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Chollei Hamlet Watershed Solid Waste Site, Ngarchelong, Palau: Ecological baseline assessment and suggested priority actions

By The Environment, Inc.

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Editing and layout: Mark Smaalders

SPREP
PO Box 240, Apia
Samoa
E: sprep@sprep.org
T: +685 21 929
F: +685 20 231
Website: www.sprep.org

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Acronyms

ENSO	El Niño Southern Oscilation
EQPB	Environmental Quality Protection Board
ICWM	Integrated Coastal and Watershed Management
IWP	International Waters Project
SPREP	Secretariat of the Pacific Regional Environment Programme
TEI	The Environment, Inc.
USD	United States dollar

Units of measure

kg	kilogram
km^2	square kilometers
lbs	pounds
m^2	square meters
m^3	cubic meters

1 Background

1.1 The International Waters Project (IWP)

The International Waters Project (IWP)[1] is a 7-year, USD 12 million initiative concerned with management and conservation of marine, coastal and freshwater resources in the Pacific islands region, and is specifically intended to address the root causes of environmental degradation related to trans-boundary issues in the Pacific. The project includes two components: an Integrated Coastal and Watershed Management (ICWM) component, and an Oceanic Fisheries Management component (the latter has been managed as a separate project). It is financed by the Global Environment Facility under its International Waters Programme. The ICWM component is implemented by the United Nations Development Programme and executed by the Secretariat of the Pacific Regional Environment Programme (SPREP), in conjunction with the governments of the 14 independent Pacific Island countries: Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu. The ICWM component focuses on integrated coastal watershed management, and supports national and community-level actions that address priority environmental concerns relating to marine and fresh water quality, habitat modification and degradation and unsustainable use of living marine resources through a 7-year phase of pilot activities, which started in 2000 and will conclude at the end of 2006.

1.2 IWP activities

IWP has sought to combine the following activity areas:

- Integrated conservation and management of coastal resources, including fresh water resources.
- Integrated conservation and sustainable management of oceanic resources.
- Prevention of pollution through the integrated management of land based or marine based wastes.
- Monitoring and analysis of shore and near-shore environments to determine vulnerability to environmental degradation.

These activities reflect the National Environment Management Strategies prepared for Pacific Island countries between 1990 and 1996, which describe strategies for achieving environmental objectives relating to:

- The integration of environmental consideration in economic development.
- Improved environmental awareness and education.
- The management and protection of natural resources.
- Improved waste management and pollution control.

1.3 Advancing IWP in Palau

In Palau IWP will target pilot projects that address waste management with a view to improving freshwater and marine resources management.

In November 2004, The Environment, Inc. (TEI) was requested by the IWP National Coordinator, Office of Environmental Response and Coordination to conduct an ecological

[1] IWP is formally titled Implementation of the Strategic Action Programme of the Pacific Small Islands Developing States.

baseline study of the Chollei watershed, with a focus on the waste disposal site in Chollei, Ngarchelong. The study included the following components:

- A review of current ecological information for Babeldaob, including vegetation and coastal resource maps.
- An ecological profile for the Chollei hamlet watershed.
- Identification of appropriate indicator species for future monitoring.
- A monitoring plan for key terrestrial and marine indicator species at the Chollei hamlet watershed, including a description of possible community roles in implementing the monitoring plan.

The site is part of a sub-watershed of Chollei Hamlet in Ngarchelong. The entrance to the waste disposal site is at N 07^0 42.983', E 134^0 36.965'. The site covers an area of about 2,000 square meters (m^2).

2 Current ecological information

Babeldaob Island is the largest island in the Republic of Palau, with a land area of some 332 km^2, as well as 38.5 km^2 of mangrove, 122.2 km^2 of inner reef, 164.7 km^2 of outer reef, and 521.4 km^2 of lagoon. Ngarchelong State is located at the northern tip of Babeldaob Island, and has a land area equal to just 10 km^2**,** or 3% of Babeldaob's total area. However, Ngarchelong's marine area (and in particular the outer reef and lagoon) are significant: Ngarchelong's mangroves total 2.1 km^2 (13.5% of the total for Babeldaob); the inner reef 23 km^2 (14%); the outer reef 81.3 km^2 (49%); and the lagoon 325 km^2 (62%). Ngarchelong has 240 patch reefs and 15 reef holes. Ngarchelong is well known for its high marine biodiversity and fisheries production, with an average yield of 0.06 metric tonnes/km^2. Between 1992–1996 Ngarchelong had the third highest yields, which dropped to fifth highest yield between 1997–2001. It is reknowned for its grouper aggregation areas in the northern reefs and its giant clams. The state has two managed marine areas: the Ngarchelong/Kayangel reef channels (90 km^2 in extent, and including 8 channels that are closed from April to July) and the Ebiil Channel Conservation area (covering 15 km^2).

Active agroforestry involves planting and harvesting of coconut, wetland taro and lemons. The area has a problem with the vine *Merremia peltata* (kebeas in Palauan) and the unwanted tree *Leucaena leucocephala* (telentungd, or telentund). During the 1998/1999 ENSO event, there was extensive fire damage to farmlands in Ngarchelong. Freshwater resources are limited in Ngarchelong.

3 General site description

The existing solid waste disposal site in Chollei Hamlet, Ngarchelong is within the Chollei sub-watershed (Fig. 1) and is an estimated 1.0 km^2 in area. Mangroves cover about 0.24 km^2 of the watershed's southern end. The Ngetchur River (about 1 km in length) passes to the north, northwest, west and southwest of the site and extends about 250 meters through the mangroves along the southern boundary. The flow by the dam along the river course is about 0.6 cubic feet per second 50% of the time (Barrett et al., 1986). A review of existing ecological studies of Babeldaob does not indicate existing assessments or studies for this sub-watershed (Army Corps of Engineers 1998).

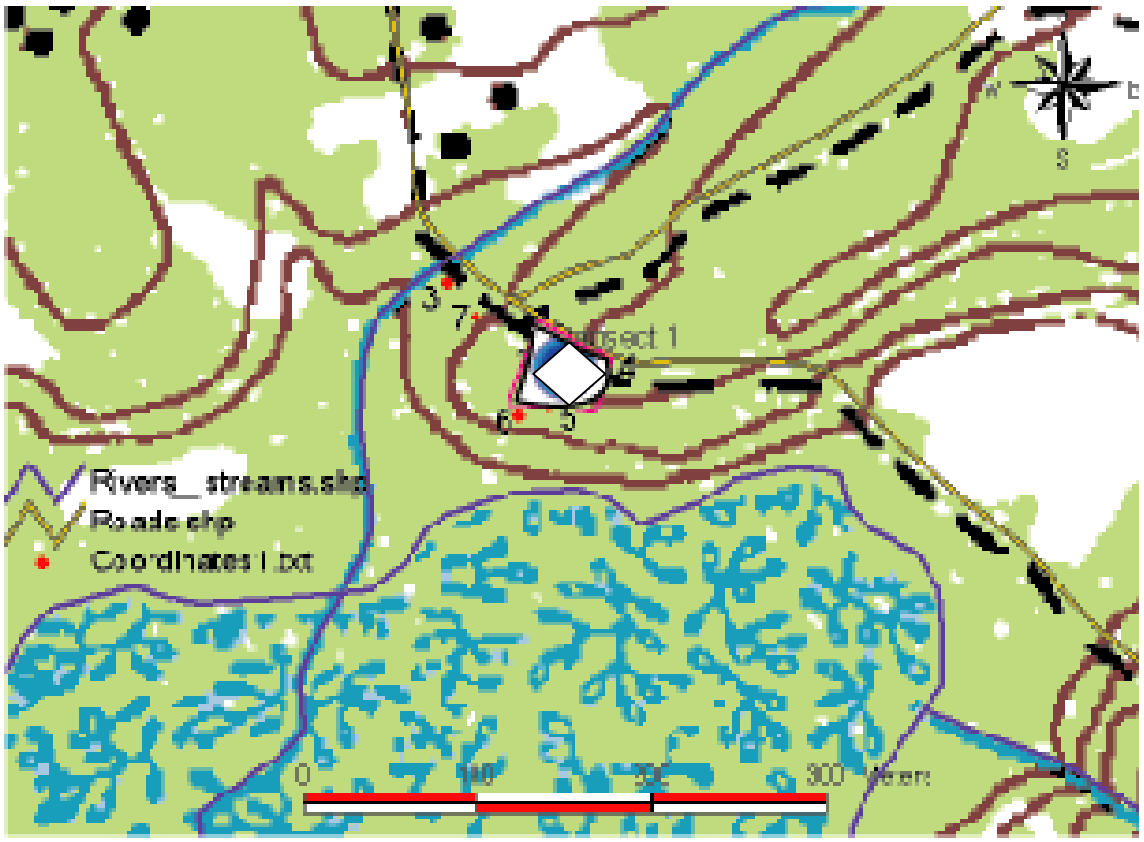

Figure 1: Site (diamond in center of map) with nearby river and mangroves.

