ASAN SPRING RESERVOIR **HAER No. GU-10**
(Asan Spring Cistern)
Santa Ana Lane near Nino Perdido Street
Asan
Guam County
Guam

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
U.S. Department of the Interior
National Park Service
Oakland, California

HISTORIC AMERICAN ENGINEERING RECORD

INDEX TO PHOTOGRAPHS

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Victor Consaga, Photographer October 2015

GU-10-1 OVERALL VIEW OF THE COMPLEX WITH THE RESERVOIR ON THE LEFT. ALSO SHOWING THE CHLORINATOR ROOM IN THE FOREGROUND OF THE COMPOUND AND THE PUMP HOUSE AT THE REAR OF THE COMPOUND. VIEW FACING SOUTHWEST.

GU-10-2 VIEW OF THE NORTHEAST END OF THE RESERVOIR, TAKEN FROM THE ROOF OF THE PUMP HOUSE. SHOWING THE FRONT RETAINING WALL AND THE ROOF. CHLORINATOR ROOM AT LEFT. NOTE THE PORTION OF THE WATER-FILLED PIT IN THE LOWER FOREGROUND. VIEW FACING EAST.

GU-10-3 VIEW OF THE SOUTHWEST END OF THE RESERVOIR, SHOWING THE ROOF. TAKEN FROM THE ROOF OF THE PUMP HOUSE. THE FRONT RETAINING WALL IS OBSCURED BY THE PUMP HOUSE ROOF. NOTE THE TOP OF THE ENGAGED PYLON WITH MANHOLE COVER, HAND RAILINGS, AND PIPE STUB. VIEW FACING SOUTHEAST.

GU-10-4 OVERVIEW OF THE NORTHEAST END OF THE RESERVOIR ROOF. NOTE THE REAR RETAINING WALL IN THE FOREGROUND. STAIRWAY EXTENDS DOWN AT RIGHT CENTER OF PHOTO. VIEW FACING WEST.

GU-10-5 OVERVIEW OF THE SOUTHWEST END OF THE RESERVOIR ROOF SHOWING THE REAR RETAINING WALL ON RIGHT. VIEW FACING NORTHEAST.

GU-10-6 OBLIQUE VIEW OF THE FRONT RETAINING WALL AND STAIRS. NOTE THE BATTERED FRONT FACE AND SIDE OF THE RETAINING WALL. CHLORINATOR ROOM ON THE RIGHT. VIEW FACING SOUTH.

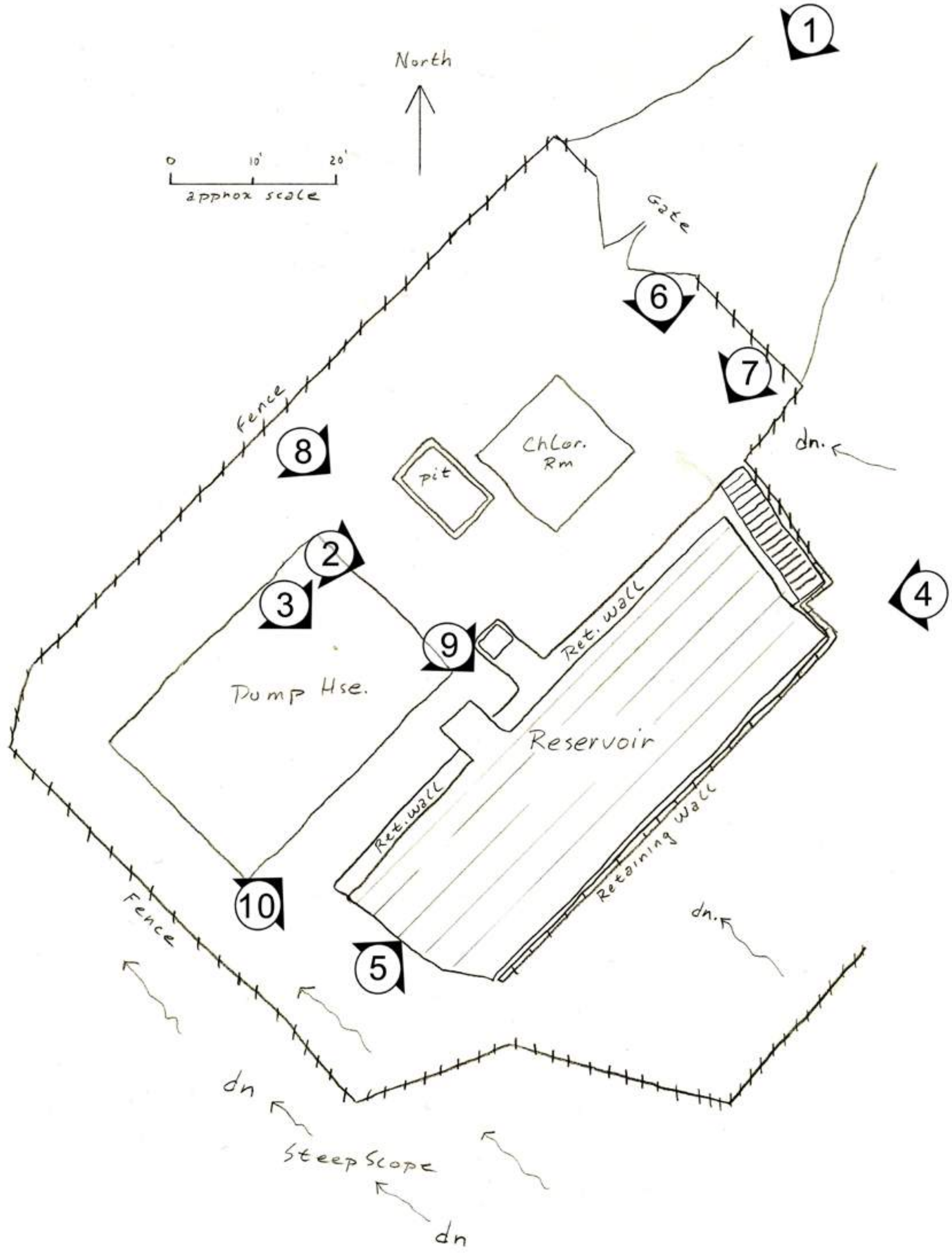
GU-10-7 OBLIQUE VIEW OF THE FRONT RETAINING WALL. NOTE THE DOUBLE TEE ROOF SLAB AT UPPER LEFT. OVERFLOW SPILLWAY AND COLLECTION BASIN ARE SEEN IN THE DISTANCE. BEHIND THE SLOPING SPILLWAY IS THE VERTICAL PYLON. CHLORINATOR ROOM IS IN RIGHT FOREGROUND, PUMP HOUSE IN RIGHT BACKGROUND. VIEW FACING SOUTHWEST.

GU-10-8 VIEW OF THE CENTER PORTION OF THE FRONT RETAINING WALL BETWEEN THE CHLORINATOR ROOM AND PUMP HOUSE SHOWING THE LOW-SLOPE GABLE ROOF OF THE RESERVOIR, THE SLOPING OVERFLOW SPILLWAY ON THE FRONT RETAINING WALL, AND THE WATER FILLED PIT IN FOREGROUND. NOTE THE SMALL BRASS PLAQUE (10" X 5") IS TO THE RIGHT OF THE OVERFLOW SPILLWAY. VIEW FACING SOUTHEAST.

GU-10-9 DETAIL OF SMALL BRASS PLAQUE. VIEW FACING SOUTHEAST.

