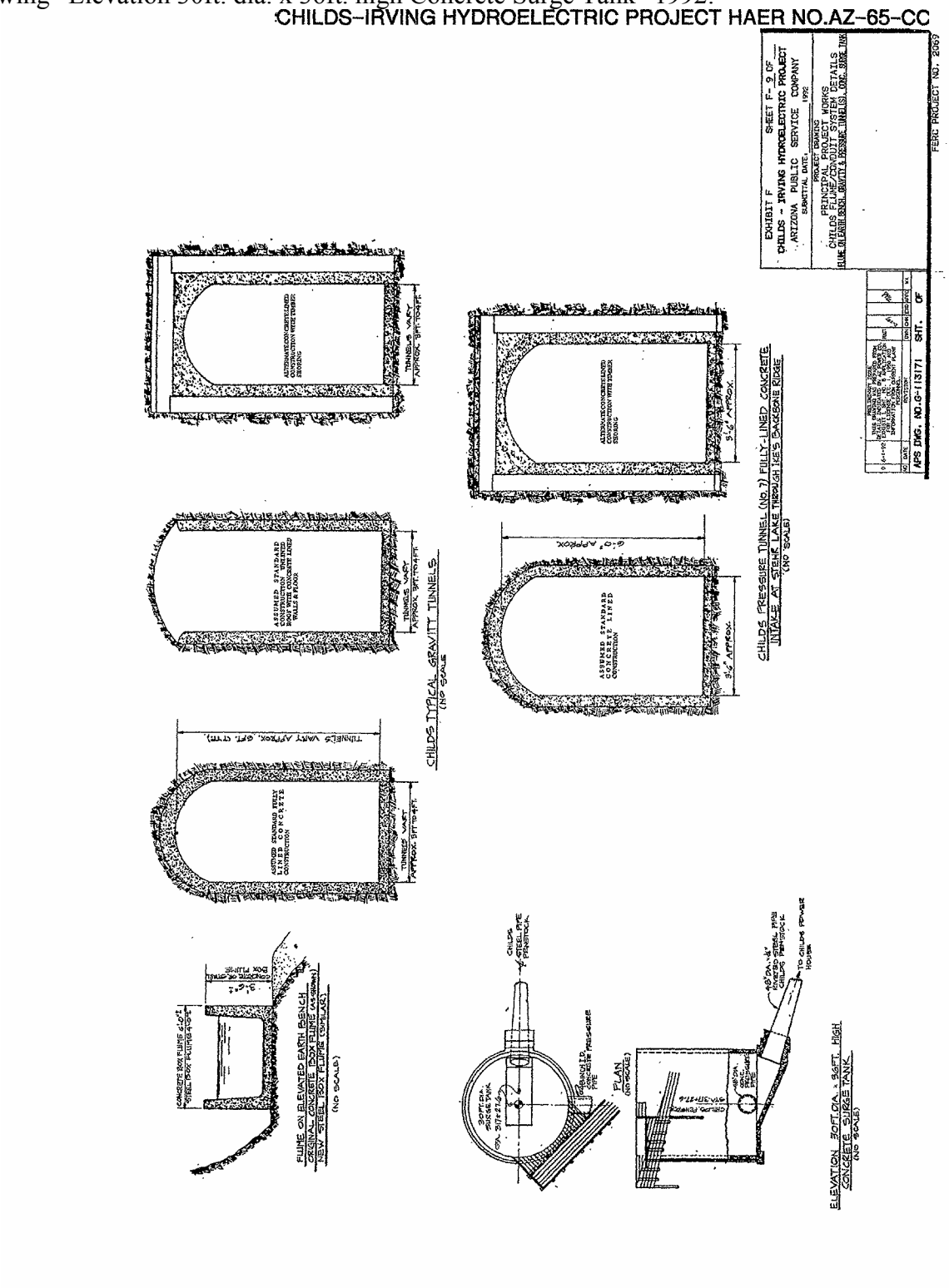
Effland, Richard W., Jr., and Barbara S. Macnider
1991 *Childs-Irving Hydroelectric Facilities.* National Register of Historic Places Registration Form. U.S. Department of the Interior, National Park Service. Washington, D.C.

Neal, Lynn, and Linda Martin
2003 *Childs/Irving Hydroelectric Decommissioning Project, Historic Properties Management Plan* (HPMP). Prepared for APS/Generation Engineering. SWCA Environmental Consultants. Flagstaff.



APS Photo Library #164

Drawing "Elevation 30ft. dia. x 36ft. high Concrete Surge Tank" 1992:



CHILDS-IRVING HYDROELECTRIC PROJECT, HAER No. AZ-65-DD
CHILDS SYSTEM: PENSTOCK PIPE
Forest Service Road 708/502
Camp Verde vicinity
Yavapai County
Arizona

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Intermountain Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

CHILDS-IRVING HYDROELECTRIC PROJECT, CHILDS SYSTEM: PENSTOCK PIPE

HAER No. AZ-65-DD

Location:	Childs Station No. 317+27.6. Forest Service Road 708/502, Camp Verde vicinity, Yavapai County, Arizona. USGS Payson Quadrangle, UTM Coordinates: NAD 27 Zone 12 436871.7756E - 3801034.601N.
Date of Construction:	1908.
Engineer:	Iva Tutt; Francis S. Vielé; Raymond S. Masson.
Present Owner:	Arizona Public Service (improvements), P.O. Box 53933, M.S. 3190, Phoenix, AZ 85072-3933; U.S. Government, U.S.D.A. Forest Service (land).
Present Use:	Hydroelectric power generation (November 2004).
Significance:	The penstock pipe carried water on its final descent and pressure attainment into the Childs Powerhouse through sections of riveted and welded steel pipe.
Historian:	James W. Steely, November 2004.

Project Information:

Between February and November 2004, Arizona Public Service (APS) and SWCA Environmental Consultants documented the hydroelectric complex, under guidance of the Historic American Engineering Record (HAER). Project managers Phil Smithers (APS) and Linda Martin (SWCA) coordinated historian Steely, photographer Jessica Maggio, and draftsman Hanson Todachine to complete the HAER documentation. Archives for the Childs-Irving Hydroelectric Project are at APS in Phoenix, Arizona.

Historic and Engineering Context:

The Childs-Irving Hydroelectric Project encompassed a unique water-pressure/electric-turbine system—according to engineering historians evaluating the historic complex since 1976—that 1) was constructed with great effort in an extremely remote landscape, 2) captured a natural water source and followed dramatic topography, 3) generated electric power in a remarkably simple and efficient manner, and 4) operated continuously for 95 years.

In addition to its individual significance nationwide, the Childs-Irving Hydroelectric Project is a classic part of Arizona history spanning the 20th century: remote low-grade mining operations sought reliable and less-expensive energy; a combination of investors, entrepreneurs and engineers modified a natural resource to supply the energy; cutting-edge technology entered a harsh and remote landscape; an isolated labor force merged those with skills learned far away with local residents, including Native Americans with traditional ties to the land; nearby communities soon offered an additional customer base; farmers and irrigation cooperatives became major consumers for their pumps and agricultural machinery; distant metropolitan areas boomed by tapping the energy source; and finally a conservative operational approach to investment and maintenance retained aging technology within a huge modern power grid for many, many years past a reasonable retirement.