4 Previous Impacts

The existing Chollei landfill has been in use for over 15 years. Originally, waste disposal occurred along the coast, and it was recommended that each hamlet relocate their disposal areas inland from the coast. The State requested that each hamlet identify a site. Chollei was the first to locate a site, which was provided by a private landowner. Subsequently, other hamlets began using the Chollei waste site rather select their own sites. Therefore the Chollei disposal site now serves most of Ngarchelong State's needs (Joe Aitaro, pers. comm. 2004.) Ngarchelong State generated about 368 lbs of solid waste per day, based on the 1999 population 278 and an estimated waste production of 1.32 lbs (0.6 kg)/person/day (Golder Associates 1999.) The Japanese funded a road project in Chollei more than 15 years ago; it is the only section of paved road in Ngarchelong. The waste disposal site is adjacent to the road and therefore there is easy access to the waste site for the community.

A water pumping station is found along the northeast boundary, on the opposite side of the main road. The habitat immediately adjacent to the river is wetland used for agroforestry, including taro production. See Plate 2. There are historical stone features at this site and nearby (see Fig. 2). Thus this area has historically significant features along its eastern side, with past human-induced changes to the landscape.

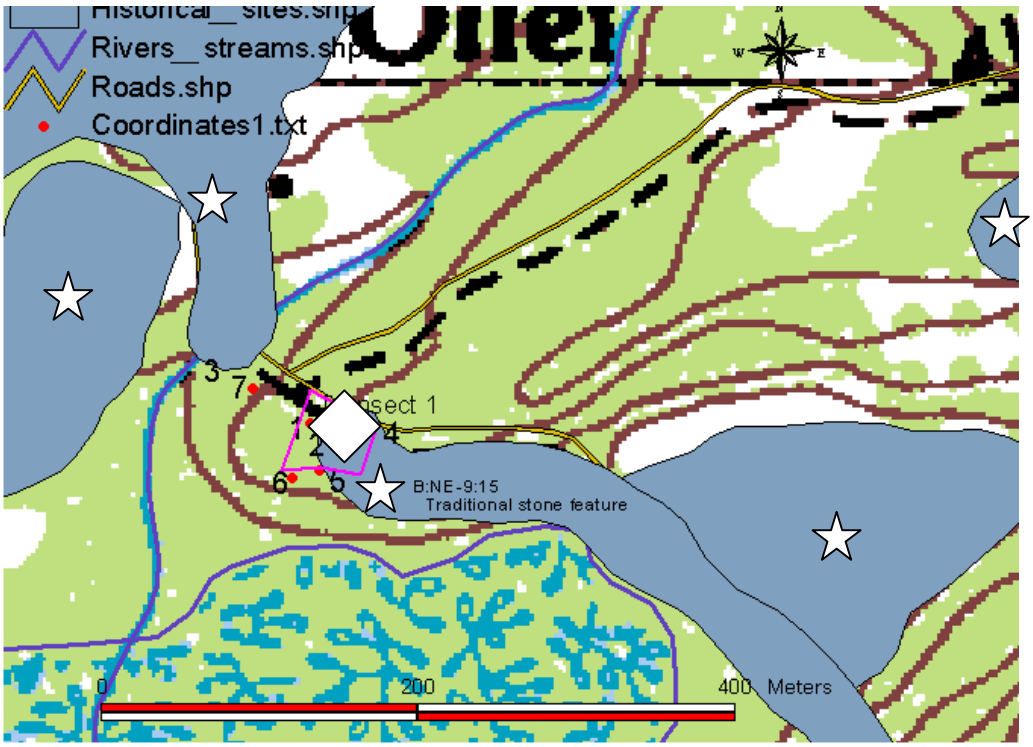

Figure 2: Traditional stone features highlighted in blue (and marked with stars) that are found within and adjacent to the site (marked by a diamond).

5 Field investigation methods

5.1 Terrestrial assessment

An assessment of the site was conducted on 6 December 2004 by Joe Aitaro and Ann and Clarence Kitalong of The Environment, Inc. (TEI). The TEI team conducted a qualitative and quantitative assessment within the waste disposal site and along the forest and river surrounding the site (see Figs. 3a and 3b). The team identified and recorded flora and fauna found within and immediately adjacent to the site. At selected points the TEI team described the habitat, flora and fauna. The red dots on Figs. 3a and 3b indicate reference points from this assessment. The team did not do any subsurface sampling during the terrestrial or coastal survey. The team also met a community representative of the Ebiil Society at the Ollei dock.

5.2 Water quality

The Palau Environmental Quality Protection Board (EQPB) Laboratory does not have a water quality database for the Chollei Watershed, according to Ms. Jennifer Boeder, Laboratory Supervisor for EQPB. The EQPB Laboratory does test drinking water (from the chlorinated water system) for fecal coliform and turbidity and has found that Chollei has one of the best records for water quality. Mr. Joe Aitaro related that the women have commented that there have been increased incidences of rashes since the waste site became operational. Water quality testing was outside the scope of this project. We recommend that EQPB be contracted to conduct baseline water quality measurements for temperature, pH, and oxygen, fecal coliform bacteria, and total suspended solids, both upstream and downstream of the intake pump of the water system. This should be undertaken for two reasons: 1) to ensure that the water is safe as a water supply for the people of Chollei and

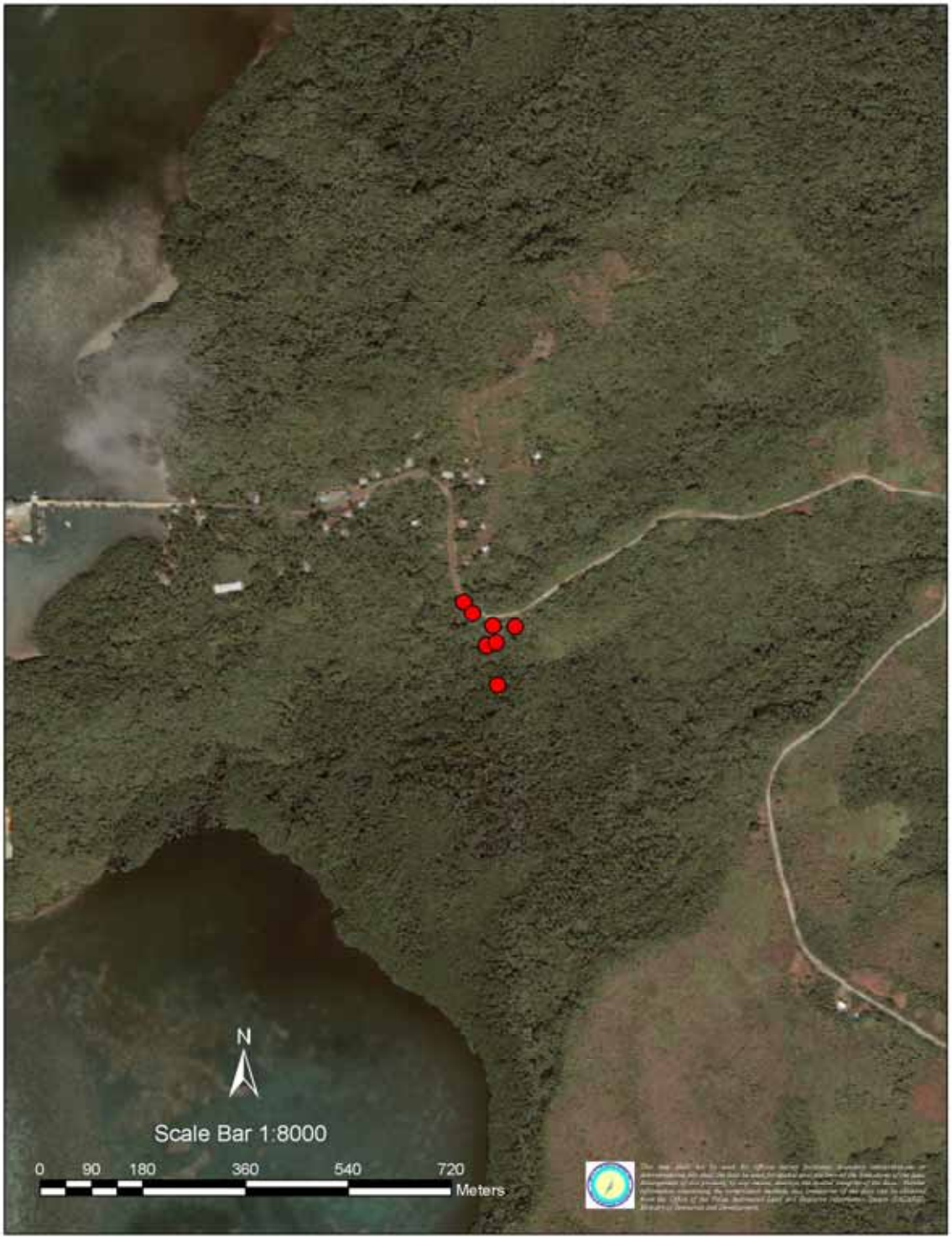

Figure 2a Habitat map of Chollei solid waste disposal site (highlighted with dots), showing Chollei watershed, including rivers and surrounding mangroves. Ikonos satellite Imagery from the Palau Automated Land and Resource Information System (PALARIS).

