

## Restoration of LaoLao Watershed by Implementing Best Management Practices and Conservation Action Plans

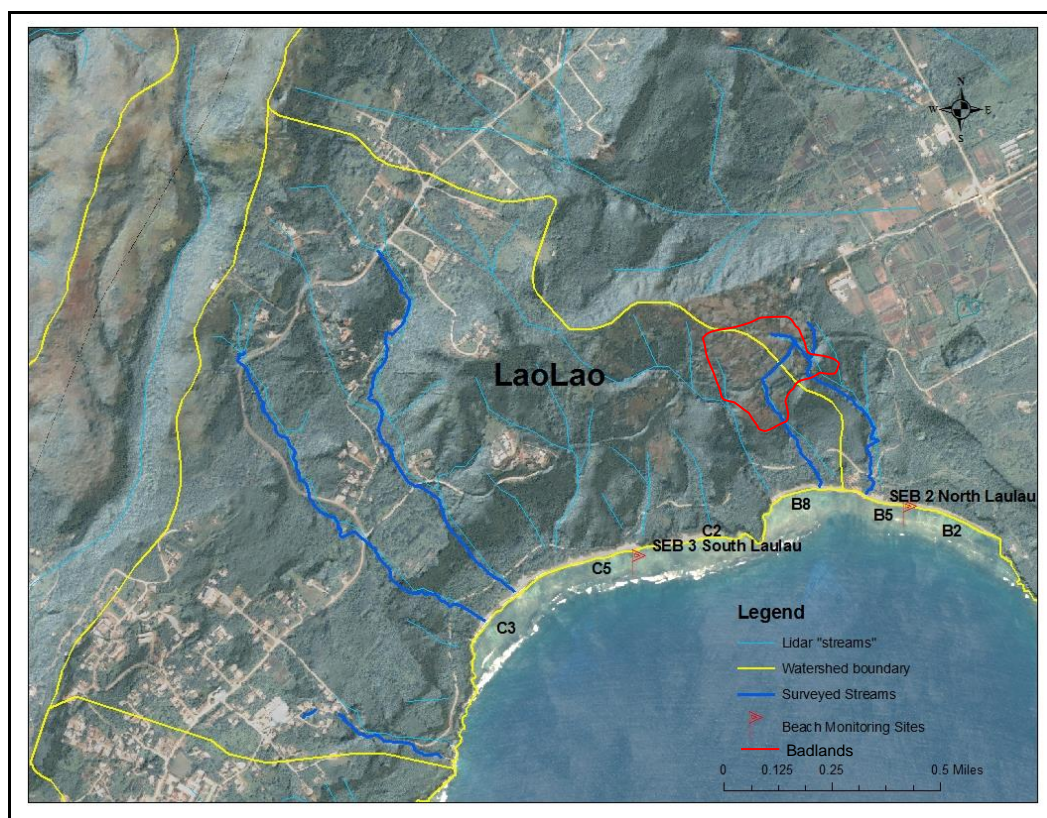
### I. Waterbody Overview

The LaoLao watershed (Water Body Segment ID 15) is located on the island of Saipan within the Commonwealth of the Northern Mariana Islands (CNMI) archipelago. LaoLao was first included in the Clean Water Act (CWA) section 303(d) list of impaired waters for failing to support the Recreational and Aquatic Life use designations (UD) in 2004. However, sedimentation was noted as a potential problem to LaoLao Bay in the first CNMI 305(b) and 303(d) Water Quality Assessment Integrated Report (IR), in 1998.

There is 4.6 Stream miles in the watershed, which are ephemeral. Several streams in the upper watershed merge in the mid-watershed and flow into LaoLao Bay. Together this watershed spans 1.2 beach miles, and 2.1 shoreline miles.

The watershed covers 1,043 acres of land, some of which is composed of badland soils in the upper watershed (FIGURE 1). The US Forestry Service (USFS) surveyed the area in 2005, dividing “land use” into several classes.

