スリランカ民主社会主義共和国
中央環境局

スリランカ民主社会主義共和国
水質管理能力向上プロジェクト
事業完了報告書

平成 30 年 3 月

（2018 年）

独立行政法人国際協力機構（JICA）

（株）建設技研インターナショナル（CTII）

（株）オリエンタルコンサルタンツグローバル（OCG）

環境
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注：JICA チーム作成

調査対象地域位置図

略　　　　語

略語	英語表記	日本語表記
ADB	Asian Development Bank	アジア開発銀行
APHA	American Public Health Association	米国公衆衛生協会
APLAC	Asia Pacific Laboratory Accreditation Cooperation	アジア太平洋試験所認定協力機構
ARMIRD	Air Resources Management and International Relations Division	大気資源管理国際関係局
BDD	Biodiversity Division	生物多様性局
BOD	Biochemical Oxygen Demand	生物化学的酸素要求量
BOI	Board of Investment	投資庁
C/P	Counterpart	カウンターパート
CA	Capacity Assessment	能力評価
CCC	Ceylon Chamber of Commerce	セイロン商工会議所
CD	Capacity Development	能力向上
CEA	Central Environment Authority	中央環境局
COD	Chemical Oxygen Demand	化学的酸素要求量
DG	Director General	局長
DO	Dissolved Oxygen	溶存酸素
EE Unit	Environmental Education Unit	環境教育課
EE&A	Environmental Education and Awareness Division	環境教育啓発部
EEA Unit	Environmental Economic Affairs Unit	環境経済課
EIA	Environmental Impact Assessment	環境影響評価
EIA Unit	Environmental Impact Assessment Unit	環境影響評価課
EM&A	Environmental Management and Assessment Division	環境管理・評価部
EMP Unit	Environmental Media and Promotion Unit	環境広報促進ユニット
EPC Div.	Environmental Pollution Control Division	環境汚染制御部
EPCU	Environmental Pollution Control Unit	環境汚染制御ユニット
EPL	Environmental Protection License	環境保護ライセンス
EPZ	Export Processing Zone	輸出加工区
GCMS	Gas Chromatography Mass Spectrometry	ガスクロマトグラフィ・質量分析法
GDO	Gampaha District Office	ガンパハ群事務所
GEMS	Global Environmental Monitoring System	地球環境モニタリングシステム
GIS	Geographic Information System	地理情報システム
GOSL	Government of Sri Lanka	スリランカ政府
HR Unit	Human Resources Unit	人材ユニット
HRDAF	Human Resources Development, Administration and Finance Division	人材開発、行政、財務部
IC/ R	Inception Report	インセプションレポート、着手報告書
IEE	Initial Environmental Examination	初期環境評価
IT Unit	Information Technology Unit	情報技術ユニット
JCC	Joint Coordinating Committee	合同調整委員会
JICA	Japan International Cooperation Agency	独立行政法人国際協力機構
LA	Local Authority	地方自治体
L Unit	Legal Unit	法務ユニット
M/M	Minutes of Meeting	協議議事録
MOF	Ministry of Finance	財務省
MOH&IP	Ministry of Highways and Investment Promotion	高速道路投資促進省
MOIC	Ministry of Industry and Commerce	工業商業省
MOIWRM	Ministry of Irrigation and Water Resources Management	灌漑・水資源管理省
MOMD&E	Ministry of Mahaweli Development & Environment	マハウェリ開発環境省

略語	英語表記	日本語表記
MOUDWSD	Ministry of Urban Development, Water Supply and Drainage	都市開発水供給排水省
MPN	Most Probable Number	最確数法
NARA	National Aquatic Resources Agency	国家水産資源庁
NC/PC	National Cleaner Production Centre	国家クリーナープロダクションセンター
NEA	National Environmental Act	国家環境法
NEIC	National Environmental Information Centre	国家環境情報センター
NWPEA	North Western Provincial Environmental Authority	北西州環境局
NWS&DB	National Water Supply and Drainage Board	国家水供給排水庁
O/M	Operation and Management	維持管理
ODA	Official Development Assistance	政府開発援助
PDM	Project Design Matrix	プロジェクト・デザイン・マトリックス
PMU	Planning and Monitoring Unit	計画モニタリングユニット
PO	Plan of Operation	実行計画
PPD	Policy and Planning Division	政策計画局
PRTR	Pollutant Release and Transfer Register	環境汚染物質排出・移動登録制度
PSI	Pollution Source Inventory	汚染源インベントリー
R/D	Record of Discussion	討議議事録
R&D Unit	Research and Development Unit	調査開発ユニット
RKB	River Kelani Basin	ケラニ川流域
SEA	Strategic Environmental Assessment	戦略的環境評価
SLAB	Sri Lanka Accreditation Board for Conformity Assessment	スリランカ適合性認定協会
SME	Small and Medium Enterprises	中小企業
SMEWW	Standard Methods for the Examination of Water and Wastewater	水と排水の標準試験方法
SOP	Standard Operation Procedure	標準作業手順書
TOR	Terms of Reference	業務指示書、委託事項
UNEP	United Nations Environment Programme	国連環境計画
WB	World Bank	世界銀行
WQI	Water Quality Index	水質指標

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付属資料一覧

第1章　プロジェクトの概要

1.1　プロジェクトの背景

スリランカ民主社会主義共和国（以下「ス」国）は、2011 年から 2013 年にかけて 6.3～8.3%もの高い経済成長率を維持し、2016 年までに国民一人当たりの所得 4,000 米ドルを達成して中進国にランク入りすることを目指している。また、「ス」国政府は、水質汚濁の防止を含む環境保全により、生活水準を改善するための持続可能な開発の達成を試みている。しかしながら、コロンボ圏の取水源であるケラニ川の測定地点において、生物化学的酸素要求量（Biochemical Oxygen Demand, BOD）、化学的酸素要求量（Chemical Oxygen Demand, COD）等の河川の汚染の程度を示す値及び重金属である鉛の濃度が、日本の環境基準を超過している。これは流域の工場群からの廃水が原因と思われる水質汚染が、「ス」国内の他の河川と比較してより進行していることを示している。ケラニ川流域には複数の浄水場が存在するため、住民の健康及び環境に対して深刻な影響を及ぼすことが危惧されている。

スリランカでは、マハウェリ開発環境省傘下の中央環境局（Central Environmental Authority、以下CEA）は、環境の保護、管理、改善の責任機関であり、水質管理はそのうち重要な項目の一つである。内陸水域における水質の維持は、CEA が環境保護ライセンス（Environmental Protection License、以下EPL）用いて実施している。EPL は、2008 年 1 月 25 日公示（No 1533/16）の官報に指定された特定活動が排出する工業排水、ガス、騒音・振動および廃棄物に関し、国の環境基準を満足していることを確認して後に発行されるものである。深刻な汚染を引き起こすと想定されるカテゴリーA の業種は、2012 年には新規に 1000 件の EPL が発行されている。EPL に規定された条件を満足している工場数は既存情報によると 50%と報告されている。

また、CEA は河川の水質モニタリングも実施しているが、採水地点及び採水方法は正確に定められておらず、採水頻度も一定ではない。加えて、河川の水質環境基準の類型指定は水環境保全に関する政策策定において重要な役割を果たすものであるが、「ス」国ではまだ指定されていない。

以上のことから、「ス」国の主要な河川における適切な水質モニタリング及び汚染源となり得る河川流域の工場への適切なインスペクションの実施は、「ス」国の水環境保全を進める上で重要な課題となっており、このような状況を踏まえて、「ス」国政府は我が国政府に対し、水質モニタリング及びインスペクションに係る技術協力プロジェクトを要請した。

本要請を踏まえて、JICA は 2014 年 9 月に実施した詳細計画策定調査において、CEA 等の「ス」国側関係機関と協力の枠組み案について合意し、同年 11 月に討議議事録（Record of Discussions, R/D）の署名・交換に至った。本プロジェクトは、当該 R/D に基づいて実施するものである。

1.2 プロジェクト概要

1.2.1 プロジェクトの名称及び目的[1]

1) プロジェクト名 : 水質管理能力向上プロジェクト
2) 上位目標 : 主要水域における水質管理が CEA によって適切になされる。
3) プロジェクト目標 : 水質管理に関する CEA とケラニ川流域の地域事務所の行政執行能力が強化される。
4) 期待される成果
   - 成果 1 : 「ス」国の一般水質環境基準に準拠した水域類型指定導入のための準備がなされる。
   - 成果 2 : ラボラトリースタッフの水質分析能力が強化される。
   - 成果 3: カウンターパート（以下 C/P）機関のインスペクションを含む水質モニタリング能力強化、汚染源インベントリー（Pollution Source Inventory, PSI）の整備及び EPL の取得が促進される。
   - 成果 4 : 内陸表面水域におけるインスペクションを含む水質モニタリングデータ、EPL データ、PSI データの情報管理システムが開発され、有効に活用される。

本プロジェクトの PDM は、付属資料 1 に示した。

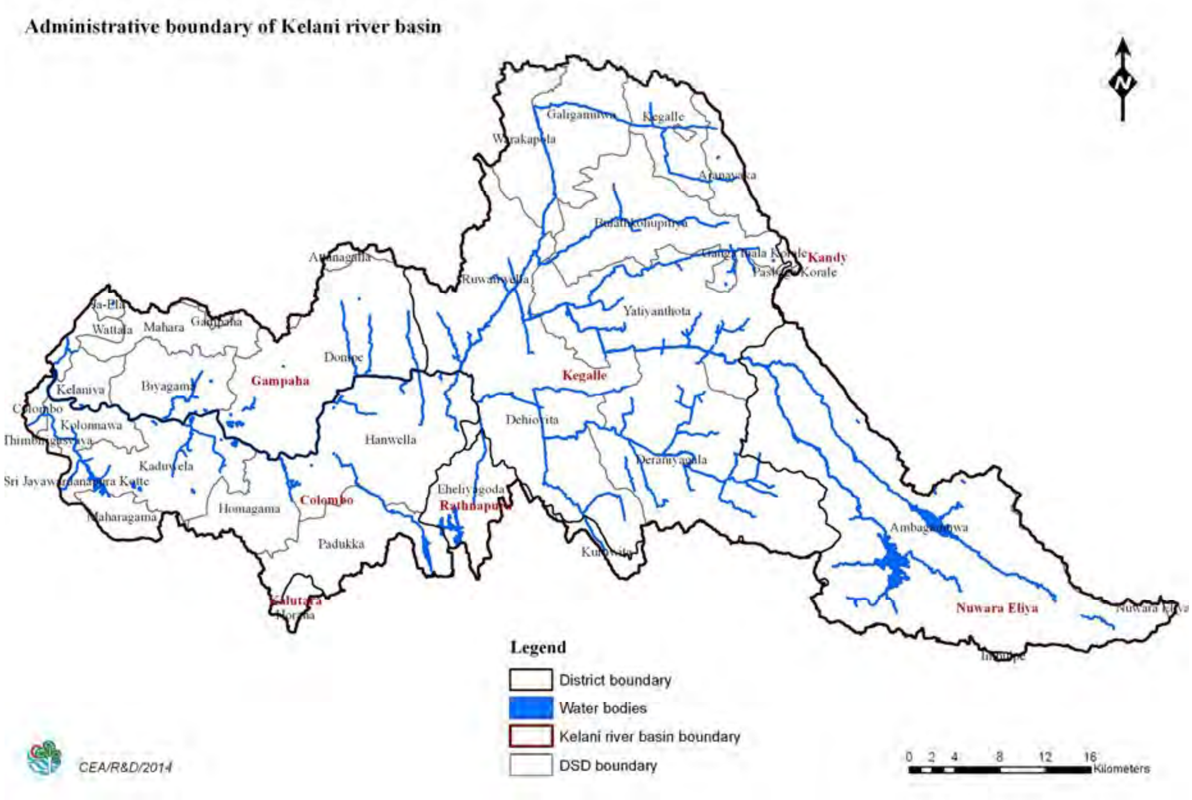
1.2.2 プロジェクトの実施時期

本プロジェクトは、2015 年 3 月から 3 年間の期間で実施された。

1.2.3 プロジェクト対象地域

ケラニ川流域が本プロジェクトの主要な対象地域である。

[1] The Project Design Matrix Version 2.0 was signed on 29th May 2015 and attached to this report as Annex 2.



出典：CEA

図 1-1　　ケラニ川流域と行政界

1.2.4　支援機関

独立行政法人国際協力機構（JICA）

1.2.5　技術協力

（株）建設技研インターナショナル（CTII）
（株）オリエンタルコンサルタンツグローバル（OCG）

1.2.6　プロジェクト実施機関

スリランカ中央環境局（CEA）

第2章　活動と成果

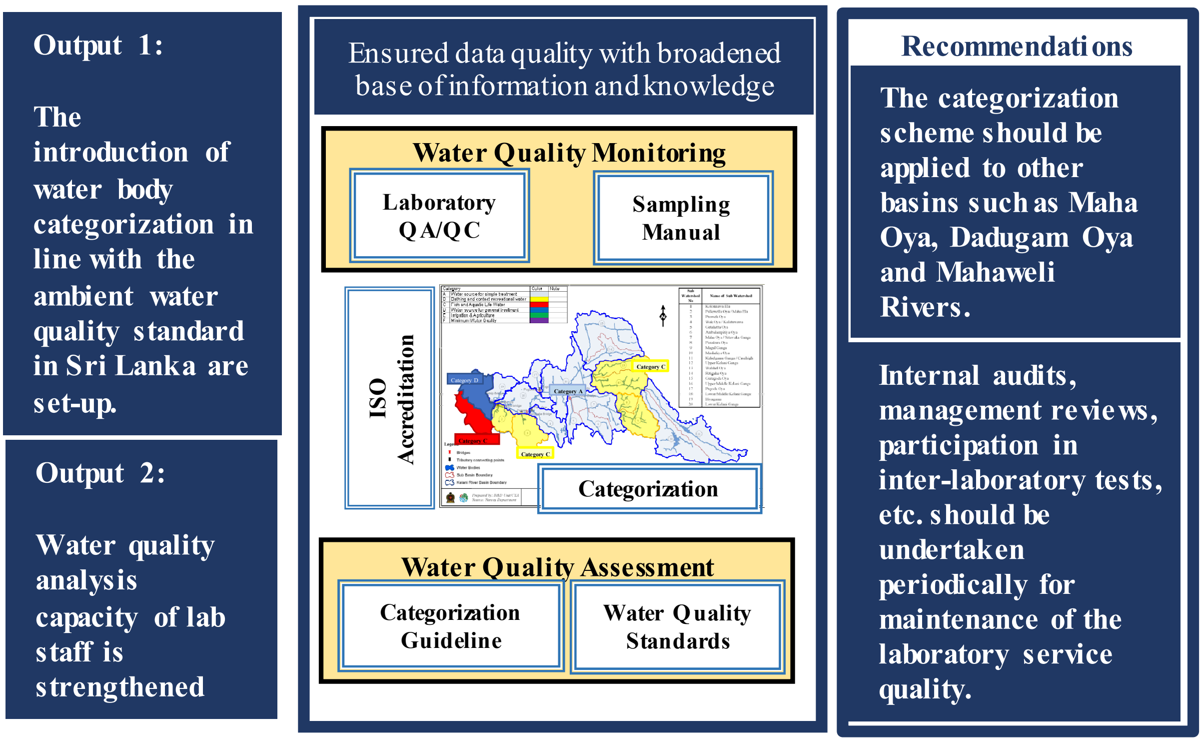
2.1　概要

CEA はプロジェクトの実施を通じ 1）水質モニタリング、2）水質評価、3）法令遵守と執行、4）情報管理、5）情報公開、の 5 つの主要分野を中心に著しい成果をあげた。プロジェクトの成果については、事業実施前後の比較、並びにプロジェクトで作成したガイドライン類等成果品について、表 2-2 および表 2-3 にあわせて示した。

本事業の実施を通じて、図 2-6 に模式的に示すように、国の河川の水質改善にはさまざまな課題が依然としてあることも認識された。特に、有機汚染物質および糞便性大腸菌に起因する水質汚染は、下水道整備区域の拡大、農業普及組織強化を通じたベスト・マネジメント・プラクティス（最適管理手法）の実施等が必要となる。また、CEA の業務分掌にはない非点源の汚染管理は、その計画と実施のために関連組織との連携が必要となる。

2.1.1　水質モニタリングと評価

このプロジェクトでは、CEA、特にラボラトリーサービスが中心となって、ケラニ川流域水質データの質および量とも改善し、水質類型の導入を実現した。



注：JICA チーム作成

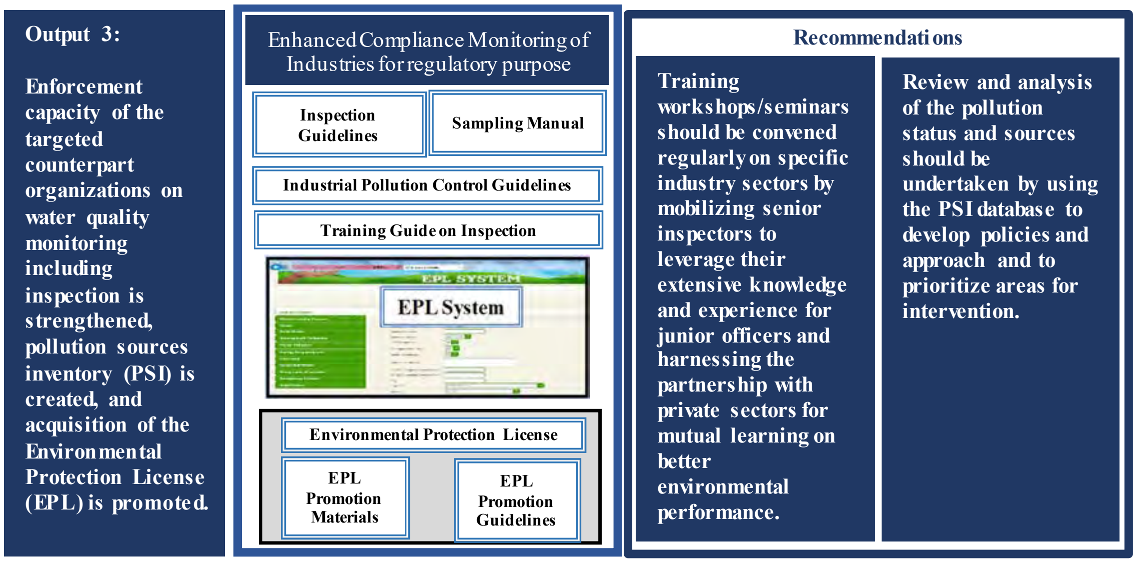
図 2-1　　水質モニタリングと評価

また、プロジェクト目標を達成するために、1）水質類型は、Ma Oya、Dadugam Oya、Mahaweli Rivers などの他の流域への適用が推奨される、2）ラボラトリーサービスの品質維持のために、内

部監査、管理レビュー、試験所間試験への参加などを定期的に実施すべきである、以上 2 つの問題が確認された。

2.1.2　法令遵守と施行

CEA は、企業の法令順守を高めるための活動を実施した。また、立入調査を改善するために広範な実地訓練を実施した。さらに、EPL の統合データベース（PSI/ EPL システム）の確立は、事業体管理の効率改善を実現する。



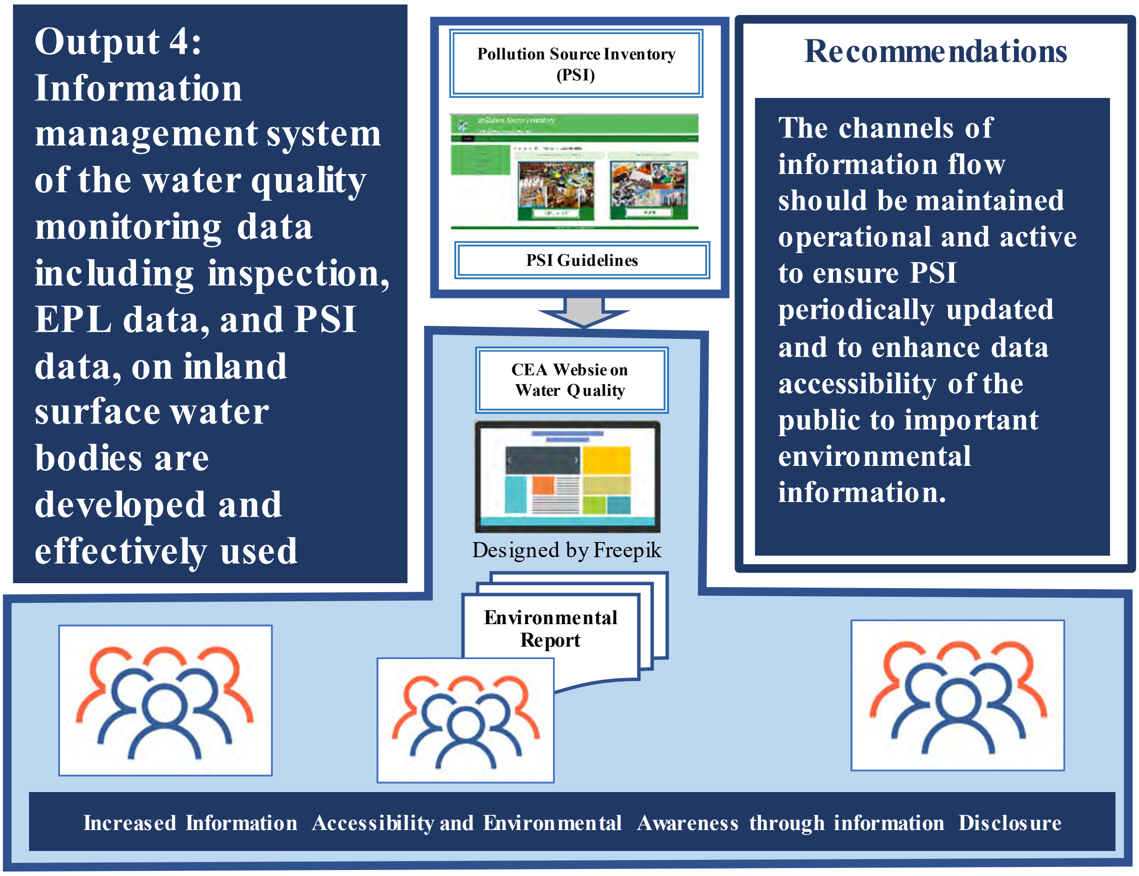
注：JICA チーム作成

図 2-2　　法令遵守と施行

プロジェクト目標を達成において、職員の技能のモニタリングを通じて、以下の 2 つの提言がなされた：1）上級検査官の豊富な知識と経験を活かし若手の検査官向けに特定の産業分野についてセミナー／ワークショップを定期的に開催し、さらに民間連携を推し進め、環境改善のための相互学習を活用する、2）政策および優先・重点取り組みの方針を決定するため PSI データベースを活用し、汚染状況と汚染源の分析を行う。

2.1.3　情報共有

CEA の各部局、州事務所が協力して、情報へのアクセスを向上させ、情報開示を通じて国民の環境意識を向上させた。汚染源インベントリーは、基礎的情報を提供する汚染源管理の重要なツールであり、そのパフォーマンスを向上させるために、データベースはさらに改善が必要となる。



注：JICA チーム作成

図 2-3　　情報共有

プロジェクト目標を達成するためには、情報入手・共有ネットワークが適切に運用され PSI が定期的に更新されること、また、重要な環境情報に対し国民の情報へのアクセスを向上させることが必要である。

2.1.4　将来に向けて

水質改善行動計画は、水域が水質目標を達成するように、水域に分布する点源および非点源からの汚染負荷を軽減するための対策の組み合わせである。計画策定段階において、予測モデルは、河川の浄化能力を考慮して、汚濁負の把握・削減を実現するための代替案の検討に使うこともできる。点源および非点源汚染の管理対策には、下水道投資、衛生改善、上乗せ基準、ベストマネジメントプラクティス（最適管理手法）あるいは総合的病害虫管理の実施が含まれる。

そのため水質改善は、CEA のみで解決できる課題ではなく、水質改善行動計画の策定は、1）国家水供給排水庁（NWS&DB）、2）地方自治体、3）農業省を含むステークホルダー間の対話を促進するためのプラットフォームが必要である。また、産業・商業省およびメガポリス西部開発省等の関連省庁の参加も重要となる。

本プロジェクト（水質管理能力向上プロジェクト）は、上記活動の実施は行っていない。しかし、本プロジェクトでは、①情報と知識をベースとしたデータ品質の確保、②法規制に基づく事業体の法令遵守の強化および③情報アクセシビリティと環境意識の向上の各分野で、水質改善に向けた包括的

なアプローチを可能にする基本的ツールを提供した。

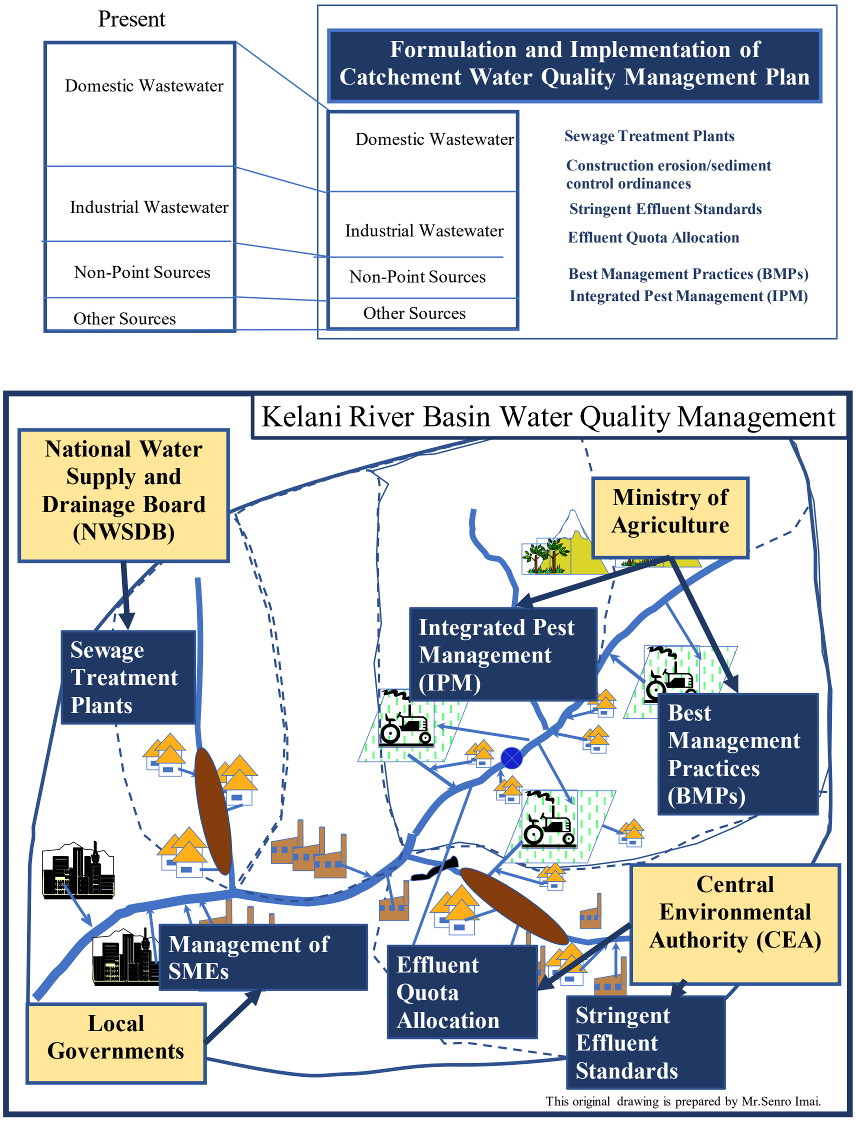


図 2-4　　水質管理計画の策定と実施

CEA が策定した「Kelani 川流域の管理と保全のための中長期的なマルチステークホルダー戦略と行動計画（Medium to Long-term Multi-Stakeholder Strategy and Action Plan for Management and Conservation of the Kelani River Basin）」の実施は、ケラニ川の水質改善を実現する上で、重要なステップとなる。本計画では、優先地域における下水処理場への投資、点源および非点源対策の実施が促進されると期待される。本計画では、CEA は工場の法令順守向上に貢献する。このような計画の実施がなければ、水質の改善は実現しない。

水質管理能力向上プロジェクトの SDG への貢献

指標 6.3.1

1. 工場排水のサンプリングと分析
2. 工場排水の評価とモニタリング

指標 6.3.2

3. 環境水質基準の適用による水質モニタリングと評価（特に糞便大腸菌、BOD および鉛について）
4. 基準観測地における水質測定

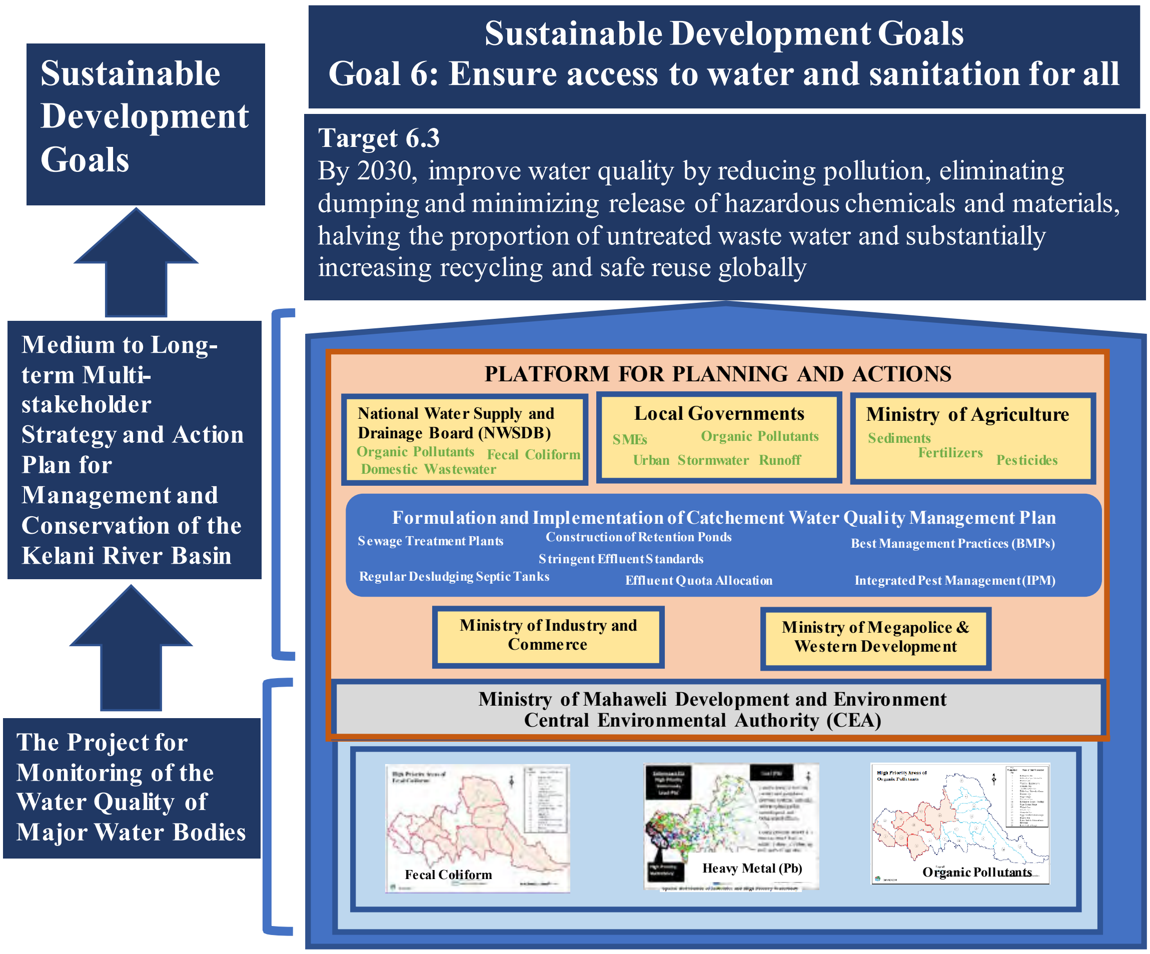
持続可能な開発のための 2030 アジェンダの 17 項目の持続可能な開発目標（SDG）は、広範囲の社会的および経済的開発課題をカバーする国連によって設定されたグローバル目標である。SDG 第 6 の目標は、水と衛生に関わる課題であ

り、「すべての人々の水と衛生の利用可能性と持続可能な管理を確保する。」を目指している。本目標には、8 つのターゲットと、11 の指標があり、指標の進捗を評価して、目標達成の進捗状況を確認するものである。指標 6.3.1 および指標 6.3.2 は、ケラニ川の水質改善により関連があり、それらは表 2-1 に示した通りである。

表 2-1　　持続可能な開発目標

目標		指標	
目標 6.3	2030 年までに、汚染の減少、有害な化学物質や物質の投棄削減と最小限の排出、未処理の下水の割合半減、およびリサイクルと安全な再利用を世界全体で大幅に増加させることにより、水質を改善する。	指標 6.3.1	安全な排水処理が行われている割合
		指標 6.3.2	適切な水質を有する水域の割合

「Kelani 川流域の管理と保全のための中長期的なマルチステークホルダー戦略と行動計画」の実施により、この SDG へ直接的な貢献をすることができる。



注：JICA チーム作成

図 2-5　　持続可能な開発目標（SDGs）に向けた計画と実施

2.2　活動と成果

3 年間に及ぶプロジェクトの活動と成果は、2.3 節に記載した。各成果の詳細活動は、本報告書の付属資料 3 に、フローチャートと共にまとめた。

活動は計画どおりに実施され、更なる改善のための課題もまとめた。課題は第 3 章に示したが、本章とも密接に関係する内容である。

表 2-2　　プロジェクト成果の概要（1/2）

分類	対象部局	分野	プロジェクト実施前の状況	プロジェクト実施後の状況	プロジェクト成果品
情報と知識をベースとしたデータ品質の確保	ラボラトリーサービス	水質観測	1. 水質モニタリングは、適切なサンプリングを規定するマニュアルやガイドラインなしに行われた。ケラニ川の採取場所は、河川の下流域でのみ実施され、コロンボの飲料水に使用される水質への上流域汚染源の相対的影響は評価されていなかった。 2. ラボラトリーサービスは、環境データの精度と確度を保証するためのマニュアルなしに運営されていた。	1. 水試料は、ケラニ川の全域に広がる 14 の環境基準地点においてサンプリングマニュアルに定義された手順に従って採取される（図 2-11）。 2. 水資料は、合計 30 項目を測定することが可能な 11 人のラボ職員によって、一連の手順書を備えたラボで分析される。	1. ラボラトリーの品質マニュアル（付属資料 13） 2. 環境水および排水のサンプリング方法（付属資料 16）
		水質評価	1. 既存の水質評価基準はなかった。 2. CEA は水利用に応じて水域のどの部分を優先的に保護すべきかを判断することができなかった。	1. 環境水質モニタリングの結果は、水利用に応じた水質目標を満たしているかどうか評価される。 2. コロンナワ・エラは鉛（図 2-14）、また、複数地域において有機汚濁物質および糞便性大腸菌（図 2-15）が、改善を必要とする優先地域として特定された。	1. 環境水質基準 2017（付属資料 8） 2. 環境水質基準の見直しと作成（付属資料 8） 3. 内陸水域の分類に関する手続きガイドライン（付属資料 9）
法規制に基づく事業体の法令遵守の強化	環境汚染制御部	法令遵守と執行	1. 排水事業者の検査は、標準的な手順なしに実施され、重大な問題を発見できなかった可能性がある。 2. 産業種と検査すべきパラメーターに関する共通の見解と理解が限られていたため、検査実施の効率的かつ効率的な計画ができなかった。 3. 処理施設の評価を担当していた検査官やその他のエンジニアは、処理工程に関する適切な知識を持っていなかった。 4. 地方自治体および中小企業は、EPL 要件を十分に認識していない。	1. 実地研修/パイロット検査に参加した検査員によって、71 の現場や企業において、標準方法に従った検査が実施された。 2. 優先セクターと優先パラメーターの指定（表 2-24）は、共通認識を醸成し立入検査計画の策定を容易にする。 3. 検査官や他の技術者は、問題の発見と改善能力を向上させるため、1）繊維加工業務、2）屠殺業、3）鶏肉処理業の 3 つの主要セクターの処理工程に関する情報にアクセスできるようになった。 4. 地方自治体と中小企業は、EPL に関する情報にもっとアクセスできるようになった。	1. 環境水および排水のサンプリング方法（付属資料 16） 2. 水質分野のインスペクションガイドライン（付属資料 14） 3. 検査指針に関する研修ガイドライン（付属資料 15） 4. 繊維加工、屠殺および鶏肉処理事業のための産業汚染管理指針（付属資料 22、23 および 24） 5. EPL 推進資料（付属資料 20） 6. EPL 推進ガイドライン（付属資料 21）

注：JICA チーム作成

表 2-3　　プロジェクト成果の概要（2/2）

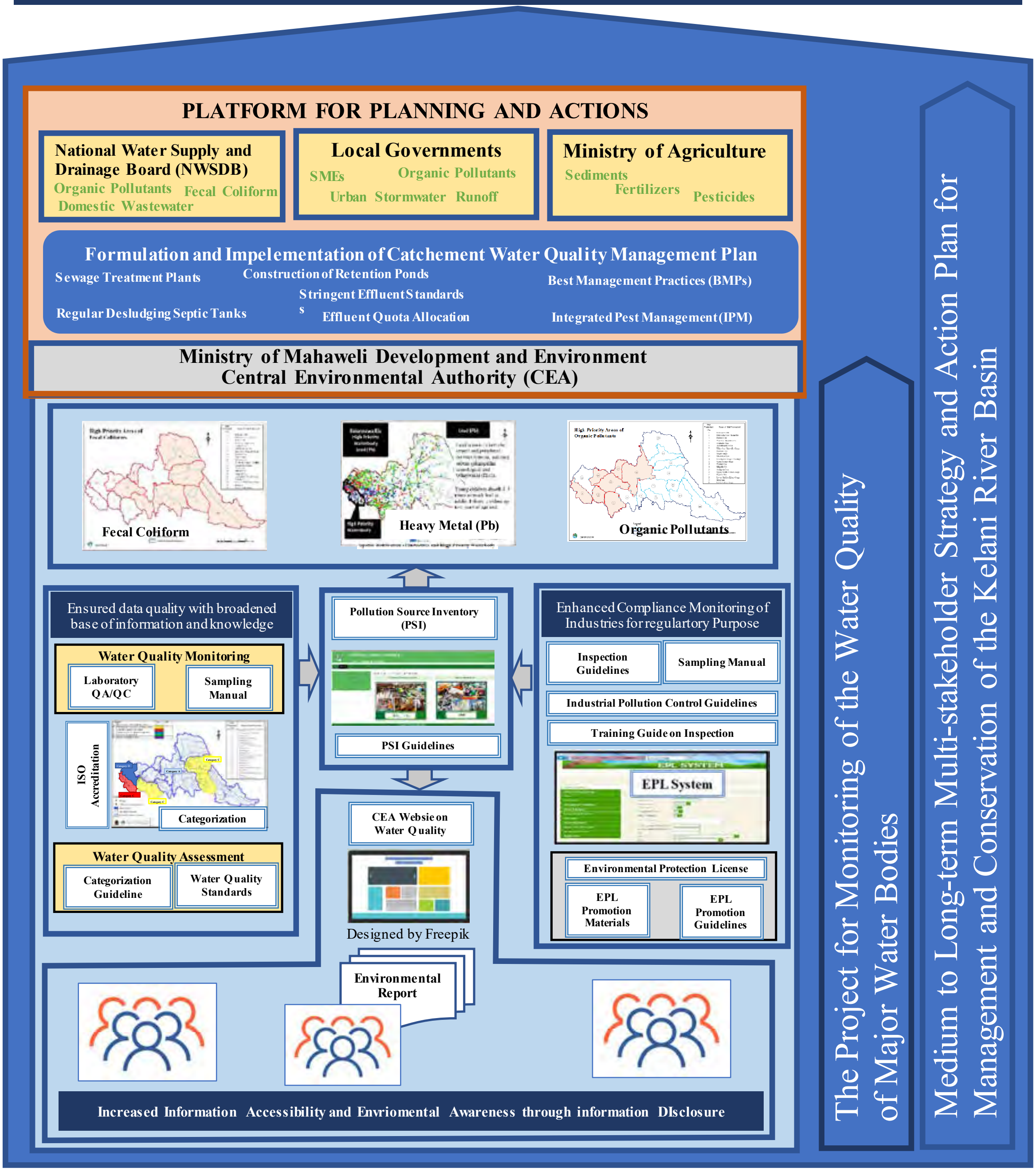
分類	対象部局	分野	プロジェクト実施前の状況	プロジェクト実施後の状況	プロジェクト成果品
情報アクセシビリティと環境意識の向上	EPC, IT, R&D, P&M Units	情報管理	1. CEA の 4 つの部署で、個別の EPL データベースがあり、共通の方針を構築し、地域オフィスで迅速な意思決定、執行のための具体的な行動を取ることを妨げた。	1. 公害対策および排出者に関する効率的な報告に関する介入の決定を支援する図表作成、汚染源解析を可能とする、汚染源の地理情報を含む、州事務所からインターネットを介してアクセス可能な、CEA 本部で管理されている汚染源に関する統合データベースがある。	1. インターネット経由でアクセス可能な汚染源インベントリー 2. 汚染源インベントリガイドライン（付属資料 19）
	EPC, EE, EM&P Units	情報公開	1. 一般の人々は、ケラニ川の水質の状態と課題を認識していなかった。 2. CEA は、情報の開示と管理に関する共通手順を持っていなかった。	1. ケラニ川の水質状況に関して出版物やウェブサイトを通じて、誰もが情報にアクセスできるようになった。 2. 環境情報の収集と普及のための内部手順が決定され、情報開示のプロセスが促進される。	1. 環境報告書 - ケラニ川流域 2017-（付属資料 27） 2. CEA ウェブサイトでは、ケラニ川の水質状況に関する新しいページが追加された 3. 情報管理に関するガイドライン（付属資料 26）

備考；EPC　：Environmental Pollution Control Unit
IT　：Information and Technology Unit
R&D　：Research and Development Unit
P&M　：Planning and Monitoring Unit
EE　：Environmental Education Unit
EM&P　：Environmental Media & Promotions Unit
2018 年 1 月 31 日現在、3 つの成果物、1）EPL 促進ガイドライン、2）環境報告書 - ケラニ川流域 2017-、および 3）情報管理ガイドライン　が承認プロセスにある。

注：JICA チーム作成

Sustainable Development Goals
Goal 6: Ensure access to water and sanitation for all

Targt 6.3
By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated waste water and substantially increasing recycling and safe reuse globally



注：JICA チーム作成

図 2-6　　プロジェクトの展開

2.3 活動状況の概略

2.3.1 【A】国内準備作業

A-1	業務実施計画（ワークプラン（案））の作成

日本国内で入手可能な資料・情報を収集・分析し、詳細計画策定調査報告書、R/D 等を踏まえ、事業実施方針を明確にした。

2.3.2 【B】全成果共通の活動

B-1	業務実施計画（ワークプラン）の合意

業務開始後、業務実施計画について C/P と協議し、技術協力プロジェクトの進め方、各成果の具体的な目標やアプローチの方法について合意した。

B-2	インセプションレポート（IC/R）の作成・協議

本プロジェクトにかかる詳細計画策定調査報告書及びキャパシティアセスメント（B-3）の実施による CA 結果等を踏まえ、プロジェクトの全体像を把握し、プロジェクト実施の基本方針・方法、業務工程計画等を作成し、これらを IC/R に取りまとめた。なお、IC/R は 2015 年 5 月に作成し、2015 年 7 月 16 日の第 2 回合同調整委員会の場で協議した。その後の共同調整委員会の会合は、2016 年 2 月 17 日と 2017 年 1 月 23 日に開催された。関連する JCC の議事録は、付属資料 4 として本報告書に添付されている。

B-3	キャパシティ・アセスメントとプロジェクト活動内容の具体化

実施機関のキャパシティの向上の程度及び課題を把握するために、CA を行い、その結果を IC/R に反映した。これらキャパシティ・アセスメントの結果は、プロジェクトの活動計画や設計に反映させ、必要に応じて見直しを行い、プロジェクトの活動計画に反映した。

B-4	活動に必要な資機材の調達

23 種の実験装置、試薬の調達が完了し、調達リストは表 2-4 に示した。

表 2-4 機材調達

#	機材	個数/式
1	脱イオン化装置	1
2	堆積物採取器	1
3	マイクロ波分解器	1
4	紫外線分光光度計	1
5	COD メーター	1
6	多項目水質分析計	2
7	遠心分離機	1
8	試薬保管庫(酸、アルカリ、可燃物用)	1
9	BOD 計/溶存酸素計	1
10	ビュレット	1
11	ラボラトリージャッキ	2
12	ドラフト	1

#	機材	個数/式
13	クリーンベンチ	1
14	オイル・グリース分析用重油標準物質	1
15	BOD 試験用ふらん瓶 (100 本)	1
16	ガスボンベ運搬カート	1
17	蒸留セット	1
18	試料運搬容器	2
19	自動ディスペンサー装置	1
20	マントルヒーター	2
21	分析室用冷蔵庫	1
22	試料保管用冷蔵庫	1
23	標準参照物質 （13 種）	13

注：JICA チーム作成

B-5	PP の実施・管理

本プロジェクトは、水質管理能力強化を基本的な目標とし、ケラニ川を対象として活動が実施される。活動の実施においては、CEA の職員数の限界も考慮し、ローカルコンサルタントの活用も視野に入れつつ、IC/R の基本管理アプローチとして簡潔に述べたように、コンサルタントなどの外部資源に可能な限り依存しないように配慮し､プロジェクトのオーナーシップの意識を醸成することによって事業の持続性を高めるよう活動を進めた。

B-6	研修員受入に係る業務

訪日研修は、日本の環境管理と経験を理解するためプロジェクト期間中に 3 回実施された。研修内容は、日本の環境管理における必要な知識と経験を得るよう計画された。詳細は付属資料 5 に添付した。

B-7	進捗監理モニタリング

プロジェクト実施状況の評価とモニタリングは、プロジェクトチームメンバーが共同で 2018 年 3 月にプロジェクトが終了するまでに 6 回実施された。

表 2-5　　モニタリングレポート

	評価期間
1	2015 年 3 月のプロジェクトの開始から 2015 年 8 月中旬まで
2	2015 年 8 月中旬から 2015 年末まで
3	2016 年 1 月から 2016 年 7 月末まで
4	2016 年 8 月から 2016 年 12 月末まで
5	2017 年 1 月から 2017 年 6 月まで
6	2017 年 6 月から 2017 年 12 月まで

B-8	プログレスレポート 1（PR1）及び 2（PR2）の作成

プロジェクトチームは、2016 年 2 月および 2017 年 12 月に、プログレスレポート 1（PR1）及び 2（PR2）を提示した。

B-9	事業完了報告書（案）（DFR）及び事業完了報告書（FR）の作成

プロジェクトチームは、プロジェクト終了前までに、1）事業完了報告書（案）、および 2）事業完了報告書、を作成し提出した。

2.3.3　【C】成果ごとの活動

成果 1	**スリランカの一般水質環境基準に準拠した水域類型指定導入のための準備がなされる。**

国家環境法（National Environmental Act : 以下 NEA）は、同国の主要な統合環境法である。中央環境局は、その主要機能を NEA により規定されており、大臣への提言、国の環境方針、その用途と価値に見合った環境保全のための基準､汚染の原因､性質､範囲および予防に関する調査･研究がある。2015 年のプロジェクトの開始時に、CEA は 1992 年に環境水質基準[2]を提案したことも確認された。

[2] Environmental Compliance and Enforcement in Sri Lanka: Rapid Assessment, Central Environmental Authority, November 2006

提案された環境水質基準は、1992 年の作成以来、正式な審査および承認プロセス無しに保留されていたため、詳細な技術的検討が必要であることが確認された。

ワーキンググループ（Working Group；以下 WG）1 の 17 名の選出されたメンバーは、環境水質基準に伴う水域類型を導入する一連の活動に携わり、水質を評価するための評価基準として使用される環境水質基準を作成した。WG メンバーは水質類型を決定するため、1）CEA の R&D ユニットによって作成されたポリゴンを使用してケラニ流域のサブ集水域の境界を特定する、2）国勢調査局およびスリランカ統計部で利用可能な土地利用統計を分析する、3）メンバーの知識と経験を基に各水域の主要な水利用を特定する、4）国家水供給排水庁で利用可能な飲料水取水地点とその処理プロセスを特定する、5）それらを CEA ラボが実施するサンプリング地点と比較する、これらの活動を実施した。合同フィールド調査により、既存の 12 のサンプリング地点に加えて 5 つの新しいサンプリング地点を追加し、流域全体にわたって適切なサンプリング地点を設定した。地点選定においては、1）河川横断面の均一性が高い地点を選択する、2）二つの河川の合流地点の直上流または下流地点を避ける、3）提案された環境水質基準に規定されているパラメーターについて、水利用の適否を判断できるようにする、点に留意した。

本プロジェクトにおいて、CEA は、指定された水利用の保全と維持に求められる物理的、化学的、および生物学的パラメーターの濃度限界による環境水質基準、および内陸水域の類型指定のための手順ガイドラインを作成した。このガイドラインにより、現地の環境条件を考慮した水利用に応じて、水域の一部分にカテゴリーを割り当てる手順が記載され、CEA は水質が指定された水利用に適切かどうかを判断することができるようになった。ガイドラインを使用することにより、CEA は、重点地域としてコロンナワ・エラを特定した。

活動 1-1　現時点における法制度のレベル及び実施システムについてレビューする。

(1)　憲法

スリランカ民主社会主義共和国の憲法は、第 27 条（14）に示されているように、環境保護、保全、改善の責任は政府にあると明示している。

27（14）国は、地域社会のために環境を保護し、維持し、改善するものとする。

環境保護に関するスリランカ国民の基本的な責務は、次の第 28 条（f）に定められている。

28（f）権利と自由の行使と享受は、職務と義務の履行と不可分であり、スリランカのすべての国民の責務である -

（f）自然を守り、富を守る。

(2)　法的枠組み

国家環境法 : 1980 年の最初の主要な統合環境法、1980 年の第 47 号、またはより一般的には国家環境法（NEA）として知られるものが 1980 年に公布された。1988 年の第 56 号法および 2000 年の第 53 号法において修正された NEA は、環境の保護、保全および管理のための基本的な国家憲章である。NEA は、1988 年の改正において環境保全のための 3 つの基本的な手段、1）環境保護ライセンス、2）環境基準、3）環境評価とプロジェクトの承認、を付加した。

環境基準 : 1980 年法律第 47 号（10）（e）において、CEA の権限、機能および義務を規定している : 環境の有益な用途の保護および質の維持のための基準、規格および標準の指定。大臣は、1988 年の国家環境法（改正）第 56 号の第 32 規則において、以下の関連する基準を公布するための権限

を与えられている。

（1）大臣は、この法律に規定されているか、または要求されているか、またはこの法律によって規制が必要とされるすべての事項に関して規制を行うことができる。

（2）特に、第（1）項によって与えられた権限の一般性を害することなく、大臣は、以下の事項のすべてまたはいずれかに関する規則を制定することができる。

(b) 国の環境政策の実施または環境の保護および有益な使用の保護のための分類のための基準あるいは標準の指定。

(c) あらゆる事項、行動または物事が有害であるか、不快であるか、健康に有害であるか、またはこの法律で言及されているその他の記述内にあるかどうかを判断するための基準あるいは標準の指定。

その他の関連法規は、本報告書付属資料 6 に要約されている。

(3) 機関と実施

環境省：マハウェリ開発環境省の前身である環境省は、現在と将来世代の利益のために持続可能な開発のための国家的コミットメントを確保するために、1990 年に環境と天然資源を管理するために設立された。同省は、社会経済開発と環境保全のニーズをバランスさせたスリランカの環境の健全な管理を促進するため、2003 年に国家環境政策を策定した。

中央環境局：中央環境局は、1980 年に国家環境法の制定により設立された。CEA の機能には、大臣への勧告、国の環境政策と環境の保護および有益な使用の保護のための基準の推薦、汚染の原因、性質、程度及び防止に関する調査・研究の実施、環境汚染またはその予防のあらゆる側面に関連する研究を実施、促進、調整、促進及び調整すること、環境の保護及び改善のための基準の開発すること、環境の有益な使用の保護と質を維持するための基準、規範、標準を特定すること、環境保護と管理のあらゆる側面に関する報告書と情報を公表すること、この法律の遵守を確実にするための調査と検査を実施すること、これらの規定のいずれかに準拠していないことに関する苦情を調査すること、が含まれる。

CEA は、1）環境汚染管理、2）環境マネジメントとアセスメント、3）環境教育と意識向上、4）人事管理と財務、5）廃棄物管理の 5 部と 3 つのユニット、計画とモニタリング、法務そして法令遵守の部局で構成されています。環境汚染管理ユニットは環境汚染管理部に属し、環境保護ライセンス制度の実施を担当しています。環境勧告、新規事業体の立地に関する手続を実施し、BOI 登録された所定の活動の EPL の同意、産業による環境汚染を制御するための技術支援（産業関連の公衆苦情を解決あるいは汚染制御するための新しい戦略/ツールの導入）を提供する。ラボラトリーは環境汚染管理部の一部門でもあり、環境水および産業排水のモニタリングと大気質の管理を担当し、関連する規制の設定および管理が行われる。

CEA は、その機能を分散させるために、全国に 9 つの州事務所および 16 の地区事務所を設置した。州事務所には、1）西部州事務所、2）サバラガムワ州事務所、3）中央州事務所、4）南部州事務所、5）東部州事務所、6）北中央州事務所、7）北部州事務所、8 ）北西部州事務所そして 9）ウバ州事務所がある。地区事務所については、1）Matara 地区事務所、2）Hambantota 地区事務所、3）Ampara 地区事務所、4）Kegalle 地区事務所、5）Kalutara 地区事務所、6）Batticoloa 地区事務所、7）Nuwara Eliya 地区事務所、8）Gampaha 地区事務所、9）Killinochchi 地区事務所、10）Monaragala

地区事務所、11）Polonnaruwa 地区事務所、12）Matale 地区事務所、13）Vavunia 地区事務所、14）Mannar 地区事務所、15）Mullaitivu 地区事務所そして 16）Puttalum 地区事務所がある。

活動 1-2　　一般水質環境基準の管理と遵守状況に関する現状と課題を明らかにする。

1992 年に提案された環境水質基準の保留：2015 年のプロジェクトの開始時に、CEA は 1992 年に環境水質基準[3]を提案したことが確認された。提案された環境水質基準は、1992 年の作成以来、保留中であり改訂が必要であることが確認された。一方でレビューを通じて、環境基準が、飲料水、水浴、レクリエーション、漁業および水生生物、灌漑および農業といった有益な水利用に応じて水域分類[4]されるように設計されたことが明らかとなった。ワーキンググループ 1 のメンバーと協議の上、海洋環境保護庁との分掌を避けるため、河川や支川に焦点を当てるべきであることも確認された。

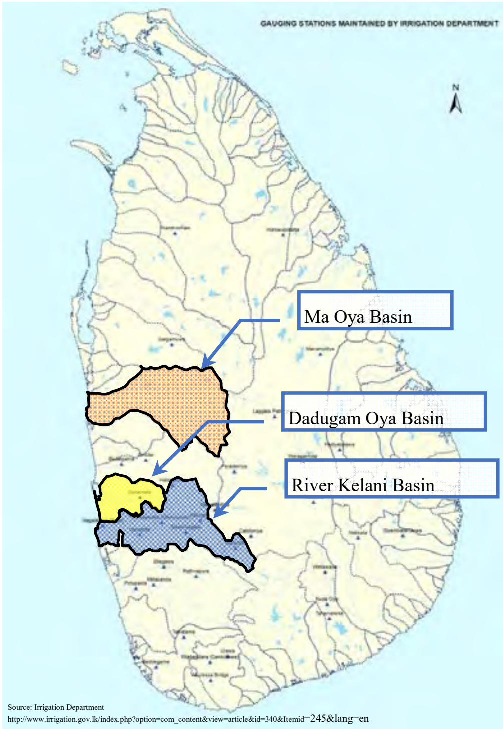


図 2-7　　ケラニとマオヤ川流域

水質モニタリング：河川水質のモニタリングは、CEA 特にラボラトリーサービス部門の主要な責務である。国家水供給排水庁は飲料水水質を保証する責任があり、水源水質の監視が必要となる。投資庁（BOI）は、BOI ゾーンの管理および、その共通排水処理プラントの排水を排水基準に適合させる必要がある。一方、灌漑局においては、資源管理の目的で河川の水位を監視している。CEA の下で、Kelani River、Ma Oya、Dadugam Oya 等の水質モニタリングプログラムがラボラトリーによって実施されている。ケラニ川の 12 地点の水質モニタリングデータは、pH、電気伝導度、濁度、温度、溶存酸素、化学的酸素要求量、塩酸塩、硫酸塩、フッ化物、クロム、鉛、硝酸塩窒素（NO_3^--N）、リン酸塩（PO_4^{3-}-P）、大腸菌群および糞便性大腸菌を含む。一方、Ma Oya の入手可能なデータは、それほど多くはなく、2005 年は 3 か月に 1 回のサンプリングを行い、2009 から 2014 年は、月ごとのサンプリングを行っている。水質はカナダの水質指数法（CWQI）によって評価された。

水域類型/分類方法が承認されていない：CEA は国内の水質評価のための分類スキームを実施していないことも確認された。

[3] Environmental Quality Standards and Designation of Water Use in Sri Lanka, Central Environmental Authority, bkh CONSULTING ENGINEERS, 1992

[4] In the report prepared by the Netherland's consultant, the term classification was used as an equivalent term of category under this project.

活動 1-3	ワーキンググループを立ち上げ、キャパシティデベロップメント（CD）のニーズを把握し、活動のタスクマトリックスについて合意する。

ワーキンググループの設立：ワーキンググループ 1（WG1）は、CEA の法務ユニット、研究開発ユニット、天然資源管理ユニット、EPC、ラボラトリーサービス、BOI の環境管理部門、MOIC、MOMD&E、灌漑局、NWS&DB を代表する 17 人のメンバーで構成された。また、議題に応じて他のメンバーも選定された。ワーキンググループメンバーリストは、付属資料 7 に添付した。

キャパシティ・ディベロップメント（CD）のニーズを特定する： a）水質を評価するためのベンチマークや基準の欠如、b）水質管理と計画のための部門間の連携不足、c）流域全体のモニタリングの不足、d）地域やセクターの優先順位付けに関する不十分な情報：

a) 水質を評価する基準の欠如：CEA は、環境水質モニタリングの結果を評価するための正式なガイドラインや基準がなく、水質が適切であるか、または改善のための早急な対応が必要であるかどうか判断できない。

b) 水質管理と計画のための部門間の連携不足。部門間の協力が限られていたため、ラボラトリーは、CEA 内の他の部門で利用可能な情報について、水質管理のために有効かつ効果的に利用できていなかった。

c) 流域全体のモニタリングの不足：ラボラトリーは、ケラニ川の中流から下流に焦点を当てて、水質の管理を実施していた。上流域のサンプリング地点が不足しているため、下流の水利用者に対する相対的な影響について、流域全体を分析するためには不十分であった。

d) 地域やセクターの優先順位付けに関する不十分な情報：評価のための情報不足の結果として、CEA は、地域やセクターの優先順位付けに関する十分な情報を持っていなかった。

活動 1-4	CD 活動を実施し、類型指定や類型区分に関するガイドライン及びマテリアルを開発し、選定された河川においてそれらの試行をする。

活動 1-3 の要請に基づき、プログラムを実施するうえでの段階的詳細活動を策定したものの、本報告書においては、同詳細活動にこだわらず、より効果的に説明するため活動の分類に基づき記載する。

水質基準の策定：プロジェクトを通して、CEA は、付属資料 8 に示すように、水質を評価するための基準となる環境水質基準を作成した。CEA は現在、ある流域において水質が指定された水利用に適しているかどうか判断できる。また、水質が、水利用に応じて、利用可能であるか、不適切であるかを判断できる。

部局間の協力による水質管理と計画に対する能力強化：WG メンバーは、水質類型手順ガイドライン（付属資料 9）に基づいてケラニ川流域への類型指定を決定した。WG メンバーは、以下に示すようにケラニ川流域の水利用に応じて類型指定（図 2-8）を実施する一連の作業を実施した。

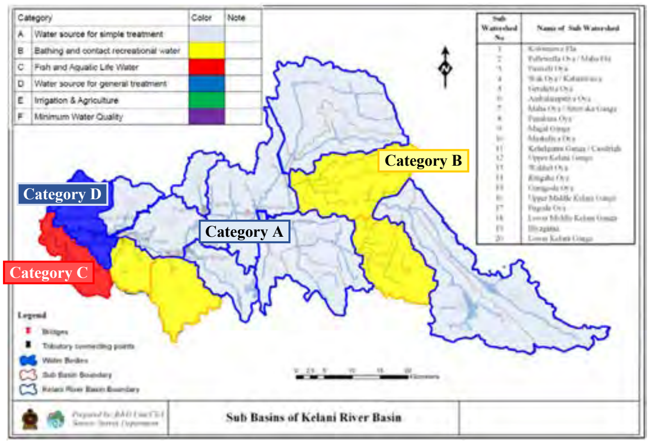


図 2-8　　ケラニ流域の類型指定

1) 研究開発ユニットが提供する GIS を用いて、ケラニ川流域の小流域境界を特定する（図 2-9）。

2）各小流域の主要な土地利用を特定するため、国勢調査局およびスリランカ統計局で入手可能な土地利用統計を解析する（図 2-10）。

3) WG メンバーの知識と経験を組み合わせて、各小流域主要な水利用を特定する。

4）国家水供給排水庁において、飲料水の取水地点およびその浄水処理方法を確認する（図 2-11）。

5）ラボラトリーにおける実績のサンプリング地点と比較する。

流域全体の水質モニタリングにおける能力強化：プロジェクト期間中、特に水質モニタリングはモニタリング計画に基づき実施された。2015 年 11 月 4 日には、合同現地調査を実施し、全流域にわたる適切なサンプリング地点を特定した。過去のサンプリング地点のいくつかは、環境基準地点としては適切ではない地点もあった。現地調査では、次の条件を満たす新しいサンプリング地点を選定した。

1) 河川横断において均一性が高い場所。

2) 2 つの支流からの流れが直ちに混ざり合わず、乱流を発生させる可能性があるような、2 つの流れまたは河川の合流点直近の上下流の場所の回避。

その結果、本プロジェクトにおいて、流域全体の水質モニタリング体制を改善するために、既存の 12 のサンプリング地点に加えて 5 つの新しいサンプリング地点[5]を追加した。全 17 のサンプリング地点のうち、2 つ地点は同じ小流域にあることが判明し、これらの 2 つのサンプリング地点は、水質の評価のための補助データとして使用することが提案された。従い、最終的には、ケラニ川流域において、14 の環境基準地点を指定した。図 2-13 は、これらの活動におい

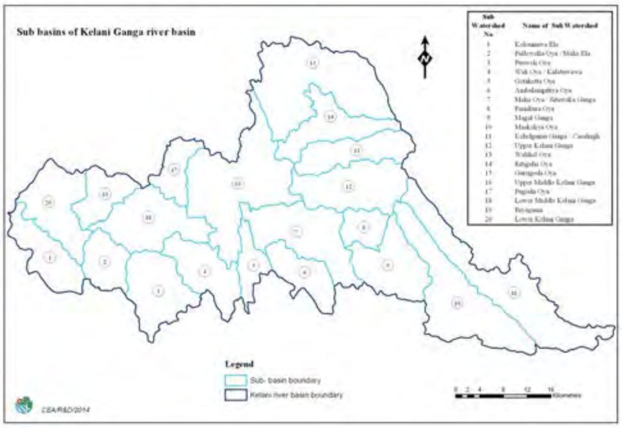


図 2-9　　ケラニ流域のサブ流域区分

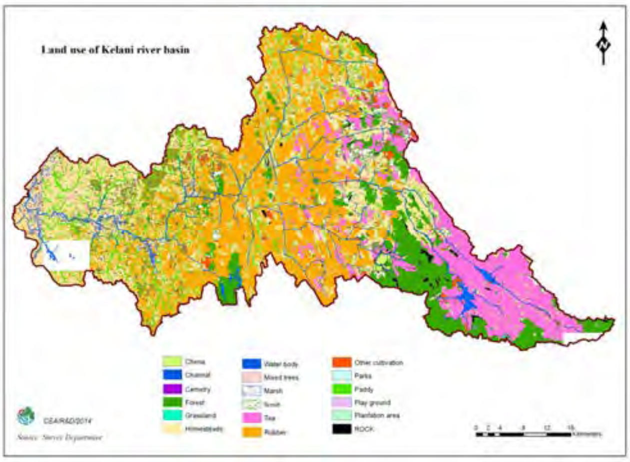


図 2-10　　ケラニ流域の土地利用区分

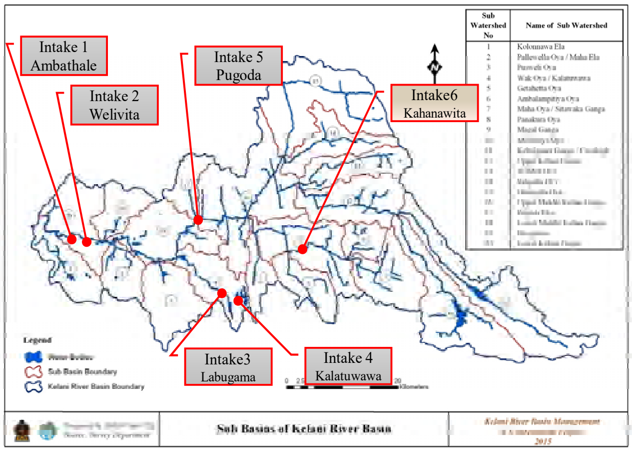


図 2-11　　ケラニ川取水地点

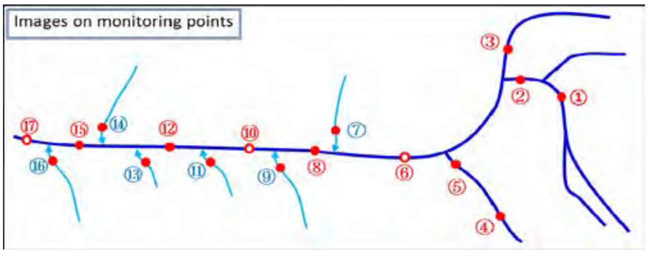
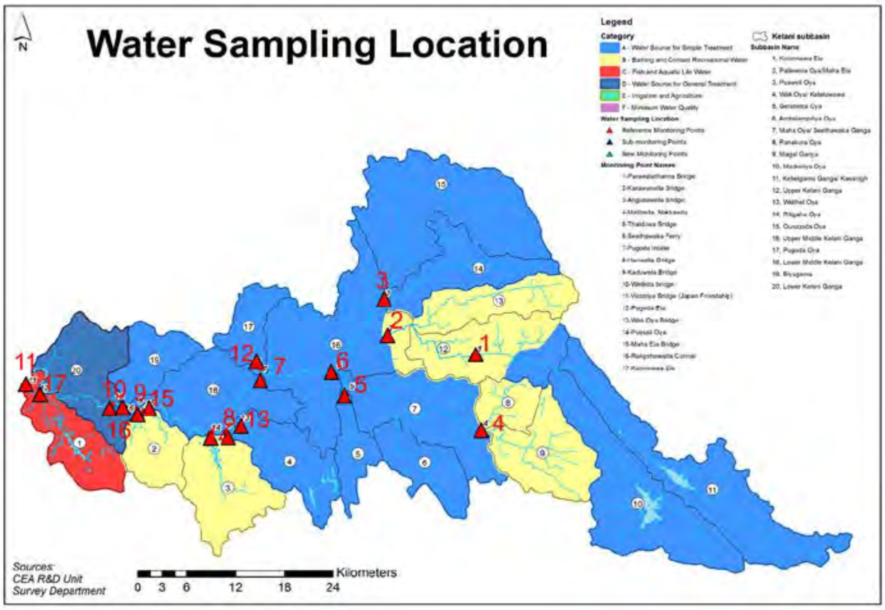


図 2-12　　ケラニ川のサンプリング地点模式図

[5] 図 2-11 中の 1, 2, 3, 4, 16 の地点が新規サンプリング地点である

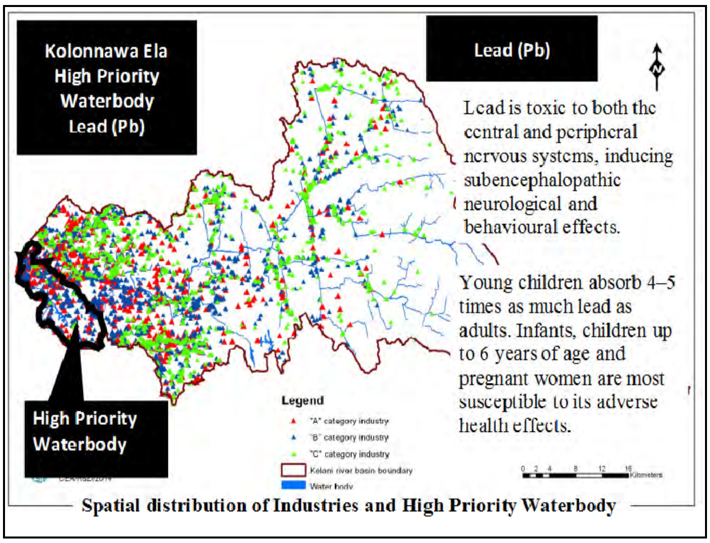
て定められたケラニ川流域のサンプリング地点を示す。2016 年には、ケラニ川全域での水質モニタリングが実施され、そのモニタリング結果は、付属資料 10 にサンプリング地点に関する情報と共に添付した。採水方法は、環境水および排水のサンプリングマニュアル（付属資料 16）に従い実施された。



注：JICA チーム作成

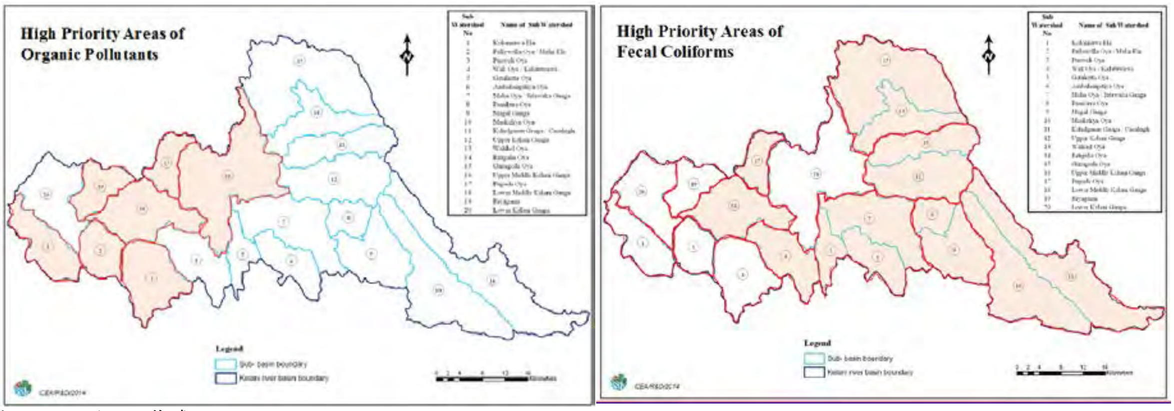
図 2-13　　ケラニ流域の類型と環境基準地点

地域やセクターの優先順位付けに関する不十分な情報：CEA は、環境水質基準とカテゴリー分類手順ガイドラインに従い、水質改善のための分野と地域を特定できる。このプロジェクトのパイロット活動では、CEA は Kolonnawa Ela を水質改善のための重点地域として特定した（図 2-14）。また、有機汚染物質および糞便大腸菌の改善のために重点地域（図 2-15）としていくつかの小流域を特定した。



注：JICA チーム作成

図 2-14　　鉛改善のための重点地域



注：JICA チーム作成

図 2-15　　有機汚染および糞便性大腸菌汚染に関する重点地域

活動 1-5	試行結果及び結果から得られた教訓を基に、水域類型指定導入のためのガイドラインを策定する。

表流水類型指定のための手順ガイドライン：類型指定手順ガイドラインは付属資料 9 として本報告書に添付した。手順ガイドラインは、地域の環境条件を考慮した水利用に応じて水域区分に類型を割り当てる手順を定めている。例えば、飲料水源の取水地点を含む小流域は、その浄水処理技術に応じて、カテゴリーA または D のいずれかに分類することができる。このような分類プロセスを通じて、各小流域には、特定の場所、河川流域またはその一部における水利用およびその用途を維持・保護するための水質目標が設定される。

環境水質基準：環境水質基準は付属資料 8 として本報告書に添付されており、これには採用した値の妥当性も併せて示した。

環境水質基準は、1988 年の国家環境法（改正）法第 32 条第 32 号に準拠して策定された、スリランカ初の環境水質基準である。これは、指定された水利用の維持・保護に推奨される、物理的、化学的および生物学的パラメーターの濃度限界が設定されている。

1988 年法律第 56 号第 32 規則第 2 条第 2 項において、基準は人の健康に及ぼす影響の程度で分類される。例えば、シアンは甲状腺および特に神経系に健康影響を及ぼす急性毒性を示すため、シアン化物などのパラメーターには注意を払う必要があり、汚染の問題に対処するためには、TSS および濁度よりも迅速な処置が必要である。人間の健康に関するこのような側面を考慮して、パラメーターの評価分類を表 2-6 に示すように提示し、汚染に対する取るべき対策を併せて示した。より高い毒性を有する第 1 クラスに分類された項目については、モニタリング中に 1 度でも基準値の超過があれば、CEA は水質管理処置をとることが推奨される。同様に、第 2 クラスの項目では、水質モニタリングの平均値が水質基準を遵守していないことが判明した場合には、第 2 クラスの項目についても注意を払わなければならない。

表 2-6　　基準項目の評価分類

Class		Parameters			Recommended Action Level
1	Parameters that may give significant health effects to humans	1. CN 2. F 3. Cd 4. Cr 5. Pb	6. Hg 7. Se 8. B 9. As 10. Phenol compound	11. NO_3-N 12. MCPA 13. Pendimethalin	CEA is recommended to take Water Quality Management Actions if an incidence of exceedance is observed for any one of the parameters during the monitoring programme.
2	Other important parameters	1. Colour 2. Conductivity 3. Turbidity 4. TSS 5. Total Hardness (as $CaCO_3$) 6. pH 7. DO at 25°C 8. BOD5 at 20°C 9. COD 10. PO4-P	11. Chloride (Cl-) 12. SO_4^{2-} 13. Cu 14. Fe 15. NH_3-N 16. Mn 17. Ni 18. Zn 19. Al 20. Oil & Grease	21. Anionic surfactants as MBS 22. Total Coliform 23. Faecal Coliform	CEA is recommended to notify the pertinent authority of exceedances of the Water Quality Standards if an average value of the water quality minoring programme is found to be in exceedance of the Water Quality Standards. For Categories B and C, CEA is recommended to notify the public through appropriate mode of education & awareness.

注：JICA チーム作成

基準の策定手順：水質基準は、1）1992 年の水質基準案をベースに、2015 年 6 月から 2016 年 2 月までの WG 会議を通じて基準（案）の作成、2）水質基準を最終化するために 2016 年に 2 回の専門家委員会の実施、3）2016 年 7 月 CEA 理事会での承認、4）法務省下の法制局への提出、5）法制局との協議、6）2017 年 7 月にガゼットとして承認、という手順で策定された。専門家委員会[6]のメンバーは、環境汚染管理部の RMSK Rathnayake 博士が推薦し、DG の KH Muthukuda arachchi 氏の承認を得た。環境基準の正式な承認を得て、2017 年の終わりまでにシンハラとタミル語に翻訳された。その後、2017 年 12 月 8 日に関係者会議を開催した。環境基準における水域類型とその根拠については、付属資料 11 に要約した。また、専門委員会および関係者会議の参加者は付属資料 12 に添付した。

成果 2　　ラボラトリースタッフの水質分析能力が強化される。

成果 2 の活動は、CEA ラボスタッフの水質分析のための能力強化を目的としている。成果 2 の達成のために掲げられた具体的活動は、以下の 3 つに分類される：（活動 2-1）中央ならびに地方のラボラトリーの現状とレベルをレビューする、（活動 2-2）ワーキンググループを立ち上げ、水質分析と分析機材の運用と維持管理を含む明確な CD 計画について合意する、（活動 2-3）CD 活動を実施し、標準手順書を開発し、ISO/ IEC 17025 等の公式認証を取得する活動を継続する。

このうち活動 2-1 では、以下の事項が明らかになった。1）CEA は 2006 年から 2007 年の間に ISO/ IEC 17025 の認定を目指した経験がある。2）しかしながら、当時の CEA は、特に ISO/ IEC 17025 の「技術的要求事項」について、十分な知識と経験を有していなかった。そのため 3）CEA は ISO 認定の取得を断念した。そこで、本レビュー結果を念頭に置き、活動 2-2 ではこのプロジェクト内で設立された WG2 のメンバーによって、具体的な CD 計画の策定を行い、合意に至った。

一連の CD の実施を通じて、十分な分析能力を有するラボラトリースタッフの人数は 4 名から 11

6 A representative of the Office of the Registrar of Pesticide was invited but could not participate in the meetings. A follow-up correspondence took place to acquire feedbacks on the proposal.

名に増加した。また、プロジェクトの終了段階ではラボラトリースタッフの全てが少なくとも 15 項目以上の分析を独立して行うことが可能となった。加えて、プロジェクト開始前の CEA ラボラトリーの分析検体数は年間 1,000 件に満たなかったが、2017 年時点では年間 1200 検体以上のペースを維持できるようになった。これらの結果は ISO/ IEC 17025 の実施を伴うラボラトリーの教育システムが機能し始めたことに起因している。ISO/ IEC 17025 認定を取得するための活動としては、Quality Manual が作成・承認され、それを補足するための付属文書である 15 種の Procedure Manuals と 12 種の SOP が作成された。同時に、QA / QC 活動を実施するために必要な 54 種の Control Record Formats（書式）が完成した。これらはプロジェクト期間中に PDCA サイクルに基づく 3 度の内部監査と 2 度のマネジメントレビューを行ううえで、重要な情報を提供した。本プロジェクトの結果、CEA ラボラトリーは 2018 年上半期に ISO/ IEC 17025 認定を受けることが見込まれ、次のメリットが期待されている。

a) CEA ラボが、国際標準のシステムを有しているラボであると認識されるようになる。
b) CEA ラボが、ISO/ IEC 17025 を運用することで信頼性の高い分析サービスを提供することができるようになる。
c) 分析エラーが削減され、CEA ラボの業務がより効率的になる。
d) CEA ラボラトリーは CoC（chain of custody）認証を通じてすべての必要な記録を管理することにより、分析プロセス全体を制御することができる。これらは、訴訟対策にも成り得る。

活動 2-1　中央ならびに地方のラボラトリーの現状とレベルをレビューする。

CEA 本部及び地方事務所のラボラトリーの現状をレビューした。地方事務所の状況については、地方のラボラトリーを管轄している CEA 本部ラボラトリーのディレクターへのヒアリングにより状況を把握した。レビューは表 2-7 に示す項目に沿って実施した。

表 2-7　ラボラトリーの現状とレベルのレビューに関する主な項目

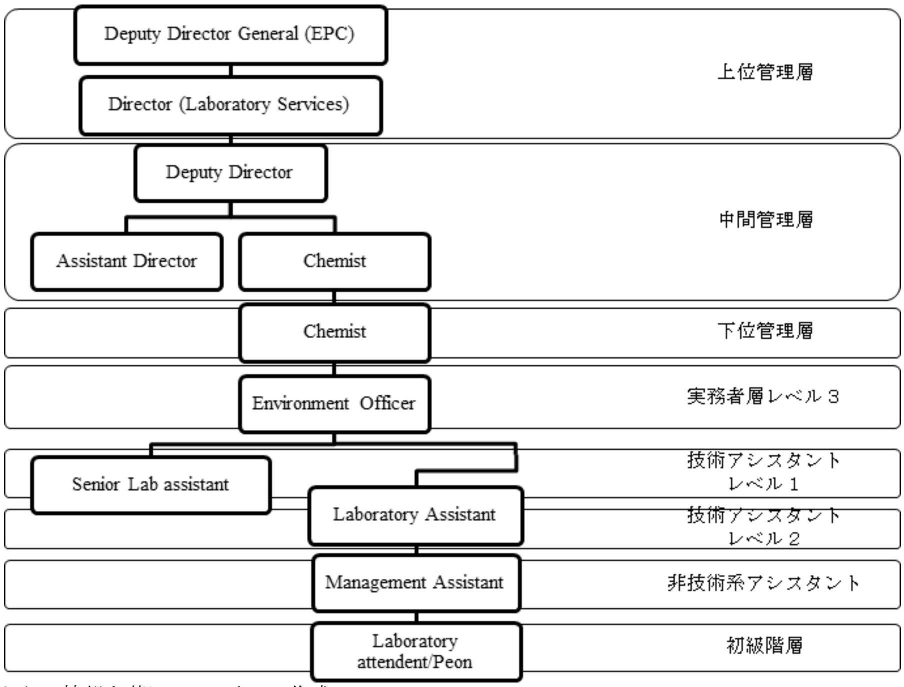
確認対象	確認項目	確認事項/ 実施事項
ラボ全般	中央及び地方のラボ	・トップの認識 ・現状把握のためのアンケートの実施（地方対象）
		・予算の状況（新規投資、ランニングコストを含む）
		・作業環境/ 設備環境
		・廃液・排ガスの処理方法と管理
		・インフラ（水道、電気、ガス）
水質分析の技術水準	分析者の力量	・水質分析技能
		・精度管理についての理解度
	機器や設備の管理状況	・分析機器の定期点検の記録
		・関連設備の管理水準
ISO/ IEC 17025 試験所認定	これまでの活動の状況	・ISO/ IEC 17025 要求事項と現状の差異分析 ・管理上の要求事項 ・技術的要求事項
	標準作業手順書の整備状況	・手順書の内容 ・作業手順書の準備状況 ・メンテナンス手順書の準備状況
	品質管理・精度管理のシステム	・品質管理の仕組みと組織体制 ・精度管理/ 品質管理実施事項 ・分析の不確かさの算出結果
	記録の管理状況	・サンプルの受け入れ記録 ・分析作業記録 ・試験結果の記録

注：JICA チーム作成

なお、CA の過程で判明した知見は、(1) 組織的、(2) 個人的、(3) 社会的および制度的観点から以下のセクションに詳述する。

(1) 組織的側面からの CA の結果

プロジェクト開始時の CEA ラボラトリーの技術者の構成は、ディレクター1 名、化学技術者 2 名、環境行政官 4 名、シニアラボアシスタント 1 名、ラボアシスタント 1 名の合計 9 名である。水質分析の実務経験に関しては、9 名のラボラトリー職員のうち、4 名が経験年数 10 年以上で、残る 5 名が経験年数 1 年以下であった。CEA 本部のラボの組織図を図 2-16 に示す。



注：CEA ラボからの情報を基に JICA チーム作成

図 2-16 CEA ラボの組織図

プロジェクトの初期段階で、CEA は地方ラボラトリーの立ち上げを行っていた。現在、それぞれの州のラボラトリーには 1 名の化学技術者か、1 名の環境行政官が配置されている。これらのラボは、CEA の州ディレクターおよびラボラトリーサービスのディレクターが所管している。州のラボの整備についての進捗状況は表 2-8 のとおりとなる。

表 2-8 州のラボの状況

州	州都	職員数	状況
Central	Kandy	1	2008 年の設立以来、順調に稼働している。
Eastern	Ampara	1	2008 年に設立された。2014 年 9 月からは連続稼働している。
North Central	Anuradhapura	1	2014 年後半に設立され、2015 年 2 月から稼働している。
Northern	Jaffna	1	2014 年後半に設立され、2015 年 2 月から稼働している。
North Western	Kurunegala	1→0→1	2014 年後半に設立され、2015 年 2 月から稼働している。現在、専任者がいないので、1 名の環境行政官を本部のラボでトレーニングしている。
Sabaragamuwa	Ratnapura	1	必要な装置と設備は準備済みだが、2017 年時点で稼働している。
Southern	Galle	1	2014 年後半に設立され、2015 年 2 月から稼働している。
Uva	Badulla	1	2014 年後半に設立され、2015 年 2 月から稼働している。
Western	Colombo	0	本部のラボが Western 州のために試験施設を提供。2016 年に District のラボの設立

注：CEA ラボからの情報を基に JICA チーム作成

本プロジェクトにおいて CEA は ISO/ IEC 17025 認定を計画していた。ISO/ IEC 17025 の管理システムは「管理上の要求事項」と「技術的要求事項」によって構成されている。ラボが中心になり、2007 年に認証を取得するための最初の作業に着手した。1 つの Quality manual、9 種の Procedure manual、2 種の Control record format および 4 種の標準作業手順書（SOP）を含む管理上の要求事項に関するいくつかの文書を完備した。一方で、いくつかの技術的要求事項に関しては、検出/ 定量限界の計算、トレーサビリティの確保、測定不確かさの計算、測定方法の検証に関する実質的な経験を有していなかった。

(2) 人的側面からの CA の結果

CEA ラボラトリーは、2015 年 2 月より地方ラボラトリーの運営を開始した。しかし、CEA 所有の機器や人材には限りがあった。いくつかの州のラボラトリーは、化学を専門とする職員がいないケースもある。また、CEA のラボラトリーで最低限の訓練を受けた環境担当官が配置されているケースもある。

試験所間試験への参加は ISO/ IEC 17025 における要求事項の一つとなっており、正確かつ再現可能なデータを生成するラボラトリー能力の客観的根拠でもある。CEA ラボラトリーはこれまで 2004 年、2005 年、2011 年および 2014 年に UNEP / GEMS または APLAC が主催する 5 回の試験所間試験のプログラムに参加したことがある。

測定データの記録および計算は、コンピュータソフトウェアを使用せずに手書きのノートで行われていた。これは 1）大量のデータを処理することが難しい、2）計算誤差を誘発しやすい、といった二つの欠点を有するが、不正行為が行いにくいといったメリットもある。なお、CEA のラボラトリースタッフの QA/ QC の理解度と知識の程度は表 2-9 に示すとおりであった。

表 2-9 QA/ QC メソッドの経験

QA/ QC メソッド	知識や経験
ブランク試験	あり
トラベルブランク	なし
繰り返し分析	時々
二重測定（資料採取から分析まで）	時々
検出限界、定量限界（3s, 10s）	なし （要求されたときのみ）
標準添加	時々
感度チェックサンプル（中程度の濃度の標準駅）	あり
参照標準物質（CRM）	なし
内部用チェックサンプル	あり
トレーサビリティ	なし, 濃度に関して あり, 天秤などの秤量に関して
不確かさの推定	なし
試験所間比較試験	あり

注：CEA ラボからの情報を基に JICA チーム作成

(3) 社会的・制度的側面からの CA の結果

CEA ラボラトリーは、通常週に 2 回、工場や施設の排水試料の測定を、また月に 1 回種々の河川のモニタリングを実施しており、土壌や顧客の持ち込みサンプルなども測定している。なお、年間の分析検体数はプロジェクト実施前では 1000 検体に満たなかった。

CEA ラボラトリーでは、ケラニ川のモニタリングにおいて pH、EC、温度、DO、CODcr、BOD、 Cr、Pb、Cl^-、NO_3^--N、PO_4^{3-}-P、T.Coli および E.Coli の測定を実施している。測定方法は、2012 年 APHA -AWWA（第 22 版）を利用している。

CEA により、EPL の審査、遵法審査等のために工場排水や表流水の分析が持ち込まれることがある。また、外部機関のサンプルを商業ベースで分析を行うこともある。工場は、CEA に登録されたラボで、排水の分析を行うこともできる。

活動 2-2	ワーキンググループを立ち上げ、水質分析と分析機材の運用と維持管理を含む明確な CD 計画について合意する。

ワーキンググループ（以下、WG2 とする）は、主に CEA ラボラトリーのスタッフで構成された（付属資料 7)。WG2 の第 1 回会合では、CA の成果が報告され、ISO/ IEC 17025 の認定に向けて CD 計画案が議論され、策定された。

CD プランには、分析機器や関連施設の安定した運用、保守手順、QA / QC、ラボラトリーのマネジメントシステムおよびラボラトリースタッフの継続的な個人能力開発が含まれており、これらは ISO/ IEC 17025 の認定要件の一部にもなっている。WG2 のメンバーは、事前に実施されたステークホルダーマッピングの結果に基づき C/P と共に選抜した。さらに、CEA は外部機関の SLAB に WG2 メンバーへの加入を要求することで､ラボラトリーの認証に関するアドバイスを期待した。

活動 2-3	CD 活動を実施し、標準手順書を開発し、ISO/ IEC 17025 等の公式認証を取得する活動を継続する。

(1) ラボラトリースタッフの測定技術の向上

プロジェクト期間中、「TRAINING PROCEDURE (CEA / WQL / LQMS / QSP - 02)」が新たに作成されその運用が開始された。本マニュアルには 10 種の下位定型書式が付随しており、分析スタッフの登録やその能力レビュー、トレーニング計画とその記録、機密保持義務通知などを網羅している。

さらに、2017 年初頭より、3 人の新しいラボラトリースタッフが採用され、ラボラトリー内で OJT による測定技術指導が積極的に実施された。これらの活動の結果として、CEA ラボラトリーの各スタッフが独立で多種多様の測定を実施できるようになるためのシステムが確立された。以下の表は、2017 年 8 月現在、CEA ラボラトリーのスタッフが測定可能な 30 項目の測定を示し、各個人が独立で実施できる測定項目については「Y」を付してある。

表 2-10　　2017 年時点における CEA 職員による分析能力

Measurement Items		Staff of the CEA laboratory as of Aug. 2017										
		C-1	C-2	C-3	C-4	EO-1	EO-2	EO-3	EO-4	SA	A-1	A-2
1	COD	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2	BOD	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
3	Cl	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
4	TSS	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
5	TDS	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
6	P	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
7	pH	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
8	$SO4^{2-}$	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
9	SO_3^{2-}	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
10	NO_3^-	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
11	NO_2^-	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
12	Alkalinity	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Measurement Items		Staff of the CEA laboratory as of Aug. 2017										
		C-1	C-2	C-3	C-4	EO-1	EO-2	EO-3	EO-4	SA	A-1	A-2
13	TH	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
14	EC	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
15	Colour	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
16	NH3	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
17	Oil&Grease	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
18	Kejudahr-N	Y			Y							
19~26	Metal (Cr,Pb,Ni,Zn, Fe,Cd,Cu,Mn)	Y		Y	Y					Y		
27~28	Metal (As,Se)	Y		Y	Y					Y		
29	T-coli form	Y		Y						Y	Y	
30	F-coliform	Y		Y						Y	Y	
Nos. of measurable parameters		30	16	29	28	16	16	16	16	29	18	16

*C-"number"; 化学技術者、 EO-"number"; 環境行政官、SA;シニアラボラトリーアシスタント、 A-"number"; ラボラトリーアシスタント

* C-3、C-4 および A-2 は 2017 年 1 月に新規加入したメンバー.

* EO-4 は 2017 年 1 月に地方ラボラトリーに異動

注：JICA チーム作成

CEA ラボラトリーは本プロジェクトの開始以降も試験所間試験への参加を継続している。プロジェクト開始年（2015 年）には pH、TDS、硬度、アルカリ度、NO_3^-の試験が実施され、NO_3^-の Z スコアは±2.0 を超過していた（Z スコア±2.0 超は「疑わしい結果」を意味する）。しかし、翌年の COD、TSS、P、pH の試験においては、いずれの Z スコアも 0 の近似値となり、非常に良好な結果が得たことが示唆された。この改善は新規に作成された「TRAINING PROCEDURE (CEA / WQL / LQMS / QSP - 02)」と日々の OJT の効果に起因するものである。また 2017 年の試験所間試験に関しては 8 月中旬に実施される予定となっており、CEA ラボラトリーはこれに再び参加することを決定している。

(2) 年間測定サンプル数の変遷

CEA ラボラトリーでは、2015 年にプロジェクトが開始して以来、受け入サンプル数を着実に増加させてきた。2016 年には、1 年あたりの受け入れサンプル数が 1363 検体となり、2014 年のプロジェクト開始前と比較して 40%の増加となった。主要な要因は、CEA が民間工場からの廃水サンプルを精力的に受け入たことにあり、これは年間サンプル数の増加に大きく寄与している（参照表 2-11）。ちなみに、2016 年の職員数は、プロジェクト開始時に比べて増加していない。加えて同年には様々な予期せぬ事態が発生し、これには、ラボラトリー長の長期医療休暇や熟練化学技術者の長期海外留学による休暇、4 名のラボラトリースタッフの出産休暇が含まれる。通常、このような状況下では、十分な人員を確保することは困難であり、測定サンプル数の増加の妨げにもなりかねないが、それにもかかわらず、実際には過去最大のサンプル数を処理することを実現した。一方でこの間のスタッフの作業負荷は非常に大きいことも見て取れた。この問題に対処するため、CEA ラボラトリーは 2017 年初頭に 2 名の化学技術者と 1 名のラボラトリーアシスタントを雇用している。

表 2-11　　測定サンプル数の増加

Category		2010	2011	2012	2013	2014	2015	2016
Industrial Water	Governmental Service	287	322	264	89	485	516	408
	Commercial	134	114	145	355	61	117	745
	Sub total	421	436	409	444	546	633	1153
Surface water	Governmental Service	361	425	408	397	400	361	210
	Commercial	107	91	95	79	4	11	
	Sub total	468	516	503	476	404	372	210
Total		889	952	912	920	950	1005	1363

注：CEA ラボからの情報を基に JICA チーム作成

2017 年の状況については、正確な測定サンプル数がまだ算出されていないものの、聞き取り調査において同年 8 月までに少なくとも 500 サンプルが受け入れられていることが判明した。年末までには測定試料のさらなる受入れが見込まれており、分析総数は 1200 を超えると考えられる。なお、CEA ラボラトリーでは増加するサンプルの受け入れに対応するため、ISO/ IEC 17025 のシステム運用に基づいて、すでに、新規採用されたスタッフに対しトレーニングを完了している。

(3)　試薬や機器の管理と利用

a)　機器

本プロジェクトでは、書式「MASTER LIST OF LABORATORY EQUIPMENT（CEA / WQL / LQMS / F-01 / A)」が新たに整備された。本書式には、1983 年以来 CEA ラボに導入された 100 以上の装置・機器に関する情報が含まれている。また、新たに導入された装置・機器が利用可能になる都度、その情報は本書式に順次登録されることとなっている。

上述の装置・機器のうち、CEA ラボラトリーは、秤量計を含む 20 の機器に関して、校正を外部機関に委託している。校正サイクルとそのスケジュールは、書式「CEA / WQL / LQMS / F-01 / B」と書式「CEA / WQL / LQMS / F-01 / D」で決定されることになっており、その結果は書式「CEA / WQL / LQMS / F-01 / C」に記録されることとなった。

CEA ラボラトリーは、これまで蒸留水水質、秤量計、温度および湿度の日々の状況を業務ルーチンとして記録してきている。本プロジェクトでは新たな内部承認システムを導入し、これは書式「SCHEDULE FOR INTERNAL VERIFICATION OF EQUPMENT（CEA / WQL / LQMS / F-01 / J)」に従って行われることになった。なお、承認結果は、書式「CEA / WQL / LQMS / F-01 / F～/ I」に記録されることとなっている。

加えて機器のメンテナンスやサービスに関する活動も書式「CEA / WQL / LQMS / F-01 / E」に記録されることが定められた。

これらの書式の運用詳細は、Procedure Manual「EQUIPMENT HANDLING AND CALIBRATION PROCEDURE (CEA / WQL / LQMS / QSP - 01)」に規定されており、合理的かつ効率的な規則が CEA ラボラトリーに完備された。ただし、故障設備の割合や故障頻度の高さなどの課題は依然として残っており、将来的には予算措置や設備更新を含む何らかの対策が重要になるとみられる。

b)　試薬

試薬管理は、新たに作成された 書式「INVENTORY RECORDS (form CEA / WQL / LQMS / F - 06 / D)」に従って行われている。ラボ所有の化学物質の物性や使用目的もまた CEA の規則のひとつとして書式「CEA / WQL / LQMS / F-06 / C」に明記されることとなった。これらの書式は、本プロジ

ェクトで大幅に改訂された Procedure Manual「PROCEDURE FOR PURCHASING AND HANDLING OF LABORATORY SUPPLIES AND SERVICES (CEA / WQL / LQMS / QSP - 06)」の付随文書に相当するものである。

本マニュアルに従うことで、試薬の購入に関する手続きや決定が適切に管理され、結果として試薬管理が完全化されることが期待される。また、本マニュアルでは、書式「SUPPLIER EVALUATION CHECK LIST (form CEA / WQL / LQMS / F-06 / E)」によるサプライヤー評価の実施が規定されており、さらにサプライヤー登録システム（書式 CEA / WQL / LQMS / 06 / B に基づく）も導入された。

一方、試薬室における試薬の保管状態は、頻繁に使用される試薬の一部が測定室の簡易棚に置かれていることを除いては、問題なく一般的なレベルで整理整頓されていた。しかし、ISO/ IEC 17025 の審査を受けるにあたり、この状況も完全に改善され、現在、試薬はストレージキャビネット内で厳重に管理されるようになっている。

(4) QA /QC 活動の状況

本プロジェクトで CEA は ISO/ IEC 17025 の取得を想定し、QA / QC に関する基本文書 Quality Manual（CEA/WQL/LQMS-QM which is the most fundamental document on QA / QC management）下に、15 種類の Procedure Manual と 56 種類の下位書式を用意した（表 2-12）。CEA の QA / QC 活動はすでにこれらのマニュアルや書式を総合的に活用することによって開始されており、今後は PDCA サイクルに基づく業務改善や測定スキルの向上が期待される。 なお、Quality Manual は、付属資料 13 として本報告書に添付されている。

プロジェクト開始当初の CEA ラボでは、計算を伴う技術的要求事項の満足度が ISO/ IEC 17025 認定取得の課題の 1 つとして残されていた。しかし、実際に問題があったのは、「計算」そのものではなく、「不確かさ要素の抽出方法の理解」と「LOD / LOQ の概念の理解」の不足であった。そこで、JICA の専門家は、特に慎重にその課題に関する講義を行った。最終的には、いくつかの測定項目において「測定不確かさ」、「LOQ」および「LOD」が、ラボラトリースタッフ自身によって算出されている（表 2-13）。また、将来的には、ISO/ IEC 17025 で取得すべき項目の数をさらに増やすために、他の測定項目においても算出がおこなわれる見込みである。

表 2-12 ラボラトリーの手順マニュアル一覧

	Procedure Manuals	Forms
1	Equipment Handling and Calibration Procedure (CEA/WQL/LQMS/QSP-01)	• Master List of Laboratory Equipment (CEA/WQL/LQMS/F-01/A) • Laboratory Equipment to be Calibrated (CEA/WQL/LQMS/F-01/B) • Record of Calibration (CEA/WQL/LQMS/F-01/C) • Calibration Schedule (CEA/WQL/LQMS/F-01/D) • Service/ Maintenance Record (CEA/WQL/LQMS/F-01/E) • Internal Verification Record Sheet of Balance (CEA/WQL/LQMS/F-01/F) • Internal Verification Record Sheet for Temperature (CEA/WQL/LQMS/F-01/G) • Internal Verification Record Sheet for Distilled Water (CEA/WQL/LQMS/F-01/H) • Temperature and Humidity Record (CEA/WQL/LQMS/F-01/I) • Schedule for Internal Verification of Equipment (CEA/WQL/LQMS/F-01/J)
2	Training Procedure (CEA/WQL/LQMS/QSP-02)	• Personnel Record (CEA/WQL/LQMS/F-02/A) • Authorization Record (CEA/WQL/LQMS/F-02/B) • Confidential Statement (CEA/WQL/LQMS/F-02/C) • Job Description (CEA/WQL/LQMS/F-02/D) • Training Plan (CEA/WQL/LQMS/F-02/E) • Staff Accession Record (CEA/WQL/LQMS/F-02/F) • Records of Training (CEA/WQL/LQMS/F-02/G) • Evaluation of Competency of Training (CEA/WQL/LQMS/F-02/H) • Employee Orientation Checklist (CEA/WQL/LQMS/F-02/I)

	Procedure Manuals	Forms
		• Competency Assessment Sheet (CEA/WQL/LQMS/F-02/J & CEA/WQL/LQMS/F-02/J-1) • List of Authorized officers (CEA/WQL/LQMS/F-02/K)
3	Internal Audit Procedure (CEA/WQL/LQMS/QSP-03)	• Internal Audit Summary Report (CEA/WQL/LQMS/F-03/A) • Internal Audit Schedule (CEA/WQL/LQMS/F-03/B) • Internal Audit Checklist (CEA/WQL/LQMS/F-03/C) • List of Trained Internal Auditors (CEA/WQL/LQMS/F-03/D)
4	Control Of Documents (CEA/WQL/LQMS/QSP-04)	• Master List of Controlled Documents (CEA/WQL/LQMS/F-04/A) • Externally Originated Documents (CEA/WQL/LQMS/F-04/B) • Record of Amendment (CEA/WQL/LQMS/F-04/C) • Document Change Request Form (CEA/WQL/LQMS/F-04/D) • List of Obsolete Documents (CEA/WQL/LQMS/F-04/E)
5	Control of Records (CEA/WQL/LQMS/QSP-05)	• Master List of Controlled Records (CEA/WQL/LQMS/F-05/A) • Register for Disposal of Records (CEA/WQL/LQMS/F-05/B)
6	Procedure for Purchasing and Handling Of Laboratory Supplies And Services (CEA/WQL/LQMS/QSP-06)	• Purchasing Request Form (CEA/WQL/LQMS/F-06/A) • Registered Suppliers List (CEA/WQL/LQMS/F-06/B) • Specification (CEA/WQL/LQMS/F-06/C) • Inventory Records (CEA/WQL/LQMS/F-06/D) • Supplier Evaluation Checklist (CEA/WQL/LQMS/F-06/E)
7	Procedure for Review Request for Testing From Customers (CEA/WQL/LQMS/QSP-07)	• Sampling Request (CEA/WQL/LQMS/F-O7/A) • Sampling Request (CEA/WQL/LQMS/F-O7/A -SINHALA) • For Customer Awareness (CEA/WQL/LQMS/F-08/B) • Review of Customer Request (CEA/WQL/LQMS/F-08/B) • Sample Inquiry Register (CEA/WQL/LQMS/F-07/B)
8	Customer Complaints Handling Procedure (CEA/WQL/LQMS/QSP-08)	• Customer Complaints Register (CEA/WQL/LQMS/F-08/A) • Customer Feedback Form (CEA/WQL/LQMS/F-08/B) • Register for Visitors (CEA/WQL/LQMS/F-08/C)
9	Procedure for Control of Nonconformities & Corrective/Preventive Actions (CEA/WQL/LQMS/QSP-09)	• Non-Conformity Record(NCR)& Corrective/Preventive Actions Request Form (CEA/WQL/LQMS/F-09/A) • Corrective Action Preventive Action Log (CEA/WQL/LQMS/F-09/B) • Record of Management Review (CEA/WQL/LQMS/F-09/C)
10	Procedure for Health and Safety (CEA/WQL/LQMS/QSP-10)	• Records of Accidents (CEA/WQL/LQMS/F-10/A)
11	Procedure for House Keeping and Cleaning (CEA/WQL/LQMS/QSP-11)	• Cleaning Schedule (CEA/WQL/LQMS/F-11/A) • Cleaning Chart (CEA/WQL/LQMS/F-11/B)
12	Procedure for Reporting Test Results (CEA/WQL/LQMS/QSP-12)	• Test Report Form (CEA/WQL/LQMS/F-12/A) • Data Analysing Record Sheet (CEA/WQL/LQMS/F-12/B) • Analytical Data Record Book (CEA/WQL/LQMS/F-12/C) • Test Assignment Record Sheet (CEA/WQL/LQMS/F-12/D)
13	Procedure for Handling of Test Items (CEA/WQL/LQMS/QSP-13)	• Sample Register (CEA/WQL/LQMS/F-13/A)
14	Procedure for Estimation of Uncertainty of Measurement (CEA/WQL/LQMS/QSP-14)	
15	Assuring the Quality of Test Results (CEA/WQL/LQMS/QSP-15)	

注：CEA ラボからの情報を基に JICA チーム作成

表 2-13　測定不確かさ、LOD、LOQ の算出

Target parameters	Uncertainty	LOD	LOQ
COD	250.0±9.0 mg/L (k=2)	1.00 mg/L	3.33 mg/L
Cl	19.71±0.52 mg/L (k=2)	2.00 mg/L	6.52 mg/L
TH	20.91±0.70 mg/L (k=2)	3.07 mg/L	10.25 mg/L
P	1.000±0.138 mg/L (k=2)	0.0012 mg/L	0.0040 mg/L
pH	4.00±0.46 (k=2)	-	-
TSS	0.000910±0.000002 g (k=2)	Not calculated yet	Not calculated yet

注：CEA ラボからの情報を基に JICA チーム作成

(5) ISO/ IEC 17025 の取得

上記手順書で確立した QA / QC 活動の状況を監視するために、CEA ラボラトリーは 2016 年末から 2 回の内部監査と 1 回のマネジメントレビューを実施した。これは ISO/ IEC 17025 認証を取得する前に実施する必須活動である。また、2017 年 9 月には第 3 回目の内部監査も実施され、ISO/ IEC 17025 の取得と維持に関する活動は CEA の研究室で日常的に行われるようになった。

一方で、ISO/ IEC 17025 の申請書類は 2017 年 2 月のマネジメントレビューの後に、認定機関である SLAB に提出された。対象となる測定項目は COD、Cl、TH、P、pH である。

SLAB は、2017 年 8 月までに、品質管理文書の事前審査、作業環境の検査環境を実施し、以下を含むいくつかの不適合を指摘した。

- ✓ 「試験室に換気システムとエアコンがない」
- ✓ 「実験室の機器・装置のレイアウトを変更する必要がある」

これらを受け CEA は、実験室を改善するために計 210 万 RS の予算を確保した。ラボラトリー長によると、現地審査、審査会議及び SLAB による認証の発行は、2018 年上半期に完了する見込みとのことである。

成果 3	**対象カウンターパート（C/P）機関のインスペクションを含む水質モニタリング能力強化、汚染源インベントリー（Pollution Source Inventory, PSI）の整備及び EPL の取得が促進される。**

成果 3-1	**事業所インスペクションに関わる能力強化**

成果 3-1 は、CEA におけるインスペクションを含む水質モニタリング実施能力強化を目指したものである。この成果は、承認された標準規則の文書化、および、インスペクションおよび水質サンプリング（サンプリングおよび分析室における測定）の方法の文書化を通じて達成される。結果として、一定の品質を担保したインスペクションおよび水質サンプリングの実施を目指したものでる。

効率的な能力強化策として、まず初めに、能力強化のニーズを知るために現状のインスペクションおよび水質サンプリングを精査した。能力強化のニーズおよび必要な活動の特定、および、活動実施に当たってフィードバックと指導を与えるためにワーキンググループを設立した。現状評価を行ったところ、インスペクションにかかわる内部手順はあるものの、文書化されていないことが判明した。また、手順等のアップデート、技術的考察、例えば事業所活動により発生する汚染源・負荷の推察、に関わる能力強化も求められた。したがって、インスペクションおよび水質サンプリング手順の最新化、文書化が最も重要なニーズであると言え、インスペクションおよび水質サンプリングのガイドラインのドラフト、作成が重要なタスクと確認された。ガイドラインのレビュー支援のほか、ガイドラインの承認支援もタスクに加えた。

ワーキンググループは水域のカテゴリーをベースとして重要汚染物質を選定した。これらの重要汚染物質は主要汚染源の特定に供せられる。限定的なマンパワーと資機材等のリソースを有効的に活用し、これに基づき特定産業種の汚染管理ガイドラインの更新を行った。

インスペクションおよび水質サンプリングガイドラインが作成され、重要な項目として、段階的な

手順、法遵守の可否に関するレポーティング、インスペクション時の適切な行動、また、レポートフォーマットの改定を行った。素案作成、また、ワーキンググループによるレビューの後、パイロットテストを実施した。パイロットテストからのフィードバックを通じて、ガイドラインを改定、最終化し、また、CEA の承認プロセスを図った。インスペクションガイドラインのためのトレーニングガイドもまた作成し、トレーニングセミナーを行った。トレーニングガイドは、インスペクション結果の分析・評価方法、および効果的な汚染管理の関わるインスペクションレポートの作成手順を網羅している。これらの結果は年間報告書に反映した。

サンプリングガイドラインは、ISO/ IEC 17025 の要求事項およびラボラトリーユニットでの目的に応じて修正した。サンプリングガイドラインもまた、ラボラトリーでの使用目的、能力に応じて簡素化した。サンプリングガイドラインに関しての重要な提案事項は、インスペクションの実施と排水サンプリングの同時実施である。同時実施は、事業所の汚染に関する実態を表し、EPL の未遵守、また、対応策支持の根拠となりうるものである。これらの根拠は、法令違反に対する法廷闘争に重要な意味を持つことになる。

本活動の、主要成果品は、インスペクションガイドラインおよびそのトレーニングガイド、水質サンプリングガイドラインで、安定した高品質の水質モニタリングを導くものである。すなわち、適切な汚染管理（プログラム、ポリシー）を提供するため主要汚染項目、優先汚染源の適切な提供することにより、ケラニ川およびスリランカの河川の現実的且つ効果的な汚染管理が期待される。

活動 3-1-1	インスペクションを含む水質モニタリングの現状をレビューし、CD のニーズを把握する。

最初に、適切な環境及び水質管理で要求される事項、最も重要な物として、一貫した、また、効率的な環境法令の遵守が洗い出された。環境関連法の施行と実施には、法令を遵守あるいは違反しているかを判断するインスペクションの質が重要である。現状のインスペクションをレビューし改善すべき要素を洗い出せば、C/P 機関の実施能力向上につながる。

この点において、環境水モニタリングと工場排水モニタリングを区分することが必要である。環境水モニタリングは、EPL システムの履行を目的とした工場排水モニタリングと異なり、成果 1 と密接に繋がる。一方で、環境水と工場排水モニタリングは密接に繋がるべきものでる。ケラニ川のような水域に流入される工場排水は、環境水質に直接的に影響を及ぼす。より効率的な能力向上を図るために、成果 3-1 では、工場排水モニタリングに焦点をあてて活動した。

水質モニタリングの現状に関する洗い出しを以下に記載する。

- ✓ インスペクションにおいて標準化された手順はあるものの、インスペクターのトレーニング、スキルアッププログラム、トレーニングのニーズ評価が定期的に実施されず、また、文書化されていない。
- ✓ CEA 内のインスペクターの人員が足りていない。
- ✓ インスペクション計画（スケジュール）は EPL の更新に対して年間計画が立てられている一方、新規 EPL、モニタリング、苦情処理、事故対策等は、関連法令に従って実施されているが、文書化はされていない。また、年間計画には、水質サンプリングは考慮されていない。
- ✓ すべての事業所に対して、書類確認、事業所内の生産ラインや排水処理ラインの確認

といったインスペクションは実施されているが、水質サンプリングは、必要に応じて、事前に要求があった場合に行われる。

- ✓ 通常、水質サンプリングは、インスペクションとは別に実施されるため、インスペクションの結果と水質分析結果が必ずしも一致せず、EPL 不履行に対する法的手続き等に、影響を及ぼす。
- ✓ インスペクション手順の画一・文書化が、インスペクションの能力向上の一環として期待されている。
- ✓ CEA に加えて、BOI および地方自治体をカウンターパート組織として含まれることが提案された。
- ✓ CEA は、その活動内容、EPL 遵守状況を年間報告書にまとめているが、水質モニタリングの考察・評価は含まれていない。

NEA 履行に関わる違反行為に対する罰則規定も併せてレビューを行った。

- ✓ NEA の履行違反に対する反則金は、セクション 31 に記される通り、最高で LKR10,000 とされている（2017 年時。日本円にして 7,300 円[7]）。

  セクション 31　この法律のいかなる規定またはそれに基づいて行われた罰則が明示的に規定されていない規則に違反あるいは遵守しない者は、2 年を超えない期間の拘束または 1 万ルピーを超えない罰金、あるいはその両方が科される。
- ✓ 違反に対するフォローアップ・警告は、インスペクション結果に基づき、電話あるいはレターにより行われる。3 回警告を行っても改善が認められない場合は、裁判所による裁決を行うことができる。
- ✓ しかしながら、裁判所による裁決は、1) CEA ラボラトリーで分析を行うには分析施設は限られており、かつ第三者機関の分析結果は、司法判断に用いることができない、2) 水質サンプリングがインスペクションの後に実施されており、違反発覚時の根拠にならない、の理由で困難な状況である。

下水ネットワーク近傍の事業所は、下水管に排水し、そのために下水処理場の準基準（設計排水基準）を満たすように処理することが必要である。EPL 関連法において、下水処理にかかわる準基準が規定されている。また、下水処理場整備は、国家水供給排水庁（NWS&DB）が管轄している。下水ネットワーク管轄外では、カテゴリーA、B 事業所では適切な排水処理を行った後に排水している。小規模事業所では、簡易汚濁槽（ソークピットやセプティックタンク）で処理しているケースが多い。BOI 産業区域では、各事業所からの排水は、合同下水処理施設で処理され、排水される。

よって、文書化されたインスペクションおよび水質サンプリングの手順のガイドライン化、実施のためのトレーニングが、成果を達成させるための必要な活動であることが確認された。

事業所の優先付け（主要汚染項目・汚染源を用いた EPL の遵守状況、法令遵守に対する指示・支援）を行うためのデータの分析・評価方法のニーズも示された。この分析・評価には、PSI システムの開発整備によるデータアクセスの利便性向上が必要であり、したがって成果 3-2 との協力、調整が必要である。

[7] The exchange rate used is 1.37 LKR/Yen.

活動 3-1-2　ワーキンググループを立ち上げ、活動のタスクマトリックスを作成し、明確な CD 計画について合意する。

WG3-1 は付属資料 7 に示すように、ラボラトリーサービス、西部州事務所、法整備ユニット、EPC 局および BOI から派遣された 13 名のメンバーから成り、プロジェクト管理、能力強化計画の立案を主目的とした。

WG3-1 のメンバーの一部は、WG3-3 を兼務し、その活動は重複していたので、効率的な運営のために、両チーム協調、統合を図った。

活動 3-1-3　年間計画、採水、報告を含む CD 活動を実施し、他のワーキンググループにフィードバックする。

活動 3-1-3 はインスペクションの現状把握とガイドラインの策定を主眼に置き、以下の 8 ステップで進めた。

(1)　インスペクションを含んだ水質モニタリングの現状把握と能力評価（CA）

JICA 専門家はメンバーと協同しインスペクションおよびサンプリング現場の状況を観察し、問題点を話し合った。インスペクターの力量は、インスペクション実施において、十分なレベルであったが、サンプリング実施の判断、インスペクションレポートの作成に一貫した手順が共有されていないことがわかり、この状況は、インスペクションの質が、個々のインスペクターの力量、考え方に依存する傾向を示すことになる。また、排水サンプリングが、ラボラトリーの事情により後日になることが多く、インスペクション実施日とサンプリングの日付が異なることを招いている。その結果、事業所排水管理への関与が、画一的ではなく、限定的な、また、不明瞭な事態を招いている。

そのほか、以下の事項が指摘された。

- ■ 問題点の抽出、改善のため、インスペクションレポートを一部選出してレビュー行ったが、この活動は継続して行われるべきである。
- ■ 定型的なインスペクションレポートをガイドとして利用すべきである。現在使用しているレポートフォーマットは概ね理にかなっているので、修正は軽微である。レポートの白票が準備されているにもかかわらず、インスペクターはしばしばそれを用いないため、必要なチェック事項等を見落としてしまうリスクがある。
- ■ インスペクションレポートは、インスペクションフォームを用いて、入力・作成し、検査時書類のハードコピーを添付するものの、ソフトコピーは作成されていない。このため、個々の事業所の履行状況を評価することはできるが、マクロレベルで多角的・横断的に評価することは難しい。このことは、履行状況のトレンドや、事業所の適切な汚染源管理に影響している事項に対する考察を妨げかねない。その観点では、PSI を用いたデータの管理・集積は有用である。
- ■ インスペクションにおいて記載するレポートフォーマットの多くの部分は、固定化された情報で変更不要であり、より効果的な検査のために、こうした共通部分の修正を最小限とする検査フォーマットに改訂した。

(2)　インスペクションおよびサンプリングに関わる評価フォーマットの準備

ベースラインサーベイは、個人レベルおよび組織レベルの現状の評価を行い、次に、インスペク

ションおよび水質サンプリングに同行、観察し、実際の問題点把握、能力向上の方法を検討した。現在のインスペクション手順と、実際の現場での活動の比較は、インスペクション実施の程度を評価するのに適している。

現状の手順での水質サンプリングは、要請があった場合に実施されている。企業におけるサンプリングの日程が事前に決定しにくいため、年間計画は作成されていない。現状では要請後 1～2 週間で実施されている。

インスペクション結果の考察・評価は、概ね適切に行われている。一点、重要なことは統一された標準手順がなく、このことは評価結果が、個々のインスペクターに依存しがちになってしまう。よって、統一されたインスペクションの手順とガイドラインが必要である。

(3) 年間計画の構成検討

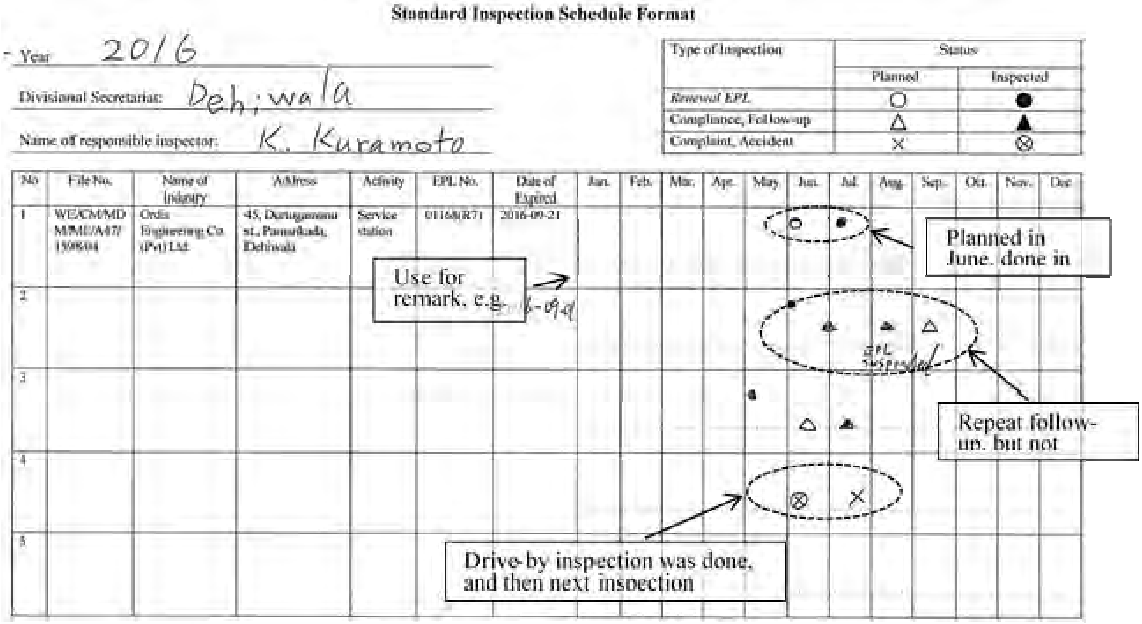
インスペクション計画は、EPL の期限をベースに作成されている（通常、有効期限の 3～4 か月前に実施）。一方、EPL の新規申請、フォローアップ、苦情処理にかかわる計画は設定しにくい。インスペクターの稼働状況等を考慮しつつ、遵守状況の経歴（例えば、新規ライセンスであったかどうか、苦情の有無、排水データ等）を用いて優先付けを行うことを提案した。

前述のように、現在の年間計画は、EPL 更新のみを対象としていたが、フォローアップ、苦情処理等の計画および実績を明記できるよう、インスペクション計画様式を変更した。表 2-14 にその様式と使用例を示す。

水質サンプリングは、リクエストベースで実施されているため、計画表は作成されていない。サンプリングはインスペクションと同時に行うことが望ましく､両者の計画表を統合することが提案された。一方で、CEA の組織分担（インスペクションは EPC 部局、サンプリングはラボラトリーユニット）、必要な機材数（pH 計等、現場測定器）等の資源配分の必要性が指摘された。

インスペクションの年間計画定型、使用法は、インスペクションガイドラインに記載されることになった。

表 2-14 インスペクション計画表の様式



Standard Inspection Schedule Format

Year 2016

Divisional Secretarias: Dehiwala

Name of responsible inspector: K. Kuramoto

Type of Inspection	Status: Planned	Status: Inspected
Renewal EPL	○	●
Compliance, Follow-up	△	▲
Complaint, Accident	×	⊗

No	File No.	Name of Industry	Address	Activity	EPL No.	Date of Expired	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec
1	WE/CM/MD M/ME/A47/ 1509/04	Ordis Engineering Co. (Pvt) Ltd.	45, Durugamanu st., Pamarkada, Dehiwala	Service station	01168(R7)	2016-09-21						○	●					
2												●	▲	▲	△			
3											●	△	▲					
4												⊗	×					
5																		

Source: JICA Team

(4)　年間計画の作成

年間計画書に関して、まず、現状のフォーマットの利点と改善すべき点を検討、抽出した。次にWG3-1 において、変更すべき事項の同意を経て、ガイドラインとともに、素案を作成した。最終承認されたインスペクションガイドラインには、修正された定型フォームおよび計画策定指針を網羅している。また、事業所の位置、周辺状況が記載されている。

例えば新規 EPL 発行等のあらかじめスケジュールが立てにくいケースについても WG3-1 内で討議され、現状の手順を踏襲することになったが、ガイドラインにおいて、具体的なタイムスケジュールをチェック、記録することを記載している。

(5)　インスペクションを含むモニタリングガイドラインの検討

水質サンプリングとインスペクションに関わるガイドラインは別冊で作成された。それぞれの構成を以下に示す。

表 2-15　サンプリングガイドラインの構成

1.0	Scope
2.0	References
3.0	Responsibility
3.1	Responsibility Related to Sampling Work
3.2	Sampling Team Formation
4.0	Procedure
4.1	Sampling
4.2	Sample Reception and Registration
5.0	Quality Control
6.0	Records (Appendix)

表 2-16　インスペクションガイドラインの構成

1.	Introduction
1.1.	Purpose of the Guideline
1.2.	Definition of Inspection
1.3.	Purposes of Inspection
2.	Scope of Inspection
2.1.	Roles and Responsibilities of Inspectors
2.2.	Types of Inspection
2.3.	Qualification of Inspectors
2.4.	Schedule of Inspection
3.	Procedure of Inspection
3.1.	Overall Outline of Inspection Procedure
3.2.	Inspection Procedure
3.3.	Inspection Report
3.4.	Enforcement

インスペクションガイドラインには、サンプリングの同時実施の必要性を記述するとともに、サンプリング実施の判断要素を説明している。インスペクションガイドラインのパイロットテストを実施した後、同トレーニングガイドを作成した。ガイドラインには、インスペクションの結果の評価のポイント、また、個々の事業所および関連セクターでの評価を網羅している。

水質サンプリングガイドラインもまた、構成、定型フォームの見直しを経て作成された。また、同ガイドラインは、ISO/ IEC 17025 の要求事項を満たすように構成され、現状および将来（3~5 年

後）のラボラトリーユニットのキャパシティに沿うように構成された。ガイドラインは、サンプリングおよび分析過程において、無用な要求事項を避けるように簡素化した。

(6)　インスペクションを含むモニタリングガイドラインの作成

インスペクションガイドライン作成において、レポートの定型フォームの改定を PSI データベースとの関連付けに主眼に置いて行った。作業は、ドラフトの作成と WG3-1 によるレビューを繰り返し、最終版はメンバー間の合意ののち、2017 年 8 月に CEA の公式承認プロセスを経た。

サンプリングガイドラインは、ISO/ IEC 17025 の要求事項に沿うように作成されたが、当面は内部 SOP として使用することとなった。将来的に公式 SOP として採用することが期待される。

(7)　年間報告書の作成

成果 3-1 に関係するデータは EPL 遵守に関係するインスペクションの結果である。データは WG3-2 と共同し、PSI データベースに入力した。これらのデータは、年間報告書に統合される。

(8)　関連機関との連携協議

ワーキンググループでは、BOI、州政府オフィサー等関連機関からも招集し、作業を共同し進めた。

活動 3-1-4	インスペクションを含む水質モニタリング結果について解析、評価し、ケラニ川の年間報告書を作成する。

以下に示す 6 ステップで作業を進めた。

(1)　パイロットテストの実施

インスペクションガイドラインの検証を目的として、パイロットテストを 2017 年 3 月から 8 月にかけて実施した。EPC ユニット、コロンボおよびガンパハ地域オフィスから合計 8 グループのインスペクションチームを構成し、延べ 71 事業所で、ガイドラインを用いてインスペクションを実施した。現地実習ののちラップアップ協議を行い、以下のコメントを得た。

a)　インスペクターのポジションを 2 段階に区分した。まず、新しいオフィサーが配置された場合は、アシスタントインスペクターとしてインスペクションをサポートし、3 年間の実務およびトレーニングを通じて、インスペクターに昇格する。

b)　インスペクションレポートの定型フォームを PSI データベースに連動するよう改定する。定型フォームを以下の 2 部構成にする。

- ✓ 住所、生産ライン等、基本的にはデータが変わらない項目。
- ✓ 個々のインスペクションで必ずチェックし、データが変わる要素が高い項目、およびインスペクションの結果および提案事項。

c)　スリランカの慣習、様式に対応した微修正（ワーディング等）

(2)　水質モニタリングに関わる現状把握と CA

インスペクションおよび水質サンプリングガイドラインに関する議論の結果は、ガイドラインの最終化に反映した。

主要なポイントは、インスペクションおよびサンプリングの結果の考察の統合に関するものである。水質モニタリングの分析・評価は、個々のインスペクションの結果との統合が必要であり、その結果、汚染状況の特性、地域分布が把握され、ケラニ川流域の汚染源管理に大きく結びつく。

(3)　年間報告書作成に関わる現状把握と CA

年間報告書の定型フォームはレビューされ合意が得られた。レポーティングに関し、重要なのは、如何に分析・評価結果を統合するかである。これは、PSI データベースのアップデートおよびその検討結果に大きく依存する。

現状では、インスペクションおよびサンプリングデータの検討は、ハードコピーをベースに行われる。この場合は、時間を費やすばかりではなく、エラーを招くこともあった。

(4)　年間計画の構成に関わるレビュー

年間計画に関わるレビューは、インスペクションガイドライン作成におけるそれと同時に、WG3-1 の協議を通じて行われ、合意形成、承認に至った。

(5)　インスペクションを含むモニタリングガイドライン修正に関わるレビュー

インスペクションおよびサンプリングガイドラインの作成は、2016 年 11 月にドラフトが作成された。パイロットテストの実施を通じて、改定を繰り返し、2017 年 8 月に CEA の承認を得た。

(6)　年間報告書の構成に関わるレビュー

年間報告書の検討は、活動 4 と共同で行った。データは PSI データベースで管理されており、分析・評価方法はガイドラインに併記した。

活動 3-1-5	スリランカの河川のためのインスペクションを含む水質モニタリングガイドラインを作成する。

モニタリングガイドラインはインスペクションの部分とサンプリングの部分を別冊で作成した（詳細は活動 3-1-4 を参照)。インスペクションガイドライン、トレーニングガイドおよびサンプリングガイドラインはそれぞれ付属資料 14、15、16 に添付した。

(1)　インスペクション、汚染管理に関わる事例紹介

日本、フィリピンその他諸国の事例をセミナーおよび WG ミーティングで紹介を行った（付属資料 17)。セミナーからのフィードバックは、ガイドラインの作成作業に反映した。

(2)　インスペクションのトレーニングマニュアルの構成検討

インスペクションガイドラインの最終化およびパイロットテスト終了後に、トレーニングマニュアルを作成し、2017 年 7 月に最終化した。

(3)　同トレーニングマニュアルの作成

同上。

(4)　同トレーニングマニュアルのレビューと改定

トレーニングガイドをもとに、各州事務所よりインスペクターを選出、招集し、トレーニングセミナーを 2017 年 8 月に実施した。その結果を反映し、インスペクションガイドライン、トレーニングガイドを最終化した。

成果 3-2　汚染源インベントリーの開発

成果 3-2 の活動は、汚染源インベントリー（PSI）の作成となる。プロジェクトの開始時に、CEA は EPL に関する 4 つの異なるデータベースを管理していることが判明した。また、2015 年 1 月に開

発された新しい EPL システムが、州事務所からオンラインでデータ入力が可能であることが確認された。一方で、データベースの使用頻度は記録されておらず、操作のための手順や指針は準備されていなかった。州事務所からのデータ入力の範囲には大きな差があり、こうした状況を改善するために、このプロジェクトの WG3-2 のメンバーと具体的な CD 計画について協議し合意した。

一連のプロジェクト活動を通して、情報の効果的な解析機能を備えたオンラインデータベースとして新しい汚染源インベントリ（PSI）が作成された。続いて、2016 年 12 月、2017 年 5 月から 7 月（合計 8 回）に州事務所職員向けに一連の PSI セミナーを開催し、その結果、PSI の目的と利用に関する十分な知識を有する CEA 職員の数が増加した。さらに、2016 年の PSI データの解析を通じて、CEA の年次報告書[8]にも貢献した。

最終的に、以下の改善がみられた。

a) PSI が整備され、企業の活動概要及び排出する汚染内容が、オンライン上で登録・確認できるようになる。
b) 特に排水モニタリング結果については、EPL に基づき企業が定期的に提出するレポート、または CEA が実施したサンプリング結果と、排水基準との比較が容易にできるようになり、汚染負荷推計のための基礎資料となる。
c) インスペクションの実施結果が登録されることで、過去のインスペクションの結果や、違反・事故等の件数が確認できるようになる。

活動 3-2-1　PSI の現状をレビューし、CD のニーズを把握する。

EPL に関する情報は、CEA 職員と協力して収集し、紙ベースの EPL 情報と電子化された情報システムとの間の差異を解析した。収集した情報のレビューによれば、CEA には表 2-17 に示すような複数のデータベースが構築されている。

また、既存 PSI を改定して新システムの作成を進めること、新たに汚染のタイプ、排水量等の情報を追加した。

表 2-17　　CEA が保有する環境データベース

#	環境データの種類	担当部署 又は データ管理部署	データ管理の状況
1	環境保護ライセンス（EPL）	EPC、R&D 他	• カテゴリーA 企業を対象とした EPL データベース（MS Access）が EPCDiv において管理されている。 • 全てのカテゴリーを含む EPL 電子データ（新規、更新）は毎月 MS Excel ファイルで地方事務所から R&D ユニットに提出される。
2	工業排水モニタリングデータ	EPC 本部ラボラトリー	• CEA によるインスペクションや EPL 取得企業からの環境レポートは地方事務所（州、郡）において紙ファイルで保管されており、電子化されていない。 • EPC 本部ラボラトリーにおいて年間約 500 件の工業排水分析を実施している。本データは EPC（本部及び県）にも紙ベースで提出されている。
3	表流水水質モニタリングデータ	EPC 県オフィス	• 電子化されており、一部は CEA ホームページに公開されている。
4	環境影響評価（EIA）レポート	EPC ラボラトリー	• 主に大規模事業に対して EIA 実施義務があり、建設開始前に EIA レポートが提出される。 • EIA レポートはデータベース化されている。

[8] The report may be referred to as Environment White Paper.

