APPENDIX 5 Reference of Environmental and Social Consideration

5 - 1 IEE Scoping Matrix

5 - 2 Environmental Mitigation Measures

5 - 3 Environmental Management Plan (EMP)

5 - 4 Environmental Monitoring Plan

5 - 5 Result of Water Quality Monitoring

5 - 6 Equipment and Reagents for Water Quality Tests

【Appendix 5: Reference of Environmental and Social Consideration】

Appendix 5-1-(1): IEE Scoping Matrix for Bridge No.1 (RDA Bridge No.240/4)

	No.	Likely Impacts	Overall Rating	Design Phase		Construction Phase						Operation Phase		
				Land acquisition	Change of Land use plan, Control of various activities by regulations for theconstruction	Reclamation of Wetland, etc.	Deforestation	Alteration to ground by cut land, filling, drilling, tunnel, etc.	Operation of Construction Equipment and Vehicles	Construction of Roads, tollgates, parking lots, Access roads for bridges and other related facilities	Traffic Restriction in construction area	Increase of Through Traffic	Appearance/ Occupancy of Roads and related building structures	Increasing influx of settlers
Social Environment: *Regarding the impacts on "Gender" and "Children's Right", might be related to all criteria of Social Environment.	1	Involuntary Resettlement	D	D										D
	2	Local economy such as employment and livelihood, etc.	D	D	D		D	D	D		D	D	D	D
	3	Land use and utilization of local resources	B	D	D				D	D	B			D
	4	Social institutions such as social infrastructure and local decision-making institutions	D	D	D					D	D		D	D
	5	Existing social infrastructures and services	D	D	D				D		D			
	6	The poor, indigenous and ethnic people	D	D	D					D	D			D
	7	Misdistribution of benefit and damage	D	D	D						D		D	D
	8	Cultural heritage	D	D	D					D				D
	9	Local conflict of interests	D	D	D					D	D		D	D
	10	Water Usage or Water Rights and Rights of Common	D	D	D									
	11	Sanitation	D							D				
	12	Hazards (Risk) Infectious diseases such as HIV/AIDS	D							D				D
Natural Environment	13	Topography and Geographical features	D					D		D				
	14	Soil Erosion	D					D		D				
	15	Groundwater	D					D						
	16	Hydrological Situation	D					D		D				
	17	Coastal Zone	D											
	18	Flora, Fauna and Biodiversity	B					B	D	D			D	D
	19	Meteorology	D							D				
	20	Landscape	D					D		D			D	D
	21	Global Warming	D											
Pollution	22	Air Pollution	D						D	D		D		
	23	Water Pollution	B					D	B	D				D
	24	Soil Contamination	D					D	D	D		D		D
	25	Waste	B					B	B	D				D
	26	Noise and Vibration	B					D	B	D		D		
	27	Ground Subsidence	D					D		D				
	28	Offensive Odor	D							D				
	29	Bottom sediment	D							D				
	30	Accidents	D					D	D			D		D

Rating:
A: Serious impact is expected. B: Some impact is expected. C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses.) D: No impact is expected. IEE/EIA is not necessary.
Reference:
Japan International Cooperation Agency (1992) "III Roads Environmental Guidelines for Infrastructure Projects", Tokyo, Japan.

Appendix 5-1-(2): IEE Scoping Matrix for Bridge No.2 (RDA Bridge No.241/2, 241/3,241/4)

	No.	Likely Impacts	Overall Rating	Design Phase		Construction Phase						Operation Phase		
				Land acquisition	Change of Land use plan, Control of various activities by regulations for the construction	Reclamation of Wetland, etc.	Deforestation	Alteration to ground by cut land, filling, drilling, tunnel, etc.	Operation of Construction Equipment and Vehicles	Construction of Roads, tollgates, parking lots, Access roads for bridges and other related facilities	Traffic Restriction in construction area	Increase of Through Traffic	Appearance/ Occupancy of Roads and related building structures	Increasing influx of settlers
Social Environment: *Regarding the impacts on "Gender" and "Children's Right", might be related to all criteria of Social Environment.	1	Involuntary Resettlement	D	D										D
	2	Local economy such as employment and livelihood, etc.	D	D	D		D	D	D		D	D	D	D
	3	Land use and utilization of local resources	B	D	D				D	D	B			D
	4	Social institutions such as social infrastructure and local decision-making institutions	D	D	D					D	D		D	D
	5	Existing social infrastructures and services	D	D	D				D		D			
	6	The poor, indigenous and ethnic people	D	D	D					D	D			D
	7	Misdistribution of benefit and damage	D	D	D						D		D	D
	8	Cultural heritage	D	D	D					D				D
	9	Local conflict of interests	D	D	D					D	D		D	D
	10	Water Usage or Water Rights and Rights of Common	D	D	D									
	11	Sanitation	D							D				
	12	Hazards (Risk) Infectious diseases such as HIV/AIDS	D							D				D
Natural Environment	13	Topography and Geographical features	D					D		D				
	14	Soil Erosion	D					D		D				
	15	Groundwater	D					D		D				
	16	Hydrological Situation	D					D		D				
	17	Coastal Zone	D											
	18	Flora, Fauna and Biodiversity	B					B	D	D			D	D
	19	Meteorology	D							D				
	20	Landscape	D					D		D			D	D
	21	Global Warming	D											
Pollution	22	Air Pollution	D						D	D		D		
	23	Water Pollution	B					D	B	D				D
	24	Soil Contamination	D					D	D	D		D		D
	25	Waste	B					B	B	D				D
	26	Noise and Vibration	B					D	B	D		D		
	27	Ground Subsidence	D					D		D				
	28	Offensive Odor	D							D				
	29	Bottom sediment	D							D				
	30	Accidents	D					D	D			D		D

Rating:
A: Serious impact is expected. B: Some impact is expected. C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses.) D: No impact is expected. IEE/EIA is not necessary.
Reference:
Japan International Cooperation Agency (1992) "III Roads Environmental Guidelines for Infrastructure Projects", Tokyo, Japan.

Appendix 5-1-(3): IEE Scoping Matrix for Bridge No.3 (RDA Bridge No.247/2)

	No.	Likely Impacts	Overall Rating	Design Phase		Construction Phase						Operation Phase		
				Land acquisition	Change of Land use plan, Control of various activities by regulations for the construction	Reclamation of Wetland, etc.	Deforestation	Alteration to ground by cut land, filling, drilling, tunnel, etc.	Operation of Construction Equipment and Vehicles	Construction of Roads, tollgates, parking lots, Access roads for bridges and other related facilities	Traffic Restriction in construction area	Increase of Through Traffic	Appearance/ Occupancy of Roads and related building structures	Increasing influx of settlers
Social Environment: *Regarding the impacts on "Gender" and "Children's Right", might be related to all criteria of Social Environment.	1	Involuntary Resettlement	D	D										D
	2	Local economy such as employment and livelihood, etc.	D	D	D		D	D	D		D	D	D	D
	3	Land use and utilization of local resources	B	D	D			D		B				D
	4	Social institutions such as social infrastructure and local decision-making institutions	D	D	D						D		D	D
	5	Existing social infrastructures and services	B	D	D			B	D	B	D			
	6	The poor, indigenous and ethnic people	D	D	D					D				D
	7	Misdistribution of benefit and damage	D	D	D					D	D		D	D
	8	Cultural heritage	D	D	D					D				D
	9	Local conflict of interests	D	D	D					D	D		D	D
	10	Water Usage or Water Rights and Rights of Common	D	D	D			D		D				
	11	Sanitation	D							D				
	12	Hazards (Risk) Infectious diseases such as HIV/AIDS	D							D				
Natural Environment	13	Topography and Geographical features	D					D		D				
	14	Soil Erosion	D			D		D		D				
	15	Groundwater	D					D		D				
	16	Hydrological Situation	B					B		D				
	17	Coastal Zone	D											
	18	Flora, Fauna and Biodiversity	D				D	D	D	D			D	D
	19	Meteorology	D							D				
	20	Landscape	D					D		D			D	D
	21	Global Warming	D							D				
Pollution	22	Air Pollution	D						D	D		D		
	23	Water Pollution	B					B		D				D
	24	Soil Contamination	D					D	D	D		D		D
	25	Waste	B					B	B	B				D
	26	Noise and Vibration	B					D	B	B		D		
	27	Ground Subsidence	D					D		D				
	28	Offensive Odor	D						D					
	29	Bottom sediment	D					D		D				
	30	Accidents	D					D	D			D		D

Rating:
A: Serious impact is expected. B: Some impact is expected. C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses.) D: No impact is expected. IEE/EIA is not necessary.
Reference:
Japan International Cooperation Agency (1992) "III Roads Environmental Guidelines for Infrastructure Projects", Tokyo, Japan.

Appendix 5-1-(4): IEE Scoping Matrix for Bridge No.4 (RDA Bridge No.283/7)

	No.	Likely Impacts	Overall Rating	Design Phase		Construction Phase						Operation Phase		
				Land acquisition	Change of Land use plan, Control of various activities by regulations for the construction	Reclamation of Wetland, etc.	Deforestation	Alteration to ground by cut land, filling, drilling, tunnel, etc.	Operation of Construction Equipment and Vehicles	Construction of Roads, tollgates, parking lots, Access roads for bridges and other related facilities	Traffic Restriction in construction area	Increase of Through Traffic	Appearance/ Occupancy of Roads and related building structures	Increasing influx of settlers
Social Environment: *Regarding the impacts on "Gender" and "Children's Right", might be related to all criteria of Social Environment.	1	Involuntary Resettlement	D	D										D
	2	Local economy such as employment and livelihood, etc.	D	D	D		D	D	D		D	D	D	D
	3	Land use and utilization of local resources	B	D	D			B	D	D				D
	4	Social institutions such as social infrastructure and local decision-making institutions	D	D	D						D		D	D
	5	Existing social infrastructures and services	D	D	D				D		D			
	6	The poor, indigenous and ethnic people	D	D	D		D							D
	7	Misdistribution of benefit and damage	D	D	D		D				D		D	D
	8	Cultural heritage	D	D	D			D		D				D
	9	Local conflict of interests	D	D	D			D	D	D	D		D	D
	10	Water Usage or Water Rights and Rights of Common	D	D	D			D						
	11	Sanitation	D						D	D				
	12	Hazards (Risk) Infectious diseases such as HIV/AIDS	D							D				
Natural Environment	13	Topography and Geographical features	D					D	D					
	14	Soil Erosion	D			D	D			D				
	15	Groundwater	D					D						
	16	Hydrological Situation	D							D				
	17	Coastal Zone	D											
	18	Flora, Fauna and Biodiversity	D			D	D	D	D	D			D	D
	19	Meteorology	D							D				
	20	Landscape	D			D	D	D		D			D	D
	21	Global Warming	D				D			D				
Pollution	22	Air Pollution	D						D	D		D		
	23	Water Pollution	B			D	D	D	B	D				D
	24	Soil Contamination	D					D	D	D		D		D
	25	Waste	B					D	B	B				D
	26	Noise and Vibration	B				D	D	B	B		D		
	27	Ground Subsidence	D					D		D				
	28	Offensive Odor	D						D					
	29	Bottom sediment	D					D		D				
	30	Accidents	D					D	D			D		D

Rating:
A: Serious impact is expected. B: Some impact is expected. C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses.) D: No impact is expected. IEE/EIA is not necessary.
Reference:
Japan International Cooperation Agency (1992) "III Roads Environmental Guidelines for Infrastructure Projects", Tokyo, Japan.