**FIGURE 1: LaoLao Watershed – Water Body Segment 15**



USFS broke down land use into nine classes. FIGURE 2 shows that LaoLao has 0.01 sq mi (2.5 acres) Cropland; 0.39 sq mi (97 acres) of Urban Vegetation; 0.12 sq mi (30.6 acres) Urban and Built-up; 0.02 sq mi (3.8 acres) of Barren/Sandy Beach/Bare Rocks; and the remaining 3.2 sq mi (789.3 acres) as mixed forest including *Leucaena* (“Tangan Tangan”) scrub, and assorted grass lands.

**FIGURE 2: LaoLao Land Use Classes (2005 USFS ArcGIS)**

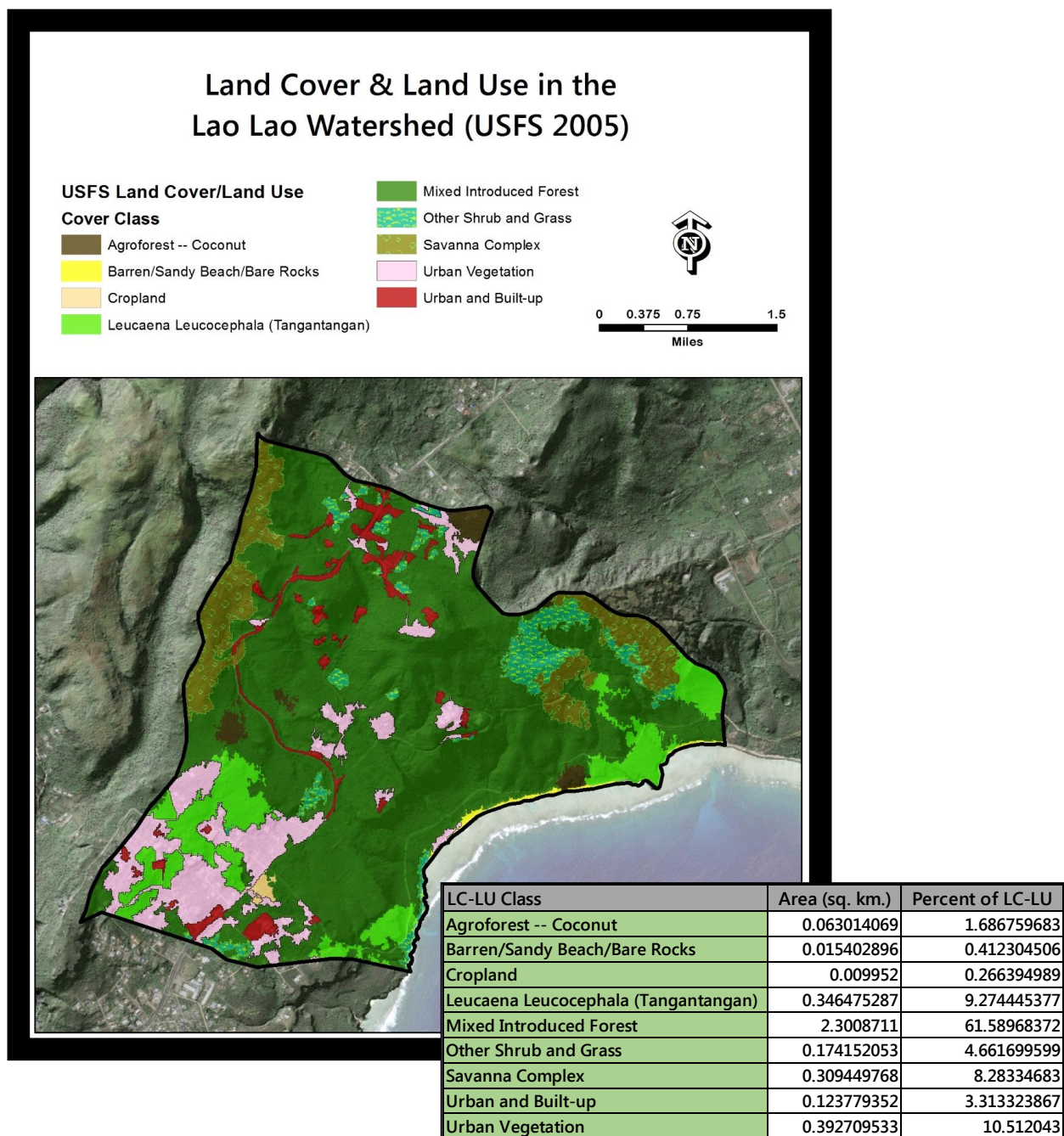
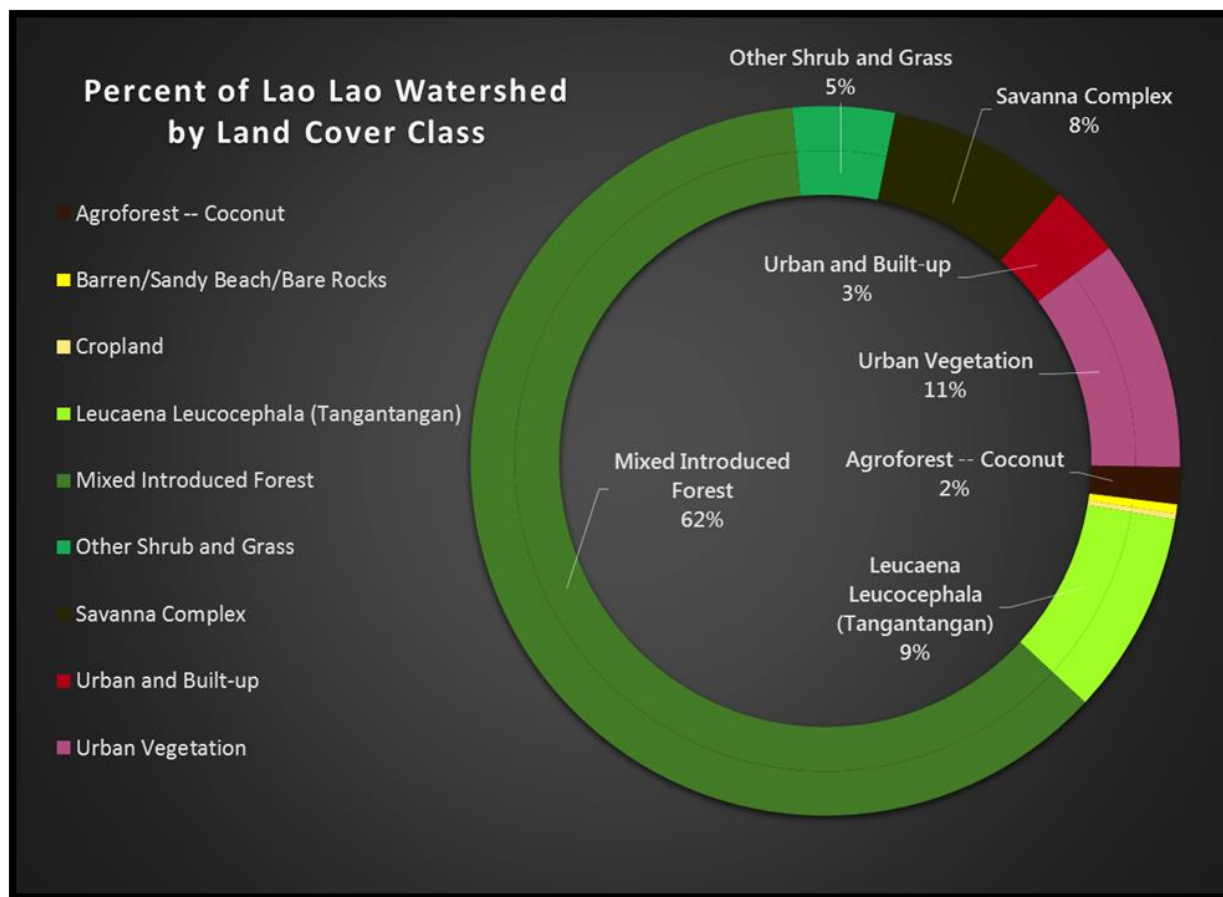