#	環境データの種類	担当部署 又は データ管理部署	データ管理の状況
5	苦情	EPC EIA	• データベース化されている。
6	CEA Annual Report	苦情ユニット	• 毎年発行されており、CEA ホームページにおいて公開されている。 • CEA の活動報告として、EPL 登録・更新状況や表流水・排水モニタリング実施結果についても報告されている。

注：CEA からの情報を基に JICA チーム作成

上記のように、プロジェクトの開始前に CEA にはいくつかの種類の EPL データベースがあり、プロジェクトの開始前の EPL データベースは、表 2-18 に示すとおりである。

表 2-18　　プロジェクト開始前の EPL のデータベース化の状況

管理 Unit / 項目	EPC	R&D Unit	Planning & Monitoring Unit	IT Unit
対象とするカテゴリー	A	A, B, C, BOI（西部州除く）	B	A, B, C, BOI
データベースの数	13,137	Total 43,009 A：9,863 B：10,499 C：22,310 BOI：337	9,105	Total 25,751 A：11,507 B：13,757 その他：487
対象地域	全土	全土	全土	全土
データベースのソフトウェア	MS Access	MS Excel	MS Excel	My SQL
データ収集の方法	提出された EPL（紙データ）からその都度入力	州事務所に A, B, C の電子データを毎月要請。	Legal Unit を通して州事務所から EPL を入手	地方事務所がオンラインで EPL 情報を入力更新
排水データ	排水量、使用化学物質を登録 廃水、廃棄物、大気・騒音の排出の有無 環境モニタリングの登録はない	廃水、廃棄物、大気・騒音の排出の有無のチェック項目があるのみ	データベース化されていない	排水量、使用化学物質を登録 廃水、廃棄物、大気・騒音の排出の有無 環境モニタリングの登録はない

注：CEA からの情報を基に JICA チーム作成（2015 年 5 月時点）

CA に関るインタビュー、CD のニーズ等の結果を以下に概括する。

(1)　汚染源インベントリ（PSI）のための有効なデータ

- ■ CEA には環境に関するいくつかのデータが存在し、その一部はデータベース化されている（例：EPL データベース、EIA データベースなど）。
- ■ 現在は、インスペクションレポートや EPL を保有する企業の環境分析報告書等に含まれる廃水モニタリング結果は、データベース化されていないため、このデータが PSI に登録されることが期待される。

(2)　PSI のためのデータ収集・更新

- ■ CEA ヘッドオフィスにはいくつかの EPL データベースがあり、それぞれのデータベースは、独自のデータ収集・更新手続きを有している。CEA は 2015 年 1 月にオンラインで EPL 情報を登録・更新できるシステムを導入している。しかし州事務所によるデータ入力・更新状況は把握されていない。
- ■ CEA のヘッドオフィスと州事務所は緊密に連携し、EPL データ収集は円滑に実施されてきた。しかしながら、文書化された手続き、ガイドライン、データ検証メカニズム等がない

ため、提出されるデータ書式やその内容のレベルには、州事務所によって差が生じている。

- 本プロジェクトで構築する PSI には企業の機密情報が含まれる可能性があるが、CEA には情報セキュリティ管理に関する規定は存在しない。企業情報の管理方法については CEA で協議する必要がある。

(3) PSI を運営管理するための人的リソース

- CEA 全体では十分な数のスタッフがいるが、環境データの収集分析においては、必要な機材や情報ネットワークの整備、適切な役割分担（管理者、技術者、事務員）がされ、かつそれぞれのスタッフの能力を向上させる必要がある。
- 管理者レベル（Director, Assistant Director）は PSI の目的や役割を理解しているが、CEA スタッフ全体としては、既存の環境データを水質管理に効果的に利用できてはいない。

活動 3-2-2	ワーキンググループを立ち上げ、活動のタスクマトリックスを作成し、明確な CD 計画について合意する。

CEA の関連部局及び関係機関からの参加者で構成されるワーキンググループ（以下、WG 3-2、メンバーリストは付属資料 7 に添付）を立ち上げ、必要な活動の検討および CD 計画の作成に携わった。

活動 3-2-3	フォーマット準備、年間計画、報告、他のワーキンググループとの共有、を含む CD 活動を実施する。

PSI システムの構築は、WG3-2 メンバー間の闊達な協議、調整を行いつつ検討された。PSI に必要なデータは、データの収集の可能性、CEA の作業、また PSI のメンテナンスに関係する要員・資機材を考慮して選定された。

詳細な作業ブレークダウンはここでは触れないが、関連タスクは、以下の通りである。（1）PSI データ収集登録に関する現況確認、（2）PSI 入力項目の決定、（3）PSI フォーマットの作成準備、（4）PSI データを用いた年報の準備、（5）地域事務所へのセミナー開催、（6）データ収集と PSI へのインプット、（7）年報作成のためのデータ共有。

(1) PSI データ収集や登録に関る課題の把握

前述のように、CEA は州事務所から、毎月、CEA 本部の R&D ユニットに報告する義務があり、全国の EPL の状況に関する体系的な報告システムが開発されていることが確認された。これは、包括的な報告であり、全国の EPL 所有者の管理システムとして見なすことができる。しかし、各州事務所は、データ検証メカニズムがなく、異なる報告テンプレートを使用していることが確認され、そのことが全国の汚染状況の体系的で効率的な分析を妨げている可能性があると考えられた。

一方、CEA は、汚染源や環境劣化に関する貴重な情報を幅広く収集・管理していること、また、4 つの独立した環境データのコンピュータデータベースを利用していることが確認された。CEA の情報技術ユニットが開発し、維持している EPL データベースは、合計 25,751 の工場をカバーし、最も包括的なコンピュータデータベースである。利用可能なデータおよびデータベースの他の詳細は、インセプションレポートに示したとおりである。しかしながら、各データベースに入力されたパラメーターは首尾一貫しておらず、体系的な分析が難しいと判断された。具体的には、1）データベースのいずれも地理的位置情報、汚水濃度と排出量などの情報が不十分であること、また、2）実際の操業時の汚染物質濃度の記録は掲載されず、設計段階時の理論値のみが記載されている。

CEA の環境汚染制御部によって入力される EPL データベースは、毎日のデータ入力量が、2 人の職員の処理能力を超えているように見受けられた。本プロジェクトで、オンラインデータベースを開発し、地方事務所からの入力が可能となれば、効率的と考えられる。CEA 内部では、まだ情報管理や情報公開政策に関する内部規則や規制が確立されていないことも確認された。

(2) PSI に登録すべき情報の決定

前述の活動で特定された諸問題を考慮の上で、ワーキンググループのメンバーは、既存のデータベースを統合することによって、PSI に関するデータベースを開発するという基本方針に合意済みである。それに基づきデータベースに統合すべき情報のスクリーニング作業を行った。選択プロセスは、正式なワーキンググループ会議のみでなく、他の特別会議の開催を必要とした。

以下の情報が PSI データベースに含まれることを決定している。

- 放流水質、河川水質、大気環境、騒音公害や廃棄物管理に関する情報を含む環境モニタリングデータ。工場排水がデータ入力の優先とされた。その後、固定発生源からの大気汚染物質を優先とする。それは 1）大気汚染に関連する規制が、準備中であること、また、2）有害廃棄物管理に関しては、適切な配置が必要であるためである。
- 既存の EPL 申込書に記載されている主な情報。生産設備、排水処理工程、廃液品質、投入材料などが含まれる。
- 既存の EPL 申請書に記載されていないその他の情報。これには、例えば担当者の連絡先が含まれる。

表 2-19 PSI システム登録情報

ステージ	項目		提供者
EPL Application	Industry Details	Industry Name and type	EPL Application form
		BOI Registration	Industry
		Sector/ Category	CEA Officer
		Industry Address	EPL Application form (Industry)
		Province/District/LA	
		Geographical location	
		Investment (Local/ Foreign)	
		Date of commencement	
		Shift / Workers	
		Land use and Land Extent	
		Pollution Checklist	CEA Officer
	Waste /Pollution Information	Manufacturing Process	EPL Application form
		Water	
		-Water requirement	
		-Source of water	
		- Daily discharge (Domestic and Industry)	
		- Generation of oil	
		- Method of discharge	
		- Final point of discharge	
		- Method of treatment	
		Solid Waste	
		-Type of Solid waste and Quantity generated	
		-Method of disposal including LAs collection, recycle	
		Atmospheric emissions	
		- Possible emissions (NOxs, SOxs, Dust and	

ステージ	項目		提供者
		Soot, Other)	
		- Number and height of Stacks/ Chimneys	
		- Source of odour	
		- Method of abatement	
		Noise Pollution	
		- Source	
		- Method of abatement	
		Vibration Pollution	
		- Source	
		- Method of abatement	
		Energy Requirements	
		- Plant generation	
		- Public supply	
		Fuel used	
		- Fuel type/ - Purpose/- Quantity used	
		Recycling/ Reuse	
		Emergency Requirements	Industry
	Application/ Inspection	Application Details	CEA Officer
		Payment Details	
		File Number	
		Inspection Detail	
		EPL Details	
EPL Renewal	Industry Details	*Same as EPL Application	EPL renewal application form/ Inspection report
	Waste/Pollution Information	*Same as EPL Application	
		Environmental Monitoring	Analytical Report
	Application/ Inspection	*Same as EPL Application	CEA Officer
(Follow up monitoring)	Waste/Pollution Information	Environmental Monitoring	Inspection report with sampling data
	Application/ inspection	Inspection Detail EPL Details	CEA Officer
(Legal Proceedings)	Waste/Pollution Information	Environmental Monitoring	Inspection report with sampling data
	Application/ Inspection	Inspection Detail	CEA Officer
		EPL Details	

Note: PSI guideline

(3) PSI フォーマットの構築（既存システムの改良）

フォーマットの構築は、実質的には、CEA の情報技術（IT）ユニットが開発、管理している既存の EPL データベースの変更作業となる。データベースに入力すべき項目の決定にあたって、既存システム、また、入力・分析手順の簡素化、検索のしやすさを考慮し、データ入力フォーマットの検討を行った。

そのため本タスクは、JICA チームと IT ユニットが連携を取りながら進められた。第 4 回 WG で IT と以下の点について合意した。

a) 「環境モニタリング」を明記したトップページを作成し、追加する。
b) EPL 遵守状況とインスペクションの結果をプルダウンメニューで付加する。
c) 排水の種類、排水方法をプルダウンメニューで付加する。
d) 廃棄物の種類・性状、廃棄方法を示すテーブルを確保する（データの構成等は行わない）

2016 年後半において、IT ユニットはプログラム言語の PHP への変換を行い、PSI データ入力シス

テムは 2016 年 7 月に完成し、JICA チームによるチェックおよび技術支援が行われた。下表は、PSI システムに関わる役割分担を表している。

表 2-20　PSI システムに関わる役割分担

活動内容		担当者	備考
1	既存 EPL データベースのプログラム言語を PHP に置換	IT ユニット	一部を除いて完了済
2	PSI のデータ入力システムの開発	JICA チーム	2016 年 7 月に完了
3	技術支援とシステム確認	JICA チーム	2016 年 9 月に完了
4	新サーバーの導入・設置	CEA	2017 年 6 月に完了
5	システムのオンライン上への展開	IT ユニット	2017 年 8 月に完了

注：JICA チーム作成

(4)　PSI データを収集するための年間計画の立案

PSI データは、CEA の情報技術ユニットが開発、管理している既存の EPL データベースのデータを移転するとともに、既存システムには登録されていない環境モニタリングデータを追加した。2015 年第 4 四半期に、補助員 5 名を採用し、CEA ラボラトリー、コロンボ事務所及びガンパハ事務所に保管されている水質モニタリングデータを収集した。

既存システム内の PSI データを新システムに移行、また、追加項目の入力を行った。既存データの収集と入力は、要員 5 名で 3 か月を費やした。

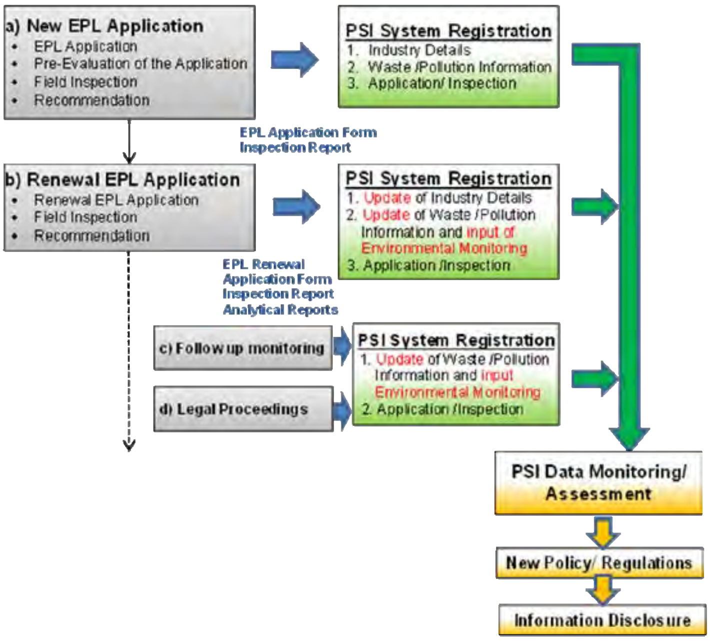


図 2-17　PSI システム構築の責任分担

PSI データは、EPL システムの運用と並行して収集・登録される（参照 図 2-17）。新規に EPL を申請する企業については、申請段階において CEA が設備や排出する汚染内容をインスペクションする。またカテゴリーA 企業であれば毎年、カテゴリーB 企業であれば 3 年ごとに EPL が更新され、設備や排出する汚染情報に変更がある場合は、企業による申請、CEA によるインスペクションが実施される。PSI システム運用開始後は、それぞれの事務所において、新規 EPL 登録企業情報を登録するとともに、EPL 更新時期には、企業から提出される環境モニタリングデータや、CEA 職員が行うインスペクションの結果を入力する。

(5)　PSI にかかる地方事務所を対象としたセミナーの開催

2016 年 12 月 8 日に CEA Auditorium room にて、新しい EPL/ PSI オンラインシステムの紹介およびEPL/ PSI オンラインシステム導入にかかる工程を紹介することを目的に、セミナーを開催した。本セミナーには、CEA の中央事務所および県事務所から合計 35 名の職員が参加した。参加者には、CEA の長官、関係部署の部長、さらにワーキンググループメンバーを含んでいる。6 つの州事務所

の代表者も列席した。欠席した北部中央、北西州および Sabaragamuwa 州事務所に対しては、C/P が下記マテリアルを共有するよう取り計らった。

- ✓ ドラフト EPL/ PSI システムガイドライン
- ✓ ドラフト EPL/ PSI システムオペレーションマニュアル

表 2-21　第 1 回 EPL/ PSI システム導入に関するセミナー概略

	プログラム	担当者
1.	プロジェクト紹介	小沼、JICA 専門家
2.	PSI システム紹介	渡津、JICA 専門家
3.	EPL/ PSI システムデモンストレーション	Leigh、JICA 専門家
4.	試験操作(参加者を 3 グループに分け、試験操作を実施)	ファシリテイター：Leigh、渡津、JICA 専門家、CEA IT Unit
5.	全体工程およびシステムリリース前後での活動説明	渡津、JICA 専門家
6.	Q & A	WG3-2 メンバー、渡津、JICA 専門家

注：JICA チーム作成

州事務所職員に対する第 2 回 PSI セミナーは 2017 年第二四半期に実施した。主目的は、PSI データベースを適切に使用するためのトレーニングを行うトレーナーの養成である。彼らトレーナーが今後、各州で職員にトレーニングを行っていくことになった。

本セミナー参加者は、各州事務所の Senior Environmental Officer（SEO）または Environmental Officer（EO）であり、企業からの EPL 申請・更新を審査する立場であり、PSI システム入力の中心となるスタッフであった。

当該セミナーでは、実際に PSI システムに、各自が持ち寄った企業情報を入力・更新する試験操作を通じて理解度を高めることを目的とした。セミナー内容や PSI システムに対する参加者の満足度は高く、またシステム改善に関する有益なコメントも多数寄せられた。第 1 回および第 2 回セミナー参加者は付属資料 18 に添付した。

表 2-22　第 2 回州事務所向け EPL/ PSI オンラインシステム紹介セミナー

	プログラム	担当者
1.	プロジェクト紹介	渡津、JICA 専門家、WG3-2 グループ長
2.	PSI システム紹介	渡津、JICA 専門家
3.	EPL/ PSI システムデモンストレーション	渡津、JICA 専門家
4.	試験操作（参加者が持参した企業情報を使用して入力・更新操作を実施）	Leigh、JICA 専門家
5.	全体工程およびシステムリリース前後での活動説明	ファシリテイター：Leigh、渡津、JICA 専門家、CEA IT Unit
6.	ラップアップ（理解度テストを含めて、旧 EPL システムの利用状況、セミナー感想、システム改善点等を記入）	渡津、JICA 専門家

注：JICA チーム作成

(6)　PSI データ収集と登録

PSI のフォーマットを作成するための活動の実施と並行して、PSI 基礎データ作成作業を 2015 年第 4 四半期に行った。環境モニタリングデータ、企業の位置情報の収集は、11 地区について約 3200 件の企業を対象に、データ収集・入力作業を行った。前述の通り、PSI データは既存 EPL データベースに登録された情報をベースとすることとしていたが、EPL 新規登録や情報更新が適切になされていないことが判明した。そこで、CEA の R&D ユニットが別途管理しているデータを使用し、2015

年、2016年に新規・更新登録された企業の基礎情報を収集し、登録作業を行った。

PSI システムの全国に向けたオンライン展開、運用開始は 2017 年 9 月であった。特にケラニ川流域における EPL 企業について、その登録状況を確認した。

(7) PSI 年次報告書の構成検討

PSI からの産業関連データはケラニ川流域年間報告書（白書）に使用される。また、PSI データは産業活動や汚染排水に関わる情報の公開にも利用できる。WG 協議を経て、以下の項目を編纂することとなった。

a) 一般産業情報
  EPL 遵守状況、事業所の種類、場所（州、DSD レベル）
b) 水質汚染関連情報
  排水が発生する事業所のセクターと数
  年間排水量
  主要汚染項目（TSS、pH、BOD、COD、油分）のモニタリング結果
c) 排ガス汚染関連情報
  排ガスが発生する事業所のセクターと数
  使用燃料の種類と日使用量
d) 廃棄物関連情報
  廃棄物が発生する事業所のセクターと数
  廃棄物発生量
  廃棄物の種類と廃棄方法
e) EPL 遵守状況
  EPL 遵守確認のためのインスペクションの回数、産業セクターごとの EPL 遵守状況

PSI データは、CSV 形式で出力が可能なので、CEA が所有する環境データベースにコンパイルが可能である。また、環境データベースを介して、CEA 本部内の各部局/ユニット、また、地域事務所との共有も可能である。

活動 3-2-4　他の組織と協働して PSI データの管理と活用をする。

CEA は、EPL カテゴリーA 及び B の企業について、EPL 情報を管理している。また、輸出特区（EPZ）に所属する企業の EPL 情報を BOI から、また EPL カテゴリーC の企業情報を地方自治体から、それぞれ受領している。これらの BOI 及びカテゴリーC 情報は、受領した CEA 州事務所において、PSI システムに登録し、その情報を活用していくこととした。

活動 3-2-5　スリランカの河川のための PSI のガイドラインを作成する。

PSI ガイドラインの構成は以下のとおりである。2016 年 11 月にドラフトが完成し、WG メンバーによるレビューを行った。また PSI システムにかかるセミナーを通じて挙げられたコメントを踏まえ、内容の見直しを行った。本ガイドラインについては、2017 年 9 月に CEA における最終決済がおり、PSI システムの全国展開とともに、各事務所に配布された。PSI ガイドラインは付属資料 19 に添付した。

表 2-23　PSI ガイドラインの目次構成

Chapter	Item
Chapter 1	INTRODUCTION
1.1	Background
1.2	Purpose of PSI
1.3	Purpose of the Guideline
Chapter 2	SCOPE OF PSI
2.1	Information on Pollution Souses under EPL system
2.1.1	Information on Pollution Souses under EPL system
2.1.2	Waste/Pollution Information under EPL system
2.2	Roles and Responsibilities
Chapter 3	PSI DATA REGISTRATION AND MENTENANCE
3.1	Overall of PSI data registration/ assessment under EPL system
3.2	Registration of PSI data
3.2.1	New license Application
3.2.2	Renewal license application
3.2.3	Follow up monitoring of Industrial Activities
3.2.4	Legal Proceedings against industries
3.3	Monitor, Assessment of PSI data
3.3.1	Items to be Monitored in PSI data
3.3.2	Method of Monitoring /Assessment
3.3.4	Data sharing with relevant authorities
Chapter 3	ENVIRONMENTAL REPORT
Appendix	A. Effluent and emission standards B. Category and Sectors to be monitored for Waste water discharge C. User manual for PSI System D. Flowchart for PSI data registration

注：JICA チーム作成

成果 3-3　ケラニ川流域における工場に対する EPL と排出水質基準制度の促進

成果 3-3 の活動は、EPL の普及促進を目的とし、CEA が事業体に対する EPL 遵守や適切な汚染処理・排水を促す能力を強化することが目的である。人員、資機材の制約を考慮し、顕著な影響を及ぼす特定の汚染項目、汚染源を対象とすることにした。

国家環境法（以下 NEA。1980 年法令第 47 として制定。1988 年に第 56、また、2000 年に第 53 として改定）で EPL システムを規定している。また、条例第 1533/16（2008）で EPL を遵守すべき事業所の種類を明確化している。

レビューでは、主にカテゴリーA・B 企業を対象とし、EPL 遵守率は 2014 年でそれぞれ 78%、77%であった。一方、カテゴリーC 企業（主に中小規模の事業所）の遵守率が低く、これらの企業に対する EPL の監督機関は、地方自治体（LA：Local Authorities）である。

改定されたインスペクションガイドラインは、法令遵守に関わるデータの収集方法、―以前のインスペクションではこのようなデータ収集が不十分で、法令違反に対する法的措置に支障が生じていた―、について詳細に記述している。詳細な手順の提示とルーチン化されたインスペクションの実施により、法令遵守や違反に対する罰則の施行に関わるレポートの作成が促進される。これらは、また、EPL や排水基準の遵守促進につながる。

WG また関係者との協議を通じて、特に中小事業所に対する EPL 促進を目的として、パンフレッ

ト／ポスターを作成することとした。さらに、基準遵守の促進のために、繊維産業、家禽処理業、と殺・食肉加工業に対する排水処理の技術ガイダンスを作成することとなった。

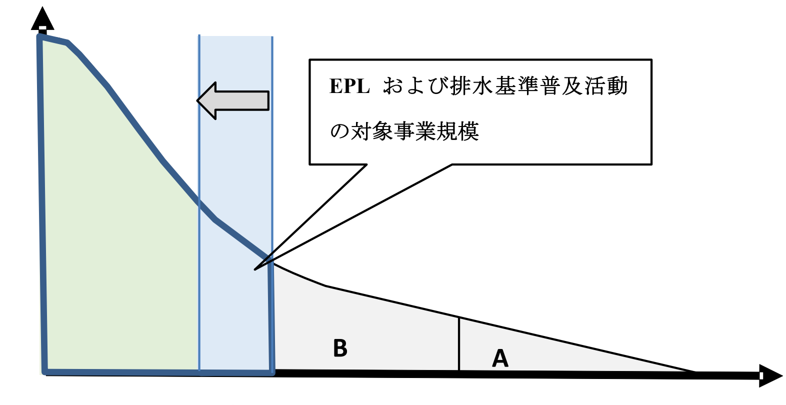
活動 3-3-1	ケラニ川流域における EPL と排出水質基準制度の現状をレビューし、改善すべき主要な課題を把握する。

カテゴリーA 企業の約 20%、BOI 地域の約 40%からは、工場排水が発生しないことが判明している。これらの事業所は本活動からは除外される。

以下の検討事項から、カテゴリーC に属する主に中小規模の事業所により注視することが効率的な活動という結論を得た。

1. カテゴリーA および B 企業のそれぞれ 76%、78%が EPL を遵守している。
2. 一方、カテゴリーC 企業の遵守率は 33%であった。
3. Kaduwela、コロンボ郊外に位置するカテゴリーA 企業 36 社のうち 33 社は EPL ライセンスなしで操業しているが、これらは排水を出していない。

WG ミーティングを通じて、EPL 違反の原因をレビューしたところ、EPL システムをよく知らない、排水処理方法がわからない、資金がないことが挙げられ、主に小規模事業所で顕著であった。



注：JICA チーム作成

図 2-18　　対象事業所規模のイメージ図

活動 3-3-2	ワーキンググループを立ち上げ、活動のタスクマトリックスを作成し、明確な CD 計画について合意する。

WG3-3 はラボラトリーユニット、Sabaragamuwa 州事務所、法整備ユニット、EPC 局および BOI からの参加者から構成された 12 名のメンバー（参照付属資料 7）から成り、プロジェクト管理、能力強化計画の立案を主目的とした。

活動 3-3-3	必要なツールと材料の開発を含む CD 活動を実施し、ケラニ川流域におけるそれらの適用をパイロットプロジェクト（PP）として実施する。

EPL 普及促進に関わる活動は、普及促進素材の試作・試行を通じて行った。活動 3-2-3 で実施されたケラニ川流域の PSI データベースの開発では、普及活動を行う優先エリアを検討する有用な情報を提供した。優先地域は、水利用用途、例えば上流の飲料水用取水ポイント、をベースに、PSI を利用して検討を行った。

(1) インスペクションに関わるパイロットテストを通じた EPL の状況分析

EPL の施行は、EPL 遵守状況、違反事項をチェックするインスペクションとサンプリング活動が主体である。多くの事業所オーナーは、EPL の施行がうまくいっていないのなら、EPL を遵守するより、違反金を支払うほうがメリットが高いという認識を持っていると言われている。したがって、EPL の普及促進には、適切なインスペクションの実施と法の執行が重要である。

インスペクションによって明らかにされた EPL 違反の理由は、EPL 執行の障害を明らかにし、必要な普及促進のツールの開発に寄与するものである。指摘されている EPL 違反の理由は、

a) 汚染管理技術に関わる知識の不足
b) 排水処理設備の導入のための資金不足
c) 行政による支援の不足

これらの理由は、一般的に想定できるものであるが、CEA／行政の廃棄物、環境管理に対するポリシー・政策に依存する。

上記理由の考察により、EPL 普及促進での企業の優先付け、対象となる汚染項目の検討が可能となる。

EPL に対する認識不足は、特に小規模事業所で言われており、彼らはライセンスなしで操業を続けている。

(2) データ評価方法の準備（主要汚染項目、汚染源の選定、等）

すべての汚染項目、汚染源を一時に対象とするのは現実的ではない。そこで、優先すべき汚染項目および汚染源・セクターを特定することとした。

優先汚染項目とセクターを特定するための指標は、WG 3-3 および WG 3-1 を通じて議論し、絞り込んでいった。表 2-24 は優先汚染項目およびセクターを表したマトリックス表である。EPL の審査とインスペクションの結果の評価は、優先汚染項目およびセクター特定に用いられた。この手法は、また、データの分析・評価法の開発およびガイドラインへの反映にも用いられた。

表 2-24　優先セクターと汚染項目のマトリックス表

Parameter / Sector	Coliforms	pH	Oil & Grease	TSS / Turbidity	Lead	Salinity / EC	Chromium Hexavalent	W. Temp.	CODCr	BOD
1. Textile Dying and Bleaching Industrial Washing Textile Printing		○		○		○	○	○	○	○
2. Chemical formulation and manufacturing and Re-Packing Re-Packing of Agrochemicals (Pesticides)		○		○	○	○		○	○	○
3. Rubber Latex based Crepe Rubber		○		○		○		○	○	○
4. Leather Tanning		○	○	○		○	○	○	○	○
5. Food and Beverages Alcohol Distillery Fruit Juice Manufacturing and Re- packing Milk Products		○	○	○		○		○	○	○

Parameter / Sector	Coliforms	pH	Oil & Grease	TSS / Turbidity	Lead	Salinity / EC	Chromium Hexavalent	W. Temp.	CODCr	BOD
Carbonated beverages										
6. Vehicle Service Stations		○	○	○		○		○	○	○
7. Animal husbandry Piggery Slaughtering and meat processing Poultry Dressing	○	○	○	○		○		○	○	○
8. Petroleum (Tank farm) and Oil refinery		○	○	○	○	○	○	○	○	○
9. Hotels and Restaurants	○	○	○	○		○		○	○	○
10. Thermal Power Plants		○	○	○	○	○	○	○	○	○

備考：○は、サンプリングを含め、インスペクションで選択すべきパラメーターを意味します。

注：JICA チーム作成

活動 3-3-4　EPL と排出水質基準制度を促進するためのガイドラインを作成する。

WG の協議により、EPL および排水基準の遵守レベルが低いセクターに注視することとした。ガイドラインは、一般的な事項を示すガイドラインおよびセクター固有の技術ガイドラインの 2 部構成とした。

EPL の普及促進はカテゴリーC 企業、つまり、LA 管轄域に絞ることとした。また、表 2-24 で示した優先セクターから、セクターガイドラインの作成候補として、過去・近年改定を行っていない繊維産業（Textile）、今まで作成されていなかった家禽処理業（poultry processing/ dressing）および、と殺・食肉加工業の 3 セクターを選定した。

これらのセクターガイドラインは、対費用効果の高い EPL および排水基準遵守方法（排水処理方法）の技術指針を対象事業所に示すものである。今後、本セクターガイドラインをもとに、他セクターの新規・改定ガイドラインを CEA 主導で策定することを期待する。

EPL プロモーションガイドラインは主に LA およびカテゴリーC 企業向けとして作成された。二部構成となり、一部は環境管理関連等の一般事項、二部は LA、カテゴリーC 企業向け普及方法となっている。パンフレットおよびポスター（付属資料 20 参照）は別途作成され、LA、CEA 各事務所に配布される予定である。EPL プロモーションガイドラインは付属資料 21 のとおり、作成された。ドラフトは WG3-1 および 3-3 でレビューされ、改定、最終化された。

セクターガイドラインは、水質管理部門に関して JICA チームと共同で作成し、環境大気/排ガス、騒音および廃棄物部門は、CEA の関係機関で作成することになった。各ガイドラインは、付属資料 22～24 を参照されたい。

表 2-25　　EPL および排水基準に関わる普及促進素材一覧

	素材		対象者、コンセプト
1	一般ガイド	パンフレット、ポスター	LA および中小事業所に対する啓発
2		EPL プロモーションガイドライン	LA に対する EPL の説明、普及促進方法
3	セクターガイドライン a) 繊維産業 b) 家禽処理業 c) と殺場および食肉加工業		CEA、LA および事業所に対する技術ガイドライン

注：JICA チーム作成

成果 4	内陸表面水域におけるインスペクションを含む水質モニタリングデータ、EPL データ、PSI データの情報管理システムが開発され、有効に活用される。

成果 4 の活動は、情報の管理、意思決定のための情報の使用、適切な水質改善方策、に関する能力を高めるように設計されている。情報管理システム（Information Managment System; 以下 IMS）は、CEA 下の各部門および関連機関のデータを統合し、関連する政府機関および一般に情報を公開する。ここでの活動は、1）現状の内陸水域の水質モニタリングデータ（EPL データ、PSI データ）の情報管理状況を見直し、改善すべき主要課題を特定する、2）WG を確立し、活動のタスクマトリックスを準備し、CD 計画に合意する、3）DB（データベース）開発を含む CD 活動を実施し、パイロットプロジェクトとしてケラニ川流域に実施する、4）スリランカにおける情報管理システムの開発を促進するための指針を作成する、の 4 つのサブ活動に分類した。

CEA の既存の情報管理状況（特に、水質、環境保護ライセンス（EPL）、汚染源インベントリー（PSI）、地理情報システム（GIS）データに関する情報）をレビュー、分析した。また、R&D ユニットによって収集された PSI データの解析により、データの重複が発見され、従来のデータ収集方法は非効率的な収集方法であり、事業体情報のための真の有効的なデータベースとは言えなかった。

WG は、中央集約的な情報管理システム（IMS）の実施を支援した。メンバーは、環境情報管理システムに大きく貢献している主要部門の代表者と関係者から構成されている。情報管理システムの作成において、WG メンバーは、データベースに含めるために必要な情報について話し合った。これには、データベースを開発し、それをパイロットプロジェクトとしてケラニ川流域（KRB）で試行する活動が含まれる。メンバーは、13 の主要項目・データをデータベースとして統合することに合意し、情報を収集・レビューした。

成果 4 には、1）ケラニ川流域の環境報告書（白書）、2）ケラニ川流域に関する情報を含むウェブサイト、3）情報管理システムガイドラインの 3 つの主要成果物がある。環境白書およびウェブサイトは、ケラニ川流域の情報を関連機関および一般に啓発および公開する一つの方法である。情報管理ガイドラインは、CEA での利用を前提としており、環境情報の収集、準備、公開等に関する手順を記載した。

活動 4-1	内陸表面水域におけるインスペクションを含む水質モニタリングデータ、環境保護ライセンスデータ、PSI データの情報管理の現状をレビューし、改善すべき主要な課題を把握する。

成果 3-2 に見られるように、レビュープロセスは、CEA の事業体情報には、収集時点、収集する情報の種類、ファイル形式、および収集後のデータの後処理を含め、複数の収集形態があることが分かった。この他、工場検査に伴う排水の測定結果は、ラボラトリーで分析されたのちに、各検査官に返却されるものの、統一的なフォーマットで管理されていなかった。プロジェクト開始時には、IT ユニットは EPL システムと呼ばれるオンラインシステムで EPL 情報を取りまとめる活動に着手していたものの、1) PSI に関する情報は含まれていない、2) オンラインでのレスポンスが悪い（システム言語の特性により応答に時間がかかっていた）、といった課題がみられた。

また、河川等の定期モニタリングデータについては、ラボラトリーで分析・取りまとめているもの

の、情報公開等は実施されていなかった。

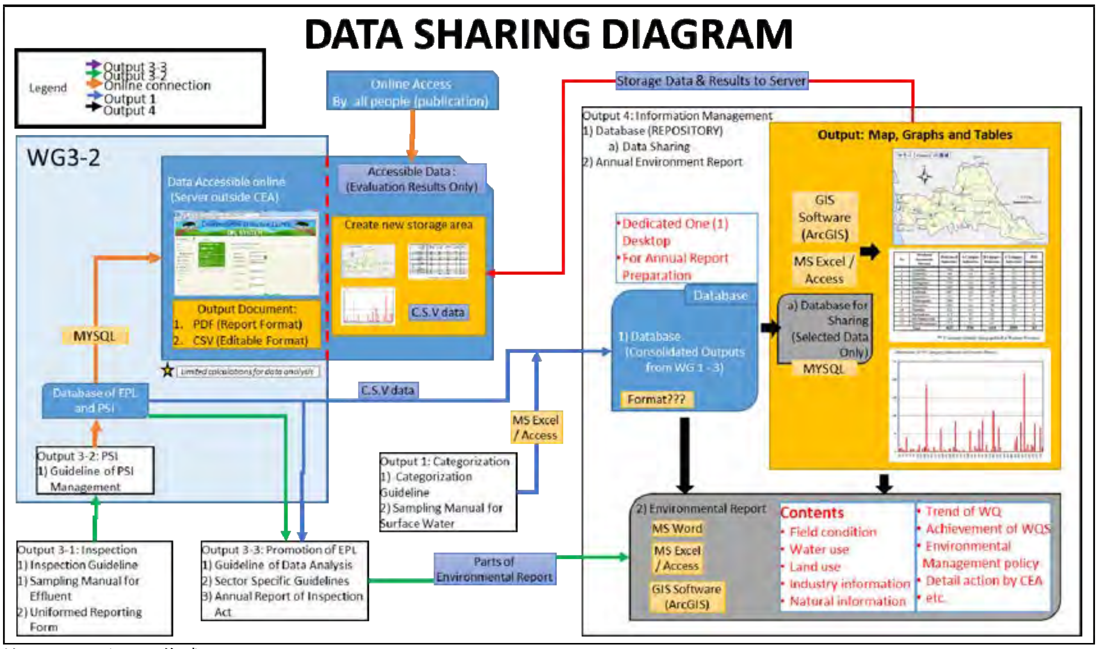
活動 4-2	ワーキンググループを立ち上げ、活動のタスクマトリックスを作成し、明確な CD 計画について合意する。

WG は、中央集約的な情報管理システム（Information Management System; IMS）の実施を支援した。WG メンバーは、環境情報管理システムに大きく貢献している主要部門の代表者と関係者から構成されている（参照付属資料 7）。情報管理システムの作成において、WG メンバーは、データベースに含めるために必要な情報について話し合った。これには、データベースを開発し、それをパイロットプロジェクトとしてケラニ川流域（KRB）で試行する活動が含まれる。メンバーは、13 の主要項目・データをデータベースとして統合することに合意し、情報を収集・レビューした。ソフトウェアやハードウェアのタイプなど、IMS の技術的構成について議論した。

活動 4-3	データベース構築を含む CD 活動を実施し、ケラニ川流域におけるそれらの適用を PP として実施する。

成果 4 には、1）ケラニ川流域の環境報告書（白書）、2）ケラニ川流域に関する情報を含むウェブサイト、3）情報管理システムガイドラインの 3 つの主要成果物がある。環境白書およびウェブサイトは、ケラニ川流域の情報を関連機関および一般に啓発および公開する一つの方法である。情報管理ガイドラインは、CEA 使用のためのものであり、環境情報の収集、準備、公開等に関する手順を記載した。

具体的な活動を記述する前に、取り扱う情報類の大まかなフローを示す。図 2-19 に示すように、各成果 1~3 で取り扱う情報は、WG4 のデータベースに格納される。成果 1 および成果 2 では、環境水の水質データを取り扱い、WG4 で作成した環境情報データベースに既定の表形式で保存する。WG3（3-1、3-2 および 3-3）においては、汚染源インベントリーおよび EPL ライセンスに係る情報を、EPL/ PSI システムで取りまとめる。PSI/ EPL システムは収集したデータを CSV（表形式）にてエクスポートでき、WG4 で取り扱うデータベースに格納されることとなる。



注：JICA チーム作成

図 2-19　　情報共有ダイアグラムイメージ

その他、環境水および PSI/ EPL 情報以外の水位、流量、降水量、苦情等のデータを組み合わせ WG4 データベースに格納する。これらの情報を利用し、環境白書を作成し、PSI/ EPL システムと同様にウェブサイトを通じて公開する。

(1) 統合データベースに必要な情報

統合すべき情報については、表 2-26 に示すように、WG メンバーによって合計 13 の項目が設定された。これらの情報は、CEA の意思決定と管理のための重要なデータであり、CEA 内部局、気象局、灌漑局、および国家水供給排水庁から収集された。収集データは、主に MS Excel、MS Word、PDF、書類等さまざまな形式で収集された。

表 2-26 データベース統合に関する情報

No	Parameter	Information	Data Type
1	Ambient Water	• Water Quality Category per sub watershed • Summary of Water Quality Category Parameters (Available Station)	XLS
2	EPL / PSI	• Industry Details (Province, District, LA, GND, DSD, GIS Location) • Industry Details (Name, Owner, Contact Information) • Industry Details Important Dates (Application Date, Date of Commencement of operation, EPL Renewal, etc) • Industry Sector, Category, Type of Industry, Nature of Industry • Pollution each industry (Solid waste, waste water, air pollution, noise, hazardous waste) • Industry (BOI registered, no. of shifts, no of workers, land use within 5 km, within industrial zone, amount of local and foreign investment) • Water Details • Solid Waste Details • Air Emission Details • Energy Requirement Details • Noise Details • EPL Application Details	CSV GIS
3	Compliance Monitoring	• Status (Renewed, Issued, Closed, etc) • No. of application received • No. of inspection made • No. of approvals granted • No. of rejections • No of Inspections according to type (Textile, disposal facility, etc.)	CSV
4	Water Board Intake Points	• Location • Water Quality Parameters (Same as CEA Laboratory) • Designed capacity and output capacity each sampling station • Labugama Kalatuwa Capacity (Reservoir)	DOC XLS
5	Complaints	• Complaint Location (Province, District, LA) • Pollution Description (Water Pollution Only) • Nature of Complaint • Action Description (Water Pollution Only) • Reason for inspection (Water Pollution Only) • Description (Observation) • Complaint Source • Reference Date of Complaint • Complaint Received By (Complaint Unit, Provincial unit, etc)	XLSX
6	Water Level / Flow Rate	• Water Level (monthly) • Flow Rate (monthly) • Location name for each station	XLSX PDF
7	Environmental Accident	• Reports on environmental accident on water quality	XLSX
8	Education / Training / Seminar	• List of seminars, trainings and education	XLSX
9	Rainfall /Temperature	• Rainfall	XLSX

No	Parameter	Information	Data Type
	Data	• Temperature • Location name of station	
10	EIA Projects	• Total number of EIA and status	DOC
11	GIS Data	• Industry Details (Type, Category, Location, Name) • Administrative Boundaries (Province, District, Local Authority, GND, DSD) • Population • Land Use • Reservoir location • Irrigation Monitoring System in Kelani River • GIS Location in Kelani River (Station ID) • Sub-basin Details (Name, Area, Land Use Category) • Rainfall / Temperature Stations (Not updated)	SHP
12	Sand Mining	• Location / Information	CSV
13	Gem Mining	• Location / Information	CSV

注：JICA チーム作成

(2)　データベースの統一フォーマット

大量のデータの取り扱いは大変な作業であり、適切なハードウェアとソフトウェアを選択してデータを管理することが不可欠である。WG は、MS Excel（図表作成）と ArcGIS（地理情報）をサポートソフトとし、MS Access を主要なデータベース管理ソフトウェアとした。

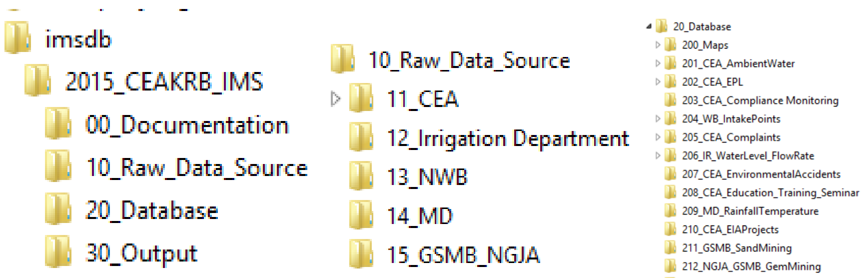
データベース管理ソフトウェアを比較すると、MS Access を利用することの利点は、IT Unit の職員が既にオフィスのインターフェースに慣れていることがあげられる（MS Excel にはリレーションシップ機能はないがそのインターフェースには類似性がある。）。MS Access は、複数のソースからのテーブル間の相互関係を伴うデータベースである。複数のテーブルをデータ ソースとして使用してデータを 1 つの表にまとめられるデータベースである。

大量のデータを整理し、不適切な管理を避けるために、構造化ファイルフォルダシステムを作成した。データは、表 2-27 に示すように、4 つのメインフォルダで管理される。

表 2-27　　データ管理のための構造化フォルダ

Folder Name	Description
00_Documentation	This folder contains the documentation of handling the database step by step.
10_Raw_Data_Source	This contains the information collected from sources. Naming conventions are not strict because these are collected format from the sources.
20_Database	The folders inside 20_Database is organized according to Source and Type of Information
30_Output	Output folder

注：JICA チーム作成

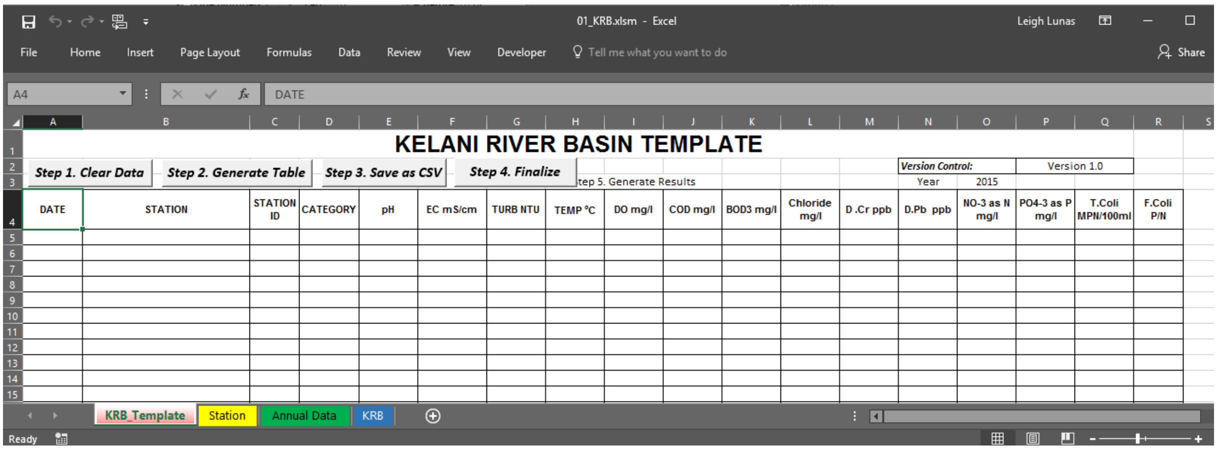


注：JICA チーム作成

図 2-20　　情報管理のためのフォルダ構成

図 2-21 は、CEA ラボラトリーの環境水データを整理するために使用されるテンプレートを示している。1）クリアデータ（既存のデータを削除する）、2）テーブルを生成する（適切な列に従ってテンプレートに記録する）、3）CSV として保存する（ファイルを CSV として保存する）、4）最

終化（テーブルを完成させて MS Access または SHP ファイルにインポートする）、の 4 つの機能を有する。

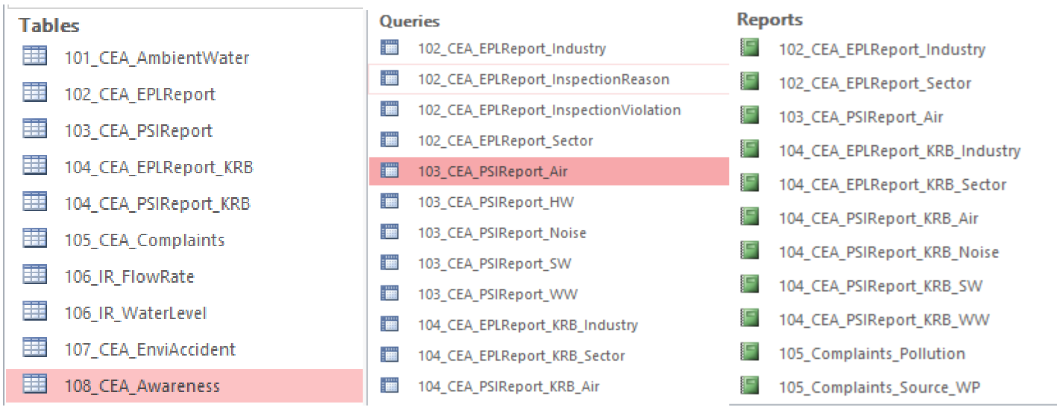


注：JICA チーム作成

図 2-21　　データ管理のテンプレート例

(3)　データ入力

データの統合においては、各パラメーターのテンプレート作成による標準化が必要である。データが移行される前に、まずそのテンプレートを利用して、MS Access データベースに統合する。また、環境白書に利用される図表作成のための表やクエリは、システムに含まれている（図 2-22）。これは、MS Access に格納されている EPL/ PSI データの例です。各業種の州コード、地区コード、産業種（BM - 金属産業、CH - 化学・石油化学工業、FD-食品・食品関連産業、ME-機械・設備、MP-鉱物・鉱物 製品）などが示されている。

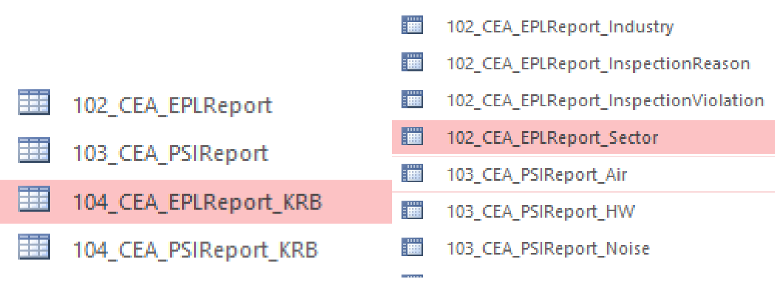


注：JICA チーム作成

図 2-22　　MS アクセスの構成内容

(4)　PSI 情報の統合

WG3-2 が作成した EPL/ PSI システムは、分散していた CEA 部局が持つ複数のデータを統合し、スリランカ全体の産業情報をすべて集約している。最終的に公開可能な情報を、IMS に統合した。



TOTAL EPL Number by Category and Area 2015

Province	District	Total	A	B	C
CE	Kandy	1514	764	750	
CE	Matale	755	387	368	
CE	Nuwara Eliya	47	40	7	
EA	Ampara	1004	375	629	
EA	Batticaloa	557	198	359	
EA	Trincomalee	562	260	302	
NC	Anuradhapura	1891	893	998	
NC	Polonnaruwa	520	234	286	
NO	Jaffna	693	332	361	
NO	Kilinochchi	205	51	154	
NO	Mannar	157	76	81	
NO	Mulative	182	76	106	
NO	Vavuniya	184	147	37	
NW	Kurunegala	177	65	112	

provincecod	districtcode	TOTAL	BM	CH	FD	ME	MP
CE	KY	25			2	2	9
CE	MT	108	1	3	5	3	74
EA	AP	145		1	31	44	41
EA	BC	255			77	73	20
EA	TC	47			17	12	10
NC	AD	225	1	2	12	8	165
NC	PO	67		1	11	1	37
NO	MU	34		2	6	6	20
SA	KE	49	3	2	4	1	19
SA	RN	6					4
SU	GL	11	1				6
SU	HB	59	1		1	1	31
SU	MR	8			2		3
WE	CM	400	10	28	15	24	98
WE	GQ	100	7	15	11	21	34
WE	KT	11	1	1	1	1	4

注：JICA チーム作成

図 2-23　MS アクセス上の EPL / PSI 保存データ

(5)　技術研修

2017 年 10 月、CEA JICA 事務所でデータベース管理システムを担当する主要人材（IT Unit、R&D Unit、P&M、EPC div.）に対して技術研修を実施した。本研修においては、IMS フォルダーシステム、MS アクセス、MySQL、PhyMyAdmin らの基礎および PHP、HTML、JAVA SCRIPT の基本スキルについて説明した。

(6)　ウェブサイトへの公開

一連の会議や議論の中で、ウェブサイトのデザインとページ構成が議論された。ケラニ川流域の表、グラフ、地図等で構成され、秘匿性の高いデータを除き、環境情報が公開される。

注：JICA チーム作成

図 2-24　ウェブサイトイメージ

(7)　環境白書の作成

環境白書と環境ウェブサイトは、本質的には同じ情報で構成される。環境白書の作成においては、まず大枠を作成し、WG メンバーに、収集した情報で報告書の地図、表、グラフなどの章を記載す

るよう依頼した。環境白書の各章には、ケラニ川流域の現況、ケラニ川モニタリング結果、EPL 情報概略、などが含まれる。

(8) 環境白書の公開

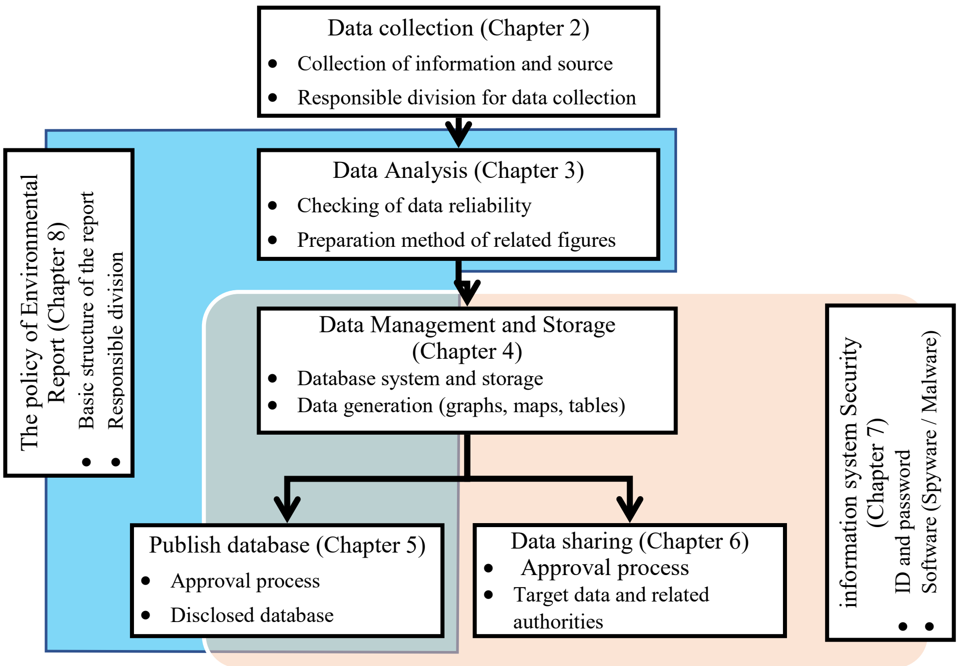
環境報告書のハードコピーは 2018 年上半期に配布される予定である。その後、ウェブサイトのダウンロードページから入手できるようになる。

活動 4-4	スリランカにおける情報管理システム開発を促進するためのガイドラインを作成する。

情報管理システムガイドラインは、システムの技術的な説明と管理の包括的な文書である。ガイドラインは 8 つの章で構成されており、図 2-25 は、ガイドラインに基づく環境情報のデータ収集から公表までのフローチャートを示している（ガイドラインは、この報告書に付属資料 26 として添付した）。

ガイドラインでは、1 章のイントロダクションに続き、第 2 章で情報管理システムのデータ収集手順を紹介する。この章では、以下の側面を鑑み、CEA 関連部門および関連機関からのデータ収集について記載した。

- CEA は、他の関連機関、省庁、民間部門が業務上重要と認識している重要な環境情報を提供する
- CEA は、内部分析のために関連機関から情報を収集する



注：JICA チーム作成

図 2-25 環境情報の収集から公開までのフローチャート

その後、CEA はこの情報を管理し、データベースに格納する。データベースシステムは、すべてのデータを結合し、重複を削除し、更新をチェックして、最新状態の河川流域の可視化と意思決定のための地図、図表などの出力を提供するように設計されている。ただし、このガイドラインは、CEA

の扱う情報数や分野を制限するものではない。WG4 での一連の議論に基づいており、CEA で現在利用可能なデータを考慮して作成した。

第 3 章では、データ解析手法を提供する。水質モニタリングデータは、特定の日時、特定の場所で採取されたサンプルを分析した結果であることを認識する必要がある。水質データの評価は、分析機関の信頼性と分析方法の妥当性のみならず､採水が適切に実施されているかどうかを検討すべきである。さらに、サンプリング地点での河川環境の代表性の観点から比較検討することも重要である。データ解析では、水質項目と水質に影響を及ぼす要因との間の基本的な関係を説明する。

第 4 章では、データの管理と保存について説明する。収集されたデータは、フォルダシステムに保存しマップ、チャート、表などの必要な視覚的出力を作成するために統合されている。これは特に CEA の内部使用のためである。CEA 内での作業と齟齬と重複を避けるために、集中管理された情報管理システムであることが重要である。基本方針として､収集したデータを必要に応じて利用者（CEA 職員、経営層、関係機関、一般）に提供し、データの更新頻度と集約頻度をまとめた。

データベースの公開については、ガイドラインの第 5 章において、個人的または公的に情報を公開するための内部ガイドラインを提供する。データを整理し、秘匿情報を分離し、一般に公開する。CEA スタッフのみに限定され公開される情報もある。本章では、情報開示のための基本的な手順を解説した。

第 6 章では、データの共有に関するガイダンスを提供する。これらのガイドラインで扱われるデータには、関連省庁から得られたデータやグラフ作成などの加工済みの情報が含まれる。ここでは、収集されたすべてのデータの関連組織とのデータ共有の範囲と方法を示す。データ共有は、公共部門を対象としている。

情報システムのセキュリティは第 7 章で提供する。情報管理システムではサイバーセキュリティが不可欠である。環境データベースには、盗まれる恐れのある秘匿情報や公開される関連機関や民間組織の情報が含まれる。情報管理システムのセキュリティでは、CEA が実装すべき情報セキュリティ対策について説明する。

ガイドラインの最後の第 8 章では、環境白書の方針を示す。集められた環境情報は、環境白書として作成することを提案する。環境白書は市民への正確な情報提供としてだけでなく、意識向上活動としても評価され、CEA が取り組む環境保全活動の普及に役立てることができる。

第3章　課題と教訓

この章では、プロジェクトの主な課題と教訓を記す。これには、1）実施上の観察から直接得られたもの、および2）他の国の水質管理アプローチとの比較によるもの、が含まれる。いくつかは、現在の状況には直ちに適用されないかもしれないが、将来のための一般的な指針を提供する。

3.1　水質評価に関する課題と教訓

a) 水域類型を担当するCEAの職員は、十分な専門知識と広範な現場経験を備え各作業を実行する能力がある。しかし、弱点としては、水質類型の現場経験が限られていることであり、地方自治体や他の多様なステークホルダーとの調整が必要となる。

b) Kelani Riverへの類型指定のパイロット活動においては、Kolonnawa Elaが鉛（Pb）に関して改善が必要な重点地域として特定された。但し、これに関しては、以下の確認が必要である。1）潮汐の影響をうける地域および時間帯を考慮したサンプルの代表性、2）当該地域における水質モニタリングのフォローアップ、3）PSIデータベースの情報解析による主要な排出源の特定、4）排出者の排水処理施設の現状の検査と評価。

c) BODおよび糞便大腸菌群も、ケラニ川流域のいくつかの基準点で水質目標を上回ることが判明した。河川全体の水質低下には、家庭排水と非点源汚染（NPS）が主に寄与していると考えられる。これらの管理には、特に、1）国家水供給排水庁による、家庭からの汚染負荷を最小限に抑えるための下水道サービス範囲の拡大と投資計画、2）中小河川に産業が集中している地域において、地方自治体による中小企業の管理、3）農業省傘下農業局による家畜排泄物の管理強化、具体的には、湿地、河川堤防の防護、植生バッファー等の導入等、ベストマネジメントプラクティス（最適管理手法）を促進すること。

d) 水質管理計画の実施のためには、明らかに部門間連携が必要になる。計画を行動に移すための関連省庁間連携のプラットフォームづくりのために本プロジェクトの経験を活用することができる。なお、参考として、水質改善行動計画は以下の内容を含むものと想定される。

  d-1) 水質改善行動計画は、水域が水質目標を達成するように、水域に分布する点源および非点源からの汚染負荷を軽減するための対策の組み合わせである。また、予測モデルは、河川の浄化能力を考慮して、汚濁負の把握・削減を実現するための代替案の検討に使うこともできる。点源および非点源汚染の管理計画には、下水道投資、衛生改善、排出権取引、ベストマネジメントプラクティス（最適管理手法）あるいは総合的病害虫管理が含まれる。汚濁負荷許容量が算出されると、排出許可に配分し、それを許可証に取り込むとが可能となる。許可サイクル、水質基準改定、その他必要な水質管理活動を水質管理計画策定過程に反映していく必要もあろう。既に汚染された地域へ新たな汚染源となりうる工場投資に許可を出さないことも考慮すべき代替案である。

e) 水質環境基準は、水利用者の安全を確保するために、実際に水質モニタリングを実施して、問題があると認められる場合には修正し、運用できる水質目標を策定するためにさらなる検証が必要となる。将来、見直し段階では以下を考慮することが必要である。

  e-1) 水質環境基準を作成する際、いくつかのパラメーターは、基準の緩い類型よりも厳しい類型において、基準値が緩和され（高い数値）が現れる場合がある。このような数値の

逆転は、科学的根拠がある場合は極力除外したが、毒性データは対象生物種と物質の関係で定まるものであり、必ずしも水利用目的に応じて数値が段階的に変化するものではない。このような逆転現象は、実際に河川類型に当てはめる場合、例えばある下流域の一部が貴重な生物種の生息地域であり、その上流が農業目的に使われている場合等に問題となる。水質目標の設定の達成度合いを評価しながら、必要に応じて数値の見直しも必要になろう。

e-2) 水質環境基準に含まれていない他のパラメーターもあるが、将来、これらを組み込むことが必要なものもあろう。そのような場合は、スムーズな承認が行われるよう、実際に環境基準に組み入れる前に、まず、水質のモニタリングを行い、水質環境基準に順次組み入れていくことが必要である。

e-3) 水質環境基準において 2 種類の農薬を組み込んでいる。それらは、国の農薬登録リストと WHO の飲料水質ガイドラインの両方に含まれている農薬を選定した。しかし、水田稲作、園芸作物、穀物およびその他の作物に対して、異なる季節に異なる生育段階に、病虫害管理、雑草防除のために多種多様な農薬が使用されており、水質類型を効果的に実施に実施するために、さらにスクリーニングと優先順位付けが必要となる。

e-4) 全国で共通の分析方法が使用されるように、各パラメーターの分析方法を公式に通知することも必要である。これは、訴訟になるようなケースでは特に重要となる。

e-5) プロジェクトでは、初めての水質環境基準を策定し、それが承認された。その策定過程[9]を、定式化することが望ましい。

3.2 ラボおよび水質モニタリングに関する課題と教訓

a) 旧式の装置や機器の交換は懸案のひとつである。旧製品は製造元がモデルの供給を停止するため、それらのアクセサリやメンテナンス部品が市場で入手できなくなっている可能性も高い。設備の突然の故障を避けるためには、体系的かつ定期的な予算編成によって設備更新を行うことが最も重要である。

b) このプロジェクトで開発された QA/ QC システムを更新し整理統合することにも重要である。包括的なマネジメントシステムを実施し、維持することは、しばしば多大（過剰）な努力を要する可能性があるためである。

c) 内部監査、マネジメントレビュー、試験所間試験への参加等は将来も継続されるべきである。これはラボラトリーの計測品質の維持には、マネジメントシステムの継続的な運用と日々の絶え間ない努力によってはじめて達成されるためである。

d) 品質の継続的向上のために、PDCA（Plan-Do-Check-Act cycle）が基本的な構成要素となる。PDCA モデルは、品質管理システムの構築と再編成のために役立つが、実験室試験プロセスの効率的かつ効果的な管理のために修正が必要である。 そのためには、実験室での分析、品質管理と訓練のために、プロジェクトで作成した各種資料を使用することが望ましい。分析対象のパラメーターの数は、職場でのトレーニングを通じて拡大していく必要がある。

[9] 1) preparation of the draft standards through the working group meetings; 2) deliberation in expert committee meetings; 3) Approval by the Board Members of CEA; 4) Submission to the Legal Draftsman's Department under the Ministry of Justice; 5) Consultation meetings with the departments; 6) Approval by the department as a gazette.

e) 地表水および排水の定期的なサンプリングに一人の職員を割り当てれば十分である。しかし、実験室での分析には、分析結果に問題があると認められれば、その分析に特化した追加の職員を動員することも必要となる。地域事務所の支援のために、中央事務所から地方への職員の異動が必要な場合もある。中央研究所と地方事務所間の連携は、段階的に強化することが必要である。

3.3 インスペクションと法令遵守に関する課題と教訓

a) インスペクションは個々の事業所に対し行われるものである。しかし、インスペクションを業種ごと、地域ごと、汚染物質ごと等のグループに分類して実施していくことも必要である。これによって、特定の優先パラメーターあるいは重要な汚染源に対し、うまく対応することが可能となる。
b) 特に上級検査官は、現場の経験から見識を高めることが可能である。彼らの見識を若手に伝達する仕組みが必要となる。
c) 上記に関連して、特定分野の豊富な現場経験を有する上級検査官を指名し、その経験を定期的にセミナーなどを開催して、他の職員に普及することも重要である。また、特定分野で顕著な環境改善の実績を上げている企業を招聘し、その経験を上記のセミナー等で共有することも望ましい。この際に、本プロジェクトで作成したセクターガイドラインを活用することができる。
d) 地方政府のインスペクターはこのようなトレーニングへの参加により技術向上が見込まれる。彼らがより効果的にインスペクションを実施し、事業所の排水管理を監督することにより、CEA の負担は減るだろう。
e) 3.2.3.2 節でも述べたように、インスペクションと汚水サンプリングの並行実施は重要である。これは、サンプリングの結果がインスペクションの判断の根拠となるためである。
f) サンプリングの質向上に、インスペクターに対するサンプリングのトレーニング体制の構築も重要である。
g) インスペクションにおける安全管理にも配慮すべきであり、インスペクション実施時の装備・服装は、安全を考慮しなければならない。例えば民族衣装であるサリーの重要性は理解するものの、安全上好ましくない。
h) スリランカでは一般的に英語でのコミュニケーションは良いが、より理解を深めるために、ガイドラインのシンハラ語等への翻訳を推奨する。
i) 抜き打ちのインスペクションの実施は、EPL 遵守促進に効果的である。
j) EIA および EPL の許可証発行を効果的にするために、EIA ユニットと EPC ユニットの連携強化は重要である。その具体的な連携方法として以下があげられる。1）EPC 部局は、EIA で示されている環境管理、モニタリング計画について、技術的な関与を行う、2）同様に、EIA ユニットは EPL 許認可に対し、その遵守状況を確認し、EPC ユニットに協力する。
k) ワーキンググループで議論したように、違反企業に対する罰則規定の制度の改定が必要である。違反に対する反則金の算出には改良が必要であろう。例えば、違反を継続している事業所に対し、日ベースの違反金を、排水処理の日コスト（電気、人件費、消耗品、メンテナンス等）をベースに算出し科すことにより、事業所は排水処理を行うほうがより理にかなっていると判断するであろう。

l)　中・長期的な改善案として、以下を提言する。

l-1) 環境水質基準が、新しく設定されており、環境基準と排水基準を比較し、特に両者の一貫性、合理性を検討することを提案する。排水基準の改訂にあたっては、以下の点は重要である。

a. CEA が策定した排水基準は事業所の特性に特化した技術に基づいた基準である。排水の質・量は、事業所により異なること、排水処理の方法とそのコストは事業所の種類、規模により異なることを考慮して、事業所により受け入れられやすい基準を基準の導入等幅広く設定する。

b. 現在の排水基準は、個々の事業所の汚濁負荷が水域に与える影響を考慮しているが、それらの累積的影響については考慮していない。したがって、排水基準を守っていても、結果的に環境水の汚濁が増加する事態になりかねない。

- ✓ Gazette No 1534/18 dated 01.02.2008 に基づき、地域や水域の特性を考慮したより厳格な基準の導入が必要である。
- ✓ すでに汚染が進んでいる水域での新規事業所の許認可は、汚濁負荷の総量を考慮して検討すべきである。

l-2) 排水基準の改定では、関係機関、特に BOI、NWSDB との調整は重要である。排水基準を改定するにあたっては、BOI は、工場団地からの汚水を、NWSDB は世帯からの汚水発生に関わる機関であり、これら行政機関の役割分担を考えて、協力することが必要となる。

a. 一般家庭、また事業所、事業地区、行政府事務所からの一般排水を処理する公共下水場の整備は特に重要である。これらの施設からの汚染物質は、BOD/COD、TSS、栄養塩（窒素およびリン化合物）、油分を含んでいる。公共下水道施設は、通常、工場からの排水が含む色素、有害な重金属、農薬、石油系有機物等を対象とした処理施設の設計とはなっていない。通常の中央汚水処理施設は、物理的な方法、スクリーニング、沈殿法、エアレーション・曝気法および塩素処理が中心で、時には最新処理として処理膜が用いられる場合もある。

b. 処理前の水質のベンチマークとして以下を参考にすることが妥当である。1）pH : 6.0-9.0、2）BOD_5 : 500 mg/L 未満、3）COD : 1,000 mg/L 未満、4）TSS : 500 mg/L 未満、5）色度 : 300 PCU 未満または実際の色、6）アンモニアおよび/または無機窒素化合物 50 mg/L-N 未満、7）無機リン化合物 50 mg/L-P 未満、8）油分 100 mg/L 未満。その他の項目は、通常の排水基準と同等と考えられる。

l-3) 効果的な排水管理では、コマンドコントロール（指揮統制）だけではなく、排水課金や経済的なインセンティブを考慮した市場ベースの管理も重要である。本プロジェクトで PSI データベースを構築した。これは上記スキームを導入する際の重要なツールとなる。理論的には、このような手法は、排出者（事業所）に、汚染対策に関し、多くの選択肢を付与するものであり、費用的に最も有利な方法を選ばせることが可能である。しかし、これを実現するためには、汚染の質・量に関する信頼できるデータ、排水課金システムや資金援助スキーム確立に関わる合意ができている必要がある。排水課金システムの検討・実施では、例えば、排出権の事業所間の取引のような市場アプローチの取り組みも検討する意義がある。

l-4)　情報発信は、事業所に対し、インセンティブを付与するために強力なツールとなる。グリーンアワードは、環境管理への取り組みを向上させるうえで効果的である。本プロジェクトは、国民への情報発信を改善した。

a.　例えば、ケラニ川流域の汚染源の位置情報を、グリーンアワード等の制度と組み合わせた情報公開とすれば、工場主にインセンティブを与えるきっかけとなる。

b.　グリーンアワードのスキームを中小企業に対しても門戸を広げる検討が望ましい。

c.　PSI データベースを用いて、優良企業を抽出できるように改善することが望ましい。

d.　アジア圏では、例えば、Industrial Ecowatch Program（フィリピン）あるいは PROPER-PROKASIH（インドネシア）が、企業の環境管理に対する貢献をランク付けするスキームの例として挙げられる。 こういった事例を参考に改善の検討を提案する。

3.4　情報管理に関する課題と教訓

a)　水質管理と計画のための部門間の連携に重点を置いた記載をしたが、CEA の強みの 1 つは、一般的なデータ共有手順を既に構築していることであり、情報が定期的に更新されるように、このようなチャネルを有効的かつ効果的に維持することが重要である。この教訓は、プロジェクト活動の他の分野にも当てはめることができる。

b)　公害管理の広範な取り組みのために、より多くの汚染源の情報を、長期間（例えば、1 年または 2 年）に渡り分析、審議することが重要である。これは、PSI をより広範に使用し、過去の実績を評価し、汚染動向変化の分析を通して、対策に役立てることができる。そのような分析作業を職員の日課とすることも重要となる。

c)　上級環境管理官（SEO）またはその他の適切な地域事務所職員に対して、EPL を発行するために必要となる全データを取得するために、EPL 発行前に PSI の入力データを検証することが必要である。

d)　PSI データベースは、将来、以下の観点から修正を検討することが必要である。1）汚染チェックリスト、排水量、日付（毎月または毎年）等によるフィルタリング機能の追加、2）要約レポートの作成機能の追加、3）表（CSV）または PDF 形式によるダウンロード可能な情報、4）有害廃棄物管理およびその他の汚染管理に関わる情報の追加、5）インターアクティブな地図情報との統合、6) 最適化のためのインターフェースとコーディングアルゴリズムの改善、7）データの盗難を避けるためのセキュリティの設定。

e)　PSI は、選択された職員のみがアクセスおよび操作できるデータベース管理システムである。その中から抽出された情報のみが環境情報データベースとして公開される。将来、すべてのデータが環境情報データベースに含まれるのならば、CEA 内部の複数ソースから情報を収集する必要はなくなる。1 つのソースからデータを取得し、自動的に出力を作成し、地図、図、または表を作成する作業の手間を省くことが可能となる。

f)　PSI データベースは、主に事業所の住所を使用して排出者の位置する自治体情報が関連づけられており、現時点では、経度および緯度データが限られている。したがって、小規模集水域ごとに情報を提示し分析するためには追加手順が必要となる。これには、データベースの改善が必要となる。

g)　ケラニ川沿いの重要ヵ所でみられるように、現場の水質情報を伝えるための掲示板の使用は、有効である。標識による情報提供の方法も専門家以外に科学的情報を提供するのに有効と考

えられる。このプロジェクトで、CEA はインターネットを利用して一般の人々に情報配信の新しいチャンネルを開発した。しかし、インターネット利用者の構成の変化のペースは速く、それに対応するために情報普及の手法は、検討の余地がある。それは以下の事実を考慮すると、その重要性が明らかになる。1）過去 10 年間でインターネット利用者の人口は、全人口の 2.5%から 32%へと著しい増加傾向を示した。2）インターネットへの接続機会の増加は、結果としてスリランカのネット上での存在感を増すことになった。特にフェースブックあるいは国民に人気のあるハングアウト等のソーシャルメディアにおけるその傾向は著しい。掲示板、学校におけるイベント、グリーンアワード、多様なソーシャルメディアを活用したネット上での情報普及活動を組み合わせて組織的にかつ系統立てて情報普及に役立てていくことが必要である。

第4章　上位目標達成のための提言

プロジェクトの上位目標は、プロジェクト・デザイン・マトリックスにおいて、次のように定義されている。

『主要水域における水質管理は、CEA によって適切に実施される。』

本章では、前章の「課題と教訓」より絞り込んで、上位目標を達成するための 5 つの提言を示した。これらは、日本国政府の支援が終了した後も、プロジェクト受益者に継続して裨益できるよう選定された助言である。

a) 水質類型は、Maha Oya、Dadugam Oya、Mahaweli Rivers などの他の流域への適用が推奨される、
b) ラボラトリーサービスの品質維持のために、内部監査、管理レビュー、試験所間試験への参加などを定期的に実施すべきである、以上 2 つの問題が確認された。
c) 上級検査官の豊富な知識と経験を活かし若手の検査官向けに特定の産業分野についてセミナー／ワークショップを定期的に開催し、さらに民間連携を推し進め、環境改善のための相互学習を活用する。
d) 政策および優先・重点取り組みの方針を決定するため PSI データベースを活用し、汚染状況と汚染源の分析を行う。
e) 情報入手・共有ネットワークが適切に運用され環境情報データベースが定期的に更新されること、また、重要な環境情報に対し国民の情報へのアクセスを向上させることが必要である。

付属資料 1　MM および RD

MINUTES OF MEETINGS
BETWEEN
JAPAN INTERNATIONAL COOPERATION AGENCY
AND
CENTRAL ENVIRONMENTAL AUTHORITY
OF
DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
ON
THE PROJECT FOR MONITORING OF THE WATER QUALITY OF MAJOR WATER BODIES

Japan International Cooperation Agency (hereinafter referred to as "JICA") has dispatched the Detailed Planning Survey Team (hereinafter referred to as "the Team") headed by Mr. Noriaki Murase to Democratic Socialist Republic of Sri Lanka (hereinafter referred to as "Sri Lanka") from September 14 to September 26, 2014 for the purpose of formulating the Project for Monitoring of the Water Quality of Major Water Bodies (hereinafter referred to as "the Project").

During its stay in Sri Lanka, the Team exchanged their views and had a series of discussions with relevant authorities of Sri Lanka for the purpose of working out the framework and contents of the Project with the authorities concerned of Sri Lanka.

As a result of discussions, both sides understood and came to an agreement on the matters referred to in the document attached hereto.

Colombo, September 19, 2014

Mr. Noriaki Murase
Leader,
Detailed Planning Survey Team,
Japan International Cooperation Agency

Mr. D.W. Prathapasinghe
Chairman
Central Environmental Authority

Mr. Saman de Silva
Board Member
Central Environmental Authority

Mr. B.M.U.D. Basnayake
Secretary
Ministry of Environment and Renewable Energy

Mr. R.M.P. Rathnayake
Director General
Department of External Resources,
Ministry of Finance & Planning

ATTACHED DOCUMENT

1. Draft of Record of Discussions

As a result of the discussions, both Central Environment Authority (hereinafter referred to as "CEA") and the Team agreed on a draft of Record of Discussions (hereinafter referred to as "R/D"), which stipulates a framework of the Project, shown in APPENDIX. After the approval of implementation of the Project by both CEA and JICA headquarters, the R/D will be finalized and signed by JICA Sri Lanka office and CEA.

The Team explained that the attached R/D was a draft and was subject to change in the authorization process by the competent authorities of both sides. The Team also explained that this Minutes of Meetings was a technical document to record discussion results between CEA and the Team as a preparation to formulate R/D.

2. Implementing Agency

Both sides agreed that the CEA is the implementing agency for the Project.

3. Duration and Schedule of the Project

The duration of the Project is three (3) years from the end of February, 2015.

The Annual Plan of Operation is to be drafted by both CEA and JICA Expert/s according to the Plan of Operation and is to be submitted to a Joint Coordinating Committee referred to in Annex III and Annex IV of the draft R/D. The activities are subject to modification within the scope of the R/D in the course of the Project implementation, if necessary.

4. Undertaking of the Government of Japan

After the approval of JICA headquarters and signing of R/D, JICA will take, at its own expense, the following measures in accordance with the laws and regulations in force in Japan.

1) Dispatch of Japanese Experts

JICA will provide the services of the Japanese experts.

2) Provision of Equipment

JICA will provide necessary equipment.

3) Training of Sri Lankan Personnel

JICA will receive the Sri Lankan personnel related to the Project for technical training in Japan.

5. Undertaking of CEA

1) Allocation of Budget

The followings will be allocated by CEA to ensure effective implementation of the Project.

a. Salary and other allowances for Sri Lankan counterpart personnel for the training and seminar in Sri Lanka provided by the Project
b. Expenses for utilities such as electricity, water supply, etc.
c. Other contingency expenses related to the Project

2) Allocation of Personnel

CEA will assign a suitable number of counterpart personnel to ensure the effective implementation of the Project. The list of counterparts is attached as Annex VI of the draft R/D.

3) Office space

CEA will provide furnished and air-conditioned office spaces in CEA, which can accommodate up to ten (10) persons in CEA for the smooth implementation of the Project.

4) Providing necessary information

CEA will coordinate with the related Sri Lankan authorities to collect necessary information to support the Project such as maps, data and standards, etc.

6. Title of the Project

Both sides agreed that the title of the Project would be "the Project for Monitoring of the Water Quality of Major Water Bodies".

7. Project Design Matrix (PDM)

The Team explained that the Project Design Matrix (hereinafter referred to as "PDM") is commonly used in Japanese technical cooperation in order to manage and implement projects efficiently and effectively. It will also be used as a reference for monitoring and evaluating the Project.

As a result of discussions, both sides agreed to apply the tentative PDM as shown in Annex I to the Project with following understanding:

1) The PDM is a logically designed matrix which defines the initial understanding of the framework of the Project and indicates the logical steps toward the achievement of the Project purpose.

2) The PDM is to be flexibly revised according to the progress and achievements of the Project, upon approval by the Joint Coordinating Committee, as shown in Annex III and Annex IV of the draft of R/D.

8. The Concept of the Project

The Team explained to the Sri Lankan side about the basic concept of JICA's technical cooperation project. Additionally, the Team explained that the initiative of the Project is to be taken by the Sri Lankan side during and after the period of Japanese technical cooperation, through full and active involvement by all related authorities, beneficiary groups and institutions. The Sri Lankan side understood the explanation and agreed to take initiative in executing the Project with assistance provided by Japanese Experts.

9. Cooperation between CEA and Board of Investment

Both sides confirmed that Board of Investment has strong concern about participation in the Project activities. CEA will discuss how Board of Investment cooperates with CEA in details.

APPENDIX **Draft of Record of Discussions**

APPENDIX

RECORD OF DISCUSSIONS

ON

THE PROJECT FOR MONITORING OF THE WATER QUALITY OF MAJOR WATER BODIES

IN

DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

AGREED UPON BETWEEN

CENTRAL ENVIRONMENTAL AUTHORITY

AND

JAPAN INTERNATIONAL COOPERATION AGENCY

Colombo, xx, xx, 201x

____
Mr. Kiyoshi Amada
Chief Representative
JICA Sri Lanka Office

Mr. D.W. Prathapasinghe Chairman Central Environmental Authority	Mr. Saman de Silva Board Member Central Environmental Authority
Mr. B.M.U.D. Basnayake Secretary Ministry of Environment and Renewable Energy	Mr. R.M.P. Rathnayake Director General Department of External Resources, Ministry of Finance & Planning

Based on the Minutes of Meetings on the Detailed Planning Survey on the Project for Monitoring of the Water Quality of Major Water Bodies (hereinafter referred to as "the Project") signed on 19 Sep 2014 between Central Environmental Authority (hereinafter referred to as "CEA") and the Japan International Cooperation Agency (hereinafter referred to as "JICA"), JICA held a series of discussions with CEA and relevant organizations to develop a detailed plan of the Project.

Both parties agreed on the details of the Project and the Main Points Discussed as described in the Appendix 1 and the Appendix 2 respectively.

Both parties also agreed that CEA, the counterpart to JICA, will be responsible for implementing the Project in cooperation with JICA, coordinating with other relevant organizations and ensuring that the Sri Lankan side takes the initiative of the Project during and after the implementation period in order to contribute toward the social and economic development of Democratic Socialist Republic of Sri Lanka (hereinafter referred to as "Sri Lanka").

The Project will be implemented within the framework of the Agreement on Technical Cooperation signed on 12 October 2005 (hereinafter referred to as "the Agreement") and the Note Verbales exchanged on 9 July 2014 between the Government of Japan (hereinafter referred to as "GOJ") and the Government of Democratic Socialist Republic of Sri Lanka (hereinafter referred to as "GOSL").

Appendix 1: Project Description
Appendix 2: Main Points Discussed
Appendix 3: Minutes of Meetings on the Detailed Planning Survey on the Project for Monitoring of the Water Quality of Major Water Bodies

Appendix 1

PROJECT DESCRIPTION

Both parties confirmed that there is no change in the Project Description agreed on in the Minutes of Meetings on the concerning the Detailed Planning Survey on the Project signed on 19 September 2014 (Appendix 3).

I. BACKGROUND

Most of the water bodies in Sri Lanka are moderately polluted due to direct pressure on water from industrialization, urbanization, and agricultural activities. Releasing of industrial effluent, domestic waste and sewage, dumping of solid wastes into water, and excessive use of agrochemicals and chemical fertilizers have caused an increase in the level of pollution and have put unintentional pressures on water resources. These pressures collectively interact, resulting in a series of complex problems such as infectious and chronic health issues and water scarcity, among others. It is expected that these issues will aggravate in the future to uncontrollable levels due to the ongoing development projects throughout the country.

Recently, the most serious pollution source on water bodies has been urban and domestic wastewater, and thus an improvement of urban drainage and sewerage system and domestic wastewater treatment facilities are urgent in Sri Lanka. These matters fall under the responsibility of the Ministry of Water Supply and Drainage (hereinafter referred to as "MOWSD") and the National Water Supply and Drainage Board (hereinafter referred to as "NWSDB"). However, due to industrialization policy of the GOSL, the industrial wastewater could increase rapidly and be the major cause of water pollution in the near future. In this context, it is very important to strengthen the administrative enforcement capacity of the CEA. The CEA is the governmental organization responsible for water quality management in all water bodies in Sri Lanka through the pollution source control for both domestic and industrial wastewater.

The current strategy of pollution control through regulation alone may prove burdensome and not cost-effective due to the lack of pollution control measures based on the procedure, economic, and information approach. Similar to most of the other countries, Sri Lanka has adopted a traditional command-and-control approach to the protection and management of the environment. The Environmental Protection License (hereinafter referred to as "EPL") from industries is the main instrument through which the pollution is controlled. However, according to a recent data, industries which have acquired the EPL remain at around 80% in the entire island. Although it was thought that the wastewater discharge could be controlled through the EPL scheme, the quality of many of the water bodies continued to deteriorate in all administrative provinces in Sri Lanka due to the weak enforcement of industrial effluent quality control.

The current practices of water quality monitoring are mostly related to point source pollution and their impacts on selected water bodies. The main agencies involved in the monitoring of water quality in common water bodies are CEA and NWSDB, but the NWSDB mainly focuses on the drinking water sources. Thus, the CEA is the main regulatory authority for the protection and management of the environment in Sri Lanka including water resources based on the National Environmental Act (hereinafter referred to as "NEA") No.47 of 1980. According to the NEA, no person shall deposit, discharge, and emit waste into the inland waters of Sri Lanka unless in accordance with the standard and criteria specified in regulations.

As such, the CEA plays a major role in the protection of water resources, enabling the NWSDB and other agencies to extract water for domestic and industrial purposes. However, their current monitoring practices are limited to a selected number of public water bodies and industrial and commercial establishments for monitoring the compliance of the EPL scheme.

Although some isolated short-term studies have been performed by various researchers and organizations, there is no systematic and complete set of data on the water quality of the major rivers. Investigating the status of water quality in the major rivers in Sri Lanka is therefore an urgent national issue for controlling and conserving the water environment in Sri Lanka. Additionally, classification of water bodies along the ambient standard is indispensable to promote the effective application of the newly developed ambient water quality standards.

Considering the current situation mentioned above, GOSL requested the GOJ for the implementation of the Project.

II. OUTLINE OF THE PROJECT

Details of the Project are described in the Logical Framework (Project Design Matrix: PDM) (Annex I) and the tentative Plan of Operation (Annex II).

1. Input

(1)Input by JICA

(a) Dispatch of Experts

The JICA experts will give necessary technical guidance, advice and recommendations to CEA on any matters pertaining to the implementation of the Project

(b) Training

Three (3) times during the Project regarding the monitoring of the water bodies and enforcement of the law toward the pollution source.

(c) Machinery and Equipment

Equipment for the water quality analysis (Annex V).

In case of importation, the machinery, equipment and other materials under II-1 (2) (c) above will become the property of the GOSL upon being delivered C.I.F. (cost, insurance and freight) to the Sri Lanka authorities concerned at the ports and/or airports of disembarkation.

(2) Input by CEA

CEA will take necessary measures to provide the followings at its own expense:

(a) Services of CEA's counterpart personnel and administrative personnel as referred to in II-2;
(b) Suitable office space with necessary equipment;
(c) Supply or replacement of machinery, equipment, instruments, vehicles, tools, spare parts and any other materials necessary for the implementation of the Project other than the equipment provided by JICA;
(d) Information as well as support in obtaining medical service;
(e) Credentials or identification cards;
(f) Available data (including maps and photographs) and information related to the Project;
(g) Running expenses necessary for the implementation of the Project;
(h) Expenses necessary for transportation within Sri Lanka of the equipment referred to in II-1 (1) as well as for the installation, operation and maintenance thereof; and
(i) Necessary facilities to the JICA experts for the remittance as well as utilization of the funds introduced into Sri Lanka from Japan in connection with the implementation of the Project

2. Implementation Structure

The Project organization chart is given in the Annex III. The roles and assignments of the relevant organizations are as follows

(1)CEA

(a) Project Director

Director General of CEA will be responsible for the overall administration and implementation of the Project.

(b)Project Manager

The Director of Laboratory Services, CEA

(c)Counterparts (Annex VI)

The following members will be responsible for the outputs of the relevant activities:

The Deputy Director General Environmental Pollution Control Division, CEA
The Director of Environmental Pollution Control Unit, CEA
The Director of Planning and Monitoring Unit, CEA
The Director of Research and Development Unit, CEA
The Director of Environmental Education & Awareness Unit, CEA
The Director of Human Resource Development Unit, CEA
The Director of Natural Resource Management Unit, CEA
The Director of Western Provincial Office, CEA

(2) Ministry of Environment and Renewable Energy (hereinafter referred to as "MOER")

(a) Secretary of MOER will be the Chairman of the Joint Coordinating Committee of the Project

The Director (Policy and Planning) of MOER will bear the overall responsibility for the coordination and oversight of the Project.

(3) JICA Experts

The JICA experts will give necessary technical guidance, advice and recommendations to CEA on any matters pertaining to the implementation of the Project.

(4) Joint Coordinating Committee
Joint Coordinating Committee (hereinafter referred to as "JCC") will be established in order to facilitate inter-organizational coordination. JCC will be held at least once a year and whenever deemed necessary. JCC will approve the annual work plan, review overall progress, conduct the evaluation of the Project, and exchange opinions on major issues that arise during the implementation of the Project. A list of proposed members of JCC is shown in the Annex IV.

3. Project Site and Beneficiaries
(1)Project site
Kelani River Basin

(2)Beneficiaries
Direct Beneficiaries: CEA and its staff
Indirect Beneficiaries: People living in Kelani River Basin

4. Duration
The duration of the Project will be three (3) years from the end of February 2015.

5. Environmental and Social Considerations
(1) CEA agreed to abide by 'JICA Guidelines for Environmental and Social Considerations' in order to ensure that appropriate considerations would be made for the environmental and social impacts of the Project.

III. UNDERTAKINGS OF CEA AND GOSL
1.CEA and GOSL will take necessary measures to:
(1) ensure that the technologies and knowledge acquired by the Sri Lankan nationals as a result of the Japanese technical cooperation contribute to the economic and social development of Sri Lanka, and that the knowledge and experience acquired by the personnel of Sri Lanka from technical training as well as the equipment provided by JICA will be utilized effectively in the implementation of the Project; and

(2) grant privileges, exemptions and benefits to the JICA experts referred to in II-1 (1) above and their families, which are no less favorable than those granted to experts and members of the missions and their families of third countries or international organizations performing similar missions in Sri Lanka.

IV. MONITORING AND EVALUATION
JICA, MOER and the CEA will jointly and regularly monitor the progress of the Project through the Monitoring Sheets based on the Project Design Matrix (PDM) and Plan of Operation (PO). The Monitoring Sheets shall be reviewed every six (6) months.

Also, Project Completion Report shall be drawn up one (1) month before the termination of the Project.

JICA will conduct the following evaluations and surveys to mainly verify the sustainability and impact of the Project and to draw lessons. The CEA and MOER are required to provide necessary support for them.

1. Ex-post evaluation three (3) years after the project completion, in principle
2. Follow-up surveys on necessity basis

V. PROMOTION OF PUBLIC SUPPORT

For the purpose of promoting support for the Project, CEA and MOER will take appropriate measures to make the Project widely known to the people of Sri Lanka.

VI. Misconduct

If JICA receives information related to suspected corrupt or fraudulent practices in the implementation of the Project, CEA, MOER and relevant organizations shall provide JICA with such information as JICA may reasonably request, including information related to any concerned official of the government and/or public organizations of the Sri Lanka.
CEA, MOER and relevant organizations shall not unfairly or unfavorably treat the person and/or company which provided the information related to suspected corrupt or fraudulent practices in the implementation of the Project.

VII. MUTUAL CONSULTATION

JICA, MOER and CEA will consult each other whenever any major issues arise in the course of Project implementation.

VIII. AMENDMENTS

The Record of Discussions may be amended by the Minutes of Meetings between JICA, MOER and CEA.
The Minutes of Meetings shall be signed by authorized persons of each side who may be different from the signers of the Record of Discussions.

Annex I	Project Design Matrix
Annex II	Tentative Plan of Operation
Annex III	Project Organization Chart
Annex IV	A List of Proposed Members of Joint Coordinating Committee
Annex V	Tentative List of Machinery and Equipment
Annex VI	List of Counterparts

Project Design Matrix

Annex I

Version 1
Dated 17, Sept, 2014

Project Title: The Project for Monitoring of the Water Quality of Major Water Bodies
Implementing Agency: Central Environmental Authority (CEA)
Target Group: Ministry of Environment (MOE)/Central Environmental Authority (CEA)/ Environmental Pollution Control (EPC) Division, Water Quality Monitoring Lab, Planning Management Unit and target Departments of regional branch offices in CEA
Period of Project: 3 years (tentative)
Project Site: Sri Lanka **Model Site: Kelani River**

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption	Achievement	Remarks
Overall Goal Water quality management in major water bodies is appropriately implemented by CEA	OG1 The by-laws and/or regulations which stipulate roles and functions of water quality management system are inaugurated by 2020. OG2 The rate of water bodies which retrieve better water quality conditions increases compared with the current rate by 2020. OG3 The number of major water bodies which introduce the water quality environmental management system are more than xxx in Sri Lanka by2020 in accordance with the guidelines prepared by the Project.	Data and documents in CEA and its regional branch offices	The principal policy for water quality management in Sri Lanka is not negatively changed.		
Project Purpose Enforcement capacity of CEA and its regional branch offices on water quality management is strengthened.	PP1 CEA conducts self-evaluation on their own capacity of policy and system making regarding water quality management such as nos. of proposals related to gazetting ambient water quality standards, introduction of ambient water quality zoning and categorization system, improvement of current EPL system, etc. based on the National Environmental Act (No.47 of 1980) and other related by-laws, and its evaluation results show improvement, compared with the initial stage of the Project.	1. Questionnaire survey for CEA, concerned departments, and regional branch offices at the initial, mid-term, and final stage of the Project	The principal policy for water quality management of CEA related to institution and budget for its implementation is not negatively changed.		
	PP2 CEA, concerned departments, and regional branch offices conduct self-evaluation on their own enforcement capacity of water quality management such as nos. of administrative guidance to factories, nos. of penalty case, etc. based on the National Environmental Act (No.47 of 1980) and other concerned by-laws, and its evaluation results show improvement, compared with the initial stage of the Project.	ditto			
	PP3 The guidelines and other outputs developed through the Project are properly applied by all concerned departments and regional offices of CEA in charge for a nationwide promotion of water quality management.	2. Data and documents in CEA, concerned departments, and regional branch offices	All related organizations in CEA and regional governments are active in promoting water quality management.		
	PP4 The number of major water bodies and regional governments which introduce zoning categorization of ambient water quality standard are more than xxx in Sri Lanka.	ditto			

	PP5 More than xxx guidelines and materials on zoning and categorization are developed and used.	3. Actual nos. of guidelines and materials			
	PP6 More than xxx times of guidance are conducted by CEA to organizations which have responsibility for water quality management of target water bodies.	4. Guidance record to target organizations and the result of the review test			
	PP7 More than xxx % of staff in the concerend departments and regional offices of CEA in charge can explain how to use the guidelines and other outputs developed through the Project.	5. Hearing and evaluation survey to target organizations			
Outputs Output 1: The introduction of water body categorization in line with the ambient water quality standard in Sri Lanka are set-up.	1-1 More than xxx reference monitoring points of ambient water quality standard are designated	1. Data and documents in CEA, concerned departments, and regional branch offices			
	1-2 A proposal for introducing ambient water quality zoning and categorization is prepared based on trial results in Kelani River.	ditto			
	1-3 More than **xxx (or xxx %)** of major water bodies have introduced zoning **and** categorization **system** in Sri Lanka	ditto			
Output 2: Water quality analysis capacity of lab staff is strengthened.	2-1 Nos. of lab staff who have sufficient analysis capability are more than xxx persons in the target labs	1. Actual nos. of staff, data, documents, and records			
	2-2 More than xxx samples are analyzed annually	2. SOPs developed			
	2-3 Equipment and instruments including reagents are properly operated and maintained	3. O/M ledgers such as results of QA/QC activities, procurement record of spareparts and reagents, and record of periodic caliburation and maintenance			
	2-4 More than xxx times of good lab practices and QA/QC activities are conducted annually	4. Hearing and evaluation survey			
	2-5 Target labs obtain more than xxx of accreditation certificates of water quality analysis for basic water quality substances from the reference lab in Sri Lanka	5. Nos. of water quality analysis certificates obtained from the reference lab in Sri Lanka			
	2-6 Target labs obtain accreditation certificate of ISO/IEC 17025 from the authorized accreditation organization	6. Accreditation certificate of ISO/IEC 17025 from the authorized accreditation organization			

Output 3: Enforcement capacity of the targeted counterpart organizations on water quality monitoring including inspection, pollution sources inventory (PSI), and the Environmental Protection License (EPL) scheme, is strengthened.	3-1 Water quality monitoring including inspection 3-1-1 More than xxx times of cooperating and sharing meetings among concerned organizations are carried out 3-1-2 Monitoring plans and reports including inspection, and analysis and evaluation of monitoring results including inspection in 2016 and 2017, are prepared by target departments, and shared with concerned departments and organizations 3-1-3 More than xxx times of sampling and water quality analysis are conducted in the ambient standard points 3-1-4 More than xxx times of workshops are conducted for sharing monitoring data and analysis results including inspection with concerned departments 3-1-5 Monitoring guideline/ guidebook including inspection for rivers in Sri Lanka is prepared 3-1-6 Level of enforcement capacity on water quality monitoring including inspection is improved 3-1-7 All violation cases revealed through monitoring including inspection are reported to the Legal Unit of CEA 3-2 Pollution Source Inventory (PSI) 3-2-1 More than xxx times of cooperating and sharing meetings among concerned organizations are carried out 3-2-2 More than xxx of PSI data are prepared targeting major pollution sources in Kelani River Basin 3-2-3 More than xxx % of major pollution sources in Kelani River Basin are identified and recorded on PSI Data Base (DB) 3-2-4 More than xxx % of PSI data are up-dated by follow-up activities 3-2-5 More than xxx times of PSI sharing meetings are held among concerned departments that manage and use PSI data 3-2-6 Level of enforcement capacity on PSI preparation is improved	1. Annual monitoring plan and report including inspection prepared 2. Actual nos. of monitoring data, documents, and records including inspection 3. Documents and records of workshops conducted 4. Monitoring guideline/ guidebook including inspection prepared 5. Comparison of capacity assessment results conducted at initial stage, mid-term evaluation, and terminal evaluation of the Project 6. Violation case records received by the Legal Unit of CEA 1. PSI data prepared 2. PSI data up-dated and records of follow-up activities 3. Documents and records of PSI sharing meetings 4. Comparison of capacity assessment results conducted at initial stage, mid-term evaluation, and terminal evaluation of the Project				

	3-3 Promotion of EPL scheme and effluent water quality standards for existing industries in the Kelani River Basin 3-3-1 More than xxx times of monitoring including inspection are conducted in Kelani river basin using guidebook developed 3-3-2 Monitoring including inspection are conducted more than xxx % of major pollution sources in Kelani river basin using guidebook developed 3-3-3 Method for selecting crusial pollution sources in Kelani river basin are developed and its result is reflected on the monitoring plan including inspection 3-3-4 Acquisition of EPL is more than xxx % in Kelani river basin 3-3-5 Practical guidance for promoting EPL and effluent quality standard is prepared 3-3-6 Illegal and/ or EPL-violating factories are reported to the authorities for sanction	1. Actual nos. of data, documents, and records related to EPL conducted in Kelani river basin 2. Actual nos. of monitoring data and records including inspection in Kelani river basin 3. Practical guidance prepared and its usage record 4. Practical guidance prepared and its usage record 5. Reports and records prepared and informed			
Output 4: Information management system of the water quality monitoring data including inspection, EPL data, and PSI data, on inland surface water bodies are developed and effectively used	4-1 More than xxx times of working group discussion meetings are carried out	1. Actual nos. of data, documents, and records concerning to information management			
	4-2 Data Base (DB) including EPL data for information management system is developed by web-base, and used by concerned organizations	2. Conditions of DB and its usage record			
	4-3 Input data is properly up-dated annually	3. Up-dated data and conditions			
	4-4 Practical guidance for promoting information management system in Sri Lanka is prepared	4. Practical guidance prepared and its usage record			
		5. Activity record of pilot project, and comparison of capacity assessment results conducted at initial stage, mid-term evaluation, and terminal evaluation of the Project			
	4-5 Annual report is prepared and shared with concerned organizations.	6. Prepared annual report and record of its sharing conditions			

Activities	Inputs		Important Assumption
	The Japanese Side	The Sri Lankan Side	
1) The introduction of water body categorization in line with the ambient water quality standard in Sri Lanka are set-up. 1-1: Review the current legal and institutional level and implementation system. 1-2: Clarify current situations and issues on management and compliance of the ambient water quality standard. 1-3: Establish a working group (WG), identify capacity development (CD) needs, and agree a task matrix of activities. 1-4: Conduct CD activities, develop tools and materials for categorization, and conduct its trial practices in selected rivers. 1-5: Prepare a set of general guidelines for introducing the categorization based on trial practices and lessons learned. 2) Water quality analysis capacity of lab staff is strengthened. 2-1: Review the current situation and level of central and regional labs in CEA. 2-2: Establish a WG and agree the specific CD plan including water quality analysis and operation and maintenance (O&M) of equipment. 2-3: Conduct CD activities, develop the Standard Operation Procedure (SOP), and continue the activities to obtain official accreditation such as ISO/IEC17025.	1) Expert Team -Team Leader/ Water Quality Management -Water Quality Analysis -Environmental Monitoring -Pollution Sources Inventory -Inspection -Data and Information Management/ Data Base -Coordinator 2) Seminars and Workshops 3) Training in Japan 4) Equipment Necessary for Project Activities 5) Pilot Projects 6) Local Consultants for Sub-contract Works	1) Counterpart (C/P) Personnel -CEA and concerned Departments -Regional Branch Offices 2) Project Office Space at CEA 3) Budget Allocation for Salary and other Expenditure for C/P during the Project Period. 4) Budget Allocation for Running cost of Equipment procured under the Project	

3) Enforcement capacity of the targeted counterpart organizations on water quality monitoring including inspection, pollution sources inventory (PSI), and the Environmental Protection License (EPL) scheme, is strengthened. <3-1> Water quality monitoring including inspection 3-1-1: Review the current water quality monitoring conditions including inspection and identify CD needs. 3-1-2: Establish a WG, prepare a task matrix of activities, and agree on the specific CD plan. 3-1-3: Conduct CD activities including preparation of annual planning, sampling, reporting, and feedback to other WGs. 3-1-4: Analyze and evaluate monitoring results including inspection and prepare an annual report on Kelani River. 3-1-5: Prepare a monitoring guideline/guidebook including for rivers in Sri Lanka. <3-2> Pollution Source Inventory (PSI) 3-2-1: Review the current PSI conditions, and identify CD needs. 3-2-2: Establish a WG, prepare a task matrix of activities, and agree on the specific CD plan. 3-2-3: Conduct CD activities including format preparation, annual planning, reporting, and data sharing with other WGs. 3-2-4: Manage and use PSI data in collaboration with other organizations. 3-2-5: Prepare a PSI guideline/guidebook for rivers in Sri Lanka.				

<3-3> Promotion of EPL scheme and effluent water quality standards for existing industries in the Kelani River Basin 3-3-1: Review the current situation of EPL scheme and effluent water quality standard in the Kelani River Basin, and identify principal issues to be improved. 3-3-2: Establish a WG, prepare a task matrix of activities, and agree on the specific capacity CD plan. 3-3-3: Conduct CD activities including the development of necessary tools and materials, and implement it in the Kelani River Basin as a pilot project. 3-3-4: Prepare a practical guidance for promoting EPL and effluent water quality standards. 4) Information management system of the water quality monitoring data including inspection, EPL data, and PSI data, on inland surface water bodies are developed and effectively used. 4-1: Review the current information management situation of the water quality monitoring data including inspection, EPL data, and PSI data, on inland surface water bodies, and identify principal issues to be improved. 4-2: Establish a WG, prepare a task matrix of activities, and agree on the specific CD plan. 4-3: Conduct CD activities including development of data base (DB), and implement it in the Kelani River Basin as a pilot project. 4-4: Prepare a practical guidance for promoting the developed information management system in Sri Lanka.				

			Pre-Conditions
			The Project is officially approved by the authority of the Government of Sri Lanka (GOSL)
			<Issues and countermesures>

Annex II

Tentative Plan of Operation

Version 1
Dated 17, Sep, 2014

Project Title: The Project for Monitoring of the Water Quality of Major Water Bodies

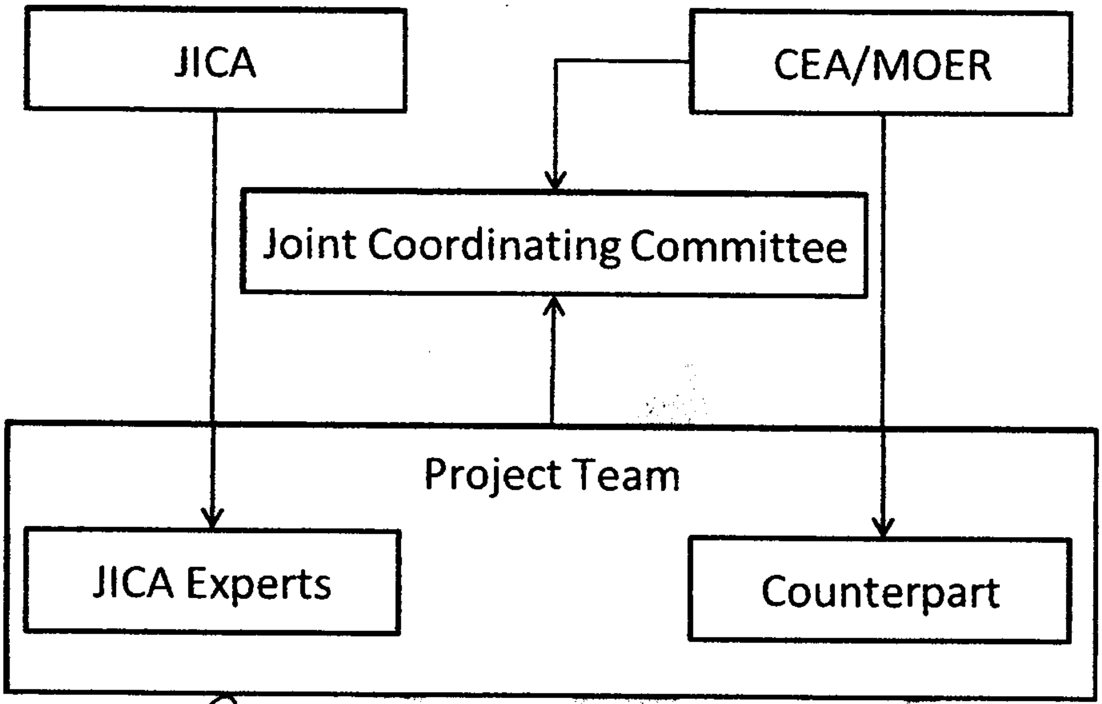
Inputs	Year	1st Year I	II	III	IV	2nd Year I	II	III	IV	3rd Year I	II	III	IV	Remarks	Monitoring: Issue	Solution
Expert																
Team Leader/ Water Quality Management	Plan															
	Actual															
Water Quality Analysis	Plan															
	Actual															
Environmental Monitoring	Plan															
	Actual															
Pollution Sources Inventory	Plan															
	Actual															
Inspection	Plan															
	Actual															
Data and Information Management/ Data Base	Plan															
	Actual															
Coordinator	Plan															
	Actual															
Equipment																
	Plan															
	Actual															
	Plan															
	Actual															
	Plan															
	Actual															
	Plan															
	Actual															
	Plan															
	Actual															
Training in Japan																
Training for Counterpart Personnel	Plan															
	Actual															
In-country/Third country Training																
Third country training for Counterpart Personnel	Plan															
	Actual															

Activities	Year	1st Year I	II	III	IV	2nd Year I	II	III	IV	3rd Year I	II	III	IV	Responsible Organization: Japan	GOSL	Achievements	Issue & Countermeasu
Output 1: The introduction of water body categorization in line with the ambient water quality standard in Sri Lanka are set-up.																	
1-1: Review the current legal and institutional level and implementation system.	Plan													JICA	CEA		
	Actual																
1-2: Clarify current situations and issues on management and compliance of the ambient water quality standard.	Plan													JICA	CEA		
	Actual																
1-3: Establish a working group (WG), identify capacity development (CD) needs, and agree a task matrix of activities.	Plan													JICA	CEA		
	Actual																
1-4: Conduct CD activities, develop tools and materials for categorization, and conduct its trial practices in selected rivers.	Plan													JICA	CEA		
	Actual																
1-5: Prepare a set of general guidelines for introducing the categorization based on trial practices and lessons learned.	Plan													JICA	CEA		
	Actual																
Output 2: Water quality analysis capacity of lab staff is strengthened.																	
2-1: Review the current situation and level of central and regional labs in CEA.	Plan													JICA	CEA		
	Actual																
2-2: Establish a WG and agree the specific CD plan including water quality analysis and operation and maintenance (O&M) of equipment.	Plan													JICA	CEA		
	Actual																
2-3: Conduct CD activities, develop the Standard Operation Procedure (SOP), and continue the activities to obtain official accreditation such as ISO/IEC17025.	Plan													JICA	CEA		
	Actual																
Output 3: Enforcement capacity of the targeted counterpart organizations on water quality monitoring including inspection, pollution sources inventory (PSI), and the Environmental Protection License (EPL) scheme, is strengthened.																	
Output 3.1: Water quality monitoring including inspection																	
3-1-1: Review the current water quality monitoring conditions including inspection and identify CD needs.	Plan													JICA	CEA		
	Actual																
3-1-2: Establish a WG, prepare a task matrix of activities, and agree on the specific CD plan.	Plan													JICA	CEA		
	Actual																
3-1-3: Conduct CD activities including preparation of annual planning, sampling, inspecting, reporting, and feedback to other WGs.	Plan													JICA	CEA		
	Actual																
3-1-4: Analyze and evaluate monitoring results including inspection and prepare an annual report on the Kelani River Basin.	Plan													JICA	CEA		
	Actual																
3-1-5: Prepare a monitoring guideline/guidebook including inspection for rivers in Sri Lanka.	Plan													JICA	CEA		
	Actual																
Output 3-2: Pollution Source Inventory (PSI)																	
3-2-1: Review the current PSI conditions, and identify CD needs.	Plan													JICA	CEA		

	Actual		
3-2-2: Establish a WG, prepare a task matrix of activities, and agree on the specific CD plan.	Plan	JICA	CEA
	Actual		
3-2-3: Conduct CD activities including format preparation, annual planning, reporting, and data sharing with other WGs.	Plan	JICA	CEA
	Actual		
3-2-4: Manage and use PSI data in collaboration with other organizations.	Plan	JICA	CEA
	Actual		
3-2-5: Prepare a PSI guideline/guidebook for rivers in Sri Lanka.	Plan	JICA	CEA
	Actual		
Output 3-3: Promotion of EPL scheme and effluent water quality standards for exisiting industries in the Kelani River Basin.			
3-3-1: Review the current situation of EPL scheme and effluent water quality standard in the Kelani River Basin, and identify principal issues to be improved.	Plan	JICA	CEA
	Actual		
3-3-2: Establish a WG, prepare a task matrix of activities, and agree on the specific capacity CD plan.	Plan	JICA	CEA
	Actual		
3-3-3: Conduct CD activities including the development of necessary tools and materials, and implement it in the Kelani River Basin as a pilot project.	Plan	JICA	CEA
	Actual		
3-3-4: Prepare a practical guidance for promoting EPL and effluent water quality standards.	Plan	JICA	CEA
	Actual		
Output 4: Information management system of the water quality monitoring data, EPL data, PSI data, and inspection data on inland surface water bodies are developed and effectively used.			
4-1: Review the current information management situation of the water quality monitoring data including inspection, EPL data, and PSI data, on inland surface water bodies, and identify principal issues to be improved.	Plan	JICA	CEA
	Actual		
4-2: Establish a WG, prepare a task matrix of activities, and agree on the specific CD plan.	Plan	JICA	CEA
	Actual		
4-3: Conduct CD activities including development of data base (DB), and implement it in the Kelani River Basin as a pilot project.	Plan	JICA	CEA
	Actual		
4-4: Prepare a practical guidance for promoting the developed information management system in Sri Lanka	Plan	JICA	CEA
	Actual		
Duration / Phasing	Plan		
	Actual		

Monitoring Plan	Year	1st Year I	1st Year II	1st Year III	1st Year IV	2nd Year I	2nd Year II	2nd Year III	2nd Year IV	3rd Year I	3rd Year II	3rd Year III	3rd Year IV	Remarks	Issue	Solution
Monitoring																
Joint Coordinating Committee (JCC)	Plan	●	●			●		●		●		●				
	Actual															
Set-up the Detailed Plan of Operation	Plan	▲														
	Actual															
Submission of Monitoring Sheet	Plan															
	Actual															
Monitoring Mission from Japan (mid-term and terminal evaluation)	Plan		■					■				■				
	Actual															
Joint Monitoring	Plan															
	Actual															
Post Monitoring	Plan															
	Actual															
Reports/Documents																
Inception Report	Plan	▲														
	Actual															
Progress Report	Plan				▲				▲							
	Actual															
Training Materials	Plan															
	Actual															
Project Completion Report	Plan												▲			
	Actual															
Public Relations																
Establishment and Operation of web site	Plan															
	Actual															
Materials for public relations related the water quality monitoring and management	Plan															
	Actual															
Seminar for Public at Colombo City	Plan															
	Actual															

Annex III   Project Organization Chart



Annex IV A List of Proposed Members of Joint Coordinating Committee

1. Functions

A Joint Coordinating Committee will be organized and notified. The committee meeting will be held at least once a year and whenever need arises.

The functions of the Committee are as follows:

1) To supervise the annual work plan of the Project in line with the Plan of Operations.
2) To review the annual and overall progress of the Project and to evaluate the accomplishment of the annual targets and achievement of the objectives.
3) To identify proper ways and means to solve the major issues arising from or in connection with the Project.

2. Composition

1) Chairperson:

Secretary, MOER

2) Members of Sri Lanka side:

Director General of CEA

The Deputy Director General of Environmental Pollution Control Division, CEA

The Director of Environmental Pollution Control Unit, CEA

The Director of Water Quality Monitoring Lab, CEA

The Director of Planning and Monitoring Unit, CEA

The Director of Research and Development Unit, CEA

The Director of Environmental Education & Awareness Unit, CEA

The Director of Human Resource Development Unit, CEA

The Director of Legal Unit, CEA

The Director of Natural Resource Management Unit, CEA

The Director of Western Provincial Office, CEA

The Director (Policy and Planning) of MOER

The representative of Board of Investment

Official(s) of the representative of Ministry of Finance and Planning

*Other personnel concerned, to be assigned by Chairperson of JCC, if necessary

3) Members of the Japanese Side:

Representative of JICA

JICA Experts

Other personnel concerned, to be assigned by JICA, if necessary

4) Observer

The representative of Ministry of Industry and Commerce
The representative of Ministry of Economic Development

Note:
The Embassy of Japan in Sri Lanka may attend as observer(s).

Annex V Tentative List of Machinery and Equipment

(To Be Discussed.)

Annex VI List of Counterparts

1) CEA
Director General

2) Environmental Pollution Control Division, CEA
Deputy Director General
Director
Deputy Director
Assistant Director
Senior Environmental Officer (4)
Environmental Officer (2)

3) Water Quality Monitoring Lab, CEA
Director
Deputy Director
Assistant Director
Chemist (4)
Laboratory Assistant (3)
Environmental Officer (3)

4) Two (2) District office in Western Province, CEA
Director
Deputy Director
Assistant Director
Senior Environmental Officer
Division Environmental Officer

5) Planning and Monitoring Unit
Director

6) Information Technology Unit CEA
Program Analyst

7) Policy and Planning Division of MOER
Director
Assistant Director

Appendix 2

MAIN POINTS DISCUSSED

1. Contents of the pilot project

Both sides understood the necessity to improve the current EPL scheme which has been not effective for the prevention of water pollution. Based on the mutual understanding, both sides basically agreed to develop new tools for an effective EPL scheme through the implementation of a pilot project, such as disclosing information on the names of factories and business entities that obtain EPL and not, introducing a performance rating system of factories and business entities, and suspending conquest for renewal. Detailed contents and target areas of the pilot project will be determined within 6 months after the Project starts.

2. The Concept of the Project

The Team explained to the Sri Lankan side about the basic concept of the JICA's technical cooperation project and the difference of schemes between the development study and the technical cooperation project. Additionally, the Team explained that the Sri Lankan side shall take necessary measures to ensure that they take the initiative of the Project during and after the period of Japanese technical cooperation, through full and active involvement in the Project by all related authorities, beneficiary groups and institutions. The Sri Lankan side understood the explanation and both sides agreed that the Sri Lankan side would take the ownership in executing the Project.

3. Allocation of Personnel

CEA will assign a suitable number of counterpart personnel to ensure an effective implementation of the Project. The list of counterparts is attached as Annex VI of the R/D.

4. Office space

CEA will provide furnished and air-conditioned office spaces in CEA, which can accommodate up to ten (10) persons in CEA for the smooth implementation of the Project.

5. Providing necessary information

CEA will coordinate with the related Sri Lankan authorities to collect necessary information to support the Project such as maps, data and standards, etc.

RECORD OF DISCUSSIONS

ON

THE PROJECT FOR MONITORING OF THE WATER QUALITY OF MAJOR WATER BODIES

IN

DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

AGREED UPON BETWEEN

CENTRAL ENVIRONMENTAL AUTHORITY

AND

JAPAN INTERNATIONAL COOPERATION AGENCY

Colombo, Nov. 26 , 2014

Mr. Kiyoshi Amada
Chief Representative
JICA Sri Lanka Office

Mr. D.W. Prathapasinghe
Chairman
Central Environmental Authority

Mr. Saman de Silva
Board Member
Central Environmental Authority

Mr. B.M.U.D. Basnayake
Secretary
Ministry of Environment and Renewable Energy

Mr. R.M.P. Rathnayake
Director General
Department of External Resources
Ministry of Finance & Planning

Based on the Minutes of Meetings on the Detailed Planning Survey on the Project for Monitoring of the Water Quality of Major Water Bodies (hereinafter referred to as "the Project") signed on 19 Sep 2014 between Central Environmental Authority (hereinafter referred to as "CEA") and the Japan International Cooperation Agency (hereinafter referred to as "JICA"), JICA held a series of discussions with CEA and relevant organizations to develop a detailed plan of the Project.

Both parties agreed on the details of the Project and the Main Points Discussed as described in the Appendix 1 and the Appendix 2 respectively.

Both parties also agreed that CEA, the counterpart to JICA, will be responsible for implementing the Project in cooperation with JICA, coordinating with other relevant organizations and ensuring that the Sri Lankan side takes the initiative of the Project during and after the implementation period in order to contribute toward the social and economic development of Democratic Socialist Republic of Sri Lanka (hereinafter referred to as "Sri Lanka").

The Project will be implemented within the framework of the Agreement on Technical Cooperation signed on 12 October 2005 (hereinafter referred to as "the Agreement") and the Note Verbales exchanged on 9 July 2014 between the Government of Japan (hereinafter referred to as "GOJ") and the Government of Democratic Socialist Republic of Sri Lanka (hereinafter referred to as "GOSL").

Appendix 1: Project Description
Appendix 2: Main Points Discussed
Appendix 3: Minutes of Meetings on the Detailed Planning Survey on the Project for Monitoring of the Water Quality of Major Water Bodie

Appendix 1

PROJECT DESCRIPTION

Both parties confirmed that there are a few changes in the Project Description agreed on in the Minutes of Meetings on the concerning the Detailed Planning Survey on the Project signed on 19 September 2014 (Appendix 3) as described below.

- Addition of "the representative of Ministry of Industry and Commerce" to the member list of Joint Coordinating Committee (Annex IV)
- Addition of items to the tentative list of machinery and equipment (Annex V)
- Revision of some descriptions in the Project Design Matrix (Annex I) and the tentative Plan of Operation (Annex II)

I. BACKGROUND

Most of the water bodies in Sri Lanka are moderately polluted due to direct pressure on water from industrialization, urbanization, and agricultural activities. Releasing of industrial effluent, domestic waste and sewage, dumping of solid wastes into water, and excessive use of agrochemicals and chemical fertilizers have caused an increase in the level of pollution and have put unintentional pressures on water resources. These pressures collectively interact, resulting in a series of complex problems such as infectious and chronic health issues and water scarcity, among others. It is expected that these issues will aggravate in the future to uncontrollable levels due to the ongoing development projects throughout the country.

Recently, the most serious pollution source on water bodies has been urban and domestic wastewater, and thus an improvement of urban drainage and sewerage system and domestic wastewater treatment facilities are urgent in Sri Lanka. These matters fall under the responsibility of the Ministry of Water Supply and Drainage (hereinafter referred to as "MOWSD") and the National Water Supply and Drainage Board (hereinafter referred to as "NWSDB"). However, due to industrialization policy of the GOSL, the industrial wastewater could increase rapidly and be the major cause of water pollution in the near future. In this context, it is very important to strengthen the administrative enforcement capacity of the CEA. The CEA is the governmental organization responsible for water quality management in all water bodies in Sri Lanka through the pollution source control for both domestic and industrial wastewater.

The current strategy of pollution control through regulation alone may prove burdensome and not cost-effective due to the lack of pollution control measures based on the procedure, economic, and information approach. Similar to most of the other countries, Sri Lanka has adopted a traditional command-and-control approach to the protection and management of the environment. The Environmental Protection License (hereinafter referred to as "EPL") from industries is the main instrument through which the pollution is controlled. However, according to a recent data, industries which have acquired the EPL remain at around 80% in the entire island. Although it was thought that the wastewater discharge could be controlled through the EPL scheme, the quality of many of the water bodies continued to deteriorate in all administrative provinces in Sri Lanka due to the weak enforcement of industrial effluent quality control.

The current practices of water quality monitoring are mostly related to point source pollution and their impacts on selected water bodies. The main agencies involved in the monitoring of water quality in common water bodies are CEA and NWSDB, but the NWSDB mainly focuses on the drinking water sources. Thus, the CEA is the main regulatory authority for the protection and management of the environment in Sri Lanka including water resources based on the National Environmental Act (hereinafter referred to as "NEA") No.47 of 1980. According to the NEA, no person shall deposit, discharge, and emit waste into the inland waters of Sri Lanka unless in accordance with the standard and criteria specified in regulations.

As such, the CEA plays a major role in the protection of water resources, enabling the NWSDB and other agencies to extract water for domestic and industrial purposes. However, their current monitoring practices are limited to a selected number of public water bodies and industrial and commercial establishments for monitoring the compliance of the EPL scheme.

Although some isolated short-term studies have been performed by various researchers and organizations, there is no systematic and complete set of data on the water quality of the major rivers. Investigating the status of water quality in the major rivers in Sri Lanka is therefore an urgent national issue for controlling and conserving the water environment in Sri Lanka. Additionally, classification of water bodies along the ambient standard is indispensable to promote the effective application of the newly developed ambient water quality standards.

Considering the current situation mentioned above, GOSL requested the GOJ for the implementation of the Project.

II. OUTLINE OF THE PROJECT

Details of the Project are described in the Logical Framework (Project Design Matrix: PDM) (Annex I) and the tentative Plan of Operation (Annex II).

1. Input
   (1)Input by JICA
      (a) Dispatch of Experts
      The JICA experts will give necessary technical guidance, advice and recommendations to CEA on any matters pertaining to the implementation of the Project
      (b) Training
      Three (3) times during the Project regarding the monitoring of the water bodies and enforcement of the law toward the pollution source.
      (c) Machinery and Equipment
      Equipment for the water quality analysis (Annex V).
         In case of importation, the machinery, equipment and other materials under II-1 (2) (c) above will become the property of the GOSL upon being

delivered C.I.F. (cost, insurance and freight) to the Sri Lanka authorities concerned at the ports and/or airports of disembarkation.

