ENVIRONMENTAL IMPACT STATEMENT (EIS)

DRAFT REPORT

BAYAWAN CITY RIVER FLOOD CONTROL PROJECT THRU DREDGING METHOD

A JOINT PROJECT OF :

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and

CITY GOVERNMENT OF BAYAWAN

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1 PROJECT DESCRIPTION

1.1 Project Location and Area

Bayawan City ia a second-class component city of the 3rd Congressional District of the province of Negros Oriental. It is located southwest of Negros Island at coordinates 9°22”00.14” N and 122°47’59.01” (Figure 1-1). Based on the 2010 census, it has a population of 114,074. It has a land area of 699.08 sq. km., the largest in the province. Bayawan is bounded in the north by the municipality of Mabinay, in the east by the Cities of Tanjay and Bais, in the southeast by Sta Catalina, and Basay in the northwest. It is a coastal city with a coastline of 15 km and 7 coastal barangays facing the Sulu Sea in the southwest. Bayawan City is subdivided into three development zones: i) urban area, which constitutes 2.3% (15.73 sq. km) of the total land area; ii) sub-urban, which is about 14.7% (102.60 sq. km) of the city’s land area and consists of agro-industrial zones; and iii) rural area, consisting of the remaining 83.1% of the land area and is mostly agricultural.

Bayawan is linked by an all-weather asphalt-concrete 2-lane provincial road for about 102 kilometers from Dumaguete City, the provincial capital of Negros Oriental. Towards the north, about 19-km of concrete road runs through and reaches barangay Kalumbuyan, part of the planned Bayawan-Kabankalan road system. The Bayawan-Mabinay road (Km 117-Km 139) remains partly concreted and sealed, which connects it to barangay Dawis in the northeast corner. Otherwise all unfinished provincial roads are sealed gravel type, including all secondary city roads which links most barangays to the provincial road network. The city is politically subdivided into 28 barangays with 8 barangays comprising the urban area. Urban barangays are Banga, Ubos, Suba, Boyco, Poblacion, Tinago, Villareal and Maninihon. There are 20 rural barangays, namely: Ali-is, Banay-banay, Bugay, Cansumalig, Dawis, Kalamutkan, Kalumboyan, Malabugas, Manduao, Minaba, Nangka, Narra, Pagatban, San Isidro, San Jose, San Miguel, San Roque, Tabuan, Tayawan and Villasol. Figure Figure 1-2 below shows the barangay boundaries of Bayawan City.

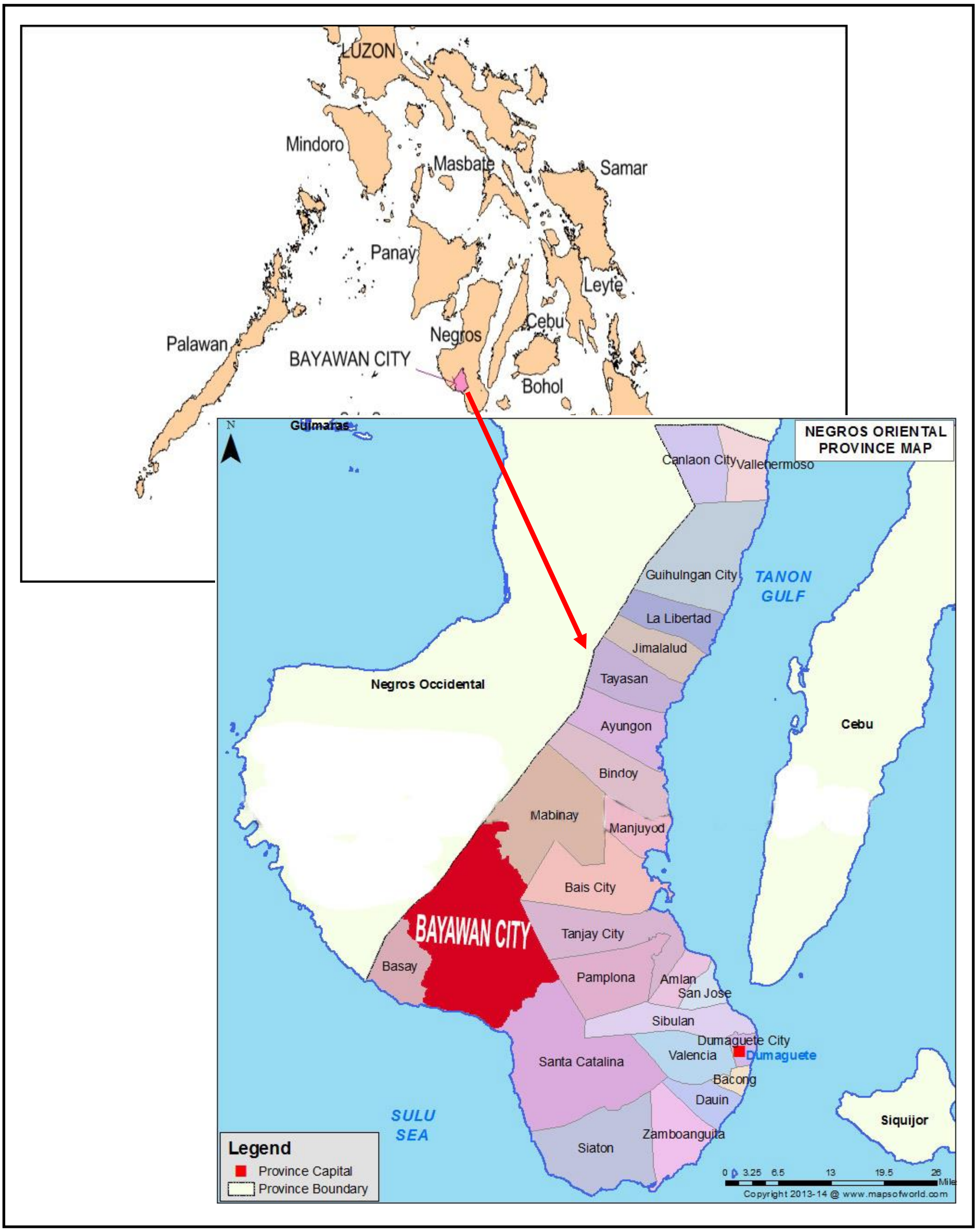
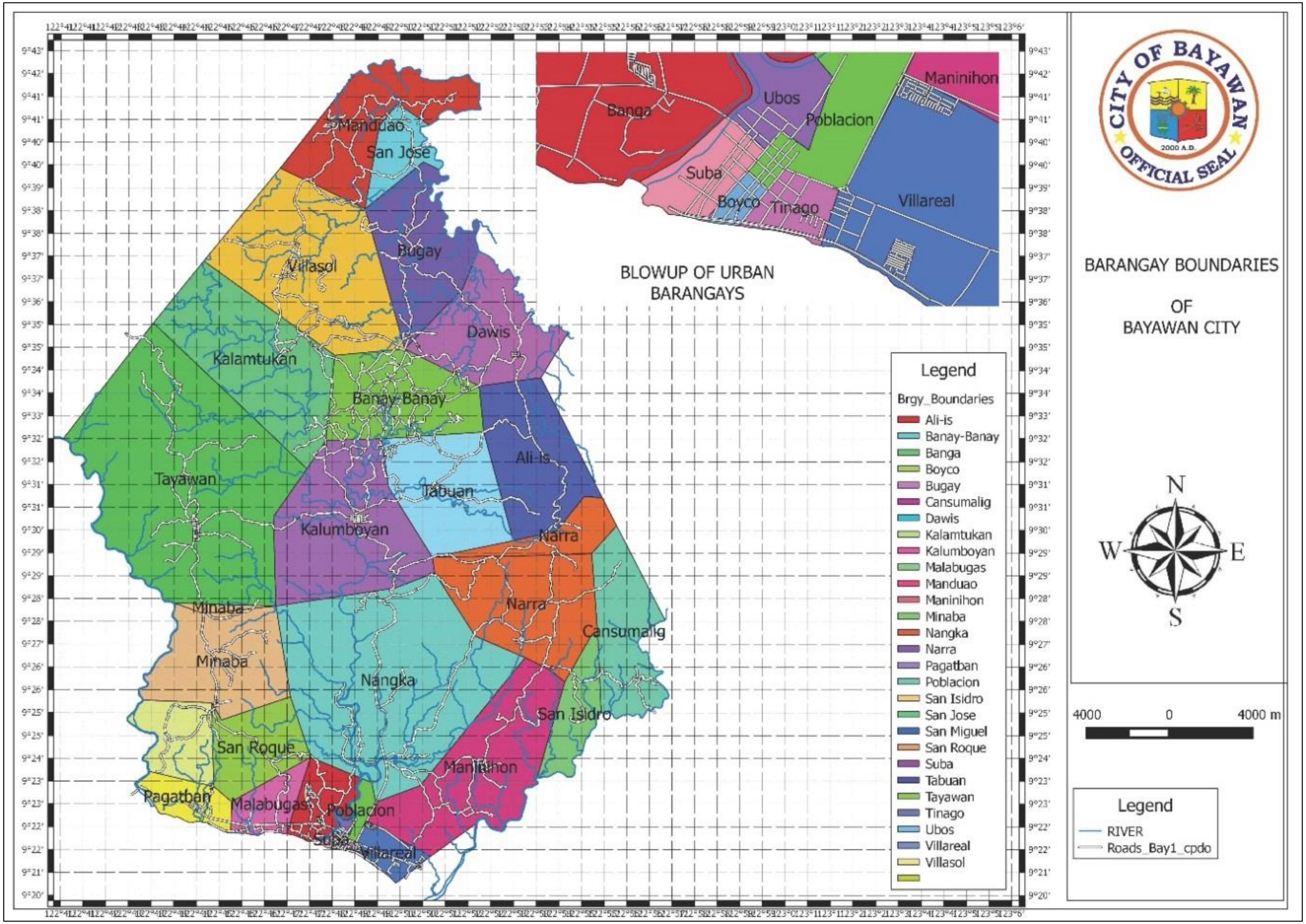


Figure 1-1 Location map



Source: CLUP

Figure 1-2 Barangay map

Project Site

The Project site is the Bayawan River, which is one of the largest rivers in Negros Oriental. Its catchment area is about 4.5 sq. kms. and stretches up to 6 kms. Bayawan River drains at Tolong Bay which is part of Sulu Sea. It passes at populated areas of which are at the center of Bayawan City. The Project will cover about six (6) kilometers reckoned from the estuary. The total project area is 2,120,000 square meters.

Table 1-1 below shows the geographic coordinates of the project site cited every one (1) kilometer interval based on PRS 92 Datum:

Table 1-1 Geographic Coordinates of the Project Site

STATION	LONGITUDE	LATITUDE
Sta. 0+000	122°47’35.20” E	9°21’36.41” N
Sta. 1+000	122°47’58.30” E	9°22’0.75” N
Sta. 2+000	122°48’2.87” E	9°22’28.26” N
Sta. 3+000	122°48’19.93” E	9°22’22.29” N
Sta. 4+000	122°48’25.03” E	9°22’37.50” N
Sta. 5+000	122°48’42.73” E	9°22’47.47” N
Sta. 6+000	122°48’39.32” E	9°23’16.20” N

Figure 1-3 Project topographic plan below shows the Project Topographic Plan, including the 1-kilometer stations for the entire dredging plan.

Buffer Zone

A minimum of 10 meters buffer zone on each side shall be enforced as no-dredging zone throughout the entire dredging area, varying based on the width of the river at certain stations. Dredging will start at the mouth of the river or Sta. 0+000 with a buffer zone of 50 meters on the left bank and 48 meters on the right bank and shall end at Sta. 6+000 with buffer zone of 746 meters on the left and 62 meters on the right bank. There shall also be a no-dredge zone 1 kilometer before and after the Bayawan bridge, specifically Sta. 0+300 upto Sta. 2+300. Figure 1-4, Figure 1-5, Figure 1-6, Figure 1-7 and Figure 1-8 show the buffer zones at specific river cross sections.

Primary and Secondary Impact Areas

Primary impact areas include the riverbanks and riparian zone, which is about 300 meters inland along the riverbanks. Secondary impact areas would include the navigational lanes at sea during the hauling of dredged materials. Figure 1-9 shows the primary and secondary impact areas of the Project.

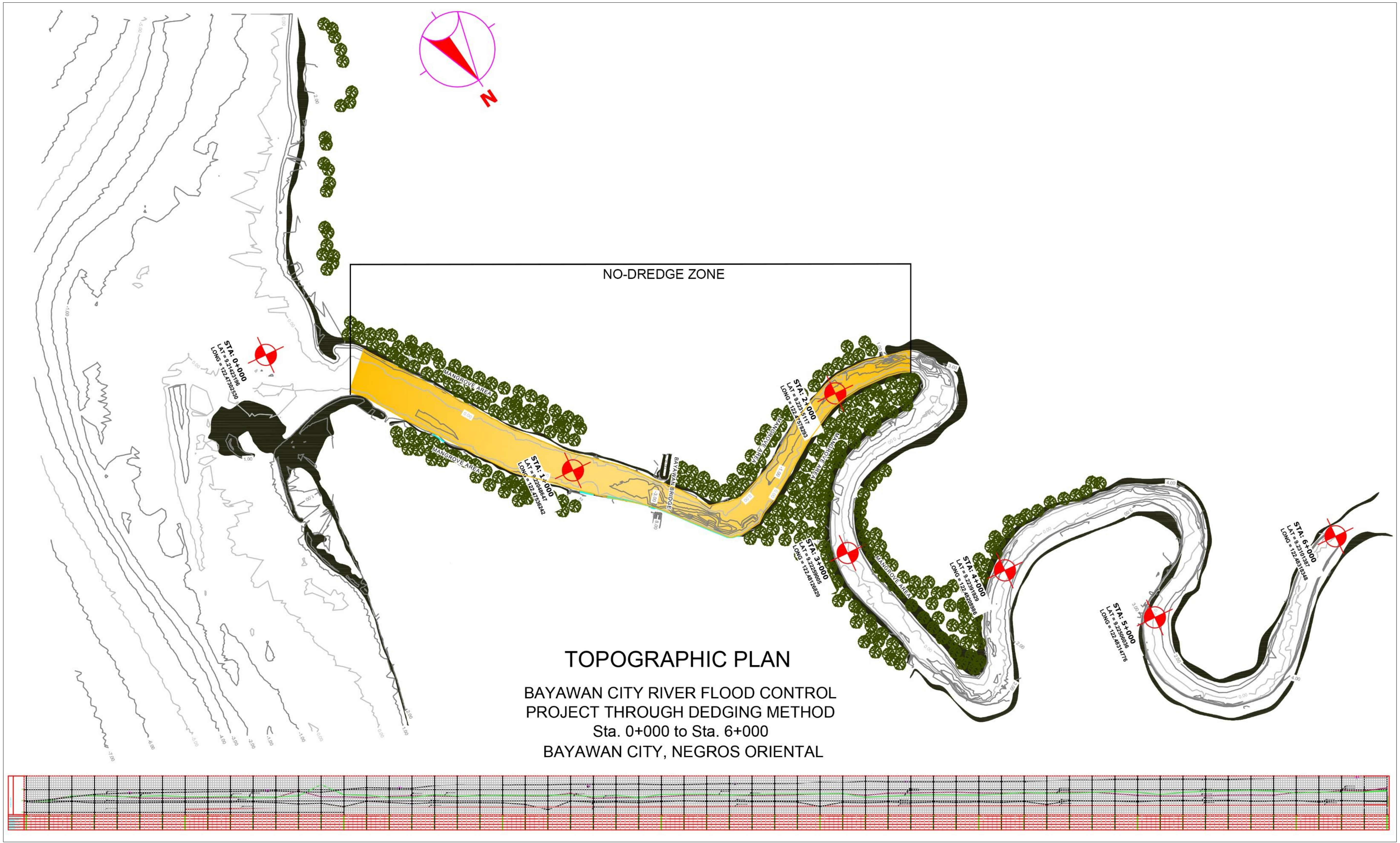


Figure 1-3 Project topographic plan

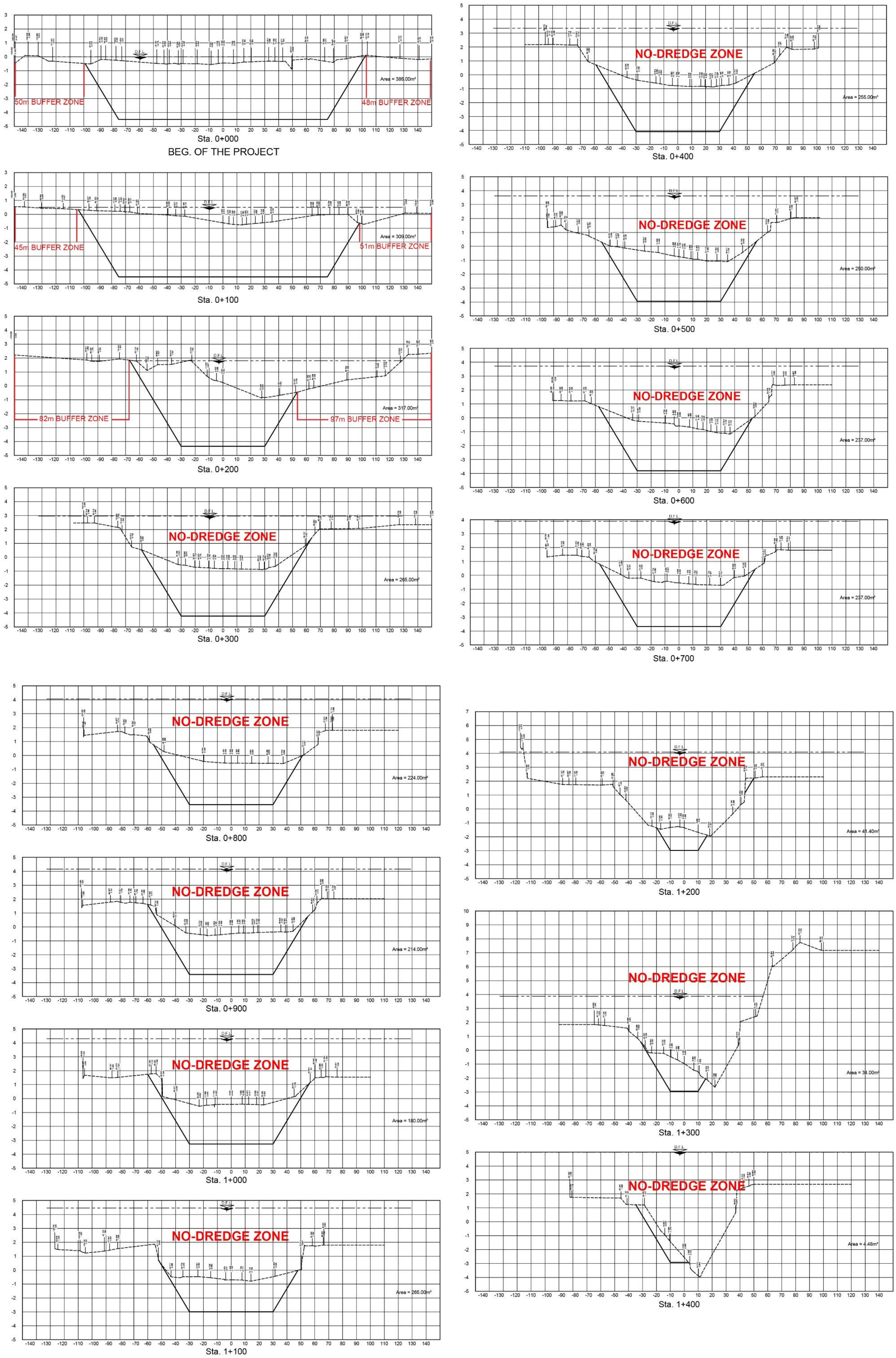


Figure 1-4 Bayawan River Cross-Sections with Proposed Dredging and Buffer Zones Sta. 0+000 to Sta. 1+400

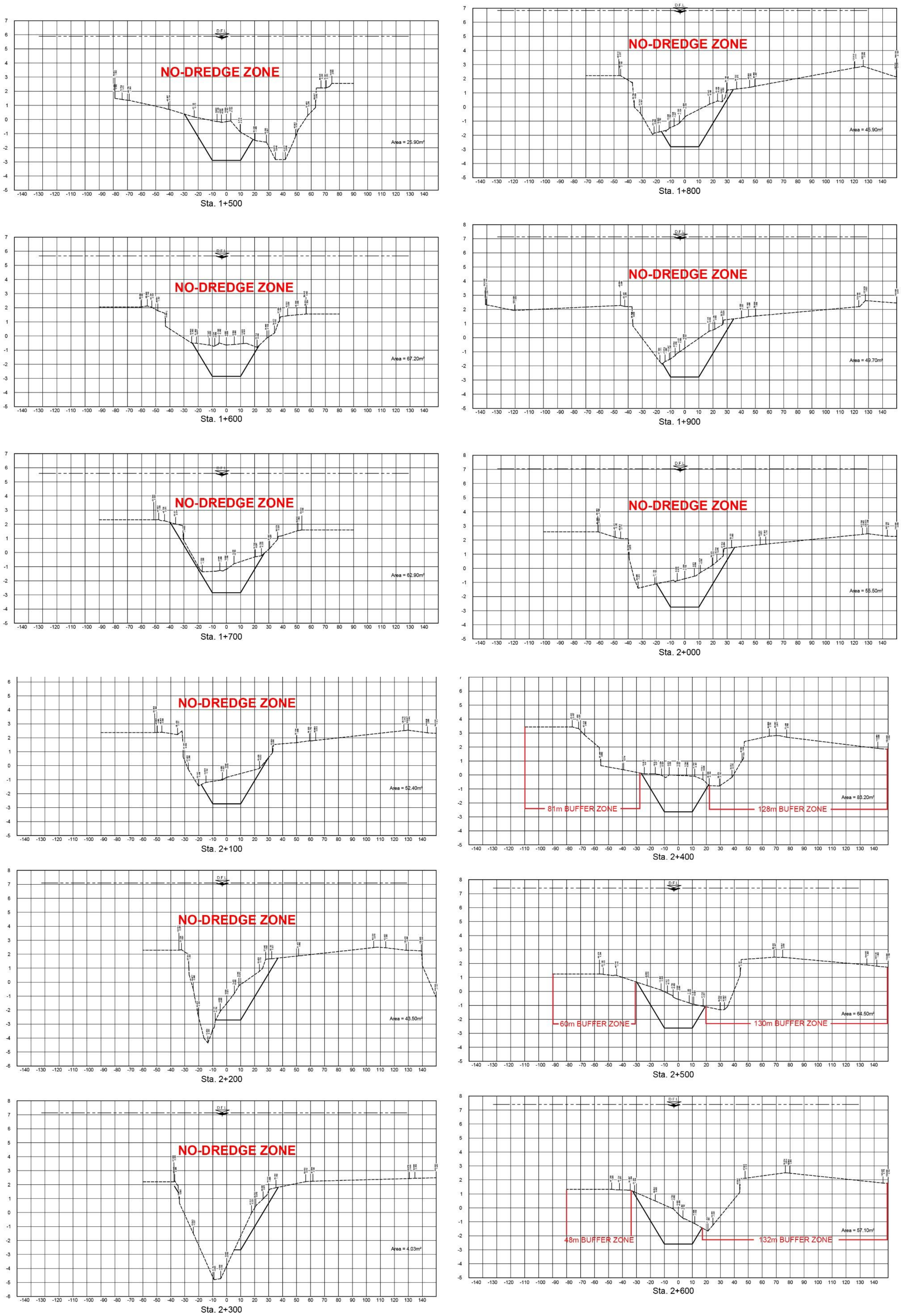


Figure 1-5 Bayawan River Cross-Sections with Proposed Dredging and Buffer Zones Sta. 1+500 to Sta. 2+600

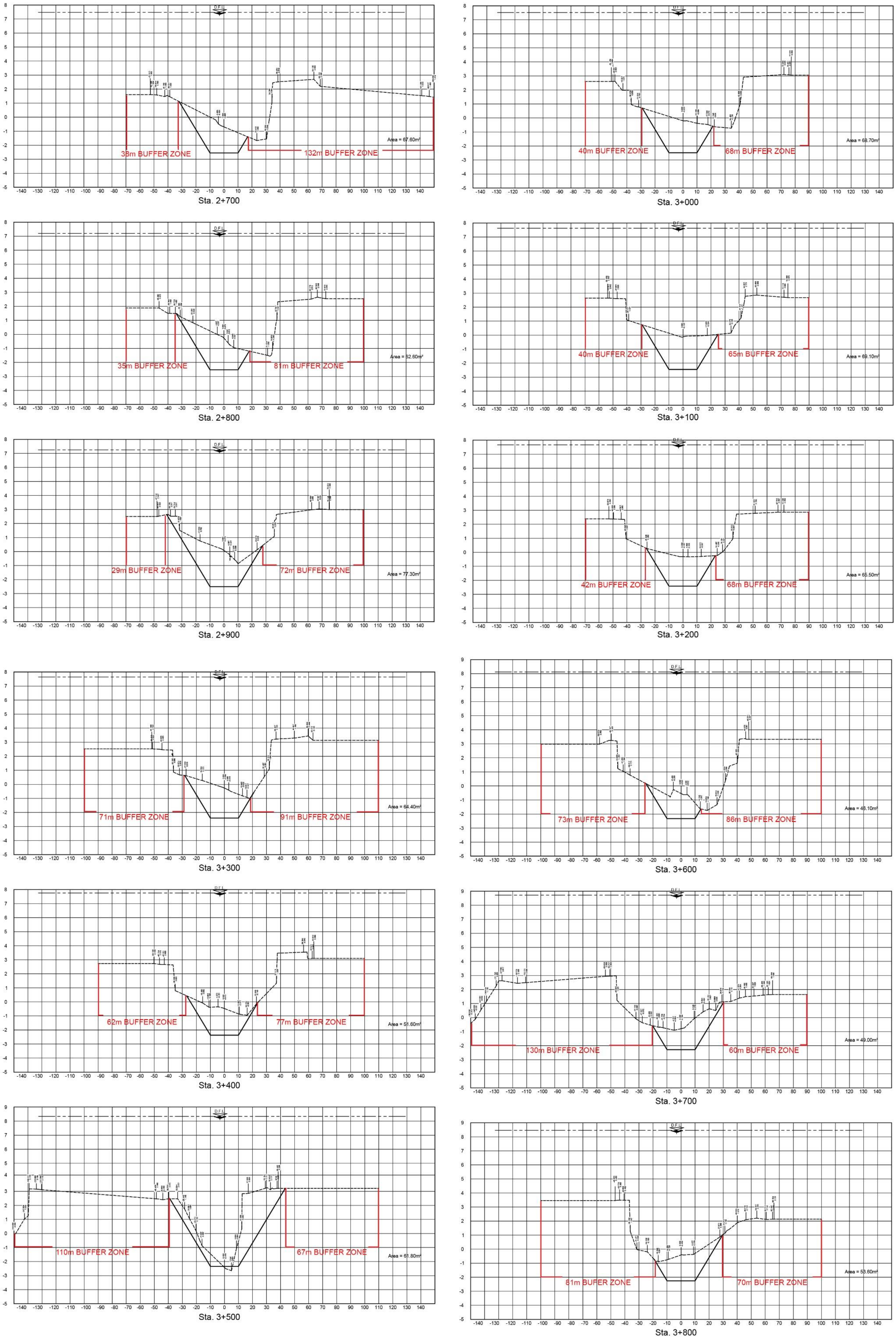


Figure 1-6 Bayawan River Cross-sections with Proposed Dredging and Buffer Zones Sta. 2+700 to Sta. 3+800

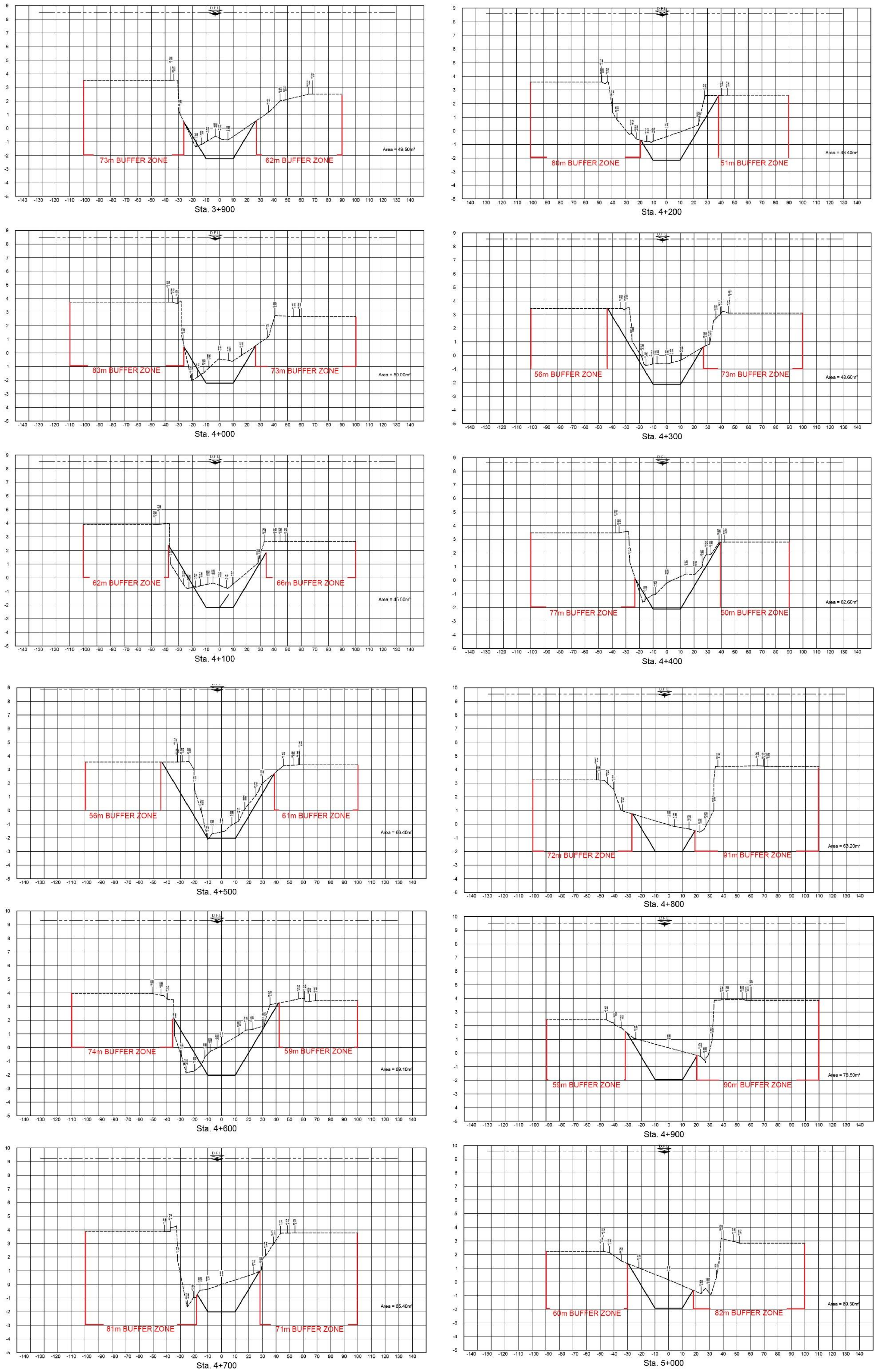


Figure 1-7 Bayawan River Cross-Sections with Proposed Dredging and Buffer Zones Sta. 3+900 to 5+000

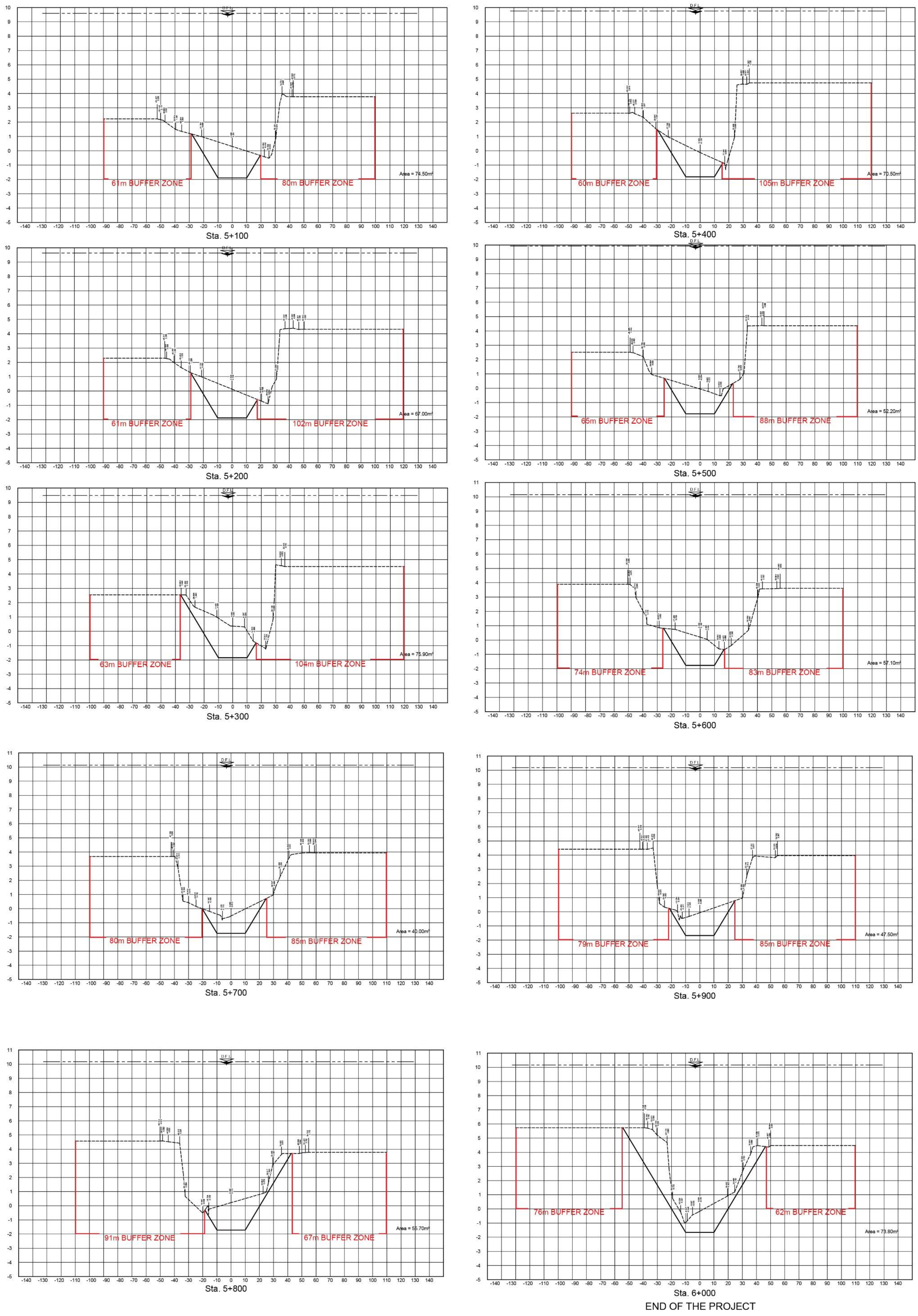
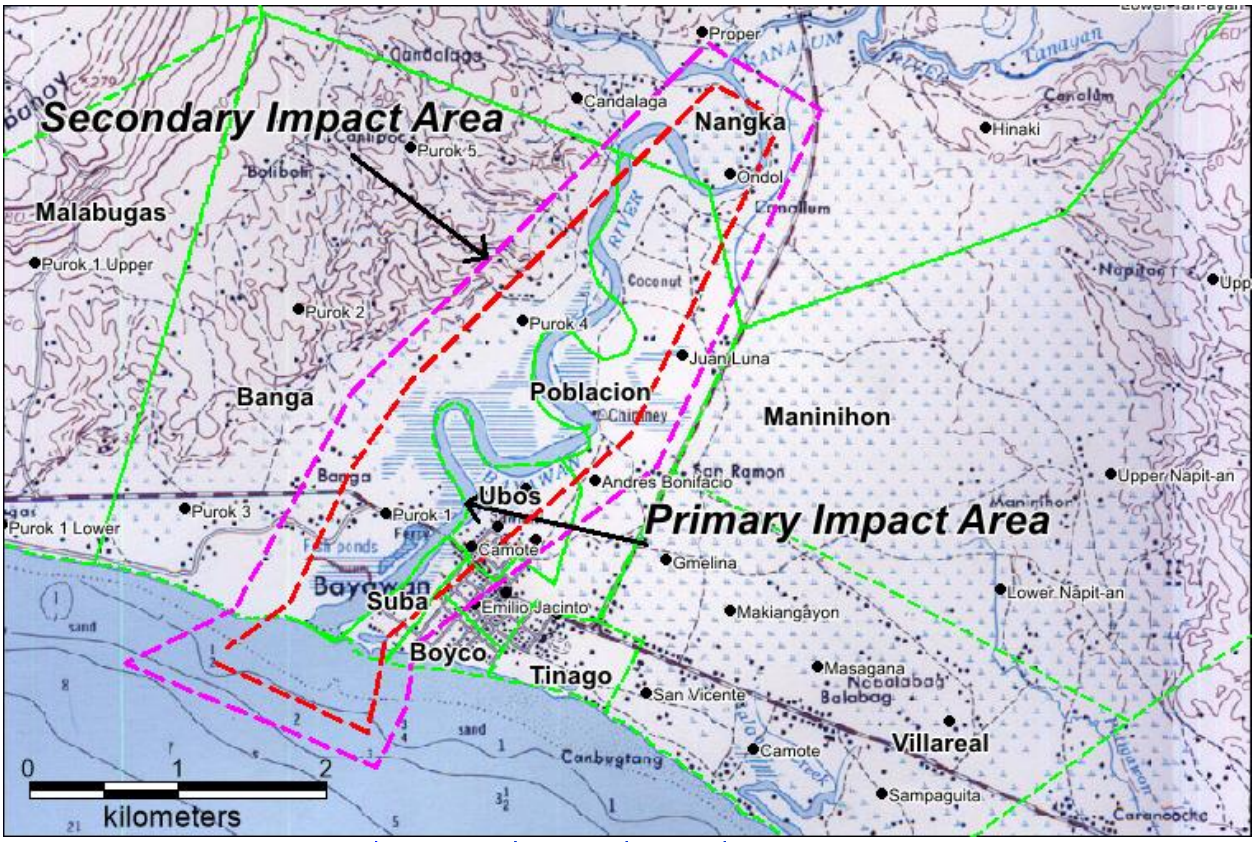


Figure 1-8 Bayawan River Cross-Sections with Proposed Dredging and Buffer Zones Sta. 5+100 to Sta. 6+000



Source: Namria

Figure 1-9 Primary and Secondary Impact Areas

Project Accessibility

The Project site starts at the estuary and mouth of the river and extends up to 6 kilometers upstream. Bayawan River Project site is situated at the Poblacion, extending up to Barangay Nangka. The river mouth can be easily accessed through the City's boulevard at Poblacion-Suba. Downstream and upstream sections of the river can also be seen from the main bridge at the national highway. Some riverbank sections can also be accessible in the upstream barangays and sitios of the City.

National Roads within Bayawan City are 58.2 kilometers in length and 15 meters in width, 19 kilometers is concrete while 18 kilometers is asphalt and 21.2 kilometers is graveled. Provincial Roads are 27.9 kilometers and 10 meters wide. 4.7 kilometers is concrete and 23.2 kilometers is unpaved with gravel filling. The city streets have a total of 12.02 kilometers with a width of 12 meters all of which is already concreted. Barangay Roads have a total of 516.19 kilometers with a 6-meter width. Concrete road is 39.52 kilometers; unpaved with gravel filling is 116.16 kilometers while the remaining earth filled is 404.94 kilometers.

Bayawan City has no commercial seaport except the existing fish port where commercial fishing boats dock and do business. Telecommunications facilities are provided by SMART Telecommunications, Globe Telecommunications, Sun Cellular, PLDT and Cruztelco. Major national dailies and local periodicals are available in local newsstands and major business establishments. Two local FM radio operate in the city. Internet cafes, calling centers, courier, telegraph and postal services are also present in the urban center. These telecommunication facilities are highly accessible in the urban area while the hinterland barangays have very limited access to these facilities.

Coming to Bayawan City from Dumaguete City through the Dumaguete South Road, from Bacolod City via Hinoboan or via Dawis Mabinay one has to contend with air-conditioned (available only for Bayawan City-Dumaguete City Route) and non-air-conditioned buses of Ceres Liner of the Vallacar Transit, Inc. Ceres Liner also offers direct trips to Cebu City via

Dumaguete City. Likewise, the popular vehicles for hire also ply the Bayawan City-Dumaguete City and Dumaguete City-Bayawan City-Kalumboyan Route.

1.2 Project Rationale

Flooding is a serious problem in Bayawan City. Sandwiched between the Bayawan and Sicopong Rivers, Bayawan City is highly susceptible to flooding during rainy days. In October 13, 2013, three days of successive torrential rains brought Bayawan City to its knees. P50.9M and P40M worth of agriculture and infrastructure, respectively, were destroyed by floods. Damage to business establishments was pegged at P8M and another P1.8M for textbooks for a total of P100.1M. Six persons, including a policeman rescuer, were killed by the rampaging floodwaters. Thirty-six families lost their homes and about 20,000 people were evacuated.

One of the many possible reasons for the monsoonal flooding events happening in the lower parts of Bayawan City is the “shallowing” of the Bayawan river delta caused by river sediment runoffs. This is a natural consequence where topsoil (in the absence of a concrete embankment) in the uplands is significantly eroded during heavy downpours and settles in the river delta. Periodic dredging of the waterways by “deepening” it is essential and necessary to prevent and mitigate flooding (inundation) of low lying areas of the city. Bayawan River also serves as the port area of the fishing vessels operating in Sulu Sea. Deepening the river channel will also facilitate navigation efficiency and ease boat traffic, thereby promoting economic activity between upland barangays and the city.

The 2013 Flood Disaster

On 06 October 2013, the city of Bayawan in Negros Oriental was inundated by riverine flash floods of up to 8 meters high near riverbanks, affecting at least 44 km^2 in 9 coastal and floodplain barangays. This was its worst flood disaster in recorded history, resulting in hundreds of millions of pesos in property, crops and infrastructural damages, 6 deaths and 11,000 displaced. Power and communication lines were cut off and isolated from the rest of the province, putting the city instantly in a state of calamity.

Heavy and prolonged precipitation was spawned by several days of rains due to an ITCZ (Intertropical Convergence Zone), and not due to the direct effects of a typhoon’s rain bands. The passage of two tropical cyclones (TY *Quedan* and TY *Ramil*) in the SW Pacific Ocean has activated the ITCZ and enhanced the SW monsoon, thereby increasing the intensity of rainfall over the Sulu Sea area.

Flash flooding and overland sheet flow was directly caused by overtopping of the heavily-silted 6-km long downstream portion of Bayawan River. Flooding took place over a 40-hour period, starting in the early afternoon of October 5 through early morning of October 7, with peak flood discharge occurring at around 7am of October 6. Reconstructed flood hydrograph showed that this was an instantaneous inundation with little lag time. Floodwater receded almost 2 days after peak flood stage. Some 855 mm of rain was dumped over a 3-day period (October 4-6), whilst 514 mm fell in 24 hours of October 6. Bayawan over the last 50 years has averaged a monthly rainfall of 368 mm for the month of October, and an annual average of 2531 mm.

The flood was exacerbated by backwater effect due to high tidal seawater flowing 5 km inwards along Bayawan River. The worst-hit areas are situated in a large, high-sinuosity meandering zone of active and abandoned river channels with current surface topography lying at 2 to 5 meters asl elevation, causing shifting river dynamics, constant avulsion, and catastrophic flooding.

Previous floods

Historically, local people remember two (2) big flood events which previously affected the Southern Negros communities, apparently caused by typhoon *Ruping* in 1990 and *Ursula* in 2003. Apparently, these did not cause massive inundation compared to this very recent event.

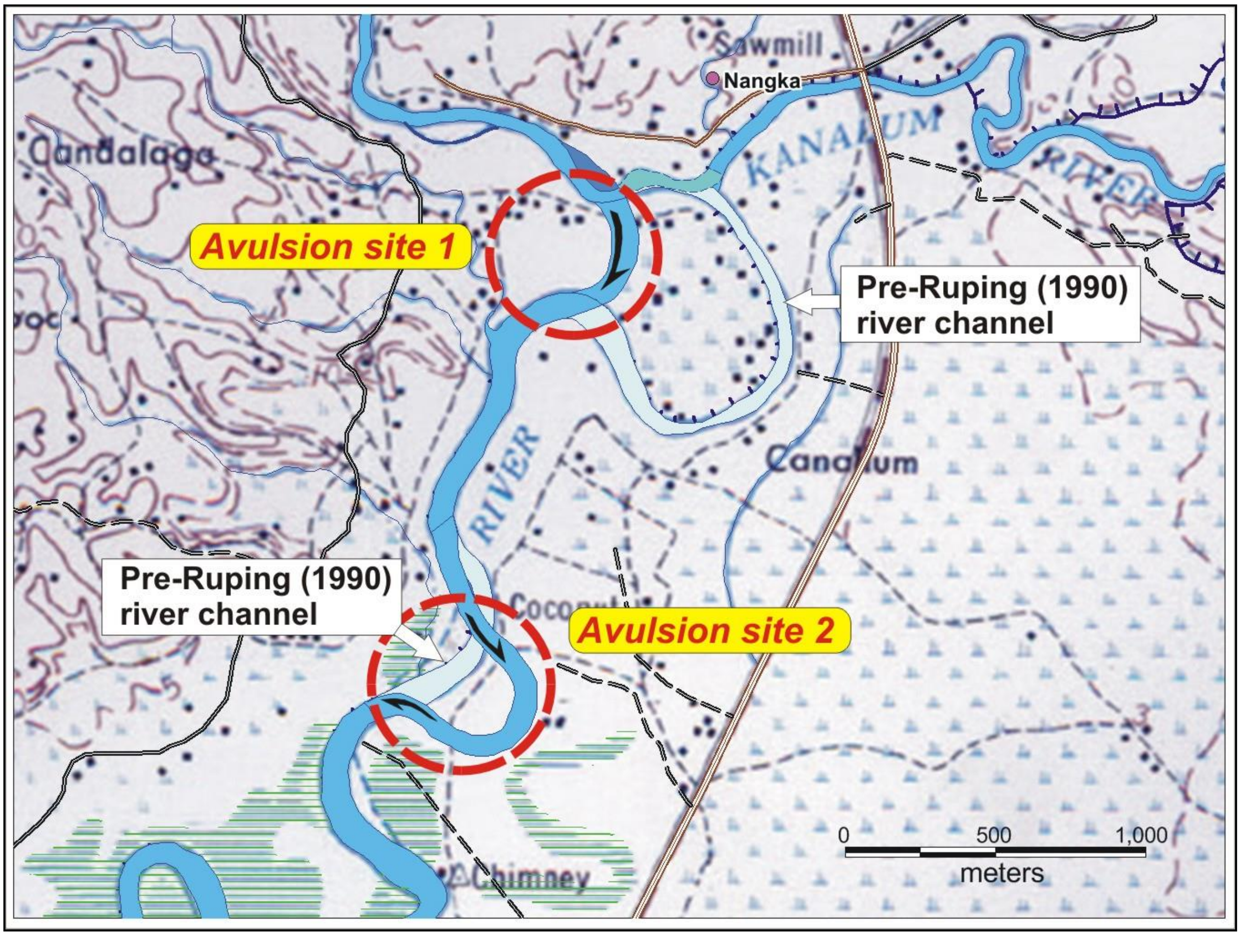
Ursula was just a tropical depression (October 21-24, 2003) with peak intensity of 55 km/hr. *Ruping* was the deadliest typhoon (November 13-14, 1990) since *Nitang* in 1984 (its heavy rainfall and winds killed 1,492 people in the whole country, total damage P10.846B) and *Amy* in 1951, when it made landfall in the eastern Philippines at 230 km/hr but weakened when it hit the central islands at 137km/hr, but poured heavy rains that caused widespread flooding across the Visayas. *Ruping*'s and *Ursula*'s floodwaters have also inundated the whole Bayawan floodplain, where about 0.30 meter and 0.10 meter of maximum flood heights were reported in the urban area, respectively.

River avulsion

During a big flood generated by rains from typhoon Ruping in 1990, a major geomorphic change of the Bayawan waterway has apparently occurred. There was a shift in river direction, geologically termed as *avulsion*, which involved cutting-off of the meandering portions of the river in Sitio Ondol in barangay Nangka and Sitio San Ramon in barangay Poblacion.

Avulsion is a natural phenomenon common in high-energy meandering river systems, where fast-flowing sediment-loaded water under the force of gravity will tend to flow in the most direct course downslope, and breaks its natural banks and levees, spilling out onto a new course with a shorter route. Second, as its slope is reduced, the amount of shear stress on the bed will decrease, resulting in deposition of sediment within the channel raising the channel bed relative to the floodplain. This will make it easier for the river to breach its levees and cut a new channel that enters the ocean at a steeper slope.

A comparison was made of the old (post-war) NAMRIA topographic map, and current digital images of topography, as shown in Figure 1-10 below.



Source: Namria

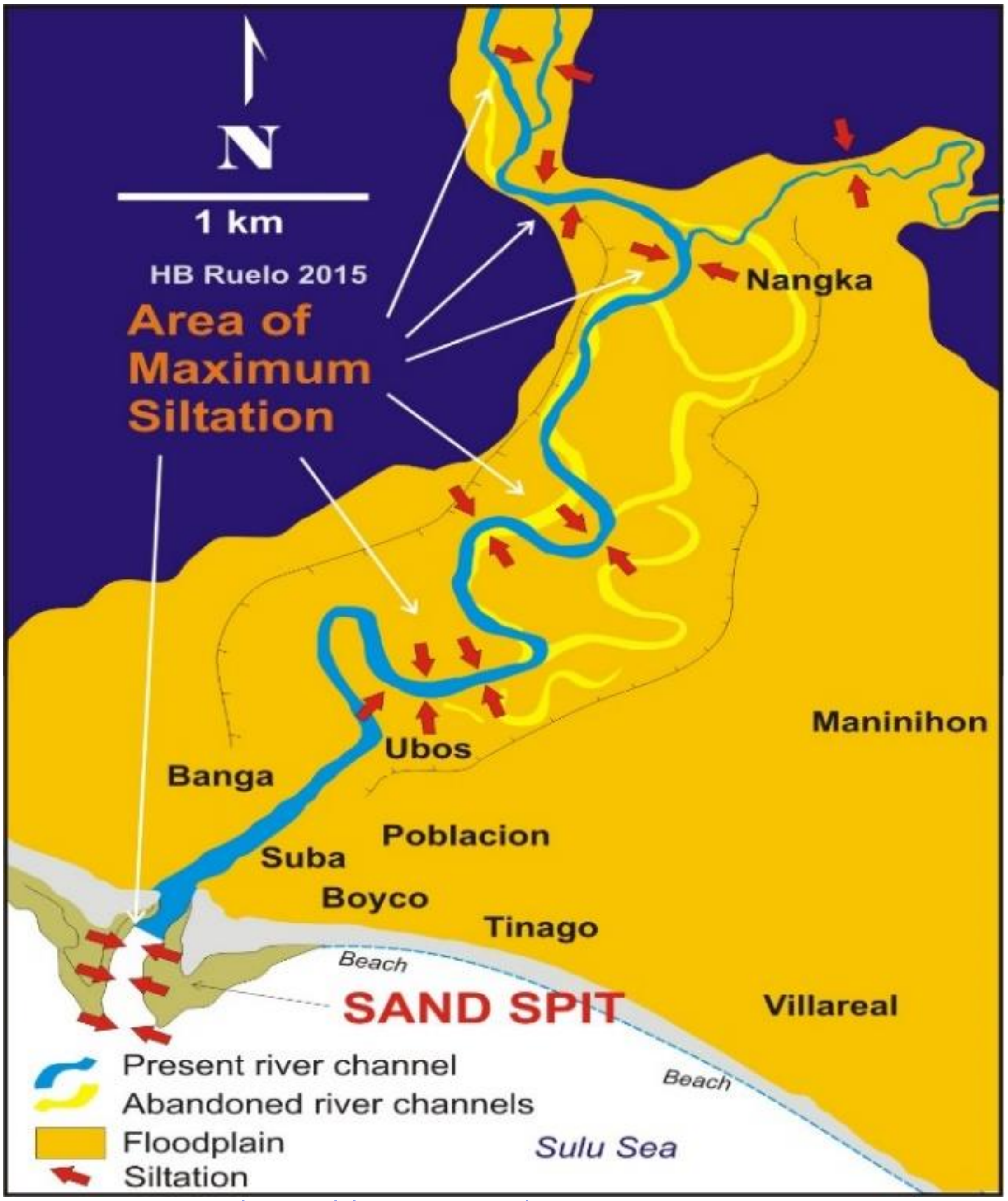
Figure 1-10 River Avulsion at 2 Sites of Bayawan River

There are two (2) primary objectives for undertaking this dredging operation:

a. To increase the river channel capacity and its ability to convey runoff water during heavy rains along the meandering channel towards its outlet at the river's mouth;

b. Deepen the river's mouth for easy access of fishing boats to the Bayawan fishport.

Doing this requires removal of accumulated sediments in heavily silted portions at the river's mouth and at selected downstream segments of the meandering Bayawan river channel and Canalum River tributary. Figure 1-11 below shows the siltation map of downstream Bayawan River.



Source: Bayawan River Dredging Pre-FS, Ruelo

Figure 1-11 Siltation Map of Bayawan River

1.3 **Project Alternatives**

Flood control includes all measures and mitigation that will reduce flood flows in the watersheds of small rivers and tributaries. Flood control is an economic problem in which the protection of life and property as well as the public benefits must be evaluated in balancing the annual savings from flood control against construction and maintenance costs.

Flood control can be either structural or non-structural against floodwaters which cause damage by inundation and by high velocities. Flood mitigating measures presently employed by the government are non-structural measures include monitoring, forecasting and warning, land-use regulations, watershed management, hazard mapping, public awareness and disaster preparedness programs.

There are two types of structural flood controls to consider: headwater and downstream flood controls.

The headwater flood controls focus on the effects of upland crops, soil cover, tillage practices and conservation measures. These are controls against flash floods. Massive reforestation initiatives should also be undertaken for long term headwater flood control.

The downstream flood controls constitute downstream engineering such as dikes, dredging, revetments, channel improvements, canalization/channelization and dams.

Generally, there are two alternatives to be considered for downstream flood control.

1. Leave the river as it is and allow it to find its new dynamic equilibrium or;

2. Dredge the river to a desirable cross section to maintain its stream path and dynamic equilibrium that lessen extent of flooding in the area.

The first alternative is a far outcry from reality. Economic opportunities provided by these floodplains have always outweighed the risk brought about by natural flooding in the area. This is one reality that may not change over a significant period of time. Furthermore, it is near impossible for the government to remove people in the area to minimize loss of lives and properties as a consequence of the natural flooding incidence.

It is therefore imperative to deepen the current river channel to be able to accommodate more volume of floodwater, thereby minimizing overflowing of the river that caused flooding and destruction in the main urban center of the City, including other low-lying areas.

<u>Goal</u>

The main goal of the Project is to mitigate flooding extent in the area by increasing the capacity of the river to carry more volume of water by changing its configuration through precision dredging. Invariably, the result will be a new equilibrium condition of the river to accommodate this extra volume of water. To achieve this new dynamic equilibrium, the entire river system has to be investigated in a holistic approach.

<u>Siting</u>

The Project site is part of the Bayawan Floodplain. The Bayawan floodplain occupies a relatively flat land as a consequence of the meandering nature of Bayawan River when it enters Sulu Sea. The meander zone presently occupies the western portion of the floodplain, forming an elongated zone of active and abandoned riverine channel ways, 1 km across and stretching inland to about 6 km at barangay Nangka. Swamps surround the active river channel at its deltaic mouth and extends 3 km inland (3 meters asl elevation) at barangays Banga and Ubos, and fringes the coastal areas at barangay Villareal. The Bayawan floodplain is an aggrading (mainly depositional) floodplain. The Bayawan River which cuts it has reached beyond its natural base level of degradation, and therefore it is subject to repeated floods, rapid sedimentation, and river avulsion during extreme flood events. Figure 1-12 below is a map showing the Bayawan Floodplain and adjacent coastal areas.

Source: NAMRIA

Figure 1-12 Bayawan City Floodplain Map

<u>Technology Selection/Operation Processes</u>

There are two major impacts that may result from dredging river systems. The generation of excessive silt and river bank erosion. The generation of excessive silt can be mitigated by providing silt curtains in the dredging area and in ecologically sensitive areas. These strategies will minimize impact to water quality in general and ecologically important niche, in particular, the ones that may be found in the river stretch.

River bank erosion is an indication of instability of river systems. This is likely to occur if there is disturbance in the dynamic equilibrium of the river flow or its channel. To achieve a new desirable equilibrium, careful consideration must be taken in the reconfiguration of river channel corresponding to its new equilibrium condition. To do this, we employ the best practicable science of modeling. HEC-RAS software package will be employed to identify the limits of dredging. The modeling results as design criteria will be approved by DPWH.

Resources

Marisand, through its construction partner and "mother" company, will deploy and provide all dredging vessels and equipment needed for the Project. Financial requirements will also be provided by Marisand. The fuel and oil used to run the dredging equipment will be sourced locally. Supply arrangements will be made to ensure sustainable and continuous operations. Supervision of dredging operations, including engineering and environmental monitoring will be handled by another of Marisand's consortium partners, POIEL Engineering and Management Services.

Reasons for Selecting the Preferred Options

Desiltation by dredging is a proven method in increasing the carrying capacity of waterways to contain excessive amounts of river surface run-off during floods brought about by periods of heavy rainfall. Bayawan River in its meandering lower segments in the floodplain area and at its mouth or confluence with the Sulu Sea has reached a stage of maturity, therefore rendering the area as very highly flood prone.

The reasons for selecting the preferred options in terms of technical, commercial, social and natural environment are based on the technical and financial feasibility of each alternative. It is assumed that dredging will have positive impact on the social and environmental aspect of the area. The primary consideration, therefor, is the financial feasibility as discussed below:

Objective of Flood Mitigation for Short Term (Urgent Development)

General Objective: Design the river channel to improve river capacity and accommodate the 25-year flood discharge along the first 6 kilometers of Bayawan River for the purpose of minimizing flooding in the City of Bayawan.

Specific Objectives: Determine alternatives for channel improvement of Bayawan River to improve river capacity and accommodate 25-year river flood flow; and determine appropriate river channel improvement in anticipation of climate change.

Financial Feasibility

The feasibility of alternatives for river channel improvement include:

Alternative 1 – River Dike System

Construction of flood -retention dikes is very expensive, and local land owners within the diked area will surely reject any proposal.

Alternative 2 – River channel improvement through dredging

This alternative is also very expensive but with the intervention of Marisand Resources Co. Ltd., it will be done without cost to the LGU.

Furthermore, this project is linked with the planned 4-hectare Bayawan City Fish Port Complex, located in Barangay Banga, at near the estuarine mouth of Bayawan River that meets Sulu Sea. Dredging shall improve the navigational depth of Bayawan River and open it up for larger capacity fishing vessels to dock into the planned fish port.

Comparative Environmental Impacts of Each Alternative

Alternative 1 – Dike system will disturb the natural riparian zone but overtime allows more sediment deposition downstream.

Alternative 2 – Controlled dredging will disturb the natural riparian zone but has better control on sediment deposition.

Furthermore, these alternatives may be subject to the effect of climate change. In anticipation of climate change, the Detailed Engineering Plan of the dredging project provides analysis of river channel improvement to accommodate design discharge of 50-year river flood flow.

Consequences of Not Proceeding with the Project

Earlier parts of this study have provided ample discussion on the flooding incidents in Bayawan City and of the sedimentation and siltation at Bayawan River. Without the project, we cannot expect to urgently minimize flooding in Bayawan City. It is therefore imperative for the river channel to be deepened and improved. As it is, residents of Bayawan, especially those in the floodplain areas are in constant fear every time there is a forecast for thunderstorms and typhoons.

Furthermore, if the river channel will not be deepened, the City cannot proceed with the planned Bayawan City Fish Port Complex. The proposed fish port is expected to boost the City's economy and provide more jobs and livelihood to the people of Bayawan.

1.4 **Project Components**

Project Area, Location, Primary and Secondary Impact Areas

The Project starts at the mouth of Bayawan River, up to 6 kilometers upstream with a no-dredge zone 1 kilometer before and after Bayawan Bridge. The identified barangays which will be affected by the project are Barangays Banga, Suba, Poblacion, Ubos and Nangka.

To recover the channel definition of the river, dredging the river silt and sediments is necessary. The configuration of the channel will be designed in conformity with parameters as stipulated by the Master Plan for Bayawan River. A separate Detailed Engineering Design and Plan will be developed to guide the precision operation of dredging. Figure 1-13 below shows the dreding plan, including the proposed site for bunkhouse and temporary facilities.

As discussed in the earlier section, a minimum of 10 meters buffer zone on both sides will be maintained throughout the entire dredging area with a no-dredge zone 1 kilometer before and after the Bayawan bridge (refer to Figure 1-4 up to Figure 1-8).

The primary impact of the Project is very significant along the river banks or its riparian zone. This is about 300 meters inland along the river banks. Meanwhile, at the river mouth, possible excessive siltation can be carried by water current and is estimated to run about 2 km as identified during the survey conducted for water quality.

The secondary impact areas would include navigational lanes during the hauling of dredge materials out of Bayawan City within Philippine territorial waters. The Project will adhere to an approved navigational route and other requirements mandated by regulatory agencies such as MARINA. Figure 1-14 shows the Project vicinity, primary and secondary area.

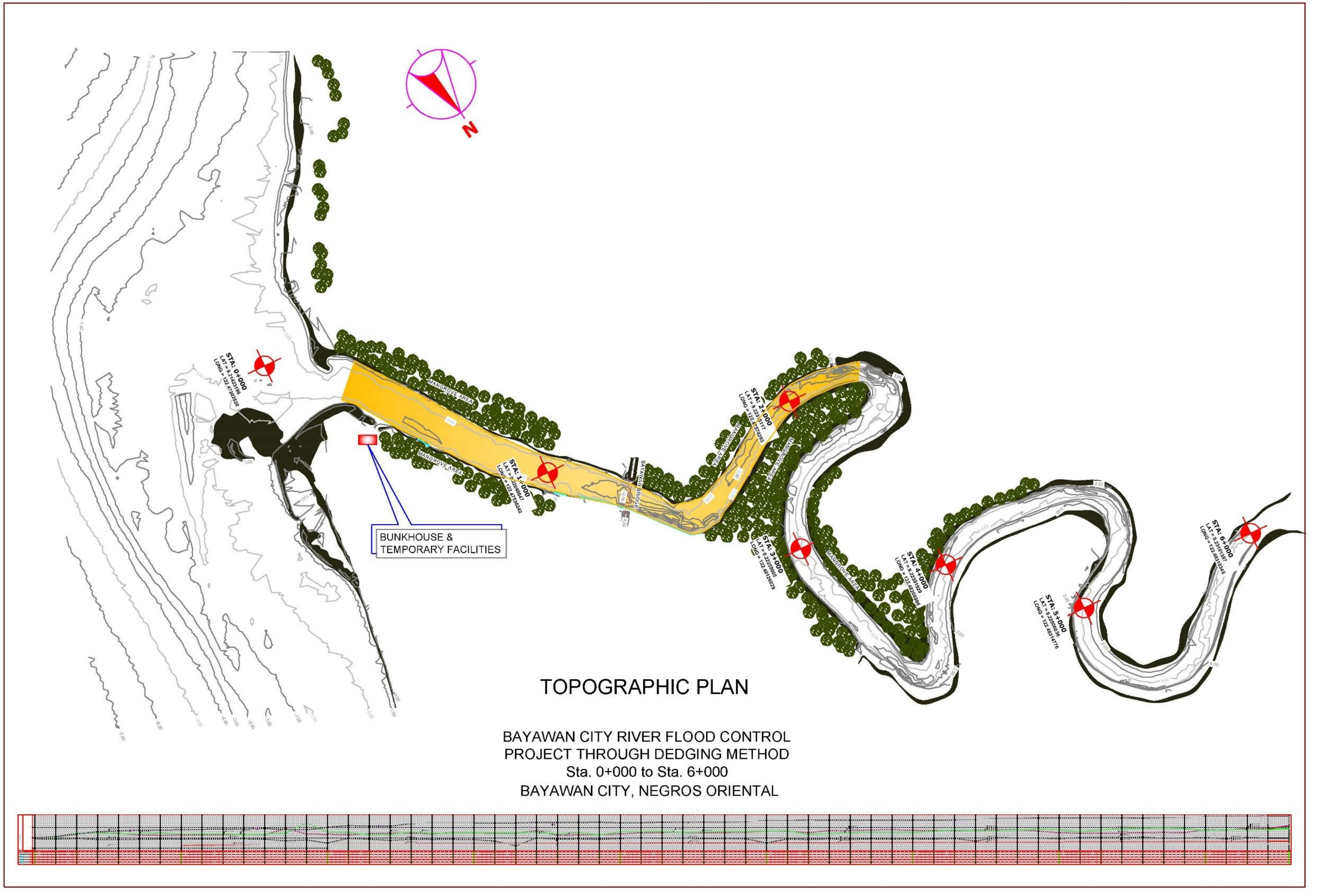
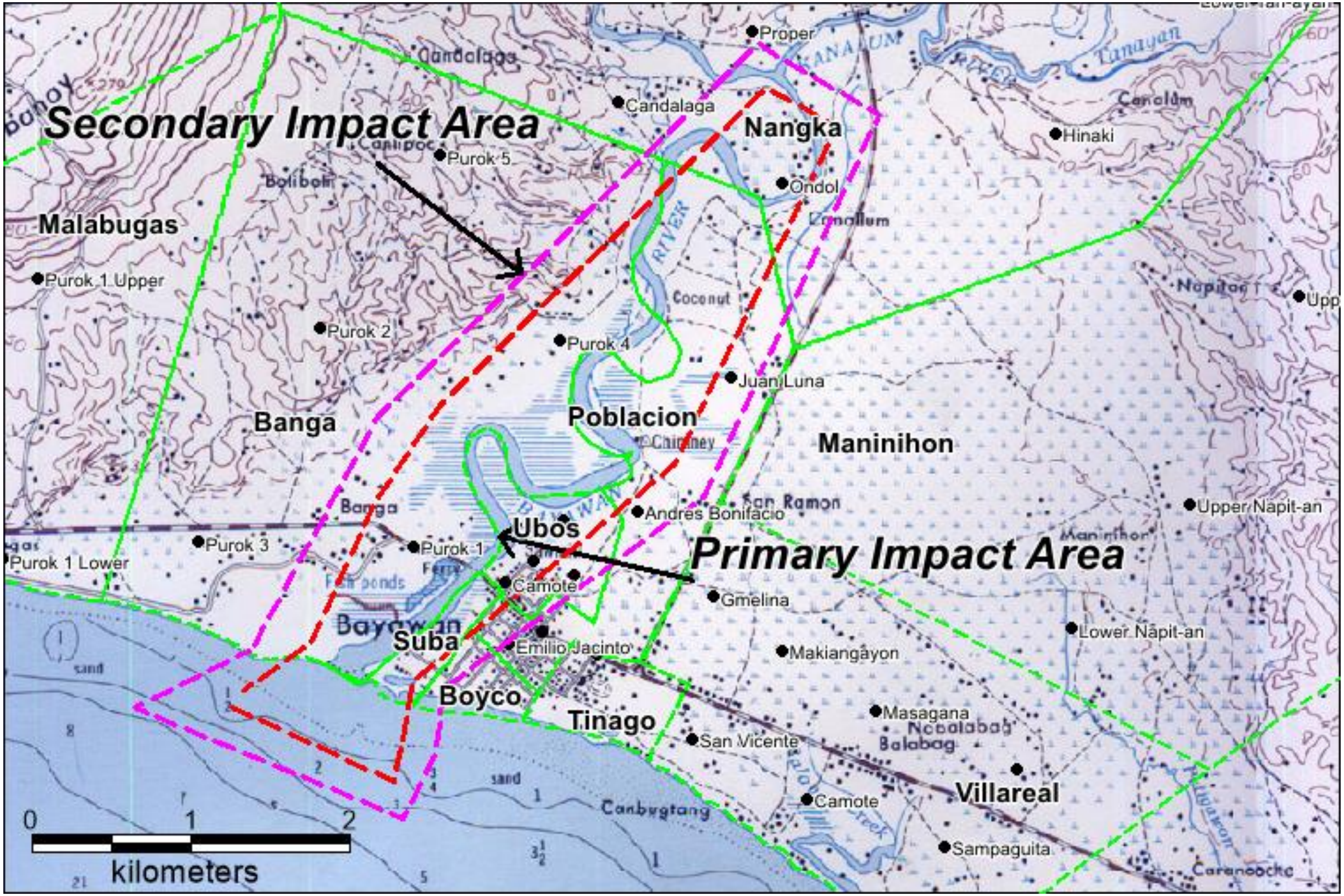


Figure 1-13 Dredging Plan and Proposed Bunkhouse and Temporary Facility



Source: Namria

Figure 1-14 Project Vicinity, Primary and Secondary Impact Areas

Central Operations Office

An office for operations will be established once the Project is operational. This will serve as the heart of the operation and will house implements and other office equipment especially communication facility. This will also serve as the center for community relations in addressing issues and implementation of programs associated with the operations. The Proponent will scout for an appropriate site for its location. This office will also be responsible for the procurement of drinking water, food supply and other domestic requirements for operations and will be sourced locally.

Project Components

The Project will consist of the following components:

• Channel sounding survey
• Dredging
• Materials Hauling

The river channel design will have a dredging depth of 4 meters at the river mouth and gradually reducing to about 1.70 meters at the end of the 6km dredging length. The trapezoidal channel that will be formed during dredging will have a 10-meter setback from each side of the riverbank. Excluded from the dredge zone is the 2-km total no-dredge length downstream and upstream of the Bayawan Bridge.

Since the dredging is limited to a depth stipulated by the Detailed Engineering Design and Plan, sounding survey will be conducted first prior to actual dredging. This will guide the operator of the dredger how to position the cutting/suction boom to comply with the depth limits.

The dredging operations will extract the silts and sediments guided by the limits set by the sounding survey. After a section of the channel has been cut, another sounding survey will be conducted to check the final channel configuration. The extracted materials are then transferred through suction to a transfer barge that will haul it to a Bulk Carrier waiting offshore.

A conveyor barge will receive the materials from the transfer barges and transfer it to the Bulk Carrier. The bulk carrier will haul the dredged materials to Singapore. Figure 1-15 illustrates the entire operation

Alluvial materials that are in excess from the design channel configuration will be removed. All materials that were dredged will all be transported to Singapore. There will be no selection of any alluvial materials during the conduct of dredging.

The operation is purely extraction only without ore/mineral processing but the recovery and exportation of dredged materials is analogous to mining industry. There will be close coordination with MGB during the conduct of dredging activities.

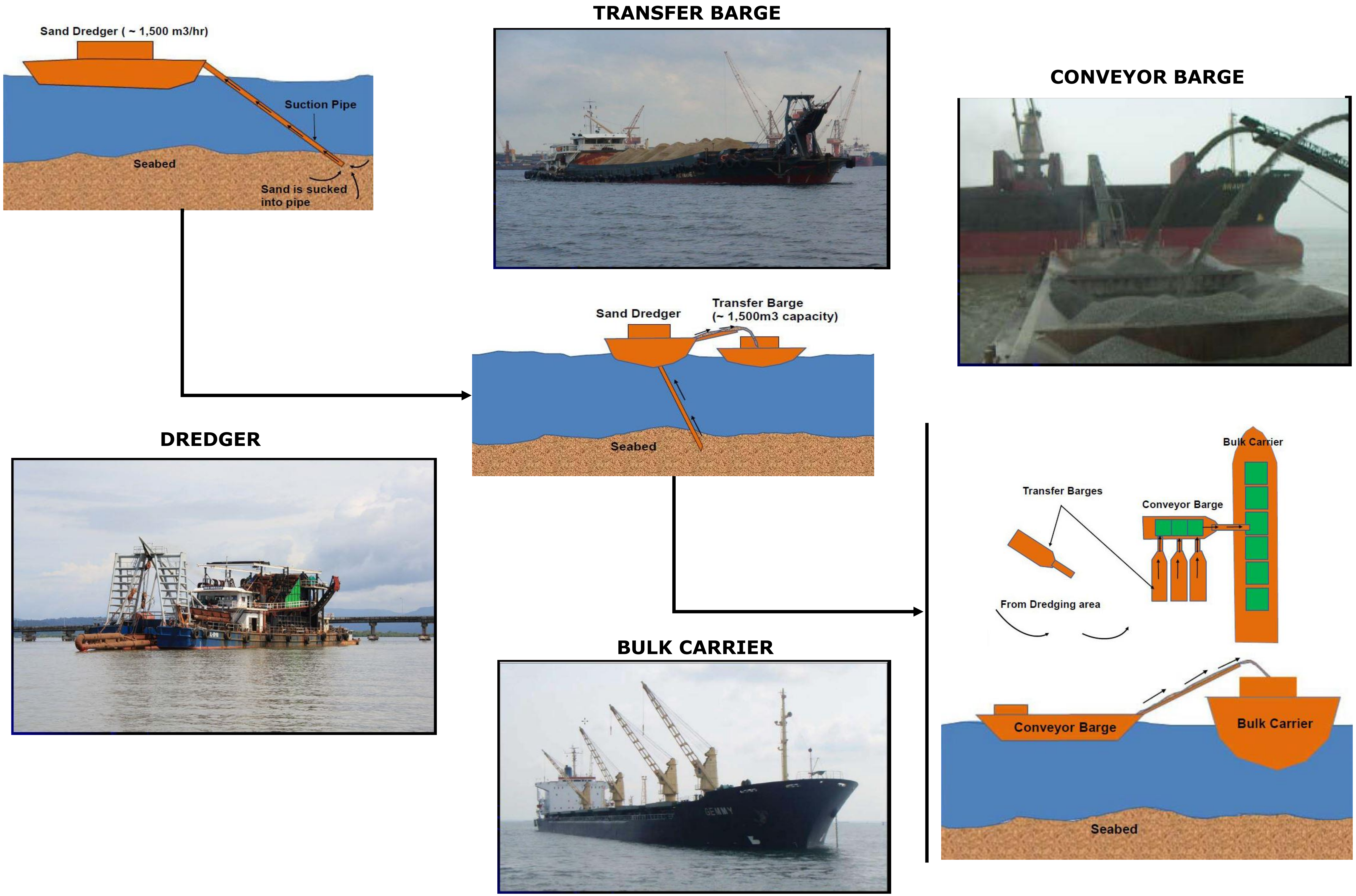


Figure 1-15 Dredging Operation Flow

Dredgers and Hauling vessels

Table 1-2 provides insights on the possible vessels that can be deployed during the dredging operations depending on the situation whether it requires bigger or smaller capacity dredger. The vessels are classified into those that are used for hauling and those that are used for dredging. Each vessel will strictly comply with the operation plan to minimize in-vessel pollution discharges and solid waste generation.

Regular maintenance and repairs will be conducted in the nearest port located at Dumaguete City.

Table 1-2 List of Vessels for Dredging Operations

VESSEL NAME	CLASSIFICATION	CAPACITY	OWNERSHIP
Unloading and Discharging Equipment			
SL T11	Conveyor Barge	1100 m3	Owned by subsidiary SL Ocean Ltd
SL T12	Conveyor Barge	1100 m3	Owned by subsidiary SL Ocean Ltd
SL T13	Conveyor Barge	1100 m3	Owned by subsidiary SL Ocean Ltd
SL T14	Conveyor Barge	2050 m3	Owned by subsidiary SL Ocean Ltd
SL T1	Conveyor Barge	2050 m3	Owned by subsidiary SL Ocean Ltd
SL T2	Conveyor Barge	2050 m3	Owned by subsidiary SL Ocean Ltd
SL T3	Conveyor Barge	1200 m3	Owned by subsidiary SL Ocean Ltd
STL I	Hopper Barge	1700 m3	Owned by subsidiary STLM Machinery & Trading Pte Ltd
STL II	Hopper Barge	1600 m3	Owned by subsidiary STLM Machinery & Trading Pte Ltd
STL III	Hopper Barge	1600 m3	Owned by subsidiary STLM Machinery & Trading Pte Ltd
STL IV	Hopper Barge	1800 m3	Owned by subsidiary STLM Machinery & Trading Pte Ltd
STL V	Conveyor Barge	1990 m3	Owned by subsidiary STLM Machinery & Trading Pte Ltd
Dredging Equipment			
SL D1	Dredging Vessel	N/A	Owned by subsidiary SL Ocean Ltd
SL D10	Dredging Vessel	N/A	Owned by subsidiary SL Ocean Ltd

Identification of Support Facilities

The following are the support facilities for the Project

- Central operations office
- Transportation garage for service vehicle
- Nearest port for maintenance

These facilities will be located once the Project commences its operations. The City of Bayawan will make arrangements and provide suitable site and size for this support facilities complete with provision for communication equipment, water and power from local utilities.

To ensure minimum environmental footprint, the following will be considered good practices:

- The central office will practice in house solid waste management in accordance with RA 9003 specifically in segregation of solid waste prior to disposal.
- All transport service vehicles will be subject to emission tests as required during its annual registration.
- Local port services will be tapped following rules and regulations as mandated by the port authority specifically on refueling and oil disposal during maintenance.

General Layout

The support facilities are land based components of the Project. The general layout is typical of an ordinary office structure that provides functional features such as conference room, communications room, office desk for personnel, storage room for special for field equipment such as sounding devices and total station, and a garage or motor pool for transport vehicles. For the dredging equipment, Figure 1-16 provides the typical layout.

The sand coming from the suction pipe will be slid and filtered down to the bottom of the loop pail.

The main storage area is actually below the loop pail and it can carry approximately less than 5 tons of sand at one time and there are 42 pillars below these storage areas and the plate is 12mm thick.

The loop pail will scoop the sand directly

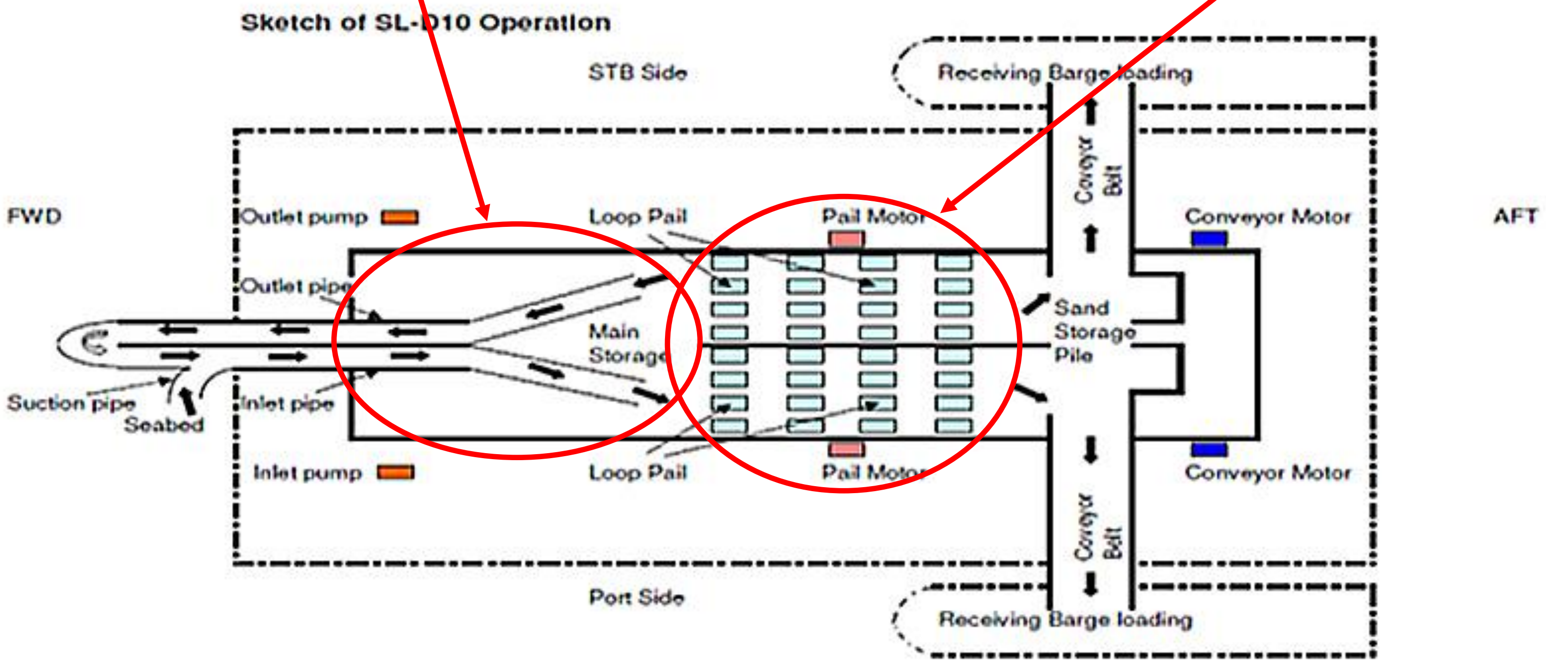


Figure 1-16 Typical Layout of Dredging Equipment

Power and Water Supply System

All dredgers are modular; therefore, power and cooling water requirements are self-generated and re-circulated respectively. The amount of water for domestic consumption, like drinking water, will be sourced locally and will be stored appropriately. The volume will not be significant.

Pollution Control and Waste Management System

Regular monitoring of air and water quality will be practiced once the project begins implementation. Groundwater, Surface water and sea water samples will be collected and submitted for water quality analysis twice a year. Air and noise quality survey will also be done twice a year. This will be practiced in conformity with the EMB's bi-annual monitoring standards.

Dredgers and hauling vessels shall also undergo emission tests to ensure that they comply with emission standards.