GU-10-10 OBLIQUE VIEW OF THE FRONT RETAINING WALL OF THE RESERVOIR, BEHIND THE PUMP HOUSE WITH THE PYLON AND 9" DIAMETER WATER SUPPLY PIPE IN BACKGROUND. NOTE THAT EXCESS WATER FLOWS DOWN THE HILLSIDE AROUND THE RESERVOIR IN THE FOREGROUND. VIEW FACING NORTHEAST.

PHOTO KEY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HISTORIC AMERICAN ENGINEERING RECORD

ASAN SPRING RESERVOIR

(Asan Spring Cistern)

HAER No. GU-10

Location: Santa Ana Lane near Nino Perdido Street
Asan
Guam County
Guam

Latitude / Longitude coordinates:
13° 28' 15.15" N
144° 43' 10.00" E

Date of Construction: February 1916

Designer: Lieutenant (JG) R. L. Stover, US Navy, Public Works Officer. U.S. Naval Station, Guam.

Builder: US Navy

Owner: Guam Water Authority

Present Use: Not in service. The water collected in the reservoir is spilled out into the street and down a storm drain.

Significance: The Asan Spring Reservoir is a significant component of the water system of Hagåtña[1] and the surrounding area on the Island of Guam. This concrete water reservoir was constructed in February 1916 to impound the flow from Asan Spring. The Asan Spring Reservoir was a consistent and dependable source of water for the area until its closure in 2003 due to bacterial contamination.

Project Information: This report was written in advance of work to re-open the Asan Spring Reservoir and place it back in service. Although this re-activation is expected to include the rehabilitation of the existing reservoir, its complete replacement also remains an option. Field work was undertaken in October 2015 and this report was researched and written by Dee Ruzicka of Mason Architects, Inc., Honolulu, Hawaii. Archival photographs were taken in October 2015 by Victor Consaga of Consaga Visual Arts, Tamuning, Guam.

Prepared by: Dee Ruzicka
Architectural Historian
Mason Architects, Inc.
119 Merchant Street, Suite 501
Honolulu, HI 96813

Date of Report: February 2016

[1] The name for the capital of Guam has changed over time. When originally established, the village was called Hagåtña. Later, it was referred to on American maps as Agana. The name was formally changed back to Hagåtña in 1998. While this report typically uses the Hagåtña spelling for this capital city, Agana is also used when appropriate, such as for historic descriptions, quotes, citations, and names that have not changed, such as Agana Springs.

DESCRIPTION:

The primary name assigned to this resource, Asan Spring Reservoir, appears in a 1917 description of the Island of Guam.[2] This name was commonly used throughout the history of the reservoir, until the present day. The secondary name, Asan Spring Cistern, was the name used for the reservoir in the monthly newspaper, *Guam News Letter*, during the construction of the reservoir in 1916.

The Asan Spring Reservoir is a concrete basin that impounds the waters of Asan Spring. It is located at an elevation of about 110' on the ocean-facing (north) slope of Palasao Ridge,[3] a steep, approximately 400' high ridge behind the coastal village of Asan. Asan Spring Reservoir is located within the boundaries of the Asan Ridge Battle Area, listed on the National Register of Historic Places in 1975 (Ref # 75001916), and also within the Asan Village site that was determined eligible for the National Register in 1983.

The reservoir has an irregular rectangular footprint about 73'-6" long and 23'-6" wide and oriented northeast to southwest. It is set back into the hillside with an exposed front retaining wall that is about 10" high above the slightly uneven grade at its base. A concrete staircase on the northeast end of the reservoir provides access from grade at the front retaining wall up to the roof of the reservoir, which is a low slope gable of precast concrete double tee slabs. The reservoir is situated within a fenced compound (about 90' x 90') of the Guam Water Authority on the hill side that also includes two other structures, a Pump House and a Chlorinator Building. These two buildings are on a relatively level section of the compound in front of the reservoir. This level section is partially paved with concrete to provide vehicle access to the two buildings. The grade at the base of the reservoir's front retaining wall has an uneven, sloping concrete apron between it and the Chlorinator Building. Other areas of the level portion of the compound are exposed natural limestone or surfaced with concrete paving. The grade begins to slope steeply upward at the front retaining wall of the reservoir, toward the rear. Behind the reservoir, the steep hillside of Palasao Ridge continues upward to the crest of the ridge, several hundred feet above the reservoir. The compound is accessed at its northeast end from Santa Ana Lane. The residential community of Asan lies downslope from the reservoir, between it and the coastline highway, Route 1 (Marine Corps Drive).

Because much of the reservoir basin is set into the hillside, the most prominent portions of it are the front retaining wall, staircase at the northeast end, and the roof. The front retaining wall is concrete with a plain, unfinished surface that is battered to recede about 2'-6" from vertical at its level top edge of the basin. The northeast end wall at the staircase is likewise battered. The other two side walls of the reservoir are buried and are not visible. The top of the front retaining wall and the top of the northeast end wall are each about 1'-5" thick. The interior of the approximate 64' x 20' reservoir basin is reported to be divided into two compartments. However, during the fieldwork for this report it was not possible to view the interior sufficiently to confirm this.

A concrete overflow spillway is positioned on the front retaining wall, about 34' from the southwest end. This enclosed spillway is about 4'-0" wide and slopes downward from the top of the front retaining wall to an open-top collection basin that routes the overflow water into a buried pipe extending northeast out of the Guam Water Authority compound. The spillway's

[2] L. M. Cox, *The Island of Guam*. Washington D.C.: Government Printing Office. 1917.
[3] Palasao Ridge is also known as Bundschu Ridge, named in honor of Marine Capt. Geary R. Bundschu who died there while directing American attacking forces during the liberation of Guam on July 21, 1944.

collection basin projects about 8'-4" from the base of the front retaining wall. Also positioned on the front retaining wall, about 4'-9" southwest of the spillway, is a 5'-5" wide, vertical, engaged, water line pylon that projects 3'-8" from the base of the retaining wall. This pylon has an 8" diameter steel pipe extending from its southwest side, which elbows ninety degrees into the adjacent Pump House. This 8" pipe was the former water line from the reservoir from ca. 1994 when the Pump House was built. On the roof of the water line pylon, a short, capped stub of 8" diameter metal pipe protrudes vertically.

Imbedded in the concrete of the front retaining wall, between the overflow spillway and engaged pylon is a small brass plate measuring 10" x 5" with the following inscription in 3/8" high letters:

DEPARTMENT OF YARDS & DOCKS U.S. NAVAL STATION GUAM FEBY 1916

About 6' northeast of the overflow spillway is a non-functioning water level measuring device constructed of 2½" diameter metal pipes. This device has a vertical section of pipe extending out of the reservoir roof, which is elbowed ninety degrees to run horizontally over the front edge of the reservoir and then elbowed another ninety degrees vertically downward to be secured at grade in front of the retaining wall. A metal cable, presumably attached to a float, is strung from the interior of the reservoir along the pipes, to an indicator at the cable's free end along the vertical pipe in front of the retaining wall. A measuring scale (now removed) was formerly attached to the vertical pipe in front of the retaining wall to show water level in the reservoir.

The roof of the reservoir is formed of 4'-0" wide precast concrete double tee slabs that are placed longitudinally to form a low slope gable roof with a transverse ridge. The ridge is not centered on the approximate 64' length of the reservoir basin, but is about 34' from the southwest end. This is accomplished by using 34'-0" long double tee slabs for the southwest roof slope and 30'-0" long slabs for the northeast roof slope. The double tee sections have a 6" thick top slab supported on 12" high legs. After the slabs were placed on the roof they were all topped with an approximate 3" thick layer of troweled concrete. The roof slabs and concrete topping have an approximate 1'-6" high slope from the ridge to the slab ends. The gable end of the roof, between the bottom of the slabs and the horizontal top of the front retaining wall, is filled with a concrete spandrel. Near the staircase, two openings between the legs of the slabs have damaged screens; the remainder of the openings are filled with concrete.

