

REPUBLIC OF LIBERIA



NATIONAL HEALTH LABORATORY STRATEGIC PLAN 2023 – 2026

November 2022



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FOREWORD

The development of National Health Laboratory Strategic Plan was guided by Liberia's Joint National Action Plan for Health Security (NAPHS) 2018 – 2022, whose purpose is to prevent, detect and respond to public health threats, prevent international spread of epidemic prone diseases and promote multi-sectoral and multi-disciplinary coordination and collaboration in the context of One Health. This strategic plan feeds into overall strategic plan of the National Public Health Institute of Liberia (NPHIL).

This strategic plan has been developed using a consultative approach involving all key stakeholders, while taking cognizance of all levels of the national laboratory system and the One Health context. The strategic priorities identified were determined following a comprehensive situation analysis of the comprehensive assessment of selected laboratories across the tiered laboratory system in all 15 counties. The results of these assessments are the basis of the development of this strategic plan. Recommendations from the situation analysis and evidence synthesis guided the prioritization of interventions for implementation in this strategic plan.

This strategic plan provides the national laboratory system with a medium-term focus: objectives and priorities to enable it to undertake actions that will move the health sector toward early detection and control measures for priority diseases and public health events. NPHIL and Ministry of Health, including other line ministries are committed to the full implementation of this plan. We look forward to working collaboratively with national and county governments, partners, and all other stakeholders to ensure successful implementation.



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ABBREVIATIONS AND ACRONYMS

AFI	Acute Febrile Illness
AFRO	African Regional Office
AMR	Antimicrobial Resistance
BMET	Biomedical Engineering Technicians
BSC	Biosafety Cabinet
CMS	Central Medical Stores
COVID	Coronavirus Disease
CPD	Continuous Professional Development
DG	Director General
DDG	Deputy Director General
DSIS	Disease Surveillance Information System
EPHS	Essential Package of Health Services
EQA	External Quality Assessment
EVD	Ebola Virus Disease
FETP	Field Epidemiology Training Program
GLLP	Global Laboratory Leadership Program
HIS	Health Information System
HTMU	Health Technology Management Unit
ICT	Information and Communication Technology
IDSR	Integrated Disease Surveillance and Response
IHR	International Health Regulations
IPC	Infection Prevention and Control
LAMLT	Liberia Association of Medical Laboratory Technology
LBTS	Liberia Blood Transfusion Service
LIMS	Laboratory Information Management System
LMIS	Logistics Management Information System
MoH	Ministry of Health
MOHSW	Ministry of Health and Social Welfare
MPCHS	Mother Pattern College of Health Sciences
M&E	Monitoring and Evaluation
NASCP	National AIDS and STI Control Program
NAPHS	National Action Plan for Health Security
NDD	National Diagnostics Division
NDU	National Diagnostic Unit
NGO	Non-governmental organization
NHA	National Health Accounts
NHLSP	National Health Laboratory Strategic Plan
NHSSP	National Health Sector Strategic Plan
NPHIL	National Public Health Institute of Liberia
NPHRL	National Public Health Reference Laboratory
NSL	National Standards Laboratory

PHL	Public Health Laboratory
PPE	Personal Protective Equipment
QA	Quality Assurance
QMS	Quality Management System
SARA	Service Availability and Readiness Assessment
SLMTA	Strengthening of Laboratory Managers towards Accreditation
SLIPTA	Stepwise Laboratory Quality Improvement Process towards Accreditation
SOPs	Standard Operating Procedures
SWOT	Strengths, Weaknesses, Opportunities and Threats
TB	Tuberculosis
TIMA	Tubman Institute of Medical Arts
ToR	Terms of Reference
TWG	Technical Working Group
WHO	World Health Organization

CHAPTER 1: PURPOSE OF THE STRATEGIC PLAN

1.1 introduction

The recent Ebola Virus Disease (EBV) outbreak and subsequent Coronavirus disease (COVID – 19) pandemic have brought the role of clinical laboratories worldwide to the forefront. In Liberia, many non-governmental organizations (NGOs) joined hands with the Liberian government to respond to these public health disasters and poured in support for laboratories in the form of capacity building, equipment and supplies and monetary donations. That notwithstanding, laboratories in Liberia are still plagued with many challenges that negatively impact the provision of quality services. They include staff shortages, lack of standardization of equipment across the tiered network, lack of equipment service contracts, stockouts, lack of communication tools and documented standard operating procedures (SOPs).

Having said that, in the last few years many countries in resource limited settings including Liberia have made many strides towards improving laboratory services through the implementation of quality management systems (QMS) as they strive for accreditation. There is a general call to strengthen laboratory systems, management, and leadership through programs such as the Strengthening of Laboratory Managers towards Accreditation (SLMTA) and the Global Laboratory Leadership Program (GLLP).

The development and implementation of this National Health Laboratory Strategic Plan (NHLSP) therefore seeks to identify priority areas and strategically align these areas with relevant activities that will see the resolution of challenges that hinder the provision of quality services throughout the tiered laboratory system.

1.2. Strategic Objective

The central purpose of this NHLSP 2023–2026 is to provide a chartered course and road map to improve and strengthen the provision and delivery of laboratory services in Liberia and to ensure equitable access to quality services. The objective is to improve, strengthen, and promote the institutional and operational capacities of laboratories which in turn will improve diagnostic and monitoring capabilities.

It is expected that this plan will be the basis for the next four years resource allocation for laboratory services by all government and donor-funded programs and activities.

CHAPTER 2: BACKGROUND INFORMATION

2.1 Country Profile

Liberia is situated on the Atlantic coastline in the western part of Africa, with a total land area of 111,370 square kilometers. It shares borders with Sierra Leone, Guinea, and Ivory Coast (Figure 1). The country has a population estimated at five million. It is divided into 15 administrative counties which are further subdivided into 136 administrative districts and 68 electoral districts. The country's capital and largest city is Monrovia.¹



Figure 1. Map of Liberia

2.2 National Health System

Liberia is divided into 15 counties covering 91 health districts. The tiered health system includes clinics, health centers, county hospitals, and referral hospitals. The Ministry of Health (MoH) and the National Public Health Institute of Liberia (NPHIL) provide oversight, coordination, and supervision to all health facilities at the county (county hospitals and referral hospitals), district (health center), and community (clinic) levels. Health service

delivery in Liberia is organized into three main tiers, consisting of the primary, secondary, and tertiary levels.

2.3 Financing the National Health System

The annual budget for Liberia is approximately USD 800 million and 10.5% of this budget is allocated to healthcare. For the financial year 2015/16, the most recent year for which National Health Accounts data is available, Liberia’s health sector was primarily financed by households and development partners, with smaller contributions from the government and the private sector (**Figure 2**). The distribution of total health expenditure by financing agent (manager of the funds) in the financial year 2015 -2016 showed that 47% of health expenditures were managed by households, 25% by the government of Liberia, 19% by NGOs, and 8% by private and public health insurance providers. Development partner and private not-for-profit financing includes mostly off-budget contributions and general government support through loans and grants. Support from the government includes general tax financing and general government support from other non-grant revenue. Meanwhile, driven by increases in donor financing and private and out-of-pocket health expenditure, total health expenditure per capita reached \$83. Allocation of resources by the government of Liberia for different functions within MoH/NPHIL is depicted in **Figure 3**.²

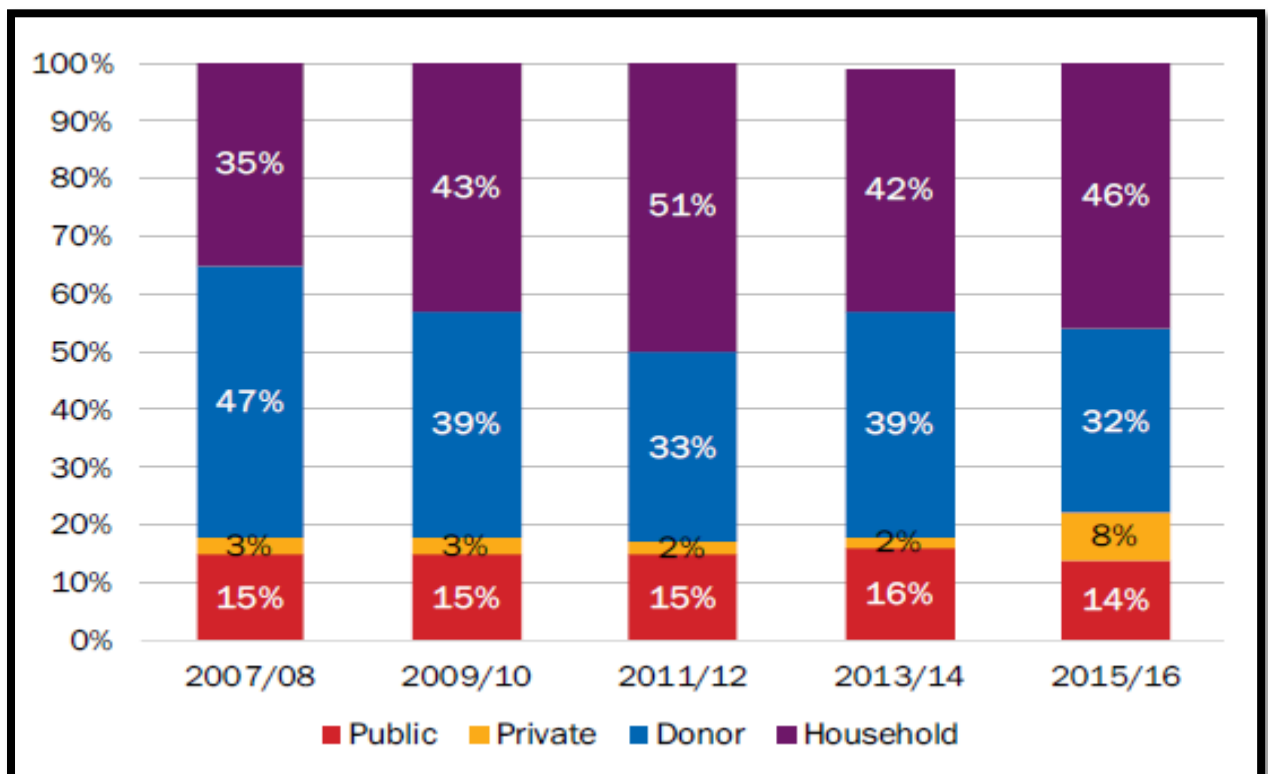


Figure 2. Total Health Expenditure by Source

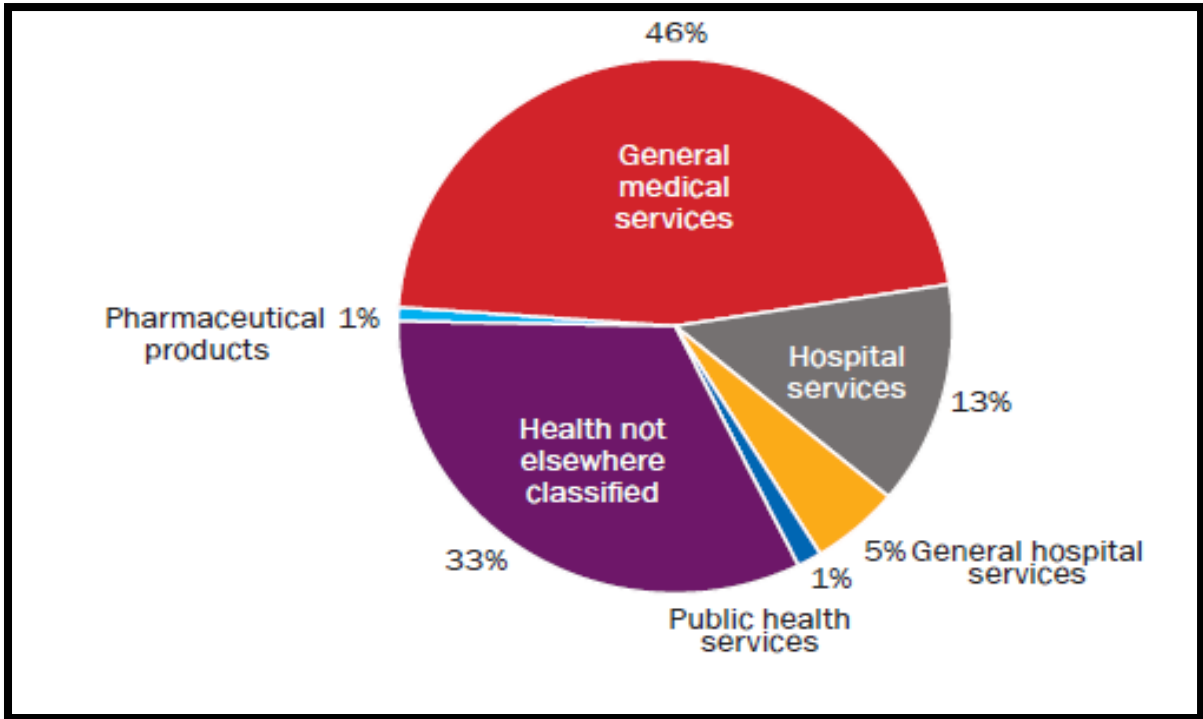


Figure 3. Breakdown of Health Allocation by Function (2017 - 2018)

2.4 Burden of Disease

Malaria remains the leading cause of morbidity and mortality in Liberia, with 38% of outpatient attendance and 42% of inpatient deaths attributable to malaria. The other diseases that make up the top ten list include diarrheal diseases, neonatal disorders, lower respiratory infections, ischemic heart disease, HIV/AIDS, stroke, tuberculosis (TB), cirrhosis and other chronic liver diseases and maternal disorders (**Figures 4 and 5**).^{2, 3}

Liberia has a generalized HIV epidemic with an adult prevalence rate of 1.4% and a higher prevalence rate for key populations (19.8% for men who have sex with men; 3.9% for people who inject drugs) and women and girls aged 15 years and over (1.8%). In the financial year 2015 - 2016, \$15 million was spent on HIV, of which the government of Liberia spent 16%, households 41%, and donors 43%. Antiretroviral therapy (ART) coverage of people living with HIV has fluctuated in the past six years, starting at 35% in 2013, dropping to 18% by 2016, and then rebounding to 29% in 2017.