FIGURE 3 shows the percentage of each type of land use by class.

**FIGURE 3: LaoLao Percent of Land Usage by Class**



## II. Identifying Types and Sources of Impairment

Sedimentation in LaoLao Bay has long been noted by residents. In the mid 1990's, fires in the upper badlands led to significant erosion and consequently, sedimentation in LaoLao Bay (FIGURE 4). Some fires were set intentionally by hunters wishing to attract deer to fresh growing shoots, while others were the result of dry conditions leading to brush fires. Several concerns about the Bay's diminished water visibility and coral conditions were reported by SCUBA divers and fishermen to CNMI natural resource agencies at that time.

The Bureau of Environmental and Coastal Quality's (BECQ) Water Quality Surveillance / Non-point Source (WQS/NPS) branch monitors two BEACH sites, and six additional reef flat sites in LaoLao Bay, for *Enterococci*, salinity, pH, temperature, DO, and turbidity. Water quality is monitored on an 8 week rotational cycle at the two BEACH sites, and monthly at the six reef flat sites. These data are used to evaluate water quality and effectiveness of recent road construction improvements using Best Management Practices (BMP) and the implementation



of restoration activities that are described within the LaoLao Bay Conservation Action Plan (CAP). The CAP was developed in 2009 as a cooperative effort between community members, organizations, and CNMI resource agencies. CAPs are used as an alternative restoration approach by CNMI resource agencies to foster community stewardship toward water quality improvements, in the interim while TMDLs remain undeveloped.

**FIGURE 4: Sedimentation at LaoLao Bay Stream Outfalls (2004)**



It was not until 2004 that LaoLao watershed (Segment 15) was included in the CWA section 303(d) list of impaired waters for the Recreational and Aquatic Life UDs for the first time. Recreational impairment was due to exceedances of the CNMI's Water Quality Standard (WQS) for the Fecal Indicator Bacteria, *Enterococci*. Over 10% of the samples taken from the two BEACH monitoring sites per annum resulted in public beach advisories. However, the six reef flat sites that are within walking distance of the BEACH sites rarely exceed the WQS. It is theorized that the source of the elevated levels in the water column may be the result of sediment from eroding badland soils and the secondary coral road containing naturally occurring *Enterococci*, rather than actual fecal contamination, as this is not a densely populated watershed with no sewer lines, and *Enterococci* is known to survive in tropical soils.

None the less, in the interest of public safety, a beach advisory is publicized using multi-social media, that warns residents and visitors not to fish or swim within 300 feet of a BEACH site whenever there is a WQS violation for *Enterococci*. An exceedance occurs whenever a single water sample exceeds the ***Enterococci* Statistical Threshold Value of 130 Most Probable Number (MPN)/100ml**; or when the Geometric Mean **exceeds 35 MPN/100ml**, based on samples taken ***within any 30 day interval, unless the single sample is less than 35 MPN/100ml.***

The BECQ Marine Monitoring Team (MMT) was established in 1996. Each year the team makes assessments of reef conditions in priority watersheds. It has developed and expanded over the years to improve data collection and accuracy. The MMT analyzes the ratio of reef accreting benthos (coral and crustose coralline algae) to non-accreting benthos (turf and macroalgae) coverage using replicate benthic assessment transects at designated monitoring sites. “Poor” habitat conditions mean, “Seasonal cycles are masked by persistent macroalgae growth, or, persistent growth dominates unless a disturbance event like large-swell and high surface currents occur”. “Good” conditions mean, “Natural seasonal changes are apparent, existing assemblage has statistically more *H. uninervis* than macroalgae based upon average of estimates....” between one fiscal year to the next.

LaoLao marine waters were also included in the CWA section 303(d) list of impaired waters for the Aquatic Life UD due to elevated orthophosphate levels in 2004. If these levels had been valid they would not have supported aquatic life. However, the spectrophotometric method used at that time resulted in falsely elevated levels due to salinity interference, thus providing erroneously higher levels in marine water samples. Therefore, these results should never have been used to assess attainment of the Aquatic Life UD. However, the MMT also found that LaoLao’s benthic habitat was only “partially” supportive of the Aquatic Life UD, thus it was listed then, and it continues to be listed as impaired now.

In the latest 2016 IR, the MMT noted a significant decline in biological conditions of the reef’s benthic habitat. This resulted in LaoLao Bay receiving a “Poor” rating, thus the watershed remains on the CWA section 303(d) impaired list for the Aquatic Life UD.