The rear edge of the roof of the reservoir has a 1'-0" wide concrete retaining wall running along its length. This wall projects about 1'-5" above the roof at the ridge. To the rear of this retaining wall is a small, shallow pool of clear water that is flowing around the reservoir at the staircase and at the southwest end. The retaining wall is continued along the northeast end of the reservoir and around the periphery of the staircase, sloping downward as it follows the stairs. A metal pipe handrail is located at the top of the stairs. A pair of metal pipe handrails are also located on the reservoir roof, at the sides of the engaged pylon. These handrails assist passage from the roof of the reservoir, over the top of the pylon, and onto the roof of the Pump House, whose eave is only a few inches from the edge of the pylon.

The top of the reservoir has three metal manhole covers. One is located on the top of the water line pylon. Two are located on the reservoir roof near the ridge, about 5' from the rear retaining wall. On the reservoir roof, between these two manhole covers and the front edge of the roof, there are several vestigial remnants of concrete that supported unknown equipment or other features. Also near the two manhole covers is a short section of 8" diameter metal pipe that projects up from the interior before angling back at 135 degrees. A plastic cover with holes seals the elbowed end of this pipe.

In front of the overflow spillway, about 20' from the front retaining wall, is a rectangular pit several feet deep and filled with clear water to within about 1' of the top. This pit measures 6'-0" x 9'-6". It has 5" thick concrete sidewalls that are flush with grade. Underwater within the pit is a system of approximately 5" diameter pipes with a section removed and the flange ends capped. This pipe system also has a large valve in place with a hand wheel and a removed valve that is laying on the bottom, underwater. A single section of concrete slab cover for the pit (measuring about 3' x 6') is misplaced within the pit, partially obscuring the piping.

Adjacent and northeast of the rectangular pit is the Chlorinator Building. This building is built of CMU with an approximate 11'-0" x 13'-4" footprint. It has a low-slope gable roof of concrete with an approximately 2'-6" overhang. About 12' southwest of the pit is the concrete Pump House. This building's footprint measures about 24'-6" x 34'-7". The Pump House has a flat concrete roof with an approximately 2'-6" overhang. The interior of the Pump House has an inoperable system of three pumps with ten horsepower electric motors on a manifold. This formerly received water from the 8" diameter intake pipe of the pylon and sent it out a 8" diameter outlet pipe on the northwest side of the Pump House. This outlet pipe now has a section removed and is capped. In addition to the pumps and manifold, the Pump House contains a seventy-five kilo watt diesel generator.

HISTORIC CONTEXT:

Early Water Development in the Hagåtña/ Asan Area

> *The development of the Asan Spring system proved to be a blessing to the people of Agana and Anigua. The water is pure and clear and the best available for drinking purposes. Furthermore the flow is extremely constant and is dependable even in the extremely dry seasons. -W. G. Johnson, 1926.*[4]

Before its development, Asan Spring naturally gushed water from the limestone and was an important water source for the pre-contact communities located in the Asan area along the western coast of central Guam. The spring at Asan was large, and it and the springs at nearby Hagåtña that fed the Hagåtña River supported a large pre-contact community, from Hagåtña to Asan. Spanish colonial activity maintained this area as a principle population center of the island, along with the village of Umatac, which had a perennial stream with a good flow that facilitated settlement.[5] The Spanish, and later groups that colonized and occupied Guam, accomplished a variety of water development projects, including the Spanish diversion of the

[4] W. G. Johnson, "The Water Systems of Agana," *The Guam Recorder*, June 1926.
[5] John F. Mink, Groundwater Resources of Guam: Occurrence and Development. Technical Report No. 1. University of Guam: Water and Energy Research Institute of the Western Pacific. 1976. Reprinted 1991. P. 1-2.

Hagåtña River.[6] However, there is no record of any development of Asan Spring before the U.S. Colonial period.

Fresh water was of paramount importance to Guam's development, as is the case with other Pacific Islands. From pre-contact times, the proximity of available fresh water was "the determining factor as to where settlements were made."[7] During the U.S. Colonial period, the presence of fresh water dictated centers of population, administration, and military. Prior to this time, water was typically taken from shallow wells, rainwater cisterns, streams, and natural springs, such as Asan Spring.

The U.S. took control of Guam from Spain during the Spanish-American War, and in January 1899, President McKinley issued an executive order giving the Navy the authority over Guam's military and civilian affairs. Under the direction of the first Navy Governor of Guam, Captain Richard Leary, the Navy set up a water distilling plant to provide additional fresh water to Hagåtña. The system utilized boilers from eight old steam-powered utility boats that were aboard the USS *Yosemite* when it arrived at Guam in June 1899.[8] The water from this initial steam-distilling system was pumped into an iron tank that stood atop a wooden tower. From there it was gravity fed to "the Government house and other federal buildings and to a few houses occupied by officers" in Hagåtña.[9] The government buildings also had a sewage flushing system installed, which used water pumped from the Hagåtña River. This steam distillation system was in operation until about 1916.

Although the potential of the Agana and Asan Springs to supply water to the area was recognized soon after the Americans arrived,[10] the first source to be developed for Hagåtña was the Fonte River. In 1902-1903, Civil Engineer Leonard M. Cox recommended that the first steps to be taken to improve the water supply in Hagåtña should be a dam on the Fonte River.[11] This water was used at the Naval Station at Apra and in the city of Hagåtña. Water for Hagåtña was taken from the dam-impounded pool and gravity fed via a 6" diameter iron pipeline to a distribution reservoir south of Hagåtña on the hill above town. From there it was distributed to the city. The original route of the piping from the distribution reservoir through Hagåtña was described as follows in 1909; "The main pipeline from the distribution reservoir runs along San Ramon Street to the corner of San Antonio and San Nicholas, and from it are led branch lines running along the following streets as far as the town boundary: San Juan de Letran, General Solano, San Ignacio, Soledad, and San Antonio. Another branch line runs along the street in front of the Palace. Hydrants will be placed at principal street crossings for protection against fire."[12]

The Fonte Dam project was funded in 1907 and in March 1910 the pipeline and distribution reservoir above the town were complete, and the first water was turned into the system from a temporary dam while the permanent Fonte River Dam was still under construction. The dam was completed the following year, but Cox had over-estimated the minimum flow for the Fonte River during dry spells. In mid-May 1912, low water levels in the system forced shut-offs to the

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[6] David T. Lotz, "Agana Spanish Bridge, National Register of Historic Places Inventory Nomination Form," U.S. Department of the Interior, National Park Service. 1974.
[7] Mink, Groundwater Resources, P. 1.
[8] Mink, Groundwater Resources, P. 2. And W. G. Johnson, "The Water Systems of Agana," *The Guam Recorder*, June 1926. P. 66.
[9] W. G. Johnson, "The Water Systems of Agana," *The Guam Recorder*, June 1926. P. 66.
[10] Mink, Groundwater Resources, P. 3.
[11] Joanmarie Orlowski, HAER No. GU-4, Fonte River Dam, National Park Service. 2004.
[12] "New Water Supply System for Agana," Guam News Letter, November 20, 1909.

city except for brief ten-minute periods in the morning and afternoon. By June, rains had allowed the system to be turned on for hour-long periods, but Navy engineers were already looking at alternate sources. U.S. Navy Civil Engineer, Lt. Cdr. Adolfo J. Menocal, recommended the Agana Spring.[13] However, this system, which included a pump at the spring and over a mile of iron pipe to the existing distribution reservoir above Hagåtña, was not operational until the spring of 1919. In the meantime, the Asan Spring was developed in 1915 to supply Hagåtña with water.

