

INTEGRATED ENVIRONMENTAL STRATEGIES – BOGOTÁ



November 24, 2010

JOINT IMPLEMENTATION PLAN



Joint Implementation Plan

“INTEGRATED ENVIRONMENTAL STRATEGIES – BOGOTÁ”
NOVEMBER 24, 2010

BACKGROUND

Bogotá has some of the worst air pollution among Latin American cities. Emissions of pollutants such as particulate matter (PM) have a significant impact on public health. It is estimated that nearly 53,000 deaths in the period 2010-2020 will be attributable to air pollution, and that the costs of pollution-related health impacts exceed 15.83 billion pesos.

To address Bogotá’s mobility needs, the city adopted a Mobility Master Plan (MMP), designed to achieve, among other things, secure, equitable, and environmentally and financially sustainable transportation. To support the MMP, Bogotá also adopted an integrated transport plan, known as the Integrated Public Transport System (known by its acronym in Spanish as SITP).

SITP is a comprehensive reform to the existing transport system, including new public transport routes and a zonal operation scheme, integrated fare collection, and a reduction in the number of operating companies to thirteen. SITP also seeks to fulfill important environmental objectives, including reducing air pollution and greenhouse gas (GHG) emissions. For example, it is anticipated that SITP vehicles will meet stringent emissions standards, and that a new network design will enable more efficient system operations, thus reducing fuel consumption.

It is estimated that, by 2020, SITP could reduce directly emitted PM by the public transport fleet by more than 60% and carbon dioxide (CO₂) emissions by about 30%. Moreover, it is likely that these benefits could be increased if additional transport measures are implemented. These reductions in air pollution will have significant positive impacts on health, thus lowering the economic costs of air pollution to the city and improving quality of life, as well as making a contribution to addressing global climate change.

The U.S. Environmental Protection Agency (EPA) has developed a multidisciplinary approach, known as Integrated Environmental Strategies (IES), which is designed to help developing countries accommodate economic growth while pursuing measures that reduce both air pollution and GHG emissions. Specifically, the IES approach enables cities to systematically assess and prioritize environmental interventions while, at the same time, build support for such interventions. The IES approach is one that can be implemented in the Bogotá context to help the city achieve substantial public health and climate benefits.

The terms of reference below outline the objectives and specific activities to be completed under this IES-Bogotá project by the Clean Air Institute (CAI) and the Universidad de los Andes (UNIANDES).

OBJECTIVES

The overarching objectives of the IES-Bogotá project include:

- Deepen the understanding of the environmental costs and benefits of Bogotá's SITP.
- Assess the emissions impacts of the SITP on a local scale by studying the overall road network, based on the definition of corridor typologies.
- Estimate the environmental and public health impacts of potential changes for the SITP proposed by CAI and UNIANDES as well as other transportation policies or measures that might affect the SITP, e.g., measures to discourage automobile use.
- Prioritize and evaluate the best set of projects to maximize environmental and health benefits.
- Advance the applicability of the IES approach as an analytical and capacity building process for assessing and prioritizing transport interventions in Latin American cities.

ACTIVITIES

This project has 11 basic activities:

1. Definition of project scope
2. Establishment of baseline scenarios for transportation, energy consumption, and emissions
3. Modeling and definition of alternative scenarios as a result of implementing the SITP
4. Formulation of specific measures complementary to SITP
5. Calculation of atmospheric concentrations
6. Estimation of variations in noise pollution
7. Assessment of personal exposure at the corridor level
8. Quantification and valuation of public health effects
9. Calculation of GHG emissions reductions and marginal abatement cost curve
10. Measures prioritization
11. Support for implementation of measures

The following sections detail the steps to successfully complete each activity.

