Bikini Atoll

NOMINATION BY THE

REPUBLIC OF THE MARSHALL ISLANDS

FOR INSCRIPTION ON THE

WORLD HERITAGE LIST 2010

"For the good of mankind and to end all world wars"

Commodore Ben H. Wyatt, military governor of the Marshall Islands, March 1946

JANUARY 2009

“mankind’s destiny is being decided today—now—this moment”

Albert Einstein, May 1946

Operation Crossroads Baker test, July 25, 1946 at Bikini Atoll (National Nuclear Security Administration, 1946)

“A peace enforced through fear is a poor substitute for a peace maintained through international cooperation based upon agreement and understanding. But until such a peace is brought about, this nation can hope only that an effective deterrent to global war will be a universal fear of the atomic bomb as the ultimate horror in war.”

Report of the Joint Chiefs of Staff,
Operations Crossroads, June 30, 1947

“Shall we put an end to the human race; or shall mankind renounce war? …There lies before us, if we choose, continual progress in happiness, knowledge and wisdom. Shall we instead, choose death, because we cannot forget our quarrels? We appeal, as human beings to human beings: Remember your humanity, and forget the rest.”

Russell-Einstein Manifesto, July 1955

Contents

List of Figures

List of Maps

Annexes

From the Senator for the People of Bikini

We, the representatives of the people of Bikini Atoll, are proud to endorse the nomination of Bikini Atoll to the World Heritage Centre for consideration by the World Heritage Committee.

We welcome the World Heritage process as an opportunity for the dramatic events at Bikini Atoll to be remembered. The experience of nuclear testing, the displacement of our people from our homeland and the devastating contamination of our country is a story that has been repeated in many places around the world including Australia, French Polynesia, Algeria and Kazakhstan. As a World Heritage site, Bikini Atoll will forever tell the story of this period of human history.

We wish also for the world to remember the role of our tiny atoll in the global politics of the 20th Century - for the role of the Bikini tests in the start of the Cold War and the nuclear arms race.

We, the people of Bikini, will always remember Bikini Atoll as our beloved homeland and will always feel pain for what we have lost. As a World Heritage site, Bikini Atoll will remind all of us, around the world, of the need for global peace and the elimination of weapons of mass destruction. Bikini Atoll may then actually fulfill the promise for which we reluctantly left our homeland, more than 64 years ago, "for the good of mankind and to end all world wars."

In support of this nomination and the ongoing protection and management of Bikini Atoll, the community will move to establish the Bikini Atoll Conservation Management Board and undertake to develop the resources and partnerships required to effectively implement the Bikini Atoll Conservation Management Plan. We will make every effort to tell the story of Bikini to visitors, to people around the world, and most of all to our children – "for the good of mankind"—and may we never forget.

Sincerely,

Hon. Tomaki Juda

Senator for the People of Bikini

Executive Summary

State Party

Republic of the Marshall Islands

State, Province or Region

Bikini Atoll

Name of Property

Bikini Atoll

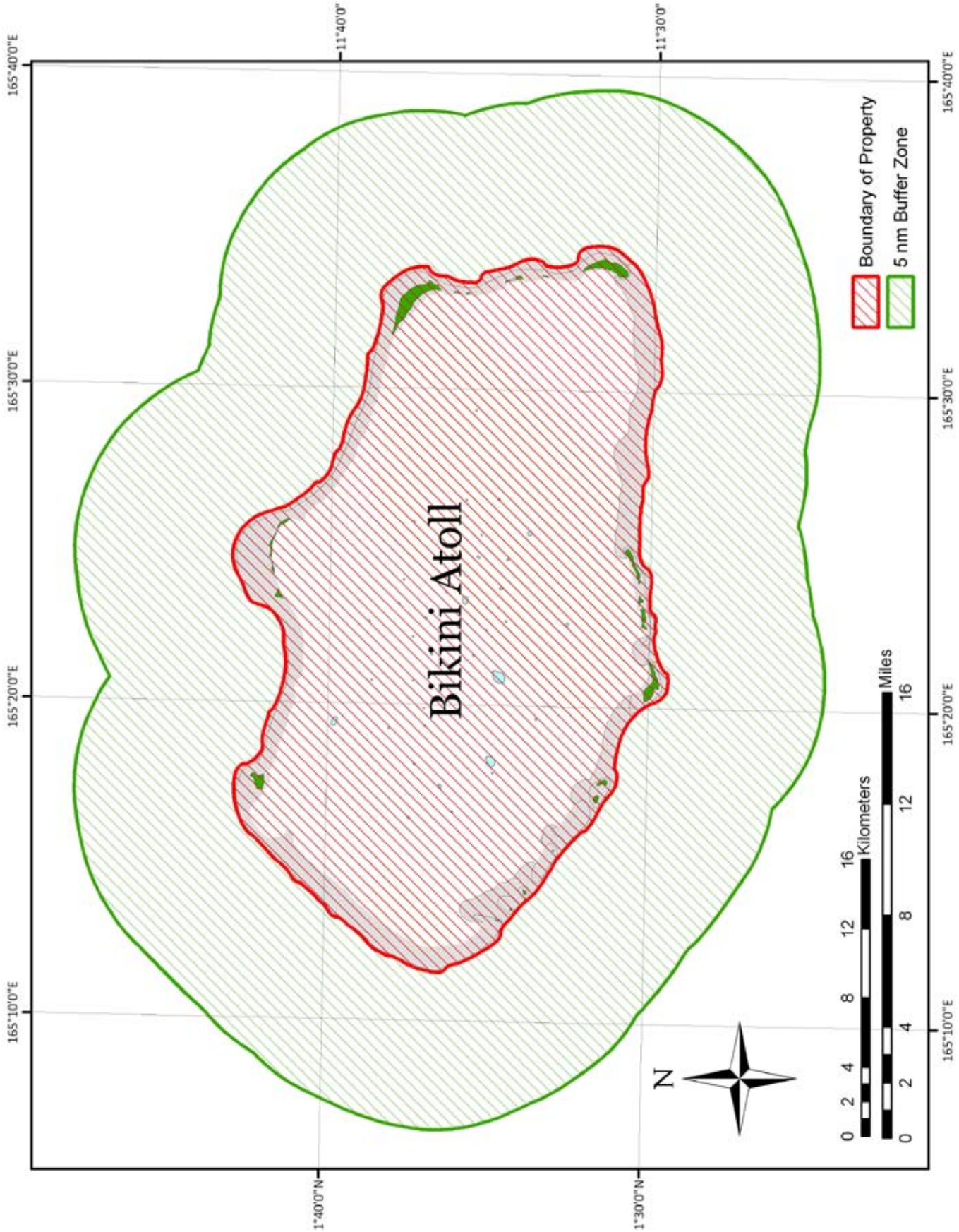
Geographical coordinates

UTM Coordinates N 11˚36'0" E 165˚22'50" (approximate centre of the property).

Textual description of the boundaries of the property

The property includes the lagoon, all islets and reefs of the atoll. The boundary is on the oceanward side of the atoll at the territorial baseline, being defined as a line connecting the seaward ocean shorelines of all islands at a depth of mean lower low water. The buffer zone consists of the surrounding seas extending five nautical miles seaward of the territorial baseline.

A4 size map of the nominated property showing boundaries and buffer zone



Statement of Outstanding Universal Value

Nuclear bomb tests at Bikini Atoll shaped the history of the people of Bikini, the history of the Marshall Islands and the history of the entire world. Bikini Atoll is distinctly 20th century heritage, standing testimony to the dawn of the nuclear age, the start of the Cold War and the era of nuclear colonialism – stages in human history of global significance.

Bikini Atoll is an outstanding example of a nuclear test site. The entire landscape and seascape of Bikini testifies to its history as a nuclear test site, from the ensemble of sunken ships and the purpose-built bunkers, to the disappeared islands and the Bravo crater. The lonely rows of coconut trees, placed in preparation for a failed resettlement, and the conspicuous absence of humans speak to the fate of a nuclear test site rendered uninhabitable.

Bikini Atoll stands as a monument and memorial to the dawn of the nuclear age. At Bikini, the quintessential tropical paradise, beloved by our modern culture as a place of peace and simplicity, is juxtaposed with the artifacts of nuclear bomb testing, evoking a remembrance of a time of lost innocence—when men held and wielded a power reserved for gods.

Bikini Atoll played host to events of global significance which are illustrated in the landscape and seascape. The sunken vessels bear witness to Operation Crossroads—the first peacetime atomic bomb tests, implicated in the start of the Cold War. The Bravo crater is evidence of the Castle Bravo test—the first deliverable hydrogen bomb, and the event that introduced the world to fallout. Aside from the bombs dropped on Hiroshima and Nagasaki, few, if any, other nuclear weapons events have had this scale of impact on the world.

The process of nuclear colonialism around the world is exemplified by Bikini, from the selection of Bikini as a remote site, distant from the population of the testing nations, to the representation of Bikini as a *terra nullius*, to the displacement of the Bikinians and the irradiation of Marshallese and military personnel. Bikini was the first site of nuclear colonialism and remains the outstanding illustration of this significant stage in human history.

Ideas and beliefs of outstanding universal significance are directly and tangibly associated with Bikini Atoll. Emanating from this narrow circle of tiny islands in the middle of a vast ocean is a myriad of symbolism that has permeated our global culture, including the universally recognized and understood mushroom cloud, the bikini swimming costume, and the radioactive pop-culture icon, Godzilla. The breadth, diversity and global significance of Bikini's symbolic reach is evidenced in the innumerable works of art, music, film and literature that have been touched and inspired by the events at Bikini, illustrating the profound impact of events at Bikini on the global culture and psyche.

Events at Bikini led directly to the creation of political and ideological movements that have shaped global society in the second half of the 20th century, mostly connected with the Castle Bravo test on March 1, 1946. The return of the irradiated *Daigo Fukuryū-Maru* and her ill crew in March 1946 led to the momentous "Suginami" petition, which in turn led to the establishment of Gensuikyo: the Japan Council Atomic and Hydrogen Bombs, an enormously significant mass movement in Japan. The Bravo shot led Albert Einstein and Russell Bertrand to write the Russell-Einstein Manifesto, which in turn led to the establishment of the Pugwash movement of influential scholars and public figures concerned with reducing the danger of armed conflict and seeking cooperative solutions for global problems. The anniversary of the Bravo test continues to be celebrated as "Bikini Day" in Japan, and as the "Nuclear Free and Independent Pacific Day" throughout the Pacific.

Criteria under which property is nominated

Bikini Atoll is nominated as a cultural site against criteria (iv) and (vi) as set out in Paragraph 77 of the *Operational Guidelines for the implementation of the World Heritage Convention,* that it:

> (iv): be an outstanding example of a type of building, architectural or technological ensemble or landscape which illustrates (a) significant stage(s) in human history; and
>
> (vi): be directly or tangibly associated with events or living traditions, with ideas, or with beliefs, with artistic and literary works of outstanding universal significance.

Name and contact information of official local institution

Managing Institution

Kili-Bikini-Ejit Local Government
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Part 1. Identification of the Property

1.a State Party

Republic of the Marshall Islands

1.b State, Province or Region

Bikini Atoll

1.c Name of Property

Bikini Atoll

1.d Geographical coordinates

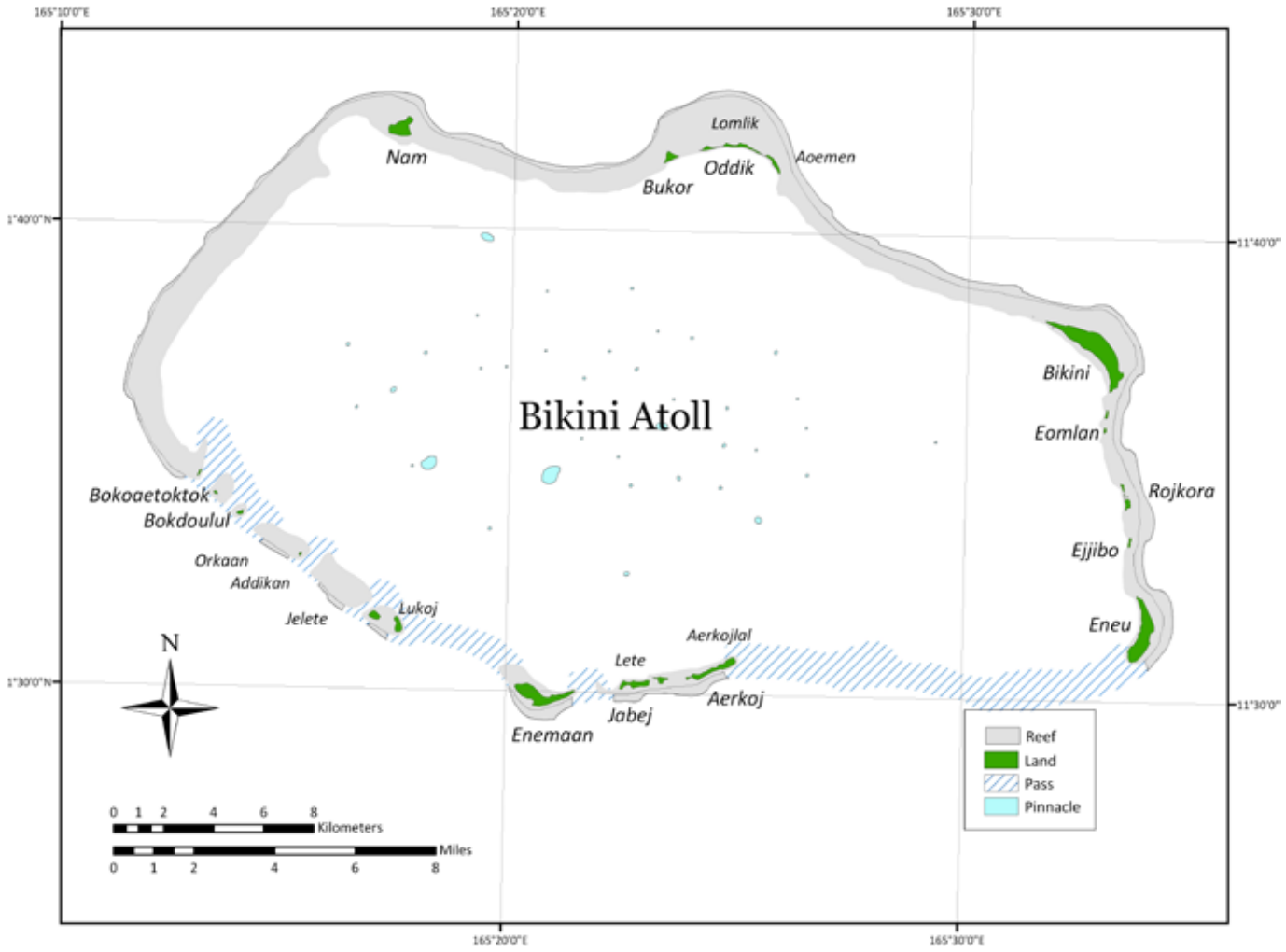
UTM Coordinates N 11˚36’0” E 165˚22’50” (approximate centre of the property).

1.e Maps and plans, showing the boundaries of the nominated property and buffer zone

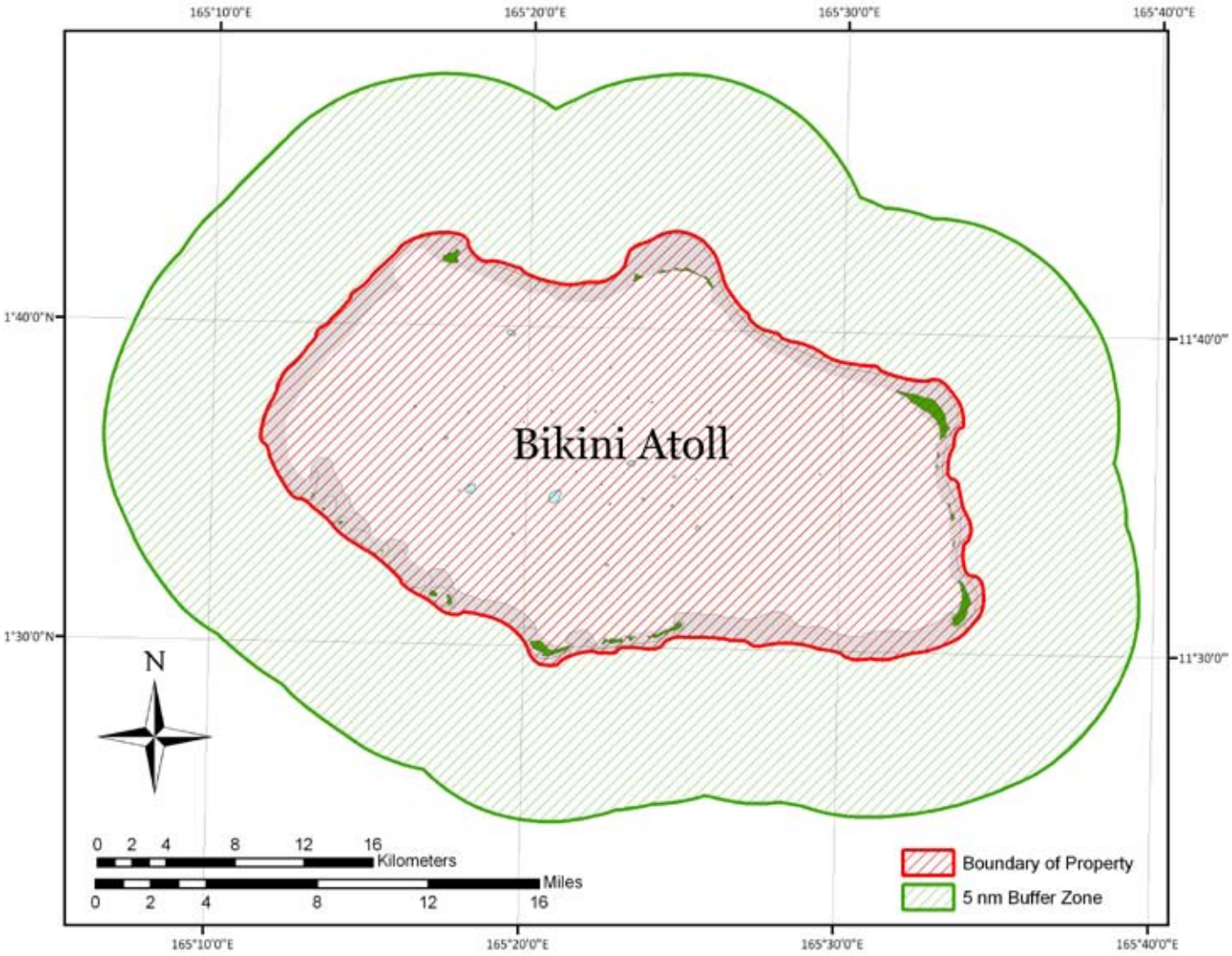
A4 size copies of these maps are attached in Annex 1, and are included in jpeg and pdf form on the accompanying DVD.

1.e.(i) Map of Bikini Atoll showing reef and land

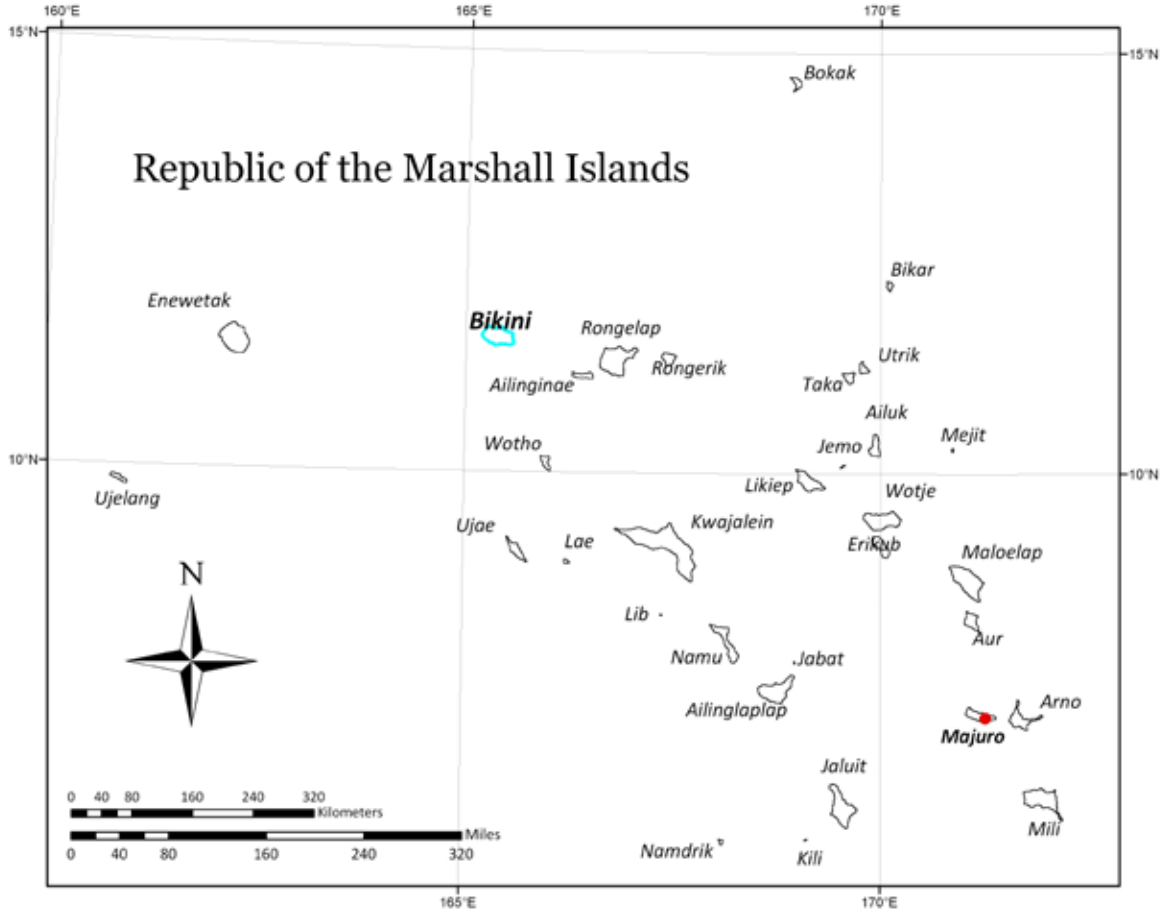
(Note: a topographical map is not available as all land is below about 2m above sea level).



