

Mag Asawang Tubig Riverside Resilience

Green-Gray Partnership
Project for Philippine Cities
and Municipalities

Municipality of Naujan, Oriental Mindoro

Ref No: GGI-00-MP-PT-2011

20 December 2021 | V 1.0

With support from:



FONDS FRANÇAIS POUR
L'ENVIRONNEMENT MONDIAL

CONSERVATION
INTERNATIONAL





About the Green-Gray Partnership

Climate change can no longer be ignored. The raging waters of typhoons Ondoy in 2009 and Haiyan 2013 are seared in Philippine collective memory. In the span of three weeks in 2020, three typhoons battered the country, inflicting over a hundred fatalities and at least PHP 25 billion (USD 518 million) worth of damage. The Philippines urgently needs to harness nature to uplift communities not just because it's better for the planet, but because making the most of available resources is an economic necessity.

In the last quarter of 2021, just as the Philippines was reining in the pandemic, Conservation International and AECOM began the Green-Gray Partnership Project with eleven local cities and municipalities to kickstart the adoption of nature-based solutions.

Integrating green natural systems into gray infrastructure provides multi-function and cost-effective solutions. Green-gray combines natural elements with hard infrastructure to protect and restore natural processes and create healthier urban environments. The combination allows the creation of natural habitats or system functionality (green infrastructure) in a resilient and optimized manner (gray infrastructure). Many green-gray solutions incorporate wetland and forest habitats. As with all habitat creation/restoration projects, the success of these initiatives depends on an understanding of the ecological structure and function of the target habitats.

Green-gray infrastructure approaches can apply in coastal, freshwater, and terrestrial settings and accomplish a variety of project goals. The typical infrastructure services such as flood management, coastal protection, and improving water quality are delivered alongside other benefits such as safeguarding biodiversity, providing livelihoods, increasing public space, and even financial returns to local communities through carbon credits.

A key reference for this engagement is the *Practical Guide to Implementing Green-Gray Infrastructure* by the Green-Gray Community of Practice, which is led by Conservation International. The guide, published in 2020, provides green-gray case studies and walks

readers through the process of project preparation, design, and implementation. It also defines the critical elements of the green-gray approach:

1. Using science and engineering to produce operational efficiencies;
2. Using natural processes to maximize benefits (i.e. ecosystem services);
3. Increasing the value provided by projects by including social, environmental, and economic benefits; and
4. Using collaborative processes to organize, engage, and focus interests, stakeholders, and partners.

Conservation International selected the pioneer batch of Green-Gray partner cities and municipalities based on the following criteria:

- **Commitment to a Resilient Future** Good track record and strong interest for pursuing a climate-resilient future for their locality;
- **Drivers of Change** Positioned as municipal leaders for a sustainable future for the Philippines;
- **Rich and Diverse Natural Assets** Representation of the abundant biodiversity of the Philippines; and
- **Vulnerability to Impacts of Climate Change** Exposure to the impacts of climate change.

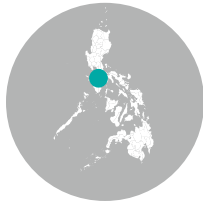
The Green-Gray Partnership Project was meant to equip local governments units (LGUs) with capacities to identify opportunities for the adoption of nature-based solutions and prepare concept notes to rally support for pilots. At the beginning of the project, it was essential to transfer knowledge of green-gray infrastructure through the guide and workshops focusing on case studies. This built a base from which the local governments drew from in order to craft a Statement of Intent and a Concept Design Note (Annex 1), both of which are contained in this document.

This document, containing a high-level design and assessment, may be used by the local governments to seek support for project preparation (in which the concept should be refined with further studies), detailed design, and implementation. Support may be sought from national government, financing institutions, grant giving foundations, and private sector partners.

Municipality of Naujan, Oriental Mindoro, Philippines

Mag Asawang Tubig Riverside Resilience

Utilizing Green-gray Infrastructure to Build Mag Asawang Tubig Riverside Resilience in Naujan, Oriental Mindoro



Location
Municipality of Naujan,
Oriental Mindoro, Luzon

Proposed Site
Mag-Asawang Tubig River
(Barangay San Antonio and
Estrella)

Key Thematic Area
Coastal and Riverine

Key Issue
Flooding in the communities along
the riverbanks

Green-Gray Solution
River Embankment

**Proposed Implementation
Timeframe**
2-3 years

- Executing Agencies**
- Municipal Planning and Development Office
 - Municipal Disaster Risk and Reduction Management Office
 - Office of the Municipal Engineer
 - Office of the Municipal Agriculturist

Project Aim
The two identified communities that are subjected to constant threat of casualties and damage to property due to flooding require infrastructure interventions to protect them from the impacts of typhoons and torrential rains. A green-gray solution is proposed to protect the communities without requiring a very high capital expenditure while reducing impacts to the environment.