<u>Asan Spring and Reservoir</u>

The system that was installed at Asan Spring in 1915 and 1916 was designed by Navy Public Works Officer Lt. (JG) R. L. Stover, who evaluated the spring and concluded it could easily be used to ameliorate the 1915 water shortage in Hagåtña. The shortage became critical during April of that year when water levels behind the Fonte River Dam dropped so low that only a few days reserve was impounded behind the dam. Lt. Stover got permission from the naval governor of Guam to install a temporary water line from Asan Spring to the water system of the City of Hagåtña. The water from Asan Spring was of high quality and had previously been used to supply Asan Village and the Marine Barracks at the Asan Presidio, west of the village.[14] The temporary line to Hagåtña was begun on May 1 and completed on the May 5, 1915. Water was turned into Hagåtña that evening, with a gravity flow pressure of 55 pounds per square inch (psi). The use of this water in Hagåtña allowed the water level behind the Fonte Dam to begin to rise.[15] The temporary water line at Asan Spring consisted of 3", 3½", and 4" pipe that was laid on the ground from the spring to Hagåtña.[16] With the success of this line, the U.S. Naval Station, Guam requested permission from the Bureau of Yards and Docks to install a permanent water line.

In September 1915, the station's plans for this permanent line were approved by the Bureau and work was authorized to proceed. Lt. Stover's plans called for the construction of a concrete cistern at Asan Spring to hold just over 100,000 gallons of water. This water tank would become the Asan Springs Reservoir. Four-inch diameter cast iron pipe was ordered that would connect the cistern to the west end of the Hagåtña water system.[17]

In November 1915, during excavation for the reservoir, it was discovered that the planned reservoir site did not have adequate bedrock to support its front wall. The excavation was extended back into the hillside to where a solid foundation could be laid. At the time of this construction, the additional "considerable excavation" into the hill was seen as a benefit, which collected the several flowing streams of the spring into one and also gave a slight bit of additional elevation to the gravity flow supply system that would extend from the reservoir.[18]

Although excavation for the reservoir progressed, concrete work had to wait for the construction of a new road up to the spring that was necessary to move the building materials in. Work on the road lasted from November 1915 to January 1916. Concrete work on the Asan Spring Reservoir was begun on February 14, 1916, and was completed by the end of the month. The 4" pipe needed to plumb the system arrived earlier that month on the four-masted schooner

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[13] W. G. Johnson, "The Water Systems of Agana," *The Guam Recorder*, June 1926. P. 66.
[14] "Naval Station Notes," Guam News Letter. May 1915. P. 3. The configuration and extent of this earlier system is not known.
[15] "Naval Station Notes," Guam News Letter. May 1915. P. 3.
[16] W.G. Johnson, "The Water Systems of Agana," The Guam Recorder. June 1926. P. 66.
[17] "Naval Station Notes," Guam News Letter. September 1915. P. 6.
[18] "Naval Station Notes," Guam News Letter. November 1915. P. 2. And "Naval Station Notes," Guam News Letter. January 1916. P. 3.

Irmgard. This 670-ton, 214' vessel with a crew of eleven ran Pacific trade from the U.S. west coast and Hawaii between 1889 and 1920. Laying of the permanent pipe was delayed for several weeks until March, when the Bureau of Yards and Docks released the funds for its installation. During the work to change the system from temporary pipe to permanent, water service from the Asan Spring Reservoir was only interrupted for short periods of less than a few hours.[19] By the end of April 1916, the temporary pipeline was removed and the Asan Spring system was up and running in the permanent pipe. This permanent pipeline was later described as 4" cast iron bell and spigot pipe that was reported extant in 1937.[20]

The 1916 construction included the uncovered concrete reservoir with an overflow spillway, and a perforated conduit extending into the hillside to collect spring water. The concrete reservoir at Asan Spring was built at a cost of $3,228.63. The 4" diameter permanent pipe was laid along the approximate 2½ miles from the cistern to Hagåtña for a cost of $3,625.50. When this system was completed, it supplied water to the village of Asan, the Marine Barracks, about 2/3 of the city of Hagåtña, and the rural population along the route; a total population of about 6,000.[21]

By the end of June 1916, additional pipe for the Asan Spring system was laid for a distance of about 6,000' to the village of Piti, south of Asan. An additional 7,000' of pipe required to run the system to the quarantine station on Cabras Island was on order from the U.S. mainland.[22] By the end of the year this pipeline was installed and carrying Asan Spring water. The Guam Recorder reported,

> The development of the Asan Spring system proved to be a blessing to the people of Agana and Anigua. The water is pure and clear and the best available for drinking purposes. Furthermore the flow is extremely constant and is dependable even in the extremely dry seasons.[23]

By 1917 Asan Spring was dependably supplying about 0.2 million gallons per day (mgd) to Hagåtña, at least half of what was used there each day. The gravity flow Asan Spring water traveled from the reservoir, at about 110' elevation above sea level, through the permanent supply pipeline to tie into the west end of the Hagåtña water system at Legaspi Street.

Aside from the high quality of water obtained, this early system at Asan Spring was desirable because it delivered water using a gravity flow system without the associated costs of electric pumping, such as at Agana Spring (approximate elevation 10'). At Agana Spring, pumping was required to move the supply through many thousands of feet of pipeline to Hagåtña. When Agana Spring was developed it used a 75 h.p. pump to move water from the source to the distribution reservoir above town at a (1926) cost of about $30 per day.[24]

The disadvantage of the early Asan Spring system was that the water it supplied to Hagåtña was at a low pressure. This was too low to be usable for firefighting in those sections of the city supplied exclusively with Asan Spring water; Anigua, Santa Cruz, and part of San Ignacio. In 1924, Congress approved $12,000 to install a 4" pipe loop system in Hagåtña to improve

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[19] "Naval Station Notes," Guam News Letter. February 1916. P. 2. And "Naval Station Notes," Guam News Letter. March 1916. P. 2. And Fred A Stindt, *Matson's Century of Ships*. Modesto CA: Privately published by Fred A Stindt. 1982. P. 206.
[20] Geo. R. Brooks, LtC (CEC) U.S. Navy, "Agana Water Supply," The Guam Recorder. May 1937. P. 7.
[21] Roy C. Smith, "Governors Annual Report," August 23, 1916. P. 2. In Guam News Letter, September 1916.
[22] "Naval Station Notes," Guam News Letter. June 1916. P. 6.
[23] W.G. Johnson, "The Water Systems of Agana," The Guam Recorder. June 1926. P. 67.
[24] W.G. Johnson, "The Water Systems of Agana," The Guam Recorder. June 1926. P. 67.

pressure. The loop contained laterals on cross streets and ran from the Legaspi Street beginning of the Asan Spring line. It then ran east on Dr. Hestler Street, North on San Antonio Street, West on Hernan Cortes Street, and south on Calle Basco, to reconnect on Legaspi. When Asan Spring water was turned into this loop, less water was used than in the previous pipe system, and as a result the Asan water pressure increased at the point of service. Water from the Fonte River system, which had a pressure of about 80 psi, was then routed into the former Asan Spring system in Hagåtña, thus providing good pressure for firefighting.[25]