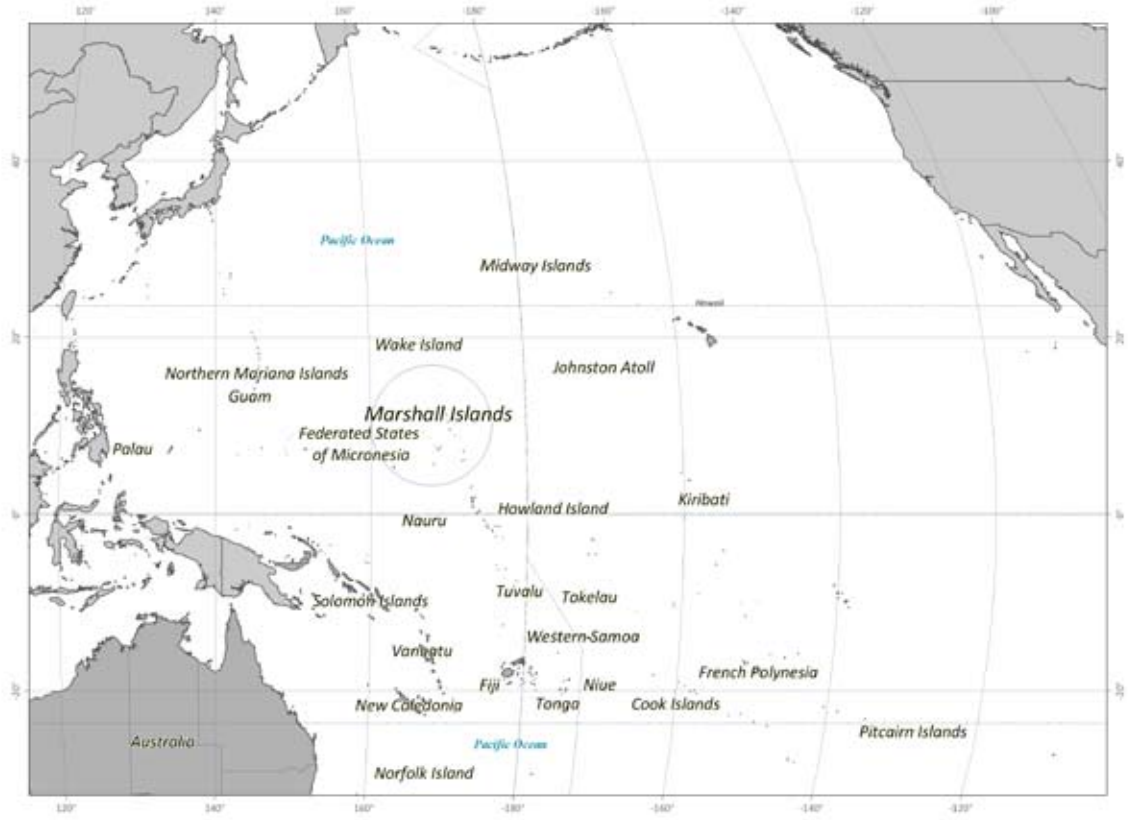
1.e.(ii) Map of Bikini Atoll showing boundary of property (red) and of buffer zone (green)



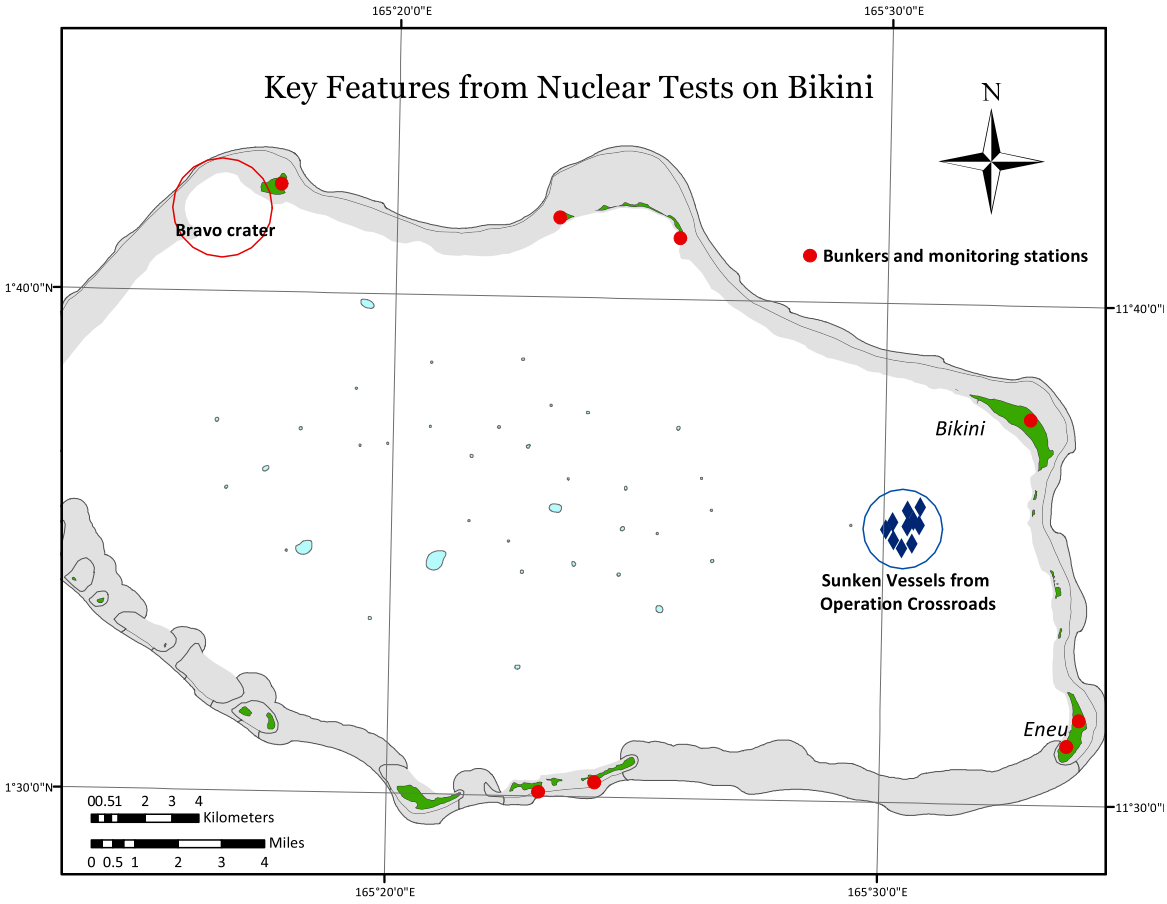
1.e.(iii) Map showing the location of Bikini Atoll within the Marshall Islands



1.e.(iv) Map showing location of the Marshall Islands in the Pacific region

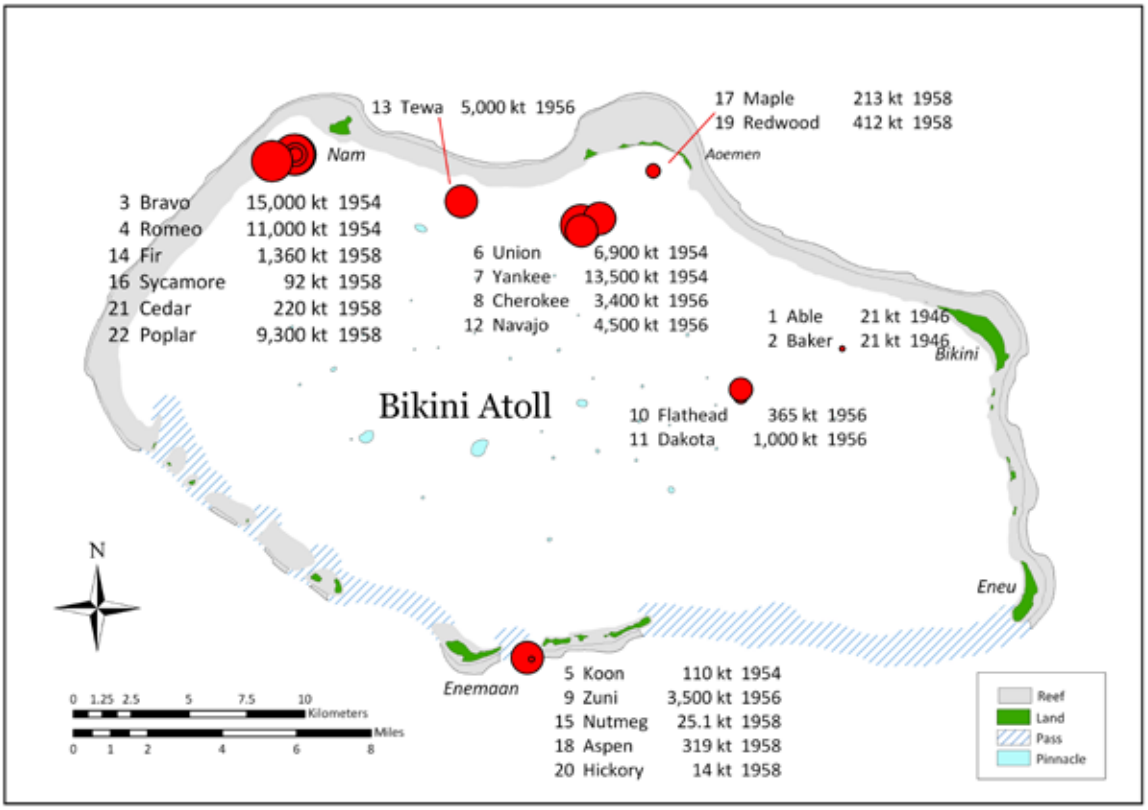


1.e.(v) Map showing locations of key features from nuclear tests on Bikini Atoll



1.e.(vi) Map showing locations of nuclear detonations on Bikini Atoll

(Source of data on location of detonations: Noshkin et al., 1997)



1.f Area of nominated property and proposed buffer zone

Area of nominated property: 73,500 ha.

Buffer zone: 130,425 ha.

Total: 203,925 ha. (2,039 square kilometers or 787 square miles)

Part 2. Description

2.a Description of Property

Forgotten by the world, and isolated in the mid-Pacific, a tiny island bears witness to survival, and to loss. It recalls the innocence of another age. This is Bikini; a coral atoll in Micronesia. It is the home of a people whose lives were destined to be changed. For in 1946 they were banished from it, their peaceful lagoon filled with warships… It was the beginning of the atomic age.

(Livingston & Rawlings, 1992)

Bikini Atoll played host to astounding spectacles, the facts and the myths of which were to change life in the 20th century forever. Despite being the stage for enormous displays of destructive power, Bikini Atoll today has a remarkable beauty and sense of peace. A ring of tiny, low-lying islands bordered by sweeping white-gold beaches and covered in lush green vegetation and swaying palm trees surround a lagoon of invitingly warm turquoise waters. It is one of the images treasured by modern culture—the untouched, wild, desert island.

Upon closer inspection, however, this island paradise bears deep and dramatic scars from the testing of twenty-three nuclear weapons by the United States of America. Today, the remains of crumbling grey concrete bunkers and monitoring stations emerge incongruously from the vegetation reclaiming the islands. A gaping hole a mile wide on the north-western side of the atoll reminds us where the world's first deliverable hydrogen bomb, code-named Castle Bravo, destroyed three islands before its fallout covered eighteen thousand square kilometers (seven thousand square miles) of the Pacific Ocean.

The lagoon is home to spectacular, very large branching *Acropora* and other corals, arrays of multi-colored fish, sponges and giant clams. A reef of remarkable health and richness of species, hovering and gliding seabirds and significant populations of rare and endangered animals, including sharks and turtles, exist here largely free from human disturbance.

Beneath the waters of Bikini lie sixteen sunken naval vessels, the evocative remnants of the Operation Crossroads tests. "Eerily perfect" (Davis, 2005, p. 616) rows of coconut trees cover the larger islands, speaking to the failed resettlement of the people of Bikini. What cannot be seen, although they can be measured, are the invisible and persistent radioactive elements in the soil, plants and animals of Bikini.

At one time the cherished and idyllic home to less than two hundred Bikinians, the beautiful and productive atoll witnessed the comings and goings of tens of thousands of military personnel, enormous quantities of machinery and equipment, and the detonation of weapons of massive destructive capacity. Bikini has now been largely abandoned: "The atoll has the air of a house long unoccupied, but also the feel of an old battlefield, of great events that once were" (Weisgall, 1994, p. 315). The site, as it stands today, eloquently illustrates the fate of a nuclear test site. The entire property of Bikini Atoll—the technological ensemble of sunken ships, along with the various bunkers, the craters and disappeared islands, and the conspicuous absence of people—stands as testimony to a significant stage in human history that encompasses nuclear colonialism, the start of the Cold War and the age of nuclear weapons.

2.a.(i) Geography of Bikini Atoll

Bikini Atoll is the northern-most atoll in the western, *Ralik*, chain of atolls—one of 29 low-lying coral atolls that rise over 6,000 meters from the abyssal plain to no more than a couple of meters above sea level, and comprise the Marshall Islands, known to the Marshallese as *Aelōñ Kein.* The atolls consist of biotic limestone on a deep basalt core, built over millions of years by living coral organisms that grew as the basalt core slowly subsided, creating a marine environment extremely rich in productivity, diversity and complexity.

The entirety of the Marshall Islands lies in the central-western part of the Conservation International Polynesia-Micronesia Hotspot (Conservation International, 2007) and the northern Marshall Islands form the Key Biodiversity Area, Kabin Meto (Conservation International, 2004). Bikini Atoll lies in this drier, northern part of the Marshall Islands. Air and water temperatures hover around 28 degrees Centigrade (82 Fahrenheit) year round, varying little from this. Annual rainfall is an average of 1500mm (60 inches).

Bikini's 23 islands, a total land area of only 720 hectares (1780 acres) encircle an elongated and irregular lagoon which extends 40 kilometers (26 miles) long, east to west, 22 kilometers (15 miles) wide, north to south, and is around 60 meters (200 feet) at its deepest. Most of these islands are joined by a shallow reef, with several deep channels on the southern side of the lagoon. Eneu Channel, the largest, is 15 kilometers (9 miles) wide. Most of the islets on Bikini are small; Bikini Island is the largest with a total area of 212 hectares (524 acres) and Eneu the next largest at 115 hectares (284 acres).

2.a.(ii) Man-made features

The Bravo crater

Originally there were 25 islands around the reef of Bikini, but three of these in the north-west of the atoll—Bokonijien, Aerokojlol and part of Nam—were destroyed by the Bravo shot in 1954. While there are other craters around the atoll at the sites of detonations, the Bravo crater—at over 2 km wide (over a mile wide) and 80 meters (250 feet) deep—is the most obvious physical scar on Bikini (see Figures 1 and 2).

Figure 1. An aerial view of the Bravo crater (E. Hanauer, 2006) (above)

Figure 2. Satellite Image of Bikini showing the Bravo crater (center left of image) in the north-west corner (Google Earth, 2008) (right)

The sunken vessels

Five kilometers from Bikini Island, in 60 meters of water, lies the *Saratoga,* victim of Bikini's second bomb, Crossroads Baker. Upright on the lagoon floor, her mast-top sits just below the surface. Three Helldiver planes and an Avenger torpedo bomber sit on her deck, with 500 pound bombs stacked on nearby racks and her anti-aircraft guns facing skyward. Nearby lies the flagship of the Japanese fleet, the *Nagato*—the scene of operational planning for the attack on Pearl Harbor. These are but two of the ten ships and several lesser vessels that were sunk directly as a result of Crossroads Able and Baker tests, comprising the most prominent remains of the nuclear testing on Bikini. As leading maritime archaeologist, Delgado (1991), describes:

> The ships assembled at Bikini for Operation Crossroads and sunk in the tests represent 34 years of naval design and development , from the oldest ship, *Arkansas*, built in 1912, to the newest, ARDC-13, which was rushed to completion in March 1946. These vessels, as the test planners intended, reflect a range of ship types, construction methods, and hull forms and in total represent in microcosm many of the elements of a typical naval force, with an aircraft carrier, battleships, cruisers, destroyers, submarines, attack transports, and landing craft. Some of these vessels, such as USS *Anderson*, are the sole surviving intact representatives of specific classes of ships… Most ships now sunk at Bikini also had significant World War II careers including roles in major engagements and battles—the Bismarck breakout, Pearl Harbor, the Battle of the Coral Sea, Midway, the Aleutians campaign, the Battle of the Solomons, the Battle of the Philippine Sea, and the Battle of the Leyte Gulf—and represent some of the better known and significant aspects of the war at sea such as wolf pack attacks in the submarine war of attrition against Japan, the seaborne line of supply and replenishment, shore bombardment, kamikaze attacks, and the development of the fast carrier task force. (Delgado et al., 1991, p. 143)

Figure 3. View of part of the *Saratoga* wreck (E. Hanauer, 2006)

Figure 4. Bridge of the *Saratoga* (E. Hanauer, 2006)

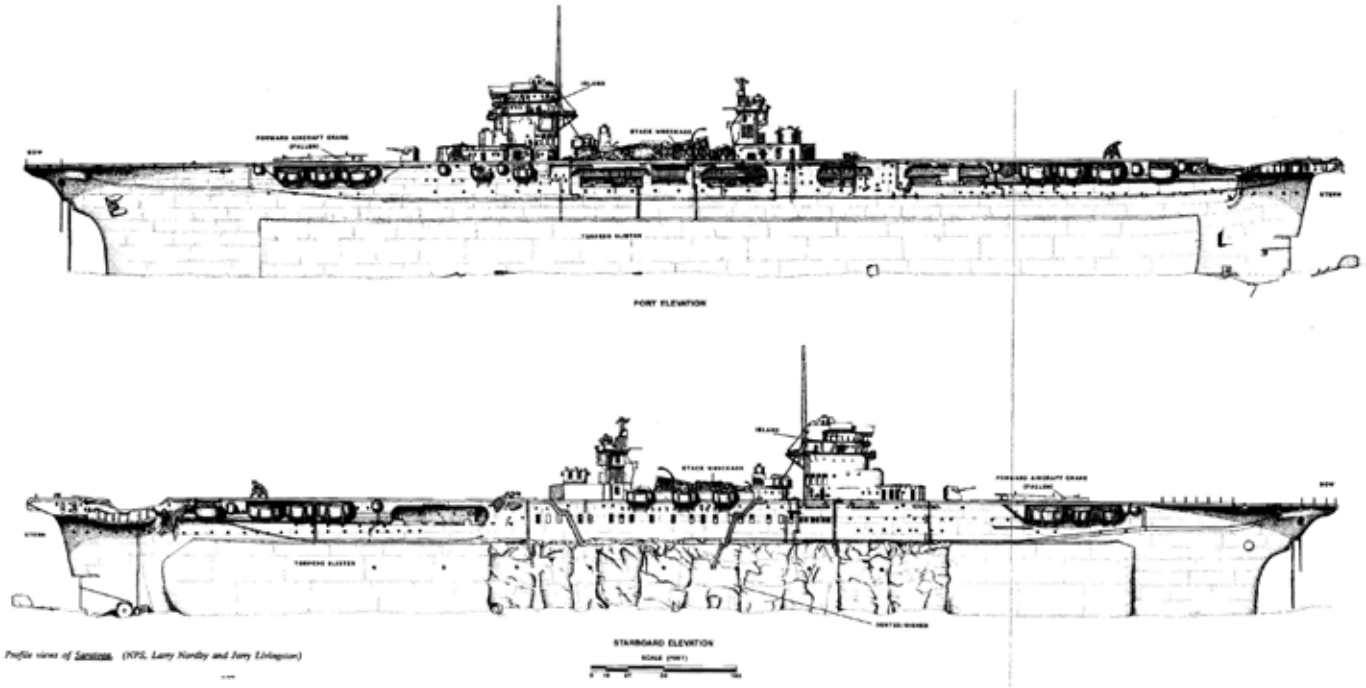
Most of these vessels lie in their original deposition, clustered in and around the shallow crater formed by the Crossroads Baker test of July 25, 1946. All exhibit structural damage from the Crossroads tests, as can be seen in the drawings of the plate damage on the *Saratoga* in Figure 7, and in the photos of the damage of ships after the blasts in Figures 5 and 6. A remarkable assemblage of war technology, nine of these ships are accessible to divers, forming the basis of a small-scale tourism operation and one of the most sought-after diving experiences in the world. It is a unique aesthetic experience to observe the slow reclamation by nature of the once-sleek warships resting here—their smooth grey surface now replaced by a patina of gloriously colored algae, sponges and corals—while sharks, turtles, groupers and myriad fish and other animals make their home in these wrecks.

The global significance of these ships is not in their role in the development of naval technology nor in their World War II actions, but in their role as test instruments for atomic weapons. As Delgado explains, "each of these vessels passed over a threshold at the 'crossroads' between conventional and nuclear warfare, as did the world that had built and manned them" (Delgado et al., 1991, p. 144). The significance of the ships is further discussed in Part 3.

Figure 5. Ship showing structural damage from the Crossroads tests (Bob Landry, 1946, Time Inc.)

Figure 6. Damage from the Crossroads tests on the USS *Independence* (Fritz Goro, 1947, Time Inc.)

Figure 7. Elevation drawing of the sunken *Saratoga* showing damage to the platework on the starboard side (L. Nordby and J. Livingston in Delgado et al., 1991, p. 107-108)



Major vessels sunk during the "Able" test of July 1, 1946

Destroyer USS *Anderson*
Destroyer USS *Lamson*
Attack Transport USS *Gilliam*
Attack Transport USS *Carlisle*
Cruiser HIJMS *Sakawa*

Major vessels sunk during the "Baker" test of July 25, 1946

Aircraft carrier USS *Saratoga*
Battleship HIJMS *Nagato*
Battleship USS *Arkansas*
Submarine USS *Apogon*
Submarine USS *Pilotfish*

Box 1. Major vessels sunk at Bikini Atoll during Operation Crossroads

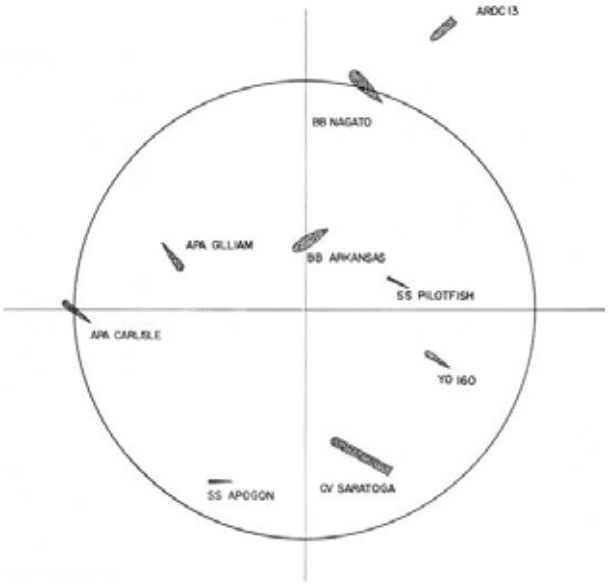


Figure 8. Actual positions of the sunken ships in or near the crater formed by the Crossroads Baker test, as plotted by the US Navy in 1989 (R. Jackson in Delgado et al.,1991,p. 84)

Bunkers and buildings

On Eneu Island of Bikini Atoll there are two structures from the testing period: the remains of the concrete Communications Station, where the officials stationed on Bikini would call the President of the United States requesting permission to go forward with the various nuclear tests, and also the concrete Monitoring Bunker from where the tests were viewed by the US military. In the late 1980s the local government decided to tear down the Bomb Assembly Building because it was in very poor condition.

On Bikini Island there is a small bunker at the back of the island that was used for storage and also communications. On several of the outer islands of Bikini Atoll there are concrete monitoring stations that are still intact. These stations can be found on Aerkoj, Aerkojlol, Enemaan, Nam, Bukor, and Aoemen.

Figure 9. Monitoring bunker on Bikini Island (E. Hanauer, 2006)

Other buildings

More recent construction was carried out to develop facilities for tourism on Bikini. Also on Eneu Island there is a crushed coral runway that allows for the landing of aircraft ranging from large propeller planes to small Lear jets. Eneu Island has a small airport terminal, several warehouses, crew quarters, a pier and dock, repair shops, a power plant, and several unfinished buildings that at one time were intended to be utilized for tourism until it was decided by the Local Government Council to use Bikini Island to accommodate tourists.

On Bikini Island there are two buildings used to house tourists that are situated along the beach, a large structure utilized as a dining hall and warehouse for supplies, a dive shop and tank filling station, a garage that also houses a water-making complex, a TV/briefing room and office used for the tourism program, several buildings used by the US Department of Energy for their ongoing monitoring program, a dock facility, a fuel farm, a power plant, and several buildings used as repair shops for routine maintenance work on the facilities.

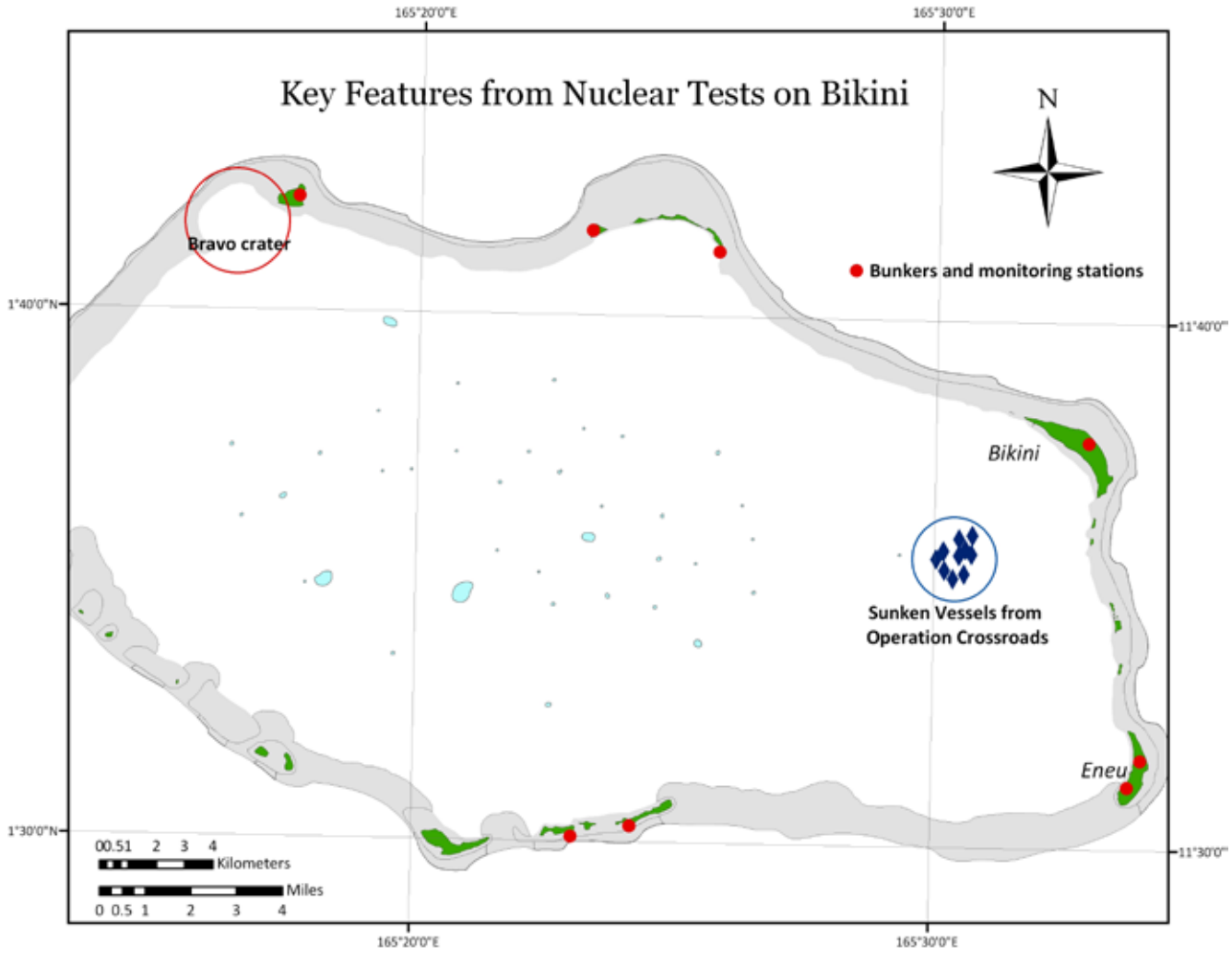


Figure 10. Map showing key features from the nuclear testing: the Bravo crater, the locations of bunkers and monitoring stations and the ships sunk during Operation Crossroads

Radiation

The International Atomic Energy Agency's (IAEA) Bikini Advisory Group preliminary findings issued in 1996 contain the following statements with regard to background radiation on Bikini:

> It is safe to walk on all of the islands...The Advisory Group reaffirmed: although the residual radioactivity on islands in Bikini Atoll is still higher than on other atolls in the Marshall Islands, it is not hazardous to health at the levels measured. Indeed, there are many places in the world where people have been living for generations with higher levels of radioactivity from natural sources—such as the geological surroundings and the sun--than there is now on Bikini Atoll...By all internationally agreed scientific and medical criteria...the air, the land surface, the lagoon water and the drinking water are all safe. There is no radiological risk in visiting the lagoon or the islands. The nuclear weapon tests have left practically no cesium in marine life. The cesium deposited in the lagoon was dispersed in the ocean long ago.
>
> The main radiation risk would be from the food: eating locally grown produce, such as fruit, could add significant radioactivity to the body... Eating coconuts or breadfruit from Bikini Island occasionally would be no cause for concern. But eating many over a long period of time without having taken remedial measures might result in radiation doses higher than internationally agreed safety levels. (quoted in Niedenthal, 2002, pp. 162-163)

The majority of radionuclides[1] produced in nuclear weapons testing are short-lived, so radiation on Bikini was most severe in the few days following a testing event. Radionuclides of concern at Bikini today include residual concentrations of cesium-137 (^{137}Cs, half-life 30 years), strontium-90 (^{90}Sr, half-life 28 years), and, to a lesser extent, plutonium-239 (^{239}Pu, half-life 24,100 years), plutonium-240 (^{240}Pu, half-life 6,560 years), and americium-241 (^{241}Am, half-life 433 years). The cesium-137 radiation burden on Bikini is about 160 times the usual expected from globally-deposited fallout, and in some parts of the atoll it could vary up to 1000 times the expected background level due to heterogeneous fallout deposition (Hamilton & Robison, 2004).