TB is a high public health burden in Liberia, as the country has one of the highest incidence rates in the world at 308 new cases per 100,000 people and a mortality rate of 60 deaths per 100,000 people. Consequently, TB is one of the health priorities in the MOH/NPHIL national health plan and in its Essential Package of Health Services.²

In 2017, the entire population of 4.7 million people in Liberia was considered at risk of malaria, with prevalence estimated at 19%, one of highest rates in the world. Prevalence varies greatly by county, with the highest rates in the southeast reaching 49%. With the assistance of donors, the MOH/NPHIL has made great strides in reducing malaria prevalence significantly from the 66% rate reported in 2005. Still, as the leading cause of outpatient department attendance (57%) and the highest cause of inpatient deaths (39%) in the country,

malaria remains a major contributor to disease burden in the country. Of the \$62 million spent on malaria in the financial year 2015 - 2016, the government of Liberia contributed 20%, households 49%, and donors 31%.²

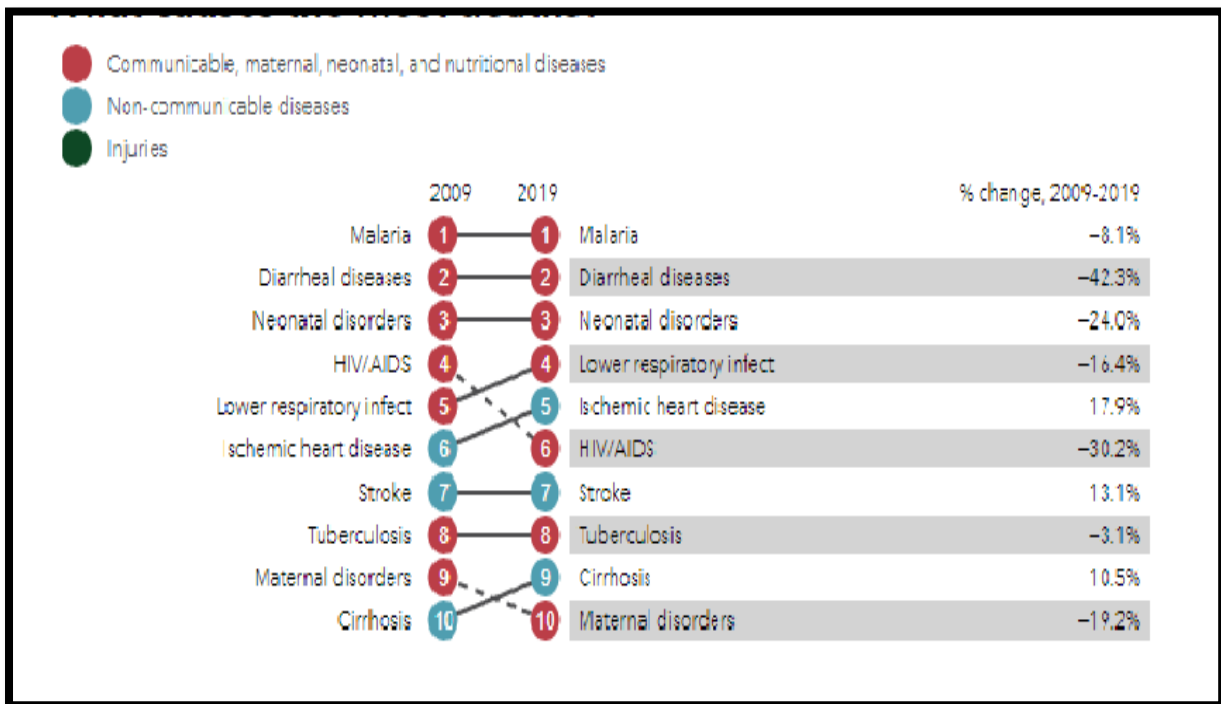


Figure 4. Leading Causes of Death in Liberia

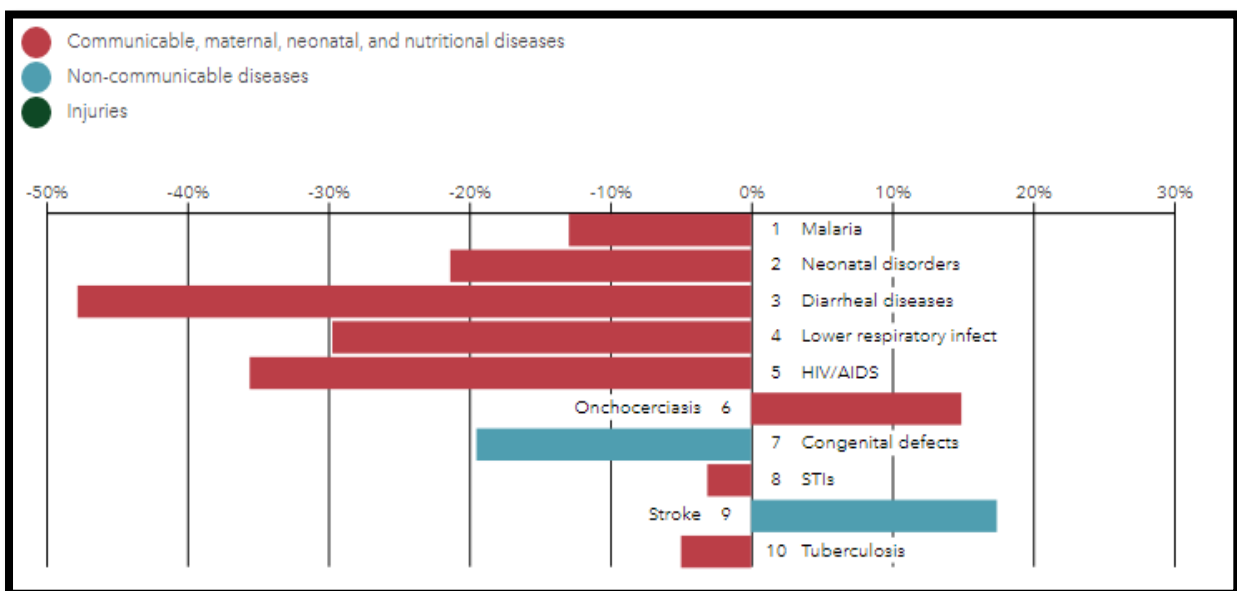


Figure 5. Leading Causes of Death and Disability in Liberia

2.5 IDSR Guidelines and Priority Diseases

The National Public Health Institute of Liberia (NPHIL) was established by the Liberian government to work with the MoH/NPHIL to strengthen the capacity for disease surveillance, support infection prevention and control (IPC) efforts, and build general public health capacity. The MoH and NPHIL have outlined diseases of major public health concern in the

Integrated Disease Surveillance and Response (IDSR) guidelines, which classify diseases into three categories: routine reportable diseases monthly, diseases or events of international public health concern, and diseases of high epidemic potential or high morbidity/mortality.⁴

Liberia first adopted the IDSR strategy in 2014. This focused on immediate notification of 10 epidemic-prone diseases and more than 30 diseases of public health importance. The Liberia-specific IDSR guidelines published in 2019 outline core public health functions, activities, and skills, and they leverage shared resources through an integrated system for diseases of major public health concern in the country. In 2019, three additional priority diseases were included in the Liberia-specific IDSR: TB, monkey pox, and dengue fever. Laboratory diagnostic capacity in Liberia is limited to confirmation of only a few of these diseases; the rest are confirmed via the international referral network (**Table 1**).

Table 1. Public Health Laboratory Testing Capacity in Liberia for IDSR Priority Diseases

IDSR Priority Disease	Diagnostic Test	Acceptable Specimen Type	Testing Laboratory
Acute flaccid paralysis	Isolation of wild poliovirus from stool	Stool	Pasteur Institute of Côte d'Ivoire
Acute watery diarrhea (cholera)	Stool culture for <i>Vibrio cholerae</i> and serotyping with polyvalent antisera	Watery stool Rectal swab	National Public Health Reference Laboratory (NPHRL), Margibi County
Acute bloody diarrhea (shigellosis)	Stool culture for <i>S. dysenteriae</i> Serotyping for <i>S. dysenteriae</i> type 1 (SD1)	Stool (recommended) Rectal swab (if stool cannot be collected)	NPHRL, Margibi County
Human rabies	Not available	Not indicated yet	Not yet identified
Lassa fever	Rapid diagnostic test for antigen detection, ELISA IgM and IgG, reverse-transcriptase polymerase chain reaction (RT-PCR)	Whole blood and serum	NPHRL, Margibi County
Measles	ELISA—antibodies (IgM) for measles virus	Serum	NPHRL, Margibi County
Meningitis	Microscopic examination Culture and isolation Serotyping and antibiotic sensitivities Molecular testing	Cerebrospinal fluid (ideal) Blood for culture (if cerebrospinal fluid not available for laboratory diagnosis)	NPHRL, Margibi County
Neonatal tetanus	Microscopic examination Culture and isolation Serotyping and antibiotic sensitivity	Blood for culture	NPHRL, Margibi County
	RT-PCR for Ebola virus	Whole blood in EDTA	NPHRL, Margibi County

Viral hemorrhagic fevers (e.g., Ebola, Marburg, Lassa)	GeneXpert	or swab	Tappita, JFD Hospital, Nimba County
	GeneXpert		Phebe Hospital, Bong County
	GeneXpert		Redemption Hospital, Montserrado County
Yellow fever	ELISA for antibodies (IgM) to yellow fever virus	Serum	NPHRL, Margibi County
	RT - PCR	Whole blood	Confirmatory testing in Senegal

2.6 Effects of Public Health Outbreaks on Laboratory Services

Outbreaks of major public health concern have had a devastating effect on the Liberian health care system, and even prior to the Ebola virus disease (EVD) outbreak, they accounted for more than 50 percent of deaths. These diseases include diarrheal diseases, TB, and measles, among others. During the Ebola outbreak, many essential services were interrupted, including diagnosing and enrolling patients into care for key public health diseases (e.g., TB, malaria, HIV/AIDS). Because EVD was new in Liberia, there was no diagnostic capacity to distinguish EVD from other types of hemorrhagic fevers previously found in Liberia. Further complicating this was the fact that Ebola initially presents as many commonly found infectious diseases, such as malaria and Lassa fever. Immediately post-EVD, the MoH/NPHIL, with support from various stakeholders, made efforts to strengthen the capability to diagnose and differentiate EVD from other infectious diseases, reinstate previous diagnostic capacity, implement new technologies, and assist in rebuilding the health care system, with special emphasis on shaping an enduring and sustainable public health laboratory network. The EVD outbreak demonstrated the critical role that a well-coordinated and operational public health laboratory network plays in detection and response to emerging infectious diseases.

2.7 The Post-EVD Laboratory System of Liberia

Since 2016, post-EVD, the MoH/NPHIL and its partners have been working to strengthen the laboratory system of Liberia. Capacity to test priority diseases was strengthened at the NPHRL as well as in the four selected regional laboratories. With partner support, laboratory capacity for conducting bacteriology testing was developed at Phebe Hospital, Jackson F. Doe Hospital, and Redemption Hospital. More than 20 MoH/NPHIL laboratory staff have been trained and provide with practical experience in bacteriological techniques. Liberia currently has four laboratories capable of handling bacteriology cultures and antimicrobial susceptibility testing: NPHRL, G. W Harley Laboratory in Nimba County, Phebe Hospital Laboratory in Bong County, and JJ Dossen Laboratory in Maryland, Tellewoyan Hospital Laboratory in Lofa County.

As part of strengthening the national equipment maintenance capacity, 15 biomedical technicians were trained in Kenya and deployed to each county. Three biomedical technicians

were trained in the United States and are serving as coordinators and supervisors for the other biomedical technicians. Several national laboratory documents were drafted and awaited for finalization. Equipment and laboratory supplies were distributed to different health facility laboratories as part of the plan to restore laboratory testing services. MoH/NPHIL vertical programs, such as the National Leprosy and TB Program and the National AIDS and STI Control Program (NACP), with the support from the Global Fund, were able to restore and scale up their laboratory testing capacities. As part of the integrated use of GeneXpert for TB and HIV viral load, 23 GeneXpert instruments were installed at different facilities throughout the country.

2.8 Effects of the COVID-19 Pandemic on Laboratory Services

The COVID-19 pandemic put an enormous pressure on healthcare services worldwide. In Liberia significant increase in workload was observed in all laboratories designated for COVID 19 testing. Also, because of this increase in workload, turnaround time became prolonged even as laboratory staff worked tirelessly around the clock to ensure that patient's results were released as efficiently as they could. The laboratory workforce was overwhelmed, and the fact that most laboratories are understaffed compounded the issue. For example, at the NPHRL, COVID-19 tests constituted 94% of all tests at the height of the pandemic. Having said that, just like the EVD outbreak, COVID-19 raised the visibility of laboratories garnering support from several MoH/NPHIL partners including WHO, USAID and CDC among others. Assistance came in the form of capacity building for both testing and surveillance, provision of supplies, personal protective equipment (PPE) and monetary support.

CHAPTER 3: THE NATIONAL LABORATORY SYSTEM

The National Health Laboratory System is part of the National Laboratory System of Liberia and includes comprehensive coverage of public health laboratories (NPHRL), clinical laboratories (National Diagnostics Division (NDD)/MOH), research institutes, and other related laboratories that serve other line ministries (e.g., Ministry of Agriculture, Ministry of Justice, Ministry of Commerce, Liberia Water and Sewer cooperation and Environmental Protection Agency), and other public and private facilities. All the laboratories operate under the One Health framework and share the same goal of providing high-quality, accurate, and timely laboratory-based information among network members in the National Health Laboratory System. The MOH/NPHIL-approved organogram, which shows the entire health laboratory support system under the One Health platform, is provided in **Figure 6**.

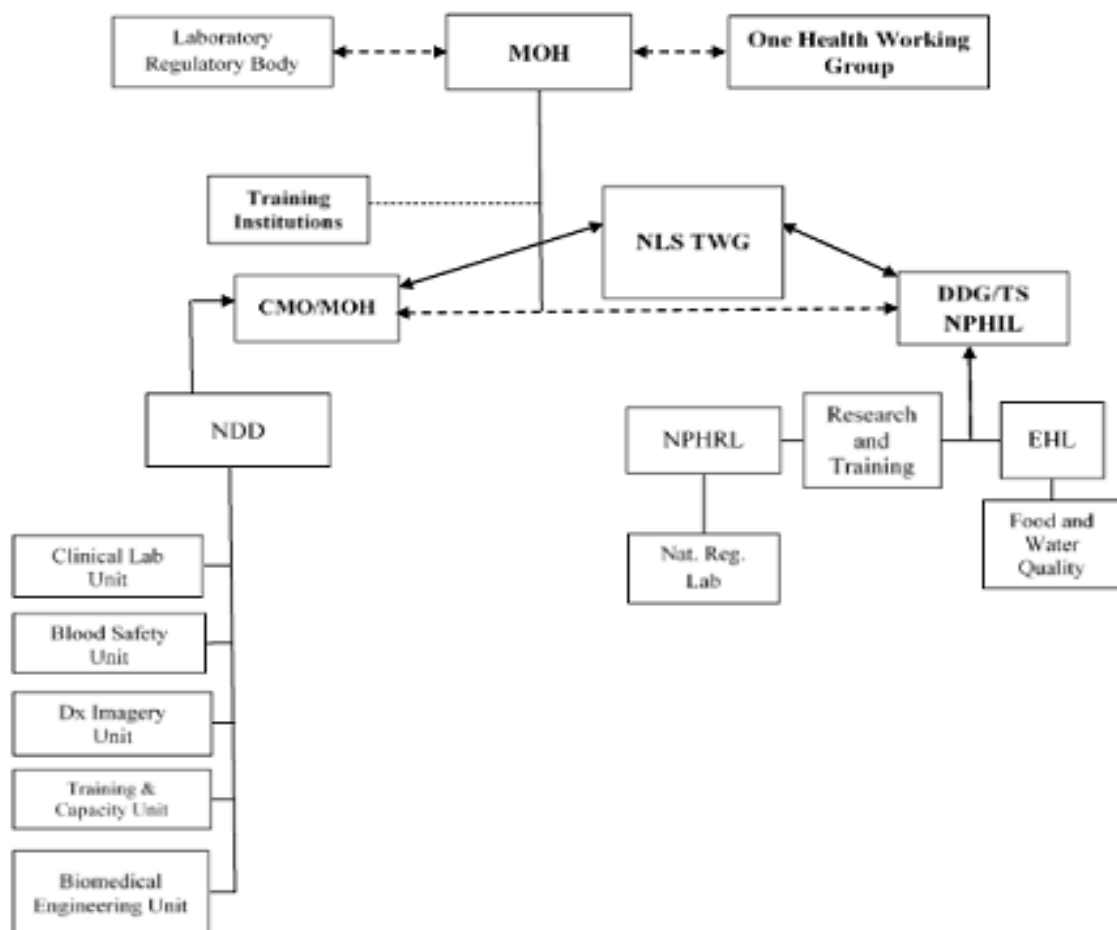


Figure 6. The National Laboratory Organogram and Coordination Framework

3.1 Public Health Laboratories

The plan of NPHIL is to establish five public health laboratories with the capacity to detect and diagnose diseases of international public health concern across the country. This will include the NPHRL (see Section 3.1.1) and four regional public health laboratories (see Section 3.1.2). The establishment of these regional laboratories is aspirational and will need a phased approach. As part of the first phase, the establishment of regional laboratories in Central and Northern Counties is proposed; in the second phase, donor support will be sought for the establishment of the two other regional laboratories in Southeastern and North-Western Counties.

3.1.1 National Public Health Reference Laboratory

The NPHRL, formerly the NRL, is mandated to strengthen diagnostic capacity for diseases of public health importance. It is composed of five units: Molecular and Genomics, Serology, Bacteriology, Parasitology, Toxicology, Biochemistry and the Tuberculosis culture and drug susceptibility testing laboratory. Current diagnostic capacity for epidemic-prone diseases includes Crimean Congo Hemorrhagic Fever (CCHF), EVD, Lassa fever, measles, rubella, cholera, typhoid fever, shigellosis, bacterial meningitis, Monkeypox, Rotavirus, Human Influenza, Dengue and yellow fever. Expansion of the testing menu to include other priority diseases is ongoing. Acute febrile illness (AFI) testing is conducted at the NPHRL. The AFI laboratory tests for 28 pathogens with associated symptoms of fever. The 28 pathogens are identified by TaqMan Array card on polymerase chain reaction. The AFI testing is for surveillance purpose and not for routine testing, although it could be useful in emergencies. In addition, the NPHRL conducts training and routine supportive supervision and mentorship to regional laboratories. The NPHRL is also mandated to conduct quality assurance and referral testing for specimens that cannot be performed elsewhere in the country.