Appendix 5-1-(5): IEE Scoping Matrix for Bridge No.5 (RDA Bridge No.59/1)

	No.	Likely Impacts	Overall Rating	Design Phase		Construction Phase						Operation Phase		
				Land acquisition	Change of Land use plan, Control of various activities by regulations for the construction	Reclamation of Wetland, etc.	Deforestation	Alteration to ground by cut land, filling, drilling, tunnel, etc.	Operation of Construction Equipment and Vehicles	Construction of Roads, tollgates, parking lots, Access roads for bridges and other related facilities	Traffic Restriction in construction area	Increase of Through Traffic	Appearance/ Occupancy of Roads and related building structures	Increasing influx of settlers
Social Environment: *Regarding the impacts on "Gender" and "Children's Right", might be related to all criteria of Social Environment.	1	Involuntary Resettlement	D	D										D
	2	Local economy such as employment and livelihood, etc.	D	D	D		D	D	D		D	D	D	D
	3	Land use and utilization of local resources	B	D	D			B	D					D
	4	Social institutions such as social infrastructure and local decision-making institutions	D	D	D				D	D	D	D	D	D
	5	Existing social infrastructures and services	D	D	D				D		D			
	6	The poor, indigenous and ethnic people	D	D	D					D	D			D
	7	Misdistribution of benefit and damage	D	D	D						D		D	D
	8	Cultural heritage	D	D	D			D						D
	9	Local conflict of interests	D	D	D				D	D	D		D	D
	10	Water Usage or Water Rights and Rights of Common	D	D	D									
	11	Sanitation	B						B					
	12	Hazards (Risk) Infectious diseases such as HIV/AIDS	D							D				D
Natural Environment	13	Topography and Geographical features	D					D						
	14	Soil Erosion	B					B		D				
	15	Groundwater	D					D						
	16	Hydrological Situation	D					D		D				
	17	Coastal Zone	B				D	B						
	18	Flora, Fauna and Biodiversity	B				D	B	D	B			D	D
	19	Meteorology	D							D				
	20	Landscape	D				D	D		D			D	D
	21	Global Warming	D											
Pollution	22	Air Pollution	D						D			D		
	23	Water Pollution	B				D	D	B	B				D
	24	Soil Contamination	D					D	D	D		D		D
	25	Waste	B					B		B				D
	26	Noise and Vibration	B					D	B	D		D		
	27	Ground Subsidence	D					D		D				
	28	Offensive Odor	D						D					
	29	Bottom sediment	D					D		D				
	30	Accidents	D					D	D			D		D

Rating:
A: Serious impact is expected. B: Some impact is expected. C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses.) D: No impact is expected. IEE/EIA is not necessary.
Reference:
Japan International Cooperation Agency (1992) "III Roads Environmental Guidelines for Infrastructure Projects", Tokyo, Japan.

Appendix 5-2-(1) Environmental Mitigation Measures (EMM)-1

Environmental Impact Component		Mitigation Measures	Location
SOCIAL ENVIRONMENT			
Loss of access	1.	Temporary bypasses will be constructed and maintained during the construction period, particularly at bridge crossings.	All 5 Bridge Locations.
Traffic Jams and congestion	2.	If there are traffic jams during construction, measures will be taken to relieve the congestion through better coordination between the contractor, the RDA, and the Police Department.	Near urban areas. Bridge. No.4
Road safety; collisions between vehicles, people and livestock	3.	Control speed of construction vehicles through road safety education and fines.	All 5 Bridge Locations.
	4.	Allow for adequate traffic flow around construction sites.	
	5.	Provide adequate signage, barriers and flag persons for traffic control.	
	6.	Communicate to the public through radio, TV, and newspaper announcements regarding the scope and timeframe of projects, as well as certain construction activities causing disruptions or access restrictions.	
Deterioration of health of workers due to poor camp conditions	7.	Make certain that there is good drainage at all construction areas, to avoid creation of stagnant water bodies.	Construction camps
	8.	Provide adequate sanitation and waste disposal at construction camps.	
	9.	Provide adequate health care for workers and locate camps away from sensitive areas. HIV/AIDS awareness for the workers	
Littering with waste construction materials	10	All construction materials will be reused, recycled or properly disposed of. This will become particularly important at the bridge and culvert replacement sites, where demolished concrete will need to be properly disposed of. All worn out parts, equipments and empty containers will be removed from the site to a proper storage location designated by the District office of the Local government.	All 5 Bridge Locations.
Sanitation and Waste Disposal in Construction Camps	11	Sufficient measures will be taken in the construction camps, i.e., provision of garbage bins and sanitation facilities. All sewage sources or toilet facilities will be at least 300m from existing residences. Prior to initiation work, the contractor will present a simple sewage management plan to Engineer for approval.	Construction camp lease area
Sanitation and Waste Disposal in Construction Camps	12	Drinking water will meet national portable water standards.	
	13	Solid waste and garbage will be collected in bins and disposed of daily, according to a basic waste management plan prepared by the contractor and approved by Engineer, prior to the commencement of civil works.	
NATURAL ENVIRONMENT			
WATER Alteration of Drainage	14	In sections along watercourses, earth and stones will be properly disposed of so that they do not block channels and streams, resulting in adverse impact on water quality and flow regime.	All 5 Bridge Locations.
	15	All necessary measures will be taken to prevent earthworks and stone works related to the access road from impeding cross drainage at channels/ streams or existing irrigation and drainage systems. 'Side-borrow' sites will be used as drainage ditches and designed such that they drain into the nearest water course.	
Stagnant water as insect-borne disease vectors	16	The formation of standing waters on construction sites in the areas often leads to the spread of insect-borne diseases. Therefore there will be a vigorous program by the contractor to avoid such standing water. The RDA/PMU/ESD/ users will be given information about the dangers of waterborne diseases such as malaria in standing water and how to prevent them.	

Appendix 5-2-(2) Environmental Mitigation Measures (EMM)-2

Environmental Impact Component		Mitigation Measures	Location
NATURAL ENVIRONMENT			
WATER Siltation	17	Construction materials containing fine particles should be stored in an enclosure such that sediment-laden water does not drain into nearby watercourses, but rather percolates slowly into the soil.	All 5 Bridge Locations.
Contamination of Water Body or Surface Drainage	18	The bridge replacement and pavement the severe possible water quality impact could come from spilled bitumen or any petroleum products used to thin the bitumen. Bitumen is stored in drums which may leak or which are often punctured during handling after long periods (>6 months in the elements) of storage. No bitumen will enter either running or dry stream-beds and none can be disposed of in ditches of small waste disposals sites prepared by the constructor. Bitumen storage and mixing areas will be properly handled according to the national acceptable standards. As a minimum, these areas will be contained, such that any spills can be immediately contained and cleaned up. Prior to initiating the work, the contractor will meet with the RDA/PMU/ESD to determine the proper sitting of the mixing areas and the handling and management of such spills. Any petroleum products used in the preparation of the bitumen mixture will also be carefully managed to avoid spills and contamination of the local water table.	Construction Site
SOIL: Soil Erosion	19	On slopes and other potentially erodible places along the roadside, appropriate vegetation that retards erosion will be planted.	Water Cross and Sections where fill heights are more than three meters
	20	On sections with high filling and deep cutting, the slopes will be protected by stone walls or masonry and planted with appropriate vegetation.	
Soil: Loss of topsoil	21	Arable lands should not be used as earth borrowing or storage sites whenever possible. If needed, the topsoil (15 cm or so) will be kept and refilled after excavation is order to minimize the impact on productive lands.	Along corridor
	22	It may be necessary to construct new access roads to quarry and borrow sites, and place them through agricultural lands. These temporary roads will be made along existing farm tracks so as to avoid losses to agricultural lands.	Nearby quarry and borrow sites.
Soil: Borrow area Recovery of ground form	23	Borrow area should be recovered at edge of excavated pits properly as original ground form after finish of borrow material extraction activities, these excavated edges of the pits should be moderated its form and slope to avoid local peoples and animals falling into the pits also recover continuity of surrounding landscape. Proper drainage system should be provided for avoiding stagnant of water.	Borrow areas
Compaction of Soil	24	Construction vehicles should operate within the Corridor of impact to avoid damaging soil and vegetation at cultivation area. It will be most important to avoid soil compaction around trees. Generally the rule will be to avoid driving heavy equipment or trucks anywhere into the ' drip-line ' of a tree.	Area near to the Bridge
FLORA: Loss of trees	25	A tree-cutting and replanting scheme will be prepared by the contractor and Engineer before commencement of the civil works. Tree clearing within the ROW of A005 and A015 will be avoided beyond what is directly required for construction activities and what will be removed to reduce accidents. A replanting scheme will be developed by Engineer and the Contractor, within the appropriate time period.	Area of Tree Plantations along roadsides.

Appendix 5-2-(3) Environmental Mitigation Measures (EMM)-3

Environmental Impact Component		Mitigation Measures	Location
NATURAL ENVIRONMENT			
FAUNA	26	Construction workers will be told to protect natural resources and wild animals, especially migrating birds. Hunting is strictly prohibited.	Vicinity of construction area
	27	Stream crossings that are dry during the work period will be kept unobstructed at all times, since during the monsoon periods these dry river beds become irrigations channel areas for local residents. Materials are not to be borrowed from this river and stream beds.	
	28	In the A005 corridor, during road construction existing channel and stream may have to be moved back away from the carriageway, and if so this will be done with great care to make sure that the natural water movement (in terms of flow and volume) is maintained.	
POLLUTION			
Dust/ Odor	29	Water will be sprayed during the construction phase in any mixing area where dry materials are handled and/ or crushed. Temporary access roads to Quarry and borrow sites will be included in the dust suppression program. A spraying schedule will be prepared by the contractor and will serve as the basis of a dust control program. RDA/PMU/ESD/Consultants will monitor this schedule should problems arise.	Vicinity of construction area
	30	Vehicles delivering materials to and from the construction sites will be covered to reduce spills.	
Dust/ Odor	31	Asphalt application will be heated liquid bitumen sprayed onto an aggregate base. Bitumen preparation sites will be noisy, with some odor and a considerable risk of fire. Therefore all bitumen preparation and loading sites will be over 500m down-wind from any communities/ residences, and the constructor will have spill and fire protection equipment available to rapidly deal with any accidents.	Throughout corridor during construction
Air Pollution	32	Vehicles and machineries are to be regularly maintained so that emissions conform to national standards. For emissions controls, national standards for construction vehicle and truck emissions will be applied.	Throughout corridor
Contamination from waste water (other than sewage)	33	All justifiable measures will be taken to prevent the wastewater produced during construction from entering directly into rivers and irrigation systems.	Area of waste water system installation
Contamination from fuel and lubricants	34	Vehicle maintenance and refueling will be confined to areas in construction camps designed to contain spilled lubricants and fuels. Waste petroleum products will be collected, stored and taken to approve disposal sites, according to RDA/PMU/ESD requirements.	Construction camp lease area
Noise	35	Noise standards at aggregate crushing plants and bitumen preparation sites will be strictly enforced to prevent extendedness of acceptable noise standards. Maintenance of machinery and vehicles will be enhanced to minimize noise.	Construction site at nearby residential area
	36	When construction is taking place at less than 100 m from the communities along the route, or the road passes within 150 m of sensitive areas such as hospitals, construction will be stopped from 20:00 to 06:00. This will reduce night time noise levels or provisions of a buffer.	

Appendix 5-3-(1) Environmental Management Plan-1

Environmental Impact Component		Mitigation Measures to be taken	Location	Time Frame	Standards	Implementation
SOCIAL ENVIRONMENT						
Loss of access	1.	Temporary bypasses will be constructed and maintained during the construction period, particularly at bridge crossings.	All 5 Bridge Locations.	During Construction		Contractor/PMU-RDA/ESD, Consultant
Traffic Jams and congestion	2.	If there are traffic jams during construction, measures will be taken to relieve the congestion through better coordination between the contractor, the RDA, and the Police Department.	Near urban areas. Bridge. No.4	During Construction		Contractor/ PMU-RDA/ESD, Consultant and Police Department
Road safety; collisions between vehicles, people and livestock	3.	Control speed of construction vehicles through road safety education and fines.	All 5 Bridge Locations.	During Construction		Contractor/ PMU-RDA/ESD, , Consultant
	4.	Allow for adequate traffic flow around construction sites.				
	5.	Provide adequate signage, barriers and flag persons for traffic control.				
	6.	Communicate to the public through radio, TV, and newspaper announcements regarding the scope and timeframe of projects, as well as certain construction activities causing disruptions or access restrictions.		At least 1 month prior to implementation		
Deterioration of health of workers due to poor camp conditions	7.	Make certain that there is good drainage at all construction areas, to avoid creation of stagnant water bodies.	Construction camps	During Construction		Contractor/ PMU-RDA/ESD, Consultant, Health Dept.
	8.	Provide adequate sanitation and waste disposal at construction camps.				
	9.	Provide adequate health care for workers and locate camps away from sensitive areas. HIV/AIDS awareness for the workers				
Littering with waste construction materials	10	All construction materials will be reused, recycled or properly disposed of. This will become particularly important at the bridge and culvert replacement sites, where demolished concrete will need to be properly disposed of. All worn out parts, equipments and empty containers will be removed from the site to a proper storage location designated by the District office of the Local government.	All 5 Bridge Locations.	During Construction		
Sanitation and Waste Disposal in Construction Camps	11	Sufficient measures will be taken in the construction camps, i.e., provision of garbage bins and sanitation facilities. All sewage sources or toilet facilities will be at least 300m from existing residences. Prior to initiation work, the contractor will present a simple sewage management plan to Engineer for approval.	Construction camp lease area	Before and during building of construction camp.		Contractor with PMU-RDA/ESD, Consultant

