



# Tumon-Maui Well Rehabilitation Project

## Planon Numa'lon Tupo' Tomhom-'Maui'

Guam Historic Properties Inventory Site 66-01-2278  
Sagan Embentáron Propiedát Hestorikát Guahán 66-01-2278

**Department of the Navy | Public Education and Interpretation Series**

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Dipáttamenton Militát/Primet Nina'huyong Publiku



**An Application of Appropriate Technology:**

**Then and Now**

**Aplikasion Apropositu na Modelu nigap yan på'go**

**2013**



Before Rehabilitation



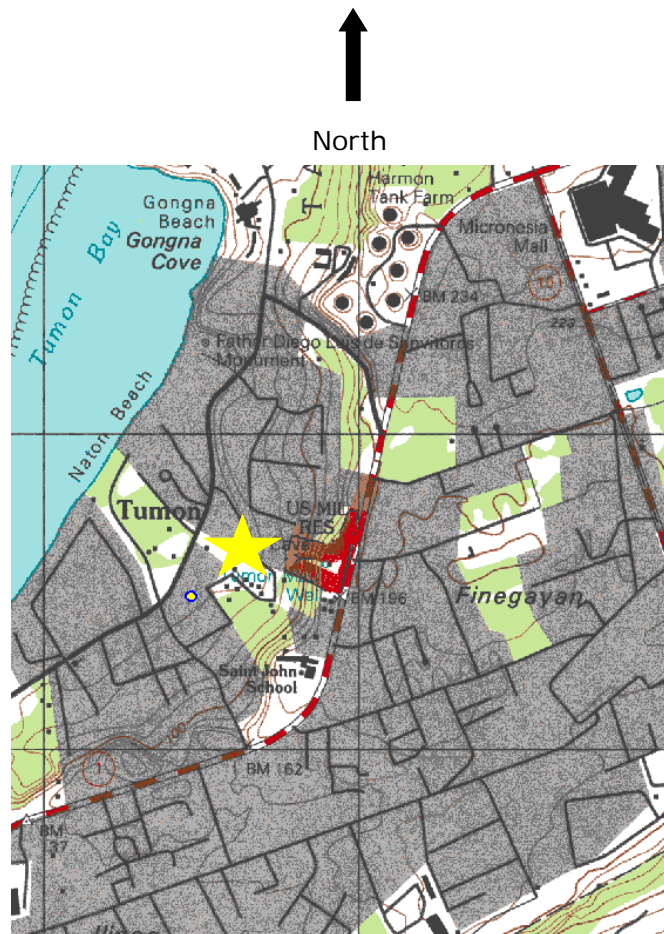
After Rehabilitation

## Where is the Tumon-Maui Well?

### Månu na gaige i Tupo' Tomhom-'Maui'?

The Tumon-Maui Well is located on Navy property along the west edge of Route 3 in Tumon on the island of Guam. The well site is not open to the public.

I propiedât i 'Navy' na gaige i Tupo' Tomhom-'Maui' gi lichen chalan 'Route 3' gi ya Guahån. Ma huhom i lugåt annai gaige i Tupo' para i pupbliku.



## Håfa este i Tupo' Tomhom-'Maui'?

Matungo' este lokkue' na lugât komu i 'U.S. Geology Service (USGS)' Tupo' #80, i Tupo' Tomhom-'Maui' tupo' hânôm gi papa' odda' ni' guâha kuâtton bomba yan loskuantos na mandikike' guma' gi sanhilo'. Guâha unu na bokongo' ni' mâs di mit pi'e inanakko'ña gi sankattan desdi i kuâtton bomba, kâsi kanna' umalapot yan i tasi, sa' gaige i tinaddong kâsi 190 esta 210 pi'e gi papa' odda'.

I sanpapa' na bânda gi tupo' na gaige i kuâtton bomba ni' anâkko' na haligi esta hulo' gi suleras, bokongo' para manrikohen hânôm, yan pasaduran bokongo' ni' kâsi 240 pi'e na inanâkko' gi lichen i kuâtton bomba umeggenghulo' kâsi 30° esta guatu gi pottan entrâda gi sanhilo'.

I kuâtton bomba na mineddong kâsi 60 pi'e gi 22 pi'e, i kisami kâsi 25 pi'e na tinakhilo' kontra i satgen simento. Gaige gi i liga yan i kisami gi hilo' odda' ni' 'shot-crete' otro na klâsen simento.

