NATIONAL ENGINEERING ASSESSMENT OF THE VULNERABILITY OF PUBLIC INFRASTRUCTURE TO CLIMATE CHANGE

Terms of Reference

Approved

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Approved by PIEVC

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INFRASTRUCTURE ENGINEERING ASSESSMENT WORK STATEMENTS

1 PREAMBLE

There is consensus that climatic change is occurring and is affecting engineering works which, in the case of buildings and infrastructure, have life spans of up to several decades. Indications are that the climatic conditions and extreme weather event thresholds will change during the operational life of many infrastructure works. This issue may undermine the validity of current engineering design standards.

The Inter-Governmental Panel on Climate Change (IPCC) defines vulnerability as the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate, including climate variability and extremes. It is a function of the character, magnitude and rate of climate change variation to which a system is exposed, its sensitivity and its adaptive capacity. The vulnerability of public infrastructure will vary according to the type of infrastructure and the level of risk that can be tolerated by the users of that infrastructure. Such information will be an important input to a risk assessment framework to develop and prioritize adaptation strategies for specific works and specific climatic regions.

There is a need to provide an engineering assessment of the vulnerability of Canada's public infrastructure to climate change. It would provide a national and regional picture of the vulnerability of different types of buildings and infrastructure such as dams, water and wastewater systems, pipelines, roads, bridges and other engineering works that encompass urban and rural areas and all representative regions of Canada.

The federal government, through Natural Resources Canada, has committed itself to deliver a national scale assessment of climate change impacts and adaptation in Canada. In the case of engineering infrastructure, there is uncertainty in how to best define and assess its vulnerability to climate change. There will be a need to consult with engineers, scientists and communities. It will require a broad understanding of vulnerability including identification of the regional distribution and magnitude of risks. It will be necessary to assess other external factors to develop holistic approaches that adapt for climate change while responding to other environmental, social and financial factors.

In order to address climate change vulnerability, the engineering profession will ultimately require innovative, yet practical methods that enable effective prioritization and decision-making on adaptation measures for areas and types of infrastructure that have the greatest vulnerability.

The Canadian Council of Professional Engineers established the Public Infrastructure Engineering Vulnerability Committee (PIEVC) to oversee the planning and execution of a broad-based national engineering assessment of the vulnerability of Canadian public infrastructure to changing climatic conditions. This is a priority for the engineering profession since the uncertainty caused by changing climatic conditions may be undermining the meteorological data used to design infrastructure.

The paramount feature of the Engineering Code of Ethics is protection of public safety. The ability of Canada's engineering profession to provide assurance of public safety is compromised when fundamental input design-basis data is uncertain.

The National Engineering Assessment will evaluate the risks to Canadian public infrastructure posed by climate change. In order to determine how to best tackle this large and complex assessment, the PIEVC will execute a scoping and pilot study to provide guidance for the National Engineering Assessment.

It is the intent of the National Engineering Assessment to apply sustainability as a fundamental premise by using, as appropriate, a systems approach to sustainability as a guiding principle. The National Engineering Assessment will not simply focus on changes in infrastructure physical design but will also incorporate a broader perspective that takes into account the triple bottom line. As such, the study will assess infrastructure vulnerability to climate change while maintaining an awareness of the real-world financial, social and environmental limitations affecting infrastructure design, operation and maintenance.

2 DEFINITIONS

In order to guide the National Engineering Assessment PIEVC has developed the following definitions.

2.1 Public Infrastructure

For the purposes of this project, Public Infrastructure is defined as those facilities, networks and assets operated for the collective public benefit including the health, safety, cultural or economic well-being of Canadians, whether operated by government and/or non-government agencies.

2.2 Engineering Vulnerability to Climate Change

For the purposes of this study, engineering vulnerability to climate change is defined as the level of risk of destruction, disruption or deterioration of engineered public infrastructure resulting from changes in the climatic conditions used to establish the engineering design and operational elements and tolerances for the public infrastructure.

3 VISION

Canadian public infrastructure that is designed, operated and maintained in a way that minimizes the risk of destruction, disruption or deterioration due to changing climatic conditions.

