# Sustainable development practices for lawmakers and civil engineers internationally: A plan of action

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#### **INTRODUCTION**

Organizations throughout the world are working to develop infrastructure that will shape the future. Infrastructure offers fundamental systems and facilities for nations everywhere. With an ever-changing environment, organizations must develop infrastructure sustainably.

Sustainably-developed infrastructure, also known as sustainable infrastructure, is defined by Community Research Connections (CRC) (1) as designing, building, and operating infrastructure in ways that will not diminish social, economic, or ecological processes. These processes correlate directly with maintaining human equity and the functionality of ecological systems. To consider fully the lifespan of infrastructure, an additional dimension must be added to the CRC's definition; **sustainable infrastructure will not diminish current social, economic, or ecological processes, but instead will enhance these processes over time.** This project will offer a development plan to be used by city officials and project developers. The plan illustrates best practices for sustainable development that ensure social, economic, and ecological growth.

Infrastructure projects throughout the world are studied prior to construction to determine whether they will be sustainable. To develop a plan for sustainable development, methods from The Atlantic Bridge and other projects will be considered as a case study.

## Case Study: The Atlantic Bridge, Panama

The Atlantic Bridge is currently under construction in the Colón Province of Panama. As a part of the 28th Law of July 17th, 2006, which established the Panama Canal Expansion program, the Autoridad Del Canal de Panamá (ACP) was required to find the means necessary to allow vehicular travel from the Eastern and Western regions of Colón. This route of travel could have been either a bridge or a tunnel, but it had to begin no later than the completion of the Third Set of Locks.

Currently, citizens traveling to the opposite side of the Colón Province can either take an access road over the Agua Clara locks (Figure 1) or a ferry (Figure 2). However, these routes have wait-times of up to an hour for a distance that is less than To determine the feasibility of a new transportation route, ACP hired URS Holdings and COWI Inc. These two companies later became known as "the consortium" for the feasibility study. The study determined the long-term sustainability of the structure. The consortium examined the area from the Colón Province to Parque Nacional Sante Fe, for development potential. Figure 3 illustrates the area inspected by the consortium approximately 2,000 square miles (5180 square kilometers).



Figure 1: Crossing via the ACP access road (ACP, 2017)

one kilometer. For citizens in the province, large waiting times have adverse effects on their daily lives. Creating a more efficient method of travel will have positive effects on the social processes of the Colón Province.



Figure 2: Crossing via the ferry provided by ACP (ACP, 2017)



Figure 3: Area considered by the consortium. during feasibility study (ACP, 2017)

#### **Development Study**

Creating this bridge will not only connect the Eastern and Western regions of Colón, but also create a direct link from Panama City to the North-Atlantic coast of Panama. Currently the primary international hub for Panama is Tocumen International Airport just minutes away from Panama City on the Pacific side of the country (Figure 4). The location of this airport, and lack of efficient routes to the Colón Province, have limited the region's development. URS and COWI determined that the bridge connecting the Eastern and Western regions of Colón would act as an infrastructural basis for future development in the area.



Figure 4: Map of Panama with Airport (ACP, 2017)

Panama City acts as the country's central hub, with direct transportation routes across the Pacific coast and to Colón. However, as seen from the map above, **as the route reaches the divide in the Colon Province, all major roadways seem to disappear.** The consortium's feasibility study determined that by developing a bridge to the other side of Colón, the North-Atlantic region of Panama would experience increased economic development.

Once the project was recognized as offering both social and economic benefits, the Panama Canal Authority examined the potential ecological effects of the structure. The Canal Authority determined the current traffic levels over the Canal by tracking the number of vehicles that take the ferry and drive over the locks each day. Reporting nearly 4,000 vehicles per day, the Canal Authority then determined the current damage to the environment from this level of traffic. Wait-times to cross the Canal can be up to an hour. A typical vehicle will use <sup>1</sup>/<sub>5</sub> of a gallon (.757 liters) of gas and emit four pounds of carbon dioxide during this time by idling. This idling is equivalent to 292,000 gallons of gas and 5.84 million pounds of carbon dioxide emissions per year. Due to the current route inefficiencies, Panama would need to plant 121,667 trees in order to offset these carbon dioxide emissions at the proposed bridge location. A bridge with a traffic flow that is not interrupted by the Canal, and would not have hourlong delays, would reduce emissions from idling cars by 4.38 million pounds per year; this is an immediate 75% reduction in emissions.

Overall, each of these preliminary steps were examined to determine the feasibility and sustainability of the Atlantic Bridge. Every infrastructure project has implications for not only the immediate build location but also surrounding communities. Practices such as performing feasibility studies and environmental tests directly correlate to other practices used in construction locations throughout the world. To develop fully sustainable infrastructure, policy makers and construction companies should follow a series of recommendations.