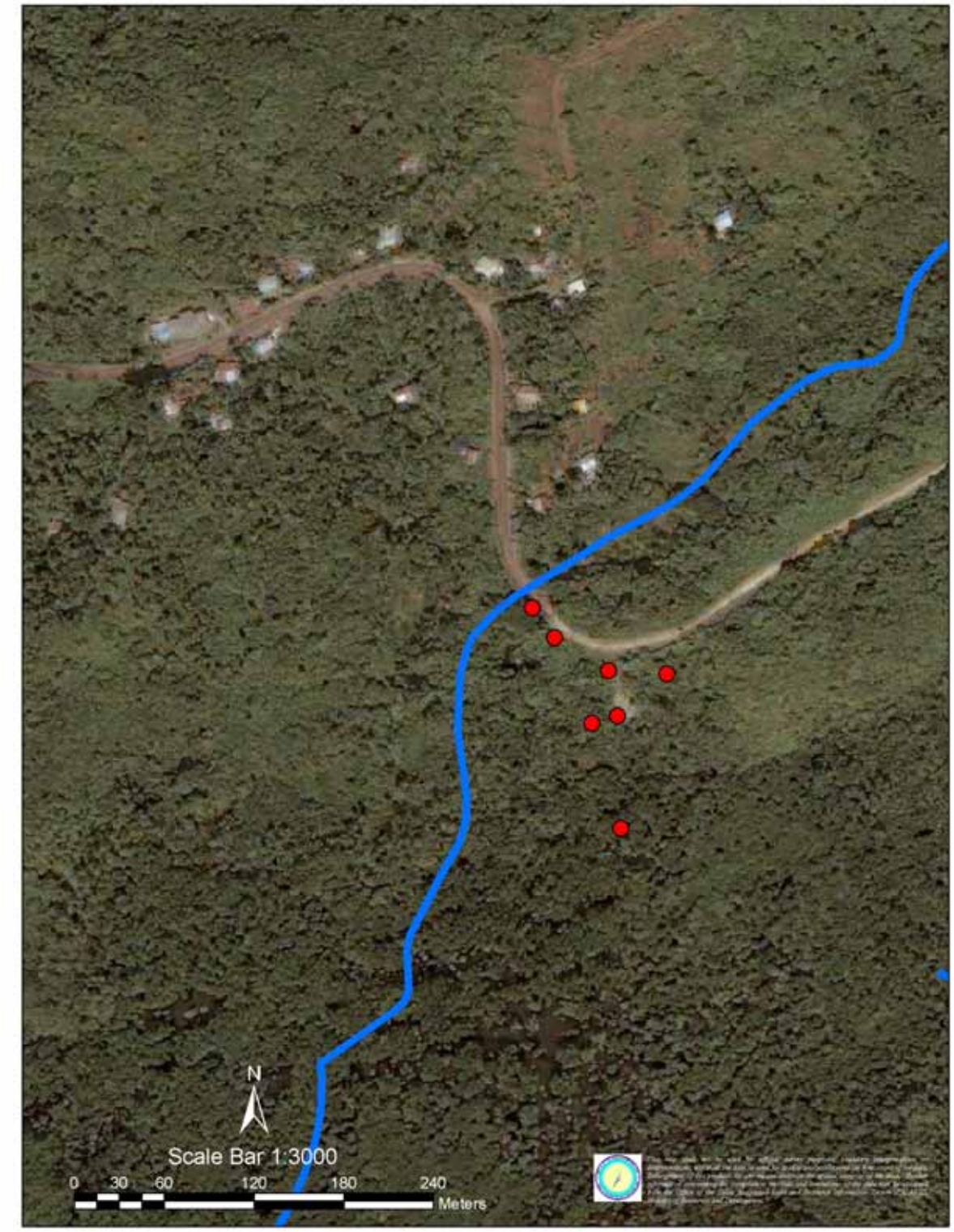

Figure 2b Closeup habitat map of Chollei solid waste disposal site (highlighted with dots), showing Chollei watershed, including rivers and surrounding mangroves. Ikonos Imagery from PALARIS.

2) to address the concerns regarding rashes, to ensure that point source pollution from the waste site is not entering taro gardens.

5.3 Soils

Two main soil types were found at the site, as shown in Fig. 4.

- Soil type 430 (Ollei-Rock Outcrop Complex) has slopes of 12–75% and covered 1,270 m^2 (65% of the site).
- Soil unit 415 (Ngardok silt loam) has slopes of 12–30% and covered 700 m^2 (35% of the site).

Additionally, two sensitive soil types outside the Chollei waste disposal site, but located downslope and within the sub-watershed included:

- Soil type 408 (Dechel Mesei Complex) with 0–2 % slopes.
- Soil type 409 (llachetomel peat) with 0–1% slopes.

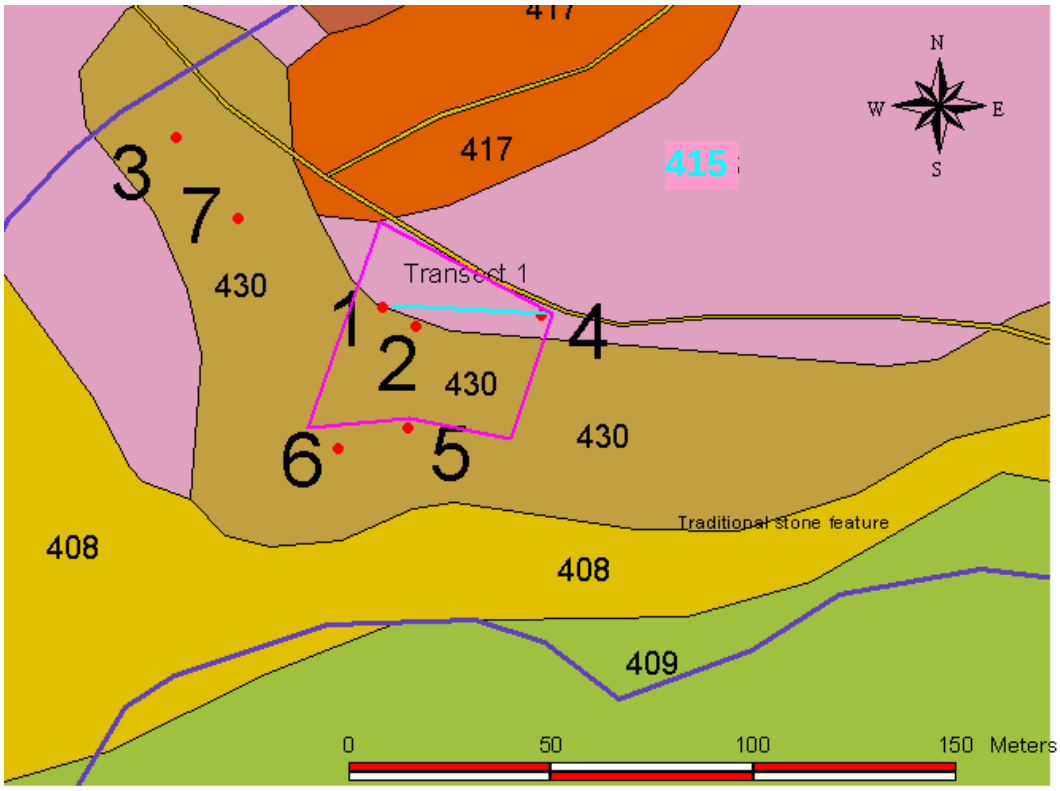

Figure 4. Site soil map

5.3.1 Soil type 430

The Ollei-Rock Outcrop Complex has 12–75% slopes in the uplands, with 50% Ollei silt loam and 35% Rock outcrop. This soil type has small areas of Ngekken and Aimeliik soils in depressed areas, with slope bases of less than 12%, and slopes more than 75%. This soil is found mainly on the west coast of Babeldaob. The Ollei soil is shallow and well drained and forms residuum from hard volcanic breccia and tuff. The surface layer is very dark brown silt loam 18 cm thick. The subsoil is brown, very gravelly loam 10 cm thick. The substratum is a deep flaggy loam. A hard bedded tuff is found at a depth of 43 cm. Ollei soil is moderately permeable, with effective rooting at 25–50cm. Removal of vegetation causes medium to very rapid runoff, with moderate to very high water erosion. The Rock

Outcrop is found mainly in areas of exposed basaltic and andesitic breccia, tuffaceaous breccia, and layers of interbedded tuff. The breccia is well suited as a source of rock for construction.