Appendix 5-3-(2) Environmental Management Plan-2

Environmental Impact Component		Mitigation Measures to be taken	Location	Time Frame	Standards	Implementation
SOCIAL ENVIRONMENT						
Sanitation and Waste Disposal in Construction Camps	12	Drinking water will meet national portable water standards.	Construction camp lease area	Before and during building of construction camp.		Contractor / PMU-RDA/ESD, Consultant
	13	Solid waste and garbage will be collected in bins and disposed of daily, according to a basic waste management plan prepared by the contractor and approved by Engineer, prior to the commencement of civil works.				
NATURAL ENVIRONMENT						
WATER Alteration of Drainage	14	In sections along watercourses, earth and stones will be properly disposed of so that they do not block channels and streams, resulting in adverse impact on water quality and flow regime.	All 5 Bridge Locations.	Whenever encountered during construction		Contractor / PMU-RDA/ESD, Consultant
	15	All necessary measures will be taken to prevent earthworks and stone works related to the access road from impeding cross drainage at channels/ streams or existing irrigation and drainage systems. 'Side-borrow' sites will be used as drainage ditches and designed such that they drain into the nearest water course.				
Stagnant water as insect-borne disease vectors	16	The formation of standing waters on construction sites in the areas often leads to the spread of insect-borne diseases. Therefore there will be a vigorous program by the contractor to avoid such standing water. The RDA/PMU/ESD/ users will be given information about the dangers of waterborne diseases such as malaria in standing water and how to prevent them.				
NATURAL ENVIRONMENT						
WATER Siltation	17	Construction materials containing fine particles should be stored in an enclosure such that sediment-laden water does not drain into nearby watercourses, but rather percolates slowly into the soil.	All 5 Bridge Locations.	During Construction		Contractor / PMU-RDA/ESD, Consultant

Appendix 5-3-(3) Environmental Management Plan-3

Environmental Impact Component		Mitigation Measures to be taken	Location	Time Frame	Standards	Implementation
NATURAL ENVIRONMENT						
Contamination of Water Body or Surface Drainage	18	The bridge replacement and pavement the severe possible water quality impact could come from spilled bitumen or any petroleum products used to thin the bitumen. Bitumen is stored in drums which may leak or which are often punctured during handling after long periods (>6 months in the elements) of storage. No bitumen will enter either running or dry stream-beds and none can be disposed of in ditches of small waste disposals sites prepared by the constructor. Bitumen storage and mixing areas will be properly handled according to the national acceptable standards. As a minimum, these areas will be contained, such that any spills can be immediately contained and cleaned up. Prior to initiating the work, the contractor will meet with the RDA/PMU/ESD to determine the proper sitting of the mixing areas and the handling and management of such spills. Any petroleum products used in the preparation of the bitumen mixture will also be carefully managed to avoid spills and contamination of the local water table.	Construction Site	During Construction		
SOIL: Soil Erosion	19	On slopes and other potentially erodible places along the roadside, appropriate vegetation that retards erosion will be planted.	Water Cross and Sections where fill heights are more than three meters	Upon Completion of construction activities at these sites		Contractor / PMU-RDA/ESD, Consultant
	20	On sections with high filling and deep cutting, the slopes will be protected by stone walls or masonry and planted with appropriate vegetation.				
Soil: Loss of topsoil	21	Arable lands should not be used as earth borrowing or storage sites whenever possible. If needed, the topsoil (15 cm or so) will be kept and refilled after excavation is order to minimize the impact on productive lands.	Along corridor	During Construction		Contractor/ PMU-RDA/ESD Consultant
	22	It may be necessary to construct new access roads to quarry and borrow sites, and place them through agricultural lands. These temporary roads will be made along existing farm tracks so as to avoid losses to agricultural lands.	Nearby quarry and borrow sites.	During Construction		

Appendix 5-3-(4) Environmental Management Plan-4

Environmental Impact Component		Mitigation Measures to be taken	Location	Time Frame	Standards	Implementation
NATURAL ENVIRONMENT						
Soil: Borrow area Recovery of ground form	23	Borrow area should be recovered at edge of excavated pits properly as original ground form after finish of borrow material extraction activities, these excavated edges of the pits should be moderated its form and slope to avoid local peoples and animals falling into the pits also recover continuity of surrounding landscape. Proper drainage system should be provided for avoiding stagnant of water.	Borrow areas	After finish of extraction activities of borrow materials		Contractor/ PMU-RDA/ESD Consultant
Compaction of Soil	24	Construction vehicles should operate within the Corridor of impact to avoid damaging soil and vegetation at cultivation area. It will be most important to avoid soil compaction around trees. Generally the rule will be to avoid driving heavy equipment or trucks anywhere into the ' drip-line ' of a tree.	Area near to the Bridge	During Construction		Contractor/ PMU-RDA/ESD Consultant
FLORA: Loss of trees	25	A tree-cutting and replanting scheme will be prepared by the contractor and Engineer before commencement of the civil works. Tree clearing within the ROW of A005 and A015 will be avoided beyond what is directly required for construction activities and what will be removed to reduce accidents. A replanting scheme will be developed by Engineer and the Contractor, within the appropriate time period.	Area of Tree Plantations along roadsides.	Soon after completion of construction activities in immediate area and during clearing operations		Contractor/ PMU-RDA/ESD Consultant
FAUNA	26	Construction workers will be told to protect natural resources and wild animals, especially migrating birds. Hunting is strictly prohibited.		Vicinity of construction area		Contractor / PMU-RDA/ESD Consultant,
	27	Stream crossings that are dry during the work period will be kept unobstructed at all times, since during the monsoon periods these dry river beds become irrigations channel areas for local residents. Materials are not to be borrowed from this river and stream beds.				
	28	In the A005 corridor, during road construction existing channel and stream may have to be moved back away from the carriageway, and if so this will be done with great care to make sure that the natural water movement (in terms of flow and volume) is maintained.				

Appendix 5-3-(5) Environmental Management Plan-5

Environmental Impact Component		Mitigation Measures to be taken	Location	Time Frame	Standards	Implementation
POLLUTION						
Dust/ Odor	29	Water will be sprayed during the construction in any mixing area where dry materials are handled and/ or crushed. Temporary access roads to Quarry and borrow sites will be included in the dust suppression program. A spraying schedule will be prepared by the contractor and will serve as the basis of a dust control program. RDA/PMU/ESD/Consultants will monitor this schedule should problems arise.	Vicinity of construction area	During reconstruction of grade and between asphalt removal and replacement		Contractor/ PMU-RDA/ESD, Consultant
	30	Vehicles delivering materials to and from the construction sites will be covered to reduce spills.		During construction		
Dust/ Odor	31	Bitumen preparation sites will be noisy with some odor and a considerable risk of fire. Therefore all bitumen preparation and loading sites will be over 500m down-wind from any communities/ residences, and the constructor will have spill and fire protection equipment available to rapidly deal with any accidents.	Throughout corridor during construction	During construction		
Air Pollution	32	Vehicles and machineries are to be regularly maintained so that emissions conform to national standards. For emissions controls, national standards for construction vehicle and truck emissions will be applied.	Throughout corridor	Beginning with and continuing throughout construction		Contractor/ with monitoring from PMU-RDA/ESD, Consultant
Contamination from waste water (other than sewage)	33	All justifiable measures will be taken to prevent the wastewater produced during construction from entering directly into rivers and irrigation systems.	Area of waste water system installation	Throughout Construction period		Contractor/ PMU-RDA/ESD, Consultant
Contamination from fuel and lubricants	34	Vehicle maintenance and refueling will be confined to areas in construction camps designed to contain spilled lubricants and fuels. Waste petroleum products will be collected, stored and taken to approve disposal sites.	Construction camp lease area	Throughout Construction period		Contractor/ PMU-RDA/ESD, Consultant
Noise	35	Noise standards at aggregate crushing plants and bitumen preparation sites will be strictly enforced to prevent extendedness of acceptable noise standards.	Construction site at nearby residential area	Beginning and throughout construction		Contractor/ with monitoring from PMU-RDA/ESD, Consultant
	36	When construction is taking place at less than 100 m from the communities along the route, or the road passes within 150 m of sensitive areas, construction will be stopped from 20:00 to 06:00. This will reduce night time noise levels or provisions of a buffer.				

Appendix 5-4-(1) Environmental Monitoring Plan: Bridge site on A005 and A015-1

Environmental component	Project Stage	Parameters to be Monitored	Location	Frequency	Standards	Implementation	Supervision
Air Quality	Design, Construction stage	SPM(dust)	Bridge Nos. 240/4, 241/2, 241/3, 241/4, 247/2 and 283/7 on A005, Bridge No. 59/1 and causeway on Panichchankeni lagoon	Design -1 time, Construction -3 times/Yr for 2 Yrs	NAAQS of Sri Lanka	Contractor through approved monitoring agency	RDA(ESD), LA
	Operation stage	SPM(dust)	Bridge Nos. 240/4, 241/2, 241/3, 241/4, 247/2 and 283/7 on A005, Bridge No. 59/1 and causeway on Panichchankeni lagoon	2 times	NAAQS of Sri Lanka	RDA through approved monitoring agency	RDA(ESD), LA
Water Quality	Design, Construction stage	EC, pH, DO, TSS, BOD, COD, Oil and grease, Coli.	Bridge Nos. 240/4, 241/2, 241/3, 241/4, 247/2 and 283/7 on A005, Bridge No. 59/1 and causeway on Panichchankeni lagoon	Design -1 time, Construction -2 times/Yr for 2 Yrs	CEA Water Quality Regulations	Contractor through approved monitoring agency	RDA(ESD), LA
	Operation stage	EC, pH, DO, TSS, BOD, COD,Oil and grease, E.Coli.	Bridge Nos. 240/4, 241/2, 241/3, 241/4, 247/2 and 283/7 on A005, Bridge No. 59/1 and causeway on Panichchankeni lagoon	2 times	CEA Water Quality Regulations	RDA through approved monitoring agency	RDA(ESD), LA
Noise levels	Design, Construction stage	dB levels	Bridge Nos. 240/4, 241/2, 241/3, 241/4, 247/2 and 283/7 on A005, Bridge No. 59/1 and causeway on Panichchankeni lagoon	Design -1 time, Construction -2 times/Yr for 2 Yrs	National Environmental (Noise Control) Regulations	Contractor through approved monitoring agency	RDA(ESD), LA
	Operation stage	dB levels	Bridge Nos. 240/4, 241/2, 241/3, 241/4, 247/2 and 283/7 on A005, Bridge No. 59/1 and causeway on Panichchankeni lagoon	2 times	National Environmental (Noise Control) Regulations	RDA through approved monitoring agency	RDA(ESD), LA
Flora	Design, Construction stage	Number of tree specimens replanted	Bridge Nos. 240/4, 241/2, 241/3, 241/4, 247/2 and 283/7 on A005, Bridge No. 59/1 and causeway on Panichchankeni lagoon	1 visit	Diversity of species	RDA, PIU in coordination with DoF and DWLC	RDA(ESD) , DoF, DWLC LA
	Operation stage	Survival rate of replanted specimen trees	Bridge Nos. 240/4, 241/2, 241/3, 241/4, 247/2 and 283/7 on A005, Bridge No. 59/1 and causeway on Panichchankeni lagoon	1 visit	Percentage survival	RDA, ESD, in coordination with DoF and DWLC	RDA(ESD) , DoF, DWLC LA

Appendix 5-4-(2) Environmental Monitoring Plan: Bridge site on A005 and A015-2

Environmental component	Project Stage	Parameters to be Monitored	Location	Frequency	Standards	Implementation	Supervision
Fauna	Design, stage	Diversity of species	Bridge Nos. 240/4, 241/2, 241/3, 241/4, 247/2 and 283/7 on A005, Bridge No. 59/1 and causeway on Panichchankeni lagoon	1 visit	As directed by DWLC	RDA, PIU in coordination with DoF and DWLC	RDA(ESD) , DoF, DWLC LA
	Construction stage	Diversity of species	Bridge Nos. 240/4, 241/2, 241/3, 241/4, 247/2 and 283/7 on A005, Bridge No. 59/1 and causeway on Panichchankeni lagoon	2 visit	As directed by DWLC	RDA, PIU in coordination with DoF and DWLC	RDA(ESD) , DoF, DWLC LA
	Operation stage	Diversity of species	Bridge Nos. 240/4, 241/2, 241/3, 241/4, 247/2 and 283/7 on A005, Bridge No. 59/1 and causeway on Panichchankeni lagoon	2 visit	As directed by DWLC	RDA, PIU in coordination with DoF and DWLC	RDA(ESD) , DoF, DWLC LA

Notes:

Design Stage = Baseline Stage

RDA(ESD)=Road Development Authority (Environmental & Social Division). , SC=supervision consultant, SPM= suspended particulate matter, PM10= Respirable particulate matter<10micrometers diameter, SO2=sulphur dioxide, NOx=oxides of nitrogen, CO=carbon monoxide, HC=hydrocarbons, Pb=lead. NAAQS= National

Air Quality Standards, LA= Local authority, PIU= Project Implementation Unit, DoF= Department of forestry, DWLC= Department of Wildlife Conservation

Appendix 5 -5 Result of Water Quality Monitoring

1. Monitoring methodology

The water system (river and stream, water poundings, lagoon) nearby the study 5 bridges were conducted on the objective monitoring points, and monitoring duration of the water quality was 3 days from 12th of March 2009 to 14th March 2009.
Sensor of test analyzer was directly soaked into water body or draw up water, and checked digital indication level of the water quality. The items of water sampling test by the analyzer were water temperature, dissolved oxygen level, pH value, electric conductivity (NaCl, saline content), turbidity level. The items of other water sampling test by other instruments and chemical reagents were air temperature, water temperature, chemical oxygen demand, dissolved oxygen level, bio-chemical oxygen demand, total coliform and transparency level (total suspended substances).