Figure 5: Full map of Panama (ACP, 2017)

### **Industry Recommendations**

All civil engineering projects should begin by considering social, environmental, and ecological impacts. Figure 6 illustrates some considerations in each of the categories:



Figure 6: Sustainable Engineering Practices

When planning any new infrastructure project, it is imperative to involve communities. Policy makers and engineers can ensure that the community has a voice by attending town hall meetings, posting in town bulletins, and sending surveys to any affected community members to seek their opinions.

Though this may require extra effort for policy makers and engineers, these steps will ensure that the community has had a chance to voice their opinion on the new project. Though the opinions of the community members may not directly result in large-scale changes, they may allow the project team to better cater to the community's wants and needs.

Once the survey has been completed, the impacts on a community of the infrastructure project may be identified. This can be a result of many causes such as, but not limited to, changes to floodplains and construction zone demolitions. After a community survey, information on the areas that may be affected by the construction should be circulated to the community.



Figure 7: Flood Plain Example (ACP, 2017)

For example, if the infrastructure project results in changes to floodplains, this may have adverse effects on surrounding communities. In the US, areas prone to flooding are required to have flood insurance and other forms of security to ensure that residents can stay in their homes. If a project will financially hinder community members, they should be properly compensated. This can be in the form of monthly subsidies to cover additional insurance or purchasing the property and land from the owner.

Every infrastructure project, no matter where its location in the world, always has skeptics of the project's true benefits. Depending on the location and contractors involved, skeptics may state that a project is only being created for the profit of the contractor. Once the construction of the Atlantic Bridge was confirmed, a revitalization project for Colon was immediately proposed. The President of Panama, Juan Carlos Varela Rodriguez, authorized a project of "human integration". This project requires an immediate investment of nearly \$500 million and will directly impact 206,553 people. The renovation project was broken into three segments: **renovation**, **housing projects, and basic health**.

The **renovation** of Colon begins with the revitalization of Colon's center at "5 de Noviembre" a highly valued historic park in the city. Along with this park, many historic buildings will be renovated and modernized, while maintaining their cultural and historic roots. Companies in the revitalization process include Pan America Construction Corp, an organization with distant ties to the president, as well as the National Council for Sustainable Development.

The **housing projects** associated with Atlantic Bridge in Colon include the construction of new housing administered by the Ministry of Housing and Land Management. These housing projects attempt to change the physical image of the city of Colon. More than 300 homes will be constructed for the project and it is expected that these homes will benefit 1,500 people, presumably Colon locals. To better serve Colon residents, a Children and Family orientation center is being developed and seven existing housing projects are being modernized.

The **basic health** benefits that resulted from the Atlantic Bridge include the construction of 405 sanitary units for the township of Cativa, a district within western Colon. These units will be built by a consortium of

companies known as S&S Construcciones Ecologicas. The basic health portion alone will cost nearly \$US 14 million and the labor force that will be used will all come from within the Colon province.

Though these examples are specific to the Atlantic Bridge projects, it is possible to study whether revitalization is feasible prior to implementing new infrastructure. Overall, the benefits offered to the citizens of Colon may be seen through the social and environmental studies performed prior to construction. However, for infrastructure to be truly sustainable, policy makers and engineers also must consider the ecological effects.

Infrastructure and the environment should be viewed as intertwined. For too many infrastructure projects, engineers and owners choose attractive designs and construction practices that result in minimal cost. Choosing the design at the lowest cost risks neglecting environmental effects. To be sustainable, infrastructure must be built with attention to connections to the environment. These connections can range from choosing materials that will not cause harm to native species, to properly relocating animals when their habitats are destroyed during construction.

This form of protection was used during the construction of the new set of locks on the Panama Canal. During construction, 2,743 reptiles were rescued, and 2,309 mammals and 227 birds were relocated. These efforts allowed the animals to develop in new habitats without causing extreme harm to them. Animals that are not relocated when their habitat is destroyed by an infrastructure project are at risk of death and possibly extinction.

Though these recommendations may not apply to every civil engineering project, it is important that policy makers and engineers still consider how their projects affect the local and extended communities. Currently, the infrastructure throughout the United States receives a score of a D+ from the American Society of Civil Engineers (ASCE).

The D+ score from the ASCE means that our infrastructure is in poor condition and performs at a low level. A D+ signifies that the infrastructure throughout the country needs large amounts of work. Beginning in the early 1900s, infrastructure projects were constructed at a rapid pace, with little regard to long-term sustainability. To create more resilient and sustainable cities, the recommendations listed above should be considered in all projects.

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