Put todû i inanakko'ña i 'complex' gi papa' odda' mâski 1300 mit pi'e, ma guaddok todû hâlôm gi âcho' âfok. Put mâs, i 'vertical shaft' mâtto hulo' esta i edda' ginen i ya kâtattan gi bokongo' manrikohen hânôm. Gi hilo' odda', gi hiyong i pottan entrâda gaige dikike' na karetan manhâlla ni' mana'falâlâgu hulo' yan papa' gi eggeng na pasaduran bokongo'. Otro siha ta'lo gi fi'on potta (gi sanlichan) guâha sagan yenireta, oddas tângken lâña yan i hilo' plânchan simento na gaige i ramentan ilektridât. Hilo' i kuâtton bomba na gaige guma' gue'han mânglo', sagan kloraks yan tubon hânôm. Gi sanhilo' i 'vertical shaft' ni' ha hago' hulo' ginen i punta gi sankattan gi bokongo' sagan hânôm na gaige i gima' chalan mânglo'. Todû este siha ni' a'annok gi lugât tupo' manma fotma luchan esta kât-tan.

Unu ha' na bokongo' ha u'usa i Tupo' Tomhom-'Maui' para u kula i rinikohen hânôm ginen i lenten hanom fresko (guâha tupo' mâs ki unu na bokongo' ha u'usa para u kula). I ma rikohe na hanom gi bokongo' humalom esta i maddok gi kuâtton bomba. Metgot na makinan ilektridât muna'kalamten i bomba ni' humâhalla i hanom ginen i maddok esta hulo' gi sesteman hânôm. Machochog'ue este para siguru na ti nina'ye hânôm tâsi sa' siempre ha na' difekto i tipo'.

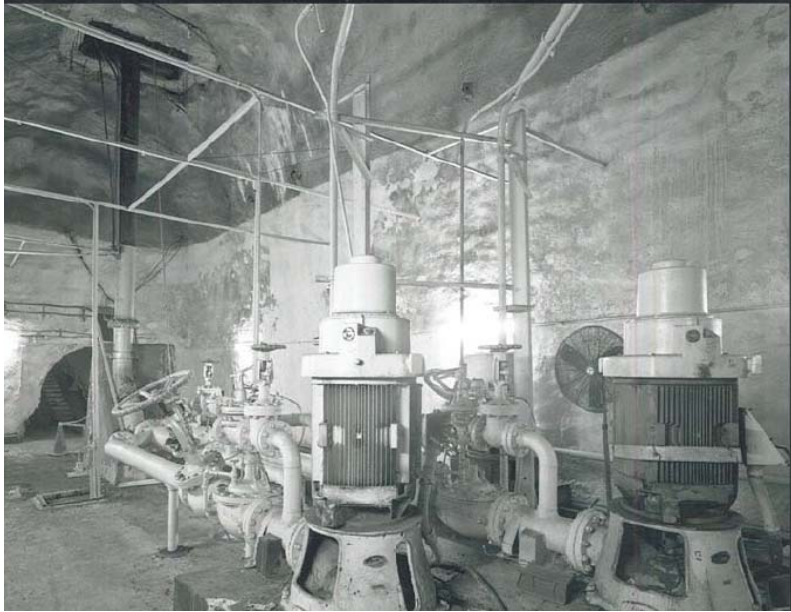
## **What is the Tumon-Maui Well?**

Alternately known as United States Geological Service (USGS) Well No. 80, the Tumon Maui Well is a water-well with an underground pump room and a number of small structures on the surface. The well has a single near-horizontal tunnel that extends about 1,000 feet' eastward from the pump chamber, approximately at sea level, which is at a depth of about 190 to 210 feet below the surface.

The underground portion of the well contains the pump room with a vertical shaft to the surface, a water collection tunnel and an access tunnel about 240 feet long that extends westward from the pump room and slopes upward at about 30° to the portal doorway on the surface. The pump room is about 60 feet by 22 feet in area with a ceiling averaging approximately 25 feet above the concrete floor. Walls and ceilings are surfaced with shot-crete, a type of cement. The total length of the underground complex is over 1,300 feet, all of which was excavated into coral limestone. In addition, a vertical shaft extends to the surface from the far eastern end of the water collection tunnel. On the surface, at the outside of the portal doorway, is a small cable-winch trolley that formerly ran up and down the sloping access tunnel on tracks. Other surface features near the portal (to the west) are a generator house, fuel tank support saddles with fuel containment structure, and a concrete pad with electrical equipment. Above the pump room on the surface are; a fan house, chlorination house, and water piping. On the surface above the vertical shaft that reaches up from the east end of the water supply tunnel is a vent house. All these features of the well site are linearly oriented on a west-east axis.