3.1.2 Regional Public Health Reference Laboratories

Regional Laboratories will be established in phases; the first phase in the central region and the second phase in the South-Eastern region. Donor support will be sought for the establishment of the two other regional laboratories in the Northern and North-Western regions.

3.1.2.1. National Tuberculosis Reference Laboratory

The National TB Reference Laboratory is part of the NPHRL in Charlesville. The TB Reference Laboratory was established to conduct TB culture and drug susceptibility testing, and to facilitate TB microscopy external quality assessment (EQA) activities and training. Renovations were made to provide a suitable environment for TB testing. There are four, fit-for-purpose rooms available at the NPHRL equipped to support sterilization, media preparation, and culture and drug susceptibility testing of TB bacteria. The TB microscopy centers are linked to clinical laboratories.

3.2 National Diagnostic Division

The NDD is responsible for overseeing all medical and diagnostic operations in Liberia. It is composed of five units: clinical laboratories, the blood safety unit, the Imagery Unit, training and capacity unit and the biomedical engineering unit. It also oversees the private laboratory facilities.

3.2.1 Clinical Laboratories

Currently, there is a network of 401 public and private clinical diagnostic centers across Liberia: 284 are public medical diagnostic laboratories, 1 is a private-public tertiary facility (JFK Medical Hospital located in Monrovia), and 116 are private medical diagnostic laboratories. These laboratories are attached to regional hospitals, county hospitals, health centers, and clinics. They provide services ranging from basic diagnostics using rapid diagnostic tests to advanced diagnostics using automated analyzers, depending on prioritization, and funding. Clinical laboratories encompass diagnostic components of other MOH/NPHIL programs, including the National Tuberculosis and Leprosy Control Program, the National Blood Safety Program, the National Malaria Control Program, the NACP, the Imagery Unit, and the HTMU/Biomedical Engineering Unit.

3.2.2 Liberia Blood Transfusion Service

The NBTSP was established by the NACP in 2008 following an assessment that identified gaps and made recommendations for strengthening the blood banking system in Liberia. Currently, there are two regional blood centers (located in Montserrado and Bong Counties) and 38 hospital-based blood donation centers.

3.2.3 Imagery Unit

The Imagery Unit is one of the core units of NDD and will be responsible for the installation and maintenance of the different instruments (e.g., ultrasound, x-ray) used for clinical imaging diagnosis in different health facilities of the country. The MOH/NPHIL will establish this unit for clinical imaging diagnosis service for the entire country.

3.2.4. Health Technology Management Unit/Biomedical Engineering Unit

The HTMU falls under the NDD, and it supervises and supports the newly established cadre of biomedical engineering technicians (BMET). At least one BMET is assigned per county (based at the county hospital) and is responsible for supporting installation, preventive maintenance, repairs, and eventual decommissioning of laboratory and medical devices across the health facilities in that county.

3.2.5 Private Laboratories

There are approximately 116 private medical diagnostic laboratories across Liberia, the majority of which are located in the capital city of Monrovia. They provide services ranging from basic diagnostics using rapid diagnostic tests to advanced diagnostics using automated analyzers. These laboratories are poorly regulated, and there is an urgent need to streamline operational licensure processes to regulate their operations.

3.3 Line Ministry Laboratories

Line ministry laboratories (One Health Program) are also part of the laboratory network of Liberia. These include the National Veterinary Laboratory, the National Standards Laboratory (NSL), the Environmental Health Laboratory, the Liberia National Police Crime Laboratory, and pre-service laboratory institutions.

3.3.1 Central Veterinary Laboratory

This laboratory is responsible for animal health and is under the direct supervision of the Ministry of Agriculture, with support from international partners.

3.3.2 National Standards Laboratory

This laboratory is responsible for the calibration of laboratory equipment by its metrology unit, and it also conducts chemical and bacteriological analysis of food and other materials as part of ensuring standards of quality. The NSL is under the direct supervision of the Ministry of Commerce.

3.3.3 Environmental Health Laboratory

This laboratory is responsible for environmental and occupational health, including food and water testing, and is overseen by the MOH and the NPHIL, in close collaboration with the Environmental Protection Agency and the NSL.

3.3.4 Liberia National Police Crime Laboratory

This laboratory is responsible for forensic research and examining evidence from criminal cases, with oversight from the Liberian National Police. This laboratory is under the direct supervision of the Ministry of Justice.

3.4 Pre-Service Laboratory Institutions

There are five laboratory training institutes in Liberia, two located in Monrovia and one in Bong County. They are the Mother Patern College of Health Sciences at Stella Maris Polytechnic, which offers associate and bachelor's degrees; the Tubman National Institute of Medical Arts, offering a diploma; the Phebe School of Nursing, offering associate and bachelor's degrees, Censil University College offering associate degrees and Nimba Community College offering associate degrees. In addition, there are laboratories attached to training institutions, ranging from primary-level institutions to tertiary institutions, including universities. Their scope of work varies, depending on the level of the institution, and they are responsible for ensuring an environment that allows for efficient transfer of skills to the trainees.

CHAPTER 4: SITUATIONAL ANALYSIS

In October of 2022, the MoH and NPHIL audit teams, in collaboration with WHO, conducted a comprehensive assessment of selected laboratories across the tiered laboratory system in all 15 counties. The results of these assessments are the basis of the development of this strategic plan.

The team used a dedicated spreadsheet (Human – S – LAT) designed by WHO AFRO. This comprehensive tool was designed to objectively assess key indicators for diagnostic services, with the aim of continuously improving laboratory diagnostic services in Liberia by addressing identified gaps. The specific objectives of the assessments were:

- To conduct a comprehensive assessment of selected laboratories in the 15 counties.
- To collect information based on 9 thematic areas that represent key indicators of diagnostic services and the laboratory system at large.
- To analyze collected data with a view of gap identification thus understanding the current capacities and limitations of laboratories at sub-national level.
- To collate this information and use it in the review of the current National Laboratory Strategic Plan which will include an action plan to support the strengthening of laboratory services.

Table 2 shows a summary of the analysis of Strengths, Weaknesses, Opportunities and Threats (SWOT).

In addition to utilizing the results of the laboratory assessments, the following documents were also reviewed:

1. World Health Organization. (2017). Joint External Evaluation of IHR Core Capacities of the Republic of Liberia. Mission Report: September 2016. Geneva.
2. National Public Health Institute of Liberia. (2021). COVID-19 Situation Report: No. 591. Retrieved October 5, 2022, from <https://www.nphil.gov.lr/index.php/covid-19-situation-report/>.
3. Ministry of Health (2019). Five – Year Strategic Plan for the National Health Laboratory System of Liberia (2019 – 2024).
4. Ministry of Health (2019). National Laboratory System of Liberia.
5. Ministry of Health (2020). National Medical Laboratory Physical Infrastructure Guidelines.
6. National Public Health Institute of Liberia. (2020). COVID-19 Situation Report: No. 165. Retrieved October 5, 2022, from <https://www.nphil.gov.lr/index.php/covid-19-situation-report/>.
7. National Guidelines for One-Health Specimen Management and Referral System.
8. Investment Plan for Building a Resilient Health System (2015 – 2021).
9. Joint External Evaluation of the Republic of Liberia Mission report, September 2016.
10. SLIPTA audit reports.
11. Technical Capacity: Antimicrobial Resistance (AMR) Debrief Session Strategic Plan and Operational Plan Session Grand Bassa, Oct 3-7, 2022

12. Technical Capacity: Biosafety and Biosecurity Debrief Session Strategic Plan and Operational Plan Session Grand Bassa, Oct 3-7, 2022
13. Technical Capacity: National Laboratory System Debrief Session Strategic Plan and Operational Plan Session Grand Bassa, Oct 3-7, 2022

Table 2. Results of SWOT Analysis of the National Health Laboratory Services

Thematic Areas	Strengths	Weaknesses
Laboratory Governance and leadership	<ul style="list-style-type: none"> • Two bodies governing laboratory operations (NPHRL and NDD) are officially in place • Terms of reference and roles of the two bodies are well defined • The one Health approach committee is in place linking health services to environmental and agricultural agencies • Oversight for private laboratories has been defined 	<ul style="list-style-type: none"> • Inadequate government budget for laboratory services • The current laboratory strategic plan is in place but lacks funding and has not been circulated to laboratories • Laboratory policy documents defining the vision and objective of laboratories are lacking in many facilities • Inadequate cost recovery mechanism in all public health facilities • Inadequate funding allocated for laboratory capacity building, staff education and training • The current Laboratory regulatory body has limitations in that it does not encompass the One Health laboratory structure
	<p>Opportunities</p> <ul style="list-style-type: none"> • Funding from partners and donors • Capacity building from partners 	<p>Threats</p> <ul style="list-style-type: none"> • Lack of sufficient budgetary allocation for provision of quality laboratory services • Unregulated pricing for costing laboratory tests in the private sector • Overdependence on donors • Project proposals are designed without community involvement

Laboratory organization and structure	<p>Strengths</p> <ul style="list-style-type: none"> • Reference laboratories have been identified for priority diseases • Reference laboratories have established partnerships with international organizations such as WHO, CDC (US and Africa), ASLM, WAHO etc. • A list of international reference laboratories is in place • Strong collaborations with the water and animal sectors through the One Health umbrella • The LAMLT, a regulatory body for laboratory workers is in place 	<p>Weaknesses</p> <ul style="list-style-type: none"> • Lack of a clear organization structure with defined lines of authority • Lack of an inventory for all testing laboratories in Liberia • Laboratories are not organized in networks for clinical testing and surveillance • Insufficient funding to support clinical and surveillance networks and other public health activities • The existing referral network is not integrated • The scope of testing for priority diseases needs to be expanded to include additional bacteria and viruses • Lack of clear linkage between public and private health sector laboratories • Limited supervisory personnel at lower levels of the overall laboratory system • Continuous education is currently not in place and is therefore not a requirement for renewal of work authorization. • Laboratory staff are not aware of their role in IHR compliance

	Opportunities <ul style="list-style-type: none"> • Collaboration with partners 	Threats <ul style="list-style-type: none"> • IHR is barely implemented at the national laboratory level • Periodic laboratory inspections by LAMLT are not done due to lack of logistics and funding
Human Resources	Strengths <ul style="list-style-type: none"> • Availability of qualified laboratory technicians and technologists • Availability of a Field Epidemiology Training Program (FETP) 	Weaknesses <ul style="list-style-type: none"> • Lack of adequate specialized cadre of staff such as microbiologists and pathologists • High rates of staff attrition and insufficient number of qualified laboratory staff • Poor distribution of available staff • Specialist training in biomedical sciences is not available locally • Limited in-service training opportunities for laboratory personnel • Irregular staff appraisals and lack competency assessments • Lack of professional development and continuing education programs • Lack of documented staff retention strategies
	Opportunities <ul style="list-style-type: none"> • Capacity building opportunities from government and partners 	Threats <ul style="list-style-type: none"> • Limited staff motivation strategies • Personnel working in laboratories as volunteers • Lack of adequate number of trained laboratory staff to support existing facilities

Laboratory Equipment and Supplies	<p>Strengths</p> <ul style="list-style-type: none"> • Structures in place for maintenance and calibration of laboratory equipment • Reliable cold chain storage facilities available at some locations • Policies for equipment maintenance have been established in laboratories that are implementing QMS • Policies for standardization of equipment and supplies are in place 	<p>Weaknesses</p> <ul style="list-style-type: none"> • Lack of preferred supplier lists • Unreliable supply of reagents and consumables, resulting in frequent stock-outs • Very limited budget for procurement of equipment and supplies to match national health demands- supplies are mainly donor driven • Equipment standardization not implemented at facility level • Inadequate and sometimes inappropriate basic laboratory equipment at all levels of the laboratory system • Weak inventory management systems at laboratory level • Poor preventative maintenance programs • Lack of adequate equipment user maintenance training • Inadequate structures for equipment calibration in-country • Lack of service contracts for most equipment • There are no guidelines for handling of obsolete equipment and procurement or donation of equipment • There is no national database for equipment currently in use
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	<p>Opportunities</p> <ul style="list-style-type: none"> • Donor support • Trained biomedical technicians 	<p>Threats</p> <ul style="list-style-type: none"> • Insufficient budgetary allocation for equipment and supplies by government • Lack of a system for surveillance of the quality of laboratory reagents • Lack of written protocols for reagent validation • Inadequate number of bioengineers to address in-country equipment maintenance needs
Quality Management System (QMS)	<p>Strengths</p> <ul style="list-style-type: none"> • Implementation of the SLMTA program in selected facilities • Availability of a quality manual and SOPs in laboratories that are implementing QMS • A unit dedicated to QMS activities has been set up at the NDD/NPHRL 	<p>Weaknesses</p> <ul style="list-style-type: none"> • Lack of accredited laboratories in the country • Lack of printing facilities to support QMS documentation. • The presence of obsolete documents within the QMS system • Inadequately financial support for QMS activities • Limited participation in external quality assessment (EQA) • Lack of adequate training for in-country EQA panel production

	<p>Opportunities</p> <ul style="list-style-type: none"> • Availability of partner support. USAID and GIZ are currently supporting QMS implementation. • In-country ASLM certified auditors 	<p>Threats</p> <ul style="list-style-type: none"> • Lack of budgetary allocation for QMS activities
Bio-risk Management	<p>Strengths</p> <ul style="list-style-type: none"> • Biosafety manuals have been documented in laboratories that are implementing QMS • Biosafety cabinets can be certified by local bioengineers • Inspection of laboratories is done by MoH/NPHRL personnel to check for compliance with biosafety requirements 	<p>Weaknesses</p> <ul style="list-style-type: none"> • There is no unit at national level dedicated to bio-risk management • Lack of defined roles and responsibilities for bio-risk management • Bio-risk assessments are not done periodically • Crucial sections such as waste disposal, safety equipment, classification of pathogens among others have not been address in the available biosafety manual • Lack of laboratory health and safety officers and committees in many laboratories • Inadequate waste management facilities (incinerators) • Inadequate training and compliance with safety and security measures • Packaging materials for sample referral is not readily available at facility level • Up-to-date legislation defining the minimal biosafety levels, measures or requirements for operation is not available

		<ul style="list-style-type: none"> Inadequate funding for biosafety and biosecurity
	Opportunities <ul style="list-style-type: none"> Availability of external funding sources for training on biosafety Strong partner support 	Threats <ul style="list-style-type: none"> Handling of highly pathogenic organisms Lack of occupational/health facilities for laboratory personnel including post-exposure prophylaxis in certain locations Occasional stock-outs of IPC supplies
Laboratory Information Management System (LIMS)	Strengths <ul style="list-style-type: none"> Availability of LIMS in facilities using the GeneXpert for diagnostic purposes Availability of trained IT specialists to support LIMS implementation Availability of back-up system to prevent loss of laboratory data Data security mechanisms have been established Manual data collection for malaria and TB is standardized 	Weaknesses <ul style="list-style-type: none"> Lack of IT infrastructure in laboratories for the efficient management of laboratory data Lack of adequate IT specialists with adequate training to support LIMS implementation Lack of internet connectivity and other utilities Lack of resources to support LIMS sustainability Lack of funds to roll out trainings for the end user Manual data collection is mostly not standardized Feedback is not received by laboratories for data collected from their facilities
	Opportunities <ul style="list-style-type: none"> Availability of structures to support the reimplementation of LIMS in some facilities 	Threats <ul style="list-style-type: none"> Lack of funds for LIMS sustainability Lack of system management support

Monitoring and Evaluation	Strengths	Weaknesses
	<ul style="list-style-type: none"> • Partner support for specific diseases e.g. IDSR priority diseases • Trained M&E personnel at the county and ministry level 	<ul style="list-style-type: none"> • Lack of core M&E tools specific to laboratories • Weak supervision and inadequate knowledge of M&E • Lack of designated qualified M&E personnel specific to laboratories • Laboratory personnel are not aware of the indicators that are monitored on a regular basis
	Opportunities	Threats
	<ul style="list-style-type: none"> • Availability of partner funding 	<ul style="list-style-type: none"> • Lack of budgetary allocation specific for laboratory system M&E activities
Communication	Strengths	Weaknesses
	<ul style="list-style-type: none"> • The annual review meeting of laboratory specialists from MoH, NPHIL and partners to deliberate on various laboratory activities 	<ul style="list-style-type: none"> • Lack of a documented communication strategy for the laboratory network • Lack of functional communication tools such telephones, internet, and fax at all laboratory levels within the tiered network • Lack of a designated helpdesk at the MoH or NPHIL • Lack of a national laboratory website • Lack of disease-specific or partner specific laboratory bulletins
	Opportunities	Threats
	<ul style="list-style-type: none"> • Availability of partner support • Availability of risk communication/health promotion units at MoH/NPHIL 	<ul style="list-style-type: none"> • Lack of budgetary allocation to support communication
	•	•

4.1 Laboratory Governance and leadership

4.1.1 Laboratory Coordination Mechanism

The laboratory services in Liberia are governed and coordinated by the NDD, a department under MoH and NPHIL. NDD is headed by a director while NPHIL has a Director General (DG) and a Deputy Director General (DDG). These group of top managers provide guidance and leadership for laboratory services in Liberia.