(2) Input by CEA
CEA will take necessary measures to provide the followings at its own expense:
(a) Services of CEA's counterpart personnel and administrative personnel as referred to in II-2;
(b) Suitable office space with necessary equipment;
(c) Supply or replacement of machinery, equipment, instruments, vehicles, tools, spare parts and any other materials necessary for the implementation of the Project other than the equipment provided by JICA;
(d) Information as well as support in obtaining medical service;
(e) Credentials or identification cards;
(f) Available data (including maps and photographs) and information related to the Project;
(g) Running expenses necessary for the implementation of the Project;
(h) Expenses necessary for transportation within Sri Lanka of the equipment referred to in II-1 (1) as well as for the installation, operation and maintenance thereof; and
(i) Necessary facilities to the JICA experts for the remittance as well as utilization of the funds introduced into Sri Lanka from Japan in connection with the implementation of the Project

2. Implementation Structure
The Project organization chart is given in the Annex III. The roles and assignments of the relevant organizations are as follows
(1)CEA
(a) Project Director
Director General of CEA will be responsible for the overall administration and implementation of the Project.
(b)Project Manager
The Director of Laboratory Services, CEA
(c)Counterparts (Annex VI)
The following members will be responsible for the outputs of the relevant activities:
The Deputy Director General Environmental Pollution Control Division, CEA
The Director of Environmental Pollution Control Unit, CEA
The Director of Planning and Monitoring Unit, CEA
The Director of Research and Development Unit, CEA
The Director of Environmental Education & Awareness Unit, CEA
The Director of Human Resource Development Unit, CEA
The Director of Natural Resource Management Unit, CEA
The Director of Western Provincial Office, CEA

(2) Ministry of Environment and Renewable Energy (hereinafter referred to as "MOER")
(a) Secretary of MOER will be the Chairman of the Joint Coordinating

Committee of the Project
The Director (Policy and Planning) of MOER will bear the overall responsibility for the coordination and oversight of the Project.

(3) JICA Experts
The JICA experts will give necessary technical guidance, advice and recommendations to CEA on any matters pertaining to the implementation of the Project.

(4) Joint Coordinating Committee
Joint Coordinating Committee (hereinafter referred to as "JCC") will be established in order to facilitate inter-organizational coordination. JCC will be held at least once a year and whenever deemed necessary. JCC will approve the annual work plan, review overall progress, conduct the evaluation of the Project, and exchange opinions on major issues that arise during the implementation of the Project. A list of proposed members of JCC is shown in the Annex IV.

3. Project Site and Beneficiaries
(1)Project site
Kelani River Basin

(2)Beneficiaries
Direct Beneficiaries: CEA and its staff
Indirect Beneficiaries: People living in Kelani River Basin

4. Duration
The duration of the Project will be three (3) years from the end of February 2015.

5. Environmental and Social Considerations
(1) CEA agreed to abide by 'JICA Guidelines for Environmental and Social Considerations' in order to ensure that appropriate considerations would be made for the environmental and social impacts of the Project.

III. UNDERTAKINGS OF CEA AND GOSL

1.CEA and GOSL will take necessary measures to:

(1) ensure that the technologies and knowledge acquired by the Sri Lankan nationals as a result of the Japanese technical cooperation contribute to the economic and social development of Sri Lanka, and that the knowledge and experience acquired by the personnel of Sri Lanka from technical training as well as the equipment provided by JICA will be utilized effectively in the implementation of the Project; and

(2) grant privileges, exemptions and benefits to the JICA experts referred to in II-1 (1) above and their families, which are no less favorable than those granted to experts and members of the missions and their families of third countries or international organizations performing similar missions in Sri Lanka.

IV. MONITORING AND EVALUATION

JICA, MOER and the CEA will jointly and regularly monitor the progress of the Project through the Monitoring Sheets based on the Project Design Matrix (PDM) and Plan of Operation (PO). The Monitoring Sheets shall be reviewed every six (6) months.

Also, Project Completion Report shall be drawn up one (1) month before the termination of the Project.

JICA will conduct the following evaluations and surveys to mainly verify the sustainability and impact of the Project and to draw lessons. The CEA and MOER are required to provide necessary support for them.

1. Ex-post evaluation three (3) years after the project completion, in principle
2. Follow-up surveys on necessity basis

V. PROMOTION OF PUBLIC SUPPORT

For the purpose of promoting support for the Project, CEA and MOER will take appropriate measures to make the Project widely known to the people of Sri Lanka.

VI. Misconduct

If JICA receives information related to suspected corrupt or fraudulent practices in the implementation of the Project, CEA, MOER and relevant organizations shall provide JICA with such information as JICA may reasonably request, including information related to any concerned official of the government and/or public organizations of the Sri Lanka.

CEA, MOER and relevant organizations shall not unfairly or unfavorably treat the person and/or company which provided the information related to suspected corrupt or fraudulent practices in the implementation of the Project.

VII. MUTUAL CONSULTATION

JICA, MOER and CEA will consult each other whenever any major issues arise in the course of Project implementation.

VIII. AMENDMENTS

The Record of Discussions may be amended by the Minutes of Meetings between JICA, MOER and CEA.

The Minutes of Meetings shall be signed by authorized persons of each side who may be different from the signers of the Record of Discussions.

Annex I Project Design Matrix
Annex II Tentative Plan of Operation
Annex III Project Organization Chart
Annex IV A List of Proposed Members of Joint Coordinating Committee
Annex V Tentative List of Machinery and Equipment
Annex VI List of Counterparts

Annex I

Project Design Matrix

Version 1
Dated 10, Nov, 2014

Project Title: The Project for Monitoring of the Water Quality of Major Water Bodies
Implementing Agency: Central Environmental Authority (CEA)
Target Group: Ministry of Environment (MOE)/Central Environmental Authority (CEA)/ Environmental Pollution Control (EPC) Division, Water Quality Monitoring Lab, Planning Management Unit and target Departments of regional branch offices in CEA
Period of Project: 3 years (tentative)
Project Site: Sri Lanka **Model Site: Kelani River**

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption	Achievement	Remarks
Overall Goal Water quality management in major water bodies is appropriately implemented by CEA	OG1 The by-laws and/or regulations which stipulate roles and functions of a water quality management system are inaugurated by 2020. OG2 The rate of water bodies with improved water quality monitoring results implemented by CEA increases by 2020 compared with the initial stage of the Project. OG3 The number of major water bodies which introduce the water quality environmental management system are more than xxx in Sri Lanka by2020 in accordance with the guidelines prepared by the Project.	Data and documents in CEA and its regional branch offices	The principal policy prescribed in the National Environmental Act for water quality management in Sri Lanka is not negatively changed.		
Project Purpose Enforcement capacity of CEA and its regional branch offices of the Kelani river basin on water quality management is strengthened.	PP1 CEA conducts self-evaluation on their own capacity of policy and system making regarding water quality management such as nos. of proposals related to gazetting ambient water quality standards, introduction of ambient water quality zoning and categorization system, improvement of current EPL system, etc. based on the National Environmental Act (No.47 of 1980) and other related by-laws, and its evaluation results show improvement, compared with the initial stage of the Project. PP2 CEA, concerned departments, and regional branch offices conduct self-evaluation on their own enforcement capacity of water quality management such as nos. of guidance to factories, nos. of penalty case, etc. based on the National Environmental Act (No.47 of 1980) and other concerned by-laws, and its evaluation results show improvement, compared with the initial stage of the Project. PP3 The guidelines and other outputs developed through the Project are properly applied by all concerned departments and regional offices of CEA in charge for a nationwide promotion of water quality management.	1. Questionnaire survey for CEA, concerned departments, and regional branch offices at the initial, mid-term, and final stage of the Project ditto 2. Data and documents in CEA, concerned departments, and regional branch offices	The principal policy for water quality management of CEA related to institution and budget for its implementation is not negatively changed. All related organizations in CEA and regional governments are active in promoting water quality management.		
	PP4 The number of major water bodies and regional governments which introduce zoning categorization of ambient water quality standard are more than xxx in Sri Lanka.	ditto			
	PP5 More than xxx guidelines and materials on zoning and categorization are developed and used.	3. Actual nos. of guidelines and materials			

	PP6 More than xxx times of guidance are conducted by CEA to organizations which have responsibility for water quality management of target water bodies.	4. Guidance record to target organizations and the result of the review test			
	PP7 More than xxx % of staff in the concerend departments and regional offices of CEA in charge can explain how to use the guidelines and other outputs developed through the Project.	5. Hearing and evaluation survey to target organizations			
Outputs					
Output 1: The introduction of water body categorization in line with the ambient water quality standard in Sri Lanka are set-up.	1-1 More than xxx reference monitoring points of ambient water quality standard are designated	1. Data and documents in CEA, concerned departments, and regional branch offices			
	1-2 A proposal for introducing ambient water quality zoning and categorization is prepared based on trial results in the Kelani river.	ditto			
	1-3 More than xxx (or xxx %) of major water bodies have introduced zoning and categorization system in Sri Lanka	ditto			
Output 2: Water quality analysis capacity of lab staff is strengthened.	2-1 Nos. of lab staff who have sufficient analysis capability are more than xxx persons in the target labs	1. Actual nos. of staff, data, documents, and records			
	2-2 More than xxx samples are analyzed annually	2. SOPs developed			
	2-3 Equipment and instruments including reagents are properly operated and maintained	3. O/M ledgers such as results of QA/QC activities, procurement record of spareparts and reagents, and record of periodic caliburation and maintenance			
	2-4 More than xxx times of good lab practices and QA/QC activities are conducted annually	4. Hearing and evaluation survey			
	2-5 Target labs obtain more than xxx of accreditation certificates of water quality analysis for basic water quality substances from the reference lab in Sri Lanka	5. Nos. of water quality analysis certificates obtained from the reference lab in Sri Lanka			
	2-6 Target labs obtain accreditation certificate of ISO/IEC 17025 from the authorized accreditation organization	6. Accreditation certificate of ISO/IEC 17025 from the authorized accreditation organization			

Output 3: Enforcement capacity of the targeted counterpart organizations on water quality monitoring including inspection is strengthened, pollution sources inventory (PSI) is created, and acquisition of the Environmental Protection License (EPL) is promoted.	3-1 Water quality monitoring including inspection 3-1-1 More than xxx times of cooperating and sharing meetings among concerned organizations are carried out 3-1-2 Monitoring plans and reports including inspection, and analysis and evaluation of monitoring results including inspection in 2016 and 2017, are prepared by target departments, and shared with concerned departments and organizations 3-1-3 More than xxx times of sampling and water quality analysis are conducted in the ambient standard points 3-1-4 More than xxx times of workshops are conducted for sharing monitoring data and analysis results including inspection with concerned departments 3-1-5 Monitoring guideline including inspection for rivers in Sri Lanka is prepared 3-1-6 Level of enforcement capacity on water quality monitoring including inspection is improved 3-1-7 All violation cases revealed through monitoring including inspection are reported to the Legal Unit of CEA	1. Annual monitoring plan and report including inspection prepared 2. Actual nos. of monitoring data, documents, and records including inspection 3. Documents and records of workshops conducted 4. Monitoring guideline including inspection prepared 5. Comparison of capacity assessment results conducted at initial stage, mid-term evaluation, and terminal evaluation of the Project 6. Violation case records received by the Legal Unit of CEA			
	3-2 Pollution Source Inventory (PSI) 3-2-1 More than xxx times of cooperating and sharing meetings among concerned organizations are carried out 3-2-2 More than xxx of PSI data are prepared targeting major pollution sources in the Kelani river basin 3-2-3 More than xxx % of major pollution sources in the Kelani river basin are identified and recorded on PSI Data Base (DB) 3-2-4 More than xxx % of PSI data are up-dated by follow-up activities 3-2-5 More than xxx times of PSI sharing meetings are held among concerned departments that manage and use PSI data 3-2-6 Level of enforcement capacity on PSI preparation is improved	1. PSI data prepared 2. PSI data up-dated and records of follow-up activities 3. Documents and records of PSI sharing meetings 4. Comparison of capacity assessment results conducted at initial stage, mid-term evaluation, and terminal evaluation of the Project			

	3-3 Promotion of EPL scheme and effluent water quality standards for existing industries in the Kelani river basin 3-3-1 More than xxx times of monitoring including inspection are conducted in Kelani river basin using guideline guidebook developed 3-3-2 Monitoring including inspection are conducted more than xxx % of major pollution sources in Kelani river basin using guideline developed 3-3-3 Method for selecting crusial pollution sources in Kelani river basin are developed and its result is reflected on the monitoring plan including inspection 3-3-4 Acquisition of EPL is more than xxx % in the Kelani river basin 3-3-5 Guidance for promoting EPL and effluent quality standard is prepared 3-3-6 Illegal and/ or EPL-violating factories are reported to the authorities for sanction	1. Actual nos. of data, documents, and records related to EPL conducted in the Kelani river basin 2. Actual nos. of monitoring data and records including inspection in the Kelani river basin 3. Guideline prepared and its usage record 4. Reports and records prepared and informed			
Output 4: Information management system of the water quality monitoring data including inspection, EPL data, and PSI data, on inland surface water bodies are developed and effectively used	4-1 More than xxx times of working group discussion meetings are carried out 4-2 Data Base (DB) including EPL data for information management system is developed by web-base, and used by concerned organizations 4-3 Input data is properly up-dated annually 4-4 Guidance for promoting information management system in Sri Lanka is prepared 4-5 Annual report is prepared and shared with concerned organizations.	1. Actual nos. of data, documents, and records concerning to information management 2. Conditions of DB and its usage record 3. Up-dated data and conditions 4. Guidance prepared and its usage record 5. Activity record of pilot project, and comparison of capacity assessment results conducted at initial stage, mid-term evaluation, and terminal evaluation of the Project 6. Prepared annual report and record of its sharing conditions			

Activities	Inputs		Important Assumption
	The Japanese Side	The Sri Lankan Side	
1) The introduction of water body categorization in line with the ambient water quality standard in Sri Lanka are set-up. 1-1: Review the current legal and institutional level and implementation system. 1-2: Clarify current situations and issues on management and compliance of the ambient water quality standard. 1-3: Establish a working group (WG), identify capacity development (CD) needs, and agree a task matrix of activities. 1-4: Conduct CD activities, develop tools and materials for categorization, and conduct its trial practices in selected rivers. 1-5: Prepare a set of guidelines for introducing the categorization based on trial practices and lessons learned. 2) Water quality analysis capacity of lab staff is strengthened. 2-1: Review the current situation and level of central and regional labs in CEA. 2-2: Establish a WG and agree the specific CD plan including water quality analysis and operation and maintenance (O&M) of equipment. 2-3: Conduct CD activities, develop the Standard Operation Procedure (SOP), and continue the activities to obtain official accreditation such as ISO/IEC17025. 3) Enforcement capacity of the targeted counterpart organizations on water quality monitoring including inspection, pollution sources inventory (PSI), and the Environmental Protection License (EPL) scheme, is strengthened. <3-1> Water quality monitoring including inspection 3-1-1: Review the current water quality monitoring conditions including inspection and identify CD needs. 3-1-2: Establish a WG, prepare a task matrix of activities, and agree on the specific CD plan. 3-1-3: Conduct CD activities including preparation of annual planning, sampling, reporting, and feedback to other WGs. 3-1-4: Analyze and evaluate monitoring results including inspection and prepare an annual report on the Kelani river basin. 3-1-5: Prepare a monitoring guideline including for rivers in Sri Lanka. <3-2> Pollution Source Inventory (PSI) 3-2-1: Review the current PSI conditions, and identify CD needs. 3-2-2: Establish a WG, prepare a task matrix of activities, and agree on the specific CD plan. 3-2-3: Conduct CD activities including format preparation,	1) Expert Team -Team Leader/ Water Quality Management -Water Quality Analysis -Environmental Monitoring -Pollution Sources Inventory -Inspection -Data and Information Management/ Data Base -Coordinator 2) Seminars and Workshops 3) Training in Japan 4) Equipment Necessary for Project Activities 5) Pilot Projects 6) Local Consultants for Sub-contract Works	1) Counterpart (C/P) Personnel -CEA and concerned Departments -Regional Branch Offices 2) Project Office Space at CEA 3) Budget Allocation for Salary and other Expenditure for C/P during the Project Period. 4) Budget Allocation for Running cost of Equipment procured under the Project	

annual planning, reporting, and data sharing with other WGs.
3-2-4: Manage and use PSI data in collaboration with other organizations.
3-2-5: Prepare a PSI guideline for rivers in Sri Lanka.

<3-3> Promotion of EPL scheme and effluent water quality standards for existing industries in the Kelani river basin
3-3-1: Review the current situation of EPL scheme and effluent water quality standard in the Kelani river basin, and identify principal issues to be improved.
3-3-2: Establish a WG, prepare a task matrix of activities, and agree on the specific capacity CD plan.
3-3-3: Conduct CD activities including the development of necessary tools and materials, and implement it in the Kelani river basin as a pilot project.
3-3-4: Prepare a guidance for promoting EPL and effluent water quality standards.

4) Information management system of the water quality monitoring data including inspection, EPL data, and PSI data, on inland surface water bodies are developed and effectively used.
4-1: Review the current information management situation of the water quality monitoring data including inspection, EPL data, and PSI data, on inland surface water bodies, and identify principal issues to be improved.
4-2: Establish a WG, prepare a task matrix of activities, and agree on the specific CD plan.
4-3: Conduct CD activities including development of data base (DB), and implement it in the Kelani river basin as a pilot project.
4-4: Prepare a guidance for promoting the developed information management system in Sri Lanka.

Pre-Conditions

A project budget (Sri Lankan portion) is secured in a Sri Lankan side.
CEA assigns necessary staffs for implementation of the Project.

<Issues and countermesures>

Annex II

Version 1

Dated 10, Nov, 2014

Tentative Plan of Operation

Project Title: The Project for Monitoring of the Water Quality of Major Water Bodies

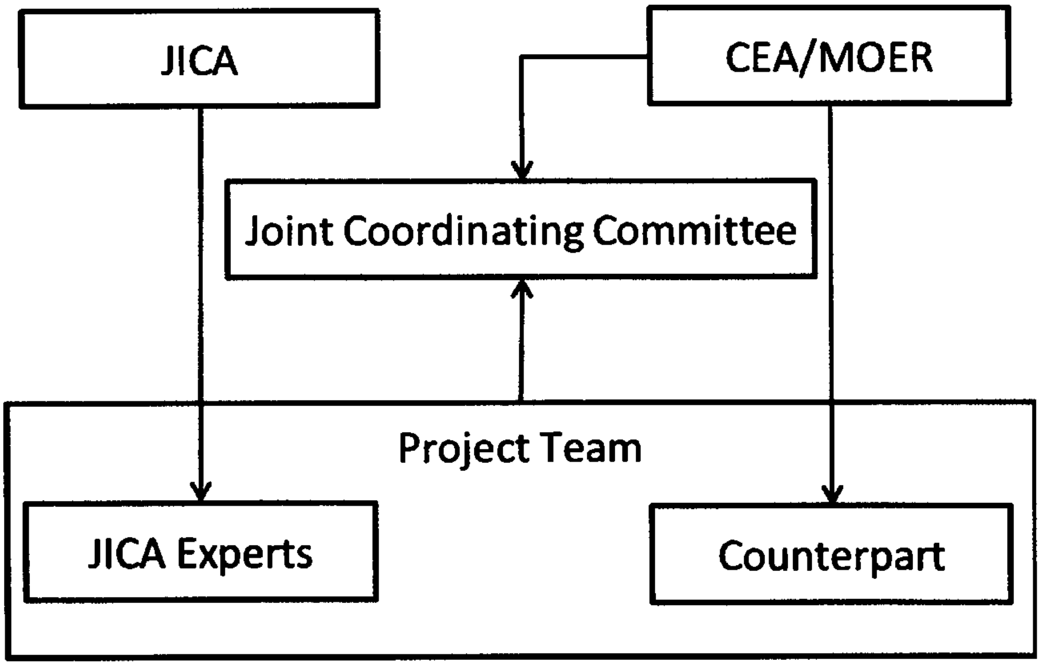
Inputs	Year	1st Year I	1st Year II	1st Year III	1st Year IV	2nd Year I	2nd Year II	2nd Year III	2nd Year IV	3rd Year I	3rd Year II	3rd Year III	3rd Year IV	Remarks	Monitoring: Issue	Monitoring: Solution
Expert																
Team Leader/ Water Quality Management	Plan															
	Actual															
Water Quality Analysis	Plan															
	Actual															
Environmental Monitoring	Plan															
	Actual															
Pollution Sources Inventory	Plan															
	Actual															
Inspection	Plan															
	Actual															
Data and Information Management/ Data Base	Plan															
	Actual															
Coordinator	Plan															
	Actual															
Equipment																
	Plan															
	Actual															
	Plan															
	Actual															
	Plan															
	Actual															
	Plan															
	Actual															
	Plan															
	Actual															
Training in Japan																
Training for Counterpart Personnel	Plan															
	Actual															
In-country/Third country Training																
Third country training for Counterpart Personnel	Plan															
	Actual															

Activities	Year	1st Year I	1st Year II	1st Year III	1st Year IV	2nd Year I	2nd Year II	2nd Year III	2nd Year IV	3rd Year I	3rd Year II	3rd Year III	3rd Year IV	Responsible Organization: Japan	Responsible Organization: GOSL	Achievements	Issue & Countermeasu
Output 1: The introduction of water body categorization in line with the ambient water quality standard in Sri Lanka are set-up.																	
1-1: Review the current legal and institutional level and implementation system.	Plan													JICA	CEA		
	Actual																
1-2: Clarify current situations and issues on management and compliance of the ambient water quality standard.	Plan													JICA	CEA		
	Actual																
1-3: Establish a working group (WG), identify capacity development (CD) needs, and agree a task matrix of activities.	Plan													JICA	CEA		
	Actual																
1-4: Conduct CD activities, develop materials for categorization, and conduct its trial practices in selected rivers.	Plan													JICA	CEA		
	Actual																
1-5: Prepare a set of guidelines for introducing the categorization based on trial practices and lessons learned.	Plan													JICA	CEA		
	Actual																
Output 2: Water quality analysis capacity of lab staff is strengthened.																	
2-1: Review the current situation and level of central and regional labs in CEA.	Plan													JICA	CEA		
	Actual																
2-2: Establish a WG and agree the specific CD plan including water quality analysis and operation and maintenance (O&M) of equipment.	Plan													JICA	CEA		
	Actual																
2-3: Conduct CD activities, develop the Standard Operation Procedure (SOP), and continue the activities to obtain official accreditation such as ISO/IEC17025.	Plan													JICA	CEA		
	Actual																

Output 3: Enforcement capacity of the targeted counterpart organizations on water quality monitoring including inspection is strengthened, pollution sources inventory (PSI) is created, and acquisition of the Environmental Protection License (EPL) is promoted.					
Output 3.1: Water quality monitoring including inspection					
3-1-1: Review the current water quality monitoring conditions including inspection and identify CD needs.	Plan	JICA	CEA		
	Actual				
3-1-2: Establish a WG, prepare a task matrix of activities, and agree on the specific CD plan.	Plan	JICA	CEA		
	Actual				
3-1-3: Conduct CD activities including preparation of annual planning, sampling, inspecting, reporting, and feedback to other WGs.	Plan	JICA	CEA		
	Actual				
3-1-4: Analyze and evaluate monitoring results including inspection and prepare an annual report on the Kelani river basin.	Plan	JICA	CEA		
	Actual				
3-1-5: Prepare a monitoring guideline including inspection for rivers in Sri Lanka.	Plan	JICA	CEA		
	Actual				
Output 3-2: Pollution Source Inventory (PSI)					
3-2-1: Review the current PSI conditions, and identify CD needs.	Plan	JICA	CEA		
	Actual				
3-2-2: Establish a WG, prepare a task matrix of activities, and agree on the specific CD plan.	Plan	JICA	CEA		
	Actual				
3-2-3: Conduct CD activities including format preparation, annual planning, reporting, and data sharing with other WGs.	Plan	JICA	CEA		
	Actual				
3-2-4: Manage and use PSI data in collaboration with other organizations.	Plan	JICA	CEA		
	Actual				
3-2-5: Prepare a PSI guideline for rivers in Sri Lanka.	Plan	JICA	CEA		
	Actual				
Output 3-3: Promotion of EPL scheme and effluent water quality standards for exisiting industries in the Kelani river basin.					
3-3-1: Review the current situation of EPL scheme and effluent water quality standard in the Kelani river basin, and identify principal issues to be improved.	Plan	JICA	CEA		
	Actual				
3-3-2: Establish a WG, prepare a task matrix of activities, and agree on the specific capacity CD plan.	Plan	JICA	CEA		
	Actual				
3-3-3: Conduct CD activities including the development of necessary materials, and implement it in the Kelani river basin as a pilot project.	Plan	JICA	CEA		
	Actual				
3-3-4: Prepare a guidance for promoting EPL and effluent water quality standards.	Plan	JICA	CEA		
	Actual				
Output 4: Information management system of the water quality monitoring data, EPL data, PSI data, and inspection data on inland surface water bodies are developed and effectively used.					
4-1: Review the current information management situation of the water quality monitoring data including inspection, EPL data, and PSI data, on inland surface water bodies, and identify principal issues to be improved.	Plan	JICA	CEA		
	Actual				
4-2: Establish a WG, prepare a task matrix of activities, and agree on the specific CD plan.	Plan	JICA	CEA		
	Actual				
4-3: Conduct CD activities including development of data base (DB), and implement it in the Kelani river basin as a pilot project.	Plan	JICA	CEA		
	Actual				
4-4: Prepare a guidance for promoting the developed information management system in Sri Lanka	Plan	JICA	CEA		
	Actual				
Duration / Phasing	Plan				
	Actual				

Monitoring Plan		Year	1st Year				2nd Year				3rd Year				Remarks	Issue	Solution
			I	II	III	IV	I	II	III	IV	I	II	III	IV			
Monitoring																	
	Joint Coordinating Committee (JCC)	Plan	●	●			●		●		●		●				
		Actual															
	Set-up the Detailed Plan of Operation	Plan	▲														
		Actual															
	Submission of Monitoring Sheet	Plan															
		Actual															
	Monitoring Mission from Japan (mid-term and terminal evaluation)	Plan		■					■				■				
		Actual															
	Joint Monitoring	Plan															
		Actual															
	Post Monitoring	Plan															
		Actual															
Reports/Documents																	
	Inception Report	Plan	▲														
		Actual															
	Progress Report	Plan				▲				▲							
		Actual															
	Training Materials	Plan															
		Actual															
	Project Completion Report	Plan												▲			
		Actual															
Public Relations																	
	Establishment and Operation of web site	Plan															
		Actual															
	Materials for public relations related the water quality monitoring and management	Plan															
		Actual															
	Seminar for Public at Colombo City	Plan															
		Actual															

Annex III　Project Organization Chart



Annex IV A List of Proposed Members of Joint Coordinating Committee

1. Functions

A Joint Coordinating Committee will be organized and notified. The committee meeting will be held at least once a year and whenever need arises.

The functions of the Committee are as follows:

1) To supervise the annual work plan of the Project in line with the Plan of Operations.
2) To review the annual and overall progress of the Project and to evaluate the accomplishment of the annual targets and achievement of the objectives.
3) To identify proper ways and means to solve the major issues arising from or in connection with the Project.

2. Composition

1) Chairperson:
Secretary, MOER

2) Members of Sri Lanka side:
Director General of CEA
The Deputy Director General of Environmental Pollution Control Division, CEA
The Director of Environmental Pollution Control Unit, CEA
The Director of Water Quality Monitoring Lab, CEA
The Director of Planning and Monitoring Unit, CEA
The Director of Research and Development Unit, CEA
The Director of Environmental Education & Awareness Unit, CEA
The Director of Human Resource Development Unit, CEA
The Director of Legal Unit, CEA
The Director of Natural Resource Management Unit, CEA
The Director of Western Provincial Office, CEA
The Director (Policy and Planning) of MOER
The representative of Ministry of Industry and Commerce
The representative of Board of Investment
Official(s) of the representative of Ministry of Finance and Planning

*Other personnel concerned, to be assigned by Chairperson of JCC, if necessary

3) Members of the Japanese Side:
Representative of JICA
JICA Experts
Other personnel concerned, to be assigned by JICA, if necessary

4) Observer

The representative of Ministry of Economic Development

Note:

The Embassy of Japan in Sri Lanka may attend as observer(s).

Annex V Tentative List of Machinery and Equipment

1. Equipment

-Water deionization System
-Water Sampler- to collect water sample from different depth with bottle
-Sediment Sampler- Ekman Verge Soil Sampler
-Microwave Digester for digestion of effluent and sludge and soil for heavy metals
-UV Visible Spectrophotometer (N, P, F, S)
-Chemical Oxygen Demand measuring Equipment
-Multi parameter Water Quality Checker pH, EC, Turbidity, Temp, ORP/ depth, TDS
-Centrifuge
-Acid Alkali/Flammable Storage Cabinet
-BOD measuring DO Meter
-Fume Hood
-Potable water testing kits to use for awareness program
-Laminar flow clean benches

2. Chemicals

-Filter paper Diameter 15.0 cm grade 1 for qualitative analysis Whatman
-Filter paper Diameter 9.0 cm grade 1 for qualitative analysis Whatman
-Filter papers Glass Fiber GF/C Circle diameter 70 mm (Whatman)
-Glutamic Acid
-Glucose
-Hexane
-Activated Charcoal
-Heavy oil standard for Oil & grease analysis

3. Glassware

-Bottles, BOD
-Burettes 50 ml
-Laboratory Jack with support rod with approximately 45cm long
-Pipettes Fillers Universal Type high Quality
-Laboratory gas cylinder handling trolley with tires
-Complete Distillation Set Up including Condenser -Liebig 400 mm, Still head used for distillation assemble for connecting flasks to condenser and thermometers (socket size to thermometer)14/23, Receiving Flask (Flat bottom) 500 ml Distillation Flask 500 ml, Quick fit Thermometer(14/23), and Connector to the receiving flask 24/29
-Funnel Holder
-Sample Carrying Boxes
-Pipette Holders
-Automatic Dispensers

Annex VI List of Counterparts

1) CEA
Director General

2) Environmental Pollution Control Division, CEA
Deputy Director General
Director
Deputy Director
Assistant Director
Senior Environmental Officer (4)
Environmental Officer (2)

3) Water Quality Monitoring Lab, CEA
Director
Deputy Director
Assistant Director
Chemist (4)
Laboratory Assistant (3)
Environmental Officer (3)

4) Two (2) District office in Western Province, CEA
Director
Deputy Director
Assistant Director
Senior Environmental Officer
Division Environmental Officer

5) Planning and Monitoring Unit
Director

6) Information Technology Unit CEA
Program Analyst

7) Policy and Planning Division of MOER
Director
Assistant Director

Appendix 2

MAIN POINTS DISCUSSED

1. Contents of the pilot project

Both sides understood the necessity to improve the current EPL scheme which has been not effective for the prevention of water pollution. Based on the mutual understanding, both sides basically agreed to develop new tools for an effective EPL scheme through the implementation of a pilot project, such as disclosing information on the names of factories and business entities that obtain EPL and not, introducing a performance rating system of factories and business entities, and suspending conquest for renewal. Detailed contents and target areas of the pilot project will be determined within 6 months after the Project starts.

2. The Concept of the Project

The Team explained to the Sri Lankan side about the basic concept of the JICA's technical cooperation project and the difference of schemes between the development study and the technical cooperation project. Additionally, the Team explained that the Sri Lankan side shall take necessary measures to ensure that they take the initiative of the Project during and after the period of Japanese technical cooperation, through full and active involvement in the Project by all related authorities, beneficiary groups and institutions. The Sri Lankan side understood the explanation and both sides agreed that the Sri Lankan side would take the ownership in executing the Project.

3. Allocation of Personnel

CEA will assign a suitable number of counterpart personnel to ensure an effective implementation of the Project. The list of counterparts is attached as Annex VI of the R/D.

4. Office space

CEA will provide furnished and air-conditioned office spaces in CEA, which can accommodate up to ten (10) persons in CEA for the smooth implementation of the Project.

5. Providing necessary information

CEA will coordinate with the related Sri Lankan authorities to collect necessary information to support the Project such as maps, data and standards, etc.

付属資料 2　プロジェクト・デザイン・マトリックス

Project Design Matrix

Project Title: The Project for Monitoring of the Water Quality of Major Water Bodies — Dated 10, Nov, 2014 Ver.1
Implementing Agency: Central Environmental Authority (CEA) — Period of Project: 3 years (tentative)
Target Group: Ministry of Environment (MOE)/Central Environmental Authority (CEA)/ Environmental Pollution Control (EPC) Division, Water Quality Monitoring Lab, Planning Management Unit and target Departments of regional branch offices in CEA Project Site: Sri Lanka Model Site: Kelani River

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
Overall Goal: Water quality management in major water bodies is appropriately implemented by CEA	OG1 The by-laws and/or regulations which stipulate roles and functions of a water quality management system are inaugurated by 2020. OG2 The rate of water bodies with improved water quality monitoring results implemented by CEA increases by 2020 compared with the initial stage of the Project. OG3 The number of major water bodies which introduce the water quality environmental management system are more than xxx in Sri Lanka by2020 in accordance with the guidelines prepared by the Project.	1. Data and documents in CEA and its regional branch offices	The principal policy prescribed in the National Environmental Act for water quality management in Sri Lanka is not negatively changed.
Project Purpose: Enforcement capacity of CEA and its regional branch offices of the Kelani river basin on water quality management is strengthened.	PP1 CEA conducts self-evaluation on their own capacity of policy and system making regarding water quality management such as nos. of proposals related to gazetting ambient water quality standards, introduction of ambient water quality zoning and categorization system, improvement of current EPL system, etc. based on the National Environmental Act (No.47 of 1980) and other related by-laws, and its evaluation results show improvement, compared with the initial stage of the Project. PP2 CEA, concerned departments, and regional branch offices conduct self-evaluation on their own enforcement capacity of water quality management such as nos. of guidance to factories, nos. of penalty case, etc. based on the National Environmental Act (No.47 of 1980) and other concerned by-laws, and its evaluation results show improvement, compared with the initial stage of the Project. PP3 The guidelines and other outputs developed through the Project are properly applied by all concerned departments and regional offices of CEA in charge for a nationwide promotion of water quality management. PP4 The number of major water bodies and regional governments which introduce zoning categorization of ambient water quality standard are more than xxx in Sri Lanka. PP5 More than xxx guidelines and materials on zoning and categorization are developed and used. PP6 More than xxx times of guidance are conducted by CEA to organizations which have responsibility for water quality management of target water bodies. PP7 More than xxx % of staff in the concerned departments and regional offices of CEA in charge can explain how to use the guidelines and other outputs developed through the Project.	1. Questionnaire survey for CEA, concerned departments, and regional branch offices at the initial, mid-term, and final stage of the Project 2. ditto 3. Data and documents in CEA, concerned departments, and regional branch offices 4. ditto 5. Actual nos. of guidelines and materials 6. Guidance record to target organizations and the result of the review test 7. Hearing and evaluation survey to target organizations	The principal policy for water quality management of CEA related to institution and budget for its implementation is not negatively changed. All related organizations in CEA and regional governments are active in promoting water quality management.
Outputs: Output 1: The introduction of water body categorization in line with the ambient water quality standard in Sri Lanka are set-up.	1-1 More than xxx reference monitoring points of ambient water quality standard are designated 1-2 A proposal for introducing ambient water quality zoning and categorization is prepared based on trial results in the Kelani river. 1-3 More than xxx (or xxx %) of major water bodies have introduced zoning and categorization system in Sri Lanka	1. Data and documents in CEA, concerned departments, and regional branch offices	
Output 2: Water quality analysis capacity of lab staff is strengthened.	2-1 Nos. of lab staff who have sufficient analysis capability are more than xxx persons in the target labs 2-2 More than xxx samples are analyzed annually 2-3 Equipment and instruments including reagents are properly operated and maintained 2-4 More than xxx times of good lab practices and QA/QC activities are conducted annually 2-5 Target labs obtain more than xxx of accreditation certificates of water quality analysis for basic water quality substances from the reference lab in Sri Lanka 2-6 Target labs obtain accreditation certificate of ISO/IEC 17025 from the authorized accreditation organization	1. Actual nos. of staff, data, documents, and records 2. SOPs developed 3. O/M ledgers such as results of QA/QC activities, procurement record of spare parts and reagents, and record of periodic calibration and maintenance 4. Hearing and evaluation survey 5. Nos. of water quality analysis certificates obtained from the reference lab in Sri Lanka 6. Accreditation certificate of ISO/IEC 17025 from the authorized accreditation organization	

Output 3: Enforcement capacity of the targeted counterpart organizations on water quality monitoring including inspection is strengthened, pollution sources inventory (PSI) is created, and acquisition of the Environmental Protection License (EPL) is promoted.	3-1 Water quality monitoring including inspection 3-1-1 More than xxx times of cooperating and sharing meetings among concerned organizations are carried out 3-1-2 Monitoring plans and reports including inspection, and analysis and evaluation of monitoring results including inspection in 2016 and 2017, are prepared by target departments, and shared with concerned departments and organizations 3-1-3 More than xxx times of sampling and water quality analysis are conducted in the ambient standard points 3-1-4 More than xxx times of workshops are conducted for sharing monitoring data and analysis results including inspection with concerned departments 3-1-5 Monitoring guideline including inspection for rivers in Sri Lanka is prepared 3-1-6 Level of enforcement capacity on water quality monitoring including inspection is improved 3-1-7 All violation cases revealed through monitoring including inspection are reported to the Legal Unit of CEA	1. Annual monitoring plan and report including inspection prepared 2. Actual nos. of monitoring data, documents, and records including inspection 3. Documents and records of workshops conducted 4. Monitoring guideline including inspection prepared 5. Comparison of capacity assessment results conducted at initial stage, mid-term evaluation, and terminal evaluation of the Project 6. Violation case records received by the Legal Unit of CEA	
	3-2 Pollution Source Inventory (PSI) 3-2-1 More than xxx times of cooperating and sharing meetings among concerned organizations are carried out 3-2-2 More than xxx of PSI data are prepared targeting major pollution sources in the Kelani river basin 3-2-3 More than xxx % of major pollution sources in the Kelani river basin are identified and recorded on PSI Data Base (DB) 3-2-4 More than xxx % of PSI data are up-dated by follow-up activities 3-2-5 More than xxx times of PSI sharing meetings are held among concerned departments that manage and use PSI data 3-2-6 Level of enforcement capacity on PSI preparation is improved	1. PSI data prepared 2. PSI data up-dated and records of follow-up activities 3. Documents and records of PSI sharing meetings 4. Comparison of capacity assessment results conducted at initial stage, mid-term evaluation, and terminal evaluation of the Project	
	3-3 Promotion of EPL scheme and effluent water quality standards for existing industries in the Kelani river basin 3-3-1 More than xxx times of monitoring including inspection are conducted in Kelani river basin using guideline guidebook developed 3-3-2 Monitoring including inspection are conducted more than xxx % of major pollution sources in Kelani river basin using guideline developed 3-3-3 Method for selecting crusial pollution sources in Kelani river basin are developed and its result is reflected on the monitoring plan including inspection 3-3-4 Acquisition of EPL is more than xxx % in the Kelani river basin 3-3-5 Guidance for promoting EPL and effluent quality standard is prepared 3-3-6 Illegal and/ or EPL-violating factories are reported to the authorities for sanction	1. Actual nos. of data, documents, and records related to EPL conducted in the Kelani river basin 2. Actual nos. of monitoring data and records including inspection in the Kelani river basin 3. Guideline prepared and its usage record 4. Reports and records prepared and informed	
Output 4: Information management system of the water quality monitoring data including inspection, EPL data, and PSI data, on inland surface water bodies are developed and effectively used	4-1 More than xxx times of working group discussion meetings are carried out. 4-2 Data Base (DB) including EPL data for information management system is developed by web-base, and used by concerned organizations. 4-3 Input data is properly up-dated annually 4-4 Guidance for promoting information management system in Sri Lanka is prepared 4-5 Annual report is prepared and shared with concerned organizations.	1. Actual nos. of data, documents, and records concerning to information management 2. Conditions of DB and its usage record 3. Up-dated data and conditions 4. Guidance prepared and its usage record 5. Activity record of pilot project, and comparison of capacity assessment results conducted at initial stage, mid-term evaluation, and terminal evaluation of the Project 6. Prepared annual report and record of its sharing conditions	

Activities	Inputs		Important Assumption
1) The introduction of water body categorization in line with the ambient water quality standard in Sri Lanka are set-up. 1-1: Review the current legal and institutional level and implementation system. 1-2: Clarify current situations and issues on management and compliance of the ambient water quality standard. 1-3: Establish a working group (WG), identify capacity development (CD) needs, and agree a task matrix of activities. 1-4: Conduct CD activities, develop tools and materials for categorization, and conduct its trial practices in selected rivers. 1-5: Prepare a set of guidelines for introducing the categorization based on trial practices and lessons learned.	The Japanese Side 1) Expert Team - Team Leader/ Water Quality Management - Water Quality Analysis - Environmental Monitoring - Pollution Sources Inventory - Inspection - Data and Information Management/ Data Base - Coordinator 2) Seminars and Workshops 3) Training in Japan 4) Equipment Necessary for Project Activities 5) Pilot Projects 6) Local Consultants for Sub-contract Works	The Sri Lankan Side 1) Counterpart (C/P) Personnel - CEA and concerned Departments - Regional Branch Offices 2) Project Office Space at CEA 3) Budget Allocation for Salary and other Expenditure for C/P during the Project Period. 4) Budget Allocation for Running cost of Equipment procured under the Project	
2) Water quality analysis capacity of lab staff is strengthened. 2-1: Review the current situation and level of central and regional labs in CEA. 2-2: Establish a WG and agree the specific CD plan including water quality analysis and operation and maintenance (O&M) of equipment. 2-3: Conduct CD activities, develop the Standard Operation Procedure (SOP), and continue the activities to obtain official accreditation such as ISO/IEC17025.			
3) Enforcement capacity of the targeted counterpart organizations on water quality monitoring including inspection, pollution sources inventory (PSI), and the Environmental Protection License (EPL) scheme, is strengthened. **<3-1> Water quality monitoring including inspection** 3-1-1: Review the current water quality monitoring conditions including inspection and identify CD needs. 3-1-2: Establish a WG, prepare a task matrix of activities, and agree on the specific CD plan. 3-1-3: Conduct CD activities including preparation of annual planning, sampling, reporting, and feedback to other WGs. 3-1-4: Analyze and evaluate monitoring results including inspection and prepare an annual report on the Kelani river basin. 3-1-5: Prepare a monitoring guideline including for rivers in Sri Lanka. **<3-2> Pollution Source Inventory (PSI)** 3-2-1: Review the current PSI conditions, and identify CD needs. 3-2-2: Establish a WG, prepare a task matrix of activities, and agree on the specific CD plan. 3-2-3: Conduct CD activities including format preparation, annual planning, reporting, and data sharing with other WGs. 3-2-4: Manage and use PSI data in collaboration with other organizations. 3-2-5: Prepare a PSI guideline for rivers in Sri Lanka. **<3-3> Promotion of EPL scheme and effluent water quality standards for existing industries in the Kelani river basin** 3-3-1: Review the current situation of EPL scheme and effluent water quality standard in the Kelani river basin, and identify principal issues to be improved. 3-3-2: Establish a WG, prepare a task matrix of activities, and agree on the specific capacity CD plan. 3-3-3: Conduct CD activities including the development of necessary tools and materials, and implement it in the Kelani river basin as a pilot project. 3-3-4: Prepare a guidance for promoting EPL and effluent water quality standards.			
4) Information management system of the water quality monitoring data including inspection, EPL data, and PSI data, on inland surface water bodies are developed and effectively used. 4-1: Review the current information management situation of the water quality monitoring data including inspection, EPL data, and PSI data, on inland surface water bodies, and identify principal issues to be improved. 4-2: Establish a WG, prepare a task matrix of activities, and agree on the specific CD plan. 4-3: Conduct CD activities including development of data base (DB), and implement it in the Kelani river basin as a pilot project. 4-4: Prepare a guidance for promoting the developed information management system in Sri Lanka.			**Pre-Conditions** A project budget is secured in a Sri Lankan side. CEA assigns necessary staffs for implementation of the Project. <Issues and countermeasures>

Project Design Matrix

Project Title: The Project for Monitoring of the Water Quality of Major Water Bodies — Dated 29, May, 2015 Ver.2
Implementing Agency: Central Environmental Authority (CEA) — Period of Project: 3 years (tentative)
Target Group: Ministry of Mahaweli Development & Environment /Central Environmental Authority (CEA)/ Environmental Pollution Control (EPC) Division, Laboratory Service and target Departments of regional branch offices in CEA — Project Site: Sri Lanka — Model Site: Kelani river

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
Overall Goal: Water quality management in major water bodies is appropriately implemented by CEA	OG1 The by-laws and/or regulations which stipulate roles and functions of a water quality management system are inaugurated by 2020. OG2 The ratio of water bodies assessed/ managed by CEA by using improved water quality monitoring methods (system/ procedure) increases by 2020 compared with the initial stage of the Project. OG3 The number of major water bodies with proposed the water quality environmental management system are at least one (1) in Sri Lanka by 2020 in accordance with the guidelines prepared by the Project.	1. Data and documents in CEA and its regional branch offices	The principal policy prescribed in the National Environmental Act for water quality management in Sri Lanka is not negatively changed.
Project Purpose: Enforcement capacity of CEA and its regional branch offices of the Kelani river basin on water quality management is strengthened.	PP1 CEA conducts self-evaluation on their own capacity of policy and system making regarding water quality management such as nos. of proposals related to gazetting ambient water quality standards, introduction of ambient water quality zoning and categorization system, improvement of current EPL system, etc. based on the National Environmental Act (No.47 of 1980) and other related by-laws, and its evaluation results show improvement, compared with the initial stage of the Project. PP2 CEA, concerned departments, and regional branch offices conduct self-evaluation on their own enforcement capacity of water quality management such as nos. of guidance to EPL holders (factories), nos. of penalty case, etc. based on the National Environmental Act (No.47 of 1980) and other concerned by-laws, and its evaluation results show improvement, compared with the initial stage of the Project. PP3 The guidelines and other outputs developed through the Project are properly applied by all concerned departments and regional offices of CEA in charge for a nationwide promotion of water quality management. PP4 The number of major water bodies and regional governments which propose zoning categorization of ambient water quality standard is at least one (1) in Sri Lanka. PP5 One (1) guideline and materials on zoning and categorization are developed and used. PP6 More than 2 times of guidance are conducted by CEA to organizations which have responsibility for water quality management of target water bodies. PP7 More than 70 % of staff in the concerned departments and regional offices of CEA in charge can explain how to use the guidelines and other outputs developed through the Project.	1. Questionnaire survey for CEA, concerned departments, and regional branch offices at the initial, mid-term, and final stage of the Project 2. ditto 3. Data and documents in CEA, concerned departments, and regional branch offices 4. ditto 5. Actual nos. of guidelines and materials 6. Guidance record to target organizations and the result of the review test 7. Hearing and evaluation survey to target organizations	The principal policy for water quality management of CEA related to institution and budget for its implementation is not negatively changed. All related organizations in CEA and regional governments are active in promoting water quality management.
Outputs: Output 1: The introduction of water body categorization in line with the ambient water quality standard in Sri Lanka are set-up.	1-1 More than 9 reference monitoring points of ambient water quality standard are designated. 1-2 A proposal for introducing ambient water quality zoning and categorization is prepared based on trial results in the Kelani river. 1-3 At least one (1) of major water bodies proposes zoning and categorization system in Sri Lanka.	1. Data and documents in CEA, concerned departments, and regional branch offices	
Output 2: Water quality analysis capacity of lab staff is strengthened.	2-1 Nos. of lab staff who have sufficient analysis capability are more than 7 persons in the target labs. 2-2 More than 1,200 samples are analyzed annually. 2-3 Equipment and instruments including reagents are properly operated and maintained. 2-4 More than 12 types of QA/QC activities are conducted by the end of the Project. 2-5 The CEA lab obtains accreditation certificates for more than 2 water quality parameters from the SLAB.	1. Proficiency test results using unknown concentration samples (staff at provincial offices are included.) 2. Actual nos. of samples analyzed 3. SOPs developed, Relevant records 4. Reports/ Documents/ Relevant Records 5. Accreditation certificate of ISO/IEC 17025 from the SLAB	
Output 3: Enforcement capacity of the targeted counterpart	**3-1 Water quality monitoring including inspection** 3-1-1 More than 10 times of cooperating and sharing meetings among concerned	1. Annual monitoring plan and report including	

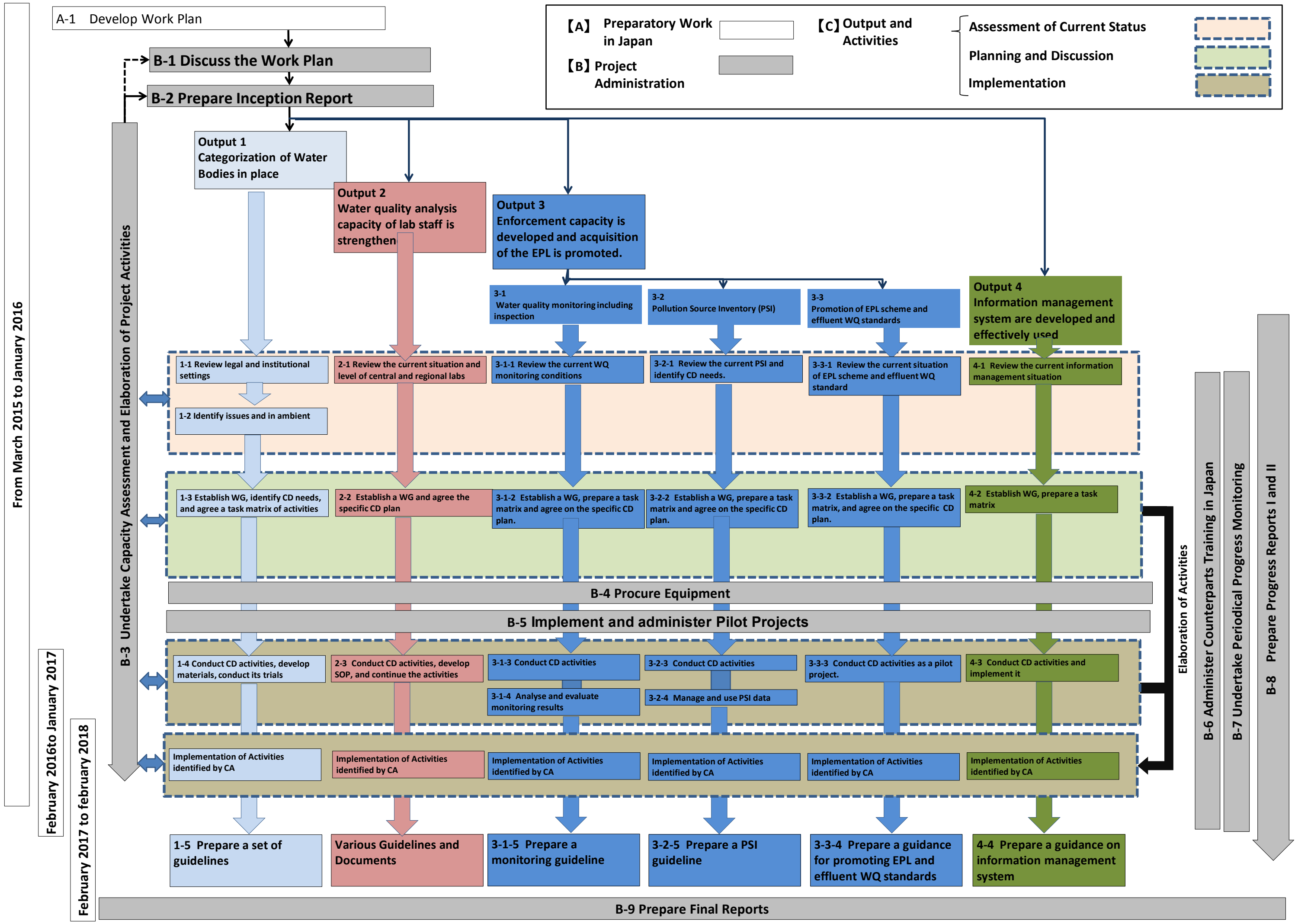
Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
organizations on water quality monitoring including inspection is strengthened, pollution sources inventory (PSI) is created, and acquisition of the Environmental Protection License (EPL) is promoted.	organizations are carried out. 3-1-2 Monitoring plans and reports including inspection, and analysis and evaluation of monitoring results including inspection in 2016 and 2017, are prepared by target departments, and shared with concerned departments and organizations. 3-1-3 More than 10 times of sampling and water quality analysis are conducted in the ambient standard points. 3-1-4 More than 6 times of workshops are conducted for sharing monitoring data and analysis results including inspection with concerned departments. 3-1-5 Monitoring guideline including inspection for rivers in Sri Lanka is prepared. 3-1-6 Level of enforcement capacity on water quality monitoring including inspection is improved. 3-1-7 All violation cases revealed through monitoring including inspection are reported to the Legal Unit of CEA.	inspection prepared 2. Actual nos. of monitoring data, documents, and records including inspection 3. Documents and records of workshops conducted 4. Monitoring guideline including inspection prepared 5. Comparison of capacity assessment results conducted at initial stage, mid-term evaluation, and terminal evaluation of the Project 6. Violation case records received by the Legal Unit of CEA	
	3-2 Pollution Source Inventory (PSI) 3-2-1 More than 10 times of cooperating and sharing meetings among concerned organizations are carried out. 3-2-2 More than 3200of PSI data are prepared targeting major pollution sources in the Kelani river basin. More than 9,800 of PSI data are prepared targeting major pollution sources in Sri Lanka. 3-2-3 More than 70 % of major pollution sources in the Kelani river basin are identified and recorded on PSI Database (DB). 3-2-4 More than 85 % of PSI data are up-dated by follow-up activities. 3-2-5 More than 6 times of PSI sharing meetings are held among concerned departments that manage and use PSI data. 3-2-6 Level of enforcement capacity on PSI preparation is improved.	1. PSI data prepared 2. PSI data up-dated and records of follow-up activities 3. Documents and records of PSI sharing meetings 4. Comparison of capacity assessment results conducted at initial stage, mid-term evaluation, and terminal evaluation of the Project	
	3-3 Promotion of EPL scheme and effluent water quality standards for existing industries in the Kelani river basin 3-3-1 More than 15 times of monitoring including inspection are conducted in the Kelani river basin using guideline guidebook developed. 3-3-2 Monitoring including inspection are conducted more than 80 % of major pollution sources in the Kelani river basin using guideline developed. 3-3-3 Method for selecting crucial pollution sources in the Kelani river basin are developed and its result is reflected on the monitoring plan including inspection. 3-3-4 Acquisition of EPL is increase more than 2 % in actual condition in the Kelani river basin 3-3-5 Guidance for promoting EPL and effluent quality standard is prepared. 3-3-6 Illegal and/ or EPL-violating factories are reported to the authorities for sanction.	1. Actual nos. of data, documents, and records related to EPL conducted in the Kelani river basin 2. Actual nos. of monitoring data and records including inspection in the Kelani river basin 3. Guideline prepared and its usage record 4. Reports and records prepared and informed	
Output 4: Information management system of the water quality monitoring data including inspection, EPL data, and PSI data, on inland surface water bodies are developed and effectively used	4-1 More than 10 times of working group discussion meetings are carried out. 4-2 Database (DB) including EPL data for information management system is developed by web-base, and used by concerned organizations. 4-3 Input data is properly up-dated annually. 4-4 Guidance for promoting information management system in Sri Lanka is prepared. 4-5 Annual report is prepared and shared with concerned organizations.	1. Actual nos. of data, documents, and records concerning to information management 2. Conditions of DB and its usage record 3. Up-dated data and conditions 4. Guidance prepared and its usage record 5. Activity record of pilot project, and comparison of capacity assessment results conducted at initial stage, mid-term evaluation, and terminal evaluation of the Project 6. Prepared annual report and record of its sharing conditions	

Activities	Inputs		Important Assumption
	The Japanese Side	The Sri Lankan Side	
1) The introduction of water body categorization in line with the ambient water quality standard in Sri Lanka are set-up. 1-1: Review the current legal and institutional level and implementation system. 1-2: Clarify current situations and issues on management and compliance of the ambient water quality standard. 1-3: Establish a working group (WG), identify capacity development (CD) needs, and agree a task matrix of activities. 1-4: Conduct CD activities, develop tools and materials for categorization, and conduct its trial practices in selected rivers. 1-5: Prepare a set of guidelines for introducing the categorization based on trial practices and lessons learned. **2) Water quality analysis capacity of lab staff is strengthened.** 2-1: Review the current situation and level of central and regional labs in CEA. 2-2: Establish a WG and agree the specific CD plan including water quality analysis and operation and maintenance (O&M) of equipment. 2-3: Conduct CD activities, develop the Standard Operation Procedure (SOP), and continue the activities to obtain official accreditation such as ISO/IEC17025. **3) Enforcement capacity of the targeted counterpart organizations on water quality monitoring including inspection, pollution sources inventory (PSI), and the Environmental Protection License (EPL) scheme, is strengthened.** <3-1> Water quality monitoring including inspection 3-1-1: Review the current water quality monitoring conditions including inspection and identify CD needs. 3-1-2: Establish a WG, prepare a task matrix of activities, and agree on the specific CD plan. 3-1-3: Conduct CD activities including preparation of annual planning, sampling, reporting, and feedback to other WGs. 3-1-4: Analyze and evaluate monitoring results including inspection and prepare an annual report on the Kelani river basin. 3-1-5: Prepare a monitoring guideline including for rivers in Sri Lanka. <3-2> Pollution Source Inventory (PSI) 3-2-1: Review the current PSI conditions, and identify CD needs. 3-2-2: Establish a WG, prepare a task matrix of activities, and agree on the specific CD plan. 3-2-3: Conduct CD activities including format preparation, annual planning, reporting, and data sharing with other WGs. 3-2-4: Manage and use PSI data in collaboration with other organizations. 3-2-5: Prepare a PSI guideline for rivers in Sri Lanka. <3-3> Promotion of EPL scheme and effluent water quality standards for existing industries in the Kelani river basin 3-3-1: Review the current situation of EPL scheme and effluent water quality standard in the Kelani river basin, and identify principal issues to be improved. 3-3-2: Establish a WG, prepare a task matrix of activities, and agree on the specific capacity CD plan. 3-3-3: Conduct CD activities including the development of necessary tools and materials, and implement it in the Kelani river basin as a pilot project. 3-3-4: Prepare a guidance for promoting EPL and effluent water quality standards. **4) Information management system of the water quality monitoring data including inspection, EPL data, and PSI data, on inland surface water bodies are developed and effectively used.** 4-1: Review the current information management situation of the water quality monitoring data including inspection, EPL data, and PSI data, on inland surface water bodies, and identify principal issues to be improved. 4-2: Establish a WG, prepare a task matrix of activities, and agree on the specific CD plan. 4-3: Conduct CD activities including development of database (DB), and implement it in the Kelani river basin as a pilot project. 4-4: Prepare a guidance for promoting the developed information management system in Sri Lanka.	1) Expert Team - Team Leader/ Water Quality Management - Water Quality Analysis - Environmental Monitoring - Pollution Sources Inventory - Inspection - Data and Information Management/ Database - Coordinator 2) Seminars and Workshops 3) Training in Japan 4) Equipment Necessary for Project Activities 5) Pilot Projects 6) Local Consultants for Sub-contract Works	1) Counterpart (C/P) Personnel - CEA and concerned Departments - Regional Branch Offices 2) Project Office Space at CEA 3) Budget Allocation for Salary and other Expenditure for C/P during the Project Period. 4) Budget Allocation for Running cost of Equipment procured under the Project	 **Pre-Conditions** A project budget is secured in a Sri Lankan side. CEA assigns necessary staffs for implementation of the Project. <Issues and countermeasures>

付属資料 3　プロジェクトフローチャート

Table 1 Activities and Outputs of the Project

Items	Activity and Output
[A]	Preparatory Work in Japan
A-1	Develop Work Plan
[B]	Project Administration
B-1	Discuss the Work Plan
B-2	Prepare Inception Report
B-3	Undertake Capacity Assessment and Elaborate Project Activities
B-4	Procure Equipment
B-5	Implement and Administer Pilot Projects
B-6	Administer Counterparts Training in Japan
B-7	Undertake Periodical Progress Monitoring
B-8	Prepare Progress Reports I and II
B-9	Prepare Final Reports
[C]	Output and Activities
Output 1	The introduction of water body categorization in line with the ambient water quality standard in Sri Lanka are set-up.
Activity 1-1	Review the current legal and institutional level and implementation system.
Activity 1-2	Clarify current situations and issues on management and compliance of the ambient water quality standard.
Activity 1-3	Establish a working group (WG), identify capacity development (CD) needs, and agree a task matrix of activities.
Activity 1-4	Conduct CD activities, develop materials for categorization, and conduct its trial practices in selected rivers.
Activity 1-5	Prepare a set of guidelines for introducing the categorization based on trial practices and lessons learned.
Output 2	Water Quality Analysis Capacity of Lab staffs is Strengthened.
Activity 2-1	Review the current situation and level of central and regional labs in CEA.
Activity 2-2	Establish a WG and agree the specific CD plan including water quality analysis and operation and maintenance (O&M) of equipment.
Activity 2-3	Conduct CD activities, develop the Standard Operation Procedure (SOP), and continue the activities to obtain official accreditation such as ISO/IEC 17025.
Output 3	Enforcement capacity of the targeted counterpart organizations on water quality monitoring including inspection is strengthened, pollution sources inventory (PSI) is created, and acquisition of the Environmental Protection License (EPL) is promoted.
Output 3-1	Water Quality Monitoring Including Inspection
Activity 3-1-1	Review the current water quality monitoring conditions including inspection and identify CD needs.
Activity 3-1-2	Establish a WG, prepare a task matrix of activities, and agree on the specific CD plan.
Activity 3-1-3	Conduct CD activities including preparation of annual planning, sampling, inspecting, reporting, and feedback to other WGs.
Activity 3-1-4	Analyse and evaluate monitoring results including inspection and prepare an annual report on the Kelani river basin.
Activity 3-1-5	Prepare a monitoring guideline including inspection for rivers in Sri Lanka.
Output 3-2	Pollution Source Inventory (PSI)
Activity 3-2-1	Review the current PSI conditions and identify CD needs.
Activity 3-2-2	Establish a WG, prepare a task matrix of activities, and agree on the specific CD plan.
Activity 3-2-3	Conduct CD activities including format preparation, annual planning, reporting, and data sharing with other WGs.
Activity 3-2-4	Manage and use PSI data in collaboration with other organizations.
Activity 3-2-5	Prepare a PSI guideline for rivers in Sri Lanka.
Output 3-3	Promotion of EPL Scheme and Effluent Water Quality Standards for existing Industries in the Kelani river basin.
Activity 3-3-1	Review the current situation of EPL scheme and effluent water quality standard in the Kelani river basin, and identify principal issues to be improved.
Activity 3-3-2	Establish a WG, prepare a task matrix of activities, and agree on the specific capacity CD plan.
Activity 3-3-3	Conduct CD activities including the development of necessary materials, and implement it in the Kelani river basin as a pilot project.
Activity 3-3-4	Prepare guidance for promoting EPL and effluent water quality standards.
Output 4	Information management system of the water quality monitoring data including EPL data, and PSI data, on inland surface water bodies are developed and effectively used.
Activity 4-1	Review the current information management situation of the water quality monitoring data including inspection, EPL data, and PSI data, on inland surface water bodies, and identify principal issues to be improved.
Activity 4-2	Establish a WG, prepare a task matrix of activities, and agree on the specific CD plan.
Activity 4-3	Conduct CD activities including development of database (DB), and implement it in the Kelani river basin as a pilot project.
Activity 4-4	Prepare guidance for promoting the developed information management system in Sri Lanka.



Note: Prepared by the JICA Team

Figure 2 Flowchart of the Project

付属資料 4　JCC 会議の MM

First Joint Coordination Committee meeting on the project for monitoring of water quality of major water bodies in Provincial

Date	12^{th} March 2015
Time	9.45^{am} – 11.45^{am}
Venue	Ministry of Mahaweli and Environmental

Present

Mr. NIhal Rupasinghe	Secretary – Ministry of Mahaweli and Environment
Mr. KH Muthukudaarchchi	Director General – Central Environmental Authority
Mr. Gamini Rajakaruna	Director General – Ministry of Mahaweli
Mr. Yasuhiko Muramatsu	Team Leader –JICA Project
Mr. Tukashi Onumi	Deputy Team Leader _ JICA Project
Mr. Hiroyuki Abe	Senior Representative of JICA Sri Lanka Office
Mr. Shinozaki Yusuke	Representative of JICA Sri Lanka Office
Mr. M G Hemachandra	Project Specialist JICA Sri Lanka Office
Mr. L G Madduma Bandara	Deputy Director – Ministry of Mahaweli
Mr. Ajith Silva	Director Planning Division Ministry of Mahaweli and Environment
Mrs. T W A W. WIjesinghe	Director (Laboratory Services) CEA
Mr. C R Perera	Deputy General Manager(Production)–NWSDB
Mr. Shantha Wijearatne	Additional Secretary Ministry of Mahaweli
Mrs. Manuja Wimalasena	Director (Legal) CEA
Mrs. Himali Karunaweera	Assistant Director (EPC) CEA
Mrs. Jeewa David	Assistant Director (NRM) CEA
Mr. Lalith Nanayakkara	Assistant Director (HRD) CEA
Mr. Ajith Herath	Assistant Director (EEA) CEA
Mr. R W S M N Manoratne	Assistant Director (DO- Gampha) CEA
Mrs. Thushara Pelawatte	Chemist (Laboratory) CEA
Miss Chandani H Edussoriya	Assistant Director (R&D) CEA
Miss Swarna Vishwanadan	Environmental Officer (Laboratory) CEA
Mrs. Chethika Ambalangodage	Senior Laboratory Assistant (Laboratory) CEA

Excused

Mr. N S Gamage	Director (Western Province Office)

Absent

Mrs. Sherin Perera	Director Environment -BOI
Mr. Asitha Seneviratne	Additional Secretary Policy Development -MOIC
Representative	from Ministry of Finance and Planning

Minutes

Mr. Nihal Rupasinghe /Secretary Ministry of Mahaweli and Environmental chaired the meeting and he welcomed the participant.

The secretary Ministry of Mahaweli and Environmental Mr. NIhal rupasinghe in his opening remarks stated that the JICA is the most suitable agency to provide technical assistance to this type of water quality monitoring project and further he stated that the historical back ground of the water management in ancient time and how our ancient kings constructed many tanks with considering engineering aspect by considering all environmental factors carefully. Further he explained deterioration of the water quality not only impact on the human being but also on the machinery and other equipment use hydro power sector as well as the other type of water sector project.

After self-introduction by the participants Senior representative of JICA Sri Lanka office explained the technical corporation between the two countries and appreciated the work done for this project and stressed the importance of the sustainability of this type of project.

Mrs. T W A Wijesinghe Director Laboratory Service CEA made a briefly presentation on project back ground and how it come to this stage after a series of discussion on inspection within the Central Environmental Authority as well as different other stakeholder agencies; further she presented the expected outcomes of this project.

Mr. Muramutsu the team leader of this project made a brief presentation on this project and he reemphasized two vital dimensions of JICA Technical Cooperation for Capacity Development: 1) Ownership and 2) Sustainability by referring lessons learned in other countries. He further expounded organizational aspects and timeline of the project.

After the presentation the secretary ministry of Environment stated that instead of present monitoring locations to see the possibility to extending the sampling locations at the origin of the river from Adam peaks to downstream at Muttakuliya. And further he stated that the Water quality data should be coupled with other Engineering aspect related to the water quality. As a National point of view he suggested to incorporate other organizations which involve in water quality monitoring activities. It is suggested to demonstrate the variation pattern of the water quality parameters along the river section and to disclose the information to the public.

By opening the discussion the Mr. MG Hemachandra Project Specialist -JICA Sri Lanka office urged the necessity of the participation of the BOI and the MOIC for the JCC meeting. Further he explained at the initial stage of this project the JICA had to face a great difficulty to get their information and view to proceed the project and had to spend more time on this.

DG of CEA Stated that two major BOI industrial parks has been located within the Kelani river basin the participation of BOI and MOIC is very important and further stated that the CEA will be sending a letter to inform them strongly.

Mr. Rangith Bandara DGM of Water Supply and Drainage Board requested some laboratory Equipment for the water supply and drainage board laboratory and to get the capacity need for their staff.

The Senior representative of JICA Sri Lanka office, the team leader of this project and the Director (Laboratory Service) of CEA responded to this request and explained that this project is totally comes under technical cooperation project and very limited budget has been allocated only for CEA laboratory to purchase minimum equipment necessary for implementation of the project.

Mr. Ajith D Silva Director Planning division of ministry of Mehaweli and Environment stated that so many requests are coming from Japan and other donor agencies to provide as In kind technical assistance and informed to WSDB to get the assistance from such type of project to strengthen their laboratories .

Mr. Muthukidarachchi the DG of CEA stated that the urgent necessity to install a real time monitoring system in kelani river and further this requested had been raised time to time from at the beginning of the CEA.

Mr. Manoratne AD of Gampha District office stated that the necessity to address the non-point sources and agriculture waste under this project and that the some industries possess ten to twenty years old effluent quality data and asked to utilize all those data to compare the trend with the data already with CEA.

Mr. Muramatsu the team leader of this project expressed full agreement on his statement; however, he also reminded the participants that this project is designed to address issues in Point Source management. Thus he mentioned that Non-point source should be addressed separately by another project.

The DG CEA mentioned that the UNICEF has agreed to provide funds for the project proposal on preparation of management plan for the Kelani river basin. This project has to be part of that project and non-point sources could be addressed on the management plan of Kelani river basin.

Ms. Jeewa David AD of the Natural Resources Management division briefly explained the project approved for the preparation of management plan of the Kelani river basin and requested to see the possibility to study the carrying capacity of the Kelani River under this project.

Mr. Muramatsu stated that assessment of carrying capacity often use computer simulation models that involves more technical experts and intensive training on use of software. The project elsewhere in the world has often failed with limited sustainability in such project using sophisticated computer simulation model and thus the approach to assessment of carrying capacity has to be carefully designed and implemented. Therefore this project will adopt simple excel sheet analysis to make it sustainable. He also reminded, however, that applicability and limitation should be carefully considered in using such technique.

DG CEA also concurred and confirmed that the water quality simulation model is frequently problematic and need more technical competency therefore simple measure suggested by Mr. Muramadsu may sufficient at this point.

While thanking for the participation for JCC meeting Mr. Muthukudarachchi urged the cooperation of all the stake holders to implement this project and concluded the meeting.

MINUTES OF MEETINGS

BETWEEN

JAPAN INTERNATIONAL COOPERATION AGENCY

AND

CENTRAL ENVIRONMENTAL AUTHORITY

OF

DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

ON

THE PROJECT FOR MONITORING OF THE WATER QUALITY OF MAJOR WATER BODIES

THE JOINT COORDINATION COMMITTEE MEETING

At the occasion of the first Joint Coordination Committee (JCC) meeting convened on 16th July 2015, the members of the JCC deliberated, among others, the Project Design Matrix (PDM), procurement of equipment for laboratory service and the programmes of counterpart training in Japan based on the Inception Report of the Project.

As a result of discussions, both sides understood and came to an agreement on the matters referred to in the document attached hereto.

Colombo, July 16, 2015

Eng. Nihal Rupasinghe
Secretary
Ministry of Mahaweli Development
and Environment

Prof. Lal Mervin Dharmasiri
Chairman
Central Environmental Authority

Dr. Hasitha Tissera
Board Member
Central Environmental Authority

阿部 裕之

Mr. Hiroyuki ABE
Senior Representative
Japan International Cooperation Agency,
Sri Lanka Office

小沼 崇史

Mr. Takashi ONUMA
Deputy Team Leader
The JICA Team

ATTACHED DOCUMENT

1. Project Design Matrix (PDM) ver.2

The JICA Team explained and discussed the proposed modification of the PDM based on the series of meetings with the counterpart members (C/P). As a result of discussions, the both sides agreed the revised PDM referred to as PDM ver.2 and attached to the minutes of meeting as Annex 1.

2. Procurement of Equipment

The JICA Team explained to the Sri Lankan side about the procurement of equipment in the Project. The equipment was selected in consultation between the C/P and the JICA Team with due consideration on the project budget and the technical requirements of ISO/IEC 17025 in order for CEA Central Laboratory to ensure effective implementation of the Project. The both sides agreed the proposed items of the equipment.

3. Counterpart Training in Japan

The JICA Team explained to the Sri Lankan side about the programmes of counterpart training in Japan to take place three (3) times with thirty six (36) participants during the project period. The JICA Team also explained that the participants should be nominated from the concerned personnel of the Project. The Sri Lankan side understood the explanation and agreed to nominate participants for the training in Japan.

4. Inception Report

The JICA Team explained to the Sri Lankan side about the Inception Report (hereinafter referred to as "IC/R") prepared based on the baseline survey and needs of capacity development of the CEA among others. The JICA Team submitted twenty (20) sets of the IC/R to Sri Lankan side. The Sri Lankan side understood the explanation and formally received the IC/R.

Annex 1	**Project Design Matrix (PDM) ver.2**
Annex 2	**List of the Equipment**
Annex 3	**Training in Japan**

Annex-1 Project Design Matrix (PDM) ver.2

Project Title: The Project for Monitoring of the Water Quality of Major Water Bodies
Implementing Agency: Central Environmental Authority (CEA)
Target Group: Ministry of Mahaweli Development & Environment /Central Environmental Authority (CEA)/ Environmental Pollution Control (EPC) Division, Laboratory Service and target Departments of regional branch offices in CEA
Project Site: Sri Lanka Model Site: Kelani river

Dated 29, May, 2015 Ver.2
Period of Project: 3 years (tentative)

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
Overall Goal: Water quality management in major water bodies is appropriately implemented by CEA	OG1 The by-laws and/or regulations which stipulate roles and functions of a water quality management system are inaugurated by 2020. OG2 The ratio of water bodies assessed/ managed by CEA by using improved water quality monitoring methods (system/ procedure) increases by 2020 compared with the initial stage of the Project. OG3 The number of major water bodies with proposed the water quality environmental management system are at least one (1) in Sri Lanka by 2020 in accordance with the guidelines prepared by the Project.	1. Data and documents in CEA and its regional branch offices	The principal policy prescribed in the National Environmental Act for water quality management in Sri Lanka is not negatively changed.
Project Purpose: Enforcement capacity of CEA and its regional branch offices of the Kelani river basin on water quality management is strengthened.	PP1 CEA conducts self-evaluation on their own capacity of policy and system making regarding water quality management such as nos. of proposals related to gazetting ambient water quality standards, introduction of ambient water quality zoning and categorization system, improvement of current EPL system, etc. based on the National Environmental Act (No.47 of 1980) and other related by-laws, and its evaluation results show improvement, compared with the initial stage of the Project. PP2 CEA, concerned departments, and regional branch offices conduct self-evaluation on their own enforcement capacity of water quality management such as nos. of guidance to EPL holders (factories), nos. of penalty case, etc. based on the National Environmental Act (No.47 of 1980) and other concerned by-laws, and its evaluation results show improvement, compared with the initial stage of the Project. PP3 The guidelines and other outputs developed through the Project are properly applied by all concerned departments and regional offices of CEA in charge for a nationwide promotion of water quality management. PP4 The number of major water bodies and regional governments which propose zoning categorization of ambient water quality standard is at least one (1) in Sri Lanka. PP5 One (1) guideline and materials on zoning and categorization are developed and used. PP6 More than 2 times of guidance are conducted by CEA to organizations which have responsibility for water quality management of target water bodies. PP7 More than 70 % of staff in the concerned departments and regional offices of CEA in charge can explain how to use the guidelines and other outputs developed through the Project.	1. Questionnaire survey for CEA, concerned departments, and regional branch offices at the initial, mid-term, and final stage of the Project 2. ditto 3. Data and documents in CEA, concerned departments, and regional branch offices 4. ditto 5. Actual nos. of guidelines and materials 6. Guidance record to target organizations and the result of the review test 7. Hearing and evaluation survey to target organizations	The principal policy for water quality management of CEA related to institution and budget for its implementation is not negatively changed. All related organizations in CEA and regional governments are active in promoting water quality management.
Outputs: Output 1: The introduction of water body categorization in line with the ambient water quality standard in Sri Lanka are set-up.	1-1 More than 9 reference monitoring points of ambient water quality standard are designated. 1-2 A proposal for introducing ambient water quality zoning and categorization is prepared based on trial results in the Kelani river. 1-3 At least one (1) of major water bodies proposes zoning and categorization system in Sri Lanka.	1. Data and documents in CEA, concerned departments, and regional branch offices	
Output 2: Water quality analysis capacity of lab staff is strengthened.	2-1 Nos. of lab staff who have sufficient analysis capability are more than 7 persons in the target labs. 2-2 More than 1,200 samples are analyzed annually. 2-3 Equipment and instruments including reagents are properly operated and maintained. 2-4 More than 12 types of QA/QC activities are conducted by the end of the Project. 2-5 The CEA lab obtains accreditation certificates for more than 2 water quality parameters from the SLAB.	1. Proficiency test results using unknown concentration samples (staff at provincial offices are included.) 2. Actual nos. of samples analyzed 3. SOPs developed, Relevant records 4. Reports/ Documents/ Relevant Records 5. Accreditation certificate of ISO/IEC 17025 from the SLAB	

A-1

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
Output 3: Enforcement capacity of the targeted counterpart organizations on water quality monitoring including inspection is strengthened, pollution sources inventory (PSI) is created, and acquisition of the Environmental Protection License (EPL) is promoted.	**3-1 Water quality monitoring including inspection** 3-1-1 More than 10 times of cooperating and sharing meetings among concerned organizations are carried out. 3-1-2 Monitoring plans and reports including inspection, and analysis and evaluation of monitoring results including inspection in 2016 and 2017, are prepared by target departments, and shared with concerned departments and organizations. 3-1-3 More than 10 times of sampling and water quality analysis are conducted in the ambient standard points. 3-1-4 More than 6 times of workshops are conducted for sharing monitoring data and analysis results including inspection with concerned departments. 3-1-5 Monitoring guideline including inspection for rivers in Sri Lanka is prepared. 3-1-6 Level of enforcement capacity on water quality monitoring including inspection is improved. 3-1-7 All violation cases revealed through monitoring including inspection are reported to the Legal Unit of CEA.	1. Annual monitoring plan and report including inspection prepared 2. Actual nos. of monitoring data, documents, and records including inspection 3. Documents and records of workshops conducted 4. Monitoring guideline including inspection prepared 5. Comparison of capacity assessment results conducted at initial stage, mid-term evaluation, and terminal evaluation of the Project 6. Violation case records received by the Legal Unit of CEA	
	3-2 Pollution Source Inventory (PSI) 3-2-1 More than 10 times of cooperating and sharing meetings among concerned organizations are carried out. 3-2-2 More than 3200of PSI data are prepared targeting major pollution sources in the Kelani river basin. More than 9,800 of PSI data are prepared targeting major pollution sources in Sri Lanka. 3-2-3 More than 70 % of major pollution sources in the Kelani river basin are identified and recorded on PSI Database (DB). 3-2-4 More than 85 % of PSI data are up-dated by follow-up activities. 3-2-5 More than 6 times of PSI sharing meetings are held among concerned departments that manage and use PSI data. 3-2-6 Level of enforcement capacity on PSI preparation is improved.	1. PSI data prepared 2. PSI data up-dated and records of follow-up activities 3. Documents and records of PSI sharing meetings 4. Comparison of capacity assessment results conducted at initial stage, mid-term evaluation, and terminal evaluation of the Project	
	3-3 Promotion of EPL scheme and effluent water quality standards for existing industries in the Kelani river basin 3-3-1 More than 15 times of monitoring including inspection are conducted in the Kelani river basin using guideline guidebook developed. 3-3-2 Monitoring including inspection are conducted more than 80 % of major pollution sources in the Kelani river basin using guideline developed. 3-3-3 Method for selecting crucial pollution sources in the Kelani river basin are developed and its result is reflected on the monitoring plan including inspection. 3-3-4 Acquisition of EPL is increase more than 2 % in actual condition in the Kelani river basin 3-3-5 Guidance for promoting EPL and effluent quality standard is prepared. 3-3-6 Illegal and/ or EPL-violating factories are reported to the authorities for sanction.	1. Actual nos. of data, documents, and records related to EPL conducted in the Kelani river basin 2. Actual nos. of monitoring data and records including inspection in the Kelani river basin 3. Guideline prepared and its usage record 4. Reports and records prepared and informed	
Output 4: Information management system of the water quality monitoring data including inspection, EPL data, and PSI data, on inland surface water bodies are developed and effectively used	4-1 More than 10 times of working group discussion meetings are carried out. 4-2 Database (DB) including EPL data for information management system is developed by web-base, and used by concerned organizations. 4-3 Input data is properly up-dated annually. 4-4 Guidance for promoting information management system in Sri Lanka is prepared. 4-5 Annual report is prepared and shared with concerned organizations.	1. Actual nos. of data, documents, and records concerning to information management 2. Conditions of DB and its usage record 3. Up-dated data and conditions 4. Guidance prepared and its usage record 5. Activity record of pilot project, and comparison of capacity assessment results conducted at initial stage, mid-term evaluation, and terminal evaluation of the Project 6. Prepared annual report and record of its sharing conditions	

Activities	Inputs		Important Assumption
1) The introduction of water body categorization in line with the ambient water quality standard in Sri Lanka are set-up. 1-1: Review the current legal and institutional level and implementation system. 1-2: Clarify current situations and issues on management and compliance of the ambient water quality standard. 1-3: Establish a working group (WG), identify capacity development (CD) needs, and agree a task matrix of activities. 1-4: Conduct CD activities, develop tools and materials for categorization, and conduct its trial practices in selected rivers. 1-5: Prepare a set of guidelines for introducing the categorization based on trial practices and lessons learned. **2) Water quality analysis capacity of lab staff is strengthened.** 2-1: Review the current situation and level of central and regional labs in CEA. 2-2: Establish a WG and agree the specific CD plan including water quality analysis and operation and maintenance (O&M) of equipment. 2-3: Conduct CD activities, develop the Standard Operation Procedure (SOP), and continue the activities to obtain official accreditation such as ISO/IEC17025. **3) Enforcement capacity of the targeted counterpart organizations on water quality monitoring including inspection, pollution sources inventory (PSI), and the Environmental Protection License (EPL) scheme, is strengthened.** <3-1> Water quality monitoring including inspection 3-1-1: Review the current water quality monitoring conditions including inspection and identify CD needs. 3-1-2: Establish a WG, prepare a task matrix of activities, and agree on the specific CD plan. 3-1-3: Conduct CD activities including preparation of annual planning, sampling, reporting, and feedback to other WGs. 3-1-4: Analyze and evaluate monitoring results including inspection and prepare an annual report on the Kelani river basin. 3-1-5: Prepare a monitoring guideline including for rivers in Sri Lanka. <3-2> Pollution Source Inventory (PSI) 3-2-1: Review the current PSI conditions, and identify CD needs. 3-2-2: Establish a WG, prepare a task matrix of activities, and agree on the specific CD plan. 3-2-3: Conduct CD activities including format preparation, annual planning, reporting, and data sharing with other WGs. 3-2-4: Manage and use PSI data in collaboration with other organizations. 3-2-5: Prepare a PSI guideline for rivers in Sri Lanka. **<3-3> Promotion of EPL scheme and effluent water quality standards for existing industries in the Kelani river basin** 3-3-1: Review the current situation of EPL scheme and effluent water quality standard in the Kelani river basin, and identify principal issues to be improved. 3-3-2: Establish a WG, prepare a task matrix of activities, and agree on the specific capacity CD plan. 3-3-3: Conduct CD activities including the development of necessary tools and materials, and implement it in the Kelani river basin as a pilot project. 3-3-4: Prepare a guidance for promoting EPL and effluent water quality standards. **4) Information management system of the water quality monitoring data including inspection, EPL data, and PSI data, on inland surface water bodies are developed and effectively used.** 4-1: Review the current information management situation of the water quality monitoring data including inspection, EPL data, and PSI data, on inland surface water bodies, and identify principal issues to be improved. 4-2: Establish a WG, prepare a task matrix of activities, and agree on the specific CD plan. 4-3: Conduct CD activities including development of database (DB), and implement it in the Kelani river basin as a pilot project. 4-4: Prepare a guidance for promoting the developed information management system in Sri Lanka.	The Japanese Side 1) Expert Team - Team Leader/ Water Quality Management - Water Quality Analysis - Environmental Monitoring - Pollution Sources Inventory - Inspection - Data and Information Management/ Database - Coordinator 2) Seminars and Workshops 3) Training in Japan 4) Equipment Necessary for Project Activities 5) Pilot Projects 6) Local Consultants for Sub-contract Works	The Sri Lankan Side 1) Counterpart (C/P) Personnel - CEA and concerned Departments - Regional Branch Offices 2) Project Office Space at CEA 3) Budget Allocation for Salary and other Expenditure for C/P during the Project Period. 4) Budget Allocation for Running cost of Equipment procured under the Project	Pre-Conditions A project budget is secured in a Sri Lankan side. CEA assigns necessary staffs for implementation of the Project. <Issues and countermeasures>

Annex 2 List of the Equipment

List of the Equipment

#	Description	QTY
1	Water deionization System	1
2	Sediment Sampler	1
3	Microwave Digester for digestion of effluent and sludge and soil for heavy metals	1
4	UV Visible Spectrophotometer	1
5	COD measuring Equipment	1
6	Multi parameter Water Quality Checker	2
7	Centrifuge	1
8	Acid Alkali/Flammable Storage Cabinet	1
9	DO meter for BOD measurement	1
10	Burettes 50ml	1
11	Laboratory Jack	2
12	Fume hood	1
13	Laminar flow clean bench	1
14	Heavy oil standard for Oil & grease analysis	1
15	Bottles, for BOD analysis 100 bottles	1
16	Laboratory gas cylinder trolley high quality	1
17	Complete distillation set for Kjeldahl analysis	1
18	Sample carrying boxes	2
19	Automatic Dispensers	1
20	Heating mantle	2
21	Laboratory refrigerator	1
22	Bottle Cooler	1
23	CRM (Certified Reference Material)	10

Annex 3 Training in Japan

Proposed Training Program in Japan

Items	Year 1	Year 2	Year 3
Title	Water Quality Management Policies in Japan and Government's Intervention	Water Quality Analysis and Laboratory Management	Data Quality and assurance on water quality management with a particular focus on river water quality management
Number of Participants	12 officers	12 officers	12 officers
Proposed Period	From 2015/11/29 to 2015/12/10	From 2016/5/24 to 2016/6/3	From 2017/5/30 to 2017/6/9
Purpose	To introduce Policies, Institutional arrangement on water quality management in Japan	To capture an overview on analytical methods and laboratory management practices	Data management and intervention for water quality management
Focus Issues	1. Laws, relevant ordinance and enforcement on water quality management at central and local levels; 2. Practices and issues in inspection of dischargers in Japan; 3. Response of dischargers on inspection, information campaign on ordinance in Japan	1. Laboratory Analysis 2. Management of Laboratory in Japan 3. Laboratory waste management practices in Japan	1. Data management practices and disclosure policies 2. QA/QC and accreditation of water quality laboratory 3. Improvement of river water quality and its measures
Major Destinations	1. Ministry of Environment, Department of Water and Air Environment 2. Tokyo Metropolitan Government, Dep. Environment 3. Designated Large Scale Factory in Tokyo 4. Kawasaki City Government 5. Environmental Science Institute of Kitakyushu International Techno-cooperative Association 6. Kitakyushu Pollution Monitoring Centre 7. Environmental Management and Planning Department of Minamata City 8. Minamata disease Museum Private laboratory	1. Ministry of Environment 2. Private Laboratory • Atomic Absorption • Preparatory treatment of water samples • Microwave digester • Practices on calibration curve • Laboratory Management, Laboratory waste management and QA/QC	1. Ministry of Environment, Department of Water and Air Environment 2. river Management Division, Saitama Prefectural Government 3. Edogawa river Management Office 4. Suppliers of Septic tank 5. Sewerage treatment plants 6. Japan Accreditation Board 7. National Institute of Technology and Evaluation 8. National Metrology Institute of Japan Tsukuba Centre

Note 1: The menu of the 2nd year' training may be modified as per request from C/P in order not to focus on only heavy metal analysis.

Note 2: Prepared by the JICA Team

No.________

Meeting Record of Second Join Coordination Committee Meeting

Subject	1. Project Design Matrix PDM 2. Procurement of Equipment for Laboratory Service 3. Counterpart Training in Japan based on the Inception Report.	Venue	Ministry of Mahaweli Development and Environment, 9th Floor- Conference Room
Date and Time	July 16th, 2015 1.00 pm – 2.30 pm	Recorded by	Kanchana Hewage-JICA Project Secretary

Attendant

Name	Designation	Organization
Eng. (Mr) Nihal Rupasinghe	Secretary	Ministry of Mahaweli & Env
Mr. Ajith De Silva	Director P/P	Ministry of Mahaweli & ENV
Ms. Thanuja Ranathunga	DO	State Ministry of Mahaweli &ENV
Ms. P Thalagala	Director	PP/MASL
Ms. T. Samarathunga	Director	WMS/MASL
Mr. S R K Aruppola	Director	MASL
Ms. M L Nimanthi Manjula	Assi. Director	MASL
Ms. A S Beling	Senior Deputy Director	BOI
Mr. W B Palugaswewa	Director	Irrigation Department
Ms. P.M. Jayadeera	Chief Engineer	Irrigation Department
Dr. R.M.S.K Rathnayake	Act. DDG	Env. Pollution control/CEA
Ms. Manjula Wimalasena	Director	Legal Unit- CEA
Mr. N.S Gamage	Director	Western Province Office/CEA
Ms. T W A W Wijesinghe	Director	Laboratory/CEA
Ms. Himali Karunaweera	Assi. Director	EPC/CEA
Ms. Jeeva David	Assi. Director	NRM/CEA
Ms. Chandanie Edussuriya	Assi. Director	R&D/CEA
Ms. P A C Nishanthi	Assi.Director	HRM/CEA
Ms. Wijayani Ambegoda	Assi.Director	Gampaha Office/CEA
Mr. Tiklak Nawarathne	Planning Officer	Planning and Monitoring/CEA
Mr. Mahinda Uyangoda	SEO	EEA/CEA
Ms. Thushara Pelawatte	Chemist	Laboratory/CEA
Mr. Hiroyunki Abe	Senior Representative	JICA-Sri Lanaka
Mr. Yusuke Shinozaky	Representative	JICA-Sri Lanaka
Mr. Takashi ONUMA	DTL/EM	JICA Project Team
Mr. Seji Okano	WQ Analysis	JICA Project Team
Mr. Manuel I Gloria	Inspection 2	JICA Project Team

<table>
<tr><td>Subject</td><td>1. Project Design Matrix PDM
2. Procurement of Equipment for Laboratory Service
3. Counterpart Training in Japan based on the Inception Report.</td><td>Venue</td><td>Ministry of Mahaweli Development and Environment, 9th Floor- Conference Room</td></tr>
<tr><td></td><td colspan="3">Ms. Kanchana Hewage Admin. Secretary JICA Project Office
<u>Excused</u>
Mr. Asitha Senevirathnne
Additional Secretary-Policy and
Planning</td></tr>
<tr><td>Data/Information</td><td colspan="3">1. Presentation slides
2. Hard Copies</td></tr>
<tr><td>Discussion topics</td><td colspan="3">• Eng. Mr. Nihal Rupasinghe/ Secretary -Ministry of Mahaweli and Environment chaired the meeting and he welcomed the participants.
• The secretary –Ministry of Mahaweli and Environment, Mr. Nihal Rupasinghe in his opening remarks stated that the JICA is the most suitable and professional agency to provide the technical assistance to Water Quality Monitoring Projects and he thanked JICA for giving their professional, technical guidance and support to the Central Environmental Authority to make this project success

<u>Confirmation of the Minutes of last Meeting</u>
• After the self introduction by the participants, Mr. Nihal Rupasinghe gave the time to state the comments for last Meeting Minute. Due to no comments raised from the participants Mr. Nihal Rupasinghe stated that it as a confirmed minute.

1) <u>Project Design Matrix PDM</u>
Mr. Onuma Takashi-the Deputy Team Leader of JICA Team explained and discussed the proposed modification of the PDM based on the series of meetings with the counterpart members (C/P) by using a presentation slide. (Hard copies of the presentation material have submitted to the participants) and the presentation mainly covered the below points.
1. Overall Goal of the Project
2. Project Purpose
3. Baseline Survey
4. Introduction of Output 1, 2, 3-1, 3-2, 3-3, 4 and the relationship in-between mentioned outputs.
5. Training in Japan</td></tr>
</table>

Subject	1. Project Design Matrix PDM 2. Procurement of Equipment for Laboratory Service 3. Counterpart Training in Japan based on the Inception Report.	Venue	Ministry of Mahaweli Development and Environment, 9th Floor- Conference Room

As a result of discussions, the both sides agreed the revised PDM referred to as PDM ver.2 (Attached to the approved minutes of meeting as Annex 1.)

2. <u>Procurement of Equipment</u>

- The JICA Team explained to the Sri Lankan side about the procurement of equipment in the Project. The equipment was selected in consultation between the C/P and the JICA Team with due consideration on the project budget and the technical requirements of ISO/IEC 17025 in order for CEA Central Laboratory to ensure effective implementation of the Project. The both sides agreed for the proposed items of the equipment.

  (Attached to the approved minutes of meeting as Annex 2.)

3. <u>Counterpart Training in Japan</u>

- The JICA Team explained to the Sri Lankan side about the programmes of counterpart training in Japan to take place three (3) times with thirty six (36) participants during the project period. The JICA Team also explained that the participants should be nominated from the concerned personnel of the Project. The Sri Lankan side understood the explanation and agreed to nominate participants for the training in Japan.

  (Proposed Training Program in Japan attached to the approved minutes of the meeting as Annex 3)

<u>Open discussion</u>

- Several participants stated that there are some exiting databases in several government Institutions which is similar to the proposed database in this project.

  But Ms. Wasantha- The Director of Laboratory Services and Dr. Sanjaya Rathnayake-The Acting Deputy Director of EPC of Central Environmental Authority mentioned that CEA is coordinating with other institutions (eg: Irrigation, BOI, NWSDB and etc..) regarding their existing databases to avoid any overlapping.
- Ms. P Thalagala of Mahaweli Authority of Sri Lanka stated the importance of a land management system as well as the water quality management.
- Mr. Nihal Rupasinghe highlighted the importance of measuring the Water quality standards of Rain Water also.
- Dr. Rathnayake of CEA mentioned that the Accreditation process should be expedited because CEA has to finish this process in the April of 2016. Mr. Onuma Takashi replied Dr. Rathnayake and said that as the first step of accreditation process is to implement the QAQC System and it will take 1 year period. Secondly an Internal Audit to be done and it will take around 6 months period. Ms. Wasantha – the Director of Laboratory of CEA also

Subject	1. Project Design Matrix PDM 2. Procurement of Equipment for Laboratory Service 3. Counterpart Training in Japan based on the Inception Report.	Venue	Ministry of Mahaweli Development and Environment, 9th Floor- Conference Room
	mentioned that CEA Laboratory has already started the documentation process for the Accreditation and hopefully they can achieve the time limits. • To give the participants a clear understanding, Mr. Onuma Takashi- the Deputy team Leader of JICA Team has explained the Categorization procedure, Calculation of GIS and Pollution load by using some presentation slides. • The Senior Representative of JICA Mr. Hiroyunki Abe questioned about the new proposed project for the Kelani River basin conservation and Dr. Rathnayake and Ms. Jeeva David from CEA answered and said that it will be a main project funded by UNICEF which covered several areas, and the main purpose of that project is to prepare a Management Plan for Kelani River basin and this project will be a part of it. • A comment came from Mr. N.S Gamege regarding the Inception report. Mr. Gamage highlighted that 5th point of A3-3 to be re-considering according to the current procedures. Dr. Rathnayake mentioned that within one week the CEA will re view the Inception Report and do the corrections. • There being no other items to take up, the meeting adjourned at 2:30 pm after the thanking speech of Dr. Sanjaya Rathnayake of Central Environmental Authority. End		
Further			

No.________

Meeting Record of Third Joint Coordination Committee Meeting

<table>
<tr><td>Subject</td><td>1. Progress Of the Project
2. Project Overview</td><td>Venue</td><td>Ministry of Mahaweli Development and Environment, 9th Floor- Conference Room</td></tr>
<tr><td>Date and Time</td><td>17th February 2016 3.00 pm – 4.30 pm</td><td>Recorded by</td><td>Kanchana Hewage-JICA Project Secretary</td></tr>
<tr><td>Attendant</td><td colspan="3">
<table>
<tr><th>Name</th><th>Designation</th><th>Organization</th></tr>
<tr><td>Mr. Udaya R Senavirathne</td><td>Secretary</td><td>Ministry of Mahaweli & Env</td></tr>
<tr><td>Mr. Ajith De Silva</td><td>Director P/P</td><td>Ministry of Mahaweli & ENV</td></tr>
<tr><td>Ms. Thanuja Ranathunga</td><td>DO</td><td>Ministry of Mahaweli &ENV</td></tr>
<tr><td>Mr. Hiroyunki Abe</td><td>Senior Representative</td><td>JICA Sri Lanka</td></tr>
<tr><td>Mr. Takuya Manabe</td><td>Representative</td><td>JICA Sri Lanka</td></tr>
<tr><td>Mr. Hemachandra</td><td>Project Specialist</td><td>JICA Sri Lanka</td></tr>
<tr><td>Mr. R P P K Rajapakshe</td><td>Manager Operations</td><td>NWS&DB</td></tr>
<tr><td>Dr. R.M.S.K Rathnayake</td><td>Act. DDG</td><td>Env. Pollution control/CEA</td></tr>
<tr><td>Ms. Majula Wimalasena</td><td>Director</td><td>Legal Unit- CEA</td></tr>
<tr><td>Ms. T W A W Wijesinghe</td><td>Director</td><td>Laboratory/CEA</td></tr>
<tr><td>Ms. Himali Karunaweera</td><td>Assi. Director</td><td>EPC/CEA</td></tr>
<tr><td>Ms. Jeeva David</td><td>Assi. Director</td><td>NRM/CEA</td></tr>
<tr><td>Ms. Chandanie Edussuriya</td><td>Assi. Director</td><td>R&D/CEA</td></tr>
<tr><td>Mr. Ajith Herath</td><td>Assi. Director</td><td>CEA</td></tr>
<tr><td>Ms. Sukitha Ranasinghe</td><td>Assi. Director</td><td>EPC/CEA</td></tr>
<tr><td>Mr. Tilak Nawarathne</td><td>Planning Officer</td><td>Planning and Monitoring/CEA</td></tr>
<tr><td>Ms. Thushara Pelawatte</td><td>Chemist</td><td>Laboratory/CEA</td></tr>
<tr><td>Mr. Yasuhiko Muramatsu</td><td>Team Leader</td><td>JICA Project Team</td></tr>
<tr><td>Mr. Takashi ONUMA</td><td>DTL/EM</td><td>JICA Project Team</td></tr>
<tr><td>Ms. Eiko Watatsu</td><td>PSI</td><td>JICA Project Team</td></tr>
<tr><td>Ms. Kanchana Hewage</td><td>Admin. Secretary</td><td>JICA Project Office</td></tr>
<tr><td><u>Excused</u></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Data/Information</td><td colspan="3">1. Presentation slides
2. Hard Copies</td></tr>
<tr><td>Discussion topics</td><td colspan="3">• Mr. Udaya R Senavirathne/ The Secretary -Ministry of Mahaweli and Environment chaired the meeting and he welcomed the participants. Also Mr. Senavirathne highlited the importance of conducting this kind of project to protect the water qality in Kelani River.</td></tr>
</table>

<table>
<tr><td>Subject</td><td>1. Progress Of the Project
2. Project Overview</td><td>Venue</td><td>Ministry of Mahaweli Development and Environment, 9th Floor- Conference Room</td></tr>
</table>

Confirmation of the Minutes of last Meeting

- After the self introduction by the participants, Mr. Senavirathne gave the time to state the comments for last Meeting Minute. Due to no comments raised from the participants Mr. Senavirathne stated that it as a confirmed minute.
- Reference to the last meeting minute The Secretary -Mr. Senavirathne inquire about the progress of the below tasks.

  * Procurement of Equipments to the CEA Laboratory
  * 1st Training in Japan
  * Laboratory Accreditation.
  * PSI Data Base

For this question, answered by the Project Manager - Ms. Wasantha Wijesinghe and she mentioned that the Procurement of Laboratory equipments are on process now. Specifications of the said equipments have been selected by the Management of the CEA with the coordination of JICA experts and the process will be end before the mid of this year.

1st Training in Japan was held during the period of 29th November to 10th December 2015 and it was very sucessful. Next training will be scheduled to be held in end of May 2016. Also Mr. Onuma Takashi- The Deputy Team Leader mentioned that the total cost for the Japan Training will be covered by JICA and it will be not indicate in the project cost reports.

Ms. Wasantha mentioned that the CEA Laboratory already started the preperation of documents related the Accreditation with the guidence of JICA Experts and she highlited the importance of gettiong the ISO certification to the CEA Laboratory. Mr. Rajapakshe of NWS&DB also agreed with Ms. Wasantha and said that the Water Board also have lot of Chemical Analysis to be done but in Sri Lanka there is no any Accredited govenment laboratory for those analysis.

Mr. Thilak Nawarathne given the updates regarding the PSI Data Base. He mentioned that the development of this Data Base have been alredy started. Also he mentioned that the JICA Experts will be covers only the Water Pollution part but in future CEA has to develop the Air/ Noise and Waste part.

- The Project Manager - Ms Wasantha Wijesinghe presented a short overview of the project and explained the project design based on the below points.(mentioned as the presentation slide)

  * Overall Goal of the project

  *Project Purpose

  * Project Outputs

  * Time lines of the Activities

  *Purpose of the 3rd JCC meeting

<table>
<tr><td>Subject</td><td>1. Progress Of the Project
2. Project Overview</td><td>Venue</td><td>Ministry of Mahaweli Development and Environment, 9th Floor- Conference Room</td></tr>
<tr><td></td><td colspan="3">I. Ambiant Water Quality Standards
II. Guideline for River Categorization
III. Standard Operation Procedures
IV. Quality Manuals
V. Guideline for Sampling/ Inspection
VI. Pollution Source Inventory

After the presentation done by Ms. Wasantha, Mr. Yasuhiko Muramatsu- the Team Leader of the Project requested the time to present the progress. Begining of his presentation, Mr. Muramatsu also mentioned the project goals and project purpose as mentioned in his presentation slide. The Team Leader mentioned that they are covering main 4 outputs by 6 number of Working Group activities. (mentioned in the presentation slide)
Mr. Muramatsu presented each task and related working groups as mentioned in the presentation slide. To give a clear breafing to the presentees in the meeting Mr. Muramatsu used some pictures, charts and diagrams.(Please refer the presentatio Slide)
Then the Team Leader explained the Key issues and challenges as below.

❖ Need for integration management
For this point Mr. Muramatsu presented the Integration Diagram of all working groups and explained the importance of integration of all working groups to achive the final output of the project. Therefore Mr. Muramatsu mentioned that the project experts will conduct Team Leaders meetings very frequency in year 2016.
❖ Membership of the working group
At this point Mr. Muramatsu mentioned the summary of each working group meetings and attendance of working group members. Mr. Muramatsu mentione that according to the summary MOMD&E and MOIC members have not participated in the meetings of the working groups and he mentioned CEA has acted to ensure their presence in the project recognizing their crucial role.

</td></tr>
</table>

Subject	1. Progress Of the Project 2. Project Overview	Venue	Ministry of Mahaweli Development and Environment, 9th Floor- Conference Room
	❖ Progressive elaboration of tasks For this point Mr. Muramatsu mentioned that when the project goes on, it is becoming evident that some of the tasks need further elaboration. The activities under Output 3-1, among others, required some modification to realign them according to the chronological order of implementation schedule.(Output 3-1 Activities mentioned in the presentation slide) • After the progress presentation of the project team Leader, Mr. Ajith De Silva - The Director of Policy and Planing advise to CEA officers to report the project progress (Physical and financial) regulaly as per the advise given before. Therefore the Secretary- Mr. Senavirathne advise JICA Project Team and CEA to report the Physical and Financial (foreign and local componant) in every quarter to the ministry with out any delay. • The hard copies of the progres report distributed to the present members. • There being no other items to take up, the meeting adjourned at 4:30 pm after the thanking speech of Dr. Sanjaya Rathnayake of Central Environmental Authority. End		
Further			

No.________

Meeting Record of Fourth Joint Coordination Committee Meeting

Subject	1. Progress Of the Project 2. Project Overview	Venue	Ministry Environment,"Saptha Parisara Mandapaya" 82,Rajamalwatte Road, Battaramulla.
Date and Time	23rd January 2017 2.30 pm – 4.30 pm	Recorded by	Kanchana Hewage-JICA Project Secretary

Attendant

Name	Designation	Organization
Mr. Udaya R Senavirathne	Secretary	Ministry of Mahaweli & Env
Mr. Mapa Pathirana	Additional Secretary	Ministry of Mahaweli & ENV
Mr. Takuya Manabe	Representative	JICA Sri Lanka
Mr. Hemachandra	Project Specialist	JICA Sri Lanka
Mr. L P R J Wijesinghe	Chief Chemist	NWS&DB
Ms. Anomajee Herath	Senior Chemist	NWS&DB
Mr. A I S Ranaweera	A/ D - Planning	MOE
Mr. M Sivakumar	Director	EPC/ CEA
Ms. T W A W Wijesinghe	Director	Laboratory/CEA
Mr. M A A N Hemakumara	Director	R&D/CEA
Ms. Hiranthi Jansz	Deputy Director	Laboratory-CEA
Ms. Gayani Dissanayake	Assistant Director	Legal Unit- CEA
Ms. Wijayani Ambegoda	Assistant Director	Gampaha
Ms. Himali Karunaweera	Assi. Director	EPC/CEA
Mr. H L Kamal Priyantha	Assi. Director	Laboratory-CEA
Ms. Jeeva David	Assi. Director	NRM-CEA
Ms. Sukitha Ranasinghe	Assi. Director	EPC/CEA
Mr. Tilak Nawarathne	Planning Officer	Planning and Monitoring/CEA
Ms. Thushara Pelawatte	Chemist	Laboratory/CEA
Mr. Yasuhiko Muramatsu	Team Leader	JICA Project Team
Mr. Kenichi Kuramoto	Inspection 1	JICA Project Team
Ms. Shibata Satobo	Internalship	JICA
Ms. Kanchana Hewage	Admin. Secretary	JICA Project Office

Data/Information	1. Presentation slides 2. Hard Copies (Progress Report 2)
Discussion topics	**Welcome Remarks.** • The meeting is chaired by Mr. Udaya R Senavirathne/ The Secretary

Subject	1. Progress Of the Project 2. Project Overview	Venue	Ministry Environment,"Saptha Parisara Mandapaya" 82,Rajamalwatte Road, Battaramulla.
	-Ministry of Mahaweli and Environment. At his welcome speech Mr. Senavirathne highlited the importance of conducting this kind of projects to protect the water qality in Kelani River due to the current situation. More than 25% of the population in Sri Lanka are using the Kelani river water for drinking purpose and in currenly the Ministry observed that there are many serious issues in the water quality. Therefore Mr. Senavirathne mentioned that we need to have a close monitoring system for the Kelani River. • After the self introduction by the participants, Mr. Manabe- The Representative of JICA Sri Lanka office, delivered a few words as opening remarks. At that time Mr. Manabe mentioned the Project is functioning smoothly from 2015 to update without any majour issues and the 60% cumilative progress showes in the end of 2016. Mr. Manabe thanked for the project team, CEA officers and for the Ministry for the given cooperation during the past years. • Mr. Mapa Pathirana- The Additional Secretary (Environmental Project & Education Training) also deliverd a very friendly speech for the opening remarks. In his speech Mr. Pathirana also mentioned the current issues which observed by the ministry in the Kelani River and Kelani River basin and he mentioned that the ministry is planning to impliement a conservation project of the Kelani river in very near future. That project will have long term and short term goals and the ministry will be planning to get the assistance from many stakeholders. Central Environmental Authority also will get major responsiblities of the proposed project and according to Mr. Mapa, the data collected by the exixsing project will be very usefull for the proposed project. According to the progress reported by the project, Mr. Mapa said that he noticed some issues as below. * Procurement of server for PSI Database (Before end of February 2017) * Lack of staff in the CEA Laboratory and the ISO Accreditation. * Delayed approval from the Legal draftsman for the Revised Ambiant Water Quality Standards.		

Subject	1. Progress Of the Project 2. Project Overview	Venue	Ministry Environment,"Saptha Parisara Mandapaya" 82,Rajamalwatte Road, Battaramulla.
	Procurement of server for PSI Database:- For this issue, CEA officers- Ms. Sukitha Ranasinghe (Team Leader for WG 3-2), Ms. Wasantha Wijesinghe (Project Manager) answered and explained the current status. According to them the Server specification have been submitted to the Administrative department in CEA for the Procurement process. The necessary budget have been alocated from the Local Componant 2017 of the project (1.77 million). Lack of staff in the CEA Laboratory and the ISO Accreditation :- For this issue, Ms. Wasantha Wijesinghe- The Director of Laboratory Services answered and said that there was an issue in the CEA Central Laboratory in past few months due to lack of staff. The Director and the Chemist were out of the office and some laboratory staff also on maternity leave, but that issue have been cleared now. New 2 Chemists and one Laboratory Assistant also recruted with effect from 2nd of January 2017 and now there wont be any problem. For the ISO Accreditation, documentation process is almost finished and the application can be submitted during the end of January 2017. Delayed approval from the Legal draftsman for the Revised Ambiant Water Quality Standards :- For this issue answered by Ms. Gayani Dissanayake- Assistant Director of Legal Unit, CEA and mentioned that they received a letter from the Legal draftsman dated on 17/01/2017 and refused to make it as a regulation. According to the letter, it says that the proposed standard would not be feasible due to the nature of the applicable water resources in Sri Lanka and need to access quality water.(A Copy of the letter submitted the the Secretary of MOE) • Then Mr. Senavirathne gave the time to state the comments for the last Meeting Minute. Due to no comments raised from the participants Mr. Senavirathne stated that it as a confirmed minute. • Mr. Yasuhiko Muramatsu- Team Leader of the project then started to present the progress of the project. (Hard copies of the 2nd Progress		

Subject	1. Progress Of the Project 2. Project Overview	Venue	Ministry Environment,"Saptha Parisara Mandapaya" 82,Rajamalwatte Road, Battaramulla.
	report have been submitted all the participants) He has given an explanation of the project status as below. * Explanation of the Project Design - Overall Goals, Project Purpose and 4 Outputs covered by the project (As per the presenatation) * The presentation structured according to the below topics. 1) Over view of the status 2) 3 Critical Issues such as Pending approval for Ambiant Water Quality Standards, Procurement of Server, ISO Accreditation for Laboratory. 3) Other important issues such as Procurement of equipment (I chemical has to be dilivered), Inspection and promotion of EPL, Information Management System. (Details are mentioned in the presentation slide) * Project Phase-out 1) Project Evaluation for Sustainability 2) Challenges beyond the project timeframe (Non point sources such as domestic waste water and agrecultural pollution) * Project evaluation •After the progress presentation of Dr. Muramatsu- the Team Leader of the project, time has given for the open discussions. At that time the Secretary - Mr. Senavirathne discussed the 3 critical issues what Dr. Muramatsu explained in his presentation. 1) Pending approval for Ambiant Water Quality Standards: Mr Senavirathe adviced to the CEA officials to study some standards using in other countries and prepare a comparative and more enforceable statement and then organise a meeting with Legal draftment with the support of project experts and local technical experts. Also Dr. Muramatsu mentioned that it is better to explained the Categorization procedure to the legal draftman at that time. 2) Procurement of Server for EPL/PSI system Mr. Senavirathne advised to the CEA officials not to get a long time for this process and arrange the procurement before end of February 2017.		

Subject	1. Progress Of the Project 2. Project Overview	Venue	Ministry Environment,"Saptha Parisara Mandapaya" 82,Rajamalwatte Road, Battaramulla.
	3) ISO Accreditation for the Laboratory If the document preperation is almost finished, Mr. Senavirathne advised to the Director EPC and Director Laboratory to submit the Application as before end of January. • Mr. Senavirathne checked the current status with the Chief Chemist of NWS&DB- Mr. L P R T Wijesinghe regarding the quality of the Kelani River. Mr. Wijesinghe mentioned that due to the dry climate, the water flow is very slow in these days. Also he mentioned that based on their survers the y have noticed some dumping yars in the kelani river. •Suggessions: Mr. Senavirathne mentioned that the real time monitoring is very important as wel as educational awareness programmes. Also Mr. Wijesinghe mentioned that it is very important BOI to arrange some micanisum to monitor the quality of the water in Kelani River. There being no other items to take up, the meeting adjourned at 4:30 pm after the thanking speech of Mr. Sivakumar- the Director - EPC Division of Central Environmental Authority. End		

MINUTES OF MEETINGS

BETWEEN

JAPAN INTERNATIONAL COOPERATION AGENCY

AND

MINISTRY OF MAHAWELI DEVELOPMENT AND ENVIRONMENT

AND

CENTRAL ENVIRONMENTAL AUTHORITY

OF

DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

ON

THE PROJECT FOR MONITORING OF THE WATER QUALITY OF MAJOR WATER BODIES

THE JOINT COORDINATION COMMITTEE MEETING

At the occasion of the final Joint Coordination Committee (JCC) meeting convened on 8th February 2018, the members of the JCC confirmed, among others, the Project outputs, procured equipment and the programmes of counterpart training in Japan based on the Draft Final Completion Report of the captioned project. The activities pursued by the CEA after this JCC meeting were also confirmed for improvement of project outputs.

As a result of discussions, the Draft Final Report was approved in this JCC meeting, then finalized as the Final Report. Other matters discussed and agreed by both sides are recorded in the document attached hereto.

The Secretary to the Ministry of Mahaweli Development and Environment, as the chairperson of the JCC according to the signed Record of Discussion dated 26th November 2014, Acting Chairman and a Board Member of Central Environmental Authority, Senior Representative from Japan International Cooperation Agency and Team leader of the JICA team set their hands hereunto and one other of same tenor.

Battaramulla, February 8, 2018

Mr. Anura Dissanayake
Secretary
Ministry of Mahaweli Development and Environment

Mr. M.G.W.M.W.T.B. Dissanayake
Acting Chairman
Central Environmental Authority

Mr. Ajita De Costa
Board Member
Central Environmental Authority

Mr. Toru KOBAYAKAWA
Senior Representative
Japan International Cooperation Agency, Sri Lanka Office

Mr. Yasuhiko MURAMATSU
Team Leader
The JICA Team

ATTACHED DOCUMENT

The JICA Team gave a presentation on 1) the achievements of the project and 2) the way ahead.

1. Achievements of the Project

1. 1 Outputs and Project Purpose

The salient points of the presentation are summarised below. It was noted that all the outputs were produced through joint implementation and collaboration among the CEA, the JICA Team and other concerned organizations.

(1) Output-1

The CEA developed the categorization scheme of inland surface water by developing the Procedural Guidelines for Categorization of Inland Surface Waters; and the Ambient Water Quality Standard which was formally approved by the Department of legal Draftsman. The CEA categorized the Kelani river basin according to the beneficial use of water based on the categorization scheme.

(2) Output-2

The llaboratory service unit of the EPC division strengthened the Quality Management System and enhanced the quality control of water quality analysis. The laboratory service unit has thus entered its final phase of the ISO/IEC 17025 accreditation. It was also noted that the parameters for accreditation of ISO/ IEC 170025 were 5 parameters: pH, COD, Chloride, Total Hardness and Phosphorus.

(3) Output-3

The CEA prepared the pollution source inventory system by using EPL information, which is connected with all provincial offices. The system was developed as a single online database by integrating the four standalone databases on EPL previously developed by different divisions of the CEA. Further, the CEA prepared the relevant guidelines and materials on inspection of industries and promotion of EPL scheme.

(4) Output-4

The output-4 was designed to enhance information disclosure on environmental status of Kelani River. The Environmental Report presented the information that has impacts on the environment such as industry establishments, mining, weather etc. The report was prepared to disclose the environmental status of the river through the CEA website for raising environmental awareness of the public.

1.2 Procurement of Equipment

The JICA Team explained to the Sri Lankan side about the procurement of equipment in the Project. The equipment was delivered and installed in the central laboratory. The training for use of the equipment was also provided. The list of the equipment is attached as Annex-2.

1.3 Counterpart Training in Japan

Counterpart training in Japan were conducted three (3) times with thirty-six (36) participants during the project period. The detailed program is attached as Annex-3.

2. Way Ahead

The Sri Lankan side agreed to pursue the following activities for improvement of project outputs with the recognition of the recommendations made in the Draft Completion Report.

1) Finalize three (3) Industrial Pollution Control Sector Guidelines by integrating air and waste management section;
2) Finalize the Environmental Report -state of the Kelani river basin- and Upload it on the CEA web-site; and
3) Upload the environmental information on the web-site to disclose the relevant information to the public prepared by the Working Group 4.

3. Final Report

The JICA Team explained to the Sri Lankan side about the Draft Final Report prepared based on the project outputs and activities during of the CEA. The DF/R was approved in this JCC meeting held on 8th February 2018, then finalized as the Final Report (Hereinafter referred to as "F/R"). The JICA Team will submit Eighteen (18) sets of F/R to the Sri Lankan side through JICA after this JCC meeting. The Sri Lankan side understood the process to formally receive the F/R.

Annex 1 **Project Design Matrix (PDM) ver.2**
Annex 2 **List of the Procured Equipment**
Annex 3 **Program of Training in Japan**

Annex-1 Project Design Matrix (PDM) ver.2

Project Title: The Project for Monitoring of the Water Quality of Major Water Bodies — Dated 29, May, 2015 Ver.2
Implementing Agency: Central Environmental Authority (CEA) — Period of Project: 3 years (tentative)
Target Group: Ministry of Mahaweli Development & Environment /Central Environmental Authority (CEA)/ Environmental Pollution Control (EPC) Division, Laboratory Service and target Departments of regional branch offices in CEA
Project Site: Sri Lanka Model Site: Kelani river

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
Overall Goal: Water quality management in major water bodies is appropriately implemented by CEA	OG1 The by-laws and/or regulations which stipulate roles and functions of a water quality management system are inaugurated by 2020. OG2 The ratio of water bodies assessed/ managed by CEA by using improved water quality monitoring methods (system/ procedure) increases by 2020 compared with the initial stage of the Project. OG3 The number of major water bodies with proposed the water quality environmental management system are at least one (1) in Sri Lanka by 2020 in accordance with the guidelines prepared by the Project.	1. Data and documents in CEA and its regional branch offices	The principal policy prescribed in the National Environmental Act for water quality management in Sri Lanka is not negatively changed.
Project Purpose: Enforcement capacity of CEA and its regional branch offices of the Kelani river basin on water quality management is strengthened.	PP1 CEA conducts self-evaluation on their own capacity of policy and system making regarding water quality management such as nos. of proposals related to gazetting ambient water quality standards, introduction of ambient water quality zoning and categorization system, improvement of current EPL system, etc. based on the National Environmental Act (No.47 of 1980) and other related by-laws, and its evaluation results show improvement, compared with the initial stage of the Project. PP2 CEA, concerned departments, and regional branch offices conduct self-evaluation on their own enforcement capacity of water quality management such as nos. of guidance to EPL holders (factories), nos. of penalty case, etc. based on the National Environmental Act (No.47 of 1980) and other concerned by-laws, and its evaluation results show improvement, compared with the initial stage of the Project. PP3 The guidelines and other outputs developed through the Project are properly applied by all concerned departments and regional offices of CEA in charge for a nationwide promotion of water quality management. PP4 The number of major water bodies and regional governments which propose zoning categorization of ambient water quality standard is at least one (1) in Sri Lanka. PP5 One (1) guideline and materials on zoning and categorization are developed and used. PP6 More than 2 times of guidance are conducted by CEA to organizations which have responsibility for water quality management of target water bodies. PP7 More than 70 % of staff in the concerned departments and regional offices of CEA in charge can explain how to use the guidelines and other outputs developed through the Project.	1. Questionnaire survey for CEA, concerned departments, and regional branch offices at the initial, mid-term, and final stage of the Project 2. ditto 3. Data and documents in CEA, concerned departments, and regional branch offices 4. ditto 5. Actual nos. of guidelines and materials 6. Guidance record to target organizations and the result of the review test 7. Hearing and evaluation survey to target organizations	The principal policy for water quality management of CEA related to institution and budget for its implementation is not negatively changed. All related organizations in CEA and regional governments are active in promoting water quality management.
Outputs: Output 1: The introduction of water body categorization in line with the ambient water quality standard in Sri	1-1 More than 9 reference monitoring points of ambient water quality standard are designated. 1-2 A proposal for introducing ambient water quality zoning and categorization is prepared based on trial results in the Kelani river.	1. Data and documents in CEA, concerned departments, and regional branch offices	

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
Lanka are set-up.	1-3 At least one (1) of major water bodies proposes zoning and categorization system in Sri Lanka.		
Output 2: Water quality analysis capacity of lab staff is strengthened.	2-1 Nos. of lab staff who have sufficient analysis capability are more than 7 persons in the target labs. 2-2 More than 1,200 samples are analyzed annually. 2-3 Equipment and instruments including reagents are properly operated and maintained. 2-4 More than 12 types of QA/QC activities are conducted by the end of the Project. 2-5 The CEA lab obtains accreditation certificates for more than 2 water quality parameters from the SLAB.	1. Proficiency test results using unknown concentration samples (staff at provincial offices are included.) 2. Actual nos. of samples analyzed 3. SOPs developed, Relevant records 4. Reports/ Documents/ Relevant Records 5. Accreditation certificate of ISO/IEC 17025 from the SLAB	
Output 3: Enforcement capacity of the targeted counterpart organizations on water quality monitoring including inspection is strengthened, pollution sources inventory (PSI) is created, and acquisition of the Environmental Protection License (EPL) is promoted.	**3-1 Water quality monitoring including inspection** 3-1-1 More than 10 times of cooperating and sharing meetings among concerned organizations are carried out. 3-1-2 Monitoring plans and reports including inspection, and analysis and evaluation of monitoring results including inspection in 2016 and 2017, are prepared by target departments, and shared with concerned departments and organizations. 3-1-3 More than 10 times of sampling and water quality analysis are conducted in the ambient standard points. 3-1-4 More than 6 times of workshops are conducted for sharing monitoring data and analysis results including inspection with concerned departments. 3-1-5 Monitoring guideline including inspection for rivers in Sri Lanka is prepared. 3-1-6 Level of enforcement capacity on water quality monitoring including inspection is improved. 3-1-7 All violation cases revealed through monitoring including inspection are reported to the Legal Unit of CEA.	1. Annual monitoring plan and report including inspection prepared 2. Actual nos. of monitoring data, documents, and records including inspection 3. Documents and records of workshops conducted 4. Monitoring guideline including inspection prepared 5. Comparison of capacity assessment results conducted at initial stage, mid-term evaluation, and terminal evaluation of the Project 6. Violation case records received by the Legal Unit of CEA	
	3-2 Pollution Source Inventory (PSI) 3-2-1 More than 10 times of cooperating and sharing meetings among concerned organizations are carried out. 3-2-2 More than 3200of PSI data are prepared targeting major pollution sources in the Kelani river basin. More than 9,800 of PSI data are prepared targeting major pollution sources in Sri Lanka. 3-2-3 More than 70 % of major pollution sources in the Kelani river basin are identified and recorded on PSI Database (DB). 3-2-4 More than 85 % of PSI data are up-dated by follow-up activities. 3-2-5 More than 6 times of PSI sharing meetings are held among concerned departments that manage and use PSI data. 3-2-6 Level of enforcement capacity on PSI preparation is improved.	1. PSI data prepared 2. PSI data up-dated and records of follow-up activities 3. Documents and records of PSI sharing meetings 4. Comparison of capacity assessment results conducted at initial stage, mid-term evaluation, and terminal evaluation of the Project	
	3-3 Promotion of EPL scheme and effluent water quality standards for existing industries in the Kelani river basin 3-3-1 More than 15 times of monitoring including inspection are conducted in the Kelani river basin using guideline guidebook developed. 3-3-2 Monitoring including inspection are conducted more than 80 % of major pollution sources in the Kelani river basin using guideline developed. 3-3-3 Method for selecting crucial pollution sources in the Kelani river basin are developed and its result is reflected on the monitoring plan including	1. Actual nos. of data, documents, and records related to EPL conducted in the Kelani river basin 2. Actual nos. of monitoring data and records including inspection in the Kelani river basin 3. Guideline prepared and its usage record	

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
	inspection. 3-3-4 Acquisition of EPL is increase more than 2 % in actual condition in the Kelani river basin 3-3-5 Guidance for promoting EPL and effluent quality standard is prepared. 3-3-6 Illegal and/ or EPL-violating factories are reported to the authorities for sanction.	4. Reports and records prepared and informed	
Output 4: Information management system of the water quality monitoring data including inspection, EPL data, and PSI data, on inland surface water bodies are developed and effectively used	4-1 More than 10 times of working group discussion meetings are carried out. 4-2 Database (DB) including EPL data for information management system is developed by web-base, and used by concerned organizations. 4-3 Input data is properly up-dated annually. 4-4 Guidance for promoting information management system in Sri Lanka is prepared. 4-5 Annual report is prepared and shared with concerned organizations.	1. Actual nos. of data, documents, and records concerning to information management 2. Conditions of DB and its usage record 3. Up-dated data and conditions 4. Guidance prepared and its usage record 5. Activity record of pilot project, and comparison of capacity assessment results conducted at initial stage, mid-term evaluation, and terminal evaluation of the Project 6. Prepared annual report and record of its sharing conditions	

Activities	Inputs		Important Assumption
	The Japanese Side	The Sri Lankan Side	
1) The introduction of water body categorization in line with the ambient water quality standard in Sri Lanka are set-up. 1-1: Review the current legal and institutional level and implementation system. 1-2: Clarify current situations and issues on management and compliance of the ambient water quality standard. 1-3: Establish a working group (WG), identify capacity development (CD) needs, and agree a task matrix of activities. 1-4: Conduct CD activities, develop tools and materials for categorization, and conduct its trial practices in selected rivers. 1-5: Prepare a set of guidelines for introducing the categorization based on trial practices and lessons learned. **2) Water quality analysis capacity of lab staff is strengthened.** 2-1: Review the current situation and level of central and regional labs in CEA. 2-2: Establish a WG and agree the specific CD plan including water quality analysis and operation and maintenance (O&M) of equipment. 2-3: Conduct CD activities, develop the Standard Operation Procedure (SOP), and continue the activities to obtain official accreditation such as ISO/IEC17025. **3) Enforcement capacity of the targeted counterpart organizations on water quality monitoring including inspection, pollution sources inventory (PSI), and the Environmental Protection License (EPL) scheme, is strengthened.** **<3-1> Water quality monitoring including inspection** 3-1-1: Review the current water quality monitoring conditions including inspection and identify CD needs. 3-1-2: Establish a WG, prepare a task matrix of activities, and agree on the specific CD plan. 3-1-3: Conduct CD activities including preparation of annual planning, sampling, reporting, and feedback to other WGs.	1) Expert Team - Team Leader/ Water Quality Management - Water Quality Analysis - Environmental Monitoring - Pollution Sources Inventory - Inspection - Data and Information Management/ Database - Coordinator 2) Seminars and Workshops 3) Training in Japan 4) Equipment Necessary for Project Activities 5) Pilot Projects 6) Local Consultants for Sub-contract Works	1) Counterpart (C/P) Personnel - CEA and concerned Departments - Regional Branch Offices 2) Project Office Space at CEA 3) Budget Allocation for Salary and other Expenditure for C/P during the Project Period. 4) Budget Allocation for Running cost of Equipment procured under the Project	

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
3-1-4: Analyze and evaluate monitoring results including inspection and prepare an annual report on the Kelani river basin. 3-1-5: Prepare a monitoring guideline including for rivers in Sri Lanka. **<3-2> Pollution Source Inventory (PSI)** 3-2-1: Review the current PSI conditions, and identify CD needs. 3-2-2: Establish a WG, prepare a task matrix of activities, and agree on the specific CD plan. 3-2-3: Conduct CD activities including format preparation, annual planning, reporting, and data sharing with other WGs. 3-2-4: Manage and use PSI data in collaboration with other organizations. 3-2-5: Prepare a PSI guideline for rivers in Sri Lanka. **<3-3> Promotion of EPL scheme and effluent water quality standards for existing industries in the Kelani river basin** 3-3-1: Review the current situation of EPL scheme and effluent water quality standard in the Kelani river basin, and identify principal issues to be improved. 3-3-2: Establish a WG, prepare a task matrix of activities, and agree on the specific capacity CD plan. 3-3-3: Conduct CD activities including the development of necessary tools and materials, and implement it in the Kelani river basin as a pilot project. 3-3-4: Prepare a guidance for promoting EPL and effluent water quality standards.			
4) Information management system of the water quality monitoring data including inspection, EPL data, and PSI data, on inland surface water bodies are developed and effectively used. 4-1: Review the current information management situation of the water quality monitoring data including inspection, EPL data, and PSI data, on inland surface water bodies, and identify principal issues to be improved. 4-2: Establish a WG, prepare a task matrix of activities, and agree on the specific CD plan. 4-3: Conduct CD activities including development of database (DB), and implement it in the Kelani river basin as a pilot project. 4-4: Prepare a guidance for promoting the developed information management system in Sri Lanka.			Pre-Conditions A project budget is secured in a Sri Lankan side. CEA assigns necessary staffs for implementation of the Project. <Issues and countermeasures>

Certified By: ....2018/02/08..........

