Government of Sri Lanka
Asian Development Bank

Technical Assistance

Project Number: 4853-SRI

Sri Lanka: Dry Zone Urban Water Supply and Sanitation Project (DZUWSSP)

SUMMARY INITIAL ENVIRONMENTAL EXAMINATION (DRAFT)

MARCH 2008

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A. Introduction

1. The Dry Zone Urban Water Supply and Sanitation Program (DZUWSSP) is intended to facilitate sustainable development in disadvantaged districts in Sri Lanka. This will be achieved by investing in priority water supply and sanitation infrastructure in selected urban areas, and assisting the National Water Supply and Drainage Board (NWSDB) to institutionalise the development of sustainable community-based infrastructure. Assistance will be targeted in those parts of the Northern and North-Western Provinces with the most acute shortages of drinking water and sanitation. Chosen urban areas are the towns of Mannar, Vavuniya, Puttalam and Chilaw.

2. DZUWSSP will be implemented over five years beginning in early 2009, and will be supported by ADB through a project loan and grant. The Ministry of Water Supply and Drainage (MWSD) is the Executing Agency (EA) and NWSDB is the Implementing Agency (IA). The Project has been classified by ADB as environmental assessment category B, where the component requiring greater attention is the Vavuniya water supply subproject (a 4 m high dam and 215 ha storage reservoir). The impacts of providing infrastructure in the four urban areas were assessed by four Initial Environmental Examination (IEE) reports (one for each location). For Vavuniya an Environmental Management Plan (EMP) for the storage reservoir and a detailed Environmental Monitoring plan (EnvMoP) for the other less sensitive sub-components have been prepared. In the other three towns, where impacts will be less significant, detailed Environmental Monitoring Plans have been prepared. This document (SIEE) summarizes the findings of all four IEEs. Studies were conducted according to ADB Environment Policy (2002) and Environmental Assessment Guidelines (2003). The NWSDB will submit the project information documents to the Central Environmental Authority and Provincial Environmental Authority (North Western Province) to obtain the necessary environmental clearances required under Government of Sri Lanka's regulatory framework.

B. Description of the Project

3. The proposed infrastructure varies in composition as each area has different needs, but improvements in a particular sector generally contain the same basic elements. These are:

Urban Water Supply: Source augmentation: increased abstraction of surface- or ground-water;
More efficient transfer: transmission main, pumping stations;
Improved treatment: new or refurbished water treatment plant (WTP) or increased chlorination;
Increased storage: ground storage tanks, overhead reservoirs (OR);
Improved/extended distribution: distribution main and network;

Urban Sanitation: New pit latrines with septic tanks and soakage pits or only soakage pits in plots with space constraints;
Improved emptying of septic tanks: new vacuum tanker vehicles;
Septage treatment: facility to dry sludge and treat liquid effluent;

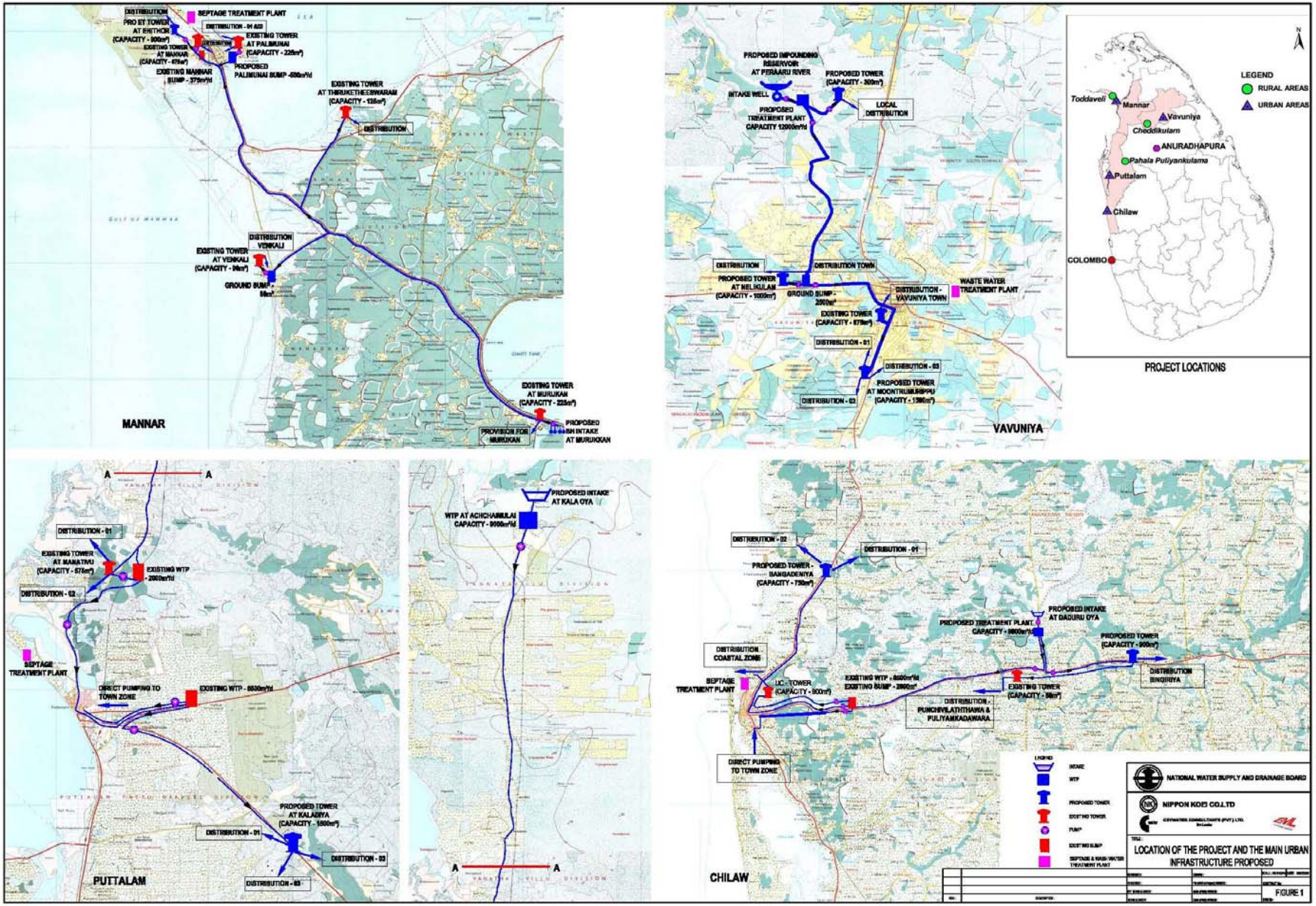

Figure 1: Location of the Project and the Main Urban Infrastructure Proposed

4. Table 1 shows the location, size and dimensions of all elements of the proposed infrastructure, and Table 2 summarises the likely approach to construction of each element and operation of each scheme as a whole. All infrastructure will be designed during a twelve to eighteen-month detailed design stage in 2009–2010, and built during a four-year construction period (2010-2013).

Table 1: Details and Dimensions of the Proposed Infrastructure

URBAN SUBPROJECTS	MANNAR	VAVUNIYA	PUTTALAM	CHILAW
Rehabilitate Tube Wells (No)	4	4	-	-
New Tube Wells (No; depth)	4; 20 m	6; 20 m		7; 20 m
New earth bund (length; crest height)	-	1.5 km; 4 m		
Reservoir (capacity; area at FSL)		3.7 million m^3; 215 ha		
Intake well (diameter; depth)		5 m; 5 m; RCC	6 m; 6 m; RCC	
Rehabilitate weir across river			Replace sluice gates	
Irrigation tanks: remove silt & plants			2 tanks; 1 canal	
New intake canals (ht, width, length)			5 m; 5 m; 1.5 km - earth 5 m; 5 m; 1.9 km - earth	2.4 m; 10 m; 40 m; RCC
New weir in river (length; crest height)				50 m; 1.5 m; RCC
Raw water pump house (pump no)			3	6
Raw Water Transmission Main	32.9 km; 50-450 mm	1.6 km; 400 mm	300 m; 500 mm	4.4 km; 400 mm
Refurbish Water Treatment Plant			✓	✓
Tank to mix treated + ground water		Existing OR	Existing tank	Existing 2000 m^3 tank
New WTP (area)		0.8 ha; RCC tanks	2 ha: RCC tanks	1.2 ha; RCC tanks
Treated water pump house (pump no)		4		
Chlorine injection units (no)	3			
Treated Water Transmission Main	10 km; 160-355 mm	15.5km; 350-450 mm	33 km; 400 mm	22.5 km; 300-400 mm
Treated Water Ground Storage Tank	1 tank; 500 m^3	1 tank; 2500 m^3	2 tanks; 2000 m^3	1 tank; 500 m^3
Pump station (no; no of pumps)		4 stations; 2 pumps		
Overhead Reservoir (no; capacity)	1; 900 m^3	3; 1000, 1500, 300 m^3	1; 1500 m^3	2; 750 m^3, 900 m^3
Distribution main (length; diameter)	15.4 km; 110-280 mm	41 km; 110-400 mm	28.5 km; 200-400 mm	29 km; 160-400 mm
Distribution pipes (length; diameter)	75 km; 63-160 mm	95 km; 90-160 mm	64 km; 90-300 mm	108 km; 90-225 mm
Household latrines (no)	500	500	500	500
Vacuum tanker vehicle (no; capacity)	1; 3000 litre	2; 3000 litre	2; 3000 litre	1; 3000 litre
Septage treatment (area; no of ponds: thickening; sludge drying; effluent treatment; reed-bed)	0.75 ha; 2T; 6D; 2ET; 1RB	1 ha 3T; 12D; 3ET; 1RB	1 ha 3T; 10D; 2ET; 1RB	0.75 ha 3T; 8D; 2ET; 1RB