This soil unit is used as watershed and unsuitable for livestock grazing or home site development because of the depth to rock and the steep slopes.

5.3.2 Soil type 415

Ngardok silt loam has 12–30% slopes with very deep well drained soil on low lying foothills. This soil is formed from residuum from very soft volcanic tuff. Cleared areas support savanna vegetation. The soil permeability is moderately rapid. Effective rooting depth is 150 cm or more. If vegetation is removed, runoff is medium and the hazard of water erosion is moderate. Most areas of this unit are used for watershed, food gathering and woodland for village use. This unit is well suited for pasture. This unit is poorly suited for home site development due slope limitations and erosion hazard. The low soil strength can be improved with adequate amounts of crushed basalt. Structures to divert runoff are needed. All soil materials need to dry before filling and compacting.

This soil unit is poorly suited to onsite waste disposal. Leach lines should be placed on the contour and pit leaching avoided (Smith 1983).

5.3.3 Soil type 408

The Dechel Mesei Complex, with slopes of 0–2%, is found at valley bottoms near sea level, in areas where water cannot drain freely into either the stream or ocean. These areas are long and narrow or irregular in shape; the vegetation in areas not cultivated for taro is primarily freshwater swamp or swamp forest. This soil unit is 50% Dechel mucky silt loam and 30 percent Mesei muck. The Mesei soil is randomly distributed thorough the unit, but typically is not adjacent to stream. The Dechel soil is adjacent to the upland, near streams or the shoreline. The components of this unit are intricately intermingled. Included in the unit are small areas of soils on dikes and levees that are better drained than the Dechel and Mesei soils, and that support trees. Small areas of soil are similar to Dechel soil but have a layer of muck or peaty muck. Soils that are similar to the Mesei soil but have muck extend to a depth of 150 cm or have silt loam or silty clay loam to a depth of less than 63 cm. While walking through the site, it was not uncommon to sink more than 0.5 m into the ground at certain points.

Dechel soil is very deep and very poorly drained. It is formed in alluvium washed from upland soils that are derived primarily from volcanic rock. Typically the surface is covered with a mat of un-decomposed and partially decomposed grasses and sedges 10 cm thick. The surface layer is dark gray muck silt loam 10 cm thick. The upper 92 cm of the underlying material is olive gray, greenish gray and dark greenish gray silty clay loam. The lower part, to a depth of 168 cm or more is dark greenish gray, very gravelly silty clay loam and dark grayish brown silty clay loam. Permeability of the Dechel soil is moderately slow. The effective rooting depth for water-tolerant plants is more than 150 cm. If vegetation is removed, runoff is very slow or ponded and the hazard of water erosion is slight. This soil is subject to frequent, very long periods of flooding and deposition throughout the year. A high water table is present, between 10 cm above to 15 cm below the surface, throughout the year.

The Mesei soil is very deep and very poorly drained. It is formed in organic material derived from decomposed and partially decomposed freshwater marsh vegetation, overlying alluvium washed from upland soils, which are derived predominantly from volcanic rock. The surface layer is dark brown and very dark grayish brown muck, about 86 cm thick. The underlying material to a depth of 150 cm is dark gray silt loam. Below

this is a depth of 188 cm or more of black muck peat. Permeability of the Mesei soil is rapid to a depth of 86 cm and moderately slow below this depth. The effective rooting depth for water tolerant plants is more than 150 cm. If vegetation is removed, runoff is very slow or ponded and the hazard of water erosion is slight. The soil is also subject to frequent, very long periods of flooding throughout the year. A high water table is between 30 cm above to 15 cm below the surface, throughout the year. If the soil is drained, the organic layer decomposes and subsides. This unit is used for the production of wetland taro.

The 408 Dechel-Mesei complex is poorly suited to most engineering uses. This unit is well suited to pond reservoir areas; however, because of the low strength of the soils, the edges of the pond should be adjacent to an area of upland soil. Special design and significant increases in construction costs and maintenance would be required to use this area for septic tank absorption fields, sewage lagoon areas, trench sanitary landfills or an area sanitary landfill.

5.3.4 Soil Type 409

Type 409 consists of llachetomel peat with 0–1% slopes. This is very deep, very poorly drained soil in the intertidal area adjacent to the shoreline. It consists of decomposing roots and litter, derived mainly from the mangroves. The surface layer is black peat 20 cm thick. The next layer is very dark grayish brown peat 21 cm thick. Below this, to a depth of 150 cm or more is very dark grayish brown peat. Permeability of the llachetomel soil is rapid. Effective rooting depth for saltwater-tolerant pants is more than 150 cm. If the vegetation is removed, runoff is very slow and the hazard of water erosion is high because of tidal wave action. The frequency, depth and duration of tidal water flooding vary with the lunar cycle and the amount of rainfall. This area is used for woodland and harvest of mangrove crabs. The area is well suited to the production of woodland mangrove species such as *Rhizophora apiculata* (bngaol) and *Sonneratia alba* (urur).

This unit is poorly suited to onsite waste disposal systems because of wetness and the flooding hazard. Effluent may be washed into the lagoon with the daily outflow of tidal waters and thus contaminate the adjacent lagoon and create a health hazard, both to swimmers and to people consuming marine resources harvested in these areas. This unit is poorly suited to homes, small buildings and roads because of low soil strength, wetness and flooding hazard. These limitations may be overcome by placing crushed coral or basalt ballast down to the bedrock and by elevating the road surface more than 1 meter above the mean high tide level.

6 Terrestrial flora and fauna

6.1 Vegetation

The onsite vegetation and vegetation immediately adjacent to the site included plants representative of savanna, agroforest, disturbed forest, native forest and wetlands. *Pandanus tectorius*, a native savanna tree was found to the northeast of the site and measured along the transect line. Taro gardens were seen along the river banks upstream and downstream of the pumping station across the street and downstream of the waste disposal site. Native forests surrounded the site. Weedy species were found in the disturbed areas on site.

Agroforests includes forests planted by humans, and forests that are the direct result of human management. Banana, papaya, and coconut trees were observed on site. Coconut trees were measured along the transect line. These trees may have been planted or the result of discarded seeds, corms, and fruits disposed of at the waste site.

6.1.1 Invasive Weeds

The invasive indigenous vine, *Merremia peltata* (kebeas) was present. This is a noxious weed that is hard to kill and has spread throughout Palau. This vine is especially common once an area is cleared. The most effective way to remove this vine is to dig out its roots and burn it. Cutting the vines is ineffective, in fact may create a greater problem.

6.2 Birds and wildlife

Birds represent an important component of the mangrove and coastal habitats found near the site. We observed or heard at least 9 species of birds including, egrets, plovers, pigeons, doves, terns, honeyeaters, flycatchers, rails, starlings, and white eyes. Starlings were common on a burnt *Calophyllum* tree onsite. The green emerald skink and cane toad, as well as butterflies and other insects were found along the causeway and on land. (see Tables 4 and 5 and Plate 1).

6.3 Species lists

6.3.1 Terrestrial plants and animals

Over 64 species of plants and animals were found at or near the site. The plants found included at least 41 species representing 27 families (Tables 1-5). One endemic plant species, *Osmoxylon oliveri* (kesiamel) was found in the adjacent forest. We found at least 18 indigenous plants during our assessment.[2] We found 12 introduced species; 10 species were identified only to the family level, and included mainly introduced weedy species. Sensitive species included the endemic and indigenous trees and rare larger trees. Over 10 species of birds and 13 species of wildlife including fungi, insects, a toad, a skink, and a bat were seen on site.