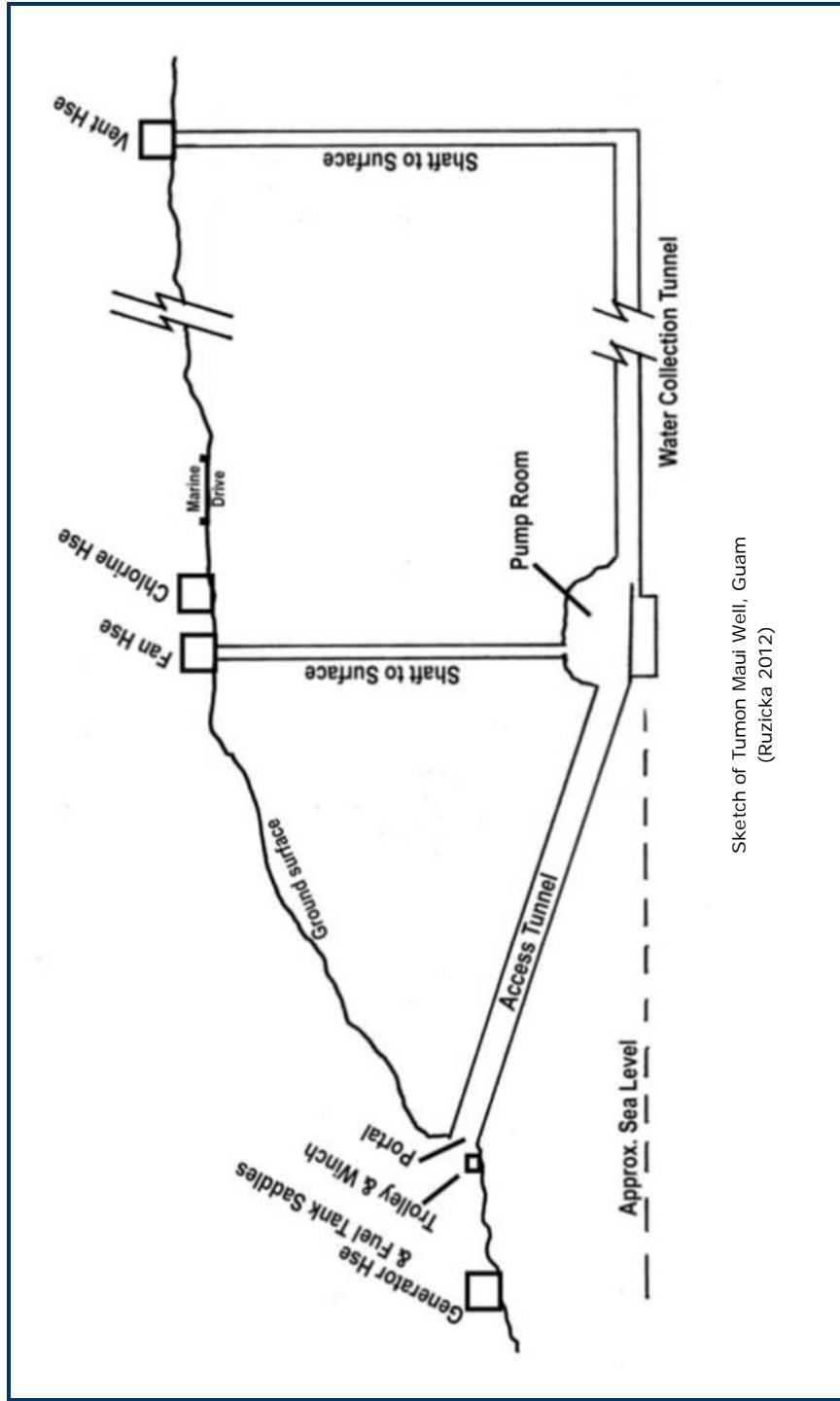
The Tumon-Maui Well uses a single collection tunnel to skim from the fresh water lens (some skimming wells use multiple tunnels). Water collected in the tunnel enters the sump in the underground pump room. Powerful electric motors run pumps that take the water from the sump to the surface components of the water system. This method eliminates the potential for salt water contamination that affects vertical wells.