In addition to the MMT biological data, the WQS/NPS branch completed a Ground-truthed sanitary survey of the entire LaoLao watershed in 2014. The potential NPSs of pollution were mapped using ArcGIS and impairment was reported to be, “likely due to a reduction in herbivory and water quality due to uncontrolled sediment laden run off from badland areas and unpaved secondary coral roads.”, as this is not a densely populated watershed.

### III. Addressing Water Quality Impairment

The impact of sedimentation to LaoLao Bay’s reef system is economically significant as the Bay is an important tourist destination. It is visited by approximately 4,000 people each month to picnic, fish, snorkel, and/or SCUBA dive (visitor data provided by Marianas Visitor Authority on 02/08/17).



In order to address this primary source of impairment, BECQ engineers and technical staff from the Wastewater, Earthmoving, and Erosion Control (WEEC) branch work with the Department of Public Lands (DPL) and Department of Public Works (DPW) to plan large land use improvements. WEEC also provides training to road crews to promote proper grading techniques for unpaved coral roads. These BMPs are recommended in Volume I and II of the 2006 CNMI and Guam Stormwater Management Manual (made possible through funding from US EPA).

Another large plan to address stormwater impacts, is DPW's multi-million dollar *Cross Island Roadway Reconstruction Project* that began in 2009. Cross Island Road traverses four of Saipan's impaired watersheds, LaoLao, Kagman, Talofofo and West Takpochao (see Figure 5). The Project was supported by Federal Highway Administration funding. Phase I began in October of that year and crossed almost the entire LaoLao watershed, costing \$6.1 million at its completion in September 2012 (01/17/17, personal communication, Henry Bautista, DPW engineer). Phase IIa began concurrently in August 2010, and was completed in August 2014 at \$3.7 Million.

**FIGURE 5: Phases of DPW Cross Island Roadway Reconstruction Project**



In addition, The LaoLao Bay CAP developed in 2009, was also being implemented by BECQ's (nee Coastal Resources Management Office) Planning Division, the Outreach and Education Coordinator, and the WQS/NPS Watershed Coordinator, in collaboration with the non-profit Micronesian Island Nature Alliance (MINA), schools, and other government agencies.

Remediation and restoration activities within the LaoLao CAP were financed with \$2,604,164 of American Restoration and Recovery Act (ARRA), and \$65,926 of EPA grant funding (LaoLao Bay Road & Coastal Management Improvement Plan ARRA/NOAA Grant No. NA09NMF4630291 Project Summary, Dec 2012). Implementation included paving the upper half of LaoLao Bay Drive, which is a secondary road leading down to the Bay, and constructing various BMPs, e.g., culverts, concrete stream crossings, and sediment chambers (FIGURE 6). Construction of which was completed in September 2012.

**FIGURE 6: LaoLao Bay Rd. Catchment Basin System with Terminal Sediment Chamber**



Photo: Tim Lang, Project Manager

Staff from BECQ, DPW, and Saipan Mayor's Office, and volunteers from MINA maintain the culverts and sediment basins by removing collected litter and sediment at least annually. BECQ records show that the amount of sediment removed in the 2015 and 2016 clean up efforts, compared to previous years had diminished from 7 cubic yards in 2013 to 3 cubic yards,



indicating that these BMPs are decreasing the amount of upland erosion and sediment loading into the Bay.