Naujan Location Map



Naujan Green-Gray Partnership Project Location Map

997

Benefitting
Residents

source:
Naujan CLUP
2016-2025

1,596

Metric tons
of CO₂
captured

656

Metric tons
of Improved
Resilience for
Fishermen

Based only on assumptions and estimates; for verification in next stage



Overview

The Municipality of Naujan has chosen the Mag Asawang Tubig River delta as the priority area for green-gray infrastructure. The estuary is subject to flooding due to several factors such as upstream waterflow, coastal flooding, and storm surge. Two communities have been identified by the local government unit to be very vulnerable to flooding and requires protection to reduce casualties and damages to these communities. The project will involve dredging of the delta area of the river going upstream for approximately one kilometer. This area adjacent to barangay San Antonio is critical due to low discharge of water, heavy siltation, perennial flooding, and vulnerable communities.

The main concept is to create embankments that will surround the identified villages prone to flooding and storm surge. The design will include the use of the dredged deposits as backfilling materials and green strategies for slope protection, limiting further erosion on the riverbanks.

Sustainable Development Goals (SDG) Targets



Rationale

Naujan is the biggest municipality in the province of Oriental Mindoro. With a total land area of 528 square kilometers, it has significant geological, historical and cultural features.

It is bounded in the north by Calapan City, in the northwest by the Municipality of Baco, in the east by part of the Verde Island Passage (a marine biodiversity conservation corridor) and Tablas Strait, in the south by the town of Victoria, in the southeast by the town of Pola and in the southwest by the town of Sablayan in the province of Occidental Mindoro. The topography consists of generally broad plains with rugged mountains on the southwest.

It is frequently visited by typhoons particularly during rainy seasons. During heavy rains, practically all rivers and tributaries overflow to the lower areas, causing floods and damaging crops and properties. Erosion of vast tracts of land occurs at times. Based on Flood Hazard Map which was released by Mines and Geosciences Bureau (MGB) after Typhoon Nona in 2015, 62 out of 70 barangays are susceptible to flooding. Major rivers contributing to flooding in Naujan are Mag-Asawang Tubig, Panggalaan, and Bucayao River. Naujan generally relies on its natural drainage pattern, except in the downtown area where there are open-type lined canals on both sides of roads.

The effect of climate change in the municipality has been noticeable because almost all of the plains were submerged in floods brought by heavy downpours. Even heavy rainfall on the southwestern mountains will submerge swathes of Naujan.

The municipality also has the Naujan Lake National Park, a nationally declared (National Integrated Protected Areas System) NIPAS area where activities and developments are co-managed by the Municipal Government, lakeside barangay governments, and the Department of Environment and Natural Resources through the PAMB. This is approximately 2074 hectares or 2.97% of the total municipal land area.

The Mag Asawang Tubig River, about 95 kilometers long and with a watershed area of 437 square kilometers, is one of the largest river systems in Oriental Mindoro. Its head tributaries drain from the central mountain range of Mindoro island in

Sablayan then form an alluvial fan to the north towards the western part of Victoria. The river then flows northward towards the floodplain barangays of Naujan. The river's branched delta is located northwest of downtown Naujan. Mangrove forests are present on both sides of the delta.

Accumulations of sand and gravel are very common along the inner bends of the meandering Mag Asawang Tubig River. Two major locations of increased sedimentation were noted for a 7-kilometer stretch of the River: (1) inner bends of the meandering midstream segments of the river and (2) in the channels and island bars near the delta adjacent to Barangay San Antonio, where the channel depth becomes shallow because of high sediment influx and decreased energy. Extraction of these deposits would increase the carrying capacity of the river as well as its stream power. At the moment, the risk of bank erosion and consequent loss of land area is great and should be a primary concern for sustainable river management.