4.1.2 Laboratory Policy and Strategic Plan

There is the five-year Strategic Plan for the National Health Laboratory System of Liberia (2019 – 2024) at national level.⁵

This plan takes into account the following elements:

- Laboratory coordination and governance/leadership.
- Laboratory management and organizational structure
- Quality management systems.
- Procurement and supply management.
- Laboratory information management system.
- Safety and waste management.
- Laboratory regulations.
- Laboratory financing.

It does not address the following:

- Laboratory benchmarks for infrastructure, equipment, testing techniques and manpower.
- Human resource management-induction and in-service.
- Laboratory equipment management.

These are addressed in the national laboratory standardization guidelines.^{6, 7, 8}

The plan is currently under different phases of implementation but is not fully funded. For example, USAID and GIZ are currently supporting QMS implementation.

4.1.3 Laboratory Services Funding

With respect to the laboratory budget, each of the 15 counties carries out annual budget year planning as required by central MoH. During this Planning the laboratory is represented by the County Diagnostics Officers (CDO) who feeds information pertaining to support for laboratory operations into the budget planning template. Following the budget planning at the county level, the draft is sent to central MoH for cleaning, alignment, finalization, and approval. However, this budget is heavily subsidized by partners as supplies for laboratory operations are mainly donor driven. The support given by donors is not streamlined although there are policy documents that have been availed to them.^{6, 7, 8} However, NDD/NPHIL need to perform a cost-effectiveness analysis to select technically and financially appropriate laboratory technologies and methods so that donors and partners are mandated to support the set criteria.

4.2 Laboratory organization and structure

4.2.1 Laboratory System Structure

The laboratory system organogram is currently under review to streamline the reporting lines between the NDD and Health Technology Management Unit (HTMU) and is therefore not in circulation

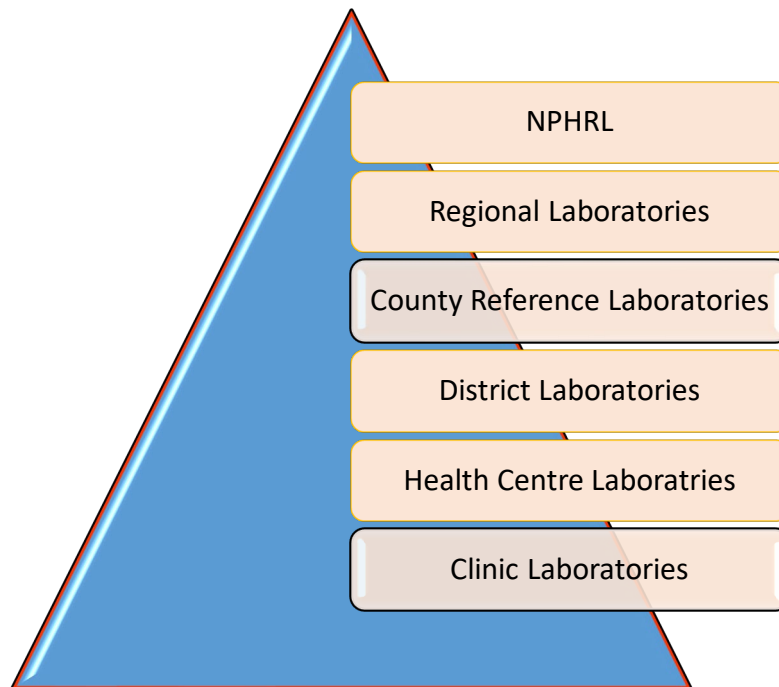


Figure 6. *The Laboratory Tiered System*

NDD and NPHIL oversee the integrated tiered network (**Figure 7**) consisting of 401 public and private registered diagnostic laboratories operating at six main levels organized along the referral system. The six main levels are:

- The NPHRL
- Regional public health laboratories
- County Reference laboratories
- District laboratories
- Health center laboratories
- Clinic laboratories

The current laboratory services serve both clinical and public health needs. Therefore, the national laboratory services, as part of the national health system, supports curative, preventative and public health components of the health system. The NPHRL, which tends to public health issues is governed by NPHIL while NDD governs clinical health laboratories. Most clinical laboratories are housed within a hospital setting.

For better management and coordination of laboratory services in the country, a strong linkage is necessary between the two governing bodies so that services are not fragmented. Also, the provision of focal persons at the lower levels of the laboratory

system will strengthen technical capabilities of these laboratories while also supporting communication needs along the tiered network.

4.2.2 Reference Laboratories Organization

The NPHRL has been identified in Liberia for diagnosis of priority diseases and response to public health threats. This laboratory is officially designated by executive order and is part of the early warning system in place for public health events/outbreaks. It is a member of public health laboratories in West African Health Organization (WAHO) and is designated for the following pathogens/diseases: Cholera, Neisseria/Haemophilus, and Shigella/Salmonella/E. coli, TB, monkey pox, EVD, yellow fever, Lassa fever, Marburg virus, HIV, malaria, and measles/rubella.

The Veterinary Reference Laboratory is functional and designated for the following pathogens: rabies, avian influenza, brucellosis, anthrax, bovine TB, foot and mouth disease African swine fever and ovine rinderpest.

4.2.3 Laboratory Networks

Laboratories in the country are not organized in networks for clinical testing (hematology, chemistry, etc.) purposes. However, to some extent there is a network for public health surveillance purposes where both public and private laboratories participate in public health events. These laboratories have been enabled to refer samples for suspected outbreaks to NPHRL for analysis. However, feedback from the NPHRL to those referring facilities still remains a major challenge.

The test menus for the different laboratory levels has been captured in section 4 of the essential package of health services.⁸ In practice, this is not implemented; there is not much difference between test menus for medical health centers and district hospital laboratories as observed during the nationwide laboratory assessments and tests done at the same level varied from facility to facility (**Table 3**).

Table 3. Testing Menu at Different Laboratory Levels

National Reference Laboratory	Regional Laboratories	District Laboratories	Health Center Laboratories
Acute flaccid paralysis	TB (Ziehl neelsen)	Malaria (Slide Test)	Malaria (Slide Test)
Acute watery diarrhea (cholera)	Stool Microscopy and concentration	TB (Slide Test)	TB (Slide Test)
Acute bloody diarrhea (shigellosis)	Hematology*	HIV (RDT)	HIV (RDT)
Human rabies	Clinical Chemistry*	Hepatitis B Virus (RDT)	Hepatitis B Virus (RDT)
Lassa fever	Malaria (Slide Test)	Hepatitis C Virus (RDT)	Hepatitis C Virus (RDT)
Measles	KOH prep	Hemoglobin	Hemoglobin
Meningitis	Urinalysis and gram stain on urine	Urinalysis	Stool microscopy**

Neonatal tetanus	CSF cell count and gram stain		Urinalysis**
Viral hemorrhagic fever (e.g., Ebola, Marburg)	India ink for Cryptococcus meningitis		
Yellow fever	Cell counts to ascetic and pleural fluids		
	Gram stain on pus and other discharges		
	Culture and sensitivity for IDSR priority samples		
	Culture and sensitivity for other suspected bacterial diseases		

*Not done at all district laboratories

**Not done at all health center laboratories

4.2.4 Specimen Referral System

The referral system as currently constituted is mainly between each laboratory and NPHRL. This referral system does not reflect the requirements of an integrated laboratory specimen referral network which would include laboratories at each level of the network and would see samples moving along the network in a stepwise manner where referral samples from a health center might move to the district laboratory for confirmation or in the event of stock outs or equipment downtime.

Riders for Health Liberia (RHL) are available in each county to transport referral samples. This is an autonomous body funded by US CDC that works in close partnership with the MoH and NPHIL. The Liberian government and World Bank through WHO has also given financial support for fleet management. These riders are trained and certified by International Air Transport Association (IATA) and refresher training offered every two years.

Emergency sample collection and packaging materials are often supplied by NPHIL, these materials are received and managed by the county and district surveillance officers with limited involvement of the CDOs.

4.2.5 Laboratory Regulation Mechanism

The Liberia Association of Medical Laboratory Technology (LAMLTL) is a regulatory body for laboratory services that was founded in Monrovia in 1976. The main goal of this

regulatory body is to uplift the standards of laboratory practice in Liberia. Their main functions are:

- To access and evaluate all medical laboratory schools for quality education.
- To access and evaluate all health facilities with medical laboratories for quality services.
- To review and provide valid practicing licenses to all members.

Currently, public laboratories operate under the act that established the institution under which they operate. A copy of this act should be held at the laboratory. However, private laboratories need to be registered and licensed by the association to operate, but this is not happening. Also, with the advent of point-of-care testing, there is a need for classification, registration and licensing of non-laboratory personnel working with these devices.

Additionally, the following areas (which form the normal part of the licensing process) are not regulated as part of the licensing mechanism or separately:

- *In vitro* diagnostic devices (including equipment).
- *In Vitro* Diagnostics (IVD) manufacturers and providers.
- Human resources (Pre-service training and continuous professional development - CPD).
- Laboratory testing methods/principles.
- Specimen transportation.
- Data management.
- Biorisk management measures.
- Laboratory related ethics.

Compliance with standards/legislation are not routinely assessed through inspection by the association. Apparently, for almost a year now, LAMLT has experienced leadership transition challenges which affected its operations. Moreover, staffing and logistics at the association is inadequate making it difficult for the organization to execute its mandate.

4.2.6 Laboratory/International Health Regulations Compliance

In Liberia, Integrated Disease Surveillance and Response (IDSR) is used as a platform for implementing IHR as it provides a framework for strengthening the surveillance, response and laboratory core capacities required by the revised IHR 2005.^{4,9}

Having said that, CDOs were provided with training in Buchanan in 2019 on IHR regulations and guidance. However, it would seem that the CDOs did not pass on the training to their respective facilities because many laboratories are not aware of their role in the implementation of IHR. Furthermore, no one has communicated the definition of Public Health Emergency of International Concern (PHEIC) to these laboratories. For this reason, many of these facilities may fail to adequately implement three of the six pillars of IHR laboratory core capacity that directly fall under their docket namely:

- Biosafety and biosecurity
- Specimen collection and transportation
- QMS

4.2.7 Collaboration with Animal Health and Food/Water Laboratory Systems

One Health is an approach that recognizes that the health of people is closely connected to the health of animals and our shared environment. The concept recognizes that because of this close connection, pathogens can cross boundaries between people and animals causing diseases. Such diseases include Salmonella infection, West Nile virus infection, Q fever (*Coxiella burnetii*), anthrax, brucellosis, Lyme disease, ringworm and EVD.

There are other threats that are common to people, animals, and the environment. First and foremost is antibiotic-resistant organisms that can quickly spread through communities, the food supply, healthcare facilities and the environment (soil and water), making it harder to treat certain infections in animals and people. Also, diseases in domestic animals bred for food can threaten supplies, livelihoods, and even economies. The contamination of water used for drinking, recreation, and more, can cause illness in both people and animals.

Despite this, many of the laboratory personnel in Liberia are neither aware of animal health and food/water Laboratory systems in the country nor the Environmental and Toxicological laboratory systems. Many have never attended a meeting organized under the One Health umbrella.

4.2.8 Antimicrobial/Antibiotic Resistance Surveillance

Currently, antituberculosis, antimalarial, antiretroviral, and antiviral drug resistance surveillance programs have not been implemented in the country. This is a limitation that needs to be addressed urgently.

Antimicrobial susceptibility testing on the other hand is done at NPHRL and at four regional laboratories namely, JJ Dossen hospital laboratory in Maryland county, Phebe Hospital laboratory in Bong County, GW Harley hospital laboratory in Nimba county and Tellewoyan Memorial hospital in Lofa county. Tests are specific for microorganisms such as enterobacteriaceae, and *Staphylococcus aureus*. Antimicrobial susceptibility testing is also done in some private laboratories such as Jehmale medical solution center in Paynesville Montserrado County.

4.3 Human Resource Management

Of the many factors that affect the quality of results in the laboratory, human resource management is the most closely correlated with success, and the most accessible opportunity for overall improvement of laboratory operations. The mission and vision of any organization will determine the type of personnel employed and the required skills set. This applies to laboratory personnel as well. When laboratories are organized in a tiered system, and services of laboratories standardized at each level of the system, the placement of personnel in the various laboratories becomes easier and more controlled. Personnel skills are simply matched to the prescribed test menu. Needless to say, the selection of laboratory personnel, their skills and competency will definitely impact patient management.

4.3.1 Human Resources Inventory and Availability

Although an inventory of laboratory personnel is generally available at the hospital administrator's office in each location, a national inventory for laboratory personnel is currently not available at NDD. However, plans are in place to put this database in place.

Staff needs assessment are not done. Concerning the volunteers currently working as technical personnel in the facilities, some are trained technical personnel hoping to be absorbed into the system by MoH/NPHIL eventually. However, staffing should consider the needs of the patients as some of the laboratories that are solely manned by unqualified volunteers limit the number of complex tests that can be done in such locations.

With respect to human resources supporting equipment maintenance, there are trained biomedical technicians inside the country. However, these technicians are trained specifically for maintenance of biosafety cabinets and the GeneXpert equipment.

4.3.2 Laboratory Workers Pre-service Training and Qualification

Most laboratory science graduates are trained at Mother Pattern College of Health Sciences (MPCHS), Phebe Hospital and School of Nursing and Tubman Institute of Medical Arts (TIMA) JFK Hospital. Having said that, most laboratory facilities in Liberia suffer from acute shortage of staff due to attrition. Also, the distribution of available staff needs to be addressed to ensure that facilities in remote areas are well manned despite their locations. Incentives for personnel should be introduced to encourage staff retention especially in remote areas.

Colleges to support the training of postgraduate senior cadre of staff such as microbiologists and pathologists are lacking. For this reason, these cadre of staff are not available in most facilities. To better address the needs of laboratories in the country, the MoH/NPHIL should liaise with the Ministry of Education to ensure that the staffing gaps identified within the system are captured in the curricula of the training colleges.

The licensing and registration of laboratory workers is well organized, with this mandate given to the LAMLT. To be registered with this board, personnel are required to present their certificates of qualifications. Licenses are valid for a period of two years after which they must be renewed. Continuous education and training are not mandatory for renewal of these work authorization licenses.

4.3.3 Laboratory Workers Knowledge and Competence Management

Overall, there are no policies or guidelines in place within the laboratories to ensure periodic laboratory staff competency assessments. Also, in-service/continuing education/training is not available for laboratory workers in certain locations.

Training in specimen collection, packaging and transportation, laboratory quality assurance, new laboratory diagnostic techniques, data management, epidemiological surveillance, computer science as applied in the laboratory, biorisk management, and laboratory management is offered but to a very limited extent. Very few laboratory staff have been invited to attend the Field Epidemiology and Laboratory Training Program (FELTP) that is supported by African Field Epidemiology Network (AFENET).

4.4 Laboratory Equipment and Supplies

Laboratory consumables and equipment are procured by the MoH/NPHIL through the Central Medical Stores (CMS). Development partners also procure laboratory consumables and equipment on behalf of the MoH/NPHIL. The storage and distribution of these consumables and equipment are coordinated by CMS. Facilities on the upper tier of the laboratory system are relatively better equipped and stocked than those on the lower levels.