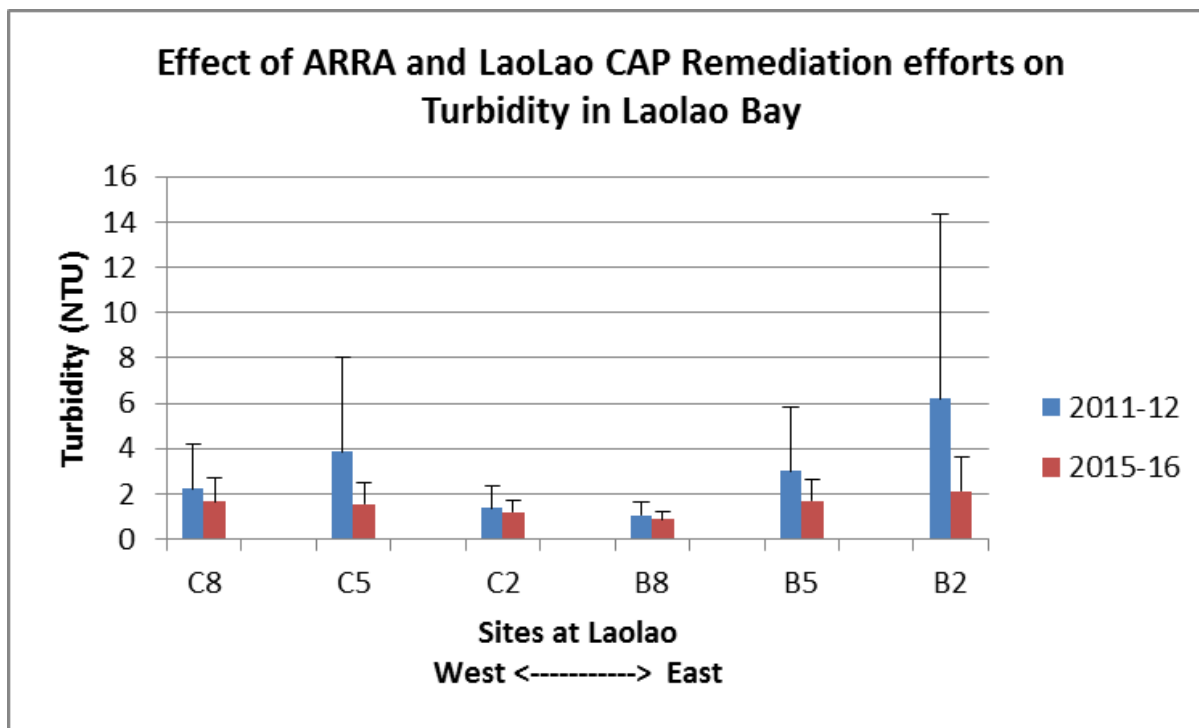
In addition, BECQ continues revegetation efforts in the upper badland area, which began in the late 1990's after burn events resulted in coastal impacts. Planting events remain on-going through coordination between WQS/NPS and the Department of Lands and Natural Resources (DLNR) Division of Agriculture and MINA. Presently shrubs and grasses are being replaced with more fire resistant native plants and trees to build soil resiliency and to diminish further erosion. BECQ's Outreach staff use these planting events to educate students and community residents about the impacts that inappropriate hunting practices and brush fires have on coastal resources.

#### IV. Results

Thus far, the *DPW Cross Island Road Reconstruction Project* and other BMP improvements to LaoLao Bay Drive outlined in the *LaoLao Bay CAP* have drastically diminished erosion in the upper and mid watershed, and the volume of sediment polluting LaoLao's coastal waters.

This is demonstrated in FIGURE 7. A comparison between turbidity levels at the LaoLao reef flats sites after road improvements (Fiscal years 2015-2016) compared to baseline water quality data collected in Fiscal Year 2011-2012 show significant decreases.