D =Drying Beds, ET = Effluent Treatment FSL =Full Supply Level, ha =Hectares, ht = height, km = kilometer, m = meter, mm = millimetre, OR =Overhead Reservoir, RB =Reed Beds, RCC =Reinforced Concrete , T =Thickening , WTP = Water Treatment Plant

Table 2: The Likely Approach to Construction and Operation of Each Infrastructure Element

ELEMENT	CONSTRUCTION METHOD
Tube Wells (TW)	• Rehabilitation: pumped removal of silt; replacement of pumps, screens, pipes as necessary • New wells: 300 mm diameter tube bored via drilling rig; steel screen, submersible pump and pipes inserted
Bund & reservoir	• Earth of required characteristics dug from borrow pits at nearest source; brought to site on trucks • Vegetation cleared from bund area; earth offloaded, positioned by bulldozer; soil compressed by roller • RCC spillway & sluices: metal reinforcing bars positioned by hand, portions encased in wooden shuttering, concrete added, shuttering removed when dry; process repeated in next portion to gradually form structure • River flows through sluice during construction. Sluice then closed and reservoir fills to Full Supply Level
Intake well	• Cavity dug by backhoe; soil & stone taken offsite in trucks; well is built from RCC as described above
Irrigation Tank de-silting	• Water drained & pumped from tank into irrigation channel in dry season; silt & plants removed by bulldozer • Removed material left on nearby land from where farmers may collect to apply to their fields
New intake canals	• Cavity for canals dug by backhoe; soil and stone removed on trucks; earth canal compacted by roller • Reinforced Cement Concrete (RCC) canal built as described above (reinforcing bars, shuttering, concrete)
Weir across river	• Bunds dug in riverbed in dry season to divert river; foundations for weir & intake canal dug by backhoe • Row of steel sheet piles inserted by hydraulic hammer; hardcore & concrete tipped in to form foundations • Metal reinforcing added by hand to form above ground structure of weir; weir created from RCC as above • Gabions (cubical metal baskets of stone) brought ready-made to site & placed by crane along river banks • Stone tipped from trucks and placed by hand and grab-crane to form two groynes (2 m high, 20 m long)
Pump House (PH)	• Foundations dug to around 0.5 m by backhoe; hardcore and concrete tipped in to form floor; • Bricks & mortar applied by masons by hand to form walls; pumps & pipes positioned by crane; roof added
Transmission main	• Trench (approx 0.8 m wide, 1.8 m deep) dug by backhoe in Right of Way (RoW) alongside main roads • Soil placed alongside trench; pipes brought in on trucks, placed into trench by pipe-rig, joined by hand; • Quarry sand shovelled around pipe for protection; approx 25% of dug soil replaced on top and compacted
Refurbish Water Treatment Plant	• Sand removed from malfunctioning filters by hand digging, replaced with fresh sand brought in on trucks; • Existing tank converted to chamber for mixing groundwater and treated water by addition of pipes & pumps
New Water Treatment Plant (WTP)	• Vegetation cleared by hand and bulldozer, cavities for new tanks and trenches for pipes dug by backhoe • Metal reinforcing rods added by hand to floor and sides of cavities, structure created from RCC as above • Sand, gravel, settling tubes, pipes, pumps, etc brought on trucks, offloaded by crane, connected by hand
Chlorine injection	• Small locally made unit (comprising chlorine cylinder, pump, injection pipe) attached to water pipes
Ground tank	• Cavity dug by backhoe; floor, sides, roof of tank built from RCC as above; pipe-work added by crane/hand
Overhead Reservoir (OR)	• Foundations dug to 1 m by backhoe, reinforcing rods, aggregate and concrete added to form base; • Above-ground supports and tank then formed from RCC as above (reinforcing bars, shuttering, concrete)
Distribution network	• Same process as for transmission mains; pipes and trenches are in RoW alongside streets in town/village
Latrines	• Small brick-mortar hut with ceramic floor basin connected to nearby septic tank and soakage pit/ or only soakage pit, built outside houses
Septage Treatment Facility (STF)	• 3 m and 1 m deep cavities dug by backhoe, aggregate & concrete poured in to form mass concrete floors; • Sides of sludge beds built from brick/mortar, concrete added to sloping sides of anaerobic & wetland pond • Grass, bamboo or reeds planted in wetland bed to absorb water and nutrients from effluent
	OPERATION AND MAINTENANCE
Water Supply	• Repair of network leaks: trenching to uncover and replace faulty pipes, done by backhoe & hand digging • At WTP, sludge is washed periodically from settling tanks and sand filters, chlorine cylinders replaced • Maintenance at WTP, OR, PH - checking pumps, pipes, valves, meters, replacing parts when necessary • Weirs & reservoir operated as in O&M manuals to retain water for abstraction & maintain downstream flow
Septage Treatment	• Scum from thickening beds and sludge from drying beds removed by small loader every few weeks; • Sludge taken by truck to municipal dump; wetland plants removed & replaced by hand every few years

C. Description of the Environment

Table 3: The Main Environmental Features of the Four Study Towns and Three Rural Areas