Pump Room Before and During Rehabilitation





Sketch of Tumon Maui Well, Guam  
(Ruzicka 2012)

## **Ngai'an i Tipo' Tomhom-'Maui' na mahâtsa?**

Ma lista para ma hâtsa i Tipo' Tomhom-'Maui' gi 1947. Lao, gi magâhet monhâyan ma hâtsa gi Agosto 1946 annai i bokongo', i kuâtton bomba yan 900 sientos pi'e gi bokongo' ma guaddok.

### **Hâfa na mahâtsa i Tipo' Tomhom-'Maui'?**

Put siklo ma u'usa i lanten hânom fresko ni' taotao islas, maguaddok natata na mâddok gi kânton tâsi pat ma u'usa naturât hânom fresko gi liyang. Pâ'go na tiempo ma adilânta i bomba ni' siña manguaddok lataddong na tupo' sa' kapâs para u na'huyong mâs meggai na hânom fresko. Mientras mâs barâtu i 'vertical shaft' na tupo', este na cho'cho' guâha problema sa' siña i lanten hânom fresko kanifes ya lumachi i barohu ya ha fakcha'i i hanom tâsi. Ya pues, chukka maolek sa' ha danchi i lanten hânom, yanggen kumalamten i bomba ya ha tutuhon chumopchop i hanom, siña kontodu i hanom tâsi hinalla ya hana'aplacha i tipo'. I mâs maolek para macho'gue i para u ma hâtsa ayu i ma â'agang 'Maui' na modelon tupo'.

I fine'nana na klâsen tupo' ni' mahâtsa gi 1923 mafa'na'an "tupo' koladot" ni' gaige gi ya 'Maui' para u pribiniye hânom para i dângkolu na tinanom tupu gi ya Hawaii (Cox 1981). Ha nisisita este na klâsen tupo' na u maguaddok kannâ' eggeng na bokongo' sa' siña ha kula i lanten hânom fresko sin u chopchop i hanom tâsi gi sanpapa'. Dipotsi, i 'Maui' na klâsen tupo' kalan ume'eggeng para u hâlom esta guatu gi kuâtton bomba ni' gaige gi hilo' i lanten hânom fresko. Unu pat mâs na bokongo' ha fâfanna' huyong ginen i kuâtton bomba para u rikohi i hanom fresko sin u abatti yan i hanom tâsi. Yanggen esta rinikohi, siña i hanom fresko u bomba ginen i kuâtton bomba sin u a'danña' i fresko yan ma'asin na hânom. Dipendi gi inestudia put hestorian i tano', i tipo' ni' kumukula i hanom gaikapâs para u pribiniye miyon na galon hânom kâda diha.

Durâten i Geran Mundo Dos, manmâtto kantidâ na militât gi ya Guahân ya esta pâ'pa'go ha' sigi ha' manhâlom yan i minigai taotao despues di i gera, mâs meggai na hânom fresko ma nisisita piot i sanlagu na pätte gi isla, ni' tina'hong hânom taiguihe i masosodda' gi sabânan sanhaya. Gaige bo'bo' yan tangken hânom ni' prumibiniye i sanhaya, lao I taotao sanlagu ma diependi ha' siha giptipo'. Ti gof meggai tupo' maguaddok gi lugât lao annok na meggai yan tâddong i lanten hânom fresko gi papa' isla.



### **When was the Tumon-Maui Well Built?**

The Tumon Maui Well is listed with a construction date of 1947. However, the well was substantially complete in August of 1946 when the access tunnel, pump room, and 900 feet of the horizontal collection tunnel had been excavated.

### **Why was the Tumon Maui Well Built?**

The fresh water lens on islands had been accessed for hundreds of years by digging shallow pits near the shore or using natural freshwater caves. Improvements in pump technology permitted development of deeper wells capable of producing large volumes of fresh water. While vertical shaft wells are relatively inexpensive to drill and operate, this method is problematic because the fresh water lens might be thin, resulting in it being missed by the drilled shaft and the underlying brackish or salty water being tapped instead. Additionally, even if the driller is successful in targeting the fresh water lens, when the pump begins to suck up the fresh water, the process may draw in salty water from below, contaminating the well. A more efficient technology was needed and resulted in the creation of what is referred to as a "Maui" type well design.