By 1926, most of Hagåtña was supplied with two kinds of fresh water; spring water from Asan and Agana Springs and Fonte River water, which could be turbid after a heavy rain. These two kinds of water were utilized in Hagåtña in two water systems there. One system carried only water from Asan Spring. The second system carried water either from Agana Springs or from the Fonte River Dam. For some areas, the water supply for users could be switched between sources as dictated by the season and available supply. Other areas, as noted above, had Asan Spring water and Fonte River water in separate systems. The Bilibic district had no municipal water, and San Antonio was supplied with Fonte River water in the wet season and Agana Spring water in the dry season.[26]

In early 1929, the water system in Asan village was improved by extending the supply line throughout the entire village through 2" diameter pipe. Fire hydrants at intervals were also piped in.[27] By 1937, Asan Spring water bound for Asan village, Tepungan, and Piti to the south was piped through 3" galvanized pipe with threaded connections. Water for these locales was metered as it left the reservoir. However, the population of all these areas had grown so that during dry seasons it was necessary to shut off the supply to Asan, Tepungan, and Piti at night. This left those communities without tap water and firefighting water during that time.[28]

The solution to this problem was implemented ca.1937 with larger pumps at Agana Springs and the development of Mania Spring (approximately 190' elevation), which is located about a mile from the coastline in the Fonte River gulch, downstream of the Fonte River Dam. The project at Mania Spring was a water containment reservoir with an outlet of 4" cast iron pipe. Approximate cost of this improvement was $9,600. Water was gravity fed from the reservoir, through the 4" pipe to near Pigo, where the pipe was connected to the 4" cast iron line carrying Asan Spring water to Hagåtña. The connection of the Maina Spring pipeline to the Asan Spring pipeline was made on April 16, 1937. This increased the amount of water available in the Asan Spring pipeline to Hagåtña by about 50,000 gallons per day and also increased the pressure of this system in Hagåtña. At the time of this addition to the Asan Spring system, neither it nor the Fonte River system were chlorinated, and detection of contamination was made by frequent sampling.[29]

By World War II, a very large percentage of the population of Hagåtña was supplied with piped water. This was in contrast to the population in all other areas of Guam, where piped water was

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[25] W.G. Johnson, "The Water Systems of Agana," The Guam Recorder. June 1926. P. 67.
[26] W.G. Johnson, "The Water Systems of Agana," The Guam Recorder. June 1926. P. 67.
[27] Lt. Edward D. Graffin (CEC U.S. Navy), "Public Works and Industries," The Guam recorder. February 1929. P. 214.
[28] Geo. R. Brooks, LtC (CEC) U.S. Navy, "Agana Water Supply," The Guam Recorder. May 1937. P. 8. And Geo. R. Brooks, LtC (CEC) U.S. Navy, "Water For The People Of Guam," The Guam Recorder. July 1937. P. 24.
[29] Geo. R. Brooks, LtC (CEC) U.S. Navy, "Agana Water Supply," The Guam Recorder. May 1937. P. 8. And Geo. R. Brooks, LtC (CEC) U.S. Navy, "Water For The People Of Guam," The Guam Recorder. July 1937. P. 24.

generally not available.[30] Asan Spring was an important source of dependable, high quality water for the city. Between 1937 and 1956 the amount of water taken from Asan Spring varied from 0.14 to 0.8 mgd.

In the 1960s a T-slab concrete roof was installed on the Asan Spring Reservoir.[31] By the late 1950s or early 1960s the original gravity fed system of water coming out of the Asan Spring Reservoir was changed to a pumped system. By pumping the water out of the reservoir instead of letting it flow out by gravity, the water pressure to the end users was increased. Structures were built on the property, in front of the reservoir at the site of the current Pump House, presumably to house the pumping equipment.[32] Anecdotal information indicates that at one time pumping equipment might have been installed on the roof of the reservoir.[33]

Ca. 1972 a CMU constructed, 12'-0" x 24'-0" pump house building with two, twenty horse power pumps and a chlorinator room was built near the north corner of the reservoir. This building and equipment is no longer extant, but record drawings are retained at the Guam Water Authority, drawing # 1195508, 1195509, 1195512, dated July 7, 1972.

Ca. 1994 the extant Pump House building was built and new pumping equipment installed in it to replace the earlier system housed in the previous building, now demolished. Also ca. 1994, the Chlorinator Building was constructed.

<u>Post-World War II Water Development</u>

Although the Navy drilled several wells ca. 1937 that proved the existence of ground water, surface water from springs and smaller rivers remained the primary sources of fresh water for Guam until after the U.S. liberation of the Island from Japanese control in 1944. One important water source that was developed pre-war was the 1941 Maanot Reservoir, a 1.2 mgd reservoir that stored water from Almagosa Spring and doubled the capacity of the water system on Guam.[34] The post-liberation water system was deemed inadequate by the Navy because of damage during the invasion and the huge demands by U.S. forces. The Navy responded primarily by drilling wells and developing smaller surface water sources, small dams and existing streams.[35] Shallow wells were added in coastal areas and deeper wells driven in the interior, mainly in the limestone aquifer of northern Guam.

By the late 1940s the Navy had developed sixty-seven main sources that produced about 12 mgd for use throughout Guam, including civilian users. Most of these were deep and shallow wells. Other notable sources at the time were surface and groundwater. The system at Almagosa Spring was the largest source at the time, supplying about 2 mgd for use at Apra Harbor and Orote Peninsula. Water treatment plants at Ylig and Pago Rivers produced a total

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[30] Rebecca A. Stephenson, "Freshwater Use Customs On Guam: An Exploratory Study," Washington D.C.: Office of Water Research and Technology, U.S. Department of the Interior. April 1979. p. 2.
[31] Joe Garrido, interview with author at Guam Historic Resources Division. October 22, 2015.
[32] Robert S. Lizama and Lynda Bordallo Aguon, "Letter RC2015-0502, Asan Spring Reservoir," from the Guam Department of Parks and Recreation. January 18, 2016.
[33] This information comes from an undated, two page document with no author noted that was received at Mason Architects from the clients (International Archaeology and Brown & Caldwell).
[34] Reed, Richard, HAER No. GU-7, Maanot Reservoir, National Park Service. 2011.
[35] COMNAVMARIANAS, "U.S. Navy Development of Guam, M.I." Compiled by Commander Naval Forces Marianas (Base Development). September 1950. P. 9.

of about 0.8 mgd for use in those areas. The Tamuning Maui-type skimming well produced about 1 mgd for that area.[36]

The system that supplied the Hagåtña area, utilizing the sources at Asan and Agana Springs, supplied about 1.5 mgd in the late 1940s.[37] By about 1957, production in the Asan/ Hagåtña area was increased by boosting the pumping from Agana Springs from 0.5 mgd to about 2.5 mgd.[38]

In 1951, the Navy completed a major water development project on the Fena River. The capacity of the Fena Valley Reservoir was about 2,500 million gallons. It is the only reservoir that is large enough to carry runoff supplies from one wet season to the next. The reservoir also impounded the outflow from upland springs. By the mid 1960s, the Fena Valley Reservoir was the source of more than half the water used on Guam.[39]

By the time the Fena Valley Reservoir opened, two large wells that were developed by the Navy at Tumon and Tamuning had been online for several years. These wells exploited the large water table present in the porous limestone of the northern plateau of Guam. These wells had horizontal infiltration tunnels under ground that tapped the thin layer of the freshwater aquifer that floats on the underlying salt water. By 2003 most of Guam's freshwater was drawn from this northern aquifer.[40]

During the 1950s and 1960s as increasing amounts of Guam's water supply were drawn from the Fena Valley Reservoir and from wells tapping the northern aquifer, the importance of the flow from Agana Springs decreased.[41] This seems in contrast to Asan Spring, where 1960s upgrades to the reservoir (roofing) and a pumping system speak to its continued use as a water source for Hagåtña and the surrounding area. The ca. 1994 additions of the Pump House and Chlorinator Room also evidence Asan Spring's importance as a water source through the late twentieth century

The use of water from Asan Spring was discontinued in 2003 by Guam Waterworks Authority because of coliform bacteria present in the water and an inadequate chlorination system to treat it.