6.3.2 Tree basal area and volume

One transect was set at the northeastern section of the site, which was agroforest and savanna (see Table 2 and Plate 4). Four trees were measured along this transect within 2.5 m of the line, covering an area 100 m^2. Two coconut trees *Cocos nucifera* (lius) were measured and had a total basal area of 0.137 m^2 and total volume of 0.913 m^3. Two *Pandanus tectorius* (ongor) were measured with a total basal area of 0.040 m^2 and total volume of 0.159 m^3. The total basal area for all four trees was 0.177 m^2 and total volume 1.072 m^3.

6.3.3 Ground cover

Ground cover plants included grasses and sedges, small plants, and vines. We quantified ground cover every 10 m along the transect line. This data was used to help delineate vegetation types for mapping. The legume, *Desmodium* sp., the grass, *Ischaemum* sp., a *Sida* sp. plant, and one unidentified grass were found as ground cover in the less disturbed northern and northeastern section of the site (see Table 3 and Plates 4-5).

7 Sensitive habitats

7.1 Definition and summary

Because of Palau's limited land mass, all of Palau's habitats, and the species within these habitats, fall into the broad definition of sensitive upper watershed habitat. We prioritized sensitive areas based upon our evaluation of previous disturbance, integrity, biodiversity,

[2] Plants endemic to Palau are found naturally (in the wild) only in Palau; indigenous plants are native to Palau but are also found naturally elsewhere.

how representative they are, occurrence elsewhere, and value of wildlife corridors. Our general definition of a sensitive habitat is an area that is rare in Palau or home to rare or endangered species. The sensitive areas on this site included the undisturbed forests and wetlands. All habitats need protection, as Palau faces the impacts of climate change and climate variability. During the 1997–1998 El Niño/La Niña event, at least 20% of our forest and savanna burned and one third of the reefs were lost due to elevated ocean temperatures. Protection of land resources increases the resilience of these systems during droughts, fires and invasive species outbreaks, which are predicted to occur with increasing frequency as the occurrence of severe ENSO events increases.

7.2 Forests

The project directly impacted forests surrounding the site to the northwest, west and south and east of the waste site. We observed much debris and garbage outside the site within the nearby forest including discarded cars. The forest acts as a natural sediment trap and filtering system for this watershed. The flow of sediment and leachate is retarded by the roots and stems and fallen leaves and low-lying grasses and plants that cover the ground. The forest provides habitat and food for wildlife and the trees are a source of lumber for building. We heard many birds and saw a native palm (demailei) that had been recently cut into strips for construction. Removal of forest will cause the loss of animals that depend upon the forest for food and shelter. Wherever possible, large sections of especially undisturbed forests should be left intact. These forests serve as important buffer areas for the nearby river and watershed. Although this site does not directly impact the nearby mangroves, indirect impacts can result from uncontrolled leachant and debris flowing into the mangroves from the waste site. We recommend the establishment of at least a 20 m (60 foot) vegetation buffer zone around the waste site and a barrier fence within the footprint of the existing waste site. The large trees along the periphery of the existing waste should be outside the barrier fence and waste site.

8 Sensitive species

Sensitive species are defined as rare to Palau or the world, endangered species and species only found in Palau.

8.1 Sensitive plant species

The endemic and native plants found on the site are sensitive plants. (Please refer to Table 1.) The wetlands upstream and downstream of the nearby river are used for taro production and other agroforest farming activities. It is important to maintain good water quality for the agroforest crops downstream and the native and endemic trees within the adjacent forests.

8.2 Sensitive animal species

Four endemic birds were seen or heard on site (Table 4). These birds included *Ptilinopus pelewensis* (dove or biib), *Myzomela rubrata kobayahii* (honeyeater or chesisebangiau), *Cettia annae* (flycatcher or chesisebarsech), and *Aplonis opaca oori* (starling or kiuid). The team did not observe or hear the following species that were listed in the scope of work as rare, endangered, threatened, sensitive or otherwise unique: Micronesian megapode, Palau ground dove, blue faced finch, and white breasted woodswallow.

9 Appropriate indicator species

Appropriate indicator species include 1) native and endemic species that are sensitive to change and 2) invasive or pest species that threaten local species or community health.

Native and endemic species found on or near the site that could be used as indicator species include:

1. Birds listed in Table 4, especially year-round resident endemics such as the pigeon, doves, honeyeaters, flycatchers and starlings. The local boa snake, emerald skink and endemic bats are also good representative native and endemic species. Native and endemic plants that are good indicator spcies include the native grass, *Oplisemenus* sp., the native bamboo *Schizostachyum lima* (lild), the endemic *Osmoxylon oliveri* (kesiamel), larger trees including *Calophyllum inophyllum* (btaches) and *Terminalia catappa* (miich), and *Premna obtusifolia* (chosm). Taro is also an important indicator species, as the women working in the mesei have been complaining about rashes. The health and production of taro downslope and downstream of the waste disposal site needs to be monitored in collaboration with women in the community.
2. There is no need to monitor marine species, as the site is not near marine ecosystems. However, mangroves are visible from the waste disposal site and can be observed for any signs of site-related impacts. If signs of stress are noted (e.g. dropping or discolored leaves) closer examination of the mangroves would be warranted.
3. Invasive or pest species that are a threat to native species and community health are good indicators of whether threats are developing or increasing on site. Indicator pests include insects such as flies and mosquitoes that can transmit disease. Rats were not seen during this study, but monitoring for their presence should be conducted. The invasive cane toad is a threat to native species and is present on site. Invasive plant indicator species could include *Mimosa invisa* (toched), *Leucaena leucocephala* (telentund), and *Merremia peltata* (kebeas).

10 Effect of project on biological resources

Potential general biological resource impacts include:

1. Health Risks to the community
2. Removal of habitats
3. Long term impacts to water quality
4. Water usage
5. Hazardous waste
6. Sewage and discharges
7. Introduced species
8. Fire
9. Noise

10.1 Health risks to the community

During our assessment, two young boys were heading to the dump with waste in a wheelbarrow (Plate 6). One was wearing boots but the other only zoris. The boys entered the site, unsupervised, to dump their waste. There were sharp bottles, metal, and debris on the ground and mosquitoes, flies, and foul odors. It is important to educate the families about the health risks associated with disposal sites from dengue, tetanus, and basic dangers associated with unmanaged wastes. Children should not be allowed entry beyond a

designated waste drop-off point, to prevent injury or illness. Rats and flies are vectors for disease and need to be controlled.

10.2 Direct impacts

Direct impacts include the removal of habitats, impacts to sensitive habitats, sensitive species and their habitats, and impacts to sensitive species movement corridors; indirect impacts include disturbance from construction or operational activities.

There are no plans to expand beyond the original footprint of the waste disposal site, which is already severely impacted by the wastes on site. This site is private property that was once residential and agroforest, with remnant traditional stone features. It is important not to disturb the traditional stone features; a cultural clearance is required by the Bureau of Cultural Affairs. It is further recommended that no additional habitat be disturbed. A barrier wall around the existing site would prevent any unintentional expansion. It is further recommended not to push the material further down slope, but to keep within the footprint of the existing site on level land (slope of 0%.) Activities should be limited to areas with the least slope, that are farthest from the streams and wetland.

10.3 Long-term impacts to water quality

Water quality in the mangrove and lagoon may be impacted by leachant and sediment runoff, which in turn impacts on organisms inhabiting those environments. Pollutants cause normal oxygen levels to drop, temperatures to rise, and nutrient levels to increase. The survival of organisms in these wetland environments depends on these parameters being maintained within a specific range. A monitoring program for water quality is necessary to address long-term impacts to the soil, and to wetlands and rivers that lead to the mangrove and lagoon. It is recommended that a monitoring program be established for the lifetime of this waste disposal site. The greatest potential runoff of leachant and sediments may occur during movement of wastes on site. It is important that all soil and leachant runoff mitigation infrastructure (i.e., silt screens, sediment traps and leachant traps) are in place before any activity begins. Throughout the duration of the project, strict erosion and leachant control practices must be implemented to protect the nearby river from runoff of either leachant or sediments from the landfill. The applicant will provide an erosion and leachant control plan that will be reviewed by the EQPB.

The existing entrance to the site is on a slight downhill slope that leads to the main road. The road has a swale and very low grass. During heavy rains, there is potential for runoff from the site through the entrance, down slope along the main road into the nearby river. The erosion and leachant control plan must address heavy rain periods. The ditches need to be designed so as to retard and divert sediment or leachant flow from the site into river downstream. Extra precaution is required as this site is close to a river.

10.4 Water usage

Currently water usage has not been discussed. If water is used from the nearby stream, the volume and quality of water must be monitored and flow rates must be maintained downstream for a healthy stream ecosystem. An onsite water storage system and a fire hydrant should be in place to deal with fire outbreaks, dust control, and drought.