Character Defining Attributes

Component/Feature No.43 on National Register form. The penstock pipe carried water on its final descent into the Childs Powerhouse on a 0.0028 feet grade through 4698.5 feet of first riveted-, then welded-, steel pipe. Its riveted pipe was produced by the Pelton Water Wheel Company of Harrisburg, Pennsylvania, and coated in asphaltum; it varied in thickness from 1/4 to 9/16 inch. The welded pipe was produced for Pelton by Friedrich Krupp, AG, of Germany, and coated with graphite paint; it varied in thickness from 9/16 to 3/4 inch. The completed pipe was built for a working stress at joints of 12,500 pounds, and joint efficiency of 70 per cent for the riveted sections. Four-inch air relief valves placed along the Penstock prevented suction and collapse of the pipe when emptied. At the Childs Powerhouse, three 18-inch branch pipes distributed water from the penstock pipe to each of the three Water Wheels inside. (Effland and Macnider 1991)

Bibliography

Effland, Richard W., Jr., and Barbara S. Macnider
1991 *Childs-Irving Hydroelectric Facilities.* National Register of Historic Places Registration Form. U.S. Department of the Interior, National Park Service. Washington, D.C.

APS Photo Library #200

Additional Bibliography

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Historic photograph collection. Historic drawings collection. Historic documents collection. Available through appointment at: APS, P.O. Box 53933, M.S. 3190, Phoenix, Arizona 85072-3933, 602-371-7689.

Neal, Lynn, and Linda Martin
2003 *Childs/Irving Hydroelectric Decommissioning Project, Historic Properties Management Plan* (HPMP). Prepared for APS/Generation Engineering. SWCA Environmental Consultants. Flagstaff.

CHILDS-IRVING HYDROELECTRIC PROJECT, HAER No. AZ-65-EE
CHILDS SYSTEM: CHILDS POWERHOUSE
Forest Service Road 708/502
Camp Verde vicinity
Yavapai County
Arizona

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Intermountain Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

CHILDS-IRVING HYDROELECTRIC PROJECT, CHILDS SYSTEM: CHILDS POWERHOUSE

HAER No. AZ-65-EE

Location: Childs Station No. 363+72.6. Forest Service Road 708/502, Camp Verde vicinity, Yavapai County, Arizona.

USGS Payson Quadrangle, UTM Coordinates: NAD 27 Zone 12 435732.4895E - 3800819.716N.

Dates of Construction: 1908-1909.

Engineer: Iva Tutt; Francis S. Vielé; Raymond S. Masson.

Present Owner: Arizona Public Service (improvements), P.O. Box 53933, M.S. 3190, Phoenix, AZ 85072-3933; U.S. Government, U.S.D.A. Forest Service (land).

Present Use: Hydroelectric power generation (November 2004).

Significance: The Childs Powerhouse was the focal point of operations for the Fossil Creek hydroelectric endeavor, eclipsed somewhat by the completion of the Irving Powerhouse in 1916. Adjustments over the years to the water delivery system and some equipment at Childs changed very little in its basic arrangements of operation, including original water wheels and generators, between 1909 and 2004.

Historian: James W. Steely, November 2004.

Project Information:

Between February and November 2004, Arizona Public Service (APS) and SWCA Environmental Consultants documented the hydroelectric complex, under guidance of the Historic American Engineering Record (HAER). Project managers Phil Smithers (APS) and Linda Martin (SWCA) coordinated historian Steely, photographer Jessica Maggio, and draftsman Hanson Todachine to complete the HAER documentation. Archives for the Childs-Irving Hydroelectric Project are at APS in Phoenix, Arizona.

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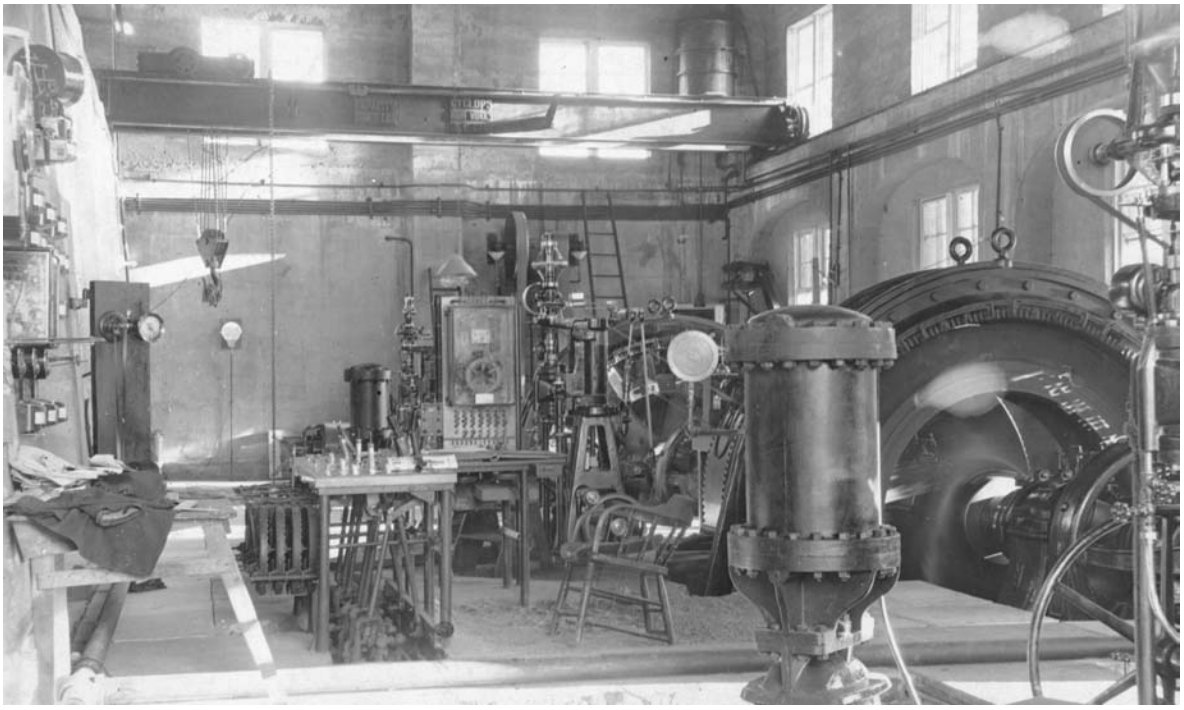
Character Defining Attributes

Component/Feature No.44 on National Register form. The one-story Childs Powerhouse was built of reinforced concrete, on a foundation 30.5 feet wide and 76 feet long, under steel trusses and a corrugated roof (possibly of asbestos-cement sheets). Inside, three Pelton-type impulse water wheels (impeller blades moved under direct water pressure, a high-pressure design as opposed to the low-pressure Irving wheel) built by Abner Doble of San Francisco, each turning at 400 revolutions per minute under 1050 foot head of pressure, delivered up to 3000 horsepower. The water wheels were each direct connected to a General Electric 400 rpm, 3-phase, 2300 volt, 1800 kilowatt alternating-current generator. Water was discharged through three tailraces directly into the Verde River. Since construction, porch awnings were added and windows covered with louvered grills, and all electric switching equipment upgraded. About 1950 the common-wall transformer house (under low-pitched gable roof in historic photos and on historic plans) was demolished and a new structural framework added to carry three transformers. (Effland and Macnider 1991; APS)

Above – APS Photo Library #152. Below – APS Photo Library #150, Childs powerhouse as viewed across the Verde River. Connected Transformer House was "daylighted" about 1950 with removal of outside walls and its separate gabled roof. Note "windmill" towers at left, above, modified to hold more switching equipment, now removed.