All personnel during the dredging activity will follow strictly in-house sanitation and waste management in accordance with RA 9003, specifically segregation of waste. Furthermore, excess and fugitive oil and grease will be stored and disposed of appropriately, making sure that it will not end up in the river.

A pollution control officer will be assigned to monitor the dredging operations and to oversee the implementation of these pollution control and waste management practices.

1.5 Process/Technology

Extraction and Dredging Process

The type of dredging that will be utilized depends on the current physical configuration of the river. For shallow and very silted river beds, wet and dry dredging methods such as backhoe, grab buckets and other suitable mechanical dredgers are employed. For deeper waters, marine or cutter suction dredgers may be employed.

Cutter suction dredger, which is made up of a vessel with suction pump, will likely be used for this operation. During operation, the suction arm on the dredger will be lowered to the required depth for dredging. Pumps onboard will then be started up for the extraction to proceed.

The extracted materials will initially consist of water, clay and sand particles. A bucket filtration system within the dredger will filter the dredged materials which will then be temporarily stored within the dredger. A conveyor belt on the side of the dredger will then transfer the dredged materials onto a conveyor barge which may be berthed alongside with it.

Marisand Resources Co. Ltd. and its consortium partners specialize in this type of dredging activity and has done similar projects in other countries of similar scenario. Figure 1-17 shows one typical dredging vessel operated by Marisand Resources Co. Ltd.

Figure 1-17 Typical Dredging System

Typical dredging capacity of this type of unit is about 500-1,000 cu. m./hour. Sounding survey will be conducted before and after channel cutting to ensure that dredging limits, as stipulated in the Detailed Engineering Plan, are strictly complied and satisfied.

Since the dredged materials are hauled through barges into a bulk carrier waiting offshore, the environmental impact on land by hauling trucks and other hauling systems will be significantly reduced.

<u>Pollution Control and Waste Management</u>

There are always impacts to dredging activities but these may be minimized with careful planning and execution of the Project. Some mitigating measures which will be employed during dredging operations are the following:

a. Improve accuracy – This can be achieved using GPS to determine the exact station and through the channel sounding survey prior to dredging;

b. Reduce turbidity – Turbidity is due to suspended sediments and this can be avoided through careful navigation of the dredging vessel in shallow water;

c. Reduce spill and loss – Employ an oil recovery system and limit overflow.

d. Regular emission test – Vessels shall be subjected to regular emission tests to ensure that they comply with emission standards.

e. Solid waste management - Regular collection of waste onboard the vessels will be imposed in coordination with the LGU.

A pollution control officer shall also be assigned to the Project to ensure that operations are in accordance with the commitments to impact mitigation. In addition, constant monitoring shall be employed by the Proponent and the MMT which shall be organized for this Project.

Description of Operations and Maintenance of Facility

All dredging operation will strictly follow specifications as provided for by the Detailed Engineering Plan as approved by DPWH. To accomplish this, an engineer will oversee the operation to ensure that dredging activities comply with the Detailed Engineering Design. In addition, sounding survey will be conducted before and after dredging operations to check with the limits set by the dredging design specifications.

Maintenance and repairs of dredging and hauling vessels shall be conducted at the nearest port, which is the Port of Dumaguete. Regular inspections shall be conducted to ensure that the vessels and all of their components are in proper working condition. Such inspections shall also determine that the vessels are in compliance with standards set by the governing agencies and authorities.

Maintenance of land-based and temporary facilities shall be done by the Proponent's support staff which will hold office in Bayawan City.

1.6 Project Size

Total amount of/depth of available silt materials based on preliminary studies

The potential materials as a resource can be gleaned from the geotechnical survey.

It is noted that the area is dominated by brown silty clay up to a depth of about 15 meters as reckoned from the ground surface while the top layer is composed of brown silty sand from 3.8 to 5.7 meters from the surface.

The Soil Classification System described the type of layer by the following:

Very Coarse Soils	Boulders		>200 mm
	Cobblers		60 – 200 mm
Coarse Soils	**G** Gravel	Coarse	20 – 60 mm
		Medium	6 – 20 mm
		Fine	1 – 6 mm
	S Sand	Coarse	0.6 – 0.2 mm
		Medium	0.2 – 0.6 mm
		Fine	0.06 – 0.2 mm
Fine Soils	**M** Silt	Coarse	0.02 – 0.06 mm
		Medium	0.006 – 0.02 mm
		Fine	0.002 – 0.006 mm
	C Clay		<0.002 mm

Project Area

The Project area or the dredging area consists of the following:

1. River channel deepening

2. Taking out of sediments and silt, including accretion area

3. Deepening of fish port area

The Bayawan River Flood Control Project will cover the estuary and river channel starting from the mouth of the river up to 6 kms upstream. This is the area to be dredged to attain a desired depth in accordance with approved detailed engineering design. The river channel area is computed using the average 80-meter bank to bank river width up to 6 kms inward. The computed river channel will include the no-dredge section that is 1 km before and after the Bayawan Bridge, as well as the 10-meter no-dredge setback.

This no-dredge zone near a bridge is in compliance with RA 7942 (Philippine Mining Act of 1995).

The estuary will also be dredged to take out land masses caused by sediment deposition and accretion. The Project proponents decided to take out these sediments as these areas will also serve as the navigation lane for the hundreds of fishing boats that will make use of the fish port that will be established at the mouth of the river. During the 3-year dredging operation, this area will also serve as the navigation and docking area for the dredgers and hauling vessels (barges/LCTs). Deepening of the fish port area will also form part of the Project Area. (See Table 1-3)

Table 1-3 Dredging Project Area

Description	Limits	Project Area		Location
		Square Meters	Hectares	
River Channel	80m average width by 6000m dredging length (inclusive of 2kms no-dredge zone)	480,000	48.00	Barangays Banga, Suba, Ubos and Poblacion
Estuary (for navigation route and docking area)	1000m to the left and to the right of the center of river mouth extending 600m outward to the sea	1,600,000	160.00	Coastal waters within Barangays Suba and Banga
Proposed Fish Port Area		40,000.00	4.00	Brgy. Banga
TOTAL		**2,120,000**	**212.00**	

Project Area per Affected Barangay

The dredging of the river channel shall traverse the entirety of Barangay Banga on the left and Barangays Suba, Ubos and Poblacion on the right. The channel shall have an average width of 80 meters, while maintaining a minimum of 10 meters buffer zone on each side. Dredging shall be done from the estuary up to 6 kilometers upstream, inclusive of a total 1 kilometer no-dredge zone before and after the Bayawan bridge. As show on Table 1-4 below, the total project area in the vicinity of Brgy. Banga/Suba is 10.40 hectares, Brgy. Banga/Ubos at 17 hectares and 20.60 hectares for the area in Brgy. Banga/Poblacion.

Table 1-4 Project Area per Barangay

Barangay	Project Area (hectares)
Barangay Banga/Suba	10.40
Barangay Banga/Ubos	17.00
Barangay Banga/Poblacion	20.60
Total Project Area	48.00

Dredging Volume

The river channel design will have a dredging depth of 4 meters at the river mouth and gradually reducing to about 1.70 meters at the end of the 6km dredging length. The trapezoidal channel that will be formed during dredging will have a 10-meter setback from each side of the riverbank. Excluded from the dredge zone is the 2-km total no-dredge length downstream and upstream of the Bayawan Bridge.

Dredging will also include channel maintenance from sediments flow over the 3-year dredging operations. From the HECRAS modelling, estimated sediments flow is 25,000 cubic meters per day based on 100-year return period (See Annex – Sediment Transport Analysis). This is equivalent to about 9,125,000 cubic meters per annum or 27,375,000 cubic meters over the 3-year period of the Project.

Dredging will also be done at the 2-km length by 600 meters width of the estuary to deepen and take out sediments caused by deposition and accretion. The seaward section of the estuary will be dredged to 15 meters deep and gradually descend to 2-meters deep at the 100-meter line from the shoreline. There will be a 100-meter no-dredge one from the shoreline towards the sea. At the river mouth, dredging depth will be 4 meters.

The proposed fish port will have a depth of 4 meters.

Table 1-5 Dredge Volume

DESCRIPTION	LIMITS	VOLUME (cu.m.)
River Channel (channel development)	4000m effective dredging length by 4m deep at the mouth gradually reducing to 1.7m deep at the 6-km end of Project by average 60m width	684,000
River Channel (channel maintenance from sediments flow)	Estimated 9,125,000 cu.m./year over 3 years dredging operation	3,000,000
Navigation Route and Docking Area	700m effective width x 2000m coastline with depth of 15m at the seaward side reducing to 2m near shoreline while maintaining 4m depth at 80m rive width	7,950,000
Proposed Fish Port	Total of 4-hectare fish port area by 4m deep	160,000
TOTAL		**11,794,000**

Workplan

Since marine/sea vessels will be used, dredging operations will start from the sea moving into the river mouth and coastline. The navigation route and docking area will be the first to be established then followed by the designed river channel and finally the deepening of the proposed fish port. Two dredgers will be used to constantly re-establish the designed channel being washed out by sediments flowing during heavy rains. Two dredgers will be used to deepen the navigation route and docking area and only 1 dredger will do the dredging works at the river channel and proposed fish port. A smaller dredger will be used after the bridge. Dredging operations will run for 3 years.

Table 1-6 Dredging Operations Workplan

DESCRIPTION	VOLUME (cu.m.)	YEAR 1	YEAR 2	YEAR 3
Navigational Route and Docking Area (2 dredgers)	7,950,000			
River Channel Development (1 dredger)	684,000			
River Channel Maintenance from Sediments Flow (2 dredgers)	3,000,000			
Proposed Fish Port (1 dredger)	160,000			

Dredged Materials

The potential materials as a resource can be gleaned from the boring test conducted at the Bayawan River (ANNEX A). The boring test revealed that brown silty sand makes up most of the top layer followed by a bottom layer of dark gray and gray silty clay. Figure 1-18 below shows the graphical profile of such a survey.

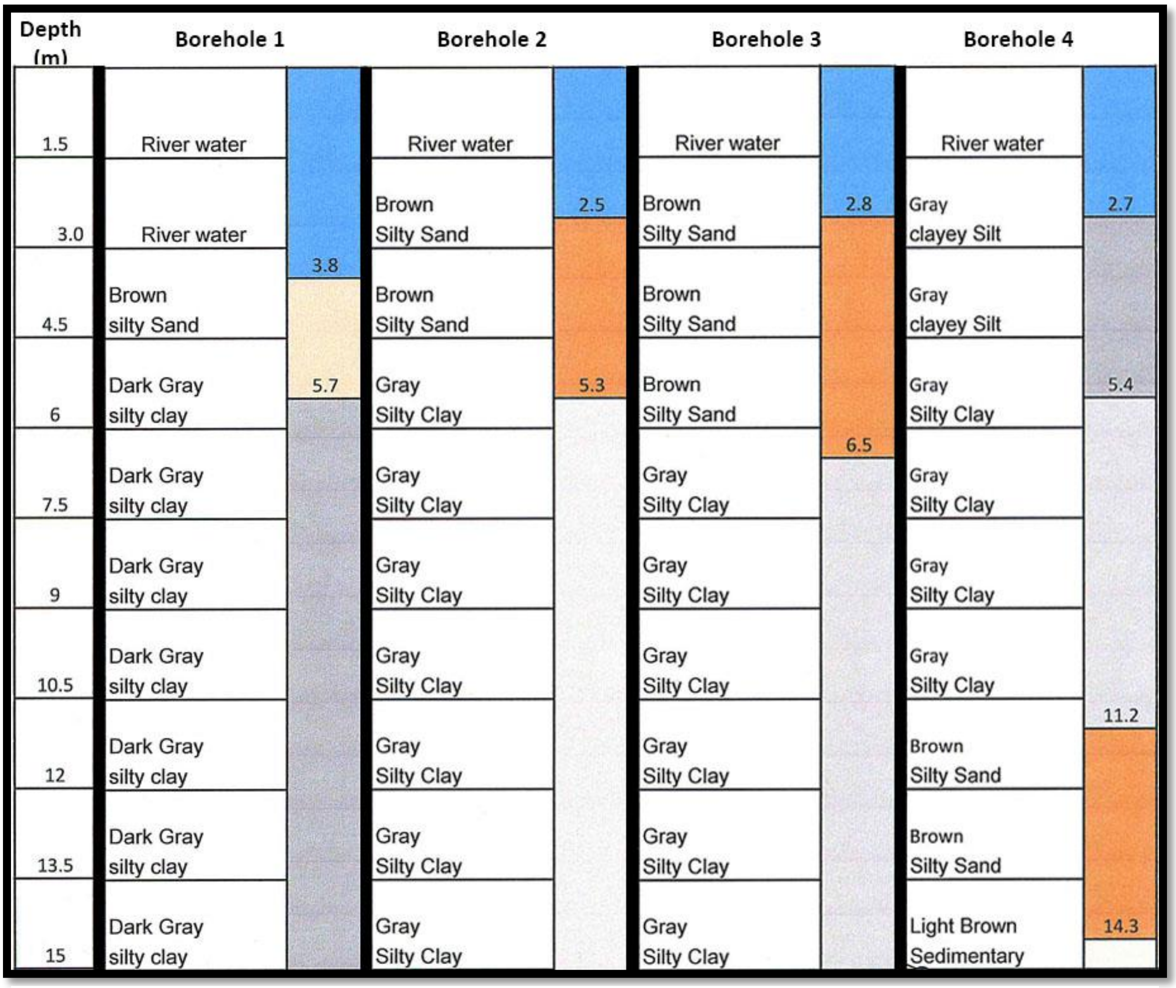


Figure 1-18 Geotechnical Profile of Bayawan River Bed

1.7 Development Plan, Description of Project Phases and corresponding Timeframes

The dredging Project will have its various activities corresponding to the phases of implementation as shown in Table 1-7.

Pre-construction Phase

The proponent organizes itself to expedite the resolution of institutional, environmental and regulatory considerations in relation to the Project undertaking. During the implementation stage, an office based in Bayawan will be set up for administrative operations and to address local issues associated with Project.

At this point, it is crucial to initiate IEC activities to make known the intention of the Project and develop good relationship with various stakeholders.

No significant waste or pollution is associated at this phase of the Project.

Operational phase

The Detailed Engineering Design will be the guiding protocol for attaining the desired channel configuration. The dredger itself will house the operating personnel and necessary implements for the effective and efficient maintenance and operations. The various technical and operational aspects are described in the preceding section specifically Section

1.5 above. The design limits are critical to minimize the phenomenon of hungry water that may erode river banks downstream. Since dredging involves the precision cutting of river channel, various sizes and capacity dredgers will be used.

The major environmental concern during this phase is the generation of silt when channel is disturbed during cutting. To mitigate this concern, silt curtain will be strategically installed to capture or minimize silt spreading.

Abandonment phase

This will include the removal of all equipment and machineries used in the operations and take these out of the Project site. The Project will also mitigate all negative environmental footprints that may have been caused by the Project or stipulated in the monitoring plan.

All records will be submitted to Bayawan City LGU for future reference and integration into the river management plan.

Project Timeframe

The implementation of the Project is limited to what has been stipulated in the MOA between Bayawan City LGU and Marisand Resources Co Ltd.

The dredging activity is dependent on two limitations:

- Duration of Three (3) years as stipulated by MOA
- The river reach of six (6) km

The estimated volume of dredge materials as provided for in the MOA for the first 6 km of the river is about 10,000,000 cu m. If dredging of the first 6 km is done in less than 3 years, then the proponent can apply for another ECC for the subsequent river reach.

Table 1-7 Project Phases, Activities and Timeframes

Phases	Activities	Timeframe
Pre-construction	• compliance with various institutional, environmental as well as regulatory requirements • Siting and establishment of Central Operations Office • Initiation of IEC • Deployment of appropriate dredgers on project site	estimated to be 4-5 months
Operations	• before and after dredging sounding survey • Dredging • Hauling of dredged materials • Bulk transport of dredged materials • Regular monitoring as per MMT	estimated to be 3 years as per MOA with Bayawan City

Abandonment	• submission of all pertinent documents and records to Bayawan City LGU • decommissioning of all dredgers and its ancillaries • transport of all dredging equipment • final checking of any possible environmental footprints for possible mitigation	3 months

1.8 **Manpower**

The Project requires specialization of manpower. Each personnel manning the various equipment has specialized skills. The company has its own training facility for this purpose. However, without compromising technical qualifications, the proponent will prioritize hiring of locals and will adopt the principle of gender equity in the selection.

Figure 1-19 shows the organizational structure of the Project. The manpower requirements are summarized in Table 1-8 below.

Table 1-8 Manpower requirement

Manpower function	No. of personnel
General Manager and CEO	1
Executive Secretary/Communication Officer	1
Administration	
Administrative Manager	1
Budget Officer	1
budget staff	1
HR Officer	1
Community Relations Officer	1
Service driver	1
community relations staff	2
Dredging Operations	
Operations Manager	1
Dredger Operator	2
Asst. Dredger Operator	2
Utility worker	2

Hauling Operations	
Barge Pilot	2
Asst. Barge Pilot	2
Utility Worker	2
Engineering and Environmental Operations	
Civil Engineers	3
Environmental Specialist	1
Technical Staff	2
TOTAL	29

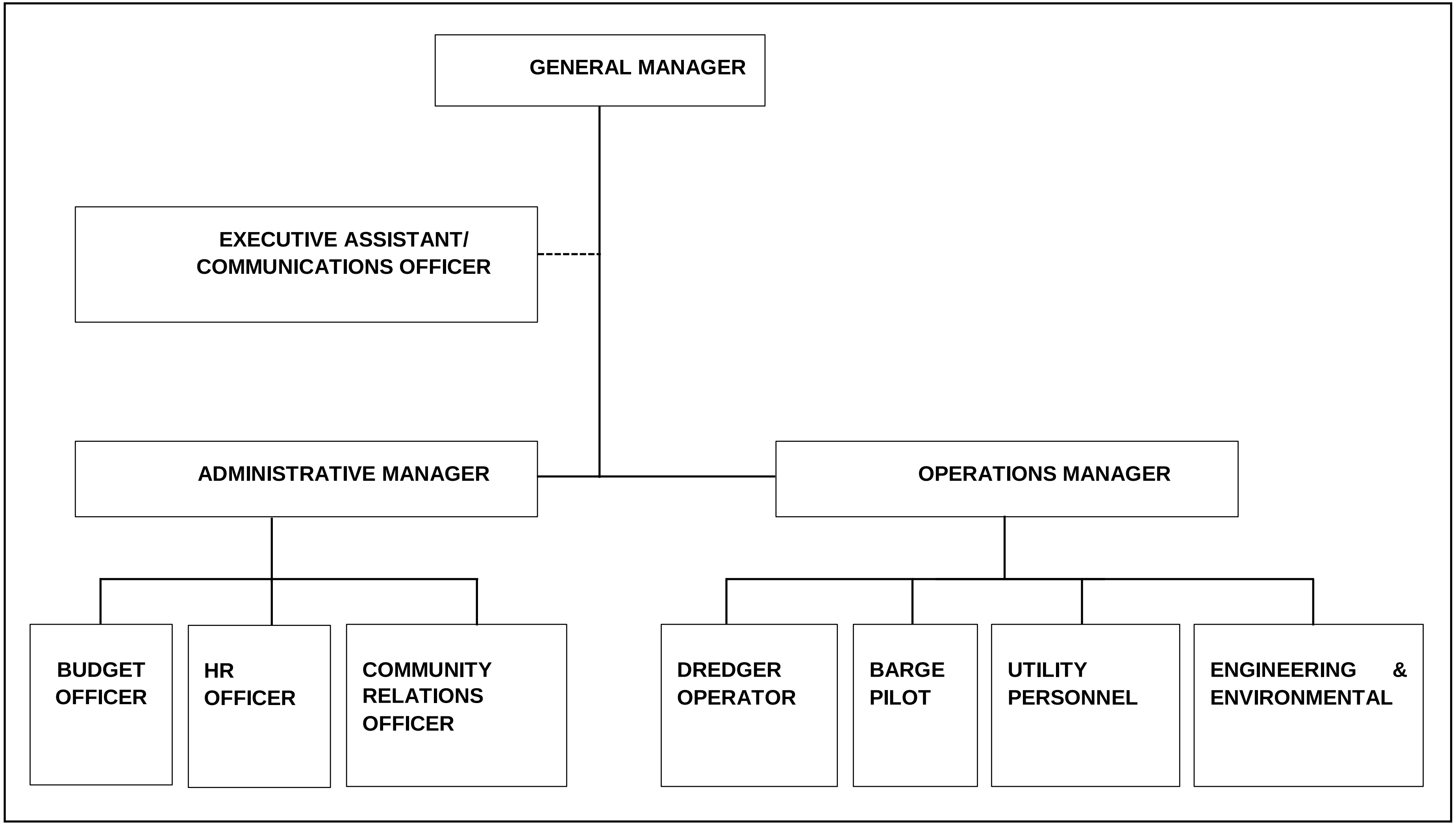


Figure 1-19 Organizational Structure

1.9 Indicative Project Investment Cost

It has been estimated that about 10,000,000 cu m of dredged materials can be removed for channel restoration and configuration. The indicative cost of the Project is about PhP 2.7 Billion.

2 KEY ENVIRONMENTAL IMPACTS AND MANAGEMENT/ MONITORING PLAN

2.1 THE LAND

Land Use and Classification

2.1.1.1 Impact in Terms of Compatibility with Existing Land Use

Baseline Conditions

Figure 2-1shows the existing urban land use map, which also shows the location of Project site. The dredging Project will be implemented in Bayawan River, from the estuary up to 6 kilometers upstream.

The Project shall traverse barangays Banga, Suba, Ubos and Poblacion. It can be observed from map below that most of Barangay Banga, on the left side of the river, is made up mostly of agricultural land with some mangrove areas along the river banks. On the right site of the river are the 3 other affected barangays where it can be observed that most of Barangays Suba, Ubos and Poblacion are covered in built-up areas, commercial and industrial areas.

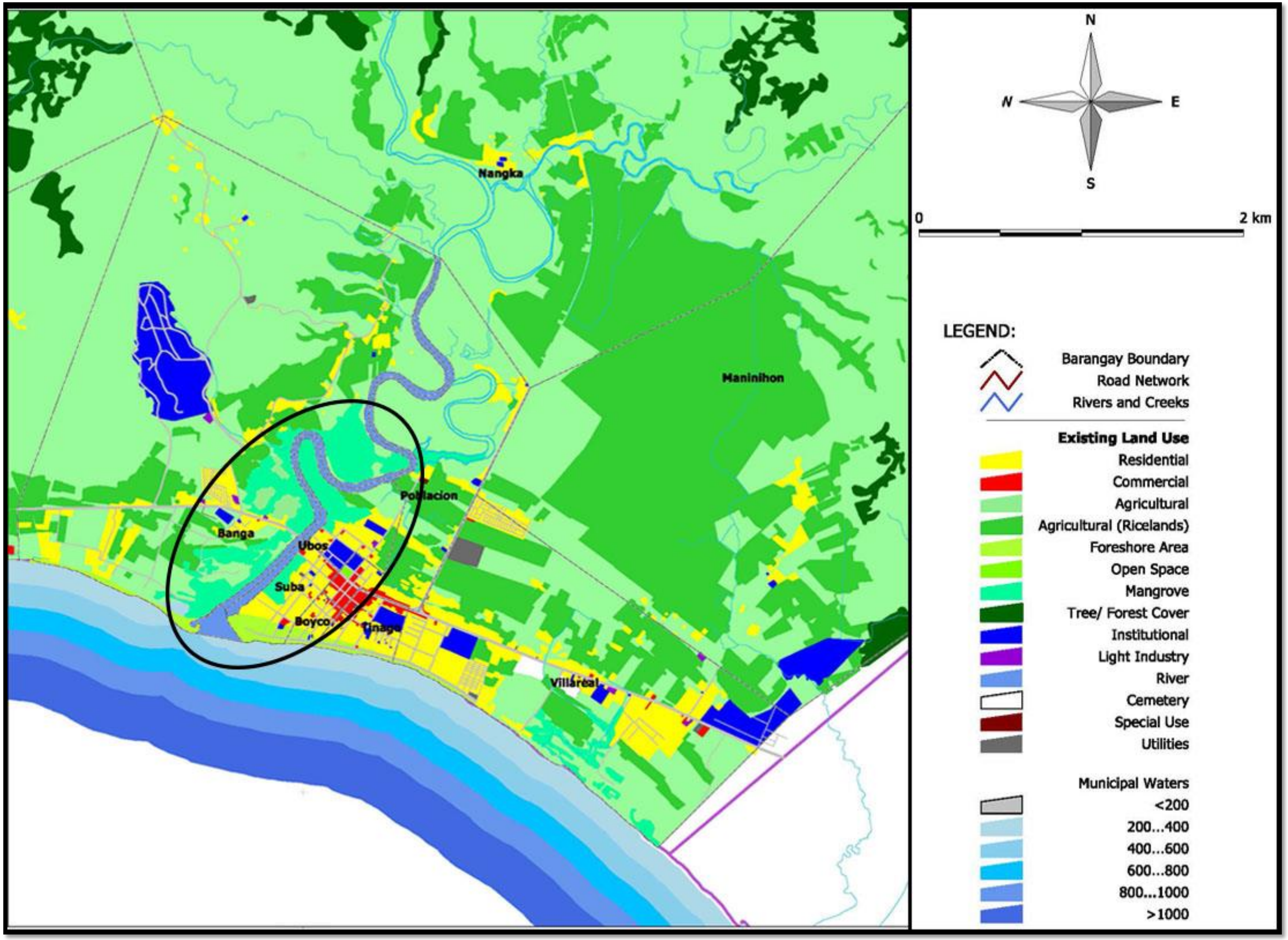
Figure 2-2 shows the existing general land use map of Bayawan City. And it shows that most of the City's land area is classified as agricultural land.

Table 2-1 Existing General Land Use lists in detail the existing percentage and total area per land use of Bayawan City.

Based on data gathered from the City's Comprehensive Land Use plan, it is stated that lands used for settlement and commercial areas is only 2,189.64 hectares or 3.13% of the city's total land area. Protection forest area accounts for only 0.88% or 614.83 hectares, while a very large portion of 66.81% (46,707.62 hectares) is used for agriculture, 13.68% or 9,562.09 hectares used for Agro-forestry and 12.74% or 8,907.97 hectares allocated for Production forest areas. Protection area includes rivers, foreshore, mangrove areas as well as areas with secondary growth forests. Production areas include rice lands, sugarcane lands, corn lands, cocal lands, agroforestry use and even open grasslands that from time to time are also planted with different kinds of annual cash crops. Infrastructure and utilities like roads, bridges and transport terminals take up 1,022.42 hectares or 1.46% and the other land uses like tourism spots, Swamps and Mangroves, Ancestral Land, Mineral Land and Industrial areas take up less than 1% each.

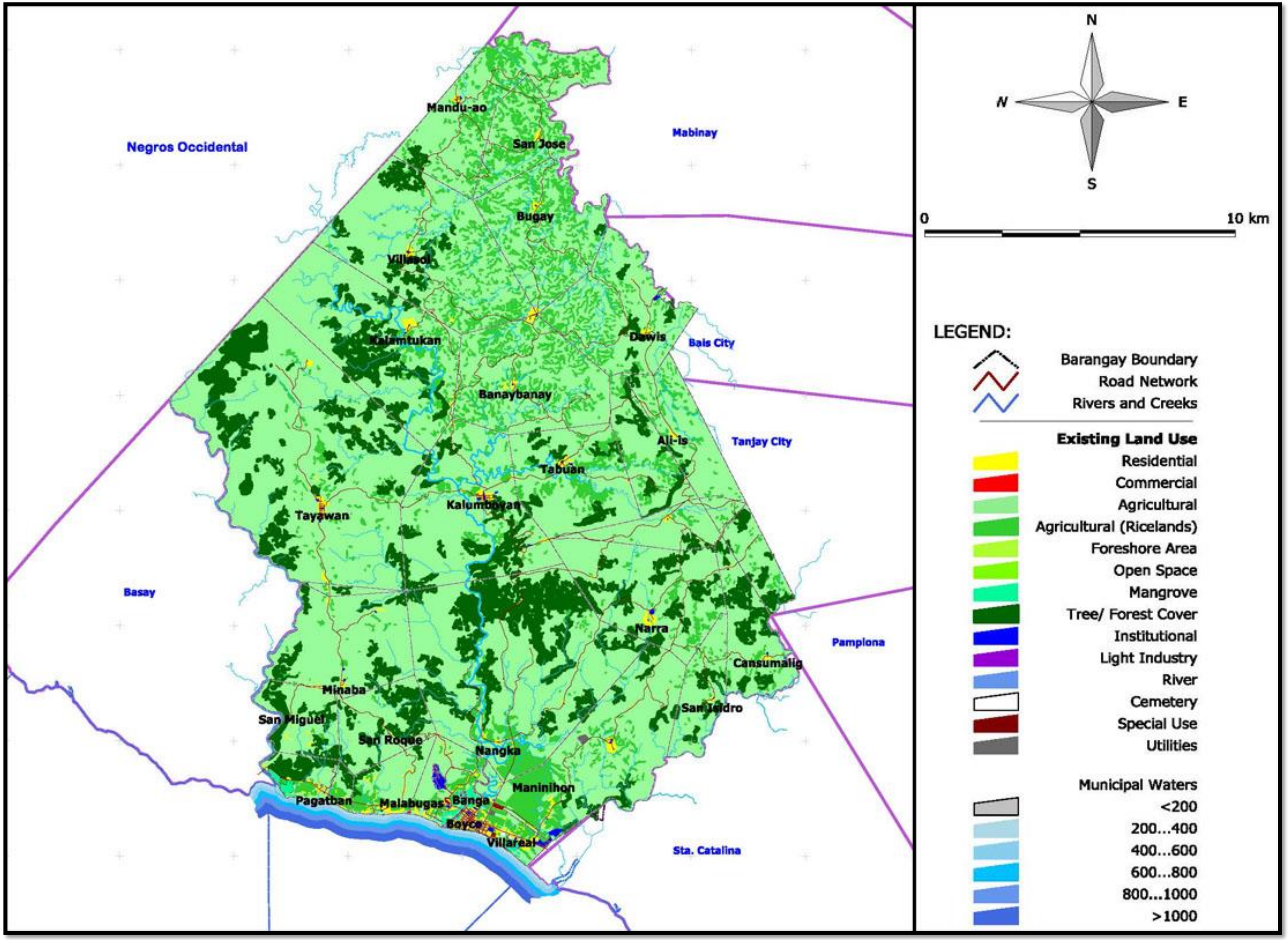
Table 2-1 Existing General Land Use

LAND USE	Existing General Land Use Allocation	% Total
Built-up	2,189.64	3.13%
Agricultural	46,707.62	66.81%
Agro-forestry	9,562.09	13.68%
Production Forest	8,907.97	12.74%
Protection Forest	614.83	0.88%
Tourism	100.00	0.14%
Swamps and Mangroves	23.34	0.03%
Ancestral Land	529.60	0.76%
Mineral Zone	150.00	0.21%
Industrial	100.00	0.14%
Special Use	0.50	0.00%
Infrastructure and Utilities	1,022.42	1.46%
TOTAL	**69,908.00**	**100%**



Source: CLUP

Figure 2-1 Existing Urban Land Use Map



Source: CLUP

Figure 2-2 Existing General Land Use of Bayawan City (CLUP)

Impact Analysis

There will be no change or inconsistency in land use during the Project implementation. To some extent, since the Project's intention is one of flood mitigation, implementation will minimize threat to destruction of lives and properties.

Management Plan

This concern is not necessary because of the nature of the Project being implemented is in the water body.

Monitoring Plan

This concern is not necessary because of the nature of the Project being implemented is in the water body.

2.1.1.2 Impact on Compatibility with Classification as an Environmentally Critical Areas (ECA)

Baseline Conditions

Generally, there is no encroachment in environmentally critical areas. The dredging activity will follow the existing river channel. The location of critical areas such as mangroves, fishponds, coral reefs are significantly far from the Project site. The mangrove forest in the city covers an aggregate area of 160.5 hectares. Mangoves are found in Barangays Pagatban, Banga, Suba, Malabugas and Villareal. Except for the area in Pagatban, most are severely depleted due to either fuel gathering or conversion to some other uses.

The mangrove species in Bayawan includes: Bakauan bato/bangkau, Bakauan Lalake, Pototan, Bakauan Babae, Piapi, Api-api, Bungalon, Pedada, Dungon, Dungon-late, Piagau, Tabigi, Lagolo, Talisay, and Nipa. The mangroves have been retained as a marine/ coastal forest for a long time, however it has reduced in area especially in Barangays Villareal, Suba and Malabugas where communities of informal settlers have encroached the areas.

Table 2-2 provides the checklist of ECAs as described by Revised Procedural Manual (RPM) and its assessments during the conduct of the study.

Table 2-2 List of Environmentally Critical Areas (ECAs)

No.	ECAs	Presence in the Project Site	Remarks/Findings
1.	Areas declared by law as: • National park • Watershed reserve • Wildlife reserve • sanctuaries	none	These areas are found in the hinterlands of Bayawan river head waters and very much far from the project site.

2.	Areas set aside as aesthetic potential tourist spot	none	The beach areas in Villareal and Banga are designated for beach and tourism activities and these will not be affected by the project.
3.	Areas which constitute habitat for any endangered or threaten species of Philippine wildlife	none	These areas are possibly found in the hinterlands of Bayawan river head waters and very much far from the project site.
4.	Areas of unique historic, archeological, geological, or scientific interests	none	There are no such areas in Bayawan City
5.	Areas which are traditionally occupied by cultural communities or tribes	none	These areas are found in the hinterlands of Bayawan river head waters and very much far from the project site.
6.	Areas frequently visited and /or hard-hit by natural calamities: • geologic hazards • floods • typhoons • volcanic activities	yes	• There are no volcanic activities in the area. • Typhoons with its associated flood frequent the place hence the objective of the project is to mitigate flooding. • Site is located in a seismically active region fronting the Negros tectonic trench in the Sulu Sea.
7.	Areas of critical slope	none	The project site is located in relatively gently sloping area, typical of alluvial formation.
8.	Areas classified as prime agricultural lands	none	These areas are far from the project site.
9.	Recharged areas of aquifers	none	Recharge areas for aquifers are found upstream of the river and are relatively far from the project site.
10.	Water bodies	none	
11.	Mangrove areas	yes	This is typical of river system but some mangrove forest areas are already depleted.
12.	Coral reefs	none	Spot dive revealed very poor visibility thus coral communities are unlikely.

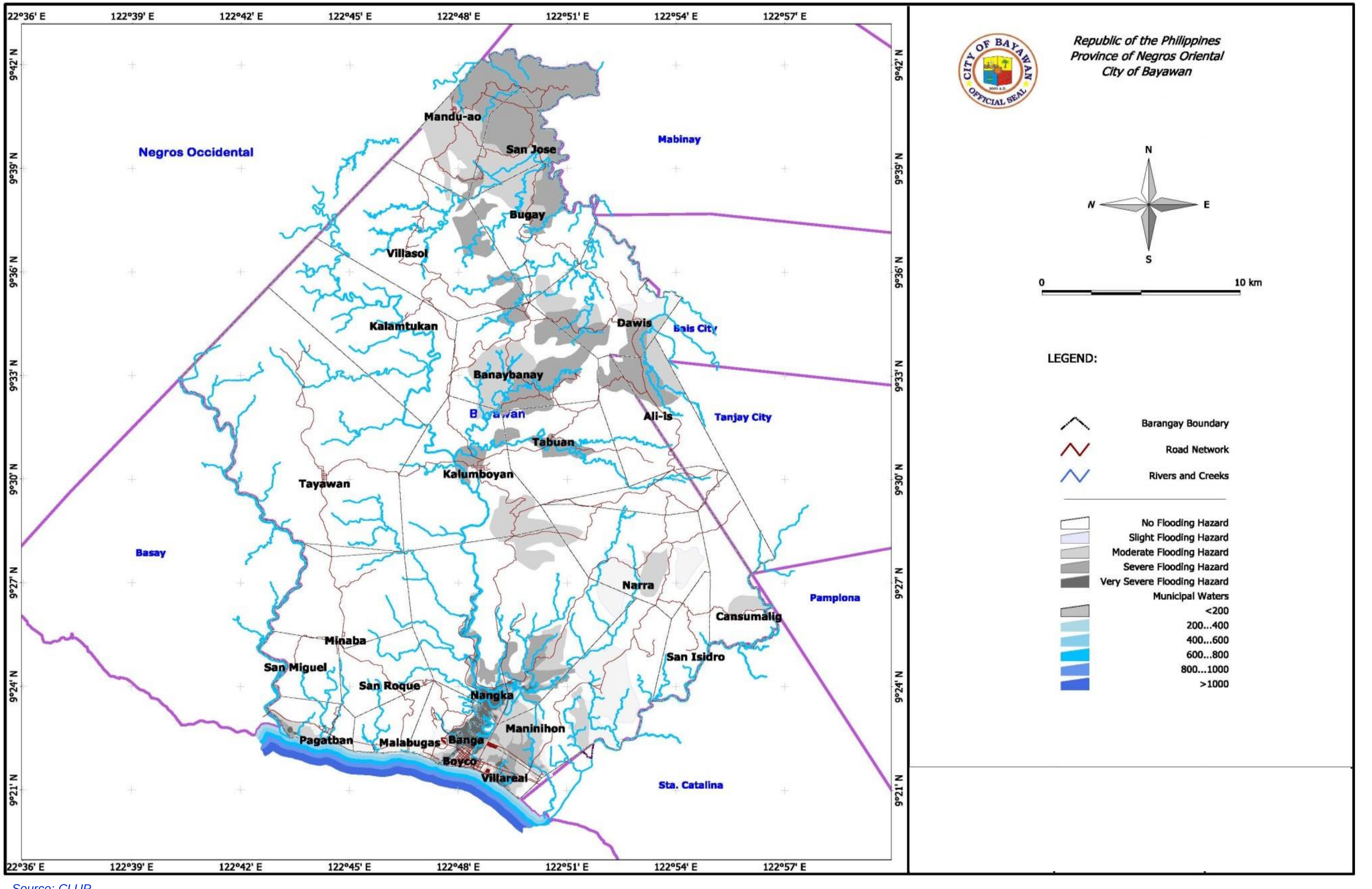
In terms of vulnerability and susceptibility to natural hazards where the Project is located, it is observed that the area is susceptible to liquefaction as is true for any alluvial planes. This can occur when disturbances, typically earthquakes, will occur. Bayawan City is located in the southwestern portion of Negros Island, a seismically active region in the Visayas fronting the Negros tectonic trench in the Sulu Sea. Several historical large-magnitude earthquakes have been recorded in the region (See Table 2-3), the strongest of which could have been the 1948 magnitude 8.1 tremor near Panay Island to the north of the city. A major active inland fault line delineated by PHIVOLCS is also nearby, similarly thought of having potential to generate large-magnitude earthquakes in the future.

Table 2-3 Large Historical Tectonic Earthquakes in the Vicinity of Bayawan City

Year	Location	Magnitude	Epicenter	Earthquake Generator
1925	Pamplona	6.8	Pamplona, Negros Or	Unknown Fault
1948	SW Negros	8.1	SW Antique	Negros trench
1955	SW Negros	6.1	Hinobaan, Negros Occ	Negros trench
1990	Bohol	6.8	Bohol Island	Reverse Fault
2012	East Negros/ Cebu	6.9	Tayasan, Negros Or	Blind Fault
2013	Bohol / Cebu	7.2	Bohol Island	Inland Fault
2014	SW Negros	6.3	Sulu Sea	Negros trench

Source: CLUP

Other areas vulnerable/susceptible to natural hazard are those which are frequently visited by flood. The main concern of the Project is the mitigation of flooding incidence in the area. Figure 2-3 illustrates flood prone areas in Bayawan. Moderate to very severe flooding is observed in areas and barangays surrounding the Bayawan river. Severe to very severe flooding is also observed in Barangays Mandu-ao, San Jose and Bugay. The areas susceptible to very severe flooding include the most of Barangay Banga, portions of the urban area and portions of Barangay Nangka.



Source: CLUP

Figure 2-3 Flood Hazard Map

Impact Analysis

Critical areas may be defined as those that are declared as conservation areas, places where endangered species might have their niche, location of important habitat such as coral reefs and sea grass and other similar characteristics. Results of ocular surveys have indicated that majority of such areas does not exist immediately within or near the project site. Generally, there is no encroachment in these environmentally critical areas identified within or near the project site.

Flooding occurrences in the area has been recurrent and destructive. This is mainly due to the dynamics of Bayawan river generating excessive depositional bars and braids along its reach making flow constrictions and reducing channel width and depth. Channelization through dredging will be compatible to mitigating measures that can potentially allow for a stable flow regime and reduce incidence of flooding. The presence of mangrove in the area will not be affected by the project because of its relatively far distance from the project site.

Management Plan

Detailed engineering design for the channelization should be developed, reviewed, approved by regulatory agencies and adopted and adhered to by the proponent. All regulatory requirements such as ECC and mining permits should be secured and complied with in the conceptualization and implementation of the project. Management will establish mechanism to support conservation programs and initiative in the area for the enhancement of the environment.

Monitoring Plan

A mechanism for monitoring and filing of records shall be established by the proponent and will be accessible to appropriate stakeholders.

2.1.1.3 Impact on existing land tenure issues

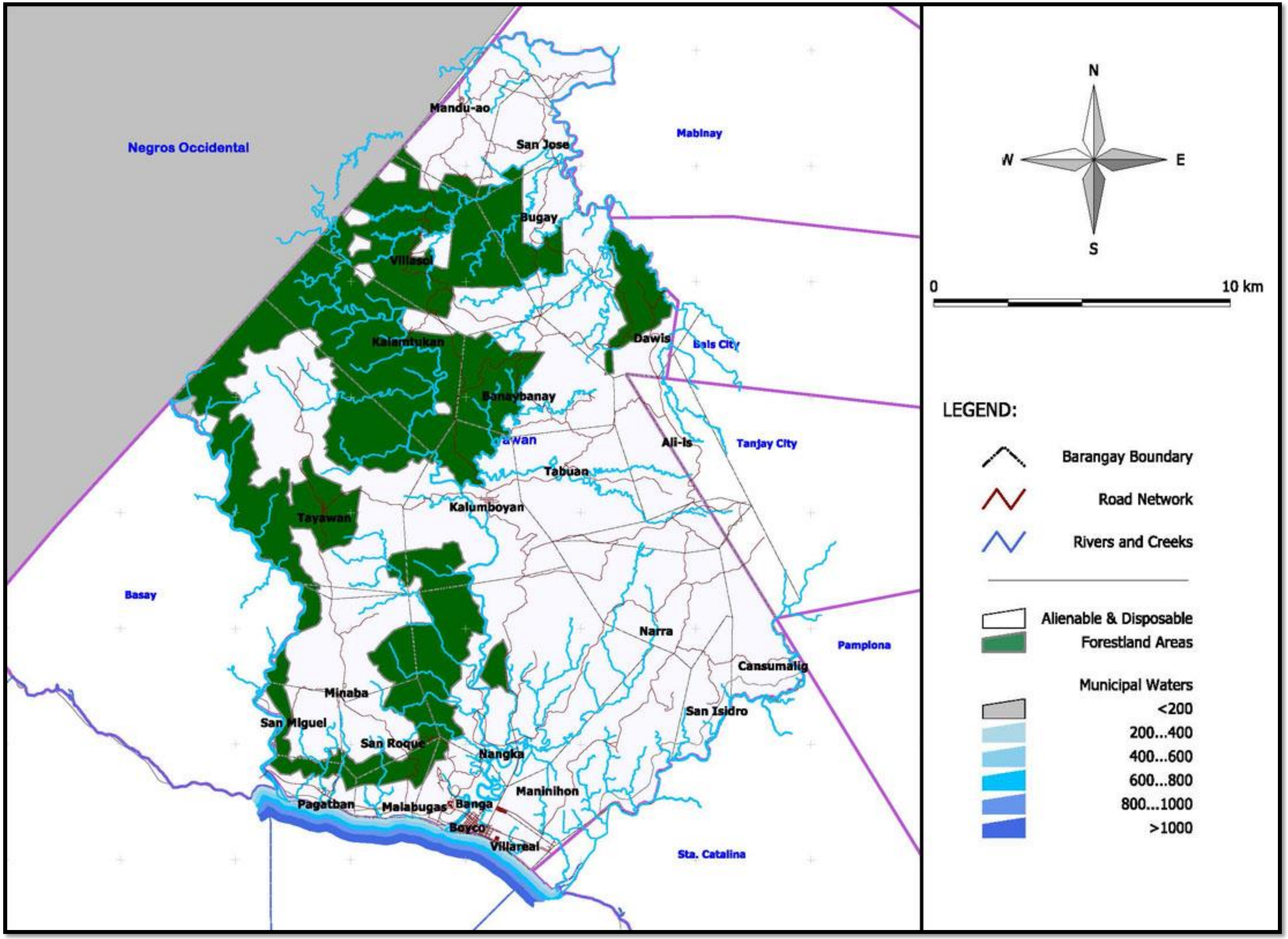
Bayawan City has approximately 20,245 ha of lands classified as forestlands (See Figure 2-4). Out of these, around 5,811 ha are considered tenured or officially and legally allocated to individuals and communities by virtue of various kinds of tenurial instruments issued by the Department of Environment and Natural Resources (DENR).

These include Certificates of Stewardship Contract (CSCs) for individual farmers/occupant; Community Based Forest Management Agreement (CBFMA) for communities thru Peoples Organization; Industrial Forest Management Agreement (IFMA) for individual or group investors; and, Certificates of Ancestral domain claim (CADCs) for indigenous people organization. The remaining 14,434 ha are not covered with any form of tenurial instrument and are considered untenured or “open access” (See Table 2-4).

Table 2-4 Allocated Forestlands

BARANGAY	ALLOCATED FORESTS (h)				OPEN ACCESS	TOTAL FORESTLANDS (h)
	CSC	CBFMA	IFMA	CADC		
Ali-is					2	2
Banaybanay					1,154	1,154
Banga	6				54	60
Bugay	653				166	819
Dawis					1,142	1,142
Kalamtukan	352				3,327	3,679
Kalumboyan	681				532	1,212
Malabugas	43				190	233
Manduao					3	3
Minaba	125	238			432	795
Nangka	822	17			821	1,661
Pagatban	53		67			120
San Jose					14	14
San Miguel	288		133		65	486
San Roque	98				545	642
Tabuan					4	4
Tayawan	438	500	850	345	2,847	4,981
Villasol		100			3,138	3,238
TOTAL	3559	855	1050	345	14,436	20,245

Source: FLUP 2004



Source: CLUP

Figure 2-4 Land Classification Map (CLUP)

Impact Analysis

The area around the Project site is classified as Alienable and Disposable. CSC, CBFMA, IFMA and CADC lands are located away from the Project site and are unlikely to be affected by the Project's activities.

There will be no potential tenurial and land issues associated with Project implementation. This concern is not necessary because of the nature of the Project being implemented in the water body.

Management Plan

There is no significant impact identified therefore, this concern is not necessary.

Monitoring Plan

There is no significant impact identified therefore, this concern is not necessary.

2.1.1.4 Impairment of Visual Aesthetics

Baseline Conditions

The only visually significant landforms, landscapes and structures located within the Project's primary and secondary impact areas are the boulevard in Banga-Suba and the city plaza, which is located in front of the old city hall in the city proper. Other than these, there are no other visually significant landforms and structure near the Project site.

Impact Analysis

The Project will have no significant impact to the visual aesthetics of landforms, landscapes and structures since the Project is concentrated on the water body.

Management Plan

There is no significant impact identified therefore, this concern is not necessary.

Monitoring Plan

There is no significant impact identified therefore, this concern is not necessary.

2.1.1.5 Devaluation of land value as a result of improper solid waste management and other related impacts

Baseline Conditions

Waste management in the city is quite good especially in the urban and coastal barangays where full segregation is implemented and with most proximate access to the sanitary landfill in Brgy. Maninihon. Currently 27 out of 28 barangays implement full segregation and are being served by garbage and septage trucks.

Bayawan City Solid Waste Management Framework:

a) Reduction of waste at-source – Households, establishments and institutions are required to segregate waste at-source. Littering is prohibited and composting at-source is highly encouraged. Non-segregated waste will not be collected and strict penalties are imposed on violators.

b) Collection - The City of Bayawan has a strict garbage collection schedule wherein biodegradable waste is collected on Mondays, Wednesdays and Fridays; non-biodegradable waste collected on Tuesdays and Saturdays; and special waste materials collected every first Thursday of the month. All collected garbage are disposed at the Bayawan City Sanitary Landfill.

The Sanitary Landfill in Brgy. Maninihon has a 1 cell with an area of 1 hectare and can accommodate 60,000 cubic meters. From the SLF cell, leachate flows towards the buffer lagoon then towards the aerobic pond and finally to the wetland for final treatment. Residual waste is disposed at the SLF cell while special waste is disposed at the Special Waste Vault.

c) Materials Recovery - There is a Central Materials Recovery Facility within the SLF site, while private junkshops serve as MRF for barangays and public schools also have MRF. Recyclable waste is recovered and sold while biodegradable waste is processed further as compost via vermi and windrow composting processes.

Impact analysis

There will be no significant impact to land value as a result of Project implementation. The Proponent will be in close coordination with the LGU to properly implement an effective solid waste management plan.

Management Plan

Each vessel will strictly comply with operation plan to minimize in-vessel pollution discharges and solid waste generation. Similarly, land-based support facilities will practice solid-waste management in accordance with RA 9003, specifically in the segregation of solid waste prior to disposal.

Monitoring Plan

Daily monitoring of the work area on land shall be done in terms of general cleanliness, fugitive litters and other solid waste generated.

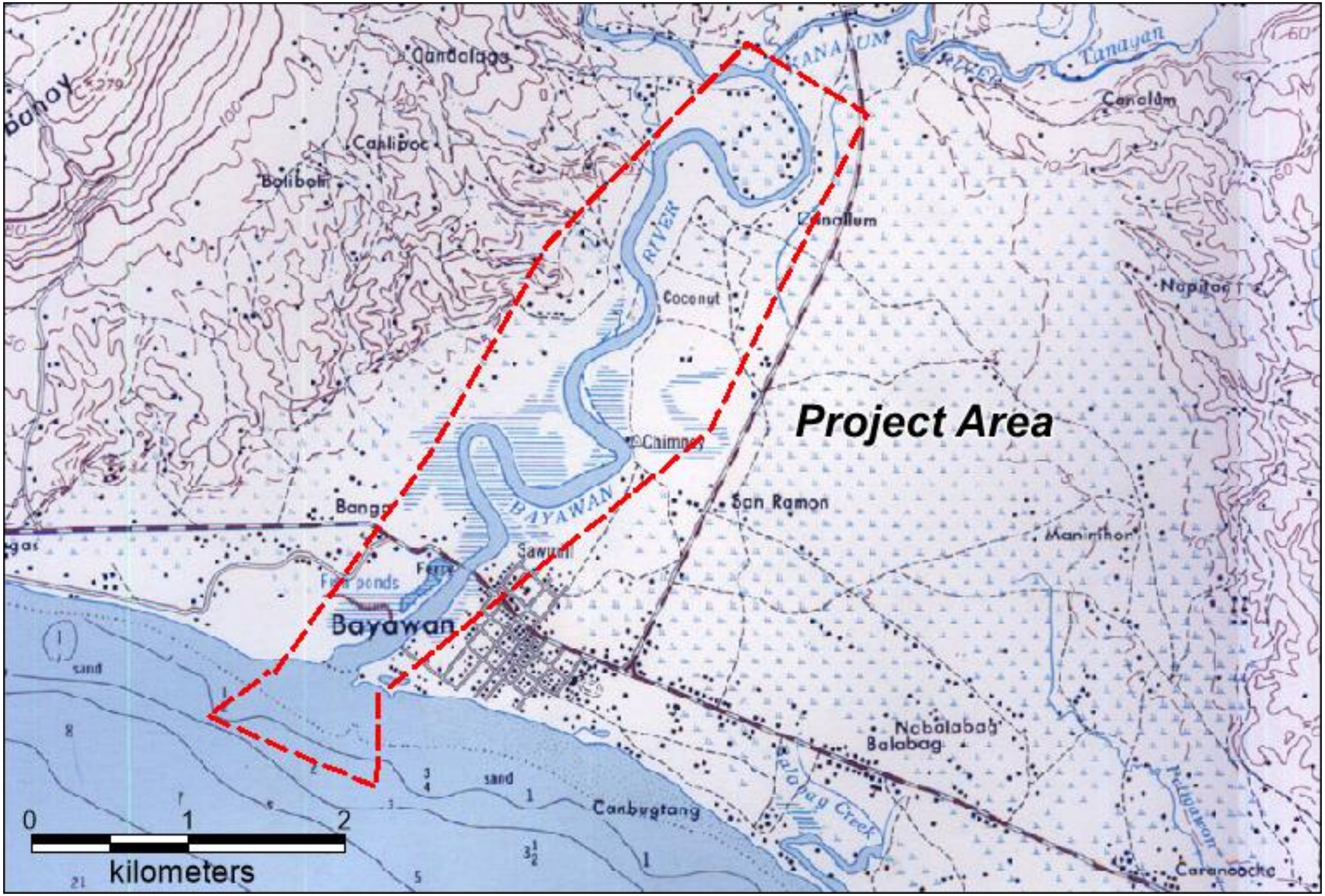
Geology/Geomorphology

2.1.1.6 Change in Surface landform/geomorphology/topography/terrain/slope

Baseline Conditions

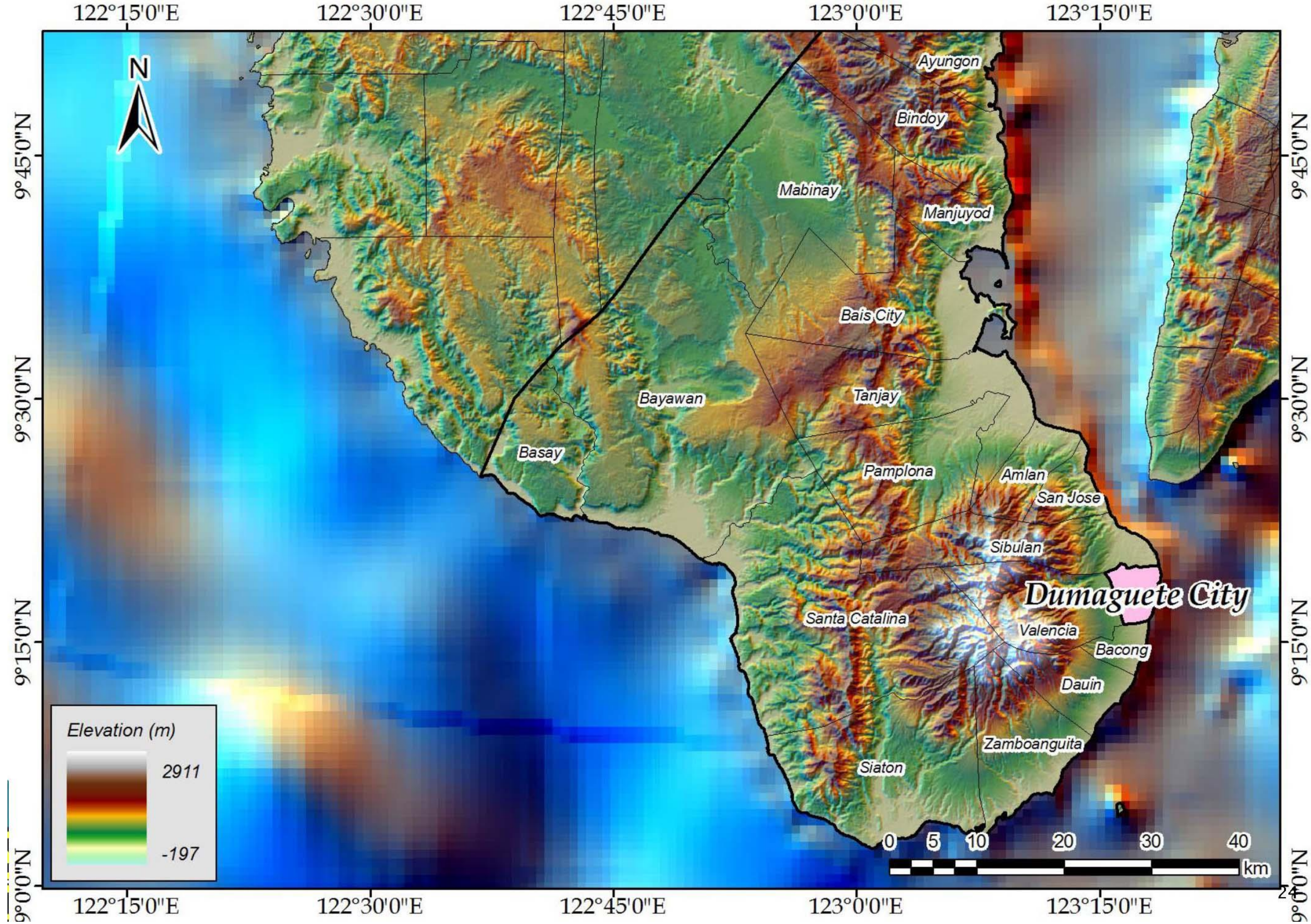
Benchmark information on the geomorphology of Bayawan River floodplain has been gathered since 2014 up to present times. A relatively large lowland area constitutes a triangle-shaped floodplain of roughly 25 km^2 in area with a delta where the mouth of the Bayawan River joins the Sulu Sea (Figure 2-5). There is no inland water body, such as a lake or large dam reservoir.

The Bayawan floodplain occupies a relatively flat land as a consequence of the meandering nature of Bayawan River when it enters Sulu Sea. The meander zone presently occupies the western portion of the floodplain, forming an elongated area of active and abandoned riverine channel ways, 1 km across and stretching inland to about 6 km. Swamps surround the active river channel at its deltaic mouth and extends 3 km inland (3 meters asl elevation) and fringes some coastal barangays.



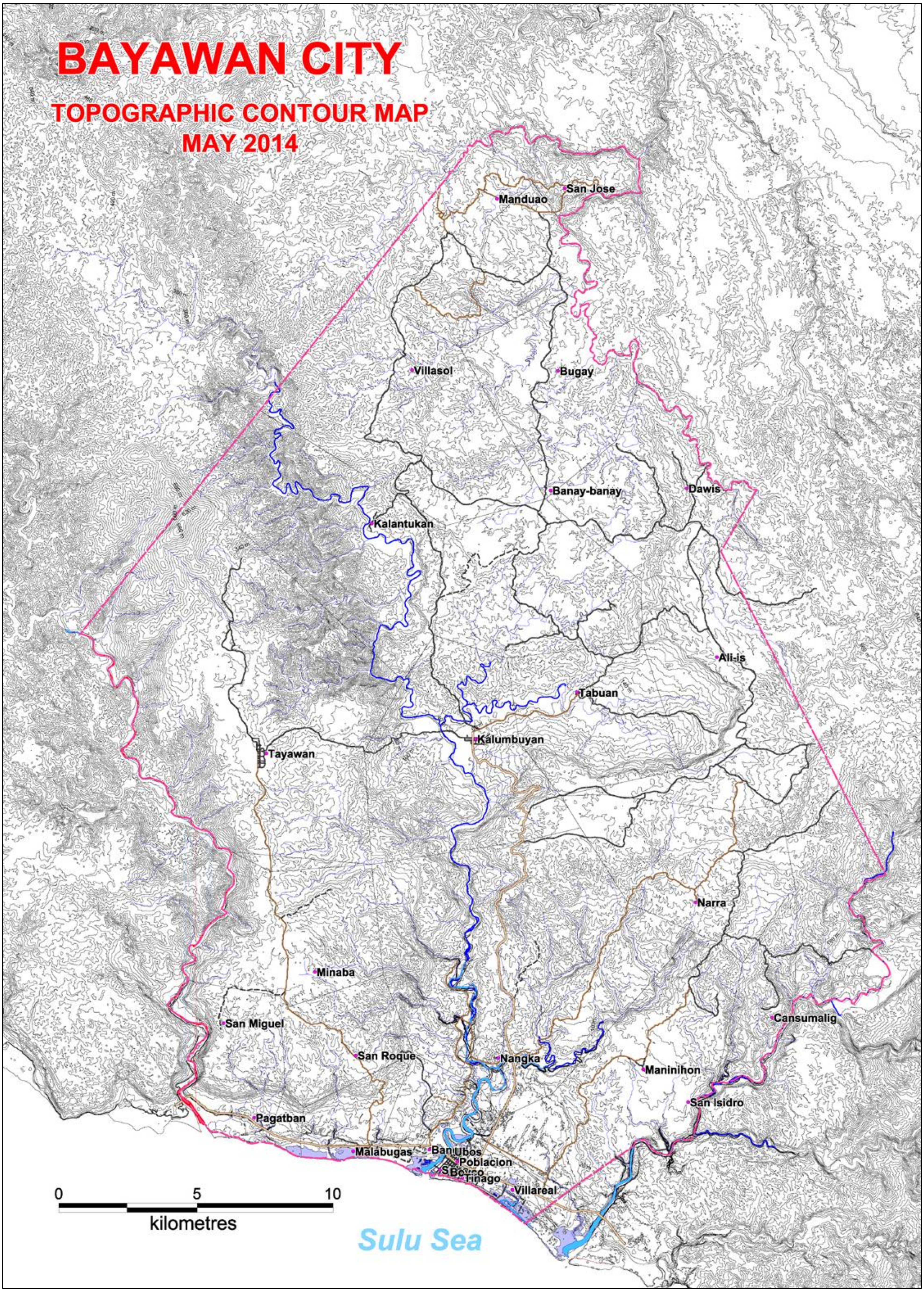
Source: NAMRIA Quadrangle Sheet

Figure 2-5 Topographic Map of Project Area



Source: Phil LIDAR 1

Figure 2-6 Southern Negros Relief Map



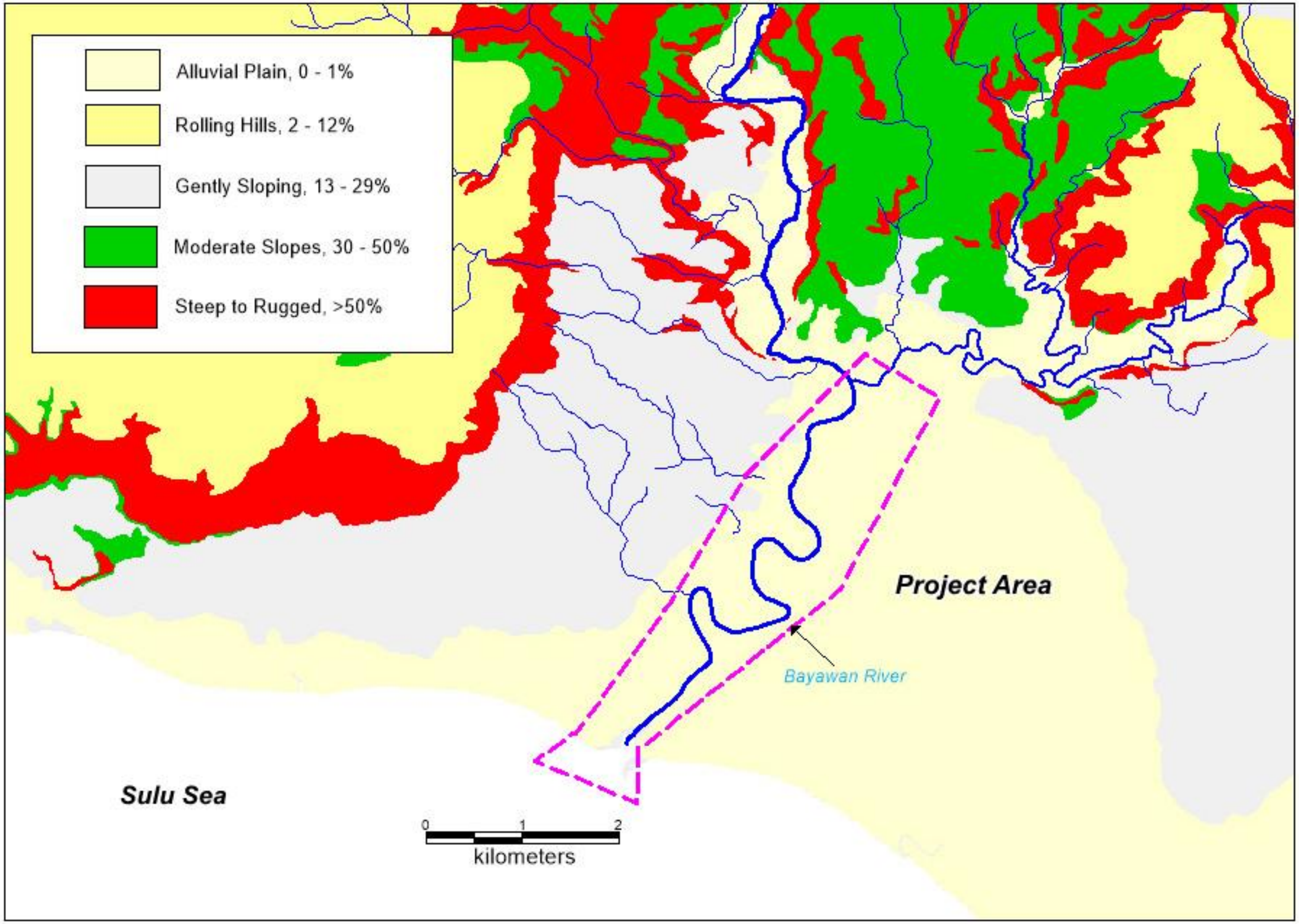
Source: IFSAR Digital Elevation Model, Ruelo 2014

Figure 2-7 Bayawan City Topographic Map

Slope conditions in the project site (See Figure 2-8) are relatively subdued and flat. The Bayawan floodplain is an aggrading, mainly depositional floodplain. The Bayawan River which cuts it has reached beyond its natural base level of degradation, and therefore it is subject to repeated floods, rapid sedimentation, and river avulsion during extreme flood events. The downstream Bayawan River in the floodplain area is a high-sinuosity meandering system, where numerous abandoned channels occur due to previous channel cut-offs and avulsion, forming temporary oxbow lakes and depressions.

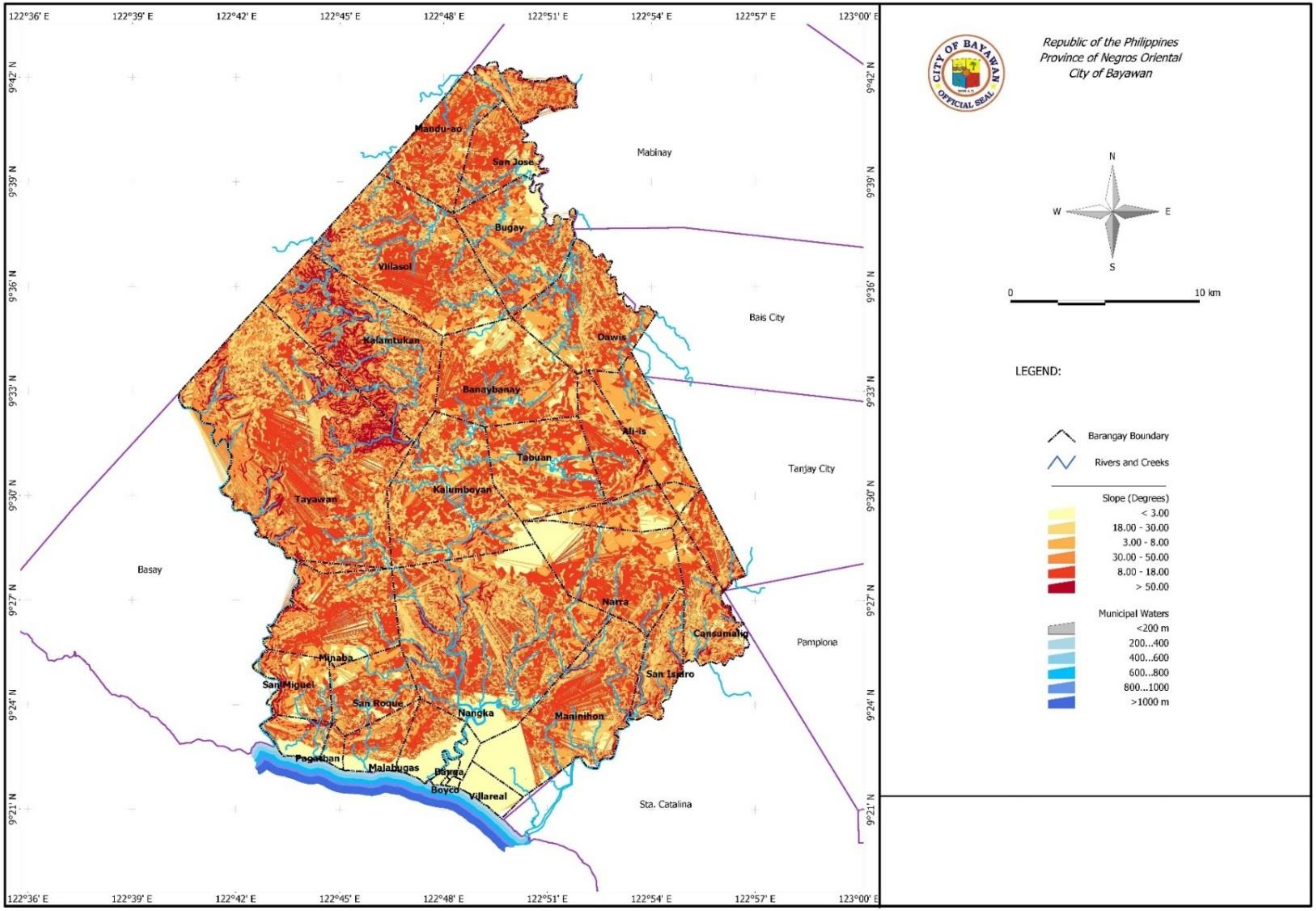
Depending on tidal seawater heights, most river bank heights are generally low (< 1 meter), forming small swampy areas along its length and at its coastal mouth. The floodplain comprises thick layered sequences of unconsolidated sand, silt, mud and gravel materials deposited by successive stages of laterally shifting fluvial (river) processes from the Bayawan River and its tributary Canalum River. There is no estimate as yet of the average floodplain thickness down to bedrock, which probably comprises limestone and sandstone rock types.

In general, Bayawan is predominantly hilly, with terrain characterized as moderately sloping to rolling (8-18%) comprising twenty-nine percent (29%) of the whole area. Flat to gently sloping (0-3% slope) and gently sloping to undulating (3-8% slope) comprising 18% and 21% respectively. Slopes having 18% and above comprises 32% of its land area. Sixty eight percent (68%) or about 479 square kilometres of land is arable with slopes less than 18%. Twenty-eight percent is suited for agro-forestry use and only a small 4% has slopes greater than 50% which is considered environmentally critical due to slope considerations. (See Figure 2-9)



Source: Bayawan Dredging Pre-FS, Ruelo

Figure 2-8 Slope Map of Project Site and Adjacent Areas

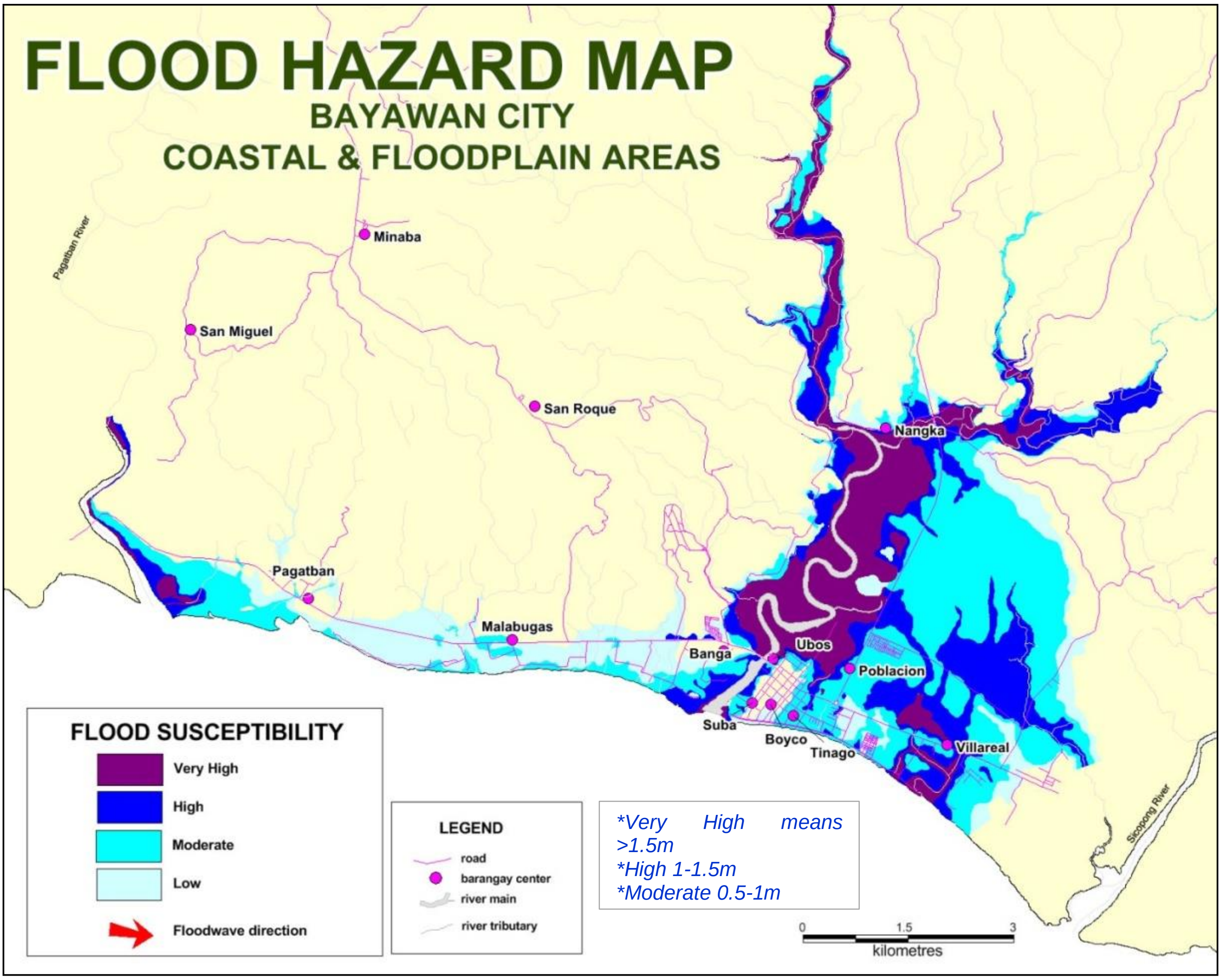


Source: CLUP

Figure 2-9 Slope Map of Bayawan City

Due to wanton destruction of the Bayawan upland forests and improper land-use practices, the project site is a flood-prone area during the rainy months in every year. Constant damages of riverbanks along the meandering portion in the floodplain area of Bayawan River are due to numerous recurring flood events. Each year, especially during the rainy months of July to October, an average of six (6) floods occur along the river's entire stretch in the floodplain area. Riverbanks in the project area are thus considered highly unstable, and are now in naturally critical condition.

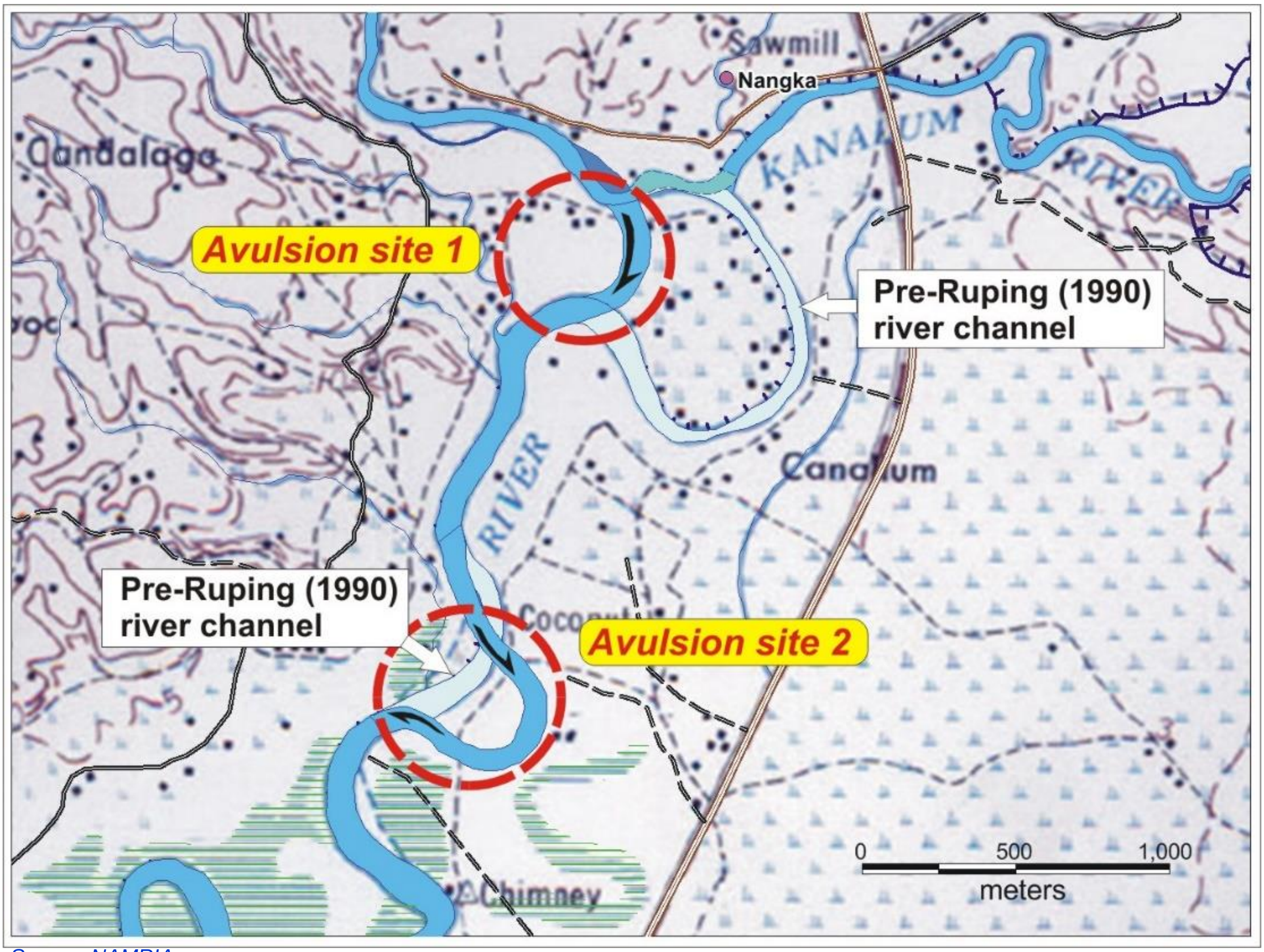
Flood events are not uncommon in Bayawan City since the main populated zone is situated in a floodplain area. Previous recollection by locals revealed big flood events with varying inundation impacts. With increasing investment in infrastructure and urbanization, flooding problems are now being attended to. In 2014, the Bayawan LGU generated a flood susceptibility map (See Figure 2-10) through various geoscientific studies of the Bayawan River catchment and flood-prone areas, geared towards enhancing the LGU's existing database and knowledge for the design and installation of a Local Flood Early Warning System or LFEWS.



Source: Bayawan Dredging Pre-FS, Ruelo

Figure 2-10 Flood Susceptibility Map for the coastal and floodplain areas of Bayawan City

During a big flood generated by rains from typhoon Ruping in 1990, a major geomorphic change of the Bayawan waterway has apparently occurred. There was a shift in river direction, due to *avulsion*, which involved cutting-off of the meandering portions of the river in Sitio Ondol in barangay Nangka and Sitio San Ramon in barangay Poblacion. A comparison was made of the old (post-war) NAMRIA topographic map, and current digital images of topography, as shown in the map (Figure 2.11) below.



Source: NAMRIA

Figure 2-11 River Avulsion at Two (2) Sites Along the Meandering Portion of Bayawan River

Impact Analysis

There will be no significant changes of the land since dredging will be conducted in-stream and in areas under water. The project is not likely to have a significant impact on the geology and geomorphology of the area. Geology will only influence the form, level and magnitude of impacts. The effects of the dredging activities will include minimal geological instability and disturbances, modification in riverine and local coastal bathymetry.

The potential impacts associated with geology and geomorphology therefore will only involve a change in subsurface depth of selected portions of the river and its mouth. The overall landscape or landform will not be altered. At the mouth of the river, sand bars will be gone after dredging. Dredging in general changes the existing geomorphology and hydrologic conditions of an area, creating essentially a non-equilibrium or unstable condition. This, however, will only be temporary.

Dredging at the project site will be conducted in specific, isolated areas of heavily silted, relatively shallow water (1 to 5 meters depth) along the natural Bayawan River waterway and its mouth (See Figure 2-12).

Zero impact will be expected in the surface topography and overall geomorphological configuration at the project site. In other words, there will be no change in surface landform/topography/terrain/slope of the surrounding land associated with project implementation. This concern does not pose significant impact because the project being implemented is in the water body.

However, dredging seeks to change appropriate slope of the river bed to accommodate the volume of water that may flow during a 25-year return period of flood incidence. This may result to a potential head cutting upstream. By strictly adhering to the detailed engineering design, the degree of head cutting that can cause upstream erosion can be minimized. This concern is temporary and the normal Bayawan River flow regime will stabilize over time, say over a period of at least 6 months after project completion.

Source: Bayawan River Dredging Pre-FS, Ruelo

Figure 2-12 Geomorphological Map of the Floodplain Area

Management Plan

To address stream bank erosion and instability, there is a need to rehabilitate the Bayawan floodplain riverbanks. Engineering intervention (i.e. rip-raps, gabions, revetments) are costly and temporary, considering the dynamic nature of floodwaters along the Bayawan waterway. This can only be done through a holistic, serious long-term program of controlling erosion in the upper (above the floodplain) stretches of Bayawan watershed, including its headwaters. A thoughtful watershed management plan should therefore be crafted and immediately implemented. Several studies have proven that bamboos have great potential to control soil erosion and can be used to stabilize river banks (Esperanza 2015). Reforestation of defoliated areas would be a priority, including application of proper tilling practices for major Bayawan crops such as corn and sugarcane.