Location	Urban: Chilaw, Puttalam & Mannar are towns on the west coast of Sri Lanka, respectively 70, 130, and 220 km north of the national capital Colombo; Vavuniya is 50 km east of Mannar.
Topography, soil, geology	The coastal towns and villages (Chilaw, Puttalam, and Mannar) are flat with sandy soils and are in a narrow Miocene to Quaternary belt of ferruginised gravels and alluvium over Miocene bedrock. Vavuniya, is in the Precambrian Vanni complex of granitic gneiss & biotite that runs diagonally across the country. Soils here are mainly the more fertile reddish brown earth and the topography is gently undulating.
Climate	Chilaw is in the intermediate rainfall zone where there is an average of 1500-2000 mm of rain per year. The other towns and villages are in the low rainfall zone and receive 500-1500 mm per year only. 40-50% of the rain falls in October-November and 20-30% in April-May. Temperatures reach daily averages of around 30 °C in May-August and fall to around 25°C in December-January, and fall by around 5-10 degrees at night. Humidity is high, often >80%.
Air Quality	There are few data, but air quality is likely to be good because of the lack of heavy industry and dispersion by coastal winds. Particulate matter will increase during the dry season and soot may increase when vegetation is burned.
Surface Water	Chilaw and Puttalam are in the drainage basins of the Dedru Oya and Kala Oya (rivers), which drain to the west coast; and Vavuniya is in the basin of the Malwatha Oya. There are large numbers of "tanks" in most areas (large man-made reservoirs formed by constructing earth bunds across rivers or in low lying areas), from where water flows into irrigation channels. Giant's Tank near Mannar is the 2nd largest in the country.
Groundwater	Groundwater is contained in alluvial deposits and ferruginous gravels in Chilaw and Puttalam and is exploited by private & public wells and by NWSDB to supply water to the towns. There is a large aquifer in Miocene limestone near Mannar that is also exploited, and perched surface aquifers on the island. There are no data on extent or yield of the aquifers or the quality of the water. There are no major aquifers in Vavuniya but some groundwater is present.
Ecology	Vegetation has been removed from the inhabited areas and their surroundings to provide land for development and agriculture. Vegetation now consists of crops & fruit trees; animals are those able to live close to man. Irrigation tanks support aquatic plants and animals and Chilaw and Puttalam lagoons are further wetland habitats. There is some riverine forest alongside some rivers, but the only protected area is Wilpattu National Park adjacent to the Kala Oya.
Land use	Most land in the urban areas is developed for housing, shops, small industry and government offices; and outside the land is mainly used for agriculture. In rural areas land is mainly used for housing and agriculture.
Industry and agriculture	The only large industries are Holcim Cement and coastal salt pans at Puttalam, where a 100 MW coal power plant is also being built. Most other industry is small, including light engineering, garment manufacture, brickworks, etc. Farming is mainly paddy rice (irrigated and rain-fed) plus maize, vegetables, livestock. There are also coastal fisheries.
Infrastructure	All target towns have a piped water supply based on groundwater, but water is only available for a few hours a day because of inefficient TW and leaking networks. There is no sewerage and people rely on septic tanks or pit latrines, and many households have no toilet. There are open concrete drains beside roads in towns, but most are blocked with silt and garbage. Solid waste is collected and dumped on land outside the towns as there are no landfills. Most people in towns and some in villages have electricity from the national grid.
Transportation	All towns are at junctions of main highways and have good road connections to neighbouring towns and districts. Roads in the centre of towns are generally congested. Public buses and motor cycles are the main transport. Chilaw, Puttalam and Vavuniya are on the railway from Colombo, but at Mannar the track was destroyed by some years ago by the LTTE (Liberation Tigers of Tamil Eelam). Villages are reached by unpaved roads from the nearest highway.
Demography	In 2006 the population of Chilaw was 68,000, Puttalam 71,000, Mannar 41,000, Vavuniya 115,000. Sex ratios are close to 1:1 and average family size is around 4 persons. Literacy is good in Puttalam and Chilaw but lower in other towns and villages. With the exception of Chilaw, the towns are affected in varying degrees by the conflict between Government and the LTTE who wish to establish an autonomous Tamil state in the north. People (particularly Muslims) have moved from Mannar & other towns in the LTTE controlled area to safer areas in the south where many live in IDP camps (Internally Displaced Persons). The main religious/ ethinc groups are Christian in Chilaw, Muslim in Puttalam, Tamil/Christian in Mannar and Tamil/Hindu in Vavunia
Socio-Economics	Unemployment is >30% in all of the target towns and villages. Those employed are mainly in agriculture/fishing, business/trading, government and the private sector. A high proportion of families own their own houses, although the condition of buildings is generally poor and there are many empty houses in Mannar. Significant numbers of families receive government assistance from the *Samurdhi* poverty alleviation programme.
Health and Education	Health and education facilities are more numerous and better equipped in towns than rural areas, but Mannar is less well provided than the other target towns. Each town has a base hospital and public and private clinics, but only the larger villages have clinics. The towns (except Mannar) have reasonably good pre-schools and primary/ junior schools, but fewer schools and colleges offering GCE and higher level teaching. Pupil teacher ratios are good, at 25-30:1.
History, Culture and Tourism	NGOs and CBOs operate in all towns and some villages, dealing particularly with displacement and other social issues. Most villages have death donation societies (which help bereaved families), farmers' associations, women's groups, etc. Culturally important buildings in towns and villages are mainly associated with the religions: temples, churches and mosques; and there is no significant tourism and none of the requisite infrastructure (hotels, resorts, etc)

D. Forecasting Environmental Impacts and Mitigation Measures

5. Construction of infrastructure is not expected to have major adverse impacts because:

- Most network improvements will be on unused ground alongside roads and can be built without causing major disruption to road users, houses, shops and businesses;
- Most new facilities (OR, PH, WTP, STF) will be located on government-owned land that is not occupied or used for any other purpose;
- Most network construction will be conducted by small teams working on short lengths at a time so most impacts will be localised and short in duration;
- The construction programme will be relatively short for a project of this nature, and should be completed in 3-4 years in the towns.

6. Therefore several environmental sectors will not be affected by the construction work, shown in Table 4. However, because the urban schemes are large and will be built in inhabited areas, it is inevitable that construction will cause some negative impacts. These are shown in Table 5, with the mitigation required to reduce each impact to acceptable levels, and the responsibility, location and programme for mitigation.

Table 4: Fields in which construction is not expected to have significant impacts

Field	Rationale
Climate	Short-term production of dust is generally the only effect on atmosphere
Geology and seismology	Excavation will not be large enough to affect these features
Wildlife, protected areas, rare or endangered species	There is little natural vegetation or wildlife in or near the target towns and villages and no protected areas. However, the Kala oya which will be the source for the Puttalam water supply borders the Wilpattu National Park. Since no major construction activities are expected in close proximity to the Park, impacts will be very minimal and efforts will be made to minimize noise and movement of construction vehicles when constructing the canal diverting the flow from Kala oya to Achchamolai Tank. Any construction work within 1.5 km of the boundary of the Wilpattu National park will be done with manual labor and use of heavy machinery will be limited.
Tourism	There is no significant tourism in or around any of the target areas
Population and communities	Construction will not affect population numbers, location or composition
Archaeology, palaeontology	No material of archaeological or palaeontological significance has been found by previous construction projects, and these are not areas of major historical importance

7. The schemes should also operate without major negative impacts because:

- Schemes have been designed to use simple technologies with low maintenance and little replacement of parts to enhance their long-term sustainability;
- Providing the responsible agency ensures that infrastructure is inspected regularly and maintained as required, repairs should be small-scale and short in duration.

8. Table 6 shows those environmental sectors that are unlikely to be affected by operation of the schemes, and Table 7 shows the potential negative impacts of operation and maintenance of each scheme, together with the mitigation required.

Table 5: Environmental Impacts Relating to Location, Design and Construction of DZUWSSP Infrastructure (Black = continuous activity; Grey = intermittent)

Potential Negative Impacts	Sig	Dur	Mitigation Activities and Method	Respon sibility	Location	D	Construction				Op	
Location						09	10	11	12	13		[1]
Users of water into which STF effluent is discharged may be concerned that their health or livelihood may be at risk (fishers, prawn farmers at coast; farmers inland)	S	T	Include users of effluent discharge zone in project consultations and explain merits and impacts of scheme	UC	STF							0
			Monitor quality of STP and STF effluent periodically – make public results of environmental monitoring									0
			Monitor impact of effluent on seawater quality at coast	UC	STF							0
STF effluent could pollute receiving water and be a health hazard if it does not meet effluent discharge standards	S	T	Include emergency procedure in O&M manuals, requiring action if discharge standards are exceeded, comprising:	DSC	STF							0
			- Shut off discharge and recycle through treatment ponds	UC								0
			- Investigate reasons for failure and take remedial action									0
			- Resume discharge only when standards are met									0
			Amend design to include recycling pumps and pipe-work	DSC								0
Where effluent is discharged to coastal lagoon, lagoon water may become eutrophic, which will damage ecology	M	T	Implement the above controls to ensure that septage plant effluent is low in organic matter, nitrate & phosphate	UC	STF							0
Design												
No calculations have been made on extent and yield of aquifers from which water is to be abstracted; excessive abstraction could deplete aquifer and cause ground subsidence, shortage of well water, seawater intrusion, etc	S	P	Design and implement programme of borehole monitoring to determine extent, yield and rate of recharge of aquifer	DSC	Wellfield							0
			Use data to determine tube well locations and sustainable rates of abstraction									0
			Redesign project with alternative water source if proposed abstraction rate exceeds sustainable yield									0
There are no data on quality of water in aquifers and few data on the quality of surface waters. So mixing treated surface water with untreated groundwater may not produce water of legally required standard. Consumption may then damage human health	S	P	Monitor groundwater quality every 2 weeks for 1 year	DSC	Wellfield							0
			Monitor quality of Per Aru, Dedru Oya and Kala Oya at proposed abstraction points every 2 weeks for 1 yr									0
			Use data to assess whether proposed treatment & mixing will produce water of required quality									0
			Redesign project if data show more treatment is needed									0
Deduru Oya weir will retain silt, which will limit capacity to store water and could affect downstream geomorphology	M	P	Include adjustable sluices in weir design to release silt	DSC	Weir							0
			Calculate sluicing regime and specify in O&M manual									0

Sig = Significance of Impact (NS = Not Significant; M = Moderately Significant; S = Significant). Dur = Duration of Impact (T = Temporary; P = Permanent)
D = Detailed Design period; Op = Period when infrastructure is operating;
DSC = Design and Supervision Consultant; OMC = Operation and Maintenance Contractor; UC = Urban Council; LA = Local Authority (See Section E)
[1] This column shows impacts remaining after mitigation: 0 = zero impact (impact successfully mitigated); + = positive impact (mitigation provides a benefit)
* Mitigation of these impacts will be provided through a separate Resettlement Framework (RF) and Resettlement Plan (RP), see Section E