2. Test instruments, analyzer and chemical reagent in sampling test use.

2.1 Specification of monitoring test instruments, analyzer and chemical reagent

Water quality analyzer: Water quality checker WQC-22A (Manufacturer: DKK-TOA Corporation)
The analyzer is composed of indicative body, sensor and attachments.
Sensor (WMS22A10) is used with 10m length of cable.
Measuring items: pH, water temperature, electrical conductivity (conversion of saline contents), DO, turbidity are feasible for measurement.
Measurement system:
Temperature: Platinum measurement resistance system
Dissolved oxygen: Diaphragm formed galvanic cell system (Automatic measurement range: 5～40℃)
pH: Glass electrode system (Automatic measurement range: 0～50℃)
Electric conductivity: 4 electrode system (Automatic measurement range: 0～50℃, 2%/℃)
(NaCl): Conversion from electric conductivity to saline contents.
Turbidity: 90 degree dispersed light measurement system (Using sporadic light by Infrared LED)
Compensation:
Dissolved oxygen: Automatic span compensation by ambient air
pH: Automatic compensation of pH7, pH4 (and pH9)
Turbidity: Automatic zero compensation by refined water (and Manual span compensation)
Indication system: Liquid crystal digital system
Permissible ranges: 0～40℃ (condition of temperature of sampling water: 0～50℃)
Indicative body:
Power source: Dry cell (Unit 2 x 6, possible continuous 50 hours measuring)
Size: W.250mm x H.160mm x L.95mm
Weight: 2.2ｋｇ (include dry cells)
Sensor:
Soak type with multiple 5 items sensor: Lead length of 10m (standard 2m) WMS22A10
Size and weight: Cylindrical type φ75 x 230mm, weight 1.3kg

2.2 Measurement method of BOD (Biochemical oxygen demand)

Dissolved oxygen (DO) kit usage: (manufacturer: KYORITSU CHEMICAL-CHECK lab., Corp., model: BOD-K, AZ-DO-10, AZ-DO-30, color comparison identification by ampoule reagent and 9 graded standard color plate: Indigo Carmin Comparison Method) are used. Measurements are made just after sampled water taken and after 5 days of cultivation (oxygen demand for dissolved process).

Inorganic nutrition base solution: Each of BOD-R1 and R2 (nutrition base for normal activation of microorganism within the sampling water)

Glass bin for cultivation: (Light shield brown glass made) 12 bins (for keeping and cultivation of sampling water)

2.3 Measurement method of COD (Chemical oxygen demand)

Usage of ION SELECTIVE PACK TEST: (manufacturer: KYORITSU CHEMICAL-CHECK lab., Corp.)

Measurement method: Normal temperature alkaline manganic acid potassic oxidation method.

Color development test: Based on potassium permanganate method

Measurement range: 0 ～100mg/L

2.4 Sampling measurement method of total caliform

1ml of sampling water is dropped evenly on a test paper peace of total caliform by pipette, the test paper is kept 15 hours in 37℃ stably for cultivation of total caliform, then total numbers of colonized caliform is counted. 3 test papers are used for counting numbers of colonies in order to get an average numbers.

2.5 Measurement method of clarity level and suspended substances

Transparency of sampling water is measured in use of clarity meter (glass cylinder: H=30cm) and supporting receptacle, suspended substances (SS:mg/l) are identified from the measured clarity (cm) by conversion table.

2.6 Measurement method of air temperature and water temperature

Usage of an alcohol thermometer

3. Monitoring results of water sampling tests

The water system (river and stream, water poundings, lagoon) nearby the study 5 bridges were conducted on the objective monitoring points, and monitoring results are shown following sections.

3.1 Monitoring results of water sampling (Bridge No.1 point)

1) Sampling location and time: Bridge No.1 (RDA. Bridge No.240/4), 14th march 2009, 10:00AM (Sampling point shows in Figure 1.1)
2) Monitoring sampler: Hiroshi Tanaka (JICA Team), Saranga Gajasinghe (RDA)
3) General condition of the site vicinity:

Bridge No.1 is located at Mahaoya DS Division along NR-A05 (National Road), Landuse along NR-A05 is composed with scattered paddies, agriculture fields, grassland mainly for grazing and teak plantation areas are allocated off to the NR05.

At the sampling location Mahaoya river flows South to North direction along NR05. The channel at the bridge crossing section is being dried up in the dry season, however the water will be over flown from Mahaoya river to the channel in rain and flood season.

On the dried channel there are inhabited Graminease grasses and some Legmimosae species.

4) Flow regime:

A flow width of Mahaoya river is vary 5m to 10m, depth of river flow is shallow as 40cm around in the deepest point and there develops sand bars. The river water is observed slightly turbid without showing river bottom due to rain fall result and the flow velocity is approximately 25cm/sec. At the reconnaissance survey conducted on March 1st the water was very clear to recognize the river bottom and small fish (3cm in size) groups were observed. The river water is mainly used for irrigation purpose.

5) Weather condition:

It was fine at the time of sampling, 4 days before (on 10th of March) rain fall was reported in this area.

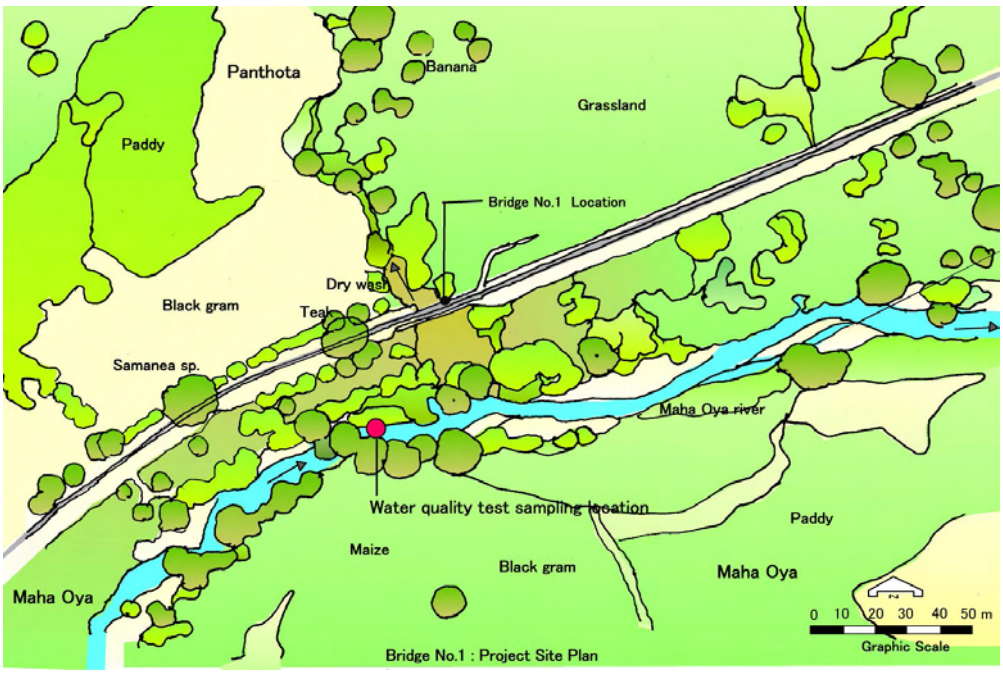


Figure 1.1 Sampling location at Bridge No.1

Table 1.1 Monitoring results at Bridge No.1 location

No.	Item	Unit	Value	Remarks
1	Air temperature	℃	29.0	
2	Water temperature	℃	28.2	
3	pH		7.4	
4	Electric conductivity (NaCl)	S/m	11.1	
5	(Saline content)	%	0.006	Converted by electric conductivity
6	Turbidity	NTU(mg/l)	8.5	
7	DO	mg/l	5.5	
8	BDO	mg/l	1.0	
9	CDO	mg/l	2.0	
10	Clarity	cm	>45	
11	SS	mg/l	<13.9	Converted by clarity
12	Oils		Nil.	By observation
13	Total caliform	n/ml	20	

3.2-1 Monitoring results of water sampling (Bridge No.2 point)

1) Sampling location and time: Bridge No.2 (RDA. Bridge No. 241/2, 241/3, 241/4), 14th march 2009, 10:40AM (Sampling point shows in Figure 1.2)
2) Monitoring sampler: Hiroshi Tanaka (JICA Team), Saranga Gajasinghe (RDA)
3) General condition of the site vicinity:

Bridge No.2 is located at Mahaoya DS Division along NR-A05 (National Road), Landuse along NR05 is composed with paddies, agriculture fields, grassland mainly for grazing area. Surrounding area of Bridge No.2 is flood plain and spreading wide range of swampy area. The flood plain area is still remained water ponds. Teak plantation areas are allocated off the NR-A05.

At the sampling location Kudaoya river of which tributary of Mahaoya river flows South to North direction along NR-A05 and Kudaoya river meets with Hahaoya river at the downstream.

There are continuously linked existing 3 bridges (241/2,242/3, 241/4) and within 2 bridges (242/3, 241/4) sites are dried without any water flows, only flood season there becomes to be flown. Water sampling was conducted at Kuda Oya river, the location under the bridge (242/3) is installed facility of weir (H=30cm) and there are rich inhabited Graminease grasses and some bushes of Legmimosae species along the river bank.

4) Flow regime:

A flow width of Kuda Oya river is vary 3m to 7m, depth of river flow is shallow as 30cm around in the deepest point and there some developed sand bars are observed. The river water observes slightly turbid without showing river bottom due to rain fall result and the flow velocity is approximately 20cm/sec. At the reconnaissance survey conducted on March 1st the water was very clear to recognize the river bottom. The river water is mainly used for irrigation purpose.

5) Weather condition:

It was fine at the time of sampling, 4 days before (on 10th of March) rain fall was reported in this area.

