Application No. 2016-35
Accepted Date: July 27, 2016
Case Planner: Frank Taitano

Seashore Clearance Application for the Installation of Conduits and Landing of Submarine Cables within the Tepungan Reef Flat and Lot 262, Piti, Guam

Prepared for

GTA
624 N. Marine Corps Drive
Tamuning, Guam 96913

Prepared by

DCA
DUEÑAS · CAMACHO & Associates Inc.
Dueñas, Camacho & Associates, Inc.
238 East Marine Corps Drive
Suite 201 Diamond Plaza
Hagatna, Guam 96910

July 2015

SEASHORE CLEARANCE APPLICATION FOR THE INSTALLATION OF CONDUITS AND LANDING OF SUBMARINE CABLES WITHIN THE TEPUNGAN REEF FLAT AND LOT 262, PITI, GUAM

GSPC Application Package Contents

Website: www.dcaguam.com
Email: dca@dcaguam.com

DUEÑAS · CAMACHO & Associates Inc

July 12, 2016

Mr. John Arroyo, Chairman
Guam Land Use Commission
c/o Guam Department of Land Management
P.O. Box 2950
Hagatna, GU 96932

Subject: Conduit Installation and Cable Landing for SEA-US Cables Guam Seashore Clearance Application, Lot 262, Municipality of Piti, Guam.

Dear Chairman Arroyo and Commission Members:

On behalf of GTA, we are pleased to submit the following document for the Commission's consideration:

- Seashore Clearance Application for the installation of conduits and landing of submarine cables within the Tepungan Reef Flat and Lot 262, Piti, Guam.

SITE DESCRIPTION

The project site encompasses a 1,701 sq. m (0.4 acre) proposed terrestrial easement within Lot 262 (Pedro G. Santos Memorial Park). Lot 262 is an approximately 6-acre parcel, zoned "A" for agricultural uses, and located in the Municipality of Piti, just north of Apra Harbor on the western coast of Guam. The proposed cable raceway would be constructed in Lot 262 and on the reef flat offshore from this parcel.

The land uses in the vicinity include the Guam Power Authority Cabras and Piti Power Plants to the west, the Tata Communications cable raceway to the east in Lot 58-1-NEW-1-1-1NEW, and the GTA Cable Station site to the south in Lot 5NEW-1, Block 2. Hoover Park (Lot Apra Harbor Reservation) is an unused military parcel adjacent and west of Lot 262.

Lot 262 is accessible via a driveway along its southern boundary, which fronts Marine Corps Drive (Route 1). The northern boundary of the property forms the shoreline along Tepungan Bay. Masso River flows through the western section of the parcel and empties into the bay along the central sector of the property. An unnamed, seasonal stream conveys stormwater into the bay via a culvert below Marine Corps Drive at the eastern end of the property.

PROJECT DESCRIPTION

GTA proposes to install six conduits to receive submarine fiber-optic cables, and shortly after, land two new submarine cables in two of the conduits for the Southeast Asia-U.S. (SEA-US) telecommunication system linking Asia with Guam, Hawaii and California. The project is needed to complete the Guam link of the SEA-US system with Asia and the rest of the U.S. The four spare conduits are needed to accommodate future cable landings anticipated by GTA.

The project will dredge a trench (3 ft deep by 6 ft wide by 404 ft long) on the reef flat, from the mean high water mark to the shoreward edge of the Tepungan Channel. Six 4.8-inch (outer) diameter ductile iron conduits will be installed in the trench. The trench will be backfilled and a concrete bulkhead (6 ft wide by 10 ft long) will be installed to keep the conduits in place. Shortly after, two 1.61-inch (41 mm) diameter fiber-optic communication cables will be landed through two of the conduits and pulled to shore where they will be spliced to land cables at a new beach manhole located above the high tide line and outside the Guam Seashore Reserve. The encased conduits will form a utility raceway that provides protection of the communication cables they will house. The cable raceway will pass through the Park, cross beneath Marine Corps Drive (Route 1), and terminate at the new GTA Cable Landing Station in Lot 5NEW-1, Block 2.

BACKGROUND AND PUBLIC BENEFIT

Since becoming privatized in 2005, GTA made a clear commitment to build and maintain a world-class communications infrastructure for the island. GTA has been innovative in its approach and has effectively driven market competition for wireless, internet and television services. GTA was the first carrier to offer the iPhone. GTA built the first 100% digital television platform on island along with continuing investment in fiber infrastructure to deliver higher broadband internet speeds.

In 2014, GTA became a consortium member in the South East Asia-US (SEA-US) submarine cable system, which will provide direct connectivity between Indonesia, Philippines, Guam, and Hawaii with California. The added capacity will also support high bandwidth broadband services in other Asia regions, including North Asia, China and Hong Kong, Southeast Asia, and Australia. Guam is truly a strategic gateway for communications between the US and the Asia Pacific rim and GTA plays a critical role in this system. GTA's involvement in the SEA-US submarine cable system will provide island residents with unmatched internet growth opportunities along with data storage, backup services, and business continuity for the business market.

In preparation for the submarine cable system, GTA is building a Cable Landing Station in the Village of Piti to support the network capabilities of SEA-US. network. As part of its community outreach with the Village of Piti, GTA will be providing the Mayor of Piti with complimentary telecom services (telephone, wireless, and high speed internet) along with landscaping and vegetation upkeep of the Pedro Santos Memorial Park over a 25-year period.

ENGINEERING * PLANNING * SURVEYING * ENVIRONMENTAL SERVICES * GEOGRAPHIC INFORMATION SYSTEM * CONSTRUCTION MANAGEMENT
GUAM P.O. Box 8900, Tamuning, Guam 96931 / 238 E. Marine Corps Drive, Suite 201 Diamond Plaza, Hagatña, GU 96910 / Tel: (671) 477-7991 / Fax: (671) 479-6315
SAIPAN Caller Box PPP, Suite 164, Saipan, MP 96950 / Chalan Pale Arnold, Ada's Building South Garapan, Saipan 96950 / Tel: (670) 234-9017 / Fax: (670) 234-3842

CONSISTENCY ANALYSIS:

Per 21 GCA, Chapter 63, Section 63108, the following is a consistency analysis of the proposed project with the Guam Seashore Protection Act:

a. That the development will not have any substantial adverse environmental or ecological effect;

The project has incorporated several measures such that the construction of the raceway would not have substantial adverse environmental or ecological effect. The project would use an existing channel to access the deep waters offshore, thereby, avoiding the need to trench approximately 1,500 feet from shore to the outer reef margin. The construction corridor has been minimized to decrease the project footprint and as much as possible avoid corals, all of which are common species seen elsewhere in similar environments around Guam and the tropics. The existing coral cover on the shallow reef flat is dominated by tiny immature spats of encrusting *Leptastrea purpurea*; however, colonies of the larger coral species will be transplanted from the trench corridor and into suitable habitat west of the corridor. Monitoring will be performed to follow the survival of these corals after construction. Knowledgeable divers will be present to guide the placement of the cable and minimize effects on corals during the cable landing. The two cables to be landed in the channel will be bundled prior to placement to further reduce their footprint on the sea floor.

b. That the development is consistent with the purpose and objectives of this Chapter;

The cable project is consistent with the purpose and objectives of Chapter 63, Section 63102 of the Seashore Protection Act of 1974. The natural marine flora and fauna will still be present in the area following the project completion.

c. Access to beaches, recreation and historical areas, and natural reserves is increased to the maximum extent possible by appropriate dedication.

Existing beach, recreation and natural reserve areas have already been established at the site, and public access to these areas would not be significantly impeded by the project after its completion. Concern for public safety, however, requires that access into the construction site be controlled during deep trenching, conduit pipe installation, and cable landing operations.

d. There is no substantial interference with or detraction from the line of sight toward the sea from the territorial highway nearest the coast;

The cable raceway would be placed below grade, and the cables landed in the channel would be submerged; therefore, the project would not detract, obstruct, or interfere with the view corridors from the surrounding areas.

e. Adequate and properly located public recreation areas and wildlife preserves are reserved;

The undertaking of the project within the Santos Park and Piti Bomb Holes Preserve would not take away from their present use and function.

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SAIPAN Caller Box PPP, Suite 164, Saipan, MP 96950 / Chalan Pale Arnold, Ada's Building South Garapan, Saipan 96950 / Tel: (670) 234-9017 / Fax: (670) 234-3842

f. Provisions are made for solid and liquid waste treatment, disposition, and management which will minimize adverse effects upon coastal reserve resources;

The cable raceway will house communications utilities, which will not generate solid or liquid waste into the Guam Seashore Reserve.

g. Alterations to existing land forms and vegetation, and construction of structures shall cause minimum danger of floods, landslides, erosion or siltation.

Turbidity curtains, silt fences and other erosion control measures will be installed and maintained during the construction of the raceway. After installation, the buried raceway will not cause flooding, landslides, erosion or siltation since the site will be restored to its original grade.

We look forward to presenting this application to you in the near future.

Sincerely,

Claudine Camacho

Claudine Camacho
Environmental Services Division

ENGINEERING * PLANNING * SURVEYING * ENVIRONMENTAL SERVICES * GEOGRAPHIC INFORMATION SYSTEM * CONSTRUCTION MANAGEMENT
GUAM P.O. Box 8900, Tamuning, Guam 96931 / 238 E. Marine Corps Drive, Suite 201 Diamond Plaza, Hagatña, GU 96910 / Tel: (671) 477-7991 / Fax: (671) 479-6315
SAIPAN Caller Box PPP, Suite 164, Saipan, MP 96950 / Chalan Pale Arnold, Ada's Building South Garapan, Saipan 96950 / Tel: (670) 234-9017 / Fax: (670) 234-3842

EXHIBIT A

SEASHORE CLEARANCE APPLICATION

SEASHORE CLEARANCE

TO: Executive Secretary, Guam Seashore Protection Commission
c/o Land Planning Division, Department of Land Management
Government of Guåhan, P.O. Box 2950, Hagatna, Guåhan 96932

The Undersigned owner(s)/lessee(s) of the following described property, situated with the ten (10) meters inland from the Mean High Water Mark (MHWM) or situated seaward to the ten (10) fathom contour, do hereby request consideration for a *Seashore Clearance Permit*.

1. Information on Applicant:

Name of Applicant: Teleguam Holdings LLC (dba GTA) U.S. Citizen: [✓] Yes [ ] No

Mailing Address: 624 N. Marine Corps Drive Tamuning, Guam 96913

Telephone No.: Business 671-644-4482 Home: ____________

2. Location, Description and Ownership:

Lot(s): 262 Block: none Tract: none

Lot Area *(In Square Meters & Feet)*: 26,249 sq. meters (282541.83 sq. feet)

Village: Piti Municipality: Piti

Registered Owner: Government of Guam

Certificate of Title No.: 2867 Recorded Document No.: 13986 / 342984

3. Current and Proposed Land Use:

Current Use: Pedro G. Santos Memorial Park Zoned: "A" Agricultural

Proposed Use: Buried fiber-optic cable utility raceway with manholes (no change to park use).

Master Plan Designation: Recreation

4. **Attach a one page** typed, brief and concise justification (letter format) explaining the compatibility of th proposed project with adjacent and neighborhood developments as they exist and the nature of request i accordance with ***Guåhan Code Annotated 21 GCA, Chapter 63, Section 63108 (a) (2).***

a. That the development will not have any substantial adverse environmental or ecological effect;
b. That the development is consistent with the purpose and objectives of this Chapter. The applicant shall have the burden of proof on all issues;
c. That access to beaches, recreation and historical areas, and natural reserves is increased to the maximum extent possible by appropriate dedication;

ATTACHMENT: Section 63108 (Interim Permit Control), Chapter 63 (Territorial Seashore Protection Act of 1974), Titl 21 GCA is attached for your information and guidance in the preparation of your application. For addition requirements, visit the Seashore Section, Land Planning Division.

4. **Continuation:**

   d. That there is no substantial interference with or detraction from the line of sight toward the sea from the territorial highway nearest the coast;
   e. That adequate and properly located public recreation areas and wildlife preserves are reserved;
   f. That provisions are made for solid and liquid waste treatment, disposition, and management which will minimize adverse effects upon coastal reserve resources; and
   g. That alterations to existing land forms and vegetation, and construction of structures shall cause minimum danger of floods, landslides, erosion or siltation.

5. **If applicant has submitted** to the Guam Land Use Commission/Guam Seashore Protection Commission other request on subject property, applicant shall list them:

   ____

   ____

6. **Support Information:** The following supporting information shall be attached to this application:

   a. Site plan required; Plans, drawn to scale, showing dimensions and shape of lot; lot size; size and location of existing building(s); location and dimensions of proposed building(s) or alterations;
   b. 8 1/2" X 14" map, drawn to scale, showing all land zones within 1000 feet radius of subject lot's boundaries;
   c. 8 1/2" X 14" map, drawn to scale, showing all building(s) or uses within 750 feet of the subject lot's boundaries. On the same map, applicant must also show any natural or topographic peculiarities of subject lot;
   d. 8 1/2" map, drawn to scale, showing all parcels with correct lot number within 500 feet of subject lot's boundaries;
   e. The most recent recorded and certified Department of Land Management survey map showing the subject property;
   f. An initial comprehensive ***Environmental Impact Access (EIA)*** as required by the Guåhan Chief Planner;
   g. An erosion control plan;
   h. If leased, lease assignment and covenant; and
   i. Additional information as required by the Guåhan Chief Planner:

   In addition to providing the required number of hard copies of the Application; provide 9-copies of the Application File in Electronic Format (example: in CD format, etc.)

7. **Approval from the Commission** does not constitute a waiver from permits required by other Government Agencies including the U.S. Army Corp of Engineer, nor does this approval imply that these permits will subsequently be granted.

8. **Filing Fee: Seventy-Five Dollars ($75.00)** filing fee as per the passage of Bill 74, signed and approved by the Governor of Guåhan on May 18, 2007, under Public Law 29-02, Chapter V, Part III *(Fees and Charges Assessed by the Department of Land Management).*

SEASHORE CLEARANCE

9. **Required Signatures:** All legal owners/lessees of designated parcel shall sign form with name(s) typed or handwritten, signed and dated:

"I hereby certify that all information contained in this application and its supplements is true and correct. I also understand that any misrepresentation in this application shall void the entire submission. Further, that thirty-two (32) sets of the above listed required information is provided."

____

(Owner(s) or Lessee(s) and Date)

Claudine Camacho (DCA, Inc.) June 27, 2016

(Representative, if any, and Date)

THIS FORM SHALL NOT BE MAILED. APPLICANT OR REPRESENTATIVE SHALL SUBMIT IN PERSON, BY APPOINTMENT ONLY, TO THE LAND PLANNING DIVISION, DEPARTMENT OF LAND MANAGEMENT.

FOR OFFICIAL USE ONLY

Date Filed: ________________ Accepted By: ________________

Date of Notice in Newspaper(s): ________________

Date of Notice to Adjacent Property Owners: ________________

Date of Public Hearing: ________________

Filing Fee(s) Paid *($)*: Yes [ ] No [ ] Check [ ] Cash [ ] Other [ ] ________________

Receipt No.: ________________ Application Number: ________________

Date of GSPC Action: ________________ Conditions: Yes [ ] No [ ] (See Below)

Conditions of Approval: ________________

____

GSPC Resolution No.: ________________ Date of Notice of Action: ________________

EXHIBIT B

STATEMENT OF AUTHORIZATION

GTA
your island. your network.™

624 North Marine Corps Drive
Tamuning, Guam 96913

STATEMENT OF AUTHORIZATION

To Whom It May Concern:

On behalf of TELEGUAM HOLDINGS, LLC dba GTA, I hereby designate and authorize our consultant, DUENAS, CAMACHO & ASSOCIATES, INC., to prepare and process the Guam Seashore Protection Commission (GSPC) Permit Application, the Department of the Army Permit Application, 401 Water Quality Certification Application, Guam Coastal Management Federal Consistency Certification Application, and other federal and local permits related to the installation of GTA conduits and cable landings in Tepungan, Piti, and to represent GTA before the Application Review Committee (ARC) and GSPC, and at public meetings and public hearings related to this process.

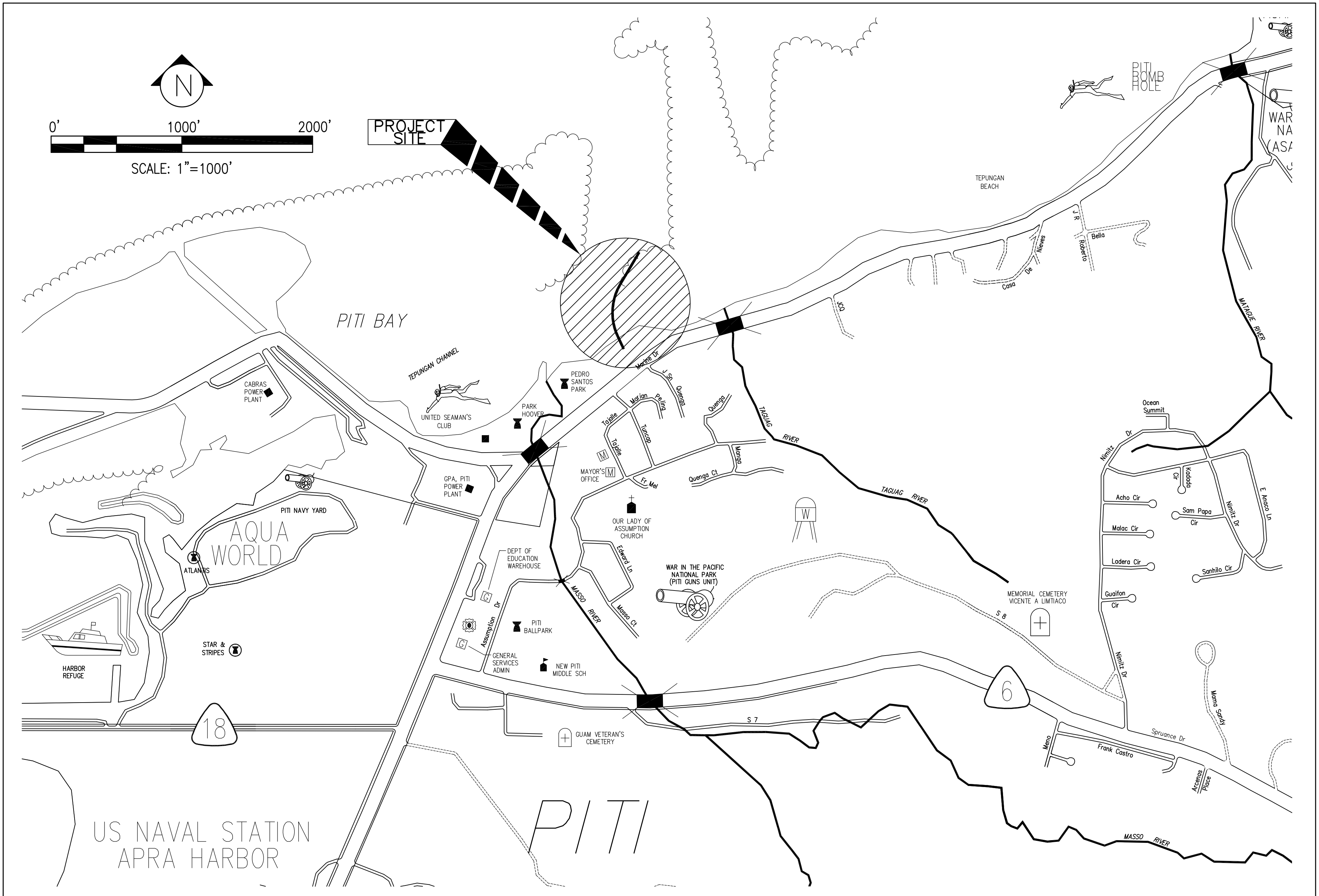
ANDREW M. GAYLE
CHIEF OPERATING OFFICER
EXECUTIVE DEPARTMENT
TELEGUAM HOLDINGS, LLC

11 APRIL 2016
DATE

EXHIBIT C

SITE DEVELOPMENT PLAN

AND ENVIRONMENTAL PROTECTION PLAN

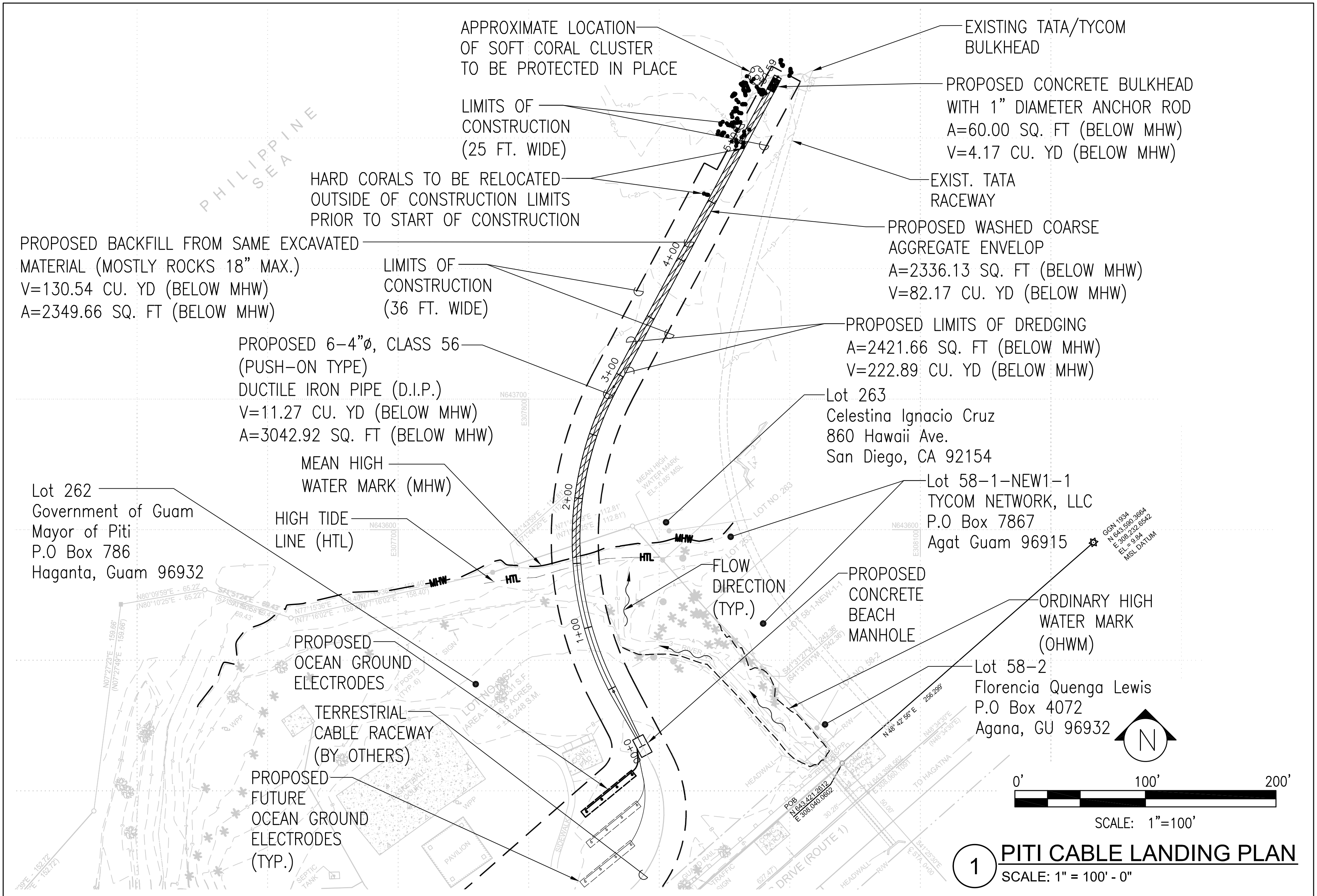


Vicinity Map

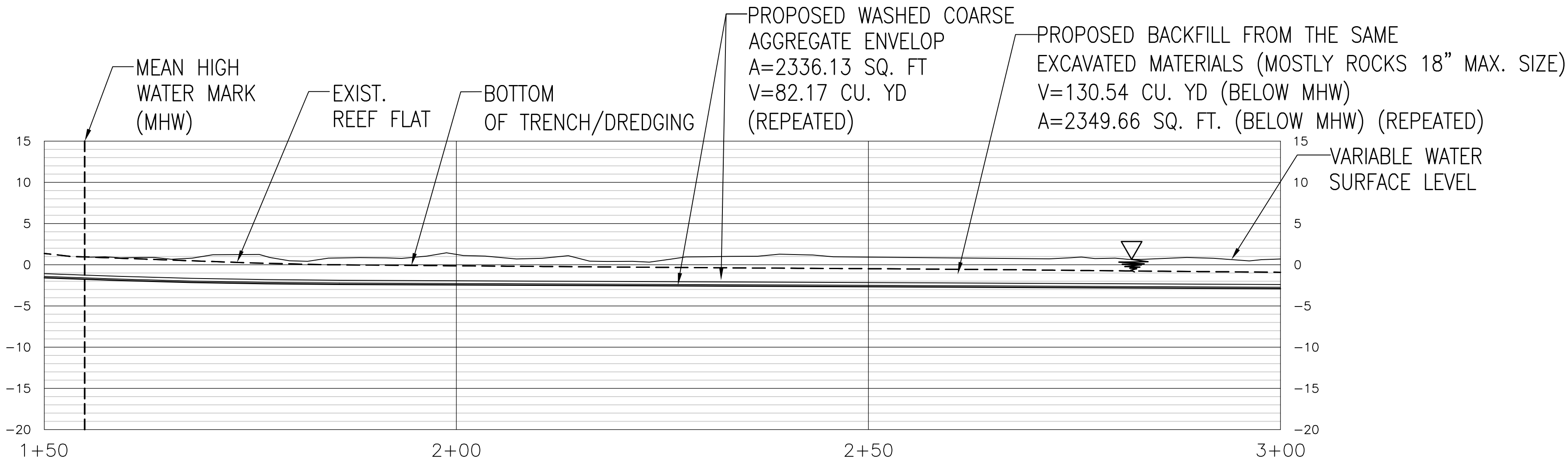
Datum: Mean lower low water

POH–2016
GTA
624 North Marine Corps Drive
Tamuning, GU 96913

GTA Cable Raceway
Route 1, Piti, Guam
Sheet 1 of 6
June 2016

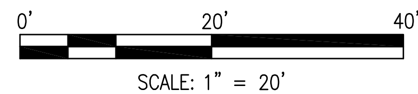


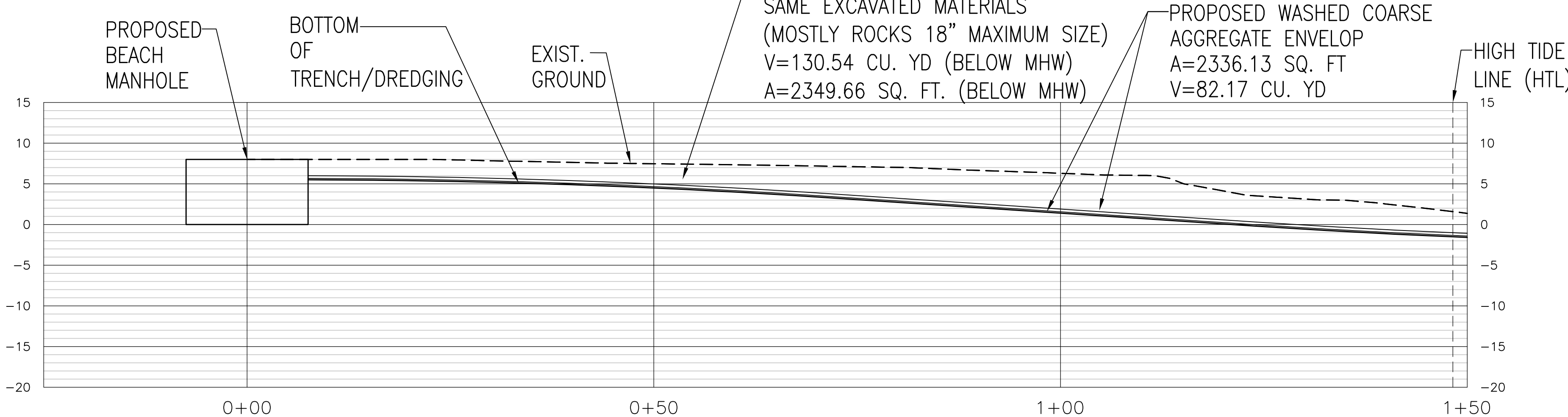
Plan View Datum: Mean lower low water	POH-2016 GTA 624 North Marine Corps Drive Tamuning, GU 96913	GTA Cable Raceway Route 1, Piti, Guam Sheet 2 of 6 June 2016



2 PITI CABLE LANDING PROFILE (STA. 1+50 TO STA 3+00)

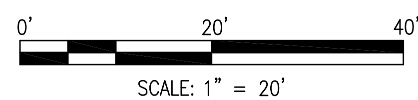
SCALE: 1" = 20' - 0"





1 PITI CABLE LANDING PROFILE (STA. 0+00 TO STA 1+50)

SCALE: 1" = 20' - 0"

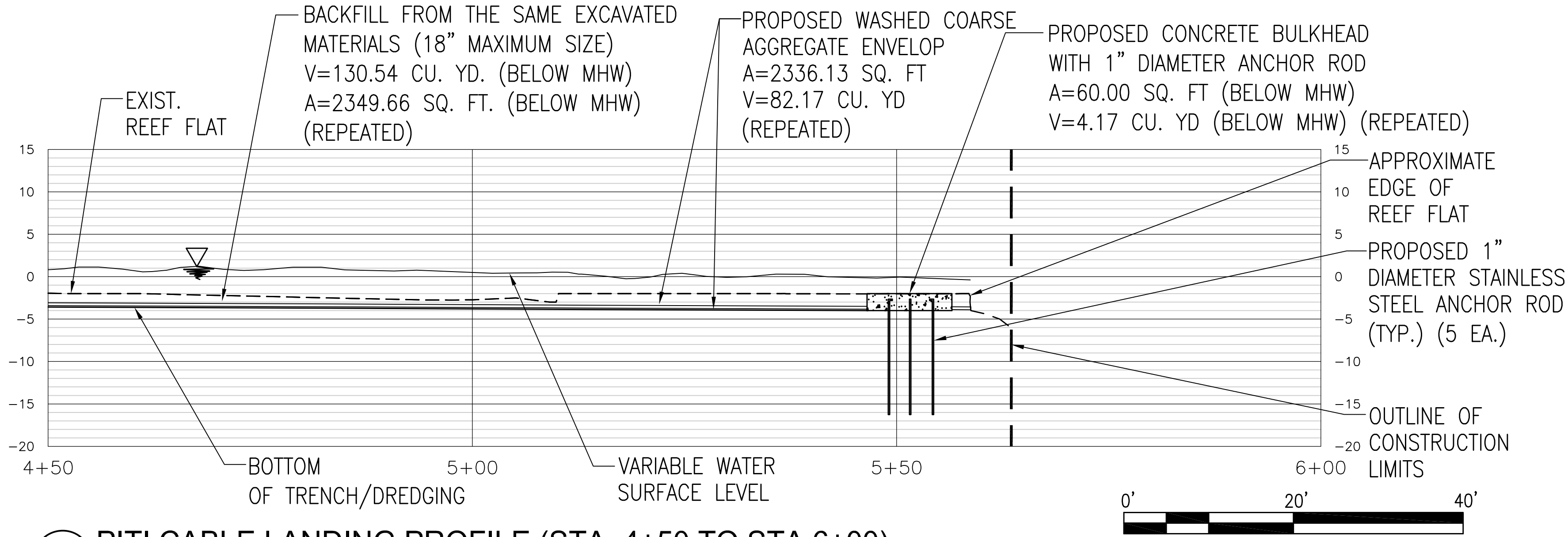


Trench Profile (1 of 2)

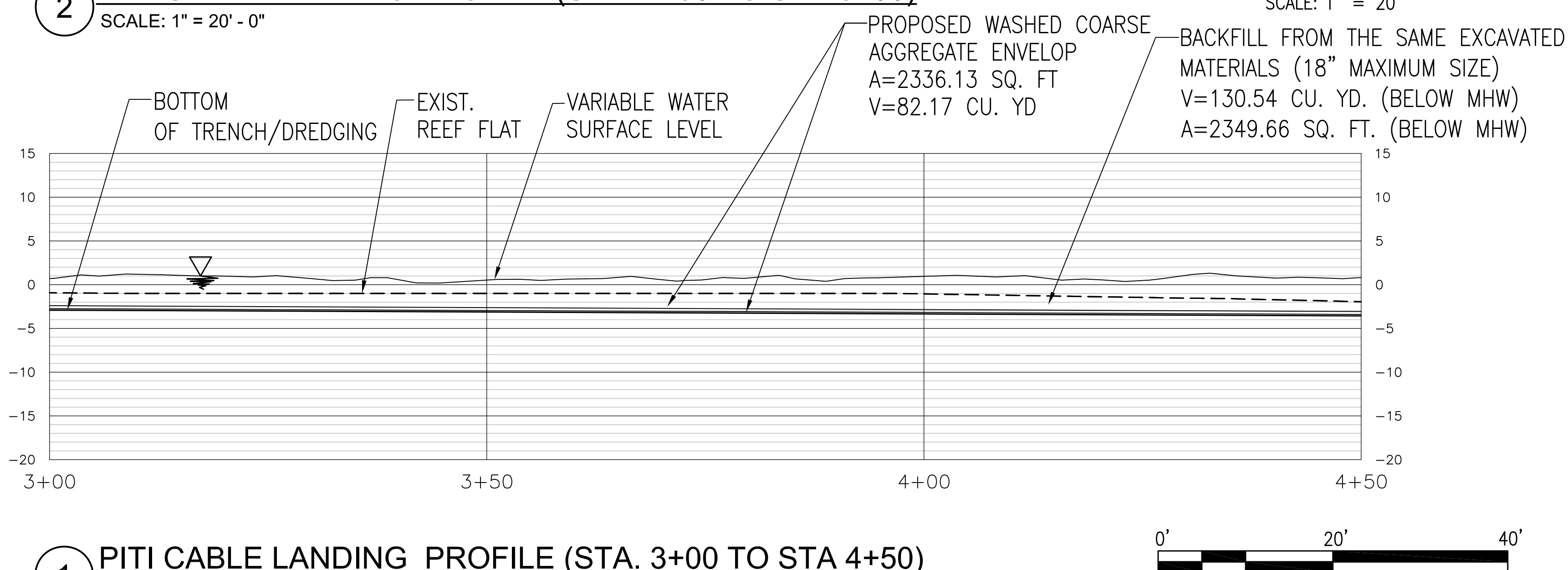
Datum: Mean lower low water

POH-2016
GTA
624 North Marine Corps Drive
Tamuning, GU 96913

GTA Cable Raceway
Route 1, Piti, Guam
Sheet 3 of 6
June 2016

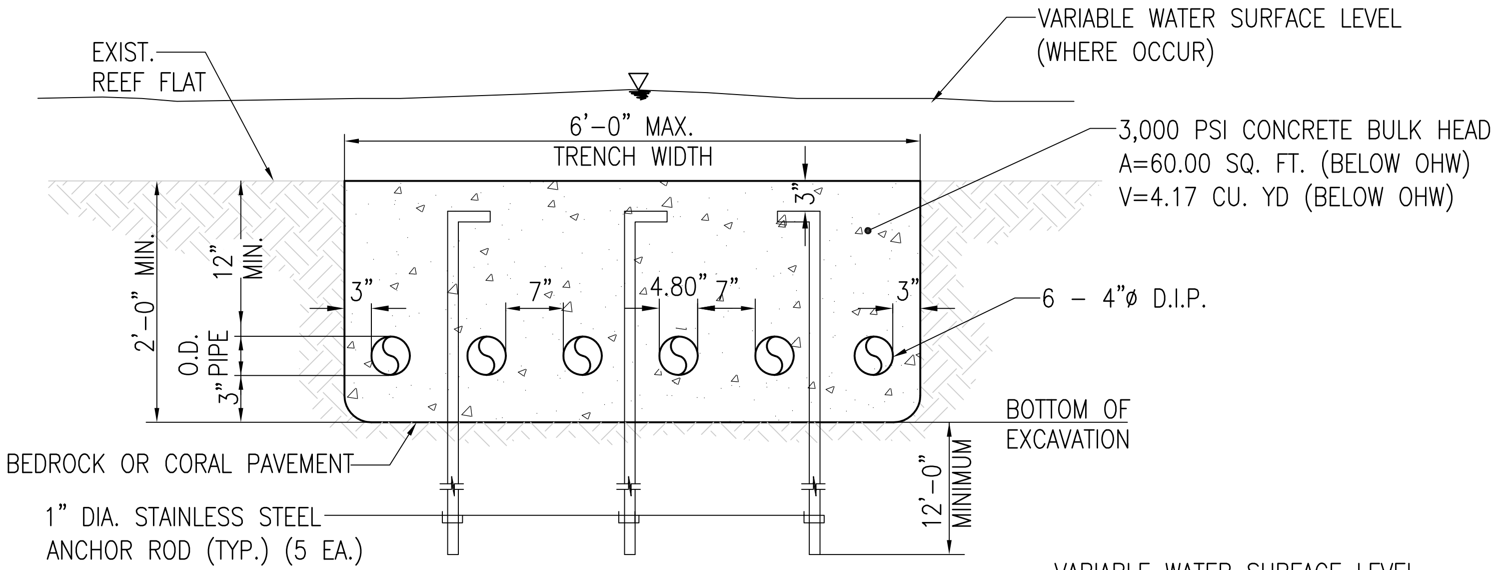


② PITI CABLE LANDING PROFILE (STA. 4+50 TO STA 6+00)
SCALE: 1" = 20' - 0"

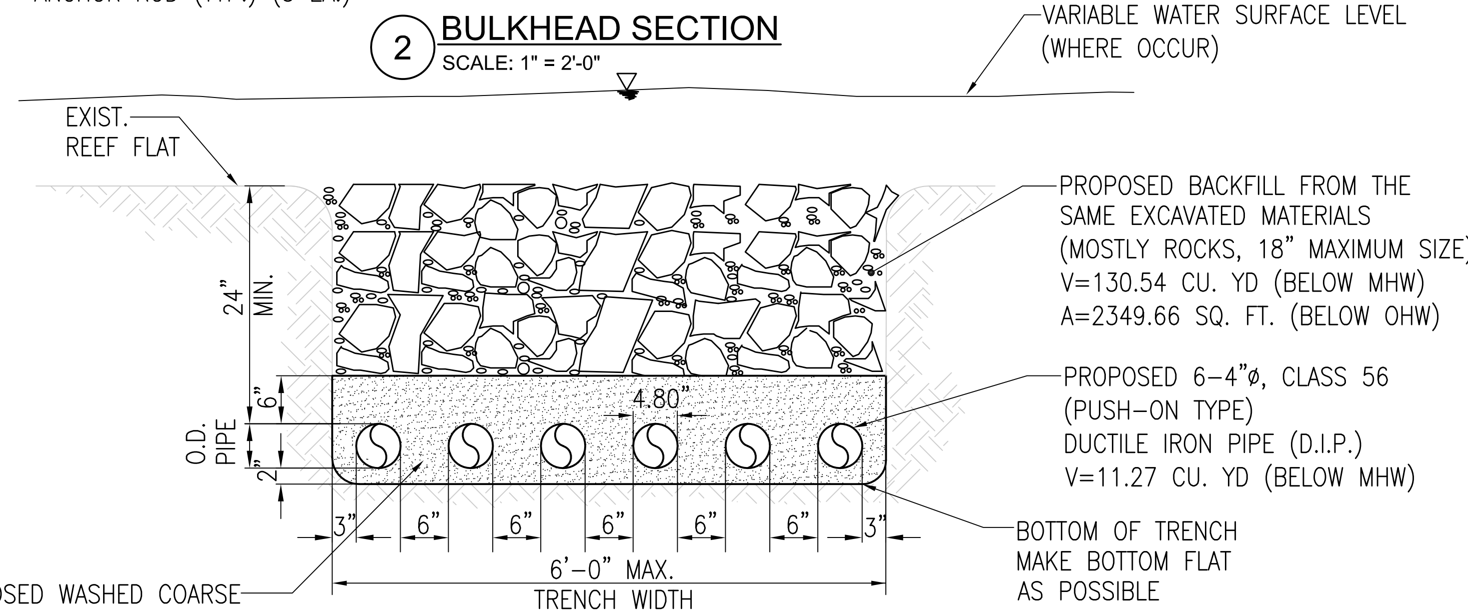


① PITI CABLE LANDING PROFILE (STA. 3+00 TO STA 4+50)
SCALE: 1" = 20' - 0"

Trench Profile (2 of 2) Datum: Mean lower low water	POH-2016 GTA 624 North Marine Corps Drive Tamuning, GU 96913	GTA Cable Raceway Route 1, Piti, Guam Sheet 4 of 6 June 2016

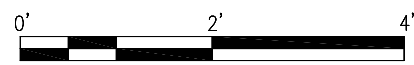


2 **BULKHEAD SECTION**
SCALE: 1" = 2'-0"



PROPOSED WASHED COARSE AGGREGATE ENVELOP
A=2336.13 SQ. FT (BELOW OHW)
V=82.17 CU. YD (BELOW OHW)

1 **TRENCH SECTION (OCEAN SIDE)**
SCALE: 1" = 2'-0"



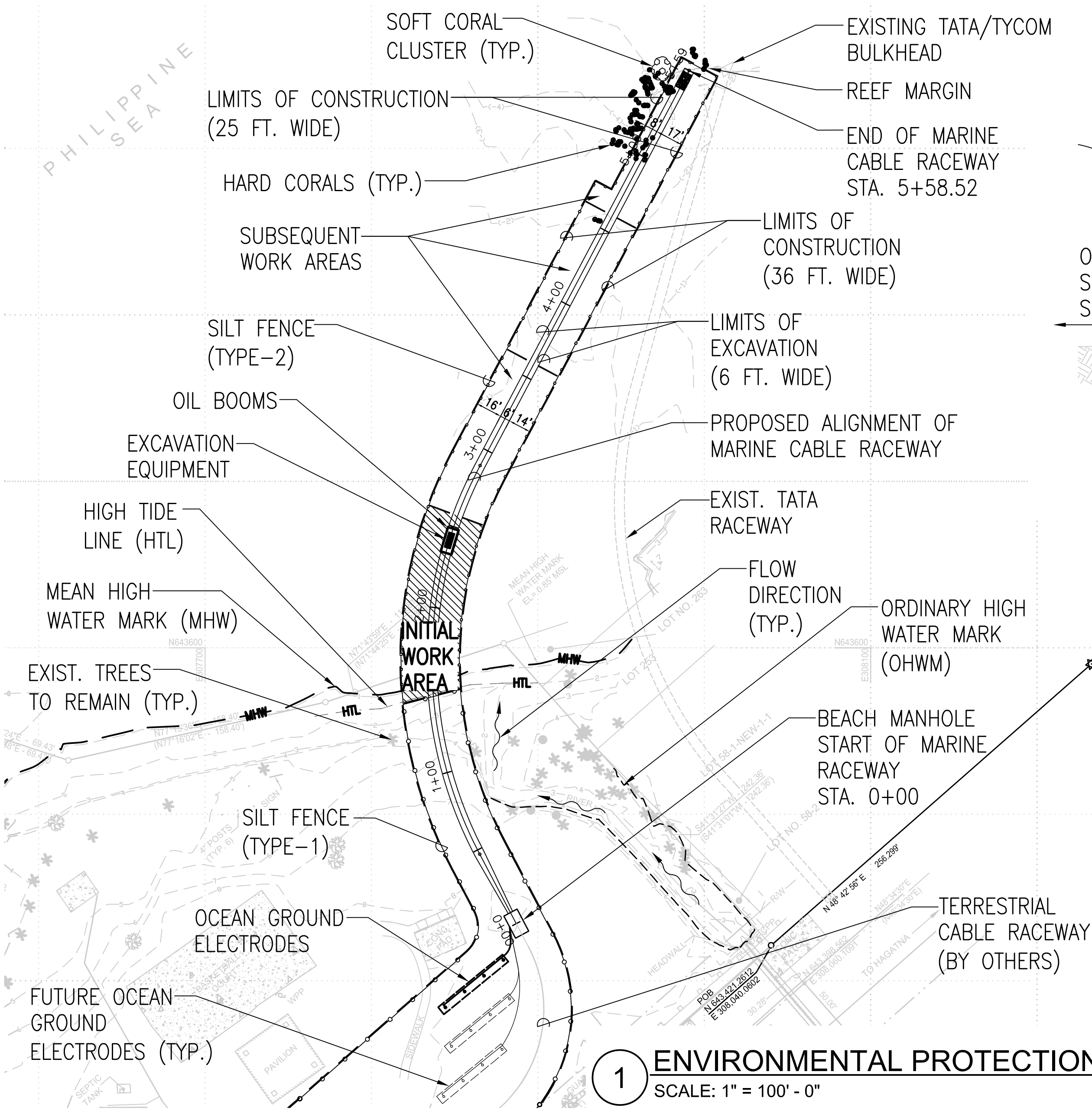
SCALE: 1" = 2'

Trench and Bulkhead Section

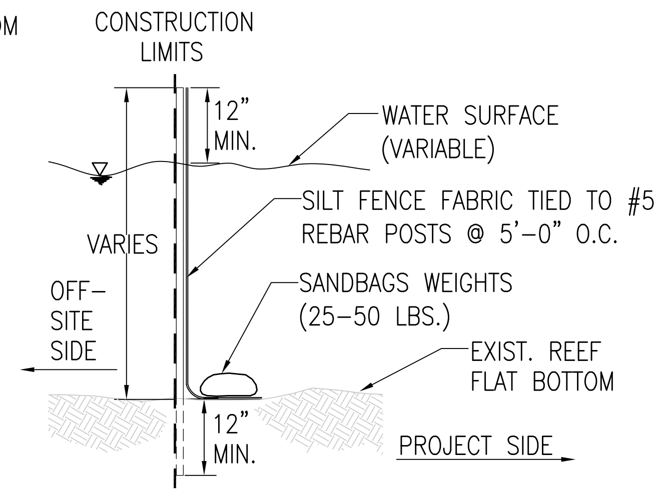
Datum: Mean lower low water

POH–2016
GTA
624 North Marine Corps Drive
Tamuning, GU 96913

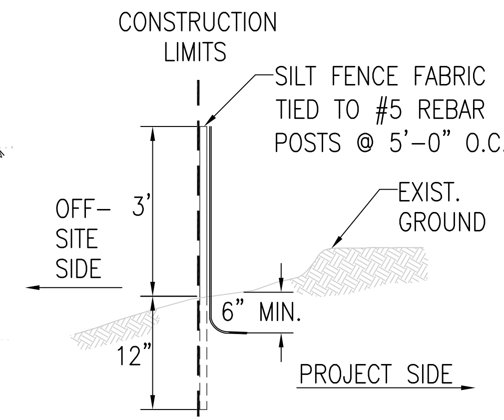
GTA Cable Raceway
Route 1, Piti, Guam
Sheet 5 of 6
June 2016



1 **ENVIRONMENTAL PROTECTION PLAN**
SCALE: 1" = 100' - 0"



3 **SILT FENCE (TYPE-2)**
NOT TO SCALE



2 **SILT FENCE (TYPE-1)**
NOT TO SCALE

Environmental Protection Plan Datum: Mean lower low water	POH-2016 GTA 624 North Marine Corps Drive Tamuning, GU 96913	GTA Cable Raceway Route 1, Piti, Guam Sheet 6 of 6 June 2016

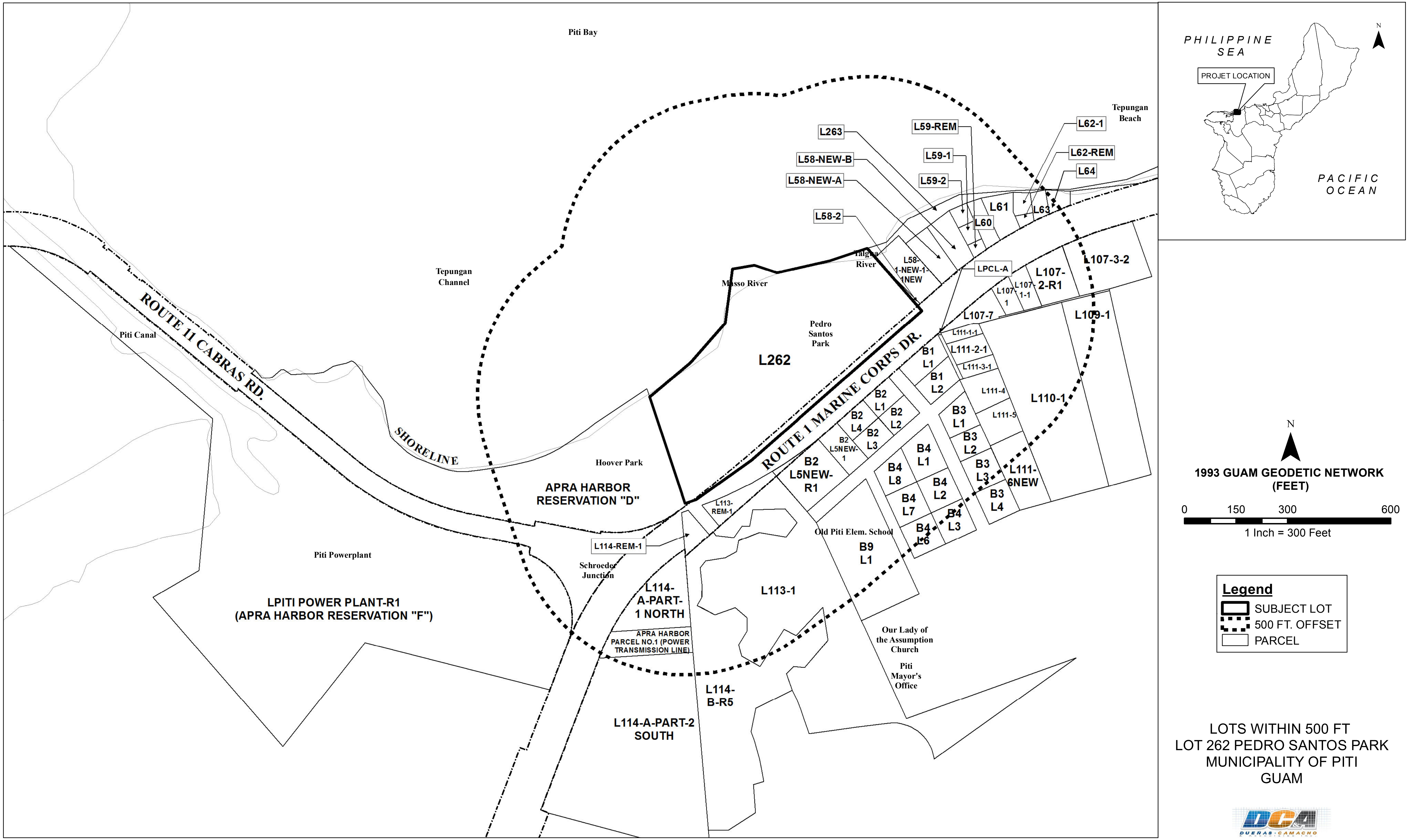
EXHIBIT D

MAPS SHOWING PARCELS WITHIN 500 FEET,

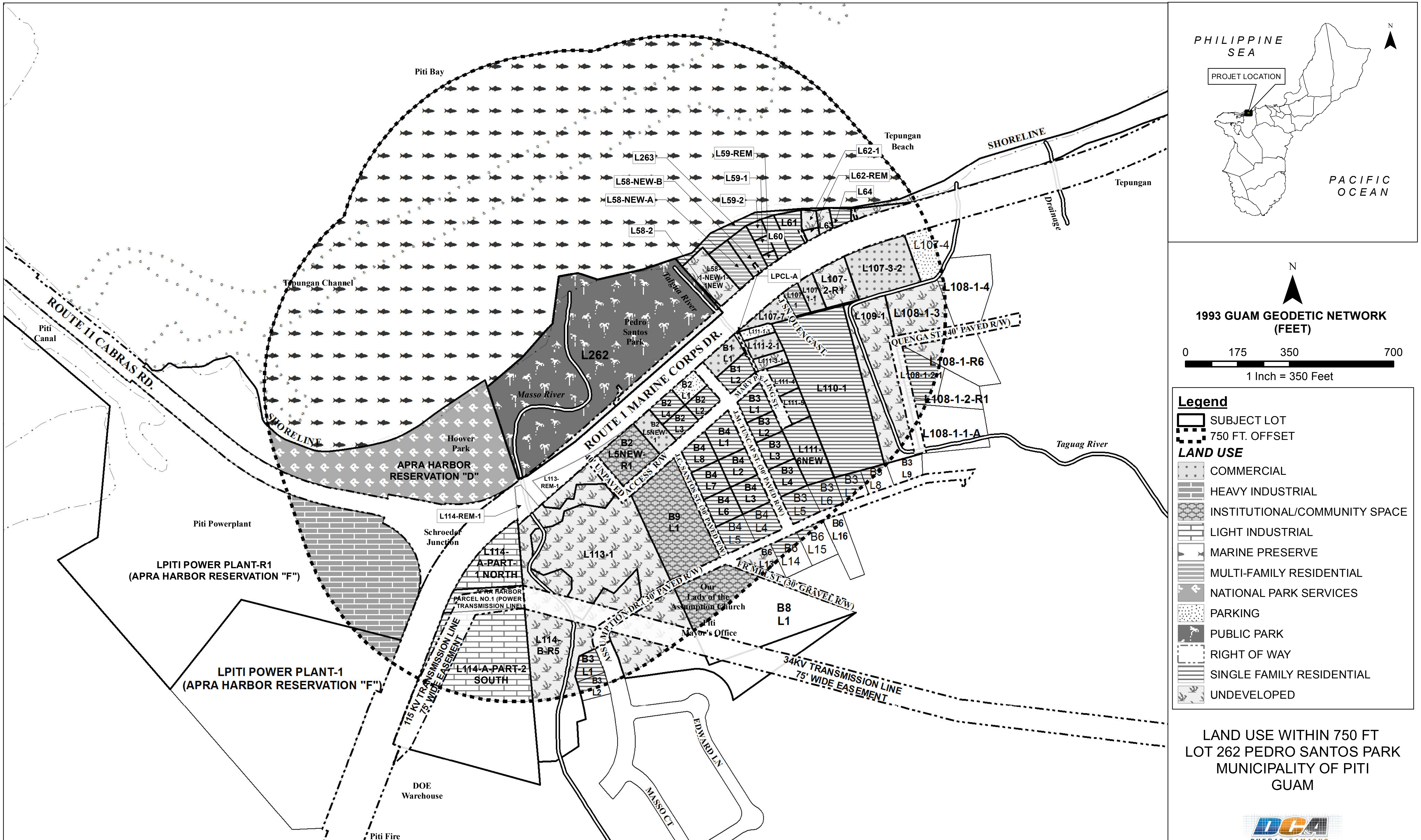
BUILDINGS AND USES WITHIN 750 FEET

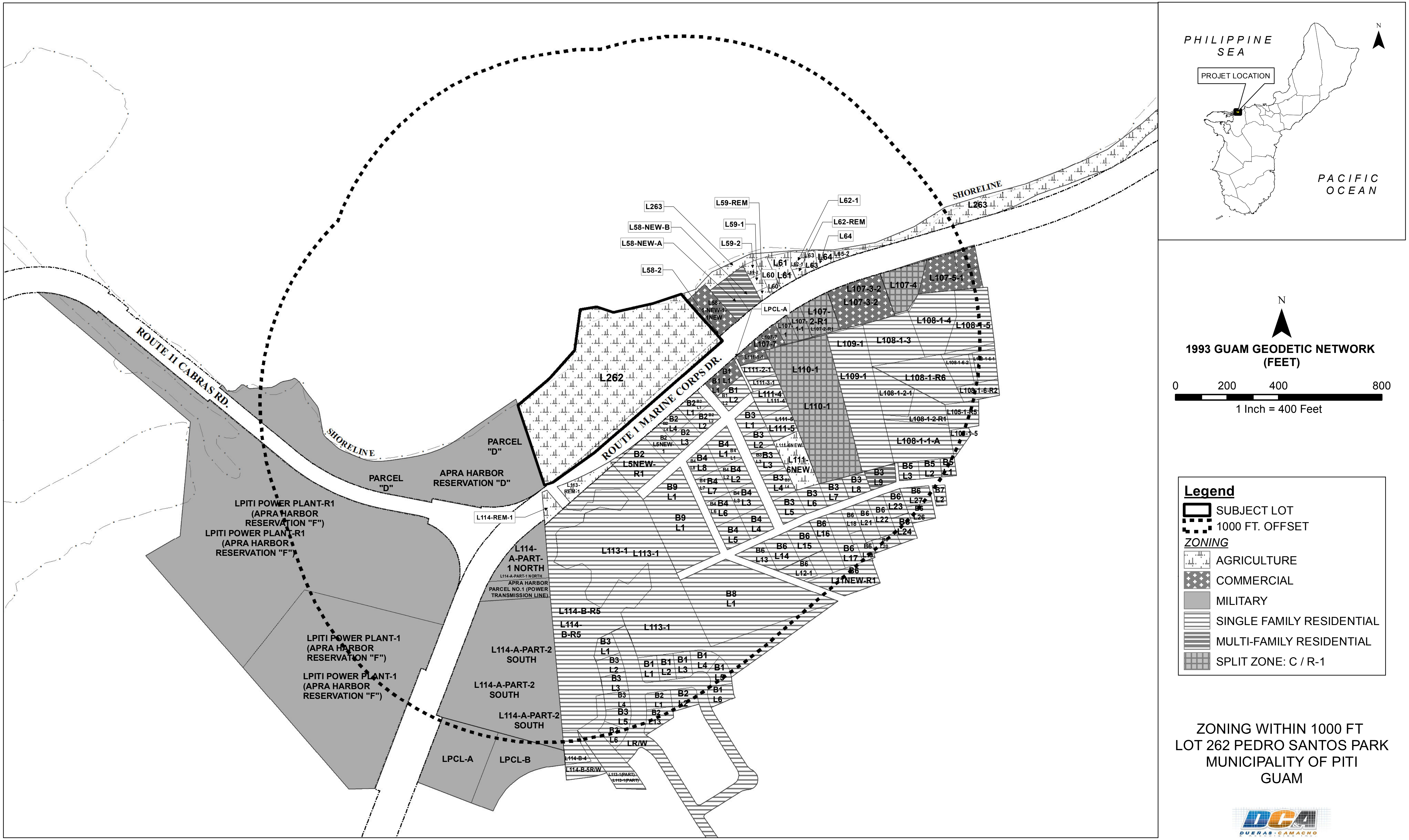
AND LAND USE ZONES WITHIN 1,000 FEET

OF LOT 262, TEPUNGAN, PITI, GUAM



LOTS WITHIN 500 FT
LOT 262 PEDRO SANTOS PARK
MUNICIPALITY OF PITI
GUAM

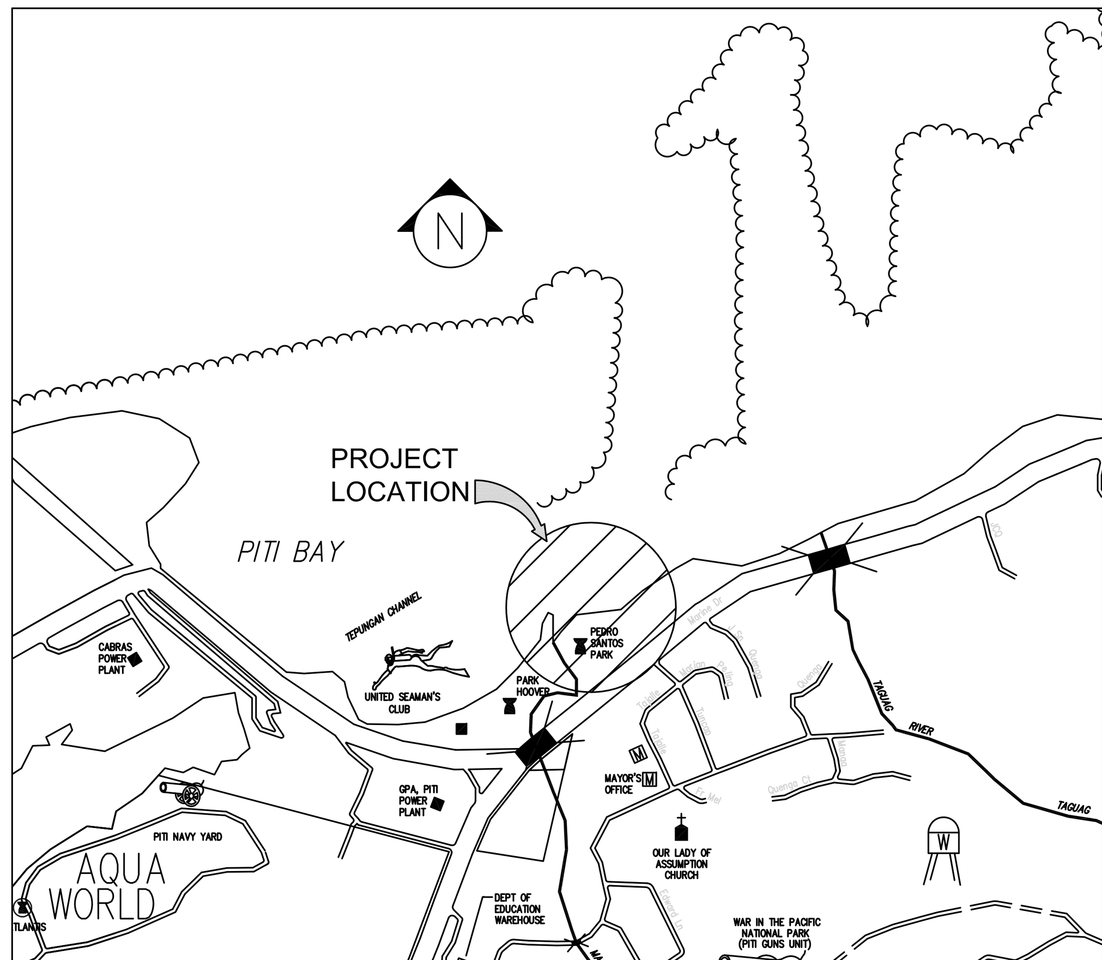

PHILIPPINE SEA
PROJET LOCATION
PACIFIC OCEAN
N
1993 GUAM GEODETIC NETWORK (FEET)
0 175 350 700
1 Inch = 350 Feet
Legend
SUBJECT LOT
750 FT. OFFSET
LAND USE
COMMERCIAL
HEAVY INDUSTRIAL
INSTITUTIONAL/COMMUNITY SPACE
LIGHT INDUSTRIAL
MARINE PRESERVE
MULTI-FAMILY RESIDENTIAL
NATIONAL PARK SERVICES
PARKING
PUBLIC PARK
RIGHT OF WAY
SINGLE FAMILY RESIDENTIAL
UNDEVELOPED
Piti Bay
Tepungan Beach
Tepungan
SHORELINE
Drainage
Tepungan Channel
Piti Canal
ROUTE 11 CABRAS RD.
ROUTE 1 MARINE CORPS DR.
L262
Pedro Santos Park
Masso River
Hoover Park
APRA HARBOR RESERVATION "D"
Piti Powerplant
LPITI POWER PLANT-R1 (APRA HARBOR RESERVATION "F")
LPITI POWER PLANT-1 (APRA HARBOR RESERVATION "F")
Schroeder Junction
115 KV TRANSMISSION LINE 75' WIDE EASEMENT
34KV TRANSMISSION LINE 75' WIDE EASEMENT
Our Lady of the Assumption Church
Piti Mayor's Office
Taguag River
DOE Warehouse
Piti Fire Station
EDWARD LN
MASSO CT
QUENGA ST. (40' PAVED R/W)
ASSUMPTION DR. (30' PAVED R/W)
FR. MILL ST. (30' GRAVEL R/W)
40' UNPAVED ACCESS R/W
L263
L59-REM
L59-1
L59-2
L58-NEW-B
L58-NEW-A
L58-2
L62-1
L62-REM
L64
L61
L60
L63
LPCL-A
L107-4
L107-3-2
L107-2-R1
L107-7
L108-1-4
L108-1-3
L109-1
L108-1-R6
L108-1-2-R1
L108-1-1-A
L110-1
L111-6NEW
L113-1
L113-REM-1
L114-REM-1
L114-A-PART-1 NORTH
APRA HARBOR PARCEL NO.1 (POWER TRANSMISSION LINE)
L114-A-PART-2 SOUTH
L114-B-R5
B2 L5NEW-R1
B9 L1
B8 L1
LAND USE WITHIN 750 FT
LOT 262 PEDRO SANTOS PARK
MUNICIPALITY OF PITI
GUAM
DUEÑAS CAMACHO