Being highly silted and inundated during heavy rains, the river overflows to the small community of San Antonio (population: 490) and Estrella (population: 577) until the town proper of Barangays Poblacion 1, Poblacion 2 and Poblacion 3 (total population: 2,825) and a part of Barangay Estrella (population: 2,308), by way of Bulwagan River and Tabang Creek. As for the infrastructure within the subject area, there is one bridge that connects the community to the Poblacion. It is more or less one kilometer from where the sea water and river water meet.



Waterway fronting Brgy. Estrella as priority area for dredging

Project Proposal

The proposed green-gray infrastructure project is an effort to protect the small riverside communities along the Mag Asawang Tubig River delta from storm surge and flooding.

Dredging the river will be key to reduce flood heights. Then, the dredged material will be used to create an embankment that will surround the identified villages prone to flooding and storm surge. The design of the embankment shall incorporate a vetiver grass on its slopes and a walkway on its crest.

Green-gray infrastructure impact

Rehabilitating Mag Asawang Tubig River delta using green-gray infrastructure may unlock multiple benefits including:

- Reduce the impact of inland flooding
- Restore the riverine ecosystems and biodiversity
- Encourage the reforestation of the uplands

Ultimately, the pilot can make a case for the municipality wide adoption of nature-based strategies to:

- Make the city inclusive, safe, resilient and sustainable
- Conserve Naujan's river network and riverine ecosystems



Waterway fronting Brgy. San Antonio as priority area for dredging

Sustainable Development Goals (SDG) Targets



Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all



Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries

Integrate climate change measures into national policies, strategies and planning

Promote mechanisms for raising capacity for effective climate change-related planning and management in least developed countries and small island developing States, including focusing on women, youth and local and marginalized communities



By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums

Strengthen efforts to protect and safeguard the world's cultural and natural heritage

By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations

By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities

Substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels



Strengthen domestic resource mobilization, including through international support to developing countries, to improve domestic capacity for tax and other revenue collection

Mobilize additional financial resources for developing countries from multiple sources

Adopt and implement investment promotion regimes for least developed countries

Promote the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries on favourable terms, including on concessional and preferential terms, as mutually agreed

Enhance international support for implementing effective and targeted capacity-building in developing countries to support national plans to implement all the sustainable development goals, including through North-South, South-South and triangular cooperation

Encourage and promote effective public, public-private and civil society partnerships, building on the experience and resourcing strategies of partnerships

Indicative Implementation Arrangements

Precise implementation arrangements remain to be determined at the pre-design preparation phase, but it is foreseen that the project shall be led and monitored by the Municipal Planning and Development Office and Municipal Disaster Risk and Reduction Management Office.

Support may be sought from the Office of the Municipal Engineer, Office of the Municipal Agriculturist. Partnership with the national government may happen through the Department of Environment and Natural Resources and the Department of Public Works and Highways.

Monitoring and Evaluation Plan

To establish the GGI as an effective solution to substitute conventional infrastructure projects, a set of metrics should be established to evaluate its results:

- Monitoring of flood level in Barangay San Antonio and Barangay Estrella
- Inventory of casualties during flooding along the river
- Periodic monitoring of silt accumulation within the river

Due Diligence

This document contains a green-gray infrastructure design concept and high-level assessments. More details are required in order to refine this concept into a robust and detailed proposal; thus, the project preparation phase for this project should include:

- Feasibility Study
- Environmental and social impact assessment or environmental and social management framework
- Stakeholder consultations at national and project level implementation including with indigenous people, if relevant
- Gender assessment and action plan
- Operations and maintenance plan, if relevant
- Loan or grant operation manual, as appropriate
- Co-financing commitment letters

If required, the preparation of this project may include the following studies:

- Diagram of the theory of change
- Economic and financial model with key assumptions and potential stressed scenarios
- Pre-feasibility study
- Evaluation report of previous project
- Results of environmental and social risk screening

Conservation International's Diversity, Equity, and Inclusion (DEI) framework

At Conservation International (CI), we are committed to promoting human rights by reducing equity gaps and facilitating the enhancement of social and environmental sustainability. All of our projects are held to strict social and environmental principles as agreed upon and laid out by internationally accepted standards such as the Community, Biodiversity, and Carbon standard, as well as the Global Environmental Fund (GEF) and Green Climate Fund (GCF) safeguards. However, CI is taking our responsibility to communities and the environment even further with a commitment to tracking and monitoring Diversity, Equity, and Inclusion (DEI) benefits through our Environmental and Social Safeguards System (CISS), a system that exceeds international standards. To achieve maximum socio-environmental and climate benefits plus long-term sustainability of any project, we believe that communities must be at the center and actively participate in the design of any conservation initiative in which we engage. Central to this, CI engages communities in:

1. Developing the project components, including governance, management processes, and distribution mechanisms in a consultative, transparent and participatory manner with relevant stakeholders (Conservation Agreements ensure that all parties are heard and decisions are made jointly).
2. Addressing gender inequality in all of our conservation programming, monitoring, and reporting efforts.
3. Guaranteeing the long-term financial viability of the project through optimizing project implementation while maximizing benefits.
4. Prioritizing non-monetary benefits whenever possible to increase the number of beneficiaries and better guarantee long-term project success.

ANNEX

Design Note

Statement of Problem and Thematic Area

Barangay San Antonio and Barangay Estrella are the two areas most vulnerable to flooding along the river. During torrential rains and typhoons, these areas are subjected to both upstream freshwater and coastal flooding. This can be worsened by storm surge and high tide. The LGU conducts mandatory evacuation during heavy rains or typhoons to avoid any human casualties. Aside from the vulnerability to flooding and storm surge, sedimentation in the area increases flood risk. The LGU has noted that sometimes it takes about 3 days for flooding to subside in these two barangays. Additionally, Barangay San Antonio is subjected to

riverbank erosion due to the land use along the river which directs currents towards the river edge of the community.

The community area in Barangay San Antonio is an old town with no vehicular road access. It can only be accessed through a concrete pedestrian bridge. While the vulnerable community in Barangay Estrella is relatively new and has been built through the initiatives of Gawad Kalinga, a local NGO focused on poverty alleviation.



Island bars near delta where channel depth becomes shallow due to high sediment influx and decrease in energy

Project Aim

The two identified communities that are subjected to constant threat of casualties and damage to property due to flooding require infrastructure interventions to protect them from the impacts of typhoons and torrential rains. A green-gray solution is proposed to protect the communities without requiring a very high capital expenditure while reducing impacts to the environment.



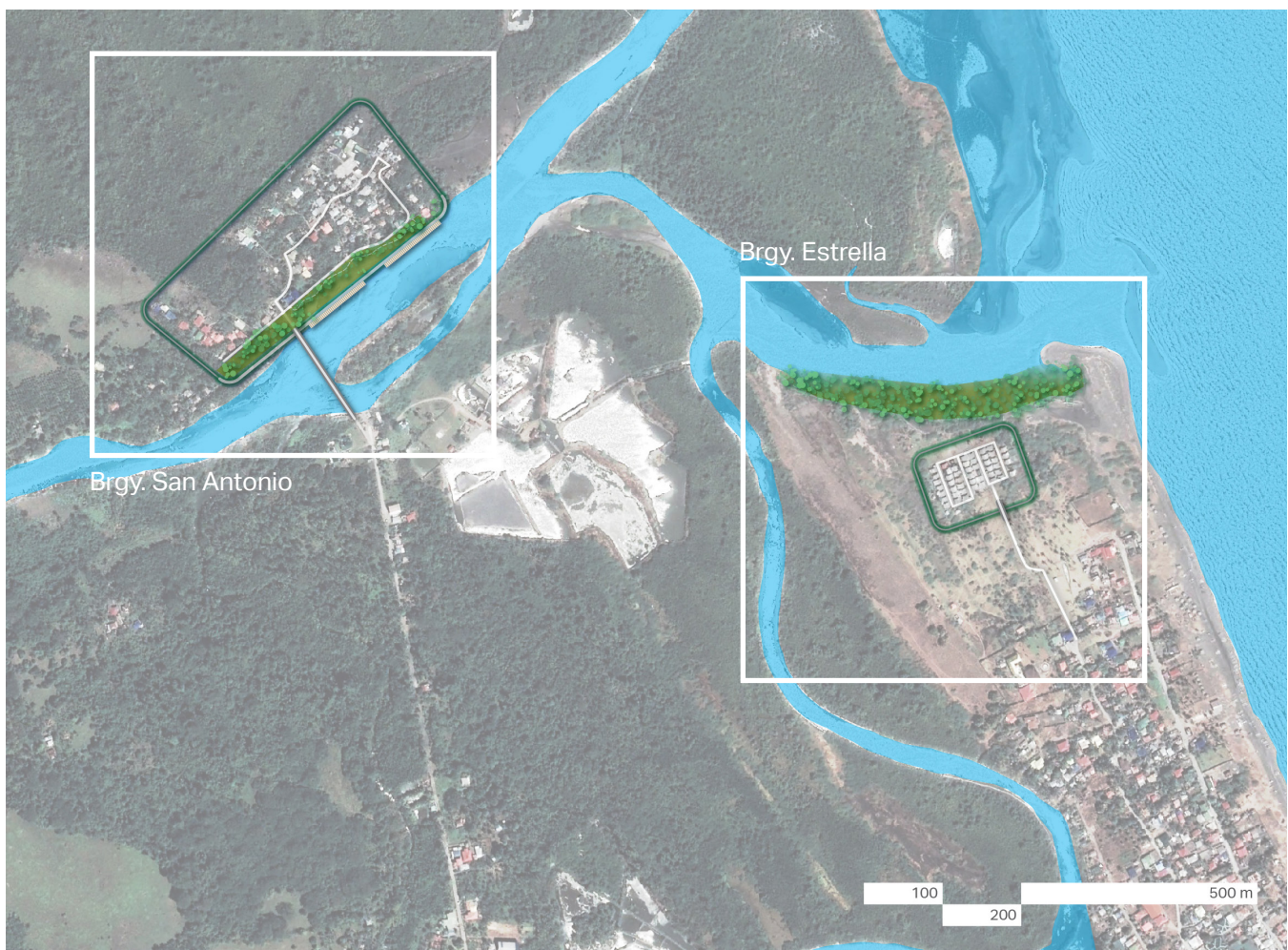
Accumulation of sand and gravel along the inner bend of a meander of upstream area of Brgy. San Antonio