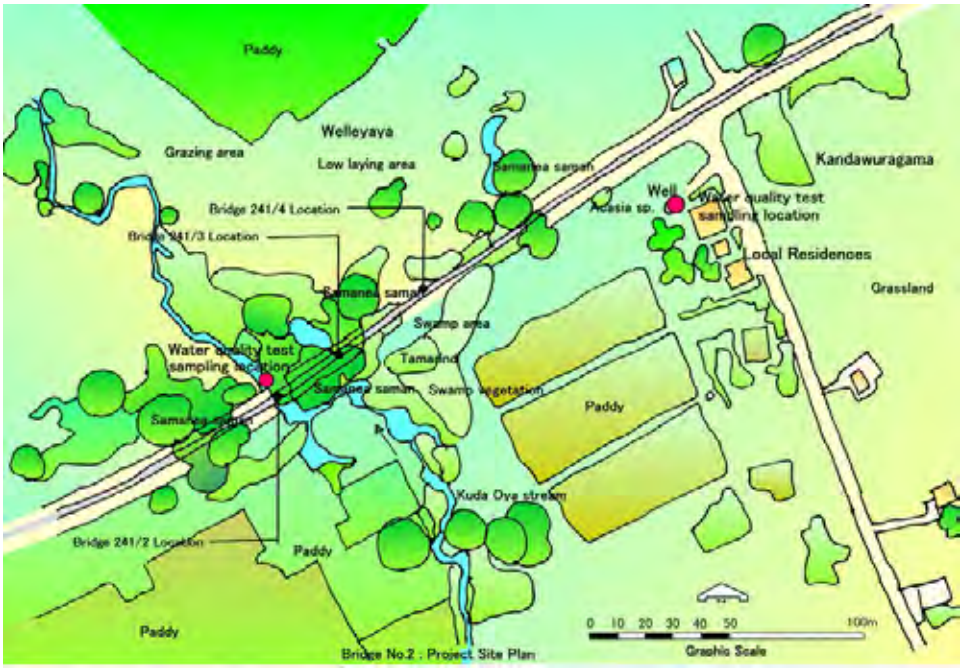


Figure 1.2 Sampling location at Bridge No.2

Table 1.2-1 Monitoring results at Bridge No.2 location

No.	Item	Unit	Value	Remarks
1	Air temperature	℃	29.0	
2	Water temperature	℃	28.0	
3	pH		6.8	
4	Electric conductivity (NaCl)	S/m	11.3	
5	(Saline content)	%	0.005	Converted by electric conductivity
6	Turbidity	NTU(mg/l)	6.0	
7	DO	mg/l	4.0	
8	BDO	mg/l	2.0	
9	CDO	mg/l	7.0	
10	Clarity	cm	>60	Slightly brown color
11	SS	mg/l	<10.41	Converted by clarity
12	Oils		Nil	By observation
13	Total caliform	n/ml	23	

3.2-2 Monitoring results of water sampling 2-2 (Well near Bridge No.2 point)

1) Sampling location and time: Well of local farm house (Near Bridge No.2, 80m apart to South Eastern ward from RDA. No. 241/4), 14th march 2009, 11:30AM (Sampling point shows in Figure 1.2)
2) Monitoring sampler: Hiroshi Tanaka (JICA Team), Saranga Gajasinghe (RDA)
3) General condition of the site vicinity:
   Well is allocated within local farmers house yard, there are 3 farmers houses and the well is used for drinking and other purposes. Surrounding area of well is planted fruits trees.
4) Flow regime:
   The well is large and shallow, diameter of the well measures approximately 4m of concrete made. Water level of the well is 3m under the ground; this area is sought a high ground water level. Surface of well water is covered with green algae groups.
5) Weather condition:
   It was fine at the time of sampling, 4 days before (on 10th of March) rain fall was reported in this area.

Table 1.2-2 Monitoring results of local farmers well at Bridge No.2 location

No	Item	Unit	Value	Remarks
1	Air temperature	℃	28.0	
2	Water temperature	℃	27.0	
3	pH		5.4	
4	Electric conductivity (NaCl)	S/m	26.70	
5	(Saline content)	%	0.013	Converted by electric conductivity
6	Turbidity	NTU(mg/l)	1.0	
7	DO	mg/l	6.0	
8	BDO	mg/l	4.0	
9	CDO	mg/l	1.0	
10	Clarity	cm	>60	
11	SS	mg/l	<12.5	Converted by clarity
12	Oils		Nil	By observation
13	Total caliform	n/ml	18	

3.3 Monitoring results of water sampling (Bridge No.3 point)

1) Sampling location and time: Bridge No.3 (RDA. Bridge No. 247/2), 13th march 2009, 11:00AM (Sampling point shows in Figure 1.3)

2) Monitoring sampler: Hiroshi Tanaka (JICA Team), Saranga Gajasinghe (RDA)

3) General condition of the site vicinity:

(1) Bridge No.3 is located at Mahaoya DS Division along NR-A05 (National Road), Landuse along NR-A05 is composed with agriculture fields, grassland mainly for grazing area. On South Western part there is low rolling hill with cattle range also teak plantation are scattered.

At the sampling location Pulaveli Aru river flows South to North direction.

The bridge crossing area is becoming flood plain in rainy season and there are rich inhabited with Gramineae grasses predominant at surrounding catchment area.

4) Flow regime:

A flow width of Pulaveli Aru river is 3m to 5m, depth of river flow is shallow as 25cm around in the deepest point. The river water observes slightly turbid without showing river bottom due to rain fall result and the flow velocity is approximately 20cm/sec. At the reconnaissance survey conducted on March 1st the water was very clear to recognize the river bottom. The river water is mainly used for irrigation and for drinking water to few fammer at up-stream.

5) Weather condition:

It was fine at the time of sampling, 3 days before (on 10th of March) rain fall was reported in this area.

Figure 1.3 Sampling location at Bridge No.3

Table 1.3 Monitoring results at Bridge No.3 location

No.	Item	Unit	Value	Remarks
1	Air temperature	℃	31.0	
2	Water temperature	℃	28.0	
3	pH		7.4	
4	Electric conductivity (NaCl)	S/m	7.6	
5	(Saline content)	%	0.004	Converted by electric conductivity
6	Turbidity	NTU(mg/l)	14.0	
7	DO	mg/l	5.3	
8	BDO	mg/l	4.5	
9	CDO	mg/l	8.0	
10	Clarity	cm	>40	
11	SS	mg/l	<15.6	Converted by clarity
12	Oils		Nil	By observation
13	Total caliform	n/ml	34	

3.4 Monitoring results of water sampling (Bridge No.4 point)

1) Sampling location and time: Bridge No.4 (RDA. Bridge No. 283/7), 13th march 2009, 9:15AM (Sampling point shows in Figure 1.4)
2) Monitoring sampler: Hiroshi Tanaka (JICA Team), Saranga Gajasinghe (RDA)
3) General condition of the site vicinity:
   Bridge No.4 is at located EravurpatuDS Division along NR05, Landuse along NR-A05 is composed with scattered paddies, agriculture fields, grassland for grazing areas or many abandoned areas. NR-A05 route is aligned on rather flat land and the areas of water crossing sections are often flooded in the rainy season and formulated low laying flood prone areas. Gramineae grasses are grown within the flood plain areas in dry season and remained small ponds area has many aquatic plants grown. Tall palm trees are planted alongside of the NR0.5 and species of Acacia are plenty as representative natural vegetation.
4) Flow regime:
   Remained pond of flood plain in dry season is still size of 10m to 15m wide and 50m in length, depth of pond is seemed 1.0m around in the deepest point.
5) Weather condition:
   It was fine at the time of sampling, 3 days before (on 10th of March) rain fall was reported in this area.

Figure 1.4 Sampling location at Bridge No.4

Table 1.4 Monitoring results at Bridge No.4 location

No.	Item	Unit	Value	Remarks
1	Air temperature	℃	32.0	
2	Water temperature	℃	27.0	
3	pH		6.6	
4	Electric conductivity (NaCl)	S/m	37.0	
5	(Saline content)	%	0.018	Converted by electric conductivity
6	Turbidity	NTU(mg/l)	16.0	
7	DO	mg/l	6.2	
8	BDO	mg/l	4.7	
9	CDO	mg/l	8.0	
10	Clarity	cm	>35	
11	SS	mg/l	<15.6	Converted by clarity
12	Oils		Nil	By observation
13	Total caliform	n/ml	51	

3.5 Monitoring results of water sampling (Bridge No.5 point)

1) Sampling location and time: Bridge No.5 (RDA. Bridge No. 59/1), 12th march 2009, 10:30AM (2 sampling points show in Figure 1.5)

2) Monitoring sampler: Hiroshi Tanaka (JICA Team), Gajashinder (RDA)

3) General condition of the site vicinity:

Bridge No.5 is located at Koralaipattu North DS Division along NR-A15, Landuse along NR-A15 is composed with grassland for grazing areas or many un-used abandoned areas and few cultivated land. Scattered coconut palms are commonly observed. NR-A15 route is aligned on flat land and causeway with bridge is crossing at narrow channel of the lagoon. Mangrove vegetation are developed along fringe of the lagoon, however these mangrove vegetation are grown mostly North side of the causeway. Tsumani in 2004 affected damages to the mangrove vegetation and dead and cutting mangrove can be seen at the some low laying area, however mangrove vegetation along the margin of the lagoon is grown in good condition. Shrimp, prawn and crab fishery is currently observed by fixed net trap at Easter side of the causeway. Existing causeway is once damaged by Tsunami, but temporary bridge has been installed for maintain local traffic and cattle moving.

4) Flow regime:

Current flow is generated by tidal affection from the lagoon estuary, narrow bottleneck at causeway channel has observed faster current towards inland direction at high tide. Depth of lagoon at sampling locations (2 points at near bridge abutments) measured about 2m to 3m. Sampling was conducted 2 points and results were almost the same value. Water at the sampling time was slightly turbid due to eroded silts from the causeway bank after rain fall of 2 days before.

5) Weather condition:

It was fine at the time of sampling, 2 days before (on 10th of March) rain fall was reported in this area.

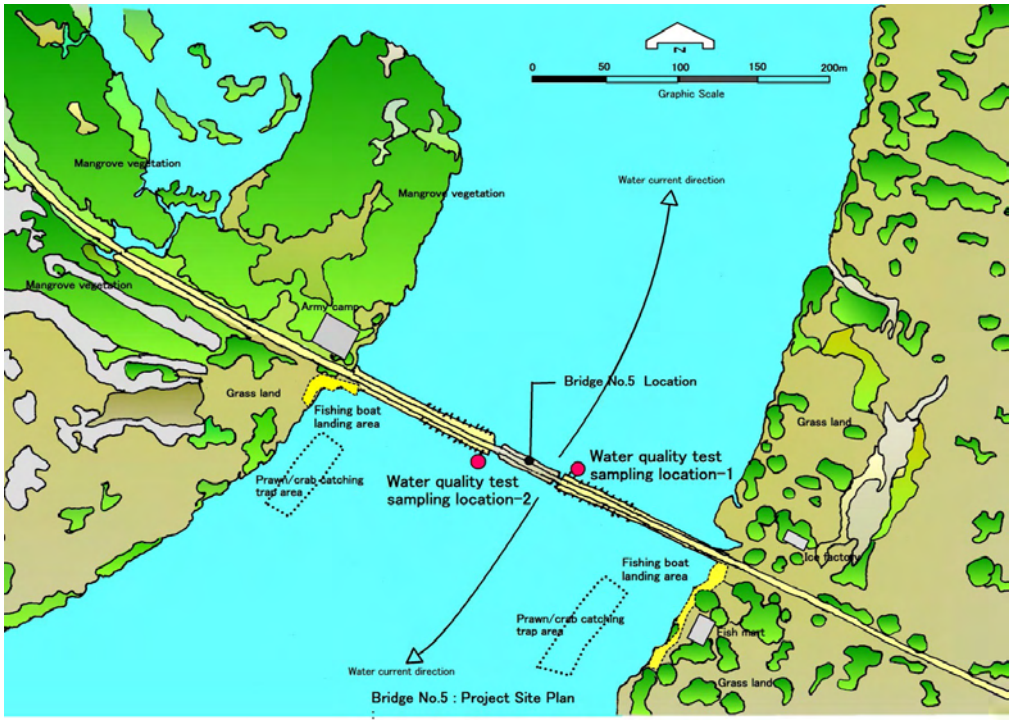


Figure 1.5 Sampling location at Bridge No.5

Table 1.5 Monitoring results at Bridge No.5 location

No.	Item	Unit	Value	Remarks
1	Air temperature	℃	36.0	
2	Water temperature	℃	29.0	
3	pH		7.2	
4	Electric conductivity (NaCl)	S/m	990	
5	(Saline content)	%	0.49	Converted by electric conductivity
6	Turbidity	NTU(mg/l)	7.5	(7.0～8.0)
7	DO	mg/l	3.5	(3.4～3.6)
8	BDO	mg/l	3.0	
9	CDO	mg/l	7.0	(7.0～8.0)
10	Clarity	cm	>40	
11	SS	mg/l	<15.62	Converted by clarity
12	Oils		None	By observation
13	Total caliform	n/ml	5	(3～7)

Appendix 5-6 Equipment and Reagents for Water Quality Tests

1. Water quality monitoring analyzer, sensor and chemical reagents
   Figure1 shows a photograph of water quality monitoring analyzer, sensor and chemical reagents.

2. Photographs of water quality monitoring on sites
   Water quality monitoring had conducted in 3 days on each study area of 5 bridges duration of 12th March 2009 to 14th March 2009. Monitoring points are 7 locations and show following photographs of site monitoring.