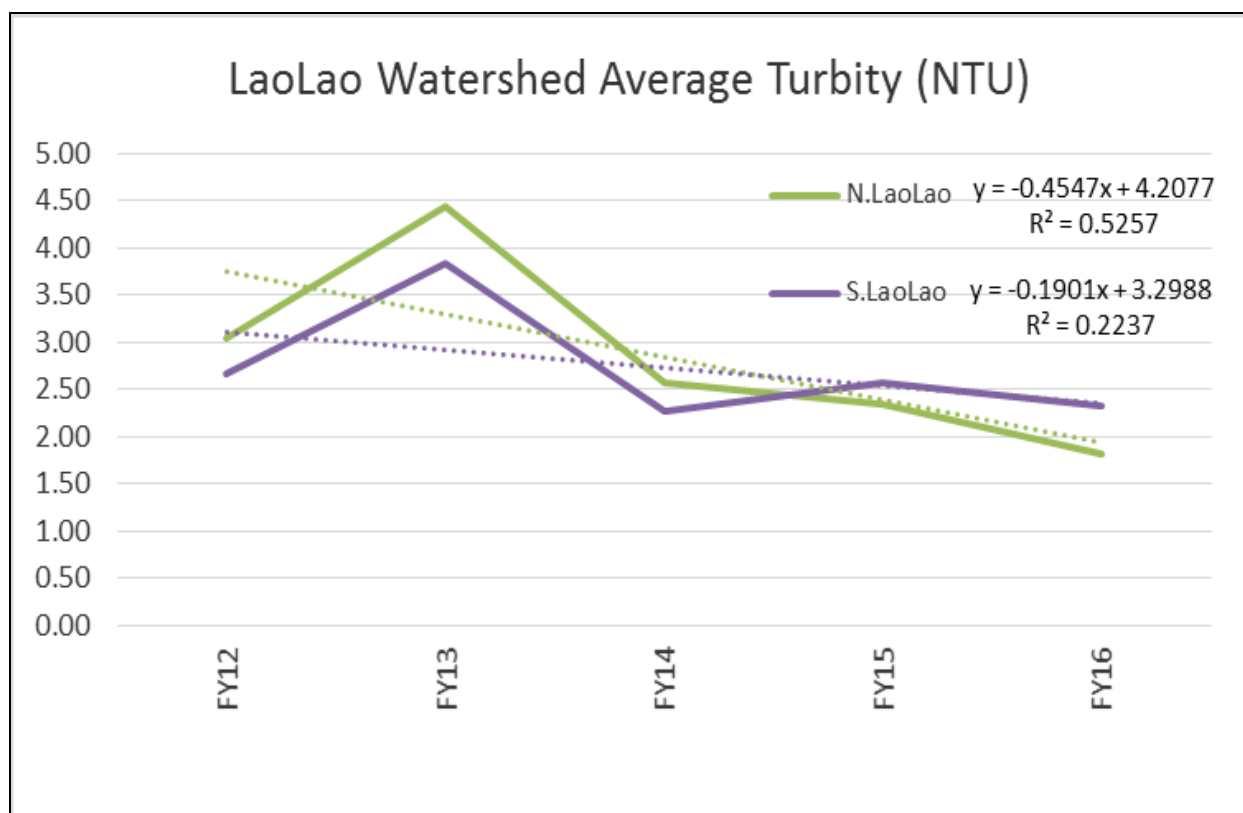
**FIGURE 7: Decrease in Turbidity of Water at LaoLao Reef Flat Sites**





This is supported by data from the two BEACH sites. FIGURE 8 on the following page shows a decreasing trend in turbidity levels at North LaoLao ( $R^2 = 0.53$ ) and at South LaoLao ( $R^2 = 0.22$ ) BEACH sites respectively.

**FIGURE 8: Decrease in Turbidity of Water at LaoLao BEACH Monitoring Sites**



In addition, FIGURE 9 demonstrates the relation between the implementation of the *Cross Island Road Reconstruction Project*, and the *LaoLao Bay CAP*, i.e., LaoLao Bay Drive improvements and revegetation efforts in the badlands, in relation to the percent decrease in *Enterococci* violations at LaoLao's BEACH monitoring sites.