The first Maui type wells, known as "skimming wells" were built on Maui in 1923 to provide water to Hawaiian sugar plantations (Cox 1981). This type of well requires excavation of a near-horizontal tunnel an appropriate level to skim the fresh water lens without drawing in the underlying salt water. Typically, Maui-type wells have a sloping shaft to access an underground pump chamber located just above the freshwater lens. One or more horizontal tunnels lead outward from the pump room to collect fresh water without mixing the underlying salty water. Once it has been collected, the fresh water can be pumped from the pump room without the potential for mixing fresh and salt water. Depending on local hydrogeology, skimming wells have the potential to provide several million gallons of fresh water daily.

The arrival on Guam of large numbers of military personnel during WWII and the continued military presence and increase in the general population following the war created an increased need for fresh water, particularly in the northern portion of the island, which lacks the surface water that can be found in the southern mountain region. There are several springs and reservoirs that provide fresh

### **Taimanu i Tupo' Tomhom-'Maui' na ma hâtsa?**

Sigon gi tiningo' put i lugât ni' gaige i lanten hânom fresko gi papa' tâno' ginen i guinaddok tupo', i taotao ni' plumânu i 'Maui' na klâsen tupo' kosaki u hâtmi i lanten hânom fresko ya u pribiniye meggai na hânom magimen para u setbe i nisisidât 'Andersen Air Force Base.' Ma tutuhon ginen papa' gi acho' âfok gi kantit a'annok ha' i bakânan Tomhom, ma guadduki eggeng yan tâddong na bokongo' para u hihot gi hanom fresko, ma guadduki kuât-ton bomba yan bokongo' rinikohi yan mana'hâlom i bomba yan i tubon hânom ni' ha nisisita para u dâgao huyong i hanom este i sanhilo, para u ma sahguan gi dipositu, manâye âmot para u pinino' i aplacha pues na u ma na'ii huyong. Kanna' todû i tiempo kumalalamten i tipo' esta i 1965 ha dâdagao huyong alakuenta miyon na galon hânom fresko kâda diha.

### **Hâfa na empottânte i Tipo' Tomhom-'Maui'?**

Empottânte este i Tipo' Tomhom-'Maui' gi sesteman hânom para i islan Guahân sa' pusipbli para u na'huyong meggai na pâlte para i sesteman hânom gi isla, estaki mahuchom gi 1985 put inaplacha kemikât. Durânten ayu na tiempo, este na tupo' ha na'huhuyong i mâs takhilo' kapasidât tupo' gi sesteman hânom para i sanlagu, i mâs fine'na'na na hânom fresko gi ya Guahân. Empottânte lakkue' este na tupo' komu modelon i 'Maui' na klâsi sa' ha kukula i hanom fresko gi papa' odda'. Este ha' na klâsen tupo' 'Maui' gi ya Guahân ni' kapâs para u na'huyong gâsgas na hânom fresko. Despues di 1995, mana'kalamten ta'lo lao ti apmam na tiempo ma huchom gi 1999.

I tipo' lakkue' propiedât ni' fuera di i gima' ni' ma hâtsa gi hilo' odda' inumenta gi lugât i tipo' gi ti apmam tâtte na tiempo, nombrâyon na u ma lista gi 'National Registry of Historic Places' gi 'Criteria C' put i modelon mahâtsa-ña yan 'Criteria D' put ha na'huhuyong man empottânte na enfotmasion hestorian ântes yan pâ'go.

Put ma ditetmina para ma lista i tipo', guâha areklamento para ma tattiyi ginen i 'Department of Interior' yanggen para u ma arekla kosaki tâya' engkebukao pat dinida gi tinilaika gi hagas na hinatsa. I areklamento ha gâgagao na u arekla i propiedât gi orihinât, u ma sustieni ayu na pâlte gi propiedât ni' man empottânte gi hestorikât,

water in the southern region, but the northern population depends on well water. Several vertical wells dug in the area demonstrated the presence and depth of an extensive lens of fresh water underlying the island.