Wasantha Wijesinghe
Director -Laboratory (Project Manager)
Central Environmental Authority

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Mr. P.B.Hemantha Jayasinghe
Director General
Central Environmental Authority

Annex 2 List of the Equipment

List of the Procured Equipment

#	Description	QTY	Model Number	Manufacture
1	Water deionization System	1	B30 bio	Adrona, SIA of Latvia(EU)
2	Sediment Sampler	1	Ekman Dredge	AMS
3	Microwave Digester for digestion of effluent and sludge and soil for heavy metals	1	Ethos Easy	Milestone
4	UV Visible Spectrophotometer	1	UV1280	Shimadzu
5	CODcr measuring Equipment	1	DBR-001	MRC Ltd of Israel
6	Multi parameter Water Quality Checker	2	U-52	Horiba
7	Centrifuge	1	Universal Centrifuge PLC-025 Bucket : T-5004	Gemmy Industrial Corp (associated with Cannic Inc.,USA),Taiwan
8	Acid Alkali/Flammable Storage Cabinet	1	M2PND90-54L	Zeba Labs - India
9	DO meter for BOD measurement	1	DO2700	Eutech- Thermofi sher Scientific-Singapore
10	Burettes	1	Burettes 50ml	No-brand
11	Laboratory Jack	2	050-05-200	ISOLAB
12	Fume hood	1	MEH 15	METHOD ENTERPRISE SDN BHD
13	Laminar flow clean bench	1	BBS-DDC	BIOBASE
14	Heavy oil standard for Oil & grease analysis	1	OG-100	Sigma-Aldrich
15	Bottles, for BOD analysis	1	100pcs 300mL-BOD bottles and stoppers	Made in USA
16	Laboratory gas cylinder trolley high quality	1	BS-673	Bossay
17	Complete distillation set	1	KIIIlz4	Gerhardt (Germany)
18	Sample carrying boxes	2	LPGMCI 35L TS1-19 LPHHCBA 55L	ANTARCTJA
19	Automatic Dispensers	1	Sxl 501. 101	Socorox (Swiss)
20	Heating mantle	2	HM-500	Azzota
21	Laboratory Refrigerator	1	MPR S313 PE	Panasonic Healthcare Co. Ltd.
22	Bottle cooler	1	PBC281	SISIL
23	CRM (Certified Reference Material)	10	BOD, COD, Conductivity, TSS, TDS, TH, Cl, Trace metal, Nitrate, Phosphate, Anion mixture, Simple Nutrient	Sigma-Aldrich Cerilliant

Certified By:

2018/02/08
Wasantha Wijesinghe
Director -Laboratory (Project Manager)
Central Environmental Authority

Mr. P.B Hemantha Jayasinghe
Director General
Central Environmental Authority

Annex 3 Program of Training in Japan

Program of Training in Japan

Items	1st year (2015)	2nd year (2016)	3rd year (2017)
Title	Water Environmental System and Administrative Management	Water Environment Management including Inspections and Laboratory Analysis	Water Environment Management including Inspections and Laboratory Analysis and Database management
Number of Participants	12 officers	12 officers	12 officers
Proposed Period	From 2015/11/30 to 2015/12/10	From 2016/5/29 to 2016/6/11	From 2017/7/10 to 2017/7/20
Purpose	To obtain the roll of public sector and system of law regarding water environment in Japan	To obtain knowledge of measure of improvement of river water quality, and improvement of analytical techniques and/or inspection capacity	To acquire knowledge regarding Water environmental management and relative environmental data
Focus Issues	1 To learn the law, regulation regarding water environment and management system on administrative order 2. To learn the environmental management system by public sector 3. To learn the method of inspection and publication of administrative works in case of Japan	1. To acquire knowledge and Practice on the Analytical Method and Laboratory Management in Japan 2. To acquire knowledge and learn on the Treatment Methodology of chemical wastewater from Laboratory 3. To acquire knowledge and learn on the Inspection method in Japan 4. To acquire knowledge and learn on the improvement method of river water	1. To acquire knowledge and Practice on handling policy for environmental data and disclosure 2. To acquire knowledge and learn on the Maintenance of mobile sensor 3. To acquire knowledge and learn on maintenance and improvement of river water
Major Destinations	1. Environmental Management Bureau, MOE 2. Water Environmental Management Bureau, Saitama prefecture 3. Environmental Comprehensive Institute in Kawasaki city 4. Tokyo Metropolitan Research Institute for Environmental Protection 5. Environmental Management Bureau, Kitakyushu-city 6. Water supply & Drainage bureau, Kitakyushu-city 7. Environmental Museum of Water 8. Welfare & Environmental Bureau, Minamata-City 9. Minamata disease municipal museum	1. Asahi Pretec Corp. 2. Yamato river management office, MLIT 3. Environmental Research & Solution Co., Ltd. (ER&S) 4. Wastewater treatment plant 5. Seibu Environmental management office of Saitama 6. Center for Environmental Science in Saitama (CESS)	1. Horiba, Ltd. 2. Environmental Research & Solutions Co., Ltd. (ER&S) 3. Fuji Clean Co., Ltd. 4. Environmental Management Bureau, MoE 5. Environmental Policy Bureau, MoE 6. Life Science and Environment research center, Kawasaki City 7. National Metrology Institute of Japan

Certified By: 2018/02/08

Wasantha Wijesinghe
Director -Laboratory (Project Manager)
Central Environmental Authority

Mr. P.B Hemantha Jayasinghe
Director General
Central Environmental Authority

付属資料 5　訪日研修記録

Administer Counterparts Training in Japan

The training in Japan was conducted tree (3) times during the Project period to assist the officer in understanding the environmental management and experiences in Japan. The training contents are designed to provide necessary knowledge and experiences concerning environmental management in Japan as shown to Figure 1. The summary of training in Japan is shown in Table 2. The participants lists are also provided.

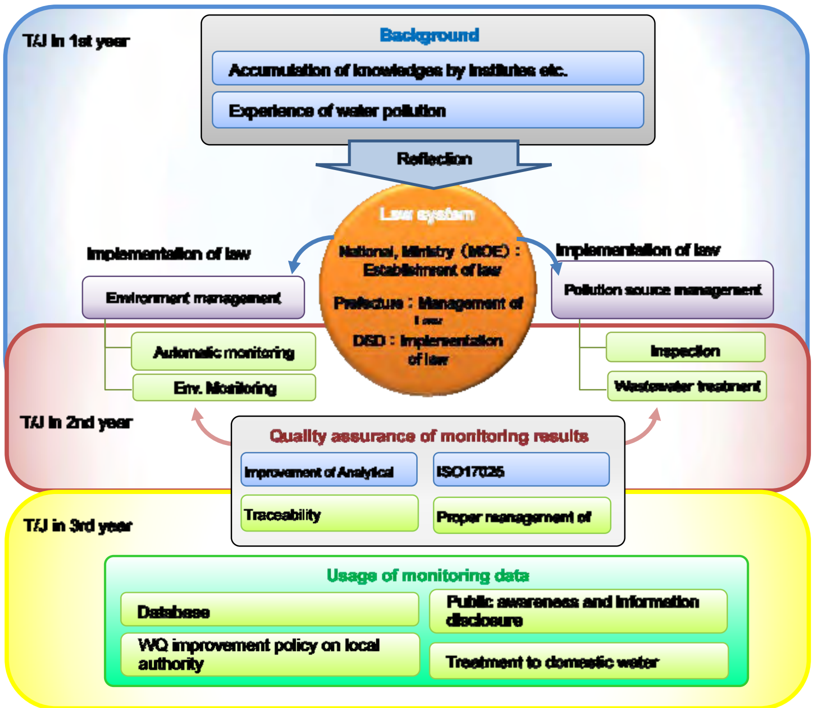

Figure 1 Conceptual Illustration of the trainings in Japan

Table 1 Summary of Training in Japan

FY	Title	Purpose	Period	No. of Participants
1st Year	Water Environmental System and Administrative Management	1. To acquire knowledge and lessons on the laws and regulations on water environment and management in Japan 2. To capture an overview on the environmental management system by governmental bodies in Japan 3. To acquire knowledge and lessons on factory inspection and environmental awareness activities in Japan	30th Nov. 2015 to 10th Dec. 2015	12
2nd Yare	Water Environment Management including Inspections and Laboratory Analysis	1. To acquire knowledge and practice on the analytical method and laboratory management in Japan 2. To acquire knowledge and learn the treatment methodology of chemical wastewater from Laboratory 3. To acquire knowledge and learn on the Inspection method in Japan 4. To acquire knowledge and learn on the improvement method of river water	29trh May 2016 to 11th June 2016	12
3rd Year	Water Environment Management including Inspections and Laboratory Analysis and Database management	1. To acquire knowledge and practice on handling policy for environmental data and disclosure 2. To acquire knowledge and learn on the maintenance of mobile sensor 3. To acquire knowledge and learn on maintenance and improvement of river water	10th July 2017 to 20th July 2017	12

Table 2 Participants of Counterpart Training in Japan in 2015

#	Name	Organization	Positions
1	Prof. Lal Mervin Dharmasiri	CEA	Chairman
2	Dr. R. M. S. K. Ratnayaka	CEA, Environment Pollution Control Division	Actg. Deputy Director General
3	Mrs. WasanthaT. W. A. W. Wijesighe	CEA, Laboratory Service	Director
4	Mrs. M. M. P. W. Wickramanayake	CEA, Legal Unit	Director
5	Ms. Manoja Priyadharshani	CEA, Western Provincial Office	Actg. Deputy Director
6	Mrs. Wijayani Ambeygoda	CEA, Gampaha District	Assistant Director
7	Mrs. Jeeva David	CEA, Natural Resources Management	Assistant Director
8	Mrs. Himali Karunaweera	CEA, Environment Pollution Control Unit	Assistant Director /EPC
9	Mrs. S. S. Ranasinghe	CEA, Environment Pollution Control Unit	Assistant Director /EPC
10	Ms. C. H. Edussuriya	CEA, Research and Development Unit	Assistant Director
11	Mrs. C. T. Pelewatte	CEA, Laboratory Service	Chemist
12	Mr. Tilak Nawarathne	CEA,	Planning Officer

Table 3 Participants of Counterpart Training in Japan in 2016

#	Name	Organization	Positions
1	Mr K.H. Muthukuda Arachchi	CEA	Director General
2	Ms Nelka Perera	EPC Division, CEA	Assistant Director
3	Ms Nadeeka Niroshani	EPC Division, CEA	Senior Environmental Officer
4	Ms Chethika Ambalangodage	Laboratory Unit, CEA	Senior Laboratory Assistant
5	Ms Gagani Gamage	Laboratory Unit, CEA	Laboratory Assistant
6	Ms Swarna Rajapakse	EPC Division, CEA	Senior Environmental Officer
7	Ms Priyanka Athukoralage	EPC Division, CEA	Senior Environmental Officer
8	Mr Harsha Walpita	Colombo Office CEA,	Senior Environmental Officer
9	Mr M S S Bandara	EPC Division, CEA	Senior Environmental Officer
10	Ms Keshika Wathuhewa	EPC Division, CEA	Environmental Officer
11	Ms Priyangika Mahagoda	EPC Division, CEA	Senior Environmental Officer
12	Mr Kamal Priyantha	Laboratory Unit, CEA	Assistant Director

Table 4 Participants of Counterpart Training in Japan in 2017

#	Name	Organization	Positions
1	Ms Gayani Dissanayake	Legal Unit, CEA	Assistant Director
2	Mr. Lalith Karunarathne	Western Province Office, CEA	Senior Environmental Officer
3	Mr. M K M Senarath	Western Province Office, CEA	Divisional Environmental Officer
4	Mr. O P K Pathirana	Gampaha District Office, CEA	Divisional Environmental Officer
5	Ms. Shanthi Deerasinghe	Gampaha District Office, CEA	Senior Environmental Officer
6	Ms. P H C Manel	Gampaha District Office, CEA	Divisional Environmental Officer
7	Ms. Shrika Priyadarshani	Gampaha District Office, CEA	Senior Environmental Officer
8	Mr. K P N A Pathirana	Western Province Office, CEA	Divisional Environmental Officer
9	Ms Lorrain Cooray	Laboratory Unit, CEA	Chemist
10	Mr Y A Nuwan Buddika	EPC Division, CEA	Environmental Officer
11	Ms Menaka Jayathilake	Laboratory Unit, CEA	Environmental Officer
12	Ms. Thanuja Ranasinghe	Planning & Monitoring Division, MOE	Development Officer

付属資料 6　水質管理に関する法制度

Table 1 Laws and Regulations regarding Water Quality Management

No.	Legal/ Regulation	Information of publish	Summary	Competent Authority
1	National Environmental Act	No.47 of 1980	Set forth the Establishment of CEA; and regulations regarding CEA and Environmental Protection (general)	CEA
		No. 56 of 1988 (Amendment)	Revise relevant stipulations regarding the role of CEA and Environmental Protection	CEA
		No. 53 of 2000 (Amendment)	Revise relevant stipulation regarding EPL	CEA
2	National Environmental (Protection and Quality) Regulation	Gazette Extraordinary No. 1534/18 of 2008	Provide for waste management of EPL with the following parts: Part I Emission or Disposal Waste Part II Management of Waste Part III Effluent standard of 7 categories for purpose of water usage and category of industry, some application form and category of Waste	CEA
3	National Environmental (Protection and Quality) Regulation	Gazette No. 1533/16	Set forth Category of EPL registration Category A (80), Category B (33) and Category C (25)	CEA
4	Mahaweli Authority Act	No.23 of 1979	Provide Mahaweli Ganga development plan including reservoir and irrigation system	Mahaweli Authority
5	Irrigation ordinance which consolidates laws	No.32 of 1946 with amendments	Describe the powers and functions of a number of institutions, such as the Commissioner and its Government Agents, the District Agricultural Committees and the Cultivation Committees	Irrigation Department
6	National Water Supply & Drainage Board (NWS&DB) Act	No.2 of 1974	Describe NWS&DB Mention to "bathing in any stream, reservoir, aqueduct, or other waterworks belonging to the Board, or washing, throwing, or causing to enter therein any dog or other animal" as punishment for offence	NWS&DB
		Act No.13 of 1992	Amend offence (increment of penalty)	NWS&DB
7	Water Resources Board Act	No.29 of 1964	Describe WRB	Water Resources Board
		No.29 of 1999	Amend duties and powers of WRB	
8	Marine Pollution Prevention Act	No.59 of 1981 No. 35 of 2008	Describe Marine Pollution Prevention Authority	Marine Environment Protection Authority
		Gazette No. 1709/15 of 2011	Set forth requirements for the Granting of a Marine Environment Protection License	
		Gazette No. 1741/19 of 2012	Provided for international Safety Guide for Oil Tankers and Terminals	
		Gazette No. 1771/19 of 2012	Provide for Oil Spill Contingency Plan Regulations	
		Gazette No. 1816/37 of 2013	Set forth regulations on Issuance of permits for dumping at sea	
9	Coast Conservation Act	No.57 of 1981	Provide for Coastal Zone and Coastal Zone Management Plan	Coast Conservation Advisory Council
		No.64 of 1988	Describe enforcement measures, activities within Coastal Zone and powers of police	

Note: Prepared by the JICA Team based on the relevant Acts and Gazettes

付属資料 7　WG メンバーリスト

Table 1 Members of Working Group 1

No.	Organization	Position	Name	Note
1	CEA	DG	K.H. Muthukuda Arachchi	Observer
2	CEA	Deputy DG	R. M. S. K. Rathnayak	Observer
3	EPC Division, CEA	Director	Devika Vithanage	Team leader
4	Laboratory Unit, CEA	Chemist	Thushara Pelawatte	
5	EPC Division, CEA	Assistant Director	Himali Karunaweera	
6	EPC Division, CEA	Officer	Nadeeka Niroshini	
7	Natural Resources Management Unit	Assistant Director	Jeeva David	
8	Research & Development Unit	Assistant Director	Chandani H Edussoriya	
9	Legal Unit	Director	Manuja Wimalasena	Observer
10	BOI, Environment Management	Director (Environmental Management)	M A S Perera	Observer
11	MOIC	Policy and Planning	Ruchira Vithana	Observer
12	MOMD&E	Director Policy Planning	To be nominated	
13	Department of irrigation	Engineer	P M Jayadeera	
14	NWS&DB	Senior Chemist	H M A K Herath	
15	The JICA Team	Team Leader/ Water Environment Management	Yasuhiko Muramatsu	
16	The JICA Team	Deputy Team Leader/Environment Monitoring	Takashi Onuma	
17	The JICA Team	Information Management System	Leigh Lunas	

Source: The JICA Team

Table 2 Members of Working Group 2

No.	Organization	Position	Name	Note
1	CEA	Deputy DG	Dr. R. M. S. K. Rathnayake	Observer
2	Laboratory Unit, CEA	Director	Wasantha Wijesinghe	Team leader
3	Laboratory Unit, CEA	Chemist	Thushara Pelawatte	
4	Laboratory Unit, CEA	Chemist	Lorrain Corray	
5	Laboratory Unit, CEA	Environmental Officer	Dimuthu Wijerathna	
6	Laboratory Unit, CEA	Environmental Officer	G. C Priyadharshani	to provincial office
7	Laboratory Unit, CEA	Environmental Officer	Swarna Vishvanathan	
8	Laboratory Unit, CEA	Environmental Officer	Menaka Jayathilaka	
9	Laboratory Unit, CEA	Sr. Laboratory Assistant	Chethika Ambalangodage	
10	Laboratory Unit, CEA	Laboratory Assistant	Gagani Gamage	
11	Laboratory Unit, CEA	Chemist	Arana Wiiesinghe	Joined from Jan 2017
12	Laboratory Unit, CEA	Chemist	Nisansala Swarnamali Bopage	Joined from Jan 2017
13	Laboratory Unit, CEA	Laboratory Assistant	Isuri Jayamaha	Joined from Jan 2017
14	SLAB	Deputy Director (Accreditation)	L H D Bandusoma	
15	The JICA Team	Water quality Analysis	Seiji Okano	
16	The JICA Team	Team Leader	Yasuhiko Muramatsu	
17	The JICA Team	Deputy Team Leader	Takashi Onuma	
18	The JICA Team	The JICA Team	Michinori Mutsuda	Joined from June 2016

Source: The JICA Team

Table 3 Members of Working Group 3-1

No.	Organization	Position	Name	Note
1	Western Province Office, CEA	Assistant Director	Ms. Manoja Priyadharshani	Team Leader
2	CEA	DG		Observer
3	MOE			Observer
4	Legal Unit	Assistant Director	Ms. Gayani Dissanayake	Observer
5	Laboratory Unit, CEA	Director	Ms. Wasantha Wijesinghe	
6	Laboratory Unit, CEA	Chemist	Ms. Thushara Pelawatta	
7	Laboratory Unit, CEA	DD/ARM&M	Mr. Kamal Priyantha	
8	EPC Division, CEA	EO	H. H. D. H Madunika	
9	BOI Environmental Management	Senior Deputy Director (Env.-BEPZ)	Mrs. N M Samaranayake	
10	JICA Expert Team	Inspection 1	Kuramoto	
11	JICA Expert Team	Inspection 2	Gloria	
12	JICA Expert Team	Team Leader	Muramatsu	
13	JICA Expert Team	Deputy Team Leader	Onuma	

Source: The JICA Team

Table 4 Members of Working Group 3-2

No.	Organization	Position	Name	Note
1	CEA	Deputy DG EPC	R. M. S. K. Rathnayake	Observer
2	EPC Division, CEA	Assistant Director	Sukitha Ranasinghe	Team leader
3	EPC Division, CEA	Senior Environment Officer	Nadeeka Ranasinghe	
4	EPC Division, CEA	Environment Officer	Arsha Kumari	
5	Laboratory Unit, CEA	Environment Officer	Swarna Vishvanathan	
6	Colombo Office	Deputy Director	Nanga Dryodl	
7	Gampaha Office	Director	Chathura Malwana	
8	Research & Development Unit	Assistant Director	Chandani H Edussoriya	
9	IT Unit	Environment Officer	Sithara Perera	
10	Planning &Monitoring Unit	Planning Officer	Thilak Nawarathne	
11	BOI, Environment Management	Deputy Director (Env.)	K L G Perera	
12	The JICA Team	PSI	Eiko Watatsu	
13	The JICA Team	Team Leader	Yasuhiko Muramatsu	
14	The JICA Team	Deputy Team Leader	Takashi Onuma	

Source: The JICA Team

Table 5 Members of Working Group 3-3

No.	Organization	Position	Name	Note
1	EPC Division, CEA	Assistant Director	Ms. Himali Karunaweera	Team leader
2	CEA	Deputy DG EPC		Observer
3	EPC Division, CEA	SEO	Swarna/Madunika	
4	Laboratory Unit, CEA	Environmental Officer	Ms. Menaka Jayathilaka	
5	Sabaragamuwa Province			
6	Gampaha Office	Director		
7	Colombo Office	SEO	Harshu Walpita	
8	BOI, Environment management	Senior Deputy Director (Env.)	Ms A S Beling	
9	JICA Expert Team	Inspection 1	Kuramoto	
10	JICA Expert Team	Inspection 2	Gloria	

No.	Organization	Position	Name	Note
11	JICA Expert Team	Team Leader	Muramatsu	
12	JICA Expert Team	Deputy Team Leader	Onuma	

Source: The JICA Team

Table 6 Members of Working Group 4

No.	Organization	Position	Name	Note
1	CEA	Deputy DG EPC	R MSK Rathnayake	Observer
2	EPC Division CEA	Assistant Director	Nelka Perera	Team Leader
3	EPC Division, CEA	Senior Environment Officer	Senarath Bandara	
4	EPC Division, CEA	Environment Officer	Keshika Wachthuhewa	
5	IT Unit	Environment Officer	Sithara	
6	R & D unit	Assistant Director	Chandani H. Edussuriya	
7	NRM Unit	Assistant Director	Jeewa David	
8	P & M Unit	Planning Officer	Thilak Nawaratna	
9	NWS&DB	Chief Engineer	Nalini P Goonawardena	
10	BOI, Environment Management	Senior Deputy Director	N m Samarayanake	
11	Irrigation Department		W. B. Palugaswewa	
12	The JICA Team	Information Management System	Leigh Lunas	
13	The JICA Team	Team Leader	Yasuhiko Muramatsu	
14	The JICA Team	Deputy Team Leader	Takashi Onuma	

Source: The JICA Team

付属資料 8　水質環境基準と根拠資料

Ambient Water Quality Standard and the Category

	No.	Parameter	Unit	Category A: Water source for simple treatment	Category B: Bathing and contact recreational water	Category C: Fish and Aquatic Life Water	Category D: Water source for general treatment	Category E: Irrigation & Agriculture	Category F: Minimum Water Quality
General	1	Colour	PTmg/l	20	-	-	100	-	-
	2	Conductivity	μS/cm	-	-	-	-	700	-
	3	Turbidity	NTU	5	-	-		-	-
	4	TSS	mg/l	25	-	40	1500	2100	-
	5	Total Hardness (as CaCO3)	mg/l	250 des 600 max	-	-	-	-	-
	6	pH	-	6.0-8.5	6.0-9.0	6.0-8.5	6.0-9.0	6.0-8.5	5.5-9.0
	7	DO at 25°C	mg/l	6	5	5	4	3	3
	8	BOD5 at 20°C	mg/l	3	4	4	5	12	15
	9	COD	mg/l	10	10	15	30	-	40
Nutrient	10	NO_3-N	mg/l	10	10	10	10	-	10
	11	NH_3-N	mg/l						
		pH<7.5		-	-	0.94	-	-	9.1
		pH7.5≦pH＜8.5		-	-	0.59	-	-	4.9
		8.5≦pH		-	-	0.22	-	-	1.6
	12	PO4-P	mg/l	0.7	0.7	0.4	0.7	-	-
Other	13	Chloride (Cl)	mg/l	250	-	-	250	600	-
	14	CN	mg/l	0.05	0.05	0.05	0.05	0.05	0.05
	15	F	mg/l	1.5	-	-	1.5	-	-
	16	SO42-	mg/l	250	-	-	250	1,000	-
Metal	17	Cd	μg/l	5	-	5	5	-	5
	18	Cr	μg/l	50	-	20	50	-	50
	19	Cu	μg/l	-	-	100	-	-	100
	20	Fe	μg/l	300 des 1,000 max	-	-	2000	-	-
	21	Pb	μg/l	50	-		50	-	-
		Hardness<120				2			
		120≦Hardness＜180				3			
		180≦Hardness				4			
	22	Mn	μg/l	1,000	1,000	1,000	1,000	1,000	1,000
	23	Hg	μg/l	1	1	1	1	2	2
	24	Ni	μg/l	70	100	100	100	200	100
	25	Se	μg/l	10	10	5	10	-	-
	26	Zn	μg/l	1,000	-	1,000	1,000	2,000	24,000
	27	B	μg/l	-	-	-	-	500	-
	28	As	μg/l	50	50	50	50	50	50
	29	Al	μg/l	200	-	-	-	5,000	5,000
Organic Micro Pollutant	30	Phenolic compounds	μg/l	2	5	2	5	5	5
	31	Oil/Grease	μg/l	100	-	100	100	-	300
	32	Anionic surfactants as MBAS	μg/l	1,000	1,000	1,000	1,000	1,000	1,000
	33	MCPA	μg/l	2	-	-	20	-	-
	34	Pendimethalin	μg/l	2	-	-	20	-	-
Micro Organism	35	Total Coliform	MPN/ 100ml	10,000	10,000	-	10,000	-	-
	36	Fecal Coliform	MPN/ 100ml	500 des 1000 max	500 des 1000 max	-	-	-	-

A Review of Environmental Quality Standards and Designation of Water Use in Sri Lanka 1992

and

Development of the Ambient Water Quality Standards 2017

Central Environmental Authority

Table of Content

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Figures

1 Context of the Ambient Water Quality Standards

1.1 Legal Framework and Regulations

National Environmental Act: The first major consolidated environmental legislation, the Act No.47 of 1980, or more commonly known as the National Environmental Act (NEA), was promulgated in 1980. The NEA, as amended by Acts No.56 of 1988 and 53 of 2000, is the basic national charter for protection, conservation and management of the environment. The NEA adopts three fundamental instruments to protect environment: 1) Environmental protection licenses, 2) Environmental Quality Standards and 3) Environmental Assessment and the approval of project in the amendment in 1988.

Environmental Quality Standards: Act No. 47 of 1980 prescribes the powers, functions and duties of CEA in (10) (e) to wit: to specify standards, norms and criteria for the protection of beneficial uses and for maintaining the quality of the environment. The minister is empowered with the Regulation 32 of the National Environmental (Amendment) Act, No. 56 of 1988 to promulgate relevant criteria.

Regulations 32. (1) The Minister may make regulations in respect of all matters which are stated or are required by this Act to be prescribed or for which regulations are required by this Act to be made.

(2) In particular and without prejudice to the generality of the powers conferred by subsection (1) the Minister may make regulations in respect of all or any of the following matters:-

(b) specification of standards or criteria for the implementation of any national environmental policy or classification for the protection of the environment and for protecting beneficial uses ;

(c) specification of standards or criteria for determining whether any matter, action or thing is poisonous, objectionable, detrimental to health or within any other description or referred to in this Act ;

2 Ambient Water Quality Standards 2017

The Ambient Water Quality Standards 2017 is the first ambient water quality Standard of Sri Lanka that was developed in consonance with Regulations 32 of the National Environmental (Amendment) Act, No. 56 of 1988. It is a set of numerical concentration limit of physical, chemical and biological parameters recommended for support and maintenance of a designated water use.

Bearing in mind the article (2) (b) of Regulations 32 of Acts No.56 of 1988, the users of the Standards should always keep in mind that the parameters have different degree of impacts on human health. The parameters such as cyanide should be given more attention and requires faster actions to address the problem of pollution than, for instance, TSS and turbidity because cyanide exhibits acute toxicity having health effects on the thyroid and particularly the nervous system. Considering such aspects on human health, a classification of the parameters is made as provided in the Procedural Guidelines for Categorization of Inland Surface Waters. The table also presents the recommended action level of pollution for taking measures.

Table 1 Recommended Action Level

Class		Parameters			Recommended Action Level
1	Parameters that may give significant health effects to humans	1. CN 2. F 3. Cd 4. Cr	5. Pb 6. Hg 7. Se 8. B 9. As	10. Phenol compound 11. NO_3-N 12. MCPA 13. Pendimethalin	CEA is recommended to take Water Quality Management Actions if an incidence of exceedance is observed for any one of the parameters during the monitoring programme.
2	Other important parameters	1. Colour 2. Conductivity 3. Turbidity 4. TSS 5. Total Hardness (as $CaCO_3$) 6. pH 7. DO at 25°C 8. BOD_5 at 20°C	9. COD 10. PO_4-P 11. Chloride (Cl-) 12. SO_4^{2-} 13. Cu 14. Fe 15. NH_3-N 16. Mn 17. Ni	18. Zn 19. Al 20. Oil & Grease 21. Anionic surfactants as MBS 22. Total Coliform 23. Faecal Coliform	CEA is recommended to notify the pertinent authority of exceedances of the Water Quality Standards if an average value of the water quality minoring programme is found to be in exceedance of the Water Quality Standards. For Categories B and C, CEA is recommended to notify the public through appropriate mode of education & awareness.

For the parameters classified into the first group having higher toxicity, once an incidence of exceeding is observed for any one of the parameters during the monitoring programme, CEA is recommended to take water quality management actions. Similarly, those in the second group have to be given attention when an average value of the water quality Monitoring programme is found to be in non-compliance with the Water Quality Standards.

(1) Parameters that may give significant health effects to humans

The parameters that may give significant health effects to humans should be given priority in any water quality monitoring actions. The parameters include, but not limited to: cyanide, cadmium, lead and nitrate-nitrogen. CEA is recommended to take Water Quality Management Actions if an incidence of exceedance is observed for any one of the parameters during the monitoring programme. Once such an incidence of exceeding is identified, the waterbody may be referred to as High Priority Waterbody. The drainage area may be referred to as High Priority Area.

(2) Other important parameters

Other parameters in the Water Quality Standards are classified as other important parameters. CEA is recommended to notify the pertinent authority of exceedances of the Water Quality Standards if an average value of the water quality minoring programme is found to be in exceedance of the Water Quality Standards. Once such an incidence is identified, the waterbody may be referred to as High Priority Waterbody. The drainage area may be referred to as High Priority Area.

3 Review of Environmental Quality Standards 1992

The Central Environmental Authority prepared a report in 1992 on a set of Environmental Quality Standards.

☐ Environmental Quality Standards and Designation of Water Use in Sri Lanka, Central Environmental Authority 1992[12]

The water quality standards recommended and proposed in the publication are referred to as the "Environmental Quality Standards 1992" in this report. By reviewing the standards, it was affirmed that the publication need thorough technical review because it has been left pending without a formal review and approval process since its preparation in 1992. It was further confirmed that they were designed to assign a Category to a waterbody according to such beneficial water use as drinking, bathing/contact recreation, fisheries and aquatic organism, irrigation and agriculture. In consultation with the CEA, it was also confirmed that a focus should be given to rivers and streams to avoid conflict of mandates with the Marine Environment Protection Authority.

The review process of the Drinking Water Source Quality, Category A and D, heavily relied on the following two literatures.

1) SLS 722:1985 Tolerance limits for inland surface waters used as raw water for public water supply, Sri Lanka Standards Institution, Colombo LK.[35]
2) Council Directive of 16 June 1975 concerning the quality required of surface water intended for the abstraction of drinking water in the Member States (75/440/EEC)[5]

The publications above set forth the quality standards of surface water intended for the abstraction of drinking water. The former is the Sri Lanka's standard used by the National Water Supply and Drainage Board. The latter is a directive adopted by the council of the European Communities. In this report, they are referred to as the Sri Lanka's Raw Water Quality Standards and EU's Raw Water Quality Standards respectively. Both standards prescribe the quality of water which would achieve pertinent drinking water quality standards after a treatment process. They provide for two quality standards for categories of water treatment process: 1) simple physical treatment and disinfection and 2) normal physical treatment, chemical treatment and disinfection process. They correspond to Category A and Category D water in the Ambient Water Quality Standards 2017. The publications were used as the primary benchmark to assess the validity of the Environmental Quality Standards 1992.

However, the following drinking water quality standards were also referred to complement data deficiency. The former Sri Lanka's Drinking Water Quality Standards (SLS 614: 1983 Potable water Quality Standards) was also referred as necessary.

3) SLS 614: 2013 Specification for Potable Water[34]
4) WHO Guidelines for Drinking Water, Fourth Edition[46]
5) WHO Guidelines for Drinking Water, Third Edition[47]
6) EU Directive 98/83/EC of 3. 11.1998 on Drinking Water Quality[4]

The literatures reviewed for determining the Standards for other categories are provided in the final section of this paper.

Table 2 Basic Approach in Determining the Standards

Category	Approach
Category A: Water source for partial treatment	The values recommended by the Environmental Quality Standards 1992[12] were reviewed and assessed as against those prescribed by the Sri Lanka's Raw Water Standard (SLS 722[35]) and its comparable EU's Raw Water Quality Standards (Category A1[A)] of EU Directive 75/440/EEC[5]). The first principle of determining the standards was to adopt the values provided that they comply either with the mandatory value of Category A1 of EU Directive 75/440/EEC or SLS 722 whichever is more stringent. For COD, Chloride (Cl^-), SO_4^{2-} and Nickel, the values of Sri Lanka's drinking water quality standards (SLS 614: 2013 Specification for Potable Water[34]) or the WHO Guidelines for Drinking Water, Fourth Edition[46], were referred and adopted. Treatment achievability by simple chlorination process was also considered.
Category B: Bathing and contact recreational water	The Category B water quality standards are developed based on the values recommended by the Environmental Quality Standards 1992[12]. More specifically, the proposed values of the equivalent category in the previous report were adopted unless the scientific evidence that become available during the review period run counter the original proposal. In circumstances wherein uncertainty prevails, safer decisions are made based on either the scientific evidence or experiences in other countries.
Category C: Fish and Aquatic Life Water	The Category C water quality standards are developed based on the Environmental Quality Standards 1992[12]. More specifically, the proposed values of the equivalent category in the previous report were adopted unless the scientific evidence that become available during the review period run counter the original proposal. The tolerable level of concentration on tropical fish species was referred and adopted wherever available. However, such sources of information are rarely available. Therefore, the derivation process unavoidably used other sources of information for most of the parameters. In the review process, pertinent standards of India, Thailand, EU and Australia and New Zealand were assessed and compared.
Category D: Water source for full treatment	The values recommended by the Environmental Quality Standards 1992[12] were reviewed and assessed as against those prescribed by the Sri Lanka's Raw Water Standard (SLS 722[35]) and its comparable EU's Raw Water Quality Standards (Category A2[B)] of EU Directive 75/440/EEC[5]). The first principle of determining the standards was to adopt the values provided that they comply either with the mandatory value of Category A2 of EU Directive 75/440/EEC or SLS 722 whichever is more stringent. For Dissolved oxygen, Chloride (Cl^-), Sulphate (SO_4^{2-}) and Oil/Grease, the values of Sri Lanka's drinking water quality standards (SLS 614: 2013 Specification for Potable Water[34]) or the WHO Guidelines for Drinking Water, Fourth Edition[46], were referred and adopted. Treatment achievability by conventional treatment process was also considered.
Category E: Irrigation & Agriculture	The Category E water quality standards are developed based on the Environmental Quality Standards 1992[12]. More specifically, the proposed values of the equivalent category in the previous report were adopted unless the scientific evidence that become available during the review period run counter the original proposal. The relevant parameters for irrigation in arid and semi-arid regions such as Sodium Absorption Ratio and Residue Sodium Carbonate in the previous proposal were rejected considering limited applicability in the humid climate. Considering the relative importance of lowland rice in the land use, a due attention was given to water quality for rice plants.
Category F: Minimum Water Quality	The Category F water quality standards are developed based on the Environmental Quality Standards 1992[12]. More specifically, the proposed values in the previous report were adopted unless the scientific evidence that become available during the review period run counter the original proposal. However, the past water quality monitoring data of Kelani River was also reviewed wherever a set of data is available to avoid excessively ambitious and thus infeasible water quality target.

Note: A) Category A1 is the water subject to treatment for transforming surface water into drinking water by simple physical treatment and disinfection, e.g. rapid filtration and disinfection as defined in EU Directive 75/440/EEC for drinking water source that apply simple physical treatment and disinfection.

B) Category A2 is the water subject to treatment for transforming surface water into drinking water by Normal physical treatment, chemical treatment and disinfection, e.g. pre-chlorination, coagulation, flocculation, decantation, filtration, disinfection (final chlorination).

4 Standard values requiring further review

4.1 Major parameters requiring future review

The standards require periodical review and revision especially because they were derived with insufficient information. Focuses of the review are as follows. Any of the parameters, it is recommended to take a phased approach to modify and improve the nation's standards.

Anionic Surfactant: The value of 1000 μg/l was adopted both for Category A and D waters. Although information on the actual pollution status in the country is not available, the value was adopted by refereeing the previous Sri Lanka's Drinking Water Quality Standards (SLS614: 1983). The updated Drinking Water Quality Standards (SLS 614: 2013) has tightened the control of Anionic Surfactant in drinking water and prescribes 200 μg/l. Considering the deviation from the SLS 614: 2013 Specification for Potable Water, a phased approach is recommended to tighten the value by assessing feasibility of applying the drinking water quality standards to ambient water quality standards by analysing extensive nation-wide monitoring data of rivers.

MCPA: The value of 20 μg/l was assigned for Category D water which is subject to conventional treatment process such as normal physical treatment, chemical treatment and disinfection. The value has limited plausibility considering the facts that the conventional treatment processes has lower treatment efficiency on MCPA and the WHO Guidelines for Drinking Water, Forth Edition, prescribes a lower value of 2 μg/l.

4.2 Other parameters requiring future review

The following six (6) parameters presented in the table below comply, at least, either SLS 722:1985 or mandatory value of EU Directive on Drinking Water Sources. However, the latest Sri Lanka's Potable Water Quality Standards prescribe more stringent values. It is recommended to take a phased approach to tighten the value by assessing feasibility of applying the drinking water quality standards to ambient water quality by analysing extensive nation-wide monitoring data of rivers.

Table 3 Other parameters requiring future review

Category	Parameters	Unit	Ambient Water Quality Standards 2017	Drinking Water Sources Standards*	Sri Lanka Potable Water Quality Standards **
A	Cd	μg/l	5	5	3
	Lead	μg/l	50	50	10
	Arsenic	μg/l	50	50	10
	Phenolic Compounds	μg/l	2	5	1
D	Lead	μg/l	50	50	10
	Phenolic Compounds	μg/l	5	5	1

* Either SLS 722:1985 or mandatory value of EU Directive on Drinking Water Sources whichever is more stringent.
** SLS 614: 2013 Specification for Potable Water

The standard for turbidity adopted a less stringent value of 5 NTU considering the status of Kelani River which is significantly affected by sediment. The value may be modified to make it stringent if the analysis extensive monitoring data of rivers rationalize to do so.

5 CATEGORY: A WATER SOURCE FOR PARTIAL TREATMENT

5.1 General Parameters

1) Colour

Standards: 20 PTmg/L

Drinking-water should ideally have no visible colour[1]. Colour in drinking-water is usually due to the presence of coloured organic matter (primarily humic and fluvic acids) associated with the humus fraction of soil. Colour is also strongly influenced by the presence of iron and other metals, either as natural impurities or as corrosion products. It may also result from the contamination of the water source with industrial effluents and may be the first indication of a hazardous situation. The source of colour in a drinking-water supply should be investigated, particularly if a substantial change has taken place.

The Environmental Quality Standards in Sri Lanka 1992 recommended 20 PTmg/l.. The Sri Lanka's Raw Water Quality Standards do not have any values on colour. However, the EU's Raw Water Quality Standards prescribes 20 PTmg/l as the mandatory value. Therefore, the Ambient Water Quality Standards in 2017 adopted 20 PTmg/l. as proposed in 1992 also considering the fact that no health-based guideline value is proposed for colour.

Table 4 Category A - Colour -

<table>
<tr><td colspan="4">Sources of Information</td><td>Colour
PTmg/l</td></tr>
<tr><td colspan="4">The Ambient Water Quality Standards in 2017</td><td>20</td></tr>
<tr><td colspan="4">Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992</td><td>20</td></tr>
<tr><td rowspan="3">Raw Water Quality Standards</td><td>Sri Lanka</td><td colspan="2">SLS 722:1985 on Raw Water Quality Standards</td><td>-</td></tr>
<tr><td rowspan="2">EU</td><td rowspan="2">EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources</td><td>Guide</td><td>10</td></tr>
<tr><td>Mandatory</td><td>20</td></tr>
<tr><td rowspan="3">Drinking Water Quality Guidelines/Standards</td><td>Sri Lanka</td><td colspan="2">SLS 614: 2013 Specification for Potable Water Hazen Units, (max.)</td><td>15</td></tr>
<tr><td>WHO</td><td colspan="2">WHO Guidelines for Drinking Water, Fourth Edition, 2017</td><td>-</td></tr>
<tr><td>EU</td><td colspan="2">EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ</td><td>*</td></tr>
</table>

* Acceptable to consumers and no abnormal change

2) Turbidity

Standards: 5 NTU

The appearance of water with a turbidity[2] of less than 5 NTU is usually acceptable to consumers, although this may vary with local circumstances. Particulates can protect microorganisms from the effects of disinfection and can stimulate bacterial growth. In all cases where water is disinfected, the turbidity must be low so that disinfection can be effective. Turbidity is also an important operational

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1 Colour can be measured spectrophotometrically or using a visual comparator. In both cases, the standard unit of measurement is the Hazen unit (HU). (True colour is often quoted as True Colour Units, or TCU; however, the numerical values are identical.) Hazen units are defined in terms of a platinum–cobalt standard (APHA Method 2120B 1992). Refer to Physical and Chemical Characteristics – Fact Sheets, Colour (True) (endorsed 1996)[www.clarence.nsw.gov.au/file.asp?g=RES-WHM-86-71-52] (Accessed 22nd August 2017)

2 Turbidity measurements are reported in nephelometric turbidity units (NTU) or Jackson turbidity units (JTU). The two units are roughly equivalent and can be used interchangeably for field purposes. For more details, refer to Myre, E., Shaw, R., The Turbidity Tube: Simple and Accurate Measurement of Turbidity in the Field, [http://citeseerx.ist.psu.edu/viewdoc/download;jsessionid=8EDFDFDA80AD64FEDE0DBC371E87EBA8?doi=10.1.1.467.1851&rep=rep1&type=pdf] (accessed 6 September 2017)

parameter in process control and can indicate problems with treatment processes, particularly coagulation/sedimentation and filtration. No health-based guideline value for turbidity has been proposed; ideally, however, median turbidity should be below 0.1 NTU for effective disinfection, and changes in turbidity are an important process control parameter.

The Environmental Quality Standards in Sri Lanka 1992 recommended 5 NTU. The Sri Lanka's Raw Water Quality Standards do not have any values on turbidity. The Ambient Water Quality Standards in 2017 adopted the value recommended by the Environmental Quality Standards in Sri Lanka 1992. This decision was made also considering the range of former Drinking Water Quality Standards of Sri Lanka SLS 614:1983 ranging from 2 to 8 Jackson turbidity units. Considering the status of Kelani River which is significantly affected by sediment, a phased approach is recommended to tighten the value by assessing feasibility of applying the drinking water quality standards to ambient water quality standards by analysing extensive monitoring data of rivers of the country.

Table 5 Category A - Turbidity -

<table>
<tr><td colspan="4">Sources of Information</td><td>Turbidity
NTU</td></tr>
<tr><td colspan="4">The Ambient Water Quality Standards in 2017</td><td>5</td></tr>
<tr><td colspan="4">Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992</td><td>5</td></tr>
<tr><td rowspan="3">Raw Water Quality Standards</td><td>Sri Lanka</td><td colspan="2">SLS 722:1985 on Raw Water Quality Standards</td><td>–</td></tr>
<tr><td rowspan="2">EU</td><td rowspan="2">EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources</td><td>Guide</td><td>–</td></tr>
<tr><td>Mandatory</td><td>–</td></tr>
<tr><td rowspan="3">Drinking Water Quality Guidelines/Standards</td><td>Sri Lanka</td><td colspan="2">SLS 614: 2013 Specification for Potable Water</td><td>2</td></tr>
<tr><td>WHO</td><td colspan="2">WHO Guidelines for Drinking Water, Fourth Edition, 2017</td><td>–</td></tr>
<tr><td>EU</td><td colspan="2">EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ</td><td>Acceptable to consumers and no abnormal change</td></tr>
</table>

The units used in SLS 614 is Jackson turbidity units, roughly equivalent to NTU.

3) Total Suspended Solids

Standards: 25 mg/L

Total suspended solids (TSS) are particles that are larger than 2 microns found in the water. Anything smaller than 2 microns (average filter size) is considered a dissolved solid. Most suspended solids are made up of inorganic materials, though bacteria and algae can also contribute to the total solids concentration. Like turbidity, TSS affect efficiency of treatment process at water plant. The loading by such solids are prevalent in Sri Lanka as a result of High Flow Rates, Soil Erosion taking place at an upper stream due to limited bank protection and often flooding. The Ambient Water Quality Standards in 2017 adopted the values recommended by the EU's Raw Water Quality Standards.

Table 6 Category A - Total Suspended Solids -

Sources of Information				Total Suspended Solids mg/L
The Ambient Water Quality Standards in 2017				25
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				-
Raw Water Quality Standards	Sri Lanka	SLS 722:1985 on Raw Water Quality Standards		-
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	25
			Mandatory	-
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		-
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		-
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		-

4) Total Hardness (as $CaCO_3$)

Standards: Desirable 250 mg/L Maximum 600 mg/L

Public acceptability of the degree of hardness of water may vary considerably from one community to another, depending on local conditions. In particular, consumers are likely to notice changes in hardness. The taste threshold for the calcium ion is in the range of 100–300 mg/litre, depending on the associated anion, and the taste threshold for magnesium is probably lower than that for calcium. In some instances, consumers tolerate water hardness in excess of 500 mg/litre. No health-based guideline value is proposed for hardness in drinking-water. The Ambient Water Quality Standards in 2017 adopted 250 mg/l as the desirable level which is equivalent to SLS 614: 2013 and 600 mg/l as the maximum level as proposed in 1992.

Table 7 Category A - Total Hardness -

Sources of Information				Total Hardness (as $CaCO_3$) mg/l	
The Ambient Water Quality Standards in 2017				250 Desirable	600 max.
Environmental Quality Standards and Designation of Water Use in Sri Lanka 1992				250 Desirable	600 max.
Raw Water Quality Standards	Sri Lanka	SLS 722:1985 on Raw Water Quality Standards		-	
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	-	
			Mandatory	-	
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		250	
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		Not of health concern at levels found in drinking-water	
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		-	

5) pH

Standards: 6.0 to 8.5

Although pH usually has no direct impact on consumers, it is one of the most important operational water quality parameters. For effective disinfection with chlorine, the pH should preferably be less than 8; however,lower-pH water is likely to be corrosive. The optimum pH required will vary in different supplies according to the composition of the water and the nature of the construction materials used in the distribution system, but it is usually in the range 6.5–8.

The Environmental Quality Standards in Sri Lanka 1992 recommended pH in a range from 6.0-8.5. The Sri Lanka's Raw Water Quality Standards set the value in a range from 6.0-9.0. The EU's Raw Water Quality Standards recommends the values in a range from 6.5 to 8.5. The Ambient Water Quality Standards in 2017 adopted the value recommended by The Environmental Quality Standards in Sri Lanka 1992 in the range from 6.0 to 8.5 which is within the range recommended by the Sri Lanka's Raw Water Quality Standards.

Table 8 Category A - pH -

Sources of Information				pH
The Ambient Water Quality Standards in 2017				6.0 to 8.5
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				6.0-8.5
Raw Water Quality Standards	Sri Lanka	SLS 722:1985 on Raw Water Quality Standards		6.0-9.0
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	6.5-8.5
			Mandatory	-
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		6.5-8.5
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		Not of health concern at levels found in drinking-water
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		6.5-9.5

6) Dissolved Oxygen

Standards: 6 mg/L

The dissolved oxygen content of water is influenced by the source and water temperature. Depletion of dissolved oxygen in water supplies can encourage the microbial reduction of nitrate to nitrite and sulfate to sulfide. It can also cause an increase in the concentration of ferrous iron in solution. No health-based guideline value is recommended.

The Environmental Quality Standards 1992 recommended 6 mg/L. The Raw Water Quality Standards of Sri Lanka set it at 4 mg/l. The value recommended by the Environmental Quality Standards 1992 is retained. The following conditions were considered in determining the value: 1) there is no direct health effects on human body of the users and 2) there is no standards for any drinking water quality standards.

Table 9 Category A - Dissolved Oxygen -

Sources of Information				DO at 25°C mg/l
The Ambient Water Quality Standards in 2017				6
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				6
Raw Water Quality Standards	Sri Lanka	SLS 722:1985 on Raw Water Quality Standards		4
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	>70%(%O_2)
			Mandatory	-
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		-
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		-
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		-

7) Biochemical oxygen demand (BOD_5)

Standards: 3mg/L

Natural organic detritus and organic waste from waste water treatment plants, failing septic systems, and agricultural and urban runoff, acts as a food source for water-borne bacteria. Bacteria decompose these organic materials using dissolved oxygen, thus reducing the DO present for fish. Biochemical oxygen demand (BOD) is a measure of the amount of oxygen that bacteria will consume while decomposing organic matter under aerobic conditions. BOD_5 is determined by incubating a sealed sample of water for five days and measuring the loss of oxygen from the beginning to the end of the test[8]. As a very general rule, a BOD level of 1-2 mg/l is considered pristine water. There would not be much organic materials present in the water. A water with a BOD level of 3-5 mg/l is considered moderately clean. In water with a BOD level of 6-9 ppm, the water is considered somewhat polluted because there is usually organic matter present.

The Environmental Quality Standards 1992 adopted 3 mg/L which is consistent with the EU's Raw Water Quality Standards. Considering the fact that the water in this category are consumed with only disinfection process, the value recommended in 1992 was adopted as the standards with a margin of safety; though the Sri Lanka's Raw Water Quality Standards set a relaxed level at 5 mg/l.

Table 10 Category A - BOD_5 -

Sources of Information				BOD_5 at 20°C mg/l
The Ambient Water Quality Standards in 2017				3
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				3
Raw Water Quality Standards	Sri Lanka	SLS 722:1985 on Raw Water Quality Standards		5
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	<3
			Mandatory	-
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		-
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		-
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		-

8) COD

Standards: 10 mg/L

Chemical oxygen demand (COD) does not differentiate between biologically available and inert organic matter, and it is a measure of the total quantity of oxygen required to oxidize all organic material into carbon dioxide and water. COD values are always greater than BOD values, but COD measurements can be made in a few hours while BOD measurements take five days[8].

Table 11 Category A - COD -

Sources of Information				COD mg/l
The Ambient Water Quality Standards in 2017				10
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				15
Raw Water Quality Standards	Sri Lanka	SLS 722:1985 on Raw Water Quality Standards		-
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	-
			Mandatory	-
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		10
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		-
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		-

COD is an important water quality parameter because, similar to BOD, it provides an index to assess the presence of organic substances in water. Higher COD levels mean a greater amount of oxidizable organic material in the water, which will reduce dissolved oxygen (DO) levels. A reduction in DO can lead to anaerobic conditions, which is deleterious to higher aquatic life forms. The COD test is often used as an alternate to BOD due to shorter length of testing time.

Although the Environmental Quality Standards 1992 proposed 15 mg/l, the Ambient Water Quality Standards in 2017 adopted 10 mg/L to be consistent with the Sri Lanka's Potable water Quality Standards.

5.2 Nutrients

1) Nitrate Nitrogen (N-NO_3^-)

Standards: 10mg/L

The primary health concern regarding nitrate and nitrite is the formation of methaemoglobinaemia, so-called "blue-baby syndrome." The WHO's drinking water guideline value for nitrate is 50 mg/litre, equivalent to approximately 10 mg/litre as nitrate nitrogen, to protect against methaemoglobinaemia in bottle-fed infants (short-term exposure). The Environmental Quality Standards in 1992 proposed 5 mg/L. The proposed value is deemed stringent since the quality of a river portion used for drinking water source is not necessarily maintained beyond the quality of finished water at treatment plant. In this context, the value is relaxed at 10 mg/l to be consistent with the Sri Lanka's Raw Water Quality Standards and the Potable Water Quality Standard.

Table 12 Category A - Nitrate Nitrogen (NO_3^- -N) -

Sources of Information				NO_3^--N mg/l
The Ambient Water Quality Standards in 2017				10
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				5
Raw Water Quality Standards	Sri Lanka	SLS 722:1985 on Raw Water Quality Standards		10
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	5.6
			Mandatory	10
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		10
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		10
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		10

The value of NO_3^- was converted to that of N-NO_3^- and rounded down to the nearest 10.

2) Phosphate (PO_4-P)

Standards: 0.7 mg/L

The health effects of drinking water with phosphates are not known. Phosphates is generally recognized as safe. Generally, phosphorus is the limiting nutrient in freshwater aquatic systems. That is, if all phosphorus is used, plant growth will cease, no matter how much nitrogen is available[19].

The Environmental Quality Standards 1992 recommended 0.7 mg/l as a provisional level, which is determined in consideration of the fact that increased phosphate levels cause eutrophication and excessive weed growth, eg. in irrigation channels and other stagnant part of a river. The standards in 1992 emphasized that lower levels may be required under specific conditions. The EU's Raw Water Quality Standards adopt a lower level at 0.4 mg/l as a guide but not mandatory. The Ambient Water Quality Standards in 2017 adopted 0.7 mg/L as recommended by the Environmental Quality Standards 1992. This decision considered the SLS 614:1983 which prescribed a nearly equivalent level at 0.7 mg/L.

Table 13 Category A - Phosphate (PO_4^{3-}-P) -

Sources of Information				PO_4^{3-}-P mg/l
The Ambient Water Quality Standards in 2017				0.7
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				0.7
Raw Water Quality Standards	Sri Lanka	SLS 722:1985 on Raw Water Quality Standards		-
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	0.4
			Mandatory	-
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		-
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		-
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		-

5.3 Other parameters

1) Chloride (Cl^-)

Standards: 250 mg/l

Excessive chloride concentrations increase rates of corrosion of metals in the distribution system, depending on the alkalinity of the water. This can lead to increased concentrations of metals in the supply. Chloride concentrations in excess of about 250 mg/litre can give rise to detectable taste in water. High concentrations of chloride give a salty taste to water and beverages. Taste thresholds for the chloride anion depend on the associated cation and are in the range of 200–300 mg/litre for sodium, potassium and calcium chloride. Concentrations in excess of 250 mg/litre are increasingly likely to be detected by taste, but some consumers may become accustomed to low levels of chloride-induced taste. No health based guideline value is proposed for chloride in drinking-water.

The Environmental Quality Standards 1992 recommended 250 mg/l. The Sri Lanka's Raw Water Quality Standards set the standard at 1200 mg/L. The Ambient Water Quality Standards in 2017 adopted the value of 250 mg/l as proposed in 1991 which is also equivalent to the Sri Lanka Drinking Water Quality Standards.

Table 14 Category A - Chloride (Cl^-) -

Sources of Information				Chloride (Cl^-) mg/l
The Ambient Water Quality Standards in 2017				250
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				250
Raw Water Quality Standards	Sri Lanka	SLS 722:1985 on Raw Water Quality Standards		1200
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	-
			Mandatory	-
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		250
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		-
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		250

2) Cyanide

Standards: 0.05 mg/L

The acute toxicity of cyanides is high. Effects on the thyroid and particularly the nervous system were observed in some populations as a consequence of the long-term consumption of inadequately processed cassava containing high levels of cyanide.

Although the value recommended by the Environmental Quality Standards 1992 was 0.005 mg/L, it was rejected because it is well below the standards prescribed by the Sri Lanka's Raw Water Quality Standards and Potable Water Quality. The Ambient Water Quality Standards in 2017 adopted 0.05 mg/l to be consistent with the Raw Water Quality Standards.

Table 15 Category A - Cyanide -

Sources of Information				CN mg/l
The Ambient Water Quality Standards in 2017				0.05
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				0.005
Raw Water Quality Standards	Sri Lanka	SLS 722:1985 on Raw Water Quality Standards		0.05
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	-
			Mandatory	0.05
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		0.05
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		*
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		0.05

* No guidelines established because occurs in drinking-water at concentrations well below those of health concern, except in emergency situations following a spill to a water source.

3) Fluoride

Standards: 1.5 mg/L

Many epidemiological studies clearly establish that fluoride primarily produces effects on skeletal tissues (bones and teeth).

Table 16 Category A - Fluoride -

Sources of Information				F mg/l
The Ambient Water Quality Standards in 2017				1.5
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				1.5
Raw Water Quality Standards	Sri Lanka	SLS 722:1985 on Raw Water Quality Standards		1.5
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	0.7-1.0
			Mandatory	15
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		1.0
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		1.5
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		1.5

In many regions with high fluoride exposure, fluoride is a significant cause of morbidity; though, low concentrations provide protection against dental caries, especially in children[47]. Fluoride is also widely used in dental preparations to combat dental caries, particularly in areas of high sugar intake. These can be in the form of tablets, mouthwashes, toothpaste, varnishes or gels for local application. In some countries, fluoride may also be added to table salt or drinking-water in order to provide protection against dental caries. The amounts added to drinking-water are such that final concentrations are usually between 0.5 and 1 mg/l[46].

The recommended value by the Environmental Quality Standards 1992 at 1.5 mg/L was adopted which is equivalent to the Sri Lanka's Raw Water Quality Standards. The decision was made considering the value recommended by WHO Guidelines for Drinking Water 2017.

4) Sulphate (SO_4^{2-})

Standards: 250 mg/L

No health-based guideline for drinking water is proposed for sulfate. However, it has gastrointestinal effects resulting from ingestion of water containing high sulfate levels.

The Ambient Water Quality Standards in 2017 adopted the value of 250 mg/L recommended in 1992 which is equivalent to the EU's Raw Water Quality Standards.

Table 17 Category A - Sulphate -

Sources of Information				SO_4^{2-} mg/l
The Ambient Water Quality Standards in 2017				250
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				250
Raw Water Quality Standards	Sri Lanka	SLS 722:1985 on Raw Water Quality Standards		-
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	150
			Mandatory	250
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		250
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		*
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		250

* Not of health concern at levels found in drinking-water

5.4 Metals

1) Cadmium

Standards: 5 μg/l

Cadmium metal is used in the steel industry and in plastics. Cadmium compounds are widely used in batteries. Cadmium is released to the environment in wastewater, and diffuse pollution is caused by contamination from fertilizers and local air pollution.

Table 18 Category A - Cadmium -

Sources of Information				Cd μg/l
The Ambient Water Quality Standards in 2017				5
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				5
Raw Water Quality Standards	Sri Lanka	SLS 722:1985 on Raw Water Quality Standards		-
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	1
			Mandatory	5
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		3
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		3
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		5

There is evidence that cadmium is carcinogenic by the inhalation route, and the International Agency For Research On Cancer has classified cadmium and cadmium compounds in Group 2A (probably carcinogenic to humans). However, there is no evidence of carcinogenicity by the oral route and no clear evidence for the genotoxicity of cadmium.

The Ambient Water Quality Standards in 2017 adopted the value of 5μg/l as recommended by the Environmental Quality Standards 1992. It is equivalent to the mandatory value of the EU's Raw Water Quality Standards. However it is also recommended to take a phased approach to tighten the value by assessing the actual water quality and feasibility.

2) Chromium

Standards: 50 μg/l

In a long-term carcinogenicity study in rats given chromium(III) by the oral route, no increase in tumour incidence was observed. In rats, chromium(VI) is a carcinogen via the inhalation route, although the limited data available do not show evidence for carcinogenicity via the oral route. In epidemiological studies, an association has been found between exposure to chromium(VI) by the inhalation route and lung cancer.

The Ambient Water Quality Standards in 2017 adopts the value of 50 µg/l as recommended by the Environmental Quality Standards in 1992 which is equivalent to the Sri Lanka's Raw Water Quality Standards and the mandatory value of the EU's Raw Water Quality Standards.

Table 19 Category A - Chromium -

<table>
<tr><td colspan="4">Sources of Information</td><td>Cr
µg/l</td></tr>
<tr><td colspan="4">The Ambient Water Quality Standards in 2017</td><td>50</td></tr>
<tr><td colspan="4">Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992</td><td>50</td></tr>
<tr><td rowspan="3">Raw Water Quality Standards</td><td>Sri Lanka</td><td colspan="2">SLS 722:1985 on Raw Water Quality Standards</td><td>50</td></tr>
<tr><td rowspan="2">EU</td><td rowspan="2">EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources</td><td>Guide</td><td>-</td></tr>
<tr><td>Mandatory</td><td>50</td></tr>
<tr><td rowspan="3">Drinking Water Quality Guidelines/Standards</td><td>Sri Lanka</td><td colspan="2">SLS 614: 2013 Specification for Potable Water</td><td>50</td></tr>
<tr><td>WHO</td><td colspan="2">WHO Guidelines for Drinking Water, Fourth Edition, 2017</td><td>50</td></tr>
<tr><td>EU</td><td colspan="2">EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ</td><td>50</td></tr>
</table>

3) Iron

Standards: 300 µg/l as the desirable level and 1,000 µg/l as the max

Iron is an essential element in human nutrition. No guideline value for iron in drinking-water is proposed. On exposure to the atmosphere, however, the ferrous iron oxidizes to ferric iron, giving an objectionable reddish-brown colour to the water. There is usually no noticeable taste at iron concentrations below 0.3mg/litre, although turbidity and colour may develop.

The Environmental Quality Standards 1992 recommends 300 µg/l as a desirable level and 1,000 µg/l as the maximum level. No values were established for the Raw Water Quality Standards in Sri Lanka. The Ambient Water Quality Standards in 2017 adopted 300 µg/l as a desirable level which is equivalent to the value of SLS 614: 2013 and 1,000 µg/l as the maximum level as recommended by the Environmental Quality Standards 1992.

Table 20 Category A - Iron -

<table>
<tr><td colspan="4">Sources of Information</td><td>Fe
µg/l</td></tr>
<tr><td colspan="4">The Ambient Water Quality Standards in 2017</td><td>300 Desirable
1,000 max</td></tr>
<tr><td colspan="4">Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992</td><td>300 Desirable
1,000 max</td></tr>
<tr><td rowspan="3">Raw Water Quality Standards</td><td>Sri Lanka</td><td colspan="2">SLS 722:1985 on Raw Water Quality Standards</td><td>-</td></tr>
<tr><td rowspan="2">EU</td><td rowspan="2">EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources</td><td>Guide</td><td>100</td></tr>
<tr><td>Mandatory</td><td>300</td></tr>
<tr><td rowspan="3">Drinking Water Quality Guidelines/Standards</td><td>Sri Lanka</td><td colspan="2">SLS 614: 2013 Specification for Potable Water</td><td>300</td></tr>
<tr><td>WHO</td><td colspan="2">WHO Guidelines for Drinking Water, Fourth Edition, 2017</td><td>B)</td></tr>
<tr><td>EU</td><td colspan="2">EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ</td><td>200</td></tr>
</table>

* Not of health concern at levels found in drinking-water.

4) Lead (Pb)

Standards: 50 µg/l

Lead is used principally in the production of lead-acid batteries, solder and alloys. The organo-lead compounds tetraethyl and tetra-methyl lead have also been used extensively as antiknock and lubricating agents in petrol, although their use for these purposes in many countries has largely been phased out. Placental transfer of lead occurs in humans as early as the 12th week of gestation and continues throughout development. Young children absorb 4–5 times as much lead as adults, and the biological half-life may be considerably longer in children than in adults. Lead is a general toxicant that accumulates in the skeleton. Infants, children up to 6 years of age and pregnant women are most susceptible to its adverse health effects.

The Ambient Water Quality Standards in 2017 adopted the value of 50 µg/l as recommended by the Environmental Quality Standards 1992 which is equivalent to the mandatory value of the EU's Raw Water Quality Standards. However, considering the deviation from the SLS 614: 2013 Specification for Potable Water, a phased approach is recommended to tighten the value by assessing feasibility of applying the drinking water quality standards to ambient water quality standards by analysing extensive nation-wide monitoring data of rivers.

Table 21 Category A - Lead -

Sources of Information				Pb µg/l
The Ambient Water Quality Standards in 2017				50
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				50
Raw Water Quality Standards	Sri Lanka	SLS 722:1985 on Raw Water Quality Standards		100
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	-
			Mandatory	50
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		10
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		10
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		10

5) Manganese

Standards: 1000 µg/l

Manganese is an essential element for humans and other animals. Adverse effects can result from both deficiency and overexposure. There have been epidemiological studies that report adverse neurological effects following extended exposure to very high levels in drinking-water. However, there are a number of significant potential confounding factors in these studies, and a number of other studies have failed to observe adverse effects following exposure through drinking-water. Manganese may be removed 80% by oxidation reaction through chlorination process[46].

A health-based value[3] of 0.4 mg/l can be derived for manganese based on the upper range value of manganese intake of 11 mg/day. However, as this health-based value is well above concentrations of manganese normally found in drinking-water, it is not considered necessary to derive a formal

[3] It was identified using dietary surveys, at which there are no observed adverse effects, using an uncertainty factor of 3 to take into consideration the possible increased bioavailability of manganese from water, allocating 20% of the TDI to drinking-water and assuming the consumption of 2 litres of water per day by a 60 kg adult.

guideline value.

The value recommended by the Environmental Quality Standards 1992 was adopted in the Ambient Water Quality Standards in 2017 considering the removability of manganese by the chlorination process, the health-based value of 0.4 mg/l and concentrations normally found in surface water. When extensive nation-wide monitoring data of rivers in Sri Lanka become available, deletion of manganese from the standards is also an option to consider.

Table 22 Category A - Manganese -

Sources of Information				Mn µg/l
The Ambient Water Quality Standards in 2017				1000
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				1000
Raw Water Quality Standards	Sri Lanka	SLS 722:1985 on Raw Water Quality Standards		-
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	50
			Mandatory	-
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		100
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		*
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		50

* Not of health concern at levels found in drinking-water.

6) Mercury

Standards: 1 µg/l

The toxic effects of inorganic mercury compounds are seen mainly in the kidney. Methylmercury affects mainly the central nervous system.

Table 23 Category A - Mercury -

Parameter				Hg µg/l
The Ambient Water Quality Standards in 2017				1
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				1
Raw Water Quality Standards	Sri Lanka	SLS 722:1985 on Raw Water Quality Standards		1
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	0.5
			Mandatory	1
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		1
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		6 for inorganic mercury
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		1

The Ambient Water Quality Standards in 2017 adopted the value of 1.0 µg/l as recommended by the Environmental Quality Standards 1992 and consistent with the Sri Lanka's Raw Water Quality Standards.

7) Nickel

Standards: 70 µg/l

Nickel is used mainly in the production of stainless steel and nickel alloys. Food is the dominant source of nickel exposure in the non-smoking, non-occupationally exposed population; water is generally a minor contributor to the total daily oral intake. However, where there is heavy pollution, where there are areas in which nickel that occurs naturally in groundwater is mobilized or where there is use of certain types of kettles, of non-resistant material in wells or of water that has come into contact with nickel or chromium-plated taps, the nickel contribution from water may be significant. The WHO Guidelines for Drinking-water Quality THIRD EDITION 2004 set the guidelines of 20 µg/l. However the latest guidelines of WHO Forth Edition recommends 70 µg/l. The SLS 614: 2013 Specification for Potable Water also adopts the previous WHO guidelines.

The Environmental Quality Standards 1992 recommended 100 µg/l. The Sri Lanka's Raw Water Quality Standards do not have any values recommended. The Ambient Water Quality Standards in 2017 adopted the value of the WHO Guidelines for Drinking Water at 70 mg/L.

Table 24 Category A - Nickel -

Sources of Information				Ni µg/l
The Ambient Water Quality Standards in 2017				70
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				100
Raw Water Quality Standards	Sri Lanka	SLS 722:1985 on Raw Water Quality Standards		-
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	-
			Mandatory	-
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		20
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		70
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		20

8) Selenium

Standards: 10 µg/l

Selenium is an essential element for humans, with a recommended daily intake of about 1mg/kg of body weight for adults. Selenium compounds have been shown to be genotoxic in in vitro systems with metabolic activation, but not in humans.

Table 25 Category A - Selenium -

Sources of Information				Se µg/l
The Ambient Water Quality Standards in 2017				10
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				10
Raw Water Quality Standards	Sri Lanka	SLS 722:1985 on Raw Water Quality Standards		50
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	-
			Mandatory	10
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		10
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		40
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		10

There was no evidence of teratogenic effects in monkeys. Long-term toxicity in rats is characterized by depression of growth and liver pathology. In humans, the toxic effects of long-term selenium exposure are manifested in nails, hair and liver.

The Drinking Water Guidelines/Standard of Sri Lanka, SLS 614, recommends 10 µg/l. The Ambient Water Quality Standards in 2017 adopted the value of 10 µg/l as recommended by the Environmental Quality Standards 1992 which is also equivalent to the mandatory value of the EU's Raw Water Quality Standards.

9) Zinc

Standards: 1000µg/l

Zinc is an essential trace element found in virtually all food and potable water in the form of salts or organic complexes. Zinc imparts an undesirable astringent taste to water at a taste threshold concentration of about 4 mg/litre (as zinc sulfate). Water containing zinc at concentrations in excess of 3–5 mg/litre may appear opalescent and develop a greasy film on boiling.

The Ambient Water Quality Standards in 2017 adopted the value of 1,000 µg/l as recommended by the Environmental Quality Standards 1992. Other standards are assigned with lenient values, which may require further review and assessment for relaxation.

Table 26 Category A - Zinc -

Sources of Information				Zn µg/l
The Ambient Water Quality Standards in 2017				1,000
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				1,000
Raw Water Quality Standards	Sri Lanka	SLS 722:1985 on Raw Water Quality Standards		-
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	500
			Mandatory	3,000
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		3,000
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		Not of health concern at levels found in drinking-water
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		-

10) Arsenic

Standards: 50 µg/l

Arsenic has not been demonstrated to be essential in humans. It is an important drinking-water contaminant, as it is one of the few substances shown to cause cancer in humans through consumption of drinking-water. There is overwhelming evidence from epidemiological studies that consumption of elevated levels of arsenic through drinking-water is causally related to the development of cancer at several sites, particularly skin, bladder and lung.

Table 27 Category A - Arsenic -

Sources of Information				As µg/l
The Ambient Water Quality Standards in 2017				50
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				10
Raw Water Quality Standards	Sri Lanka	SLS 722:1985 on Raw Water Quality Standards		50
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	10
			Mandatory	50
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		10
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		10
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		10

Although the Environmental Quality Standards 1992 recommended 10 µg/l, the Ambient Water Quality Standards in 2017 adopted the value of 50 µg/l to be consistent with the Sri Lanka's Raw Water Quality Standards which is also equivalent to the mandatory value prescribed by the EU's Raw Water Quality Standards. However, considering the deviation from the SLS 614: 2013 Specification for Potable Water, a phased approach is recommended to tighten the value by assessing the actual water quality of the rivers over the country.

11) Aluminium

Standards: 200µg/l

In humans, aluminium and its compounds appear to be poorly absorbed, although the rate and extent of absorption have not been adequately studied for all sectors of the population. There is little indication that orally ingested aluminium is acutely toxic to humans despite the widespread occurrence of the element in foods, drinking-water and many antacid preparations. It has been hypothesized that aluminium exposure is a risk factor for the development or acceleration of onset of Alzheimer disease (AD) in humans.

The Environmental Quality Standards 1992 recommended 200 µg/l. The Raw Water Quality Standards and the Drinking Water Standards of Sri Lanka do not have any recommended value.

Table 28 Category A - Aluminium -

Sources of Information				Al µg/l
The Ambient Water Quality Standards in 2017				200
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				200
Raw Water Quality Standards	Sri Lanka	SLS 722:1985 on Raw Water Quality Standards		-
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	-
			Mandatory	-
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		200
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		*
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		-

* A health-based value of 0.9 mg/l could be derived, but this value exceeds practicable levels based on optimization of the coagulation process in drinking-water plants using aluminiumbased coagulants: 0.1 mg/l or less in large water treatment facilities and 0.2 mg/l or less in small facilities.

5.5 Organic Micro Pollutant

1) Phenolic Compounds

Standards: 2 µg/l

Phenolic compounds have been enlisted by USEPA EU as pollutants of priority concern due to the fact that these chemicals are noted to be toxic and have severe short` and long□term effects on humans and animals[24]. The occurrence of phenolic compounds in the aquatic environment is therefore not only objectionable and undesirable but also poses a danger as far as human health and wildlife are concerned[48]. The latest WHO Guidelines for Drinking Water, Fourth Edition, 2017 does not have any values recommended.

The Ambient Water Quality Standards in 2017 adopted the value of 2.0 µg/l as recommended by the Environmental Quality Standards 1992 which is more stringent than Raw Water Quality Standards of Sri Lanka and EU. Considering the deviation from the SLS 614: 2013 Specification for Potable Water, a phased approach is recommended to tighten the value by assessing feasibility of applying the drinking water quality standards to ambient water quality standards by analysing extensive nation-wide monitoring data of rivers.

Table 29 Category A -Phenolic Compounds -

Sources of Information				Phenolic Compounds µg/l
The Ambient Water Quality Standards in 2017				2
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				2
Raw Water Quality Standards	Sri Lanka	SLS 722:1985 on Raw Water Quality Standards		5
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	-
			Mandatory	10
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		1
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		-
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		-

2) Oil/Grease

Standards: 100µg/l

Petroleum oils are widely used in human settlements, and improper handling or disposal can lead to significant pollution of surface water and groundwater. They can give rise to the presence of a number of low molecular weight hydrocarbons that have low odour thresholds in drinking-water. Although there are no formal data, experience indicates that these may have lower odour thresholds when several are present as a mixture.

The Ambient Water Quality Standards in 2017 adopted the value of 100 µg/l as recommended by the Environmental Quality Standards 1992 which is also consistent with the Sri Lanka’s Raw Water Quality Standards.

Table 30 Category A - Oil/Grease -

Sources of Information				Oil/Grease µg/l
The Ambient Water Quality Standards in 2017				100
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				100
Raw Water Quality Standards	Sri Lanka	SLS 722:1985 on Raw Water Quality Standards		100
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	-
			Mandatory	-
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		200
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		-
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		-

3) Anionic surfactants as MBS

Standards: 1000µg/l

In many countries, persistent types of anionic detergent have been replaced by others that are more easily biodegraded, and hence the levels found in water sources have decreased substantially. The concentration of detergents in drinking-water should not be allowed to reach levels giving rise to either foaming or taste problems. The presence of any detergent may indicate sanitary contamination of source water.

The Ambient Water Quality Standards in 2017 adopted the value of 1000 µg/l to be consistent with the permissible level of the former Sri Lanka’s Drinking Water Quality Standards (SLS614: 1983). Considering the deviation from the SLS 614: 2013 Specification for Potable Water, a phased approach is recommended to tighten the value by assessing feasibility of applying the drinking water quality standards to ambient water quality standards by analysing extensive nation-wide monitoring data of rivers.

Table 31 Category A - Anionic Surfactants -

Sources of Information				Anionic surfactants as MBS µg/l
The Ambient Water Quality Standards in 2017				1000
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				200
Raw Water Quality Standards	Sri Lanka	SLS 722:1985 on Raw Water Quality Standards		-
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	-
			Mandatory	-
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		200
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		-
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		-

4) MCPA

Standards:2µg/l

MCPA [4-(2-methyl-4-chlorophenoxy)acetic acid,(CAS No. 94-74-6) is a chlorophenoxy post-emergence herbicide that is very soluble, is highly mobile and can leach from the soil.

There are only limited and inconclusive data on the genotoxicity of MCPA. IARC evaluated MCPA in 1983 and concluded that the available data on humans and experimental animals were inadequate for an evaluation of carcinogenicity. Further evaluations by IARC on chlorophenoxy herbicides in 1986 and 1987 concluded that evidence for their carcinogenicity was limited in humans and inadequate in animals (Group 2B). Recent carcinogenicity studies on rats and mice did not indicate that MCPA was carcinogenic. No adequate epidemiological data on exposure to MCPA alone are available.

The Ambient Water Quality Standards in 2017 adopted the value of 2 µg/l as recommended by the WHO Guidelines for Drinking Water, Fourth Edition, 2017.

Table 32 Category A - MCPA –

Sources of Information				MCPA µg/l
The Ambient Water Quality Standards in 2017				2
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				-
Raw Water Quality Standards	Sri Lanka	SLS 722:1985 on Raw Water Quality Standards		-
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	-
			Mandatory	-
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		-
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		2
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		-

5) Pendimethalin

Standards:2µg/l

Pendimethalin (CAS No. 40487-42-1) is a pre-emergence herbicide that is fairly immobile and persistent in soil.

In a short-term dietary study in rats, a variety of indications of hepatotoxicity as well as increased kidney weights in males were observed at the highest dose level. In a long term dietary study, some toxic effects (hyperglycaemia in the mouse and hepatotoxicity in the rat) were present even at the lowest dose level. On the basis of available data, pendimethalin does not appear to have significant mutagenic activity. Long-term studies in mice and rats have not provided evidence of carcinogenicity; however, these studies have some important methodological limitations. No values are set for the Raw Water Quality Standards and Sri Lanka's drinking water quality standards.

The Ambient Water Quality Standards in 2017 adopted the value of 2 µg/l which is 10 times stringent than the WHO Guidelines for Drinking Water, Fourth Edition, 2017 to ensure achieving a great margin of safety. When extensive nation-wide monitoring data of rivers in Sri Lanka become available, relaxation of the Standards is also an option to consider.

Table 33 Category A - Pendimethalin –

Sources of Information				Pendimethalin µg/l
The Ambient Water Quality Standards in 2017				2
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				-
Raw Water Quality Standards	Sri Lanka	SLS 722:1985 on Raw Water Quality Standards		-
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	-
			Mandatory	-
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		-
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		20
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		-

5.6 Micro Organism

1) Total Coliform

Standards: 10,000 MPN/ 100ml

The term "total coliforms" refers to a large group of Gram-negative, rod-shaped bacteria that share several characteristics. The group includes thermotolerant coliforms and bacteria of faecal origin, as well as some bacteria that may be isolated from environmental sources. Thus the presence of total coliforms may or may not indicate faecal contamination. In extreme cases, a high count for the total coliform group may be associated with a low, or even zero, count for thermotolerant coliforms. Such a result would not necessarily indicate the presence of faecal contamination. It might be caused by entry of soil or organic matter into the water or by conditions suitable for the growth of other types of coliform. In the laboratory total coliforms are grown in or on a medium containing lactose, at a temperature of 35 or 37 °C. They are provisionally identified by the production of acid and gas from the fermentation of lactose[44].

Category A water is subject to Chlorination process and Total coliforms should be absent immediately after disinfection. The Ambient Water Quality Standards in 2017 adopted a less stringent value as a provisional guide to assess the cleanliness of source water.

Table 34 Category A - Total Coliform -

Sources of Information				Total Coliform MPN/ 100ml
The Ambient Water Quality Standards in 2017				10,000
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				5000
Raw Water Quality Standards	Sri Lanka	SLS 722:1985 on Raw Water Quality Standards		E)
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	50
			Mandatory	-
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		-
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		-
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		-

* Not more than 5000, with less than 5 per cent of the samples with value 20000, and less than 20 per cent of the samples with the value 5000

2) Faecal Coliform

Standards: 500 MPN/ 100ml as Desirable level and 1000 MPN/ 100ml as maximum level.

The term "faecal coliform" has been used in water microbiology to denote coliform organisms which grow at 44 or 44.5 degree C and ferment lactose to produce acid and gas. In practice, some organisms with these characteristics may not be of faecal origin and the term "thermotolerant coliform" is, therefore, more correct and is becoming more commonly used. Nevertheless, the presence of thermotolerant coliforms nearly always indicates faecal contamination. Usually, more than 95 per cent of thermotolerant coliforms isolated from water are the gut organism Escherichia coli, the presence of which is definitive proof of faecal contamination. As a result, it is often unnecessary to undertake further testing to confirm the specific presence of E. coli.

Category A water is subject to Chlorination process and Faecal coliforms should be absent immediately after disinfection. The Ambient Water Quality Standards in 2017 adopted values as a provisional guide to assess the cleanliness of source water.

Table 35 Category A - Feacal Coliform -

Sources of Information				Faecal Coliform MPN/ 100ml	
The Ambient Water Quality Standards in 2017				500	1000
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				250des	600 max
Raw Water Quality Standards	Sri Lanka	SLS 722:1985 on Raw Water Quality Standards		-	
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	20	
			Mandatory	-	
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		-	
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		-	
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		-	

6 CATEGORY B: BATHING AND CONTACT RECREATIONAL WATER

The category of water may also be referred to as contact recreational water such as those for swimming assuming whole-body contact with water. The Environmental Quality Standards in 1992 mainly relied on the Class 2 of Thai Standard 1985. Other major sources of standard values derivation included the EU 76/160/EEC of 8.12.1975 bathing water.

In general, the potential risks from chemical contamination of recreational waters will be very much smaller than those from other hazards such as 1) drowning and injury, 2) sun, heat and cold, 3) faecal pollution, 4) free-living microorganisms such as Human pathogenic vibrio species, aeromonas species, free-living amoebae, leptospira species as discussed in the WHO's Guidelines for safe recreational water environments. It is unlikely that water users will come into contact with sufficiently high concentrations of most contaminants to cause adverse effects following a single exposure. Even repeated (chronic) exposure is unlikely to result in adverse effects at the concentrations of contaminants typically found in water and with the exposure patterns of most recreational water users. However, it remains important to ensure that chemical hazards and any potential human health risks associated with them are recognized and controlled and that users can be reassured as to their personal safety (WHO).

6.1 General parameters

1) pH

Standards: 6.0-9.0

pH has a direct impact on the recreational uses of water only at very low or very high pH values. Under these circumstances, it may contribute to irritation of the skin and eyes.

The Ambient Water Quality Standards in 2017 adopted the range of 6.0 to 9.0 as recommended by the Environmental Quality Standards 1992 which is also consonant with the EU's guidelines on bathing water.

Table 36 Category B -pH-

Source of Information		pH
The Ambient Water Quality Standards in 2017		6.0-9.0
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		6.0-9.0
India Primary Water Quality Criteria	Class B	-
Indian Water Quality Standards IS 2296:1992	Class B	6.5-8.5
Thai Standards 1985	Class 2	5.0-9.0
EU 76/160/EEC of 8.12.1975 bathing water	G	-
	I	6.0-9.0
EU Directive 2006/7/EC on bathing water quality		-
ANZEC 2000		-

2) Dissolved Oxygen

Standards: 5 mg/L

The Ambient Water Quality Standards in 2017 adopted 5 mg/L as recommended by the Environmental Quality Standards 1992 which is also consonant with the relevant standards prescribed in the Indian Water Quality Standards 1992.

Table 37 Category B - Dissolved Oxygen -

Source of Information		DO at 25°C mg/l
The Ambient Water Quality Standards in 2017		5
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		5
India Primary Water Quality Criteria	Class B	-
Indian Water Quality Standards IS 2296:1992	Class B	5
Thai Standards 1985	Class 2	6
EU 76/160/EEC of 8.12.1975 bathing water	G	80%-120% (O_2)
	I	-
EU Directive 2006/7/EC on bathing water quality		-
ANZEC 2000		6.5

3) BOD_5

Standards:4 mg/L

Natural organic detritus and organic waste from waste water treatment plants, failing septic systems, and agricultural and urban runoff, acts as a food source for water-borne bacteria. Bacteria decompose these organic materials using dissolved oxygen, thus reducing the DO present for fish. Biochemical oxygen demand (BOD) is a measure of the amount of oxygen that bacteria will consume while decomposing organic matter under aerobic conditions. BOD_5 is determined by incubating a sealed sample of water for five days and measuring the loss of oxygen from the beginning to the end of the test[8]. As a very general rule, a BOD level of 1-2 mg/l is considered pristine water. There would not be much organic materials present in the water. A water with a BOD level of 3-5 mg/l is considered moderately clean. In water with a BOD level of 6-9 ppm, the water is considered somewhat polluted because there is usually organic matter present. The Ambient Water Quality Standards in 2017 adopted 4 mg/L as recommended by the Environmental Quality Standards 1991. It was also confirmed that the adopted value does not significantly deviate from those in India.

Table 38 Category B - BOD_5 -

Source of Information		BOD_5 at 20°C mg/l
The Ambient Water Quality Standards in 2017		4
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		4
India Primary Water Quality Criteria	Class B	3
Indian Water Quality Standards IS 2296:1992	Class B	3
Thai Standards 1985	Class 2	1.5
EU 76/160/EEC of 8.12.1975 bathing water		-
EU Directive 2006/7/EC on bathing water quality		-
ANZEC 2000		-

4) COD

Standards: 10 mg/L

Chemical oxygen demand (COD) does not differentiate between biologically available and inert organic matter, and it is a measure of the total quantity of oxygen required to oxidize all organic material into carbon dioxide and water. COD values are always greater than BOD values, but COD measurements can be made in a few hours while BOD measurements take five days. COD is an important water quality parameter because, similar to BOD, it provides an index to assess the presence of organic substances in water. Higher COD levels mean a greater amount of oxidizable organic material in the water, which will reduce dissolved oxygen (DO) levels. A reduction in DO can lead to anaerobic conditions, which is deleterious to higher aquatic life forms. The COD test is often used as an alternate to BOD due to shorter length of testing time.

The Ambient Water Quality Standards in 2017 adopted 10 mg/L as recommended by the Environmental Quality Standards 1991.

Table 39 Category B - COD -

Source of Information		COD mg/l
The Ambient Water Quality Standards in 2017		10
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		10
India Primary Water Quality Criteria	Class B	-
Indian Water Quality Standards IS 2296:1992	Class B	-
Thai Standards 1985	Class 2	-
EU 76/160/EEC of 8.12.1975 bathing water		-
EU Directive 2006/7/EC on bathing water quality		-
ANZEC 2000		-

6.2 Nutrient parameters

1) Nitrate Nitrogen (NO_3-N)

Standards: 10 mg/L

The primary health concern regarding nitrate and nitrite is the formation of methaemoglobinaemia, so-called “blue-baby syndrome.” The WHO’s drinking water guideline value for nitrate is 50 mg/litre, equivalent to approximately 10 mg/litre as nitrate nitrogen, to protect against methaemoglobinaemia in bottle-fed infants (short-term exposure). Although the Environmental Quality Standards 1992 adopted 5 mg/L, it is found to be more stringent than the values of the Sri Lanka’s Raw Water Quality Standards and the WHO drinking water quality standard at 10 mg/l. The Ambient Water Quality Standards in 2017 adopted 10 mg/L.

Table 40 Category B - Nitrate Nitrogen (NO_3^--N) -

Source of Information		NO_3^--N mg/l
The Ambient Water Quality Standards in 2017		10
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		5
India Primary Water Quality Criteria	Class B	-
Indian Water Quality Standards IS 2296:1992	Class B	-
Thai Standards 1985	Class 2	5
EU 76/160/EEC of 8.12.1975 bathing water		-
EU Directive 2006/7/EC on bathing water quality		-
ANZEC 2000		10

2) Phosphate (PO_4-P)

Standards: 0.7 mg/L

Phosphates is generally recognized as safe. Generally, phosphorus is the limiting nutrient in freshwater aquatic systems. That is, if all phosphorus is used, plant growth will cease, no matter how much nitrogen is available[19]. The Ambient Water Quality Standards in 2017 adopted 0.7 mg/L as recommended by the Environmental Quality Standards 1992 which is also equivalent to the guideline value of Phosphate for Category A of the Ambient Water Quality Standards in 2017.

Table 41 Category B - Phosphate (PO_4^{3-}-P) -

Source of Information		PO_4^{3-}-P mg/l
The Ambient Water Quality Standards in 2017		0.7
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		0.7
India Primary Water Quality Criteria	Class B	-
Indian Water Quality Standards IS 2296:1992	Class B	-
Thai Standards 1985	Class 2	-
EU 76/160/EEC of 8.12.1975 bathing water		-
EU Directive 2006/7/EC on bathing water quality		-
ANZEC 2000		-

6.3 Other Parameters

1) Cyanide

Standards: 0.05 mg/L

The acute toxicity of cyanides is high. Effects on the thyroid and particularly the nervous system were observed in some populations as a consequence of the long-term consumption of inadequately processed cassava containing high levels of cyanide.

Although the Environmental Quality Standards 1992 recommended 0.005 mg/l, the Ambient Water Quality Standards in 2017 adopted a less stringent value of 0.05 mg/L which is equivalent to the value adopted by Category A for the Ambient Water Quality Standards in 2017.

Table 42 Category B - Cyanide-

Source of Information		CN mg/l
The Ambient Water Quality Standards in 2017		0.05
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		0.005
India Primary Water Quality Criteria	Class B	-
Indian Water Quality Standards IS 2296:1992	Class B	0.050
Thai Standards 1985	Class 2	-
EU 76/160/EEC of 8.12.1975 bathing water		-
EU Directive 2006/7/EC on bathing water quality		-
ANZEC 2000		0.1

6.4 Metals

1) Manganese

Standards: 1000 µg/l

Manganese is an essential element for humans and other animals. Adverse effects can result from both deficiency and overexposure. Most countries do not have any standard values for manages as water for contract recreational water except ANZEC 2000. The Ambient Water Quality Standards 2017 adopted the value of 1000 µg/l equivalent to Category A for Drinking water source water of The Ambient Water Quality Standards 2017.

Table 43 Category B - Manganese -

Source of Information		Mn µg/l
The Ambient Water Quality Standards in 2017		1000
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		1000
India Primary Water Quality Criteria	Class B	-
Indian Water Quality Standards IS 2296:1992	Class B	-
Thai Standards 1985	Class 2	1000
EU 76/160/EEC of 8.12.1975 bathing water		-
EU Directive 2006/7/EC on bathing water quality		-
ANZEC 2000		100

2) Mercury

Standards: 1 µg/l

The toxic effects of inorganic mercury compounds are seen mainly in the kidney. Methylmercury affects mainly the central nervous system. The Ambient Water Quality Standards in 2017 adopted the value of 1 µg/l as recommended by the Environmental Quality Standards 1992 which is also equivalent to ANZEC 2000.

Table 44 Category B - Mercury -

Source of Information		Hg µg/l
The Ambient Water Quality Standards in 2017		1
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		1
India Primary Water Quality Criteria	Class B	-
Indian Water Quality Standards IS 2296:1992	Class B	-
Thai Standards 1985	Class 2	2
EU 76/160/EEC of 8.12.1975 bathing water		-
EU Directive 2006/7/EC on bathing water quality		-
ANZEC 2000		1

3) Nickel

Standards: 100 µg/l

The Ambient Water Quality Standards in 2017 adopted the value of 100 µg/l as recommended by the Environmental Quality Standards 1992 which is also in line with the value recommended by ANZEC 2000.

Table 45 Category B - Nickel -

Source of Information		Ni µg/l
The Ambient Water Quality Standards in 2017		100
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		100
India Primary Water Quality Criteria	Class B	-
Indian Water Quality Standards IS 2296:1992	Class B	-
Thai Standards 1985	Class 2	100
EU 76/160/EEC of 8.12.1975 bathing water		-
EU Directive 2006/7/EC on bathing water quality		-
ANZEC 2000		100

It is unlikely to have contact with sufficiently high concentrations to cause adverse effects; though, it is recommended to retain the value and assess through regular monitoring activity.

4) Selenium

Standards: 10 µg/l

The Ambient Water Quality Standards in 2017 adopted the value of 10 µg/l as recommended by Environmental Quality Standards 1992. The value is also consonant with the Drinking Water Guidelines/Standard of Sri Lanka, SLS 614 as presented in the section for Category A. It is unlikely to have contact with sufficiently high concentrations to cause adverse effects; though, it is recommended to retain the value and assess through regular monitoring activity.

Table 46 Category B - Selenium -

Source of Information		Se µg/l
The Ambient Water Quality Standards in 2017		10
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		10
India Primary Water Quality Criteria	Class B	-
Indian Water Quality Standards IS 2296:1992	Class B	-
Thai Standards 1985	Class 2	-
EU 76/160/EEC of 8.12.1975 bathing water		-
EU Directive 2006/7/EC on bathing water quality		-
ANZEC 2000		10

5) Arsenic

Standards: 50 µg/l

The Ambient Water Quality Standards in 2017 adopted the value of 50 µg/l as recommended by the Environmental Quality Standards 1992. The value is also equivalent to ANZEC 2000.

There is no recommended value in 1) the EU 76/160/EEC of 8.12.1975 bathing water and 2) the EU Directive 2006/7/EC on bathing water quality. According to WHO Guidelines for Drinking Water, Fourth Edition, the levels in natural waters generally range between 1 and 2 µg/l. However, in waters, particularly ground waters, where there are sulphide mineral deposits and sedimentary deposits deriving from volcanic rocks, the concentrations can be significantly elevated (up to 12 mg/l). To ensure free of health hazard, it is recommended to retain the proposed value of 50 µg/l.

Table 47 Category B - Arsenic-

Source of Information		As µg/l
The Ambient Water Quality Standards in 2017		50
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		50
India Primary Water Quality Criteria	Class B	-
Indian Water Quality Standards IS 2296:1992	Class B	200
Thai Standards 1985	Class 2	10
EU 76/160/EEC of 8.12.1975 bathing water		-
EU Directive 2006/7/EC on bathing water quality		-
ANZEC 2000		50

6.5 Organic Micro Pollutants

1) Phenolic Compounds

Standards: 5 µg/l

The Ambient Water Quality Standards in 2017 adopted the value of 5 µg/l as recommended by Environmental Quality Standards 1992. The value is also consonant with the guide recommended by the EU directive on bathing water quality.

Table 48 Category B -Phenolic Compounds -

Source of Information		Phenolic Compounds µg/l
The Ambient Water Quality Standards in 2017		5
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		5
India Primary Water Quality Criteria	Class B	-
Indian Water Quality Standards IS 2296:1992	Class B	5µg/l as C_2H_5OH
Thai Standards 1985	Class 2	5
EU 76/160/EEC of 8.12.1975 bathing water	G	≦5
	I	No specific odour ≦50
EU Directive 2006/7/EC on bathing water quality		-
ANZEC 2000		-

2) Anionic surfactants as MBAS

Standards: 1000 µg/l

Although the Environmental Quality Standards 1992 recommended 300 µg/l in line with the guide value of the older version of the EU directive on bathing water. The latest EU directive on bathing water 2006, does not have any numerical standard for the parameter. The water quality standard is deemed to provide enough protection of water users; thus, the standard is established at 1000 µg/l.

Table 49 Category B - Anionic surfactants as MBAS -

Source of Information		Anionic surfactants as MBS µg/l
The Ambient Water Quality Standards in 2017		1000
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		300
India Primary Water Quality Criteria	Class B	-
Indian Water Quality Standards IS 2296:1992	Class B	1000
Thai Standards 1985	Class 2	-
EU 76/160/EEC of 8.12.1975 bathing water	G	300
	I	-
EU Directive 2006/7/EC on bathing water quality		-
ANZEC 2000		200

6.6 Micro Organism

1) Total Coliform

Standards: 10,000 MPN/100ml

Although the Environmental Quality Standards 1992 recommended 1000 MPN/ 100ml, the recommended value appeared to be unnecessarily stringent. The latest EU directive on bathing water does not have any values on total coliform, the former version retained 10,000 MPN/100ml as the mandatory value. The Ambient Water Quality Standards in 2017 adopted 10,000 MPN/100ml to provide enough protection of water users.

Table 50 Category B -Total Coliform-

Source of Information		Total Coliform MPN/ 100ml
The Ambient Water Quality Standards in 2017		10,000
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		1,000
India Primary Water Quality Criteria	Class B	F)
Indian Water Quality Standards IS 2296:1992	Class B	500
Thai Standards 1985	Class 2	5,000
EU 76/160/EEC of 8.12.1975 bathing water	G	500
	I	10,000
EU Directive 2006/7/EC on bathing water quality		-
ANZEC 2000		-

6) Faecal Foliform

Standards: 500 MPN/100ml as the desirous level and 1000 MPN/100 ml as the maximum level

Although the Environmental Quality Standards 1992 recommended 50 MPN/ 100ml, the Ambient Water Quality Standards in 2017 adopted the value of 500 as the desirable level and 1000 as the maximum level. The value is consonant with the latest EU directive on bathing water quality. The Ambient Water Quality Standards in 2017would provide enough protection of water users.

Table 51 Category B - Faecal Foliform -

Source of Information		Faecal Coliform MPN/ 100ml
The Ambient Water Quality Standards in 2017		500 des 1000 max
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		50
India Primary Water Quality Criteria	Class B	-
Indian Water Quality Standards IS 2296:1992	Class B	-
Thai Standards 1985	Class 2	1000
EU 76/160/EEC of 8.12.1975 bathing water	G	100
	I	2000
EU Directive 2006/7/EC on bathing water quality	Excellent	500
	Good	1000
	Sufficient	900
ANZEC 2000		150

7 CATEGORY C: FISH AND AQUATIC LIFE WATER

Majority of the information used in the Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992 was derived from the Canadian Guidelines for fishery protection. The challenges in establishing water quality Standards for fishery is limited availability of toxicological data of pollutants on fish and aquatic life species endemic to the regions. In the review process, therefore, other sources of information were collected and compared to complement the data deficiency. They were 1) Water Quality Criteria and Standards for Freshwater and Marine Aquaculture and 2) Ronald D. Zweig, John D. Morton, Macol M. Stewart, Source Water Quality for Aquaculture A Guide for Assessment, World Bank. Both publications provided more information on fish and aquatic life in tropical settings and, also, the Asia and Pacific regions rather than relying solely on species dominantly found in the Northern Hemisphere. However it's undeniable that the basis of standard values derivation has faced technical challenges of data scarcity on endemic species. The second challenge in deriving the standard value was variations among species. In the revised water quality standards, general values applicable to broader fish species were also adopted wherever applicable and reasonable.

7.1 General parameters

1) Total Suspended Solid

Standards:40 mg/l

Total suspended solids (TSS) are particles that are larger than 2 microns found in the water. Anything smaller than 2 microns (average filter size) is considered a dissolved solid. Most suspended solids are made up of inorganic materials, though bacteria and algae can also contribute to the total solids concentration. The loading by such solids are prevalent in Sri Lanka as a result of High Flow Rates, Soil Erosion taking place at an upper stream due to limited bank protection and often flooding.

Table 52 Category C - Total Suspended Solid-

Source of Information		Total Suspended Solids mg/l
The Ambient Water Quality Standards in 2017		40
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		-
Indian Standards 1982	Class D	-
India Primary Water Quality Criteria	Class D	-
Water Quality Standards in India (IS 2296:1992)	Class D	-
EU 78/659/EEC of 18.7.1978	Salmonid waters G	-
	Salmonid waters I	-
	Cyprinid waters G	-
	Cyprinid waters I	-
Canadian	Fresh water aquatic life	-
	Fishery protection	-
Thai Standards 1985	Class 2	-
ANZEC 2000	Freshwater production	40

High concentrations have several negative effects, such as decreasing the amount of light that can penetrate the water, thereby slowing photosynthetic processes which in turn can lower the production of dissolved oxygen; high absorption of heat from sunlight, thus increasing the temperature which can result to lower oxygen level; low visibility which will affect the fish' ability to hunt for food; clog fish' gills; prevent development of egg and larva[43].

In a report on Water Quality Criteria, it is reported that the average TSS value of ASEAN, Australia, Kenya, Malaysia, New Zealand, Philippines and South Australia[43] is less than 40 mg/L for freshwater. However, Malaysia accepts a value of up to 150 mg/L for freshwater. For the TDS, only Kenya and Malaysia have a required standard, which ranges between 500 to 1,200 mg/L. Among the papers reviewed in this paper, only ANZEC 2000 recommend the value of TSS for freshwater production at 40 mg/L.

2) pH

Standards: 6.0-8.5

The pH can also affect fish health. For most freshwater species, a pH range between 6.5 - 9.0 is ideal, but most marine animals typically cannot tolerate as wide range pH as freshwater animals, thus the optimum pH is usually between pH 7.5 and 8.5 (Boyd, 1998). Below pH 6.5, some species experience slow growth (Lloyd, 1992). At lower pH, the organism's ability to maintain its salt balance is affected (Lloyd, 1992[23]) and reproduction ceases. At approximately pH 4.0 or below and pH 11 or above, most species die (Lawson, 1995[22])[43].

The Ambient Water Quality Standards in 2017 adopted the range of 6.0-8.5 recommended by the Environmental Quality Standards 1992 which is equivalent the values recommended by relevant Indian criteria.

Table 53 Category C -pH -

Source of Information		pH
The Ambient Water Quality Standards in 2017		6.0-8.5
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		6.0-8.5
Indian Standards 1982	Class D	6.5-8.5
India Primary Water Quality Criteria	Class D	6.5-8.5
Water Quality Standards in India (IS 2296:1992)	Class D	6.5-8.5
EU 78/659/EEC of 18.7.1978	Salmonid waters G	-
	Salmonid waters I	6.0-9.0
	Cyprinid waters G	-
	Cyprinid waters I	6.0-9.0
Canadian	fresh water aquatic life	-
	fishery protection	-
Thai Standards 1985	Class 2	5.0-9.0
ANZEC 2000		-

3) Dissolved Oxygen

Standards:5 mg/l

Dissolved oxygen is needed by fish to respire and perform metabolic activities. Thus low levels of dissolved oxygen are often linked to fish kill incidents. On the other hand, optimum levels can result to good growth, thus result to high production yield. In general, a saturation level of at least 5 mg/L is required. Values lower than this can put undue stress on the fish, and levels reaching less than 2 mg/L may result to death (but 3 mg/L to some species)[43].

Zweig *et al.* compiled literatures on recommended values on dissolved oxygen. The species found in cold region are removed from the original data. Dissolved oxygen at 5.0 mg/L provides appropriate protection to most the fishes and other

Table 54 Recommended values on Dissolved Oxygen

Species (common names)	DO (mg/L)	Comment	Reference
Tilapia	5.0	Preferred	Lloyd 1992
	3.0-4.0	Tolerable	Lloyd 1992
Warm water Crustaceans	5.0	Can only survive lower DO for a few hours	Lloyd 1992
Warm water fish	>5.0	Recommended	Lawson 1995
	>1.5	Live for several days	
	>1.0	Live for several hours	
	<0.3	Lethal concentration	
General Guidelines	>5.0-6.0		Lawson 1995

Source: Zweig, R., D., Morton J.D., Stewart, M. M, Source Water Quality for Aquaculture A Guide for Assessment.

Although the Environmental Quality Standards 1992 recommended 3 mg/L, the Ambient Water Quality Standards in 2017 adopted the value of 5 mg/L based on the information by Zweig *et al*.

Table 55 Category C - Dissolved Oxygen -

Source of Information		DO at 25°C mg/l
The Ambient Water Quality Standards in 2017		5
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		3
Indian Standards 1982	Class D	4
India Primary Water Quality Criteria	Class D	4
Water Quality Standards in India (IS 2296:1992)	Class D	4
EU 78/659/EEC of 18.7.1978	Salmonid waters G	50% > 9 100% > 7
	Salmonid waters I	50% > 9
	Cyprinid waters G	50% > 8 100% > 5
	Cyprinid waters I	50% > 7
Canadian	fresh water aquatic life	-
	fishery protection	-
Thai Standards 1985	Class 2	6
ANZEC 2000		-

4) BOD_5

Standards:5 mg/l

The major concern of BOD is the potential for it to deplete oxygen to levels which are dangerous to fish. If a source water contains a large amount of BOD, microbial growth will be enhanced especially at high temperatures. With this microbial growth and the corresponding degradation of organic matter, oxygen will be consumed[49].

Zweig *et al*. reports that the optimal range of BOD_5 for cyprinid culture is less than 8–15 mg/L. The Ambient Water Quality Standards 2017 adopted 5 mg/L.

Table 56 Category C - BOD_5 -

Source of Information		BOD_5 at 20°C mg/l
The Ambient Water Quality Standards in 2017		5
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		4
Indian Standards 1982	Class D	-
India Primary Water Quality Criteria	Class D	-
Water Quality Standards in India (IS 2296:1992)	Class D	-
EU 78/659/EEC of 18.7.1978	Salmonid waters G	<3
	Salmonid waters I	-
	Cyprinid waters G	<6
	Cyprinid waters I	-
Canadian	fresh water aquatic life	-
	fishery protection	-
Thai Standards 1985	Class 2	1.5
ANZEC 2000		-

5) COD

Standards: 15mg/l

The upper limit of COD for the optimal range for cyprinids in pond or river waters, is 20–30 mg/l. For salmonids the corresponding levels are up to 10 mg/l. The Ambient Water Quality Standards 2017 adopted the value of 15 mg/L as recommended by the Environmental Quality Standards 1992.

Table 57 Category C -COD -

Source of Information		COD mg/l
The Ambient Water Quality Standards in 2017		15
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		15
Indian Standards 1982	Class D	-
India Primary Water Quality Criteria	Class D	-
Water Quality Standards in India (IS 2296:1992)	Class D	-
EU 78/659/EEC of 18.7.1978	Salmonid waters G	-
	Salmonid waters I	-
	Cyprinid waters G	-
	Cyprinid waters I	-
Canadian	fresh water aquatic life	-
	fishery protection	-
Thai Standards 1985	Class 2	-
ANZEC 2000		-

7.2 Nutrient parameters

1) Ammonium Nitrogen (NH_4^+)

Standards: 0.94 mg/l (pH<7.5), 0.59 mg/l(pH=8.0), 0.22 mg/l(pH=8.5)

High concentrations of ammonia cause an increase in the ammonia concentration and pH in fish blood. This can cause gill damage, reduce the oxygen-carrying capacity of blood, increase the oxygen demand of tissues, damage red blood cells and the tissues that produce them, and affect osmoregulation[22].

Table 58 Category C - Ammonium Nitrogen (NH_4^+) -

Source of Information		pH<7.5 (mg/l)	pH=8.0 (mg/l)	pH=8.5 (mg/l)
The Ambient Water Quality Standards in 2017		0.94	0.59	0.22
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		0.94	0.59	0.22
Indian Standards 1982	Class D	-		
India Primary Water Quality Criteria	Class D	-		
Water Quality Standards in India (IS 2296:1992)	Class D	1.2		
EU 78/659/EEC of 18.7.1978	Salmonid waters G	NH_3 <0.005		
	Salmonid waters I	NH_3 <0.025		
	Cyprinid waters G	NH_3 <0.005		
	Cyprinid waters I	NH_3 <0.025		
Canadian	fresh water aquatic life	-		
	fishery protection	-		
Thai Standards 1985	Class 2	0.5		
ANZEC 2000 Trigger values for freshwater Level of protection (% species)	99%	0.32		
	95%	0.9		
	90%	1.43		
	80%	2.3		

Ammonia toxicity is greatly affected by the solution chemistry. The toxicity of total ammonia nitrogen (TAN which is equal to $NH4^+ + NH_3$) depends on what fraction of the total is unionized, since this is the more toxic form. Ammonium may also be toxic, but only at very high concentrations (Boyd 1990, 156). Ionized and unionized ammonia exist at an equilibrium depending on pH, temperature and salinity. The proportion of total ammonia nitrogen in the form of unionized ammonia increases as pH increases, so at a higher pH a smaller amount of total ammonia nitrogen causes toxic effects (Boyd

1990, 156). The effect of pH on ammonia toxicity can be pronounced. A change in pH levels from 7.0 to 8.0 increases the toxicity of a given concentration of ammonia by a factor of 10 (Lloyd 1992[23])[49]. Given the above mentioned conditions, the Ambient Water Quality Standards 2017 adopted the value recommended by the Environmental Quality Standards 1992 which is based on US-EPA Quality Criteria for water.

2) Phosphate

Standards: 0.4 mg/l

Phosphorous is a limiting nutrient needed for the growth of all plants- aquatic plants and algae alike. Excess concentrations especially in rivers and lakes can result to algal blooms. A lake with a concentration of below 0.010 mg/L is considered as oligotrophic, while concentrations between 0.010 and 0.020 mg/L are indicative of mesotrophy, and concentrations exceeding 0.020 mg/L are already considered eutrophic (Muller and Helsel, 1999).

The value of 0.4 mg/l proposed in the Environmental Quality Standards 1992 was adopted as a provisional guide. No other guidelines are recommended for this category of water. A review of the Standards is recommended when extensive nation-wide monitoring data of rivers become available.

Table 59 Category C -Phosphate -

Source of Information		PO_4-P mg/l
The Ambient Water Quality Standards in 2017		0.4
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		0.4
Indian Standards 1982	Class D	-
India Primary Water Quality Criteria	Class D	-
Water Quality Standards in India (IS 2296:1992)	Class D	-
EU 78/659/EEC of 18.7.1978	Salmonid waters G	-
	Salmonid waters I	-
	Cyprinid waters G	-
	Cyprinid waters I	-
Canadian	fresh water aquatic life	-
	fishery protection	-
Thai Standards 1985	Class 2	-
ANZEC 2000		-

7.3 Others

1) Cyanide

Standards: 0.05 mg/L

The Ambient Water Quality Standards in 2017 adopted the value of 0.05 mg/L. This decision was made considering the practicability and feasibility of water quality management to determine a stringent value only for Category C. For sensitive fishing area, an authorized government agency shall be consulted to determine appropriate concentration. A review of the Standards is recommended when extensive nation-wide monitoring data of rivers become available.

Table 60 Category C -Cyanide -

Source of Information		CN mg/l
The Ambient Water Quality Standards in 2017		0.05
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		0.005
Indian Standards 1982	Class D	-
India Primary Water Quality Criteria	Class D	-
Water Quality Standards in India (IS 2296:1992)	Class D	-
EU 78/659/EEC of 18.7.1978	Salmonid waters G	-
	Salmonid waters I	-
	Cyprinid waters G	-
	Cyprinid waters I	-
Canadian	fresh water aquatic life	0.005
	fishery protection	-
Thai Standards 1985	Class 2	-
ANZEC 2000 Trigger values for freshwater Level of protection (% species)	99%	0.004
	95%	0.007
	90%	0.011
	80%	0.018

7.4 Metals

1) Cadmium

Standards: 5 µg/l

The Environmental Quality Standards 1992 adopted the Canadian Guidelines for fresh water aquatic life is adopted.

Table 61 Category C -Cadmium -

Source of Information		Cd µg/l				
The Ambient Water Quality Standards in 2017		5				
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		H	<60	60-120	120-180	>180
		Cd	0.2	0.8	1.3	1.8
Indian Standards 1982	Class D	-				
India Primary Water Quality Criteria	Class D	-				
Water Quality Standards in India (IS 2296:1992)	Class D	-				
EU 78/659/EEC of 18.7.1978	Salmonid waters G	-				
	Salmonid waters I	-				
	Cyprinid waters G	-				
	Cyprinid waters I	-				
Canadian	fresh water aquatic life	H	<60	60-120	120-180	>180
		Cd	0.2	0.8	1.3	1.8
	fishery protection	-				
Thai Standards 1985	Class 2	5⋆ 50⋆⋆				
ANZEC 2000 Trigger values for freshwater Level of protection (% species)	99%	0.06				
	95%	0.2				
	90%	0.4				
	80%	0.8				

Cadmium in surface waters is usually found together with zinc but at much lower concentrations. The cadmium present in surface waters may be either dissolved or insoluble. Of the dissolved forms, those which may be poisonous to fish include the simple ion and various inorganic and organic complex ions.

A wide range of concentration is recommended for cadmium depending on species of concern. For simplicity purpose, it is recommended to adopt 5 µg/l as the standard applicable to waterbodies with alkalinity over 100 mg/L. For sensitive fishing area, an authorized government agency shall be consulted to determine appropriate cadmium concentration.

2) Chromium

Standards: 20 µg/l

In surface waters, the most stable forms of chromium are the oxidation states III and VI. Of these two forms, chromium III is poorly soluble and is readily adsorbed onto surfaces, so that the much more soluble chromium VI is the most common form in fresh water. For this reason, maximum admissible concentrations for chromium are generally based on toxicity data for the hexavalent form. Chromium compounds in the trivalent state (III) are more toxic to fish and other aquatic organisms than are those in the hexavalent state VI[49]. Zweig et al. compiled the Maximum chromium concentrations for aquaculture as presented in the table below.

Table 62 Maximum chromium concentrations for aquaculture

Species	Chromium concentration
Salmonid	< 5 ppb annual mean; Hardness 0–50 mg /L
	< 10 ppb annual mean; Hardness 50–100 mg/L
	< 20 ppb annual mean; Hardness 100–200 mg l/L
	< 50 ppb annual mean; Hardness > 200 mg l/L
Cyprinid	< 150 ppb annual mean; Hardness 0–50 mg l/L
	< 175 ppb annual mean; Hardness 50–100 mg l/L
	< 200 ppb annual mean; Hardness 100–200 mg l/L
	< 250 ppb annual mean; Hardness > 200 mg l/L
General guidelines	< 210 ppb chromium (III)
	< 11 ppb chromium (VI) in freshwater

Source: Zweig, R., D., Morton J.D., Stewart, M. M, Source Water Quality for Aquaculture A Guide for Assessment.

Table 63 Category C - Chromium -

Source of Information		Cr µg/l
The Ambient Water Quality Standards in 2017		20
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		2
Indian Standards 1982	Class D	-
India Primary Water Quality Criteria	Class D	-
Water Quality Standards in India (IS 2296:1992)	Class D	-
EU 78/659/EEC of 18.7.1978	Salmonid waters G	-
	Salmonid waters I	-
	Cyprinid waters G	-
	Cyprinid waters I	-
Canadian	fresh water aquatic life	to fish 20 to aquatic life 2
	fishery protection	-
Thai Standards 1985	Class 2	50
ANZEC 2000 Trigger values for freshwater Level of protection (% species)	99%	ID(Cr III) /0.01 (Cr VI)
	95%	ID/1.0
	90%	ID/6
	80%	7.7/0.14

The Ambient Water Quality Standards in 2017adopted the value of 20 µg/l based on the recommendation of the Maximum chromium concentrations for aquaculture as reported by Zweig *et al*. and the values recommended by the Canadian water quality guidelines. 20 µg/l is applicable to fish. For aquatic life 2 µg/l shall be applied.

3) Copper

Standards: 100 µg/l

Copper has a low toxicity to mammals and does not bioaccumulate readily. However copper is very toxic to aquatic organisms. Therefore rather than causing a human health risk, the main concern regarding copper contamination is its toxicity to aquatic organisms. Copper is most toxic to aquatic organisms in its cupric ion form. Hardness and dissolved organic matter reduce the amount of cupric ion and thus reduce the toxicity of copper. In hard water, copper forms carbonate precipitates and is very slow to redissolve. Also, calcium in hard waters competes with copper for binding sites, further reducing toxicity. Dissolved organic matter binds strongly with copper resulting in reduced cupric ion concentration and thus lower toxicity[49].

The Ambient Water Quality Standards in 2017 adopted the value of 100 µg/l which is equivalent to the upper range of the EU's directive.

Table 64 Category C -Copper -

Source of Information		Cu µg/l				
The Ambient Water Quality Standards in 2017		100				
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		Hardness	<60	60-120	120-180	>180
		Cu	2	2	3	4
Indian Standards 1982	Class D	-				
India Primary Water Quality Criteria	Class D	-				
Water Quality Standards in India (IS 2296:1992)	Class D	-				
EU 78/659/EEC of 18.7.1978	Salmonid waters G	CaCO3(mg/L)	10	50	100	300
		Cu	5	22	40	112
	Salmonid waters I					
	Cyprinid waters G	CaCO3				
		Cu	5	22	40	112
	Cyprinid waters I					
Canadian	fresh water aquatic life	H	<60	60-120	120-180	>180
		Cu	2	2	3	4
	fishery protection					
Thai Standards 1985	Class 2	100				
ANZEC 2000 Trigger values for freshwater Level of protection (% species)	99%	1				
	95%	1.4				
	90%	1.8				
	80%	2.5				

4) Lead

Standards: 2µg/l (Hardness <120 mg/L), 3µg/l (Hardness 120-180mg/L), 4µg/l (Hardness >180 mg/L)

Chronic lead toxicity in aquatic organisms leads to nervous system damage while acute toxicity causes gill damage and suffocation (Svobodová and others 1993, 27). Chronic lead toxicity is easily identified in fish by the blackening of the fins (Dojlido and Best 1993, 112).

Table 65 Maximum lead concentrations for aquaculture

Species	Lead concentration Reference
Salmonids	4.0–8.0 ppb Svobodová et al. 1993
	< 4.0 ppb annual mean; hardness < 50 mg/L EC 1979
	< 0.0 ppb annual mean; hardness 50–150 mg/L
	< 20.0 ppb annual mean; hardness > 150 mg/L
Cyprinids	< 70.0 ppb Svobodová et al. 1993
	< 50.0 ppb annual mean; hardness < 50 mg l/L
	< 25.0 ppb annual mean; hardness 50–150 mg/L
	< 250.0 ppb annual mean; hardness 150–250 mg/L
Freshwater	< 3.2 ppb USEPA 1986
All species	< 20.0 ppb Meade 1989

Source: Zweig, R., D., Morton J.D., Stewart, M. M, Source Water Quality for Aquaculture A Guide for Assessment.

The toxicity of lead is dependent on the alkalinity, hardness and pH of the water. Toxicity is decreased by high alkalinity (that is, high calcium carbonate) because calcium carbonate competes for uptake at the gill surface (Lloyd 1992, 39). The solubility of lead and thus its toxicity is lower in hard waters than in soft waters (Dojlido and Best 1993, 112). For the same reason, lead toxicity is higher at lower pH levels which would be common particularly at ponds bottoms and among benthos and nutrients (Svobodová and others 1993,)[49]. Zeig et al. present a table on maximum lead concentrations for aquaculture. The Ambient Water Quality Standards in 2017 adopted the value recommended by the Environmental Quality Standards 1992.

Table 66 Category C -Lead -

Source of Information		Pb µg/l				
The Ambient Water Quality Standards in 2017		H	120		120-180	>180
		Pb	2		3	4
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		H	<60	60-120	120-180	>180
		Pb	2	2	3	4
Indian Standards 1982	Class D	-				
India Primary Water Quality Criteria	Class D	-				
Water Quality Standards in India (IS 2296:1992)	Class D	-				
EU 78/659/EEC of 18.7.1978	Salmonid waters G	-				
	Salmonid waters I	-				
	Cyprinid waters G	-				
	Cyprinid waters I	-				
Canadian	fresh water aquatic life	H	<60	60-120	120-180	>180
		Pd	1	2	4	7
	fishery protection	-				
Thai Standards 1985	Class 2	50				
ANZEC 2000 Trigger values for freshwater Level of protection (% species)	99%	1				
	95%	3.4				
	90%	5.6				
	80%	9.4				

5) Manganese

Standards:1000 mg/L

Manganese toxicity to fish is not prominent. At higher concentrations, the precipitates may occlude gills and cause stress or mortality[49]. The Ambient Water Quality Standards in 2017 adopted the value of 1000 µg/l as recommended by the Environmental Quality Standards 1992.

Table 67 Category C - Manganese-

Source of Information		Mn µg/l
The Ambient Water Quality Standards in 2017		1000
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		1000
Indian Standards 1982	Class D	-
India Primary Water Quality Criteria	Class D	-
Water Quality Standards in India (IS 2296:1992)	Class D	-
EU 78/659/EEC of 18.7.1978	Salmonid waters G	-
	Salmonid waters I	-
	Cyprinid waters G	-
	Cyprinid waters I	-
Canadian	fresh water aquatic life	-
	fishery protection	-
Thai Standards 1985	Class 2	1000
ANZEC 2000 Trigger values for freshwater Level of protection (% species)	99%	1200
	95%	1900
	90%	2500
	80%	3600

6) Mercury

Standards: 1 µg/l

The lethal levels of mercury for fish range from 1 mg /L for tilapia to 30 mg l/L for guppies and 2 mg l/L for a crustacean (Cyclops abyssorum). While methyl mercury accounts for more than 90 percent of the mercury found in fish at higher trophic levels, it constitutes less than 1 percent of the total mercury found in aquatic systems (Malm and others 1990, 12). Methyl mercury is 1,000 times more soluble in fats than in water and concentrates in muscle tissue, brain tissue, and the central nervous system. Hence mercury levels in fish may be in excess of 10,000 to 100,000 times the original concentration in surrounding waters.

Table 68 Category C -Mercury -

Source of Information		Hg µg/l
The Ambient Water Quality Standards in 2017		1
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		0.1
Indian Standards 1982	Class D	-
India Primary Water Quality Criteria	Class D	-
Water Quality Standards in India (IS 2296:1992)	Class D	-
EU 78/659/EEC of 18.7.1978	Salmonid waters G	-
	Salmonid waters I	-
	Cyprinid waters G	-
	Cyprinid waters I	-
Canadian	fresh water aquatic life	0.1
	fishery protection	-
Thai Standards 1985	Class 2	2
ANZEC 2000 Trigger values for freshwater Level of protection (% species)	99%	0.06
	95%	0.6
	90%	1.9
	80%	5.4

The contaminant rises through the food chain and high concentrations of mercury accumulate in predators such as trout, pike, walleye, bass, tuna, swordfish, and shark. In highly contaminated areas methyl mercury may be accumulated in smaller species which are lower in the food chain such as those found in aquaculture (Philips 1993, 302). In addition to fish,
aquatic invertebrates also accumulate mercury to high concentrations[43].

Although the Environmental Quality Standards 1992 recommended 0.1 µg/l, the Ambient Water Quality Standards in 2017 adopted 1.0 µg/l considering the values in Australia and New Zealand.

7) Nickel

Standards: 100 µg/l

Nickel is only moderately toxic to fish. For salmonid culture, nickel has a 96-hr LC50 value of 8 mg /L in soft waters and 50 mg l/L in hard waters[49]. The Ambient Water Quality Standards in 2017 adopted the value of 100 µg/l which is be nearly equal to the values recommended by the Environmental Quality Standards 1992.

Table 69 Category C -Nickel -

Source of Information		Ni µg/l				
The Ambient Water Quality Standards in 2017		100				
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		H	<60	60-120	120-180	>180
		Ni	25	65	110	150
Indian Standards 1982	Class D	-				
India Primary Water Quality Criteria	Class D	-				
Water Quality Standards in India (IS 2296:1992)	Class D	-				
EU 78/659/EEC of 18.7.1978	Salmonid waters G	-				
	Salmonid waters I	-				
	Cyprinid waters G	-				
	Cyprinid waters I	-				
Canadian	fresh water aquatic life	H	<60	60-120	120-180	>180
		Ni	25	65	110	150
	fishery protection	-				
Thai Standards 1985	Class 2	100				
ANZEC 2000 Trigger values for freshwater Level of protection (% species)	99%	8				
	95%	11				
	90%	13				
	80%	17				

8) Selenium

Standards: 5 µg/l

Selenium presents few problems for marine organisms, and it may even help in detoxifying accumulated mercury[49]. Zweig et al. recommend that concentrations of selenium should not exceed 5 ppb in freshwater and 71 ppb in saltwater based on USEPA 1993[42].

Table 70 Category C -Selenium -

Source of Information		Se µg/l
The Ambient Water Quality Standards in 2017		5
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		1
Indian Standards 1982	Class D	-
India Primary Water Quality Criteria	Class D	-
Water Quality Standards in India (IS 2296:1992)	Class D	-
EU 78/659/EEC of 18.7.1978	Salmonid waters G	-
	Salmonid waters I	-
	Cyprinid waters G	-
	Cyprinid waters I	-
Canadian	fresh water aquatic life	1
	fishery protection	-
Thai Standards 1985	Class 2	-
ANZEC 2000 Trigger values for freshwater Level of protection (% species)	99%	5
	95%	11
	90%	18
	80%	34

9) Zinc

Standards: 1000 µg/l

There is very little evidence to indicate any significant human health effect of zinc. It is however toxic to aquatic organisms. The Ambient Water Quality Standards in 2017 adopted the value of 1000 µg/l as a provisional guideline considering operational aspects of the water quality management. This decision was made considering the limited practicability and feasibility of water quality management to determine a stringent value only for Category C. For sensitive fishing area, an authorized government agency shall be consulted to determine appropriate concentration. A review of the Standards is recommended when extensive nation-wide monitoring data of rivers become available.

