CLIMATE RESILIENCE MEASURES (SUMMARY)

1. The Pilot Program for Climate Resilience (PPCR) is an integral part of the project that is intended to promote the economic transformation of participating corridor towns in Cambodia by improving priority infrastructure and building institutional capacity. The PPCR has supported "Climate Proofing Infrastructure in the Southern Economic Corridor (SEC) towns" as part of its first batch of assistance to Cambodia. The selection of prioritized subsectors has been undertaken by TA 7644-REG GMS Corridor Towns Development Project and the priority list includes (i) Battambang Wastewater Treatment, (ii) Battambang Flood Control, (iii) Bavet Wastewater Treatment, (iv) Neak Loeung Flood Protection, and (v) Poipet Wastewater Treatment.

2. The outcome of the project is the safe; climate-resilient; cost-effective; all-year operational; flood-proof; and separated wastewater system with treatment plants in Battambang, Bavet, and Poipet. The flood control subproject project in Battambang will protect two selected areas against erosion and flooding. In Neak Loeung the outcome is flooding protection of 363 hectares (ha) of land and a safe access road on the top of the flood protection dike.

3. The PPCR funding will be a loan of $5 million and a grant of $4.4 million with project preparatory of $600,000 additional funding for TA 7644-REG. The preparatory cost of $600,000 is deducted from the $5 million grant.

A. Possible Impacts of Climate Change

4. Possible impacts of climate change in the project areas have been assessed based on review and analysis of data from various sources. The proposed figures for climate change related variances to temperature, precipitation and river flow are as follows:

- A general temperature increase of 0.7ºC
- An average precipitation increase of 0%–5% (5% at Battambang, Poipet, and Bavet and 0% at Neak Loeung)
- An increase of annual flows in Mekong between Phnom Penh and Neak Loeung of 5% (no change during the wet season and 20%–40 % increase during the dry season).
- Changes to the water level at individual locations have to be estimated based on local conditions.

5. The most appropriate basis for climate change considerations for this project is judged to be the overview of expected consequences of climate change during the period 2020–2050 given by the Mekong River Commission (MRC). The main predictions reported by the MRC are the following:

- The mean annual temperature is expected to increase by 0.7ºC over the entire Mekong basin; 0.9ºC for the Upper Mekong and 0.7ºC for the Lower Mekong.
- The mean annual rainfall is expected to increase by 5% over the entire Mekong basin, except in Cambodia and the Mekong Delta. The increase may reach 10% for the Upper Mekong, while Cambodia and the Mekong Delta will have unchanged or even up to 8% decreased rainfall. The largest increase is expected in the wet season, but will also occur in the dry season in Upper Mekong.
- The river flow of Mekong is expected to increase by 4%–13% in the wet season and by 10%–30% in the dry season. The largest increases will appear from the Chinese border to Kratie in Cambodia.

- The snow melt contribution from Upper Mekong is expected to increase and to start earlier because of the increased temperatures.
- The increased flow in the Mekong River will improve water availability in the dry season, but also increase the risk of flooding in the wet season. The low-lying areas downstream of Kratie to the Mekong Delta including the Tonle Sap area are expected to be particularly at risk. The areas affected by flooding due to rainfall and upstream flow from Mekong are estimated to increase by 9%, not including effects of a possible sea level rise. Areas with flooding depths higher than two meters are estimated to increase by almost 40%.
- The storage capacity of hydropower installations may potentially reduce impacts of flooding in some areas. The Lower Mekong Basin 20-year development plan alone estimates a decrease of the wet season river flow by 7%–17%, while the climate change scenarios for this season estimates an increase of the flow by 2%–11%. The combined effect is expected to vary between a decrease of 13% to an increase of 3%.
- During dry season the development plan alone estimates a decrease of wet season river flow by 30%–60%, while the climate change scenarios for this season estimates an increase of the flow by 18%–30%. The combined effect is expected to be an increase of 40%–76%.
- There is a high degree of uncertainty related to both the climate change scenarios and the different development plans in the basin.

B. Vulnerability of Cambodia and the project towns to Climate Change Impacts

6. The subprojects will improve flood risk management in Cambodia by strengthening the capacity of the government and the involved communities in preparing for, responding to, and recovering from the impacts of flood. It will emphasize risk reduction strategies aimed at preventing flood events from becoming disasters for the affected population. It will also build on coping strategies and mechanisms of communities and promote community-based disaster risk reduction and management.