10.5 Hazardous wastes

No hazardous wastes such as used oil, acid from batteries, old medical supplies and pesticides, insecticides and herbicides were seen on site; if present, these need to be contained and removed from the site. There is a significant potential risk associated with the entry of such wastes into the nearby river, which supplies water to the farmland

downstream, and the subsequent accumulation of toxic substances in food plants, or freshwater or marine organisms, which may subsequently be eaten, either by people or local animals. It is important that all precautions be taken to prevent leakage of hazardous wastes from the landfill site.

10.6 Sewage waste

No plans for sewage treatment and disposal were stated to TEI by OERC. Recycling of aluminum cans, organic matter, cardboard and plastics can be implemented for this site.

10.7 Introduced species

Introduced species have severely impacted native species throughout the Pacific Region. It is important to eradicate invasive species as quickly and effectively as possible. The prevention of introduction from equipment or containers is critical and most cost effective.

The indigenous vine, *Merremia peltata,* or *kebeas,* was found on site. This vine is out of control along the entire Compact road and a control or eradication program for this vine should begin immediately. Any other noxious weeds that are found on site now or during the proposed cover fill needs to be eradicated if possible and if not at least contained.

The invasive cane toad, *Bufo marina*, was also seen on site and poses a potential threat to endemic skinks and insects. The African snail, *Achatina fulica*, was not seen on site. This snail is known to cause the extinction of endemic tree snails throughout the Pacific and may carry disease. Although not seen onsite, domestic cats as well as rats pose a threat to endemic bird populations. Rats are also carriers of disease, and there is evidence of rat predation on freshwater snails *Neritina* spp. snails (Smith, 1991). A potential threat is the brown tree snake, *Boiga irregularis,* which has almost eradicated the native bird populations in Guam.

10.8 Fire

Fire has been an ongoing problem at the waste disposal site. Evidence of a recent fire were visible at the site (Plate 3). Fire is a health hazard due to the chemicals released in the smoke by the fire, which can spread to within the vicinity of residential homes on windy days.

10.9 Noise

The use of heavy equipment and the traffic flow for waste disposal can cause disturbance within the nearby community and impact the normal behavior of wildlife and birds. A perimeter corrugated barrier fence landscaped with native bushes and trees would serve as a buffer for noise and also prevent movement of wildlife into the site, or potentially harmful invasive organisms from entering the surrounding area.

11 Biological impacts and mitigation

Biological impacts considered most significant are listed in order of importance below.

Significant Biological Impacts and Related Mitigation

Impacts	Mitigation	Monitoring
Health risks to the community due to unregulated disposal and entry into the site include personal injury from debris and waste, and illnesses related to polluted areas such as tetanus, hepatitis and leptospirosis.	Restrict access by unsupervised, unauthorized persons. No unsupervised children should enter the site and if possible no one should go beyond a certain drop off point without supervision. Staff working at the site need to have regular tetanus and hepatitis shots and proper equipment and clothing for this job. Signs need to be placed by the entrance as well as a gate to secure the site each day. The sign needs to indicate: a) operational hours of the waste disposal site; b) operational procedures explaining the types of wastes that must be recycled; c) instructions on disposal of un-recyclable material; d) contact information in order to have clarification; and e) a map showing location of areas for recycling.	Regularly monthly inspections by EQPB and Environmental Sanitation.
Long term impacts to water quality from leachant and sediment runoff. Water pollution can impact many organisms in habitats in, adjacent to and downstream of the site. Leachant runoff is already being observed and may increase as a result of chemical pollutants from hazardous wastes.	An erosion control plan or soil conservation plan should be developed, that includes an inventory of material onsite and a phasing of construction, and placement and implementation of erosion control infrastructure. For example, silt screens and sediment traps should be constructed and set in place before the improvement activities begin. This includes screens that line the mangrove edge and diversions or traps before water enters the lagoon. Funding should be appropriated to monitor and maintain the screens and traps and other erosion control measures throughout the lifetime of this landfill. At least two EQPB monitoring stations are needed: one upstream of the pumping station and one downstream of the pumping station and the landfill. An emergency mitigation plan for unpredicted heavy rains and unforeseen problems is needed. Signs need to be posted along the river to	A biologist and engineer should be retained throughout the duration of the project. Their scope of work would include monitoring and maintaining structures or activities developed for mitigation. EQPB engineers will visually inspect all drainage including drainage beyond leachate pond and system for early detection of any signs of overflow or leakage problems and recommend mitigation measures and if necessary, design or maintenance protocol modification. Set up two monitoring stations upstream of pumping station and downstream of pumping station and the waste site. Test for coliform

Significant Biological Impacts and Related Mitigation

Impacts	Mitigation	Monitoring
	prevent recreational swimming in this area. Avoid any obstruction of the natural drainage within the nearby stream and wetland areas. Work with EQPB to set up a system of disposal, compaction and cover. Concentrate waste into "cells" working from one cell to the next in a systematic progression. These cells should be located away from all boundaries and natural drainage areas to avoid impacts within this watershed. Construct a perimeter silt fence around the entire area and a series of sediment ponds placed on site – especially near the river as part of the surface erosion control plan. Implement good erosion control management practices.	bacteria, total suspended solids, pH, oxygen and temperature. These stations need to be monitored monthly, as this is the source of drinking water in Chollei and the water source for taro farms in the area. Women are complaining about rashes, so it is important to follow-up with Mr. Joe Aitaro, IWP Coordinator, concerning this problem and determine if there is a point source of pollution. Construct and set up silt/sediment screens and sediment/leachate traps before the improvement activities begin. This includes screens that line the waste site and also diversion or traps to filter and retard flow rates and allow for settlement before discharge enters the river. Work with NRCS to develop a soil conservation plan for this site and work with the engineering staff at EQPB to develop a proper design for leachate drainage and ponding on site. Appropriate funds through the IWP program to monitor and maintain the sediment and leachate screens and traps and other erosion control measures throughout the lifetime of this landfill. Provide training for the manager of the Chollei waste disposal site through the EQPB staff and programs sponsored by IWP-OERC on protocols for waste management including maintenance of leachate and sedimentation systems and recycling. Appropriate materials will be available on site to cover bare areas and cover stockpiled soil used for waste cover – especially during heavy rains. Materials may include gravel, woven coconut fronds, bundles of

Significant Biological Impacts and Related Mitigation		
Impacts	**Mitigation**	**Monitoring**
		tied grass and industrial erosion control matting. Have ongoing consultations for the lifetime of this project with the EQPB engineers, EQPB water quality supervisor, and biologists at OERC to ensure the monitoring plan is implemented.
Removal of vegetation and impacts to wildlife, especially endemic plants, birds and freshwater organisms. Removal of vegetation can cause potential soil erosion and sediment overload into nearby watersheds, which can disrupt the life cycles of a variety of organisms. Loss of vegetation equates to loss of habitat for nesting birds, and loss of food for wildlife; it can also cause loss of topsoil.	Implement a basic policy to avoid any obstruction of the natural drainage within the nearby stream and wetland areas. Dispose of material towards the center of the site and away from all boundaries to avoid impacts to nearby forested areas. Take all precautions to prevent sedimentation and leachant flow into the adjacent forest, wetlands and river. Utilize common native species, preferably endemic, indigenous or rare plants (held in a small nursery on site) for landscaping the buffer zones and barrier fence surrounding the waste site. Surface erosion control should involve planting ground cover plants immediately after earthwork is done. Mitigation measures should include a silt fence surrounding the entire area and a series of sediment ponds placed on site. Good erosion control management practices and monitoring should be applied for the duration of this proposed project. Construct a barrier perimeter fence to a) ensure that waste remains within the original footprint, b) avoid spillage into the adjacent areas, c) buffer noise within the waste site, d) prevent movement of wildlife into, invasive and pest species out of the site. Relocate discarded waste like abandoned cars that are discarded outside the footprint of this site. Plant ground cover plants immediately after any earth moving occurs as part of the surface erosion control plan.	Conduct weekly monitoring for the duration of the project to document changes in abundance of indicator species and overall implementation of the management plan. Conduct regular inspections with the Environmental Sanitation Division and EQPB; the team will inspect natural freshwater drainage, manmade leachate drainage systems, the barrier fence perimeter, the adjacent areas, and overall operations and procedures. Utilize common native species, preferably endemic, indigenous or rare plants for landscaping the buffer zones and barrier fence surrounding the waste site. Inspect landscape around perimeter of barrier fence and ensure vegetation is healthy. Set up a schedule for regular EPQB site inspection of perimeter drainage and barriers before any shifting or relocation of material within waste disposal area.
Hazardous wastes can impact the both plant and animal health. Wastes include oils, gasoline	All hazards waste including gasoline, battery acid, oil or other material need to be properly contained on site and subsequently properly disposed of according to EQPB regulations. A sign at the entrance to the waste disposal site should itemize hazardous materials that are	