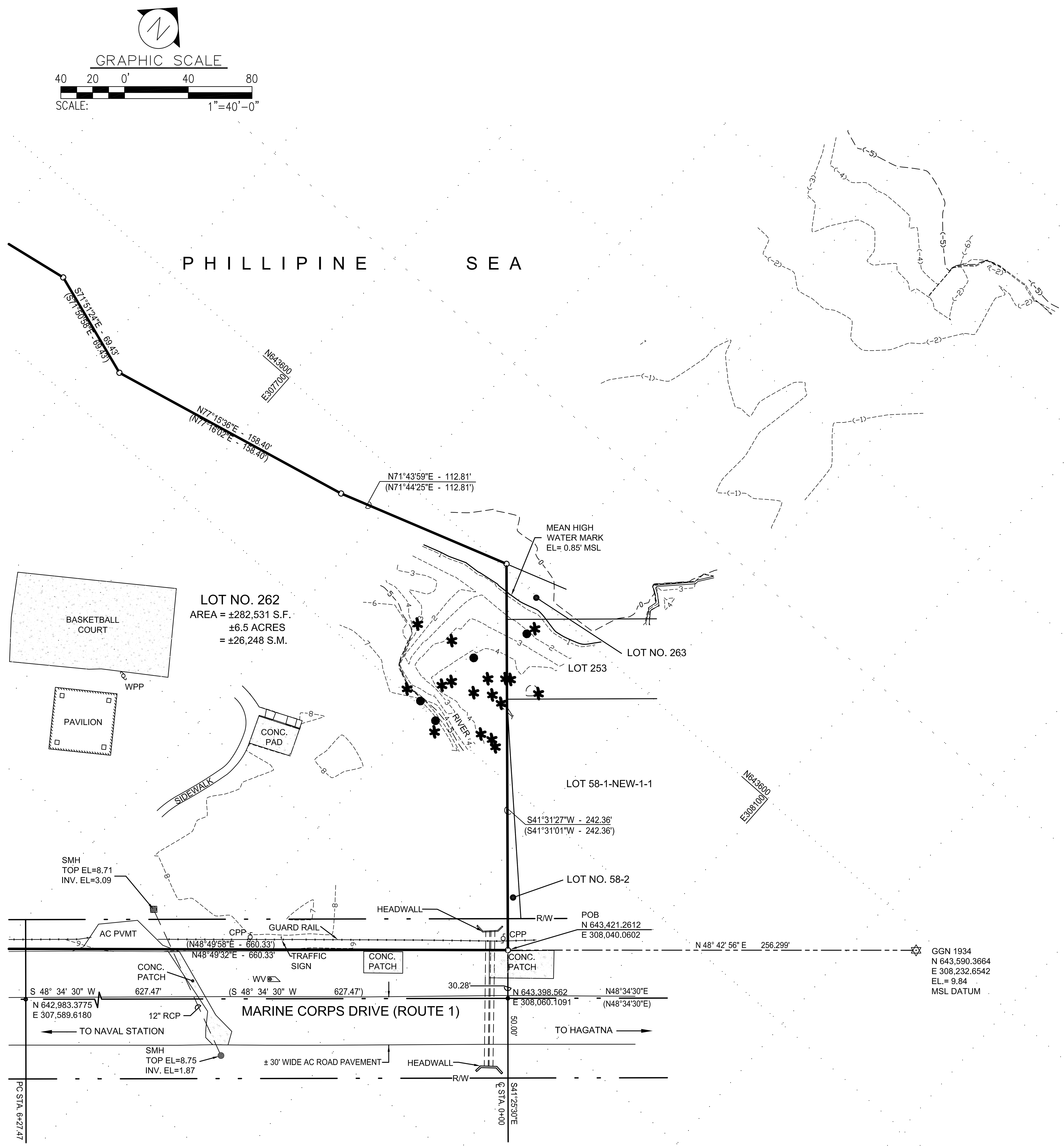
ZONING WITHIN 1000 FT
LOT 262 PEDRO SANTOS PARK
MUNICIPALITY OF PITI
GUAM

EXHIBIT E

TOPOGRAPHIC MAP OF LOT 262, TEPUNGAN, PITI, GUAM



LOCATION MAP
NOT TO SCALE



LEGEND & SYMBOLS:

- PROPERTY CORNERS
- COCONUT TREE
- TREE
- CPP CONCRETE POWER POLE
- WPP WOODEN POWER POLE
- SMH SANITARY MANHOLE
- WV WATER VALVE
- MAJOR CONTOUR
- MINOR CONTOUR

NOTES:

1. HORIZONTAL CONTROL SURVEY WAS BASED FROM 1993 GUAM GEODETIC NETWORK (GGN) 1934 WITH COORDINATES 643,590.3664 FEET NORTH AND 308,232.6542 FEET EAST.
2. VERTICAL CONTROL SURVEY WAS BASED FROM 1993 GUAM GEODETIC NETWORK (GGN) 1934 WITH AN ELEVATION OF 9.84 FEET MEAN SEA LEVEL (MSL) DATUM.
3. ALL DISTANCES, DIMENSIONS, COORDINATES AND ELEVATIONS ARE IN FEET AND DECIMALS THEREOF.
4. BEARINGS AND DISTANCES IN PARENTHESIS ARE RECORD DATA, ALL OTHERS ARE 1993 GRID VALUES AND FIELD CONDITIONS.
5. CONTOUR LINES AS SHOWN WERE DEVELOPED FROM SPOT ELEVATIONS USING GPS AND CONVENTIONAL TOPOGRAPHIC SURVEY METHODS.

REFERENCE MAP:

LAND REGISTRATION SURVEY LOT NOS.464, 465 AND 466 MUNICIPALITY OF ASAN AND LOT NOS.262, 263 AND 264 MUNICIPALITY OF PITI, L.M. NO.14-76T030.

DUEÑAS · CAMACHO
ENGINEERING (CIVIL/STRUCTURAL) ■ CONSTRUCTION MANAGEMENT ■ PLANNING ■ ENVIRONMENTAL SERVICES ■ SURVEYING ■ DEVELOPMENT CONSULTATION ■ GEOGRAPHIC INFORMATION SYSTEMS
P.O. Box 8900 Tamuning, Guam 96931

NESTORIO C. IGNACIO · REGISTERED PROFESSIONAL LAND SURVEYOR · No. 65 · GUAM

CERTIFICATE OF SURVEYOR

I, NESTORIO C. IGNACIO, HEREBY CERTIFY THAT THIS MAP WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT IT IS BASED ON A FIELD SURVEY MADE IN SEPTEMBER 24, 2015.

NESTORIO C. IGNACIO, P.L.S. No. 65 — DATE 9/25/15

PROJECT: PROPOSED SEA-US CABLE LANDING SITE
MUNICIPALITY OF PITI, GUAM

CONTENTS: TOPOGRAPHIC/AS-BUILT SURVEY MAP

SURVEYED BY: FBS & MPG	DATE: SEPTEMBER '15
DRAWN BY: FSS	DATE: SEPTEMBER '15
CHECKED BY: NCI	DATE: SEPTEMBER '15
SUPERVISED BY: NCI	DATE: SEPTEMBER '15

PROJECT NO. GP15-64
CAD FILE: DCAI-S-15-47.DWG

SHEET NUMBER
TP
SHT. 1 OF 1

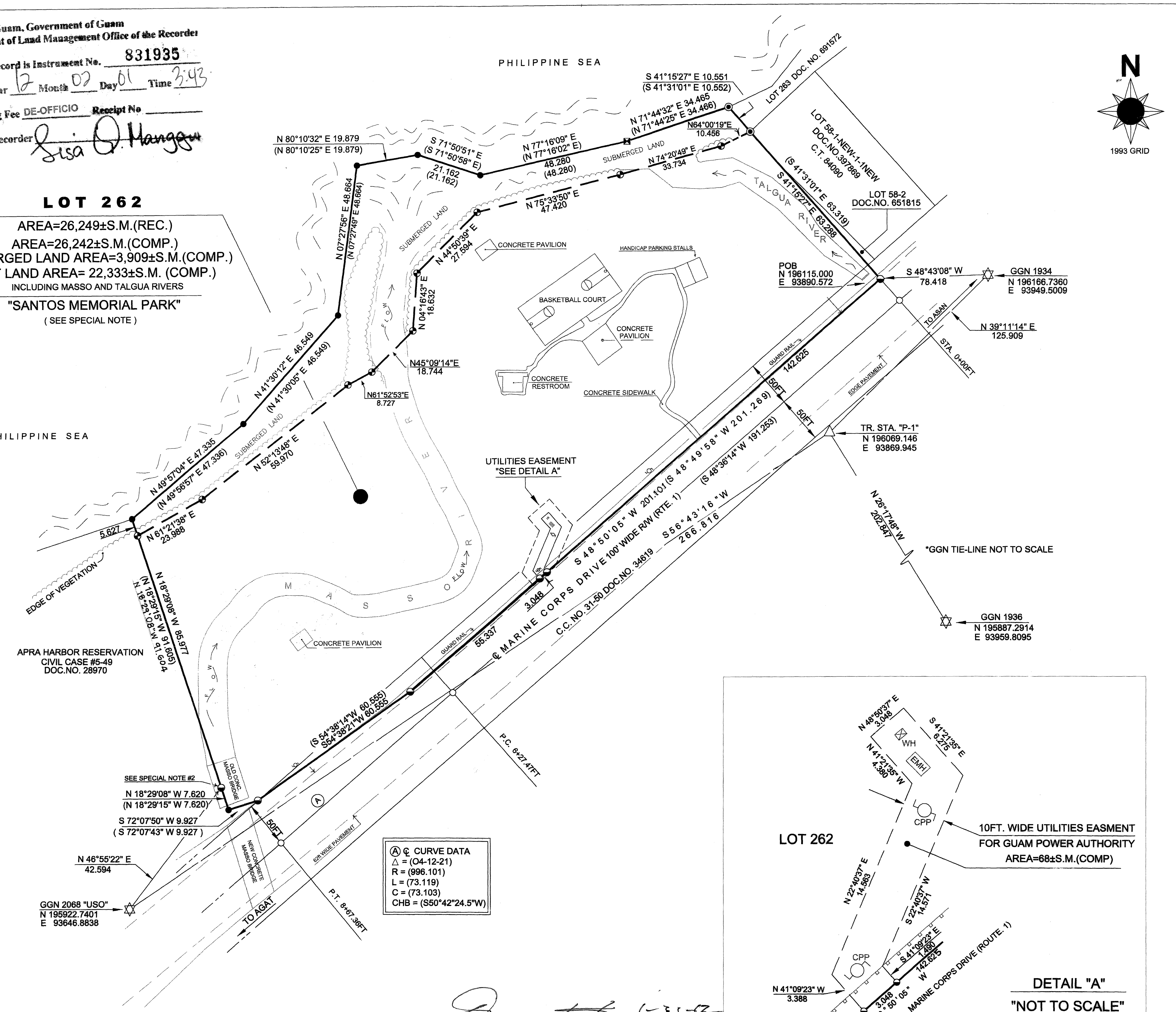
EXHIBIT F

PROPERTY MAP OF LOT 262, TEPUNGAN, PITI, GUAM

Island of Guam, Government of Guam
Department of Land Management Office of the Recorder
File for Record is Instrument No. 831935
On the Year 12 Month 02 Day 01 Time 3:43
Recording Fee DE-OFFICIO Receipt No
Deputy Recorder Lisa Q. Manggau

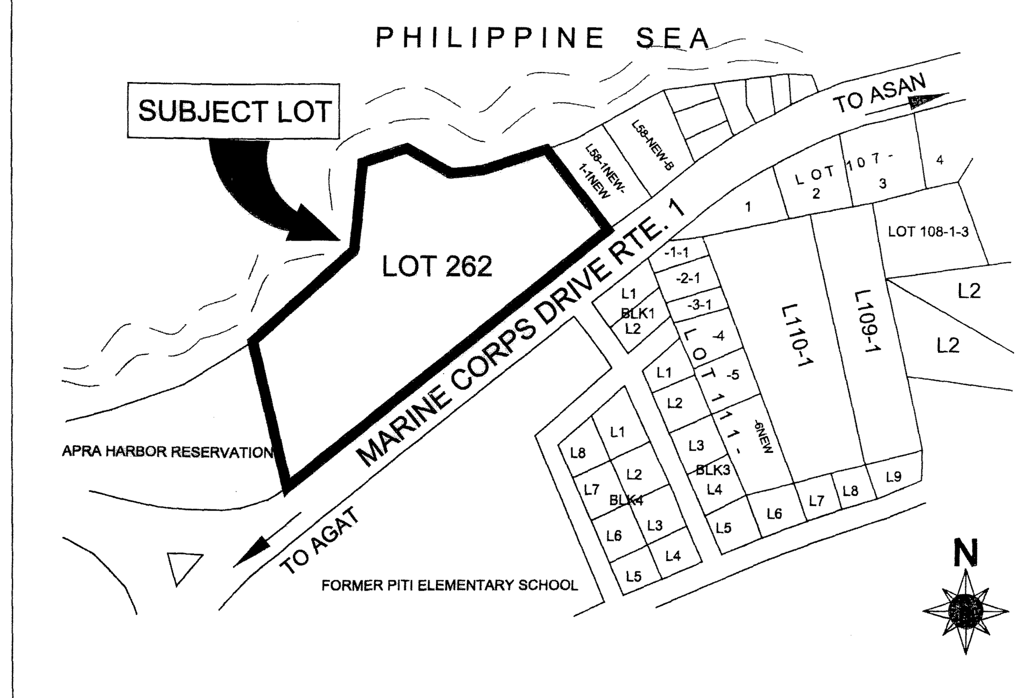
LOT 262

AREA=26,249±S.M.(REC.)
AREA=26,242±S.M.(COMP.)
SUBMERGED LAND AREA=3,909±S.M.(COMP.)
NET LAND AREA= 22,333±S.M. (COMP.)
INCLUDING MASSO AND TALGUA RIVERS
"SANTOS MEMORIAL PARK"
(SEE SPECIAL NOTE)



Ⓐ ℄ CURVE DATA
Δ = (O4-12-21)
R = (996.101)
L = (73.119)
C = (73.103)
CHB = (S50°42'24.5"W)

N
1993 GRID



VICINITY MAP (NOT DRAWN TO SCALE)

NOTES:
1. SURVEY WAS BASED ON FOUND CORNERS AS SHOWN.
2. ALL DISTANCES ARE IN METERS UNLESS OTHERWISE NOTED.
3. BEARINGS AND DISTANCES WITHIN PARENTHESIS ARE RECORD, ALL OTHERS ARE 1993 VALUES.
4. SUBJECT LOT (S) IS/ARE ZONED "A" AGRICULTURAL AS OF APPROVAL OF THIS MAP.
5. SUBJECT LOTS IS/ARE NOT WITHIN THE GROUND WATER PROTECTION ZONE (GPZ).
6. ASBUILTS ARE AS SHOWN IN PLAT AS OF APPROVAL OF THIS MAP.
7. ROAD CENTERLINE STATIONING ARE IN FEET.

REFERENCES:
1. DWG. # SDCO-21-0775, L.M. CHECK # 132 FY 76, I-030, LAND REGISTRATION SURVEY OF LOT 464, 465 , 466 & 262, 263 & 264, PREPARED BY PLS 23, NO DOCUMENT.
2. DWG. # MS-91054, L.M. CHECK # 219FY91, RETRACEMENT SURVEY AND CONSOLIDATION SURVEY MAP OF LOT253 & 58-1-1NEW INTO LOT 58-1NEW-1-1NEW, PREPARED BY PLS.NO.53, DOC.NO. 466669
3. L.M.DWG. # C4-57T382, SUBDIVISION OF LOT 58-A &58-4A, DOC.NO. 33585
4. APRA HARBOR RESERVATION CUT-BACK FOR GOVERNMENT OF GUAM RECREATIONAL AREA DWG. PWC. 12440, DOC.NO. 108908.
5. DOC.NO. 322035, DEED OF GIFT TO GOVERNMENT OF GUAM.
6. ACCEPTANCE DOCUMENT NO. 342894 FOR GOVERNMENT OF GUAM.
7. NAVFAC DRAWING NOS. 1268499 ROUTE NUMBER ONE APRA HARBOR RESORVATION STA. 0+00 TO STA. 177+95.62 .

CERTIFICATIONS AND APPROVALS

SATISFACTORY TO AND APPROVED BY :
Monte Mafnas 1-17-12
MONTE MAFNAS DATE
ACTING DIRECTOR, DEPARTMENT OF LAND MANAGEMENT

CHECKED BY :
Frank Taitano 12-9-11
FRANK TAITANO DATE
PLANNER, DLM
1-6-11
JIMMY I. CAMACHO DATE
ENGINEERING TECHNICIAN, DLM

CERTIFICATION OF GUAM CHIEF PLANNER
APPROVAL PURSUANT TO TITLE 21, GUAM CODE ANNOTATED, CHAPTER 62, SUBDIVISION LAW.
NOT REQUIRED
MARVIN Q. AGUILAR DATE
ACTING GUAM CHIEF PLANNER

CERTIFICATION OF GUAM CHIEF SURVEYOR/CHIEF OF CADASTRE
THIS MAP HAS BEEN EXAMINED FOR CONFORMANCE WITH TITLE 21, GUAM CODE ANNOTATED, CHAPTER 60, ARTICLE 5, UNIFORM TRIANGULATION SYSTEM AND REGULATIONS THEREUNDER THIS 1st DAY OF February 2012
2-1-12
PAUL L. SANTOS, PLS # 68
GUAM CHIEF SURVEYOR / CHIEF OF CADASTRE

REVISIONS	DESCRIPTION	BY	APPROVED BY	DATE

RETRACEMENT SURVEY MAP OF LOT 262

LAND SQUARE NO. 21 MUNICIPALITY OF PITI SECTION NO. 1

SURVEY DATA			BASIC LOT DATA
JOB NO.	2664-04-11	04-2011	LOT "APRA HARBOR RESERVATION"
COMPUTED BY	PJC	04-2011	CERTIFICATE OF TITLE NO. 2867
DRAWN BY	PJC/MJ/WQ	04-2011	REGISTERED ON: SEPTEMBER 14,1949
RESEARCHED BY	PJC	04-2011	ESTATE NO.
FIELD BY PE/DD DLM CREW		04-2011	IN THE NAME OF :
CHECKED BY	PLS		THE NAVAL GOVERNMENT OF GUAM
SCALE IS IN METRIC SYSTEM AS SHOWN			
SHEET 1 OF 1			
DWG. NO. I4-011T715			
L.M. CHECK NO. 230 FY 2011			

10FT. WIDE UTILITIES EASMENT
FOR GUAM POWER AUTHORITY
AREA=68±S.M.(COMP)

DETAIL "A"
"NOT TO SCALE"

Vicente D. Gumataotao 1-31-12
VICENTE D. GUMATAOTAO DATE
MAYOR OF PITI

SYMBOLS

- FOUND REBAR UNKNOWN
- FOUND 6" X 6" CONCRETE MONUMENT WITH BRASS DISK SET BY UNKNOWN, NO DOCUMENT
- INACCESSIBLE CORNER
- GGN CONTROL STATION
- SET REBAR WITH CAP MARKED "DLM" AS WITNESS CORNERS.
- SET REBAR WITH CAP MARKED "DLM"
- HIGHWAY MONUMENT FOUND
- CONCRETE POWER POLE
- EDGE OF VEGETATION
- WITNESS CORNER LINE

SPECIAL NOTE:

1. THE DIFFERENCE BETWEEN RECORD AND COMPUTED AREA IS BASED ON FIELD CONDITIONS.
2. NAIL SET WITH CAP MARKED "DLM" ON CONCRETE.
3. WITNESS CORNERS SET APPROXIMATELY 1.5 METERS FROM EDGE OF VEGETATION.

20 10 0 20 40
GRAPHIC SCALE
1"=20m

I, PAUL L. SANTOS, HEREBY CERTIFY THAT THIS MAP WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION, THAT IT IS BASED ON A FIELD SURVEY MADE ON APRIL 2011, IN CONFORMANCE WITH ALL APPLICABLE LAWS AND REGULATIONS, AND THAT I AM RESPONSIBLE FOR THE ACCURACY OF ALL DATA AND INFORMATION SHOWN HEREIN. I ALSO CERTIFY THAT ALL THE MONUMENTS ARE OF THE CHARACTER AND OCCUPY THE POSITIONS INDICATED ON THIS MAP.

11-30-11
PAUL L. SANTOS DATE
PROFESSIONAL LAND SURVEYOR NO. 68

PAUL L. SANTOS No. 68 PROFESSIONAL LAND SURVEYOR

GOVERNMENT OF GUAM
GUBETNAMENTON GUÅHAN
DEPARTMENT OF LAND MANAGEMENT
DIPÅTTAMENTON MINANEHAN TÅNO'
LAND SURVEY DIVISION
DIBISION AGRAMENSIAN TÅNO'

#13986

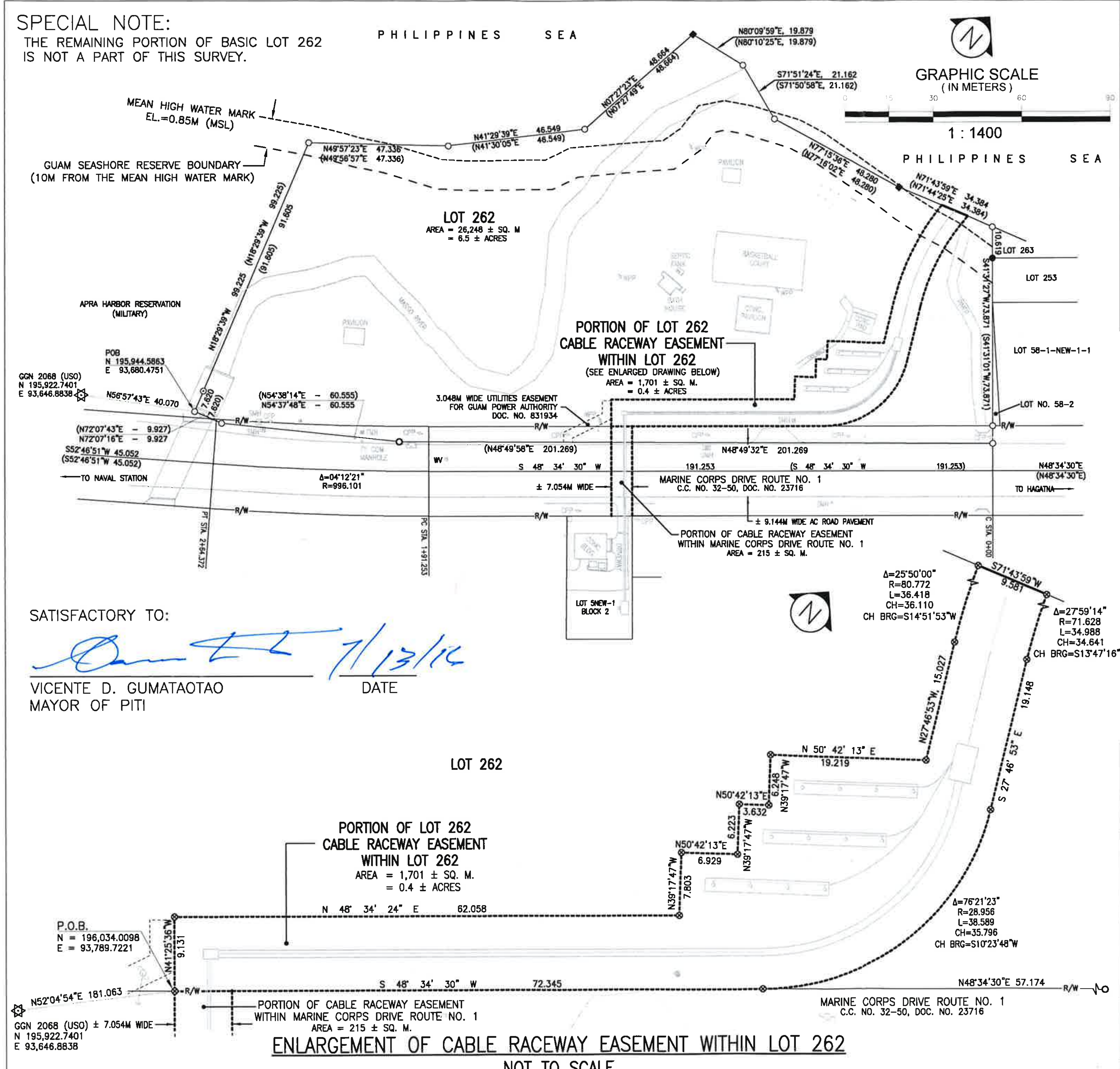
EXHIBIT G

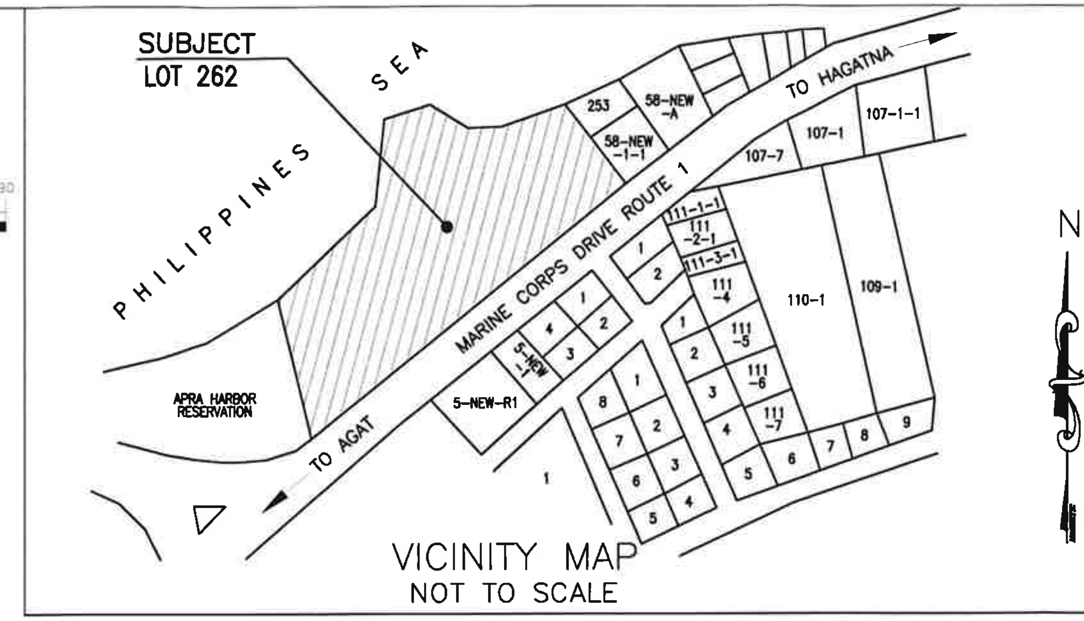
SURVEY SKETCH MAP OF LOT 262

MUNICIPALITY OF PITI, GUAM

(SEVERANCE OF PORTION OF LOT 262 FOR A

CABLE RACEWAY EASEMENT)





CABLE RACEWAY EASEMENT: EXHIBIT "A"

REFERENCES:

1. LAND REGISTRATION SURVEY OF LOT NOs. 464, 465 AND 466 MUNICIPALITY OF ASAN AND LOT NOS. 262, 263 AND 264 MUNICIPALITY OF PIT, PREPARED BY PLS NO. 23, 132 FY 76, I-030, DWG. NO. SDCO-21-0775.
2. RETRACEMENT SURVEY MAP OF LOT 262, PREPARED BY PLS NO. 68, 230 FY 2011, DOC. NO. 831935.

NOTES:

1. SURVEY WAS BASED ON FOUND PROPERTY CORNERS AS SHOWN ON THIS MAP.
2. ALL DISTANCES AND DIMENSIONS SHOWN HEREON ARE IN METERS, UNLESS OTHERWISE NOTED.
3. BEARING AND DISTANCES IN PARENTHESES ARE RECORD DATA, ALL OTHERS ARE 1993 GRID VALUES.

SYMBOLS:

- GUAM GEODETIC NETWORK (GGN) STATION
- FOUND 6X6 CONC. MON. WITH NO IDENTIFICATION
- FOUND #4 REBAR WITH PLASTIC CAP ILLEGIBLE
- FOUND CHISELED X CENTERED WITH A NAIL
- SET #4 REBAR WITH PLASTIC CAP MARKED PLS # 65
- CORNERS, NOT FOUND

SURVEY SKETCH MAP OF LOT 262

MUNICIPALITY OF PITI, GUAM
(SEVERANCE OF PORTION OF LOT 262 FOR A CABLE RACEWAY EASEMENT)

CERTIFICATE OF SURVEYOR:

I, NESTORIO C. IGNACIO, HEREBY CERTIFY THAT THIS SKETCH MAP WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION. THAT IT IS BASED ON A FIELD SURVEY MADE ON NOVEMBER 12, 2008, IN ACCORDANCE WITH ALL APPLICABLE LAWS AND REGULATIONS.

Nestorio C. Ignacio 7/11/16

NESTORIO C. IGNACIO, P.L.S. NO.65 DATE

NESTORIO C. IGNACIO CERTIFICATE No65 EXP. 04-30-17 GUAM PROFESSIONAL LAND SURVEYOR

DUEÑAS · CAMACHO

- ENGINEERING (CIVIL/STRUCTURAL)
- CONSTRUCTION MANAGEMENT
- PLANNING
- ENVIRONMENTAL SERVICES
- SURVEYING
- DEVELOPMENT CONSULTATION
- GEOGRAPHIC INFORMATION SYSTEMS

P.O. Box 8900 Tamuning, Guam 96931

DWG. NO. DCAI-S-15-4

EXHIBIT H

ENVIRONMENTAL IMPACT ASSESSMENT

Environmental Assessment for the Conduit Installation and Cable Landing for SEA-US Cables, Piti, Guam

Prepared for

GTA
624 N. Marine Corps Drive
Tamuning, Guam 96913

and

NEC Orchestrating a brighter world
NEC CORPORATION OF AMERICA
6536 N. State Hwy 161
Irving, TX 75039

Prepared by

DCA
DUEÑAS · CAMACHO & Associates Inc.
Dueñas, Camacho & Associates, Inc.
238 East Marine Corps Drive
Suite 201 Diamond Plaza
Hagatna, Guam 96910

June 2016

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APPENDICES

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ACRONYMS AND ABBREVIATIONS

BMP	Best Management Practice
CFR	Code of Federal Regulations
DPW	Department of Public Works
EA	Environmental Assessment
FONSI	Finding of No Significant Impact
GPA	Guam Power Authority
GPZ	Groundwater Protection Zone
GWA	Guam Waterworks Authority
MBTA	Migratory Bird Treaty Act
mph	miles per hour
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NOAA	National Oceanographic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
SEA-US	Southeast-Asia United States
SHPO	State Historic Preservation Officer
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
WERI	Water and Environmental Research Institute

1 PURPOSE OF AND NEED FOR PROPOSED ACTION

This Environmental Assessment (EA) evaluates the alternatives for installation of conduits and landing of cables for the Southeast Asia-United States (SEA-US) cables in Tepungan, Piti, Guam. This EA analyzes the potential impacts of the Proposed Action Alternative and the No Action Alternative, and is intended to provide sufficient evidence and analysis to determine whether the proposed project will negatively affect the environment. If there is a significant impact to the environment, a mitigation of these impacts would follow.

1.1 Summary of Proposed Action

The project proposes to install six conduits to receive submarine fiber-optic cables, and shortly after, land two new submarine cables in two of the conduits for the Southeast Asia-U.S. (SEA-US) telecommunication system linking Asia with Guam, Hawaii and California. The project is needed to complete the Guam link of the SEA-US system with Asia and the rest of the U.S. The four spare conduits are needed to accommodate future cable landings anticipated by GTA.

The project will dredge a trench (3 ft deep by 6 ft wide by 404 ft long) on the reef flat, from the mean high water mark to the shoreward edge of the Tepungan Channel. Six 4.8-inch diameter ductile iron conduits will be installed in the trench. The trench will be backfilled and a concrete bulkhead (6 ft wide by 10 ft long) will be installed to keep the conduits in place. Shortly after, two fiber-optic marine cables will be landed through two of the conduits and pulled to shore where they will be spliced to land cables at a new beach manhole located above the high tide line and outside the Guam Seashore Reserve.

1.2 Location

Guam is a U.S. territory and the largest and southernmost island in the Mariana Islands archipelago. The project site is in the eastern portion of Pedro G. Santos Memorial Park (Lot 262), an approximately 6-acre parcel located in the Municipality of Piti, just east of Apra Harbor on the western coast of Guam (Figure 1). The proposed cable raceway would be constructed in Lot 262 and on the reef flat offshore from the Park. Santos Park is located east of the Guam Power Authority Cabras and Piti Power Plants, and north of the GTA Cable Station site in Lot 5NEW-1, Block 2.

1.3 Purpose and Need for Action

The project proposes to install six conduits to receive submarine fiber-optic cables, and shortly after, land two new submarine cables in two of the conduits for the Southeast Asia-U.S. (SEA-US) telecommunication system linking Asia with Guam, Hawaii and California. The project is needed to complete the Guam link of the SEA-US system with Asia and the rest of the U.S. The four spare conduits are needed to accommodate future cable landings anticipated by GTA.

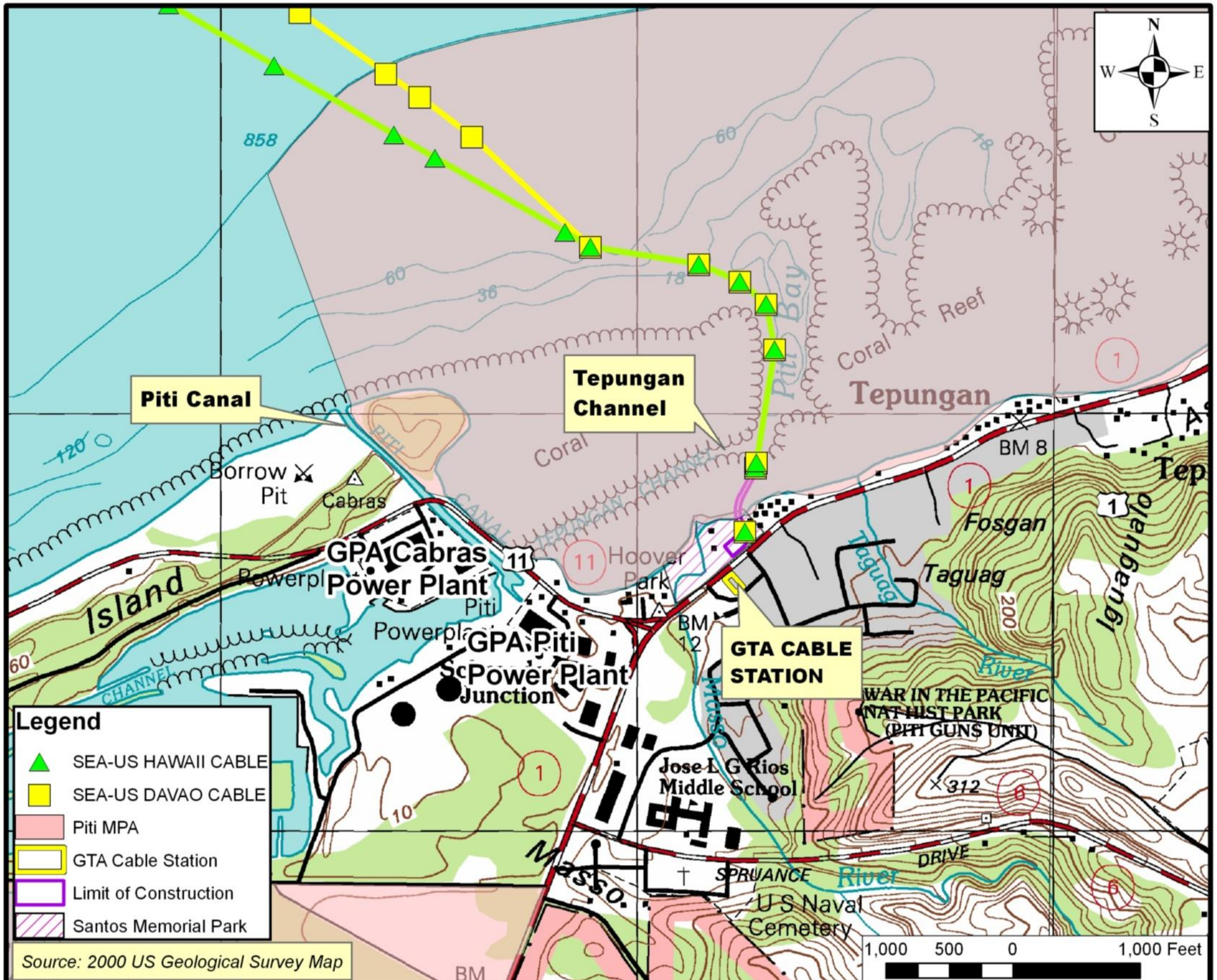

Figure 1-1. Site location map of GTA cable raceway and SEA-US cable landing site, Piti, Guam.

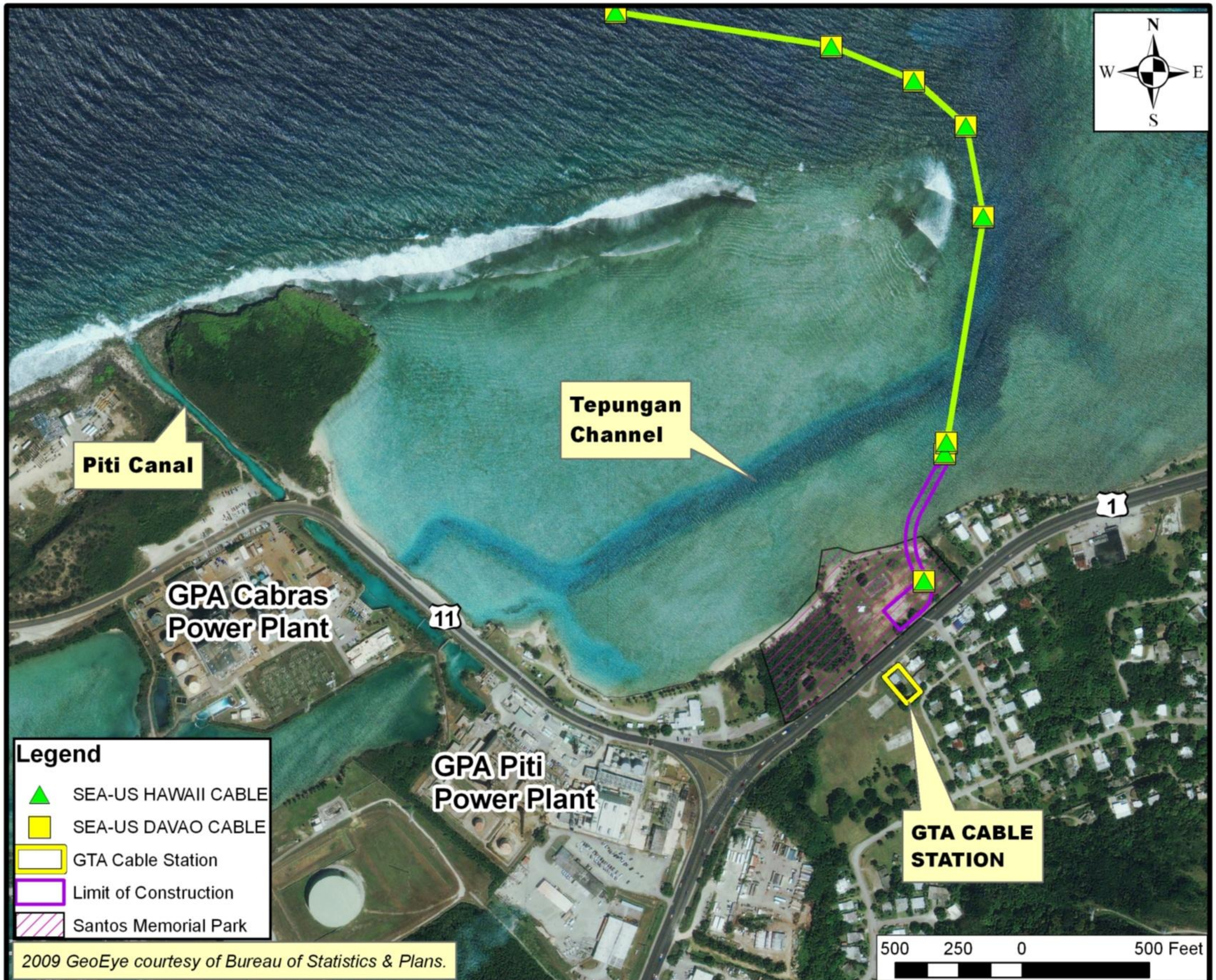

Figure 1-2. Aerial view of GTA cable raceway and SEA-US cable landing site, Piti, Guam.

2 ALTERNATIVES INCLUDING THE PROPOSED ACTION

This EA includes an analysis of the potential effects of the Proposed Action Alternative and a No Action Alternative. This chapter presents the alternatives that will be evaluated in this EA document, i.e., No Action Alternative and Proposed Action Alternative. Other alternatives that were considered but eliminated from further analysis are also discussed in this chapter.

2.1 No Action Alternative

Under the No Action Alternative, the project site would not be developed and the SEA-US cable system would not be landed on Guam. There would be no connectivity on this cable system with Hawaii, the U.S. mainland and Asia. The project site would remain in its present condition.

2.2 Proposed Action Alternative

The Proposed Action would install a cable raceway in Pedro Santos Memorial Park and the adjacent Tepungan reef flat that would ultimately receive two cables from the SEA-US Cable System and connect them to GTA's Cable Landing Station (CLS) on the south (opposite) side of Marine Corps Drive.

The project will dredge a trench (3 ft deep by 6 ft wide by 404 ft long) on the reef flat, from the mean high water mark to the shoreward edge of the Tepungan Channel. Six 4.8-inch (outer) diameter ductile iron conduits will be installed in the trench. The trench will be backfilled and a concrete bulkhead (6 ft wide by 10 ft long) will be installed to keep the conduits in place (Figure 2-1). Shortly after, two fiber-optic marine cables will be landed through two of the conduits and pulled to shore where they will be spliced to land cables at a new beach manhole located above the high tide line. The work flow would proceed as follows:

<u>Installation of Cable Raceway</u>

1) The materials and equipment will be staged within the Santos Park grounds. Prior to construction, fixed silt curtains will be deployed on the shallow exposed reef flat to the north, south and western boundaries of the work zone. A floating turbidity curtain will be deployed in the deeper sectors, such as prior to the final excavation into the channel. Marine organisms (e.g., sea cucumbers, starfish and certain corals) within this zone will be manually relocated outside of the work zone. The silt curtains will be checked daily prior to commencing work.

2) Dredge material will be excavated and placed in a mobile container on the reef flat, then hauled onshore to in Santos Park at a location well above the mean high water mark and outside the Guam Seashore Reserve. The excavator will operate in the tidal zone and work only as conditions allow. No in-water stockpiling would be performed.

3) Washed coarse aggregate will be placed in the trench as bedding material. A single layer of six ductile iron conduits will be placed over the bedding material, covered by a layer of bedding material, and then backfilled with the same materials excavated from the trench to restore the trench to the same grade as the surrounding area. Each length of conduit will consist of 22 18-foot long sections connected to form a conduit approximately 404 feet long from MHW mark to the start of the channel.

The conduits will be connected to an additional 155 length of conduit from the MHW mark shoreward, where the conduits will terminate at a beach manhole. Ocean ground electrodes will be installed to ground the cables. The beach manhole and ocean ground will be located inland and outside of the Guam Seashore Reserve, i.e., more than 10 m (32.8 feet) inland of the MHW mark.

4) Near the seaward terminus of the trench, pre-cut forms will be installed along the walls of the trench and tremie concrete will be pumped into the forms to construct a concrete bulkhead over the conduits in the trench. The bulkhead will be allowed to cure and the site will be demobilized.

A rubber-tired rock truck and a tracked excavator will be used to perform the construction. Two temporary elevated platforms (4 ft tall) will be placed on the reef flat as a work platform for a tracked excavator fitted with a hydraulic rock breaker. The platforms will be lifted and leapfrogged by the excavator so that the excavator can move forward without much impact to the reef. The platforms will have a fully sealed containment should there be a hydraulic leak by the equipment. The platform support structures will have two 24 ft x 6-inch wide steel runners as the only contact on the reef to minimize their footprint.

The work would proceed in sections starting at the near shore area and terminating at the channel margin. The section of trench would be excavated, the pipes inserted, and the trench would be backfilled before proceeding to the next section. The work will be performed in short sections to provide site control and minimize sedimentation.

<u>Landing of SEA-US Cables</u>

The landing of two SEA-US cables would commence shortly after the installation of the cable raceway, and would proceed as follows:

1) The stern of the cable ship would position itself at the mouth of the channel powered by its own thrusters to avoid anchoring on live corals. Two 1.6-inch (41 mm) diameter fiber-optic cables would be bundled on-board the cable ship prior to landing through the channel at Tepungan. The bundling will consolidate the cables into a smaller footprint on the seabed within the channel.

2) Floats will be attached to the bundled cable and it will be floated into the channel, where divers will position it over the seabed. Divers will cut the floats and gently lay the cable in place after confirming the placement avoids corals. If the cable needs to be repositioned, a stopper will be used to create slack on the cable and allow divers to manipulate the cable into place.

3) The cables will be unbundled as they approach the reef flat conduits, and pulled through two of the previously installed 4-inch diameter ductile iron conduits and into the beach manhole, where they will be spliced to the terrestrial cable raceway.

4) Articulated (split) pipe (6 in. diameter) would be placed on the cable from the end of the ductile iron pipe to a seaward distance of 200 m (656 ft). The cable will be selectively pinned with clamps at locations where no live corals are present at five locations in the channel and five locations at the channel mouth to prevent lateral movement of the cable. The wing clamps will be stainless steel plates (40 cm long x 10 cm wide) with pre-drilled holes for two 2 cm diameter bolts (one on each side). After the plates are positioned over the cables, a 3 cm diameter hole for each bolt will be drilled down to 30 cm with a pneumatic drill, and the bolts will be inserted and secured in place with a non-toxic marine epoxy. The sediment generated from this activity is anticipated to be very small, approximately 0.05 gallon per hole, or a total of 1.12 gallon (0.0055 cu yds) for all 20 holes.

2.3 Alternatives Considered and Eliminated from Further Analysis

2.3.1 Alternative Landing Sites Considered

2.3.1.1 Landing Sites at Piti

The project considered two alternative landing sites (Options B and C) that would be within proximity to the GTA Cable Landing Station (CLS) in Piti. From the 60 ft depth (20 m) depth contour, Option B is approximately 1,400 m long (4,593 ft, and Option C is approximately 500 m (1,640 ft) long.

Option B proposed to land through the same initial section of Tepungan Channel as Option A, but instead of landing at Santos Park, the route would continue into the west branch of Tepungan Channel and land on the east side of the Route 11 (Cabras Highway) near Hoover Park. This route was not pursued because of the additional bends in the route compared to the other alternatives, which is undesirable since the cable has a limited bending ratio. Also, the landing site would require permission from the federal government for use of the parcel encompassing Hoover Park, a 4.6-acre U.S. Navy property licensed to the United Seamen's Service.

Option C proposed to land through the Piti Canal, an existing man-made cooling water intake channel for the nearby power plants. The Canal is approximately up to 50 feet wide and up to 10 feet deep. The canal is a straight, man-made route with no bends; however, the presence of several colonies of a listed coral species, and the extremely rough conditions at the mouth of the canal deemed this alternative unfeasible (Kerr and Burdick, 2016).

2.3.1.2 Other Landing Sites

GTA has evaluated other potential sites for the proposed project. The Tata Communications raceway installed in the nearby Tepungan lot east of the Park was seriously pursued; however, GTA was unable to reach an agreement with Tata for the use of the spare conduits. Similarly, Tata and TyCom also own an existing raceway in Taleyfac, Agat that was unavailable for this reason. Another potential cable landing site in Taelayag, Agat was also explored with the owner, Pacific SatCom; however, this site was not pursued because it is located several miles south of the GTA cable landing station site, has not yet been permitted or developed, and there are seagrass beds, a special aquatic site, located offshore in the vicinity. Two existing cable landing sites in northern Guam (Tumon Bay and Tanguisson), managed by AT&T Global Communications Services, Inc. - Guam, were also considered but were unavailable to GTA. The landing of the cables through the Asan River to the east of Tepungan was also a consideration raised during discussions with National Marine Fisheries Service (NMFS); however, the adjacent War in the Pacific Park encompasses both terrestrial and submerged lands under the jurisdiction of the National Park Service and federal government permission would need to be secured.

2.3.2 Alternative Construction Methods Considered

2.3.2.1 Horizontal directional drilling (HDD)

HDD would fulfill the basic purpose of installing a conduit system for submarine cables. However, this construction method was not pursued. DCA, in conjunction with a local cable-laying contractor, considered and analyzed the use of HDD for construction of marine communications cable conduit (raceway) projects across reef flats, from deep water to the shore area. The bore will be shallow as the exit elevation will be no deeper than -60 feet. The following are the conclusions:

1. **Shallow Bore Under Reef Flats Have Conditions Unfavorable for HDD**. Reef flats are coralline with numerous voids and pockets of sand. Favorable conditions for HDD work require a homogeneous substrate, i.e. soil or rock formations that do not have substantial variations in both density and hardness. Reef formations are typically non-homogeneous. The drilling process encounters grave risks in non-homogeneous formations with following typical problems often encountered.