Various reports on the radiological conditions of Bikini point out that there are places in the world where people have lived for many generations with higher levels of environmental radiation from natural sources. However, during predictive human dose assessments on Bikini by the Lawrence Livermore National Laboratory (LLNL) in the 1980s, it was realized that "the most significant pathway for human exposure to *residual* fallout contamination in the Marshall Islands was ingestion of ^{137}Cs present in locally grown foods such as coconut, breadfruit, and pandanus" (Hamilton & Robison, 2004, p. 5). The reason that this particular pathway is significant is that coral atoll soil is potassium-poor, and so plant uptake of the chemically-similar cesium is higher than on continental soils. As part of this finding, the application of potassium fertilizer was found to be effective in reducing the cesium-137 uptake in plants, and large-scale field experiments were established on Bikini.

Radiological assessments have focused on the potential for resettlement on Bikini. The recommendations consistently state that if rehabilitation of the land by a combination of soil-scraping and application of potassium were carried out, and if food were a mixture of imported food and locally grown, then people could live safely on Bikini, subject to radiation doses higher than the average, but lower than many populated areas in the world (Lokan et al., 1998; Hamilton & Robison, 2004).

1 A "radionuclide" is an unstable form of a chemical element that decays spontaneously, emitting radiation.

2.a.(iii) Natural environment

The natural environment is discussed in some depth here although at this time Bikini is being nominated as a cultural site (and not as a cultural landscape or a mixed site). The natural environment of Bikini and its condition form an integral part of the part of the landscape and seascape comprising the nuclear test site. What is especially remarkable is the recovery of the marine environment to a healthy and diverse ecosystem, and the ecological processes in play as a direct result of the bomb detonations. It is thought that research on the attributes of the marine environment, discussed below, is of enormous value to science and, in the future, may constitute a justification for nomination of Bikini under criterion *(ix): be outstanding examples representing significant ongoing ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals*.

The Bikini property is a holistic single atoll system surrounded by open ocean. The location provides natural isolation from neighboring systems and from human intervention. This provides sufficient size for the ongoing functioning of the natural systems. While the terrestrial environment has been significantly disturbed, the marine environment reef system has a very high biodiversity, showing the range of species—including endemic biota, apex predators (sharks) and migratory species such as turtles—that demonstrate the system is functioning well. In addition, there are increasing numbers of birds, probably due to the absence of human hunting pressure.

Marine environment

Bikini Atoll presents an excellent example of the ongoing ecological and biological processes in the development and evolution of coral reefs, demonstrating an impressive recovery of corals and marine life after repetitive human intervention and modification through nuclear blasts. The study of this is of significant interest to science for understanding the impact on marine ecosystems following major disruption and the subsequent processes of recovery of these ecosystems.

The Bravo crater resulted from three islands being pulverized and millions of tons of sediment and carbonate being airborne and subsequently suspended, transported and deposited. While this extraordinary disturbance event was devastating for reefs directly impacted, it created new lagoonal space and new opportunities for reef development and colonization. A coral biodiversity study conducted at Bikini in 2002 presents stunning evidence of the recovery of coral reefs in the Bravo crater five decades after the event (Richards et al., 2008). One of the most profound aspects of the Bravo crater site is the occurrence of huge thriving matrixes of branching coral. The coral clearly colonized the site after the bombing ceased, and it is suggested that through time, as more calcifying organisms inhabit the microhabitat provided by the branching (*Porites cylindrica*) coral, the reef will solidify to eventually form the consolidated patch reef that is typical of lagoonal habitat found elsewhere. In this way, Bikini Atoll, and particularly the Bravo crater site, provides a superb example of early succession and the development of reef structure.

In providing a rare opportunity to examine the long-term impacts of nuclear testing on coral biodiversity in-situ, Bikini also offers science an opportunity to understand the resilience, or capacity for biodiversity to persist after disturbances of coral reefs—crucial information for devising appropriate management actions to mitigate biodiversity loss. Current records of long-term or large-scale resilience to disturbances are scant. There are few opportunities to study large-scale impacts and long-term recovery because most disturbances are cumulative and on-going. Bikini Atoll provides an opportunity to investigate biodiversity resilience in-situ because the disturbance to the reef system was acute and there have been minimal subsequent anthropogenic or natural disturbances since the testing ceased.

There is growing concern about the insidious effects of enhanced greenhouse gas concentrations on ocean chemistry (Feely et al., 2004). The ability for organisms to calcify is decreased and the ability for reefs to form and maintain their structure in increasingly acidic environments is compromised. Our understanding of the full range of consequences of changing ocean chemistry is extremely limited at present, hence the reef structures in the Bravo crater provide an unparalleled opportunity to document the geological processes of reef development under the current and forecasted future sub-optimal oceanic conditions in the absence of other anthropogenic impacts.

Figure 11. Scientist Zoe Richards collects samples of coral in the Bravo crater at Bikini (S. Pinca, 2002)

In addition to its value for understanding coral reef ecosystem function, the marine environment of Bikini is home to many species that are threatened or depleted in the rest of the world, including coral species, giant clams, turtles and sharks. Recent red-listing of Scleractinian coral species revealed alarming results with one-third of reef-building corals threatened with extinction (Carpenter et al., 2008). Approximately 50 of the 183 species of coral recorded at Bikini Atoll (Richards et al., 2008) fall within an IUCN threatened category. Given that Bikini Atoll reef ecosystems are relatively pristine (Pinca et al., 2002) in comparison to reefs occurring in more populated regions, Bikini provides some of the most significant reef habitat in the northern Pacific and, in effect, a refuge that may support the recovery in other more heavily impacted parts of the world such as South East Asia. Today, Bikini Atoll is the type locality of two species of coral (*Acropora vaughnai* and *Acropora palmarae*). Surveys of coral biodiversity carried out in 2002 (Richards et al., 2008) revealed that eleven species of coral occur at Bikini Atoll despite never before being recorded in the Marshall Islands. Four of these species are considered, on current records, to be regionally restricted to Bikini Atoll–*Acanthastrea hillae*, *Acropora bushyensis*, *Montipora cocosensis* and *Polyphyllia talpina*. Two species (*Acanthastrea brevis* and *Montastrea salebrosa*) were found to be locally abundant and distributed widely at Bikini Atoll, indicating that Bikini Atoll provides significant habitat for the conservation of these species.

Figure 12. Giant branching acropora have reestablished in the Bravo crater (S. Pinca, 2002)

The rare and threatened species of giant clam *Tridacna gigas* appeared to be particularly abundant in Bikini lagoon compared to many other atolls of the Marshall Islands. This species is literally disappearing from the Pacific region and is found freely growing in Bikini as well as in the nearby atolls of Rongelap and Ailinginae. The locations where it was mostly found in Bikini are the lagoonal sites in the northwest (near the Bravo crater) and central northern areas (in front of Aomoen Island). At this latter site, many *Hyppopus hyppopus* giant clams are similarly found (Pinca et al., 2002).

Pinca et al. (2002) found very high diversity of fish fauna at Bikini (species richness is 359) due to the high variability of habitats offered by lagoon, pass and ocean environments. The southern and eastern walls of Bikini sustain a high biomass of carnivores (*Lutjaunidae, Lethrinidae, Sphyraenidae, Carangidae*), while the lagoon is rich in invertebrate feeders and herbivores (*Mullidae, Ephinephelidae, Caesionidae*) (Pinca et al., 2002).

Figure 13. Gray reef sharks at Shark Pass on Bikini Atoll (M. Harris, 1999)

One special characteristic of Bikini that differentiates it from other atolls in the Marshalls and from many reefs in the world is the particularly high concentration of several shark species that are considered threatened, including gray reef shark (*Charcharhinus amblyrhyncos),* reef whitetip shark (*Trienodon obesus),* reef blacktip shark *(C. melanopterus)* and silvertip shark (*C. albimarginatus)*. The highest concentration is found at the so-called Shark Pass in the south where hundreds of *C. amblyrhyncos* swim inoffensively and undisturbed along the inner wall and at the pass itself. Silvertips (*C. albimarginatus*) are in deeper water and more difficult to spot, but they are attracted by the visit of the casual diver and come often to shallower depths. Tiger sharks (*Galeocerdo cuvier*) are also known to inhabit the lagoon of Bikini and to approach the shore at night or to swim by the decompression bars in the middle of the lagoon. The spotted eagle ray (*Aetobatus narinari*) is also a frequent sight in the lagoon waters (Pers. comm.).

The special abundance of sharks at Bikini Atoll is indicative of a healthy and diverse ecosystem. Many studies have proved that top predators are indicators of elevated biodiversity, individual density and ecosystem complexity and productivity (Sergio et al., 2006). A location capable of supporting a dense population of top predators is able to support populations of smaller species.

Vegetation

So dramatic was the impact of testing on the islands that a vegetation survey by Fosberg (1986) in 1985 reported that on all the islands of Bikini "no unaltered vegetation has survived" (p. 2), although the native species have survived. There are several stands of important species on some of the islands, including *Pisonia grandis*, a favorite nesting place for birds, and *Pemphis acidula*, which is a species of cultural importance in the RMI (Reimaanlok, 2008). Fosberg (1986) describes the islands of Eneu and Bikini as dominated by planted coconut palms "on a precisely laid-out 30 foot square grid system" (p. 3). These trees remain untended, and the physiognomy of the plantation varies from tall and luxuriant, with dense undergrowth, to stunted coconut palms with sparse undergrowth. Vegetation on other islands in 1985 showed a mixture of the usual atoll strand vegetation (*Scaevola* and *Tournefortia*) and exotic species. Fosberg (1986) was reluctant to predict the rates of succession and the resulting communities on Bikini Atoll, and there is a need to carry out a vegetation survey to understand how these atoll terrestrial systems have recovered from the testing and associated impacts.

Birds

The impressive feature of Bikini's birds are described by Vandervelde and Vandervelde (2003). Upon arriving on Eneu, one can observe boobies and terns. Mixed flocks of terns feed in front of the resort, but these are insignificant delights compared to visiting the bird nesting grounds on islands in the north and southwest of the atoll. Twenty-six species of birds are documented for Bikini Atoll, including 3 IUCN Red-listed species: Buller's Shearwater (*Puffinus bulleri*), Sooty Shearwater (*Puffinus griseus*) and the Bristle-thighed curlew (*Numenius tahitiensis*). It is thought that the birds of Bikini have benefited from the absence of humans, as they were traditionally eaten by the people of Bikini. The Red-tailed Tropicbird (*Phaeton rubricauda*) now nests on Bikini, but was unknown to Bikinians prior to the testing.

Figure 15. "Eerily perfect" rows of coconut trees (J.S. Davis, 2002)

Figure 14. Aerial view of the rows of coconut trees (Google Earth, 2008)

2.b History and Development

2.b.(i) The formation of Bikini Atoll

The geological development of Bikini is typical of many Pacific atolls, as described by Scott and Rotondo (1983) and Dickinson (2004), with coral reefs growing on a subsiding volcanic island. After volcanic activity ceased in the Miocene period, the rocks cooled and the original island subsided slowly below sea level, and was covered by a thick coral reef. In the Pleistocene (the last two million years) the atoll underwent erosion when exposed by low sea level during ice ages, and reef growth when sea level was close to its present level during warm periods. Drilling at Bikini and Enewetak Atolls showed that the coralline limestone caps on these atolls exceed 1,200 meters in depth, and provided the first subsurface evidence to support Darwin's subsidence theory of atoll formation. Although the form of the atoll is several million years old, the youngest islands only breached the surface between 2,000 and 4,000 years ago, amid a slight lowering of sea-level.

2.b.(ii) First settlement & traditional life on Bikini

In order to understand the significance of the loss of Bikini to its people, it is important to understand the history and traditional life of the Bikinians and the depth of connection to place that had developed over thousands of years and still persists. The lifestyle and culture described here survived largely intact up until the Bikinians left their island in 1946, at which point the way of life for this community was irrevocably changed.

It is thought that people began to populate the Marshall Islands shortly after the emergence of land, between 2,000 and 3,500 years ago (Rainbird, 1994). The oral history of the settlement of Bikini as related by Kilon Bauno (in Niedenthal, 2002) describes the journey of Larkelon, an "iroij" or chief, who brought his people from Wotje Atoll to Rongelap. There they intermarried with the Rongelap people, and then, looking for a new kingdom, sailed on to Bikini. People were already living on Bikini, led by the chief Laninbit. Faced with the bold Larkelon and his many people and canoes, Laninbit conceded the lands and waters of Bikini. Laninbit ordered his people to collect their belongings and in a matter of hours the original Bikinians sailed off to the south, resting only for a short moment on one of the southern islands in the atoll then continuing into the sunset never to be heard from again. It was if the great seas of the earth had swallowed their boats whole, and drowned the entire clan of people. Larkelon triumphantly began his reign as the chief of Bikini (pp. 15-20). Bikinians today trace their lineage directly to Larkelon; "King Juda," the chief at the time of the nuclear testing in 1946, was a direct descendant of Larkelon (Weisgall, 1994, p. 40).

Traditional life on Bikini was much like life elsewhere in the Marshalls and on other Micronesian atolls. Houses were small, simple thatched huts with woven pandanus mats covering the ground. The few tools and utensils were made only from the island's resources: wood, coral, shell and fibers from coconut and pandanus. Bikinians were accomplished seafarers who travelled between islands, and between atolls, in sturdy, double-prowed canoes lashed together from planks of breadfruit trees. These canoes, with an asymmetric hull balanced by an outrigger, are widely considered to be masterpieces of sailing technology. Likewise, fishing was a sophisticated activity using a range of tools from the simple hook and line to nets, traps, spears, clubs, rope and coconut fronds. Some methods involved the participation of many people, and some were practiced by the individual. Fishing was accompanied by complex taboos, procedures and magic chants that integrated the spiritual and social life with the methods for gathering food (Petrosian-Husa, 2004). The Bikinians were skilled agro-foresters, carefully cultivating several varieties of breadfruit and pandanus in the poor atoll soils and often difficult growing conditions. A wide range of plants and associated rituals were used in traditional medicine.

The relative isolation of the atoll created for the Bikinians a tightly integrated society bound together by close extended family association and tradition, where the amount of land you owned was a measure of your wealth. Unlike in the rest of the Marshall Islands, Bikinians identify a chief from among themselves and resist any claims to chief-status from others.

Marshallese traditional life incorporated sophisticated and well-adapted technologies, integrated with a spiritual and social life that was based on the interaction with the natural environment. Bikini Atoll forms the basis of identity for the Bikinians, in the same way that sea and country do for indigenous peoples around the world.

2.b.(iii) European contact, Germans and the copra trade, 16th century to 20th century

Hezel (1983) describes the first recorded contact between Marshallese and Europeans as the landing of the *Florida*, captained by Saavedra, on the islands of "Los Jardines"—thought to be either Bikini or Enewetak Atoll—on October 1, 1529. The meeting was mostly friendly and the islanders greeted the Spanish with

singing, dancing and a feast of fish, breadfruit and coconut. There was an incident where a musket was fired to demonstrate its function to the curious chief, at which "most of the Marshallese flew out of the house and dashed madly through the bush, most of them not stopping until they were in their canoes heading for safe refuge on another part of the atoll" (p.16). Although much of the rest of the Marshall Islands was "discovered" by Gilbert and Marshall in 1788, Bikini was not seen again by Europeans until almost 40 years later, in 1825, when Russian Otto von Kotzebue's ship sighted the atoll from the mast top 11 miles away. Kotzebue named the atoll Eschscholtz after the ship's scientist and doctor—a name that persisted even when the site was announced in the *New York Times* in 1946 as the location chosen for nuclear testing.

Wesigall (1994) records reports of a trading schooner calling at the atoll in 1834, a visit during which it is believed the captain and two crew were murdered, resulting in retaliation by the crew of a sister ship who are thought to have murdered some thirty Bikinians—one-third of the population. The first documented contact between Bikinians and non-Marshallese occurred in 1858 when Chramtschenko, Kotzebue's lieutenant, returned, locating a channel and entering the lagoon of Bikini. In 1957, a year prior to Chramtschenko's visit, American Protestant missionaries arrived on Ebon in the far south of the Marshalls to establish the first mission, having much success as Christianity spread throughout the archipelago. Missionaries did not travel to the northern parts of the Marshalls until much later and it was not until 1908 that a Marshallese pastor arrived to establish the first mission on Bikini.

German copra traders arrived in the Marshall Islands in the 1860s and established a trade centered on Jaluit and Likiep Atolls. Seeing an opportunity to expand colonial power in Micronesia, Germany signed a treaty with a paramount chief for access rights to several ports and, in 1885, declared the Marshalls a German protectorate with the approval of Britain. The fertile atolls in the southern Marshalls were attractive to the traders because they could produce a much larger quantity of copra. Thus, while the Bikinians engaged in a subsistence-level copra trade in order to buy rice, sugar and other goods, no Germans settled on Bikini. Bikinians maintained isolation, had their own dialect and, while people in the southern isles were more actively engaged in the copra trade and adopted western dress, the Bikinians wore traditional coconut and pandanus woven mats and skirts well into the 20th century. A chiefly system of rule had developed in the Marshalls with some chiefs having jurisdiction across several atolls, but Bikini maintained independence from this system until the late 19th century.

Figure 16. Bikinian woman and family prior to 1946 (unknown, n.d.)

Figure 17. King Juda (right), the chief of the Bikinians in 1946 (unknown, 1946)

2.b.(iv) The Japanese, militarization and World War II, 1915-1944

Japan took control of most German holdings in Micronesia at the outbreak of World War I and, in 1919, was awarded the Marshall Islands as a class "C" mandate of the League of Nations. Although fortification and militarization of the islands was banned under the mandate, in the 1930s Japan closed Micronesia to the rest of the world and commenced military build-up throughout the islands in anticipation of World War II. As Niedenthal (1991) explains, "Bikini and the rest of these peaceful, low-lying coral atolls in the Marshalls suddenly became strategic" (p. 1).

The Bikini Islanders' life of harmony drew to an abrupt close when, early in the Pacific conflict, the Japanese decided to build and maintain a watchtower on their island to guard against an American invasion of the Marshalls. Throughout the war the Bikini station served as an outpost for the Japanese military headquarters in the Marshall Islands at Kwajalein Atoll. Life under the Japanese military was difficult; young men were sent

to school to learn Japanese and put to work laboring, and often there were cruel beatings as punishment for resisting the Japanese soldiers ("Japanese on Bikini," 1990).

Toward the end of the war in the Pacific, February of 1944 saw a gruesome and bloody battle in which the American forces captured Kwajalein Atoll, effectively crushing the Japanese hold on the Marshall Islands. The battle involved 40,000 US troops and resulted in 372 Americans and 8,000 Japanese dead. The day after an airstrike aimed at the watchtower on Bikini, an American ship pulled into the lagoon. The five remaining Japanese soldiers, hiding in a foxhole, then killed themselves with a grenade. Bikini was liberated.

2.b.(v) The Nuclear Age arrives 1945-1946

The war in Europe ended on May 8, 1945 with the unconditional surrender of Nazi Germany. From July 16 to August 2, Josef Stalin, Winston Churchill (replaced later by Clement Attlee) and Harry S Truman met in Potsdam, Germany to determine the administration of post-Nazi Germany. The US and Britain were suspicious of Stalin's motives as communist governments had already been installed in the countries under Soviet influence. Not knowing if the Soviets knew about atomic bombs, during this meeting Truman mentioned an unspecified "powerful new weapon" to Stalin—a move widely seen as a subtle warning for the Soviets to regard the United States' might with respect.

During the Potsdam Conference, on July 26, Japan was given an ultimatum by the United States, Great Britain, and China to surrender, or meet "prompt and utter destruction" (Potsdam Declaration, 1945). Japan declared that it would ignore the ultimatum and Truman ordered the atomic bombing of Hiroshima on August 6 and of Nagasaki on August 9, 1945, killing as many as 140,000 people in Hiroshima and 80,000 in Nagasaki. The atom bomb had entered the world. Within a few weeks, Japan had surrendered and the war in the Pacific was over.

Establishment of the United Nations Atomic Energy Commission

Over the coming months a series of meetings was held by the Soviet Union, United States, China, France and the United Kingdom to try to determine peace agreements with defeated nations and settle territorial disputes outstanding at the end of World War II. At the center of this geopolitical maneuvering, particularly between the United States and the USSR, was the question of who owned atomic secrets, and who controlled atomic power. In the December Interim Meeting of Foreign Ministers in Moscow, at the instigation of US secretary of state, James F. Byrnes, it was agreed to establish a "commission to consider problems arising from the discovery of atomic energy and other related matters" under the United Nations (Soviet-Anglo-American Communiqué, 1945). The United Nations Atomic Energy Commission (UN AEC[2]) was established as the very first resolution of the first United Nations General Assembly on January 24, 1946, and called for the "elimination from national armaments of atomic weapons and all other major weapons adaptable to mass destruction" (United Nations General Assembly, 1946).

While American diplomacy was taking these steps, within the United States there was dissent about what to do with nuclear weapons. In 1945 the Americans were unsure how far the Soviets had proceeded in the development of the bomb. Truman considered the Moscow agreement a general commitment only, as his distrust of Stalin deepened. Congress and the public were not ready for an international body to take control of nuclear technology that was currently only in the hands of the United States (Weisgall, 1994, p. 59).

The Cold War begins

> *It is difficult to say precisely when the Cold War began. There were no surprise attacks, no declarations of war, no severing even of diplomatic ties. There was, however, a growing sense of insecurity at the highest levels in Washington, London and Moscow, generated by the efforts the wartime allies were making to ensure their own post-war security.*
>
> (Gaddis, 2007, p. 27)

Several events in the next few months brought tension in post-World War II relations to a head. After the defeat of Japan, Stalin had protested that the Soviet Union was offered little role in the occupation of post-war Japan. On February 9, 1946, in a speech to constituents, Stalin expressed hostility towards capitalism and declared a 5-year plan to double output of iron, steel, coal and oil (1946). On February 12, the Soviets announced that a new communist government had been formed in North Korea (Weisgall, 1994, p. 60), breaking an agreement reached at the Moscow conference the previous December to jointly assist Korea to become an independent democracy (Soviet-Anglo-American Communiqué, December 27, 1945). The next day George F. Kennan sent his famous "Long Telegram" from the

2 The acronym UN AEC is used here to distinguish the United Nations Atomic Energy Commission from the United States Atomic Energy Commission established in August 1946, and also known as the "AEC".

US embassy in Moscow to Washington, describing the Soviet outlook: "Soviet power," he wrote, is "impervious to the logic of reason and highly sensitive to the logic of force" (quoted in Weisgall, 1994, p. 60). This telegram confirmed for Washington the threat of Soviet expansion and galvanized hard-line policy towards Moscow. On March 2, the Soviet Union refused to withdraw troops from Azerbaijan in Iran, an area of "vital strategic and economic importance to the West" (Weisgall, 1994, p. 61), as had been agreed early in the war. Three days later, on March 5, 1946, Churchill delivered his "Sinews of Peace" address, reinforcing that the United Nations organisation was critical to peace, but that:

> It would nevertheless be wrong and imprudent to entrust the secret knowledge or experience of the atomic bomb, which the United States, Great Britain, and Canada now share, to the world organization, while it is still in its infancy. It would be criminal madness to cast it adrift in this still agitated and un-united world.

He further declared that "a shadow has fallen upon the scenes so lately lighted by the Allied victory. Nobody knows what Soviet Russia and its Communist international organization intends to do in the immediate future, or what are the limits, if any, to their expansive and proselytizing tendencies" (Churchill, 1946). Stalin saw this as an ultimatum, describing Churchill as a racist "warmonger" and likening him to Hitler ("Stalin compares," 1999). The Sinews of Peace address is considered by many to be the start of the Cold War.

Is the Navy obsolete? – Operation Crossroads is conceived

Meanwhile in the United States, public opinion expressed in the press and in Congress a "nearly universal belief that the atomic bomb had rendered navies obsolete" (Weisgall, 1994, p. 13). "It does seem to me…that atomic energy has driven ships off the surface of the sea," said Senator Edwin C. Johnson before the Senate's Special Committee on Atomic Energy, in December, 1945, "I don't see how a ship can resist the atomic bomb" (quoted in Weisgall, 1994, p. 13).

In a report reprinted in *Life* magazine in November 1945, Army Air Force Commanding General Henry H. Arnold wrote:

> The influence of atomic energy on Air Power can be stated very simply. It has made Air Power all-important… The only known effective means of delivering atomic bombs… is the very heavy bomber... Development of the air arm, especially with the concurrent development of the atomic explosive, guided missiles and other modern devices, will reduce the requirement for, or employment of mass armies and navies. (quoted in Weisgall, 1994, p. 13)

At this time, most military aviators flew in the Army Air Force. These discussions "represented one more chapter in the decades old rivalry and mistrust between the Army and the Navy and the culmination of the 25-year debate over the role of airplanes and ships" and furthered a push for an independent air force, separate from both army and navy (Weisgall, 1994, p. 18). This debate, combined with various recommendations to dispose of 38 captured Japanese vessels and a desire to better understand the effects of nuclear weapons, resulted in a plan for tests. A joint army-navy program of atomic tests was announced by Admiral Ernest J. King, commanding officer of the Navy, on October 27, 1945. The tests would involve 80 to 100 ships from captured Japanese and German fleets, and from surplus US vessels. Planning commenced in earnest and the tests were approved by Truman on January 10, 1946.

