Initial Environmental Examination

November 2022

Cambodia: Cross-Border Livestock Health and Value-Chain Infrastructure Improvement Project

Prepared by the Ministry of Agriculture, Forestry and Fisheries for the Asian Development Bank and the Asian Infrastructure Investment Bank.

ABBREVIATIONS

ADB	–	Asian Development Bank
AHP	–	animal health and production
AI	–	artificial insemination
BSC	–	biosafety cabinet
CLHVCIP	–	Cross-Border Livestock Health and Value Chains Improvement Project
CSE	–	Construction Supervision Engineer
EARF	–	environmental assessment and review framework
EHS	–	environmental, health, and safety
EIA	–	environmental impact assessment
EMP	–	environmental management plan
GDAHP	–	General Directorate of Animal Health and Production
GMP	–	good manufacturing practice
GRM	–	grievance redress mechanism
HACCP	–	hazard analysis and critical control point
HEPF	–	high efficient particulate air filter
IBAT	–	integrated biodiversity assessment tool
IEE	–	initial environmental examination
IFC	–	International Finance Corporation
ISO	–	International Organization for Standardization
IUCN	–	International Union for Conservation of Nature
MoE	–	Ministry of Environment
MOWRAM	–	Ministry of Water Resource and Meteorology
NAHPRI	–	National Animal Health & Production Research Institute
NCBC	–	National Cattle Breeding Center
NVVC	–	National Veterinary Vaccine Center
OM	–	Otdar Meanchey
PDAFF	–	Provincial Department of Agriculture, Forestry and Fisheries
PIC	–	project implementation consultants
PIU	–	project implementation unit (national)
PPIU	–	provincial project implementation unit
POAHP	–	provincial office of animal health and production
PPCU	–	project public complaint unit
QC	–	quarantine center
SOP	–	standard operation procedures
TSA	–	Tonle Sap Authority
TSBR	–	Tonle Sap Biosphere Reserve
UNESCO	–	United Nations Educational, Scientific, Cultural Organization
VDL	–	veterinary diagnostic lab
VOC	–	volatile organic compounds
VVPC	–	veterinary vaccine production center
WB	–	World Bank

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I. Description of the Project

A. Background

1. The Greater Mekong Subregion (GMS) Cross-border Livestock Health and Value Chains Improvement Project (CLHVCIP) is a priority in the Strategy for Promoting Safe and Environment-Friendly Agro-Based Value Chains in the Greater Mekong Subregion endorsed by the GMS Ministers of Agriculture in September 2017 in Cambodia. The project concept was developed through consultations in GMS countries, including Cambodia, between November 2018 and June 2019.

2. The Project in Cambodia is aligned with the following impact: GMS vision as a leading supplier of safe and environmentally friendly agriculture products realized. The Project outcome is improved health, value chains and formal trade of livestock and livestock products. The project has three outputs:

(i) **Output 1**: Livestock health and value chain infrastructure expanded and upgraded in a climate-friendly manner; Key activities are grouped into: (a) Disease Control Zones and Quarantine Centers; (b) National Veterinary Vaccine Center; (c) National Cattle Breeding Center; (d) Doun Keo Live Bird market; (e) National Animal Health and Production Research Institute; and (f) Public Abattoirs and Wet Markets.

(ii) **Output 2**: Capacity for improved production and health of livestock and livestock products strengthened; Key initiatives under this output include provision of (a) Animal Health Improvement through Livestock Epidemiology and Informatics Program; (b) Livestock Value Chain Development Services through introduction of Good Abattoir Management Practice and Risk-based Meat Inspection; (c) Animal Production Services, including Good Animal Husbandry Practices, and Forage Production; (d) Capacity building.

(iii) **Output 3:** Enabling policies for better supply, health, safety, and trade in livestock and livestock products enhanced. The project will support of 4 groups of policy activities: (a) national livestock policies, (b) cross-border livestock trade policies; (c) regulations and standards; and (d) private livestock sector development.

3. Output 1 has most of the physical investment thus with most of the environmental impacts, as output 2-3 are mostly “software” activities. Therefore, the environmental impact assessment (EIA) presented in this report will mainly cover the output 1.

B. Prioritized Subprojects for Environmental Due Diligence

4. To carry out project activities under Output 1, at the TRTA inception stage, the ADB and the government agreed to identify subprojects representing major types of impactful activities so that they can be ready for implementation once the project is approved. Their feasibility studies and associated social safeguard, environmental impact assessment (EIA), and climate change assessment can also serve as models for future subprojects to be identified during the project implementation. Therefore, this consolidated report covers the following 5 “prioritized” subprojects in 5 provinces.

(i) Upgrade National Diagnostic Laboratory in Phnom Penh Capital City (under National Animal Health and Production Research Institute group of Output 1)

(ii) Establish a new National Cattle Breeding Center (NCBC) in Kampong Thom Province (under National Cattle Breeding Center group of Output 1)

(iii) A new Veterinary Vaccine Production center in Kandal Province (under National Veterinary Vaccine Center group of Output 1)
(iv) A new Animal Health Inspection Station in Otdar Meanchey Province (under Disease Control Zones and Quarantine Centers group of Output 1)
(v) Doun Keo Poultry market, including a slaughter line, under output 1, in lieu of the proposed Siem Reap slaughterhouse due to delays to site selection for this subproject (the resolution of which has now been pushed into project implementation).

5. **Project Management.** The prioritized 5 subprojects are in 5 provinces, namely Phnom Penh, Kampong Thom, Kandal, Otdar Meanchey and Takeo. Some subprojects are central level activities, and some are local level. The project will be managed at both national and local levels:

(i) At the national level, the Ministry of Agriculture, Forestry and Fisheries (MAFF) of Cambodia will be the Project Execution Agency (EA). The EA will be responsible for overall coordination, and monitoring of the project. The General Directorate of Animal Health and Production (GDAHP) under the MAFF, is the Implementing Agency (IA). A National Project Management Office will be established to support the EA as its Secretariat and as the overall project's focal to the ADB; and the IA for implementing central-level activities.
(ii) At the local level, the Province of Phnom Penh, Takeo, and Otdar Meanchey, in response to their wider suit of project activities, will each establish Provincial Project Implementation Units (PPIU) within their respective Provincial Office of Animal Health and Production (POAHP) that will support the provincial in implementing provincial level activities. In Kandal and Kampong Thom, the development of the NVVC and the NCBC will be centrally managed by the PIU at GDAHP.

6. In line with the project's environmental category by ADB as B, initial environmental examination (IEE) is required. This IEE report consolidated the assessment of environmental impacts of all subprojects and their health and safety (H&S) issues. Based on the assessment, Environmental Management Plans (EMP) are developed to prevent or mitigate potential negative environmental impacts and H&S risks.

C. National Animal Health and Production Research Institute Laboratory

7. This subproject will upgrade the existing laboratory of National Animal Health and Production Research Institute (NAHPRI) to International Organization for Standardization (ISO) 17025 and BSL2 standards and significantly expand the epidemiology, meat, and feed testing regimes. This will require additional laboratory space and the automation of several tests. The planned test numbers are detailed in Table I-1 . These facilities will require various new sampling and laboratory equipment with sufficient sample and reagent handling and storage capacity.

Table I-1 Planned GDAHP Tests at the NAHPRI laboratory

	2022	2023	2024	2025	2026	2027	2028
Samples for diagnostic analysis	22,500	22,500	35,000	40,000	50,000	70,000	80,000
Samples for feed analysis	34	500	2,000	5,000	10,000	20,000	40,000
Samples from vet drug analysis	0	50	200	200	200	200	200
Samples test for meat residues analysis	250	200	2,000	2,000	4,000	4,000	8,000
TOTAL	**24,806**	**25,273**	**41,224**	**49,225**	**66,226**	**96,227**	**130,228**

GDAHP= General Directorate of Animal Health and Production.
Source: Asian Development Bank.

8. Waste disposal issues will be addressed. The wastewater streams generated will be managed to meet national or international standards with the Decentralized Wastewater Treatment System (DEWATS).

1. Existing Lab, location, and facilities

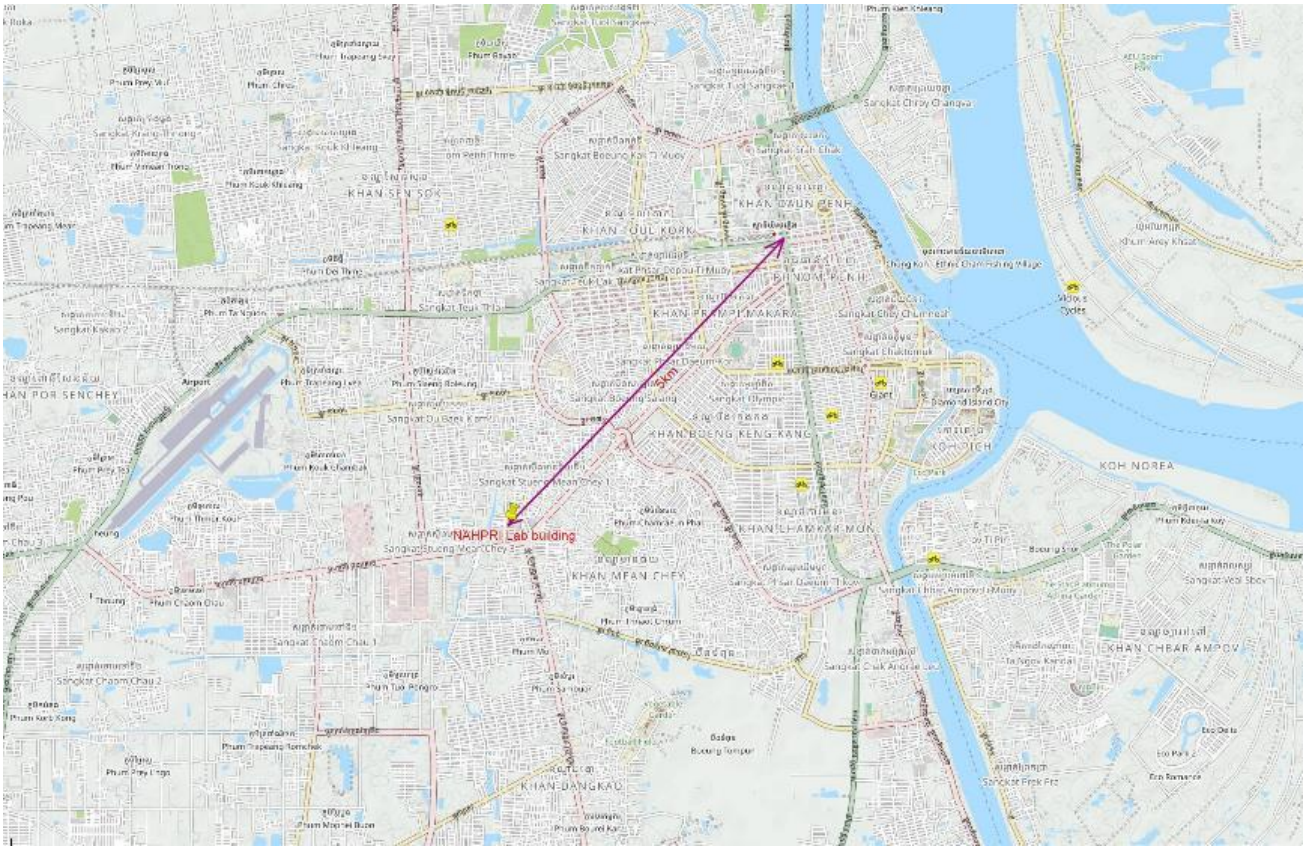
9. The NAHPRI is co-located with the GDAHP administrative offices in Trea village, Steung Meanchay commune, Sangkat, Meanchey district, Phnom Penh Capital City. It is a three-story building that includes laboratories and office space for laboratory management. Currently, its primary activities involve the testing of field epidemiological samples, primarily using ELIZA tests, and, to a lesser degree, for testing meat samples for AMR and pathogens and some quality tests for feed samples. An incineration facility is located at the west side of the lab building for disposal of bio-hazard wastes. Its incinerator is using electricity typical for hospital, see Table below.

10. At present, the NAHPRI lab can do the following test:

(i) Diagnosis of parasitological disease;
(ii) Bacteriological and microbiological analyses;
(iii) Virological diagnoses using RT-PCR and ELISA techniques, e.g., FMD, ASF, Avian Influenza, Newcastle Disease;
(iv) Pathological diagnoses (autopsies);
(v) Biochemistry (drug testing, residue testing) using ultra performance liquid chromatography, rapid test kits, screening tests for antibiotic residues in meat, milk and eggs; and
(vi) Some feed quality analyses.

11. The existing lab operation has a total staff of 78 (55 permanent position and 23 contract staff). After the restructuring, and with extended diagnostic analysis capacity, the total number of staff will be increased to 98. The NAHPRI Lab is in an urban populated area, at southwest side of the city, with a straight-line distance of about 5 km from the city center.

Figure I-1. Location of NAHPRI Lab in Southwest side of PHNOM PENH



Source: Asian Development Bank.

12. Being in an urban area of PHNOM PENH city, the Lab is accessible to the urban water supply system, power supply system, and drainage/sewer system. Currently, only 9 percent of discharged water in Cambodia is properly treated before being released into the main water bodies. This sewer system is mostly narrow and has old settings remaining from the colonial period. Sewage and other wastewater combine with rainwater in a series of covered and open canals which then flow into the city's rivers, lakes and wetlands. In addition to the absence of infrastructure, a lack of appropriate regulation and enforcement has resulted in the buildup of raw sewage in water bodies posing a threat to the urban environment particularly for residents in low-income areas around canals and lakes.

2. Planned NAHPRI Restructuring

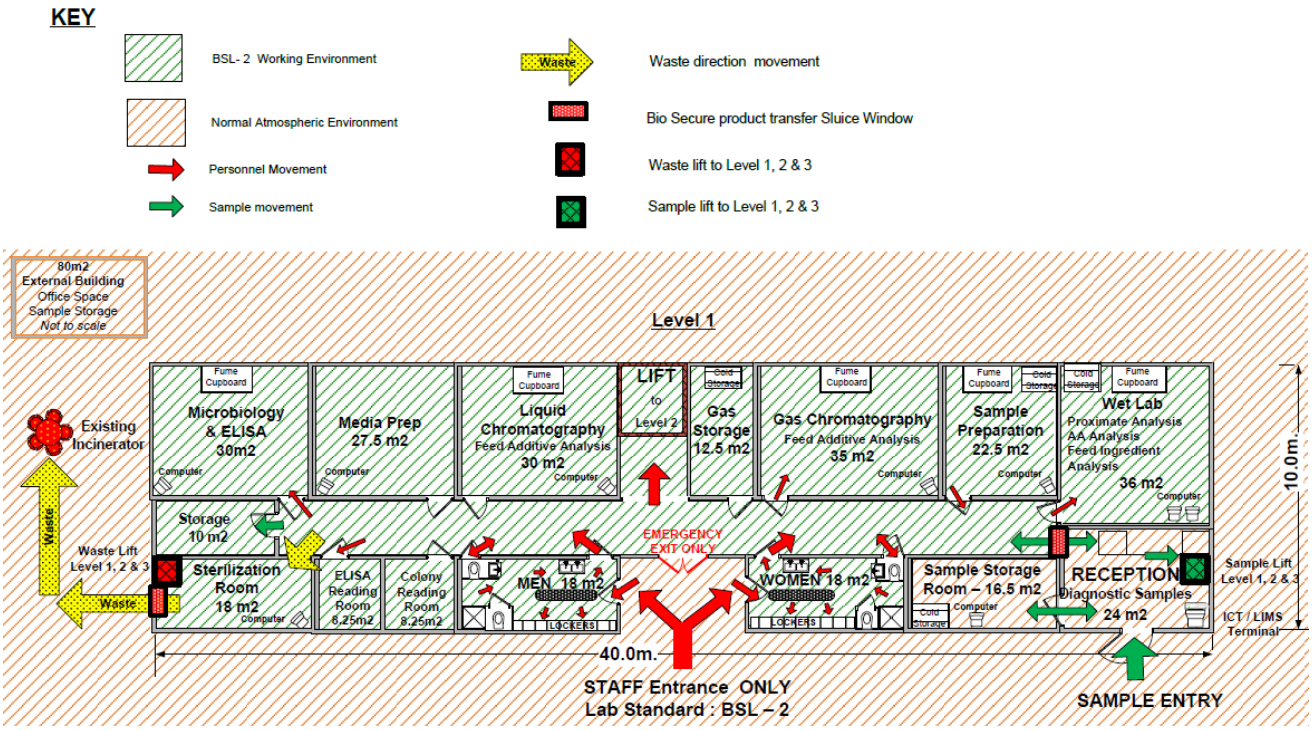
13. The GDAHP will relocate most of the offices currently housed in the NAHPRI laboratory. The plan for the restructuring of the building space to accommodate a feed testing laboratory on the first floor and a drug and meat testing laboratory on the second floor, while retaining the epidemiology sample analysis on the third floor of the building has been prepared. The restructuring includes limited reconstruction of laboratory space, the replacement of the internal stairwell with a secure lift, introduction of a sample receiving and storage space, installation of sample and waste dumbwaiter lifts and the establishment of a bio-secure entrance with male and female change areas and toilets.

14. The existing 3-story NAHPRI building will be upgraded to enable it to be entirely biosecurity level 2 (BSL-2), with movement of the offices currently occupying half of the 2nd level

elsewhere and dedication of this half to expand the Meat and Residues Testing lab capacity. The ground floor level will be refurbished to create a dedicated specimen reception and storage area, and a Feed Testing laboratory.

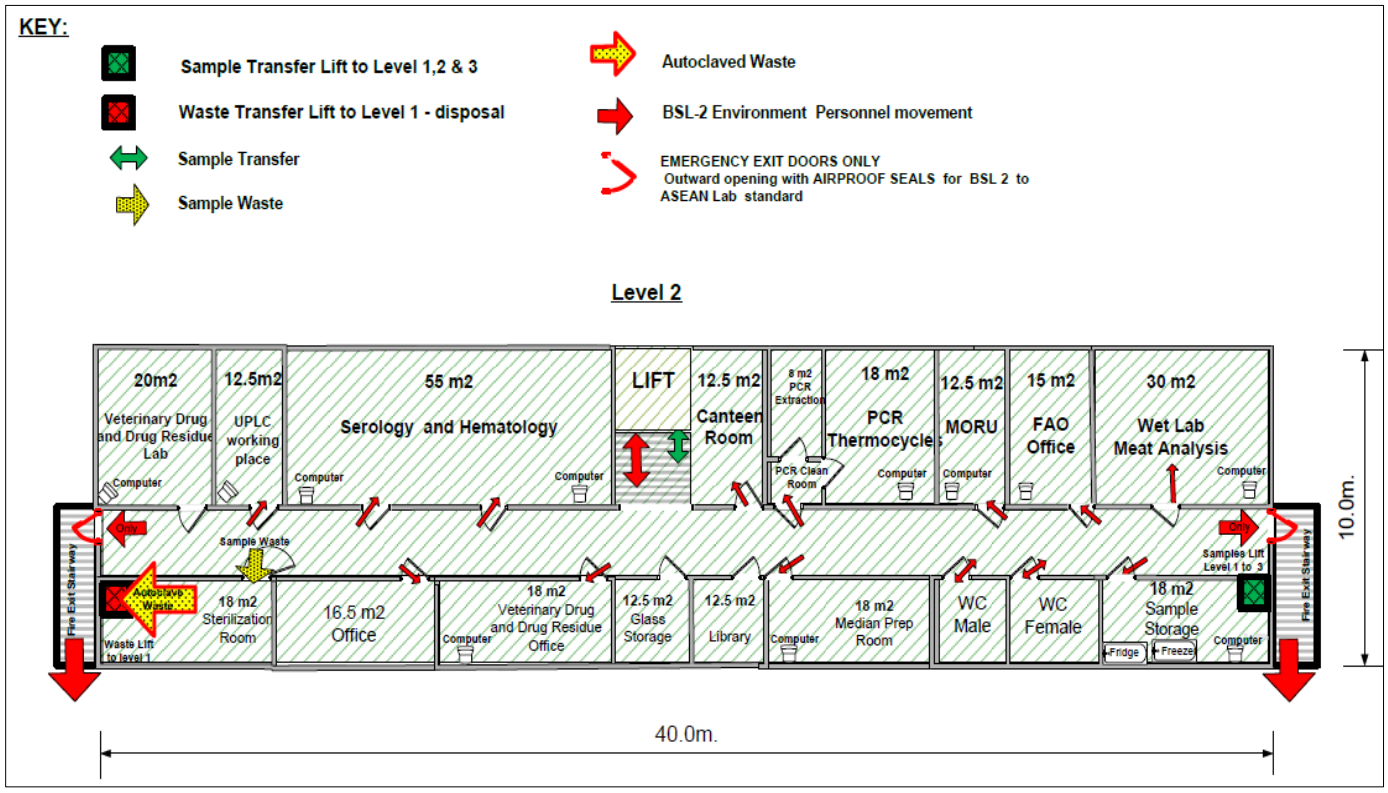
15. The lab will be provided with ISO-compliant equipment for: (i) the detection and monitoring of livestock diseases; (ii) zoonosis control; (iii) animal feed and veterinary medical product testing for quality and safety; and (iv) antimicrobial residue (AMR) testing, with extended capacity in meat & feed quality tests, drug & drug residual analysis. The layout of the lab building will be rearranged/restructured. The project will also train staff and upgrade the laboratory space and procedures to enable ISO 17025 and Biosecurity Level 2 certification and the establishment of a Laboratory Management Information System.

Figure I-2 NAHPRI 1st Floor Layout



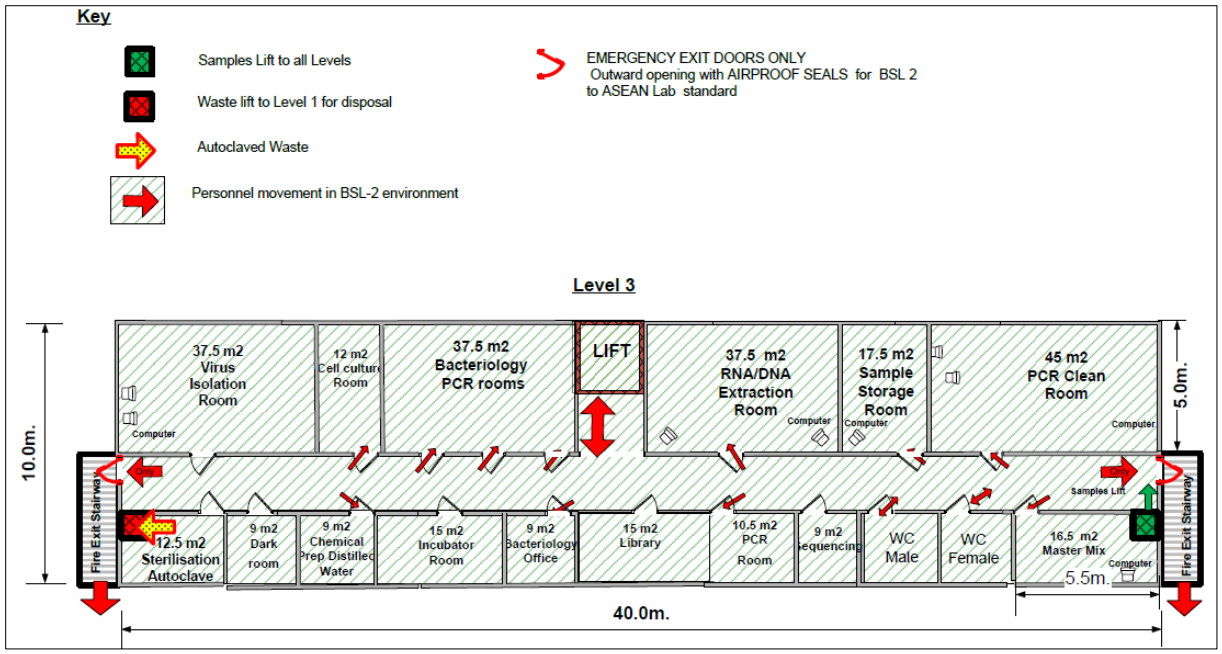
Source: Asian Development Bank.

Figure I-3. NAHPRI 2nd Floor Laboratory Layout



Source: Asian Development Bank.

Figure I-4. NAHPRI 3rd Floor Laboratory Layout



Source: Asian Development Bank.

16. Currently the national lab uses a lot of chemicals some of which are poisonous, and/or flammable, or corrosive, thus classified as hazardous materials. After the upgrading and expansion, more chemicals are expected to be needed. A list of additional equipment for NAHPRI has been prepared and is attached in Annex 1.

D. National Cattle Breeding Center

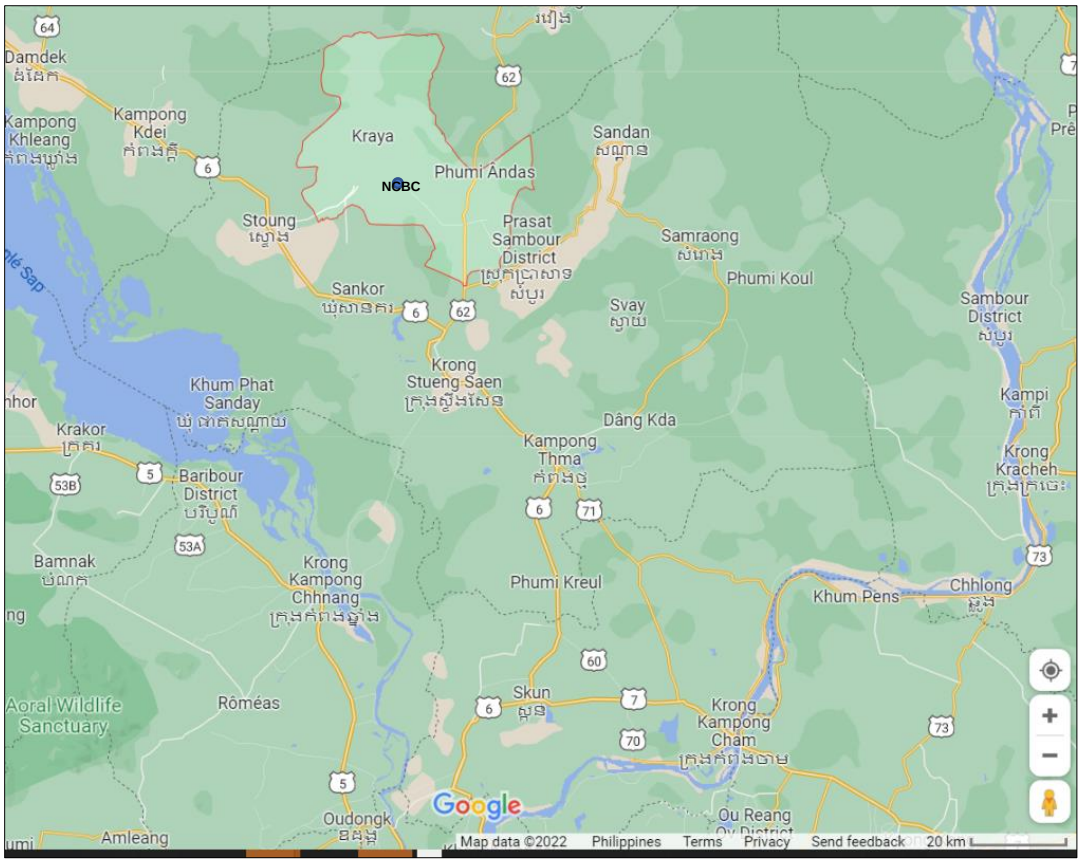
17. The project will support the construction of a National Cattle Breeding Center (NCBC) to accommodate up to 16 improved bulls with a production target of 320,000 straws per year by 2028. The NCBC will include a semen production laboratory, a liquid nitrogen plant, an AI training facility including accommodation for 10 trainees, bull housing and handling facilities, feed storage and processing facilities, and decentralized wastewater and solid waste treatment facilities, 4 staff houses and a forage production area of about 30 hectares, all enclosed by security fencing. In addition, the project will construct three liquid nitrogen and frozen semen storage and distribution facilities in locations that are still under identification.

18. The NCBC will be constructed inside a 134- ha land located at Phdeath and Kropue villages, Phanheum commune, Prasath Balang district, Kampong Thom province, that has been transferred to the GDAHP for animal experimentation and training.

19. The available services to the site boundary include three phase power supply and a permanent public access roadway. The site will also accommodate a new livestock research institute. There is an existing water pond for storing storm water, which can be used for irrigation the forage. There is no centralized sewerage system in the area.

20. The complete site comprises of seven component areas; a semen processing laboratory with supporting infrastructure, a liquid nitrogen plant, a bull housing shed with supporting infrastructure, a decentralized wastewater treatment system (DEWATS) including a biodigester and manure drying shed, a forage production area, and an accommodation area for four family homes and an artificial insemination (AI) trainee dormitory.

Figure I-5. Location of the NCBC in Kampong Thom Province



Source: Asian Development Bank.

1. Main Features of the new NCBC

21. Within the 134-ha area, the new NCBC will only use small part with clear boundaries will be marked. The following table summarizes the main features of the facility.

Table I-2. List of Components/Main Facilities of the New NCBC infrastructure

components of facility			contents
Main Facilities	Semen Lab with biosecurity entrances (two-story reinforced concrete structure with 410 m^2 of floor space on each level)	semen processing lab	Lab room (172m^2) for processing semen and activity detection
		frozen semen cold storage	A room (33m^2) for cold storing of processed semen in liquid nitrogen tanks.
		semen dispatch room	A room (13m^2) for dispatching processed semen
		Liquid nitrogen generator	A set of liquid nitrogen generator with capacity of 150 L liquid nitrogen/day, is provided which consist of air filter, air compressor, air precooling system, air purification system, fractionating tower, cooling water circulation system, liquid nitrogen storage and liquid nitrogen tanking.
		inwards goods	A room (17m^2) for accepting consumables

		room	delivered from outside to the lab.
		A dedicated clean room of 63 m^2	provides autoclave, sterilizing and laundry capacity for the laboratory
		Changing area and toilets	2 rooms (two for male, two for female) connected with bathrooms for the lab staff to change and disinfect dressings
	Bull housing shed and supporting infrastructure, 60 m long x 16 m wide with an elevated roof ridge	Bull pens	Pens for holding maximum elite 16 bulls, Holding pen and socializing pen. The holding pen is where the bull is fed, watered, and sleeps. 19. The socializing pen allows for adjacent bulls to visually see each other
		Quarantine pen	Provide a safe bio secure environment for any incoming bulls or animals to be observed and tested before entering and after leaving the ABC bio secure area, . Waste from the quarantine area will be pumped to the DEWATS.
		Bull exerciser yard	a four spoked revolving wheel 18 m in diameter.
		Hay and concentrated feed shed	for storing dry rice straws bought from the nearby village and concentrated feed bought from feed supplier
	Trainers/trainees accommodations		Classrooms/guest room for accommodation and training to the trainers/trainers of up to 10 trainees each time.
	Forage land		30 ha. of land for improved quality and quantity forage plantation experiment, and harvested forage be used to feed bulls as fresh cut and carry feed sources for the bulls
Ancillaries	Residential buildings		4 buildings including 4 bedrooms for up to 8 staff, together with family members (4 person/family)
	Dormitory		designed for on-site capacity training for current and future AI technicians and Veterinarians
	Perimeter and biosecurity fencing With outer security fence		The perimeter of the site will be fenced on all sides along the legal boundary lines. There will be one access point into the property off the public access roadway. All people and vehicles entering the property will pass through a staffed bio secure checkpoint. The entry process will include approved access permission, footwear disinfection and vehicle wheel wash. This entrance enables bio secure personnel or service vehicles to enter the laboratory/office and accommodation areas which will be enclosed with an outer security fence.
	An inner security fence will enclose the bull housing facility area		The electrified fence will be located a minimum of 50 meters from the bull facility area to provide both a physical and biosecurity barrier from any other animals entering or leaving the property the bull holding area. There will be one bio secure vehicle entrance point into the bull facility area and one bio secure personnel entrance door from the laboratory building only.
Utilities	Water supply	for Lab, residential and	Provided by local water supply system

		training buildings	
		for bull pen	The existing groundwater well and pump will be used to abstract groundwater for bulls watering and bullpens washing.
	Liquid Nitrogen Generator		separate building adjacent to the laboratory holds equipment to produce the liquid nitrogen required for the semen processing and storage
	drainage		Storm water is separated from foul water, effluent from bull housing area conveyed by pipelines to DEWATS for treatment and domestic wastewater from semen lab, training facilities, residential buildings are connected with septic tanks for primary treatment before entering into DEWATS.
	Power supply		Provided by the Kampong Thom power supply system
Waste Management Facilities	Manure drying shed		A concrete floor shed with clear plastic roofing will be constructed. The shed will have a sand layer on which the manure and sludge from DEWATS are dried naturally. Leachate from the sand bed is collected and pumped back to the DEWATS
	DEWATS		Wastewater from bull pens (washing water with urine and remaining manure) will be drained into DEWATS for treatment. Treated effluent will flow into a lined retention pond and applied onto the forage land.
	Septic tanks		Each of the residential building and Lab will have its own septic tank for primary treatment of domestic wastewater, then diverted into DEWATS
	Dead animals' burial site		Site land burial with lime will be used to manage any dead animals.

DEWATS = Decentralized Wastewater Treatment Systems.
Source: Asian Development Bank.

22. The semen processing laboratory will be a two-story reinforced concrete structure with 410 m^2 of floor space on each level, built to Cambodian building codes. The lower level will include a bio secure foot entrance area for all personnel entering the building. Office staff will proceed via internal stairs to the second-floor offices.

23. Bull housing shed and supporting infrastructure. Up to sixteen bulls can be housed in a permanent open sided shed. The shed footprint is 60 m long x 16 m wide with an elevated roof ridge along its length to facilitate air movement over the animals being housed. The shed is oriented at approximately 75 degrees to the prevailing wind direction which enables this aeration cleaning technique to be used and takes any odor away from the housing and laboratory area.

24. Each bull has access to two pens, both 20 m2 in area, which provides a high level of animal welfare. The holding pen is where the bull is fed watered and sleeps. This pen has two x 2 m high concrete panels to separate them physically and visually from the adjacent bulls. At the front and back of the holding pen is a three rail 1.8 m high steel member fence, each with an access gate leading to both the sheds central race and the bulls socializing pen below the covered outside yard.

25. The socializing pen allows for adjacent bulls to visually see each other and have only nose/head interactions. This interaction process is necessary to establish bull hierarchy and avoid possible future fighting during halter walking. All harvested bulls are halter led to the semen

collection area and will interact with other bulls during that process.

26. The holding pen floor is a grooved precast concrete slab sloped at 1.5 degrees towards the central lane. On both sides of the central lane are drains for each pens' daily effluent wash down water to be contained and transported to the biogas production unit. A high-pressure pumped water system using harvested roof water from the bull shed roof water and stored in storage tanks, will be used for this cleaning process and the evaporative cooling fans located in the sheds. The fans establish environment animal comfort to maximize semen harvesting production.

Figure I-6. 3D images of bull housing and services areas

Source: Asian Development Bank.

27. The socializing pens will have a 20 cm deep sand base installed, retained by a curb wall on the outside edge, for animal standing comfort. Sand reduces the risk of hoof slippage with any reactionary engagement while socializing with the bull in the next pen. Urine soaks into the sand and faeces will be removed by a shovel into a wheelbarrow and deposited in the manure drying shed. The socializing pens will drain into a covered drain on the outside of the pen, where there will also be a livestock laneway.

28. A bull exerciser yard is provided at one end of the bull pen shed. This is a four spoked revolving wheel 18 m in diameter. The bull's halter is attached to one spoke of the wheel which is electrically driven and turns very slowly. This trains the bull to be led by the halter with one revolution enabling 50 m of exercised walking to occur.

29. Due to the need for preventative animal health, a set of cattle yards with a head bail, body crush, weigh scales, parasite control race and loading/unloading ramp are attached by gated

access to the bull shed facility. This allows for any animal health procedures (e.g., vaccination, blood testing, parasite control, hoof trimming etc.) to occur within the breeding center's bio secure area. A loading unloading ramp extends over the top of the inner security fence to enable any quarantined animals to enter or exit the facility without a bio security risk to the other bulls on-site.

30. All laboratory use, human and animal drinking water will be supplied from a borehole via a storage tank on-site that is fitted with a non-return inflow valve inside the tank. The storage tank will hold a 3-day volume of water based on normal use for the laboratory, housing, and animal drinking water needs. It will supply water via a pressure pumped supply system within line on/off valves on each supply point junction to allow specific area repair, if necessary, without total site water disruption. The water supply tank will be established on a well-drained area between the inner and outer security fenced area, near the laboratory facility with a 240-v electrical connection.

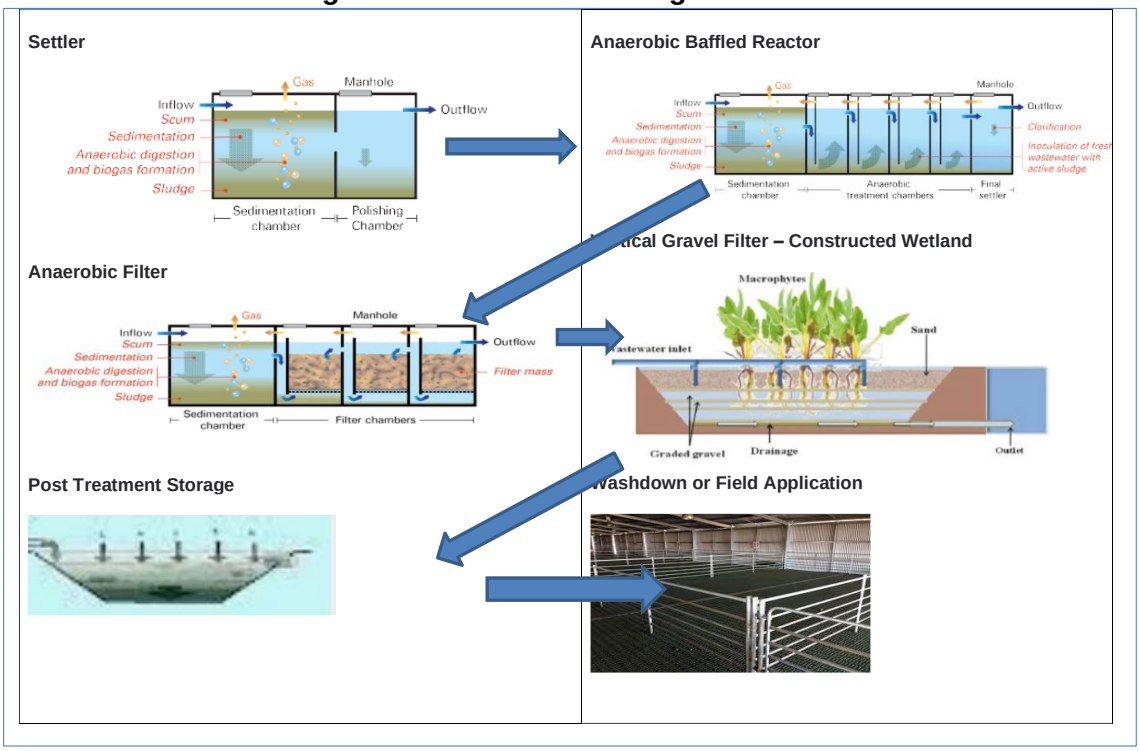
31. A supply pipe from the on-farm water well will be plumbed into this storage tank as an emergency backup supply in case of municipal water supply failure. This source of water can then also be used as an on-site water source for firefighting.

32. A quarantine pen will be established outside of the inner security fence to provide a bio secure environment for any incoming bulls or animals to be observed and tested before entering and after leaving the ABC bio secure area. Waste from the quarantine area will be pumped to the DEWATS.

33. DEWATS for treatment of wastewater from animal holding areas and for wastewater and semi-liquid waste from the laboratory unit will be installed. Sewage from accommodation buildings will flow to separate septic tanks for each building.

34. **Animal waste**. Any relatively dry manure will be collected with a shovel and wheelbarrow and placed in the manure drying shed for dehydration and sale as manure. Liquid washdown waste from animal holding areas will be channeled directly to a DEWATS which is designed to comply with applicable national wastewater discharge requirements. Primary treatment will be via in a settler sedimentation tanks; secondary treatment combines anaerobic baffled reactors and anaerobic fixed bed filters; and tertiary treatment combines a vertical gravel filter constructed wetland. Discharge from the tertiary treatment component will be collected in an aerobic detention pond, which in turn is backstopped by a levee to capture possible storm water overflow.. Regular de-sludging of DEWATS will occur with removed sludge being dried on a covered de-watering platform with a sand surface from which excess fluids draining back into the DEWATS (**Figure I-7**).

Figure I-7. DEWATS Design for NCBC



Source: Asian Development Bank.

35. **Laboratory wastewater and wastes.** The laboratory wastewater will also be treated in the DEWATS, with solvents being neutralized in each laboratory unit before discharge to the wastewater treatment system. Liquid wastes considered as toxic materials (e.g., strong lab chemicals) will not be discharged and instead will be containerized for treatment and/or disposed by an accredited hazardous waste contractor.

36. **Forage Area.** The site will establish approximately 30 ha of quality forage or pasture establishment as fresh cut and carry feed sources for the bulls. Some of the proposed forage area will be irrigated using high nutrient water outflow from the DEWATS.

37. **Staff Accommodation and Dormitory.** The project will establish four 2-bedroom family homes for staff accommodation and gender-segregated dormitory accommodation for 6 female and 6 male trainees will be constructed on the site. Water from the well supply will be connected to these properties. The accommodation area will include concrete roading with vehicle parking and waste collection. Each house and the training center will be serviced by separate septic tanks

38. To keep management and operation of the ABC, 19 staff are required and working for 260 days per year. There are residential buildings for 4 families (3 member/family), and rest of 11 staff work in NCBC only during working hours. The AI training courses will be run for up to 10 trainees at a time and run for 7-10 days. It is expected that about 10 courses per year from PY4 onwards.

39. **Liquid Nitrogen Generator.** A separate building adjacent to the laboratory holds equipment to produce the liquid nitrogen required for the semen processing and storage. Additionally, a backup power supply generator is housed in the same building.

E. National Veterinary Vaccine Center

40. To address the current dependency of Cambodia on the importation of all livestock vaccines, a National Veterinary Vaccine Center (NVVC) is proposed that would initially manufacture essential livestock vaccines, including Hemorrhagic septicemia (HS) for cattle and buffalo, Newcastle Disease (NDV) and Fowl Cholera for poultry. This will reduce imported vaccine demand of Cambodia. The planned vaccine production is as per the table below.

Table I-3. Planned Cambodia vaccine production

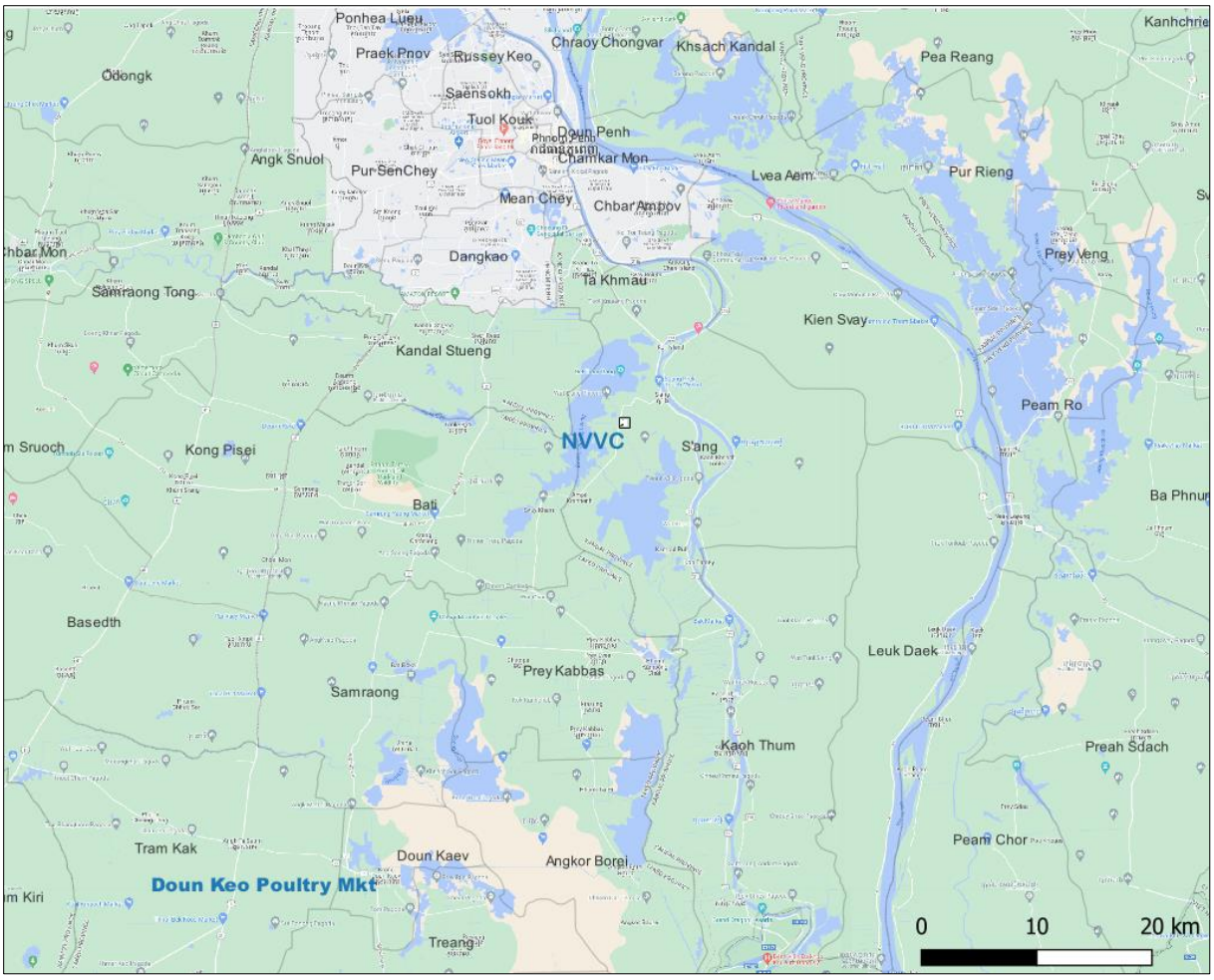
Description of activities Vaccine production center	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**
Hemorrhagic Septicemia production vaccine (doses)				1,000,000	3,000,000	3,000,000	3,000,000
Fowl Cholera (doses)	0	0	0	0	3,000,000	10,000,000	10,000,000
New Castle vaccine (doses)	0	0	0	0	3,000,000	10,000,000	10,000,000

Source: Asian Development Bank.

41. The NVVC will apply Office International des Épizooties (OIE: World Organization for Animal Health) vaccine production procedures. Adherence to these manufacturing protocols ensures high quality vaccine production. OIE standardized manufacturing procedures require a Bio Security Level two (BSL2) operating environment, managed air temperature, quality, and pressure, GMP/GLP, Standards of Practice (SOPs), product stocktaking and wastewater treatment. The NVVC plans to acquire accreditation as an ASEAN Animal Vaccine Testing Laboratory to ensure that all domestically produced vaccines meet the required international manufacturing standards.

42. The proposed NVVC is in Tanou village, Phnom Sa'ang commune, Sa'ang district, Kandal province, 27 km away from the center of Phnom Penh and 34 km away from Kandal Center, accessible to National Road No.21. The chosen site for the NVVC is on the floodplain of the Mekong River which will require extensive infilling/foundation and erosion protection to ensure elevated facility is protected from the annual flood of the Mekong River now and from climate change.

Figure I-8. Location of the NVVC and Takeo market



Source: Asian Development Bank.

43. Local villages have access to rural water supply system and power grid, and only a few of households have groundwater wells. The site is surrounded by farmland and unconnected to a public sewer system. Water and wastewater drain towards Prek Khleng Stream, 1.5 km away at east, then into Tonle Basak River, which is about 5 km at east.

1. Main Facilities of the New NVVC

44. The project will support the development and ultimate certification of vaccine production and testing facility for Good Management Practice (GMP) and Good Laboratory Practice (GLP). New production lines for several animal vaccines will be built under this subproject.

45. The production method for the three vaccines are as follows:

(i) **Hemorrhagic Septicemia** (**bacterial**, inactivated, oil adjuvant/OAV), A local isolate of *Pasteurella multocida* of the prevalent serotype in bovines is cultured on solid medium in Roux flasks, then harvested into formalinized physiological saline. A 100-liter batch fermenter will yield a minimum of 66,000 doses (each of 3 ml) of OAV, with emulsification of equal volumes of a light mineral oil and the bacterial suspension, with 5% pure anhydrous lanolin as emulsifying agent. The mixture is

then re-emulsified, bottled and stored at 4°C for 2 weeks prior to use. The sterilized medium for the aerated culture method is casein hydrolysate (2 g), sucrose (6 g), yeast extract (6 g), sodium chloride (5 g), anhydrous dipotassium hydrogen orthophosphate (8.6 g), anhydrous potassium dihydrogen orthophosphate (1.36 g), and distilled water to 1 liter.

(ii) **Fowl Cholera** (**bacterial**, inactivated, adjuvant), Fowl cholera is caused by pathogenic avian serotypes of *Pasteurella multocida*, with an inactivated vaccine prepared using locally circulating well characterized serotypes established in efficacy and safety trials, then killed in formalin and prepared with aluminum hydroxide as an adjuvant. The P. multocida seeds are prepared as pure cultures on agar plates then scaled up in broth media, free from extraneous bacteria and fungi. Cultures are sub passaged until the desired volume is prepared, then harvested when they reach a suitable density, measured by spectrophotometry (optical density). Cultures are then inactivated by formaldehyde, filtered then diluted to reach the proper concentration for blending into completed product with adjuvant, prior to filling sterile final containers. Inactivated vaccine is normally administered by intramuscular injection in the leg or breast muscles, with two doses typically administered at 2- to 4-week intervals, achieving full immunity approximately 2 weeks after the second dose.

(iii) **Newcastle Disease** (**viral,** live, lowly pathogenic attenuated strains). ND virus strains (NDM, NDF, NDI-2) have been selected and cloned to enhance production and application but are of low virulence and successfully used as vaccines in NDV endemically infected countries. ND vaccines are produced from immersion of the working virus seed into sterile PBS (pH 7.2) then inoculation into the allantoic cavity of 9-10-day old embryonated chicken eggs, then incubated at 37°C. The infected eggs are chilled at 4°C before being harvested. The tops of the eggs are removed and the allantoic fluids aspirated after depression of the embryo, stored at 4°C, tested for bacterial contamination, then pooled for lyophilisation. The live vaccine is then tested by titrating the virus in embryonated chicken eggs to calculate the EID50 after 5–7 days of incubation at 37°C, with eggs chilled and tested for haemagglutinin activity, indicative of the presence of live virus. The live virus vaccine is usually administered to birds by incorporation in the drinking water or as an aerosol, or intranasal or conjunctival instillation.

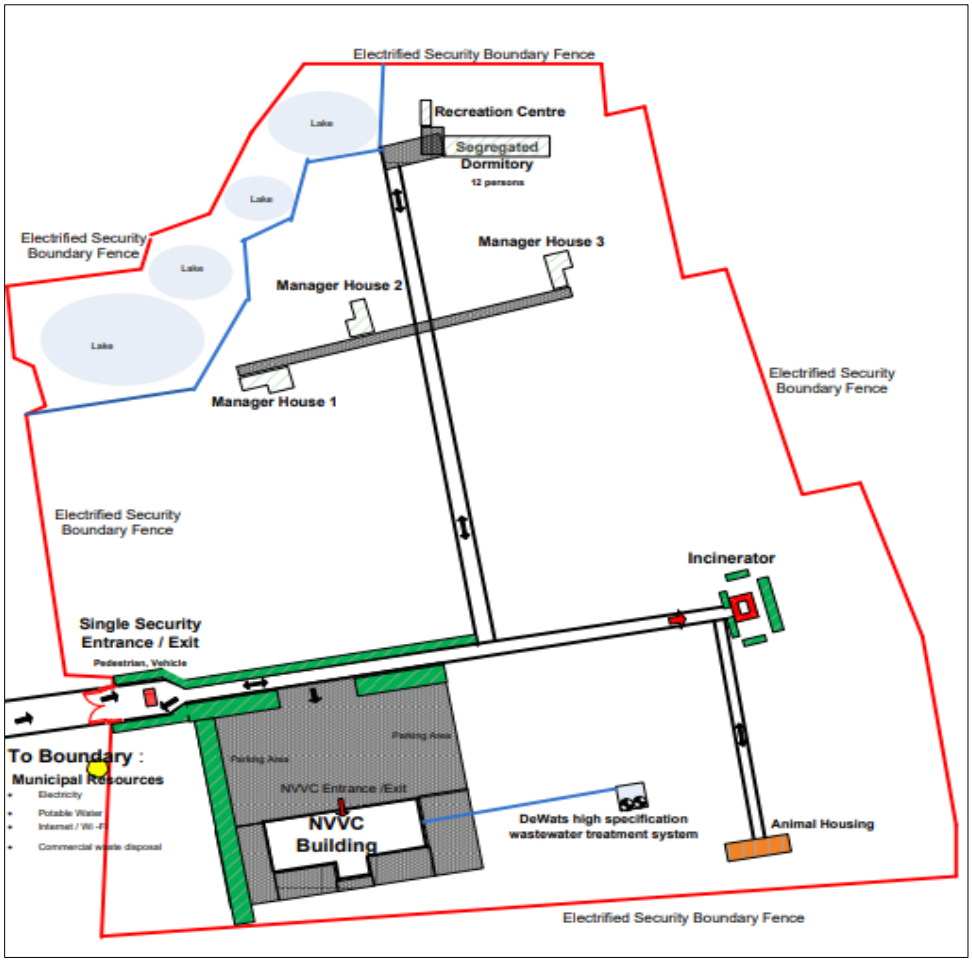
46. The above three vaccines to be produced are the same as those by the veterinary vaccine production center (VVPC) in Lao People's Democratic Republic (Lao PDR) for years, also in the sister GMS livestock project being prepared in parallel. Therefore, the VVPC production processes and associated pollutions and EHS risks are good reference and proxy for NVVC of Cambodia, details described in 4.1.4.The manufacturing of veterinary vaccines requires diligent quality control if vaccines are to be sufficiently efficacious and depends on: (i) the immune provoking quality of the master and working seeds of the pathogen; (ii) appropriate adjuvants used; rigorous manufacturing processes; (iii) a bio secure building, facilities and equipment; (iv) personnel adequately trained and able to follow required sanitary standard operating procedures (SOP's), careful control and monitoring of the manufacturing conditions is maintained; and (v) appropriate tests are used and conducted efficiently for assurance of the quality of the vaccine product.

47. To achieve the above, each major production step requires sterilization to prevent cross-contamination of different materials. To ensure the substances and reactors/containers are properly sterilized, sample tests need to be carried out for process and quality control (QC). The OC laboratory will have double story with independent bio-secure access to both the Virology and

Bacteriology production units to comply with BSL-2 requirements. There will be de-contamination room designed to sterilize hazardous contaminated materials originating from the production by a double-ended autoclave.

48. The site works will include roads and covered parking, landscaping, and security fencing. The layout of the first floor of the NVVC, where viral and bacterial vaccine production and their quality control will occur is detailed in Figure I-9.

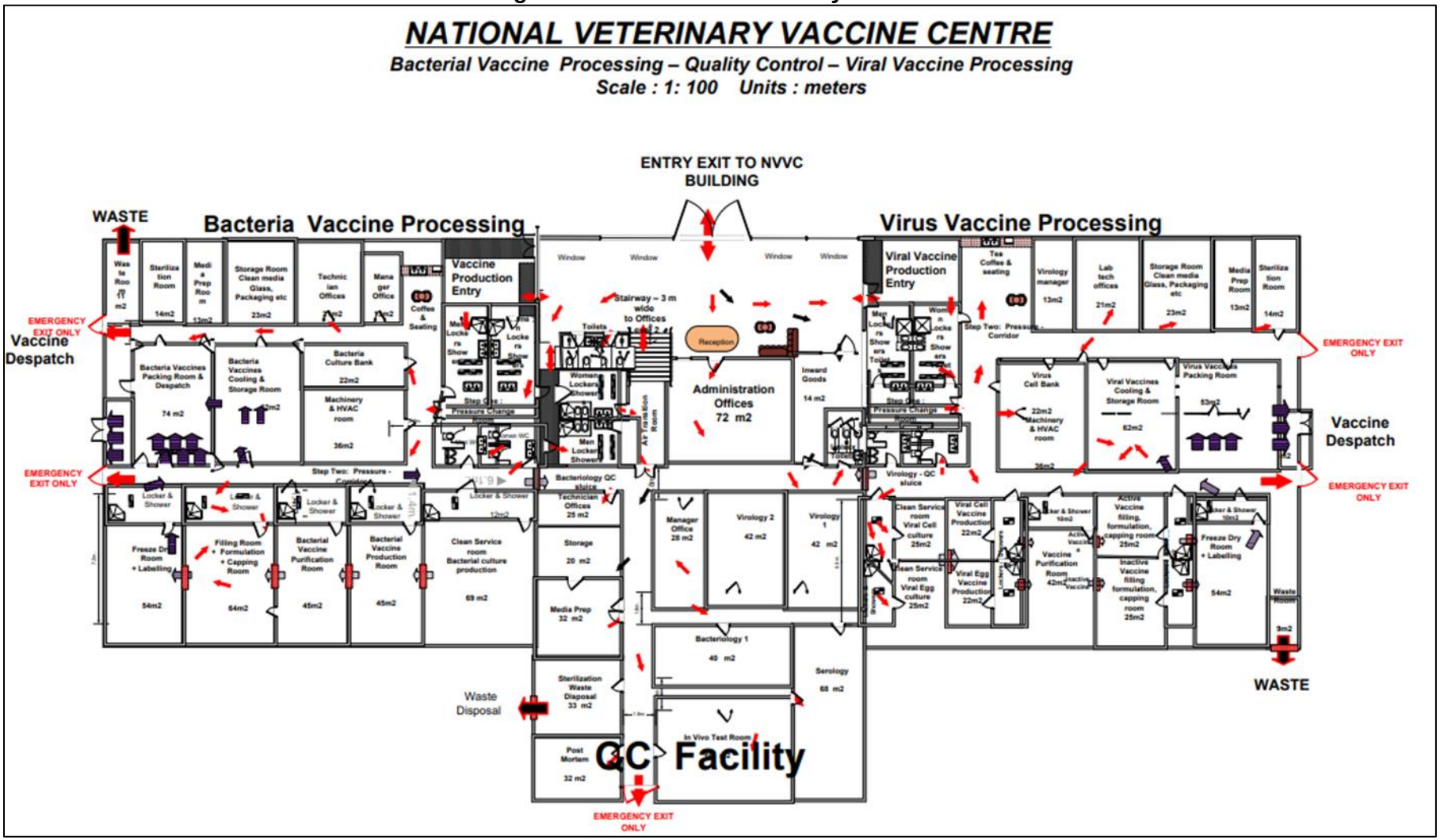
Figure I-9. NVVC Site plan



Source: Asian Development Bank.

49. **Quality Control (QC) building.** The QC laboratory will have separate rooms for each of the following: virology clean cell culture room, virology processing, Serology, in vivo testing, bacteriology, pathology, post-mortem, media preparation, sterilization/waste disposal, and men's and women's toilets/change rooms. Test record keeping will be supported through a computerized/networked laboratory information management system (LIMS).

Figure I-10. NVVC first floor layout



Source: Asian Development Bank.

2. Pollution control of vaccine production

50. For control of air pollution, the FS proposed that the Air Quality Pressures and Circulation system under its Heating, Ventilation and Air Conditioning (HVAC) will establish positive-pressure areas where sterile products are processed while negative pressure will be applied in areas where pathogens are processed. In general, any organism considered to be pathogenic will be handled in specifically designed areas under negative pressure, in accordance with any containment requirements for the product concerned. Air vented from the production process will be passed through an in line high efficiency particulate air filter (HEPA) before open air discharge where the discharge must conform to the relevant Cambodian air discharge laws. An airlock system will be established at the entrance of the viral and bacterial production units for the changing and shower rooms. For the QC lab no air pressure system is required other than a normal air conditioner for the environmental comfort of working staff. The following air pressures will be applied to specific spaces:

(i) 5 Pascal: Corridors, Men WC, Women WC
(ii) 15 Pascal: Fermenter rooms and the virus inoculation room
(iii) 25 Pascal: Media preparation rooms and cell culture rooms (non-infected room),
(iv) 45 Pascal: Vaccine Purification rooms

51. **For wastewater treatment**: The wastewater treatment system will ensure that all GMP and regulatory requirements are attained. According to the FS, cleaning of all chemical and biological instruments and vessels used in the production units is to be achieved by hot water and/or ultraviolet light sterilization. Production wastewater will then be piped into a newly installed wastewater system that is adequately sized for future production capability. Chemical and biological waste will be neutralized and treated in the wastewater system.

52. **Solid and hazardous wastes.** General wastes will be collected and disposed of in a municipal waste landfill. Infectious wastes will be packaged and vacuum autoclaved thus turned into non-hazardous. For hazardous wastes not accepted by the landfill, incineration option is applied, and it will be through a small (30 kg/load), medical grade incinerator on the property, filled with HEPA approved discharge filters that will be maintained by the supplier. The incinerator will be in a roofed site within a secure lockable perimeter fence. A maintenance contract will ensure the incinerator operates safely and correctly within its approved capacity and enable regular air emission monitoring inspections. This is essential if the incinerator is to comply with the relevant Cambodian air discharge laws and support GMP/GLP protocols for the NVVC site.

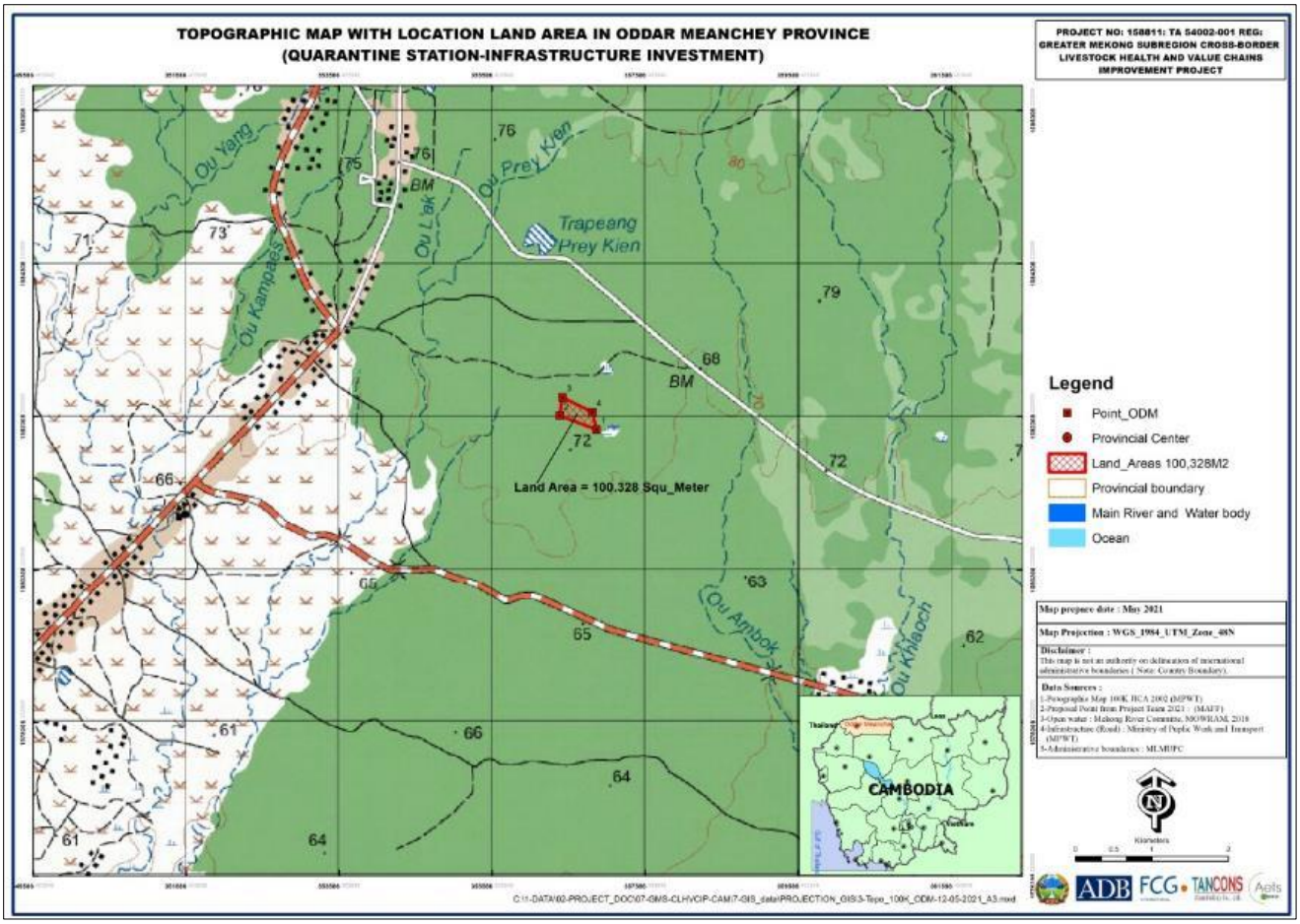
F. Otdar Meanchey Inspection Center

53. The project will construct new animal inspection station at Otdar Meanchey (OM) near the border with Thailand inside the Disease Control Zone (DCZ). It will consist of holding areas and testing laboratories on the proposed sites, with enhanced capacity for inspection and pen-side testing of slaughter pigs & cattle. It will have new laboratories and will provide base level testing services, laboratory diagnostics that are compliant with International Organization for Standardization (ISO), and waste management that meets national or international standards and a decentralized wastewater treatment system.

54. The proposed location of the OMIC is in Sangkat Koul Kriel at the northeast of Samraong city, at a distant around 25km and from the international border gate at Ou Smach. The inspection center will be located within an administration forestry area of the Provincial Department of Agriculture Forestry and Fisheries Otdar Meanchey (PODAFF-OMC) with the total area allocated

for the project of around 10 ha within the total of PDAFF-OMC land area of around 162 ha.

Figure I-11. Location of the Otdar Meanchey Livestock Inspection Center



Source: Asian Development Bank.

55. The site is relatively isolated, the nearest villages being Samroang Senchey 1 (1km), Koun Kriel (2km), and Kirivoant (5km). The site is accessible via a road from Samraong city that includes a 7 km length of dirt surface. There is a 3~5 km access road passing through the 160 ha. of this land, closer to the proposed inspection center, connecting the site with road #2668, road separates the site from the adjacent conservation forest. This access road is in poor condition and will require sealing. The Otdar Meanchey government has committed to seal this road section to improve the OM IC access.

56. Otdar Meanchey is a province in northwest Cambodia bordering with Thailand, located about 470 km from Phnom Penh. The site is the main entry point for pigs and cattle from Thailand, both to supply the domestic meat market and for transit to Viet Nam.

57. This site is not accessible to any public water, sewer/drainage and power systems. There are 6 groundwater wells with water of variable quality that may not be suitable for livestock because of high iron content. Villagers' household water uses are dependent on surface water collected in constructed public ponds and some individual families' water ponds. The site currently relies on solar energy as there is no transmission line from the main road to the site.

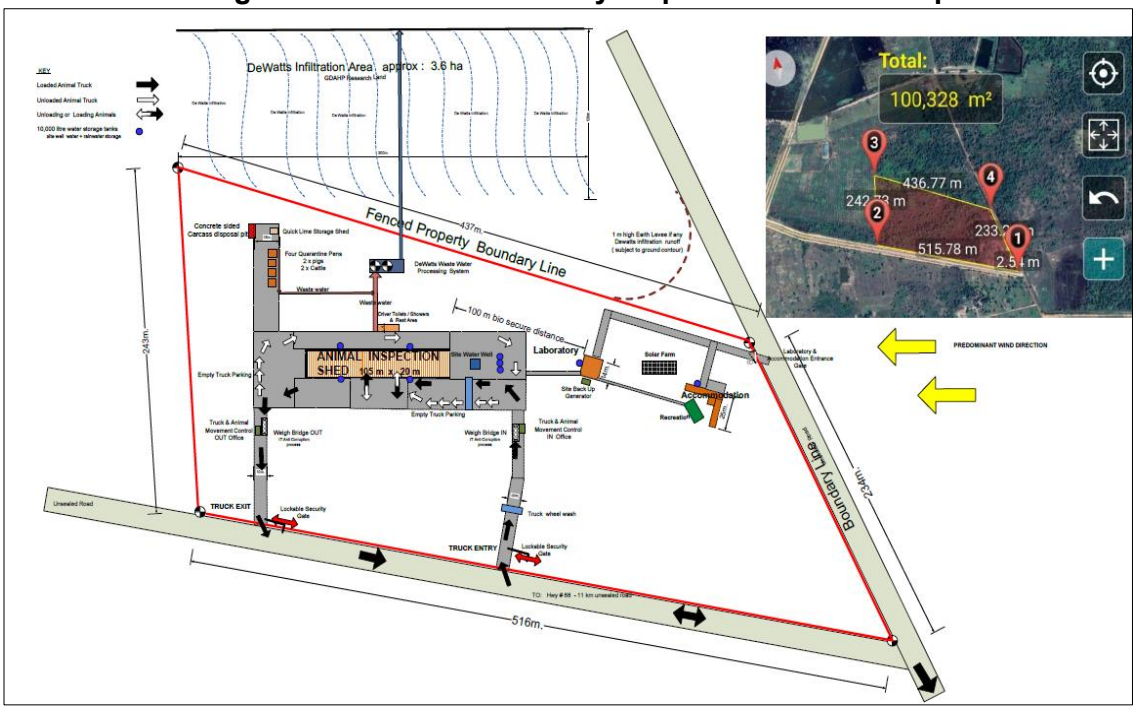
1. Main Facilities under the project

58. The OM facility is an inspection station for the temporary holding of pigs and cattle imported from Thailand for health inspecting and that are intended to proceed directly after inspection to slaughterhouses in Cambodia. At present, these animals are inspected in the holding yards of private traders, which are widely dispersed and often both unsanitary and unsuitable for effective inspection.

59. The site will include a livestock inspection station, a small laboratory, staff accommodation, a driver rest room, a pit for dead animals, a shed for manure drying, and a decentralized wastewater treatment system, the discharge of which will be used by the adjoining research station for crop and forage irrigation.

60. Five batches of 400 pigs and 40 cattle will be inspected daily for a total of 2000 pigs and 200 cattle per day. The pig and cattle inspection center will be roofed and contain a series of 40m2 cubicles able to hold 50 pigs or 20 cattle, which represent the load of a typical livestock truck. The cattle and pig inspection areas will be separated, and each will have its own loading/unloading ramp and animal inspection race and, in the case of the cattle, a cattle crush. Following initial inspection in the livestock inspection races, animals will be held in these pens in batches for a two-hour inspection during which their temperatures will be remotely measured, and their behavior monitored. A raceway above the pens will simplify inspection. Where considered necessary, simple pen-side tests will be used for disease detection, including for FMD and ASF. The identification of a notifiable disease will lead to the rejection of the truckload and its re-export to Thailand by the concerned trader. Manure will, when not too wet, be collected and moved to a manure drying station where it will be dried to about 30% moisture content and sold as fertilizer. The livestock inspection center will be washed down into the DEWATS and sanitized each evening.

Figure I-12. Otdar Meanchey Inspection Center site plan



Source: Asian Development Bank.

Table I-1. List of Components/Main Facilities of the OMIC

component	facility	Main structures/function
Main facilities	cattle holding area	Holding 200 cattle per batch, 10 cattle pens @ 40m^2/pen; each can hold 20 cattle
	Pig holding area	Holding 400 pigs per batch: 12 pens @ 40m^2 each, can hold 50 pigs
	Laboratory	Capable for rapid pen-side & sample preparation
Utilities	Water supply	Groundwater well and rainwater collection pond
	drainage	Animal pens is slope designed to allow wash-down flow into DEWATS;
	Power supply	Mains power, to be supplied by province administration
	air-conditioning	1 HP (750W)
Pollution control devices and facilities	Manure drying bed	TO treat: Animal related wastes, i.e., manure, feed residues, bedding materials
	DEWATS	To treat: wastewater from process, e.g., pen washing water, Lab operation and animal urine etc.
	Septic tank	to treat the domestic wastewater before discharge to the DEWATS
	Disinfection system	disinfectant (sodium hypochlorite) Installed at Inlet and outlet
	Dead animals' disposal	Burial area

DEWATS = Decentralized Wastewater Treatment Systems.
Source: Asian Development Bank.

61. The OMIC will include a small laboratory, both for the testing of inspected animals and for the future coordination of a Otdar Meanchey DCZ. Staff will be accommodated in a gender segregated dormitory facility. Staffing will include a station manager, 2 laboratory technicians, 5 livestock inspectors and about 10 locally hired laborers and guards. The OMIC will operate 6 days per week.

62. BORDA Cambodia provided the preliminary design for the wastewater system with the following characteristics:

(i) The proposed location for the DEWATS system is behind the Inspection Center building by about 50m nearby the wetland area. Treated wastewater is then easily accessible for gardening or final discharge. As per request from the Department of Animal Health and Production, a polishing pond is considered to store treated wastewater before discharging to the wetland area.
(ii) The DEWATS is designed to treat 55 m3 per day from animal pens and truck cleaning mixed and flow into the DEWATS system.
(iii) The DEWATS will have 3 modules: Settler (2 chambers); Anaerobic Baffled Reactor (6 chambers); Anaerobic Filter (2 chambers), 32 control manholes (iron cast manhole covers), 2 Horizontal Gravel Filter and 1 polishing pond.
(iv) The size of the DEWATS system is 585.60 m2 (32.00m x 18.30m) and is not prone to flooding (according to the Department of Animal Health and Production).

G. Doun Keo Live Bird market

63. GDAHP are keen to support the developing native poultry industry that has proven to be a lucrative source of income for numerous smallholder farmers in Cambodia. However currently, the wet markets with poultry in Takeo and elsewhere have poor biosecurity and hygiene standards and are in urgent need of upgrades, particularly to include separation of live bird displays from the carcass, slaughter and other food areas. As FAO had conducted a recent study that led to a proposed upgrade in Takeo, progression of this proposal to tender has been agreed. The objective is to improve overall hygiene, reduce the likelihood of infection of poultry and poultry traders with zoonotic avian influenza, the high pathogenic avian influenza (HPAI) viruses and reduce the risk of carrying HPAI virus from the market back to farms.

64. . The prioritized subproject is live bird section of Doun Keo market, located at south side of urban area of Takeo Town in Takeo Province. The market is accessible to the town water supply system. Wastewater discharged from the market is drained through the street gutter, combined with rainwater, flow into a lagoon located about 2km away for natural treatment before being reused for irrigating rick field. It is also accessible to local power grid and within the scope of the town's domestic solid waste management.

1. Main Facilities of the poultry section of Takeo market

65. The market design includes separate tiled, drained pit areas for chickens and ducks, where poultry will be held in cages, surrounded by elevated walkways for customers, separated by a pipe barrier. Live birds will either be purchased and removed from the marketplace or transferred to a slaughter person in a separated slaughter area with 5 slaughter points, each with slaughter slabs, basins with hot and cold water, a plucking machine and a stainless-steel blood collection bucket and slaughter restraint and bleeding cone. Slaughtered birds will leave the market without passing through the live bird area.

66. **Poultry Slaughtering**, basically manual process, will be carried out with the following process: (i) slaughter only in designated slaughter points separate from live birds; (ii) correct slaughter procedures shown at each slaughter point; (iii) restrained bird (using a bleeding cone) bled for at least 3 minutes before scalding; (iv) scalding water should be at 60-62^{0}C and regularly replenished; (v) all poultry carcasses should be eviscerated and gizzard slitting and cleaning must be carried out separately from the carcass washing (vi) carcass cleaned with clean running water immediately after evisceration; (vii) carcass and edible offal should be packed in clean packaging immediately after cleaning; (viii) all slaughter must pe done on impervious benches provided; (ix) all knives for slaughtering should be sterilized 80^{0}C water; (x) poultry carcass may be singed immediately after cleaning; and (xi) blood for edible purpose must be collected in clean containers above the floor.

67. The slaughtering area will require low-rise stainless-steel tables to enable slaughterers and those dressing slaughtered birds to squat or sit on small stools and prevent workers reverting to working on the floor. The slaughtering will be done using bird cones over blood collecting vessels. Combined with hot water, sinks and stainless-steel bird dressing tables and solid waste bins, the facility should be sufficient for 400-500 birds per day. Inclusion of solar panels and an electrically boosted solar hot water system on the roof and supplying a battery is intended to make the facility largely energy self-sufficient.

Table I-2. Subproject on Doun Keo Live Bird Market

components	facility	Specifications	Main structures/function
Main facilities	Carcass selling area	17stalls, with each 1.5~2.0 m^2	-Ceramic tiles shall be used fully in each poultry selling area.
	Live birds selling area	29 stalls with each 1.5~2.0 m2	-Ceramic tiles shall be used fully in each poultry selling area. -Each stall can have enough place for keeping 50~70 chickens or 35~45 ducks
	Slaughter area	3 stalls with each 3m x 2m	-can provide enough space for a scalding tank, sink, killing cones and a plastic mobile garbage bin -The rear wall of the slaughter area will be full height (3m high). -The front wall of slaughter area shall be 1.2 m high. Entrance to each stall shall be 1.2 m wide -Ceramic tiles shall be installed to wall surfaces up to a height of 1.5 m and the remains shall be applied washable paint.
Utilities	Water supply		water supply relies on local urban water supply system for slaughtering bird and domestic water supply
	Rain Catchment Tank	4X 1 m^3	-The rain catchment tank shall be 4 m^3 galvanized panel tank, 1 m^3 per panel for daily flushing after DKPM is closed
		Local power system	The air-conditioning 1 HP (750W)
	Drainage	4	Four trenches including traps installed on the floor to drain off the wastewater, connected to Takeo Town sewer system
Wastes management facilities	Solid Waste management	6 Collection bins (120 litter/bin)	plastic mobile garbage bins for collection of solid waste are provided along the poultry selling areas
		Storing site	Collected solid wastes can be stored temporarily in WASTE BINS AREA (3.0 m^2) under the staircase
	Exhaust fans	5 fans	provided to each stall to vent the air to the roof through the galvanized duct
	on-site wastewater system	DEWATs proposed underground	to treat the wastewater before discharge to the public sewerage
	Disinfection devices		Thoroughly disinfection at end of each market day
	Condemned or dead bird		Disposal through sealed bins, lime, and landfill

Source: Asian Development Bank.

II. Legal, and Administrative Framework

A. Domestic Legal and Policy Framework for Environmental Protection

1. Primary Law Governing Environmental Management

69. Cambodia's Constitution, confirmed in 1993 by the Royal Government of Cambodia, lays fundamental legal requirement on environmental protection in its Article 59 that: The state shall protect the environment and balance the abundant natural resources and establish a precise plan of management of land, water, air, wind, geology, ecological systems, mines, energy, petrol and gas, rock and sand, gems forests and forestry, products, wildlife, fish and aquatic resources.

70. Based on the Constitution, The Law on Environmental Protection and Natural Resource Management (NS/RKM/1296/36), enacted by National Assembly in 1996, and promulgated by Preah Reach Kram/NS/RKM-1296/36 is the primary governing law for environment management. The purposes of this law are to:

(i) protect and promote environment quality and public health through prevention, reduction and control of pollution,
(ii) assess the environmental impacts of all proposed projects prior to the issuance of a decision by the Government,
(iii) ensure the rational and sustainable conservation, development, management and use of the natural resources of the Kingdom of Cambodia,
(iv) encourage and provide possibilities for the public to participate in the protection of environment and the management of the natural resources and suppress any acts that cause harm to the environment.

71. Under this law, the developers or project owners need to prepare an Initial Environmental Impact Assessment (IEIA) or a full Environmental Impact Assessment (EIA) report.

72. The hierarchy of legislation in Cambodia is: (i) Royal Decree signed by the King; (ii) Sub-decree signed by the Prime Minister; (iii) Ministerial Decision signed by a Minister; and (iv) Regulation issued by Ministry.

73. A Royal Decree ratifies laws passed by parliament. These can be supplemented by "Prakas" or ministerial decisions. These laws allow sub-decrees and regulations to be passed which can stipulate procedures and standards to be met in order to ensure compliance with the law. Many sub-decrees and standards have been drafted but not yet ratified by parliament.

2. Laws/Sub-Decrees relevant to Environment and Natural Resources Management

74. The Government of Cambodia has also established laws and regulations for forests, protected areas, and land management to ensure sustainable development that are relevant to environmental protection and natural resources management. The key elements of the legal and policy framework for the project are summarized in Table below.

Table II-1. National Laws, Legislative and Policy Related to Environmental Protection and Natural Resources Management and Cultural Resources

Law/Decree/ Decision	Year	Summary
Royal Decree on the Protection of Natural Areas	1993	Classified 23 protected areas in Cambodia into four categories: (i) natural parks; (ii) wildlife sanctuaries; (iii) protected landscapes; and (iv) multiple-use areas. Designated the Tonle Sap (316,250 ha) as a multiple-use area or area necessary for the stability of the water, forestry, wildlife and fishery resources, for tourism, and for conservation of long-term existing natural resources with a view to assure sustainable economic development.
Law on Land (NS/RKM/0801/14)	2001	Provides that: (i) unless it is in the public interest, no person may be deprived of ownership of his immovable property; and (ii) ownership deprivation shall be carried out according to legal forms and procedures and after an advanced payment of fair and just compensation. (Article 5)
Royal Decree on the Establishment and Management of Tonle Sap Biosphere Reserve (Royal Decree No. NS/RKT/0401/070)	2001	Establishes the Tonle Sap Biosphere Reserve (TSBR) in accordance with the statutory framework of the World Network of Biosphere Reserves. Divides the TSBR into 3 zones: (i) core areas; (ii) buffer zone and (iii) flexible transition zone. • Core area: set aside for long-term protection, human activity is limited to monitoring and research. • Buffer zone: is area surrounding the core areas helping to protect the environment. It may accommodate education and training activities. • Transition area: may contain a variety of agricultural activities and human settlements. Here all stakeholders have to cooperate to achieve sustainable development
Law on Water Resources Management (NS/RKM/0607/01 6)	2007	Requires license/permit/written authorization for the: (i) abstraction & use of water resources other than for domestic purposes, watering for animal husbandry, fishing & irrigation of domestic gardens and orchards; (ii) extraction of sand, soil & gravel from the beds & banks of water courses, lakes, canals & reservoirs; (iii) filling of river, tributary, stream, natural lakes, canal & reservoir; and (iv) discharge, disposal or deposit of polluting substances that are likely to deteriorate water quality and to endanger human, animal and plant health. (Articles 12 & 22) Its Article 24 stipulates that Ministry of Water Resources and Meteorology (MOWRAM), in collaboration with other concerned agencies, may designate a floodplain area as flood retention area.
Law on Protected Areas	2008	Defines the framework of management, conservation & development of protected areas to ensure the conservation of biodiversity, & sustainable use of natural resources in protected areas. Protected and conservation areas have been classified into eight categories: (i) National Park (ii) Wildlife sanctuary (iii) Protected landscape. (iv) Multi-purpose-use management area (v) Biosphere reserve (vi) Natural Heritage Site ; (vii) Marine park (viii) Ramsar Site Article 11 divides the protected area into 4 zones namely, core zone, conservation zone, sustainable use zone & community zone. Article 36 strictly prohibits all types of public infrastructure in the Core Zone & Conservation Zone; & allows development of public infrastructures in the Sustainable Use Zone & Community Zone with approval from the Royal Government at MoE's request. Article 41 provides for the protection of each protected area against destructive/harmful practices, such as destroying water quality in all forms, poisoning, using of chemical substances, disposing of solid and liquid wastes into water or on land. Article 44 requires all proposals & investments within or adjacent to protected area boundary an Environmental and Social Impact Assessment. Annex. (Paragraph 2) sets out the objectives for the TSBR. Each protected area shall be divided into four (4) management zoning systems: 1. Core zone: management area(s) of high conservation values containing threatened and critically endangered species, and fragile ecosystems. Access to the zone is prohibited except the Nature Conservation and Protection Administration's officials and researchers who, with prior permission from the Ministry

Law/Decree/ Decision	Year	Summary
		of Environment, conduct nature and scientific studies for the purpose of preservation and protection of biological resources and natural environment with the exception of national security and defense sectors. 2. Conservation zone: management area(s) of high conservation values containing natural resources, ecosystems, watershed areas, and Natural landscape located adjacent to the core zone. Access to the zone is allowed only with prior consent of the Nature Conservation and Protection Administration at the area with the exception of national security and defense sectors. Small-scale community uses of Non-Timber Forest Products to support local ethnic minorities' livelihood may be allowed under strict control, provided that they do not present serious adverse impacts on biodiversity within the zone. 3. Sustainable use zone: management area(s) of high economic values for national economic development and management, and conservation of the protected area(s) itself thus contributing to the local community, and indigenous ethnic minorities' livelihood improvement. After consulting with relevant ministries and institutions, local authorities, and local communities in accordance with relevant laws and procedures, the Royal Government of Cambodia may permit development and investment activities in this zone in accordance with the request from the Ministry of Environment. 4. Community zone: management area(s) for socio-economic development of the local communities and indigenous ethnic minorities and may contain existing residential lands, paddy field and field garden or Sweden (Chamkar).
Law on Forestry	2002	**Article 1:** This law defines the framework for management, harvesting, use, development and conservation of the forests in the Kingdom of Cambodia. The objective of this law is to ensure the sustainable management of these forests for their social, economic and environmental benefits, including conservation of biological diversity and cultural heritage.
Law on the Protection of Cultural Heritage	1996	Article 1, The purpose of this law is to protect the national cultural heritage and cultural property in general against illegal destruction, modification, alternation, exportation or importation. Article 2 states that the national cultural heritage comprises cultural property created or discovered on national territory.
Decision No. 01 on the designation of the three areas to protect the temple complex in the provinces outside the of Angkor area, Siem Reap	1997	Article 1: Establish, identify and manage the protection of ancient temples, historical and prehistoric sites and historical sites in three zones: Zone 1: Temple zone; It is strictly forbidden to touch the boundary at a distance of 30 meters from the outer wall of the temple. If there is a pond around, set a distance of 30 meters from the outer pond of the temple enclosure wall. This area is not allowed to plant trees to avoid falling trees pressing on the temple enclosures. Zone 2: Is an Archeological Park Zone; must be protected and maintained. This area is designated 300 meters from the boundary of the Zone 1. Zone 3: is the land use zone according to the regulations. It is bordered by 1500 meters outside the temple enclosure wall or 1500 meters from the pond around the outside enclosure. Article 2: • Zone 1: Areas must be strictly protected from harassment, even in the air, on the surface, such as underground construction of all kinds of small and large buildings in this area is prohibited. It is forbidden to pioneer, clear the forest, plant or cultivate other crops... • Zone 2: Areas to be maintained, protected and prohibited as follows: o Prohibit damage to natural resources, forests and cultural heritage in this area o It is forbidden to build houses or public buildings in the area. Can be built only with the permission of the Ministry of Culture and Fine Arts (MoCAF). • Zone 3: An area to be preserved as a resort and park for environmental protection, history and archeology: New construction is prohibited in the area. Except in special cases with the permission of the Ministry of Culture and Fine Arts, the construction shall not exceed 6 meters. Make a boundary pillar named after the temple.

Source: Asian Development Bank.

Table II-2. A Summary of other Sub-decrees to Environment

Sub-decree	Year	Summary
Sub-decree No. 27on Water Pollution Control	2009	Regulates activities that cause pollution in public water areas in order to sustain good water quality so that the protection of human health and the conservation of biodiversity are ensured. Its Annexes 2, 4 and 5 provide the industrial effluent standards, including effluent from wastewater stabilization ponds, water quality standards for public waters for the purpose of biodiversity conservation, and water quality standards for public waters and health, respectively.
Sub-decree No 72 on EIA Process	1999	- To determine an Environmental Impact Assessment (EIA) upon every private and public project or activity, and it must be reviewed by the Ministry of Environment (MoE), prior to the submission for a decision from the Royal Government. - To determine the type and size of the proposed project(s) and activities, including existing and ongoing activities in both private and public prior to undertaking the process of EIA. - A Project Owner must conduct Initial Environmental Impact Assessment (IEIA) in order to comply with the EIA requirement as stated in the annex of this sub-decree.
Sub-decree No 36 on Solid Waste Management,	1999	Article 1: Regulates solid waste management to ensure the protection of human health and the conservation of biodiversity through using appropriate technical approaches. Article 2: This sub-decree applies to all activities related to disposal, storage, collection, transport, recycling, dumping of garbage and hazardous waste. Article 4: The Ministry of Environment shall establish guidelines on disposal, collection, transport, storage, recycling, minimizing, and dumping of household waste in provinces and cities in order to ensure the safe management of household waste. The authorities of the provinces and cities shall establish the waste management plan in their province and city for short, medium and long-term.
Sub-decree No 42 on Control of Air Pollution and Noise Disturbance	2000	Regulates air and noise pollution from mobile and fixed sources through monitoring, curb and mitigation activities to protect the environmental quality and public health. It contains the following relevant standards: (i) ambient air quality standard (Annex 1); and (ii) maximum allowable noise level in public and residential areas (Annex 6). Article 3 A. “Source of pollution” is defined and separates mobile sources (including transport) and fixed sources such as factories and construction sites. Article 3 B. “Pollutant” is defined as smoke, dust, ash particle substance, gas, vapor, fog, odor, radio-active substance
Environmental Guidelines on Solid Waste Management	2006	Contains a Landfill Ordinance that regulates landfill requirements to: (i) reduce as far as possible the adverse effects of waste disposal on the environment; (ii) preserve groundwater, surface water & air quality & to reduce emissions of greenhouse gases (iii) ensure waste is not harmful to human, natural & animal health during operation & decommissioning; and (iv) provide information and technical recommendation on the construction, operation and closing/follow-up management of landfills to ensure public health and safety and environmental protection.
Sub-decree on Control of Slaughterhouse and Slaughtering Business and Primary Animal Product Processing Premises	2017	**Article 1:** This Sub-decree determines the control of slaughterhouse and slaughtering business, examination of animal hygiene, meat and animal product at slaughterhouses, primary animal product processing premises and sale outlets aiming to prevent the spread of animal diseases, protect animal health, guarantee the product quality and protect public health in the Kingdom of Cambodia. This Sub-decree doesn’t allow the slaughtering on any holy day at any slaughterhouse in compliance with what is enshrined in the Constitution of the Kingdom of Cambodia that Buddhism is the state’s religion. This sub decree forbids slaughtering or killing of animals outside of slaughterhouses unless specific authorization as defined by Prakas. **Article 2:** The control of the slaughterhouse and slaughtering business, the examination of the slaughterhouse’s hygiene, animal hygiene, meat and animal products at slaughterhouses, the control primary animal product and processed product, processing plant premises and sale outlets shall be under competency of Ministry of Agriculture, Forestry and Fisheries.
Sub-Decree on the Protection of	2002	Article 1, The purpose of this sub-decree is implementation of cultural heritage protection through definition of cultural property and archaeological excavations.

Sub-decree	Year	Summary
Cultural Heritage		Article 2, It is to regulate the trade in cultural property and control the exporting and importing of cultural property.
Sub-decree N0. 235 on Management of Drainage and Wastewater Treatment System	2017	-aims to improve the management of drainage and wastewater treatment system in term of efficiency, transparency, and accountability to ensure safety, public health, and biodiversity conservation. -The scope of this Sub-Decree applies on the management of drainage and wastewater treatment system in capital, provincial, district, khan and resorts or recreation centers in the Kingdom of Cambodia. Its annexes 1,2 provide Effleunt Discharge Standard from Commercial Building, Borey, Satellite City and Resort or Recreation Center Discharges Directly to the Drainage/Sewerage System connected to Centralized Wastewater Treatment Plant, and to the Public Waterbody or Drainage/Sewerage System
Sub-decree on Garbage and Urban Solid Waste Management	2015	-The goal of this sub-decree is to enhance the management of garbage and solid waste of downtowns with effectiveness, transparency and accountability, referring to ensure aesthetics, public health and environmental protection -This sub-decree covers separating, storing, cleaning, collecting, transporting, recycling and management of landfills of garbage and solid waste of downtowns in the Kingdom of Cambodia

Source: Asian Development Bank.

3. Regulation on Environmental Impact Assessment

a. Environmental Impact Assessment Requirement

75. Environmental impact assessment (EIA) in Cambodia is guided by the Royal Government of Cambodia (RGC) sub-decree No 72 ANRK.BK on EIA promulgated requiring On 11 August 1999, with the objectives: (1) to determine an Environmental Impact Assessment (EIA) upon every private and public project or activity, and it must be reviewed by the Ministry of Environment (MoE), prior to the submission for a decision from the Royal Government; (2) to determine the type and size of the proposed project(s) and activities, including existing and ongoing activities in both private and public prior to undertaking the process of EIA; and (3) to encourage public participation in the implementation of EIA process and take into account of their conceptual input and suggestion for re-consideration prior to the implementation of any project.

76. In compliance with the sub-decree No 72 ANRK.BK on environmental impact assessment, all individuals, private companies, joint-venture companies, public companies, ministries and government agencies are obliged to conduct an EIA for proposed projects or activities, which must be pre-submitted for approval from the Ministry of Environment (MoE).

b. EIA Classification

77. In order to provide guidelines on effective implementation of sub-decree No 72 ANRK.BK on environmental impact assessment Procedures for development projects, MoE promulgated sub-decree No. 21 on Environmental Impact Assessment Classification for Development Projects.

78. According to this sub-decree, the environmental impact assessment for projects is classified in three categories.

(i) projects requiring full environmental impact assessment (full ESIA), equivalent to ADB's environmental category A
(ii) projects that require initial environmental impact assessment (IEIA), equivalent to ADB's environmental category B
(iii) projects requiring the Contract on Environmental Protection (EPC) equivalent to

ADB's environmental category C plus simple EIA analysis and EMP

(iv) The sub-decree includes an annex listing projects under various sectors and their categorization on the basis of their nature, type and size. The sector and EIA classification for livestock production and health care that are related to the prioritized sub-projects under CLHVCIP-Cambodia is summarized in Table 2-2 below.

79. Since domestic EIA criteria don't include vaccine production, breeding center etc., directly, the EIA criteria for laboratory can be reference or as proxy for NAHPRI veterinary diagnostic laboratory. The EIA criteria for pharmaceutical factories can be reference or as proxy for vaccine production. The domestic EIA criteria on animal farm can be proxy for breeding center and quarantine station, since both are animal holding/husbandry facilities.

Table II-3. EIA Classification for Development Projects relevant

Type of Projects and activities	**Need full ESIA (ADB's cat. A)**	**Need initial ESIA (ADB's cat. B)**	**Need EPC (ADB cat. C+** simple impact analysis and EMP**)**
Slaughterhouse		≥100 head/day	10 - <100 head/day
Livestock farm (cattle, buffalo, horse and others)		≥500 head	100- < 500 head
Poultry farms		≥50,000 head	5,000-<50,000
Food and canned food processing		≥500 tons/year	<500 tons/year
Tanneries and leather processing	All sizes		
Farm of chicken, duck, and other birds raised for meat and/or eggs		≥ 50,000 head	5,000 - < 50,000 head
Animal feed factories		≥10,000 t/year	<10,000 t/yr. (30t/d)
Laboratories		All sizes	
Natural sewage water treatment and Drainage System		All sizes	
Organic fertilizers factories		All sizes	
Pharmaceutical factories		(All sizes)	

Source: Prakas No. 021 PRK.BST dated 03 February 2020.

c. Public Consultation

80. According to sub-decree No. 120, issued by Ministry of Environment on April 11, 2018, on the deployment model of working conditions for infrastructure and tourism development, the planning of public participation consist of three stages: (i) information dissemination at the project site; (ii) the interviews with local authorities, affected communities and stakeholders; and (iii) the consultation workshops.

4. Occupational and Community Safety and Health

81. Government Occupational and Community Safety and Health (OHS) guidelines follow the OHS Program for Cambodia (2010-2013) that was developed by the International Labor Organization (ILO). The draft guidelines provide the framework for instituting OHS at the workplace and in the community. The OHS guidelines for Cambodia will likely need to be supplemented with the international the IFC EHS/OHS Guidelines for Construction and Decommissioning, Waste Management Facilities, and Toll Roads. The contractor will have to identify the appropriate national and IFC OHS guidelines in their bid documents for joint review

by the contractor and IA (Implementation Agency).

82. Additionally, the National MoH's guideline on Covid-19 and National Guideline for Infection prevention and control for healthcare facilities of Cambodia will be applied due to current situation Covid-19 outbreak to reduce the incidence and risk of preventable Nosocomial Infection (NI). Occupational and community health and safety, as laid out in the EHS guidelines, will be a cross-cutting assessment for the subprojects,

83. The Ministry of Labor and Vocational Training (MLVT) has the following guidelines which will be implemented during the construction phase of the Project:

84. MLVT Prakas2 No. 075/11 K.B/BR.K (March 2011) - Sanitation at the Construction Site: The Prakas sets to ensure that the sanitation and safety conditions are fulfilled for the workers at the construction site by owner, director, contractor or sub-contractor of construction establishment or construction company and responsible person to construction site. Article 3 and 4 set to provide workers with shelter, sanitation facilities and safe potable water for drinking and washing.

85. MLVT Prakas No. 076/11 K.B/BR.K (March 2011) - The Protection of Risk Resulting From Climate Change at Construction Site. Articles of this Prakas required safety measures and break times for worker at the construction site during extreme weather events.

86. MLVT Prakas No. 077/11 K.B/BR.K (March 2011) - Providing of Information at the Construction Site. This Prakas states requirements for owner or responsible person of a construction site to provide information, i.e. name and address of the owner of enterprise, construction establishment, Construction Company, name and address of architect, nature of construction, i.e. road, railway, bridge, dam, canal, residential building, industrial building, and commercial building, date for the start of the construction and estimated time to finish the construction works, and estimated number of workers to be employed for construction activities.

87. MLVT Prakas No. 078/11 K.B/BR.K (March 2011) - Stock of Materials, Waste Disposal and Clearance at Construction Site. This Prakas provides safety guidelines and requirements for the safe storage of construction of materials and hazardous substances/objects that can pose health and safety risks to workers.

5. Applicable Evaluation Standards for This IEE

a. Relevant Sub-decrees

88. Ministry of Environment (MoE) and other Government authorities passed regulations (also referred to as sub-decrees) to provide further protection for the environment and key directives and environmental standards (including ambient quality standards and discharging standards) in support of the Law on Environmental Protection and Natural Resources Management. The important specific regulations and standards for environmental quality are contained in three sub-decrees where environmental ambient quality and discharging/emission standards are specified in annexes of these sub-decrees.

(i) Sub-decree on EIA Process (1999);
(ii) Sub-decree on Solid Waste Management (1999);
(iii) Sub-decree on Water Pollution Control (April 1999);
(iv) Sub-decree on Air Pollution Control and Noise Disturbance (2000), and
(v) Sub-decree No. 235 on The Management of Drainage and Wastewater Treatment System, Prime Minister, 2017.

b. Applicable Evaluation Ambient Quality Standards

Surface Water Quality Standard

89. The Sub-Decree on Water Pollution Control aims to minimize and phase out the various activities which cause pollution in public water areas in order to sustain good water quality that is suitable for human usage by improving wastewater management.

90. To prevent and reduce the water pollution of the public water areas so that the protection of human health and the conservation of biodiversity should be ensured, ambient quality for public surface water is divided into two types: one is for public water area and the other is for biodiversity conservation.

Table II-4. Water quality standard in public water areas for public health protection

No.	Parameter[a]	Unit	Surface water Standard[b]
1	Carbon tetrachloride	µg/l	< 12
2	Hexachloro-benzene	µg/l	< 0.03
3	DDT	µg/l	< 10
4	Endrin	µg/l	< 0.01
5	Diedrin	µg/l	< 0.01
6	Aldrin	µg/l	< 0.005
7	Isodrin	µg/l	< 0.005
8	Perchloroethylene	µg/l	< 10
9	Hexachlorobutadiene	µg/l	< 0.1
10	Chloroform	µg/l	< 12
11	1,2 Trichloroethylene	µg/l	< 10
12	Trichloroethylene	µg/l	< 10
13	Trichlorobenzene	µg/l	< 0.4
14	Hexachloroethylene	µg/l	< 0.05
15	Benzene	µg/l	< 10
16	Tetrachloroethylene	µg/l	< 10
17	Cadmium	µg/l	< 1

[a] Parameters are partially listed here and to be used for this IEE.
[b] Source Annex 5 of Sub-decree No 27 ANRK.BK on Water Pollution Control, 2009.
Source: Asian Development Bank.

Table II-5. Water quality standard in public water areas for bio-diversity conservation

Parameter[a]	unit	Standard value[b]		
		river	Lake/reservoir	Coastal water
pH		6.5-8.5	6.5-8.5	7.0-8.3
BOD5	mg/l	1-10	NV	NV
Suspended Solid	mg/l	25-100	1-15	n/a
Dissolved Oxygen	mg/l	2.0-7.5	2.0-7.5	2.0-7.5
Coliforms	MPN/100ml	<5000	<1000	<1000
COD	mg/l	NV	1-8	2-8
Total Nitrogen	mg/l		0.1 – 0.6	0.2– 1.0
Total Phosphorus	mg/l		0.005– 0.05	0.02 – 0.09
Oil content	mg/l	NV	NV	0

NV=No value

[a] Parameters are partially listed here and to be used for this IEE.

[b] Source: Annex 4 of Sub-decree on No 27 ANRK.BK Water Pollution Control, 2009.

Source: Asian Development Bank.

Groundwater Quality Standard and Drinking Water Quality Standard

91. The Royal Government of Cambodia has established a comprehensive policy on National Water Supply and Sanitation for both urban and rural water supplies. Based on this policy and to ensure access to safe drinking water to all people, quality standards for both drinking water and groundwater are developed by an inter-ministerial process initiated by Ministry of Industry, Mines and Energy and concerned ministries with support from the World Health Organization.

Table II-6. Groundwater and Drinking Water Quality Standard

No.	Parameter[a]	Unit	Groundwater	Drinking Water Quality[a]
1	pH	-	6.5-8.5	6.5-8.5
2	Electrical Conductivity (EC)	µs/cm	500-1500	NV
3	Total Dissolved Solid (TDS)	mg/l	<800	800
4	Turbidity	NTU	<5.0	5
5	*Total Hardness (as CaCO3)*	*mg/l*	*<300*	300
6	Chloride (Cl^-)	mg/l	<250	250
7	Fluoride (F^-)	mg/l	<1.5	1.5
8	Nitrate (NO3)	mg/l	<50	50
9	Sulphate (SO_4^{-2})	mg/l	<250	250
10	Aluminum (Al)	mg/l	<0.2	0.2
11	Arsenic (As)	mg/l	<0.05	0.05
12	Cadmium (Cd)	mg/l	<0.003	0.003
13	Chromium (Cr-total)	mg/l	<0.05	0.05
14	Iron (Fe)	mg/l	<0.3	0.3
15	Manganese (Mn)	mg/l	<0.1	0.1
16	Mercury (Hg-total)	mg/l	<0.001	0.001
17	Thermo tolerant Coli form (E-Coli)	MPN/100ml	0	0
18	Total Coliform	MPN/100ml	0	0

MPN = Most Probable Number, NV = No value.

[a] Parameters are partially listed here and to be used for this IEE.

Source: Cambodian Drinking Water Quality Standard, 2004 adopted from WHO standard.

Ambient Air Quality Standard

92. The sub-decree N0 42 ANRK.BK on Air Pollution Control and Noise Disturbance is dated July 10th, 2000. Its purpose is to protect the quality of environment and public health from air

pollutants and noise pollution (below tables). This sub-decree applies to all movable sources and immovable sources of air and noise pollution. It is also applied to evaluation of ambient air quality and to monitoring of air pollution status in Cambodia.

Table II-7. Ambient Air Quality Standard

Parameters[a]	Cambodian[b]				IFC-EHS[c] Guidelines WHO interim target 1 µg/m³
	Period 1h Average mg/m³	Period 8h Average mg/m³	Period 24h Average mg/m³	Period 1year Average mg/m³	
Carbon monoxide (CO)	40	20	-	-	
Nitrogen dioxide (NO_2)	0.3	-	0.1	-	40（1yr.） 200 (1 hr.)
Sulfur dioxide (SO_2)	0.5	-	0.3	0.1	500 (10 min) 125 (24hr.)
Ozone (O_3)	0.2	-	-	-	100 (8 hr. daily)
Lead (Pb)	-	-	0.005	-	
Particulates	-	-	0.33	0.1	150 (PM_{10} 24hr) 75 ($PM_{2.5}$ 24hr)

[a] Parameters are partially listed here and to be used for this IEE.
[b] Sub-decree N0 42 ANRK.BK on Air Pollution Control and Noise Disturbance.
[c] Environmental, Health, and Safety Guidelines, IFC.

Source: Cambodia National Quality Standards for Agriculture, Ministry of Agriculture, Forest, and Fishery.

93. There is a lack of parameters (such as ammonia gas NH3, H2S representing odor emission from livestock production) in the ambient air quality standards. This IEE will carry out qualitative analysis for proposal of mitigation measures against odor emission.

Table II-8. Cambodia National Soil Quality Standards

Parameter	Standard	
	Unit	Value
pH		
Salinity	ppt	6-8
Oil & Grease	mg/kg	-
Chloride	mg/kg	-
Petroleum Hydrocarbons		
Kerosene hydrocarbons (c10-c14)	mg/kg	-
Diesel hydrocarbons (c15-c28) (mg/L)	mg/kg	-
Heavy oil hydrocarbons (c29-c36) (mg/L)	mg/kg	-
BTEX		
Ethylbenzene	mg/kg	0.018
Benzene	mg/kg	0.0068
Toluene	mg/kg	0.08
Xylene	mg/kg	2.4
Metals		
Nickel	mg/kg	50
Copper	mg/kg	63
Zinc	mg/kg	200

Parameter	Standard	
	Unit	Value
Arsenic	mg/kg	12
Cadmium	mg/kg	1.4
Lead	mg/kg	70
Iron	mg/kg	-
Chromium	mg/kg	64
Mercury	mg/kg	6.6

Source: Cambodia National Quality Standards for Agriculture, Ministry of Agriculture, Forest, and Fishery.

c. Applicable Discharge Standards

Wastewater Discharging Standards

94. The Sub-decree No. 235 on the Management of Drainage and Wastewater Treatment System (2017) include 2 annexes that stipulate wastewater discharged into public sewer system connected into centralized wastewater treatment plant (WWTP), and wastewater pre-treated on-site before being discharged into public sewer system, respectively.

Table II-9. National and International Effluent Discharge Standard

Parameter	Unit	Permissible Standard[a]		EHS guidelines' Standard[b]		
		Discharge to Sewer WWTP[c]	Discharge to Waterbody[c]	for Treated Sewage Discharge	On meat processing	livestock production
1. pH		5–9	6–8	6–9	6–9	6–9
2. Total Suspended Solid (TSS)		<150	<80	50		
3. Oil or Grease	mg/l	<20	<5	10	10	10
4. BOD5	mg/l	<80	<30	30	50	50
4. COD ($Cr_2O_7^{2-}$)	mg/l	<120	<50	125	250	250
5. detergents-LAS	mg/l	<15	<7			
6. Total Nitrogen	mg/l	<10	<6	10	10	10
7. Total Phosphorus	mg/l	<1	<0.5	2	2	2
8. Ammonia (NH_3)	mg/l	<8	<5			
9. Total coliform	MPN[a] /100 m	NV	500~2500	400	400	400

WWTP = wastewater treatment plant.

[a] Source: Annex 1&2 of Sub-decree No. 235 on The Management of Drainage and Wastewater Treatment System, Prime Minister, 2017. NV=No Value, a MPN = Most Probable Number.

[b] Since Cambodia doesn't have relevant sectoral discharge standards, the EHS Guidelines of IFC are listed.

[c] Annex 1 of Sub-decree No. 235: This apply to wastewater from Commercial Building, Borey, Satellite City and Resort or Recreation to the Drainage/Sewe that are connected to Centralized Wastewater Treatment Plant.

Source: Asian Development Bank.

Noise Standard

Table II-10. Maximum permitted noise level in public and residential area (dB (A))

Location	Cambodian Standard			IFC-EHS Guidelines	
	06:00 to 18:00	18:00 to 22:00	22:00 to 06:00	Day 7.00-22.00	Night 22.00-7.00
Silence Area Hospital; Library, School, Nursery	45	40	35	55	5
Resident Area Hotel; Administration place, House	60	50	45		
Commercial, Services Areas and mix	70	65	50	70	70
Small Industrial factories intermingling in residential areas	75	70	50		

Note: This standard is applied to control of noise level of any source of activity that emitted noise into the public and residential areas.
Source: Annex 6 of Sub-Decree on Air Pollution Control and Noise Disturbance, 2000.

Hazardous Waste Management

95. Regulation of hazardous wastes in Cambodia is defined in the Sub-Decree on Pollution Control and the Sub-Decree on Solid Waste Management (27 April 1999).

(i) **Hazardous Substance**: according to Sub-decree on Pollution Control, hazardous substance are defined as "any substances that cause danger to living organisms, damage or break down any objects or building or adversely impact and damage the environment". The types of hazardous substances include organic compounds, heavy metals and their compounds, carcinogenic substances, persistent synthetic compound, phosphorous and its compounds, Substances which may have an adverse effect on the oxygen balance, particularly ammonia, and nitrites, etc.

(ii) **Hazardous Waste**: according to Sub-Decree on Solid Waste Management, hazardous wastes are defined as: radioactivity substances, explosive substances, toxic substances, inflammable substances, pathogenic substances, irritating substances, corrosive substances, oxidizing substances, or other chemical substances which may cause the danger to human (health) and animal or damage plants, public property and the environment".

96. The Table: Type of hazardous wastes incorporated in the Sub-Decree includes the following wastes which are applicable to this Project: Infectious diseases wastes, Agriculture drugs wastes; Ash wastes from incinerators; Wastes from expired products; Waste from production of drugs and medicines, and expired drugs.

97. Under Article 7 of the Sub-Decree on Solid Waste Management: "the disposal of waste in public sites or anywhere that is not allowed by authorities shall be strictly prohibited". There are no quantitative parameters given but good sensible practice is expected. Such practices would include:

(i) All general waste and food waste should be removed to a government approved landfill;
(ii) All demolition waste must be removed to a government-approved location;
(iii) All waste oil and grease should be disposed by a registered sub-contractor. The final destination of the oily wastes should be established

B. ADB Environmental Safeguards Policy and IFC EHS

98. **ADB Requirements**. Safeguard requirements for all projects funded by ADB are defined in SPS 2009 which establishes an environmental review and assessment process to ensure that projects funded through ADB loans are environmentally sound; are designed to operate in compliance with applicable regulatory requirements; and are not likely to cause significant environmental, health, or safety hazards. SPS 2009 is underpinned by the ADB Operations Manual, Bank Policy (OM Section F1/BP, October 2013). The policy also promotes adoption of international good practice as reflected the World Bank Group's Environmental, Health and Safety (EHS) Guidelines. This IEE is intended to meet SPS 2009 requirements.

99. ADB Environmental safeguard and requirements and International Finance Corporation's (IFC) environmental, health and safety (EHS) are set out in the following:

(i) Environment Policy of 2002;
(ii) Safeguards Policy Statement (SPS) of 2009;
(iii) SPS Operations Manual, 2013; and
(iv) Access to Information Policy, 2018.

100. Guidelines for international best practice will also be drawn from IFC Environmental Health and Safety Guidelines:

(i) Environmental, Health, and Safety General Guidelines, International Finance Corporation;
(ii) Environmental, Health, and Safety Guidelines for Meat Processing, International Finance Corporation ;
(iii) Environmental, Health, and Safety Guidelines for Mammalian Livestock Production;
(iv) Environmental, Health and Safety Guidelines for Meat Processing; and
(v) Environmental, Health, and Safety Guidelines for Health Care Facilities.

C. International Conventions

101. Besides national legislation, a number of international conventions, treaties and protocols related to environmental management and protection have been signed and ratified by the Royal Government of Cambodia. These include:

(i) United Nations Framework Convention on Climate Change (UNFCC), 1992, entered into force on 21 March 1994 (Cambodia ratified on 18 December 1995);
(ii) Kyoto Protocol 1997, entered into force on 16 February 2005 (Cambodia accessed on 22 August 2002);
(iii) Vienna Convention for the Protection of the Ozone Layer, entered into force on 22 September 1988 (Cambodia accessed on 27 June 2001);
(iv) Montreal Protocol on Substances that Deplete the Ozone Layer, 1987, entered into force on 1 January 1989 (Cambodia accessed on 27 June 2001);
(v) The International Convention for the Prevention of Marine Pollution from Ships, 1973 as modified by the Protocol of 1978 relating thereto "MARPOL 73/78", fully entered into force on 2 October 1983 (Cambodia ratified on 1994);
(vi) Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal, entered into force on 5 May 1992 (Cambodia accessed on 02 March 2001);

(vii) United Nations Convention to Combat Desertification, entered into force on 26 December 1996 (Cambodia ratified on 18 August 1997);

(viii) Convention on International Trade in Endangered Species of Wild Fauna and Flora, entered into force on 01 July 1975 (Cambodia ratified on 04 July 1997);

(ix) Cambodia joined the UNESCO Network of Biosphere Reserves in 1997. It committed to the Millennium Development Goals and subsequently endorsed the Sustainable Development Goals at the UN General Assembly in 2015;

(x) At the regional level, it ratified the following ASEAN Agreements: (a) on Transboundary Haze Pollution in 2006; and (b) on Disaster Management and Emergency Response, which entered into force in 2009; and

(xi) At the subregional level, Cambodia, along with Lao PDR, Thailand and Viet Nam, signed the "Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin" (or the Mekong Agreement) in April 1995.

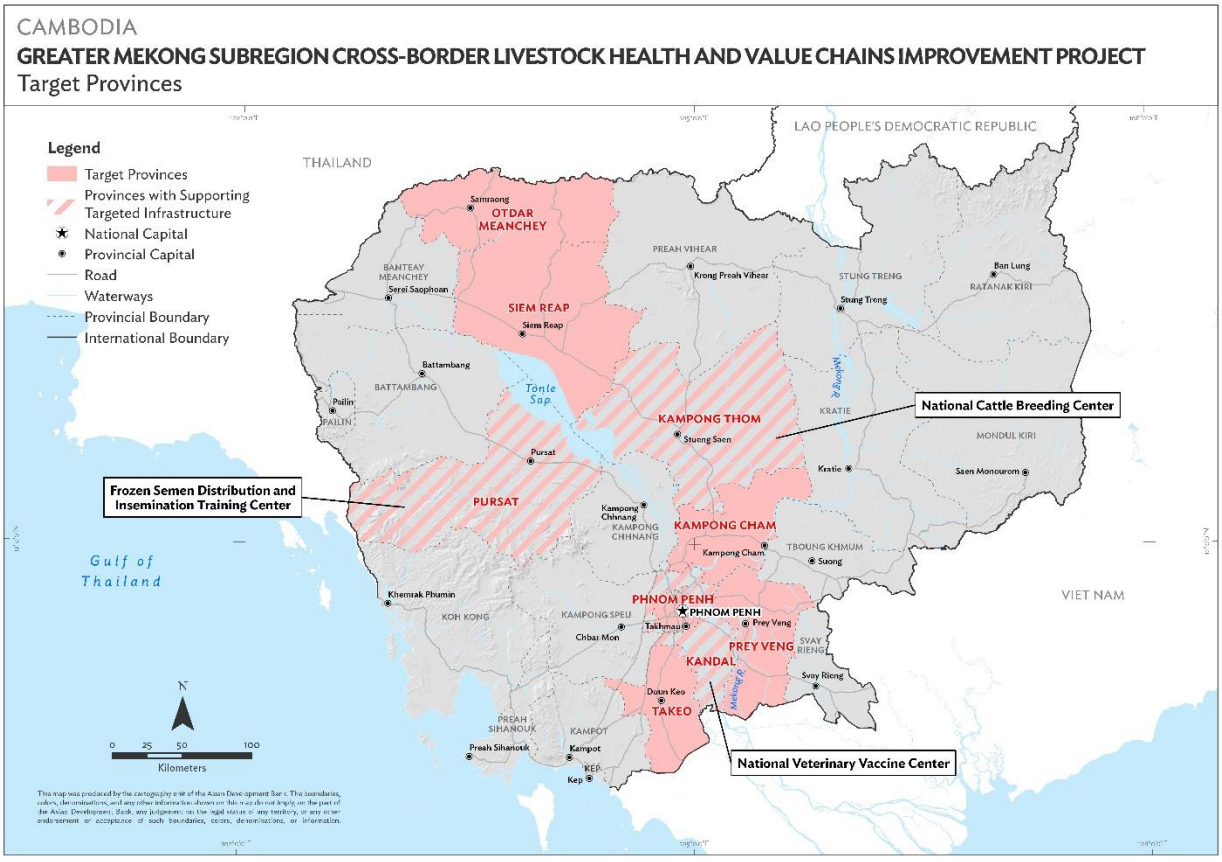
III. Baseline of the Project

A. Geographic Feature

102. The Kingdome of Cambodia is in the southern portion of the Indochina Peninsula in Southeast Asia. It is situated both in the Northern and Eastern hemispheres of the Earth. Cambodia is bordered by three countries. It is bounded by Viet Nam to the east and southeast, Lao PDR to the northeast and Thailand to the northwest. Cambodia is bounded by the Gulf of Thailand to the southwest. It has total area of 181,035.00 km2 (including 176,515.00 km2 of land area and 4,520.00 km2 water area) with population of 16,486,542 (as of Feb. 2021). It has a 443-kilometer coastline along the Gulf of Thailand.

103. The prioritized 5 subprojects under CLHVCIP in Cambodia are proposed to be located in 5 provinces, details of the site address are listed in Table III-1 below.

Figure III-1. Map of the Kingdom of Cambodia and the Prioritized Subprojects Locations



Source: Asian Development Bank.

Table III-1. Location of Subprojects

	Veterinary Diagnostic Laboratory	NCBC	New Vaccine Prod. Centre	New Animal Inspection Center	Poultry Market
Province	Phnom Penh	Kampong Thom	Kandal	Otdar Meanchey	Takeo
District	Meanchey	Brasath Balang	Saang	Samroung Krong	
Commune	Steung Meanchey	Phanheum	Saang Phnom	Koru Kriel Sangkat	
Village	Trea	Phdeath and Kropue villages,	Tanou	Samroung Senchey	

Source: Asian Development Bank.

104. **Phnom Penh**, the capital city of Cambodia is located in the southern heard of the country and fully surrounded by the Kandal Province. The municipality is on the banks of the Tonlé Sap, Mekong, and Basak Rivers, consisting of typical plain wet area for Cambodia, covering rice fields and other agricultural plantations. The province also features three of the biggest rivers of the country the Tonle Basak, the Tonle Sap and the mighty Mekong. These rivers provide freshwater and other natural resources to the city.

105. **Kandal Province** is in the middle-south of the country bordering to the North with Kampong Chhnang and Kamponf Cham, in the East with Prey Veng, in the West with Kampong Speu and Takeo and to the South with Viet Nam.is one of the smaller provinces of Cambodia. It is 3,568 square kilometers big, one of the smaller provinces of Cambodia. This province surrounds but does not include the Cambodian capital Phnom Penh. Its capital is Ta Khmau (lit. Black Grandfather) and is around 20km south of Phnom Penh.

106. **Takeo** province is located in the South of the country bordering to the North and East with Kandal, to the West with Kampong Speu and Kampot and to the South with Viet Nam. It is 3,563 square kilometres big. The low-lying area seems to include much of the surrounding province area, which is probably why a kingdom that once had its heart here was referred to as Water Chenla. There seems to be water everywhere in the surrounding countryside during the rainy season.

107. **Otdar Meanchey.** Province is located in the far northwest of the country bordering to the North with a lengthy borderline to Thailand, to the East with Preah Vihear, to the West with Banteay Meanchey and Siem Reap to the South. The province is 6,158 square kilometers big, one of the smallest provinces of Cambodia. In the North the province consists of the reknown Dangkrek Mountains, which are the hill foot of the massive mountain range (the real Dangkrek Mountains) coming from Thailand.

108. **Kampong Thom** province borders the provinces of Siem Reap to the northwest, Preah Vihear to the north, Stung Treng to the northeast, Kratie to the east, Kampong Cham, Kampong Chhnang to the south, and the Tonle Sap to the west. Kampong Thom is Cambodia's second largest province by area (13,814 km^2).

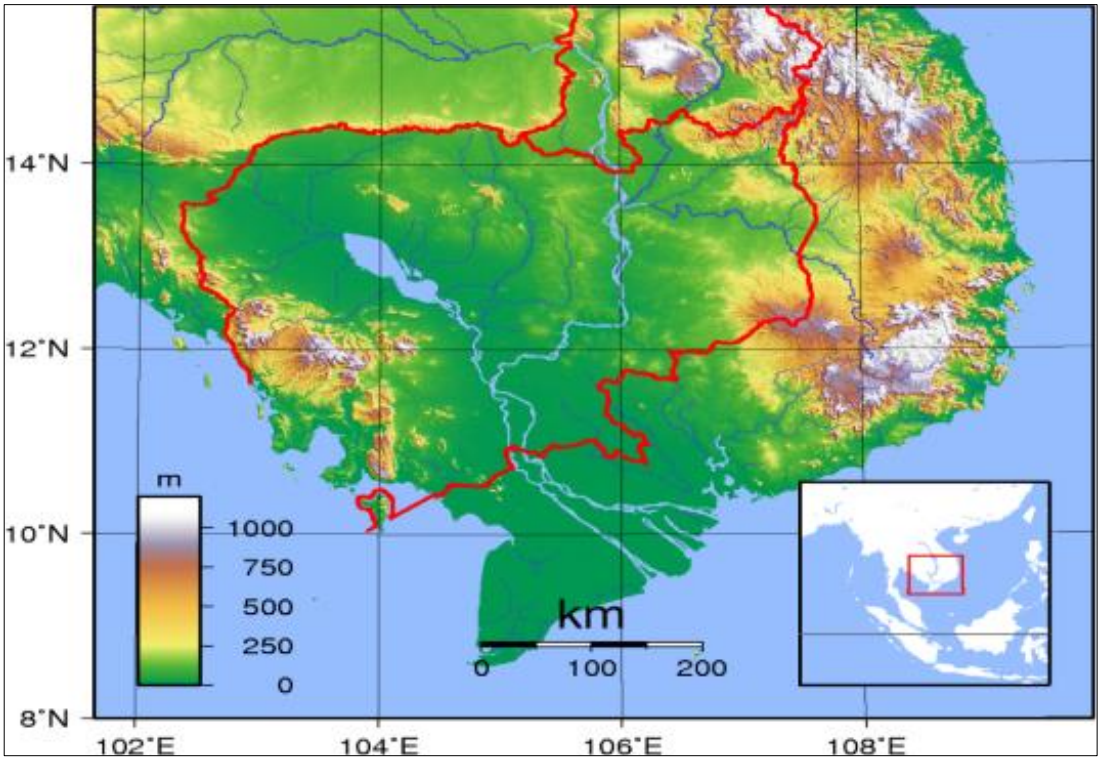
B. Topography and soil

109. Cambodia’s topography is described as bowl-shaped with distinct geographic feature of lacustrine plain, formed by the inundations of the Tonle Sap (Great Lake), measuring about 2,590 square-kilometers during the dry season and expanding to about 24,605 square kilometers during the rainy season The Tonle Sap Basin and Mekong downstream area is the center. This densely

populated plain, which is devoted to wet rice cultivation, is the heartland of Cambodia. Much of this area has been designated as a biosphere reserve. Most (about 75%) of the country lies at elevations of less than 100 meters above sea level.

110. The country is rimmed by mountains consisting of Cardamom Mountains (highest elevation 1,813 m) and their southeast extension the Dâmrei Mountains ("Elephant Mountains") (elevation range 500–1,000 m), as well the steep escarpment of the Dângrêk Mountains (average elevation 500 m) along the border with Thailand's Isan region. The highest elevation of Cambodia is Phnom Aoral, near Pursat in the centre of the country, at 1,813 meters.

Figure III-2. Topographic Map in Cambodia

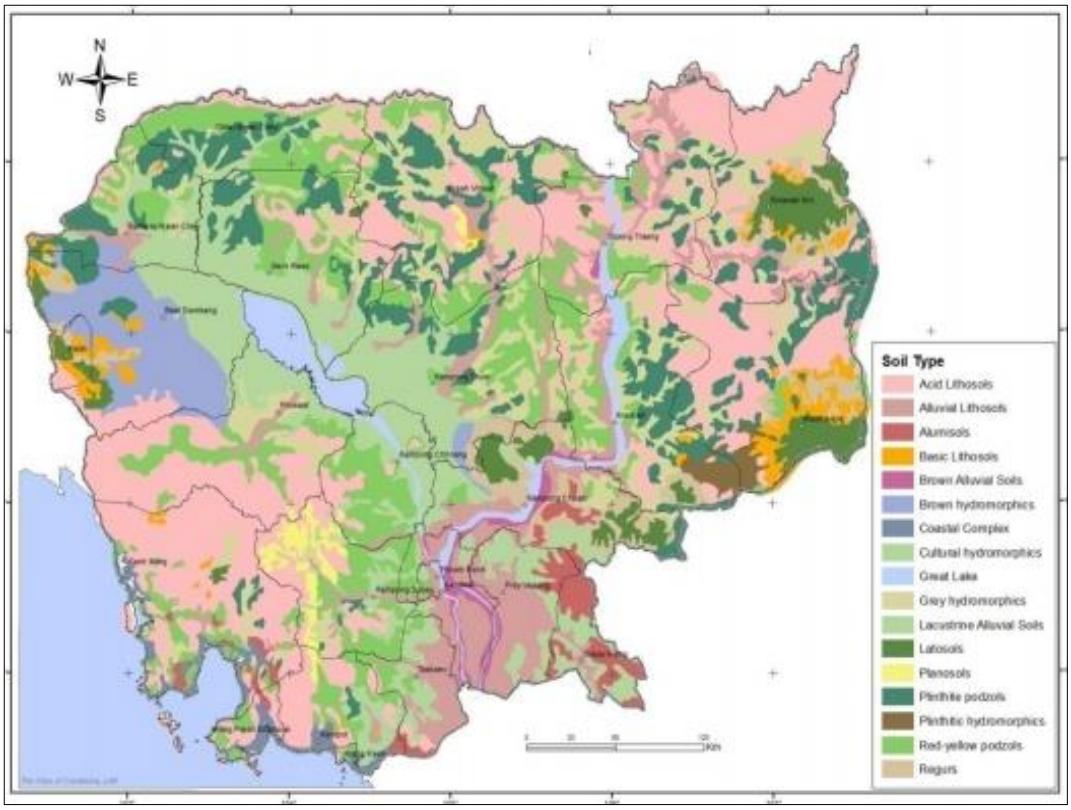


Source: Asian Development Bank.

111. Natural resource in Cambodia includes oil and gas, timber, gemstones, iron ore, manganese, phosphates, hydropower potential, arable land. In 2018, land use pattern in Cambodia is: agricultural land: 32.1%, arable land: 22.7%, permanent crops: 0.9%, permanent pasture: 8.5%, forest: 56.5%, other: 11.4%.

112. In the lowland part of Mekong River Basin and Tonle Sap Basin is a thick sedimentation layer extensively distributed year to year from upstream areas by runoff. The sandstones were intruded in the late Jurassic period, in the Pursat province area. There is the sedimentary layer that disconformably covers the bedrock around the river basin. In Cambodia, the geomorphic and topography is characterized by low middle and south portion and high west, north, and east portion. Its middle and south regions are plains accounting for 3/4 of its total area. The Tonle Sap Basin and Mekong downstream area as center, ground elevation slowly raises from below 100m. The Southwest Kravah Mountains run in trend northeast-southeast, has elevation over 1 500m and the highest part country is Phnom Aural with an elevation of 1 813m.

Figure III-3. Map of Soil Type, Cambodia



Source: Asian Development Bank.

C. Climate of Project Provinces

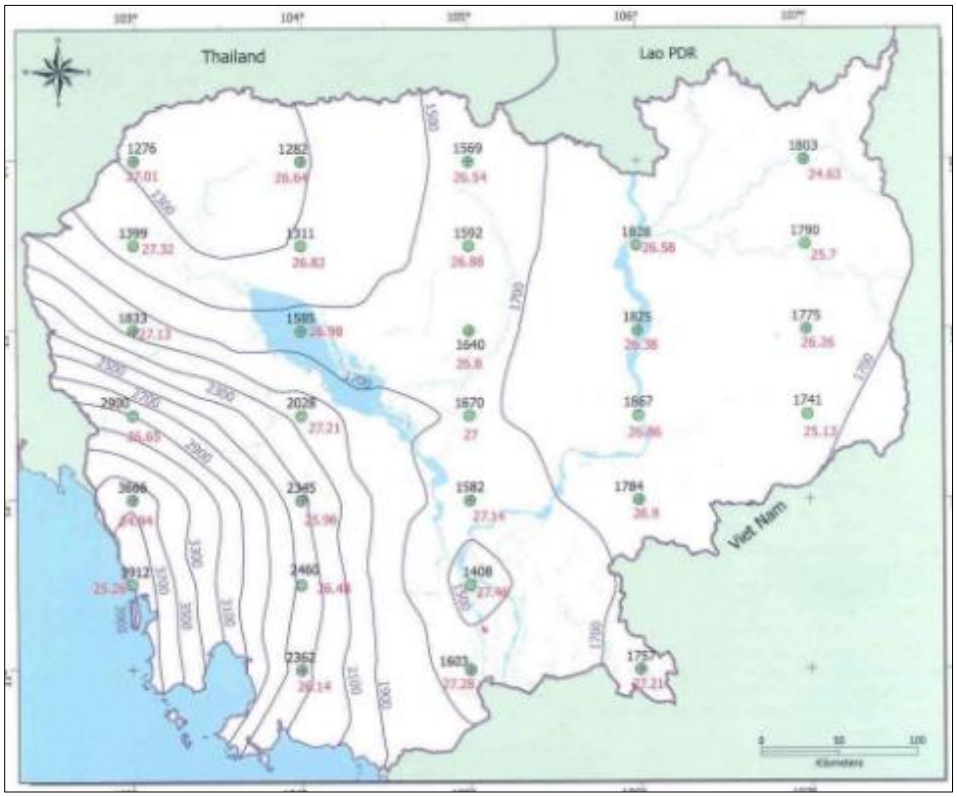
113. Being in Southeast Asia in the tropical zone, just 10-13 degrees north off the equator. Cambodia's climate is governed by the monsoon cycle, with a distinct two major seasons. From mid-May to early October, the strong prevailing southwest monsoon brings in moisture and rains from Indian Ocean. From early November to mid-March, the lighter and drier winds of the northeast monsoon bring variable cloudiness, infrequent precipitation, and lower humidity. The weather between these seasons is transitional. Like most of Southeast Asia, the country has a tropic climate - warm and humid.

114. Average temperature has minimal variations regionally and seasonally. Weather is coolest in January and hottest in April. Relative humidity ranges between 65-70% in March and 85-90% in September. Annual evaporation is from 2,000 to 2,200 mm, i.e., highest in March and April at 200 mm to 240 mm and lowest in September-October at 120 mm to 150 mm11. The mean wind speed in Cambodia is low at about 2 m/s. December is known as the month of strong steady wind from the north.

115. Cambodia is rich in water resources and the rainy season occurs from May to October. The annual rainfall is normally 1,200 to 1,900 mm with humidity of 69%~80%, while in the lowland area around Tonle Sap Lake and Mekong River Basin, rainfall is about 2,500 to 3,000 mm, in the western mountainous area and the eastern plateau. About 80% of rainfall occurs during the Southwest season. The temperatures are fairly uniform throughout the country, with only small variations from the average annual temperature of around 28°C. In Cambodia, January is the

coldest month where temperatures as low as 12°C have been recorded and April is the warmest where temperatures can reach 42°C.

Figure III-4. Map of Annual Rainfall, Cambodia



Source: Asian Development Bank.

116. **Climate in Phnom Penh**. According to data made available by the Ministry of Water Resource and Meteorology (MOWRAM), in the last recent 2 year (2019, 2021) in PHNOM PENH, the dry season starts from later November of the previous year till March with monthly rainfall ranging 0~67.4 mm. The rainy season is from April till early November with monthly rainfall raging 71.2~461.4 mm. Total annual rainfall was 1079.3 mm in 2019 mm and 1593.2 mm in 2020. The monthly average minimum temperature was 22.6 0C in 2019 and 22.4 0C in 2020, monthly averaged maximum temperature was 35.6 ^{0}C in 2019 and 35.8 ^{0}C in 2020. There is no distinct prevailing wind direction throughout the year.

Table III-2. Monthly wind directions and speed in Phnom Penh in recent 3 years

Month		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Year	1	2	3	4	5	6	7	8	9	10	11	12	13
20018	W-dd	N	SE	S	N	SSW	W	W	S	W	NE	SE	N
20018	W-ss	10	12	16	10	17	16	13	16	10	10	10.0	10.0
2019	W-dd	N	S	S	S	NE	SW	W	W/NW	W	E	NE	N
2019	W-ss	10	10	10	8	18	12	12	12	12	10	10.0	10.0

2020	W-dd	NE	SE/NE	SE/S	SE	SW	SE	W/SW	NW/W	W	SW	S	N
2020	W-ss	10	10	8	12	13	14	12	10	12	10	12.0	10.0

W- SS Wind Speed (m/s), W- dd Wind Direction.
Source: Department of Meteorology, Ministry of Water Resources and Meteorology.

117. **Climate in Takeo**. According to data of the Ministry of Water Resource and Meteorology (MOWRAM), in the last recent 2 years (2019, 2021) in Takeo, the dry season start from later November of the previous year till April with monthly rainfall ranging 0~104.1 mm. The rainy season starts from May till October with monthly rainfall raging 126.8~358 mm. Total annual rainfall was 1341.8 mm in 2019 mm and 1369.5 mm in 2020. The monthly averaged minimum temperature was 22.4 ^{0}C in 2019 and 22.7 ^{0}C in 2020, monthly averaged maximum temperature was 35.6 ^{0}C in 2019 and 35.8 ^{0}C in 2020.

118. **Climate in Kandal**. During the last 2 years (2019, 2021) in Kandal, the dry season starts from November of the previous year till March (in 2020) or April (2019) with monthly rainfall ranging 0~27 mm (in 2019) and 0~113 mm (in 2020). The raining season start from November of the previous year till May with monthly rainfall ranging 0~27 mm in 2019, and from December of the previous year till March with monthly rainfall ranging 0~8mm in 2020. Total annual rainfall was 982 mm in 2019 mm and 1269 mm in 2020. The monthly average minimum temperature was 22.8 ^{0}C in 2019 and 23.0 ^{0}C in 2020, monthly averaged maximum temperature was 35.5 ^{0}C in 2019 and 35.6 ^{0}C in 2020.

119. **Climate in Otdar Meanchey**. From the data made available by the Ministry of Water Resource and Meteorology (MOWRAM), in the last 2 years (2019, 2021) in OM, the dry season starts from November of the previous year till March (in 2019) or February (in 2020) with monthly rainfall ranging 0~15.5 mm in 2019 and 0~0mm in 2020. The rainy season starts from April till early October with monthly rainfall ranging 53.2~207.9 mm in 2019 and 22.0~233.0mm in 2020. Total annual rainfall was 1073.6 mm in 2019 mm and 1064.7 mm in 2020. The monthly averaged minimum temperature was 21.3 ^{0}C in 2019 and 21.2^{0}C in 2020, monthly averaged maximum temperature was 37.5 ^{0}C in 2019 and 37.0 ^{0}C in 2020.

120. **Climate in Kampong Thom.** The NCBC site is warm to hot year-round, and the climate is dominated by the annual monsoon cycle with its alternating wet and dry seasons. The wet season coincides with southwest monsoon rains in May to October and the dry season happens in November to April. On the average, more than 80% of the annual rainfall occurs in the wet season. December and January are the cool months, and the hottest period is in March to April. Daily mean temperatures range between 21-25 ^{o}C for minimum and 30-35 ^{o}C for maximum. Average relative humidity varies from 70 % in March to 85 % in September. Kampong Thom station in Kampong Thom province is located having high precipitation with total annual average rainfall of about 1496.6 mm for the last thirty-seven years (1981-2017).

D. Hydrology and Surface Water

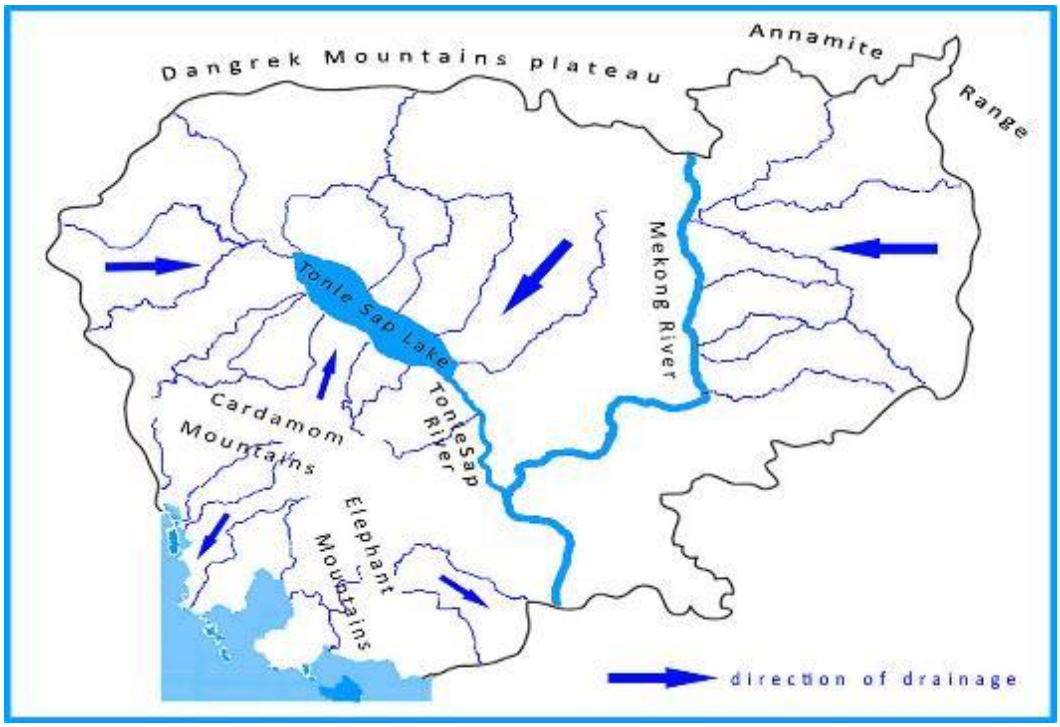
121. The hydrologic setting of Cambodia is dominated by the Mekong River and Tonle Sap Lake system. Mekong River is among the world's largest rivers in terms of length and average discharge, while Tonle Sap Lake is the largest freshwater lake in Southeast Asia. Tonle Sap, or Great Lake, is in the center of the Cambodian central plain, with an elevation of 10–30 meters above sea level covering about 6% of the country (MoE, 2009).

122. The Mekong River in Cambodia starts from upstream of Cambodia- Lao PDR border and flows through Stueng Treng, Kratie, and Kampong Cham Province in the country then ends up at

the downstream of Cambodia-Viet Nam border with total length of 486 km. The Mekong River basin in Cambodia covers 86% of total country area.

123. Tonle Sap is a natural floodplain lake located at central Cambodia. It is called “Great Lake” as it is the largest inland freshwater lake in Southeast Asia. The lake is fed by numerous erratic tributaries and by the Srêng and Sên rivers, which are perennial northern tributaries. During the June-to-November monsoonal regime, the swollen Mekong reverses the southeastward flow of the Sab River, which increases Tonle Sap’s area from about 1,050 square miles (2,700 square km) to about 4,000 square miles (10,360 square km); its depth also increases from 3–10 feet (0.9–3 m) to 30–45 feet (9–14 m), permitting vessels with 9 feet (3 m) of draft to navigate it up through the various tributaries, on which are situated the towns of Kompong Thom, Battambang, and Pursat. During the rainy season the lake’s width increases from about 22 miles (35 km) to 65 miles (105 km). At low water it is little more than a reed-infested swamp, with channels for fishing craft.

Figure III-5. Hydrological Map of Water Direction in Cambodia



Source: Department of Meteorology, Ministry of Water Resources and Meteorology.

E. Ecological Resources

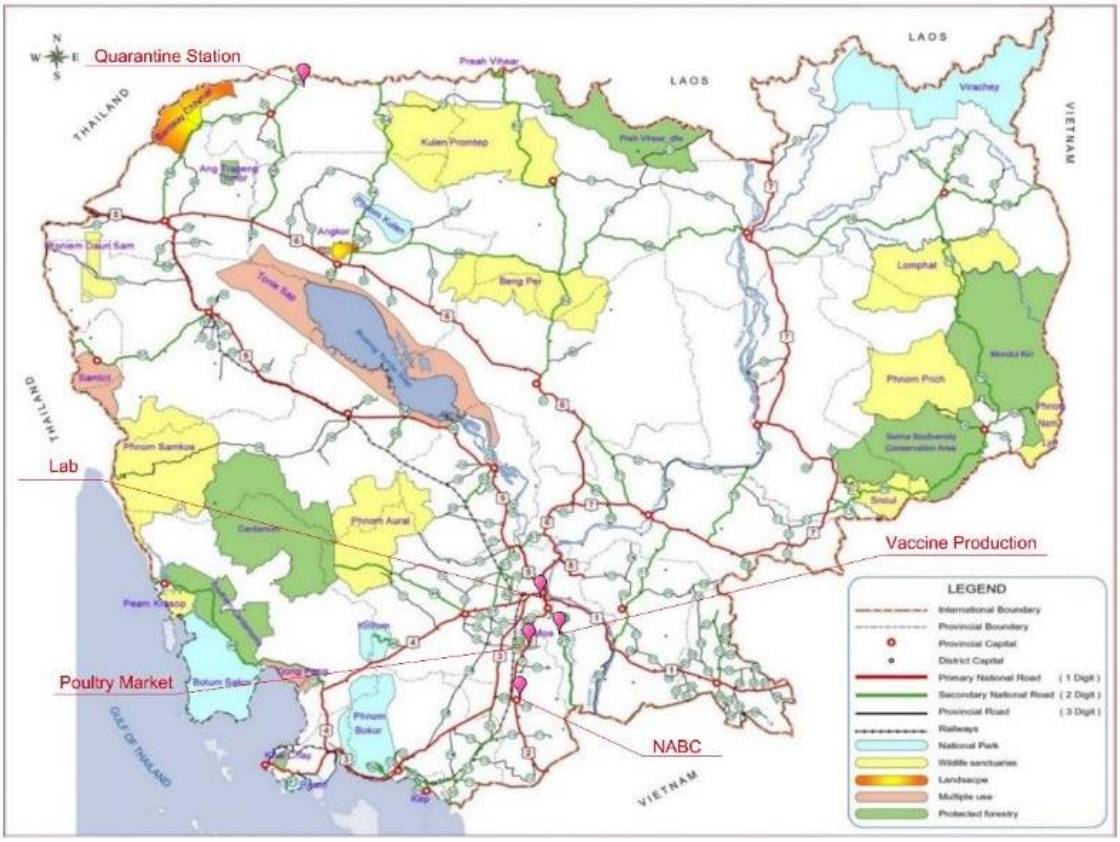
1. Protected Areas

124. There are 23 protected areas in Cambodia, including 7 national parks, 10 Wildlife Sanctuaries, 2 protected landscapes and 3 multiple use area. These protected areas are distributed at north side, northeast side and southwest side of the country, while the 5 subprojects are located at 3 provinces that are south to the Phnom Penh, and one north province (Otdar Meanchey). These four provinces have no areas within the scope of the protected areas orare at least 10 km from the listed protected areas.

2. Tonle Sap Biosphere Reserve (TSBR)

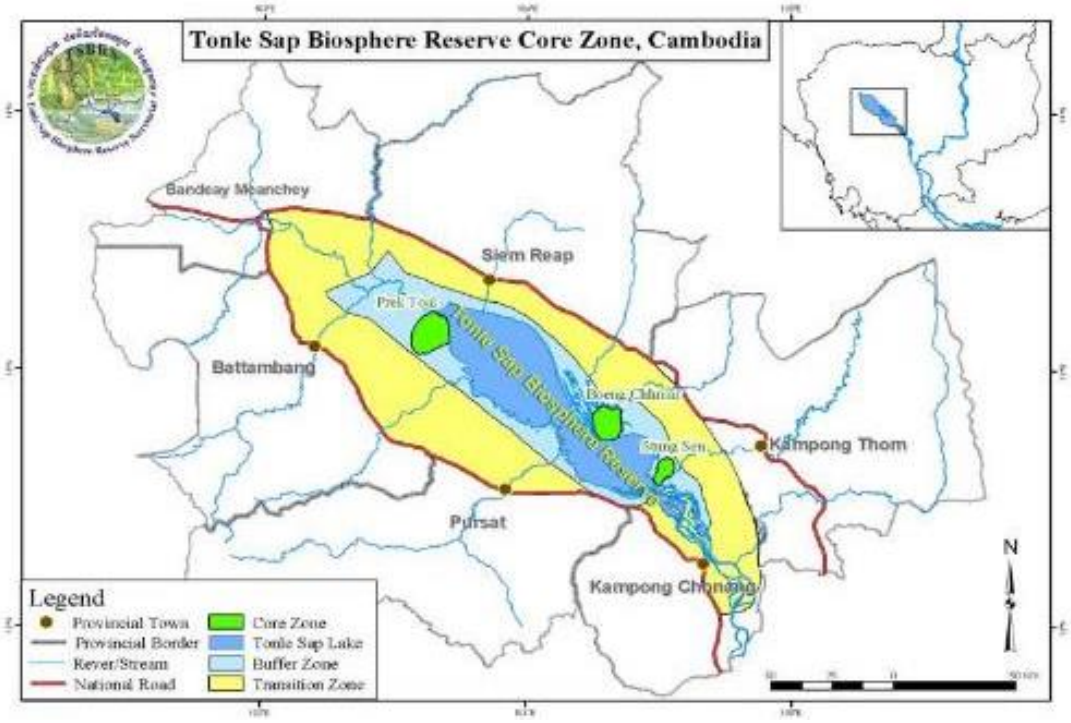
125. The Tonle Sap forms a natural floodplain reservoir in the depression of the Cambodian plain. It is fed by three main perennial and numerous erratic tributaries and is drained by Tonle Sap River into the Mekong River near Phnom Penh. Located in the center of Cambodia, Tonle Sap Lake is the largest freshwater lake in Southeast Asia and with a unique hydrology which has, for centuries, been at the core of Cambodian life and culture. The flow of the Tonle Sap River is reversed when the level of the Mekong water rises in the flood season (June-September) pushing water into the lake and increasing the inundated area up to five-fold, raising water level by up to 10 meter and increasing the lake water surface from 2,500~3,000 square kilometers in the dry season to 10,000~16,000 square kilometers in the wet season. Raising vegetation on the floodplain is largely secondary in nature but the flooded forest supports populations of Globally Threatened species and is one of the region's most important areas for bird conservation, supporting a highly productive and diverse inland fishery and large human population. UNESCO designated Tonle Sap a World Network Biosphere Reserve in 1997.

Figure III-6. Map of Protected Areas in Cambodia and the 5 subproject sites



Source: Department of Meteorology, Ministry of Water Resources and Meteorology.

Figure III-7. Map of Tonle Sap Biosphere Reserve Core Zone



Source: Department of Meteorology, Ministry of Water Resources and Meteorology.

126. The biosphere has three 'core areas'– in Prek Toal in Battambang province and Boeung Chhma and Steung Sen in Kompong Thom province located on the lowland side of Tonle Sap Lake. The core areas comprise 21,342 hectares in Prek Toal and 14,560 hectares in Boeung Chhma which is also an internationally recognized wetland under the Ramsar Convention (see below). Both are important breeding and feeding grounds for endangered species of large water birds. Steung Sen spans 6,355 hectares and features trees rare to the flood plain. The Ministry of Environment Estimates less than 20,000 people living in or near these areas – about 10,000 in Prek Toal, about 2,000 in Boeung Chhma and almost 7,000 in Steung Sen. Their distance to the NCBC subproject site is around 30 km. Therefore, the project will have no impact on the biosphere.

3. Forest and Vegetation

127. Cambodia has one of the highest levels of forest cover in the region as the interdependence of Cambodia's geography and hydrology makes it rich in natural resources and biodiversity among the bio-richest countries in Southeast Asia. The Royal Government of Cambodia estimates approximately 10.36 million hectares of forest cover, representing approximately 57.07% of Cambodia's land area (Forestry Statistics of Cambodia, Forestry Administration, 1012). On the contrary, international observers and independent sources provide rather different numbers. Consensus permeates, as most sources agree, that deforestation, loss of seasonal wetlands, and habitat destruction - among countless minor factors-correlates with the absence of strict administrative control and indifference in law enforcement - not only in Cambodia but the entire region. About 69,000 ha (1%) of forest cover is planted forest. Overall Cambodia's forests contain an estimated 464 million metric tons of carbon stock in living forest biomass. Approximately 40% of Cambodia's Forests have some level of protection, while one of the Cambodia Millennium Development Goals targets is to achieve a 60% forest cover by 2015.

According to the Forestry Administration Statistics, a total of 380,000 hectares of forest were cleared between 2002 and 2005/2006 - a deforestation rate of 0.5% per year. The main cause of deforestation has been determined to be large scale agricultural expansions. The forest cover and other land use in 4 provinces where the prioritized subprojects are located are described in the table below.

Table III-3. The Forest Cover and Other Land Use of the 5 subprojects in 4 provinces

Forest Types	Phnom Penh		Takeo		Otdar Meanchey		Kandal	
	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
Evergreen forest	0	0.0	1,923	0.6	61,608	5.1	0.0	0.0
Semi-evergreen forest	0	0.0	0.0	0.0	20,967	1.7	0.0	0.0
Deciduous forest	0	0.0	9,134	2.6	126,921	10.6	138	0.0
Other Forest	0	0.0	2,621	0.8	14,537	1.2	16,000	4.5
Total Forest	0	0.0	13,678	3.9	224,033	18.6	16,138	4.5
Non Forest	37,374	100.0	335,365	96.1	439,132	36.5	340,235	95.5
Total Area	37,374	100.0	349,043	100	663,165	55.2	356,373	100

ha = hectare.

Source: Forestry Statistics of Cambodia, Forestry Administration (FA), 2015.

4. Flora and Fauna

128. Over 50 percent of the land is covered in forests, out of which the dense forest are found in the mountains and along the southwestern coast. Plants growing in Cambodia include rubber, kapok (a tree with seeds that yield a cotton-like fiber), palm, coconut, and banana, all of which are used for commercial purposes. The fauna of Cambodia includes elephants, deer, wild ox, panthers, bears, and tigers. Cormorants, cranes, parrots, pheasants, and wild ducks are also found, and poisonous snakes are numerous.

129. The five subproject sites are in urban area rural farmland/animal farmland areas, or elevated floodplain area. These sites are highly modified environment, and their main areas of influence are not habitats for rare species of flora and fauna. In particular for the Tonle Sap region, the project is not in areas of flooded forest or other notable habitat. In addition, biodiversity screening in the sites of vaccine production center in Kandal, the inspection center in Otdar Meanchey using IBAT[1] was carried out. The IBAT tool indicated that the 5 prioritized subproject sites do not contain any protected areas or habitats of particular biodiversity value. This was confirmed with subsequent site visits to the subproject areas which showed that they in highly disturbed environment dominated by agricultural and urban land use.

F. Social and economic profile

130. The General Population Census of Cambodia (GPCC) 2019 was conducted from March 03 to March 13, 2019. According to this Census, total provisional population of Cambodia, as of March 2019 stood at 15,288,489. The total population has increased from 13,395,682 in the 2008 Census. Thus, the population has grown by 1,892,807 persons, which represents 14.1%, over the period of 11 years from 2008 to 2019. The male population was 7,418,577 (48.5%) and the female population stood at 7,869,912 (51.5%). The average size of households was stable since 2008 at 4.6 persons. (General Population Census MoP 2019). Population concentrated in the southeast, particularly in and around the capital of Phnom Penh; further distribution is linked

[1] IBAT is a central database for globally recognized biodiversity information including Key Biodiversity Areas and Legally Protected Areas https://www.ibatforbusiness.org/.

closely to the Tonle Sap and Mekong Rivers.

Table III-4. Population in the 5 Provinces where prioritized sub-projects are located

Province	Households	Males	Females	Total	Household Size
Phnom Penh	399,203	1,039,192	1,090,179	2,129,371	5.3
Kandal	273,111	580,129	615,418	1,195,547	4.4
Takeo	199,362	432,649	466,836	899,485	4.5
Otdar Meanchey	56,331	134,350	126,902	261,252	4.6
Kampong Thom	154,458	327,013	350,247	677,260	4.4

Source: General Population Census. Ministry of Planning (MoP), 2019.

131. Seasonal monsoons and diverse topography significantly influence Cambodia's economy. The southwest monsoon brings the rainy season (May to October), which is suitable for planting and growing the rice seedlings, and the northeast monsoon sends back dry air (November to March), which makes possible the paddy harvest.

132. The country's lakes and rivers also affect the economy. They are an abundant source of fish, a mainstay of the Cambodian diet, and they make possible irrigated agriculture, on which the country depends for its livelihood. The principal waterway, the Mekong River, is an important trade route and avenue of communication. Since ancient times, the Tonle Sap (Great Lake), the Tonle Sab and the Mekong rivers, and their tributaries have been centers of economic and political power. Phnom Penh--the site of the royal residence, the administrative capital, and, in general, the locus of power, of culture, and of business--is situated at the junction of the Tonle Sab and the Mekong

133. Cambodia has experienced strong economic growth over the last decade; GDP grew at an average annual rate of over 8% between 2000 and 2010 and about 7% since 2011. Cambodia's two largest industries are textiles and tourism, while agricultural activities remain the main source of income for many Cambodians living in rural areas. The tourism, garment, construction and real estate, and agriculture sectors accounted for the bulk of growth. Around 700,000 people, the majority of whom are women, are employed in the garment and footwear sector. An additional 500,000 Cambodians are employed in the tourism sector, and a further 200,000 people in construction. Tourism has continued to grow rapidly with foreign arrivals exceeding 2 million per year in 2007 and reaching 5.6 million visitors in 2017. Mining also is attracting some investor interest and the government has touted opportunities for mining bauxite, gold, iron and gems.

134. The World Bank in 2016 formally reclassified Cambodia as a lower middle-income country because of continued rapid economic growth over the past several years. But the Country is facing the challenges of limited human resources, high income inequality, and poor job prospects. According to the Asian Development Bank (ADB), the percentage of the population living in poverty decreased to 13.5% in 2016. More than 50% of the population is less than 25 years old. The population lacks education and productive skills, particularly in the impoverished countryside, which also lacks basic infrastructure.

135. **Phnom Penh**. Double-digit economic growth rates in recent years have triggered an economic boom. The main economy is based on commercial such as garments, trading, small and medium enterprises. The property business is booming since the past few years.

136. **Kandal.** As the province is around Phnom Penh, it serves as an economic belt of the

capital. For instance, Cambodia has become the sixth largest garment exporter in the world in 2007 (most of these factories are in Kandal province). The industry created job opportunities for about 0.5 million Cambodians and generated some 0.3 billion U.S. dollars of monthly payment for the employees. Also, agricultural exports flourished in 2007, as palm oil, peanuts, rice, pepper and other rural products became ever more popular in the international markets.

137. **Takeo.** The province economy consists basically of agricultural farming, fishery, rice, and fruit cropping. Especially the rural households depend on agriculture and its related sub-sectors.

138. **Otdar Meanchey.** The province's economy is 93% based on farming and the remaining other 7% are based on fishing and trading. Because of its border with Thailand and the rise in cross-border trade with Thailand during recent years, the international trade is also booming and becoming another important sector of the province's economy. There are several developing plans from province-based NGO's, the Ministry of Foreign Affairs from Thailand and Cambodian government itself. The economy and infrastructure of the province was destroyed during the Khmer Rouge stand and needs a whole new stable backbone.

G. Sub-Projects' environmental baseline

139. During the early feasibility stage, the 5 subproject sites were visited by safeguard team comprising national environmental, social and climate specialists for the preparation of this IEE and other safeguard documents with needed sample tests being carried out to get firsthand data in addition to second hand and routine monitoring data. The method for determining the subproject scope of assessment is discussed in the introduction to Chapter IV.

1. NAHPRI Lab in Phnom Penh

140. This subproject is in a populated urban area. The Area of Influence (AoI) and scope of assessment is 500 meters from boundary of the Lab building. The Lab building is accessible through the street No 371 at west side and Veng Sreng Street at south side of the Lab building. There are houses or buildings along the street/road and near NAHPRI Lab. From Google Earth Map, residential areas, office zones like GDAHP, public services like museums, religious building, are in this scope and a water body 180 m west to the Lab.

Figure III-8. Scope of assessment for NAPHRI Lab

Source: Asian Development Bank.

Table III-5. Main Sensitive Environmental Receptors – the NAHPRI Lab in Phnom Penh

No.	Name	Location		Protection Target	Direction to the sub-project site	Distance to the sub-project sites
		E	N			
1	Stung Meanchey Studio of Bayon T. V	487359	1275407	Noise and Air	On the North	On the boundary of project site
2	National Institute of Business (NIB)	487711.05	1275447.09	Noise and Air	East	0.31 km
3	Phnom Penh Gendarmerie Command (Gendarmerie Royal De Phnom Penh)	487412.12	1275205.98	Noise and Air	East	Behind the project site.
5	Beltei International School - Private School	487523	1275068	Noise and Air	South-east	0.29 km
6	Residential areas - Borey Peng Hout	487704.57	1275113.08	Noise and Air	South-east	0.38 km
7	Church	487308.79	1275022.03	Noise and Air	South	0.27 km
8	Rental Factory	487204.04	1275006.55	Noise and Air	South-west	0.30 km

Note: Beside the above sensitive area, the rest are mixed areas (Factory, residential area and shop house) within 700-meter vicinity of project site.
Source: Asian Development Bank.

141. The NAHPRI lab is in an urban area and served by urban sewer system wherein the

wastewater combines with storm water (combined sewer system). The wastewater from the lab, after being treated by on-site treatment, currently septic tanks, are drained through the combined sewer system which discharges into water pond/lake. However, a standard wastewater treatment plant (WWTP) is under construction funded by Japanese government. In near future, the post-treatment wastewater from NAPHRI lab is expected to discharge into sewer to this WWTP.

142. **Current waste generation**. Diagnostic testing operations generate wastewater and solid and hazardous wastes. The solid and liquid waste (excluding vessels cleaning wastewater and domestic wastewater) generated from operation of the existing lab facilities are summarized in tables below.

Table III-6. Solid and Hazardous Wastes from Existing NAHPRI Lab Operation

Source	name of solid waste	Quantity (kg/day)		
		solid waste	biohazard	sharps
Bacteriology tests	Faeces and media		15	
	Glass slide and needle			0.5
Parasitology test	Faeces		2.73	
	Glass slide			0.0227
	Cover glass			0.0091
	Haematokrit apillaren			0.0091
	Needle			0.0227
Virology test	PCR plate or strips		1.4545	
	Tip, tube		2.1818	
	Tissue and gloves		9.0909	
	Glass slide blade, and needle			0.8
Drug Residue test	Meat	15		
	Plastic+ related waste	25		
	Sodium hydroxide pellets	0.5		
Total	**72.3 kg/d**	**40.5**	**30.5**	**1.36**

Source: Asian Development Bank.

Table III-7. Liquid Wastes from Existing NAHPRI Lab Operation

source	name of liquid waste	Volume (ml/day)			characteristics
		General	Chemical hazard	Biohazard	
Bacteriology test	Crystal violet solution	100	0.1		chemical hazard
	Iodine solution (Potassium)	100	0.1		chemical hazard
	Decolorizer solution (95% alcohol)	100	0.1		chemical hazard
	Safranin solution	100	0.1		General waste with high organic matters

source	name of liquid waste	Volume (ml/day)			characteristics
		General	Chemical hazard	Biohazard	
	Disinfectant: Haiter bleach 10%	4000	4.0		
	Blood			500	Bio-hazardous
sub-total		***4400***	***4.4***	***500***	
Parasitology	Blood			22.727	Bio-hazardous
	Giemsa staining			40.909	Bio-hazardous
	Methylene blue solution		91.0		chemical hazard
	Detergent solution	136.364	0.1		
	Pepsin	36.364	0.0		General waste with high organic matters
	Methanol		227.3		Chemical hazard
	Acetic acid 10%		136.4		chemical hazard
	Formalin		136.4		chemical hazard
sub-total		***172.728***	***591.2***	***63.636***	
Virology	Bleach 40%	3000	3.0		General waste with high organic matters
	Virkon			20020	Biohazard
	Washing buffer, lysis buffer, TAE etc.		10,010.0		General waste with high organic matters
sub-total		***3000***	***10,013.0***	***20020***	
drug residual test	Formic acid 98%		2,000.0		chemical hazard
	Trichloroacetic acid, Cl3CCOOH > 99.5%		500.0		chemical hazard
	Ethylene diamine tetraacetic acid (EDTA)		1,000.0		chemical hazard
	Methanol		8,000.0		chemical hazard
	Acetonitrile		10,000.0		chemical hazard
	Hexane		1,000.0		chemical hazard
	Ammonia solution		500.0		chemical hazard
	Ethyl acetate		500.0		chemical hazard
	Acetic acid		1,000.0		chemical hazard
	Formalin		5,000.0		chemical hazard
	Hazard Water mixed		50,000.0		chemical hazard
sub-total			***79,500.0***		
Grand Total	**In ml/day**	**7,573**	**90,108.6**	**20,584**	
	in liters/day	**7.57**	**90.1**	**20.58**	**118.26**

Note: the liquid waste exclude wastewater from cleaning of vessels/apparatus that are about 2.0~2.5 m^3/d.
Domestic wastewater from 78 staff (about 3900L/d, or 1170 t/a) are also not included.
Source: Asian Development Bank.

143. From the table above, the lab generates solid wastes about 72kg/day of which 32 kg/day

is biohazardous wastes and sharps. General or domestic waste are separated from biohazardous, infectious waste which is sterilized by autoclaving and incinerated currently at the lab. General and domestic solid waste is hauled to local designated PHNOM PENH's domestic waste disposal site. Ash from incinerator is disposed through a Singapore-based treater.

144. The above table shows that liquid waste from laboratory processes amount to around 120 L/day. Part of the chemicals and solvents are utilized or stored temporarily in waste glass bottles, waiting for collection by the Red Cross which treat them at its incineration facilities. The rest is washed down and mixed with other domestic wastewater to septic tanks and then to general sewer system.

145. Bio-hazardous liquid waste (around 21 L/day) is sterilized and mixed with vessels cleaning wastewater and drained into the lab septic tanks with domestic and washing wastewater. The latter is discharged to the PHNOM PENH public sewer system. Domestic wastewater from 78 staff which include both lab staff and those of the research institute that share the entire compound is connected to a septic tank for primary treatment before being connected to the PHNOM PENH public sewer system.

146. A monitoring of the effluent quality and volume of raw wastewater at the outfall of NAHPRI lab building during operation hours was carried out during the IEE preparation stage. The discharge volume was monitored as 12-14 M3/day. The monitoring results are summarized in the table below and compared to the applicable standard. In this case, the EHS standard for Treated Sanitary Sewerage Discharge for BOD_5 is the standard used and listed below (copied from **Table II-9**). For COD, Cambodia standard is applied. The results show that all the samples exceeded the standard for all parameters except pH. Thus, appropriate treatment prior to discharge need to be addressed.

Table III-8. Wastewater from Existing NAHPRI Lab Operation (after septic tank)

No	Parameter	unit	Monitored result				Standard[a]
			Dec15 am	Dec 15 pm	Dec16 am	Dec16 pm	Treated Sanitary Sewage Discharges
1	pH	mg/L	7.35	7.59	7.39	7.59	6-8
2	(TSS)	mg/L	117.00	85.00	161.00	128.00	<50
3	NH3-N	mg/L	22.5	21.00	25.00	19.17	<5
4	BOD_5	mg/L	173.20	185.60	182.54	171.27	<30
5	CODcr	mg/L	433.00	501.00	502.00	471.00	<120
6	Phenol	mg/L	0.17	0.16	0.156	0.166	<0.1
7	TN	mg/L	35.12	33.18	34.34	33.98	<10
8	TP	mg/L	4.46	4.19	4.65	4.45	<2
9	Total Coliform	MPN/100ml	$1.1X10^4$	$1.1X10^4$	$1.1X10^4$	$1.1X10^4$	400
10	flow	m^3/h	1.838	1.476	1.717	1.442	

[a] Standard: see Table II-9 of this IEE. Note that for BOD_5, IFC-EHS standard is used.
Source: MoE for GMS-CLHVCIP in Cambodia, Dec. 2021.

147. The gaseous wastes (fumes) have been managed by BioSafety Cabinets or fume hood or cupboard installed in the testing rooms and bio-hazard liquid and solid waste have been well-managed by sterilizing by autoclaving and incineration. Air emission from incinerator is currently not monitored. The stack height is only 3m.

148. Noise is generated from sample preparation instruments such as centrifuges, grinding machines, and other lab equipment at the level that is generally low and will be compliance with Cambodia Noise Standard.

2. National Cattle Breeding Center (NCBC) in Kampong Thom

149. The Subproject is to establish a new NCBC infrastructure on existing GDAHP land in a rural area. The land area was recognized as a degraded deciduous forest zone where the former villagers used some plots for their traditional rice production.

150. Water resources. Based on the site survey, there were no significant surface water bodies near the project site. The Tumnup Reservoir is 5 km northwest of the site. The community uses underground water from aquifer and surface water during the wet season. There were 2 existing ponds (one with 10mx10m size and another one with 30mx40mx3m depth) used by the former owner for cattle supplied for the whole year period. Usually, the villagers around this area used the water from the well (3–5-meter depth) for their water supplies, except some families who use filter tank supported by a NGO for their water supply.

151. The samples of groundwater were collected by the PoAHP and sent to Phnom Penh to analyze its water quality for farming establishment purpose. The following table shows an extract of the results for water analysis last May 2022. These results show that the total coliform counts for two samples (1 and 3) where within the Cambodia groundwater standard (Table II-6) while the channel water (3) exceeded it, typical for surface water in rural area with sewage and run off. The pond water was alkaline, and well water (sample 3) was acidic, with reasons unknown.

Table III-9 Results of Groundwater Quality Analysis at NCBC site

Sample No.	Description	Parameter	Result	Guide Value
1	Pond Water	Total Coliform Count	0 cfu/ml	0 MPN/100ml
		pH	9.29	6.5-8.5
2	Channel Water	Total Coliform Count	10 cfu/ml	
		pH	7.73	
3	Well Water	Total Coliform Count	0 cfu/ml	
		pH	5.90	

Note: colony forming unit (cfu) and Most Probable Number (MPN) are equivalent.

Source: Asian Development Bank.

152. Electricity is supplied through a newly installed 66 KvA transmission line. Road Connectivity is very good with permanently paved road funded by ADB and AusAID. Inside the proposed land area there are only a few tracks that even a motorcycle cannot use during the wet season.

153. Agriculture and Land Use: In general, the villagers had occupied 2ha – 5ha of the soft land title for their farming production such cashew nut, cassava, and some mango tree etc. However, many villagers raised cattle and buffalo with local breeds in traditional practice on this government land for supplementary incomes. The yield of cashew nut was about 1,500kg per ha.

154. Project site is not located in any protected area or cultural heritage.The Cambodia Wildlife Sanctuary is around 132 km northwest of the site, while the Prasat Beng Meala (historical landmark) is 78 km northwest. Sensitive environmental receptors for air quality impacts are the nearest communities Phan Nheum Commune (>2 km west) and Toul Kreu Commune (>2km southeast).

3. National Veterinary Vaccine Center in Kandal Province

155. This subproject is to establish a new NVVC infrastructure in a rural area about 6 km from Tonle Basak River. The scope of the assessment in terms of air, noise, water is show in **Table III-10** and **Figure III-9** and Figure III-10. Within this scope, sensitive environmental receptors are identified and listed in the Table.

Figure III-9. Existing condition at the proposed NVVC site

Condition of in site proposed project site

The site with fence to determine the boundary

The type Plant at site

Source: Asian Development Bank.

Figure III-10. Assessment scope for NVVC in Kandal (Pink shows receptors, not flooded area)

The elevated land

Farmland east to the site

Pond north to the site

Condition of in site proposed project site

The site with fence to determine the boundary

The type Plant at site

Source: Asian Development Bank.

Table III-10. Main Sensitive Environmental Receptors—NVVC in Kandal

Environmental element	Protection target	Direction and Distance to the sub-project sites	population	remark
Water environment	Prek Khleng Stream	1.5km from sub-project (east side)		
	Tonle Basak River	6 km from subproject (east side)		The water quality data in Tonle Basak Rive see in the attached below
Air and acoustic environment	Tanou village	0.7-1.0km	2,386	
	Veal village	2.5km	2,079	
	Tuol Sala village	2.0km	1,920	
Ecological environment	rice field, farm field, and village garden	Rice field and farm field are near the site. Village is 0.7-1km for site.		- No forest resources and sensitive ecology. - Dry rice and farm filed are surrounding the subproject

Source: Asian Development Bank.

156. Site investigation showed that the NVVC subproject is located near a stream (public water body). Therefore, water quality baseline survey was carried out for NVVC (in Kandal) subproject, and the results are in the tables below. Water quality in Tonle Basak River, obtained from secondary sources (2018), is also reported below. Water quality were within the Cambodia guide values for both Preak Slaeng Stream and Tonle Basak River.

Table III-11. Water Quality in Preak Slaeng Stream near NVVC, in Kandal (Dec 15, 2021)

No	Parameters	Unit	Results	Standards	remarks
				CAM	
1	pH	-	7.35	6.5-8.5	Compliance with Cambodia National Standard
5	TSS	mg/l	28.00	25-100	
8	(BOD)5	mg/l	1.40	1.0-10	
9	(COD)Mn	mg/l	3.67	1.0-8.0	
17	TN	mg/l	0.67	1.0-6.0	
18	TP	mg/l	0.04	0.005 – 0.05	
19	Total coliform	MPN/100 ml	1500	<5000	

Source: MoE Laboratory in Cambodia, monitoring point in at nearest to the proposed site of NVVC.

Table III-12. The Water Quality in Tonle Basak River

No	Parameters	Unit	Results	Standards	remarks
				CAM	
1	pH	-	6.83	6.5-8.5	Compliance with Cambodia National Standard
2	Temperature	C	21.98		
3	TDS	mg/l	38.40		
4	DO	mg/l	6.08	2.0-7.5	
5	TSS	mg/l	50.00	25-100	
6	$CaCO_3$	mg/l	97.00		
7	TH	mg/l	49.00		
8	(BOD)5	mg/l	2.07	1.0-10	
9	(COD)Mn	mg/l	5.39	1.0-8.0	
10	Oil and Grease	mg/l	3.15		
11	NH3	mg/l	0.01		
12	Cl	mg/l	8.50		
13	MBAS	mg/l	ND		
14	NO3	mg/l	0.21		

No	Parameters	Unit	Results	Standards CAM	remarks
15	PO4	mg/l	ND		
16	SO4	mg/l	0.69		
17	TN	mg/l	0.57	1.0-6.0	
18	As	mg/l	0.0003		
19	Cadmium (Cd)	mg/l	0.0002	0.001	
20	Cu	mg/l	0.001		
21	Fe	mg/l	0.29		
22	Pb	mg/l	ND		
23	Mn	mg/l	0.002		

Source: MoE Laboratory for Washing Factory Project, Kandal, 2018, monitoring point in at the river section belong to Prek Samrog village, Rokar Khpos commune, Sa'ang district, about 4 km from Vaccine Production subproject site. The point of monitoring is at upstream section of Tonle Basak before Prek khlerg Stream flows into.

4. Otdar Meanchey Livestock Inspection Center

157. The proposed Livestock Inspection Centre subproject is located in Samrong Senchey-1 village, Korn Kreal commune, Samrong town, Otdar Meanchey province. It is confirmed that the Provincial Department of Agriculture, Forestry and Fisheries (PDAFF) has provided a plot of land of 14.9 ha, a small part of Korn Kreal Agricultural Station Area (more than 100 ha) which is not the protected forest area under the Ministry of Environment.

158. The present land use conditions in the surrounding area are: 60% of this 1,620,300 m2 of public land is the water conservation forest land and the rest of 40% is for agriculture development (production of farming, rice, cashew, coconuts, banana, etc.). The proposed 100,328m2 of land for the inspection center is on the present secondary forest, on which timber trees such as Thlung and Thbaeng etc. stand. There is no farming, cultivation activities and any private owned properties on this proposed site. The conservation forest cited here has the function of conserving water resource and is not a critical habitat.

Figure III-11. Existing conditions at the site of Otdar Meanchey Station

The natural vegetation in the site

The access road

Fruits & vegetables fields of Koun Kriel Agricultural Station for research purpose

The dam, reservoir at northwest side

Rice field at downstream

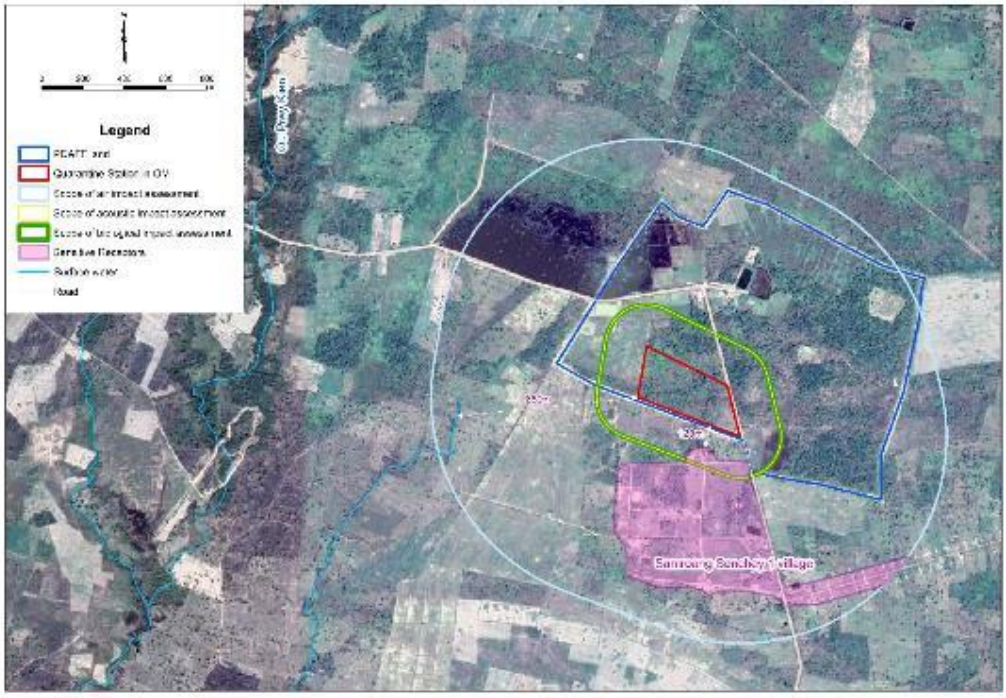
Source: Asian Development Bank.

Table III-13. Main Sensitive Receptors—Animal Inspection Center in OM

Environmental element	Protection target	Distance to the sub-project	population	remark
	Water pond in the Samrong Senchey-1 Village	1-1.5 km south		The ponds were public ponds built by Ministry of Rural Development for local villager's household use
	Water pond inside the Koun Kriel Agricultural Research Station	350m northwest		Water stored in the pond is used by Koun Kriel Agricultural Research Station for crops irrigation
Air and acoustic environment	Samrong Senchey-1 village	1 km south	413	
	Koun Kriel	2 km west	201	
Ecological environment	The proposed inspection center site a piece of a conservation forest land, divided by an access road.	Divided by the access road. The larger part of conservation forest is on the east of the access road		The conservation forest here has function of conserving water resource. It is not a critical habitat
	There are some indigenous stands of forest trees	inside the proposed site of inspection center		
	Wet rice field, and Cassava, Cashew	West, west south to the site		

Source: Asian Development Bank.

Figure III-12. Assessment scope for Animal Inspection Station subproject in OM



Source: Asian Development Bank.

5. Poultry section of Takeo market

159. The existing Market is in an urban community, surrounded by commercial establishments and households. No water body is located near the market. The wastewater of the town and market is conveyed by combined rainwater and sewer system leading to two natural ponds outside the town for natural degradation.

160. The current area for the Poultry section of Doun Keo market is by the roadside open to traffic and restaurants and businesses. Birds are lined up along the curbside awaiting slaughter and plucking. The slaughtering and plucking were being conducted among motorbikes and piles of rubbish which is a major hygiene and food safety issue. It sell live birds to traders who may then transport to other places for slaughter. Many customers also buy live birds to kill at home because of food safety concerns.

6. Ambient Air Quality

161. Ambient air quality baseline data were collected from recent investment projects located in the same provinces where the 5 prioritized subprojects are located. All these data showed that ambient air quality complies with both Cambodia national standard and IFC- EHS guidelines and air quality in the project provinces is good. Given that the project areas are mostly rural or suburban (except for the lab and the poultry market), these data are considered still representative of the current air quality.

Table III-14. Existing ambient air quality in Phnom Penh City

Parameter	Results (mg/m^3)		Standards		remarks
	Brew[a]	Trans[b]	CAM (mg/m^3)	EHS (ug/m^3)	
Carbon Monoxide (CO)	2.50	3.00	< 20 (8 hrs)		Compliance to both Cambodia national and EHS standard
Nitrogen Dioxide (NO_2)	0.028	0.024	0.1 (24 hrs)	40 （1yr.） 200 (1 hr.)	
Sulfur Dioxide (SO_2)	0.021	0.018	0.3 (24 hours)	500 (10 min) 125 (24hr.)	
Total Suspended Particles (TSP)	0.227	0.157	0.33 (24 hrs)		
PM10	0.139		-	150 (24hr)	
PM2.5	0.088		-	75 (24hr)	

[a] MoE for Brewery Factory, April 2016, monitoring point is at Chheung Ek Commune, Dankor District, Phnom Penh, about 6km from NAHPRI Lab.

[b] MoE for Transmission Line Improvement Project in Phnom Penh, December 2015, monitoring point is at Or Bekhaom commune, Tuol Kok district, Phnom Penh, 3~4 km from GDAHP Laboratory, Phnom Penh.

Source: Cambodia. Ministry of Environment.

Table III-15. Existing ambient air quality in Takeo (Rock Investment Project in 2016)

No	Parameters	Unit	Air quality result		Standards		remarks
			1. Khvav village	2. Chheur Teal village	CAM	EHS	
1	CO2	mg/m^3	0.42	0.80	20 (8 hr.)		Compliance both Cambodia national and EHS standard
2	NO_2	mg/m^3	0.011	0.013	0.1 (24 hr .)	40（1yr.） 200 (1 hr.)	
3	Sulfur Dioxide (SO_2)	mg/m^3	0.006	0.008	0.3	500 (10 min) 125 (24hr.)	
4	TSP	mg/m^3	0.093	0.001	0.33		
5	PM_{10}	mg/m^3	0.042	0.057		150 (24hr)	
6	$PM_{2.5}$	mg/m^3	0.028	0.031		75 (24hr)	

Source: MoE for a Rock Investment Project in Takeo, 2016, monitoring points are about 60 km from Phnom Tamao Breeding Station.

Table III-16. Existing ambient air quality in Kandal

(Washing Factory in 2018, all in mg/m^3)

No	Parameter	Monitoring result	Standards		remarks
			CAM	EHS	
1	CO	4.05	20 (8 hours)		Compliance both Cambodia national and EHS standard
2	NO_2	0.016	0.1 (24 hours)	40（1yr.） 200 (1 hr.)	
3	SO_2	0.012	0.3 (24 hours)	125 (24hr.)	
4	TSP	0.165	0.33 (24 hours)	150	
5	PM10	0.09	0.05	150 (24hr)	

Source: MoE for a Washing Factory investment, monitoring point is at Prek Samrog village, Rokar Khpos commune, Sa'ang district, Kandal Province, about 4 km from Vaccine Production subproject site, same location with surface water quality monitoring for Tonle Basak River.

Table III-17. Air Quality in Otdar Meanchey

(Coal Mine Project in 2018, mg/m^3)

No	Parameter	Result	Standards		remarks
			CAM	EHS	
1	CO	1.500	20 (8 hours)		Compliance both Cambodia national and EHS standard
2	NO_2	0.010	0.1 (24 hours)	40（1yr.）200 (1 hr.)	
3	SO_2	0.008	0.3 (24 hours)	125 (24hr.)	
4	TSP	0.059	0.33 (24 hours)	150 (PM10 24hr)	
5	PM10	0.024	NV	150 (24hr)	

Source: MOE for Coal Mine Exploration Project of the Yun Khean Minerals (Cambodia) Co., Ltd, monitoring point is at Or Svay Commune, Anlong Veng District, about 60 km form proposed New Quarantine site.

162. A baseline odor survey at the previously proposed site for NCBC subproject in Takeo was carried out. The monitoring result indicated that no ammonia and hydrogen sulfide pollutants in air was detected. We may surmise that the same condition would exist in the new proposed site in Kampong Thom as the characteristics of both areas are similar except that the old site has more existing cattle ranching. This means the odor is even less concern in the new site currently.

Table III-18. Odor pollutants in air inside the previous NCBC subproject site in Takeo

(for GMS-CLHVCIP in Cambodia, Dec, 2021, mg/m^3)

No	Parameter	Monitoring result	Standards		remarks
			CAM	EHS	
1	NH_3	ND			
2	H_2S	ND			
3	PM_{10}	0.036	<0.05 (24hr)	150 (24hr)	Compliance

Source: MoE for GMS-CLHVCIP in Cambodia, inside previous NCBC subproject site in Takeo, December 2021

IV. Anticipated Environmental Impact

163. Given the nature of the CLHVCIP and the 5 prioritized subprojects with their moderate scale especially NAPHRI lab and Poultry section being renovation within the existing facility, construction impacts are limited and general. These impacts will be localized, short-term, and can be effectively mitigated through the application of good construction and standard site practices and adherence to the provisions of the environmental management plan (EMP) in the next chapter.

164. Given the nature of five subprojects and the project overall, it is anticipated that the main potential environmental impacts will be from operational processes. These include (i) wastewater and the adequate treatment and slurry discharge/use; (ii) solid and hazardous wastes, their management and disposal; (iii) odor and air emissions; and (iv) Health & Safety including biosafety risks. Therefore, the chapter begin with impacts assessment during operation phase. With particular attention paid to area of influence as defined by the ADB's Safeguard Policy Statement 2009, the scope of investigation and assessment are mainly he followings:

(i) The primary project site(s) and related facilities that the borrower/client develops or controls. The primary project sites for the 5 Subprojects include direct construction sites, utility pipelines, and access roads, borrow pits, disposal areas, and construction camps.

(ii) Associated facilities that are not funded as part of the project whose viability and existence depends exclusively on the project. No associated facilities are

identified for the five projects.

(iii) Effects from cumulative impacts from further planned development of the project, other sources of similar impacts. Cumulative impacts are considered where appropriate in the baseline and impact sections.

165. For this IEE, the assessment includes the footprint of all subproject activities, the access road, and areas in which a direct or indirect impact on the physical, biological, social, or cultural environment might occur, which can vary by topic. Where different areas are used, this is discussed in the respective baseline and impact sections. The details about scope and focus of the assessment of environmental impacts are presented in the table below. This scoping method was used also in the baseline investigation in Chapter III, though biodiversity related survey has much bigger scope.

Table IV-1. Scope and focus of investigation and Assessment

Factor	NAHPRI Lab		Breeding center	Vaccine Production	Inspection Station	Poultry Market
Air	scope	500 m from the boundary	1 km from the boundary	1 km from the boundary	1 km from the boundary	1 km from the boundary
	parameters	（VOA）	Olfactory, NH3, H2S	TSP	Olfactory, NH3, H2S	Olfactory, NH3, H2S
Surface water	scope	feasibility of discharging into urban sewer system	feasibility of being discharged /application to forage land	500 m upstream and 1500 m downstream of the effluent outlet	feasibility of being discharged /application to forage land	feasibility of discharging into urban sewer system
	parameters	COD, BOD5, NH3-N, SS, TN, TP, Fecal coliform	COD, BOD5, NH3-N, SS, TN, TP, Fecal coliform	COD, BOD5, NH3-N, SS, TN, TP, Fecal coliform	COD, BOD5, NH3-N, SS, TN, TP, Fecal coliform	COD, BOD5, NH3-N, SS, TN, TP, Fecal coliform
Groundwater	scope	100 m minimum distance from well water	100 m minimum distance from well water	100 m minimum distance from well water	100 m minimum distance from well water	100 m minimum distance from well water
	parameters	Nitrate-N, phosphate-P, ammonia N, Fecal coliform	Nitrate-N, phosphate-P, ammonia N, Fecal coliform	Nitrate-N, phosphate-P, ammonia N, Fecal coliform	Nitrate-N, phosphate-P, ammonia N, Fecal coliform	Nitrate-N, phosphate-P, ammonia N, Fecal coliform
Acoustic	scope	200 m	200 m	200 m	200 m	200 m
	parameters	Leq（A）	Leq（A）	Leq（A）	Leq（A）	Leq（A）
Biodiversity, habitats etc	Scope	n/a	Min 1 km from boundary	Min 1 km from boundary	Min 1 km from boundary	n/a
	Parameters	n/a	biodiversity areas	Location of biodiversity areas	Location of biodiversity areas	n/a
Physical cultural resources (PCR)	Scope	200 m	200 m	200 m	200 m	200 m
	Parameters	Location of PCR	Location of PCR	Location of PCR	Location of PCR	Location of PCR

Source: Asian Development Bank.

A. Impacts during Operation

166. For livestock facilities and projects, adverse environmental impacts and complex health and safety risks come from their operation phase. Among the main project activities represented by the five subprojects, laboratory operations, vaccine production, slaughtering and animal holding related are distinctive from each other. They will be assessed in separate sections below. Consequently, separate sets (or subplans) of measures and monitoring during operation are developed for five types of subprojects respectively in the EMP.

1. Impacts of NAHPRI Lab Operation

167. The following table summarizes the major pollution and issues, their sources from the animal testing laboratory's operations and their current management.

Table IV-2. Summary of Main Pollution and Characteristics (existing lab)

source	pollutants	main sources	Current pollution management
Sample testing in isolation rooms	Biohazard fumes and gases	Aerosol/fumes containing biohazardous material, and VOCs	Captured and filtered by BSC before emitting into air. Rooms without BSC use fume hoods to capture fumes
	noise	LAeq from testing instruments such as centrifuge, grinding machines	Gradually attenuated
	Wastewater from pre- and post-cleaning of vessels/ instruments and reagent preparation	COD, BOD_5, TSS, NH_3-N, detergents, SS, total coliform, chemicals used	Washdown into outfalls of the Lab building and discharged into PHNOM PENH urban sewer system
	General or domestic solid waste	organic and inorganic materials	Collected by bins marked as domestic or general waste
	Bio-hazardous waste (liquid and solid)	Containing active virus, bacteria, antigens, etc., that contain infectious materials	Collected by bins marked for bio-wastes and infectious wastes separately, transferred to room for sterilizing by autoclaving and incinerated
	Other Bio-hazardous waste	Filter elements from BSC,	Collected and Recycled by a Singapore Company
Offices	Domestic wastewater	COD, BOD_5, TSS, NH_3-N, detergents, SS, total coliform	Washdown into outfalls of the Lab building and discharged into PHNOM PENH urban sewer system
Incineration facility	Odor	H_2S, NH_3,	Chimney stack emitted
	Hazardous wastes	Ash (inorganic)	Recycled by a Singapore Company
	Emissions	PM, Dioxin and Furan	Stack emissions

Note: all general solid waste, after being collected in bins are hauled to local designated community's domestic waste disposal site.
Source: Asian Development Bank.

Water pollution

168. The lab is currently operated in its full capacity at 24,806 tests/year. The number of staff working in the lab will increase from existing 78 persons to 100 persons after upgrading, and staff will only stay during working hours in the lab building. The NAHPRI lab operates for 300 working day per year for providing diagnostic service. Wastewater from the veterinary diagnostic lab include:

(i) Chemical hazardous liquid, including wasted liquid chemicals from laboratory tests. Because of the nature of chemical toxicity, this wastewater should not be mixed with domestic wastewater without pre-treatment for decontamination of hazard chemicals. Currently, the existing lab operation has made such chemical hazard liquid wash-down and mixed with other type of wastewater into the outfall of lab building.

(ii) General wastewater, which includes (i) domestic wastewater from the lab staff, (ii) wastewater from two existing water purification units for lab use, (iii) cleaning of vessels and testing apparatus after they are sterilized by autoclaving (iv) post[2]-cleaning of vessels/ instruments that contacted with chemical hazard material; Wastewater iii-iv contains very minor biohazard waste due to autoclaving, and minimal chemical hazardous waste as a result of triple washing and therefore regarded as general wastewater.

(iii) Cleaning disinfection of testing vessels/apparatus generate wastewaters containing chemical pollutants, organic or inorganic. The pre-cleaning (the first 2 rounds) usually contains higher concentration of chemical pollutants and require different treatment from domestic or general wastewater. However, the existing lab operation did not separate the pre-cleaning and post–cleaning wastewater. They are all washed down into the lab sewer network.

169. It shows that current discharge concentration has exceeded applicable wastewater discharging standard. In the project, NAHPRI lab's capacity of animal feed analysis, drug and drug residual analysis will be more than five times the current level (130,228 by 2028). As a result, total amount of wastewater from the lab is expected to increase. Environmental management facilities, especially wastewater treatment facility will be designed and provided to address both existing and further operation environmental issues.

170. Wastewater quality was calculated. The total volume of wastewater was projected to double from the current measured value of 14 M3/day. Concentration estimates for individual streams made use of the measured values for the total mixed lab wastewater and references from literature.

(i) Maximum values from the actual measurements were used to estimate the concentration of pollutants for both vessels cleaning streams.

(ii) Concentration of wastewater from purifier was estimated using weak domestic wastewater as reference.

[2] Post-cleaning refers to the third and afterwards cleaning.

Table IV-3. Estimated process wastewater from NAHPRI Lab (after upgrading)

Type of Wastewater	Volume Flow	COD	BOD	SS
		concentration	concentration	concentration
	M3/d	mg/L	mg/L	mg/L
Domestic wastewater	4	350	180	200
Wastewater from water purifier*	**7**	250	100	100
Wastewater from vessels cleaning, and liquid waste	10.5	500	185	160
from pre-vessels cleaning	7	500	185	160
Total lab wastewater	**28**	**426**	**166**	**154**
Sample test of Lab in 2022	**12-14**	**433-500**	**170-185**	**85-160**

Source: Typical characteristics of wastewater | Water Treatment | Waste Water Treatment | Water Treatment Process & Plant Design (thewatertreatments.com).

171. The combination of all the streams resulted in slightly lower estimated value of COD and BOD and TSS when compared to current measured values. The differences are small, and hence, these results can be used for quantitative analysis and assessment in this IEE section.

172. Preliminary estimate of a decentralized wastewater system is provided below, based on removal efficiencies provided by BORDA and confirmed through literature on the performance of a DEWATS system in Nepal (ref.). This shows that the influent wastewater can be treated to meet applicable effluent standard using a combination of an anaerobic baffled reactor followed by horizontal and vertical flow constructed wetlands. However, the availability of space for the DEWATS setup need to be verified.

Table IV-4. Estimate of Lab effluent treatment by DEWATS

Discharge		Primary Treatment		Secondary Treatment		Tertiary Treatment		Applicable Std
		Septic Tank		ABR		Const Wetland		
Parameter	Lab's WW	% removal	Effluent1	% removal	Effluent2	% removal	Effluent3	
BOD	166	23%	128.1	45%	70	58%	30	30
COD	426	22%	332.5	47%	176	51%	86	120
TSS	154	34%	101.6	68%	33	69%	10	150
Total Col	1.00E+04					95%[a]	500	500

ABR- Anaerobic Baffled Reactor;. [a]overall removal efficiency for the three reactors.
Source of removal rates: BORDA-CAM 2022.

173. The DEWATS is mostly implemented with natural (extensive) systems in the developing countries although a variety of intensive systems like membrane filtration, sequencing batch reactor, etc. are also used in the developed countries. The major advantages of the DEWATS with extensive systems are: no (or very little) energy is required, limited sludge production, very low O&M cost, and increases wastewater reuse opportunities.

174. The table above shows that the above DEWATS design based on its technical information can treat the lab wastewater to meet applicable standard, subject to additional evaluation by the design engineers. Note that the above calculations have already considered the existing septic

tanks.

175. The Sequencing Batch Reactor may also be considered if space requirements are inadequate for the DEWATS. A typical SBR may need an area of around 20 m2 for tank volume of 2 x 29 m3 (two tanks) to accommodate the daily flowrate of 20 m3/day. The SBR require a skilled operator due to its complex control systems but is highly reliable.

Solid and Hazardous Waste.

176. NAHPRI lab operation will generate garbage from staff, lab waste containing bio-hazard materials and chemical-hazard materials, including filter elements.

(i) General Solid Waste (garbage, etc.): estimated to be 50 kg/d (around 15 t/a), calculated for around 100 staff including that of the institute and 0.5 kg/d/person. These will continue to be handled by PPH municipal solid waste system.

(ii) Lab wastes: include solid waste containing active virus, pathogenic microorganisms and their antigens, as well as sharps, broken vessels, one-off materials that contacted with biohazardous materials. Biohazardous waste is estimated to be around 91 kg/day and sharps are 3 kg/day. They are classified as medical or hazardous wastes and can't be disposed of together with garbage. Special treatment is required, as currently they are sterilized by autoclaving, then incinerated onsite.

(iii) Ash from the incinerator. According to the instructions of the incinerator supplier, average ash residue is 3%. If all hazardous wastes (94 kg/day) is incinerated, the estimated ash would be around 3 kg/d. The management of this ash through a Singaporean hazardous waste treater, including the contaminated air and water filters, is planned to continue.

(iv) Air filters used in the lab currently and in future after upgrading include following types.

  (a) Filter elements of biosafety cabinet (BSC). The working principle of biological safety cabinet is mainly to pump the air in the cabinet outward, so that the cabinet maintains negative pressure, and protects the staff through vertical airflow. The outside air pass through a high-efficiency particulate air filter (HEPA) into the cabinet to avoid sample contamination, while contaminated air is filtered by HEPA before emitting into outside air. After the service life of HEPA filter expires, regularly inspected at least once a year, it will be replaced by a well-trained professional staff from Singapore Company.

  (b) The filters from fume cupboard[3] are also to be regularly replaced, and they are also categorized as hazardous wastes. Filters for water purification are considered as general waste.

177. **Liquid hazardous waste.** Lab operation use chemicals, reagents media in the test. After the upgrading, the lab will increase its capacity in analysis and more chemicals will be introduced in the lab operation. The list of chemicals (Appendix 1) show that some of chemicals, reagents medias are VOCs, strong acids, strong alkali, flammable, corrosive, explosive, carcinogenic. These will generate chemical hazardous wastes. Table III-7 shows that the current amount is 90 L/day of chemical hazardous liquid. Of these, 50L/d is reported as Hazard Water Mixed while

[3] Fume cupboard a ventilated enclosure for storing or experimenting with chemicals with harmful vapors, odor, moisture or flammable, explosive and corrosive substances. It is commonly installed in laboratory to protect operator, prevent pollutants from diffusion outside.

the rest are spent lab chemicals such as acetonitrile, methanol, and hexane. In addition, around 20 L/day of biohazardous liquid waste is also generated.

178. On the assumption that these wastes will double, the appropriate treatment scheme will have to be in place. A proposed setup is as follows: the hazard mixed water (100 L/d, assumed to have low concentration of chemicals) is deployed to the wastewater treatment system together with the autoclaved biohazardous liquid waste (40 L/d) and the 16 L/d general liquid waste. This will leave around 80 L/d of chemical wastes (acetonitrile, methanol, etc.) that are highly combustible. Further engineering design will determine if such liquid wastes can be treated by the incinerator on-site given their high heat value or disposed of by a competent third-party government-accredited hazardous waste treater such as Red Cross or the Singapore-based company.

Air Emissions

179. Air emissions from a lab are the fumes from volatile organic compounds (VOCs) such as Methanol, Acetonitrile, Hexane, Ethyl acetate, and Acetic acid used in the tests. These types of tests are processed in fume cupboards/hoods. Another major source of air emission is the flue gas emitted from the stack of incinerator which is installed at west side of the lab building for final disposal of bio-hazardous wastes after being sterilized by autoclaving.

180. According to USA's Investigation and Research on Industrial Pollution Sources, loss of VOCs in laboratory is 1%~4% of raw VOCs used. Considering the worse conditions (4% of VOCs loss), the estimated quantity of waste VOCs gases will be 2.4 L/d (based only on the waste chemicals). These are captured, during processing, in fume hood filters, and the rest through air filters installed for the laboratory chemicals room. Therefore, impacts will not be significant as these are built into the design.

181. Since the NAHPRI Lab building is located in a relatively densely populated urban area and the nearest residential building is less than 10 meters, the fugitive emission of VOCs is likely to be unhealthy to the nearby residents. Proper maintenance of fume hoods and regular replacement of lab room air filters is thus a necessity to ensure adequate removal of contaminants before air leaves the laboratory.

182. The incinerator of this Lab is a multipurpose incinerator from UK by INCINER8 Ltd, one of the largest suppliers of incinerators in the world. It can treat general waste, camp waste, animal by-products, medical waste, plastics & packaging, domestic waste, bandages, and gauzes. But currently its performance is substandard.

Figure IV-1. Key parts of the incinerator used by NAHPRI lab and photo

Source: Asian Development Bank.

183. To control air emission from its stack, the incinerator used by NAHPRI lab is designed such that all exhaust gas must pass through a secondary burner for complete combustion of harmful gas components. Exhaust gases are then retained for a period of time at a high temperature (850 - 1200°C, depending on the application). The incinerator is designed to ensure all 3 conditions for destroying dioxins, furans, and similar gaseous components, namely, minimal 2 seconds at homogeneous high temperature >850°C, and excess of oxygen>6%, are met.

184. However, the incinerator stack is only 3 meter high, much lower than the surrounding buildings which are more than 10 m high. There is a potential risk of accidental emission of very unhealthy pollutants (such as dioxins and furans) from the incinerator stack into the ambient air since the actual operation temperature of the incinerator is lower than the specified temperature (currently around 700 ^{0}C, according to the lab staff) and feedstuff to the incinerator includes chloro-containing plastics. The existing lab operation has nearly 1/3 of biohazardous wastes which are plastics. In addition, other pollutants such as PM10 are likely to be emitted to nearby receptors in view of this low stack height. Air emission standards may not be met.

185. Given the above analysis, and if the current incinerator continues to be used, it is highly recommended that:

(i) Incinerator operators be intensively trained to ensure the incinerator are operated up to its specified temperature, especially when plastic waste are included into stuff to be incinerated.

(ii) The height of stack of incinerator may be increased to 3-5 meters higher than the highest building surround the lab, and the fume cupboard be installed with filter (active carbon as the filter element to absorb VOCs.

Occupational health and safety

186. Veterinary laboratories are hazardous environments. Most hazards fall into three main categories: biological, chemical, and physical. There are biological risks from handling dangerous pathogens, including infectious zoonotic agents (i.e., those that may infect humans), recombinant forms of infectious agents, viral vectors, biologicals introduced into experimental animals and allergens from handling animals. Hazardous chemicals can result in exposure during use, if misused or mishandled, or through inappropriate storage. Appropriate personal protective equipment must be used to protect personnel from exposure to toxic, carcinogenic or otherwise hazardous chemicals. Risks from physical hazards can include ergonomic issues associated with manual tasks, handling sharps, poor housekeeping, ionizing radiation, ultraviolet radiation, fire, high-pressure steam, liquid nitrogen, solid CO2 vessels and animals (bites, kicks, and other trauma to staff). Workers should recognize the potential for burns or cuts while handling or sorting hot sterilized items or sharp instruments and use caution when removing them from autoclaves/sterilizers or from steam lines that service the autoclaves.

187. Segregation of wastes by sorting different wastes into color-coded bins or containers at source has been practiced and will continue being practiced at the NAHPRI lab operation to ensuring different waste streams are handled and disposed of correctly. A particular concern in laboratories is the safe handling of sharps which require special containers. BSC and fume cupboard are installed in the lab for lab test processes generating aerosols or involving the use of VOCs, acid mist and alkali fog to prevent operators from direct exposure to biohazard and chemical hazard materials. NAHPRI has established a quality management system with SOP, protocols, guidelines, that comply with the applicable national H&S legislation. The CLHVCIP in Cambodia will strengthen capacity of NAHPRI in managing health and safety risk.

188. **Noise During lab operation**, will mainly come from lab equipment operation and blowers, that are about 55~85dB (A), at relatively lower level. During lab operation, noise from lab equipment operation and blowers, that are about 55~85dB(A), level of such noise is at relatively lower level at source and will attenuated to the level compliance with Cambodian noise standard when reaching to the nearest social receptor 10 meter from the lab building.

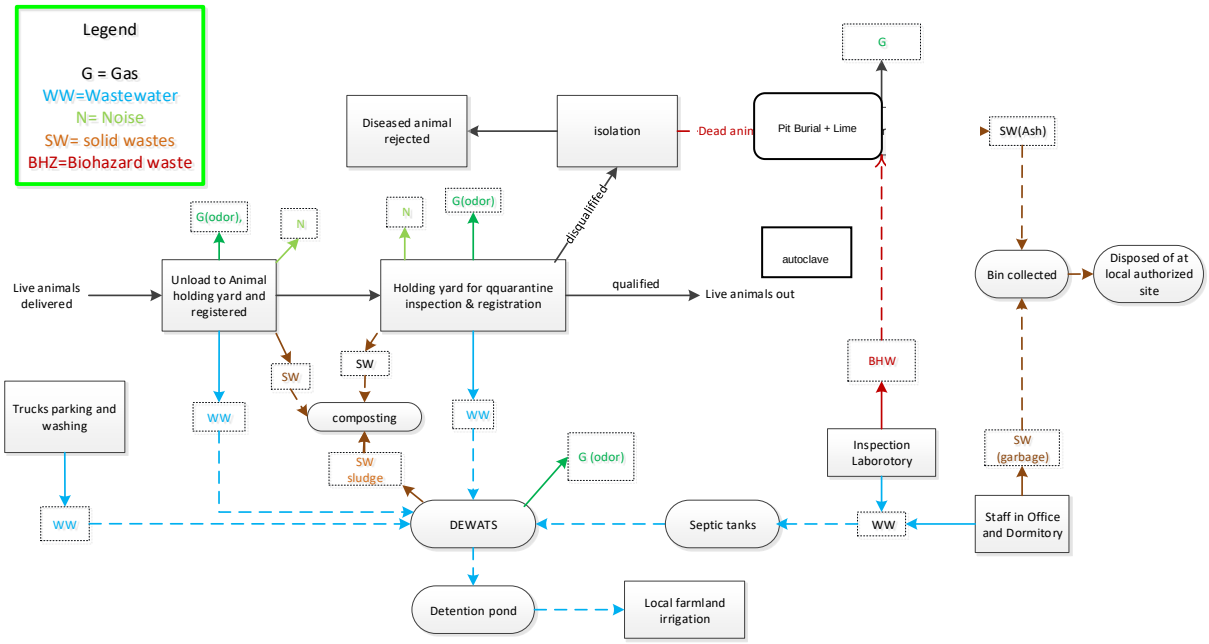
2. Impact of Otdar Meanchey Inspection Center

189. During operation, the inspection station and breeding center have a lot in common since both are essentially livestock holding facilities though different in some functions and holding time. However, their scale varies drastically, as the inspection station can hold up to several thousand animals for different period of time for each batch, whereas the breeding center is several times smaller. Despite the differences, their main environmental impacts come from husbandry part thus very similar, followed by veterinary related wastes and H&S issues.

190. The animal holding yard for animal inspection and registration will generate solid waste (animal waste, staff garbage, sludge from wastewater treatment), wastewater (liquid wastes, animal urine, wastewater from pen and trucks cleaning, and domestic wastewater), air (odor) emissions, and hazardous materials mainly from animal health inspection laboratory.

191. A QC operation flowchart was prepared to identify main pollution sources anticipated during operation of the new QC. The flowchart also includes waste management facilities designed in the subproject feasibility study to show how pollution issues are addressed (Figure IV-2 below). The main pollution course and characteristic are summarized in the figure that follows.

Figure IV-2. Indicative flowchart and identification of pollution sources and pollution control proposed in FS at Inspection Center



Source: Asian Development Bank.

Table IV-5. Pollution Sources and Characteristics of OMIC

Pollution source	Pollution type	Code on flowchart	pollutants	main pollution parameters	pollution treatment in FS
Animal uploading/downloading and holding yard	Air emissions	G1	odor	H_2S, NH_3,	Fugitive emission to the air
	Wastewater	WW1	Animal urine	COD, BOD_5, NH_3-N, TN, TP, SS, total coliform	To DEWATS, then to detention pond for farmland irrigation
		WW1	Cleaning of holding yard		
	Solid waste	SW1	manure	organic material	Dried at sand bed and sold as fertilizer Or composted
	Noise	N1	animal sounds	Leq(A)	
Trucks parking and cleaning	Wastewater	WW2	SS, organics	COD, BOD_5, NH_3-N, TN, TP, SS, total coliform	To DEWATS, then to detention pond for farmland irrigation
	Solid wastes		Animal Manure	organic material	Dried at sand bed and sold as fertilizer or composted
Inspection lab/ Isolation area	Wastes (liquid and solid)	BHW1	Animal health inspection waste	Used rapid detection kits that might be infectious	sterilizing by autoclaving and landfilling
		BHW2	Dead animals	organic material that might be pathogen carrier	Decontaminated disposal by apply lime deeply buried nearby

Pollution source	Pollution type	Code on flowchart	pollutants	main pollution parameters	pollution treatment in FS
	wastewater	WW3	General cleaning	COD, BOD_5, NH_3-N, TN, TP, SS, total coliform	To DEWATS, then to detention pond for farmland irrigation
Office/ Staff dormitory	Wastewater	WW3	Domestic wastewater	COD, BOD_5, SS	To DEWATS, then to detention pond for farmland irrigation
	Solid waste	SW3	Processing waste	general solid waste	Collection bins
DEWATS	Solid waste	SW2	Sludge	Containing organic pollutants, mostly biodegradable	Composted or included in drying of saleable manure

Note: all general solid waste, after being collected in bins will be hauled to local designated community's domestic waste disposal site.

Source: Asian Development Bank.

192. The OMIC will be a temporary holding facility for up to 2000 pigs and 200 cattle on any day for Inspection or directly to slaughterhouse to be unloaded and reloaded. Animals imported from Thailand will be delivered to the station for health inspection and registration. Animals will not be held overnight, nor will they be fed (just watered) during their inspection period. The live pigs and cattle will be delivered by trucks into the OMIC. When entering, trucks will be driven through a sink where truck wheels can be pre-washed. The trucks pass through a roadway to unload pigs and cattle separately into the pig pens and cattle pens designed for holding them separately.

Wastewater amount estimate

193. The FS report provided the estimates for generation of manure and wastewater in the processes, including wet manure that was not collected for drying, urine, pens washdown, and truck washing (Table IV-9). In addition, this IEE prepared an estimate using industry norms. In analogy with similar EIA/IEE and wastewater norms of husbandry in Asia, the following key parameters are used for quantitative estimates:

(i) for holding pig: a norm of daily pig watering of 35L/d is used to estimated water supply, about 60% will be digested and 40% of them become wastewater.

(ii) for holding cattle: a norm of daily water need of 50L/d is used to estimate water supply, 60% will be digested and 40% of them become wastewater.

(iii) Wastewater from pens cleaning: based on NZ dairy industry water use each animal pen of the holding yard (40 m2) will use 600L water (i.e., 15L/m2), holding area for pig is 580 m2, and for cattle is 480 m2 and pens are cleaned once a day for cleaning, 90% of them will become wastewater.

(iv) Wastewater from truck cleaning: in GMS, normally trucks used for cross-border delivery of animals with truck load of 20 cattle ride per truck, 50 pigs ride per truck. The number of trucks for delivery of 2000 pigs and 200 cattle that are to be cleaned on site are estimated to be 50 vehicle/day. A norm of 600 L of water for cleaning such heavy load trucks are use, and 85% of them will become wastewater.

(v) Domestic Wastewater from operation staff: they will be 5 professional staff, accommodated in dormitory, stay overnight during working days. And 10 staff hired locally who will stay in QC only during working hours.

(vi) For professional staff who stay overnight: Norm of water supply of 140 L/day.per

person are used to estimate water demand, and 90% of them will become wastewater; Norms of garbage of 1.0 kg/day.person are used to estimate garbage to be produced by staff.

(vii) For other staff who are not stay overnight: Norm of water supply of 60 L/day.person are used to estimate water demand, and 90 80% of them will become wastewater; Norms of garbage of 0.5 kg/day.person are used to estimate garbage to be produced by staff.

194. At daily processing of 2000 pigs and 200 cattle at the OM Inspection center and respective floor areas of major parts as provided in the pre-FS so far, total wastewater is estimated about 90 M3/day (see details in Table below; for urine and wet manure, see discussion on Solid Waste which follows).

Table IV-6 Water and wastewater Estimate of OMIC

water user		water use estimate				wastewater		
		rate		volume		rate	volume	
		unit		L/d	m^3/a		L/d	m^3/a
animal drinking and watering	Cattle	L/d	50	4167	1300	42%	1750	546
	pigs	L/d	35	29167	9100	42%	12250	3822
pen cleaning	cattle	L/m2	15	7200	2246.	90%	6480	2022
	pigs	L/m2	15	8700	2714.	90%	7830	2443
truck cleaning/disinfection		L/vehicle	600	30000	9360	85%	25500	7956
domestic water	staying overnight	L/d	140	700	218	90%	630	186
	staying at day	L/d	60	600	50	90%	540	43
Lab use		L/d	50	50	16	90%	45	13
Urine and wet manure of animals	All animals						~34,000	
Total				**8 0583.**	**25005**		**90,000**	**17030**

Note: norm/rate are quoted in analogy with similar EIA/IEE for project in Asia. Assume, the OMIC operated 6 day a week, 312 day a year.

Source: Asian Development Bank.

Wastewater characteristic of OMIC

195. Based on data from similar projects involving animal holding and QC function in Southeast Asia, OMIC is expected to have similar wastewater characteristic in terms of major pollutions and their likely concentration, summarized in Table below.

196. OMIC is in a rural area without access to a centralized wastewater treatment plant (WWTP), hence a decentralized wastewater treatment is the choice. DEWATS which includes constructed wetland can have overall removal efficiency for COD and BOD5 of around 90%, according to BORDA Cambodia, summarized in above section on national Lab. The other pollutants, TN, TP, and Total Coliform also need to be addressed to conform to the standards.

197. BORDA Cambodia provided the pre-design estimates based on 55 M3/day wastewater at initial stage of this animal station (much less than full design capacity as described in Chapter 1) using concentrations estimated earlier in this study. The DEWATS will have 3 modules: Settler (2 chambers); Anaerobic Baffled Reactor, (6 chambers); Anaerobic Filter (2 chambers), 32 control manholes (iron cast manhole covers), 2 wetlands (Horizontal Gravel Filter type) and 1 polishing pond.

198. Based on the removal efficiencies provided by BORDA Cambodia, the preliminary design will be able to treat the calculated flowrate of 55 M3/d to meet the applicable standard (Table below).

Table IV-7 Estimated wastewater Treatment for OMIC (preliminary design)

Discharge Standard			**Primary Treatment**		**Secondary Treatment**				**Tertiary Treatment**	
Parameter	Cambodia Standard	OMIC WW	Settler DEWATS		Anaerobic Baffled Reactor Dewats		Anaerobic Filter Dewats		Constructed Wetlands	
			removal	Eff1	Removal	Out	Removal	Out	Removal	Out
COD	<50 mg/l	1006	40%	604	82%	109	61%	42	41%	25
BOD	<30 mg/l	438	42%	254	73%	69	67%	23	43%	13
TSS	<80 mg/L	692	34%	197	68%	63	61%	25	56%	11

Note: Reference for verifying removal efficiencies: Shirish Singh, et al. Performance of an anaerobic baffled reactor and hybrid constructed wetland treating high-strength wastewater in Nepal—A model for DEWATS. ecological engineering 3 5 (2 0 0 9) 654–660.

Source: Asian Development Bank.

199. However, the preliminary flow estimates did not account for the urine and wet manure, which were estimated here as 34 M3/day, thus bringing total flowrate to 90 M3/day. Furthermore, the concentration of the wastewater would significantly increase from the addition of urine and wet manure.

200. A study of livestock industry waste in Malaysia (Livestock Wastewater Generation and Farm Management: The Gap Analysis. Daud and Anijiofojor, March 2017Acta Horticulturae 1152(1):265-272) indicated COD of 2839 mg/L, BOD of 597 mg/L, and TSS of 703 mg/L. These concentrations are considered more representing real situation in DMCs as supported by other sources; therefore, they are used for projection of OMIC wastewater treatment by, the DEWATS.

Table IV-8 DEWATS Design for OMIC (recommended)

Discharge Standard			**Primary Treatment**		**Secondary Treatment**				Tertiary Treatment	
Para-meter	Cambodia Standard	OMIC WW	Settler DEWATS		Anaerobic Baffled Reactor Dewats		Anaerobic Filter Dewats		Constructed Wetlands	
			removal	Eff1	Removal	Out	Removal	Out	Removal	Out
COD	<50 mg/l	2839	40%	1703	82%	307	61%	120	41%	71
BOD	<30 mg/l	597	42%	346	73%	93	67%	31	43%	18
TSS	<80 mg/L	703	34%	464	68%	148	61%	58	56%	25

Source: Asian Development Bank.

201. The DEWATS above can meet the standards for BOD and TSS, but the COD is still above the discharge standard for public water body. It is advised that a retention pond with removal rate of 65% for COD be included as the final stage of the treatment. This will bring final COD to meet applicable discharge standard and further improve BOD and TSS removal.

Solid Waste and its Management.

202. Solid wastes of animal holding are dominated by organic wastes, such as manure, residues of feed and bedding materials, that can be utilized. The Table below shows the estimated manure and urine deposited at the inspection station (FS). These calculations are based on the understanding that animals are processed over 10-12 hr. period daily, are watered but not fed during the inspection period, and will be coming off an extended period in a truck during which they will have voided much of their faeces and urine.

Table IV-9. Estimated manure and urine deposited at OMIC (from FS)

	Cattle	Pig	Total	Units
Number per day	200	2,000		
Kg/head liveweight	300	90		
Manure Production				
% manure production (dry matter) for half day	1.0%	0.75%		
Kg dry matter per head per day	3	0.7		
dry matter percent of manure	20%	20%		
Kg fresh manure/head	15	3.4		
percent manure collected	60%	50%		
60% manure to drying, with strong demand by farmers	1,800	3,375	5,175	kg per day
Wet manure to DEWATS	**1,200**	**3,375**	**4,575**	Kg per day
Urine Production				
Urine production per head	8	1		liters per half day
Production per day	1,600	2,000		Liters /d
Total			**3,600**	liters/day
Washdown water				
Livestock pens liter/head/day	70	10		
Total livestock pens	14,000	20,000	34,000	L/day
Total for truck and livestock raceway areas			10,000	L/day
Total washdown water			**44,000**	
Total domestic WW			**1,148**	
TOTAL FOR OMIC			**53,323**	**L/d**

Source: Asian Development Bank.

203. According to WB/IFC EHS guidelines on livestock production, fresh manure is about 14 kg/pig/day and 27 kg/cattle /day. Using these norms to the number of livestock holdings, the total amount of manure is about 33-34 tons/day (14 kgx2000+ 27kg x 200) at full capacity. Since initially

the OMIC will be operating at about 1/3 of designed capacity, about 10 tons/day manure is expected. Roundly equal amount of urine is generated too by industrial norm, i.e., 10 M3/day urine.

204. The FS provided figures for manure generation based on the typical weights of cattle and pigs in the region, and also considering initially that the OMIC is only for inspection with short holding time and 800 heads which is about one third of its designed capacity. The results of calculations for solid waste generation (Table IV-9) are: 5 t/day to drying, 4.5t/d manure to DEWATs, so the total is similar to 10 t/day. This indicates that FS estimate of solid wastes is on par with that based on EHS guidelines. However, FS under- estimated the urine amount which should be about the same as manure, i.e., 10 M3/day.

205. Moreover, the FS estimate of washing water consumption is higher than the IEE's estimate described earlier and nearly half fresh manure is washed down to DEWATs. These indicates that FS assumed semi-conventional pen cleaning by washing with hose, which use a lot of water thus generating more wastewater. Experience in other developing countries show that conventional pen cleaning consume water 20-25M3/day/1000 pigs (or 20-25L/day/pig). Since part of the manure is washed down, the wastewater is high in organic pollution, harder to treat.

206. Therefore, dry or semi-dry pen cleaning is recommended, i.e., scrapping the manure manually or mechanically combined with washing/spraying of pen floor. It will greatly reduce water consumption and wastewater amount, separate as much as possible the solids from liquid thus lowering pollution level in wastewater, making both easier to treat. These are particularly important considering that in future when the OMIC operates in full capacity and serve as quarantine station. The wastewater and solid wastes generated will be much higher than in the project. Therefore, the IEE estimates are more realistic and used in the following analysis on the wastes management.

207. The Dry Litter Technology (DLT) focuses on beneficial uses of nutrient resources through natural composting processes. DLT incorporates the use of carbon materials, sloping pen floors, and requires no water for pen clean-up. The pig wastes are mixed into the carbon-rich materials and discharged out of the pens by the pigs. Through this process, odor is significantly reduced on the system. The carbon mix is then properly composted, resulting in a rich, organic soil amendment for crop production (Dry Litter Technology - eco-piggeries (weebly.com)).

Table IV-10 Estimated quantity of solid waste of OMIC

Source	designed capacity	initial No.	Unit waste kg/d.head	Waste estimate Ton /d	Waste estimate t/d initially	Planned disposal by FS
Cattle (C) and Pig (p) Manure	C:200 P:2000	800	27/cattle 14 /pig	33	5,175 4575	60% Dried sold as fertilizer 40% to DEWATS
DEWATS sludge					0.033	dried and mixed with manure sold as fertilizer
garbage from staff	5 staff		1			bins collected, hauled outside daily, and disposed of
	10 staff		0.5		0.005	
Lab's bio-hazard waste*					0.001	sterilized by autoclaving and disposed as general waste
Total				**33**	10	4.6t/d manure washed by pen cleaning to DEWATs

Source: Asian Development Bank.

208. As discussed above, solid waste at OMIC will be about 33 tons/day when in full operation, and initially will be 10 t/day under the project. They are mostly the manure, residue feed and bedding materials collected and subsequently dried and sold as fertilizer. Sand dry or composting is proposed in the pre-FS for the wastes predominantly manure. The small amount of biohazardous waste is autoclaved and disposed as general waste.

209. As the project will initially operate at 1/3 capacity, the design of sand drying bed may be for 10 t/day, however, the future capacity of 33 tons/day should be planned at this point. This includes space allocation and detailed design plans.

210. **Animals that die during transport, and sick or dead animals** from quarantine pens, should be separated and transported to external facilities in separate containers for treatment and final disposal. Depending on the risk classification of the animal, including the nature of the disease suspected, typical disposal procedures for sick or dead animals include the following:

211. Dead carcass will be managed through burial with lime disinfection. A designated pit with lining will be provided. Carcasses can be disposed of by pit burial in a lined (clay or concrete non-permeable material) site location. Surface runoff should be prevented from entering the pit by the construction of diversion banks. Similar banks should be constructed to prevent any liquids escaping from the burial site. Lime (calcium oxide) has been used for centuries in agriculture as a disinfectant and in burial pits to increase the rate of decomposition of carcasses. It is now known that the disinfectant properties of lime are due to its ability to raise the pH to 10. The procedures for burial will be included in the EMP.

Assessment of Odor and its Control.

212. The main odor from OMIC is primarily during denitrification of manure in the bull pens and sand drying bed. Norms of heavy cattle manure emitting H2S (0.04g/day/cattle), NH3 (0.4g/day/cattle) are used. Since odor is mainly comprised of H2S and NH3, their discharge at sources is estimated first, using the norms. Norms of odor gas emission are: H_2S of 0.3 g/d/pig and 0.04 g/day/cattle. NH_3 is 1.1 g/d/pig and 0.4 g/day/cattle. The results are calculated and summarized below.

Table IV-11. Estimated odor emission from OMIC

odor sources	H_2S			NH_3		
	g/d.head	g/d	kg/a	g/d.head	g/d	kg/a
cattle pen[a]	0.04	3.33	1.04	0.40	33.33	10.40
pigs pan[b]	0.3	250	78	1.1	917	286
DEWATS[c]		2.69	0.84		69.47	21.7
Total		256.02	79.88		1019.47	318.07

[a] norm for cattle: reference is made to the norm used in NCBC

[b] norm for pig: reference is made to research on quantitative analysis of impact of odor from pig farm and countermeasure

[c] USA EPA research on municipal WWTP: treat 1 g of BOD5 generate.

Source: Asian Development Bank.

213. To assess the potential impact of odor (namely, H2S and NH3 discharged) to the environmental receptors (mainly the nearest village), AERSCREEN was used to predict the impact of representative NH_3 and H_2S odor substance from the bull pens and sand drying bed as fugitive emission on ambient air quality. The model includes such input parameter of climate,

geographic coordination of odor emitting place, types and height of emission source. Takeo climate parameters, such as tropic humid weather with maximum temperature of 37.5^{0}C, minimum temperature 21.2^{0}C, rural farmland use type and other parameters illustrated in Table IV-12 below. As the result of modelling, incremental NH_3 and H_2S concentration at the distance downwind of the NCBC is listed in Table IV-13 below. This result indicated that at 47 m away from the holding yard and the DEWATS at the downwind direction, NH_3 and H_2S reaches to their maximum incremental, 21.5880µg/m^3 and 0.7941µg/m^3 respectively, and the increments will then become gradually smaller afterward.

Table IV-12. Parameters used to assess odor fugitive from OMIC on ambient air

Pollution place	Geographic coordination (°C)		Elevation (m)	Emission type: rectangular fugitive source			Pollutant emission rate[a] (kg/h)	
	longitude	latitude		Length (m)	Width (m)	Height (m)	H_2S	NH_3
Holding yard and DEWATS sludge	103.665945	14.312522	0.00	400.00	250.00	3.00	0.0107	0.0425

[a] Based on the estimated quantity illustrated on Table IV-22.

Source: Asian Development Bank.

Table IV-13. Incremental NH_3 and H_2S concentration due to contribution of OMIC at distance downwind the holding yard and DEWATS

Distance at downwind direction (m)	Rectangle fugitive emission source		
	Concentration of NH3 (µg/m³)	Concentration of H2S (µg/m³)	remark
1	1.6029	0.0954	
25	3.0373	0.1808	
47	3.5499	0.2113	Maximus concentration
50	3.5388	0.2106	
100	2.8619	0.1704	The staff dormitory
150	2.514	0.1496	
200	2.1691	0.1291	
250	1.8865	0.1123	
300	1.6732	0.0996	
350	1.497	0.0891	
400	1.3475	0.0802	
450	1.2214	0.0727	
500	1.1144	0.0663	
550	1.0284	0.0612	
600	0.9713	0.0578	
650	0.9193	0.0547	
700	0.8719	0.0519	
750	0.8279	0.0493	
800	0.7978	0.0475	

Distance at downwind direction (m)	Rectangle fugitive emission source		
	Concentration of NH3 (μg/m³)	Concentration of H2S (μg/m³)	remark
850	0.7601	0.0452	
900	0.7258	0.0432	
950	0.6941	0.0413	
1000	0.6666	0.0397	Nearest house in Samrong Senchey-1 village (southeast to the OMIC site
1050	0.6419	0.0382	
1100	0.6186	0.0368	
1150	0.5968	0.0355	
1200	0.5771	0.0344	
1250	0.5584	0.0332	
1300	0.5413	0.0322	
1350	0.5253	0.0313	
1400	0.5101	0.0304	
1450	0.4956	0.0295	
1500	0.4819	0.0287	
1550	0.4687	0.0279	
1600	0.4562	0.0272	
1650	0.4442	0.0264	
1700	0.4328	0.0258	
1750	0.4219	0.0251	
1800	0.4114	0.0245	
1850	0.4014	0.0239	
1900	0.3918	0.0233	
1950	0.3826	0.0228	
2000	0.3738	0.0222	Koun Kriel village (west to the OMIC site)
2050	0.3653	0.0217	
2100	0.3571	0.0213	
2150	0.3493	0.0208	
2200	0.3417	0.0203	
2250	0.3345	0.0199	
2300	0.3275	0.0195	
2350	0.3207	0.0191	
2400	0.3142	0.0187	
2500	0.3019	0.018	

Source: Asian Development Bank.

214. As described in section 3.7.4, Samrong Senchey-1 Village (about 1000 m away from the OMIC site), is in the AoI of the scope of ambient air impact assessment of OMIC subproject.

Beyond the scope of air impact assessment of OMIC subproject, there is a Koun Kriel village located at the west side (on the other side of National Road N0.66). In addition, the OMIC will establish a dormitory area at the south of the holding yard (about 100 m from the odor emitting source) for staff. The Samrong Senchey-1 Village and staff dormitory areas are regarded as the 2 points environmental concern. As there has been no livestock farm near the OMIC site (in contrary with NCBC where there are a dairy farm and zoological park but monitoring of odor pollutant of NH_3 and H_2S results showed not detected**)**. Assume that the baseline of odor pollutant of NH_3 and H_2S are zero, the projected NH_3 and H_2S concentration at the points of environmental concern are summarized in Table IV-14 below.

Table IV-14. Projection of the impact of odor emission on points of environmental concern of OMIC subproject

Pollution source	Staff dormitory area Inside the OMIC			The nearest village Samrong Senchey-1 Village		
	Distance to the source (m)	Odor pollutants concentration		Distance to the source (m)	Odor pollutants concentration	
		NH_3 (µg/m³)	H_2S (µg/m³)		NH_3 (µg/m³)	H_2S (µg/m³)
Increments contributed by NCBC operation	100	2.8619	0.1704	1000	0.3738	0.0222
Baseline		NV	NV		NV	NV
Additive value		~2.8619	~0.1704		~0.3738	~0.0222

Source: Asian Development Bank.

215. The degree of odor in the air can generally be used to judge the degree of influence by olfactory method. When the concentration odor substance in air is below the olfactory threshold, one will not feel odor, when the concentration odor substance in air reaches to the olfactory threshold, one will feel the odor, the stronger the concentration odor substance in air, the stronger one will feel. Relation between NH_3 and H_2S odor substances concentrations in air with olfactory intensity is shown in Table IV-15 below.

Table IV-15. NH_3 and H_2S concentrations in air and olfactory intensity

Olfactory intensity		1	2	2.5	3	3.5	4	5
NH_3	(mg/m³)	0.0758	0.455	0.758	1.516	3.79	7.58	30.32
	(ug/m³)	75.8	455	758	1,616	3790	7,580	3,0320
H_2S	(mg/m³)	0.0008	0.0091	0.0304	0.0911	0.3036	1.0626	12.144
	(ug/m³)	0.8	9.1	30.4	91.1	303.6	1,062.6	12,114

Source: Asian Development Bank.

216. Compared with olfactory intensity table, the additive concentrations of NH_3 and H_2S at the staff dormitory area will be about 2.8619 µg/m³ and 0.1704 µg/m³ respectively, at Samrong Senchey-1 Village will be about 0.3738 µg/m³, and about 0.0222 µg/m³ respectively, which are all below Olfactory intensity 1. This projection implies that the of odor emission from OMIC operation is minor, both the staff dormitory area inside the OMIC and Samrong Senchey-1, the nearest Village to the OMIC will hardly feel odor.

3. Impact of Cattle Breeding Center

217. The breeding center has a lot of characteristics in common with inspection station but 200 times smaller. Therefore, its adverse impacts are similar to those of the latter but much smaller in magnitude. During operation of breeding center, the bull holding area will generate solid waste (including animal waste), wastewater, air emissions/odor, and hazardous (including biohazardous) wastes. Improper and inadequate management of these waste streams may lead to contamination of environment together with potential regulatory noncompliance.

218. The indicative flowchart below shows the processes, input, output, and pollution for each major step of the breeding facility and associated liquid N2 generator. It also includes proposed waste management facilities, such as DEWATS for treating wastewater, and sand bed for manure collection & dry. The main pollution streams and characteristic is summarized in the Table below.

Table IV-16. Pollution Sources and Pollution Characteristics of NCBC operation

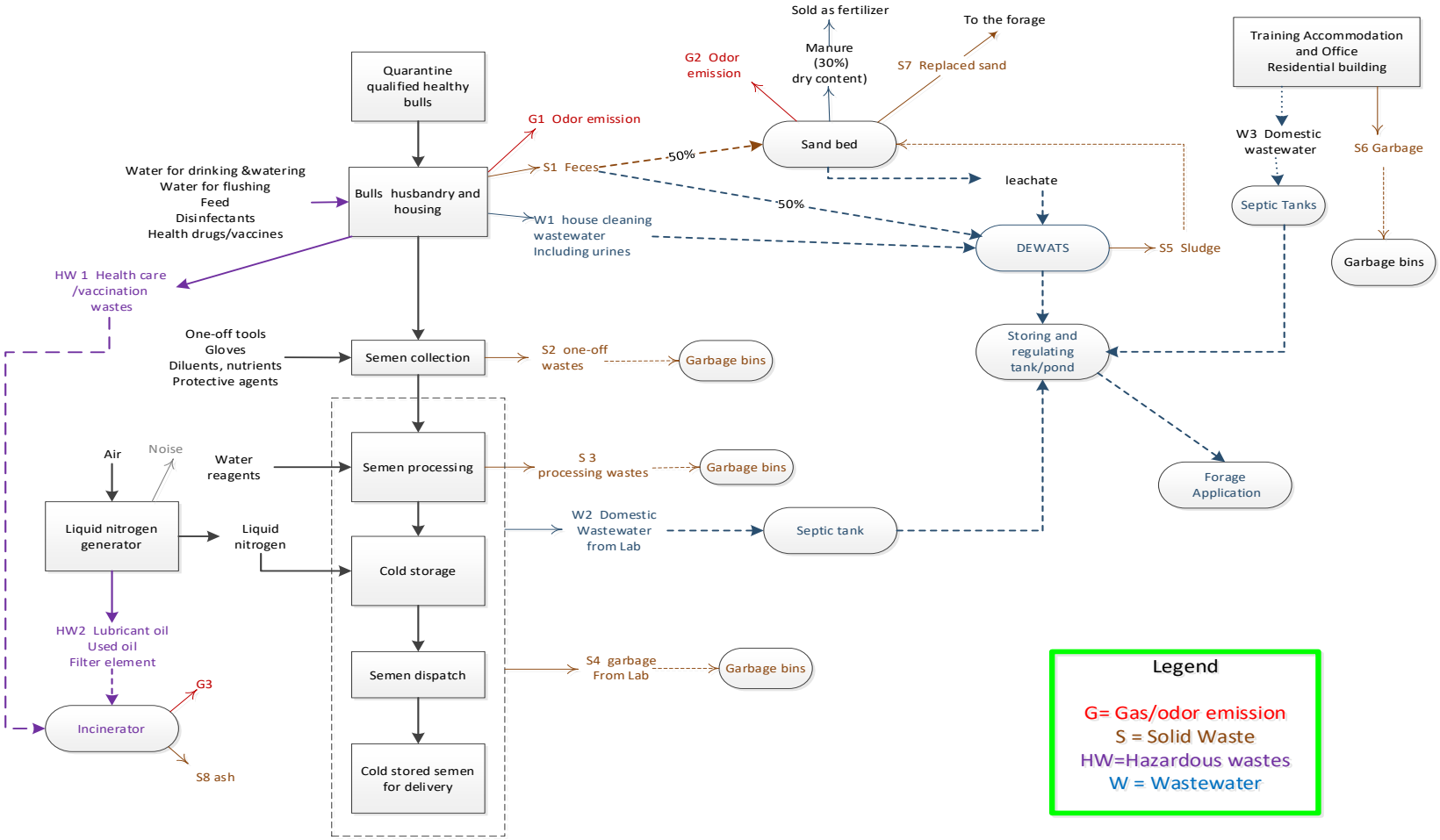
Place of source	Code on flowchart	Pollution or sources	main pollution parameters	Where pollution goes
Bulls house	G1	odor	H_2S, NH_3,	Fugitive emission to the air
	W1	urine	COD, BOD_5, NH_3-N, TN, TP, SS, total coliform	To DEWATS, stored in temporal pond, then to forage land
	W1	floor wash water		
	S1	faeces	organic material	Dried at sand bed and sold as fertilizer
	HW1	hazardous waste	Bottles for vaccine and disinfectant, Needles and other sharps	sterilizing by autoclaving and disposed as general solid waste Accredited treater for sharps
	HW1	dead cattle	organic material that might be pathogen carrier	Decontaminated disposal by apply lime deeply buried nearby
Sand bed	G2	odor	H_2S, NH_3	Fugitive emission to the air
	W4	leachate	COD, BOD_5, NH_3-N, TN, TP, coliform	To DEWATS, stored in temporal pond, then to forage land
	S7	Replaced sand	organic pollutants, mostly biodegradable	To the forage land
Semen Lab	W2	purification, vessels cleaning & disinfection	COD, BOD_5, SS	To septic tanks, then DEWATS, stored in temporal pond, then to forage land
	S2	one-off wastes	general solid waste	Collection color-coded bins
	S3	Processing waste	general solid waste	Collection color-coded bins
	S4	garbage	general solid waste	Collection bins
Liquid nitrogen generator		Machines	Leq（A）	Gradually attenuated
	HW2	Lubricant, Used oil Filter	Hazardous waste from liquid nitrogen generator	incinerated on-site or disposed to accredited hazardous waste treater
DEWATS	S5	Sludge	Containing organic pollutants, mostly biodegradable	To sand bed
Staff building and AI training	W3	Domestic water	COD, BOD_5, NH_3-N, TN, TP, SS, total coliform	septic tank- DEWATS, --stored in temporal pond-- forage land

Place of source	Code on flowchart	Pollution or sources	main pollution parameters	Where pollution goes
facility	S6	Household garbage	general solid waste	Collection bins then to waste collector
Incinerator	G3		H2S, NOx, TSP, Dioxins, heavy metals	Emission through stack to the air
	S8	ash	general solid waste	Collection tanks

Note: all domestic solid waste will be hauled to local designated community's domestic waste disposal site.

Source: Asian Development Bank.

Figure IV-3. Indicative flowchart and identification of pollution sources at NCBC



Source: Asian Development Bank.

Wastewater Quantitative Estimate

219. The planned NCBC is a small-scale infrastructure, and its operation is anticipated to generate wastewater as illustrated in the flowchart and the quantity of these sources are related to the number of bulls, the staff/trainees present, and semen processing lab activities. Quantification of the main pollution sources are based on following key variables and operation practice provided by the feasibility studies:

220. **The bull housing and health care**. The maximum stock of the bull housing is 16 bulls in bullpens with an exercise yard, regularly health cared and vaccinated. The bulls' diet annually will be approximately: Fresh cut & carry forages (55% grasses and forages from forage area on the ABC farm site (subject availability and energy quality), hay (30%), ground concentrate feeds (12%) and molasses mineral blocks (3%).

221. A groundwater supply pump will supply bull pens for drinking and watering, total about 700 L/day (50 L/day/head estimated in the FS); Harvesting of rainwater from the roof of the bull shed (1,120 m2) into two 10,000-liter storage tanks will be used for bull pen daily cleaning and misting fans for cooling of the animals. Both will need water total about 3800 L/ day at maximal (271 L/day/head).

222. **Semen Lab operation.** The feasibility study estimated that 750 L/d of water is required for lab use only. This will be supplied by tap water of the town. Normal hot water washing process will occur for all Lab use clothes e.g., lab Coats, hats, reusable PPL gear.

223. **Residential and training facilities** are designed to accommodate 4 staff families (3 people per household including the ABC working staff member), another 11 staff will stay in NCBC only during working hours. residential buildings and AI training courses will be run for up to 10 trainees at a time and run for 7-10 days. Industrial norms and pollution coefficients cited in the table below are from New Zealand and People's Republic of China in the cattle breeding sector.

Analysis of Wastewater and its Treatment

224. Based on data from similar project in Southeast Asia, the new breeding center is expected to have wastewater characteristics similar to OMIC. DEWATS was proposed to treat its wastewater. Since the discharge in the NCBC site will also be to a public water body, the same setup as that of OMIC will be designed, but the design volumetric flow will only be 9 M3/day as estimated above.

225. Given the volume flow and wastewater concentration estimated for the breeding center and using the DEWATS configuration as recommended, the proposed wastewater treatment setup can treat BOD and COD etc to meet discharge standard.

226. The final effluent from the wastewater treatment will be used for irrigation within the site. The NCBC area has groundwater resources that are used currently by some farmers. As precaution, as recommended bu this IEE, the design of infrastructure has included lining of ground with impermeable layer at facilities such as bull bens, manure drying bed, DEWATS facility, and retention pond.

Table IV-17. Water Balance and wastewater projection for NCBC

water user	Purpose	water supply demand						wastewater			
		rate		No. of bull or person	volume			rate	volume		
		unit			l/d	d/y	m^3/a		l/d	d/y	m^3/a
bull	drinking & watering	l/d.head	50	16	800	365	292	42%	336	365	123
bull housing	watering and washing	l/d.head	271	16	4340	365	1585	90%	3910	365	1424
sand bed									180	365	66
Urine	**Almost same amount as manure of cattle**	**L/d/head**	26	16					420	365	153
semen Lab	Lab use clothes washing & disinfection	l/d	150		150	260	39	90%	135	260	35
	water for lab reagent preparation and vessels cleaning	l/d	750		750	260	195	30%	225	260	58
office, residential,	domestic water supply (staying overnight)	l/d.person	120	24	2880	365	1051	90%	2600	365	946
	domestic water supply (staying working hours)	l/d.person	40	11	440	260	114	90%	396	260	103
training	domestic water supply	l/d.person	40	10	400	100	40	90%	360	70	25
Total					**9,756**		**3,314**		**8,546**		**2,934**

Notes:
1. Leachate from sand bed:12.75 L/d. head, calculated by 30% of half fresh manure (41.25 L/d. head, 80% moisture, collected and dried at sand bed (estimated by FSR), 20% of moisture evaporated.
2. Lab use clothes are washed once a day in automatic washing machine, each operation use 120 L/d, plus 30 L/d for disinfection.

Source: Asian Development Bank.

Solid wastes and its management

227. Based on industrial norms, data from the FS, and similar projects, major solid wastes from the new breeding center are predicted and quantified in Table IV-18 below. The solid wastes are dominated by manure and other organics that can be utilized.

Table IV-18. Estimated solid wastes for NCBC operation

Sources of solid wastes	rate	no. of bull or person	quantify			ways of disposal proposed by FS
	kg/d / head		kg/d	d/y	t/a	
Bull fresh manure to dryer	28	16	450	365	164	sand dried, sold as fertilizer
Dried Bull manure			137		50	
garbage from lab, residential	1	19	19	365	7	on-site collected by bins, hauled to local official designated disposal site
garbage from training	1	10	10	70	0.7	
DEWATS sludge			1	365	0.36	sand dried, sold together with manure as fertilizer
replace sand			40		15	Applied into forage land
TOTAL			606		233	

Source: Asian Development Bank.

228. The subproject feasibility study expected that about 50% of the manure (estimated to be 450 kg/d fresh manure) will be collected, dried and sold. The subproject will construct a concrete floored shed with clear plastic roofing beside the DEWATS for manure drying. The shed will have a sand layer on which the manure is dried. When the DEWATS needs to be de-sludged, that will be pumped onto the sand drying bed, with any liquid flowing through a drain back to the DEWATS. Sand in the sand bed in the socializing pens is regularly cleaned (twice a year or more regularly if required). The replaced sand will contain some nutrient and be applied into the forage land.

229. Other general waste, like packing material, together with domestic solid waste (estimated to be less than 20 kg/d) will be collected by bins on-site and hauled to local official designated disposal site.

230. Waste from the bull health care, vaccination and semen process will have small quantity of bio-hazardous waste. This waste will be sterilized by autoclaving and disposed as general waste. Other hazardous wastes such as that from Liquid nitrogen generator (i.e., filter to purify air, used oil from O&M) shall be disposed through accredited hazardous waste treaters.

Odor Emission and its Management

231. Like OMIC, the NCBC will emit odors that may potentially impact the surrounding communities. Given that the NCBC houses only 16 bulls in a rural area, odor emissions are expected to be smaller compared to OMIC.

232. The main odor from NCBC is primarily during denitrification of manure in the bull pens and sand drying bed. Norms of heavy cattle manure emitting H2S (0.04g/day/cattle), NH3 (0.4g/day/cattle) are used. It is estimated that 0.23 kg/a of H2S and 2.34 kg/a of NH3 are to be emitted from bull pens. At the sand drying bed, half of manure (240 kg/d) will be collected. Referring to EHS guidelines on livestock production and other research papers, nitrogen, and

sulfur content in manure content of heavy cattle are 0.57% and 0.02% respectively, and 5% of them will be released as H2S, and NH3 respectively. The result of estimates is in the table below.

Table IV-19. Estimate of odor for NCBC operation

emitting sources	H_2S			NH_3		
	g/d/head	kg/a	kg/hr.	g/d/head	kg/a	Kg/hr.
bull pens	0.04	0.23		0.40	2.34	
sand bed		0.15		0.48	4.36	
Total		0.38	0.00005		7.70	0.00084

Source: Asian Development Bank.

233. The modeling results for OMIC showed that odor threshold was not exceeded for H2S and NH3 concentrations higher than that in the table here. As described in Chapter III, the two communities Phan Neum and Toul Kreu are around 2 km from the project site, which is even farther compared to the distance between OMIC and its nearest community 1 km). This implies that the odor emission from NCBC operation is minor, both for the residential & dormitory area inside the NCBC.

4. Impact of vaccine production

234. NVVC will produce vaccines for maintenance of animal health, including both bacteria and virus based. The planned vaccine production includes three products described in Chapter 1-National Veterinary Vaccine Center. Anticipated impacts during operations are also those related to the generation of wastes and occupational hazards.

235. The animal vaccine production involves physical, biological, and chemical processes as bacteria/virus working seeds preparation, culture media preparation, inoculation, fermentation (for bacteria-based), inactivation, vaccine purification, adjuvant preparation, dispensing and emulsification, vaccine filling and capping, freeze dry, storage and cooling, packaging and dispatch, and series sampling and test by animals etc for in-process and quality controls to ensure vaccine purity, safety, and potency.

236. Therefore, understanding the production processes and the major input, output and throughput /byproducts is essential to identify the pollution and EHS issues for each key step, paving the way for quantification, prevention and mitigation. Utilities, such as water purification, heating-ventilation air conditioning (HVAC) air control system, air compressor, will also generate waste gases, solid waste, wastewater, and noise.

Major vaccine production processes

237. The veterinary vaccine production normally begins with master seed/working seed and culture preparation. Master seeds are imported from which they prepare working seed. As shown in the flowchart, there are various culture media, commonly used including amino acid, eggs, milk, glycerol, sugar etc. The culture media can be prepared from 1) dehydrated ingredients purchased and formulated on site or 2) produced on site from locally available materials. It also is determined by type of vaccine, especially two major type, viral and bacterial vaccines.

238. **For bacterial vaccines,** currently the media used at VVPC in Lao PDR include mainly peptone, glucose and other protein dry powders purchased. They formulated the media on site

by adding distilled water and other appropriate material for culture, using a proteolytic enzyme (usually trypsin) either by itself or in combination with a chelating agent such as ethylenediamine tetra-acetic acid (EDTA) and thus diluted into a suitable growth medium.

239. The culture preparation will mainly generate wastewater: 1) from cleaning the containers and reactors, high in volume but low in concentration; 2) failed media preparation which is infrequent according to VPPC in Lao PDR which however has 40 years of experience, thus low in volume but high in organics thus high BOD. However, for NVVC in Cambodia, initial years can expect more failure in media preparation thus more wastewater than VVPC's data. There are also small amounts of solid wastes largely organic and non-hazardous.

240. The main production takes place in a fermenter, a stainless-steel vessel of 200L in volume, though planned production is 50-100L/batch depending on the order. The fermenter is cleaned by distilled water and sterilized by boiling water inside or injecting steam. Then the cultural media is poured in and injected with working seeds. Fermentation usually takes a few hours or days depending on the vaccine's varieties, and its progress is tested regularly mainly by microscopic until completion. Formalin is then added to inactivate the fermentation. The products are harvested and tested for quality control (QC).

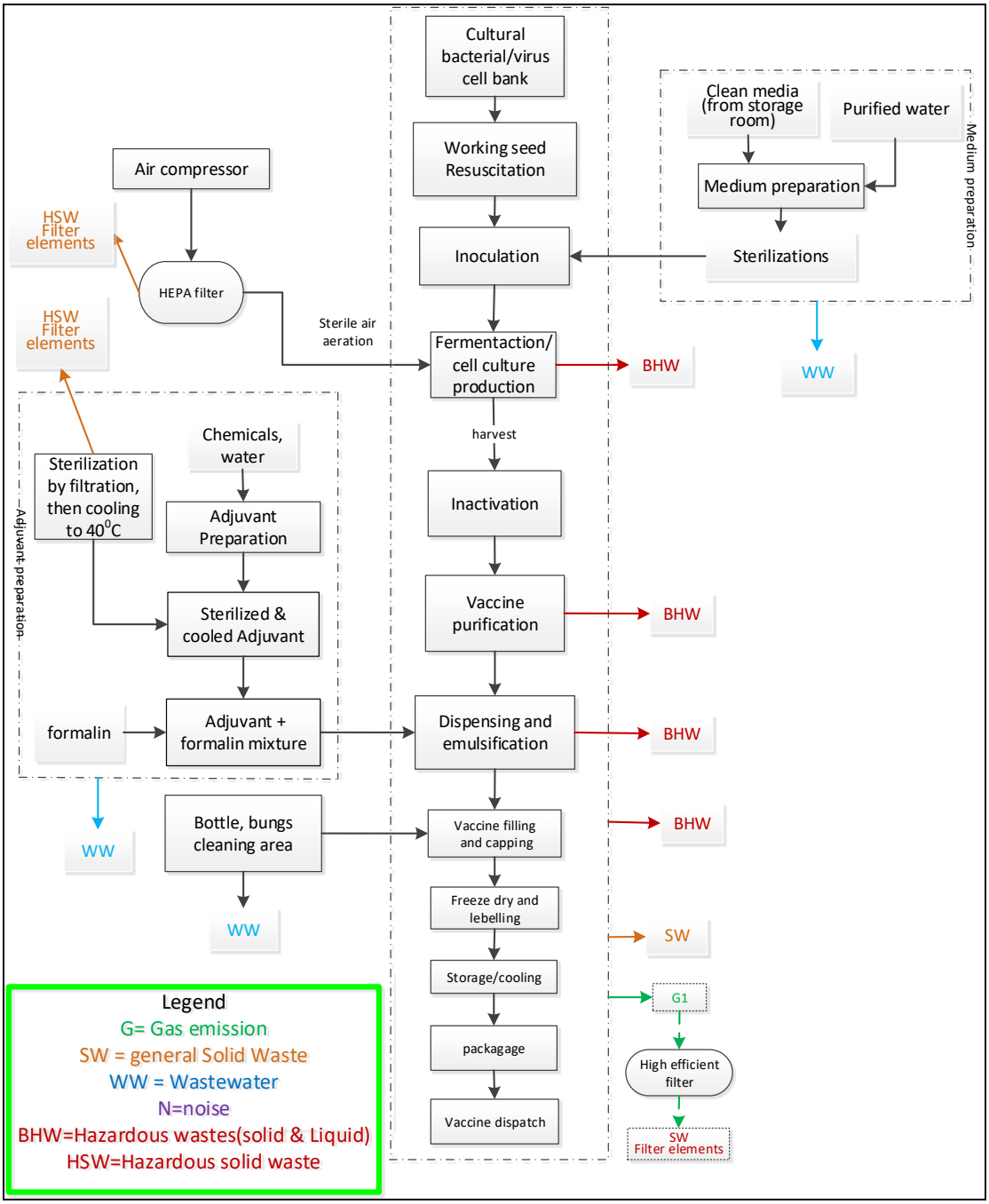
241. QC tests include: (1) Safety; (2) potency of vaccines, both by injecting into live animals and observing for about a month; and (3) purity or contamination of vaccines, usually by microscopic and biochemical tests.

242. **For viral vaccine production**, following resuscitation, the working seed is inoculated into the culture media to grow. The media used for viral vaccines is fertilized eggs (for poultry vaccines) or living rabbits (for ruminant vaccines). After growth in incubators for a period of 7-10 days and checked daily, the vaccine is harvested by breaking the eggs and collecting the liquid, with addition of a solvent made from skim milk powder that protects the vaccine potency. The embryos are then discarded after sterilization by autoclave. The adjuvants are added to viral vaccines into the egg liquid, with diluents used to obtain the required concentration, then bottled in 1ml dose containers, tapped into a final product vessel, and stored in -17 C degrees. The adjuvant mostly used is an aluminum gel, rather than oil-based adjuvants (which are costlier, more challenging to handle, although enable a longer shelf-life and in some circumstances, greater immune protection). The residuals or spillover of these steps becomes wastewater which is apathogenic.

243. After post-harvest steps, the vessels are cleaned and washed for the next batch and sterilized to prevent cross-contamination. This cleaning generates wastewater containing biohazards, e.g., live attenuated virus or killed bacterial remnants derived from the seeds. The vessels must be disinfected by injecting hot steam.

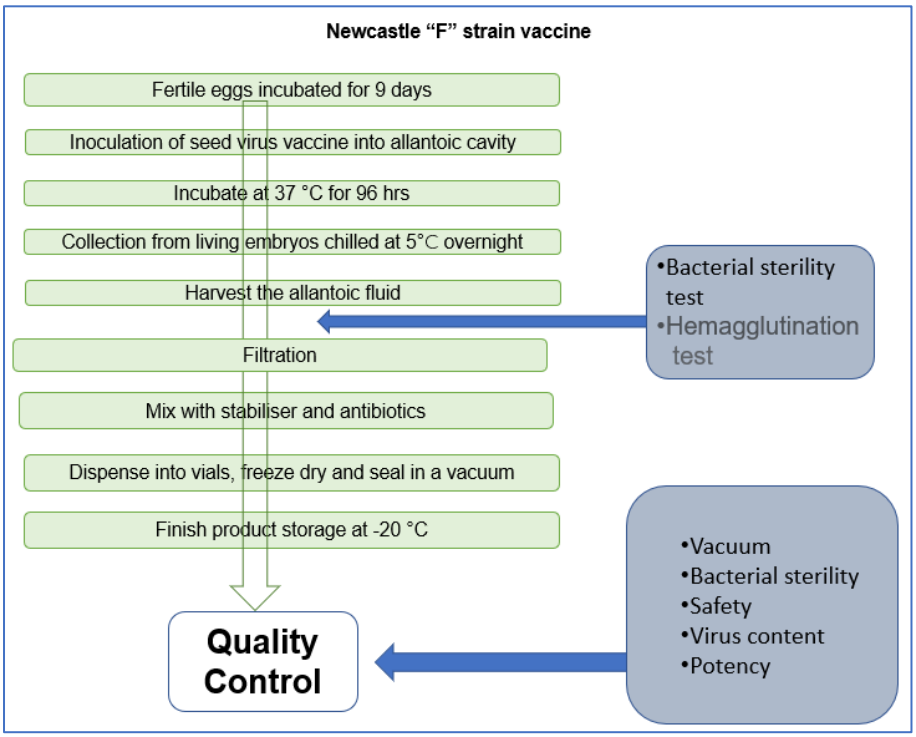
244. Initially, three vaccines production at NVVC will adopt the very similar technical processes as the VVPC in Lao PDR described above, which is depicted in indicative flowchart of main steps for bacterial and viral vaccines production (Figures below) including pollutant generating streams.

Figure IV-4. Indicative flowchart of Bacterial vaccine production units



Source: Asian Development Bank.

Figure IV-5 Flowchart for Viral vaccine production process



Source: Asian Development Bank.

Wastewater from vaccine production

245. The steps above all require de-contamination by cleaning of production vessels (by acid and alkali and purified water) and sterilization by steam before further production. This requires hot water, alkaline detergents and generates wastewater of moderate volume and high pH to ensure sterility of organic matter. Representative samples of all batches of culture media are subjected to a period of incubation at 37°C for not less than 21 days to check on the efficacy of sterilization (FAO's vaccine production manual).

246. The resuscitation of vaccine seeds (live attenuated or killed viral and bacterial vaccines) requires careful control of environmental conditions (pH, temperature etc). For the failed batches which can be frequent, expected during initial years of NVVC, the wasted liquid contains vaccine seed materials and thus infectious. It is sterilized to avoid release of the pathogen into the environment. As the vaccines used are attenuated strains or killed pathogens, there is minimal OH&S threat. At VPPC (Lao PDR) after 40 years of experience and process control at each step, failed batches are less frequent. Using steam or heating of waste liquid in the reactors to boiling point sterilizes the material prior discharge as general wastewater.

247. For laboratory wastewater treatment, the cleaning of all chemical and biological instruments and vessels used in the production units is to be achieved by hot water and/or ultraviolet light sterilization. This will then be piped into a newly installed septic tank system that is adequately sized for future production capability. Laboratory chemical and biological waste will be processed through a biofilm tank that includes anaerobic and air-infused aerobic filters and chlorination of the wastewater before discharge.

248. **To determine the volume of various streams of wastewater**, the existing operations of the LAO VPPC is used as basis for estimation by extrapolation and analogy. Currently, LAO VVPC uses tap water and is metered at 13 m3/day average at its production rate of 8 M doses of vaccine. Among this, 8 m3/day is for production and 5 m3/day for non-production, e.g., toilets and general cleaning etc. Water goes into vaccines is small, around 50 L/d average, given usually 1mL/dose for most vaccines. Deducting spillage, leakage and evaporation, wastewater, 90-95% of water used becomes wastewater that can be collected for facilities like this with most activities indoor. The IEE used 90 % to estimate NVVC wastewater for treatment.

249. Projecting this 8 m3/d to the CAM vaccine rate of 23 M doses by 2028, the estimated water need is 23 m3/day. Considering the moderate difference between different vaccines production and less experience for a new production center thus more frequent failure, total water use for production after considering a design margin of 1.1 is about 27 m3/day maximum. Wastewater generated would then be 25 m3/day (90% of water use). This is the recommended design capacity of treatment system for production wastewater.

250. **For the concentration of production wastewater**, A sampling of raw effluent of VPPC in Lao PDR December 2021 and April 2022 are used given limited data in literature survey. The results showed the following for major pollutants high concentrations of BOD and COD were detected. The averages are used as proxy for likely future discharge concentrations of NVVC's production wastewater.

Table IV-20. Effluent concentration of LAO VVC

Parameter	Unit	Standard Limit[a]	Analytical Result	
			(Dec 2021)	(4Apr2022)
Ammonia	mg/L	4	Not detected	
Biochemical oxygen demand (BOD)	mg/L	40	4,000	3,690
Chemical oxygen demand (COD)	mg/L	130	8,646	5,436
pH	-	6-9.5	14	3.02
Total suspended solids (TSS)	mg/L	40	2,557	148

[a] Lao PDR Wastewater Discharge Standard (in Public Area).

Source: Asian Development Bank.

251. Key production steps above all require de-contamination of reactors and vessels by cleaning with acid and alkali and purified water etc., and sterilization by pure steam before the next step of production. This might explain VPPC in Lao PDR has extreme pH values for current effluent, strongly acidic or alkali. These wastewaters can be high in volume and chemicals and should be neutralized (e.g., by mixing) before discharging. Following sterilization by autoclaving or boiling water or injecting steam, a representative sample of all batches of culture media are subjected to a period of incubation at 37°C for not less than 21 days as a check on the efficacy of sterilization, according to FAO's vaccine production manual.

252. For wastewater treatment, the FS proposed a DEWATS design consisting of a settler/septic tank, anaerobic baffled reactor, anaerobic filter, vertical constructed wetlands, and a retention pond may be able to treat the effluent to meet CAM standard for discharge to a public water body.

Table IV-21. Decentralized wastewater treatment setup for NVVC

Discharge Standard		Primary Treatment		Secondary Treatment (DEWATS)					Tertiary Treatment			
Parameter	Cambodia Standard	Settler		Anaerobic Baffled Reactor		Anaerobic Filter			Constructed Wetland		Retention pond	
		In (mg/L)	removal	In	Removal	Out	Removal	Out	Removal	Out	Removal	Out
COD	<50 mg/l	7040.5	42%	4083	86%	572	62%	217	47%	115	65%	40
BOD	<30 mg/l	3845.0	42%	2230	87%	290	67%	96	50%	48	75%	12

Source: Asian Development Bank.

253. However, the DEWATS design by BORDA may not always be the best solution and hence, other wastewater treatment systems should be considered, if the capacity requirement is met, and the effluent standards are satisfied. As stated earlier, DEWATS provides ease of O&M and low requirements for operational skills.

Solid and hazardous wastes from production

254. Solid wastes streams from vaccine production include:

(i) **Biohazardous waste** (solid and liquid) can be generated throughout the production process (such as waste processing (unwanted) liquid, one-off consumable like gloves and swabs, cleaning of bioreactors that are in direct contact with pathogenic microorganism.

(ii) **Hazardous waste** (filter elements Sterilization by filtration, filter elements of the HEPA installed on the heating ventilation air conditioning system of vaccine GMP production unit, the BSC of the QC unit and the air compressor.
General solid waste, such as garbage from staff, filter element installed on HVAC system, material warehouse, sludge from the on-site wastewater treatment station. Garbage from staff and other packaging wastes are typically handled by municipality.

255. Test animals are indispensable for QC of vaccine production and testing**. T**he VVPC in Lao PDR has mainly used chickens, rabbits, and small pigs. Small animals are used whenever permitted scientifically due to consideration in O&M, cost of holding and difficulty in handling the dead bodies killed after the tests. This is expected for NVVC given Cambodia is also one the developing countries with limited resources.

256. The VPPC in Lao PDR has two courtyards beside the main production building to house test animals for viral and bacterial vaccines separately. Both are closely guarded due to biosafety concerns since the animals carry diseases or vaccines. Each courtyard has its own septic tank to received wastes, including manure, urine and feed residue that is washed down during the cleaning of pens. Each tank has diameter of 3~4m and depth 3m. VVPC has closed and disinfected septic tanks periodically. when full, these are desludged and septage is used as compost for gardening, fruit trees, and grass in the big compound surrounding the VVPC.

257. **For test animals,** small laboratory animals are destroyed then sterilized in 4-5 autoclaves at the Lao's VVPC main building. Their incinerator near animal houses is used to dispose of the larger test animals as these are culled after use and other hazardous wastes. Similar methods are expected for NVVC in Cambodia.

258. Contaminated material is sterilized in a double-ended autoclave, the dirty side of which is accessible from the decontamination section and the clean side from the adjacent room housing the bottle and container cleaning section. The autoclave is normally operated by steam originating from either a central boiler or from smaller electric generator. Steam pressure of at least 15kg per square centimeters is required, usually conducted at 135C for minimal 10 minutes as is done in Lao PDR.

259. Hazardous spent chemical, solvents and other wastes will not be disposed to sinks, instead they are to be neutralized at individual laboratory stations and stored in separate leak-proof containers in a ventilated HEPA air filtered waste storeroom, as practiced in many DMCs labs. They will be disposal by a registered chemical waste contractor according to FS. However, alternative is proposed for consideration in 4.2.

260. For the new NVVC, the autoclaving of biohazardous wastes will be adopted. NVVC, however, will also provide burial pits for test animal and the disposal procedure includes lime cover, as discussed earlier in NCBC solid waste handling. For setptic tank sludge from test animals, the experience in Lao PDR shows that the septage is non-hazardous and can be utilized as compost and thus will be adopted in NVVC.

Air emissions and noise

261. The main concern for air emission is from incinerator planned at the future NVVC. The plan for NVVC is a medical waste incinerator. Medical waste incinerators emit toxic air pollutants and toxic ash residues that are the major source of dioxins in the environment. NVVC must procure an incinerator that incorporates controls over these emissions. Proper operation of this device must also be ensured. The EMP will enumerate mitigation measures to minimize these impacts. Another source of air pollution is flue gas emission from steam generator, as the boiler using diesel as fuel will be used as per the FS. Flue gas from boiler will include particulate matter, NOx, SOx, and CO. The quantities are anticipated to be small and hence, the impacts are not significant. These can be minimized through proper operation and maintenance.

262. Odor from onsite wastewater treatment and animal house can also generate odor. Air exhaust from the site, if unfiltered, may also be biohazardous. The design of the buildings include provision for positive pressure in sterile areas and negative pressure in areas with pathogenic organisms. In addition, HEPA filters are provided before air exits the building. Hence, biohazards are mitigated. The analysis on odor dispersal for OMIC has also shown that these effects are felt only for very short distances. The nearest receptor at NVVC is around 700m west and OMIC predictions show that the olfactory intensity is not reached at this distance.

263. **Noise** may come from air compressor, cooling system, centrifuge, and other machineries. The levels of community noise would not be significant as equipment are housed inside the VVC premises and thus noise is easily attenuated.

5. Impact of Poultry section of market

264. Overall, the environmental impacts and pollution of wet market of this scale is small and well known and can already be addressed through the environmental code of practice (ECOP). However, since this subproject will have a slaughtering line, a simplified impact analysis is added to this IEE. During operation, pollution sources originate from the following areas shown in below and summarized in Table IV-22.

Table IV-22. Pollution Sources and Pollution Characteristics of DKPM

Place of source	Pollution type	Code on flowchart	Characteristics	main pollution parameters	Way that pollution source goes
Carcass selling area	Air emissions	G1	Odor from non-fresh bird	H_2S, NH_3,	Fugitive emission to the air
	Wastewater	WW1	Floor cleaning and disinfection	COD, BOD_5, NH_3-N, TN, TP, SS, total coliform	wash down through trench to underground septic tanks, and DEWATS, then to the town sewer
	Solid waste	SW1	Bird meet residue	organic material	Collected by plastic bins provided to each stall, stored temporarily under staircase, disposed at town landfill site
		garbage	From sellers or customs	Organic and some inorganic	
Live bird selling area	Air emissions	G2	odor	H_2S, NH_3	Fugitive emission to the air
	Wastewater	WW2	Selling pits cleaning and disinfection	COD, BOD_5, NH_3-N, TN, TP, total coliform	wash down through trench to underground septic tanks, and DEWATS then to the town sewer
	Solid waste	SW2 and garbage	Bird dung, and garbage from sellers and customs	Mostly organic and some inorganic	Collected by plastic bins provided to each stall, stored temporarily under staircase, disposed at town landfill site
Slaughter line	Air emissions	G3	odor	H_2S, NH_3	Vent to the air to the roof through exhaust fan installed
	Wastewater	WW3	Wastewater from scalding & de-feathering, cleaning of carcass and offal	COD, BOD_5, NH_3-N, TN, TP, oils, total coliform	wash down through trench to underground septic tanks, and DEWATS then to the town sewer
			Floor cleaning and disinfection		
	Solid waste	SW2	dung slag, inedible offal, feathers	Mostly organic and some inorganic	Collected by plastic bins provided to each stall, stored temporally under staircase, disposed at town landfill site
			Garbage from slaughter operators		
DEWATS	Air emission	G4	odor		Fugitive emission to the air
	Solid waste	sludge			Collected by plastic bins provided to each stall, stored temporally under staircase, disposed at town landfill site

Source: Asian Development Bank.

265. To improve overall hygiene, reduce the likelihood of infection of poultry and poultry traders with zoonotic avian influenza, the high pathogenic avian influenza (HPAI) viruses, and reduce the risk of carrying HPAI virus from the market back to farms, the poultry market subproject is to build a new live bird market in Takeo on the existing DKPM which has poor biosecurity and hygiene standards. The design has taken following measures:

(i) With good roofing to protect against inclement weather,
(ii) With good non-porous concrete floor, ceramic tiles wall of each selling area for easy cleaning and sanitation and good drainage system
(iii) Facilities for disposal of solid poultry waste e.g., poultry litter and other discarded

or condemned poultry carcasses or parts (Important for biosecurity)

(iv) Facilities for retention & treatment of liquid poultry waste available (Important for biosecurity)

(v) The slaughter line is separated physically from the live bird selling area to avoid cross contamination from live poultry to dressed poultry carcass and products, and reduce indirect exposures to AI and zoonotic diseases

(vi) Hand washing facilities are available at the poultry slaughter and evisceration area to avoid cross contamination: reduce indirect exposures to AI virus, food borne pathogens and spoilage bacteria.

(vii) Tap with running water in a basin (big bowl) are available for cleaning the poultry carcass and edible offal to avoid cross contamination: reduce indirect exposures to AI virus, food borne pathogens and spoilage bacteria.

(viii) Systems for protecting carcasses from flies need to be developed, with mesh covers or automated fly swats used in stalls and the area for live bird sales needs to be covered with a roof to provide protection for traders and birds and venting to allow for exit of hot air.

Water demand and pollution.

266. Preliminary estimates of water usage and wastewater generation were provided by Environment safeguards consultant and presented in the table below. These were based on industry norms which were validated through industry references. The study by Gil and Allende (2018)[4] cites that water usage in poultry slaughter is around 13-35 L/day.

Table IV-23 Estimate of Water Usage and Wastewater Generation

place of water use	Water supply				Wastewater	
	norm	unit	No of birds	L/d	rate	L/d
water for chicken slaughter	20	l/bird	350	7000	80%	5600
water for duck slaughter	35	l/bird	150	5250	80%	4200
water for floor cleaning and disinfection	15	l/m^2.day	150	2250	80%	1800
Total				**14,500**		**11,600**

Source: Asian Development Bank.

267. Therefore, the poultry section of the wet market as designed will generate wastewater about 12 M3/day, based on the above estimates. The typical concentration of pollutants based on literature survey are presented below.

[4] Slaughterhouse Water Use and Wastewater Characteristics | Oklahoma State University (okstate.edu)

Table IV-24 Typical Wastewater Quality from Poultry Slaughtering

Source	Animals slaughtered	BOD mg/l	COD mg/l	TSS mg/l	Oils mg/l	pH
Aziz et al., 2018	Poultry, Malaysia	573 to 1,177	777 to 1,825	395 to 783	2,362 to 3,616	6.3 to 6.9
Rajakumar et al., 2011	Poultry, India	750 to 1,890	3,000 to 4,800	300 to 950	800 to 1,385	7 to 7.6
IEE draft1		957	1856	921		

Source: Aziz, H. A. et.al. 2018. Poultry Slaughterhouse Wastewater Treatment Using Submerged Fibers in an Attached Growth Sequential Batch Reactor. International Journal of Environmental Research and Public Health, 15(8). Also cited in the Okstate U study.

268. Typically for wet market, septic tank is standard design for its wastewater and some liquid wastes, then overflow to sewer system since the poultry market is in the downtown. The current sewer drains into a lagoon about 1.5 km away outside the town, typical simple and cheap treatment suited for rural area in less developed countries.

269. The project proposed a better wastewater treatment through DEWATS.. A design flowrate of 10 m3/day was used by FS. This may not be sufficient given above estimate of 12 m3/d. Moreover, this wet market has existing drainage on floor. As good practice also promoted by MoE in Cambodia, renovation like this should help to tackle the pollutions of the existing facility, i.e. the wet market to which the subproject is a section. Therefore, it is recommended that the DEWATS design scale be enlarged as long as the site condition permits to able to collect and treat part of the wastewater from the wet market as well, not just the poultry section.

270. Using the upper range of pollutant concentrations provided by Aziz et al and removal efficiencies cited in this IEE (used in the other subprojects), this analysis in IEE shows that the DEWATS setup should be able to meet the Cambodia standard for sewer discharge with the same treatment stages used. However, poultry slaughterhouses also produce significant concentration of oil and grease (up to 3616 mg/L, Aziz et al.) which need to be addressed through an oil-water separator which may be installed before the settler of DEWATs.

Table IV-25. DEWATS for wet market wastewater

Discharge Standard		Primary Treatment		Secondary Treatment		Tertiary Treatment		
Parameter	Cambodia Standard[a]	Settler		Anaerobic Baffled Reactor Dewats		Anaerobic Filter Dewats		
		In (mg/L)	removal	In	Removal	Out	Removal	Out
COD	<100 mg/l	1825	40%	1095	86%	153	62%	58
BOD	<80 mg/l	1177	42%	683	87%	89	67%	29
TSS	<80 mg/l	783	34%	517	68%	165	62%	63

[a] Annex 2 of Sub-decree No. 27 on Water Pollution Control, MOE, 1999 (Public water area and sewer).

Source: Asian Development Bank.

271. **Solid Waste.** the operation will produce birds' dung from live bird selling area, gastrointestinal containers, inedible offal and other slaughtering waste from slaughtering area, garbage from office staff, sellers, and sludge from settler/septic tank/DEWATS. These solid wastes are mainly organic matter and biodegradable, thus can be utilized by digestion with or

without biogas collection, or by composting. The manure waste generation is estimated about 100kg/day, other wastes is about 20kg/day. Most of them are utilized or collected as fertilizer etc. The remaining together with those of the big market will enter the town's garbage management system.

272. **Odor** from the operation are mainly originated from bird dung, which contain organic matter. Once excreted, the dung will quickly ferment to emit odor gases such as NH_3, H_2S, etc. If dung can't be promptly removed and cleaned from the site, intensity of odor gases might be multiplied to further emit such odor gases as methyl mercaptan, dimethyl sulfide, dimethyl disulfide, dimethylamine, etc. and breeding large numbers of nuisance mosquitoes and flies and spread outside to impact air environment.

273. In summary, the assessment and analysis above show that with the subprojects design and recommendations in the IEE to enhance, their pollutions and resulted adverse impacts during operation comply with applicable environmental standards and requirements. As most of the standards are concentration-based, even if each sub/project can meet standards, if too many of them concentrate in one area, **the cumulative impacts** in terms of pollution load can exceed the carrying capacity of the area in question. However, these are beyond the project level and the reach of government agencies in charge of this project. A comprehensive approach in development planning and environmental/pollution management planning at least for administrative area or at watershed level is needed.

B. Alternative Analysis

274. The project's impacts during operation are largely determined by the project design. The purpose of the impact assessment is to inform the project design reflected in FS to avoid and minimize the adverse impacts from the outset. Therefore, this chapter begins with impact assessment for design phase, which is in effect alternative analysis and comparison from environmental perspective.

275. During the TRTA, social development team (gender and social safeguards), environment (including climate change specialist) and by assigned GDHAP Counterparts paid field visit to the following provinces: Otdar Meanchey, Siem Reap, Kampong Cham, Prey Veng, Takeo, and Phnom Penh, including the proposed sites for the five subprojects to ensure environmental and social safeguards due diligence activities are undertaken to the satisfaction of both Cambodia and ADB.

1. With and without project comparison

276. Table IV-26 present a comparison of "with project" and "without project" scenario from environmental point of view, which basically also summarizes the positive effects of the project.

Table IV-26 Comparison of "with project" and "without project" scenario

	With project scenario	Without project
NAHPRI lab subproject		
advantages	The subproject will upgrade the existing NAHPRI lab facility to meet IOS 17025 and BSL-2 standards and strengthen NAHPRI's capacity in providing diagnostic service to meet engaging demands for feed quality and safety through the refurbishing of existing lab	Diagnostic service capacity of NAHPRI will be the same as it was and there will be no incremental pollution source

	With project scenario	Without project
	infrastructure and eventually improve food quality and safety. Wastes management will be improved to address both existing and future EHS issues.	
disadvantages	With the increased service capacity, especially with increased capacity in analyzing animal feed quality, the NAHPRI Lab will generate incremental wastes, and may impose adverse impact on environment if no wastes management is designed, constructed, and properly operated	The existing insufficient wastes management facilities, especially wastewater management facility will continue to impose adverse impact to the water environment
National Cattle Breeding center subproject		
advantages	Cattle genetics are improved through enhancing bovine artificial insemination (AI) capacity in Cambodia, therefore improve livestock production. Wastes management will be incorporated in the design, construction, and operation simultaneously with the new infrastructure	The site condition remains unchanged because no polluting wastes will be generated on the site.
disadvantages	The pollutions generated by the new NCBC may potentially impose adverse impact on environment if no waste management facilities are designed, constructed and properly operated	cattle genetic remains unimproved without bovine artificial insemination (AI) capacity in Cambodia
National Veterinary Vaccine Center project		
advantages	Cambodia can manufacture essential livestock vaccines to replace parts of the imported vaccine demand by the national vaccine production in the near future to improve the national livestock health.	There would be no potential risks impacting environment and local residents' health imposed by the subproject
disadvantages	Adverse impacts on environmental and on residents' health due to discharging/emitting of pollutants from vaccine production that may contain infectious wastes, if biosecurity and wastes management facilities are not appropriately designed, constructed and operated.	Improvement of livestock health in Cambodia must continue its dependence on the importation of all livestock vaccines, which will be costly.
Animal Inspection Center subproject		
advantages	At the Thai-Cambodia border to set up a form of road checkpoint huts and gates, a Disease Control Zone (DCZ) initially for FMD, which is a key means to control other transboundary animal diseases (TAD). Capacity for inspection and pen-side testing of slaughter pigs & cattle will be strengthened.	The existing forest land that are to be used for establishing the quarantine station and local environment conditions will not be disturbed.
disadvantages	Waste generated from holding areas and testing laboratories may impose potential adverse impact on environment if pollution controls are not appropriately designed, construction and managed.	The TAD cannot be effectively brought into control.

Source: Asian Development Bank.

2. Alternatives in Site selection

277. Some proposed sites were excluded due to potential environmental and social impact during IEE process, for example:

(i) Proposed site for locating slaughterhouse subproject inside the Toekvil Agricultural

Research Station in Chhrey Village, Toekvil Commune, Siem Reap Town, Siem Reap Province. Due to being very close to the groundwater intake well, which is a major source of water supply to Siem Reap Town and concerns of potential impact of wastewater on the quality of groundwater, this proposed site was not selected. The second proposed site for locating slaughterhouse subproject in in Prasath Bakong District, Siem Reap Province, due to its location in the transitional zone of TSBR, which is sensitive to any development activities that are not in line with TSBR management plan, this site was not selected.

3. Alternatives on wastewater treatment

278. **For NAHPRI lab subproject**, two on-site wastewater treatment systems are designed by FS to treat process wastewater and domestic wastewater both existing and incremental to Cambodian wastewater discharging standard before being connected into PHNOM PENH existing combined sewer system. Options for managing different types of wastewaters are considered. Since the typical method to treat general wastewater or sewage is biochemical process, mixing chemical wastewater can disrupt the biodegradation process and make it unworkable. Also, the chemical residues can corrode pipes and equipment, thus require neutralization as pre-treatment. Therefore, separating chemical wastewater and pre-treating (e.g., by physical and chemical methods such as neutralization) before on-site biochemical treatment (e.g., DEWATS) are proposed.

279. The baseline investigation also reveals that the NAHPRI Lab's current wastewater discharge totals 12-14 M3/day already (see 3.8.4). It is observed during sampling that the location of outfall seems to receive from both the lab and adjacent NAHPRI institute. If wastewater from both entities can't be separated, the design (e.g., scale) and costing of wastewater treatment system should cover both within the GDAPH compound. Doing so is also more cost effective and better for operation and maintenance (O&M).

Table IV-27. Alternative on wastewater treatment for Lab and vaccine production

Alternatives / comparison	Option 1	Option 2
	Discharge chem. WW directly to the treatment onsite (DEWATS)	Separate chem. WW and pre-treat, then go in on-site bio-chemical treatment (DEWATS)
Advantage	Simpler thus cheaper to build and run, easier O&M	Treat wastewater better ensure meet national discharging standard and accountable directly
Disadvantage	Disrupt biochem. treatment harder to meet discharge standard; corrode pipes &equipment	increase O&M cost of lab operation
conclusion		Recommended

Source: Asian Development Bank.

280. **For Vaccine production wastewater,** its wastewater is similar to that of Lab, i.e., high in chemicals and biohazard, but much higher in organics, judging by data from Lao PDR, due to the cultural media used. The FS has initially proposed an aerated/chlorine wastewater treatment system as described below.

281. This method involves three separate tanks, which may be constructed separately or be combined into a single rigid polyethene tank system. The first, anaerobic sedimentation chamber is used to settle out solids and apply aerobic oxidation. The second aerated tank includes

automatically operated compressed air injection and random flow media that increase the surface area where oxidation can occur. In final sedimentation tank, the wastewater is chlorinated to kill both bacteria and viruses and the water flows from that tank into a ground seepage pit. The septic tank complex, including the soakage pit will be surrounded by a security fence. According to the FS, the system is suitable for treatment of most laboratory wastes generated by the VVPC facility, with solvents being neutralized in each laboratory unit and then diluted as allowable before discharge to the wastewater treatment system. Liquid wastes considered as toxic materials will not be discharged and instead will be containerized for treatment and/or disposal by an outside contractor.

282. Animal testing and vaccine production wastewater, together with testing vessels and apparatus cleaning wastewater are wash-town into outfalls of lab building, collected in a tank for homogenization and automatically neutralization with pH 6-9; then flows into heterogeneous catalysis oxidation unit for decomposing COD, BOD into smaller soluble molecules; then goes into an advanced oxidation unit, where carboxyl oxidation technology is applied to break down chemicals; then flow into high efficiency pulsed ion exchange unit where any heavy metals are separated and sludge and treated water are separated. The treated wastewater is further purified by multi-filters and disinfected (by ClO2, stronger disinfectant than ultraviolet). Through these treatment process, the treated and disinfected wastewater will be in compliance with Cambodia discharge standard.

283. However, most of the wastewater streams from the vaccine production have already undergone sterilization, thus the bacterial load is significantly reduced and does not need a chlorination step. Furthermore, the system as described only treats an influent with BOD5 of around 250 mg/L, whereas the NVVC's BOD5 is 3800 mg/L.

Wastewater from animal holding and breeding

284. The wastewater from breeding center, quarantine and /or inspection station, etc are similar and mainly from holding parts, all high in organics resulting in high BOD, COD, NH3-N, and pathogenic substances indicated by bacteria parameters. The most suitable treatment is biochemical, also called secondary treatment. It includes many kinds of technologies. The one proposed by pre-FS for all three types of subprojects is DEWATS developed by German agency BORDA as discussed in 4.1.2-4.1.3 .

285. **The slaughtering wastewater** is high in organic but also high in grease, which can disrupt typical biochemical treatment process. Therefore, the IEE preparer suggested to use oil -water separator to remove grease as pre-treatment.

4. Alternatives on solid waste treatment

286. **For organic wastes** that dominates most subprojects' solid wastes, several treatment and utilization methods are proposed during FS. They are compared from environmental perspective with those proposed by the IEE, see Table IV-28.

Table IV-28. Options to treat and utilize organic solid wastes

Subproject	Features	FS proposed method	IEE proposed alternative
Large holding facility	Big waste amount e.g. several t/d	Sun or wind-dry on sand bed, then sold as fertilizer	Sun/wind dry + composting can kill pathogen more than simple dry thus safer and more nutritious fertilizer.
	Pros	Simpler,cheaper, easier O&M	Costlier to build and O&M, technically more demanding
	cons	Hard to sell or land application due to big amount generated routinely; also constrained by seasonal fertilizer demand.	Better end products, safer for users and agro-produces; also dryer so can be shiped farer away, thus wider application
Small holding,e.g. breeding	Just a few t/d manure etc	Sand dry and produce biogas to be used by the facility (currently dumped)	Sun/wind dry with shed and good ventilation design, then sold and apply to land
	Pros	Better utilize methane and also reduce GHG emission	Cheaper and easier in O&M, more sustainable
	Cons	Small scale not worth capital investment and O&M cost of piping, equipment and steps required in biogas, unviable	Over time can get harder to find buyers or land to apply, also constrained by seasonal fertilizer demand.
Conclusion			**Recommended**

Source: Asian Development Bank.

C. Impacts during Construction

287. During sub-projects construction, new infrastructures will be constructed, or existing infrastructures will be restructured or upgraded. Site-specific construction activities include the use of water resources, land preparation, excavation, mechanical works, building material hauling, stockpiling of construction materials. These activities may generate solid waste, wastewater, noise, air emission and soil erosion, and disturbance to nearby residents and potentially pollute water bodies, disturbing local ecology and local physical cultural resources. It is expected that these potential impacts will be localized, short-term, and can be effectively mitigated through the application of good construction and site housekeeping practices and adherence to the provisions of the EMP.

288. Emission of these pollutants may generate adverse impacts on ambient air quality and acoustic environment. Given the magnitude of the construction activities that are mostly in rural areas where the nearest community is around 1.0 km from the subproject site (except for Lab and Takeo Market), these impacts will be short-term, minimal to moderate impact.

289. It is anticipated that construction and restructuring (for the lab) activities will generate airborne dust, and organic volatile compounds depending on materials used. Wastewater from contractor workers is anticipated which will combine with the lab wastewater to drain into PHNOM PENH sewer system. Noise is also anticipated from these activities. Solid waste during restructuring may include waste aggregates, glasses, and packing materials. Contactor is encouraged to recycle these materials as much as possible and remove these waste materials out of the lab site before completion. Domestic garbage from contractor workers will be collected and be regularly cleared by PHNOM PENH domestic garbage servicer.

1. Impact on Ambient Air

290. Land clearing and excavation works during pre-construction and construction may result in localized elevation of airborne particulate matter, which could pose a nuisance and health impacts to nearby residents depending on their proximity to the 5 subproject sites and during dry, windy conditions. Construction vehicles travelling along the unpaved access roads to the subproject sites will add to dust produced by vehicles currently using that road.

291. Restructuring activities (in NAHPRI Lab) will generate airborne dust, and organic volatile compounds likely from paint works. The amounts of dust reaching nearest neighbors is likely to be moderate to minimum and of short duration, lasting only during the specific activities.

2. Noise impact

292. Pre-construction and construction activities will produce noise mainly through use of heavy vehicles travelling to and from the subproject sites and construction equipment in use on the sites. Noise from construction activities may be detectable beyond the site boundary at dwellings nearby though intensity and duration of these noise likely will not be large. Noise from restructuring activities and during installation and commissioning of equipment will be intermittent and will be felt only during these activities. Vehicle traffic on the sites' access roads is not expected to generate excessive vibration and are unlikely to affect residences and businesses due to their setback from the road and the low vibration frequency. Operation of some machinery on sites during construction may produce low-intensity vibration, which are unlikely to be noticeable beyond the sites' boundary.

3. Impact on Water Bodies

293. There are no surface water bodies near the 5 subproject sites, except for the vaccine production center where the location of the site is close to Prek Khleng stream. The main pollutants in construction wastewater and domestic sewage from worker camp will be suspended solids and organic pollutants. It is suggested that (i) the compacted earthen dikes be established by the contractors at the small water ponds inside the sub-projects sites and at the boundaries of the sub-projects sites to prevent water quality degradation in the ponds; (ii) worker camp latrines are provided with septic tanks to pre-treat the domestic wastes.

4. Impact on ecology

294. Excavation work related to new subproject sites' access road, preparation of the building construction area, and installation of wastewater treatment system will necessitate substrate removal and stockpiling. Resulting vegetation removal of exposure of unconsolidated ground will cause increase dust concentrations and sediment runoff during high wind and rainfall events. Given the compact footprint of the new infrastructures, the spatial extent of exposed surfaces during pre-construction and construction activities will be limited. The slight gradient suggest that minimal runoff offsite would be expected.

295. The project sites include the follows: city (NAHPRI and existing market); cultivated lands (NCBC, NVVC); and land near secondary forest (OMIC).. Thus, impact of construction activities on vegetation is minimal. Impact on fauna is also deemed minimal as most of the areas are disturbed or built up area already, except for OMIC for which, mitigation measures in the EMP are expected to minimize the impact.

5. Impacts of Solid and Hazardous Wastes

296. Solid waste generated during construction will include construction and demolition (C&D) waste, excavated spoil during earth works (for construction of road and new buildings) and refuse generated by construction workers on construction sites. Some hazardous wastes such as used oil, empty paint containers, and oil or paint contaminated rags will be generated. These may also include absorbents used for the management of unintended oil spills. The impacts of these will be localized, occasional, and minimal.

V. Public Consultation and information Disclosure

A. Objective and Methodology

297. Public Participation requires all stakeholders concerned with the development project including ministries/institutions, local authorities, relevant departments, project owners, consulting companies, representatives of affected people and non-governmental Organizations concerned with the project areas (Declaration of General Guideline for Developing IEE and full EIA Report, MoE, 2009). It is required by ADB's Safeguard Policy Statement that meaningful consultation with stakeholders be conducted at early stage of the project cycle. In responding to this requirement, at project preparation phase, 2 rounds of public consultation were conducted.

B. Method

298. SPS environmental principle 6 requires the borrower to "Disclose a draft environmental assessment (including the EMP) in a timely manner, before project appraisal, in an accessible place and in a form and language understandable to affected people and other stakeholders" (this usually means not in English only). To translate ADB's policy in practice, the following procedure and requirements are adopted by the project:

(i) Step 1. Draft the public annoucement about IEE with key content below:
  (a) Objective of the disclosure and the follow-up consultation
  (b) A summary of the project and EIA/IEE including EMP
  (c) Weblink to e-version of draft documents and
  (d) Addresses/locations to get or view the hardcopies (local government office, community centers, public library, etc.).
  (e) Deadline for feedback from the public: the longer the better to allow sufficient time for the public to read, think, discuss, consult and coordinate to form opinions (at least two weeks between draft EIA/IEE disclosure and consultation dates)
  (f) Contact information for the public to send feedback: names of persons, email and post address, telephone numbers, websites, social media, or other means.

(ii) Step 2. Publicise the annoucement minimum two weeks prior to consultation at
  (a) Traditional media: bulletin board, popular newspaper, TV/radio channels
  (b) Social media to the public: facebook, Instagram, Whatsapp, Telegram etc
  (c) Mobile phone text messaging or mass emails to key stakeholders

(iii) Step 3. Consultation, usually a combination of typical methods below
  (a) Get feedback through contacts in the announcement: deadline by last consultation.
  (b) Questionnaire or Online surveys: anonymous, efficient, broader, less interactive.
  (c) Meetings or interviews: costlier, limited participants, afraid to speak out at meetings, but more interactive (might be difficult during covid19 restriction).
  (d) Representativeness of the PAP and stakeholders: by age, gender, ethnicity, profession, education level etc.

C. Information Disclosure

299. This IEE/EIA will be disclosed by ADB as required including a copy on the Project section at ADB's website. Environmental information on the project, including the IEE/EIA and other

safeguards information will be disclosed in accordance with ADB's Public Communications Policy (2011) and SPS (2009). This includes:

(i) The EMP will be translated into Khmer and be available for review at POAHP offices.
(ii) The IEE will be disclosed on ADB's project website (www.adb.org);
(iii) Copies of the IEE are available upon request; and
(iv) Semi-annual environmental monitoring reports on project's compliance with the Environmental Management Plan (EMP) and other necessary information will be available at www.adb.org.

300. On-going Public Consultation. Meaningful consultation to safeguard the environment and residents will continue throughout the construction and operation phases. The implementing agencies will be responsible for organizing the public consultations, with the support of the project implementation consultant. Civil works contractors will be required to frequently communicate and consult with the communities in the project area of influence, especially those near the project areas. Eye-catching public notice boards will be set at each work site to provide information on the purpose of the project activity, the duration of disturbance, the responsible entities on-site (contractor, implementing agency), and the grievance redress mechanism (GRM). This plan is included as part of EMP, and costs are included in EMP implementation costs.

D. Findings of First Round of Consultation

301. First round of public consultation and participation process is conducted during the Project Preparation Stage or during conducting of Environmental Assessment or Environmental Management Plan. The consultation process lasted from May till later September, due to lockdown or restrictions for preventing COVID-19. Activities involved in this round of consultation is summarized in table below.

Table V-1. First round of consultation at feasibility study stage

Name of subproject	Diagnostic Lab.	Breeding/AI Center	Vaccine Production Center	Quarantine Center	Slaughterhouse
location	PHNOM PENH	Takeo	Kandal	OM	SR
Date of consultation		16th of June 2021	27th of May 2021 and July	6th August 2021	17th September, 2021
Groups of people consulted		1. DAFF, AHP Office, and Local authorities 2. Young people in Kandeung Touch Village, Kandeung Commune 3. Villagers of Aopheasang, Kandoeung Tuoch, and Kandoeung Thom Village of Kandoeung Commune	1. AHP Office, and Local authorities in Sa'ang commune office 2. local communities in Tanou, Tuol Sala, and Veal village, Sa'ang Phnom commune 3. young people group in Tuol Sale village, Sa'ang commune	1. AHP Office, and Local authorities of Korn Kreal Commune 2. local communities in Samrong Senchey-1, Korn Kreal and Kirivon village, Korn Kreal commune, Samrong Town	1. POAHP, and Commune-Village Authorities of Teukvil Commune 2. local communities in Chhrey Village, Prey Thmei Village of Teukvil Commune
Summary of environmental concerns by people consulted		1. Phnom Tamao site selection is good due to its public land ownership, far from village/houses and no sensitive resources, inside the 90 ha scope of the breeding station, except office building, staff dormitory, warehouse, cattle shed, silage shed, rice straw shed and warehouse belonging to the Station. 2. Local people are mainly farmers who support the subproject and hope to benefit from the subproject. 3. Negative environmental impacts are thought to be minor or can be mitigated during construction 4. Odor, mosquitos & flies dust impact to air quality during operation 5. During operation, with	1. Local communities are mostly farmer, and garment workers, business persons. Some villagers are livestock smallholders and expect to benefit from receiving vaccination and therefore support the subproject. 2. Local people experienced disturbance of dust; noise caused during infilling 3. Nearly no worry about the short-termed environmental impact during construction 4. Suspect of any potential impact of pollution 'source from vaccine production to public health during operation, the leakage of chemicals will impact animals raised by local villagers 5. Some concerns about possible pollution on water,	1. Local communities are mostly farmers, some families raise livestock and collect manure to generate bio-gas or as farmland fertilizer, and support for the subproject. 2. Concerns of spreading of animal disease from the quarantine station to transmission to local animals 3. Concerns of potential impact of pollution sources or hazardous waste to public health during operation. 3. Concerns of potential wastewater pollution to the water ponds	1. Since Siem Reap is a big tourist town in Cambodia, so this proposed slaughterhouse is important and needed for support to Siem Reap town 2. Local communities are mostly farmers engaged in plantation of rice, vegetable crops, and animal raising 3. The slaughterhouse construction is not problem to social or local people, while concerns of possible impact of solid waste, wastewater and odor from slaughterhouse operation on the nearest houses.

Name of subproject	Diagnostic Lab.	Breeding/AI Center	Vaccine Production Center	Quarantine Center	Slaughterhouse
		improved health and increased number of cattle in on the site, wastewater or runoff in raining season from the breeding station or upstream area may contain toxic (pesticide, fertilizer and animal manures) and may pollute surface and groundwater quality, and impact agricultural (rice field and village garden) production at downstream, where the Kandeung Commune are located 4. Recommend planting more trees at the site boundary to reduce odor.	air, odor, soil during operation of the proposed big-sized subproject, and hope mitigation measures will be taken to prevent. 4. wastewater treatment facility (a pond at least) is expected to treat the wastewater to meet national discharging standards.	(including public pond build by donor) and individual family owned) that are the main household water sources, as there is no public water supply system.	3. Suggest taking actions to manage wastes, and mitigation measures to reduce odor emission.

Source: Asian Development Bank.

VI. Environmental Management Plan

302. The Environmental Management Plan (EMP) is a set of actions and arrangements to mitigate the adverse impacts assessed and found during IEE process. It is developed in line with applicable domestic and ADB guidelines and standards, drawn on experience in the EMPs of similar projects and WB/IFC's EHS guidelines and related international good practice. This EMP is prepared for the five prioritized subprojects, which are covered in the consolidated IEE under the Cross-border Livestock Health and Value Chains Improvement Project in Cambodia (CLHVCIP). It includes a number of components crucial to effective environmental management within the project: (i) organizational responsibilities and arrangement for supervision, monitoring and reporting; (ii) mitigation measures of impacts during construction (common to all subprojects) and operation which has separate set of measures for each subproject which also represent main types of project activities; (iii) EMP training plan largely applicable to all; and (iv) monitoring scheme which are separate for operation phase of different types of subprojects ; and v) grievance redress mechanism (GRS) applicable to all.

A. Institutional Arrangement and Responsibilities

303. The overall responsibility for EMP implementation and compliance with loan assurances lies with the Executing Agency, MAFF and the lead Implementing Agency GDAHP. The IA will establish a PIU based in Phnom Penh, responsible for general project implementation. As the ultimate owner of the project, MAFF/GDAHP takes the main responsibility of ensuring EMPs implementation or cause PPIUs to implement the EMP. The Implementing Agency at provincial level is the POAHP of the subproject provinces in PHNOM PENH, Takeo, and OM for provinces implementing the full suite of project activities, under which respective project implementation unit (PPIUs) comprising relevant provincial government representatives including the Provincial Department of the Environment.

304. This sub-section of the EMP presents a discussion of environmental management structure and activities that will be undertaken as part of overall project implementation. The key roles of the main stakeholder in EMP implementation, and detailed responsibilities of various key parties in the project for environmental management during pre-construction, construction and operation stages of the project are summarized below.

Table VI-1. Key Roles of Agencies in EMP

Agency	Summary of Overall Function in EMP
Project Steering Committee	Policy and technical guidance for subproject implementation, coordination inter-government agencies affairs
Project Management Unit (PMU)	Responsible for general project implementation and reporting, and for the execution of EMP by overseeing self-reporting and monitoring by sub/projects or contractors and verify by field check and other means through third party (e.g., NGO, auditor, regulators as external environmental monitoring agency), compile regular reports to the ADB on environ performance of the project and the EMP implementation.
Project Implementation Units (PIUs)	Responsible for subproject implementation, and for self-reporting and monitoring, or cause its contractor to self-report and monitor its respective performances in environmental safeguards, submit regular reports to PIU environ performance of its respective subproject and the EMP implementation.

Agency	Summary of Overall Function in EMP
PIU Environmental Safeguard focal	Nominated person responsible for its respective subproject(s) environmental management and support to PIU-ESC
Construction supervision engineer (SE)	-Responsible for environmental due diligence in its supervision during construction, to ensure contractors' activities comply with environmental laws, decrees, sub-decrees, technical directives, standards, and technical specifications of the contract.
Contractors and their EHS Officer	Implement the mitigation measures specified in the contract, Construction Plan (see below text) and in the EMP
External environmental monitoring entity	Engaged by the PIU to carry out external quantitative environmental monitoring to judge compliance or non-compliance.
Project Implementation Consultants (PIC)	Project final design and implementation, support and capacity development, Engineering supervision for all construction and reporting including Construction Supervision Consultant (PMIS-CSC). Their environmental consultants need to support PMU/PIUs in environmental management of the project construction and operation.
National or Local Environ. Authority	MoE is Responsible for the enforcement of ecological & environmental policies, relevant laws, decrees, sub-decrees, particularly the domestical approval of IEEs/EIAs developed for subprojects under CLHVCIP in Cambodia. PoE is responsible for the enforcement of ecological & environmental policies, relevant laws, decrees, sub-decrees, within its jurisdictions

Source: Asian Development Bank.

Table VI-2 Detailed responsibility of key agencies at different phase

Phase	Major parties	Environmental Responsibility
Design and preparation	Owner/ PIU	-Nominate focal person for environmental safeguard, responsible for coordination among TRTA and local government authorites related to environmental safeguard issues. -Comply with Cambodian environmental protection requirements on investment projects -Nominate alternative subproject sites for selection of enviromentally sound location of subproject sites
	EIA team	-Carry out environmental due diligence that are associated with the feasibility study, and to ensure solutions on addressing enviornmental issues are incorporated into the project and subprojects design, and prepare EIA/IEE, including EMP for prioritized subprojects, and submit environmental safeguards documents to ADB for clearance ; -Develop EAFR for subprojects, feasibility study and assoidated environmental due diligence of which are to be carried out by PIU or owner during CLAPCIP implementation
	MoE	Domestic approval of IEEs/EIAs for each subproject, guide its local environmental authorities to enforcing environmental policies, laws, decrees and subdecrees
	Others…	Provide services for establishing environmental baselines required for EIA/IEE
Construction	PIU and PPIUs	-Establish and implement GRM, carry out public consultation during implementation -Eengage third party for providing external environmental monitoring -Compile semi-annual reports on its supervision and monitoring of the implementation of EMP
	Project Implementation Consultants	-Provide technical assitance to PIU and PPIUs to prepare environmental safeguards documents for subprojects whoes feasibility study and associated environmental due diligency are to be

Phase	Major parties	Environmental Responsibility
		done by PIU and PPIUs. -Provide trainings on EMP implementation -Nominate its PMIS-CSC who provide technical guidance to PIU, PPIUs, and CSE on carrying out their environmental due diligence in its supervision during construction.
	Contractor	- Prepare Construction organisation and management plan including site-specific EHS ; - implement mitigation measures in the above Construction plan and EMP
	Construction Engineering Supervisor	-to be on site daily to provide routinely checking of the proformance of contractor in EHS. - submit perioridic reports (at least monthly) to PIU and PPIU, about civil work progress and quality, including performance on the EMP implementation in their reports
	External environ. monitor	-Engaged by PIU to carry out external **quantitative** monitoring as per the EMP -Submit its monitoring results with explanation if the result complies with applicable standards or not, and analysis of the reasons for non-compliance
	Local Environ. Authorities in PHNOM PENH, Takeo, Kandal and OM provinces etc.	-Responsible for enforcement of environmental policies, laws, decrees and sub-decrees under guidance of MoE -Be one parties in GRM, dealing with complaints through GRM.
	Others	Possibly the other gov. agencies, assisting PIU and PPIUs to address environmental issues, or dealing with complaints through GRM
Operation period	PIU and PPIUs	- Overall responsible for EMPs of operation phase in the project and their respective subprojects; - Manage the transfer of assets (including wastes management facilities) established to owner/operators
	Owner /operator	-Implement environmental mitigation measures proposed in EMP for each subproject's operation phase and sectoral SOP both existing and those to be improved under this project. -Ensure pollution and wastes management facilities designed, constructed for the subproject are well operated to be really functioning.
	MoE and Local Environ. Authorities	Includes environmental performance subproject owners/operators into their routine environmental regulating, monitoring and enforcement. .
	Relevant gov. agencies	Assist MoE and Local Environ. Authorities to deal with environmentally non-compliance operation, if necessary.

Source: Asian Development Bank.

B. Supervision and Reporting

305. **According to FIDIC**, international good practice on **construction** biding, contracting and managing, normally AFTER a contractor wins the bid and signs the contract with the owner (the PMU/PIU in this case), will and can s/he visit the sites thus able to develop site-specific plans for construction. Facilitated by the owner in addition to data and information about the sites provided prior to bidding, the contractor will visit all sites related to his contract package in order to prepare the **"Construction organization and management plan**" (hereafter as the Construction Plan) and submit to the owner and the Engineer as defined by FIDIC. Once the owner and the Engineer on behalf of the owner review and clear such construction plan, they will issue the Order to Commence the construction.

306. Such Construction Plan needs to encompass EHS aspects as required in many countries

and FIDIC guidelines. In ADB projects, this means to include the EMP with site specifics as part of such Construction Plan, especially on safety including traffic and access management. Abundant information and evidence all point to the need for engineering solution to EHS issues first and foremost. Moreover, most of the EMP measures for construction are at the same time also good construction practice, thus inseparable from construction measures. For this reason, FIDIC guidelines and many DMCs also require that the duties of supervision engineers especially resident SEs include not only supervising civil work quality and timeliness but also EHS aspects which can affect the former two.

307. **During construction**, supervision, monitoring, and reporting of EMP implementation should have the following layers, to be efficient and cost-effective:

(i) **First layer**: Routinely checking on-site by supervision (resident) Engineer who are supposed to be on site daily and submit to PIU/IA at least a monthly report anyway about civil work progress and quality - Just include performance on the EMP implementation in their reports.
(ii) **Second layer**: The PIU/IAs assisted by environmental staff (PIU-ESC) and consultants (PMIS -I/NES) will carry out on-site supervision and inspection on random or regular basis and record the findings and remedies or correction plan etc., in writing.
(iii) **Quantitative monitoring**: can be undertaken by external monitoring entity engaged by the PIU. The contract with monitor needs to request them to submit the testing results with explanation if the result comply with applicable standards or not, and analysis of the reasons for non-compliance.
(iv) Based on work of a-c, the PMO can easily compile semi-annual or annual report to the ADB on environ performance of the project and the EMP implementation.

308. **During operation**, supervision and reporting will be undertaken mainly by the PIU or the owners of each of the subproject:

(i) The PIU/IA (supported by its environmental staff or consultants) needs to carry out on-site supervision and inspection on random or regular basis, and record the findings and corrections etc., in writing.
(ii) **Quantitative monitoring**: be undertaken by external monitoring entity engaged by the PMO. The contract with monitors needs to request them to submit the testing results with explanation if the result comply with applicable standards or not, and analysis of the reasons for non-compliance.
(iii) Based on work of a-b, the GDAHP/PIU can easily compile semi-annual report to the ADB on environ performance and the EMP implementation of the project.

309. To achieve this end, more direct and effective means is field supervision, inspection, and training. Their findings and recommendations and trainings should be documented in semi-annual report of the GDAHP/PIU as a management tool and submitted to the ADB. The main content and indicative outline of the environmental report is the following:

1. Introduction:
    a. concise project description (can be copied every time but indicates changes);
    b. Project progress in this reporting period: copy from the overall progress report to ensure consistency or make a reference if it is too lengthy.
2. Mitigation measures: their implementation status (fully followed or not, if not, which parts are not and why; actual performance and findings, any issues and gaps, reasons for them, corrective actions proposed and/or remedy already taken; (**Note**: no need to

repeat the EMP measures, as the EMP is publicized for everyone to see).
3. Quantitative monitoring: summary of results and conclusion, explain if comply with applicable standards or not, and analyze the reasons of non-compliance. (**Note:** full data and original reports' scans submitted in the annex);
4. Training: carried out during this period, how, to whom, results and effects; If no training carried out during the period, say so in Intro or Conclusion without this chapter.
5. Any complaints through GRM: what, when and where, how they are resolved etc. If no grievances during the period, say so in Intro or Conclusion without this chapter.
6. Requirements for the changes in the project: if 1a exists in this reporting period, explain domestic EIA requirements, progress made, and how to also meet ADB requirements.
7. Conclusion on this reporting period and recommendations/work plan for the next.

C. Mitigation measures and subplans

310. Based on the impact assessment and risk analysis, past experiences of similar projects, applicable national requirements and international good practice as reflected in the IFC's EHS general guidelines, concrete measures are developed to mitigate adverse impacts and risks during preparation, construction, and operation. For preparation phase including future subprojects to be designed and construction during CLHVCIP implementation, mainly the siting criteria are developed and included also in the environmental framework to guide future subprojects screening

311. For construction, since all subprojects identified and most in future are expected to be non-linear small-medium scale, the environmental impacts and issues during construction are largely the same as discussed in Chapter IV. Therefore, one set of construction mitigation measures has been developed (see Tables below).

312. As shown in the impact assessment chapter, operation of different types of activities in the five subprojects are quite different from each other albeit some similarity among animal holding/husbandry facilities. Therefore, it is better to have separate table (or subplans) to present the mitigation measures for each. This also facilitates implementation by the host and supervision and monitoring by the PIU/PPIUs.

313. At the project preparation, PIU/PPIUs assisted by consultants and advised by ADB, MoE incorporated waste streams management facilities into the subproject designs based on analysis of the foreseeable adverse impacts potentially imposed by sub-project under CLHVCIP in Cambodia, for the purpose of avoiding, reducing and adverse impact, and proposed mitigation measures to further minimize the adverse impact (as illustrated in tables below)

Table VI-3. Mitigation Measures for Design Stage

impacts	Mitigation measures	remarks
Air emission	- Incorporate fume cupboards, BSC for managing waste gases into the subproject design of NAHPRI Lab and NVVC - Incorporate ventilation system for animal housing and manure drying site into the sub-projects design of NCBC, IC, and poultry market - Specify incinerator(s) with reliable control of air emission - NAHPRI existing incinerator: The height of stack of incinerator may be increased to be 3-5 meters higher than the highest building surround the lab.	SOP GMP is introduced to Cambodia during DED and other work through CLHVCIP
Noise	- Specify low noise liquid nitrogen generator, testing equipment, vaccine production equipment into the technical specification	
Solid Waste	- Incorporate the provision of color-coded bins for separately collecting general waste, bio-hazard waste, chemical hazard waste into the subproject design for NAHPRI lab, NVVC, OMIC - incorporate autoclaves into the subproject design for managing bio-hazard waste for NAHPRI lab, NVVC, OMIC and NCBC. - incorporate manure management facilities into subprojects design for NCBC, OMIC - Incorporate solid waste management facility in subproject design for poultry market	A subplan for managing bio-hazardous wastes for NAHPRI lab, NVVC, OMIC is developed separately
wastewater	- Incorporate wastewater management facilities in all subproject designs. Given the small-scale nature of each sub-project and most of them are not accessible to public sewerage system, decentralized wastewater treatment system (DEWATS) with various combination pre-and post-treatment units are to be applied to be suitable for various types of wastewaters. - Preventive measure, such as lining main facilities with impermeable layers to prevent infiltration of waste streams into groundwater are included into the infrastructure design (particularly for NCBC subproject)	
Location and siting criteria for current and future subprojects	- Avoid locating in protected area, the any natural or historic heritage site legally or tentatively be protected/conserved at national or international levels. - Avoid locating site at area belonging to groundwater recharging zone and groundwater are centralized drinking water source. - Before converting land to subproject sites, survey the subproject area to identify, categorize, and delineate natural and modified habitat types and ascertain their biodiversity value at the regional or national level. - Ensure that any natural or modified habitat to be converted to subproject sites do not contain critical habitat, including known habitat of critically endangered or rare species - at least 1km from the boundary of protected area, natural habitat, cultural heritage site, biosphere etc. - 200 m from human settlements - 200 m from drinking water source (groundwater intaking well, pond, stream/rivers - Not in the prevailing wind upstream of any settlement - sites elevated by 4 meters, sufficient against floods with a recurrence interval of 1 in 10 years	At least, authorities responsible for enforcement of relevant protected areas under national law or international conventions should be consulted and clearance from such authorities should be obtained before decision-making

Source: Asian Development Bank.

Table VI-4. Mitigation measures for Construction

Note: implementors for all measures are contractors and their workers. Routine monitoring is mainly by supervision (resident) Engineers who are supposed to be on site daily and cover EHS aspects too. On top of that, PIUs/PMUs assisted by environ personnel need to inspect on site.

Environmental Aspect	Activities and Location	Mitigation Measure(s)
Overall during pre-construction	Bidding and contracting	1. Comply with all statutory requirements set out by Government; 2. Confirm Gov. Approval and Secure Requisite Permits, Clearances; 3. PMUs ensure the EMP be included in bidding docs thus in contracts of civil work. - 4. The tender documents shall include a lump sum bid item "Environmental Mitigation Measures". It shall be clarified in the specification documents that the applicable measures in the ECOP and EMP are to be charged to this item. This will allow the construction supervision engineer to require the contractor to quickly address the environmental issues during construction.
Encroachment of protected areas, physical cultural resources, local sacred sites or artifects etc	Selection criteria for quarry, borrow pits, disposal sites etc.	<u>Quarry, borrow pits and disposal sites selection criteria:</u> - Located beyond of right-of-way/demarcation of riparian zone: at least 5 (five) meters from the foot of river with embankment; at least 100 (one hundred) meters from the riverbank of large river without embankment; at least 50 (fifty) meters from the riverbank for tributary without embankment outside of settlement area - Alternatively, outsource of quarry, borrows pits and disposal with competent and certified third parties
Release of silt, or runoff cause siltation of water body. Release of domestic wastewater from construction camp and construction activities to pollute water	All sites where earthworks/landscaping takes place All construction camps and sites	- Labor camps, storage / cleaning areas for fuel, machinery and vehicles will be located >500 m from water bodies - Adequate supervision of the works, confining excavation works to the dry session. - Discretionary use of silt traps where warranted and careful placing of excavated material - All earthworks located within 50 m of rivers and channels, will only be conducted during dry season) - Construct silt traps, deviation channels, mounting barriers or trenches around the stockpiles of materials. - Provide adequate water supply and temporary toilet facilities at the worker's camp. Regular disinfection of toilets. - Construct intercepting channels to prevent construction runoff entering waterways - Divert runoff from sites to sedimentation ponds or existing drainage - Construct temporary sedimentation tank be installed, recycled after sedimentation - Oil-water separators will be installed before the sedimentation tank for oily wastewater treatment - Machine wash-down sites are equipped with water collection basins and sediment traps - Locate storage / cleaning areas for fuel, machinery, and vehicles >500 m from water body - Storage facilities for fuels, oil, and other hazardous materials will be within secured areas on impermeable surfaces, and provided with bunds and cleanup installations - Portable or constructed toilets with adequate sewage and septage storage must be provided on site for construction workers and must be emptied (or siphoned) in an appropriate manner into an existing off-site septic treatment system or to the public sewer system
Dust and other airborne pollutants emission	All facilities, with particular attention to sites near homes, schools, hospitals, or	- Require the contractor to cover materials with tarpaulin or other suitable materials while in transit to avoid spillage of materials. - Moisten earthen roads during dry and dusty conditions, particularly roads near residences and through the town core area.

Environmental Aspect	Activities and Location	Mitigation Measure(s)
	offices	- Impose speed limits on construction vehicles. - Conduct regular maintenance on construction equipment and vehicles to control air emissions during vehicle operation. - Sites borrow pits and spoil disposal sites must be at least 300 m from residential areas to reduce dust from these sites. - Effective dust suppression measures will be implemented - Provide workers with personal protective equipment (PPE) - Sensitive receptors such as schools, hospitals, or housing, regularly spraying water on the construction site for de-dusting, and keep windows and doors open for air circulation for repair and renovation subproject
Nuisance Noise: Affect workers and community health	All construction sites, particularly noisy construction equipment is used	- Limit construction activities, particularly operation of noise generating equipment at night (6am up to 6pm only). Adopt Noise Guidelines (58 dBA for residential areas, 73 dBa for Commercial and Industrial Areas) - Position any stationary equipment that produces high noise levels such as diesel generators as far as practical from sensitive receptors. - Erect temporary barriers around construction sites especially near schools, hospitals, and houses. - Install noise suppression devices to noise generating equipment. - Require drivers to minimize blowing of horn and to comply with speed limits. - Provide information to community on schedule of construction activities through billboard/signs.
Clearing of vegetation/ soil erosion	All construction sites on forested or vegetated land	- Cutting of trees will be undertaken as per approved design and only upon approval of relevant authorities. Avoid cutting trees as much as possible and minimize damage to native vegetation. - Implement landscaping and planting of trees/vegetation at sites of the proposed facilities. - Soil erosion management plan to be prepared by the contractor and to be approved by the responsible authority before construction starts. - Roads and paths to the facilities will only be sufficiently wide to accommodate construction vehicles/equipment to minimize land take. - Manual labor will be utilized in sloping terrain where use of heavy equipment would cause unnecessary damage. Steep exposed slopes will be graded and covered with bush and grass to minimize erosion. - Maintain slope stability at cut faces by implementing erosion protection measures. - Construction in erosion and flood-prone areas should be mainly restricted to the dry season. - Control silt runoff and cover soil stockpiles. - Locate temporary soil stockpiles in areas where runoff will not induce sedimentation of waterways. - Establish protection measures for river embankment works, cut slopes, material stockpiles and other areas at risk of soil erosion prior to periods of heavy rainfall - Restore borrow/disposal pits and work sites to prevent/reduce erosion - Stabilize earthwork areas within 30 days after earthworks have ceased at the sites - Strip and stockpile topsoil, and cover (by geotechnical cloth) or seed temporary soil stockpiles - Conduct regular site inspections and monitoring for soil erosion, contamination - Indigenous strands of forest trees on the site be compensated and moved to a to nearby site
Impact on Ecological Resources	Construction sites that are near and easily accessible to forest area	- The contractors will prohibit activities such as cutting wood for cooking, hunting, or wildlife trade.

Environmental Aspect	Activities and Location	Mitigation Measure(s)
Effects of temporary worker populations	All construction sites	Engaging local contractors as far as capabilities allow, to undertake the construction. Consultation with local people on acceptable areas for siting of facilities. If construction camps are required, installation of suitable toilets such as pit latrines and grey water drainage facilities. Arrangements for collection of solid waste. Briefing of workers and awareness raising of the local population on dangers of communicable diseases.
Construction debris and spoil; Pollute land	All construction sites	- Surplus excavated material/cut soil will be used as backfill material for low-lying areas that have been identified by the village authority. - Provide appropriate segregation bins or areas for construction wastes. - Secure and control storage of all hazardous materials including fuels. - Reuse recyclable construction wastes such as wood, steel, and scaffoldings or sell to junk shops. - Solid waste to be collected and disposed in approved disposal site of the districts. - Define spoil disposal sites and borrow pit locations, at least 50 m from water bodies or settlement or other sensitive receptors, in the construction tender documents
Safety hazards to workers and local people	All construction sites	Allocation of responsibility for site safety to contractor site supervisors, who will ensure that appropriate safety measures, such as use of safety clothing and equipment and placing of hazard warnings are put in place. Apply good housekeeping at construction sites to ensure worker safety. Designate areas for waste segregation and storage. Provide appropriate fire extinguishers and keep fire extinguisher stations clear and accessible.
Disruption of traffic, or increased volume of traffic	All construction sites within or adjoining towns	- Contractors should plan construction operations in consultation with area residents and businesses. Local authorities can arrange temporary trading sites and alternative traffic routes during construction. - Prepare a traffic control and management plan together with the local traffic police prior to any construction. The plan shall include provisions for diverting or scheduling construction traffic to avoid morning and afternoon peak traffic hours, regulating traffic at road crossings with an emphasis on ensuring public safety through clear signs, controls and planning. - In case of lane closures, deploy workers to direct traffic. - Signage and other appropriate safety features will be installed to indicate construction works are being undertaken - Speed limits shall be established in the work sites to minimize the risk of accidents.
Social disturbance, temporary disruption of Community Roads, Paths, and Accesses	All construction site closer to local communities	- Walking access will be maintained to affected properties and access routes will be temporarily lined with timber or similar material. Particular attention will be given to ensuring safety along roads and paths used by pedestrians. - Install barriers and safety warning signs on road sections and if necessary, deploy traffic aides/ flag persons at affected locations. Information boards at blocked roads will provide information about the temporary closure of roads, schedule of works and the traffic-rerouting plan. Install signs at construction sites to inform people of the project GRM, potential dangers (e.g., moving vehicles, hazardous materials, excavations) and safety issues) - Require the contractor to immediately rehabilitate the excavated areas and any damaged road and path sections. - Enclose construction site perimeters so that pathway use, and access remains unimpeded. - Install safety barricades around all excavations. - Ensure that all sites are secure, discouraging access through appropriate fencing. - Lock and secure all work sites to prevent unauthorized access
COMMUNITY HEALTH	All construction site	- Prior to any works, inform residents and businesses in advance through media, information boards, and direct

Environmental Aspect	Activities and Location	Mitigation Measure(s)
AND SAFETY		consultations, of the construction activities, dates, and duration of expected disruption. - Especially for the communities within 40 m of works and who will be subjected to higher noise/dust levels, conduct meetings with residents prior to any works. - Record all community feedback and solutions discussed and agreed. - Based on feedback from the community consultations: (i) update contractor site plans as needed to incorporate the solutions, including revisions in work schedules, daily working hours, construction methods, and/or mitigation methods; (ii) revise CSC monitoring schedules and monitoring criteria as needed to reflect the updated contractor site management plans.
Disruption of physical, cultural resources	All facilities	If any cultural relics chance find by contractor, including graveyards and/or individual graves during excavation or construction, they shall: − In the event of accidental finds of relics, contractor should immediately cease any works in the area and protect the site − Delineate the discovery area. − Secure the site to prevent any damage or loss of removable objects (e.g., in cases of removable antiquities or sensitive remains, a night guard should be arranged); − Immediately notify the supervisory project engineer and environment specialist who will notify the responsible authority. − Follow direction from the responsible authority regarding changes in the site layout; and − Resume construction work after permission is given by the responsible authority. − Contractor will ensure that the workforce is briefed on this procedure during prior training on EMP/ECC.
Occupational Health and Safety	All construction site	- Require the contractor to implement the construction health and safety plan in accordance with the World Bank EHS Guidelines (http://www.ifc.org/ehsguidelines) as a minimum standard. The contractor will appoint an environment, health, and safety officer to ensure implementation of the plan. The plan will at minimum include: • Provision of first-aid facilities readily accessible by workers. • Provision of personal protective equipment (PPEs) such as hard hats, gloves, rubber boots, etc. • Wearing of PPEs while working onsite will be a mandatory requirement for workers. • Posting of safety signs/reminders in strategic areas within the construction area. • Installation of sufficient lighting at night. • Ensure that vehicle and equipment operators are properly licensed and trained. • Provide staff with COVID 19, communicable disease and HIV-related awareness training. The contractor will be required to provide priority hiring of qualified construction workers from the villages and to consult with the local authorities to avoid conflict if migrant workers will be brought to the site.

Source: Asian Development Bank.

Table VI-5 Mitigation measures for the Operation of the project Laboratory

(All measures are implemented by the operators with cost include in O&M budget, and supervised by PMU and PIU)

EHS issues	Activity	Mitigation Measure
Wastewater treatment (WWT) and management		
Domestic wastewater from Toilets, staff sanitary use, Lab cleaning, and washing Groundwater pollution	O&M of septic tank, wastewater treatment system, and related drainage, etc.	• Domestic wastewater is discharged into septic tank which discharges into onsite WWT like DEWATS. • Conduct regular operation and maintenance of wastewater treatment facility (including the septic tanks that require regular desludging) to treat the wastewater up to discharging standard. • Regularly monitor the influent/effluent wastewater to detect potential failures or inefficiencies. • Maintain personnel competent in the operations, monitoring, and maintenance of the wastewater system.. • Solid wastes are separated from the domestic wastewater by physical screen in drainage. • O&M of septic tank: maintain plumbing and ventilation (gas release of the septic tank) • Septage clean-up: Need to clean up septage from septic tanks regularly, based on its design capacity, • Septage treatment/disposal to be undertaken by the septage cleanup service provider.
Process and tests wastewater high in chemicals etc. and complex. Treated discharge does not meet standard, causing pollution	***wastewater from labs' tests and preparation etc.***	• Optimize the testing SOP to reduce water use and wastewater amount. • For hazardous chemicals like acids and alkalis: reuse as much as possible; neutralize them by mixing properly in order to avoid corroding the drainage, WWT equipment and pipes. Spent solvent and liquid: should store temporarily in glass bottles, not drain into drainage and thus become wastewater which not only increases its volume but its chemicals, harder to treat. ; . • Observe and monitor regularly the inlet and outlet of above two WWT components to ensure proper operation and take actions to adjust their operation depending on monitoring results. • Follow the SOP for the O&M of WWT like DEWATs and drain pond/field with needed training to Lab staff. Manage WWT sludge and other biodegradable wastes and proper disposal and/or reuse
Direct discharge or spillage incidents of wastewater	due to malfunction, poor O&M or power outage	• Design should include bypass and emergency storage tanks on site. • In case of leakage/fracture of WWT ponds (due to earthquake or other reasons), WWT process shall be halted. The inspection and repair shall be carried out until safe condition. In case of flood in the WWT, reserve pumps shall be turned
• Solid waste management		
Hazardous wastes contaminate land and water	Sampling and testing of the samples in the laboratory	• All contaminated liquid or solid wastes are labeled, recorded to facilitate their proper handling and storage. • Follow the instruction in Material Safety Data Sheet (MSDS) in storage, handling, transport or use as well as disposal and OHS procedure in case of intoxication and exposure) • Collect the hazardous waste at a temporary storage area before transfer to third party which is certified for hazardous treatment and dumping; provided in specific areas which lined, with enclosed walls and roofs to store hazardous waste containers. • Establish and maintain service agreement with hazardous waste treaters as described in this IEE. Maintain agreement with treater of air cartridge and incinerator ash.

		• All biohazardous wastes should be decontaminated and sterilized by e.g. autoclave or high heat. Install, maintain, and use properly sized sterilization devices (e.g., autoclave) to timely sterilize infectious wastes into general wastes, reducing need for further treatment. • For hazardous chemicals like acids and alkalis: reuse as much as possible; neutralize them by mixing properly following relevant lab SOP and safety procedure. • For inflammable chemicals/solvents: reuse as much as possible permitted by H&S rules; burn by onsite incinerator with O&M improved to meet its standard performance.Initiate regular training on safe practices to handle hazardous wastes. • Use of appropriate PPEs for the lab workers.
Other Hazardous waste	Sharps etc	• Sharps are those instruments used to puncture, cut, or scrape body parts and that, in a waste container, can cause punctures or cuts to solid waste handlers or the public. • All sharps waste is placed in appropriate container and decontaminated (autoclaving) prior to disposal. • Glasswares not contaminated with biohazardous materials are disposed as laboratory glass in sealed cardboard boxes.
Odor and other Aesthetic and sanitary nuisance	General solid wastes, garbage	• Collect and segregate the wastes by its category (especially, separate hazardous wastes with general non-hazardous wastes) • Reduce, reuse and/or recycle of certain wastes (plastic, metal, glass, and cardboard) • Promote waste segregation to avoid hazardous waste mixing with general wastes. • Maintain air release of the septic tank downwind against the workspace
Air emissions of labs		
Air emission and smell/	Operation of fume hoods and ventilation in labs	• keeping all apparatus at least 6 inches back from the face of the hood and keeping the slots in the hood baffle free of obstruction. • elevating large equipment at least two inches off the base of the fume hood, to allow for the passage of air underneath the apparatus. • minimizing movement and other forms of potential air disturbances past the face of the hood while working. • eliminating sources of ignition inside the hood when flammable liquids or gasses are present. • limiting the storage of chemicals and apparatus in the hood to those that are required for current work. • Maintain good ventilation of the workspace (lab), Including use of air blower • Use of fume hood and other methods to suction the hazardous vapor and odor • Regular maintenance of fume hoods • Use PPE such as mask to reduce the odor (affecting the workers)

Flue gas emission with common air pollutants and probably toxic dioxin	From boilers, and Solid waste onsite management at labs i.e., handling, storage, incineration	• Proper O&M of boilers on site or switch to gas or electricity boilers if possible; Maintain feed of the wastes and air to reduce incomplete combustion that produces toxic carbon monoxide (CO) • Avoid combustion of material that potentially release dioxin and other toxic gases. Reduce the introduction of chlorinated plastic materials (e.g. PVC) in the incineration process to minimize formation of dioxins • Retrofit onsite existing incinerators to ensure optimal operation and add filers at chimney. • Operate onsite incinerator in their standard condition, i.e., burn at temperature 850 degrees for min two seconds to avoid and destroy dioxin etc. • Minimize use of existing incinerator especially if a competent hazardous waste treater is available to take the hazardous wastes.
Occupational Health and Safety		
hazards: Fire, Explosions, Chemical and Thermal Burns Cuts; Absorption or Inhalation of Chemicals	Operation and tests in standard animal test labs	**Measures related to Fire:** • Never be open flames in the laboratory. Specifically, never heat any organic solvent in an open vessel, such as a test tube, Erlenmeyer flask, or beaker, with a flame. • Volatile solvents should be heated in a hood with a steam bath, not a hot plate. • Never keep volatile solvents, such as ether, acetone, or benzene in an open beaker or Erlenmeyer flask. • All staff to know where the nearest safety shower and fire extinguisher are located. All staff in the laboratory will be trained in the use of fire extinguishers. **Explosions:** • Never heat a closed system or conduct a reaction in a closed system (unless specifically directed to perform the latter process and then only with frequent venting). • Before starting a distillation or a chemical reaction, make sure that the system is vented. **Chemical and Thermal Burns:** • Avoid contact with inorganic chemicals such as the mineral acids and alkalis which are corrosive to the skin and eyes. • Avoid and prevent spill of organic chemicals, such as acid halides, phenols, and so forth are corrosive and often toxic. • If there are spilled on the desk, in the hood, or on a shelf, call for assistance in cleaning them up. • Be careful with hot plates to avoid burns. Always assume that hot plates are hot **Cuts/Injury:** • Avoid cut while attempting to force a cork or rubber stopper onto a piece of glass tubing, a thermometer, or the side-arm of a distilling flask. • Be sure to make a proper-sized hole, lubricate the cork or stopper (lubrication is essential with a rubber stopper), and use a gentle pressure with rotation on the glass part. • Severed nerves and tendons are common results of injuries caused by improper manipulation of glass tubes and thermometers. • Always pull rather than push on the glass when possible

		Absorption of Chemicals: • Keep chemicals off the skin. • Be careful about touching face or eyes in the lab; make sure hands are clean first. • Use gloves available in the lab. However, gloves provide only a temporary layer of protection against chemicals on your skin and may be permeable to some chemical reagents, without visible deterioration. • If gloves come in contact with a chemical reagent, remove them, wash hands, get a new pair immediately **Inhalation of Chemicals:** • Keep nose away from chemicals. Many of the common solvents are extremely toxic if inhaled in any quantity or over a period. • Do not evaporate excess solvents in the laboratory; use the hood or a suitable distillation apparatus with a condenser. • When in doubt, use the hood or consult with instructor about the use of chemicals required for your work **Ingestion of Chemicals:** • Avoid accidental ingestion: must be fitted with suction bulbs to transfer chemicals.; Do not suct by mouth, • Wash hands before handling anything (cigarettes, chewing gum, food) which goes into your mouth. • Wash hands when you leave the laboratory, • Do not eat or drink in the laboratory. Never use laboratory glassware as a food or drink container, • Remove gloves and wash your hands before using the water fountain or bathroom, • Never use chemicals (salt, sugar, alcohol, bicarbonate, etc.) from the laboratory or stockroom on food. The source containers may be contaminated or mislabeled, • Never store food or drink in a laboratory refrigerator or ice machine. Never consume ice from a laboratory ice machine.

Source: Asian Development Bank.

Table VI-6 Environmental measures for Veterinary vaccine production

(All measures are implemented by the operators with cost include in O&M budget and supervised by PMU and PIU). Most of the measures under Table 6.5 for Lab are applicable here (thus not repeated in this table) and should be incorporated by the operators in their manual of operations.

EHS issues	Activity	Mitigation Measure
Wastewater treatment (WWT):		
Wastewater from fermentation, vaccine purification and storage, laboratory operations, and domestic wastewater from staff	O&M of wastewater treatment plant	• Liquid wastes from fermentation process and vaccine purification are sterilized prior to discharge into WWT; maintain proper operation of autoclave, the main tool for sterilization; conduct efficiency tests like standard test kits on autoclaves and post-autoclave substances to ensure adequate sterilization • Conduct regular operation and maintenance of wastewater treatment facility in accordance with Operations Manual (including the settler/septic tanks that require regular desludging) for proper functioning. • Regularly monitor the influent/effluent wastewater to detect potential failures or inefficiencies. • Maintain personnel competent in the operations, monitoring, and maintenance of the wastewater system. Conduct retraining

		on wastewater treatment plant operations as needed.
• Solid waste management		
Solid wastes from vaccine production may contain contaminants or health hazards.	Disposal of Solid Wastes Sludge of WWT	• Adopt waste minimization and segregation processes (see Lab operations); Use of organic wastes as raw material for composting. • All solid wastes from fermentation and vaccine purification and packaging are sterilized before disposal as regular waste for landfill. Solid wastes such as debris after harvesting eggs, disposable culture bottles, unwanted cultures or biological agents are best sterilized or disinfected before transfer from contained area. • Sludge from WWT may be dried and composted. Otherwise, disposed through municipal waste landfill.
Improper disposal of Hazardous waste (lab chemicals, sharps)	Disposal of lab chemical wastes and sharps	• Adopt proper labeling of these chemical wastes and use proper containers (see their MSDS for guidance) • Use commercially available dedicated sharps containers (i.e., resistant to puncture) for temporary storage • Collect the hazardous waste at temporary storage before transfer to third party which is certified for hazardous treatment and dumping; provided in specific areas which lined, with enclosed walls and roofs to store hazardous waste containers. • Establish and maintain service agreement with hazardous waste treaters, e.g. Red Cross.
Test animals may carry disease	Disposal of test animals	• test animal carcasses are disinfected by lime (at least) and buried deep in non-permeable pit made of concrete or, as minimal, compacted clay. Pit burial involves the excavation of a 3-5m deep pit into the earth with the placing of carcasses and other materials into the lined pit and covering the stock and any contaminated materials with the excavated earth.
• Air emissions and odor		
odor from WWT or vaccine production		• Use PPE to reduce the odor (affecting the workers) • Maintain air release of the settler/septic tank (component of WWTP) downwind against the workspace
OHS and biosafety (BSL-2 -work that involves agents with moderate hazards to personnel and the environment)		
Improper work practices may lead to health hazards, Potential for spread of disease.	Adopt BSL-2 work practice	• Access to the test animal facility is restricted; • In the event of emergency, people responsible for the animals must easily be reached. Post their contact numbers in emergency bulletins; • Personnel must have specific training in animal facility procedures, the handling of infected animals and the manipulation of pathogenic agents; • Personnel must be supervised by individuals with adequate knowledge of potential hazards, microbiological agents, animal manipulations and husbandry procedures; and • Procedures involving the manipulation of infectious materials, or where aerosols or splashes may be created, should be conducted in Biosafety Cabinets or by use of other physical containment equipment. • Appropriate personal protective equipment must be utilized to reduce exposure to infectious agents, animals, and contaminated equipment.
Heat hazards Chemical Hazards	Sterilization and decontamination by hot water Inhalation of VOC's	• In addition to adequate design of steam and thermal fluid pipelines (insulated and marked), these should be regularly inspected and maintained. • Steam vents and pressure release valves should be directed away from areas of access. • Adequate training of personnel and regular safety orientation • Regular maintenance of air filters and ventilation system to ensure adequate air exchange

Source: Asian Development Bank.

Table VI-7 Mitigation Measures for animal holding, breeding and quarantine centers

(All measures are implemented by the operators with cost include in O&M budget, and supervised by PMU and PIU)

EHS issues	Activity	Mitigation Measure
Wastewater treatment (WWT):		
Wastewater from biohazardous work (e.g., semen)	Operations of semen processing lab	• All biohazardous liquid wastes are sterilized before conveying to on-site WWT
Wastewater from bull housing Manure and urine, Replaced sand	Operations of livestock holding pen and facilities	• Reduce water use and spills from animal watering by preventing overflow of watering devices and using calibrated, well-maintained self-watering devices. • Reduce leachate from silage by allowing plant material to wilt in the field for 24 hours, varying cutting and harvesting times, and adding moisture-absorbent material as the silage is stored. • Urines and all washdown are connected by pipeline buried underground to the DEWATS, then to retention pond and applied to forage land. • Replaced sand are applied to forage land
Leachate from manure drying; domestic wastewater	Operation of manure drying area; O&M of WWT	• Convey by floor ditches/drainage and then pipeline into septic tanks and WWT like DEWATS; • Regular desludging (and other maintenance works) of septic tanks etc.
• Solid waste management		
Organic wastes: manure, residues of feeds and bedding materials etc	Livestock holding, biggest in volumn	• Promote dry or semi-dry pen cleaning: i.e., scrapping the manure manually or mechanically combined with washing/spraying of pen floor. It will greatly reduce water consumption and wastewater amount, separate as much as possible the solids from liquid thus lowering pollution level in wastewater, making both easier to treat and solid part easier to utilize. • Dry Litter Technology System is a waste management system that offers adaptable solutions for piggery operations. The pig wastes are mixed into the carbon-rich materials and discharged out of the pens by the pigs. Through this process, odor is significantly reduced on the system. The carbon mix is then properly composted, resulting in a rich, organic soil amendment for crop production.
Bio-hazard waste dead animals	Animal testing activities	• Sterilized by autoclaving before being further thermal treated by incineration. • Dead animal disinfected by lime at least and bury deep in non-permeable pit made of concrete or, as minimal, compacted clay.
Sludge from DEWATS and septic tanks	O&M of WWTP	• DEWATS: Need to dredge regularly (as per design capacity) and pumped into sand bed for drying as part of sold fertilizer • Septic tanks: need to desludge regularly as per design capacity and pumped into sand bed for drying and sold as fertilizer
Garbage	Disposal of solid wastes	• Collected by Bins marked for domestic garbage or general waste; • Promptly hauled out by NCBC to municipality approved disposal site.
Air emissions, dust and odor		
Odor from bull pens, manure drying bed	On site storage and (semi-) composting of organic wastes	• Ventilation system is provided to the bull pens and manure sand drying bed. • Reduce emissions and odors during land application activities by applying a few centimeters below the soil surface and by selecting favorable weather conditions (e.g., when wind direction is blowing away from inhabited areas, not toward).

Dust and air emissions		• Provision of capacity building in facility management, including procedures for regular O&M; • Training in O&M of treatment systems to ensure continuous operation. Enforce speed restrictions on vehicles utilizing a facility and spraying water on unpaved roads to suppress dust. Install covers on dust or noise emitting machinery. Provide workers with PPE •
Greenhouse gases		• Refer to climate assessment report and its measures proposed;
Noise	Mainly from liquid N2 generation	• Liquid nitrogen generator is properly fixed and maintained to minimize vibration and noise
OHS and biosafety		
Physical hazards	Animal handling	• Instruct staff in correct livestock care, to reduce incidence of bites and kicks
Exposure to chemical hazards	Operation of forage area	• Train personnel to apply pesticides and ensure that personnel have received the necessary certifications, or equivalent training where such certifications are not required. • Respect post-treatment intervals to avoid operator exposure during reentry to crops with residues of pesticides. • Respect pre-harvest intervals to avoid operator exposure to pesticide residues on products during harvesting. • Ensure hygiene practices are followed (in accordance to FAO and PMP) to avoid exposure of family members to pesticides residues.
Exposure to biological agents		• Inform workers of potential risks of exposure to biological agents and provide training in recognizing and mitigating those risks • Provide personal protective equipment to reduce contact with materials potentially containing pathogens. • Ensure that those who have developed allergic reactions to biological agents are not working with these substances

Source: Asian Development Bank.

Table VI-8 ECOP for wet market and on-site poultry slaughtering

(All measures are implemented by the operators with cost include in O&M budget, and supervised by PMU and PIU)

EHS issues	Activity	Mitigation Measure
Wastewater management		
Obstruction of drains in towns. Degradation of water bodies wastewater	Market operations: large quantities of solid waste are generated in markets, which can be casually discarded into nearby drains, causing obstruction and ponding.	• Awareness raising support to commune authorities and market managers regarding solid waste collection and management (e.g., measures to reduce, reuse and recycle). • Minimize wastewater generation through water saving measures. • Adoption of operation procedures and maintenance of treatment facilities. Provide technical assistance for capability building in operation and maintenance (O&M). • Techniques to minimize wastewater: Removal of solid organic waste from transport equipment before rinsing and washing. Organic materials should be collected separately for recycling; Use of dripping trays to collect blood and ensure that it is transported to the blood tank rather than into the wastewater stream; Application of appropriate tank and equipment cleaning procedures. Cleaning-in-Place (CIP) procedures are useful to reduce chemical, water, and energy consumption in cleaning operations; Choosing cleaning agents and application rates that do not have adverse impacts

		on the environment, or on wastewater treatment processes and sludge quality for agricultural application.
• Solid waste management		
Concentration of solid waste	Solid waste accumulates in markets during trading hours,	• Provision of areas where solid waste is temporarily disposed by market users, and readily collected for transport to a suitable landfill site. • Segregate recyclable or reusable wastes. Segregate organic waste for processing into animal feed and compost. • Disposal of fat at landfills (if no biodigester)
Hazardous waste	Products such as blood, hides and feathers may contain dangerous pathogens.	• Provision of appropriate waste handling and disposal systems, and training in system O&M. • Examples of high-risk material include birds that died from causes other than slaughtering, birds or bird parts condemned as unfit for human consumption, and birds suspected of carrying a disease that can be transferred to animals (Newcastle diseases, Highly Pathogenic Avian Flu). See also the IFC-EHS Guidelines on Poultry Processing (Final - Poultry Processing.doc (ifc.org))
Odor and hygiene		
Odor, dust, noise	Waste from carcasses can rapidly decompose and emit strong odor. Facilities can emit nuisance dust and noise emissions.	• • Maintenance of clean live bird handling areas by removing fecal matter and dead birds on a daily basis; · Emptying and cleaning fat traps frequently; Emptying and cleaning fat traps frequently; • Reducing the inventory of raw carcasses, waste, and byproducts and minimizing any storage to short periods of time in a cold, closed, well-ventilated area. • Dead birds, waste, and byproducts should not be stored in open spaces, where possible; Sealing off animal by-products during transport and transporting blood in insulated containers to reduce temperature increase;
Poultry slaughtering		
• Occupational health and safety		
Physical, chemical and biological hazards faced by workers	. General market and slaughterhouse operations	Good industry practice is detailed in the IFC EHS guidelines for food and beverage processing; https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/policies-standards/ehs-gDARuidelines; See also: Final - Poultry Processing.doc (ifc.org) • Avoiding spillage and leakage of product or wastes, and implementing cleaning procedures, including drying wet floors after cleaning • Ensuring adequate lighting in all work areas (maintenance)

Source: Asian Development Bank.

Table VI-9 COVID-19 Risk Management

ACTIVITIES	MITIGATING MEASURES
Working Camp Siting and Management	• Siting of Camps and Field Offices • Not in area susceptible to flooding, landslide or other natural disaster • Not in area affected by construction dust, noise, sewage or other pollution • Not in a residential area;Minimum housing standards • Separate bed for each worker; Beds should not be arranged in tiers of more than two • Separate accommodation of the sexes or to accommodate couples • Adequate natural light during the daytime and adequate artificial light • Adequate ventilation to ensure sufficient movement of air • Adequate supply of safe potable water; Adequate sanitary facilities ; Adequate drainage • Adequate furniture for each worker to secure his or her belongings, such as a locker • Common dining areas, canteens or mess rooms, located away from the sleeping areas • Appropriately situated and furnished laundry facilities • reasonable access to plug sockets for charging telephones and other devices • Rest and recreation areas and health facilities, where not available in the community • Minimum accommodation sizes • Inside dimensions over 198 centimeters by 80 centimeters; • Headroom of over 203 centimeters allowing full free movement; Beds minimum 2m apart • One toilet, one tap / basin, one toilet for every 6 people • Convenient location to accommodation; Provision of soap • Separate facilities for men and women • Ventilation to open air; Fresh cold running water; Clean and hygienic • Septic tank/sewage treatment facility, or pit latrines located at least 200m from surface waters, and in areas of suitable soil profiles and above the groundwater levels • Health and Safety within worker accommodation • Separate area for sick workers to prevent transmission of disease • Smoke detector in sleeping area • Fire safety throughout accommodation such as fire extinguishers, fire alarms, fire blankets • Worker training in fire prevention and procedures • Fire exit sign, adequate means of escape and clearly maintained exit • Security lighting within camp and for sanitation block and lighting for route from sleeping area to sanitation block • Electrical cables to be in safe condition, elevated and not in areas liable to flood • 2 weekly inspections for cleanliness, state of repair of building, accommodation and fire equipment. • Record inspection results and retain for review
Construction site working conditions	• Form a joint team to plan and organize commencement and/or return to work • Develop or convene a joint occupational safety and health committee with members representing the employer and workers • Train team members on the basic principles for the formulation and implementation of occupational safety and health preventive and control measures.

ACTIVITIES	MITIGATING MEASURES
	• Develop and communicate a work plan on safe working for COVID-19 • Such plan should be fully aligned with any government regulations and guidelines on COVID-19 prevention and control, or in the absence thereof, with international good practice guidelines as may be updated from time to time • Risk assessment to decide when to work, who works and how • Undertake a risk assessment to determine the preventive and control measures • Ensure preventative measures are in place before resuming or beginning construction work • Adopt engineering, organizational and administrative measures • Avoid physical interaction and maintain physical distancing requirements as prescribed by national policy of at least 2 meters, or in the absence thereof, international good practice • Ventilate enclosed workplaces including work camps and communal spaces • Avoid concentration of workers - limit the capacity of common areas such as work camp dining areas and changing rooms to allow the minimum separation of 2 meters and organize one-way systems. This includes sleeping areas which must be a minimum of 2 meters between beds • Put in place training and information on COVID-19 and measures required for its management. • The construction site is to be segregated to the extent possible in zones or other methods to keep different crews physically separated at all time • Stagger break and lunch schedules to minimize the number of people in close proximity to one another • Regularly clean and disinfect • Increase the frequency of cleaning and disinfection, in particular heavily trafficked areas and common areas, including work camps • All door handles, railings, ladders, switches, controls, eating surfaces, shared tools and equipment, taps, toilets, and personal areas are wiped down at least twice a day with a disinfectant • Discourage the sharing of items such as cups, glasses, plates, tools • Promote personal hygiene • Provide workers with the conditions and means necessary for frequent hand washing (soap, water or alcohol gel) with a posted hand washing protocol at site entries, exits, bathrooms, communal areas, offices, and any other areas with commonly touched surfaces • Inform workers of the need to avoid physical contact when greeting, and avoid touching eyes, nose and mouth • Inform workers of the need to cover the mouth and nose with a disposable handkerchief when coughing or sneezing • Dispose of tissues in a lined and covered waste bin and wash hands afterwards • Provide personal protective equipment (PPE) and inform workers of its correct use • Identify appropriate PPE related to the tasks and health and safety risks faced by workers according to the results of risk assessment and the level of risk, and provide it to workers free of charge and in sufficient number, along with instructions, procedures, training and supervision • Non-medical face-coverings (such as homemade cloth masks provided by contractor to all its workers, and supervisors) should be worn as mitigation for catching and transmitting the virus, but are not to be treated as substitutes for proper hand washing • Health surveillance and insurance • Before entering the site, staff and visitors must confirm that they are not currently exhibiting flu-like symptoms • Monitor the health status of workers, develop protocols for cases of suspected and confirmed COVID-19. The protocol state that: 1).Workers with symptoms or confirmed cases must be isolated within the construction camp or stay at home for 7 days after symptoms started

ACTIVITIES	MITIGATING MEASURES
	• If symptoms persist after 7 days, the person must isolate until the symptoms stop • People who have been in close contact with the person with confirmed COVID-19 be quarantined for 14 days 2). All workers in quarantine or isolation must be provided with adequate food, water, medical assistance and sanitation • Identify workers who have had close contact with people infected with COVID-19 and follow national medical guidance • Communicate confirmed cases of COVID-19 infection to the appropriate authorities • All workers should be provided with health insurance that includes COVID-19 treatment • Consider other hazards, including psychosocial • Promote a safe and healthy working environment free from violence and harassment. • Encourage health promotion and wellbeing in the workplace through enough rest, balance of physical and mental activity and adequate work life balance • Implement prevention and control measures for the use and storage of chemicals, particularly those used for disinfection during COVID-19 • The contractor will be asked to develop and review emergency preparedness plans and set up key procedures to prevent and control the pandemic and regularly review and update its plan. Such plan should include: o Setting out clear responsibility of managers, supervisors and employees o Make sure that it employees must familiarize themselves with the symptoms of COVID-19 o provided the control and preventative guidance to all workers regardless of exposure risk o provided guidance for employers regarding safety practices for “critical infrastructure workers” who may have been exposed to a person with a suspected or confirmed case of COVID-19 o institute the protective measures at all jobsites o Personal Protective Equipment and Work Practice Controls o institute regular housekeeping practices, which includes cleaning and disinfecting frequently used tools and equipment, and other elements of the work environment o Jobsite Exposure Situations for ▪ Employee Exhibiting COVID-19 Symptoms ▪ Employee Tests Positive for COVID-19 ▪ Employee Has Close Contact with a Tested Positive COVID-19 Individual o Recordkeeping and reporting • Periodically monitor prevention and control measures to determine whether they have been adequate to avoid or minimize risk, and identify and implement corrective actions for continuous improvement • Establish and maintain records related to work-related injuries, illnesses and incidents, worker exposures, monitoring of the work environment and workers’ health

Source: Asian Development Bank.

D. Quantitative Environmental Monitoring

314. The objective of quantitative environmental monitoring is to verify the actual status of environment and pollution discharged, and also to provide evidence if the mitigation measures are effective or not so as to improve timely. The monitoring for construction focuses on implementing the measures through contractor supervision and field checking rather than quantitative monitoring. Most impacts during construction can be detected by senses and observation, thus only resort to instrument testing when in dispute or needing data to substatite.

Table VI-10. Environmental Monitoring for Construction

(Supervised by the PIU, PPIU and their PIC. In case of testing needed, PIUs should contract external monitor/labs which can be paid by contractors who have the responsibilities for EMP)

Mitigation measure	Parameters	Location	Methods	Frequency
Air emission mainly dust	Visible dust	All construction sites	Visual inspection; 3rd party sampling and analysis if complaints arise	During windy conditions, in case of complaints
Water discharged by construction site and camps	Visible sedimentation, other key pollutants: BOD, TSS, Coliform	At outlet of construction sites, camps	Visual inspection, 3rd party sampling and analysis if complaints	Weekly or after rain events; in case of complaints
Noise	Noise level	Near sensitive receptors	Handheld noise meter	During noisy construction works
Occupational health and safety	Wearing of PPE, record of near-miss, accidents	At all work sites	Safety observations	Daily and weekly

Source: Asian Development Bank.

315. During operation, monitoring of pollution discharge is crucial for the environmental authority of the country. The quantitative monitoring plan is aligned with Cambodian requirements for these types of subprojects. Their design is streamlined and made practical to facilitate their execution- the responsibility of the subproject hosts/operators. Supervision will be responsibility of the local environmental authority or MoE whichever is applicable.

Table VI-11 . Environmental Monitoring for Operation

Subject	Parameters	Location	Method and Frequency	Responsible
Air emission	Odor	Downwind of sludge house	Observation	Operator
	Incinerator (Particulates, NOx and SO2)	Downwind from incinerator	3rd Party testing Annually	Operator External Monitor (regulator)
Waste-water	COD, BOD, TSS and Total Coliform	Discharge point of onsite WWT	Monthly by operator, quarterly by external monitor (regulator) for sampling and analysis	Operator, External Monitor
Groundwater	Nitrate Total Coliform	Groundwater wells near NCBC and OMIC	Annual Through 3rd party sampling and analysis	Operator, External Monitor

Source: Asian Development Bank.

Table VI-12 Budget Estimated for Environmental Measures

Item	Description	Estimated Cost
A.	***Environmental Costs during Construction***	
	Environmental Health, Safety, and Environmental Officer	275,000
	Water Quality Monitoring (laboratory and in-situ analysis)	20,000
	Air and Noise Quality Monitoring (1-hr sampling and laboratory analysis)	20,000
	Subtotal	**315,000**
B.	**Cost of Designed Environmental Measure**	
	NAHPRI Wastewater treatment System	89,000
	NVVC Wastewater System	71,000
	NCBC Wastewater System	86,000
	Takeo market Wastewater System	26,000
	OMIC Wastewater System	194,000
	Incinerators (NCBC, NVVC, 10 kg/d) $5500 each	11,000.00
	Autoclave for Biohazardous wastes (3 x 15,000)	45,000
	Subtotal	**522,000**
	TOTAL	**837,000**

Source: Asian Development Bank.

E. Capacity Building and training

316. A capacity building program will focus on the environmental safeguards' requirements of relevant laws and regulations and ADB's SPS reflected in the EMP; means for effective implementation of the EMP, the environmental monitoring plan, and the GRM; and international good environment, health, and safety construction practices. Trainers will be mainly environmental officers and consultants of EA and IAs.

Table VI-13 . EMP Training Plan

Period	Target groups	Main content	Arrangement & Cost estimate
	PIU staff	1.The entire EMP and EHS issues in the zone 2.Environmental monitoring 3.GRM 4. Other related requirements	2x, 12 persons US$2000
Preparation	Supervision Engineers (SE)	1.The ECOP for construction and SE's responsibility in supervision and reporting, 2.SEs' contractual and statutory duties in supervising, monitoring and reporting 3. GRM 4. Other related requirements	
Construction	Contractors, its foremen and workers	1.The ECOPP for construction, especially mitigation measures. 2.H&S and ERP requirements, and preventive and mitigation measures; and GRM 3.Applicable domestic permits falling in contractors' responsibility; Other requirements;	2x, 24 persons US$5000
Operation	subprojects its staff	1.EMP and SOP for operation. 2.Domestic EIA rules applicable to the project sectors, industries, and activities.	2X, 24 persons US$5000

		3.Domestic environ standards for wastewater discharge, solid and hazardous waste management, and air emissions applicable. 4.Environ monitoring and reporting required in the EMP and by domestic regulations	

Source: Asian Development Bank.

F. Grievance redress mechanism (GRM)

317. The GRM for the five prioritized subproject will be consistent with the requirements of the ADB Safeguard Policy Statement (2009) and will be established to prevent and address community concerns, reduce risks, and assist the project to maximize environmental and social benefits. The GRM will be accessible to all members of the community and free of charge. In addition to serving as a platform to resolve grievances, the GRM will help achieve the followings:

(i) Open channels for effective communication, including the identification of new environmental issues of concern arising from the project.
(ii) Demonstrate concerns about community members and their well-being; and
(iii) Prevent and mitigate any adverse environmental impacts on communities caused by project implementation and operations.

318. A grievance redress mechanism (GRM) will be established for the subprojects in compliance with ADB SPS (2009). ADB requires that the borrower/client establish and maintain a GRM to receive and facilitate resolution of affected peoples' concerns and grievances about the borrower's/client's social and environmental performance at the different levels. The GRM will be accessible to diverse members of the community, including more vulnerable groups such as women and youth. Multiple points of entry, including face-to-face meetings, written complaints, telephone conversations, or e-mail, will be available. Opportunities for confidentiality and privacy for complainants will be honored where requested.

319. At the national and EA level, the execution agency, the GDAHP will be the key governmental agency for establishing the GRM, and set up a Grievance Redress Committee, the members of which comprises representatives for the 5 POAHPs, PPIU Environment Safeguard Counterpart, PIU-Environment Safeguard Officer, and representatives of the 5 POAHPs, leaders of villages where the subprojects are located. The Grievance Redress Committee will be the GRM access point and will be responsible for monitoring and recording complaints.

320. The PIU will assign an Environmental Safeguard Officer, who will be responsible for overseeing and functioning of the GRM, coordinating with the PPIU Environmental Safeguard Counterpart, be the GRM Record keeping and document storage of all GRM complaints (Formal or Informal), and contacting with ADB if Affected People appeal the process GRM reporting. The PIU will establish a Project Public Complaint Unit (PPCU) which will act as a central recording and coordinating unit for all subprojects under the Project. The PIU will ensure that the GRM is publicized locally so that the community is fully aware of the mechanism and the local points of entry to it. The setting up of the GRM in the PIU and its initial implementation will be supported by the environmental consultant of the PIC.

321. The contractor will be the entry point for affected people during construction. The entry points for the GRM will be, first, at the local level. These are: the contractor, the village leader, the PIU Environmental Safeguard Counterpart, the commune chief, and operators of project facilities. Since the contractor will be the most direct contact for the initial complaint and also for correcting the work practice which causes the complaint and providing redress, the contractor will

assign an employee as the contact person and ensure that people know how to contact them at all times. It is appropriate that this employee should also be the EHS officer for the contractor since the duties will be complimentary.

322. All these entities will be equipped with logbooks and will report complaints received and acted upon or received and passed up to the next level for resolution. These monitoring and reporting procedures will be designed and established by the PIU supported by the PIC. Before construction starts, signs will be erected at each construction site and put on bulletin boards at the commune council office and community centers providing the public with updated project information and summarizing the grievance redress mechanism process including details of the GRM entry points. The contact details for the entry points (names of officers, phone numbers, addresses, e-mail addresses, etc.) will be publicly disseminated on information boards at construction camps and active sites and on the website of the local government.

323. The preferred action sequence for complaints handling is that the complaint should be investigated and resolved by the local unit receiving the complaint. If this is not possible, the complaint should be referred to the District Chief's office and PIU. The next level, if a resolution is still not found, is the Provincial Grievance Redress Committee (whose wider membership will enable coordinated action in response).

324. The PPCU will maintain records of complaints and actions taken to correct them. This data will be included in GDAHP's quarterly reports to the ADB. To accomplish this, the PPCU will establish a GRM tracking and documentation system. The system will include the following elements: (i) tracking forms and procedures for gathering information from project personnel and complainant(s); (ii) staff to update the database routinely; (iii) systems with the capacity to analyze information so as to recognize grievance patterns, identify any systemic causes of grievances, promote transparency, publicize how complaints are being handled, and periodically evaluate the overall functioning of the mechanism; (iv) processes for informing stakeholders about the status of a case; and (v) procedures to retrieve data for reporting purposes.

325. All efforts should be made to resolve complaints at the local level. If, after all the procedures described above, the AP is still dissatisfied the complaint can be taken to the ADB Resident Mission and beyond that to the ADB's Office of the Special Projects Facilitator[5] and the Accountability Mechanism.[6]

326. Reporting. During construction, the PPCU will be informed by contractors and construction supervisors, village leaders, commune chiefs if people complain about the project. During operation, the PPCU will be advised of complaints by the village leaders, commune chiefs, POAHPs and GDAHP. The PPCU will inform data on complaints and resolutions can be included in GDAHP's progress reports to ADB.

[5] https://www.adb.org/site/accountability-mechanism/problem-solving-function/office-special-facilitator .
[6] https://www.adb.org/site/accountability-mechanism/overview.

VII. Conclusions and Recommendations

327. The environmental impact assessment for the project shows that there will be overall moderate negative environmental impacts expected from the activities of this project. Most environmental impacts are deemed low to moderate, localized, and temporary, and can be addressed by mitigation measures in the Environment Management Plan as part of the IEE.

328. During sub-projects construction, new infrastructures will be constructed, or existing infrastructures will be restructured or upgraded. Site-specific construction activities include the use of water resources, land preparation, excavation, mechanical works, building material hauling, stockpiling of construction materials. These activities may generate solid waste, wastewater, noise, air emission and soil erosion, and disturbance to nearby residents and potentially pollute water bodies, disturbing local ecology, and local physical cultural resources. It is expected that these potential impacts will be localized, short-term, and can be effectively mitigated through the application of good construction and site housekeeping practices and adherence to the provisions of the EMP.

329. For livestock facilities and projects, adverse environmental impacts and complex health and safety risks come from their operation phase. Among the main project activities represented by the five subprojects are laboratory operations, vaccine production, slaughtering and animal inspection. The impacts of their operations have been assessed and corresponding mitigation plans include operation and maintenance of properly designed waste treatment facilities, monitoring of wastewater discharges, and implementation of generally accepted procedures for handling and disposal of solid and hazardous wastes. These were incorporated in the Environment Management Plan and Environment Monitoring Plan.

330. Public consultations involving affected people and local officials have been conducted through the Multi-Stakeholder Consultation Meetings in compliance with ADB's information disclosure and consultation requirements. Since inception and during Master plan stage, the project has already undergone several changes in structural and other activities that has significantly reduced the potential social impacts from displacement of residents and impacts of land disturbances on the environment. This was an outcome of PIU's continuous consultations with the stakeholders, specifically the affected persons.

331. The PIU at GDAHP will include the EMP in the bid and tender documents for civil works to ensure that the Project will be carried out consistent with the EMP which integrated both domestic and ADB requirements on environ, health and safety for preparation, construction and operation.

Appendix 1 List of raw materials and consumables (existing and after the project)

Name of chemical/reagents		characteristics	currently used	To add in project
ELISA				
1	Bio Tek Instruments Synergy LX Multi-Mode Reader			√
2	BioTek Instruments 50™ TS Microplate Washers			√
3	Thermo Scientific™ Finnpipette™ F1 Multichannel Pipettes volume 30-300µL			√
4	DWK Life Sciences Acura Electro™ 956 12-Channel Pipetters 10-200µL			√
5	MTC Bio Propette™ LE Multi-Channel Pipettor, 1/EA , 30 to 300µL			√
6	IKA® MS 3 digital shakers			√
7	Fisherbrand™ SureOne™ Aerosol Barrier Pipette Tips, 20 to 200µL			√
8	Fisherbrand™ SureOne™ Aerosol Barrier Pipette Tips, 30-300µL			√
9	Beta-agonist ELISA Kit			√
10	nitrofuran (AOZ) 1 UNIT	carcinogenic		√
11	nitrofuran (AMOZ) 1 UNIT			√
12	nitrofuran (AHD) 1 UNIT			√
13	nitrofuran (SEM) 1 UNIT			√
14	dexamethasone 1kit			√
15	Aflatoxin B1/BOX	carcinogenic		√
16	APS-Ave001 Ivermectin ELISA			√
17	APS-Ave001 Avermectin ELISA			√
UPLC-MS/MS				
18	**Turbovap** Suitable to evaporate solvent in tubes from 1.5 to 60 ml with blocks to fit different tubes sizes, at least 1.5, 10, 15 and 50 ml tubes With adjustable stand for accurate tube height control Power Supply: 220-240 V – 50/60 Hz			√
19	**Analytical balances:** Max.Capacity: >= 100 g; Readability: 0.01 mg;Repeatability: 0.05 mg			√
20	Volumetric flask with stoppered 10ml		√	
21	Volumetric flask with stoppered 25ml		√	
22	Volumetric flask with stoppered 50ml		√	
23	EMCLAB Pipette Filler Plus with AC adapter spare 0.45 µm, 0.1 to 100 ml			√
24	Dispenser 1ml-10ml			√

	Name of chemical/reagents	characteristics	currently used	To add in project
25	HandyStep ® S			√
26	PD-Tips (Precision Dispenser Tips) 12.5ml, no sterile			√
27	PD-Tips (Precision Dispenser Tips) 5ml, no sterile			√
28	**Formic acid:** Description: Formic acid, 98%; Purity/Grade: LC-MS/MS grade	VOC，corrosive	√	
29	**Potassium dihydrogen orthophosphate:** Description: Potassium dihydrogen phosphate; analytical grade		√	
30	**Trichloroacetic acid:** Description: Trichloroacetic acid, Cl3CCOOH Purity/Grade: analytical grade, ⩾99.5%	pungent, harmful to health, 2B carcinogenic	√	
31	**Bulk C18:** Bulk C18 end-capped sorbent, Phenomenex Sepra C18-E (end capped) bulk sorbent, 50µm LC packing or similar		√	
32	**EDTA:** Description: Ethylene diamietetraacetic acid (EDTA) disodium salt,	flammable, pungent	√	
33	**CBA SPE columns (6 ml, 500 mg):** Carboxylic acid (CBA) bonded sorbent in SPE columns format Size: 500 mg, 6 ml; Isolute CBA SPE columns (6 ml, 500 mg) or similar		√	
34	**PCX SPE columns (3 ml, 60 mg):** Polymeric cation exchange (PCX) resin in SPE columns format, suitable for B antagonist, Size: 60 mg, 3 ml; Bond Elut Plexa PCX (60mg/3ml) P/N 12108603 or similar		√	
35	**Freezers:** Designed for laboratory use, spark free Capacity: approximately 400 l; Temperature: -20°C			√
36	Clenbuterol HCl, ampoule pack, 1.0 mg/ml, 1 ml			√
37	Clenbuterol-D6 HCl, ampoule pack, 0.1 mg/mg; 1 ml (ISTD)			√
38	Ractopamine HCl, powder form, 100 mg			√
39	Ractopamine-D6 HCl, ampoule pack, 0.1 mg/mg; 1 ml (ISTD)			√
40	Salbutamol, ampoule pack, 1.0 mg/ml, 1 ml			√
41	Salbutamol-D9 HCl, ampoule pack, 0.1 mg/mg, 1 ml (ISTD)			√
42	Amoxicillin, 250 mg		√	
43	Ampicillin, 100 mg		√	
44	Penicillin-G potassium, 200 mg		√	
45	Penicillin-V potassium, 250 mg		√	
46	Cefalonium, 100 mg		√	

	Name of chemical/reagents	characteristics	currently used	To add in project
47	Ceftiofur, 100 mg		√	
48	Tetracycline hydrochloride, 250 mg		√	
49	Oxytetracycline hydrochloride, 250 mg		√	
50	Chlortetracycline hydrochloride, 250 mg		√	
51	Doxycycline hydrochloride, 100 mg		√	
52	Sulfadiazine, 100 mg			√
53	Sulfamethazine (sulfadimidine), 250 mg			√
54	Trimethoprim, 250 mg			√
55	Difloxacin, 100 mg			√
56	Sarafloxacin, 100 mg			√
57	Marbofloxacin, 100 mg			√
58	Enrofloxacin, 100 mg			√
59	Danofloxacin, 100 mg			√
60	Ciprofloxacin, 100 mg			√
61	Norfloxacin, 100 mg			√
62	Oxolinic acid, 100 mg			√
63	Nalidixic acid, 100 mg			√
64	Flumequine, 250 mg			√
65	Ofloxacin, 100 mg			√
66	Pefloxacin			√
67	Erythromycin A, 250 mg			√
68	Josamycin, 100 mg			√
69	Lincomycin, 250 mg			√
70	Spiramycin, 100 mg			√
71	Pirlimcycin, 1 mg			√
72	Tilmicosin, 100 mg			√
73	Tylosin phosphate, 100 mg			√
74	Apramycin sulphate salt, 1 g			√
75	Dihydrostreptomycin sesquisulfate, 500 mg			√

	Name of chemical/reagents	characteristics	currently used	To add in project
76	Gentamicin sulphate, 1 g			√
77	Kanamycin sulphate (Kanamycin A), 500 mg			√
78	Neomycin trisulfate salt hydrate, 100 mg			√
79	Paromomycin sulphate, 500 mg			√
80	Spectinomycin dihydrochloride pentahydrate, 250 mg			√
81	Streptomycin sulphate, 250 mg			√
82	Sisomicin sulphate salt, 1 g			√
83	Roxithromycin, 95%, 1 g (ISTD)			√
84	Methacycline, standard grade, 1 g (ISTD)			√
85	Penicillin G D7, 10 mg (ISTD)			√
86	13C6-Sulphadiazine (ISTD)			√
87	D5-Oxolinic Acid, 10 mg (ISTD)			√
88	PCB-series precision balances, Weighing range 1000 g, readability 0.01, reproducibility 0.01/0.03			√
89	HR-series analytical balances, Analyitcal electronic balance, accurate to 0.1 mg-102 g, internal adjustment			√
90	Laboratory mixer, 1ml up to 12 liters.Tubular Mixing Units: 5/8” Micro – Solid one-piece construction with the following mixing units: 3/4” Tubular – Generally as 1” Tubular. Capacity 20ml up to 250ml.;5/8” Micro – Solid one-piece construction. Capacity 5ml up to 50ml. 3/8” Mini-Micro – Generally as 5/8” Micro. Capacity 1ml to 10ml.			√
91	Vortex-Genie® 2T with integrated timer Possible settings: 1 to 60 sec (Interval operation), 1 to 60 min (Hands-free mode) or permanent run.; 600 to 2700 rom			√
92	Scienceware® Secador® auto-desiccator cabinet, model 3.0, vertical profile, clear, AC/DC input 230 V AC, CE compliant			√
93	Refrigerated centrifuge (max 4000 rpm); Cole-Parmer MPR115 Advanced Centrifuge Bundle, 1 L capacity, 230 VAC, 50 Hz; specifications & Description: Max Speed (rpm):15000; Max RCF x g: 22000; Rotor Type: Fixed-Angle and Swing-Out with buckets and adapters; Max Temperature (° C): 40; Min Temperature (° C):-9; Refrigerated: Yes; Timer Range:0 to 99 minutes, 1-second increments; Max Capacity (mL): 1000			√

	Name of chemical/reagents	characteristics	currently used	To add in project
94	Shakers Multi Reax; 150 to 2000 rp; Digital speed display Type of movement: Circular, vibrating With overheating protection With holder for 26 vessels, Ø 10 to 16 mm, max. length 160 mm and holder for 12 vessels, Ø 16 to 32 mm, max. length 120 mm			√
95	Single-channel microlitre pipette Transferpette® electronic with mains adapter, 50 to 1000 µl			√
96	Pipette tips 50-1000 µl, Standard, Refill, Non-sterile, 10 x 96			√
97	Vactrap™ Vacuum Trap System,2 L (Bottle 1) + 1 L (Bottle 2)			√
98	Fisherbrand™ Isotemp™ Shaking Water Baths, With a capacity up to 27 liters (7 gallons) shaking water baths have intuitive digital control and are easy-to-use.			√
99	Methanol	poisonous, pungent, flammable, VOC,	√	
100	Acetonitrile (HPLC gradient quality & LC-MS/MS grade)	Same as above	√	
101	Hexane	Same as above	√	
102	Ammonia solution	Same as above		√
103	Ethyl acetate	Same as above	√	
104	Acetic acid	Same as above	√	
105	-Glucuronidase *Helix pomatia*- type H2 (Sigma: Cat G0876)			√
106	Sodium acetate anhydrous			√
107	Sodium hydroxide pellets	strong caustic	√	
CHARM II				
	For Meat			
108	Tetracycline/Tissue/100kit		√	
109	Sulfa Drug/Tissue/100kit		√	
110	Betalactam/Tissue/100kit		√	
111	Amphenicol/Tissue/100kit		√	
112	Gentamycin-Neomycine/Tissue/100kit		√	
113	Streptomycin/Tissue/100kit		√	
114	Macrolide/Tissue/100kit		√	
115	Scintillation Fluid, Optifluor,1 Gallon		√	
	For Feed			
116	Macrolide/Feed/100kit			√

	Name of chemical/reagents	characteristics	currently used	To add in project
117	Betalactam/Feed/100kit			√
118	Amphenicol/Feed/100kit			√
119	Gentamycin-Neomycine/Feed/100kit			√
120	Tetracycline/Feed/100kit			√
121	Gentamycine-Streptomycin/Feed/100kit			√
Rapid Test				
122	Clenbuterol, Ractopamine, and Salbutamol Combined Rapid Test(Urine, meat, feed)			√
125	Clenbuterol/Ractopamine/Salbutamol Rapid Test Kit for Serum			√
126	Tetracycline(Seafood)RapidTest Kit			√
127	Quinolone(Seafood)RapidTest			√
128	Nitrofurans (AOZ, AMOZ, AHD, SEM) Rapid Test Kit (Furaltadone (AMOZ)RapidTest)			√
129	Nitrofurans (AOZ, AMOZ, AHD, SEM) Rapid Test Kit (Nitrofurantoin(AHD)RapidTest)			√
130	Nitrofurans (AOZ, AMOZ, AHD, SEM) Rapid Test Kit (Furazolidone (AOZ)RapidTest)			√
131	Nitrofurans (AOZ, AMOZ, AHD, SEM) Rapid Test Kit (RAPG-SEM-001)			√
132	QuaTest BTSQbeta, tetra, sulfa and quinolone 4 in 1rapid test kit			√
133	Formalin	poisonous,corrosive, flammable, VOC	√	
134	Borax			√
	(ANKOM DELTA, Automated Fiber nalyzer)			
	a. ADF			
135	acetone	VOC	√	
136	Acid detergent Solution- cetyle trimethylammonium bromide (CTAB), 1.00N		√	
137	H2SO4 (Sulfuric acid)	strong acidity	√	
	b. NDF			
138	acetone	VOC	√	
139	Neutral Detergent solution- sodium dodecyl sulfate (USP)		√	
140	Ethylenediaminetetraacetic disodium salt (dehydrate)		√	
141	Sodium borate, Sodium phosphate dibasic (anhydrous)		√	
142	Triethylene glycol		√	
144	Alpha-amylase—Heat-stable bacterial alpha-amylase: activity = 17,400 Liquefon Units / ml (FAA, ANKOM Technology).		√	
145	Sodium sulfite—Na2SO3, anhydrous (FSS, ANKOM		√	

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	Name of chemical/reagents	characteristics	currently used	To add in project
	Technology)			
	c. Crude fiber		√	
146	petroleum ether	vapor flmmable, explosive	√	
147	acetone	VOC	√	
148	0.255N H2SO4 and 0.313N NaOH	strong acidity, strong caustic	√	
149	Gross energy		√	
150	Benzoic acid (combustion tablets or standard grade crystals)	vapor pungent	√	
151	Phenolphthalein indicator (0.1% in 95% ethanol)		√	
152	Barium hydroxide 0.1N, titrate	poisonous, strong caustic	√	
153	Sodium carbonate 0.1N		√	
154	Chloridric acid 0.1N, titrate		√	
155	Methyl orange		√	
156	Hydrochloric acid, 6M.	strong acidity, corrosive, pungent	√	
157	Standard solution of calcium.		√	
	Media			
158	CHROM agar™ Pasteurella	158	√	
159	Blood Agar base	159	√	
160	Buffered Peptone water	160	√	
161	Microbiology Chromocult Coliform Agar or E.coli /Coliform Agar	161	√	
162	Egg Yolk tellurite Emulsion 100%is used with Baird Parker Agar Base.	162	√	
163	Baird Parker Agar Base	163	√	
164	MacConkey agar	164	√	
165	SS Agar (Salmonella and Shigella)	165	√	
166	Tryptic Soy Agar 500g	166	√	
167	Tryptic Soy Broth	167	√	
168	TSI agar (Triple Sugar Iron Agar)	168	√	
169	LIM Medium (Lysine - Indole - Motility)Medium	169	√	
170	Klebsiella Chromo Select Selective Agar Base for microbiology (code: 90925)	170	√	
171	HiCulture ™ Transport Swabs with Cary -Blair Medium 100	171	√	
172	Klebsiella Chromo Select Selective Agar Base for microbiology (code: 90925)	172	√	
173	Klebsiella Selective Supplement for microbiology (code: 15821) 5vl	173	√	

	Name of chemical/reagents	characteristics	currently used	To add in project
174	Modified Semi-solid Rappaport Vassiliadis Agar (ISO) (Dehydrated)	174	√	
175	Mueller Hinton agar	175	√	
176	Mueller Hinton broth	176	√	
177	Salmonella Chromogenic Agar Base	177	√	
178	Salmonella Selective Suplement	178	√	
179	Plate Count Agar		√	
180	TSI agar (Triple Sugar Iron Agar)		√	
181	XLD agar (Xylose Lysine Deoxycholate)		√	
182	Rappaport-Vassiliadis (RV) Enrichment Broth		√	
183	Muller-Kauffmann Tetrathionate-Novobiocin Broth (MKTTn)		√	
184	Rappaport-Vassiliadis (RV) Enrichment Broth		√	
185	TCBS Agar for the isolation and selective cultivation of Vibrio cholera		√	
186	GSP Agar Pseudomonas Aeromonas Selective		√	
187	Rambach agar		√	
188	Transport media swab animy (himedia)		√	
189	Transport media swab Choacoal (himedia)		√	
190	Agar powder		√	
191	Brain - heart-infusion broth		√	
192	Pasta agar B powder		√	
193	Plate count agar		√	
194	Selenite cystine broth		√	
195	Trypto casein soy broth		√	
196	TSC Agar base		√	
197	Thioglucollate resazurin broth USP		√	
198	Urea agar		√	
199	Albumin (Albumin for Egg)		√	

Source: Asian Development Bank.