Green-Gray Infrastructure Strategy

Mag-Asawang Tubig River especially at the estuary will require immediate dredging as the LGU has identified that it is heavily silted and the last time that they have conducted dredging has been more than a decade ago. This will improve waterflow from the river to the coast and will reduce flooding and the time needed for the flood to subside. The sediments collected are proposed to be the fill material that will be used in geotubes for the river embankment. It should be further studied to understand the silt's composition and whether it is a good fill material. The proposed embankment will be utilized in both sites. These embankments are designed to surround the community not only along the edge of river but also inland as the LGU has identified that coastal flooding is another threat that poses damages to the communities. The embankment can also serve as a pedestrian linear park that will connect the

different areas of the community; this is very relevant to Barangay San Antonio as the community is only served by narrow pedestrian linkways. The river embankment will incorporate vegetation such as vetiver grass to enhance biodiversity as well as to counter erosion from flooding or waterflow. All roads and pedestrian linkways coming from the outside of the communities should be designed to connect to the embankment. A drainage pipe with a one-way flat valve shall be incorporated in strategic locations in the embankment to allow water from the interior to flow out.

Barangay San Antonio is a fishing village and small fisherman boats are docked along the river, therefore providing a docking point beyond the proposed river embankment shall be included as part of the infrastructure design.