7. The outcome of the subprojects will be improved preparedness to manage and reduce the impacts of flood events. The reduction of risks associated with flood events will enable the communities in the Project towns to benefit substantially from the subprojects by (i) avoidance of loss of properties and reduced causalities (deaths, injuries and water-borne diseases during and after floods); (ii) increased agricultural productivity; (iii) improved access to rural roads and canals; and (iv) reduction of economic losses from disruption of business and agricultural activities.

C. Measures for Climate Resilience

8. The output will seek to strengthen the outcome of the project to provide safe, cost effective, climate-resilient all-year access roads, wastewater systems, flood control systems and other infrastructure from the impacts of climate change and climate variability, and piloting adaptation measures to protect the wastewater and flood protection facilities against long-term risks posed by climate change.

9. **Output 1: Poipet Wastewater Treatment**. The climate resilience of civil works in Poipet, susceptible to flooding, is improved by adjustments to the design of the separate sewerage network system, wastewater treatment plant (WWTP) and storm water canals by minimizing use of moisture susceptible materials or using hydraulically stabilized materials on

the dikes around the treatment ponds. This will ensure that structural layers do not lose significant strength during flooding and soaking cycles. The manholes, pumping stations for sewerage and flood protection dikes must be of watertight construction in order to withstand the design flood level.

10. The subproject is considered a climate resilience adaptation measure to reduce adverse impact of climate change risk through the construction and rehabilitation of storm drains leading to natural streams and the river adjacent to the WWTP. Adaptation to flooding caused by climate change for the sewerage systems facilities such as the storm water drainage canals, WWTP and related structures will in general be designed to accommodate a 50-year return period and adjusted with a Climate Change compensation due to expected increase in annual precipitation of 5%.

11**.** **Output 2: Battambang Wastewater Treatment**. The subproject consists of separate facilities for sewage water and storm water management, made of different components which need to be safeguarded against normal flooding and increased flooding due to climate change. The pipe system including chambers and pump stations must be of watertight construction and the level of the top of the structures must be higher than the flood level at a 50 year recurrence event plus a climate change portion of extra freeboard to accommodate 5% increased annual precipitation in the future. If the WWTP is subjected to severe flooding it needs to be designed and constructed to handle the risk for extreme flooding. As the WWTP is based on open ponds surrounded by dikes, risk for bank erosion of the dikes must also be taken into consideration.

12. The climate resilience of civil works in Battambang, susceptible to flooding, is improved by adjusting the design of the separate sewerage network system, WWTP and storm water canals by minimizing use of moisture susceptible materials or using hydraulically stabilized materials on the dikes around the treatment ponds. This will ensure that structural layers do not lose significant strength during flooding and soaking cycles. The manholes, pumping stations for sewerage and flood protection dikes must be of watertight construction in order to withstand the design flood level.

13. **Output 3: Bavet Wastewater Treatment.** If the subproject is subjected to severe flooding, it needs to be designed and constructed with due regard for flood risks. As the WWTP is based on open ponds surrounded by dikes, the risk for bank erosion of the dikes must also be taken into consideration. The climate resilience of civil works in Bavet, susceptible to flooding, is improved by adjustments to the design of the separate sewerage network system, WWTP and storm water canals by minimizing use of moisture susceptible materials or using hydraulically stabilized materials on the dikes around the treatment ponds. This will ensure that structural layers do not lose significant strength during flooding and soaking cycles. The manholes, pumping stations for sewerage and flood protection dikes must be of watertight construction in order to withstand the design flood level.

14. The subproject is considered a climate resilience adaptation measure to reduce adverse impact of climate change risk through the construction and rehabilitation of storm drains leading to natural streams and the river adjacent to the WWTP. Adaptation to flooding caused by climate change for the sewerage systems facilities such as the storm water drainage canals, WWTP and related structures will in general be designed to accommodate a 50 year return period and adjusted with a Climate Change compensation due to expected increase in annual precipitation of 5%.