Riparian and river cross section surveys shall be conducted as necessary to know the physical condition of the river system. Based on the surveys, the appropriate slope will be estimated and established and compared to the Detailed Engineering Plan which is approved by DPWH prior to project implementation. Head cutting upstream will be regularly monitored especially in the upstream river portion that does not have a defined river channel configuration due to excessive siltation.

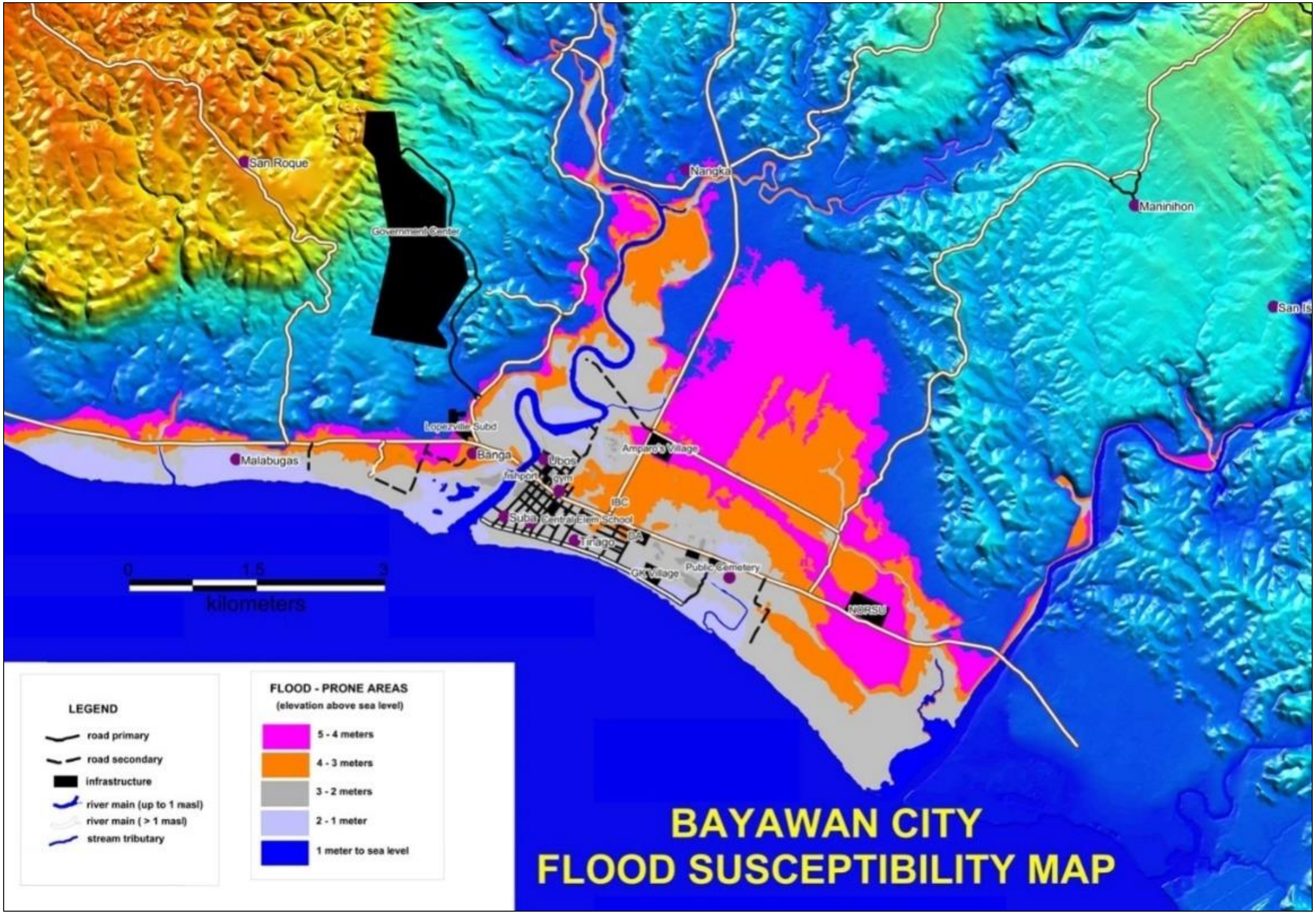
Monitoring Plan

Considering its current observable physical conditions, monitoring changes in riverbanks due to the dredging operations will be conducted and immediately reported to the project management team. The baseline topographic and geomorphological map will be constantly updated, and any observable drastic changes will be assessed.

During dredging operations, cross-sectional surveys will be made before and after every channel cut to check appropriateness of cutting to desired slope. Upstream conditions will be regularly monitored for any significant sign of excessive head cutting so that preventive measures can be implemented appropriately.

A desktop technical study covering Bayawan City was done previous to commencing the field-based topographic and bathymetric surveys. The study involved processing and analysis of satellite data-derived digital terrain models (DTM) from IFSAR (InterFerrometric Small-Aperture Radar). This DTM elevation data at 0.5m resolution is the best available topographic datasets for local use, which was further enhanced to generate a complete high-resolution digital topographic database covering the downstream portions of Bayawan City.

The elevation models derived from the IFSAR data are then used in a GIS (Geographic Information System) platform supporting Mapinfo software. The processed data depicts the surface topography or terrain of the Bayawan area, and were used as elevation domains (See Figure 2-13) in determining flood susceptibility. This was used together with the actual flood height surveys to generate the flood hazard map. It is to be noted that the SRTM data was obtained using radar technology, and this means that opaque objects - like buildings, bridges, and other man-made features - can show up as landforms in the data as well. A detailed topographic map at 1-meter and 2-meter contour intervals were generated after enhancement of the DTM data using Global Mapper, a 3-D elevation data processing software.



Source: elevation domains generated from IFSAR DTM data

Figure 2-13 Flood Susceptibility Map

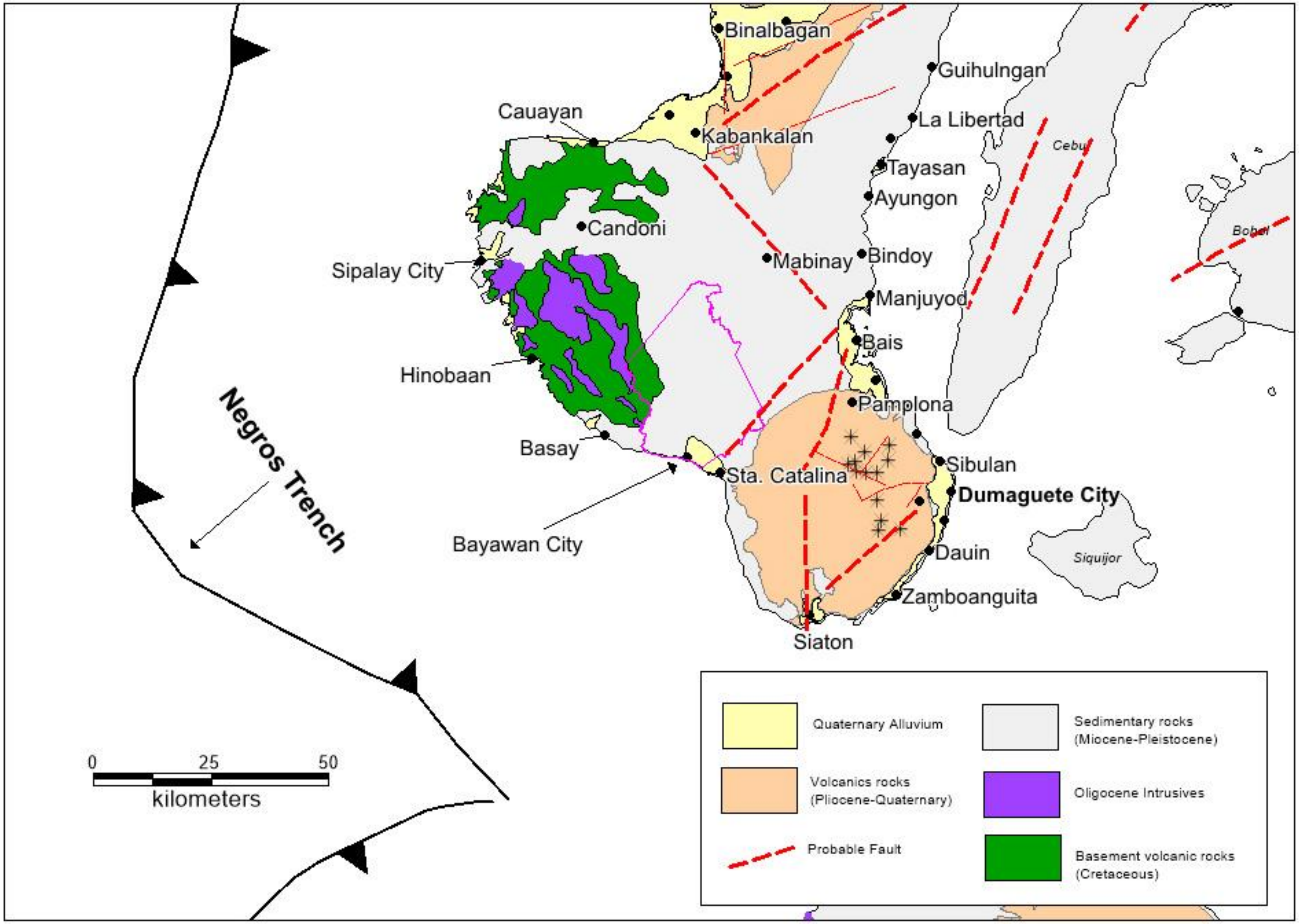
2.1.1.7 Change in sub-surface geology/underground conditions

Baseline Geological Conditions

Bayawan City is located in the southwestern portion of Negros Island, a seismically active region in the Visayas fronting the Negros tectonic trench in the Sulu Sea. The area sits in a sedimentary basin between the Cretaceous-Oligocene volcano-plutonic terrain of SW Negros and the Quaternary Volcanic Complex of SE Negros (See Figure 2-14). Several historical large-magnitude earthquakes have been recorded in the region (See Table 2-5), the strongest of which could have been the 1948 magnitude 8.1 tremor near Panay Island to the north of the city. Several probable fault and lineaments were delineated by PHIVOLCS and these are currently being mapped and verified if these are active or not.

Table 2-5 Large historical tectonic earthquakes in the vicinity of Bayawan City

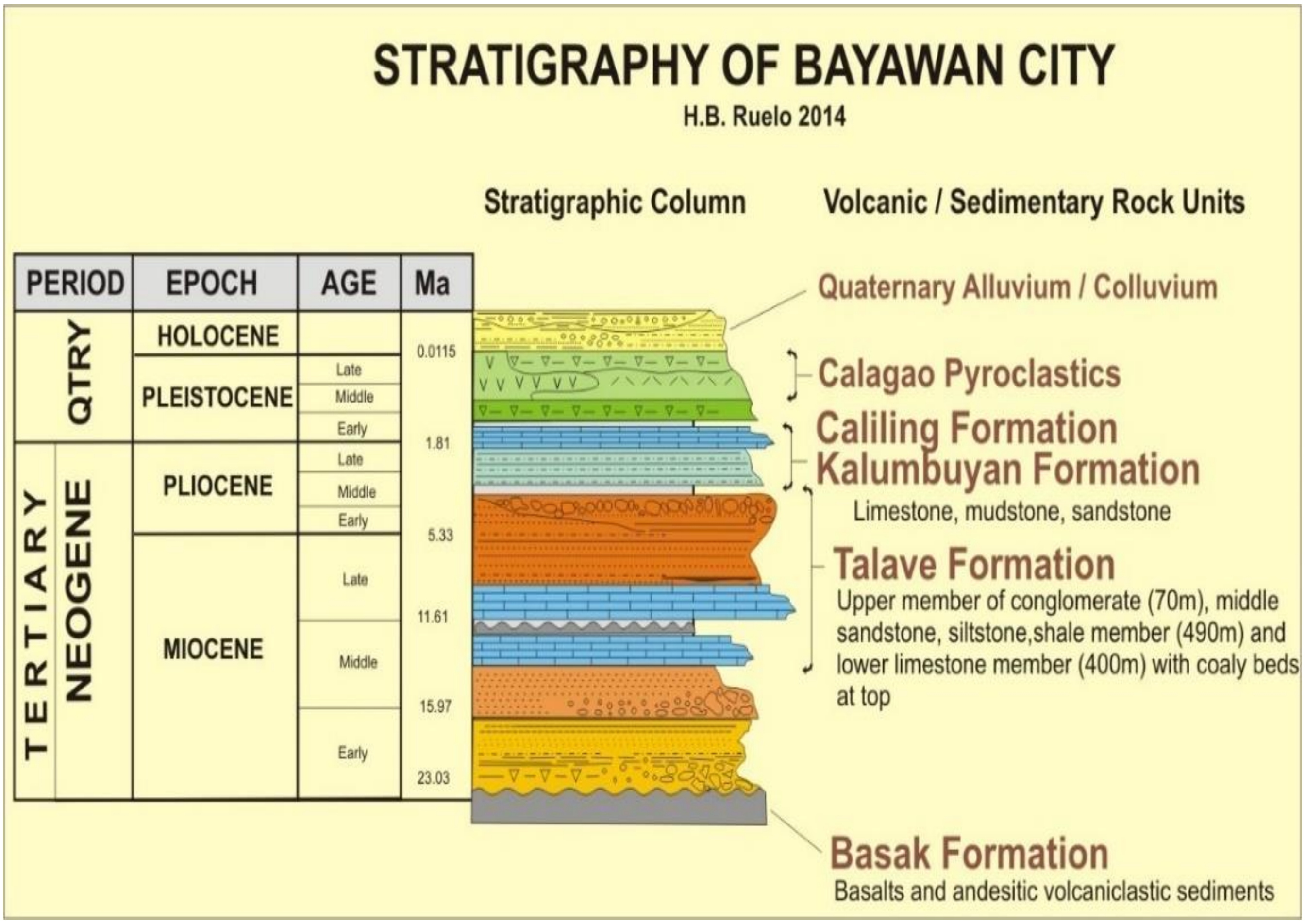
Year	Location	Magnitude	Epicenter	Earthquake Generator
1925	Pamplona	6.8	Pamplona, Negros Or	Unknown Fault
1948	SW Negros	8.1	SW Antique	Negros trench
1955	SW Negros	6.1	Hinobaan, Negros Occ	Negros trench
1990	Bohol	6.8	Bohol Island	Reverse Fault
2012	East Negros/ Cebu	6.9	Tayasan, Negros Or	Blind Fault
2013	Bohol/ Cebu	7.2	Bohol Island	Inland Fault
2014	SW Negros	6.3	Sulu Sea	Negros trench



Source: CLUP

Figure 2-14 Regional geologic setting of Bayawan City

The city is underlain predominantly by gently folded to flat-lying sedimentary rocks – limestone, mudstone, siltstone, sandstone, and a smaller portion by older basement (Basak Formation) igneous rocks of andesitic to basaltic composition (See Figure 2-15).



Source: Bayawan River Dredging Pre-FS, Ruelo

Figure 2-15 Stratigraphic Column of Bayawan City

The sedimentary rocks belong to the Talave Formation, Kalumbuyan Formation and Caliling Limestone of Mid-Miocene to Pliocene in age. The Calagao Pyroclastics are abundant only in Basay municipality, to the western portion of Bayawan, and towards Hinobaan and Sipalay farther west in Negros Occidental. The sedimentary rock types are fragile and are easily weathered or decomposed in the tropical wet climate, which contributes more fine-grained sediment supply to the river system, and which then exacerbates riverine siltation and flooding (See Figure 2-16).

Figure 2-16 Representative Sedimentary Rock Types of Bayawan City

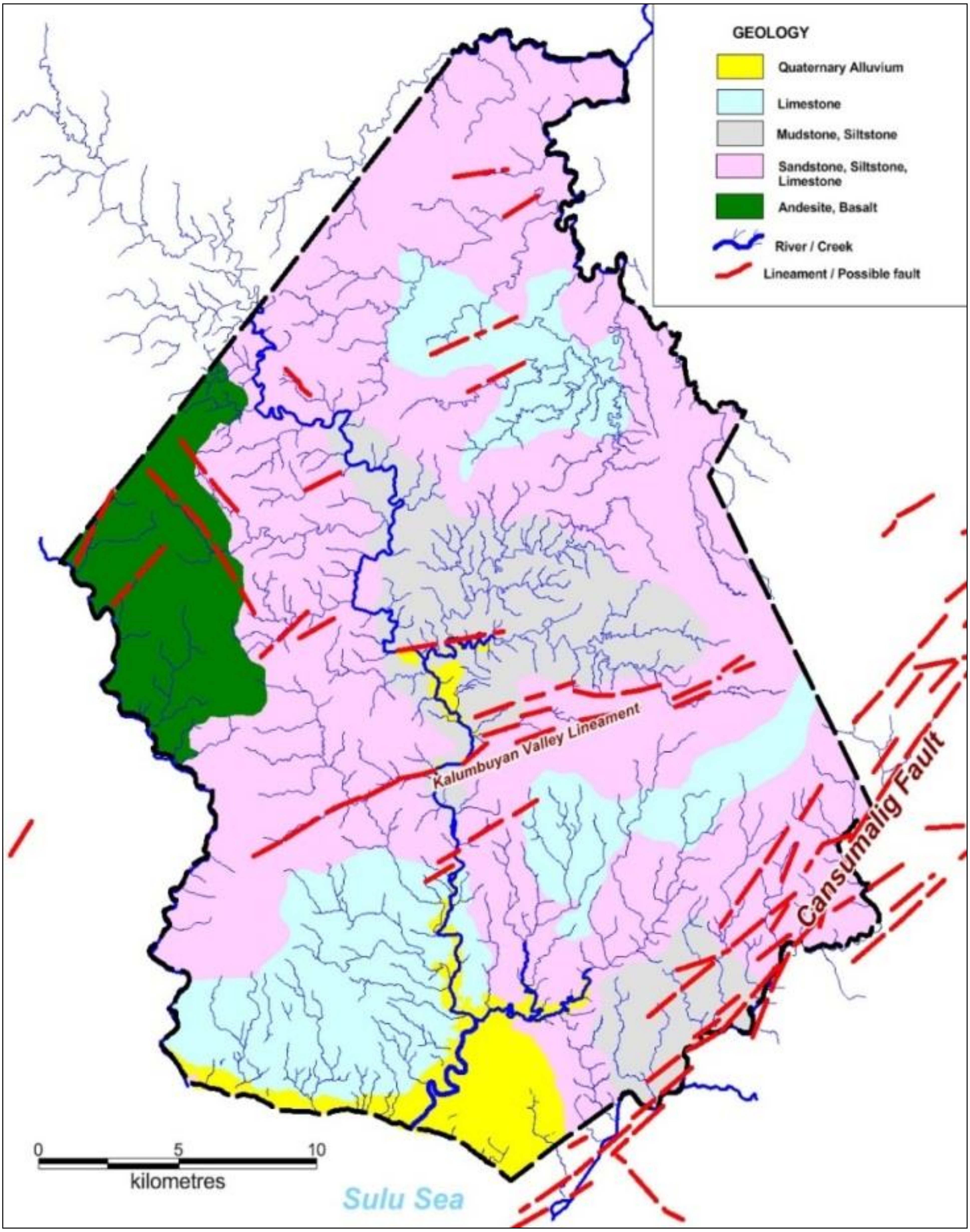
A relatively large flood plain of unconsolidated Quaternary alluvial materials is developed at the downstream portion of the river, coalescing with a long coastal zone of largely beach sands and swampy mud flats.

Fault structures run through northeast-southwest directions, the most prominent of which is the inactive Cansumalig Fault system at its southeast boundary with Sta. Catalina municipality. The Kalumbuyan Valley Lineament apparently represents another zone of sub-parallel linear structures traversing the middle portion of the city (Figure 2.17).

Baseline Geomorphological Conditions

The topographic relief of Bayawan is generally moderate with rolling hills in plateaus and steeper deeply eroded hill slopes and stream-dissected valleys. The highest places are in the northwest portion at just above 500 meters above sea level (asl), while the plateaus in the eastern and northern portions have elevations between 200 to 400 meters asl. A prominent topographic depression, the Kalumbuyan-Tabuan Valley occupies the central part, while the floodplain, swamps and beaches dominate the low-lying area (See Figure 2-17).

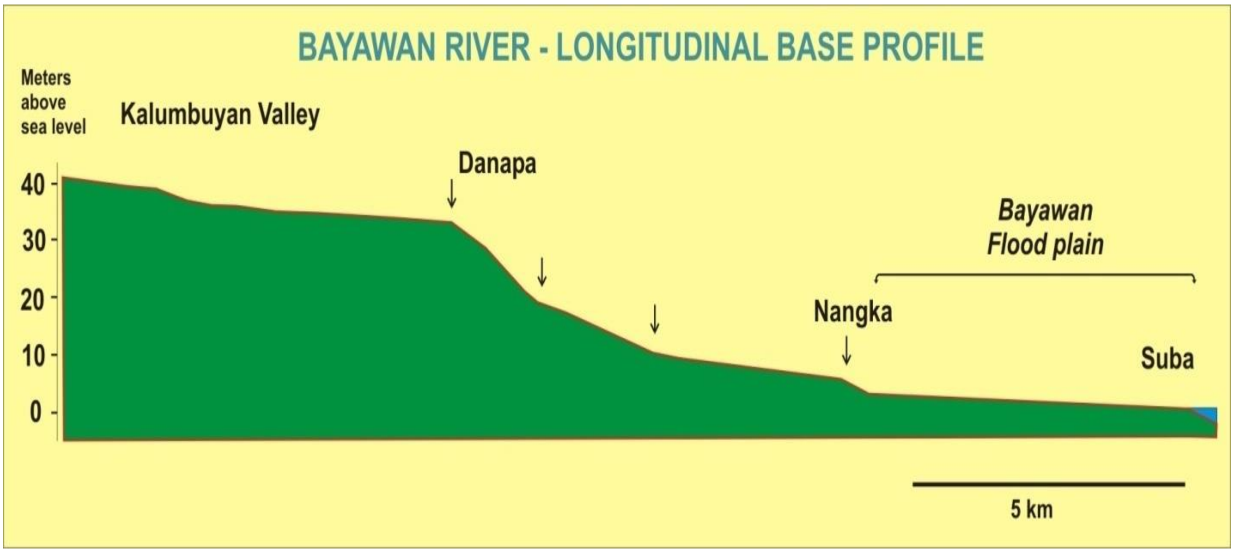
The Bayawan floodplain corresponds to the principally triangular-shape flat area underlain by Quaternary alluvial deposits of Bayawan River and its tributaries. The entire urban and semi-urban areas of Bayawan City are located in this geomorphic terrain. Elevation in floodplain part of the city, including the coastal areas east and west of it, falls within the range of 0 to 5 meters above sea level, a condition that favors flooding from riverbank overflows and increased tidal levels. The low elevation and stream gradient of the floodplain area favors meandering of the Bayawan River as it enters Sulu Sea.



Source: CLUP

Figure 2-17 Geological Map of Bayawan City (showing stream drainage, distribution of rock types and geologic fault structures)

This relatively large east-west valley occupies the central part in the barangays of Kalumbuyan and Tabuan, 14 km long and 9 km across. The valley floor lies from 40 to 100 meters asl, while the steep valley edges are at elevations ranging from 200 to 400 meters asl.

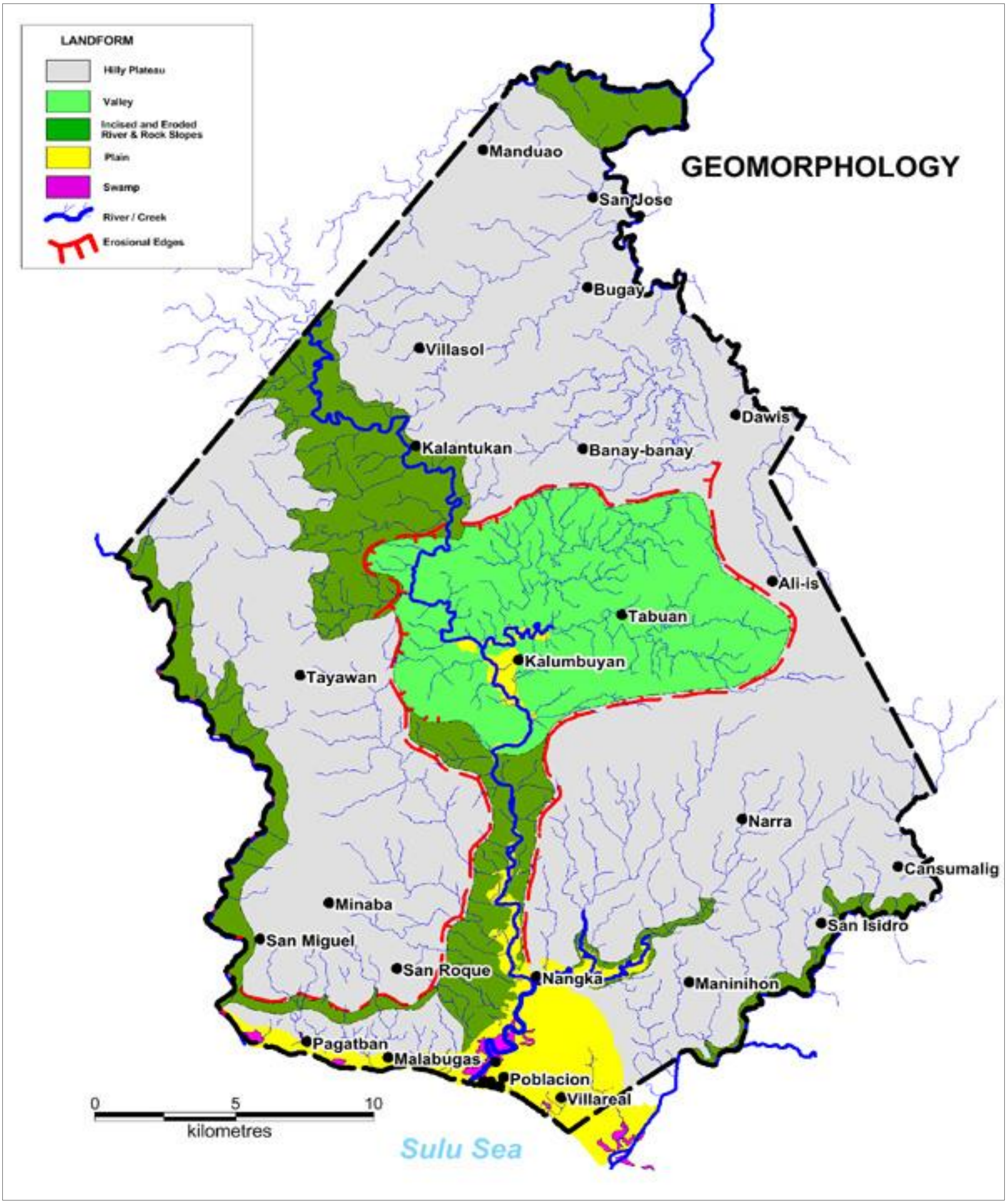


Source: Bayawan Dredging Pre-FS, Ruelo

Figure 2-18 Bayawan River Longitudinal Section

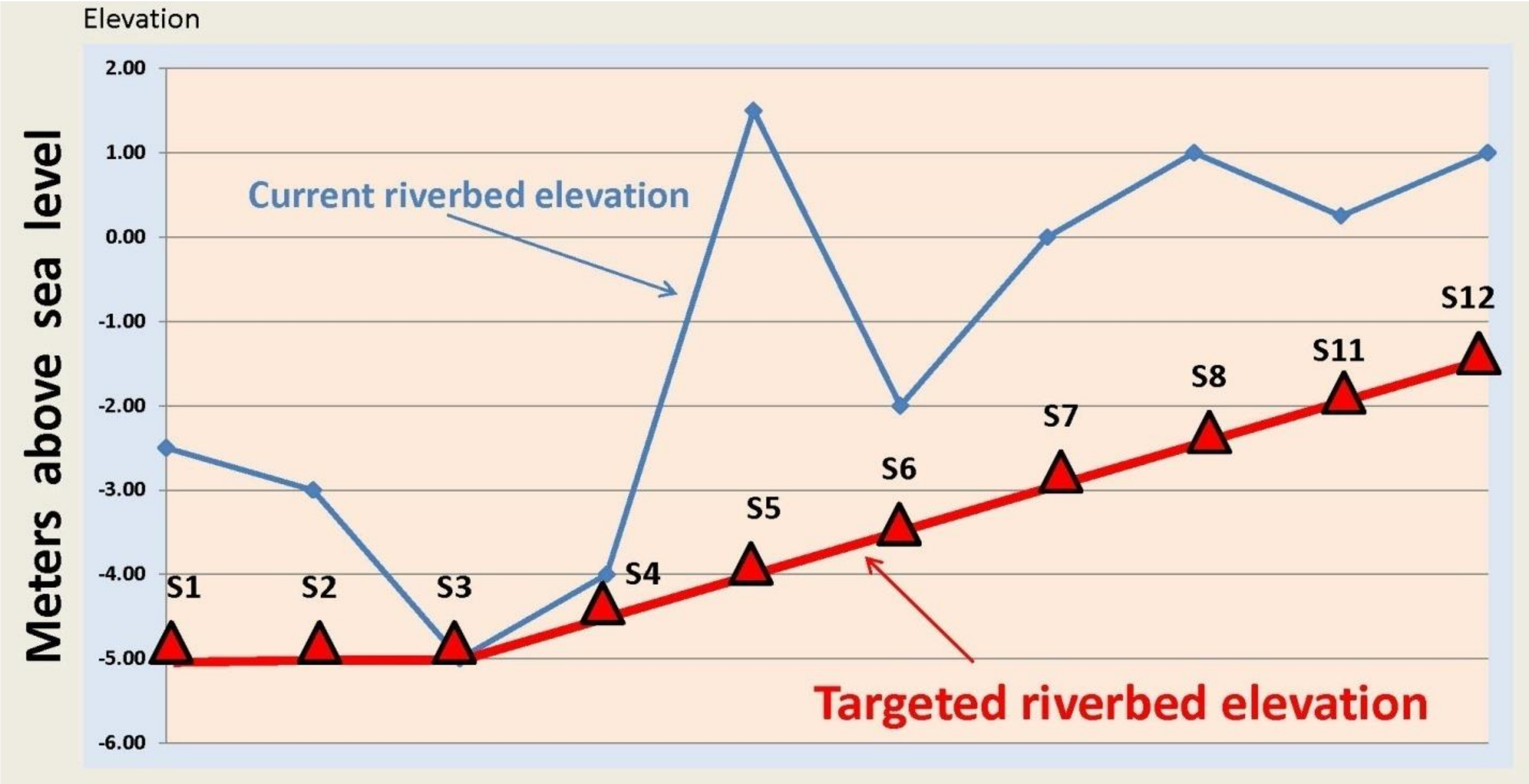
Steep slopes arising from river incision, weathering and erosion of bedded sedimentary rock formations form linear steep-sided slopes and gullies along the entire length of the main Bayawan River in the central part, along Pagatban River border with Basay municipality to the west, and Sicopong River border with Sta. Catalina municipality in the eastern part. The rest of the topography are plateaus and rolling hills, and a bit of mountainous terrain in the eastern and western boundaries with maximum elevation of 560 meters asl.

The coastal area stretches 13.9 km from west to east, with six (6) barangays along its length having elevations up to 3 meters above sea level (meters asl). It widens into a large deltaic floodplain measuring some 6 km across and 5 km inland upon merging with Bayawan River, attaining a maximum of 6 meters asl in elevation at barangay Nangka.



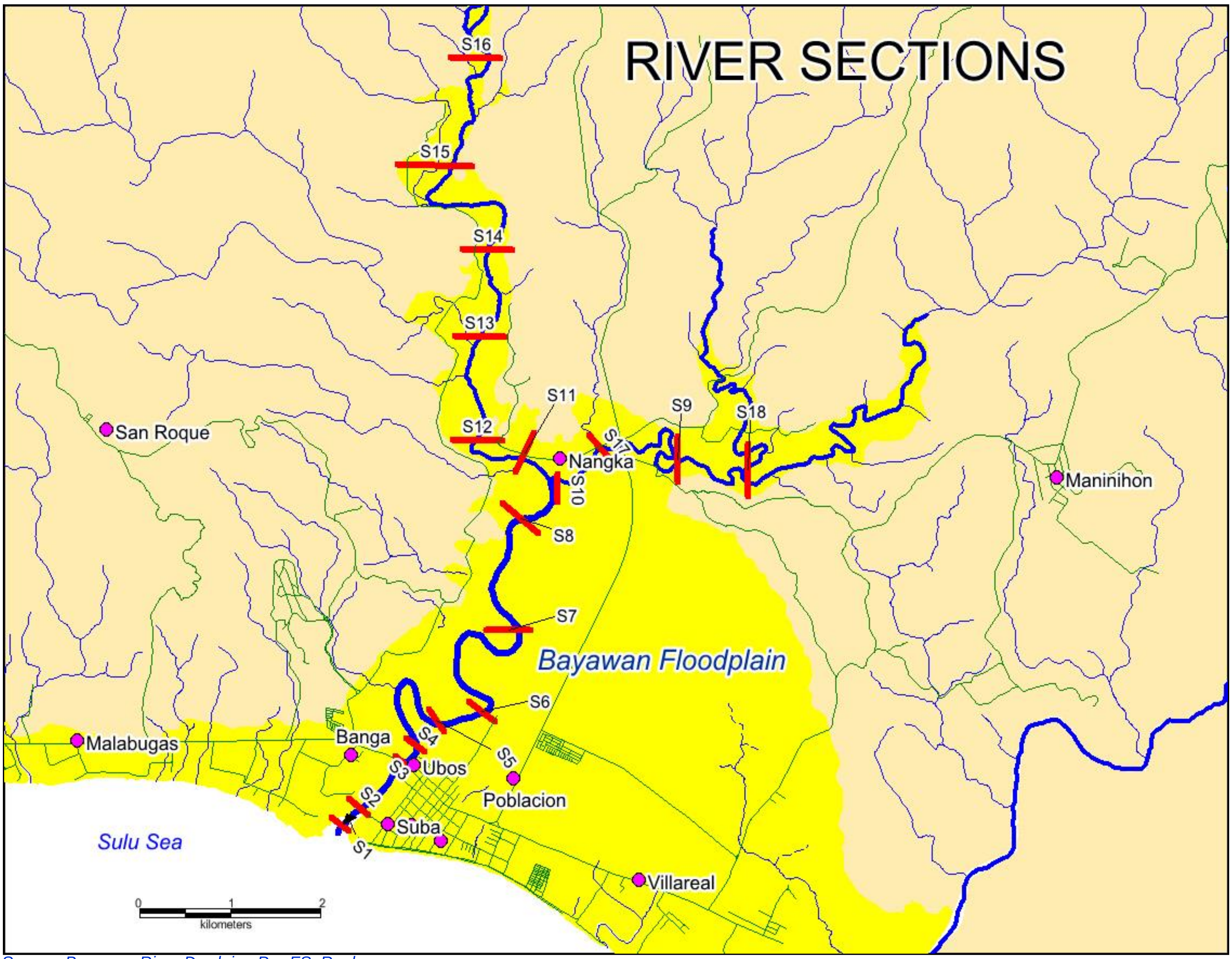
Source: CLUP

Figure 2-19 Geomorphological Map of Baywan City



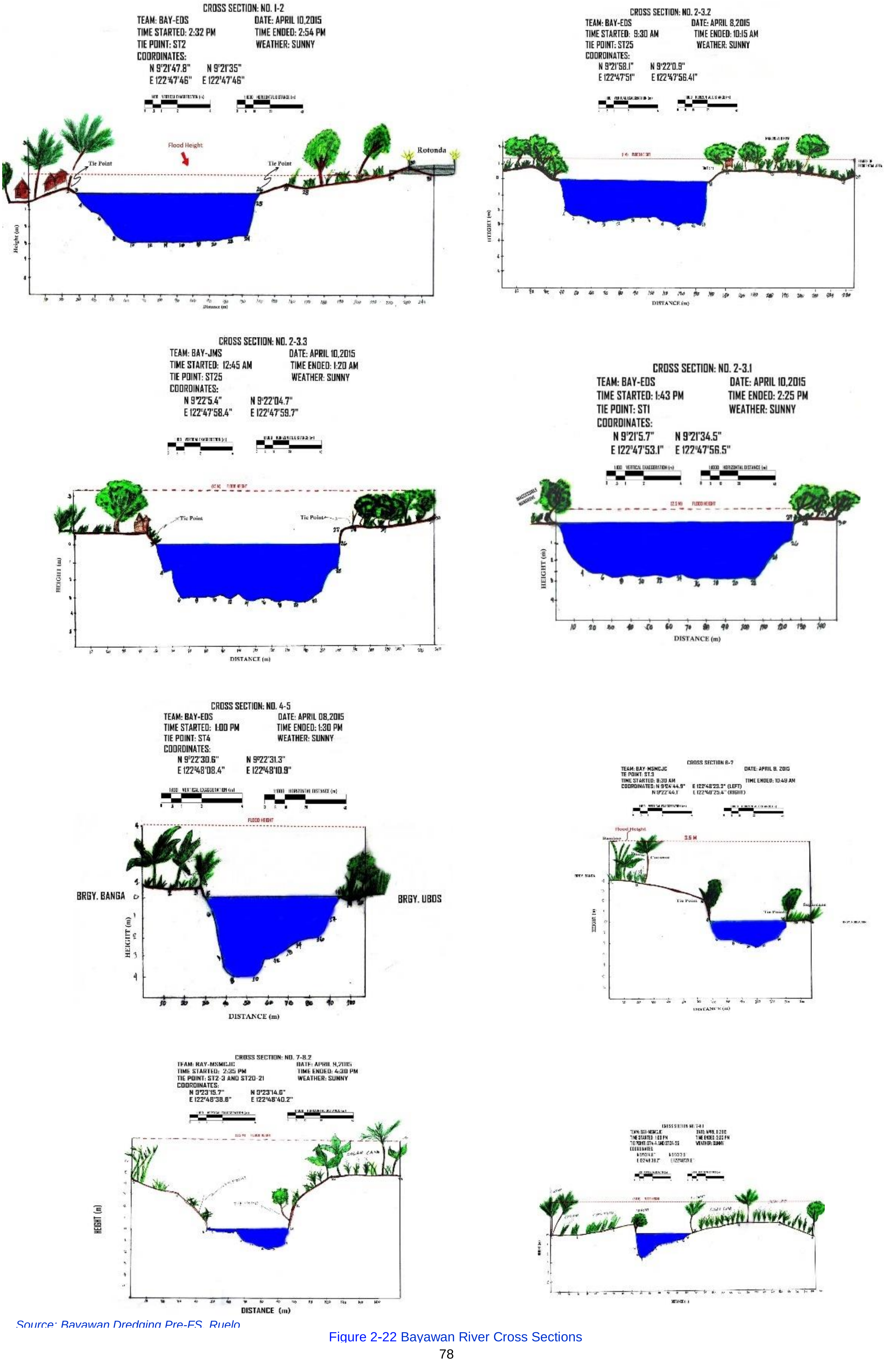
Source: Bayawan River Dredging Pre-FS. Ruelo

Figure 2-20 Plotted riverbed elevations (2014) and target elevation for dredging



Source: Bayawan River Dredging Pre-FS, Ruelo

Figure 2-21 Map showing location of downstream sections of Bayawan River



Source: Bayawan Dredging Pre-FS, Ruelo

Figure 2-22 Bayawan River Cross Sections

Impact Analysis

There will be no drastic effects on the landscape and any geological formation that can be considered as significant impact. The alluvial depositional and erosional processes of Bayawan River will still continue to operate in the area even beyond the life of the project. Dredging is basically an extractive process, and therefore changes in sub-surface configuration within the dredged watery areas will occur. When dredging operations commence, no changes are expected to happen in sub-surface or underground conditions outside of the targeted dredging sites (i.e. open land areas), except on already unstable riverbanks where riverine materials extraction by dredging might trigger small localized riverbank collapse with minimal subsidence.

There will be no significant change in sub-surface or underground geomorphology during project implementation. Channel cutting will be limited and will not drastically diminish the sub-surface or geomorphological characteristics of the river bed. The Project Management team shall provide solid waste disposal area for the garbage of the dredging team workers in strategic places. Construction wastes shall be cleaned immediately and haul back to the construction yard or storage within the field office parking area.

Management Plan

DPWH should have reviewed, assessed and approved the detailed engineering plan and operating protocols for dredging will be anchored on the stipulated design parameters. The Project Design incorporates hydrological as well as geomorphological processes associated with the Bayawan River dynamics. Proper risk management and control tasks should be crafted and implemented to avoid and/or reduce the any adverse impact that this dredging operation may cause to the immediate environment. The proponent will exert every effort to implement the dredging project using the most cutting edge and appropriate technology so project implementation can adhere to and follows strictly the design limits. Mechanisms should be in place that would allow coordination among all personnel involved in the dredging activities.

Monitoring Plan

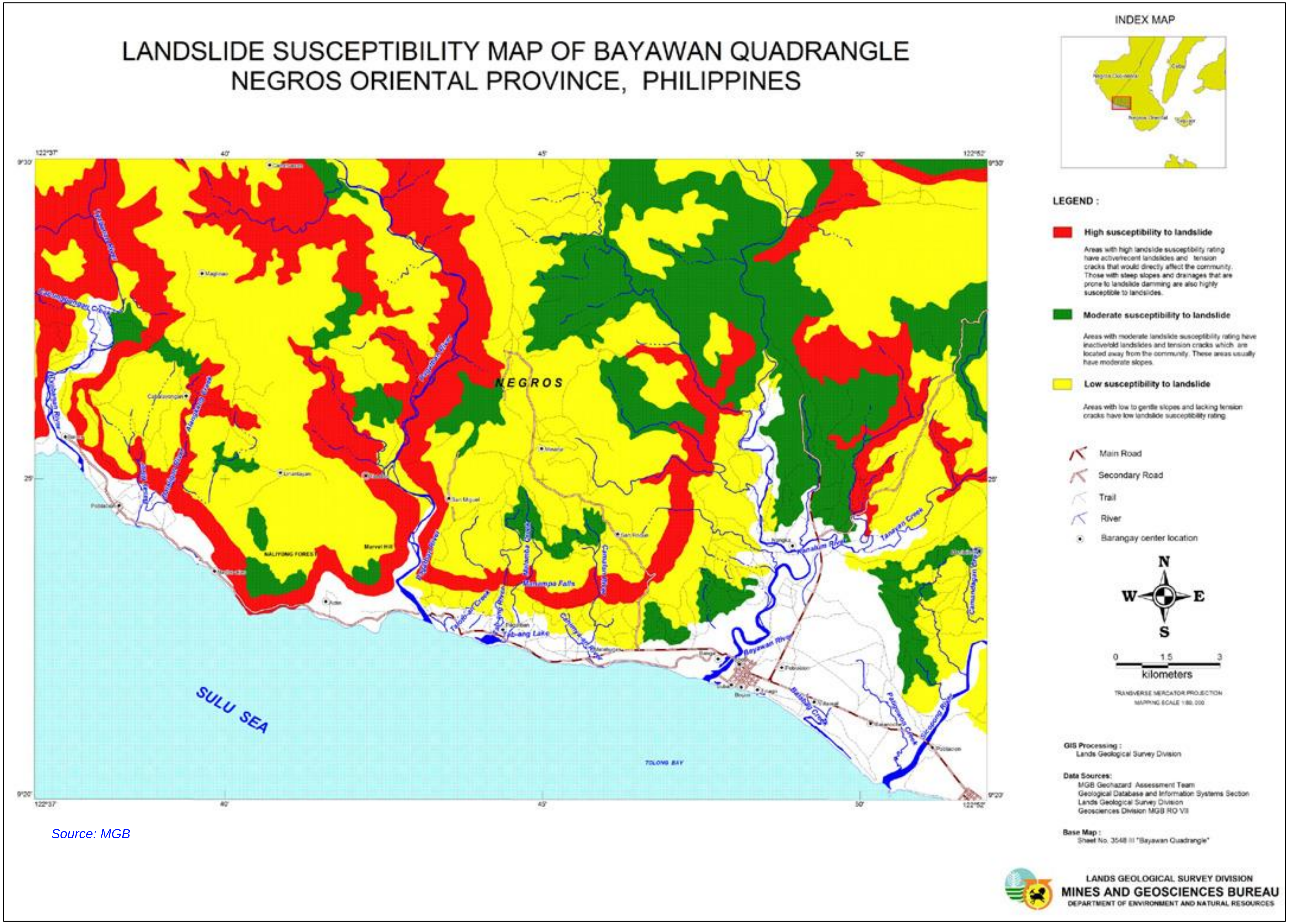
A monitoring mechanism will be developed by the proponent that enables acquisition and storage of related data of the project and be made accessible by appropriate stakeholders for future reference. Periodic, monthly to quarterly accomplishment and status reports during the dredging operations will be done. All dredging activities will be reviewed to conform with the Project Design.

2.1.1.8 Inducement of subsidence, liquefaction, landslides, and mud/debris flow

Baseline Conditions

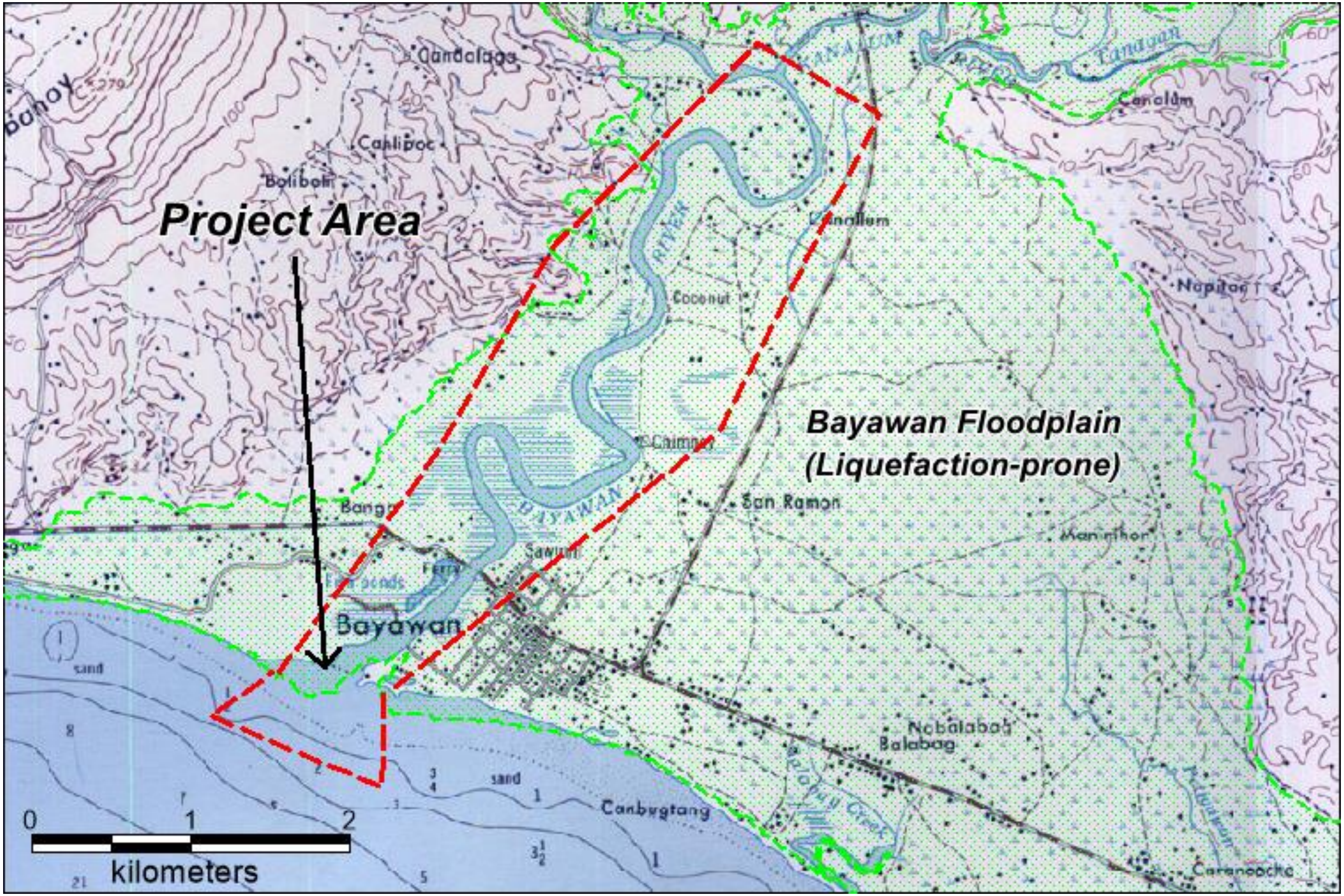
The hydrological and climatic condition of the whole Bayawan River watershed is very dynamic. The Bayawan River upper catchment areas and headwaters have active headward erosion. Midstream, the river is deeply incised and is actively eroding laterally. Bayawan River at its downstream portion flows into a relatively large 25 km^2 compound floodplain with surface elevations developed from 7 meters asl (above sea level) to 2 meters asl. The Bayawan floodplain is an aggrading floodplain, where sediment run-off is relatively high.

The dredging Project Site, being in a relative flat floodplain terrain, is not prone to landslides (See Figure 2-23). The upstream portion, beyond the floodplain, has dominantly moderate susceptibility, with some steep limestone escarpments having high susceptibility to rock fall and rock slides. Previous mud/debris flows and subsidence has not been documented in the floodplain locality. The thick, unconsolidated alluvial deposits which make up the whole Bayawan floodplain, (Figure 2-24) however, is liquefaction-prone. PHIVOLCS has just completed liquefaction susceptibility studies at the Bayawan floodplain in July 2017, but detailed reports results are still pending.



Source: MGB

Figure 2-23 Landslide Susceptibility Map of Project Site



Source: NAMRIA

Figure 2-24 Liquefaction Susceptibility Map of Project Site

Earthquake Hazard

Based on data from PHILVOLCS, there are 5 active fault lines in Negros Island. The largest fault in the entire island is the Central Negros Fault which crosses Vallehermoso, Guihulngan City in Negros Oriental up to Isabela, Binalbagan and Himamaylan City in Negros Occidental. The other Central Negros Fault is relatively smaller and found in Mabinay up to Kankalan City. 3 smaller faults are found in Negros Oriental alone. The Southernmost fault covers Valencia, Bacong, Dauin, Zamboanguita and Siaton, while another fault crosses Siaton up to Santa Catalina. The other Southern Negros Fault is the one that affects Bayawan City directly. This fault traverses Bais City, Tanjay City and parts of Barangays Cansumalig, Narra and Malilihon in Bayawan City. Please refer to Figure 2-25 for the distribution of active faults in Region 7.

Liquefaction Hazard

The coastal plains of the city, being historically swamplands are most prone to liquefaction in the event that there are strong earth movements or earthquake. Earthquakes affecting the city might be more of tectonic origins rather than volcanic since it is quite far from Canlaon Volcano, the only active volcano in Negros Island or from Mount Talinis, another volcano but dormant. Proximate tectonic earthquake generators are the Negros Trench at the Sulu Sea and the Southern Negros Fault. It is estimated that a total of 3,609 hectares of the city is liquefaction-prone, with 69% of it classified high-hazard. Thirteen barangays can be affected, consisting of the seven urban barangays, Malabugas, Pagatban, and portions of San Miguel, Nangka, Maninihon and Minaba (See Figure 2-26).

Table 2.6 Liquefaction-prone areas in Bayawan City, Negros Oriental

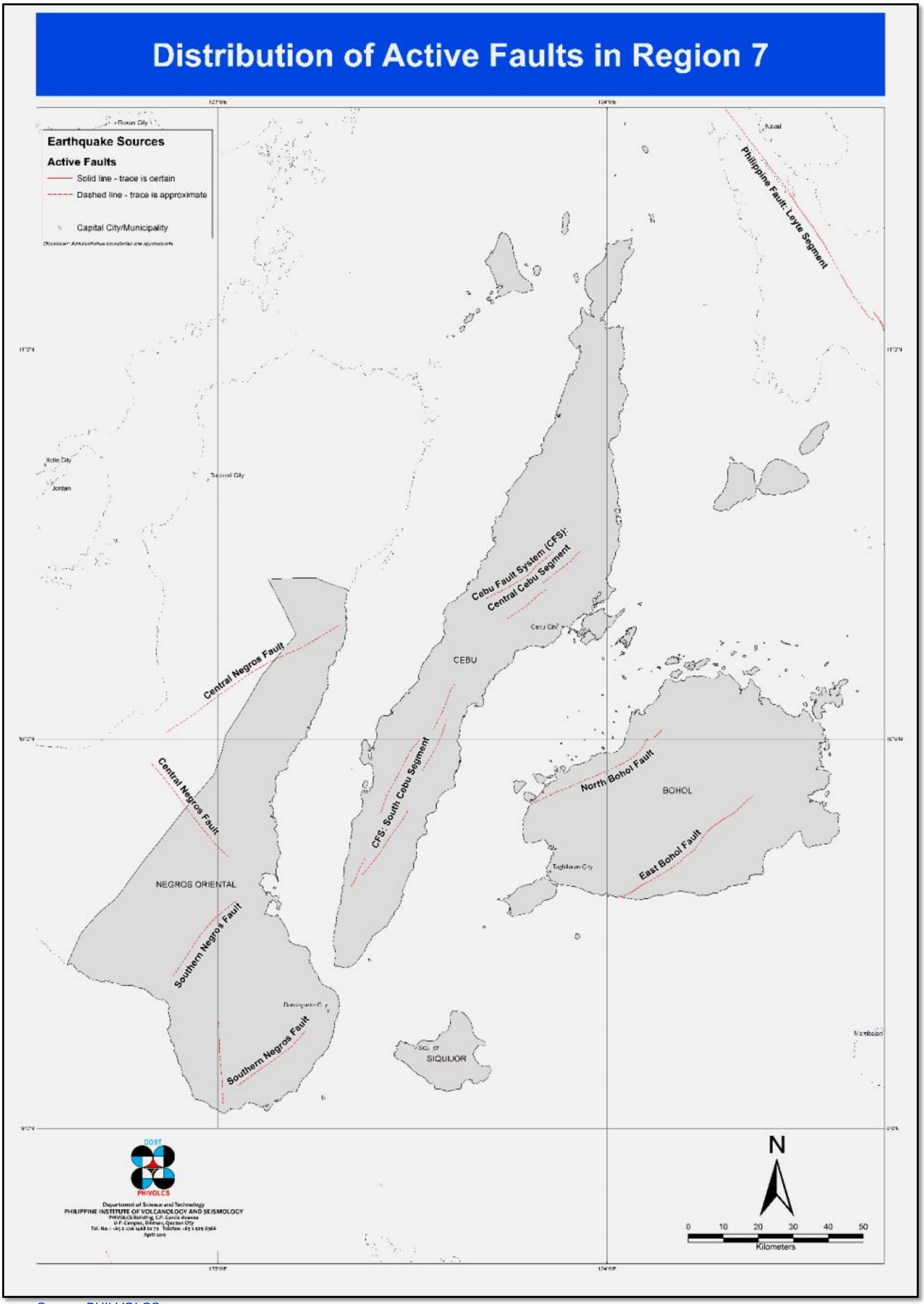
BARANGAY	**Low**	**Moderate**	**High**	**Grand Total (Hectares)**
Banga		43	354	397
Boyco			12	12
Malabugas		52	251	303
Maninihon	71	271	529	871
Minaba		7		7
Nangka	272	236	331	839
Pagatban	15	44	184	243
Poblacion			209	209
San Miguel		123		123
Suba			45	45
Tinago			31	31
Ubos			59	59
Villareal			470	470
Grand Total	358	776	2,474	3,609

Source: PHILVOLCS REDAS 1.2

Tsunami Hazard

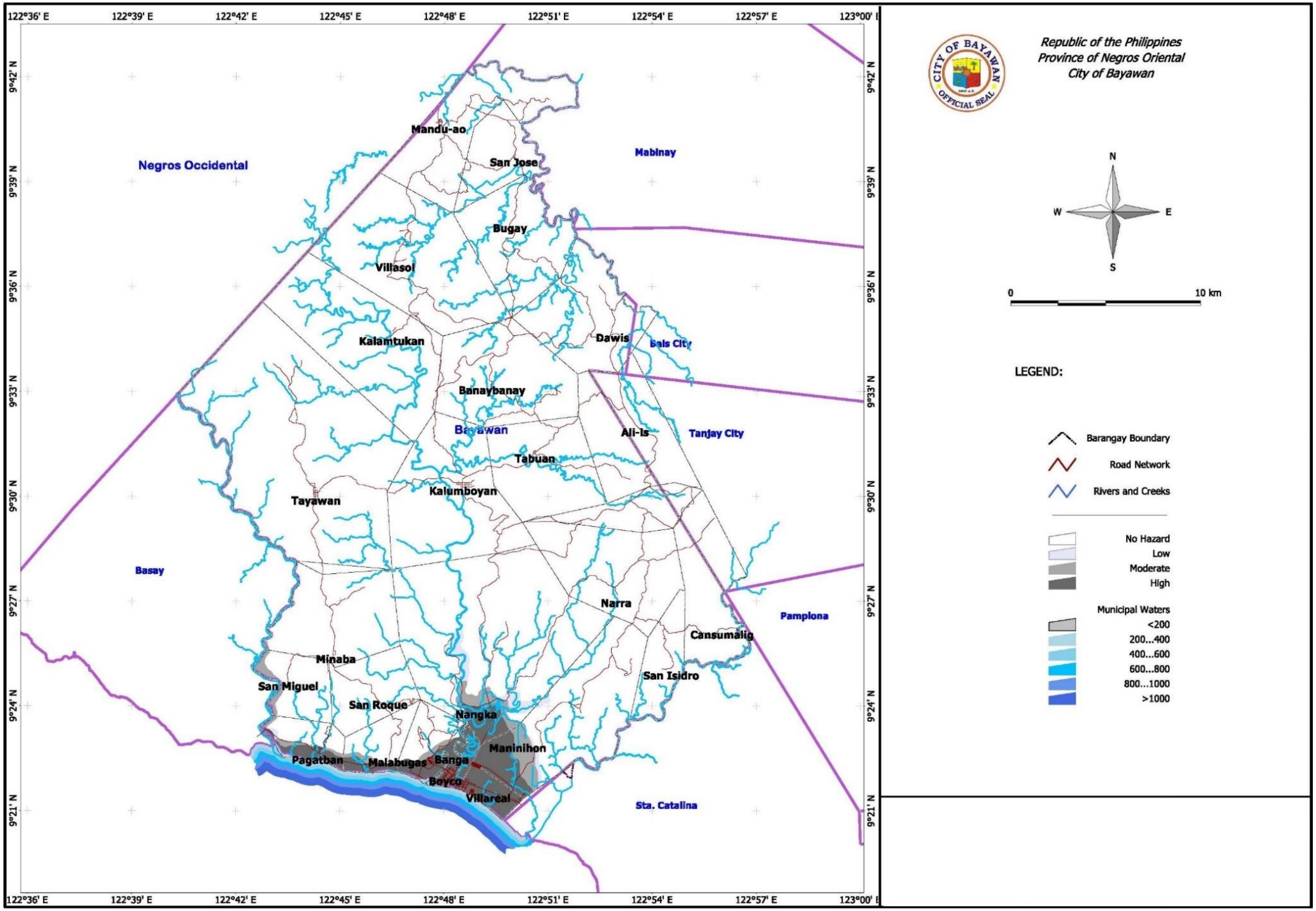
Being a coastal city, it has a local tsunami hazard along its fifteen (15) kilometres coastline. The potential earthquake generator that can cause a tsunami is the Negros Trench. Based on Philvolcs historical data and REDAS software it is estimated that a major earthquake with tsunami can inundate 3,110 hectares of the city which includes all the coastal and urban barangays and portions of Barangay Nangka and Maninihon (See Figure 2-27).

It is estimated that 6,000 households and about 4billion pesos worth of public and private infrastructure can be affected by tsunami hazard; with about 30,000 residents can be vulnerable.



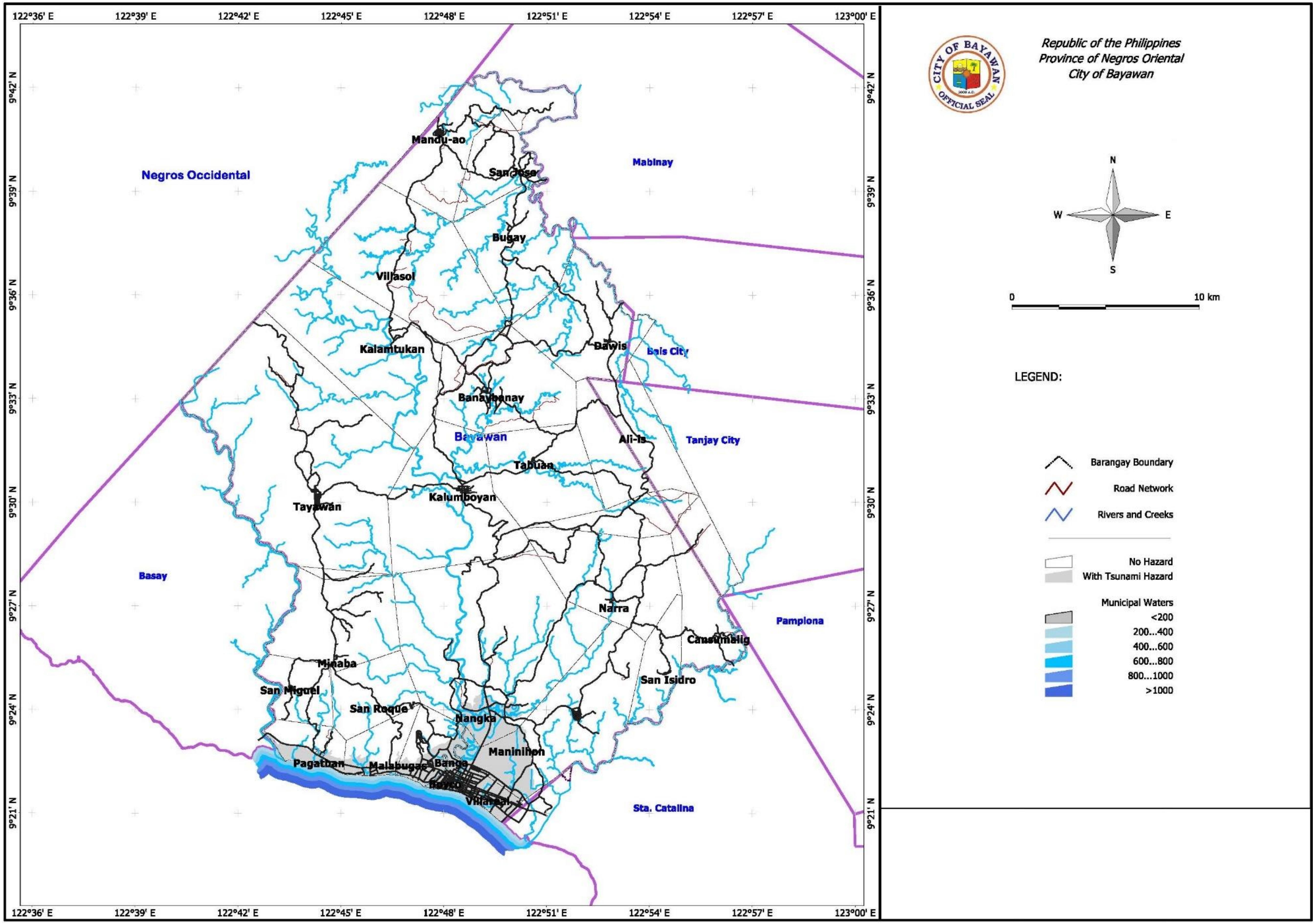
Source: PHILVOLCS

Figure 2-25 Map of Active Faults in Region 7



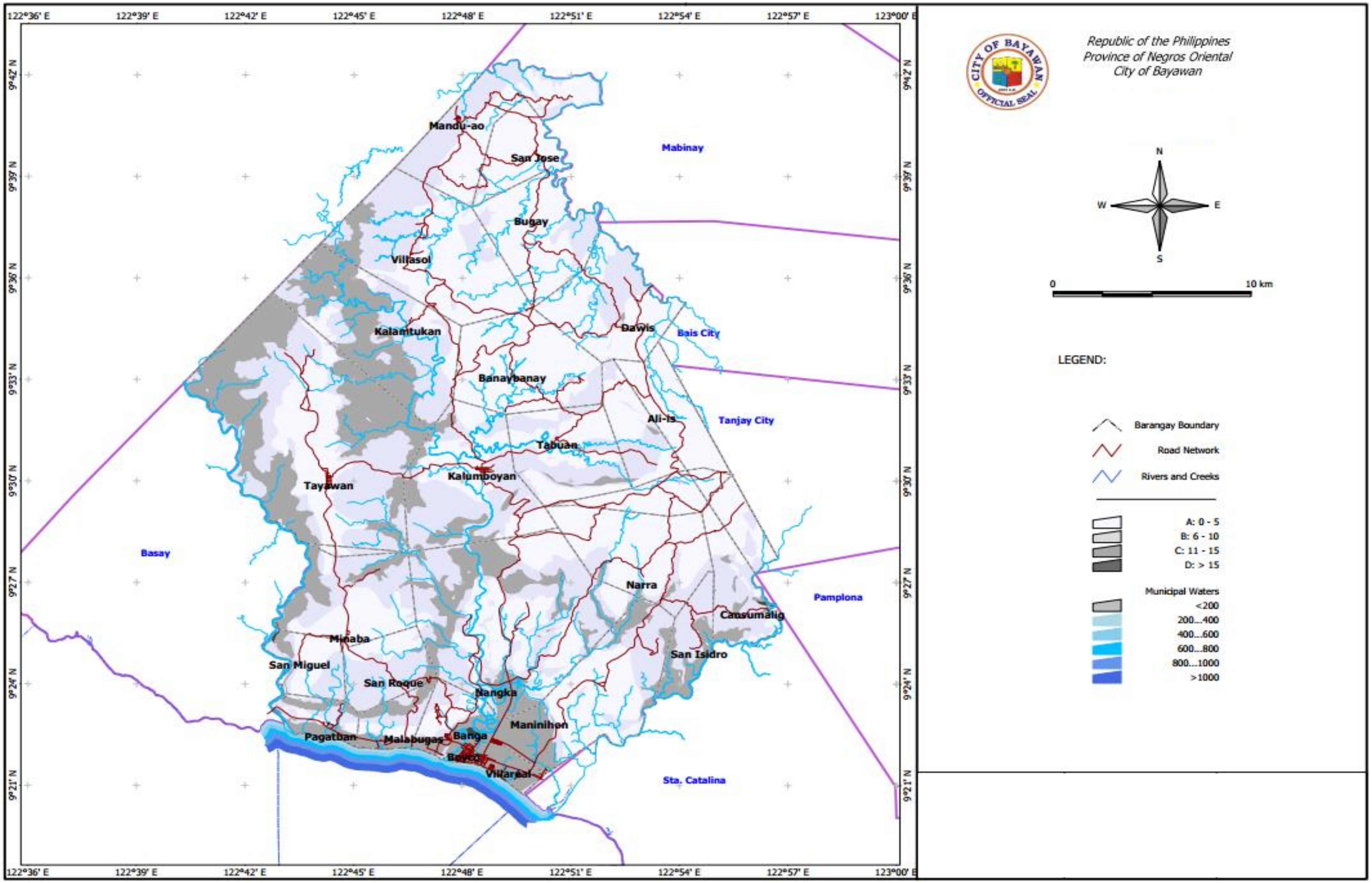
Source: CLUP

Figure 2-26 Liquefaction Hazard Map (CLUP)



Source: CLUP

Figure 2-27 Tsunami Hazard Map (CLUP)



Source: CLUP

Figure 2-28 All Hazard Map (CLUP)

The severity of each hazard type was assigned with a score scale of 0 to 5; which indicates a zero-score value for no hazard progressively up to a score of five for very severe or very high hazard. The hazards that are considered in the analysis are: soil erosion, erosion susceptibility, landslide, flooding, and liquefaction and tsunami hazards. Then, during the sieve mapping of all the hazards maps, the scores are summed up to come with a unified hazard map with corresponding score ranges. A stratified range values were later on devised to indicate the amount or severity of hazards; hence values 0 to 5 indicates low hazard areas (most ideal for settlements and population centers), 5-10 for moderate, 10-15 for high and 15 and above for very high-risk areas. Figure 2-28 above illustrates the integrated and simplified map by overlaying all hazards in the city.

It can be noted that most of the barangay proper or centers which serves as settlement areas in the hinterland barangays have low to moderate hazard risks. However, it is observed that all urban and coastal barangays, including Barangay Nangka have moderate to high hazard risks. This can be attributed to the earthquake-induced hazards such as liquefaction and tsunami which although has very low frequency of occurrence poses tremendous threat and risks to the settlement areas; it can be noted that the coastal and urban barangays are mostly impacted by these hazards. Flooding and erosion which occurs more frequently especially during the annual onset of rainy season, adds further to the threat. Moreover, it is deemed that the effects of global warming and climate change further increased the risks and vulnerability of coastal settlements as in this case.

Impact Analysis

The dredging operation poses no impact to trigger subsidence, liquefaction, landslides, and mud/debris flow. Localized subsidence of already unstable riverbanks may occur in some places, but this will only be temporary and minimal in terms of volume and area.

The highly eroded upstream reaches of Bayawan River provide sediments into the riverine system, which exacerbates siltation in the floodplain area. There are no actual measurements made on the sediment yield of the Bayawan River watershed. A rough estimate
e of 200,000 tons or the equivalent of roughly 133,000 cubic meters per year is the estimated sediment yield for the Bayawan River catchment. Likewise, no rough estimates based on actual measurements were made for sediment runoff during flood events.

Bank heights of the meandering river in the floodplain are generally low, measuring from 3 meters to just less than a meter during high tidal levels. This is due to the natural low relief (e.g. low elevation) of the floodplain itself and compounded by highly silted river beds. Near the coast and up to 1.3 km inland, an area where estuarine swamps are developed, the highest tides generally overflow the riverbank.

In the event of intense ground-shaking due to a large-magnitude earthquake and resulting liquefaction at the Project Site, should it occur, will cause the unstable eroded banks to collapse. This event will probably induce landslides in the upstream portion, and will add to the sediment yield of the riverine system. These are expected to be localized with minimal effects, but will contribute sediments to the river and exacerbate siltation.

Management Plan

The proponent will develop protocols in preparation for any of these hazards to occur during project implementation. These protocols should incorporate safety of people as the main core value.

The proponent will also support any risk reduction and risk management initiatives and programs of Bayawan City. Precisely, the main objective of the project is to address the risk posed by frequent flooding in the area. It will take effort in procuring safety devices and implements that safeguard personnel at the workplace and enable immediate response to emergency cases.

Monitoring Plan

A very strong earthquake (e.g. > M7) event will possibly cause liquefaction and intense ground shaking in the floodplain area. There is no way to predict it, but preparedness is the key component, which shall include awareness and educational campaign to the project team and communities in which they work.

The project management team will work closely with the Bayawan DRRM (Disaster Risk Reduction Management) office, which monitors hydrometeorological and weather condition, earthquakes, and issues warning of impending floods through its Local Flood Early Warning System. It also conducts IEC (Information Education and Communication) activities, including search and rescue operations during times of emergencies and disasters.

Pedology

2.1.1.9 Soil erosion/ loss of topsoil/ overburden

Baseline Conditions

Summary of Geotechnical Investigation

A Geotechnical Investigation was conducted on March 5, 2017 at 4 different locations of the Bayawan river to determine its Geotechnical Profile. A boring test was employed in this investigation where sediment samples we taken as deep as 15 meters from the surface of the water. The first borehole/site was located upstream, working its way down to the mouth of the river where the fourth and final sample was taken. Table 2-6 below contains the geographic coordinates of the four sampling sites used in the Geotechnical Investigation and Figure 2-29 is the Sampling Site Map.

Table 2-6 Geotechnical Investigation Sampling Site Coordinates

SAMPLING SITE	COORDINATES	
	LONGITUDE	LATITUDE
Site 1	122°48’23.90” E	9°22’40.69” N
Site 2	122°48’07.05” E	9°22’36.12” N
Site 3	122°48’05.75” E	9°22’08.31” N
Site 4	122°47’44.85” E	9°21’48.03” N

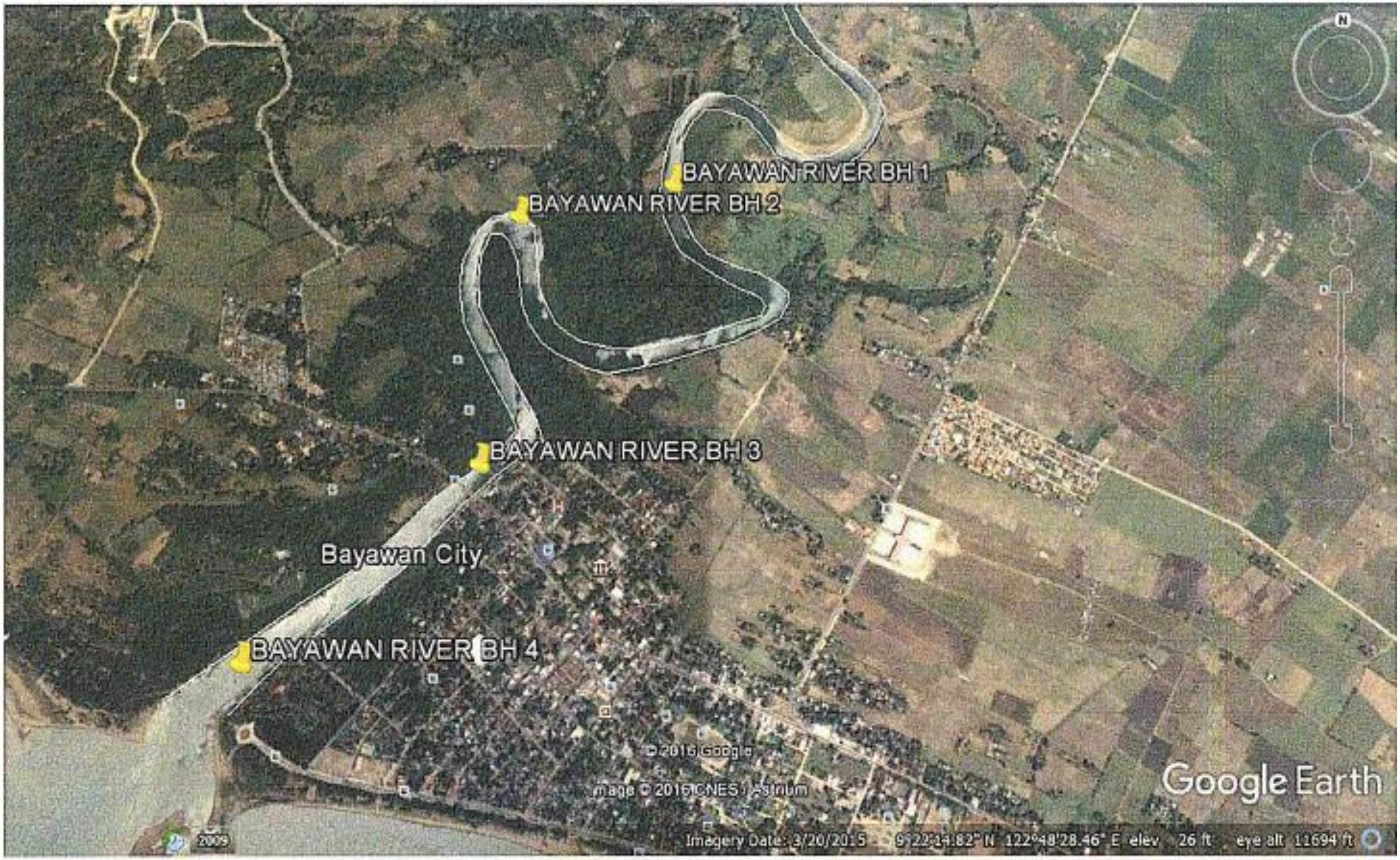


Figure 2-29 Geotechnical Investigation Sampling Site Map

Soil was classified by USCS method and Figure 2-30 below shows the results of this investigation. It shows that the topsoil is composed of 5 to 6 meters of Brown Silty Sand, except for sampling site 4, which is located at the mouth of the river, which has a topsoil cover of Gray clayey silt. Nest layer of sediments for boreholes 2, 3 and 4 were composed of Gray Silty Clay while Dark Silty Clay was found in borehole 1 upstream. Light brown sediment is also found in the bottom of the mouth of the river starting at 14.3 meters deep.

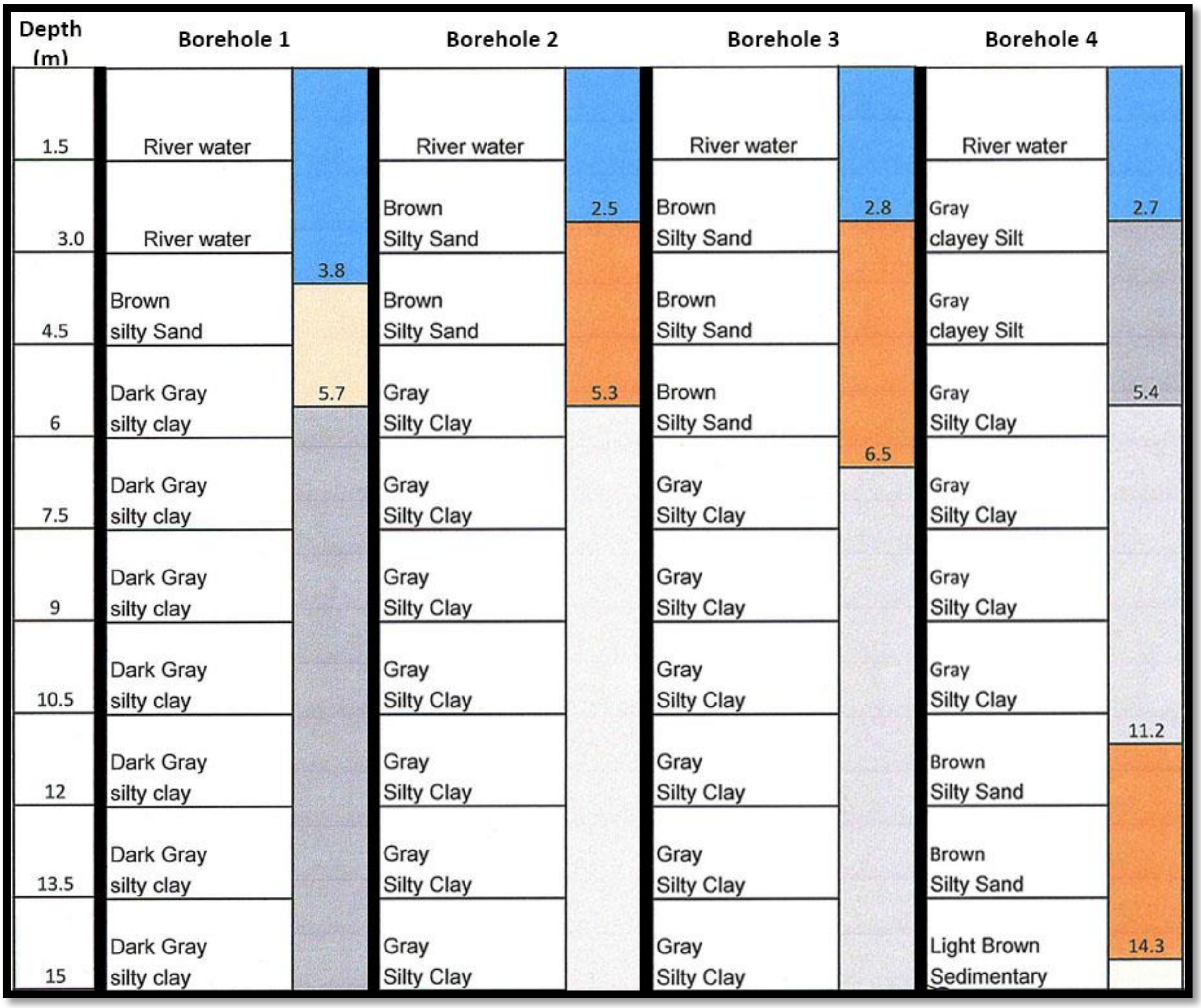
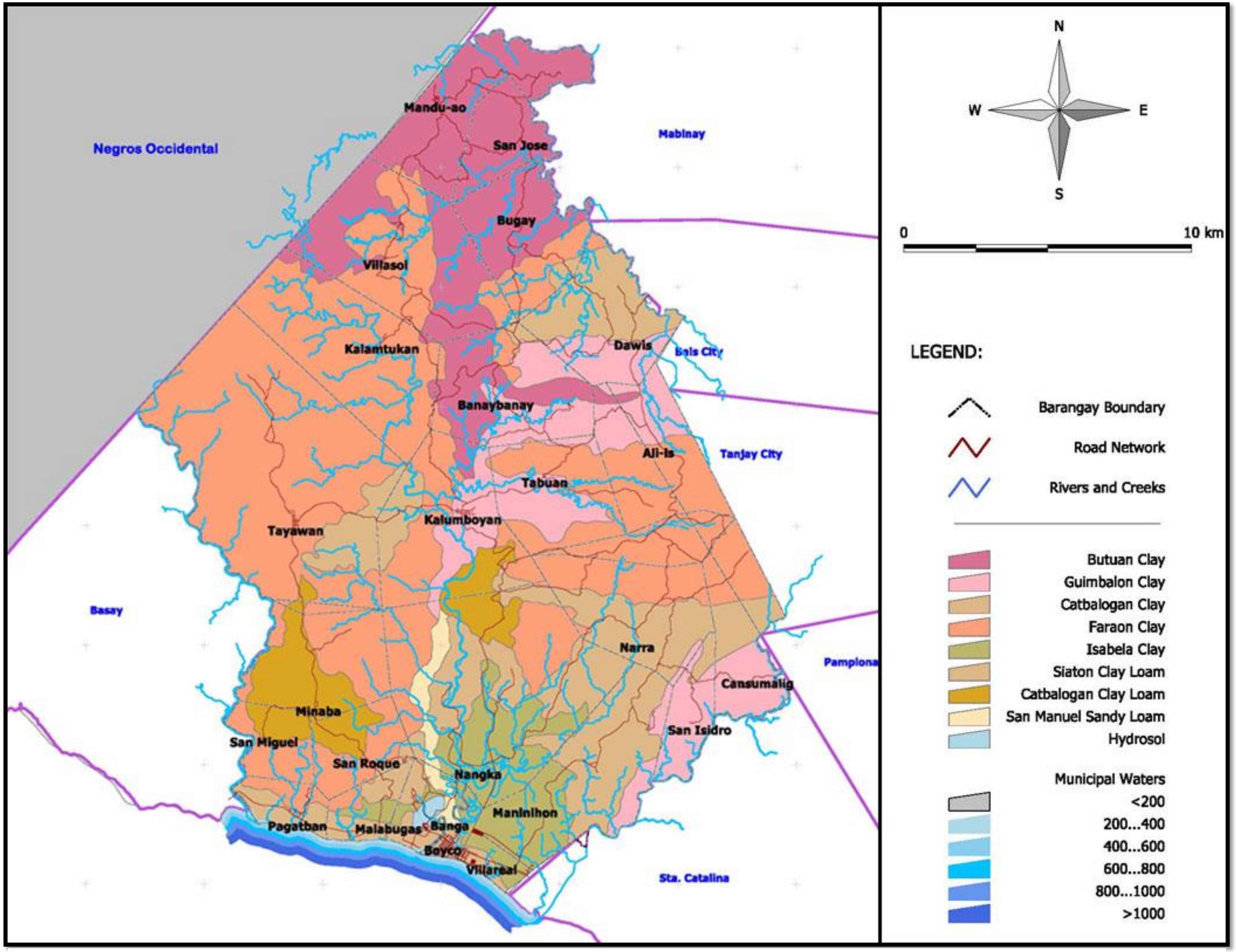


Figure 2-30 Geotechnical Profile of Bayawan River

Soil Types

The soil types of Bayawan in the project area comprises alluvial soil profiles which are generally classified as fine sandy loam, while the upstream soil constitutes dominantly clayey types. Faraon Clay is the prevalent type of soil in the area. This black soil type is derived from the decomposition of coralline limestone. Its landscape has a rolling to undulating topography with slopes not exceeding 30%. Its slightly acid and alkaline reaction makes it a good soil for sugarcane, corn and legumes. Coconut however, is the principal crop grower in this soil type for it helps protect the soil from erosion. Since rice prefers a slightly acidic soil with PH of from 5.5 to PH 60, it does not grow well on this type of soil. Fortunately, most of the irrigated ricelands are located in the coastal areas where the dominant soils are Isabela Clay and Siaton Clay Loam. (See Figure 2-31).