Significant Biological Impacts and Related Mitigation		
Impacts	**Mitigation**	**Monitoring**
lubricants, and herbicides. No hazardous wastes should be added to this waste site; if any are found on site, they should be contained and relocated according to EQPB regulations.	not to be dumped. A contact number should be posted which people can call if they must dispose of hazardous waste or sewage. The manager of the waste site should work directly with the Ngarchelong State governor and EQPB to make arrangements for containment and transport of any hazardous materials to appropriate location, with technical assistance from EQPB.	
Introduced species can potentially wreak havoc on natural plant and animal communities. The greatest threat to the bird community is the potential introduction of the brown tree snake of Guam. It is important to destroy the toad population at this site.	Remove and burn invasive weeds found on site. The *Merremia peltata* needs to be removed. The Division of Agriculture should be consulted regarding invasive or potentially invasive plants and animals associated with plants. The source of all soil transported to the site for regular cover of wastes needs to come from a source that is free of invasive weeds. All planting should be of endemic and indigenous species, thus avoiding any potential problems with introduced species. Whenever possible local non-invasive seeds and plants should be used to rehabilitate and landscape the site. It is important that all plants imported be screened and approved by the Division of Agriculture. All equipment and materials shipped or flown in for this project should be screened for introduced plants or animals. Any introduced plants and animals found should be destroyed immediately. The quarantine and customs agents need to be consulted to determine the best way to screen for unwanted introduced pests.	A mechanism needs to be in place to monitor for and eradicate any accidental introductions.
Fires have occurred on site within recent weeks. Uncontrolled fire causes air pollution and potential health risks to nearby residents, hotel guests and workers in the vicinity.	A fire control and prevention plan, with an inventory of all necessary fire control equipment, should be developed for the site. Rain catchment tanks should be designed and constructed with capacities sufficient to hold water for periods of fire outbreaks, dust control and droughts. Construct fire barriers around the periphery of the site to avoid fire outbreaks to adjacent areas. Place a sign on site that bans smoking while on site, or setting fires on site without an EQPB and State permit.	

11.1 Comparision of project alternatives

Two alternatives for the proposed project are as follows:

1). The alternative of no action.The site will remain unmanaged, the volume of waste and associated pests will increase, the waste site will reach full capacity more quickly, and there will be an ongoing health risk to the surrounding environment and the community.

2). The alternative is to set up a recycling and compost area and work with local engineers to design a proper leachant drainage system and a barrier surrounding the site to contain the waste. This alternative is recommended.

12 Actions for main partners

12.1 Inspections

We recommend that the Environmental Sanitation team and the EQPB inspection team use their standard inspection forms for waste site inspections nationwide. There will be regular ongoing inspections for dengue prevention and for permitting waste sites in Palau. In addition, a qualified engineer and biologist from these agencies can perform more specific inspections. The engineer can assist in the design and maintenance protocol and training for a small scale and simplified version of the leachate drainage system that is based upon the proposed design of the improvement of the national landfill in Ngerbeched. The biologist assigned to the project can use the existing species lists provided in this ecological profile to check for indicator plants and animals recommended in this report throughout the duration of this project. We recommend that the Environmental Sanitation Team and EQPB team work in coordination and cooperation with Ngarchelong State and OERC to streamline the inspection process and ensure that all parties are working as a team to support the recycling effort and on site waste disposal management.

We have provided a simple inspection and report form for the manager (Annex 1). This form is to help in daily monitoring and logging of activities at the waste disposal site. We recommend daily inspections by the State-designated manager of the Chollei site, with weekly inspections by EQPB and OERC for the first month. If inspections are satisfactory, visits could be reduced to biweekly inspections for the second and third months. If inspections are satisfactory, then reduced site visits to monthly inspections for the fourth through 12^{th} months. Thereafter, if inspections are satisfactory, reduce site visits to quarterly inspections for the lifetime of the site.

12.2 Roles of key stakeholders

- The Environmental Sanitation team should maintain its role in inspecting and recommending actions to the State and OERC-IWP project coordinator as necessary to prevent the spread of disease.
- EQPB should provide technical support in the design of the leachate drainage system, disposal of batteries and other wastes, and assist in recycling efforts as part of its education awareness program.
- OERC-IWP should continue the overall coordination and support between the State of Ngarchelong, EQPB and Dept of Health's Environmental Sanitation Division, Ministry of Health.
- An elementary school aluminum can campaign drive should be undertaken to help launch this project. A recycling drive through the schools of Ngarchelong

would get the communities actively involved in this process. (It is important to have recycling bins built in advance of the drive and a mechanism to transport the cans to the recycling center in Koror.)

- Agriculture and EQPB should help promote home compost piles and help families set up compost at home. This can be done through community visits, a school demonstration project and a science class project. The school principals and teachers could work with the communities — including the local stores, churches, the Ebiil Society, the traditional men's groups and women's groups — to conduct a recycling drive for aluminum and organic waste. This program can begin in early spring and culminate on Earth day with a tree planting around the school or community center using the home made compost. At the same time prizes for the classes with the most cans can be awarded with prizes donated by local businesses. (A big thermometer showing how many cans they have collected each day would be a good incentive for the students.)
- The Governor, Delegate and Legislature of Ngarchelong State should pass legislation that supports the waste management program. This could take the form of a resolution of support or could require recycling for each household, impose a user fee for the waste site, and impose fines for littering and illegal disposal outside the designated site.

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Annex 1: Tables

Table 1. Checklist of plants found at the Chollei waste disposal site during walks within and adjacent to the proposed site on December 6, 2004. "x" = present

Scientific name	Walk	T1	Forest
POLYPODIACEAE			
Phymatosorus scolopendria (chebechab) Nd			
SCHIZAEACEAE			
Lygodium auriculatum Nd			x
MONOCOTYLEDONAE			
ARACEAE			
Alocasia macrorrhiza (bisech ra Belau) X			
Rhaphidophora sp. (toilalech)			
ARECACEAE			
Cocos nucifera (lius) X	x	2	
Cocos nucifera (lius) saplings	x	x	
Heterospathe elata var. *palauensis (*demailei) Nd			x
CYPERACEAE			
Fimbristylis sp.	x		
Scirpus sp.	x		
Scleria sp. (baklild)	x		
MUSACEAE			
Musa sp.	x		
Musa sp. saplings	x		
PANDANACEAE			
Pandanus tectorius Nd	x	2	
POACEAE			
Bambusa vulgaris (bambuu) X	x		
Eriochloa sp.	x		
Ischaemum polystachyum var. *chordatum* (kelelakameng) Nd	x		x
Oplismenus sp.	x		
Schizostachyum lima Nd	x		x
DICOTYLEDONAE			
ARAILIACEAE			
Osmoxylon oliveri (kesiamel) E	x		
ASTERACEAE			
Bidens alba X	x		
Crassocephalum crepidioides X	x		
CARICACEAE			
Carica papaya (bobai) X	x		

Table 1. Checklist of plants found at the Chollei waste disposal site during walks within and adjacent to the proposed site on December 6, 2004. "x" = present

Scientific name	Walk	T1	Forest
CASUARINACEAE			
Casuarina equisetifolia (ngas) Nd			
CLUSIACEAE			
Calophyllum inophyllum (btaches)Nd	x		
COMBRETACEAE			
Terminalia catappa (miich) Nd	x		
CONVOLVULACEAE			
Ipomea pescaprae Nd	x		
Merremia peltata (kebeas) Nd	x		
EUPHORBIACEAE			
Macaranga carolinensis var. *carolinensis*(bedel) Nd	x		x
FABACEAE			
MIMOSIODEAE			
Leucaena leucocephala (telentund) X	x		
Mimosa invisa X	x		
FABACEAE			
PAPILIONIOIDEAE			
Crotalaria pallida X	x		
Desmodium sp.	x		
Derris trifoliata (kemokem) Nd	x		
MALVACEAE			
Sida sp.	x		
MUNTINGIACEAE			
Muntingia calabura (budo) X	x		
PASSIFLORACEAE			
Passiflora foetida(kudamono) X	x		
POLYGALACEAE			
Polygala paniculata Nd	x		
RHIZOPHORACEAE			
Rhizophora apiculata (bngaol) Nd	x		mangrove (offsite)
RUBIACEAE			
Ixora casei (kerdeu) Nd			
SOLANACEAE			
Physalis ?	x		
SONNERATIACEAE			mangrove (offsite)
Sonneratia alba (urur) Nd	x		

Table 1. Checklist of plants found at the Chollei waste disposal site during walks within and adjacent to the proposed site on December 6, 2004. "x" = present

Scientific name	Walk	T1	Forest
VERBENACEAE			
Premna obtusifolia (chosm) Nd	x		
Stachytarpheta jamaicensis (louch beluu) X	x		
Totals			
Families	27		
Species	41		
Endemic Species	1		
Indigenous Species	18		
Introduced Species	12		
Unknown	10		

Table 2. Tree Volume and Basal Area Transect 1: Chollei Waste Disposal Site, Dec 6, 2004.