### **How was the Tumon-Maui Well Built?**

Using knowledge of the location of the underlying fresh water lens gained from drilled wells, engineers designed a Maui-type well to access Guam's fresh water lens to provide large amounts of potable water to serve the needs of Andersen Air Force Base. Starting at the base of a limestone bluff overlooking Tumon Bay, they excavated a sloping access tunnel to a depth near the fresh water, excavated a pump room and single collection tunnel, and installed the pumps and plumbing required to deliver the water to the surface, where it could be stored, treated, and distributed. The well was in almost continuous use until 1965, producing about 1 million gallons per day (mgd) of fresh water.

### **Why is the Tumon-Maui Well Important?**

The Tumon Maui Well is a significant component of the water system of the Island of Guam, which accounted for a large portion of the island's water supply until its initial closure in 1995 because of chemical pollution. During that time, the well was one of the highest capacity wells of the northern aquifer system, the primary source of Guam's freshwater. The well is also significant as an example of a Maui-type water well that operates to skim underground freshwater from the thin basal layer. It is the only Maui type well on Guam that is capable of producing reliable fresh water. After 1995, it was placed back in service for a short time and then closed again in 1999.

The well is also a historic property, which with exception of the above-ground buildings added to the well site in recent years, is eligible for listing on the National Register of Historic Places under Criteria C for its distinctive construction characteristics and Criteria D for its potential to yield information important to prehistory or history. Because the well has been determined eligible for listing, the rehabilitation must follow certain standards set forth for by the United States Secretary of Interior to avoid an adverse, or negative, effect to its character defining features. The standards define rehabilitation as "the process of returning a property to a state of utility, through repair or alteration, which makes possible an efficient Well?

The purpose of the rehabilitation project is to re-open the well and place it back in service.

i modelon hinatsa yan i kutturât., Mâs empottânte gi areklamento i ha sedi i tinilaika gi propiedât hestorikât i pusipbli na u kontenuha ma usa i guinaha, maseha para i nuebu pat para ma kontenuha i orihinât na cho'cho', mientras ha sustiene i gaige na hestorikât

### **Sa' hâfa na para u ma arekla i tipo'?**

Ayu na para u ma arekla i tipo' kosaki siña mababa ta'lo yan u mana'kalamten.

### **Taimanu ma tattiyi i inarekla?**

Put para u siguru, i 'Secretary of Interior' ha na' guâha areklamenton para ma tattiyi i para u na'lo i Tipo' Tomhom-'Maui', fine'na'na ma nisisita na u guâha kuâlifikao taotao, taiguihi i ha tungo' manplanu put hestorikât para u ditetmina manu na pâlte gi hinatsan tupo' annok na guâha hestorikât. Kumekeilekña na hâfa gi inarekla siña ma sustieni para u siguru na gaige i hestorikât na pâlte yanggen monhâyan i che'cho'.

Ha suponi i inarekla na put siangkâsu ma fa'maolek pat ma rinueba i bânda hestorikât, taiguihi i tipo', nisisâriu na yanggen ma sedi u annok na chilong gi tiempon antes yan pâ'go, lao i inarekla yan tinilaika ti ha na'dânu pat destrosa i matiriât, i modelon hinatsa pat i finon finattinas ni' man empottânte para u annok na gagaige ha' hestorikât na pine'lo. Put ehemplo, taimanu macho'gue – kao ti maolek i che'cho', ni' siña chaddek dumânu i gima'hestorikât. Este na difekto siña lachi ma usa na ramentan muna'gasgas gi sanhiyong pat ma pega 'insolation' ya tinilaika i modelon matiriât hestorikât. Kanna' todû este na uson matiriât yan tinilaika ti u ma aksepta sigon gi areklamento. Parehu ha, yanggen guâha hinatsa gi sanhiyong ya esta pumarehu yan otro, i matiriât yan i inadotna gi gima' piot ya ha diroga i figuran hestorikât siempre ti u ma apreba sa' ti ha tattiyi i areklamento.

Ma konsidera na i Tipo' Tomhom-'Maui' yan kanna' todû i chechetton gi lugât gi sanpapa' pat sanhilo' odda' annok na 'character defining' pues ma sustiene. Yanggen guâha nisisâriu para ma tulaika put para u mana'la'maolek i sistema pat u pribiniye asiguridât, debidi i plânu u chine'gue ni' kuâlifikao na taotao yan u ginehilo'i ni'' taotao hestorikât gi 'Navy' para u siguru na i plânu ha tattiyi i ginagâgao-ña i che'cho' mientras ha sustetieni i hestorikât i tipo'.