Table 71 Category C -Zinc -

Source of Information		Zn µg/l				
The Ambient Water Quality Standards in 2017		1000				
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		30				
Indian Standards 1982	Class D	-				
India Primary Water Quality Criteria	Class D	-				
Water Quality Standards in India (IS 2296:1992)	Class D	-				
EU 78/659/EEC of 18.7.1978	Salmonid waters G	-				
	Salmonid waters I	$CaCO_3$	10mg/l	50mg/l	100mg/l	500mg/l
		Zn	30	200	300	500
	Cyprinid waters G	-				
	Cyprinid waters I	$CaCO_3$	10mg/l	50mg/l	100mg/l	500mg/l
		Zn	300	700	1000	2000
Canadian	fresh water aquatic life	30				
	fishery protection	-				
Thai Standards 1985	Class 2	1000				
ANZEC 2000 Trigger values for freshwater Level of protection (% species)	99%	2.4				
	95%	8				
	90%	15				
	80%	31				

10) Arsenic

Standards: 50 µg/l

There is only limited information on the toxicity of arsenic to aquatic species. Based on existing information, arsenic is relatively non-toxic to aquatic organisms. A short-term exposure of approximately 1,000 ppb is necessary for mortalities to occur. However arsenic may affect phytoplankton growth at levels as low as five times the background concentration.

The Ambient Water Quality Standards in 2017 adopted 50 µg/l as recommended by the Environmental Quality Standards 1992 which is also equivalent to the Canadian value for fresh water aquatic life.

Table 72 Category C - Arsenic-

Source of Information		As µg/l
The Ambient Water Quality Standards in 2017		50
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		50
Indian Standards 1982	Class D	-
India Primary Water Quality Criteria	Class D	-
Water Quality Standards in India (IS 2296:1992)	Class D	-
EU 78/659/EEC of 18.7.1978	Salmonid waters G	-
	Salmonid waters I	-
	Cyprinid waters G	-
	Cyprinid waters I	-
Canadian	fresh water aquatic life	50
	fishery protection	-
Thai Standards 1985	Class 2	10
ANZEC 2000 Trigger values for freshwater Level of protection (% species)	99%	1(As III)/ 0.8 (As V)
	95%	24/13
	90%	94/43
	80%	360/140

7.5 Organic Micro Pollutants

1) Phenolic Compound

Standards: 2 µg/l

Odorous organic compounds such as those from petroleum distillates and discharges from paper processing are a common source of off-flavors in fish. The primary effect is on the flavor of the product because fish grown in water contaminated with these compounds will be unpalatable before contaminant concentrations reach an unhealthy level. The Ambient Water Quality Standards in 2017 adopted 2 μg/l .

Table 73 Category C -Phenolic Compound -

Source of Information		Phenolic Compound μg/l
The Ambient Water Quality Standards in 2017		2
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		1
Indian Standards 1982	Class D	-
India Primary Water Quality Criteria	Class D	-
Water Quality Standards in India (IS 2296:1992)	Class D	-
EU 78/659/EEC of 18.7.1978	Salmonid waters G	-
	Salmonid waters I	※2
	Cyprinid waters G	-
	Cyprinid waters I	※2
Canadian	fresh water aquatic life	1
	fishery protection	-
Thai Standards 1985	Class 2	5
ANZEC 2000		-

2) Oil/Grease

Standards: 100 μg/l

Few of the constituent of oil and refined oil products will readily dissolve in water. There are also large differences between oil and its different products as to their toxicity to fish; most of them have 48h LC50 values within the range of 0.5 to 200 mg /L. The toxicity varies according to the chemical composition of the different products, with the water solubility of the different petroleum hydrocarbons, and with the degree of emulsification of insoluble components in the water. It is generally agreed that the lighter oil fractions (including kerosene, petrol, benzene, toluene and xylene) are much more toxic to fish than the heavy fractions (heavy paraffins and tars).

The Ambient Water Quality Standards in 2017 adopted 100μg/l which is equivalent to an Indian standard.

Table 74 Category C - Oil/Grease-

Source of Information		Oil/Grease μg/l
The Ambient Water Quality Standards in 2017		100
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		10
Indian Standards 1982	Class D	100
India Primary Water Quality Criteria	Class D	-
Water Quality Standards in India (IS 2296:1992)	Class D	-
EU 78/659/EEC of 18.7.1978	Salmonid waters G	-
	Salmonid waters I	-
	Cyprinid waters G	-
	Cyprinid waters I	-
Canadian	fresh water aquatic life	-
	fishery protection	-
Thai Standards 1985	Class 2	-
ANZEC 2000		-

3) Anionic Surfactants as MBAS

Standards:1000 μg/l

They do have a common physico-chemical effect in that they can damage the lipid components of cell membranes. Because the surface tension of the ambient water is decreased, the lipids are less water repellant and this leads to hydration and enlargement of the cell volume.

Table 75 Category C - Anionic Surfactants as MBAS-

Source of Information		Anionic surfactants as MBS µg/l
The Ambient Water Quality Standards in 2017		1000
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		1000
Indian Standards 1982	Class D	-
India Primary Water Quality Criteria	Class D	-
Water Quality Standards in India (IS 2296:1992)	Class D	-
EU 78/659/EEC of 18.7.1978	Salmonid waters G	-
	Salmonid waters I	-
	Cyprinid waters G	-
	Cyprinid waters I	-
Canadian	fresh water aquatic life	-
	fishery protection	-
Thai Standards 1985	Class2	-
ANZEC 2000		-

At low surfactant concentrations this enlargement is reversible. Higher concentration can cause a suppression of metabolic processes in the cells. Long-term exposure may damage the cells which then become necrotic in the later stages. These changes result mainly in an impairment of the gill respiratory epithelium. In addition, the exposure of fish to some surfactants can cause changes in the activity of respiratory enzymes, especially cytochromoxidase. Surfactants can also damage the protective layer of mucus on the skin; the layer loosens and the resistance of the fish to infection decreases. Sublethal surfactant concentrations can also damage eggs and sperm. The toxicity of surfactants to fish is influenced by a number of biotic and, especially, abiotic factors. The age of the fish is a particularly important biotic factor[11].

The value recommended by the Environmental Quality Standards 1992 of 1000 µg/l as a provisional guideline.

7.6 Micro Organism

No standards are recommended for Micro Organism for Category C.

8 CATEGORY D DRINKING WATER SOURCES FOR GENERAL TREATMENT

8.1.1 General parameters

1) Colour

Standards: 100 PTmg/l

Drinking-water should ideally have no visible colour[4]. Colour in drinking-water is usually due to the presence of coloured organic matter (primarily humic and fluvic acids) associated with the humus fraction of soil. Colour is also strongly influenced by the presence of iron and other metals, either as natural impurities or as corrosion products. It may also result from the contamination of the water source with industrial effluents and may be the first indication of a hazardous situation. The source of colour in a drinking-water supply should be investigated, particularly if a substantial change has taken place.

The Environmental Quality Standards in Sri Lanka 1992 recommended 100 PTmg/l.. The Sri Lanka's Raw Water Quality Standards does not have any values on colour. However, the EU's Raw Water Quality Standards prescribes 50 and 100 PTmg/l as the guide and mandatory values respectively. The Ambient Water Quality Standards in 2017 adopted 100 PTmg/l. as proposed in 1992 which is also equivalent to the EU's Raw Water for drinking purpose. Considering the fact that the majority of the substances that may affect colour of water is removable by chlorination plus filtration and coagulation process, the value of 100 PTmg/l is adopted.

Table 76 Category D - Colour -

Sources of Information				Colour PTmg/l
The Ambient Water Quality Standards in 2017				100
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				100
Raw Water for drinking purpose	Sri Lanka	SLS 722:1985 Raw Water Quality Standards		-
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	50
			Mandatory	100
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		15
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		15
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		*

*: Acceptable to consumers and no abnormal change

2) Total Suspended Solids

Standards:1500 mg/L

Total suspended solids (TSS) are particles that are larger than 2 microns found in the water. Anything smaller than 2 microns (average filter size) is considered a dissolved solid. Most suspended solids are made up of inorganic materials, though bacteria and algae can also contribute to the total solids concentration. Like turbidity, TSS affect efficiency of treatment process at water plant. The loading by such solids are prevalent in Sri Lanka as a result of High Flow Rates, Soil Erosion taking place at

[4] Colour can be measured spectrophotometrically or using a visual comparator. In both cases, the standard unit of measurement is the Hazen unit (HU). (True colour is often quoted as True Colour Units, or TCU; however, the numerical values are identical.) Hazen units are defined in terms of a platinum–cobalt standard (APHA Method 2120B 1992) .
Refer to the following publication for more details. Physical and Chemical Characteristics – Fact Sheets, Colour (True) (endorsed 1996)[www.clarence.nsw.gov.au/file.asp?g=RES-WHM-86-71-52] (Accessed 22nd August 2017)

an upper stream due to limited bank protection and often flooding. The Ambient Water Quality Standards in 2017 adopted the value of 1500 mg/L as a provisional target of water quality. This decision was also made by considering removability by conventional treatment process.

Table 77 Category D - Total Suspended Solid -

Sources of Information				TSS mg/L
The Ambient Water Quality Standards in 2017				1500
Environmental Quality Standards and Designation of Water Use in Sri Lanka 1992				1500
Raw Water for drinking purpose	Sri Lanka	SLS 722:1985 Raw Water Quality Standards		-
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	-
			Mandatory	-
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		-
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		-
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		*

* Acceptable to consumers and no abnormal change.

3) pH

Standards: 6.0-9.0

Although pH usually has no direct impact on consumers, it is one of the most important operational water quality parameters. For effective disinfection with chlorine, the pH should preferably be less than 8; however, lower-pH water is likely to be corrosive. The optimum pH required will vary in different supplies according to the composition of the water and the nature of the construction materials used in the distribution system, but it is usually in the range 6.5–8.

The Environmental Quality Standards in Sri Lanka 1992 recommended pH in a range from 6.0-9.0. The Sri Lanka's Raw Water Quality Standards set the value in a range from 6.0-9.0. The EU's Raw Water Quality Standards recommends the values in a range from 5.5-9.0. The Ambient Water Quality Standards in 2017 adopted the value recommended by the Environmental Quality Standards in Sri Lanka 1992 in the range from 6.0-9.0 that is consistent with the Sri Lanka's Raw Water Quality Standards.

Table 78 Category D - pH -

Sources of Information				pH
The Ambient Water Quality Standards in 2017				6.0-9.0
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				6.0-9.0
Raw Water for drinking purpose	Sri Lanka	SLS 722:1985 Raw Water Quality Standards		6.0-9.0
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	5.5-9
			Mandatory	-
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		6.5-8.5
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		*
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		6.5-9.5

* No film visible on the surface of the water and no odour

4) Dissolved Oxygen

Standards: 4 mg/L

The dissolved oxygen content of water is influenced by the source and water temperature. Depletion of dissolved oxygen in water supplies can encourage the microbial reduction of nitrate to nitrite and sulfate to sulfide. It can also cause an increase in the concentration of ferrous iron in solution. No health-based guideline value is recommended.

The Environmental Quality Standards 1992 recommended 4 mg/L. The Raw Water Quality Standards of Sri Lanka set it at 4 mg/l. The value recommended by the Environmental Quality Standards 1992 is retained. The following conditions were considered in determining the value: 1) there is no direct health effects on human body of the users and 2) there is no standards for any drinking water quality standards.

Table 79 Category D - Dissolved Oxygen -

Sources of Information				DO at 25°C mg/l
The Ambient Water Quality Standards in 2017				4
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				4
Raw Water for drinking purpose	Sri Lanka	SLS 722:1985 Raw Water Quality Standards		4
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	*
			Mandatory	-
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		-
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		-
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		-

* >50% (%O2)

5) BOD_5

Standards: 5 mg/L

Natural organic detritus and organic waste from waste water treatment plants, failing septic systems, and agricultural and urban runoff, acts as a food source for water-borne bacteria. Bacteria decompose these organic materials using dissolved oxygen, thus reducing the DO present for fish. Biochemical oxygen demand (BOD) is a measure of the amount of oxygen that bacteria will consume while decomposing organic matter under aerobic conditions.

Table 80 Category D - BOD_5 -

Sources of Information				BOD_5 at 20°C mg/l
The Ambient Water Quality Standards in 2017				5
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				5
Raw Water for drinking purpose	Sri Lanka	SLS 722:1985 Raw Water Quality Standards		5
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	<5
			Mandatory	-
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		-
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		-
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		-

BOD_5 is determined by incubating a sealed sample of water for five days and measuring the loss of oxygen from the beginning to the end of the test[8]. As a very general rule, a BOD level of 1-2 mg/l is considered pristine water. There would not be much organic materials present in the water. A water with a BOD level of 3-5 mg/l is considered moderately clean. In water with a BOD level of 6-9 ppm, the water is considered somewhat polluted because there is usually organic matter present.

The Ambient Water Quality Standards in 2017 adopted 5 mg/l as proposed in 1992 which is consistent with the Sri Lanka’s and EU’s Raw Water Quality Standards.

6) COD

Standards: 30 mg/L

Chemical oxygen demand (COD) does not differentiate between biologically available and inert organic matter, and it is a measure of the total quantity of oxygen required to oxidize all organic material into carbon dioxide and water. COD values are always greater than BOD values, but COD measurements can be made in a few hours while BOD measurements take five days[8]. COD is an important water quality parameter because, similar to BOD, it provides an index to assess the presence of organic substances in water. Higher COD levels mean a greater amount of oxidizable organic material in the water, which will reduce dissolved oxygen (DO) levels. A reduction in DO can lead to anaerobic conditions, which is deleterious to higher aquatic life forms. The COD test is often used as an alternate to BOD due to shorter length of testing time.

The Ambient Water Quality Standards in 2017 adopted 30 mg/L as recommended by the Environmental Quality Standards 1992. The values is based on a recommended value for a category A3 of the EU's Raw Water for drinking purpose.

Table 81 Category D - COD -

Sources of Information				COD mg/l
The Ambient Water Quality Standards in 2017				30
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				30
Raw Water for drinking purpose	Sri Lanka	SLS 722:1985 Raw Water Quality Standards		
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	
			Mandatory	
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		10
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		

* Intensive physical and chemical treatment, extended treatment and disinfection e.g. chlorination to break-point, coagulation, flocculation, decantation, filtration, adsorption (activated carbon), disinfection (ozone, final chlorination).

8.2 Nutrient parameters

1) Nitrate Nitrogen (NO_3-N)

Standards:10 mg/L

The primary health concern regarding nitrate and nitrite is the formation of methaemoglobinaemia, so-called "blue-baby syndrome." The WHO's drinking water guideline value for nitrate is 50 mg/litre, equivalent to approximately 10 mg/litre as nitrate nitrogen, to protect against methaemoglobinaemia in bottle-fed infants (short-term exposure). The Environmental Quality Standards in 1992 proposed 5 mg/L. The proposed value is deemed stringent since the quality of a river portion used for drinking water source is not necessarily maintained beyond the quality of finished water at treatment plant. In this context, the value is relaxed at 10 mg/l to be consistent with the Sri Lanka's Raw Water Quality Standards and the Potable Water Quality Standard.

Table 82 Category D - Nitrate Nitrogen Nitrate Nitrogen (NO^{3-} -N) -

Sources of Information				NO_3-N mg/l
The Ambient Water Quality Standards in 2017				10
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				5
Raw Water for drinking purpose	Sri Lanka	SLS 722:1985 Raw Water Quality Standards	Raw water for use drinking	10
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	
			Mandatory	10
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		10
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		10
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		10

The value of NO_3^- was converted to that of N-NO_3^- and rounded down to the nearest 10.

2) Phosphate

Standards:0.7 mg/l

The health effects of drinking water with phosphates are not known. Phosphates is generally recognized as safe. Generally, phosphorus is the limiting nutrient in freshwater aquatic systems. That is, if all phosphorus is used, plant growth will cease, no matter how much nitrogen is available[19].

The Environmental Quality Standards 1992 recommended 0.7 mg/l as a provisional level, which is determined in consideration of the fact that increased phosphate levels cause eutrophication and excessive weed growth, eg. in irrigation channels and other stagnant part of a river. The standards in 1992 emphasized that lower levels may be required under specific conditions. The EU's Raw Water Quality Standards adopt a lower level at 0.4 mg/l as a guide but not mandatory. The Sri Lanka's Potable Water Quality Standards prescribed a nearly equivalent level at 0.7 mg/L. The Ambient Water Quality Standards in 2017 adopted 0.7 mg/L as recommended by the Environmental Quality Standards 1992. The values should be subject to further review after appropriate sets of monitoring data become available.

Table 83 Category D - Phosphate -

Sources of Information				PO_4-P mg/l
The Ambient Water Quality Standards in 2017				0.7
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				0.7
Raw Water for drinking purpose	Sri Lanka	SLS 722:1985 Raw Water Quality Standards		-
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	0.7
			Mandatory	-
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		-
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		-
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		-

8.3 Others

1) Chloride

Standards: 250 mg/l

Excessive chloride concentrations increase rates of corrosion of metals in the distribution system, depending on the alkalinity of the water. This can lead to increased concentrations of metals in the supply. Chloride concentrations in excess of about 250 mg/litre can give rise to detectable taste in water. High concentrations of chloride give a salty taste to water and beverages. Taste thresholds for the chloride anion depend on the associated cation and are in the range of 200–300 mg/litre for sodium, potassium and calcium chloride. Concentrations in excess of 250 mg/litre are increasingly likely to be detected by taste, but some consumers may become accustomed to low levels of chloride-induced taste. No health based guideline value is proposed for chloride in drinking-water.

The Environmental Quality Standards 1992 recommended 250 mg/l. The Sri Lanka's Raw Water Quality Standards set the standard at 1200 mg/L. The Ambient Water Quality Standards in 2017 adopted the value of 250 mg/l as proposed in 1991 to make with a margin of safety.

Table 84 Category D - Chloride -

Sources of Information				Chloride (Cl) mg/l
The Ambient Water Quality Standards in 2017				250
Environmental Quality Standards and Designation of Water Use in Sri Lanka 1992				250
Raw Water for drinking purpose	Sri Lanka	SLS 722:1985 Raw Water Quality Standards		1200
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	-
			Mandatory	-
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		250
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		-
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		250

2) Cyanide

Standards: 0.05 mg/L

The acute toxicity of cyanides is high. Effects on the thyroid and particularly the nervous system were observed in some populations as a consequence of the long-term consumption of inadequately processed cassava containing high levels of cyanide1.

Table 85 Category D - Cyanide -

Sources of Information				CN mg/l
The Ambient Water Quality Standards in 2017				0.05
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				0.005
Raw Water for drinking purpose	Sri Lanka	SLS 722:1985 Raw Water Quality Standards		0.05
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	-
			Mandatory	0.05
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		0.05
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		*
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		0.05

* No guidelines established because occurs in drinking-water at concentrations well below those of health concern, except in emergency situations following a spill to a water source.

Although the value recommended by the Environmental Quality Standards 1992 was 0.005 mg/L, it was rejected because it is well below the standards prescribed by the Sri Lanka's Raw Water Quality Standards and Potable Water Quality. The Ambient Water Quality Standards in 2017 adopted 0.05 mg/l to be consistent with the Raw Water Quality Standards.

3) Fluoride

Standards: 1.5 mg/L

Many epidemiological studies clearly establish that fluoride primarily produces effects on skeletal tissues (bones and teeth). In many regions with high fluoride exposure, fluoride is a significant cause of morbidity; though, low concentrations provide protection against dental caries, especially in children[46].

Table 86 Category D - Fluoride -

Sources of Information				F mg/l
The Ambient Water Quality Standards in 2017				1.5
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				1.5
Raw Water for drinking purpose	Sri Lanka	SLS 722:1985 Raw Water Quality Standards		1.5
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	0.7-17
			Mandatory	-
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		1.0
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		1.5
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		1.5

It was also confirmed that the latest guidelines of WHO Forth Edition recommends 1.5 mg/l and the removal of 50% or more of fluoride is achievable by coagulation process[46]. The recommended value by the Environmental Quality Standards 1992 at 1.5 mg/L was adopted which is equivalent to the Sri Lanka's Raw Water Quality Standards. This decision was made considering the removal efficiency of the treatment process.

4) Sulphate

Standards:250 mg/L

No health-based guideline for drinking water is proposed for sulfate. However, it has gastrointestinal effects resulting from ingestion of water containing high sulfate levels.

The Ambient Water Quality Standards in 2017 adopted the value of 250 mg/L as recommended in 1992 which is also equivalent to the EU's Raw Water Quality Standards.

Table 87 Category D - Sulphate -

Sources of Information				SO_4^{2-} mg/l
The Ambient Water Quality Standards in 2017				250
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				250
Raw Water for drinking purpose	Sri Lanka	SLS 722:1985 Raw Water Quality Standards		-
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	150
			Mandatory	250
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		250
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		*
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		250

* Not of health concern at levels found in drinking-water

8.4 Metals

1) Cadmium

Standards:5 µg/l

In a long-term carcinogenicity study in rats given chromium(III) by the oral route, no increase in tumour incidence was observed. In rats, chromium(VI) is a carcinogen via the inhalation route, although the limited data available do not show evidence for carcinogenicity via the oral route.

Table 88 Category D - Cadmium -

Sources of Information				Cd µg/l
The Ambient Water Quality Standards in 2017				5
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				5
Raw Water for drinking purpose	Sri Lanka	SLS 722:1985 Raw Water Quality Standards		-
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	1
			Mandatory	5
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		3
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		3
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		5

In epidemiological studies, an association has been found between exposure to chromium(VI) by the inhalation route and lung cancer.

Cadmium is removed 80% or more by coagulation process and 0.002 mg/l should be achievable using coagulation or precipitation softening according to WHO Guidelines for Drinking Water, Fourth Edition, 2017. The Ambient Water Quality Standards in 2017 adopts the value of 5 µg/l as recommended by the Environmental Quality Standards in 1992 which is equivalent to the mandatory value of the EU's Raw Water Quality Standards. This decision also considered the removal efficiency of cadmium by coagulation process.

2) Chromium

Standards: 50µg/l

In a long-term carcinogenicity study in rats given chromium(III) by the oral route, no increase in tumour incidence was observed. In rats, chromium(VI) is a carcinogen via the inhalation route, although the limited data available do not show evidence for carcinogenicity via the oral route.

Table 89 Category D - Chromium -

Sources of Information				Cr µg/l
The Ambient Water Quality Standards in 2017				50
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				50
Raw Water for drinking purpose	Sri Lanka	SLS 722:1985 Raw Water Quality Standards		50
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	-
			Mandatory	50
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		50
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		50
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		50

In epidemiological studies, an association has been found between exposure to chromium(VI) by the inhalation route and lung cancer. The Environmental Quality Standards 1992 recommended 50 µg/l. The Raw Water Quality Standards of Sri Lanka, SLS 722, recommends the same value of 50 µg/l. The Ambient Water Quality Standards in 2017 adopted 50 µg/l.

3) Iron

Standards: 2000**µg/l**

Iron is an essential element in human nutrition. No guideline value for iron in drinking-water is proposed. On exposure to the atmosphere, however, the ferrous iron oxidizes to ferric iron, giving an objectionable reddish-brown colour to the water. There is usually no noticeable taste at iron concentrations below 0.3mg/litre, although turbidity and colour may develop.

Although the Environmental Quality Standards 1992 recommends 200 µg/l, the Ambient Water Quality Standards in 2017 adopted a lenient value of 2000 µg/l to be consistent with the mandatory value of the EU's Raw Water for drinking purpose with consideration on removability of the iron by coagulation process.

Table 90 Category D - Iron -

<table>
<tr><th colspan="4">Sources of Information</th><th>Fe
µg/l</th></tr>
<tr><td colspan="4">The Ambient Water Quality Standards in 2017</td><td>2000</td></tr>
<tr><td colspan="4">Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992</td><td>200</td></tr>
<tr><td rowspan="3">Raw Water for drinking purpose</td><td>Sri Lanka</td><td colspan="2">SLS 722:1985 Raw Water Quality Standards</td><td>-</td></tr>
<tr><td rowspan="2">EU</td><td rowspan="2">EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources</td><td>Guide</td><td>1000</td></tr>
<tr><td>Mandatory</td><td>2000</td></tr>
<tr><td rowspan="3">Drinking Water Quality Guidelines/Standards</td><td>Sri Lanka</td><td colspan="2">SLS 614: 2013 Specification for Potable Water</td><td>300</td></tr>
<tr><td>WHO</td><td colspan="2">WHO Guidelines for Drinking Water, Fourth Edition, 2017</td><td>*</td></tr>
<tr><td>EU</td><td colspan="2">EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ</td><td>200</td></tr>
</table>

* Not of health concern at levels found in drinking-water.

4) Lead

Standards: 50 µg/l

Placental transfer of lead occurs in humans as early as the 12th week of gestation and continues throughout development. Young children absorb 4–5 times as much lead as adults, and the biological half-life may be considerably longer in children than in adults. Lead is a general toxicant that accumulates in the skeleton. Infants, children up to 6 years of age and pregnant women are most susceptible to its adverse health effects. It needs to be recognized that lead is exceptional compared with other chemical hazards, in that most lead in drinking-water arises from plumbing in buildings, and the remedy consists principally of removing plumbing and fittings containing lead, which requires much time and money.

The Ambient Water Quality Standards in 2017 adopted the value of 50 µg/l as recommended by the Environmental Quality Standards 1992 which is equivalent to the mandatory value of the EU's Raw Water Quality Standards. However, considering the deviation from the SLS 614: 2013 Specification for Potable Water, a phased approach is recommended to tighten the value by assessing feasibility of applying the drinking water quality standards to ambient water quality standards by analysing extensive nation-wide monitoring data of rivers.

Table 91 Category D - Lead -

Sources of Information				Pb µg/l
The Ambient Water Quality Standards in 2017				50
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				50
Raw Water for drinking purpose	Sri Lanka	SLS 722:1985 Raw Water Quality Standards	Raw water for use drinking	100
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	-
			Mandatory	50
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		10
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		10
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		10

5) Manganese

Standards: 1000µg/l

Manganese is an essential element for humans and other animals. Adverse effects can result from both deficiency and overexposure. Manganese is known to cause neurological effects following inhalation exposure, particularly in occupational settings, and there have been epidemiological studies that report adverse neurological effects following extended exposure to very high levels in drinking-water. However, there are a number of significant potential confounding factors in these studies, and a number of other studies have failed to observe adverse effects following exposure through drinking-water. At levels exceeding 0.1mg/litre, manganese in water supplies causes an undesirable taste in beverages and stains sanitary ware and laundry. The presence of manganese in drinking-water, like that of iron, may lead to the accumulation of deposits in the distribution system. Concentrations below 0.1 mg/litre are usually acceptable to consumers. The health-based guideline value for manganese is 4 times higher than this acceptability threshold of 0.1mg/litre.

The value recommended by the Environmental Quality Standards 1992 was adopted in the Ambient Water Quality Standards in 2017. No guidelines are established for WHO's drinking water quality guideline because it occurs in drinking-water at concentrations well below those of health concern, except in emergency situations following a spill to a water source. Generally, manganese is removed 80% or more by chlorination process and 50 % or more by coagulation process[46].

Table 92 Category D - Manganese -

Sources of Information				Mn µg/l
The Ambient Water Quality Standards in 2017				1000
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				1000
Raw Water for drinking purpose	Sri Lanka	SLS 722:1985 Raw Water Quality Standards		-
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	100
			Mandatory	-
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		100
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		*
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		50

* No guidelines established because occurs in drinking-water at concentrations well below those of health concern, except in emergency situations following a spill to a water source

6) Mercury

Standards: 1 µg/l

The toxic effects of inorganic mercury compounds are seen mainly in the kidney. Methylmercury affects mainly the central nervous system. The Ambient Water Quality Standards in 2017 adopted the value of 1.0 µg/l as recommended by the Environmental Quality Standards 1992 and consistent with the Sri Lanka's Raw Water Quality Standards. Mercury is removable by 80% or more by coagulation process. It should be also possible to achieve a concentration below 1 µg/l by treatment of raw waters that are not grossly contaminated with mercury using methods that include coagulation/sedimentation/filtration, flocculation by Polyaluminum Chloride and ion exchange.

Table 93 Category D - Mercury -

Sources of Information				Hg µg/l
The Ambient Water Quality Standards in 2017				1
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				1
Raw Water for drinking purpose	Sri Lanka	SLS 722:1985 Raw Water Quality Standards		1
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	0.5
			Mandatory	1
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		1
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		6*
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		1

* The value is applicable for inorganic mercury.

7) Nickel

Standards: 100 µg/l

IARC[5] concluded that inhaled nickel compounds are carcinogenic to humans (Group 1) and metallic nickel is possibly carcinogenic (Group 2B). However, there is a lack of evidence of a carcinogenic risk from oral exposure to nickel.

Table 94 Category D - Nickel -

Sources of Information				Ni µg/l
The Ambient Water Quality Standards in 2017				100
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				100
Raw Water for drinking purpose	Sri Lanka	SLS 722:1985 Raw Water Quality Standards		-
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	-
			Mandatory	-
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		20
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		70
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		20

Conventional surface water treatment, comprising chemical coagulation, sedimentation, and filtration, can achieve 35–80% removal of nickel (Zemansky, 1974; Hunter et al., 1987; Duguet & Rizet, 1996). Better nickel removal occurs with waters containing high concentrations of suspended solids; for waters low in solids, the addition of powdered activated carbon can be used to enhance nickel removal

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(Welté, 2002). According to WHO Guidelines for Drinking Water, 20 µg/l should be achievable by conventional treatment (e.g. coagulation) for nickel. The Ambient Water Quality Standards in 2017 adopted the value of 100 µg/l as recommended by the Environmental Quality Standards 1992. This decision was made considering the treatment efficiency.

8) Selenium

Standards:10 µg/l

Selenium is an essential element for humans, with a recommended daily intake of about 1mg/kg of body weight for adults. Selenium compounds have been shown to be genotoxic in in vitro systems with metabolic activation, but not in humans. There was no evidence of teratogenic effects in monkeys. Long-term toxicity in rats is characterized by depression of growth and liver pathology. In humans, the toxic effects of long-term selenium exposure are manifested in nails, hair and liver. The Drinking Water Guidelines/Standard of Sri Lanka, SLS 614, recommends 10 µg/l.

The Ambient Water Quality Standards in 2017 adopted the value of 10 µg/l as recommended by the Environmental Quality Standards 1992 which is also equivalent to the mandatory value of the EU's Raw Water Quality Standards.

Table 95 Category D - Selenium -

Sources of Information				Se µg/l
The Ambient Water Quality Standards in 2017				10
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				10
Raw Water for drinking purpose	Sri Lanka	SLS 722:1985 Raw Water Quality Standards		50
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	-
			Mandatory	10
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		10
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		40
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		10

9) Zinc

Standards: 1000 µg/l

Zinc is an essential trace element found in virtually all food and potable water in the form of salts or organic complexes. Zinc imparts an undesirable astringent taste to water at a taste threshold concentration of about 4 mg/litre (as zinc sulfate). Water containing zinc at concentrations in excess of 3–5 mg/litre may appear opalescent and develop a greasy film on boiling.

Table 96 Category D - Zinc -

Sources of Information				Zn µg/l
The Ambient Water Quality Standards in 2017				1000
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				1000
Raw Water for drinking purpose	Sri Lanka	SLS 722:1985 Raw Water Quality Standards		-
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	1000
			Mandatory	5000
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		3,000
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		*
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		-

* Not of health concern at levels found in drinking-water

The Ambient Water Quality Standards in 2017 adopted the value of 1,000 µg/l as recommended by the Environmental Quality Standards 1992 and consistent with the guide value of the EU's Raw Water for drinking purpose.

10) Arsenic

Standards: 50 µg/l

Arsenic has not been demonstrated to be essential in humans. It is an important drinking-water contaminant, as it is one of the few substances shown to cause cancer in humans through consumption of drinking-water. There is overwhelming evidence from epidemiological studies that consumption of elevated levels of arsenic through drinking-water is causally related to the development of cancer at several sites, particularly skin, bladder and lung. Arsenic is removed 80 % or more by coagulation process and 10 µg/l should be achievable by conventional treatment (e.g. coagulation) according to WHO Guidelines for Drinking Water.

Although the Environmental Quality Standards 1992 recommended 10 µg/l, the Ambient Water Quality Standards in 2017 adopted the value of 50 µg/l to be consistent with the Sri Lanka's Raw Water Quality Standards and the mandatory value of the EU's equivalent standards. This decision was made considering the conventional treatment achievability.

Table 97 Category D - Arsenic -

Sources of Information				As µg/l
The Ambient Water Quality Standards in 2017				50
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				10
Raw Water for drinking purpose	Sri Lanka	SLS 722:1985 Raw Water Quality Standards		50
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	-
			Mandatory	50
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		10
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		10
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		10

8.5 Organic Micro Pollutants

1) Phenolic Compounds

Standards:5 µg/l

Phenolic compounds have been enlisted by USEPA EU as pollutants of priority concern due to the fact that these chemicals are noted to be toxic and have severe short - and long - term effects on humans and animals[24]. The occurrence of phenolic compounds in the aquatic environment is therefore not only objectionable and undesirable but also poses a danger as far as human health and wildlife are concerned[48].

The Ambient Water Quality Standards in 2017 adopted the value of 5.0 µg/l as recommended by the Environmental Quality Standards 1992 which is also consistent with the Sri Lanka's Raw Water Quality Standards and the mandatory value of EU's Raw Water for Drinking Purpose. Considering the deviation from the SLS 614: 2013 Specification for Potable Water, a phased approach is recommended to tighten the value by assessing feasibility of applying the drinking water quality standards to ambient water quality standards by analysing extensive nation-wide monitoring data of rivers.

Table 98 Category D - Phenolic Compounds -

Sources of Information				Phenolic Compounds µg/l
The Ambient Water Quality Standards in 2017				5
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				5
Raw Water for drinking purpose	Sri Lanka	SLS 722:1985 Raw Water Quality Standards		5
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	1
			Mandatory	5
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		1
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		-
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		-

2) Oil/Grease

Standards: 100 µg/l

Petroleum oils are widely used in human settlements, and improper handling or disposal can lead to significant pollution of surface water and groundwater. They can give rise to the presence of a number of low molecular weight hydrocarbons that have low odour thresholds in drinking-water. Although there are no formal data, experience indicates that these may have lower odour thresholds when several are present as a mixture.

The Ambient Water Quality Standards in 2017 adopted the value of 100 µg/l as recommended by the Environmental Quality Standards 1992 which is also consistent with the Sri Lanka's Raw Water Quality Standards.

Table 99 Category D - Oil/Grease -

Sources of Information				Oil/Grease µg/l
The Ambient Water Quality Standards in 2017				100
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				100
Raw Water for drinking purpose	Sri Lanka	SLS 722:1985 Raw Water Quality Standards		100
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	-
			Mandatory	-
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		200
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		-
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		-

3) Anionic surfactants as MBS

Standards: 1000 µg/l

In many countries, persistent types of anionic detergent have been replaced by others that are more easily biodegraded, and hence the levels found in water sources have decreased substantially. The concentration of detergents in drinking-water should not be allowed to reach levels giving rise to either foaming or taste problems. The presence of any detergent may indicate sanitary contamination of source water. The Ambient Water Quality Standards in 2017 adopted the value of 1000 µg/l considering the former Sri Lanka's Drinking Water Quality Standards(SLS 614: 1983). Considering the deviation from the SLS 614: 2013 Specification for Potable Water, a phased approach is recommended to tighten the value by assessing feasibility of applying the drinking water quality standards to ambient water quality standards by analysing extensive nation-wide monitoring data of rivers.

Table 100 Category D - Anionic Surfactants -

Sources of Information				Anionic surfactants as MBS µg/l
The Ambient Water Quality Standards in 2017				1000
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				200
Raw Water for drinking purpose	Sri Lanka	SLS 722:1985 Raw Water Quality Standards		-
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	-
			Mandatory	-
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		200
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		-
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		-

4) MCPA

Standards: 20 mg/L

MCPA [4-(2-methyl-4-chlorophenoxy)acetic acid,(CAS No. 94-74-6) is a chlorophenoxy post-emergence herbicide that is very soluble, is highly mobile and can leach from the soil.

Table 101 Category D - MCPA –

Sources of Information				MCPA µg/l
The Ambient Water Quality Standards in 2017				20
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992				-
Raw Water for drinking purpose	Sri Lanka	SLS 722:1985 Raw Water Quality Standards	Raw water for use drinking	-
	EU	EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources	Guide	-
			Mandatory	-
Drinking Water Quality Guidelines/Standards	Sri Lanka	SLS 614: 2013 Specification for Potable Water		-
	WHO	WHO Guidelines for Drinking Water, Fourth Edition, 2017		2
	EU	EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ		-

There are only limited and inconclusive data on the genotoxicity of MCPA. IARC evaluated MCPA in 1983 and concluded that the available data on humans and experimental animals were inadequate for an evaluation of carcinogenicity. Further evaluations by IARC on chlorophenoxy herbicides in 1986 and 1987 concluded that evidence for their carcinogenicity was limited in humans and inadequate in animals (Group 2B). Recent carcinogenicity studies on rats and mice did not indicate that MCPA was carcinogenic. No adequate epidemiological data on exposure to MCPA alone are available.
MCPA is removed 80 % or more by Activated carbon and Ozonation process. Once MCPA is detected beyond the value, it is recommended to adopt treatment process to allow efficient removal of MCPA. Considering the deviation from the SLS 614: 2013 Specification for Potable Water, a phased approach is recommended to tighten the value by assessing feasibility of applying the drinking water quality standards to ambient water quality standards by analysing extensive nation-wide monitoring data of rivers.

5) Pendimethorin

Standards: 20 mg/L

Pendimethalin (CAS No. 40487-42-1) is a pre-emergence herbicide that is fairly immobile and persistent in soil.

In a short-term dietary study in rats, a variety of indications of hepatotoxicity as well as increased kidney weights in males were observed at the highest dose level. In a long term dietary study, some toxic effects (hyperglycaemia in the mouse and hepatotoxicity in the rat) were present even at the lowest dose level. On the basis of available data, pendimethalin does not appear to have significant mutagenic activity. Long-term studies in mice and rats have not provided evidence of carcinogenicity; however, these studies have some important methodological limitations.

The Ambient Water Quality Standards in 2017 adopted 20 μg/l as recommended by WHO Guidelines for Drinking Water, Fourth Edition, 2017.

Table 102 Category D - Pedimethorin –

<table>
<tr><td colspan="4">Sources of Information</td><td>Pedimethorin μg/l</td></tr>
<tr><td colspan="4">The Ambient Water Quality Standards in 2017</td><td>20</td></tr>
<tr><td colspan="4">Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992</td><td>-</td></tr>
<tr><td rowspan="3">Raw Water for drinking purpose</td><td>Sri Lanka</td><td>SLS 722:1985 Raw Water Quality Standards</td><td>Raw water for use drinking</td><td>-</td></tr>
<tr><td rowspan="2">EU</td><td rowspan="2">EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources</td><td>Guide</td><td>-</td></tr>
<tr><td>Mandatory</td><td>-</td></tr>
<tr><td rowspan="3">Drinking Water Quality Guidelines/Standards</td><td>Sri Lanka</td><td colspan="2">SLS 614: 2013 Specification for Potable Water</td><td>-</td></tr>
<tr><td>WHO</td><td colspan="2">WHO Guidelines for Drinking Water, Fourth Edition, 2017</td><td>20</td></tr>
<tr><td>EU</td><td colspan="2">EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ</td><td>-</td></tr>
</table>

8.6 Micro Organism

1) Total Coliform

Standards: 10,000 MPN/ 100ml

The term "total coliforms" refers to a large group of Gram-negative, rod-shaped bacteria that share several characteristics. The group includes thermotolerant coliforms and bacteria of faecal origin, as well as some bacteria that may be isolated from environmental sources. Thus the presence of total coliforms may or may not indicate faecal contamination. In extreme cases, a high count for the total coliform group may be associated with a low, or even zero, count for thermotolerant coliforms. Such a result would not necessarily indicate the presence of faecal contamination. It might be caused by entry of soil or organic matter into the water or by conditions suitable for the growth of other types of coliform. In the laboratory total coliforms are grown in or on a medium containing lactose, at a temperature of 35 or 37 °C. They are provisionally identified by the production of acid and gas from the fermentation of lactose .

Category D water is subject to Chlorination process and Total coliforms should be absent immediately after disinfection. The Ambient Water Quality Standards in 2017 adopted a less stringent value as a provisional guide to assess the cleanliness of source water.

Table 103 Category D - Total Coliform -

<table>
<tr><td colspan="4">Sources of Information</td><td>Total Coliform MPN/ 100ml</td></tr>
<tr><td colspan="4">The Ambient Water Quality Standards in 2017</td><td>10000</td></tr>
<tr><td colspan="4">Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992</td><td>5000</td></tr>
<tr><td rowspan="3">Raw Water for drinking purpose</td><td>Sri Lanka</td><td>SLS 722:1985 Raw Water Quality Standards</td><td>Raw water for use drinking</td><td>*</td></tr>
<tr><td rowspan="2">EU</td><td rowspan="2">EU Directive 75/440/EEC of 16.6.1775 on Drinking Water Sources</td><td>Guide</td><td>5000</td></tr>
<tr><td>Mandatory</td><td>-</td></tr>
<tr><td rowspan="3">Drinking Water Quality Guidelines/Standards</td><td>Sri Lanka</td><td colspan="2">SLS 614: 2013 Specification for Potable Water</td><td>-</td></tr>
<tr><td>WHO</td><td colspan="2">WHO Guidelines for Drinking Water, Fourth Edition, 2017</td><td>-</td></tr>
<tr><td>EU</td><td colspan="2">EU Directive 98/83/EC of 3. 11.1998 on Drinking WQ</td><td>-</td></tr>
</table>

* Not more than 5000, with less than 5 per cent of the samples with value 20000, and less than 20 per cent of the samples with the value 5000

2) Faecal Coliform

Standards: No value

Category D water is subject to Chlorination process and Faecal Coliform should be absent immediately after disinfection. No value is recommended considering the treatment process.

9 CATEGORY E: IRRIGATION & AGRICULTURE

The values proposed in the Environmental Quality Standards 1992 adopted mostly those of Category 7 of the nation's minimum water quality. A prominent feature of the previous standards was application of Sodium Absorption Ratio (SAR) and Residue Sodium Carbonate (RSC). They are the indicators for managing salinity problems of upland crop soil in arid and semiarid lands. The following is the source of information.

- R.S. Ayers, D.W. Westcot, Water quality for agriculture, FAO IRRIGATION AND DRAINAGE PAPER, 29 Rev. 1, Reprinted 1989, 1994[32]

One of the assumptions in using the guidelines as stated in the footnote of the Table 1 in Section 1.4 of the FAO's paper is that the climate is semi-arid to arid and rainfall is low. The following is the citation of the paper.

> Site Conditions: Soil texture ranges from sandy-loam to clay-loam with good internal drainage. The climate is semi-arid to arid and rainfall is low. Rainfall does not play a significant role in meeting crop water demand or leaching requirement. (In a monsoon climate or areas where precipitation is high for part or all of the year, the guideline restrictions are too severe. Under the higher rainfall situations, infiltrated water from rainfall is effective in meeting all or part of the leaching requirement.) Drainage is assumed to be good, with no uncontrolled shallow water table present within 2 metres of the surface.

According to a publication of FAO, the definition of arid-zone in terms of precipitation is in a range up to 800 mm. On the other hand, according to the website of the Department of Meteorology, the mean annual rainfall varies from 900mm in the driest parts (South Eastern and North Western) to over 5000 mm in the wettest parts (western slopes of the central highlands). Based on the mean annual rain fall and its distribution, the country is classified into to three major climatic zones: Dry zone (1,250 mm - 1,525 mm), Intermediate zone (1,525 mm - 2,280 mm) and wet zone (2,280 mm - 5,100 mm). Thus it is strongly recommended that the standards proposed in the Environmental Quality Standards 1992 for Irrigation & Agriculture have to be used with great caution to avoid misapplication of the FAO's technical guidance in the paper. In this context, the following parameters relevant to the salinity problems are carefully reviewed and/or removed as appropriate in the review process: Conductivity, TDS, SAR, NO_3^-N and Residue Sodium Carbonate.

On the other hand, it is noteworthy that nearly 70% of Sri Lanka's lands support agriculture sector; and among agricultural land uses, rice farming occupies an extent of about 727, 520 ha which is almost 50% of total land available for agriculture in the country showing highest priority for rice farming. Thus, in developing the standards, an effort was made to provide guidance on water quality adequate for rice production. However, an emphasis is also given to general upland farming wherever possible because the agriculture sector has diverse production sub-sectors such as lowland rice, upland crop, tree crop to livestock.

9.1 General parameters

1) Conductivity

Standards: 700 µS/cm (0.7 dS/m)

Conductivity of irrigation water is often discussed in the context of salinity hazard on upland crop. As discussed in the introductory part, hazard of salinity by irrigation water on crop is limited in humid area. However, considering seasonal dry spell in the southeast, east, and northern parts of the country, electrical conductivity was retained as a general measure of hazards because the most influential water quality guideline. The primary effect of high conductivity of irrigation water on crop productivity is the inability of the plant to compete with ions in the soil solution for water (physiological drought). The higher the conductivity, the less water is available to plants, even though the soil may appear wet. Because plants can only transpire "pure" water, usable plant water in the soil solution decreases dramatically as conductivity increases[36].

The Ambient Water Quality Standards in 2017 adopted 0.7 dS/m as recommended by the Environmental Quality Standards 1992 which is derived from the FAO's Irrigation and Drainage Paper[32]. The publication is the most often cited in designing water quality in dry area.

Table 104 General guidelines for salinity hazard of irrigation water based upon conductivity

Limitations for use	Electrical Conductivity (dS/m)
None	≤ 0.75
Some	0.76 - 1.5
Moderate[1]	1.51 - 3.00
Severe[2]	≥ 3.00

1 Leaching required at higher range.
2 Good drainage needed and sensitive plants may have difficulty at germination.
Source: T.A. Bauder, R.M. Waskom, P.L. Sutherland and J. G. Davis, Fact Sheet No. 0.506 , Irrigation Water Quality Criteria, Colorado State University Extension

Table 105 Category E – Conductivity -

Sources of Information	Conductivity dS/m
The Ambient Water Quality Standards in 2017	0.7
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992	0.7

2) Total Suspended Solid

Standards: 2100 mg/l

The total suspended solids include floating and suspended solids and dissolved organic substances. They may clog the soil pores, coat the land surface and reduce water penetration and aeration[32]. High solids loads in water, as measured by Total Suspended Solids (TSS) will also require consideration of pump pickup, inlet clogging, settling of the solids in low spots in the irrigation line when the system is at rest, and clogging of the sprinkler nozzles by solid particles as well as the potential to coat the plants with light inhibiting material and chemical residues[30].

The Ambient Water Quality Standards in 2017adopted the value of 2100 mg/l as a provisional guideline which is equivalent to the value recommended by the Indian Water Quality Standards[45].

Table 106 Category E - Total Suspended Solid -

Sources of Information		Total Suspended Solids mg/l
The Ambient Water Quality Standards in 2017		2,100
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		-
Indian Standard 1982	Class E	-
India primary water quality criteria	Class E	-
Water Quality Standards in India (Source IS 2296:1992)	E	2,100
Malaysia River Water Quality Parameter for Monitoring system	Class IV Acceptable for Irrigation	-
Thai Standard 1985	Class 5	-
Proposed Cat.7 Others		-
ANZEC 2000	Trigger value (low risk)a,b	-
Japan's MAFF	Pollution Study Committee	-
Chiba Prefecture		-
National Academy of Sciences (1972).		-

3) pH

Standards: 6.0-8.5

The acidity (or alkalinity) of a water supply can affect plant growth, irrigation equipment, pesticide efficiency and drinking water. The generally accepted pH for irrigation water is between 5.5 and 7.5, but some problems can occur within this range. Alkaline water may contain high concentrations of bicarbonate (generally in water of pH 8 and above) and carbonates (generally pH 9 and above). This can cause calcium and magnesium to precipitate from the soil, this can affect plant growth. Some trace elements, like copper and zinc, will also be less available to the plant in this situation. Acidic water can also have a detrimental effect on plant growth, particularly causing nutritional problems, while strongly acidic water (below pH 4) can contribute to soil acidification. A pH less than 6 indicates corrosiveness, which can lead to damage to metal pipes, tanks and fittings. Water lower than pH 6.0 or higher than pH 8.5, when used in spray mixes, can lessen the effectiveness of some pesticides[20].

Table 107 Category E - pH-

Sources of Information		pH
The Ambient Water Quality Standards in 2017		6.0-8.5
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		6.0-8.5
Indian Standard 1982	Class E	6.5-8.5
India primary water quality criteria	Class E	6.0-8.5
Water Quality Standards in India (Source IS 2296:1992)	E	6.0-8.5
Malaysia River Water Quality Parameter for Monitoring system	Class IV Acceptable for Irrigation	5.0-9.0
Thai Standard 1985	Class 5	—
Proposed Cat.7 Others		5.5-9.0
ANZEC 2000	Trigger value (low risk)	-
Japan's MAFF	Pollution Study Committee	6.0-7.5
Chiba Prefecture		6.0-7.5
National Academy of Sciences (1972).		-

The Ambient Water Quality Standards in 2017 adopted the value in a range between 6.0-8.5 as recommended by the Environmental Quality Standards 1992.

4) Dissolved Oxygen

Standards: 3 mg/l

Past research has shown that reducing the concentration of DO in the root zone of plants will compromise the plants' ability to absorb nitrate and water1[6]. Research has also demonstrated that roots

[6] R.J. Flannery and J.H. Lieth

are injured by O_2 deficiency and that plant metabolism changes during acclimation to low concentrations of O_2[25]. In lowland rice cropping, oxygen supply by irrigation water is important contributor to soil REDOX potential which may also affect carbon and nitrogen cycle in the soil-crop system. Especially in the latter stage of rice production, amount of organic material supplied from root system often exceed the supply of oxygen, which also affect rice yield too.

The Ambient Water Quality Standards in 2017 adopted the value of 3 mg/l recommended by the Environmental Quality Standards 1992 which is also equivalent to the acceptable value for Irrigation of the Malaysia River Water Quality Parameter for Monitoring system.

Table 108 Category E -Dissolved Oxygen -

Sources of Information		DO at 25°C mg/l
The Ambient Water Quality Standards in 2017		3
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		3
Indian Standard 1982	Class E	-
India primary water quality criteria	Class E	-
Water Quality Standards in India (Source IS 2296:1992)	E	-
Malaysia River Water Quality Parameter for Monitoring system	Class IV Acceptable for Irrigation	3
Thai Standard 1985	Class 5	—
Proposed Cat.7 Others		3
ANZEC 2000	Trigger value (low risk)a,b	-
Japan's MAFF	Pollution Study Committee	5
Chiba Prefecture		5
National Academy of Sciences (1972).		-

5) BOD_5

Standards:12 mg/l

The Environmental Quality Standards 1992 adopted the value of a lenient category 7 of minimum quality of water.

Table 109 Category E – BOD_5-

Sources of Information		BOD_5 at 20°C mg/l
The Ambient Water Quality Standards in 2017		12
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		5
Indian Standard 1982	Class E	-
India primary water quality criteria	Class E	-
Water Quality Standards in India (Source IS 2296:1992)	E	-
Malaysia River Water Quality Parameter for Monitoring system	Class IV Acceptable for Irrigation	12
Thai Standard 1985	Class 5	-
Proposed Cat.7 Others		5
Japan's MAFF	Pollution Study Committee	-
Chiba Prefecture		-
National Academy of Sciences (1972).		-

The contamination by organic material *per se* does not have adverse effects on crop growth for most cases as seen in use of soil organic amendments. The Class IV Acceptable for Irrigation of the Malaysia River Water Quality Parameter also recommends the parameter at 12 mg/L. The Ambient Water Quality Standards in 2017 adopted the value of 12 mg/L.

9.2 Nutrient parameters

9.3 Others

1) Chloride

Standards: 600 mg/L

Sodium and chloride are the primary ions absorbed through leaves, and toxicity to one or both can be a problem with certain sensitive crops such as citrus. According to Mass (1990), most upland crops are tolerable below 70 mg/l of chloride, sensitive crops are affected in the range from 70 to 140 mg/l, moderately tolerant plants show injury in the range of 141 to 350 mg/l, most crops are affected above 350 mg/l. Thus, the proposed standards at 100 mg/L may be retained for upland crop. However for paddy rice, Chiba prefectural government in Japan recommend 500-700 mg/l as the threshold of chloride concentration. On the other hand, Water Quality Standards in India (Source IS 2296:1992) also set forth the criteria at 600 mg/L. From these values, it is recommended that the standard of Chloride for Lowland Rice should be set at 600 mg/L.

The Ambient Water Quality Standards in 2017adopted the value of 600 mg/L mainly considering the rather higher tolerable level of rice. For sensitive area, an authorized government agency shall be consulted to determine appropriate level.

Table 110 Category E -Chloride -

Sources of Information		Chloride (Cl) mg/l
The Ambient Water Quality Standards in 2017		600
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		100
Indian Standard 1982	Class E	600
India primary water quality criteria	Class E	-
Water Quality Standards in India (Source IS 2296:1992)	E	600
Malaysia River Water Quality Parameter for Monitoring system	Class IV Acceptable for Irrigation	-
Thai Standard 1985	Class 5	-
Proposed Cat.7 Others		-
ANZEC 2000	Trigger value (low risk)a,b	-
Japan's MAFF	Pollution Study Committee	-
Chiba Prefecture		500-700

2) Sulfate

Standards:1000 mg/L

The Environmental Quality Standards 1992 for Sulphate adopted the value of Class E of Water Quality Standards in India (Source IS 2296:1992).

Table 111 Category E -Sulfate -

Sources of Information		SO_4^{2-} mg/l
The Ambient Water Quality Standards in 2017		1000
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		1000
Indian Standard 1982	Class E	1000
India primary water quality criteria	Class E	-
Water Quality Standards in India (Source IS 2296:1992)	E	1000
Canadian Criteria	CCREM, 1987; FEPA, 1991; ICPR, 1991	1000

Toxicity is rarely a problem for crops, except at very high concentrations where high sulphate may interfere with uptake of other nutrients. As with boron, sulphate in irrigation water has fertility benefits. The Ambient Water Quality Standards in 2017 adopted 1000 mg/l as recommended by the Canadian Criteria. The guideline is especially applicable to livestock water quality.

9.4 Metals

1) Mercury

Standards: 2 µg/l

Mercury associated with soils can be directly washed into surface waters during rain events. Surface runoff is an important mechanism for transporting mercury from soil into surface waters, particularly for soils with high humic content (Meili 1991). Mercury may also be released to surface waters in effluents from a number of industrial processes, including chloralkali production, mining operations and ore processing, metallurgy and electroplating, chemical manufacturing, ink manufacturing, pulp and paper mills, leather tanning, pharmaceutical production, and textile manufacture (Dean et al. 1972; EPA 1971c)[39].

Table 112 Category E - Mercury-

Sources of Information		Hg µg/l
The Ambient Water Quality Standards in 2017		2
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		1
Indian Standard 1982	Class E	-
India primary water quality criteria	Class E	-
Water Quality Standards in India (Source IS 2296:1992)	E	-
ANZEC 2000 Primary Industry	LTV in irrigation water (long-term use up to 100 yrs)	2
	STV in irrigation water (short-term use — up to 20 yrs)	2
Malaysia River Water Quality Parameter for Monitoring system	Class IV Acceptable for Irrigation	-
Thai Standard 1985	Class 5	-
Proposed Cat.7 Others		2
ANZEC 2000	Trigger value (low risk)	2

Although the Environmental Quality Standards 1992 recommended the value of 1 µg/l, the Ambient the information on basis of standard values derivation was not available. ANZEC 2000 recommends 2 µg/l both for LTV in irrigation water (long-term use up to 100 yrs) and STV in irrigation water (short-term use - up to 20 yrs). The value of 2 µg/l is adopted for upland crop irrigation and livestock watering.

2) Nickel

Standards: 200 µg/l

Nickel is a natural constituent of soil and is transported into streams and waterways in runoff either from natural weathering or from disturbed soil. Much of this nickel is associated with particulate matter. Nickel also enters bodies of water through atmospheric deposition. Much of the nickel released into waterways as runoff is associated with particulate matter; it is transported and settles out in areas of active sedimentation such as the mouth of a river. Additionally, when a river feeds into an estuary, the salinity changes may affect absorptivity due to complexation and competition for binding sites (Bowman et al. 1981)[40].

The Environmental Quality Standards 1992 adopted the value of Class 7 the Minimum Quality of the nation's water. Ni is the most recent candidate to be added to the list of 13 essential mineral elements for higher plants. There is usually much more concern about nickel toxicity than limitation in soils and in plants, for example, in relation to application of sewage sludge, which is often high in nickel (Brown et al., 1989). The upper acceptable limits of Ni in irrigation water are 0.2 and 2.0 mg/L for long term and short-term use, respectively. From this data, the limit may be established at 200 µg/l. The dermal exposure to nickel at 100 µg/l would not produce adverse effects.

Table 113 Category E -Nickel -

Sources of Information		Ni µg/l
The Ambient Water Quality Standards in 2017		200
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		100
Indian Standard 1982	Class E	-
India primary water quality criteria	Class E	-
Water Quality Standards in India (Source IS 2296:1992)	E	-
ANZEC 2000 Primary Industry	LTV in irrigation water (longterm use up to 100 yrs)	200
	STV in irrigation water (shortterm use up to 20 yrs)	2000
Malaysia River Water Quality Parameter for Monitoring system	Class IV Acceptable for Irrigation	-
Thai Standard 1985	Class 5	-
Proposed Cat.7 Others		100
ANZEC 2000	Trigger value (low risk)a,b	1000
Japan's MAFF	Pollution Study Committee	-
Chiba Prefecture		-
FAO Irrigation and Drainage Paper 29		200
National Academy of Sciences (1972).		-

3) Zinc

Standards: 2000 µg/l

The largest input of zinc to water results from erosion of soil particles containing natural traces of zinc (45,400 metric tons/year) (EPA 1980d). Erosion resulting from human activities accounts for 70% of this soil loss; geologic or natural erosion constitutes the other 30% (EPA 1980d). However, this source of low levels of zinc is widely dispersed and is, therefore, unlikely to elevate aquatic concentrations significantly.

Table 114 Category E - Zinc-

Sources of Information		Zn µg/l
The Ambient Water Quality Standards in 2017		2000
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		1000
Indian Standard 1982	Class E	-
India primary water quality criteria	Class E	-
Water Quality Standards in India (Source IS 2296:1992)	E	-
ANZEC 2000 Primary Industry	LTV in irrigation water (longterm use up to 100 yrs)	2000
	STV in irrigation water (shortterm use up to 20 yrs)	5000
Malaysia River Water Quality Parameter for Monitoring system	Class IV Acceptable for Irrigation	-
Thai Standard 1985	Class 5	-
Proposed Cat.7 Others		1000
ANZEC 2000	Trigger value (low risk)a,b	20000
Japan's MAFF	Pollution Study Committee	500
Chiba Prefecture		-
FAO Irrigation and Drainage Paper 29		2000
National Academy of Sciences (1972).		24000

The Environmental Quality Standards in 1992 adopted the value of Class 7 the Minimum Quality of the nation’s water. Zinc is essential micronutrients of rice plants. It is also noteworthy that Zinc (Zn) deficiency is the most widespread micronutrient disorder in rice. Relevant water quality standards recommend the value for the parameter as follows.

1. Japan's MAFF recommend 500 µg/l as irrigation water quality for lowland rice.
2. FAO Irrigation and Drainage Paper 29 recommend 2000 µg/l for upland crop.
3. National Academy of Sciences (1972) recommends 24,000 µg/l for Livestock water.

The recommended maximum value for drinking water for livestock is 24 mg/L, and for water used for long-term and short-term irrigation 2 and 10 mg/L, respectively.

4) Boron

Standards: 500 μg/l

The Environmental Quality Standards 1992 at 500 μg/l is applicable for irrigation of crops that are sensitive to boron (Ayers and Westcot, 1985). Excessive boron can be toxic. Overfertilizing or concentrating boron near seedling crops can result in toxic levels, and some crops are very sensitive to boron. Some sensitive crops include avocado, bean, grape, grapefruit, lemon, orange and wheat according to Maas 1987. However, it is also noteworthy that boron is used as boron fertilizers, soil applications and foliar application. Some crops are tolerant. They include: alfalfa, beet, cotton, grain sorghum, oat, sugar beet and tomato. Further the National Academy of Sciences (1972) recommended 5000 μg/l as livestock water. The footnote of the table should provide information of applicability of the proposed values.

Table 115 Category E -Boron -

Sources of Information		B μg/l
The Ambient Water Quality Standards in 2017		500
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		500
Indian Standard 1982	Class E	2000
India primary water quality criteria	Class E	2000
Water Quality Standards in India (Source IS 2296:1992)	E	2
ANZEC 2000 Primary Industry	LTV in irrigation water (longterm use up to 100 yrs)	500
	STV in irrigation water (shortterm use up to 20 yrs)	*
Malaysia River Water Quality Parameter for Monitoring system	Class IV Acceptable for Irrigation	-
Thai Standard 1985	Class 5	-
Proposed Cat.7 Others		-
ANZEC 2000	Trigger value (low risk)a,b	5000
Japan's MAFF	Pollution Study Committee	-
Chiba Prefecture		-
National Academy of Sciences (1972).		5000

5) Arsenic

Standards:50 μg/l

Arsenic in soil may be transported by wind or in runoff or may leach into the subsurface soil. However, because many arsenic compounds tend to partition to soil or sediment under oxidizing conditions, leaching usually does not transport arsenic to any great depth (EPA 1982c; Moore et al. 1988; Pantsar-Kallio and Manninen 1997; Welch et al. 1988). Arsenic is largely immobile in agricultural soils; therefore, it tends to concentrate and remain in upper soil layers indefinitely. Downward migration has been shown to be greater in a sandy soil than in a clay loam (Sanok et al. 1995).

Table 116 Category E - Arsenic-

Sources of Information		As µg/l
The Ambient Water Quality Standards in 2017		50
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		50
Indian Standard 1982	Class E	-
India primary water quality criteria	Class E	-
Water Quality Standards in India (Source IS 2296:1992)	E	-
ANZEC 2000 Primary Industry	LTV in irrigation water (long term use up to 100 yrs)	100
	STV in irrigation water (short term use up to 20 yrs)	2000
Malaysia River Water Quality Parameter for Monitoring system	Class IV Acceptable for Irrigation	-
Thai Standard 1985	Class 5	-
Proposed Cat.7 Others		50
ANZEC 2000	Trigger value (low risk)a,b	500-5000
Japan's MAFF	Pollution Study Committee	50
Chiba Prefecture		-
FAO Irrigation and Drainage Paper 29		100
National Academy of Sciences (1972).		200

The Ambient Water Quality Standards in 2017 adopted the value of 50 µg/l as recommended by the Environmental Quality Standards 1992 which is equivalent to the value recommendd by the Japan's MAFF for lowland rice.

6) Aluminium

Standards:5000 µg/l

Although the Environmental Quality Standards 1992 recommended 5 µg/l, the Ambient Water Quality Standards in 2017 adopted 5000µg/l which is equivalent to the value recommended by ANZEC 2000 for Primary Industry for "LTV in irrigation water (long-term use up to 100 years), 20,000 µg/l for "STV in irrigation water (short-term use — up to 20 years) and 5,000 µg/l for cattle.

Table 117 Category E - Aluminium -

Sources of Information		Al µg/l
The Ambient Water Quality Standards in 2017		5000
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992		5
Indian Standard 1982	Class E	-
India primary water quality criteria	Class E	-
Water Quality Standards in India (Source IS 2296:1992)	E	-
ANZEC 2000 Primary Industry	LTV in irrigation water (long term use up to 100 yrs)	5,000
	STV in irrigation water (short term use — up to 20 yrs)	20,000
Malaysia River Water Quality Parameter for Monitoring system	Class IV Acceptable for Irrigation	-
Thai Standard 1985	Class 5	-
Proposed Cat.7 Others		-
ANZEC 2000	Trigger value (low risk) a,b	5,000
Japan's MAFF	Pollution Study Committee	-
Chiba Prefecture		-
FAO Irrigation and Drainage Paper 29		5,000
National Academy of Sciences (1972).		5,000

Following is a citation form TOXICOLOGICAL PROFILE FOR ALUMINUM, 5.4.2 Water, p.201,

- The concentrations of dissolved aluminium in water vary with pH and the humic-derived acid content of the water (Brusewitz 1984). Aluminium is only sparingly soluble in water between pH 6 and pH 8. Because the pH of about 95% of naturally-occurring water is between 6 and 9 and since high aluminium concentrations occur in surface water bodies only when the pH is < 5, the aluminium concentration in most natural waters is extremely low (Filipek et al. 1987; Snoeyink and Jenkins 1980; Sorenson et al. 1974). In general, aluminium concentrations in surface waters at pH levels above 5.5 will be < 0.1 mg/L (ppm) (Brusewitz 1984; Miller et al. 1984; Sorenson et al. 1974; Taylor and Symons 1984).

9.5 Organic Micro Pollutants

No values are recommended for organic pollutants for Category E.

9.6 Micro Organism

No values are recommended for Micro Organism for Category E.

10 CATEGORY F: MINIMUM WATER QUALITY

Majority of the values recommended in the Environmental Quality Standards 1992 for this category adopted those prescribed in Class 4 of Thai Standard 1985. The major challenge in establishing the standards of the minimum quality is lack of scientific basis because it is not derived from any toxicological or health impact studies. The values of the Environmental Quality Standards 1992 were assessed on their validity by identifying any technical inconsistencies with other proposed and revised values of other categories and available monitoring data.

10.1 General parameters

1) pH

Standards:5.5-9.0

The Ambient Water Quality Standards in 2017 adopted the value of pH 5.5-9.0 as recommended by the Environmental Quality Standards 1992 on the basis of the past monitoring data of Kelani River.

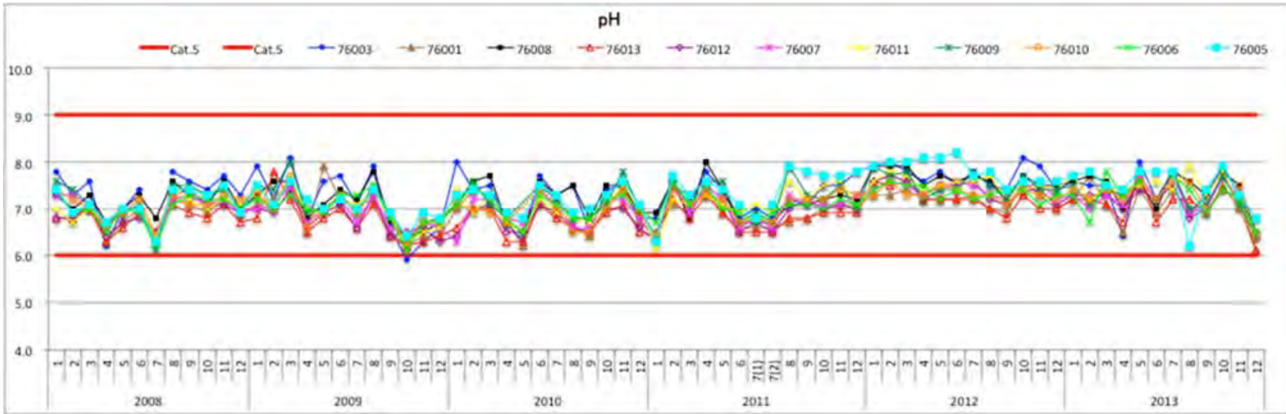

Figure 1 Range of pH along Kelani River

Table 118 Category F -pH -

Sources of Information	pH -
The Ambient Water Quality Standards in 2017	5.5-9.0
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992	5.5-9.0
Thai Standard 1985 Class 4	5.0-9.0

2) Dissolved Oxygen

Standards:3 mg/l

Considering the acute mortality of fish[7], the value was proposed at 3 mg/l at 25°C in the Environmental Quality Standards 1992. The Ambient Water Quality Standards in 2017 adopted the value of 3 mg/l as recommended by the Environmental Quality Standards 1992.

Table 119 Category F – Dissolved Oxygen-

Sources of Information	DO at 25°C mg/l
The Ambient Water Quality Standards in 2017	3
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992	3
Thai Standard 1985 Class 4	2

[7] The previous report had a note that it will not be applied to embryo's and larvae.

The past monitoring data however indicated that Kalani River and mostly at its tributaries has undergone seasonal drop in the value of DO below the proposed value.

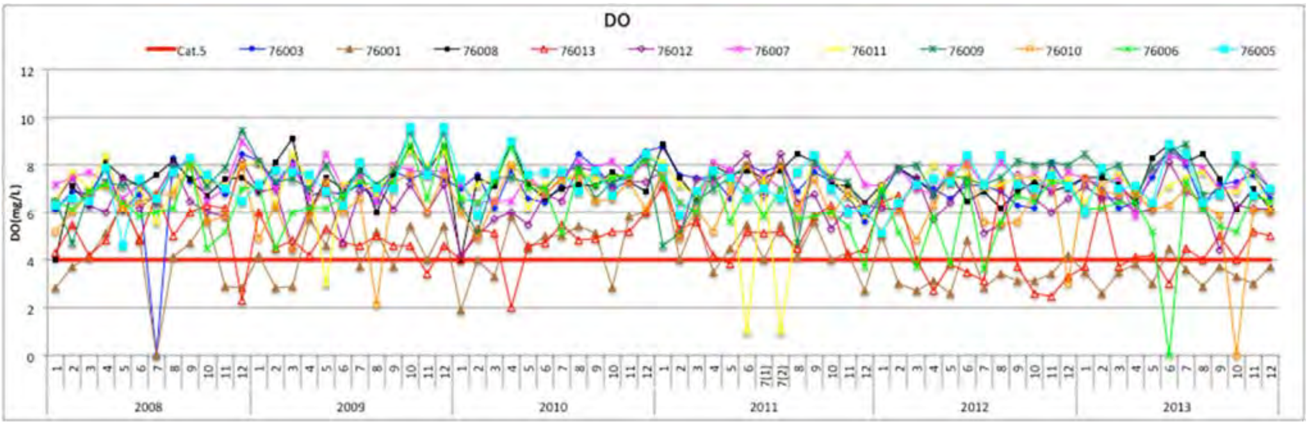

Figure 2 DO along Kelani River

3) BOD_5

Standards:15 mg/l

The Environmental Quality Standards 1992 recommended the value of 5 mg/l, however, the Ambient Water Quality Standards in 2017 adopted a value of 15 mg/l on the basis of the past monitoring data of Kelani River. The review of the past monitoring data of Kelani River found that the values of BOD often go beyond 5 mg/l at the tributaries discharging into the main river. The frequency of incompliance appears to be overly excessive as to say the minimum quality of the nation's water. At the monitoring station 76001, it went beyond 15 mg/L once in the 72 sampling occasions over the 6 years. If the standard was 10 mg/L, incompliance occurs more than 15% of frequency.

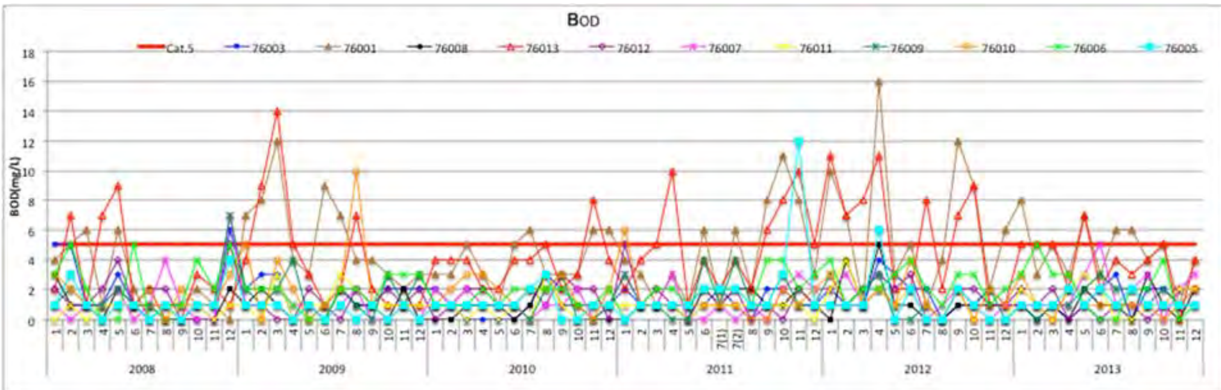

Figure 3 BOD_5 along Kelani River

Table 120 Category F -BOD_5 -

Sources of Information	BOD_5 at 20°C mg/l
The Ambient Water Quality Standards in 2017	15
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992	5
Thai Standard 1985 Class 4	4

4) COD

Standards:40 mg/l

No information is available on the basis of derivation. No affirmative information available to support or deny the value recommended by Environmental Quality Standards 1992. The Ambient Water Quality Standards 2017 adopted the value of 40 mg/l.

Table 121 Category F -COD -

Sources of Information	COD mg/l
The Ambient Water Quality Standards in 2017	40
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992	40
Thai Standard 1985 Class 4	

10.2 Nutrient parameters

1) Nitrate Nitrogen (NO_3-N)

Standards:10 mg/l

The Environmental Quality Standards 1992 recommended the value of 5 mg/l considering the limitation of eutrophication. As for the occurrence of eutrophication, the main cause is the large input of nutrients such as phosphorus and nitrogen. Besides nutrient inputs, the first condition supporting eutrophication development is purely physical - it is the containment (time of renewal) of the water[8]. Thus it usually occurs in pond, reservoirs and other closed waterbody where water flow or movement of water is limited and the residential time is longer. In rivers and channels, occurrences of eutrophication are rare; though it depends on flow velocity and other factors. Thus controlling nitrate-nitrogen as the minimum criteria of nation's water may be misleading and shall be implemented if any carefully. As stated in the part on drinking water sources, the value is recommended to be 10 mg/l.

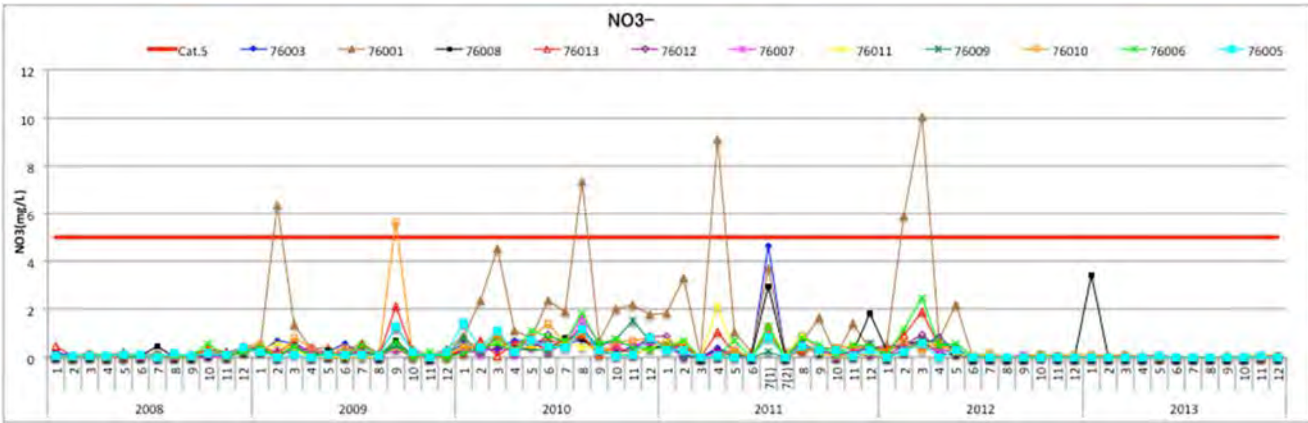

Figure 4 Nitrate Nitrogen (NO_3—N) along Kelani River

Table 122 Category F -Nitrate Nitrogen (NO_3^-N) -

Sources of Information	NO_3-N mg/l
The Ambient Water Quality Standards in 2017	10
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992	5
Thai Standard 1985 Class 4	5

8 Eutrophication and Health, World Health Organization Regional Office for Europe and EUROPEAN COMMISSION < http://ec.europa.eu/environment/water/water-nitrates/pdf/eutrophication.pdf > [Accessed September 1, 2015]

2) Ammonium Nitrogen (NH_4^+)

Standards: 9.1 mg/ for pH<7.5, l 4.9 mg/l for pH=8.0, 1.6 mg/l for pH=8.5

The standard is related to the survival of fish (U.S. EPA, Quality Criteria for water 1986, one hour exposure.) Considering potential risk of fish killing, the values recommended by the Environmental Quality Standards 1992 was adopted as the Ambient Water Quality Standards in 2017.

Table 123 Category F -NH_4^+-N -

Sources of Information	pH<7.5	pH=8.0	pH=8.5
	mg/l		
The Ambient Water Quality Standards in 2017	9.1	4.9	1.6
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992	9.1	4.9	1.6
Thai Standard 1985 Class 4	0.5		

10.3 Others

1) Cyanide (CN)

Standards:0.05 mg/l

The Environmental Quality Standards 1992 adopted the value of 0.005 mg/l as recommended by the Canadian Guidelines for fresh water aquatic life. The Ambient Water Quality Standards in 2017 adopted 0.05 mg/l to be consistent with the value of Category E: Irrigation & Agriculture.

Table 124 Category F - Cyanide-

Sources of Information	CN mg/l
The Ambient Water Quality Standards in 2017	0.05
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992	0.005
Thai Standard 1985 Class 4	0.005

10.4 Metals

1) Cadmium

Standards:5 µg/l

The Ambient Water Quality Standards in 2017 adopted the value of 5 µg/l as recommended by the Environmental Quality Standards 1992.

Table 125 Category F -Cadmium -

Sources of Information	Cd µg/l
The Ambient Water Quality Standards in 2017	5
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992	5
Thai Standard 1985 Class 4	5 50

2) Chromium

Standards: 50µg/l

The Ambient Water Quality Standards in 2017 adopted the value of 50 µg/l as recommended by the Environmental Quality Standards 1992.

Table 126 Category F - Chromium-

Sources of Information	Cr µg/l
The Ambient Water Quality Standards in 2017	50
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992	50
Thai Standard 1985 Class 4	50

3) Cupper

Standards:100 µg/l

The Ambient Water Quality Standards in 2017 adopted the value of 100 µg/l as recommended by the Environmental Quality Standards 1992.

Table 127 Category F -Cupper -

Sources of Information	Cu µg/l
The Ambient Water Quality Standards in 2017	100
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992	100
Thai Standard 1985 Class 4	100

4) Manganese

Standards:1000 µg/l

The Ambient Water Quality Standards in 2017 adopted the value of 1000 µg/l as recommended by the Environmental Quality Standards 1992.

Table 128 Category F - Manganese-

Sources of Information	Mn µg/l
The Ambient Water Quality Standards in 2017	1000
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992	1000
Thai Standard 1985 Class 4	1000

5) Mercury

Standards: 2µg/l

The Ambient Water Quality Standards in 2017 adopted the value of 2 µg/l as recommended by the Environmental Quality Standards 1992.

Table 129 Category F - Mercury-

Sources of Information	Hg µg/l
The Ambient Water Quality Standards in 2017	2
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992	2
Thai Standard 1985 Class 4	2

6) Nickel

Standards:100 µg/l

The Ambient Water Quality Standards in 2017 adopted the value of 100 µg/l as recommended by the Environmental Quality Standards 1992.

Table 130 Category F - Nickel-

Sources of Information	Ni µg/l
The Ambient Water Quality Standards in 2017	100
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992	100
Thai Standard 1985 Class 4	100

7) Zinc (Zn)

Standards:24,000 µg/l

The recommended maximum value for drinking water for livestock of 24 mg/L is adopted as the Ambient Water Quality Standards in 2017.

Table 131 Category F - Zinc-

Sources of Information	Zn µg/l
The Ambient Water Quality Standards in 2017	24,000
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992	1000
Thai Standard 1985 Class 4	1000

8) Arsenic

Standards:50 µg/l

In view of the drinking water standard and the standard for aquatic life, the Standards of 50 µg/l was adopted.

Table 132 Category F -Arsenic -

Sources of Information	As µg/l
The Ambient Water Quality Standards in 2017	50
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992	50
Thai Standard 1985 Class 4	10

9) Aluminium (Al)

Standards: 5000µg/l

The guideline for CATEGORY E: IRRIGATION & AGRICULTURE was adopted as the Ambient Water Quality Standards in 2017.

Table 133 Category F -Aluminium -

Sources of Information	Al µg/l
The Ambient Water Quality Standards in 2017	5000
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992	-
Thai Standard 1985 Class 4	-

10.5 Organic Micro Pollutants

1) Phenolic compounds

Standards:5 µg/l

The Ambient Water Quality Standards in 2017 adopted the value of 5 µg/l as recommended by the Environmental Quality Standards 1992.

Table 134 Category F -Phenolic Compound -

Sources of Information	Phenol index µg/l
The Ambient Water Quality Standards in 2017	5
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992	5
Thai Standard 1985 Class 4	5

2) Oil/Grease

Standards:300 µg/l

The Ambient Water Quality Standards in 2017 adopted the value of 300 µg/l as recommended by the Environmental Quality Standards 1992.

Table 135 Category F -Oil/Grease -

Sources of Information	Oil/Grease µg/l
The Ambient Water Quality Standards in 2017	300
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992	300
Thai Standard 1985 Class 4	-

3) Anionic surfactants as MBAS

Standards:1000 µg/l

The Ambient Water Quality Standards in 2017 adopted the value of 1000 µg/l as recommended by the Environmental Quality Standards 1992.

Table 136 Category F - Anionic surfactants as MBAS-

Sources of Information	Anionic surfactants as MBS µg/l
The Ambient Water Quality Standards in 2017	1000
Environmental Quality Standards and Designation of Water Use in Sri Lanka, 1992	1000
Thai Standard 1985 Class 4	-

10.6 Micro Organism

No value is recommended for Microorganisms.

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Table A1. Ambient Water Quality Standards 2017

	No.	Parameter	Unit	Category A: Water source for simple treatment	Category B: Bathing and contact recreational water	Category C: Fish and Aquatic Life Water	Category D: Water source for general treatment	Category E: Irrigation & Agriculture	Category F: Minimum Water Quality
General	1	Colour	PTmg/l	20	-	-	100	-	-
	2	Conductivity	μS/cm	-	-	-	-	700	-
	3	Turbidity	NTU	5	-	-		-	-
	4	TSS	mg/l	25	-	40	1500	2100	-
	5	Total Hardness (as $CaCO_3$)	mg/l	250 des 600 max	-	-	-	-	-
	6	pH	-	6.0-8.5	6.0-9.0	6.0-8.5	6.0-9.0	6.0-8.5	5.5-9.0
	7	DO at 25°C	mg/l	6	5	5	4	3	3
	8	BOD_5 at 20°C	mg/l	3	4	4	5	12	15
	9	COD	mg/l	10	10	15	30	-	40
Nutrient	10	NO_3.N	mg/l	10	10	10	10	-	10
	11	NH_3-N	mg/l						
		pH<7.5		-	-	0.94	-	-	9.1
		pH7.5≦pH＜8.5		-	-	0.59	-	-	4.9
		8.5≦pH		-	-	0.22	-	-	1.6
	12	PO_4-P	mg/l	0.7	0.7	0.4	0.7	-	-
Other	13	Chloride (Cl)	mg/l	250	-	-	250	600	-
	14	CN	mg/l	0.05	0.05	0.05	0.05	0.05	0.05
	15	F	mg/l	1.5	-	-	1.5	-	-
	16	SO_4^{2-}	mg/l	250	-	-	250	1,000	-
Metal	17	Cd	μg/l	5	-	5	5	-	5
	18	Cr	μg/l	50	-	20	50	-	50
	19	Cu	μg/l	-	-	100	-	-	100
	20	Fe	μg/l	300 des 1,000 max	-	-	2000	-	-
	21	Pb	μg/l	50	-		50	-	-
		Hardness<120				2			
		120≦Hardness＜180				3			
		180≦Hardness				4			
	22	Mn	μg/l	1,000	1,000	1,000	1,000	1,000	1,000
	23	Hg	μg/l	1	1	1	1	2	2
	24	Ni	μg/l	70	100	100	100	200	100
	25	Se	μg/l	10	10	5	10	-	-
	26	Zn	μg/l	1,000	-	1,000	1,000	2,000	24,000
	27	B	μg/l	-	-	-	-	500	-
	28	As	μg/l	50	50	50	50	50	50
	29	Al	μg/l	200	-	-	-	5,000	5,000
Organic Micro Pollutant	30	Phenolic compounds	μg/l	2	5	2	5	5	5
	31	Oil/Grease	μg/l	100	-	100	100	-	300
	32	Anionic surfactants as MBAS	μg/l	1,000	1,000	1,000	1,000	1,000	1,000
	33	MCPA	μg/l	2	-	-	20	-	-
	34	Pendimethalin	μg/l	2	-	-	20	-	-
Micro Organism	35	Total Coliform	MPN/ 100ml	10,000	10,000	-	10,000	-	-
	36	Fecal Coliform	MPN/ 100ml	500 des 1000 max	500 des 1000 max	-	-	-	-

Table A2. Analytical Method for Ambient Water Quality Standards (Draft)

	No.	Parameter	Unit	Laboratory Service			Analytical Method for Portable Water SLS614, 2013		
				Usual method	Name	Alternative	Referee	Name	Alternative
General	1	Colour	PTmg/l				APHA 2120 B	Visual Comparison Method	
	2	Conductivity	µS/m	APHA 2510 B					
	3	Turbidity	NTU	APHA 2130 B			APHA 2130 B	Nephelometric Method	
	4	TSS	mg/l	APHA 2540 D					
	5	Total Hardness (as $CaCO_3$)	mg/l				APHA 2340 C	EDTA Titrimetric method	
	6	pH	-	APHA 4500 H B			APHA 4500-H^+B	pH Value Electrometric Method	
	7	DO at 25°C	mg/l	APHA 4500 O C		APHA 4500 O G			
	8	BOD_5 at 20°C	mg/l	APHA 5210 B	Titmetric	APHA 5210 D			
	9	COD	mg/l	APHA 5220 B	COD Open Reflux Method	APHA 5220 D	APHA 5220 B	Chemical Oxygen Demand (COD) Open Reflux Method	
Nutrient	10	NO_3-N	mg/l	APHA 418 D			APHA 4500 NO3 E	Nitrogen (Nitrate) Cadmium Reduction Method	APHA 4110 B
	11	NH_3-N pH<7.5	mg/l	APHA 4500 NH3 C			Appendix A		
		pH=8.0							
		pH=8.5							
	12	PO_4-P	mg/l	APHA 4500 P –E			APHA 4500 PC	Phosphorus Vanadomolybdophospheoric Acid Colorimetric Method	APHA 4110 B
Other	13	Chloride (Cl)	mg/l	APHA 4500 Cl- B			APHA 4500 Cl B	Chloride Argentometric Method	APHA 4110 B
	14	CN	mg/l				APHA 4500 CN C, EPA 335.4	Cyanide Total Cyanide after Distillation	APHA 4500 CN G & H
	15	F	mg/l				APHA 4500 F^- C	Fluoride Ion-Selective Electrode Method	APHA 4110 B
	16	SO_4^{2-}	mg/l	APHA 4500 SO_4^{2-} E			APHA 4500 SO_4^{2-} E	SulfateTurbidimetric Method	APHA 4110 B
Metal	17	Cd	µg/l	APHA 3111 B			APHA 3113 B	Metals by Electro thermal AAS Electro thermal AAS Method	ICP-MS (APHA 3125, EPA 200.8)
	18	Cr	µg/l	APHA 3111 B			APHA 3114 C	Arsenic and Selenium y Hydride Generation / AAS Continuous Hydride Generation/ AAS method	ICP-MS (APHA 3125, EPA 200.8)

	No.	Parameter	Unit	Laboratory Service			Analytical Method for Portable Water SLS614, 2013		
				Usual method	Name	Alternative	Referee	Name	Alternative
	19	Cu	µg/l	APHA 3111 B			APHA 3111 B	Metals by Flame AAS Direct Air-Acetylene Flame Method	ICP-MS (APHA 3125, EPA 200.8)
	20	Fe	µg/l	APHA 3111 B			APHA 3500 Fe B	Iron Phenanthroline Method	APHA 3111 B
	21	Pb	µg/l	APHA 3111 B			APHA 3113 B	Metals by Flame AAS Direct Air-Acetylene Flame Method	ICP-MS (APHA 3125, EPA 200.8)
	22	Mn	µg/l	APHA 3111 B			APHA 3111 B	Metals by Flame AAS Direct Air-Acetylene Flame Method	ICP-MS (APHA 3125, EPA 200.8)
	23	Hg	µg/l	APHA 3114 C			APHA 3111 B	Metals by Flame AAS Direct Air-Acetylene Flame Method	ICP-MS (APHA 3125, EPA 200.8)
	24	Ni	µg/l	APHA 3111 B			APHA 3113 B	Metals by Flame AAS Direct Air-Acetylene Flame Method	ICP-MS (APHA 3125, EPA 200.8)
	25	Se	µg/l	APHA 3114 C			APHA 3114 C	Arsenic and Selenium y Hydride Generation / AAS Continuous Hydride Generation/ AAS method	ICP-MS (APHA 3125, EPA 200.8)
	26	Zn	µg/l	APHA 3111 B			APHA 3111 B	Metals by Flame AAS Direct Air-Acetylene Flame Method	
	27	B	µg/l	APHA 3111 D					
	28	As	µg/l	APHA 3114 C			APHA 3114 C	Arsenic and Selenium y Hydride Generation / AAS Continuous Hydride Generation/ AAS method	ICP-MS (APHA 3125, EPA 200.8)
	29	Al	µg/l	APHA 3111 D			APHA 3113 B	Metals by Electro thermal AAS Electro thermal AAS Method	-
Organic Micro Pollutant	30	Phenolic compounds	µg/l				APHA 5530 B & D	Phenols Cleanup Procedure and Direct Photometric Method	
	31	Oil & Grease	µg/l	APHA 5520 B			APHA 5520 B	Oil and Grease Liquid-Liquid, Partition-Gravimetric Method	
	32	Anionic surfactants as MBAS	µg/l				APHA 5540 C	Surfactants Anionic surfactants as MBAS	

	No.	Parameter	Unit	Laboratory Service			Analytical Method for Portable Water SLS614, 2013		
				Usual method	Name	Alternative	Referee	Name	Alternative
	33	MCPA	µg/l	US-EPA 555rev1.0	Determination of Chlorinated Acids in Water by High Performance Liquid Chromatography with a Photodiode Array Ultraviolet Detector				
	34	Pendimethalin	µg/l						
Micro Organism	35	Total Coliform	MPN/ 100ml	APHA 9121 B			SLS1461		
	36	Faecal Coliform	MPN/ 100ml	APHA 9121 E					

付属資料 9　水質類型手順ガイドライン（2016 年 12 月 31 日時点の改定版）

PROCEDURAL GUIDELINES FORCATEGORIZATION OF INLAND SURFACE WATERS

Central Environmental Authority

Ministry of Mahaweli Development and Environment

Abbreviation

BOD	Biochemical Oxygen Demand
BOI	Board of Investment
CEA	Central Environment Authority
COD	Chemical Oxygen Demand
CBO	Community Based Organization
EPC Div.	Environmental Pollution Control Division
EPL	Environmental Protection Licence
GEMS	Global Environmental Monitoring System
GIS	Geographic Information System
GOSL	Government of Sri Lanka
IT Unit	Information Technology Unit
LA	Local Authority
LUnit	Legal Unit
MOF	Ministry of Finance
MOIC	Ministry of Industry and Commerce
MOMD&E	Ministry of Mahaweli Development and Environment
NARA	National Aquatic Resources Agency
NEA	National Environmental Act
NGO	Non-Government Organization
NWS&DB	National Water Supply and Drainage Board
R&D Unit	Research and Development Unit
SEA	Strategic Environmental Assessment
SMEWW	Standard Methods for the Examination of Water and Wastewater

Definition of Terms

Boundary	The term "boundary" in this guideline is used to denote a limit or a border of a section of waterbody that is assigned with a category and neighbours with another waterbody designated with another category.
Categorization	The term "categorization" is a process to assign a certain category of a designated beneficial water use to a waterbody or portion thereof.
Water Quality Guidelines	Water quality guideline is a set of numerical concentration limit of physical, chemical and biological parameters recommended for support and maintenance of a designated water use.
Water Quality Objectives	Water Quality Objectives are the specific water quality targets of a waterbody, or portions thereof established by assigning a category and agreed with the relevant stakeholders to support and to protect the designated uses of water at a specific site, river basin or part(s) thereof.
Reference Monitoring Points	Reference Monitoring Points is a specific location for assessing the achievement status of Water Quality Guidelines for a designated waterbody.
High Priority Area for Improvement	When specific waterbodies, or portions thereof, do not meet the Water Quality Objectives, the waterbody may be referred to as High Priority Waterbody.

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Appendix

Chapter 1. INTRODUCTION TO CATEGORIZATION

1.1 Introduction

In Sri Lanka, there are 103 natural rivers[1] with a total length of about 4,500 km (UNESCO and Ministry of Agriculture, Irrigation and Mahaweli Development: 2006). Fresh water is important and essential for survival of people, production of foods and economic growth. Industries, including manufacturing, mining and energy sectors which are expected to contribute significantly to economic growth of the country, also largely depend on the freshwater resource for their production.

Like other countries in the world, the rivers in Sri Lanka are used, for diverse but specific purposes such as sources of drinking water, bathing and recreation, fishing, irrigation and agriculture. Kelani River for instance, with a total drainage area of 2,321km^2 occupying approximately 3.5% of the country's total surface area, is a true lifeline for the 4.6 million people who inhabit in Colombo and Gampaha districts, accounting for approximately 23 % of the total population of the country[2]. The river is also used for such purposes to sustain the welfare of the population.

It is obvious that such beneficial use of water should be protected so as to avoid any adverse effects on the users of the water; though, the recent decades have witnessed the rapid deterioration of the surface water quality as a result of increased discharges of wastewater from domestic, industrial and agricultural sources.

Ambient water quality guidelines effective in the country provide a set of numerical concentration limit of physical, chemical and biological parameters recommended for the support and maintenance of designated water use. The Procedural Guidelines for Categorization of Inland Surface Waters set forth a procedure for assigning a category to a section of a water body according to the beneficial water uses considering local environmental conditions. For instance, a stretch of a waterbody running into an intake point for drinking water may be categorized into either Category A or D depending on the treatment technology used for producing drinking water. Through such process of categorization, each section of a waterbody will be established with water quality objectives and water quality targets to support and protect the designated uses of water at a specific site, river basin or part(s) thereof. Water quality monitoring by the CEA is a vital part to ensure protection of water quality by providing information to judge if the actual water quality meets its objectives. Unless the water quality does comply with the numerical values prescribed in the Ambient Water Quality Guidelines, appropriate actions and measures should be designed and taken to protect the intended water users.

By adopting the Procedural Guidelines, the country will have immense social and economic impacts. More specifically, the Government, as a whole, will be able to minimize fiscal impacts for pollution control; while maximizing the efficiency and efficacy of the intervention for pollution control by way of the followings: 1) the CEA will be able to identify priority pollutants, geographical locations and seasons of not

1 Natural Resource Management Center, Department of Agriculture, Sri Lanka.

2 Census of Population and Housing 2011, Enumeration Stage February - March 2012, POPULATION OF SRI LANKA BY DISTRICT, Department of Census and Statistics, 2012 .04. 20

achieving the water quality objectives; 2) the CEA will be able to analyze and identify specific industrial sectors in a specific geographical area; 3) the CEA will be able to draw key approaches and identify technical measures in addressing the water quality problems in the most cost effective and efficient manner; 4) the industry will also benefit by avoiding unnecessary environmental investment as the CEA will be able to make informed decision making. Further, it is evident that the water users will have a safe and secure environment at the earliest period possible.

1.2 Purpose of the Procedural Guidelines

This guideline set forth the general procedure for categorization of the waterbodies, which include those for selecting target river basins, initial data collection, development of work plan, field surveys, water quality monitoring, determination of categorization of boundaries, in consonance with the relevant provisions in Act No. 47 of 1980. Further the guideline provides fundamental information on water quality management.

1.3 Applicability

The procedures set forth in the guidelines shall be applied to the perennial rivers and streams in Sri Lanka having continuous flow.

1.4 Categories

The perennial river and streams in Sri Lanka shall be categorized according to their best usage and as prescribed in the table below. Each category is identified by the designated, water uses. The waters may be suitable for other beneficial uses, but shall be managed to protect and enhance the designated uses.

Table 1.1 Proposed Categories and their description

Category	Description
Category A: Water source for partial treatment	Water Supply Category 1. For waters whose waterbodies remain uninhabited or otherwise protected, and which require only approved partial treatment process commonly adopting simple physical treatment and disinfection process to meet the National Drinking Water Quality Standards. The values are also consonant with the Sri Lanka Standard 722:1985 on Tolerance Limits for Inland Surface waters used as raw water for public water supply. These waters shall also include pristine water with outstanding quality that may be found within national parks and other protected areas.
Category B: Bathing and contact recreational water	Recreational Water Category. For primary and secondary contact recreational activities such as swimming and diving. The use of waters includes drinking purposes without appropriate treatment process.
Category C: Fish and Aquatic Life Water	Fishery Waters Category:. For commercial and municipal fishing waters which are widely used for fishing purpose by local fisher folk and other waterbodies which are locally known or identified as habitats of fishes or other aquatic products being consumed by humans or are being used for the propagation of such.
Category D: Water source for general treatment	Water Supply Category II. For waters whose quality requires full treatment processes commonly adopting normal physical and chemical treatment accompanied by disinfection as designated by NWS&DB in order to meet the national Drinking Water Quality Standards.
Category E: Irrigation & Agriculture	Agricultural and other uses Category. For compatible agricultural uses (irrigation, livestock watering, etc.) and other uses.
Category F: Minimum Water Quality	The minimum water quality of the nation's waterbody. This would include those used for navigational purposes, etc.

Chapter 2. PROCEDURES FOR CATEGORIZATION

2.1 Overview of the Process

An overall procedure for categorization of waterbodies is outlined in the table below. It begins with preparation, which is followed by a field study. Geographical information collected and assembled during the preparatory period would be an important part for the entire process of the categorization.

Table 2.1 Overall Procedure for Categorization

Steps	Activities	Outputs
2.2 Preparatory Stage	2.2.1 Selection of Target River Basins	✓ Preliminary Categorization of the waterbody ✓ Water Quality Monitoring Plan for Survey ✓ Field Verification Study Plan
	2.2.2 Initial Data Collection and Analysis	
	2.2.3 Develop a Work Plan	
2.3 Field Verification Study	2.3.1 Field Survey	✓ Field data on water use and water quality status ✓ Confirmed boundary
	2.3.2 Water Quality Monitoring	
2.4 Determination of Draft Categorization and Boundaries	2.4.1 Consolidation and Assessment of Data	✓ Initial proposed and recommendation on categorization of waterbody
	2.4.2 Determination of Draft Categorization and Boundaries	
2.5 Stakeholder Meeting	Stakeholder Meeting	✓ Comments and feedback from stakeholders
2.6 Reporting and recommendation	Report Writing	✓ Proposal and recommendation on categorization of waterbody
2.7 Formalization process	Submission to the Board meeting	✓ Approval of categorization
2.8 Official Notice and Publication	Official Notice and Publication	✓ Official Notice

2.2 Preparatory Stage

This stage is intended to characterize the waterbody mainly on its use. The final product of this stage is approximate boundaries and assignment of tentative category of waterbodies.

2.2.1 Selection of Target River Basin

In pursuing categorization of rivers, priority is given to perennial rivers. The selected river is submitted to the Board Meeting of CEA to have an approval and secure necessary budget to do so. The tasks and responsibility divisions for selection of the target river are summarised in the table below.

Table 2.2 Selection of Target River

Task	Responsible Divisions	Main activity
Select target river basin	EPC Division	• Prioritize a target river basin • Estimate necessary budget for categorization, etc.
Coordination with the Board Meeting	EPC Division	• Prepare necessary documents • Submit and explain the relevant documents to the Board Members • Have an approval to proceed to categorization.

2.2.2 Initial Data Collection and Analysis

(1) Collect, assemble and evaluate present existing information.

The officers in charge of pursuing the categorization process shall collect, assemble and evaluate the existing information.

Table 2.3 Necessary Information for Categorization

Items	Details
Maps	▪ Administrative boundary maps, ▪ Land use maps, ▪ Topographic maps, ▪ Vegetation cover maps, ▪ Soil maps. ▪ Maps with scale of 1:25,000 are preferable
River system	▪ Name of main stream and tributaries, boundaries, drainage area
Infrastructure	▪ Location of roads and bridges ▪ Intake point of drinking water supply or irrigation water supply ▪ Diversion dams, floodways or man-made channels
Surface water Quality	▪ Location of monitoring stations ▪ Receiving water quality status providing time-series information
Pollution sources	▪ Location of major pollution sources, ▪ Estimate of pollution load from domestic, industrial, agricultural points and non-point sources ▪ background/upstream conditions.
Surface water hydrology	▪ Location of measuring sites, tables indicating low and high flows for particular reaches of the rivers in the study area. ▪ Description of hydraulic parameters, description of operating rules for any gates/hydraulic structures, known floods ,their frequency and magnitude, heavy rainfalls in the catchment.
Specific regulations	▪ National, Provincial, Municipal laws and regulations referring to the water environment in the area ▪ Decrees, laws and/or local ordinances on declared protection areas and special zones, e.g., preservation areas, protected areas, etc. ▪ Important flora and fauna would be useful.
Other	▪ Zoning plans of the local governments where the waterbody is located ▪ Occurrence of deltas, sand bars, ▪ Important habits of fish and aquatic lives.

The tasks and responsibility divisions for collecting data are summarised in the table below.

Table 2.4 Tasks and Responsibility Divisions for Data Collection

Task	Responsible Divisions	Main activity
Data collection from regional office and other departments.	EPC Division	• Request the regional offices and departments to submit the relevant data • Assemble the collected data
Preparation of relevant information of sub-basin for categorization	R&D Unit	• Prepare maps of the sub-basins based on the monitoring point, intake point, etc. • Set recommended monitoring points in each sub basins • Submit the results of sub-basin map to EPC division

(2) Perform Preliminary categorization

With the use of land use, soil cover and relevant maps overlaid on topographic map, or satellite maps, it is possible to approximate boundaries and assign tentative categorization of waterbodies. The following steps may be followed:

1) Identify boundaries of catchments by using the GIS data available at the Research & Development Unit of CEA;
2) Identify locations of water intake points for drinking water and display on a map;
3) Identify water quality sampling points on the map;
4) Identify primary land use of each catchment by compiling and analysing available statistics;
5) Identify main water use of each catchment based on best available knowledge;

The tasks and responsible divisions for preliminary categorization are summarised in the table below.

Table 2.5 Tasks and Responsible Divisions for Preliminary Categorization

Task	Responsible Divisions	Main activity
Data analysis	EPC Division	• Analyse and identify main water use based on sub-basin maps • Assess the sub basin to integrate or disintegrate into management area(s) (some of sub basins may be integrated into one management area) • Identify the critical issues to set the categorization and reflect the issues to field survey
Propose preliminary Categorization to the waterbody	EPC Division	• Set tentative categorization to each management area

2.2.3 Develop a Work Plan

Develop a work plan comprising of a field verification study and/or a water quality monitoring plan as needed. Such planning process may need to identify information gap. This would include, but not limited to: additional parameters to be quantified and monitored, additional water quality analysis to complement specific season(s), locations and geographical extent of water using zones such as recreational water use, fishing area, important habitats for aquatic life to be protected. At this stage, coordination with provincial Offices and Concerned Agencies shall be initiated. The field verification study may be commissioned as needed to consulting firms or other appropriate external resources depending on the nature and volume of works to be done. The tasks and responsible divisions for developing a work plan are summarised in the table below.

Table 2.6 Tasks and Responsible Divisions for Developing a Work Plan

Task	Responsible Divisions	Main activity
Prepare work plan to identify the characteristics of target waterbody	Regional Office	• Prepare draft field survey and monitoring plan • Submit the plan to Central Laboratory and EPC division • Finalize the plan with the guidance of Central Laboratory and EPC division
	Central Laboratory	• Assist Regional Offices in preparing plan that includes monitoring parameters, frequency and period of monitoring • Coordinate with the relevant regional offices in same river basin for the water quality monitoring
	EPC Division	• Identify the issue to be surveyed on target waterbody

		• Assist the Regional office in performing the tasks

(1) Field survey plan

The purposes of field verification study are identifying the information gap, clarify actual river basin condition and confirmation of boundary.

Field verification study should be planned in advance to give time for necessary arrangements. Basic consideration in planning the fieldwork includes:

- Establishing local contact. If not one member of the relevant officers is familiar with the survey area it is necessary to establish local contact person in advance.
- Weather conditions. For safety reasons, fieldwork during rainy periods should be avoided.
- Timetable. Make a realistic estimate of the days needed to complete the fieldwork, providing reasonable allowance for possible delays. If it is impossible to completely cover the entire area at one time, the activity may be phased as necessary.
- Accommodation and arrangements for meetings as needed. Arrangements should be made for accommodation if the relevant officer is staying on field overnight , for meetings for group interviews and community mapping activities.
- Provisions for logistics should be ensured.
- Materials and equipment. Before going on fieldwork, be sure that the necessary materials and equipment have been prepared. These include: survey questionnaires in sufficient copies, GPS with batteries, cameras, maps of the target area, permanent markers, compass, record book, safety aid kits, etc.

Appendix 1 provides a format used in preparing a field survey plan.

(2) Water quality monitoring plan for survey

For the water quality monitoring, the parameters, sampling frequency and sampling sites shall be determined on the basis of the analysis to fill information gap for categorization of waterbody.

Regional Office should collect and assemble the information in the table below to prepare the monitoring plan, then submit to Central Laboratory and EPC division. The monitoring plan form is attached in Appendix-2.

Table 2.7 Water quality monitoring plan

Sampling Location				Monitoring parameters	Monitoring month	Monitoring period	Handling of samples
ID	Name	GPS (N: E:)	Aspect				
RO-001	Thalduwa bridge	N: 769150 E: 413566	Confluence point of polluted branch river	e.g. pH, DO, EC, BOD	e.g. Jan, Apr, Jul, Oct	Jan. 2017 to Oct, 2017	All parameters analysis own laboratory
RO-002	Karawenella bridge	N: 776036 E: 418547		e.g. pH, DO, EC, BOD	e.g. every month	Jan. 2017 to Dec, 2017	BOD analysis will ask Central Laboratory
RO-003							

2.3 Implementation of Verification Survey

2.3.4 Field Survey

The field verification study aims at confirming the findings of the initial data collection and analysis through any combination of the following methods: (a) visual survey (observation), (b) participatory mapping, and (c) interviews. The choice of method is discretionary and can be decided on during the planning stage.

(1) Visual Survey

Visual survey may be done by transect walk. The transect walk will:

- Confirm the information initially plotted on the thematic maps.
- Confirm the different actual uses of the waterbody, enable preliminary categorization, and confirm the physical boundaries of the designated categorization.
- Enable designation of future monitoring stations.

(2) Participatory mapping

Participatory mapping may be undertaken in place of transect walk or to substantiate it for purposes of confirming the actual uses and conditions of the waterbody and surrounding areas. It takes into account the use of indigenous knowledge of local communities.

Using the map produced in advance, the group of local residents may be asked to help confirm and identify the boundaries of different uses of waterbodies, and the biophysical conditions in the designated areas.

(3) Interview survey

Group interview is recommended for this purpose because it is expected to yield reasonably dependable results, is easier and faster to conduct, and for ease of data management and analysis.

The key to a successful outcome is the choice of respondents. Key informants should be chosen carefully. Key informants are persons with special or ample knowledge of the area and local situations that influence the water uses, and the biophysical conditions in the study area. Usually, key informants are: local community officials, fishing community, leaders of community organizations, elders, model citizens, teachers or community achievers. A good mix of key informants is expected to yield reasonably accurate results.

Guide questions for purposes of confirming water usage, corresponding boundaries of waterbody for different uses, and issues related to water quality should be prepared in advance. The guiding questions may be modified, as the survey team may deem necessary for better results.

2.3.5 Water Quality Monitoring

Water quality assessment will enable the relevant officers to form judgment on whether or not the waterbody is meeting the Water Quality Guideline values corresponding to its designated use or uses.

2.3.6 Consolidation and Assessment of Data

The findings from secondary data review, analysis of map overlays, visual surveys, key informant interviews and community mapping shall be consolidated, harmonized and analysed to come up with judgment on the categorization appropriate for a particular waterbody or sections of rivers or streams including appropriate determination of boundaries and identification of monitoring stations.

The analysis, presented in appropriate format including the final thematic map of categorization produced from the process, the documentation of key informant interviews and minutes of consultation meetings shall be consolidated into a report.

2.3.7 Determination of Draft Categorization and Boundaries

The rules and procedures presented in Table 2.8 will guide the determination of categorization and boundaries of classified waterbodies. Environmental category and the boundary will be decided as draft categorization in the waterbody, based on the results of consolidation and assessment of data. The draft categorization will be finalized through the stakeholder meeting.

Table 2.8 Rules and Procedures for Categorizing Rivers or Streams

#	Condition	Category					Setting of Boundary
		A	B	C	D	E	
1	Rivers or portions of rivers or streams which are used as source of existing public water supply of NWS&DB with partial treatment process commonly adopting simple physical treatment and disinfection.	A					✓ The upper boundary shall be the headwaters. ✓ The lower boundary shall be the intake point of the water supply facility or the lower boundary of the basin, whichever is more appropriate for management of water quality.
2	Rivers or portions of rivers or streams located within areas which have been identified by NWS&DB as potential source of public water supply and for which reason human activities that could degrade water quality are regulated, provided that such waters are not within farming areas or otherwise located downstream of farming areas that are known to be using pesticides, fertilizers or other chemicals, or suspected to be using such chemicals.	A					✓ The upper boundary shall be the headwaters. ✓ The lower boundary shall be the identified intake point of the planned facility or the potential point of intake as determined by an authorized government agency or the lower boundary of the basin, whichever is more appropriate for management of water quality.
3	Rivers or portions of rivers or streams which is not used as source of existing public water supply of NWS&DB with partial treatment system in its entire downstream, but located within 1) areas which have been declared by national laws and/or local decrees or ordinances as protected areas or 2) primary forests but not declared as protected areas under the relevant laws provided that the protection of the waters deemed necessary and appropriate for maintenance or betterment of welfare of local residents or for purposes of protecting important flora or fauna	A					✓ In rivers or streams whose entire length does not fall within this category, the upper boundary shall be the headwaters and the lower boundary shall serve as the upper boundary of the next category level. ✓ For 1) waters, whose lower boundary shall be the point where the waters cross with the designated boundary in the corresponding law, decree, or ordinance or as may be reflected in the local land use plans or the lower boundary of the basin, whichever is more appropriate for management of water quality. ✓ For 2) water, the lower boundary shall be the most downstream portion of the primary forest area or as may be reflected in the local land use plans or the lower boundary of the basin, whichever is more appropriate for management of water quality.

#	Condition	Category					Setting of Boundary
		A	B	C	D	E	
4	Tributary of category A waters	A					✓ Lower boundary is at the confluence with the main river
5	Rivers or portions of rivers or streams which are primarily being utilized for contact recreational purposes such as swimming and diving, provided that no source of public drinking water supply Category A are located downstream of such waters. The use of waters does not include daily bathing purposes.		B				1. In case of rivers or streams contiguous to a Category A waters, ✓ The upper boundary shall be the lower boundary of the Category A waters. 2. In case of rivers or streams not contiguous to a Category A waters, ✓ The upper boundary shall be the headwaters. ✓ The lower boundary may be confirmed by the field visits, but should not extend to areas that are directly receiving untreated domestic wastewater, discharges from industries, commercial area, landfill areas, or otherwise extend to where there are visible signs of pollution. The determination of the lower boundary should also consider the lower boundary of the basin.
6	Tributary to Category B waters		B				✓ Lower boundary is at the confluence with the main river
7	Rivers or portions of rivers or streams which are widely used for fishing purpose by local fisher folk.			C			1. The upstream boundary of rivers contiguous to a Category A or B waters shall be the same as the lower boundary of the waters of higher category. 2. In case of rivers or streams not contiguous to a Category A or B waters, the upper boundary shall be the headwaters. ✓ The lower boundary may be designated based on findings on site.
8	Waters not specifically falling under (7) above, but are locally known or identified habitats of fishes or other aquatic products being consumed by humans or are being used for the propagation of such.			C			1. In case of rivers or streams contiguous to a Category A or B waters, ✓ The upper boundary shall be the lower boundary of the Category A or B waters. ✓ The lower boundary shall be the downstream limit of the aquatic habitat as confirmed by the field surveys or the lower boundary of the basin, whichever is more appropriate for management of water quality. 2. In case of rivers or streams not contiguous to a Category A or B waters, ✓ The upper boundary shall be the headwaters. ✓ The lower boundary shall be the downstream limit of aquatic habitat as confirmed by the field surveys or the lower boundary of the basin, whichever is more appropriate for management of water quality.
9	Tributary to Category C waters			C			✓ Lower boundary is at the confluence with the main river.
10	Rivers or portions of rivers or streams which are used as source of existing public water supply of NWS&DB with full treatment process commonly adopting normal physical and chemical treatment accompanied by disinfection, but not falling within Category A, B or C waters.				D		1. In case of rivers or streams contiguous to a Category A, B or C waters, ✓ The upper boundary shall be the lower boundary of the higher waters. ✓ The lower boundary shall be the intake point of the water supply facility or the lower boundary of the basin, whichever is more appropriate for management of water quality. 2. In case of rivers or streams not contiguous to a Category A, B or C waters, ✓ The upper boundary shall be the headwaters.

#	Condition	Category					Setting of Boundary
		A	B	C	D	E	
							✓ The lower boundary shall be the intake point of the water supply facility.
11	Rivers or portions of rivers or streams located within areas which have been identified by NWS&DB as potential source of public water supply with full treatment process and for which reason human activities that could degrade water quality are regulated, provided that such waters are not within farming areas or otherwise located downstream of farming areas that are known to be using pesticides, fertilizers or other chemicals, or are suspected to be using such chemicals.				D		1. In case of rivers or streams contiguous to a Category A, B or C waters, ✓ The upper boundary shall be the lower boundary of the higher waters. ✓ The lower boundary shall be the identified intake point of the planned facility or the potential point of intake as determined by an authorized government agency or the lower boundary of the basin, whichever is more appropriate for management of water quality. 2. In case of rivers or streams not contiguous to a Category A or B waters, ✓ The upper boundary shall be the headwaters. ✓ The lower boundary shall be the identified intake point of the planned facility or the potential point of intake as determined by an authorized government agency or the lower boundary of the basin, whichever is more appropriate for management of water quality.
12	Tributary to Category D waters				D		✓ Lower boundary is at the confluence with the main river.
13	Waters suitable for irrigation, livestock watering and other uses.					E	✓ The upper boundary of rivers or streams contiguous to a Category A, B, C or D rivers, streams or creeks shall be the same as the lower boundary of the waters of higher category. ✓ The lower boundary shall be the downstream limit as confirmed by the field surveys or the lower boundary of the basin, whichever is more appropriate for management of water quality. ✓ The lower boundary may be the discharge point to the bay, coast or sea as indicated by the dividing line between the inland and the coastal areas.
17	Tributary to Category E waters					E	✓ Lower boundary is at the confluence with the main river

2.4 Stakeholder Meeting

Stakeholder meeting is held to obtain consensus of draft categorization to finalize it among related authority and NGO, CBO in the target river basin. The meeting materials include categorization map, information on each reference monitoring points and collected relevant data. The stakeholder meeting may hold on several times to make agreement.

CEA should prepare necessary document/ presentation to explain the recommended categorization with background information. Appendix-3 provides a format for recording Comments and Answers in the stakeholder meetings.

2.5 Reporting and Recommendation

The report shall include the followings:

(1) Background information

(2) Description of the waterbody including a short description of its administrative boundaries, physical characteristics such as size of drainage area, depth, width, surface area, length, flow direction, general behaviour, discharge and general description of land uses, biological health, Description of the climate and average annual rainfall in the river basin, Description of the topography, soil type, vegetation cover and the present land use status. Estimate vegetation cover/denuded areas (hectare). As much as possible, describe the history of vegetation within and in the immediate vicinity of the river basin or drainage area. The thematic map of the river to be classified should be attached. . Objective

Description of the objectives of categorization -both general and specific objectives.

(3) Methodology of categorization

Brief description of the methodology used in categorization including the evaluation method of main water uses, field verification study, consultation and stakeholder meeting.

(4) Findings of the categorization study

Description of existing physical and biological conditions and actual uses of the water upon which the recommendations were based. Also, include results of water quality sampling and assessment.

(5) Draft categorization

The recommended categorization for the waterbody should be presented in an easily understandable format that shows the specific boundaries of classified waterbodies and other basic information. Categorization map must include the proposed monitoring stations and recommendations for further studies, if necessary.

(6) Annexes and Attachments

The filled in survey forms, outputs or documentation of participatory mapping, and minutes of meetings and public consultations shall be attached.

(7) References

References should be properly cited.

2.6 Formalization of Categorization in the Target River Basin

After completion of the categorization, a hard copy and an electronic copy of the report should be officially submitted to the Board meeting to obtain approval on the categorization of target river. The tasks and responsible divisions for formalization process are summarised in the table below.

Table 2.9 Tasks and Responsible Divisions for Formalization Process

Task	Responsible Divisions	Main activity
Prepare final draft of categorization and relevant information	EPC division	• Prepare final categorization and report on target river basin based on results of stakeholder meeting • Submit relevant information to R&D unit
	R&D Unit	• Prepare Categorization map
Authorization	EPC division	• Submit final draft categorization and relevant information to Board meeting.

2.7 Official Notice and Publication

Authorized categorization map and relevant information should be uploaded to the CEA web site. The uploading of information should be in unmodifiable formats like PDF, JPEG etc. The tasks and responsible divisions for official notice and publication are summarised table below.

Table 2.10 Tasks and Responsible Divisions for Official Notice and Publication

Task	Responsible Divisions	Main activity
Sharing information	EPC division	• Share the authorized categorization information to related division, authorities
Up load to CEA web site	IT Unit	• Authorized document regarding categorization up load to CEA web site.

Chapter 3. WATER QUALITY ASSESSMENT AND MANAGEMENT

3.1 Management Process

The categorization process may identify specific waterbodies, or portions thereof, that do not meet the Water Quality Objectives. Such a status of water quality of a waterbody, or portions thereof, may be referred to as High Priority Waterbody (HPW) and the drainage area may be referred to as High Priority Area (HPA) for operational purpose of these guidelines. This is a body of water in which the level of a water pollutant is higher than the level desired for protecting its beneficial use under the Ambient Water Quality Guidelines. In other words, it is the waterbody that has received the amount of pollution load beyond the total load that a waterbody can receive without violating Water Quality Objectives. It is obvious that such area shall be prioritized for water quality management interventions to improve the water quality.

Table 3.1 Overall Procedure for Assessment and Management

	Steps		Activities		Outputs
3.2 Water Quality Assessment	3.2.1	Water Quality Monitoring	(1)	Objectives of Water Quality Monitoring	Annual Monitoring Plan for Evaluation
			(2)	Selection of measurement parameters	
			(3)	Frequency and Duration of Sampling	
	3.2.2	Evaluation of Monitoring results	(1)	Parameters that may give significant health effects to humans	Identification of High Priority Area
			(2)	Other important parameters	
	3.2.3	Report and Publication		Preparation of Report and Publication	Information materials
3.3 Water Quality management	3.3.1	Water Quality Management Actions	(1)	Strengthening the CEA managed EPL process and its implementation	Measures to control water quality
			(2)	Improved approval process for new industries	
			(3)	Other instruments	
	3.3.2	Formulation of action plans for water quality management		Action planning and implementation	Action Plans

Pollution sources lying in a High Priority Area may include either natural or man-made sources, point sources and non-point sources. The guideline here under also provides for a management process with a focus on point sources considering the mandates of the Central Environmental Authority. However, recognizing the relative significance of non-point sources(NPS) in the overall pollution status, the management of NPS will also be considered and handled wherever possible.

3.2 Water Quality Assessment

The terms monitoring and assessment are frequently confused and used synonymously[3]. For the purpose

[3] The definitions of the terms were adopted and modified from the following literature.
Water Quality Assessments -A Guide to Use of Biota, Sediments and Water in Environmental Monitoring – Second Edition. Edited by Deborah Chapman, Published on behalf of United Nations Educational, Scientific and Cultural Organization, World Health Organization, United Nations Environment programme

of this guideline, the following definitions are used:

WATER QUALITY ASSESSMENT is the process of evaluation of the physical and chemical conditions of water especially in relation to natural quality, human effects and intended uses, particularly those which may affect human health and that of the aquatic system itself.

WATER QUALITY MONITORING is the actual collection of information at set locations and at regular intervals in order to provide the data which may be used to define current conditions, establish trends, etc.

3.2.1 Water Quality Monitoring

Water quality monitoring is a long-term, standardized measurement and observation of the water quality in order to define status and trends[1]. Upon the completion of the initial categorization of a river, CEA should not terminate monitoring of the river as long as the water is used for beneficial purpose. Instead, CEA should design water quality to optimize resources for the monitoring, by prioritizing the monitoring sites, pollutants and frequencies. The key message is that any water quality monitoring program has to be designed and planned according to the objectives of monitoring taking into account such factors as time, budget, equipment, manpower, and implementation constraints. As water quality monitoring entails time and resources, the programme should be properly planned to optimize the use of resources.

(1) Objectives of Water Quality Monitoring

Upon the completion of assigning categories to a river, CEA may need to monitor the quality of the water body for various purposes. However, it is evident that setting up a monitoring programme requires a clear definition of the objectives, in order to avoid waste of time, efforts and money[4] because it is a time-consuming and costly process. The water quality monitoring after the categorization would be undertaken primarily to determine the achievement status of the water quality objectives of a specific water body or sections of a waterbody. The process of monitoring will be undertaken in tandem of water quality management interventions to assess effectiveness and efficiency of the intervention.

However, most waterbodies require monitoring for one or more purposes such as 1) to assess a long-term evolution of pollution to provide early warning signals of large, potentially catastrophic event and to minimize its impacts and 2) to develop a rapid inventory and situation assessment following a catastrophic event among others. Especially, the Kelani River requires continued vigilance because it is the lifeline of the people living in the capital.

The mode of operation such as sampling frequency, selection of variables to be monitored, and locations of sampling should vary according to the objectives of the monitoring along with the available information of the waterbody and its quality.

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[4] DiederikRousseau and Peter Kelderman, 3.1. CONCEPTS OF MONITORING, Online Module Water Quality Assessment, UNESCO-IHE Institute for Water Education
<https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwjentLitpLSAhXKsI8KHfiyCgIQFggbMAA&url=http%3A%2F%2Focw.unesco-ihe.org%2Fpluginfile.php%2F3826%2Fmod_folder%2Fcontent%2F0%2F3.1_Concepts_Monitoring.pptx%3Fforcedownload%3D1&usg=AFQjCNH_51bMjmzTgLPMFxZWVEYSLpTG-g&sig2=n9H5GPY76v9Zy2z7-sBm4A> [Accessed 15 February 2017].

Typology of water quality monitoring and general guidelines are provided in Table 3.2.

Table 3.2 General Guidelines on Water Quality Monitoring

	Type of operation	Major focus of water quality assessment	Station density and location	Recommended Parameters considered	Recommended Sampling frequencies	Duration	Interpretation lag
1	Initial categorization of river and stream	Categorization of waterbody according to designated beneficial use.	Medium	All the parameters suspected to be present	Monthly monitoring	At least one year Desirably 2 to 3 years considering weather variation	<6 months
2	Trend monitoring	Long-term evolution of pollution due to changes of land use, point and non-point sources	low	low for single objective; high for multiple objective	Monthly	> 10 years	> 1 year
3	High Priority Waterbody monitoring	Assessment of HPW's water quality status to evaluate efficiency and efficiency of intervention.	High in HPA	All relevant parameters	Monthly	Unlimited until the water quality meets the objectives	<1 month
4	Emergency survey	Rapid assessment of water quality after a chemical spillage from factory or other catastrophic events to protect important water uses.	medium to high	All relevant parameters	high	very short (day to weeks)	very short (days)
5	Early warning surveillance	At critical water use locations such as major drinking water intakes or fisheries; continuous and sensitive measurements	very limited	very limited	continuous	unlimited	instantaneous
6	Background monitoring	Measurement of background levels of some naturally occurring substances in an upper reach of a river system especially those without anthropogenic pollution sources.	Low	low to high	low	variable	medium
7	Basic Survey	Identification and location of major survey problems and their spatial distribution. This is especially important when fundamental information on pollution location is limited.	medium	medium to high	depending on media	once per year to once every 4 years	1 year
8	Preliminary Surveys	Inventory of pollutants , their space and time variability prior to monitoring programme design	high	low to medium (depending on objectives)	usually low	short <1 year	short (months)
9	Multi-purpose monitoring	Space and time distribution of water quality in general	Medium	Medium number	Medium (12/year)	Medium (>5 years)	Medium (1 year)

Source: JICA Project Team, modified Table 2.2. Categories and principal characteristics of water quality assessment operations in Water Quality Assessments -A Guide to Use of Biota, Sediments and Water in Environmental Monitoring – Second Edition. Edited by Deborah Chapman, Published on behalf of United Nations Educational, Scientific and Cultural Organization, World Health Organization, United Nations Environment programme.

The levels (high, medium, low) of all operation characteristics (frequency, density, number of variables, duration, interpretation lag) are given in relation to Initial categorization of river and stream, which has been taken as a reference.

(2) Selection of measurement parameters

It is desirable to analyse all the parameters in the Water Quality Guidelines. However, as emphasized in the preceding section, the selection of parameters for any water quality assessment programme depends primarily upon the objectives of the programme and available information. Appropriate selection of variables will help the objectives to be met, efficiently and in the most cost effective way. From the practical view point, at the time of planning for monitoring, it is necessary to estimate incremental work load resulting from the field work and the laboratory analysis in comparison with the absorptive capacity. The water quality parameters can be grouped into the following broad categories: general, nutrients, others, metals, organic micro pollutants and microorganisms as presented in the Table 3.3. For the purpose of interpretation of laboratory results, measurement of temperature is also of primary importance in addition to the parameters prescribed in the Water Quality Guidelines. Note that the different parameters are applied to each category. The information on the number of monitoring parameters in the table may be used for planning and designing a water quality monitoring programme to estimate incremental work load of laboratory analysis.