2.1 Bridge No. 1 (RDA bridge No. 240/4)
Date and time of monitoring: 14th March 2009, 10:00 AM

2.2-1 Bridge No. 2 (RDA bridge No. 241/2)
Date and time of monitoring: 14th March 2009, 10:40 AM

2.2-2 Well of local farm house, Vicinity of No. 2 (RDA bridge No. 241/4)
Date and time of monitoring: 14th March 2009, 11:30 AM

2.3 Bridge No. 3 (RDA bridge No. 247/2)
Date and time of monitoring: 13rd March 2009, 11:00 AM

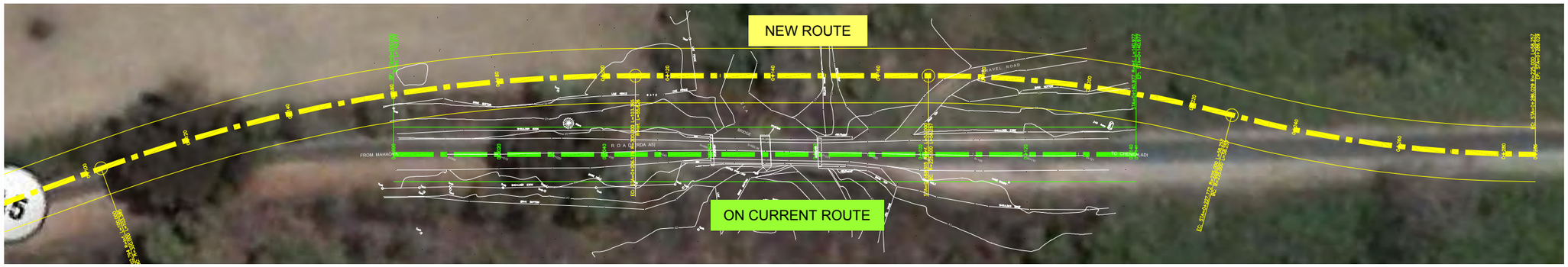
2.4 Bridge No. 4 (RDA bridge No. 283/7)
Date and time of monitoring: 13rd March 2009, 9:15 AM

2.5-1 Bridge No. 4 (RDA bridge No. 59/1)
Date and time of monitoring: 12th March 2009, 10:30 AM

2.5-2 Bridge No. 4 (RDA bridge No. 59/1)
Date and time of monitoring: 12th March 2009, 11:20 AM

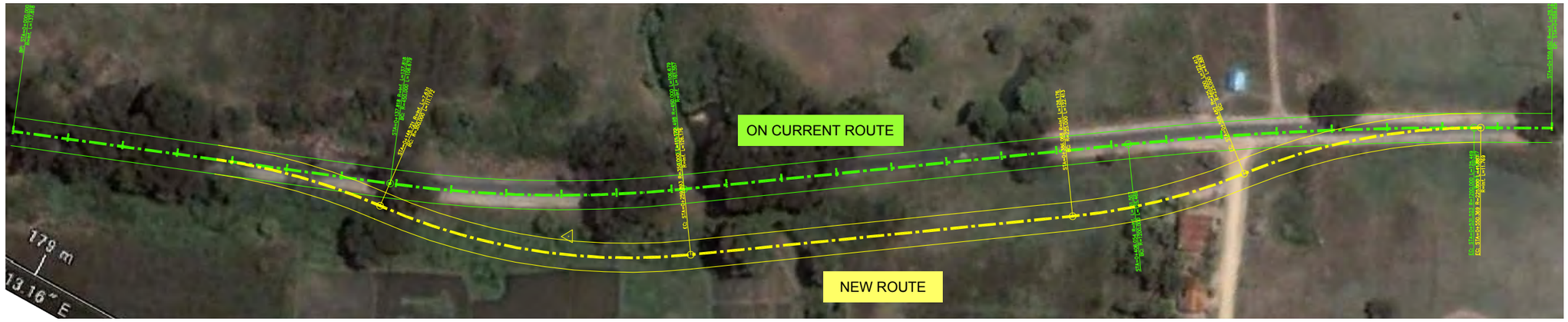
APPENDIX 6 Route Comparison Table

Table Ap 6-1 Bridge No.1: Route Comparison

ITEM	NEW ROUTE (WITHOUT DETOUR) : YELLOW ALIGNMENT		ON CURRENT ROUTE (WITH DETOUR) : GREEN ALIGNMENT DETOUR BY JAPAN【RECOMMENDED】		ON CURRENT ROUTE (WITH DETOUR) : GREEN ALIGNMENT DETOUR BY SRI LANKA	
DESCRIPTION						
	Northern new route from the existing bridge because southern side is too close to the Maha Oya river. • Earth Work: around 500 m (Volume: around 8,000 cu.m) • Bridge length: 26 m • Detour: none Additional survey is required to confirm this alignment.		On existing route • Earth Work: around 500 m (Volume: around 1,000 cu.m) • Bridge length: 26 m • Detour: On river bed Additional survey is required to confirm the longitudinal alignment.		Same as at left	
ENVIRONMENTAL EFFECT	• The river at this bridge site dries up during the dry season. In the rainy season, flood water from Maha Oya river, which runs parallel to the national route No.5, tops the 1 m embankment flow to natural irrigation stream. • There are no houses around the bridge, although one security booth is located on the road side. • No effect on current traffic because existing road will continue to be used during construction. • Land acquisition and compensation required for northern area where farm land is located. • The alignment of the road shall be selected to preserve a large tree (Samaneasp), on Maha Oya side.	△	• The detour requires drainage, such as adequate pipe culverts, considering flood in rainy season. • Because of low traffic volume, the detour can be river road with 3% longitudinal gradient and gravel pavement. • In the rainy season, maintenance work for detours will be necessary because of damage to the earth work by flood. • The existing bridge must be removed after completion of the detour. There are no problems with the removal, because there are no houses around the bridge.	○	Same as at left	○
EFFECT ON RIVER	• The construction work will not affect the irrigation system even in the rainy season. • The existing abutment on the east side looks like extruding to river side. The new bridge shall move the location to the east with a longer span.	○	• The construction work will not affect the irrigation system even in the rainy season. • The abutment of east side looks like extruding to river side. The new bridge shall be correct the location to east with longer span of bridge.	○	Same as at left	○
RUNNING COMFORT (AFTER COMPLETION)	• This present bridge is located on a straight section of national road about 800 m long. So, it is not recommended to use a worse alignment for this small bridge. • R=225 m must be used. However the running comfort can be secured.	△	• To widen the road on both side of approachs to the bridge will offer good sight for drivers. This alignment also coordinates with the existing bridge on the Maha Oya river 400 m west from this bridge. • The new road is straight with good running comfort.	○	Same as at left	○
RUNNING COMFORT (UNDER CONSTRUCTION)	• The existing road can be used during the construction period.	○	• Using a detour, running comfort will be temporarily worse.	△	Same as at left	△
CONSTRUCTION EFFICIENCY	• The existing road can be utilized during construction work. No need for a detour and no need to wait for procurement of temporary materials.	○	• The detour can be embankment on the river bed with drainage pipes if the construction work starts in March (first month of the dry season).	○	• The detour can be embankment on the river bed with drainage pipes if the construction work starts in March (first month of dry season). • However, if the detour is constructed by the Sri Lankan side before the tender, it must be durable against flood because there will be a rainy season between the tender and start of construction work.	△
CONSTRUCTION PERIOD	• Construction can be completed within the first dry season (7 months) if the work can start from March.	○	• The construction period, including detour, can be completed within the first dry season (7 months) if the work can start from March.	○	Same as at left	○
RISK OF DELAY	• Little risk of delay because of no need to detour.	○	• Little risk of delay because the Japanese side has responsibility to construct the detour.	○	• Some risk because Sri Lankan side has responsibility to construct the detour. • One solution will be to use a Japanese contractor for detour construction by Sri Lankan side fund.	△
COMPARISON OF CONSTRUCTION COST Note) The cost includes both tasks namely GOJ & GOS. Further the comparison of the cost is made on the basis of the ratio of the each route.	• 1.16	△	• 1.00	○	• 1.00	○
	• Liability of GOS: 4 million yen	△	• Liability of GOS: Nil	◎	• Liability of GOS: 4 million yen	△
EVALUATION	△		◎		○	

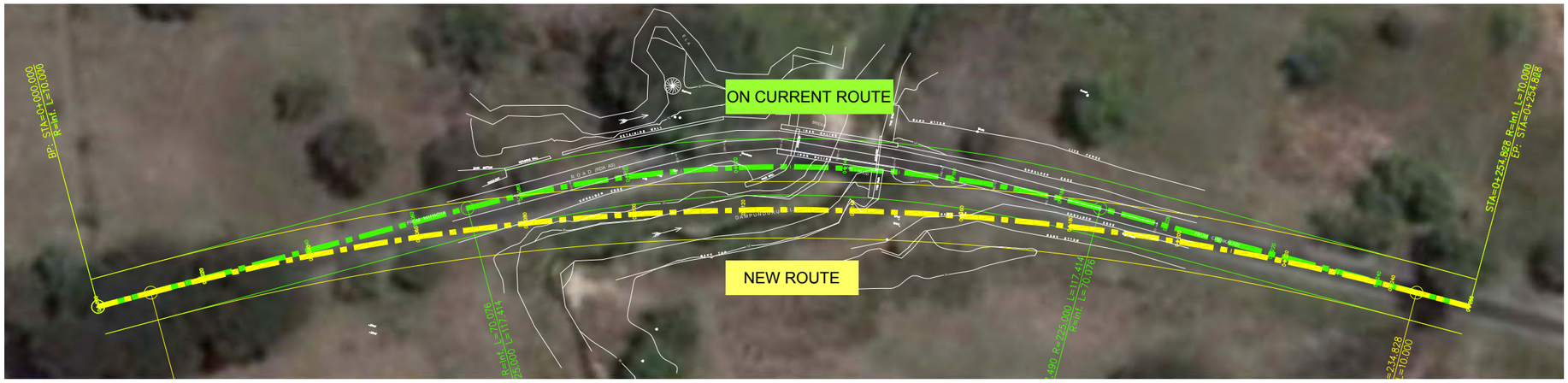
Note
Evaluation Order: (Bad) ▲<△<○<◎ (Good)

Table Ap.6-2 Bridge No.2: Route Comparison

ITEM	NEW ROUTE (WITHOUT DETOUR) : YELLOW ALIGNMENT		ON CURRENT ROUTE (WITH DETOUR) : GREEN ALIGNMENT DETOUR BY JAPAN【RECOMMENDED】		ON CURRENT ROUTE (WITH DETOUR) : GREEN ALIGNMENT DETOUR BY SRI LANKA	
DESCRIPTION						
	Southern new route from existing bridge to avoid large land mark trees. • Earth Work: about 500 m (Volume: around 17,000 cu.m) • Box Culvert: 7 m、 Bridge length: 85 m • Detour: None		On the existing route, to avoid big trees (Samanea sp,), the existing road will be moved to the south. • Earth Work: about 500 m (Volume: around 17,000 cu.m) • Box Culvert: 7 m、 Bridge length: 85 m • Detour: include 85 m of temporary bridge		Same as at left	
ENVIRONMENTAL EFFECT	• The new alignment shall be south of the existing road to avoid a large tree; however, it will be closer to a house. • The new route will be close to an existing house. The raised road may cause higher floods in the vicinity of the house. • An existing well may be contaminated by drivers with trash.	▲	• The temporary road will be close to the existing house; however, to select proper alignment as a temporary road, it can be kept adequate distance from the house. • The new road will be almost the same distance from the house. The raised road may not affect the house. • The wider bridge length will improve the discharge of flood water through giving large water flow section. • The Japanese side will attempt not to affect large trees during construction.	○	Same as at left	○
EFFECT ON RIVER	• The new road will be constructed on a part of the existing stream. The stream course must be changed. • The longer bridge length will improve the discharge of flood water by providing large water flow section. • If Sri Lankan side does not remove the existing bridge immediately after completion of the new bridge, it will damage the new road by blocking flood water flow.	△	• There is no need to change water flow because the detour crosses the stream by temporary bridge. • The detour must be removed to secure original conditions considering water flow direction and swamp area.	○	Same as at left	○
RUNNING COMFORT (AFTER COMPLETION)	• Running comfort is relatively worse because of S shape curve of approach road.	△	• Running comfort is relatively good to connect existing road with gentle curve.	○	Same as at left	○
RUNNING COMFORT (UNDER CONSTRUCTION)	• The existing road can be used during the construction period.	○	• Using the detour, running comfort will be worse because of the surface.	△	Same as at left	△
CONSTRUCTION EFFICIENCY	• The main work can start without waiting for detour materials. • The stream course must be moved parallel to the new embankment. • The second bridge from Maha Oya side has a very short span, so it can be a box culvert for new route.	○	• It takes time to procure steel for the temporary bridge. • Construction cost is relatively large • Construction quantity is small because of being on the existing road. • The span of the second bridge from Maha Oya side is very short, so it can be a box culvert on the new route.	△	• It takes time to procure steel for the temporary bridge. • Construction quantity is small because of being on the existing road. • Construction quantity is small because of being on the existing road. • The span of the second bridge from Maha Oya side is very short, so it can be a box culvert on the new route.	△
CONSTRUCTION PERIOD	• Construction period except for superstructures is within the first dry season (7 months) if the work starts from March.	○	• Construction period requires two dry seasons because of detour construction.	△	Same as at left	△
RISK OF DELAY	• Little risk of delay because of no need for a detour.	○	• Little risk of delay because the Japanese side will be responsible for constructing the detour.	○	• Some risk of delay because the Sri Lankan side will be responsible for constructing the detour.	▲
COMPARISON OF CONSTRUCTION COST Note) The cost includes both tasks namely GOJ & GOS. Further the comparison of the cost is made on the basis of the ratio of the each route.)	• 1.00	○	• 1.01	△	• 1.01	△
	• Liability of GOS: 7 million yen	○	• Liability of GOS: Nil	◎	• Liability of GOS: 30 million yen	△
EVALUATION	△		◎		○	