1. DEFINITION OF PROJECT SCOPE

CAI and UNIANDES will work with the City of Bogotá to organize workshops to define the scope of the project. Participants from the City of Bogotá include:

- Transmilenio
- SITP
- District Treasury Secretary (Secretaría de Hacienda)
- District Health Secretary (Secretaría Distrital de Salud)
- District Mobility Secretary (Secretaría Distrital de Movilidad)
- District Environmental Secretary (Secretaría Distrital de Ambiente)

National and international experts will be included in the scoping effort, which is intended to identify the range of potential interventions that can help enhance the environmental performance of the SITP. These interventions will be further assessed in later activities. The steps to complete this activity follow:

Conduct a workshop to formalize the project team, convene stakeholders, and initiate project (completed August 2010)

Conduct an international workshop to share information about the SITP and related technical analyses, and discuss components and specific needs of the IES-Bogotá project (completed September 2010; summary attached)

Conduct a technical mission to Bogotá to finalize joint implementation plan, and meet with City of Bogotá representatives to review project status, present draft implementation plan, and discuss progress on activities 1-3 (completed November 2010; presentation attached)

Present final implementation plan to Inter-American Development (completed by November 30, 2010; represented by this document)

2. ESTABLISHMENT OF BASELINE SCENARIOS FOR TRANSPORTATION, ENERGY CONSUMPTION, AND EMISSIONS

The first project activity includes the development of baselines scenarios that explain the current status of transportation, energy consumption, and emissions that can then be used to understand the impacts of future technological and policy changes related to the SITP and complementary measures to improve air quality.

This activity involves the following sub-activities:

2.1 A literature review of studies applicable to Bogotá

Conduct a literature review on transportation, energy consumption, emissions of criteria pollutants and GHGs (completed December 2010)

2.2 Projections of transportation use in Bogotá, including the following steps:

Build and run a transportation network model that includes characteristics of roadways, vehicle types, O-D matrices for private and public transportation during the morning peak hour, modal distribution of peak hour trips, public transport frequencies and routes (completed October 25, 2010)

- Work with experts to identify the models to be used (e.g., migration from EMME3 to VISUM) and the methodologies to be employed)
- Work with experts to determine how to incorporate changes in traffic operations and transport supply at a street level

Calibrate the model to reproduce 2008 observed data (anticipated to be completed December 20, 2010)

Minor adjustments to Bogotá's Decontamination Plan (abbreviated by its Spanish acronym as PDDDB) base year (2010) at the city level

2.3 Projections of energy consumption in Bogotá, including the following steps:

Initially use the energy consumption data for the transportation sector that have been developed by the Ministry of Energy

Refine data, if necessary, to establish final inputs for the energy consumption model

Run the model used by the Ministry of Energy, Energy and Power Evaluation Program (ENPEP) to produce final baseline

2.4 Development of emissions baseline, including the following steps:

Calculate activity factor for entire fleet

- Define baseline corridors and other zones to be modeled
- Make minor adjustments to the PDDB base year (2010) at the city level
- Apply emissions factors to calculate corridor-level baseline emissions
- Establish baseline scenarios with projections for 5 and 10¹ years at the corridor level
- Develop report including descriptions of models, assumptions, inputs, outputs, and conclusions
 - Develop draft document
 - Conduct team member review of draft
 - Revise report, if necessary

3. MODELING AND DEFINITION OF SCENARIOS AS A RESULT OF IMPLEMENTING THE SITP

This activity will focus on applying appropriate models to examine the changes in transportation, energy consumption, and resulting emissions from the implementation of SITP.

This activity involves the following steps:

- Model the transportation network resulting from implementation of SITP
- Develop and run the model used for the baseline scenario with the changes that the SITP project proposes
- Review the model assumptions and results with Transmilenio and SITP
- Use model to project emissions for 5 and 10 years
- Summarize results for report
- Develop draft chapter
- Conduct team member review of draft
- Revise chapter, if necessary

¹ 20 year timeframe was not projected at the corridor level due to high inherent uncertainties

4. FORMULATION OF SPECIFIC MEASURES COMPLEMENTARY TO SITP

CAI and UNIANDES will work with the City of Bogotá to identify and assess specific alternative measures that will complement the SITP measures. These complementary measures may include clean vehicle technologies and alternative sources of energy that could be applied to Bogotá; public transport, traffic, and travel demand management; non-motorized transport measures; land use measures; and eco-driving alternatives by using the VSP (Vehicle Specific Power) methodology. Some of these complementary measures may already have been identified in the PDDB. The project team will also define additional measures.