Table 3.3 Different Parameters applied to each Category

Monitoring Group	No.	Parameter	Number of Monitoring Parameters					
			A	B	C	D	E	F
			Water source for simple treatment	Bathing and contact recreational water	Fish and Aquatic Life Water	Water source for general treatment	Irrigation & Agriculture	Minimum Water Quality
	1	Temperature	1	1	1	1	1	1
General	9	Colour, Conductivity, Turbidity, TSS, Total Hardness (as $CaCO_3$), pH, DO at 25°C, BOD_5 at 20°C, COD	8	4	5	6	5	4
Nutrient	3	NO3-N, NH3-N, PO4-P	2	2	3	2	0	1
Other	4	Chloride (Cl-), CN, F, SO_4^{2-}	4	1	1	4	3	1
Metal	13	Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ni, Se, Zn, B, As, Al	11	5	10	9	7	9
Organic Micro Pollutant	5	Phenol index, Oil & Grease, Anionic surfactants as MBS, MCPA, Pendimethalin	5	5	3	5	2	3
Micro Organism	2	Total Coliform, Fecal Coliform	2	2	0	1	0	0

Note: Temperature is not the parameters in the Water Quality Guidelines; though, it is recommended to be measured.

(3) Frequency and Duration of Sampling

Monthly sampling is recommended for most of the monitoring programme. However, it should also be designed considering the objectives, available information, budget and feasibility. At the time of planning, it may be necessary to undertake 24-hours monitoring with 1 or 2-hours intervals to see the diurnal variation of the concentration and thus to determine the best timing for sampling.

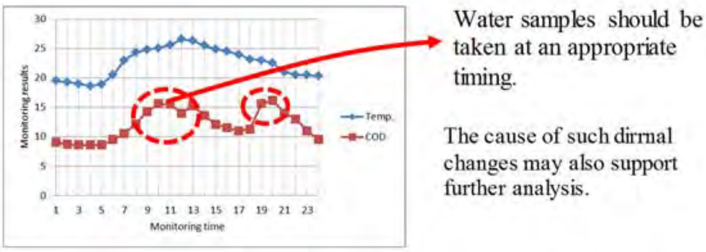


Figure 3.1 Sampling timing

3.2.2 Evaluation of Monitoring Results and Identification of High Priority Waterbody

Each of parameters relevant to the Ambient Water Quality Guidelines may have different degree of impacts on human health. The parameters such as cyanide should be given more attention and requires faster actions to address the problem of pollution than, for instance, TSS and turbidity because cyanide exhibits acute toxicity having health effects on the thyroid and particularly the nervous system. Considering such aspects on human health, a classification of the parameters is made as presented in Table 3.3. The table also presents the recommended action level of pollution for taking measures. For the parameters classified into the first group having higher toxicity, once an incidence of exceedance is observed for any one of the parameters during the monitoring programme, CEA is recommended to take water quality management actions. Similarly, those in the second group have to be given attention when an average value of the water quality Monitoring programme is found to be in exceedance of the Water Quality Guidelines.

(1) Parameters that may give significant health effects to humans

The parameters that may give significant health effects to humans should be given priority in any water quality monitoring actions. The parameters include, but not limited to: cyanide, cadmium, lead and nitrate-nitrogen. CEA is recommended to take Water Quality Management Actions if an incidence of exceedance is observed for any one of the parameters during the monitoring programme. Once such an incidence is identified, the waterbody may be referred to as High Priority Waterbody. The drainage area may be referred to as High Priority Area.

(2) Other important parameters

Other parameters in the Water Quality Guidelines are classified as other important parameters. CEA is recommended to notify the pertinent authority of exceedances of the Water Quality Guidelines if an average value of the water quality minoring programme is found to be in exceedance of the Water Quality Guidelines. Once such an incidence is identified, the waterbody may be referred to as High Priority Waterbody. The drainage area may be referred to as High Priority Area.

Table 3.4 Recommended Action Level

Class		Parameters			Recommended Action Level
1	Parameters that may give significant health effects to humans	1. CN 2. F 3. Cd 4. Cr	5. Pb 6. Hg 7. Se 8. B 9. As	10. Phenol compound 11. NO_3-N 12. MCPA 13. Pendimethalin	CEA is recommended to take Water Quality Management Actions if an incidence of exceedance is observed for any one of the parameters during the monitoring programme.
2	Other important parameters	1. Colour 2. Conductivity 3. Turbidity 4. TSS 5. Total Hardness (as $CaCO_3$) 6. pH 7. DO at 25°C 8. BOD_5 at 20°C	9. COD 10. PO_4-P 11. Chloride (Cl^-) 12. SO_4^{2-} 13. Cu 14. Fe 15. NH_3-N 16. Mn 17. Ni	18. Zn 19. Al 20. Oil & Grease 21. Anionic surfactants as MBS 22. Total Coliform 23. Fecal Coliform	CEA is recommended to notify the pertinent authority of exceedances of the Water Quality Guidelines if an average value of the water quality minoring programme is found to be in exceedance of the Water Quality Guidelines. For Categories B and C, CEA is recommended to notify the public through appropriate mode of education & awareness.

Two examples of evaluation of monitoring results are provided in Appendix4.

3.2.3 Report and Publication

The report submitted by provincial offices shall include the information presented in the table below.

Table 3.5 Information provided by Provincial Office

Reference Monitoring Point			Applied Category	Monitoring Results				Evaluation	Note
Code #	Name of Place	GIS info.		Number of sample	Parameters	Average	Maximum		
1	gampaha	Xxxx xxxx	B	12	COD	5.326	10.5	HPA	
1	gampaha	Xxxx xxxx	B	12	BOD	3.26	4.2	OK	
1	gampaha	Xxxx xxxx	B	12	TSS	1.15	3.25	OK	
1	gampaha	Xxxx xxxx	B	12					

It is recommended that the information of categorized reference monitoring points, monitoring results and the evaluation of High Priority Area's condition be published annually.

3.3 Water Quality management

3.3.4 Water Quality Management Instruments

When a waterbody, or portion thereof, does not meet the water quality objectives, CEA needs to formulate a plan of actions to address the water quality problems with a focus on the waterbody that failed to meet the objectives. It may be a combination of point and non-point sources control or either one of them depending on the water quality status. Table 3.8 presents major applicable actions.

(1) Strengthening the EPL process and its implementation

The action is to enhance industry inspection to promote compliance to effluent standards and EPL scheme with a geographical focus in the High Priority Area. The information available, especially in the EPL database, should be examined to identify and prioritize potential major contributors to the discharge of the pollutants. At this stage, the industries may include those discharging 1) directly and 2) indirectly to the High Priority Waterbody, which should be subject to review and assessment.

(2) Improved approval process for new industries

Approval of EPL for new industries is often made by assessing the individual treatment technology and pollutants in the effluent, based on the design of the facility. However, an area is identified as High Priority Area, a consideration should be given to sitting of industrial facilities to avoid excessive concentration.

(3) Other instruments

Other instruments would include, but not limited to: Enforcement of stringent effluent standards, Enforcement of Industry-Specific effluent standards and Market-based incentive policies. They need to be elaborated and other relevant technical guidelines should be developed.

Table 3.6 Water Quality Management Instruments

Classification		Water Quality Management Instruments	Description
1	Strengthening the EPL process and its implementation	Enhanced industry inspection to promote compliance to effluent standards and EPL scheme with a geographical focus in the High Priority Area	✓The scope of industries that will undergo enhanced inspection are those discharging wastewater to the High Priority waterbody; ✓Prioritization may be given to those discharging 1) directly and 2) indirectly to the High Priority waterbody; ✓This intervention would allow thorough inspection of priority sector in priority areas. ✓Identification of such target industries needs to be performed by analysing the EPL data in collaboration with the Research & Development Unit.
2	Improved approval process for new industries	Approval of EPL for new industries should not be made solely on the individual treatment technology and pollutants in effluent, instead, a consideration will be given to sitting of industrial facilities to avoid excessive concentration, especially in High Priority Area.	✓Site selection is a critical decision made by private industries that affect pollution, which will be governed by land use planning of the public sectors; ✓This intervention is intended to minimize the pollution load of the specific parameter in High Priority Waterbody by avoiding excessive concentration of specific industry discharging relevant pollutants; ✓Polluting industries will be relocated away from the most polluted area, where pollution will be reduced at the expense of environmental quality elsewhere; ✓Appropriate prior consultations and information dissemination to industries is strongly recommended.
3	Enforcement of stringent effluent standards	Area specific stringent effluent standards with a geographical focus	✓CEA is empowered by the relevant Act to enforce stringent effluent standards; ✓The tool is to give focus to the High Priority Area to minimize pollution loads into the waterbody. ✓Appropriate prior consultations and information dissemination to industries are strongly recommended.
4	Enforcement of Industry-Specific effluent standards	Area specific/industry specific stringent effluent standards with a geographical focus on targeted industrial sector	✓ Industry Specific Effluent Standards, or Technology-based effluent standards that are attainable by adopting particular technology, for particular industry, sector or sub-sector, including, but not limited to: pollution prevention technique, process change and end-of-pipe treatment system. ✓Technology-based Standards may, in fact, result in meeting the water quality objectives; they are not specifically designed to ensure that the discharge from each facility meets the Water Quality Guidelines for that particular waterbody. ✓Appropriate prior consultations and information dissemination to industries are strongly recommended.
5	Market-based instruments, incentive mechanisms	Adopting differential licensing fee to relevant industrial sector in the High Priority Area, which may be combined with (1) taxes and subsidies and (2) transferable discharge permits to the dischargers based on pollution load assessment	✓This intervention has commonality with the 2nd instrument above to minimize pollution load in the specific parameter in High Priority Waterbody by avoiding excessive centralization of specific industry discharging relevant pollutants; ✓Polluting industries will be relocated away from the most polluted area, where pollution will be reduced at the expense of environmental quality elsewhere; ✓ Appropriate prior consultations and information dissemination service recommended.
			✓ WQ model enables estimation of assimilative capacity of the waterbody that is subsequently allocated over the various pollution sources within the waterbody. The predictive modelling procedures are further used to evaluate alternative pollution allocation schemes in the same waterbody. By optimizing alternative point and non-point source control strategies, the cost effectiveness and pollution reduction benefits of allocation trade-offs may be evaluated. The alternative point and non-point source

Classification	Water Quality Management Instruments	Description
		control strategies may include: sewerage investment, improvements in sanitary practices, effluent trading, implementation of good management practices and Integrated Pest management. Once allowable loadings have been developed, limits are incorporated into discharge permits. Planning process may need to integrate the permitting cycle, the Water Quality Guidelines revisions, and other required water quality management activities.
6 Development and Dissemination of Best management practices[5](BMP) in using fertilizers	BMP is a practice or combination of practices that are determined to be the most effective economically practical means of controlling point and non-point pollutant levels compatible with environmental quality goals. They include, but not limited to: Permanent vegetative cover, Animal waste management, Strip cropping s, Terracing, Diversion, Grazing land protection, Waterway, Cropland protection, Conservation tillage, Stream protection, Sediment retention and erosion and Tree planting systems.	✓ Best management practices (BMPs) are individual or combinations of management, cultural and structural practices. ✓ Agriculture best management practices can be grouped according to their functions. The US-EPA, 1993 guidelines identifies the following categories: ▷ Managing sedimentation. Measures to control the volume and flow rate of surface water runoff, keep the soil in place, and reduce soil erosion. ▷ Managing nutrients. Measures to help to keep the nutrients in the soil, minimizing their movement into water bodies. ▷ Managing pesticides. Measures to reduce non-point source contamination from pesticides, by helping limiting pesticide use and managing its application. ▷ Managing confined animal facility: Measures to reduce or limit the discharge from confined animal facilities. ▷ Managing livestock grazing. Measures to reduce impacts of grazing on water quality. ▷ Managing irrigation. Measures to help farmers to improve water use efficiency.
7 Promotion of Integrated Pest Management (IPM)	IPM is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties. Pesticides are used only after monitoring indicates they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism. Pest control materials are selected and applied in a manner that minimizes risks to human health, beneficial and non-target organisms, and the environment[6].	✓ The most effective, long-term way to manage pests is by using a combination of methods that work better together than separately. Approaches for managing pests are often grouped in the following categories. ▷ Biological control Biological control is the use of natural enemies—predators, parasites, pathogens, and competitors—to control pests and their damage. Invertebrates, plant pathogens, nematodes, weeds, and vertebrates have many natural enemies. ▷ Cultural controls Cultural controls are practices that reduce pest establishment, reproduction, dispersal, and survival. For example, changing irrigation practices can reduce pest problems, since too much water can increase root disease and weeds. ▷ Mechanical and physical controls Mechanical and physical controls kill a pest directly, block pests out, or make the environment unsuitable for it. Traps for rodents are examples of mechanical control. Physical controls include mulches for weed management, steam sterilization of the soil for disease management, or barriers such as screens to keep birds or insects out. ▷ Chemical control

5 R. Cestti, J. Srivastava and S. Jung, Agriculture Non-Point Source Pollution Control Good Management Practices Chesapeake Bay Experience, Environmentally & Socially Development Unit Europe and Central Asia The World Bank Washington, D.C. <http://lshs.tamu.edu/docs/lshs/end-notes/agricultural%20nps%20pollution%20control%20good%20management%20practices-2134197531/agricultural%20nps%20pollution%20control%20good%20management%20practices.pdf>[Accessed 20 February 2017].

6 Statewide IPM Program / Agriculture and Natural Resources, University of California, <http://www2.ipm.ucanr.edu/WhatIsIPM/> [Accessed 25 February 2017].

Classification	Water Quality Management Instruments	Description
		Chemical control is the use of pesticides. In IPM, pesticides are used only when needed and in combination with other approaches for more effective, long-term control. Pesticides are selected and applied in a way that minimizes their possible harm to people, non-target organisms, and the environment. With IPM you'll use the most selective pesticide that will do the job and be the safest for other organisms and for air, soil, and water quality; use pesticides in bait stations rather than sprays; or spot-spray a few weeds instead of an entire area.

3.4 Formulation of action plans for water quality management

General steps of formulating action plans for water quality management is presented in the table below.

Table 3.7 General Steps for Formulation of Action Plans

Major Steps		Description
1	Identify the Water Quality Problems	Assess water quality status of the target river to identify High Priority Waterbody and other problematic waterbody. Analyze the causes of the problem by using EPL database.
2	Prepare a list of Actions	Use brainstorming to compile a list of actions to achieve a goal and record those below the goal. Arrange this list of suggested actions in sequential order.
3	Coordinate with the relevant authorities	Depending the nature of the actions identified, some other government bodies may need to be coordinated.
4	Prepare a timeline	Prepare a realistic and feasible timeline considering the budget constraints to achieve the goal.
5	Assign tasks	Identify the responsible officers and units who carry out the specific tasks.
6	Estimate cost	Financial, physical and human resources must be allocated to each action step. If resources are limited, or fall short of requirements at any stage, it may be necessary to return to an earlier step and revise the action plan.
7	Develop strategies for monitoring progress	List ways in which progress of the action plan can be monitored. These monitoring activities will include the water quality status monitoring in High Priority Waterbody.

End of Document

Appendix-1 Field survey plan

Date : ______________________

Purpose:for selection of new monitoring points in river basin

Name of study plan: ______________________ Preparation date : ______________

Activity Period : From ________ to ________ Requiring Budget: ________ Rs

Authorization by : ______________________ Prepared by : ______________

Code #	Reason for survey	Method of survey	Period of Survey	Expected information/ Outcome	Responsible Divisions/ Person
FS-1		Observation: Interview:			
FS-2	Fix actual monitoring points, check the availability of monitoring	Observation of around the field	Day of 5th June	Fixed monitoring points	
FS-3					

Appendix-2 Monitoring plan

Date : ______________________

Purpose: To identify characteristics of target river basin in the seasonable change

Name of Monitoring Plan: ______________________ Preparation date : ______________

Monitoring Period : ______________________ Requiring Budget: ______________ Rs

Authorization by : ______________________ Prepared by : ______________

Sampling Location				Monitoring parameters	Monitoring month	Monitoring period	Handling of samples
ID	Name	GPS (N: E:)	Aspect				

Appendix-3 Comments and Answers form for stakeholder meeting

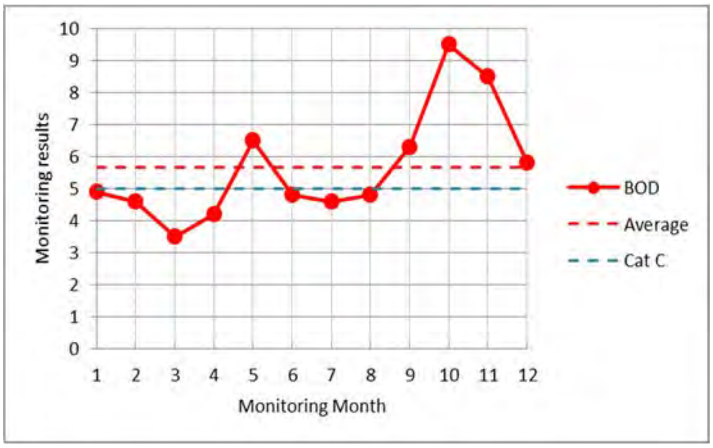
No.	Comment	Original / Corresponding sentence	Answer	Note
1				
2				
3				
4				
5				

Appendix-4　Two examples of evaluation of monitoring results

Case 1

Case1 is a situation where the waterbody is assigned with Category D and the target is 5 mg/Lfor BOD.

Month	1	2	3	4	5	6	7	8	9	10	11	12	Average
BOD_5	4.9	4.6	3.5	4.2	6.5	4.8	4.6	4.8	6.3	9.5	8.5	5.8	5.67



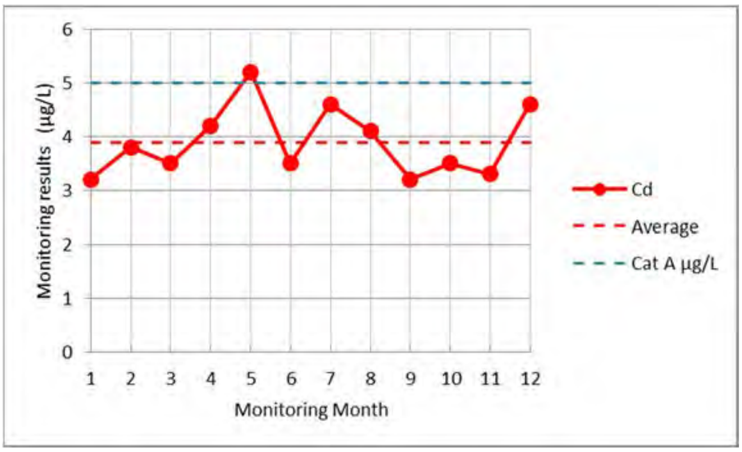
The monitoring result indicates 1) attainment of the water quality objective for 7 sampling occasions and 2) there were five incidences where the actual water quality exceeded the objectives. In such a case, however, it is judged as a High Priority Waterbody because the average value of　BODat5.67mg/L goes beyond 5mg/L.

Figure 3.2　Measuring data of BOD_5 and Evaluation

Case 2

Case 2 is a situation where the waterbody is assigned with Category A and the target is 5 µg/L for Cd.

Month	1	2	3	4	5	6	7	8	9	10	11	12	Average
Cd	3.2	3.8	3.5	4.2	5.2	3.5	4.6	4.1	3.2	3.5	3.3	4.6	3.89



The motioning result indicates that the actual water quality meets the objectives for the period of 11 months; and one incidence of exceedance was observed.
The waterbody is, nonetheless, judged as attaining the target because the average value at 3.89µg/L is lower than 5µg/L of value.

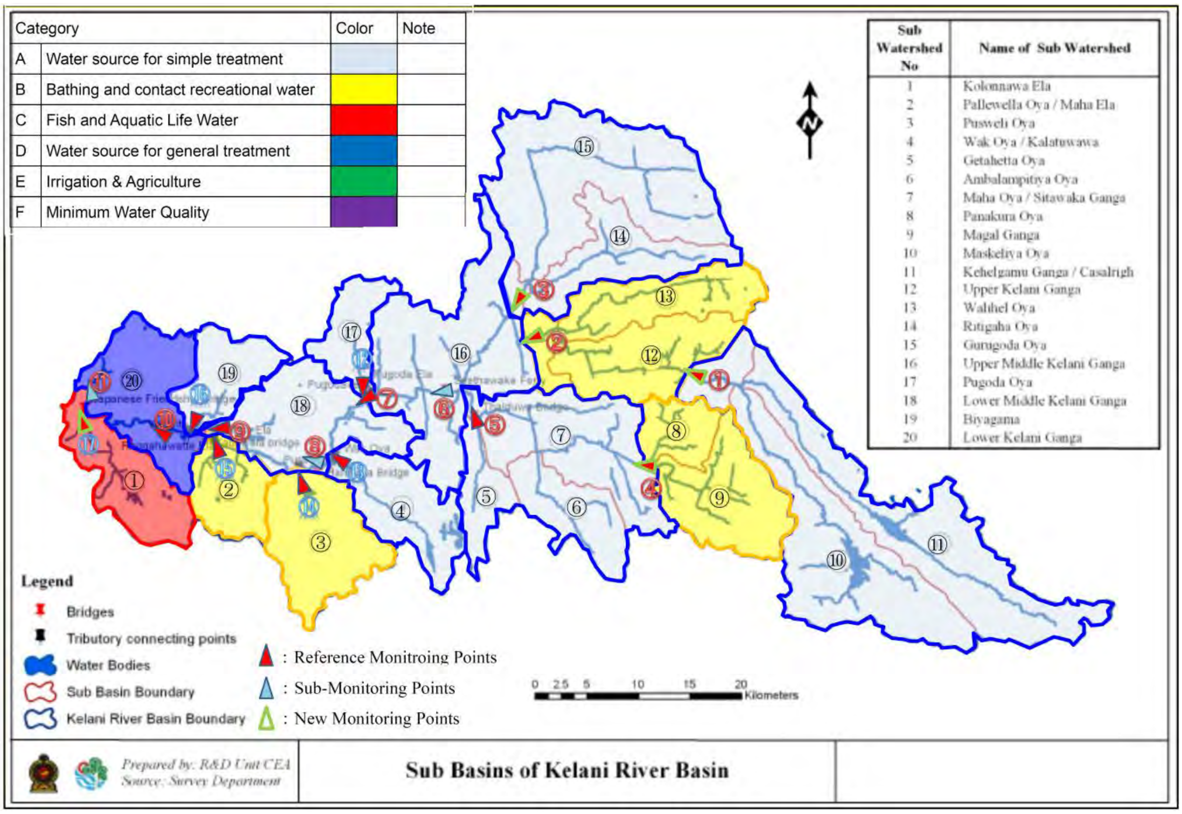
Figure 3.3　Measuring data of Cd and Evaluation

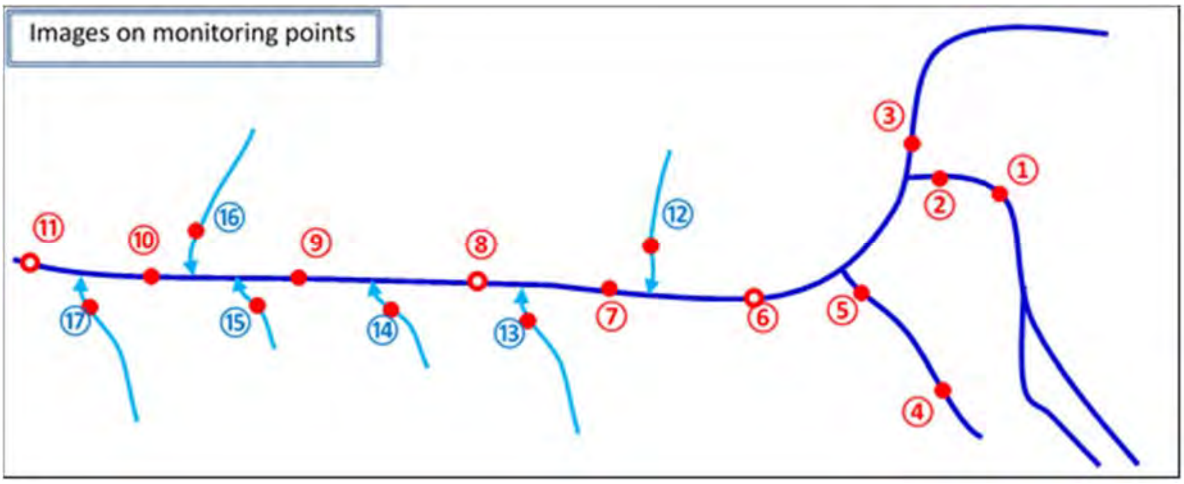
付属資料 10　水質観測データ

Reference monitoring points in the Kelani river basin

1 Category Map in the Kelani river basin

The Kelani river basin was separated to 20 sub-basin, and set up on 14 reference monitoring points and 3 sub-monitoring points. The map shown in below;





Black ① : Area code

Red ① : Monitoring points on main stream

Blue ① : Monitoring points on branch river

● : Reference Monitoring point

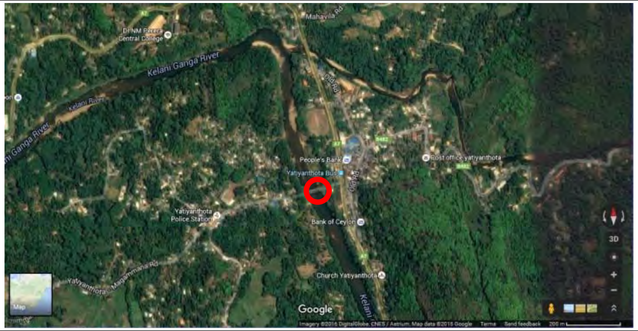
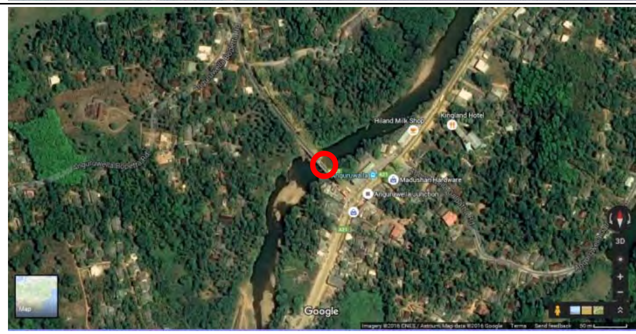
○ : Sub-monitoring points

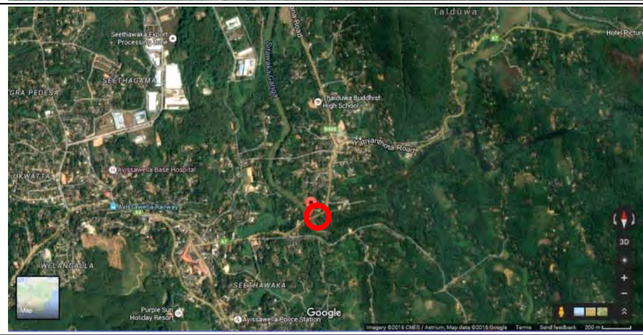
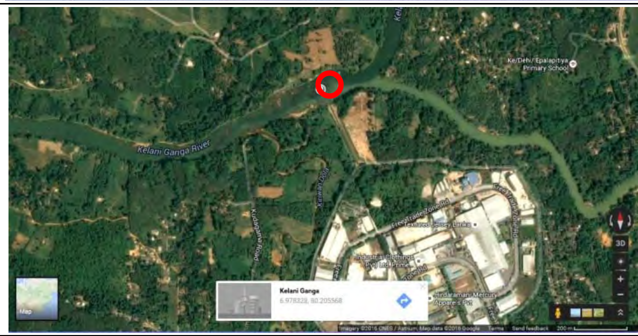
2 Monitoring points

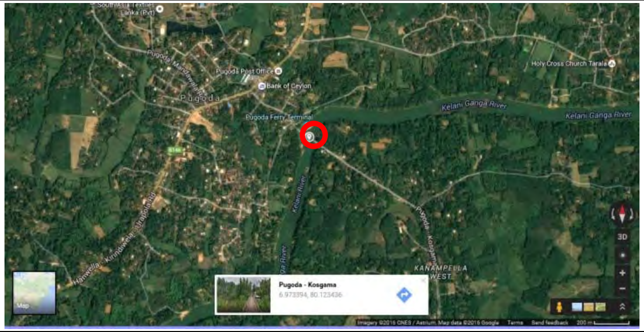
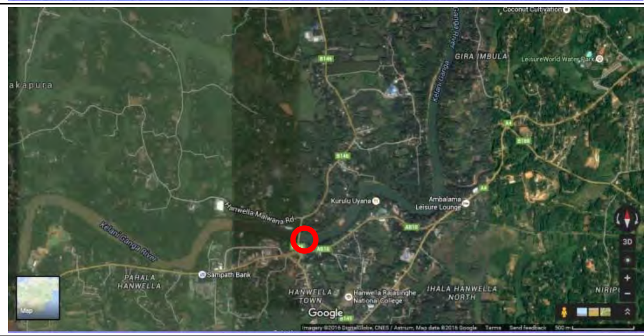
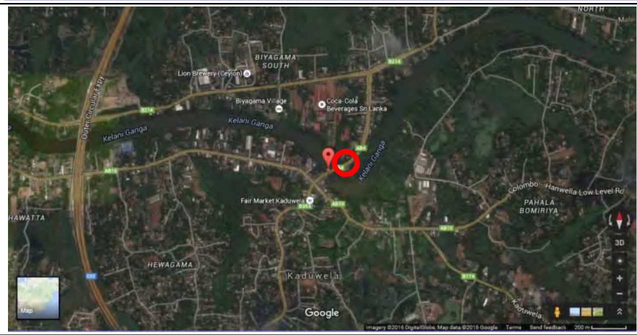
Monitoring points is shown below;

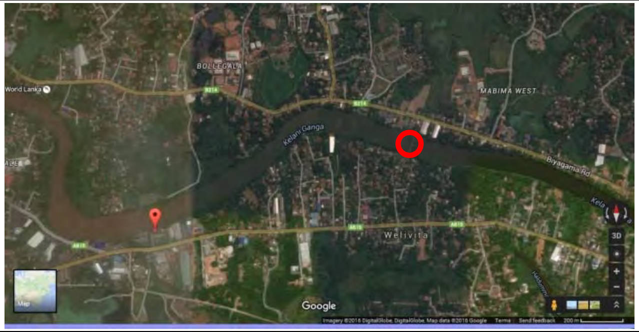
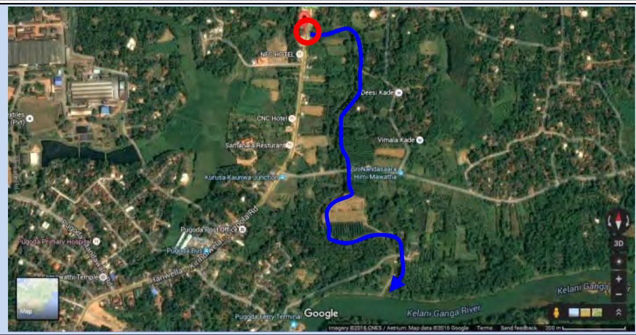
Area Code	Name of Sub-basin	Monitoring Point										
		Category	Point No.	Reference Monitoring Points	Laboratory CODE	Latitude	Longitude	Sub-Monitoring points	Laboratory CODE	Latitude	Longitude	Note*1
10	Maskeliya Oya	A	1	Parawalathanna Bridge		6°59'28.00"N	80°25'08.00"E	---	---	---	---	New
11	Kehelgamu Ganga / Casalrigh											
12	Upper Kelani Ganga	B	2	Karawanella Bridge		7°01'12.00"N	80°15'45.00"E	---	---	---	---	New
13	Walihel Oya											
14	Ritigaha Oya	A	3	Anguruwella Bridge (Gurugoda oya Bridge)		7°03'37.9"N	80°15'33.6"E	---	---	---	---	New
15	Gurugoda Oya											
8	Panakura Oya	B	4	Nakkavita Bridge		6°54'43.0"N	80°22'07.2"E	---	---	---	---	New
9	Magal Ganga											
5	Getahetta Oya	A	5	Thalduwa Bridge	O76005	6°57'14.00"N	80°13'12.00"E	---	---	---	---	
6	Ambalampitiya Oya											
7	Maha Oya / Sitawaka Ganga											
16	Upper Middle Kelani Ganga	A	6	---	---	---	---	Seethawaka ferry	O76006	6°58'37.00"N	80°11'39.00"E	
		A	7	Pugoda Ferry	O76009	6°58'24.00"N	80°07'24.00"E	---		---	---	
18	Lower Middle Kelani Ganga	A	8	---	---	---	---	Hanwella bridge	O76007	6°54'36.00"N	80°05'00.00"E	
		A	9	Kaduwela bridge	O76008	6°56'11.00"N	79°59'06.00"E	---	---	---	---	
20	Lower Kelani Ganga	D	10	Welibita bridge	O76003	6°56'18.00"N	79°56'50.00"E	---	---	---	---	
		D	11	---	---	---	---	Japan Friendship Bridge	O76002	6°57'37.00"N	79°52'40.00"E	
17	Pugoda Oya	A	12	Pugoda Ela	O76010	6°58'56.00"N	80°07'25.00"E	---	---	---	---	Branch river
4	Wak Oya / Kalatuwawa	A	13	Wak Oya	O76011	6°55'02.00"N	80°05'53.00"E	---	---	---	---	Branch river
3	Pusweli Oya	B	14	Pusseli Oya	O76012	6°54'26.00"N	80°03'57.00"E	---	---	---	---	Branch river
2	Pallewella Oya / Maha Ela	B	15	Maha Ela	O76013	6°56'00.00"N	79°59'32.00"E	---	---	---	---	Branch river
19	Biyagama	A	16	Raggahawatte Ela	O76001	6°56'21.00"N	79°58'09.00"E	---	---	---	---	Branch river
1	Kolonnawa Ela	C	17	Kolonnawa Ela		6°57'03.00"N	79°52'29.00"E	---	---	---	---	Branch river New
	Total											

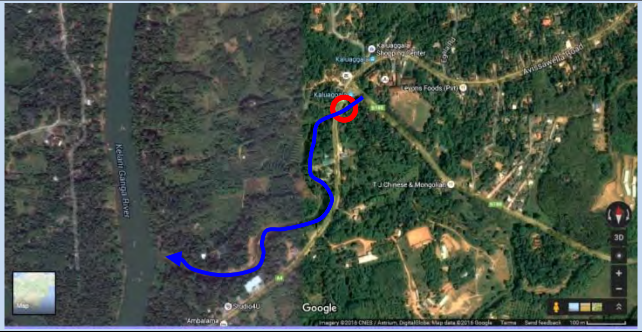
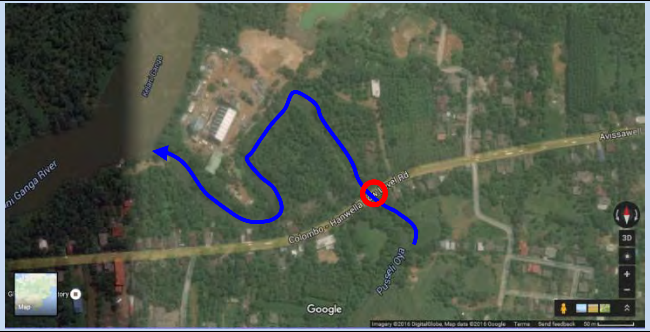
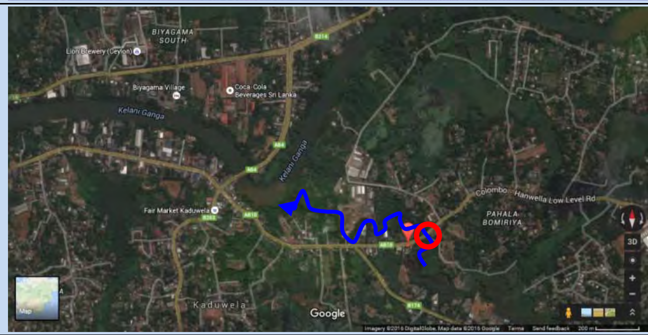
3 Detail information of monitoring points

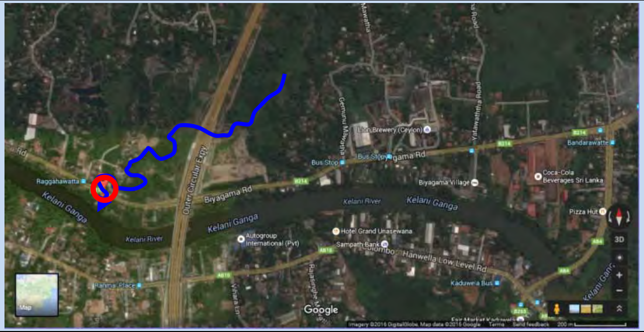
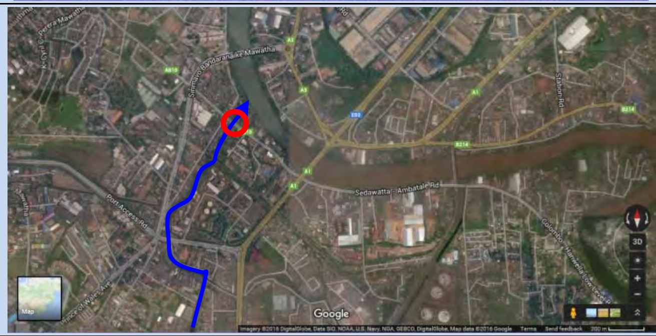
No.	Name of monitoring points/ (Reference or Sub) Laboratory Code/Main stream or Branch river	Category	GPS Latitude (E) Longitude (N)	Location map	Picture
1	Parawalathanna Bridge (Reference) no-code Main stream	A	6°59’28.00”N 80°25’08.00”E		
2	Karawanella Bridge (Reference) no-code Main stream	B	7°01’12.00”N 80°15’45.00”E		
3	Anguruwella Bridge (Gurugodaoya Bridge) (Reference) no-code Main stream	A	7°03’37.9”N 80°15’33.6”E		

No.	Name of monitoring points/ (Reference or Sub) Laboratory Code/Main stream or Branch river	Category	GPS Latitude (E) Longitude (N)	Location map	Picture
4	Nakkavita Bridge (Reference) no-code Main stream	B	6°54’43.0”N 80°22’07.2”E		
5	Thalduwa Bridge (Reference) O76005 Main stream	A	6°57'14.00"N 80°13'12.00"E		
6	Seethawaka ferry (Sub-monitoring points) O76006 Main stream	(A)	6°58'37.00"N 80°11'39.00"E		

No.	Name of monitoring points/ (Reference or Sub) Laboratory Code/Main stream or Branch river	Category	GPS Latitude (E) Longitude (N)	Location map	Picture
7	Pugoda Ferry (Reference) O76009 Main stream	A	6°58'24.00"N 80°07'24.00"E		
8	Hanwella bridge (Sub-monitoring points) O76007 Main stream	(A)	6°54'36.00"N 80°05'00.00"E		
9	Kaduwela bridge (Reference) O76008 Main stream	A	6°56'11.00"N 79°59'06.00"E		

No.	Name of monitoring points/ (Reference or Sub) Laboratory Code/Main stream or Branch river	Category	GPS Latitude (E) Longitude (N)	Location map	Picture
10	Welibita bridge (Reference) O76003 Main stream	D	6°56'18.00"N 79°56'50.00"E		
11	Japan Friendship Bridge (Sub-monitoring points) O76002 Main stream	D	6°57'37.00"N 79°52'40.00"E		
12	PugodaOya (Reference) O76010 Branch river	A	6°58'56.00"N 80°07'25.00"E		

No.	Name of monitoring points/ (Reference or Sub) Laboratory Code/Main stream or Branch river	Category	GPS Latitude (E) Longitude (N)	Location map	Picture
13	WakOya (Reference) O76011 Branch river	A	6°55'02.00"N 80°05'53.00"E		
14	PusweliOya (Reference) O76012 Branch river	B	6°54'26.00"N 80°03'57.00"E		
15	Maha Ela (Reference) O76013 Branch river	B	6°56'00.00"N 79°59'32.00"E		

No.	Name of monitoring points/ (Reference or Sub) Laboratory Code/Main stream or Branch river	Category	GPS Latitude (E) Longitude (N)	Location map	Picture
16	Raggahawatte Ela (Reference) O76001 Branch river	A	6°56'21.00"N 79°58'09.00"E		
17	Kolonnawa Ela (Reference) no-code Branch river	C	6°57'03.00"N 79°52'29.00"E		

Water Quality Monitoring in January 2016

ID	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	pH	EC	TURB	TEMP	DO	COD	BOD_5	Cl^-	As P, PO_4^{-3}	As N, NO_3^-	Total Coliform	Fecal Coliform	Cr	Pb	Cd	Fe	Mn	Zn	As
		mS/cm	NTU	^0C	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml	MPN/100ml	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l
1	7.2	0.05	33	23.4	13.2	6	2	3	0.02	0.62	5000	700	<0.01	<0.01	<0.01	0.47	0.03	0.01	<0.04
2	7.3	0.06	10	24.2	7.8	2	1	3	0.1	0.14	5000	800	<0.01	<0.01	<0.01	0.42	0.04	1.2	3.92
3	7	0.08	8	26.1	7.7	13	2	5	0.06	0.2	5000	900	<0.01	<0.01	<0.01	0.27	0.34	0.07	5.81
4	7.1	0.03	39	26.3	7.5	5	1	2	0.01	0.17	9000	230	<0.01	<0.01	<0.01	0.34	0.02	<0.01	<0.04
5	7.8	0.05	13	26.9	7	9	2	4	0.02	0.49	9000	500	< 0.01	< 0.01	< 0.01	0.36	0.04	<0.01	3.94
6	7	0.52	36	29.3	5.6	9	5	16	0.02	0.7	9000	2200	<0.01	<0.01	<0.01	0.56	0.02	<0.01	0.34
7	7.1	0.07	30	28.6	6.5	9	1	0.5	0.02	0.24	9000	2200	<0.01	<0.01	<0.01	0.1	0.02	<0.01	<0.04
8	7.3	0.07	28	28.1	6.6	6	1	0.5	0.09	0.39	2400	230	<0.01	<0.01	<0.01	0.05	0.03	0.1	1.63
9	7.7	0.11	36	28.7	6.1	6	1	3	0.01	<0.01	9000	1400	<0.01	<0.01	<0.01	0.03	0.02	<0.01	<0.04
10	8.2	0.12	12	28.3	6.2	6	1	3	0.26	0.39	1700	1300	<0.01	<0.01	<0.01	<0.01	0.03	0.01	<0.04
11	7.3	13.8	370	28.4	3.7	23	2	2617	0.14	0.03	≥16000	16000	0.03	<0.01	<0.01	<0.01	0.08	0.14	7.68
12	7.2	0.26	50	28.3	5.8	12	3	11	0.03	0.25	≥16000	800	<0.01	<0.01	<0.01	0.64	0.03	<0.01	0.3
13	7.3	0.06	123	28.3	4.3	15	1	2	0.02	0.72	16000	1100	<0.01	<0.01	<0.01	0.92	0.04	<0.01	<0.04
14	7.3	0.09	70	28.3	5.4	16	2	4	0.02	<0.01	9000	5000	<0.01	<0.01	<0.01	0.72	0.09	<0.01	1.54
15	7.5	0.25	169	28.3	3.6	22	1	15	0.01	0.07	16000	9000	<0.01	<0.01	<0.01	0.18	0.02	<0.01	5.58
16	7.7	0.63	79	27.9	4.5	28	8	35	0.09	2.19	≥16000	16000	<0.01	<0.01	<0.01	0.09	0.02	0.01	<0.04
17	7.2	3.86	51	28.6	0.9	55	3	709	0.25	0.01	≥16000	9000	<0.01	<0.01	<0.01	0.04	0.03	0.11	4.13

Water Quality Monitoring in February 2016

ID	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	pH	EC	TURB	TEMP	DO	COD	BOD_5	Cl^-	As P, PO_4^{-3}	As N, NO_3^-	Total Coliform	Fecal Coliform	Cr	Pb	Cd	Fe	Mn	Zn	As
		mS/cm	NTU	^0C	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml	MPN/100ml	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l
1	7.1	0.05	13	25.6	6.4	1	<1	1	<0.01	< 0.01	5000	1700	< 0.01	< 0.01	< 0.01	<0.01	<0.01	< 0.01	< 0.04
2	7.1	0.05	13	25.2	8.5	5	1	1	<0.01	< 0.01	9000	2800	< 0.01	< 0.01	< 0.01	<0.01	0.01	< 0.01	3.01
3	6.9	0.08	14	29.5	6.7	1	<1	2	<0.01	< 0.01	9000	1700	< 0.01	< 0.01	< 0.01	<0.01	0.01	< 0.01	5.74
4	7.3	0.03	5	29.4	6.5	1	< 1	1	<0.01	< 0.01	5000	2400	< 0.01	< 0.01	< 0.01	<0.01	<0.01	<0.01	< 0.04
5	7.8	0.06	22	29.9	7.9	4	2	2	<0.01	< 0.01	5000	2200	< 0.01	< 0.01	< 0.01	<0.01	0.02	< 0.01	3.89
6	7.6	0.47	39	28.8	6.5	9	<1	16	0.01	0.86	5000	1300	<0.01	<0.01	<0.01	0.57	<0.01	<0.01	0.35
7	7.7	0.08	22	27.6	7.2	6	2	6	<0.01	0.48	9000	3000	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.04
8	7.9	0.07	16	27.2	6.8	1	<1	4	0.01	0.31	9000	3000	<0.01	<0.01	<0.01	0.43	0.01	0.02	1.61
9	7.9	0.1	216	27.4	6.8	8	2	3	0.01	0.48	16000	3000	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.04
10	8.3	0.21	9	27.6	7.4	1	<1	15	<0.01	0.51	16000	5000	<0.01	0.01	<0.01	<0.01	0.02	<0.01	<0.04
11	7.6	11.5	8	27.9	6.4	15	2	2217	0.02	0.55	≥16000	9000	<0.01	0.05	<0.01	<0.01	0.04	0.04	7.82
12	7.6	0.73	110	29	4.7	16	4	28	0.04	0.77	9000	2400	<0.01	<0.01	<0.01	0.09	<0.01	<0.01	0.29
13	7.6	0.05	27	27.6	6.7	2	2	5	0.12	0.74	9000	1300	<0.01	<0.01	<0.01	2.14	0.04	<0.01	<0.04
14	7.9	0.07	47	28.7	6.2	3	2	7	0.02	0.45	16000	2400	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	1.53
15	7.7	0.16	31	28.7	3.2	2	1	13	0.01	0.26	9000	5000	<0.01	<0.01	<0.01	0.03	0.04	<0.01	5.31
16	7.8	1.32	70	29.5	2.9	18	7	114	0.09	3.95	16000	3000	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.04
17	7.2	3.41	341	28.2	0.8	45	36	640	0.31	0.99	≥16000	16000	<0.01	0.02	<0.01	<0.01	0.04	0.01	3.21

Water Quality Monitoring in March 2016

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
ID	pH	EC	TURB	TEMP	DO	COD	BOD_5	Cl^-	As P, PO_4^{-3}	As N, NO^-_3	Total Coliform	Fecal Coliform	Cr	Pb	Cd	Fe	Mn	Zn	As
		mS/cm	NTU	^0C	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml	MPN/100ml	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l
1	6.8	0.03	8	31.6	6.1	7	1	13	< 0.01	0.26	5000	800	< 0.01	< 0.01	< 0.01	0.08	<0.01	0.01	< 0.04
2	6.9	0.04	15	26.8	6.9	4	2	6	< 0.01	0.17	5000	1300	< 0.01	< 0.01	< 0.01	0.11	< 0.01	0.01	5.1
3	6.8	0.06	19	31	5.3	3	1	8	< 0.01	0.02	9000	2400	< 0.01	< 0.01	< 0.01	0.06	< 0.01	0.08	0.04
4	6.9	0.04	78	26.4	7.6	3	1	3	< 0.01	0.17	3000	1300	< 0.01	< 0.01	< 0.01	0.16	<0.01	0.02	< 0.04
5	7.1	0.04	23	30.6	6.1	6	2	4	< 0.01	0.03	9000	1700	< 0.01	< 0.01	< 0.01	0.2	<0.01	< 0.02	3.92
6	7.2	0.4	15	31.2	6.6	12	2	12	0.05	0.35	2800	330	<0.01	<0.01	<0.01	<0.01	<0.01	0.08	0.34
7	7.2	0.06	10	30.2	7.2	9	2	1	<0.01	0.74	800	500	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.04
8	7.2	0.06	15	29.4	6.3	15	1	1	<0.01	0.6	800	500	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	1.63
9	7.7	0.08	12	30.2	6.4	9	2	1	<0.01	0.58	5000	330	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.04
10	7.8	0.2	10	29.6	5.4	10	1	9	ND	0.41	700	500	<0.01	<0.01	<0.01	<0.01	<0.01	0.04	<0.04
11	7.4	6.75	16	30.1	5.5	88	1	1932	0.03	<0.01	≥16000	9000	<0.01	<0.01	<0.01	<0.01	<0.01	0.1	4.51
12	7.3	0.36	54	29.3	5	21	2	17	0.06	0.48	5000	330	<0.01	<0.01	<0.01	0.3	<0.01	<0.01	0.3
13	7	0.05	15	30.2	6.3	13	2	2	0.51	0.54	5000	500	<0.01	<0.01	<0.01	0.31	0.03	0.68	<0.04
14	7.4	0.07	56	29	6.1	35	2	4	0.01	0.49	16000	2800	<0.01	<0.01	<0.01	0.32	<0.01	<0.01	1.54
15	7.3	0.2	72	30.1	3.6	19	5	18	0.02	0.24	9000	1700	<0.01	<0.01	<0.01	0.03	<0.01	<0.01	5.58
16	7.5	1.09	65	30.4	2.5	26	6	73	0.06	4.25	16000	9000	<0.01	<0.01	<0.01	<0.01	<0.01	0.04	<0.04
17	7.3	6.64	10	29.8	4.6	88	2	753	0.04	0.28	≥16000	16000	<0.01	<0.01	<0.01	<0.01	<0.01	0.53	4.14

Water Quality Monitoring in April 2016

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
ID	pH	EC	TURB	TEMP	DO	COD	BOD_5	Cl^-	As P, PO_4^{-3}	As N, NO^-_3	Total Coliform	Fecal Coliform	Cr	Pb	Cd	Fe	Mn	Zn	As
		mS/cm	NTU	^0C	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml	MPN/100ml	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l
1	6.5	0.05	8	27.1	7.3	9	2	3	< 0.01	0.04	9000	3000	< 0.01	< 0.01	< 0.01	<0.01	<0.01	< 0.01	< 0.01
2	6.8	0.05	20	28.1	7.2	5	1	3	< 0.01	0.17	9000	2200	< 0.01	< 0.01	< 0.01	<0.01	<0.01	< 0.01	0.34
3	6.6	0.06	18	30.2	6.5	4	1	4	< 0.01	0.09	5000	2400	< 0.01	< 0.01	< 0.01	<0.01	<0.01	< 0.01	<0.04
4	6.9	0.03	12	28.4	7.1	3	1	2	< 0.01	0.56	3000	1700	< 0.01	< 0.01	< 0.01	<0.01	<0.01	< 0.01	< 0.01
5	7.3	0.04	21	29	6.8	5	1	3	< 0.01	0.45	9000	1700	< 0.01	< 0.01	< 0.01	0.01	0.2	0.13	0.51
6	7.4	1.02	57	31.2	4.5	4	1	39	0.03	0.58	-	-	<0.01	<0.01	<0.01	0.09	0.03	0.01	0.29
7	8.1	0.09	43	29.4	7.2	3	1	4	0.01	0.28	-	-	<0.01	<0.01	<0.01	0.07	0.03	<0.01	<0.04
8	7.6	0.05	98	29.2	6.6	4	<1	3	0.01	0.28	-	-	<0.01	<0.01	<0.01	0.1	0.03	<0.01	1.62
9	8.3	0.13	16	29.6	6.2	8	1	3	0.01	0.38	-	-	<0.01	<0.01	<0.01	0.06	0.03	<0.01	<0.04
10	8	.0.13	13	29.7	6.6	11	1	6	0.01	0.42	-	-	<0.01	<0.01	<0.01	0.04	0.04	<0.01	<0.04
11	7.6	3.29	17	29.4	6.1	20	1	871	0.02	0.58	-	-	<0.01	<0.01	<0.01	0.08	0.05	0.03	5.03
12	7.7	1.91	124	31	3.1	23	5	72	0.12	0.4	-	-	<0.01	<0.01	<0.01	0.12	0.16	<0.01	0.34
13	7.6	0.06	33	29.5	6.4	3	1	4	0.01	0.31	-	-	<0.01	<0.01	<0.01	0.27	0.02	0.01	<0.04
14	7.7	0.07	61	29.6	6.1	3	<1	7	0.01	0.25	-	-	<0.01	<0.01	<0.01	0.14	0.03	<0.01	1.54
15	7.7	0.19	25	29.8	6.2	30	10	17	0.02	0.18	-	-	<0.01	<0.01	<0.01	0.21	0.03	<0.01	5.45
16	7.8	2.46	33	31.2	3.4	35	9	172	0.12	0.56	-	-	<0.01	<0.01	<0.01	0.08	0.05	0.08	<0.04
17	7.7	1.42	70	30.3	0.3	59	18	172	0.58	0.62	-	-	<0.01	<0.01	<0.01	0.22	0.09	0.01	3.45

Water Quality Monitoring in May 2016

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
ID	pH	EC	TURB	TEMP	DO	COD	BOD_5	Cl^-	As P, PO_4^{-3}	As N, NO^-_3	Total Coliform	Fecal Coliform	Cr	Pb	Cd	Fe	Mn	Zn	As
		mS/cm	NTU	^0C	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml	MPN/100ml	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l
1																			
2																			
3																			
4																			
5																			
6	6.9	0.34	79	29.4	5.5	12	2	15	<0.01	0.81	-	-	<0.01	<0.01	<0.01	0.22	<0.01	<0.01	0.36
7	7	0.04	99	28.2	6.8	9	3	5	0.01	0.46	-	-	<0.01	<0.01	<0.01	0.11	<0.01	<0.01	<0.04
8	7	0.04	61	28.3	7.7	5	4	7	0.05	0.51	-	-	<0.01	<0.01	<0.01	0.05	<0.01	<0.01	1.63
9	7.1	0.04	32	28.5	5.5	10	2	7	0.01	0.59	-	-	<0.01	<0.01	<0.01	0.28	<0.01	<0.01	5.58
10	6.9	0.05	28	28.4	6.7	8	3	8	0.02	0.5	-	-	<0.01	<0.01	<0.01	0.36	<0.01	<0.01	<0.04
11	7.1	0.07	46	28.4	6.4	6	3	9	0.01	0.63	-	-	<0.01	<0.01	<0.01	0.34	<0.01	<0.01	<0.04
12	7	0.18	38	29.5	5.6	17	3	16	0.01	0.28	-	-	<0.01	<0.01	<0.01	0.86	<0.01	0.07	0.3
13	7.2	0.04	25	29.8	6.8	13	3	7	0.01	0.43	-	-	<0.01	<0.01	<0.01	0.47	<0.01	<0.01	<0.04
14	6.8	0.05	35	29.3	6.7	13	3	8	0.07	0.25	-	-	<0.01	<0.01	<0.01	0.76	<0.01	<0.01	1.54
15	6.6	0.1	22	29.7	3.9	12	11	13	0.01	0.17	-	-	<0.01	<0.01	<0.01	1.02	<0.01	0.01	<0.04
16	6.7	0.21	30	29.3	3	15	9	19	0.04	1.24	-	-	<0.01	<0.01	<0.01	0.85	<0.01	0.01	<0.04
17	6.5	0.56	60	29.1	3.9	40	10	52	0.19	0.29	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	4.13

Water Quality Monitoring in June 2016

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
ID	pH	EC	TURB	TEMP	DO	COD	BOD_5	Cl^-	As P, PO_4^{-3}	As N, NO^-_3	Total Coliform	Fecal Coliform	Cr	Pb	Cd	Fe	Mn	Zn	As
		mS/cm	NTU	^0C	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml	MPN/100ml	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l
1	6.8	0.04	32	24.1	6.8	10	2	1	0.63	< 0.01	1100	270							
2	6.8	0.03	59	24.8	6.8	8	1	1	0.68	< 0.01	1700	800							
3	6.9	0.05	19	27.4	6.9	5	1	2	0.62	< 0.01	2200	1300							
4	6.6	0.03	6	26.2	6.6	7	1	1	0.64	< 0.01	1400	330							
5	6.9	0.03	29	27.4	6.9	7	1	2	0.4	0.01	5000	1300							
6	7	0.13	230	27.9	7.2	3	2	4	0.03	0.85	-	-	<0.01	<0.01	<0.01	0.5	0.01	<0.01	<0.04
7	7	0.03	125	27.3	7.4	4	1	7	0.03	0.4	-	-	<0.01	<0.01	<0.01	0.38	<0.01	0.01	<0.04
8	7.1	0.03	83	26.9	7.4	3	1	2	0.01	0.52	-	-	<0.01	<0.01	<0.01	0.43	<0.01	<0.01	1.74
9	7.4	0.04	39	27.5	7.1	9	1	73	0.01	0.39	-	-	<0.01	<0.01	<0.01	0.5	0.02	0.01	5.62
10	7.3	0.04	26	27.4	6.9	2	1	14	0.01	0.35	-	-	0.03	<0.01	<0.01	0.61	0.02	<0.01	<0.04
11	7.6	0.07	23	27.4	6.7	6	2	11	0.02	0.41	-	-	0.04	<0.01	<0.01	0.57	0.03	0.01	7.72
12	6.9	0.11	104	29	6	8	1	3	0.03	0.59	-	-	<0.01	<0.01	<0.01	1.3	0.02	<0.01	0.32
13	6.9	0.03	198	28.5	3.8	1	<1	4	<0.01	0.23	-	-	<0.01	<0.01	<0.01	0.58	0.01	<0.01	<0.04
14	7.1	0.05	39	28.7	5.3	9	1	6	0.07	0.18	-	-	<0.01	<0.01	<0.01	1.23	<0.01	0.01	1.57
15	6.9	0.11	37	29.5	2.3	16	10	6	0.01	0.12	-	-	<0.01	<0.01	<0.01	0.91	0.01	0.01	<0.04
16	7.2	0.14	19	28.7	3.5	8	5	4	0.08	1.07	-	-	0.02	<0.01	<0.01	1.23	0.02	0.01	<0.04
17	7.1	0.05	50	27.8	0.3	70	17	4	0.12	0.35	-	-	0.03	<0.01	<0.01	0.87	0.26	0.07	6.51

Water Quality Monitoring in July 2016

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
ID	pH	EC	TURB	TEMP	DO	COD	BOD$_5$	Cl$^-$	As P, PO$_4^{-3}$	As N, NO$_3^-$	Total Coliform	Fecal Coliform	Cr	Pb	Cd	Fe	Mn	Zn	As
		mS/cm	NTU	^{0}C	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml	MPN/100ml	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	μg/l
1																			
2																			
3																			
4																			
5																			
6	7.6	0.62	54	28.8	5.5	15	5	26	0.78	0.43	5000	1100	-						
7	7.8	0.04	24	26.5	7.2	10	3	1	< 0.01	0.07	9000	1700	-						
8	7.7	0.04	27	26.1	6	20	1	12	0.03	0.1	9000	1700	-						
9	8.2	0.06	21	26.6	7	13	2	8	< 0.01	0.35	9000	2400	-	-					
10	8.4	0.07	17	26.5	6.9	16	2	4	0.05	0.31	16,000	9000	-						
11	8.1	1.44	16	27.1	6.1	20	2	298	0.02	0.51	≥16,000	5000	-	-					
12	7.8	0.04	70	27.3	5.2	15	2	1	< 0 .01	0.09	5000	2200	-						
13	7.7	0.05	31	27.8	7	9	3	2	0.06	0.18	5000	2200	-	-					
14	7.7	0.07	41	27.6	5.6	16	1	7	0.04	0.31	5000	2200		-					
15	7.6	0.14	65	28.4	4	21	1	14	0.02	0.4	9000	2400	-	-					
16	7.9	0.72	95	28.2	3.9	32	4	42	0.13	3.92	9000	3000	-	-					
17	7.9	0.68	119	28.3	1.1	55	12	70	0.19	0.24	16,000	5000	-	-					

Water Quality Monitoring in August 2016

	1	2	3	4	5	6	7	8	9	10	11	12	20	21	22	23	24	25	26
ID	pH	EC	TURB	TEMP	DO	COD	BOD$_5$	Cl$^-$	As P, PO$_4^{-3}$	As N, NO$_3^-$	Total Coliform	Fecal Coliform	TSS	Oil & Grease	Total Hardnees	Colour			NH$_3$
		mS/cm	NTU	^{0}C	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml	MPN/100ml	mg/l	mg/l	mg/l	@436 nm	@525nm	@625nm	mg/l
1																			
2																			
3																			
4																			
5																			
6	7.7	0.38	**19**	29.8	**5**	4	1	20	0.01	0.16	**5000**	**1700**	7	ND	44	1	< 0.1	<0.1	1.23
7	8	0.08	**45**	28.7	9	5	2	3	< 0.01	< 0.01	**3000**	**1700**	5	ND	24	1.7	< 0.1	< 0.1	0.52
8	7.9	0.06	**43**	28.9	8.1	9	3	3	0.01	0.05	**9000**	**3000**	2	ND	16	0.4	< 0.1	< 0.1	0.13
9	**8.7**	0.09	**89**	28.7	7.2	3	1	2	0.01	0.16	**5000**	**2400**	2	ND	48	0.4	< 0.1	< 0.1	0.32
10	**8.7**	0.17	**19**	28.8	7	**3**	1	4	0.02	0.28	**9000**	**3000**	3	ND	85	0.3	0.9	0.8	<0.01
11	7.9	5.34	**12**	28.9	6.8	**16**	1	**1340**	<0.01	0.16	**≥16,000**	**5000**	45	ND	**525**	0.3	1	0.9	5
12	7.8	2.04	**72**	30.7	**2.5**	**42**	2	48	0.06	0.62	**5000**	**2200**	32	ND	56	0.6	< 0.1	< 0.1	3.12
13	7.9	0.05	**19**	30	**5.4**	1	<1	3	0.01	0.2	**3000**	**1100**	4	ND	20	1.2	< 0.1	< 0.1	0.91
14	7.9	0.07	**60**	29.9	**5.6**	10	1	6	0.01	0.43	**16,000**	**5000**	6	ND	32	1.7	< 0.1	< 0.1	2.81
15	8.1	0.15	**72**	30	**3.1**	14	1	17	0.03	0.34	**9000**	**3000**	16	ND	24	2.3	< 0.1	< 0.1	3.42
16	8.1	1.78	**57**	30.2	**4.3**	**37**	**3**	48	0.16	5.08	**9000**	**2400**	24	ND	186	2.4	< 0.1	< 0.1	6.85
17	7.6	3.4	**36**	28.8	**1.9**	**29**	**3**	**718**	0.1	0.18	**≥16,000**	**5000**	43	ND	345	1.3	0.6	0.7	8.11

Water Quality Monitoring in September 2016

	1	2	3	4	5	6	7	8	9	10	11	12	20	21	22	23	24	25	26
ID	pH	EC	TURB	TEMP	DO	COD	BOD_5	Cl^-	As P, PO_4^{-3}	As N, NO^-_3	Total Coliform	Fecal Coliform	TSS	Oil & Grease	Total Hardnees	Colour			NH_3
		mS/cm	NTU	^0C	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml	MPN/100ml	mg/l	mg/l	mg/l	@436 nm	@525nm	@625nm	mg/l
1	7.3	0.04	9	24.4	8.6	2	1	1	<0.01	0.42	5000	330	3	<1	20	4.5	<0.1	<0.1	0.36
2	7.6	0.04	6	25	7.4	12	2	1	<0.01	0.36	5000	1700	8	<1	8	5.3	<0.1	<0.1	<0.01
3	7.6	0.05	16	28.4	8.2	3	2	3	<0.01	0.24	5000	2200	5	<1	16	4.9	<0.1	<0.1	0.03
4	7.1	0.02	17	27.4	8.6	1	<1	1	<0.01	0.54	3000	1100	9	<1	4	4.5	<0.1	<0.1	0.06
5	7.8	0.03	14	27.9	6.4	2	1	<1	<0.01	0.34	5000	1100	9	<1	8	5.6	<0.1	<0.1	0.08
6	8.5	1.16	29	28.8	4.7	9	2	51	0.06	0.41	5000	1300	13	< 1	16	1.1	<0.1	<0.1	6.08
7	8.7	0.08	16	27.7	9	37	5	9	0.01	0.56	9000	3000	8	<1	80	0.5	<0.1	<0.1	0.08
8	8.2	0.05	8	27.6	6.5	7	3	5	0.07	0.5	5000	2400	8	<1	16	0.5	<0.1	<0.1	<0.1
9	8.7	0.09	13	28.1	7.2	36	4	7	<0.01	0.54	9000	5000	7	<1	24	0.4	< 0.1	<0.1	0.48
10	8.7	0.18	12	28.1	6.7	12	4	11	0.02	0.66	9000	5000	11	<1	32	0.5	<0.1	< 0.1	0.05
11	7.8	11.4	9	28.4	6.3	5	4	3058	0.01	0.25	16,000	5000	26	<1	996	<0.4	<0.1	<0.1	1.53
12	8.9	2.73	51	30.6	2.5	1	<1	169	0.1	0.89	5000	1300	13	ND	16	2.8	0.5	0.3	20
13	8.1	0.04	8	28.1	8.2	4	3	10	0.01	0.48	5000	1700	10	ND	10	1.1	<0.1	<0.1	<0.01
14	8.2	0.06	31	28.5	6.1	14	4	9	0.01	0.33	9000	3000	6	ND	28	1.6	<0.1	<0.1	<0.01
15	8.5	0.44	47	28.8	7.3	12	5	39	0.02	0.71	16,000	2400	14	ND	40	4.1	0.8	0.2	0.16
16	8.5	2.34	27	29.2	1.6	19	11	147	0.14	4.34	16,000	3000	31	ND	204	4.1	0.9	0.2	19.34
17	7.5	9.4	17	28.5	6.8	5	3	2593	0.03	0.37	9000	3000	18	1	808	1.2	< 0.1	<0.1	6.37

Water Quality Monitoring in October 2016

	1	2	3	4	5	6	7	8	9	10	11	12	20	21	22	23	24	25	26
ID	pH	EC	TURB	TEMP	DO	COD	BOD_5	Cl^-	As P, PO_4^{-3}	As N, NO^-_3	Total Coliform	Fecal Coliform	TSS^-	Oil & Grease	Total Hardnees	Colour			NH_3
		mS/cm	NTU	^0C	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml	MPN/100ml	mg/l	mg/l	mg/l	@436 nm	@525nm	@625nm	mg/l
1																			
2	6.7	0.04	7	25.7	8.8	2	1	5	0.06	0.26	1700	800	1	<1	8	8.8	<0.1	<0.1	0.03
3																			
4	7.1	0.03	8	25.5	8.2	10	3	4	0.14	0.41	2200	300	2	<1	8	2.3	0.5	0.6	1.27
5																			
6	7.9	0.37	25	29.7	5.4	10	2	27	0.04	0.81	2400	800	13	1	60	5.2	2	1.3	4.23
7	8	0.06	45	28.7	7.1	32	2	28	0.01	0.53	3000	1300	8	ND	16	2	0.1	<0.1	1.95
8	7.8	0.05	41	28.7	6.4	6	1	3	< 0.01	0.68	5000	230	8	ND	20	1.5	0.4	0.4	0.16
9	8.1	0.08	81	27.7	6.2	9	3	61	0.01	0.6	16,000	9000	7	ND	20	1.9	0.1	0.1	0.16
10	8.6	0.16	20	28.8	6.1	8	1	15	0.05	2.89	9000	3000	11	1	24	1.5	0.2	0.3	0.13
11																			
12	7.9	1.02	71	30.1	4.8	21	1	16	0.04	1.48	3000	1700	13	ND	28	6.7	3.2	2.3	1.66
13																			
14	7.8	0.05	58	28.9	5.1	10	2	13	0.01	0.95	9000	3000	6	ND	24	3.4	0.7	0.3	0.39
15	8.2	0.16	61	30.1	4.4	21	6	14	0.02	0.67	3000	2400	14	1	40	4.6	1.6	1	0.89
16	8	1.76	52	30.1	3	29	8	64	0.04	2.88	9000	5000	31	1	104	3.7	1.1	0.7	6.92
17	7.5	2.12	33	28.7	4.9	15	3	469	0.01	0.78	≥ 16,000	16,000	18	ND	184	1.9	<0.1	0.1	0.46

Water Quality Monitoring in Novermber 2016

	1	2	3	4	5	6	7	8	9	10	11	20	21	22	23	24	25	26
ID	pH	EC	TURB	TEMP	DO	COD	BOD_5	Cl^-	As P, PO_4^{-3}	As N, NO^-_3	Total Coliform	TSS^-	Oil & Grease	Total Hardnees	Colour			NH_3
		mS/cm	NTU	^0C	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml	mg/l	mg/l	mg/l	@436 nm	@525nm	@625nm	mg/l
1																		
2	6.8	0.03	47	24.9	8.1	4	1	<0.01	0.29	9000	1700	3	3	19	5.3	<0.1	<0.1	<0.01
3																		
4	7.2	0.02	12	25.4	6	4	<1	<0.01	0.37	3000	1100	2	2	27	4.5	<0.1	<0.1	<0.01
5																		
6	7.5	0.29	9	27.6	5.6	7	3	0.01	2.83	3000	500	16	ND	16	2	0.3	0.3	2.01
7																		
8	7.8	0.16	12	27.1	5.1	11	1	0.01	1.22	9000	1700	15	ND	15	5.3	2.5	1.9	0.69
9	8.4	0.06	8	26.6	6.9	8	4	0.04	1.15	9000	1100	18	ND	18	3.9	1.6	1.2	0.43
10	7.3	0.04	13	27.1	6.5	9	4	0.02	0.64	16000	2200	11	ND	11	3.7	1.4	1.1	0.45
11																		
12	7.2	0.1	24	27.1	6	17	2	0.03	0.84	5000	900	9	ND	9	9.7	4.7	3.2	1.51
13	7.4	0.04	8	27.2	6.5	10	3	0.01	1.53	5000	800	8	ND	8	3.2	0.9	0.7	0.39
14	8	0.05	10	26.6	4.5	14	2	0.05	1.3	5000	1300	10	ND	10	6.6	3.2	2.3	0.74
15	8.1	0.46	10	27.3	5	8	9	0.02	0.43	9000	1400	8	ND	8	4	1.3	0.9	0.5
16	7.3	0.04	18	26.3	3.2	15	11	0.03	<0.01	9000	800	12	ND	12	6	2.8	1.9	1.94
17	7.3	0.06	7	27.2	1.4	23	13	0.07	1.38	16,000	2,400	16	2	16	3	0.9	0.7	15.66

Water Quality Monitoring in December -2016

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
ID	pH	EC	TURB	TEMP	DO	COD	BOD_5	Cl^-	As P, PO_4^{-3}	As N, NO^-_3	Total Coliform	Fecal Coliform	Cr	Pb	Cd	Fe	Mn	Zn	As	TSS^-
		mS/cm	NTU	^0C	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml	MPN/100ml	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	mg/l
1																				
2	7.4	0.03	8	25.5	8	3	1	1	4	<1	32					0.06	0.41	<0.01	2400	800
3																				
4	7.3	0.02	6	27.2	8	5	2	1	2	<1	48					<0.01	0.46	0.01	5000	1400
5	7.4	0.03	8	27.4	7.6	3	<1	2	1	<1	28					0.01	0.5	<0.01	3000	1100
6																				
7																				
8																				
9																				
10																				
11																				
12																				
13																				
14																				
15																				
16																				
17																				

付属資料 11　環境基準設定のための基本方策

Table 1 Fundamental Approach in Determining the Standards

Category	Approach
Category A: Water source for partial treatment	The values recommended by the Environmental Quality Standards 1992[1)] were reviewed and assessed as against those prescribed by the Sri Lanka's Raw Water Standard (SLS 722[2)]) and its comparable EU's Raw Water Quality Standards (Category A1[3)] of EU Directive 75/440/EEC[4)]). The first principle of determining the guidelines was to adopt the values provided that they comply either with the mandatory value of Category A1 of EU Directive 75/440/EEC or SLS 722 whichever is more stringent. For COD, Chloride (Cl^-), SO_4^{2-} and Nickel, the values of Sri Lanka's drinking water quality standards (SLS 614: 2013 Specification for Potable Water[5]) or the WHO Guidelines for Drinking Water, Fourth Edition[6)], were referred and adopted. Treatment achievability by simple chlorination process was also considered.
Category B: Bathing and contact recreational water	The Category B water quality standards are developed based on the values recommended by the Environmental Quality Standards 1992[1)]. More specifically, the proposed values of the equivalent category in the previous report were adopted unless the scientific evidence that become available during the review period run counter the original proposal. In circumstances wherein uncertainty prevails, safer decisions are made based on either the scientific evidence or experiences in other countries.
Category C: Fish and Aquatic Life Water	The Category C water quality standards are developed based on the Environmental Quality Standards 1992[1)]. More specifically, the proposed values of the equivalent category in the previous report were adopted unless the scientific evidence that become available during the review period run counter the original proposal. The tolerable level of concentration on tropical fish species was referred and adopted wherever available. However, such sources of information are rarely available. Therefore, the derivation process unavoidably used other sources of information for most of the parameters. In the review process, pertinent guidelines of India, Thailand, EU and Australia and New Zealand were assessed and compared.
Category D: Water source for full treatment	The values recommended by the Environmental Quality Standards 1992[1)] were reviewed and assessed as against those prescribed by the Sri Lanka's Raw Water Standard (SLS 722[2)]) and its comparable EU's Raw Water Quality Standards (Category A2[7)] of EU Directive 75/440/EEC[4)]). The first principle of determining the guidelines was to adopt the values provided that they comply either with the mandatory value of Category A2 of EU Directive 75/440/EEC or SLS 722 whichever is more stringent. For Dissolved oxygen, Chloride (Cl^-), Sulphate (SO_4^{2-}) and Oil/Grease, the values of Sri Lanka's drinking water quality standards (SLS 614: 2013 Specification for Potable Water[5)]) or the WHO Guidelines for Drinking Water, Fourth Edition[6)], were referred and adopted. Treatment achievability by conventional treatment process was also considered.
Category E: Irrigation & Agriculture	The Category E water quality standards are developed based on the Environmental Quality Standards 1992[1)]. More specifically, the proposed values of the equivalent category in the previous report were adopted unless the scientific evidence that become available during the review period run counter the original proposal. The relevant parameters for irrigation in arid and semi-arid regions such as Sodium Absorption Ratio and Residue Sodium Carbonate in the previous proposal were rejected considering limited applicability in the humid climate. Considering the relative importance of lowland rice in the land use, a due attention was given to water quality for rice plants.
Category F: Minimum Water Quality	The Category F water quality standards are developed based on the Environmental Quality Standards 1992[1)]. More specifically, the proposed values in the previous report were adopted unless the scientific evidence that become available during the review period run counter the original proposal. However, the past water quality monitoring data of Kelani River was also reviewed wherever a set of data is available to avoid excessively ambitious and thus infeasible water quality target.

Note:
1) Environmental Quality Standards and Designation of Water Use in Sri Lanka, Central Environmental Authority, bkh CONSULTING ENGINEERS, 1992
2) SLS 722:1985 Tolerance limits for inland surface waters used as raw water for public water supply, Sri Lanka Standards Institution, Colombo LK.,
3) A1 is the water subject to treatment for transforming surface water into drinking water by simple physical treatment and disinfection, e.g. rapid filtration and disinfection as defined in EU Directive 75/440/EEC for drinking water source that apply simple physical treatment and disinfection.
4) COUNCIL DIRECTIVE of 16 June 1975 concerning the quality required of surface water intended for the abstraction of drinking water in the Member States (75/440/EEC)
5) SLS 614: 2013 Potable water Quality Standards
6) WHO Guidelines for Drinking Water, Fourth Edition
7) A2 is the water subject to treatment for transforming surface water into drinking water by Normal physical treatment, chemical treatment and disinfection, e.g. pre-chlorination, coagulation, flocculation, decantation, filtration, disinfection (final chlorination).

付属資料 12　専門家会議メンバーとステークホルダー協議参加者

Table 1 Members of Expert Committee Meetings

	Experts	Titles and Affiliations	Expertise
1	Mr. Jagath Gunawardana	Former President, the Central Committee for National Environmental Council	Environmental Laws
2	Mr. S.A.M.Azmy	Head, Environmental Studies Division, National Aquatic Resources Research and Development Agency	Irrigation water quality, Biological concentration, dynamics of chemical substances in the environment, fisheries, agricultural chemicals, trace metals, aquatic organism indicators etc.
3	Mr. Amarakoon	Chief of Laboratory Services- NWS&DB	Drinking Water Quality
4	Dr. Mahesh Jayaweera	Senior Lecturer in Environmental Engineering, University of Moratuwa, Department of Civil Engineering	Heavy metals in groundwater, eutrophication, sewage treatment, wastewater treatment
5	Ms. S.N Kamalaimathy	Senior Chemist/ NWS&DB	Drinking Water Quality
6	Mr. W A D D Wijesooriya	Colombo Port City Project Office	Adsorption of phosphorus on sediment, Industrial wastewater treatment

Source: The JICA Team

Table 2 Participants of Stakeholder Meeting

	Name of the Institute	Number	Remarks
1	National Water Supply and Drainage Board	7	DGM (Production - Ambatale) / AGM (P &D Documentation) / DGM (Development) / AGM (Laboratory Services) / Chief Chemist (W) / Chief Chemist (W-N) / Snr. Chemist (Ambatale)
2	Water Resources Board	1	General Manager
3	Department of Irrigation	1	Director General
4	Local Authorities in the Kelani River basin	26	Ja-Ela PS / Gampaha PS / Mahara PS / Wattala Mabola UC / Wattala PS / Kelaniya PS / Peliyagoda PS / Biyagama / Colombo MC / Kotikawatte - Mulleriyawa PS / Kaduwela MC / Sri Jayawardenapura Kotte MC / Homagama PS / Seethawakapura PS / Ehaliyagoda PS / Dompe PS / Seethawakapura UC / Dehiowita PS / Deraniyagala PS / Ruwanwella PS / Bulathkohupitiya PS / Kegalle PS / Aranayake PS / Yatiyantota PS / Hatton-Dikoya UC / Ambagamuwa PS
5	Department of Agriculture	1	Director General
6	NARA[1]	2	Environmental Studies Division
7	Ministry of Mahaweli Development & Environment	3	Director- Environment Pollution Control Division / Planning Division / Legal Officer
8	Ministry of Local Governments and Provincial Councils	2	Commissioner /Provincial Councils Division and Local Government Division
9	Mahaweli Authority of Sri Lanka	1	DG
10	Western Province Solid Waste Management Authority	1	Chairman
11	National Gem and Jewelry Authority	1	Director General
12	Ceylon Electricity Board	1	General Manager
13	Ceylon Petroleum Cooperation	1	Chairman and Board Member of CPC
14	Open University	1	Biologist
15	Staff of District Secretariats	6	Gampaha / Colombo / Kegalle / Rathnapura / Kandy / Nuwaraeliya
16	Divisional Environmental Officers	8	Colombo / Gampaha / Kegalle / Rathnapura
17	WG 1 members	8	
18	Central Environmental Authority - focal persons of Provincial Office	28	Chairman / DG / DDGs-EPC, Admin, Awareness, EIA / Directors-EPC, Lab, Legal, P & M, and R&D Unit / Directors- Western, Southern, Central, Uva, Sabaragamuwa, North Central, North Western, Eastern, Northern Provincial Offices / Director - Gampaha District Office / Director - Water Management Unit / Assistant Director-EPC, Laboratory and Air Quality Unit / Deputy Assistant Director-Laboratory and Water Quality Unit

[1] National Aquatic Resources Research and Development Agency

	Name of the Institute	Number	Remarks
19	Members of Expert Committee	5	Refer to Table 1
20	Supportive staff	6	Laboratory
21	JICA Sri Lanka	2	-
22	JICA Team	2	

Source: The JICA Team

付属資料 13　ラボラトリー精度管理マニュアル

LABORATORY
CENTRAL ENVIRONMENTAL AUTHORITY

QUALITY MANUAL

CEA/WQL/LQMS-QM

Master Copy

THIS IS A CONTROL DOCUMENT

Approved By: Dr Sanjaya Rathnayake (DDG/EPC) Signature: …………………………………………………
Head of Laboratory Date : ………………………………………………….

Authorized By : T.W.A.W Wijesinghe Signature : …………………………………………….
Quality Manager Date: …………………………………………………

Prepared By : ………………………………………….
Deputy Quality Manager

1.0 INTRODUCTION

The Water Quality Laboratory (WQL) of the Central Environmental Authority analyses water and waste water samples (Environmental Samples) from different sources for different parameters with analytical techniques conforming to the international standards. This Laboratory Quality Manual has been prepared to meet the requirements for laboratory accreditation of the International Organization for Standardization/International Electro- Technical Commission (ISO/IEC 17025). It has been formatted using clause numbers from ISO/IEC 17025 to provide ease in review.

1.1 Quality Manual Authorization and Approval

This Quality Manual has been reviewed by the Technical Manager, approved and issued by the Quality Manager, of the Laboratory. This is a controlled document, and unauthorized printing or photocopying is prohibited. Copies not showing the original signature are considered uncontrolled copies, and may not reflect currently issued policy/procedure.

1.2 Controlled Distribution of the Quality Manual

The WQL is responsible for maintaining the official master copy of the Quality Manual. General distribution of this manual is accomplished as follows. The laboratory has five controlled copies and one uncontrolled copy as shown below.

- Copy No 1. Director General
- Copy No. 2. Quality Manager
- Copy No. 3. Technical Manager
- Copy No. 4. Deputy Technical Manager
- Copy No. 5. Deputy Quality Manager
- Uncontrolled copy: Available for reference only for laboratory staff

2.0 REFERENCES

The following reference documents are indispensable for the application of these techniques.

- ISO/IEC 17025 – General requirements for the competence of testing and calibration laboratories (CEA/WQL/LQMS/EX-02)
- National Environmental Act (CEA/WQL/LQMS/EX-01)
- Textbook of 22nd edition of Standard Methods for the Examination of Water and Waste Waters (CEA/WQL/LQMS/EX-03)

  Edited by Eugene W. Rice
  Rodger B. Baird
  Andrew D. Eaton
  Lenore S. Clesceri
- Documents related to Quality Management System of the laboratory listed in Master List of Controlled Documents and related subdocuments. (CEA/WQL/LQMS/F-04/A)

3.0 QUALITY POLICY

The Laboratory of the Central Environmental Authority is committed to

- Achieve and maintain a high standard of quality in all aspects of analytical measurements carried out on behalf of the Central Environmental Authority for its Environmental pollution control activities of Government of Sri Lanka and for its enforcement purposes and for all other customers.
- Provide environmental testing services for its regulatory purposes to other Government organizations, Industries and customers at all the time with the services conforming to requirements of ISO /IEC 17025.
- Implement and continuously develop the Laboratory Quality Management System by improving the quality of test results generated in the Laboratory
- Provide training to assure competency of all personnel concerned with testing activities and to be familiar with the Laboratory Quality Management System in the implementation of the policies and procedures in performing their duties.

DIRECTOR GENERAL

Central Environmental Authority

3.1 Quality Objectives

- Responding customer requests for sampling within 02 weeks, if the distance is below 50 kilometers from CEA and within 04 weeks for beyond 50 kilometers.
- Issuing Test Reports within 02 weeks from the date of sampling.
- Participating in Inter-Laboratory Comparison to cover the scope in a span of 03 years.
- Obtaining customer feedbacks once per six months and taking adequate corrective actions

4.0 MANAGEMENT REQUIREMENTS

4.1 Organization

4.1.1 Legal Identity

The Central Environmental Authority was established in 1981 under the provisions of the National Environmental Act No 47 of 1980, to co-ordinate environmental activities to formulate and review environmental policies to implement and enforce environmental programs for the protection, management and enhancement of the environment of Sri Lanka. The Central Environmental Authority consists of Environmental Pollution Control Division, Environmental Management and Assessment Division, Waste Management Division, Environmental Education and Awareness Division, Human Resources Development Unit Administration Unit, Finance Unit Legal Unit, Planning and Monitoring Unit, Complaint Unit Internal Audit Unit and Provincial Offices

Refer National Environmental Act (CEA/WQL/LQMS/EX-01)

Annexure -1 – Organization Chart

4.1.2 Regulatory Authority

The Water Quality Laboratory is functioning under the Environmental Pollution Control Division which is legally empowered to specify the Standards, Norms and Criteria for the protection and beneficial uses and maintaining the quality of the environment. The Laboratory has responsibility to carryout analytical measurements on maintaining and controlling the volume, types, constituents and effects of the waste discharges, emissions or other sources of pollution which are of danger or potential danger to the quality of the environment or any segment of the environment and in undertaking investigation and inspection to ensure compliance with the Environmental Act and to investigate complaints related to noncompliance with any of its provisions. The CEA laboratory adherer the requirement of SLAB for conformity assessment in carrying out testing

Refer to the National Environmental Act (CEA/WQL/LQMS/EX-01)

4.1.3 Scope

This Laboratory Quality Management System covers the work carried out in the laboratory's permanent facilities identified as the Water Quality Laboratory of Central Environmental Authority and field parameters measured in field or industries identified by authorized officers for field inspection and other customers.

The laboratories scope of the tests is listed in the Annexure II.

4.1.4 Conflicts of Interests

Since all the departments in the Central Environmental Authority are acting on one vision and one mission, to control the environmental pollution there is no potential conflict of interest on the Laboratory's activities Even though the laboratory is part of the organization, laboratory does not involve any activities which influence its testing activities.

4.1.5 Positions and Responsibilities

a) Positions/Responsibilities/Qualifications of the key staff who operate the quality system

a-1) Head of the Environmental Pollution Control Division

Deputy Director General (EPC) of Central Environmental Authority

- The Head of the EPC Division
- Over all in-charge of the laboratory
- In- charge of the management review meeting

a-2) Technical Manager

Qualification

Technical Manager must have a Master's Degree in Analytical Chemistry or equivalent qualifications and more than 05 years laboratory working experience.

Responsibilities

- Make recommendations to the Director laboratory on future requirements of manpower, training and capital equipment to the laboratory
- Identify chemical, glassware, equipment necessary for the laboratory
- To ensure technical operations of the laboratory is carried out in a technically sound manner
- Implement the quality system procedures written in the Quality Manual and associated sub manuals in the laboratory
- Review the quality system procedures in the Quality Manual., procedures in the Procedure Manual and associated technical instructions
- Issuing test Reports
- Identify training needs
- Conduct management review meeting
- Communicate with customers

a-3) Deputy Technical Manager

Deputy Technical Manager assists Technical Manager in performing his duties.

Qualification

Deputy Technical Manager must have a Degree in Science including Chemistry as a subject or equal qualifications and minimum 03 years laboratory working experiences.

Responsibilities

Deputy Technical Manager assists the Technical Manager in performing his responsibilities.

a-4) Quality Manager

Qualifications

Quality Manager must have a Master's Degree in Analytical Chemistry or equivalent qualifications with more than 05 years laboratory working experience.

Responsibilities

- Overall supervision of laboratory staff and in-charge of the laboratory
- Manages administration functions of the laboratory
- Accepts work and environmental monitoring projects from industries, public and other divisions of CEA
- Approves chemical, glass ware and equipment necessary for the laboratory
- Signs letters, memos and analytical reports issued by the Laboratory
- Grants permission to officers to enter laboratory on nonworking days
- Setting up and operating the quality system
- Advises and supervises the staff regarding implementation of policies /procedures in quality management system and monitors all aspects of quality system regularly
- Manages documents in the quality system
- Approving and issuing Quality Manual, Procedure Manual and other related documents
- Organizing the audits and reviews of the quality system
- Organizing the Management review meetings

- Initiation of extra audits if necessary
- Analyzes customer feedback and reports to the management review meeting
- Monitors corrective and preventive actions implementation
- Conducts root cause analysis of nonconformance and rectify the quality system
- Explains improvements in quality system to the staff

a-5) Deputy Quality Manager
Qualifications

Deputy Quality Manager must have a Degree in Science including Chemistry as a subject or equal qualifications and minimum 03 years laboratory working experiences.

Responsibilities

Deputy Quality Manager assists the Quality Manager in performing his responsibilities.

a-6) Laboratory Staff

Graduates with Chemistry as one of the subjects or equivalent qualification with minimum 03 years' experience and Laboratory Assistants with Diploma in Laboratory Technology in Chemistry with minimum one year working experience are carrying out the analysis of samples and sampling of test items in accordance with the documented procedures in the quality system.

Scope of authorizations of laboratory staff for the functions identified under the quality management system is detailed in Authorization Record (CEA/WQL/LQMS/F-02/B).

b) Ensuring undue involvement of Laboratory personnel

A confidentiality statement (CEA/WQL/LQMS/F-02/C) signed by each staff member is kept in personnel folders. It mentions each staff member is bound to be free of undue influences from commercial, financial or any kind of external pressure and will always protect confidentiality of test results, test reports and will not alter test items test results or test reports.

c) Protection of customer's confidential information

Test reports are stored in lockable cupboards and keys of these cupboards are kept under the custody of Laboratory Director. All laboratory staff have access to these cupboards for reference. Files can be taken out of the laboratory only with the approval from Technical Manager/Deputy Technical Manager.

Following procedures are used to ensure the confidentiality of the laboratory.

- A customer can enter the Laboratory with prior approval of the Technical Manager or Quality Manager.
- Officers are permitted to bring their visitors to the lobby or their rooms but not to the laboratory.
- At the end of the day, the officer who leaves at last from the laboratory locks the door of the laboratory and the key is handed over to the security office and records in the log book in the security office.
- All Laboratory staffs are authorized to take this key from security office after signing the log book.

d) Operational Integrity

To maintain the competence of testing, impartiality and operational integrity, only trained and well experienced personnel are authorized to carry out sampling and testing in accordance with the SOP's and the activities done by each person are recorded in the documents identified in elsewhere of the quality system in consistent/traceable manner. To avoid any possible damage to the operational integrity, only laboratory staff is permitted to enter the Laboratory area. This warning is displayed at the laboratory entrance. Sample analysis is assigned to officers such that it avoids any possible bias in reporting results.

e) The Organization and Management Structure of the Laboratory

The schematic representation is below.

DIRECTOR GENERAL

HEAD OF THE EPC DIVISION
DEP. DIRECTOR GENERAL (EPC)

DIRECTOR LABORATORY
(QUALITY MANAGER)

ACT. DEPUTY DIRECTOR LABORATORY
(TECHNICAL MANAGER)

CHEMIST/ASSISTANT DIRECTOR

ENVIRONMENTAL OFFICER/LABORATORY OFFICER
(DEP. QUALITY MANAGER/DEP. TECHNICAL MANAGER)

SENIOR LABORATORY ASSISSTANT

LABORATORY ASSISTANT

LABORATORY ATTENDANT/KKS

f) Responsibilities of Key Staff

All the functions defined in the Laboratory Quality Management System are considered as key responsibilities of the laboratory staff. Laboratory Staff are authorized to carry out those functions in their Authorization Records in Personnel Folders. (CEA/WQL/LQMS/F-02/B)

g) Assessment of competence of Technical Procedures

For all members of staff, procedures for assessment of competence of testing, follow up of documented procedures, practicing good laboratory practices are available.

Competency Assessment Sheet (CEA/WQL/LQMS/F-02/J)

h) Technical Manager (TM)

Under Section **4.1.5, a)**, Technical Manager covers the responsibilities of all technical operations.

i) Appointment of Quality Manager (QM)

Quality Manager is appointed by the Director General of Central Environmental Authority as the policy decision committee which shows the commitment of the top management for implementing quality policy. Responsibilities of QM are identified in the Section **4.1.5, a)** and the position of QM can be identified in the organization structure with direct access to top Management.

j) Appointment of Deputies for key personnel

Deputies for Key personnel have been identified in the organization structure of the Laboratory. Refer to 4.1.5.e

k) Ensuring the Relevance and Importance of Work

All personnel are aware of relevance and importance of their work as responsibilities and authorities. All authorizations to perform work within the specified quality management system and responsibilities in maintaining quality management systems are clearly communicated to each staff member.

Refer to Authorization Record. (CEA/WQL/LQMS/F-02/B)

4.1.6 Communication Process

The Laboratory has an effective communication system with all other parts of the organization including the Director General and Senior Managers of Central Environmental Authority. The networking facilities with e-mail and internet facilities are established by the management which supports the effective management of quality system. In addition, QM is given the authority to directly communicate with the Director General and Senior Managers in effective management of Quality System.

4.2. Quality Management System

4.2.1 General

The Water Quality Laboratory (WQL) has established a Laboratory Quality Management System (LQMS) through the Quality Manual, Procedure Manuals, Standard Operational Procedures, Registers, Forms and other documents which give instructions on performing laboratory functions related to quality system. The LQMS is understood by all members of staff and the implementation of the LQMS is done by authorized personnel in the laboratory under the supervision of Quality Manager.

4.2.2 Quality policy Statement

Quality Policy with the signature of the Director General of the CEA s given in page 08 of this manual.

4.2.3 Commitment of Top Management

The management and senior managers of the Central Environmental Authority is fully committed to implement, maintain and develop the quality management system of the Laboratory.

This commitment is provided by

1. Establishing a proper suppliers system to the laboratory (CEA/WQL/LQMS/QSP-06)
2. Establishing a good communication system between the top management and all other important parties in maintaining the quality system
3. Attending management review meetings (CEA/WQL/LQMS/F-09/C)
4. Upgrading technical requirement (CEA/WQL/LQMS/QSP-06)
5. Implementing continues capacity building program for technical staff of the laboratory (CEA/WQL/LQMS/F-02/G)

4.2.4 Commitment for Customer Requirements

Issues related to customer requirements, statutory and regulatory requirements are discussed in the Management review Meeting annually and forwarded to the laboratory for required actions and QM/TM is responsible for conducting the meeting.

Refer Records of Management Review Meeting (CEA/WQL/LQMS/F-09/C)

Effective communication from management occurs through the use of but not limited to memos, newsletters, electronic presentations, emails, or verbally to laboratory personnel regarding the importance of meeting customer, statutory, and regulatory requirements.

Refer to CEA/WQL/LQMS/EX-01 for statutory and regulatory requirements of Central Environmental Authority

4.2.5 Documentation Structure of the Laboratory Quality Management System

Quality Manual → **Procedure Manual** → **Method Manual (SOP)**

Procedure Manual:

1. Equipment Handling and Calibration Procedure
2. Training Procedure
3. Procedure for Internal Audits
4. Control of Documents
5. Control of Records
6. Procedure for Purchasing and Handling of Laboratory Supplies and Services
7. Procedure for Review of Request for Testing form Customers
8. Customer Complaints Handling Procedure
9. Procedure for Handling Nonconformities & Corrective/ Preventive Actions
10. Procedure for Health and safety
11. Cleaning Procedure
12. Procedure for Reporting Test Results
13. Procedure for Handling of Test Items
14. Procedure for Estimation of Uncertainty
15. Assuring the Quality of Test Results.

Method Manual (SOP):

1. Determination of Chemical Oxygen Demand in environmental samples
2. Determination of Biological Oxygen Demand in environmental samples
3. Determination of Total Suspended Solids in environmental samples
4. Determination of Oil and Grease in environmental samples
5. Determination of Nitrate in environmental samples
6. Determination of Phosphate in environmental samples
7. Determination of Free Ammonia in environmental samples
8. Determination of Chloride in environmental samplers
9. Determination of Alkalinity in environmental samples
10. Determination of Total Hardness in environmental samplers
11. Determination of Total Dissolved Solids in environmental samples
12. Determination of color in environmental samples

In addition to the above structure, Quality system is covered by Equipment logs, Registers, Formats for records (Master List of Records CEA/WQL/LQMS/F-05/A)

4.2.6 Roles and Responsibilities of Technical Manager and Quality Manager

Refer to 4.1.5. a)

4.2.7 Changing Quality Management System

The Changes in the quality system are discussed in Management review meetings and the QM is committed to maintain the integrity and effectiveness of the quality system in making changes. Quality Manager and Technical Manager are directly responsible for making changes if any.

4.3 Document Control

4.3.1 General

The document control procedure in laboratory describes the process for controlling quality documents that form part of its management system. The quality documents include those required for the generation of laboratory data. These documents include those published by the laboratory or externally. Documents of external origin include regulations, standards, test methods, instructions and manuals.

Reference Copies of all controlled documents are kept in the laboratory for laboratory Staff Reference. These documents cannot be taken out of the laboratory without approval from Quality Manager.

Quality Manager issues forms, sheets generated from manuals, files, registers and those identified by a given identification number.

Documents other than related to quality system such as externally published documents and reference materials are separately kept in a labeled place where those can easily be identified by the laboratory staff. Invalid or obsolete documents of the quality system are promptly removed from all points of issue.

Refer to Procedure for Control of Documents CEA/WQL/LQMS/QSP-04

4.3.2 Document Approval and Issue.

Documents issued to personnel in the laboratory as part of the management system are reviewed by Technical Manager and approved by Quality Manager for use prior to issue in accordance with the laboratory's document control procedure. The laboratory's master list identifies the current revision status and distribution of documents in the management system. Through the use of the master list, quality documents are posted to personnel to preclude the use of invalid or obsolete documents.

4.3.3. Document Changes

Changes to documents are reviewed and approved in accordance with the laboratory's document control procedure. Unless designated otherwise, this procedure is followed by the same personnel as in the original review or approval.

The altered or new text is identified in the document - Document Change Request Form (CEA/WQL/LQMS/F-04/D). Changes can be described in general terms since the details can be demonstrated in the archived document.

Refer to Control of Documents Procedure (CEA/WQL/LQMS/QSP – 04)

4.4. Review of Requests from Customers

Laboratory has established and maintained a procedure for Review of Request for Testing from outside customers and internal divisions of CEA and records are maintained. If there is any difference between customer requirements and laboratory procedures /policies, Technical Manager informs the customer of the deviations from their requirements. At present the Laboratory does not subcontract tests to the outside laboratories. The Laboratory does not accept any tender or contract agreement for its testing services.

Refer to Procedure for Review of Request for Testing from Customers (CEA/WQL/LQMS/QSP-07)

4.5 Subcontracting of Tests and Calibrations

Not Applicable

4.6 Purchasing Supplies and Services

4.6.1 General

The Laboratory of Central Environmental Authority has a policy and procedure for the purchasing and handling of laboratory supplies and services (CEA/WQL/LQMS/QSP-06). Laboratory forwards the requirements to Administration division in accordance to the above Procedure. The Administration division follows the Government Procurement Procedure in purchasing Services and supplies to the laboratory.

Refer to Procedure for Purchasing and Handling of Laboratory Supplies and Services (CEA/WQL/LQMS/QSP-06).

4.6.2 Inspection and Verification

Laboratory accepts those supplies that affect the quality of test after inspection or verification as complying with standard specifications defined in the LQMS.

Refer to Specifications –CEA/WQL/LQMS/F-06/C

4.6.3 Purchasing Documents

Purchasing documents for items affecting the quality of laboratory output, describe the services or supplies ordered. These documents are reviewed and approved for technical content prior to submission by the Quality Manager. Purchasing Request Form (CEA/WQL/LQMS/F-06/A)

Refer to Procedure for Purchasing and Handling of Laboratory Supplies and Services (CEA/WQL/LQMS/QSP-06)

4.6.4 Evaluation of suppliers

Registered Suppliers list (CEA/WQL/LQMS/F-06/B) for Laboratory chemical, glassware and other services are available in the Administration division. Technical manager with administration division evaluates the suppliers list at the end of each year by evaluating their services, dedication in supplying orders and their commitment to after sales services. This evaluated suppliers list is used by Administration division for the procurement of next year’s laboratory requirements.

Refer to Procedure for Purchasing and Handling of Laboratory Supplies and Services (CEA/WQL/LQMS/QSP-06)

4.7 Services to the Customer

4.7.1 Cooperate with Customers

The Laboratory is willing to cooperate with customers or their representatives in clarifying the customer requests and in monitoring the laboratory's performance in relation to performance of work, the laboratory ensures confidentiality to other customers. On request of a customer, D/Lab or Technical Manager allows the customer to enter the laboratory after signing the Register for Visitors (CEA/WQL/LQMS/F-08/C) to see the performance of analysis with quality control standards and calibration of equipment. In addition, the customer can inspect reports of proficiency testing schemes and participate in technical awareness programs conducted by the laboratory. Laboratory maintains a good communication with customer at all the time.

4.7.2 Customer Feedback

The laboratory always welcomes customer feedback on their services and general performance. Records of the comments, both positive and negative, are maintained and are taken into account for identifying management system improvements during the reviews performed by management.

Refer to Customer Feedback Form (CEA/WQL/LQMS/F-08/B)

4.8 Complaints

The laboratory welcomes complaints from customers or internal staff and those complaints are registered in complaints Register.(CEA/WQL/LQMS/F-08/A) The Laboratory is bound to treat complaints from customers and any internally detected quality anomalies as a source of useful information to upgrade the quality system. Any problem associated with quality system is rectified as soon as possible and if necessary, a quality audit is held and remedial action is taken to reduce the likelihood of recurrences.

Refer to Customer Complaints Handling Procedure (CEA/WQL/LQMS/QSP-08)

4.9 Control of Nonconforming Testing

4.9.1 General

The laboratory has a control of non-conforming work procedure that is implemented when any aspect of testing work, or the results of this work, does not conform to requirements of the management system, testing methods, or the requests of the customer.

This procedure addresses the following elements:

- responsibilities and authorities for the management of identified non-conforming work and taking actions such as the halting of work, the withholding of test reports;
- application of criteria to evaluate the significance of non-conforming work;
- remedial action taken, together with any decision about the acceptability of the nonconforming work;
- notification of the customer, and if necessary, recall of work; and
- Responsibility for authorizing the resumption of work.

Refer to Procedure for Control of Nonconformities and Corrective/Preventive Actions CEA/WQL/LQMS/QSP-09

4.9.2 Follow-Up

If the non-conforming work could recur, or there are other significant problems identified, the corrective action procedure is promptly followed.

Refer to Procedure for Control of Nonconformities and Corrective/Preventive Actions CEA/WQL/LQMS/QSP-09

4.10 Improvement

The Laboratory is committed to continually improve the effectiveness of the quality management system through the commitment of quality policy, audit results, analysis of data, customer feedback, corrective and preventive actions suggested in reviewing internal audits and suggestions at management review. Technical improvements are carried out by participating in proficiency testing programs and inter laboratory testing programs, entertaining customer complaints and developing and upgrading the skills of the staff by giving necessary trainings.

Refer to Record of Management Review (CEA/WQL/LQMS/F-09/C)

4.11 Corrective Action

4.11.1 General

The laboratory has established a procedure for implementation of any corrective action originated through internal/external audits, customer complaints or suggestions for improvements in quality system or as customer feedback and non-conforming work or deviation from the policies and procedures in the quality management system or technical operations. The Quality Manager is responsible for implementation /follow up of corrective actions, preventive actions and root cause analysis.

Refer to Procedure for Control of Nonconformities and Corrective/Preventive Actions (CEA/WQL/LQMS/QSP-09)

4.11.2 Root Cause Analysis

It is the policy of the laboratory to analyze the root causes of any non-conforming work, deviation from quality management system or technical operations before initiation of corrective actions.

Refer to Procedure for Control of Nonconformities and Corrective/Preventive Actions (CEA/WQL/LQMS/QSP-09)

4.11.3 Selection and Implementation of Corrective Actions

Selection and implementation of the corrective actions to eliminate any deviation from the system depends on the degree of the magnitude and the risk of the problem.

Any changes resulting from the corrective action investigation are implemented and designated considering their degree of risk on the quality system and then recorded in Nonconformity Record (NCR) & Corrective/Preventive Action Request Form CEA/WQL/LQMS/F-09/A

Implementation of the corrective action is evident by signing off the NCR by Quality Manager after elimination of the non-conformity.

4.11.4 Monitoring of Corrective Actions

The Quality Manager monitors the results to ensure that the corrective actions taken have been effective.

4.11.5 Additional Audits

Where the identification of non-conformities or deviations casts doubts on the laboratory's conformance with management system policies and procedures or conformance with ISO/IEC17025, the areas of activity affected by the non-conformance are audited as soon as possible in accordance with Internal Audit Procedure. (CEA/WQL/LQMS/QSP-03)

The Quality Manager reserves the right to initiate extra audits in the following cases

1. Customer complaints
2. A request from top management
3. After management review

4.12 Preventive Actions

4.12.1 Preventive Action Identification

The laboratory practices the procedure to follow the corrective actions as well as preventive actions which have been identified in non-confirming work related to technical operations and policies in the management system. In addition, preventive actions are planned to improve the quality management system.

Refer to Procedure for Control of Nonconformities and Corrective/Preventive Actions (CEA/WQL/LQMS/QSP-09)

4.12.2 Preventive Action Plan

Following actions are considered as preventive actions for deviation from conformity.

for technical operations

1. Laboratory maintains the control charts for reference material testing and for other instrumental parameters
2. Laboratory staff participation of proficiency testing schemes for checking performance of analysis

For quality management system

1. Extra audits planned by Quality Manager after evaluating customer complaints or customer feed back
2. Review of Quality System

4.13 Control of Records

4.13.1 General

4.13.1.1Procedure

The laboratory has an established procedure for identification, collection and indexing access, filing, storage and disposal of quality system records and technical records including reports from internal audits, management review records and corrective and preventive action records

Refer to Procedure for Control of Records CEA/WQL/LQMS/QSP-05

4.13.1.2 Record Integrity

The laboratory records are to be legible and readily retrievable. All records are stored in lockable cupboards to prevent damage or deterioration or loss. Retention times of all records are clearly defined in the Master List of Records (CEA/WQL/LQMS/F-05/A)

Records such as calculations and instrumental readings which generate test results are clearly recorded in the documentation system of the quality system. The laboratory does not store or issue any record in soft copies.

Refer to Procedure for Control of Records (CEA/WQL/LQMS/QSP-05)

4.13.1.3 Record Security

All records related to quality systems are stored as hard copies in lockable cupboards and access is controlled and limited to the laboratory staff.

4.13.1.4 Electronic Records Backup

The laboratory does not store technical records in electronic versions.

4.13.2 Technical Records

4.13.2.1 Record Information

The laboratory retains all records of instrumental data, calibration records, quality control records, staff records and copies of test reports issued for five years. Traceability of each record is maintained with list of responsible persons and storage locations mentioned in master list of records (CEA/WQL/LQMS/F-05/A)

4.13.2.2Recording

Observations, data, and calculations are recorded at the time they are made in the Data analyzing Record Sheets (CEA/WQL/LQMS/F-12/B) and are identifiable to the activity performed. Method numbers and titles are used to provide traceability of records identification.

4.13.2.3Correction to Records

When errors occur in records, each mistake is lined out, not erased, not made illegible, nor deleted. The correct value is entered, initialed, or signed by person making the correction.

4.14 Internal Quality Audits

4.14.1 Internal Audit Program

The laboratory has established a procedure for conduct internal audits of its activities according to a schedule to verify that its operations continue to comply with the requirement of the management system. Quality Manager is responsible for planning and organizing audits. Trained and qualified personnel, independent of the activity to be audited are responsible for conducting internal audits.

Refer to Procedure for Internal Audit (CEA/WQL/LQMS/QSP-03)

4.14.2 Corrective Action

As results of internal audit, audit findings are discussed and corrective actions requested are implemented. The lead auditor writes audit report including audit summary (CEA/WQL/LQMS/F-03/A) and corrective actions requests (CEA/WQL/LQMS/F-09/A).

4.14.3 Record and Management

The internal audit checklist and internal audit summery report covers the area of activity audited and audit findings and corrective actions requested.

4.14.4 Follow-up audits

Implementation and effectiveness of corrective actions taken are reviewed and recorded to follow up of audit activities. Lead auditor is responsible for follow up of audits.

4.15 Management Reviews

Management review is conducted annually after completion of total audit cycle. Deputy Director General (EPC), Director Laboratory Services, QM, TM, DQM, DTM conducts review of laboratory quality system.

Refer to Record of Management Review (CEA/WQL/LQMS/F-09/C)

Following agenda is considered in the management review meeting.

- previous management review meeting minutes
- suitability of quality policy and procedures
- Reports from managerial and supervisory staff.
- Internal audit findings
- Reports on Corrective and preventive actions and root cause analysis
- Assessments by external bodies
- The results of inter laboratory tests and comparisons
- Changes in the operations frame work
- Customer feedback
- Customer Complaints (Quality Manager should provide report on analysis of customer complaints)
- Recommendations for the improvement of quality system including resources and training

Management review records are kept by Deputy Quality Manager and stored in a lockable cupboard.

Refer to Records of Management Review (CEA/WQL/LQMS/F-09/C)

5.0 TECHNICAL REQUIREMENTS

5.1 General

The following factors which determine the correctness and reliability of the tasks performed by the Laboratory are monitored and evaluated.

- human factors
- accommodation and environmental conditions
- test methods
- equipment
- measurement traceability
- handling of test items

5.2 Personnel

5.2.1 Staff Training and Competence of Testing

Laboratory management ensures that laboratory personnel have the knowledge, skills, and abilities to perform their duties. Competence is based on education, experience, demonstrated skills, and training. Staff records contain the documentation of personnel education, experience, skills, and training for the position held. Trainees undergo a training program in accordance with the laboratory's training procedure.

For in-house training, competent testing responsible or authorized officer serves as the trainer. Trainees perform procedures after training is completed and competency has been demonstrated. The documented demonstration of competence is an exercise that the trainee performs independent of supervision. The trainee is considered competent after the specified criteria have been successfully met.

Refer to Procedure for Staff Training and Competency of Testing (CEA/WQL/LQMS/QSP-02)

5.2.2 Review of Training and Competence

It is the policy of CEA laboratory to review and identify training needs annually and provide trainings to staff. Quality Manager is the authorized person to review and evaluate staff training by arranging members of staff to carry out a particular test.

Refer to Procedure for Staff Training and Competency of Testing (CEA/WQL/LQMS/QSP-02)

This procedure is same as the competence testing of staff and they are identified to check that the documented procedure is being followed. Obtained results are examined and ideally checked by a trainer.

5.2.3 Employees

The Laboratory uses permanent staff for testing and does not use temporary staff or unqualified staff to perform laboratory work.

Refer to Staff Accession Record (CEA/WQL/LQMS/F-02/F)

5.2.4 Job Descriptions

The laboratory maintains active job descriptions for managerial, technical, and key support personnel involved in tests. Job descriptions are established based on current duties and technologies utilized.

Refer to Job Descriptions -Annexure IV

5.2.5. Management Authorization

Competent members of staff are authorized by QM/TM to sign test reports. This is recorded in the Authorization Records **(**CEA/WQL/LQMS/F-02/B) with the date of authorized or competency is confirmed.

5.3 Accommodation and Environment

5.3.1 Facility

The laboratory environmental conditions facilitate the correct performance of analytical testing. Test methods used by the laboratory include instructions addressing applicable environmental conditions. Examples of environmental influences are energy sources, lighting, biological sterility, dust, humidity, and temperature. The laboratory monitors critical environmental conditions to ensure that results and the quality of the measurement are not adversely affected or invalidated. The Laboratory maintains the environmental Temperature at 20-25 deg. C

5.3.2 Monitoring

Where environmental controls are needed, the environmental conditions are monitored, recorded and controlled by the laboratory as required for control of the quality of test results. Testing activities are stopped when the environmental conditions invalidate the test results or adversely affect quality control. Temperature and humidity are monitored and recorded as part of the laboratory test.

Refer to Temperature and Humidity Record (CEA/WQL/LQMS/F-01/I)

5.3.3 Separation of Incompatible Activity

The laboratory is properly differentiated to separate individual activities so as not to adversely affect quality of measurements by each other activities.

Refer to Laboratory floor plan -Annexure III

5.3.4 Controlled Access

Access to and use of areas affecting the quality of test results are properly controlled in the laboratory. No visitors are allowed to enter the testing area. But if customers/Internal auditors/external auditors want to see the testing performance, D/Lab or TM can grant the approval for those after signing the visitors register. Refer to CEA/WQL/LQMS/F-08/C

5.3.5 Good Housekeeping

Measures have been taken to maintain the good housekeeping in the laboratory. Floors, walls and glass partitions of the laboratory are cleaned regularly by the contracted cleaners. This cleaning procedure includes washing, if necessary, sweeping, brushing and mopping. This is done under the supervision of authorized officer.

Cleaning Services are performed according to the cleaning schedule

(CEA/WQL/LQMS/F-11/A).In addition, daily mopping of laboratory working benches and other instrumental table belonging to laboratory staff, are carried out.

Refer to Cleaning Procedure (CEA/WQL/LQMS/QSP-11)

Procedure for Health and Safety (CEA/WQL/LQMS/QSP-10)

5.4 Test Methods and Method Validation

5.4.1 General

The CEA Laboratory uses internationally recognized test methods for analysis of environmental samples. These test methods are clearly documented with all good laboratory practices.

Refer to Standard Operation Procedure Manual CEA/WQL/LQMS-SOPM

5.4.2 Selection of the Methods

Selection of test methods is based on International recognition and method validations. Methods are extracted from the latest edition of “Standard Methods for Examination of Water and Waste Water” published by American Public Health Agency. (CEA/WQL/LQMS/EX-03)

5.4.3 Laboratory Developed Methods - *Not Applicable*

5.4.4 Non-standard Methods – *Not Applicable*

5.4.5 Validation of Methods

Those Selected methods are validated in the CEA Laboratory by using reference standards. Validation data are recorded at the end of Standard Operation Procedures

5.4.6 Estimation of Uncertainty of Measurements.

The Laboratory has a procedure for Estimation of Uncertainty of Measurement, to determine the uncertainty of all measurement analyzed under controlled environmental conditions for extended period of time by competent analysts. In Standard Operation Procedures, calculated uncertainty of measurement is mentioned for each test.

Procedure for Estimation of Uncertainty of Measurement CEA/WQL/LQMS/QSP-14

5.4.7 Control of Data

Calculations and data transfers are subject to rechecking at all the levels by authorized persons in the laboratory and reviewed before the data is reported. All changes are identified and verified where they occur. This process is detailed in the Procedure for Reporting Test Results CEA/WQL/LQMS/QSP-12. Computers are not used for checking of calculations or data transfer.

5.5 Equipment

5.5.1 General

The laboratory is equipped with all necessary instruments required for correct performance of tests. Those instruments are operated under required accuracy to maintain the specified measurement uncertainty of test results.

Refer to Equipment Logs of each instrument and Master list of Equipment (CEA/WQL/LQMS/F-01/A) for more information.

5.5.2 Calibration of Equipment

All the instruments are calibrated according to the calibration schedule (CEA/WQL/LQMS/F-01/D) and regularly checked for correct performance.

5.5.3 Handling of Equipment

Equipment are operated by authorized persons and responsibility is given in Authorization Record (CEA/WQL/LQMS/F-02/B)

5.5.4 Equipment Identification

Each and every equipment has a separate equipment log in which all the details of equipment are recorded in the Master List of Laboratory Equipment (CEA/WQL/LQMS/F-01/A). Each equipment is numbered with reference number given in equipment log. Equipment log contains records for maintenance, service, calibration, and handling of equipment.

5.5.5 Equipment Records

Records are maintained of each item of equipment according to the Master List of Laboratory Equipment (CEA/WQL/LQMS/F-01/A). The records include the data of

- identity of the item of equipment;

- manufacturer's name, type identification, and serial number or other unique identification;
- performance checks that equipment conforms to testing parameters and acceptance criteria;
- location of the equipment;
- manufacturer's instructions;
- dates, results and copies of reports and certificates of calibrations, adjustments, acceptance criteria, and the due date of next calibration;
- calibration schedule and maintenance carried out to date; and
- any damage, malfunction, modification or repair to the equipment.

5.5.6 Management of Equipment

The laboratory has a procedure for the safe handling, transport, storage, use and planned maintenance of measuring equipment to ensure proper functioning and to prevent contamination or deterioration.

Refer to Equipment Handling and Calibration Procedure (CEA/WQL/LQMS/QSP-01)

5.5.7 Out of Service

Equipment gives suspect results, or has been shown to be defective or outside specified limits, is taken out of service. It is isolated to prevent its use or clearly labeled or marked as being "Out of Service" to prevent its use until it has been repaired and shown by calibration or test to perform correctly.

5.5.8 Retesting and Calibration

Laboratory personnel examine the effect of quality control analyses that indicate the defect or departure from specified limits on previous tests according to Control of Non-conforming Work. Equipment under the control of the laboratory and requiring calibration is labeled or coded to indicate the calibration status, including the date when last calibrated and the date due for recalibration. Alternatively, equipment calibration status may be identified in an associated record to indicate the status of calibration.

5.5.9 Equipment Leaving the Laboratory

If for any reason equipment leaves the direct control of the laboratory, the function and calibration status of the equipment is checked upon return and shown to be satisfactory before the equipment is returned to service.

5.5.10 Calibration Confirmation

Intermediate calibration confirmation checks are performed to maintain confidence in the calibration status of the equipment. These checks are conducted in accordance with the procedure, Equipment Handling and Calibration Procedure (CEA/WQL/LQMS/QSP-01)

5.5.11 Correction Factors

Where calibrations give rise to a set of correction factors, these factors are communicated to users.

5.5.12 Safeguards

Test and calibration equipment, including both hardware and software, are safeguarded from adjustments that would invalidate the test or calibration results. Safeguards are provided using access control to the laboratory.

5.6 Measurement Traceability

5.6.1 General

All the equipment used for tests having a significant effect on test results are calibrated according to the predefined calibration schedule. Laboratory has developed a procedure for calibration of the equipment.

Refer to Equipment Handling and Calibration Procedure (CEA/WQL/LQMS/QSP-01)

5.6.2 Specific Requirements

5.6.2.1 Calibration – Requirements for Calibration Laboratories

Not Applicable

5.6.2.2 Testing

5.6.2.2.1 Testing and calibration activities

The requirements of 5.6.2.1 Calibration-Requirements for calibration laboratories, are included in the laboratory's calibration procedure for equipment that has a significant contribution from its calibration to the total measurement uncertainty. The measurement of uncertainty is determined and recorded in accordance with the procedure for Estimation of Uncertainty of Measurement. Equipment that does not contribute appreciably to the total uncertainty of the test result is excused from the calibration.

5.6.2.2.2 Non-traceability to SI Units

Where measurement traceability for testing activities to SI units is not possible, the policies stated in 5.6.2.1.2 are followed.

5.6.3 Reference Standards and Reference Materials

The Laboratory uses standard reference materials to calibrate the tests and working certified standard materials for performance evaluation of equipment. Those working standards are rechecked against the calibrated standards calibrated by internationally recognized calibration agency. Intermediate checks are done to maintain the confidence in the calibration status of reference standards and reference materials.

5.7 Sampling

Not included in the scope of accreditation.

5.8 Handling of Test Items

The Laboratory has established procedure for handling of test items.

Refer to Procedure for Handling of test items (CEA/WQL/LQMS/QSP-13)

5.8.1 Protection of Samples

The laboratory procedure CEA/WQL/LQMS/QSP-13, describes the receipt, processing, protection, storage, retention and disposal of samples. This procedure addresses the laboratory activities conducted to protect sample integrity.

5.8.2 Identification of Samples

The laboratory has a system for uniquely identifying samples. The sample number is used to track its progress from the time the sample is collected in the field until the analysis is completed and the sample is disposed. The sample number is also used to provide traceability between the sample and the data. The numbering system also provides traceability during transfer of samples within the laboratory and between customers in the case of commercially transferred samples. The identification system is described in the procedure CEA/WQL/LQMS/QSP-13.

5.8.3 Departures, Additions or Exclusions

Upon receipt of the sample, abnormalities or deviations from normal or specified conditions, for example contract specifications, analysis requested, and chain of custody, are recorded in accordance with the procedure CEA/WQL/LQMS/QSP-13. When samples received do not meet established acceptance criteria procedure CEA/WQL/LQMS/QSP-13, laboratory personnel consult the customer for further instructions before proceeding. Communications with the customer is documented.

5.8.4 Protection of Samples during Processing and Storage

The procedure CEA/WQL/LQMS/QSP-13, provides the details for protecting test items from deterioration, loss or damage during storage and processing. The laboratory has arrangements for storage and security that protect the condition and integrity of samples. Sample security arrangements apply both in the laboratory and in the custody areas.

5.9 Assuring Quality of Test Results

5.9.1 Quality Control Procedures

The laboratory has quality control procedures to validate the results of tests undertaken according to Assuring the Quality of Test Results CEA/WQL/LQMS/QSP-15. For the assurance of quality of test results, the laboratory uses the following procedures.

1. Use of standard reference materials /quality control samples for each test
2. Participation of Proficiency Testing or inter laboratory comparison schemes
3. Carrying out of duplicate tests for each set of samples

The results of these reference materials /quality control samples are displayed in controlled charts to maintain the results within the predetermined levels of acceptance.

5.10 Reporting Results

5.10.1 General

Test reporting is addressed in the procedure for Reporting Test Results which gives the details for reporting data using consistent reporting formats of laboratory worksheets. Results are reported on analytical data book and reports are reviewed against acceptance criteria that address accuracy, clarity and objectivity.

Refer to Procedure for Reporting Test Results CEA/WQL/LQMS/QSP-12

5.10.2 Test Reports

Unless the Laboratory has exceptional reasons for not doing so, each test report include at least the following information.

- Title as “Test Report”
- Name and address of the laboratory

- Unique identification of the test report is the report number given by the laboratory. This number is mentioned in an each page, as an identification and continuation in order to ensure that particular page is a part of the test report and clear identification of the end of the test report.
- Name and address of the officers /Customer who requested the test report or if different, purpose of the test report
- Name and address of the industry/ location, water body or the place where sample is collected
- Type of sample/sampling
- Date of samples collected
- Name of the officer who collected the sample and name of the witness
- Identification of the method used
- A description of, the condition of, and unambiguous identification of the sample
- Dates of performance of tests
- Analytical results with units
- Date of issue of test report
- Names, functions and the signatures of the persons authorizing the test report
- A statement to the effect that the results relate only to the items tested
- Identification of the unaccredited tests as “non-accredited’ in the test report
- Enclosures such as permissible levels of standard specifications, drawings, comments

Refer the standard format of the of Test Report (CEA/WQL/LQMS/F-12/A)

Test results obtained from the accredited test methods are marked “Accredited” instead of test method reference number given in the reference column of the test report

5.10.3 Additional Requirements for Test Report

a) Specific Requirements

The following information is included in test reports for the interpretation of the test results, if necessary

- Deviations from, additions to, or exclusions from the test method, and information on test conditions, such as environmental conditions;
- A statement of conformance or non-conformance with specifications;
- A statement of the estimated uncertainty of measurement when requested by a customer; or a statement on the estimated uncertainty of measurements where uncertainty affects the compliance to a standard limits
- Opinions and interpretations as detailed Section 5.10.5
- Additional information that may be requested by methods, customers or groups of customers.

b) Sampling Results

In addition to the instructions listed in Sections 5.10.2 Reporting Results and 5.10.3.1 Specific Requirements, sampling information and conditions are posted to the laboratory for review on the sample collection record.

5.10.4 Calibration Certificates

Not Applicable

5.10.5 Opinions and Interpretations

Technical Manager expresses its opinion and interpretation of the compliance or noncompliance of the results through the laboratory classification assigned to each sample.

5.10.6 Testing Results Obtained from Subcontractors

Subcontracting laboratories are not utilized by CEA laboratories, therefore, there is no such data found for incorporation in the analysis report to the customer.

5.10.7 Electronic Transmission of Results

Test results are not subjected to transmit by telephone, facsimile or other electronic means, in order to meet the criteria of Control of Data.

5.10.8 Format of Test Report

The format for laboratory test report is designed to accommodate the type of test conducted to minimize the possibility of misunderstanding or misuse. The test repot format is described in the procedure for Reporting Test Results (CEA/WQL/LQMS/QSP-12).

5.10.9 Amendments to the Test Report

Material amendments to a test report after issue are made only in the form of a further document which includes the statement "Supplement to the Test Report, serial number or as otherwise identified", or an equivalent form of wording. Such amendments meet all the requirements in this Quality Manual. When it is necessary to issue a complete new test report, this is uniquely identified and contains a reference to the original that it replaces.

付属資料 14　インスペクションガイドライン

Inspection Guideline
for
Water Quality Section

June 2017

Central Environmental Authority

JICA Expert Team

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Appendix

A. National Environmental Act No. 47 of 1980 and
   National Environmental (Amendment) Act No. 56 of 1988:
      Section 23 A (1), (2) (a) and (b):
      Section 23 G, 23 H;
      Section 24 A, (1) (2) and (3)
   Gazette notification No. 1533/16 dated 25/1/2008 (List of prescribed activities)
   And
   Gazette notification No. 1534/18 dated 1/2/2008 (Environmental Protection Regulation and Effluent Standards)
B. Inspection Plan Sheet and Preparation Check Sheet
C. Standard Format of Inspection Report
D. Standard Inspection Schedule Format
E. Priority Sectors and Parameters to Be Inspected
F. General Viewpoints on Facility Condition on EPL Compliance
G. Specific Viewpoints on Selected Industry Sectors
H. Chemical Behaviour of Selected Pollution Parameters

1. INTRODUCTION

1.1. Purpose of the Guideline

The purpose of this guideline is to assist the CEA and inspectors to conduct industry inspection in order to check compliance with the regulation on environmental protection and effluent or emissions quality gazetted under the National Environmental Act (NEA), in a most consistent, comprehensive, competent, and professional manner.

The guideline focuses on providing standardized inspection procedures to the CEA inspectors so that the CEA can ensure that all inspection activities are treated as equally important and all appropriate information for inspecting factory performance are collected by the inspectors. And also it aims to assess the information to establish the correctness of any suspected violation of the NEA.

The EPL (Environmental Protection License) procedure covers not only wastewater pollution but also air pollution, noise pollution, vibration and solid waste; this guideline specially concentrates on wastewater pollution only.

1.2. Definition of Inspection

1.2.1. Legal Basis on Inspection

The EPL system is a one of the key tools for regulating wastewater (and other pollutive) discharges from industries or establishments engaged in prescribed activities. It is decreed under the Act No. 47 of 1980 under the NEA as amended by Act. No. 56 of 1988 and 53 of 2000. The EPL system requires industrial sectors (EPL holders or those engaged in prescribed activities) to apply for and obtain the concerned license and to comply with environmental standards and criteria.

The CEA derives power to investigate and inspect from the following sections of the NEA:

Art. 10 (1) (c) to undertake surveys and investigations as to the causes, nature, extent and prevention of pollution and to assist and co-operate with other persons or bodies carrying out similar surveys or investigations;

Art. 10 (1) (g) to undertake investigations and **inspections** to ensure compliance with this Act and to investigate complaints relating to non-compliance with any of its provisions;

Some of the important provisions of the NEA regarding the EPL procedure, wastewater, and inspection are as follows:

Section 23 A (1), (2) (a) and (b):

Section 23 G, 23 H;

Section 24 A, (1) (2) and (3)

The important regulations that come under the EPL procedure are the following:

Gazette notification No. 1533/16 dated 25/1/2008: listing out the prescribed activities which the EPL is required.

Gazette notification No. 1534/18 dated 1/2/2008: listing down the EPL regulations and the tolerance limit of the discharged wastewater.

1.2.2. Definition

Inspection is a visit to an industry engaged in a prescribed activity for the purpose of collecting information to determine if the industry is complying with the EPL procedure and pertinent environmental laws and regulations. In inspection work, the CEA inspectors visit an industry to gather information and/or collect samples and/or conduct tests, as necessary, to find out whether the industry meets the required standards and criteria or not.