Source:CLUP

Figure 2-31 Soil map of Bayawan City (CLUP)

Erodibility Potential

Soil erosion studies have been previously conducted covering the whole Bayawan area. (Philippine Environmental Governance Project 2011), which generated an erosion susceptibility map (See Figure 2-32). Largely due to anthropogenic influences, large areas of denuded forests and agricultural lands within the Bayawan watershed were identified as the most highly prone to erosion.

During extreme rainfall events, riparian zones along the Bayawan River banks dissipate stream and floodwater energy. The meandering curves of the river, combined with vegetation and root systems, slow the flow of water, which reduces soil erosion and flood damage. Sediment is trapped, reducing suspended solids to create less turbid water, replenish soils, and build stream banks. Pollutants are filtered from surface runoff, enhancing water quality via biofiltration.

The floodplain comprises thick layered sequences of unconsolidated sand, silt, mud and gravel materials deposited by successive stages of laterally shifting fluvial (river) processes from the Bayawan River and its tributary Canalum River. Depending on tidal seawater heights, most river bank heights are generally low (< 1 meter), forming small swampy areas along its length and at its coastal mouth. Slope conditions in the project site is relatively subdued and flat. The Bayawan floodplain is an aggrading, mainly depositional floodplain, and therefore it is subject to repeated floods, rapid sedimentation, and river avulsion during extreme flood events.

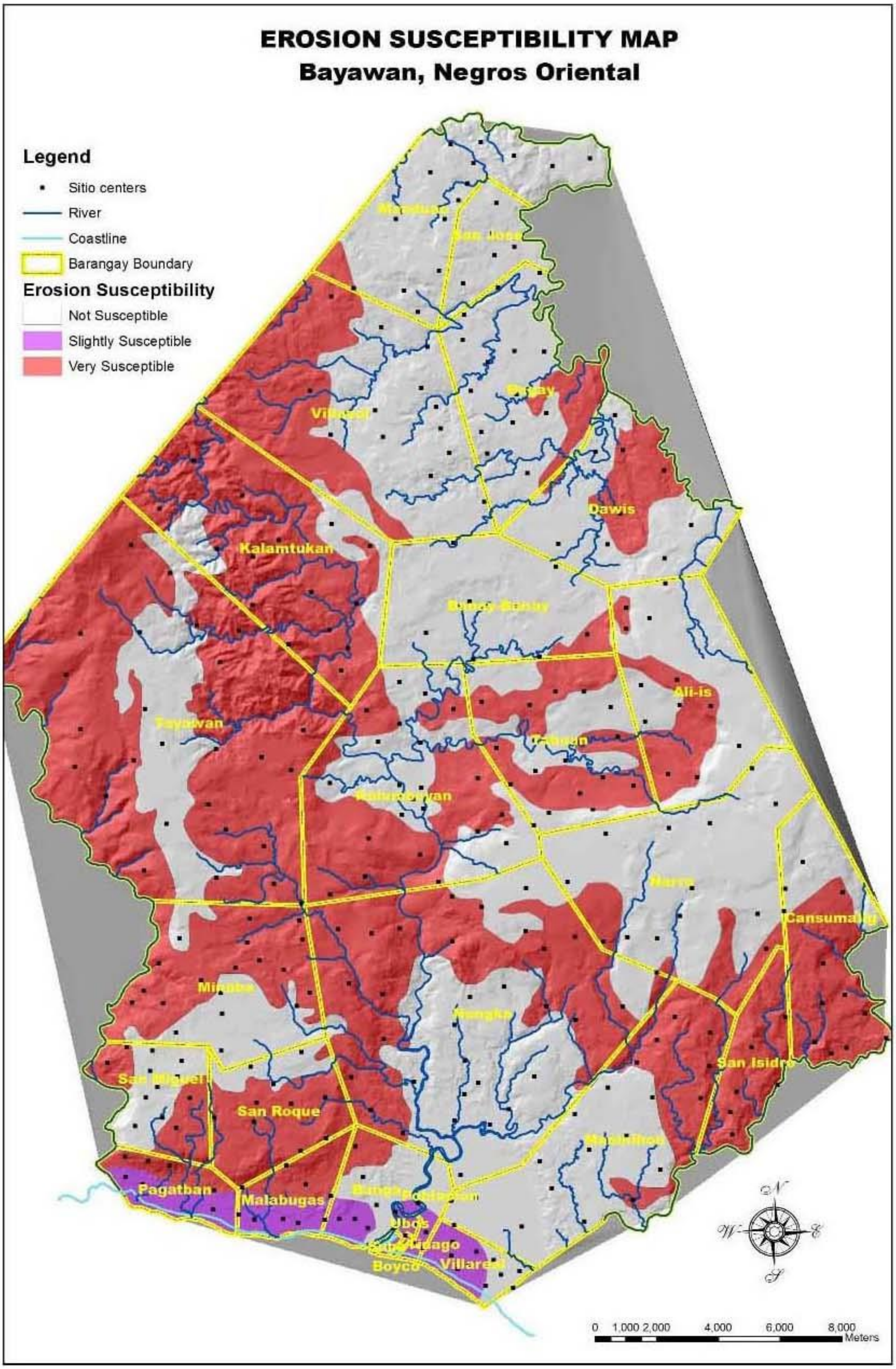
Erosion studies have been previously conducted covering the whole Bayawan area. (Philippine Environmental Governance Project 2011), which generated an erosion susceptibility map shown in Figure 2-32. Large areas of denuded forests and agricultural lands within the Bayawan watershed were identified as the most highly prone to erosion.

Riverbank Stability and Soil Erosion

In terms of soil erosion, severe erosion is observed in Barangays, Villasol, Kalamtukan and Tayawan, mostly in areas classified as forestland. There is also severe soil erosion along the Pagatban River which runs from south to north traversing the western portions of San Miguel, Minaba and Tayawan. High sloping areas between Kalumboyan and Nangka, Tabuan and Narra and Ali-is are severely eroded. Similarly, those along the Sicopong River particularly in Barangays San Isidro and Cansumalig have severe soil erosion also. Severely eroded areas account only for 13% of the total land area, while moderately eroded is only 8%. Most of the city has slight to moderate soil erosion. (refer to Figure 2-33)

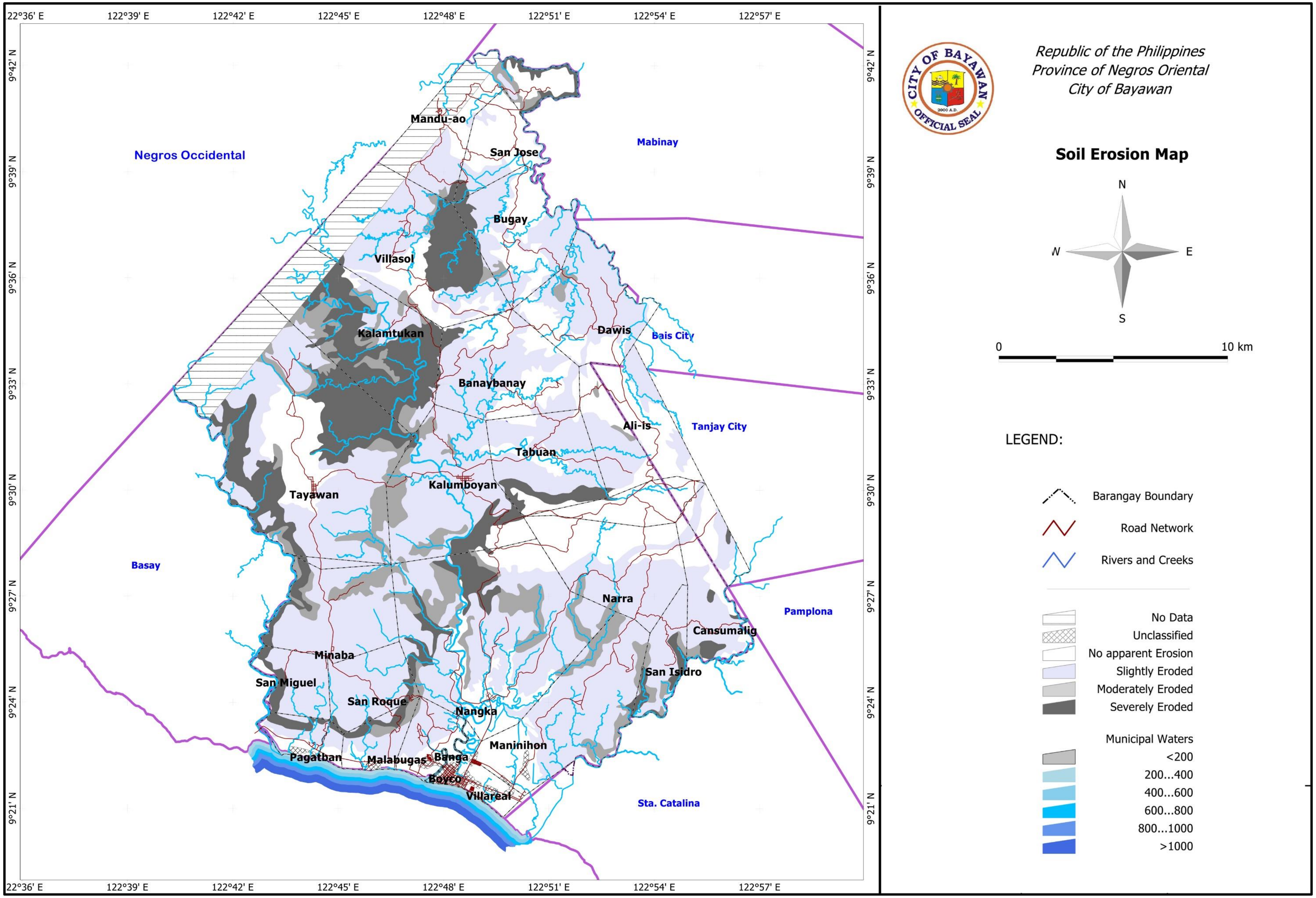
River Sediment Sources

Sediments being dumped on to the lower segments of Bayawan River in the floodplain area come from the river's watershed area of 430 km^2, comprising at least twenty (20) sub-basins. Our field inspection and detailed geomorphic mapping of the upstream and floodplain areas along and adjacent to Bayawan River showed that the vegetation cover is highly modified agricultural lands, swamps, and open areas. There are no existing forest lands or lush vegetal cover, rending these areas to erosion during times of heavy rainfall. About ninety percent (90 %) of the vegetal cover confined along the riverbanks are perennially threatened by recurrent riverbank erosion and collapse.



Source: EcoGov, 2012

Figure 2-32 Erosion Susceptibility Map



Source: CLUP

Figure 2-33 Soil Erosion Map of Bayawan City

Sediments Transfer Analysis

Using HEC-RAS

Particle dispersion modelling using software like HEC-RAS (Hydrologic Engineering Centre-River Analysis System) are simulations of hydrological scenarios, and which represents mathematical representations of stream/river events. There are a number of variables or parameters to be considered. It is a standard program for analyzing river hydraulics, including water depth, velocity, effects of hydraulic structures, and inundation (flood) boundaries. Simply, it is used to model water flowing through rivers, helps engineers analyze where water and sediments will go during a flood.

HEC-RAS is a computer program that models the hydraulics of water flow through natural rivers and other channels. Variables are accounted for only in the direction of flow. It is not appropriate for complex pipe network systems, and the steady flow analysis is applicable only for ground slope of less than 1:10 (low-lying or almost flat, like a floodplain area) and not for steeper slopes.

Data Requirement and Sampling

1. Cross sections of channel
2. Suspended sediment sampling (grain-size analysis)
3. Sampling of bedload (grain-size analysis)

Facts about sediment transport in rivers

- Estimation of transport of sediments of a particular river system is sometimes difficult. This is due to changing complex parameters that govern its hydraulic and hydrogeological conditions.
- A sediment model requires several information - a geometry data, a quasi-unsteady flow data, a sediment data, and a sediment analysis plan. The modeling of sediment transport is difficult noticeably.
- Grain-size is an important control in sediment transport, including the shape and size of the channel, the water velocity, its volume and ‘concentration’ of solids in the flowing water
- A large amount of sediment is transported during flood flows. The total volume of both suspended and bed material load increases with increasing volume of stream flow.
- River sedimentation, however, is not due solely to big flood events.
- High sediment yields, due primarily to elevated erosion of the upper watershed, may occur during any increased precipitation input in the river system. High turbidity conditions (total suspended solids) during rains of many environmentally ‘critical’ rivers attest to this.

Bayawan River Simulation

The ultimate aim of the HEC-RAS simulation, therefore, is to know the rate of sediment transport and calculating the ‘movable boundaries’ of Bayawan River (Figure 2-34) in the floodplain area.

The attached simulation revealed that for a 100-Year Design Discharge (Q_{100}), the flood flow rate into the last 8-km stretch of Bayawan River amounts to 3,466.52 m^3/sec, calculated at mean sea level of zero (0).

The flow hydrograph (Figure 2-35) generated by the simulation shows an abrupt flood onset or ‘peak flood’, and the above quantity was the peak of the flood flow over a period of 12 hours, and decreased gradually over the next 48 hours.

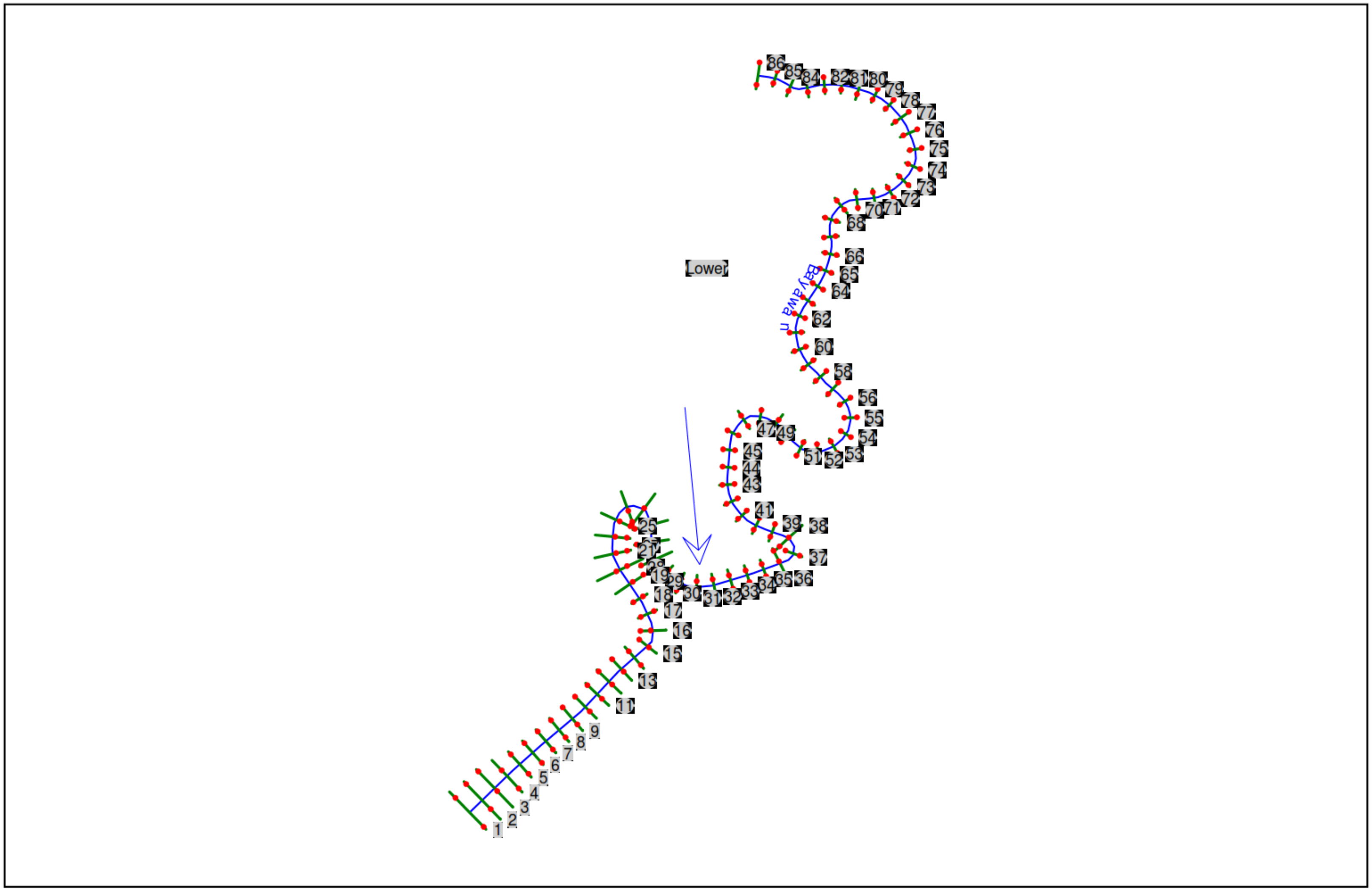


Figure 2-34 Bayawan River and location of cross sections. Flow directions are from top to bottom of the map coverage

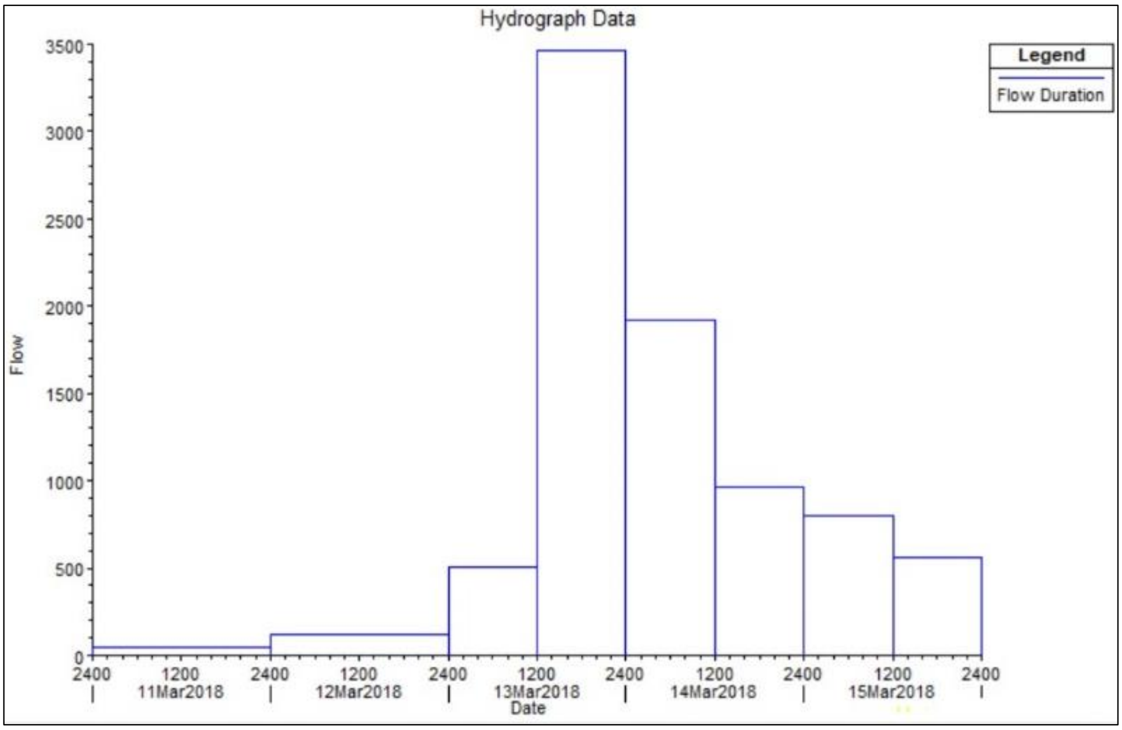


Figure 2-35 Quasi-steady histogram showing lateral flow series data at internal boundary

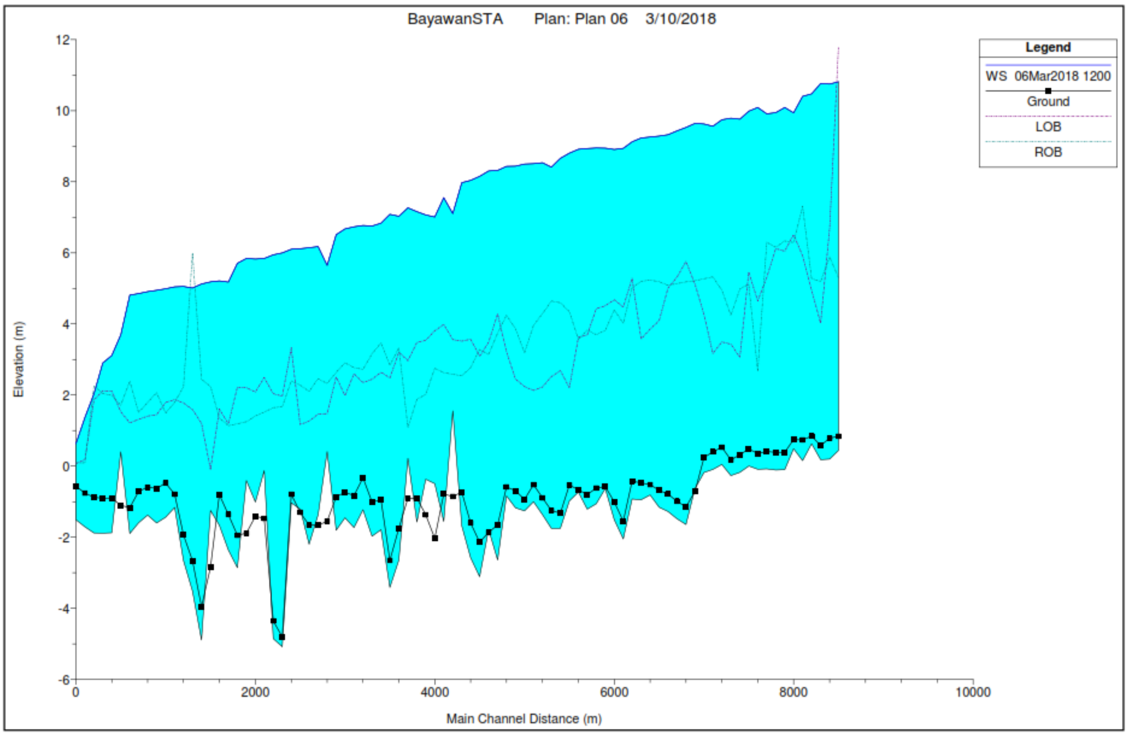


Figure 2-36 Chart showing simulated flood level (WS or water surface) with respect to the riverbank (LOB, ROB) elevations of Bayawan River.

Riverbed material

In 2015, sediment grain-size analysis was conducted on surface samples along different parts of the river (e.g. in-channel, bar, overbank) over a length of 8 km, including the river mouth and adjacent beach areas. In the absence of a drilling equipment, selected stratigraphic sectioning of riverbanks were conducted, which involved detailed documentation of the layering characteristics, sizes and textures of basically paleosol (buried soil horizons) and alluvial materials making up the banks and riverbed materials.

It appears that cyclic floods in the past have formed the unconsolidated sediment succession seen on riverbank outcrops. A typical section at elevation 13 meters asl, located in the river section just above the floodplain along Bayawan River is presented in Figure 4. Coarse beds comprising rounded polylithic clasts and well-sorted coarse to silty sand represents in-channel gravel and sand bars, respectively. Coarser particles result from deposition of bed load materials. Fine-grained mud represents overbank flood deposits, formed from settling of suspended loads during the waning phases of flood events.

Most overbank sediments from the flood of 6 Oct 2013 in Bayawan consist of coarse-fine sand and mud. New gravel bars, however, were formed in some places (e.g. abandoned river channels) where floodwater maximum heights reached at least 2.5 meters.

Sediment-grain size analysis was done on about 80 randomly collected sand and silt samples from the river, shoal (sand bars) and the beach area. Generally, riverbed materials consist of 5% Gravels, 90% Sand and 10% Mud (Silt and Clay). A total of 30 samples containing detrital magnetite were analyzed using magnetic separation methods (Figure 2-38).

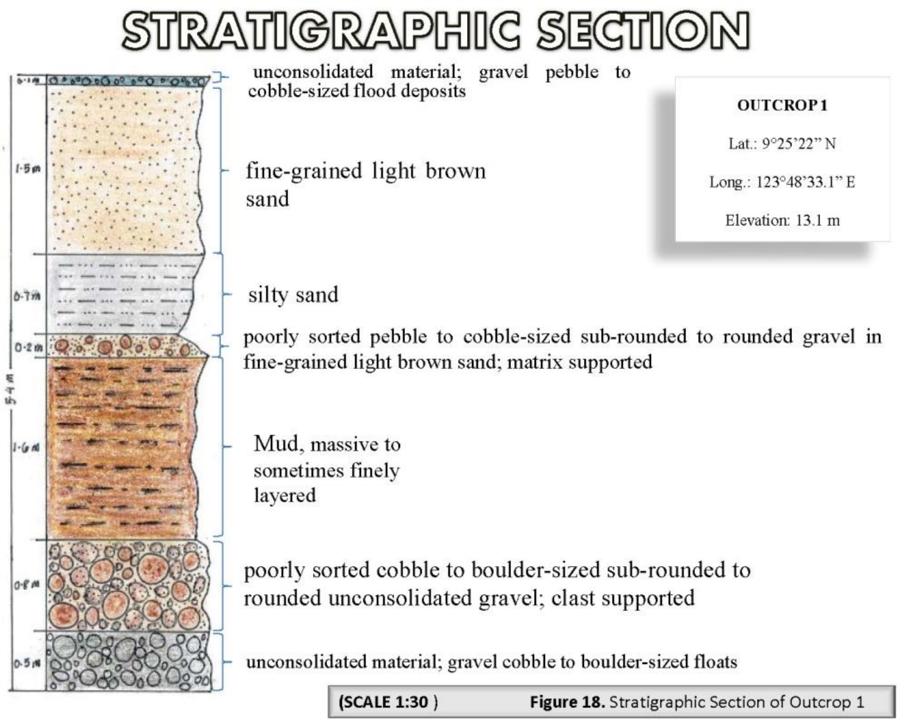


Figure 2-37 Typical sediment succession at the Bayawan River

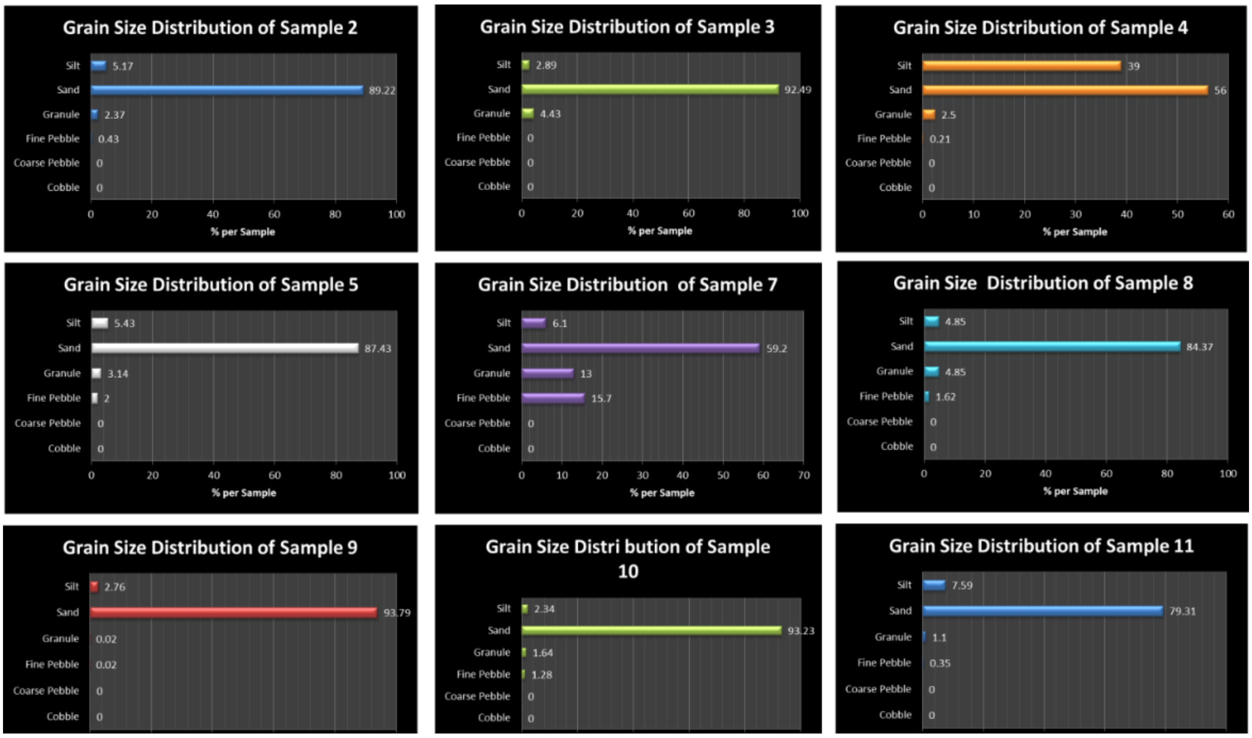


Figure 2-38 Representative Graphs of Sediment Grainsize Analysis

Total Suspended Solids

There is no in-depth study of water quality in Bayawan River. A single dataset on Total Suspended Solids (TSS) surveys conducted monthly in 2013-2014 by the Biology Department of Silliman University was provided by Mr. Ion Joseph T. Bollos of CENRO-Bayawan. This is shown in Table 2-7 below.

Table 2-7 August 2013 to June 2014 Total Suspended Solids Analysis of Bayawan River(units in mg/L or parts per million)

Method of Analysis : Vacuum filtration using GFC filter											
Sites	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14
1	134	61	70	70	116	129	99	78	110	63	95
1	306	74	83	80	103	124	94	73	119	73	94
2	182	120	81	78	97	121	137	62	121	54	140
2	150	114	74	73	99	137	126	79	94	49	149
3		87	96	96	97	133	120	74	102	51	81
3		101	107	107	102	132	118	79	109	54	137
Ave	193	93	85	84	102	129	116	74	109	57	116
Std Dev	78	23	14	14	7	6	16	6	10	9	29
Note : Maximum permissible limit for TSS under Class D water is not more than 60 mg/L increase based DAO-34 series 1990											

The above data represents river turbidity conditions during 'normal' river flow, or non-flood periods. During floods, TSS obviously increases to several tens to hundred folds.

Sediment Transport Studies

There is still limited baseline data on actual real-time measurements of suspended sediments during floods along Bayawan River. Estimates or measurements of total planimetric area inundated or total volume delivered during the October 2013 flood event at Bayawan would probably give an alternative useful data for the sediment influx study of Bayawan River. This is based on the premise that high suspended sediment concentrations in rivers occur during high flood events. The 'fluid density' for a turbid 'dirty water concentration' is 16 - 530 g/l, or 16 - 530 kg/m^3 (Costa 1988). Fluid density, and therefore the transport capacity, increases markedly with increasing sediment concentrations.

The sediment concentration for the October 2013 flood event was not directly estimated. Floods sediment deposits of sand, mud, and clay, however, were randomly measured at selected sites in the floodplain after the event, which averaged 10 cm or 0.10 m. This average thickness was spread over 20 km^2 of flooded area in the Bayawan floodplain. The estimated volume of flood deposits, therefore, would be around 2 million m^3. This amount does not include those post-flood sediments which were deposited in the main river channel and those which were washed away to the Sulu Sea. A rough estimate would be about 50% of the total sediments transported, which would be around 2 million m^3.

During a moderate flood on July 15, 2015, some sediment sampling density measurements were done in 2016, and results revealed sediment concentrations in the range between 2.5% to 8% (2.5 to 8 kg/m^3) sediment by volume. The flood peak occurred over a 5-hour period on that day, and total rainfall was estimated at 2-year return period. The peak flow period in Bayawan River had a volume calculated at 550 m^3/sec. The estimated volume of sediments transported, with an average fluid density of 5%, is therefore around 28 m^3/sec. Over a 6-hour flood peak period, the total transported sediments would be around 600,000 m^3.

Based on the attached calculated flow rate of 3,466.52 m^3/sec, the volume of sediments transported can be estimated by applying a 'fluid density factor' for floodwaters of 5% sediment by volume (50,000 mg/L). The result would be around 173 m^3/sec of sediments being moved during peak flood flow. This sediment transport amounts to about 600,000 m^3/hour. Previous studies (Ruelo 2013) showed that the October 2013 Bayawan flood had some 6 hours of intense flooding, which would have a total of 3.6 million m^3 of sediments being transported into the Bayawan River main channel and floodplain. Another estimate could be made, based on the attached simulation over a 12-hour peak flood flow (Figure 1), giving a total of 7.2 million m^3 of sediments.

Summary

It is yet difficult to arrive at realistic average values of sediment fluxes along Bayawan River. No continuous river flow gauging has ever been done, but flow measurements were made based on previous rainfall data, river sectioning, grain-size analysis, and computer simulations.

Using HEC-RAS modelling capability, big flood events (e.g. 100-year return similar to the October 2013 flood) would transport from 3.6 million m^3 of sediments into the Bayawan River main channel and floodplain, during 6 hours peak flow with 5% sediment by volume. Such big flood events are 'rare', but may become frequent in the future with increasing upland erosion and extreme wet weather conditions.

Moderately 'normal' floods having 2-year return periods, however, would give values of 600,000 m^3 of transported sediments for the same sediment concentration (5 % by volume) and peak flood duration of 6 hours. This could be a realistic value input for moderate floods that may occur once or twice a year. A rough yearly estimate, therefore, would be around 1 million m^3 of sediments that could be moved, transported, and deposited into the Bayawan River main channel, floodplain and near-coastal areas.

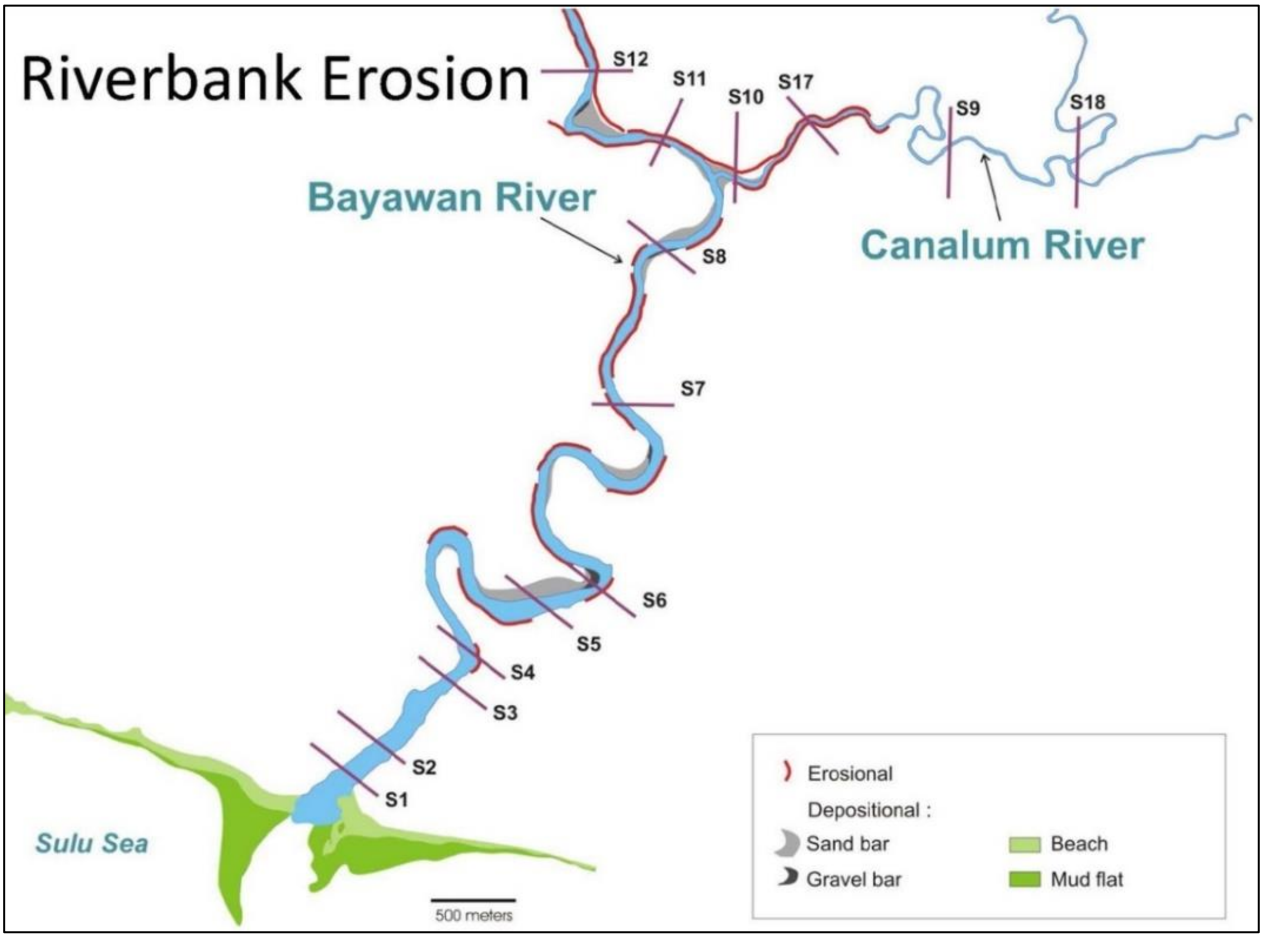
Impact Analysis

The dredging operation will not cause or exacerbate soil erosion. No currently open land area will be affected. Most of the erosion incidence are caused by natural loss from precipitation runoff (due to poor vegetal cover) or through various anthropogenic activities such as land development, land conversion or extensive and improper agricultural use (i.e. inappropriate tilling practices on corn and sugarcane lands).

There will be no potential impacts associated with land use. Dredging is temporary, causing only localized momentary turbidity in selected riverine and coastal localities.

Dredging and desiltation works normally have the potential to affect in-stream and riverbank soils and habitats. As a flood control mitigating component, however, it can be viewed as one of several "Ecosystem Services", which impacts positively on the lives of the Bayawan people.

The Bayawan River riparian zone in the floodplain area is significant because of their role in soil conservation. The dredging project will have no adverse on the riparian zone of the river. Riparian zones dissipate stream energy. The meandering curves of the river, combined with vegetation and root systems, dissipate stream energy, which results in less soil erosion and a reduction in flood damage. Sediment is trapped, reducing suspended solids to create less turbid water, replenish soils, and build stream banks. Pollutants are filtered from surface runoff which enhances water quality via biofiltration.



Source: Bayawan Dredging Pre-FS, Ruelo

Figure 2-39 Existing Erosional Conditions of Riverbanks

Management Plan

Project Management will support initiatives on the preservation of the Bayawan River riparian soil stability.

Monitoring Plan

Project Management will regularly check for any bank erosion in the river reach that may be the result from head cutting during dredging operations.

2.1.1.10 Change in soil quality/ fertility

Baseline Conditions

Sediment grain-size analysis was conducted on surface samples along different parts of the river (e.g. in-channel, bar, overbank) over a length of 8 km, including the river mouth and adjacent beach areas. In the absence of a drilling equipment, selected stratigraphic sectioning of riverbanks were conducted, which involved detailed documentation of the layering characteristics, sizes and textures of basically paleosol (buried soil horizons) and alluvial materials making up the banks and riverbed materials.

Generally, riverbed materials consist of the following:

- Gravel
- Sand
- Mud (Silt and Clay)
- Debris (wood, logs and other objects)

It appears that cyclic floods in the past have formed the unconsolidated sediment succession seen on riverbank outcrops. A typical section at elevation 13 meters asl, located in the river section just above the floodplain along Bayawan River. Coarse beds comprising rounded polylithic clasts and well-sorted coarse to silty sand represents in-channel gravel and sand bars, respectively. Coarser particles result from deposition of bed load materials. Fine-grained mud represents overbank flood deposits, formed from settling of suspended loads during the waning phases of flood events.

Most overbank sediments from the flood of October 6, 2013 in Bayawan consist of coarse-fine sand and mud. New gravel bars, however, were formed in some places (e.g. abandoned river channels) where floodwater maximum heights reached at least 2.5 meters.

Sediment-grain size analysis was done on about 80 randomly collected sand and silt samples from the river, shoal (sand bars) and the beach area. The results are presented in ANNEX B – Sedimentological Analysis. A total of 30 samples containing detrital magnetite were analyzed using magnetic separation methods. The average magnetite sand fraction content is relatively low at 1.71 %.

Four (4) river sand samples were also collected from different sections of the project site and sent to MGB for laboratory analysis on Gold, Silver and Iron. Table 2-8 below shows the summary of the laboratory test results, while actual test results are attached in ANNEX C – Sand Analysis Test Results

Analysis from MGB shows that there is no gold or silver content found in any of the four sand samples. Further analysis shows that there is only an average of 4.39% iron content found in the river sand. This means that the sand and sediments which will be dredged from Bayawan river have no high-value minerals of commercial value.

Table 2-8 Sediment Analysis Reports (MGB)

SAMPLE	GOLD (gm/MT)	SILVER (gm/MT)	IRON (%)
01	Nil	Nil	4.04
02	Nil	Nil	3.97
03	Nil	Nil	4.90
04	Nil	Nil	4.63

Soil erosion, loss of top soil and state of overburden will impact the river by adding sediment load. Soil quality and its associated vegetative cover contribute a lot on the water quality and sediment loading of the river. The essential driver is rainfall run off that carries with it excess nutrients and sediments. The excessive nutrients may result to water euthropication and excess sediments may alter stability of flow dynamics of the river. There is a dearth of data on this concern. However, the dredging project invariably does not contribute to these processes.

Impact Analysis

There will be no negative impacts towards the soil quality and fertility during the dredging operation. Any material that will be dredged will not be disposed on to any open land area of Bayawan City. All dredged materials will be loaded to the ship that will transport the same dredged materials to its destination outside of Bayawan City.

Only the natural erosion processes present in the Bayawan River system may alter the conductivity of the soils. The *hyporheic zone* – which is the area of active mixing between surface riverine water and groundwater – has been identified as critically important in stream nutrient cycling, in moderating stream temperature regimes, and in creating unique habitats within streams. The geomorphic factors driving hyporheic exchange flows at the project site is the channel morphology of the river in a floodplain, a system encompassing a large meandering mature river with a developed floodplain, and where most of the hyporheic exchange is that of groundwater recharge.
A once meandering stream system that historically has been in a constant state of flux may be dammed for flood control which leads to consequences such as sediments consolidation without the flushing flows, clogging the top layers of soil cover. Other anthropogenic impacts can damage the nutrient exchange processes through organic contamination.

Theoretically, dredging activity will alter the bankfull flooding characteristic of the river therefore the nutrients that can be deposited will decrease correspondingly. However, this change is expected to be substantially minimal.

During channel cutting, the subsurface water stored in the river bank will seep into the river thus may have a potential in lowering the water table in the immediate vicinity. This may impact vegetation. However, this is temporary and the level will recover once the river has stabilized.

Management Plan

Generally, there is no significant impact identified that changes the soil fertility or quality due to the project. Therefore, this concern does not warrant extensive assessment. The lowering of water table, though insignificant, can be expected such that the project management team will install observation wells for this concern.

Monitoring Plan

Observation wells will be monitored regularly

Terrestrial Ecology

Ecology and Ecosystem Services:

Based on the approved Philippine Land Classification, both sides of the adjacent terrestrial land 20m from Bayawan River is classified under Alienable and Disposable land thus most of its uses are agricultural in nature. The terrestrial portion serves area for settlement, high-value crop plantation and space for natural recreation. The terrestrial ecosystem has longer food chains and more complex food webs because it has more primary producers which can support more organisms in contrast to lotic environments (river ecosystems).

For purposes of discussion, the riparian zone which is intermediate between the river and the dry land will have a separate analysis. By definition, the Riparian Zone in Bayawan River are the areas 20m from the highest water mark of the river. The Terrestrial Zone are all areas beyond the 20m mark. Pursuant to Article 51 of PD 1067 otherwise known as the water code of the Philippines, the banks of rivers and streams and the shores of the seas and lakes throughout their entire length and within a zone of three (3) meters in urban areas, twenty (20) meters in agricultural areas and forty (40) meters in forest areas, along their margins, are subject to the easement of public use in the interest of recreation, navigation, flotage, fishing and salvage. No person shall be allowed to stay in this zone longer than what is necessary for recreation, navigation, floatage, fishing or salvage or to build structures of any kind.

Riparian lands are considered very productive for they support greater variety and abundance of animal life and adjacent habitats. At the project site, terrestrial ecology of the riparian zone is relevant to this project. The reconfiguration of the channel will invariably affect the flow dynamics of the river. These changes in flow regime will impact the riparian zone at the project site by potentially changing the supply of fresh water.

Materials and Methods:

Sampling sites were selected using random selection of segments in the terrestrial portion of the river. Three sampling stations both Left and Right of the river (reference of North facing the up the river) were established in 3 sites (Lower downstream, Middle downstream and Upper downstream).

For the floral survey, two 100m transect lines were established parallel to the river in both sides of the 3 sampling sites. The 1st transect line is positioned within the 20m riparian area while the second transect line was laid beyond the 20m riparian area to have samples for both riparian and terrestrial flora. A 10mx10m plot was established within the 100m transect with an interval of 10m. All vegetation inside the plots were recorded and counted.

For the faunal survey, the same square plots were used in all stations. All fauna found and heard (bird calls) were recorded and counted. Animal trapping was not employed in the study since dredging has no significant effect on the terrestrial fauna (e.g. birds, mammals).

Data Analysis:

For flora and fauna, species composition, density and diversity indices (Margalef’s Species Richness, Pielou’s Evenness and Shannon Index) were computed for analysis. Conservation status, range distribution and economic uses were also incorporated in the results.

Sampling Site Description:

Using a base map of the Bayawan River, the entire riparian and terrestrial zone within the 6km dredging area was divided into segments. Using simple random sampling technique, three (3) sampling sites were selected. Geographic coordinates of the sampling sites were marked and recorded for reference. Figure 2.1.4a shows the relative location of the sampling stations in Bayawan River for terrestrial and riparian ecology.

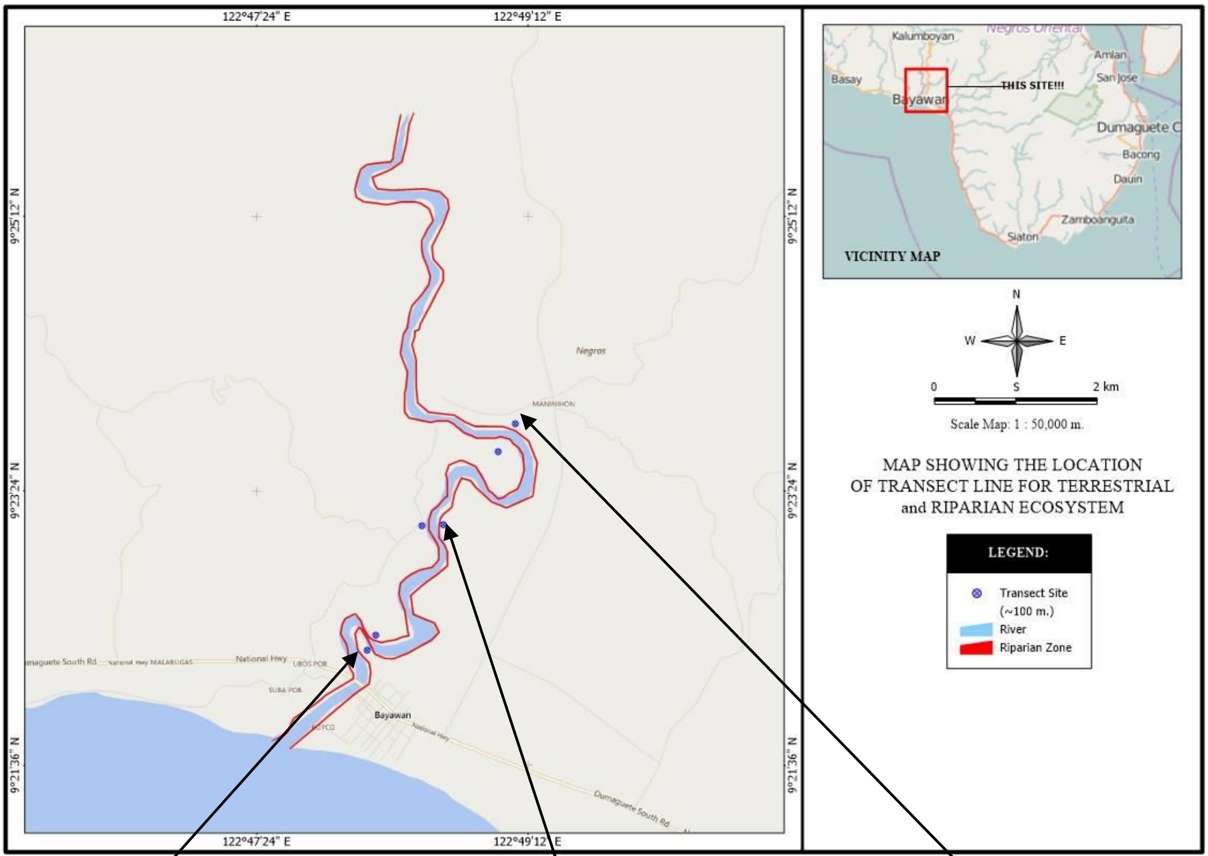


Figure 2-40 Map Showing the Location of Sampling Sites for Flora and Fauna Survey in the Terrestrial and Riparian Zone of Bayawan River

River bank erosion is very evident in the whole stretch of the 6km dredging zone. Trees in the riparian zone are falling into the river due to soil erosion. It can also be observed that the riparian zones do not have enough vegetation to hold the soil during flooding.

2.1.1.11 Vegetation Removal and Loss of Habitat

Terrestrial Floral Density:

In every 110 m^2 of land in the terrestrial zone, the average density per floral species was computed for both left and right portions of the Bayawan River. It can be observed that the most dominant species in terms of count is the Corn (*Zea mays*) followd by the ornamental plant Pintado (*Euphorbia heterophylla*). There are only a few trees standing in the terrestrial zone. The most dominant tree species is the coconut with a mean density of 6 trees per 110 m^2 area. The rest of the species have a density of 1 or below 5 individuals per 110 m^2 area.

Table 2-9 Comparison of the Floral Density between Left and Right Portion of the Terrestrial Zone of Bayawan River

RIGHT PORTION

Species Name	Total Mean Density
Tree Species	
Artocarpus blancoi	1
Bambusa blumeana	1
Ceiba pentandra	1
Cocos nucifera	6
Gmelina arborea	1
Leucaena leucocephala	5
Litsea glutinosa	1
Melanolepis multiglandulosa	1
Nauclea orientalis	1
Pithecellobium dulce	1
Psidium guajava	1
Pterocarpus indicus	1
Swietenia macrophylla	1
Non-Tree Species	
Chromolaena odorata	7
Colocasia esculenta	1
Euphorbia heterophylla	77
Ficus pseudopalma	1
Ficus septica	3
Macaranga tanarius	2
Manihot esculenta	2
Mimosa pudica	5
Musa spp.	12
Paspalum conjugatum	1
Stachytarpheta jamaicensis	1
Urena lobata	5
Zea mays	53

LEFT PORTION

Species Name	Total Mean Density
Tree Species	
Citrus maxima	1
Cocos nucifera	4
Gmelina arborea	1
Mangifera indica	1
Psidium guajava	1
Samanea saman	2
Swietenia macrophylla	1
Terminalia catappa	1
Mangrove Species	
Nypa fruticans	5
Sonneratia caseolaris	3
Non-tree Species	
Celosia cristata	1
Chromolaena odorata	3
Colocasia esculenta	1
Euphorbia heterophylla	30
Ipomea batatas	1
Ixora coccinea	23
Manihot esculenta	4
Mimosa pudica	14
Stachytarpheta jamaicensis	1
Vigna radiata	86
Zea mays	198

It can be observed during the survey that the floral composition varies depending on the location of the sampling site. Some of the sampling sites were located in an agricultural plantation dominated by corn or sugar cane while others are just grass lands with a few planted trees. Due to the high variance of the means between species, the researchers did not compute for the standard error of each species. The data presented in the above table shows the mean density of each species for the entire terrestrial zone despite the fact that some of these plants are absent in some sampling areas. Generally, there is a low tree density in the terrestrial zone.

Terrestrial Flora Ecological Index:

The Shannon Category Index was computed for the diversity of floral species in both left and right sides of the terrestrial zone. Based on literature, typical values of Shannon ranges between 1.5 to 3.5 in most ecological studies. Results showed that the right side of Bayawan River has higher floral diversity compared to the left side as shown in the Shannon and Margalef Diversity Indices.

Table 2-10 Summary of Ecological Indices for Flora in the Terrestrial Zone of Bayawan River

Terrestrial Zone	Total Individuals (Nt)	Total Species (Ns)	Margalef's Species Richness (d)	Pielou's Evenness (J')	Shannon (H')
Right	402	26	4.95	0.6	1.97
Left	536	21	3.54	0.51	1.56

Using the relative values of the Shannon Index, <1.9 values are considered very low diversity.

Terrestrial Faunal Density:

Results showed that the Phil Pied Fantail locally known as *Bangkiyod* had the highest count with 5 individuals. Its natural habitat is subtropical or tropical moist lowland forests. A total of 28 individuals were recorded in the entire terrestrial zone of Bayawan River. Table 2-11 shows the individual count per species within the terrestrial zone of Bayawan River.

Table 2-11 Faunal Density in the Terrestrial Zone of Bayawan River

Species name	Common name	Number of individuals
Copsychus saularis	Oriental Magpie robin	2
Gallirallus philippensis	Buff-banded rail	1
Aplonis panayensis	Asian glossy starling	1
Ptilinopus occipitalis	Yellow-breasted fruit dove	1
Geopelia striata	Zebra dove	1
Cinnyris jugularis	Olive-backed sunbird	2
Todiramphus chloris	White Collard kingfisher	3
Pycnonotus goiavier	Yellow-vented bulbul	4
Gallus gallus domesticus	Chicken	1
Lanius cristatus	Brown shrike	2
Aerodramus sp.	Swiflet	2
Rhipidura nigritorquis	Phil. Pied Fantail	5
Varanus salvator	Water monitor lizard	1
Diplacodes sp.	Red Dragonfly	2
	Nt	**28**
	N_0	**14**

Terrestrial Fauna Ecological Indices:

Shannon’s Category Index, Margalef’s Species Richness and Pielou’s Evenness were computed to analyze the diversity of the terrestrial zone. Table 2-12 shows the Ecological Indices computed for the faunal species found in the terrestrial zone of Bayawan River.

Table 2-12 Summary of Ecological Indices for the Fauna in the Terrestrial Zone of Bayawan River

	Total Individuals (Nt)	Total Species (Ns)	Margalef's Species Richness (d)	Pielou's Evenness (J')	Shannon (H')
Fauna	28	14	4.2	0.94	2.48

Based on the relative values of the Shannon Category Index, values <2.49 is considered to have low diversity.

Historical occurrence of pest infestation:

Back in October 2011, six areas in Bayawan City struggled with a coconut leaf beetle infestation, also known as brontispa, that affected at least 11,335 coconut trees. The affected areas were Barangays Villareal, Tinago, Boyco, Suba and Tabuan. Majority of the infected coconut trees were newly planted and aged 3 years and below and Bayawan was the only area in Negros Oriental that was reported to have brontispa infestation. Chemical spraying and slash-and-burn methods were used to combat the infestation.

Impact Analysis

Pest infestation could not be accounted by the dredging activity in the river. Hence, dredging has no impact to crop or tree infestation.

Management Plan

It is the primary responsibility of the City Agriculturist to ensure that all infestation phenomena will be controlled and mitigated. The proponent will coordinate to the Office of the LGU Agriculture to report any sightings of infested floral or faunal species along the terrestrial zone of Bayawan River.

Monitoring Plan

Since infestation is not caused by the dredging activity in the River, monitoring of pest infestation shall remain in the ambit of the LGU of Bayawan City.

2.1.1.12 Threat to Existence and/or Loss of Important Local Species

Terrestrial Zone

Terrestrial Floral Composition:

A total of thirty-six (36) macro-flora were recorded in the terrestrial zone of the three sampling sites in Bayawan River. They were further categorized into tree, non-tree and mangrove species. There were 17 tree species, 17 non-tree species (herbs, shrubs, grasses) and 2 mangrove species. Most of the recorded flora belonged to the least concern category except for the native tree Narra (*Pterocarpus indicus*) which has a vulnerable status. Table 2-13 shows the list of macro-flora recorded in the terrestrial zone of Bayawan River.

Table 2-13 List of Floral Composition, Endemicity, Conservation Status recorded in Bayawan River

Scientific Name	Common Name	Distribution	Conservation Status	Economic Importance	Location relative to the river	
					Right	Left
Tree Species						
Artocarpus blancoi	Antipolo	Endemic	Least Concern	Food, Medicinal	/	
Bambusa blumeana	Kawayan tinik	Native	Least Concern	Raw material	/	
Ceiba pentandra	Doldol	Introduced	Least Concern	Firewood	/	
Citrus maxima	Pomelo	Native	Least Concern	Food, Medicinal		/
Cocos nucifera	Lubi	Native	Least Concern	Food, Raw material	/	/
Gmelina arborea	Yemane	Exotic	Least Concern	Lumber	/	/
Leucaena leucocephala	Ipil-ipil	Native	Least Concern	Firewood	/	
Litsea glutinosa	Lau-at	Native	Least Concern	Lumber	/	

Mangifera indica	Manga	Naturalized	Least Concern	Food, Medicinal		/
Melanolepis multiglandulosa	Alum	Native	Near Threatened	Lumber	/	
Nauclea orientalis	Bangkal	Native	Least Concern	Lumber	/	
Pithecellobium dulce	Camachile	Introduced	Least Concern	Lumber	/	
Psidium guajava	Bayabas	Naturalized	Least Concern	Food, Medicinal	/	/
Pterocarpus indicus	Narra	Native	Vulnerable	Lumber	/	
Samanea saman	Acacia	Introduced	Least Concern	Shade, Lumber		/
Swietenia macrophylla	Mahogany	Exotic	Least Concern	Lumber	/	/
Terminalia catappa	Talisay	Native	Near Threatened	Shade, Lumber		/
Mangrove Species						
Nypa fruticans	Nipa	Native	Least Concern	Raw material		/
Sonneratia caseolaris	Pedada (pagatpat)	Native	Least Concern	Unregulated		/
Non-Tree						
Celosia cristata	Tapay-tapay	Introduced	Least Concern	Ornamental		/
Chromolaena odorata	Hagonoy	Introduced	Least Concern	Medicinal	/	/
Colocasia esculenta	Gabi	Native	Least Concern	Food, Medicinal	/	/
Euphorbia heterophylla	Pintado	Introduced	Least Concern	Ornamental	/	/
Ficus pseudopalma	Niog-nioyan	Endemic	Least Concern	Ornamental	/	
Ficus septica	Hawili/ Lagnub	Endemic	Least Concern	Medicinal	/	
Ipomea batatas	Kamote	Native	Least Concern	Food, Medicinal	/	
Ixora coccinea	Santan	Exotic	Least Concern	Ornamental	/	
Macaranga tanarius	Binunga	Native	Least Concern	Food, Medicinal	/	
Manihot esculenta	Kamoteng kahoy	Introduced	Least Concern	Food, Medicinal	/	/
Mimosa pudica	Makahiya	Native	Least Concern	Medicinal	/	/
Musa spp.	Saging	Naturalized	Least Concern	Food, Medicinal	/	
Paspalum conjugatum	Carabao grass	Exotic	Least Concern	Ornamental	/	
Stachytarpheta jamaicensis	Kandikandilaan	Introduced	Least Concern	Ornamental	/	/
Urena lobata	Dalupang	Native	Least Concern	Ornamental	/	
Vigna radiata	Mongos	Native	Least Concern	Food, Medicinal		/
Zea mays	Mais	Introduced	Least Concern	Food, Medicinal	/	/
				N_0	*28*	*19*

There were two mangrove species recorded within the terrestrial zone (Nipa and Pedada). Nipa palms grow in soft mud and slow-moving tidal and river waters that bring in nutrients. The palm can be found as far inland as the tide can deposit the floating nuts. The plant will survive occasional short-term drying of its environment (IUCN, 2010) thus explaining its presence in the terrestrial zone. However, utilization of Nypa requires appropriate permits while there is no regulation for Pedada. Three species were found to be endemic in the Philippines. Results showed that the right side of the river has a higher floral species composition compared to the left side. Corn (Zea mays) plantation is common in both sides of the river.

Terrestrial Faunal Composition:

Associated faunal species were also recorded in the terrestrial zone. A total of 14 species belonging to 13 families were found inhabiting the terrestrial zone of Bayawan River. Based on IUCN Conservation Status, all species were found to be of least concern. There were endemic species recorded such as the Yellow vented bulbul (*Pycnonotus goiavier*) and the Swiftlet (*Aerodramus sp.*). Most of the recorded species were birds (Class Aves) with one reptile and one invertebrate (Class Insecta). Table 2-14 shows the list of faunal species recorded within both sides of the terrestrial zone of Bayawan River.

Table 2-14 Species Composition of Associated Fauna found in the Terrestrial Zone of Bayawan River

Family	Species name	Common name	Distribution	Conservation Status
Muscicapidae	*Copsychus saularis*	Oriental Magpie robin	Native	Least Concern
Rallidae	*Gallirallus philippensis*	Buff-banded rail	Native	Least Concern
Sturnidae	*Aplonis panayensis*	Asian glossy starling	Native	Least Concern
Columbidae	*Ptilinopus occipitalis*	Yellow-breasted fruit dove	Endemic	Least Concern
Columbidae	*Geopelia striata*	Zebra dove	Native	Least Concern
Nectariniidae	*Cinnyris jugularis*	Olive-backed sunbird	Resident	Least Concern
Alcedinidae	*Todiramphus chloris*	White Collard kingfisher	Wide Range	Least Concern
Pycnonotidae	*Pycnonotus goiavier*	Yellow-vented bulbul	Native	Least Concern
Phasianidae	*Gallus gallus domesticus*	Chicken	Native	Domesticated
Laniidae	*Lanius cristatus*	Brown shrike	Native	Least Concern
Apodidae	*Aerodramus sp.*	Swiflet	Endemic	Least Concern
Rhipiduridae	*Rhipidura nigritorquis*	Phil. Pied Fantail	*Wide Range*	Least Concern
Varanidae	*Varanus salvator*	Water monitor lizard	Native	Least Concern
Libellulidae	*Diplacodes sp.*	Red Dragonfly	*Wide Range*	Least Concern

Consistent with the results of the floral survey which shows low tree density, it is expected that the associated faunal species would also be low.

2.1.1.13 Threat to Abundance, Frequency and Distribution of Important Species

Baseline data for flora shows that narra tree (*Pterocarpus indicus*) is the only species which falls under the vulnerable category of the IUCN. All the other species are under the least concern category which means that potential loss during dredging operations is insignificant since it can be easily replaced in other sites. For faunal species, there are no threatened or locally important endemic species recorded inhabiting the terrestrial zone. Almost all of the recorded species are terrestrial birds which can easily transfer from one habitat to another because of its ability to fly. Baseline data also reveals that the diversity in both floral and faunal species in the terrestrial zone ranges from low to very low. Dredging does not have direct impact on the terrestrial zone which is located beyond the 20m easement from the highest river water mark.

Impact Analysis

Dredging operations does not affect the floral composition and abundance but it can affect bird population aggregates inhabiting the shrubs and trees. The noise from the engine of the heavy equipment may drive away nesting or foraging faunal species away from their natural home range.

Management Plan

During planning and preparation, in case that a tree is determined that it will be affected during the operations, appropriate permits from the LGU and the DENR shall be sought prior to inflicting the damage. When a tree will be cut, tree replacement ratio consistent with the DENR regulations will apply to be implemented by the proponent. To mitigate the noise of the dredging equipment, sound dampening mats (SDMats) will be installed in the engine compartments of the heavy equipment to minimize disturbance of floral species.

Monitoring Plan

In the course of the operation, constant recording of faunal species will be conducted twice a day (before and after the daily dredging activity) by the proponent to monitor the different type of species in the area. It might be that an endemic species will appear when disturbed by noise. It is important to keep track of the resources inhabiting the area to determine if their numbers are increasing or decreasing.

2.1.1.14 Hindrance to Wildlife Access

River dredging will not cause any hindrance to wildlife access within the terrestrial zone of Bayawan River. Only faunal entry particularly fishes along the river might be potentially affected by the project.

Riparian Zone

Riparian Floral Composition:

A total of forty-one (41) species of macro-fauna were recorded in the riparian area of Bayawan River. The macro-fauna was further grouped into tree species, mangrove species and non-tree species (herbs, shrubs, vines, grasses). A total of 21 species of tree species, 2 mangrove species and 18 non-tree species were recorded shown in Table 2-15. It can be observed that the left portion of the river has higher species richness compared to the right portion.

Table 2-15 List of Floral Composition, Endemicity, Conservation Status, Economic Importance recorded in the Riparian Area of Bayawan River

Scientific Name	Common Name	Distribution	Conservation Status	Economic Importance	Location relative to the river	
					Right	Left
Tree Species						
Artocarpus heterophyllus	Nangka	Native	Least Concern	Food	/	
Bambusa vulgaris	Bagakay	Naturalized	Least Concern	Raw material		/
Canarium ovatum	Pili	Native	Least Concern	Raw material		/
Cassia alata	Asunting/ Akapulko	Introduced	Least Concern	Medicinal	/	
Chrysophyllum cainito	Caimito	Naturalized	Least Concern	Food		/
Cocos nucifera	Lubi	Native	Least Concern	Food, Raw material	/	/
Coffea canephora	Kape	Introduced	Least Concern	Food, Medicinal		/
Gmelina arborea	Yemane	Exotic	Least Concern	Lumber		/
Hibiscus tilliaceus	Malabago	Native	Least Concern	Raw material		/
Lagerstroemia speciosa	Banaba	Native	Least Concern	Lumber		/
Leucaena leucocephala	Ipil-ipil	Native	Least Concern	Firewoord	/	/
Mallutos philippinensis	Banato	Native	Least Concern	Lumber		/
Mangifera indica	Manga	Naturalized	Least Concern	Food, Medicinal		/
Melanolepis	Alum	Native	Near threatened	Lumber		/

Scientific Name	Common Name	Distribution	Conservation Status	Economic Importance	Location relative to the river	
multiglandulosa						
Moringa oleifera	Kamunggay	Introduced	Least Concern	Food, Medicinal	/	
Muntingia calabura	Mansanitas	Introduced	Least Concern	Food, Medicinal	/	/
Nauclea orientalis	Bangkal	Native	Least Concern	Lumber		/
Psidium guajava	Bayabas	Naturalized	Least Concern	Food, Medicinal		/
Swietenia macrophylla	Mahogany	Exotic	Least Concern	Unregulated	/	/
Syzygium cumini	Duhat/ Lumboy	Native	Least Concern	Food, Medicinal		/
Terminalia catappa	Talisay	Native	Near threatened	Shade, Raw material	/	/
Mangrove Trees						
Nypa fruticans	Nipa	Native	Least Concern	Raw material		/
Sonneratia caseolaris	Pedada (pagatpat)	Native	Least Concern	Unregulated		/
Non-tree Species						
Abelmoschus esculentus	Okra	Native	Least Concern	Food, Medicinal	/	
Celosia cristata	Tapay-tapay	Introduced	Least Concern	Ornamental	/	
Chromolaena odorata	Hagonoy	Introduced	Least Concern	Medicinal	/	/
Euphorbia heterophylla	Pintado	Introduced	Least Concern	Ornamental		/
Euphorbia hirta	Mangagaw	Naturalized	Least Concern	Medicinal		/
Ficus pseudopalma	Niog-nioyan	Endemic	Least Concern	Medicinal		/
Ficus septica	Hawili/ Lagnub	Endemic	Least Concern	Medicinal		/
Ixora coccinea	Santan	Exotic	Least Concern	Ornamental		/
Macaranga tanarius	Binunga	Native	Least Concern	Medicinal	/	/
Manihot esculenta	Kamoteng kahoy	Introduced	Least Concern	Food, Medicinal	/	
Mimosa pudica	Makahiya	Native	Least Concern	Medicinal	/	
Musa spp.	Saging	Naturalized	Least Concern	Food, Medicinal	/	/
Paspalum conjugatum	Carabao grass	Exotic	Least Concern	Ornamental	/	
Pennisetum purpureum	Napier	Naturalized	Least Concern	Forage	/	/
Ricinus communis	Tangan-tangan	Native	Least Concern	Ornamental	/	
Saccharum spontaneum	Wild tubo	Naturalized	Least Concern	Ornamental	/	
Stachytarpheta jamaicensis	Kandikandilaan	Introduced	Least Concern	Ornamental	/	/
Vigna radiata	Mongos	Native	Least Concern	Food, Medicinal		/
Zea mays	Mais	Introduced	Least Concern	Food		/
				N_0	**20**	**32**

Out of the 41 species only two were listed as near threatened in the IUCN conservation status. All other flora was recorded as least concern. Uses of the different floral species ranges from food, raw material for house building, lumber and Medicinal Value. No threatened species were recorded in the sampling sites.

Riparian Floral Density:

Results showed that the right portion of the river has higher total floral density per 110 m^2 with a total of 323 individuals compared to the left portion with a total of 292 individuals. However, the left portion of the riparian area in Bayawan River supports more species with a total composition of 32 species compared to the 20 species in the right portion. Table 2-16 shows the mean density of the different species in every 110 m^2 area.

Table 2-16 Comparison of the Floral Density Between the Right and Left Portion of the Riparian Zone of Bayawan River

RIGHT PORTION

Species name	Total Mean Density
Tree Species	
Artocarpus heterophyllus	1
Cassia alata	1
Cocos nucifera	8
Leucaena leucocephala	5
Moringa oleifera	5
Muntingia calabura	5
Swietenia macrophylla	2
Terminalia catappa	2
Non-tree Species	
Abelmoschus esculentus	2
Celosia cristata	5
Chromolaena odorata	24
Macaranga tanarius	4
Manihot esculenta	7
Mimosa pudica	20
Musa spp.	27
Paspalum conjugatum	3
Pennisetum purpureum	146
Ricinus communis	8
Saccharum spontaneum	33
Stachytarpheta jamaicensis	18
Nt	**323**
No	**20**

LEFT PORTION

Species name	Total Mean Density
Tree Species	
Bambusa vulgaris	1
Canarium ovatum	1
Chrysophyllum cainito	1
Cocos nucifera	4
Coffea canephora	5
Gmelina arborea	2
Hibiscus tilliaceus	1
Lagerstroemia speciosa	1
Leucaena leucocephala	
Mallutos philippinensis	3
Mangifera indica	1
Melanolepis multiglandulosa	2
Muntingia calabura	3
Nauclea orientalis	1
Psidium guajava	2
Swietenia macrophylla	1
Syzygium cumini	1
Terminalia catappa	1
Mangrove Species	
Nypa fruticans	5
Sonneratia caseolaris	11
Non-tree Species	
Chromolaena odorata	22
Euphorbia heterophylla	109
Euphorbia hirta	6
Ficus pseudopalma	0
Ficus septica	4
Ixora coccinea	1
Macaranga tanarius	0
Mimosa pudica	3
Musa spp.	0
Pennisetum purpureum	0
Stachytarpheta jamaicensis	3
Vigna radiata	27
Zea mays	69
Nt	**292**
No	**32**

Results showed that the most dominant floral species is the Napier grass (*Pennisetum purpureum*) with a total density of 146 individuals per 110 m^2. Napier grass is a species of perennial tropical grass native to the African grasslands. It has low water and nutrient requirements, and therefore can make use of otherwise uncultivated lands. Historically, this wild species has been used primarily for grazing; recently, however, it has been incorporated into a pest management strategy. This technique involves the desired crop being planted alongside a 'push' plant, which repels pests, in combination with a 'pull' crop around the perimeter of the plot, which draw insects out of the plot. Napier grass has shown potential at attracting stemborer moths (a main cause of yield loss in Africa) away from maize[3] and hence is the "pull" crop. This strategy is much more sustainable, serves more purposes and is more affordable for farmers than insecticide use.

In addition to this, Napier grasses improve soil fertility, and protect arid land from soil erosion. It is also utilized for firebreaks, windbreaks, in paper pulp production and most recently to produce bio-oil, biogas and charcoal (*Farell et.al., 2002*).

Tree species generated low mean density values which means the tree vegetation in the riparian areas are sparse. Shrubs and grasses dominate the river riparian area. There are also corn fields recorded in the riparian zone.

Riparian Flora Ecological Index:

The Shannon Category Index was computed for the diversity of floral species in both left and right sides of the riparian zone. Results showed that the left side of the Bayawan River riparian area has higher floral diversity compared to the right side as shown in the Shannon and Margalef Diversity Indices. This is contrary to the results generated from the terrestrial survey.

Table 2-17 shows the ecological indices computed for the floral species in the Riparian Zone of Bayawan River.

Table 2-17 Summary of Ecological Indices for the Flora in the Riparian Zone of Bayawan River

Riparian Zone	Total Individuals (Nt)	Total Species (Ns)	Margalef's Species Richness (d)	Pielou's Evenness (J')	Shannon (H')
Right	702	20	3.46	0.68	2.05
Left	863	32	5.6	0.6	2.10

Based on the relative values of the Shannon Category Index, values < 2.49 is considered to have low diversity. In conclusion, the diversity of floral species found in the riparian area of Bayawan River is low based on Shannon Index.

Riparian Faunal Composition:

Two surveys were conducted for associated fauna in the riparian area of Bayawan River to cover the wet and dry season.

Wet Season:

A total of 27 species belonging to 22 families of macro-fauna were recorded within the riparian zone of Bayawan River. Out of the 27 species, one was under vulnerable status which is the Phil Sailfin Lizard. Most of the species recorded were birds (*Class Aves*) there were also mammals recorded in the riparian area such as carabaos and goats.

Table 2-18 List of Macro-fauna Recorded within the Riparian Area of Bayawan River during Wet Season

Family	Scientific Name	Common Name	Distribution	Conservation Status
Acrididae	*Oxya hyla intricata*	Grasshopper	*Large Range*	Unranked
Agamidae	*Hydrosaurus pustulatus*	Phil. Sailfin Lizard	*Endemic*	Vulnerable
Alcedinidae	*Alcedo sp.*	Kingfisher	*Wide Range*	Least Concern
Alcedinidae	*Todiramphus chloris*	Collared Kingfisher	*Wide Range*	Least Concern
Apodidae	*Aerodramus sp.*	Swiftlet	*Wide Range*	Data deficient
Ardeidae	*Egretta garzetta*	Little Egret	*Large Range*	Least Concern
Bovidae	*Capra aegagrus hircus*	Goat	*Extremely Wide Range*	Least Concern
Bovidae	*Bos taurus*	Cow	*Extremely Wide Range*	Least Concern
Bovidae	*Bubalus bubalis*	Carabao	*Wide Range*	Least Concern
Bufonidae	*Rhinella marina*	Cane toad	*Broad Range*	Least Concern
Chrysomelidae	*Anomoea sp.*	Orange bug	*Large Range*	Least Concern
Columbidae	*Geopelia striata*	Zebra dove	*Large Range*	Least Concern
Corvidae	*Corvus macrorhynchos*	Crow	*Large Range*	Least Concern
Crambidae	*Spoladea sp.*	Moth	*Regularly Occurring*	Unranked
Cuculidae	*Centropus Viridis*	Philippine Coucal	*Endemic to Phils*	Least Concern
Estrildidae	*Lonchura sp.*	Brown Maya	*Very Large Range*	Least Concern
Gallidae	*Gallus gallus*	Chicken	*Extremely Wide Range*	Least Concern
Libellulidae	*Diplacodes trivialis*	Ground skimmer	*Widespread and Common*	Least Concern
Libellulidae	*Diplacodes sp.*	Red Dragonfly	*Widespread*	Least Concern
Lycaenidae	*Chilades lajus*	Lime blue	*Widespread*	Least Concern
Muridae	*Rattus exulans*	Polynesian rat	*Broad Range*	Least Concern
Muscicapidae	*Copsychus saularis*	Oriental Magpie Robin	*Large Range*	Least Concern
Arachnida	*Various Species*	Spiders	*Various*	Various
Rhipiduridae	*Rhipidura nigritorquis*	Pied Fantail	*Extremely Wide Range*	Least Concern
Scindidae	*Eutriopis multifasciata*	Tabili	*Widely Distributed in Asia*	Least Concern
Sturnidae	*Aplonis panayensis*	Asian glossy starling	*Extremely Wide Range*	Least Concern
Varanidae	*Varanus salvator*	Asian water monitor	*Wide Distribution*	Least Concern

For species endemism, results showed that only the Phil Sailfin Lizard (*Hydrosaurus pustulatus*) was found to be endemic in the Philippines.

Dry Season:

A total of 10 species belonging to 10 families of macro-fauna were recorded within the riparian area of Bayawan River during the dry season. All of which were found to be of least concern. There were no endemic species cited in the riparian area. Table 2-19 shows the composition of macro-fauna recorded within the riparian area of Bayawan River taken during the dry season.

Table 2-19 List of Macro-fauna Recorded within the Riparian Area of Bayawan River during Dry Season

Family	Species name	Common name	Distribution	Conservation Status
Muridae	*Rattus exulans*	Polynesian rat	Exotic	Least Concern
Muscicapidae	*Copsychus saularis*	Oriental Magpie robin	Native	Least Concern
Alcedinidae	*Todiramphus chloris*	White Collard kingfisher	Native	Least Concern
Columbidae	*Geopelia striata*	Zebra dove	Native	Least Concern
Pycnonotidae	*Pycnonotus goiavier*	Yellow-vented bulbul	Native	Least Concern
Estrildidae	*Lonchura atricapilla*	Chestnut munia	Resident	Least Concern
Apodidae	*Aerodramus sp.*	Swiflet	Wide Range	Least Concern
Scincidae	*Lamprolepis smaragdina*	Emerald Tree Skink	Native	Least Concern
Bufonidae	*Rhinella marina*	Cane toad	Exotic	Least concern
Libellulidae	*Diplacodes sp.*	Red Dragonfly	Widespread	Least Concern

Comparing the species richness for the two seasons, results showed that there were more types of species recorded during the wet season compared to the dry season. Most of the species recorded in the dry season were birds while wet season had records of Mammals, Reptiles and Amphibians.

Riparian Faunal Density:

Wet vs Dry Season

A total of 304 individuals of fauna were recorded in the riparian area of Bayawan River during the wet season as compared to 19 individuals recorded during the dry season. The most dominant species recorded during the dry season is the Brown Maya (*Lochura sp.)* with a total count of 65 individuals. However, the Brown Maya was not found in the sampling sites during the dry season. The variance could be accounted for the absence of insect groups in the three sampling areas during the dry season survey. Table 2-20 shows the comparison of the faunal densities between wet and dry seasons.