Specific steps under this activity include:

Identify and characterize specific alternative measures complementary to the SITP

Estimate the costs of each of the complementary measures and identify potential sources of funding

Run models developed under activity 3 to quantify emissions reductions associated with selected complementary measures

Conduct internal team review of complementary measures, including emissions reductions, costs, and potential sources of funding

Present SITP complementary measures and their impacts to authorities and stakeholders and obtain feedback to assist in prioritizing measures

Complete prioritization of complementary measures

Summarize results for report

Develop draft chapter

Conduct team member review of draft

Revise chapter, if necessary

5. CALCULATION OF ATMOSPHERIC CONCENTRATIONS

Under this activity, dispersion models will be used with the required inputs to calculate atmospheric concentrations under the SITP and complementary measures. Dispersion models will be developed in consultation with appropriate modeling experts. This activity includes the following sub-activities:

5.1 Identifying air quality model(s), including the following steps:

Work with experts to design the modeling study (background, objectives, schedule, deliverables, etc.)

Work with experts to define the domain and database(s) (applicable preprocessor programs, modeling domain, horizontal grid resolution, sources of data, number of vertical layers, meteorological data, emissions inventory, etc.)

Evaluate model(s) applicability

Train graduate student(s) and/or Uniandes and CAI staff to apply the model

Conduct team review of candidate model(s) and select appropriate model(s)

5.2 Development of initial and boundary air quality conditions by interpolating from measured data, using default background values, and/or using regional scale model predictions. Steps include:

Select the best approach to define the initial and boundary conditions

Compile and pre-process the data to create the air quality input files to the model

5.3 Model application to quantify air quality impacts, including the following steps:

Test run the model to verify expected operation, and explore opportunities to calibrate the model with available data

Refine the model inputs, as necessary

Conduct a diagnostic analysis of the model, including:

- Prepare input files for the model and run the model for the base year
- Use the results of this diagnostic application to establish and improve reliability of the input data and proper functioning of the model
- Develop graphical displays (mapping and time series plots) for quality assurance and diagnostic testing
- Adjust the inputs, if necessary

Run the air quality model with revised inputs, if necessary, for baseline, SITP, and complementary measures scenarios

5.4 Summary of results

Develop draft chapter/report

Conduct team member review of draft

Revise chapter/report, if necessary

6. ESTIMATION OF VARIATIONS IN NOISE POLLUTION

This activity will focus examining the changes in noise pollution from the implementation of SITP.

This activity involves the following steps:

Review and evaluate current literature on noise pollution

Collaborate with a noise pollution expert to review existing data on noise pollution in Bogotá and to identify potential gaps in information

Define the methodology to be used in consultation with the expert, including noise emissions factors from vehicles

Train graduate student(s) in noise pollution modeling related to traffic

Model noise pollution to estimate baseline noise levels for key corridors

Estimate variations in noise pollution associated with implementation of the SITP and complementary measures.

Summarize results for report

Develop draft chapter/report

Conduct team member review of draft

Revise chapter/report, if necessary

7. ASSESSMENT OF PERSONAL EXPOSURE AT THE CORRIDOR LEVEL

This activity will focus on monitoring exposure of individuals to PM and black carbon at the corridor level.

This activity involves the following steps:

Collaborate with a personal exposure monitoring expert to help determine exposure factors in microenvironments in Bogotá associated with traffic and to extrapolate experimental results

Train graduate student(s) in experimental methodologies for monitoring and modeling personal exposure

Conduct field campaign in key corridors

Using modeling tools, evaluate exposure of different populations in each corridor under the SITP and complementary measures identified in earlier activities

Summarize results for report

Develop draft chapter/report

Conduct team member review of draft

Revise chapter/report, if necessary

8. QUANTIFICATION AND VALUATION OF PUBLIC HEALTH EFFECTS

Air quality modeling results will be used to estimate impacts on human health associated with baseline, SITP, and complementary measures. The health effects information will be combined with economic valuation functions to estimate the value of the impacts for each scenario. This activity includes the following sub-activities:

8.1 Identification of health impacts model(s) such as Quality of Life Index, the international version of EPA's BenMAP (Environmental Benefits Mapping and Analysis model), the World Health Organization's Air Quality Impact Assessment Tool (AirQ) or a model developed in Analytica. This activity includes the following steps:

Work with experts to design the modeling study (background, objectives, schedule, deliverables, etc.)

Work with experts to define information requirements

Evaluate model(s) applicability

Train graduate student(s) to apply the model

Conduct team review of candidate model(s) and select appropriate model(s)

8.2 Collection of input data needed to run the health impacts model(s), which includes the following types of data:

The set of concentration-response functions that associate health effects with ambient concentrations of PM

Baseline incidence rates for each health effect to be estimated (incidence rates needed typically include age-specific mortality rates, hospital admission rates, etc.)