The MoH/NPHIL and partners have developed harmonization and standardization guidelines for procurement and placement of equipment.^{6,7,10} However, these guidelines have not been enacted as evidenced by operations within the laboratories. Currently, many partners purchase equipment with varying specifications presenting a variety of complications among them, difficulties in servicing and maintenance due to lack of service contracts, the need for varied EQA and training to support the different platforms.

There is very limited capacity for installation, validation, calibration, and maintenance of laboratory equipment and therefore, formal contracts need to be established with suppliers to ensure after sales service. Also, mechanisms for disposal of obsolete equipment are not in place. For this reason, obsolete equipment remains within many facilities creating challenges pertaining to storage as space is very limited. Additionally, the SOP addressing equipment procurement as well as the guide for equipment donations has not been availed to these laboratories.

4.4.1 Laboratory Equipment Financial Resources

At national level, there is no specific budgetary allocation for supply of equipment to public laboratories and therefore NDD relies heavily on donor support.

4.4.2 Laboratory Supplies Management

The standardization of critical supplies is necessary and very beneficial in any laboratory supply chain. In practice, the acquisition of supplies cannot be easily standardized because of the use of varied platforms of testing within the laboratories.

Although there is a procurement and supplies management system for public laboratories at national level, laboratory personnel do not know how it works because their requisition procedure does not extend beyond the administrator or the pharmacy unit in their facilities. Requisitions from the laboratory are sent to the county logistician through the administrator's office or the pharmacy. In private laboratories, these requisitions are sent directly to stores.

The storage facilities available for laboratory supplies including cold chain products in most of the public and private laboratories is insufficient and mainly confined to the workspace of the laboratory.

At national level, there is no authorized body to validate reagents and kits, neither is there any system for reago-vigilance that ensures that only those kits that meet the stipulated quality conditions are procured. Also, the disposal of expired/unwanted reagents needs

to be streamlined, documented, taking into consideration government and international regulations/requirements, and implemented.

In general, capacity building for supply chain management specifically for laboratory supplies is required. Poorly coordinated inventory and procurement systems will not support the uninterrupted supply and service delivery that laboratories aim to achieve. Many facilities experience regular stock-outs of essential reagents as well as equipment downtime, limiting their ability to carry out basic tests. The establishment of a laboratory logistics unit within the MoH/NPHIL may improve the procurement and supply management of laboratory supplies. This unit should be responsible for forecasting, quantification, procurement, and distribution of all supplies (laboratory equipment, reagents and consumables). Also, a list of preferred suppliers for the various reagents and consumables needs to be compiled and the criteria for evaluation of such suppliers established to improve the quality of supplies.

For public laboratories, laboratory reagents and supplies have been placed into the national supply chain master plan (2022 – 2027) but there is no guarantee that funds will be available.

4.5 Quality Management System

In many resource-constrained settings, including Liberia, the Strengthening Laboratory Management toward Accreditation (SLMTA) program has been adopted. This is a training and mentoring program developed to achieve immediate and measurable improvement in laboratories. This structured improvement approach helps laboratories progress toward accreditation by national or international standards.

Two partners are currently supporting QMS in Liberia that is, USAID and GIZ. Currently, most of the support is fragmented and not very well coordinated. For laboratories that are implementing QMS, the process is fraught with challenges. For instance, circulation of obsolete documents due to lack of printing facilities, insufficiently documented procedures and inadequacies in the infrastructure, equipment, supplies, human resources and other aspects compromise the ability to implement sound QMS. A concerted effort is required to support at least the national and regional laboratories to accreditation.

Some of the poor performing quality essentials based on the September – October 2022 SLIPTA audits include management reviews, internal audits, customer service, identification of conformities, corrective and preventive action.

4.5.1 Laboratory Quality Policy and Plan/ Standards for Laboratories

At central level, the MoH/NPHIL has set up a quality unit within NDD and appointed a national quality officer. However, because few laboratories have been selected to participate in SLMTA due to financial constraints, many laboratories do not have a quality officer to oversee the implementation of the QMS. Many more do not have laboratory quality policies and plans. For those that have quality plans, these plans are mostly not funded.

4.5.2 Disease Specific SOP Availability

Documentation of SOPs is the hallmark of QMS implementation. In Liberia the laboratories that have documented SOPs for the tests and procedures within their test menu from the pre-analytical to post-analytical stage are only those that have been mentored through the QMS programs. Key documents like the specimen collection and management SOPs/guidelines and the specimen acceptance criteria are missing in these facilities. Where these guidelines are available, the requirements for a laboratory test request form is not covered and for this reason, many of these laboratories do not have dedicated test report forms; patients' results are captured in the requisition form.

4.5.3 Laboratory External Quality Assessment and Internal Quality Control

Assessing the performance of any laboratory is a critical aspect of laboratory quality management, and there are several ways to conduct these assessments. One of the commonly employed assessment methods is the external quality assessment (EQA).

Liberia has an EQA program that specifically targets NPHRL and does not trickle down to the clinical laboratories. The program is supported by WHO and covers the following areas: Bacteriology (supplied by NICD South Africa), virology (Lassa fever and COVID obtained from NIH) and serology (measles, yellow fever and rubella from institute Pasteur). These panels are all received once a year except for the serology panels which are sent twice in a year.

There are no EQA programs for clinical chemistry and hematology. Participation in EQA is not mandatory for both public and private laboratories.

With respect to internal quality control (IQC), laboratories that are not in the QMS mentorship program do not have policy guidelines or recommendation for IQC performance. Additionally, in laboratories where clinical chemistry analyses are done, analysts have not been trained in statistical IQC and Levey Jennings (LJ) charts performance to enable them to track the performance of controls.

4.5.4 Laboratory Accreditation

Many agencies, organizations, or regions develop their own accreditation requirements rather than using internationally recognized standards. The advantages of such developed standards are that they are optimized for local use, recognizing local strengths and weaknesses and they can be developed in progressive steps which may eventually lead to full international recognition. The weaknesses are that the standards may be narrow or biased, consequently not being recognized by other international organizations.

Liberia has opted for the ISO 15189, an international standard used for accreditation of the clinical laboratories. To support laboratories towards accreditation, SLMTA activities are ongoing in selected laboratories. However, to date, there are no accredited laboratories in the country.

4.5.5 Laboratory Supervision

Laboratories in Liberia are supervised from the county level. A CDO has been appointed in each of the 15 counties. This officer plays a supervisory role where his duties include:

- Ensuring availability of supplies.
- Ensuring staffing levels are adequate.
- In-service training at the county level.
- Coordinating of all laboratory activities in the county in collaboration with the county health officer.
- Laboratory personnel recruitment in the county.

On average, the CDO is supposed to visit the laboratories at least once a month but also on schedule. Having said that, these visits do not often happen as scheduled and when they do, standardized checklists are not used to collect data from the visited facilities. The laboratories are usually not sure what quality indicators are monitored during each visit as they do not receive any feedback after such visits.

4.6 Bio-risk Management

The risk of laboratory-acquired infections among personnel handling pathogenic organisms is ever present. Therefore, adequate training, due diligence and awareness is crucial for all laboratory workers.

The biorisk management system is based on an approach which enables an organization to effectively identify, assess, control, and evaluate the biosafety and biosecurity risks inherent in its activities. It is built on the concept of continual improvement through a cycle of planning, implementing, reviewing, and improving the processes and actions that an organization undertakes to meet its goals. This is known as the Plan-Do-Check-Act (PDCA) principle.^{11, 12}

4.6.1 Laboratory Biosafety and Biosecurity Documentation

A dedicated unit for biosafety and biosecurity for laboratories has not been constituted at national level although the NDD is involved with provision of training in biosafety and biosecurity using support from International Quality Laboratory Services (IQLS).

Dedicated biosafety units need to be also established in the facilities to support safety issues such as inspections, audits, and documentation. In facilities where biosafety manuals are available, these need to be updated to capture crucial sections such as personal safety while manipulating samples, distillation and sterilization, waste disposal, classification of pathogens, access control, safety equipment (PPE, safety shower, eye wash center, fire blanket), use of the safety cabinet, testing/certification of the BSC and emergency procedures (fire, contamination, flooding etc.).

At the laboratory level, facilities mostly do not have designated safety officers, sufficient PPE, safe waste-disposal mechanisms, infection prevention and control mechanisms and adequate waste-management procedures. There is therefore a need to recruit and train more safety officers to support all registered laboratories. Such officers would spearhead the implementation of biosafety principles within the laboratories.

4.6.2 Policies and Regulations

Up-to-date legislation defining the minimal biosafety levels, measures, or requirements for operation of laboratories at the various levels is not available. Furthermore, specific policies or regulations for waste management and disposal have not been availed to laboratory personnel.

4.6.3 Good Practices in Biorisk Management

It is good practice to classify laboratories by biosafety levels depending on the type of organisms handled within each given laboratory. The levels range from four (4) (the highest containment level) to one (1) (the lowest containment level). A biosafety level one laboratory handles organisms such as nonpathogenic strains of *E. coli*, *S. aureus* and other organisms not suspected to be highly pathogenic, while level four handles organisms that are easily transmitted by aerosols and cause fatal diseases such as Ebola and Marburg viruses and many other hemorrhagic viruses.

Biological risks and pathogens have not been identified or classified in peripheral laboratories. In addition, biorisk assessments have not been implemented. Although safety inspections are done from time to time by personnel from MoH/NPHIL, these inspectors do not seem to have a firm schedule for the inspections and when they are done, facilities do not receive any reports on the outcome of these inspections.

4.6.4 Staff Occupational Work Services

Relevant vaccinations have been identified and are generally provided for laboratory staff in some locations. However, occupational health services including post exposure prophylaxis are lacking in various locations. This makes the laboratory working environment insecure and risky.

4.7 Laboratory Information Management System

The information produced by diagnostic laboratories has a great impact on healthcare systems in the form of diagnosis and treatment of diseases. This data has many other secondary uses in research and formulation of policy. To this effect, it is in the best interest of laboratory personnel that the data they avail is accurate and released to clients expeditiously.

In many resources constrained settings, laboratory data is captured manually in ledgers; this is the case with Liberia. However, recent advances in data management have seen the increased use of the LIMS in the laboratory setting. LIMS allows the laboratory to coordinate the flow of data right from the receipt of samples to the release of results seamlessly.

4.7.1 LIMS at the Laboratory Level

Currently, electronic LIMS is available in facilities that use the geneXpert for diagnosis but has not been modified to include other testing parameters. All laboratories use dedicated ledgers to record patient/specimen information and results. However, these ledgers are not standardized except those used to collect data pertaining to malaria and TB. Having said that, the unstandardized ledgers capture all the required information and are easy to use.

Note that in 2018, an expanded LIMS was piloted in selected facilities in Liberia including the NPHRL. This LIMS was not sustainable due to a number of issues mainly pertaining to lack of adequate funding. Some of the challenges that were faced included lack of service contracts and licensing, end users were not trained, stability of electricity, limitation of access points (leading to chronic lack of internet connectivity) and

responsibilities for maintenance, service and sustainability of operations and equipment were not defined.

4.7.2 Laboratory Information Notification /Feed-back and Communication

Laboratory information is collected from laboratories (public and private) by the CDO monthly. The personnel are not sure if collected information is shared with MoH/NPHIL because according to them, they do not see any visible positive change in their operations emanating from the collection of this data. Furthermore, the facilities are not assured of any feedback from such collected data.

4.8 Monitoring and Evaluation

Currently there are no effective systems or clearly defined laboratory indicators to assess the laboratory system's performance for effectiveness and efficiency in the delivery of quality, affordable and timely health services in accordance with the National Health Policy 2021–2030. The currently ongoing M&E is mainly for IDSR funded programs. There is a need to train M & E personnel and develop M&E tools and indicators that can track the progress and achievements of laboratory core objectives on a regular basis.

4.9 Communication

Communication and the general flow of information throughout the laboratory system is very complicated. The laboratory interacts with different types of clients and service providers on a day-to-day basis. Such clients include patients and clinicians. The laboratory also communicates with MoH/NPHIL, other laboratories, partners and, professional associations. It is the responsibility of laboratory management to ensure that the information flow is bidirectional. The communication strategy should be captured in an SOP as a plan that is used whenever the laboratory has information that it wants to disseminate. The plan should include the elements of the strategy, recipients of the information, the communication options that the laboratory will use, and the purpose of the communication.

The means of communication are simple: the spoken word, the written word, and visual images. The tools include written memoranda, emails, reports, notices, bulletins, flyers, telephone/fax service, manuals, and formal presentations, among others.

4.9.1 Communication Strategy

Currently, the laboratory services network does not have a written communication strategy.

At national level, a support desk is not available at MoH or NPHIL to handle staff inquiries. Also, there is no bulletin released by MoH/NPHIL or any of the partners to address relevant laboratory or disease outbreak updates. Moreover, a national laboratory website containing downloadable laboratory related activity updates or guidelines (and other material pertaining to laboratory operations) is not available. Furthermore, facilities do not maintain an address book with details of other laboratories, partners or suppliers that they may need to contact from time to time.

4.9.2 Communication Possibilities

Generally, communication tools such as phones, faxes and internet connectivity have not been provided for use by laboratory personnel. This is the situation in both public and private laboratories; making it very difficult for laboratory personnel to relay or receive any pertinent information within the network.

CHAPTER 5: THE STRATEGIC PLAN

5.1 Context and rationale of the National Health Laboratory Strategic Plan

The NHLSP was developed to implement the National Health Laboratory Services Policy (2023–2026) and is aligned with the following:

1. The National Action Plan for Health Security (NAPHS 2018 – 2021) whose objectives were to; expand and maintain testing capacities at minimum of 8 core tests, expand and maintain a specimen referral network that covers at least 80% of the country at district level, implement robust point of care diagnostics for applicable country priority diseases and implement a national laboratory quality system that includes licensing of laboratories.
2. The National Health Policy Plan (2011–2021), which sought to decentralize laboratory across the tiered system based on medical services offered at each level.
3. Strategic Plan for the National Public Health Institute of Liberia (NPHIL 2017-2022), whose first four objectives seek to contribute to development and sustainability of the public health workforce, develop, enhance, and expand the surveillance platform, establish a comprehensive, integrated, and sustainable public health diagnostic system, and establish multi-sectoral epidemic preparedness and response capacities and capabilities.
4. The Liberia National Health Sector Strategic Plan, 2021–2025, which proposed two strategic objectives: (1) availability of well-functioning laboratory services in all hospitals and all major and minor health centers by 2025, and (2) increasing access for all to quality laboratory services and blood transfusion services by 2025.
5. The National Monitoring and Evaluation Plan for the National Health Sector Strategic Plan (NHSSP), 2021–2025 recognizes the need to strengthen the quality assurance/quality control systems for laboratory services and a linkage to a reference laboratory at the national level which needs further strengthening.
6. National Technical Guidelines for Integrated Disease Surveillance and Response in Liberia which focuses on improving laboratory capacity for identifying pathogens and monitoring drug sensitivity and strengthening the involvement of laboratory personnel in epidemiological surveillance.
7. The One Health Concept where collaborative efforts of several sectors and disciplines (human, animal, water/food, and environment) work locally, nationally, and globally – to attain optimal health for people, animals and the environment. The One Health approach understands that the health of people is closely connected to the health of animals and our shared environment. The concept recognizes that because of this close connection, pathogens can cross boundaries between people and animals causing diseases.
8. Global Health Security Agenda 2015 which promotes an integrated IHR accelerated plan toward world safety against infectious disease threats through innovative, multi-sectoral, local, and international partnership response.

The strategic plan is also aligned with regional and global initiatives focused on improving the quality of health laboratory services in Africa, notably:

1. Maputo Declaration, January 2008: the Maputo Declaration calls for the strengthening of laboratory systems in Africa and for scaling-up of services for improving laboratory support for TB, malaria, and HIV/AIDS.
2. Yaoundé, Cameroon Declaration; Resolution AFR/RC58/R2, September 2008: The Yaoundé, Cameroon Declaration calls for the strengthening of public health laboratories (PHLs) as centers of excellence for outbreak management in the WHO/AFRO sub region.
3. Dakar, Senegal, September 2008, 5th Meeting of the Regional HIV/AIDS Public Health Laboratory Network; this meeting called for the strengthening of national HIV/AIDS testing for improved quality assurance services.
4. Kigali, Rwanda, September 2009; Resolution AFR/RC59/WP/3: Policy orientations on the establishment of centers of excellence for disease surveillance, public health laboratories, and food and medicines regulation.
5. African Society for Laboratory Medicine Freetown Declaration 2015 which recognizes the critical role of public health laboratory systems in supporting the Global Health Security Agenda by requesting countries to establish functional public health laboratory networks for early detection and response to emerging disease threats.