Childs Powerhouse interior. APS Photo Library #3. View is looking east with switching panels at left, operator's station in middle, #1 power unit's cutoff-valve head on right and governor on extreme right, #2 power unit's generator and exciter at right middle ground, #3 power unit in background, and overhead crane on tracks above.

Use and Operation *(see also Photos, Maps and Drawings)*

Engineering Context

The use of wheels turning shafts for generating mechanical power is a human-work multiplying innovation dating at least from Greek antiquity. The guidance of natural watercourses to turn wheels and shafts for mechanical power grew to widespread use in Europe during the middle ages. In the early 19th century in the United States, tests of the mechanical efficiency of such water wheels led to vastly improved designs. One British-born engineer—James B. Francis working with water-powered industrial mills on the Merrimack River through Lowell, Massachusetts—combined efficiency studies with French development of the water "turbine." Nineteenth century turbine innovators such as Francis sought to extract the maximum power from the water's "head," or pressure from its drop in elevation, whether from a flowing stream or from a natural or artificial "fall." The turbine they envisioned is "a rotary engine that extracts energy from a fluid flow…usually [with] a casing around the blades that focuses and controls the fluid" (Farlex 2004).

> The main difference between early water turbines and water wheels is a swirl component of the water which passes energy to a spinning rotor. This additional component of motion allowed the turbine to be smaller than a water wheel of the same power. They could process more water by spinning faster and could harness much greater heads. (Schoenau 2004)

The "Francis turbine" developed in Massachusetts in the 1850s utilized 90 percent of the force of water directed to its rotor blades, as opposed to a contemporaneous industry standard of 65 percent or less (Hawke 1988). The Francis design, "the first modern water turbine," is an "inward flow reaction turbine," meaning that penstock-pressured water fills the turbine housing, the wheel turns in reaction (rather than from highly focused "impulse" pressure as with a Pelton wheel; see below), and a low-pressure head of water moves the turbine relatively fast (Farlex 2004). "By the 1870s variants on the Francis turbine became the most widely used hydraulic prime movers in America, at a time when water power was still more important than steam for industrial purposes" (Hawke 1988).

The impulse-type "Pelton wheel" was patented in 1880 by Lester Allan Pelton (1829-1908) in California after watching the characteristics of other water wheels and turbines.

> The Pelton Wheel operates off the inertia of water that impacts on cupped buckets. The Pelton is used wherever there exists a high head of water of at least 50 ft and needs very little flow…. The Pelton is comparatively small for its output and can attain high operating speeds reducing the need for expensive gearing. (Schoenau 2004)

Inventor Pelton further modified the Francis turbine's innovations by sculpting the wheel's blades into "buckets" with two cups each (Alston 2004). "You can approximate that design by cupping your hands upwards, then bringing them together, with the fingernails of one hand

touching the ones of the other" (Stern 2004). Pressurized water, focused by a needle-valve nozzle into a jet at the end of its penstock, strikes the center joint of the two cups. The water first pushes the blade, which turns the wheel; then the water's movement across the semi-hemispherical shape of the cup transfers even more energy from the water and turns the wheel faster.

> That was Pelton´s great discovery. In other turbines the jet hit the middle of the [single] cup and the splash of the impacting water wasted energy. In technical terms, the impact there resembled an inelastic collision, whereas in the turbine which Pelton developed, the deflection of the jet resembled an elastic collision….
>
> Through the later 1870s Pelton developed his design, settling in the end on a double cup with a wedge-shaped divider in the middle, splitting the jet–half to the left, half to the right…. In the winters of 1877 and 1878 he tested turbines of different sizes, including a small one for running his landlady´s sewing machine….
>
> Pelton then tried to sell his turbines, but met with little success until the spring of 1883, when the Idaho Mining Company of Grass Valley in Yuba County, California, arranged a competition between different designs, before deciding which design it would buy. Pelton´s turbine won by reaching an efficiency of 90.2%, whereas the three competing water wheels only attained 76.5%, 69.6% and 60.5%. After that sales grew at a tremendous rate, and in 1888 Pelton with some partners formed in San Francisco the Pelton Water Wheel Company, which expanded production even more. (Stern 2004)

The first large-scale production of electricity for consumer and industrial use also resulted from a burst of innovations and spirited competition in the 1880s in the United States. In 1879 Thomas Edison adapted the direct-current (DC) generator—producing a flow of electricity from the rotary motion of magnets, an 1830s British discovery of Michael Faraday—to the successful power of a vacuum-tube light bulb. The most credited first "hydroelectric" application linking Edison's DC-powered lights to a water-powered system opened in 1882 at two paper mills in Appleton, Wisconsin. The same year a small California system, with a generator and paddle wheel turned by irrigation water in Etiwanda Colony below the San Gabriel Mountains, lit the colony developer's home and an elevated outdoor carbon-arc light (Clucas 2002). Soon Edison offered a number of other inventions powered by DC, including powerful motors that approached the output of steam engines. But Edison's motors, like steam engines, needed to be close to the application of power, since DC voltage drops considerably when wired too far—less than two miles—from the generator (*EPRI Journal* 1979:36). Edison's obsession with DC devices obscured consumer and industrial opportunities possible through centralized generation of electricity distributed over long distances. (*EPRI Journal* 1979; Farlex 2004)

Serbian-born inventor Nicola Tesla, while working briefly for Edison, developed an understanding of alternating current (AC) that could be transmitted long distances by wire or cable without dramatic loss of power. Tesla "realised that…doubling the [AC] voltage would halve the current and reduce losses by three-quarters," that AC could be "transformed" back and

forth from DC, and AC voltage could be stepped up and down for efficient transmission over long distances (Farlex 2004). Tesla patented his system, based on constant-speed AC generators, including transmission and transformers in 1887. He then joined forces with inventor George Westinghouse in proving their AC power-distribution system superior to Edison's DC inventions. Tesla's breakthrough system produced relatively low-voltage AC current from generators, stepped it up to high-voltage AC for distribution through long-distance wires, then transformed it back to lower-voltage AC to power lights and machines a considerable distance from the generator. Further, AC could be converted to low-voltage DC at the job site to power small variable-speed tools such as drills, saws, and tram locomotives.

> With Tesla and his patents, Westinghouse built a power system for a gold mine in Telluride, Colorado, in 1891, with a water driven 100 horsepower (75 kW) generator powering a 100 horsepower (75 kW) motor over a 2.5 mile (4 km) power line. Then in a deal with General Electric, which Edison had been forced to sell, Westinghouse's company went on to construct a power station at the Niagara Falls [, New York], with three 5,000 horsepower Tesla generators supplying electricity to an aluminum smelter at Niagara and the town of Buffalo 22 miles (35 km) away. The Niagara power station commenced operation on April 20 1895. Its opening set the scene for the electric power industry for over a hundred years. (Farlex 2004)

The same year as the Niagara power project's opening, 1895, the City of Sacramento, California, first drew 11,000 volts of AC power from Folsom Powerhouse on the American River 22 miles away. This innovation demonstrated the rapid spread of hydroelectric technology across the United States, and forced New York's Niagara project to share with California several of its "firsts" in the transmission of AC voltage a long distance for municipal and industrial consumption. The Folsom operation also wedded the experience of water systems related to mining operations—heretofore moving American River water through ditch and flume systems only to assist in mineral excavation and washing—and the growing trend of assisting mining with water-powered mechanical and electrical devices. The Folsom Powerhouse focused a water head of 50 feet into four "McCormick" (probably the manufacturer of Francis reaction turbines) dual turbines of 1260 horsepower each, direct-connected to four 750-kW General Electric generators, producing 3000 kW. (*EPRI Journal* 1979; Bell 2004)