The "hole in the map"—Bikini is chosen

In the midst of vacillating US policy on control of nuclear weapons, Vice Admiral Blandy's first job upon his appointment as commander of Joint Task Force One, in January 1946, was to select a site for the tests of atomic weapons on a naval fleet. On January 15, Truman announced that the United States would insist on being the United Nations trustee of the Pacific islands captured from Japan during the war, although this was not formalized until April 2, 1947. Military planners had been working to select a site as early as October 1945, and more than a dozen locations had been considered in the Pacific, Atlantic and Caribbean. Serious consideration was given to: Ulithi in the Caroline Islands, to the west of the Marshalls; two northern Marshall Islands sites, Bokak and Bikar; and even to the Galapagos Islands in the eastern Pacific (Weisgall, 1994, p. 32-33). Weisgall outlines the criteria for selection of the site:

> The site had to meet numerous conditions: it had to be in an area controlled by the United States, in a climatic zone with predictable winds and free from storms and cold temperatures, and with a large sheltered area for anchoring target vessels and measuring radiation effects. It had to be located within 1,000 miles of a B-29 air base, as the first test was to be an air drop. The site had to be uninhabited or have a small population that could be easily relocated. As Blandy later wrote, 'It was important that the local population be small and cooperative so that they could be

moved to a new location with a minimum of trouble.' But most important, given the risk of radioactive contamination, the site had to be far away from population centers in the United States. As the AEC later stated to Congress, it felt that 'tests should be held overseas until it could be established more definitively that continental detonations would not endanger the public health and safety.' (1994, p. 31)

In the end, Bikini was selected, in part, for its proximity to Kwajalein Atoll to the south and Enewetak Atoll to the west—US military installations that could accommodate aircraft for the test. Comedian Bob Hope explained the selection process differently: "As soon as the war ended, we located the one spot that hadn't been touched by war and blew it to hell" (quoted in Weisgall, 1994, p. 33).

Test Atomic Bombs to Blast 100 Ships at Marshalls Atoll

Two Separate Attacks Set for May and July —20,000 Men to Take Part in Experiments —Special Recording Devices Ready

By SIDNEY SHALETT
Special to The New York Times.

WASHINGTON, Jan. 24—The momentous tests of airborne atomic bombs against warships, which will decide the future of modern seapower, will be conducted at Bikini Atoll in the Marshall Islands next May and July.

Two of the devastating city-smashing bombs that were used against Japan will be dropped against 100 floating targets, of which thirty-five will be warships ranging from submarines to carriers and battleships. Twenty thousand personnel will take part in the tests.

"Crossroads" is the code name given by the United States Joint Chiefs of Staff to the tests, on which so many vital factors of future naval and military strategy depend.

Vice Admiral William H. P. Blandy, chosen by the Joint Chiefs as commander of Joint Task Force One, composed of the Navy, Army, Air Force and civilian scientific leaders who will direct the tests, gravely told the Senate Special Committee on Atomic Energy today that the name was deliberately chosen because of its "possible significance"—that seapower, airpower, and perhaps humanity itself—were at the crossroads.

Admiral Blandy, who is Deputy Chief of Naval Operations for Special Weapons [atomic bombs and guided missiles] appeared with the newly appointed Army, Navy and civilian members of his staff before the Atomic Energy Committee to make the first official disclosure of details of the coming tests.

Later, the same officials conducted a long press conference at the Navy Department, where they further unfolded the synopsis of the dramatic story in response to a barrage of specific questions.

The principal points revealed by

Continued on Page 4, Column 2

The New York Times
Published: January 25, 1946

Figure 18. Front page of the *New York Times,* January 25, 1946

On January 24, 1946, the very same day that the UN General Assembly established the Atomic Energy Commission with a goal of disarmament, Blandy announced to Congress that Bikini Atoll, in the Marshall Islands, was to be the site of this major atomic experiment. Blandy also announced the name of the tests—Operation Crossroads—"because seapower, airpower and perhaps humanity itself are at the crossroads" (quoted in Shalett, 1946).

Questions started to be asked about the purpose of the just-announced Operation Crossroads. Atomic scientists from the Los Alamos team who had developed the bomb strongly opposed the tests. Influential Senator Scott Lucas spoke on the Senate floor on January 31: "If we are to outlaw the use of the bomb for military purposes, why should we be making plans to display atomic power as an instrument of destruction?" (Weisgall, 1994, p. 73).

In February of 1946, Commodore Ben H. Wyatt, the military governor of the Marshalls, traveled to Bikini. On a Sunday after church, he assembled the Bikinians to ask if they would be willing to temporarily leave their atoll so that the United States could begin testing atomic bombs for "the good of mankind and to end all world wars." King Juda, then the leader of the Bikinian people, stood up after much confused and sorrowful deliberation among his people, and announced, "We will go, believing that everything is in the hands of God." The meeting was re-enacted for the film cameras on the Bikinians' last day on their homeland on March 6. Several takes were needed to convey the desired effect that the Bikinians were, indeed, happy to leave. (Weisgall, 1994, p. 113).

Figure 19. Filming the scene where Wyatt asks the Bikinians to leave their atoll "for the good of mankind" needed at least eight takes to convey the desired effect (US Government, 1946)

One hundred and sixty-seven Bikinians set sail for Rongerik on March 7. Emso Leviticus describes leaving Bikini Atoll:

> We left our island after loading everything we owned including our canoes, various kinds of food, bibles, dishes, tools and even some pieces of our church and Council house. We loaded it all onto one of the big ships…and then, after finding our places on the ship, we waved goodbye to our islands and sailed to Rongerik. (in Niedenthal, 2002, p. 52)

Bikinian Anthem

Written in 1946 by Lore Kessibuki (1914-1994) at the time of exodus from Bikini, this song remains the anthem of the displaced Bikinians even today.

I jab ber emol, aet, i jab ber ainmon
ion kineo im bitu
kin ailon eo ao im melan ko ie
Eber im lok jiktok ikerele
kot iban bok hartu jonan an elap ippa
Ao emotlok rounni im lo ijen ion
ijen ebin joe a eankin
ijen jikin ao emotlok im ber im mad ie

No longer can I stay; it's true.
No longer can I live in peace and harmony.
No longer can I rest on my sleeping mat and pillow
Because of my island and the life I once knew there.
The thought is overwhelming
Rendering me helpless and in great despair.
My spirit leaves, drifting around and far away
Where it becomes caught in a current of immense power
And only then do I find tranquility.

Box 2. The Bikinian Anthem

Figure 20. Bikinians load their possessions to leave Bikini (US Government, 1946)

Figure 21. Bikinian outrigger canoe being loaded for the trip to Rongerik. (US Government, 1946)

Figure 22. Bikinian women carrying their possessions to leave Bikini (unknown, 1946)

Within four days of the Bikinians' removal an immense military effort focused on making Bikini ready for the tests, scheduled for May 15. Preparations involved blasting channels, bulldozing large areas and erecting buildings and concrete bunkers, the placement of multi-tonned concrete mooring blocks to hold a test fleet of "target" ships in position in the lagoon, towers to mount test instruments and cameras, seven pontoon causeways, seaplane landing ramps, a water distillation and distribution system, power-generators, moorings for small boats, and huts to house technical equipment:

> By June, parts of Bikini looked like a huge playground. The island was equipped with five concrete basketball courts, ten volleyball courts, four base-ball fields, a 100-foot-square concrete athletic court, swim floats, life-guard platforms, swimming beaches, a beer garden, an archery range, courts for horseshoe pitching, paddle tennis courts, twenty-six dressing huts, and a trap-shooting range. The island even had its own local radio station, "Radio Bikini," which interviewed Crossroads participants and broadcast the comings and goings of various dignitaries. (Weisgall, 1994, pp. 148-149)

Tens of thousands of military personnel, scientists, and observers arrived as Bikini's various islands and lagoon were transformed into a massive military base and a test platform for three tests—an air burst and shallow and deep water tests. In stark contrast to what existed here for thousands of years, the entire landscape and culture of Bikini had been utterly, radically transformed in a remarkable few months. As Firth comments, "Bikini was changed almost beyond recognition" (1987, p. 6). "Bikini" was lost now as a homeland to its people and became, instead, part of the US's "Pacific Proving Ground."

Figure 23. The sign atop the Officers' Club at Bikini Atoll reading "Up and Atom" (1946, © Time Inc.)

The Acheson-Lilienthal Report and the Baruch Plan

In January 1946, as the Truman administration was trying to formulate international policy on the control of atomic weapons in support of the establishment of the UN Atomic Energy Commission, a special committee was established. Led by Dean Acheson, and assisted by a technical advisory group led by David E. Lilienthal, the special committee prepared a plan—the "Acheson-Lilienthal Report"—that laid out a policy by which "no nation would make atomic bombs or the materials for them" (Acheson and Bush radio address, quoted in Weisgall, 1994, p. 70) through careful control over the production of fissionable material by an international body. The report was publicly released on March 28, 1946 to widespread praise.

On March 22, Truman postponed the Operations Crossroads tests from May 15 to July 1, an act that provided some reassurance to the UN Security Council meeting held the following Monday. Days earlier Moscow radio had accused the United States of "brandishing the atomic weapon for purposes which have little in common with the peace and security of the nations" and Stalin had emphasized that the United Nations' strength was based on "the principle of equality of states and not of one state over others" (quoted in Weisgall, 1994, pp. 91-92). There was speculation that the tests would be cancelled altogether. The conflict between attempts at international atomic diplomacy and preparations for this massive atomic experiment were debated repeatedly in Congress.

On June 14, 1946 Bernard Baruch presented the "Baruch Plan"—adapted from the Acheson-Lilienthal Report—to the UN Atomic Energy Commission. The Soviets refused to sign it, and less than three weeks later, the United States detonated the world's first peace-time atomic bomb at Bikini Atoll.

2.b.(vi) Ground Zero: Bikini as a nuclear test site 1946-1958

Operation Crossroads

In all, 242 naval vessels sailed to Bikini, where approximately half would serve as "target ships" for the tests in the lagoon. Forty-two thousand men, 37 women nurses and 150 aircraft participated in what the *New York Times* called the "most stupendous single set of experiments in history" ("Star's Secrets", 1946). Two hundred pigs, 200 mice, 60 guinea pigs, 204 goats and 5,000 rats were exposed to the explosions to better understand the effects of an atom bomb on humans (Shurcliff cited in Weisgall, 1994, p. 120). More than 700 film and still cameras were set up to record the event, 328 of these airborne, manned by over 500 photographers. More than 10,000 instruments, including some developed specifically for the tests at Bikini, were placed on ships, aircraft and the surrounding islands. One hundred and seventy journalists set up "a floating newsroom" on the *Appalachian* (DeGroot, 2006, p. 119). According to Weisgall, "Operation Crossroads was above all else, an extravaganza. It was the grandest scientific experiment ever, more exhaustively photographed, reported, and measured than any previous event in history" (1994, p. 117).

The ninety-five ships assembled as "targets" for Operation Crossroads represented naval technology from the 1910s through the 1940s. Altogether, they formed the fifth or sixth largest "navy" in the world at that time and included every type of ship that had fought in the Second World War, as well as veterans from the First World War. Battleships, aircraft carriers, submarines, cruisers, destroyers, attach transports, landing craft—all were brought to Bikini. The majority of the ships were United States-built, although one German (the state-of-the-art *Prinz Eugen*) and two Japanese warships also filled out the test contingent.

Test Able was carried out on July 1, 1946. A bomb named "Gilda" was dropped from a B-29, and exploded 300m (1,000 feet) above the lagoon, and half a mile from the planned target. Five of the vessels moored in the lagoon sank immediately. However, observers were stationed far away from the explosion and there was a general disappointment expressed by witnesses and in the media that the bomb did not live up to its hype. Laurence, the *New York Times* reporter who had witnessed the Trinity explosion a year earlier, as well as the bombing of Nagasaki, described the Able test: "I saw a reddish-purple ball of fire, smaller than the one I had seen in New Mexico, shooting upward like a meteor going in the wrong direction. It was quickly surrounded by a gigantic spherical envelope of fog. The envelope collapsed with great violence, like a balloon punctured by an invisible hand. Out of it, like a monster hatched from a giant egg, emerged a mushroom-topped cloud" (quoted in Graybar, 1986, p. 901).

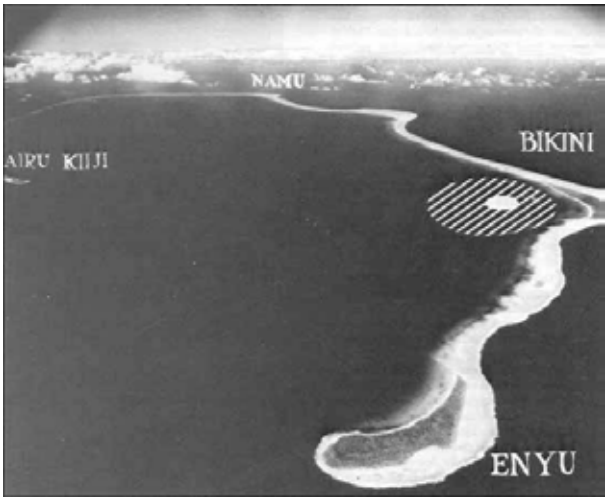


Figure 24. US Navy press release photo of the target area for Operation Crossroads (1946)

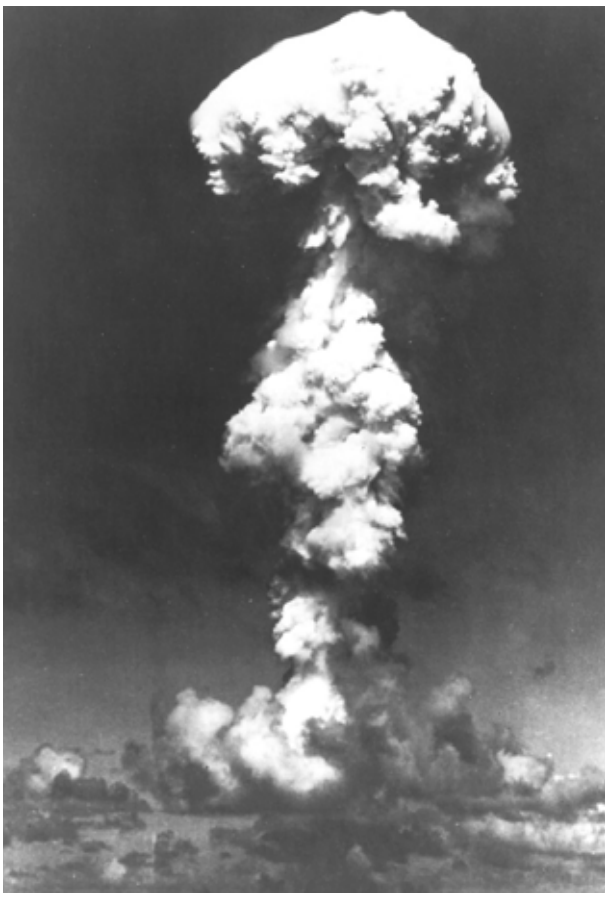


Figure 25. The Crossroads Able test (Photo: National Nuclear Security Administration / Nevada Site Office, 1946)

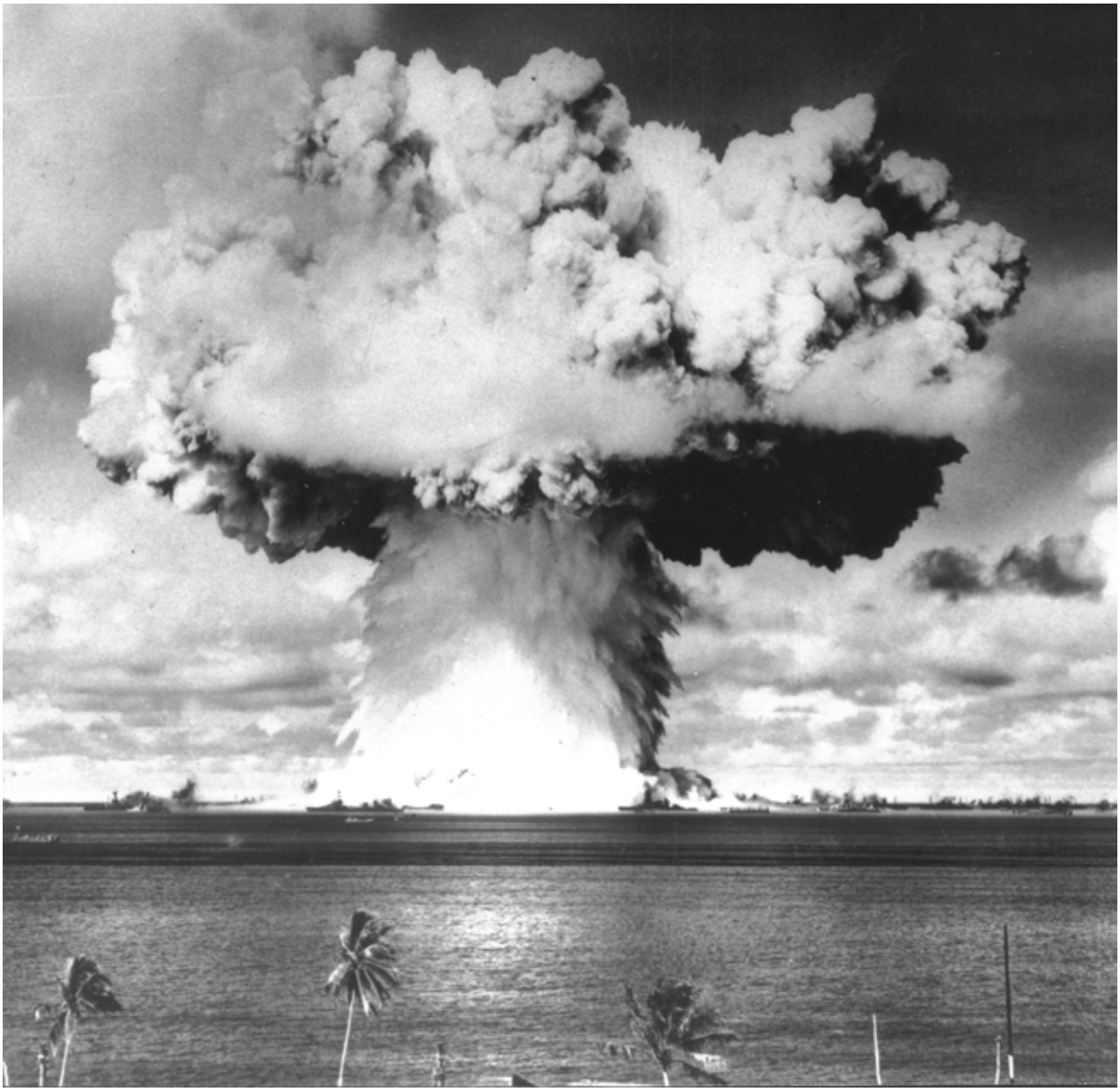


Figure 26. The Crossroads Baker test (Photo: National Nuclear Security Administration / Nevada Site Office, 1946)

The submarine Test Baker followed on July 25, suspended 30 meters below the surface of the water and detonated at 8:35 am. The countdown was broadcast worldwide. Weisgall (1994) imagines the scene:

> As they waited for the blast, many observers saw the test as a harbinger of push-button warfare. Men pushed buttons, an atomic bomb was set off, and to add a Wellsian touch, crewless drone boats and robotic pilotless planes would move through the lagoon and over the ghost fleet of abandoned ships. (p. 221)

The water column, holding 2 million tons of water, reached a mile high within one second. Shock waves hit the islands at speeds of over 5,000 kilometers per hour. A crater was carved in the lagoon floor moving 2 million cubic yards of material, and five ships and three other vessels were sunk. According to Weisgall, "the Baker shot unleashed the greatest waves ever known to humanity, with the possible exception of those produced by the 1883 explosion of the island of Krakatoa"[3] (1994, p. 224). While the spectacle of Baker created quite a different impression than that of Able, it was the radioactive fallout that was most significant. It was with surprise that the navy found the radioactive contamination could not be scrubbed away, and that ships would be ineffective at protecting their crews in nuclear warfare.

This submarine explosion elicited quite a different response from eyewitnesses to the previous Able explosion: *New York Times* journalist, Laurence, wrote that "the phenomenon itself was one of the most spectacular and awe-inspiring sights ever seen by man

3 The first wave was measured at 94 feet (30 meters) high.

on this planet," while the *New York Herald Tribune* correspondent, White, exclaims that it was an "explosion so fantastic, so mighty and so beyond belief that men's emotions burst from their throats in wild shouts" (quoted in Weisgall, 1994, p. 222).

The *New York Times* headline of July 25 summed up the extraordinary juxtaposition of a plan for international control of atomic energy with the display of nuclear thunder: "Atomic Bomb Sinks Battleships and Carriers; Four Submarines are Lost in Mounting Toll; Soviet Flatly Rejects Baruch Control Plan" (Weisgall, 1994, p.255). Soon after, the Soviet newspaper *Pravda* reported that "If the atomic bomb did not explode anything wonderful, it did explode something more important than a couple of out-of-date warships; it fundamentally undermined the belief in the seriousness of American talk about atomic disarmament" (quoted in Graybar, 1986, p. 902).

After Operation Crossroads the US moved all testing to Enewetak Atoll, 350 km (200 miles) west of Bikini, where a total of 43 devices were tested between 1948 and 1958. A comparison of Enewetak and Bikini is carried out in section 3.c Comparative Analysis. Bikini was not used again as a test site until the dramatic and deadly Operation Castle Bravo experiment nearly eight years later.

Figure 27. Aerial view of the Crossroads Baker test (Photo: National Nuclear Security Administration / Nevada Site Office, 1946)

Figure 28. Stamp cancellation for Operation Crossroads (US Navy, 1946)

Figure 29. Decontamination of ships after Operation Crossroads (National Archives, 1946)

Figure 30. USS *Skate* in the aftermath of Able, its superstructure crushed, conning tower bent, and "very radio-active" (National Archives, 1946)

Figure 31. The Castle Bravo bomb (1954, U.S. Airforce/ Defense Nuclear Agency)

Operation Castle Bravo

On March 1, 1954, for the people of Rongelap just 130 km east of Bikini Atoll, two suns rose. One in the east brought light, warmth and life, and the other brought unimaginable destruction that changed the world forever. The world's first deliverable hydrogen bomb test, Castle Bravo, was conducted at Bikini Atoll. Bravo introduced the world to horrors of nuclear weapons beyond those known from Hiroshima or Nagasaki—fallout and resulting radiation illness at a great distance from the explosion—and sowed the seeds of the global nuclear disarmament movement.

In preparation for the test, the US military weather station on Rongerik, a smaller atoll east of Rongelap, began regular observations to determine barometric conditions, temperature, and the velocity of the wind up to 30,000 meters above sea level. The weather briefing the day before the detonation stated that there would be no significant fallout for the populated Marshalls. A later briefing, however, stated that "the predicted winds were less favorable; nevertheless, the decision to shoot was reaffirmed, but with another review of the winds scheduled for midnight" (Martin & Rowland, quoted in Niedenthal, 2002, pp. 6-7). The midnight briefing "indicated less favorable winds at 10,000 to 25,000-foot levels," winds at 6,000meters (20,000 feet) "were headed for Rongelap to the east," and "it was recognized that both Bikini and Eneman Islands would probably be contaminated" (Martin & Rowland, quoted in Niedenthal, 2002, pp. 6-7).

Early in the morning on March 1, 1954 the device, code-named "Shrimp," was detonated on the surface of the reef in the northwestern corner of Bikini Atoll. The area was illuminated by a huge and expanding flash of blinding light. A raging fireball of intense heat that measured into the millions of degrees shot skyward at a rate of 500 kilometers (300 miles) an hour. Within minutes the monstrous cloud, filled with nuclear debris, shot up more than 35 kilometers (20 miles) and generated winds hundreds of kilometers per hour. These fiery gusts blasted the surrounding islands and stripped the branches and coconuts from the trees. Joint Task Force ships, stationed about 60 kilometers (40 miles) east and south of Bikini in positions enabling them to monitor the test, detected the eastward movement of the radioactive cloud from the 15 megaton blast. They recorded a steady increase in radiation levels that became so high that all men were ordered below decks, and all hatches and watertight doors were sealed. Millions of tons of sand, coral, plant and sea life from Bikini's reef, from three islands and the surrounding lagoon waters, were sent high into the air by the blast, leaving a crater more than 2 kilometers wide (over a mile wide) and 80 meters (250 feet) deep.

One-and-a-half hours after the explosion, 23 fishermen aboard the *Daigo Fukuryū-Maru* (*Lucky Dragon #5*), a Japanese fishing vessel, watched in awe as a "gritty white ash"—which the Japanese came to know as *shi no hai* (the ashes of death) ("Ashes to Ashes," 1954)—began to fall on them. The men aboard the ship were oblivious to the fact that the ash was the fallout from a hydrogen bomb test. Shortly after being exposed to the fallout their skin began to itch and they experienced nausea and vomiting. All 23 crew developed radiation sickness. The boat's return to Japan two weeks later and the death of one crew member within months, from acute radiation illness, was to have a resounding impact in Japan, as Saito describes:

> Japanese were in shock when *Yomiuri Shinbun* scooped on March 16, 1954 that the crew on the tuna fish boat *Lucky Dragon 5* had been exposed to the nuclear fallout in Bikini Atoll. After the tuna were unloaded and distributed to local markets all over Japan, it was discovered that they contained high levels of radiation. As tuna—part of the Japanese staple diet—were now exposed to nuclear pollution, people began to feel that the entire nation was threatened by nuclear weaponry. The fear of radioactive materials and their threat to Japanese everyday life was pervasive. Newspapers were relentless in reporting medical conditions of the crew of *Lucky Dragon 5* and objects contaminated by the H-bomb fallout, such as raindrops and vegetables. Groups of people flooded to Tokyo University Hospital to ask physicians for medical examination because they had eaten tuna; the so-called tuna horror, the fear of tuna exposed to radioactivity ("A-bomb tuna"), was widespread. Several episodes of people who mistook white substances like pollen as H-bomb fallout were also reported. Public arenas were saturated with narratives and images expressing fear of nuclear weapons. According to the opinion poll conducted by *Asahi Shinbun* (May 20, 1954), 70 percent of the population was afraid of exposure to radioactivity. (2006, p. 368)[4]

Meanwhile, on Rongelap Atoll, located about 150 km east of the test on Bikini, John Anjain, at his breakfast at the time, describes the event:

> On the morning of the 'bomb' I was awake and drinking coffee. I thought I saw what appeared to be the sunrise, but it was in the west. It was truly beautiful with many colors—red, green and yellow—and I was surprised. A little while later the sun rose in the east. Then some time later something like smoke filled the entire sky and shortly after that a strong and warm wind—as in a typhoon—swept across Rongelap. Then all of the people heard the great sound of the explosion. Some people began to cry with fright. (Dibblin, 1990, p. 25)

Three to four hours after the blast, the white, snow-like ash began to fall from the sky onto the 64 people living on Rongelap and also onto the 18 people residing on Ailinginae Atoll. The Rongelapese, not understanding what was happening, observed with amazement as the radioactive dust soon formed a layer on their island two inches deep, turning the drinking water a brackish yellow. Children played in the fallout; their mothers watched in horror as night came and they began to show the physical signs of exposure. Lomoyo Abon, living on Rongelap at the time, describes the experience:

> That night we couldn't sleep, our skin itched so much. On our feet were burns, as if from hot water. Our hair fell out. We'd look at each other and laugh—you're bald, you look like an old man. But really we were frightened and sad. (Dibblin, 1990, pp. 24-25)

The people experienced severe vomiting and diarrhea, and their hair began to fall out; the island fell into a state of terrified panic. Two days after the test the people of Rongelap were taken to Kwajalein for medical treatment.

On Bikini Atoll the radiation levels increased dramatically. In late March following the Bravo test, the off-limit zones were expanded to include the inhabited atolls of Rongelap, Utrik, Ujelang and Likiep. In the spring of 1954, the atolls of Bikar, Ailinginae, Rongelap and Rongerik, were all contaminated by the Yankee and Union weapons tests which were detonated on Bikini Atoll. They yielded the equivalent of 6.9 and 13.5 megatons of TNT respectively. The people of Rongelap did return to their homeland in 1957 but were evacuated again in 1985 by the Greenpeace *Rainbow Warrior*.

Bravo, at 15 megatons, was a thousand times more powerful than the Fat Man and Little Boy atomic bombs that were dropped on Nagasaki and Hiroshima. Its "success" was beyond the wildest dreams of the American scientists who were involved in the detonation—they thought that the blast would only carry a payload of approximately 5 megatons. Bravo is to this day the largest detonation ever conducted by the United States. As Weisgall (1994) describes:

4 See also Totten & Kawakami, 1964.

> The Bravo shot finally brought home to the American public and the world the realization that the killing power of radioactive fallout from a thermonuclear bomb greatly exceeds the fiery blast and heat of the direct explosion that causes it. Its impact and scope are mind-numbing…Hiroshima paled in comparison to Bravo, which represented as revolutionary advance in explosive power over the atomic bomb as the atomic bomb had over the conventional weapons of World War II. (pp. 306-307)

Other tests

While Operation Crossroads and the Castle Bravo tests were the most significant, 23 additional nuclear tests were carried out between 1946 and 1958 on Bikini, of a total of 67 tests in the Marshall Islands (see Annex 2 for a list of all tests). In 1958, the United States anticipated the acceptance of a call for suspension of atmospheric nuclear testing and assembled a large number of devices for testing before the moratorium came into effect. As a result, Operation Hardtack was a series of 35 tests carried out in the Pacific Proving Grounds in only five months between April and August, 1958; ten of these on Bikini.

While a radiological survey in 1947 had determined that within a few years the islands could be re-inhabited, the United States decided not to return the Bikinians. Instead, the islands were retained as a military testing ground with an additional twenty nuclear tests taking place between 1954 and 1958. As these additional tests occurred, further changes–the construction of additional, larger concrete bunkers, the placement of additional test equipment, and the laying of miles of undersea cables—continued the alteration of Bikini Atoll. At the end of the testing in 1958, Bikini's landscape, both above and below the surface of the water, reflected its transformation.

Bikini was and remains the world's first large-scale nuclear landscape—an area of the globe forever transformed by nuclear testing, and this landscape remains essentially untouched and unaltered. The physical legacy of the testing is inherent in the many bunkers and test equipment left on the islands, in the cables and sunken ships, in the various nuclear blast craters in the lagoon, and, markedly, in the vanished islands and the large "Bravo" crater that disrupts the atoll's chain of islands. These, as well as the fallout remaining in the islands' soil, all bear testimony to the enormous destructive power of the technology that was demonstrated here. The lonely rows of coconut palms, planted in the hope the Bikinians could return to their home and resume their way of life, now symbolize the loss of this way of life forever.

2.b.(vii) The "Nuclear Nomads" of Bikini

In 1946, the Bikinians had arrived on Rongerik Atoll to the east of Bikini, an atoll that had been previously uninhabited due to a lack of food and water resources, and a traditional belief that an evil spirit lived there and contaminated the fish. Within a short time the Bikinians began to suffer from food shortages and fish poisoning. In 1947, Ujelang was selected for the Bikinians' new home and a new village was constructed there in preparation. However, in December of that year the US decided to use Enewetak as an additional nuclear test site and to relocate the people of Enewetak to Ujelang, based on their traditional ties to that atoll.

On the verge of starvation, in March 1948, the Bikinians were moved to a tent city on Kwajalein Atoll while a new home was found for them. In June the Bikinians selected Kili Island—a single island with no lagoon or protected anchorage in the southern Marshall Islands—because the island was not ruled by a paramount king, or *iroij,* and was uninhabited. This choice ultimately doomed their traditional diet and lifestyle, which were both based on lagoon fishing.

In November, 1948, the Bikinians moved to Kili. Most of the year Kili is surrounded by 3 to 5 meter waves that deny the islanders the opportunity to fish and sail their canoes. After a short time on Kili—a place that the islanders believe was once an ancient burial ground for kings and is therefore overwrought with spiritual influence—they began to refer to it as a "prison" island. Because the island does not produce enough local food for the Bikinians to eat, the importation of US Department of Agriculture rice and canned goods and other purchased food had become an absolute necessity for their survival. In the following years rough seas and infrequent visits by the field trip ships caused food supplies to run critically low many times on the island and once even required an airdrop of emergency food rations. These difficult conditions continued for the people of Bikini over the next decade. (Note: Source of the above paragraphs: Micronitor, 1996; Niedenthal, 2002; Weisgall, 1994; Dibblin, 1990. For more information on the chronology of the "nuclear nomads" of the Marshall Islands see Annex 2).

2.b.(viii) Resettling Bikini

In 1967, US government agencies began considering the possibility of returning the Bikinian people to their homelands based on data on radiation levels on Bikini Atoll from the US scientific community. This scientific optimism stemmed directly from an US Atomic Energy Commission (AEC) report that stated "The exposures of radiation that would result from the repatriation of the Bikini people do not offer a significant threat to their health and safety" (Shields et al., 1967, p. 1).

Accordingly, in August of 1968 (the story appeared on the front page of the *New York Times*) President Lyndon B. Johnson promised the 540 Bikinians living on Kili and other islands that they would now be able to return to their homeland and ordered the atoll to rehabilitated and resettled ("US to let Bikinians back on A-test Isle," 1968; Bromley Smith draft memorandum to President Johnson cited in Weisgall, 1994, p. 314). A group of nine Bikinians visited Bikini Atoll on behalf of the Bikinians living on Kili and other islands. Upon seeing the landscape, one man murmured "It's all changed, it's not the same," while the others nodded silently in agreement ("9 Return to Bikini," 1968).

In August of 1969 an eight-year plan was prepared for the resettlement of Bikini Atoll. The first phase of the work involved the clearing of the radioactive debris on Bikini Island, accomplished by bulldozers being driven methodically between the trees in neat rows, and then pushing the debris into huge piles which were later removed. This operation created a massive grid pattern over the entire islands of Bikini and Eneu. By late 1969 the first cleanup phase was completed. The second phase of the reclamation included the replanting of the atoll, construction of housing and the resettlement of the community. During the year of 1971 this effort proceeded slowly as the US government withdrew their military personnel and equipment, and brought to an end the weekly air service that had been operating between Kwajalein Atoll and Bikini Atoll.

In late 1972 the planting of the coconut trees was finally completed. During this period it was discovered that as the coconut crabs grew older on Bikini Island they ate their sloughed-off shells. Those shells contained high levels of radioactivity; hence, the AEC announced that the crabs were still radioactive and could be eaten only in limited numbers. The conflicting information on the radiological contamination of Bikini supplied by the AEC caused the Bikini Council to vote not to return to Bikini at the time previously scheduled by American officials. The Council, however, stated that it would not prevent individuals from making independent decisions to return. Three extended Bikinian families, their desire to return to Bikini being great enough to outweigh the alleged radiological dangers, moved back to Bikini Island and into the newly constructed houses. They were accompanied by approximately 50 Marshallese workers who were involved in the construction and maintenance of the buildings.

The population of islanders on Bikini slowly increased over the next 5 years to about 100 people until in June of 1975, during regular monitoring of Bikini, radiological tests discovered "higher levels of radioactivity than originally thought." US Department of Interior officials stated that "Bikini appears to be hotter or questionable as to safety" and an additional report pointed out that some water wells on Bikini Island were also too contaminated with radioactivity for drinking. A couple of months later the AEC, on review of the scientists' data, decided that the local foods grown on Bikini Island, including pandanus, breadfruit and coconut crabs, were also too radioactive for human consumption. Medical tests of urine samples from the 100 people living on Bikini detected the presence of low levels of plutonium 239 and 240. (Note: Source of above three paragraphs: Niedenthal, 2002, pp. 10-12)

In October of 1975, after contemplating these new and confusing reports on the radiological condition of their atoll, the Bikinians filed a lawsuit in US federal court demanding that a complete scientific survey of Bikini and the northern Marshalls be conducted. As a result the US agreed to conduct an aerial radiological survey of the northern Marshalls, but meanwhile the Bikinians, unaware of the severity of the radiological danger, remained on their contaminated islands. In May of 1977 the level of radioactive strontium-90 in the well water on Bikini Island was found to exceed the US maximum allowed limits. A month later a Department of Energy study stated that "All living patterns involving Bikini Island exceed Federal guidelines for thirty year population doses." Later in the same year, a group of US scientists, while on Bikini, recorded an 11-fold increase in the cesium-137 body burdens of the more than 100 people residing on the island. Alarmed by these numbers, the DOE told the people living on Bikini to eat only one coconut per day and began to ship in food for consumption. In April of 1978 medical examinations performed by US physicians revealed radiation levels in many of the now 139 people on Bikini to be well above the US maximum permissible level. The very next month US Department of Interior officials described the 75% increase in radioactive cesium 137 as "incredible." The Interior Department then announced plans to move the people from Bikini within 75 to 90 days, and so in September of 1978, Trust Territory officials arrived on

Bikini to once again evacuate the people who were living on the atoll (Note: Source of above paragraph: Hamilton & Robison, 2004; Niedenthal, 2002; Lokan et al., 1998; Simon, 1995). The nuclear landscape of Bikini, which prior to the testing had been a treasured and productive homeland, had been rendered uninhabitable.

Since the aborted repatriation to Bikini in the 1970s, a number of scientific studies have been performed on Bikini Atoll. Beginning in the late 1970s through to the present day, Lawrence Livermore National Laboratory has studied the radiological conditions of Bikini, usually with two missions per year. In the early 1980s, the Bikini Atoll Rehabilitation Committee (BARC), a group of highly regarded American scientists, completed and submitted a report about the radiation on Bikini Atoll to the US Congress. In February of 1995 the Nationwide Radiological Study was completed by Dr. Steven Simon and a group of scientists from all over the world for the Marshall Islands government. In addition, the National Academy of Sciences also released a report about Rongelap Atoll in which Bikini Atoll cleanup options and radiological conditions were discussed. Beginning in the early 1990s, the Bikinians have had their own independent scientist reviewing these studies. In 1996 the International Atomic Energy Agency (IAEA) responded to requests from the Marshall Islands to comprehensively review and validate the radiological studies to date, which was reported on in 1998. (Note: Source of above paragraph: Niedenthal, 2002; Hamilton and Robison, 2004; Lokan et al., 1998)

2.b.(ix) Bikini as a tourist destination

In 1989 the US Navy and the US National Park Service Submerged Cultural Resource Unit conducted an assessment of the sunken ships of Operation Crossroads to determine potential hazards from leaking fuel, unexploded conventional ordnance, heritage value and tourism potential. The teams surveyed the lagoon, located most of the sunken ships, and conducted a series of dives, extensively documenting the USS *Saratoga*, HIJMS *Nagato*, USS *Arkansas*, and USS *Pilotfish* (Delgado et al., 1990).

Development of the infrastructure to support the clean-up and resettlement programs on Bikini Atoll started early in calendar year 1991. The program was concentrated at Eneu Island, which had been declared safe for habitation, and was the main support base for the clean-up activities. Warehouses, crew quarters and a power plant were constructed and potassium fertilizer was spread throughout Eneu Island as a safety measure.[5]

With the opening of the tourism program on Bikini Island in 1996, there were numerous upgrades and additions to the facilities. In 1998, cleanup activities began on Bikini Island with a 120 hectare (300 acre) land-clearing project. However, the adoption of a new 15 millirem EPA radiological cleanup standard in December of 1998 placed the cleanup of Bikini on hold pending further funding from the US government. Since 1996 Bikini has hosted up to around 250 tourists each year and provided the unparalleled experience of diving amidst the sunken vessels and abundant sharks, and relaxing in the beautiful surrounds of Bikini Island. Bikini has become a renowned dive location, consistently being reviewed as one of the premier diving experiences in the world (Note: see http://www.bikiniatoll.com/divetour.html for examples of reviews).

Figure 32. Diving on the wreck of the *Saratoga* (E. Hanauer, 2006)

5 The application of potassium on coral-soils has been found to reduce the uptake of radioactive Cesium-137 into plants, and thus into the human food chain.

Part 3. Justification for Inscription

3.a Criteria under which inscription is proposed, and justification for inscription under these criteria

Nuclear bomb tests at Bikini Atoll shaped the history of the people of Bikini, the history of the Marshall Islands and the history of the entire world. Bikini Atoll is nominated as a cultural site against criteria (iv) and (vi) as set out in Paragraph 77 of the *Operational Guidelines for the implementation of the World Heritage Convention.*

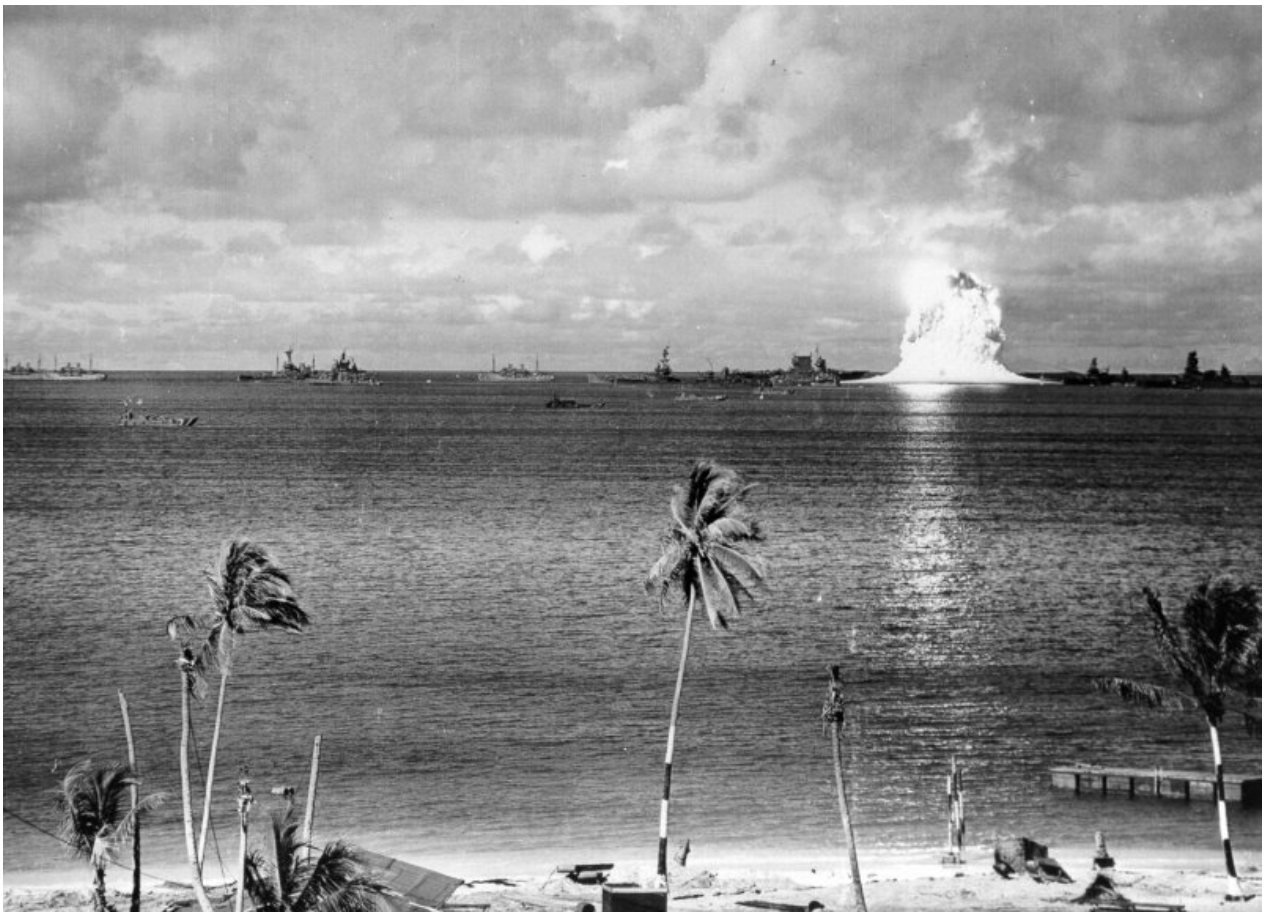


Figure 33. A view of the Baker shot showing the test fleet, with Bikini island in the foreground (US Navy, 1946)

3.a.(i) Criterion (iv): be an outstanding example of a type of building, architectural or technological ensemble or landscape which illustrates (a) significant stage(s) in human history;

Bikini Atoll is an outstanding example of a *nuclear test site*—both a technological ensemble and a landscape/seascape—bearing witness to the dawn of the nuclear age, the start of the Cold War and the era of nuclear colonialism. As a nuclear test site, Bikini Atoll is distinctly 20th century heritage. The World Heritage Committee and ICOMOS have acknowledged the need to include works of outstanding universal value from the heritage of the modern age, taking into account that the 20th century is now history (ICOMOS, 2004).

The entire landscape and seascape of Bikini Atoll testifies to its history as a *nuclear test site*, from the ensemble of sunken ships—which lie in the positions where they were placed and subsequently sunk as "targets"—and the purpose-built bunkers and buildings, to the disappeared islands and the Bravo crater. Even the abandoned rows of coconut trees, planted in preparation for the failed resettlement, symbolize the fate of a nuclear test site—ongoing contamination making it unsuitable for human habitation.

Outstanding universal value under this criterion is demonstrated through recognition of Bikini Atoll as:

- A monument and memorial to the dawn of the nuclear age;
- A site bearing witness to nuclear testing events of global significance—turning points in the world's history;
- A testimony to nuclear colonialism.

A monument and memorial to the dawn of the nuclear age

A tiny island bears witness to survival, and to loss. It recalls the innocence of another age.

(Livingston & Rawlings, 1992).

Bikini Atoll is of outstanding universal value as a monument and memorial to the dawn of the nuclear age—the era that defined the second half of the 20th Century.

In its landscape, natural environment and in the artifacts of the testing, Bikini Atoll offers an opportunity to memorialize many of the contested meanings of the nuclear age for its different audiences. For the people of Bikini, the atoll is remembered as the abundant and beautiful homeland and remains the locus of their spiritual and cultural identity. For the people of Rongelap, Utrik and other affected atolls, Bikini is the source of their radiation illness and loss of their homelands. For victims of nuclear colonialism and testing around the world, Bikini speaks to their experiences, losses and grief, as it does for the servicemen of Bikini and other nuclear test sites who were exposed to radiation.

More than this, Bikini Atoll is a monument and memorial of global significance, for it reminds us of the world's lost innocence. At first glance we see the quintessential tropical paradise—white beaches, palm trees, turtles and sharks swimming on a vibrant reef in clear, turquoise waters—images beloved by modern culture, as well as by the islanders themselves. These are images that bring to mind an idyllic, peaceful, and simple world. In the abandoned, poisoned land, the sunken ships, the disappeared islands and the abundant photos and footage of the nuclear tests, we remember clearly the time where innocence was lost—when men held and wielded a power reserved for gods.

As a nuclear test site, Bikini has, in a way, stood as a monument and memorial to the loss of innocence from the moment it was chosen. Even prior to the testing, E.B. White (March 9, 1946) wrote in the New Yorker of this symbolic loss of innocence:

> Bikini Lagoon, although we have never seen it, begins to seem like the one place in the world we cannot spare… it grows increasingly valuable in our eyes—the lagoon, the low-lying atoll, the steady wind from the east, the palms in the wind, the quiet natives who live without violence. It all seems unspeakably precious, like a lovely child stricken with a fatal disease. (quoted in Weisgall, 1994, p. 152)

The trace, memory and spirit of the time—the *zeitgeist*—of Bikini Atoll as a nuclear test site is recorded in films, photos, journalism, technical reports, oral histories, memoirs and works of art. The mechanisms by which Bikini Atoll functions as a monument and a memorial is expanded from the tangible by the inclusion of symbols, works of art and representations of Bikini that have accompanied the process of its journey from a beloved, beautiful home to an abandoned nuclear test site. These are discussed in more detail below, in the justification under Criterion (vi).

A site bearing witness to nuclear testing events of global significance—turning points in the world's history

Bikini Atoll bears witness to individual events of global significance—in particular Operation Crossroads in 1946 and the Castle Bravo detonation in 1954. Both of these events represent turning points in the world's history. Operation Crossroads, the first peace-time nuclear detonations, was extensively documented and publicized, and was a prominent event contributing to the start of the Cold War. The Castle Bravo test, the first deliverable hydrogen bomb, introduced the world to the devastating, persistent and extensive nature of nuclear fallout, and sowed the seed of international action for nuclear disarmament.

Operation Crossroads: As discussed in Part 2b. History and Development, Operation Crossroads occurred at a time of awkward diplomacy between the Soviets and the Americans, and the display of power by the US conflicted with ongoing efforts to place nuclear weapons under the control of the United Nations, thus contributing significantly to the distrust and paranoia that characterized the start of the Cold War. Farrell (1987) suggests the significance was such that "at the crossroads of Bikini, the country [the US] opted for a diplomatic, military, political and cultural Cold War that has persisted, with minor variations, to this day" (p.65). The cover article for *Time* magazine, on July 1, 1946 speaks of the "Tremor of Finality" of Operation Crossroads:

> Against the peaceful backdrop of palm frond and pandanus, on this most "backward" of islands, the most progressive of centuries would write in one blinding stroke of disintegration the inner meaning of technological civilization: all matter is speed and flame. ("Crossroads," July 1, 1946)

Delgado (1991) explains the significance of the ships sunk during Operation Crossroads:

> The place of these ships in the history of naval development, their roles in naval history and their World War II combat records establish their significance only up to the moment they were selected for Operation Crossroads. From that point on their previous histories become secondary, for the pre-Crossroads significance of the ships is overshadowed by the social, political, and military decisions that brought them to Bikini, and the forces unleashed by the detonation of two atomic bombs that sent them to the bottom of the atoll's lagoon. Each of these vessels passed over a threshold at the "crossroads" between conventional and nuclear warfare, as did the world that had built and manned them. Regardless of type, age, or career, each vessel that now lies where it was sunk by the Able and Baker test blasts is of equal significance as the only uncompromised material record of the early, formative stages of nuclear weapons design and the development of a nuclear military policy. (p. 144)

The ships now lying at the bottom of Bikini Atoll in their shallow crater bear witness to this turning point in the history of the 20th Century.

Castle Bravo: The world's first deliverable hydrogen bomb was a landmark event in the history of the world. Just as the atomic weapons dropped on Hiroshima and Nagasaki had brought the theories of nuclear physicists into a terrible reality, this next major technological development was to shock the world and directly give rise to the nuclear disarmament movement. The Castle Bravo event, although conducted in great secrecy, was to be the US's greatest radiological disaster and would, very publicly, introduce the world to "fallout." In his definitive *History of the World Nuclear Disarmament Movement*, Wittner (1997) states the significance of the Bravo event:

> Although the US government had tested the world's first thermonuclear device in 1952 and the Soviet Union had made its own nuclear breakthrough the following year, not until 1954 did nuclear testing deeply impress itself on public consciousness. The turning point was the first US H-Bomb test, conducted by the Atomic Energy Commission [USAEC] on March 1, 1954. It occurred at Bikini Atoll. (p.1)

Boyer (1985) situates the cultural impact of the Bravo test at that time:

> In the mid-1950's the issue of nuclear weapons again surged dramatically to the forefront, once more becoming a central cultural theme. …The reason was fear… It was the United States' 1954 test series [the Castle Series] that really aroused alarm, spreading radioactive ash over seven thousand square miles of the Pacific, forcing the emergency evacuation of nearby islanders, and bringing illness and death to Japanese fishermen 80 miles away. (p. 352)

Ralph Lapp, a physicist on the Manhattan Project and author of the bestselling book about the incident, *Voyage of the Lucky Dragon* (1958) claims that:

> The true striking power [of nuclear weapons] was revealed on the deck of the Lucky Dragon. When men 100 miles from an explosion can be killed by the silent touch of the bomb, the world suddenly becomes too small a sphere for men to clutch the atom. For this knowledge, gained so strangely from the adventures of 23 men, the world may some day rank this voyage with that of Columbus. (p. 198)

The Bravo crater in the north-western corner of the atoll, along with the still-contaminated, uninhabited islands of Bikini, stand as testimony to the Castle Bravo event—the detonation of the world's first H-bomb. Aside from the bombs dropped on civilian populations of Hiroshima and Nagasaki, no other single nuclear weapons events have had this scale of impact on the world.