Table 2-20 Comparison of the Macro-fauna Density between Wet and Dry Season in the Riparian Area of Bayawan River

Scientific Name	Common Name	Total Count	
		Wet Season	Dry Season
Birds			
Copsychus saularis	Oriental Magpie Robin	1	2
Todiramphus chloris	Collared Kingfisher	8	3
Aerodramus sp.	Swiftlet	20	2
Aplonis panayensis	Asian glossy starling	7	0
Pycnonotus goiavier	Yellow vented bulbul	0	2
Lonchura atricapilla	Chestnut munia	0	1
Egretta garzetta	Little Egret	7	0
Rhipidura nigritorquis	Phil. Pied Fantail	3	0
Geopelia striata	Zebra dove	7	1
Corvus macrorhynchos	Crow	4	0
Lonchura sp.	Brown Maya	65	0

Chilades lajus	Lime blue	19	0
Mammals			
Rattus exulans	Polynesian rat	3	1
Amphibian			
Rhinella marina	Cane toad	5	2
Reptiles			
Hydrosaurus pustulatus	Phil. Sailfin Lizard	1	0
Varanus salvator	Asian water monitor	2	0
Lamprolepis smaragdina	Emerald Tree Skink	0	1
Insects			
Anomoea sp.	Orange bug	4	0
Oxya hyla intricata	Grasshopper	53	0
Spoladea sp.	Moth	13	0
Diplacodes trivialis	Ground skimmer	59	0
Diplacodes sp.	Red Dragonfly	23	4
	Nt	**304**	**19**
	N_0	**19**	**10**

Ecological Index:

Shannon's Diversity Index was computed for both wet and dry season to compare the faunal diversity of the riparian zone of Bayawan River between season. It was found out that the fauna has more or less similar values. This is due to the fact that the Shannon Index accounts both species composition and abundance or density. It might be true that wet season has 304 individual counts but it has also 19 species while the dry season has only 19 counts but across 10 families. Both evenness and dominance were balanced in the two seasons. Table 2-21 shows the comparison of the ecological indices across seasons for the macro-fauna in the riparian zone of Bayawan River.

Table 2-21 Summary of Ecological Indices for the Fauna in the Riparian Zone of Bayawan River across Seasons

Riparian Fauna	Total Individuals (Nt)	Total Species (Ns)	Margalef's Species Richness (d)	Pielou's Evenness (J')	Shannon (H')
Wet	304	19	3.32	0.79	2.33
Dry	19	10	3.39	0.94	2.18

Based on the relative values of the Shannon Category Index, values < 2.49 is considered to have low diversity. In conclusion, the diversity of faunal species found in the riparian area of Bayawan River is low in both wet and dry season.

Impacts on Riparian Ecology

Threat to abundance, distribution, existence and/or loss of important local species:

Baseline data for riparian flora reveals that there are no threatened species thriving in the riparian zone of Bayawan River. However, there is one vulnerable faunal species recorded which is the endemic Philippine Sailfin Lizard (*Hydrosaurus pustulatus*). The Philippine sailfin lizard is an excellent swimmer and has flattened toes that enable it to run across water. It is omnivorous, feeding on fruit, leaves, flowers, insects, and small animals. It lives near rivers banks of the Philippines. Other than one reptile, all faunal species are on the Least Concern category. Most of the species recorded were also birds which is capable of flight. There were no economically important crustaceans captured during sampling however, it can be observed during the survey that mud crab traps were installed by local fishermen to catch small crustaceans for subsistence living.

Impact Analysis

Dredging operations can momentarily increase river sedimentation affecting some flora and fauna occupying within the river water line. However, this momentary siltation will be easily wiped out by virtue of the river's natural flushing effect. Silt will not affect the large vertebrates but it has a momentary impact on the associated macro-benthos attached in the riparian substrate.

Management Plan

During planning and preparation, in case that a tree is determined that it will be affected during the operations, appropriate permits from the LGU and the DENR shall be sought prior to inflicting the damage. When a tree will be cut, tree replacement ratio consistent with the DENR regulations will apply to be implemented by the proponent. To mitigate the noise of the dredging equipment, sound dampening mats (SDMats) will be installed in the engine compartments of the heavy equipment to minimize disturbance of floral species. However, tree cutting is not applicable to mangrove trees. In case that a mangrove needs to be removed in the downstream to cater passage of heavy equipment, the mangrove trees must be earth-bowled and transferred to a viable site.

Riverbank enhancement by planting bamboo or other endemic tree species along the riparian areas shall also be conducted by the proponent in collaboration with the LGU of Bayawan City. This will prevent further erosion and will hold the soil after the dredging operations has completed. The LGU must revisit the stipulations in the Philippine water code that no permanent structures shall be built along the riparian zones. The LGU must relocate all households within the riparian area to keep them away from danger during flooding and to establish a continuous green belt in the riparian area to increase biodiversity.

Monitoring Plan

In the course of the operation, constant recording of faunal species along the riparian area will be conducted twice a day (before and after the daily dredging activity) by the proponent to monitor the different type of species. It might be that an endemic species will appear when disturbed by noise. It is important to keep track of the resources inhabiting the area to determine if their numbers are increasing or decreasing.

Hindrance to Wildlife Access

River dredging may cause hindrance to fish passage but it is only momentary. After the dredging project, the water column of the river will increase thus increasing the space for primary production. The siltation will also reduce improving the water quality of the water and a better access to freshwater and riparian wildlife species.

2.2 THE WATER

Hydrology and Hydrogeology

Bayawan abound with rivers and tributary creeks that can provide life-giving water to its vast arable lands. It has four major river networks and watersheds namely, Bayawan River in its central region and has the largest watershed area of about 37,874 hectares (54% of the total land area), Ilog River to the north which drains to Kabankalan City and Municipality of Ilog in Negros Occidental, which is located at the southeastern portion of Negros Island, Sicopong River to the east and Pagatban River to the west (Figure 2-41). Bayawan River watershed is deemed the most important and critical watershed for Bayawan City. There is also the

Camaya-an and Niludhan watersheds which are small watersheds near the coast on the western side of the city.

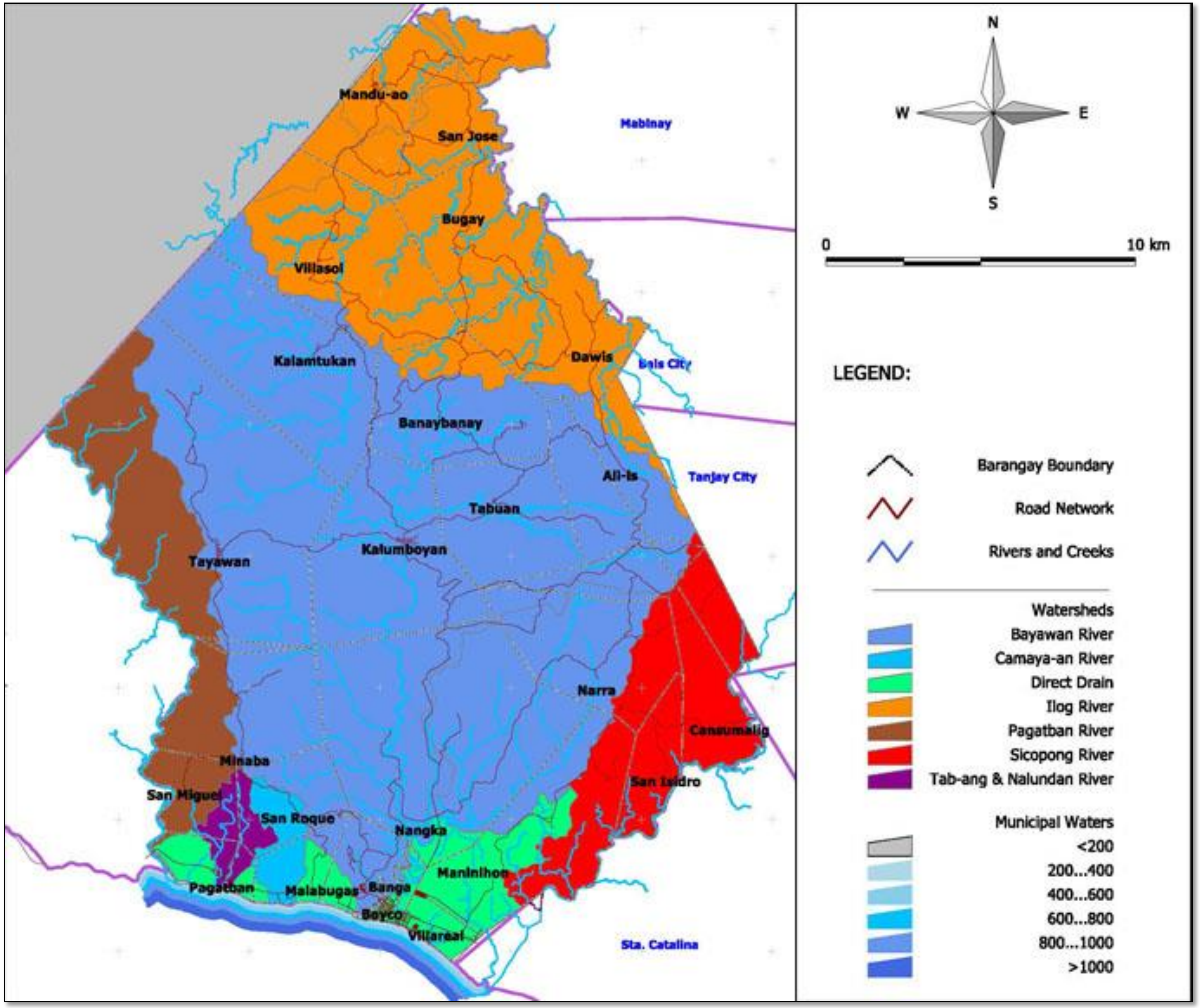
2.2.1.1 Change in Drainage Morphology/Inducement of Flooding/Reduction in Stream Volumetric Flow

Delineation of Watershed/sub watersheds/ floodplain

The Bayawan River watershed is a relatively moderate-size river system, measuring about 430 km^2. It flows southerly and is slightly elongated along 38 km from the farthest upstream drainage divide to its mouth, and about 20 km across its longest midstream width. The basin forms a major semi-elongated dendritic drainage network (Figure 2-42) cutting through and draining the middle part of the city, while its headwaters emanates from beyond the city's northern boundary with the adjacent province of Negros Occidental.

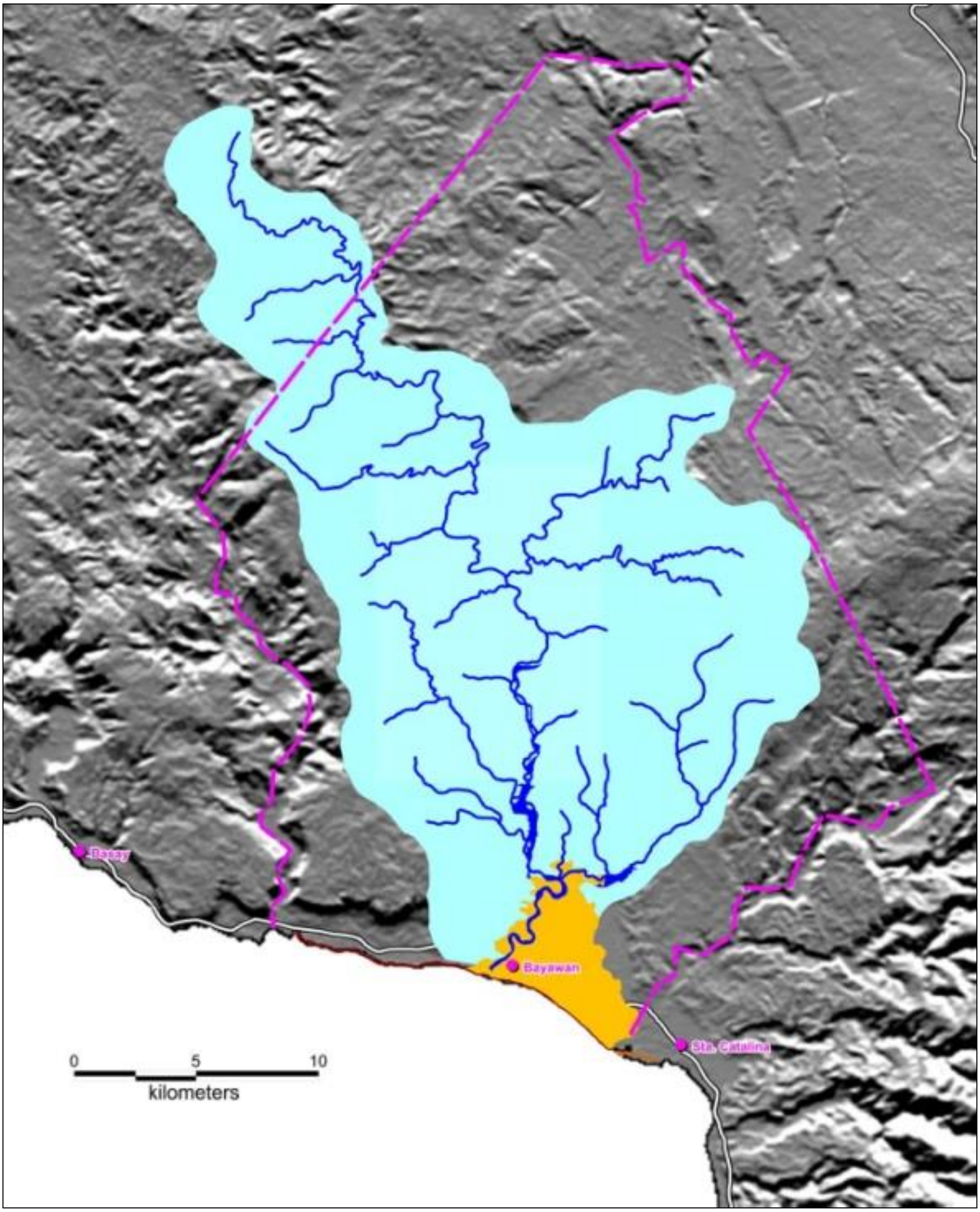
The watershed boundaries are located in the Pagatban River to the west, Ilog-Hilabangan River to the northwest, and the Sicopong River to the east. All the other small river systems and creeks near the coastal area drain directly to the Sulu Sea. (Figure 2-43).

The Pagatban River watershed reaches upto the municipalities of Basay and Hinobaan, while the Ilog River watershed traverses the municipalities of Mabinay and Candoni. The Sicopong River watershed is located in Sta. Catalina.



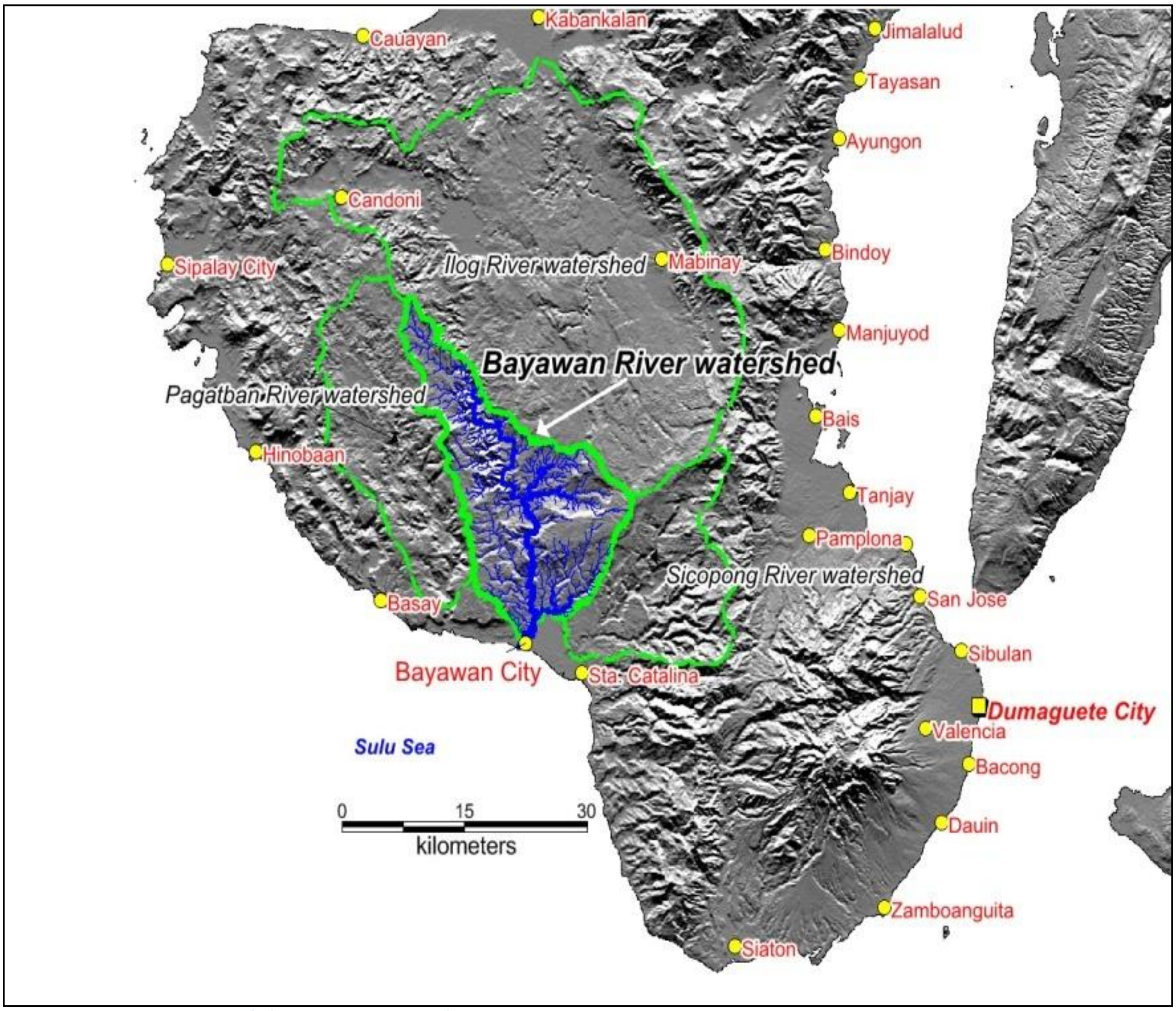
Source:CLUP

Figure 2-41 Bayawan City Watershed Map (CLUP)



Source: Bayawan Dredging Pre-FS, Ruelo

Figure 2-42 Watershed (blue), Major Drainage Patterns and Floodplain (orange)



Source: Bayawan Dredging Pre-FS, Ruelo

Figure 2-43 Bayawan Watershed and Adjacent Basin

The drainage network includes the Canalum River as a major contributing tributary, and some five (5) other tributaries. The main river channel way meanders through the downstream floodplain for about 7.5 km at an elevation of < 5 meters above sea level, and the midstream channel is entrenched braided pattern over 10 km (elevation of 5 to 40 meters above sea level) further north in hilly to moderately steep topography.

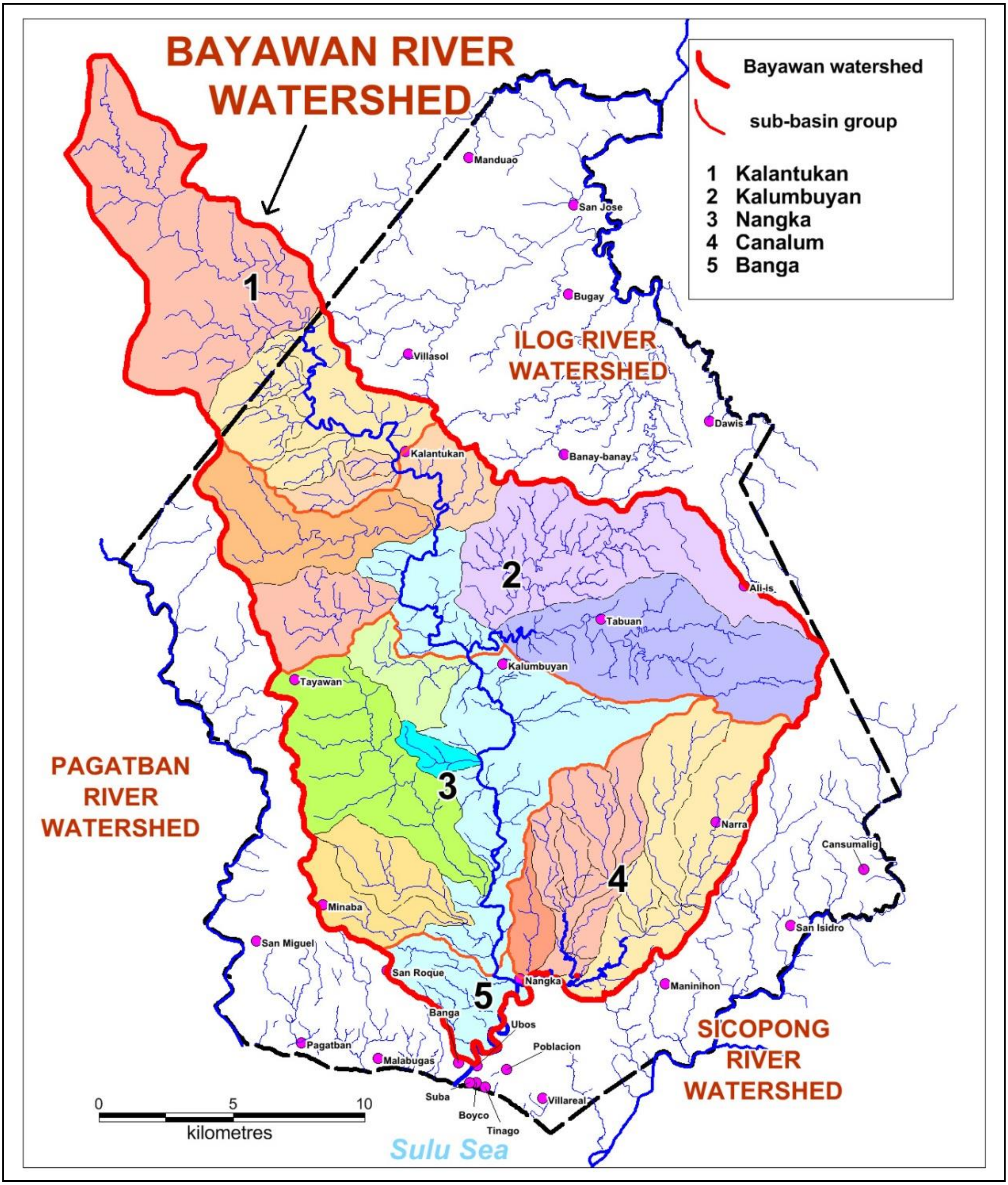
The farthest headwaters to the northwest are located in Negros Occidental province, in the municipality of Ilog and City of Kabankalan.

A large downstream area of low-lying floodplain is repeatedly threatened by recurrent floods, comprising a large urban population and adjacent agricultural grounds. It constitutes a relatively flat-lying area of 2,500 hectares or 25 km^2, encompassing the city's urban center and adjacent agricultural lands in six (6) contiguous barangays.

The Bayawan watershed has an area roughly 430 km^2, composed of at least twenty (2) sub-basins, comprising five (5) sub-basin groups outlined in Table 2-22and Figure 2-44 below.

Table 2-22 Catchment Statistics of the Bayawan Watershed

Stream Catchment	Catchment Number	Area (km^2, planar surface)	Outflow point Elev (masl)
Ilog headwaters	1		180
Kalantukan			120
	KALANTUKAN	94.63	
Kalantukan West	2		100
Kalantukan East			100
Tayawan North			80
Kalumbuyan North			80
Tabuan			80
Kalumbuyan Main			80
	KALUMBUYAN	143.6	
Kalumbuyan West	3		80
Tayawan South			20
Minaba			20
Nangka-Kalumbuyan main			20-80
	NANGKA	108.6	
Canalum Creek	4		5
Tan-ayan			10
Canalum River			10
	CANALUM	70.3	
Banga	5	12.85	5
	BAYAWAN BRIDGE	**429.98**	2



Source: Bayawan Dredging Pre-FS, Ruelo

Figure 2-44 Bayawan Catchment Basin and Sub-basins

The catchment of the Bayawan River basin is the section of land that drains into the main waterway. There are a number of parameters that are used to define this catchment, and those that are necessary for the planned dredging work design are summarized in Table 2-23 below.

Table 2-23 Parameters Used to Define the Bayawan Catchment Area

Catchment Area	430 km^2 , covering 12 barangays
Drainage pattern	Dendritic, semi-elongate catchment shape
Topography	Moderate, deeply dissected
Land-use	Mainly agricultural, cultivated, pasture and minor forest
Main channel and catchment length	Main channel 38 km from headwaters to river mouth, 20 km across widest stretch ; dense stream dissection
Upstream	high catchment slope over 60% of catchment area, including large low-lying valley at 40 to 100 meters asl
Midstream	entrenched braided pattern over 10 km length at elevation of 5 to 40 meters above sea level
Downstream	meandering for about 7.5 km total length at an elevation of < 5 meters above sea level
Floodplain Area	22 km^2 , covering 7 barangays
Average slope over maximum channel length	40^o to 10^o in upstream, 10^o midstream and 2^o downstream (floodplain)

Stream Flow Measurements

Running at its base flow, the river is basically a low-energy fluvial system. Average stream velocity measurements conducted in May 2014 showed averages ranging from 0.10 to 0.30 meters/sec for the downstream areas, those with river bed slopes of 2^o and lesser. Baseflow discharges (Table 2-24) that were measured for Canalum River ranged from 0.40 to 1.0 m^3/sec, while it averaged 2.0 m^3/sec for Bayawan River at barangay Nangka.

After the confluence of the Bayawan main channel and Canalum Rivers at Nangka, the Bayawan River starts meandering and baseflow discharges measured were at 11 to 20 m^3/sec from S8 to S5, and 44 to 55 m^3/sec from S4 to the mouth of the river. A realistic averaged baseflow discharge would be at S8 and S7, which is about 15 m^3/sec.

Table 2-24 Measured base flow stream discharge at the downstream portions of Bayawan and Canalum Rivers

Section	Baseflow area (sqm)	Flow velocity (m/sec)	Carrying capacity (m3/sec)	Baseflow discharge (m3/sec)
S1	436	0.10	57	44
S2	545	0.10	69	55
S3	444	0.10	56	44
S4	470	0.10	67	47
S5	102	0.20	36	20
S6	180	0.10	29	18
S7	85	0.20	80	17
S8	35	0.30	72	11
S9	5	0.20	20	1
S10	4	0.30	12	1
S11	23	0.10	20	2
S12	6	0.30	129	2
S17	2	0.20	14	0.4
S18	2	0.30	138	0.6

Identification of Aquifers

Domestic water for distribution in the Bayawan urban area come from springs, but shallow wells are also widely used. Private tube-wells and open wells extract groundwater that are extensively used in the Bayawan floodplain area for domestic purposes.

Surface water consists of freshwater that flows and collects in the Bayawan River and its tributaries. Groundwater, on the other hand, collects in porous layers (known as aquifers) of the Quaternary alluvial plain and fractured bedrocks. The whole Bayawan floodplain area constitutes a large shallow aquifer, dominated by loose, soft fluviosol soil type. The major user of surface water is the agricultural sector, particularly for the provision of irrigation services. Another source of groundwater are cold bicarbonate springs from limestone-covered areas, which is abundant in Bayawan.

Static water levels (water table) in Bayawan ranges from 2 to 5 meters in depth. Lowering of the water table during dry periods is not significant, but could be about 1 to 3 meters.

Geologic conditions determine the path by which water from precipitation reaches the saturation zone or the water table. The water table is near the surface, and so there is considerable percolation through the soil. In the Bayawan floodplain, there seems to be no impermeable layers above the water table that may also prevent such direct percolation. During periods of heavy precipitation, flooding usually occurs and the whole floodplain is saturated with water.

Flooding History

Flood events were not uncommon in Bayawan City since the main populated zone is situated in a floodplain area. Previous recollection by locals revealed big flood events with varying inundation impacts. With increasing investment in infrastructure and urbanization, flooding problems are now being attended to.

The 2013 Flood Disaster

On 06 October 2013, the city of Bayawan in Negros Oriental was inundated by riverine flash floods of up to 8 meters high near riverbanks, affecting at least 44 km^2 in 9 coastal and floodplain barangays. This was its worst flood disaster in recorded history, resulting in millions of pesos in property, crops and infrastructural damages, 6 deaths and 11,000 displaced. Power and communication lines were cut off and isolated from the rest of the province, putting the city instantly in a state of calamity.

Heavy and prolonged precipitation was spawned by several days of rains due to an ITCZ (Intertropical Convergence Zone), and not due to the direct effects of a typhoon's rain bands. The passage of two tropical cyclones (TY *Quedan* and TY *Ramil*) in the SW Pacific Ocean has activated the ITCZ and enhanced the SW monsoon, thereby increasing the intensity of rainfall over the Sulu Sea area.

Flash flooding and overland sheet flow were directly caused by overtopping of the heavily-silted 6-km long downstream portion of Bayawan River. Flooding took place over a 40-hour period, starting in the early afternoon of Oct 5 through early morning of Oct 7, with peak flood discharge occurring at around 7am of Oct 6. Reconstructed flood hydrograph showed that this was an instantaneous inundation with little lag time. Floodwater receded almost 2 days after peak flood stage. Some 855 mm of rain was dumped over a 3-day period (Oct 4-6), whilst 514 mm fell in 24 hours of Oct 6. Bayawan over the last 50 years has averaged a monthly rainfall of 368 mm for the month of October, and an annual average of 2531 mm.

The flood was exacerbated by backwater effect due to high tidal seawater flowing 5 km inwards along Bayawan River. The worst-hit areas are situated in a large, high-sinuosity meandering zone of active and abandoned river channels with current surface topography lying at 2 to 5 meters asl elevation, causing shifting river dynamics, constant avulsion, and catastrophic flooding.

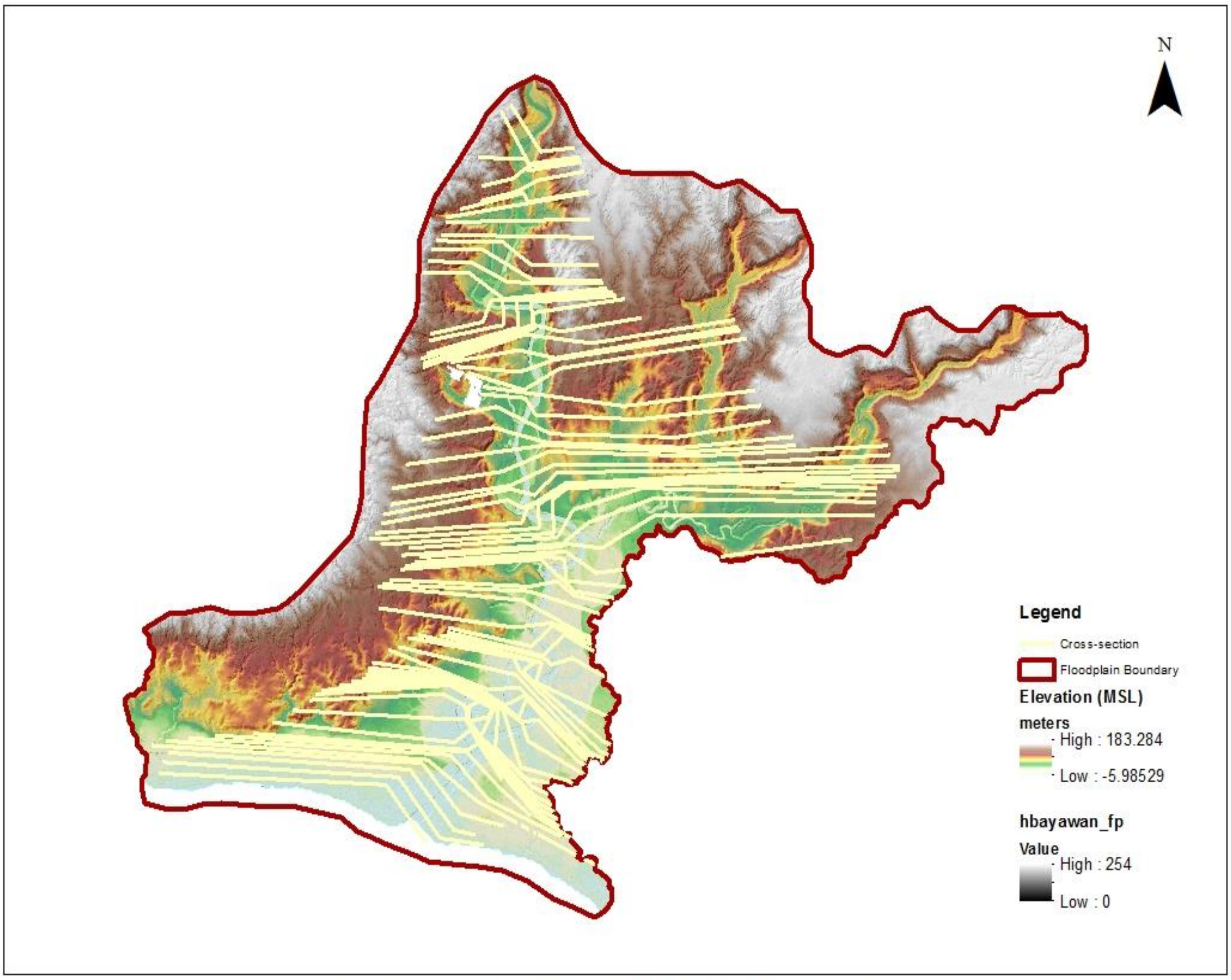
Previous floods

Historically, local people remember two (2) big flood events which previously affected the Southern Negros communities, apparently caused by typhoon *Ruping* in 1990 and *Ursula* in 2003. Apparently, these did not cause massive inundation compared to this very recent event. *Ursula* was just a tropical depression (October 21-24, 2003) with peak intensity of 55 km/hr. *Ruping* was the deadliest typhoon (November 13-14, 1990) since *Nitang* in 1984 (its heavy rainfall and winds killed 1,492 people in the whole country, total damage P10.846B) and *Amy* in 1951, when it made landfall in the eastern Philippines at 230 km/hr but weakened when it hit the central islands at 137km/hr, but poured heavy rains that caused widespread flooding across the Visayas. *Ruping*'s and *Ursula*'s floodwaters have also inundated the whole Bayawan floodplain, where about 0.30 meter and 0.10 meter of maximum flood heights were reported in the urban area, respectively.

Computational Flood Inundation of Bayawan River

Inundation in the floodplain of Bayawan River was generated using HEC-RAS 4.1, a software developed by the US Army Corps of Engineers. The model makes use of Lidar-derived elevation data with integrated bathymetric points. A total of 17,686 bathymetric points were integrated to the elevation model to represent the terrain beneath the water surface.

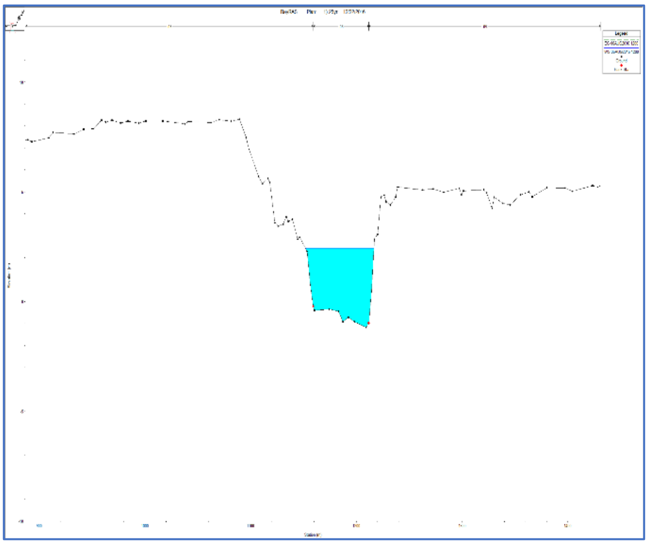
A total of 73 cross sections along the floodplain of Bayawan River were used in the analysis, each 200 meters apart. Figure 2-45 shows the cross sections along the floodplain. The locations of these cross sections are indicated by the geographic coordinates in Table 2-25.



River Cross Sections Used in the Analysis

(a)

(b)



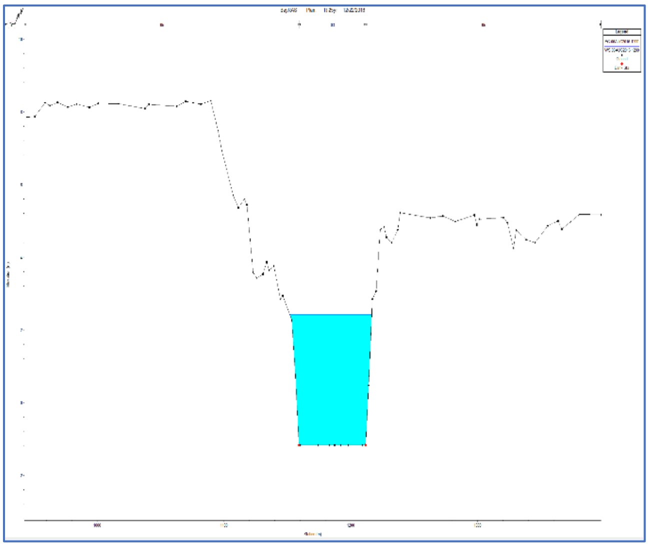


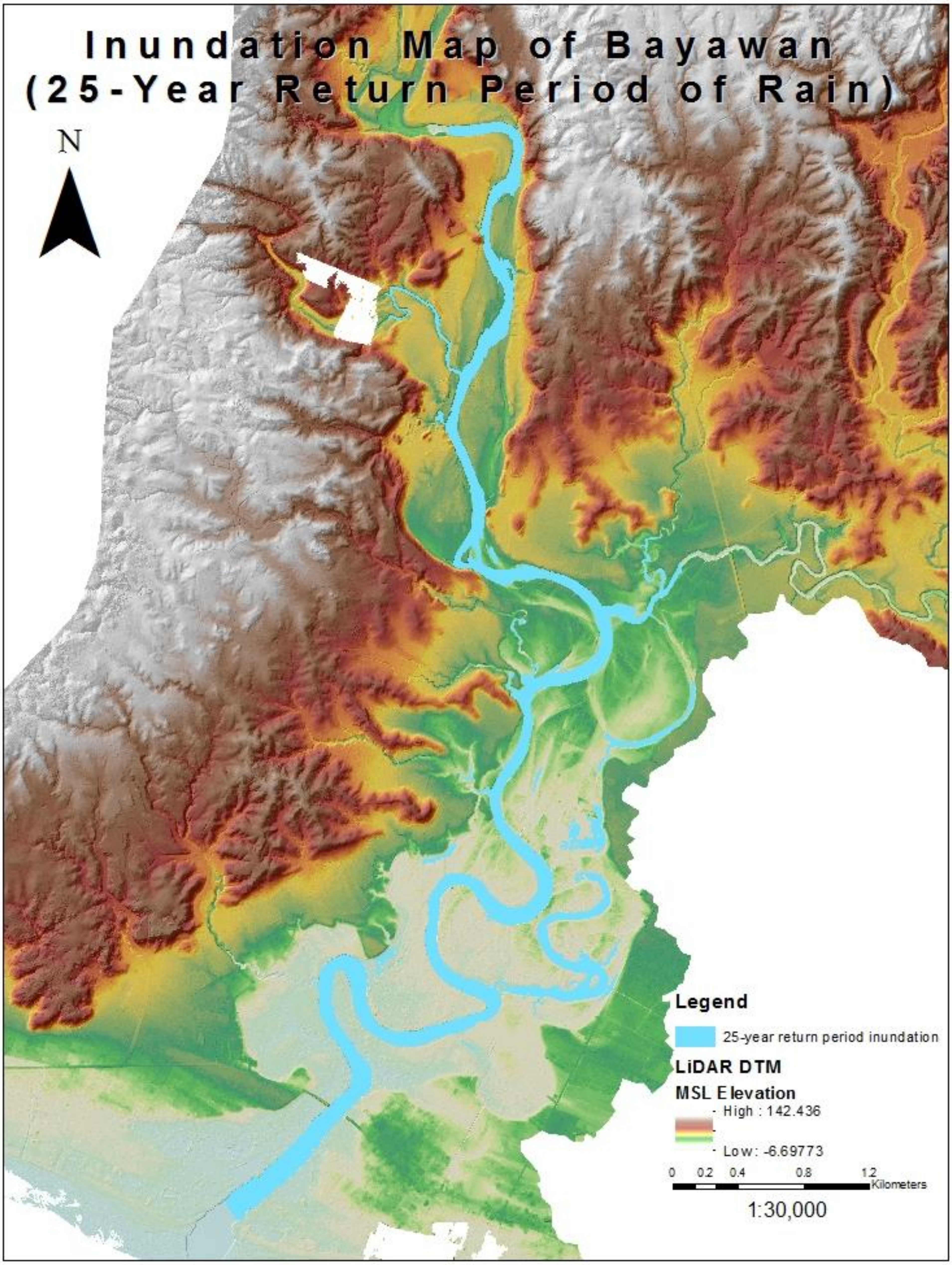
Figure 2-45 Bayawan River (a) Actual Cross-section and (b) Edited Cross-section with Proposed Dreding

Table 2-25 Coordinates of Cross-sections used in the Floodplains

Station	Latitude			Longitude			Station	Latitude			Longitude		
	D	M	S	D	M	S		D	M	S	D	M	S
1	9	26	34	122	48	35.73	38	9	23	42.25	122	48	58.94
2	9	26	29.58	122	48	30.72	39	9	23	36.52	122	48	56.54
3	9	26	25.04	122	48	29.04	40	9	23	33.9	122	48	51.11
4	9	26	19.34	122	48	30.58	41	9	23	32.36	122	48	44.82
5	9	26	13.99	122	48	34.39	42	9	23	26.65	122	48	43.63
6	9	26	8.49	122	48	33.05	43	9	23	20.75	122	48	42.59
7	9	26	5.76	122	48	30.13	44	9	23	15.23	122	48	39.43
8	9	25	59.02	122	48	29.95	45	9	23	8.91	122	48	36.97
9	9	25	52.52	122	48	29.27	46	9	23	2.98	122	48	39.19
10	9	25	47.02	122	48	26.6	47	9	22	58.2	122	48	43.62
11	9	25	40.82	122	48	24.13	48	9	22	52.85	122	48	46.91
12	9	25	34.96	122	48	21.39	49	9	22	46.74	122	48	38.43
13	9	25	29.38	122	48	18.07	50	9	22	51.01	122	48	33.9
14	9	25	24.05	122	48	16.42	51	9	22	53.11	122	48	28.57
15	9	25	22.66	122	48	22.55	52	9	22	48.82	122	48	24.49
16	9	25	22.66	122	48	29.11	53	9	22	42.2	122	48	23.76
17	9	25	23.04	122	48	35.65	54	9	22	36.29	122	48	26.23
18	9	25	20.89	122	48	41.11	55	9	22	32.1	122	48	30.87
19	9	25	14.32	122	48	40.8	56	9	22	28.75	122	48	36.73
20	9	25	10.6	122	48	37.15	57	9	22	25.47	122	48	32.13
21	9	25	3.58	122	48	34.72	58	9	22	23.17	122	48	25.99
22	9	24	57.34	122	48	36.27	59	9	22	21.66	122	48	19.47
23	9	24	51.57	122	48	39.05	60	9	22	23.96	122	48	13.48
24	9	24	45.91	122	48	38.78	61	9	22	29.07	122	48	9.92
25	9	24	40.7	122	48	35.28	62	9	22	35.46	122	48	8.88
26	9	24	35.2	122	48	31.66	63	9	22	35.63	122	48	3.55
27	9	24	29.14	122	48	29.17	64	9	22	29.16	122	48	2.84
28	9	24	22.8	122	48	28.12	65	9	22	23.19	122	48	5.47
29	9	24	16.76	122	48	30.66	66	9	22	17.93	122	48	9.14
30	9	24	10.63	122	48	32.9	67	9	22	12.32	122	48	8.97
31	9	24	4.41	122	48	33.39	68	9	22	7.68	122	48	4.63
32	9	23	58.98	122	48	30.07	69	9	22	2.74	122	48	0.31
33	9	23	55.84	122	48	32.82	70	9	21	57.68	122	47	56.24
34	9	23	54.52	122	48	39.05	71	9	21	53.36	122	47	51.58
35	9	23	54.12	122	48	45.65	72	9	21	49.4	122	47	46.17
36	9	23	52.37	122	48	51.75	73	9	21	45.31	122	47	41.21
37	9	23	48.29	122	48	56.8							

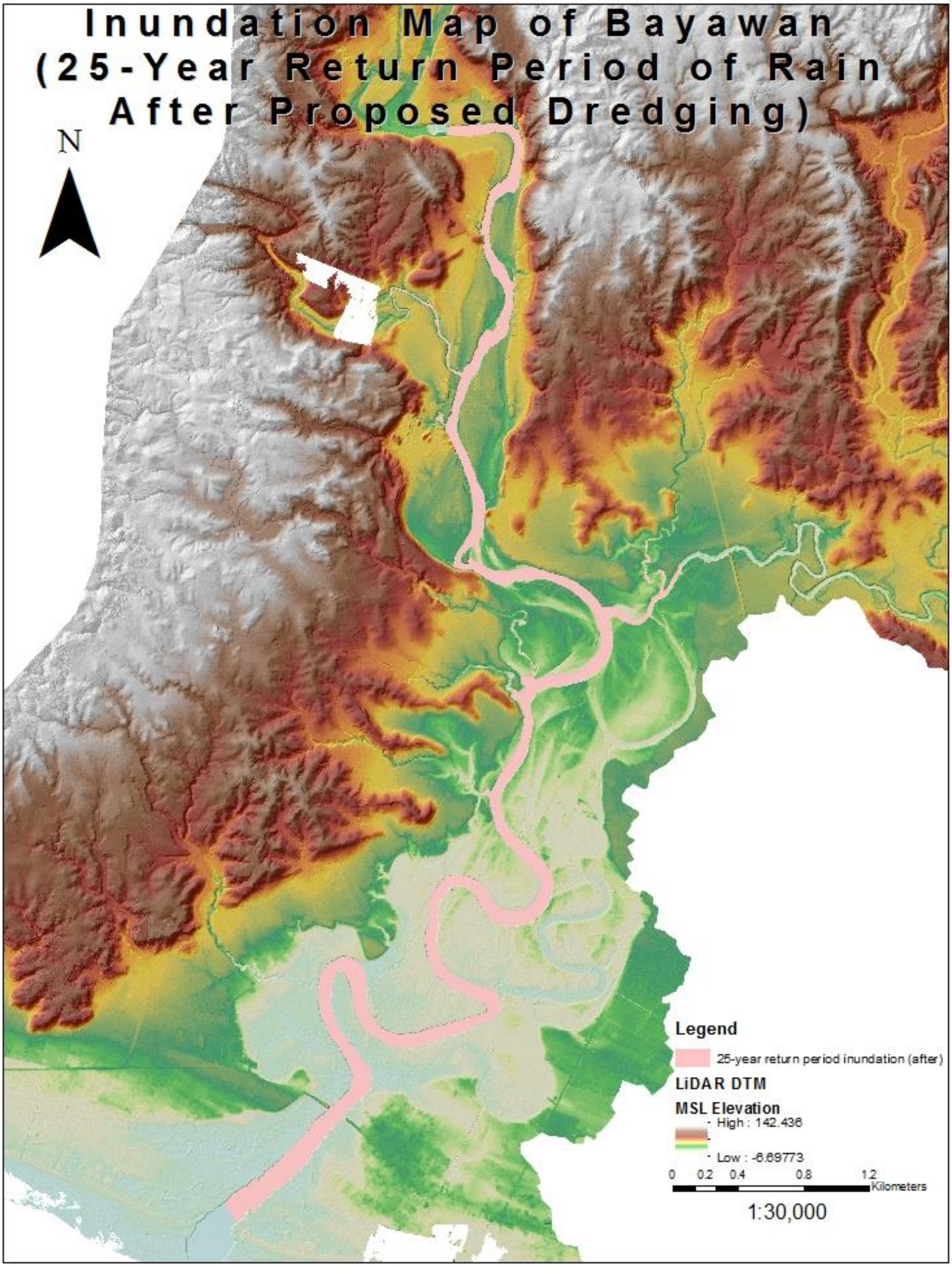
Figure 2-46 shows the flood inundation for 25-year return period of rainfall for the current river scenario and Figure 2-47 portrays the flood inundation when the proposed dredging is implemented. Figure 2-48 shows the situation when the two results are superimposed.

The total inundation area in Figure 2-46 is 1,222,985 square meters or approximately 1.22 square kilometers. On the other hand, the inundation area in Figure 2-47 is 923,033 sq. meters or 0.92 square kilometers. This shows that if the dredging project is implemented, the reduction in the inundation area is 299,952 square meters or about 0.30 square kilometers. It can also be seen that there is no inundation in much of the eastern tributaries of the river if the proposed dredging is implemented.



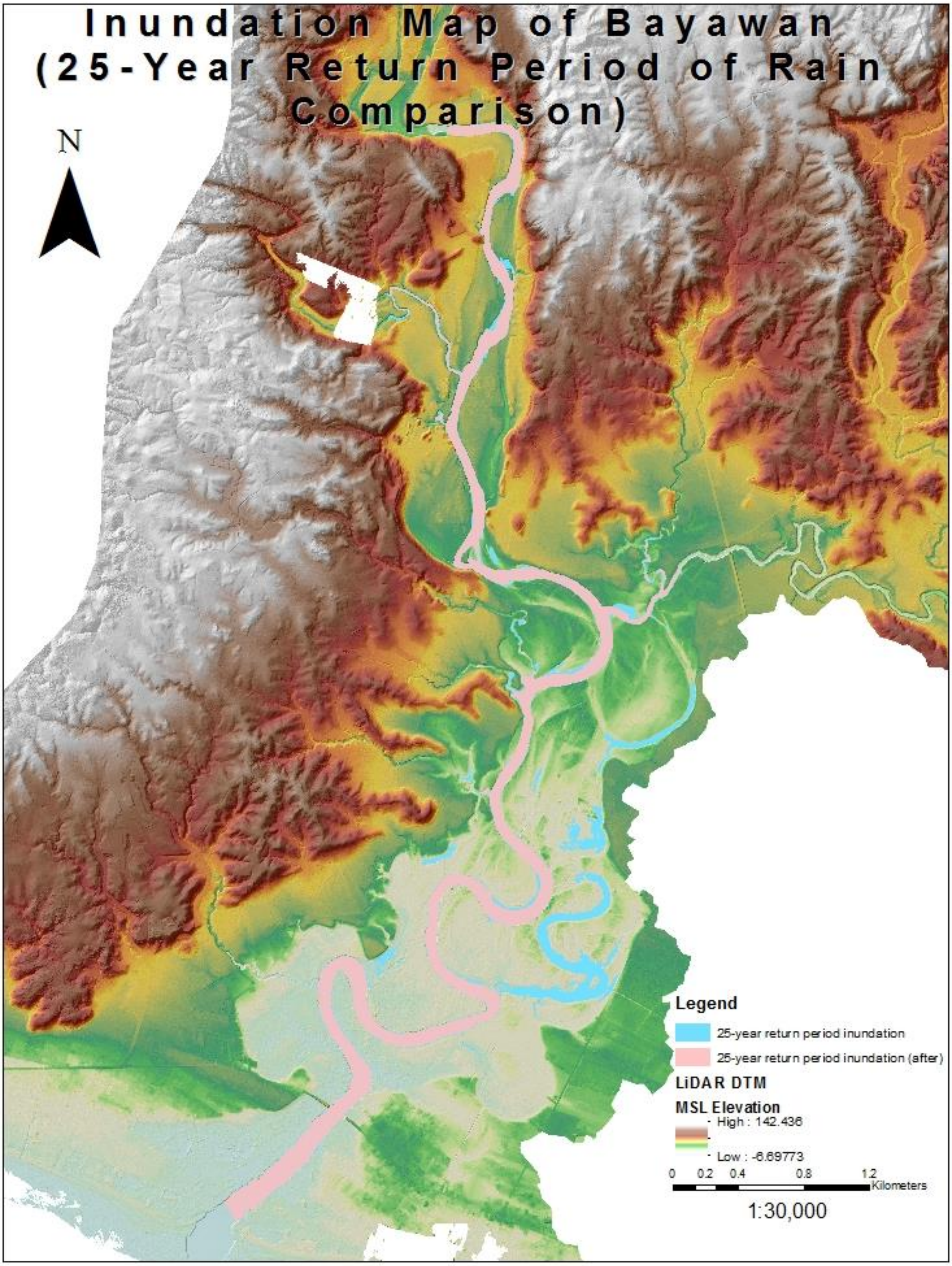
Source: Phil LiDAR

Figure 2-46 Flood Inundation of Bayawan River for a 25-year Return Period of Actual Cross-section



Source: Phil LiDAR

Figure 2-47 Flood Inundation of Bayawan River for a 25-year Return Period of Cross-Section with Proposed Dredging



Source: Phil LiDAR

Figure 2-48 Superimposed Flood Inundations With and Without the Proposed Dredging

Impact Analysis

Without the project, the deposition of sediments and malow the river channel to accommodate greater volume of flow, thus reducing the occurrence of flooding downstream. The project therefore could mitigate the flooding scenario in the area.

Management Plan

Critical to the design channel configuration is its slope and depth that will accommodate an estimated volume flow equivalent to a 25-year return cycle of inundation. Therefore, dredging operations will strictly follow limits as stipulated by the detailed engineering plan.

To do this, it is essential that a sounding survey will be conducted before and after dredging operation at a given section at a time. Records of these surveys will be kept for further assessment and future reference.

Monitoring Plan

The slope and other design limits for dredging should be followed. A mechanism of record keeping will be established by the proponent on this regard.

Upstream conditions and the coastline area will be monitored as well for any significant change due to head cutting and sediment deposition respectively. If any change occurs, this will be reported immediately to initiate mitigating measures.

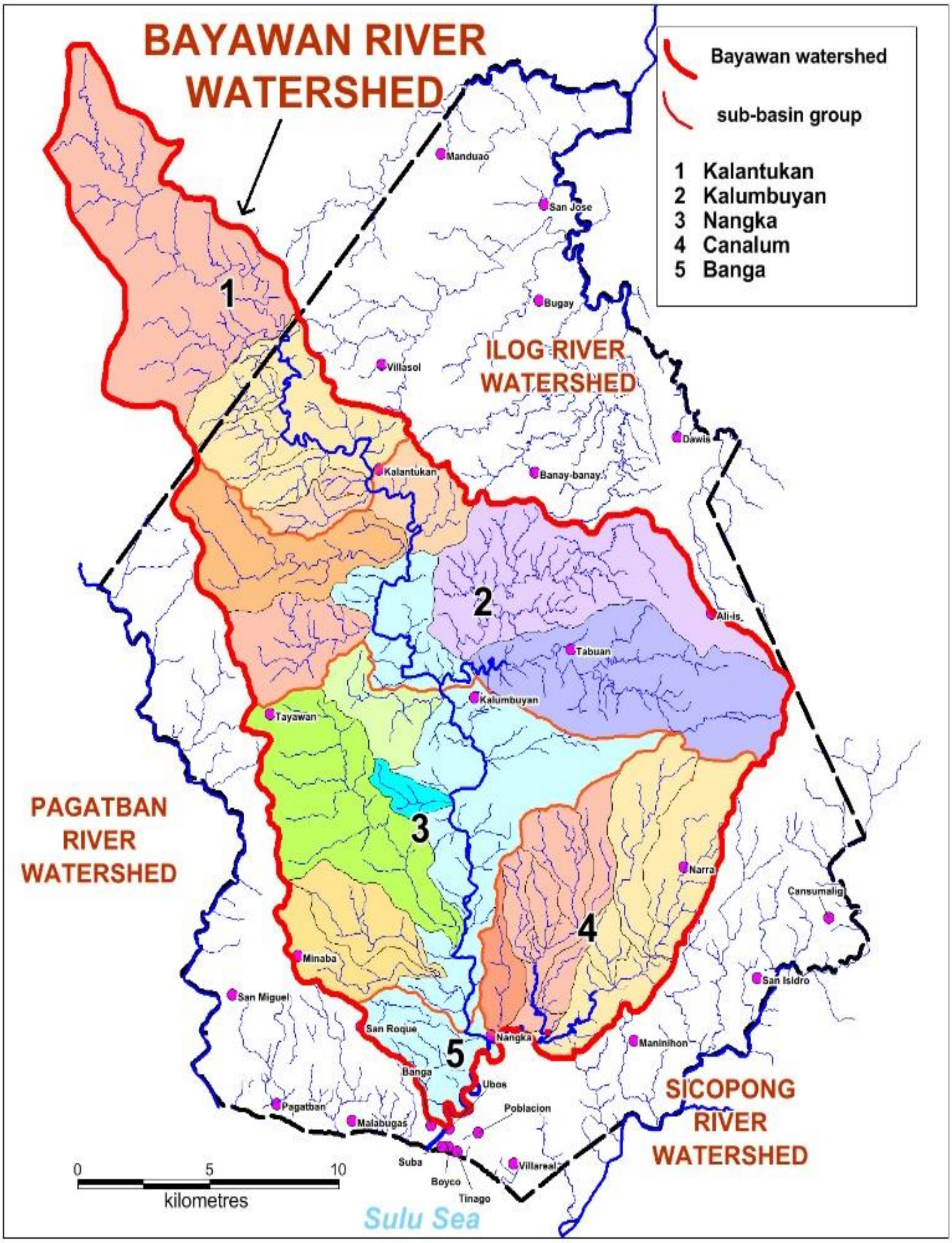
2.2.1.2 Change in Stream, Water Depth

Baseline Conditions

The Bayawan River watershed is a relatively moderate-size river system, measuring about 430 km^2. It flows southerly and is slightly elongated along 38 km from the farthest upstream drainage divide to its mouth, and about 20 km across its longest midstream width. The basin forms a major semi-elongated dendritic drainage network (Figure 2-55) cutting through and draining the city's middle part, while its headwaters emanates from beyond the city's northern boundary with the adjacent province of Negros Occidental.

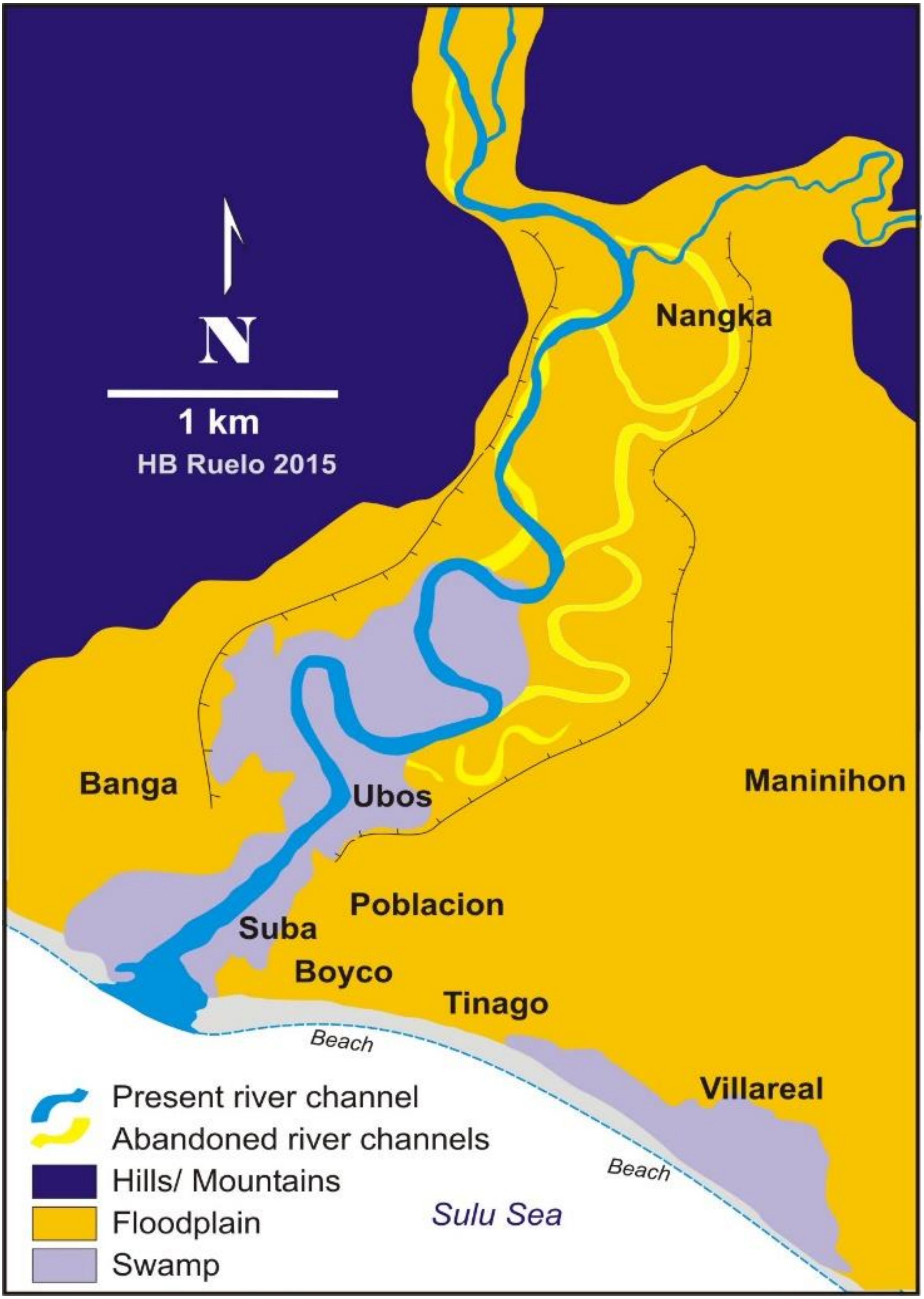
Bayawan River in the floodplain area at its current condition is a mature, heavily silted meandering fluvial system. In the 1950's through 1970's, local people have remembered the river's pristine nature where water depths allowed large barges and ships to easily navigate up to 6km inland towards Barangay Nangka (Figure 2-50). There are no old bathymetric data available for comparison with current conditions, but the true measure of the severely degraded channel way is the occurrence of more frequent and devastating floods affecting the whole Bayawan floodplain. The Bayawan River which cuts through the rapidly aggrading floodplain has reached its natural base level of degradation, and therefore it is subject to repeated floods, rapid sedimentation, and river avulsion during extreme flood events.

Water depths are so shallow, especially during low tides, measuring from 3 to 0.20 meters during the drier months. Bank heights of the meandering river in the floodplain are generally low, measuring from 3 meters to just less than a meter during high tidal levels. This is due to the natural low relief (e.g. low elevation) of the floodplain itself and compounded by heavily silted river beds. Near the coast and up to 1.3 km inland, an area where estuarine swamps are developed, the highest tides generally overflow the riverbank.



Source: Bayawan Dredging PreFS, Ruelo

Figure 2-49 Watershed Map of Bayawan River



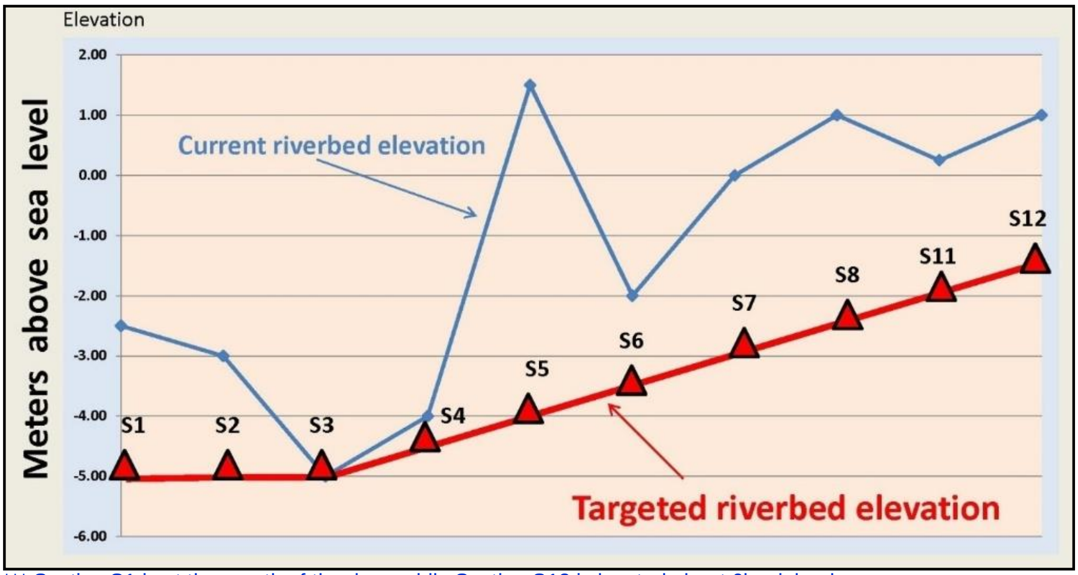
Source: Bayawan Dredging Pre-FS, Ruelo

Figure 2-50 Map of Bayawan River in the Floodplain Area

Impact Analysis

The project will cause some changes in the water depth of Bayawan River in the floodplain area. This, however, will not be drastic and massive alteration of the overall river depth. Only shallow portions of the river will be dredged, such that the original and natural base level of erosion/ aggradation be restored.

Dredging is apparently an extractive process, where the current pre-dredged bottom topography of the river and/or coastal area will be reduced. A change in water depth will be expected (Figure 2-51), which is the overall objective of the dredging process.



*** Section S1 is at the mouth of the river, while Section S12 is located about 6km inland

Figure 2-51 Bayawan River Longitudinal Section Showing Riverbed Profile Before and After Dredging

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At each dredging site of the river segment, excavation of silted sediments will be done starting at the central portion of the water channel, down to a depth of 2 to 3 meters from the current river bottom. The cross-sectional riverbed profile will be maintained such that river bank slopes will not be steepened and so further erosion will be avoided (Figure 2-52).

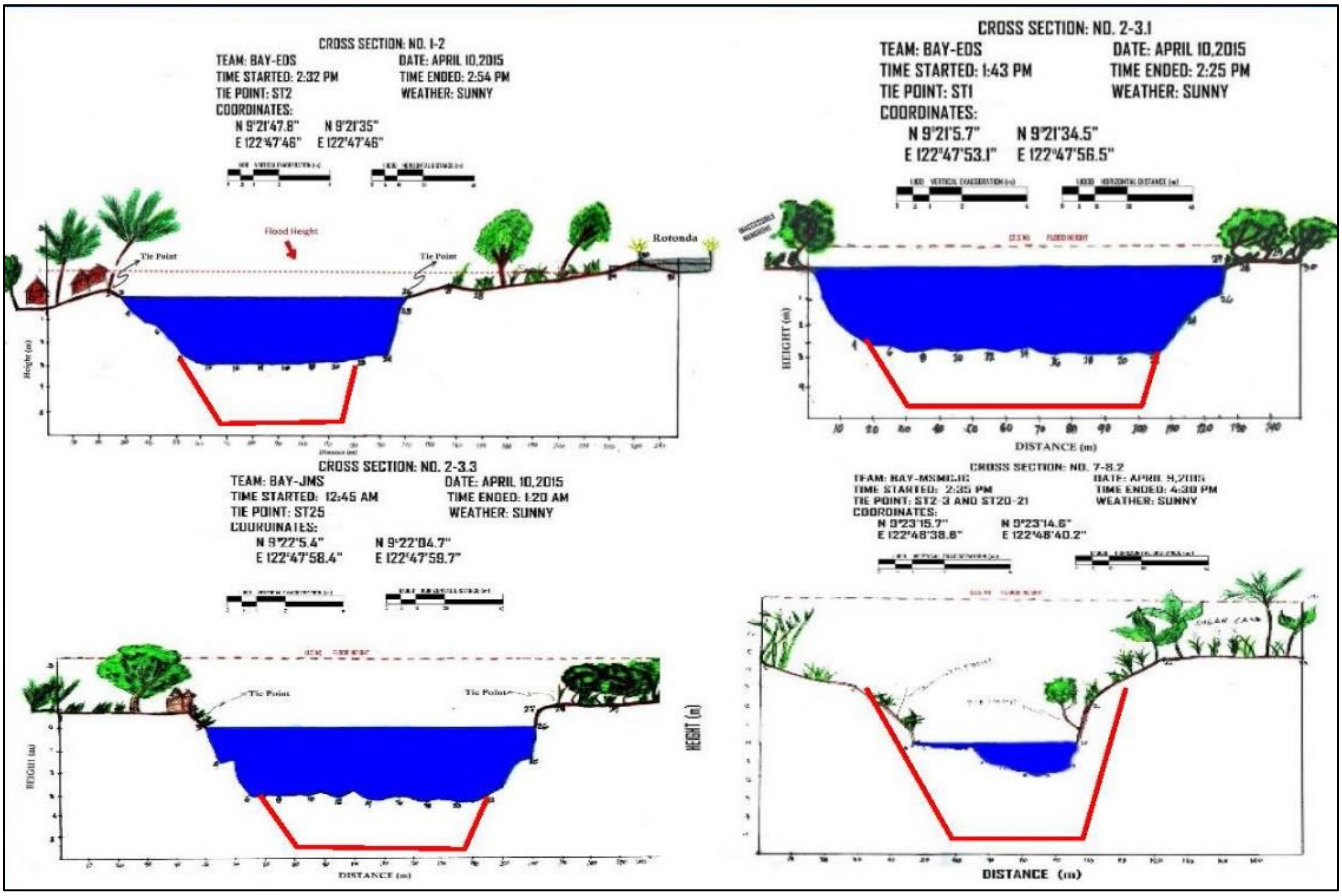


Figure 2-52 Bayawan River Cross-sections Showing Riverbed Profile Before and After Dredging

<u>Management Plan</u>

Design limits for dredging must be strictly followed. All sounding surveys before and after dredging will be regularly assessed and these records will be kept for future reference.

Groundwater level will be regularly measured to identify the extent of the effect from dredging. An appropriate groundwater monitoring wells will be set up for this purpose.

<u>Monitoring Plan</u>

All groundwater monitoring wells will be kept functional and weekly records of water depth will be conducted.

2.2.1.3 Depletion of Water Resources/Competition in Water Use

<u>Baseline Conditions</u>

The Bayawan River watershed is a large drainage system with large recharge capabilities. Being situated in dominantly permeable sedimentary rocks (sandstone, siltstone, shale and limestone), the ground formation has several productive aquifers with an all-year round supply of surface and spring water (See Figure 2-53).
Domestic water for distribution in the Bayawan urban area come from springs, but shallow wells are also widely used. Private tube-wells and open wells extract groundwater that are extensively used in the Bayawan floodplain area for domestic purposes.

Surface water consists of freshwater that flows and collects in the Bayawan River and its tributaries. Groundwater, on the other hand, collects in porous layers (known as aquifers) of the Quaternary alluvial plain and fractured bedrocks. The whole Bayawan floodplain area constitutes a large shallow aquifer, dominated by loose, soft fluviosol soil type. The major user of surface water is the agricultural sector, particularly for the provision of irrigation services. Another source of groundwater are cold bicarbonate springs from limestone-covered areas, which is abundant in Bayawan.

Static water levels (water table) in Bayawan ranges from 2 to 5 meters in depth. Lowering of the water table during dry periods is not significant, but could be about 1 to 3 meters.

Geologic conditions determine the path by which water from precipitation reaches the saturation zone or the water table. The water table is near the surface, and so there is considerable percolation through the soil. In the Bayawan floodplain, there seems to be no impermeable layers above the water table that may also prevent such direct percolation. During periods of heavy precipitation, flooding usually occurs and the whole floodplain is saturated with water.

Saltwater intrusion occurs in the Bayawan floodplain area, but there is no measured data as yet. There is no over-extraction of groundwater because there is a continuing recharge from precipitation and subsurface flow from Bayawan River, and domestic water is abundantly supplied from numerous artesian springs. Recharge from precipitation penetrate the alluvial soil directly to the groundwater, or may enter surface streams, and percolate from these channels to the groundwater reservoir.

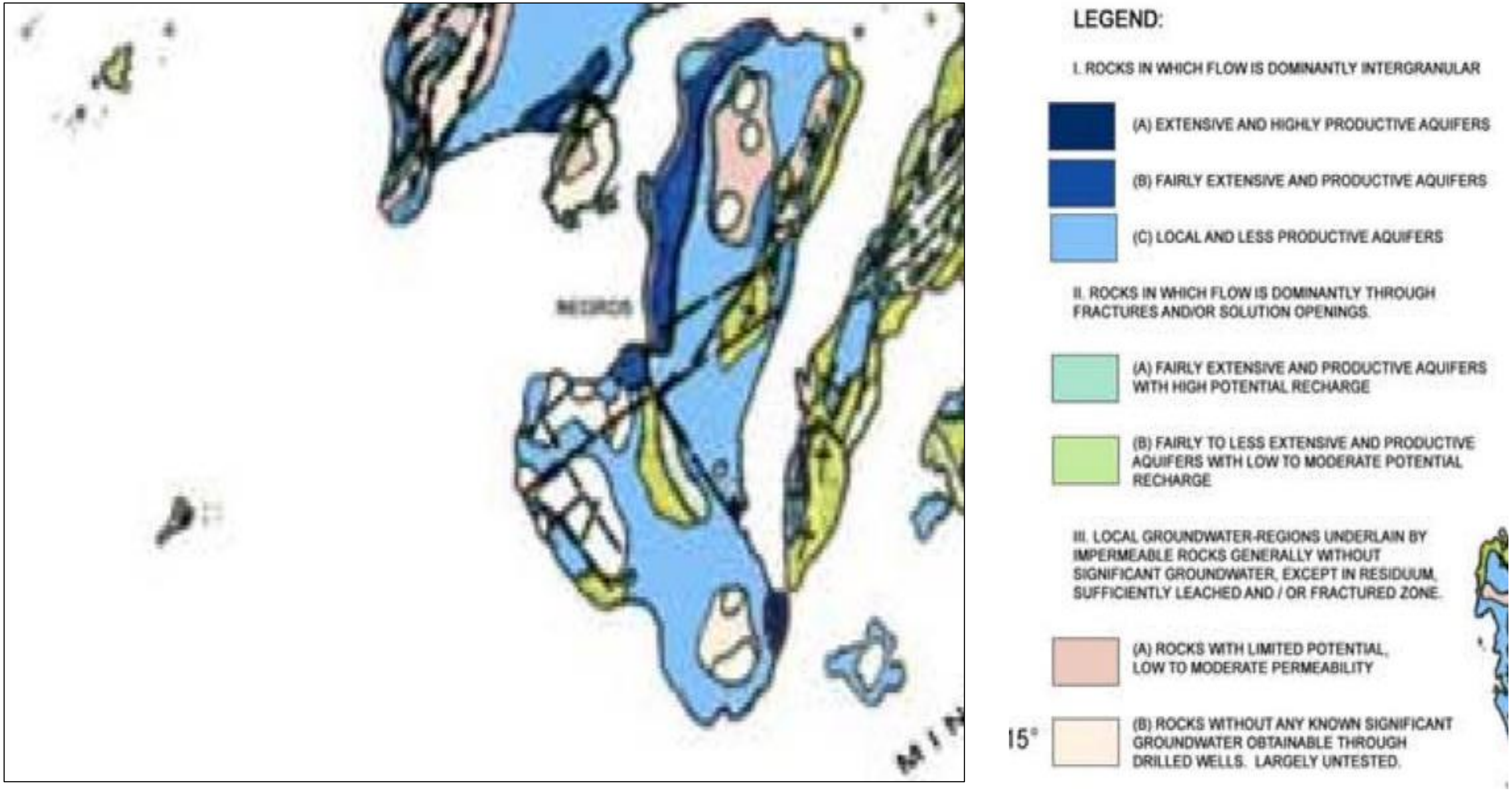


Figure 2-53 Groundwater Availability Map, Negros Island

Table 2-26 Water Well Data of Bayawan City

Well No	Local No	Ground Elev	Owner	Location	Well Depth Meters
1	Cambulo spring	3	Bayawan WD	Sitio Cambulo, Banga	NA
2	Manampa Spring	2	Bayawan WD	Sitio Manampa, Pagatban	NA
101	KK 1	4	DPWH	Poblacion	
102	KK 2	4	DPWH	Poblacion	7
103	KK 3	4	DPWH	Poblacion	9
104	KK 4	4	DPWH	Poblacion	
105	KK 5	4	DPWH	Poblacion	9
106	KK 6	4	DPWH	Bgy. San Ramon	7.6
107	KK 7	6	DPWH	Bgy. San Ramon	12.2
108	KK 8	5	DPWH	Bgy. Villareal	
109	KK 9	7	DPWH	Bgy. Maninihon	24
110	KK 10	5	Sosimo Obang	Bgy. Napit-an	12.5
112	KK 12	4.5	Julio Besabes	Bgy. Napit-an	
113	KK 13	6	Victor Gerian	Bgy. Napit-an	
114	KK 14	3	DPWH	Bfy. Napit-an	12.2
115	KK 15	4	Baltazar Ferrer	Bgy. Maninihon	
116	KK 16	7	DPWH	Bgy. Banga	9.2
117	KK 17	2	DPWH	Bgy. Malabugas	15.2
118	KK 18	2	Simplicio Turida	Bgy. Malabugas	
119	KK 19	2	Patria Turida	Bgy. Malabugas	
120	KK 20	2	Magno Marfil	Bgy. Malabugas	
121	KK 21	5	Fermin Tuisa	Bgy. Banga	
122	KK 22	4	B. Padilla	Bgy. Banga	
123	KK 23	3.9	Joel Silvano	Bgy. Banga	
124	KK 24	3.7	Rogelio Pamilaga	Bgy. Banga	
125	KK 25	7	DPWH	Bgy. Banga	27.4
126	KK 26	3	Jerry Sarana	Bgy. San Ramon	
127	KK 27	4	Boy Campio	Bgy. San Ramon	
128	KK 28	5	Pancha Pinero	Bgy. San Ramon	
129	KK 29	7	Fabian Caligcid	Bgy. Nangka	
130	KK 30	6	Barangay Well	Bgy. Nangka	
131	KK 31	6	Luis Bilbot	Bgy. Nangka	5
132	KK 32	6	Vergilio Taborada	Bgy. Nangka	
133	KK 33	6	DPWH	Bgy. Nangka	
134	KK 34	6	Jose Balor	Bgy. Nangka	5.5
135	KK 35	6	S. Duhaylungsod	Bgy. Nangka	9
136	KK 36	6	Ricardo Sulla	Bgy. Nangka	32
137	KK 37	5	Rodrigo Resisio	Bgy. Maninihon	
138	KK 38	5	DPWH	Bgy. Maninihon	
139	KK 39	5	H. Quilojano	Bgy. Maninihon	
140	KK 40	6	Jose Torrefranca	Bgy. Maninihon	
141	KK 41	4	H. Tabaosares	Bgy. Maninihon	
142	KK 42	5	Barangay Hall	Bgy. Caranoche	
143	KK 43	5	Ria Maypa	Bgy. Pagatban	
144	KK 44	5	DPWH	Bgy. Pagatban	
145	KK 45	5	Barangay Well	Bgy. Pagatban	2.7
146	KK 46	5	Santiago Rabot	Bgy. Pagatban	2
147	KK 47	5	Barangay Well	Bgy. Banga	27.4
148	KK 48	2	Teofilo Mahusay	Bgy. Suba	

Impact Analysis

There will be no depletion of local water resources during the dredging operations. The Bayawan floodplain and adjacent coastal areas, constitutes a large aquifer that is substantially recharged from a large watershed. Existing shallow water wells will still maintain their static water level even if dredging occurs. Bayawan's freshwater supply is mainly sourced from large artesian cold springs located in the upland limestone area, which is being recharged.

Surface (fresh and saline) water and groundwater exchanges is so dynamic and common in the Bayawan floodplain area, being in an unconsolidated thick aquifer setting. The high permeability of the floodplain sediments is the key. The elevation of the riverbed at the project site ranges from 1 meter above to 5 meters below sea level, which lies at or below the static water level or water table.

Groundwater flow is guaranteed not to be disrupted when dredging occurs, as it is driven by strong gradients in the Bayawan River system, and dredging will not alter this system and therefore will not deplete water resources of the city. Modifications caused by dredging will not significantly affect groundwater availability.

Management Plan

There is no significant impact identified on depletion of water resources. However, limits to depth of dredging as set by the design should be followed strictly.

In anticipation of climate change, Project Management will aggressively implement watershed conservation programs in collaboration with key local and national agencies. The proponent will support this effort.

Monitoring Plan

Monitoring of groundwater level will be done regularly. Depth to groundwater from monitoring wells and those that are existing for domestic use will be recorded. Design depth limits before and after dredging shall be monitored and recorded. This will be correlated with any change in groundwater level.