The implementation of this national laboratory strategic plan will take four years and will provide a national framework to guide investment in health laboratory services by the Liberian government, health development partners and other stakeholders.

5.2 Vision/Mission Statements and Core Values

5.2.1 Vision

Well-organized and sustainable system of quality laboratory services under the One Health concept that is accessible and affordable to all Liberians.

5.2.2 Mission Statement

To provide a comprehensive, integrated, sustainable and high-quality laboratory system to support diagnostic services, disease surveillance, and research.

5.2.3 Core Values

- Ethical and professional: Deliver services in the right manner, at the right time, with the right people and attitudes (i.e., honesty, trustworthy, reliability, and uprightness in executing duties); work in accordance with set rules, regulations, and professional conduct.
- Adaptable and collaborative: Ability to adapt as diagnostic needs and technologies evolve and to work in a collaborative manner with all stakeholders and partners.
- Transparency: Openness to information and professional conduct.

- **Accountability:** Obligation to demonstrate that work has been conducted in compliance with agreed rules and standards, including performance measures.
- **Confidentiality and privacy:** Records, interest, and affairs related to the clients are confined to the relevant persons.
- **Equity:** Laboratory services provided equally, regardless of gender, geographical location, ethnicity, and socioeconomic factors.
- **Customer satisfaction:** Quality services that make clients satisfied according to their expectations.
- **Integrated service delivery systems,** rather than vertical or individual disease-specific programs.
- **Tiered laboratory structure and network** to reflect the links and referral network.

5.3 Strategic Framework

This national laboratory strategic plan articulates the shared vision and goals for laboratory services for the period 2023 – 2026 and targets the following thematic areas:

- Laboratory governance and leadership
- Laboratory organization and structure
- Human resources
- Laboratory equipment and supplies
- Quality management system
- Bio-risk Management
- Laboratory information system
- Monitoring and Evaluation
- Communication

5.3.1 Laboratory Governance and Leadership

Objective

To ensure provision of sufficient budgetary allocation for the implementation of laboratory services nationwide.

Strategic Interventions

1. Ensure a dedicated national laboratory budget through consultation with the MoH/NPHIL.
2. Establish and define a coordination mechanism for donor funding by mapping donors and tracking resources in the preparation of the budgeted operational plan.

Strategic Activities

- Train laboratory managers on developing annual work plans and budgets.
- Perform an assessment to determine financial needs of the national laboratory system.
- Ensure that the national budget includes adequate funding to support sustainable laboratory operations.

- Provide a dedicated budget line at facility level for the procurement of laboratory commodities from income generated during monthly drug revolving funds implementation.
- Develop a funding transition plan and a financial strategy toward government-funded laboratory services.
- Perform a gap analysis and advocacy for directed donor funding.
- Perform cost effective analysis to ensure the selection of technically and financially appropriate technologies and methods.
- Explore the possibilities for establishing standardized and fair cost recovery mechanisms at all levels for selected chargeable tests.

5.3.2 Laboratory Organization and Structure

Objective

To have a clear and cohesive organizational structure with appropriate lines of authority to coordinate and manage the provision of comprehensive health laboratory services at all levels of the tiered system in all counties within the country.

Strategic Interventions

1. Provide adequate administrative and technical oversight with clearly defined roles and lines of authority over laboratory services across all organizations and the private sector.
2. Include legislative authority for the regulation, oversight, and management of the Laboratory System in the draft MoH public health law (set to replace the 1976 version) geared to strengthen the legal and regulatory framework for the delivery of laboratory services nationwide.

Strategic Activities

- Put in place an organizational chart depicting lines of communication, roles, and responsibilities of top laboratory services managers.
- Develop a clear flowchart of the laboratory specimen referral system/network and strengthen specimen referral and transport within this network.
- Advocate for an adequate budget to support the shipment of samples across the referral system/network.
- Provide an inventory of all laboratories performing laboratory testing in the entire laboratory referral network.
- Draw up plans that will see laboratories organized in networks for clinical testing purposes and surveillance such that a clear system exists for the referral of samples within a location.
- Support the already established LAMLT to expand their licensing criteria to include key areas of laboratory services such as in vitro diagnostic devices, equipment, IVD manufacturers and providers, Human resources (Pre-service training and continuous professional development (CPD)), Laboratory testing methods/principles, specimen

transportation, data management, bio-risk management measures and laboratory related ethics.

- Strengthen laboratory testing for the detection of priority diseases.
- Revise the antimicrobial resistance (AMR) national action plan to include additional sites.
- Develop integrated One Health AMR surveillance Strategy.
- Establish an AMR coordination center within NDD.
- Improve laboratory AMR pathogens detection and surveillance under One Health by equipping dedicated laboratories for antimicrobial surveillance and expanding capacity for antimicrobial sensitivity testing.

5.3.3 Human Resources

Objective

Ensure that the provision of adequate personnel with the necessary skills, competencies, remuneration and motivation to deliver quality and comprehensive laboratory services at all designated healthcare levels.

Strategic Interventions

1. Improve laboratory personnel employment terms and benefits to achieve retention.
2. Strengthen and standardize pre-service training programs for laboratory personnel so that all required cadre of staff is available for deployment.
3. Develop career paths for all laboratory professionals.

Strategic activities

- Develop a database to capture details of current employees in both public and private laboratories.
- Conduct human resources audits periodically to determine and fill staffing gaps within laboratories.
- Define and provide incentives for staff in remote areas.
- Provide training opportunities for laboratory personnel to improve skills in management, leadership, and new technologies.
- Support training of all cadre of staff for deployment at the different levels of the laboratory tiered system.
- Conduct annual staff appraisals at all levels of the laboratory tiered network to provide personnel with a clear pathway for promotions and capacity building where necessary.
- Support the already established LAMLT to include CPD point system in the licensing procedure.

5.3.4 Laboratory Equipment and Supplies

5.3.4.1 Equipment

Objective

To ensure that laboratories are adequately and appropriately equipped to meet the requirements of service delivery.

Strategic Interventions

1. Harmonize and standardize equipment across the laboratory system to reflect the defined level of testing.
2. Ensure appropriate technology/adequate placement of equipment at all levels of the laboratory system.
3. Acquire service contracts for all equipment and ensure that maintenance plans are put in place.

Strategic activities

- Develop a database for all equipment in all public facilities across the tiered network.
- Draw a plan with specific timelines for implementing the already developed national plan for harmonization of equipment.
- Schedule by regions/zones and initiate the harmonization and standardization of equipment across the laboratory system and share the plan with all facilities, stakeholders and donors so that donated equipment meets the set criteria.
- Strengthen coordination between MoH/NPHIL and partners with respect to equipment procurement to ensure the set criteria is met with each purchase.
- Review purchasing guidelines to ensure that every equipment that is procured has a service contract.
- Ensure that purchased equipment conform to the voltage provisions in the country i.e. 220 volt and that provision for backup power is made (solar system or generator).
- Advocate for budgetary allocation to support the service and maintenance of equipment.
- Dispose obsolete equipment according to the national and international guidelines.
- Coordinate the evaluation of all point-of-care devices through NDD in collaboration with LAMLT.
- Increase the number of trained biomedical engineers in the country to support the preventive maintenance of critical equipment such as BSCs and centrifuges.

5.3.4.2 Supplies

Objective

To ensure adequate and uninterrupted supply of laboratory reagents and consumables at all levels of the laboratory system.

Strategic Interventions

1. Improve the laboratory supply chain management.
2. Harmonize procurement and distribution of supplies for integrated laboratory services.
3. Provide in-service training in supply chain management for all relevant staff.
4. Computerize the Logistics Management Information System (LMIS).
5. Implement guidelines for environmentally safe disposal of laboratory supplies and biannual fumigation of storage spaces.

Strategic Activities

- Evaluate the laboratory supply chain system and identify gaps.
- Review existing SOPs for adequacy and make the necessary revisions.
- Train new and existing laboratory focal staff to support inventory management, forecasting and calculation of ordering amounts and implement the procedures at facility, county and national level.
- Identify key indicators to be used in monitoring the performance of the supply chain including timeliness.
- Document product specifications to promote the use of the same kits and reagents in order to increase standardization and comparability between labs.
- Provide feedback to NDD/NPHRL leadership on laboratory supply chain related issues following attendance of the national supply chain technical working group (TWG) meetings.
- All regional laboratories at county level to provide NPHRL/NDD with inventory on supplies received on a quarterly basis.
- Ensure data elements for laboratory commodities aligns with the national supply chain database and ensure that performance is monitored including timeliness.
- Reinforce entry of laboratory data elements to the existing computerized LMIS to include all essential standardized supplies.
- Develop laboratory guidelines and SOPs for disposal of supplies. National and international guidelines must apply.
- Maintain a list of preferred suppliers and monitor their performance based on set criteria including the quality of deliveries on an annual basis.
- Establish, implement and maintain reago-vigilance unit to screen the quality of reagents entering the country.
- Provide storage spaces and trained personnel to manage supplies in all regional laboratories at county level.

5.3.5 Quality Management System

Objective

To provide laboratory services that meet the quality stipulated by international standards of practice and provide a platform for assessing the competence of analysts.

Strategic Interventions

1. Strengthen the Quality Assurance Unit at the National Diagnostic Division (NDD) to oversee quality management programs.
2. Strengthen current EQA programs explore the provision of locally produced EQA panel that support different areas of testing through NPHRL.

Strategic Activities

- Define the terms of reference (TOR) for quality assurance unit at NDD.
- Support the quality assurance (QA) unit at NDD logistically to perform their duties in overseeing the implementation of quality management programs.
- Extend the SLMTA program to support additional laboratories across the 15 counties including private and autonomous laboratories.
- Establish a national pool of trainers, auditors and mentors to support QMS activities. Station these personnel within the counties for ease of logistics.
- Define the tests to be prioritized for local proficiency testing (PT) panel production.
- Build capacity on PT panel production for all prioritized tests at the NPHRL.
- Enroll laboratories in EQA schemes that will provide panels at least twice in a year for tests not prioritized for PT panel production.

5.3.6 Bio-risk Management

Objective

To provide appropriate laboratory infrastructure and implement a bio risk management program that ensure the safety of personnel, the community, and the environment.

Strategic Interventions

1. Review the national biosafety and biosecurity guidelines and ensure that all facilities meet at least the minimum biosafety and biosecurity criteria for operation depending on the types of organisms handled at each level.
2. Ensure worker's safety by supporting the setting up of occupational health clinics in all locations.

Strategic activities

- Strengthen national laboratory biosafety and biosecurity system by setting up a unit at NPHRL/NDD.
- Implement biosafety and biosecurity best practices in all laboratories across the tiered network.
- Implement bio risk assessments at the laboratory level.
- Provide biosafety equipment and establish a maintenance program for this equipment.
- Train a pool of biosafety officers to support activities in deficient laboratories.
- Establish a biosafety committee that will meet periodically to discuss biosafety and biosecurity issues.

- Develop and disseminate to all facilities a national list of dangerous chemicals, infectious agents, and other dangerous materials.
- Secure dangerous pathogens and toxins at a minimum number of national level laboratories.
- Develop an electronic database and tracking system that monitors the inventory of dangerous pathogens and toxins (including information management).
- Document procedures for disposal of dangerous chemicals and infectious agents and make provisions for such disposal.
- Establish an effective occupational health and safety program (including PEP) for laboratory personnel in liaison with the occupational health unit of the MoH/NPHIL.
- Strengthen human resource capacity for biosafety and biosecurity Programs through provision of continuous training.

5.3.7 Laboratory Information Management System

Objective

To ensure that all laboratories within the tiered system, have a functional and comprehensive LIMS (paper based or electronic) that manages and disseminates data for use by all relevant stakeholders to facilitate evidence-based decision-making.

Strategic Interventions

1. Strengthen paper-based LIMS and improve laboratory performance in patient care and surveillance.
2. Implement electronic LIMS gradually in selected laboratories.

Strategic Activities

- Develop guidelines and a standardized paper-based system with tools e.g. Registers, request forms and, monthly reporting tools for all indicators to facilitate data capture and reporting.
- Train laboratory staff on the paper-based System to ensure that all required data is capture at all times.
- Pilot the improved standardized paper-based systems in selected laboratories within the counties then gradually roll out.
- Recruit more IT specialists and provide them with adequate training to ensure support for LIMS implementation.
- Implement and maintain an electronic, integrated LIMS in selected laboratories in the system to improve laboratory data and information management.
- Train end users on LIMS and provide technical support.
- Avail a dedicated budget to support sustainability of the LIMS.
- Develop and implement an electronic, mobile, and web-based platform for effective specimen tracking across the national sample referral system.

- Establish a forum for multi-sectoral data sharing among all laboratories and agencies with activities affecting human health, to enhance collaboration for implementing the One Health model.

5.3.8 Monitoring and Evaluation

Objective

To improve the quality of laboratory services by using selected measurable indicators (qualitative and quantitative) to monitor and evaluate the implementation of core objectives and quality of laboratory services.

Strategic Interventions

To develop and implement an M & E system to assess performance of laboratory Services.

Strategic activities

- Establish and implement a functional M&E system for health laboratories in alignment with the National M & E plan.
- Develop an M & E framework to track key variables (indicators, milestones, reporting, sources of data, feedback mechanism).
- Appoint and train M&E coordinators to be stationed within the NDD and NPHIL.
- Train laboratory personnel on the M&E plan and procedures.
- Manage and utilize M&E data for improving laboratory services.

5.3.9 Communication

Objective

To improve communication within the tiered laboratory system and networks, with partners and other service providers.

Strategic Interventions

1. Advocate for a dedicated budget to support communication activities.
2. Adopt a communication strategy that will support the flow of information within the laboratory system, with partners and other support agencies.
3. Ensure the training of staff at all levels of the tiered laboratory system in scientific communication and publication.

Strategic Activities

- Document and implement a clearly defined communication strategy for the laboratory network.
- Develop a laboratory data communication plan to standardize and streamline data reporting and feedback.
- Advocate for a budgetary allocation to support communication within the entire laboratory tiered network.
- Procure communication tools such as telephones, printers, internet and faxes at all laboratory levels within the tiered network to facilitate ease of communication.

- Set up a manned helpdesk at the NDD and NPHIL to support laboratory workers and stipulate hours of operation.
- Introduce the production of a laboratory specific bulletin for updating laboratory personnel on various activities, disease outbreaks etc.
- Set up a national laboratory website to support dissemination of information and downloading of valuable guidelines and bulletins.
- Conduct training of laboratory staff in scientific communication and manuscript publication.

CHAPTER 6: IMPLEMENTATION, MONITORING AND EVALUATION

6.1 Implementation Framework

The strategic activities to be implemented in the 2023 – 2026 timeline of this strategic plan are captured in **Table 4**. Responsibilities for the various activities, costing and implementation indicators have been appended in the table.

The MoH and NPHIL will spearhead the coordination of these activities with the support of partners. Priority strategic activities will be identified in line with the country's needs and partners/stakeholders will be encouraged to align their support to these prioritized areas.

6.2 Review Meetings

The implementation of this strategic plan will be captured as part of the agenda of the laboratory TWG so that progress can be tracked, implementation plans reviewed, and changes made (as required) during these meetings.

6.3 Funding and Resource Mobilization

A national strategic plan is an extensive project with huge monetary implications. A budgetary allocation from the government will only cover a very small percentage of the total budget. Therefore, it is imperative that costing is done very carefully considering factors such as yearly inflation, changes in work volumes and unexpected public health events among other factors. Following this, other sources of funding should be sought. The following should be considered:

- Based on the costing, advocate for special funds to be specifically allocated for implementing the strategic plan by the government.
- Standardize operations to bring costs of reagents and supplies down through bundling and bulk purchases.
- Consider setting Public- Private Partnerships in selected laboratories to improve efficiency and generate income.
- Seek support from partners.

6.4 Monitoring and Evaluation

M & E is an essential component of this strategic plan, in that, it will support the monitoring and evaluation of progress and the impact of implementation on the overall strategic objectives.