Este ha' siha para u mana'nuebu gi Tipo': Tulaika i bomba gi kuâtton bomba yan i tubon hânôm, i sesteman manhâlla yan i kareta yan u mana'la'metgot i motun yenereta, i gima' tângken kloraks yan i mâkinan mânglo'.

contemporary use while preserving those portions and features of the property which are significant to its historic, architectural, and cultural values." More importantly, the standards allow changes to be made to historic properties to make it possible to continue to use the resource, either for a new use or to continue the original function, while retaining the characteristics that define it as a historic resource.

### **Why Rehabilitate the Well?**

The purpose of the rehabilitation project is to re-open the well and place it back in service.

### **How were the Rehabilitation Standards Followed?**

In order to ensure the Secretary of Interior's Standards for Rehabilitation of the Tumon-Maui Well were followed, it was first necessary for an appropriately qualified individual, such as a historic architect, to determine which elements of the well complex were character-defining. In other words, what needed to be retained in order to ensure that the well would retain its historic character after completion of the rehabilitation process?

Rehabilitation assumes that at least some repair or alteration of a historic structure, such as the well, will be needed in order to allow efficient contemporary use; however, repairs and alterations must not damage or destroy materials, features or finishes that are important in defining the structure's historic character. For example, certain treatments--if improperly applied--may cause or accelerate physical deterioration of the historic building. This can include using improper repointing or exterior masonry cleaning techniques, or introducing insulation that damages historic fabric. In almost all of these situations, use of these materials and treatments will result in a project that does not meet the Standards. Similarly, exterior additions that duplicate the form, material, and detailing of the structure to the extent that they compromise the historic character of the structure will fail to meet the Standards.

In the case of the Tumon-Maui Well, almost all of the subsurface and surface components were considered to be "character-defining" and were retained. Where modifications were required to upgrade systems or provide for enhanced safety, the rehabilitation work was designed by qualified architects and included oversight by the Navy's own historic architect to ensure the design met project goals while

Este ha' siha para u mana'nuebu gi Tipo': Tulaika i bomba gi kuátton bomba yan i tubon hânom, i sesteman man-hâlla yan i kareta yan u mana'la'metgot i motun yenereta, i gima' tângken kloraks yan i mâkinan mânglo'.

### **Hâfa na ti siña ma hâtsa lameggai na tupo' 'Maui'?**

Put kapâs este na klâsen tupo' i 'Maui' para u na'huyong meggai na hânom fresko, hâfa na ti mahâtsa pâ'go? Guâha siha rason. Mampos guaguan para mahâtsa este na klâsen tupo' pâ'go na tiempo. I 'technology' pâ'go na tiempo gi guinaddok mâs gai adilanto sa' pusipbli na u ma guaddok i nuebu na tupo' esta i lenten hânom fresko ginen i papa' tâno' sa' mâs libiânu ki ântes. Put uttimu, este na klâsen tupo' ti ha nisisita dângkolu na propiedât taiguihi i sesteman 'Maui.'



Entrance to Tunnel

maintaining the well's historic character. Rehabilitation of the well included the replacement of pumps and piping in the underground pump room, replacement of the winch and trolley system, and upgrades to the generator, fan, chlorination, and vent houses. A granulated activated carbon system was also installed to remediate groundwater contamination.

**Why Not Build More Maui Type Wells?**

Given the efficiency of Maui type wells for delivering large volumes of fresh water, why are they not being constructed today? There are several reasons. It would be very expensive to construct a well of this type today. Also, improvements in vertical well drilling technology make it possible for new wells to do a more efficient job tapping and delivering fresh water from the underground lens than was possible in the past. Lastly, vertical wells encumber less real estate than the Maui type systems.



Rehabilitated Entrance to Tunnel



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Estague' fina'lepblon idukasion pupbliku yan ina'danña' ma na'huyong para u kumple pätte gi kontratan prugrama entre i 'Department of Defense', i Konsuhelon Abiso put Inadahen Hestorikât, i Ufisiât Inadahem Hestorikât Guahân yan i Ufisiât Inadahen Hestorikât Notte Mariana put para u fan mamuebi i militât para Islas Guahân yan Tinian yan sigon gi enfotmasion ni' a'annok put i lugât.