Septage plant workers may contract disease from sludge	M	T	Test dried sludge for enteric bacteria/pathogens regularly	UC	STF							0
			Extend drying period if necessary to kill all pathogens									0
Location and Design: Puthunkulam Reservoir-Vavuniya												
Downstream water flow is needed to maintain primary riverine forest growing on banks of Per Aru	S	P	Conduct studies - calculate minimum environmental flow:	NWSDB	Per Aru							0
			1. Ecological study of riverine forest in reservoir and downstream: extent of habitat, number & species of trees									0
			2. Hydrological study of river flow throughout year									0
			3. Ecological calculations of river flow needed to sustain riverine forest downstream (including new planted area)									0
			4. Identify area downstream to plant riverine forest to compensate for habitat lost in reservoir									0
			5. Prepare planting plan. Plant and maintain new forest before reservoir is filled									0
			Design reservoir operating regime to maintain at least minimum environmental flow at all times (including filling)	DSC	Reservoir							0
			Include sluices in bunds if needed to provide env flow	DSC	Bund							0
Some private land will be acquired in reservoir footprint	M	P	*Purchase land as described in Resettlement Framework	NWSDB	Reservoir							0
			*Provide landowners with alternative land where possible									0
			*Compensate farmers in cash for loss of crops & fruit									0
			* Compensate owners in cash for loss of productive trees									0
			* Provide new grazing land to replace areas lost									0
Reservoir will provide breeding habitat for mosquitoes and increase malaria and dengue in nearby communities	S	P	Remove shrub and some other vegetation from draw down area before filling and roll level to avoid forming pools when water level falls	Contractor	Reservoir							0
			Repeat vegetation clearance and rolling every few years	NWSDB								0
			Include in O&M procedure weekly variations in water level to strand and kill larvae	DSC								0
			Introduce to reservoir fish species (or other) that eat mosquito larvae, such as copepods	NWSDB								0
Construction of all elements												
Excavation will produce large amounts of waste soil/stone which could affect soil, topography, air when dumped	M	P	Re-use excavated material in this project where feasible	Contractor	All sites							0
			Find beneficial uses of waste soil in construction, land raising and infilling of excavated areas (eg prawn farms)									0
Excavation could create dust in dry windy weather	M	T	Remove waste soil as soon as it is excavated	Contractor	All sites							0
			Cover or damp down soil or sand stockpiled on site									0
			Plan work to only bring sand to site when needed									0
Dust could be produced when sand/soil is transported	M	T	Use tarpaulins to cover sand/soil when carried on trucks	Contractor	All sites							0
Rainwater could collect in excavated areas	M	T	Conduct all excavation in the dry season	Contractor	All sites							0
Private land may need to be acquired for certain facilities	M	P	*Purchase land as set out in Resettlement Framework	NWSDB	All sites							0

(eg WTP)			* Compensate owner in cash for loss of any crops & trees									0
Excavation could damage other infrastructure	S	P	Ask LA to confirm nature and location of all infrastructure	DSC	All sites							0
			Amend design to avoid infrastructure if necessary									0
Traffic, people and activities could be disrupted by trucks carrying waste soil or delivering materials to site	M	T	Plan routes with LA to limit entry of heavy vehicles into town, and avoid narrow streets, congested roads, etc	Contractor	All sites							0
			Plan work to avoid peak traffic periods									0
Shrines or areas of local importance could be damaged	M	P	Consult community to identify any sensitive areas	DSC	All sites							0
			Adjust design to avoid any especially sensitive sites									0
			Avoid working at times when sensitive sites may be used	Contractor	All sites							0
Workers and the public are at risk from accidents on site	M	T	Prepare and implement a site Health and Safety Plan that includes measures to:	Contractor	All sites							0
			- Exclude the public from all construction sites;									0
			- Ensure that workers use Personal Protective Equipment									0
			- Provide Health & Safety Training for all personnel;									0
			- Follow documented procedures for all site activities;									0
			- Keep accident reports and records.									0
There will be social and economic benefits if local people are employed in Contractor's workforce	M	T	Contractor should employ at least 50% of workforce from communities in vicinity of work sites if possible	Contractor	All sites							+
Additional measures for construction near military installations												
Construction work may disturb military personnel and activities	S	T	Include Sri Lankan Army in consultations as stakeholder at project locations near military installations	NWSDB	Military Installation							0
			Consult Commanding Officers regarding work program									0
			Take action to avoid disturbing personnel & activities, eg	NWSDB & Contractor								0
			- Prohibit night-time working near camps									0
			- Security checks/clearance for all personnel & vehicles									0
			- Regular contractor-military liaison to avoid any hindrance to military activity (routine or emergency)									0
Additional measures for weirs, bunds and reservoirs, or pipe-bridges												
Quarrying of soil and stone to provide material for bunds will leave large cavities in the borrow areas	M	P	If bund material is quarried, refill borrow pits with waste soil and stone from excavation elsewhere in this project	Contractor	Borrow Pits							0
Transporting material to bund site will cause noise, dust, vehicle emissions at site and along route	M	T	Source material from as close to bund site as possible	Contractor	Bund site							0
			Source material from within reservoir footprint if suitable									0
Spills of toxic materials could affect aquatic ecology in the waterways across which bunds are constructed	M	T	Do not store toxic materials at or near rivers, streams, irrigation tanks or the sea	Contractor	Waterways							0
			Build watertight bunds to separate work areas from river									0
			Include accident and spill prevention measures in contractor's Method Statement									0
Fishing communities may be concerned that construction	N	T	Include fishing communities as project stakeholders	NWSDB	Coastal							0

of coastal pipe bridge may affect local fishery			Provide fishing communities with water/sanitation service	DSC	Sites							+
Additional measures for de-silting of irrigation tanks or canals												
Silt removed from tanks/canals can reduce the quality of soil, air, water and topography at disposal site	M	T	Reduce dust by removing silt for use/disposal when damp	Contractor	Tanks							0
			Deposit silt into small bunded areas on unused land									0
Organic silt is a lost resource if it is dumped and not used	M	T	Train NWSDB staff: silt processing, marketing, accounts	NWSDB	Tanks							+
			Public education to raise farmers' awareness of benefits of using silt as a fertilizer									+
			Pilot project to demonstrate benefits and train staff									+
Vegetation from tanks and on-land sites could fertilize fields if composted	M	T	Train NWSDB staff in composting methods & benefits	NWSDB	Tanks/WTP							+
			Set up composting plant near tanks/WTP site									+
			Public/farmer education on benefits of using compost									+
De-silting tanks during dry season will deprive local farmers of irrigation water and income for one growing season	M	T	*Compensate farmers for loss of 1 season's crop income	NWDSB	Tanks							0
			*Compensate farm workers for loss of 1 season's wages									0
			Include affected farmers and workers in consultations and inform them of impacts and compensation									0
			*Conduct detailed surveys to identify those eligible	DSC								0
Additional measures for water supply networks												
Roadside trees may be removed along pipeline route	M	P	Only remove trees if it cannot be avoided	Contractor	Network							0
			Plant and maintain two trees for every one removed									0
Shops and other businesses may lose income if customers' access is impeded	M	T	Leave spaces for access between mounds of soil	Contractor	Network							0
			Provide walkways and metal sheets to maintain access across trenches for people & vehicles where required									0
			Increase workforce in these areas to finish work quickly									0
			Consult businesspeople: inform them of work in advance	NWSDB	Network							0
			*Compensate business for lost income: Resettlement Fwk									0
Traffic may be disrupted by soil, vehicles and machinery on road	M	T	As above: plan work with LA: conduct when traffic is light	Contractor	Network							0
			Ask police to provide signs and diversions when needed									0
			As above: increase workforce to finish this work quickly									0
Local residents and sites of social/cultural importance (schools, hospitals, temples) may be disturbed by noise, dust and impeded access	M	T	As above: remove waste quickly, cover/spray stockpiles, import sand only when needed, cover soil/sand on trucks	Contractor	Network							0
			As above: increase workforce to finish work quickly									0
			As above: use bridges to allow access (people/vehicles)									0
			Use modern vehicles/machinery & maintain as specified									0
			Consult residents; inform them of work in advance	NWSDB	All sites							0
Roads/people may be disturbed by repeated excavation	M	T	Integrate subprojects to conduct excavation at same time	DSC	Network							0
			Locate different infrastructure on opposite sides of road									0