By the end of the 19th century, mining and associated industrial processes embraced electric-powered machinery for a number of reasons. Mines generally developed around deposits in remote areas; electricity transmitted by wires from single generating plants ("central stations") greatly reduced the costs of constantly shipping exhaustible fuel to the mine site. Equipment for excavating mines and extracting minerals had to be compact and portable; by 1900 air-powered mining tools proved most efficient, charged by pumps in turn powered by electrical generators. Air pumps also supplied oxygen to workers deep in mineshaft labyrinths. Once workers opened mineshafts wide enough and deep enough, elevators and trams could be built into mines for hauling workers in and raw materials out; electric vehicles powered by unobtrusive wires brought no dependent fuel or choking combustion into the mine. Successful and large-scale mines processed their low-grade ore as much as possible on site to reduce shipping fees;

conveyor belts, tumbling mills, sifters, smelters, and other giant machinery worked most efficiently when powered by electric motors. (Effland and Macnider 1991)

Fossil Creek Water System

The inventions of James Francis and Nicola Tesla, and the early hydroelectric projects of California, were widely published by the late 19th century in the United States, and their successes grew to industrial-scale enterprises. As Arizona and other Western regions opened to settlement and natural resource extraction through railroad connections, government and industrial agents mapped these landscapes thoroughly and noted mineral and water resources necessary to any sustained development. With knowledge of hydroelectric systems already in service in California and east of the Mississippi River, especially those supplying power to mining and industrial operations, anyone with some knowledge of harnessing water power could recognize the potential at Fossil Creek.

Indeed, hydroelectric power arrived elsewhere in Arizona just as the Fossil Creek project investors formulated their plans. "The development of hydroelectric power from Fossil Creek was not the first such project in Arizona," wrote Effland and Macnider (1991:8/4) in their Childs-Irving National Register nomination. "Hydroelectric generation of power in Phoenix began in 1902 with establishment of plants on both the Arizona and Grand canals."

The popular Childs-Irving Hydroelectric Project story that about 1900 Verde River rancher Lew Turner spontaneously envisioned a hydroelectric facility in the Fossil Creek wilderness is quaint. But this creation myth conveniently omits the existing context of hydroelectric successes in the last decade in neighboring California and nearby Phoenix. The story also only hints at the presence of growing mining operations in the Bradshaw Mountains to the west, each with management hungry for cheaper power and therefore exploring every water course in the region for hydroelectric potential. Finally, this simplified origin of the The Arizona Power Company (TAPCO), so quickly assembled in 1902 by Turner plus Long Beach, California, electrical engineer Iva Tutt and others, breezes past another inspiration associated with Niagara and Sacramento: their hydroelectric operations represented a pioneering and essential assembly of financing and technological expertise. TAPCO and its Fossil Creek venture assembled a modern consortium of remote investors, equipment manufacturers, engineering designers, industrial consumers, and political opportunists. (*EPRI Journal* 1979; Effland and Macnider 1991)

> TAPCO [and its Fossil Creek venture] is but one of at least five hydroelectric generating projects that were planned at the turn-of-the-century to provide power for expanding mining operations in the region [of central and northern Arizona]…. Of these enterprises, it was only the Fossil Creek project that succeeded…. (Effland and Macnider 1991:8/3)

The success of Fossil Creek is based largely on its geology (the consistent springs) and geography (its natural drop—without high natural waterfalls—of 1575 feet from the springs to the Verde River). The Childs-Irving project achieved an unusually strong static head pressure

through "the high degree of topographic relief that allows for a drop of 1 foot per 1000 feet over a distance of only 11.26 miles," creating a static head of 480 feet at plant "No. 2," Irving, sufficient for one low-pressure generator ideal for powering a Francis turbine. (Effland and Macnider 1991:8/1)

Thus, designers of the Fossil Creek water diversion and distribution system combined proven techniques (dam and flume construction, basic turbine and generator couplings) with new technology (reinforced concrete, steel pipe) in an extremely remote workplace (portable concrete mixers, machinery and prefabricated structures reduced to wagon-sized loads). (Alston 2004)

Power House No. 1 (Childs) Engineering Design

The 1908-1909 "No. 1" Powerhouse embodied TAPCO's initial expectations for a Fossil Creek hydroelectric system. Workers established a construction camp on a natural terrace along the north bank of the Verde River, accessed by the original road from the railhead to the east at Mayer (Alston 2004). The terrace offered two construction opportunities bisected by the drainage of Quail Tank: on its southeastern plain a site for the Powerhouse, and on its northwestern plain room for the housing and maintenance compound necessary for Powerhouse operation. Northeast of the Powerhouse, the flume system diverted water—after generally following Fossil Creek southerly for several miles downstream—abruptly southwest through Ikes Backbone via (present) Tunnel # 7, into the 4698-foot Penstock delivering water to the terrace and the Powerhouse intake.

The one-story Childs Powerhouse was built of reinforced concrete, on a foundation 30.5 feet wide and 76 feet long, under steel trusses and a corrugated roof (possibly of asbestos-cement sheets). The concrete floor secured the steel-pipe Penstock discharge into three 18-inch branch pipes distributing pressurized water to each of the three water wheels inside. Sub-floor concrete tailraces directed dissipated water from the turbines outside, thence into the Verde River. The concrete foundation also anchored the turbine, generator, exciter and other equipment. The cast-concrete powerhouse walls supported the overhead crane used for initial positioning of equipment, as well as removing and installing components and their "bonnets" during maintenance. Since construction of the building, operators added porch awnings along the southwest elevation, placed louvered grills over several windows, and upgraded all electric switching equipment and transformers.

About 1950 the common-wall transformer house (under low-pitched gable roof in historic photos and on historic plans, on the northeast side of the building), with floor a few feet higher than the generating room, was demolished and a new free-standing structural framework added to carry its three transformers (Effland and Macnider 1991; APS). APS removed these walls and roof to create open-air switching and transformer positions for safety and maintenance.

Water Wheels, or Turbines

Inside the Powerhouse generating room, three high-pressure Pelton-type impulse water wheels, with steel bonnets labeled "Abner Doble" of San Francisco, each turned at 400 revolutions per minute under 1050 foot head of pressure, delivering a maximum total of 3000 horsepower.

> Various inventors…contributed to this [Pelton] type of water turbine, and subsequent important contributions to Pelton-wheel technology were made by William A[bner]. Doble, a San Francisco engineer who patented improvements in bucket forms and nozzle designs beginning February 7, 1899. Doble became chief engineer of Pelton's company in 1912, and his patents represent a second stage in the development of Pelton turbines. (ASME 2004)

At the Childs Powerhouse, the turbines were mounted on the Powerhouse floor in evenly spaced positions along a common axis to accept pressurized water from the Penstock terminals under the floor. From each branch pipe terminal, pressurized water entered its needle-valve nozzle focused against its impeller (wheel) and twin-bucket blades to achieve constant speed (400 rpm) to maintain the attached generators' "base loads" (60 Hz). Each Pelton wheel in the Childs Powerhouse was about six feet in diameter, securing 16 buckets around its perimeter. (Alston 2004)

Pressure Governance

Water pressure in the Childs Powerhouse was regulated through adjustment of each nozzle's needle valve, to maintain constant turbine speed (400 rpm), which in turn regulated each generator's speed within a specific range to maintain the "base load" at the "frequency" of 60 cycles or Hertz (Hz). Generally, a hydropower governor "senses changes in speed and adjusts the water flow to the runner [or turbine wheel] to correct any deviation from the desired speed" (CanREN 2004).