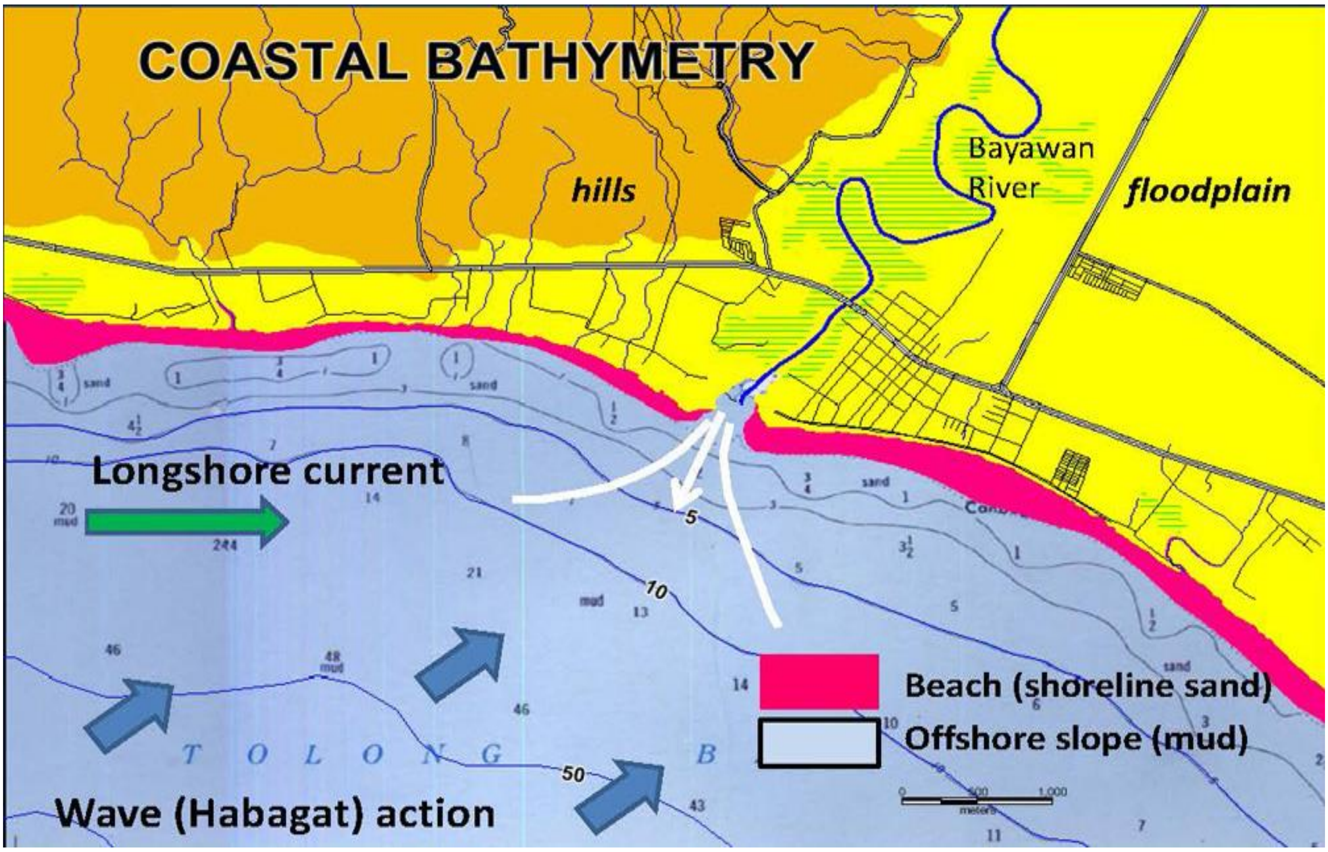
Oceanography

Baseline Conditions

Bathymetric Survey and Map

Bayawan River empties into the Sulu Sea, a large deep-water body occupying the western border of the Visayan islands Bayawan's total coastal length is 15.3 km. of which about 500 m forms part of the deltaic mouth of the river. Longshore drift currents move eastward around the Sulu Sea has apparently prograded the beach shoreline and formed sand bars and spits.

The outflow portion of the Bayawan delta is basically a tide-dominated shoreline, with a strong influence of longshore currents, and which move sediments along the entire beach line coming from fluvial systems of both Pagatban (8 km west) and Bayawan Rivers (Figure 2-54). Wave currents due to Habagat (SW monsoon) weather conditions are generally directed orthogonal to and slightly oblique of the Bayawan shoreline.



Source: Bayawan River Dredging Pre-FS, Ruelo

Figure 2-54 Bathymetric Map of Coastal Zone (in meters) Showing Riverine Outflow and Longshore Currents Direction

Measurement of Water Current

Surface current profile measurements were conducted off the coastal waters of Bayawan on February 25, 2018 from 9:00 AM to 2:00 PM. Six current drogues were deployed during the sampling period. For each drogue, GPS positions were taken every sampling interval. The determination of the velocity is based on the formula

$$\vec{v} = \frac{\mathrm{D}\vec{r}}{\mathrm{D}t}$$

where $\mathrm{D}\vec{r}$ is the change in displacement and $\mathrm{D}t$ is the sampling time interval. The change in displacement was determined from the change in the coordinates (latitude and longitude) at time interval $\mathrm{D}t$. The sampling interval ranged from 40 to 80 minutes. There were 5 current measurements per drogue with a total of 30 current measurements during the whole sampling period.

During the sampling period, the surface current was predominantly towards the southwest direction (Figure 2-55). The current speed ranged from 0.1-1.4m/s.

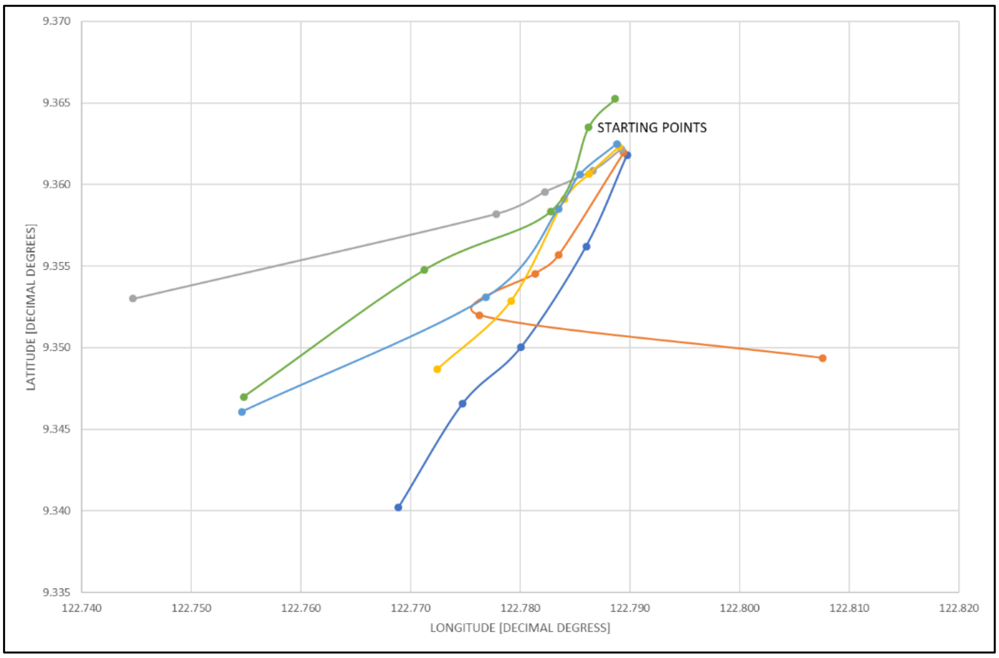


Figure 2-55 Results of Surface Current Measurement off Bayawan Coastal Waters

Analysis of Available Proximate Tides Data

There is no existing tidal gauge in the city and predictions are based on constants derived from the harmonic analysis of a year's observation for tides. Normally there are two high and two ebb currents each day, as the principal variations in the tides follow the moon's changing phases (Figure 2-56). Records of 09 April 2015 shows that the mean difference of the highest and lowest tidal levels is around 1.31 meters (Table 2-27).

A river section at Bayawan bridge illustrates the vertical difference of the tidal pattern (Figure 2-57). The highest tidal seawater rise can flow up to 5 km inwards along Bayawan River, in the vicinity of barangay Nangka. The DOST-ASTI (Department of Science and Technology-Advanced Science & Technology Institute) has installed, since mid-2013, a water level monitoring station located at Bayawan bridge. The instrument monitors the tidal level fluctuations as well as the water level along downstream Bayawan River.

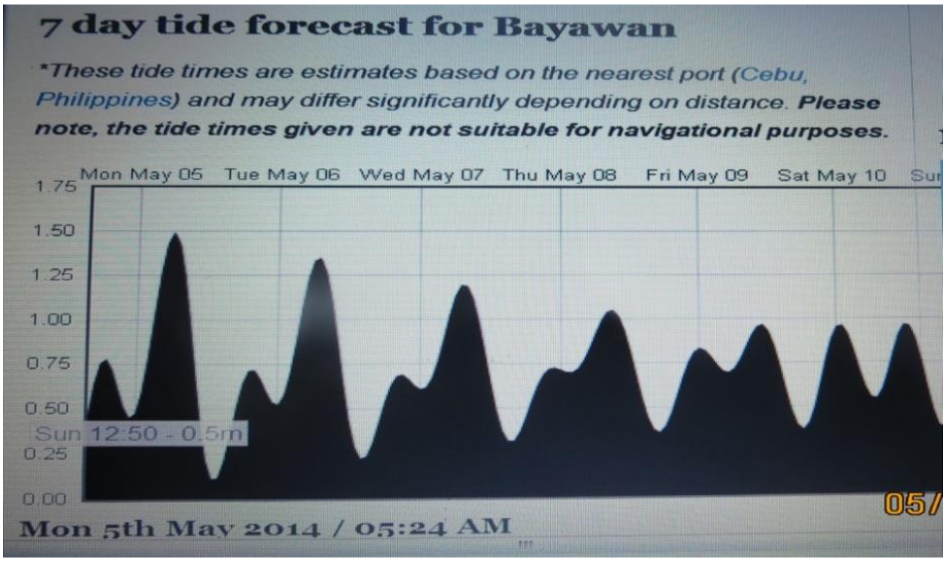
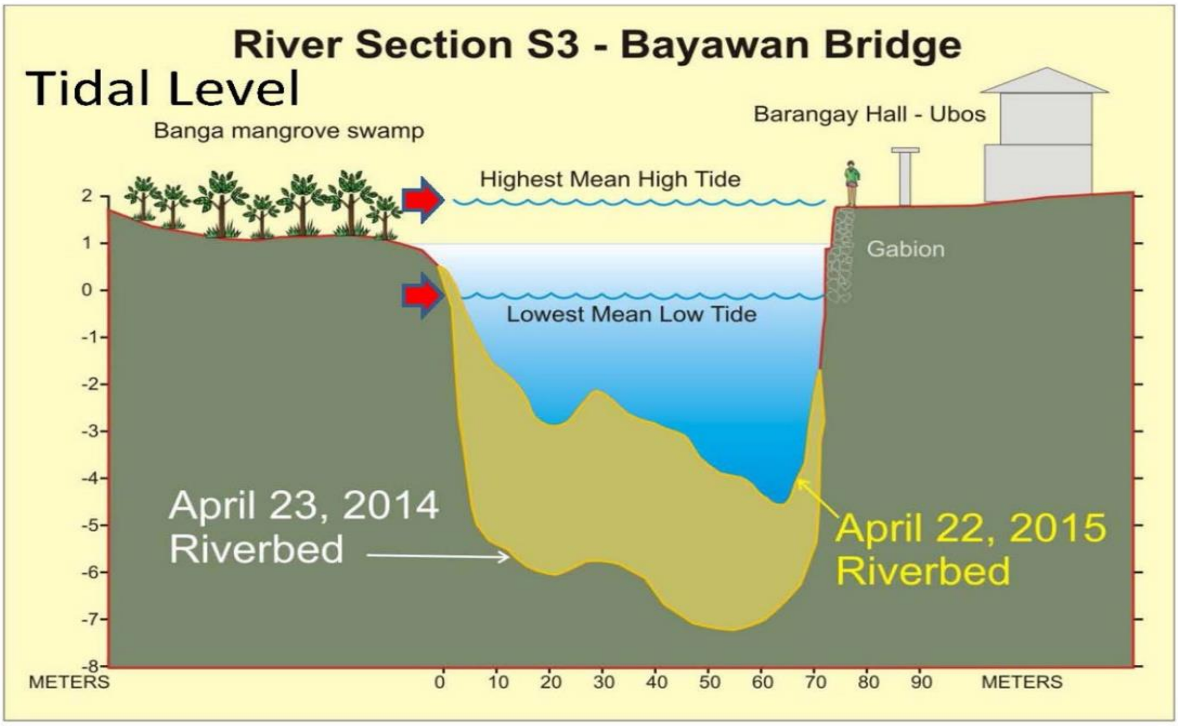


Figure 2-56 Normal Tidal Pattern for Bayawan

Table 2-27 Comparison of Tidal Data of Bayawan, Cebu, and Manila

Comparison of Tidal Levels					
Date :	**09-Apr-15**				
			Bayawan		
	Manila Tidal	Cebu Tidal	Tides.INFO	Bayawan Bridge*	Sensor reading*
1st High Tide	0215 H	0150 H	0401 H	0130 H	
1st Low Tide	0530 H	0705 H	1013 H	0600 H	
2nd High Tide	1230 H	1325 H	0626 H	1300H	1.63
2nd Low Tide	2030 H	2025 H	2238 H	2020H	0.32
* from ASTI-DOST water level monitoring meter					
Date :	**10-Apr-15**				
			Bayawan		
	Manila Tidal	Cebu Tidal	Tides.INFO	Bayawan Bridge*	Sensor reading*
1st High Tide				0200 H	0.87
1st Low Tide				0650 H	0.63
2nd High Tide					
2nd Low Tide					
* from ASTI-DOST water level monitoring meter					



Source: Bayawan Dredging Pre-FS, Ruelo

Figure 2-57 Cross-section at Bayawan Bridge Showing Vertical Height Difference of Highest and Lowest Tidal Level

Backwater Effect

Because of its low topographic relief, a large-section of the river, up to 6 kilometers inward, is affected by semi-diurnal ingress of sea water during high tides from Sulu Sea, and the water flow dynamics of the river is therefore influenced by this condition (backwater effect). This river outlet at Barangay Suba is strongly affected by longshore currents and strong tidal action, an area where fresh and salt water are mixed, which have formed estuarine or swampy mangrove areas. Sea-level rise (and land subsidence) further causes the backwater effect.

Hydrodynamic Modelling

A Hydrodynamic Modelling based on the Bathymetry, currents and tidal analysis is impossible to achieve at this time. It is not feasible to come up with this because only very few people in the country are adept in this kind of Software or Program

Particle Dispersion Modeling and Map

Though this may be more achievable than the hydrodynamic model, it would take a very long time for our team to come up with a map and model. Hence, this also is not feasible in this study.

Storm Surge Hazard, exposure, vulnerability, risk maps

Being located in north pacific basin which is the most active region of cyclogenesis in the world, the Philippines is frequently visited by tropical cyclones (TC). An average of 20 TC per year enter the Philippine area of responsibility (PAR), around 9 of which make landfall. Tropical cyclone enhances monsoons which cause heavy rainfall, bring in strong winds that are capable of destroying properties. This strong wind also causes storm surges that inundate the coastal portions of the country.

Storm tide levels are categorized into 4 groups, which is based on its peak height, this is done to create a storm surge advisory (SSA) based on the probable storm tide height. The 4 groups are SSA 1 (0.01m to 2m), SSA 2 (2.01m to 3m), SSA 3 (3.01m to 4m) and SSA 4 (4m and above).

Figure 2-58, Figure 2-59, Figure 2-60 and Figure 2-61 below show the Storm Surge Hazard Maps based on the type of Storm Surge Advisory.

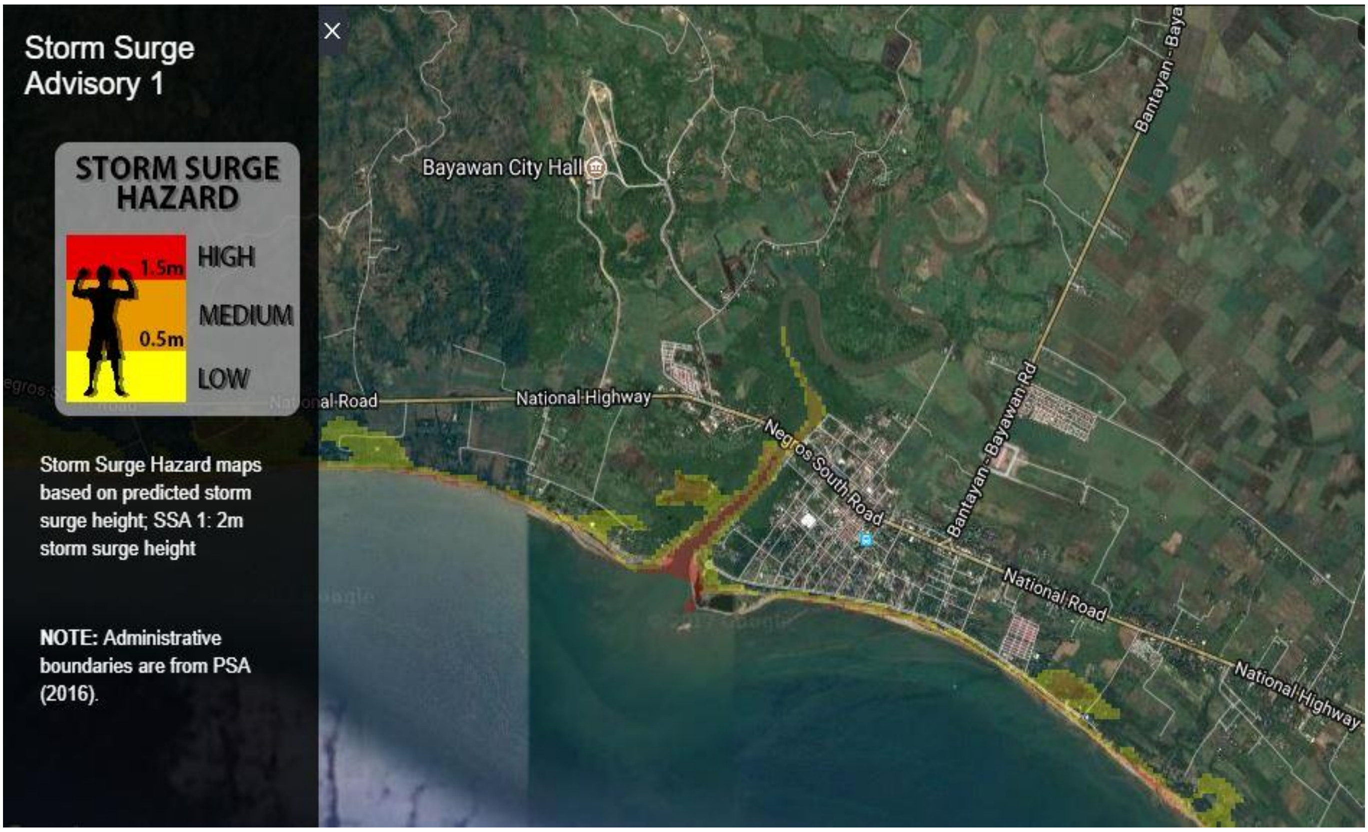


Figure 2-58 Bayawan City SSA 1 Hazard Map

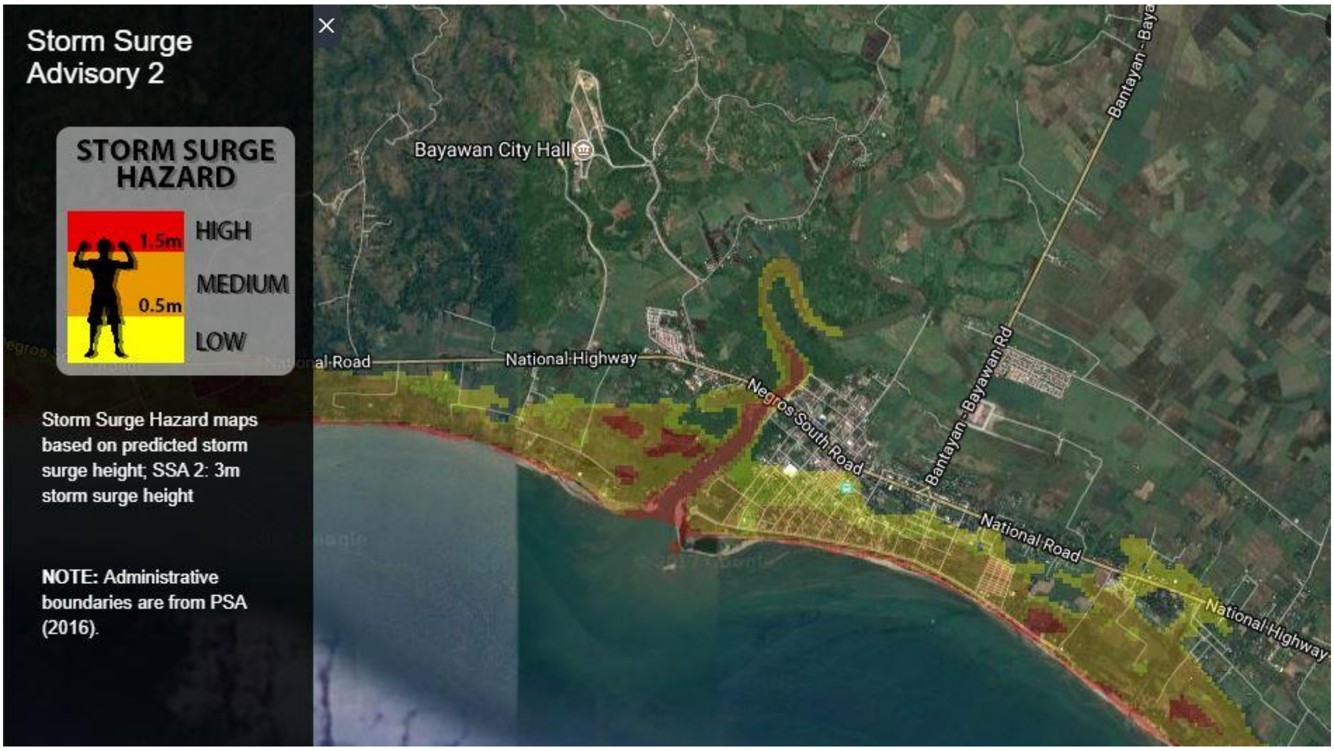


Figure 2-59 Bayawan City SSA 2 Hazard Map

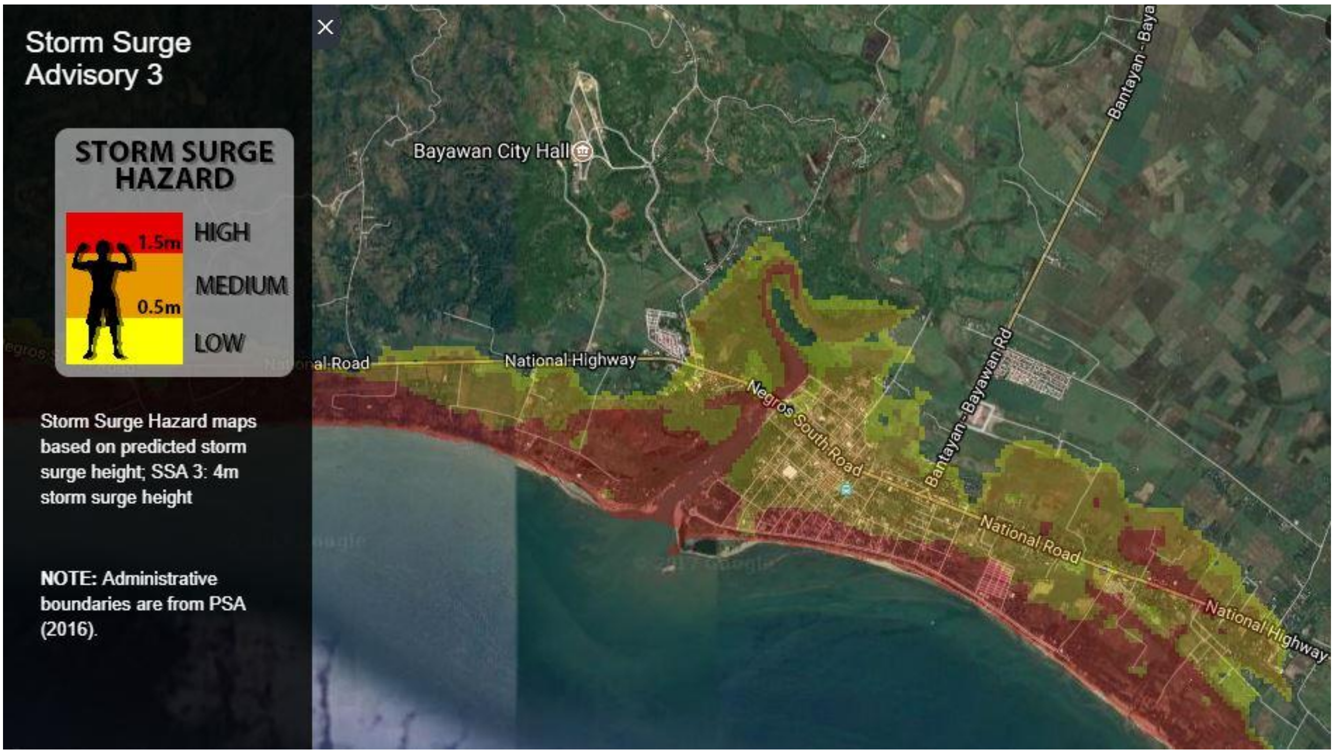


Figure 2-60 Bayawan City SSA 3 Hazard Map

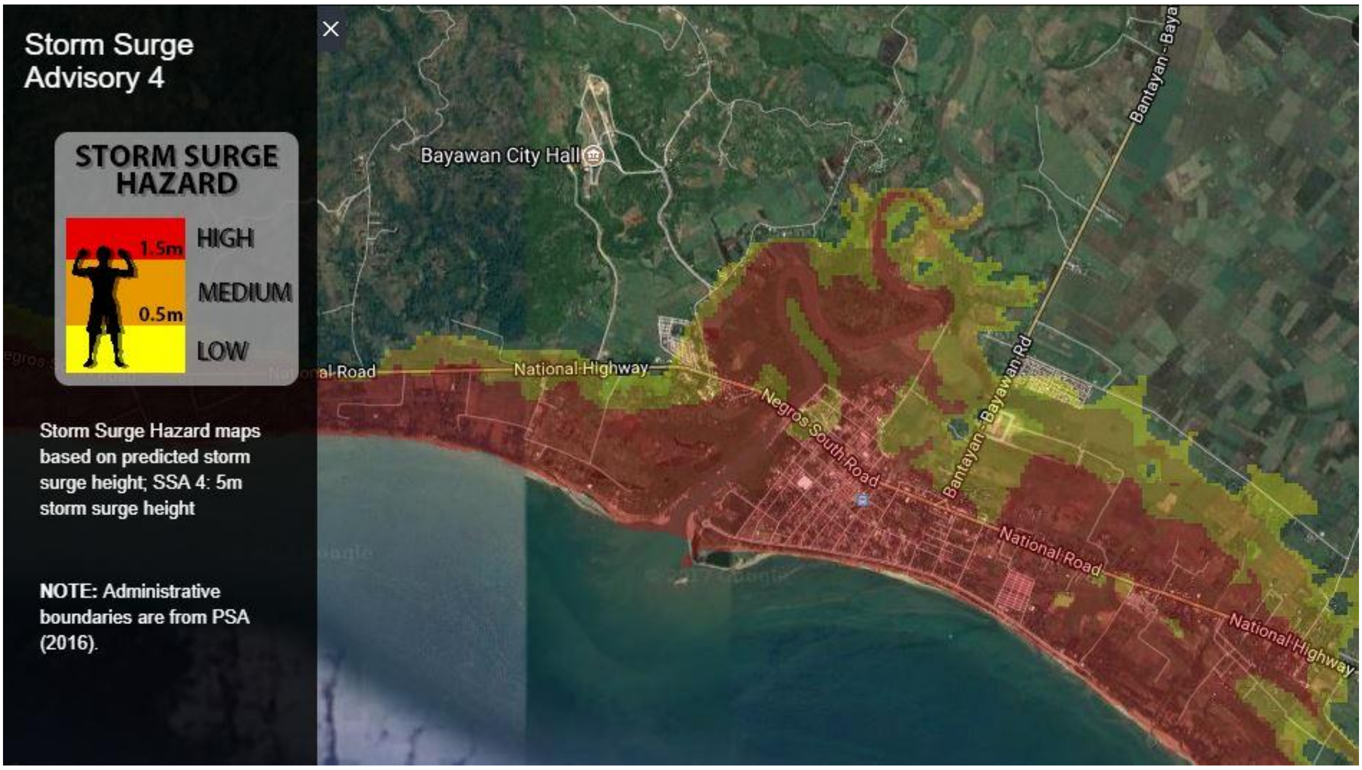


Figure 2-61 Bayawan City SSA 4 Hazard Map

Impact Analysis

Dredging will not change or disrupt the tidal circulation pattern in the project area. it is expected that the circulation pattern will remain the same during and after project implementation.

However, schedule of operations using specific dredger size may be dependent on the variation of tides. Knowledge of tidal patterns is essential if navigation on the river reach is the primary consideration.

At this point, it is worthwhile to note that the dredging design is anchored on channel and slope reconfiguration to accommodate flood water for 25-year return period. The depth of cutting is very much limited without consideration for appropriate depth for navigation.

Management Plan

Appropriate dredgers and type of dredging operations will be selected that conforms to the level of tide occurring at a given time. The choice should not compromise the design limits set by the Detailed Project Design as approved.

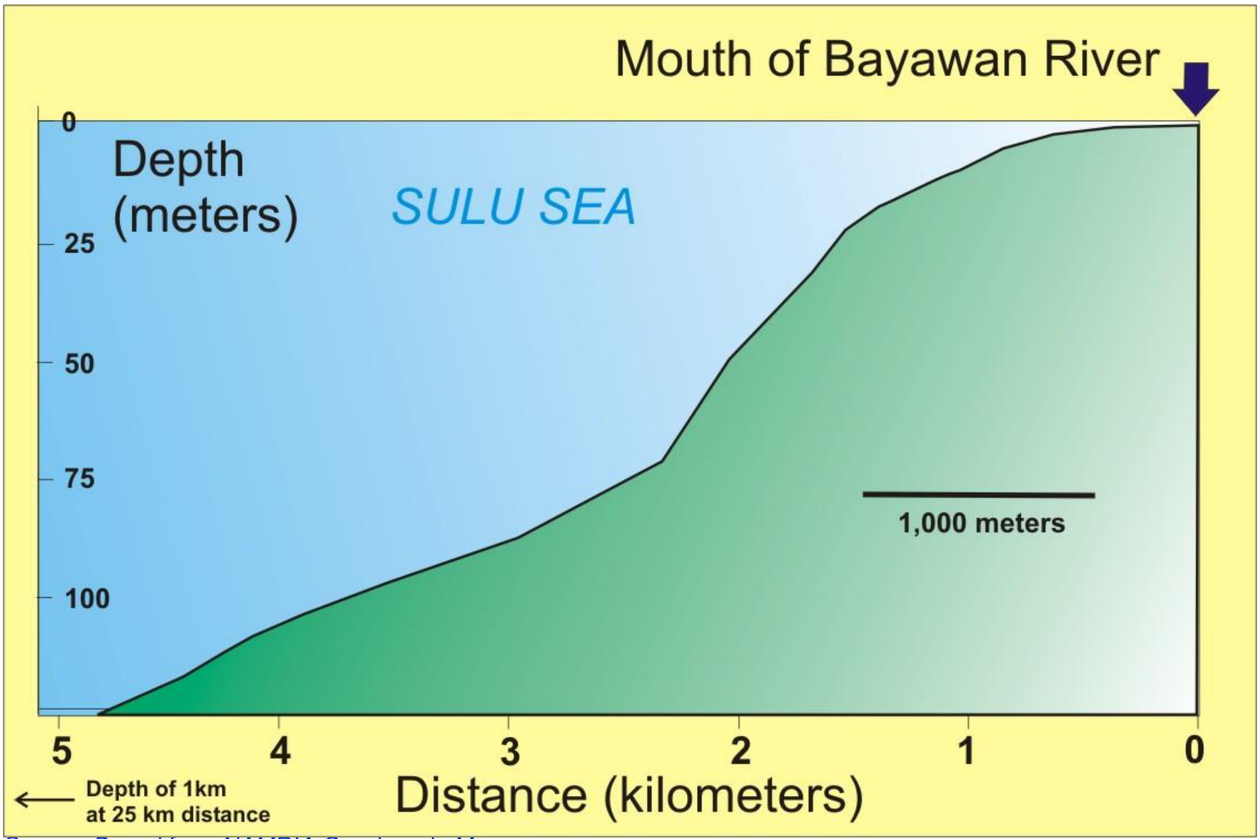
Monitoring Plan

The sounding survey records as monitored will guide the dredging operations to ensure that design limits are not compromise. Any deviation should be reported and appropriate action taken as soon as possible.

2.2.1.4 Change in Bathymetry

Baseline Conditions

Based from regional hydrographic data (NAMRIA), the underwater coastal shelf slope is shallowly dipping in the first 100 meters from the shoreface and is moderately to steeply inclined (Figure 2-62). Some 2km away from the river's mouth, the sea bottom drops to about 50 meters in depth, and about 100 meters is attained 4km away from the Bayawan shoreline.

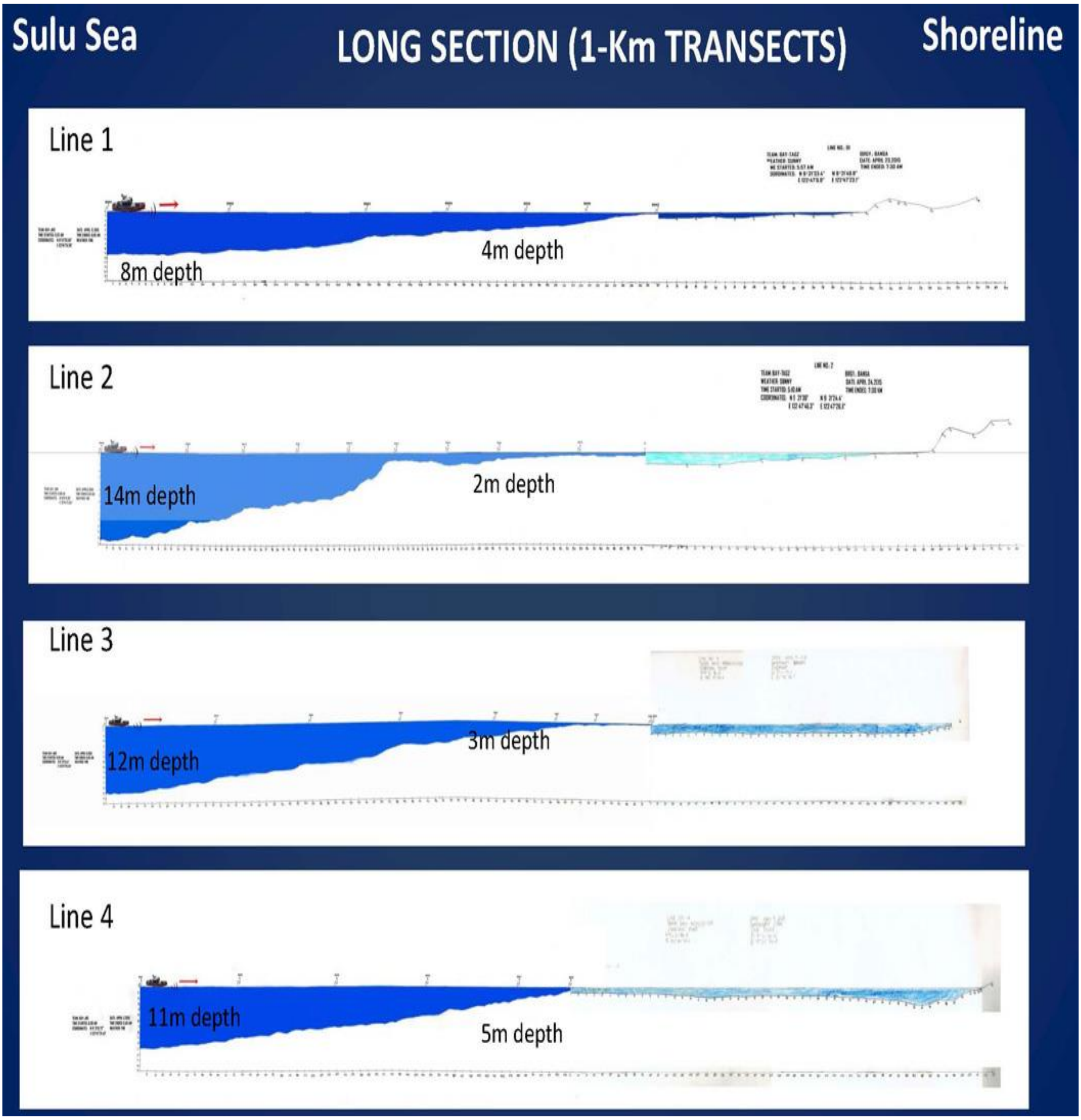


Source: Based from NAMRIA Quadrangle Map

Figure 2-62 Coastal Transect from Bayawan River

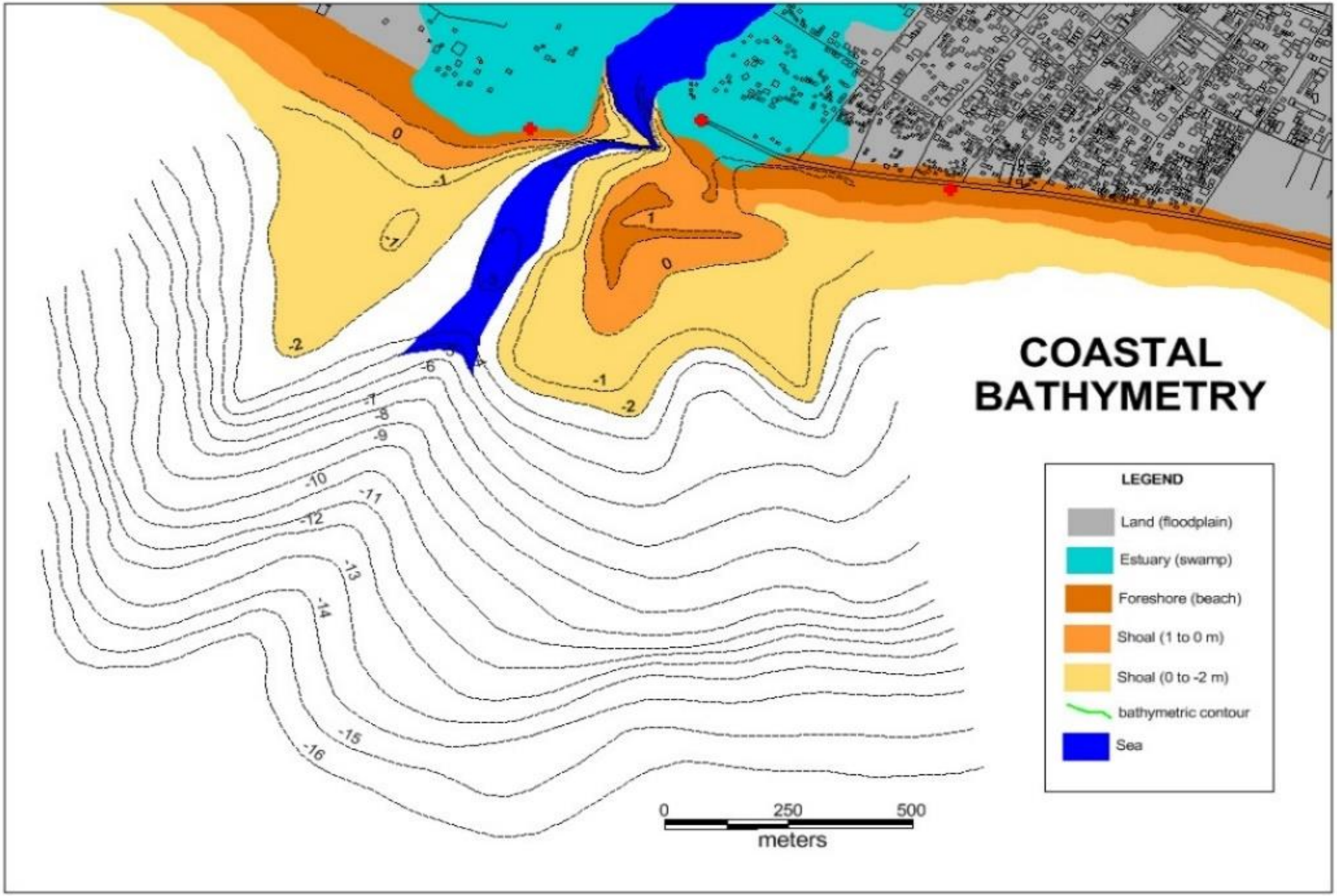
Bathymetric mapping in mid-2015 of 1km long transects showed a long shallow sea bottom profile at the mouth of Bayawan River. Only some 500 meters from the foreshore, the depth of the sea bottom ranges from 5 to 2 meters below mean sea level. About 1 km away, bottom depths varied from 14 to 8 meters (Figure 2-63).

The constructed bathymetric map of the Bayawan River mouth shows a 1.5 km wide and 0.5km long shoal of heavily silted area on both sides of a shallow river channel joining the Sulu Sea (Figure 2-64). This shallow heavily silted area is emergent (as sand bars) while its larger submerged portion has an average depth of 2 meters below mean sea level.



Source: Bayawan Dredging Pre-FS, Ruelo

Figure 2-63 Representative Coastal Bathymetric Transect Profiles

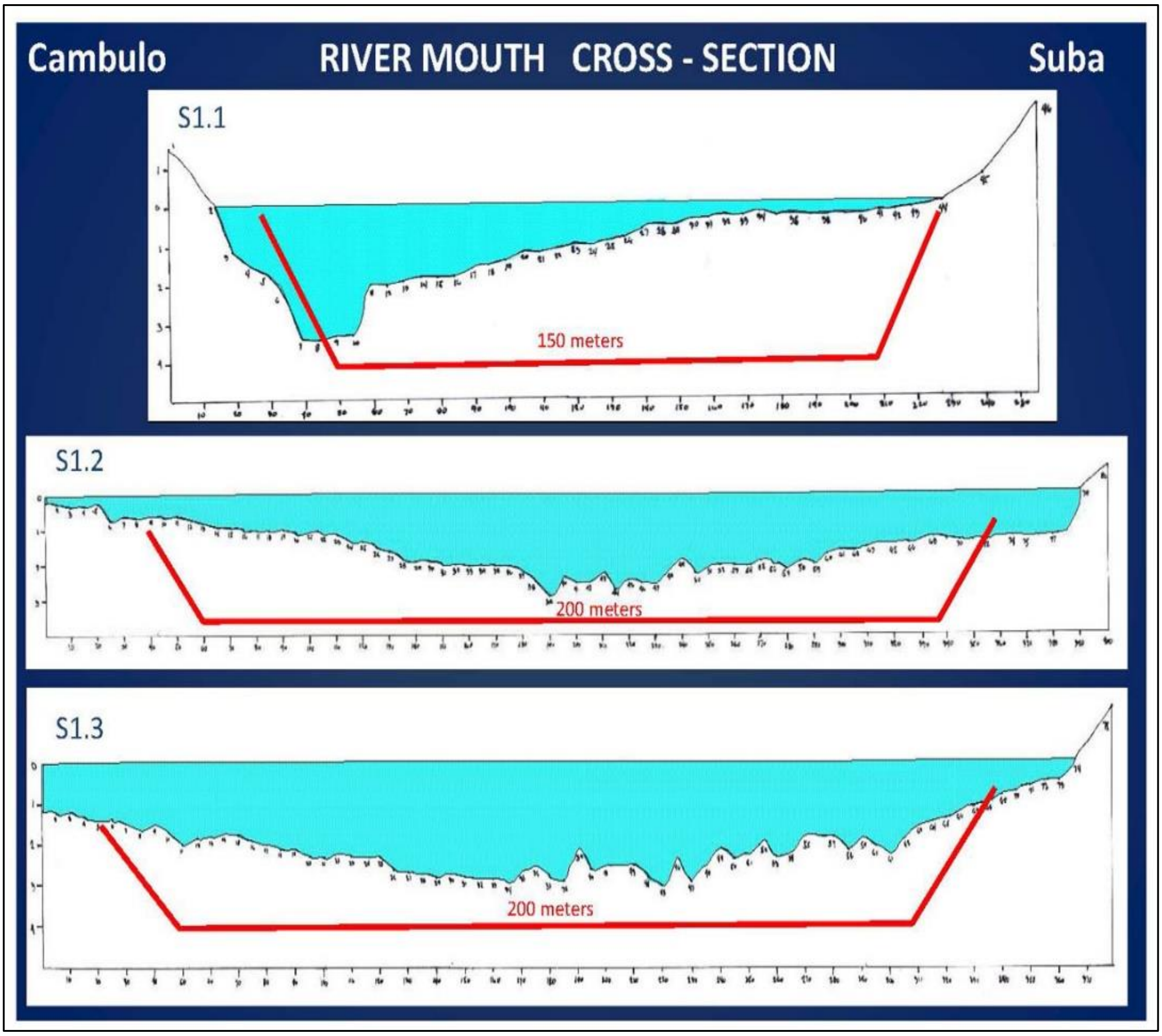


Source: Bayawan Dredging Pre-FS, Ruelo

Figure 2-64 Coastal Bathymetry at the Mouth of Bayawan River

Impact Analysis

As dredging will lower down the coastal seabed elevation, changes in its morphology will certainly occur. The post-dredging water depth profile would be about 4 to 8 meters below mean sea level, which is the sea bottom level during the 1950s. The dredging operations are to be done in the 1.5 km wide and 0.5km long shoal of the river's mouth, with target bottom down to 4 meters depth. A priority area to be dredged would be the central portion of the river's mouth, wherein about 150 to 200 meters of sediments could be removed (Figure 2-65). The outflow capacity of the river could then increase if desilting would be done at this area.



Source: Bayawan Dredging Pre-FS, Ruelo

Figure 2-65 Cross-sectional Profile at the Mouth of Bayawan River (showing priority area to be dredged)

Dredging the river mouth (sand spit and accreted shoals) will not likely permit larger waves to reach the shoreline that will cause, accelerate and intensify beach erosion.

There is also nature's way of healing itself - the excavated and desilted mouth of Bayawan River can still be covered or deposited by future sediments borne by future flood events. Sediment input into the river system, however, can be mitigated by holistic and appropriate watershed management practices.

Without the project, there is still heavy sediment-laden floods that will exacerbate existing physical conditions at the mouth of the river. A long-term solution to flooding in Bayawan City needs to reduce sediment yield and control upstream soil erosion. Dredging is only a temporary remedy for near-future inundation and improving navigation of fishers' boats along the river's mouth.

Management Plan

Channel cutting should incorporate precession in its operation by strictly limiting the depth and other specification as stipulated in the detailed engineering plan and utilize state of the art dredging equipment. To ensure appropriate design slope, sounding survey will be conducted before and after dredging operation on a given river section.

Monitoring Plan

The coastline area will be monitored regularly to check for any significant changes, especially coastal erosion and aggradation. The coastal area will be regularly monitored by photo documentation to check significant changes of the coastline due to sediment loading by longshore currents.

Water Quality

2.2.1.5 Degradation of Groundwater Quality

Baseline Conditions

Bayawan city is rich in spring water sources and have relatively shallow ground water table especially along the coastal plains and in the central valley areas. The Bayawan Water District, the city's main water service provider of domestic water utilizes or extracts water from Manampa Spring to deliver the local water supply demand; although recently, it has put in place deep-well pumps to augment supply. The LGU has also tapped Nahulog Spring in Malabugas which provides water for the abattoir, public market, fire station and some government offices. All hinterland barangays in the city have their own respective water systems which are mostly at level 2 also utilizes spring sources, except for Tayawan which is located on a high plateau that utilizes deep-well extraction.
There are 27 spring sources developed all-throughout the city that provides domestic potable water needs of the constituents, and at about six spring sources provide water for irrigation purposes namely Pagatban, Cansilong, Mantapi, Ohot, Palanan, Kandahay and Uban-Uban. The threat to these spring sources is the respective degradation of watershed cover. Recently, the FLUP implementation made some advances through the establishment of water production areas (WPAs) micro-watershed management mechanism.

The groundwater table is also relatively shallow with existing open-dug or pump wells able to extract in 6 to 18 meters. Areas proximate to the coast and the river are able to extract water in less than 6-meter deep wells. In Tayawan however, being located on a high plateau wells go as deep as 60 to 75 meters, but water is still found to be available year-round. Groundwater extraction from wells especially in the coastal areas has been highly discouraged since the 1990s primarily because of water quality monitoring indications that there are an increasing number of wells with water becoming not potable due *E. Coli* and other contaminants, brought about by the increasing population, density of households and establishments. The City Health Office and the local water district have gained success in this campaign for the constituents to use water delivered by the public utility. More recently, the increasing knowledge on threats of salt-water intrusion cases from other places have further reinforced the information campaign, however a local policy and a more systematic intervention is yet to be done.

Groundwater samples were collected for analysis to determine the groundwater quality of the Project site. Table 2-28 below is the result of the analysis:

Table 2-28 Groundwater Quality Test Results

Sampling Date: October 17, 2017				
Sampling Site Coordinates: 9°22'11.82"N / 122°47'57.81"E				
PARAMETERS	**METHODS**	**UNIT**	**RESULT**	**DENR STANDARD (Class C)**
Ph	Glass Electrode		7.8	6.5 – 9.0
DO	Iodometric	mg/L	10	5
Salinity	By Computation	g/Kg	0.045	
BOD_5	Azide Modification (Dilution Technique)	mg/L	<1	7
TSS	Gravimetric (dried @ 103°C - 105°C)	mg/L	124	80
Oil & Grease	Gravimetric (Petroleum Ether Extraction)	mg/L	3	2
Total Coliform	Multiple Tube Fermentation Technique	MPN/100ml	$54x10^3$	
Fecal Coliform	Tube Fermentation Technique	MPN/100ml	920	200
Sulfate (SO_4^{2})	Gravimetric	mg/L	23	275
Nitrate as NO_3 - N	Brucine Sulfate	mg/L	0.06	7

Figure 2-66 Groundwater Quality Sampling Site Map

Impact Analysis

The implementation of the project will not result to degradation of groundwater quality in the area. There is no disturbance that will occur in the recharge area. The river can be considered as an effluent river, typical for those found in alluvial plains. The groundwater that seeps into the river will have a potential to increase its volume approximately proportional to the materials extracted from the channel reconfiguration. This amount is expected to be insignificant compared to the available volume of groundwater in the area thus lowering of water table is not likely.

The location of existing wells as shown in Figure 2-67 is relatively far from the project site therefore the effect by dredging is nil.

****Blue circles to the left are cold water springs*
Source: LWUA

Figure 2-67 Location of Waterwells in Bayawan City Urban and Sub-urban Areas

Management Plan

There is no significant impact identified therefore this concern is not necessary. However, proponents and stakeholders should realize the complexities associated with the behavior of the groundwater in particular. Hydrological as well as geological processes occurring offsite may have impacts on the project site. For example, the unregulated use of recharge areas, indiscriminate tapping and extraction from wells, natural occurrence of geologic processes, reduction of rainfall due to climate change and other related anthropogenic activities may as well contribute to changes in groundwater characteristics.

Monitoring Plan

Groundwater level from existing wells in the vicinity of the project site will be monitored regularly to check changes in water level in the course of project implementation. MMT will designate areas of concern on this regard and records from monitoring activities will be kept for future reference.

Dredging depth limits should be monitored as well. Sounding survey will be conducted before and after dredging and results are regularly assessed. This should be a made as a standard operational protocol.

2.2.1.6 Degradation of Surface Water Quality

The survey was conducted at six (6) pre-determined stations beginning from upstream down to the sea (See Figure 2-68).

Four sampling points were established within the river system namely A (river delta), B (400-m from the river delta), C (after the bridge), and D (6 km. from the river delta).

Surface water parameters such as dissolved oxygen, pH, and water temperature were measured using OrionTM field meters while turbidity was determined with a Secchi Disk from all the mentioned stations.

Salinity was also determined in the laboratory with an Atago field refractometer from collected water samples.

Additionally, 1-gallon water samples from Points A, B and D were collected for selected chemical parameters. These samples were kept chilled (iced) in an ice chest while in transit back to the laboratory. Water sample for coliform testing and oil and grease were also collected using special sealed containers from points A, C and D.

Table 2-29 below lists the geographic coordinates of the 4 sampling stations in testing for surface water quality.

Table 2-29 Surface Water Sampling Sites Coordinates

SAMPLING SITE	COORDINATES	
	LONGITUDE	LATITUDE
Site A	122°47'38.11"E	9°21'39.82"N
Site B	122°47'48.49"E	9°21'51.67"N
Site C	122°48'7.22"E	9°22'9.56"N
Site D	122°48'41.30"E	9°23'1.22"N

Figure 2-68 Surface Water Quality Sampling Points

Table 2.18 shows the Standard Methods performed by an independent laboratory in Mandaue City, Cebu on the collected samples (APHA et al. 2012).

Table 2-30 Water Quality Test Parameters and Standard Testing Methods

PARAMETERS	TEST METHOD
Surfactants as MBAS, mg/l	5540 C. Colorimetric
Nitrate, mg/l	AOAC No. 973.50 Colorimetric
Phosphate, mg/l	4500-P C. Vanadomolybdophosphoric Acid-Colorimetric
Chloride, mg/l	4500-Cl^- B. Argentometric
Arsenic, mg/l	Silver Diethyldithiocarbamate – Colorimetric
pH	4500-H^+ B. Electrometric
Total suspended solids, mg/l	2540 D. gravimetric
Total dissolved solids, mg/l	2540 C. gravimetric
True color, TCU	2120 B. Visual Comparison
Dissolved oxygen, mg/l	4500-0 C. Azide Modification
Biological oxygen demand, mg/l	5210 B. 5-Day BOD test
Total Coliform, MPN per 100ml	Multiple Tube Fermentation Technique
Fecal Coliform, MPN per 100ml	Multiple Tube Fermentation Technique
Oil and Grease, mg/l	5520 B. Partition - Gravimetric

Water quality parameters results are listed in Table 2-31. Concentrations of surfactants were below detection limits and below the threshold limit (0.5 mg/L) for Class C (freshwater) and Class SC (coastal) waters. Concentrations of arsenic as well as phosphates were also below detection limit. Concentrations of total suspended solid were 34, 74 and 76 mg/L in the river delta, middle section and upper section of the river, respectively. These values should be considered “ballpark” figures considering that it will likely vary depending on rainfall and other man-made activities in the upland. The amount of total dissolved solids is expected to increase in the river delta (7,466 mg/L) as the river water mixed with seawater making it brackish at the surface. The TDS concentration of normal seawater is about 35,000 mg/L. The dissolved oxygen concentrations in the surface waters of the three stations were considered satisfactory.

Table 2-31 Results of Water Quality Parameters from Stations A, B & D

Sampling Date: December 13, 2016				
PARAMETERS	DENR STANDARDS (CLASS C)	(A) Delta - seawater	(B) River downstream	(D) River upstream
Surfactants as MBAS, mg/L	1.5	< 0.01*	< 0.01*	< 0.01*
Nitrate, mg/L	7	0.73	2.38	2.46
Phosphate, mg/L	0.5	< 0.5*	< 0.5*	< 0.5*
Chloride, mg/L	350	3,164	392	2.5
Arsenic, mg/L	0.02	< 0.01*	< 0.01*	< 0.01*
pH	6.5 – 9.0	7.96 @ 20.9^{0}C	7.96 @ 20.8^{0}C	7.96 @ 20.7^{0}C
Total suspended solids, mg/L	80	34	74	76
Total dissolved solids, mg/L		7,466	1,130	196
True color, TCU	75	20	20	25
Dissolved oxygen, mg/L	5	6.9	6.4	7.2
Biochemical Oxygen Demand, mg/L	7	6	25	6

Total Coliform MPN per 100ml	10,000	1.6×10^5	7.9×10^3	1.1×10^4
Fecal Coliform MPN per 100ml	200	5.4×10^4	3.3×10^3	4.9×10^3
Oil and Grease mg/L	2	2.2	< 1.4*	2.4
	Note: * means below detection limit of the method used.			

Table 2-32 Results of Water Quality Parameters form 4 Stations

Sampling Date: December 13, 2016				
PARAMETERS	**POINT A**	**POINT B**	**POINT C**	**POINT D**
Salinity (ppt)	6	1	0	0
Temperature (°C)	28.9	28.5	28.1	27.8
pH	7.85	7.93	8.26	8.04
DO (mg/l)	4.41	4.91	4.16	8.22
Turbidity (m)	0.3	0.2	0.1	0.1

Impact Analysis

Possible source of Pollution

The area does not have any heavy industries or similar manufacturing plant that may emit industrial chemicals or similar industrial pollutants. The project site is however surrounded with agricultural activities therefore may leach out excessive nutrients to the river over time.

During operations or machinery maintenance, spill of fugitive oil and grease may be generated. These spills may go to the body of water. This can be mitigated by implementing strict rules on disposing wastes to the site following operational and monitoring plan.

Turbidity

The suspended sediment load and turbidity of a river are increased during the removal of bed or bank material and as a consequence, water quality characteristics such as temperature, are affected. The effects may persist for some distance downstream. Settling out of the material in suspension will alter the composition of the substrate.

The increased suspension of sediments in the water column as a result of dredging can negatively affect life stage developments of fish and amphibian species by reducing the availability of intra-gravel water flow and dissolved oxygen, which is critical to successful egg development.

Toxic substances

A major concern for water quality is waste discharges and the re-suspension of sediments that are contaminated due to the disturbance of river beds.

Management Plan

Operational and maintenance protocols must incorporate the handling of fugitive oil and grease and other solid wastes grounded on RA 9003 or the Solid Waste Management Act. Drains provided for in capturing fugitive oil spills and grease will be installed.

Silt curtains and the likes will be installed in and around the active dredging activity to lessen the volume and spreading of suspended silts resulting from the disturbance of river beds.

Monitoring Plan

Drains provided for in capturing fugitive oil spills and grease will be monitored all the time so accumulated materials can be disposed of properly.

The silt curtain that addresses silt spreading will be constantly monitored for its efficiency and efficacy in capturing silt generated from dredging. The turbidity of the river especially on the river mouth will be regularly monitored as well.

Records on sounding survey and related data will be regularly assessed by the MMT.

2.2.1.7 Degradation of Coastal/Marine Water Quality

The survey was conducted at three seaward stations, approximately 1 kilometer from the mouth of the river namely: Site 1, Site 2 and Site 3.

6-liter samples were taken for pH, BOD_5, DO, TSS, Nitrates and Phosphates. Additional 300 mL in special containers were taken from each site for Fecal/Total Coliform testing and wide-rimmed glass containers were used in taking samples for Oil and Grease analysis.

Table 2-33 lists the geographic coordinates of Marine Water Sampling Points and Figure 2-69 is the sampling site map.

Table 2-33 Coastal Water Sampling Site Coordinates

SAMPLING SITE	COORDINATES	
	LONGITUDE	LATITUDE
SITE 1	122°47'33.22"E	9°21'36.29"N
SITE 2	122°47'05.49"E	9°21'51.08"N
SITE 3	122°48'04.11"E	9°21'33.43"N

Figure 2-69 Coastal Water Quality Sampling Points

Table 2-34 Results of Marine Water Quality Parameters

Date Sampled: December 13, 2016 (BOD) April 17, 2018 (other parameters)				
Water Parameters	**DENR Standard (Class SC)**	**Site 1**	**Site 2**	**Site 3**
pH	6.5-8.5	8.57	8.52	8.44
BOD_5, mg/L	n/a	2	4	2
DO, mg/L	5	4.90	4.74	4.93
Oil and Grease, mg/L	3	<1.4*	<1.4*	<1.4*
Nitrates, Phosphates, mg/L	10	0.45	<0.1*	0.85
Fecal Coliform, MPN/100ML	200	2.2×10^4	330	68
Total Coliform, MPN/100ML	200	1.7×10^5	490	140
Turbidity		4.3	0.8	4.4

Note: * Method Detection Limit

Using the DENR DAO 2016-08 of the Water Quality Guidelines and General Effluent Standards, it is determined that the coastal area of Bayawan may be classified as Class SC, meaning the coastal waters are for Fishery Water Class III, Recreational Water Class II and Marshy and/or mangrove area declared as fish and wildlife sanctuary. Based on the standards for Class SC, it is determined that pH, DO, nitrates and phosphates are within standard in all sampling sites. Oil and Grease for all sampling sites are also way below the detection limit. Only the fecal and total coliform in sampling sites 1 and 3 are significantly elevated.

Turbidity was also measured at the same sampling sites and spot dive revealed very limited visibility which means that this level of turbidity is not conducive for coral communities to thrive.

Impact Analysis

Dredging as a flood mitigation measure allows for a greater volume of water discharge out of the river during high flows or flood occurrences in a 25 or 50-year return cycle. This will invariably result to greater volume of silts and sediments discharging into the marine waters.

It is expected that additional silt load will occur in an already heavily silted river mouth. Coral communities cannot develop in these areas as confirmed during the survey. However, if the silt plume is not controlled, it may spread a longer distance and affect water quality on those offsite areas.

Accidental oil spills and fugitive oil and grease from dredging operations and maintenance will impact marine water quality. These substances have the tendency to stay in the surface of the water and can be possibly carried away to far distances by tidal or surface currents.

Management Plan

One primary challenge for proponent of dredging is the containment and control of suspended particles and silts from spreading across the length of the river reach and more in particular in the marine waters at the mouth of the river.

To address this issue, there will be an installation of silt curtains appropriately designed and located in and around the active working area and in the river mouth to mitigate silt load due to dredging operations.

Dredging at the mouth of the river should consider effects on salt intrusion. Proponent will consider the formation of the original bars and braids that primarily resulted to stratification of fresh and salt water interface and suppressed saline intrusion.

Monitoring Plan

The silt curtain that addresses silt spreading will be constantly monitored for its efficiency and efficacy in capturing silt generated from dredging. The turbidity of the river especially on the river mouth will be regularly monitored by secchi disk profiling to correlate this data with the efficiency of silt curtains.

Sampling the marine waters regularly will allow one to detect changes at the early stage and move management to mitigating action.

Freshwater Ecology

Ecology and Ecosystem Services:

Freshwater ecosystems cover 0.8% of the earth's surface and contain 0.009% of its total water which generates nearly 3% of its net primary production. It has a salinity of less than 0.5ppt. Rivers are large lotic waterbodies created by natural processes with running water moving in one direction (downhill).

River biodiversity is relatively lower compared to coastal and marine environments because of its shorter food chain and a smaller food web to support different kinds of organisms. Most of the river's nutrient source is dependent on the litter-fall of the vegetation along its riparian area known as allochthonous input. In each river segment, different types of functional feeding groups thrive in the area to adapt to the availability of food. Upstream segments usually have higher shredders to grind course particulate organic matter making its byproducts available for other feeding groups in the next river segments. However, along the midstream and the downstream portions of the river, there are also primary producers (autochthonous input) thriving such as algae, periphyton and macrophytes which changes again the composition of the faunal species.

The River Continuum Concept presents an idea that there are different functional feeding groups existing in the different segments of the river. The said principle was applied in determining the different microbenthic composition of Bayawan River.

Rivers provide a variety of ecosystem goods and services to the different organisms as well as to the adjacent local communities. It has provisioning services (source of food, water, electricity, recreation, irrigation, etc.), regulating services (nutrient cycling, flood control, climate moderation) and supporting services (habitat of different fauna, biodiversity). Based on local information, Bayawan River used to have high fish biomass. In fact, a fish catch facility was constructed near the river delta. However, severe siltation from surface run-off and river bank erosion has degraded the river condition and significantly reduced the fish population. Currently, the estuarine portion of the river serves as a docking area for fishing vessels. However, during low tide the boats are trapped within the downstream portion due to the large volume of silt deposited in the entire river stretch. Some locals still use the river as source of edible shells and crabs for subsistence living.

Materials and Methods:

Two separate macro-benthic and fish surveys were conducted last September 16-17, 2017 and April 28-29, 2018 respectively to compare data for wet and dry season. Three sampling stations were randomly selected within the 6km dredging zone representing the upper downstream, mid downstream and lower downstream of the river. For macro-invertebrates, three replicates were established per sampling station to cover both the Left and Right sides of the river with three trials per replicate. (Orientation of Direction is always facing the north or facing up the river)

For macro-benthic survey, improvised nets were used to capture invertebrate samples from the river substrates. In every trial, a five-minute collection effort was employed where river substrates were sieved on the net to filter associated biotic components such as mollusks and crustaceans from the silt. Abiotic components sieved on the net such as dead shells, rocks and litter were discarded. All collected live samples were identified, counted and released back to the water after recording in the slate boards.

To capture the fisheries data of the river, a 100m fishing net with a mesh size of 8mm was installed at each sampling station positioned crisscrossing the river channel. The fishing net was retrieved after 30 minutes. All trapped fishes were collected for size measurement and species Identification.

Data Analysis

Total Mean Count (substitute for density), Species Composition and Diversity Indices were computed for macro-benthos and fishes. Single Factor Analysis of Variance (ANOVA) was used to compare the significant differences between sampling stations and between seasons (wet and dry);

Sampling Site Description

Using a base map of the Bayawan River, the entire river stretch within the 6km dredging area was divided into segments. Simple Using simple random sampling technique, three (3) sampling sites were selected. Geographic coordinates of the sampling sites were marked and recorded for reference. Figure 2-70 shows the relative location of the sampling stations in Bayawan River and Table 2-35 lists the geographic coordinates of the 3 sampling sites.

Table 2-35 Freshwater Ecology Sampling Site Coordinates

Sampling Site	Coordinates
Station 1 – Lower Downstream	9^{0}22’27.12” , 122^{0}48’11.31”
Station 2 – Middle Downstream	9^{0}23’11.09” , 122^{0}48’35.71”
Station 3 – Upper Downstream	9^{0}23’39.58” , 122^{0}49’0.25”

Local guides from the LGU counterpart provided for the boat and crew to convey the researchers to the selected sampling stations. Photos were taken during wet and dry season to compare the actual form of the river.

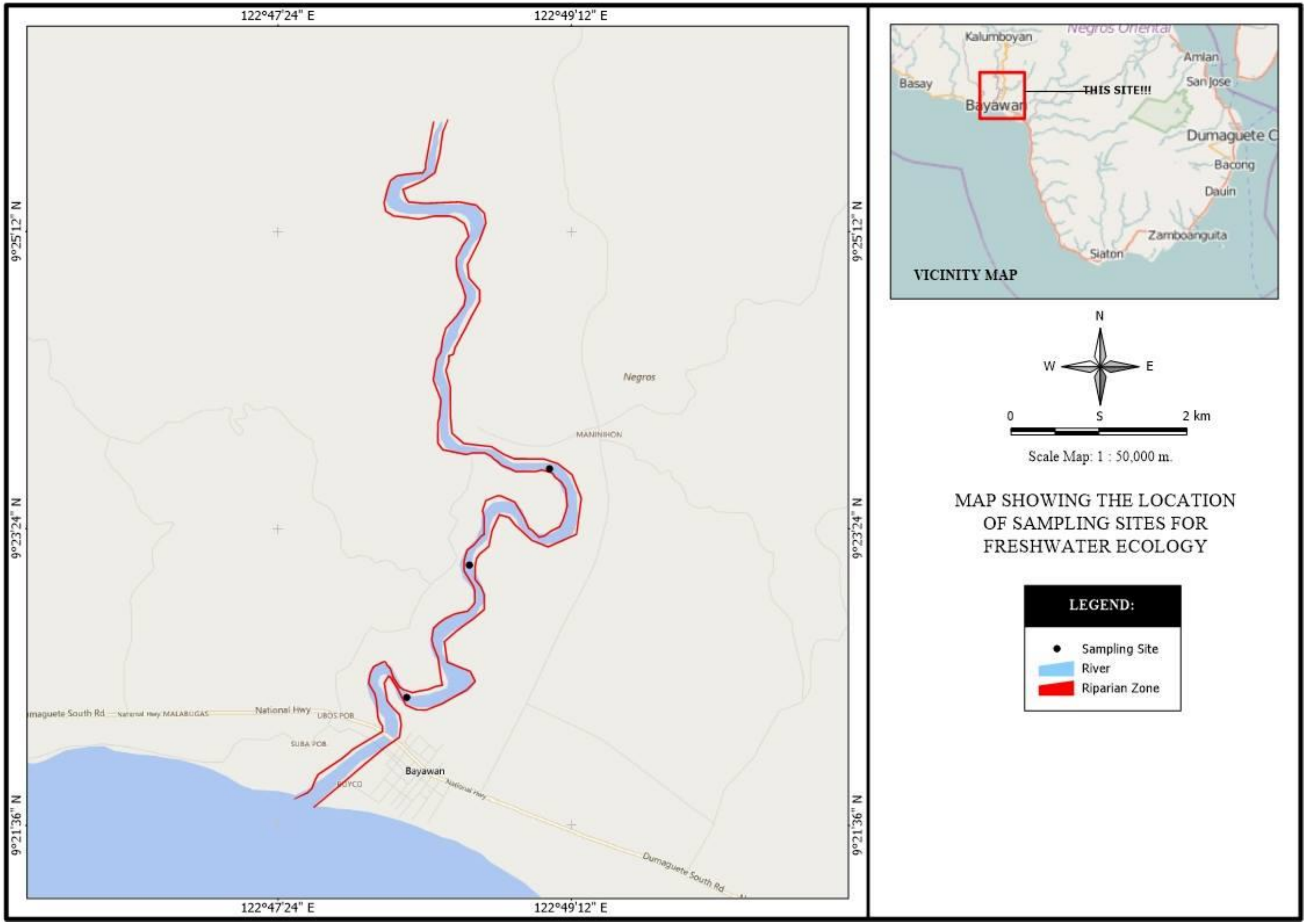


Figure 2-70 Freshwater Ecology Sampling Site Map

WET SEASON
(September, 2017)

DRY SEASON
(April, 2018)

Upper Downstream Station

Middle Downstream Portion

Lower Downstream Portion

2.2.1.8 Threat to Existence and/or Loss of Important Local Species and Habitat

Wet Season

Associated Fauna

Marcro-invertebrate Composition / Species Richness:

A total of 16 species distributed into 10 families were recorded within the three sampling stations of the river during the wet season. Among the major invertebrate groups, mollusks dominated the entire river followed by crustaceans and some records of insect larvae. Table 2-36 shows the macro-invertebrate species listing and distribution across the three sampling sites during wet season.

Table 2-36 List of macro-benthic species recorded in Bayawan River during Wet Season

Phylum	Family	Species	Mean Count		
			Lower Downstream	**Middle Downstream**	**Upper Downstream**
Mollusca	Cyrenidae	*Curbicula fluminea*	0	10	4
Mollusca	Unionidae	*Simpsonella sp.*	1	3	0
Mollusca	Ampullariidae	*Pila sp.*	1	2	0
Mollusca	Neritidae	*Clithon corona*	0	1	1
Mollusca	Neritidae	*Clithon sp*	0	2	1
Mollusca	Thiaridae	*Stelomeliana sp 2*	0	7	13
Mollusca	Thiaridae	*Stelomeliana sp 2*	0	1	3
Mollusca	Thiaridae	*Tarebia granifera*	15	7	7
Mollusca	Thiaridae	*Thiara sp.*	0	0	3
Mollusca	Thiaridae	*Melanoides sp.*	0	0	1
Mollusca	Thiaridae	*Syrmylasma sp.*	4	2	0
Arthropoda	Libellulidae	*Dragongfy larvae (unidentified)*	0	0	2
Arthropoda	Atyidae	*Shrimp (unidentified)*	1	0	4
Arthropoda	Sesarmidae	*Perisesarma sp.*	1	1	2
Arthropoda	Paguroidea	*Hermit crab (unidentified)*	0	1	0
Arthropoda	Ocypodidea	*Uca sp.*	1	0	0
		Total Mean Count	**24**	**38**	**39**
		SE	**10.75**	**16.74**	**13.15**
		N_o	**7**	**11**	**11**

Mollusks are the largest marine phylum who thrives in both freshwater and marine environments. They are mostly herbivorous grazing on algae or filter feeders. Mollusks also serve as an important source of protein and a primary source of food to the community living in subsistence. Some molluscan species are considered bio-indicators for both organic and inorganic contaminants since they exhibit bioaccumulation of toxic substances. Table 2-36 shows that the species composition (No) is increasing from lower to middle stream downstream. This can be accounted for the change in salinity within the entire river channel. The lower the salt concentration, the higher the number of species present in the sampling area.

Macro-invertebrate Count (Substitute for density):

The total mean count for macro-invertebrates in the lower downstream portion of the river is 24±10.75 individuals per 5 min effort. The middle and lower downstream portions have 38±16.74 and 39±13.15 individuals per 5 min effort respectively. Results showed the total mean count of all species is increasing from lower downstream to upper downstream. Tarebia granifera or the round body thirid was the most dominant species in the lower downstream with a total of 15 counts. In the middle downstream, *Curbicula fluminea or the golden clam (locally known as Bibi)* was the most dominant with 10 counts while the long sharp gastropods with rounded whorls (*Stelomeliana sp.*) was the most dominant in the upper downstream portion.

The figure below shows the total mean count of marco-invertebrates in the three sampling stations in Bayawan River during wet season

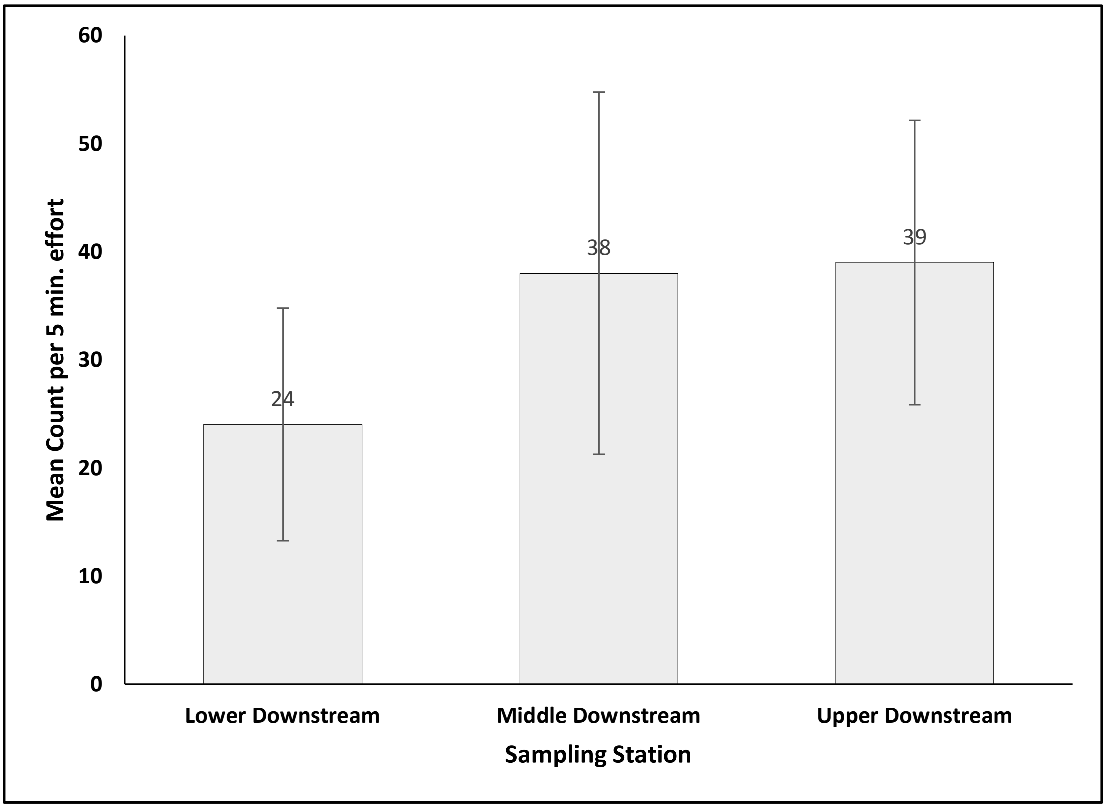


Figure 2-71 Graph comparing the total mean count per sampling station in Bayawan River recorded during wet season

Assuming that all assumptions were met, application of Analysis of Variance (ANOVA) reveals that there is no significant difference (P=0.14) in the mean counts between sampling sites. This implies that the mean count per sampling site is the same even though they vary in number.

Table 2-37 shows the ANOVA table for the three sampling sites.

Table 2-37 Single Factor ANOVA

Source of Variation	***SS***	***df***	***MS***	***F***	***P-value***	***F crit***
Between Groups	496.89	2	248.44	2.74	0.14	5.14
Within Groups	543.33	6	90.56			
Total	1040.22	8				

Since P-value is equal to or greater than 0.35, then we accept the null hypothesis (there is no significant difference in the mean counts between sampling sites).

Ecological Index:

Different indices of diversity were computed for each sampling site. Species richness (S) is the simplest measure of biodiversity by just counting the number of species in a given area. The Margalef's Index can be calculated (d = (Ns-1)/lnNt) where Ns is the total number of species and Nt is the total number of individuals. This means that the higher the value, the more diverse the area is. However, diversity is not only measure in composition but on how evenly distributed the number of individuals present in an environment. The Pielou's Evenness Index (J') was computed using (J'=H'/H'max) where H' is the Shannon Index. Shannon Index (H') was also computed (H'=∑pi(lnpi)) to quantify entropy. The higher the value, the more diverse the area is. The Shannon Index increases as richness and evenness increases.

Table 2-38 shows the summary of biodiversity indices computed for the macro-benthos in all 3 sampling sites in Bayawan River during wet season.

Table 2-38 Ecological Indices of the Macro-benthic Fauna in the three sampling sites during wet season

Sampling Site	**Total Species *(Ns)***	**Total Individuals *(Nt)***	**Margalef's Species Richness *(d)***	**Pielou's Evenness *(J')***	**Shannon *(H')***
Lower Downstream	7	66	3.97	0.64	0.92
Middle Downstream	11	110	7.72	0.82	1.69
Upper Downstream	11	116	8.73	0.84	1.85

Based on the above table, the upper downstream portion of the Bayawan River is the most diverse among the 3 sampling sites with an H' value of 1.85. Typical values are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4. The fact that the index incorporates both components of biodiversity can be seen as both a strength and a weakness. It is a strength because it provides a simple, synthetic summary, but it is a weakness because it makes it difficult to compare communities that differ greatly in richness (Magurran, 2004).

Fish Composition / Species Richness:

A total of 14 individuals from 10 species representing 12 genera and 12 families were recorded in Bayawan river. The result could be attributed that Bayawan river supports “low” diversity of fish species. However, it should be noted that *Lactarius lactarius* is the only fish species recorded present in all sampling stations. Furthermore, *L. lactarius* is an amphidromous and an osmo-regulator. Thus, it can swim from marine to estuarine naturally and able to regulate from different salinity—primary reason for *L. lactarius* to be present in all sampling stations. Table 2-39 shows the fish species listing recorded in Bayawan River during wet season.

Table 2-39 List of Species Recorded in Bayawan River during Wet Season

Taxon	Total Count		
	UPPER DOWNSTREAM	MIDDLE DOWNSTREAM	LOWER DOWNSTREAM
Atherinidae			
Atherinomorus duodecimalis	0	0	2
Cynoglosidae			
Paraplagusia bilineata	0	0	1
Gobiidae			
Awaous melanocephalus	1	0	0
Lactariidae			
Lactarius lactarius	1	1	1
Lutjanidae			
Lutjanus argentimaculatus	0	0	1
Muraenesocidae			
Muraenesox bagio	0	0	1
Plotosidae			
Plotosus lineatus	0	0	1
Polynemidae			
Eleutheronema tetradactylum	0	0	1
Scatophagidae			
Scatophagus argus	0	0	1

Terapontidae			
Terapon jarbua	0		1
GRAND TOTAL	**2**	**2**	**10**

The results showed that the lower downstream has the highest species richness with a record of 9 species followed by both middle and upper downstream. Applying the river continuum concept, the segment of the river nearest to the estuarine area has higher productivity compared to the upper portions of the river. This is due to the absence of tree canopy covering the river and the increase in river width thus more area for phytoplankton and macrophytes available for photosynthesis. The food chain in the lower downstream supports more organisms compared to the upper portions of the river. However, the heavy silt of the river limits the growth of all associated organisms in the area.

Fish Count (Substitute for Density):

Results showed that lower downstream had the highest fish count (10 individuals) among the sampling sites followed by both middle and upper downstream.

Figure below shows the total count of fishes caught per 30-minute effort in Bayawan River during the wet season.

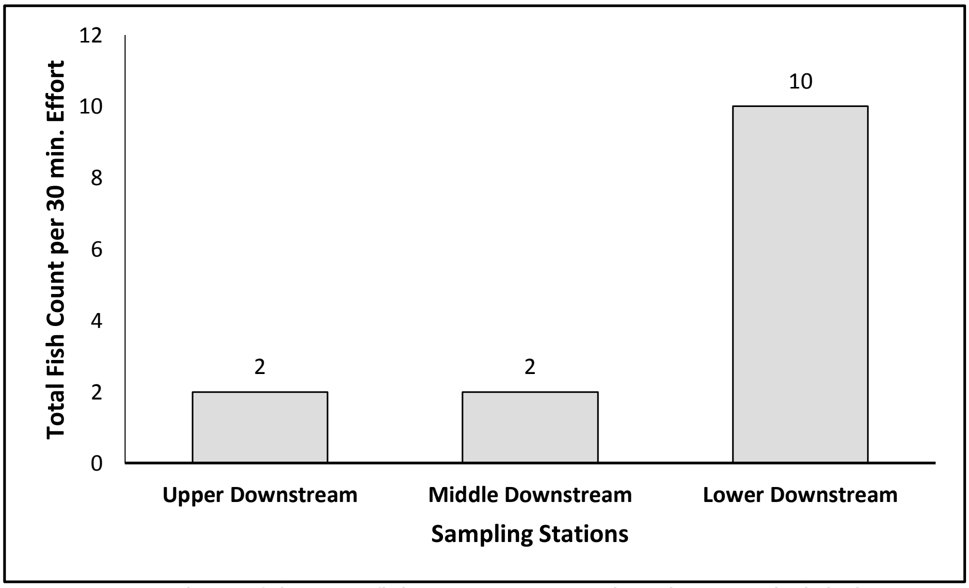


Figure 2-72 Comparison of the total fish count per sampling site recorded during wet season

The Upper and Middle Downstream have lesser number of fishes compared to Lower Downstream. Low fish density can be accounted for the heavy siltation of the river. The silt covers the primary producers in the river such as macro (green algae) and micro algae (plankton) and macrophytes which is the source of food for the invertebrates which is being eaten by fishes. The silt destroys the ecological balance between producers and consumers.

Fish Biomass:

Fish sizes were observed to be almost the same for all the species recorded in Bayawan river during the wet season. Hence, it is projected that the limiting factor for fish biomass was the fish count. Thus, a directly proportional relationship can be seen in both Fish Count and Fish Biomass. In such a way that when the Fish count increases, Fish biomass also increases.