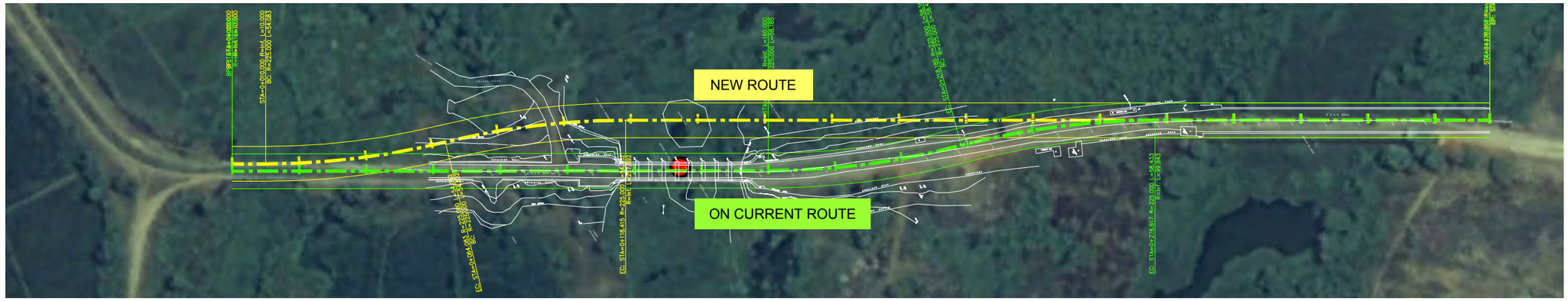
<u>Note</u>
Evaluation Order: (Bad) ▲<△<○<◎ (Good)

Table Ap.6-3 Bridge No.3: Route Comparison

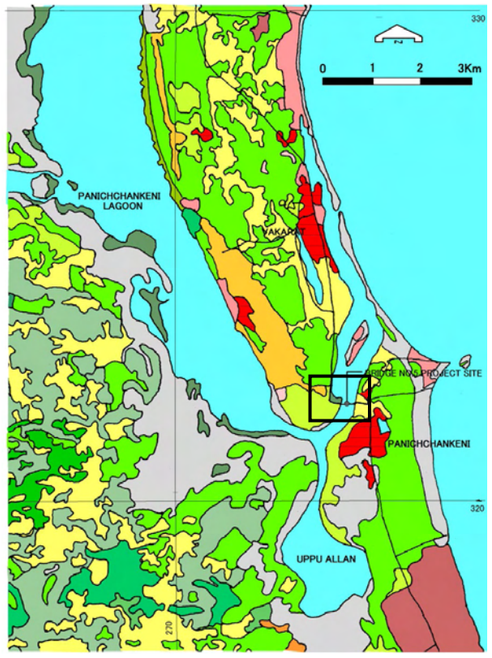
ITEM	NEW ROUTE (WITHOUT DETOUR) : YELLOW ALIGNMENT 【RECOMMENDED】		ON CURRENT ROUTE (WITH DETOUR) : GREEN ALIGNMENT DETOUR BY JAPAN		ON CURRENT ROUTE (WITH DETOUR) : GREEN ALIGNMENT DETOUR BY SRI LANKA	
DESCRIPTION						
	Southern new route from existing bridge (Current alignment is improved) • Earth work: about 250 m (Volume: around 3,000cu.m) • Bridge length: 16 m • Detour: None Additional survey is required to confirm this alignment.		On existing route The road alignment of Maha Oya side is out of Standard, the alignment must be improved(R=225m) • Earth work: about250 m (Volume: around 1,000 cu.m) • Bridge length: 16 m • Detour (Temporary bridge 16 m) Additional survey is required to confirm the longitudinal alignment.		Same as at left	
ENVIRONMENTAL EFFECT	• There are no houses. Current traffic can be secured during construction work. • On upstream, one house uses the stream for drinking water. However, the construction site is down stream of the house, so there will be no effect.	○	• There are no houses. Current traffic can be secured during construction work. • On upstream, one house uses the stream for drinking water. However, the construction site is down stream of the house, so there will be no effect.	○	Same as at left	○
EFFECT ON RIVER	• The new road will be constructed on a part of the existing stream. The stream course must be changed. However, this stream is small and the required construction work is also small. • To change the stream line, adequate water flow section must be secured if the curved stream is corrected to a strait stream.	△	• The stream line does not need to change; however, revetment work will be necessary.	○	Same as at left	○
RUNNING COMFORT (AFTER COMPLETION)	• R=450m will be used. The steep curve (R=around 50 m) will be improved.	○	• R=225m will be used. The steep curve (R=around 50 m) will be improved.	○	Same as at left	○
RUNNING COMFORT (UNDER CONSTRUCTION)	• The existing road can be used during the construction period.	○	• Using detour, running comfort will be worse because the alignment is worse.	△	Same as at left	△
CONSTRUCTION EFFICIENCY	• The main work can start without waiting for temporary materials. • The current stream must be moved for the new route. • Electric power line, 10 m south of the road, must be moved.	○	• It takes time to procure steel for temporary bridge. • Construction quantity is small because of being on the existing road. • Construction cost is relatively large.	△	• It takes time to procure steel for temporary bridge. • Construction quantity is small because of being on the existing road.	△
CONSTRUCTION PERIOD	• Construction period except for superstructures will be within the first dry season (7 months) if the work can start from March.	○	• Construction period requires two dry seasons because of detour construction.	△	Same as at left	△
RISK OF DELAY	• Little risk of delay because of no need to detour.	○	• Little risk of delay because the Japanese side will be responsible for constructing the detour.	○	• Some risk of delay because the Sri Lankan side will be responsible for constructing the detour.	▲
COMPARISON OF CONSTRUCTION COST Note) The cost includes both tasks namely GOJ & GOS. Further the comparison of the cost is made on the basis of the ratio of the each route.)	• 1.00	○	• 1.06	△	• 1.06	△
	• Liability of GOS: 2 million yen	○	• Liability of GOS: Nil	◎	• Liability of GOS: 9 million yen	△
EVALUATION	◎		○		△	

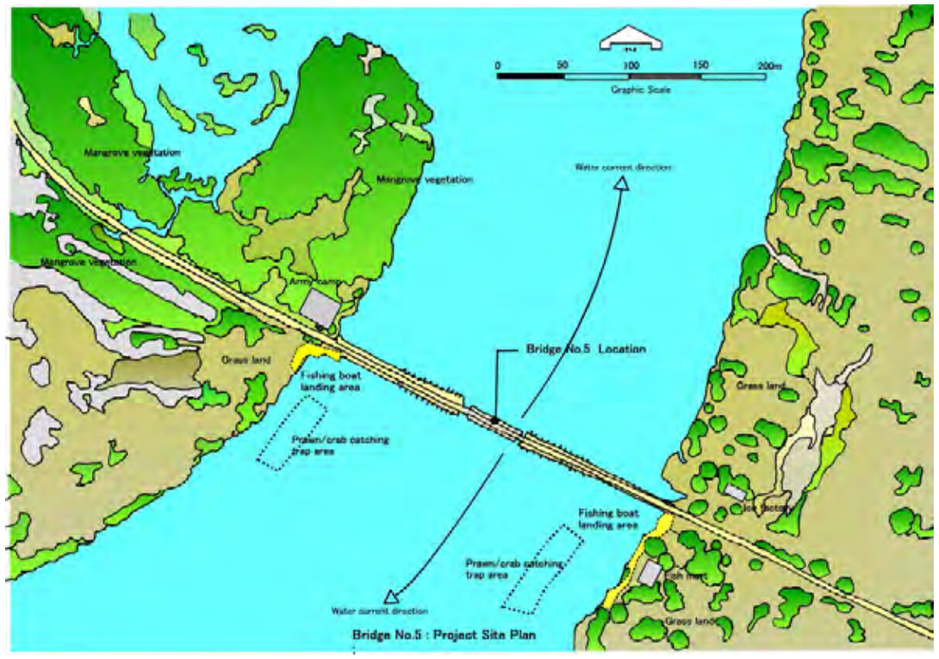
Note
Evaluation Order: (Bad) ▲<△<○<◎ (Good)

Table Ap.6-4 Bridge No.4: Route Comparison

ITEM	NEW ROUTE (WITHOUT DETOUR) : YELLOW ALIGNMENT 【RECOMMENDED】		ON CURRENT ROUTE (WITH DETOUR) : GREEN ALIGNMENT DETOUR BY JAPAN		ON CURRENT ROUTE (WITH DETOUR) : GREEN ALIGNMENT DETOUR BY SRI LANKA	
DESCRIPTION						
	Northern new route from existing bridge • Earth work: about 350 m (Volume: around 7,000 cu.m) • Bridge length: 36 m • Detour: None Additional survey is required to confirm this alignment.		On existing route • Earth work: about350 m (Volume: around3,000 cu.m) • Bridge length: 36 m • Detour: On river bed about 40 m Additional survey is required to confirm the longitudinal alignment		Same as at left	
ENVIRONMENTAL EFFECT	• There are no houses near the bridge. • This area is a wetland on public land and is subject to dumping of trash. Part of the southern area is privately owned. • Construction effect on the environment is small. • The new route shall be close to the existing bridge to reduce private land acquisition. • The existing road must be removed by the Sri Lankan side.	○	• There are no houses near the bridge. • There wil be some effect from transporting waste from removing the existing bridge. • The detour requires drainage, such as adequate pipe culverts, to cope with floods in the rainy season. • Because of low traffic volumes, the detour can be in the river with a 3% longitudinal gradient and gravel pavement. • In the rainy season, maintenance of the detours to repair flood damage to earth work will be necessary. • The existing road must be removed after construction of the detour; however, there is little problem because no houses exist near the bridge.	△	Same as at left	○
EFFECT ON RIVER	• This bridge is located in a flood zone. There is no need to change the water system.	○	• This bridge is located in a flood zone. There is no need to change the water system.	○	Same as at left	○
RUNNING COMFORT (AFTER COMPLETION)	• R=225 m must be used, however the running comfort can be secured.	○	• R=225 m must be used, however the running comfort can be secured.	○	Same as at left	○
RUNNING COMFORT (UNDER CONSTRUCTION)	• The existing road can be used during the construction period.	○	• The running comfort will be worse because of the detour alignment.	△	Same as at left	△
CONSTRUCTION EFFICIENCY	• The main work can start without waiting for temporary materials.	○	• It takes time to procure steel for temporary bridge. • Construction quantity is small because of being on the existing road. • Construction cost is relatively large.	△	• It takes time to procure steel for temporary bridge. • Construction quantity is small because of being on the existing road.	○
CONSTRUCTION PERIOD	• Construction period except for superstructures is within the first dry season (7 months) if the work can start from March.	○	• Construction period requires two dry seasons because of detour construction.	△	Same as at left	△
RISK OF DELAY	• Little risk of delay because of no need for a detour.	○	• Little risk of delay because the Japanese side will be responsible for constructing the detour.	○	• Some risk of delay because the Sri Lankan side will be responsible for constructing the detour.	▲
COMPARISON OF CONSTRUCTION COST Note) The cost includes both tasks namely GOJ & GOS. Further the comparison of the cost is made on the basis of the ratio of the each route.)	• 1.00: : :	◎	• 1.01	○	• 1.01	○
	• Liability of GOS: 13 million yen: :	○	• Liability of GOS: Nil: :	◎	• Liability of GOS: 10 million yen: :	△
EVALUATION	◎		○		△	