Sources

A. Architectural Drawings:

No original or historic drawings of the Asan Spring Reservoir were located for this report. Archives that were visited to search for drawings include:

NAVFAC Technical Library, Building 103, Apra Harbor Joint Base Marianas.

MARC Archives at the University of Guam.

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[36] COMNAVMARIANAS, "Development of Guam." 1950. P. 9.
[37] COMNAVMARIANAS, "Development of Guam." 1950. P. 9.
[38] Porter E. Ward, Stuart H. Hoffard, and Dan A. Morris, Hydrology of Guam, Geological Survey Professional Paper 403-H, Washington D.C.: U.S. Department of the Interior. 1965. P. H19.
[39] Porter E. Ward, Stuart H. Hoffard, and Dan A. Morris, Hydrology of Guam, Geological Survey Professional Paper 403-H, Washington D.C.: U.S. Department of the Interior. 1965. P. H12.
[40] Stephen B. Gingerich, Hydrologic Resources of Guam, USGS Water Resources Investigations Report 03-4126, Mangilao, Guam: Water and Environmental Research Institute, University of Guam. 2003.
[41] Porter E. Ward, Stuart H. Hoffard, and Dan A. Morris, Hydrology of Guam, Geological Survey Professional Paper 403-H, Washington D.C.: U.S. Department of the Interior. 1965. P. H19.

During the research phase, Guam Water Authority was contacted through the project engineers, Brown & Caldwell, to locate any historic drawings of the extant structures, with negative results.

Resources at the Guam Public Library, Nieves M. Flores Public Library, 254 Martyr St., Hagåtña, Guam could not be accessed due to the closure of the building for renovation during the field visit.

B. Early Views:

No historic photographs of the Asan Spring reservoir were located for this report.

C. Bibliography:

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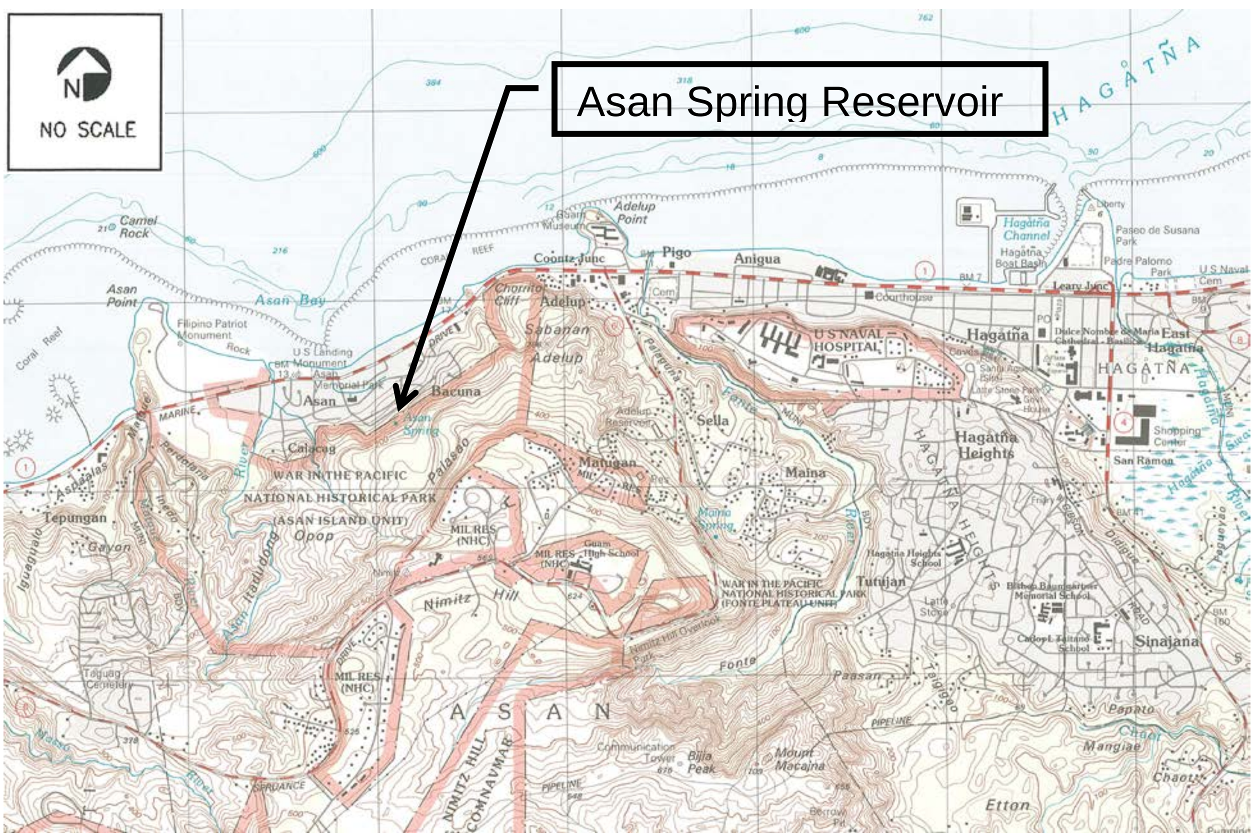
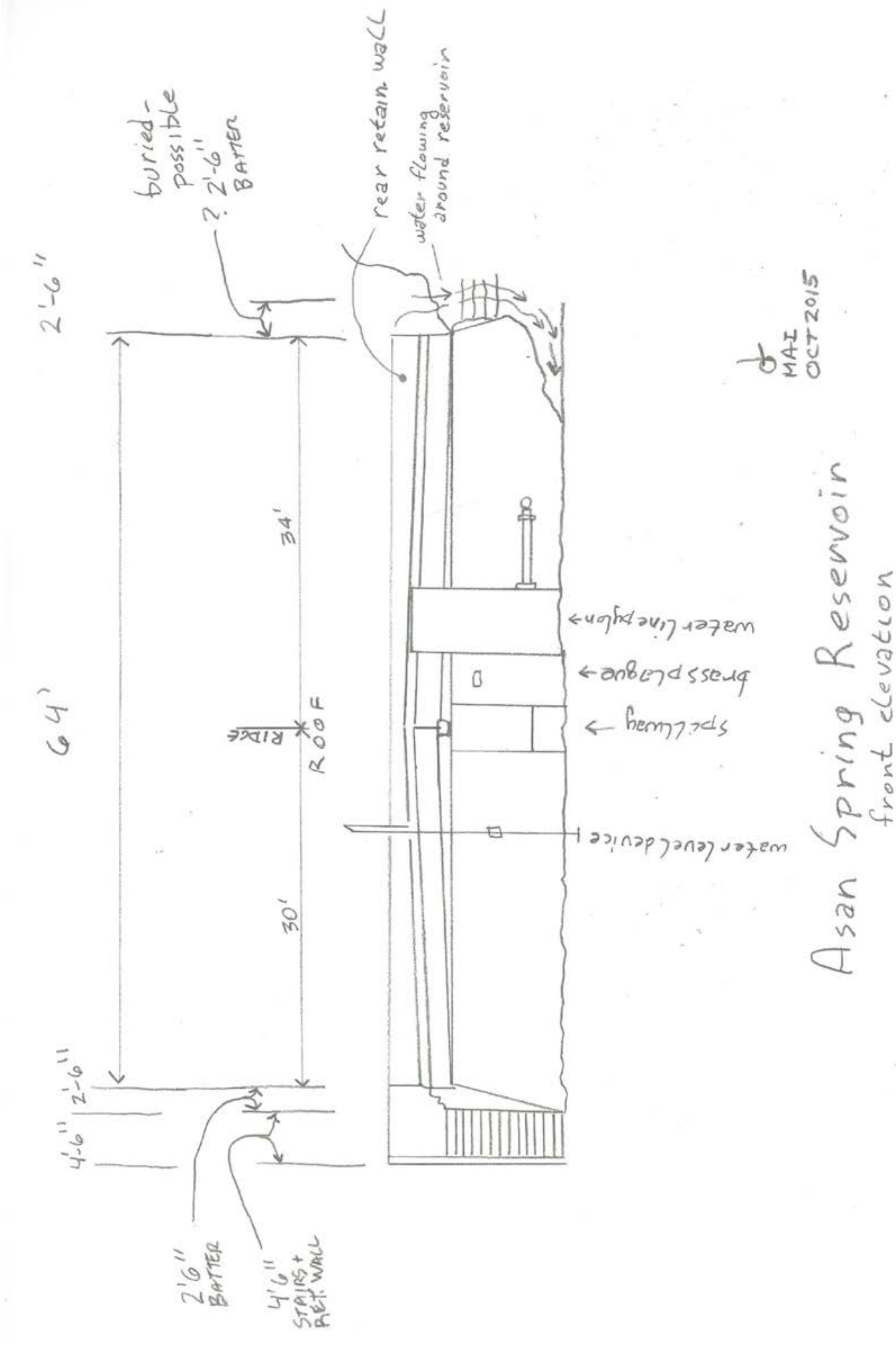
"Water is Precious." *The Guam Recorder*. August 1937. P. 31.