Figure 2-73 shows that Lower Downstream (241.19g) had the highest fish biomass among the stations followed by Middle Downstream (33.62 g) and Upper Downstream (20 g). It should also be noted that large-bodied and highly commercialized fishes (*Lutjanus argentimaculatus, Scatophagus argus*) were only seen in Lower Downstream. However, it cannot suffice the need of the fishermen. In general, Bayawan river can no longer serve as a fishing ground. It has lost its provisioning ecosystem service which is fisheries production for the community.

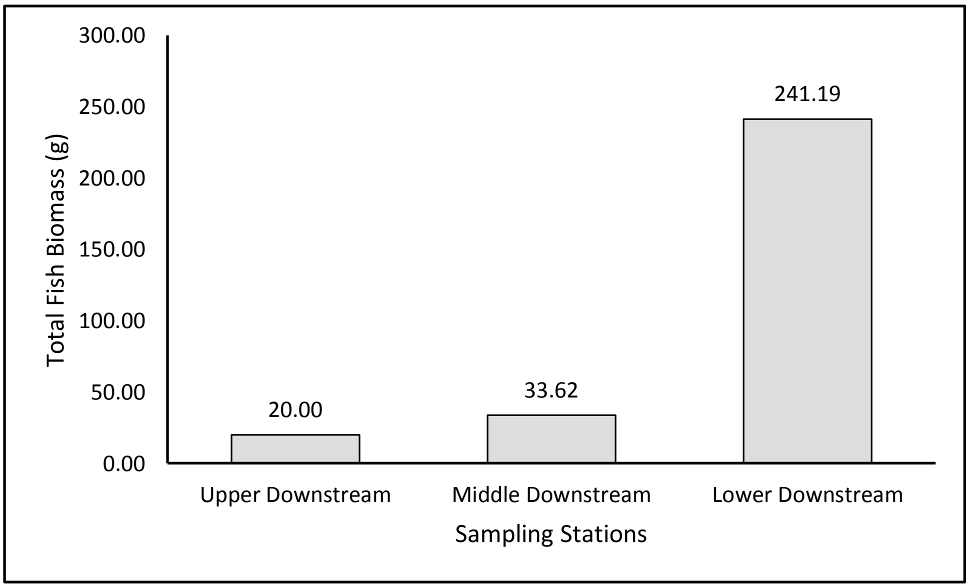


Figure 2-73 Total Fish Biomass Recorded in Bayawan River during Wet Season

Ecological Index:

Indices of diversity (*H'* and *d*) and evenness (*J'*) were calculated using the formulae as outlined by Heip *et al.* (1998):

Fish diversity was calculated using the Shannon diversity index (*H'*). It determines the proportion of the number of individuals of a single fish species with respect to the total number of individual fishes within an order. Species richness was calculated using Margalef's species richness index (*d*). It determines the impact of the number of the species on the total number of individuals found. Evenness was calculated using Pielou's evenness index (*J')*. It evaluates the distribution of individuals for each fish species found among the sampling stations.

Table 2-40 Ecological Indices of Fishes among Sampling Sites in Bayawan River for Wet Season

	Total Individuals (*N*)	**Total Species (*S*)**	**Margalef's Species Richness (*d*)**	**Pielou's Evenness (*J'*)**	**Shannon (*H'*)**
Upper Downstream	2	2	1.44	1	0.69
Middle Downstream	2	2	1.44	1	0.69
Lower Downstream	10	9	3.47	0.97	2.16

Results showed that Lower Downstream had the highest Species Richness (*d=3.47*) and Shannon Diversity (*H'=2.16*) among the sampling stations. Lower Downstream was in fact a brackish water (mixture of seawater and freshwater). This could be anticipated that the Lower Downstream meet the salinity requirement for the fishes to be abundant in terms of individuals and species in this area. Individuals of both Upper and Middle Downstream are observed equally distributed within sampling stations (*J'=1*).

Dry Season

Associated Fauna

Macro-invertebrate composition / Species Richness:

For dry season, a total of eleven (11) species with one (1) unidentified macro-benthic organism were recorded in Bayawan River. It belonged to nine (9) genera, eight (8) families and two (2) phyla. The most dominant phylum was Mollusca with nine (9) species followed by Arthropoda with three (3) species. *Tarebia granifera,* a gastropod mollusk was common in the three sampling stations and mostly distributed in both sides of the river. According to Madhyastha and Dutta (2012), the conservation status of *T. granifera* based from IUCN red list category is least concerned. The species spreads globally from South to Southeast Asia and has been reported as the intermediate host of parasitic worms including *Paragonimus westermani*, *Metagonimus trematodes*, *Centrocestus formosanus* and *Stellantchasmus falcatus*. On the other hand, no anecdotal evidence in the local's infestation of the parasitic worms. Of all listed bivalve mollusks, *Corbicula fluminea* and *Simpsonella* sp. were harvested by the locals for their food consumption. The interesting part of this bivalve *Simpsonella* sp. which belongs to Unionidae Family is that it has a unique life cycle (mature glochidia attach in gills, fins or skin of a host fish) aside from that their practical importance due to worldwide imperiled status (Graf and Cummings, 2007).

Table 2-41 shows the species composition and mean count of Bayawan River invertebrate macro-fauna recorded during the dry season.

Table 2-41 List of macro-benthic invertebrates recorded in Bayawan River during Dry Season

Phylum:Family	Species	Upper Down Stream		Middle Down Stream		Lower Down Stream	
		Mean ± SE					
		Right	Left	Right	Left	Right	Left
1. Mollusca: Unionidae	1. *Simpsonella* sp.	2.33 ± 0.67	0.75 ± 0.75	----	0.33 ± 0.33	----	----
Mollusca: Cyrenidae	2. *Corbicula fluminea*	10.00 ± 1.60	3.75 ± 0.75	----	0.33 ± 0.33	3.50 ± 2.50	----
Mollusca: Solenidae	3. *Solen* sp.	----	----	----	----	0.50 ± 0.50	----
Mollusca: Thiaridae	4. *Thiara* sp. 1	0.11 ± 0.11	1.75 ± 0.62	6.33 ± 4.04	38.00 ± 28.62	----	----
Mollusca: Thiaridae	5. *Thiara* sp. 2	0.11 ± 0.11	5.13 ± 1.80	----	----	----	----
Mollusca: Thiaridae	6. *Tarebia granifera*	1.22 ± 0.66	6.63 ± 1.08	5.67 ± 1.20	4.33 ± 3.84	54.00 ± 37.00	----
Mollusca: Thiaridae	7. *Melanoides* sp.	0.11 ± 0.11	0.25 ± 0.16	0.17 ± 0.17		----	----
Mollusca: Thiaridae	8. *Melanoides tuberculata*	0.11 ± 0.11	2.63 ± 0.80	----	0.33 ± 0.33	----	----
Mollusca: Neritidae	9. *Clithon* sp.	1.00 ± 0.58	----	----	----	----	----
2. Arthropoda: Hymenosomatidae	10. *Amarinus* sp.	----	0.13 ± 0.13	----	----	----	----
Arthropoda: Gecarcinucidae	11. *Parathelphusa* sp.	----	0.13 ± 0.13	----	----	----	1.00 ± 0.00
Arthropoda: Paguroidea	12. Hermit crab (unidentified)	0.22 ± 0.22	----	----	----	----	----
	Total Mean Count +SE	15 ± 4.17	21 ± 6.22	12± 5.41	43 ± 33.46	58 ± 40	1.00 ± 0.00
	N_0	9	9	3	5	3	1

Results showed that the number of species (N_0) present from upper downstream, middle downstream to the lower downstream is gradually decreasing. It assumes that the decreasing of richness has something to do with the salinity. When approaching the lower downstream the salinity increases in which no longer favorable condition for freshwater invertebrates except for saline-tolerant species.

Macro-invertebrate Count (Substitute for density):

In terms of mean count of invertebrate-river fauna, the highest mean count per 5 min sampling effort were recorded in both sides of the river from left middle downstream to right lower downstream and was occupied by gastropods, *Thiara* sp. 1 and *Tarebia granifera* with mean densities of 38.00 ± 28.62 and 54.00 ± 37.00 respectively. Figure 2-74 shows the comparison of the mean count of marco-invertebrate per major phyla across the three sampling sites recorded during the dry season.

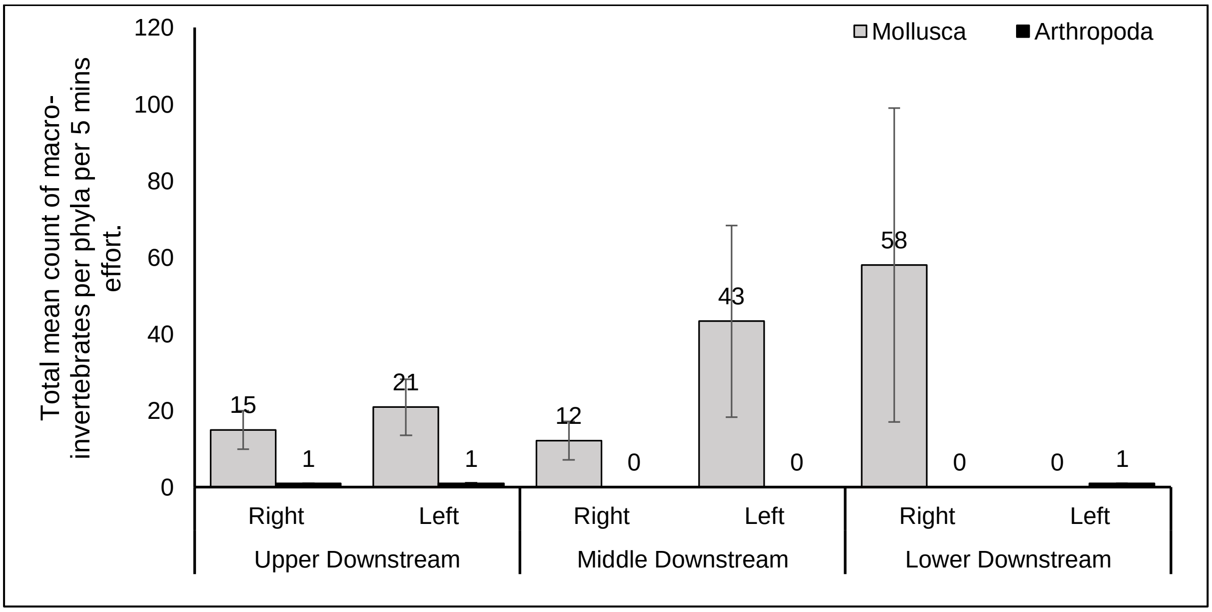


Figure 2-74 Graph comparing the mean count per phyla in each sampling station (both right and left sides of the river) recorded during the Dry Season

For the total mean density of the phylum, Phylum Mollusca had the highest density ranging from 15.00 to 58.00 ind./5 minutes sampling effort whereas Phylum Arthropoda ranges only from 0.22 t0 1.00 ind./5 minutes sampling. These gastropods occur in high density in the middle downstream because of their distinct characteristic like, *Thiara* sp. 1 which can thrive in coastal rivers: in fresh and brackish waters (Van, 2016) and *T. granifera* adapt in rivers in tidal area (Madhyastha and Dutta, 2012) but does not tolerate high levels of salinity (Brandt, 1974) that is why it preferred the intermediate station.

Applying the Kruskal-Wallis rank sum test to check for significant differences of the mean counts between the 3 sampling sites, results showed that the mean counts between sites had no significant differences (H=0.86, 2 df, *p*=0.65).

Table 2-42 Results of the Kruskal-Wallis rank sum test

	H-statistic	**df**	**p-value**
Count vs Stations	0.86	2	0.65

Therefore, despite the differences in counts of individuals per species, the mean count across all sites are considered the same.

Ecological Index:

The species diversity of the both sides of the river from the different stations were very low according to Shannon category index (1949) which is *H'* <1.9999. Table 2-43 shows the summary of the diversity indices computed for the macro-invertebrates recorded in Bayawan River during the dry season.

Table 2-43 Ecoogical indices of macro-invertebrates in Bayawan River recorded during Dry Season

Sampling Site	Total Species *(Ns)*	Total Individuals *(Nt)*	Margalef's Species Richness *(d)*	Shannon Evenness (E_{sh})	Shannon *(H')*	Simpson's Index
Lower Right Downstream	9	116	0.49	0.25	0.28	0.13
Lower Left Downstream	9	3	0.00	0.00	0.00	0.00
Middle Right Downstream	3	73	0.80	0.69	0.75	0.56
Middle Left Downstream	5	130	0.80	0.28	0.46	0.23
Upper Right Downstream	3	137	2.94	0.52	1.15	0.57
Upper Left Downstream	1	169	2.62	0.78	1.71	0.83

The evenness of the density was high in left upper downstream with E_{Sh} = 0.78 which is closer to 1. Margalef's index showed that the right side $I_{margalef}$ = 2.94 and left side $I_{margalef}$ = 2.62 in the upper downstream were both high which means that the relationship between richness and evenness of the density was more close to equal. This implies that the higher the index, the greater the richness and more even. Whereas the left middle downstream and right lower downstream indicates that there was a dominance of the species based on the calculated Simpson's Index D_{Si} = 0.23 and D_{Si} =0.13 respectively, the value closes to 0 means it has low diversity and has presence of a dominant species.

Fish Composition / Species Richness:

A total of 28 individuals from 7 species representing 6 genera and 6 families were recorded in Bayawan river. The result could be attributed that Bayawan river supports "low" diversity of fish species. However, it should be noted that *Lactarius lactarius* and *Photopectoralis bindus* are the fish species recorded present in all sampling stations. Furthermore, *L. lactarius* and *P. bindus* are an amphidromous and an osmo-regulator. Thus, it can swim from marine to estuarine naturally and able to regulate from different salinity—primary reason for *L. lactarius* and *P. bindus* to be present in all sampling stations. Table 2-44 shows the species richness of the fishes in Bayawan River recorded during dry season.

Table 2-44 List of Fish Species recorded in Bayawan River during Dry Season

TAXON	TOTAL COUNT		
	UPPER DOWNSTREAM	MIDDLE DOWNSTREAM	LOWER DOWNSTREAM
Ambassidae			
Ambassis gymnocephalus	0	2	3
Lactariidae			
Lactarius lactarius	2	2	4
Leiognathidae			
Photopectoralis bindus	1	3	4
Lutjanidae			
Lutjanus fuscescens	0	0	2
Lutjanus argentimaculatus	0	0	1
Scatophagidae			
Scatophagus argus	0	0	2
Terapontidae			
Terapon jarbua	0	0	2
GRAND TOTAL	**3**	**7**	**18**

Following the River Continuum Concept, it is expected that Lower Downstream would have the highest number of species (7 species) among the stations. Vannote *et al.,* 1980, presented a diagram showing the structural and functional group of organisms in a stream. He stated that predators change relative to the stream size or order. In relation, fishes as predators are mostly seen in Lower Downstream—this is primarily due to salinity, elevation and siltation. The fishes recorded in the area are so-called "secondary river-dwellers" this means that these fishes are not freshwater fishes. In fact, these fishes are mostly estuarine and some marine fish dwellers. Thus, if these fishes swim towards Middle or Upper Downstream their cells may rupture due to a change in salt concentration or salinity. Also, increasing elevation adds more gravitational force to the fish as it swims towards headwaters.

Fish Count (Substitute for Density):

Figure 2-75 shows the total count of fishes in Bayawan River recorded during dry season.

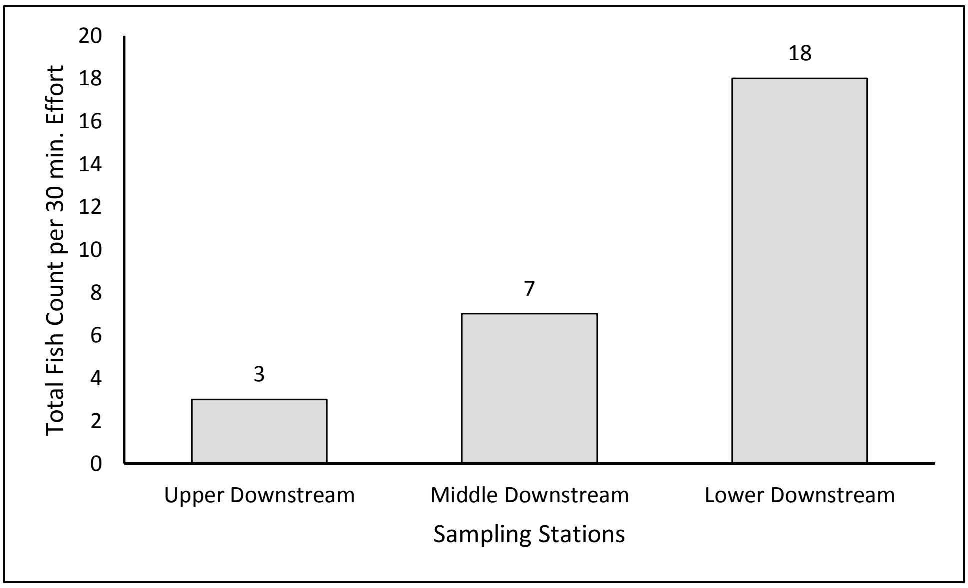


Figure 2-75 Total number of Fishes in Bayawan River recorded during Dry Season

Results showed that Lower Downstream had the highest fish count (18 individuals) among the stations followed by Middle Downstream (7 individuals) and Upper Downstream (3 individuals). Notice that there are no error bars in the graph since only one site per sampling station was established for fish traps.

Fish Biomass:

Fish sizes were observed to be almost the same for all the species in Bayawan river recorded during dry season. Hence, it is projected that the limiting factor for fish biomass was the fish count. Thus, a directly proportional relationship can be seen in both Fish Count and Fish Biomass. In such a way that when the Fish count increases, Fish biomass also increases.

Figure 2-76 shows the total fish biomass of the fishes in the 3 sampling sites of Bayawan River taken during dry season.

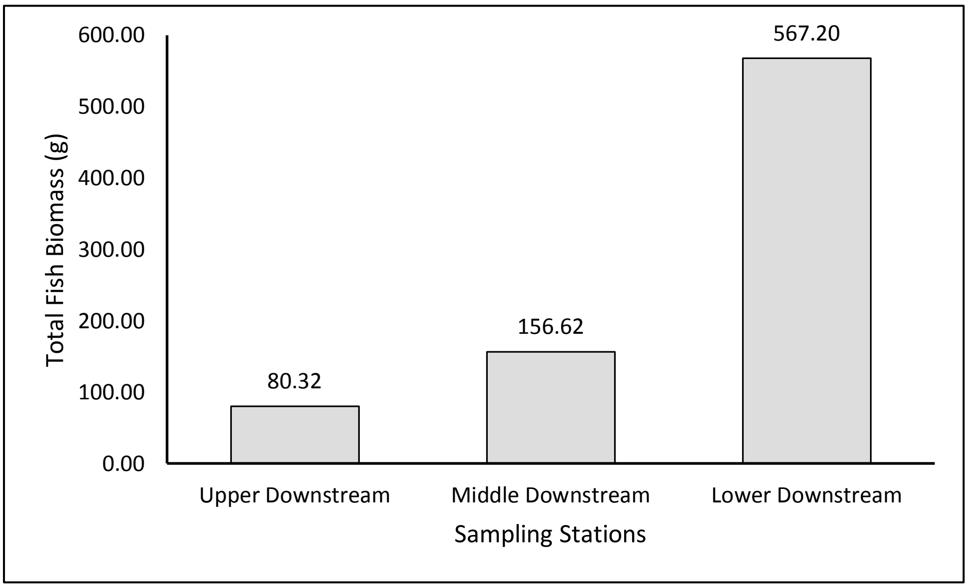


Figure 2-76 Total Fish Biomass in Bayawan River recorded during Dry Season

Figure 2-76 shows that Lower Downstream (567.20 g) had the highest fish biomass among the stations followed by Middle Downstream (156.62 g) and Upper Downstream (80.32 g). It should also be noted that large-bodied and highly commercialized fishes (*Lutjanus argentimaculatus, Eleutheronema tetradactylum*) were only seen in Lower Downstream. The same results compared to wet season survey shows that Bayawan river can no longer serve as a fishing ground. It has lost its provisioning ecosystem service which is fisheries production for the community.

Ecological Index:

Indices of diversity (*H’* and *d*) and evenness (*J’*) were calculated using the formulae as outlined by Heip *et al.* (1998):

Fish diversity was calculated using the Shannon diversity index (*H’*). It determines the proportion of the number of individuals of a single fish species with respect to the total number of individual fishes within an order. Species richness was calculated using Margalef’s species richness index (*d*). It determines the impact of the number of the species on the total number of individuals found. Evenness was calculated using Pielou’s evenness index (*J’*). It evaluates the distribution of individuals for each fish species found among the sampling stations.

Table 2-45 Ecological Indices of Fishes among the Sampling Stations in Bayawan River recorded during the Dry Season

	Total Individuals (*N*)	**Total Species (*S*)**	**Margalef’s Species Richness (*d*)**	**Pielou’s Evenness (*J’*)**	**Shannon (*H’*)**
Upper Downstream	3	2	0.64	0.94	0.91
Middle Downstream	7	3	1.08	0.98	1.03
Lower Downstream	18	7	1.86	0.92	2.08

Results showed that Lower Downstream had the highest Species Richness (*d=1.86*) and Shannon Diversity (*H’=2.08*) followed by Middle Downstream with Species Richness (*d=1.08*) and Shannon Diversity (*H’=1.03*) Lastly, Upper Downstream with Species Richness (*d=0.64*) and Shannon Diversity (*H’=0.91*). Lower Downstream was in fact a brackish water (mixture of seawater and freshwater). This could be anticipated that the Lower Downstream meet the salinity requirement for the fishes to be abundant in terms of individuals and species in this area. On the other hand, Middle Downstream had the most even number of individuals among the stations (*J'=0.98*).

<u>Wet vs Dry Season</u>

Fishes

Fish Composition:

Comprising both dry and wet season, a total of 42 individuals from 13 species representing 12 genera and 12 families were recorded in Bayawan river. However, mean species richness of both season still supports "low" diversity *(H'=1.18, SE ±0.4e-02).*

Recent scientific studies state that tropical inland waters (streams) developed later compared to temperate and neotropical waters (Tomanova *et al.,* 2007). As such, structural and functional group of tropical inland waters are still developing. Diversity and complexity of organisms are predicted to be less evident in tropical inland waters (Tomanova *et al.,* 2007; Greathouse and Pringle, 2006).

Table 2-46 List of Fish Species recorded in both Wet and Dry Season at Bayawan River

TAXON	DRY SEASON	WET SEASON
Ambassidae		
Ambassis gymnocephalus	5	0
Atherinidae		
Atherinomorus duodecimalis	0	2
Cynoglosidae		
Paraplagusia bilineata	0	1
Gobiidae		
Awaous melanocephalus	0	1
Lactariidae		
Lactarius lactarius	8	3
Leiognathidae		
Photopectoralis bindus	8	0
Lutjanidae		
Lutjanus fuscescens	2	0
Lutjanidae		
Lutjanus argentimaculatus	1	1
Muraenesocidae		
Muraenesox bagio	0	1
Plotosidae		
Plotosus lineatus	0	1
Polynemidae		
Eleutheronema tetradactylum	0	1
Scatophagidae		
Scatophagus argus	2	1
Terapontidae		
Terapon jarbua	2	2
GRAND TOTAL	**28**	**14**

To determine whether there are significant differences in the number of species among seasons, Single-Factor Analysis of Variance (ANOVA) was used. Results showed that there are no significant differences in the number of species among seasons (P-value=0.22).

Fish Count:

Figure 2-77 shows the total count of fishes recorded in both Dry and Wet Season at Bayawan River, Bayawan City, Negros Oriental. Results showed that Dry Season have higher number of individuals (28 individuals) compared to Wet Season (14 individuals).

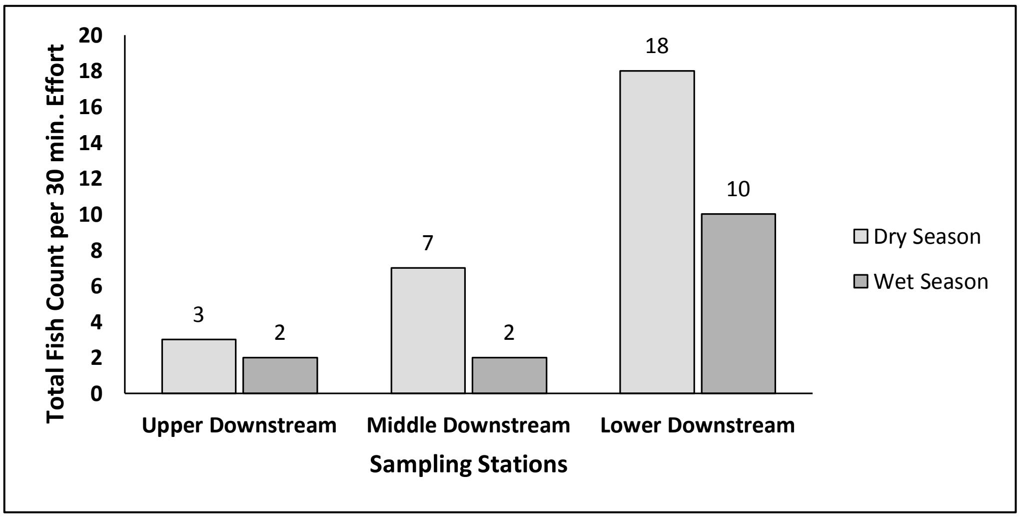


Figure 2-77 Total number of Fishes Recorded in both Wet and Dry Season at Bayawan River

Kruskal-Wallis for non-parametric test was used to determine if there are significant differences among the seasons. Results revealed that there are no significant differences in the number of individuals among the seasons (P-value=0.26).

Fish Biomass:

Figure 2-78 shows the total fish biomass in both Dry and Wet Season at Bayawan River, Bayawan City, Negros Oriental. Results showed that Dry Season have higher fish biomass in all sampling stations compared to Wet Season.

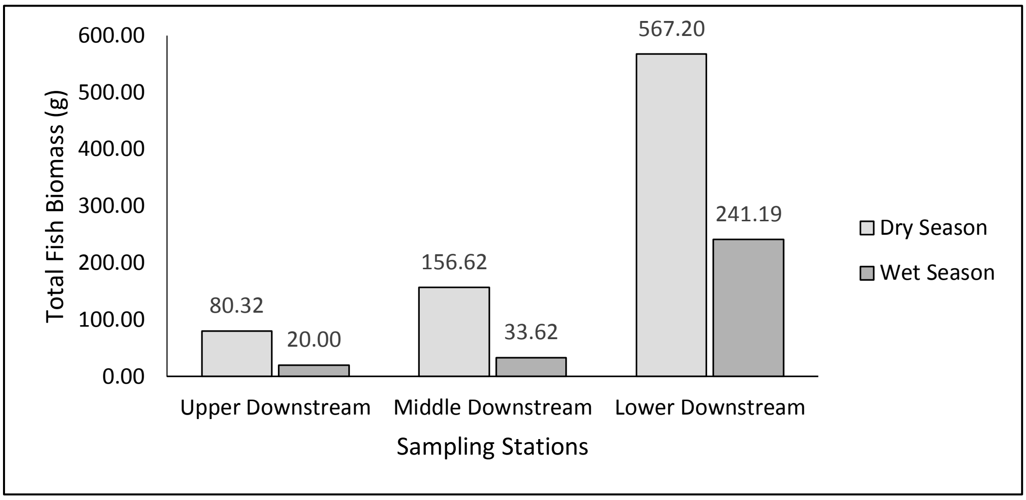


Figure 2-78 Total Fish Biomass Recorded in both Wet and Dry Season at Bayawan River

Kruskal-Wallis for non-parametric test was used to determine if there are significant differences among the seasons. Results revealed that there are no significant differences in Fish Biomass among the seasons (P-value=0.27).

Ecological Indices:

Indices of diversity (*H'* and *d*) and evenness (*J'*) were calculated using the formulae as outlined by Heip *et al.* (1998):

Fish diversity was calculated using the Shannon diversity index (*H'*). It determines the proportion of the number of individuals of a single fish species with respect to the total number of individual fishes within an order. Species richness was calculated using Margalef's species richness index (*d*). It determines the impact of the number of the species on the total number of individuals found. Evenness was calculated using Pielou's evenness index (*J')*. It evaluates the distribution of individuals for each fish species found among the sampling stations.

Table 2-47 Ecological Indices in both Wet and Dry Season

	Margalef's Species Richness (*d*)	Pielou's Evenness (*J'*)	Shannon (*H'*)
Dry Season	1.34	0.95	1.19
Wet Season	2.12	0.98	1.18

Results showed that Wet Season had higher Species Richness (*d=2.12*) and Evenness (*J'=0.*98) compared to Dry Season. Whereas, Dry Season had higher Diversity (*H'=1.19*) compared to Wet Season. However, Kruskal-Wallis for non-parametric test revealed no significant differences in all indices among seasons (*d, P-value=0.26; J', P-value=0.12; H', P-value=0.84*).

Table 2-48 Fish Distribution, Economic Importance and Conservation Status

TAXON	DISTRIBUTION	ECONOMIC VALUE	CONSERVATION STATUS
Ambassidae			
Ambassis gymnocephalus	Indo-West Pacific	Minor Commercial	Not Evaluated
Atherinidae			
Atherinomorus duodecimalis	Indo-West Pacific	No Interest	Not Evaluated
Cynoglosidae			
Paraplagusia bilineata	Indo-Pacific	Minor Commercial	Not Evaluated
Gobiidae			
Awaous melanocephalus	Asia and Oceania	Minor Commercial	Not Evaluated
Lactariidae			
Lactarius lactarius	Indo-West Pacific	Commercial	Not Evaluated
Leiognathidae			
Photopectoralis bindus	Indo-West Pacific	Minor Commercial	Not Evaluated
Lutjanidae			
Lutjanus fuscescens	Asia and Oceania	No Interest	Not Evaluated
Lutjanidae			
Lutjanus argentimaculatus	Indo-West Pacific	Commercial	Not Evaluated
Muraenesocidae			
Muraenesox bagio	Indo-West Pacific	Commercial	Not Evaluated
Plotosidae			
Plotosus lineatus	Indo-Pacific	Commercial	Not Evaluated
Polynemidae			
Eleutheronema tetradactylum	Indo-West Pacific	Highly Commercial	Not Evaluated
Scatophagidae			
Scatophagus argus	Indo-Pacific	Minor Commercial	Not Evaluated
Terapontidae			
Terapon jarbua	Indo-Pacific	Minor Commercial	Not Evaluated

Survey results showed that only one (1) fish species *Eleutheronema tetradactylum* belonged to highly commercial category. Based on fishbase.org, the conservation status of all listed fish species was not yet evaluated globally. The distribution of the different fish species is common in the Indo-West Pacific Region.

Table 2-49 List of Invertebrate River Fauna with their Conservation Status, Distribution, Uses, Trade and Importance

Species	Conservation Status	Distribution	Uses/Trade/Importance	Author
1. *Simpsonella* sp.	Imperil	Nearctica, Neotropica, Afrotropica, Palearctica, Indotropica and Australasia	Studied for evolution biology due to its existence in Mesozoic or possibly well into Paleozoic time	Graf et al. (2007)
2. *Corbicula fluminea*	Least Concern	Southern and Eastern Asia (Eastern Russia, Thailand, Philippines, China, Taiwan, Korea, and Japan)	The soft body of this species is used as a food for humans. They can also be used as food for fish, poultry, livestock, and as a fertilizer of agricultural fields. The shell may be used to produce lime, and the species is also the material of traditional Chinese medicine.	Aldridge et al. (2012)
3. *Solen* sp.	Least Concern			
4. *Thiara* sp. 1	Least Concern			
5. *Thiara* sp. 2	Least Concern			
6. *Tarebia granifera*	Least Concern	Bangladesh; Bhutan; Cambodia; China (Guangdong, Hainan); Hong Kong; India (Andhra Pradesh, Bihar, Madhya Pradesh, Meghalaya, Orissa, Tripura, West Bengal); Indonesia (Papua, Sumatera); Japan; Malaysia (Peninsular Malaysia); Myanmar (Myanmar (mainland)); Nepal; Philippines; Singapore; Sri Lanka; Taiwan, Province of China; Thailand; Viet Nam	This species has been reported as the intermediate host of Paragonimus westermani, Metagonimus trematodes, Centrocestus formosanus and Stellantchasmus falcatus. Used as a food for fish.	Madhyastha and Dutta (2012)
7. *Melanoides* sp.	Least Concern			
8. *Melanoides turberculata*	Least Concern	Bangladesh; Benin; Brunei Darussalam; Burundi; China; Congo; Congo, The Democratic Republic of the; Egypt; Eritrea; Ethiopia; Gabon; India; Kenya; Lao People's Democratic Republic; Libya; Malawi; Malaysia; Mauritania; Mozambique; Namibia; Niger; South Africa; South Sudan; Sri Lanka; Sudan; Swaziland; Tanzania, United Republic of; Thailand; Timor-Leste; Uganda; Viet Nam; Yemen (North Yemen, Socotra, South Yemen); Zimbabwe	This species has been spread worldwide, for example via the aquarium trade and rice cultivation. It is well known that this species is eaten by molluscivorous fish, such as some cichlid species and carp, but its use as a commercially interesting food source in fish farming requires confirmation. It is sometimes used in ethnic ornaments.	Van and Lange (2017)
9. Clithon sp.	Least Concern			
10. *Amarinus* sp.	Least Concern			
11. *Parathelphusa* sp.	Least Concern			
12. *Hermit crab (unidentified)*	Least Concern			

Table 2-49 lists the invertebrate river fauna with only 1 being imperil and the rest of least concern. It is also observed that these are mostly found in Asia and have various uses, trades and importance.

2.2.1.9 Threat to Abundance, Frequency and Distribution of Species

Threats to the River Ecosystem:

The heavy siltation of the river has caused the collapse in the food chain as evidenced by the low fish density and fish biomass. There were also no economically important invertebrates captured during the survey. The high amount of silt and mud deposits in the river is caused by erosion in the banks. Continuous erosion would decrease the depth of the river channel and would thus cause further erosion in the bank. In effect, small amounts of rain will cause flooding in the riparian and adjacent terrestrial ecosystems and the run off would further contribute to the river siltation. Silt prohibits light penetration and changes the nutrient content of the water.

Another threat would be the inorganic fertilizer and pesticide inputs to the river from the agricultural areas in the riparian and terrestrial zone. Most of the river banks were already converted into corn fields, sugarcane plantations and vegetable gardens. Inorganic chemicals from these agricultural lands will be brought to the river by run off and would thus pollute the water.

Impact Analysis

Dredging generally generates significant amount of silt due to sediment disturbance in the bottom portion of the river. The high water turbidity can increase surface water temperature and lead to thermal stratification. This can adversely affect invertebrate populations, interfere with the behavior, feeding and growth of fish species. It can also cause damage to fish gills by abrasion (hyperplasia), and clogging. An increase in stream water turbidity can cause a reduction in the depth of light penetration into the water column. This effectively decreases rates of photosynthetic activity and thus primary productivity in submerged plants (a basic food source for aquatic animals). A reduction in the food source at the primary level may then have a knock-on effect upon higher trophic levels. High suspended sediment concentrations may also increase the susceptibility of fish to disease. Mucus secreted by fish in response to high concentrations of suspended solids attracts bacteria and fungus.

However, based on baseline information from two separate surveys (wet and dry season), the river macro fauna (invertebrates and fishes) in Bayawan River have very low count and composition as a result of heavy siltation. Dredging activity in the river would actually improve the water quality as it will mitigate the further erosion of the banks. The fish population and macro-benthos community will recover after the water column will return to its original depth and width. The dredging process will further cause siltation but it would be just momentary. The river current is another factor that would contribute to the increased nutrient flow, gas exchange and cleansing of sediment in the river (flushing).

Management Plan

Invariably, threat to fresh water species and its habitat is strongly associated with the water quality. Water quality reflects the health of the river system that encourages diversity of organisms to thrive. The focus of management therefore centers on the recovery of river's health after active dredging.

Some of the controlling factors are structure and gradient of channel-bed, the adaptability of the flora and fauna and the particle size distribution of the sediment. Occasional periodic increases in both suspended and deposited sediment are a natural phenomenon, and river habitats have adapted to cope with a range of sediment concentrations resulting from natural events. The key controlling factors that determine the speed of river recovery are:

- Spatial and temporal extent of damage due to the increased sediment concentrations;
- Elimination of the sediment source;
- Ability of the river to flush out the suspended and deposited material

Turbidity is caused by suspended silts from active dredging. Arresting these generated silts is the primary task in dredging operations. It is imperative therefore for silt curtains to be strategically installed and designed to minimize the propagation and spread of silt in the river. This mitigation will form part of the operational protocols that the management will develop and implement.

Sounding survey before and after dredging will allow one to have an idea on the original gradient and structure of the river bed. Management will exert effort in returning this original configuration that support species habitat.

Monitoring Plan

Levels of turbidity will be conducted using secchi survey to establish thresholds agreed by MMT to determine efficiency of silt curtains in particular and the dredging operations in general.

The silt curtain that addresses silt spreading will be constantly monitored for its efficiency and efficacy in capturing and controlling silts generated from dredging. The turbidity of the river especially on the river mouth will be regularly monitored and constantly assess and correlated to ecological stability.

Regular assessment of benthic communities shall be done to provide indicator as to the health of the river system. All acquired data will be stored and regularly assessed to determine patterns reflecting the status of the river.

Marine Ecology

Ecology and Ecosystem Services:

The Philippines lies within the apex of the Coral Triangle (Indo-Malayan Triangle) which is the global center of marine biodiversity. The total coral reef area ranges from 10, 750 km^2 to 33, 500 km^2 depending on the depth at which the corals are assumed to be found. Corals are tiny animals that live in colonies underwater, either in patches or extensive reefs. Each colony is composed of thousands of tiny polyps which secrete salivary calcium carbonate material that hardens to form the rigid structural mass of the reefs.

Philippine coral reefs are home to 721 species of reef fishes. Its symbiotic algae zooxanthellae contribute to the primary productivity of the oceans. Corals also help break the strong waves generated by the sea before reaching the shores. Coral reefs are one of the most diverse ecosystems in the planet hosting numerous number of species from the smallest invertebrates to the largest fishes in the ocean.

Seagrasses are monocotyledonous vascular flowering plants that live completely submerged in shallow coastal areas (Phillips, et.al., 2003, White et.al., 2004). They are distributed along the coastlines of tropical and temperate waters and are sensitive to changes in water quality (Dennison, 2009). They have adapted life in saline waters with a root system that can withstand wave action (stems buried within a soft substrate) and a reproductive system that distributes pollen by water (complex pollination mechanisms involving mass spawning and the longest pollen grains in the Animal Kingdom). They can normally be found in areas where light can easily penetrate enabling photosynthesis to occur. They are usually located between the coral reefs and mangrove areas colonizing the soft, shallow and sandy-muddy bottom (White, et.al., 2004).

A lot of key ecological services are being provided by seagrasses. They serve as critical coastal nursery habitat for estuarine fisheries and wildlife including globally threatened species. They function as direct food sources for fish, waterfowl, dugongs, manatees and sea turtles. Seagrasses also acts as an agent in the nutrient cycling process. Their main role as a nutrient source occurs when a dead seagrass decomposes and releases its nutrients to the water (Phillips, et.al., 2003, White et.al., 2004). They exude dissolved organic matter into the surrounding sediments which stimulates various microbes, including nitrogen fixing bacteria. These bacteria absorb dissolved nitrogen in the water and convert it into ammonia to be used for other organisms. Seagrass leaf canopies baffle the water column thereby reducing water motion within the meadow. It allows small particles to settle out in the floor increasing the organic content of the sediments. The roots of the seagrasses also provide a binding mechanism of the sediments. The organic substances released by the rhizomes provide a sticky matrix that helps bind the sediment grains together. Seagrasses also play an important role in mitigating carbon dioxide concentrations. They form an important carbon sink for the planet (Dennison, 2009).

The Philippines has a relatively high mangrove diversity with 42 species. It ranks 5th among countries with the most number of endemic species

Mangroves provide tremendous values and benefits to mankind and other marine organisms. They are a source of valuable plant products used as food, traditional herbal medicine and other wood and forest products. Mangrove forests serve as nesting grounds for hundreds of bird species, as well as nurseries, and are home to a wide variety of reptile, amphibian, mammals, fish, crabs, shrimps, mollusks and many other invertebrates. Being archipelagic in nature, a large part of the population of the Philippines depend on the mangroves for food, livelihood, and shelter derived from the mangrove ecosystem. In fact, more than half of the country's 1,500 towns and 42,000 villages depend on these marine habitats for food and other goods and services (Primavera 2000). Recognizing the vulnerability of the country to storm surges and strong winds due to typhoons, planting of mangroves has been identified as one of the adaptation strategies to such climatic events. Mangrove forest plays an important role in the protection of the coastline. Studies noted that in areas without mangroves, the coconut trees were uprooted due to wave action during stormy weather. The event did not occur in coastal areas where a strip of mangroves was easily eroded compared to those with mangrove trees. In coastal areas directly exposed to the strong wave action of the Pacific Ocean, coastal erosion was reduced either by mangrove trees or cliffs. Mangroves also act synergistically with adjacent ecosystems such as seagrass and coral reef communities for coastal protection. In the face of climate change, many of the regulating services of mangroves are actually becoming more necessary and valuable, especially their buffering capacity against storms and flooding. Mangroves can hold back the sea waves and reduce wave forces with their extensive and dense above-ground roots by an estimated 70– 90 % on average (Macintosh 2010). Furthermore, mangroves are as effective as concrete seawall structures for reduction of tsunami-hit house damage behind the forest. Mangroves are also potential sources of livelihood for the community in the Philippines through the development of policies and programs that can help provide incentives to local people who are largely dependent on mangroves. Mangroves are in a vigorous condition and capable of storing vast amounts of carbon. They estimated that the 40-year-old plantation has the largest carbon density with 370.7 tons per ha, followed by the 15- year-old plantation with 208.5 tons per ha, 20-year-old plantation with 149.5 tons per ha, and lastly by natural stand with 145.6 tons per ha.

When the sea-bottom was checked from the mouth of the river up to 1km seaward, there were no coral reef or seagrass beds in the adjacent marine ecosystem of Bayawan River. When there are large rivers, it is expected that corals will not settle due to the lower salinity as a result of freshwater mixing from the river. Another factor is the heavy siltation brought by suspended particles from the eroding river banks. The effect of siltation on corals is a well-studied topic in coral ecology. In a review by Rogers (1990) on the effects of siltation on corals and coral reefs, it was observed that corals can tolerate a total suspended solid (TSS) concentration of less than 10 mg/L. Further TSS concentrations will smother the coral eventually resulting to death. Common seagrass species in the estuarine area such as the *Enhalus acoroides* is absent in the adjacent marine ecosystem. Due to the heavy siltation, water turbidity is very high (visibility of 0.5m) thus preventing the sun light from penetrating to the water column for seagrass photosynthesis.

Nevertheless, natural mangrove stands were present in the estuarine area. The researchers focused their effort in obtaining mangrove data.

Materials and Methods:

Standard transect plot method was used to assess the mangrove vegetation in the estuarine ecosystem. A 100m transect line was laid both sides parallel to the river and perpendicular to the shoreline. Five (5) 10mx10m plots were established both sides within the 100m transect. All mangroves species present inside the plots were assessed according to species composition, density and crown cover.

Sampling Site Description:

Using a base map of the Bayawan River, the mangrove areas within the estuarine area were divided into segments. Applying the simple random sampling technique, two (2) sampling sites were selected one at each side of the river. Geographic coordinates of the sampling sites were marked and recorded for reference. Figure 2-79 shows the relative location of the mangrove survey sampling stations in Bayawan River.

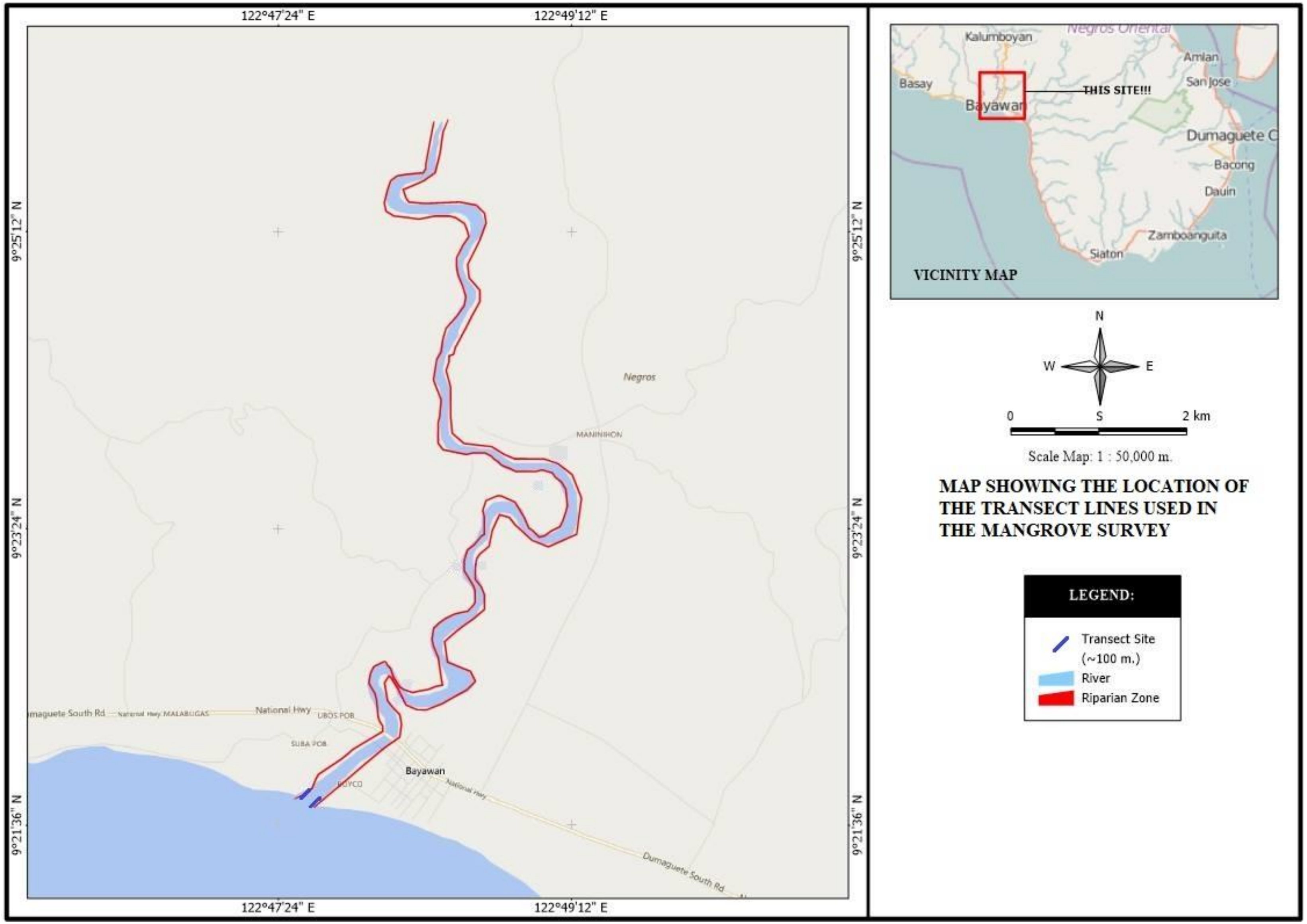


Figure 2-79 Map showing the location of the sampling sites of the Mangrove Survey in Bayawan River

2.2.1.10 Threat to Existence and/or Loss of Important Local Species and Habitat



Mangrove Composition:

The mangrove in both sides of the river mouth were composed of nine (9) species belonging to six (6) families (Avicenniaceae, Euphorbiaceae, Meliaceae, Myrsinaceae, Palmae, Rhizophoraceae and Sonneratiaceae). This implies that the area has very poor species richness with 9 species out of 42 mangrove species according to Melana and Gonzales (1996). Table 2-50 shows the species composition with conservation status of the mangrove species found in Bayawan River.

Table 2-50 Mangrove Composition and Conservation Status Adopted from IUCN

Family	Species	Red List category
Avicenniaceae	*Avicennia lanata*	VU
Euphorbiaceae	*Excoecaria agallocha*	LC
Meliaceae	*Xylocarpus granatum*	LC
Myrsinaceae	*Aegiceras corniculatum*	LC
Palmae	*Nypa fruticans*	LC
Rhizophoraceae	*Ceriops decandra*	NT
	Rhizophora apiculata	LC
	Rhizophora mucronata	LC
Sonneratiaceae	*Sonneratia alba*	LC

These species are commonly found in the seaward zone specifically *Avicennia lanata* and *Sonneratia alba* that serves as frontal species against strong waves and typhoon. *Nypa fruticans* is commonly estuarine inhabitants and dominated the right side of the river. They often grow in soft mud and slow-moving tidal and river waters that bring in nutrients. It is observed Rhizophora species in the inner portion of the river mouth which suitable in the area because this type off mangrove thrive in muddy substrate and also fast-growing species about 60 cm within their first year (Ng and Sivasothi, 1999). The type of mangrove in the study site is a fringe mangrove. In this type of mangrove, highly affected by tides, which are often exposed to pure seawater and commonly seen mangroves that contain prop-roots, buttresses and pneumatophores.

Table 2-51 shows the country occurrence / home range distribution of the list of mangrove species found in the estuarine area of Bayawan River.

Table 2-51 Mangrove Occurrence of the Species found in Bayawan River (Adopted from IUCN)

Family	Species	Countries occurence
Avicenniaceae	*Avicennia lanata*	**Native:** Malaysia (Peninsular Malaysia)
Euphorbiaceae	*Excoecaria agallocha*	**Native**: Australia; Bangladesh; Brunei Darussalam; Cambodia; China; Fiji; India; Indonesia; Japan; Malaysia; Maldives; Micronesia, Federated States of ; Myanmar; New Caledonia; Niue; Norfolk Island; Palau; Papua New Guinea; Philippines; Singapore; Solomon Islands; Sri Lanka; Taiwan, Province of China; Thailand; Tonga; Vanuatu; Viet Nam
Meliaceae	*Xylocarpus granatum*	**Native**: Australia; Bangladesh; Brunei Darussalam; Cambodia; China; Comoros; Fiji; Guam; India; Indonesia; Kenya; Madagascar; Malaysia; Marshall Islands; Mayotte; Micronesia, Federated States of ; Mozambique; Myanmar; New Caledonia; Northern Mariana Islands; Palau; Papua New Guinea; Philippines; Seychelles; Singapore; Solomon Islands; Somalia; South Africa; Sri Lanka; Tanzania, United Republic of; Thailand; Tonga; Vanuatu; Viet Nam
Myrsinaceae	*Aegiceras corniculatum*	**Native**: Australia; Bangladesh; Brunei Darussalam; Cambodia; China; India; Indonesia; Malaysia; Myanmar; Papua New Guinea; Philippines; Singapore; Solomon Islands; Sri Lanka; Taiwan, Province of China; Thailand; Viet Nam
Palmae	*Nypa fruticans*	**Native:** Australia (Northern Territory, Queensland); Bangladesh; Brunei Darussalam; Cambodia; China (Hainan); Guam; India; Indonesia (Jawa, Kalimantan, Maluku, Papua, Sulawesi, Sumatera); Japan (Nansei-shoto); Malaysia (Peninsular Malaysia, Sabah, Sarawak); Micronesia, Federated States of ; Myanmar; Northern Mariana Islands; Palau; Papua New Guinea (Bismarck Archipelago, North Solomons, Papua New Guinea (main island group)); Philippines; Singapore; Solomon Islands; Sri Lanka; Taiwan, Province of China; Thailand; Viet Nam
Rhizophoraceae	*Ceriops decandra*	**Native:** Bangladesh; India; Malaysia; Myanmar; Thailand
	Rhizophora apiculata	**Native**: Australia; Bangladesh; Brunei Darussalam; Cambodia; China; Guam; India; Indonesia; Kiribati; Malaysia; Maldives; Micronesia, Federated States of ; Myanmar; Nauru; New Caledonia; Northern Mariana Islands; Palau; Papua New Guinea; Philippines; Singapore; Solomon Islands; Sri Lanka; Thailand; Vanuatu; Viet Nam
	Rhizophora mucronata	**Native:** Australia; Bangladesh; Brunei Darussalam; Cambodia; Comoros; Djibouti; Egypt; Eritrea; India; Indonesia; Iran, Islamic Republic of; Japan; Kenya; Madagascar; Malaysia; Maldives; Mauritius; Mayotte; Micronesia, Federated States of ; Mozambique; Myanmar; Oman; Pakistan; Palau; Papua New Guinea; Philippines; Réunion; Saudi Arabia; Seychelles; Singapore; Solomon Islands; Somalia; South Africa; Sri Lanka; Sudan; Taiwan, Province of China; Tanzania, United Republic of; Thailand; United Arab Emirates; Vanuatu; Viet Nam; Yemen
Sonneratiaceae	*Sonneratia alba*	**Native**: Australia; Brunei Darussalam; Cambodia; China; Comoros; India; Indonesia; Japan; Kenya; Kiribati; Madagascar; Malaysia; Mayotte; Micronesia, Federated States of ; Mozambique; Myanmar; New Caledonia; Palau; Papua New Guinea; Philippines; Seychelles; Singapore; Solomon Islands; Somalia; Sri Lanka; Taiwan, Province of China; Tanzania, United Republic of; Thailand; Tuvalu; Vanuatu; Viet Nam

Mangrove Density:

The mean mangrove density (individuals per $100m^2$) per species was computed for both right and left side of Bayawan River. Results showed that the *Nypa fruticans* has the highest density with 19 ind/$100m^2$ recorded on the right portion of the river. However, it can be observed that the species richness in the right portion of the river is low with only 4 species. On the other hand, the highest density recorded on the left portion was Piapi (*Avicennia lanata*) with a density of 9 ind/$100m^2$. The left portion has higher species richness with a total of 8 species. Figure 2-80 and Figure 2-81shows the comparison of the mean mangrove density in the right and left portions of the river per species.

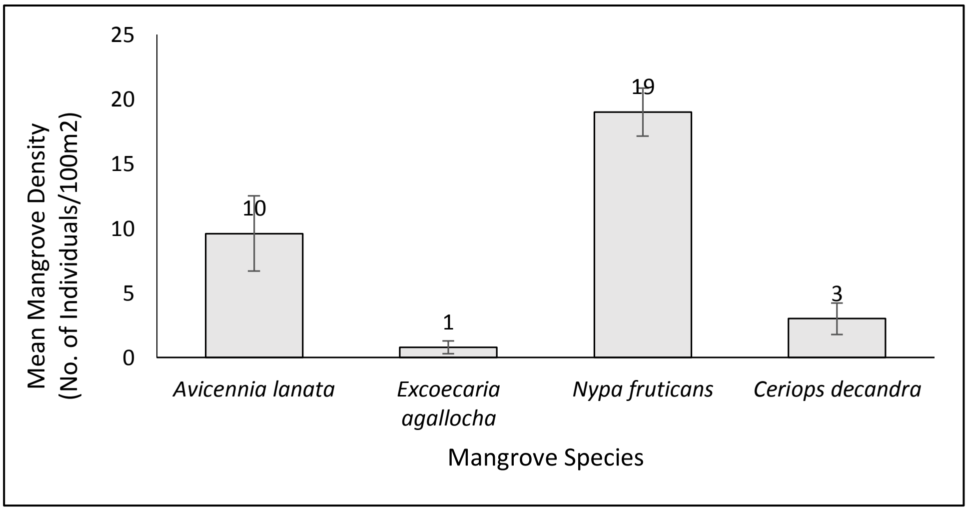


Figure 2-80 Mean Density of Mangroves per Species in the Right Side of Bayawan River

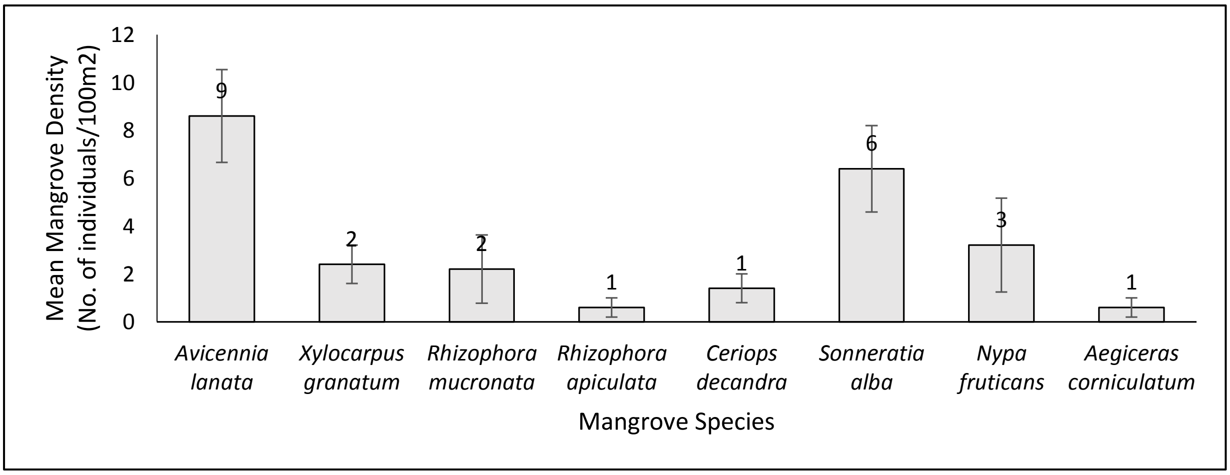


Figure 2-81 Mean Density of Mangroves per Species in the Left Side of Bayawan River

Rhizophora and Avicennia species may cause low mangrove density due to its expansive pneumatophores and consumes space for other mangroves to grow.

Mangrove Crown Cover:

The average crown cover/100 m2 for both right and left sides were 14.90 and 41.00. It can be observed that the avicennia and sonneratia species bears the highest mangrove covers because of its large canopy. The large canopy of these species plays an important role in protecting the shoreline and the community behind. It attenuates wave action and breaks the wind from typhoon. These types of species are suited in the seaward direction and are the front liners in the mangrove community. Table 2-52shows a comparison of the mean crown cover of the different mangrove species found in both sides of Bayawan River.

Table 2-52 Comparison of the Mean Crown Cover of Mangrove found in the Left and Right Side of the River

Family	Species Name	Common Name	Average Crown Cover	
			Left	Right
1. Avicenniaceae	*Avicennia lanata*	Piapi	6.9	12.5
2. Euphorbiaceae	*Excoecaria agallocha*	Buta-buta	4	0
3. Meliaceae	*Xylocarpus granatum*	Tabigi	0	5
4. Myrsinaceae	*Aegiceras corniculatum*	Saging-saging	0	2
5. Palmae	*Nypa fruticans*	Nipa	0	0
6. Rhizophoraceae	*Ceriops decandra*	Malatangal	4	2.4
	Rhizophora apiculata	Bakauan-lalaki	0	2.8
	Rhizophora mucronata	Bakauan-babae	0	4.5
7. Sonneratiaceae	*Sonneratia alba*	Pagatpat	0	11.8
		Total Mean Cover	**14.9**	**41**

Rhizopohora species on the other hand bears lower mean crown cover.

Ecological Index:

The diversity index of the mangroves in the estuarine area of Bayawan river for both right and left sides were computed using Shannon Category Index, Margalef's Species Richness and Pielou's evenness. Results showed that the Pielou's Index is approaching the value of 1. This means that there is a dominant species in both left and right sides of the river. Table 2-53 shows the summary of the different ecological indices computed to check the mangrove diversity in the estuarine area of Bayawan River.

Table 2-53 Summary of Ecological Indices for the Mangrove Ecosystem of Bayawan River

Riparian Fauna	Mean Density (Nt)	Total Species (Ns)	Margalef's Species Richness (d)	Pielou's Evenness (J')	Shannon (H')
Right	35	4	1.12	0.81	1.13
Left	37	8	2.22	0.91	1.90

Using the Shannon Category Index, the values generated were H' = 1.13 and H' = 1.90 respectively. Based on the relative values of Shannon's Index, the mangrove diversity in the estuarine area of Bayawan River was found to be very low.

Table 2-54 shows the categories of Shannon's species diversity index.

Table 2-54 Categories of Species Diversity Index

Relative values	H' Values
Very high	> 3.5000
High	3.0000 - 3.4999
Moderate	2.5000 - 2.9999
Low	2.0000 - 2.4999

Very low	< 1.9999

Impacts on Mangrove Ecology and other Coastal and Marine Ecosystems

Presence of Pollution Indicator Species

There were no pollution indicator species recorded during the mangrove survey.

Threat from Red Tide Phenomenon

Historical occurrence of red tide for the Negros Island were recorded in the north west portion of Negros Occidental and Bais Bay in Negros Oriental. The project area is relatively far from these bodies of water and historically, none was reported to occur in the past in Bayawan City. Red tides may occur due to excessive pollution of the water. The project will not generate industrial pollutants and other associated chemicals. Thus, it is unlikely that the dredging operations will cause occurrence of red tide in the marine environment. However, the upland agricultural activities if not monitored, regulated and managed may increase the possibility for the phenomenon to occur.

Habitat and Species Disturbance

Baseline information of the marine ecosystem reveals that there are no coral reef or seagrass beds area within the 1km impact area (seaward) of the dredging operations. In addition, diversity index of mangroves shows that there is low mangrove diversity in the estuarine area. Further, there are no threatened species of mangrove present in the area except for the Piapi (*Avicennia lanata*). Based on local interviews, they do not fish on the estuarine due to low fish biomass as evidenced by low Catch per Unit Effort (CPUE). The poor condition of the water as a result of sedimentation is responsible for the low diversity in the area.

Impact Analysis

The dredging operations may generate additional silts which may may cover the benthic community, especially at the river mouth. However, this disturbance is temporary and the high potential for decolonization allows these communities to thrive again over time. The number of mangrove around the project site is sparse. These will not be disturbed by dredging and will remain part of the estuarine and riparian zone. In general, fish stocks and other species would be disrupted but would be expected to return to normal as the new channel matured. Recovery of the river bed would depend upon the morphology and type of substrate left in the new channel.

Management Plan

During hauling of dredged materials, navigational lane must be established to avoid disturbance on any coral reefs that may be existing offshore.

Although there are no coral reef and seagrass colony in the area, the silt and sediments that the dredging operation generates must be managed and suppressed from traveling offsite due to the dynamics of seasonal marine current and tidal actions. Silt curtains must be installed and designed appropriately to address this issue.

Dredging of the main channel may have serious effects on the invertebrate community. The reach may not be recolonized after dredging. An area of the river bed would have to be left undisturbed to allow subsequent recolonization. The area one kilometer before and after the Bayawan bridge will serve not only to protect the bridge toe from scouring but to allow for the recolonization of invertebrates and other benthic organisms.

The increased suspension of sediments in the water column as a result of dredging can negatively affect life stage developments of fish and amphibian species by reducing the availability of intra-gravel water flow and dissolved oxygen, which is critical to successful egg development. The project should make all attempts and consider various alternatives to recover the original structure and characteristic of the river bed like ponds, ripples and the likes that promotes and enhance recolonization of various river species.

In case that there will be affected mangroves in the estuarine area, these individuals must be earth-bowled and transferred to a similarly viable location. Tree replacement must also be observed for every mangrove mortality recorded during the dredging operations.

Monitoring Plan

The main concern that impacts the habitat and various organisms in the project area is the increase in turbidity of the water. This is mainly due to the silts that is generated during the active dredging activity.

Prior to and after active dredging, turbidity can be estimated using the secchi survey and then patterns identified and set by MMT to monitor the effectiveness of silt curtains. Deviation from the agreed pattern should prompt corrective measures right away.

The design limits for channel reconfiguration should be monitored and strictly adhered to. Any deviation from the design during implementation should be reported right away following the protocol to set by MMT.

2.2.1.11 Threat to abundance, frequency and distribution of species

Marine fishery is one of the major economic activities in Bayawan City with an annual production of approximately 3,500 tons. Inland fishery and aquaculture remains minimal and small scale; crab pots production for example is only a low 1.04-ton production per year. Tilapia and bangus ponds are present in the city but are patronized only during typhoon season when marine fish catch is very lean. There are over five hundred registered fishermen in the city, with 363 registered motor boats. Majority or 356 of these motorboats however are non-motorized, indicative of the prevalence of marginal and small-scale fisher folks in the city. The municipal waters are also home to several pelagic marine fishes and considered a migration of the high- valued yellow fin and blue fin tuna. This has made the city famous as a landing and docking site of various fishing and tuna-gathering marine vessels; and home to tuna traders and exporters.

Dredging operations may have some effects on abundance, frequency and distribution of marine species but the effect is temporary and reversible over time and space. The greatest single threat is over exploitation of this resource.

Market surveys should be done monthly by the MAO of Bayawan City. This will insure timely information on fish supply and prices of fishery products during and after the dredging operation.

Impact Analysis

It is certain that the dredging operation in the river will have very minimal and temporary impacts on the mangroves, fisheries and other marine resources in the estuarine area of Bayawan River. However, the hauling of the dredged materials from the river to the bulk carriers awaiting the deeper part of Sulu sea may disturb the fishing grounds of the fisher folks. This disturbance might result to migration of demersal as well as pelagic fishes in the area. On the other hand, while the bulk carriers are anchored offshore for weeks, this could likely create shade and cooler water thus resulting to an equivalent aggregating device for the fish. These impacts are again temporary in nature.

The pressure exerted on the marine resource by over fishing overshadows the threat that may be caused by dredging activity.

Management Plan

A comprehensive and aggressive IEC should be developed and implemented by the proponent to keep the stakeholders aware of the current implementation of the project. The formation of the office for public concerns as part of the operational structure of the dredging project should be well supported and functioning as efficient and as effective as possible.

The critical period is during the habagat season when most of the fishers will be fishing actively. Mechanism should be established where the disturbance from hauling activities will not result into misunderstanding and conflict between the proponent and the rest of the stakeholders. Regular “pulong-pulong” can be conducted by the proponent to improve public relations and serve to communicate concerns by the fishers and other stakeholders regarding the project.

Annual budget on the alternative livelihood program to fishers should be allocated by the LGU to partially offset the problem of overexploitation of fishery resources. The LGU can also tap various business organization of the city for funding & training as part of their corporate social responsibilities (CSR).

Monitoring Plan

The list of fishers affected by the project should be regularly updated. Other essential data may be gathered such as fish catch, type of fish caught and other associated data useful in promoting conflict resolution that may arise during project implementation.

Monitoring mechanism will not only involve acquisition of data but a mechanism to store these data as well. These data will be open to regular public review.

2.3 THE AIR

Meteorology and Climatology

2.3.1.1 Change in local micro-climate

The Province of Negros Oriental experiences has Type III climate as shown in Figure 2.62. There are two distinct seasons: relatively dry from January to May and wet from June to December. Typhoons usually occur between May and November. The average annual rainfall is 1218.4 mm based on data from the PAGASA station in Dumaguete City. Table 2-55 shows the monthly average rainfall.

This distinct wet and dry season relates largely to the seasonal production and economic activities in the city which are mostly based on agriculture and fishery. Infrastructure and development projects especially in the hinterlands are also limited by the wet season especially during long and heavy downpours. The city faces strong winds and heavy rains during the southwest monsoon which comes from its coast and the Sulu Sea. Typhoons especially in the later part of the year affect the city. Dry spells like El Nino adversely impact production when it tends to extend the dry season, delaying or even arresting planting season for the mostly un-irrigated agricultural lands particularly in the hinterlands.

The climate at Bayawan is tropical and monsoonal, belonging to Type III of the modified Coronas Classification. There are two pronounced seasons – relatively wet from late May to December, and drier from January to April. The southwest monsoon begins in June and ends in mid-October. Typhoons generally pass through the area in October to December. Lowland temperatures range from 25 – 30^{o} C, while the upland area experiences a cooler 22 – 25^{o} C temperature range.

Over the last 50 years, the City Agriculture Office has collated rainfall data from 1963 to 2013. The annual rainfall average for Bayawan is 2531 mm. The month of August seems to be the wettest with 468 mm average. The driest year was in 2010, with 899 mm of rain, and the wettest was in 1963 with 5325 mm. The longest drought period was recorded for 2 consecutive years in 1982 and 1983 (1455 and 1073 mm, respectively). Some 3 months of nil precipitation was experienced in 1998, during February to April. The driest months for the rainy season occurred in October-December of 1997, with only 100 mm of rain falling in a 3-month period.

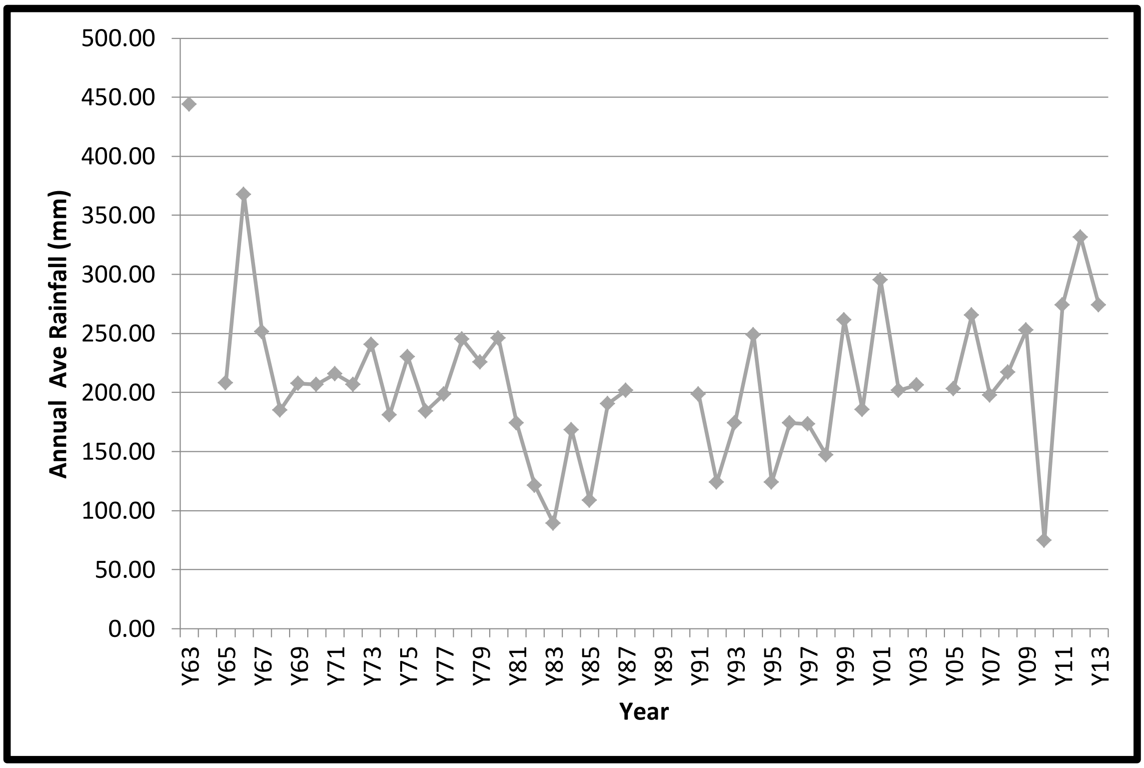


Figure 2-82 Plot of historical annual averaged rainfall at Bayawan for the period 1963-2013

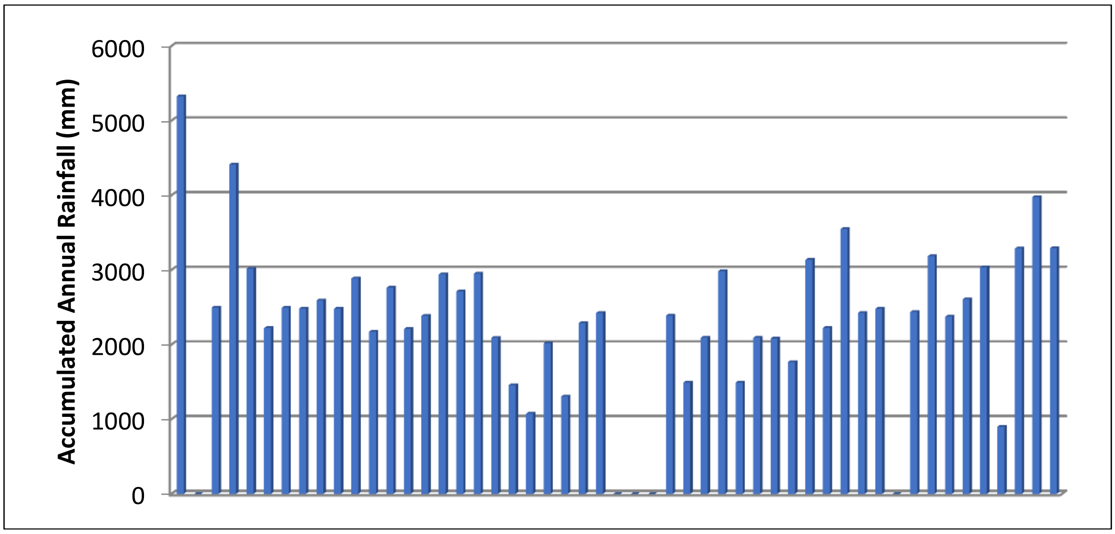


Figure 2-83 Accumulated Annual Rainfall rc(from left to right, 1963-2013)

**Zero data means year with incomplete records of monthly rainfall*

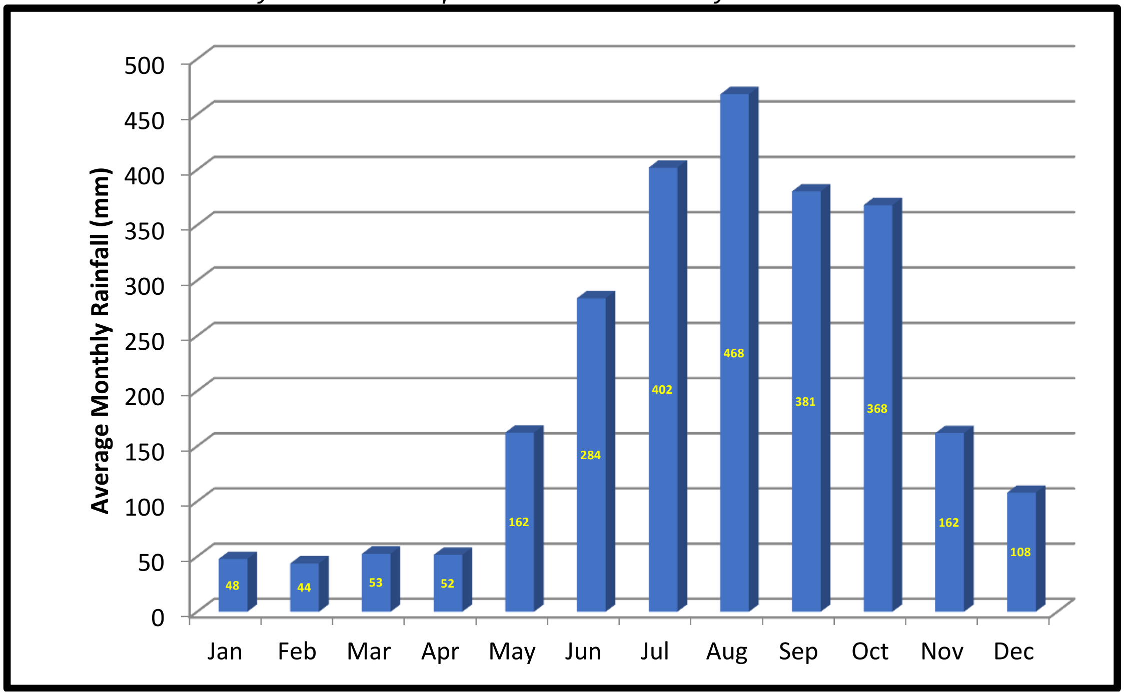
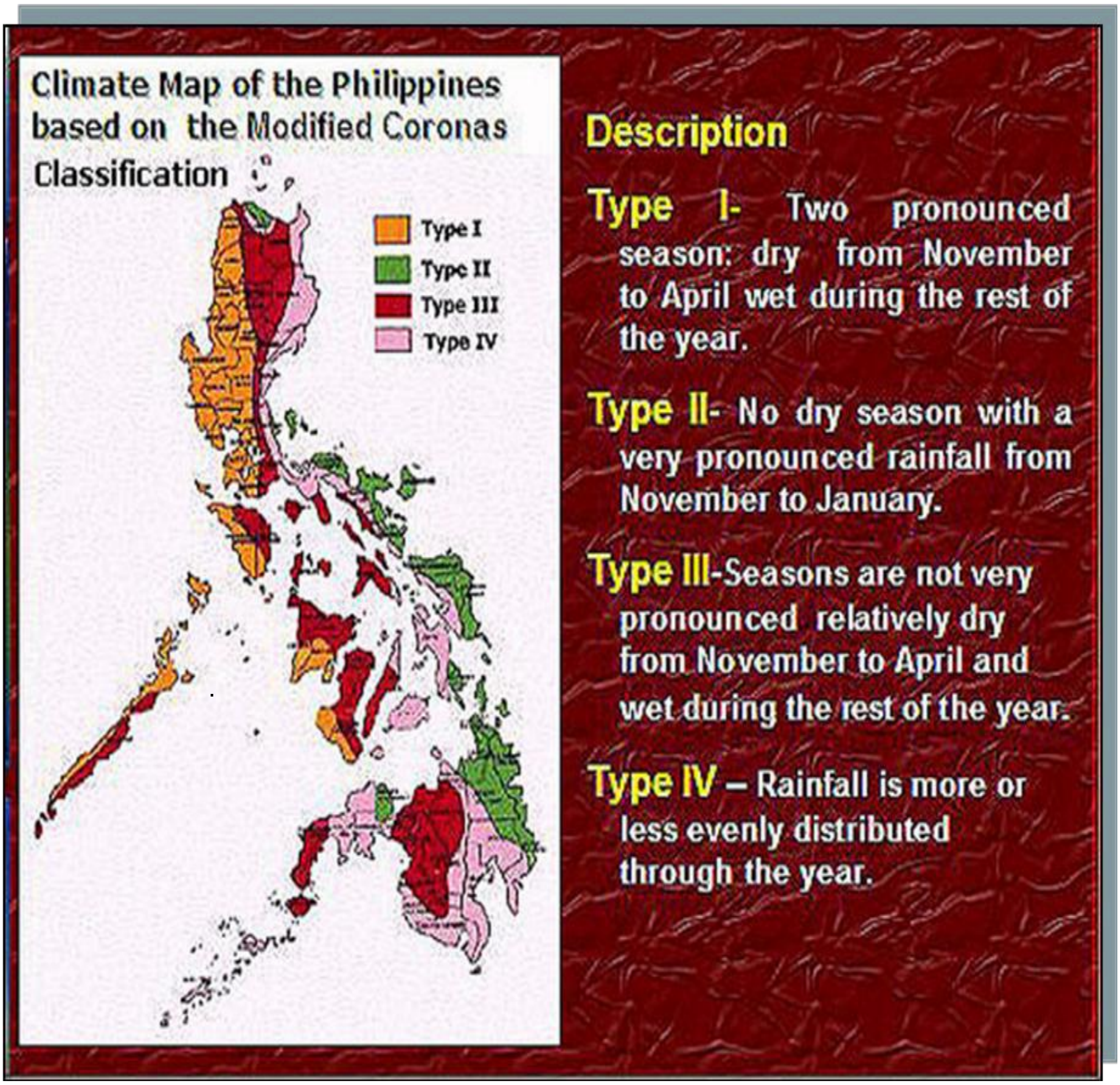


Figure 2-84 Averaged monthly rainfall at Bayawan, from precipitation data recorded for the period 1963-2013

Table 2-55 Monthly Rainfall

MONTH	AVERAGE RAINFAL (mm)
January	82.0
February	61.4
March	46.3
April	53.7
May	81.8
June	129.7
July	122.7
August	110.6
September	127.3
October	156.7
November	138.7
December	107.3
ANNUAL RAINFALL 2016	1218.4

Source: PAGASA



Source: PAGASA

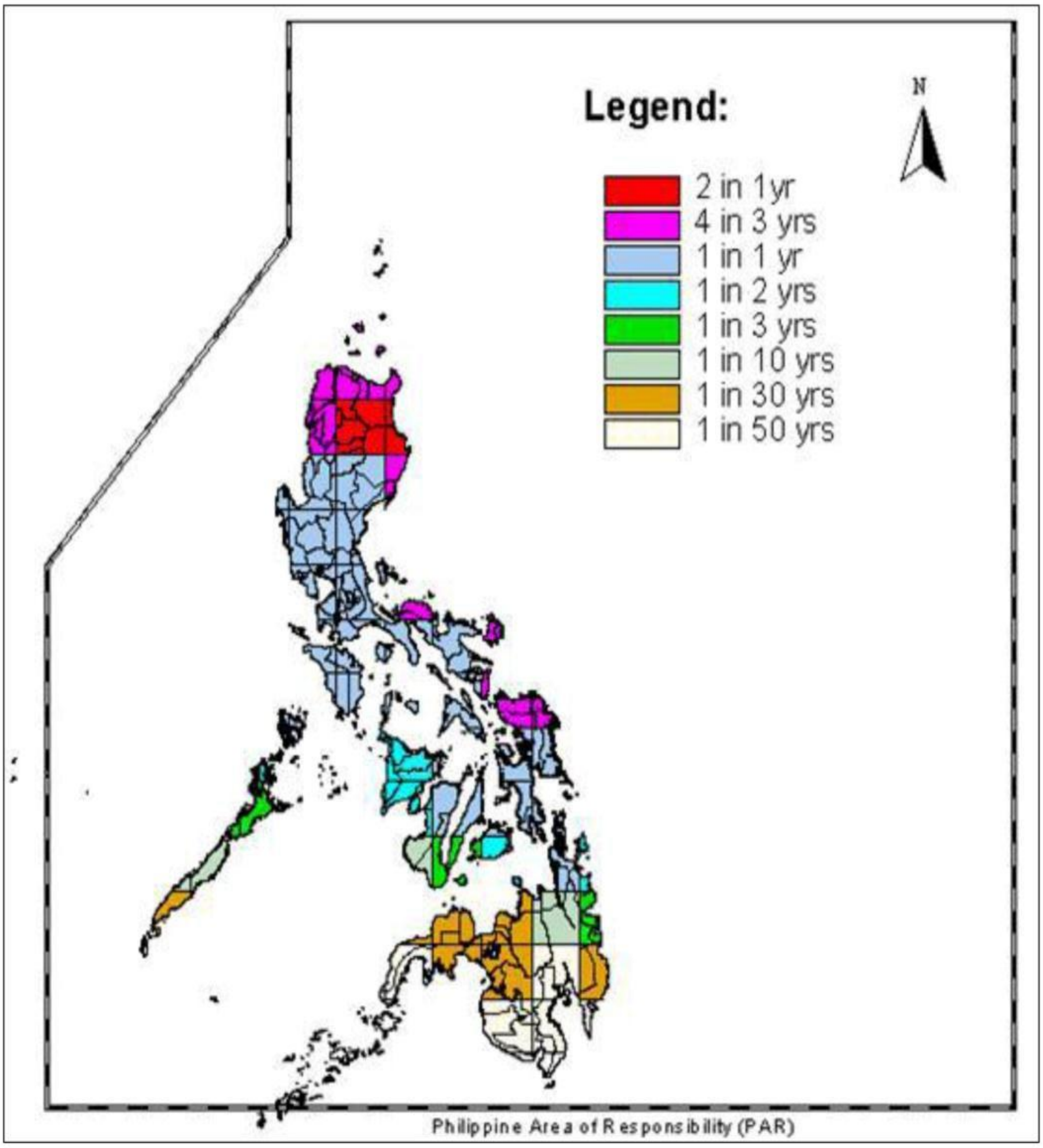
Figure 2-85 Modified Coronas Classification of Climate in the Philippines

Tropical cyclones are characterized by a low-pressure center where winds of varying intensities blow around the center. Tropical cyclones are classified according to maximum winds near the center as follows:

Table 2-56 Topical Cyclone Classification

Classification	Maximum Wind Speed
Tropical Depression (TD)	Winds from 45 to 63 KPH (km/hour)
Tropical Storm (TS)	Winds from 63 to 117 KPH
Typhoon (T)	Winds of more than 117 KPH

On the average, about twenty (20) tropical cyclones visit the Philippine Area of Responsibility every year. Out of this twenty (20) tropical cyclones, eight (8) developed into a destructive typhoon which brings voluminous rains and strong winds causing tremendous damages. Figure 2-86 below indicated the number of tropical cyclones that hit specific regions at a given number of years.