The Child's three turbines each employed a Woodward oil-pressure governor, consisting of a cluster of spinning flyballs or flyweights (a development of steam inventor James Watt in 1769), housed in a metal dome atop the governor stand. TAPCO replaced the original Lombard governors in the 1940s after that company closed and spare parts were no longer available (Alston 2004). Gears and a jackshaft from the turbine turned a continuous belt to gears spinning the flyballs' small vertical shaft.

Thus the turbine-powered governor, through changes in the flyballs' centrifugal spin, sensed any change in turbine speed and mechanically moved two shafts between a bell crank to open a valve in the base of the governor. This valve introduced pressurized oil from the adjacent reservoir (standing vertically on the Powerhouse floor adjacent to the governor stand) into a cylinder (actuator) below the floor. The actuator then moved a series of connecting rods to adjust the positions simultaneously of a "cataract" valve, to divert water flow away from the turbine, and

the needle valve in the nozzle aimed at the bottom of each Pelton wheel. As the cataract valve opened, the nozzle valve closed with controlled slow motion to prevent back-pressure buildup in the Penstock. Each governor stand included a safety mechanism in the form of a "dashpot" that served as an anti-racing device that restored the pressurized-oil actuator/cylinder's "distributing valve" to its neutral position once the governor re-established the desired speed. (Alston 2004)

Generator and Exciter

The water wheels were each direct-shaft connected to a generator built by General Electric as an alternating current (AC), 3-phase, 60-cycle dynamo running at 400 rpm. The resulting 60 Hz cycle standard, credited to Nicola Tesla as one of his innovations with the Westinghouse Company in the 1880s, was the common link between consumer lights and machinery powered by Childs-Irving. This enduring U.S. standard applied at Fossil Creek from initial operations also contributed to this system's long life as part of the 60 Hz power grid of North America.

Each generator shaft continued to a direct-connection with the "exciter," a small DC generator that created the magnetic, alternating field in the main AC generator.

> The output voltage of an AC generator is controlled by…the strength of [its] DC field…. The DC field voltage produced by the [main, AC] generator…is applied to the stationary field of an exciter. An exciter is a small DC generator which is used for the purpose of providing DC field current to an AC generator field…. This concept permits the use of a [AC main] generator…with a lower control current capability as the exciter acts, in essence, as an amplifier. (Kilowatt Classroom 2004)

Each of the Childs Powerhouse's generator-exciter combinations supplied 1800 kilowatts at 2300 volts to insulated cable that carried the current to a distribution bus. The bus in turn supplied current to three transformers, each single-phase 3000 kilovolt Ampere (kVA) units that stepped voltage up to 69000 volts (69 kV) to the transmission lines. Historically, TAPCO customers received this current from transformers stepped back down to 2400 volts, then to 120 volts or 240 volts for lighting and machinery. By 2004, from Childs-Irving and other APS transmission through the North American grid, industrial customers typically received their current from transformers as three-phase 480 volts to 13.8 kV, and residential customers received power from transformers stepping current down to 120/240 volts AC. (Alston 2004)

Water Discharge

After release from the Pelton turbines, dispelled water moved through tailraces in the Powerhouse floor southwest a short distance into the Verde River. (Alston 2004)

Childs Powerhouse in Historic Context

Contextual information on other hydroelectric facilities built at the time of Childs-Irving indicates that the Fossil Creek facility's performance stood statistically between many very small

projects of the period and a handful of much larger enterprises. One example of smaller operations was the 850 kW generator in Phoenix at Arizona Falls on the Arizona Canal, installed in 1902. The original Arizona Falls operation ceased in 1950, but was revived in 2004 by the Salt River Project with a 750 kW generator reportedly capable of powering 150 modern homes (Phoenix 2004). One example of a much larger operation was the plant of five generators built into the U.S. Bureau of Reclamation's first major dam, Roosevelt Dam on the Salt River 75 miles west of Phoenix, producing 4500 kW by 1909 during its construction. The Bureau of Reclamation completed Roosevelt Dam in 1911 and thereafter increased its generating capacity to 36000 kW, still (in 2004) contributing much energy to the Phoenix Basin power grid (Green Nature 2004).

By comparison, the Childs-Irving Hydroelectric Project first offered 2700 horsepower (1800 kW) when the three generators at the Childs Powerhouse commenced operation in 1909. This output more than met the needs at the time of the United Verde (UV) Mine at Jerome, which initially contracted for 1600 horsepower (1220 kW) to energize its first new electrical mining machinery. Completion of the Irving Powerhouse in 1916 added 2100 horsepower (1600 kW) to the Fossil Creek system, meeting additional mining customer demand during World War I. But this addition also maximized the full potential of the Fossil Creek overall plant, and TAPCO soon added a steam-powered plant at Clarkdale—tied into the existing grid but closer to several mining customers including UV at Jerome—with more than 3500 kW output by itself. (Effland and Macnider 1991)

The sale of power from TAPCO's combined Fossil Creek and Clarkdale system to customers in the Phoenix Basin throughout the 1920s indicates that about 7000 kW was a substantial output for the region. TAPCO's capacity survived on these urban sales as its large mining customers dramatically scaled back their production after World War I. And Phoenix found a source of electric power to fuel its accelerating population growth even as Roosevelt Dam sputtered for a decade far below its hydroelectric capacity because of an extended drought throughout its surface watershed.

Standardization of the North American electrical power grid by about 1930 (*EPRI Journal* 1979), and commensurate upgrades of the Childs-Irving Hydroelectric Project, ensured that the remote wilderness-spring-fed 60 Hz technology contributed to an ever-expanding national matrix well into the 21st century. Incredibly, the original Childs-Irving water wheels, generators, and much associated equipment, including the water delivery system itself, still functioned in 2004 through excellent maintenance and relatively minor upgrades (Alston 2004). Installation in 2004 of the newest technology at Arizona Falls in Phoenix, achieving 100 kW less output than its 1902 installation, also confirmed that the Fossil Creek system recognized and achieved its greatest capacity from its initial design and equipment, beginning 95 years earlier.