Population forecasts at the same geographic resolution (i.e., grid domain) as the air quality model (age specific population data are required for most health effects because most concentration-response functions only apply to a specific age range)

8.3 Model application to quantify health impacts, including the following steps:

Test run the model to verify expected operation, and explore opportunities to calibrate the model with available data

Refine the model inputs, as necessary

Conduct a diagnostic analysis of the model

- Prepare input files for the model and run the model for the base year and a hypothetical control strategy
- Use the results of this diagnostic application to establish and improve reliability of the input data and proper functioning of the model
- Develop graphical displays (mapping and time series plots) for quality assurance and diagnostic testing
- Adjust the inputs, if necessary

Run the health effects model with revised inputs, if necessary, for baseline, SITP, and complementary measures scenarios

8.4 Economic valuation of health effects associated with SITP and complementary measures, including the following steps:

Identify appropriate metrics such as willingness to pay, cost of illness, and income loss that can be used to value health impacts

- Collect data and valuation functions for selected metrics
- Adapt selected valuation functions to Bogotá, if necessary
- Apply valuation functions to health effects model outputs to assess the economic impacts of SITP and complementary measures

8.5 Summary of results

- Develop draft chapter/report
- Conduct team member review of draft
- Revise chapter/report, if necessary

9. CALCULATION OF GHG EMISSIONS REDUCTIONS AND MARGINAL ABATEMENT COST CURVE

The purpose of this activity is to estimate potential reductions of CO₂ emissions from the above measures, and to estimate marginal abatement cost (MAC) curves for each of the measures to identify lowest marginal cost opportunities. These MAC curves should graphically express social costs to reduce GHGs and air pollutants, as well as the total reduction of emissions associated to such costs. Steps include:

- Conduct literature review
- Develop MACs
- Conduct project team review
- Revise MACs, if necessary
- Summarize results for report
- Develop draft chapter/report
- Conduct team member review of draft
- Revise chapter/report, if necessary

10. MEASURES PRIORITIZATION

Under this activity, measures will be prioritized based on the results of analyses described above, including the economic analyses and MAC assessments. This prioritization will allow for the development of a formal implementation plan. This activity involves the following steps:

Apply an optimization model to support a preliminary prioritization of measures

Conduct a workshop with stakeholders, experts, and governmental representatives from other cities to review activities to date and proposed prioritization of measures

Formulate implementation plan, including recommendations for evaluation of progress

11. SUPPORT FOR IMPLEMENTATION OF MEASURES

The focus of this activity is to communicate the benefits of SITP and complementary measures in order to build support for the implementation plan. This activity includes the following steps:

Develop communication plan

Prepare communication materials

Organize a national forum that includes participation of other local governments and universities from cities developing BRT systems

Organize an international forum to present results and to identify potential international and national initiatives/resources that could help foster the proposed plan and replicate similar efforts

DELIVERABLES

REPORT	ACTIVITY NUMBER UNDER CONTRACT	ACTIVITY	DUE DATE
Report 1a:	3.1	Definition of Project Scope Delimitación y presentación del alcance del trabajo	November 24, 2010
Report 1b:	3.2	Definition of Baseline Definición de línea base	December 24, 2010
Report 2:	3.3 and 3.4	Modeling and Definition of Scenarios and; Formulation of Specific Measures Modelación, definición de escenarios y ; Formulación de acciones	February 2011
Report 3:	3.5; 3.6; 3.7; 3.8; 3.9	Calculations of atmospheric concentrations; Calculations of and noise levels; Assessment of personal exposure (*) Quantification and valuation of public health effects Calculation of GHG emission reductions Measures prioritization Cálculo de concentraciones atmosféricas; Cuantificación de beneficios en contaminación auditiva; Evaluación de exposición personal (*); Valoración económica de los beneficios en salud; .Cálculo de reducción de emisiones de GEI; Priorización de Medidas	July 2011
Final Report:	3.10	Support for Implementation of Measures Apoyo a la implementación de medidas	September 2011

* This activity was included after the contract . It is one outcome of Activity 3.1

This calendar and reports are consistent with products agreed under CAI and Uniandes contract with IADB.