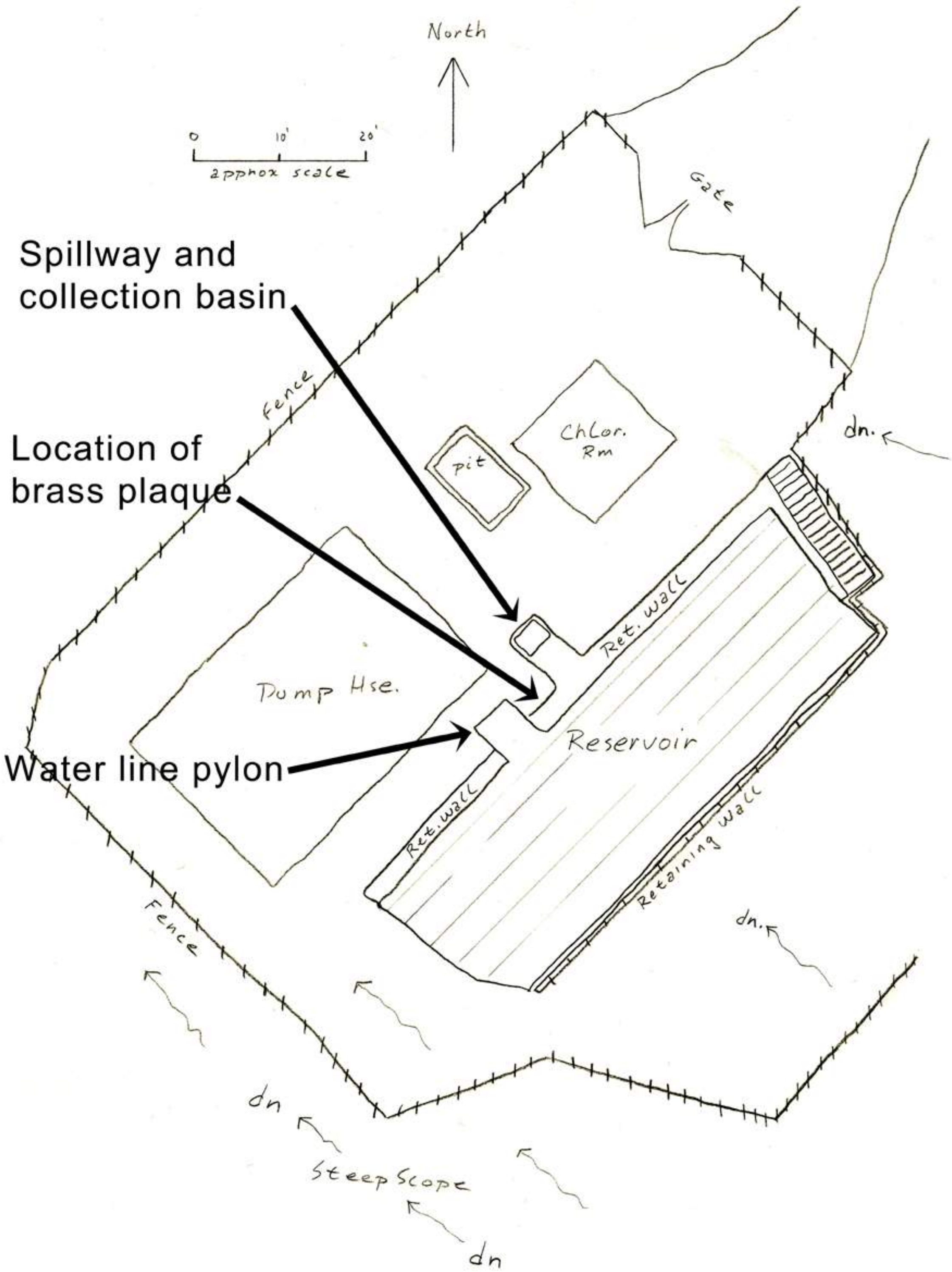
Location map



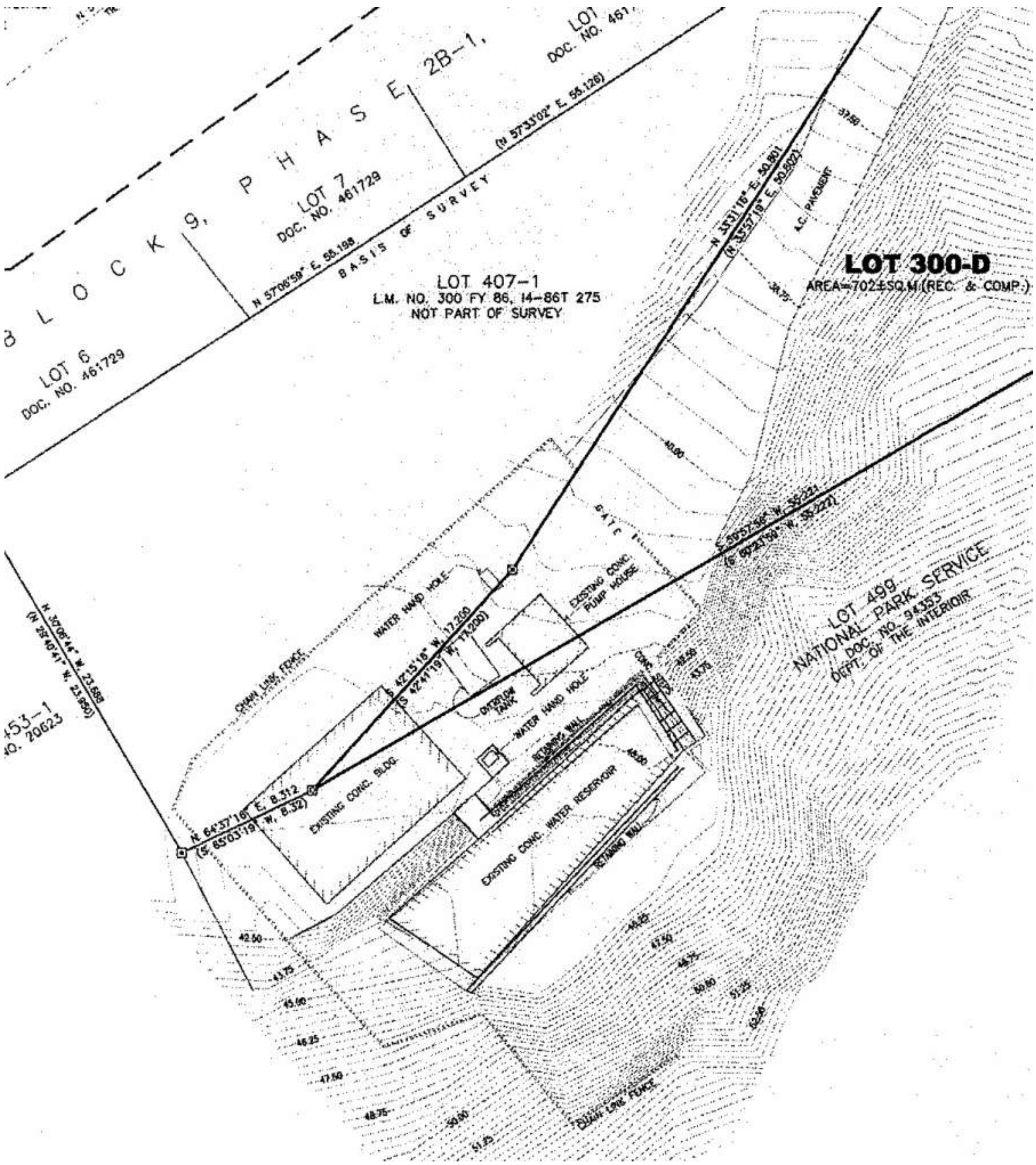
Field sketch of front elevation of Asan Spring Reservoir. *(Source: Mason Architects, Inc.)*



Sketch Plan of Asan Spring Reservoir compound. *(Source: Mason Architects, Inc.)*



Portion of drawing dated August 2014 showing the site plan at Asan Spring Reservoir. This drawing was produced by the Government of Guam, Guam Waterworks Authority and is in the public domain. North at top. *Drawing "Retracement Survey Map of Lot 300-D, Asan Spring Reservoir and Water Pump Booster Station, Municipality of Asan." Duenas Camacho & Assoc. August 2014. Drawing courtesy of Brown & Caldwell.*



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HAER No. GU-10-1

HISTORIC AMERICAN ENGINEERING RECORD
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HAER No. GU-10-2

HISTORIC AMERICAN ENGINEERING RECORD
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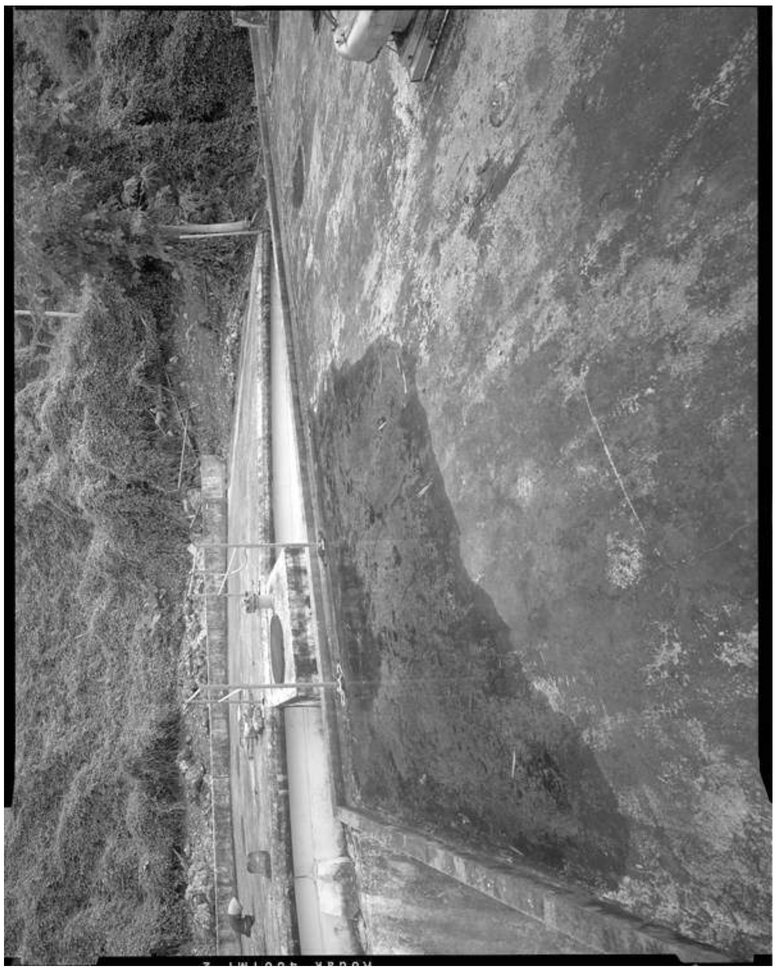

HISTORIC AMERICAN ENGINEERING RECORD
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HISTORIC AMERICAN ENGINEERING RECORD
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HAER No. GU-10-5

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HISTORIC AMERICAN ENGINEERING RECORD
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HAER No. GU-10-9

HISTORIC AMERICAN ENGINEERING RECORD
SEE INDEX TO PHOTOGRAPHS FOR CAPTIONS

HAER No. GU-10-10

Field photo taken October 21, 2015. Detail of plaque.

Field photo taken October 21, 2015. Detail of plaque.

Field photo taken October 21, 2015. Detail of plaque.

Field photo taken October 21, 2015. Detail of plaque.