Source: PAGASA

Figure 2-86 Average Number of Tropical Cyclones per Year

Historically most typhoons in the Central Visayas region occur in the months of October to December. Two typhoons spawned heavy downpour and caused flooding in the city, apparently caused by Typhoons *Ruping* in 1990 and *Ursula* in 2003. *Ursula* was a tropical depression (October 21-24, 2003) with peak intensity of 55 km/hr. *Ruping* was the deadliest typhoon (November 13-14, 1990) since *Nitang* in 1984 (its heavy rainfall and winds killed 1,492 people in the whole country, total damage P10.846B) and *Amy* in 1951, when it made landfall in the eastern Philippines at 230 km/hr but weakened when it hit the central islands at 137km/hr, but poured heavy rains that caused widespread flooding across the Visayas. Typhoon *Uring* in November 1991caused devastation and flooding in areas north of Bayawan.

Typhoons *Sendong* in December 2011 and *Pablo* in December 2012 wreaked havoc in Northwestern and Eastern Mindanao, but passed Bayawan to its south and caused minor flooding in many areas of Southeastern Negros. Supertyphoon *Yolanda* in 2013, which passed farther north of Bayawan, also caused overtopping of the main Bayawan River and inundated parts of the floodplain.

In recent years, extreme weather events have become more frequent and intense towards the south, in the Visayas and Mindanao regions. During the disastrous October 6, 2013 flood event, the Bayawan coastal area received 514 mm of rain during a 24-hour period, just about half of the historical rainiest month (1040 mm) of total monthly rainfall recorded in August 1963.

The southwest monsoon begins in June and ends in mid-October. Northeast winds (Amihan) occur during November to May, with speed averaging 4 m/s while southwest winds (Habagat) come during June to October, with speed averaging 3 m/s.

Figure 2-87 below provides insights on the climate change projections on Region 7 under medium range emission scenario for 2020 and 2050. Based on this scenario, rainfall is expected to increase by 15-17mm and temperature is projected to increase at about 1-2 degrees.

Table a: Seasonal temperature increases (in °C) in 2020 and 2050 under medium-range emission scenario in provinces in Region 7

	OBSERVED BASELINE (1971-2000)				CHANGE in 2020 (2006-2035)				CHANGE in 2050 (2036-2065)			
	DJF	MAM	JJA	SON	DJF	MAM	JJA	SON	DJF	MAM	JJA	SON
Region 7												
BOHOL	26.6	28.0	28.2	27.8	0.9	1.2	1.2	1.0	1.8	2.3	2.3	1.9
CEBU	26.8	28.4	28.2	27.9	0.9	1.2	1.1	1.0	1.9	2.4	2.1	1.9
NEGROS ORIENTAL	27.0	28.4	28.0	27.8	0.9	1.2	1.0	1.0	1.9	2.3	2.0	1.9

Table b: Seasonal rainfall change (in %) in 2020 and 2050 under medium-range emission scenario in provinces in Region 7

	OBSERVED BASELINE (1971-2000)				CHANGE in 2020 (2006-2035)				CHANGE in 2050 (2036-2065)			
	DJF	MAM	JJA	SON	DJF	MAM	JJA	SON	DJF	MAM	JJA	SON
Region 7												
BOHOL	376.1	209.6	412.9	514.5	9.8	-7.1	4.5	6.8	21.2	-11.9	18.9	22.6
CEBU	324.0	228.3	595.1	607.4	17.7	0.8	7.7	7.7	19.6	0.5	18.9	17.8
NEGROS ORIENTAL	225.8	226.0	639.5	636.9	15.0	-4.9	9.3	4.7	17.4	-6.8	20.7	10.5

Table c: Frequency of extreme events in 2020 and 2050 under medium-range emission scenario in provinces in Region 7

Provinces	Stations	No. of Days w/ Tmax >35 °C			No. of Dry Days			No. of Days w/ Rainfall >300mm		
		OBS	2020	2050	OBS	2020	2050	OBS	2020	2050
BOHOL	Tagbilaran	260	1710	3413	8176	6836	6473	0	1	6
CEBU	Mactan	25	1488	2463	7112	5720	5693	0	0	1
NEGROS ORIENTAL	Dumaguete	66	826	1499	8451	6032	5642	0	0	0

Figure 2-87 Region 7 Climate Change Projections

Impact Analysis

Projected increase in rainfall due to climate change during certain months of the year will result to more flooding incidence and destruction of lives and properties in the area. The project is not expected to contribute to this climate change. On the contrary, the project precisely attempts to mitigate the effects of this change.

Wetter conditions as projected will saturate the subsurface of the alluvial plains in the project area thus it is expected that there will be an increase in volume of surface water and bankfull flow will be frequent. Without the project, this condition will result to a frequent bankfull overflow from an already silted and shallow river channels.

The projected decrease in rainfall in the months of March to August will result to a decrease in the volume of surface water in the catchment area. This will impact agricultural activities especially in the upstream where the irrigation system is being set up. The increase in demand for irrigation water during these times will eventually decrease the flow of the surface water downstream in the project area. However, this decrease will be compensated by an increase in rainfall in the subsequent months. Water management therefore is critical in striking a balance between water use and its availability over time and space.
In the ecological point of view, climate change will alter air and water temperature, runoff of water, biodiversity, and precipitation. This is correlated to the increase in water temperature and lead to stress and imbalance on freshwater ecology thus may alter primary production.

Management Plan

River system has always been of service to society as a whole. Civilizations thrive along the river. River systems have always been dynamic and adjust themselves corresponding to changes. Left alone, it adopts over time to keep its productivity.

These dynamic adoption and adjustments by the river can be both destructive and beneficial in the point of view of society. The river can form fertile and productive lands in its flood plains but this flooding can at the same time cause destruction of lives and properties as well. Optimizing the services offered by the river without compromising its integrity has always been the challenge of any river management.

“Go with nature approach” has been advocated as one of the best management framework for river management. The corresponding increase and decrease of rainfall due to climate change will disturb the hydrological stability of Bayawan River. Understanding how it behaves is an essential step in addressing adverse impacts brought about by its dynamics. A comprehensive hydrological as well as geological understanding of the Bayawan River can lead to good structural and non-structural management options for its use.

Dredging and channeling the river anchored on hydrological and geological studies and design that accommodates these changes will lessen the impact of flooding incidence.

Other management considers non-structural approach such as:

- Management of ground water recharge
- Management of storm water flows
- Design policy on adaptability and livelihood diversification for agricultural sector
- Promotion of water conservation
- Management and regulation of small scale dredgers

These non-structural management options are beyond the scope of the EIA study for this project and should be considered theoretical and generic.

Monitoring Plan

Since the hydrological stability is threaten as a result of climate change, strict compliance of design parameters for dredging should be done. This includes recording data on river slope before and after dredging a river reach at a given time.

Other parameters to be monitored on a regular basis are:
- Water temperature resulting from increase in suspended silts

- Actual channel profile on a given river reach after dredging
- Ground water level from established wells
- Water turbidity and salinity
- Presence or absence of algal blooms
- Benthic indicators of dredged river bed
- TSS, nutrients and heavy metals

2.3.1.2 Contribution in terms of greenhouse gas emissions

IPCC Guidelines indicate that greenhouse gases include carbon monoxide, methane, nitrous oxide, hydrofluorocardons, perfluorocarbons, sulfur hexafluoride, nitrogen trifluoride, trifluoromethyl Sulphur pentafluoride, halogenated ethers and other halocarbons.

Since dredging operations are conducted in a body of water, using sea based equipment, then this type of operation would fall under "Domestic Water-borne Navigation" in the Classification and Definition of Categories of Emissions and Removals. Falling under this category, greenhouse gases that should be monitored are CO_2, CH_4, N_2O, NO_x, CO, NMVOC and $SO_{2.}$

2.3.2 Air Quality

2.3.2.1 Degradation of Air Quality

The dredgers and loading and transport vessels that will be used are powered by diesel engines. It has been estimated from literatures that diesel engines can generate daily an estimated TSP of 8-42 µg/m3 near a road. It can then be expected that the lone presence of the dredger and loading vessel in the river channel can generate about the same concentration which even when added to the ambient, will result to a condition less than the standard limits

The generation of air pollutants from diesel engines depends on the size, the speed in which it is running, quality of fuel and the amount/quality of air used for combustion. Figure 2-88 shows potential relative amounts of flue gas that can be generated from a typical diesel engine. Manufacturers of Diesel engines generally established NOx generation in the range of 500 to 1000 ppm as measured in the exhaust system. There are numerous parameters that can result to complexities in pinning down acceptable standards for air pollution regulation. The US EPA has established Emission Factors in an attempt to established emission calculations for regulation purposes. Table 2-57 shows the typical emission factors of Diesel engines.

Typical engine for dredgers is about 600 KW. Using an emission factor of 0.018848 kg/kw-hr for NOx, generation rate is estimated to be about 11,300 kg/hr or 3.13 g/s. Similarly, generation rate for SOx is about 0.207 g/s for emission factor of .001246 kg/kw-hr of the same engine. When these gases leave the exhaust, this is subject to diffusion of ambient air at the project site. The mean air velocity in the area is about 4 m/s from northeast during Amihan and about 2 m/s from the south during Habagat.

Considering a Gaussian distribution for the diffusion pattern, one can estimate the change of concentration of these gases over time and space. SCREEN3 a DOS based model was used to make a rough estimate on this dispersion.

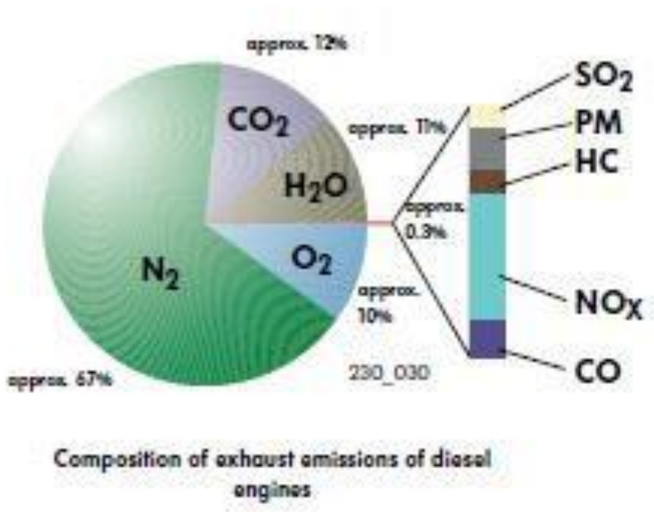


Figure 2-88 Typical Flue Gas generation of Diesel engines

Results have indicated that the maximum NOx is about 0.095 ppm occurring at 500 meters and 0.064 ppm at 935 meters from the location of operation during Habagat and Amihan respectively. Similarly, the maximum SOx is about 12,32 µg/Nm3 at 500 meters and 8.36 µg/Nm3 at 935 meters from the location of operation during Habagat and Amihan respectively.

It may appear that maximum SOx is very low compared to the standard of 180 µg/Nm3. The maximum NOx on the other hand is just close to the standard of 0.08 ppm. At this point it is relevant to note that actual ambient scenario may result to even smaller values if conditions deviate from base assumptions like increase in turbulence or temperature. It is expected then that the sole contribution of flue gases from dredging operations will be nil thus exceeding the DENR standards is unlikely.

Table 2-57 US EPA Emission Factors

Pollutant	Diesel Fuel (SCC 2-02-001-02,2-03-001-01)	
	Emission Factor (lb/hp-hr) (power output)	Emission Factor (lb/MMBtu) (fuel input)
NOx	0.031	4.41
CO	6.68 E-03	0.95
SOx	2.05 E-03	0.29
Pm10	2.20 E-03	0.31
CO^2	1.15	164
Aldehydes	4.63 E-04	0.07
TOC		
Exhaust	2.47 E-03	0.35
Evaporative	0.00	0.00
Crackcase	4.41 E-03	0.01
Refueling	0.00	0.00

[a] References 2,5-6,9-14.. To convert from lb/hp-hr to kg/kw-hr, multiply by 0.608. To convert from lb/MMBtu to ng/J, multiply by 430. SCC = Source Classification Code. TOC = Total Organic Compounds.

For further analysis, an Air and Noise Quality survey was conducted in 3 sampling sites around the project area to determine the characterization of ambient air quality. Table 2-58 below lists the geographic coordinates of sampling sites and Figure 2-89 shows the sampling site map.

Table 2-58 Air Quality Sampling Site Coordinates

LOCATION	COORDINATES	
	LONGITUDE	LATITUDE
Estuarine (Brgy. Suba)	122°47'47.04"E	9°21'44.01"N
Downstream (Brgy. Ubos)	122°48'6.22"E	9°22'7.10"N
Upstream (Brgy. Nangka)	122°48'42.55"E	9°23'4.12"N

Figure 2-89 Air Quality Sampling Site Map

Samples were taken from near the mouth of the river at Brgy. Suba, along the Bayawan bridge at Brgy. Ubos and upstream of the river at Brgy. Nangka. Table 2-59 shows the results of the survey.

Table 2-59 Air Quality Test Results

Date sampled: October 17, 2017						
PARAMETERS	UNIT	METHOD	DENR STANDARD	Estuarine	Downstream	Upstream
PM_{10}	µg/Ncm	Gravimetric	200	11	5	8
NO_2	µg/Ncm	Gas Bubbler - Greiss Saltzman	260	<1	4	3
SO_2	µg/Ncm	Gas Bubbler - Pararosaline	340	<7	10	7
TSP	µg/Ncm	High Volume - Gravimetric	300	19	11	14

Impact Analysis

There is currently no Air Quality Monitoring Station in the immediate surroundings of the project site. The project area is relatively rural and most of its air pollutants come from vehicular traffic. Furthermore, the river area is an open area allowing good air circulation that helps in dispersing and diffusing gas emissions from source such as flue gases from the dredging machines. Criteria pollutants in the area is expected to be lower than standards set by EMB.

Dredging and hauling of dredge materials will be done in the water. There will be no stockpiles on river banks, instead the dredged materials are hauled by barges and delivered to a bulk carrier for transport outside the Philippines. The project therefore does not generate any dust that compromises the ambient condition of the project site nor will it impact the natural water flow continuity during bankfull overflow.

Other potential impacts on the ambient air by the project are:

- Hamper aesthetic value due to smoke from exhaust
- Contribute acidity to water bodies
- Impact on vegetation to acid rain

Smoke emissions from diesel engine would indicate low performance. Tuning up the engine would mitigate this issue.

When it rains, the flue gases will react and form acid and the slightly acidic rain water will eventually reach the river thus increasing its acidity. However, this impact is nil considering low concentration and the diffusive action of the ambient air and the flowing water in the river.
In general, impacts mentioned above are considered temporary and insignificant considering that these pollutants can be easily dispersed and diffused by air currents inherent in an area which is relatively an open space.

Management Plan

The production of pollutant gases is a function of engine performance. Therefore, all equipment must be at its utmost condition to minimize generation of criteria pollutants in flue gases from main engines and its ancillaries. Standard operations and preventive maintenance schedules (OPMS) will be strictly followed.

The production of NOx and SOx also depends on the type of fuel used to run the dredger. Low sulfur content would be desirable therefore management should consider this option as a matter of policy. Furthermore, turbo charging the engine minimizes generation of criteria pollutants due to a more efficient combustion.

Mufflers and scrubbers will be installed at the exhaust to capture pollutant gases and subsequently effectively dispose collected materials following environmental regulations specifically the Clean Water Act.

Furthermore, all environmental regulatory emission devices, if required and deemed necessary, must be installed.

Project implementation will strictly be guided and ever mindful by RA 8749 or the Clean Air Act and RA 9275 or the Clean Water Act.

Monitoring Plan

The project will develop a standard operational monitoring of flue gases such as smoke emissions. This is an indicator of the performance of the main engine for dredgers and barges. If smoke emission is excessive, the engine must be decommissioned and tuned up appropriately.
Emitted flue gases may interact with water and changes its acidity therefore regular sampling will be conducted to monitor this impact.

Other monitoring activities will be set by the MMT as the project proceeds. Results of these tests will be recorded and stored for reference.

2.3.2.2 Increase in Ambient Noise Levels

The Project area can be described as rural and relatively isolated and inhabited. Most of the land surrounding the site is agricultural. Noise level in the area is within the standards set by NPCC for Class C Light Industrial Area. Noise generally comes from traffic condition along the road network.

An ambient noise survey was conducted along with the air quality survey. Samples were taken from the estuarine area, downstream of the river along the Bayawan bridge and upstream of the river at Barangay Nangka. Table 2-60 shows the geographic coordinates of sampling site locations and Figure 2-90 is the sampling site map.

Table 2-60 Ambient Noise Level Sampling Site Coordinates

LOCATION	COORDINATES	
	LONGITUDE	LATITUDE
Estuarine (Brgy. Suba)	122°47'47.04"E	9°21'44.01"N
Downstream (Brgy. Ubos)	122°48'6.22"E	9°22'7.10"N
Upstream (Brgy. Nangka)	122°48'42.55"E	9°23'4.12"N

Figure 2-90 Ambient Noise Sampling Site Map

Survey results below show that Noise level near the mouth of the river is only around 57 dB, at the Bayawan bridge at 56 dB and river upstream at 52 dB. The noise levels at all sampling areas are well below the Standard for NPCC Class C area which is 70 dB. (Table 2-61)

Table 2-61 Ambient Noise Survey Results

Date Sampled: October 17, 2017		
LOCATION	**TIME**	**RESULT**
Estuarine	5:10 P.M.	57 dB
Downstream	3:10 P.M.	56 dB
Upstream	2:10 P.M.	52 dB
Method used: Direct Measurement – Using Noise Maker		

Impact Analysis

Short-term temporary increases to noise will occur in the vicinity of the dredging operations. Noise levels generated by the dredging operation will vary according to the size and type of the equipment used, and more importantly, the size and type of the engines.

Four of the more common forms of dredger are: Cutter suction dredgers (CSDs), bucket ladder dredgers and grab dredger, and trailing suction hopper dredgers (TSHDs).

Limited information is provided regarding the CSD, but the majority of the noise is reported as occurring in the 70 Hz to 1 kHz range, with a maximum SPL of just less than 110 dB, the suggested detection range is only 500 m. Whereas the data for the TSHD once again reported energy in the 70 Hz to 1 kHz range, with SPLs of up to 140 dB at a range of 40 m.

Attenuation modeling is not necessary for the study since expected noise level is less than 200dB.

Management Plan

All equipment used will be required to meet regulatory requirements for mufflers and other sound suppression techniques. In addition, all workers within the vicinity of the dredging area must be required to wear earmuffs to control occupational hazard of noise.

Appropriate mufflers should be installed as necessary to minimize the generation of noise. In scenarios where there is significant cluster of community that may be affected by noise, daytime operations may be considered.

Monitoring Plan

Noise levels along the river banks will be monitored regularly at least once a month or when the need arises due to complaints. If ever, further noise mitigating measures like setting up of barriers along the river bank will be implemented to attenuate the noise around the sensitive receiver. Other monitoring activities will be set the MMT as the project proceeds.

2.4 THE PEOPLE

Displacement of Settlers

Bayawan City's population of 114,074 lives mostly in rural areas at 75.6% and only 24.4% or 27,848 inhabitants in the urban area. Population grows at 1.1% per annum with one male for almost every two females. There is an average of five members per household with dependency ratio of 47% and labor force ratio of 56%. The inhabitants of Bayawan speaks and understand many Visayan dialects and their variation like Cebuano, Ilonggo and Kinaray-a; while everybody is conversant Tagalog and English. Table 2-62 provides the demographic data of Bayawan City.

The total household population is 113,916 and it is almost equally divided amongst males and females with 54,720 Females and 59,196 Males. Table 2-63 shows the city's household population by age group and gender. Furthermore, Table 2-64 provides the literacy profile of household population 10 years over. Around 81,911 of the city's population above 10 years old is literate and 5,044 men and women are illiterate.

Table 2-62 Bayawan City Population by Barangay

Province, City, Municipality and Barangay	Total Population
CITY OF BAYAWAN (TULONG)	**114,074**
Ali-is	3,114
Banaybanay	3,596
Banga	6,078
Villasol (Bato)	4,074
Boyco	1,502
Bugay	4,982
Cansumalig	2,402
Dawis	5,112
Kalamtukan	3,886
Kalumboyan	7,124
Malabugas	4,828
Mandu-ao	4,575
Maninihon	5,894
Minaba	2,170
Nangka	9,940
Narra	5,707
Pagatban	1,980
Poblacion	2,787
San Jose	1,794
San Miguel	1,652
San Roque	1,872
Suba (Pob.)	2,532
Tabuan	4,770
Tayawan	5,585
Tinago (Pob.)	3,240
Ubos (Pob.)	1,662
Villareal	10,047
San Isidro	1,169

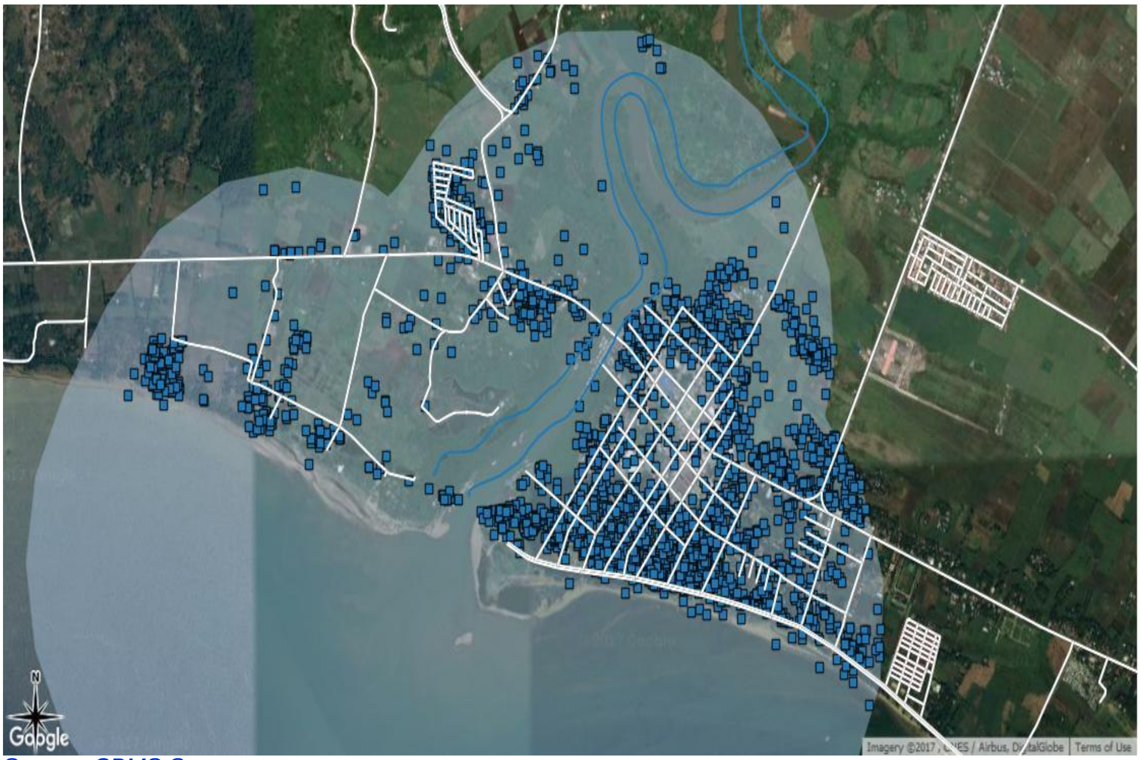
Table 2-63 Household Population by Age Group and Gender

Five-year Age Group	Total Household Population		
	Total	Male	Female
Total	**113,916**	**59,196**	**54,720**
0-4	12,696	6,624	6,072
5-9	14,185	7,415	6,770
10-14	15,098	7,697	7,401
15-19	13,495	7,086	6,409
20-24	9,289	4,910	4,379
25-29	7,539	4,114	3,425
30-34	7,000	3,706	3,294
35-39	6,579	3,401	3,178
40-44	6,107	3,126	2,981
45-49	5,669	2,895	2,774
50-54	4,536	2,316	2,220
55-59	3,714	1,922	1,792
60-64		1,350	1,328
65 and over	5,331	2,634	2,697

Table 2-64 Literacy of Household Population 10 Years Old and Over by Age Group and Gender

Age Group	Household Population 10 Years Old and Over			Literate			Illiterate		
	Both Sexes	Male	Female	Both Sexes	Male	Female	Both Sexes	Male	Female
Total	**87,035**	**45,157**	**41,878**	**81,991**	**42,220**	**39,772**	**5,044**	**2,937**	**2,106**
10-14	15,098	7,697	7,401	14,338	7,164	7,174	760	533	227
15-19	13,495	7,086	6,409	13,160	6,860	6,300	335	226	109
20-24	9,289	4,910	4,379	8,965	4,721	4,243	324	189	136
25-29	7,539	4,114	3,425	7,228	3,899	3,329	311	215	96
30-34	7,000	3,706	3,294	6,704	3,493	3,210	296	213	84
35-39	6,579	3,401	3,178	6,270	3,202	3,069	309	199	109
40-44	6,107	3,126	2,981	5,787	2,915	2,872	320	211	109
45-49	5,669	2,895	2,774	5,335	2,701	2,633	334	194	141
50-54	4,536	2,316	2,220	4,166	2,110	2,056	370	206	164
55-59	3,714	1,922	1,792	3,311	1,739	1,572	403	183	220
60-64	2,678	1,350	1,328	2,382	1,225	1,157	296	125	171
65 and over	5,331	2,634	2,697	4,347	2,191	2,156	984	443	541

Figure 2-91 maps out the settlements which are within the 1-kilometer impact area of the project site. There are approximately 2,732 households which may be affected by the project.



Source: CBMS Survey

Figure 2-91 Households within 1 km of Proposed Project Site

Displacement/Disturbance of Properties

Dredging operations will be conducted on water and away from land properties, so there is little to no chance of causing any damage. However, since dredging and hauling vessels will be passing through the coastal waters and the river, then damage is very much possible to properties on water such as motorized boats, fishing vessels, fishing nets, etc.

Change/Conflict in Land Ownership

There shall be no conflict in land ownership because dredging operations will be conducted on water.

Change/Conflict in Right of Way

There shall be no conflict in land right of way because dredging operations will be conducted on water. However, navigational traffic must be expected in the coastal waters off Bayawan since several vessels such as dredgers, haulers and carrier will be regularly plying the sea.

Impact on Public Access

There will be no impact to public access on land but there will be impact to public access in the river once dredging operations begin. There shall also be more navigational traffic at sea.

Public Participation

Critical to the implementation of the project is the awareness of the various stakeholders of the river system. It has been observed based on the Public Scoping and Consultation that most residents of Bayawan City are aware of the need for the desiltation of the river and are very much in favor of the dredging operation (Annex F Public Scoping Document).

Despite the public's favorable response to the project, it is still very much important to conduct an effective IEC program. Invariably, IEC for river ecology and its environmental services should as much as possible reach various sector of society. However, since the dynamics of the river system occurs slowly and sometimes in geologic times, knowledge should be imparted not only for the present but for the future stakeholders as well.

<u>Impact Analysis</u>

The project will not disrupt any of the properties in the identified impact areas. The main objective of the project is to mitigate the effects of excessive flooding incidence in the area. Therefore, the project brings positive impact on those areas susceptible to flooding. Moreover, there will be no displacement of people during project implementation.

In-migration, Proliferation of Informal Settlers

<u>Baseline Conditions</u>

Table 2-65 below provides information on households by tenure status. A huge majority of the households in Bayawan City are owned or being amortized, however, based on observations from previous surveys, there are still presence of illegal settlers near the river but it is only very minimal.

Table 2-65 Households in Occupied Housing Units by Tenure Status

Tenure Status of Lot	No. of households
Owned/Amortized	20,172
Rented	452
Rent-free w/ consent	3,074
Rent-free w/o consent	441
Not Applicable	228
Not Reported	0
TOTAL	**24,367**

<u>Impact Analysis</u>

The implementation of the project will not result to in-migration of the area. Government programs are implemented to suppress these illegal settlers. Most of the illegal settlers have been relocated to the government-owned and operated Gawad Kalinga Village, a low-cost housing program. Figure 2-92 shows the location of the Gawad Kalinga Village at Brgy. Villareal.

Figure 2-92 Gawad Kalinga Village at Brgy. Villareal

Cultural/Lifestyle change

There are listed indigenous cultural communities and indigenous people in six (6) barangays of Bayawan City, namely Kalamtukan, Tayawan, Minaba, Narra and Cansumalig. All of these tribes are called "Bukidnon" with a total of 1,628 families or about 8,966 individuals. The tribes in Narra, Cansumalig and Kalamtukan have the top most number of families with 472, 378, and 294 respectively. Among these communities, Tayawan has the least with only 85 but also the only community which has a documented ancestral domain claim or CADC from DENR which is about 350 hectares. The table that follows illustrates the summary and location of these communities and Figure 2-93 shows the location of these IP Settlements.

Table 2-66 Inventory of Indigenous Cultural Communities

BARANGAY	TRIBE	ANCESTRAL LAND/DOMAIN	NO. OF FAMILIES	NO. OF INDIVIDUALS	TRIBAL LEADER
Kalamutkan	Bukidnon	AD	294	1,922	Roger dela Peña
Tayawan	Bukidnon	AD	85	548	Cresenciano V. Bonghay
Minaba	Bukidnon	AD	116	440	Rigolo O. Nobleza
Nangka	Bukidnon	AD	283	1,433	Tito V. Quartero
Narra	Bukidnon		472	2,359	Romeo O. Luyas
Cansumalig	Bukidnon		378	2,264	Wilson A. Nama

Source: NCIP Office, Bayawan City

Legend:

Figure 2-93 IP Settlements in Bayawan City

- Location of IP Settlements

- Urban Area

Impact Analysis

Indigenous people are located in the hinterland barangays of Bayawan City, far from the project site. Because of relative distance from the project site, the project will unlikely result nor promote cultural changes in general. However, there will be influx of foreign workers hired for the needed technical expertise for dredging operations. It is expected that there will be cultural interactions among the locals. The locals may benefit from these interactions through small business enterprising activities. Guidelines and protocols will be provided to these foreign workers so as to avoid unnecessary misunderstanding and promote positive community relations among the locals.

Impact on Physical Cultural Resources

There are no identified physical cultural resources in or near the proposed project site.

Threat to Delivery of Basic Services/Resource Competition

Bayawan City has all major players in the telecom services like SMART, PLDT, GLOBE and SUN as well as local CRUZTELCO. Mobile Services is reliable in the city proper but complete signal coverage in the whole city is not yet available especially the hinterland areas. Landline telephone services is also very limited with only 747 aggregate installed lines; considering that there are about five thousand households in the urban area and most installations are for institutional and commercial establishments. Computer shops, internet cafes, express mail services, and cable television are enjoyed by residents of the urban and peri-urban area but the wider rural population have yet to enjoy these. On the other hand, satellite television and local FM radio broadcast covers almost the entire city including the hinterlands.

Domestic water distribution is catered by the Bayawan Water District in the coastal and urban areas only with 80% of the population gained access. Rural barangays however have their respective small water associations with mostly level 2 or communal connections. Grid electricity has covered 100% of the barangays but access is mostly available in the barrio proper only; most sitios in the hinterlands do not have access, hence 30% only of the total households in the city have grid electricity connection.

Waste management in the city is quite good especially in the urban and coastal barangays where full segregation is implemented and with most proximate access to the sanitary landfill in Brgy. Maninihon. Currently 27 out of 28 barangays implements full segregation and is being served by garbage and septage trucks.

In terms of education facilities, public school services for elementary and high school are well distributed already all throughout the city. There are 52 elementary schools and 23 secondary schools with one privately-operated in each level. As to day care centers, 4 are private located in the urban area and there are 77 public day care centers all over. Classroom to student ratio is better for elementary at 1:41 while secondary schools is at 1:55, hence more are needed to address gaps at the secondary level. The city is served only with two tertiary schools, the NORSU-Bayawan-Sta. Catalina Campus and the Southern Tech College. It is estimated that there are about 12,121 out-of-school youths in the city, still a daunting task to improve human resource capital in the city.
Protective services is provided by 38 PNP officers, and augmented by 58 auxiliary police, 61 SCAA, 28 watchmen and 22 traffic aides for peace and order. There are 9 firemen and 15 aides for fire protection. Currently the PNP have 2 trucks, 3 police cars and 3 motorcycles. The Public Safety Office has also two rescue vehicles, an ambulance, a traffic vehicle and 2 rescue boats. The fire department have four fire trucks at their disposal. The headquarters of these protective services are in the city proper and outposts at the hinterland barangays have very limited facilities, mobility, communication and response capabilities.

<u>Impact Analysis</u>

There will be no adverse effects caused by project implementation on the delivery of basic services as currently provided in the project site.

Threat to Public Health and Safety

The City has three public hospitals, two main rural health units and every barangay have their respective health centers, health services in the city is still very much lagging. The hospitals have a total of 50 bed capacity or1: 2,281 ratio; short of the ideal 1:1,000. Hospital facilities like laboratory, x-ray and other diagnostic equipment are still in very limited capability.

Moreover, there are only 14 medical doctors and 7 dentists serving at 1:8,148 ratio, a far cry from the 1:1,000 ideal prescribed by the WHO. Table 2-67 and Table 2-68 provides information on the livebirths and mortality rates in the City while Table 2-69 provides information on common causes of death. It can be gleaned from the information below that most deaths, 68.2% of the total mortality rate, occurred while not attended by a nurse or physician. It is also noted that some of the most common causes of mortality are cerebro vascular diseases and heart disease.

Table 2-67 Livebirths, Total Deaths, Infant, Fetal and Maternal Deaths

Index	Number	Rate
Livebirths	1,508	12.9
Total Deaths	603	5.2
Infant Deaths	21	13.9
Fetal Deaths	9	6
Maternal Deaths	3	2

Source: Philippine Health Statistics, 2012

Table 2-68 Mortality by Attendance

Attendance	Number	Percentage
Attended	184	31.8
Not Attended	395	68.2
TOTAL	579	100

Source: Philippine Health Statistics, 2012

Table 2-69 Selected Causes of Death

Cause of Death	Number	Rate
Intestinal Infectious Disease	7	6
TB (All Forms)	21	18
Septicemia	15	12.8
Malignant Neoplasm	34	29.1
Malignant Neoplasm of the trachea, brinchus and lung	6	5.1
Malignant Neoplasm of Breaast	6	5.1
Leukemia	6	5.1
Diabetes	21	18
Nutritional Deficiency	3	2.6
Heart Disease	41	35.1
Cerebro Vascular Disease	72	61.6
Pneumonia	34	29.1

Chronic Lower Respiratory Disorder	12	10.3
Gastric, Duodenal and Peptic Ulcer	10	8.6
Liver Disease	4	3.4
Acute Pancreatitis	1	0.9
Nephritis, Nephrotic Syndrome & Nephrosis	11	9.4
Condition originating in the perinatal period	10	8.6
Congenital Anomalies	3	2.6
Transport Accidents	15	12.8
Accidental Drowning & Submersion	10	8.6
Assault	22	18.8
Other causes	239	204.5

Source: Philippine Health Statistics, 2012

<u>Impact Analysis</u>

The project will not pose any threats to public health and safety

Generation of Local Benefits from the Project

The economic structure of the City is still mainly at the primary sector. Farming of sugar, rice, corn and copra and marine fishery are the dominant livelihood activities. There are very limited manufacturing and industry value-addition of agricultural and fishery products. Light industries include only rice and corn milling, sugar milling, lumber milling and ice plants. The tertiary sector is mostly in general merchandising, trading and lending. Tourism services such as hotels, restaurants, resorts and the likes are also still very limited.

In 2012, the city business permits and licensing office reported 917 business permitees. These business establishments are mostly located in the urban area, while retail trade of mostly sari-sari stores are in the hinterlands. There are four commercial banks and two cooperative banks that exist and serving the city. Mining activities are very minimal with small-scale mining of rock phosphate and lime in Malabugas and San Roque; low-grade coal is reportedly also being extracted in Manduao.

Farming and fishing are still the main economic activity in the city. Rice, sugarcane, corn, and coconut remain the main or preferred crops in the city. Hence, monocropping still prevails that further exacerbates the perennial problems on soil erosion, soil quality degradation, river siltation and also flooding of the low lands because of reduced water carrying capacity of major rivers and tributaries.

Livestock production of piggery, poultry, cattle and small ruminants and other fowls are still at the backyard level. There are no big farms or contract growers or investors on poultry or piggery in the city. Hence, most of the poultry products especially eggs and broiler chickens in the city came from other municipalities in the province or in Negros Occidental or even from Cebu Province, making retail costs of these products relatively and generally higher compared to prices in Dumaguete City or even Bacolod City.

In the fishery sector, marine fishery is the dominant player with annual production of about 3,500 tons. Inland fishery and aquaculture remains minimal and small scale; crab pots production for example is only a low 1.04 ton production per year. Tilapia and bangus ponds are present in the city but are patronized only during typhoon season when marine fish catch is very lean. There are over five hundred registered fishermen in the city, with 363 registered motor boats. Majority or 356 of these motorboats however are non-motorized, indicative of the prevalence of marginal and small-scale fisher folks in the city. The limited commercial scale fishery in the city also somewhat limits opportunities for sustained surpluses in landed fish that may encourage processors or manufacturing industry to come and invest into.

Impact Analysis

Over all, flooding in the project area has always disrupted businesses and other economic activities. The mitigation of this flooding incidence minimizes these disruptions. More importantly, the project will inherently save lives and properties. These are the main benefits that the project can generate in the area. Other than this, the dredging operations shall include the dredging of sea port for the proposed Bayawan City Fishport Complex near the river mouth. The fishport is expected to generate more revenue for the city and more jobs for the people.

Dredging operations requires skilled and well trained, experienced personnel. Main dredger operators and personnel are mostly Singaporian, Chinese or Vietnamese that have undergone special training in a facility owned by Marisand. However, there is a potential local employment opportunity that will function as support group. There is as well a transfer of skill and technology occurring during project implementation.

The project will entail a sizable amount of financial support. The local as well as the national government just don't have enough funds available and the potential option is to tap the river itself as the source for financial support. Marisand Resources offered this dredging project without financial obligation from either the local or national government in lieu of the dredged materials taken out after channel re configuration. On top of it, the company will pay Php5 per cum of hauled dredged materials which will be used to further fund the City's local economic development programs and projects. This proposal makes economic sense for as long as the impact to the environment is always taken into consideration.

Management Plan

Information, dissemination and communication should be strengthened to allow various stakeholders to understand the limitation of the project as a mitigating measure of flooding in the area. Flooding will definitely occur in the future in varying degree of intensity. It is only a matter of time. This is how nature works. The limits of dredging, as modeled, were set to a 25-yr return period of flooding incidence. Beyond this, dike system becomes necessary. This point should be emphasized.

Organizational set up for the project should include mechanism that strengthens protection of the environment. This includes strengthening of MMT with enough financial, tools, logistics and policy support from the local government and proponent to ensure effective and efficient delivery of its mandate.

The operational organization should be manned with competent and qualified personnel and shall include a mechanism for community relations that emphasizes in IEC for transparency, accountability and participatory approached to project implementation.

Monitoring Plan

A database will be developed not only for project's operational monitoring purposes but also for monitoring river dynamics in the future.

The contents of this database will depend a lot on the agreed monitoring activities by MMT. However, in broad context, it will include sounding data before and after dredging and all monitoring parameters encoded on a GIS platform if possible.

Traffic Congestion

Access to the project site has been discussed in the first section. The most relevant concern on traffic congestion is on the marine waters. The relative far distance of the city to major ports of entry and the absence of a seaport or airport is a developmental handicap of the city. Movement of produce, goods and services are always associated with higher overhead costs.

However, Bayawan does have its own fishport located near the delta of the river which serves over 300 motor boats of varying sizes. The existing fishport, however, also poses navigational problems due to the heavy siltation in the river, which is also one of the major reasons why the need for desiltation is very much supported by local fisherfolk.

Impact Analysis

Fishing boats will not be able to use the existing fish port once dredging operations begin so there is a need to temporarily relocate the existing fishport upon the start of project implementation. The location for the temporary fishport has been identified at Brgy. Villareal. Figure 2-94 shows the exact location of the proposed temporary fishport. The proposed temporary docking area has already been prepared and is ready to be used by fishermen once the project begins.

Figure 2-94 Proposed Temporary Docking Area

Transport of provisions such as food and other operational needs will follow regular road network and other existing access points. A protocol for this will be established and becomes part of operational procedures.

Hauling of dredged materials does not involve any land base activities. There is no storage of dredged materials on land either.

Dredged materials are directly hauled from the river through barges to a bulk carrier located offshore. It is then expected that there will be marine navigation traffic occurring at the waters of Bayawan City and regional waters of Central Visayas. Fishing activity will be disturbed as these barges passes in their fishing areas. Furthermore, there will an effect on commercial transport sector. However, the disturbance will only take place for a short time when the barges pass.

Management Plan

The project will comply with all regulatory requirements imposed by institutions such as MARINA, BFAR, MGB, FARMCs and other similar group who are stakeholders and who are affected by the project’s use in navigating themselves in the marine waters.

During operations, hauling of dredged materials will be done in a regular basis. The navigational path of hauling barges may intersect with the traditional fishing ground of the local fishers. A mechanism will be set up to prevent untoward incidence that may happen in this traffic scenario. The following may offer a solution:

- A set of rules will be agreed, implemented and strictly enforced by both parties regarding navigational traffic in the municipal waters.

- An emergency and contingency protocol will be established in case of accident and other life-threatening scenarios occurring in the municipal waters.

- Among others, financial consideration might be one of the arrangements. Due prudence must be exercised and it must be anchored on social justice and conventional morals.

- A meeting with local/affected fisher folks should be conducted to design other scheme that benefit both parties and reduce the risk of accidents. The result of such meeting can be in a form of MOA.

Monitoring Plan

Once the ECC is released, a Multi-Sectoral Monitoring Team (MMT) shall be initiated and established by the proponent as stipulated by RPM of DAO 03-30. In general, the role and responsibility of MMT are described by RPM. However, these roles can be modified to suit the needs not only for the project but for all possible stakeholders as well.

Funds shall be established to have a working MMT and the amount is dependent on the extent of the activities that the team will be doing.

SOCIAL IMPACT ASSESSMENT

The flood mitigation Project aims to effect positive social and economic impact to the residents of Bayawan City. However, like with any major projects and developments, a balance must be considered in the social, environmental and economic aspects.

As part of the preparations for the Project, as series of Public Consultations were undertaken, including Barangay consultations, general assembly, legislative-executive council conference and Public Scoping. A Technical Management Team (TMT) composed of department heads and other technical officials of Bayawan City was also created for this Project. Through these venues, important questions about the implementation of the Project and how it will affect the community were raised by the stakeholders.

Social Impact

A very important matter that must be considered is how the Project will affect the social well-being of the residents of Bayawan City.

Sandwiched between the Bayawan and Sicopong Rivers, Bayawan City is highly susceptible to flooding during rainy days. The project aims to mitigate and reduce the risk of flood occurrences along Bayawan River. The primary objective is to increase the river channel capacity to accommodate more flood water, thereby minimizing overflowing of the river that causes flooding and destruction to lives and properties.

Furthermore, establishing a more defined river channel shall also prevent soil erosion along the riverbanks.

Economic Impact

The primary livelihoods in the City are farming and fishing. This being a water-based Project, there will be no impact to farming but there will be significant impact to fishermen. An important economic impact that has been identified once the Project begins implementation is the relocation of fishing boats to a temporary docking area at Brgy. Villareal. Fishing boats will not be able to use the existing fish port once Project operations begin. However, the city has undertaken measures to make this transition as smooth as possible and the temporary docking area has already been prepared for use by the fishermen once the Project begins.

Another benefit that may be reaped in the dredging activity is the establishment of a commercial sea port near the mouth of the river for the proposed Bayawan City Fishport Complex. The establishment of this proposed fish port facility is expected to generate more livelihood for the people.

Moreover, Marisand has offered to undertake this Project without financial obligation from the City. On top of it, the Company has offered to give PhP5.00 for every cubic meter of hauled dredged materials which will be used to fund the City's economic development programs.

Flooding Incidence and Mitigation

The Bayawan floodplain also covers the city's urban area. Hence, during flooding incidents, major institutions in the urban area are also affected. In fact, during the October 2013 flood that devastated the City, 40 million worth of infrastructure was destroyed. It was due to this incident that the City established an overall alternative to flood control, with dredging being one of major its components. Another alternative that the City is undertaking for the purposes of flood mitigation is massive reforestation.

Common Sickness Brought by Flood

Flooding can potentially increase transmission of communicable water-borne diseases such as leptospirosis. However, there have been no noted cases of diseases due to flooding.

Archaeological Sites

There are no archaeological sites which will be affected by the dredging project.

Soil Erosion and Mitigation

Erosion by water is a natural process that cannot be avoided which is why it is no surprise that there is widespread soil erosion along the riverbanks of Bayawan River. The City plans to implement measures against soil erosion and one of them, as mentioned earlier, is to create a more defined river channel through dredging, which will also help mitigate soil erosion. Another possibility that is being considered is the construction of embankments and revetment walls along severely eroded areas to avoid the loss of property and lives.

3 ENVIRONMENTAL MANAGEMENT PLAN

Project Phase / Environmental Aspect	Environmental Component likely affected	Potential Impact	Option for mitigation, prevention and enhancement	Responsible Entity	Cost (Php)	Guarantee/ Financial Arrangements
Pre-Operations						
Mobilization of Dredging Equipment	The People	Navigational Traffic	Acquisition of permits	Marisand Resources	200,000	part of development
			Conduct Social preparations	Marisand Resources/ LGU Bayawan	300,000	part of operation
			Post Notices	Marisand Resources	50,000	part of operation
Operations						
Dredging	The Water	Increase in turbidity	Install Silt Curtain	Marisand Resources	300,000	part of operation
		Saline intrusion	Maintain slope as per design limits	Marisand Resources	part of operation	part of operation
		Change in Flow Regime of channel	Sounding before and after channel cutting	Marisand Resources	part of operation	part of operation
		Presence of Oil and Grease from machineries	Quarterly monitoring for water quality	Marisand Resources	100,000	MMT Arrangements
	The People	Noise	Install Mufflers	Marisand Resources	200,000	part of operation
			Scheduled Operations	Marisand Resources	option to operations	part of operation
		Navigational Traffic	Acquisition of permits	Marisand Resources	part of mobilization	part of mobilization
			Conduct Social preparations	Marisand Resources/ LGU Bayawan	part of mobilization	part of mobilization
			Post Notices	Marisand Resources	part of mobilization	part of mobilization
	Resource use	Use disturbance	Compensation	Marisand Resources	part of mobilization	part of mobilization
Abandonment	Land and water	Possible negative environmental footprints	Follow closure and abandonment procedures/policy	Marisand Resources	part of mobilization	part of mobilization

3.1 Brief Description of Environmental Impacts

This section identifies the different environmental impacts that can be generated from the implementation of the project. All potential impacts are evaluated based on magnitude, significance, duration and quality guided by the checklist provided by the RPM of DAO 2003. These will serve as basis for formulating the Environmental Management Plan. The project will impact the physical, biological and social aspects of the environment. The following sections summarize the significant environmental consequences of the proposed project.

The Land

Since dredging activities essentially occurs on the river channel, environmental impact on the land and its terrestrial components can be considered insignificant. However, the new channel configuration will result to a new flow regime of the river reach. This may alter the stable sediment balance of the river. This scenario is temporary and over time the river will establish itself to new stable flow regime. The increase in water flow is expected to bring more sediment loading thus affecting the coastal area consistent with the long shore current forming it.

During operations, operating personnel may use a patch of land in the river bank as respite or temporary facility. This may generate solid wastes and other litters that may impact the aesthetic value of the patch. However, this impact is insignificant and can be mitigated easily by following strict compliance on the operational rules regarding the use. Upon abandonment of the patch, the user will immediately clean up the place to its original state.

The Water

Existing water quality may be impacted by wastewater discharges from the on-site sewerage system, domestic wastewater or by rainwater run-off from floodplains. Discharge of wastewater into surface water may impair surface water quality by causing changes to its physical, chemical and biological properties.

The surrounding lands in the project site are essentially agricultural. It is expected then that runoff from these areas will carry residual nutrient from applied fertilizers that may enrich the river and if not checked will result to eutrophication.

Dredging operation does not contribute any of the above. However, during operations, it will generate substantial silt that may increase turbidity thus affecting water quality. Again this scenario is temporary and good mitigation by employing silt curtains properly can reduce this impact.
Because of its low topographic relief, a large-section of the river, up to 6 kilometers inward, is affected by semi-diurnal ingress of sea water during high tides from Sulu Sea, and the water flow dynamics of the river is therefore influenced by this condition (backwater effect). This river outlet at Barangay Suba is strongly affected by longshore currents and strong tidal action, an area where fresh and salt water are mixed, which have formed estuarine or swampy mangrove areas. Sea-level rise (and land subsidence) further causes the backwater effect.

Dredging will not change or disrupt the tidal circulation pattern in the project area. it is expected that the circulation pattern will remain the same during and after project implementation.

Noise and Particulates in Air

Noise levels above the alert threshold of 86 decibels and hazard threshold of 95 decibels will be produced from heavy equipment's operation. It has been estimated that dredgers can generate as much as 110 dB. This can directly impact the workers immediately in the vicinity of the machineries. Ear mufflers are standard ways of mitigating these impacts.

The pressure levels of sound will diminish following the inverse distance law. This means that farther away from the source of noise, the decibel levels decreases with distance. The river banks are well covered with vegetation and this will further decrease the pressure levels by acting as barriers. It has been estimated that upon reaching the river banks, the pressure level has decreased from 110 dB to about 40 dB which can be considered as tolerable. The impact of noise will be negative, moderate, reversible in nature.

During Project operations, only sea-based dredgers and hauling vessels will be used. No land-based equipment will be utilized. Hence, no dust pollutants are expected during Project implementation. The suction, loading and hauling of wet dredged materials will also not produce dust or particulates.

Significant source of particulates in air in the Project site will come from road networks in the surrounding area. The general population is most likely to be exposed in these road networks where significant impact can occur.

Furthermore, because the project site is relatively open and rural, the generated plumes from the dredging machineries can be dispersed and diluted by the air currents. The negative impact will only be temporary and reversible in nature.

The Navigational Traffic

The dredged materials will be transported from the dredging site to a bulk carrier anchored a distance away from the shoreline. This is done by carrying smaller amounts of the materials using transport barges that can accommodate about 1,500 cu m of materials at a time. These barges then convey the load to the bulk carriers.

It is expected then that there will be navigational traffic in the area due to frequent hauling by barges. This traffic might impact fishing activities in the area. Therefore, social preparation is necessary to avoid future misunderstanding between the proponent and the local fisher folks.

3.2 Key Environmental Impact Management and Monitoring Plans

Mitigation and monitoring plans have been developed to mitigate the environmental impacts associated with the proposed project implementation. The Mitigation Plan incorporates measures that include avoidance and protection, reduction and mitigation, and remuneration and enhancement measures. Strategies for these mitigation measures include:

- Application of cutting edge technology, disposal methods, and engineering designs;
- Pollution controls, recycling and conservation of resources, monitoring, special social services or community awareness and education;
- Compensatory measures for restoration of disturbed resources and livelihood displacement.

The Monitoring Plan has been developed to assess the effectiveness of the management plan. Monitoring would be undertaken to evaluate the success or failure of the environmental management plan measures and to reorient that plan, if required. The management plan has been developed to ensure that the impacts that cannot be mitigated are minimized to the maximum extent possible. The combination of the environmental mitigation plan and the environmental monitoring plan will result in the creation of a mechanism for the effective management of all environmental consequences associated with the project to enable the project to proceed in an environmentally sound manner.

4 ENVIRONMENTAL RISK ASSESSMENT & EMERGENCY RESPONSE POLICY AND GUIDELINES

During scoping, ANNEX 2-7e of RPM of DENR provided a guide in identifying potential hazards associated with project implementation. The list includes storage of hazardous materials, production of hazardous materials and processes that result to hazardous scenario. None of those listed are associated with this dredging project. Therefore, the project does not belong to Level 1 nor Level 2 level of threshold inventory. Furthermore, the nature of the project does not qualify for the risk screening level as described by Annex 2-7e.

4.1 Safety Risks

Fire

1. The risk of fire is nil since the Project does not concern with combustible products, manufacturing or process. During dredging operations, only the vessel's engine will be susceptible to occurrence of fire since all other components of the dredging operations will not involve any chemicals, fire-causing scenarios or electrical-related problems.

2. Possible occurrence of fire at the engine room and engine parts. Though smoking and other unnecessary fire-causing activities are prohibited in all parts of the vessel, occurrence of fire, although nil, is still a possibility. Other possible occurrence of fire would be at the kitchen area of the vessel where the crew members cook their meals. Other possibility of fire occurrence is when there are faulty electrical wirings at the vessel.

3. Should this low risk of fire occurrence in the engine room or fuel tank occur, possible hazard would be the possibility of oil spill to the sea of the remaining fuel of the vessel. Less hazard to the environment is foreseen during kitchen fire since this can be very easily contained and very less likely to spread to the other parts of the vessel, being made of steel and with very little combustible materials at the kitchen area.

4. The vessels that will be used during dredging operation are complete with fire safety certificates, firefighting equipment and emergency response protocol. All emergency response procedures, drills and guidelines are regularly updated with the crew following existing laws on maritime safety and emergency response.

Explosion

1. The risk of explosion is also nil as the Project does not require the use of explosives or the likes. The possibility of an explosion is only possible during accident at the engine room.

2. Possibility of oil spill at the sea may occur immediately after large explosions causing vessels to sink

3. The crew that will be deployed during dredging operations in this Project are the same crew ever since the dredging vessel has been in operation. Hence, their familiarity with the operation of the vessel is an added assurance to the less likelihood for accidents to happen. Compliance to health and safety requirements shall also be imposed, including constant updating of vessel safety and emergency response protocols following domestic and international standards.

Release of Toxic Substances

1. The only toxic substance that may be released by the vessel is the possibility of oil spilling into the sea.

2. This may occur during leaks in fuel tanks and sinking of the vessel.

3. Possible hazard during spill is the spreading of oil to a wider area and causing harm to the surrounding mangroves and fishing grounds which are outside the Project area.

4. The same adherence to domestic and international health, safety and emergency response protocols shall be observed and practiced during dredging operations.

4.2 Physical Risk

1. Flash flooding can occur downstream of the river. From key informant interview, this phenomenon was known to occur. This natural hazard may cause destruction of dredging machineries and harm to operating personnel.

2. Risk levels can be characterized by treating the cross product of the hazard level and the exposure level of receptors. Table 4-1 provides insights on the risk level of imposed to the environment.

Table 4-1 Matrix of Risk Levels on Receptors

Receptor	**exposure**				
water	Very high	**Very high**	**Very high**	high	
air	low	medium	medium	low	
personnel	Very high	**Very high**	**Very high**	high	
land	Very low	medium	medium	low	
		high	Very high	medium	**Probability of generation**
		Flash flooding	*Oil and grease*	*Accidental fire*	**Hazard**

The above analysis provides insights as to where the focus of mitigation is significant. Risk mitigation can be achieved by reducing or modifying the **source,** by managing or breaking the **pathway** and/or modifying the **receptor**. These are all incorporated in the mitigating measures that will be implemented.

3. Flash flooding can only be anticipated. Early warning system may be helpful in breaking the path between the receptor and the stressor i.e. working personnel and dredging equipment as receptor and flash flooding as stressor.

Regular monitoring and adherence to DPWH dredging design is mandatory during dredging operation.

4.3 Emergency Plan

An Emergency Plan is prepared with the following objectives:

- to contain or control incidents so as to minimize the effects, and limit damage to man, the environment and property taking into consideration the worst-case scenario;
- to implement the measures necessary to protect man and environment from the effects of major accidents;
- to communicate the necessary information to the public and to the emergency

  service provider (such as fire protection, civil defense. disaster coordination and other appropriate local government unit or agency) in the area; and
- to provide for the restoration and clean-up of the environment following a major

  accident.

It has been observed that Bayawan River water level can rise even if the weather condition in the area is fair. This can happen when a considerable rainfall occurs in the farthermost upstream. This flash flooding scenario can pose hazard to the dredging operation downstream. Therefore, it is necessary for the dredging team to prepare a systematic action plans to avoid unnecessary loss of lives and properties.

The emergency plan should consider as well occupational hazards and related accidents. The emergency plan will have the following elements that cover the scenario of flash flooding, on board fire and other first aid and medical emergencies:

- Occupational health and safety protocols
- Education and training drills
- Location of emergency equipment and implements
- Signage, early warning systems and Communication
- First aid and medical emergency
- Emergency and monitoring field office/unit in each Barangay situated along the riverbanks

4.4 Occupational Health and Safety Protocols

- The dredging plant must be equipped with standard fire extinguishers and installed in appropriate places;
- Standard working clothes including safety helmet, safety boots and safety vest must be worn at all times when at the working area;
- First aid cabinet complete with medical emergency implements will be installed;
- Communications such as hand-held radios must be available at all time;
- Sound alarm system must be installed;
- List of personnel on board must be logged on at any point in time
- Life jackets must be available corresponding to the number of personnel (minimum) on board;
- Emergency shutdown procedures must be conspicuously posted on each machine or at each process where appropriate.

4.5 Education and Training Drills

The plan will provide a comprehensive education of all workers regarding health and safety protocols and will conduct training drill on a regular basis especially the occurrence of flash flooding.

4.6 Location of Emergency Equipment and Implements

The plan will provide a map of all locations of emergency equipment on board the vessel. It will provide further the emergency path to take wherever any personnel may be at on the vessel at any point in time.

4.7 Signage and Communication Systems

An early warning system will be set up in case of impending threat of flash flooding. A working communication system must be installed on board and specific instruction will be posted containing codes or telephone numbers to call in case of emergency. The Project will make use of the existing water level monitoring stations of the CDRRMC, which have been installed along certain sections of Bayawan River.

4.8 First Aid and Medical Emergency (minor medical emergency):

Whenever an employee or visitor is injured or develops a medical emergency condition on plant property, follow the protocol below and notify your immediate supervisor as soon as possible.

1. Inform the plant manager and plant safety engineer of the nature and location of the medical emergency.
2. Unless you have been designated by management to be a first aid responder, do not provide first aid. Make the victim as comfortable as possible until medical help arrives.

4.9 Fire emergency

When fire occurs, the following will be the protocol:

1. **S-Sound the alarm:** Either sound it yourself or call out to someone else to sound it.
2. **A-Alert others:** Quickly tell others in the area of the fire. Do this in a calm, firm manner. Do not cause a panic. Secure the area for the fire department.
3. **F-Fight the fire:** Do this only in the case of a manageable fire, one that you have the training and experience to fight --for example, a fire in a wastebasket. If possible two employees should fight the fire together using two fire extinguishers. If you have any doubt about your ability to fight the fire, then do not attempt to combat it.
4. **E-Evacuate the area:** If necessary.

The preceding plan elements will be converted into an ACTION PLAN for the entire dredging operations. The action plan will incorporate organizational team specific for this emergency scenarios for systematic communication, implementation and accountability.

The following is the proposed emergency plan:

Nature of Incident	Control Mechanism	Protective Measures	Communication	Post Scenario	Key Personnel
Onboard Fire	* Suspend emergency protocols for onboard fire * Turn off any running machinery * Deploy fire extinguishers/tools	* Implement emergency protocol for onboard fire * Implement protocol on evacuation	* Sound emergency alarm * Inform central office * Call for emergency	* Write report * Decommission for repair * Implement Clean up	Safety personnel
Flash Flood	* Suspend Operations * Ground and anchor vessels	* Implement protocol on evacuation	* Sound emergency alarm * Inform central office * Call for emergency	* Write report * Decommission for repair * Implement Clean up	Safety personnel
Physical Accidents	* Determine cause of accident *Apply first aid, if qualified *Accompany victim and wait for assistance	* Transport for medical services	* Call for emergency * Inform central office	* Write report	Safety personnel

5 SOCIAL DEVELOPMENT PLAN/FRAMEWORK (SDP) AND IEC FRAMEWORK

5.1 Social Development Plan (SDP)

The table below shows a typical Social Development Plan patterned after pro forma

Table 5-1 Social Development Plan

Concern	Responsible community/ beneficiaries	Gov. agency/NGO/service	proponent	Indicative Timeline	Source of Fund
Education and Sanitation	City Government	DepEd, City Health Office, CENRO	Community relations officer/MMT	During Operations	LGU-IRA, Proponent
Upland Reforestation	Upland barangays	CENRO, City Agriculture Office	Community relations officer/MMT	During Operations	LGU-IRA, Proponent
Mangrove planting	Coastal barangays	CENRO, City Agriculture Office, BFAR	Community relations officer/MMT	During Operations	LGU-IRA, Proponent
Riparian Rehabilitation	City Government		Community relations officer/MMT	During Operations	LGU-IRA, Proponent

Flooding incidence in Bayawan City has been more frequent than before. Partly, this is due to an overloaded river channel by silts, debris and sediments from upstream. Partly still, are the excessive anthropogenic activities upstream resulting to soil degradation and subsequent erosion. Dredging project is only part of the possible mitigation of flooding in the area. A long-term program that allows for the river to stabilize itself should be implemented. These programs may include:

- IEC on river systems;
- Reforestation/tree growing upstream;
- Regulated Quarrying of river beds;
- Riparian rehabilitation.

On the other hand, risk reduction and mitigating measure by the government provides palliative mechanism if indeed disaster such as flooding occurs in the area.
The project proponent can contribute partly on these activities as part of their corporate social responsibility. The project will align itself with relevant programs and other river rehabilitation and conservation initiatives undertaken by the provincial government and other people's organization.

The table below provides a matrix for IEC framework patterned after pro forma of Annex 2-19 of the RPM.

5.2 Information and Education Campaign (IEC)

Table 5-2 IEC Framework

Target sector	Topic related to Project	Methodology	Information Medium	Indicative Timeline	Indicative cost
Pre-Operations					
• Local Chief Executives • CPDOs • CDRRMC • NGOs • Fisher Organization • Other Stakeholders	• Project rationale and objectives; • Organizational structure of proponent; • Technical aspect of project implementation; • Potential Environmental impacts and its mitigations; • Monitoring and Social aspects of the project	• Forum • Radio Interviews • Newspaper publishing	• PPT presentations • Interviews • Newspaper Article • Leaflets/fliers	Once before Operations	Php200,0000.00
Operations					
On site Communities	Notice of operations	• Billboards • pulong-pulong • Plant tour	• Signage • Forum hosting	During operations	Php100,000.00
Abandonment	Notice of Abandonment	• Billboard • Radio Announcement	• Signage • Radio	After Completion of Operation	PhP50,000.00

A Public Scoping was conducted during the planning stages of the Project and outcome of the public scoping indicated that the general community around the project site has significant knowledge about the project (Refer to ANNEX F Public Scoping).

To avoid any misunderstanding and misconception regarding the implementation of the project, some degree of transparency has to be in place. This can be done through an extensive IEC.
In general, information regarding the technical, social and environmental aspect of the project implementation should have a wide dissemination. Potential target groups include the following:

- Local chief executives;
- CPDO and CDRRMC;
- Fishermen's organizations;
- NGOs
- General community around the project area.

These target groups are essential because they are the frontline in addressing flooding issues that the project hopes to mitigate. Fisher's organization and the general community are the major stakeholders because they are the ones directly impacted by flooding incidence. By providing them with enough information, they have the potential to provide indigenous inputs for the successful project implementation. Furthermore, the activities will promote a stronger positive relationship between the proponent and stakeholders.

IEC activities will be conducted before commencement of operations and during the operations phase of the project.

Before project operations, IEC will include but not limited to the following topics:

- Project rationale and objectives;
- Organizational structure of proponent;
- Technical aspect of project implementation;
- Potential Environmental impacts and its mitigations;
- Monitoring and Social aspects of the project.

During operations, activities will include:

- Establishment of signage
- Monitoring plans
- Sponsoring "pulong-pulong"
- Plant tours
- Radio Announcement/Reporting

6 ENVIRONMENTAL COMPLIANCE MONITORING

6.1 Self-monitoring Plan

Table 6-1 provides an overview for the proposed self-monitoring plan of the proposed project as suggested in the pro forma of Annex 2-20 of the RPM.

RPM DAO 03 30 have stipulated on how EQPL will be accomplished. To wit: “2 NOTE: Sections on EQPLs to be filled out only if EQPLs are willing to be committed by the Proponent at the pre-ECC stage. Otherwise, Proponent may opt to have EQPLs established post-ECC and mutually agreed upon among Proponent, EMB and other MMT members. Otherwise, only the LIMIT Level shall be the reference for regulatory compliance. This means that environmental management measures are formulated not to exceed this regulated threshold.”

The proponent opted to have the LIMIT Level as reference for regulatory compliance as set by MMT.

Table 6-1 Environmental Management and Monitoring Plan (EMMoP)

Key Environmental Aspect	Potential Impact	Parameter to be Monitored	Project Phase	Sampling and Measurement Plan			Lead Person	Annual Estimated Cost	EQPL MANAGEMENT SCHEME					
				Method	Frequency	Location			EQPL RANGE			MANAGEMENT MEASURE		
									ALERT	ACTION	LIMIT	ALERT	ACTION	LIMIT
The Land	Coastal erosion/ deposit ion	Change in Coastline configuration	Construction	Ocular spotting	Semi-annual	River mouth	Proponent	Php20,000						
The People	noise	dB(A)	Construction	Sound Meter	Monthly	River banks	Proponent	Php80,000						
	Navigational Traffic	No. of fishers affected	Construction	Log Book	Monthly	Municipal waters	Proponent	Php20,000						
	resource use	Use disturbance	Construction	compensation	Marisand Resources	part of operation	part of operation	to be established with MMT						
Impact on Water	Increase in turbidity	TSS	Construction	Secchi disk	Monthly	River Channel	Proponent	Php20,000						
	Saline intrusion	salinity	Construction	refractometer	Monthly	River Channel	Proponent	Php20,000						
	Change in Flow Regime of channel	Channel depth	Construction	Sounding Survey	After every cut	River Channel	Proponent	Part of Operation						
	Presence of Oil and Grease from machineries	Oil and grease, DO	Construction Abandonment	Water Quality Test	Quarterly	River Channel	Proponent	Php36,000						
Impact on Air	Degradation of Ambient Air	TSP, PM_{10}, NO_2, SO_2	Construction	Ambient Air Quality Test	Semi Annual	Estuarine, Downstream Upstream	Proponent	Php100,000						

6.2 **Multi-Partite Monitoring Framework**

As proposed by DAO 2017-15 GUIDELINES ON PUBLIC PARTICIPATION UNDER THE PHILIPPINE ENVIRONMENTAL IMPACT STATEMENT (EIS) SYSTEM, members of the MMT would represent as much as possible affected stakeholders of the Project. The proponent proposes the following composition of the MMT:

Table 6-2 Proposed MMT Membership

MEMBER	ORGANIZATION	ROLE	BASIS FOR SELECTION	EQPL MANAGEMENT
CENRO	CENRO	Environmental impact monitoring	Expertise in Environment-related concerns	
PENRO	DENR	Environmental impact monitoring	Expertise in Environment-related concerns	
RHU Chief	City Health Office	Address health concerns caused by environmental impacts	Expertise in Health-related concerns	
MGB Representative	MGB	Monitor transport and exportation of dredged materials	Expertise in mineral exportation	
District Engineer	DPWH	Monitor project Implementation in accordance with approved Design	Technical and engineering expertise	
NGO Representative	To be determined	Civil society participation	Mission related to environmental management	
Community Leader	To be determined	Civil society participation	Represent vulnerable sectors	
Barangay Captains	Barangay Ubos, Suba, Poblacion and Banga	Represent affected barangays	Barangays along project site	

Specific functions of the MMT are presented in Section 17 of DAO 2017-15. However, during the formal organization, these roles can be modified and agreed upon for a more effective and efficient conduct of various monitoring activities for the Project.

This team essentially should be able to act autonomously and generally performs the following:

- Compliance reporting
- Field Validating
- Monitoring of effectiveness of environmental management measures

Specific activities and their associated schedules of monitoring will conform to the monitoring plan as proposed by the proponent and endorsed by the review committee during the conduct of the EIA.

The MMT will work closely with the community officer of the proponent. A proposed organization of MMT is shown in Figure 6-1, Members of the MMT will select from among themselves as members of any of the three sub-committees as shown.

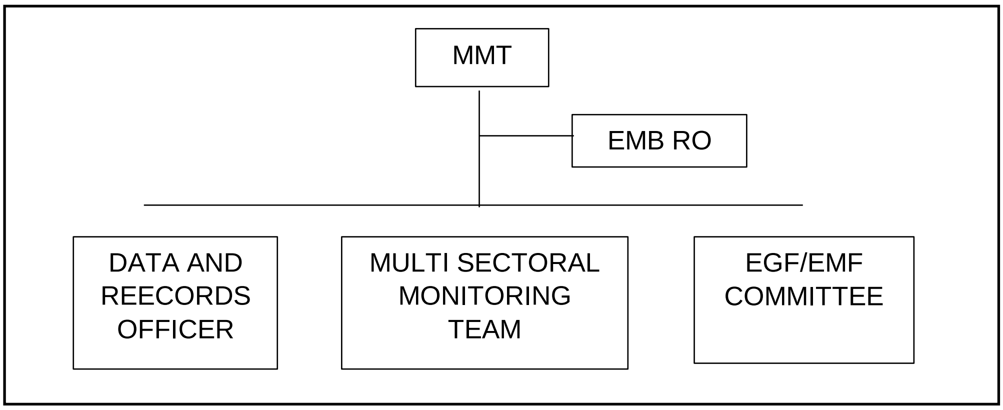


Figure 6-1 MMT Organization

6.3 Environmental Guarantee Fund and Environmental Monitoring Fund Commitments

For an effective and efficient functionality of the MMT and as compliance with the ECC, the proponent commits itself for an EMF on an annual and replenishable basis.

Table 6-3 Proposed Start-up Fund for MMT

SN	Start up Activity	cost	unit	Quantity	No. of Days	Total Cost
1	**Organizational Meetings, election/designation of officers /Exec Com and Sectoral / Committee members**					
	meals/venue	500.00	pax	20.00	1.00	10,000.00
	transportation/allowance	200.00	pax	20.00	1.00	4,000.00
	materials	2,000.00	ls	1.00	1.00	2,000.00
2	**Training-Workshop on the Preparation of the MMT Manual of Operations (MOO)**					
	meals/venue	500.00	pax	20.00	2.00	20,000.00
	transportation/allowance	200.00	pax	20.00	2.00	8,000.00
	materials	2,000.00	ls	1.00	2.00	4,000.00
	resource person	3,000.00	ls	1.00	2.00	6,000.00
3	**Training-Workshops on the preparation and use of the customized MMT Compliance Monitoring and Validation Report (CMVR)**					
	meals/venue	500.00	pax	20.00	2.00	20,000.00
	transportation/allowance	200.00	pax	20.00	2.00	8,000.00
	materials	2,000.00	ls	1.00	2.00	4,000.00
	resource person	3,000.00	ls	1.00	2.00	6,000.00
4	**Preparation of the next year's Annual Work and Financial Plan (AWFP) – fully operational MMT**					
	meals/venue	500.00	pax	20.00	1.00	10,000.00
	transportation/allowance	200.00	pax	20.00	1.00	4,000.00
	materials	2,000.00	ls	1.00	1.00	2,000.00
5	**Monitoring Tools and Implements**					
	Sound Meter	50,000.00	ls	1.00		50,000.00
	refractometer	30,000.00	ls	1.00		30,000.00
	sicchi disk	2,000.00	ls	1.00		2,000.00
	anemometer	25,000.00	ls	1.00		25,000.00
	Electronic camera	10,000.00	ls	1.00		10,000.00
	TOTAL					**225,000.00**

Table 6-4 Annual Environmental Management Fund

SN	Compliance Monitoring and Reporting Activities	cost	unit	Quantity	No. of Days	Frequency per year	Annual Cost
1	**Honorarium of MMT and its TWG**	1,000.00	pax	20	2	2	**80,000.00**
1	**Quarterly Document Review Mtg.**						**64,000.00**
	meals/venue	500.00	pax	20	1	4	40,000.00
	transportation/allowance	200.00	pax	20	1	4	16,000.00
	materials	2,000.00	ls	1	1	4	8,000.00
3	**Site Validation**						**57,600.00**
	meals/venue	500.00	pax	4	1	12	24,000.00
	transportation/allowance	200.00	pax	4	1	12	9,600.00
	Per Diem	500.00	pax	4	1	12	24,000.00
4	**Report Preparation Mtg.**						**38,400.00**
	meals/venue	500.00	pax	4	2	4	16,000.00
	transportation/allowance	200.00	pax	4	2	4	6,400.00
	Per Diem	500.00	pax	4	2	4	16,000.00
5	**Laboratory Cost**	5,000.00	ls	1	1	4	**20,000.00**
	Annual Total						**260,000.00**

The EGF is a fund that proponents shall commit to establish when an ECC is issued for projects or undertakings determined by EMB to pose significant risk to answer for damage to life, property, and the environment caused by such risk, or requiring rehabilitation or restoration measures. It shall also be used to implement damage prevention measures, environmental education, scientific or research studies, IEC, training on environmental risk or environmental accident-related matters.

The Project will not pose significant risk as stipulated above. The closest scenario that may occur is when there is an accident in the marine waters where hauling of dredged materials is being done on a regular basis. An example would be a collision between hauling barges and the fishers' fishing boat. This is highly unlikely if operational protocols are being followed such as blowing of warning horns and hauling during daytime where visibility is obvious.

However, if ever the accidents do occur, the EGF can be drawn for just compensation of parties affected by the scenario. Furthermore, the fund can be used for IEC and simulation training for the affected fishers to prevent such mishap from happening.

Marisand Resources Co. Ltd. will commit to a trust fund for Environmental Guarantee Fund in the amount of PhP2,000,000.00

7 DECOMMISSIONING / ABANDONMENT / REHABILITATION POLICY

During the dredging operations, the channel cutting will be done progressively from the mouth of the river to about six (6) kilometers upstream of the river reach, excluding 1 km before and after the bridge.

Possible disturbance can occur along the river bank where workers will seek respite or set temporary facility. This may result to the generation of solid wastes and other litters.
The Project must seek first the approval for the use of the patch from the owner or whoever is responsible.

The Project will adopt the “as-is-where-is “policy for this scenario. Project management will ensure that there will be minimal or if possible, no negative footprints that will be left behind for the temporary use of this patch. Upon abandonment, the patch should be in a condition as the original. If ever, the disturbance will be immediately rehabilitated upon transferring to another patch.
The general policy is to prevent, reduce, and mitigate all possible negative footprints that may occur in every stage of dredging activity. In this manner, there is avoidance of possible cumulative impact on the Project site. When the Project is terminated, the same policy will be applied for all areas that may have negative environmental footprints.

8 INSTITUTIONAL PLAN FOR EMP IMPLEMENTATION

Once the ECC is issued, a Multi-Partite Monitoring Team (MMT) will be initiated and organized by the proponent with the supervision of EMB. This team essentially should be able to act autonomously and generally performs the following:

- Compliance reporting
- Field Validating
- Monitoring of effectiveness of environmental management measures

As proposed by RPM, members of the MMT would represent as much as possible affected stakeholders of the Project. The proponent proposed the following:

- City Environment and Natural Resources Officer
- DENR – PENRO
- RHU Chief
- MGB
- DPWH District Engineer
- Accredited NGO
- Community Leader
- Chief Executive of Affected Barangays

To streamline the activities of the MMT, three (3) committees will be formed whose membership will be selected from among themselves:

- Committee on Data and Records
- Committee on Sectoral monitoring
- Committee on Environment Guarantee Fund

The MMT will have an office provided for by the Proponent and will work very closely with the Community relations officer of the Proponent. Figure 8.1 shows proposed set-up.

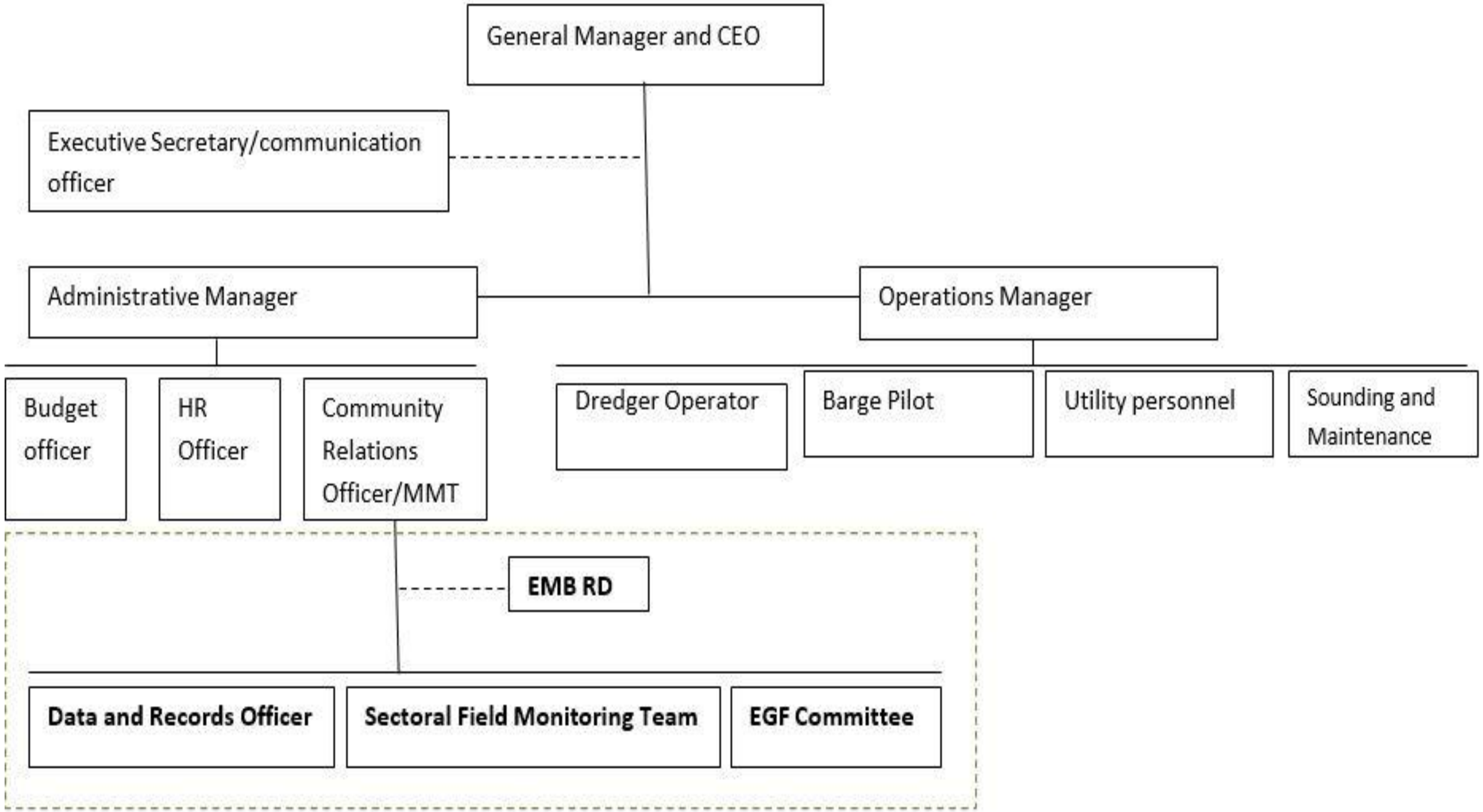


Figure 8-1 Proposed Organizational Set-up for MMT