People will be inconvenienced and their health may be at risk if water supply system is shut down for long periods	M	T	Plan work carefully to keep shutdown to minimum	DSC	Water Network							0
			Provide alternative water to affected residents	NWSDB								0
			Inform communities of any shutdown well in advance	NWSDB								0
Additional measures for Septage Treatment Facilities												
Wildlife and habitats around site may be damaged	M	P	Erect fence around site and prohibit trespass outside	Contractor	STF							0
			Prohibit hunting, fishing, etc by site personnel									0
			Train all workers in value and fragility of wildlife & habitats									0
Aquatic species in lagoons may be damaged by spillages	M	P	As above: do not store toxic materials at STF site	Contractor	STF							0
			As above: Method Statement to include spill prevention									0

Table 6: Fields in which operation of the schemes is not expected to have significant impacts

Field	Rationale
Climate, geology, seismology	The environmental footprint of the schemes is not large enough to affect these
Tourism	There is no significant tourism in or around the target towns and villages
Industry	Water will not be supplied for industrial use
Archaeology, palaeontology	No material of archaeological or palaeontological significance has been found by previous construction projects, and these are not areas of major historical importance

Table 7: Environmental Impacts Relating to Operation and Maintenance of DZUWSSP Infrastructure

Potential Negative Impacts	Sig	Dur	Mitigation Activities and Method	Respon sibility	Location	D	Construction				Op	[2]
						09	10	11	12	13		
Operation and Maintenance (O&M) of all elements												
Environment of towns & villages will deteriorate rapidly if infrastructure is not maintained and systems malfunction	S	P	Prepare detailed O&M procedures for all infrastructure	DSC	All sites							0
			Inspect & maintain all systems as in O&M procedures	NWSDB, UC,								0
			Replace all parts and conduct repairs when necessary									0
			Regularly train workers in O&M and H&S procedures									0
When infrastructure is repaired, health and safety of workers and the public could be at risk	S	T	As before: prepare and operate H&S plan with same measures as used in construction phase	OMC	All sites							0
Local people will benefit if employed to operate and maintain infrastructure	S	P	Workers employed to operate facilities should be residents of surrounding communities	NWSDB, UC,	All sites							+
Public health may not improve without improved practices	S	P	Conduct campaign to raise awareness of sanitation issues	NWSDB	All Town							+
Additional measures for weirs, bunds and reservoirs												
Closure of sluices in river weirs may retain silt upstream, which could affect downstream geomorphology	M	P	Include adjustable sluices in all weirs, bunds, causeways	DSC	Weir/bund							0
			O&M procedure should include periodic checking of silt on upstream side and opening sluices to purge if needed	DSC, NWSDB	River weir							0
Closure of weir sluices may impede fish migration	S	P	Keep at least one sluice open at all times	DSC, NWSDB	River weir							0
			Always open maximum feasible number of sluices									0
Abstraction of water may affect downstream ecology by reducing flow and changing water quality and quantity	S	P	Operate sluices to allow minimum downstream flow in dry season at least equivalent to minimum natural flow	DSC, NWSDB	River weir							0
			Place flow meter at sluice; monitor environmental flow									0
Additional measures for reservoir												
Water will be high in nitrate, phosphate, organic matter if existing vegetation is allowed to decompose in reservoir	S	T	Remove trees that cannot survive in water & most of the ground vegetation before reservoir fills	Contractor	Reservoir							0
Community will not be able to collect wood from inundated area	M	T	Consult local communities - arrange for receipt of wood	NWSDB	Reservoir							0
			Carry felled trees from reservoir to villages for local use	Contractor								0
Shrines or forest areas of local importance could be lost when reservoir fills	M	P	As above: consult community; identify any sensitive areas	DSC	Reservoir							0
			Arrange for relocation or pay community to set up new site	NWSDB	Reservoir							0
Additional measures for Water Treatment Plant (WTP)												
Washing sludge from sedimentation tanks onto waste	M	P	Wash material into tanks, allow to dry, take to dump site	NWSDB	WTP							0

Sig = Significance of Impact (NS = Not Significant; M = Moderately Significant; S = Significant). Dur = Duration of Impact (T = Temporary; P = Permanent)
D = Detailed Design period; Op = Period when infrastructure is operating;
DSC = Design and Supervision Consultant; OMC = Operation and Maintenance Contractor; UC = Urban Council; CBO = Community Based Organisation (see Section E)
[2] This column shows impacts remaining after mitigation: 0 = zero impact (impact successfully mitigated); + = positive impact (mitigation provides a benefit)
* Mitigation of these impacts will be provided through a separate Resettlement Framework (RF) and Resettlement Plan (RP), see Section E

ground will cause dust and reduce soil quality			Cover dry waste with tarpaulins when carried on trucks									0
Additional measures for Septage Treatment Facilities (STF)												
Dried sludge can be used as an agricultural fertilizer	M	T	Train operators staff in sludge drying, marketing, accounts	NWSDB	STF							+
			Public education to raise farmers' awareness of benefits of using sludge as fertilizer									+
			Regularly test dried sludge for enteric bacteria/pathogens									0
			Assess feasibility of setting up compost plant to process sludge and plants removed from STF wetland bed	DSC								
Local residents may be concerned about odour & visual impact from STF	NS	P	Consult community; explain that impacts should not occur	DSC	STF							0
			If necessary plant trees at edge of facility									0
			Locate first in the series of treatment ponds away from houses									0
Additional measures for water supply networks												
Network repairs could disrupt business	NS	T	As before: inform business of any work in advance	NWSDB	Network							0
			As before: provide walkways/bridges for people/vehicles	OMC	Network							0
			As before: ask police to provide diversions when needed	NWSDB	Network							0
Network repair could disturb residents and sites of social and cultural importance in town	NS	T	As before: complete work quickly in sensitive areas	OMC	Network							0
			As before: provide walkways/bridges for people/vehicles									0
			As before: use & maintain modern vehicles/machinery									0
			As before: inform residents of work in advance	NWSDB	Network							0
			As before: avoid working at sensitive times									0
Additional measures for urban sanitation												
Waste oil from tanker servicing could pollute land & water	M	P	Ensure work is conducted by reputable company with responsible waste disposal practices	UC	Towns							0
Exhaust emissions may increase if vehicles not serviced	NS	T	Service vehicles every 6 months; repair when necessary	UC	Towns							0
Vacuum tankers may disturb sites of social/cultural importance (schools, hospitals, temples) when emptying septic tanks	M	T	Do not empty tanks near churches/temples during festivals and times of religious observance	UC	Towns							0
			Empty tanks in schools, clinics, hospitals at weekends									0

E. Institutional Requirements and Environmental Monitoring Plan

9. Tables 5 and 7 show that six agencies are responsible for providing the environmental mitigation, as follows:

(i) **NWSDB** is the Implementing Agency (IA) responsible for supervising construction of the infrastructure and conducting the non-infrastructure elements.

(ii) NWSDB will establish a **Project Coordinating Cell (PCC)** at its Head Office in Colombo, responsible for Central coordination, monitoring and oversee accounts consolidation. NWSDB will also establish and duly strengthen **Regional Offices (ROs)** in Puttalam and Vavuniya, to manage implementation of the project in North-Western and Northern Provinces respectively.

(iii) The PCC will appoint **Design and Supervision Consultants (DSC)** who will support the ROs in designing the infrastructure, managing the tendering of Contractors and supervising the construction process. NGOs will be appointed to manage and implement the public consultation process and conduct public awareness campaigns.

(iv) Each RO will appoint and manage **Construction Contractors** (CC) to build elements of the infrastructure in their area. The DSC will supervise the construction and each CC will be required to implement mitigation measures specified in the contract documents.

(v) When the infrastructure is operating, NWSDB will be responsible for urban water supply, the **Urban Councils** (UC) will be responsible for urban sanitation. Each organization may employ **O&M Contractors** (OMC) to maintain and repair the infrastructure as necessary, or undertake some of these functions.

10. An inter-ministerial Project Implementation Coordination Committee (PICC) will provide policy guidance and coordination. The PICC will be chaired by the secretary of MWSD, and members will include senior officials from the Ministry of Finance & Planning, NWSDB, Ministry of Local Government, Central Environment Authority; and representatives of provincial governments, local authorities, aid agencies and NGOs. A Provincial Project Coordination Committee (PPCC) will be set up in to monitor project implementation at the local level, and will communicate to the PICC.