1.3. Purposes of Inspection

The purposes of inspection may be summarised as follows:

1. To determine the status of compliance of industries or establishments engaged in prescribed activities with the EPL requirements and conditions;
2. To collect information and data which may be used as evidence in the environmental litigation process;
3. To verify accuracy of information submitted by industries or establishments engaged in the prescribed activities, pertaining to new EPL applications, renewals, or modifications, etc.;
4. To investigate complaints or reports of (environment related) accidents made by private or public entities;
5. To assess industry's performance, and
6. To guide the companies in the improvement of their performance in wastewater management and treatment.

Since the inspection is the first contact of the CEA with the industry being inspected based on the EPL; the inspectors should be fully prepared and be ready to explain the purpose of the inspection to the industry's representatives.

The inspection shall be focused primarily on collecting information about the industry's operations and characterization of its water discharges, etc., in order to assess whether the wastewater or other discharges have potential to cause damage to the environment.

Why do we need to protect water environment?

⇩

Water is one of the most important natural environmental resources

⇩

People as well as all lives depend on and benefit from water environment

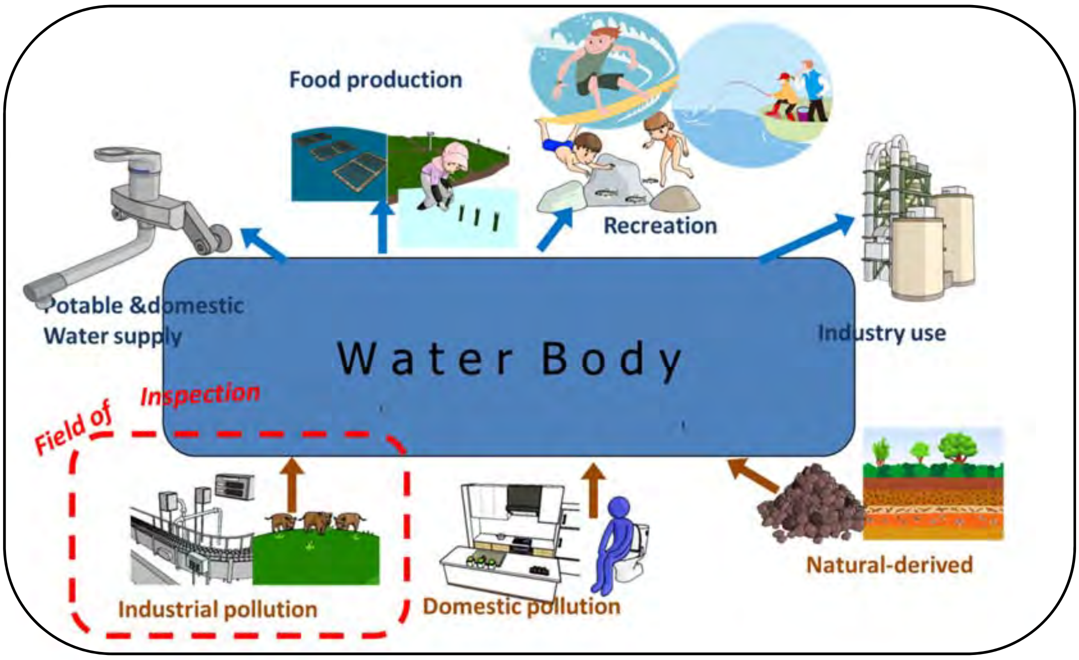
Beneficial use of water

- Potable & Domestic Water Supply
- Industrial Water Supply (Processing, Cleaning, Washing)
- Food Production (Agricultural, Livestock)
- Fisheries and Aquatic Resources
- Recreation (Swimming, Diving, Boating, etc…)
- Waste Disposal

⟷

Source of water pollution

- Point Sources
  - ✓ Industrial Pollution
  - ✓ Domestic Pollution
- Non-point Sources
  - ✓ Agricultural Runoff
  - ✓ Naturally Derived
- Natural Sources
  - ✓ Storm or Rainwater Runoff
  - ✓ Flood, etc.

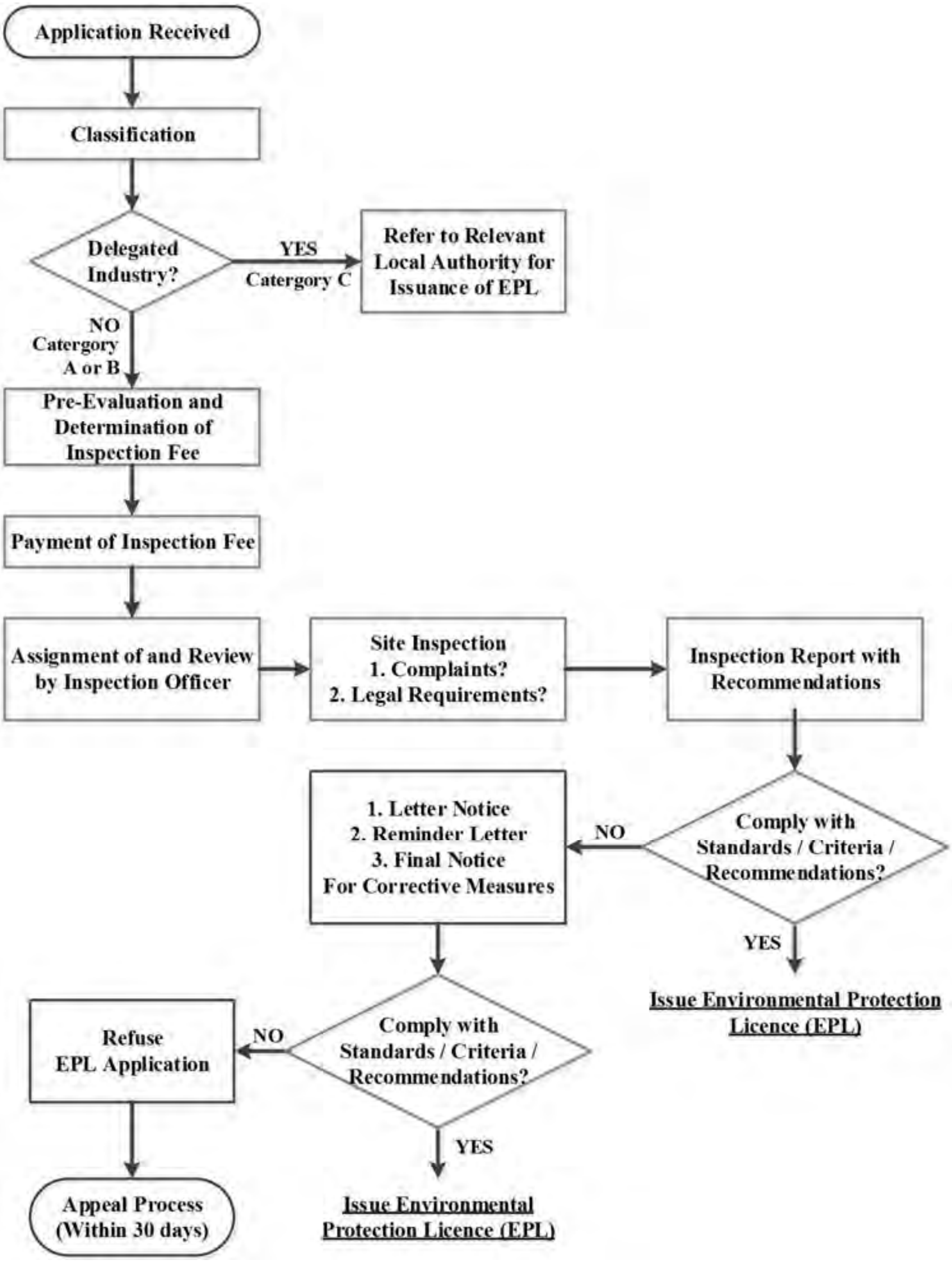


What is an EPL System?

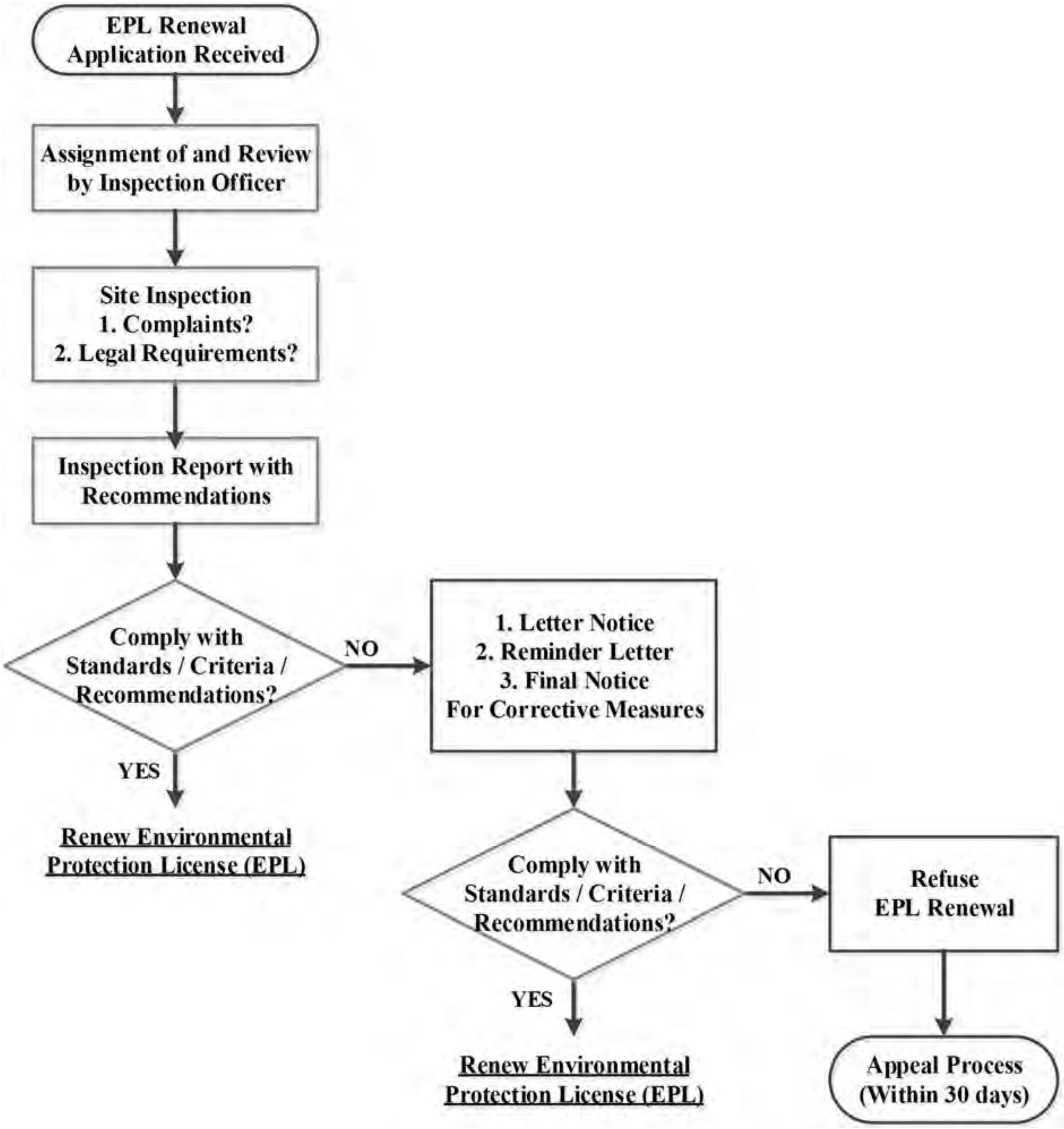
The EPL is a license that is required by the NEA to be obtained for prescribed activities which involves or results in discharging, depositing, or emitting waste into the environment; thereby causing pollution. All industries, companies, establishments, or facilities which discharge effluent, dispose of solid wastes, emit smoke, gases, fumes, or vapour, or generate noise into the environment shall comply with the standards and criteria published under the National Environmental Act and its provisions.

The EPL system encourages the industries or establishments engaged in the prescribed activities to perform or operate in an environmentally friendly and sustainable manner.

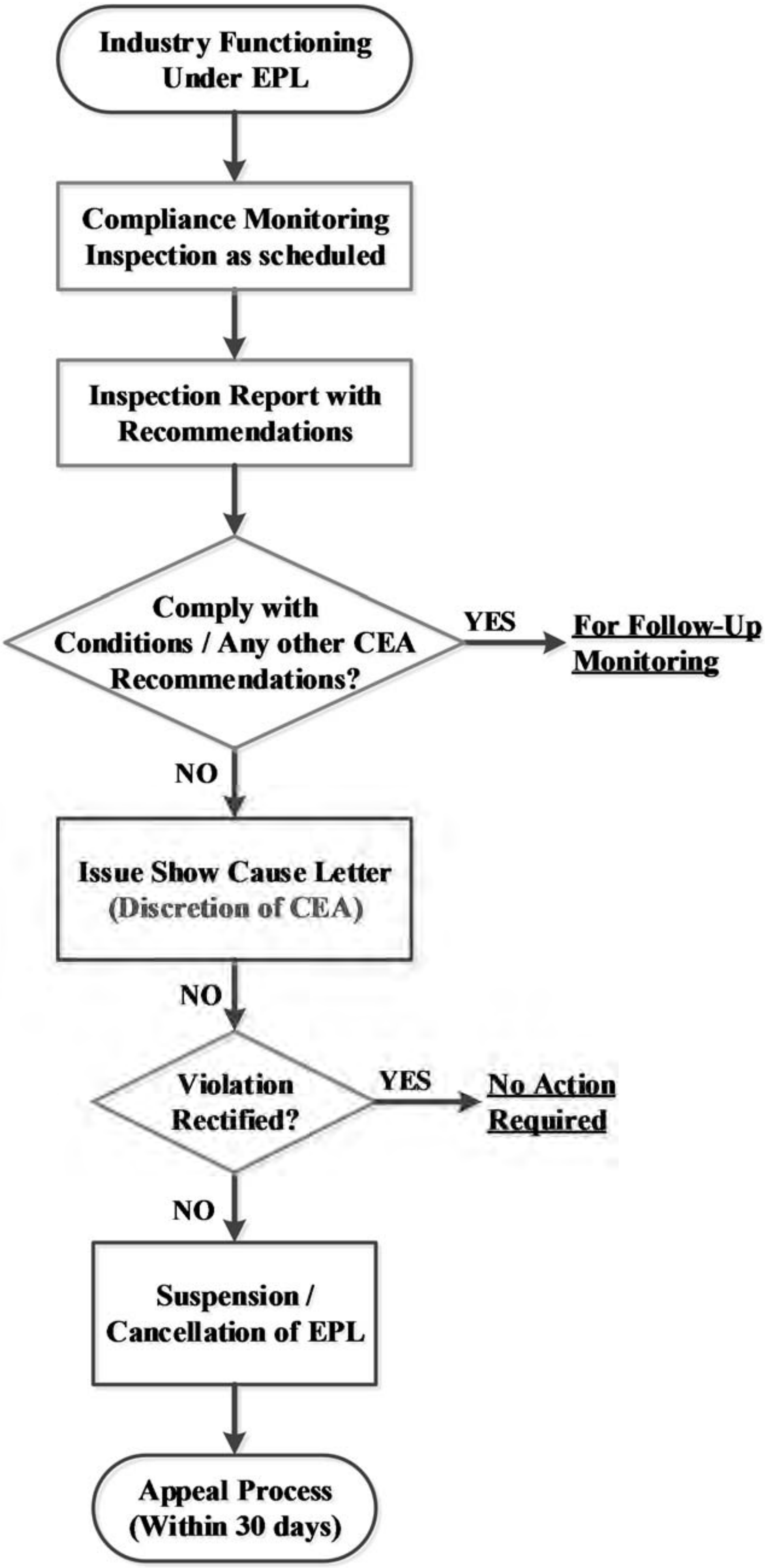
Procedure for Issuing NEW Environmental Protection License (EPL)



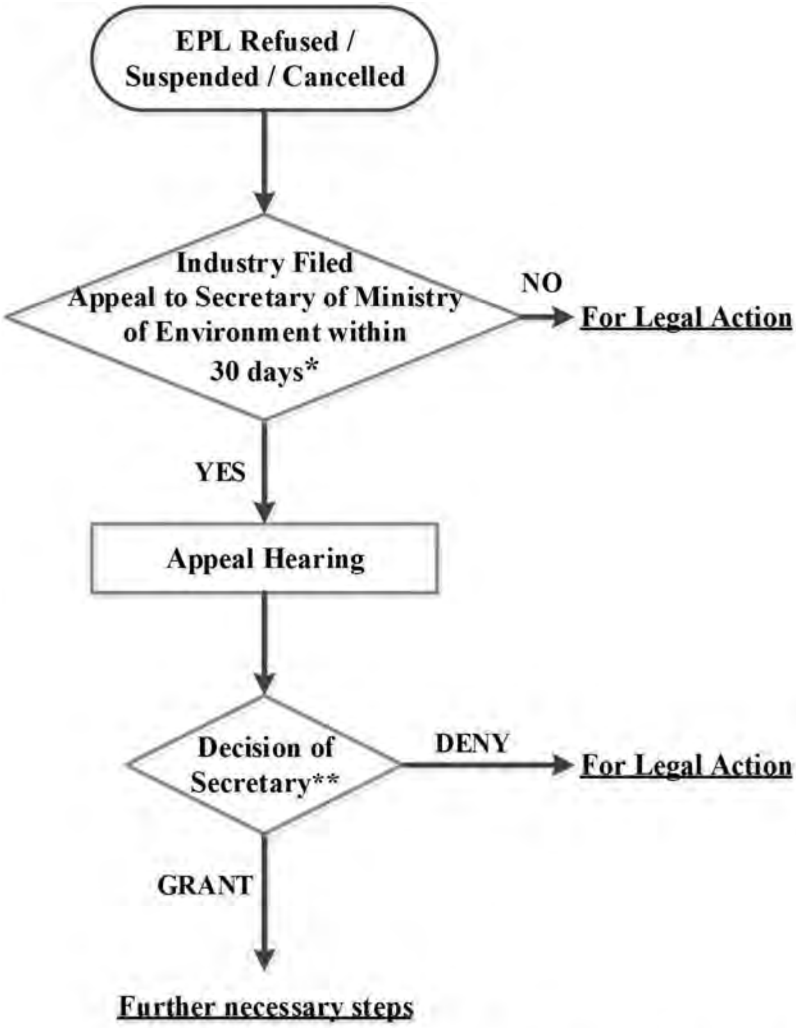
Procedure for Issuing Environmental Protection License (EPL) RENEWAL



Compliance Monitoring Procedure



Appeal Process



* Refusal, suspension or cancellation of the EPL (appeal is a discretion of the industries)

** The DECISION of the Secretary of Ministry of Environment is FINAL and CONCLUSIVE

2. SCOPE OF INSPECTION

2.1. Roles and Responsibilities of Inspectors

The CEA inspectors, in particular, are the ones authorized by law to conduct inspection. This authorization is applicable for any activity prescribed by the law.

The main role of the inspector is to assure compliance with the requirements and conditions of the EPL. The inspector promotes compliance by the use of techniques which detect violations. The inspectors must also compile all the information collected and make the report which indicates:

Explanation of the condition on the EPL

Recommendation on compliance with the EPL

In order to conduct the inspection woks adequately and smoothly, the inspectors have responsibilities as listed below:

1) Legal Responsibility

Inspectors must conduct all inspection activities within the legal framework established by the activities including:

- presenting proper credentials
- proper handling of confidential business information

The inspectors must also be familiar with the license conditions and the environmental requirements indicated in the EPL system and relevant laws and/or regulations.

2) Procedural Responsibility

The inspectors perform a major role in compliance monitoring. Inspectors, therefore, must be thoroughly familiar with the general procedures and evidence collection techniques to ensure adequate inspection and to avoid endangering potential legal proceedings or procedural grounds.

The CEA staffs who conduct compliance inspection shall ensure that they have practical and actual knowledge of regulatory requirements, inspection methodology / technique, and also health / safety measures.

3) Safety Responsibility

It is possible that, aside from the manufacturing or production facilities themselves, wastewater treatment plants as well as other pollution control facilities pose a certain degree of health and safety risks to the inspectors. The inspector, therefore, must be familiar with all the safety risks, obligations, and practices during the conduct of the inspection.

4) Professional Responsibility

It is expected the inspectors to perform their duties with the highest degree of professionalism. In addition the inspector is the representative of the CEA or may be the initial / sole connection of the CEA to the industry. Inspectors, therefore, must be professional, that is, well-prepared, honest, tactful, courteous, respectful, diplomatic, and properly attired.

5) Quality Assurance Responsibility:

Because inspection is the main basis for judging whether or not the performance of an industry can qualify for an EPL and meet its requirements; the inspectors shall ensure the quality and accuracy of the inspection and sampling of wastewater, if collected. All data introduced to the inspection file should be fully accurate and representative of the existing conditions.

2.2. Types of Inspection

There are five (5) types of inspection works conducted under the CEA jurisdiction under EPL system.

1) "Drive-by" Inspection:

A "drive-by" inspection may be the simplest one taken by the CEA. A visual examination of a factory or facility or industry undertaking a prescribed activity is made from an automobile or another viewpoint not within the facility's boundary, and usually made without the industry's knowledge. It will be taken in the working hours and the waste management practice, presence or absence of visual environmental conditions, or any aspects of industry operation would be observed. A drive-by inspection can also be used as means of identifying facilities or operation potentially subject to specific requirements under the law and regulations.

2) Walk-though Inspection:

A walk-through inspection may be the most commonly used type of the inspection. This inspection includes entry into the facility, review of documents, hearing or conference with industry owner and/or representative, observation of regulated activities, operations, and practices, and exit from the facility.

This inspection is useful to establish a presence and can be especially valuable as follow-up for verifying that corrective action has been taken following earlier more elaborate compliance evaluation. It is also useful for identifying any unauthorized expansions or changes in operation or processing, and for verifying hidden operations.

3) Compliance Evaluation Inspection:

A compliance evaluation inspection targets verification of EPL compliance and/or renewal, so that it shall be more structured. It requires the inspection team to have a wide range of knowledge, skills, and abilities.

4) Sampling Inspection:

Sampling inspection focuses on taking physical samples of discharged water or effluent. Sampling inspection may be conducted as a part of Walk-through Inspection or Compliance Evaluation Inspection. Since compliance evaluation inspection may be used for verification of EPL compliance of the factory; sampling inspection shall be taken in the same time.

5) "Beyond Compliance" Inspection:

Beyond-compliance inspection is used for encouraging better environmental performance and behaviour that achieves standards more protective than are legally required. In some case, it is expected that inspection assists to identify opportunities for reducing pollution by prevention rather than treatment. In the other cases, this inspection can be targeted at the management systems and processes that facilities use to institutionalize their environmental performance and compliance.

In fact, inspection may be taken in the combination of above inspection types.

2.3. Qualification of Inspectors

2.3.1. Team formation for the Inspection

It is the policy under the CEA that at least two (2) officers shall be assigned for the inspection work as a team. Recruitment and advancement of staff assignment shall be based on the CEA Scheme of Recruitment and Promotion. Basic team formation is described in the following table:

Table 2.1 Team Formation of the Inspection

Title	Qualifications	Trainings
1) Inspector	More than 3 years on-site training in the inspection works as assistant inspector, Evaluation by inspector and supervisor 1)	Training capacity building, on-job-training in the inspection work, technical seminar, workshop
2) Assistant Inspector	Basic recruitment under the CEA scheme	3 months induction training by HRD 2), technical seminar, workshop

1) Director of his/her division, for example
2) Human Resource Division or responsible section in charge

The leader of the inspection team shall be appointed by their supervisors from among the qualified inspectors. The inspector shall be responsible to train in the field and evaluate the assistant inspector on practical knowledge and skills.

The person who is involved in the inspection must be skilled in obtaining the critical information which is necessary to determine compliance or non-compliance with the EPL, aside from his/her administrative competencies.

Since a main purpose of the inspection is to evaluate compliance assurance under the EPL system; the inspectors needs a combination of skills / experiences in engineering, technical, scientific, legal, economic, and administrative matters.

2.3.2. Necessary Knowledge

1) Technical Knowledge

Inspectors are required to possess technical knowledge on industrial processes and manufacturing operations in order to identify and find problems and pollution releases; otherwise, inspection cannot be properly conducted. It will then be difficult to convey any credible technical advice or assistance to the industries and/or facilities being inspected.

It is also important for inspectors to have sufficient technical understanding of pollution control measures as well as monitoring techniques.

2) Legal Knowledge

The inspection may be the first and only contact with the industry. As such, the inspectors should collect necessary information which shall form sufficient basis or evidence for sound and fair judgement on compliance with effluent standards and/or EPL requirements or conditions. Furthermore, the inspector may be called to give evidence on the collected data or he may be called as an expert witness in legal cases.

In addition to the judgment on EPL compliance, the information collected should also be adequate to proceed to legal action. Therefore, all the staff involved in inspection must have sufficient knowledge relevant to legal matters and collection of evidence that will stand scrutiny in a court of law.

3) Knowledge on Health and Safety

Inspectors must have sufficient knowledge on health and safety in order to protect themselves and others who may be involved in the inspection work. Such health and safety knowledge includes industrial hygiene requirements. Dangers may be physical, such as from machinery or unsafe ground or areas, electrical facilities, or from chemical, toxic or hazardous materials.

Besides the abovementioned sufficient knowledge to cope with core functions; inspectors shall be familiar and updated with new policy instruments like "company internal environmental plans", "environmental management systems", "self-auditing", "certification" and "annual corporate environmental reports":

- Inspectors must have a clear picture regarding environmental management systems, audit, certification, and annual environmental report;
- They must be able to form an overall opinion of the environmental performance of company for auditing skills and understanding of business management;
- They must be able to form a sound opinion of an environmental management system in a company on the basis of audits, its reports, and certificate;
- They need knowledge and skills with regard to auditing due to the new approach in supervision in order to perform in-depth inspections if necessary;
- Their opinion on the environmental performance must be made as explicit and substantiated as possible for conducting a meaningful discussion with the company management;

- They must be able to distil from the information collected to identify compliance with relevant regulatory requirements, and with targets of voluntary agreements, where applicable;
- They must be able to validate the environmental information from the company. This requires sound knowledge of measuring, registration, and reporting systems.
- They must have a good communication and cooperation with licensing and enforcing officials.
- They must be able to clearly distinguish between supervision and enforcement; hence, they require flexibility, improving skills and a systematic approach.

2.3.3. Trainings

It is the policy under the CEA to organize trainings for candidate inspectors to ensure that their skills and knowledge are adequate and satisfactory for proper and competent inspection works. Expected subjects include but are not limited to the following:

1. Basic knowledge and skills on chemical, physical, biological environment,
2. Legal framework related to environmental protection and pollution control in Sri Lanka.
3. Chemical engineering on wastewater treatment technologies for factories to be inspected.
4. Production processes of factories to be inspected
5. Communication and coordination skills between inter and intra relevant authorities.
6. Water quality sampling
7. Specific experience, if necessary, *e.g.*, toxicology, aquatic biology,
8. Others

The trainings are conducted in the following manners:

1) Basic Training

   Once staff is appointed as an inspector; basic training must be given. Basic training may be an “Entry Level course”, that is to say, a first training given to new staff. It includes the above subjects for training. Entry level training programmes shall be arranged for a period of three (3) months or six (6) training modules.

2) Regular training

   The CEA give regular trainings to ensure inspectors to retain or raise their skills for promotion. The regular trainings shall be held once a year.

3) External training

   The CEA may also organize external trainings which encourage inspectors and any other staff in the CEA to improve and expand their skills as well.

4) On-site training

The purpose of on-site training is to accumulate practical experiences on handling and performance of inspection works, and to experience actual situation through how the trainer collect information by visual observations, interviews, etc. Only a leader of inspection team, meaning, a Senior Environmental Officer or higher position may act a trainer.

5) Performance evaluation system

Performance evaluation shall be undertaken in order to assess and validate the inspector's knowledge and skills. The performance evaluation may be done through tests, examinations, and/or interviews after regular / external training or on-site training. It also serves as a basis for promotion. Performance evaluation shall be undertaken every year.

2.4. Schedule of Inspection

2.4.1. Renewal of EPL

CEA prepares an annual schedule for the EPL renewal process. The schedule of the inspection for EPL renewal process of each EPL holder is provisionally set three (3) months prior to the EPL expiry date and marked accordingly on the annual schedule.

2.4.2. New EPL

According to the regulation, "Gazette notification No. 1534/18" published under the NEA, and application for a new EPL shall be made at least thirty (30) days prior to the commencement of the activity. Therefore CEA has to conduct an inspection for the new EPL within one (1) month of submission of the complete application by the prescribed industry.

2.4.3. Complaint and Accident

CEA has the system to respond to complaints and/or accident cases as immediately as possible once claimed.

"Drive-by" inspection (page 9: Types of Inspection) could be useful to quickly find out the actual situation of problem. It should be conducted within twenty four (24) hours of receipt of the report or complaint.

The results of "drive-by" inspection shall be referred to for the formulation of further inspections.

2.4.4. Compliance Monitoring, Follow up

Compliance monitoring or follow-up inspection could be formulated in accordance with justification and recommendation issued in the previous inspections. Due to limitation of team formulation of inspectors, the following criteria for prioritization for scheduling of such irregular inspections are suggested:

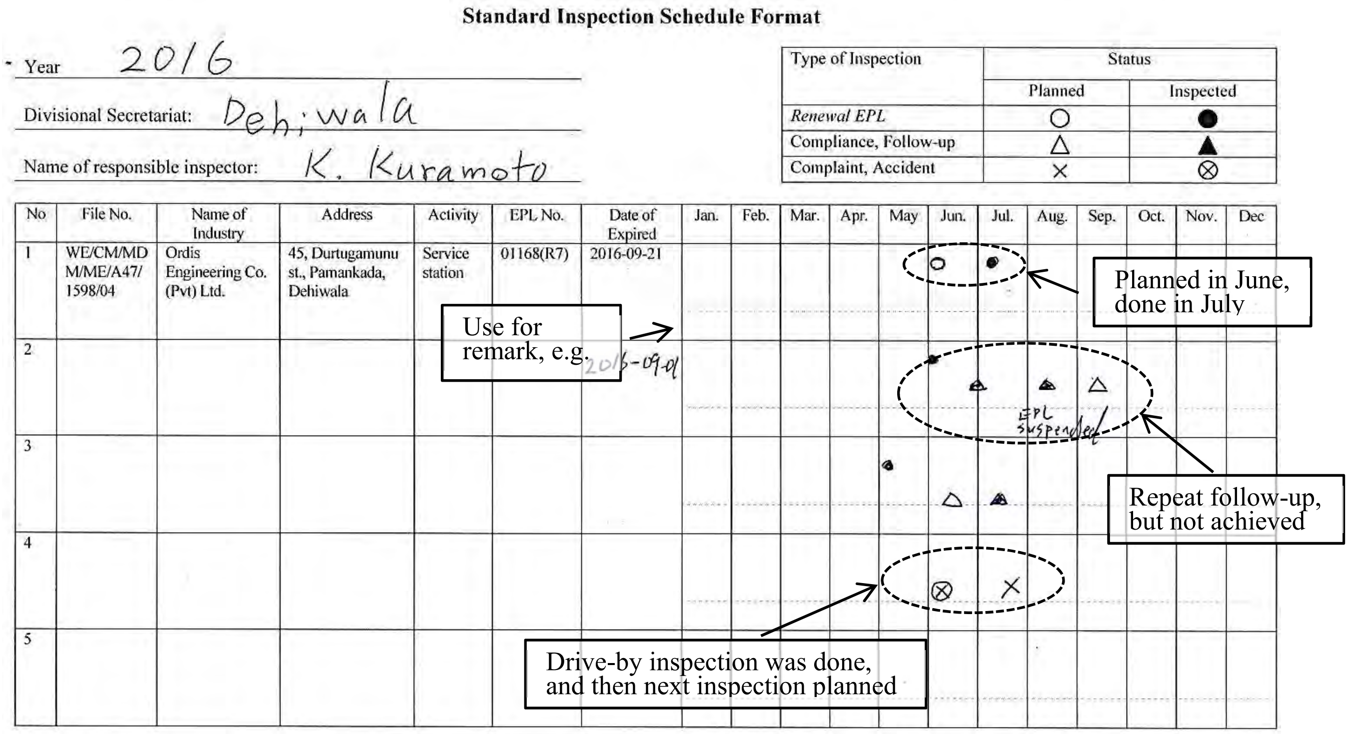
- Possible critical environmental problems or adverse effects may occur if no action is taken by the industry or facility or establishment;
- EPL holders which have remained in violation of standards or regulations for an extended period of time beyond what was allowed;

- Times and/or duration of non-compliance after the EPL holders are informed of violations or deficiencies;
- Past due date indicated in the justification and recommendation;
- Belonging to a priority sector (see Appendix C: Priority sectors and parameters to be inspected), and others

2.4.5. Standard Inspection Schedule and Monitoring Format

A standard inspection schedule format is attached in Appendix C: Standard Inspection Schedule Format. The figure below is an example of schedule with symbols to indicate current (monthly) status.

Table 2.2. Example of Inspection Schedule



Standard Inspection Schedule Format

Year 2016

Divisional Secretariat: Dehiwala

Name of responsible inspector: K. Kuramoto

Type of Inspection	Status	
	Planned	Inspected
Renewal EPL	○	●
Compliance, Follow-up	△	▲
Complaint, Accident	×	⊗

No	File No.	Name of Industry	Address	Activity	EPL No.	Date of Expired	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec
1	WE/CM/MD M/ME/A47/ 1598/04	Ordis Engineering Co. (Pvt) Ltd.	45, Durtugamunu st., Pamankada, Dehiwala	Service station	01168(R7)	2016-09-21						○	●					
2											●	▲		▲	△ EPL suspended			
3											●	△	▲					
4												⊗	×					
5																		

Planned in June, done in July

Use for remark, e.g. 2016-09-01

Repeat follow-up, but not achieved

Drive-by inspection was done, and then next inspection planned

3. PROCEDURE OF INSPECTION

3.1. Overall Outline of Inspection Procedure

There is a standard inspection procedure in order the inspectors to effectively carry out inspection works.

The major inspection activities include:

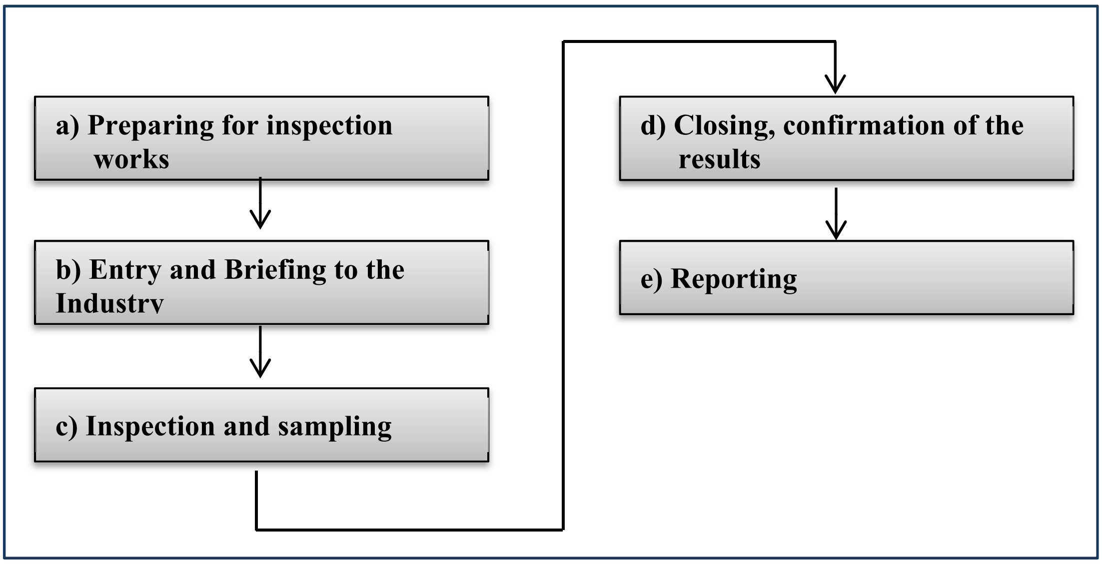


Figure 3.1 Standard Procedure for the Inspection

3.2. Inspection Procedure

3.2.1. Preparing for Inspection Work

Preparation for the inspection must be taken as follows:

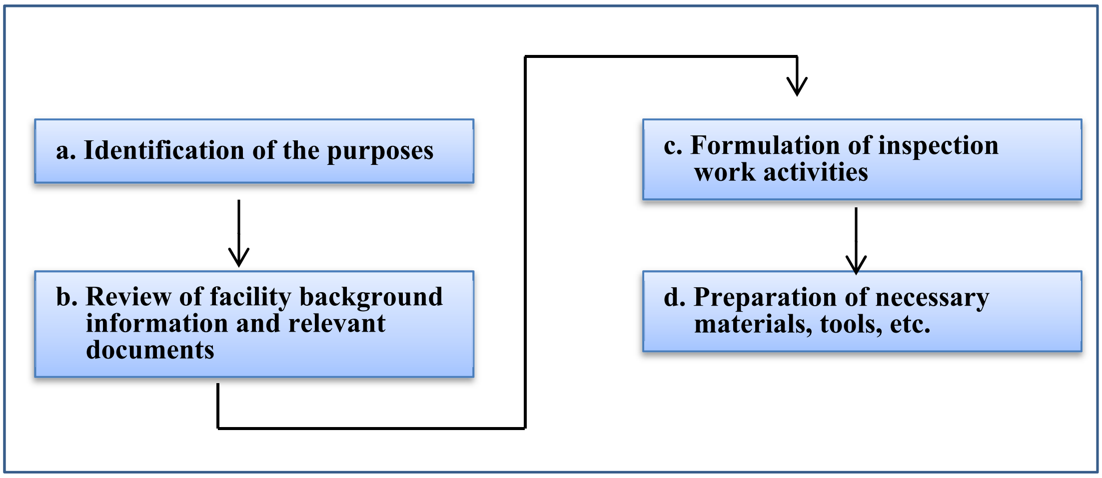


Figure 3.2 Procedure for the Preparation of Inspection

a) Identification of the Purposes

The purposes of the inspection should be clarified so that inspection work plan is formulated based on the types of inspection described in the Section 2.2. Basically, the purposes may depend on the type of application, whether new or renewal of the EPL, or investigation for environmental accident or complaints.

Inspection targets:

New application of prescribed activities: First inspection would be conducted in this case. The inspection mainly focuses on how the industry identifies and mitigates their pollution to be discharged to the environment. The results of the inspection shall be used for evaluating and then finally issuing for EPL.

Renewal of EPL: Basically, this is the same as above case of new application; although, some of activities may be minimized or skipped. The purpose will be to check for compliance with EPL conditions and environmental standards.

Regular Compliance Monitoring: This shall be carried out in accordance with the schedule prepared by authorized office.

Request Basis: A special purpose shall be given based on the request. The basis may be such as environmental accidents or complaints.

b) Review of industry background information and relevant documents

Collection and analysis of available background information is essential to the effective planning and overall success of an inspection. Relevant materials such as documents obtained from the CEA, other inspector's personal experiences, experience from similar factories, etc. could be useful to the inspector to become familiar with the operation and history of the industry to be inspected. The following expected information shall be reviewed:

- Vicinity map;
- Plant or Factory layout;
- Manufacturing or production process flow diagram
- Sources of water supply;
- Water Balance (incoming supplies and outgoing discharges)
- Wastewater quality and quantity in each different processes;
- Wastewater treatment methodology;
- Discharge points;
- Sampling points;
- Production levels;
- Previous inspection reports and results of wastewater analysis and others.

In addition, special entry requirements, safety requirements, etc. shall be checked if necessary.

c) Formulation of inspection work activities

The inspection plan should first address the inspection type, purposes, and goals of the inspection. The CEA prepares a standard procedure of inspection with inspection report format. Actual inspection works shall be based on the standard procedures, and the following items must be considered:

- Objectives
  - What type of inspection is adapted?
  - What is to be accomplished?
- Activities
  - What activities are to be conducted?
  - What information must be collected?
  - What records will be reviewed?
  - Will sampling of wastewater be conducted?
- Procedures
  - What procedures are to be used?
  - Are there special procedures requested?
- Resources
  - Who is involved in the inspection team?
  - What equipment will be used or needed?
- Schedule
  - Will notice of inspection be distributed in advance to the factory to be inspected if necessary?
  - What will be the milestone?

Once the inspection plan is scheduled; a team meeting shall be held in order to ensure proper coordination among the inspection team members and concerned persons. In case specific sampling work of wastewater is planned; this shall be coordinated with the laboratory.

It is necessary to obtain the documents and/or orders for inspection regarding the other related administrative issues, for instance, mission order, travel order, IDs, certificate of appearance and commitment form, to avoid any problems during inspection.

d) Preparation of necessary materials, tools, etc.

The following items shall be prepared and checked:

- Identification card;
- Inspection check sheet, notebooks, pens, calculators, compass, and GPS;
- Camera, flashlight, stop watch, tape measure, ruler;
- Sampling kit and field meter or test instruments (pH, Temperature, DO, and others), tools for flow measurement (bucket, cylinder, etc.);
- Safety tools/devices: working wear, shoes, helmet, gloves, etc., and
- Others, as required

Inspectors shall follow the safety regulation issued by the company during facility inspection.
The following is recommendable working wear:

e) Check List for Preparation Work

The inspector shall validate the inspection procedure with Inspection Plan Sheet; and then the preparation process shall be recorded in the Preparation Check Sheet.

Inspection Plan Sheet and Preparation Check Sheet are given in Appendix B.

3.2.2. Entry and Briefing to the Industry

Entry to the Facility

When inspection team enters the facility, the inspectors should follow correct administrative procedures and requirements. They should go through company protocols and conduct themselves in a professional manner starting with the presentation of their credentials. In addition, they shall properly and clearly explain the purpose and legal basis of the inspection, if necessary.

In case the inspection team is not allowed to enter the industrial premises to conduct the inspection, the inspection team leader shall inquire about the reason for denial of entry; and if there is any obstacle or misunderstanding, he shall try to clear it. If entry is still denied despite the explanation; the lead inspector shall calmly inform and warn the industry representative that denial will be a violation of the NEA, and relevant legal procedures may follow. The denial of entry shall be immediately reported in writing to the CEA management for proper and immediate action.

Briefing

After entry to the facility, the inspection team will hold a short meeting with the owner /or representative of the industry to give brief information on the purpose and scope of inspection and the planned activities in that facility. At that time, the inspection team will gain understanding on the plant operation, and seek assistance and cooperation from the industry staff in gathering the necessary data and information. It is also a chance to learn more information about the industry operation, plant/factory layout, management structure, plant safety requirements and other information relevant to the inspection.

Basically the inspectors should clarify the following:

- Explain the purpose of the inspection and the scope of activities during the inspection.
- Identify or look for the responsible persons at the site, and request technical personnel to accompany the team during the site inspection. This will facilitate access to areas that are normally off limits.
- Clarify safety issues or concerns in the site.
- Verify the site activities and their environmental implications.
- Verify applicability of the EPL.
- Request to take samples and photographs, if necessary, but only after obtaining permission to do so.

The following information should be obtained from the industry:

- History of reports and correspondence on previous inspections,
- Notices sent to the industry, especially on previous infringements or violations or deficiencies and approvals;
- Reports on the industry from other relevant authorities;
- EPL applications, previous environmental recommendations and complaints; any other relevant documents/reports;
- Discussions, previous approach, timing and expected results with colleagues and supervisors;
- ISO 14001 certification, or others such environmental certificates;
- Company's business partners, etc.;
- Company environmental reports;
- Press release about the company, including pollution incidents;
- Layout plan (especially showing the sewer and drainage pipe lines and/or channels), manufacturing or production process flow diagram
- Test results (such as results of analysis of samples)

3.2.3. Inspection and Sampling

3.2.3.1. Inspection

Overall Observation of Facility Condition

Before conducting facility inspection, the inspection team should make an overall observation of the periphery of the facility to grasp facility condition. For new applications for EPL, such details as general size of the facility including the number of buildings at the site shall be verified. Any signs of apparent spills around the facility, conditions of surrounding vegetation, odour problems and possibility of direct discharge of wastewater to receiving stream must be identified and recorded, preferably including photographs, if permitted. In addition, all other observations pertaining to waste storage areas or chemical storage areas, fuel oil/waste oil storage area, secondary containment which is visible from outside should be noted.

The other points to be observed are listed below:

- Dead or unhealthy vegetation;
- Ponds or lagoons in the property that appear to contain oily or discoloured water or sludge;
- Leaky containers
- Uncovered piles of waste
- Oil or discoloration of water in streams or rivers surrounding the property
- Strong or noxious odour, etc.

> The inspection team should be flexible to amend the inspection plan and consider pursuing the observations depending on the actual situation. If inspection is for complaint investigation; or if inspector suspects a potential breach of regulations; the inspector should conduct interviews and general observation at the immediate vicinity, especially with the residential community, before proceeding with the facility inspection. Taking pictures of the surroundings and gathering additional evidences should be also conducted at this stage.

Facility Inspection

Facility inspection shall focus on checking of production process, wastewater treatment process, and any other relevant aspects. It is very important to obtain a full description and understanding of the facilities' processes and to verify information provided by the industry representative. The inspection also allows the inspector to identify problem areas that can be improved through pollution reduction techniques.

The facility inspection should cover all the areas of the industry where wastewater and/or pollutants are generated, processed, pumped, conveyed, treated, or stored. The industry's production processes, storage areas, and treatment equipment shall also be surveyed.

The inspector should gain a full understanding of the industry's wastewater generation and treatment. For better understanding of the entire process, it is necessary to start survey from raw materials processing to the finished products.

Throughout the inspection, the inspector needs to observe all sources or potential sources of wastewater discharge. The information collected shall include discharge condition such as:

- Discharged water is temporarily stored or continually discharged (batch or continuous discharge);
- Discharged volume at each discharge point;
- Frequency of each discharge, etc.;
- For certain industries, wastewater discharge during production may be low or minimal but will greatly increase during cleaning at the end of shift or end of production run.

Wastewater flow is needed to estimate total pollution load. If available, wastewater flow rate or volume from each process shall be obtained from the industry representative. Or the flow rate shall be measured during the inspection. The information related to incoming flow (water supply) to the facility will be provided by the industry. The inspector may be able to estimate a rough water balance. If the water balance shows possible large discrepancies between incoming flow (water supply) and outgoing water discharge; the inspector should inquire into possible reasons from the industry representative.

The points to be inspected and observed are dependent on the types of factories. In general, the following possible problems with treatment facilities shall be surveyed[1]:

1. Abnormal build-up during treatment
   - Excessive plant growth in the stabilization ponds;
   - Excessive scum, foam, floating material accumulated in treatment and settling tanks;
   - Fouling of fabric or other solids in micro-screens with grease and solids;
   - Sludge accumulation in clarifiers indicated by floating sludge pads and gas bubbles, etc.
2. Unusual discharge
   - Surcharging (overflow) of influent lines and overflow weirs
3. Alternative Discharge Points
   - Old valves or channels from previously upgraded system;
   - Pipes or channels showing occasional use;
   - Erosion or run-off from land discharge sites, etc.
4. Abnormal/Obnoxious Odour from
   - Wet wells, grit chamber, aerobic/anaerobic biological units, scum removal devices, and sludge handling facilities, etc.
5. Broken or Unusual Equipment
   - Note presence of special pump
   - Presence of floating aerators in diffused air systems
   - Any structure that appears to be temporary
   - Clogged sprinklers, dripping nozzles, broken pipes (land discharge)
6. Other Basic Observations
   - Are the by-products of treatment or production being disposed of properly?
   - Are safeguards adequate to prevent the discharge of untreated or partially-treated wastes?
   - Is there evidence of past spills?
   - Is there ponding of wastewater in the irrigation field (land discharge)? etc.

[1]Referred to Water Quality Program Inspection Manual, Washington State Department of Ecology

3.2.3.2. Water Sampling

If sampling is needed in order to confirm water quality discharged and/or any suspicion of water pollution exceeding effluent standard; sampling work, at least sample collection, shall be undertaken in the same time of inspection as much as possible.

Therefore, it is required to involve a sampling officer or his/her representative, or the inspectors have to be qualified to conduct sampling procedures.

If it is not possible to collect samples due to some unavoidable reason; the inspector shall inform the laboratory section of the necessity of; and then have the sampling scheduled as soon as possible.

Inspection team shall decide on the necessity of water sampling, and then if sampling is recommended, selection of target parameters/ pollutants must also be considered. The followings are examples of criteria for judgement of sampling:

- Abnormal wastewater is observed.
- Wastewater treatment plant does not function properly.
- Recent results of water monitoring have not satisfied the standard level.

Selection of target parameters / pollutants must be based on the character and source of polluted water. Appendix D: Priority Sectors and Parameters to Be Inspected, *Matrix Table of Priority Parameters*, may guide the selection of target parameters according to industry sector.

The inspector shall provide, beforehand, to the sampling team detailed information on actual conditions and background of the necessity of sampling.

3.2.4. Closing and Confirmation of the Results

After the facility inspection is completed, the inspection team shall conduct the closing conference or meeting in order to confirm the preliminary findings with factory side. At this time, it is not reasonable for the inspection team to express their judgement whether the industry is in compliance or not due to insufficient data such as their effluent quality results of analysis.

In the closing conference, the inspector will describe deficiencies found, areas of some concern, etc. The inspector can also request other required data which are not readily available during the inspection.

> Timing and venue of closing meeting shall be flexible. Discussion and conclusion could be taken during or just after facility inspection in the site. Importance is to share results and make agreement with the representative of industry.

3.2.5. Assessment and Evaluation of Results of Inspection

The purpose or purposes of an inspection influence the assessment and evaluation of the results of an inspection.

a. If the purpose of the inspection is to determine the status of compliance with the EPL conditions and environmental regulations, the results of the inspection, in particular, the results of analysis of effluent (and gaseous) samples collected are compared with the relevant parameters in the effluent standards (*Gazette notification No. 1534/18 dated 1/2/2008*). The type of industry defines the priority pollution parameters. The industry sector guidelines provide information on the priority pollution parameters by industry sector.
   Aside from the effluent standards, compliance with gaseous emissions standards, solid waste disposal regulations, and toxic and hazardous materials and waste management should also be evaluated.
   For inspection for renewal or regular inspection for monitoring, compliance with specific and additional conditions in the EPL needs to be assessed. This requires prior review of the EPL conditions.

   b. If the purpose of the inspection is to collect information and data which could be used as evidence in the environmental litigation process, it is imperative that the procedure for identifying and collecting information and data be strictly followed to ensure that any evidence collected is admissible in a court of law. Refer also to Section 3.4.2, Table 3.1., and Section 3.4.2.2. of the *Inspection Guideline for Water Quality Section, June 2017*.

c. If the purpose of the inspection is to verify accuracy of information submitted by industries or establishments engaged in the prescribed activities pertaining to new EPL applications, renewals, or modifications, the observations and other results of the inspection are compared with the information officially submitted by the industry or establishment. The results of analysis of samples collected by CEA sampling officers and analysed in the CEA laboratory takes precedence over any other result. However, due allowance should be made for normal variations in the results of analysis of samples taken at different occasions even from the same sampling stations.

d. If the purpose of the inspection is to investigate complaints by private or public entities, the results of the inspection should be compared with the specific basis of the complaints. The effluent standards (*Gazette notification No. 1534/18 dated 1/2/2008*) and environmental laws and regulations are the basis for determining the validity and legality of a complaint.

e. If the purpose of the inspection is to assess an industry's (environmental) performance (aside from compliance with effluent and discharge standards), the results of the inspections should be compared with the data on industry performance in the pertinent industry sector guidelines. In the future, it will be possible obtain information from the database (PSI or Pollution Source Inventory) on industry performance such as specific wastewater generation rates (*i.e.*, volume of wastewater generated per unit product quantity).

f. If the purpose of the inspection is to guide the companies for the improvement of their performance in wastewater management and treatment, the results of the inspections should be compared with the data on industry performance in the pertinent industry sector guidelines. Methods for improving environmental performance presented in the industry sector guidelines may be offered to the industry or establishment.

g. The inspection team should take the time to quantify the specific pollution generation rate (such as, m^3 wastewater or kg BOD_5, COD, TSS or other relevant pollutant generated per unit quantity of product produced) per industry type. However, this requires information such as wastewater flow rates and untreated raw wastewater characteristics. Information on the latter is not routinely reported or obtained. Nevertheless, such specific pollution generation rates are helpful in determining the environmental performance of industries and may guide them towards improving their environmental performance. In addition, consolidating and analysing the data can provide insights that are useful in overall environmental management.

3.2.6. Conclusion Regarding Compliance

The results of inspection must be the evidence on compliance with the EPL; however, the inspection report should not conclude on judgement of the EPL compliance; it should just indicate recommendation in terms of the compliance. The report should contain only the facts on the inspection. It, however, is realized that the inspector's conclusion on the compliance of the company are the critical factors in the decision as to whether a violation occurred or not. It is essential that the inspection report includes the inspector's recommendation regarding the decision of compliance and further action.

Although the inspector may communicate with the company on his/her view on certain matters; facts and/or figures should not be mixed with his/her personal opinions. If the inspector has concluded non-compliance by the company inspected and provided recommendations for further actions; due date of action to be taken by the company shall be set and agreed with representative. In addition those instruction and due date should be mentioned in the enforcement letter sent to the company.

3.3. Inspection Report

3.3.1. Inspection Report Attributes

The inspector has the basic responsibility of providing documented evidences on discrepancies discovered during the facility inspection. One of the main objectives of the inspection is to organize and coordinate all inspection information and findings into a comprehensive usable document in accordance with the standard form. In order to meet this objective, information in an inspection report must be presented in a clear and well-organized manner. And then the results of all inspection work are properly described in the form of a written report. The CEA formulates a standard form of Inspection Report; the inspection team shall use this standard form for their reporting. The standard format of inspection report is included in the Appendix C.

In order to satisfy the requirements in the reporting, that is to say, to organize and coordinate all evidences collected in the inspection in a comprehensive and useable manner; the inspection report shall have the following attributes:

- Accurate
  - All information must be factual and based on sound inspection practices. Enforcement personnel must be able to depend on the accuracy of all information.
- Relevant
  - Information in the inspection report should be pertinent to the subject of the report.
- Comprehensive
  - The subject of the report should be substantiated by as much factual, relevant information as is feasible.
- Co-ordinated
  - All information pertinent to the subject should be organized into a complete package. Documentary support (photographs, statements, results of analysis of samples, etc.) accompanying the report should be clearly referred so that anyone reading the report will get a clear picture of the subjects.
- Objective
  - Information should be objective and factual; but the report should not draw conclusions related to judgement and/or penalties.
- Clear
  - The information in the report should be presented in a clear, well-organized manner.
- Neat and Legible
  - Adequate time should be taken to allow the preparation of a neat and legible report.

3.3.2. Inspection Report Outline

The CEA formatted inspection report specifies the following outline which can be adapted to most situations related to the inspection works:

1. Introduction
   - General Information
     - File No. / Industry ID, Name of the Industry, company, enterprise or facility inspected, address, and other contact information
     - Purposes of the inspection;
     - Facts of the inspection (date/time, location, member of inspection team, etc.)
     - Participants involved in the inspection
   - Summary of Findings
     - Name and position of the company personnel interviewed;
     - Summary of the inspection findings.
   - History of the Company
     - Status of the company;
     - Size of organization;
     - Type of operations performed at the company under the inspection

2. Inspection Activities
   - Opening conference or entry briefing
     - Procedures used at arrival, including presentation of credentials and written notice of inspection order;
     - Special problems or observations in case there was reluctance on the part of company officials to give consent, or if consent was withdrawn or denied;
     - Any topics discussed in the opening conference
   - Records
     - Types of records reviewed;
     - Any inadequacies in record-keeping procedures, or if any required information was unavailable or incomplete;
     - Note if record-keeping requirements were being met.
   - Evidence collection
     - Photograph taken in the inspection;
     - Drawings, sketches, maps, charts, or other documents made or taken during the inspection.
   - Physical samples
     - Purpose for which samples were obtained;
     - Exact location from which they were obtained and time and date of sampling;
     - Sampling methods used to collect sample;
     - Physical aspects of the samples;
     - Results of laboratory analysis, if any.
   - Recommendations
     - Recommendations based on the observations and analytical data
     - Recommendations after discussion with company representative.

3. Attachments
   - List of attachments
     - List of all documents, analytical results, photographs, and other supporting information attached to the inspection report.
   - Documents
     - Copies of all documents and other evidences collected during the inspection. All documents should be clearly identified and labelled.
   - Results of Analysis
     - Sample data and results, if any.

3.4. Enforcement

3.4.1. Follow-up and Feed-back Procedures

The results of inspection are used to determine EPL compliance and enforcement. Follow-up must then be done in order to ensure that the inspection has been properly performed under inspector's full responsibility. This is where the image of the authority might be enhanced.

In the follow-up action, it is for the authorities to define clear procedures as follows:

- Defines the content and standard of the report of the visit;
- Defines the standard actions for non-compliance;

3.4.2. Violations

Enforcement programmes benefit from a range of response mechanisms and authorities provided by environmental related laws and/or regulations. Response mechanisms can be divided into the following two (2) types:

3.4.2.1. Informal Enforcement Mechanism

Informal response could be initial action to inform the facility management about possible violations. It can include "phone-call", "site visit", "warning or enforcement letters" and "notice of violation. Informal mechanism aims to simply lead the violator to compliance or it may initiate legal process. Informal mechanism itself does not function to impose a penalty, or enforce legal action on the facility management; however, it is intended to encourage them to improve their process or address potential deficiencies.

Informal approach is effective when actions needed for rectifications are simple and do not require much time and that violation does not represent an imminent danger to human health and environment. Moreover, it is best applied with companies who have an outstanding compliance history such that the informal notification is likely to be respected. This type of approach requires follow-up inspections often within a specific period to mitigate or correct the violation.

Table 3.1 Summary of Informal Responses

Situation	Typical Response	Conditions for More Severe Actions
Exceeding standard complaint	Enforcement letter Investigation and letter on corrective measures	Where exceedances are severe or persistent Reflecting public nuisance due to environmental damage
Poor maintenance of pollution control equipment	Letter requiring good maintenance improvement	If the industry failed to correct any problems after due advice and warning
Installation of additional machineries	Renewal of EPL with revisions to reflect additional machineries	If the additional machinery causes significant pollution or nuisance
Significant revision or expansion of production line or process	Inspection and recommendation with mitigation measures/renew licence	If the expansion causes increased environmental pollution problems

3.4.2.2. Formal Enforcement Mechanism

Formal enforcement mechanisms act as a kind of legal procedure which is accompanied by procedural requirements to protect the right of individuals.

Litigation process is initiated when there is a violation of the NEA and regulations published thereunder.

付属資料 15 インスペクションガイドラインのためのトレーニングガイド

TRAINING GUIDE
on the
Guideline for Inspection

July 2017

Central Environmental Authority

JICA Expert Team

Table of Contents

1. TRAINING GUIDE ON THE GUIDELINE FOR INSPECTION

1.1. Purpose

1.1.1. Guideline for Inspection

The purpose of the Guideline for Inspection is to assist the CEA and inspectors to conduct industry inspection in order to validate compliance with the regulations on environmental protection and quality gazetted under the National Environmental Act (NEA), in a most consistent, comprehensive, competent, and professional manner.

1.1.2. Training Guide

The purpose of this Training Guide is to provide instructions for the trainers on the conduct of the training on the proper use and implementation of the Guideline for Inspection. The purpose of the training on the Guideline for Inspection is to develop and enhance the knowledge and skills of the participants in conducting effective inspections in a consistent, comprehensive, competent, and professional manner.

1.2. Description

1.2.1. Scope and Content

This scope of this Training Guide is the whole of the Guideline for Inspection from the Scope of Inspection to Enforcement with special emphasis placed on the section on Procedure of Inspection and assessment and/or evaluation of the results and observations during an inspection. Where time is available, introduction to or review of production processes and sources of wastes from selected industries may be included in the training course.

1.2.2. Methodology

The training methodology consists of class room type lectures on laws and regulations and on standard procedures, case studies with drills and exercises on completing the entries in the report forms with accuracy, and evaluation of progress in acquiring the necessary knowledge and skills.

1.2.3. Course Program and Duration

The training course may be conducted in six to eight (6-8) hours in one (1) day or the topics and sessions may be spread out in two to four (2-4) days depending on the availability of the trainers and trainees.

The table below illustrates an example of one-day training program.

Table 1.1 Example of One-day Training Programme

Start	End	Topic / Session	Presenter	Remarks
8:30 AM	8:45 AM	Registration and Distribution of Course Materials	Secretariat	Handouts
8:45 AM	9:05 AM	Review of Laws and Regulations, esp. Act No. 56 of 1988, Gazette No. 1534/18	Legal Officer	Session **1**
9:05 AM	9:20 AM	Inspectors: Roles and Responsibilities; Qualifications	HRD Officer	Session **2**
9:20 AM	9:50 AM	Schedule of Inspection – Renewals, New Applications, Complaints	SEO	Session **2**
9:50 AM	10:20 AM	Overview / Outline of Inspection Procedure	SEO	Session **3**
10:20 AM	10:30 AM	Tea Break	Secretariat or Canteen	
10:30 AM	10:50 AM	Inspection Procedure: • Preparation	SEO	Session **3**
10:50 AM	11:00 AM	Inspection Procedure: • Entry and Briefing of Industry	SEO	Session **3**
11:00 AM	11:45 AM	Inspection Procedure: • Inspection and Sampling	SEO	Session **3**
11:45 AM	12:00 PM	Inspection Procedure: • Closing & Confirmation of Results	SEO	Session **3**
12:00 PM	12:30 PM	Enforcement: • Follow-up, Feedback, Violations	SEO	Session **3**
12:30 PM	1:00 PM	Lunch Break	Secretariat or Canteen	
1:10 PM	1:30 PM	Enforcement: • Formal Enforcement Mechanism	SEO, Legal Officer	Session **3**
1:30 PM	2:00 PM	Inspection Report Workshop: • New EPL Application	SEO	Session **4**
2:00 PM	2:20 PM	Inspection Report Workshop: • EPL Renewal, Monitoring	SEO	Session **4**
2:20 PM	2:40 PM	Inspection Report Workshop: • Complaint, Accident	SEO	Session **4**
2:40 PM	3:00 PM	Inspection Report Workshop: • Environmental Recommendation	SEO	Session **4**
3:00 PM	3:20 PM	Tea Break	Secretariat or Canteen	
3:20 PM	4:00 PM	Assessment and Evaluation of Results of Inspection	SEO	Session **5**
4:00 PM	4:30 PM	Viewpoints of Facility Condition: • Priority Sectors • General and Specific Industries	SEO	Session **5** Appendix E, F, G

2. COURSE OUTLINE

2.1. Scope

This training course is intended to cover all the topics in the Guideline for Inspection including the Appendices and attachments.

Session 1 focuses on the legal basis and aspects of the authority and powers of the Central Environmental Authority (CEA) to conduct inspections in order to fulfil its mandate and on the legal basis and aspects of the Environmental Protection License (EPL) system. This session emphasizes the provisions of the National Environmental (Amendment) Act No. 56 of 1988, Section 24A and Gazette Notification No. 1534/18 – 2008 on the EPL and Gazette Notification No. 1533/16 – 2008 on the prescribed activities for which an EPL is required.

Session 2 focuses on the roles and responsibilities and qualifications of inspectors, the types of inspections that may be conducted, and the policies and procedures governing the scheduling of inspections according to type.

Session 3 presents the inspection procedure and explains each step in detail, highlighting techniques for identifying potential violations and safety risks, among others. This session also enumerates the steps to be taken and the evidence to be gathered in situations where potential and/or actual violations are noticed or observed.

Session 4 focuses on the standard inspection report forms and the information that needs to be obtained through observations, interviews, and investigations to arrive at a comprehensive and accurate picture of the environmental performance of the industry or facility being inspected.

Session 5 focuses on evaluating and assessing the observations and results of the inspection, based mainly on the data in the completed standard inspection report forms. While the evaluation and assessment is primarily at the level of the individual industry, factory, or facility, the evaluation and assessment may be extended to encompass multiple industries, factories, or facilities in a given region, district, or provincial office, where appropriate for the participants of the training course.

Where time allows, introduction to or review of production processes and sources of wastes from selected industries may be included in the training course. This may include procedures that may be adopted to identify priority pollution parameters and crucial pollution sources for a given watershed or office jurisdiction.

2.2. Method of Delivery

Sessions 1, 2, and 3 are conducted as classroom type lectures. The first part of Session 4 is conducted as classroom type lectures which will be followed by drills in accomplishing the report forms using either data from hypothetical cases or actual inspections. At the end of the exercises in Session 4, a workshop is conducted to identify problematic or confusing entries for clarification and improvement.

Session 5 provides an opportunity to share experiences in interpreting, assessing, and evaluating the results of an inspection. The participants may be organized into small groups to share interpretation and evaluation of theoretical or actual cases and their field experiences. As much as possible, the members of a group should come from different provincial or district offices to broaden the range of experiences being shared.

Session 5 also provides an opportunity for participants to either be introduced to or given a review of production processes and sources of wastes from selected industries.

2.3. Trainers

2.3.1. Qualifications

The trainers shall be senior officers with at least five (5) years of actual, hand-on experience related to the specific topics where the trainer is the resource person. This applies to the technical, legal, and human resources development aspect of the inspection procedure.

2.4. Trainees

The trainees or course participants shall be environmental officers who may qualify as assistant or regular inspector after undergoing the required training. Personnel from Local Authorities who are or will be assigned to conduct inspections of industries or factories may also participate as trainees in inspection work.

2.4.1. Qualifications

The trainees shall be regular employees of the office they are assigned to and must have completed at least a four-year technical course, preferably in engineering or chemical or biological sciences.

Trainees from Local Authorities may be exempted from having to meet these academic qualifications upon written request by the pertinent Local Authority.

2.5. Logistics

2.5.1. Course Materials

The course materials include the following:

1. Inspection Guideline for Water Quality Section, June 2017
2. National Environmental Act No. 47 of 1980
3. National Environmental (Amendment) Act No. 56 of 1988
4. Gazette notification No. 1533/16 dated 25/1/2008 (List of Prescribed Activities)
5. Gazette notification No. 1534/18 dated 1/2/2008 (Environmental Protection Regulation and Effluent Standards)
6. Standard Inspection Report Forms for:
    a. New EPL Application
    b. EPL Renewal, Monitoring
    c. Complaint, Accident
    d. Environmental Recommendation
7. Standard Inspection Schedule Form
8. List of Priority Sectors and Parameters to Be Inspected
9. General Viewpoints on Facility Condition on EPL Compliance
10. Specific Viewpoints on Selected Industry Sectors
    a. Beverage Industry
    b. Textile Industry
    c. Desiccated Coconut Industry
    d. Slaughterhouse and Meat Packing Industry
    e. Poultry Dressing Industry
11. Chemical Behaviour of Selected Pollution Parameters
12. Stationery
    a. Note paper
    b. Pens or pencils
    c. Folder or Binder for course materials
    d. Bags (optional)

The trainees or course participants may be requested to bring one or two files of a facility or industry they have inspected for use in the workshops of Session 4.

2.5.2. Venue and Meals

The venue should be large enough to comfortably accommodate the expected number of participants. The chairs should be arranged in a classroom configuration, all facing front (speaker's podium and screen). Each participant should be provided with sufficient desk space to allow him/her to comfortably take notes and to complete report forms and questionnaires.

It should be possible to readily re-arrange the desks and tables into small groups for the workshops.

For the Resource Persons, the venue should be equipped with the following:

1. Audio system, preferably with multiple microphones for the participants and wireless microphone for the resource person
2. Projector that can be readily connected to the Resource Persons laptop or notebook computer, remote controller for projector, and laser pointer.
3. Whiteboard with white board pens, preferably in 3 or more colours
4. Poster size paper with permanent ink markers in 3 or more colours

Meals and snacks should preferably be served in another room. Generally, meals consist of a morning snack (tea break), lunch, and afternoon snack (tea break).

Washrooms for personal hygiene should be readily accessible from the training venue.

3. TRAINING ON THE CONDUCT OF INSPECTION

3.1. Session 1: Laws and Regulations

3.1.1. National Environmental Act, Act No. 47 of 1980, and Amendments

Referring to the hand outs, the following sections are emphasized:

- Section 1.2.1 of the *Inspection Guideline for Water Quality Section, June 2017* which lists the legal basis for inspection.
- Articles 10 (1) (c) and (g) of the *National Environmental Act No. 47 of 1980* which grants the CEA the power to investigate and inspect.

The main purpose of the inspection is to determine the status of EPL compliance of industries or establishments engaged in prescribed activities. The trainees must become knowledgeable on the following documents:

- Gazette notification No. 1533/16 dated 25/1/2008 which lists the prescribed activities for which the EPL is required
- Gazette notification No. 1534/18 dated 1/2/2008 which lists the EPL regulations and the tolerance limit of the discharged wastewater.

3.1.2. Gazette 1533/16 - 2008: Prescribed Activities

This Gazette indicates prescribed activities to be controlled under the EPL system. The prescribed activities are listed based on the types of activity as follows:

Table 3.1 Prescribed Activities Listed in Category A

No.	Type of Activity	Sector Code	Category No. of List A
1	Chemical & Petrochemical	CH	1-22
2	Textile & Leather	TL	23-29
3	Food and Food Related Food Industry	FD	30-42
4	Metal Industry	BM	43-46
5	Machinery & Equipment	ME	47
6	Mineral & Mineral Product	MP	48-56
7	Waste Disposal/Waste water/Water Treatment	SZ	57-63
8	Timber &Wood	TW	64-65
9	Lodging & Health Services	SL	66-68
10	Transport Related Services	TR	69-72
11	Power	SP	73
12	Paper & Printing	PP	74-75
13	Telecommunication Towers	TC	79
14	Other Activities	OT	76-78,80

Table 3.2 Prescribed Activities Listed in Category B

No.	Type of Activity	Sector Code	Category No. of List B
1	Chemical & Petrochemical	CH	1-6
2	Textile & Leather	TL	7-13
3	Food and Food Related Food Industry	FD	14-21
4	Machinery & Equipment	ME	22,31
5	Mineral & Mineral Product	MP	23-25
6	Waste Disposal/Waste water/Water Treatment	SZ	26-28
7	Lodging & Health Services	SL	29
8	Transport Related Services	TR	30,32
9	Other Activities	OT	33

Table 3.3 Prescribed Activities Listed in Category C

No.	Type of Activity	Sector Code	Category No. of List C
1	Chemical & Petrochemical	CH	1-2
2	Food and Food Related Food Industry	FD	3-10
3	Machinery & Equipment	ME	22-24
4	Mineral & Mineral Products	MP	11-17
5	Timber &Wood	TW	18-19
6	Lodging & Health Services	SL	20
7	Transport Related Services	TR	21-24
8	Paper & Printing	PP	25

3.1.3. Gazette 1534/18 - 2008: Environmental Protection License

This gazette indicates EPL application procedure and tolerance limits for wastewater discharge. The structure contains as follows:

Table 3.4 Structure of Gazette 1534/18

Contents	Description highlighted
Issue of EPL for emission or disposal of waste	- Prohibit to discharge / deposit / emit waste into the environment or to carry on any prescribed activities stated in the NEA without permission of the EPL - CEA's mandate / responsibility on issuing the EPL
Issue of license for the management of waste	- Prohibit to handle (generate / collect / dispose, etc.) or to establish facility for disposal without licence issued by the CEA - Requirement / duty on issuing license - CEA's power on issuing license
General	- Tolerance limits for the discharged water - Application form - License fee - Maintenance record - List of scheduled waste

Refer to text box on page 4, Section 1.3 of the *Inspection Guideline for Water Quality* Section, for a description of the EPL System.

3.1.4. Purposes of Inspection

Section 1.3. of the *Inspection Guideline for Water Quality Section, June 2017* enumerates the various purposes of inspection.

3.1.5. Environmental Impact of Pollution

The text block on page 3 explains why we need to protect (water) environment.

Industrial activities prescribed in the EPL system are those which may cause environmental problems due to pollutants generated. Those pollutants are mostly chemical substances present in effluent water, gaseous emissions, or solid wastes. The other environmental problems are noise and vibration which could affect human health and living condition.

The table below on typical environmental impacts may be displayed during the presentation.

Table 3.5 Typical Environmental Impacts

Type of Pollution	Typical Source in Industrial Activities	Impacts
Water pollution	- Raw materials, production, by-production - Production process, wastewater treatment process - Fuel, mechanical oil, grease - Leachate from solid waste - Domestic use (kitchen, toilet, e.g.)	- Degradation of vegetation / animal - Human health disturbance - Degradation of living condition
Air pollution	- Production process - Machinery (boiler, generator, e.g.) - Waste burning - Loading / unloading, transportation	- Degradation of vegetation / animal - Human health disturbance - Degradation of living condition
Noise / vibration	- Machinery - Loading / unloading, transportation	- Human health disturbance - Degradation of living condition
Solid waste	- Raw materials, production, by-production - Domestic use	- Cause of water / air pollution - Cause of pest, infectious disease - Degradation of beautification

It is important for inspectors to understand the chemical behaviour of pollutants which are likely to be generated by the production or manufacturing operations of the prescribed industry in terms of:

- What pollution parameters are expected to be generated?
- How those pollutants behave in the water environment?
- What are major source of pollutant, and how those affect to human being?

Use Appendix G: Chemical Behaviour of Pollution Parameters to explain in detail.

3.2. Session 2: Scope of Inspection

3.2.1. Roles and Responsibilities of Inspectors

Section 2.1. of the *Inspection Guideline for Water Quality Section, June 2017* enumerates the roles and responsibilities of inspectors.

This session emphasizes that the inspectors shall perform as a representative of the Authority (CEA) or a guardian of the law in the field of pollution control. Therefore, the inspector must have wide variety of skills and experiences.

1) **Legal Responsibility**
Inspector must conduct all inspection activities within the legal framework established by the activities including presenting proper credentials and proper handling of confidential (business) information. Therefore he/she must be familiar with requirement indicated in relevant laws and regulations.

2) **Procedural Responsibility**
The inspector performs a major role in compliance monitoring; therefore, he/she must be thoroughly familiar with the general procedures and evidence collection techniques to ensure adequate inspection.

   In addition, he/she shall ensure his/her practical knowledge of regulatory requirements, inspection methodology / technique, and also health / safety measures.

3) **Safety Responsibility**
The inspector must be familiar with all the safety risks, obligations, and practices during the conduct of the inspection.

4) **Professional Responsibility**
Inspector must be professional, that is, well-prepared, honest, tactful, courteous, respectful, diplomatic, and properly attired.

5) **Quality Assurance Responsibility:**
The inspector shall ensure the quality and accuracy of the results of inspection.

3.2.2. Types of Inspection

Section 2.2. of the *Inspection Guideline for Water Quality Section, June 2017* enumerates the types of inspections that are conducted. While five (5) types of inspection are enumerated under the EPL system, inspections may be carried out singly or as a combination of inspection types described below.

1) **Drive-by Inspection**
A drive-by inspection may be the simplest method. It may involve visual examination of a prescribed factory made from an automobile or another viewpoint not within the facility's boundary. Since a drive by inspection is often conducted without the knowledge of the industry being inspected, it can be effective in determining the real present condition.

   Because this inspection does not require any specific tools / materials; it is useful as an urgent inspection of accident / complaint cases.

2) **Walk-though Inspection**
Walk-through inspection is the most common used of inspection. This inspection includes entry into the facility, document review, hearing or conference with industry owner and/or representative, observation of regulated activities, operations, and practices, and exit from the facility.

3) **Compliance Evaluation Inspection**
A compliance evaluation inspection aims to verify EPL compliance with regulations and conditions. Thus, it is based on walk-though inspection but is more structured. It requires the inspection team to possess a wide range of knowledge, skills, and abilities, especially, of the industry being inspected.

4) **Sampling Inspection**
Sampling inspection may be conducted as a part of Walk-through Inspection or Compliance Evaluation Inspection. The results of analysis of effluent samples serve as primary basis for determination of compliance with effluent standards.

5) **Beyond Compliance" Inspection**
Beyond-compliance inspection is used for encouraging better environmental performance and behaviour that achieves standards more protective than are legally required.

3.2.3. Qualifications of Inspectors

It is the policy under the CEA that at least two (2) officers shall be assigned for the inspection work as a team. While recruitment and advancement is subject to the CEA policies and procedures, additional qualifications are required of inspectors. These additional qualifications are defined in Table 2.1 of the *Inspection Guideline for Water Quality Section, June 2017* which also describes the formation of the inspection team.

Since a main purpose of the inspection is to evaluate compliance under the EPL system; the inspectors should need a combination of the skills / experiences / knowledge on engineering, technical, scientific, legal, economic, and administrative matters. In order to satisfy inspector's responsibilities indicated in "3.2.1 Roles and Responsibilities of Inspectors", inspector must have sufficient knowledge as shown below:

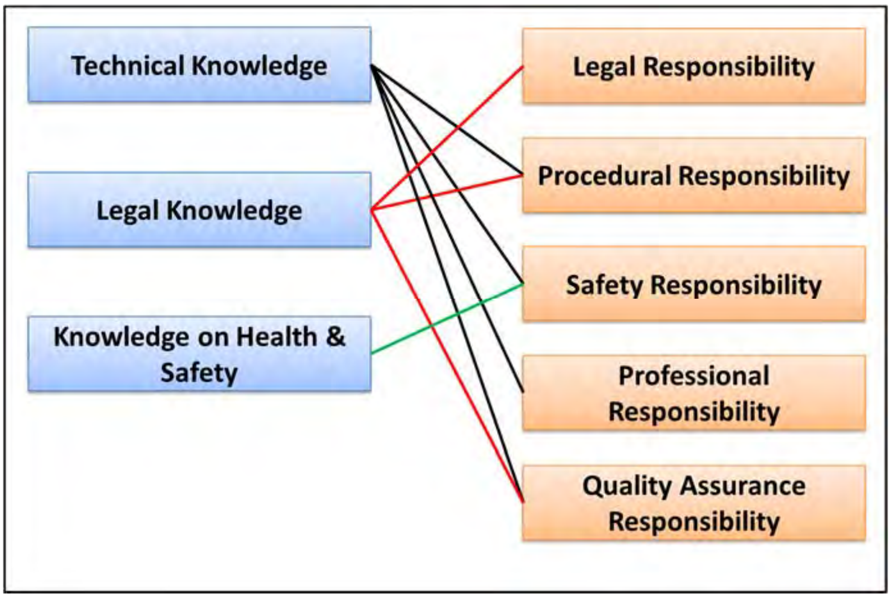


Figure 3.1 Relation Between Necessary Knowledge and Inspector's Responsibility

3.2.4. Training

The types and scope of trainings that a candidate inspector is required to undergo are described in Section 2.3.3 of the *Inspection Guideline for Water Quality Section, June 2017*. Trainings include basic, regular, external, and on-site training. External trainings may focus on specialized knowledge or skills while on-site training provides hands-on practical experiences.

3.2.5. Schedule of Inspections

Scheduling of inspection works is important to effectively conduct inspection in a timely manner. For new EPL application, inspection is scheduled within one (1) month after receipt of a complete and valid application. For renewal of EPL, the compliance inspection is scheduled three (3) before the expiration date. The inspection schedule of a provincial, district, provincial, or main office is prepared annually in half year periods and updated every half year.

> Once a year, the location of the facilities shall be reviewed with the intention of identifying those that are in close geographical proximity with each other. The expiration dates of these industries in close proximity to each other may then be adjusted so that their EPL expiration dates fall in the same month (for example, by extending the validity period of the EPL of some industries).
>
> This will then allow all those industries in close proximity to each other to be inspected in a single trip. Such an inspection schedule will increase the number of industries that can be inspected in one trip for higher efficiency.

Basic concept for scheduling inspection is summarized below:

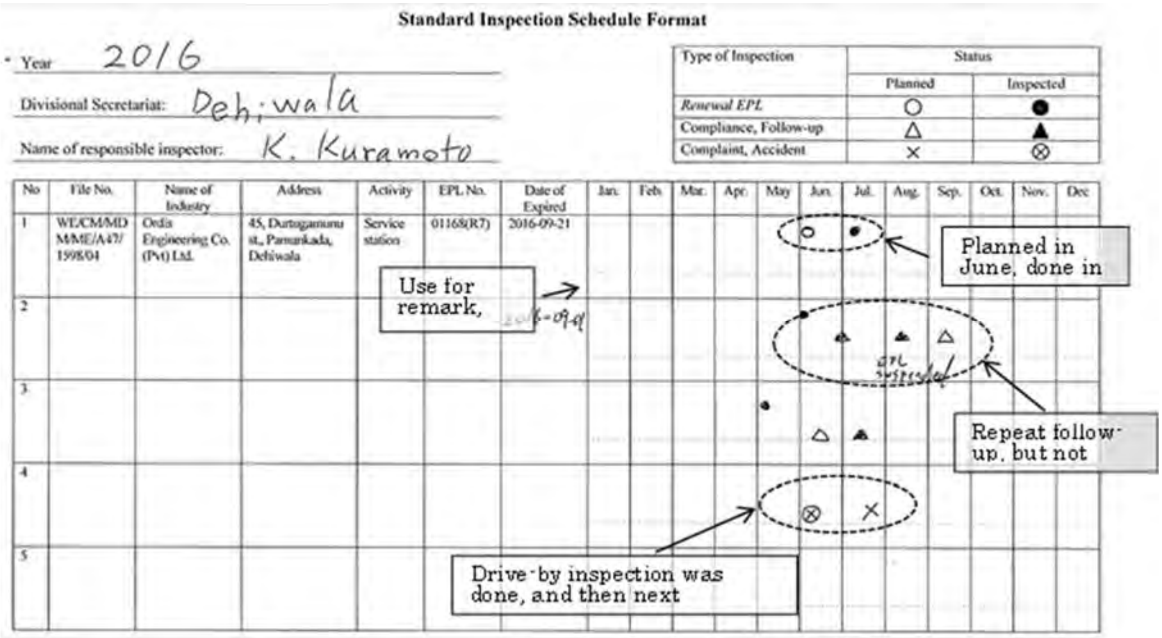
1)	**Renewal of EPL** The schedule of the inspection for EPL renewal of each EPL holder is provisionally set three (3) months prior to the EPL expiry date and marked accordingly on the annual schedule.
2)	**New EPL** Regulation in "Gazette notification No. 1534/18" directs new industries to submit complete application form at least thirty (30) days prior to the commencement of the activity. Therefore, inspection for the new EPL shall be made within one (1) month of submission of the complete application by the prescribed industry.
3)	**Complaint and Accident** The CEA must respond to valid complaints and/or reports of accidents as immediately as possible. A drive-by inspection is useful to catch the actual situation of the problem. The inspection of a complaint or accident should be conducted within twenty four (24) hours from receipt of report or complaint.

4) Compliance Monitoring, Follow up

Compliance monitoring or follow-up inspection is formulated in accordance with justification and recommendation issued in the previous inspections. Due to a limitation of number of teams of inspectors, suggested criteria for prioritization for scheduling of such irregular inspections are as follows:

- Possible critical environmental problems or adverse effect have or will have occurred due to lack of actions by the concerned industry or establishment;
- Violation not acted upon by EPL holders;
- Length of time and/or duration of non-compliance from the time the EPL holders was informed of non-compliance and instructed to comply;
- Due date indicated in the justification and recommendation;
- Belonging to a priority sector (see Appendix C: Priority sectors and parameters to be inspected), and others

Standard Inspection Schedule Format



Standard Inspection Schedule Format

Year 2016

Divisional Secretariat: Dehiwala

Name of responsible inspector: K. Kuramoto

Type of Inspection	Status	
	Planned	Inspected
Renewal EPL	○	●
Compliance, Follow-up	△	▲
Complaint, Accident	×	⊗

No	File No.	Name of Industry	Address	Activity	EPL No.	Date of Expired	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec
1	WE/CM/MD M/ME/A47/ 1998/04	Ordis Engineering Co. (Pvt) Ltd.	45, Durtugamunu st., Pamankada, Dehiwala	Service station	01168(R7)	2016-09-21						○	●					
2												● ▲		▲	△			
3											●	△	▲					
4												⊗	×					
5																		

3.3. Session 3: Procedure of Inspection

3.3.1. Outline of Inspection Procedure

Refer to Figure 3.1 of the *Inspection Guideline for Water Quality Section, June 2017*. The standard inspection procedure is divided into the five (5) steps as follows:

1. Preparing for Inspection Work
2. Entry and Briefing of the Industry
3. Inspection and Sampling
4. Closing and Confirmation of Results
5. Reporting

(1) Preparation Work

Refer to Figure 3.2 of the *Inspection Guideline for Water Quality Section, June 2017* to illustrate the steps taken to prepare for the Inspection work.

Referring to Section 3.2.1 of the *Inspection Guideline for Water Quality Section, June 2017*, explain in detail the following steps, using concrete examples to illustrate the important points to consider:

a. Identification of the purposes
b. Review of industry background information and relevant documents
c. Formulation of inspection work activities
d. Preparation of necessary materials, tools, etc.

Use Figure 3.2 from Standard preparation procedure is given below:

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a) Identification of the Purposes

The purposes of the inspection should be clarified so that inspection work plan is formulated based on the specific purposes of the inspection. Typically, inspection targets are the following:

- New EPL: This is a full-scale or comprehensive inspection procedure.
- Renewal of EPL: The main purpose is to clarify the condition of EPL, whether or not EPL holder complies with requirements and conditions on a continuing basis. The inspection results serve as basis or evidence for the decision on the renewal of the EPL.
- Compliance Monitoring, Follow-up: This inspection is formulated based on the previous results and what recommendations and/or instructions have been given.
- Complaint / Accident: This is done on a request basis; a special purpose shall be given based on the request.

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b) Review of industry background information and relevant documents

Review of available background information is essential to the effective planning and overall success of an inspection. Significant information may be collected in the process of inspection for new / renewal EPL. A review of previous results of inspection is useful in pre-determining potential areas of concern.

It is strongly suggested to collect and review the information on which could be the source and/or cause or any issue related to suspected or known violations and/or problems.

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c) Formulation of inspection work activities

Specific inspection work activities shall follow the standard procedure of inspection and shall consider the following:

- Objectives
- Activities
- Procedures
- Resources
- Schedule

Examples of the above items are given for clarity and better understanding.

Once the inspection plan is formulated; a team meeting (or any communication) is held in order to ensure proper coordination among the inspection team members and concerned persons.

"Inspection plan sheet" as well as "Preparation Check List" is prepared to avoid missing important documents or activities or to avoid miscommunication.

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d) Preparation of necessary materials, tools, etc.

The following items are prepared and checked:

- Identification card;
- Inspection check sheet, notebooks, pens, calculators, compass, and GPS;
- Camera, flashlight, stop watch, tape measure, ruler;
- Sampling kit and field meter (pH, Temperature, DO, and others), tools for flow measurement (bucket, cylinder, etc.);
- Safety tools/devices: working wear, shoes, helmet, gloves, etc., and
- Others as required

(2) Entry and Briefing to the Industry

Entry to the Facility

Emphasize the following:

- Inspectors are authorized by law to conduct inspection.
- Inspectors shall show their credentials to authorised persons when requesting permission to enter.
- Upon entry, the inspectors shall:
    - Explain purpose and legal basis for inspection
    - Follow correct administrative procedures and requirements
    - Abide by company or industry protocols, especially, safety practices
    - Conduct themselves in a professional manner
    - Always keep in mind that they represent CEA and the Government.

In case the inspection team is not allowed to enter the industrial premises to conduct the inspection:

- The inspection team leader shall inquire about the reason for denial of entry and try to clear it.
- If entry is still denied despite the explanation; inform and warn the industry representative that denial of entry is a violation of the NEA
- The denial of entry shall be immediately reported in writing to the CEA management for proper and immediate action.

Briefing

After entry to the facility, the inspection team will hold a short meeting with the owner /or representative of industry in order to:

- Explain the purpose, scope, and planned activities of the inspection
- Request assistance and cooperation from the industry staff in gathering the necessary data and information
- Obtain more information about industry operation, plant/factory layout, management structure, pollution and waste management, plant safety requirements, and other information relevant to the inspection.

Basically the inspectors should clarify the following:

- Explain the purpose of the inspection and the scope of activities during the inspection.
- Identify or look for the responsible persons at the site, and request technical personnel to accompany the team during the site inspection to facilitate access to areas that are normally off limits.
- Clarify safety issues or concerns in the site.

- Verify the site activities and their environmental implications.
- Verify applicability of the EPL.
- Request to take samples and photographs, if necessary, but only after obtaining permission to do so.

(3) Inspection and Sampling

Inspection

Before conducting facility inspection (inspection in the facilities), the inspection team should make an overall observation of the periphery of the facility to grasp facility condition. Any signs indicating problem, malfunction, violation, etc. shall be clarified and recorded.

> Typical signs of potential pollution are:
> - Leakage of oil, chemicals,
> - Condition of vegetation in the industry site
> - Abnormal odour problems
> - Direct discharge of wastewater to receiving stream

Facility inspection aims to check production process, wastewater treatment process, and any other relevant aspects. The results could verify industry performance such as the efforts made to reduce pollution.

In addition, it is important to obtain a full description and understanding of the facilities' processes and to verify information provided by the industry representative. The inspection also allows the inspector to identify problem areas that can be improved through pollution reduction techniques.

The points to be inspected and observed are dependent on the types of factories. In general, the following possible problems with treatment facilities shall be surveyed:

1) Abnormal build-up during treatment
- Excessive plant growth in the stabilization ponds;
- Excessive scum, foam, floating material accumulated in treatment and settling tanks;
- Fouling of fabric or other solids in micro-screens with grease and solids;
- Sludge accumulation in clarifiers indicated by floating sludge pads and gas bubbles, etc.

2) Unusual discharge
- Surcharging (overflow) of influent lines and overflow weirs

3) Alternative Discharge Points
- Old valves or channels from previously upgraded system;
- Pipes or channels showing occasional use;
- Erosion or run-off from land discharge sites, etc.

4) Abnormal/Obnoxious Odour from
- Wet wells, grit chamber, aerobic/anaerobic biological units, scum removal devices, and sludge handling facilities, etc.

5) Broken or Unusual Equipment
- Note presence of special pump
- Presence of floating aerators in diffused air systems
- Any structure that appears to be temporary
- Clogged sprinklers, dripping nozzles, broken pipes (land discharge.

Water Sampling

Some of the conditions or observations that may lead to the decision to collect samples include:

1. EPL requirement – to verify compliance with effluent standards
2. Unreported discharges; accidental discharges such as major leaks
3. Abnormal conditions of discharge – odour, colour, turbidity
4. Malfunction of wastewater treatment plant
5. Previous results of analysis (whether from CEA or industry) of sample show non-compliance with effluent standards

The inspection team shall judge the necessity of water sampling. If sampling is recommended, the inspection team designates the sampling stations and selects the target parameters / pollutants. Use Appendix D: Priority Sectors and Parameters to be Inspected, *Matrix Table of Priority Parameters*, of the *Inspection Guideline for Water Quality Section, June 2017* as a selection guide.

Sampling shall be conducted in strict accordance with the established protocols. As much as possible and especially if non-compliance is suspected, sampling shall be undertaken during the inspection itself.

Selection of target parameters / pollutants must be based on the characteristics and source of the polluted water.

(4) Closing and Confirmation of the Results

After the inspection is completed, the inspection team conducts a closing conference:

- to inform the industry of the preliminary findings and recommendations (if any)
- to confirm that the industry (representative) understands the preliminary findings and recommendations as well as any deadline set.
- if possible, to obtain agreement on the results and findings or at least, to confirm that there is no major objection to the findings.
- If possible, to obtain the acknowledgement of the industry (representative) on the (onsite) results, findings, and recommendations.

3.3.2. Enforcement

The results of inspection are used for determining EPL compliance and enforcement. Follow-up must then be done in order to ensure that the inspection has been properly performed under inspector's full responsibility.

In case violations and/or environmental problems are suspected, enforcement programmes benefit from a range of response mechanisms and authorities provided by environmental related laws and/or regulations. Response mechanisms can be divided into the two (2) types.

Informal response is initial action to inform the facility management about possible violations. This action may be taken through "phone-call", "site visit", "warning or enforcement letters" and "notice of violation. Informal mechanism aims to simply lead the violator to compliance or to initiate legal process.

Informal mechanism itself does not function to impose a penalty, or enforce legal action; it is intended to encourage the industry to improve their process.

Formal enforcement mechanisms are legal procedures undertaken as a next step if the industry has not satisfied the recommendations indicated through informal responses. Formal enforcement procedures are accompanied by procedural requirements to protect the right of individuals or industries.

3.4. Session 4: Inspection Report

3.4.1. Purpose of Inspection Report

The inspector has the basic responsibility of providing documented evidences on discrepancies discovered during the facility inspection. One of the main objectives of the inspection report is to organize and coordinate all inspection information and findings into a comprehensive usable document in accordance with the standard form. In order to meet this objective, information in an inspection report must be presented in a clear and well-organized manner.

Since the results of all inspection work shall be properly described in the report prepared by inspectors; standard formats of inspection report are specified by the CEA.

3.4.2. Attributes of the Inspection Report

Section 3.2.4.1 Inspection Report of the *Inspection Guideline for Water Quality Section, June 2017* lists the following attributes of the inspection report:

- Accurate and Objective – factual and based on observations, unbiased, but not drawing any conclusion about penalties
- Relevant – related to the purposes of the inspection
- Comprehensive – includes all observations and findings of the inspection
- Co-ordinated – logically arranged and organized
- Clear, Neat, and Legible

3.4.3. Standard Format for Inspection Report

Table 3.6 Formulation of Standard Inspection Report Format

Section	Description
1. General Information	This section describes general information about inspection work as follows: • Date and target industry on the inspection • Name of inspectors • Purposes of inspection • Representative of industry
2. Results of Inspection	The summary of inspection results containing: • Basic observation of inspection; • Rough sketch of industry premises and surroundings • Public complaints • Justification & recommendation
3. Industry Profile	Industry profile includes: • Name & location, owner of industry; • Sector and category; • Condition of industry premises and surroundings; • Relevant permits / licence.
4. Manufacturing Process	Manufacturing process indicates list of raw materials, production/ by-production, chemicals, etc.
5. Energy Requirement	This section describes energy and fuel consumption, and machinery installed.
6. Types of Pollution Wastewater Solid Waste Air Emission / Dust Noise / vibration	This section indicates the following on each possible pollution type: • Possible sources of pollution; • Abatement methods including method of discharging / treatment of wastewater, etc.

The information to be inspected may be dependent on the purposes of the inspection. For instance, New EPL application shall aim at ascertaining all information indicated in the application form submitted by the industry. On the other hand, inspection for reports or cases of complaints and/or accidents may concentrate on some specific information likely to be related to the complaint and/or accident. Thus, four (4) types of inspection format are used as follows:

Table 3.7 Four (4) Types of Standard Inspection Report Formats

Types of Inspection* Section	New EPL	Renewal EPL	Compliance / Follow-up	Complaint / Accident
1. General Information	included	included	included	included
2. Results of Inspection	included	included	included	included
3. Industry Profile	included	excluded Specify if some condition has been changed	excluded Specify if some condition has been changed	Included
4. Manufacturing Process	included			Excluded
5. Energy Requirement	included			Excluded
6. Types of Pollution	included			Excluded

*: As of those 4 types, inspection for Environmental Recommendation is take for the purposes of suggestion to industry which has not been started operation.

3.5. Session 5: Viewpoints of Facility Condition

3.5.1. Assessment and Evaluation of Results of Inspection

The purpose or purposes of an inspection influence the assessment and evaluation of the results of an inspection.

a. If the purpose of the inspection is to determine the **status of compliance** with the EPL conditions and environmental regulations:
   - Refer to relevant parameters in the effluent standards (*Gazette notification No. 1534/18 dated 1/2/2008*)
   - Refer to industry sector guidelines to provide information on the priority pollution parameters by industry sector.
   - Include compliance with gaseous emissions standards, solid waste disposal regulations, and toxic and hazardous materials and waste management
   - Refer to specific and additional conditions in the EPL conditions.

b. If the purpose of the inspection is to collect information and data which could be used as evidence in the environmental litigation process:
   - Strictly follow the procedure for identifying and collecting information and data
   - Ensure that any evidence collected is admissible in a court of law.
   - Refer also to Section 3.4.2, Table 3.1., and Section 3.4.2.2. of the *Inspection Guideline for Water Quality Section, June 2017*.

c. If the purpose of the inspection is to verify accuracy of information submitted by industries or establishments:
   - Compare observations and other results of the inspection with the information officially submitted by the industry or establishment
   - The results of analysis of samples collected by CEA sampling officers and analysed in the CEA laboratory takes precedence over any other result.
   - Allow for normal variations in the results of analysis.

d. If the purpose of the inspection is to investigate complaints by private or public entities:
   - Compare results of the inspection with the specific basis of the complaints.
   - The effluent standards (*Gazette notification No. 1534/18 dated 1/2/2008*) and environmental laws and regulations are the basis for determining the validity and legality of a complaint.

e. If the purpose of the inspection is to assess an industry's (environmental) performance:
   - Compare the results of the inspections with the data on industry performance (benchmark) in the pertinent industry sector guidelines.
   - Refer to the database (PSI or Pollution Source Inventory) on industry performance.

f. If the purpose of the inspection is to guide the companies for the improvement of their performance in wastewater management and treatment:
   - Compare the results of the inspections with the data on industry performance in the pertinent industry sector guidelines.
   - Suggest the methods for improving environmental performance presented in the industry sector guidelines.
   - Link to National Productivity Secretariat

g. The inspection team should take the time to quantify the specific pollution generation rates:
   - Collate data such as, m^3 wastewater or kg BOD_5, COD, TSS or other relevant pollutant generated per unit quantity of product produced) per industry type.
   - Specific pollution generation rates are helpful in determining the environmental performance of industries and may guide them towards improving their environmental performance.
   - Consolidating and analysing the data can provide insights that are useful in overall environmental management.

3.5.2. Pollution Parameters and Priority Sectors

"Priority Sectors" mean expected major industries in the Kelani River basin which are likely to generate significant water pollution. Due to their characteristic features, scale of those factories varies in Category "A" to "C". It is, of course, important for inspection to cover all industrial sectors; however, it may be useful to prioritize those sectors in the planning of inspection because of significant impacts as mentioned above.

On the other hand, priority parameters are also set. The parameters are selected from the following viewpoints:

- Possibly affecting the beneficial uses of the water;
- Possibly causing significant adverse impacts to natural environment and/or human health, etc.;
- Relatively neither sophisticated nor costly to measure;
- Relatively easy to develop mitigation measures.

The table in the next page is a matrix between priority sectors and parameters.

Table 3.8 Matrix Table of Priority Parameters

Parameter / Sector	Coliforms	pH	Oil & Grease	TSS / (Turbidity)	Lead	EC	Chromium Hexavalent	W. Temp.	COD_{Cr}	BOD_5
1. Textile Dying and Bleaching Industrial Washing Textile Printing		○		○		○	○	○	○	○
2. Chemical formulation and manufacturing and Re- Packing Re-Packing of Agrochemicals (Pesticides)		○		○	○	○		○	○	○
3. Rubber Latex based Crepe Rubber		○		○		○		○	○	○
4. Leather Tanning		○	○	○		○	○	○	○	○
5. Food and Beverages Alcohol Distillery Fruit Juice Manufacturing and Re-packing Milk Products Carbonated beverages		○	○	○		○		○	○	○
6. Vehicle Service Stations		○	○	○		○		○	○	○
7. Animal husbandry Piggery Slaughtering and meat processing Poultry Dressing	○	○	○	○		○		○	○	○
8. Petroleum (Tank farm) and Oil refinery		○	○	○	○	○	○	○	○	○
9. Hotels and Restaurants	○	○	○	○		○		○	○	○
10. Thermal Power Plants		○	○	○	○	○	○	○	○	○

Remark: ○means parameters to be selected in inspection, including sampling, works.

3.5.3. Viewpoints on Facility Condition

Viewpoints which assist inspectors adequately to observe the facility condition and to give recommendation and/or instruction to achieve EPC compliance are described as below:

(1) General Viewpoints on Facility Condition

General viewpoints focus on all possible sectors in Sri Lanka and are not limited to specific sectors.

Those points will be classified into:
a) primary sources on effluent discharges,
b) wastewater / effluent treatment, and
c) general viewpoints as below:

(a) Primary Sources of Information on Effluent Discharges

There are three (3) primary sources of information:
a) production / manufacturing process flow diagram
b) wastewater sewer plan and rain water drainage plan, and
c) water balance

Production / Manufacturing Process Flow Diagram

A major part of wastewater could be generated in the production / manufacturing process. Therefore, inspectors shall carefully check the production line whether these function properly, whether wastewater is generated according to the planned process line described in the application note, etc.

The guideline will guide the inspector in prioritizing the inspection of these specific machines, equipment, or tanks which use water and/or discharge wastewater or effluent.

Wastewater Sewer Plan and Rain Water Drainage Plan

Wastewater generated in the Production / Manufacturing Process will be introduced to the wastewater treatment facility. Those processes shall be adequately planned and installed. Inspectors shall carefully check those plan whether the facilities are properly installed in accordance with the plan.

Rain water, which does not contain industrial pollution but may contain solid spread on the ground, shall be also properly treated and discharged. Rain water discharge plan will be based on drainage system consisting of conduit, culvert, etc. Major points of view to be checked are stagnation or blockage of drainage routes (conduit, culvert, screen, etc.) by solid waste.

Water Balance

Total discharge should be ideally itemized to distinguish between water discharge that needs to be treated, such as industrial wastewater and domestic sewage, and water discharge that does not need to be treated, such as cooling tower or boiler blowdown, water used or reused for watering plants or irrigation within the compound of the industry or facility, or even evaporation losses. A large discrepancy between water supply and wastewater discharge may indicate illegal discharge of wastewater. Inspector could assume possible such illegal discharge by comparing water supply and discharged volumes.

(b) Wastewater or Effluent Treatment

Most of the wastewater generated by industries engaged in prescribed activities (required to secure EPL) will require adequate treatment in order to comply with the effluent standards. The wastewater or effluent ultimately discharged by an industry to the environment is treated effluent from the WWTP (Wastewater Treatment Plants) or ETP (Effluent Treatment Plants).

Judgment of compliance with effluent standards depends on the results of wastewater sampling and analysis; while observations on the WWTP and its treated effluent during inspection can provide insights to indicate if urgent action is required or what actions may be required of the industry to ensure continuing compliance with the effluent standards.

The single, most important indicator of the quality of the treated effluent is its clarity. Good quality treated effluent is **clear** and **colourless** (of course, it does not ensure that clear and colourless water does not contain pollutants). Most likely, turbid and/or coloured effluent exceeds the effluent standards.

Wastewater treatment does not necessarily destroy pollutants but convert them to innocuous or less pollutive forms. Most wastewater treatment plants generate residuals, often in the form of sludge which contains a large amount of wastewater. If wastewater sludge is dewatered, the water removed such as filtrate may contain high concentrations of pollutants removed from the sludge. The inspector should ensure that the wastewater removed during sludge dewatering is recycled to the headworks of the WWTP for proper treatment.

(2) Specific Viewpoints on Selected Industry Sectors

The following five (5) industrial sectors are selected from the priority sector:

1. Beverage Industry
2. Textile Industry
3. Desiccated Coconut Industry
4. Slaughterhouse and Meat Packing Industry
5. Poultry Dressing Industry
6. Piggery Industry (Animal Husbandry)

Except textile industry, these are categorized as food related industry, which rarely use materials containing toxic / harmful substances. Therefore, there is less expectation to generate toxic wastewater; while domestic pollution such as COD, TSS, pH is dominant in pollution and which could degrade human living environment.

Description of the specific viewpoints is formulated to consist of:

- Introduction: overall of industry profile of process
- Production / manufacturing process flow: describing process flow diagram to indicate how the products are made
- Source of wastewater and treatment plant: describing how wastewater is generated in the production process, and how it shall be treated.

So those viewpoints could direct inspectors how the industry performance shall be evaluated from the beginning (material / chemical storage, production line) to the end (wastewater treatment and final discharge).

付属資料 16 サンプリングマニュアル

1.0 SCOPE

This procedure applies to any effluent, surface water, waste water, or ground water body which may or may not be environmentally polluted or cause any environmental problem in Sri Lanka.

2.0 REFERENCES

ISO 5667 1 2006_Sampling

ISO 5667 3 2003_Handling of Water Sample

ISO 5667 4 1987_Sampling for Lake

ISO 5667 6 2005_Sampling of River

ISO 5667 10 1992_Sampling of Wastewater

Procedure for Review of Request for Testing from Clients: CEA/WQL/LQMS/QSP-07

Procedure for Control of Nonconformities & Corrective Actions / Preventive Actions: CEA/WQL/LQMS/QSP-09

3.0 RESPONSIBILITY

3.1 Responsibility Related to Sampling Work

Responsibility related to sampling work shall be set up according to Quality Manual: CEA/WQL/LQMS-QM.

The Technical Manager has overall responsibility of planning and management of sampling activities. The (sampling) officer collecting the samples is responsible for handling samples until receipt by the Sample Receiving Officer; and from issuance of the (results of analysis) report until final disposal of the sample. The designated Sample Receiving Officer is responsible for handling samples from reception until issuance of the (analysis) report.

The person who is involved in the sampling procedure shall be qualified and trained based on the Procedural Manual for “Training Procedures, CEA/WQL/LQMS/QSP-02”. The table below lists persons who are involved in the sampling works:

Table 1 List of Persons who involved in Sampling Works

Position or Designation	Responsibilities / Roles
Director of Laboratory (DL)	Overall responsibility for approval of sampling / analysis
Technical Manager (TM)	Overall planning, coordination, management, and control of sampling and testing activities until issuance of the test results.
Deputy Technical Manager (DTM)	Assist the TM, manage in the absence of TM Control any sampling procedure on behalf of the TM
Chemist / Environmental Officer / Laboratory Assistant / (Authorised Officer for Sampling)	Preparation of sampling , Planning of sampling , Collection of sample, Registration of sample, etc. and Preparation of Test Report
Sampling Officer	Person who conducts sampling work. Those shall be appointed from above position.
Sample Receiving Officer	Authorized person who receives samples and assigning Reference No.; Registration of sample handover

3.2 Sampling team formation

It is the policy of CEA Laboratory to assign at least two (2) members of staff. One of them, who has more sufficient experience on sampling work, shall perform as a leader. Sampling officer should have any responsibility to take sampling work in the field. Both of these collectors or one of them shall deliver the samples under their/his custody.

4.0 PROCEDURE

4.1 Sampling

4.1.1 Preparation

SAMPLING REQUEST FORM: This standard format (CEA/WQL/LQMS/F-O7/A) shall be used by officers of Central Environmental Authority (CEA) in requesting test reports from the Laboratory of CEA. Written request made by the client is also acceptable. All necessary information including, e.g., testing parameter, shall be fully described in this request form. This form shall be sent to the DL for approval. Upon approval, the DL instructs the TM to assign the officers for sampling and analysis. The TM shall make the necessary arrangements for sampling, analysis, and issuing of test report.

Refer to Appendix 1 for the standard format of the Sampling Request Form. (CEA/WQL/LQMS/F-O7/A)

SAMPLE CONTAINERS: It is the policy of CEA Laboratory to use sample containers that are made of materials compatible with and inert to the test parameter or analyte as per the latest available edition of the Standard Methods for the Examination of Water and Wastewater, published by APHA, AWWA, and WEF.

The objective of the above policy is that sample containers shall be free of analytes of interest, especially when sampling and analysing for very low analyte concentrations. The container material shall not absorb or adsorb or elute any of the analytes of interest.

The bottles used for the collection of waste water and potable water are kept separated to avoid cross contamination.

Following types and sources of sample containers are used in CEA Laboratory for different analytes of interest.

Table 2 Sample Container Materials for Selected Analytes

Analyte of Interest	Container Material	Type of Container	Preservation Method and Period
COD_{Cr}	Polyethylene or polypropylene plastic or Glass	300 - 500 ml volume	In cool box at below 4° C- or add drops of sulphuric acid
Below is a reference parameter[1]			
pH[2]	Polyethylene or polypropylene plastic	300 – 500 ml volume	Measure on site
EC[2]	polypropylene plastic	300 – 500 ml volume	Measure on site
TSS	Polyethylene or polypropylene plastic or Glass	500 – 1,000 ml volume	In cool box at below 4° C, up to 24 hours only
BOD_5	Glass BOD Bottle	Glass bottles with quick fit glass lid, 100 - 300 ml volume	In cool box at below 4° C, up to 24 hours only
Oil & Grease	Glass	Glass bottle with wide mouth lid, 500 ml - 1 litre bottle	Add drops of hydrochloric acid
Heavy metals (Pb, Cr^{6+}, e.g.)	Polyethylene or polypropylene plastic	500 – 1,000 ml volume	Add drops of nitric acid
Coliform	Sterile glass bottle	Wide mouth 300 – 500 ml volume	In cool box at below 4° C, up to 24 hours only

1: Designated as “priority parameter” for crucial pollution sources.
[2]: pH and EC shall basically be measured in site. It is a case to be measured in the laboratory.

Upon issued by the TM, the sampling Officers could prepare container for multiple testing requirements except “pH”, “CODcr (if H_2SO_4 used for preservation)”, “oil & grease” and “coliform”.

For the collection of composite samples, CEA Laboratory shall use plastic (HDPE) containers large enough for proposed sampling period.

CLEANING OF SAMPLE CONTAINERS: Please refer to and follow the Procedural Manual for “Cleaning Procedure, CEA/WQL/LQMS/QSP-11”.

The sampling officer shall prepare from designated storage all necessary items such as bottles, preservation reagents, labels, etc. according to the sample request form.

4.1.2 Sampling Methods

TYPES OF SAMPLES: There are two (2) main types of water samples:

1 Grab sample;

2 Composite sample and integrated sample.

(1) Grab sample

A **grab sample** is a discrete sample taken at one time or instance from a single point.

(2) Composite sample

A composite sample is a series of multiple grab sub-samples taken at different times from the same sampling point and combined and mixed together.

There are three types of composite sampling depending on site condition.

1) Time weighted composite sampling

If the effluent flow rate is relatively constant (less than 15% variation from average), time weighted composite sampling is done.

Equal volumes of discrete grab sub-samples are taken at fixed, regular time intervals.

The volume of each grab sub-sample and the frequency of taking grab sub-samples are determined by the sampling officer according to the analytes of interest and time period of composite sampling.

2) Flow weighted or flow proportional composite sampling

In case of significant flow rate variations (more than 15% variation from average), flow weighted or flow proportional composite sampling is done.

The volumes of discrete grab sub-samples are a fixed proportion or percentage of the volume of water (=flow rate x time) passing through the sampling station.

There are also two (2) ways of collecting flow weighted or flow proportional composite samples separated based on the volume of water passing through the sampling station:

1 fixed volume of grab sub-sample is taken at variable time intervals, or

2 variable volumes of grab sub-samples are taken at fixed time intervals

The instantaneous flow rate must, therefore, be measured or known in order to determine how much volume of water has passed through the sampling point. The volumes of grab sub-samples and the time intervals for taken them are determined by the sampling officer based on flow rate measurements.

3) Integrated Sampling

An integrated sample is a special type of composite sample and consists of a mixture of grab sub-samples collected from different locations and/or depths of a water body within a short period of time (time needed to transfer from one location and/or depth to another) until grab samples are collected from all the desired points.

Integrated samples are usually taken for ambient water sampling of large bodies of water such as rivers, lakes, and even large ponds.

Points of consideration in sampling works are:

Grab sampling

- The water sample is ideally directly collected using the pertinent sample bottle or container.
- If the sample bottle contains a preservative and there is a risk of over-filling the sampling bottle, an intermediate sample container is used to collect a sample.
- Whenever possible, the material of the intermediate container should be the same as that of the pertinent sample bottle. However, if this is not practicable, such as due to high risk of breakage when using an intermediate sample container made of glass, the intermediate sample container may be changed to a suitably inert material such as plastic. If other materials are used for intermediate purpose, that situation and reason must be recorded.
- For ambient water sampling in rivers, lakes, dug wells, e.g., a water trap sampler or container is used to get grab samples from certain depth level of the water body. The depth of the water and depth of the sampling point shall be recorded.

Sample Collection

(1) Sampling point / location

Selection of sampling points or sampling stations affects the data results; therefore, for the accurate evaluation of performance of EPL holders on effluent quality or assessment of ambient water quality, the following basic concepts shall be considered for the selection of sampling points as follows:

General

- Sampling points and their access route shall be safe and secure.

Effluent water sampling

- Sampling points shall be representative of final effluent discharged.
- Sampling points shall be located downstream of all treatment processes.
- The discharged volume or flow rate at the sampling points shall be measured or estimated, or otherwise based on flow rate data in the application.

Ambient water sampling

- Sampling points shall be also representative of water body monitored. Typical selection method of sampling point is summarised as below:
  - River / stream: upper stream – middle – down stream, connection to subsidiary stream, outlet of discharged water
  - Lake: centre – on shore, inlet, and outfall points

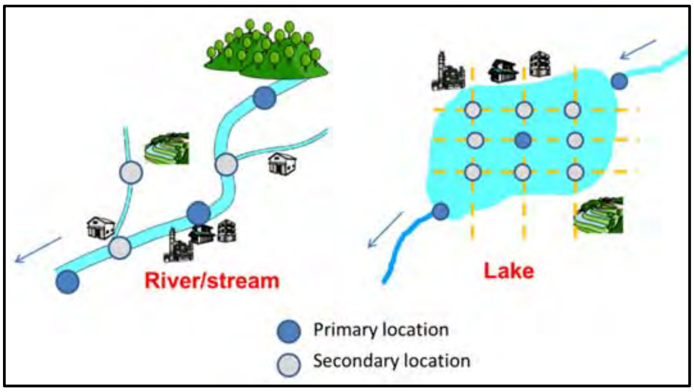


Figure 1 Typical selection method of sampling location for ambient surface water

(2) Sample collection method

General

General procedure for grab sampling with direct collection

Lower upside-down the sample bottle or intermediate container into the middle of the water stream (at least 10 cm below the surface and in the middle, or other specified depth)

↓

Slowly rotate the bottle / container to a vertical or upright position to fill the container with water sample while facing the incoming water current.

↓

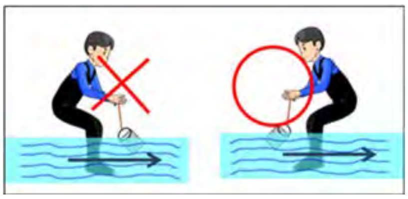
Quickly but gently raise it out of the water stream.

↓

Leave enough space for the addition and mixing of preservative. Cover or cap the container immediately.

Note

The hand holding the sampling container or the (mechanical) holder, and/or the person collecting sample in the water stream, shall always be downstream of the sample bottle to avoid contamination of the water sample being collected.



In order to collect samples properly and to be sure they are truly representative; the following special care must be:

- Avoid stirring up any settled sediment from the bottom of the water way; suspended solids larger than 6 mm shall be intentionally excluded.
- In case the water stream contains lighter-than-water or floating constituents that need to be analysed, such as oil and grease, a wide mouth container shall be used to collect the water sample. The mouth of the sample container (usually an intermediate container) shall be only partially submerged in the water stream, up to approximately 75%-85% of the diameter of the mouth, in order to include the lighter-than-water or floating constituents in the collected water sample.

- Whenever possible and especially for small, well-mixed flow streams, collect sample directly into the sample bottle or container, using a clean and dry (glass or plastic) funnel as necessary.
- Alternatively, collect the whole flow stream in a pail or bucket of appropriate material, mix thoroughly, and take a sample (aliquot) from this mixture.
- Unless the sample bottle contains a preservative, it is recommended that the sample bottle be rinsed 2-3 times with the water to be sampled before filling the bottle with sample.
- Collect samples where the effluent or water flow is well mixed (turbulent flow) or mechanically stirred, if necessary.
- Collect samples from the centre of the discharging line or pipe or channel where water flow is fastest.
- Samples shall be collected in sufficient amounts to allow the performance of all the required analyses, including any additional amount needed for duplicate tests, as required by laboratory procedures for the analytes of interest.
- When several discharge flow streams have to be sampled, it is the policy of CEA Laboratory to start the sampling at the least possibly contaminated discharge stream. For instance;
  - The level of contamination may be deduced from an understanding of the wastewater treatment processes.
- In case of flowing pipes, the liquids flow at maximum velocity at the centre of the pipe with the velocity decreasing to zero at the wall. In order to ensure the homogeneity, it is the policy of CEA Laboratory to select a sample collection point where there is sufficient turbulence to obtain a homogeneous stream, meaning near the centre of pipe as much as possible.

<u>Grab Sampling:</u>

When the source is known to be relatively constant in composition over an extended time period, grab samples are collected at a specific spot at the site over a short period of time (typically seconds or a few minutes). Grab sampling of effluent is appropriate under the following conditions:

- Effluent water is not continually discharged (such as intermittent discharge from batch operations)
- The characteristics or quality of effluent water is relatively constant (generally applicable to treated effluent from effluent treatment plants operated under stable, relatively constant conditions)

Grab sampling is generally not appropriate for ambient water quality monitoring. The following cases, on the other hand, could be considered; as determined by the **sampling officer**.

- A small stream with uniform conditions throughout its cross section
- It would not be reasonable to take composite / integrated sample especially from the viewpoints of safety, time constraint, e.g. The Sampling Officer, however, shall record that decision.

Integrated Sampling:

For the collection of samples for ambient water quality monitoring or for very large effluent streams, integrated sampling is more appropriate. An integrated sample is composed of a mixture of discrete grab sub-samples are taken at various depths and at various points across the width of the water body at a selected location or sampling station. Volumes of the grab sub-samples to be taken are determined by the sampling officer according to analytes of interest and sampling objectives.

Collection of integrated samples would be done in the following manner related to the depth and width of stream:

- For depths of 1.0 m or less, collecting one (1) grab sub-sample at mid-depth will suffice unless there is obvious stratification of the water stream or body.
- For depths of more than 1.0 m but less than 3.0 m, collect two (2) grab sub-samples: the first at the surface (between 0.30 m and 0.50 m below the surface) and the second near the bottom (preferably, 1.00 m but not less than 0.5 m above the bottom to avoid stirring up sediment which may contaminate the sample) of the water stream or body.

- For depths exceeding 3.0 m, collect grab sub-samples at the surface (between 0.30 m and 0.50 m below the surface) and at successive depths 1.5 m to 3.0 m apart with the last depth grab sub-sample taken at least 0.50 m above the bottom of the water stream or body.
- For widths of 3.0 m or less, collecting one (1) grab sub-sample at middle will suffice unless there is visibly obvious difference between the water near the shore or bank and at the middle.
- For widths greater than 3.0 m but less than 10.0 meters, collect one width grab sub-sample at the middle, and at successive distances 2.0 m to 4.0 m apart but not less than 1.0 m from the shore or bank of the water stream or body.
- For widths greater than 10.0 meters, collect one width grab sub-sample at the middle, and at successive distances 3.0 m to 6.0 m apart but not less than 1.0 m from the shore or bank of the water body.

In the sampling of dug wells, composite sample is collected by mixing three (3) grab sub-samples collected at the top or surface, middle, and bottom of the well. Equal volumes of these grab samples are collected. The sampling officer shall determine and specify the volumes to be collected according to the analytes of interest and sampling objective.

Composite Sampling:

When the concentration of the analytes of interest varies over a short period of time (less than 1 hour), composite samples are collected by combining multiple grab sub-samples taken manually or by automatic waste water sampler. Composite samples are used only to determine analytes that remain unchanged under the conditions of sample collection, preservation, and storage.

For more representative samples from effluent streams or any other water body, CEA Laboratory shall preferably use composite sampling procedure if enough time is available. Composite samples are collected either by hand (manually) or by using an approved automatic composite sampler. Composite sampling shall be basically taken by the following manners:

- It is the most reasonable to use a composite sampling period of at least eight (8) to twelve (12) hours, if possible, but not less than four (4) hours.
- The time interval between grab samples should be such that at least five (5) grab samples are collected within the selected composite sampling period. Ideally, taking of grab sub-samples for compositing should be frequent enough to capture significant changes in the characteristics of the water stream being sampled as indicated by variations in flow rates or water quality characteristics such as colour, turbidity, and smell.
- The volume to be collected for each grab sub-sample shall be such that it will not cause the composite sample container to overflow based on the frequency of taking grab sub-samples and the composite sampling period.
- The volume of each grab sub-sample shall likewise be such that the accumulated volume of composite sample at the end of the compositing period is at least 50% more than the total sample volume required for all the intended analytes.
- In no case shall the volume of grab sub-sample be less than 100 ml.

It is the policy of CEA Laboratory to collect several sample bottles from one location or sampling point or station, one sample bottle for each of the following specific analytes or analytical parameters:

- One for COD preserved with H_2SO_4
- One for BOD_5 preserved at 4° C, no preservatives
- One for T.S.S. preserved at 4° C, no preservatives

4.1.4 Sample Collection Checklist

This check list defines information to be collected and recorded during sampling, sealing, labelling and transporting of the samples to the Laboratory, as follows:

- Purpose of sampling,
- Location of sampling point,

- Name and address of the contact person at the field or sampling site or station,
- Type of sample,
- Method of sampling,
- Method of preservation, if the sample is waste water,
- Appearance of the sample,
- Date and time of sample collection,
- Collected sample identification numbers,
- References such as maps, distances and photographs of sampling site, and
- Field observation and measurements.
- Any other relevant information is recorded in the field notebook

The above information shall be recorded in the sample collection checklist. Refer to Sample Collection Checklist in Appendix II (CEA/WQL/LQMS/F-13/A).

4.1.5 Sample Preservation

It is the policy of CEA Laboratory to take sample preservatives to the field in separate labelled containers. These containers shall be packed in small boxes for the safety of **the sampling team** and to avoid possible damages due to leak of containers

These containers are stored close to the location where cleaned sample bottles are placed. A person who takes sample preservative boxes to the field under the sampling Officer shall refill the preservative containers as soon as he returns the box to the laboratory.

Preservative containers shall be labelled as shown below:

PRESERVATIVE	
Chemical Name	:
Test	:
Volume / L of sample	:

In addition to the above chemical preservatives for some analytes, refrigeration at or below 4° C is required. For such preservations, **sampling officer** shall take cold boxes filled with ice (and water) to the field for sampling activities.

4.1.6 Measurements in the Field

The CEA uses field measurement for the following analytes:

Analytes	**Measuring method**[3]
temperature	Thermistor method
pH	Glass electrode method
DO	Polarographic method
EC	Electrode method
Salinity	Conductivity conversion
Turbidity	Tungsten lamp transmitting source

3: HORIBA Multi-parameter Water Quality Meter U-5000 or U-10

4.1.7 Sample Labelling

It is the policy of CEA Laboratory to label sample containers as soon as they are filled with collected samples. CEA Laboratory shall use the following format of label for sample labelling:

CENTRAL ENVIRONMENTAL AUTHORITY
FIELD SAMPLE

CLIENT	:
SAMPLE LOCATION	:
SAMPLE TYPE	:
SAMPLE NO.	:
DATE AND TIME	:
SUB SAMPLE FOR	:
SAMPLING OFFICER	:
Ref. No.	:

These sample labels shall be glued with cellulose tapes which have a surface that can easily be written on with a water insoluble marker pen.

All information shall be filled in at the field or sampling station by the **sample officer**.

The bottle number is the unique identification of sample container until it is delivered to the Laboratory

The Bottle Number is the identification number of samples in the sample collection check list. Bottle numbers used on a particular day is valid only for that day for that particular sample

SAMPLE SEALING:

The objective of sample sealing is to allow detection of unauthorized tampering with samples from collection up to the time of analysis. It is the policy of CEA Laboratory to use self-adhesive paper seals with signature of the sampling officer.

4.1.8 Sample Transport and Delivery to the Laboratory

It is the policy of CEA Laboratory to transfer the labelled samples to the laboratory as soon as possible. Cooling boxes or insulated ice chests with ice or any materials for keeping cool condition shall be used to transport the samples to the laboratory.

4.1.9 Safety Precautions in Sampling

It is the policy of CEA Laboratory to comply with every safety precaution in the collection, handling, and analysis of samples.

In the field visits for sampling, sampling personnel shall take gloves and boots to the field. When they collect samples, or inspect industrial processes and/or facilities, they shall wear their laboratory overcoats, gloves, and if necessary, rubber boots. In addition, they shall follow safety instruction issued by the facilities in all cases, and especially in case of effluent water sampling.

In case of taking samples from man holes or confined spaces, the sampling officer shall take to the field the necessary gear for safe access such as a tripod and harness. The tripod and harness shall be used by the person who collects samples from deep pits, man holes, or other confined spaces.

If dust and/or chemical or other potentially harmful vapours are likely to be present in the environment from which samples are to be collected, the person who collects sample from such environment shall use appropriate particulate and/or chemical vapour mask and eye goggles.

4.2 Sample Reception and Registration

The procedure from sample reception and registration in to the laboratory is set forth in the "Procedure for Handling of Test Items, CEA/WQL/LQMS/QSP-13".

5.0 QUALITY CONTROL

In the sampling work and field test of water monitoring, the following two (2) types of error shall be considerable:

- Sampling handling error: Sample handling error could be caused by contamination of the sample water during sampling work or due to contaminated sampling containers and/or bottles.
- Measurement error: Measurement error cannot be eliminated but it could be reduced by instrument calibration and maintenance.

A quality control sample is useful to assure data quality of water sampling. The test results of quality control samples taken in the field can reflect the precision and accuracy of the sampling collection. The following table guides quality control methods:

Table 3 Quality Control Methods

Methods	Description
Field blank	Determine interferences present in the field environment
Field duplicates	Two (2) separate samples are collected at the same time and/or place. Results give a measure of the precision associated with sample collection, preservation, storage and laboratory procedures.