Naujan GGI Concept Strategy Plan



Naujan GGI Concept Strategy Blow-up Plan: Brgy. San Antonio

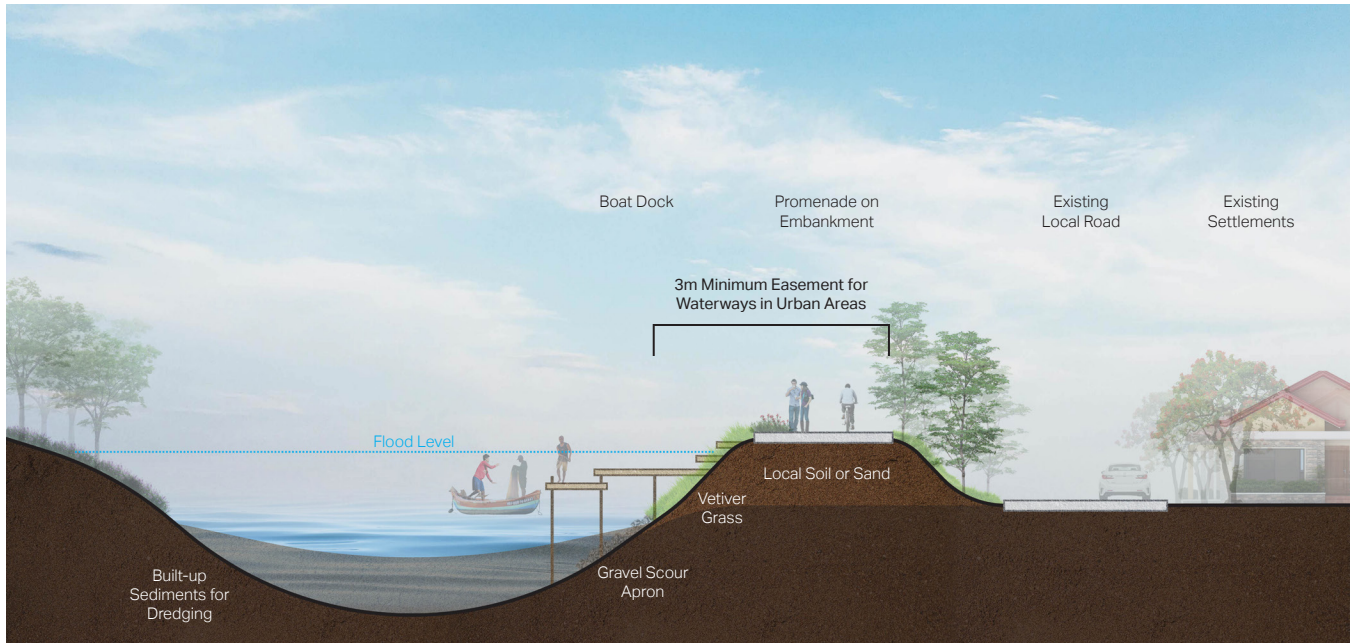
<p>0.4 km total length of stage 1 seawall/embankment</p>	<p>0.2 km total length of boat dock</p>
<p>0.7 km total length of stage 2 embankment</p>	<p>0.7 ha total land area for promenade and park</p>



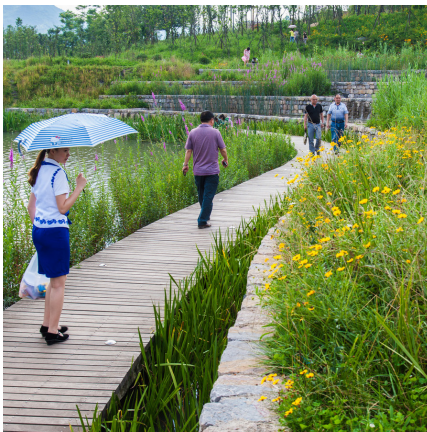
Naujan GGI Concept Strategy Blow-up Plan: Brgy. Estrella

<p>0.5 km total length of embankment</p>	<p>1.4 ha total land area for planted mangrove</p>
---	---

Green-Gray Infrastructure Concept Strategy



*Naujan GGI Concept Strategy Section:
Brgy San Antonio*



Promenade

Creek rehabilitation via waterside promenade with footpaths, cycle tracks and landscaping next to proposed river cruise .