The National Engineering Assessment will determine the dimensions, characteristics and extent of the vulnerability of Canadian Public Infrastructure to climate change. Though this process, the engineering assessment will identify key areas of public risk related to climate induced infrastructure failure. Priorities will be established for follow-on work to develop clear guidelines and standards for Canada's professional engineers to support the design, construction and maintenance of safe, reliable and financially sustainable public infrastructure in Canada to meet the challenges of a changing climate.

4 MISSION STATEMENT

PIEVC will assist the engineering profession in gaining an understanding of the implications of climate change on Canadian public infrastructure, ultimately leading to the development of policies, standards and tools to guide Professional Engineers in their day-to-day practice.

The National Engineering Assessment will provide an engineering assessment of the vulnerability of Canadian public infrastructure to climate change with the ultimate objective of developing policies, standards and tools to aid Professional Engineers in their day-to-day practice. The assessment may also assist government agencies in developing regulations and policies necessary to address Canada's climate change vulnerability.

5 OBJECTIVES

The National Assessment will result in:

- Identification of key areas of public infrastructure vulnerability to climate change.
- Identification of existing engineering codes and standards that may require amendment to adequately address climate change.
- Identification of new engineering codes and standards that may be required to adequately address climate change.
- Recommendations regarding the key components of engineering codes and standards and of government regulations to address the vulnerability of engineered systems to climate change.

6 THE ROLE OF PIEVC

The specific objectives of PIEVC are:

- To develop the Terms of Reference for a National Engineering Assessment of the vulnerability of public infrastructure to the impacts of climate change and to oversee the execution of the project;
- To set up and manage the infrastructure expert working groups and report on their work as required;
- To review the recommendations from the infrastructure expert working groups and advise on responses and follow-on work that is required;
- To facilitate the development and/or inclusion of specific best engineering practices that adapt to climate change impacts in appropriate documentation.

During the National Engineering Assessment, PIEVC will establish relevant expert working groups (EWGs) establish priorities and provide direction to the overall assessment process. PIEVC will confirm that the project remains focused on its objectives and will ensure that consistent methodologies and protocols are employed across all elements of the National Engineering Assessment.

7 EXECUTION OF THE NATIONAL ENGINEERING ASSESSMENT

7.1 General Applicability of Protocols

As a first step, the National Engineering Assessment will conduct a Scoping Study of the vulnerability of drainage infrastructure to climate change. Methodologies and protocols developed for the Scoping Study will be generally applied to the National Engineering Assessment. The Scoping Study will also provide recommendations regarding assessment priorities for the National Engineering Assessment. In this way, the Scoping Study will provide a basis for the National Engineering Assessment.

PIEVC believes that potential storm water and drainage infrastructure failure can have common impacts and that there are examples of storm water and drainage infrastructure vulnerability across Canada. Based on this judgment, PIEVC has established storm water and drainage infrastructure vulnerability as the area to be reviewed by the scoping and pilot study.

Pending funding, the Stormwater and Drainage Infrastructure Scoping Study will be conducted over a four month period. A more detailed review of drainage

infrastructure, based on the results of the Scoping Study, will be completed later in 2006.

7.2 The National Engineering Assessment

7.2.1 Infrastructure Assessments

The National Engineering Assessment will comprise a number of smaller elements. The Scoping Study and subsequent review of drainage infrastructure will form one element of the larger project. Other elements will include engineering assessments of other types or areas of public infrastructure. PIEVC will identify the priority areas for the National Engineering Assessment studies.

7.2.2 Expert Working Groups

PIEVC will form a number of expert working groups (EWGs), which will provide direct technical advice for the assessments. Expert working groups may oversee more than one assessment study, depending on the scope of the study.

PIEVC established the Stormwater and Wastewater Expert Working Group (SWEWG) to oversee the Drainage Scoping Study. The SWEWG may be assigned other tasks as work on the National Engineering Assessment progresses.