Note
Evaluation Order: (Bad) ▲<△<○<◎ (Good)





Note
Evaluation Order: (Bad) ▲<△<○<◎ (Good)

Table Ap.6-5 Bridge No.5: Route Comparison

ITEM	NEW ROUTE: LANDSIDE (WITHOUT DETOUR): PURPLE ALIGNMENT		NEW ROUTE OCEAN SIDE (WITHOUT DETOUR): YELLOW ALIGNMENT		ON CURRENT ROUTE (WITH DETOUR) : GREEN ALIGNMENT: DETOUR BY JAPAN【RECOMMENDED】		ON CURRENT ROUTE (WITH DETOUR) : GREEN ALIGNMENT: DETOUR BY SRI LANKA	
DESCRIPTION	Land side from existing route. • Earth work length: about 167m (Volume: 12,000cu.m) • Bridge length: 133 m • Detour : None Additional land mine and UXO clearance is required to take new alignment.		Ocean side from existing route. • Earth work length: about 167m (Volume: 12,000cu.m) • Bridge length: 133 m • Detour : None Additional land mine and UXO clearance is required for the new alignment.		On existing route • Earth work length: about 167m (Volume: 12,000cu.m) • Bridge length: 133 m • Detour: with 80 m bailey bridge		Same as at left	
CAUSEWAY	• Soil improvement work (e.g. vertical drain method) will be necessary to prevent ground sinkage because embankment will be constructed on soft sediments (Thickness=6-8m, N-value <3).	▲	Same as at left	▲	• The existing embankment will be utilized. Therefore, the risk of sinkage is lower than other new routes (soil improvement work is not required).	○	Same as at left	○
ENVIRONMENTAL EFFECT	• There are no houses, however some facilities (e.g. collection yard and cold strage facilities for fisherman) may have to be relocated. • This route effects prawn and crab fisheries based on the use of fixed traps set on the inner lagoon. • Land acquisition will be necessary. • Ground improvement work is necessary on the Trincomalee side. • The port for fishermen's boat must be resettled.	▲	• There are no houses, however some facilities may be resettled. • This route effects prawn and crab fisheries based on the use of fixed traps set on the inner lagoon. The effect in ocean side is smaller than inner lagoon plan. • It effects on mangroves on Trincomalee side. • Land acquisition will be necessary. • Ground improvement work is necessary on the Trincomalee side.	△	• There are no houses, and no effect on existing facilities. • This route effects fishing for prawn and crab with fixed trap. The effect in ocean side is smaller than inner lagoon plan. • Land acquisition will not be necessary (lease only).	○	Same as at left	○
EFFECT ON LAGOON	• Mitigation measures, like silt fence, will be necessary. • The existing causeway and bridge must be removed by the Sri Lankan side immediately after construction to enable the benefits of the new wide bridge to be realized.	○	• Water pollution during the construction will be mitigated by the existing causeway. • Pollution by removal of the existing bridge will be small. • The existing causeway and bridge must be removed by the Sri Lankan side immediately after construction to enable the benefits of the new wide bridge to be realized.	○	• Water pollution will be mitigated because the existing causeway will shut off the flow of suspended solids material into inner lagoon during the construction period. • An earth coffer-dam will shut off the flow of suspended solids into inner lagoon in case of removal of existing causeway. • Water pollution will be mitigated because the new causeway will shut off the flowing of suspended solids into the inner lagoon in case of removal of detour.	○	Same as at left	○
RUNNING COMFORT (AFTER COMPLETION)	• Running comfort is good because of good sight and straight road. • Risk of gound sinkage exists due to thick sediment layer.	○	• R=225 m curve must be used. The alignment will be worse compared to the other sections because national road 15 is under improvement.	△	• Running comfort will be better than other routes because of good sight with straight road. • There is no risk of ground sinkage because the construction will be on the existing causeway.	◎	Same as at left	◎
RUNNING COMFORT (UNDER CONSTRUCTION)	• Current traffic must use existing road, which is dangerous, during the construction period.	△	Same as at left	△	• Using a detour, the running comfort will be improved although the alignment is worse.	○	Same as at left	○
CONSTRUCTION EFFICIENCY	• Detour is not required. • The existing causeway can be a part of a cofferdam. • Existing causeway cannot be used as a temporary construction road. • Reduction of the construction period cannot be expected due to soil improvement work.	○	Same as at left	○	• Construction of detour and removal of existing bridge are required before the main construction work. • Bailey bridge (80 m long), granted by tsunami rehabilitation project, can be used for detour.	○	• Construction of detour and removal of existing bridge are required before the main construction work. • Bailey bridge (80 m long), granted by tsunami rehabilitation project, can be used for detour. • Current traffic and construction equipment way are not separated in Sri Lankan design of detour. It bothers the construction work by Japan.	▲
CONSTRUCTION PERIOD	• Construction period except for superstructures is within two dry seasons if the work can start from March.	○	Same as at left	○	• Construction period requires two dry seasons includes detour construction.	○	Same as at left	○
RISK OF DELAY	• Little risk of delay because of no need to detour. • Quick removal of existing causeway/bridge will be accepted to GOS.	△	Same as at left	△	• Little risk of delay because the Japanese side will be responsible for constructing the detour. • Project progress can be controlled by Japan.	○	• Some risk of delay because the Sri Lankan side will be responsible for constructing the detour. • It is difficult to separate usual traffic from construction equipment by the detour planned by the Sri Lankan side.	▲
COMPARISON OF CONSTRUCTION COST Note) The cost includes both tasks namely GOJ & GOS. Further the comparison of the cost is made on the basis of the ratio of the each route.)	• 1.00	○	• 1.00	○	• 1.03	△	.03	△
	• Liability of GOS: 16 million yen	△	• Liability of GOS: 16 million yen	△	• Liability of GOS: Ni	◎	• Liability of GOS: 37 million yen	▲
EVALUATION	▲		△		◎		▲	

<u>Note</u>
Evaluation Order: (Bad) ▲<△<○<◎ (Good)

APPENDIX 7 Technical Memorandum (March 25, 2009)

Technical Memorandum
for the Preparatory Survey
on the Project for the Reconstruction of Five Bridges
in the Democratic Socialist Republic of Sri Lanka

At the end of the field survey for the captioned project, both parties agreed following items based on the discussion on March 25, 2009.

- The design conditions for the Project are confirmed by both parties as shown in "Annex: Bridge Design Conditions".
  The length of new No.1 Bridge (240/4) shall secure current cross-sectional flow area of the existing bridge.
- At the vicinity of No. 2 Bridge (241/2, 241/3, 241/4), it was sometimes observed (once in every two to three years) that the flood water overflows above the road by 50 – 100cm. If the approach roads for the new No.2 Bridge will block the overflow water, the cross-sectional flow area of the new bridge shall compensate the blocking area by lengthening the new bridge against the existing one.
- The length of new No.3 Bridge (247/2) shall secure current cross-sectional flow area of the existing bridge.
- The length of new No.4 Bridge (283/7) shall secure current cross-sectional flow area of the existing bridge. It will be considered if the superstructure of existing bridge could be re-used as part of new No.4 Bridge.
- The length and bridge type of Panichchankeni Causeway and new No.5 Bridge (59/1) shall be determined by the Survey Team through design review on the Feasibility Study and Detailed Design done several years ago. Although the detailed design was approved by the Sri Lankan side, the Survey Team may revise or change the design if necessary.

March 25, 2009, Colombo, Sri Lanka

Mr. Hideaki Takaura
Bridge Designer / Construction Planning
Preparatory Survey Team

Mr. T Vasanthakumar
Senior Designs Engineer (Bridge Designs)
Road Development Authority

Annex Bridge Design Conditions

Bridge Design Conditions

The design conditions to be applied for the preparatory design stage are summarized below.

(1) Design Standards

- RDA Bridge Design Manual: 1997
- RDA Geometric Design Standards of road: 1998
- British Standard BS5400

(2) Design Concept

1) Design High Water Level

Both side agreed that the Design High Water Level shall be determined from hearing results of the flood level except for bridge No.5 (Panichchankeni Causeway and bridge).

In this preparatory study, the hydrolcgical analysis will not be done because the available topographical data surrounding the bridge sites are limited due to the delay of mine clearance.

Regarding bridge No.5, the Survey Team will review the hydrological analysis done by the feasibility study (JICA 2005) and determine the Design High Water Level.

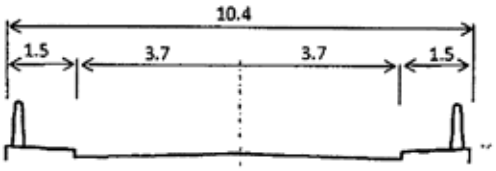
The hydrological analysis shall be done at the detailed design phase, if necessary.

2) Bridge Type and Dimensions

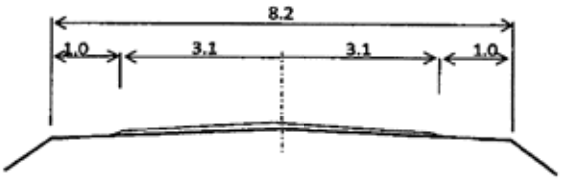
Bridge type will be basically Pretension Prestressed Concrete bridge or Reinforced Concrete bridge. The bridge width will cover 2-lane traffic and the cross section will follow the adjacent ADB project on National highway AA05.

Bridges on AA05

- Design Speed : 70km/h
- Cross section for the bridges

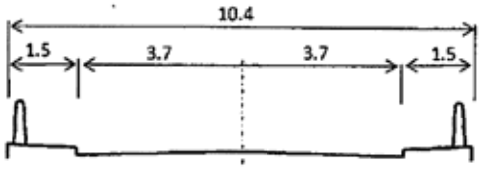


- Cross section for approach roads

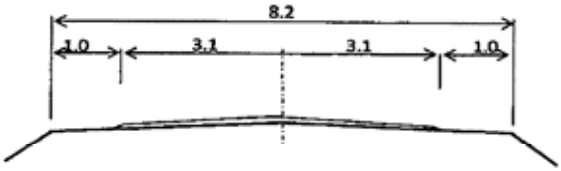


Bridge on AA15

- Design Speed : 70km/h
- Cross section for the bridges



- Cross section for approach roads



(3) Design Load

1) Dead Load

Material	Unit Weight (kN/m^3)
Plain Concrete	24.0
Reinforced Concrete	25.0
Asphalt Pavement	23.0

Steel	78.5
Embankment	18.0

2) Live Load

HA,HB live load of the standard for bridge design (BS5400) shall be applied for the bridge design.

3) Other Loads

Other loads shall be in accordance with the bridge standard (RDA Bridge Design Manual), such as earthquakes, wind load, water and /or earth pressure, and buoyancy for substructure design.

(4) Material Strength

The design strength of concrete shall be based on Sri Lamkane standards.

1) Design Strength of Concrete

Description	Strength (N/mm^2)
Deck Slab, Infill Concrete between beams	40.0
Bearing Support, Pile Cap, Parapet, Abutment body wall, Abutment wing wall, Pier, Footings for pier and abutment, Transition slab	30.0
Lean concrete	15.0
Bored Pile	30.0

2) Yield Strength of Reinforcements

The following reinforcement materials will be used for this Project and are based on Sri Lanka's Standards.

Type	Yield Strength (N/mm^2)
Tor Steel	460
Mild Steel	250

(5) Seismic conditions

According to RDA Bridge Design Manual, earthquake load is not considered in bridge design.

APPENDIX 8 Vertical Head Room Clearance for Panichchankerni Bridge

Appendix8: Vertical Head Room Clearance for Panichchankerni Bridge

ROAD DEVELOPMENT AUTHORITY
Engineering Services Division
03 APR 2009
Bridge (Design)
BATTARAMULLA

My No: RDA/ES/JBEP

3rd April 2009

Director/Planning

Vertical Head Room clearance for Panichchankerny bridge.

This refers to the above information that was requested by the JICA study team working on 05 bridges grant aid project in Eastern Province.

The Provincial Director / EP has contacted the Panichchankerny Fishermen Co-operative society and they have suggested to provide 2.3 m vertical head clearance while the Department of Fisheries and Aquatic Resources recommends to provide 2.5 m.

As such I wish to inform you that in finalizing the formation level of the above bridge, 2.5 m vertical clearance has to be provided.

I shall be thankful if you could forward this information to the JICA team for them to finalize the finished level of the new bridge.

The original letter submitted to PD/EP by the Fishermen Co-operative Society is attached herewith.

Director/Engineering Services
Road Development Authority

Copies to :	DD/BD	-	f.i.pl.
	Provincial Director/EP	-	f.i.pl.