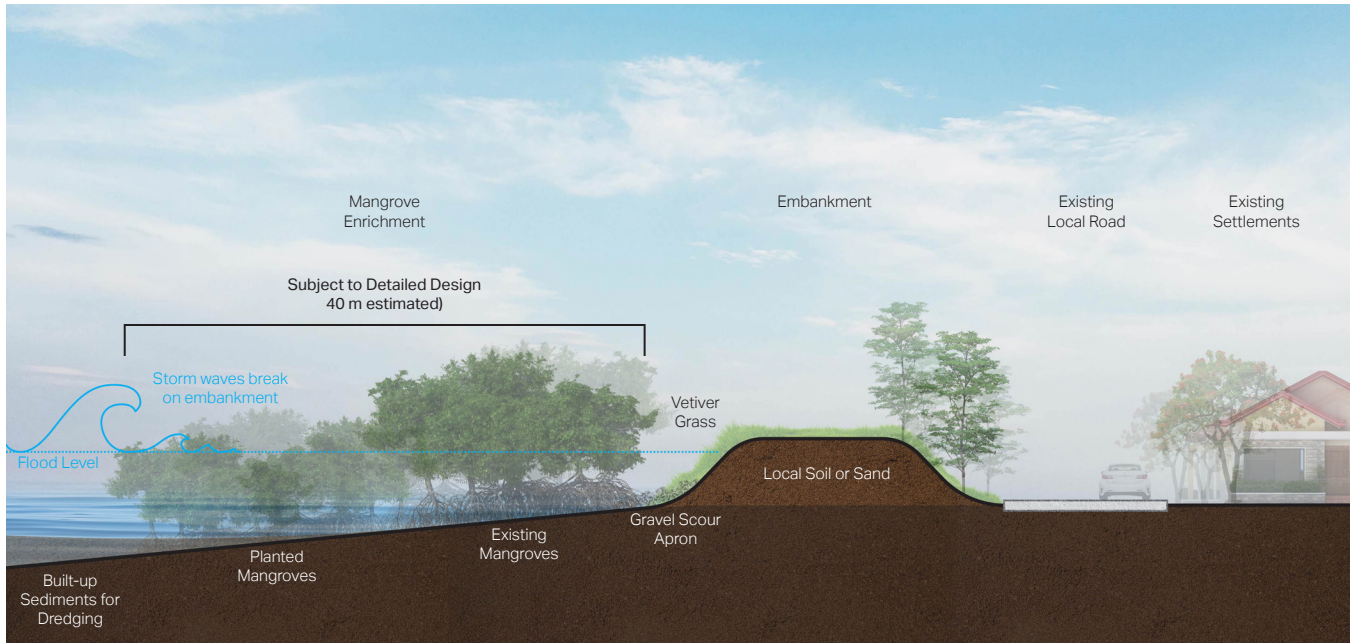
Embankment

River embankments, sown with vetiver grass to protect against currents and waves, can be constructed above river flood levels to protect against flooding. They can also be constructed around a flood overflow area.

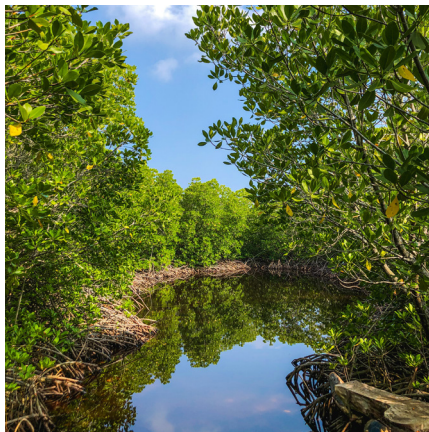


Dredged local soil or sand

Use of large geotextile bags filled with local soil or sand dredged from waterways for embankments.



*Naujan GGI Concept Strategy Section:
Brgy Estrella*



Mangrove enrichment

Due to their interconnecting roots and branches, mangroves reduce wave energy. In comparison, they only have a minimal impact on storm surge which penetrates the mangroves.



Dredged local soil or sand

Use of small geotextile bags filled with local soil or sand dredged from waterways for embankments.

Benefits of a GGI Solution

The proposed GGI solution will protect the communities from flooding and storm surge. This will not only protect human lives but also protect the properties of the residence inside the embankment. It will also avoid future evacuation measures conducted by the LGU during typhoons and will probably be only limited to exceptional cases where the flooding is projected to be very high.

Integrated Holistic Approach

The proposed GGI Solution is a pilot project that is envisioned to be potentially scaled-up or replicated to the other parts of the municipality. Whilst, the proposed solution is addressing the key issue at hand, it is important to note that addressing the root cause of the problem is essential.

A proposed future project for Barangay San Antonio is a vehicular access road that can provide the Barangay with better connectivity especially during times of emergencies. Currently, the community is only accessible through a concrete pedestrian bridge crossing the Mag-Asawang Tubig River and the LGU is proposing this to be upgraded. Another option is securing a right-of-way from the Antipolo Jct Road to ensure that a vehicular road can be accommodated.

Additionally, the municipality has identified that infrastructure solutions should also be incorporated to upstream areas to mitigate riverbank erosion to reduce the amount of silt accumulation within the municipal's river and estuary.

Implementation Period

A timeline of 1-2 years is estimated to prepare, implement, and construct this GGI solution. Due to lack of data and information readily available, additional studies and scoping work shall be required to validate and collect more information regarding the key issues identified by the LGU and the assumptions that have provided during the concept design stage. The proposed project timeline shall cover the following phases:

1. Predesign Phase

3-5 months;

This will include all the necessary study, scoping and data collection needed to establish, verify, and gather information required to proceed with a detailed engineering design.

2. Design Phase

2-4 months

A detailed engineering design shall be required to fully develop the conceptual design after using the verified data to accurately design the infrastructure according to the required specifications to address the key issue.