11. Resettlement issues will be coordinated by Resettlement Specialists in the ROs, who will ensure consistency across all subprojects. A local Resettlement Specialist will be appointed to each RO, who will prepare and implement local Resettlement Plans following the Resettlement Framework developed during project preparation.

12. Environmental issues will be coordinated by an Environmental Specialist in each of the ROs who will ensure compliance with ADB and national environmental safeguards. Each IEE contains an Environmental Monitoring Plan (summarised in Table 8), which will be implemented by the Environmental (Monitoring) Specialist (EMS) who is part of the DSC team during the construction phase, and by the responsible Government agency (NWSDB, or UC) during operation.

Table 8: Environmental Monitoring Plan

Mitigation Activities and Method	Location	Responsible for Mitigation	Monitoring Method	Monitoring Frequency	Responsible for Monitoring
LOCATION					
Consult users of effluent discharge zone; explain scheme impacts	STF	UC	Resident survey; observe meeting	6 months	EMS
Include emergency procedure in O&M manuals:	STF	DSC	O&M manuals	One check	EMS
- Shut off lagoon discharge and recycle effluent through STF	STF	UC	Site observation	Monthly	UC
- Investigate reasons for failure and take remedial action	STF	UC	Site observation	Monthly	UC
- Resume lagoon discharge only when standards are met	STF	UC	Site observation	Monthly	UC
Amend design to include recycling pumps and pipe-work	STF	DSC	Design reports	One check	EMS
DESIGN					
Conduct borehole monitoring of extent, yield, recharge of aquifer	Wellfield	DSC	Design reports; site observation	Monthly	EMS
Use data to plan well location and sustainable rates of abstraction	Wellfield	DSC	Design reports	One check	EMS
Redesign project with alternative water source if necessary	Wellfield	DSC	Design reports; NWSDB record	As needed	EMS
Monitor quality of groundwater every 2 weeks for one year	Wellfield	DSC	Water quality survey report	One check	EMS
Monitor quality of Per Aru, Dedru Oya and Kala Oya every 2 weeks for one year	Wellfield	DSC	Design reports	One check	EMS
Use data to assess treatment method and redesign if necessary	Wellfield	DSC	Design reports	One check	EMS
Include adjustable sluices in weir design to release silt	Weir	DSC	Design reports	One check	EMS
Calculate sluicing regime and specify in O&M manual	Weir	DSC	Design reports: O&M manuals	One check	EMS
Extend STF sludge drying period if necessary to kill all pathogens	STF	UC	Site observation; O&M manual	6 months	NWSDB
LOCATION AND DESIGN: PUTHUNKULAM RESERVOIR					
Conduct studies necessary to calculate environmental flow	Per Aru	NWSDB	Site observation; study reports	As needed	EMS
1. Ecological study of riverine forest in reservoir and downstream	Per Aru	NWSDB	Site observation; design reports	Weekly	EMS
2. Hydrological study of river flow throughout year	Per Aru	NWSDB	Site observation; design reports	Monthly	EMS
3. Calculations of river flow needed to sustain riverine forest	Per Aru	NWSDB	Study and design reports	One check	EMS
4. Identify area downstream to plant riverine forest	Per Aru	NWSDB	Site observation; design reports	Weekly	EMS
5. Prepare planting plan; plant before reservoir is filled	Per Aru	NWSDB	Site observation; design reports	Weekly	EMS
Design operating regime to maintain environmental flow at all times	Reservoir	DSC	Design reports	One check	EMS
Include sluices in bund if needed to provide environmental flow	Bund	DSC	Design reports; site observation	One check	EMS
* Purchase land as described in Resettlement Framework	All sites	NWSDB	Owner survey; NWSDB records	As needed	IMA

* Provide landowners with alternative land where possible	Reservoir	NWSDB	Owner survey; NWSDB records	As needed	IMA
* Compensate owners in cash for loss of crops & productive trees	Reservoir	NWSDB	Owner survey; NWSDB records	As needed	IMA
* Provide new grazing land to replace areas lost	Reservoir	NWSDB	Farmer survey; NWSDB records	As needed	IMA
Remove vegetation from draw down area and roll level	Reservoir	Contractor	Site observation	Monthly	EMS
Repeat vegetation clearance and rolling every few years	Reservoir	NWSDB	O&M manuals; site observation	Annually	NWSDB
Include in O&M procedure weekly variations in water level	Reservoir	DSC	O&M manuals; site observation	Weekly	EMS
Introduce to reservoir fish species that eat mosquito larvae	Reservoir	NWSDB	NWSDB records; fisher survey	Monthly	EMS
CONSTRUCTION: all elements					
Re-use excavated material in this project where feasible	All sites	Contractor	Site observations; CC records	Monthly	EMS
Find beneficial uses for waste soil (construction, land raising, infill)	All sites	Contractor	Site observations; CC records	Monthly	EMS
Remove waste soil for disposal as soon as it is excavated	All sites	Contractor	Site observations	As needed	EMS
Cover or damp down soil and sand stockpiled on site	All sites	Contractor	Site observations	As needed	EMS
Only bring sand (for backfill or concrete) to site when needed	All sites	Contractor	Site observations; CC records	As needed	EMS
Use tarpaulins to cover dry soil and sand when carried on trucks	All sites	Contractor	Observations on and off site	As needed	EMS
Conduct all excavation in the dry season	All sites	Contractor	Site observations	Monthly	EMS
* Purchase land as described in Resettlement Framework	All sites	NWSDB	Owner survey; NWSDB records	As needed	IMA[3]
* Compensate owners in cash for loss of any crops and trees	All sites	NWSDB	Farmer survey; NWSDB records	As needed	IMA
Ask local authority to confirm location of any infrastructure on site	All sites	DSC	Design reports	As needed	EMS
Amend design to avoid infrastructure if necessary	All sites	DSC	Design reports	As needed	EMS
Reuse & recycle pipe material wherever possible. Safely dispose (in LA agreed solid waste management site) of other material.	All sites	Contractor	Site observations; CC records	Monthly	EMS
Plan transport routes with LA to limit entry of heavy vehicles into town and avoid narrow streets, congested roads, etc	All sites	Contractor	Observations off site: CC record	Weekly	EMS
Plan work with town authorities: transport waste when traffic is light	All sites	Contractor	Site observations; CC records	Monthly	EMS
Consult community to identify any locally sensitive areas	All sites	DSC	Design reports; meeting notes	Monthly	EMS
Adjust design to avoid any especially sensitive sites	All sites	DSC	Design reports	Monthly	EMS
Avoid working at times when sensitive sites may be used	All sites	Contractor	Site observations	Weekly	EMS
Prepare and implement a site H&S Plan (safety of workers/public):	All sites	Contractor	Site observations; CC records	Monthly	EMS
- Exclude public from the site	All sites	Contractor	Site observations; CC records	Monthly	EMS
- Ensure that workers wear Personal Protective Equipment	All sites	Contractor	Site observations; CC records	Monthly	EMS

[3] Resettlement issues (asterisked) will be monitored by an Independent Monitoring Agency (IMA) established under the Resettlement Framework