Performance indicators have been identified for each strategic activity and captured in the strategic plan matrix. These indicators will act as tools for the routine tracking of each activity. The indicators will also support the management of resources, enabling stakeholders to review data and assess the impact on the targeted areas, then adjust goals, implementation approach and funding accordingly.

Table 4. Strategic Plan Matrix (2023 - 2026)

1. Laboratory Governance and Leadership							
<i>Objective</i>							
To ensure provision of sufficient budgetary allocation for the implementation of laboratory services nationwide.							
Strategic Activities (Targets)	Performance Indicator	Responsibility	Budget (USD)	Timeline			
				2023	2024	2025	2026
1.1 Train laboratory managers on developing annual work plans and budgets	Annual work plans and budgets submitted from all facilities	MoH/NPHIL					
1.2 Perform an assessment to determine financial needs of the national laboratory system.	A budgeted work plan for the national laboratory system	MoH/NPHIL					
1.3 Ensure that the national budget includes adequate funding to support sustainable laboratory operations.	Lack of stock outs and equipment downtime attributed to lack of finances	MoH/NPHIL					
1.4 Provide a dedicated budget line at facility level for the procurement of laboratory commodities from income generated during monthly drug revolving funds implementation.	Percentage of monthly drug revolving fund allocated to laboratories						
1.5 Develop a funding transition plan and a financial strategy toward government-funded laboratory services.	Percentage reduction on reliance on donor funding	MoH/NPHIL					
1.6 Perform a gap analysis and advocacy for directed donor funding.	Approved laboratory strategic plan availed to donors	MoH/NPHIL					

1.7 Perform cost effective analysis to ensure the selection of technically and financially appropriate technologies and methods.	Document showing the financial and quality comparison of various technologies and methods	MoH/NPHIL					
1.8 Explore the possibilities for establishing standardized and fair cost recovery mechanisms at all levels for selected chargeable tests.	National deliberations on the possibility of establishing standardized and fair cost recovery mechanisms at all levels for selected chargeable tests	MoH/NPHIL					
2. Laboratory organization and structure							
<u>Objective</u>							
To have a clear and cohesive organizational structure with appropriate authority to coordinate and manage the provision of comprehensive health laboratory services at all levels in all counties within the country.							
					Timeline		
Strategic Activities (Targets)	Performance Indicator	Responsibility		2023	2024	2025	2026
2.1 Put in place an organizational chart depicting lines of communication and roles and responsibilities of top laboratory services managers.	Approved organizational chart depicting lines of communication and roles and responsibilities of key laboratory personnel	MoH/NPHIL					
2.2 Develop a clear flowchart of the laboratory specimen referral system/network and strengthen specimen referral and transport within this network	Approved flowchart for the referral network	MoH/NPHIL					

2.3 Advocate for an adequate budget to support the shipment of samples across the referral system/network.	Approved laboratory budget accounting for shipment of samples across the referral system/network	MoH/NPHIL					
2.4 Provide an inventory of all laboratories performing laboratory testing (health center, hospital, public health, academic, research, etc.).	Approved inventory of all laboratories performing laboratory testing including private laboratories	MoH/NPHIL					
2.5 Draw up plans that will see laboratories organized in networks for clinical testing purposes and surveillance such that a clear system exists for referral of samples within a location.	Documents describing each network including the following information: member laboratory names or types, networking mechanisms (especially how samples and data are shared across the networks), documentation developed (SOPs, testing algorithm, reports forms) and funding sources	MoH/NPHIL					
2.6 Support the already established LAMLT to expand their licensing criteria to include key areas of laboratory services such as <i>in vitro</i> diagnostic devices, equipment, IVD manufacturers and providers, Human resources (Pre-service training and CPD), Laboratory testing methods/principles, specimen transportation, data	Approved mandate and expanded criteria for licensing of laboratories and personnel	MoH/NPHIL					

management, bio-risk management measures and laboratory related ethics.							
2.7 Strengthening laboratory testing for detection of priority diseases	Percentage increase in reportable priority diseases	MoH/NPHIL					
2.8 Revise the antimicrobial resistance (AMR) national action plan to include additional sites.	Revised AMR national action plan	MoH/NPHIL					
2.9 Develop integrated One Health AMR surveillance Strategy.	Documented surveillance Strategy	MoH/NPHIL					
2.10 Establish an AMR coordination center within NDD.	Established AMR coordination center	MoH/NPHIL					
2.11 Improve laboratory AMR pathogens detection and surveillance under One Health by equipping dedicated laboratories for antimicrobial surveillance and expanding capacity for antimicrobial sensitivity testing.	AMR surveillance implemented in identified laboratories	MoH/NPHIL					
3. Human Resources							
<u>Objective</u>							
Ensure the provision of adequate personnel with the necessary skills, competencies, remuneration and motivation to deliver quality and comprehensive laboratory services at all designated healthcare levels.							
				Timeline			
Strategic Activities (Targets)	Performance Indicator	Responsibility	Budget (USD)	2023	2024	2025	2026
3.1 Develop a database to capture details of current employees in both public and private laboratories.	Functional database with current inventory of all personnel in laboratory services	MoH/NPHIL					
3.2 Conduct human resources audits periodically to determine and fill staffing gaps within laboratories.	Audit reports	MoH/NPHIL					

3.3 Define and provide incentives for staff in remote areas.	Approved improved term of employment/incentives for staff working in remote areas	MoH/NPHIL					
3.4 Provide training opportunities for laboratory personnel to improve skills in management, leadership and new technologies.	List of available training programs and proof of staff attendance	MoH/NPHIL					
3.5 Support training of all cadre of staff for deployment at the different levels of the laboratory tiered system.	Approved improved training curricula from accredited colleges	MoH/NPHIL					
3.6 Conduct annual staff appraisals at all levels of the laboratory tiered network to provide personnel with a clear pathway for promotions and capacity building where necessary.	Annual staff appraisal reports	MoH/NPHIL					
3.7 Support the already established LAMLT to include CPD point system in the licensing procedure.	Approved mandate and expanded criteria for licensing of personnel	MoH/NPHIL					
4. Laboratory Equipment and Supplies							
4.1 Equipment							
<u>Objective</u>							
To ensure that laboratories are adequately and appropriately equipped to meet the requirements of service delivery.							
				Timeline			
Strategic Activities (Targets)	Performance Indicator	Responsibility	Budget (USD)	2023	2024	2025	2026
4.1.1 Develop a database for all equipment in all public facilities across the tiered network.	Functional database with all relevant equipment captured therein						

4.1.2 Draw a plan with specific timelines for implementing the already developed national plan for harmonization of equipment.	Plan of action for equipment harmonization with specific timelines	MoH/NPHIL					
4.1.3 Schedule and initiate the harmonization and standardization of equipment across the laboratory system. Share the plan with all facilities, stakeholders and donors so that donated equipment meets the set criteria.	Harmonized equipment across the laboratory system	MoH/NPHIL					
4.1.4 Strengthen coordination between MoH and partners with respect to equipment procurement to ensure the set criteria is met with each purchase.	Agreement between MoH and partners pertaining to equipment procurement with the criteria clearly stipulated	MoH/NPHIL					
4.1.5 Review purchasing guidelines to ensure that every equipment that is procured has a service contract.	Service contracts for each essential equipment	MoH/NPHIL					
4.1.6 Advocate for budgetary allocation to support the service and maintenance of equipment.	Laboratory budget inclusive of equipment service and maintenance	MoH/NPHIL					
4.1.7 Dispose obsolete equipment according to the national guidelines.	Approved guidelines for disposal of obsolete equipment	MoH/NPHIL					
4.1.8 Coordinate the evaluation of all point-of-care devices through NDD in collaboration with LAMLT.	Approved guidelines for management of point-of-care devices	MoH/NPHIL					
4.1.9 Increase the number of trained biomedical engineers in the country to support the preventive maintenance of critical equipment such as BSCs and centrifuges.	Number of trained biomedical engineers in comparison to baseline	MoH/NPHIL					

4.2 Supplies							
<i>Objective</i>							
To ensure adequate and uninterrupted supply of laboratory reagents and consumables at all levels of the laboratory system.							
Strategic Activities (Targets)	Performance Indicator	Responsibility	Budget (USD)	Timeline			
				2023	2024	2025	2026
4.2.1 Evaluate the laboratory supply chain system and identify gaps.	Supply chain evaluation report	MoH/NPHIL					
4.2.2 Review SOPs for adequacy and make the necessary revisions.	Revised SOPs	MoH/NPHIL					
4.2.3 Train new and existing laboratory focal staff to support inventory management, forecasting and calculation of ordering amounts and implement the procedures at facility, county and national level.	Training records of personnel	MoH/NPHIL					
4.2.4 Identify key indicators to be used in monitoring the performance of the supply chain including timeliness.	Identified and documented key indicators	MoH/NPHIL					
4.2.5 Document product specifications to promote the use of the same kits and reagents in order to increase standardization and comparability between labs.	Documented product specifications for all essential supplies	MoH/NPHIL					
4.2.6 Provide feedback to NDD/NPHRL leadership on laboratory supply chain related issues following attendance of the national supply chain technical working group (TWG) meetings.	Minutes of TWG meetings	MoH/NPHIL					
4.2.7 All regional laboratories at county level to provide NPHRL/NDD with inventory on supplies received on a quarterly basis.							

4.2.8 Ensure data elements for laboratory commodities aligns with the national supply chain database and ensure that performance is monitored including timeliness.	Records of selected indicator performance	MoH/NPHIL					
4.2.9 Reinforce entry of laboratory data elements to the existing computerized LMIS to include all essential standardized supplies.	Identifiable laboratory elements within the national database	MoH/NPHIL					
4.2.10 Develop laboratory guidelines and SOPs for disposal of supplies. National and international guidelines must apply.	Approved guidelines for the disposal of supplies	MoH/NPHIL					
4.2.11 Maintain a list of preferred suppliers and monitor their performance based on set criteria including the quality of deliveries on an annual basis.	Approved list of preferred suppliers and performance evaluation reports	MoH/NPHIL					
4.2.12 Establish, implement and maintain reago-vigilance unit to screen the quality of reagents entering the country.	Established and functional reago-vigilance unit	MoH/NPHIL					
4.2.13 Provide storage spaces and trained personnel to manage supplies in all regional laboratories at county level.	Physical storage space for supplies available at each regional laboratory	MoH/NPHIL					

5. Quality Management System

Objective

To provide laboratory services that meet the quality stipulated by international standards of practice and provide a platform for assessing the competence of analysts.

Strategic Activities (Targets)	Performance Indicator	Responsibility	Budget (USD)	Timeline			
				2023	2024	2025	2026
5.1 Define the TOR for quality assurance unit at NDD.	Approved TOR for the quality assurance unit at NDD	MoH/NPHIL					
5.2 Support the quality assurance (QA) unit at NDD logistically to perform their duties in overseeing the implementation of quality management programs.	Budgetary allocation for QMS activities	MoH/NPHIL					
5.3 Extend the SLMTA program to support additional laboratories across the 15 counties including private and autonomous laboratories.	List of laboratories on the SLMTA program	MoH/NPHIL					
5.4 Establish a national pool of trainers, auditors and mentors to support QMS activities. Station these personnel within the counties for ease of logistics.	List of trained personnel and training records	MoH/NPHIL					
5.5 Define the tests to be prioritized for local PT panel production.	Approved list of tests targeted for local PT production	MoH/NPHIL					
5.6 Build capacity on PT panel production for all prioritized tests at NPHRL.	PT panel production implementation records	MoH/NPHIL					
5.7 Enroll laboratories in EQA for tests not prioritized for PT panel production.	Records of performance on the various EQA programs	MoH/NPHIL					
6. Bio-risk Management							
<i>Objective</i>							
To provide appropriate laboratory infrastructure and implement a biorisk management program that ensure the safety of personnel, the community and the environment.							

Strategic Activities (Targets)	Performance Indicator	Responsibility	Budget (USD)	Timeline			
				2023	2024	2025	2026
6.1 Strengthen national laboratory biosafety and biosecurity system by setting up a unit at NDD.	Functional biosafety and biosecurity unit set up at NDD	MoH/NPHIL					
6.2 Implement biosafety and biosecurity best practices in all laboratories across the tiered network.	Performance scores in biosafety audits	MoH/NPHIL					
6.3 Implement biorisk assessments at the laboratory level.	Records of biorisk assessments at facility level	MoH/NPHIL					
6.4 Provide biosafety equipment and establish a maintenance program for this equipment.	Availability of biosafety equipment (with service contracts and documented maintenance schedules) at different facilities	MoH/NPHIL					
6.5 Train a pool of biosafety officers to support activities in deficient laboratories.	Records of training	MoH/NPHIL					
6.6 Establish a biosafety committee that will meet periodically to discuss biosafety and biosecurity issues.	Minutes of meetings	MoH/NPHIL					
6.7 Develop and disseminate to all facilities a national list of dangerous chemicals, infectious agents and other dangerous materials.	Approved list of dangerous chemicals, infectious agents and other dangerous materials	MoH/NPHIL					
6.8 Secure dangerous pathogens and toxins at minimum number of national level laboratories.	Approved list of facilities certified to handle dangerous pathogens and toxins	MoH/NPHIL					

6.9 Develop an electronic database and tracking system that monitors the inventory of dangerous pathogens and toxins (including information management).	Electronic list of facilities certified to handle dangerous pathogens and toxins	MoH/NPHIL					
6.10 Document procedures for disposal of dangerous chemicals and infectious agents and make provisions for such disposal.	Approved SOPs for disposal of dangerous chemicals and infectious agents	MoH/NPHIL					
6.11 Establish an effective occupational health and safety program (including post exposure prophylaxis) for laboratory personnel in liaison with the occupational health unit of the MoH.	Availability of occupational health clinics in every location	MoH/NPHIL					
6.12 Strengthen human resource capacity for biosafety and biosecurity programs through provision of continuous training.	Continuous training certificates in personnel files	MoH/NPHIL					
7. Laboratory Information Management System							
<i>Objective</i>							
To ensure that all laboratories within the tiered system, have a functional and comprehensive LIMS that manages and disseminates data for use by all relevant stakeholders to facilitate evidence-based decision-making.							
				Timeline			
Strategic Activities (Targets)	Performance Indicator	Responsibility	Budget (USD)	2023	2024	2025	2026
7.1 Develop guidelines and a standardized paper-based system with tools e.g. Registers, request forms and monthly reporting tools for all indicators to facilitate data capture and reporting.	Availability of approved standardized registers, request forms, monthly reporting tools	MoH/NPHIL					
7.2 Train laboratory staff on the paper-based system to ensure that all required data is captured at all times.	Records of training available at each facility	MoH/NPHIL					

7.3 Pilot the improved standardized paper-based systems in selected laboratories within the counties then gradually roll out.	Records of piloting and roll out	MoH/NPHIL					
7.4 Recruit more IT specialists and provide them with adequate training to ensure support for LIMS implementation.	Number of available IT specialists compared to baseline	MoH/NPHIL					
7.5 Develop and implement an electronic, integrated LIMS in selected laboratories within the laboratory system to improve laboratory data and information management.	Availability of an operational LIMS at the selected facilities	MoH/NPHIL					
7.6 Train end users and provide technical support.	Records of training	MoH/NPHIL					
7.7 Avail a dedicated budget to support sustainability of LIMS.	Laboratory budget inclusive of LIMS servicing and maintenance	MoH/NPHIL					
7.8 Develop and implement an electronic, mobile and web-based platform for effective specimen tracking across the national sample referral system.	Sample tracking records	MoH/NPHIL					
7.9 Establish a forum for multi-sectoral data sharing among all laboratories and agencies with activities affecting human health, to enhance collaboration for implementing the One Health model.	Database	MoH/NPHIL					
8. Monitoring and Evaluation							
<i>Objective</i>							
To improve the quality of laboratory services by using carefully selected measurable quality indicators to monitor and evaluate the implementation of core objectives and quality of laboratory services.							