3. Implementation Phase

12-24 months

This will include the compliance to the required regulations/standards, seeking of approval of concerned agencies, and observance of due diligence. Upon obtaining the necessary approval and permits, the construction of the infrastructure or implementation of the prescribed program shall be done.

4. Operation, Maintenance and Adaptive Management

periodical

This shall include periodic monitoring of the infrastructure, maintenance and repair if required, evaluation of the impacts to surrounding communities, rehabilitation and retrofitting if required.

page intentionally left blank

Facts and figures

1.

AECOM launched when a handful of employees from design and engineering companies shared a dream of creating an industry-leading firm dedicated to making the world a better place.

2.

AECOM became an independent company formed by the merger of five entities. While our official founding was in 1990, many of our predecessor firms had distinguished histories dating back more than 120 years.

3.

Since then, more than 50 companies have joined AECOM and, in 2007, we became a publicly traded company on the New York Stock Exchange.

4.

As the world's trusted infrastructure consulting firm with an unrivaled heritage delivering design, planning, engineering, consulting and construction management solutions.

AECOM in the Philippines

Established in 1996, AECOM in the Philippines has grown into a 200+ strong team of planners, engineers, environmental scientists, geologists, landscape architects and technical management specialists driven by a common purpose to deliver a better world.

Creating Sustainable Legacies

We are leading the change towards a more sustainable and equitable future by partnering with our clients to provide solutions that help them achieve their environmental and social value ambitions and advancing sustainable business operations to help prevent the worst impacts of climate change.



47,000 people



Fortune 500 #163



Work across seven continents



2 Million Work Hours Awards



Revenue \$13.2 billion in fiscal year 2020



100% Rating on Corporate Equality Index / Best Places to Work for LGBT Equality 2021

Accolades

- ENR rankings No 1
- Environment Firm
- Transportation Design Firm
- Facilities Design Firm
- Mixed-Used Buildings
- Education Buildings
- Aviation
- Highways
- Chemical Remediation
- Top 10 Military Friendly company 2020
- Military Friendly® Top 10 Company
- Military Friendly® Top 10 Supplier
- Diversity Program
- Military Friendly® Top 10 Employer
- Military Friendly® Top 10 Spouse Employer
- National safety council: 155 Perfect Record Awards
- Achieved a minimum of 12 consecutive months without a recordable injury or illness.
- For each award, achieved a minimum of one million consecutive hours without an injury or illness that resulted in days away from work and zero fatalities.



Bogota, Colombia (C) Conservation International

Since 1987, Conservation International (CI) has worked to spotlight and secure the critical benefits that nature provides to humanity.

Combining fieldwork with innovations in science, policy and finance, we’ve helped protect more than 6 million square kilometers (2.3 million square miles) of land and sea across more than 70 countries. Today, with offices in more than two dozen countries and a worldwide network of thousands of partners, our reach is truly global. But we couldn’t have made it this far without you. Your contributions support our work to protect nature for the benefit of us all.

CI’s work in Asia-Pacific began in 1989 with a pledge to protect some three dozen of the Earth’s biodiversity hotspots, including the Philippine archipelago and the Sundaland rainforests of Southeast Asia.

Since then, our focus in Asia-Pacific has expanded across the region to include other ocean and forest areas considered critical to human well-being. We help improve food security, support innovative financing for conservation projects and establish protected area networks that encompass essential ecosystems.

CI’s unique combination of experience with ecosystem conservation and restoration, community co-design, and stakeholder leadership allows us to advise and lead [green-gray initiatives](#) around the world in collaboration with local, regional and national governments and engineering partners.

Priorities

- **Stabilizing our climate by protecting and restoring nature**
- **Doubling ocean protection**
- **Expanding planet-positive economies**

About AECOM

AECOM is the world's trusted infrastructure consulting firm, delivering professional services throughout the project lifecycle — from planning, design and engineering to program and construction management. On projects spanning transportation, buildings, water, new energy and the environment, our public- and private-sector clients trust us to solve their most complex challenges. Our teams are driven by a common purpose to deliver a better world through our unrivaled technical expertise and innovation, a culture of equity, diversity and inclusion, and a commitment to environmental, social and governance priorities. AECOM is a *Fortune 500* firm and its Professional Services business had revenue of \$13.2 billion in fiscal year 2020. See how we are delivering sustainable legacies for generations to come at [aecom.com](https://www.aecom.com) and [@AECOM](https://twitter.com/AECOM).