- Provide Health and Safety training for all personnel	All sites	Contractor	CC records; worker interviews	Monthly	EMS
- Follow documented procedures for all site activities	All sites	Contractor	Site observations; CC records	Monthly	EMS
- Keep accident reports and records	All sites	Contractor	CC records	Monthly	EMS
Employ 50% of workforce from communities near sites if possible	All sites	Contractor	CC records; worker interviews	Monthly	EMS
Consult local residents: inform them of work in advance	All sites	NWSDB	Meeting records	Monthly	EMS
CONSTRUCTION: additional measures near Kala Oya intake (Puttalam)					
Works within 1.5 km of boundary of Wilapattu NP be done manually without the use of heavy machinery	Kala Oya intake	Contractor	CC records; observations	Weekly	EMS
CONSTRUCTION: additional measures near military installations					
Include Sri Lankan Army in consultations as stakeholder	Near military	NWSDB	NWSDB records	Monthly	EMS
Consult Commanding Officers regarding work programme	Near military	NWSDB	NWSDB records	Monthly	EMS
Take action to avoid disturbing military personnel and activities:	Near military	NWSDB/CC	NWSDB/CC records	Monthly	EMS
- Prohibit night-time working near camps	Near military	NWSDB/CC	NWSDB/CC records; observation	Weekly	EMS
- Security checks/clearance for all personnel and vehicles	Near military	NWSDB/CC	NWSDB/CC records	Weekly	EMS
- Regular liaison to avoid any hindrance to military activity	Near military	NWSDB/CC	NWSDB/CC records	Weekly	EMS
CONSTRUCTION: additional measures for weirs, bunds and reservoirs, or pipe-bridges					
Refill any borrow pits with waste from project excavation elsewhere	Borrow pits	Contractor	Site observations	Monthly	EMS
Source material from close to bund site, within reservoir if suitable	Bund site	Contractor	CC records; site observation	Monthly	EMS
Do not store toxic materials at or near rivers, streams, tanks, sea	Waterways	Contractor	Site observations	Weekly	EMS
Build watertight bunds to separate work areas from river	Waterways	Contractor	Site observations	Weekly	EMS
Include accident/spill prevention measures in Method Statement	Waterways	Contractor	CC records	One check	EMS
Include fishing communities as project stakeholders	Coastal sites	NWSDB	Fisher surveys; NWSDB records	Monthly	EMS
Provide fishing communities with water & sanitation service	Coastal sites	DSC	Design reports; fisher surveys	As needed	EMS
CONSTRUCTION: additional measures for de-silting of irrigation tanks or canals					
Reduce dust by removing silt for use or disposal when damp	Tanks/canals	Contractor	Site observations	Weekly	EMS
Deposit silt into small bunded areas on unused land	Tanks/canals	Contractor	Site observations	Weekly	EMS
Train NWSDB staff in silt processing, marketing, accounting	Tanks/canals	NWSDB	NWSDB records; staff interviews	Monthly	EMS
Public education to raise farmers' awareness of silt fertilizer	Tanks/canals	NWSDB	NWSDB record; farmer interviews	Monthly	EMS
Pilot project to demonstrate benefits and train staff	Tanks/canals	NWSDB	Site observations	Monthly	EMS
Train NWSDB staff in composting methods and benefits	Tanks/WTP	NWSDB	NWSDB records; staff interviews	Monthly	EMS
Set up composting plant near tanks and WTP site	Tanks/WTP	NWSDB	Site observations	Monthly	EMS

Public/farmer education on benefits of using compost	Rural areas	NWSDB	NWSDB record; farmer interviews	Monthly	EMS
*Compensate farmers for loss of one season's crop income	Tanks	NWSDB	Farmer survey; NWSDB record	As needed	EMS
*Compensate farm workers for loss of one season's income	Tanks	NWSDB	Worker survey; NWSDB record	As needed	EMS
Consult farmers & workers: inform of impacts and compensation	Tanks	NWSDB	Farmer/worker survey	As needed	EMS
*Conduct surveys to identify those eligible	Tanks	DSC	Resident survey; site observation	As needed	EMS
CONSTRUCTION: additional measures for water supply networks					
Only remove trees if it cannot be avoided	Network sites	Contractor	Site observations	Weekly	EMS
Plant and maintain two trees for every one removed	Network sites	Contractor	Site observations	As needed	EMS
Leave spaces for access between mounds of soil	Network sites	Contractor	Site observations	Weekly	EMS
Provide bridges to allow people & vehicles to cross trenches	Network sites	Contractor	Site observation; resident survey	Weekly	EMS
Increase workforce in sensitive areas to finish work quickly	Network sites	Contractor	Site observations; CC records	Monthly	EMS
Inform businesspeople and residents of work in advance	Network sites	NWSDB	Resident survey; NWSDB record	Monthly	EMS
*Compensate businesses for lost income via Resettlement Fmwk	Where required	NWSDB	Shopkeeper survey; NDB record	As needed	IMA
Plan work with LA: conduct when traffic is light	Network sites	Contractor	CC records; observations off site	Monthly	EMS
Request LA/police to provide diversions where possible	Network sites	Contractor	Site observations; CC records	Weekly	EMS
Use modern vehicles and machinery and maintain as specified	Network sites	Contractor	Site observations; CC records	Monthly	EMS
Integrate subprojects to conduct excavation at the same time	Network sites	NWSDB/DSC	Design reports; site observation	Monthly	EMS
Locate different infrastructure on opposite sides of the road	Network sites	DSC	Design reports; site observation	Monthly	EMS
Plan work carefully to keep system shutdown to a minimum	Water network	DSC	Design reports; resident surveys	Monthly	EMS
Provide alternative water to affected residents	All sites	NWSDB	Site observation; resident survey	Weekly	EMS
Inform communities of any shutdown well in advance	All sites	NWSDB	Site observation; resident survey	Weekly	EMS
CONSTRUCTION: additional measures for Septage Treatment Facilities					
Erect fence around site and prohibit trespass outside	STF	Contractor	Site observation	Weekly	EMS
Prohibit hunting, fishing, etc by site personnel	STF	Contractor	Site observation	Weekly	EMS
Train all workers in value and fragility of wildlife and habitats	STF	Contractor	CC records; worker surveys	As needed	EMS
Do not store toxic materials at STF site	STF	Contractor	Site observation	Weekly	EMS
Include accident/spill prevention measures in Method Statement	STF	Contractor	CC records	One check	EMS
OPERATION AND MAINTENANCE: all elements					
Prepare detailed O&M procedures for all infrastructure	All sites	DSC	Design reports; O&M procedure	As needed	EMS
Inspect and maintain all systems as in O&M procedures	All sites	NWSDB, UC, CBO	Site observation	Weekly	NWSDB
Replace all parts and conduct repairs when necessary	All sites		Site observation	Weekly	NWSDB

Regularly train workers in O&M and H&S procedures	All sites		Worker survey; agency records	Monthly	NWSDB
Prepare/operate H&S plan with same measures as in construction	All sites	OMC	Site observations; OMC records	Monthly	NWSDB
Workers employed at facility sites should be local residents	All sites	NDB, UC, CBO	Worker survey	Annually	NWSDB
Conduct campaign to raise awareness of sanitation issues	All sites	NWSDB	Resident survey; NWSDB record	Quarterly	NWSDB
O&M: additional measures for weirs, bunds and reservoirs					
Include adjustable sluices in all weirs, bunds, causeways	Weir/bund	DSC	Design reports; site observation	One check	EMS
O&M procedure should include periodic checking & purging of silt	River weir	DSC, NWSDB	O&M manuals; site observation	Weekly	EMS
Keep at least one sluice open at all times	River weir	DSC, NWSDB	O&M manuals; site observation	Weekly	NWSDB
Always open maximum feasible number of sluices	River weir	DSC, NWSDB	O&M manuals; site observation	Weekly	NWSDB
Operate sluices to allow minimum downstream flow in dry season at least equivalent to minimum natural flow	River weir, reservoir	DSC, NWSDB	O&M manuals; site observation	Weekly	NWSDB
Place flow meter at sluice; monitor environmental flow	Weir, reservoir	DSC, NWSDB	O&M manuals; site observation; NWSDB records	Weekly	NWSDB
O&M: additional measures for reservoir					
Remove trees and ground vegetation before reservoir fills	Reservoir	Contractor	Site observation; design reports	Monthly	EMS
Consult local communities - arrange for receipt of wood	Reservoir	NWSDB	Resident survey; NWSDB record	Monthly	EMS
Carry felled trees from reservoir to villages for local use	Reservoir	Contractor	Site observation; resident survey	Monthly	EMS
Consult community: identify any culturally sensitive areas	Reservoir	DSC	NWSDB record; resident survey	As needed	EMS
Relocate shrines or pay community to set up new site	Reservoir	NWSDB	NWSDB record; resident survey	As needed	EMS
O&M: additional measures for Water Treatment Plant					
Wash settling tank sludge into empty open tank and allow to dry	WTP	NWSDB	O&M manuals; site observation	Annually	NWSDB
Cover dry waste with tarpaulins when carried to dumpsite	WTP	NWSDB	O&M manuals; site observation	Annually	NWSDB
O&M: Measures for Septage Treatment Facility (STF)					
Train operator's staff in sludge drying, marketing and accounting	STF	NWSDB	Site observation; NWSDB record	As needed	NWSDB
Public education to raise farmers' awareness of benefits of using sludge as a fertilizer	Town & rural areas	NWSDB	NWSDB records; farmer surveys	As needed	NWSDB
Assess feasibility of setting up composting of sludge & plants removed from STF wetland bed	STF	UC	Design reports; site observation	One check	NWSDB
Consult community, explain that odour & visual impacts unlikely	STF	DSC	Resident surveys; DSC records	As needed	EMS
If necessary plant trees at edge of facility	STF	DSC	STP Contracts; site observation	6 months	EMS
Locate first of the treatment ponds away from houses	STP	DSC	Design reports; site observation	One check	EMS
O&M: additional measures for water supply networks					