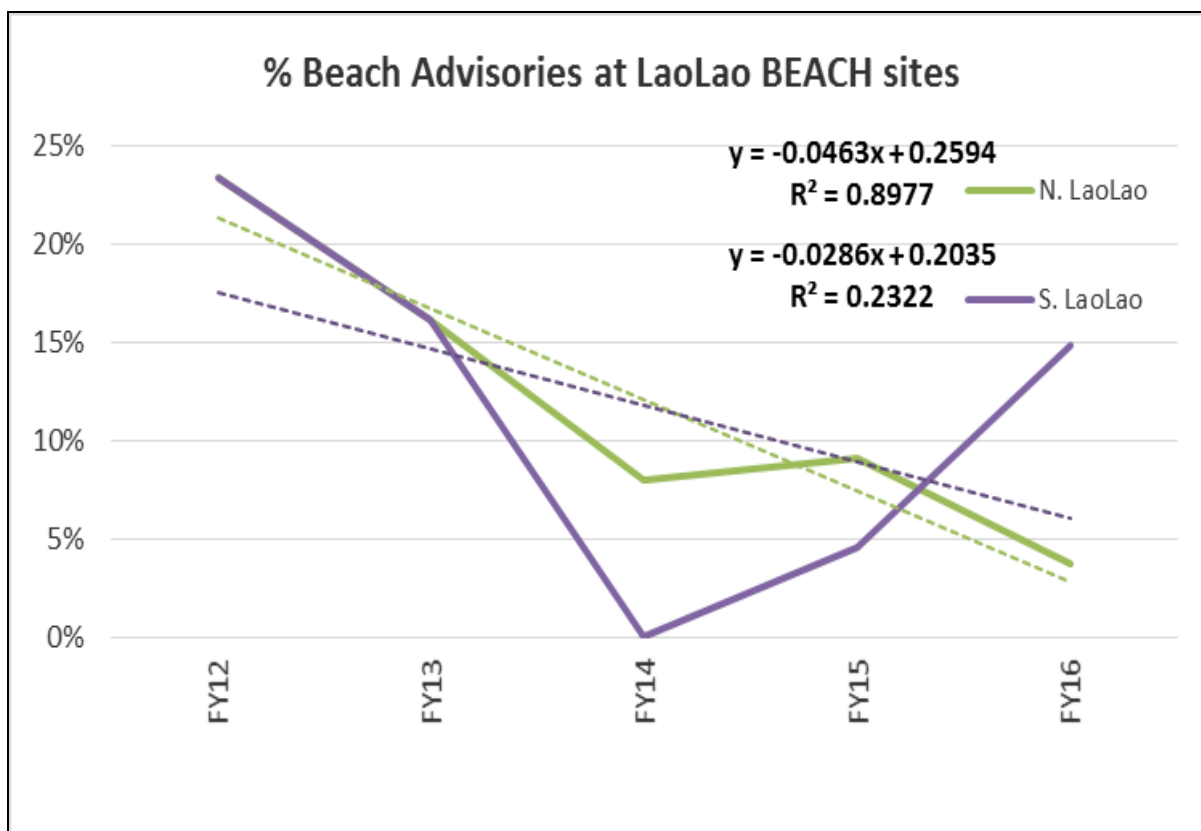
**FIGURE 9: Road Improvements and Revegetation Efforts vs. Enterococci Violations\* at LaoLao BEACH sites**

		Enterococci % Violations											
Sample Station ID	Sampling Station Name	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
SEGMENT 15: LAOLAO													
SEB 02	North Laolao	19	30	14	19	13	19	7	10	23	16	8	9
SEB 03	South Laolao	19	25	10	33	37	15	25	14	23	16	0	5
								Phase I Cross Island Roadway Reconstruction Begins Oct '09, Phase IIa begins in Aug '10	Revegetation project, Road Engineering Training & LaoLao Bay Dr. graded '11	LaoLao Bay Dr. 0.4mi paved and BMPs constructed & Phase I Cross Island Roadway Sep '12	Phase IIb begins in Aug '13	Phase IIa completed in Aug '14	Phase IIb completed in May '15

\*Table adapted from the 2016 CNMI IR, Appendix IX

The decrease in sedimentation led to a decrease in *Enterococci* violations as well. A linear regression of the percent of Beach Advisories (WQS violations) over a five year period from fiscal year 2012 to 2016 shows a significant decrease at LaoLao BEACH monitoring sites (North LaoLao  $R^2 = 0.90$  and South LaoLao  $R^2 = 0.23$ ) as demonstrated (FIGURE 10).

**FIGURE 10: Significant Decrease in LaoLao Watershed's Beach Advisories**



Of note, there was a sudden increase in *Enterococci* violations as the Rainy season began in fiscal year 2016. Super Typhoon Soudelor swept directly over Saipan on August 3 through 5, 2015, causing extensive flooding, landslides, and the destruction of a PACIOOS tower located off shore of the North LaoLao BEACH site. These violations, are therefore considered anomalies associated with sedimentation carrying naturally occurring *Enterococci*, as opposed to fecal contamination, given that there are no sewer lines in the immediate area.

These concentrated efforts to improve roadway BMPs, along with community based restoration activities and outreach has resulted in statistically significant water quality improvements in the LaoLao watershed. For this reason, LaoLao (Segment 15) was removed from the CWA section 303(d) list of impaired water for the Recreational UD in the 2016 IR.

This demonstrates how effective integrating funding from several different sources towards targeted infrastructure improvements can significantly improve a waterbody's quality and the efficacy of implementing CAPs, as a model for restoration efforts in other watersheds.