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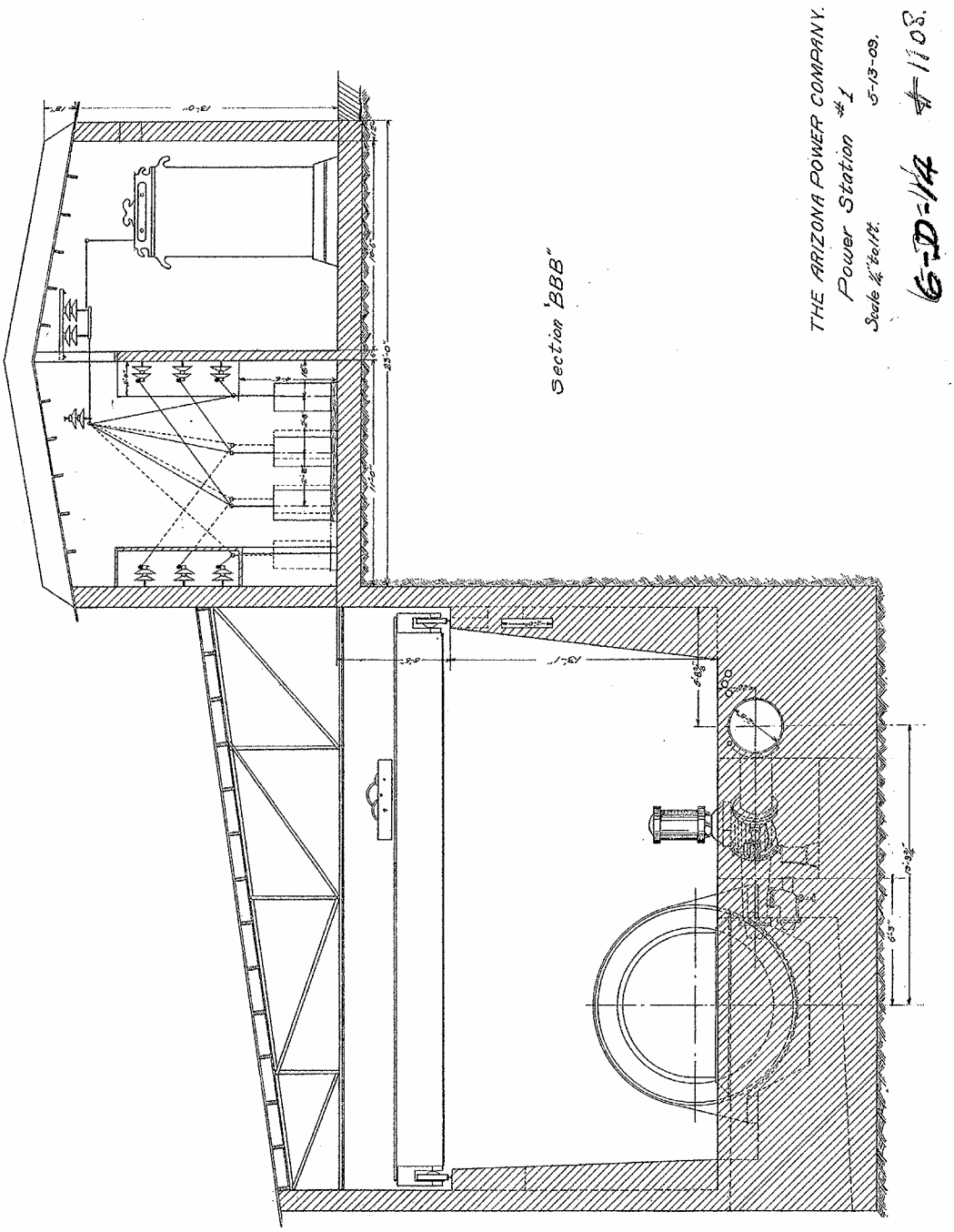
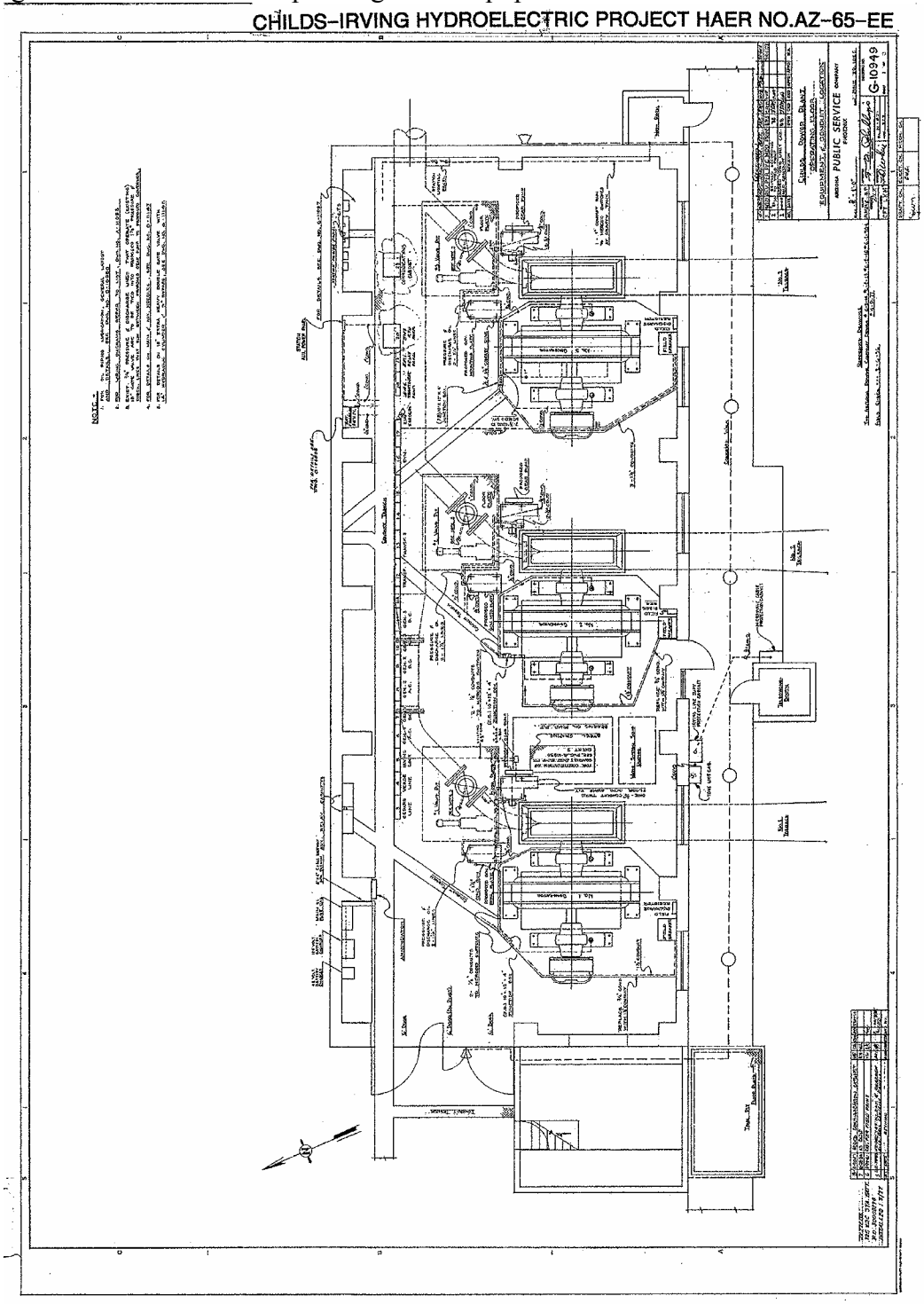
Drawing "Power Station # 1" 1909:

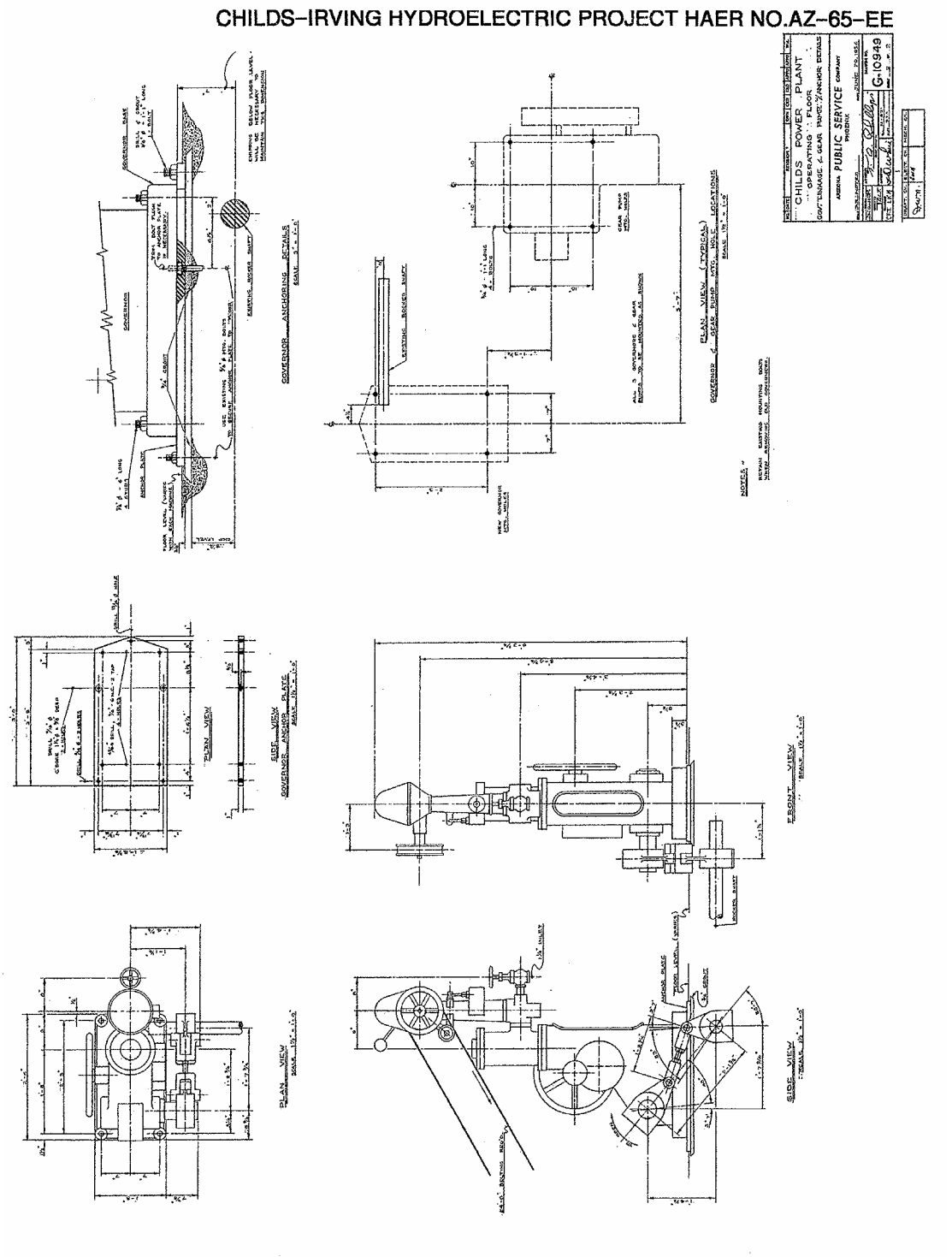
CHILDS–IRVING HYDROELECTRIC PROJECT HAER NO.AZ–65–EE



Drawing "Childs Power Plant Operating Floor Equipment and Conduit Location" 1956:



Drawing "Childs Power Plant Operating Floor Gov. Linkage and Gear Pump w/ Anchor Details" 1956:



CHILDS-IRVING HYDROELECTRIC PROJECT, HAER No. AZ-65-FF
CHILDS SYSTEM: OFFICE
Forest Service Road 708/502
Camp Verde vicinity
Yavapai County
Arizona

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Intermountain Support Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD

CHILDS-IRVING HYDROELECTRIC PROJECT,
CHILDS SYSTEM: OFFICE

HAER No. AZ-65-FF

Location:	Childs Station No. 363+72.6. Forest Service Road 708/502, Camp Verde vicinity, Yavapai County, Arizona. USGS Payson Quadrangle, UTM Coordinates: NAD 27 Zone 12 435728.6157E - 3800918.801N.
Date of Construction:	1908.
Engineer:	Iva Tutt; Francis S. Vielé; Raymond S. Masson.
Present Owner:	Arizona Public Service (improvements), P.O. Box 53933, M.S. 3190, Phoenix, AZ 85072-3933; U.S. Government, U.S.D.A. Forest Service (land).
Present Use:	Hydroelectric power generation (November 2004).
Significance:	In 1927 the building was labeled a pump house and by 1939 it had doubled in size to become a cork-insulated icehouse. By 1960 it had been converted to an office, until the machine shop was converted to offices about 1985. Thereafter the building was downgraded to storage.
Historian:	James W. Steely, November 2004.

Project Information:

Between February and November 2004, Arizona Public Service (APS) and SWCA Environmental Consultants documented the hydroelectric complex, under guidance of the Historic American Engineering Record (HAER). Project managers Phil Smithers (APS) and Linda Martin (SWCA) coordinated historian Steely, photographer Jessica Maggio, and draftsman Hanson Todachine to complete the HAER documentation. Archives for the Childs-Irving Hydroelectric Project are at APS in Phoenix, Arizona.

Historic and Engineering Context:

The Childs-Irving Hydroelectric Project encompassed a unique water-pressure/electric-turbine system—according to engineering historians evaluating the historic complex since 1976—that 1) was constructed with great effort in an extremely remote landscape, 2) captured a natural water source and followed dramatic topography, 3) generated electric power in a remarkably simple and efficient manner, and 4) operated continuously for 95 years.

In addition to its individual significance nationwide, the Childs-Irving Hydroelectric Project is a classic part of Arizona history spanning the 20th century: remote low-grade mining operations sought reliable and less-expensive energy; a combination of investors, entrepreneurs and engineers modified a natural resource to supply the energy; cutting-edge technology entered a harsh and remote landscape; an isolated labor force merged those with skills learned far away with local residents, including Native Americans with traditional ties to the land; nearby communities soon offered an additional customer base; farmers and irrigation cooperatives became major consumers for their pumps and agricultural machinery; distant metropolitan areas boomed by tapping the energy source; and finally a conservative operational approach to investment and maintenance retained aging technology within a huge modern power grid for many, many years past a reasonable retirement.