    - When a large void is encountered during the pilot hole drilling process, the drill bit and guiding camera equipment breaks off and has to be replaced. This can only be done by withdrawing the drilling assembly, replacing the drill bit and camera and re-entering the pilot hole. If the hole collapses, re-drilling the pilot may be necessary. However, more often than not, drilling at a new alignment will be necessary to avoid the void complex. The costs associated with this problem are significant in terms of equipment replacement, redesign costs, change orders and delays.
    - When the density of the substrate changes radically such as from hard coral rock to sand, the drilling process can become tedious or untenable. In such cases, a new alignment will be required.

2. **Loss of Drilling Fluid**. When voids (even small voids) along the HDD alignment daylight to the surface of the reef flat, the drilling fluid/lubricant, a fine clay mixture, will leak into the tidal waters and will cause a fine sediment to settle on the affected reef flat or remain in a sediment cloud that will take some time to disperse. These occurrences are pollution events, sometimes quite severe, that will adversely affect marine resources at and

near the drill alignment. Costs associated with lost fluid and pollution cleanup will be incurred along with the resulting delays. Costs associated with pollution effects cannot be reasonably calculated as the loss of marine life is unknown.

3. **More Materials Required**. An HDD marine conduit project will require more piping equipment than a normal surface or cut and cover project. A guide pipe is typically inserted into the bore hole enlarged by reaming the pilot hole, followed by the installation of inner-ducts. The marine cable(s) is then pulled through inner-duct.

4. **Mobilization Costs**. Since HDD is an unusual construction method, local contractors are not normally equipped with the specialized drilling equipment that is needed. The cost of mobilizing equipment to the island can be considerable, especially in comparison to the scale of the project.

The substantial risks involved in the use of HDD at a shallow depth under a reef flat for creating the appropriate space for a marine cable conduit involve potentially large construction and redesign costs, potentially costly change orders, the threat of pollution, and interminable delays. While HDD has been used for construction of deep ocean outfalls, the process is unsuitable for the shallow alignments required for a marine cable conduit. That is the reason all marine cable-landing projects have been constructed using a combination of articulated pipe (split-pipe) armor protected surface cable installation and cut-and-cover trenched cable installation.

2.3.2.2 Direct Laying on Reef Flat

An alternative is to directly land the cables on the reef flat and protect them using articulated pipes instead of placing them in buried conduits. Articulated pipe is formed from two halves of split-pipe armored protectors that are clamped around the cable. This approach would require recurring disturbance during excavation of the shore to land each future cable and splice it to the beach manhole. This alternative would also provide less protection of the cable than buried conduits on the exposed shallow reef flat, potentially requiring frequent disturbance for repairs.

After an evaluation of these alternatives, the current project approach was selected that would dredge a trench to embed six conduits that will accept future landings of submarine cables (see Figure 2-1). This approach would meet the project criteria to protect the cables and minimize the risk of potential cable faults and subsequent interruptions in connectivity. There will be no need to disturb the reef flat, or dredge or excavate below the high tide line for future cable landings because the conduits will already be in place. Therefore, the cables will only need to be pulled through the buried conduits from shore and spliced at the beach manhole located well above the high tide line and outside the Guam Seashore Reserve.

2.4 Environmental Effects of the Proposed Action Alternatives

A summary of the environmental effects of the No Action Alternative and Proposed Action Alternative is presented in Table 1.

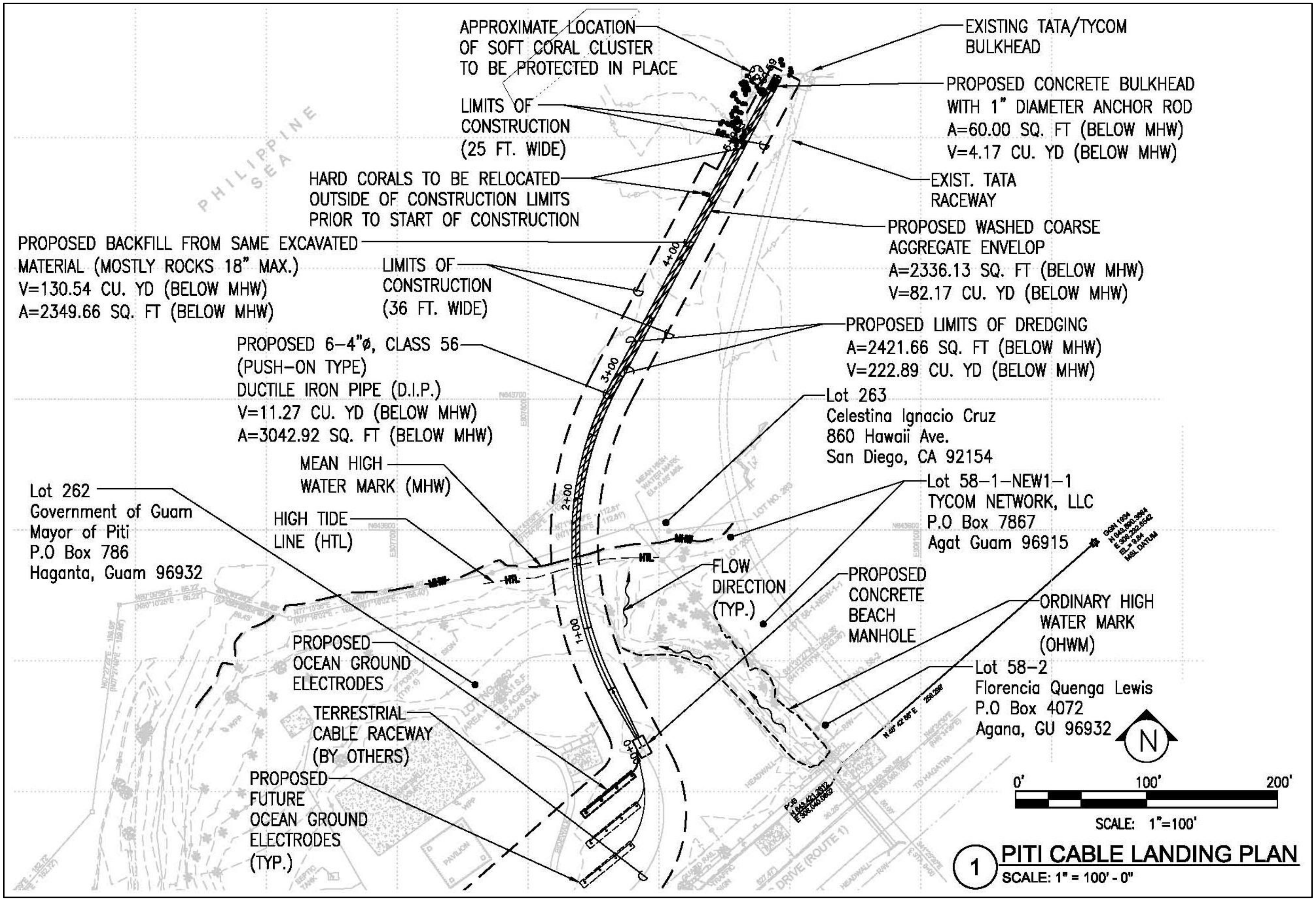

Figure 2-1. Cable raceway plan, Santos Park, Piti, Guam.

Table 1-1. Summary of Environmental Effects of the Proposed Action Alternatives

Resource		No Action	Proposed Action Alternative
1	Geology, Soils and Topography	**No impact.**	**Less than significant impact.** Disturbance of soils and reef substrate and topography along the cable route during construction would be temporary; the raceway trench would be backfilled to the same grade.
2	Water Resources	**No impact.**	**Less than significant impact.** Disturbance of silt on reef flat and shore would be temporary. Silt and sedimentation control devices would be installed during construction and water quality would be monitored. There would be no impacts to groundwater or production wells
3	Biological Resources	**No impact.**	**Less than significant impact.** Lawn and gravel areas on land and vines and coconut trees on shore, would be temporarily disturbed and restored after construction. Corals on reef flat would be relocated out of construction corridor, except for *Leptastrea purpurea* colonies, which are tiny, encrusting and difficult to move, and common elsewhere around the island. The cables will be bundled prior to landing to minimize their footprint, and pre-landing surveys would mark the route to minimize impacts on live corals and benthic organisms. Biological monitoring during construction and cable landing activities would be implemented to reduce potential interactions with sea turtles and marine mammals; work would be halted until these animals leave the area voluntarily.
4	Threatened & Endangered Species	**No impact.**	**Less than significant impact.** Biological monitoring would be implmented and work would halt until protected species, such as sea turtles and dolphins, have voluntarily left the area. One colony of *Acropora globiceps*, a threatened coral, was found to the east of the proposed cable route and will not be disturbed. Additional pre-landing surveys will be performed to confirm there are no other colonies in the path of the bundled cables. Impacts to *A. globiceps* will be avoided by pre-marking the final route prior to the cable landing.
5	Cultural Resources	**No impact.**	**Less than significant impact.** A monitoring and discovery plan would be implemented during construction; however, there is low likelihood of cultural properties in the site based on a previous archaeological survey.
6	Transportation, Traffic and Parking	**No impact.**	**Less than significant impact.** A highway encroachment permit would be secured, and a traffic control plan would be implemented prior to construction. There would be temporary inconvenience to the public as safety concerns require access to a portion of the park and reef flat to be

Resource		No Action	Proposed Action Alternative
			controlled during construction.
7	Utilities – Water	**No impact.**	**Less than significant impact.** The project would have an insignificant demand for water during construction, but would not generate any additional demand for potable water afterwards.
8	Utilities – Sanitary Sewer	**No impact.**	**Less than significant impact.** The project would generate insignificant amounts of wastewater during construction, but would not generate any post-construction wastewater loads to the municipal sewer system.
9	Utilities – Solid Waste	**No impact.**	**Less than significant impact.** Excess material from excavation would be taken to an approved hardfill/landfill. The project would not generate any long-term solid waste loads to the municipal landfill.
10	Utilities – Electricity and Communications	**No impact.**	**Less than significant impact.** Communication and power lines are available in the area to extend into the project site. The project would positively benefit the public through the increased bandwidth.
11	Law Enforcement and Emergency Services	**No impact.**	**Less than significant impact.** The project would not generate any additional demand for law enforcement or emergency services.
12	Land Use	**No impact.**	**Less than significant impact.** Proposed land use is compatible with adjacent zoning and existing and proposed uses.
13	Noise	**No impact.**	**Less than significant impact.** Best management practices would be implemented during construction to minimize potential noise to sensitive receptors in the vicinity of the project site. There would be no long-term effects on noise quality after construction.
14	Air Quality	**No impact.**	**Less than significant impact.** Best management practices would be implemented during construction to minimize the potential production of dust. There would be no long-term effects on air quality after construction.
15	Aesthetics	**No impact.**	**Less than significant impact.** The project would temporarily affect views of Tepungan Channel and Santos Park during construction. There would be no long-term impacts on aesthetics after construction.
16	Socioeconomic Characteristics	**No impact.**	**Less than significant impact.** Construction-related employment would benefit Guam's economy. The interconnectivity of the local network with the SEA-US cable system would increase bandwidth and market competition, enhancing communication for island residents.

3 AFFECTED ENVIRONMENT

This chapter describes the affected environment of the proposed action alternative within the Piti project site.

3.1 Topography

The topography of Lot 262 is gentle and fairly flat from past grading activities to accommodate the park and amenities (Figure 3-1). In the eastern sector of the parcel where the proposed action would occur, the terrain slopes slightly towards the north from an elevation of 9 ft above mean sea level at the southern boundary, 8 ft in the central sector, and abruptly descending to 1 ft at the northern shoreline. The main topographic features are two stream channels that run generally from south to north at the western end (Masso River) and eastern end (unnamed stream) of the parcel, and empty into Tepungan Bay.

The mean lower low water mark is at 0.85 feet and parallel to the northern boundary, placing the inland boundary of the Guam Seashore Reserve within the northern sector of Lot 262. Offshore from Lot 262, the project corridor is a part of a shallow, intertidal reef flat with a depth of about 1 m (3.2 ft) at high tide and low surface relief interrupted by occasional pools. The reef margin drops to about 2 m as it transitions into Tepungan Channel, which ranges from approximately 200 to 500 ft wide and up to approximately 75 ft deep.

3.2 Geology

The underlying geology of Lot 262 is mapped primarily as beach deposits (Siegrist and Reagan, 2007). These are described as "beach sand and gravel, beach rock in the intertidal zone, and small isolated patches of recently emerged detrital limestone" (Siegrist and Reagan, 2007). A small area along Marine Corps Drive is mapped as aluvium, which falls outside the project corridor.

Guam lies in an active seismic region subject to major earthquakes, such as the April 26, 2002 quake that measured 7.1 on the moment magnitude scale (M_W) (URS, 2005). The Pago-Adelup fault runs across the mid-section of the island separating the limestone plateau in the north from the volcanic southern half (Siegrist et al., 1998) and is located approximately 3.5 miles south of the Piti project site. According to the *Guam Hazard Mitigation Plan*, surface fault ruptures have not been observed historically along any of the known faults on Guam (URS, 2005).

3.3 Soils

The soils in Lot 262 and a large part of the surrounding land area are mapped as Urban land-Ustorthents complex, nearly level in the *Soil Survey of the Territory of Guam* (Young, 1988). Young (1988) describes this unit as 60 percent Urban land and 30 percent Usthortents. Urban land comprises developed areas of buildings, roads and parking lots which rest on an underlying base of crushed coral or directly on top of limestone substrate. As expected, the paved Urban land component is impermeable to water, hence, runoff is rapid. The Usthortents component comprises quarried fill material that may consist of crushed coral gravel and pockets of very gravelly clay and clay loam (Young, 1988). As is typical of limestone, the permeability of Ustorthents is moderately rapid and runoff is slow.

None of the soils in the project site are identified as having major components that meet the soil requirements for prime farmland when irrigated (Young, 1988).

3.4 Water Resources

3.4.1 Surface Water

3.4.1.1 Freshwater

The project site is in the Asan-Piti watershed, a 2.9- sq. mile area which encompasses portions of Asan and Piti municipalities, and drains north into the Philippine Sea (Kottermair, 2012). Two freshwater streams flow beneath Marine Corps Drive (Route 1), through Lot 262, and empty into Piti Bay. Masso River passes through the western sector of the property and empties into the bay approximately 200 feet west of the project corridor. The second stream or creek is unnamed and flows intermittently from a culvert below Route 1 through the eastern sector of the property (Photo 3-1). The shallow stream channel is approximately 3 to 4 feet wide and empties into the bay adjacent to the project corridor.

Photo 3-1. Unnamed seasonal creek adjacent to project site, facing north.

3.4.1.2 Marine Water

Tides. The average tide level ranges from 1.3 ft. during neap tides and 2.1 ft. during spring tides. Edward K. Noda and Associates, Inc. (1990) calculated storm tidal ranges for the west coast of Guam to be 23.6 ft. high with period of 16 seconds (5-year significant wave) and 46.5 ft. high with period of 22 seconds (100-year significant wave).

Photo 3-2. Tepungan reef flat at low tide, facing south towards Santos Park.

Currents. Marsh & Gordon (1972 and 1974) state that the most important factors affecting movement of water across the Piti reef flats are tidal conditions and surf actions on the reef margin north of the Tepungan Channel. Water circulation on the reef flat is primarily unidirectional during ebbing, and flooding during spring tides with water moving over the northern reef margin and flowing in a southern direction towards the southwestern sector of the Tepungan Channel and reef flat south of the Channel. The water then moves in a northeast direction along the Tepungan Channel and southern reef flat, and veers north towards the mouth of the Tepungan Channel. There is also movement of water during flooding tides into the entrance of the Channel, especially when the surf action on the northern reef margin is reduced.

Huddell et al. (1974) placed a current meter at a depth of 35 feet between 25 February and 2 March 1971, and at a depth of 55 feet between 22 August and 12 September 1971 approximately 200 feet of the northwest tip of Cabras Island. The water currents generally flowed towards the west at a speed up to 0.30 meters per second during February and March 1971, and flowed equally towards the east and west at a slower speed, i.e., up to 0.14 meters per second. Dye studies conducted near shore off the northwest tip of Cabras Island showed movements towards the west during flood tides and general movement towards the east during ebb tides.

Fluorescein dye studies were conducted during ebb spring tides at three sites along the Tata raceway, i.e., 50 m (154 feet) and 100 m (328 feet) from MHW line, and at the inland edge of the Tepungan Channel on 28 August 2000 by Duenas & Associates, Inc. (D&A, 2000). Similar dye studies were conducted on the same day during flood tides at four sites, i.e., 20 m (66 feet), 50 m, and 100 m seaward of the MHW line, and at the inland edge of the Tepungan Channel. The direction of the dye track was recorded with a compass at one-minute intervals over a three to four-minute period. Three trials were conducted at each site.

Water movement during neap tide, 50 m seaward of the MHW line, was basically towards the Tepungan Channel; one trial showed water moving towards shore. During flood tide, water movement was influenced by the currents moving south from the northern reef margin (i.e., north of the inland sector of the Tepungan Channel) which moved the water to the east. At the edge of the Tepungan Channel, all six trials during neap and flood tides showed water moving immediately into the Channel. At a site 14 m (45 feet) from the edge of the channel or 100 m seaward of the MHW line, water moved in a northeast direction obliquely towards the channel during flood tide. During ebb tide, the water moved back and forth along a north-south direction. The one inshore dye study during flood tide, i.e., 20 m from MHW line, showed the water influenced by eddies with movement basically in a northeast direction. Water movement was less than 0.16 meters per second.

Salinity. Previous salinity measurements were obtained with an Atago S-10 hand refractometer at 8 sites on the Tepungan reef flat during 0 tide (MLLW) on 28 August 2000 (D&A, 2000). Measurements were taken at low tide to detect freshwater springs, if any, and the influence of the freshwater creek located adjacent and east of the Park. Temperature readings with a total submersible thermometer were also taken at the sites.

The three shoreline samples showed salinity values of 17 ppt in the vicinity of the trench, 20 ppt southwest of the trench, and 24 ppt northeast of the trench. A salinity sample taken from mid-reef, i.e., 50 m from MHW line, recorded a reading of 32 ppt. The three salinity readings obtained from sites 75 m, 100 m and 114 m (channel edge) from the MHW line all showed nearly normal seawater at 33 ppt. The lower salinity of nearshore waters seemed to be attributed to the rather rapid flow of the freshwater creek during morning precipitation. No freshwater springs were detected along the shoreline.

Temperature readings along the shore and reef flat were consistent at 29.5^{o}C to 30^{o}C. The freshwater creek recorded a much cooler temperature of 27^{o}C; the channel waters recorded a temperature of 29^{o}C.

Water Quality. The *2001 Revised Guam Water Quality Standards* designates the coastal waters in Tepungan Channel and the nearby reef flat as M-2 (good) marine waters. Marine water in this category are intended to be of sufficient quality to allow for the propagation and survival of marine organisms, particularly shellfish and other similarly harvested aquatic organisms, corals and other reef-related resources, and whole body contact recreation. The site is within Piti Bomb Holes Marine Preserve, which is a designated marine protected area; no fishing, harvesting, or collecting of any kind of marine organism is allowed without a permit. No recreational activities at the project sites were observed during pedestrian surveys.

Guam Environmental Protection Agency (Guam EPA) has two water sampling stations within Santos Park at Tepungan, i.e., approximately 60 feet northeast of the mouth of Masso River, and in Masso River across from the Park's restroom building.

Based on freshwater and marine water monitoring programs for various parameters, including sediment loads and bacteria, Kottermair (2012) cites bacterial and turbidity levels as the main water quality concerns in the watershed. Guam Environmental Protection Agency (Guam EPA) has two weekly water sampling stations in the vicinity of the project site, i.e., at the mouth of Masso River (N-16) in Santos Park, and Hoover Park (United Seamen's Service) (N-17). The stations are sampled for Enterococci bacteria, which is an indicator of wastewater contamination. If warranted based on the sampling results, Guam EPA will issue an advisory to notify during that specific week's sampling, the bacteria concentration at that beach was above the accepted Guam Water Quality Standard for marine recreational beaches. From 2008 to 2011, the N16 sampling station at Pedro Santos Memorial Park had 42, 28, 47, and 48 advisories issued per year, and the number of days the site was on the advisory ranged from 200 to 337 days per year (Kottermair, 2012). Guam EPA has placed the waters off Santos Park on the 2012 list of impaired waterbodies under Section 303(d) of the Clean Water Act, since *Enteroccocus* levels from this site exceed Guam Water Quality Standards in greater than ten percent of the samples (Guam EPA, 2015). The quality of these waters is affected by the influx of silt onto the inner section of the reef flat and the persistent presence of *Enterocci* in the nearshore waters. Much of the silt deposited on the reef flat and entering Tepungan Channel originates from the Masso River, with some contributed by the unnamed freshwater stream and direct stormwater runoff from the beachfront properties in the area.

3.4.2 Floodplains

The Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM) prepared for Guam designates Santos Park within Coastal Flood Zone VE with velocity hazard (wave action), a Special Flood Hazard Area with base flood elevations of 10 and 11 feet (Figure 3-1) (FEMA, 2007, Panel No. 66000167D). The Special Flood Hazard Area encompasses the coastal properties in the vicinity to the east and west of Santos Park, and extends inland to Marine Corps Drive or beyond in some areas.

3.4.3 Groundwater

Santos Park is not located within the recharge area or stream source area of the Northern Guam Sole Source Aquifer (Figure 3-2) (U.S. EPA, 2012). The Park does not contain any groundwater production or monitoring wells. U.S. EPA defines a sole or principal source aquifer as an aquifer that supplies at least 50% of the drinking water consumed in the area overlying the aquifer.

3.5 Climate

A general pattern of the temperature, wind speed and direction, relative humidity and precipitation for the island of Guam (Table 3-1) can be obtained from the long-term climatic records maintained and compiled by the National Oceanographic and Atmospheric

Administration (NOAA) National Climatic Data Center (2001), and the NOAA Weather Services Meteorological Observatory at Tiyan (former Naval Air Station (NAS) Agana.

Guam enjoys a tropical marine climate with a mean annual temperature of 81.8° F (27.7°C). The mean monthly temperature at Tiyan over a 30-year period (1971-2000) ranged from 80.3° F (26.8° C) in February to 82.9° F (28.3° C) in June. Guam's mean monthly precipitation follows a distinct seasonal pattern, with a dry season from January through June, and a wet season from July through December. Over a 30-year period (1971-2000), the mean monthly precipitation at Tiyan ranged from 2.89 in. (7.34 cm) in March, to 13.64 in. (34.65 cm) in August, with a mean total annual rainfall of 85.34 in. (216.76 cm). The GPH and JPS Back of House site receives approximately 2500 mm (98.5 in.) of rainfall annually, based on a 50-year rainfall database and distribution map by WERI; in contrast, some areas of the island receive over 115 in. annually (Lander and Guard, 2003).

Over a 10-year period (1973-82), the mean monthly relative humidity in the morning ranged from 83 percent (January and February) to 89 percent (July to September); in the afternoon, the relative humidity ranged from 66 percent in March to 77 percent in August. As expected, the higher relative humidity occurred during the wet season. As a result of easterly trade winds, the prevailing wind direction at Tiyan is easterly for most of the year, i.e., April to December, while an east northeasterly wind direction dominates from January to March based on 38 years of observations (1945-1982). At Tiyan, the higher average wind speeds (i.e., 7.4 to 9.4 mph) occurred during the dry season from January through June.

Guam is exposed to frequent tropical cyclones, many of which bring destructive winds and heavy rainfall. Over a 53-year period (1945-1997), a total of 96 tropical storms and typhoons passed within 75 nautical miles of the island; 49 of these tropical cyclones were typhoons (Guard *et al.*, 1999). Tropical storms and typhoons are most prevalent during the wet season, e.g., Super Typhoon Pongsona in December 2002; however, typhoons have also affected the island during the dry season, e.g., Super Typhoon Pamela in May 1976, and Typhoon Dolphin in May 2015.

Table 3-1. Temperature, Wind, Relative Humidity and Precipitation, Tiyan, Guam

Climatic Condition	Month											
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
TEMPERATURE (°F)												
Minimum	75.3	74.7	75.1	76.3	76.9	77.4	76.9	76.6	76.5	76.8	77.0	76.5
Maximum	85.7	85.8	86.4	87.6	88.0	88.3	87.9	87.5	87.6	87.8	87.2	86.4
Median	80.5	80.3	80.8	82.0	82.5	82.9	82.4	82.1	82.1	82.3	82.1	81.5
WIND (mph)												
Avg. Speed	8.6	8.9	8.8	9.4	8.2	7.4	5.8	5.8	5.7	7.0	8.7	9.3
Prevailing Direction	ENE	ENE	ENE	E	E	E	E	E	E	E	E	E
RELATIVE HUMIDITY (%)												
0700	83	83	84	84	86	86	89	89	89	88	88	84
1300	69	67	66	67	70	71	75	77	76	74	75	71
PRECIPITATION (in.)												
Monthly Normals	3.68	3.41	2.89	2.92	5.42	5.78	9.60	13.64	12.16	11.75	8.72	5.37

Observations periods at Tiyan, Guam: Temperature and Precipitation 1971-2000; Wind 1945-82; and Relative Humidity 1973-82.

3.6 Biological Resources

3.6.1 Terrestrial Flora

The vegetation within the Santos Park project area was investigated by biologists from Dueñas, Camacho & Associates, Inc. during field visits in August and September 2015. A pedestrian survey was conducted to characterize the existing vegetation community and identify any species of concern that may require special consideration. Three communities were identified within and adjacent to the project area: Urban Built-up and Open Clearing; Strand; and Scrub Forest.

3.6.1.1 Scrub Forest

Fosberg (1960) describes scrub forest as a secondary vegetation type that may have once been limestone forest but has since had a long history of human disturbance leading to its present condition. Scrub forest is present along the unnamed seasonal creek in the eastern sector of Santos Park (Photo 3-1). The vegetation along the creek comprises coconut (*Cocos nucifera*), binalo or Pacific rosewood (*Thespesia populnea*) and pago (*Talipariti tiliaceum*) trees.

3.6.1.2 Strand

The beach strand is an assemblage of hardy, usually pantropical species that have adapted to tolerate the harsh conditions by the seashore. The strand community occurs along the northern boundary and coastline of the Park, and primarily consists of low-lying alaihai or beach morning glory vines (*Ipomoea pes-caprae*) interspersed with coconut trees.

Photo 3-3. Strand along northern shoreline of project site facing west.

3.6.1.3 Urban Built Up and Open Clearing

The urban built-up and open clearing community characterizes the developed areas of the Park (Photo 3-4). The vegetation comprises a manicured lawn with juvenile to mature specimen trees and shrubs, such as coconut, plumeria (*Plumeria obtusa*), talisai or tropical almond (*Terminalia catappa*), and da'ok or Alexandrian laurel (*Calophyllum inophyllum*) trees.

Photo 3-4. Urban built-up /open clearing community in Santos Park facing south.

3.6.2 Terrestrial and Avian Fauna

3.6.2.1 Methodology

General pedestrian surveys were conducted to assess the presence of terrestrial and avian fauna that may exist within the project sites. The surveys were conducted in September 2015 (Table 3-2). Land survey crews conducting the topographic survey of the project sites were interviewed regarding any incidental observations. Visual observations were conducted with the use of 10 x 40 binoculars, in addition to any audible observations.

The search for mollusks focused on the presence of endemic tree snails, namely *Partula radiolata*, which was listed as endangered under the Endangered Species Act by the U.S. Fish and Wildlife Service in 2015. Survey methods included searching the ground within the site for any shell remains, historic or present. The undersides of leaves of broad-leaved species within the coastal community were also examined.

Table 3-2. Terrestrial and Avian Fauna
Observed within and adjacent to the Piti Site

SPECIES	COMMON NAME	STATUS	ABUNDANCE
REPTILES			
Carlia ailanpalai	Curious skink	I	R
BIRDS			
Passer montanus	Eurasian tree sparrow	I	U
Gallus gallus domesticus	Domestic chicken	I	R
Egretta sacra	Pacific reef-heron	M	R
Key to Status (Guam Department of Agriculture, 1998): I = introduced resident, N = native; E = endemic; M = migratory; V = visitor. Abundance Ratings (all others): Birds (sightings/vocalizations per 8-minute period): R = rare (1 to 2); U = uncommon (3 to 6 per observation); C = common (7 to 10); A = abundant (more than 10). Other fauna (sightings per 1-hr period): R = rare (1-4); U = uncommon (5 to 9); C = common (10 to 19); A = abundant (20 or more).			

3.6.2.2 Mollusks

No native tree snails of the *Partulidae* family were observed on the few trees in the Tepungan site and vicinity. These included coconut (*Cocos nucifera*) and binalo or Pacific rosewood (*Thespesia populnea*) trees, which are among the known host plants for native tree snails.

3.6.2.3 Amphibians

The amphibian fauna of Guam is non-native, and includes naturalized species such as the marine toad (*Rhinella marina* or *Bufo marinus*) and eastern dwarf tree frog (*Littoria fallax*), and recently established species such as the greenhouse frog (*Eleutherodactylus planifostris*) (Christy et al., 2007). No toads or frogs were observed in the vicinity of the Tepungan project site during the 2015 pedestrian surveys; however, marine toads are likely to occur in or near the intermittent stream and Masso River.

3.6.2.4 Reptiles

The introduced curious or four-toed skink (*Carlia ailanpalai*) was the only reptile observed during 2015 pedestrian surveys. Skinks were noted in the leaf litter adjacent to the intermittent stream in the eastern sector of the Park.

3.6.2.5 Birds

Eurasian tree sparrows (*Passer montanus*) and stray chickens were observed in Santos Park during 2015 pedestrian surveys. A Pacific reef heron (*Egretta sacra*), gray phase, was observed foraging over the Tepungan reef flat.

3.6.2.6 Mammals

A stray dog (*Canis lupus familiaris*) strolling through the Park was the only mammal observed during pedestrian surveys at the Tepungan site. Feral ungulates, such as pigs and deer, are not present or expected in the property given the level of development and regular human presence in the area.

3.6.3 Marine Community

3.6.3.1 Methodology

The cable landing route was surveyed by Kerr and Burdick (2016) in November 2015 along a 10 m corridor from the Tepungan Channel mouth towards shore using belt transects and photo transects to assess bottom substrate, algae, sessile organisms, mobile invertebrates, fishes, and reef-building corals (Appendix A). Since this survey, there has been realignment of the route to consolidate the cables into a smaller footprint. The survey area either overlaps portions or is within 35 m of the consolidated route, and would have the same general findings and community descriptions.

Benthic cover estimates were derived from a point-count analysis of images captured along a series of 50 m photo transects. Coral species were also recorded within an area extending 5 m from each side of the transect. Benthic cover data was not obtained for the final 100 m of the route because of the shallow depth. All fishes within 5 meters of the transect line (10 m x 50 m belt transect) were recorded to species. The survey recorded all mobile invertebrate species (exceeding 5 cm maximal dimension) within 3 meters of the transect (6 m x 10 m belt transect), and made counts of invertebrates within 1 meter of the transect (2 m x 50 m belt transect).

Starting from the channel mouth, the survey covered the zones described as 1) seaward slope (0 to 225 m); 2) west margin and slope of the channel (225 to 480 m); 3) channel bottom in central sector (480 to 650 m); and 4) channel bottom in southern sector (towards shore) (650 to 850 m). The seaward slope and west margin and slope zones comprised mostly hardbottom substrate, while the central and southern sectors towards shore were characterized as mostly unconsolidated sediment.

Additional surveys were performed in January and April 2016 within the 36-foot wide construction corridor of the reef flat to quantitatively assess the species composition, population density and size distribution of hard corals (Scleractinia, Milliporina, *Heliopora*, and Stylasteridae) in the survey area. The area several meters beyond the corridor was also canvassed for rare coral species.

3.6.3.2 Corals

The benthic habitat in the channel was previously mapped as pavement turf (50% to 90% cover) near shore, uncolonized sand (90% to 100% cover) in the channel, and aggregate coral reef (10% to 50% cover) along the seaward slope at the channel mouth (Burdick, 2005) (Figure 3-3). Based on the recent marine surveys, coral cover was generally low overall, ranging from 3-4%, with the highest cover occurring at the seaward slope and declining to less than 2% with the approach towards shore (Kerr and Burdick, 2016).

The seaward slope from the mouth of the channel to a distance of 225 m towards shore comprised high-relief hard bottom with 13.4% coral cover, and had the highest cover among the zones in the survey (Table 3-4). Coral cover was 1.6% along the west margin and slope of the channel, and less than one percent along the central sector (0.2%) and southern sector (0.9%) of the channel.

The marine survey recorded 68 species of hard corals, including Scleractinian, *Millepora* and *Heliopora* species, with diversity spanning 13 families (Table 3-3). Since the total species count includes taxa that were identified to genus but not confidently to species level, unidentified conspecifics were conservatively lumped into a single category; therefore, the total number of species may be higher (Kerr and Burdick, 2016).

The additional survey of the shallow, intertidal reef flat recorded seven species of hard scleractinian corals, all of which are common species that are found in similar environments around Guam and the tropical western Pacific (Kerr and Burdick 2016). Of these, *Pocillopora damicornis* (cauliflower coral) and *Leptastrea purpurea* (crust coral) dominated the survey area, nearly always as widely scattered, very small and young colonies, often of fingernail-size proportions (5-7 cm^2). As observed by Kerr and Burdick (2016), the shallow depth and high rate of sedimentation appears to have resulted in very low coral cover. The remaining corals were occurred at much lower densities of between 1 and 7 colonies per 100 sq. m: *Acropora* cf. *pulchra*, *Goniastrea retiformis*, *Leptoria phrygia*, *Pocillopora* cf. *verrucosa*, and *Porites* sp(p). (Kerr and Burdick 2016). The survey report mapped 21 non-*Leptastrea* corals within the construction corridor, and 21 additional small colonies of primarily *Pocillopora damicornis* between 5-15-cm with approximate locations (Kerr and Burdick 2016). These 21 colonies are included in the total 42 non-*Leptastrea* colonies that are present within the construction corridor. The seaward face of the reef margin contained moderately sized *Porites* spp. colonies, *Pocillopora damicornis* colonies, as well as multiple, clustered colonies of the alcyoniid soft coral, *Sinularia* sp. (approximately 2 m x 1 m) (Kerr and Burdick 2016).

Table 3-3. Coral Species Observed during Marine Survey (Kerr and Burdick, 2016)

FAMILY/SPECIES	FAMILY/SPECIES	FAMILY/SPECIES
ACROPORIDAE	**EUPHYLLIDAE**	**MILLEPORIDAE**
Acropora abrotanoides	*Euphyllia cf. cristata*	*Millepora platyphylla*
Acropora cf. quelchi	*Euphyllia glabrescens*	**OCULINDAE**
Acropora globiceps	**FUNGIIDAE**	*Galaxaea fasicularis*
Acropora latistella	*Fungia fungites*	**POCILLOPORIDAE**
Acropora microclados	**HELIOPORIDAE**	*Pocillopora damicornis*
Acropora spp.	*Heliopora coerulea*	*Pocillopora meandrina*
Acropora surculosa	**Incertae sedis (formerly**	*Pocillopora setchelli*
Acropora tenuis	**FAVIIDAE)**	*Pocillopora spp.*
Acropora verweyi	*Leptastrea pupurea*	*Pocillopora verrucosa*
Acropora wardii	**LOBOPHYLLIDAE**	*Stylocoeniella armata*
Astreopora listeri	*Lobophyllia* cf. *flabelliformis*	**PORITIDAE**
Astreopora myriophtalma	**MERULINIDAE**	*Goniopora* cf. *tenuidens*
Astreopora randalli	*Astrea curta*	*Porites* cf. *myrmidonensis*
Montipora cf. tuberculosa	*Cyphastrea agassizi*	*Porites deformis*
Montipora grisea	*Cyphastrea* cf. *ocellina*	*Porites lobata*
Montipora hoffmeisteri	*Cyphastrea chalcidicum*	*Porites lutea*
Montipora spp.	*Cyphastrea serailia*	*Porites murrayensis*
Montipora verrucosa	*Dipsastreae favus*	*Porites rus*
AGARICIIDAE	*Dipsastraea matthaii*	*Porites* spp.
Gardineroseris planulata	*Dipsastraea pallida*	**SIDERASTREIDAE**
Pachyseris speciosa	*Dipsastraea* spp.	*Psammocora contigua*
Pavona chiriquiensis	*Favites magnistellata*	*Psammocora haimeana/*
Pavona divaricata	*Goniastrea edwardsi*	*Profundacella*
Pavona duerdeni	*Goniastrea pectinata*	*Psammocora superficiales*
Pavona sp. “contorta”	*Goniastrea retiformis*	
DIPLOASTREIDAE	*Goniastrea stelligera*	
Diploastrea heliopora	*Hynophora microconos*	
	Leptoria phrygia	
	Platygyra daedalea	

Note: “sp.” indicates a species unidentifiable to species level in the field. “cf.” indicates the species may be the one indicated.

Table 3-4 Percent Benthic Cover along Marine Survey Route (Kerr & Burdick, 2016)

Zone Distance Major Structure	Seaward Slope 0 to 225 m Hardbottom	Channel side-West 225 to 480 m Hardbottom	Channel bottom-Center 480 to 650 m Unconsolidated sediment	Channel bottom-South 650 to 850 m Unconsolidated sediment
Hardbottom cover				
Coral	13.4	1.6	0.2	0.9
Crustose coralline algae	26.2	28.4	0.5	2.1
Fleshy macroalgae	13.5	32.0	14.2	4.8
Turf algae	19.8	25.5	17.5	13.3
Branching coralline algae	6.3	6.7	0.0	1.6
Cyanobacteria	12.4	0.1	0.2	2.0
Soft coral	0.1	0.1	0.0	0.4
Sponges	0.0	0.1	0.0	0.4
Unconsolidated sediment				
Rubble	0.0	1.6	28.0	24.9
Sand	4.9	1.8	38.6	49.1

3.6.3.3 Fish

The survey recorded 90 species of fish observed within 5 m of the transects, and spanning 25 families (Table 3-5). The diversity was highest (78 species) along the outer reef slope, which is characterized by a complex topographic relief and variety of bottom types (Kerr and Burdick, 2016). Although this habitat type can harbor a large number of planktivorous fishes, the survey recorded few such species, apparently because of a lack of notable upwelling; instead, the survey primarily found members of Chaetodonidae (butterflyfish) and Acanthuridae (surgeonfish, tangs, and unicornfish) (Kerr and Burdick, 2016).

The survey recorded a few species from the Mullidae (goatfish) and Lethrinidae (emperorfish and breams) families in the central sector (deeper portion with sandy bottom), and an unidentified member of the Blenniidae (blennies) in the southern sector (shoreward intertidal bench). No large schools of food fishes were observed, presumably as a result of past, and potentially current, pressure from spearfishing within the MPA (Kerr and Burdick, 2016).

Table 3-5. Fish Species Observed during Marine Survey (Kerr and Burdick, 2016)

FAMILY/SPECIES	FAMILY/SPECIES	FAMILY/SPECIES
ACANTHURIDAE	**EPHIPIDAE**	**MALACANTHIDAE**
Acanthurus lineatus	*Platax orbicularis*	Malacanthus latovittatus
Acanthurus nigricans	**FISTULARIIDAE**	**MULLIDAE**
Acanthurus olivacerous	*Fistularia commersonii*	*Parupeneus barberinus*
Acanthurus triostegus	**GOBIIDAE**	*Parupeneus multifasciatus*
Ctenochaetus striatus	*Oplopomus oplopomus*	*Parupeneus cyclostomus*
Naso literatus	**HOLOCENTRIDAE**	**NEMIPTERIDAE**
Naso unicornis	*Myripristis berndti*	*Scolopsis lineata*
Naso vlamingii	*Myripristis* sp.	**OSTRACIIDAE**
Zebrasoma scopas	*Neoniphon* sp. cf. *sammara*	*Ostracion cubicus*
APOGONIDAE	**LABRIDAE**	**PINGUIPEDIDAE**
Apogon sp.	*Calotomus carolinus*	*Parapercis clathrata*
BALISTIDAE	*Cheilinus trilobatus*	**POMACANTHIDAE**
Balistapus undulatus	*Chlorurus microrhinos*	*Centropyge flavissima*
Melichthys vidua	*Chlororus sordidus*	**POMACENTRIDAE**
Sufflamen chrysoptera	*Epibulus insidator*	*Abudefduf sexfasciatus*
BLENNIIDAE	Cf. *Coris* sp.	*Abudefduf vaigiensis*
gen. sp.	*Halichoeres hortulanus*	*Amblyglyphidodon curacao*
Meiacanthus atrodorsalis	*Halichoeres trimaculatus*	*Chromis alpha*
CHAETODONTIDAE	*Hemigymnus fasciatus*	*Chromis* sp.
Chaetodon auriga	*Hemigymnus melapterus*	*Chromis ternatensis*
Chaetodon citrinellus	*Labroides dimidiatus*	*Chromis viridis*
Chaetodon lunulatus	*Macropharyngodon*	*Chrysiptera brownriggii*
Chaetodon melannotus	*melagris*	*Chrystiptera* sp.
Chaetodon mertensii	*Oxycheilinus unifasciatus*	*Dascyllus aruanus*
Chaetodon ornatissimus	*Scarus altipinnis*	gen. sp.
Chaetodon reticulatus	*Scarus globiceps*	*Neopomacentrus violascens*
Chaetodon unimaculatus	*Scarus rubroviolaceus*	*Plectroglyphidodon*
Forcipiger flavissimus	*Scarus schlegeli*	*johnstonianus*
Hemitaurichthys polylepis	*Stethojulis bandanensis*	*Plectroglyphidodon lacrymatus*
Heniochus chrysostomus	*Thallassoma lutescens*	*Pomacentrus vaiuli*
Heniochus monoceros	*Thallassoma purpureum*	*Stegastes lividus*
Heniochus varius	**LETHRINIDAE**	**SERRANDIDAE**
CIRRHITIDAE	*Lethrinus harak*	*Epinephelus* sp.
Paracirrhites arcatus	**LUTJANIDAE**	**TETRAODONTIDAE**
ELEOTRIDAE	*Lutjanus fulvus*	*Arothron melagris*
Ptereleotris heteroptera	*Macolor macularis*	*Canthigaster solandri*
	Macolor niger	**ZANCLIDAE**
	Monotaxis grandoculis	*Zanclus cornutus*

Note: "sp." indicates a species unidentifiable to species level in the field. "cf." indicates the species may be the one indicated.

3.6.3.4 Mobile Macroinvertebrates

A total of 35 mobile invertebrate species were recorded during the survey, spanning 8 taxonomic Orders or Classes (Table 3-6). The highest diversity was among members of Echinodermata, which were observed in the following classes: Asteroidea (3 species), Echinoidea (2 species), and Holothuroidea (13 species). The next most common group were the Mollusca, which included the following classes: Bivalvia (1 species) and Gastropoda (13 species). The survey found these as either burrowing, sand-inhabiting predatory members of Conidae (cone shells) or Naticidae (moon shells), or as cryptic but visible members of Cypraeidae (cowries) (Kerr and Burdick, 2016). Many specimens of the tropical oyster *Saccostrea* sp. were observed on the reef flat, and may thrive here because of its tolerance of the freshwater seepage in this area (Kerr and Burdick, 2016).

Table 3-6. Conspicuous Invertebrates Observed during Marine Survey (Kerr and Burdick, 2016)

CLASS/ORDER & SPECIES	CLASS/ORDER & SPECIES	CLASS/ORDER & SPECIES
ALCYONACEA	**ECHINOIDEA**	**HOLOTHUROIDEA**
cf. *Clavularia* sp.	*Echinostrephus aciculatus*	*Actinopyga echinites*
Lobophyton sp.	*Metalia dicrana*	*Actinopyga mauritiana*
Sarcophyton sp.	**GASTROPODA**	*Bohadschia argus*
Sinularia sp.	*Conus pulicarius*	*Holothuria atra*
ASTEROIDEA	*Conus* sp.	*Holothuria edulis*
Acanthaster planci	*Cypraea moneta*	*Holothuria whitmaei*
Linckia laevigata	*Cypraea pustulosa*	*Stichopus chloronotus*
Linckia multiora	*Cypraea vitellus*	*Thelenota ananas*
BIVALVIA	gen. sp.	
Saccostrea sp.	*Lambis lambis*	
DECAPODA	*Lambis scorpius*	
Calcinus sp.	*Phyllidia* sp.	
Callianassidae sp.	*Polinices* sp.	
Thalamita sp.	*Strombus gibberulus*	
DEMOSPONGIAE	*Tectus niloticus*	
gen. sp.	*Vasum* sp.	

Note: Conspicuous invertebrates are greater than 5 cm maximal dimension. "sp." indicates a species unidentifiable to species level in the field. "cf." indicates the species may be the one indicated.

3.6.4 Sensitive, Threatened and Endangered Species

Species of Greatest Conservation Need. The *Guam Comprehensive Wildlife Conservation Strategy* (GCWCS) was prepared by the Guam Department of Agriculture and approved by the USFWS in February 2007. A total of 65 species and 20 groups in the Strategy were recommended as Species of Greatest Conservation Need (SOGCN) (Guam Department of

Agriculture, 2006). These include 14 marine mammals, 11 groups of marine fish, hard and soft corals, and 2 species of turtles (Table 3-4). Hard and soft corals and nine of the fish groups were observed at the project site during surveys. Napoleon wrasse and bumphead parrotfish are occasionally seen near the project site, but were not seen during the marine surveys; other species of parrotfish and wrasses were observed in the deeper and steeper portions of the site, indicating the suitability for these two species (Kerr and Burdick, 2016). Green sea turtles were observed during marine surveys of the project area, and appear to frequent the mouth of Tepungan Channel (Kerr and Burdick, 2016). No seagrasses occur within the reef flat or channel at the project site; these marine plants occur near shore to the east in Piti Bay (see Figure 3-3).

Table 3-7. Marine Species of Greatest Conservation Need
(Guam Department of Agriculture, 2006)

Mammals	Birds	Fish
Bryde's Whale Sei Whale Humback Whale Cuvier's Beaked Whale Sperm Whale Dwarf Sperm Whale Pygmy Sperm Whale Melonheaded Whale Killer Whale Shortfinned Pilot Whale Risso's Dolphin Spinner Dolphin Striped Dolphin Dugong, Dugong dugon	White-tailed tropic bird Pacific reef heron* Brown booby Migratory Shore birds	Napolean Wrasse, *Cheilinus undulatus** Bumphead parrotfish, *Bolbometopon muricatum** Surgeonfish, Acanthuridae* Parrotfish, Scaridae* Emperors, Lethrinidae* Groupers, Serranidae* Rabbitfish, Siganidae Snappers, Lutjanidae* Goatfish, Mullidae* Butterflyfish, Chaetodontidae* Angelfish, Pomacanthidae* Wrasse, Labridae* Trevallies, Carangidae
Marine Plants	Other Marine Fauna	Reptiles
Sea grass, *Halodule uninervis* Sea grass, *Enhalus acoroides* Sea grass, *Halophila minor*	Giant Clam, *Tridacna maxima* Giant Clam, *Tridacna derasa* Triton's Trumpet, *Charonia tritonis* Spiny Lobster, *Paniluris sp.* Hard Coral, *Scaleractinia** Soft Coral*	Green Sea Turtle, *Chelonia mydas** Hawksbill turtle, *Eretmochelys imbricata*

*Observed during surveys or known to occur at project site (Kerr and Burdick, 2016).

Migratory Birds. The only species listed as protected species under the Migratory Bird Treaty Act (MBTA) (50 CFR Part 10.13) that was observed in the project vicinity was the Pacific reef heron (*Egretta sacra*).

Guam Threatened and Endangered Species. Thirty-one species, i.e., 11 birds, three mammals, ten reptiles, four mollusks, and three plants, are listed as endangered by the Guam Department of Agriculture under the Endangered Species Act (ESA) of Guam (5 GCA, Section 63205(c)). The Guam tree snail (*Partula radiolata*), the humped tree snail (*Partula gibba*) and the fragile tree snail (*Samoana fragilis*) or akaleha' are listed as endangered under the Guam ESA, but were not encountered during the pedestrian surveys of project corridor.

Federal Threatened and Endangered Species. The U.S. Endangered Species Act (ESA) (16 U.S.C. 1531-1544) of 1973, as amended, prohibits the taking of any listed species without prior approval of the Secretary of the Interior. The USFWS previously listed 11 species under the Act as either threatened or endangered for Guam, i.e., two mammals (little Mariana fruit bat and Mariana fruit bat); six birds (Mariana swiftlet), Mariana crow, Guam Micronesian kingfisher, Mariana common moorhen, Guam rail and Guam bridled white-eye; two reptiles (green sea turtle and hawksbill sea turtle; and one plant (hayun lagu). There is the slight possibility of the Marianas fruit bat to be foraging near the site over the riparian forest of the Masso River; however, the most recent counts indicate that fewer than 50 bats remain in Guam (USFWS, 2012a). The proposed project would not disturb riparian habitat associated with the Masso River.

The Mariana common moorhen (*Gallinula chloropus guami*) is a waterbird species that is found primarily at freshwater wetlands and occasionally in brackish water wetlands. According to the U.S. Fish & Wildlife Service (2012b), “wetlands that support about equal amounts of emergent, submergent, and/or floating vegetation and open water are more suitable to moorhens for feeding, nesting, and loafing than wetlands that are predominately open water or that support mostly emergent wetland vegetation.” Moorhen were not observed in the intermittent creek during pedestrian surveys. The narrow creek is shallow and does not contain emergent, submergent or floating vegetation, but primarily discharges stormwater from upland areas via a culvert beneath Route 1; therefore, it is not considered preferred moorhen habitat.

The USFWS rule in October 2015 (80 FR 59424) listed 16 animal species from the Mariana Islands as endangered, and seven plants as threatened under the Endangered Species Act (ESA). Among the newly listed animal species are the tree snails protected under the Guam ESA. None of these recently listed species were found in the project area.

Effective October 10, 2014, 20 species of corals were listed as threatened under the U.S. Endangered Species Act (79 FR 53851). Three of these coral species are known to occur in Guam's waters: *Acropora globiceps, Acropora retusa,* and *Seriatopora aculeata*. The marine survey of the Tepungan reef flat did not find any of the three ESA-listed threatened coral species that are present in Guam's waters (Kerr and Burdick, 2015); however, one of the listed corals, *Acropora globiceps*, occurs in deeper waters at the mouth of the bay. One colony of *A. globiceps* was found to the east of the proposed cable route and will not be disturbed. Additional pre-landing surveys will be performed to confirm there are no other colonies in the path of the bundled cables. Impacts to *A. globiceps* will be avoided by pre-marking the final route prior to the cable landing.

Essential Fish Habitat. Essential fish habitat (EFH) is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (MSA § 3(10)). "Waters" include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle. The waters of Piti Bay and Tepungan Channel are within the EFH designated for Guam.

3.6.5 Critical Habitat

In November 2004, the USFWS designated critical habitat for three endangered Mariana Island species on Guam: the Mariana fruit bat, Mariana crow, and Guam Micronesian kingfisher (69 FR 62943). The habitat totals 376 acres, all within the U.S. Fish and Wildlife Service's 771-acre Ritidian unit of the Guam National Wildlife Refuge. The Refuge provides habitat for the threatened Mariana fruit bat, and endangered Mariana crow and *Serianthes nelsonii* tree. The remainder of the Refuge comprises an overlay refuge of 22,456 acres of federal land administered by the U.S. Navy and U.S. Air Force (USFWS, 2005). The Tepungan site is located over 10 miles southwest of the Navy's refuge overlay lands at Finegayan, and over 15 miles southwest of the Ritidian unit. The project site is not within any of the designated Refuge Overlays or critical habitat.

3.7 Cultural Resources

Micronesian Archaeological Research Services, Inc. (MARS) prepared an Archaeological Monitoring, Identification, Evaluation, and Data Recovery Plan for the proposed cable raceway in Lot 262 (Santos Park) and Lot 5NEW-1, Block 2 (GTA Cable Landing Station) (Moore, 2016). The Area of Potential Effect (APE) in the Plan covers the cable trench on the reef flat to the beach manhole and ocean ground bed in Santos Park (see Figure 2-1), and the connecting cable trench that leads to the GTA Cable Landing Station south of the Park on the opposite side of Marine Corps Drive. Previous archaeological testing using six backhoe trenches along Masso River in the west sector of the Park found culturally sterile layers of beach sand, exposed disturbed wet clays and introduced fill (Moore and Amesbury, 2013). In the eastern sector of the Park, 12 backhoe trenches dug for an archaeological testing program found no significant historic properties (Moore and Amesbury, 2009). The APE for the project does not encompass any historic resources listed on either the Guam Register of Historic Places (GRHP) or the National Register of Historic Places (NRHP). Based on the findings of previous archaeological surveys in the Park and vicinity, the landing and connecting trench are not expected to encounter significant historic properties in Santos Park (Moore, 2016). There is a possibility of encountering buried intact cultural deposits on the seaward side of Lot 5NEW-1, Block 2 between the GTA Cable Landing Station and Marine Corps Drive, and that remnants of the old Spanish Road through this sector Piti Village may be encountered in the connecting trench (Moore, 2016).

3.8 Access Road and Traffic

Marine Corps Drive (Route 1), the island's main coastal highway, provides access to the project site via frontage along the southern boundary of Lot 262. The access is a paved driveway from Route 1 that leads to a gravel-paved parking area in the eastern sector of Santos Park. In the vicinity of the Park, Route 1 has five asphalt-paved travel lanes within a 100-foot wide right-of-way. Route 1 leads south of Lot 262 to a signalized intersection with Route 11, which provides access to the GPA power facilities, Cabras Island, and the Commercial Port of Guam.

3.9 Utilities

3.9.1 Potable Water

Guam Waterworks Authority (GWA) provides potable water from groundwater and surface water sources to the Northern, Central and Southern Public Water Systems (PWS) on Guam (GWA, 2006). Some water also comes from the U.S. Navy to serve the Central and Southern PWS. The 100-foot wide Marine Corps Drive right-of-way contains two potable water lines, i.e., an 18-inch diameter Navy water line on the inland side, and a smaller 14-inch diameter water line GWA on the Park side. The GWA water line supplies the restroom facilities in the Park through a small lateral line, and will be tapped to serve the GTA Cable Landing Station.

3.9.2 Sanitary Sewer

There is a 8-inch diameter GWA gravity sewer line within the Marine Corps Drive right-of-way. The gravity line serves the Santos Park restroom facilities, and will be tapped to serve the GTA Cable Landing Station.

3.9.3 Solid Waste

The Layon Landfill in Inarajan is the island's municipal solid waste landfill. Commercial and residential solid waste is collected and hauled to the landfill by the Department of Public Works Solid Waste Division or other commercial solid waste companies on a daily basis, except on Sundays. Construction debris and green waste is accepted at local permitted hardfills.

3.9.4 Electrical Power and Communications

Guam Power Authority's (GPA) Cabras and Piti Power Plants are located approximately 0.25 miles west of the project site. Piti Power Plant is a steam generating station burning No. 6 residual fuel oil, and uses a seawater cooling system that withdraws cooling water from Piti Canal, and discharges the heated water into Piti Channel after it passes through and cools the plant (RW Beck, 2000). Cabras Power Plant has two steam generating (Units 1 and 2) and two slow speed diesel generating (Units 3 and 4) units that all burn No. 6 residual fuel oil; the plant uses the same once-through seawater cooling system process as the Piti Power Plant (RW Beck, 2000). A fire at the Cabras Power Plant on August 31, 2015 damaged Units 3 and 4, and the units remain offline.

In 2001, TyCom installed a cable raceway from Lot 58-1-NEW-1-NEW east of Santos Park to accommodate communication conduits. The raceway leads out to Marine Corps Drive to a manhole on the ocean side of Marine Corps Drive fronting the Park. There is also a GTA communication line in the same road right-of-way.

3.10 Public Services

3.10.1 Law Enforcement and Emergency Services

The Guam Police Department (GPD), the island's municipal law enforcement agency, is headquartered in Tiyan, central Guam. The nearest police station is the Agana Precinct, which is approximately 3 miles north of the site by road via Marine Corps Drive; the main headquarters is in Tiyan approximately 8 miles from the site. The Guam Fire Department (GFD) provides response to fires and medical emergencies. Piti Station No. 7 is the nearest fire station in GFD's Southern District and is approximately 0.3 miles south of the site via Marine Corps Drive.

Guam has three hospitals available to provide treatment for medical emergencies on the island: the Naval Regional Medical Center in Agana Heights, the Guam Memorial Hospital (GMH) in Tamuning, and recently constructed third hospital, the Guam Regional Medical City (GRMC), located in Dededo in northern Guam. NRMC is the closest hospital to the project site, located approximately 3.5 miles northeast of the site. The next closest hospital is GMH, which is located approximately 7 miles to the north, via Marine Corps Drive.

3.11 Land Use

The Official Zoning Map of Guam designates Pedro C. Santos Park as “A” Agriculture or Rural Zone. The adjacent Lot 58-1-NEW-1-1NEW to the east is Zone “C” for Commercial use and accommodates the existing Tata Communications cable raceway. Other commercially-zoned properties are located to the south and southeast (76/Circle K gas station and Seawalker tours). Multi-family “R-2”-zoned properties further east of the Park support a 2-story apartment. Hoover Park to the west of the Park is a military property with no zone designation under the Government of Guam. The Power Plants to the southwest are industrial land uses. Parcels to the south are “R-1”-zoned parcels supporting single-family residential uses within Piti Village.

Santos Park is a village park with two pavilions, a restroom facility, and parking area. Commercial uses are located to the south along the opposite side of Route 1, including the existing GTA substation and proposed cable station site, 76/Circle K Gas Station, and Seawalker Tours, and a two-story residence. The Piti/Cabras Power Plants are a prominent land use to the southwest of the Park. Piti Village is situated south of Santos Park across the Route 1 highway.

Piti Bay is located at the southwestern extent of the Piti Marine Protected Area (MPA), one of five MPA's established in 1997 by Guam Public Law 24-21 (see Figure 1-1). The preserve extends inland from 10 meters (33 feet) above the mean high water mark or to the nearest public right-of-way, and seaward out to the 600-foot depth contour. Within a marine preserve, the taking or altering of aquatic life, living or dead coral, and any resources to include, but not limited to mangroves, seagrass, sand, and rocks, is unlawful except as specifically permitted by the Director of Agriculture through regulations.

The Guam Seashore Reserve includes that land and water extending seaward to the ten fathom contour (including all islands within the Government jurisdiction, except Cabras Island and those villages where residences have been constructed before 1974) and extending inland to the nearest point of either: a) a distance on the horizontal plane of 10 m (32.8 feet) from the mean high water mark; or b) from the mean high water mark to the inland edge of the nearest public right-of-way. The Guam Seashore Protection Commission (GSPC) has jurisdiction over the seashore reserve and any proposed development within the reserve must first be granted a permit from the GSPC.

3.12 Air Quality

Air quality can be considered Fair at the project site. The Tepungan site lies within the 3.5-kilometer radius of the Cabras/Piti Power Plants, which is designated as a non-attainment area for sulfur dioxide by Guam EPA under the National Ambient Air Quality Standards (NAAQS) that covers a 3.5-kilometer (km) (2.2-mile) radius from the respective facility. The NAAQS are U.S. EPA standards for six criteria air pollutants: carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter, and ozone (O_3). A non-attainment designation indicates a certain air region has not met the NAAQS based on ambient air quality monitoring data. Power plants and motor vehicles are sources of sulfur dioxide when they burn sulfur-containing fuels, especially diesel.

Guam Power Authority is charged with controlling the potential impacts of pollutants by switching fuel type consumed by the power plants depending on the wind direction. Under normal conditions, high sulfur content fuel is burned when winds carry the emissions away from the island and over the ocean; low sulfur fuel is used when winds carry emissions inland. Since winds rarely blow from the southwest, the Tepungan site is relatively free from the emissions of the power plants. Vehicular traffic from Route 1 to the south is a minor mobile emissions source.

3.13 Aesthetics

Santos Park is landscaped with various juvenile and mature trees (such as coconut), an open lawn, and a small rain garden adjacent to the main pavilion. These elements contribute to the park's aesthetics.

3.14 Socioeconomic Characteristics

3.14.1 Population and Households

The August 2011 release of information from the *2010 Census for Guam* reported a total island population of 159,358, which represents an increase of 2.9 percent from the previous population of 154,805 reported in the 2000 Census (U.S. Census Bureau, 2011). The Census reported a population of 1,454 in the Piti municipality in 2010; much of the population is concentrated in Piti Village, located south of Santos Park.

Most of the island's population is concentrated in the more developed northern and central regions, which support Guam’s commercial and tourist districts. 2010 Census information on household size indicates the average household size on Guam declined from 3.89 persons among the 38,769 total households in the 2000 Census (U.S. Census Bureau, 2003) to 3.67 persons among the 42,026 households in the 2010 Census (Bureau of Statistics and Plans, 2012).

3.14.2 Income and Employment

In March 2013, the civilian labor force equaled 73,170 persons, with 63,440 persons employed and 9,730 (13.3%) unemployed, based on data from the Guam Department of Labor Bureau of Labor Statistics (Bureau of Statistics and Plans, 2014). The civilian labor force comprises people aged 16 years or older, excluding non-immigrant aliens, military force members and their dependents. The unemployment rate of 13.3% was higher than in recent years, i.e., 11.8% in 2012 and 9.3% in 2009. Census data shows the mean household income in 1999 was $49,617 and the median income was $39,317 among the 38,769 households (U.S. Census Bureau, 2003). In 2010, the mean and median household incomes were $49,263 and $39,052, respectively, according to the Guam Department of Labor (Bureau of Statistics and Plans, 2014).

The major sectors contributing to Guam’s economy are the Federal Government, Government of Guam (GovGuam), Construction, and Tourism (Bank of Hawaii and East-West Center, 2003). The island receives around one million visitors annually, and in 2013 civilian and military arrivals traveling by sea and air reached a total of 1,328,761, based on data collected by the Guam Visitors Bureau (Bureau of Statistics and Plans, 2014). The record number of visitor arrivals occurred in 1997, when 1,381,513 visitors were received on Guam (First Hawaiian Bank, 2006). In September 2011, the total civilian payroll employment on Guam comprised 61,990 employees, with 46,030 (about 75%) in the private sector and 15,960 (about 26%) in the public sector (Bureau of Statistics and Plans, 2012). Over 37%, or 17,320, of the private sector employees worked in service-related jobs. Other major employment areas in the private sector were retail trade (about 29% or 13,610 employees), construction (13% or 5,990 employees), and transportation (around 9% or 4,350 employees). The majority (75%) of public sector employees worked for the Government of Guam, while the remaining 25% were employed by the Federal Government.

The Federal Government (including military bases and civilian workers) accounts for significant revenues to the island; total federal direct expenditures reached $2.012 billion in 2010 (Bureau of Statistics and Plans, 2012). The U.S. Government Accountability Office estimates that the military buildup will cost the Department of Defense (DOD) approximately $7.5 billion in military construction funding from fiscal years 2009-2016, with an additional $6.09 billion in spending by the Government of Japan for infrastructure and facilities (U.S. Government Accountability Office, 2011). The total cost estimate will be distributed among the Department of Defense (DOD) and the Governments of Guam and Japan.

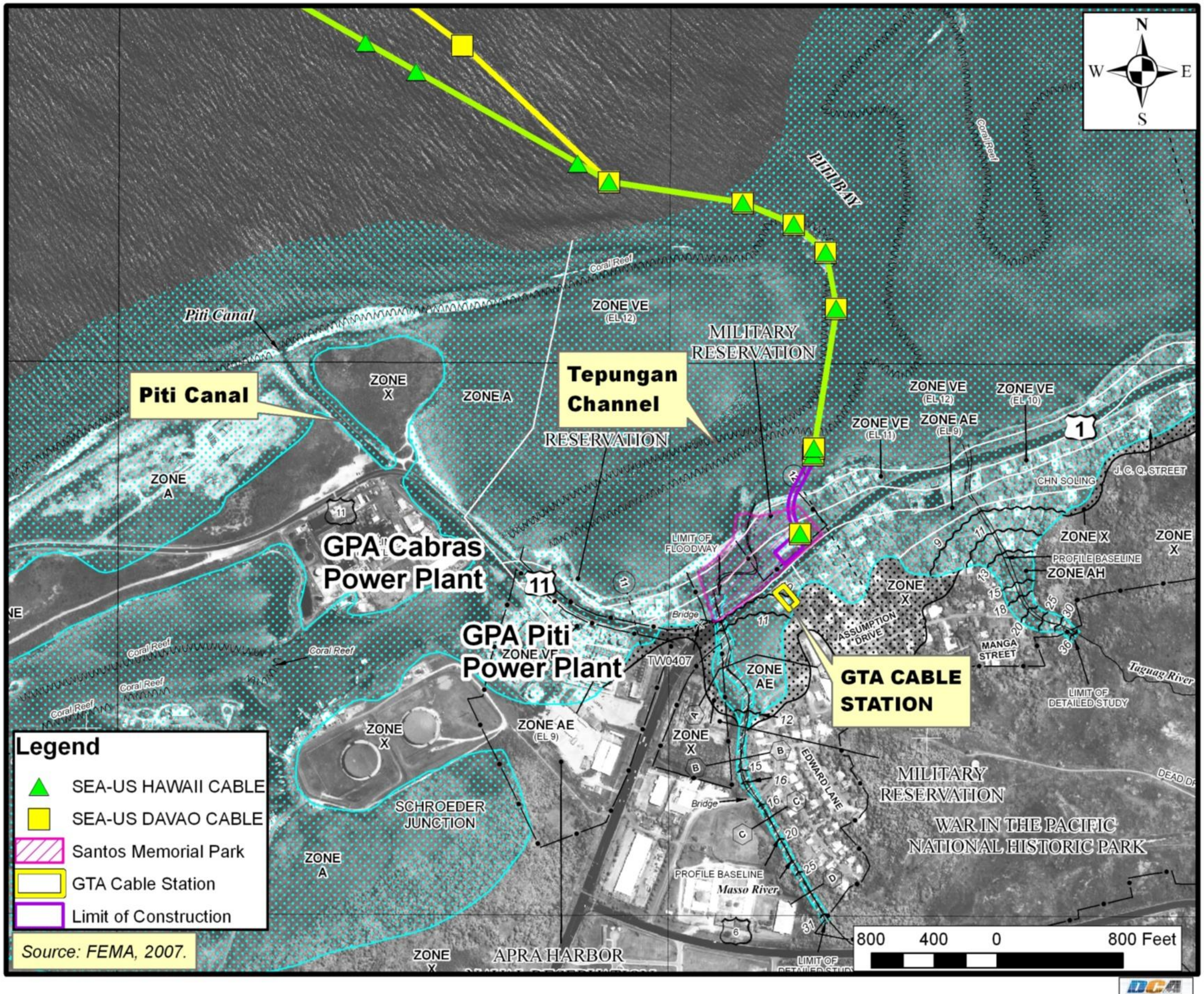

Figure 3-1. Flood hazard map at the project site, Santos Park, Piti (Taken and adapted from FEMA, 2007).

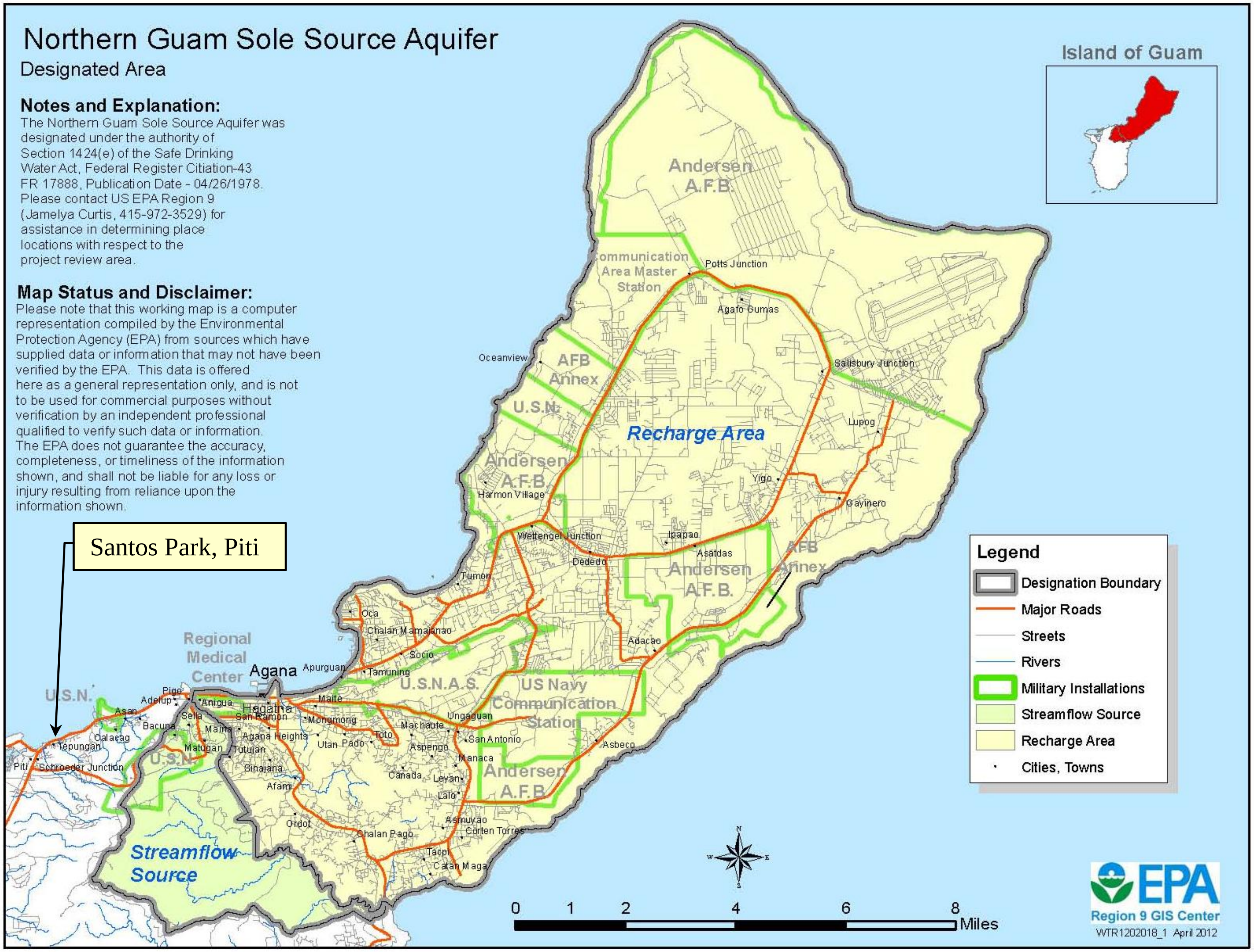

Figure 3-2. Northern Guam Sole Source Aquifer Map (Taken from U.S. EPA, 2012)

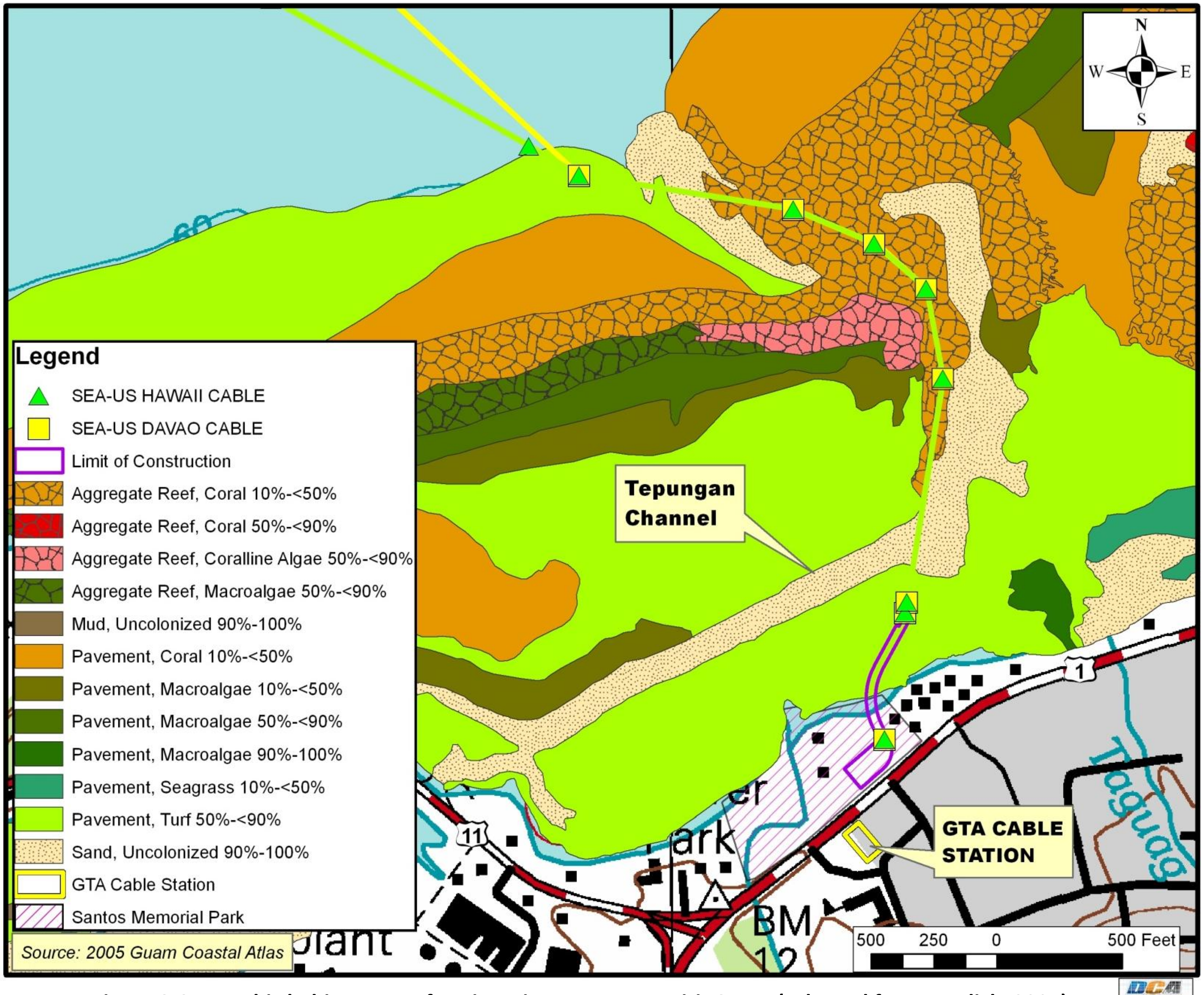

Figure 3-3. Benthic habitat map of project site, Tepungan, Piti, Guam (Adapted from Burdick, 2005).

4 ENVIRONMENTAL CONSEQUENCES

4.1 Topography, Geology, and Soils

No Action Alternative
The No Action Alternative would not involve new construction; hence, it would have no new effects on geology, soils and topography.

Proposed Action Alternative
The project would have temporary impacts to soils since the excavation and fill activities within a 6-foot wide, 404-foot long trench on the reef flat will disturb the rubble and rock substrate, while the excavation of an additional 155 feet from the mean high water mark to the beach manhole would disturb sand and soils. There would be no long-term effects on topography, water levels or soils since the disturbed area will be restored to the same grade as the surrounding area. The soils at the site are not considered prime farmland soil units (Young, 1988).

4.2 Water Resources

No Action Alternative
The No Action Alternative would not involve new construction activities; therefore, this alternative would not have any effects on floodplains, surface or groundwater resources.

Proposed Action Alternative
Surface Water. The Tepungan site was selected for the degraded condition of the reef flat, which is negatively affected by terrigenous deposits from the Masso River and an unnamed intermittent stream. Freshwater inundation affecting salinity on the shallow reef flat also contributes as a non-conducive condition for coral growth. The excavation and fill activities to construct the marine raceway will generate silt and increase turbidity in the shallow marine waters of the reef flat. The additional excavation of 155 feet from MHW mark to the beach manhole will generate dust and sediments from disturbance of the sand and soils. These would be temporary impacts that would be contained by implementation of erosion control devices during construction, including turbidity curtains and sandbags where appropriate. The nearby unnamed intermittent creek will be avoided as the project footprint is outside the channel, and streamflow will not be impeded by the project activities. The project would not generate additional significant stormwater runoff, since the cable raceway would be buried and the site topography restored to the original grade.

There is a potential for fuel and hydraulic fluid to leak from vehicles during construction. These risks would be minimized by daily inspections of the vehicles and hoses prior to starting the job each day, adhering to emergency response plans, and the use of materials to contain and clean up accidental spills. In addition, the tracked excavator that would perform excavation activities would be placed on a raised work platform with a full containment built-into the platform. Should any leaks occur, they would be contained on the platform and addressed with the appropriate spill clean-up kit. As a further safeguard, only non-toxic hydraulic fluid would be used in the equipment so as to minimize impacts on resources in the event of a leak. The installation of a concrete bulkhead at the terminus of the raceway has the potential for cement to leak into the surrounding area. Wooden forms would be used to form the bulkhead and would also serve to contain the material during construction. Turbidity curtains would be installed around the work zone to prevent mixing of the water in the work zone with the surrounding area until the bulkhead has finished curing. A water quality monitoring plan would be implemented during construction to monitor the waters surrounding the construction zone for turbidity, pH and total suspended solids, and ensure these parameters remain within the Guam Water Quality Standards (Guam EPA, 2001). The results of these periodic monitoring events would be reported to Guam EPA in accordance with the approved plan. No excavated material would be stockpiled in marine waters; all material would be taken to a designated upland area for dewatering. The dewatered area would be contained by berms or sand bags to prevent direct migration of runoff to surface fresh or marine waters, and allow for on-site percolation into the sandy substrate.

Floodplains. The project site is within a special flood hazard zone for velocity (wave action) with base flood elevations of 10 and 11 feet (FEMA, 2007). The cable raceway would be buried, hence, the project would not impede floodwaters or cause backwater effects, since the site topography would be restored to the original grade. Embedment of the cables would provide protection from wave action on the shallow reef flat.

Groundwater. The project site would not impact groundwater resources for potable water since it is not located within the recharge area or stream source area of the Northern Guam Sole Source Aquifer, nor does the park contain any groundwater production or monitoring wells.

4.3 Biological Resources

No Action Alternative

The No Action Alternative would not involve new construction. Existing vegetation and fauna would not be disturbed by development.

Proposed Action Alternative

The project would not disturb any of the scrub forest along the intermittent stream in the eastern sector of the park, and the project would not result in the loss of wetlands or waters of the United States. The marine raceway would disturb portions of strand vegetation comprising beach morning glory vines and coconut trees. Very few trees occur within the raceway corridor in the Park, which is mostly a maintained lawn or gravel base course. Trees and vegetated areas will be replanted after completion of the project where the root system will not interfere with the buried facilities. Vegetation will be preserved where possible since it plays an integral role in controlling erosion along the shoreline. While common fauna, such as sinks and sparrows would be temporarily displaced by construction activities, these species are anticipated to return after the site is restored. There would be no long-term impacts on terrestrial biological resources, as the operation of the buried cable raceway is generally considered benign.

The work would proceed in sections along the trench to keep the active construction footprint small. In a concerted effort to minimize effects on benthic habitat, the construction corridor on the reef flat has been reduced from 36 ft to 25 ft wide to avoid corals along the western margin near the terminus of the raceway. This has reduced the number of non-*Leptastrea* corals in the original corridor by 70 percent, from 143 to 42 coral colonies. Sessile invertebrates would be impacted; however, conspicuous sessile organisms, such as sea cucumbers and sea stars, would be manually relocated out of the construction corridor prior to construction. Fish and other motile organisms would be temporarily displaced during construction. The excavation and filling activities along the trench with a tracked excavator will impact numerous encrusting spats of the coral *Leptastrea purpurea* on the reef flat, which are tiny (5-7 cm^2) colonies that are difficult to move; however, since the grade would be restored after installation of the conduits, there is a very good potential for the site be recolonized by *Leptastrea* after construction. A total of 42 mature corals within the work corridor on the reef flat and 14 corals on the adjacent western and seaward channel margin would be relocated to a site with suitable depth and similar species composition, and monitored for a minimum of 18 months. According to Kerr and Burdick (2016), these corals are common species seen elsewhere in similar environments around Guam and the tropical western Pacific.

Prior to the landing of the two 1.61-inch (41 mm) diameter SEA-US cables, the cables will be bundled together to reduce their footprint on the seabed. During the shore landing of the cables, care will be taken to avoid laying the 1.6-inch (41 mm) diameter cables on large coral colonies during the alignment process, especially at the mouth of Tepungan Channel. The cable ship will be held in place at the mouth of the channel by its own thrusters and would not anchor in areas of live corals. Prior to landing the cables, divers will mark the route with least impact to corals, and where the cable would be exposed to the least impact from physical terrain. As they are paid out from the cable ship, the cables will have floats attached, and they will be floated towards the conduits at the bulkhead. The floats will be cut and the cables laid in place by divers. If the cable needs to be repositioned, a stopper would be used to provide slack on the cable and allow manipulation of the cable before its final placement over the substrate. Likewise, the installation of the split pipes around the fiber-optic cables for 200 m (656 ft), and selected pinning of the cables to the substrate at intervals at the channel mouth, will be conducted in such a manner as to minimize damage to live corals along the cable route. A post-construction and cable-laying inspection will be conducted to confirm these measures have been carried out.

The implementation of these and other best management practices would minimize impacts to the existing marine life in Guam's coastal waters. There will be no net loss of wetlands or other waters of the U.S. from the proposed action. No seagrass beds are located within the project site.

4.3.1 Sensitive, Threatened and Endangered Species

No Action Alternative

The No Action Alternative would not involve new construction; hence, it would have no effect on sensitive, threatened or endangered species.

Proposed Action Alternative

There is no designated or proposed critical habitat in the vicinity of the Tepungan site. Based on coordination with Ms. Valerie Brown, National Marine Fisheries green and hawksbill sea turtles are expected to occur within the area, as are spinner dolphins. Green sea turtles (*Chelonia mydas*) and hawksbill sea turtles (*Eretmochelys imbricata*) have an endangered status in Guam's waters. Dolphins are protected under the Marine Mammal Protection Act. Although the park is not a nesting site for sea turtles, green sea turtles apparently forage in the area and were observed at the mouth of the channel during the marine survey (Kerr and Burdick, 2016). Bumphead parrotfish and Napoleon wrasse have been occasionally observed in the area, although not during the marine survey (Kerr and Burdick, 2016).

Work would be performed during low tides and outside of coral spawning periods in July and August. Biological monitoring would be performed during in-water work to detect the presence of listed species, such as sea turtles, dolphins, or migratory birds, that may wander into the work site. If any protected species are observed in the vicinity of the work site, Department of Agriculture would be contacted and work would not commence until the species voluntarily leaves the area. The area contains one coral species, *Acropora globiceps*, that has been federally-listed as threatened. One colony of *A. globiceps* was found to the east of the proposed cable route and will not be disturbed. Additional pre-landing surveys will be performed to confirm there are no other colonies in the path of the bundled cables. Impacts to *A. globiceps* will be avoided by pre-marking the final route prior to the cable landing. Best management practices, such as the installation of turbidity curtains and sandbags, would be implemented throughout the course of in-water construction to minimize the movement of sediment beyond the project area. These include the NMFS Protected Resources Division's BMPS, which are recommended for general in- and near-water work including boat and diver operations to reduce potential adverse effects on protected marine species.

4.4 Public Services

4.4.1 Law Enforcement and Emergency Services

No Action Alternative

The No Action Alternative would not adversely affect law enforcement and emergency services.

Proposed Action Alternative

There would not be any significant effect on or increase in demand for law enforcement, fire protection, or medical care services from the project during or after completion. These services, if needed during construction, are within a reasonably short distance to the site (e.g., 0.3 miles to Piti No. 7 Fire Station).

4.5 Cultural Resources

No Action Alternative

The No Action Alternative would not involve new construction and would not have an effect on cultural or historic resources.

Proposed Action Alternative

Previous archaeological surveys and test pits conducted in the Park by Micronesian Archaeological Research Services (MARS) did not reveal any historic or cultural properties eligible for listing on the Guam or National Registers of Historic Places. Nonetheless, a Monitoring and Discovery Plan has been prepared to address any potential discoveries during construction of the raceway. A qualified archaeologist will monitor construction activities in accordance with this Plan, and work will be halted and the contractor must contact the State Historic Preservation Office (SHPO) should there be any discoveries of historic or cultural resources during construction.

4.6 Access Road and Traffic

No Action Alternative

The No Action Alternative would not have an effect on transportation, traffic and parking.

Proposed Action Alternative

Except for periodic visits by maintenance personnel, the project would not generate any regular traffic after construction is completed.

The construction activities for the marine raceway would take place over an 8-week period within the 36-foot wide corridor. Public access to the reef flat would be restricted during this period for safety reasons. Similarly, vessels would be advised via a Coast Guard Notice to Mariners not to approach the area during the cable landing while the cable ship is offshore.

Public access to Santos Park would be limited during construction and cable landing activities for safety reasons. During construction, this project is expected to have a temporary impact on the traffic patterns along Route 1 (Marine Corps Drive) and potentially Route 11 (Cabras Highway) as materials and equipment are moved in and out of the Park. An encroachment permit would be required to safely accommodate construction access to the Park from Route 1. The permit would include a site specific traffic control plan that will be prepared and submitted to the Department of Public Works and Port Authority of Guam for review and approval. The traffic control plan would be implemented with appropriate lights and/or signage to safely divert motorists and facilitate the movement of vehicles during these construction periods. Construction is scheduled to occur during daylight hours. Motorists would be inconvenienced and may opt to travel on alternate routes or at alternate times of day.

4.7 Utilities

4.7.1 Water and Sanitary Sewer

No Action Alternative

The No Action Alternative would not have an effect on potable water or wastewater infrastructure.

Proposed Action Alternative

The proposed communication raceway would have only an insignificant demand on water supply and minor generation of wastewater during construction. No long-term demand is anticipated on these utilities after construction of the raceway is completed.

4.7.2 Solid Waste

No Action Alternative
The No Action Alternative would not involve new construction or generation of solid waste.

Proposed Action Alternative
Since bedding material is needed to protect the conduits in the trench, a portion of the excavated material from the reef flat would be excess and taken off-site for reuse as cover over solid waste at the Layon Municipal Sanitary Landfill in Inarajan.

The project is not anticipated to generate a significant amount of green waste since much of the existing vegetation is open lawn or gravel, with a few scattered trees. The construction phase may involve small quantities of solvents and fuels; these would be handled in accordance with applicable Guam EPA regulations regarding cleanup of spills. No generation of these materials is anticipated after construction of the communications raceway.

4.7.3 Electrical Power and Communications

No Action Alternative
The No Action Alternative would not require new electrical power connections or demands and would not affect the existing electrical power supply system.

Proposed Action Alternative
The proposed project will require new electrical power connections to serve the cables when they come ashore, but this demand is not expected to have an adverse effect on the existing electrical power supply system. Existing electrical infrastructure is in place to service the project.

The project would have a positive effect by improving the communications network on Guam through an increase in bandwidth to all users of the GTA network. The project footprint would not affect the existing Tata raceway located to the east of the project site..

4.8 Land Use

No Action Alternative
The No Action Alternative would not involve new construction; hence, it would not affect land use.

Proposed Action Alternative
The proposed project is compatible with the existing "A" (Agriculture/Rural) zone designation for Lot 262, and a zone change is not required to accommodate the use of the portion of the park for a communications raceway per coordination with Guam Department of Land Management

(Pers. communication, Frank Taitano, Planning Division, DLM). The buried cable raceway would not interfere with the existing recreational use of the park, nor the surrounding area. These surrounding uses include an idle federal parcel (Hoover Park) and two power generation facilities to the west; a cable raceway and residential (single-family and multi-family apartment) uses to the east; and a mix of single-family residential and commercial uses (76/Circle K Gas Station, GTA CLS, and Seawalker Tours) to the south.

4.9 Noise

No Action Alternative
The No Action Alternative would not change ambient noise levels.

Proposed Action Alternative
During construction, there would be short-term impacts to noise levels from the operation of heavy equipment vehicles over the two-month construction period. These standard vehicles and equipment would operate within OSHA guidelines, and construction workers would wear appropriate ear protectors. The nearest sensitive receptors are a single-family residence and apartment building to the east of the park, and a single-family residence to the south; these would be temporarily inconvenienced by the noise generation caused during construction. Best management practices and working within reasonable hours, however, would minimize noise impacts to occupied residential areas adjacent to the project.

After the construction phase is completed, the buried communications raceway would not contribute significantly to the ambient noise of the area. Temporary noise would occur during the cable landing activities, which would span over a couple of days. The noise would not be significant as no earthmoving would be involved; however, a tracked vehicle may be used to pull the cable towards the beach manhole on shore.

4.10 Air Quality

No Action Alternative
The No Action Alternative would not have an effect on existing air quality.

Proposed Action Alternative

Air quality may be temporarily affected by the generation of dust during construction activities. The project site is located within the sulfur dioxide (SO^2) non-attainment zone surrounding the Cabras and Piti Power Plants. While heavy equipment vehicles and vessels used in the construction activities are potential mobile sources of sulfur dioxide, the construction period would be about a couple of months and would involve only a few vehicles. Per Guam Air Quality Standards, the contractor will be required to operate and maintain construction vehicles per the applicable regulations governing air pollutant emissions. All vehicles used in construction are required to have properly functioning and maintained air emission controls.

4.11 Aesthetics

No Action Alternative
The No Action Alternative would not involve earthmoving or construction and, therefore, would not impact aesthetic resources.

Proposed Action Alternative
During construction, there would be a temporary impact to the view of Tepungan Channel and Santos Park over the two-month construction period in the park and on the reef flat. The project would not permanently obstruct or degrade natural scenic views since the conduits would be buried and the site restored to original contours.

4.12 Socioeconomic Characteristics

No Action Alternative
The No Action Alternative would not involve new construction. No new jobs or economic opportunities would be generated, either in the short or long-term.

Proposed Action Alternative
The construction activity and operation of the cable raceway would not demand a large number of employees; however, long-term and lasting economic impacts and public benefits are anticipated from this project.

Since becoming privatized in 2005, GTA made a clear commitment to build and maintain a world-class communications infrastructure for the island. GTA has been innovative in its approach and has effectively driven market competition for wireless, internet and television services. GTA was the first carrier to offer the iPhone. GTA built the first 100% digital television platform on island along with continuing investment in fiber infrastructure to deliver higher broadband internet speeds.

In 2014, GTA became a consortium member in the South East Asia-US (SEA-US) submarine cable system, which will provide direct connectivity between Indonesia, Philippines, Guam, and Hawaii with California. The added capacity will also support high bandwidth broadband services in other Asia regions, including North Asia, China and Hong Kong, Southeast Asia, and Australia. Guam is truly a strategic gateway for communications between the US and the Asia Pacific rim and GTA plays a critical role in this system. GTA's involvement in the SEA-US submarine cable system will provide island residents with unmatched internet growth opportunities along with data storage, backup services, and business continuity for the business market.

In preparation for the submarine cable system, GTA is building a Cable Landing Station in the Village of Piti to support the network capabilities of SEA-US. network. As part of its community outreach with the Village of Piti, GTA will be providing the Mayor of Piti with complimentary telecom services (telephone, wireless, and high speed internet) along with landscaping and vegetation upkeep of the Pedro Santos Memorial Park over a 25-year period.

4.13 Cumulative Effects

Cumulative effects are the combined, incremental effects of development on the environment. The effects of even minor actions may accumulate over time and result in significant impacts on the environment. The cumulative impacts from the proposed action variants were evaluated in conjunction with effects from other local and federal government past, present and reasonably foreseeable future projects. The region of influence for cumulative impacts on these resources is the island of Guam, although the discussion below focuses on the Asan-Piti watershed encompassing the proposed action.

The installation of cable raceway and landing of one cable in Lot 58-1-NEW-1-1NEW and Tepungan reef flat by TyCom is a past action that is relevant for consideration because of its proximity to the proposed action, although the raceway was installed about 15 years ago. A potential future action is the landing of a cable on Docomo Pacific's proposed ATISA system to link Guam with the main three islands (Saipan, Rota and Tinian) in the Commonwealth of the Northern Mariana Islands (CNMI).

Other past or future actions for consideration in the Asan-Piti watershed include the following identified as restoration (Figure 4-1) and development projects by Kottermair (2012):

Past Actions

- Assumption Rd. Bridge stabilization
- Masso Reservoir restoration and revegetation
- Natural Resources Conservation Service (NRCS) David Flores Streambank Protection
- Masso streambank stabilization
- Pedro Santos Memorial Park Improvement, "Eco-Park"
- Asan River Flood Control Rehabilitation

Future Actions

- General Services Administration (GSA) Building Retrofitting
- Jose L.G. Rios Middle School Retrofitting
- Tepungan Public Park (Fish Eye) Restoration
- J Street Development Slope Stabilization
- Asan River/Limtiaco Court Raingarden
- Stream (Unnamed) Restoration
- Asan Mayor's Office/Community Center
- Adelup Raingarden
- Hanjin Development (residential subdivision)
- JHP Development (residential subdivision)
- Smaller individual lot residential development

Some future actions may be on-going or have already been completed since Kottermair's 2012 report.

TyCom Networks Guam LLC installed the existing cable raceway at Tepungan in 2001 and landed a cable shortly afterwards. There has not been any cable landing activity at the site since then and the remaining spare conduits are idle. When considered with the proposed action and reasonably foreseeable activities for cable landings through these six conduits, the cumulative impact of a new raceway in the proximity of the existing TyCom raceway is the additional disturbance on the reef flat and in Tepungan Channel.

Construction of the raceway would have short-term impacts on air, noise and water quality; however, these impacts would be minimized by best management practices. Therefore, there would be no long-term impacts to these resources after construction is complete. The proposed action would not contribute towards the cumulative impact of sedimentation loading and pollution entering Piti Bay from unsewered land uses and terrigenous sources in the Asan-Piti Watershed (Kottermair, 2012).

Under the proposed action, construction of the raceway would impact the tiny encrusting Leptastrea spats on the reef flat, which are too small and difficult to relocate. This impact would be cumulative with similar past effects on *Leptastrea* during construction of the TyCom raceway. Since the grade would be restored after installation of the conduits, there is a very good potential for the site to be recolonized by *Leptastrea* after construction. Mature corals would be relocated out of the raceway construction corridor into an area in the vicinity where there exist conditions for potentially more luxuriant growth than on the shallow, exposed Tepungan reef flat. Corals were also transplanted for the TyCom raceway to an area in Piti Bay, and monitored for a 14-week period, with 97 percent of the corals surviving.

The placement of GTA's cables in the channel would have a cumulative impact when combined with the past TyCom cable and potential future cables that may be landed. The use of pre-marked routes and careful handling and placement by divers would minimize the effect on corals within the landing corridor. The proposed action would further minimize this impact through the bundling of the two 1.61-inch (41 mm) diameter SEA-US cables prior to landing to minimize their footprint on the seabed. Other cumulative effects would be through the addition of hard substrate that provides support upon which corals and other sessile organisms may settle, such as the existing TyCom cable that has been gradually colonized by corals growing on the split pipe protectors.

Under the proposed action, construction of the raceway would impact the tiny encrusting *Leptastrea* spats on the reef flat, which are too small and difficult to relocate. This impact would be cumulative with similar past effects on *Leptastrea* during construction of the TyCom raceway. Since the grade would be restored after installation of the conduits, there is a very good potential for the site to be recolonized by *Leptastrea* after construction. Other cumulative effects include the emission of greenhouse gases (GHG) during the construction phase of the project, which is temporary and short-term.

TyCom Networks Guam LLC installed the existing cable raceway at Tepungan in 2001 and landed a cable shortly afterwards. There has not been any cable landing activity at the site since then and the remaining spare conduits are idle. There would be cumulative impacts with the placement of GTA's cables in the channel through the addition of hard substrate that provides support upon which corals and other sessile organisms may settle, such as the TyCom cable that has been gradually colonized by corals growing on the split pipe protectors.

The cumulative impact of a new raceway in the proximity of the existing TyCom raceway is additional disturbance on the reef flat and in Tepungan Channel. Aside from being economically efficient, the installation of all six conduits at one time also avoids cumulative construction-related impacts from the individual installation of each conduit as it is needed. The construction on the reef flat would be a short-term event, and once the conduits are installed, they would allow the reef flat to remain undisturbed for all future landings. Two SEA-US cables would be landed immediately following construction of the raceway. Afterwards, four future cables will be landed over a period of time; hence, the impacts would be gradual.

The proposed action would have a long-term cumulative positive socioeconomic effect on the local economy through increased bandwidth and market competition, which is anticipated to lead to unmatched internet growth opportunities along with data storage, backup services, and business continuity for the business market.

With the implementation of best management practices, the proposed cable raceway construction, cable landings and cable system operation in combination with past, present and reasonably foreseeable future projects will have no significant adverse cumulative impact on air quality, noise, topography and soils, water resources, biological resources, cultural resources, land use, electrical and water utilities, and socioeconomic conditions.

4.14 Relationship Between Temporary Use of the Environment and Maintenance and Enhancement of Long-Term Productivity

The temporary use of the environment in the form of construction of the proposed raceway would be associated with non-permanent impacts to air quality, noise, and transportation while providing economic benefits to the local workforce through construction contracts. Long-term benefits include the improvements to the island's communication network, leading to greater efficiency and productivity by all users of the network through the increased bandwidth it would provide.

4.15 Probable Irretrievable and Irreversible Commitments of Resources

The Proposed Action Alternative would consume negligible amounts of fossil fuels and utilize human labor during the two-month construction period for the cable raceway and subsequent landing of cables. The efficient completion of construction would minimize the demand on fossil fuels and human labor resources. Except for those scleractinian corals and conspicuous macroinvertebrates that will be manually relocated prior to construction, sessile organisms within the project corridor would be irreversibly impacted by the construction on the shallow reef flat for the cable raceway.

The use of the Tepungan reef flat and channel is a long-term commitment of marine habitat that can be considered irreversible since it is unlikely that the landed cables will be removed after they have been laid in place and colonized by corals, as has occurred at other cable landing sites in northern Guam.

The use of the public park is a long-term (25-year) commitment of public land resources; however, after construction, there would be little noticeable adverse impact on the park from the buried cable raceway. Instead, there would be long-term public benefits through the maintenance and landscaping of the Park by GTA over the 25-year period of use to support communications utilities.

4.16 Environmental Compliance

4.16.1 Federal Water Pollution Control Act (Clean Water Act), 33 U.S.C. 1251

Section 402 of the Clean Water Act established the National Pollutant Discharge Elimination System (NPDES) program that initially controlled the discharge of pollutants from point sources such as wastewater outfalls. The program has expanded to include the control of stormwater discharges. Under current regulations a NPDES permit would be required for construction activities that disturb more than 1 acre. The Proposed Action Alternative would require the construction operator to submit a Notice of Intent to U.S. EPA and prepare a Stormwater Pollution Prevention Plan (SWPPP). The construction operator would submit a Notice of Termination when permit coverage is no longer needed.

4.16.2 Solid Waste Management and Litter Control Act (51 GCA)

The Guam Solid Waste Management and Litter Control Act give Guam EPA authority to regulate solid waste as well as the transportation, processing, storage, treatment and disposal of hazardous waste. Solvents and other chemicals used during construction would be appropriately stored and disposed according to these regulations. Solid waste and excess excavated material would be transported to an approved hardfill or landfill during construction. No long-term solid waste generation is anticipated after construction activities are completed.

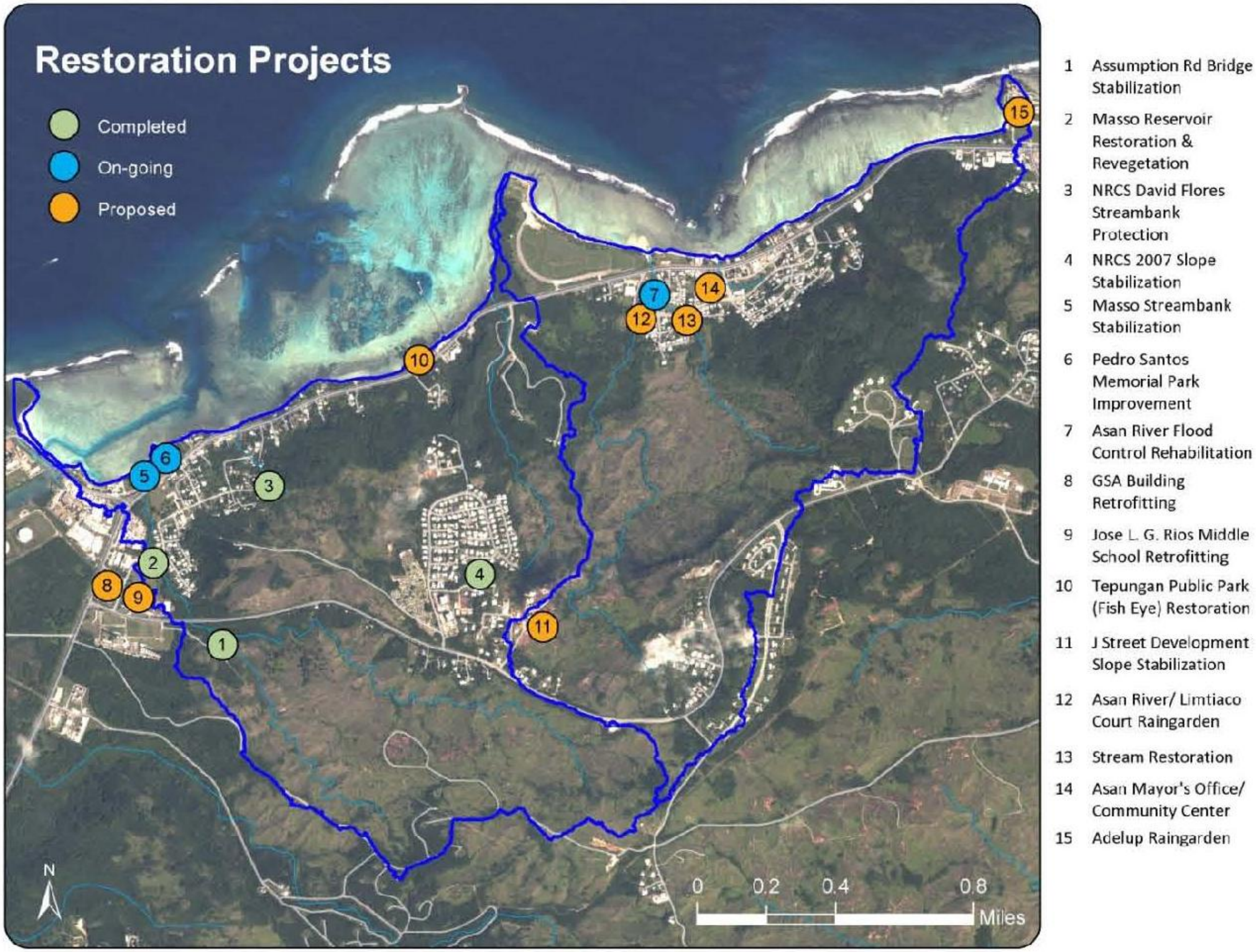

Figure 4-1. Restoration projects within and in the vicinity of the Asan-Piti Watershed (Taken from Kottermair, 2012).

5 REFERENCES

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APPENDIX A

MARINE BIOLOGICAL SURVEY
FOR THE GUAM TELEPHONE AUTHORITY
PROPOSED CABLE LANDINGS, PITI, GUAM
(KERR & BURDICK, 2016)

MARINE BIOLOGICAL SURVEY FOR THE GUAM TELEPHONE AUTHORITY PROPOSED CABLE LANDINGS, PITI, GUAM

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Executive Summary

We performed a quantitative survey of the marine biological communities along three proposed landing routes of fibre-optic cables in Piti, Guam. We used belt transects and photo quadrats to assess bottom substrate, algae, sessile organisms, mobile invertebrates, fishes, and reef-building corals. Particular attention was paid to a search for listed and candidate threatened or endangered species. We surveyed a total distance of 2.7 km of transects along which we considered total search areas from 5,400 m^2 to 27,000 m^2, depending on survey type. Coral cover was highest within the hardbottom seaward slope zone of each of the landing alternatives, at about 13% for the shared seaward slope transects for landing alternatives A and B and approximately 28% for landing alternative C. Crustose coralline algae comprised the largest proportion of benthic cover within the seaward slope zone of each of the landing alternatives, at approximately 26% for landing alternatives A and B, and approximately 30% for landing alternative C. A total of 109 hard coral species, 29 genera, and 13 families were encountered along the three landing alternatives. The total species counts were relatively similar across the landing alternatives, but when normalized by transect length, the number of species per meter of landing alternative C was more than double that of landing alternative A (0.184 compared to 0.072) and nearly three times that of landing alternative B (0.063). A total of 100 species of fishes in 76 genera and 32 families were seen on the belt transects. The most speciose family was the Labridae, with 26 species in 15 genera, followed closely by the Pomacentridae, with 24 species in 10 genera, and then the Acanthuridae of 13 species in four genera. Of mobile invertebrates, a total of 54 species in 40 genera from 11 taxonomic Orders or Classes were seen along the transects. Dominant Classes/Orders included the Echinodermata, with 24 species in 14 genera, nine families and three classes: the Echinoidea, Asteroidea and Holothuroidea. One endangered coral was seen: A total of five *Acropora globiceps* colonies were observed within the vicinity of the proposed landing alternatives, including four colonies within the vicinity of landing alternative C and a single colony within the vicinity of the shared length of landing alternatives A and B. Small green turtles were also seen at the mouth of Tepungan (Piti) Channel. The most toxic and potentially dangerous organism seen was a single specimen of an unidentified member of the Cubozoa on the shallow portion of landing C.

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Introduction

Guam Telephone Authority (GTA) is part of a consortium of interests that is laying an undersea fibre-optic cable network and one of the landing sites will be on Guam. The exact landing site for the proposed cable is still under consideration, but there are three different options, all of which occur in the Piti Marine Protected Area (Fig. 1), approximately 13.469 N, 144.694 E.

Duenas, Camacho & Associates, Inc. (DCA) contracted the authors to perform a quantitative survey of the marine biological communities along the proposed landing routes. This report provides the results of that survey and accompanying recommendations to assist with the permitting and civil design for the intended project. The scope of the surveys included a quantitative survey of the benthic habitat and macro-organisms at the site. Particular attention was paid to a search for listed and candidate threatened or endangered species.

The report below summarises our findings, including a list of recommendations. Due to the high number of figures and tables, it is organised with these elements forming an appendix following the literature cited.

Scope of work

Specifically, the scope of work included the following:

- Qualitative assessment of abundances of the main organisms and the general impression of the health of the marine communities.
- Checklists of the marine plants (macroalgae and sea grasses), hard corals (including non-scleractinian species), invertebrates (the major non-coralline phyla), and fishes.
- Detailed locations of any listed and candidate threatened or endangered species.
- Descriptions of any notable or otherwise unusual species, toxic or dangerous organisms, or especially rare species,
- Recommendations for proceeding given the nature of the marine communities along the proposed landings.

Site description

GTA's preferred site is Cable Landing A, adjacent to an existing cable system that was installed in 2002 by TyCom (Tata Communications). This landing extends approximately 950 m in length when considered from the 20 m depth contour outside the mouth of the channel to shore. The reason for preferring this option is the shore-side infrastructure near Santos Memorial Park, as well as a nearby cable station owned by GTA, which could receive the cable. Further, this option has a minimal bend, which would facilitate the landing. There are two other options. The second (proposed landing B) would go through Tepungan Channel, a cooling water intake for Piti Power Plant, and is about 1400 m in length, beginning at the same point as landing A and paralleling landing A for about the first 600 m before bending and heading west. The third option (landing C) would go through Piti Canal, a supplemental cooling water intake for Piti Power Plant, which from the 20 m depth contour on the reef slope is about 500 m in length. The latter two options are less preferred by GTA due the limited bending ratio of the fibre-optic cable in the case of the channel for option B and frequent heavy-wave action in the case of option C. Starting, intermediate and ending points of these proposed routes guiding our marine surveys are given in Table 1.

Methods

General methods

Surveys were performed during the day and on SCUBA, except the shallow shoreward portion of landing C, which was done on snorkel. Guided by the provided GPS coordinates, we laid 50 metre transect tapes along the proposed cable-landing routes. Their locations were checked and recorded at the surface using a GPS unit. These transects formed the centre alignments for the photo quadrats or belt transects of varying widths (usually 3 to 5 m on either side; see below). Five main types of data were gathered along the transects, the proportion of benthic cover of sessile organisms, cover of algae, the proportion of bottom covered by hard reef framework rock or sediment (as sand or rubble), reef-building corals (including non-scleractinians), fishes, and conspicuous mobile invertebrates. Methods for surveying these organisms varied slightly among them and are given in more detail below.

The goal of the photo quadrats was to assess bottom type (e.g., sand, hard-bottom, etc.) and record sessile organisms, e.g., fleshy algae, calcareous algae, sponges, etc. Benthic cover estimates were derived from a point-count analysis of images captured along a series of 50 meter transects laid across the length of each landing alternative. A total of ten to 11 digital images were captured for each transect, with a single photo taken every five meters along the left side of the transect tape, beginning at the 0-meter mark and ending at the 45-meter or 49-meter mark. The 11th image was captured at the 49-meter mark in order to increase the sample size; these images did not overlap with the first image of subsequent transects. The digital camera was mounted on a PVC pipe in order to maintain a constant sample area. Benthic cover estimates were generated through an analysis of the photo transect images using the Coral Point Count with Excel Extension (CPCe) application. A total of 16 points were overlaid on each image using a random-stratified approach, whereby a single point was randomly placed within each cell of a four by four grid placed over the image. The benthic feature falling under each point was identified.

Sessile organisms

Corals were identified in the photos to species when possible, although some taxa, such as massive *Porites*, *Montipora*, and others, often could not be identified to species level using the photo transect images. Fleshy macroalgae were identified to genus when possible, although the resolution of the images limited the identification of many macroalgae taxa. When identification to genus was not possible, fleshy macroalgae were identified as "fleshy macroalgae –erect" or "fleshy macroalgae –adherent". Other benthic features were classified using broad biological cover types, including turf algae, crustose coralline algae, branching coralline algae (articulated and non-articulated), cyanobacteria, chrysophytes, zooxanthids and corallimorpharians, and sponges (erect and encrusting). Algae identifications generally follow Lobban and Tsuda (2003) and Little and Littler (2003), while sessile invertebrate taxonomy usually follows Paulay (2003).

Substrate

Three additional non-biological benthic classes, including "sand on hard substrate", "sand", and "rubble" were also utilized. "Sand on hard substrate" was used when a point fell on a thin layer of sand covering hard-bottom habitat (e.g., aggregate reef and pavement), while the "sand" class was used when the point fell on unconsolidated sediment that appeared to be more than a few cm thick and which was dominated by sand- and silt-sized particles. The class "rubble" was used when a point fell on unconsolidated rubble, predominately comprised of highly eroded coral skeleton fragments. The "rubble" designation was used even if a point fell on turf algae, macroalgae, or crustose coralline algae colonizing the rubble, and "sand" was used when fleshy macroalgae (e.g, unattached *Padina* spp.) covered the sand. However, in recognition of the importance of assessing the potential impacts to corals by the proposed project, if the point fell on a coral colony growing on a piece of rubble, the coral taxa was attributed to the point. The decision to classify all non-coral biological cover on unconsolidated sediments allowed an assessment of the proportion of the length of each landing alternative comprised by hard bottom versus unconsolidated sediment; such an assessment would not be possible if only biological cover classes were used.

Coral species diversity

In addition to the photo quadrats above, coral species were also observed within an area extending approximately five meters from either side of each transect were recorded. While an attempt was made to record all coral taxa occurring within the vicinity of the transects, it is likely that not all taxa – particularly uncommon or rare cryptic species – were observed and recorded. However, dominant taxa, as well as any Endangered Species Act-listed coral species that occurred in the vicinity of the transects were accounted for. Images were obtained for most species encountered along each transect.

It should be noted that the coral taxonomy used in this report follows recent publications by Budd et al. (2012) and Huang et al. (2014a–b). Notable changes relevant to taxa encountered in our surveys include the incorporation of the former Mussidae genera *Acanthastrea* and *Lobophyllia* into the family Lobophylliidae, the transfer of the monotypic genus *Diploastrea* from Faviidae to Diploastraeidae, the inclusion of all former Faviidae genera into the family Merulinidae, the transfer of *Montastrea curta* to *Astrea*, the transfer of *Favia stelligera* to *Goniastrea*, the transfer of all other *Favia* to *Dipsastraea*, and the transfer of *Montastrea magnistellata* to *Favites*. The results of these studies also indicate that *Leptastrea* likely does not belong in the family Faviidae, and the cited authors have temporary considered its family designation uncertain (*incertae sedis*). For the purposes of this study we consider this genus as residing within its own, unnamed family.

Fish diversity

All fishes seen within 5 m of the transect line, i.e., within a 10-m X 50-m belt transect were recorded to species. Any fishes covered under the Endangered Species Act that occurred in the vicinity of the belt transect were also searched for. Images were obtained for notable or rare species encountered along each transect. Fish identifications follow Myers (1999) and Allen and Erdmann (2012).

Mobile invertebrates

All large (> 5 cm maximal dimension) mobile invertebrates were recorded within 3 m of the transect line, i.e., within a 6-m X 50-m belt transect were recorded to species. In addition, counts were made of all such invertebrates within 1 m of the transect line, i.e., within a 2-m X 50-m belt transect. Since, the surveys were diurnal and we were not tasked with excavating for burrowing animals, we also recorded the empty tests of burrowing echinoids and mollusks. Many small invertebrates are nocturnal and burrowing, hence counts of these were likely vast underestimates. However, the most commonly encountered and important species, such as those potentially harvested for food, were accurately assessed. Interesting species or those that could not be identified to species were photographed or collected for later identification via consultation with taxonomic specialists or with the aid of monographic literature. Mobile invertebrate taxonomy generally follows Paulay (2003).

Results and Discussion

General considerations

We surveyed 2.7 km of transects along which we considered total search areas from 5,400 m^2 to 27,000 m^2, depending on survey type (see Methods). A 136-m portion in the central portion of landing C could not be completed either because some of the distance is non-marine and emergent even at high tide, or because of high surf on the reef front throughout the duration of the field portion of the project. Data for fish and invertebrates along the initial portion of the shared landings A and B was done as a 100-m transect, while all others were evaluated along 50-m lengths.

Benthic cover

Mean benthic cover values, including hardbottom and unconsolidated sediment cover types, for each landing alternative are presented in Table 2. Coral cover was generally low for each alternative, ranging from approximately 3-4% coral cover for landing alternatives A and B to approximately 11% for landing alternative C. However, these low values were significantly influenced by the substantial portion of each of the landing alternatives comprised of uncolonized sand and rubble habitat. In order to better account for the large variability in benthic cover encountered along each landing alternative, and to identify portions of each landing alternative that may possess significant coral cover, benthic cover values are also presented for each distinct reef zone/major habitat type (Tables 3 – 5) occurring within each landing alternative. The change in the mean cover values for key cover types across the length of each landing alternative is visually represented in Figures 2 – 10, with the transition between major reef zones/habitat types (as described in Tables 3 – 5) demarcated by vertical dashed lines. Coral cover was highest within the hardbottom seaward slope zone of each of the landing alternatives, at about 13% for the shared seaward slope transects for landing alternatives A and B and approximately 28% for landing alternative C. Crustose coralline algae comprised the largest proportion of benthic cover within the seaward slope zone of each of the landing alternatives, at approximately 26% for landing alternatives A and B, and approximately 30% for landing alternative C.

The shared portion of landing alternatives A and B extended across approximately 225 meters of the seaward slope, beginning at depth of 20 m, and across a similar length along the west margin and slope of Tepungan Channel. This second major zone, referred to in Tables 3 and 4 as Channel side-West was predominately characterized by high-relief hardbottom. Coral cover was low (< 2%), while the crustose coralline algae, fleshy macroalgae (including both adherent and erect forms), and turf algae each comprised more than 25% cover. The next major zone shared by landing alternatives A and B was the Channel bottom-Center zone, which extended approximately 170 meters across the channel floor. This zone was predominately comprised of unconsolidated sediment (39% sand and 28% rubble), while the hardbottom habitat within this zone (33%) exhibited only 0.2% coral cover. The next zone encountered along landing alternative A, the Channel bottom-South zone, extended approximately 200 m across the base of the southern slope of Tepungan Channel and upslope to the margin of the adjacent reef flat. Like the Channel bottom-Center zone, the substrate of the Channel bottom-South zone was predominantly comprised of unconsolidated sediment (49% sand and 25% rubble), with some hardbottom habitat (25%) and very low coral cover (< 1%).

The remaining length of landing alternative A extended approximately 100 m to shore across a shallow reef flat characterized by low relief pavement. Benthic photo transect images, and thus benthic cover data, could not be obtained for this zone due to the shallow water depth. The shallow depth and the high rate of sedimentation (evidenced by the layer of sediment observed on the substrate and by a plume of highly turbid water directly observed by the authors in the area after heavy rains) appears to have resulted in very low coral cover. This area was examined for corals, and although some corals, including a few small *Porites* and *Leptastrea purpurea* colonies as well as several *Pocillopora damicornis* colonies, were observed near the channel margin, no other coral colonies were observed in the vicinity of the proposed landing that extended shoreward across the reef flat. It is possible that a relatively limited number of small, isolated colonies of *Leptastrea purpurea*, *P. damicornis*, massive *Porites* species, and perhaps a handful of other stress-tolerant coral species may occur elsewhere in this zone.

The final zone of landing alternative B diverged from landing alternative A at the 650 meter mark and extended approximately 750 meters along the bottom of the southern slope of Tepungan Channel. The substrate within this zone was predominately comprised of unconsolidated sediment (37% sand and 51% rubble). A limited amount of hardbottom (12%) with low coral cover (< 1%) was recorded in this zone. However, a significant number of *Acropora* cf. *pulchra* thickets, ranging in size from less than a square meter to more than 5 square meters, were observed in this zone. Isolated, but occasionally large coral colonies, and patches of hardbottom with numerous coral colonies were also observed. The photo transects captured some of these features, and the species present in the vicinity of the transects were recorded during the coral diversity surveys, but for some areas the significant, but patchy coral growth occurring near the transect was not quantified. These features are readily visible in the video files provided with this report.

The area surveyed for landing alternative C spanned two major reef zones, including a 136-meter expanse of seaward reef slope and 250 meters along a shallow, man-made channel.

The seaward slope substrate was comprised entirely of hardbottom, with relatively high cover of hard corals (28%) and crustose coralline algae (30%) and low fleshy macroalgae cover (6%). The quantitative survey of the seaward slope began at a depth of 20 m and terminated near the base of the reef front, at a depth of approximately 5 m. The transects could not be continued into shallower water due to the hazard posed by even moderate surf in this reef zone. While no quantitative data were obtained for depths shallower than 5 m, observations made at a distance indicated that the proposed landing would traverse a channel in the reef front, which lies immediately seaward of the man-made intake channel, and which is separated from it by large boulders. The channel was approximately 6-10 meters wide and 3-5 meters deep, with large boulders, rubble, and sand along the bottom. Few coral colonies were observed along the bottom of the channel, while some encrusting corals, such as *Leptastrea*, *Montipora*, *Leptoria*, and *Goniastrea*, and sturdy, low relief-forms of corals such as *Millepora*, *Pocillopora*, and *Porites* typical of shallow exposed reef environments, were observed along the channel wall and margin.

Surveys of the man-made intake channel began immediately shoreward of the large boulders separating the intake channel from the reef margin and extended 250 meters southward, with the final transect terminating approximately 10 meters from a culvert running beneath Route 11. The substrate in the center of the channel was comprised predominantly of unconsolidated sediment, with the seaward portion dominated by rubble, transitioning to a sand-dominated substrate shoreward. The channel ranged in depth from approximately one meter at the seaward end to approximately four meters. Few corals were observed in the center of the channel, and only a single massive *Porites* colony was detected in the photo transect surveys (between 350 and 400 meters). A significant number of coral colonies, mainly colonies of *Pavona* spp. and *Porites* spp., were observed along the base of the walls and on the walls themselves.

Coral diversity

A total of 109 hard coral species, 29 genera, and 13 families were encountered across the total of 2736 m surveyed for the three landing alternatives (Tables 6 – 7, Figures 11 – 17). The total species count includes taxa that were identified to genus but could not be confidently identified to species level; unidentified conspecifics were conservatively lumped into a single category (e.g., *Montipora* spp.), thus the total number of species actually present within the area surveyed was likely higher than the total presented here, possibly exceeding 130 species. A total of 68 hard coral species (28 genera and 13 families) were encountered across the 950 m length of transects surveyed for landing alternative A, 88 species (28 genera and 13 families) across the 1400 m length of transects surveyed for landing alternative B, and 71 species (23 genera and 10 families) across the 386 m length of transects surveyed for landing alternative C. The total species counts were relatively similar across the landing alternatives, but when normalized by transect length, the number of species per meter of landing alternative C was more than double that of landing alternative A (0.184 compared to 0.072) and nearly three times that of landing alternative B (0.063). It should be noted, however, that a considerable number of species encountered in the vicinity of landing alternative C were found on or near the base of the man-made walls of the intake channel, whereas the bottom of the channel was predominately comprised of uncolonizedsand and rubble.

Fish diversity

A total of 100 species of fishes in 76 genera and 32 families were seen on the belt transects (Table 8; Figs. 18 – 24). The most speciose family was the Labridae, with 26 species in 15 genera, followed closely by the Pomacentridae, with 24 species in 10 genera, and then the Acanthuridae of 13 species in four genera. Several common fishes usually seen on Guam in the surveyed habitats were not seen, such as members of the Pempheridae. In this case, these are nocturnal species and were most likely missed.

The combined portions of landings A and B had the highest species richness, with 78 species. This portion of the reef is characterised by a complex topographic relief and a variety of bottom types, which likely accounted for the high diversity there. This type of outer reef slope habitat can harbour a large number of planktivorous fishes. Very few species of this trophic guild were seen during our survey, apparently because of a lack of notable upwelling. Instead, we recorded species primarily from Chaetodontidae and Acanthuridae, including a single exemplar of *Naso vlamingii*.

The portion of landing A not shared consisted of two types of habitat, a deeper portion with a sandy bottom, and a shoreward intertidal bench. The former habitat had a few species from the families, Mullidae and Lethrinidae, primarily *Lethrinus harak*. The intertidal portion had one unidentified species from the family Blennidae, non *Salarius* sp. The long unshared portion of landing B was primarily of sand and rubble, but with several isolated and large colonies of branching corals, or it lay adjacent to a cut bench. Hence, this area was quite diverse. Fishes dominating here included coral-inhabiting species of the Pomacentridae and Apogonidae. Other dominant forms included Lethrinidae and small members of the Labridae, primarily *Halichoeres* spp and *Coris* spp.

The proposed landing C consisted of two distinct large-scale habitat types for fishes. The first was the steep and surgey reef front with low coral cover. This portion of the route hosted numerous species from the Labridae, Acanthuridae and the Balistidae. The shallower reef-front portion tended to be bare of most cover and consisted of large rubble which hide small members of the Labridae and the Holocentridae. The inner portion of landing C consisted of a protected channel, which we found surprisingly diverse, presumably because of its proximity to a pool of recruits seaward, constant flushing and protection from the high surf blocked by a pile of boulders. Here, small coral colonies had a diversity of Pomacentridae, mostly *Dascyllus aruanus* and young Chaetodontidae.

No large schools of food fishes were seen on any of the cable routes, presumably a result of past, and potentially current, pressure from spearfishing within the MPA. Popular food species of fishes we saw, e.g., *Scarus rubroviolaceous* and *Naso unicornis*, tended to be small and occur as singletons. The largest schools of fishes seen were smaller, but still targeted species, such as *Acanthurus triostegus* and *Chlorurus sordidus*.

Mobile macro-invertebrates

A total of 54 species in 40 genera from 11 taxonomic Orders or Classes were seen along the transect (Table 9; Figs. 25 – 32). Dominant Classes/Orders included the Echinodermata and Mollusca. The most abundant group of mobile invertebrates were the Echinodermata with 24 species in 14 genera, nine families and three classes: the Echinoidea, Asteroidea and Holothuroidea. The Ophiuroidea (brittle stars) are a diverse group of echinoderms found on Guam. Members of this group likely occurred in the area, but they are generally small, cryptic or nocturnal and so were likely missed. The most speciose echinoderms class were the holothuroids with 13 species in six genera, while we only found three species from the Asteroidea. Many of the Echinoidea were burrowing forms, and occurred at high abundance, but were only seen from empty tests in sandy areas, especially the inner portions of landings B and C.

The next most common group of invertebrates were the Mollusca. Most of these were either burrowing, sand-inhabiting predators from the Conidae or Naticidae, or were cryptic, but visible members of Cypraeidae, especially a *C. moneta* X *C. annulata* hybrid. A few specimens of the "giant clam", *Tridacna maxima* were seen along the reef-front section of landing C. However, no large exemplars of this or con-familial species were seen. Along the shoreward-most section of landing A, we saw many specimens of the tropical oyster *Saccostrea* sp., perhaps in abundance there as it tolerates the obvious freshwater seepage in the part of the reef flat.

Other interesting species only rarely encountered on the transects included an unidentified member of the Cubozoa, a very toxic cnidarian.

Recommendations

Threatened or endangered species

A total of five *Acropora globiceps* colonies were observed within the vicinity of the proposed landing alternatives, including four colonies within the vicinity of landing alternative C and a single colony within the vicinity of the shared length of landing alternatives A and B. The location of each of the colonies is depicted in Figure 33 and their GPS coordinates in Table 10. No *Acropora retusa* or *Seriatopora aculeata* colonies were observed.

Additionally, no endangered fishes were seen at any of the sites. *Bolbometopon muricatus* (Bump-head parrotfish) and *Cheilinus undulatus* (Napolean wrasse) are occasionally seen near these areas, but not during our surveys. Had they been recorded, they would have most likely been seen on or near the deeper and steeper portions of all three landing routes. Other large labrids (parrotfishes and wrasses), as well as other large desirable food fishes occurred on these portions of the transects, indicating that this was suitable habitat for the two endangered species.

We did see however, small *Chelonia mydas* (Green sea turtles). This species appear to frequent the mouth of the channel. In only several hours at this site, we noted at least three specimens hovering at the surface. As well, and while not an endangered species, a large *Aetobatus narinari* (Spotted eagle ray) occurred on the deeper end of landings A and B.

Finally, and as noted above, we saw several specimens of the "giant clam", *Tridacna maxima* were seen along the reef-front section of landing C. These specimens attained a maximum width of about 12 cm. However, no large exemplars of this or con-familial species were seen.

Toxic or potentially dangerous species

Most organisms seen on the transects are harmless species. The few toxic species were quite rare. As mentioned above, in the canal portion of landing C, we saw a large and potentially dangerous unidentified species (cf. *Carybdea* sp.) of Cubozoa in the family Carybdeidae. Contact with the tentacles of many members of this group can be painful or lead to life-threatening complications. A single stonefish (Scorpaenidae) was seen in a crevice at the shoreward end of landing B. Several species of cone snail were seen in the sandy portions of all landings, but the species seen were all of non-dangerous species. No sharks were seen on any landing routes.

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Table 1. Starting, intermediate and ending points of proposed landings A – C, Piti, Guam.

Landing	Point	Depth (m)	Latitude	Longitude
A	Start	20	13.470883	144.691383
	Middle	7	13.467107	144.693591
	End	0	13.465319	144.693177
B	Start	20	13.470883	144.691383
	Middle	7	13.467107	144.693591
	End	0	13.464319	144.688406
C	Start	20	13.46902	144.683554
	End	2	13.465772	144.686049

Table 2. Mean benthic cover values, including hardbottom and unconsolidated sediment cover types, for each landing alternative.

	A			B			C		
Hardbottom cover									
Coral	4.3	±	7.0	2.9	±	5.8	10.8	±	16.5
Crustose coralline algae	15.1	±	14.5	9.5	±	13.6	11.8	±	16.8
Fleshy macroalgae	16.5	±	14.7	11.1	±	13.9	2.2	±	3.1
Turf algae	18.8	±	14.3	13.4	±	14.2	5.6	±	7.9
Branching coralline algae	3.9	±	5.5	2.4	±	4.8	2.0	±	3.3
Cyanobacteria	3.7	±	9.6	2.4	±	7.8	4.6	±	7.8
Soft coral	0.5	±	1.3	0.3	±	1.1	0.0	±	0.0
Sponges	0.1	±	0.3	0.1	±	0.3	0.3	±	0.6
Unconsolidated sediment									
Rubble	12.8	±	21.3	30.1	±	30.3	21.1	±	28.4
Sand	22.8	±	27.4	26.8	±	25.0	40.5	±	40.0

Table 3. Benthic cover values, including hardbottom and unconsolidated sediment cover types associated with distinct reef zones encountered along the length of proposed landing alternative A. Benthic cover data was not obtained for the final 100 meters of landing A.

Zone	Seaward slope	Channel side-West	Channel bottom-Center	Channel bottom-South
Distance	0 to 225 m	225 to 480 m	480 to 650 m	650 to 850 m
Major Structure	Hardbottom	Hardbottom	Uncon sed	Uncon sed
Hardbottom cover				
Coral	13.4	1.6	0.2	0.9
Crustose coralline algae	26.2	28.4	0.5	2.1
Fleshy macroalgae	13.5	32.0	14.2	4.8
Turf algae	19.8	25.5	17.5	13.3
Branching coralline algae	6.3	6.7	0.0	1.6
Cyanobacteria	12.4	0.1	0.2	2.0
Soft coral	0.1	1.4	0.0	0.4
Sponges	0.0	0.1	0.0	0.4
Unconsolidated sediment				
Rubble	0.0	1.6	28.0	24.9
Sand	4.9	1.8	38.6	49.1

Table 4. Benthic cover values, including hardbottom and unconsolidated sediment cover types associated with distinct reef zones encountered along the length of proposed landing alternative B.

Zone	Seaward slope	Channel side-West	Channel bottom-Center	Channel bottom-South
Distance	0 to 225 m	250-480	480-650	650-1400
Major Structure	Hardbottom	Hardbottom	Uncon sed	Uncon sed
Hardbottom cover				
Coral	13.4	1.6	0.2	0.8
Crustose coralline algae	26.2	28.4	0.5	0.5
Fleshy macroalgae	13.5	32.0	14.2	2.6
Turf algae	19.8	25.5	17.5	6.8
Branching coralline algae	6.3	6.7	0.0	0.4
Cyanobacteria	12.4	0.1	0.2	0.6
Soft coral	0.1	1.4	0.0	0.1
Sponges	0.0	0.1	0.0	0.1
Unconsolidated sediment				
Rubble	0.0	1.6	28.0	50.7
Sand	4.9	1.8	38.6	37.1

Table 5. Benthic cover values, including hardbottom and unconsolidated sediment cover types associated with distinct reef zones encountered along the length of proposed landing alternative C.

Zone	Seaward slope	Intake channel
Distance	0 to 136 m	200-450 m
Major Structure	Hardbottom	Uncon sed
Hardbottom cover		
Coral	28.3	1.4
Crustose coralline algae	30.4	0.0
Fleshy macroalgae	6.0	0.0
Turf algae	14.8	0.0
Branching coralline algae	5.4	0.0
Cyanobacteria	11.9	0.0
Soft coral	0.0	0.0
Sponges	0.6	0.0
Unconsolidated sediment		
Rubble	0.0	32.9
Sand	0.0	65.6

Table 6. Hard corals, including Scleractinian, *Millepora* and *Heliopora* species, recorded for each landing alternative. Scleractinian coral genus and family attributions follow recent revisions by Budd et al. (2014) and Huang et al. (2014). Entries using "spp." may include more than one unidentified species.

		Landing		
FAMILY	**Species**	**A**	**B**	**C**
ACROPORIDAE	*Acropora abrotanoides*	X	X	X
	Acropora aculeus			X
	Acropora azurea			X
	Acropora cerealis		X	
	Acropora cf. *globiceps*			X
	Acropora cf. *nasuta*		X	X
	Acropora cf. *pulchra*		X	X
	Acropora cf. *quelchi*	X	X	
	Acropora cf. *valida*			X
	Acropora cophodactyla			X
	Acropora globiceps	X	X	X
	Acropora humilis		X	X
	Acropora latistella	X	X	
	Acropora microclados	X	X	
	Acropora monticulosa			X
	Acropora palmerae			X
	Acropora spp.	X	X	
	Acropora surculosa	X	X	X
	Acropora tenuis	X	X	X
	Acropora verweyi	X	X	
	Acropora wardii	X	X	X
	Astreopora listeri	X	X	X
	Astreopora myriophthalma	X	X	X
	Astreopora randalli	X	X	
	Astreopora spp.			X
	Montipora cf. *danae*		X	X
	Montipora cf. *tuberculosa*	X	X	
	Montipora grisea	X	X	X
	Montipora hoffmeisteri	X	X	
	Montipora informis		X	
	Montipora nodosa		X	
	Montipora spp.	X	X	X
	Montipora verrucosa	X	X	
AGARICIIDAE	*Gardineroseris planulata*	X	X	
	Pachyseris speciosa	X	X	
	Pavona cf *varians*		X	
	Pavona chiriquiensis	X	X	X

Table 6. Hard corals, including Scleractinian, *Millepora* and *Heliopora* species, recorded for each landing alternative. Scleractinian coral genus and family attributions follow recent revisions by Budd et al. (2014) and Huang et al. (2014). Entries using "spp." may include more than one unidentified species.

		Landing		
FAMILY	**Species**	**A**	**B**	**C**
	Pavona danai		X	X
	Pavona decussata			X
	Pavona divaricata	X	X	X
	Pavona duerdeni	X	X	
	Pavona frondifera			X
	Pavona sp. "albimarginata"		X	
	Pavona sp. "contorta"	X	X	X
	Pavona varians		X	X
	Pavona venosa		X	X
DIPLOASTREIDAE	*Diploastrea heliopora*	X	X	X
EUPHYLLIDAE	*Euphyllia* cf. *cristata*	X	X	
	Euphyllia glabrescens	X	X	
FUNGIIDAE	*Fungia fungites*	X	X	
	Fungia scutaria		X	X
	Herpolitha limax			X
HELIOPORIDAE	*Heliopora coerulea*	X	X	
Incertae sedis	*Leptastrea purpurea*	X	X	X
(formerly FAVIIDAE)	*Leptastrea transversa*			X
LOBOPHYLLIDAE	*Acanthastrea echinata*	X	X	
	Lobophyllia cf. *flabelliformis*	X	X	
MERULINIDAE	*Astrea curta*	X	X	X
	Cyphastrea agassizi	X	X	
	Cyphastrea cf. *ocellina*	X		
	Cyphastrea chalcidicum	X	X	X
	Cyphastrea microphthalma			X
	Cyphastrea serailia	X	X	
	Dipsastraea danae		X	
	Dipsastraea favus	X	X	X
	Dipsastraea maritima		X	
	Dipsastraea matthaii	X	X	X
	Dipsastraea pallida	X	X	X

Table 6. Hard corals, including Scleractinian, *Millepora* and *Heliopora* species, recorded for each landing alternative. Scleractinian coral genus and family attributions follow recent revisions by Budd et al. (2014) and Huang et al. (2014). Entries using "spp." may include more than one unidentified species.

		Landing		
FAMILY	**Species**	**A**	**B**	**C**
	Dipsastraea spp.	X	X	X
	Favites magnistellata	X	X	X
	Goniastrea edwardsi	X	X	X
	Goniastrea pectinata	X	X	X
	Goniastrea retiformis	X	X	X
	Goniastrea stelligera	X	X	X
	Hynophora microconos	X	X	X
	Leptoria phyrgia	X	X	X
	Oulophyllia crispa			X
	Platygyra daedalea	X	X	X
	Platygyra pini		X	X
MILLEPORIDAE	*Millepora platyphylla*	X	X	X
	Millepora tuberosa		X	
OCULINDAE	*Galaxea fascicularis*	X	X	X
POCILLOPORIDAE	*Pocillopora damicornis*	X	X	X
	Pocillopora elegans		X	
	Pocillopora eydouxi			X
	Pocillopora ligulata		X	
	Pocillopora meandrina	X	X	X
	Pocillopora setchelli	X	X	X
	Pocillopora spp.	X	X	X
	Pocillopora sp. "coniculus"		X	
	Pocillopora verrucosa	X	X	X
	Stylocoeniella armata	X	X	X
PORITIDAE	*Goniopora* cf. *tenuidens*	X	X	
	Porites annae			X
	Porites cf. *myrmidonensis*	X	X	X
	Porites cylindrica			X
	Porites deformis	X	X	X
	Porites lobata	X	X	X
	Porites lutea	X	X	X
	Porites monticulosa			X
	Porites murrayensis	X		
	Porites rus	X	X	X
	Porites spp. (massive)	X	X	X

Table 6. Hard corals, including Scleractinian, *Millepora* and *Heliopora* species, recorded for each landing alternative. Scleractinian coral genus and family attributions follow recent revisions by Budd et al. (2014) and Huang et al. (2014). Entries using "spp." may include more than one unidentified species.

		Landing		
FAMILY	**Species**	**A**	**B**	**C**
SIDERASTREIDAE	*Psammocora contigua*	X	X	X
	Psammocora haimeana/profundacella	X	X	
	Psammocora nierstraszi			X
	Psammocora sp. “loculata”		X	
	Psammocora stellata		X	
	Psammocora superficiales	X	X	

Table 7. Locations of the five colonies of the Endangered Species Act (ESA)-listed species, *Acropora globiceps*, observed within a 10 meter-wide belt extending the length of each surveyed transect. Although only these five *A. globiceps* colonies were observed, it is likely that additional colonies occur near the survey area. No other ESA-listed coral species were observed.

Colony	Landing	Latitude	Longitude
1	A-B	13.470888	144.692653
2	C	13.468232	144.683718
3	C	13.468029	144.683869
4	C	13.468117	144.683836
5	C	13.468179	144.683837

Table 8. Fishes observed within 5 m of the transect lines on landing routes A – C at Piti. "sp." indicates a species unidentifiable to species level in the field. "cf." indicates the species may be the one indicated.

		Landing		
FAMILY	**Species**	**A**	**B**	**C**
ACANTHURIDAE	*Acanthurus lineatus*	X		
	Acanthurus nigricans	X	X	X
	Acanthurus nigrofuscus		X	X
	Acanthurus olivaceous	X	X	
	Acanthurus nigricauda		X	X
	Acanthurus triostegus	X	X	X
	Acanthurus xanthopterus		X	
	Ctenochaetus striatus	X	X	X
	Naso literatus	X	X	X
	Naso unicornis	X	X	X
	Naso vlamingii	X		X
	Zebrasoma flavescens		X	
	Zebrasoma scopas	X		X
APOGONIDAE	*Apogon luteus*		X	
	Apogon sp.	X	X	
AULOSTOMIDAE	*Aulostomis chinensis*			X
BALISTIDAE	*Balistapus undulatus*	X	X	X
	Balistoides viridescens		X	
	Melichthys vidua	X	X	X
	Pseudobalistes flavomarginatus			X
	Rhinecanthus aculeatus		X	X
	Sufflamen chrysoptera	X	X	X

Table 8. Fishes observed within 5 m of the transect lines on landing routes A – C at Piti. "sp." indicates a species unidentifiable to species level in the field. "cf." indicates the species may be the one indicated.

		Landing		
FAMILY	**Species**	**A**	**B**	**C**
	Sufflamen sp.			X
BLENNIIDAE	gen. sp.	X		X
	Ecsenius opsifrontalis		X	
	Meiacanthus atrodorsalis	X		X
	Salarius fasciatus			X
CARANGIDAE	*Caranx melampygus*			X
CHAETODONTIDAE	*Chaetodon auriga*	X	X	X
	Chaetodon citrinellus	X	X	X
	Chaetodon lunulatus	X		X
	Chaetodon melannotus	X		
	Chaetodon mertensii	X		X
	Chaetodon ornatissimus	X		X
	Chaetodon reticulatus	X	X	X
	Chaetodon trifacialis		X	
	Chaetodon ulietensis	X		
	Chaetodon unimaculatus	X		
	Forcipiger flavissimus	X		
	Hemitaurichthys polylepis	X		
	Heniochus chrysostomus	X		X
	Heniochus monoceros	X		
	Heniochus varius	X		X

Table 8. Fishes observed within 5 m of the transect lines on landing routes A – C at Piti. "sp." indicates a species unidentifiable to species level in the field. "cf." indicates the species may be the one indicated.

		Landing		
FAMILY	**Species**	**A**	**B**	**C**
CIRRHITIDAE	*Paracirrhites arcatus*	X	X	X
ELEOTRIDAE	*Ptereleotris evides*		X	
ELEOTRIDAE	*Ptereleotris heteroptera*	X		X
EPHIPPIDAE	*Platax orbicularis*	X		
FISTULARIIDAE	*Fistularia commersonii*	X	X	
GERRIDAE	*Gerres acinaces*		X	
GOBIIDAE	*Amblygobius phaelena*		X	
	cf. *Cryptocentrus* sp.		X	
	Oplopomus oplopomus	X		
	Valenciennea strigata		X	
HOLOCENTRIDAE	*Holocentrus* sp.		X	
	Myripristis berndti	X	X	
	Myripristis sp.	X		
	Neoniphon sp. cf. *sammara*	X	X	
	Sargocentron sp. non *spiniferum*			X
LABRIDAE	*Anampses caeruleopunctatus*		X	
	Anampses meleagrides		X	
	Calotomus carolinus	X	X	

Table 8. Fishes observed within 5 m of the transect lines on landing routes A – C at Piti. "sp." indicates a species unidentifiable to species level in the field. "cf." indicates the species may be the one indicated.

		Landing		
FAMILY	**Species**	**A**	**B**	**C**
	Cheilinus trilobatus	X	X	X
	Chlorurus microrhinos	X		
	Chlorurus sordidus	X	X	X
	Coris aygula		X	
	Epibulus insidiator	X	X	
LABRIDAE	cf. *Coris* sp.	X	X	X
	Halichoeres hortulanus	X	X	X
	Halichoeres trimaculatus	X	X	X
	Hemigymnus fasciatus	X		
	Hemigymnus melapterus	X	X	X
	Labroides dimidiatus	X	X	X
	Macropharyngodon meleagris	X		
	Novaculichthys taeniourus		X	X
	Oxycheilinus unifasciatus	X	X	
	Scarus altipinnis	X	X	
	Scarus globiceps	X	X	
	Scarus psittacus			X
	Scarus rubroviolaceus	X		
	Scarus schlegeli	X	X	
	Stethojulis bandanensis	X	X	
	Thallassoma lutescens	X		
	Thallassoma purpureum	X		
	Thallassoma sp.			X
LETHRINIDAE	*Lethrinus harak*	X	X	

Table 8. Fishes observed within 5 m of the transect lines on landing routes A – C at Piti. "sp." indicates a species unidentifiable to species level in the field. "cf." indicates the species may be the one indicated.

		Landing		
FAMILY	**Species**	**A**	**B**	**C**
	Lethrinus olivaceous		X	X
LUTJANIDAE	*Lutjanus fulvus*	X		
	Macolor macularis	X	X	
	Macolor niger	X		X
	Monotaxis grandoculis	X		
MALACANTHIDAE	*Malacanthus latovittatus*	X	X	
MICRODESMIDAE	*Gunnellichthys pleurotaenia*		X	
MULLIDAE	*Mulloidichthys flavolineatus*		X	X
	Parupeneus barberinus	X	X	
	Parupeneus multifasciatus	X	X	X
	Parupeneus cyclostomus	X	X	
MYLIOBATIDAE	*Aetobatis narinari*		X	
NEMIPTERIDAE	*Scolopsis lineata*	X	X	X
OSTRACIIDAE	*Ostracion cubicus*	X	X	
PINGUIPEDIDAE	*Parapercis clathrata*	X	X	
POMACANTHIDAE	*Centropyge flavissima*	X	X	X

Table 8. Fishes observed within 5 m of the transect lines on landing routes A – C at Piti. "sp." indicates a species unidentifiable to species level in the field. "cf." indicates the species may be the one indicated.

		Landing		
FAMILY	**Species**	**A**	**B**	**C**
POMACENTRIDAE	*Abudefduf sexfasciatus*	X		
	Abudefduf vaigiensis	X	X	
	Amblyglyphidodon curacao	X		X
	Amphiprion sp.		X	
	Chromis alpha	X	X	
	Chromis atripectoralis		X	
	Chromis sp.	X		X
	Chromis ternatensis	X		
POMACENTRIDAE	*Chromis viridis*	X	X	X
	Chrysiptera brownriggii	X	X	X
	Chrysiptera sp.	X	X	X
	Chrysiptera vaiuli		X	X
	Dascyllus aruanus	X	X	X
	Dascyllus trimaculatus		X	X
	gen. sp.	X		
	Neopomacentrus violascens	X		
	Plectroglyphidodon dickii		X	
	Plectroglyphidodon johnstonianus	X		
	Plectroglyphidodon lacrymatus	X		
	Pomacentrus pavo		X	
	Pomacentrus vaiuli	X		
	Stegastes albifasciatus			X
	Stegastes lividus	X		X
	Stegastes nigricans		X	X

Table 8. Fishes observed within 5 m of the transect lines on landing routes A – C at Piti. "sp." indicates a species unidentifiable to species level in the field. "cf." indicates the species may be the one indicated.

		Landing		
FAMILY	**Species**	**A**	**B**	**C**
SCORPAENIDAE	*Synanceia verrucosa*		X	
SERRANIDAE	*Cephalophis urodeta*			X
	Epinephelus hexagonatus		X	
	Epinephelus merra		X	
	Epinephelus sp.	X	X	
SIGANIDAE	*Siganus spinus*		X	
SYNODONTIDAE	*Synodus gracilis*			X
TETRAODONTIDAE	*Arothron hispidus*		X	
	Arothron meleagris	X	X	
	Canthigaster bennetti			X
	Canthigaster solandri	X	X	X
ZANCLIDAE	*Zanclus cornutus*	X	X	X

Table 9. Conspicuous (> 5 cm) invertebrates seen on landings A – C at Piti. "sp." indicates a species unidentifiable to species level in the field. "cf." indicates the species may be the one indicated.

		Landing		
CLASS/ORDER	**Species**	**A**	**B**	**C**
ALCYONACEA	cf. *Clavularia* sp.	X		X
	Lobophyton sp.	X		
	Sarcophyton sp.	X		
	Sinularia sp.	X	X	X
ANTHOZOA	*Palythoa* sp.			X
	Stichodactyla sp.		X	
ASTEROIDEA	*Acanthaster planci*	X		X
	Linckia laevigata	X	X	X
	Linckia multifora	X		X
BIVALVIA	*Saccostrea* sp.	X		
	Tridacna maxima			X
CUBOZOA	gen. sp.			X
DECAPODA	*Calcinus* sp(p).	X	X	
	Callianassidae sp.	X		
	Dardanus sp.		X	X
	Thalamita sp.	X		
DEMOSPONGIAE	gen. sp.	X		

Table 9. Conspicuous (> 5 cm) invertebrates seen on landings A – C at Piti. "sp." indicates a species unidentifiable to species level in the field. "cf." indicates the species may be the one indicated.

		Landing		
CLASS/ORDER	**Species**	**A**	**B**	**C**
ECHINOIDEA	*Brissus latecarinatus*			X
	Diadema savignyii			X
	Echinometra mathaei			X
	Echinometra sp. A			X
	Echinostrephus aciculatus	X	X	X
	Echinothrix calamaris			X
	Echinothrix diadema			X
	Metalia dicrana	X	X	
GASTROPODA	*Cerithium nodulosus*		X	
	Conus pulicarius	X		
	Conus sp.	X		
	Cypreae moneta	X		
	Cypreae pustulosa	X		
	Cypreae vitellus	X		
	gen. sp.	X		
	Lambis lambis	X	X	
	Lambis scorpius	X	X	
	Phyllidia sp.	X		
	Polinices sp.	X		
	Strombus gibberulus	X		
	Tectus niloticus	X		
	Vasum sp.	X		X

Table 9. Conspicuous (> 5 cm) invertebrates seen on landings A – C at Piti. "sp." indicates a species unidentifiable to species level in the field. "cf." indicates the species may be the one indicated.

		Landing		
CLASS/ORDER	**Species**	**A**	**B**	**C**
HOLOTHUROIDEA	*Actinopyga echinites*	X		X
HOLOTHUROIDEA	*Actinopyga mauritiana*	X		X
	Bohadschia argus	X	X	X
	Bohadschia ocellata			X
	Bohadschia vitiensis			X
	Bohadschia argus	X		
	Holothuria atra	X		X
	Holothuria edulis	X		
	Holothuria fuscopunctata		X	
	Holothuria whitmaei	X	X	X
	Stichopus chloronotus	X	X	X
	Synapta maculata			X
	Thelenota ananas	X	X	
POLYCHAETA	Sabellidae sp.		X	
	Terebellidae sp.		X	

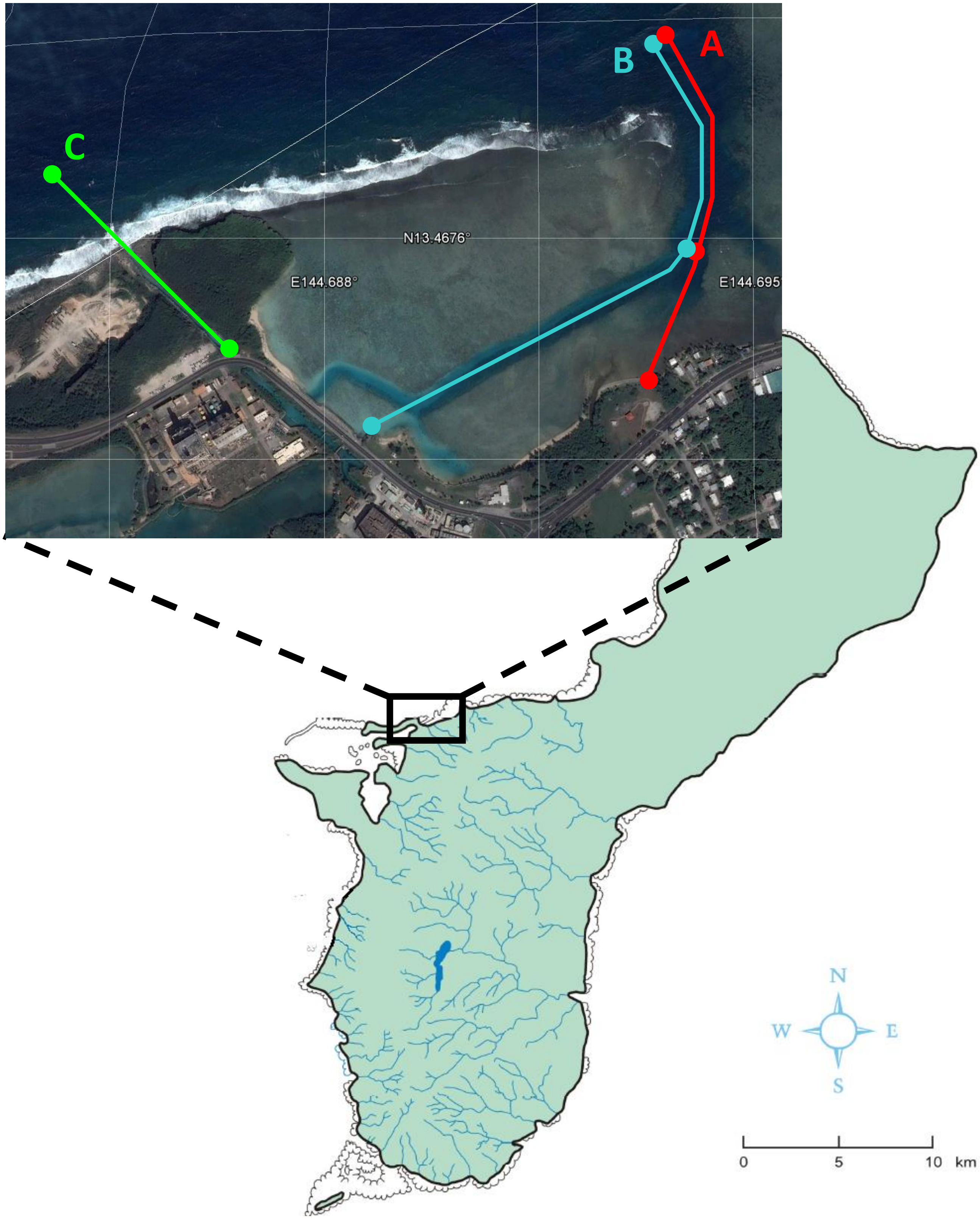


Figure 1. Map of Guam, showing the location of the survey site in Piti (Tepungan). Inset shows approximate locations of proposed cable landings A (in red), B (blue), and C (green). Filled circles represent starting, intermediate and ending poionts whose GPS-derived coordinates are in Table 1.

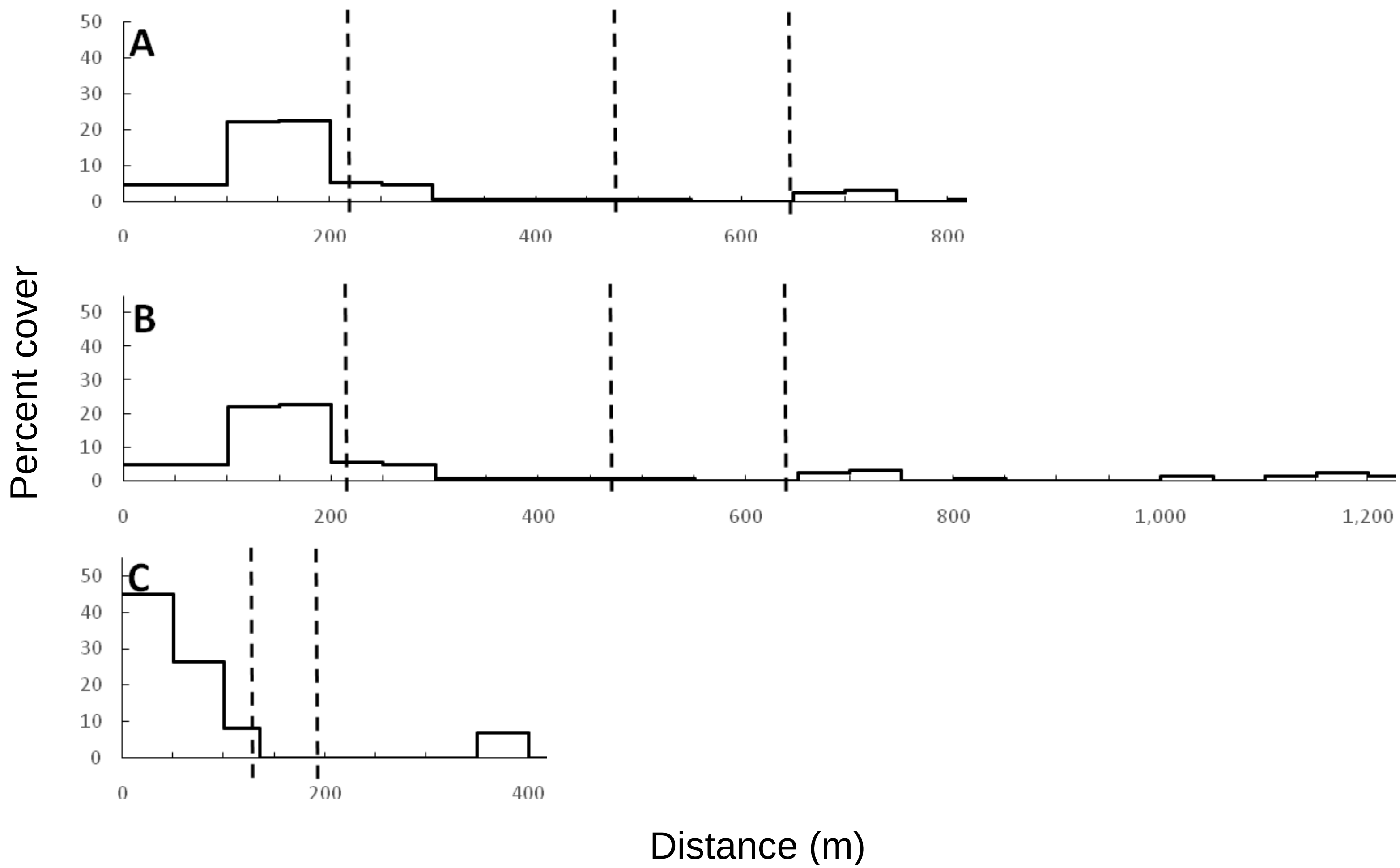


Figure 2. Percent cover of hard corals, including scleractinian corals, *Millepora* spp., and *Heliopora coerulea* along the proposed cable landings A – C at at Piti Bay. See Fig. 1 for landing locations. Percent cover values derived from point count analysis of benthic photo transect images. Vertical dotted lines represent the major habitat transitions described in Tables 3–5. Landing alternatives A and B shared the same transects for the first 750 m. The first transect on proposed landing A was 10 m X 100 m. A 136-m section along proposed cable landing C was not surveyed because of high surf or is emergent even at high tide. Photo transect images could not be obtained for the final 100 m of the proposed landing A alternative.

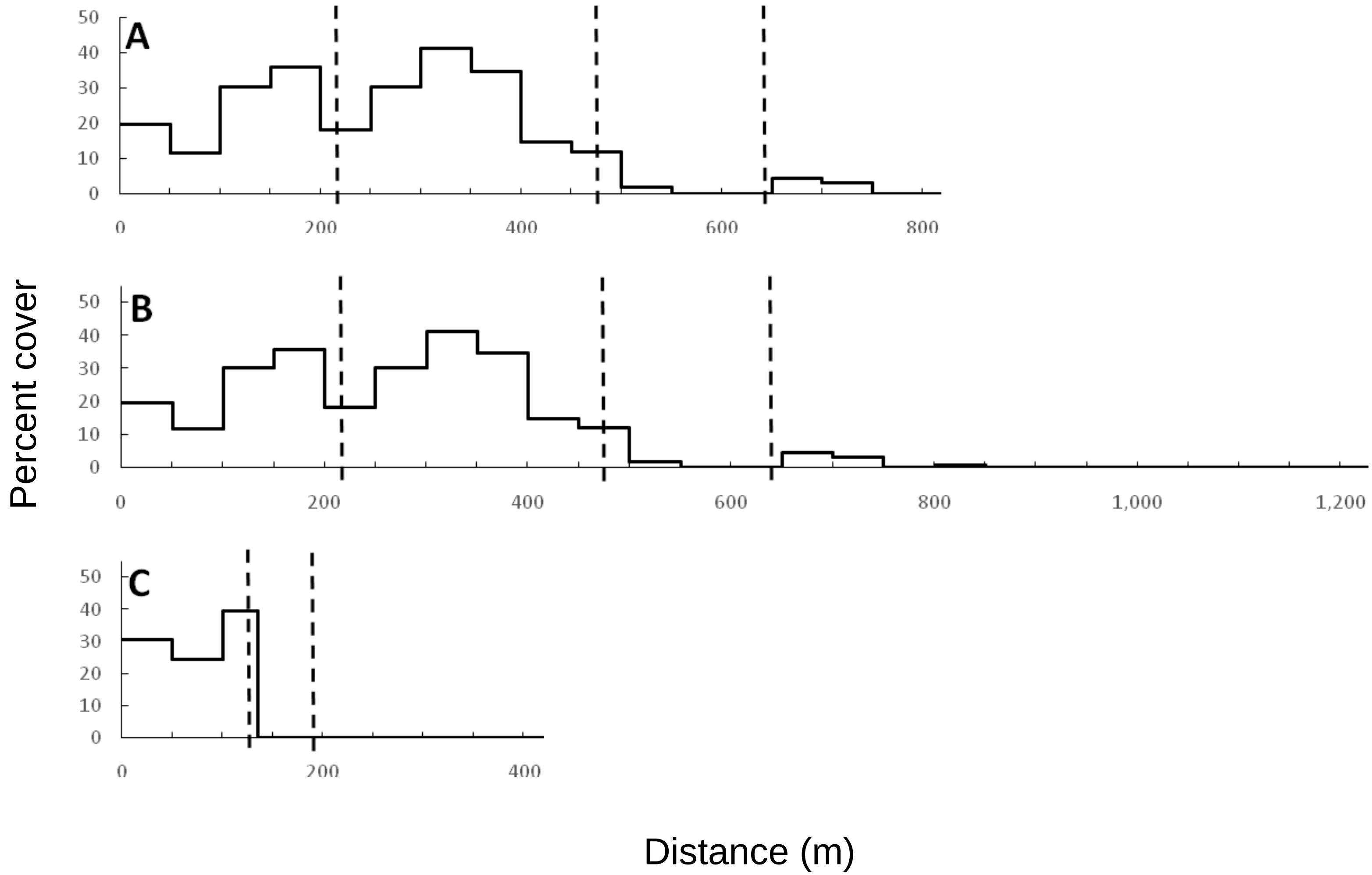


Figure 3. Percent cover of crustose coralline algae along the proposed cable landings A – C at at Piti Bay. See Fig. 1 for landing locations. Percent cover values derived from point count analysis of benthic photo transect images. Vertical dotted lines represent the major habitat transitions described in Tables 3–5. Landing alternatives A and B shared the same transects for the first 750 m. The first transect on proposed landing A was 10 m X 100 m. A 136-m section along proposed cable landing C was not surveyed because of high surf or is emergent even at high tide. Photo transect images could not be obtained for the final 100 m of the proposed landing A alternative.

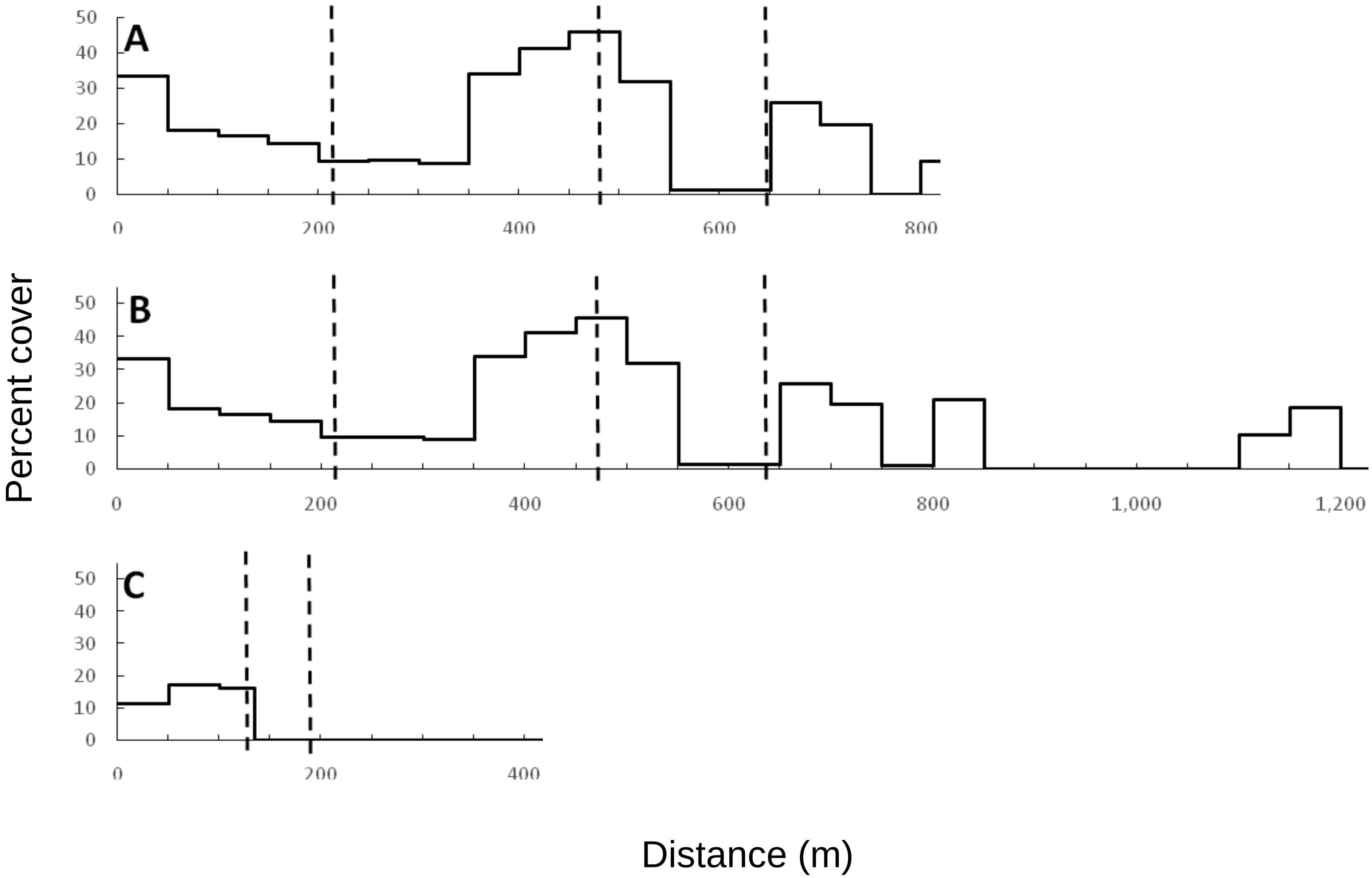


Figure 4. Percent cover of turf algae along the proposed cable landings A – C at at Piti Bay. See Fig. 1 for landing locations. Percent cover values derived from point count analysis of benthic photo transect images. Vertical dotted lines represent the major habitat transitions described in Tables 3–5. Landing alternatives A and B shared the same transects for the first 750 m. The first transect on proposed landing A was 10 m X 100 m. A 136-m section along proposed cable landing C was not surveyed because of high surf or is emergent even at high tide. Photo transect images could not be obtained for the final 100 m of the proposed landing A alternative.

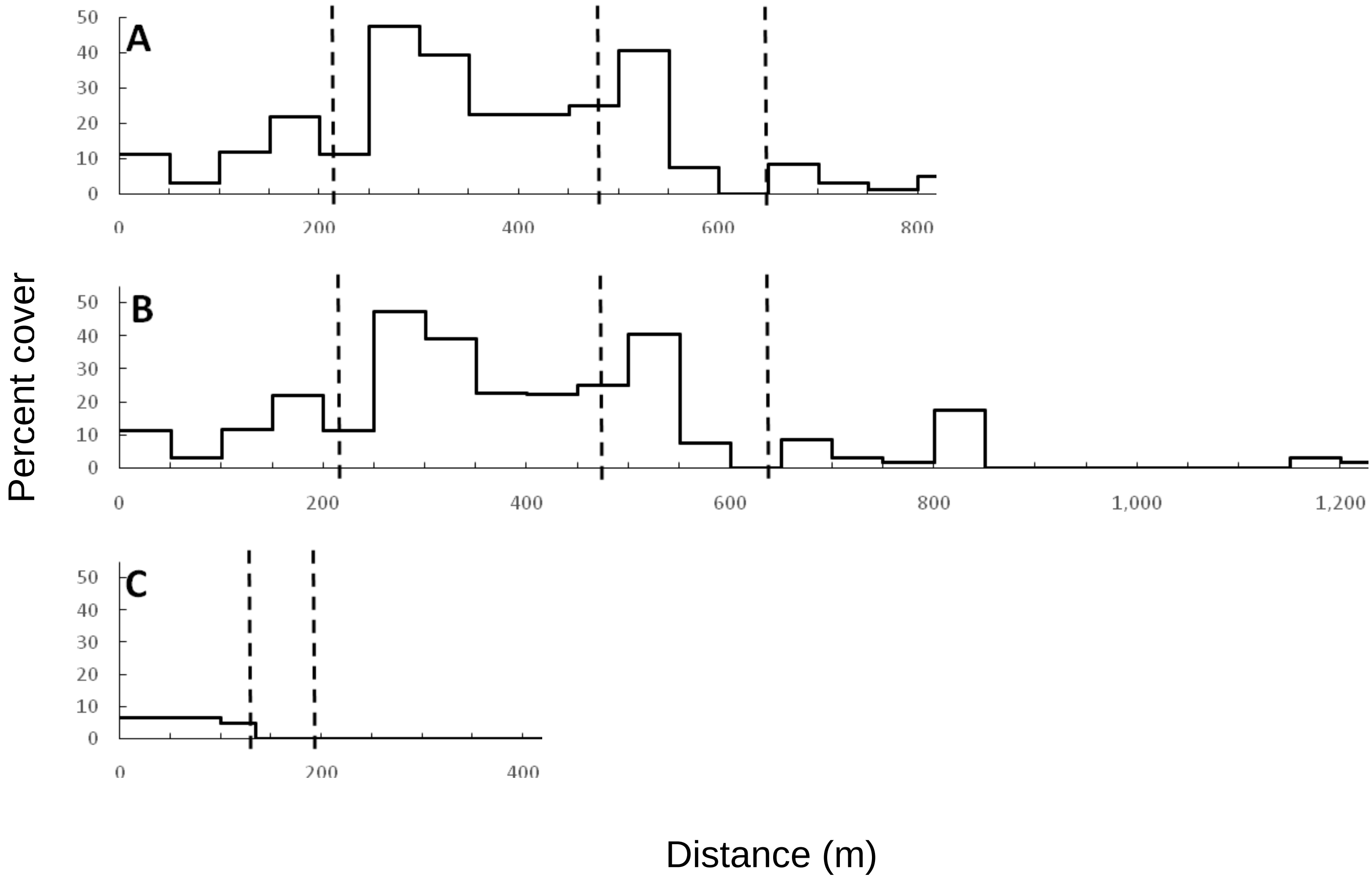


Figure 5. Percent cover of fleshy macroalgae, including erect and adherent forms, along the proposed cable landings A – C at at Piti Bay. See Fig. 1 for landing locations. Percent cover values derived from point count analysis of benthic photo transect images. Vertical dotted lines represent the major habitat transitions described in Tables 3–5. Landing alternatives A and B shared the same transects for the first 750 m. The first transect on proposed landing A was 10 m X 100 m. A 136-m section along proposed cable landing C was not surveyed because of high surf or is emergent even at high tide. Photo transect images could not be obtained for the final 100 m of the proposed landing A alternative.

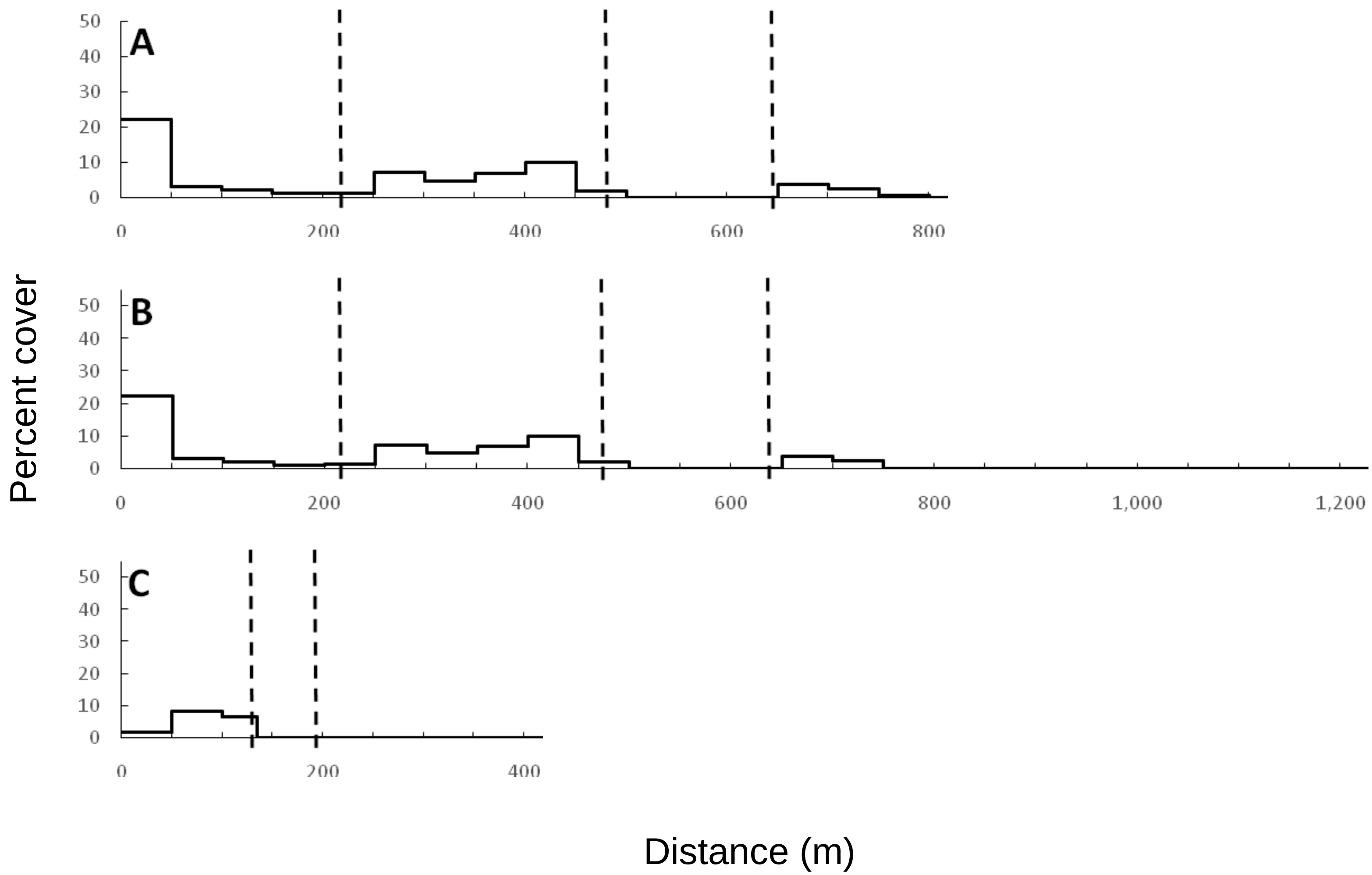


Figure 6. Percent cover of branching coralline algae, including articulated and non-articulated forms, along the proposed cable landings A – C at at Piti Bay. See Fig. 1 for landing locations. Percent cover values derived from point count analysis of benthic photo transect images. Vertical dotted lines represent the major habitat transitions described in Tables 3–5. Landing alternatives A and B shared the same transects for the first 750 m. The first transect on proposed landing A was 10 m X 100 m. A 136-m section along proposed cable landing C was not surveyed because of high surf or is emergent even at high tide. Photo transect images could not be obtained for the final 100 m of the proposed landing A alternative.

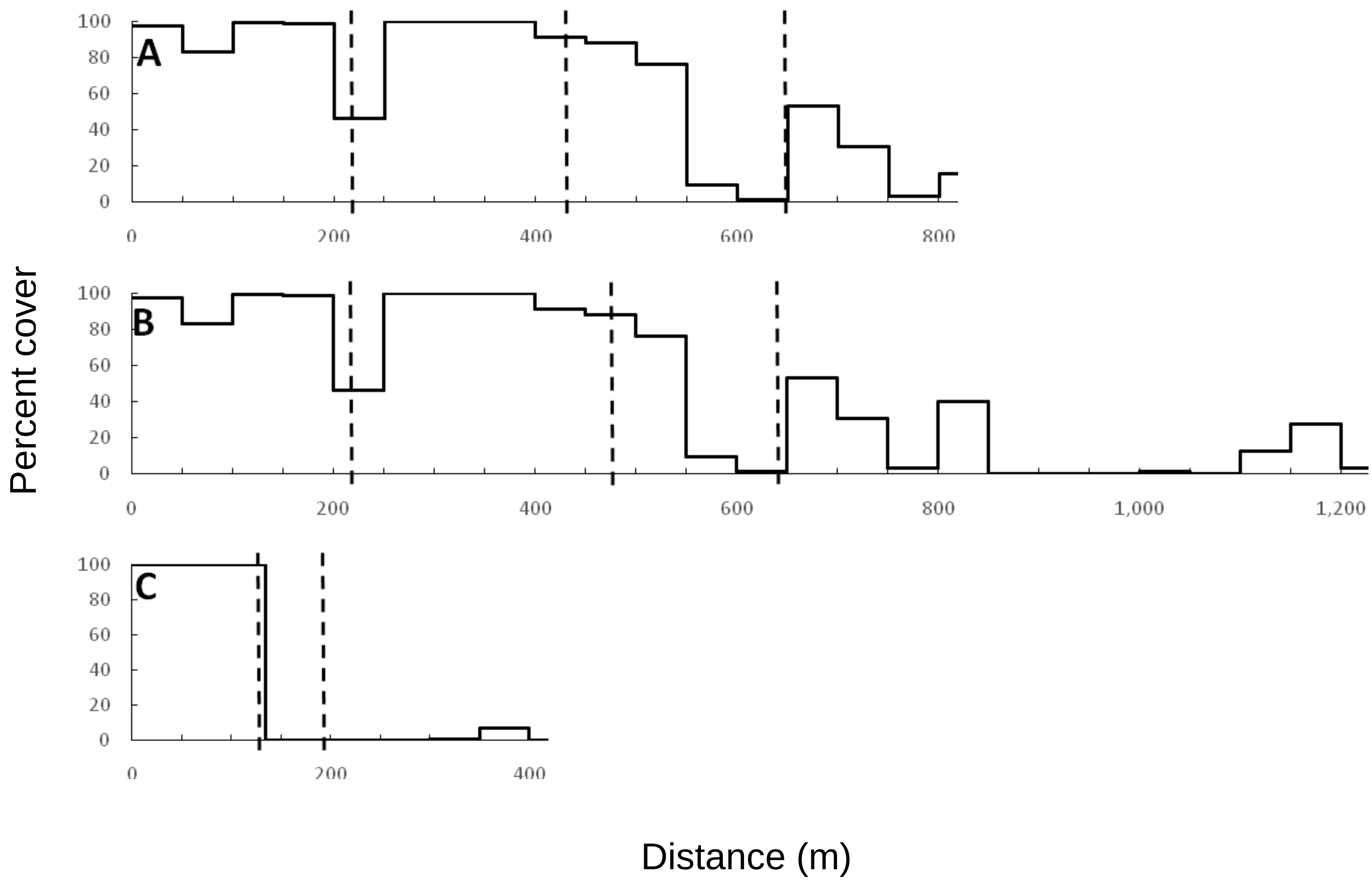


Figure 7. Percent cover of hardbottom along the proposed cable landings A – C at at Piti Bay. See Fig. 1 for landing locations. Percent cover values derived from point count analysis of benthic photo transect images. Vertical dotted lines represent the major habitat transitions described in Tables 3–5. Landing alternatives A and B shared the same transects for the first 750 m. The first transect on proposed landing A was 10 m X 100 m. A 136-m section along proposed cable landing C was not surveyed because of high surf or is emergent even at high tide. Photo transect images could not be obtained for the final 100 m of the proposed landing A alternative.

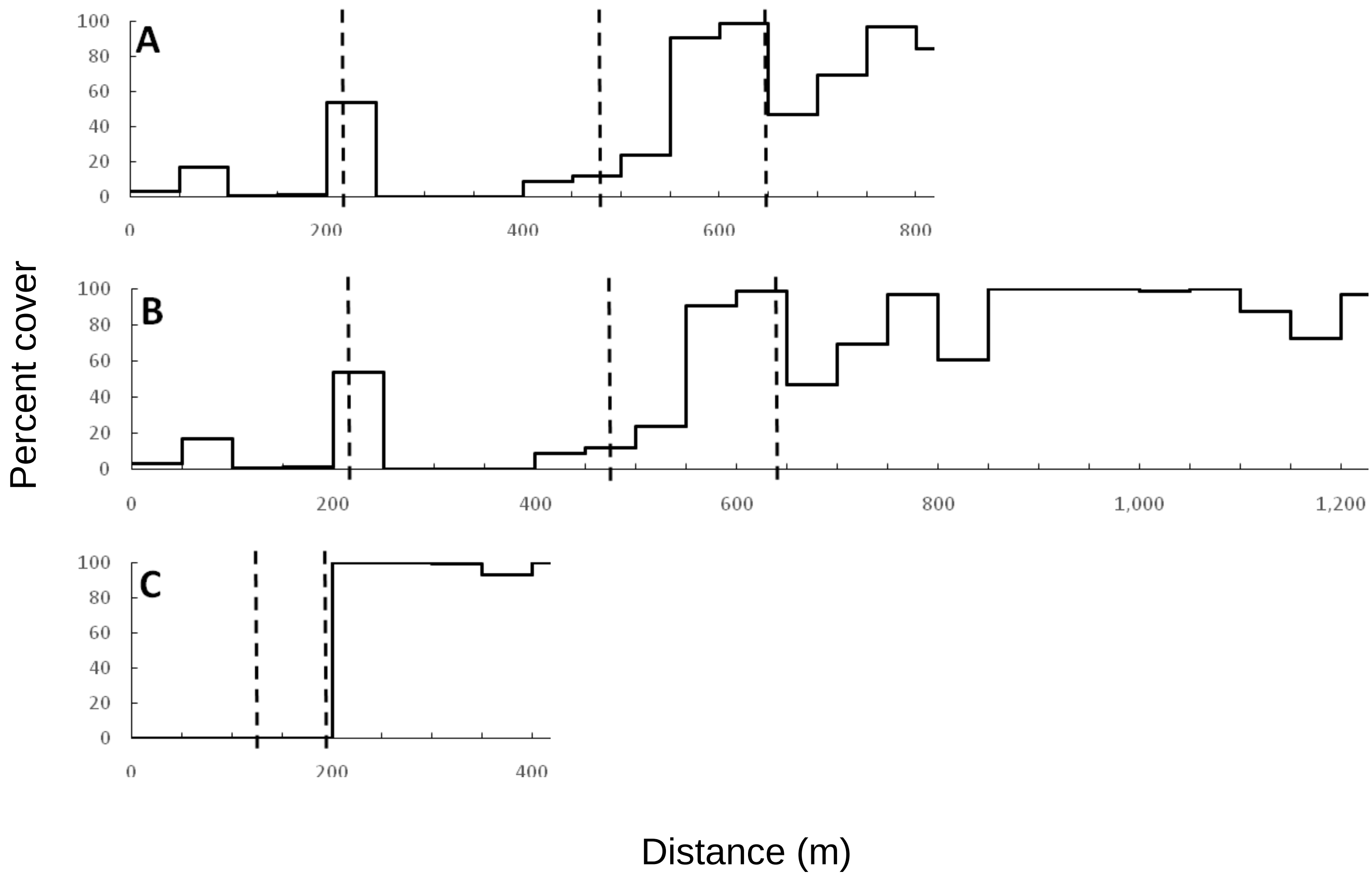


Figure 8. Percent cover of unconsolidated sediment, including sand and rubble, along the proposed cable landings A – C at at Piti Bay. See Fig. 1 for landing locations. Percent cover values derived from point count analysis of benthic photo transect images. Vertical dotted lines represent the major habitat transitions described in Tables 3–5. Landing alternatives A and B shared the same transects for the first 750 m. The first transect on proposed landing A was 10 m X 100 m. A 136-m section along proposed cable landing C was not surveyed because of high surf or is emergent even at high tide. Photo transect images could not be obtained for the final 100 m of the proposed landing A alternative.

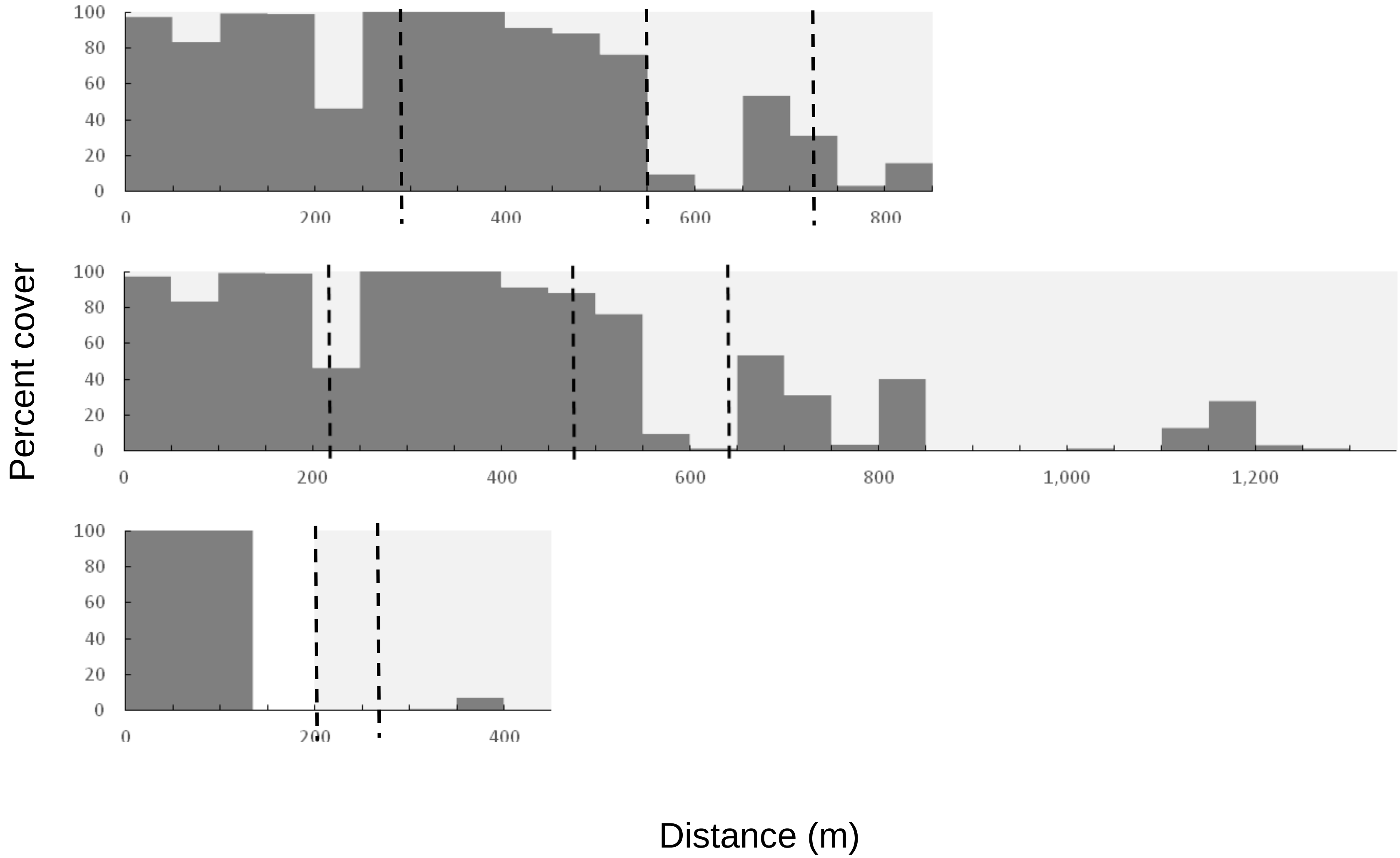


Figure 9. Percent cover of hardbottom and unconsolidated sediment, including sand and rubble, along the proposed cable landings A – C at at Piti Bay. See Fig. 1 for landing locations. Percent cover values derived from point count analysis of benthic photo transect images. Vertical dotted lines represent the major habitat transitions described in Tables 3–5. Landing alternatives A and B shared the same transects for the first 750 m. The first transect on proposed landing A was 10 m X 100 m. A 136-m section along proposed cable landing C was not surveyed because of high surf or is emergent even at high tide. Photo transect images could not be obtained for the final 100 m of the proposed landing A alternative.

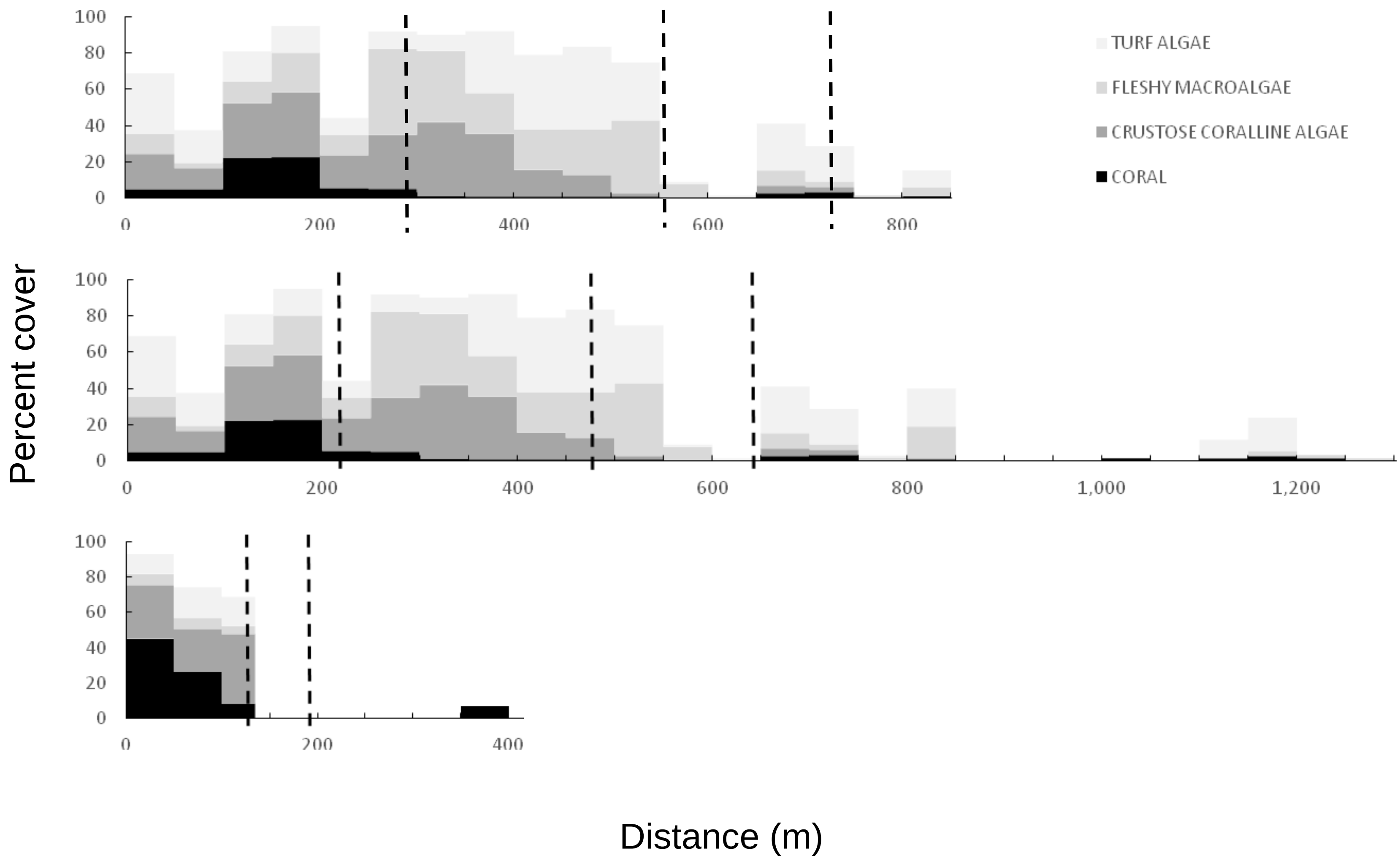


Figure 10. Percent cover of hard coral, crustose coralline algae, fleshy macroalgae, and turf algae along the proposed cable landings A – C at at Piti Bay. See Fig. 1 for landing locations. Percent cover values derived from point count analysis of benthic photo transect images. Vertical dotted lines represent the major habitat transitions described in Tables 3–5. Landing alternatives A and B shared the same transects for the first 750 m. The first transect on proposed landing A was 10 m X 100 m. A 136-m section along proposed cable landing C was not surveyed because of high surf or is emergent even at high tide. Photo transect images could not be obtained for the final 100 m of the proposed landing A alternative.

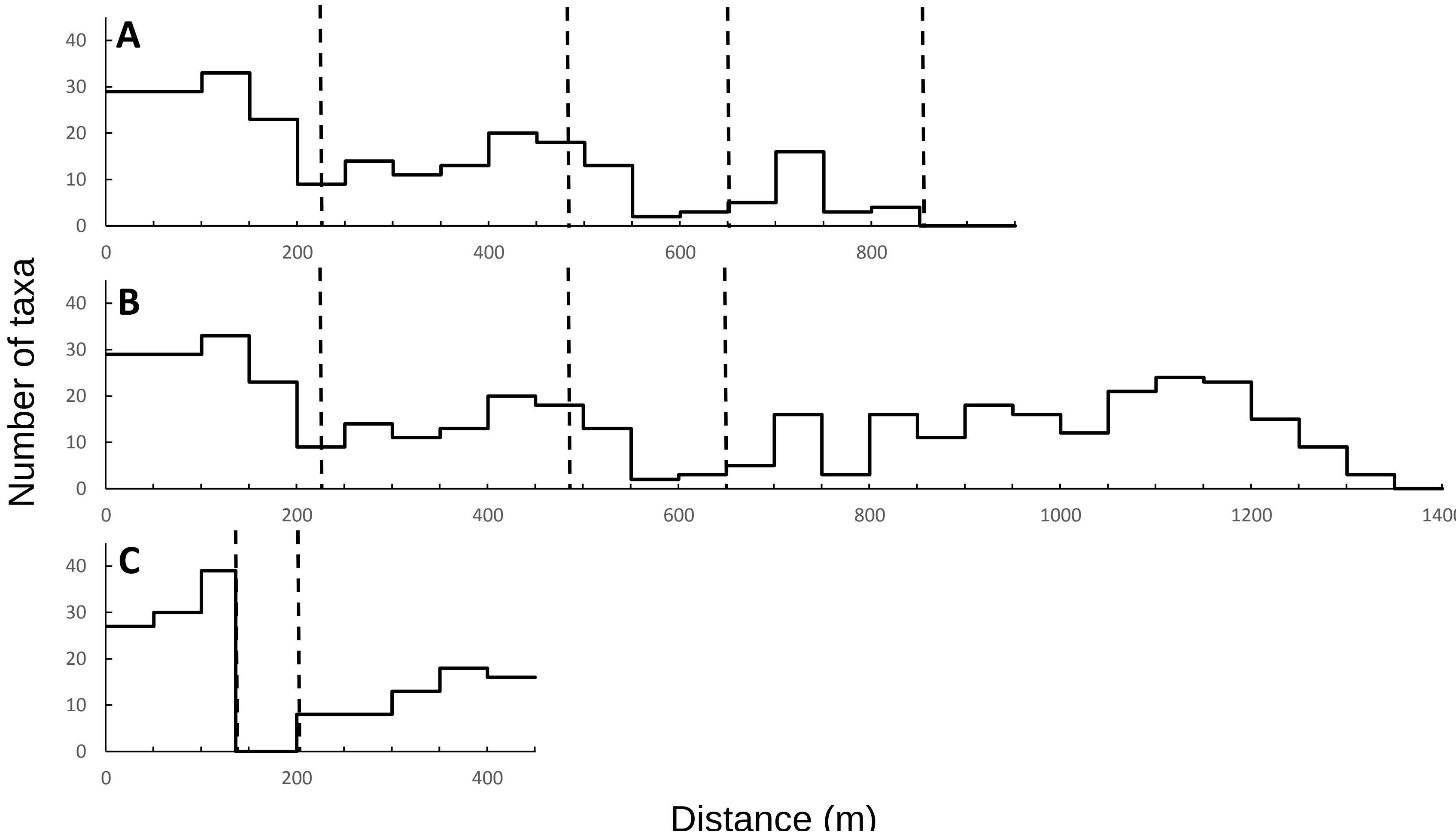


Figure 11. Number of species of all corals, including scleractinian corals, *Millepora* spp., and *Heliopora coerulea* along the proposed cable landings A – C at at Piti Bay. See Fig. 1 for landing locations. Abundances are total species seen on each 10-m X 50-m transect. Vertical dotted lines represent the major habitat transitions described in Tables 3–5. Landing alternatives A and B shared the same transects for the first 750 m. The first transect on proposed landing A was 10 m X 100 m. A 136-m section along proposed cable landing C was not surveyed because of high surf or is emergent even at high tide.

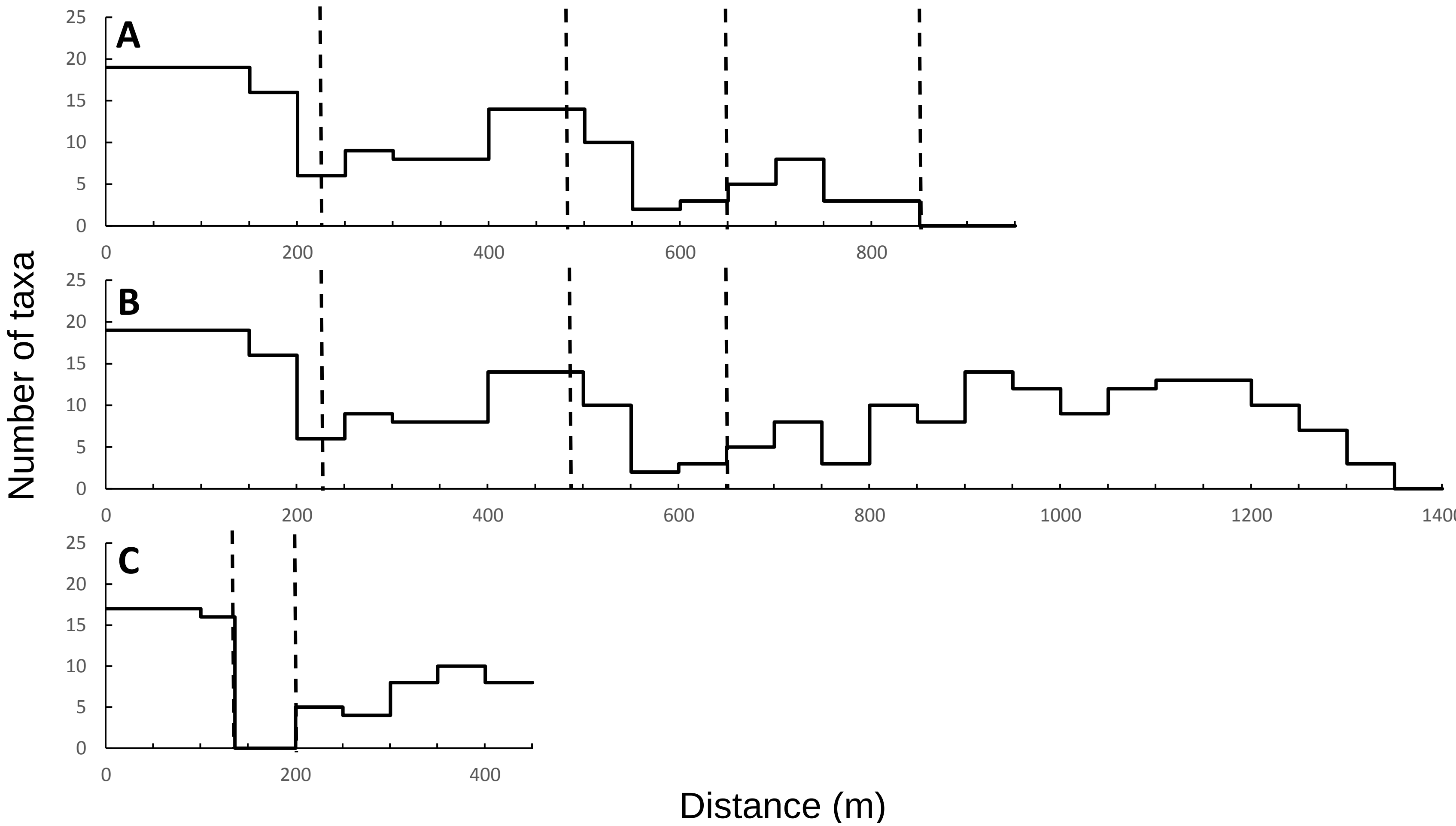


Figure 12. Number of genera of all corals, including scleractinian corals, *Millepora* spp., and *Heliopora coerulea* along the proposed cable landings A – C at at Piti Bay. See Fig. 1 for landing locations. Abundances are total coral genera seen on each 10-m X 50-m transect. Vertical dotted lines represent the major habitat transitions described in Tables 3–5. Landing alternatives A and B shared the same transects for the first 750 m. The first transect on proposed landing A was 10 m X 100 m. A 136-m section along proposed cable landing C was not surveyed because of high surf or is emergent even at high tide.

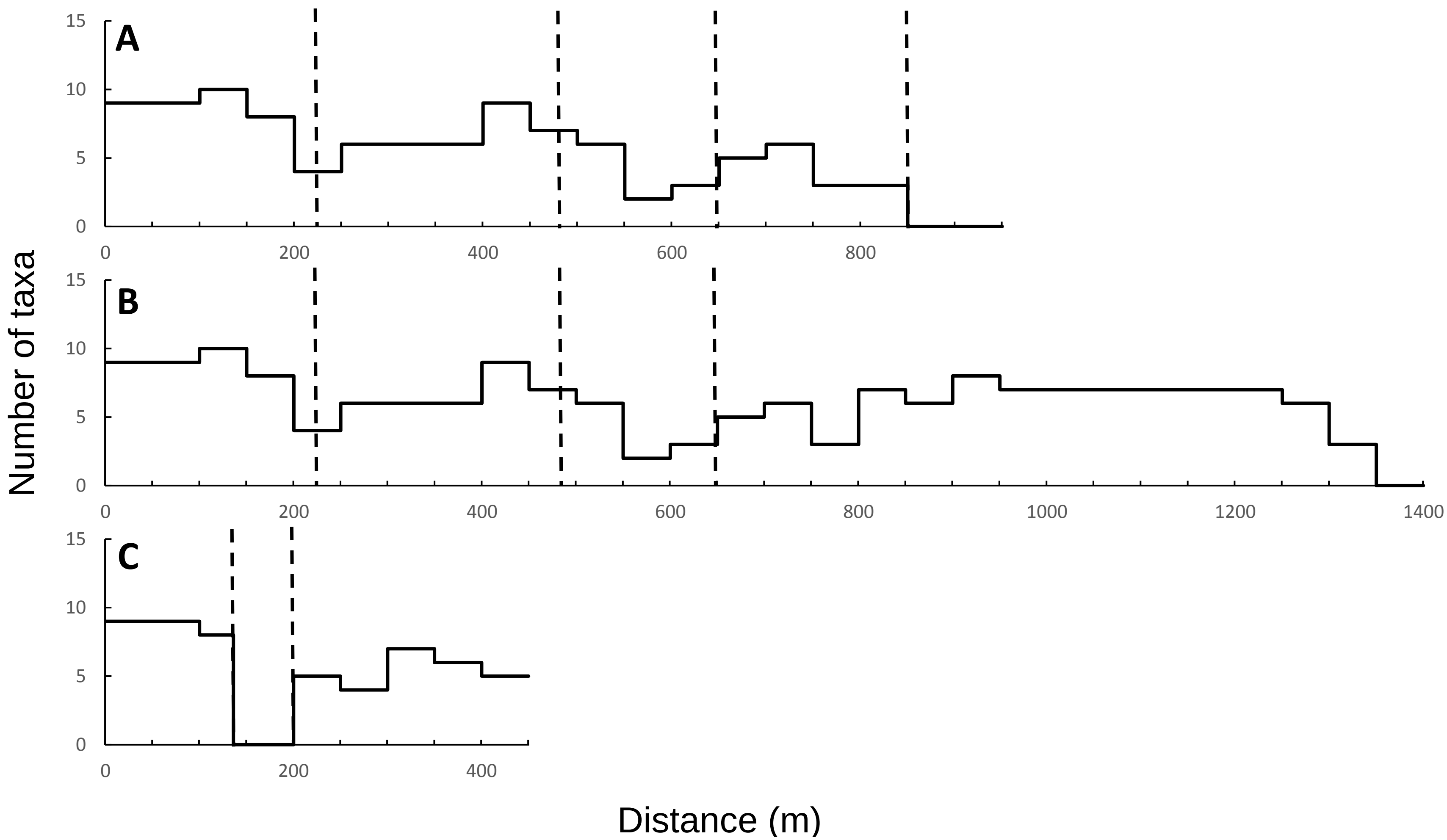


Figure 13. Number of families of all corals, including scleractinian corals, *Millepora* spp., and *Heliopora coerulea*. along the proposed cable landings A – C at at Piti Bay. See Fig. 1 for landing locations. Abundances are total coral families seen on each 10-m X 50-m transect. Vertical dotted lines represent the major habitat transitions described in Tables 3–5. Landing alternatives A and B shared the same transects for the first 750 m. According to recent literature, the family to which the coral genus *Leptastrea* belongs is now uncertain, and it is likely no longer affiliated with other Merulinidae genera; it is here considered the sole genus within a separate, unnamed family. The first transect on proposed landing A was 10 m X 100 m. A 136-m section along proposed cable landing C was not surveyed because of high surf or is emergent even at high tide.

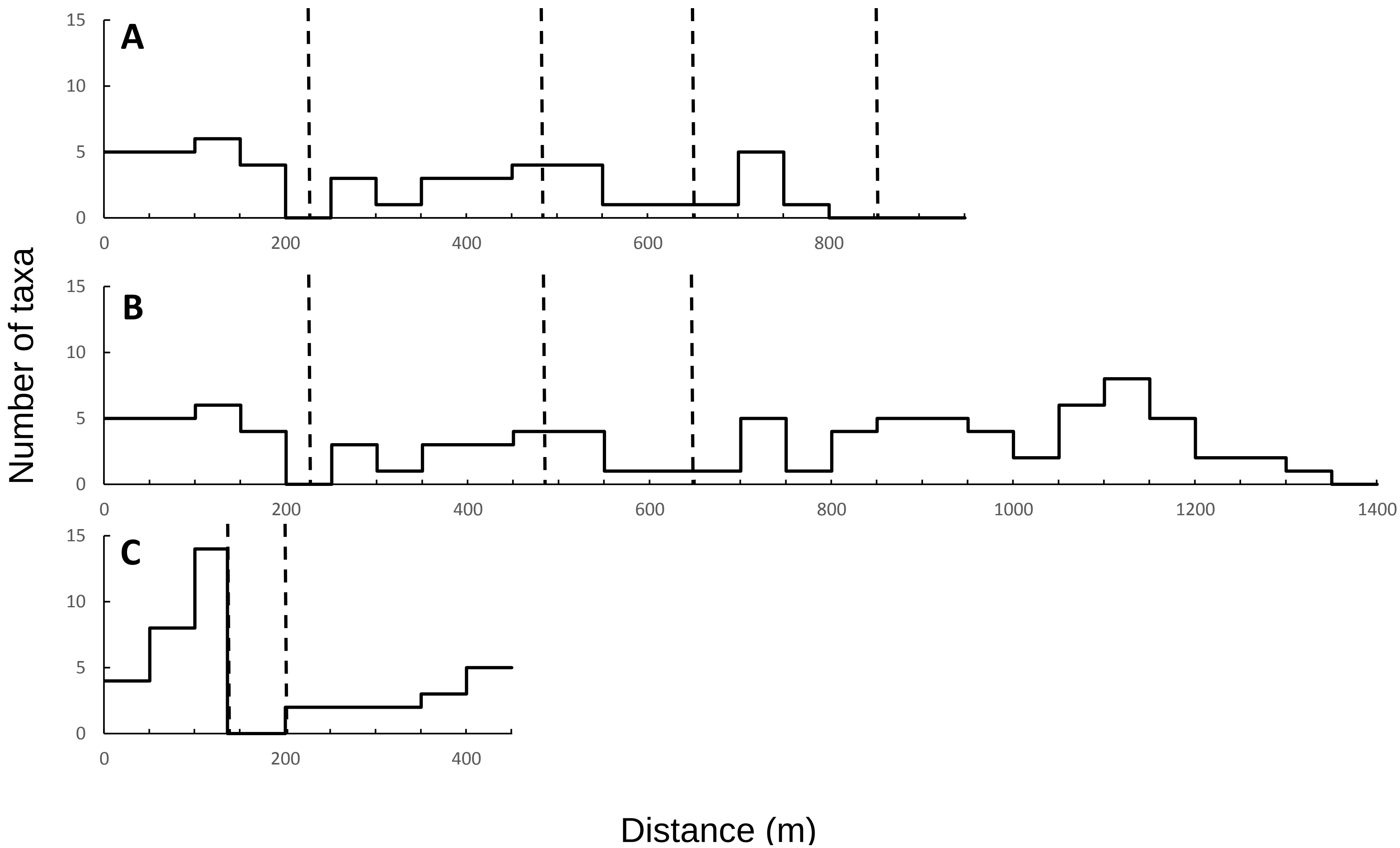


Figure 14. Number of species of the family Acroporidae along the proposed cable landings A – C at at Piti Bay. See Fig. 1 for landing locations. Abundances are total coral species seen on each 10-m X 50-m transect. Vertical dotted lines represent the major habitat transitions described in Tables 3–5. Landing alternatives A and B shared the same transects for the first 750 m. The first transect on proposed landing A was 10 m X 100 m. A 136-m section along proposed cable landing C was not surveyed because of high surf or is emergent even at high tide.

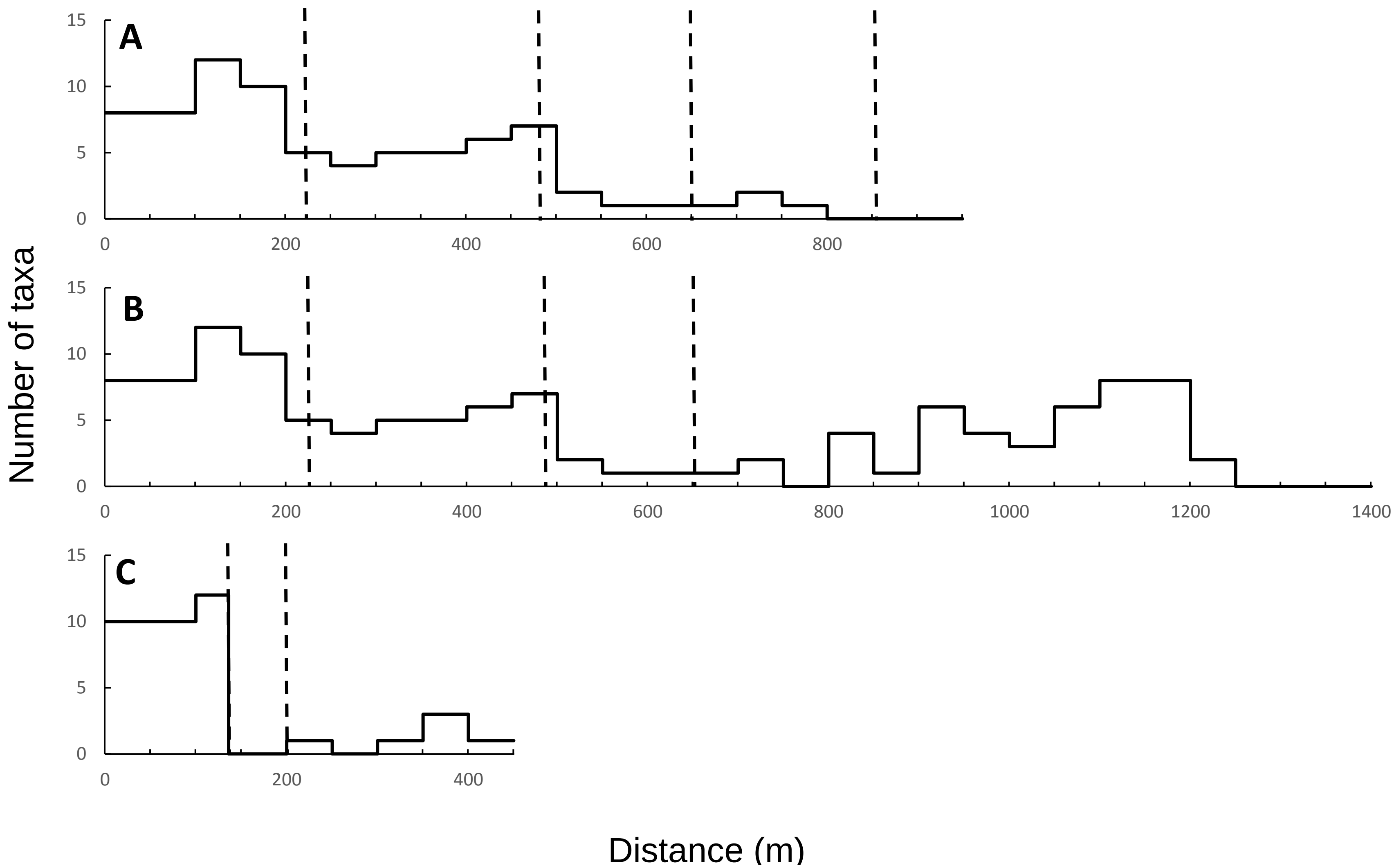


Figure 15. Number of species of the family Merulinidae along the proposed cable landings A – C at at Piti Bay. See Fig. 1 for landing locations. Abundances are total coral species seen on each 10-m X 50-m transect. Vertical dotted lines represent the major habitat transitions described in Tables 3–5. Landing alternatives A and B shared the same transects for the first 750 m. The first transect on proposed landing A was 10 m X 100 m. A 136-m section along proposed cable landing C was not surveyed because of high surf or is emergent even at high tide.

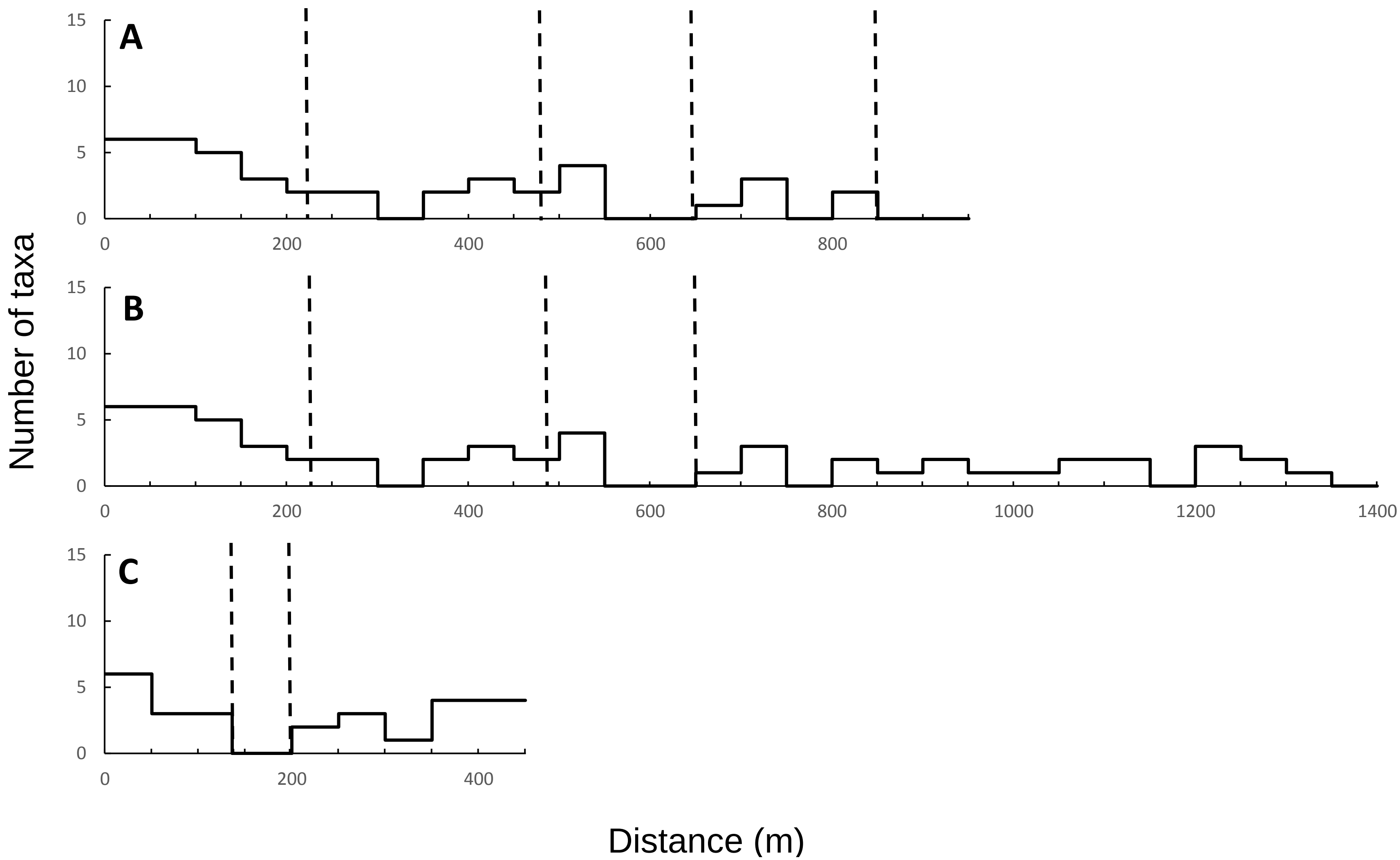


Figure 16. Number of species of the family Poritidae along the proposed cable landings A – C at at Piti Bay. See Fig. 1 for landing locations. Abundances are total coral species seen on each 10-m X 50-m transect. Vertical dotted lines represent the major habitat transitions described in Tables 3–5. Landing alternatives A and B shared the same transects for the first 750 m. The first transect on proposed landing A was 10 m X 100 m. A 136-m section along proposed cable landing C was not surveyed because of high surf or is emergent even at high tide.

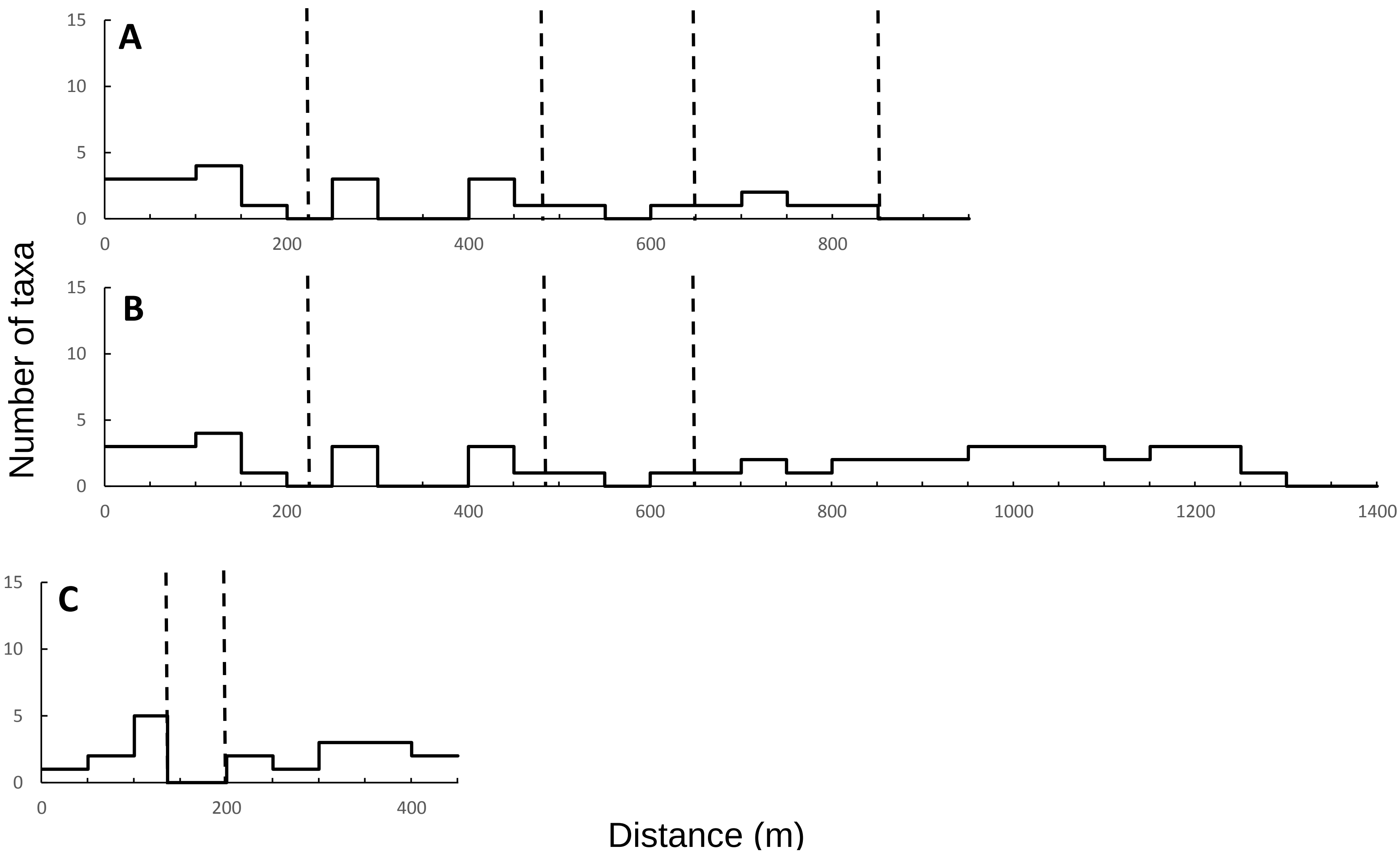


Figure 17. Number of species of the family Pocilloporidae along the proposed cable landings A – C at at Piti Bay. See Fig. 1 for landing locations. Abundances are total coral species seen on each 10-m X 50-m transect. Vertical dotted lines represent the major habitat transitions described in Tables 3–5. Landing alternatives A and B shared the same transects for the first 750 m. The first transect on proposed landing A was 10 m X 100 m. A 136-m section along proposed cable landing C was not surveyed because of high surf or is emergent even at high tide.

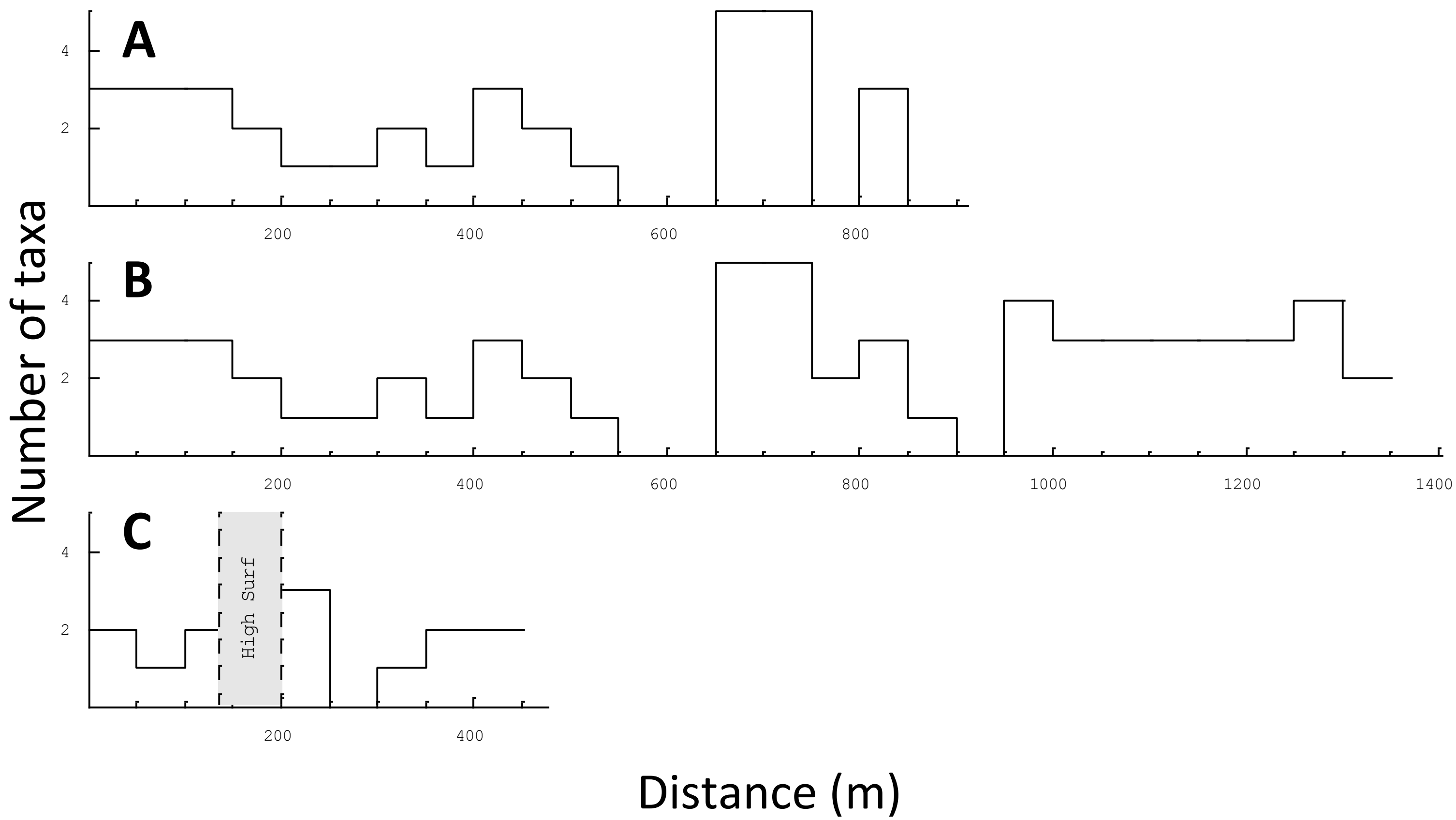


Figure 18. Number of species in the family Pomacentridae (damselfishes) along the proposed cable landings A – C at Piti Bay. See Fig. 1 for landing locations. Abundances are total species seen on each 4-m X 50-m transect. The first transect on proposed landing A was 100 m. A 136-m section along proposed cable landing C was not surveyed because of high surf or is emergent even at high tide.

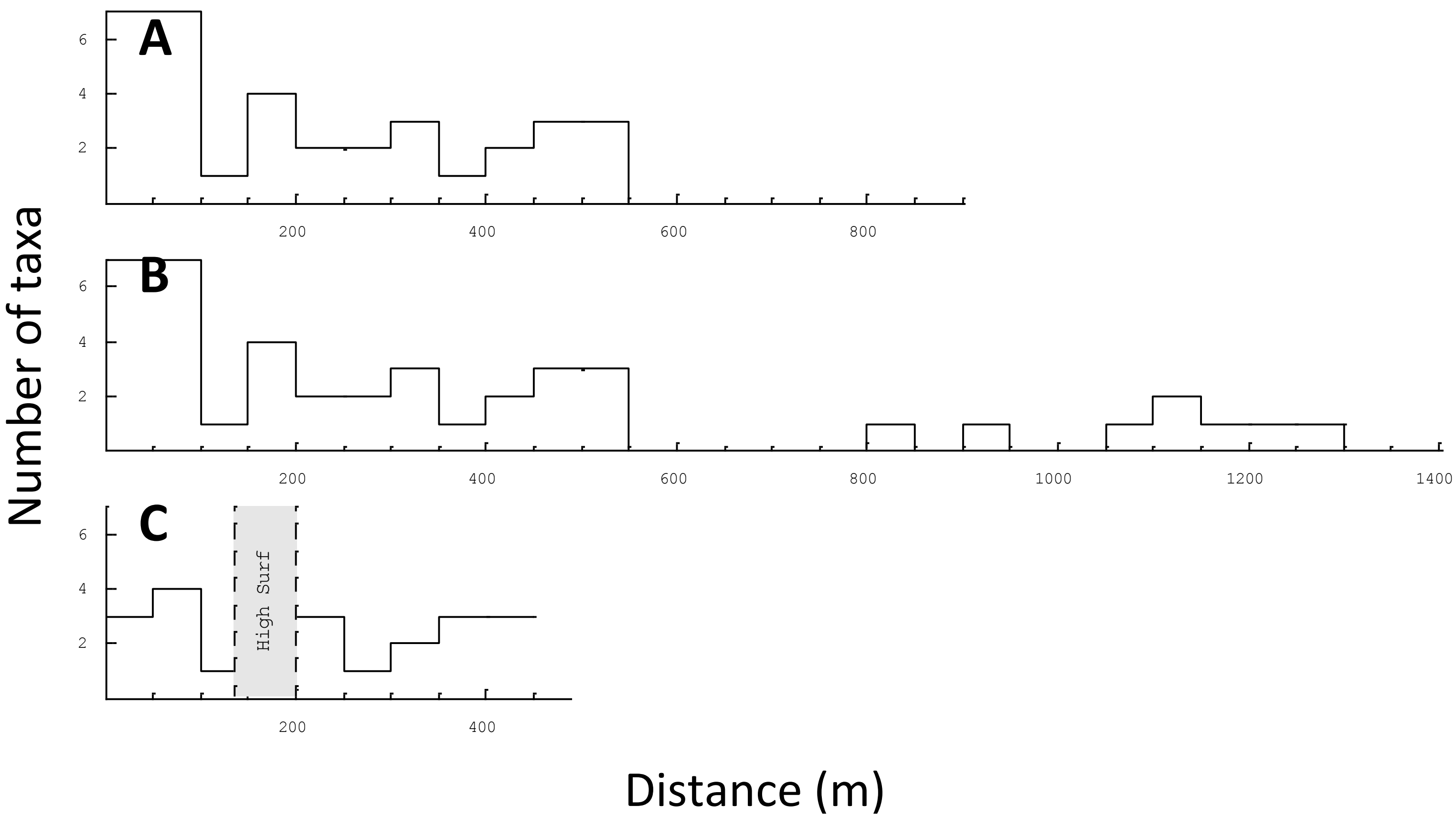


Figure 19. Number of species in the family Chaetodontidae (butterflyfishes) along the proposed cable landings A – C at Piti Bay. See Fig. 1 for landing locations. Abundances are total species seen on each 4-m X 50-m transect. The first transect on proposed landing A was 100 m. A 136-m section along proposed cable landing C was not surveyed because of high surf or is emergent even at high tide.

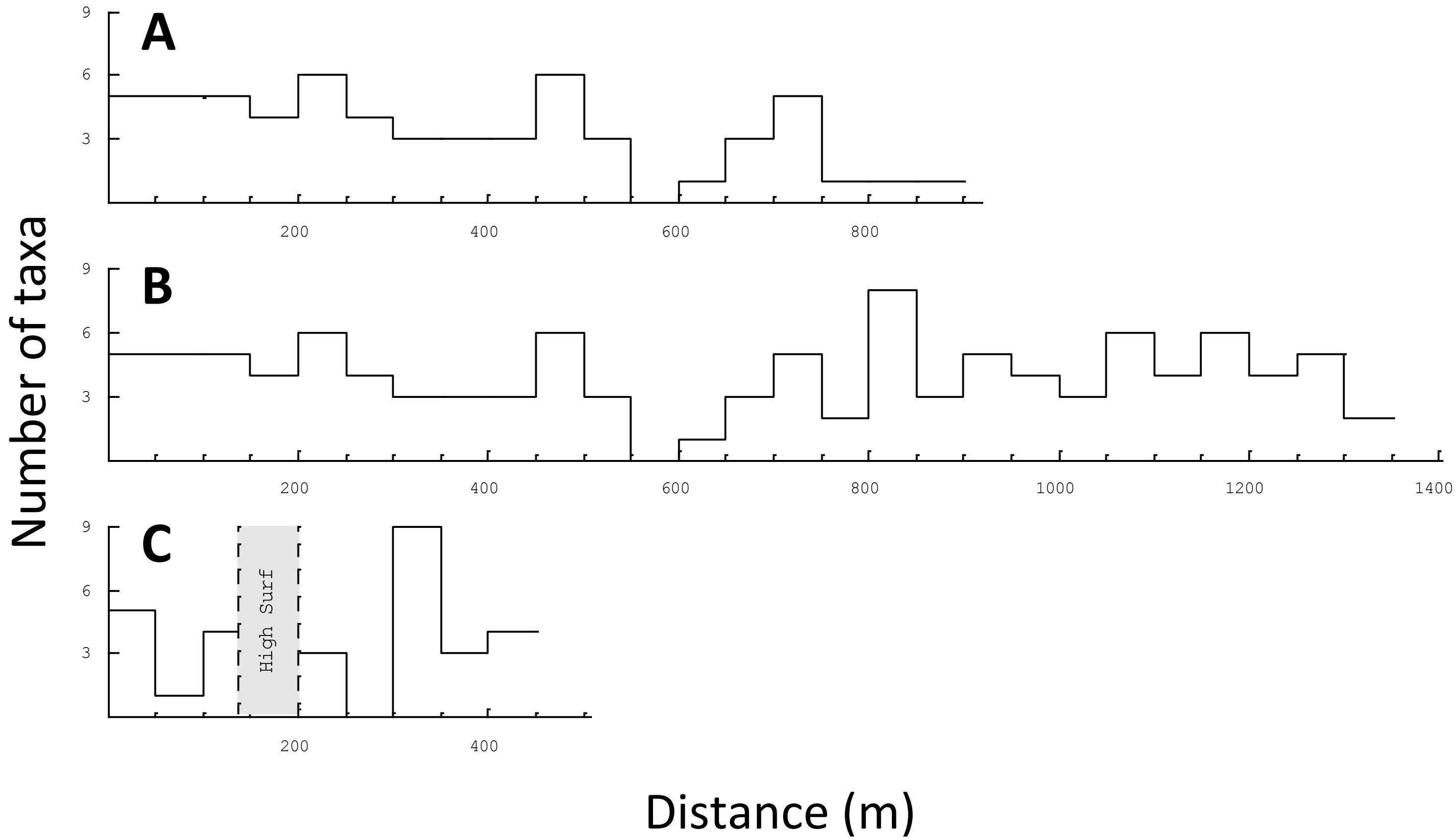


Figure 20. Number of species in the family Labridae (wrasses and parrotfishes) along the proposed cable landings A – C at at Piti Bay. See Fig. 1 for landing locations. Abundances are total species seen on each 4-m X 50-m transect. The first transect on proposed landing A was 100 m. A 136-m section along proposed cable landing C was not surveyed because of high surf or is emergent even at high tide.

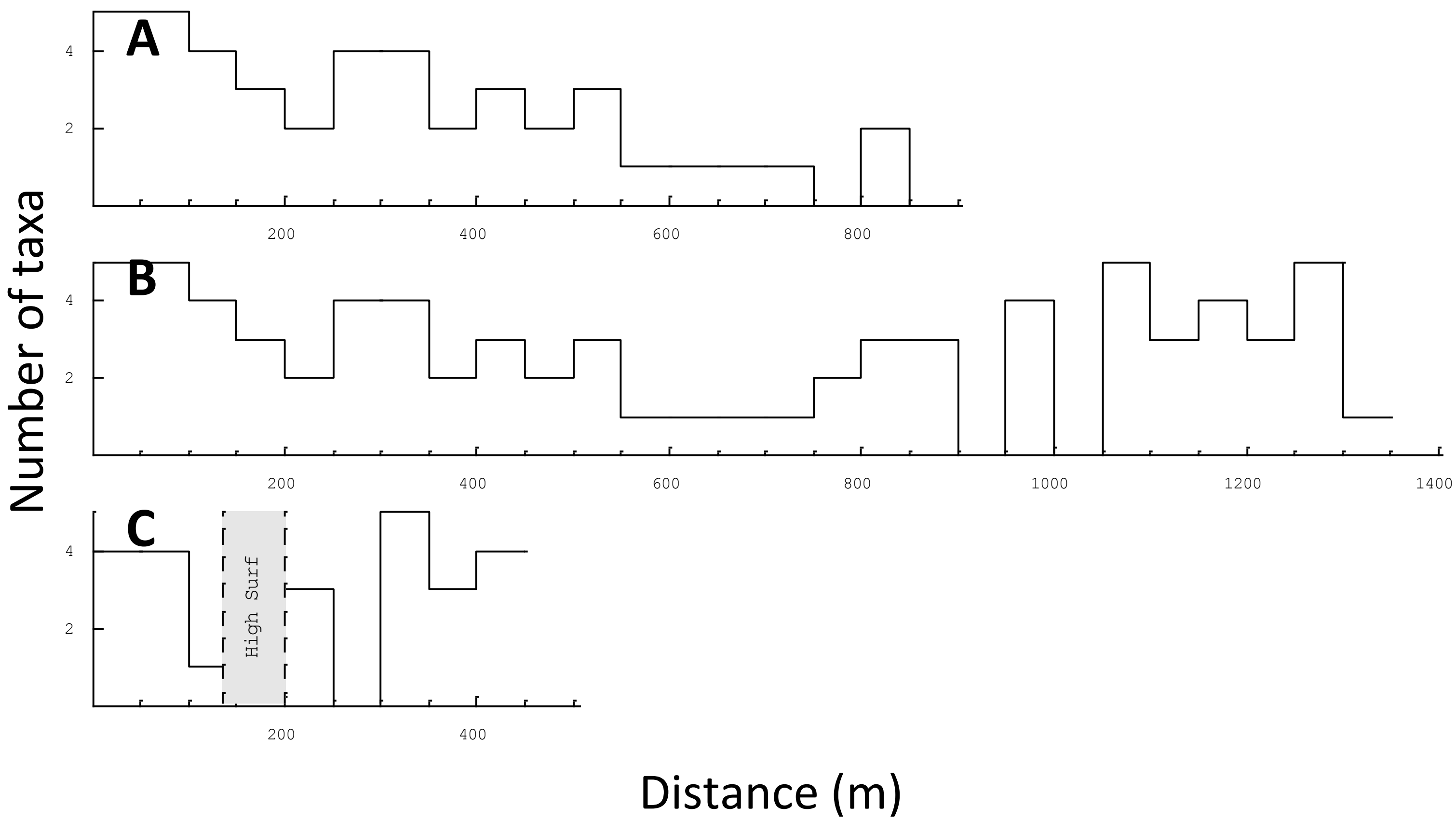


Figure 21. Number of species in the family Acanthuridae (surgeonfishes and unicornfishes) along the proposed cable landings A – C at Piti Bay. See Fig. 1 for landing locations. Abundances are total species seen on each 4-m X 50-m transect. The first transect on proposed landing A was 100 m. A 136-m section along proposed cable landing C was not surveyed because of high surf or is emergent even at high tide.

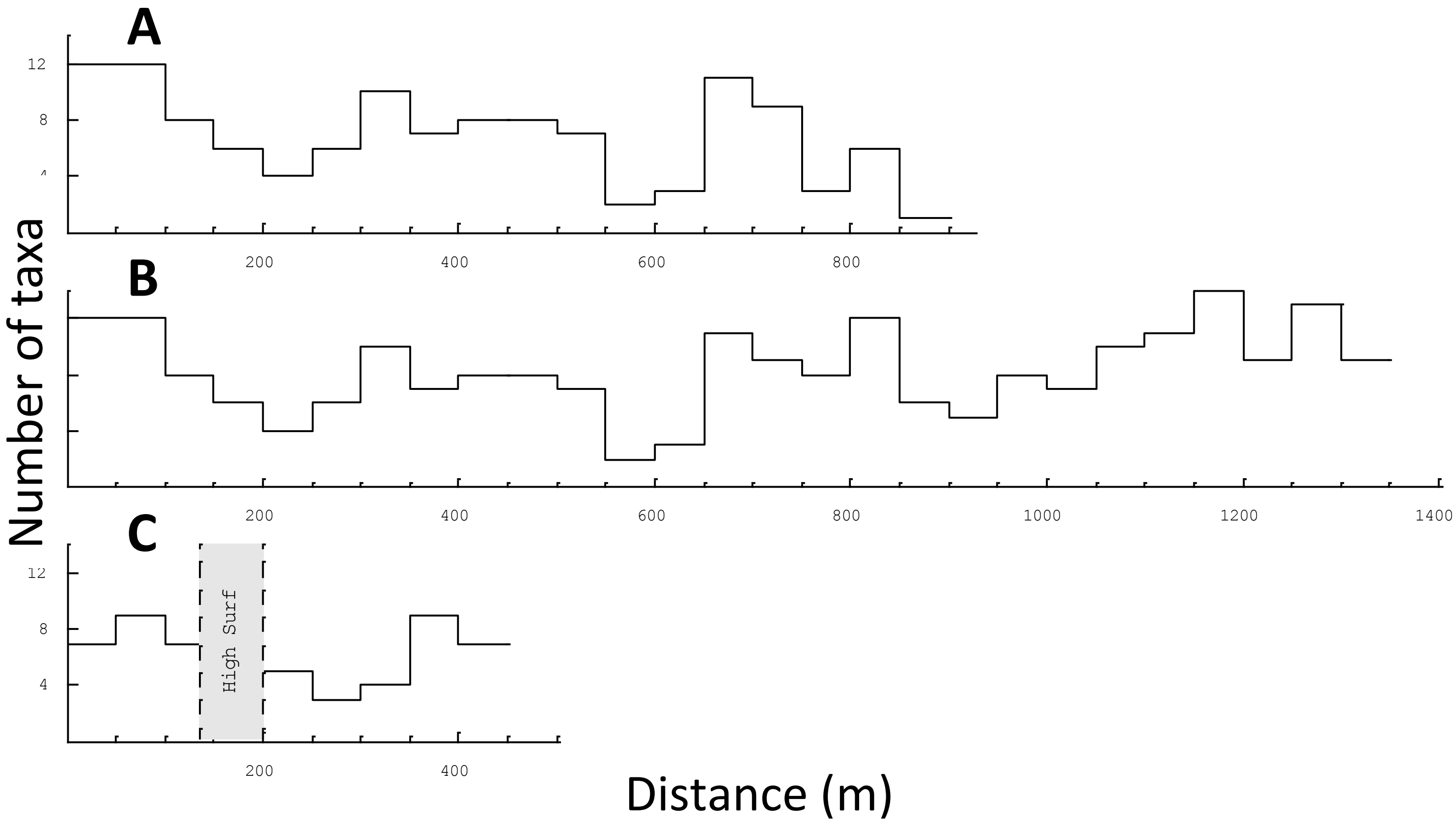


Figure 22. Number of taxonomic families of fishes along the proposed cable landings A – C at Piti Bay. See Fig. 1 for landing locations. Abundances are total species seen on each 4-m X 50-m transect. The first transect on proposed landing A was 100 m. A 136-m section along proposed cable landing C was not surveyed because of high surf or is emergent even at high tide.

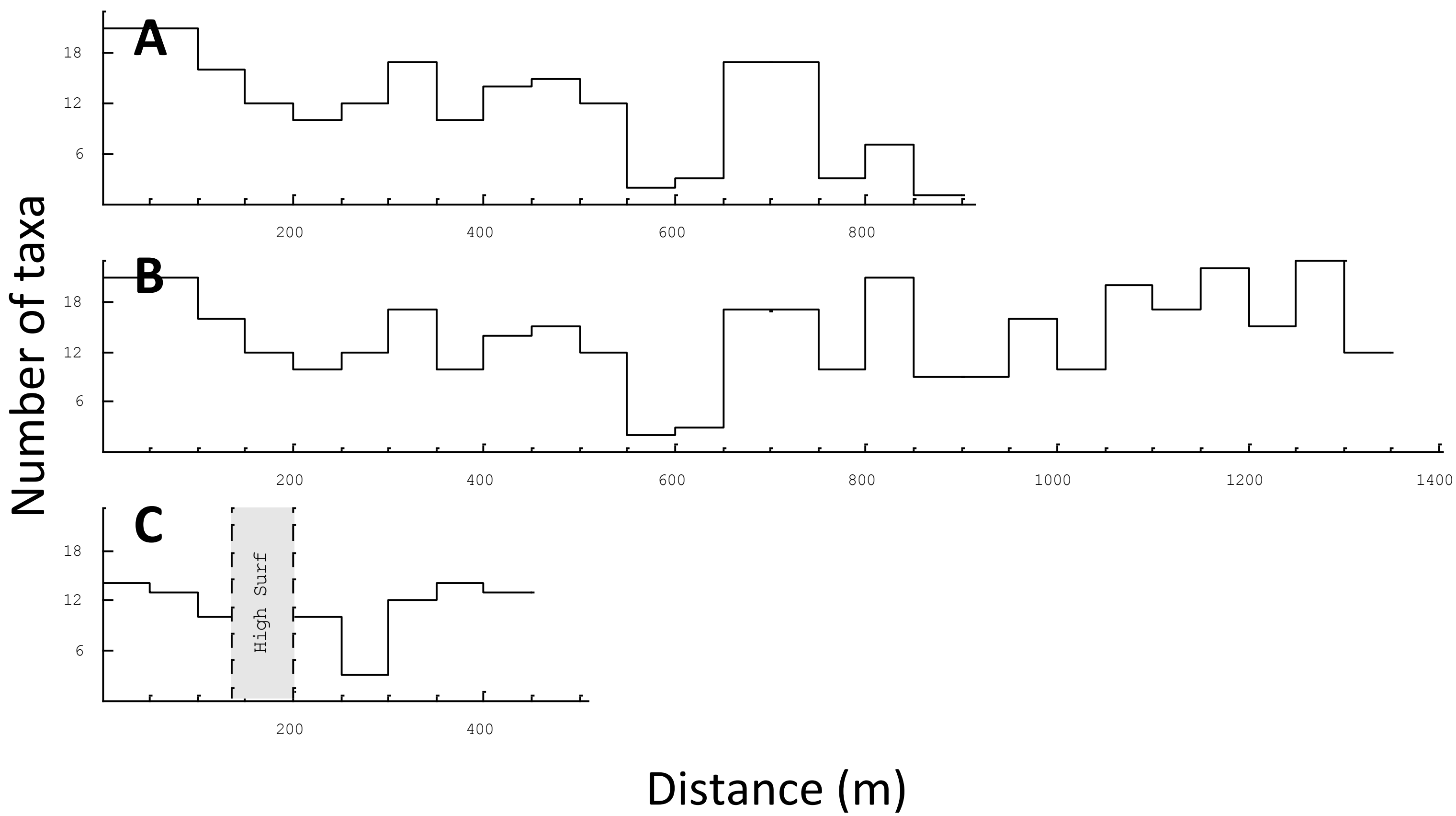


Figure 23. Number of genera of all fishes along the proposed cable landings A – C at Piti Bay. See Fig. 1 for landing locations. Abundances are total species seen on each 4-m X 50-m transect. The first transect on proposed landing A was 100 m. A 136-m section along proposed cable landing C was not surveyed because of high surf or is emergent even at high tide.

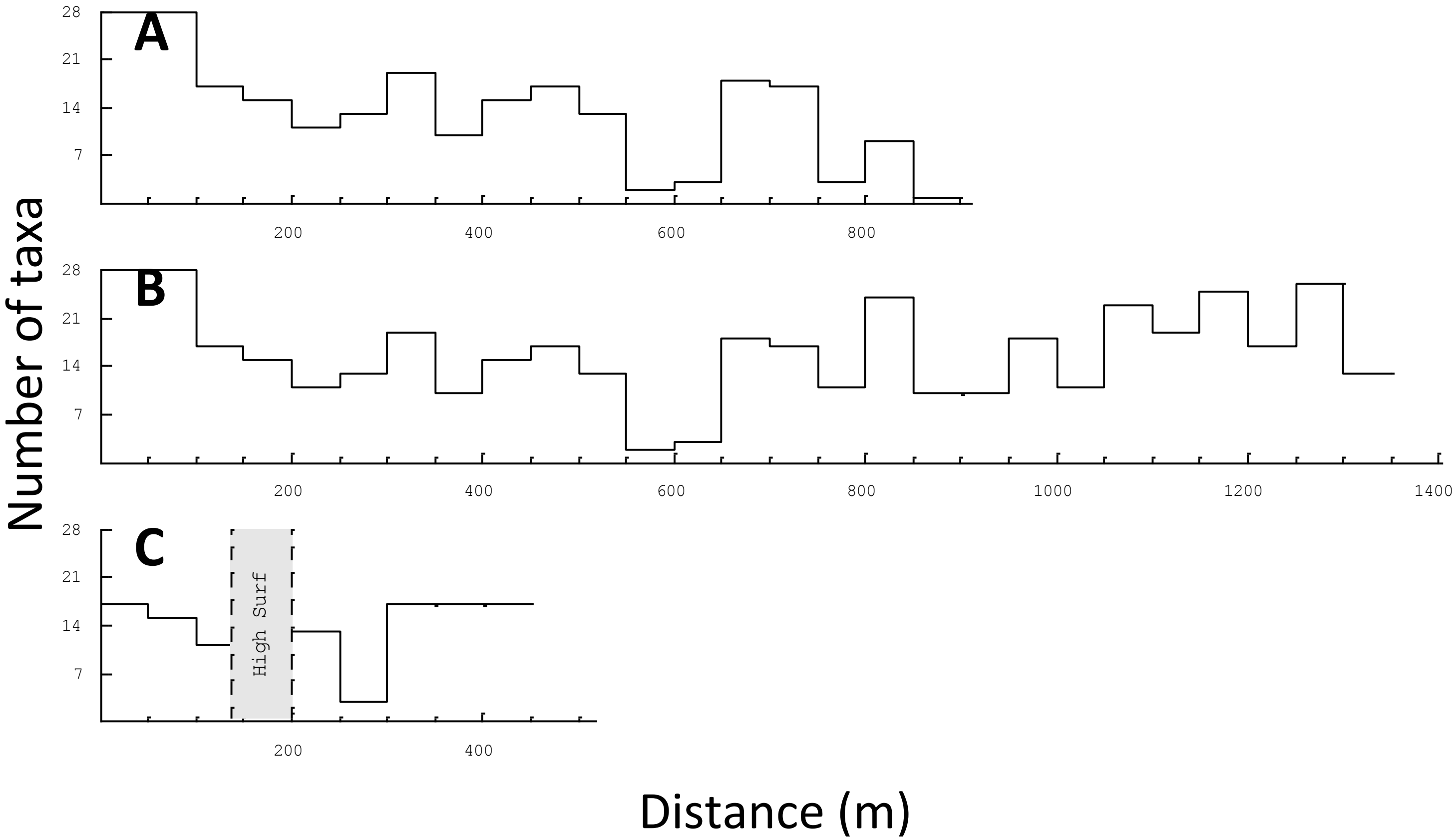


Figure 24. Number of species of all fishes along the proposed cable landings A – C at Piti Bay. See Fig. 1 for landing locations. Abundances are total species seen on each 4-m X 50-m transect. The first transect on proposed landing A was 4 m X 100 m. A 136-m section along proposed cable landing C was not surveyed because of high surf or is emergent even at high tide.

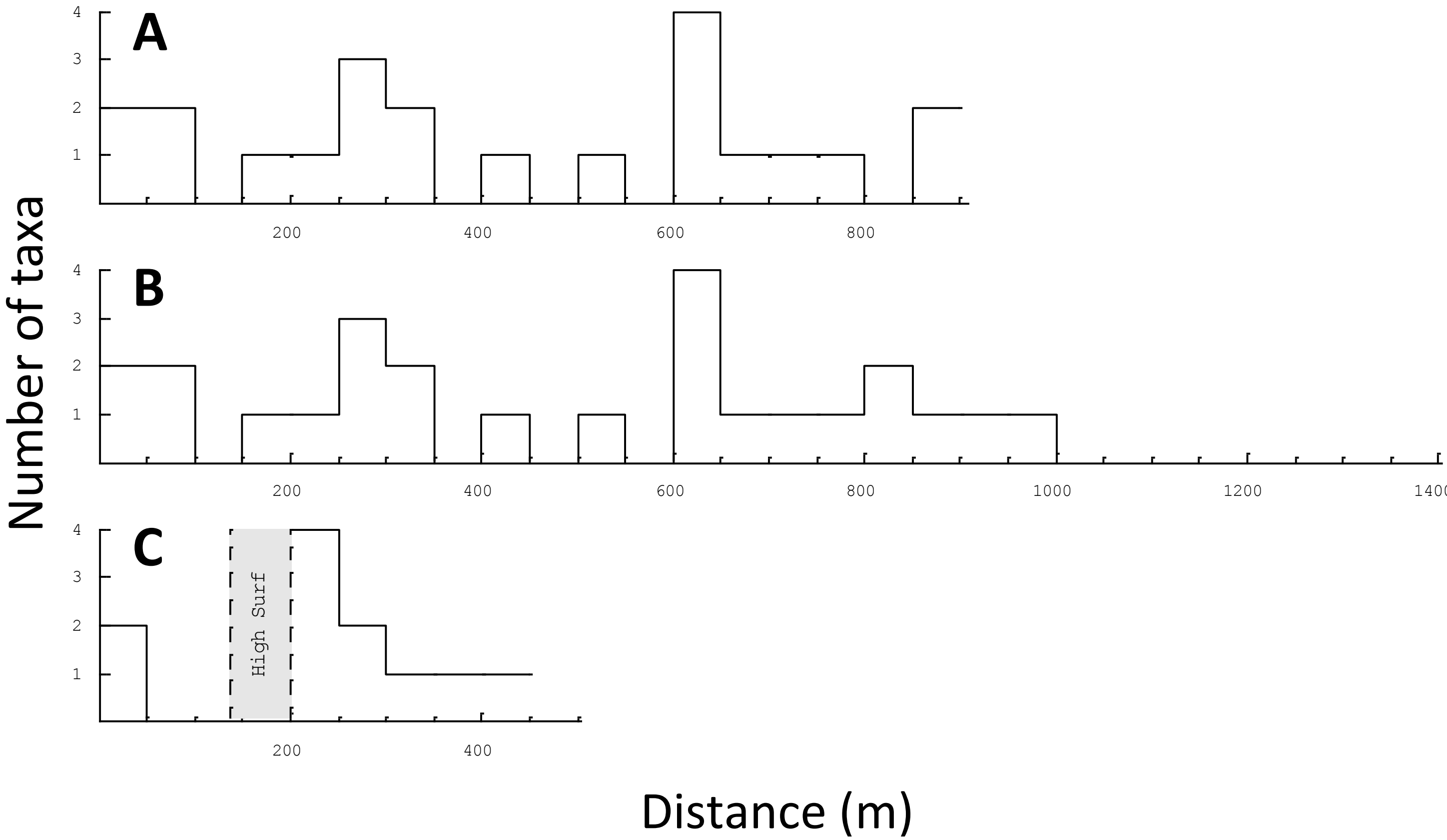


Figure 25. Number of species of Mollusca (clams, conch shells, cowries, etc.) along the proposed cable landings A – C at Piti Bay. See Fig. 1 for landing locations. Abundances are total species seen on each 4-m X 50-m transect. The first transect on proposed landing A was 100 m. A 136-m section along proposed cable landing C was not surveyed because of high surf or is emergent even at high tide.

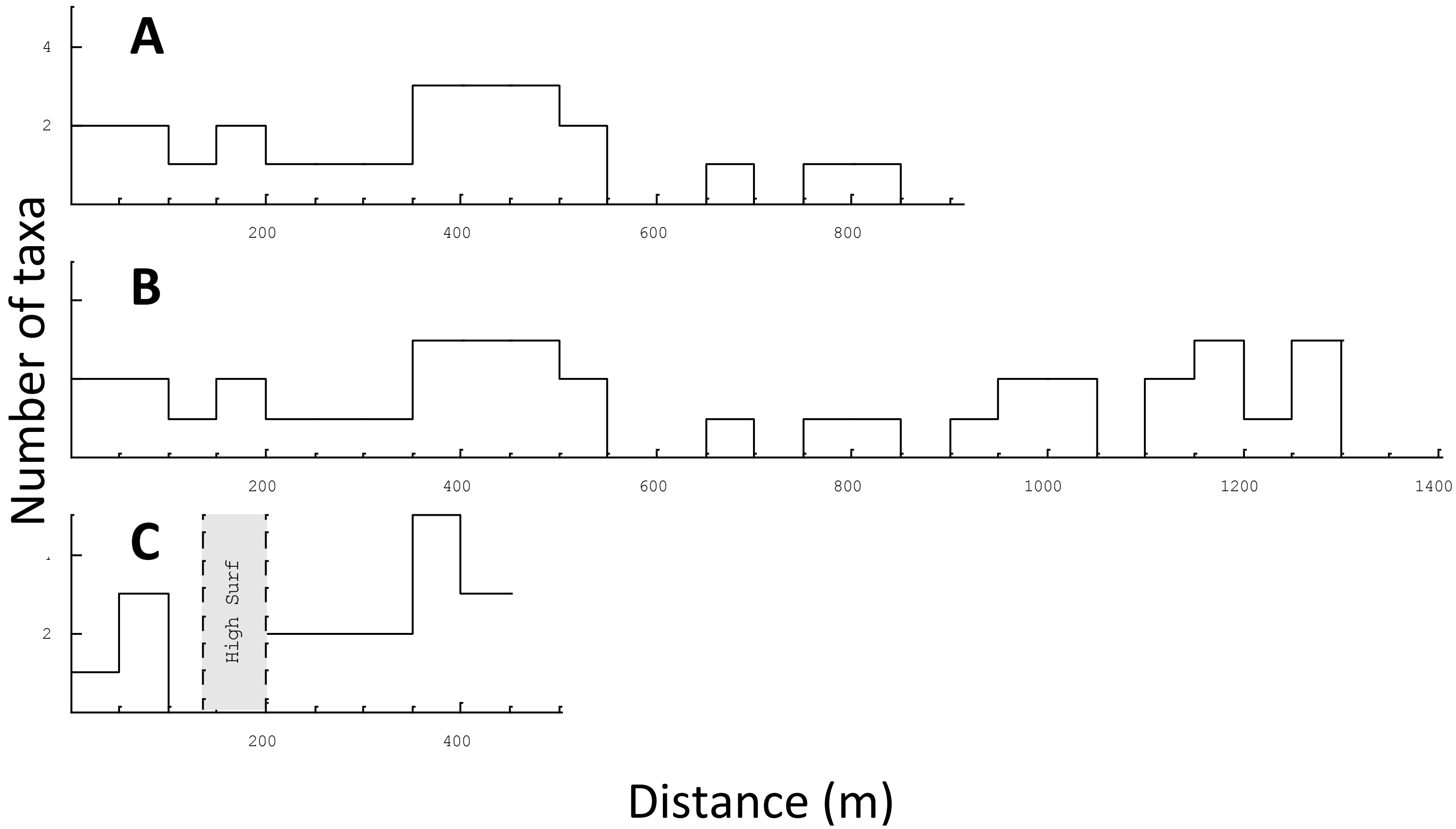


Figure 26. Number of species of Holothuriodea (sea cucumbers) along the proposed cable landings A – C at Piti Bay. See Fig. 1 for landing locations. Abundances are total species seen on each 4-m X 50-m transect. The first transect on proposed landing A was 100 m. A 136-m section along proposed cable landing C was not surveyed because of high surf or is emergent even at high tide.

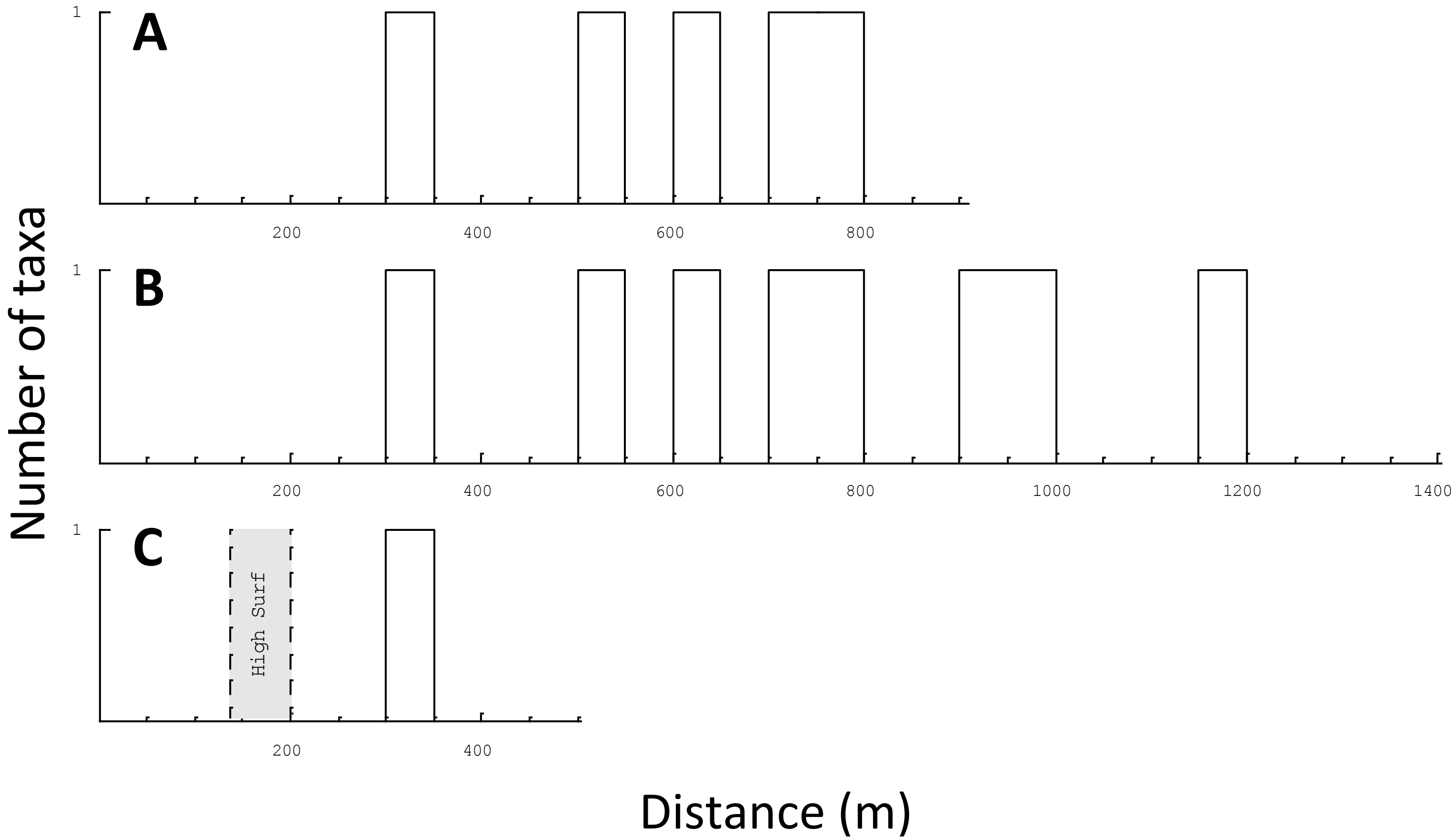


Figure 27. Number of species of Decapoda (crabs) along the proposed cable landings A – C at Piti Bay. See Fig. 1 for landing locations. Abundances are total species seen on each 4-m X 50-m transect. The first transect on proposed landing A was 100 m. A 136-m section along proposed cable landing C was not surveyed because of high surf or is emergent even at high tide.

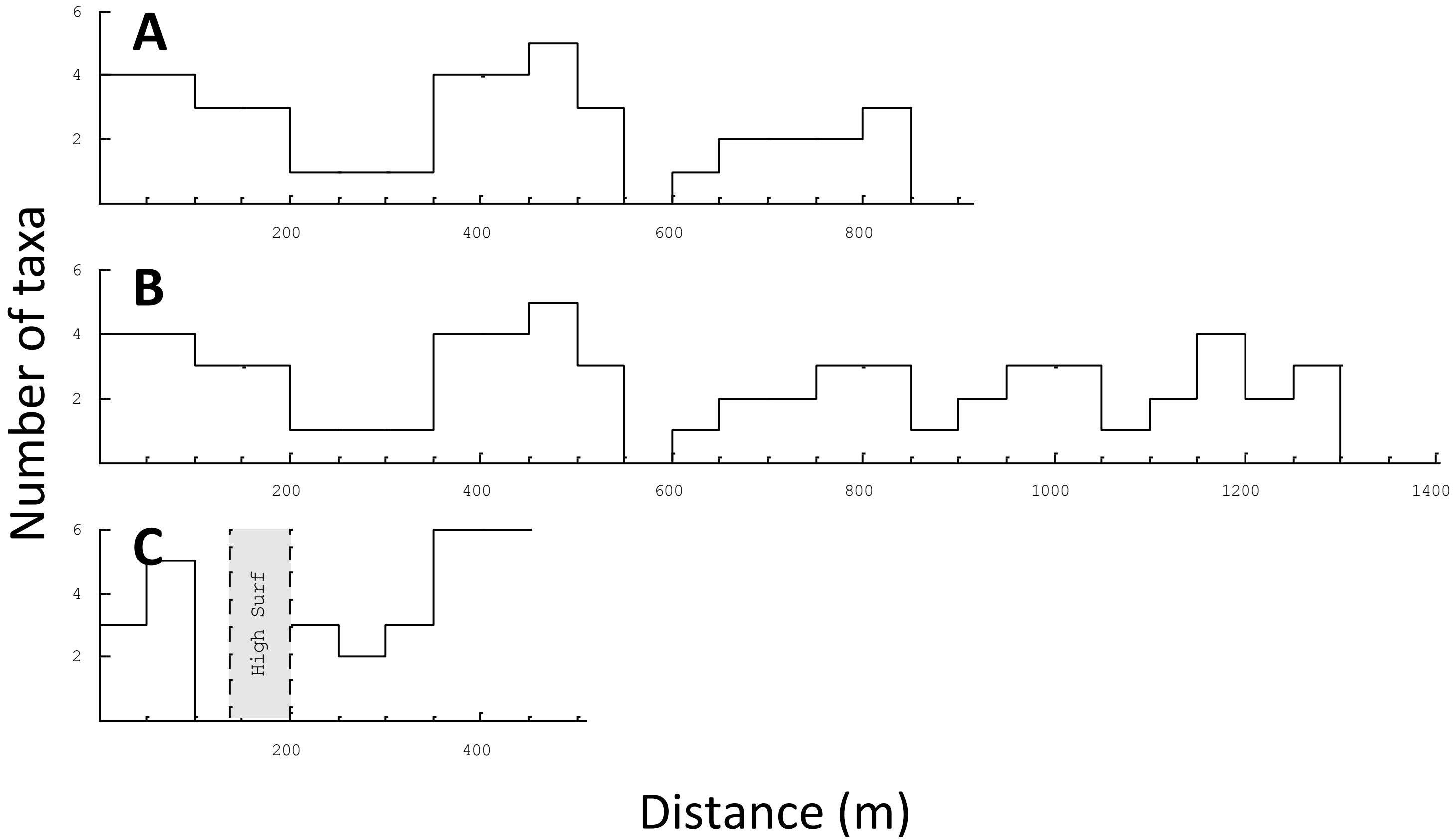


Figure 28. Number of species of Echinodermata (sea stars, sea urchins and sea cucumbers) along the proposed cable landings A – C at Piti Bay. See Fig. 1 for landing locations. Abundances are total species seen on each 4-m X 50-m transect. The first transect on proposed landing A was 100 m. A 136-m section along proposed cable landing C was not surveyed because of high surf or is emergent even at high tide.

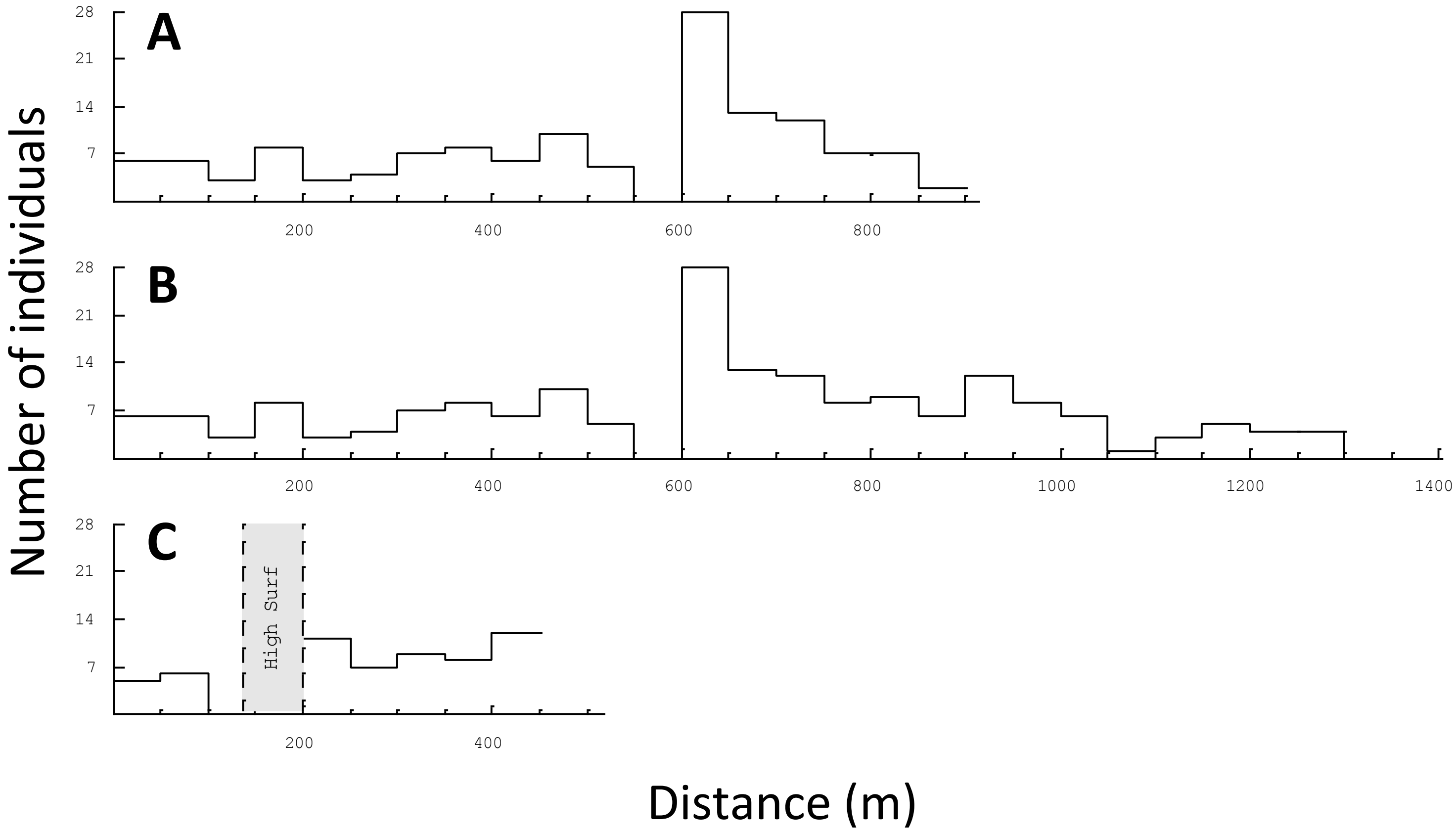


Figure 29. Number of individuals of all species of conspicuous invertebrates along the proposed cable landings A – C at Piti Bay. See Fig. 1 for landing locations. Abundances are total species seen on each 4-m X 50-m transect. The first transect on proposed landing A was 100 m. A 136-m section along proposed cable landing C was not surveyed because of high surf or is emergent even at high tide.

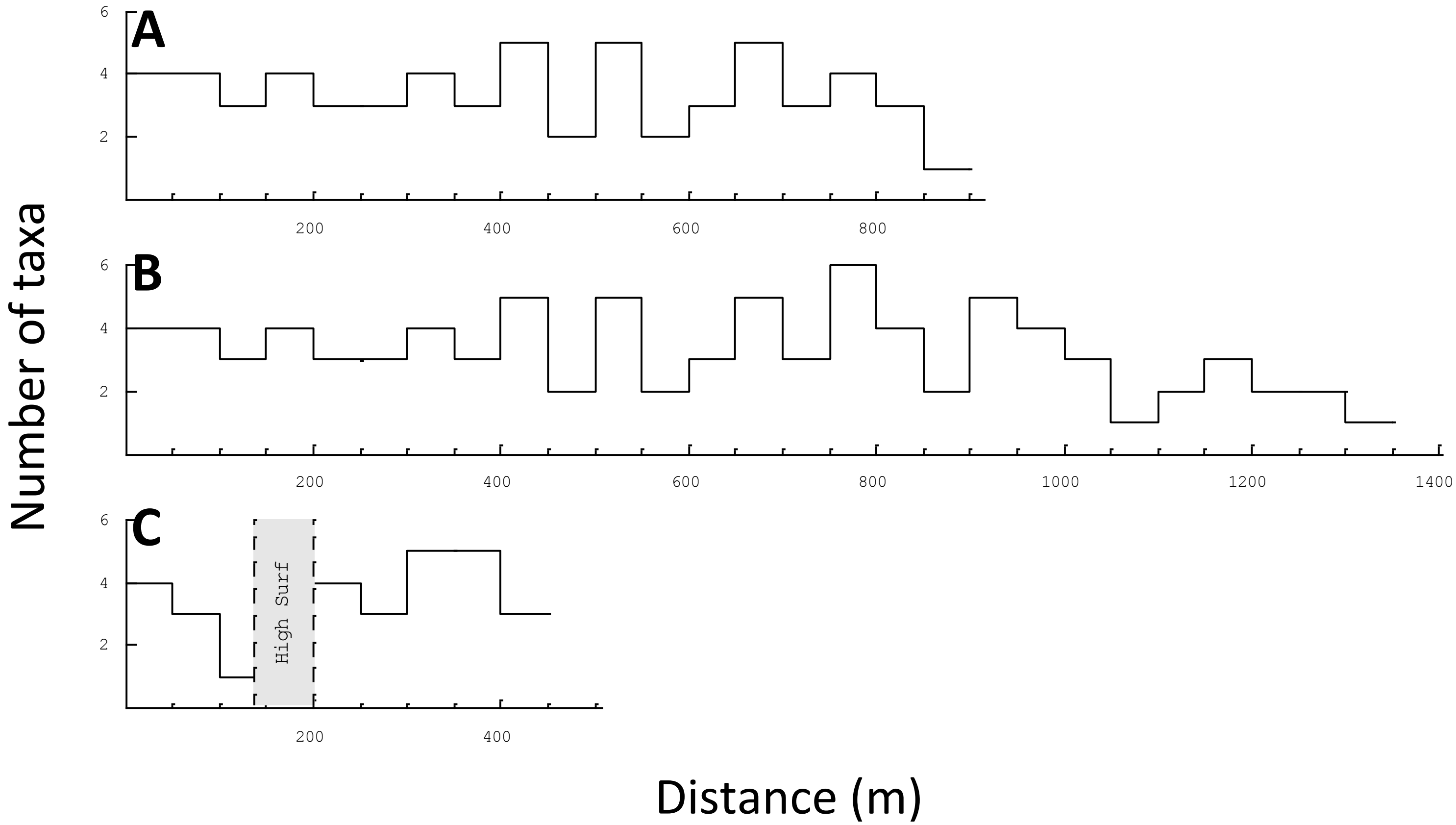


Figure 30. Number of taxonomic Classes and Orders of conspicuous invertebrates along the proposed cable landings A – C at Piti Bay. See Fig. 1 for landing locations. Abundances are total species seen on each 4-m X 50-m transect. The first transect on proposed landing A was 100 m. A 136-m section along proposed cable landing C was not surveyed because of high surf or is emergent even at high tide.

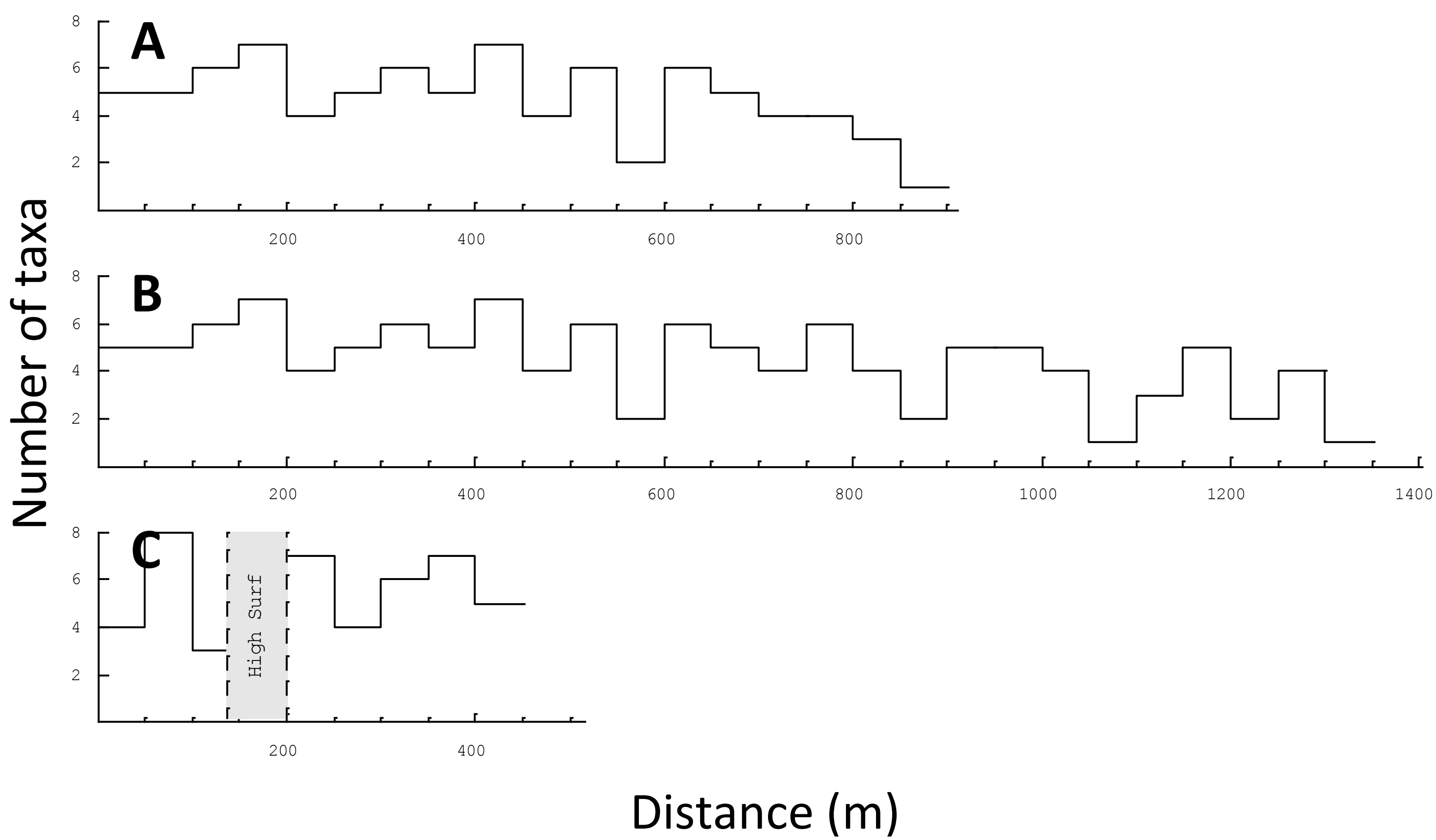


Figure 31. Number of genera of conspicuous invertebrates along the proposed cable landings A – C at Piti Bay. See Fig. 1 for landing locations. Abundances are total species seen on each 4-m X 50-m transect. The first transect on proposed landing A was 100 m. A 136-m section along proposed cable landing C was not surveyed because of high surf or is emergent even at high tide.

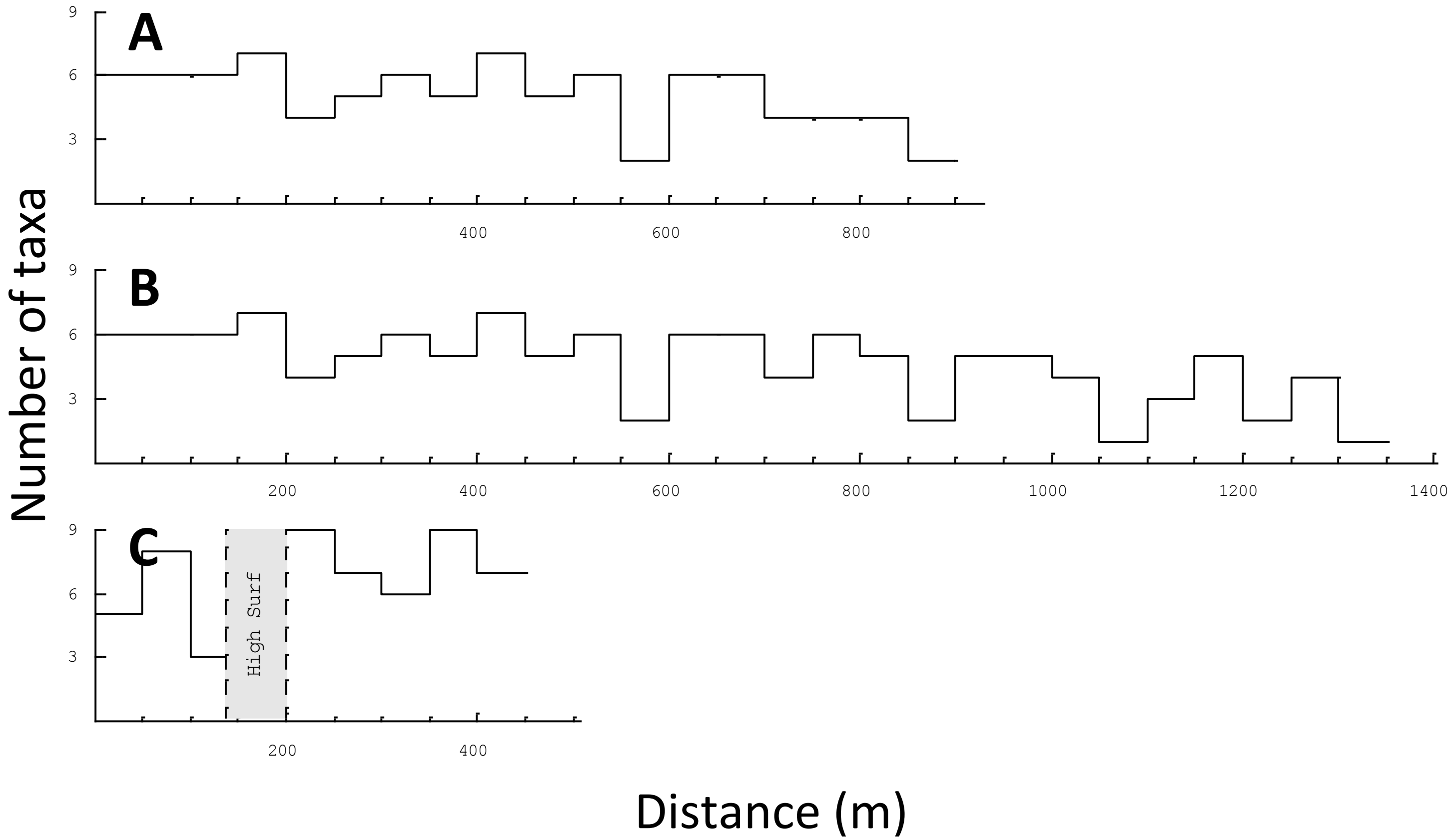


Figure 32. Number of species of conspicuous invertebrates along the proposed cable landings A – C at Piti Bay. See Fig. 1 for landing locations. Abundances are total species seen on each 4-m X 50-m transect. The first transect on proposed landing A was 100 m. A 136-m section along proposed cable landing C was not surveyed because of high surf or is emergent even at high tide.

Figure 33. Map showing approximate locations of the five colonies of *Acropora globiceps*. See Table 7 for GPS coordinates.

Appendix A: Biological Survey of a Proposed Bulkhead Site on Landing B

Introduction. We were also asked by Duenas, Camacho, and Associates, Inc., to perform an additional more detailed survey on the area potentially hosting a new bulkhead and shoreward landing and construction corridor for the new cable. The survey site (Fig. A1) began about 100 m from shore at the reef-flat margin and was approximately 12 X 100 m on its sides oriented generally NE about 6 m west of the present cable bulkhead at 13.4663 N° and 144.6935 E°. The surveys were carried out on 29 January (proposed bulkhead area only) and 2 April (construction corridor), 2016.

Survey methods. The survey quantitatively assessed the species composition, population density, and size distribution of hard corals (Scleractinia, Milliporina, *Heliopora*, Stylasteridae) in the survey area. All corals were identified *in situ*, hence the morphologically nearly identical and difficult to distinguish non-branching species *Porites lutea* and *P*. *australiensis* were considered together as *Porites* spp. Coral colony population density within a 12 X 12 m area centred on the proposed bulkhead were assessed within ten 1 m^2 quadrats haphazardly placed within the site. These quadrats were also used to measure coral colony size of 25 colonies as colony area (cm^2). In addition, the location of all non-*Leptastrea* corals observed within an approximately 12 meter-wide belt comprising the proposed construction corridor on the reef flat pavement habitat extending to shore were recorded using a GPS receiver and mapped using Google Earth Pro. The entire survey site several meters beyond these borders were also canvassed for rare coral species. Large echinoderms (> 5 cm total length) were counted over the bulkhead site. We also qualitatively assessed the existing bulkhead and the adjacent reef flat to the north of the existing bulkhead.

Site description. The site is part of a shallow intertidal reef flat of about 1 m depth at high tide and abruptly drops along its western margin an additional 1 m into Tepungan Channel. The shallow portion is rugose reef pavement with coralline rubble, sand and finer terrigenous sediments. The deeper, subtidal margin of the site is similar but with a deeper sand cover. The area appears heavily influenced by freshwater input from a nearby drainage stream. For example, the area around the proposed bulkhead had many scattered dead colonies of the bushy, branching coral *Pocillopora damicornis* at an approximate density of 5 – 6/m^2. All of these dead colonies were equally eroded, indicating that they had all likely been killed during the same event, either freshwater inundation during heavy rain, or perhaps an extended period of subaerial exposure. Further, all of the dead colonies were about 10 – 15 cm diameter, indicating that they were all of about equal age at death and so had recruited into the area at a single time.

Results and Discussion All hard corals seen were scleractinians. No species of coral observed during the survey are federally listed as threatened or endangered. In fact, all are common species seen elsewhere in similar environments around Guam and other islands in the tropical western Pacific. Most corals species, as well as all coral colonies over about 10 – 15 cm^2 in size were concentrated along the western margin of the survey area in the slightly deeper portion of the reef flat and adjacent channel margin abutting the existing bulkhead. A minimum of seven species of scleractinian corals were seen in the survey area (Table A1), all of which occurred nearest the reef-flat margin. *Pocillopora damicornis* colonies dominated here at about 9 colonies per m^2 and attaining sizes of around 400 cm^2. *Leptastrea purpura* occurred here and elsewhere in the survey area as tiny colonies of about 5 – 7 cm^2. Less common were *Porites* spp. Only seven colonies were seen near the deep margin, but two were quite large, over 1000 cm^2. Four other species also occurred along the western margin as one or two small colonies, including *Poc*. cf. *verrucosa*, *Goniastrea retiformis*, *Leptoria phrygia* and *Acropora* cf. *pulchra*, which occurred as a single unattached branchlet. By contrast, only two species of corals were seen over the remaining large portion of the survey area, all as tiny encrusting colonies of less than 10 cm^2 in size: *Poc*. *damicornis*, at about 0 – 1 colonies per m^2 and *L. purpurea*, at about 23 colonies per m^2.

The locations of all individual non-*Leptastrea* colonies or clusters of colonies encountered along construction corridor reef flat pavement habitat are depicted in Figure A1. This corridor within which the colonies were mapped extended approximately 18 meters west from the existing bulkhead, Additional coral colonies were observed on the vertical or near-vertical seaward face of the reef flat margin (as opposed to on top of the flat), and on a handful of raised hardbottom features set apart from the main reef-flat structure; corals observed in these areas (but which were not mapped) included several moderately-sized massive *Porites* spp. colonies and *Pocillopora damicornis* colonies, as well as multiple, clustered colonies of the alcyoniid soft coral, *Sinularia* sp., which together formed a large group of about 2 X 1 m.

To summarise, the corals *Poc. damicornis* and *L. purpurea* dominated the survey site, nearly always as widely scattered, very small and young colonies, often of fingernail-sized proportions. This is likely because both of these species, in contrast to the other coral species seen at the survey site and in adjacent areas, reproduce year-round via brooding. In coral-reef environments, brooding corals usually specialize in disturbed environments, such as shallow-water, nearshore environments.

A total of four species of large echinoderms were also seen in the survey area (Table A2), three species of sea cucumbers (*Bohadschia argus*, *Holothuria atra* and *Stichopus chloronotus*) and one species of sea star (*Linckia laevigata*). These are also common in this type of environment on other reefs on Guam and on islands in the western tropical Pacific. All species occurred at very low densities and appeared concentrated near the deeper northern edge of the survey area.

Outside the survey area, we noted that a similar sized area to the west of the existing bulkhead had a coral composition quite similar to that reported above for the survey area. This area may be a suitable recipient site for colonies that may require removal from the impact site. The existing bulkhead had a few scattered and tiny colonies of *Leptastrea purpurea*. Further, shoreward of the survey area, there were few to no corals, as it experienced extended periods of subaerial exposure at low tide, coupled with freshwater inundation from rain and shore discharge.

Table A1. Corals at the proposed bulkhead site. Sample size n = 25 randomly sampled colonies for the most common species or for rare species the total number of colonies seen over this site (12 X 12 m). Colony size and population density is mean and one standard deviation when $n > 1$. *Porites* sp(p). refers to the morphologically similar *P. lutea* or *P. australiensis*.

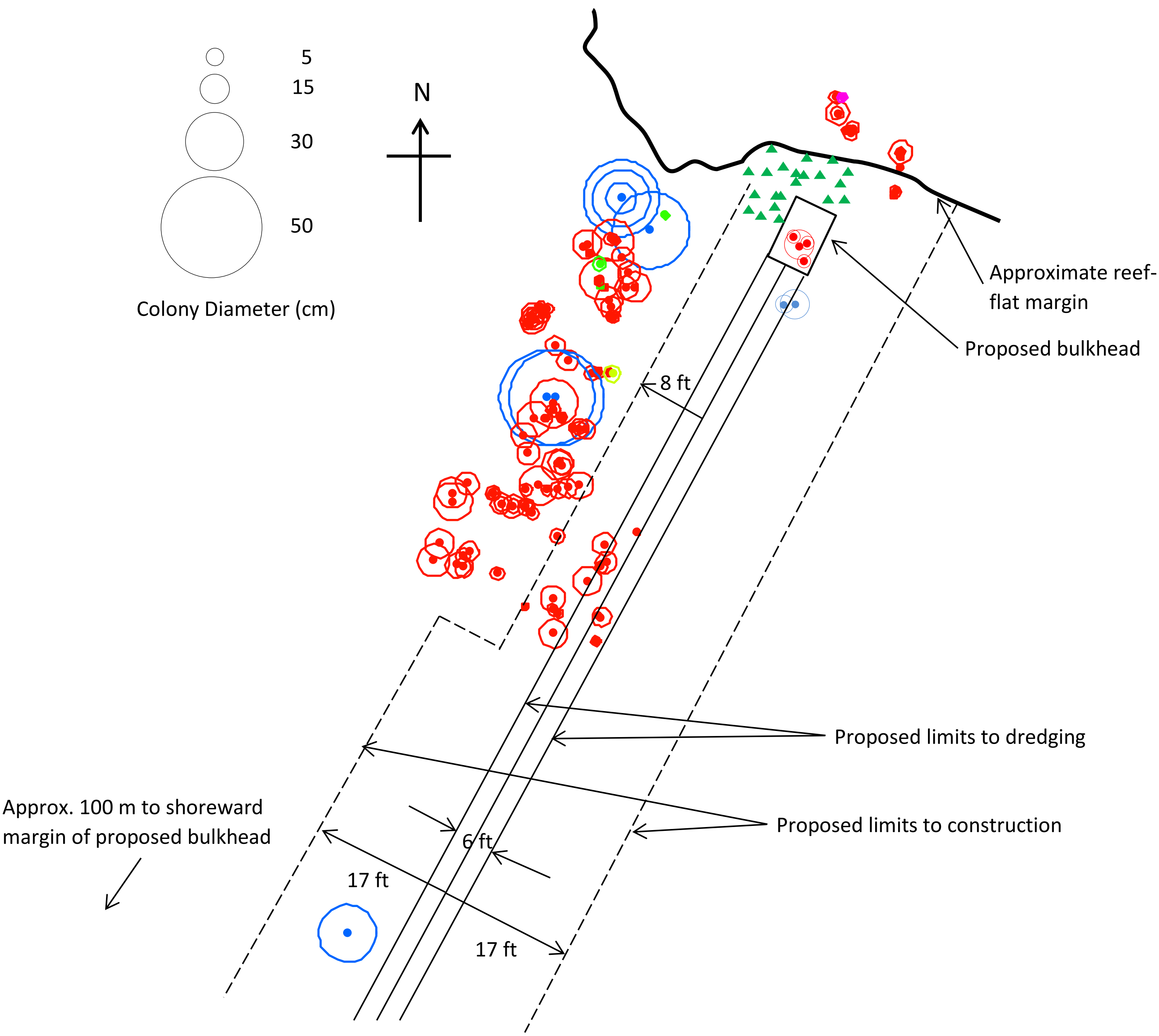
Family	**Species**	**Colony size (cm²)**	***n***	**Density (*n*/100 m²)**
Acroporidae	*Acropora* cf. *pulchra*	256	1	1
Merulinidae	*Goniastrea retiformis*	58.5±31.8	2	2
	Leptoria phrygia	225	1	1
Pocilloporidae	*Pocillopora damicornis*	105.1±114.9	25	956.0±116.6
	P. cf*, verrucosa*	70	1	1
Poritidae	*Porites* sp(p).	412.0±605.6	7	7
incertae sedis	*Leptastrea purpurea*	3.8±3.5	25	2360.0±3268.8

Table A2. Echinoderms at the proposed bulkhead site. Sample size *n* is the total number of animals seen over the entire survey site (12 X 12 m).

Class	**Family**	**Species**	**Density (n/100 m^2)**
Asteroidea	Ophidiasteridae	*Linckia laevigata*	2
Holothuroidea	Holothuriidae	*Bohadschia argus*	2
		Holothuria atra	2
	Stichopdidae	*Stichopus chloronotus*	4

Figure A1. Location of corals along the proposed bulkhead corridor. *Pocillopora damicornis* (in red), *Porites* spp. (blue), *Goniastrea retiformis* (green), and *Favia* sp. (purple). The numerous (*ca*. 10/m^2) and tiny (*ca*. 1 cm^2) colonies of *Leptastrea purpurea* are not shown (see text for discussion).

Note added in draft: Green triangles indicate 21 additional small colonies of primarily *P. damicornis* between 5-15 cm in diameter for which only approximate locations (± 5 m) are reported.



APPENDIX B

ARCHAEOLOGICAL MONITORING, IDENTIFICATION, EVALUATION, AND DATA RECOVERY PLAN FOR THE GUAM TELEPHONE AUTHORITY CABLE SYSTEM, LOT 262 AND LOT 5NEW-1 BLOCK 2, PITI, GUAM (MOORE, 2016)

ARCHAEOLOGICAL MONITORING, IDENTIFICATION, EVALUATION, AND DATA RECOVERY PLAN FOR THE GUAM TELEPHONE AUTHORITY CABLE SYSTEM LOT 262 AND LOT 5NEW-1 BLOCK 2 PITI, GUAM

Prepared by

Darlene R. Moore

Micronesian Archaeological Research Services, Inc.

Prepared for

Duenas, Camacho and Associates, Inc.

March 15, 2016

Micronesian Archaeological Research Services

March 15, 2016

RECEIVED
MAR 15 2016
GUAM HISTORIC RESOURCES DIV.

Mr. John Mark Joseph, Archaeologist
Guam Historic Resources Division
Dept. of Parks and Recreation
490 Chalan Palasyo
Agana Heights, Guam 96910

RE: Guam Telephone Authority's (GTA) Proposed Cable Landing Project in Piti, Guam, Lots 262 and 5NEW-1 Block 2.

Dear Mr. Joseph,

On behalf of our client, Duenas, Camacho, and Associates, Inc. (DCA), Micronesian Archaeological Research Services (MARS) submits the attached **Archaeological Monitoring, Identification, Evaluation, and Data Recovery Plan** for GTA's proposed Cable Landing Project in Piti, Guam for your review and approval.

If you have any questions, please let us know.

Sincerely,

Darlene Moore

Darlene Moore, Archaeologist

CC:Duenas, Camacho and Associates, Inc.

A Guam Non-Profit Corporation
P.O. Box 22303 ▫ GMF, Guam 96921
Tel: (671) 734-1129 ▫ Fax: (671) 734-1132 ▫ Email: ~~mars@kuentos.guam.net~~

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Introduction

Duenas, Camacho and Associates, Inc. (DCA) contracted Micronesian Archaeological Research Services, Inc. (MARS) to provide archaeological services for the Guam Telephone Authority (GTA) Cable System, involving conduit installation and the Southeast Asia-United States (SEA-US) cable landing at Pedro M. Santos Memorial Park (Lot 262) in Piti, Guam (Figs. 1-4). The area of potential effect (APE) includes an offshore and beach-side landing site, a trench across the Park and across (or under) Marine Corps Drive (Route 1). South of Marine Corps Drive, the cable trench will connect the landed cable to the improved GTA Substation (Lot 5NEW-1 Block 2). The locations for the subsurface disturbances related to the Cable System and connecting trenches are shown in Figure 4. The cable trench dimensions are approximately 1,110 ft long, 6 ft wide and approximately 3 ft to 5 ft deep. The proposed trench measures approximately 380 ft long and 3 ft deep offshore from mean high water to a new bulkhead at the Tepungan Channel margin, and approximately 180 ft long and 3ft deep from the mean high water to a new beach manhole. The proposed trench measures approximately 550 ft from the beach manhole to a new cable vault at the GTA Substation on the opposite side of Marine Corps Drive. The marine cable will terminate at a new beach manhole measuring approximately 15 ft long by 9 ft wide and 9 ft deep. Three ocean ground electrode beds will be installed to ground the cables. Each bed is 5.5 ft wide, 55 ft long, and 15 ft deep, and the beds are spaced 10 ft apart. The APE is 36 ft wide to encompass the new 6-foot wide cable trench, and widens in the vicinity of the beach manhole and ocean ground electrodes, and staging area (southwest of the electrodes). The marine cable will transition to a land cable at the beach manhole. Conduits to convey the land cable will be installed from the beach manhole to a new intermediate manhole that will be installed in the Park directly across from the GTA Substation. Conduits will be installed from the intermediate manhole to the Substation, and terminate at a new cable vault outside the Substation. The excavation will be 4 to 5 ft deep as it crosses Route 1 (Marine Corps Drive). The cable vault will have the same dimensions as the beach manhole (15 ft. long by 9 ft. wide by 9 ft. deep).

The proposed project includes the following parts:

Part 1 is the cable trench and conduit installation offshore from Santos Memorial Park.

Part 2 is the connecting cable trench and conduit installation onshore in Santos Memorial Park, and across Marine Corps Drive to the GTA Substation on Lot 5NEW-1 Block 2, south of Marine Corps Drive. This includes installation of a beach manhole and ocean ground beds.

Part 3 is the beach cable landing at Santos Memorial Park through the installed conduits.

Project Background

Archaeological investigations related to the proposed improvements to the GTA Substation (Lot 5NEW-1 Block 2, Piti) were completed for RIM Architects in June, 2015 by the archaeological consulting firm SEARCH. Prior to implementing a subsurface testing program on the GTA property, SEARCH submitted to Guam Historic Resources Division (GHRD) a comprehensive Research Design that includes an extensive review of the historic and archaeological history of the Piti vicinity (DeFant 2015). Because the GTA Research Design also pertains to the cable landing and connecting trenches, the detailed historical information contained in that document will not be repeated here.

Once GHRD approved the SEARCH Research Design, the archaeologists supervised the excavation of six backhoe trenches situated within the proposed footprint for the new building on the GTA Substation property (DeFant and Leon Guerrero 2015) (Fig. 5). Significant cultural deposits were not identified in the trenches, which were dug to depths of 1.4 m below ground surface. Exposed soils consisted of coral gravel fill over loamy clay and sand containing cinder blocks, metal cables, rebar, miscellaneous metal pieces, PVC pipe filled with concrete, aluminum soda cans, plastic bottle, plastic bucket lid and a section of a wooden pole.

In 2012 Garcia and Associates (GANDA) monitored the excavation of four backhoe excavations in Piti for GTA (Craft 2012). Trenches 1 and 2 were located in the right-of-way on the inland side of Marine Corps Drive just southwest of its junction with Route 11 (Cabras Island Rd.). Trenches 3 and 4 were located in the right-of-way on the inland side of Marine Corps Drive just south of the Route 11 junction. The depth of the trenches varied from .65 to 1.60 m. All four trenches exposed layers of construction fill and/or disturbed soils. No significant cultural deposits were identified.

MARS completed an archaeological testing program at Santos Memorial Park for Duenas Camacho and Associates, Inc. in 2009 (Moore and Amesbury 2009). Twelve backhoe trenches were excavated. No significant historic properties were identified. Five of the trenches dug during this testing project were located on the east side of the Park, in or near the path of the proposed cable landing and trenching (Fig. 6). These five trenches ranged in length from 3.0 to 5.5 m, width from .75 to 1.0 m, and depth from 1.20 to 2.0 m. Generally, the five trenches exposed limestone fill over moist, sandy clay. Thickness of the fill ranged from .65 to 1.20 m. In BT 4, the clay layer beneath the fill was very moist and contained abundant decaying plant parts which suggests that portions of the Park formerly were a low lying area that supported water tolerant plants, such as mangroves. In BT 5, closest to the shoreline, the water table was reached at a depth of 1.75 m.

Other archaeological projects completed in the vicinity of the project area also encountered introduced fill material overlying disturbed clays (see details below). The subsurface soils in the vicinity of the project area suggest that portions of the area were wet, probably prone to flooding, and possibly provided a habitat for mangroves, and or gardens. On the other hand, cultural deposits and features dating to the Latte Period and the Spanish Period have been identified at the east end of Piti, near the place name Tepungan (Workman and Haun 1992).

The Area of Potential Effect (APE) for the proposed Cable System project does not encompass any historic resources listed on either the Guam Register (GRHP) or the National Register of Historic Places (NRHP). In processing the Department of the Army Permit application, the US Army Corps would engage in National Historic Preservation Act (NHPA) Section 7 consultation. This Archaeological Monitoring, Identification, Evaluation, and Data Recovery Plan would support the Corps' anticipated finding of "No Adverse Effect" for the Cable Landing project. Guam Historic Resources Division (GHRD) is anticipated to concur with that finding once an approved **Archaeological Monitoring, Identification, Evaluation, and Data Recovery Plan** is in place. GHRD requires that the Plan address the entire project.

Based on MARS' conversations with GHRD former employee and archaeologist, Rich Olmo, prior to his departure from GHRD and considering that an extensive background review prepared by SEARCH for the Piti vicinity was previously approved by GHRD, the Plan for the Cable Landing project will describe the archaeological investigations (including archaeological monitoring, analysis, and reporting) that will occur during and after construction of the proposed project.

Because the privately funded Cable Landing project requires a permit from the U.S. Army Corps of Engineers, the archaeological research for this project will comply with the Federal regulatory mandate, including the amended National Historic Preservation Act of 1966 (especially Section 106), the National Environmental Policy Act, Executive Order 11593, the Archaeological and Historic Conservation Act of 1974, the Housing and Community Development Act of 1974, and the Archaeological Resources Protection Act of 1979. The Secretary of the Interior's Standards and Guidelines for Archaeology and Historic Preservation will be followed during the project.

The Guam regulatory mandate for the proposed undertaking includes Public Law 20-151 and 21-104. Public Law 20-151 requires that the project area historic properties be professionally assessed in order to fulfill GHRD permitting conditions. Under Public Law 12-126 agencies, such as GTA, must conduct their undertakings so as to maximize the protection of territorial cultural resources.

Environmental Background

Young (1988) describes the soils in Santos Memorial Park and Lot 5NEW-1 Block 2 as consisting of the Urban land Ustorthents complex. Urban land consists of areas covered by buildings, roads, and parking lots. Some of these areas have a base of crushed coral and some rest directly on limestone. Areas of Urban land are impermeable to water and runoff is rapid. Ustorthents is quarried fill material. Commonly the fill is crushed coral gravel. Included in this unit are small areas of Shioya soils along the shoreline. Shioya soils are made up of water-deposited coral sands derived from the reef. Currently, the eroding edge of the shoreline at Santos Memorial Park has a vertical drop of 50-80 cm to the narrow beach, which is underwater during periods of high tide. No significant cultural material was seen on the beach.

The previous trenching on Santos Memorial Park (Moore and Amesbury 2009) and on the GTA Substation property (DeFant and Leon Guerrero 2015) found that much of the area had been previously filled. The fill material overlays moist sandy clay. No intact cultural deposits have been noted in the clay.

Previous Archaeological Background

Recent archaeological projects completed in Piti include DeFant and Leon Guerrero (2015); Moore and Amesbury (2013); Moore (2013); Craft (2012); DeFant and Moore (2012); DeFant (2011); Vernon and O'Day (2009); Moore and Steffy (2008); Hunter-Anderson (2002); and Workman and Haun (1992). The results of most of these projects are described in the Research

Design prepared for the GTA Substation project (DeFant 2015). Those included in the DeFant document are not repeated here. Those not included in the DeFant document are included here.

In 2013, MARS did archaeological testing and monitoring of the Masso River Embankment Restoration Project in Santos Memorial Park (Moore and Amesbury 2013). Six backhoe trenches were dug on the west side of the park. Three trenches were located adjacent to the south side of the river and three were located adjacent to the north side of the river. The trenches on the river's north side exposed culturally sterile layers of beach sand, while the trenches on the river's south side exposed disturbed wet clays and introduced fill. A few glass and historic ceramic fragments were recovered from the clay below the fill in Trench 3 on the south side of the river. Two historic ceramic sherds were recovered from the trenches north of the river, along with a possible hammerstone and a slingstone (which was picked up on the beach).

In 2013, MARS monitored backhoe excavations for a new electrical conduit for the renovation of the Day Buy Day grocery store (the former New J Market) located on the inland side of Marine Corps Drive in Piti, east of the project area. The 1.0 m deep trench was situated under the paved parking lot in front of the building. Below about .75 m of introduced fill was a wet sandy clay. Three pieces of coal were noted in the clay.

In 2009, GANDA completed an archaeological investigation at the 76/Circle K Guam location (former Piti Mobile Station) in Piti (Vernon and O'Day 2009). This project area is located a short distance east of the GTA Substation and southeast of Santos Memorial Park (see Fig. 3). The 3 m deep excavation for a French Drain exposed about 1.0 m of fill over a previously disturbed, saturated sandy clay. The project lacked historically significant resources. Materials encountered in the excavation included metal and PVC pipes, wire, and rough cut lumber with galvanized nails and mortise-and-tenon joints. The authors proposed that these were the remains of an old wooden structure of some sort. The GHRD office suggests that the timbers could represent a section of cord road, built to cross the wet clay in Piti (Mr. JM Joseph, Territorial Archaeologist, pers. comm. 2015).

In 2008, MARS completed a survey of *Hotnun Sanhiyong,* Guam's Outside Ovens for the Guam Historic Preservation Office (Moore and Steffy 2008). Two ovens were documented in Piti; the Fejeran Oven and the Quan Oven. Both were built by former Piti resident, Jose Cruz Fejeran. The Quan Oven is listed on Guam's Historic Property Inventory, GHPI Data Form 66-03-2276, the Fejeran Oven was too recent to be placed on the list. The Quan oven was located in the corner, west of J.C. Tuncap Street and north of J.C. Santos Street (see Fig. 3). Associated with the Quan oven was a raised barbecue grill and a separate, above ground water tank or fish pond. Recent construction on this property may have destroyed one or more of these features.

In 2001, MARS monitored the cable landing site situated on Lot 58-1-New-1-1New, Piti (Hunter-Anderson 2002:34). This landing site is situated along the Piti shoreline just east of the proposed GTA landing site (see Fig. 3). A drainage ditch separates the two sites. The beach manhole excavation measured 13 ft by 19 ft by 11 ft deep. A 15 cm thick layer of crushed coral gravel had been spread on ground surface prior to the excavation. Below the gravel to a depth of 1.0 m was a dark brown sticky clay, from 1.0 m to 1.7 m below ground surface was an orangebrown sticky clay, from 1.7 m to 2.13 m was a dark gray/green muck, and from 2.13 m to 3.35 m was a whitish gray sand with numerous coral heads, staghorn coral and marine shells. Groundwater was observed at a depth of 2.13 m. The muck layer was thought to represent a former mangrove habitat, but due to the unstable excavation walls, no sample was taken. No intact cultural deposits were observed in the manhole or in the four feet wide, four feet deep trench that was located south of the manhole. However, the excavation for the manhole exposed some Latte Period pottery sherds, modern glass bottles and ordnance from WWII. The ordnance was turned over to the appropriate authorities.

Beginning in 1990 and intermittently continuing until 1993 MARS monitored mechanical excavations related to the reconstruction of Marine Corps Drive from Route 8 to Route 11 (Cabras Island Road) (Wells et al. 1995). No intact cultural deposits were identified in the Piti Highway corridor, located on the seaward side of the road.

Archaeological Expectations for the Project Area

Based on the findings of the previous archaeological projects completed in the vicinity of the project area, the landing and connecting trench are not expected to encounter significant historic properties in Santos Memorial Park. However, it is possible that the connecting trench will encounter buried intact cultural deposits on the seaward side of Lot 5NEW-1 Block 2, between the GTA Substation Building and Marine Corps Drive. This portion of the project area has not been previously investigated. Additionally, it is possible that remnants of the old Spanish Road through this part of Piti may be encountered in the connecting trench.

It is likely that the excavations related to the cable landing and connection trenching will encounter ordnance and discarded materials related to WWII. DeFant (2015) noted that a monitoring project in Piti in 1992 (Workman, Brown, and Haun 1992) encountered a "cache of rifle and small artillery ammunition in a buried earthen bunker…" In association were idler wheels from a tank, mess kits, and bipods for infantry rifles." The location of this accumulation of WWII debris was given as across Route 1 from the coastal portion of the GTA Substation property, Lot 5NEW-1 Block 2.

A gleyed deposit containing decaying wood and roots may be encountered in the excavations. An analysis of this organic material could provide information about the types of vegetation that were growing in the area, prior to the clearing and infilling that has taken place.

Methods and Procedures

The purpose of the Archaeological Monitoring, Identification, Evaluation, and Data Recovery Plan is to ensure that historic resources in the project area are identified and appropriately treated prior to their being lost from the archaeological record. The plan describes the steps to be taken when assessing historic significance.

The main criteria for determining the significance of archaeological materials are the federal government's guidelines for nomination to the National Register of Historic Places, especially Criteria A and D. Criterion A states that a site is significant if it is associated with events important to broad patterns of our prehistory or history. This would include WWII. Criterion D states that a site is significant if it has yielded or has the potential to yield important information about the prehistoric or historic record of a place or people. This would include, for example, data pertaining to prehistoric settlement, subsistence, social organization, land use, or religion, including mortuary practices.

The report style and content guidelines spelled out in the March 18, 2014 GHRD Basic Reporting Requirement will be followed.

The construction excavations related to the landing and the trench connecting the cable to the substation will be monitored by qualified archaeologists. The objective of the monitoring is to identify and evaluate potentially significant historic resources prior to their destruction and to notify DCA and GTA upon discovery of significant properties. The archaeological monitor will carry out an appropriate level of site recordation (including plan mapping, stratigraphic profiles, written descriptions and photographs). Diagnostic/museum quality artifacts, necessary to document and evaluate identified deposits or features, will be collected. Samples will be taken. Site coordinates will be located with sub-meter accuracy and site boundaries plotted on current USGS maps. Each site will have a permanent datum point established. Guam Historic Properties Inventory data forms will be updated or completed.

If the archaeologists determine that significant remains have been identified and data recovery procedures beyond what can be accomplished during the time allotted can be performed, MARS will make recommendations regarding preservation or further treatment to DCA and GTA. Any additional archaeological work may not require preparation of a new research design, but a change work order may be necessary to cover expenses for additional data recovery, if needed.

Anticipated cultural materials include both prehistoric and historic items. Diagnostic items in disturbed soils may be collected. If intact cultural deposits are encountered the archaeologists will collect individual items and quantitative samples and place them in appropriately labeled collection bags. A field catalog will be maintained. Hand excavated soils will be screened through a 1/8 inch mesh if possible. Charred material from intact features, such as earth-ovens or hearths will be collected for radiocarbon processing. Appropriate soil samples for further study will be taken during hand excavations and/or from the walls of the trenches. All recovered materials will be taken to MARS' facility on Guam for processing and analyses.

The ceramics, artifacts, and non-human faunal remains will be analyzed on Guam. The traditional ceramics will be subjected to an attribute analysis that records information about temper content, surface treatment, rim type, wall and rim thickness. The pottery data set can be compared with pottery collections from other Guam sites to see how similar or different they are. That information may provide insight as to how the people were organized on the island. Marine shells will be sorted to the lowest possible taxon (family, genus, or species), counted and weighed. The marine shell data set can be compared with other collections from similar time periods to look at differences in shell habitats and/or collection strategies. Stone and shell tools and other artifacts will be described and photographed. The tools provide information about the range of activities that were carried out at the site.

Charred materials will be sent to off-island laboratories for radiocarbon dating. If deposits of decayed wood are encountered, samples will be taken and sent to off-island laboratories for identification. Soil samples may be submitted to off-island laboratories for pollen and phytolith analyses. The results of such specialized studies can provide information about past environmental conditionals in this part of Guam. Knowledge of past environmental conditions is important for accurate archaeological interpretations, such as land utilization.

If human remains are encountered, GTA and DCA will consult with GHRD to determine the appropriate measures to be taken. If they are to be removed, the costs of recovery, analysis, and reburial will be negotiated (see Burial Treatment Plan below).

Research Questions and Approaches

Archaeological inquiry is guided by both broad and site-specific research questions arising from a review of the pertinent literature and from the archaeologist's prior field experience. A major question for all projects is **When and how was the project area utilized?** Descriptions of the archaeological features and items identified during the survey will help to answer this question.

There is a growing body of archaeological evidence for prehistoric rice on Guam, but as yet little is known about where it was grown. Rice is known to have been planted in Piti in historic times. **Was rice grown in the project area?**

What was the Masso River shoreline like before dredged reef rubble was introduced to the site? If the trenching encounters soil deposits that contain decaying roots or plant material, samples will be taken and sent off-island for identification and possible radiocarbon dating.

The road through Piti linking the historic village of Sumay with Hagatna is known to have been built during Spanish times, but little is known about road construction techniques utilized in the 1700s and 1800s. If old road beds are encountered along the trench corridor, photos and GPS coordinates will be taken, profiles will be drawn, and samples taken as appropriate.

Interpretation and Dissemination of Information

MARS will prepare draft and final reports which present the methods employed, the results of the monitoring activities, an assessment of the research questions, and recommendations regarding further work, based on the significance of the findings. Government of Guam site inventory forms will be completed or updated for sites identified in the project area. Two copies of the final technical report and an electronic versions will be submitted to GHRD. Copies of the final report will be available to DCA and GTA.

Personnel

MARS staff are familiar with Guam archaeology and are qualified to perform the inventory survey, to perform laboratory analyses of recovered cultural material, to select samples for radiocarbon dating, and to send them to off-island specialists for processing. All archaeological work and personnel will conform to the Secretary of the Interior's historic preservation standards and guidelines.

Work Schedule

MARS will work closely with DCA and the construction contractors to monitor the mechanical excavations. Laboratory work including cleaning, sorting, counting, weighing, and describing the items will be initiated once the monitoring tasks have been completed. It is expected that these studies will be completed within three months after field work is finished.

Curation and Disposition of Recovered Material

MARS will store the cultural material recovered from the project area until the various analyses have been completed and the final report accepted. Once these requirements are met, the cultural material and copies of field records, photographs, and the report will be turned over to the Guam Museum.

Burial Treatment Plan

Burials are to be treated in accordance with Executive Order 89-24 and with the GHRD's General Guidelines for Archaeological Burials as amended March 2010. The guidelines specify that when human bones are found at an archaeological site, they are to be left undisturbed if possible. This requirement sometimes results in the redesign of a project.

Data recovery in a burial area entails the systematic exposure of the human remains in their archaeological context. This is accomplished by hand excavation of burial features and associated cultural deposits. Because prehistoric burials on Guam usually are located within former residential areas, the associated cultural deposits often include hearths, earth-ovens, pits, post holes, as well as various artifacts and other culturally generated materials, especially marine shell middens.

Burials will be hand excavated using small wooden picks and small to medium brushes. After the skeletal remains have been exposed, photographs will be taken and scaled plan maps drawn. If necessary, additional plan maps will be drawn during exhumation to document the locations of previously obscured bones and artifacts. Burial register forms will be completed for each burial. Burial orientation will be determine by sighting along the long axis of the vertebral column, from the cervical vertebrae to the sacrum. Burial position will be categorized as extended, semi-flexed, flexed, and tightly flexed.

The analysis of the skeletal material will be completed on Guam by a qualified osteologist. In the laboratory, the skeletal remains will be allowed to air dry and will be cleaned with small brushes. Reconstruction of post-mortem breaks will be carried out only where readily apparent "joins" are available and where the resulting measurement is significant for comparative purposes. Such reconstruction will be accomplished using water-soluble glue. The remains will be measured in accordance with standard osteological techniques. Gender will be assessed for adults. Age at death will be estimated for each individual. Dental and skeletal remains will be examined for pathology and anomalies. Estimates of the minimum number of individuals (MNI) represented by human remains will be based on spatial and anatomical distribution of bones from burial and nonburial contexts. The results of these investigations will be compiled into a descriptive analysis of the remains and will be incorporated into the Final Technical Report that MARS prepares for the project.

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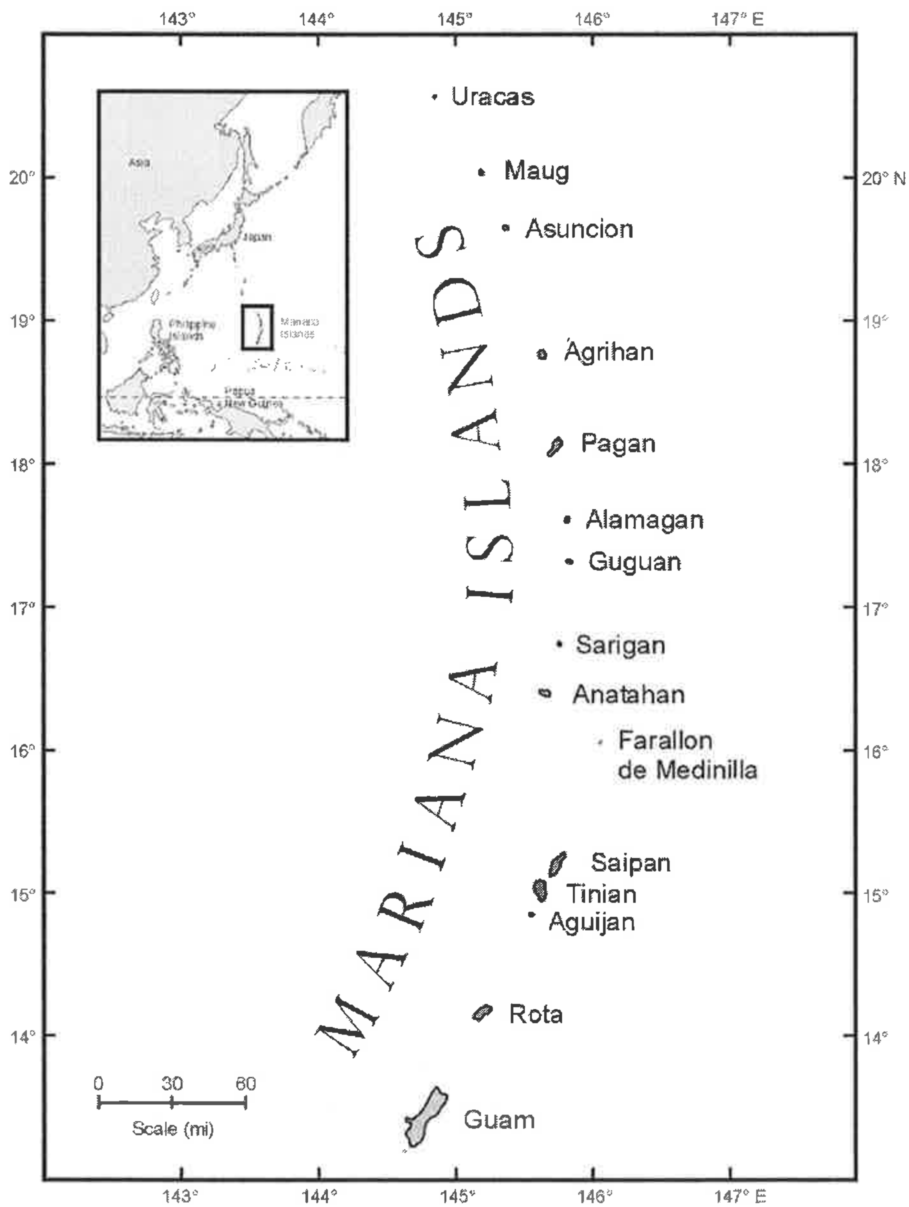

Figure 1. Map of the Mariana Islands, showing Guam. Inset shows the Mariana Islands in the Western Pacific. Courtesy of Barry Smith, University of Guam Marine Laboratory.

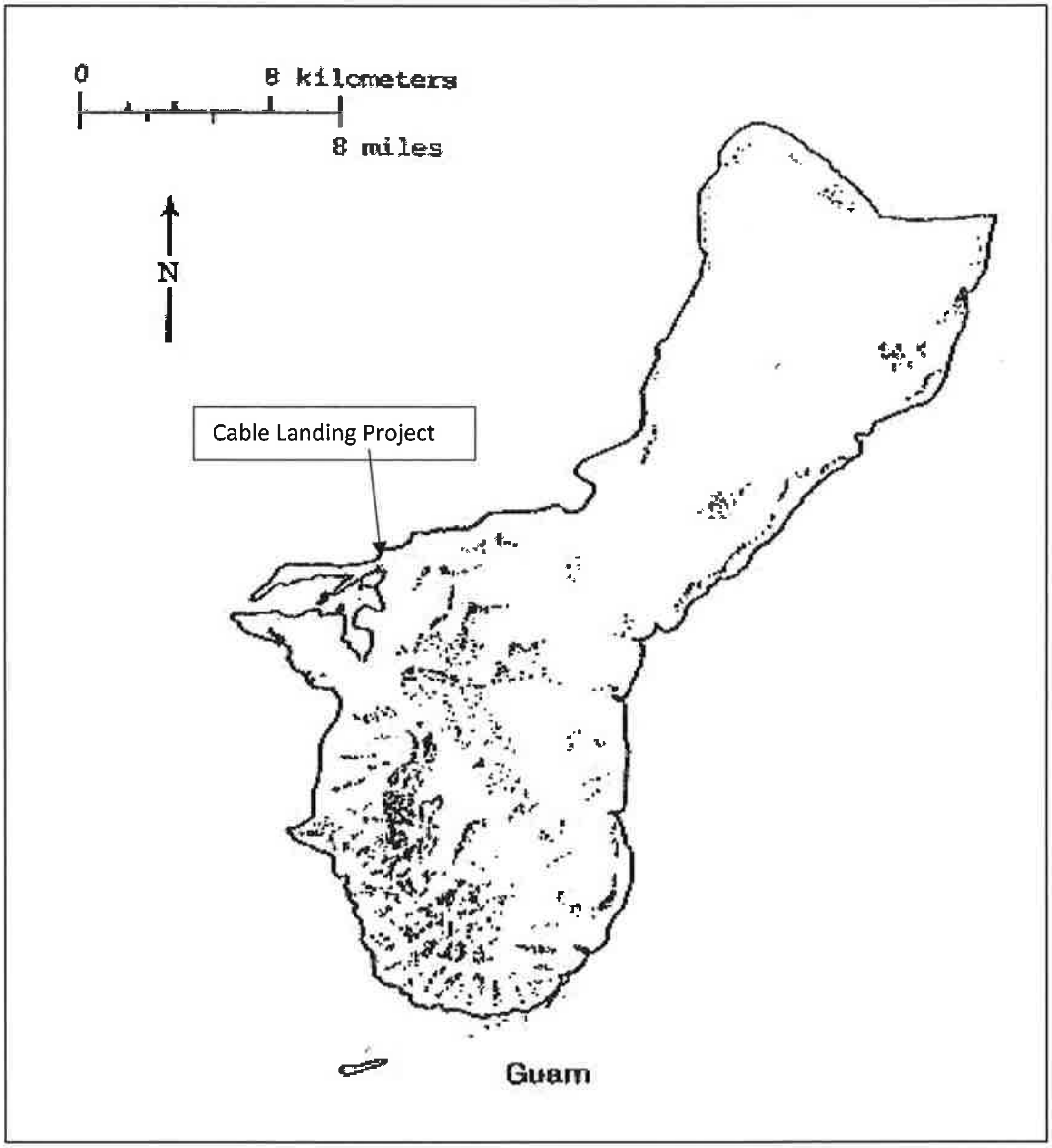

Figure 2. Map of Guam showing the location of the GTA Cable Landing project in Piti.

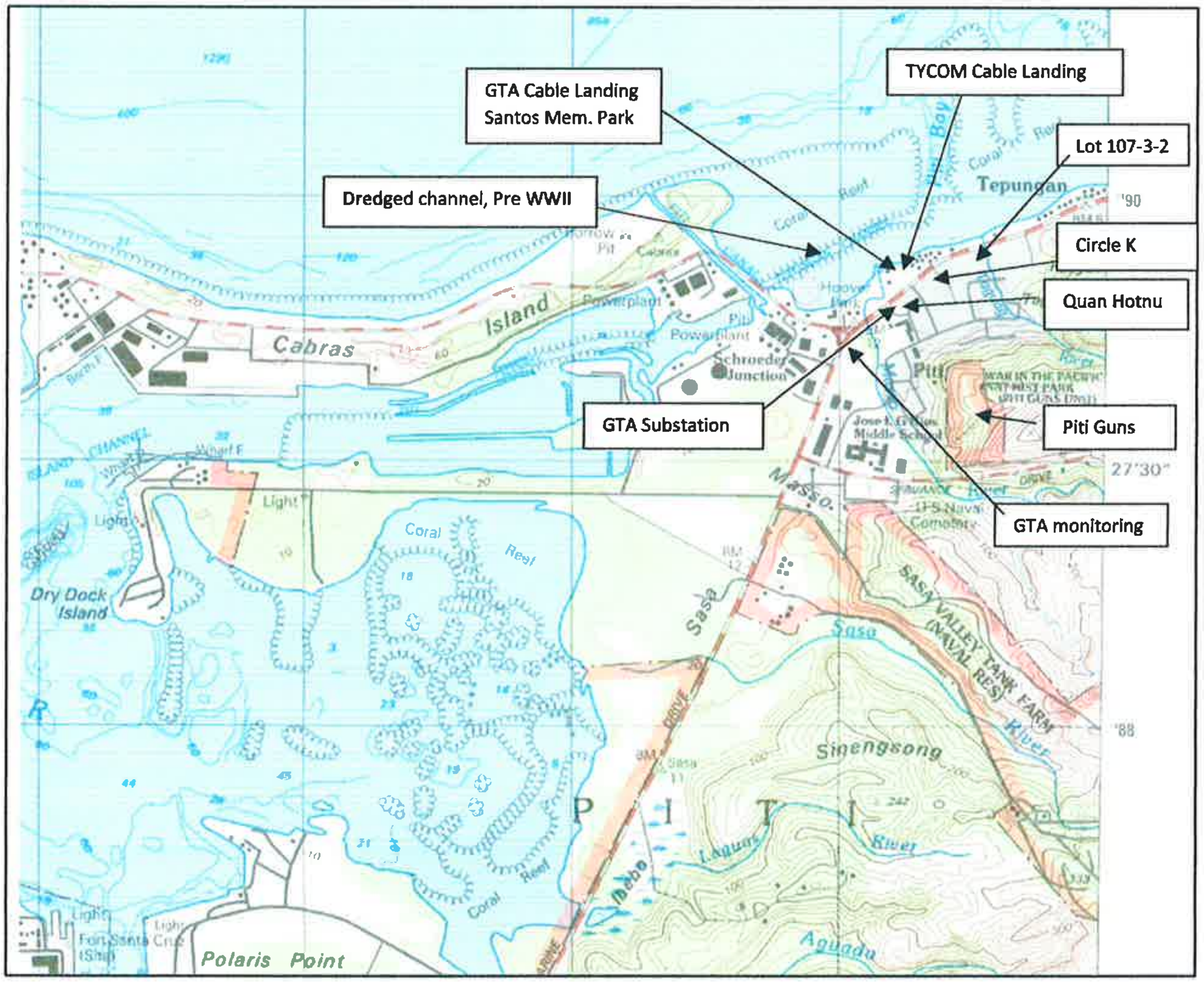

Figure 3. Section of the Apra Harbor Quadrangular Map (2000) showing the location of the GTA Cable Landing at Santos Memorial Park, the GTA Substation, and other sites or archaeological projects completed in the nearby vicinity. Historic sites on Guam's inventory are the Quan Hotnu (66-03-2276) and the Piti Guns (66-03-1046). The other projects did not encounter significant historic properties.

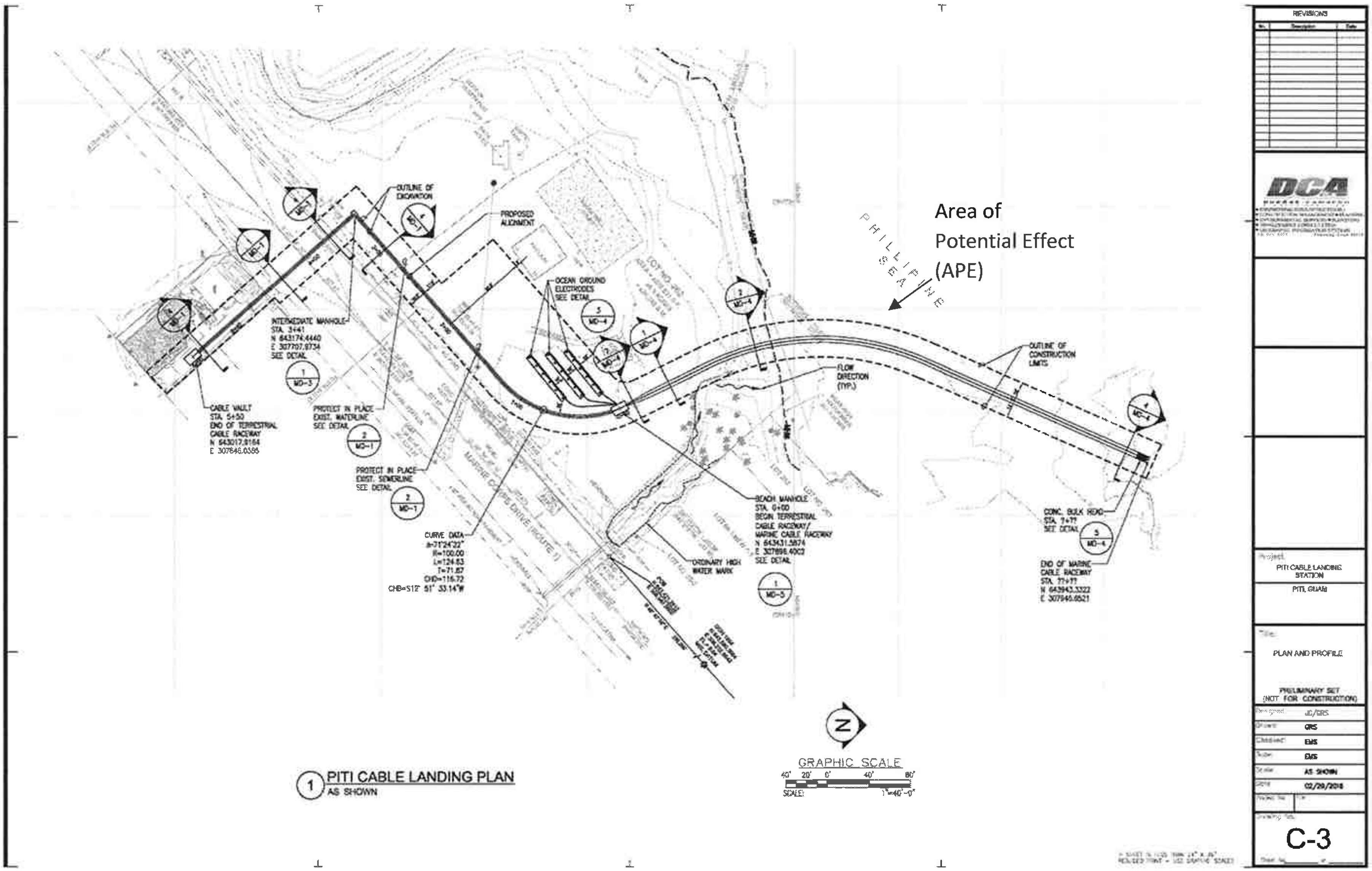

Figure 4. Plan view of the project area.

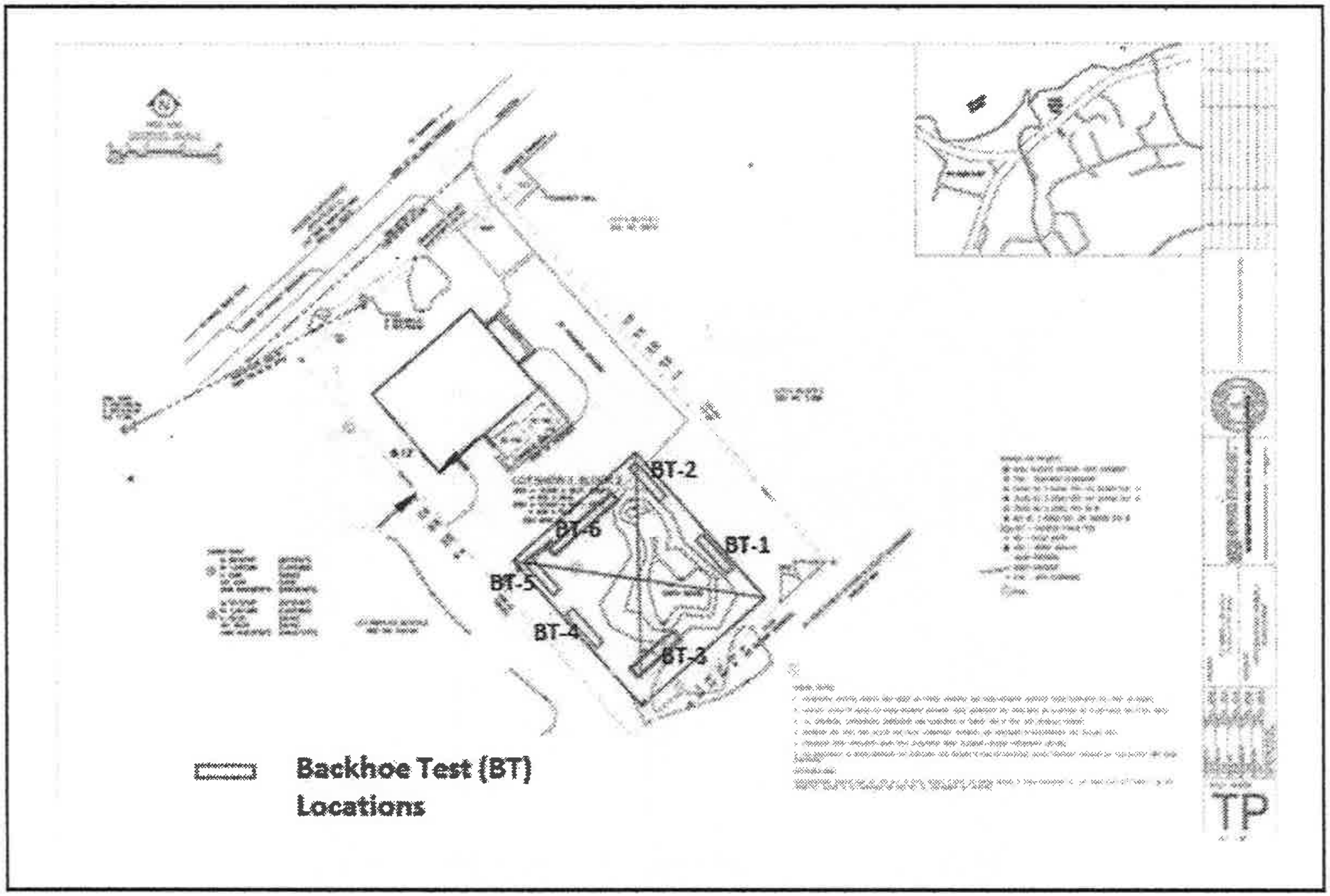

Figure 5. Plan view of the backhoe testing completed by SEARCH in 2014 at the GTA cable station (adapted from DeFant and Leon Guerrero 2014).

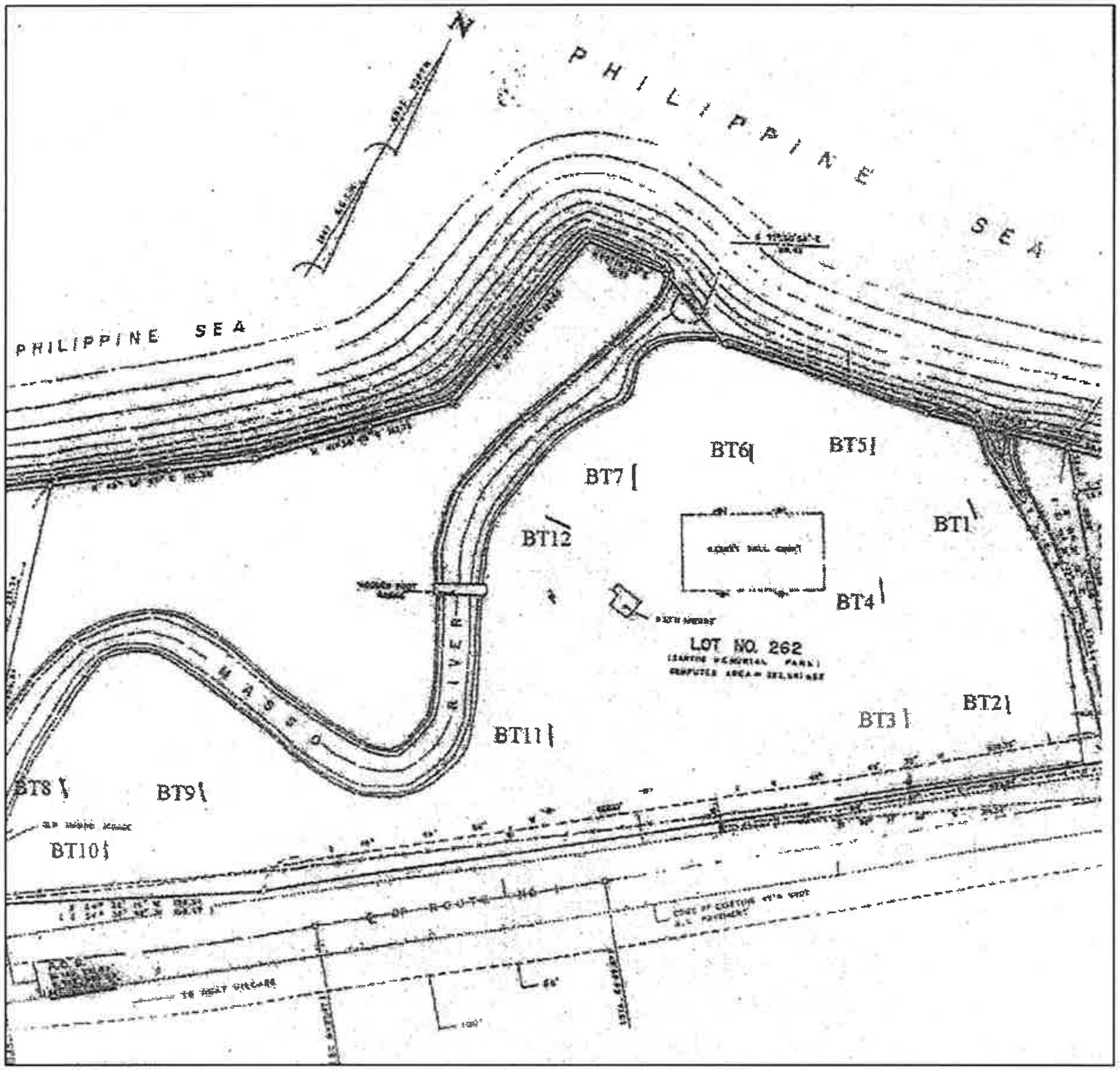

Figure 6. Plan of Santos Memorial Park showing the location of backhoe testing in 2009 (after Moore and Amesbury 2009).