Strategic Activities (Targets)	Performance Indicator	Responsibility	Budget (USD)	Timeline			
				2023	2024	2025	2026
8.1 Establish a functional M&E system for health laboratories in alignment with the National M & E plan.	Approved laboratory M&E plan	MoH/NPHIL					
8.2 Develop an M & E framework to track key variables (indicators, milestones, reporting, sources of data and feedback mechanism).	Approved M&E framework						
8.3 Appoint and train M&E coordinators to be stationed within the NDD and NPHIL.	Appointed M&E coordinators	MoH/NPHIL					
8.4 Train laboratory personnel on the M&E plan and procedures	M&E training records	MoH/NPHIL					
8.5 Manage and utilize M&E data for improving laboratory services.	Continuous improvement plans incorporating M&E data	MoH/NPHIL					
9. Communication							
<i>Objective</i>							
To improve communication within the tiered laboratory system and networks, with partners and other service providers.							
Strategic Activities (Targets)	Performance Indicator	Responsibility	Budget (USD)	Timeline			
				2023	2024	2025	2026
9.1 Document and implement a clearly defined communication strategy for the laboratory network.	Documented and approved communication strategy for the laboratory network	MoH/NPHIL					
9.2 Develop a laboratory data communication plan to standardize and streamline data reporting and feedback.	Documented and approved communication strategy for the laboratory network	MoH/NPHIL					

9.3 Advocate for a budgetary allocation to support communication within the entire laboratory tiered network.	Laboratory budget inclusive of communication tools	MoH/NPHIL					
9.4 Procure communication tools such as telephones, printers, internet and faxes at all laboratory levels within the tiered network to facilitate ease of communication.	Communication tools present	MoH/NPHIL					
9.5 Set up a manned helpdesk at the NDD and NPHIL to support laboratory workers and stipulate hours of operation.	Availability of support desk at NDD/NPHIL	MoH/NPHIL					
9.6 Introduce the production of a laboratory specific bulletin for updating laboratory personnel on various activities, disease outbreaks etc.	Periodical approved laboratory bulletins	MoH/NPHIL					
9.7 Set up a national laboratory website to support dissemination of information and downloading of valuable guidelines and bulletins.	Approved active laboratory website	MoH/NPHIL					

Table 5. Pullout Costing Template

N°	STRATEGY	ACTIVITIES	TOTAL COST (\$ US)	Source of funding	Additional Sources of Funding	Year 1	Year 2	Year 3	Year 4
1.	1. Laboratory Governance and Leadership	1.1 Train laboratory managers on developing annual work plans and budgets	20,000	GOL & Partners		X	X	X	X
	<i>Objective: To ensure provision of sufficient budgetary allocation for the implementation of laboratory services nationwide.</i>	1.2 Perform an assessment to determine the financial needs of the national laboratory system.	12,000	GOL & Partners		X	X	X	X
		1.3 Ensure that the national budget includes adequate funding to support sustainable laboratory operations.	-			X	X	X	X
		1.4 Provide a dedicated budget line at facility level for the procurement of laboratory commodities from income generated during monthly drug revolving funds implementation.	-			X	X	X	X
		1.5 Develop a funding transition plan and a financial strategy toward government-funded laboratory services.	7,500	GOL & Partners		X		X	
		1.6 Perform a gap analysis and advocacy for directed donor funding.	-			X	X	X	X
		1.7 Perform cost effective analysis to ensure the selection of technically and	-			X	X	X	X

		financially appropriate technologies and methods.							
		1.8 Explore the possibilities for establishing standardized and fair cost recovery mechanisms at all levels for selected chargeable tests.	-			X	X	X	X
	Sub-total 1		39,500						
2.	2. Laboratory organization and structure	2.1 Put in place an organizational chart depicting lines of communication and roles and responsibilities of top laboratory services managers.							
	<i>Objective: To ensure provision of sufficient budgetary allocation for the implementation of laboratory services nationwide.</i>	2.2 Develop a clear flowchart of the laboratory specimen referral system/network and strengthen specimen referral and transport within this network	40,000	GOL & Partners		X	X	X	X
		2.3 Advocate for an adequate budget to support the shipment of samples across the referral system/network.	-			X	X	X	X
		2.4 Provide an inventory of all laboratories performing laboratory testing (health center, hospital, public health, academic, research, etc.).	120,000	GOL & Partners					
		2.5 Draw up plans that will see laboratories organized in networks for clinical testing purposes and surveillance such that a clear system exists for referral of samples within a location.	-			X	X	X	X

		2.6 Support the already established LAMLT to expand their licensing criteria to include key areas of laboratory services such as in vitro diagnostic devices, equipment, IVD manufacturers and providers, Human resources (Pre-service training and CPD), Laboratory testing methods/principles, specimen transportation, data management, bio-risk management measures and laboratory related ethics.	20,000	GOL & Partners		X	X	X	X
		2.7 Strengthening laboratory testing for detection of priority diseases	1,200,000	GOL & Partners		X	X	X	X
		2.8 Revise the antimicrobial resistance (AMR) national action plan to include additional sites.	10,000	GOL & Partners			X		
		2.9 Develop integrated One Health AMR surveillance Strategy.	45,000	GOL & Partners			X		
		2.10 Establish an AMR coordination center within NDD.	-			X	X	X	X
		2.11 Improve laboratory AMR pathogens detection and surveillance under One Health by equipping dedicated laboratories for antimicrobial surveillance and expanding capacity for antimicrobial sensitivity testing.	300,000	GOL & Partners		X		X	
	Sub-total 1		1,735,000						
	3. Human Resources	3.1 Develop a database to capture details of current employees in both public and private laboratories.	10,000	GOL & Partners			X		

	<i>Objective: Ensure the provision of adequate personnel with the necessary skills, competencies, remuneration and motivation to deliver quality and comprehensive laboratory services at all designated healthcare levels.</i>	3.2 Conduct human resources audits periodically to determine and fill staffing gaps within laboratories.	60,000	GOL & Partners		X		X	
		3.3 Define and provide incentives for staff in remote areas.	600,000	GOL & Partners		X	X	X	X
		3.4 Provide training opportunities for laboratory personnel to improve skills in management, leadership, and new technologies.	-			X	X	X	X
		3.5 Support training of all cadre of staff for deployment at the different levels of the laboratory tiered system.	675,000	GOL & Partners		X	X	X	X
		3.6 Conduct annual staff appraisals at all levels of the laboratory tiered network to provide personnel with a clear pathway for promotions and capacity building where necessary.	-			X	X	X	X
		3.7 Support the already established LAMLT to include CPD point system in the licensing procedure.	4,000	GOL & Partners		X	X	X	X
	Sub-total 1		1,349,000						
	4. Laboratory Equipment and Supplies	4.1.1 Develop a database for all equipment in all public facilities across the tiered network.	10,000	GOL & Partners			X		
	4.1 Equipment	4.1.2 Draw a plan with specific timelines for implementing the	-			X	X	X	X

		already developed national plan for harmonization of equipment.							
	Objective: To ensure that laboratories are adequately and appropriately equipped to meet the requirements of service delivery.	4.1.3 Schedule and initiate the harmonization and standardization of equipment across the laboratory system. Share the plan with all facilities, stakeholders, and donors so that donated equipment meets the set criteria.	-			X	X	X	X
		4.1.4 Strengthen coordination between MoH and partners with respect to equipment procurement to ensure the set criteria is met with each purchase.	-			X	X	X	X
		4.1.5 Review purchasing guidelines to ensure that every equipment that is procured has a service contract.	5,000	GOL & Partners		X		X	
		4.1.6 Advocate for budgetary allocation to support the service and maintenance of equipment.	-			X	X	X	X
		4.1.7 Dispose obsolete equipment according to the national guidelines.	120,000	GOL & Partners		X	X	X	X
		4.1.8 Coordinate the evaluation of all point-of-care devices through NDD in collaboration with LAMLT.	-			X	X	X	X
		4.1.9 Increase the number of trained biomedical engineers in the country to support the preventive maintenance of critical equipment such as BSCs and centrifuges.	300,000	GOL & Partners			X		X

	Sub-total 2		435,000						
	4.2 Supplies	4.2.1 Evaluate the laboratory supply chain system and identify gaps.	20,000	GOL & Partners		X		X	
	Objective: To ensure adequate and uninterrupted supply of laboratory reagents and consumables at all levels of the laboratory system.	4.2.2 Review SOPs for adequacy and make the necessary revisions.	10,000	GOL & Partners		X		X	
		4.2.3 Train new and existing laboratory focal staff to support inventory management, forecasting and calculation of ordering amounts and implement the procedures at facility, county and national level.	70,000	GOL & Partners			X		X
		4.2.4 Identify key indicators to be used in monitoring the performance of the supply chain including timeliness.	-			X	X	X	X
		4.2.5 Document product specifications to promote the use of the same kits and reagents in order to increase standardization and comparability between labs.	-			X	X	X	X
		4.2.6 Provide feedback to NDD/NPHRL leadership on laboratory supply chain related issues following attendance of the national supply chain technical working group (TWG) meetings.	-			X	X	X	X
		4.2.7 All regional laboratories at county level to provide NPHRL/NDD with inventory on supplies received on a quarterly basis.	20,000	GOL & Partners			X		

		4.2.8 Ensure data elements for laboratory commodities aligns with the national supply chain database and ensure that performance is monitored including timeliness.	-			X	X	X	X
		4.2.9 Reinforce entry of laboratory data elements to the existing computerized LMIS to include all essential standardized supplies.	-			X	X	X	X
		4.2.10 Develop laboratory guidelines and SOPs for disposal of supplies. National and international guidelines must apply.	48,000	GOL & Partners			X		X
		4.2.11 Maintain a list of preferred suppliers and monitor their performance based on set criteria including the quality of deliveries on an annual basis.	-			X	X	X	X
		4.2.12 Establish, implement and maintain reago-vigilance unit to screen the quality of reagents entering the country.	960,000	GOL & Partners		X	X	X	X
		4.2.13 Provide storage spaces and trained personnel to manage supplies in all regional laboratories at county level.	86,000	GOL & Partners			X		X
	Sub-total 2		1,214,000						
3	5. Quality Management System	5.1 Define the TOR for quality assurance unit at NDD.	-			X		X	

Objective: To provide laboratory services that meet the quality stipulated by international standards of practice and provide a platform for assessing the competence of analysts.	5.2 Support the quality assurance (QA) unit at NDD logistically to perform their duties in overseeing the implementation of quality management programs.	160,000	GOL & Partners			X		
	5.3 Extend the SLMTA program to support additional laboratories across the 15 counties including private and autonomous laboratories.	360,000	GOL & Partners		X	X	X	X
	5.4 Establish a national pool of trainers, auditors, and mentors to support QMS activities. Station these personnel within the counties for ease of logistics.	150,000	GOL & Partners			X	X	
	5.5 Define the tests to be prioritized for local PT panel production.	5,000	GOL & Partners		X	X		
	5.6 Build capacity on PT panel production for all prioritized tests at NPHRL.	25,000	GOL & Partners		X	X		
	5.7 Enroll laboratories in EQA for tests not prioritized for PT panel production.	-			X	X	X	X
	Sub-total 2		700,000					
6. Bio-risk Management	6.1 Strengthen national laboratory biosafety and biosecurity system by setting up a unit at NDD.	-			X	X	X	X
Objective: To provide appropriate laboratory infrastructure and implement	6.2 Implement biosafety and biosecurity best practices in all laboratories across the tiered network.	50,000	GOL & Partners		X		X	

a bio risk management program that ensures the safety of personnel, the community, and the environment.	6.3 Implement bio risk assessments at the laboratory level.	30,000	GOL & Partners		X		X	
	6.4 Provide biosafety equipment and establish a maintenance program for this equipment.	300,000	GOL & Partners				X	
	6.5 Train a pool of biosafety officers to support activities in deficient laboratories.	20,000	GOL & Partners		X		X	
	6.6 Establish a biosafety committee that will meet periodically to discuss biosafety and biosecurity issues.	-			X	X	X	X
	6.7 Develop and disseminate to all facilities a national list of dangerous chemicals, infectious agents, and other dangerous materials.	10,000	GOL & Partners		X	X		
	6.8 Secure dangerous pathogens and toxins at minimum number of national level laboratories.	-			X	X	X	X
	6.9 Develop an electronic database and tracking system that monitors the inventory of dangerous pathogens and toxins (including information management).	10,000	GOL & Partners		X			
	6.10 Document procedures for disposal of dangerous chemicals and infectious agents and make provisions for such disposal.	-			X	X	X	X
	6.11 Establish an effective occupational health and safety program (including post exposure prophylaxis) for laboratory personnel	-			X	X	X	X

	in liaison with the occupational health unit of the MoH.								
	6.12 Strengthen human resource capacity for biosafety and biosecurity programs through provision of continuous training.	70,000	GOL & Partners		X		X		
Sub-total 6		490,000							
7. Laboratory Information Management System	7.1 Develop guidelines and a standardized paper-based system with tools e.g. Registers, request forms and monthly reporting tools for all indicators to facilitate data capture and reporting.	40,000	GOL & Partners		X		X		
Objective: To ensure that all laboratories within the tiered system have a functional and comprehensive LIMS that manages and disseminates data for use by all relevant stakeholders to facilitate evidence-based decision-making.	7.2 Train laboratory staff on the paper-based system to ensure that all required data is always captured.	40,000	GOL & Partners		X		X		
	7.3 Pilot the improved standardized paper-based systems in selected laboratories within the counties then gradually roll out.	10,000	GOL & Partners		X	X			
	7.4 Recruit more IT specialists and provide them with adequate training to ensure support for LIMS implementation.	70,000	GOL & Partners		X	X			
	7.5 Develop and implement an electronic, integrated LIMS in selected laboratories within the laboratory	10,000	GOL & Partners			X			

		system to improve laboratory data and information management.							
		7.6 Train end users and provide technical support.	60,000	GOL & Partners		X		X	
		7.7 Avail a dedicated budget to support sustainability of LIMS.	-			X	X	X	X
		7.8 Develop and implement an electronic, mobile, and web-based platform for effective specimen tracking across the national sample referral system.	35,000	GOL & Partners			X		
		7.9 Establish a forum for multi-sectoral data sharing among all laboratories and agencies with activities affecting human health, to enhance collaboration for implementing the One Health model.	-			X	X	X	X
	Sub-total 7		265,000						
4.	8. Monitoring and Evaluation	8.1 Establish a functional M&E system for health laboratories in alignment with the National M & E plan.	10,000	GOL & Partners				X	
	Objective: To improve the quality of laboratory services by using carefully selected measurable quality indicators to monitor and evaluate the implementation of core	8.2 Develop an M & E framework to track key variables (indicators, milestones, reporting, sources of data and feedback mechanism).	12,000	GOL & Partners				X	
		8.3 Appoint and train M&E coordinators to be stationed within the NDD and NPHIL.	6,000	GOL & Partners			X	X	

	objectives and quality of laboratory services.	8.4 Train laboratory personnel on the M&E plan and procedures	24,000	GOL & Partners			X	X	
		8.5 Manage and utilize M&E data for improving laboratory services.	-			X	X	X	X
	Sub-total 8		52,000						
	9. Communication	9.1 Document and implement a clearly defined communication strategy for the laboratory network.	-			X	X	X	X
	Objective: To improve communication within the tiered laboratory system and networks, with partners and other service providers.	9.2 Develop a laboratory data communication plan to standardize and streamline data reporting and feedback.	5,000	GOL & Partners		X		X	
		9.3 Advocate for a budgetary allocation to support communication within the entire laboratory tiered network.	-			X	X	X	X
		9.4 Procure communication tools such as telephones, printers, internet, and faxes at all laboratory levels within the tiered network to facilitate ease of communication.	70,000	GOL & Partners				X	
		9.5 Set up a manned helpdesk at the NDD and NPHIL to support laboratory workers and stipulate hours of operation.	1,000	GOL & Partners				X	
		9.6 Introduce the production of a laboratory specific bulletin for updating laboratory personnel on various activities, disease outbreaks etc.	24,000	GOL & Partners			X	X	X

		9.7 Set up a national laboratory website to support dissemination of information and downloading of valuable guidelines and bulletins.	20,000	GOL & Partners		X	X	X	X
	Sub-total 9		120,000						
	TOTAL		US\$ 6,399,500						

Table 6. Pullout Costing Summary

Thematic Area	Total Cost (USD)	2023	2024	2025	2026
Laboratory governance and leadership	\$39,500				
Laboratory organization and structure	\$1,735,000				
Human resources	\$1,349,000				
Laboratory equipment and supplies	\$1,649,000				
Quality management system	\$700,000				
Bio-risk Management	\$490,000				
Laboratory information system	\$265,000				
Monitoring and Evaluation	\$52,000				
Communication	\$120,000				
Total	\$6,399,500.0				

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