Character Defining Attributes

Component/Feature No.46 on National Register form. This reinforced-concrete building measured 16 feet wide by 18 feet long, with three wood-frame windows, under a flat-sloped wood-frame roof covered with asphalt. (Effland and Macnider 1991)

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Neal, Lynn, and Linda Martin
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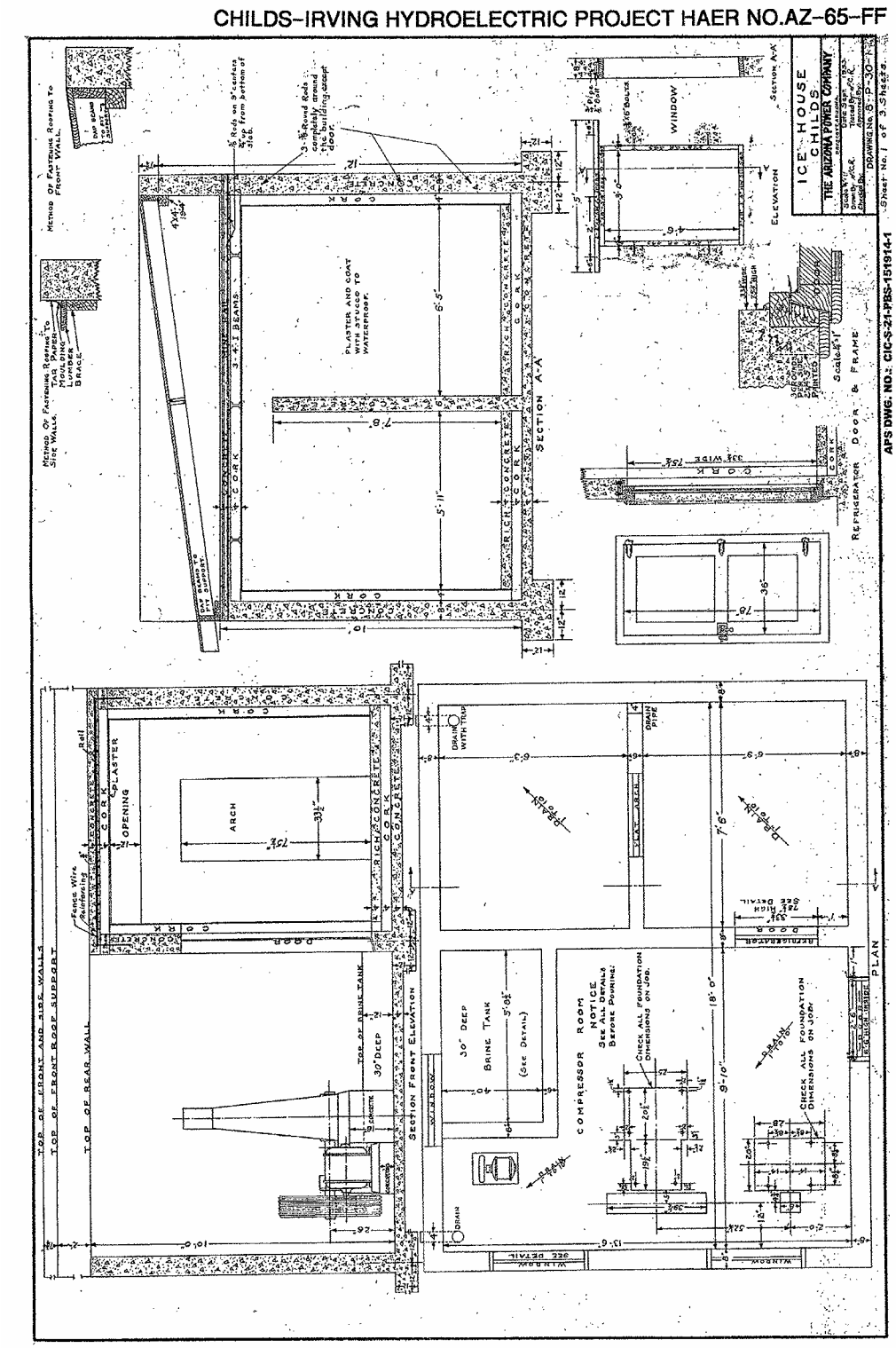
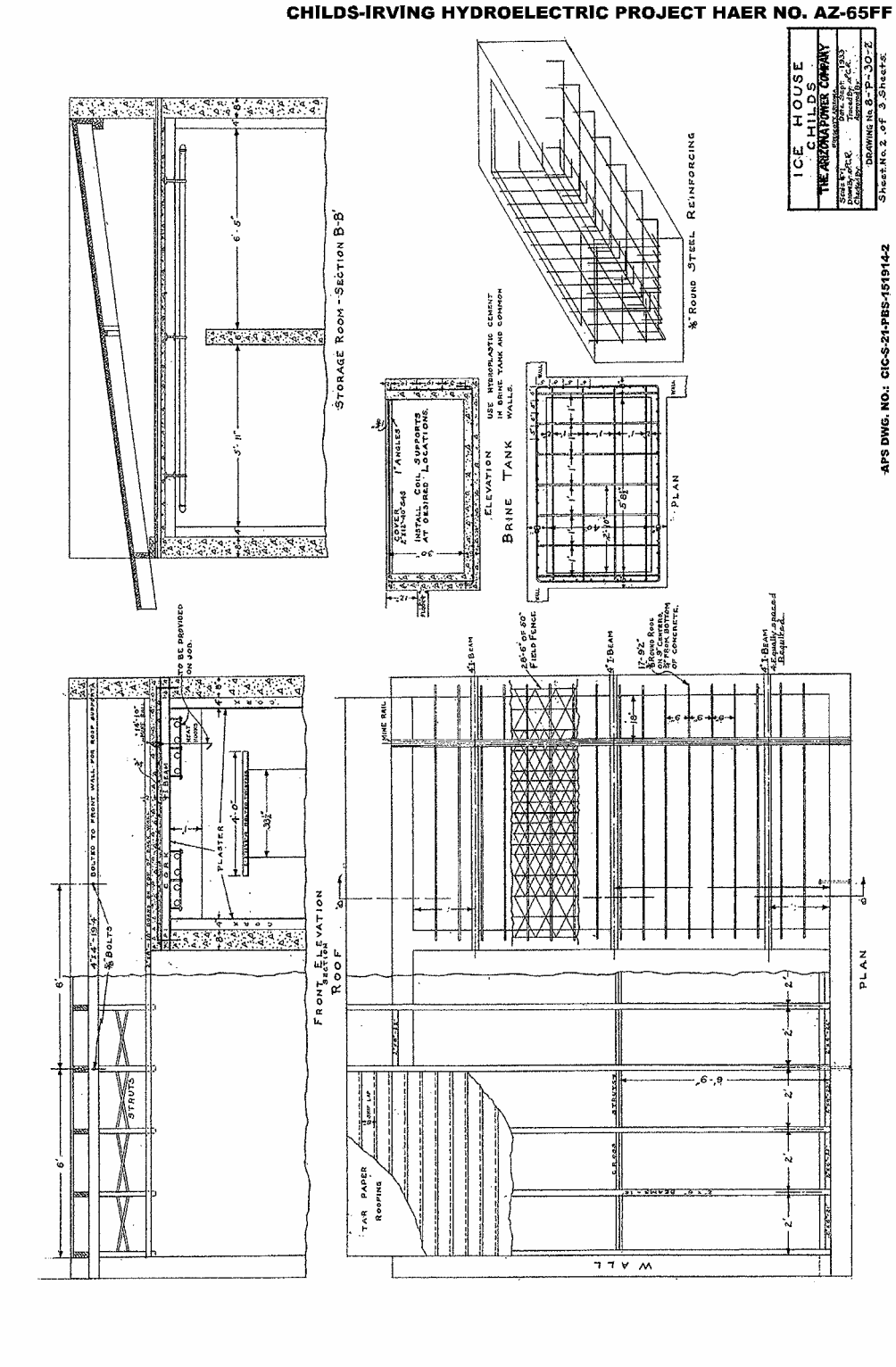
Drawing "Ice House Childs…Sheet No. 1" 1933:



Drawing "Ice House Childs…Sheet No. 2" 1933:



Drawing "Ice House Childs…Sheet No. 3" 1933: