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12 September 2023

MEMORANDUM:

FOR : **THE REGIONAL DIRECTOR**
Mines and Geosciences Bureau
MIMAROPA Regional Office

THRU : **THE CHIEF**
Geosciences Division

FROM : **FRANCIS JADE R. COMETA**
Science Research Specialist II

SUBJECT : **GEO-ENVIRONMENTAL ASSESSMENT OF THE PROPOSED
SITES FOR THE NEW MUNICIPAL SANITARY LANDFILL
FACILITY LOCATED IN BARANGAY NEW IBAJAY, EL
NIDO, PALAWAN**

INTRODUCTION

The Local Government Unit (LGU) of El Nido is planning to establish a Sanitary Landfill Facility (SLF) in Barangay New Iba Jay, in compliance with Republic Act No. 9003 or the Ecological Solid Waste Management Act of 2000. The ocular inspection of the proposed sanitary landfill site was conducted by the undersigned together with the representatives from the LGU of El Nido headed by Mr. Raul B. Maximo, Municipal Environment and Natural Resources Officer (MENRO).

SCOPE AND LIMITATIONS

This report primarily covers the necessary information related to the geologic and environmental (geo-environmental) conditions present in the sanitary landfill site. The main purpose of this geo-environmental assessment is to determine if the site satisfy the criteria required for establishing sanitary landfill facility as stated at Section 1 of NSWMC Resolution No. 64, Series of 2013

(Adoption of Modified Guidelines on Site Identification Criteria and Suitability Assessment Procedure for Sanitary Landfills). The Section lists thirteen (13) parameters used to identify and screen feasible sites for categorized sanitary landfill facilities:

- (1) Proximity to Groundwater Resources
- (2) Proximity to Perennial Surface Waters
- (3) Local Geological Conditions (Underlying Rock Formations)
- (4) Seismic Conditions (Proximity to Faults)
- (5) Soil Properties and Availability of Cover Material
- (6) Topography (Terrain and Slope)
- (7) Vulnerability to Flooding
- (8) Proximity to Residential Areas and Other Sensitive Land Users
- (9) Proximity to Ecologically Sensitive or Environmentally Critical Areas
- (10) Consistency with Current or Proposed Land Use Classification
- (11) Proximity to Airports
- (12) Landfill Area and Lifespan
- (13) Haul Distance, Accessibility and Road Conditions

PROJECT DESCRIPTION, LOCATION AND ACCESSIBILITY

The Municipality of El Nido has a residual waste of 10.75 tons per day (TPD) according to the latest Waste Analysis and Characterization Study (WACS) of the municipality extracted from its 10 Year Solid Waste Management Plan (SWMP). Based on the Department of Environment and Natural Resources Administrative Order (DAO) No. 10 series of 2006, municipalities that generate less than 15,000 kgs (15 tons) of residual wastes per day are classified to have Category 1 Sanitary Landfill. According to MENRO Raul B. Maximo, the acquisition of the land for the proposed SLF will depend on the result of the geo-environmental assessment report and the design will be created in accordance with the findings stated in the report.

El Nido is the northernmost municipality in the mainland Palawan and is bounded by West Philippine Sea in the west and the municipalities of Linapacan in the northeast and Taytay in the south. The municipality has a total land area of 92,326 hectares and has jurisdiction over eighteen (18) barangays namely: Aberawan, Bagong Bayan, Barotuan, Bebeladan, Bucana, Buena Suerte, Corong-corong, Mabini, Maligaya, Manlag, Masagana, New Ibajay, Pasadena, San Fernando, Sibaltan, Teneguiban, Villa Libertad, Villa Paz. The municipality also has 45 islands/islets included within its borders.

The Local Government Unit of EL Nido is proposing two (2) sites as possible SLF sites in the municipality. The proposed sites were both located in Barangay New Ibajay, El Nido, Palawan. Barangay New Ibajay is located in the eastern side of the municipality and has a land area of 5,565.29 hectares. Based on the Tax Declaration provided by the MENRO, the proposed SLF Site 1 is approximately 10.00 hectares and SLF Site 2 is 8.93 hectares. Both sites can be accessed in two ways, via Taytay El Nido Highway which takes around 50 minutes travel time from the town proper or via El Nido-New Ibajay Junction Road which takes around 1 hour and 30 minutes travel time from the town proper.

The most common way to travel from Manila to El Nido is through commercial flights offered from Ninoy Aquino International Airport (NAIA) to Puerto Princesa International Airport. From Puerto Princesa City, there are available public utility vans and buses going straight to El Nido. There is also a direct flight from NAIA to EL Nido via Lio Airport serviced by Air Swift Philippines.

METHODOLOGY

The geologic assessment consisted of data gathering from the municipal database as well as review of available literature, on-site field assessment, interviews with concerned municipal authorities, and desktop analysis using Geographic Information System (GIS) software, Google Earth™ and Interferometric Synthetic Aperture Radar (IFSAR)-derived satellite imagery. Identification of lithology and soil type in the area, location of nearby streams and water sources, and observation of the nearest residential structures were performed during the on-site assessment. Information gathered using GIS software include elevation and slope data, natural drainage, and distances of different location points (airport, barangay proper, residential areas, etc.) with respect to the proposed landfill site.

FINDINGS

The discussion for the results of the assessment follows the criteria for sanitary landfill site selection and screening indicated in NSWMC Resolution No. 64, Series of 2013.

I. Proximity to Groundwater Resources

Absolute Criteria: The site shall not be located on shallow unconfined aquifers.

The area should be more than 500 meters upgradient of groundwater reservoir or water supply intakes (water supply wells, jetmatic pumps, or open dug wells) used for private or public drinking, irrigation or livestock.

Proposed SLF Site 1

There were no open dug well or spring well found within the area during the assessment but there was a shallow well observed 470 meters north of the proposed site. Fortunately, according to the interviewed local, the well is only used for household purposes and not for drinking or livestock. (Photo No. 1)

Proposed SLF Site 2

There is an open dug well found around 30 meters from the northern side of the proposed site. Since the area does not have an active water system, it can be inferred that the water from the well is used for daily activities. Usage of the water for drinking was not verified since the occupant was not there during the assessment. (Photo No. 2)

In addition, it is a conditional criterion that a minimum distance of two (2) meters should be maintained between the base of the landfill liner and the highest depth of the water table at the site; however, the highest depth of the water table, which should be taken during rainy season, was not measured during the site visit.

II. Proximity to Perennial Surface Waters

Absolute Criteria: The site shall not be located within 300 meters upgradient (point of intake) of any surface waters used for public or private drinking water supply, irrigation, or livestock.

Proposed SLF Site 1

No major perennial stream was observed within or nearby the proposed site. However, an intermittent stream was observed 330 meters north of the proposed site that was used primarily for agriculture. The stream was dry during the assessment and based on resident's account, the river only flows during rainy seasons. (Figure 5; Photo No. 3)

Proposed SLF Site 2

There were no major perennial stream observed within or nearby the proposed site. However, since the area is situated along a gully, it is considered as natural drainage of surface water during heavy rains. This waters were then used to irrigate the small rice field near the proposed site. (Figure 5)

III. Local Geological Conditions (Underlying Rock Formation)

Absolute Criteria: The site shall not be located on areas with underlying rocks characterized as joints, fractured or with fissures; carbonate (limestone or dolomite); karst, and other porous rock formation; or in areas with sinkholes or caverns.

No significant outcrop was observed during the assessment because majority of the proposed sites were either converted to kaingin field or is highly vegetated. Based on the geologic map of Northern Palawan Block acquired from the database of the Mines and Geosciences Bureau, the 2 proposed sanitary landfill sites in Barangay New Ibayay is underlain by Bacuit Formation which consists of sandstone, altered tuff, calcareous sandstone, chert and slate and Quaternary Alluvium. (Figure 2)

IV. Seismic Conditions (Proximity to Faults)

Absolute Criteria: No facility shall be constructed at a site within 75 meters from a Holocene fault (faults from 60 million years old to present) or a known recent fault.

The whole Province of Palawan is considered to be an aseismic region. This is enforced by historical and instrumental records from the Philippine Institute of Volcanology and Seismology (PHIVOLCS), where no significant earthquakes and active faults have been mapped (Bautista and Oike, 2000) (Figure 4a) in the island province and its nearby surrounding vicinity. (Figure 3a and 3b)

V. Soil Properties and Availability of Cover Material

Absolute Criteria: The site shall not be located in unstable, very soft and settling soils (sand, coarse sand or fine sand) with high potential for liquefaction, slumping, or erosion.

According to the map from the Bureau of Soil and Water Management, the soil within the proposed sites is classified to be Coron Clay Loam and San Manuel Clay Loam. (Figure 4)

Proposed SLF Site 1

During the site assessment, it was observed that the topsoil has a clayey texture with yellowish brown color. (Photo Nos. 4a and 4b) The clayey soil is the product of high weathering rate of the Bacuit Formation.

Proposed SLF Site 2

During the site assessment, it was observed that the topsoil has a clayey texture with yellowish brown color. (Photo No. 5a and 5b) The clayey soil is the product of high weathering rate of the Bacuit Formation.

To determine if the onsite soil material is a suitable source of daily soil cover, a comprehensive soil study must be done to characterize the general properties of the soil present in the area

VI. Topography (Terrain and Slope)

Absolute Criteria: The site shall not be located on a landslide-prone area with ground slopes nominally greater than 50% or 2:1 horizontal-to-vertical ratio or as determined by authorities.

Proposed SLF Site 1

Based on the slope map generated using ArcGIS, the slope of the proposed site is low to moderate with majority of the area having less than 50% rise (Figure 5). Moreover, based on the Landslide Susceptibility database of MGB-MIMAROPA, the proposed sanitary landfill site has low to moderate susceptibility to landslide and other forms of mass movement (Figure 6).

Proposed SLF Site 2

Based on the slope map generated using ArcGIS, the slope of the proposed site is moderate to high with majority of the area ranges from 30% to 50% rise (Figure 5). This is likely because the proposed site is situated along a gully. Moreover, based on the Landslide Susceptibility database of MGB-

MIMAROPA, the proposed sanitary landfill site has moderate to high susceptibility to landslide and other forms of mass movement (Figure 6).

VII. Vulnerability to Flooding

Absolute Criteria: The site shall not be located in areas prone to seasonal flooding such as swamplands, marshes and wetlands, areas that are deemed very highly susceptible to meteorologically - influenced and related natural hazards (flood-prone areas) as declared by the DENR-MGB or other appropriate authorities.

Based on the Flood Susceptibility database of MGB-MIMAROPA, both of the proposed sites are not susceptible to any form of flooding. (Figure 7)

VIII. Proximity to Residential Areas and Other Sensitive Land Users

Absolute Criteria: The site shall not be located in or within 250 meters of existing or proposed residential, commercial or urban development areas, and areas of historical, archaeological, cultural, geological, or scientific interests, which are more than 100 years old and declared by the National Historical Institute or National Museum.

According the lot owner, there are no existing nor proposed significant residential areas 250 meters from the vicinity of the sites. Additionally, Dewil Valley where Ille Cave and other cave system is located that have a significant historical, archaeological, and cultural importance is approximately 3 km aerial distance from the proposed sites.

Proposed SLF Site 1

Sparse houses were observed around the vicinity the proposed site. The nearest was around 200 meters from the site. Based on the occupants, most of these houses were only used during the kaingin season to tend for the crops. These houses were mostly made of light materials such as bamboo and nipa. (Photo No. 6)

Proposed SLF Site 2

Sparse houses were also observed around the vicinity of the proposed site. The nearest was around 50 meters from the site. The house was made from

bamboo and other light materials. There were no one present during the assessment, but based on its construction, it might be used as permanent residence of the occupant. (Photo No. 7)

IX. Proximity to Ecologically Sensitive or Environmentally Critical Areas

Absolute Criteria: The site shall not be located within 500 meters from the boundaries of ecologically sensitive areas under National Integrated Protected Area System (NIPAS) Act or by any related issuances such as national parks (areas of national significance), conservation parks (areas with valuable wildlife or interesting natural features), recreational parks (area managed primarily for public recreation with some native vegetation), forest reserves, sites of flora and fauna of national or regional significance, wildlife sanctuary, mangrove areas, coral reefs, or wetlands of important biodiversity.

Proposed SLF Site 1

No ecologically sensitive areas of such kind were identified within the vicinity of the proposed sanitary landfill site. Additionally, the area is outside the El Nido Managed Resource Protected Area. It was noted that the proposed site is covered by Republic Act No. 7611 or Strategic Environmental Plan (SEP) for Palawan Act. Based on the ECAN map of Palawan, the proposed SLF site is under the Multiple Use Zone classification. (Figure 8)

Proposed SLF Site 2

During the assessment, mangrove forest was observed 150 meters along the northeastern side of the proposed site. It is noted that Palawan is covered by Republic Act No. 7611 or Strategic Environmental Plan (SEP) for Palawan Act. Under the said act, mangrove areas are classified as core zones. Based on the ECAN map of Palawan, the proposed SLF site is within the Traditional Use Zone Classification (Figure 8). According to the El Nido ECAN Resource Management Plan, establishing an SLF facility is not included in the activities allowed inside the Traditional Use Zone.

X. Consistency with Current or Proposed Land Use Classification

Absolute Criteria: The location of the facility shall be consistent with the existing or proposed land use classification or Comprehensive Land Use Plan (CLUP) of the host local government.

Proposed SLF Site 1

Based on the CLUP Map of Bgy. New Ibajay, parts of the proposed site falls within prime agriculture and general agriculture zone. (Figure 8)

Proposed SLF Site 2

Based on the CLUP Map of Bgy. New Ibajay, parts of the proposed site falls within production forest classification. (Figure 8)

XI. Proximity to Airports

Absolute Criteria: The site shall not be located within three (3) kilometers from an airport servicing turbojet aircraft or 1.6 kilometers from an airport servicing piston driven or turboprop (propeller) aircraft.

Both of the proposed site is approximately 11.0 kilometers aerial distance southeast of the nearest operational airport which is the Lio Airport located at Bgy. Villa Libertad, El Nido Palawan.

XII. Landfill Area and Lifespan

Absolute Criteria: The site shall be large enough to accommodate waste for a period of five (5) years, with provision for expansion, during which people must internalize the value of environmentally sound and sustainable waste disposal.

The lifespan of the proposed SLF is computed using the formula from the Technical Guidebook of Solid Wastes Disposal Design, Operation and Management produced by the National Solid Waste Management Commission and Japan International Cooperation Agency (NSWMC & JICA, 2010).

Proposed SLF Site 1

Based on the submitted tax declaration, the total area of the proposed SLF is 10 hectares or 100,000 m². Assuming that the entire area will be dedicated for waste disposal, a 3-m average waste disposal depth, a 450 kg/m³ specific weight of compacted waste, and a 3:1 compacted waste to cover material

ratio, the estimated lifespan of the proposed sanitary landfill site was calculated to be **6.7 years** (Annex A).

Proposed SLF Site 2

Based on the submitted tax declaration, the total area of the proposed SLF is 10 hectares or 100,000 m². Assuming that the entire area will be dedicated for waste disposal, a 3-m average waste disposal depth, a 450 kg/m³ specific weight of compacted waste, and a 3:1 compacted waste to cover material ratio, the estimated lifespan of the proposed sanitary landfill site was calculated to be **6.0 years** (Annex A).

XIII. Haul Distance, Accessibility and Road Conditions

Absolute Criteria: The site shall be accessible from major roadways and thoroughfares. And if it is not accessible, the project design shall include means of access.

Based on the latest WACS of El Nido, there are three (3) major waste generating areas in the municipality which are the Barangay Bucana, Barangay Corong-corong, and the Town Area composed of 3 Barangays namely, Barangay Maligaya, Barangay Masagana, and Barangay Buena Suerte. The proposed site is around 26 km land travel from the abovementioned areas. The road to the 2 sites is via a national road which is generally well paved with some rough road sections.

It was also observed during the assessment that current access road to the proposed sites is an unpaved barangay road which needs to pass by a river without bridge before arriving at the proposed site (*Photo No. 8*). According to the owner of the lot, there is an old logging road that is connected to the main road north of the site. The said logging road can be developed to provide access to the proposed site.

SUMMARY OF RESULTS

Proposed SLF Site 1

The proposed site was unable to satisfactorily fulfill all the conditions stated in the National Solid Waste Management Commission (NSWMC) Resolution No. 64, Series of 2013 having six (6) *passed rating*, seven (7) *conditional rating* and

no failed rating.

Criteria on Site Selection	Rating	Remarks
Proximity to Groundwater Resources	Conditional	No aquifers or deep wells were found within the proposed site. However, there is a shallow well found 470 meters down gradient of the proposed site.
Proximity to Perennial Surface Waters	Conditional	The nearest perennial river is more than 300 meters away from the proposed site. However, there is a small intermittent stream 300 meters from the site primarily used to water the nearby rice field.
Local Geological Conditions (Underlying Rock Formation)	Conditional	The site is potentially underlain by Bacuit Formation. However, the characteristic of the bedrock is not fully known due to lack of exposure and thus it should be further examined.
Seismic Conditions (Proximity to Faults)	Passed	The Palawan Province is recognized to be seismically inactive region.
Soil Properties and Availability of Cover Material	Conditional	The soil is type is categorized as Coron Clay Loam and San Manuel Clay Loam based on the soil map. Coron and San Manuel clay loam soil is predominantly clayey with minimal silt composition. However, a comprehensive soil test is recommended to verify its characteristics.
Topography (Terrain and Slope)	Passed	The site has moderate susceptibility to mass wasting. The slope of the proposed area is low to moderate with majority of the area having less than 50% rise.
Vulnerability to	Passed	

Flooding		The proposed site is not susceptible to any form of flooding.
Proximity to Residential Areas and Other Sensitive Land Users	Passed	There are no residential zones within 250 meters of the proposed site.
Proximity to Ecologically Sensitive or Environmentally Critical Areas	Conditional	There are no ecologically sensitive areas within 500 meters of the proposed site. However, the proposed site is covered by Republic Act No. 7611 or Strategic Environmental Plan (SEP) for Palawan Act and therefore a SEP clearance must be secured prior to SLF operation.
Consistency with Current or Proposed Land Use Classification	Conditional	Majority of the site is classified as general agricultural land area, but it can be converted into a sanitary landfill use if the site is selected.
Proximity to Airports	Passed	The proposed site is 11 kilometers away from the nearest airport.
Landfill Area and Lifespan	Passed	Based on the used computation using reasonable estimation, the life span of the proposed site is more than 5 years.
Haul Distance, Accessibility and Road Conditions	Conditional	The majority of the waste generation centers are less than 30 kilometers away from the proposed site. Since the area only accessible thru an unpaved barangay road, a new road should be constructed connecting the site to the main road. The existing old logging road can be developed for this purpose.

Proposed SLF Site 2

The proposed site has failed to satisfactorily fulfill all the conditions stated in the National Solid Waste Management Commission (NSWMC) Resolution No. 64, Series of 2013 having four (4) *passed rating*, five (5) *conditional rating* and four (4) *failed rating*.

Criteria on Site Selection	Rating	Remarks
Proximity to Groundwater Resources	Failed	There is a shallow well around 30 meters from the proposed site.
Proximity to Perennial Surface Waters	Failed	There were no perennial stream near the proposed site. But because the site is situated on a gully, it become a natural drainage of water during heavy rains. There is also a small rice field at the northern side of the site.
Local Geological Conditions (Underlying Rock Formation)	Conditional	The site is potentially underlain by Bacuit Formation. However, the characteristic of the bedrock is not fully known due to lack of exposure and thus it should be further examined.
Seismic Conditions (Proximity to Faults)	Passed	The Palawan Province is recognized to be seismically inactive region.
Soil Properties and Availability of Cover Material	Conditional	The soil is type is categorized as Coron clay loam and San Manuel clay Loam based on the soil map. Coron and San Manuel clay loam soil is predominantly clayey with minimal silt composition. However, a comprehensive soil test is recommended to verify its characteristics
Topography (Terrain and Slope)	Failed	The site has moderate to high

		susceptibility to mass wasting. The slope of the proposed area is moderate to high with majority of the area having less than 50% rise.
Vulnerability to Flooding	Passed	The proposed site is not susceptible to any form of flooding.
Proximity to Residential Areas and Other Sensitive Land Users	Conditional	There are no residential zones within 250 meters of the proposed site. But there is a small house 30 meters from the site which can be a permanent residence.
Proximity to Ecologically Sensitive or Environmentally Critical Areas	Failed	There is a mangrove forest approximately 150 meters from the site. These mangrove areas are classified as Core Zones under Republic Act No. 7611 or Strategic Environmental Plan (SEP) for Palawan Act. Additionally, based on the ECAN Map, the area of the proposed site is classified as Traditional Use Zone where the establishment of an SLF site is not considered as activities allowed in the zone. A SEP clearance must also be secured prior to SLF operation.
Consistency with Current or Proposed Land Use Classification	Conditional	The site is classified as production forest land area based on the CLUP Map of El Nido.
Proximity to Airports	Passed	The proposed site is 11 kilometers away from the nearest airport.
Landfill Area and Lifespan	Passed	Based on the used computation using reasonable estimation, the life span of the proposed site is more than 5 years.
Haul Distance, Accessibility and	Conditional	The majority of the waste generation

Road Conditions		centers are less than 30 kilometers away from the proposed site. Since the area only accessible thru an unpaved barangay road, a new road should be constructed connecting the site to the main road. The existing old logging road can be developed for this purpose.
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CONCLUSION AND RECOMMENDATIONS

For the Proposed SLF Site 1 in Barangay New Ibajay, El Nido, Palawan to pass the geo-environmental assessment, the Local Government Unit of El Nido must be able to provide effective and proper solution, mitigation and engineering countermeasure for the criteria with conditional rating. The following are recommendations made for the establishment of SLF site:

- Hydrogeological survey is recommended to determine the extent, yield, and productivity of the aquifers found down gradient of the proposed site. These potential sources of water can then be protected from contamination with proper engineering measures during the development of the sanitary landfill. Furthermore, the selection parameters specify that a minimum distance of 2 meters should be maintained from the highest water table to the base of the landfill liner to prevent groundwater contamination.
- Since there is an intermittent stream traversing the northern portions of the proposed site, appropriate engineering measures must be undertaken to protect the surface waters and catchment basins from contamination. Constant monitoring of the water quality of the nearby surface waters is also recommended.
- To determine the characteristics of the bedrock, a geotechnical study may be conducted by the Engineering Dept. of the LGU. The result of the study can be used in the final design of the landfill.
- Since the area is covered by Republic Act No. 7611 or Strategic Environmental Plan (SEP) for Palawan Act, the Local Government Unit of San Vicente must secure a SEP clearance from the Palawan Council for Sustainable Development (PCSD) prior to landfill establishment.

- To determine if the onsite soil material is a suitable source of daily soil cover, a comprehensive soil study must be done to characterize the general properties of the soil present in the area which include permeability, pH, organic matter content, silt, sand, and clay content, and cation exchange capacity. If feasible, the site must have lining of a 1 m (or more) of non-fissured, remolded and recompacted clay with a hydraulic conductivity less than $1 \times 10^{-6} \text{ ms}^{-1}$. Ideally the daily soil cover should have good water and air permeability, allowing easy leveling and compaction of waste.
- Site engineers and/or landfill operators must ensure that a clay lining is installed at the lining base. Installation of a clay lining is a precautionary measure for possible groundwater contamination by leachate from the landfill.
- Since the general land use plan of El Nido is still pending for approval in the provincial level, the LGU of El Nido may convert the present classification of agricultural land into landfill use. However, a monthly monitoring of the leachate facility must be done to ensure that the facility has no breaks or other defects that can lead to groundwater and soil contamination which can affect the nearby agricultural land. Appropriate actions must be done immediately if there are defects on the facility or adverse effects on the water quality.
- A siltation/leachate pond should be provided at the lower slope using existing gullies or ephemeral creek as possible location. This is to aid in the avoidance of ponding of surface water at the landfill site since garbage when saturated with water promote production of leachate. Sufficient drainage systems such as drainage ditch should be installed at the landfill site.
- In the computation of the estimated lifespan of the proposed sanitary landfill facility, the area and depth of the disposal bed, as well as the waste to cover material ratio, were simply assumed. Although these values are assumed, it is still enough to ascertain that the required minimum year of operation will be complied. Using the assumed values, the minimum area needed to fulfill the required minimum years of operation is 4.38 has.

- Since the current access road from the national highway leading to the proposed site is an unpaved road and needed to pass by a river, a new access road should be constructed. The old logging road connected to the highway may be reopened and used for this purpose. The said logging road should be improved by widening and concreting. These improvements should be included in the project development plan.

In consideration of the results of the site assessment and recommendations above, the proposed Sanitary Landfill Site 1 has conditionally passed the criteria for landfill use.

However, the proposed SLF Site 2 located in the same barangay is found to be unsuitable for landfilling.

The viability of the site for landfilling shall depend on the capability of the municipality to address the issues discussed above.

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APPENDIX A – Formula used for the estimated lifespan of the proposed sanitary landfill sites.

The following formula were adapted from the *Technical Guidebook of Solid Wastes Disposal Design, Operation and Management* produced by the National Solid Waste Management Commission (NSWMC) and Japan International Cooperation Agency (JICA) in 2010.

$$LS = \frac{DLC}{CMV + ADLV} \quad (1)$$

$$DLC = DA * DD \quad (2)$$

$$ADLV = \frac{ADLW}{SWW} \quad (3)$$

Where **LS** = estimated life span of the landfill (years)

DLC = Designed Landfill Capacity (m³)

CMV = Cover Material Volume (m³/year)

ADLV = Annual Designed Landfill Volume (m³/year)

DA = area for waste disposal (m²)

DD = average waste disposal depth (m)

ADLW = Annual Designed Landfill Weight (kg/year)

SWW = Specific Weight of solid waste (kg/m³)

DRW = Daily Residual Waste (kg/day)

Proposed SLF Site 1

Values used:

DA = 10 hectares = 100,000 m²

DD = 3 meters

ADLW = 15,137,410.00 kg/year (based on the municipality's 2019 Solid Waste Management Plan)

SWW = 450 kg/m³ (typical specific weight of normally compacted solid waste)

CMV = 1/3 of **ADLV** (assuming a 3:1 ratio of compacted waste to cover material)

$$LS = \frac{DA * DD}{CMV + \frac{ADLW}{SWW}} = \frac{100,000 * 3}{\left\{ \left(\frac{15,137,410.00}{450} \right) \div 3 \right\} + \frac{15,137,410.00}{450}}$$

= 6.7 Years

Proposed SLF Site 2

Values used:

DA = 8.93 hectares = 89,300 m²

DD = 3 meters

ADLW = 15,137,410.00 kg/year (based on the municipality's 2019 Solid Waste Management Plan)

SWW = 450 kg/m³ (typical specific weight of normally compacted solid waste)

CMV = 1/3 of **ADLV** (assuming a 3:1 ratio of compacted waste to cover material)

$$LS = \frac{DA * DD}{CMV + \frac{ADLW}{SWW}} = \frac{89,300 * 3}{\left\{ \left(\frac{15,137,410.00}{450} \right) \div 3 \right\} + \frac{15,137,410.00}{450}}$$

= 6.0 Years

APPENDIX B – Figures

Figure 1. Topographic Map of the vicinity showing the location of the proposed SLF site in Brgy. New Ibayay, El Nido, Palawan.

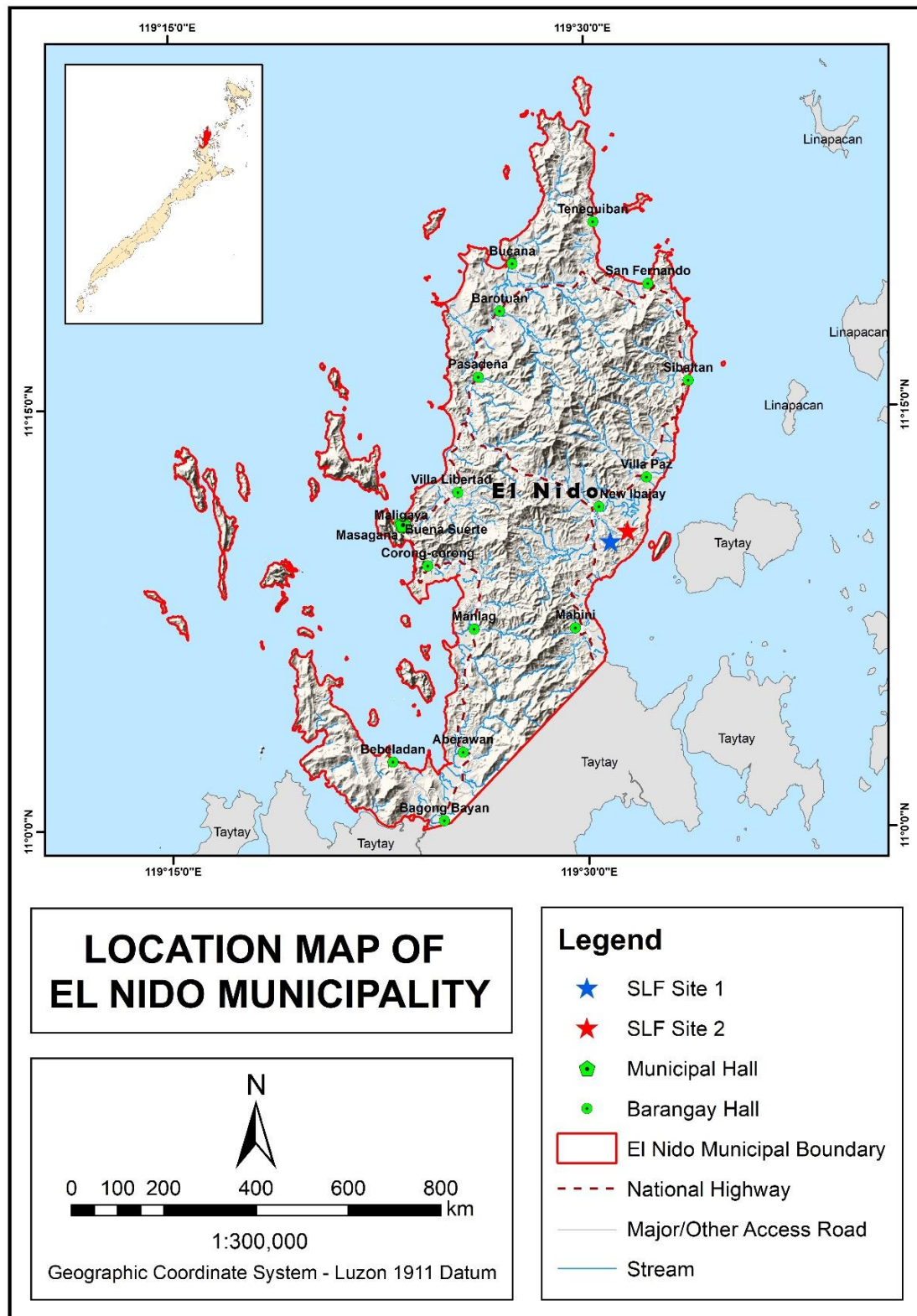
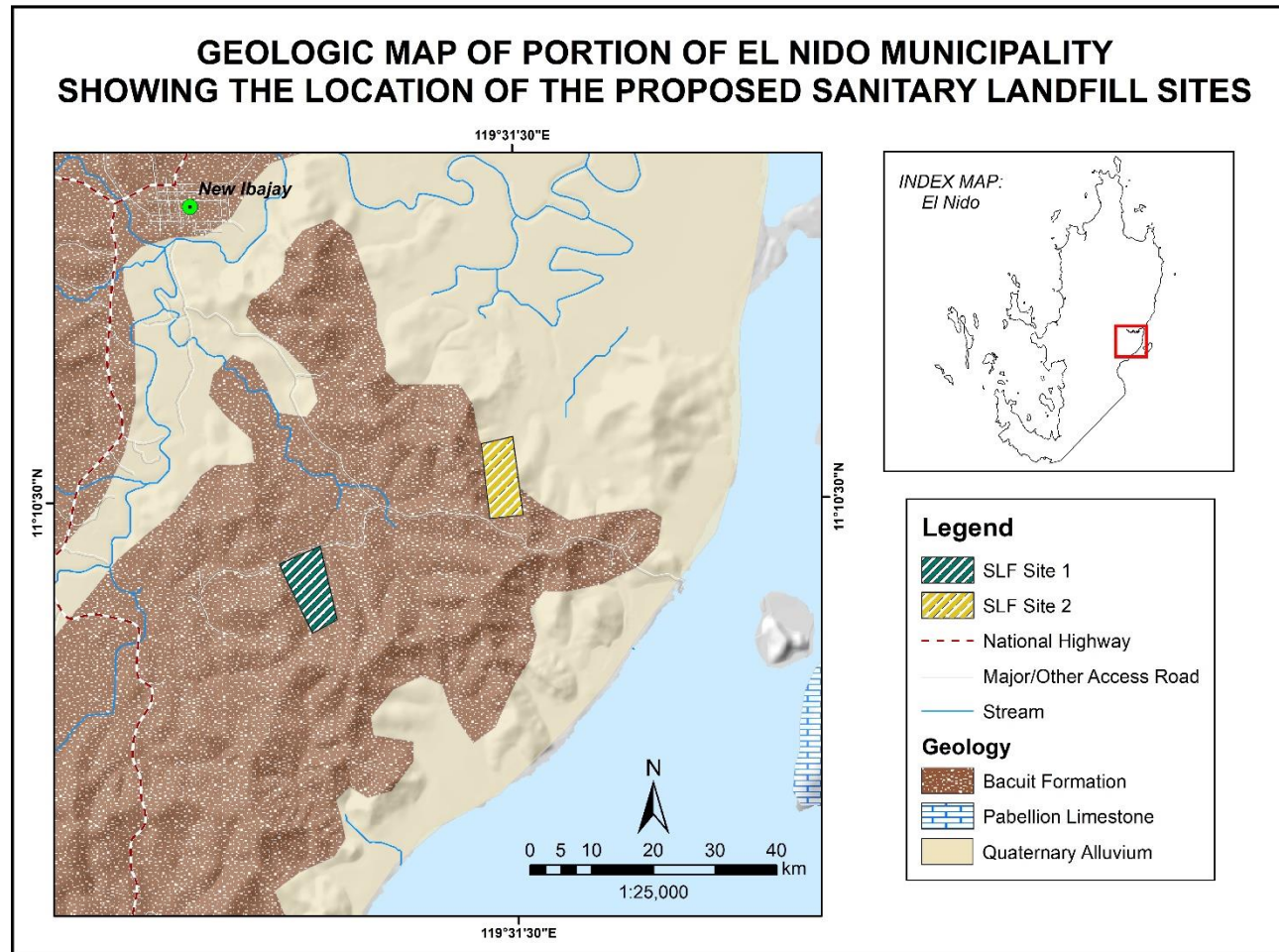


Figure 2. Geologic Map of the vicinity showing the location of the proposed SLF site in Brgy. New Ibayay is underlain by Bacuit Formation, which consists of an alteration of sandstone and shale, chert, interbedded conglomerate and limestone.



Figures 3a. Philippine Fault Map from PHIVOLCS. **3b.** Seismicity maps dated 1907-2012 adopted from PHIVOLCS showing that Palawan Island has not experienced earthquakes of high magnitude in recent times. Both maps show that there is minimal to nil seismic activity in the province of Palawan.

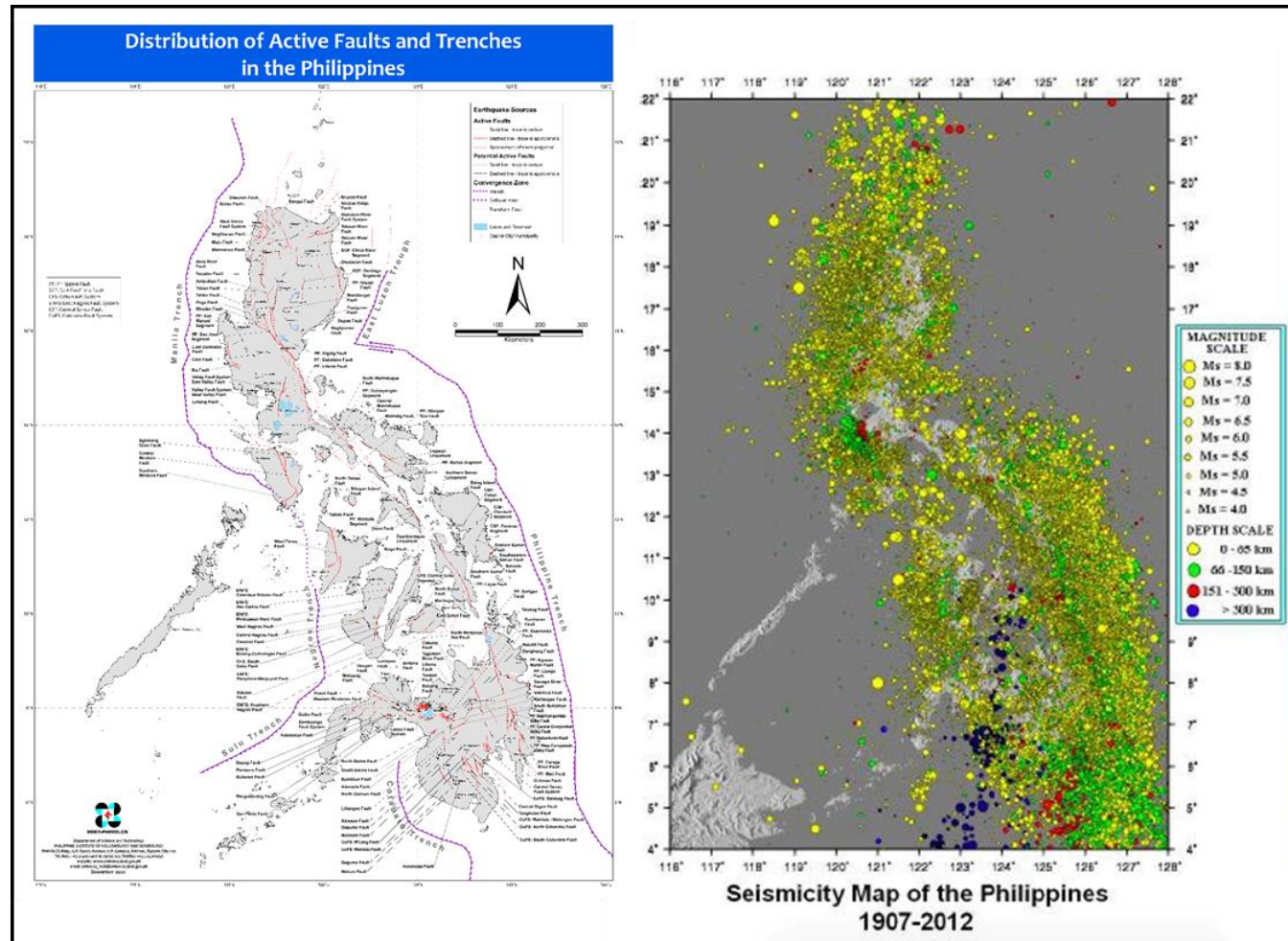


Figure 4. Soil Classification map from Bureau of Soil and Water Management the showing that portions of the area is classified to be Coron clay loam and San Manuel clay loam which is predominantly clayey with silt.

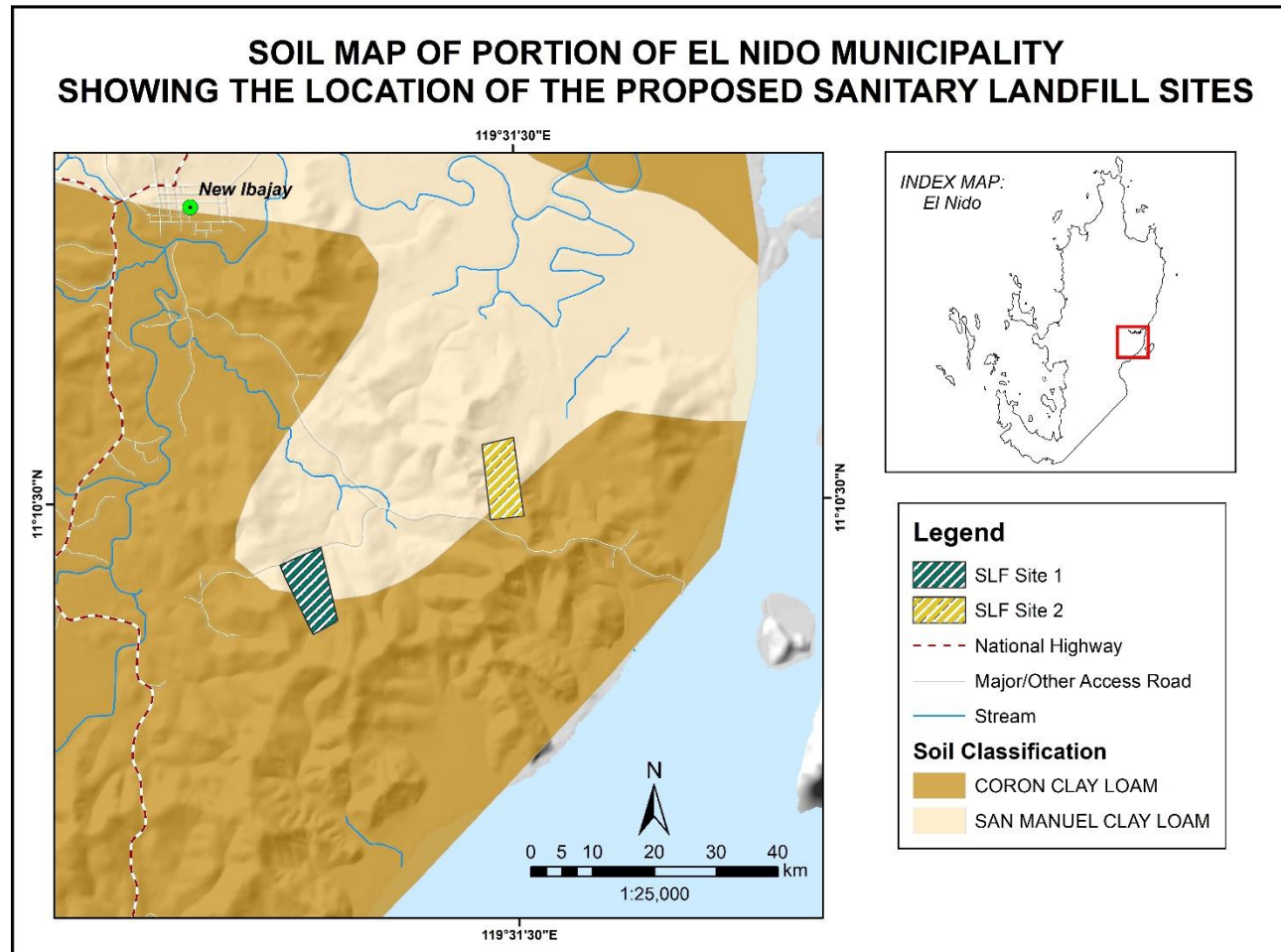


Figure 5. The generated slope map of the proposed site and its immediate vicinity shows that the area has low to moderate sloping terrain with majority of grounds not reaching maximum slope of 50% rise.

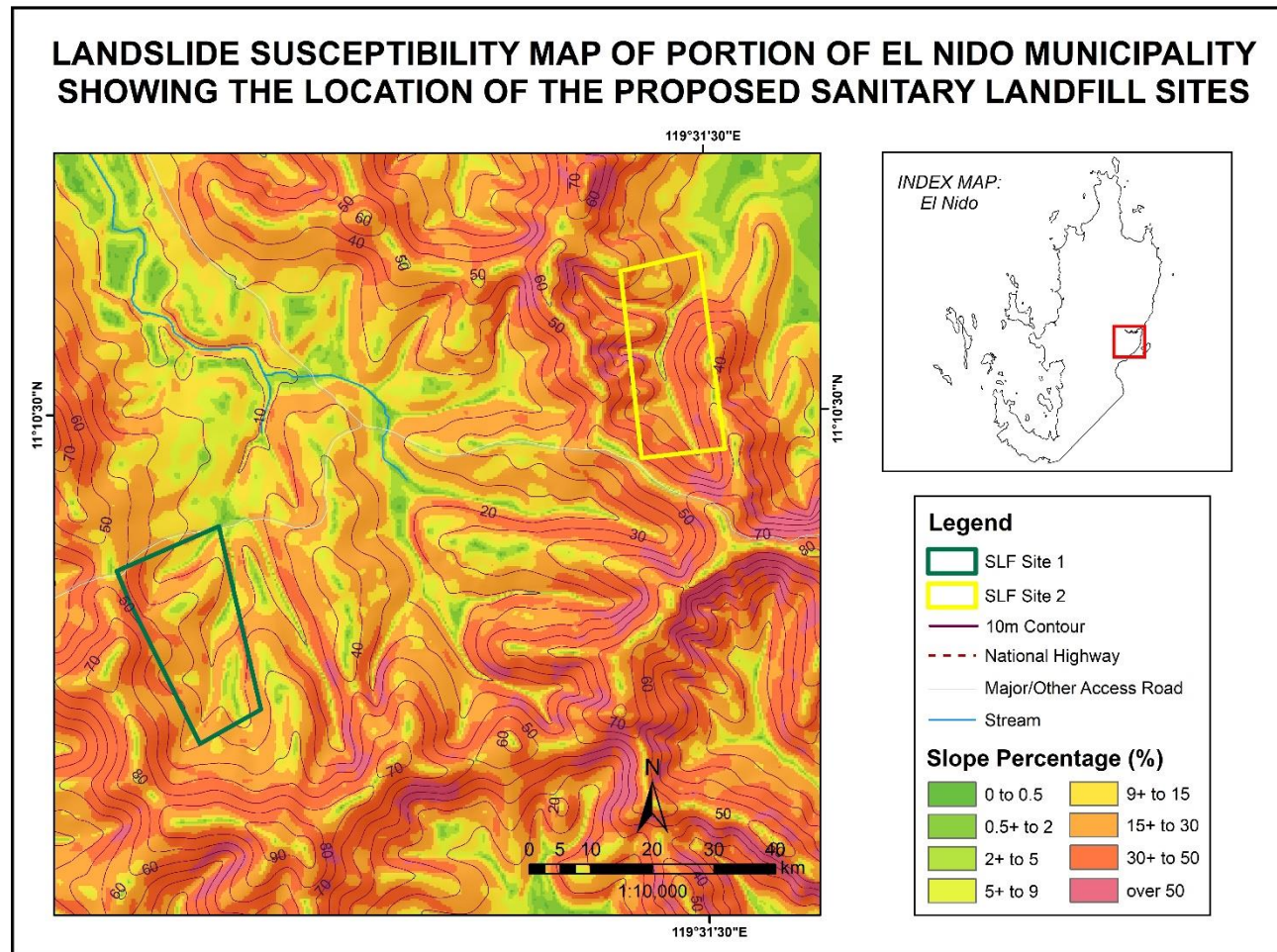


Figure 6. The generated landslide susceptibility map of the vicinity shows that the proposed SLF Site in Brgy. New Ibajay has moderate susceptibility to landslide.

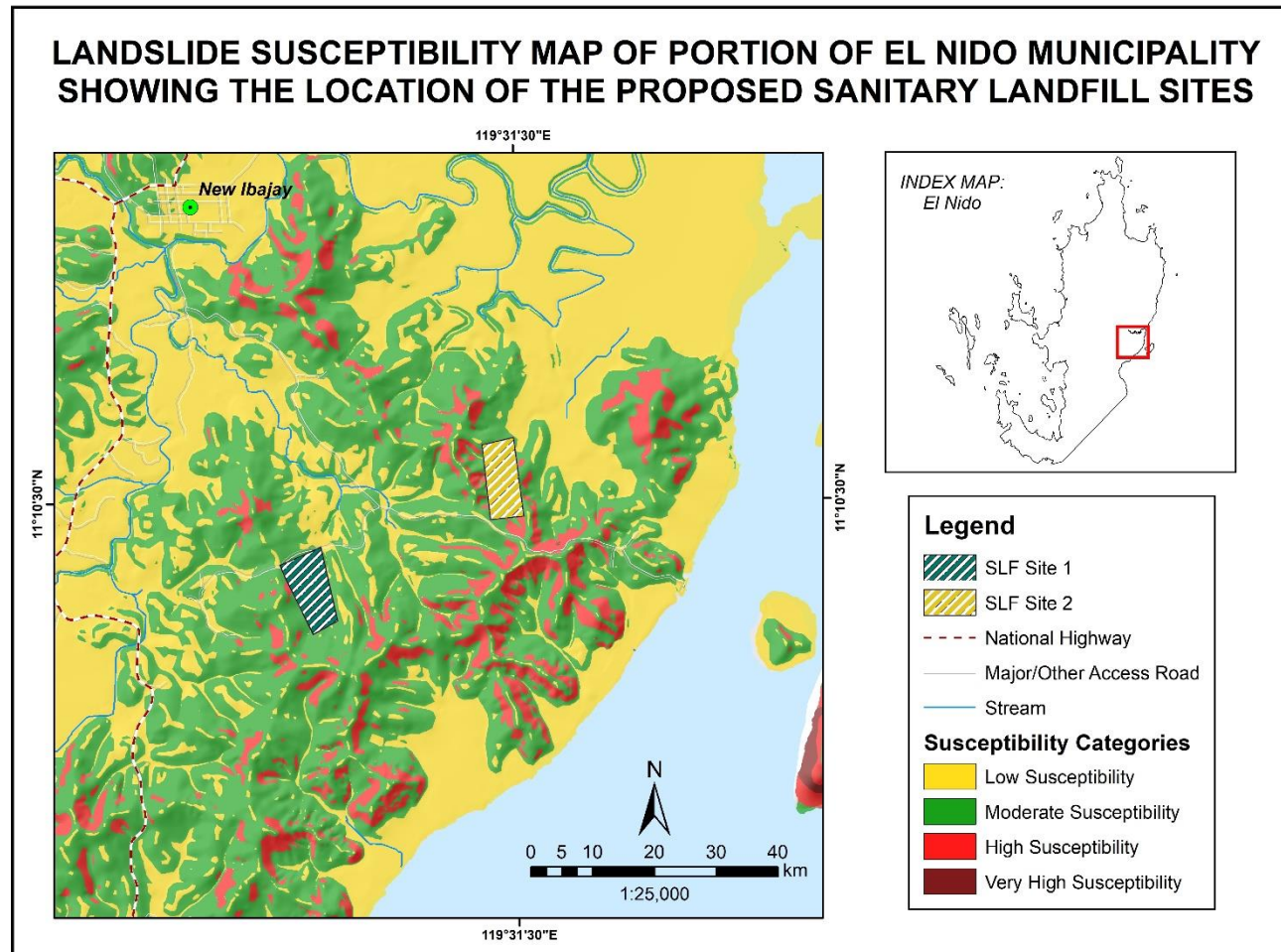


Figure 7. The generated flooding susceptibility map of the vicinity shows that the proposed SLF Site in Brgy. New Ibañay has moderate susceptibility to landslide and nil susceptibility to flooding.

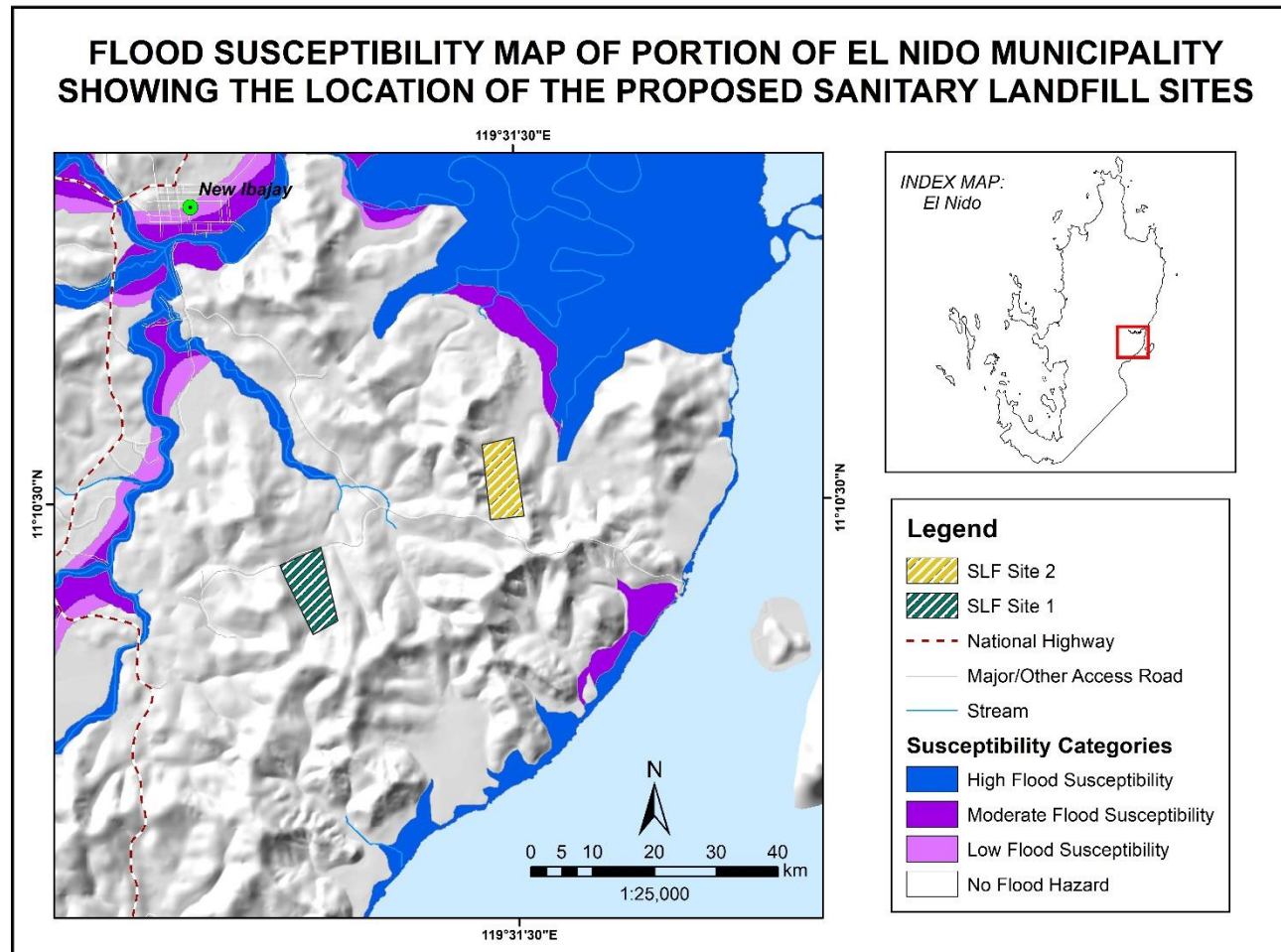


Figure 8. The generated ECAN map of the vicinity shows that the proposed SLF site is within Multiple Use Zone classification.

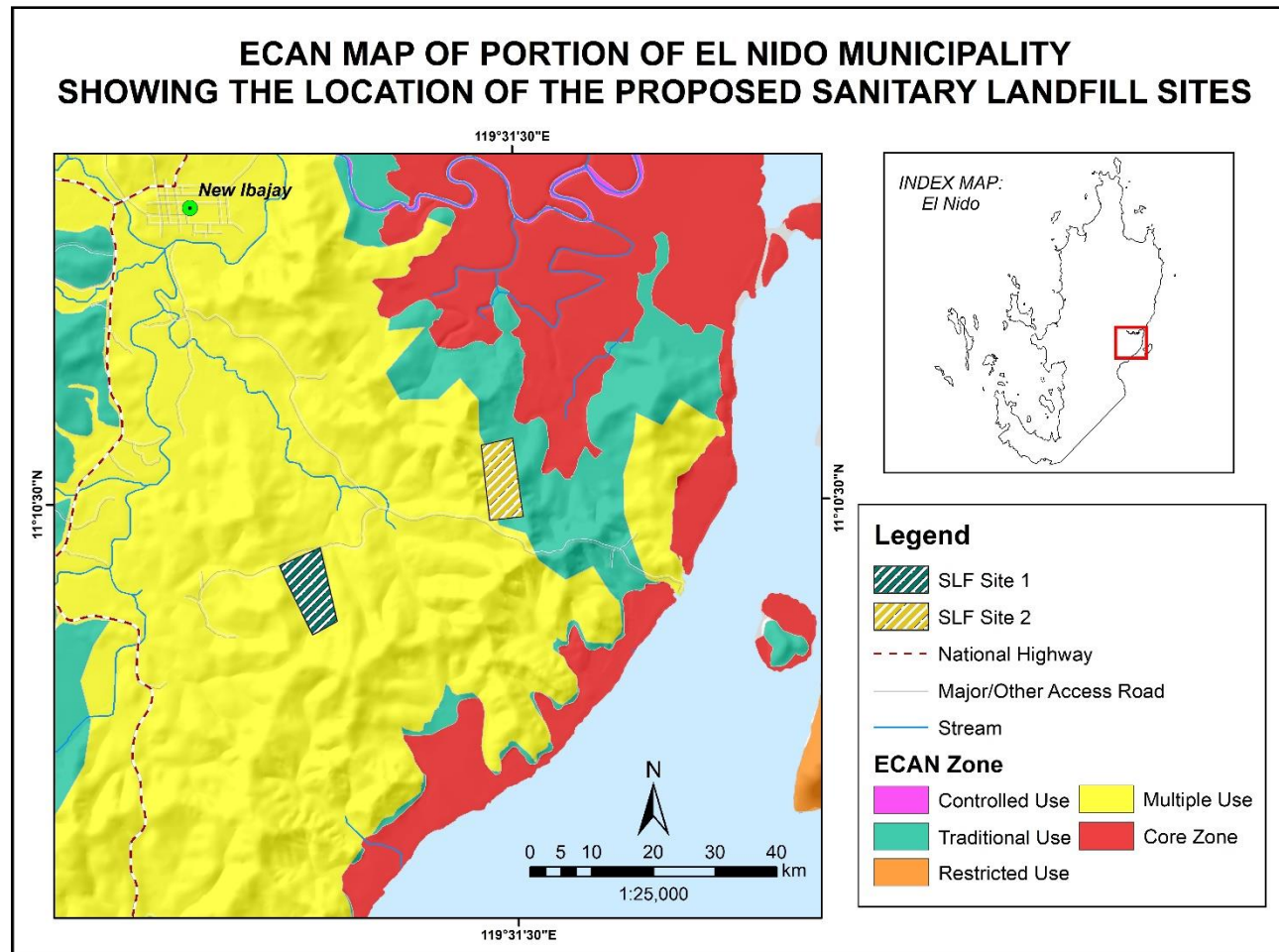
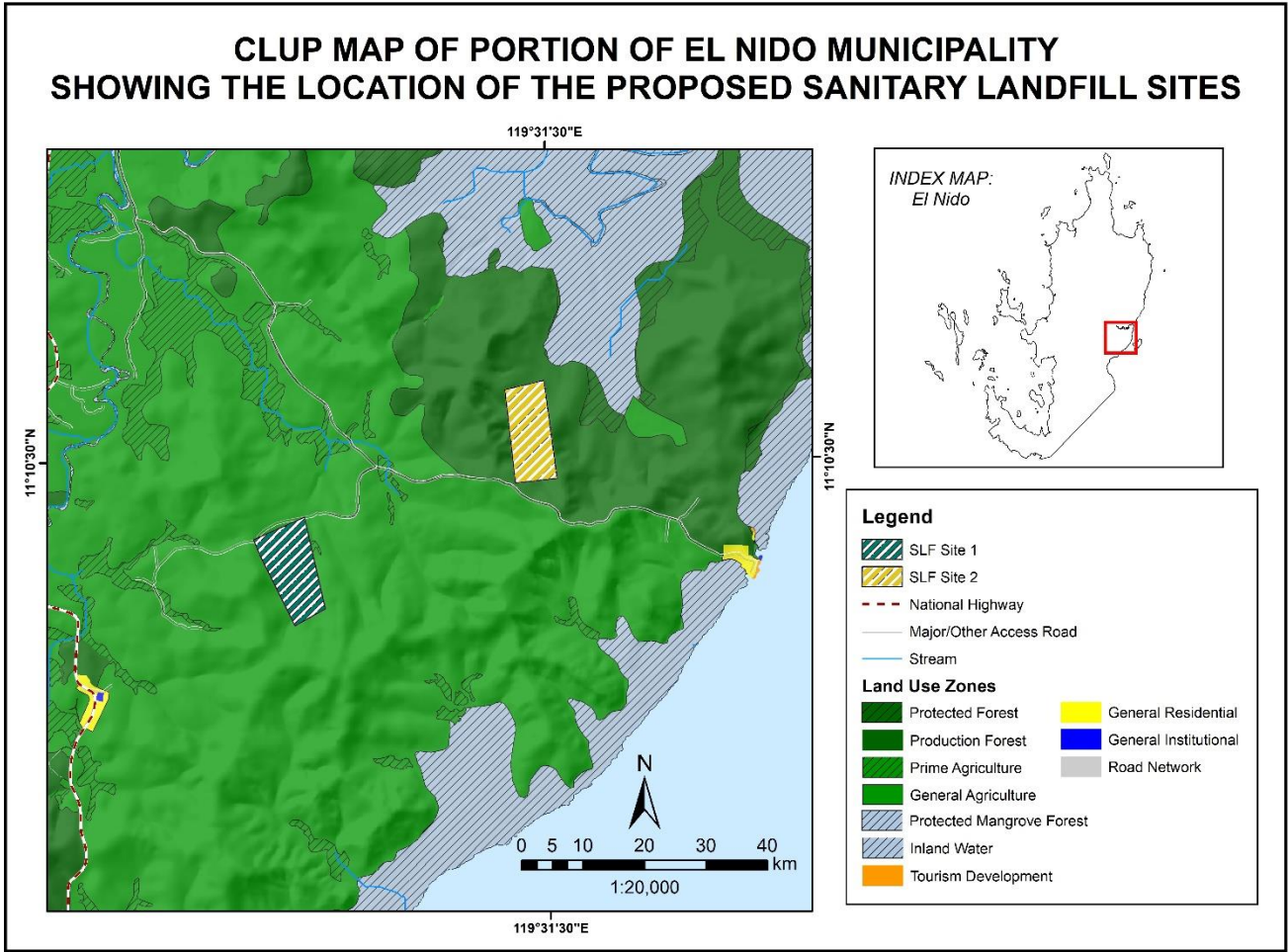


Figure 9. The generated CLUP map of the vicinity shows that the proposed SLF site is within Prime and General Agriculture Zone.



APPENDIX C – Photos

Photo No. 1. Shallow well observed down gradient of the proposed SLF Site 1.



Photo Nos. 2. Shallow well observed down gradient of the proposed SLF Site 1.



Photo No. 3. Intermittent tributary stream north of the proposed SLF Site 1.



Photo Nos. 4a. The soil cover is observed to be clayey with yellowish brown color. **4b.** Brown soil, roll into a ball when wet and can be flattened without breaking.

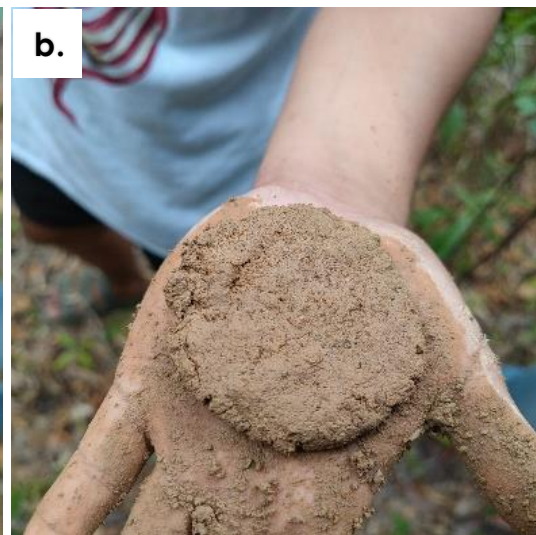


Photo Nos. 5a. The soil cover is observed to be clayey with yellowish brown color. **5b.** Brown soil, roll into a ball when wet and can be flattened without breaking.



Photo No. 6. The nearest residential house to the proposed SLF Site 1.



Photo No. 7. The nearest residential house to the proposed SLF Site 1.



Photo No. 8. The river traversing the access road from the national highway to the proposed SLF sites.



APPENDIX D – References

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