7.2.3 The Resource and Support Group

PIEVC activities are supported by a Resource and Support Group (RSG). The primary focus of the RSG is to ensure that PIEVC objectives and deliverables are prepared in support of their respective PIEVC members to facilitate timely decision-making at the PIEVC level. Members of the RSG may from time to time become engaged in the review and execution of engineering assessments, as designates of PIEVC.

7.3 Timing

In order to address the exposure of the engineering profession and the needs of stakeholders, it is necessary that the first stages of the National Engineering Assessment be conducted as soon as possible. As a result, PIEVC will plan and execute the National Engineering Assessment generally in parallel to the Scoping Study. The Scoping Study consultant must be aware of this sensitivity and work cooperatively with PIEVC, RSG and SWEWG to ensure that early results from the Scoping Study are available to inform the development of the implementation plan for the National Engineering Assessment.

Work on the National Engineering Assessment will commence with the Scoping Study. However, overarching activities in support of the National Engineering

Assessment will continue in parallel to the Scoping Study. This work will include literature reviews, formation of expert working groups and their initial meetings, prioritization and overall project scoping conducted by PIEVC and the Secretariat.

Early results from the Scoping Study will be used to establish an overall direction for the National Engineering Assessment.

As the study priorities are developed and confirmed by PIEVC, subsequent infrastructure assessments will be initiated. The overall National Engineering Assessment report will be completed by the end of 2007.

8 NATIONAL ENGINEERING ASSESSMENT REPORT

Results from the infrastructure assessment studies will be consolidated into a single overarching report. The report will outline similarities and differences in infrastructure vulnerabilities identified by the studies. Based on this analysis, the report will provide a synthesis of the studies and will provide an overall assessment of the vulnerability of Canadian public infrastructure to climate change.

8.1 The National Engineering Assessment Report Coordinating Committee

PIEVC will form a coordinating committee to directly oversee the writing of the National Engineering Assessment Report. The coordinating committee will comprise the PIEVC Secretariat and two to three members of PIEVC or the RSG.

9 AN INTEGRATED PROCESS

The National Engineering Assessment will comprise a number of integrated activities overseen by PIEVC. This process is depicted in Figure 1.

PIEVC will oversee the National Engineering Assessment; and may continue beyond the completion of the National Engineering Assessment report in order to oversee the implementation of recommendations from that report. PIEVC will also form a number of expert working groups to provide direction to individual infrastructure assessments. Results from each assessment will feed back to PIEVC to inform the overall process and allow PIEVC to make educated decisions about study priorities and direction. Results from the individual assessments will also feed forward to the National Engineering Assessment itself, forming part of the foundation used to formulate conclusions and recommendations. The National Engineering Assessment Report Coordinating Committee will review all of the data to prepare the overarching synthesis report for the process.

Figure 1 is based on potential assessments of three types or areas of infrastructure. However, the National Engineering Assessment may require additional assessments of many other types of infrastructure. This will be determined by PIEVC as the project progresses.

A high level Gantt chart outlining the overall National Engineering Assessment process is presented in Figure 2. The actual timing of assessment studies depends upon funding and the direction of PIEVC as work progresses.

10 INFRASTRUCTURE ASSESSMENT WORK STATEMENTS

Each infrastructure engineering assessment included within National Engineering Assessment will be guided by a dedicated work statement. These work statements will be developed by PIEVC and the EWG overseeing the planning and execution of the infrastructure assessment. As PIEVC and the EWGs develop these Work Statements they will be incorporated within this National Engineering Assessment TOR under Annex A. The complete National Engineering Assessment TOR includes both the main body of this document and the work statements included in Annex A.

11 PROJECT MANAGEMENT

PIEVC, supported by the RSG and its EWGs, will oversee the execution of the infrastructure engineering assessments.

The PIEVC Secretariat will manage contractual arrangements with the consultants.

For the purposes of the National Engineering Assessment and its subsidiary infrastructure assessments PIEVC defines the Consultant as any agency, authority, government department, company or combination thereof with a collective capability to understand climate and engineering vulnerabilities under current and potential future conditions.

For each infrastructure assessment, the Consultant will provide key personnel to oversee each facet of the infrastructure assessment with coordination through a single project manager. The project manager will provide a one-window interface between the Consultant and the PIEVC Secretariat and the associated EWG.