A testimony to nuclear colonialism

The effects of colonialism and military activity in the Pacific have been accepted as significant themes for Pacific World Heritage (Thematic Framework for World Cultural Heritage in the Pacific, 2005; Smith & Jones, 2007). The United States, the United Kingdom and France all tested nuclear devices in the Pacific between 1946 and 1996, enabled by their colonial histories in the region. The process of Pacific nuclear colonialism finally gave rise to the Nuclear Free and Independent Pacific Movement based on the understanding of Pacific peoples that nuclear tests could be halted only if their countries were decolonized and became sovereign nations. Due to similarities in landscape, culture and experience with other Pacific nuclear test sites, Bikini is presented as exemplary testimony to this significant phase in Pacific history—that of nuclear colonialism.

However, nuclear colonialism was not restricted to the Pacific and Bikini Atoll, now unpeopled, stands as exemplary testimony to a lost way of life, on behalf of all victims of nuclear colonialism. Over 2,050 nuclear devices have been detonated worldwide in the years since 1945. Major testing programs were carried out by the United States, the Soviet Union, France and Britain (in conjunction with Australia). Countries that carried out lesser programs are China, India, Pakistan and North Korea. Some test sites bear familiar names such as Nevada, Maralinga, Trinity and Moruroa. Other sites are less familiar to us: Semipalatinsk in Kazakhstan, Amchitka in the Aleutian Islands of Alaska, Kiritimati (Christmas Island) in Kiribati, Lop Nur in western China, and Novaya Zemlya in the Barents Sea. All the sites used for testing bear irreversible scars telling their powerful stories of lost lands, lost health, and lost cultures and ways of life. In all cases the people and institutions running the tests ignored the presence of local indigenous populations, or displaced them. In all cases local communities were involuntarily exposed to radiation and fallout from the tests. In all cases servicemen were exposed to radiation without information or choices. In the worst cases, people were used as human guinea pigs.

The Abolition 2000[6] Conference in 1997 recognized the burden that nuclear colonialism has placed on indigenous peoples by releasing the Moorea Declaration on Colonialism:

> This meeting, held in Te Ao Maohi a year after the end of French nuclear testing, has highlighted the particular suffering of indigenous and colonised peoples as a result of the production and testing of nuclear weapons. The anger and tears of colonised peoples arise from the fact that there was no consultation, no consent, no involvement in the decision when their lands, air and waters were taken for the nuclear build-up, form the very start of the nuclear era.
>
> Colonised and indigenous peoples have, in the large part, borne the brunt of this nuclear devastation - from the mining of uranium and the testing of nuclear weapons on indigenous peoples land, to the dumping, storage and transport of plutonium and nuclear wastes, and the theft of land for nuclear infrastructure. (Abolition 2000, 1997, paras.2,3)

Of enormous significance not only to the Bikinians, but to all indigenous peoples who were victims of nuclear colonialism, Bikini demonstrates what can happen when an idyllic society, living a quiet subsistence lifestyle, meets a global superpower with enormous wealth and military or industrial capability:

> A pattern of militarisation, environmental devastation and the displacement of Indigenous or local peoples is visible in the landscapes of many Cold War test sites, island and continental. However, in the Pacific Islands where all human behaviour is informed by the oceanic environment of fragile islands amid vast tracts of water, the archaeological expression of nuclear testing is unlike that found elsewhere. The tiny, remote islands affected by nuclear testing represent a large portion and in some cases the entire land surface on which particular peoples have lived or regularly visited for at least a millennium. Some of these archaeological landscapes are readily

6 Abolition 2000 is a network of over 2000 organizations in more than 90 countries world-wide working for a global treaty to eliminate nuclear weapons.

> characterised by material remains—military hardware, bunkers, concrete domes, shipwrecks, airstrips. More insidiously, some are recognisable only in the illnesses of those who have dwelt in these landscapes while others now exist only in the memories of those who once lived there (Smith, 2007, p. 52).

Bikini is isolated, remote and difficult to access—all reasons why it was chosen as a site for nuclear testing. This same inaccessibility means that relatively few people will actually experience Bikini, and much of its meaning as the world's heritage is contained in the *representations* of Bikini as a place, and the portrayal of the events of Bikini to the world. Davis (2005) discusses the role of representation in legitimizing nuclear colonialism:

> Representations are a means of transmitting certain conceptualizations of a place to other people. Since these representations emphasize some characteristics of a place at the expense of others… They 'do work' by reinforcing conceptualizations of a place that legitimize certain uses and prohibit others. In turn, the new form of landscape informs a new conceptualization. (p. 609)

What was to the Bikinians their homeland, a place of abundance and life, was represented to the world as a "deserted Isle" (Davis, 2005), a barren and uninhabited *terra nullius* distant from the home population of the testing nation and therefore a safe place for tests. Representations of Bikini were made in the form of films, radio broadcasts, magazines and leading newspapers such as the *New York Times*, thus legitimizing the use of Bikini as a test site. Bikini and Enewetok Atolls were renamed to the "Pacific Proving Grounds"—a name that removed any connotation that this was a real place and a real home for real people: "The 'hole in the map' was a pre-condition for a nuclear hole in the ground; it alone created the necessary marginality for experimentation to be deemed acceptable" (Cosgrove quoted in Davis, 2005, p. 613).

In January 1946, Bikini was the landscape of a small group of people living within the ecological carrying-capacity of the atoll, with technologies developed and adapted over two thousand years for life on an atoll: fishing, navigation, sailing canoes and agriculture. Just a few months later the homesick Bikinians were banished to inhospitable islands while Bikini was radically transformed to conduct the largest scientific and military experiment in history. Cameron (1970) describes the following:

> Bikini had been, after all, a place of human habitation, a homeland. When the atoll was acquired by the US Navy, it had about 150 inhabitants. It had, however, something even more important: geography. The trifling life of the little island could not reasonably share in a transcendental experience that was, when all was said and done, dedicated to death. The whole function of Bikini was to be remote, far away, and as inaccessible as possible from anything valued by man, because it was to be destroyed… A place had to be found where the principle of overkill could be examined, where nuclear bombs could be tested in the atmosphere without inconveniencing anyone, at least anyone much. The Micronesian people of the central Pacific are by definition nobody much. (p. 24)

This process of representation is exemplary of what subsequently happened elsewhere. Bikini was the first colonial nuclear test site and set the precedent for similar representations to be made of the homelands of other indigenous communities around the world subjected to nuclear colonialism, including in the tropical atolls of Kiribati and French Polynesia, the deserts of Australia and Algeria, the rocky islands of Aleutian Alaska and the vast and arid steppes of Kazakhstan. Bikini Atoll shares much in common with other test sites—places of nuclear colonialism—around the world, but is an outstanding example due to its resonating symbolism, integrity and authenticity as will be discussed in section 3.c. Comparative Analysis.

3.a.(ii) Criterion (vi): be directly or tangibly associated with events or living traditions, with ideas, or with beliefs, with artistic and literary works of outstanding universal significance

Ideas and beliefs of outstanding universal significance are directly and tangibly associated with nuclear testing on Bikini Atoll. Emanating from this narrow circle of tiny islands in the middle of a vast ocean is a myriad of symbolism that has permeated our global culture. Events at Bikini led directly to the creation of political and ideological movements that have shaped global society in the second half of the 20th century.

The outstanding universal value of Bikini Atoll under this criterion is demonstrated through recognition of Bikini as:

- A source of globally significant cultural symbols and icons of the 20th century, and
- The location of events giving rise directly to the globally significant nuclear disarmament movement.

A source of globally significant cultural symbols and icons

The events at Bikini Atoll have inspired various cultural symbols and icons of the 20th century. These symbols are of outstanding universal significance by virtue of their ubiquity, universal recognition, and for the meanings they carry. In the case of the mushroom cloud, the symbol creates a focal point for the values attributed to nuclear weapons—enormous power, fear of spectacular annihilation, and later, of radioactive fallout. Godzilla initially arose from the Pacific Ocean floor as the very embodiment of nuclear devastation and radioactivity, a manifestation of Japan's terror of the bomb. The bikini swimming costume and SpongeBob SquarePants are icons of popular culture, one created before the world truly understood nuclear weapons, and the other devised long after the threat of nuclear weapons was anything but a backdrop—a cultural wallpaper. In line with the high technology of the bomb testing, these icons are modern and technological themselves—truly late 20th century popular culture.

The Mushroom Cloud: Images of the mushroom cloud were the primary way that information about the atomic tests was conveyed. Initially, photographs of the mushroom clouds were shown to Bikinians living on Rongerik to explain what was happening on Bikini. In 1954 *Life* magazine issued a pictorial special about the hydrogen bomb tests (April 19, 1954). Spectacularisation of nuclear testing using images of the mushroom cloud was a deliberate ideological move designed to make the population (of the US in particular) comfortable with the bomb—to make it commonplace. Images from Nevada and Bikini, in particular, were used to do this (Rosenthal 1991, Kirsch 1997). It was through *images* of the mushroom clouds that information about nuclear tests was made available to the public.

The universally recognized and understood mushroom cloud became the primary symbol used in propaganda both by the military, and by the anti-nuclear movement. The mushroom cloud was "associated not only with possible annihilation, but also with actual radioactive fallout and controversies over genetic defects" (Kirsch, 1997, p. 246). Rosenthal (1991) describes the significance of the mushroom cloud as a cultural symbol:

> A quarter century after the nuclear mushroom cloud has been seen in real life, it remains the unchallenged symbol of the nuclear age because its name, shape, and size make it adequate to carry all the meanings we need for it to bear. Clearly a culmination of the scientific knowledge our century values supremely, the mushroom cloud stands as apt image of science's power over nature. Clearly a triumph of the technology our country claims as measure of its superiority, the mushroom cloud stands tall as image of "America first." Clearly both a product and a prophecy of war, the mushroom cloud stands as undisputed sign of military might. Clearly a power of life-and-death proportions, the mushroom cloud stands as appropriate symbol for our secular age's placing in human hands the judgment once assumed to be in God's. And in its remarkable receptivity to projections upon it of even vaguely congruent images, whether fetus or phallus or smiling face, brain or tree or globe, the mushroom cloud projects back the array of human responses to all that it stands for: responses of pride, parochial possessiveness, creative resistance, denial, despair. (p.88)

Figure 34. Mushroom cloud from the Castle Romeo bomb test (US Government, 1954) (left)

Figure 35. This classic photo of Crossroads Baker was reprinted in newspapers around the world, and remains the symbol of the bomb even today (US Government, 1946)

Figure 36. "The First Bomb at Bikini" by Charles Bittinger, official artist for the US Navy (Naval Historical Center, Washington DC, 1946)

Figure 37. Fireball of H-bomb explosion after test blast over Bikini Atoll (1956, © Time Inc.)

The Bikini: The bikini swimming costume is a pop culture icon that has forever changed fashion. Originally named "le Atome" for its small size by its inventors—two French designers, Louis Réard and Jacques Heim,—it was launched upon the world as "le Bikini" on July 5, 1946, just days after the first test at Bikini Atoll. Political, social and fashion commentary conflated the meaning of the bikini at this time as Rosebush (n.d.) summarizes:

> Réard's famous fashion statement changes the world; like the bomb, the bikini is small and devastating. Vogue editor Diana Vreeland calls the bikini "the atom bomb of fashion," and a Paris fashion writer suggests it is the image of a woman emerging tattered from the blast. Perhaps the shock of seeing the Marshallese islanders in the nuclear age enable the Technologists to discover seeing themselves in the tribal age. And to enjoy it.

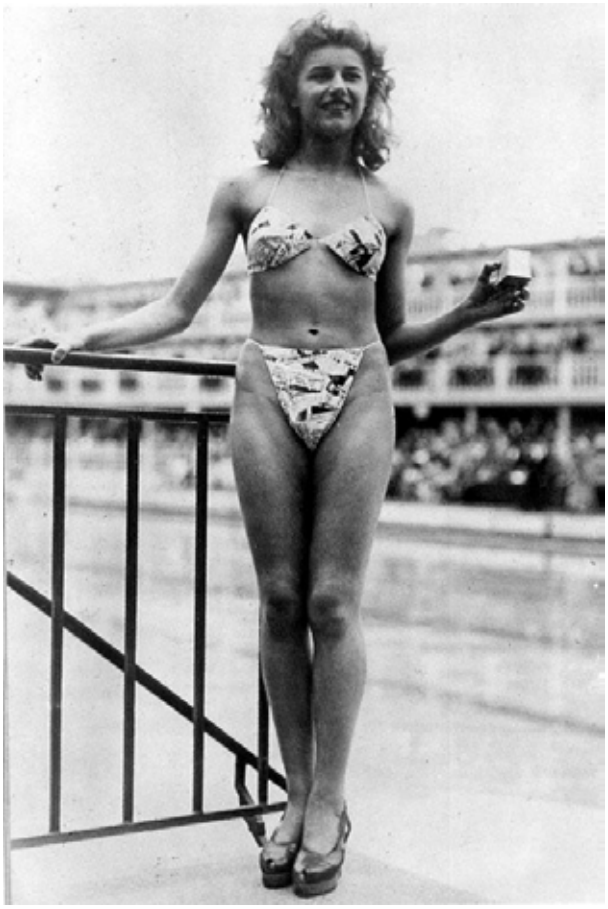


Figure 38. Michele Bernadini models the first Bikini in Paris, July 18, 1946 (unknown)

Figure 39. Godzilla (1946, © Toho Co. Ltd.)

Godzilla: Godzilla is the premier pop culture icon of Japan. The first Godzilla movie (*Gojira*, 1954) appeared just months after the Bravo test and the return of the irradiated *Daigo Fukuryū-Maru* and its crew to Japan. The movie refers overtly to the fishing boat and the US hydrogen-bomb tests at Bikini and Enewetak. In the film, American nuclear weapons testing in the Pacific awakens a seemingly unstoppable, radioactive dinosaur-like beast that attacks Tokyo, symbolizing the resurgent grief over Hiroshima and Nagasaki, and fear that these events would be repeated. Godzilla is now one of the world's most recognized monsters, having appeared in over 60 films, and his most well-known power is his atomic breath. Ryfle proposes that "*Godzilla*, then, is arguably the most important and enduring postwar monster movie—important because it attempted to address a global issue that still resonates 50 years later" (2007, p. 52).

Other works of art and culture: Works of art and culture that are directly inspired and touched by Bikini are too numerous to catalogue but some examples are presented here to show the breadth, diversity and global significance of Bikini's symbolic reach. Salvador Dali, in his 1947 painting "The Three Sphinxes of Bikini," presents us with images of the mushroom cloud mixed with images of trees and of the human head, suggesting the interaction of man, nature and atomic weapons. At the commencement of testing on Bikini in 1946, artist Laurence Hyde saw it as "a microcosm of the world-to-be if humanity, for the last time, failed to live up to its name. It would appear that Hiroshima and Nagasaki were not enough." Hyde developed a series of woodcuts that became the graphic novel *Southern Cross*, telling the story of both the testing, and the displacement and destruction of a Bikinian family. In the 1956 film *Moby Dick* (directed by John Huston and scripted by Ray Bradbury), Captain Ahab (Gregory Peck), when asked where he expects to find the whale, points on a chart to Bikini Atoll—a symbolic connection of the White Whale

to the bomb. A little more offbeat, in 1996 a cultivar of iris was officially named "No Bikini Atoll," possibly for its resemblance to the mushroom cloud. In 2002, critically acclaimed composer Steve Reich and artist Beryl Korot (2003) created the documentary video opera, "Three Tales" which tells the story of the Hindenberg disaster, the tests at Bikini Atoll and the cloning of Dolly the sheep, selected as three signposts of the 20th century. The music accompanying footage of the removal of the Bikinians and the detonations is described as "some of the saddest music Reich has composed" (Packett, 2002). *SpongeBob SquarePants*, a broadcasting phenomenon, is the most popular children's television program in the world, broadcast in 25 languages in 170 countries. SpongeBob SquarePants lives on Bikini Bottom, beneath the tropical isle of Bikini Atoll and episodes contain occasional references to the actual testing with footage of the bombs. In 2007, *Time* magazine named Sponge Bob Square Pants one of the "100 Best TV Shows of All Time" (Poniewozik, 2007). These are but a smattering of the works of art that are directly associated with Bikini.

Figure 40. Salvador Dali's "The Three Sphinxes of Bikini" (1947) (top right)

Figure 41. Woodcut from Laurence Hyde's graphic novel about Bikini, Southern Cross (1951) (right)

Figure 42. Captain Ahab points to Bikini Atoll as the likely location of the White Whale in the 1956 film, Moby Dick (lower right)

Figure 43. A cultivar of Iris, officially recognized in 1996 named "No Bikini Atoll" (Cooley's Iris Garden, n.d.) (left)

Figure 44. Scene from staged version of Three Tales by Steve Reich and Beryl Korot (W. Bergmann, 2002)

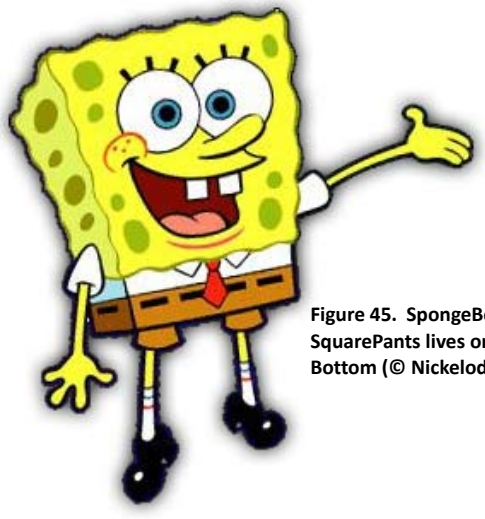


Figure 45. SpongeBob SquarePants lives on Bikini Bottom (© Nickelodeon)

Events giving rise directly to the globally significant nuclear disarmament movement

Events at Bikini were the seed from which grew movements (expressions of values) demonstrating the global significance of the nuclear age in the late 20th century: the nuclear disarmament movement.

The very same month of the return of the *Daigo Fukuryū-Maru* to Japan, a group of middle-class housewives from Tokyo began the "Suginami Appeal"—a campaign against the hydrogen bomb. In his definitive history of nuclear disarmament movements around the world, Wittner (1997) describes that the campaign "blossomed into a nationwide movement and, by the following year, had attracted the signatures of 32 million people—about a third of the Japanese population" (p. 8). Between March 18 and October 22, 1954, all of the 46 prefectural parliaments passed anti-nuclear resolutions (Hiroshima City in Saito, p.369).

In August 1955, the First World Conference against Atomic and Hydrogen Bombs was held in Hiroshima, leading directly to the establishment of Gensuikyo: The Japan Council against Atomic and Hydrogen Bombs in September of the same year (Introducing the Japan Council against Atomic and Hydrogen Bombs (Gensuikyo), n.d.). Wittner states that "Gensuikyo became one of Japan's most important and enduring mass movements" (1997, p. 9). The reach and significance of the Gensuikyo organization in the anti-nuclear movement is demonstrated by the petition of over 100 million signatures presented in 2000 to the UN Office for Disarmament Affairs in support of the "Appeal from Hiroshima and Nagasaki for a Total Ban and Elimination of Nuclear Weapons" (Dhanapala, 2000).

The *Daigo Fukuryū-Maru* has been retained as a monument of the events at Bikini Atoll and is now on display at the Tokyo Metropolitan *Daigo Fukuryū-Maru* Exhibition Hall which receives over 300,000 visitors every year, and educates on the devastating effects of nuclear weapons (*Daigo Fukuryū-Maru* Exhibition Hall, 2005; Kennedy, 1999).

The horror experienced by Japan, and the exposure of the Marshallese to fallout, quickly gave rise to anti-nuclear sentiment in direct response to the Bravo shot on Bikini in 1954. Prime Minister Jawarlal Nehru of India was the first to propose a ban on nuclear testing—shortly after the US Bravo test in April 1954. The Bravo shot at Bikini provoked Bertrand Russell and Albert Einstein to write the Russell-Einstein Manifesto, launched at the first Pugwash conference in July 1955. The manifesto was signed by the leading scientists at the time. The influential Pugwash movement was awarded the Nobel Peace Prize in 1995.

Figure 47. Bertrand Russell and Albert Einstein wrote the Russell-Einstein manifesto as a response to the Bravo test on BIkini.

The Castle Bravo detonation resonates around the world even today as the blast, and its consequences are commemorated in a peace march held each year in Shizuoka Prefecture in Japan. This march calls for the abolition of nuclear weapons and commemorates the death of Aikichi Kuboyama, the radio operator of the *Daigo Fukuryū-Maru* who has become a symbol of the test in Japan ("Peace march", 2008). In the Pacific Islands, the "Nuclear Free and Independent Pacific Day" is celebrated on the same day. In the Marshall Islands, the day is commemorated by the Bikinians. All these commemorations refer to this day—March 1, the anniversary of the Castle Bravo—as "Bikini Day."

(Note: An in-depth discussion of the early days of the nuclear disarmament movement, galvanized to action by the Castle Bravo detonation, can be found in Wittner, 1997).

Figure 46. The Tokyo Metropolitan *Daigo Fukuryū-Maru (Lucky Dragon #5)* Exhibition Hall receives over 300,000 visitors each year (anonymous, n.d.)

3.b Proposed Statement of Outstanding Universal Value

Nuclear bomb tests at Bikini Atoll shaped the history of the people of Bikini, the history of the Marshall Islands and the history of the entire world. Bikini Atoll is distinctly 20th century heritage, standing testimony to the dawn of the nuclear age, the start of the Cold War and the era of nuclear colonialism – stages in human history of global significance.

Bikini Atoll is an outstanding example of a nuclear test site. The entire landscape and seascape of Bikini testifies to its history as a nuclear test site, from the ensemble of sunken ships and the purpose-built bunkers, to the disappeared islands and the Bravo crater. The lonely rows of coconut trees, placed in preparation for a failed resettlement, and the conspicuous absence of humans speak to the fate of a nuclear test site rendered uninhabitable.

Bikini Atoll stands as a monument and memorial to the dawn of the nuclear age. At Bikini, the quintessential tropical paradise, beloved by our modern culture as a place of peace and simplicity, is juxtaposed with the artifacts of nuclear bomb testing, evoking a remembrance of a time of lost innocence—when men held and wielded a power reserved for gods.

Bikini Atoll played host to events of global significance which are illustrated in the landscape and seascape. The sunken vessels bear witness to Operation Crossroads—the first peacetime atomic bomb tests, implicated in the start of the Cold War. The Bravo crater is evidence of the Castle Bravo test—the first deliverable hydrogen bomb, and the event that introduced the world to fallout. Aside from the bombs dropped on Hiroshima and Nagasaki, few, if any, other nuclear weapons events have had this scale of impact on the world.

The process of nuclear colonialism around the world is exemplified by Bikini, from the selection of Bikini as a remote site, distant from the population of the testing nations, to the representation of Bikini as a *terra nullius*, to the displacement of the Bikinians and the irradiation of Marshallese and military personnel. Bikini was the first site of nuclear colonialism and remains the outstanding illustration of this significant stage in human history.

Ideas and beliefs of outstanding universal significance are directly and tangibly associated with Bikini Atoll. Emanating from this narrow circle of tiny islands in the middle of a vast ocean is a myriad of symbolism that has permeated our global culture, including the universally recognized and understood mushroom cloud, the bikini swimming costume, and the radioactive pop-culture icon, Godzilla. The breadth, diversity and global significance of Bikini's symbolic reach is evidenced in the innumerable works of art, music, film and literature that have been touched and inspired by the events at Bikini, illustrating the profound impact of events at Bikini on the global culture and psyche.

Events at Bikini led directly to the creation of political and ideological movements that have shaped global society in the second half of the 20th century, mostly connected with the Castle Bravo test on March 1, 1946. The return of the irradiated *Daigo Fukuryū-Maru* and her ill crew in March 1946 led to the momentous "Suginami" petition, which in turn led to the establishment of Gensuikyo: the Japan Council Against Atomic and Hydrogen Bombs, an enormously significant mass movement in Japan. The Bravo shot led Albert Einstein and Russell Bertrand to write the Russell-Einstein Manifesto, which in turn led to the establishment of the Pugwash movement of influential scholars and public figures concerned with reducing the danger of armed conflict and seeking cooperative solutions for global problems. The anniversary of the Bravo test continues to be celebrated as "Bikini Day" in Japan, and as the "Nuclear Free and Independent Pacific Day" throughout the Pacific.

3.c Comparative analysis (including state of conservation of similar properties)

Bikini Atoll is being presented for World Heritage nomination as an outstanding example of a nuclear test site. In comparing Bikini Atoll with several other key atomic test sites, the primary purpose is to show that the powerful symbolism, the remembrance of events and the integrity of Bikini's nuclear landscape uniquely position Bikini Atoll to stand testament to all the nuclear test sites of the world, and to tell the story of all the peoples who have suffered at the hands of nuclear colonialism. Due to the significance of the nuclear age for humanity, the specific heritage values expressed by Bikini leave opportunity for other sites expressing different values of the nuclear age, such as technological achievement, to be added to the World Heritage list at a later time.

The following discussion compares Bikini with a small number of nuclear test sites from around the world, and also with Hiroshima Peace Memorial (Genbaku Dome). The comparative analysis is carried out thematically, on the basis of the values presented in section 3.a:

(i) monuments and memorials to the dawn of the nuclear age;

(ii) sites of nuclear testing events of global significance;

(iii) sites bearing testimony to nuclear colonialism;

(iv) sources of nuclear-related globally significant cultural symbols and icons; and

(v) the location of events giving rise directly to the nuclear disarmament movement.

In addition we compare Bikini and other sites on the basis of the overall expression of attributes of a nuclear test site based on the integrity and authenticity of these attributes and the state of conservation.

On the basis of the expression of nuclear weapons values and on its role as a nuclear test site, the sites selected for comparison include: the Hiroshima Peace Memorial (Genbaku Dome)—already inscribed on the World Heritage List, Trinity—the site of the world's first nuclear detonation, Enewetak Atoll in the Marshall Islands, and several other key nuclear test sites in the Pacific region and around the world. The table below summarizes the framework for the comparative analysis, which is discussed in more detail under each theme.

	Bikini Atoll	Hiroshima Peace Dome (Genbaku), Japan	Trinity, USA	Enewetak Atoll, Marshall Islands	Moruroa and Fangataufa, French Polynesia	Maralinga and Emu Field, Australia	Kiritimati (Christmas Island), Kiribati	Nevada, United States	Semipalatinsk, Kazakhstan
Monument and memorial to the dawn of the nuclear age	+++	+++	++	+	-	-	-	-	-
Nuclear testing events of global significance	+++	+++	+++	+	+	+	+	+	+
Expression of nuclear colonialism	+++	-	-	++	++	++	+	-	++
Symbolism of global significance	+++	+++	++	+	+	-	-	+	-
Giving rise directly to the nuclear disarmament movement	+++	+++	-	-	+++	+	-	-	-
Expression of nuclear attributes in the landscape	+++	+++	+++	+++	+	+	+	+++	+
Authenticity	+++	+++	+++	+++	+	+	?	+++	?
Integrity of the site	+++	+	+	+	+	-	?	-	-
State of Conservation	+++	+++	+	+	++	-	?	?	-

Sites are rated for Outstanding Universal Value against the attributes above as: +++ exceptional, ++ considerable, + some, - insignificant, and ? not known

3.c.(i) Monuments and memorials to the dawn of the nuclear age

Delgado (1991) emphasizes that "the effort to memorialize and celebrate the impact of the bomb began at the same time the new age dawned" (p. 144). The site of Trinity was proposed as an "Atomic Bomb National Monument" in 1946, and was declared a National Historic Landmark in 1965. The Peace Park at Hiroshima was established under a law in 1949 that aimed to have all of Hiroshima rebuilt as a "Peace Memorial City." To date only one site representing the nuclear age is listed on the World Heritage List—Genbaku, the Hiroshima Peace Memorial.

These sites of Hiroshima, in Japan, and Trinity in New Mexico, along with Bikini Atoll, are the three outstanding sites representing the dawn of the nuclear age; however, they each carry unique meanings and symbolism. The Trinity Site was proposed as a national monument as a celebration of technological achievement—a symbol of American national pride in the skill and investment that resulted in the detonation of the "world's first nuclear device" on July 16, 1945 (National Park Service, n.d.). In stark contrast, the Genbaku Dome, the Hiroshima Peace Memorial, is the pre-eminent symbol of the first use of nuclear weapons on a civilian population. It was inscribed on the World Heritage list in 1996 and has been conserved in the state it was after the bombing of Hiroshima on August 6, 1945 as the only building remaining standing in the vicinity of ground zero. The Peace Dome and the Peace Park that surrounds it form a "locus of contested memory and contested values" (Beazley, 2007, p.33) commemorating the 140,000 lives that were lost, and at the same time, the peace that nuclear weapons have brought to the world. Bikini is an exceptional monument to the dawn of the nuclear age as it has a different and unique meaning from these sites of comparison at Trinity and Hiroshima – Bikini stands as a monument and memorial to the ushering in of the Cold War and the era of nuclear colonialism, and, as discussed in section 3.a, evokes remembrance of humanity's loss of innocence.

Figure 48. A monolith marking the position of the Trinity explosion, the "world's first nuclear device" in 1945 at White Sands, New Mexico (Anonymous, n.d.)

Figure 49. The World Heritage-listed, Hiroshima Peace Memorial (Genbaku Dome) (Anonymous, n.d.)

3.c.(ii) Nuclear testing events of global significance

Of the more than 2,000 nuclear testing events since 1945, only a few are truly globally significant, most notably the following:

- Trinity—the first detonation of a nuclear device on July 16, 1945.
- Operation Crossroads Able and Baker on July 1 and July 25, 1946 – the most public of all the tests, with international press and observers present, and the globally significant contribution to the start of the Cold War at this time.
- Ivy Mike on Enewetak—the world's first thermonuclear (hydrogen) device and significant as a key technological development.
- Castle Bravo on March 1, 1954—the world's first deliverable hydrogen device but more importantly, the contamination of the *Daigo Fukuryū-Maru* and the fallout across the Marshall Islands introduced the world to radioactive fallout from such a weapon.
- "Big Ivan" (known as "Tsar Bomba" in the west), tested by the Soviets on October 31, 1961–significant as the largest thermonuclear weapon ever tested at 50 megatons.

The Little Boy dropped on Hiroshima on August 6, 1945 and Fat Man dropped on Nagasaki on August 9, 1945 are not compared here as they were not experiments, but were weapons deliberately used against a population in wartime.

Thus Bikini was host to two of the world's most significant nuclear testing events, however the significance and impact of these tests was distinct from other nuclear testing events, particularly the role that Crossroads played in the start of the Cold War, and the global resonance of the Bravo test as described in section 3a.

3.c.(iii) Expression of nuclear colonialism

The ultimate expression of nuclear colonialism is either the displacement of people to make way for the testing, or their exposure to the effects of nuclear testing. In both cases, these events have catastrophic effects on the lives of individuals, their cultural identity, economic situation, health and way of life. Bikini Atoll is the strongest expression of nuclear colonialism due to:

- The forced displacement of the Bikinians, and the catastrophic health concerns and displacement of other Marshall Islanders resulting from radioactive contamination of a swathe of these islands and their people;
- The extensive documentation of the entire process of nuclear colonisation, as part of the development of the Bikini Atoll nuclear test site; and
- The representation of Bikini as a "deserted isle" in order to legitimise the testing—representation that was unprecedented, and that established the form for representation of other sites of nuclear colonialism.

The sites of Enewetak and Moruroa have similarly strong expressions of nuclear colonialism. Enewetak's history is similar to Bikini's with the people of Enewetak being displaced to make way for the testing. The experience of nuclear colonialism in French Polynesia, while not displacing people from the atolls, which were initially uninhabited, did transform the local economy and culture and gave rise to a strong domestic struggle against the French colonialists, eventually leading to the regionally-significant Nuclear Free and Independent Pacific Movement (Danielsson & Danielsson, 1986; Smith, 2007). However, the entire process of nuclear colonialism, as it happened in other places around the world, is exemplified by Bikini, from the selection of Bikini as a remote site distant from the population of the testing nations, to the representation of Bikini as a *terra nullius*, to the displacement of the Bikinians, the irradiation of Marshallese and military personnel and the resulting uninhabitable lands. Bikini was the first site of nuclear colonialism and remains the outstanding example, in part because every phase of the process was documented. In presenting Bikini Atoll as the strongest expression of nuclear colonialism, it is not intended in any way to diminish the experience of other victims of nuclear colonialism. Instead, it is suggested that Bikini can stand as a particularly evocative example; a testimony for all victims of nuclear colonialism.

3.c.(iv) Source of symbols and icons of global significance

While the preeminent symbol of the nuclear age, the mushroom cloud, is associated with all atmospheric nuclear test sites as well as with Hiroshima and Nagasaki, images that have propagated this symbol are sourced mainly from the Bikini and Nevada test sites (Rosenthal 1991, Kirsch 1997). Other key symbols and icons of the age of nuclear weapons readily come to mind: the peace symbol which made its first appearance on the first Aldermaston march in 1958, shortly after Britain conducted its first nuclear tests in the Pacific; and the Greenpeace *Rainbow Warrior*, sunk by French intelligence agents in Auckland Harbour in 1985 while preparing to travel to Moruroa to protest French nuclear testing. However, both of these important symbols are only tangentially connected to place. Bikini stands out from all other nuclear test sites as the place which is the single source of an array of diverse and iconic symbols representing different and conflated meanings of the nuclear age, and as the source of the works of art and culture that are inspired directly by Bikini.

3.c.(v) Giving rise directly to the nuclear disarmament movement

The global significance of events at Bikini, and the role they played in the early establishment of the nuclear disarmament movement worldwide, starting in 1954, is described in section 3a. Bikini played a particular role in the 1950s during the phase in which the movement became established and organized as a mass movement, most significantly in Japan. Later on, the movement gained momentum as public outcry against proposed British tests on Kiritimati (Christmas Island) became more vocal, leading to the establishment of the powerful Campaign for Nuclear Disarmament (CND) in 1958. Similar mass movements developed in America and across Western Europe from 1957, related in general to the fallout events from testing in the Pacific and leading to the US and USSR moratorium on atmospheric testing in 1958 (Wittner, 1997). It was the testing on Moruroa and Fangataufu in French Polynesia starting in 1966, along with the experience of the Marshall Islands, which provided the impetus for the nuclear disarmament mass movement in the Pacific and Australasia. The "Conference for a Nuclear-Free Pacific" was convened in Fiji in 1975, initiating the Nuclear Free and Independent Pacific Movement. This movement played a profoundly important social, cultural and political role in the region, recognizing the need for independence of Pacific colonies and setting the tone for the public's attitude towards not only nuclear weapons, but nuclear technologies in general. The movement led directly to the establishment of the *South Pacific Nuclear Free Zone Treaty* ratified by 16 state parties in the region. Thus, while other test sites (Kiritimati, Moruroa and Fangataufu) played significant roles in the nuclear disarmament movement in later times, it is events at Bikini Atoll which gave rise to the early days of the movement.

3.c.(vi) Authenticity, integrity and state of conservation

Bikini Atoll is exemplary of other nuclear test sites, however Bikini stands out from all these sites in the degree of documentation and publicity that was given to these sites. The removal of the Bikinians was scripted and filmed (several times), much effort went into portraying the post-war military site and the biology and geography was surveyed extensively both before and after the tests as well as the very detailed and specific records of the tests themselves. Nowhere else in the Pacific or in other distant-nation test sites were the activities so well documented or publicized; most were carried out in utmost secrecy (and information on some is still unavailable or was never collected). The integrity, authenticity, well documented cultural history and the well-preserved artifacts of the testing, including the ships, along with the accessibility of the site to tourists who can explore firsthand these material remains of the testing era, make Bikini an outstanding example of a nuclear test site.

Trinity and Hiroshima: Delgado (1991) has compared the artifacts of Bikini to those of Trinity and the Japanese target cities:

> The ships of Operation Crossroads, lying where they were sunk by two nuclear blasts, are the last "vestigial" remnants of that time and place. Substantially unchanged, they are the only essentially unmodified museum of the dawn of the era of the atomic bomb—unlike the picked-over, filled-in, and fenced ground zero of the Trinity Site, or the rebuilt Hiroshima and Nagasaki. (Delgado et al., 1991, p. 143)

Enewetak Atoll: At the close of testing in 1958 Enewetak continued to be used for US military purposes until the start of a cleanup and rehabilitation program in 1977. An estimated 73,000 cubic meters of contaminated soil as well as debris from the testing was removed from the islands, mixed with cement, placed in a bomb crater on Runit Island, and capped with a concrete dome now known as the "Runit Dome." Enewetak Atoll was declared safe for habitation and people returned to the southern islands of their atoll in 1980, while the northern part of

the atoll around the Runit Dome remains off-limits. The Runit Dome in itself is a remarkable artifact of nuclear testing, and in itself forms a monument to the nuclear era. However, Bikini Atoll stands out from Enewetak as a nuclear test site due to the fact that it has not been used for other purposes (except small-scale tourism) since the testing, and so the entire atoll, rather than one island as for Enewetak, retains the authenticity and integrity of a nuclear test site.

Figure 50. Runit Dome on Enewetak (Defense Special Weapons Agency, n.d.)

Nevada Test Site (NTS), United States: The enormous Nevada site, as the primary testing location for US nuclear devices, is clearly a significant nuclear test site, having seen more than four decades of nuclear testing, but it differs fundamentally from Bikini in that it is continental, and on the homeland of the testing nation and was host to over 900 tests—an order of magnitude greater than Bikini. A further difference is that the NTS remains today an active site for various other activities such as hazardous chemical spill testing, emergency response training, conventional weapons testing, and waste management and environmental technology studies. (Source: Nevada Test Site, 2008)

Semipalatinsk Test Site (STS), Kazakhstan: The Semipalatinsk Test Site was the primary venue for Soviet nuclear weapons testing, witnessing over 450 tests between 1949 and 1989. STS was the largest underground nuclear test site in the world; however, between 1997 and 2000 a joint US-Kazakhstan program—the "Weapons of Mass Destruction Elimination Initiative"—destroyed key testing infrastructure including the extensive tunnel network, and the site is not fenced, allowing animals and people free access to the site. Three nuclear research reactors are now housed on the site and there are reports of scrap metal collection and mining on the site. The STS differs substantially from Bikini in that it is a continental site, was devoted primarily to underground testing, and is today used for many different purposes. (Source: Loukianova et al., 2008)

Moruroa and Fangataufa, French Polynesia: In French Polynesia, Fangataufa atoll is abandoned but Moruroa remains guarded by French Legionnaires (Smith, 2007, p. 62). Both atolls were host to atmospheric testing from 1966 to 1974, and then underground testing from 1975 to 1996. The underground blasts involved drilling down into the basalt geological structures supporting the reefs. Moruroa exhibits a highly modified landscape with roads, quarries, blockhouses and towers—all artifacts from the nuclear testing. However, strict military secrecy by the French means that much less is known about the testing at Moruroa and so there is a far lesser degree of authenticity and documentation than for Bikini.

Maralinga and Emu Fields, Australia: The evidence and artifacts left from nuclear tests in Maralinga and Emu Fields differ from Bikini in several ways. The tests themselves were relatively fewer, and were a mixture of atomic weapons and what were called "minor trials"–conventional explosives used to disperse radioactive plutonium. Subsequent cleanup efforts are now thought to have dispersed this waste even further thus these sites have little integrity as former nuclear test sites.

3.c.(vii) Summary statement of comparative analysis

Bikini Atoll is shown to have a different and unique meaning when compared to existing monuments and memorials of the dawn of the nuclear age, Hiroshima Peace Memorial and the Trinity Site. Bikini was host to two of the world's most significant nuclear testing events, the significance and impact of which are distinct from other nuclear testing events. Bikini Atoll is an exemplary expression of the entire process of nuclear colonialism from the selection of the site, the displacement and irradiation of people, to the resulting uninhabitable lands, thus being able to represent this process for all sites of nuclear colonialism. Bikini Atoll stands out from all other nuclear test sites as the single source of a diverse array of globally significant, iconic symbols related to the nuclear age. Events at Bikini, in particular the Bravo shot, gave rise to the establishment of the nuclear disarmament movement in the 1950s, with other sites playing a role in later stages of the movement. The authenticity, integrity and the state of conservation of the nuclear attributes of Bikini make it an internationally outstanding example of a nuclear test

site.

3.d Integrity and Authenticity

3.d.(i) Statement of Authenticity:

The authenticity of Bikini Atoll as a place, and in its various cultural meanings, is extensively documented and expressed in a wide range of ways. Many of these information sources are readily accessible primary sources of documentation, either from the period of nuclear testing itself, or from more recent times. Because of the relatively recent nature of the historic events at Bikini (less than 70 years ago), there remain people in the Marshall Islands, United States, Japan and throughout the world who remember the events at Bikini.

The significant attributes of Bikini Atoll include:

- the physical artifacts and the landscape, including the sunken vessels, remnant structures of bunkers and monitoring stations, the craters in the reef, the grids of planted coconuts, and the radiation;
- the natural ecosystems, both marine and terrestrial, and changes in these ecosystems during and since the nuclear tests;
- the representation of Bikini, and the symbolism and meaning that emanates from Bikini throughout global culture; and
- the meaning of Bikini as a homeland lost to its people.

The tangible expressions of nuclear testing at Bikini Atoll are documented in scientific and descriptive studies of the physical artifacts. The ships were documented in an archaeological survey (Delgado et al., 1991) and have been written about and photographed in a wide range of respected publications, including *National Geographic* (Eliot, 1992). The landscape and technological assemblage was extensively filmed and photographed during the testing and the current remnants are easily identifiable against this documentation. Radiation, although unseen, is clearly a physical attribute of the site and has been documented in several studies during and since the testing.

The authenticity of Bikini and of the significance of events at Bikini was well-documented through US media, and this has been greatly supported in more recent years by the release of military and government documents and film footage through the Freedom of Information Act. In presenting the universal significance of Bikini Atoll, it is difficult to ascertain, for example, the degree to which the events at Bikini impacted the Soviet's approach to the negotiations at the start of the Cold War. As Graybar states, "In the absence of documents from the Kremlin one can never be sure what impact the tests had on the talks at the United Nations" (1980, p. 122).

The integrity of the site has not been compromised. The artifacts from the testing, and the physical condition of the natural environment are authentic in that they have not been modified or rebuilt since the testing events and the subsequent clean-up efforts. The results of the clean-up efforts (the bulldozed land and the untended grids of coconut trees) are themselves part of the evolution of a nuclear test site, as they demonstrate a growing understanding of the persistent nature of radiation from nuclear bombs.

Hines (1963) states that "Operation Crossroads unquestionably was the most thoroughly documented, reported, and publicized peacetime military exercise in history" (p. 32) while Weisgall (1994) places it as "the grandest scientific experiment ever, more exhaustively photographed, reported, and measured than any previous event in history" (p. 117). The events of the actual tests, between 1946 and 1958, are captured in the plethora of reports, radio recordings, photos, films and documentaries of the period. Most of this information, originally recorded by the US military, is now in the public domain.

The global political climate at the time of the testing, and Bikini's role in it, is documented in newspaper articles, letters, speeches, petitions, records of meetings, and in manifestos. Bikini's importance in all of this is evidenced by the many articles in the *New York Times* and *Washington Post*, both on the front page and in special reports. The Soviet newspaper, *Pravda*, reported on both Operation Crossroads and on the Bravo shot, and the Bravo test was covered closely by the *Yomiuri Shimbun* (Saito, 2006), Japan's largest circulation daily newspaper. All these are primary sources that attest to the authenticity of Bikini Atoll's global significance. The resonance of Bikini as a source of nuclear symbolism has made its way into art, film, television, literature and a plethora of commentaries on global culture and the nuclear bomb in the second half of the 20th century. In fact, the wide range of information sources that present and interpret Bikini's symbolism illustrates beautifully the profound social, psychological and cultural impact the events of Bikini have had on generations of humans, all over the world. Many of these sources are referenced throughout this document.

The spiritual connection of the Bikinians with their islands, and their experience of forced migration as

subjects of nuclear colonialism, is recorded in interviews and transcribed into books, as well as being captured by the cameras of the US military. The history of the people of Bikini is retained in their culture as an oral tradition.

3.d.(ii) Statement of Integrity:

The Bikini property is a holistic single atoll system surrounded by open ocean. It has a very high degree of integrity for two reasons: the first being the reason for selection as a nuclear test site—its remoteness; the second being the unintended effects of testing—persistent environmental radiation that has prevented people from returning here to live. It is now a place that is far from man-made disturbances and is impacted only by a very small number of tourists and residents.

Artifacts of the nuclear testing:

Artifacts, buildings and submerged ships related to testing are in good condition, given the usual natural processes of deterioration. Bikini, in its totality, is a protected and managed "archaeological park" with its various components creating a vast and whole "nuclear landscape" above and below the water. The archaeological integrity of the site has been protected by its isolation and by its "off limits" nature, as well as radioactive contamination. Very few materials have been removed, and those which have been removed have been part of the ongoing process of nuclear site management as weapons and the equipment evolved during the active use of Bikini as a test site. Bikini evolved as a nuclear landscape, and within this context, the shifting of platforms, the erecting of new bunkers, even the planting of rows of trees and the construction of homes for the failed resettlement reflect the evolution of Bikini.

Archaeological assessment of the ships was undertaken in 1989-1990 by the US National Park Service. The ships and the surrounding landscape were determined to be eligible, were they in the US, for designation as a National Historic Landmark district, and potentially, again if in the US, as a unit of the national park system because of the unique nature of the site and its archaeological integrity. In addition to the ships, artifacts observed and documented included test equipment and items left inside and on the ships, as well as material lying on the lagoon floor. In the case of the aircraft carrier USS *Saratoga*, for example, the archaeological integrity of the ship as a contributing element to the entire site included small arms such as pistols in small arms lockers, the ship's silver service in the galley, shells in ready ammunition lockers, aircraft in the hangar, fire- fighting equipment, test towers on the flight deck, scattered lead sheets from test gauges, a field artillery piece on the flight deck, and vehicles and aircraft washed off the deck and lying alongside the carrier on the lagoon floor. In the case of the aircraft, their cockpits still held 50-gallon fuel cans strapped empty in the seats to simulate a pilot's chest cavity during the blasts, and 500-lb. bombs in the bomb bays. A pair of thick protective goggles to allow observers to gaze at the "Able" surface test detonation was observed lying on the carrier's navigation bridge. The ships in particular demonstrate a high level of archaeological integrity reflecting the events of July 1 and July 25, 1946.

The processes of deterioration, especially in the ships, are irreversible and directly related to the atomic tests. In the case of the ships, blast damage introduced micro-fractures and may have turned steel into the isotope of steel, accelerating the deterioration of the ships. As such, the unnatural processes at work, and the ultimate disintegration of the ships over the next century is demonstrative of the legacy of the tests, and an integral and key aspect of this landscape—as such, these processes and the ongoing changes in the ships and structures should be monitored, assessed and documented. Even in a deteriorated form the ships are a highly significant archaeological site.

Natural environment

The terrestrial environment of Bikini has been very much disturbed from its natural state by the construction of the test site, the bomb blasts that stripped away vegetation and the rehabilitation efforts to reduce contaminated soil and replant coconut trees. These disturbances are clearly physical, but another more insidious result is the invasive plants and animals that arrived on the many vessels and aircraft that came and went from Bikini. Thus, the integrity of Bikini's natural terrestrial system is not intact, but these impacts further illustrate the fate of a nuclear test site.

The marine environment has recovered remarkably from the testing and the reef system has a very high biodiversity, showing the range of species, including endemic biota, apex predators (sharks) and migratory species such as turtles, that demonstrate the system is functioning well. The buffer zone of the site extends 5 nautical miles out, affording the atoll ecosystems additional integrity. It is thought that neighboring Rongelap Atoll, some 150 kilometers to the east, has played a role in re-colonizing the coral reefs of Bikini Atoll. Rongelap Atoll also enjoys a high level of conservation management and protection by its owners, thus further enhancing the integrity of Bikini's natural marine system.

Part 4. State of Conservation and Factors Affecting the Property

4.a Present state of conservation

4.a.(i) Decomposition of the sunken vessels

The natural processes of corrosion and deterioration inherent in all sunken vessels appears to be accelerated at Bikini. There are two theories currently being evaluated. The first is that the nuclear blasts introduced consistent micro-fractures throughout the structure of the steel of each ship, that this nuclear effect has resulted in a higher level of chloride absorption and subsequent accelerated corrosion, and that the steel, as it deteriorates, is subject to larger scale fracturing. Another possibility is that the radiation from the two bursts converted elements in the steel into isotopes. The isotope of steel is said to have a half life of seven years, and several generations of half lives have further weakened the steel. Deterioration is most apparent on USS *Saratoga*, where the flight deck is collapsing, interior spaces with overheads are collapsing, and the "island" superstructure has tilted and begun to collapse inward and to the port (left) side of the ship (Delgado et al., 1991). It was recently reported that the gun director on top of the *Saratoga* bridge had collapsed into the elevator shaft (J. Niedenthal, pers. comm., January 2008).

The gradual loss of structural integrity of the ships does not represent a loss of archaeological integrity, nor does it represent a loss of heritage value. The Bikini test ships are representative of more than historic shipwrecks. They are large test instruments exposed to the effects of nuclear blasts, and the deterioration of the vessels is a long-term effect of the blasts, and as such is a representative and significant feature of the site.

Figure 51. Divers on the Apogon conning tower. The ships at Bikini Atoll appear to demonstrate accelerated corrosion as a result of the atomic tests (E. Hanauer, 2006)

4.a.(ii) Deterioration of buildings

The few buildings from the testing period that remain on Bikini, Eneu and Aemon are in a general state of disrepair. The construction of reinforced concrete is subject to deterioration in the salty environment as the reinforcing bars rust and expand, cracking the concrete. As for the ships, the natural deterioration process of these few buildings is illustrative of the long-term fate of an abandoned nuclear test site and as such, the current state of conservation is a part of the characteristic of the site as a whole.

4.b Factors affecting the property

4.b.(i) Development pressures

None of these pressures applies at Bikini. There are no plans to resettle or develop Bikini except for the potential for small-scale tourism development.

4.b.(ii) Environmental pressures

Climate change and illegal fishing discussed here are not expected to have an impact on the cultural artifacts, but are discussed here with relation to Bikini's natural attributes.

Climate change

As with all low-lying atolls, Bikini Atoll is threatened by climate change; however, it is as yet unknown how this will impact the atoll in the long-term. Climate change is predicted to result in sea-level rise, and increased exposure to storm surge and rising tides that are known to wash over entire islands. As this deposits salt in the soil, existing terrestrial flora may change or degrade, potentially leading to desertification. In addition, climate change is predicted to result in warmer sea temperatures and changes in the major oceanic currents that currently provide climate regulation. This leads to unpredictable impacts, but we could expect to see an increase in coral bleaching events and possibly a shift in species assemblages within coral reefs to those species with higher temperature tolerance. Ocean acidification is predicted to seriously impact the ability of corals to grow and form skeletons.

Illegal fishing pressure

Illegal fishing of Bikini sharks can be a serious threat to richness and the ecological balance of this atoll. Reef shark fins are highly valued by the Asian market and some illegal longline fishing has happened in the near-shore waters of a few atolls including Bikini. A shark-finning boat found fishing off Bikini in 2002 was successfully prosecuted and no major incidents have been reported since. This threat is not only detrimental to the tourism industry, sharks being one of the main attractions of the atoll, but could greatly damage the functioning of the reef trophic web, naturally dominated by sharks. One of the challenges of protecting the natural values of the atoll will be the monitoring and enforcement of illegal fishing activities.

4.b.(iii) Natural disasters and risk preparedness

Bikini Atoll only experiences the occasional storm, as the Marshall Islands rarely experiences typhoons. The entire area of the Marshall Islands is very geologically stable and does not experience earthquakes. With climate change, there is an expectation of increased incidence of storm surges, but it is unlikely these would significantly affect the residential quarters on the leeward side of Bikini Island.