Inform businesspeople and residents of work in advance	Network sites	NWSDB, CBO	Resident survey; NWSDB record	As needed	NWSDB
Provide bridges to allow people & vehicles to cross trenches	Network sites	OMC	Site observation; resident survey	As needed	NWSDB
Request LA/police to provide diversions where possible	Network sites	NWSDB	Site observation; NWSDB record	As needed	NWSDB
Complete work quickly in sensitive areas	Network sites	OMC	Site observations; OMC records	As needed	NWSDB
Use modern vehicles and machinery and maintain as specified	Network sites	OMC	Site observations; OMC records	As needed	NWSDB
Avoid working at times when sensitive sites may be used	Network sites	NWSDB, CBO	Site observations	As needed	NWSDB
O&M: additional measures for urban sanitation					
Tankers serviced by company with responsible waste disposal	Town	UC	Service record; site observation	6 Months	NWSDB
Service vehicles every 6 months & repair when necessary	Town	UC	Service record; site observation	6 months	NWSDB
Do not empty tanks near churches/temples at times of observance	Town	UC	Site observation; O&M manual	6 months	NWSDB
Empty tanks in schools, clinics, hospital at weekends	Town	UC	Site observation; O&M manual	6 months	NWSDB
LONG-TERM SURVEYS (4 years)					
Regularly test dried sludge for enteric bacteria/pathogens	STF	NWSDB/UC	Sludge sampling & analysis	See VII.C	Consulting laboratory
Survey of chemical and bacteriological quality of municipal water	Source and Domestic sites	NWSDB	Water quality sampling and analysis	See VII.C	Consulting laboratory
Survey of chemical and bacteriological quality of STF effluent	STF	NWSDB/UC	Water quality sampling and analysis	See VII.C	Consulting laboratory
Survey of chemical and bacteriological quality of receiving water	STF	NWSDB/UC	Water quality sampling and analysis	See VII.C	Consulting laboratory
Survey of public health and incidence of water borne disease	Towns	NWSDB	Hospital records; resident surveys	See VII.C	Social studies consultant

F. Public Consultation and Information Disclosure

13. Primary stakeholders include: residents, shopkeepers and businesspeople who live and work near the construction sites; and owners and users of any land that is acquired for the project. Secondary stakeholders are: NWSDB; other relevant government institutions; NGOs and CBOs working in the affected communities; other community representatives (prominent citizens, religious leaders, women's groups); the beneficiary community in general; and the ADB.

14. Stakeholders were involved in developing the IEEs through face-to-face discussions on site and large public meetings held in the towns and rural areas in December 2007 and January 2008. Views expressed were incorporated into the IEEs and the planning and development of the project. IEEs were made available in the local language at public locations in the towns and villages and this SIEE will be disclosed to a wider audience via the ADB website. The consultation process will be expanded during project implementation when NWSDB will appoint a nationally-recognised NGO to handle this key element to ensure that stakeholders participate fully in subproject execution.

G. Findings and Recommendation

15. Environmental issues were considered throughout the development of the project and changes were also made to outline designs to reduce or avoid impacts. Actions include:

- Locating pipelines in the RoW alongside existing roads and WTP, Sewage Treatment Facility (STF) and other facilities on government land, to avoid the need to acquire land or relocate people;
- Locating pipelines beneath the road surface in certain narrower streets to avoid demolishing structures that have been built in the RoW (parts of houses or shops).

16. The project will however involve significant construction in and around inhabited areas, so it is not possible to avoid all negative impacts. During the construction phase, impacts mainly arise from the need to dispose of large quantities of waste soil and stone, and from disturbance of residents, business and traffic. These are common impacts of construction in urban areas and there are well developed methods for their mitigation. These include:

- Finding beneficial uses for waste material (for example in refilling borrow pits);
- Covering soil and sand during transportation and when stored on site;
- Planning work to minimise disruption of traffic and communities;
- Providing temporary structures to maintain access across trenches where required.

17. Where land is acquired for the project (such as the proposed reservoir in Vavuniya), this will be done through the Land Acquisition Act (1950), whereby Government pays the market value based on an analysis of recent transactions. ADB policy on Involuntary Resettlement requires that no-one should be worse off as a result of an ADB-funded project, so a Resettlement Framework was prepared to deal with any remaining losses. This establishes that:

- Farmers will be compensated for loss of crops/fruit, and owners for loss of trees;
- New areas will be provided to replace any grazing land that is lost; and
- Businesses will be compensated for income lost when construction work is nearby.

18. A range of measures were established to mitigate the various other impacts, as shown in Tables 5 and 7.

19. Once the schemes have been built, most should operate without major environmental impacts, providing the relevant agencies inspect and maintain the infrastructure following O&M procedures prepared in the design stage. The project will provide the agencies with training, support and budgets to enable them to fulfil these responsibilities.

20. There are however uncertainties in the analysis of impacts of operating the water supply schemes, as further to feasibility studies detailed data on the extent, yield or quality of water in aquifers, or the rates of flow in rivers from which water is to be abstracted will need to be collected. It will be necessary therefore to conduct a range of studies during the detailed design stage to ensure that abstraction is conducted only at sustainable levels and that proposed treatment methods will deliver water of the legally required standards. The following studies have been incorporated in the design of the Project and several are already on-going:

- Hydrological and ecological studies to calculate the minimum "environmental flow" needed to maintain downstream ecology in the Per Aru (Vavuniya);
- Hydrogeological surveys to determine the extent and safe yield of aquifers in Mannar, Vavuniya, and Chilaw;
- Water quality surveys of aquifers in Mannar, Vavuniya, Chilaw, and Puttalam, and surface water in Vavuniya, Puttalam, and Chilaw.

21. If the studies show that the amount of water envisaged cannot be abstracted sustainably or treated to the required standard by methods proposed, subprojects will need to be modified accordingly in relation to extraction yields, sources and treatment levels. Precautions are also needed at the Septage Treatment Facilities, to protect the health of workers and the users of water into which treated effluent is discharged. These are:

- Regular monitoring of the quality and quantity of treated effluent and the quality of the water into which the effluent is discharged;
- Regular monitoring of the bacteriological quality of dried sewage sludge to ensure that it is safe to handle prior to disposal, and safe to sell to farmers as fertilizer.

22. If water is abstracted sustainably and treated to the mandatory standards, then the citizens of the towns and villages should benefit substantially as they will be provided with a constant supply of good quality water and an improved sanitation service. Their quality of life should therefore improve significantly. The project will conduct a programme to raise public awareness of sanitation and hygiene issues so the health of the community should also improve.

23. One further aspect requiring attention regards climate change and climate adaptation. Whilst existing models[4] generally point to a general increase in temperature and a possible decline in rainfall in the Dry Zone of Sri Lanka with a consequent increase in evapotranspiration and soil moisture by 2050, it is noted that studies have only used one global circulation model (out of 7 available at present) and one time slice. Although the data cannot be considered to be conclusive, rainwater harvesting (such as that in reservoirs) is encouraged as this would be advantageous based on predictions of an increase in rainfall during the south west monsoon.

H. Conclusions

24. The environmental impacts of the proposed improvements in water supply and sanitation infrastructure proposed by the DZUWSSP have been assessed by the Initial Environmental

[4] WEDC. 2006. 32nd WEDC International Conference: Impacts of Climate Change on Water Resources in Sri Lanka. Colombo.

Examination studies summarised in this document, conducted according to ADB policy and procedures. Many impacts have been avoided by action during development of the project, and the IEEs describe further action that will be taken during detailed design, construction and operation.

25. Most impacts identified by this analysis should be easily reduced to acceptable levels by the proposed mitigation measures, provided that each measure is implemented as described in the IEEs. However it is not yet possible to draw final conclusions regarding the impacts of the schemes as a whole, because of the uncertainties regarding the impacts of operating the water supply components. This should be possible once the studies summarised in Paragraph 20 have been completed.

26. In addition, the Project shall obtain necessary prescribed environmental clearances in agreement with Sri Lankan Law. IEE's will be submitted to Central and Provincial Environmental Agencies for review, who in turn may ask for additional information. Given that NWSDB has implemented a number of large scale projects, they are noted to be familiar with the process of obtaining national/provincial environmental clearances. Nonetheless, to ensure that environmental documents are updated and adequate monitoring introduced, a total of 36 person months (pms) of national environmental expert inputs, 2 pms of international expert inputs, 1 pm of national environmental ecologist and 8 pms of forestry specialist inputs have been included as part of the Project's consultancy. Close monitoring and obtaining of necessary environmental clearances prior to completing relevant bidding documents is required to ensure that all environmental mitigation measures recommended by both ADB and the Government have been incorporated in design and construction activities.