The ideal Consultant will have:

- A pragmatic understanding of engineering practice in commercial and industrial environments;
- Strong operational knowledge of practices in the infrastructure area;
- A fundamental understanding of climate variability and change and its far reaching effects in the Canadian economy;

- Experience in interpreting forensic studies of infrastructure failure, vulnerabilities and risks under climate variability and extremes;
- A solid technical understanding of climate change science, impacts studies and adaptation strategies;
- A detailed understanding of engineering design of the subject infrastructure and its links to climatic design information and its uncertainties;
- Demonstrated ability to generate positive and focused recommendations from engineering assessment analysis; and
- A fundamental understanding of the practice and governance of engineering in Canada.

Figure 1

Overall National Engineering Assessment Execution Process

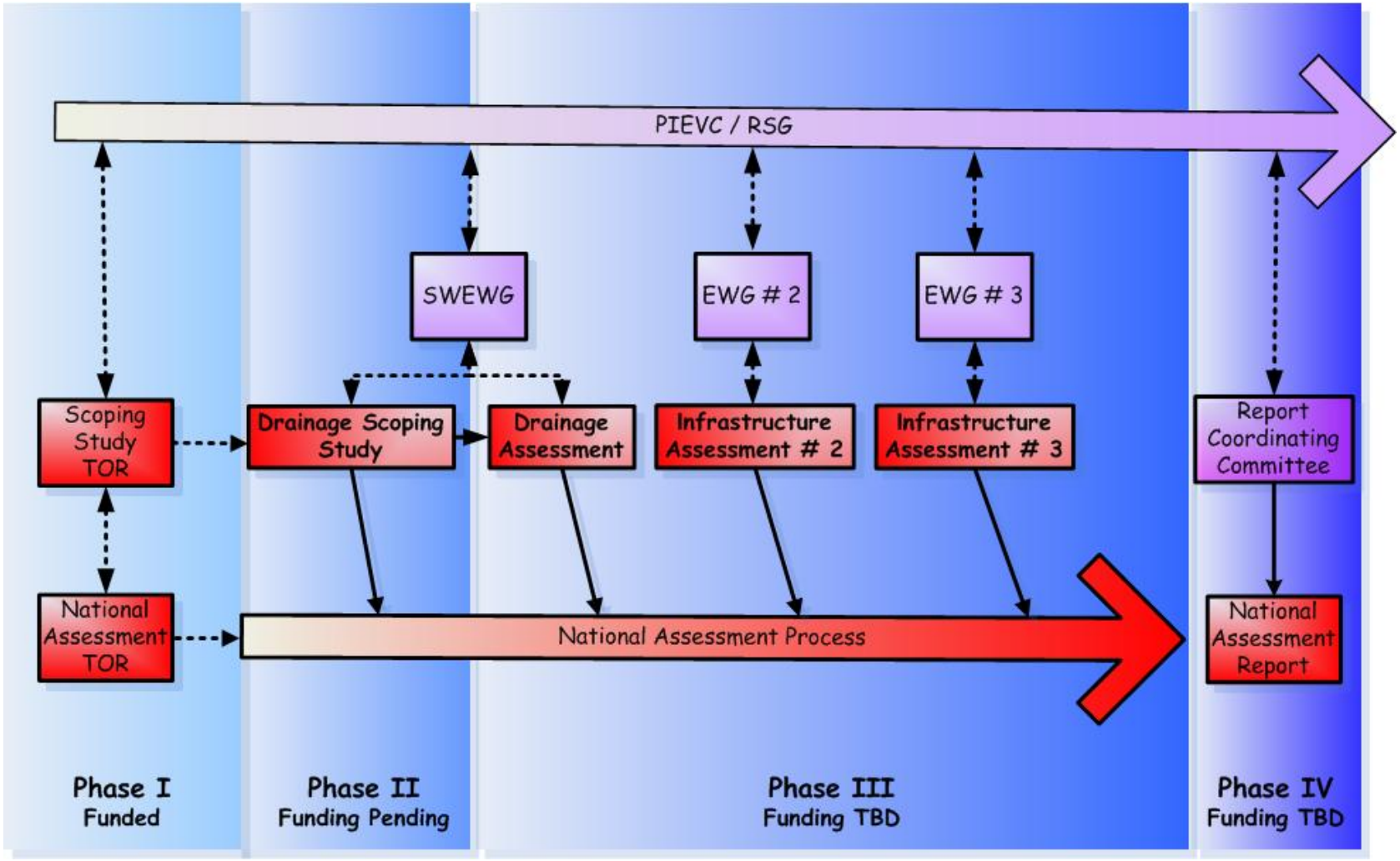

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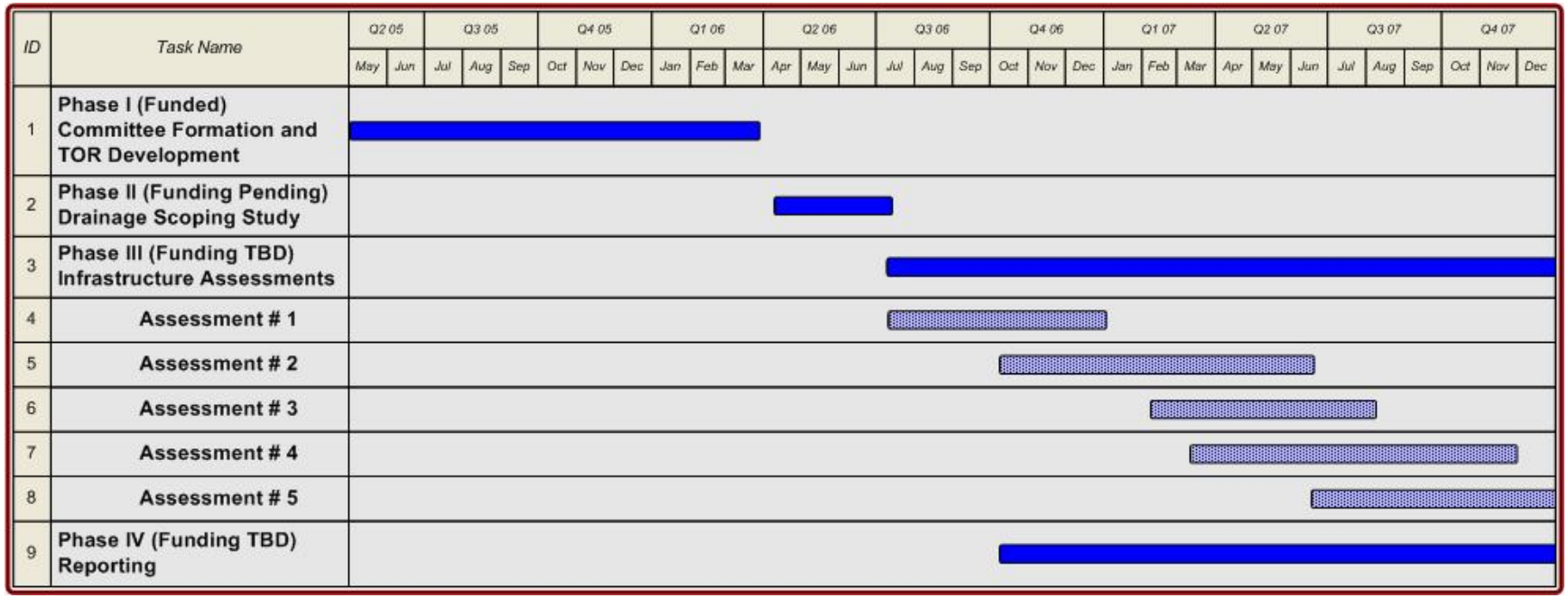
Figure 2

High Level Gantt chart for Overall National Engineering Assessment Process



ANNEX A

INFRASTRUCTURE ASSESSMENT WORK STATEMENTS

1. Scoping and Pilot Study - Storm Water and Drainage Infrastructure Assessment Work Statement – Rev 6 – Approved by PIEVC: March 23, 2006