4.b.(iv) Visitor/tourism pressures

The current and expected future levels of tourism to Bikini Atoll remain very low, mainly due to the relative inaccessibility of the atoll. At present, there are less than 10 resident workers and no more than 12 tourists there at any one time. The total number of tourists per year historically has been 200-250. This might be expected to increase to a total of 400 with developments in tourism.

Divers on the sunken vessels pose some threat through damage to the vessels and unauthorized removal of artifacts. Two other activities available on Bikini are diving and snorkeling of the reef, and sport fishing. Both of these activities will have negligible impact on Bikini, again due to the low numbers. General movement of visitors walking or driving on the islands does not impact the site due to the highly disturbed nature of the terrestrial environment.

4.b.(v) Number of inhabitants within the property and the buffer zone

Estimated population located within:

Area of nominated property 25

Buffer zone N/A

Total 25

Year 2008

Part 5. Protection and Management of the Property

5.a Ownership

As in the rest of the Marshall Islands, land on Bikini Atoll is held under customary tenure through traditional clan relationships. Land is divided into parcels, called 'weto', under specific customary ownership. Bikini Atoll has a recognized 'Iroij' or chief, and each parcel of land also has 'Alaps' (caretakers of the land) and 'Dri-jerbal' (workers).

Under Marshall Islands law, all marine areas (lagoon and ocean) below the mean high water mark are legally owned by the people of the Marshall Islands, through the Government of the Marshall Islands, with the recognition of traditional and customary rights of landowner, clan and municipality to control the use of and materials in marine areas (Public Lands and Resources Act, 1996).

Local governments have the power to make any ordinances over the area of local government jurisdiction, so long as they are not inconsistent with any other legislative instrument that has the force of law in the Marshall Islands (including regulations from national agencies but not including other municipal ordinances). local government jurisdiction is to a distance of 5 miles from the mean low water line (Constitution of the Republic of the Marshall Islands). In effect, this means that the ownership and control of resources in Bikini Atoll comes under both customary landowners, and the Kili-Bikini-Ejit Local Government.

All rights, title and interest to the ships sunk by the nuclear tests in 1946 in Bikini Atoll's lagoon were transferred from the Government of the United States to the people of Bikini under Section 177 of the Compact of Free Association of 1985. This agreement is significant because it is the only place in the world where the United States has ceded its rights to its sunken naval vessels (Agreement Between the Government of the United States and the Government of the Marshall Islands for the Implementation of Section 177 of the Compact of Free Association, Article VI, 1985).

5.b Protective designation

Legislation, regulations and ordinances have been established at national and local level to ensure the legal protection of the artifacts and natural environment at Bikini Atoll.

5.b.(i) Protection of historic and cultural resources

The property currently has a high degree of protection through local ordinances and strictly controlled access.

The Historic and Cultural Preservation Act (1991) and its subsidiary regulations protect historic and cultural resources including governing access to submerged resources, the export of historic and cultural artifacts and control over land modification activities. The act provides for fines of up $10,000 or six months imprisonment for violations (The Historic and Cultural Preservation Act: Title 45, Ch 2, 1991; Regulations Governing The Taking And Export Of Artifacts, 1991; Regulations Governing Access To Prehistoric And Historic Submerged Resources, 1991; Regulations Governing Land Modification Activities, 1991).

In addition, Kili-Bikini-Ejit Local Government established ordinances in 1988 prohibiting entry to Bikini Atoll or diving on ships without a permit issued by KBE Local Government, and prohibiting removal of any object from Bikini lagoon (Ordinance No. 14-1988). These were updated in 1996 to additionally require that all divers be accompanied by the official Bikini dive operation (Ordinance No. 2-1996). All divers and yachts visiting Bikini Atoll are required to gain permission from KBE Local Government (through the Tourism Manager) and to sign a liability waiver confirming that they understand their responsibilities (Yacht Liability Waiver, 2008).

5.b.(ii) Protection of biological resources

Bikini has a high level of biodiversity protection, based on a decree (July 30, 1997) from the KBE Local Government that it is illegal to fish for sharks or turtles in the lagoon, or to use gill nets or throw nets within the lagoon area. All bird habitats are preserved by this same decree. All fishing around the area of the sunken ships is prohibited. Additionally, at national level, licensed pelagic fishing vessels are prohibited from fishing within the 12 nautical mile territorial seas of any atoll.

5.c Means of implementing protective measures

Access to Bikini is restricted to recreation and tourism visitors, and to scientific survey teams. All people wishing to visit Bikini by aircraft must obtain prior permission from the Kili-Bikini-Ejit Local Government through an established permitting procedure.

Divers on the sunken vessels must be accompanied by a diver employed by Bikini. Divers that visit Bikini are usually very experienced and well-certified to dive on, and to penetrate, the sunken vessels without causing damage. Divers are required to sign waivers and are prohibited from removing artifacts from the ships. This may be enforced by bag checks upon departure. Yachts are able to visit Bikini but must gain permissions from Bikini Atoll Local Government, and are not permitted to dive the wrecks unless accompanied by a diver employed by Bikini.

Nationally, licensed fishing boats are required to be part of the Vessel Monitoring System (VMS), which allows the Marshall Islands Marine Resources Authority (MIMRA) to track the position of vessels and if they are found within 12 nautical miles of any atoll, to pass this information on to the Sea Patrol operation (an arm of the Marshall Islands Police) and support apprehension and prosecution for any illegal fishing.

When the dive operation is running on Bikini, staff there can observe unauthorized vessels in or near the lagoon. They can then approach the vessel using one of the boats on Bikini Atoll and collect evidence, such as photos, to support prosecution. They can radio the Marshall Islands Sea Patrol to pursue the unauthorized vessel. Bikini Atoll has successfully pursued one prosecution of an unauthorized vessel fishing for shark fins in 2002.

All of these protective measures are more difficult to implement when the regular dive operation is not running. An option is being developed to install a radar system at the western end of the atoll to notify staff on Bikini Island of any unauthorized vessel in the vicinity, which can then be reported to Sea Patrol.

5.d Existing plans related to municipality and region in which the proposed property is located

No existing relevant plans.

5.e Property management plan or other management system

Bikini Atoll Conservation Management Plan—DRAFT. (See Annex 3).

5.f Sources and levels of finance

The Bikini Atoll Tourism Operation is financed from three different sources. The maintenance, fuel costs, and some of the operations costs of the tourism operation are funded from the Resettlement Trust Fund for the People of Bikini (US Public Law 100-446). For the calendar year 2007 the amount funded by the trust was $624,000. The second source of funding is from the revenues of the tourism operations. In calendar year 2007, the gross revenue from the operation amounted to $529,062. The third and final source of revenue is from the US Department of Energy for fuel and water charges for the operation of their field station that amounted to $32,202 in 2007. As the day-to-day aspects of conservation and management of the site will be integrated with the tourism operation, this funding should cover the infrastructure, operating costs and personnel.

Finance for conservation assessments and interpretation of the site will need to be sought externally, in the form of international assistance. It is expected that international expert partners will assist in project development and fundraising to achieve the necessary financing.

5.g Sources of expertise and training in conservation and management techniques

The Kili-Bikini-Ejit Local Government has had the benefit of internationally renowned expertise in the assessment and management of both cultural and natural resources of Bikini Atoll, and is in the process of developing new partnerships to enhance this capacity.

James P. Delgado is the President of the Institute of Nautical Archaeology and one of the world's leading maritime archaeologists. He is the author or editor of some thirty books, including the *British Museum Encyclopaedia of Underwater and Maritime Archaeology* and host of the international TV documentary series *The Sea Hunters*. Since leading the initial resource assessment of the sunken vessels at Bikini, Delgado has advised Bikini Atoll on management and interpretation of these artifacts.

William Jeffery of James Cook University and Vickie Richards of the Western Australian Maritime Museum

recently carried out a state of conservation assessment of the sunken vessels in Chuuk Lagoon, in the Federated States of Micronesia. Bikini Atoll is in the early stages of developing a partnership with these experts and their institutions to carry out a baseline assessment of the state of conservation and establish a monitoring protocol.

Charles D. Beeker is the Director of the Office of Underwater Science at Indiana University. This group's focus is on the research and interpretation of submerged cultural and biological resources emphasizing park development and sustainable use. Bikini Atoll is in the early stages of developing a partnership with Indiana University to develop interpretation and field guides for the artifacts at Bikini, and to enhance the management of visitation to the site.

Zoe Richards of James Cook University, Maria Beger of the University of Queensland and Silvia Pinca of the Secretariat of the Pacific Community, form a core of marine biologists who have carried out biological resources assessments on several atolls in the Marshall Islands, and who have made recommendations for the conservation management of these sites. These experts conducted a biological survey of Bikini Atoll in 2002 and have an established partnership with Bikini Atoll.

5.h Visitor facilities and statistics

5.h.(i) Organized diving tourism

The main visitors to Bikini Atoll over the past several years have been as part of the dive tourism program run by Bikini Atoll Divers, a business owned by the Kili-Bikini-Ejit Local Government. To date, tourism on Bikini has mainly been focused on the sunken vessels which are considered one of the premier SCUBA diving experiences in the world (see http://www.bikiniatoll.com/divetour2.html for articles, reviews and testimonials of the tourism-diving experience of Bikini Atoll). While the vessels sunk during Operation Crossroads in 1946 are the premier attraction, there is also the opportunity to go sport fishing and to dive or snorkel some of the beautiful coral reef, or to walk on and explore some of the islands.

The current and expected future levels of tourism to Bikini Atoll remain very low, mainly due to the relative inaccessibility of the atoll and the associated high costs. In the history of the tourism operation, there have been no more than 12 tourists on Bikini at any one time. The total number of tourists per year has been between 200 and 250.

With the difficulties encountered in air travel within the Marshall Islands resulting in the stranding of visitors on a couple of occasions in 2007 and 2008, the Kili-Bikini-Ejit Local Government has reluctantly closed the organized tour operation on Bikini until the domestic airline problems are resolved. The facilities described below are maintained on Bikini until the dive operation can resume.

It is understood that World Heritage listing has the potential to greatly increase tourism interest in Bikini; however, tourism will continue to be constrained by transport issues. Thus, even with World Heritage listing the number of tourists might be expected to increase to a total of only 400 per year.

Diving facilities: A typical visit to Bikini over a week includes 12 deep decompression dives—these are dives that are below normal recreational diving limits and require the use of staged decompression stops prior to surfacing. Facilities for divers include tanks, two dive boats, a tank filling station for both air and nitrox (decompression gas), oxygen generation equipment, and dive equipment repair shop. Decompression stops are facilitated by a decompression station that is hung from the dive boat.

Figure 52. One of Bikini's boats in preparation for a dive on the sunken ships. (Bikini Atoll Divers, n.d.)

Accommodation and dining: Visitors to Bikini sleep in private, air-conditioned comfort with 24 hour power and hot running water, on one of the most beautiful beaches in the Pacific. A dining hall provides an "all you can eat" buffet style selection for breakfast, lunch and dinner.

Figure 53. Bikini Atoll accommodation on one of the most beautiful beaches in the Pacific (J. Niedenthal, 1996)

Interpretation and explanation: Over the course of the week-long dive tour of Bikini historical documentary films are shown, complete briefings about each of the ships and their respective histories are given, and there is a tour of the island and the atoll. The Bikinians feel this to be important because this allows their story to be taken away by tourists and retold to their families and friends. In short, the tourism program helps perpetuate a story the islanders want the world to remember. Before each dive the divemasters give a full briefing about the vessel's history and unique characteristics, and a comprehensive dive plan. Most visitors to Bikini access the official website, http://www.bikiniatoll.com/ and its wealth of information before making the journey to Bikini.

Figure 54. A breifing is given before each dive giving the history of the sunken ships (Bikini Atoll Divers, n.d.)

Visiting yachts and private vessels: Yachts and private vessels may visit Bikini, as long as they meet requirements for safety and are able to manage decompression diving. All boats wishing to visit must obtain a permit from the Kili-Bikini-Ejit Local Government.

5.i Policies and programmes related to the presentation and promotion of the property

Bikini Atoll Website: Aside from the on-site interpretation program run as part of the dive operation, the Bikini Atoll official website http://www.bikiniatoll.com/ presents detailed information about the site, tourism, the history of the atoll and the people of Bikini.

Marshall Islands Peace Museum: A project is under development to establish a Peace Museum on Majuro that would present the nuclear history of the Marshall Islands in order to promote the cause of world peace.

Youth Conservation Theatre Program: A proposal has been developed for a travelling youth theatre program to promote the natural and cultural values of the Marshall Islands with a particular focus on the values of the proposed World Heritage sites, Bikini and Ailinginae. Significant start-up funding and technical assistance is required for this program and is being sought.

5.j Staffing levels (professional, technical, maintenance)

A small number of professional and technical staff are employed for the management of the Bikini Atoll site and the dive operation. When the organized dive tourism is operational, the following job roles are in place:

Staff Position	Location	Number
Tourism Manager	Majuro	1
Tourism Assistant and Reservation Manager	Majuro	1
Head Divemaster - Bikini	Bikini	1
Assistant Divemasters- Bikini	Bikini	2
Dive guides	Bikini	2
Cook, housekeeping	Bikini	3
Maintenance	Bikini	6

Responsibilities for monitoring the state of conservation, and for surveillance of the atoll for violations of any rules will be assigned to existing staff roles.

Figure 55. Bikini Island sunset (E. Hanauer, 2006)

Part 6. Monitoring

6.a Key indicators for measuring State of Conservation

6.a.(i) Cultural resources

The state of conservation of the site mainly refers to the condition of the sunken vessels and the few buildings remaining as part of the landscape. Bikini Atoll is developing a program in partnership with maritime archaeologists and conservation scientists at James Cook University, and at the Western Australian Maritime Museum. This program will conduct a baseline assessment of the state of conservation of the vessels and buildings, and develop a protocol and indicators for a regular assessment of the state of conservation of these artifacts. Local staff divers of Bikini Atoll will be trained in how to conduct a regular state of conservation assessment. Monitoring protocol will likely involve taking photographs at fixed monitoring points and comparing these photographs over the years.

Other features of the site that contribute to the overall character of an abandoned nuclear test site include the rows of coconut trees and the generally low level of buildings and construction. The *Bikini Atoll Conservation Management Plan* outlines the need to assess any proposed demolition, construction, land-clearing, earthmoving etc. in light of its impact on the attributes of Bikini Atoll as a former nuclear test site. Thus an indicator for the state of conservation of the site will relate to the presence or absence of these activities and the impact of such activities on artifacts of the testing era and on the overall landscape.

6.a.(ii) Natural resources

A team of scientists carried out a baseline survey of the marine environment Bikini Atoll in 2002, establishing a set of indicators for monitoring the condition of the marine environment. These indicators include:

- Coral and fish biodiversity: presence/absence and semi-qualitative abundance in timed swims
- Macroalgae target species and genera semi-quantitative abundance
- Percent cover of substrate, coral and algae
- Reef health including counts of *Acanthaster planci* (crown-of-thorn starfish), dead and bleached coral
- Counts of target species of invertebrates
- Fish size and abundance of commercially and ecologically important species

While the survey established a baseline in 2002, there is no ongoing program of monitoring due to lack of available resources. There is a need to carry out baseline assessment of avifauna and vegetation on the island and to develop monitoring indicators.

6.b Administrative arrangements for monitoring property

Responsible Agency:

Jack Niedenthal, Trust Liaison for the People of Bikini

Kili-Bikini-Ejit Local Government

Post Office Box 1096

Republic of the Marshall Islands, MH 96960

Phone: +692 625-3177

Fax: +692 625-3330

Email: bikini@ntamar.net

Website: www.bikiniatoll.com

6.c Results of previous reporting exercises

The most recent archeological assessment occurred in 1991 (Delgado et al., 1991), revealing the historical and archaeological significance of the artifacts at Bikini Atoll, and leading to the development of interpretation materials and the opening of Bikini Atoll to dive tourism. The most recent assessment of the marine biodiversity (Pinca et al., 2002) revealed the remarkable recovery of the coral reef ecosystem at Bikini and the impressive biodiversity, presence of threatened species and health of the marine environment.

Part 7. Documentation

7.a Photographs, slides, image inventory and authorization table and other audiovisual materials

7.a.(i) List of multi-media items accompanying nomination in CD/ DVD format

Maps of the site and buffer zone in PDF and JPEG format (Annex 1).

Images including photographs and artwork catalogued in table below (Annex 5).

Operation Crossroads Parts I and II [Motion Picture] (1946). (Annex 6).

Joint Task Force 7 Operation Castle Commander's Report. [Motion picture] (1954). (Annex 6).

Bikini: Forbidden Paradise [Motion picture] (1992). 30 copies on DVD included with submission of nomination to the World Heritage Centre (separate DVD).

7.a.(ii) Internet resources

The official Bikini Atoll website is at www.bikiniatoll.com. The website includes a wealth of information on the site, the history of the Bikinian people and of the nuclear testing, cultural significance of Bikini Atoll and information for tourists.

Many more resources related to Bikini Atoll and the nuclear testing on Bikini can be found on the internet. The US Government and its various agencies have made many documents, images and photos available on the internet through publicly available and searchable archives. Other groups interested in the history of nuclear weapons, or the prevention of their use in the future also have material on Bikini Atoll. These resources can be best located through a "Google" search.

7.a.(iii) Image Inventory and Photograph and Audiovisual Authorization Form

Id. No	Format (slide/ print/ video)	Caption	Date of Photo (mo/yr)	Photographer /Director of the video	Copyright owner (if different than photographer/ director of video)	Contact details of copyright owner(Name, address, tel/fax, and email)	Non exclusive cession of rights
001	jpeg	Bikinian Outrigger	1946	US Government	Public domain		Yes
002	jpeg	Coconut trees- before testing	1946	US Government	Public domain		Yes
003	jpeg	Traditional house	1946	US Government	Public domain		Yes
004	jpeg	King Juda	1946	US Government	Public domain		Yes
005	jpeg	Bikinian Woman and Family pre-1946	1946	US Government	Public domain		Yes
007	jpeg	Women carrying- leaving Bikini	1946	US Government	Public domain		Yes
008	jpeg	Leaving Bikini 1946	1946	US Government	Public domain		Yes
009	jpeg	Bikinian Church	1946	US Government	Public domain		Yes
010	jpeg	Live Coral 1946	1946	US Government	Public domain		Yes
011	jpeg	Giant Clam 1946	1946	US Government	Public domain		Yes
012	jpeg	Filming of Wyatt and Juda with Bikinians	March 6, 1946	US Government	Public domain		Yes
013	jpeg	Church	1946	US Government	Public domain		Yes
014	jpeg	Canoe being loaded on ship	1946	US Government	Public domain		Yes
020	jpeg	Operation Crossroads- Able	July 1, 1946	US Government	Public domain		Yes
022	jpeg	Operation Crossroads-Baker	July 25, 1946	US Government	Public domain		Yes
023	jpeg	Operation Crossroads-Baker	July 25, 1946	US Government	Public domain		Yes
024	jpeg	Operation Crossroads-Baker	July 25, 1946	US Government	Public domain		Yes
025	jpeg	Operation Crossroads-Baker	July 25, 1946	US Government	Public domain		Yes
026	jpeg	Radio Bikini	June 1946	US Government	Public domain		Yes
027	jpeg	Saratoga going down	July 1946	US Government	Public domain		Yes
028	jpeg	Cleaning ship after crossroads	July 1946	US Government	Public domain		Yes
029	jpeg	Goats during Operation Crossroads	July 1946	US Government	Public domain		Yes
030	jpeg	Bravo explosion	March 1954	US Government	Public domain		Yes
031	jpeg	Bravo	March 1954	US Government	Public domain		Yes
032	jpeg	H-bomb from LIFE magazine	March 1954	Unknown	Time Inc.		No
036	jpeg	Castle Romeo	March 1954	US Government	Public domain	National Nuclear Security Administration / Nevada Site Office	Yes
040	jpeg	Bikinians' tent city on Kwajalein	n.d.	US Government	Public domain		Yes
051	jpeg	Resort on Bikini Island	1996	Jack Niedenthal		bikini@ntamar.net Post Office Box 1096 Marshall Islands, MH 96960 Phone: +692 625-3177	Yes

052	jpeg	Bunker	2006	Eric Hanauer		ehanauer@san.rr.com 7151 Rock Valley Court, San Diego CA 92122. Ph: +1 858 558-7278.	No
053	jpeg	Rows of coconut trees- aerial view	2008	Google Earth		For usage permission requests go to: http://www.google.com/permissions/geoguidelines.html	No
054	jpeg	Gazebo at resort	1998	Jack Niedenthal	-	As above	Yes
055	jpeg	Hammerhead dive boat	n.d.	unknown			No
056	jpeg	Bravo crater	2006	Eric Hanauer	-	As above	No
057	jpeg	Helmet on Saratoga	2006	Eric Hanauer	-	As above	No
059	jpeg	Saratoga bridge	2006	Eric Hanauer	-	As above	No
060	jpeg	Saratoga elevation drawing	1991	L. Nordby and J. Livingston/ US Government	Public domain		Yes
061	jpeg	Saratoga island	2006	Eric Hanauer	-	As above	No
062	jpeg	Rows of coconut trees	2002	Jeffery Sasha Davis	-	sashadavis@yahoo.com	No
064	jpeg	Bravo crater- Google Earth	2008	Google Earth	-	For usage permission requests go to: http://www.google.com/permissions/geoguidelines.html	No
065	jpeg	Sunset on Bikini	2006	Eric Hanauer	-	As above	No
066	jpeg	Apogon conning tower	2006	Eric Hanauer	-	As above	No
067	gif	Bikinian Flag	?		KBE Local Government	As above	Yes
M1	mpeg	Operation Crossroads Part I	1946	Handy (Jam) Organization (Producer)	Public Domain - Creative Commons License	from http://www.archive.org/details/Operatio1946	Yes
M2	mpeg	Operation Crossroads Part II	1946	Handy (Jam) Organization (Producer)	Public Domain - Creative Commons License	http://www.archive.org/details/Operatio1946_2	Yes

7.b Texts relating to protective designation and management of property

Bikini Atoll Conservation Management Plan- DRAFT (as of December 2008). A management plan under development to protect and conserve the site, and to interpret and communicate the heritage values of Bikini Atoll. Annex 3.

Marine Resource Ordinance (Dated July 28, 1997): Ordinance passed in 1997 with the object of conserving the marine and wildlife resources of Bikini Atoll. Annexed on DVD.

Ordinance No. 14-1988 (October 8, 1988): Ordinance to prevent unauthorized diving in Bikini Atoll lagoon and to prevent removal of artifacts from ships. This ordinance was created soon after the ships were made the property of the Bikinians under Section 177 of the Compact of Free Association in 1986. Annexed on DVD.

Ordinance No. 2-1996 (May 30, 1996): Ordinance to prevent unauthorized diving in Bikini Atoll lagoon and to prevent removal of artifacts from ships. This ordinance was developed soon after the establishment of a commercial dive operation on Bikini Atoll and required that all divers be supervised by the authorized dive operation. Annexed on DVD.

Liability Release Form and Express Assumption of Risk for Diving at Bikini Atoll: All tourist divers at Bikini are required to sign a liability release form that also informs them of the rules regarding removal of artifacts. During times when the dive operation is active, each diver is required to sign this form. Visiting yachts are required to sign this form also. Annexed on DVD.

The Historic and Cultural Preservation Act (Title 45, Ch 2) (1991) Available at http://marshall.csu.edu.au/Marshalls/html/RMILAW/HPA1991.html

Regulations Governing The Taking And Export Of Artifacts 1991 Available at http://marshall.csu.edu.au/Marshalls/html/RMILAW/RMI_HPO_Law.html

Regulations Governing Access To Prehistoric And Historic Submerged Resources 1991 Available at http://marshall.csu.edu.au/Marshalls/html/RMILAW/RMI_HPO_Law.html

Regulations Governing Land Modification Activities 1991 Available at http://marshall.csu.edu.au/Marshalls/html/RMILAW/RMI_HPO_Law.html

7.c Form and date of most recent records or inventory of property

Submerged Cultural Resources Survey, 1991: The most recent assessment of the sunken vessels on Bikini Atoll was carried out in 1991 by a US National Park Service Team. The assessment was carefully documented in a report and an illustrated book, as listed below.

Delgado, J.P., Lenihan, D.J, & Murphy, L.F. (1991). *The Archaeology of the Atomic Bomb: A Submerged Cultural Resources Assessment of the Sunken Fleet of Operation Crossroads at Bikini and Kwajalein Atoll Lagoons, Republic of the Marshall Islands*. Santa Fe, N.M.: US Department of the Interior, National Park Service, Submerged Cultural Resources Unit. Note: an online version can be found at http://www.nps.gov/history/history/online_books/swcrc/37/contents.htm

Delgado, J. P. (1996). *Ghost Fleet: the Sunken Ships of Bikini Atoll.* Honolulu: University of Hawaii Press.

Marine Biodiversity Survey, 2002: A survey of the health and biodiversity of marine life was carried out by a team of scientists on Bikini in 2002. The report was published in print form only, a copy of which is held in the Kili-Bikini-Ejit Local Government office.

Pinca, S., Beger., M., Richards, Z., & Peterson, E. (2002). *Coral Reef Biodiversity: Community-based Assessment and Conservation Planning in the Marshall Islands: Baseline surveys, capacity building and natural protection and management of coral reefs of the atolls of Bikini and Rongelap*. Report to the Rongelap Government, Republic of the Marshall Islands.

Radiological Surveys, ongoing: The last complete survey was done by the RMI by Dr. Steve Simon. This was the Marshall Islands Radiological Survey of Bikini Atoll, part of the Marshall Islands Nationwide Radiological Study in February of 1995. All of the scientific findings regarding Bikini Atoll were reviewed by a panel of scientists put together by the International Atomic Energy Agency (IAEA) in 1996 and released in 1998. Lawrence Livermore National Laboratories, in conjunction with the US Department of Energy, has ongoing studies monitoring the environment of Bikini Atoll. This includes soil and water sampling to measure the rate of radiological decay. A 2004 report provides an overview of the history and current radiological conditions at Bikini.

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7.d Address where inventory, records and archives are held

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"Remember your humanity, and forget the rest."