Distance (m)	Scientific name	Common name	Circumference (m)	Dia (m)	Basal Area (m2)	Height (m)	Volume (m^3)
22	*Cocos nucifera*	lius	0.87	0.277	0.060	5	0.301
40	*Cocos nucifera*	lius	0.98	0.312	0.076	8	0.612
					0.137		0.913
33	*Pandanus tectorius*	ongor	0.52	0.166	0.022	4	0.086
34	*Pandanus tectorius*	ongor	0.48	0.153	0.018	4	0.073
					0.040		0.159
	Grand total				**0.177**		**1.072**

Table 3. Ground Cover Chollei Waste Disposal Site

meters	burnt grass (%)	Desmodium	Ischaemum	*Sida* sp.	Sp. B	Comment
0	0	0	0	0		
10	100%	0	0	0		recently burned
20	0	90%	0	0		
30	0	50%	10%	10%	2%	
Total	100%	140%	10%	10%	2%	
Mean	25%	35%	2.5%	2.5%	0.5%	

Table 4. Checklist of birds seen (v) or heard on Dec 6, 2004

SCIENTIFIC(PALAUAN) NAMES	Status	Walk	Comment
CLASS: AVES			
ARDEIDAE: herons, egrets, and bitterns			
Bubulcus ibis (keremlal sechou)	Mc	1	seen
CHARADRIIDAE:Plovers			
Pluvialis dominica(derariik)	Mc	2	seen
COLUMBIDAE:pigeons and doves			
Ptilinopus pelewensis (biib)	Ea	1	heard
Ducula oceanica (belochel)	Rc	1	heard
LARIDAE: terns and noddies			
Sterna sumatrana (kerkirs)	Rc	x	overhead
MELIPHAGIDAE: honeyeaters			
Myzomela rubratra kobayahii (chesisebangiau)	Ec	4	seen
MUSCICAPIDAE (flycatchers)			
Cettia annae (chesisebarsech)	Ec	4	seen
RALLIDAE: rails			
Rallus philippensis (terriid)	Rc	1	heard
STURNIDAE: Starlings			
Aplonis opaca oori (kiuid)	Ec	5	seen
ZOSTEROPIDAE			
Zosterops finchii (chetalial)	Ra	x	heard
Totals			
Familes		9	
Species		10	

Status codes: R = Resident, E = endemic, M = migrant, I = introduced, u = uncommon, c = common, a = abundant, "*" = species on endangered species list (Title 45, Chap 5).

Table 5. Check list of wildlife other than birds, seen at the proposed site while walking through the site on Nov 6th, 2004.

Scientific (Palauan) common names	Walk	Comments
KINGDOM FUNGI		
Division Ascomycetes		
Lichen species	x	
Divison Basidiomycota (club Fungi), Class Homobasidiomycetes- brachet fungi		
mushroom spp.	x	
PHYLUM ATHROPODA		
Subphylum Chelicerata, Class Arachnida		
spider Sp. 1	x	
Subphylum Mandibulata, Class Insecta, Order Diptera		
Mosquitoes	x	
Flies	x	
Order Hymenoptera		
Small black ant Sp.1	x	
Large black ant Sp.2	x	
Order Lepidoptera		
Papilio polytes (bangikoi)	x	seen
Order Orthoptera		
Grasshopper sp. (chebub)	x	seen
Subphylum Vertebrata		
Class Amphibia, Order Anura (toads), Bufonidae		
Bufo marinus (dechedech e ra ngebard)	1	seen
Class Reptilia, Boidae		
Candola carinata	1	seen
Scincidae (skinks)		
Lamprolepis smaragdina (chemaidechechedui)	1	seen
Class Mammalia, Order Chirotera		
Pteropus mariannus pelewensis(oliik)	1	seen
Total Number of Species: 13		

Annex 2: Photographic Plates— Plate 1


Schizostachyum lima (lild) plants in forest south of site


Native forest along stream behind disposal area on southern end.


Forest immediately adjacent to disposal area (clearing in background)



Large cauliflower fungi Boa Snake Cane toad



Emerald skink Starling on burnt btaches tree. Forest floor at southern boundary.

Plate 2

View of site from South facing N.

Discarded vehicles SW along road.

Stream along S and SW boundary

Stream to NE of site, water pump station to left.

Plate 3

Northwestern and North view of disposal area in Chollei, Dec 6, 2004

Southwest and southern end of disposal area in Chollei, Dec 6, 2004

NW and West view of site inside and outside disposal area

NE view showing fallen corrugated fence and swale for road.

Entrance to the disposal area.

Plate 4

E and NE view of disposal area with fallen fence. Red arrow shows the direction transect line was set.

Ground cover at 0 m no vegetation, 10 m with burnt grass and 20 m with *Desmodium.*

Ground cover at 30 and 40m along transect at northeast end of landfill.

Includes *Ischaemum*, *Desmodium*, and *Sida* spp.

Plate 5

Weeds found within landfill along NE section of landfill boundary

Plate 6

Young boys going to the Chollei disposal area, Dec 6, 2004.

Young boys heading to the Chollei disposal area, Dec 6, 2004.

Annex 3: Proposed daily inspection report

Proposed Daily Inspection and Report Form for the Site Manager

1. Time:_____

2. Date: Day___Month ___ Year_____

3. Name:_____

4. Estimated volume of non-recycled waste _____lbs

5. Estimated amount of following recycled materials:

6. Aluminum cans_____lbs, Organic waste _____lbs, Cardboard____lbs, 7. Glass_____lbs

7. Compost produced _____lbs

8. Unauthorized dumping outside the site?_____

9. Barrier wall: ok?_Yes or No_____ if No what is problem _____

10. Drainage system: ok? Yes or No Any problem?_____

11. If so Repair made?_____

12. Color of drainage water? Clear_____, Brown with sediment_____ Any odor_____

13. Pest species (if present check with Y for yes and N for no if not present)

a. Flies ____

b. Mosquitoes ____

c. Rats____

d. Toads____

e. Kebeas_____

f. Any new invasive weeds____

14. Any dead animals on site?_____ If Yes, what kind of animal_____

15. Fire occurrence? Yes___ No___ If Yes, Time____,and Date

Cause of fire _____, Approximate location of fire and area in square feet_____.

16. Hazardous wastes? Yes___ No___ If Yes, what is the type of waste_____ Relocation site of waste_____

17. Birds observed or heard by the site (write number or just check with an "x")

kiuid ___, chesisebangiau___, chesisebarsech____, biib____, belochel _____,

other birds or wildlife:_____

18. Comments for the day_____

_____

_____

Annex 4: Scope of work

The work undertaken by TEI on this project comprised the following:

Literature Review

Review of existing studies, including but not limited to the following:

- Bibliography for Babeldaob Compact Road construction EIS (US Army Corps of Engineers 1998).
- Environmental Concerns Study (TEI 2003)
- Palau 2020 National Master Development Plan (SAGRIC 1996).
- Integrated Solid Waste Management Plan. (Golder and Associates 1999).
- The Study for Promotion of Economic Development in the Republic of Palau (JICA 2000).

Data Review

- Historical and ongoing water quality monitoring program data for Chollei from the Palau Environmental Quality Protection Board (EQPB).
- Available current studies and ongoing current studies in the Chollei watershed

Site inspection

- (with Mr. Joe Aitaro).

Field work

- Field work to assess existing waste disposal site and sub-watershed, including adjacent forest and the nearby river.

Annex 5: Deliverables

a) Review of Current Ecological Information of Babeldaob

b) General Distribution of habitats and habitat map.

c) A species checklist of plants and animals.

d) Information on species abundance and status. .

e) An assessment of biological sensitivity.

f) Appropriate indicator species.

g) Effects on biological resources.

h) Impacts on the site. .

i) Alternatives.

j) Mitigation measures.

k). Monitoring plan.

No appendices for the biological survey work were needed, as the data set was small and summarized in the species checklist.