Field photo taken October 21, 2015. Chlorinator Building.

Field photo taken October 21, 2015. Chlorinator Building.

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Field photo taken October 21, 2015. Chlorinator Building.

Field photo taken October 21, 2015. Chlorinator Building, interior.

Field photo taken October 21, 2015. Chlorinator Building, interior.

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Field photo taken October 21, 2015. Chlorinator Building, interior.

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Field photo taken October 21, 2015. Chlorinator Building, interior.

Field photo taken October 21, 2015. Pump House.

Field photo taken October 21, 2015. Pump House.

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Field photo taken October 21, 2015. Pump House.

Field photo taken October 21, 2015. Pump House.

Field photo taken October 21, 2015. Pump House interior.

Field photo taken October 21, 2015. Pump House interior.

Field photo taken October 21, 2015. Pump House interior.

Field photo taken October 21, 2015. Pump House interior.

Field photo taken October 21, 2015. Pump House interior.

Field photo taken October 21, 2015. Pump House interior.

Field photo taken October 21, 2015. Pump House interior.

Field photo taken October 21, 2015. Pump House interior.

Field photo taken October 21, 2015. Pump House interior.
Note, all 3 pumps are powered by 10hp electric motors.

Field photo taken October 21, 2015. Pump House interior.

Field photo taken October 21, 2015. Pump House interior.
Note, generator is 347 amp, 125kva, 75kw.

Field photo taken October 21, 2015. Pump House interior.