15. **Output 4: Neak Loeung Flood Protection.** The subproject is considered a climate resilience adaptation measure as it reduces adverse impact of climate risk through the construction of flood protection measures that prevents perennial flooding of the 363 hectare area. This area is located in the eastern section of the town center which will be developed as the expansion area of the urban centre for commercial and business establishments and urban housing programme. Adaptation of climate change for the flood control structures and storm water pumps including the access road will in general be designed according to a 50-year recurrence period and adjusted with a Climate Change compensation to accommodate an expected increase in annual precipitation of 5%.

16. Socio-economic benefits will accrue to more than 40% of the local population since the subproject will mitigate the annual flood events and minimize health risks due to unsanitary environmental conditions. It will also enhance economic activities to benefit the local business and commercial establishments. The flood protection dikes minimize physical damages to the households where women play critical roles. It will also reduce the exposure of women and children to water-borne infections (WBI) from the overflow of open drainage canals and leaking of sewerage pipes which often carry both storm water run-offs and wastewater.

17. **Output 5: Battambang Flood Control.** Frequent flooding in the western and eastern parts of Sangke River adversely affects the economic activities of inhabitants of residential and commercial areas. Flooding that occurs in more than five days have resulted in very unsanitary living conditions in the town centre and in the sub-urban areas of Battambang. Most of the major urban roads including the town centre are flooded during the June to October period. On the western side of Sangke River, an embankment protection structure will be constructed with a length of 100 meters. This area was selected from among several candidate areas and given high priority for flood protection as it is annually affected by severe erosion by Sangke River. The flood control structure will curb erosion and reduce the negative impact for the area.

18. The subproject is considered a climate resilience adaptation measure as it reduces adverse impact of climate risk through the construction of flood protection measures that prevents perennial flooding of the Sangkat Rattanak and erosion of the river bank at Apsara Market. Adaptation of climate change for the flood control structures and storm water pumps including the access road will in general be designed according to a 50-year recurrence period and adjusted with a Climate Change compensation to accommodate an expected increase in precipitation of 5%.

D. Climate Resilience Activities

19. Overall, climate resilience activities will seek to strengthen the outcome of the Project in providing cost effective, climate-resilient measures in the four corridor towns by adapting the proposed infrastructure to the impacts of climate change and climate variability. These activities fall under two Project output categories; (i) subproject infrastructure adapted to extreme weather conditions due to climate change and (ii) increased resilience of project infrastructure to long term climate change. Factors considered in making engineering adjustments included cost-effectiveness, current climate variability and potential future risk. It is important to note that existing climate change impact assessments are insufficient for scientifically supported probability analyses of future climate change. Therefore, the civil engineering adjustments required to meet such expected future conditions are difficult to calculate quantitatively. A margin of safety has been introduced by instead applying a risk factor.

20. One of the essential deliverables will be a vulnerability map, based on an agreed set of physical and socio-economic indicators. The following may be relevant: (i) climate change trends and projections; (ii) impacts of climate changes on hydrology, ecology, and soil; (iii) natural environment including topography, geology, land use, and climate hazards; (iv) social environment including poverty levels and population density; (v) physical environment; and (vi) hazards risk mapping.

21. An important activity will be to review the sustainability and capacity of the executing agency's (EA) current engineering designs, standards and guidelines to withstand climate change and propose amendments. The Ministry of Public Works and Transport (MPWT) currently uses a set of standards and guidelines for engineering design which do not consider long-term implications of climate changes. MPWT should review its requirements, standards and guidelines on learning from this project and expertise. It is also important to design and implement training programs for the EA staff on the science and implications of climate change on the countries' infrastructure.

E. Implementation Arrangements

22. The EA will implement the PPCR through project management unit (PMUs) established by the EA. A Climate Change Adaptation Specialist will be engaged through the Project Implementation Support (PIS) Consultant and will work in the detailed engineering design (DED) team to develop the technical solutions and bidding documents for the defined civil works. The sustainability of the project will be secured by providing trainings in the EAs, by integrating climate change adaptation into engineering tools and guidelines and by producing vulnerability maps to assist with planning and engineering.

23. There will be two climate resilience packages, (i) additional adaptational civil works and (ii) consulting services securing this. The implementation of activities will be undertaken by the PIS consultant led by a team leader to oversee the work of all experts hired under the consulting service. The team leader will work closely with the PMU and the Project DED consultants for activities financed under the PPCR. The team leader will be responsible for coordinating activities and with other ADB- and PPCR-financed components, through the PMUs.