6.0 RECORDS (APPENDIX)

I.	Sampling Request	CEA/WQL/LQMS/F-07/A
II.	Sample Collection Checklist	CEA/WQL/LQMS/F-13/A
III.	Sample Collection Checklist (Surface Water)	CEA/WQL/LQMS/F-13/B
IV.	Sample Register	CEA/WQL/LQMS/F-13/C

付属資料 17 インスペクション能力強化のためのセミナー

Table 1 Schedule and Main Topics on Technical Seminar

Title	date	Number of Attendances	Main Topics
1 Water Control System	Sep. 17, 2015	101	・ Environmental-related legal framework related to EPL system in Sri Lanka ・ Experiences on Environmental-related legal system in other countries ・ Introduction of environmental report in Japan ・ Case study
2 Pollution Control Management	May 13, 2016	61	・ Principle of pollution control management ・ Overview of Wastewater Treatment Process ・ Advanced pollution control management
3 Water Pollution Management in Selected Industry Sectors	Jun. 9, 2016	57	・ Role of Inspection in Environmental Management ・ Wastewater Management in the BEVERAGE (Non-Alcoholic) Industry Sector ・ Wastewater Management in the DESICCATED COCONUT Industry Sector ・ Wastewater Management in the TEXTILE Industry Sector ・ Wastewater Management in the PIGGERY Industry Sector ・ Wastewater Management in the SLAUGHTERHOUSE and MEAT PACKING Industry Sector ・ Wastewater Management in the POULTRY DRESSING Industry Sector
4 Orientation Meeting for the Pilot Test	Nov. 10, 2016	29*	・ Outline of the draft inspection guideline ・ Outline of implementation of the pilot test ・ Practical work for inspection planning
5 Wrap-up on Pilot Test / On-the-Job Training (OJT) of Inspection Guidelines	Apr. 6, 2017	30*	・ Overall Results of Evaluation ・ Sharing of Experiences, Comments, and Suggestions: EPC Representative ・ Sharing of Experiences, Comments, and Suggestions: Gampaha Representative ・ Sharing of Experiences, Comments, and Suggestions: Colombo Representative
6 Training Seminar on the Inspection Guideline	Aug. 4, 2017	73	・ Overview / Outline of Inspection Procedure ・ Inspectors: Roles and Responsibilities; Qualifications ・ Review of Laws and Regulations, Enforcement: ・ Schedule of Inspection ・ Inspection Procedure and Experiences in the pilot test ・ Standard Inspection Report Format

*: Only inspectors who were involved in the pilot test participated.

Source: The JICA Team

付属資料 18　PSI セミナー参加者

Table 1 Participants of First Seminar for Introduction of EPL/ PSI online system

#	Organization	Designation	Name
1	Uva Province	Director	N. S Gamage
2	Central Province	Director	Susantha Wedage
3	Northern Province	Director	M A C Najeeb
4	Eastern Province	Director	C. Malwana
5	Western Province	Director	M Sivakumar
6	Western Province - Gampaha District Office	Director	Geethaanjali Senavirathne
7	Southern Province	Assistant Director	D.M Gajadeera
8	CEA - EPC Division	Actg.DDG-EPC	R M S K Rathnayake
9		Actg. Director-EPC	M S D Munasinghe
10		Assis. Director-EPC	S. S Ranasinghe
11		Actg DD-EPC	Himali Karunaweera
12		SEO/EPC	P.S Athukoralage
13		SEO-EPC	D M S S Bandara
14		Trainee-EPC	B G H H S Welikanda
15		Trainee-EPC	H P I Udeshika
16		Trainee-EPC	P Anoja
17	CEA - Admin/Finance/HR Division	DDG	Buddhika Weheragoda
18	CEA- Planning and Monitoring Division	Director	Chandi Wijayasinghe
19		Planning Officer	T. Nawarathne
20	CEA- NRM Division	Assis. Director	Jeewa Warnakulasuriya David
21	CEA - IT Unit	EO	W D H C Withanage
22		EO	D.G.K Katugampala
23		Management Assistant	F.N. Maduwala
24	CEA - R & D Division	Director	M.A.A.N Hemakumara
25		AD	C.H. Edussuriya
26	CEA - Lab	Actg. DD (WQ)	Hiranthi Jansz
27		Actg. DD	Kamal Priyantha
28		SEO	M. P Priyantha
29		EO	V. Swarna
30	JICA Sri Lanka Office	JICA Representative	Takuya Manabe
31		JICA Project Specialist	M.G Hemachandra
32	JICA Team	Deputy Team Leader/ Environmental Monitoring	Onuma Takashi
33		Pollution Source Inventory	Eiko Watatsu
34		Information Management System	Leigh Lunas
35		Secretary	Kanchana Hewage

Source: The JICA Team

Table 2 Schedule and Participants of Second Seminar on EPL/ PSI online system

District/ Provincial Office	Participants	Designation	Date of Training
Western Province Colombo District Office	Mrs. Vernika Ranawakaarachchi	AD	02nd May
	Mr. Harsha Walpita	SEO	
	Mr. Lalith Karunarathne	SEO	
	Mr. M K M Senarath	SEO	
	Mr. O P K Pathirana	SEO	

District/ Provincial Office	Participants	Designation	Date of Training
Western Province Gampaha District Office	Ms. Wijayani ambegoda	AD	04th May
	Ms. Shanthi Deerasinghe	SEO	
	Ms. P H C Manel	DEO	
	Ms. Shika Priyadarshani	SEO	
	Mr. K P N A Pathirana	DEO	
Western Province Kalutara District Office	Mrs. H D Chandrika	AD	05th May
	Mrs. M G L Fernando	SEO	
Uva Provincial Office	Mr. J I P Perera	Chemist	05th May
	Mr. B M C R Bandara	Act. SEO	
	Mr. H P N Indunil	EO	
	Mr. R M J S Bandara	EO	
CEA Headquarters	Mr. Thilak Nawarathne	Planning Officer	15th May
	Ms. Shakeela Bandara	EO/ WM Unit	
	Ms. S S Ariyarathne	SEO/WM Unit	
	Ms. P M S Rajapaksha	SEO/ EPC	
	Ms. Arsha Kumari	SEO/ EPC	
Southern Province Office	Ms. W M S Wijayanthi	DEO	16th May
	Ms. W D Pushpalatha	DEO	
	Ms. H D Shirani	EO	
	Mr. S H A Jayantha	DEO	
	Ms. K G Chandrakanthi	DEO	
	Mr. D M Gajadeera	AD	
	Mr. Sunil Gurusinghe	DD	
CEA EPC Unit	Mr. M Sivakumar	Director-	17th May
	Ms. Himali Karunaweera	AD	
	Ms. S S Ranasinghe	AD	
	Ms. P S Mahagoda	SEO	
	Mr. D S S Bandara	SEO	
	Ms. P S Athukoralage	SEO	
	Ms. H H D H Madunika	EO	
	Mr. Y A N Buddhika	EO	
Central Province Office	Ms. C P Palihapitiya	AD	20th July
	Ms. R G S Jayasinghe	EO	
Sabaragamuwa Province Office	H.W.W Havawitharanc	SEO	20th July
	Amila Warunapriya	EO	
	S.D U. Gnanakeethi	SEO	
	H.D Priyadarshani	DEO	
Eastern Province Office	M.C.M Pnyis	DEO	20th July
	D.P. Kadigaja	EO	
	N.M Eafue		
	M.I.N Pshqe	SEO/DEO	
	N. Rajeswaran	DEO	
Nothern Province Office	S. Nishanth	EO	20th July
	P. Thuvavahan	EO	
	K.S. Sivanrian	EO	
Nothern Central Province Office	C.N. Thilakarnthe	EO	20th July
	G.K.L Knmarathilaka	EO	
	P.S. Senavirathna	EO	

Source: The JICA Team

付属資料 19　PSI ガイドライン

Pollution Source Inventory Guideline

Central Environmental Authority

JICA Expert Team

Table of Contents

Appendix

A. Environmental Laws, Act No. 47 of 1980 Establishing CEA
B. Effluent and emission standards
C. Category and Sectors to be monitored for Waste water discharge
D. User manual for PSI System
E. Flowchart for PSI data registration

1. INTRODUCTION

1.1. Background

The CEA published its first regulation to control industrial pollution in February 1990 under the provisions of the National Environmental Act (NEA). Since then CEA has been issuing Environmental Protection License (EPL) to Prescribed Activities (industries) that discharge/deposit/emit waste into environment with a view to control environmental pollution.

Even though the CEA has this tool to control environmental pollution from such industries, many complains are received by the CEA daily from the public and observed that there are industries still operated without EPL's or else industries without compliance with the standards and criteria's published under the NEA.

Under the National Environmental Policy document prepared by the Ministry of Environment it is strongly emphasis that the need of Pollution source information for better decision making in field of environment.

Based on this document environmental pollution control division of the CEA together with laboratory developed a project proposal to JICA funding. Under the technical corporation project was approved and part of that project PSI was developed.

1.2. Purpose of PSI

Pollution Source Inventory (PSI) is tracking pollution across Sri Lanka and ensuring the CEA has access to information about waste discharge/deposit/emit into environment and use of such information for decision making and appropriate intervention for environmental protection and quality improvement.

The PSI contains data on high, medium and low polluting industries and their pollution sources with possible impacts on the environment. Information about the pollution through the PSI is essential to protect the environment and enhance the environmental quality and assist the government in identifying priorities for environmental decision making.

The desired out comes of the PSI are to;

- Maintain EPL database to collect all information regarding the waste discharge/ deposit/ emit into environment.
- Provide information to evaluate waste/pollution with possible impact on the environment and support CEA for decision making.

1.3. Purpose of the Guideline

This guideline is to assist the CEA to provide a procedure for collection, storage, analysis of pollution source information in order to check compliance based on the EPL system.

2. SCOPE OF PSI

Pollution Source Inventory (PSI) consists of waste and pollution information provided by Environmental Protection License (EPL) system.

* Information provided by Hazardous Waste License (HWL) system will be added in future.

2.1. Information on PollutionSousesunder EPL system

2.1.1. Environmental Protection License (EPL) System

The Environmental Protection License (EPL) is a regulatory/legal tool under the provisions of the National Environmental Act (NEA) to control the environmental pollution caused by the industrial activities (National Environmental Act No: 47 of 1980 amended by Acts No 56 of 1988 and No 53 of 2000). Industries and activities which required an EPL are listed in Gazette Notification No 1533/16 dated 25.01.2008.

The environmental pollution includes the discharge of effluents, deposition of wastes, emission of smoke/ gases/ fumes/ vapour or excessive noise/ vibration.

Based on this EPL System, all industries / companies / facilities must declare their discharges and emissions into the environment from prescribed (industrial) activities in compliance with national discharge and emission standards.

Industries are classified under 3 lists i.e., List "A","B" and "C" depending on their pollution potential. EPL must be issued accordance with the prescribed industrial activities coming under List A, B and C.

- ✓ Part "A" comprises of 80 significantly high polluting industrial activities. EPL for industries in lists "A" have to be obtained from the relevant Provincial Offices or District Offices of the CEA. Prescribed industrial activities coming under List A is maximum of one year from the effective date of the Licence.
- ✓ Part "B" comprises of 33 numbers of medium level polluting activities. EPL for industries in lists “B” have to be obtained from the relevant Provincial Offices or District Offices of the CEA. Prescribed industrial activities coming under List B is maximum of three years from effective date of the Licence.
- ✓ Part "C" comprises of 25 low polluting industrial activities which have been delegated to Local Government Authorities, namely Municipal Councils, Urban Councils and Pradeshiya Sabhas. EPL for the industries in List "C" has to be obtained from the respective Local Authorities. Prescribed industrial activities coming under List C is maximum of three years from the effective date of the Licence.

Industries who apply EPL shall take necessary action to maintain the quality of the waste to conform to the standards and criteria stipulated by the regulation of the NEA.

EPL holder must submit analytical reports as requested by the EPL issuing Authorities. Analytical reports include the monitoring data of the discharge of effluents, deposition of wastes, emission of smoke/ gases/ fumes/ vapour or excessive noise/ vibration.

Inspection will be carried out by the officers of relevant licensing authorities.

2.1.2. Waste/Pollution Information under EPL system

Waste/ pollution information under EPL system will be collected by **EPL application form**, **EPL renewal application form**, **analytical reports** and other related documents submitted by industries.

EPL application forms includes the general description of industry, manufacturing process, and specific environmental information such as water, solid waste, atmospheric emissions, noise pollution, energy requirements and recycling/ reuse. EPL renewal application forms will be submitted to renew the EPL and to declare any changes, alterations or extension to the activities.

Inspection reports prepared by inspecting officers are also useful information to clarify the condition of the industrial activities. Inspection will be carried out not only for issuing EPL, but also for regular monitoring, environmental recommendation, and accidents and complains. The result of inspection shall clarify compliance/ violation of the industrial activities.

There are additional items to be collected as supplemental information such as BOI registration[1], geographical location information and emergency requirements.

Collected waste/ pollution information will be registered in PSI system.

Table 2.1Items to be registered in PSI system

Stage	Items		Provided by
EPL Application	Industry Details	Industry Name	Application form
		Industry Type	
		BOI Registration	Industry
		Sector/ Category	CEA Officer
		Industry Address	Application form (Industry)
		Province/District/LA	
		Geographical location	
		Investment (Local/ Foreign)	
		Date of commencement	
		Shift / Workers	
		Land use	
		Land Extent	
		Pollution Checklist	CEA Officer
	Waste /Pollution Information	Manufacturing Process	Application form
		Water	
		-Water requirement	
		-Source of water	
		- Daily discharge (Domestic) - Daily discharge (Industry)	
		- Generation of oil	
		- Method of discharge	
		- Final point of discharge	
		- Method of treatment	
		Solid Waste	
		-Type of Solid waste -Quantity generated	

[1]Any prescribed activity which is registered under section 17 of the Act of the Board of Investment of Sri Lanka (BOI), has to be obtained EPL from BOI.

Stage	Items		Provided by
		-Method of disposal including LAs collection, recycle	
		Atmospheric emissions	
		- Possible emissions (NOxs, SOxs, Dust and Soots, Other)	
		- Number and height of Stacks/ Chimneys	
		- Source of odour	
		- Method of abatement	
		Noise Pollution	
		- Source	
		- Method of abatement	
		Vibration Pollution	
		- Source	
		- Method of abatement	
		Energy Requirements	
		- Plant generation	
		- Public supply	
		Fuel used	
		- Fuel type	
		- Purpose	
		- Quantity used	
		Recycling/ Reuse (Specify)	
		Emergency Requirements	Industry
	Application/ Inspection	Application Details	CEA Officer
		Payment Details	
		File Number	
		Inspection Detail	
		EPL Details	
EPL Renewal	Industry Details	*Same as EPL Application	EPL renewal application form/ Inspection report
	Waste/Pollution Information	*Same as EPL Application	
		Environmental Monitoring	Analytical Report
	Application/ Inspection	*Same as EPL Application	CEA Officer
(Follow up monitoring)	Waste/Pollution Information	**Environmental Monitoring**	Inspection report with sampling data
	Application/ Inspection	Inspection Detail	CEA Officer
		EPL Details	
(Legal Proceedings)	Waste/Pollution Information	**Environmental Monitoring**	Inspection report with sampling data
	Application/ Inspection	Inspection Detail	CEA Officer
		EPL Details	

Based on submitted EPL application/ EPL renewal application, CEA officers (Provincial and district officers) will check "**Pollution Checklist**" shown below.

- ✓ Is within industrial zone (Yes or No)
- ✓ Waste water (Yes or No)
- ✓ Solid waste (Yes or No)
- ✓ Hazardous waste (Yes or No)
- ✓ Air pollutant emission (Yes or No)

- ✓ Noise emission (Yes or No)
- ✓ Vibration emission (Yes or No)
- ✓ Complaints (Yes or No)

Based on analytical reports submitted by industry and inspection report with sampling data, CEA officers register these data to PSI system, "**Environmental Monitoring**".

2.2. Roles and Responsibilities

Pollution Source Inventory (PSI) provides information on waste/ pollution information under EPL system. PSI system is online database by using internet, and it is designed to register and update by each provincial and district offices. The information will be monitored and analysed regulatory and report to publish by CEA head office.

In order to adequately and smoothly conduct PSI registration and maintenance works, CEA divisions and officers should have responsibilities as indicated below:

Table 2.2Roles and Responsibilities for PSI system management

Name of Department/Division	Name of Position	Responsibilities / Roles
Provincial Office and District Office	Director, Deputy Director, and Assistant Director	Supervision for Senior Environment Officer
	Senior Environmental Officer	Inspection Registered data check Analysis of the PSI data
	Environmental Officer	Inspection Receive documents (Application form and analytical report) from industries Data registration and check
CEA Environmental Pollution Control Division	Director, Deputy Director, and Assistant Director	Decision for environmental pollution control policy Publish the Environmental Report Supervision of the analysis by Senior Environment Officer
	Senior Environmental Officer	Inspection Analysis of the PSI data Preparation of the Environmental Report
	Environmental Officer	Inspection Random check of registered PSI data
CEA Waste Management Division	Director, Deputy Director, and Assistant Director	Supervision for Senior Environment Officer
	Senior Environmental Officer	Monitoring of the PSI data (Waste)
	Environmental Officer	
CEA Planning& Monitoring Division	Director, Deputy Director, and Assistant Director	Supervision for Senior Planning Officer
	Senior Officer	Monitoring of the PSI data (EPL number)

Name of Department/Division	Name of Position	Responsibilities / Roles
	Planning& Monitoring Officer	
CEA Environmental management & Assessment Division R&D Unit	Senior Officer	Monitoring of the PSI data for GIS mapping
	GIS Expert	
CEA IT Unit	IT Officer	PSI system check Server maintenance Support for PSI user

Environmental Pollution Control (EPC) Division consists of EPC unit and Laboratory unit. There are water quality team and air and noise monitoring team in Laboratory unit.

Analysis of the PSI data for specific environmental items (water, waste, air and noise) and preparation of Environmental Report are conducted by responsible unit and team.

3. PSI DATA REGISTRATION AND MENTENANCE

3.1. Overall of PSI data registration/ assessment under EPL system

There is a standard procedure in order the CEA officers to effectively carry out EPL/PSI system operation and maintenance works.

Waste/ pollution information will be collected through EPL system. It is very important to review and update the PSI data at **EPL renewal application stage**, because the submitted analytical reports and the result of inspection will clarify the industrial activities.

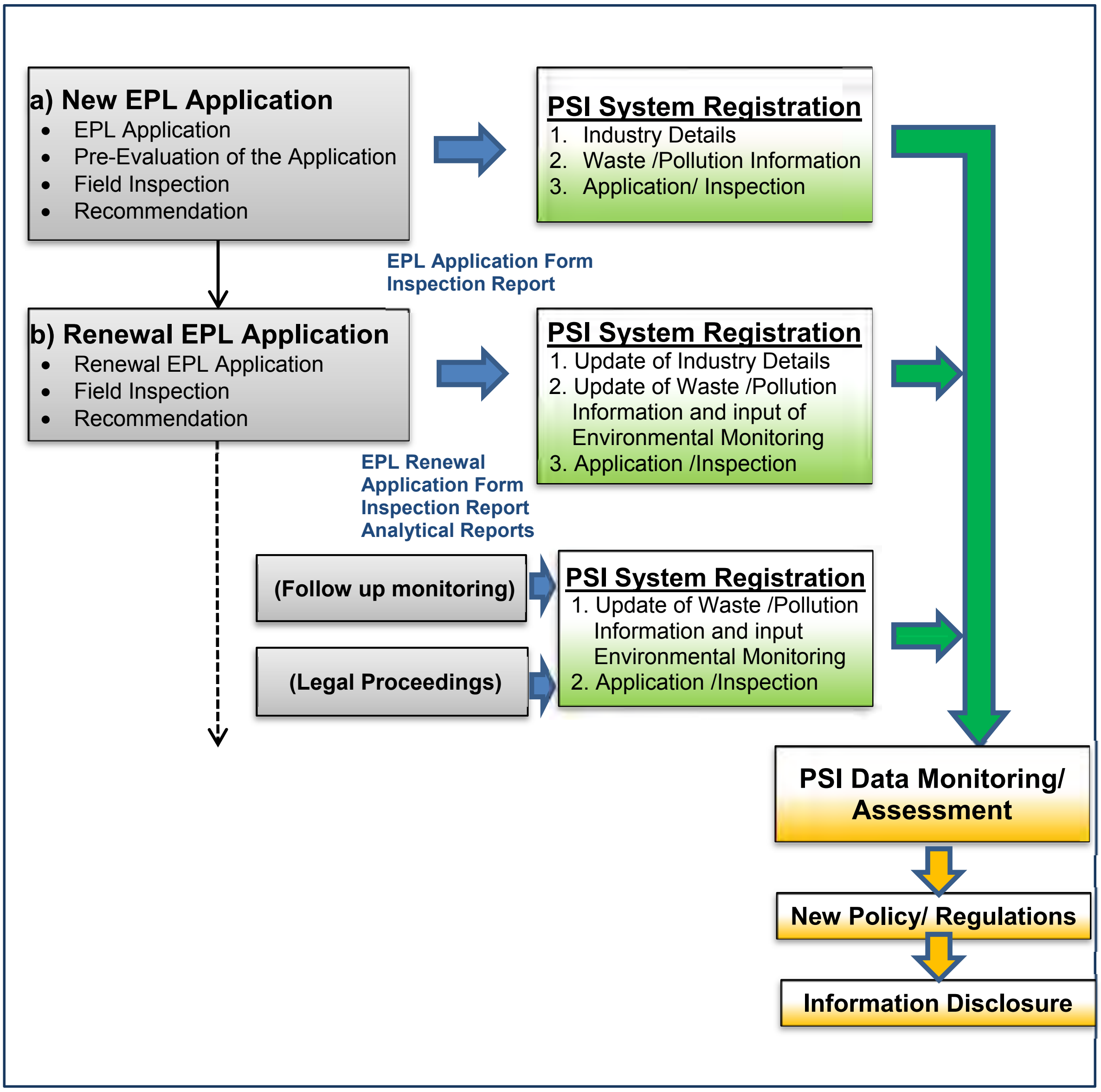


Figure 3.1Overall of PSI operation with EPL system

3.2. Registration of PSI data

3.2.1. New license Application

Application procedure is shown as follows:

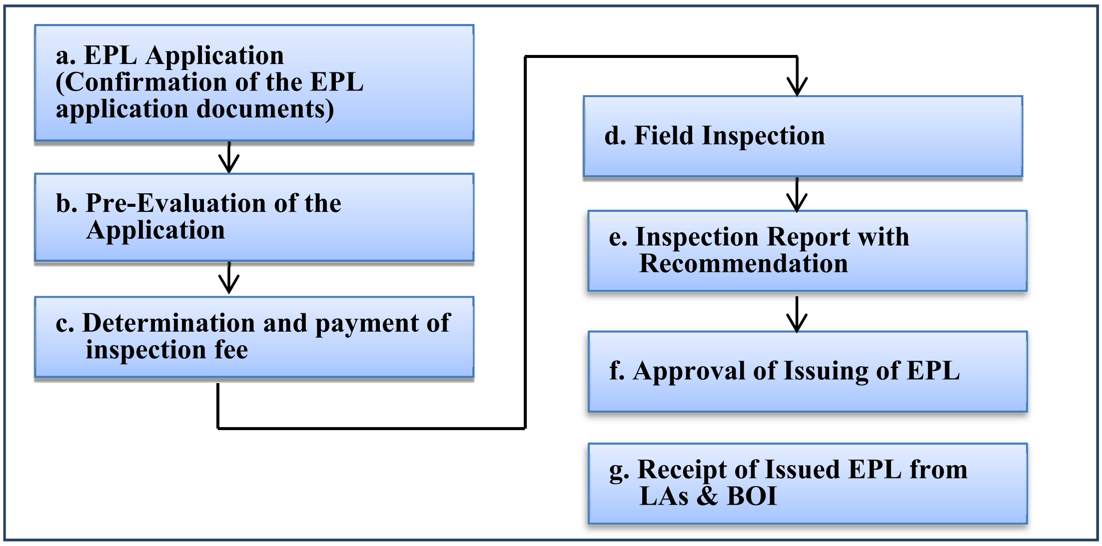


Figure 3.2 Procedure for New EPL Application

a) EPL Application (Confirmation of the EPL application documents)

The applicant must provide all the particulars requested in EPL application Form and submit to the Provincial Office or District Office with following supporting documents.

1. Certificate for the Registration of Business
2. Legal authorization to use the land for the particular industrial activity.
3. Copy of Survey Plan of the land.
4. Legal authorization for establishing the particular industry at the site.
5. Production Certificate necessary for specific products. (Distilleries, medicinal products, pesticide manufacturing etc.)
6. Proposal for pollutant abatement.
7. Any other detail/document requested by the Authority

b) Pre-Evaluation of the Application

Relevant Provincial/ District office of the CEA will pre-evaluate to check the relevancy of issuing the EPL, the adequacy of the details furnished and to determine the inspection fee to be requested.

After pre-evaluation of the application, Environmental Officer (EO) in Provincial /District Office will register the Industry Details Information to PSI system.

EO will check "Pollution Checklist" and register Waste/Pollution Information (i.e. specific environmental information such as water, solid waste, atmospheric emissions, noise pollution, energy requirements and recycling/ reuse).

EO will fulfil the supplemental information such as BOI registration, geographical location information and emergency requirements by the interview of the EPL applicant.

Senior Environmental Officer (SEO) in Provincial /District Office will check the registered PSI data, especially "Pollution Checklist" and the checked specific environmental information. (For example, if waste water is "Yes" in the Pollution Checklist, SEO will check the PSI data related to "Water".)

Industry Details and Waste/Pollution Information can be registered by the EPL applicant (industrialist). In that case, PO/DO must confirm "Industry ID" and check registered data.

c) Determination and payment of inspection fee

Based on the details furnished by the applicant, the relevant Provincial/District Office decides the amount of the inspection fee to be paid and a written request will be made to the applicant. After the payment is made the receipt should be submitted to the relevant Provincial/District Office. Once the receipt is received, proceed to next step.

d) Field Inspection

A team of officers will carry out a field inspection in order to assess the data furnished in the application with respect to the industry and to decide the possibility to operate such industry with controlling pollution.

After field inspection, a team of officers will confirm the Waste/Pollution Information registered in PSI system.

e) Inspection Report with Recommendation

Inspection team will prepare a report based on the field inspection details regarding the industry, technical reports provided by the applicant and social aspects along with their recommendations. If the site is recommended proceed to next step.

If the recommendation suggested requesting a proposal for additional pollution control measures, the industrialist will be informed to fulfil such request. Decision to issue the EPL will be made based on the evaluation of the additional details provided by the applicant.

According to the provisions of the National Environmental Act, any applicant for a licence who is aggrieved by the refusal by the Authority to grant a licence may within thirty (30) days, after the date of notification of such decision to him/her, appeal in writing against such decision, to the Secretary of the Ministry of Environment.

After confirmation of additional pollution control measures, a team of officers will edit Waste/Pollution Information in PSI system. A team of officers register the result of inspection in Inspection Details.

f) Approval of Issuing of EPL

Authorized officers of the CEA grant approval for issuing of EPL based on the recommendation made by the inspection team and then Legal Division of the CEA grants legal approval for the draft conditions of the EPL.

Authorized officers also have to confirm PSI data registration.

g) Receipt of Issued EPL from LAs and BOI

EPL for the industries in List "C" has to be obtained from the respective Local Authorities (LAs).

Within the Export Processing Zones (EPZs), the BOI carries out the enforcement of provision under National Environmental Act and its regulations. The BOI issues EPL for industries established in EPZs.

Relevant Provincial/ District office of the CEA will receive issued the EPL from Local Authorities and BOI.

After receiving EPL from LA (Category C) and BOI, EO in Provincial /District Office will register the Industry Details Information to PSI system. EO will check “Pollution Checklist” and register Waste/Pollution Information (i.e. specific environmental information such as water, solid waste, atmospheric emissions, noise pollution, energy requirements and recycling/ reuse). Senior Environmental Officer (SEO) in Provincial /District Office will check the registered PSI data, especially “Pollution Checklist” and the checked specific environmental information. (For example, if waste water is “Yes” in the Pollution Checklist, SEO will check the PSI data related to “Water”.)

3.2.2. Renewal license application

An EPL renewal application has to be forwarded for each prescribed activity

1. Before three months prior to the date of expiry of the EPL.
2. Before one month effecting any changes alterations or extensions to the activity.

Application procedure is shown as follows:

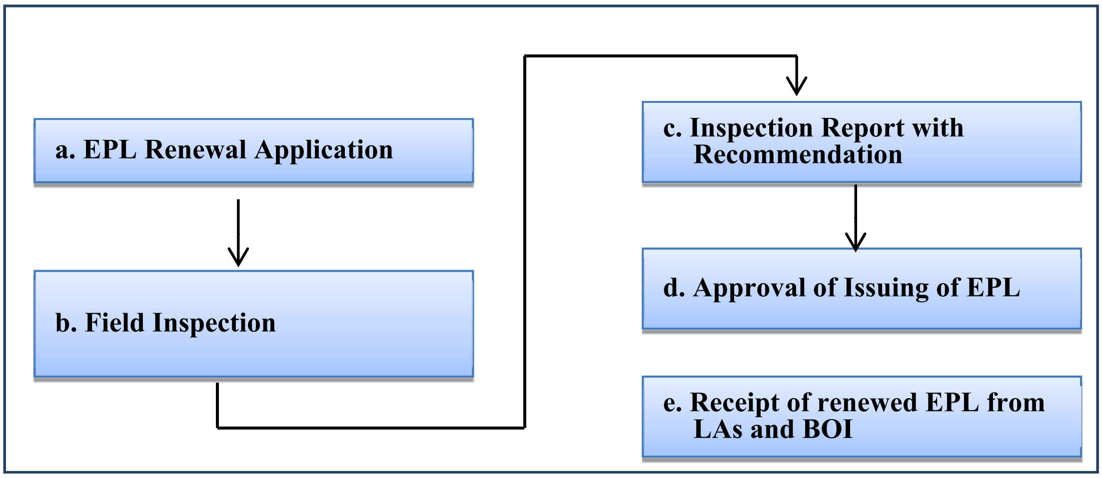


Figure 3.3Procedure for Renewal EPL Application

a) EPL Renewal Application (Confirmation of the renewal EPL application documents)

The applicant must provide all the particulars requested in EPL Renewal application Form and submit to the PO or DO with relevant documents.

> Based on submitted document, EO in Provincial /District Office will edit the Industry Details, Waste/Pollution Information and Application information to PSI system.

b) Field Inspection

A team of officers of CEA will carry out a field inspection to ascertain whether the conditions stipulated by the previous EPL are violated.

If the industrialist apply for the renewal of EPL prior to the expiry date of the existing EPL, it is not necessary to pay inspection fee for the inspection carried out in order to EPL renewal.

The applicant/industrialist will be informed to have relevant pollution control measures if the violation of conditions observed.

> Before field inspection, a team of officers will confirm Waste/Pollution Information.

c) Inspection Report with Recommendation

Inspection team will prepare a report based on the field inspection details regarding the industry, technical reports provided by the applicant and social aspects along with their recommendations. If the site is recommended proceed to next step.

If the recommendation suggested requesting a proposal for additional pollution control measures, the industrialist will be informed to fulfil such request. Decision to issue the EPL will be made based on the evaluation of the additional details provided by the applicant.

> After confirmation of additional pollution control measures,a team of officers will reconfirm and edit Waste/Pollution Information and register Inspection information in PSI system.
>
> A team of officers or responsible officers will register Environmental Monitoring Information in PSI system, based on analytical reports submitted by the applicant/industrialist.

d) Approval of Issuing of EPL

Authorized officers of the CEA grant approval for issuing of EPL based on the recommendation made by the inspection team and then Legal Division of the CEA grants legal approval for the draft conditions of the EPL.

> Authorized officers also have to confirm PSI data registration.

e) Receipt of renewed EPL from LAs and BOI

Relevant Provincial/ District office of the CEA will receive renewed the EPL from Local Authorities and BOI.

> EO in Provincial /District Office will edit the Industry Details, Waste/Pollution Information and Application information to PSI system.

3.2.3. Follow up monitoring of Industrial Activities

Follow up monitoring of industrial activities is carried out to;

1. Check the performance of pollution control systems established in the industry.
2. Check whether the industry complies with conditions stipulated in the EPL.
3. Check whether there is any change, expansion or alteration to the industrial process or machineries.

Monitoring activities are carried out by;

1. Inspecting the industries at regular intervals.
2. Going through the reports on wastewater analysis, noise/ vibration measurements and reports on efficiency/evaluation of pollution control systems adapted in an industrial activity.

In these instances the industrialists will be requested to consult reputed laboratories to obtain such test reports periodically, as may be indicated in the EPL.

> After follow up monitoring, a team of officers will reconfirm and edit Waste/Pollution Information and register Inspection information in PSI system.

A team of officers or responsible officers will register Environmental Monitoring Information in PSI system, based on analytical reports submitted by the applicant/industrialist or the sampling conducted by the relevant authorities in these monitoring activities.

3.2.4. Legal Proceedings against industries

Legal proceedings are adopted under part IV A of the NEA when;

1. An industrial activity/ process acts in violation of any terms, conditions and standards stipulated in the licence.
2. The prescribed industries who do not obtain an EPL
3. A prescribed activity emits waste to the environment without conforming to the stipulated standards.

If the industrialist continues to violate the conditions legal action will be initiated.

Legal Procedure includes following cause of actions

1. Cancellation /suspension of EPL
2. Rejection of application for EPL
3. Hearing of appeals by the secretary of the Ministry of Environment.
4. Sending Legal Notices
5. Filing Cases.

When Legal Proceedings will be done against industries, the CEA officer will reconfirm and edit Waste/Pollution Information and register EPL Detail information in PSI system.

A team of officers will register Environmental Monitoring Information in PSI system, based on analytical reports submitted by the applicant/industrialist or the sampling conducted by the relevant authorities in these monitoring activities.

3.3. Monitor, Assessment of PSI data

3.3.1. Items to be Monitored in PSI data

PSI provides information on type of industries operated, raw material used, energy sources, water requirement, etc. and substances emitted to the air, land and water.

The items to be monitored regularly are shown as follow;

Table 3.1Items to be monitored in PSI system

No.	Items	Monitored by
a)	**Industry General Information**	
a)-1	Number of application received	**EPC Division EPC unit**
a)-2	Number of Industry by EPL status	**Planning & Monitoring Division**
a)-3	Industry name/ Industry type/ Location (Province, District, LA, DSD, GN, Geographic Information)	**EMA Division R&D unit**
b)	**Pollution Source Information- Water**	
b)-1	Number and type of Industry that discharges waste water	**EPC Division Water Quality Laboratory**
b)-2	Method of discharge	
b)-3	Amount of discharged water (m3/day)	
b)-4	Number of company, sector which submit the analytical report	
b)-5	Monitoring data by major parameters (TSS, pH, BOD, COD, oil and grease)	
b)-6	Recycling/ reuse of water	
c)	**Pollution Source Information- Air Pollution**	
c)-1	Number and type of Industry that emits air pollution, noise	**EPC Division Air Quality Laboratory**
c)-2	Industry stationary source (Number of Stacks and chimneys)	
c)-3	Fuel use (Fuel type and daily consumption)	
d)	**Pollution Source Information- Solid Waste**	
d)-1	Number and type of Industry that generates solid waste	**Waste Management Division**
d)-2	Total amount of solid waste (kg/day)	
d)-3	Type of solid waste and disposal method	
d)-4	Recycling/ reuse of solid waste	
e)	**EPL compliance**	
e)-1	Number of inspection made	**EPC Division EPC unit**
e)-2	Type of Industry received inspection	
e)-3	Purpose of the inspection	
e)-4	Result of the inspection (recommendation, type of violation)	

3.3.2. Method of Monitoring /Assessment

a) Industry General Information

EPL monthly monitoring shall be conducted by Planning & Monitoring Division mainly.

Planning & Monitoring Officer will be monitored and assessed the number of EPL Company by EPL status, category, sector, location.

Senior officer in Planning & Monitoring Division will confirm it and report to the CEA management monthly meeting. Senior officer will compile it for the Environmental report.

R&D unit under Environmental Management and Assessment Division will also check the location of industry by category and sector and use for GIS mapping.

b) Pollution Source Information

Assessment of pollution control shall be conducted by EPC division annually. The following items will be monitored and assessed.

- Number of company, sector which submit the analytical report.
- Number of company which receive regal action or suspend the EPL renewal.
- Mean, min, max of discharged water by parameter, category and sector.

IT unit will provide excel (CSV) data from EPL/PSI system.

PO and DO also confirm the data in each region.

3.3.3. Data Accuracy Check

PSI data accuracy check will be conducted by EO in EPC division monthly.

EO will select and check random date registered in PSI system. EO will also select the PSI data in specific area, category to check the blank data and duplication. Similar industry name such as “Service station” “Piggy Farm”, “Poultry Farm”, “Laundry” should be checked by file number, location to identify the specific industry.

EO will report the result of data accuracy check to SEO in EPC division and IT unit. Through Director of EPC, EO will inform PO/ DO to review and edit the suspicious data.

In case of data duplication, PO/ DOmust identify “Industry ID” of wrong data, and will inform it to IT unit.

3.3.4. Data sharing with relevant authorities

PSI system can access by using user login function provided the system administrator. However, PSI system contains confidential data of industries, so the data accessibility should have limitation.

Environmental report including PSI information will be distributed to related agencies. The following chapter show the item to be reported to public.

4. ENVIRONMENTAL REPORT

Environmental report including PSI information will be developed and distributed in order to make known the environmental condition of Sri Lanka to the public.

It will help to enhance the awareness of importance of environment in Sri Lanka, and to promote preventing or controlling the discharge, deposition or emission of waste and streamline the activity to operate in environmental friendly manner and thereby maintaining sustainability in the development process of the nation.

The items to be reported in an environmental report shown as follow;

a) Industry General Information

- Number of Industry by EPL status, Industry type and Location(e.g. Province, DSD level)

b) Pollution Source Information- Water

- Number and type of Industry that discharges waste water
- Amount of discharged water (m3/day)
- Monitoring data by major parameters (TSS, pH, BOD, COD, oil and grease)

c) Pollution Source Information- Air Pollution

- Number and type of Industry that emits air pollution, noise
- Fuel use (Fuel type and daily consumption)

d) Pollution Source Information- Solid Waste

- Number and type of Industry that generates solid waste
- Total amount of solid waste (kg/day)
- Type of solid waste and disposal method

e) EPL compliance

- Number of inspection by the purpose, EPL status, Industry type

All PSI data can be provided by excel (CSV) data from EPL/PSI system.

Responsible unit and team shown in Table 3.1 will prepare the material and EPC unit will compile the data for publishing.

LIST OF APPENDIX

A. Effluent and emission standards

B. Category and Sectors to be monitored for Waste water discharge

C. User manual for PSI System

D. Flowchart for PSI data registration

Appendix A
Effluent and emission standards

SCHEDULE I

Tolerance Limits for the Discharge of Industrial Waste in to Inland Surface Waters

No.	*Parameter*	*Unit type of limit*	*Tolerance Limit values*
01.	Total suspended solids	mg/1, max.	50
02.	Particle siz of the total suspended solids	µm, less than	850
03.	pH at ambient temperature	-	6.0 - 8.5
04.	Biochemical oxygen demand (BOD_5 in five days at 20^0c or BOD_3 in three days at 27^0c)	mg/1, max.	30
05.	Temperature of discharge	^{0}C, max.	Shall no exceed 40^0 C in any section of the stream within 15 m down stream from the effluent outlet.
06.	Oils and greases	mg/1, max.	10
07.	Phenolic compounds (as C_6H_5OH)	mg/1, max.	1
08.	Chemical oxygen demand (COD)	mg/1, max.	250
09.	Colour	Wavelength Range	Maximum spectral absorption coefficient
		436 nm (Yellow range)	$7m^{-1}$
		525 nm (Red range)	$5m^{-1}$
		620 nm (Blue range)	$3m^{-1}$
10.	Dissolved phosphates (as P)	mg/1, max.	5
11.	Total Kjeldahl nitrogen (as N)	mg/1, max.	150
12.	Ammoniacal nitrogen (as N)	mg/1, max.	50
13.	Cyanide (as CN)	mg/1, max.	0.2
14.	Total residual chlorine	mg/1, max.	1.0
15.	Flourides (as F)	mg/1, max.	2.0
16.	Sulphide (as S)	mg/1, max.	2.0
17.	Arsenic (as As)	mg/1, max.	0.2
18.	Cadmium (as Cd)	mg/1, max.	0.1
19.	Chromium, total (as Cr)	mg/1, max.	0.5
20.	Chromium, Hexavalent (as Cr^{6+})	mg/1, max.	0.1
21.	Copper (as Cu)	mg/1, max.	3.0
22.	Iron (as Fe)	mg/1, max.	3.0
23.	Lead (as Pb)	mg/1, max.	0.1
24.	Mercury (as Hg)	mg/1, max.	0.0005
25.	Nickel (as Ni)	mg/1, max.	3.0
26.	Selenium (as Se)	mg/1, max.	0.05

SCHEDULE I *(Contd.)*

TOLERANCE LIMITS FOR THE DISCHARGE OF INDUSTRIAL WASTE IN TO INLAND SURFACE WATERS

No.	*Parameter*	*Unit type of limit*	*Tolerance Limit values*
27.	Zinc (as Zn)	mg/1, max.	2.0
28.	Pesticides	mg/1, max.	0.005
29.	Detergents/surfactants	mg/1, max.	5
30.	Faecal Coliform	MPN/100 ml, max	40
	Radio Active Material :		
31.	(*a*) Alpha emitters	micro curie/ml, max	10^{-8}
	(*b*) Beta emitters	micro curie/ml, max	10^{-7}

Note 1 : All efforts should be made to remove unpleasant odour as far as possible.

Note 2 : These values are based on dilution of effluents by at least 8 volumes of clean receiving water. If the dilution is below 8 times, the permissible limits are multiplied by the 1/8 of the actual dilution.

Note 3 : The above mentioned general standards shall cease to apply with regard to a particular industry when industry specific standards are notified for that industry.

Note 4 : Pesticides as per World Health Organization (WHO) and Food and Agriculture Organization (FAO) requirements.

LIST II

TOLERANCE LIMITS FOR INDUSTRIAL WASTE DISCHARGED ON LAND FOR IRRIGATION PURPOSE

No.	*Parameter*	*Unit type of limit*	*Tolerance Limit value*
1.	Total dissolved solids	mg/1, max.	2100
2.	pH at ambient temperature	-	5.5 - 9.0
3.	Biochemical oxygen demand	mg/1, max.	250
	(BOD_5 in five days at 20^0 C or BOD_3 in		
	three days at 27^0c)		30
4.	Oils and greases	mg/1, max.	10
5.	Chemical Oxygen Demand (COD)	mg/1, max.	400
6.	Chlorides (as C1)	mg/1, max.	600
7.	Sulphates (as SO_4)	mg/1, max.	1000
8.	Boron (as B)	mg/1, max.	2.0
9.	Arsenic (as As)	mg/1, max.	0.2
10.	Cadmium (as Cd)	mg/1, max.	2.0
11.	Chromium , total (as Cr)	mg/1, max.	1.0
12.	Lead (as Pb)	mg/1, max.	1.0
13.	Mercury (as Hg)	mg/1, max.	0.01
14.	Sodium adsorption ratio (SAR)	-	10 - 15
15.	Residual sodium carbonate (RSC)	mo1/1, max.	2.5

LIST II *(Contd),*

TOLERANCE LIMITS FOR INDUSTRIAL WASTE DISCHARGED ON LAND FOR IRRIGATION PURPOSE

No.	*Parameter*	*Unit Type of limit*	*Tolerance Limit Values*
16.	Electrical conductivity	µS/cm. max.	2250
17.	Faecal coliform	MPN/100m1, max.	40
18.	Copper (as Cu)	mg/1, max.	1.0
19.	Cyanide (as CN)	mg/1, max.	0.2
20.	Radio Active Material :		
	(a) Alpha emitters	Micro curie./m1, max.	10^{-9}
	(b) Beta emitters	Micro curie/m1, max.	10^{-8}

Hydraulic Loading Applicable for Different Soils :

Soil Texture Class	Recommended dosage of settled Industrial Effluents (m^3 /hectare, day)
1. Sandy	225 - 280
2. Sandy laom	170 - 225
3. loam	110 - 170
4. Clay loam	55 - 110
5. Clay	35 - 55

LIST III

TOLERANCE LIMITS FOR INDUSTRIAL AND DOMESTIC WASTE DISCHARGED INTO MARINE COASTAL AREAS

No.	*Parameter*	*Unit Type of limit*	*Tolerance Limit Values*
1.	Total suspended solids	mg/1, max.	150
2.	Particle size of -		
	(*a*) Floatable solids	mm, max.	3
	(*b*) Settlabe solids	µm, max	850
3.	pH at ambient temperature	-	5.5 - 9.0
4.	Biochemical oxygen demand (BOD_5 in five days at 20 ^{0} C or BOD_3 in three days at 27 ^{0} C)	mg/1, max.	100
5.	Temperature	^{0}C, max	45^{0}C at the point of discharge
6.	Oils and greases	mg/1, max.	20

LIST III *(Contd.,)*

TOLERANCE LIMITS FOR INDUSTRIAL AND DOMESTIC WASTE DISCHARGED INTO MARINE COASTAL AREAS

No.	*Parameter*	*Unit Type of limit*	*Tolerance Limit Values*
7.	Phenolic compunds (as Phenolic OH)	mg/1, max.	5
8.	Chemical oxygen demand (COD)	mg/1, max.	250
9.	Total residual chlorine	mg/1, max.	1.0
10.	Ammoniacal Nitrogen (as N)	mg/1, max.	50
11.	Cyanide (as CN)	mg/1, max.	0.2
12.	Sulphides (as S)	mg/1, max.	5.0
13.	Fluorides (as F)	mg/1, max.	15
14.	Arsenic (as As)	mg/1, max.	0.2
15.	Cadmium (as Cd)	mg/1, max.	2.0
16.	Chromium, total (as Cr)	mg/1, max.	2.0
17.	Chromium, Hexavalent (as Cr^{6+})	mg/1, max.	1.0
18.	Copper (as Cu)	mg/1, max.	3.0
19.	Lead (as Pb)	mg/1, max.	1.0
20.	Mercury (as Hg)	mg/1, max.	0.01
21.	Nickel (as Ni)	mg/1, max.	5.0
22.	Selenium (as Se)	mg/1, max.	0.1
23.	Zinc (as Zn)	mg/1, max.	5.0
24.	Pesticides	mg/1, max.	0.005
25.	Organo-Phosphorus compounds	mg/1, max.	1.0
26.	Chlorinated hydrocarbons (as C1)	mg/1, max.	0.02
27.	Faecal coliform	MPN/100m1, max.	60
28.	Radio Active Material :		
	(c) Alpha emitters	micro curie/m1, max	10^{-8}
	(d) Beta emitters	micro curie/m1, max	10^{-7}

Note 1 : All efforts should be made to remove unplesant odour and colour as far as practicable.

Note 2 : These values are based on dilution of effluents by at least 8 volumes of clean receiving water. if the dilution is below 8 times, the permissible limits are muiltiplied by the 1/8 of the actual dilution.

LIST IV

TOLERANCE LIMITS FOR WASTE FROM RUBBER FACTORIES BEING DISCHARGED INTO INLAND SURFACE WATERS

	Parameters	Units Type of limit	Tolerance Limit Value	
			Type I* Factories	Type II** Factories
1	pH value at ambient temperature	-	6.5 to 8.5	6.5 to 8.5
2	Total suspended solids	mg/1, max.	100	100
3	Total Solids	mg/1, max.	1500	1000
4	Biochemical Oxygen Demand, BOD_5 in five days at 20^0C or BOD_3 in three days at 27^0C	mg/1, max.	60	50
5	Chemical Oxygen Demand (COD)	mg/1, max.	400	400
6	Total Nitrogen (as N)	mg/1, max.	300	60
7	Ammonical Nitrogen (as N)	mg/1, max.	300	40
8	Sulphides (as S)	mg/1, max.	2.0	2.0

* *Type I Factories* – Latex Concentrate

** *Type II Factories* – Standard Lanka Rubber ; Crepe Rubber and Ribbed Smoked Sheets

Note I : All efforts should be made to remove unplesant odour and colour as far as practicable.

Note 2 : These values are based on dilution of effluents by at least 8 volumes of clean receiving water. If the dilution is below 8 times, the permissible limits are multiplied by the 1/8 of the actual dilution.

LIST V

TOLERANCE LIMITS FOR WASTE FROM TEXTILE INDUSTRY BEING DISCHARGED INTO INLAND SURFACE WATERS

No.	*Parameter*	*Unit type of limit*	*Tolerance Limit values*
01.	pH at ambient temperature		6.5 to 8.5
02.	Temperature	^0C, max.	40 measured at site of sampling
03	Total suspended solids	mg/1, max.	50
04	Biochemical Oxygen Demand BOD_5 in five days at 20^0c or BOD_3 in a three days at 27^0c	mg/1, max.	60
05	Colour	**Wavelength Range**	**Maximum spectral Absorption coefficient**
		436 nm (Yellow range)	$7m^{-1}$
		525 nm (Red range)	$5m^{-1}$
		620 nm (Blue range)	$3m^{-1}$
06.	Oils and grease	mg/1, max.	10
07.	Phenolic compounds (as Phenolic OH)	mg/1, max.	1.0
08.	Chemical Oxygen Demand (COD)	mg/1, max.	250
09.	Sulphides (as S)	mg/1, max.	2.0

LIST V *(Contd).,*

TOLERANCE LIMITS FOR WASTE FROM TEXTILE INDUSTRY BEING DISCHARGED INTO INLAND SURFACE WATERS

No.	*Parameter*	*Unit type of limit*	*Tolerance Limit values*
10.	Chromium total (as Cr)	mg/1, max.	2.0
11.	Hexavalent Chromium (as Cr^{+6})	mg/1, max.	0.5
12.	Copper, total (as Cu)	mg/1, max.	3.0
13.	Zinc, total (as Zn)	mg/1, max.	5.0
14.	Ammoniacal nitrogen (as N)	mg/1, max.	60
15.	Chloride (as Cl)	mg/1, max.	70

Note I : All efforts should be made to remove unplesant odour and colour as far as practicable.

Note 2 : These values are based on dilution of effluents by at least 8 volumes of clean receiving water. If the dilution is below 8 times, the permissible limits are multiplied by the 1/8 of the actual dilution.

LIST VI

TOLERANCE LIMITS FOR WASTE FROM BEING DISCHARGED FROM TANNING INDUSTRIES

No.	*Parameter*	*Unit Type of Limit*	*Tolerance Limit Values for Effluents Discgharged into Inland Surface Waters*	*Tolerance Limit Values for Effluents Discharged into Marine Coastal Areas*
01	pH value at ambient temperature	^0C	5.5 - 9.0	5.5 - 9.0
02	Total suspended solids	mg/1, max.	100	150
03	Biochemical Oxygen Demand (BOD_5 in five days at 20^0C or BOD_3 in three days at 27^0C)	mg/1, max.	60	100
04	Chemical Oxygen Demand (COD)	mg/1, max.	250	300
05	Colour	**Wavelength Range**	**Maximum Absorption coefficient**	
		436 nm (Yellow range)	$7m^{-1}$	-
		525 nm (Red range)	$5m^{-1}$	-
		620 nm (Blue range)	$3m^{-1}$	-
06	Alkalinity (as Ca CO_3)	mg/1, max.	750	-
07	Chloride (as C1)	mg/1, max.	1000	-
08	Hexavalent Chromium (as Cr^{+6})	mg/1, max.	0.5	0.5
09	Chromium total (as Cr)	mg/1, max.	2.0	2.0
10	Oils and Grease	mg/1, max.	10	20
11	Phenolic Compounds (as phenolic OH)	mg/1, max.	1.0	5.0
12	Sulphides (as S)	mg/1, max.	2.0	5.0

Note I : All efforts should be made to remove unplesant odour and colour as far as practicable.

Note 2 : These values are based on dilution of effluents by at least 8 volumes of clean receiving water. If the dilution is below 8 times, the permissible limits are multiplied by the 1/8 of the actual dilution.

LIST VII

Tolerance Limits for discharge of Effluents into Public Sewers with Central Treatment Plants

No.	*Parameter*	*Unit type of limit*	*Tolerance Limit values*
1.	Total suspended solids	mg/1, max.	500
2.	pH at ambient temperature	-	5.5 - 10.0
3.	Temperature	^{0}C, max.	45
4.	Biochemical oxygen demand (BOD_5 in five days at 20^{0}C or BOD_3 in three days at 27^{0}C)	mg/1, max.	350
5.	Chemical Oxygen Demand (COD)	mg/1, max.	850
6.	Total Kjeldahl nitrogen (as N)	mg/1, max.	500
7.	Free ammonia (as N)	mg/1, max.	50
8.	Ammoniacal nitrogen (as N)	mg/1, max.	50
9.	Cyanide (as CN)	mg/1, max.	2
10.	Total residual chlorine	mg/1, max.	3.0
11.	Chlorides (as Cl)	mg/1, max.	900
12.	Flourides (as F)	mg/1, max.	20
13.	Sulphide (as S)	mg/1, max.	5.0
14.	Sulphates (as SO_4)	mg/1, max.	1000
15.	Arsenic (as As)	mg/1, max.	0.2
16.	Cadmium (as Cd)	mg/1, max.	1.0
17.	Chromium , total (as Cr)	mg/1, max.	2.0
18.	Copper (as Cu)	mg/1, max.	3.0
19.	Lead (as Pb)	mg/1, max.	1.0
20.	Mercury (as Hg)	mg/1, max.	0.005
21.	Nickel (as Ni)	mg/1, max.	3.0
22.	Selenium (as Se)	mg/1, max.	0.05
23.	Zinc (as Zn)	mg/1, max.	5.0
24.	Pesticides	mg/1, max.	0.2
25.	Detergents/surfactants	mg/1, max.	50
26.	Phenolic compounds (as phenolic OH)	mg/1, max.	5
27.	Oil And Grease	mg/1, max.	30
28.	Radio Active Material :		
	(*e*) Alpha emitters	micro curie/m1, max	10^{-8}
	(*f*) Beta emitters	micro curie/m1, max	10^{-7}

Notes : The following conditions should be met :

* discharge of high viscous material should be prohibited.
* Calcium Carbide sludge should not be discharged.
* substances producing inflammable vapours should be absent.

Appendix B

Category and Sectors to be monitored for Waste water discharge

Category A

No.	Type of Activity	Sector Code	Category No. of List A	Waste Water Discharge
1	Chemical & Petrochemical	**CH**	1-22	1-2,4-5, 7-14,18-20
2	Textile & Leather	TL	23-29	23-29
3	Food and Food Related Food Industry	**FD**	30-42	30-35,37-40
4	Metal Industry	**BM**	43-46	43-44
5	Machinery & Equipment	**ME**	47	-
6	Mineral & Mineral Product	**MP**	48-56	49-50,52,56
7	Waste Disposal/Waste water/Water Treatment	**SZ**	57-63	57,59-60
8	Timber &Wood	**TW**	64-65	64
9	Lodging & Health Services	**SL**	66-68	66-68
10	Transport Related Services	**TR**	69-72	70-71
11	Power	**SP**	73	73
12	Paper & Printing	**PP**	74-75	74-75
13	Telecommunication Towers	**TC**	79	-
14	Other Activities	**OT**	76-78,80	76-78,80

Category B

No.	Type of Activity	Sector Code	Category No. of List B	Waste Water Discharge
1	Chemical & Petrochemical	**CH**	1-6	1,6
2	Textile & Leather	**TL**	7-13	7-8,10
3	Food and Food Related Food Industry	**FD**	14-21	14-17,19
4	Machinery & Equipment	**ME**	22,31	-
5	Mineral & Mineral Product	**MP**	23-25	23
6	Waste Disposal/Waste water/Water Treatment	**SZ**	26-28	26
7	Lodging & Health Services	**SL**	29	29
8	Transport Related Services	**TR**	30,32	32
9	Other Activities	**OT**	33	33

Appendix C
User manual for PSI System

USER MANUAL – Pollution Source Inventory System

HOW TO ACCESS TO THE ENVIRONMENTAL PROTECTION LICENCING (EPL) SYSTEM and HAZARDOUS WASTE MANAGEMENT LICENCING (HWM) SYSTEM

Ver.1

Contents

Introduction

Pollution Source Inventory (PSI) is tracking pollution across Sri Lanka and ensuring the CEA has access to information about waste discharge/deposit/emit into environment and use of such information for decision making and appropriate intervention for environmental protection and quality improvement.

The PSI contains data on high, medium and low polluting industries and their pollution sources with possible impacts on the environment. Information about the pollution through the PSI is essential to protect the environment and enhance the environmental quality and assist the government in identifying priorities for environmental decision making.

This manual will support for data registration, monitoring and assessment by CEA officers (Central, Provincial and District) and Industries.

USER CATEGORY

There are three types of PSI system user.

1. "Officer" who registers and edits PSI data for specific area.

2. "Administrator" who monitors PSI data for the whole country.

3. "Customer" who registers own company data only.

1. User Login

In order to access the system you have to log into the system with the username & password given to you.

- Type the URL (http://203.115.26.11:8881/auth/login) on your web browser and enter the username and password given to you. (Refer Figure 1)
- User (CEA Officers) has to enter valid User Name and Password to access the PSI system.
- Administrator (CEA Management Officers) has to enter User Name as “admin” and Password to access the PSI system.
- When User/Administrator forget its User Name and Password, please contact IT Unit of CEA Central. (011-2888999, 011-7877277)

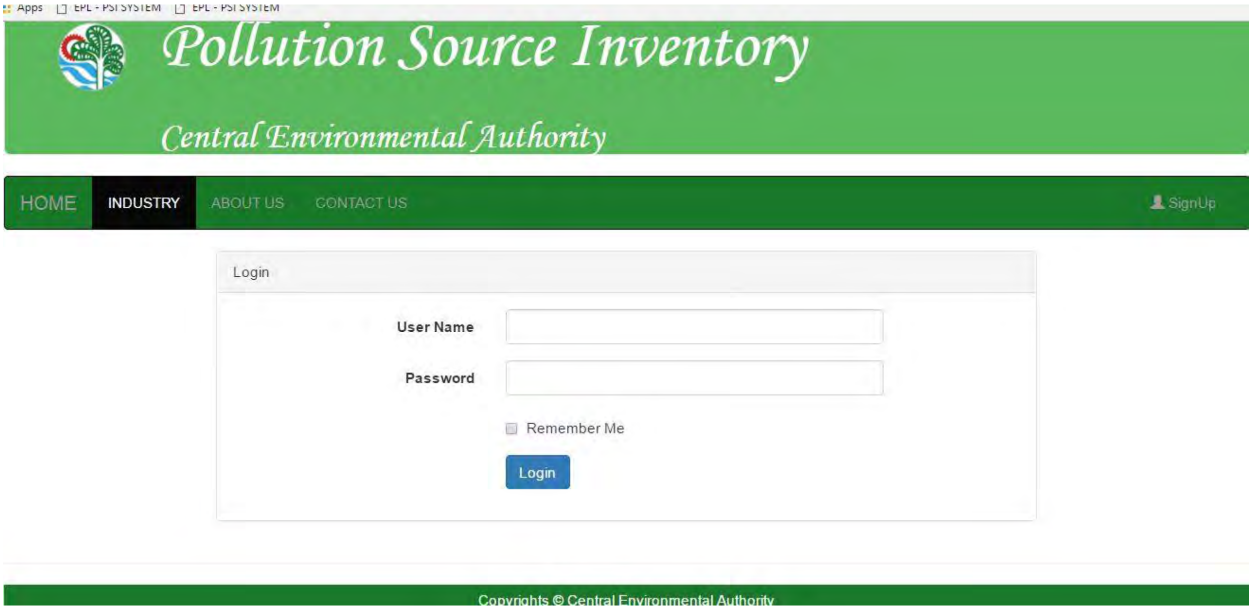


Figure 1 – Login Interface

Figure 2–Home page Interface

Create User account for User (CEA Officer)

- Click Users/Groups Detail icon in Menu Options. (Refer Figure 3)
- Display Users/Groups window and Click on “Inspectors/Users” Button (Refer Figure 4)
- Display existing User names list Interface and click on “Add New User” button (Refer Figure 5)

Figure 3– Home page Interface

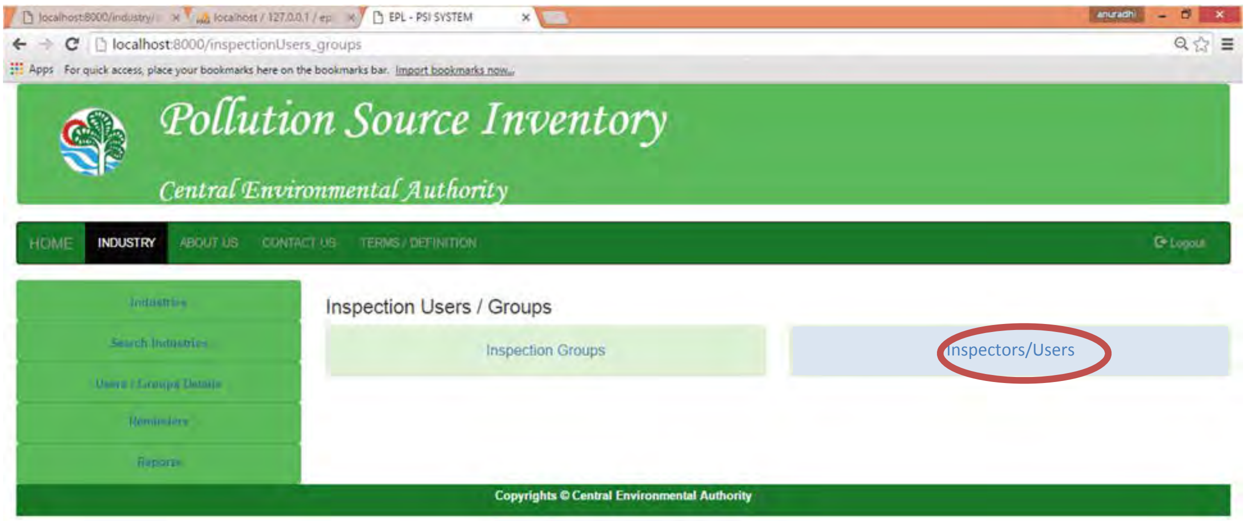


Figure 4 – Users/Groups Interface

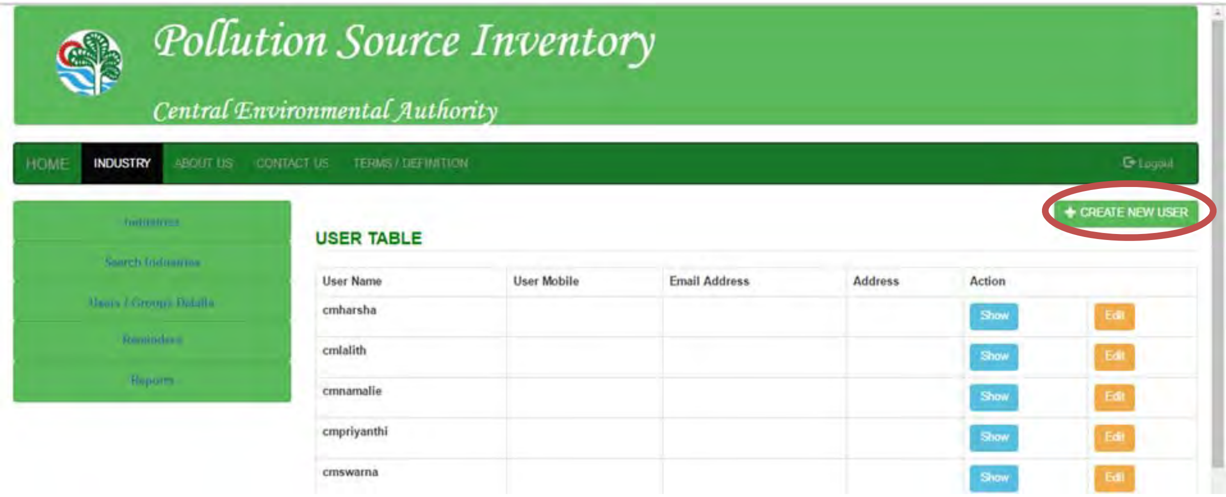


Figure 5 – Add New User Interface

- It displays Add New User Interface (Refer Figure 6)
- Enter User Name, Password, and other details
- Select the groups that this user is belongs to.
- Click on “Register” button to save the user details

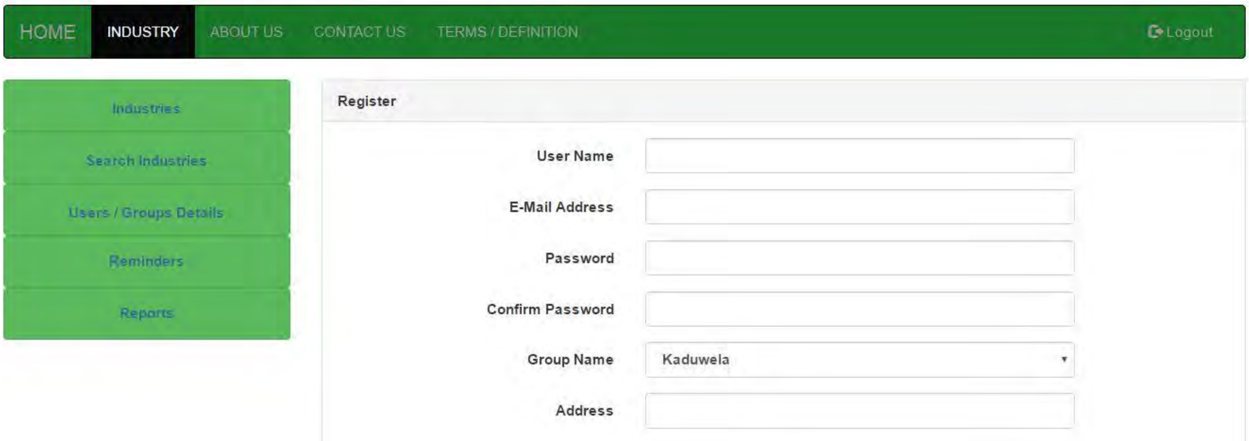


Figure 6 – Add New User Interface

Edit User Account Details

- Move to User list Interface, select the user you want to edit and Click on “Edit” button.
- Display EDIT window and make the necessary changes and Click on “Update user” (Figure 7).

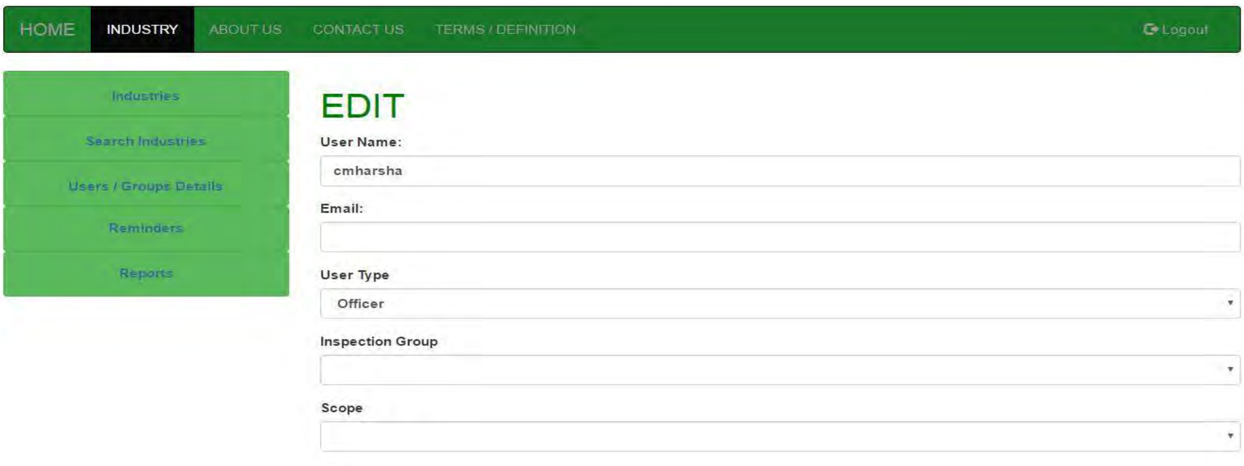


Figure 7 – Edit User List Interface

Create Customer account for Industries

- Type the URL (http://203.115.26.11:8881/auth/login) on your web browser and Click “SignUp” button (Refer Figure 8).
- Display Register window and enter the items, such as User Name, E-mail Address and Password, then click “Register” button. (Refer Figure 9)
- When Customer (Industries) forgets its User Name and Password, please contact IT Unit of CEA Central. (011-2888999, 011-7877277)

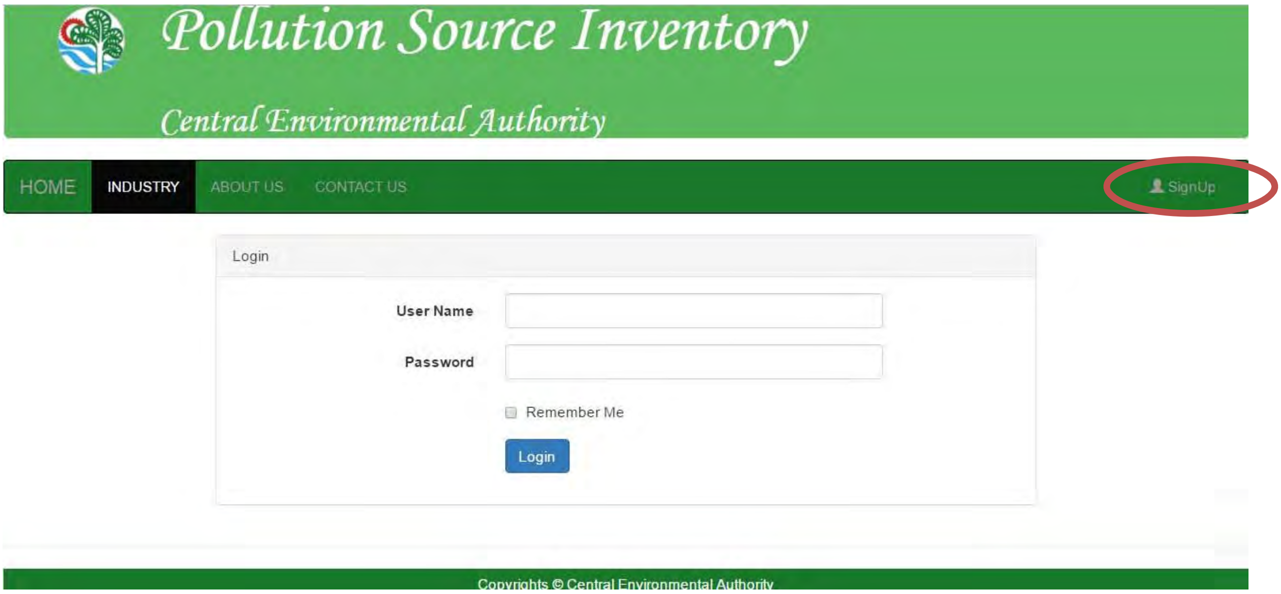


Figure 8– Login Interface

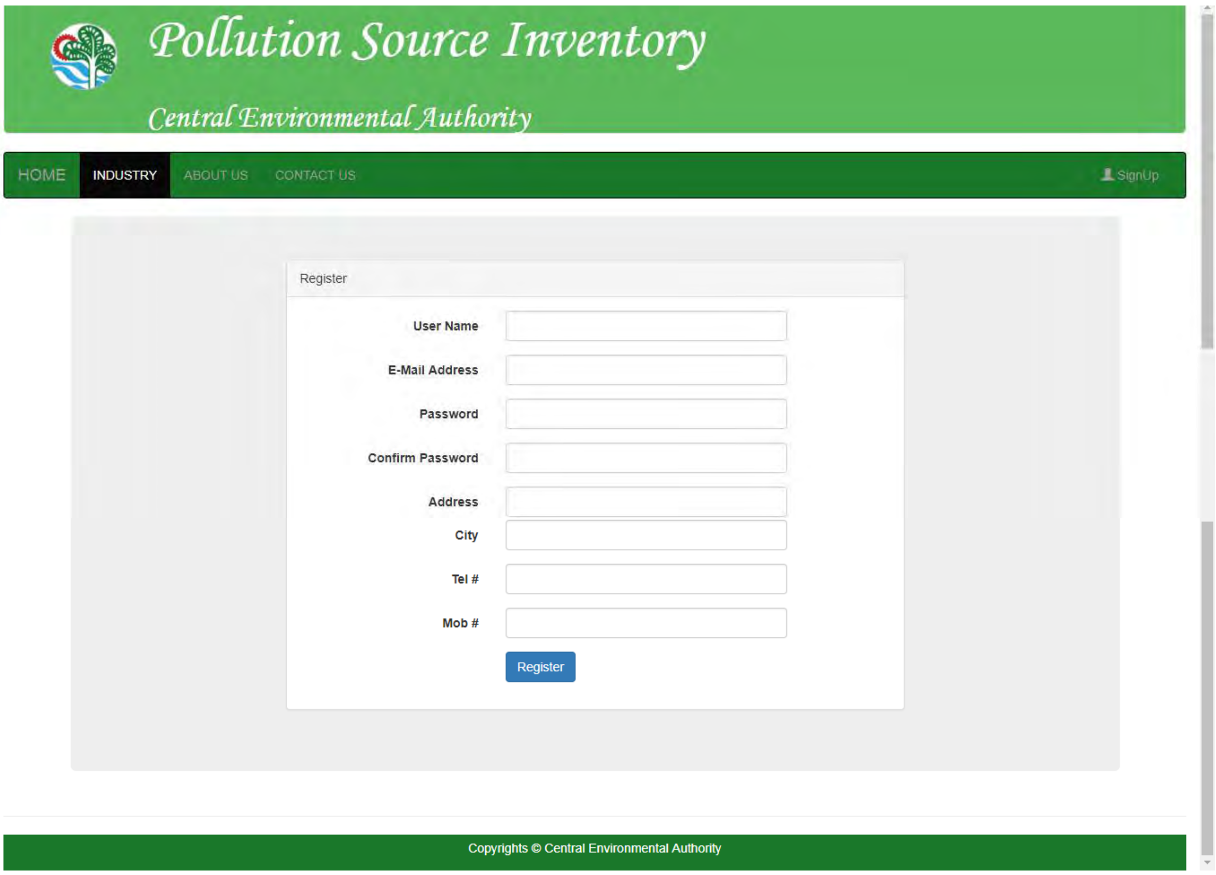


Figure 9 – Customer account Interface

2. Add new Industry

When you receive new EPL application, let's start to register industry information.

- Select "Industry" icon in Menu Options (Figure 10).
- It displays "List of Industries Interface" and click on "Create New Industry" button. (Figure 11).

Figure 10 – Home Page Interface

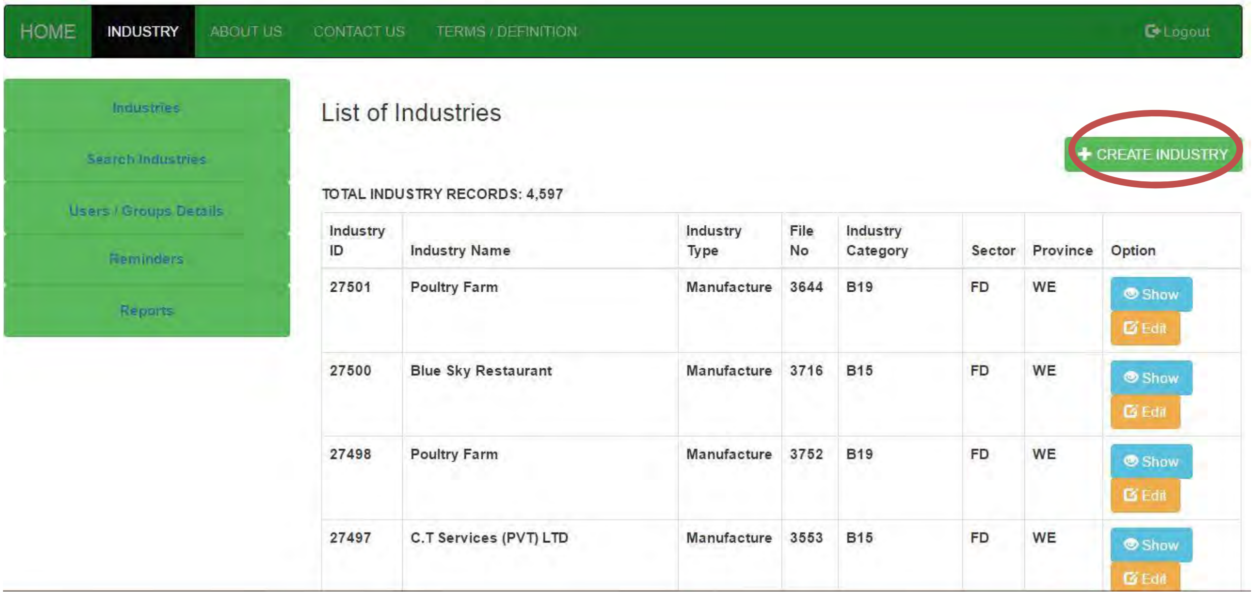


Figure 11– List of Industries Interface

- It displays Add New Industry Interface (Refer Figure 12)
- Enter the information based on submitted EPL Application.
- You must enter the following items for registration otherwise the registration is not completed.
    - ✓ Name of Industry
    - ✓ Type of Industry
    - ✓ BOI Registration
    - ✓ Category of Industry
    - ✓ Sector of Industry
    - ✓ Province
    - ✓ District
    - ✓ Local Authority
    - ✓ Pollution Check List

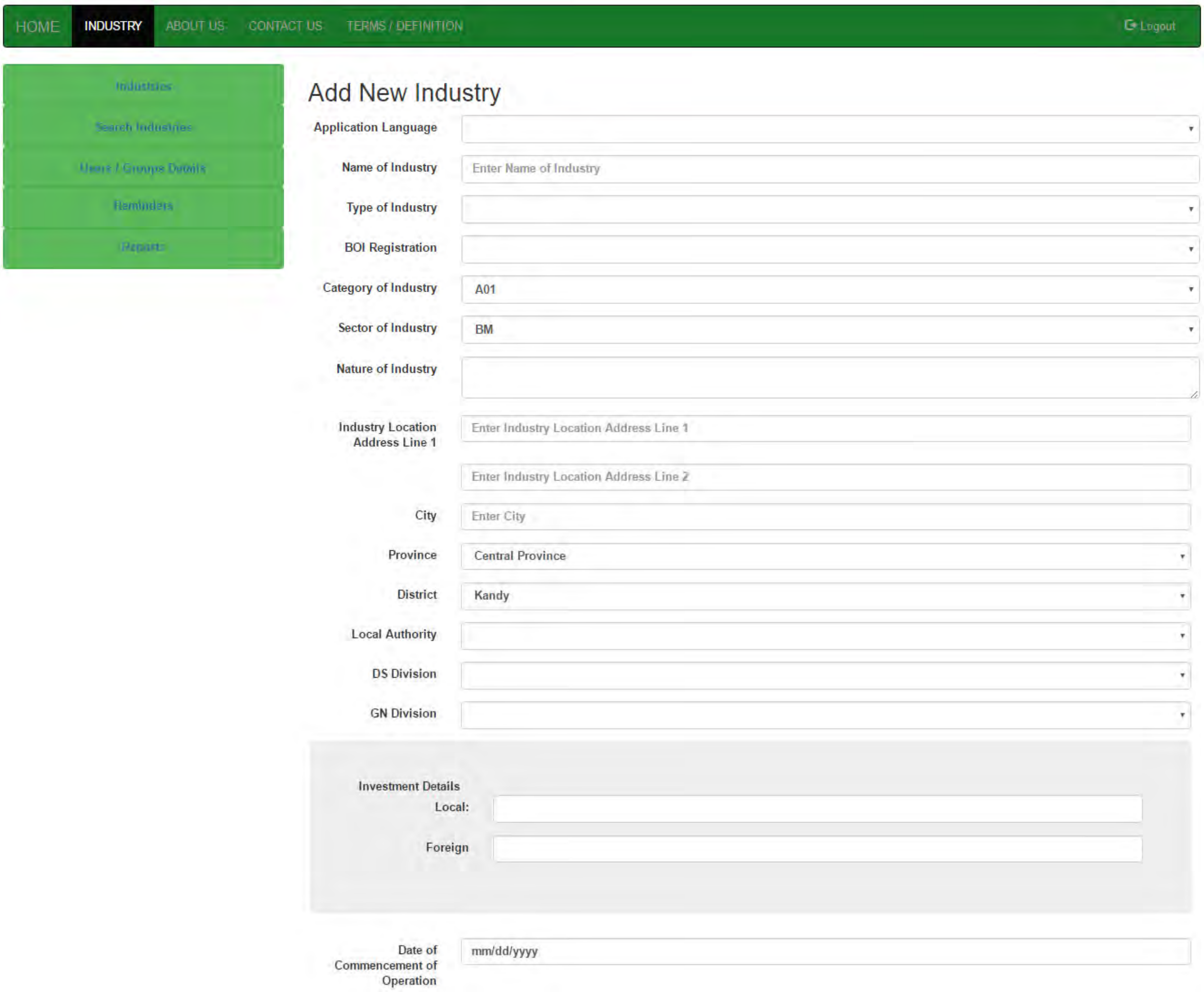


Figure 12 – Add New Industries Interface

- Enter “Pollution Checklist” correctly, **<u>because this is basic pollution information in PSI system.</u>**

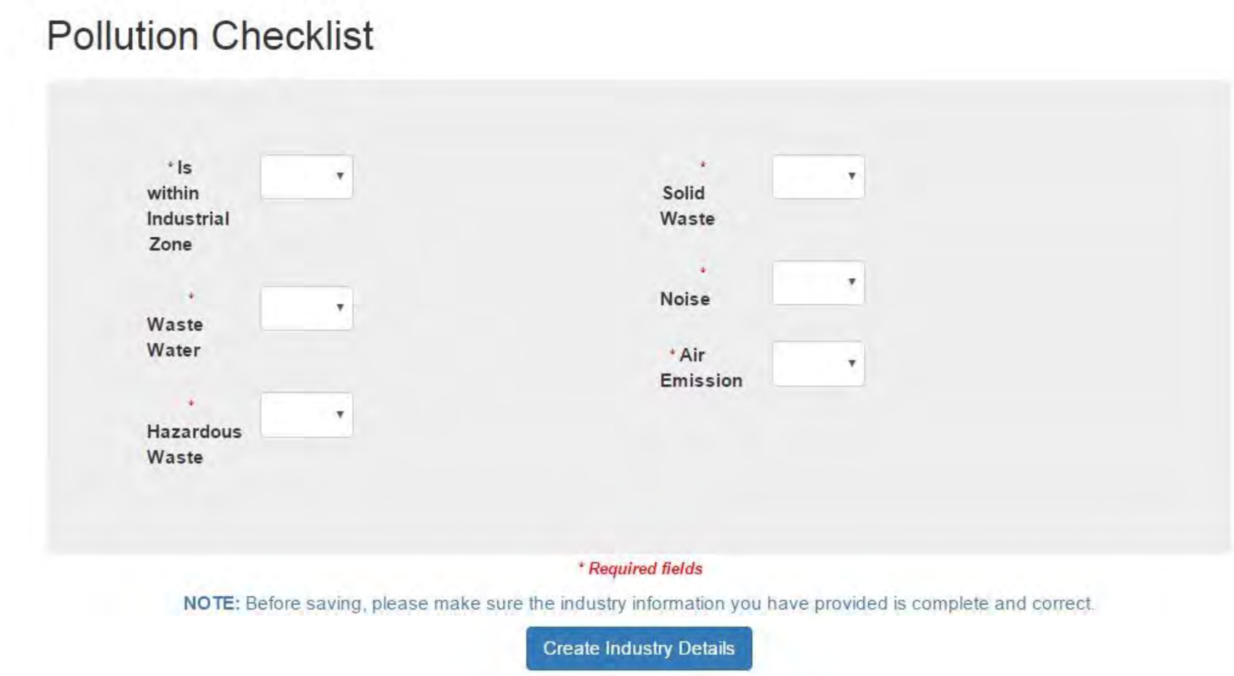


Figure 13 – Add New Industries Interface

- Click on “Create Industry Detail” button, then industry details is registered.
- If you need to change information, click on “Edit” button to tarn edit Industries Interface.

Figure 14 – Add New Industries Interface

3. Add /Edit pollution Information

The user has to register correct information on pollution/ waste emitted by industry activities, based on EPL application form. The following information has to be confirmed by field inspection.

- ✓ Industry Detail
- ✓ Manufacturing Process
- ✓ Water
- ✓ Solid Waste
- ✓ Atmospheric Emission
- ✓ Noise Pollution
- ✓ Vibration Pollution
- ✓ Energy Requirements
- ✓ Fuel Used
- ✓ Recycling / Reuse
- ✓ Geographical Location

Manufacturing Process

- Click on Manufacturing Process tab and display Manufacturing process Interface.
- This Interface contains another four main tabs.
    - o Products and byproducts
    - o Raw material
    - o Chemicals
    - o Security
- To add each items, click "Add New Product/ By Product" and enter details. (Refer Figure 15-17)
- Click "Create Manufacturing Details" button to save details.
- If you want to edit information, click "edit" button and edit the detail.

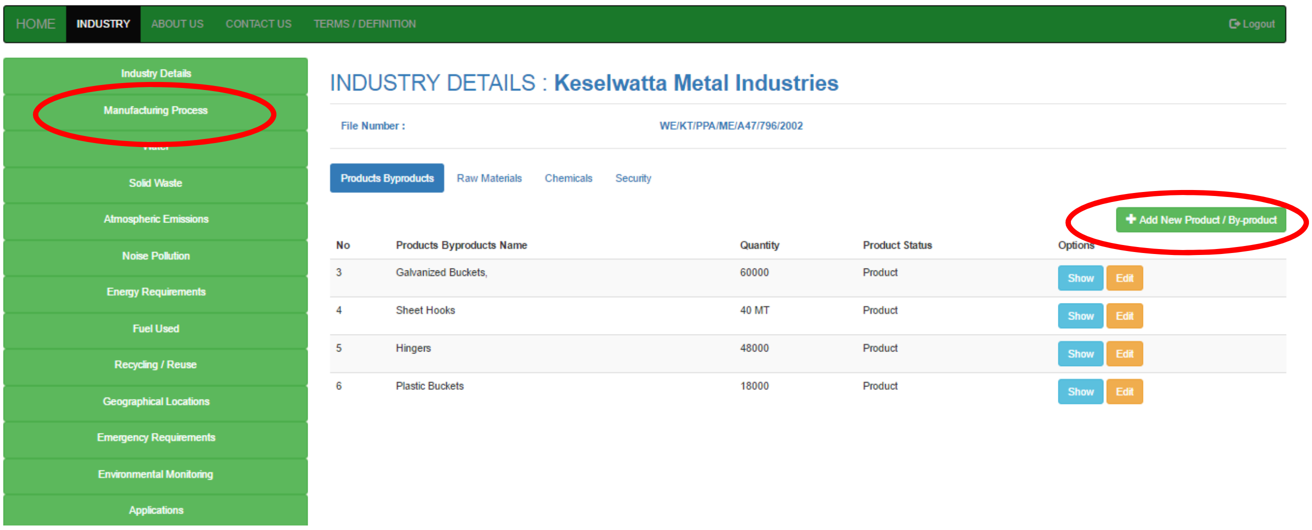


Figure 15 – Manufacturing Process Interface

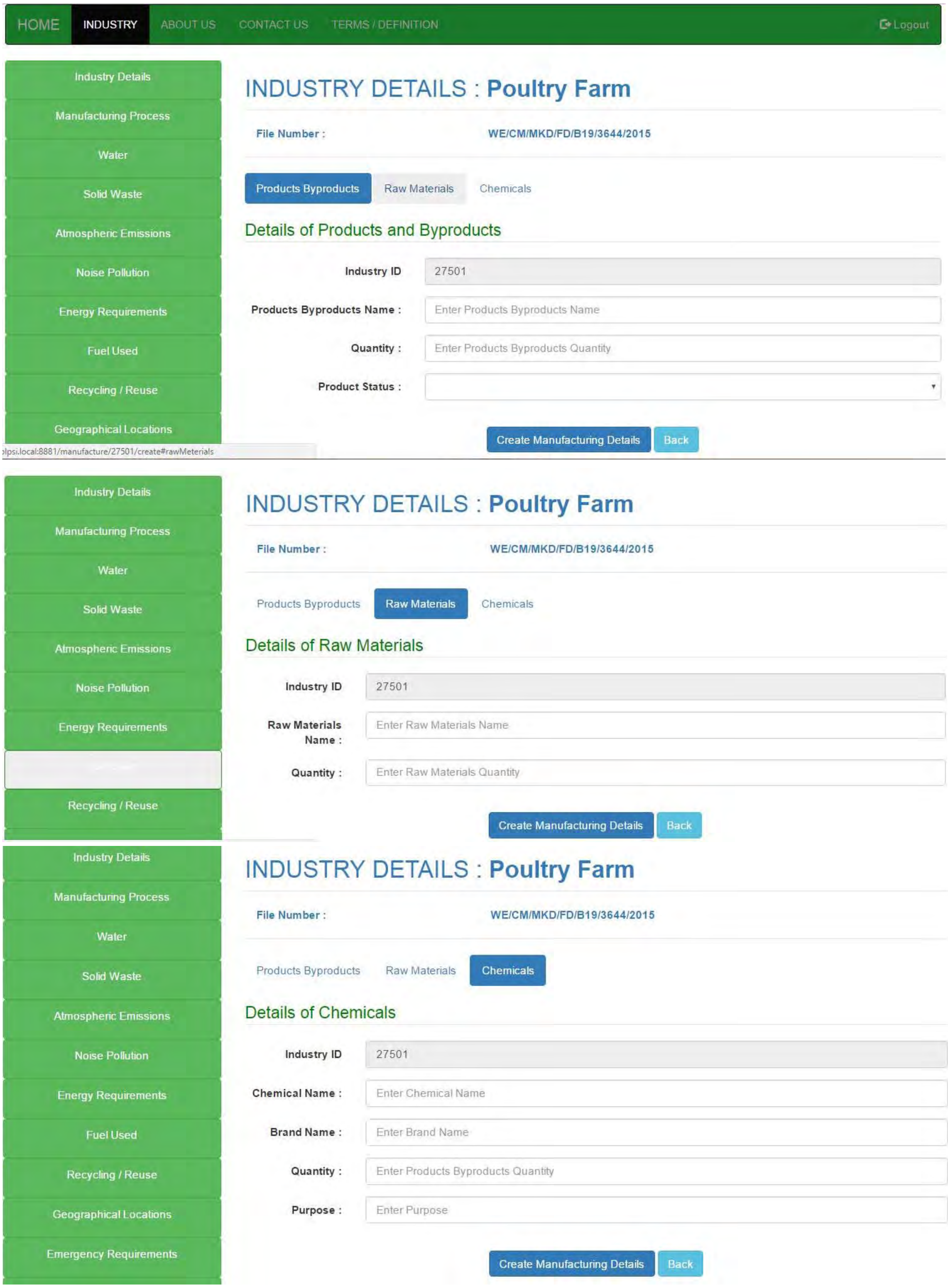


Figure 16 – Manufacturing Process Interface

Figure 17 – Manufacturing Process Interface-Security

Water

- If user select "Yes" in pollution check list in "Industry Details", click "Water" Menu and display Water details. (Refer Figure 18)
- User can enter the requested details for water requirements, Source of water, Total daily discharge.
- After entering all the details and click "Update Water Details" button.
- If you want to edit information, click "Edit" button and edit the detail.

Figure 18 – Water Detail Interface

- Select "'Method of discharge'' and ''Final point of discharge'' from pulldown options.

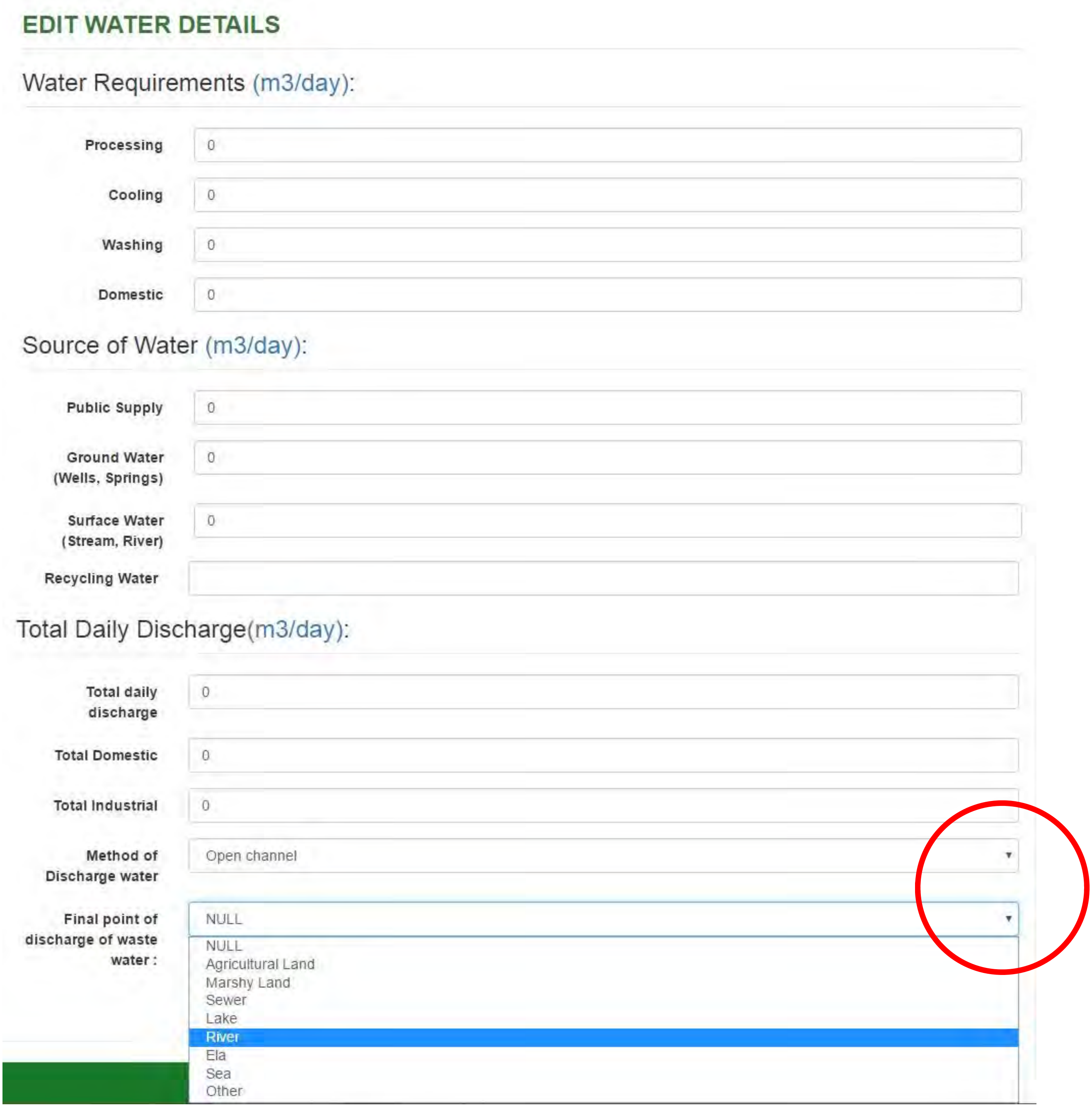


Figure 19 – EDIT Water Interface

Solid Waste

- If user select “Yes” in pollution check list in “Industry Details”, click “Solid Waste” menu and display solid waste interface.(Refer Figure 20,21)
- Enter “Total quantity of solid waste” in Kg.
- Select the type of solid waste and its quantity for each items.
- Select “Method of disposal” for each itms.
- After entering all the details and click “Update Solid Waste Details” button.
- If you want to edit information, click “Edit” button and edit the detail.

Figure 20 – Solid Waste Detail Interface

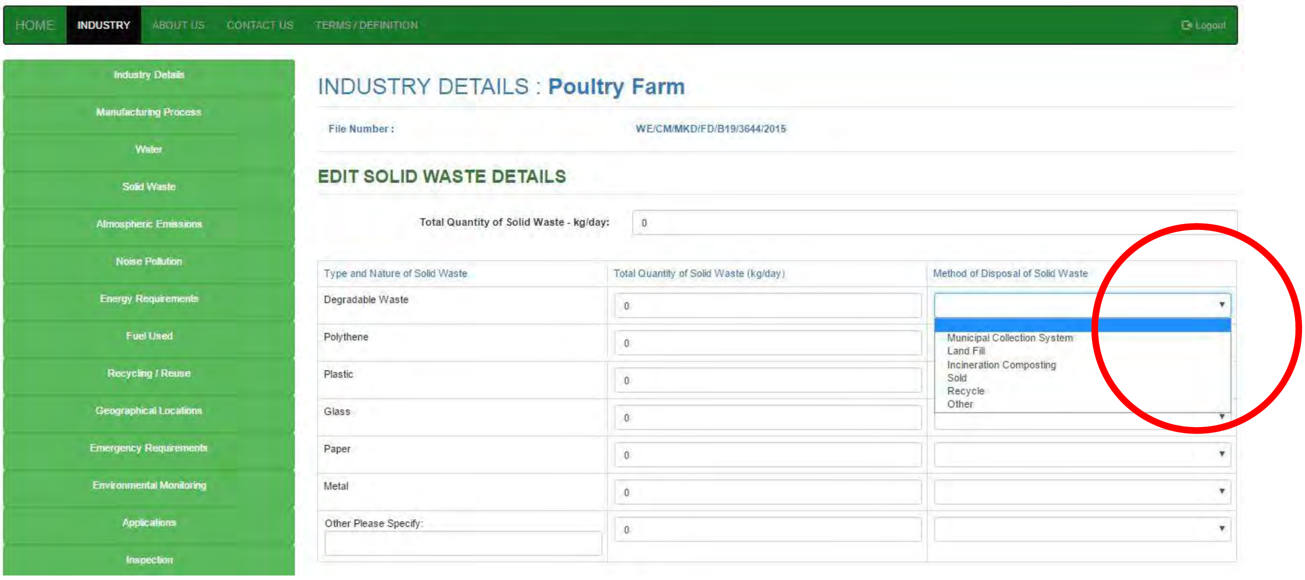


Figure 21 – EDIT Solid Waste Interface

Atmospheric Emission

- If user select “Yes” in pollution check list in “Industry Details”, click “Atmospheric Emission menu and displays Atmoshperice Emission section. (Refer Figure 22,23)
- Select if there is emission to atmosphere by air pollution type(Oxides of Nitorogen, Oxidas of Sulphur, Dust and Soot, Others).
- After entering all the details and click “Update Atmospheric Emission” button.
- If you want to edit information, click “Edit” button and edit the detail.

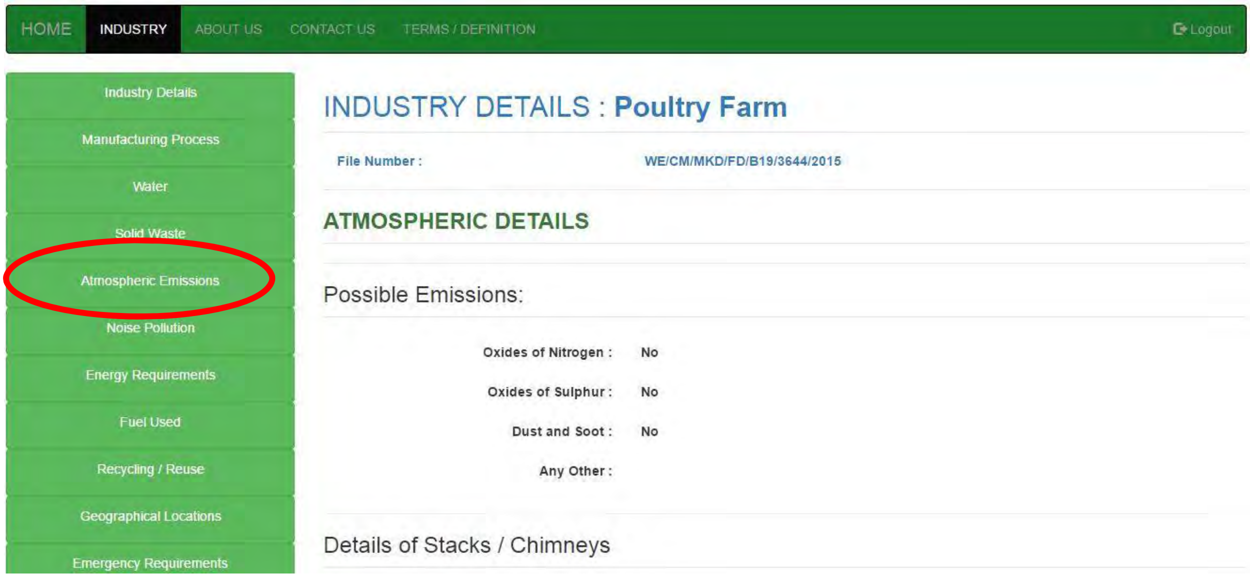


Figure 22 – Atmospheric Detail Interface

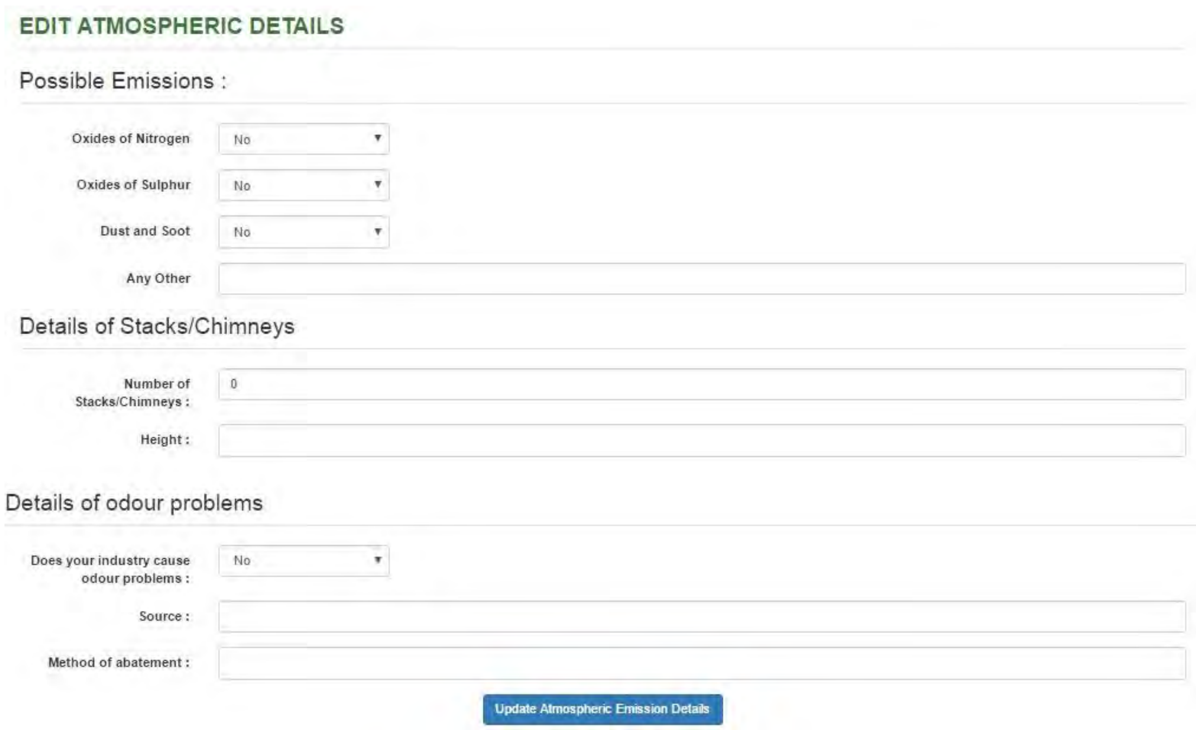


Figure 23 – EDIT Atmospheric Detail Interface

Noise Pollution

- If user select "Yes" in pollution check list in "Industry Details", click "Noise Pollution" Menu and display Noise poluution Entry.(Refer Figure 24,25)
- Enter "Source" and "Method of abatement".
- After entering all the details and click "Update Noise Pollution" button.
- If you want to edit information, click "Edit" button and edit the detail.

Figure 24 – Noise Pollution Detail Interface

Figure 25 – EDIT Noise Pollution Interface

Vibration Pollution

- If user select "Yes" in pollution check list in "Industry Details", click "Vibration" Menu and display Vibration poluution Entry.(Refer Figure 26)
- Enter "Source" and "Method of abatement".
- After entering all the details and click "Update Vibration Pollution" button.
- If you want to edit information, click "Edit" button and edit the detail.

Figure 26 – Vibration Pollution Detail Interface

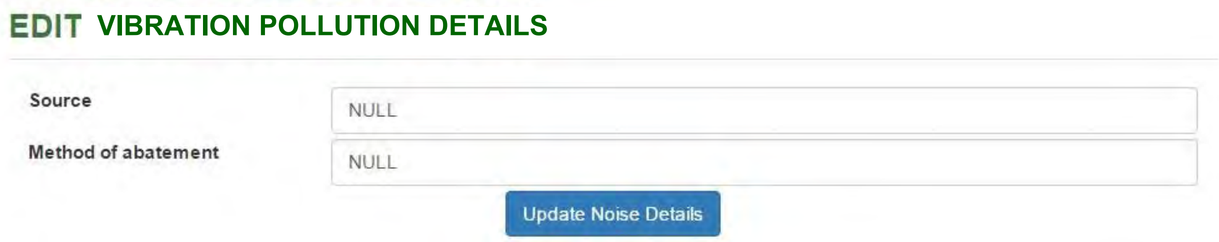


Figure 27 – EDIT Vibration Pollution Interface

Energy Requirments

- Click “Energy Requirment” menu and display Energy Requirement Detail menu.(Refer Figure 28,29)
- Click “Edit” button and enter In – Plant generation (in kw/h) and public supply (in kw/h).
- After entering all the details and click “Update Energy Requirements” button.
- If you want to edit information, click “Edit” button and edit the detail.

Figure 28 – Energy Requirement Detail Interface

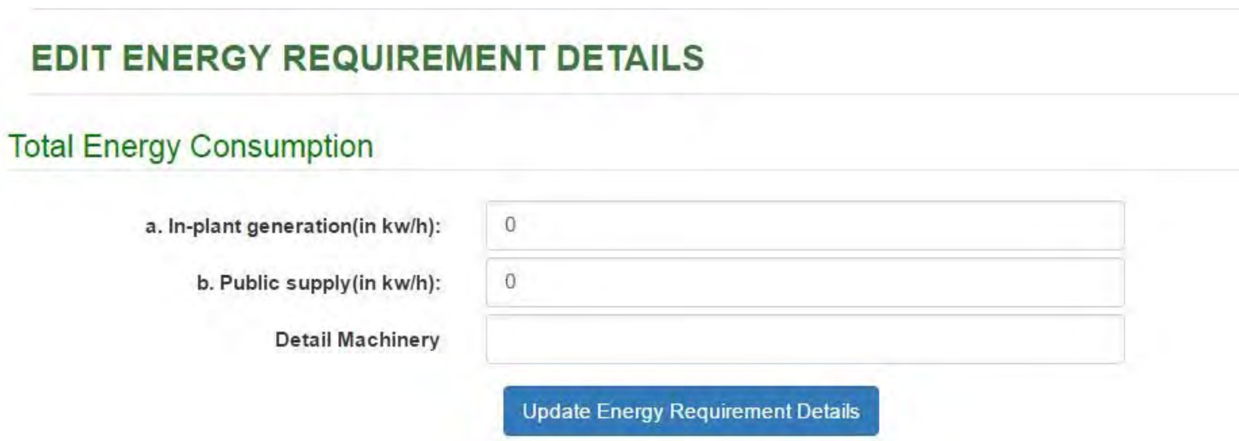


Figure 29 – EDIT Energy Requirement Interface

Fuel Used

- Click "Fuel used" menu and display the section. (Refer Figure 30,31)
- Click "Create New Fuel " and enter Types of fuel used, purpose and daily consumption.
- There is pulldown options including the following fuel type;
  - ✓ Diesel
  - ✓ Gasoline/Petrol
  - ✓ Kerosene
  - ✓ Heavy oil/ Frnance oil
  - ✓ LPG (Liquefied petroleum gas)
  - ✓ Coal
  - ✓ Biomass/Husk/Woods
  - ✓ Electricity
  - ✓ Others
- If you want to add other type of fuel, click "Create New Fuel" button again and enter the detail.
- After entering all the details, click "Create Fuel Detail" button.
- If you want to edit information, click "Edit" button and edit the detail.

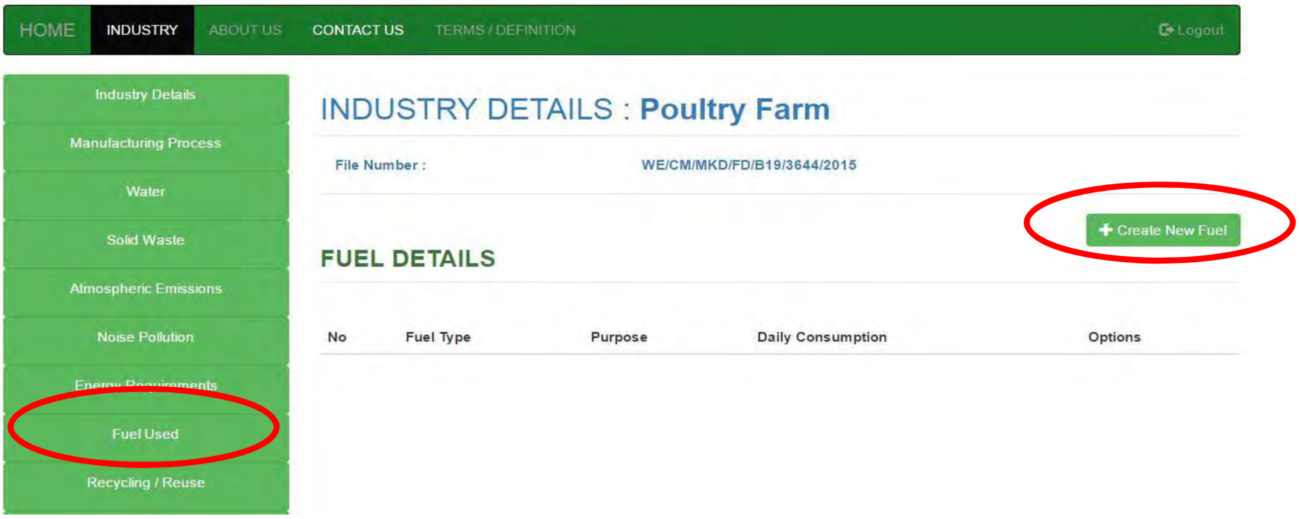


Figure 30 – Fuel Detail Interface

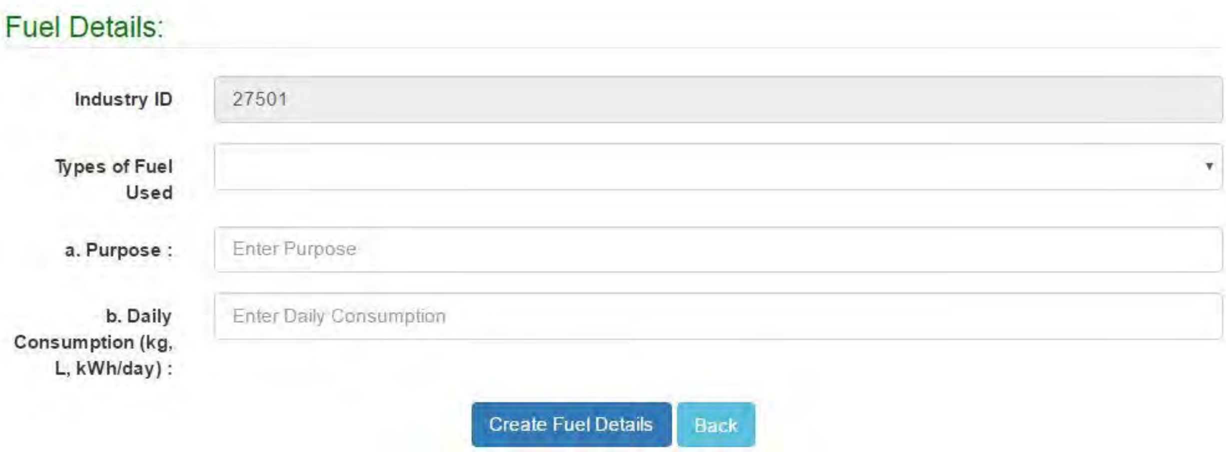


Figure 31 – Add Fuel Used Interface

Recycling / Reuse

- Click Recycling / Reuse menu and display Recycling / Reuse Interface. (Refer Figure 32,33)
- If there any "Possible salvage of any waste material for reuse", fill "Specify" field.
- After entering all the details, click "Update Recycle Detail" button.
- If you want to edit information, click "Edit" button and edit the detail.

Figure 32 – Recycle Detail Interface

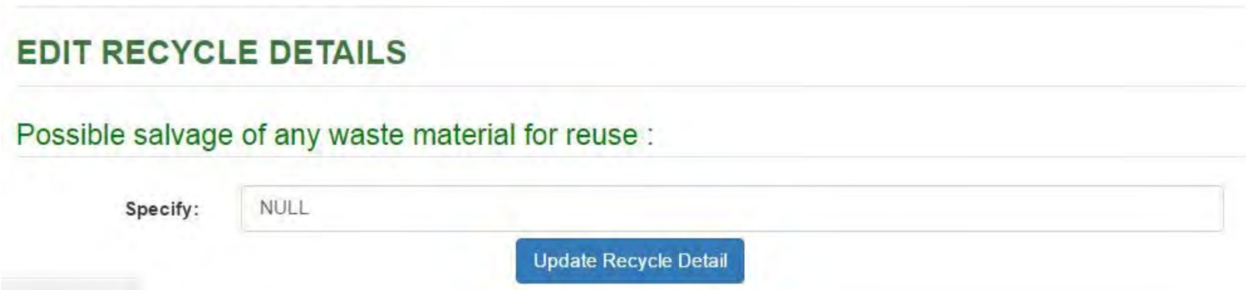


Figure 33 – Recycling/ Reuse Interface

Geographical Location

- Select "Geographical Location" icon in Menu Options and displays Geographical Location interface (Refer Figure 34,35)
- Enter thegeographical location information based on submitted EPL Application, the result of the field inspection or Google map checking.
- After entering all the details, click "Update Energy Requirements" button.
- If you want to edit information, click "Edit" button and edit the detail.

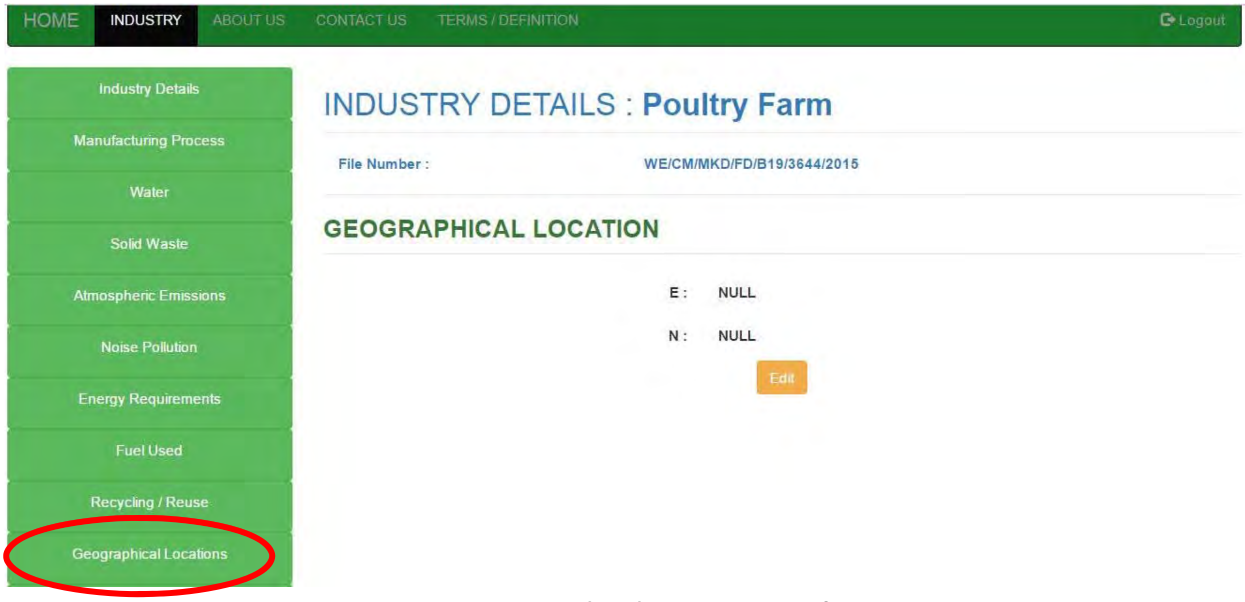


Figure 34 – Geographical Location Interface

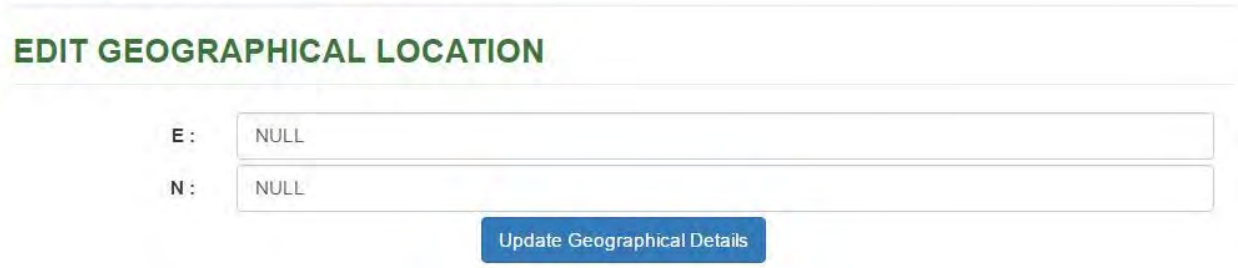


Figure 35 – EDIT Geographical Location Interface

Emergency Contact

- Select "Emergency Requirements" icon in Menu Options and displays Emergency Contact Detail interface (Refer Figure 36,37).
- Enter the information based on submitted EPL Application.
- After entering all the details, click "Update Energy Requirements" button.
- If you want to edit information, click "Edit" button and edit the detail.

Figure 36 – Emergency Contact Detail Interface

Figure 37 – EDIT Emergency Contact Detail Interface

4. Add Application/ Inspection information

Based on Application form and the result of field inspection, user enters information on application and inspection details.

Application Details

- Click “Application” tab and display Application details interface(Refer Figure 38,39).
- Click “Create New Application” button, and enter the information based on submitted EPL application.
- Select the type of application by New EPL or Renewal EPL.
- If you want to edit information, click “Edit” button and edit the detail.

Figure 38 – Application Detail Interface

Figure 39 – Add Application Interface

Inspection Details

- Click “Inspection Detail” tab and display Inspection details interface(Refer Figure 40,41).
- Click “Create Inspection Details” button, and enter the information based on Inspection report.
- Select the purpose of the inspection by pulldown options.
- Select the reccomendation of the inspection by pulldown options.
- If you sellect ‘’Disapproved/Violation’’, select the type of violation by pulldown options.
- If you want to edit information, click “Edit” button and edit the detail.

Figure 40 – Inspection Details Interface

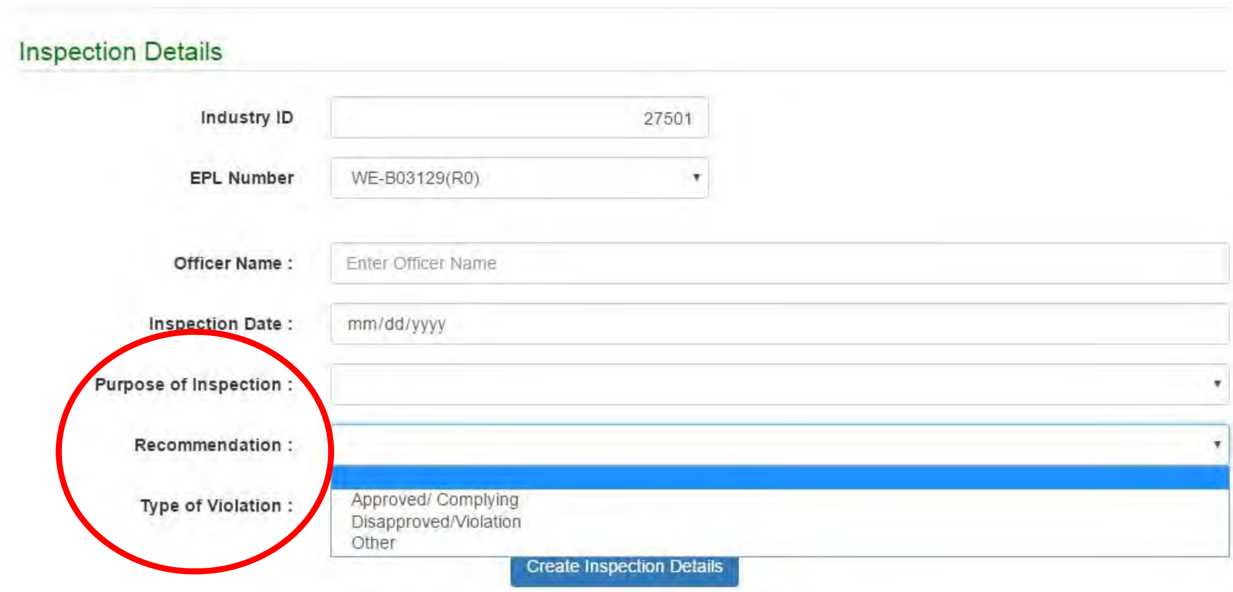
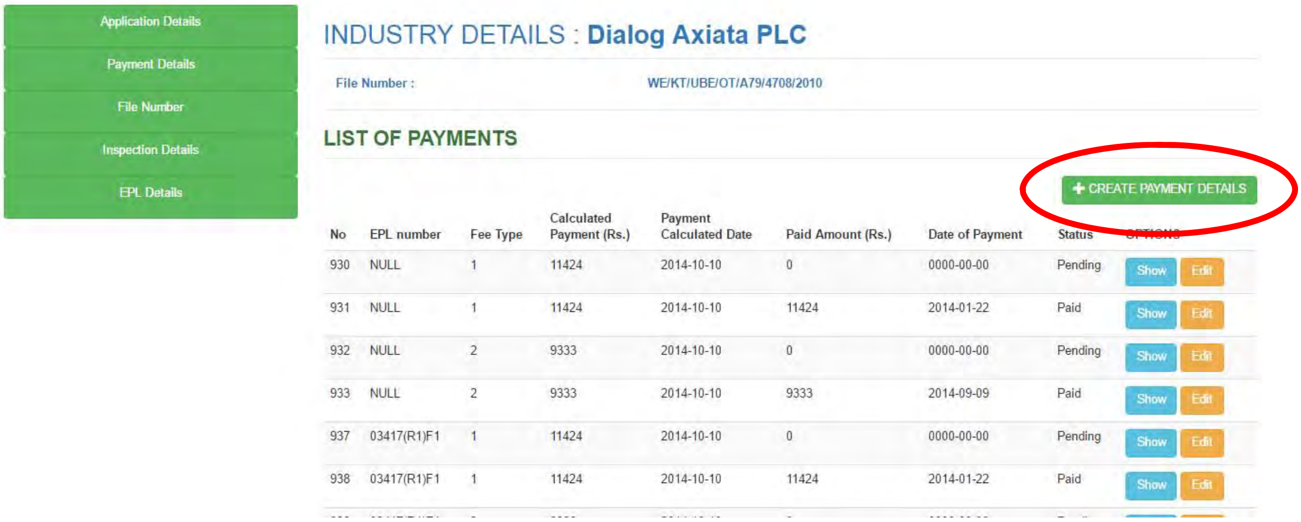


Figure 41 – EDIT Inspection Details Interface

Payment Details

- Click “Payment Details” tab and display Payment details interface. (Refer Figure 42,43)
- Click “Create Payment Details” button, and enter the information.
- After entering all the details, click “Create Payment Details” button.
- If you want to edit information, click “Edit” button and edit the detail.



No	EPL number	Fee Type	Calculated Payment (Rs.)	Payment Calculated Date	Paid Amount (Rs.)	Date of Payment	Status	OPTIONS
930	NULL	1	11424	2014-10-10	0	0000-00-00	Pending	Show Edit
931	NULL	1	11424	2014-10-10	11424	2014-01-22	Paid	Show Edit
932	NULL	2	9333	2014-10-10	0	0000-00-00	Pending	Show Edit
933	NULL	2	9333	2014-10-10	9333	2014-09-09	Paid	Show Edit
937	03417(R1)F1	1	11424	2014-10-10	0	0000-00-00	Pending	Show Edit
938	03417(R1)F1	1	11424	2014-10-10	11424	2014-01-22	Paid	Show Edit

Figure 42 – Add Payment Interface

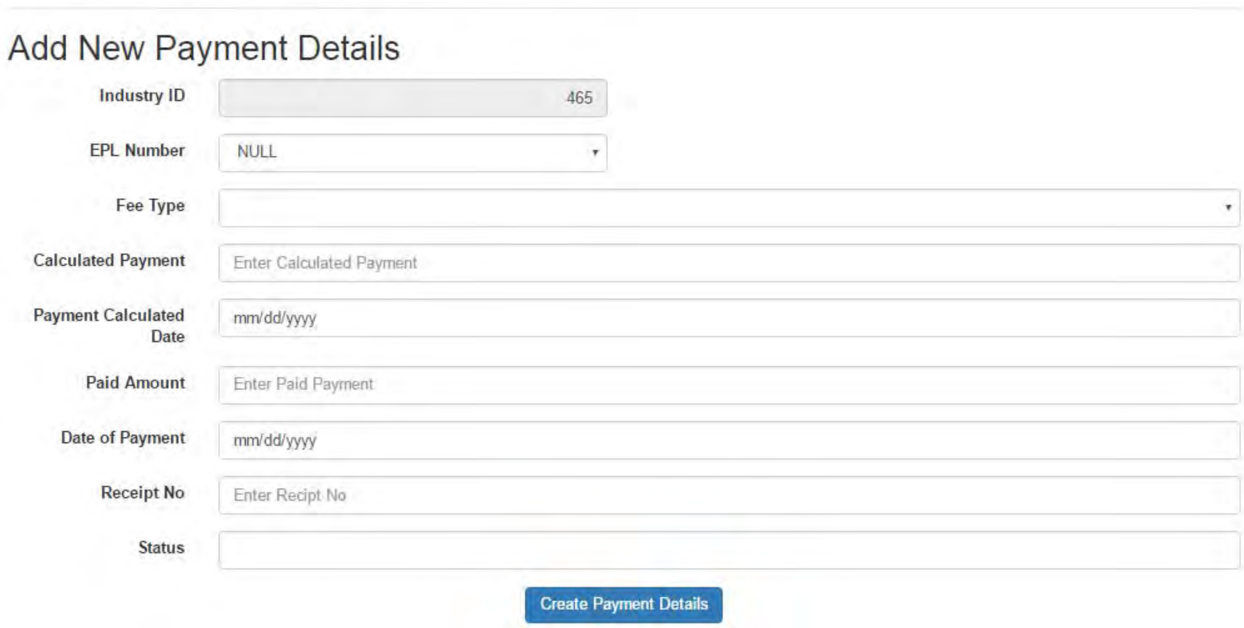


Figure 43 – View Payment Interface

File Number

- Click “File Number” tab and display File Number interface. (Refer Figure 44,45).
- After entering all the details, click “Update File Number Details” button.
- If you want to edit information, click “Edit” button and edit the detail.

Figure 44 – File Number Interface

Figure 45 – EDIT File Number Interface

EPL Details

- Click “EPL details” tab and display EPL details interface. (Refer Figure 46)
- Enter the information based on submitted EPL application.
- When the EPL status is changed (eg. Suspended, Cancelled, Closed), the sellect the status by pulldown options. (Refer Figure 47)
- If you want to edit information, click “Edit” button and edit the detail.

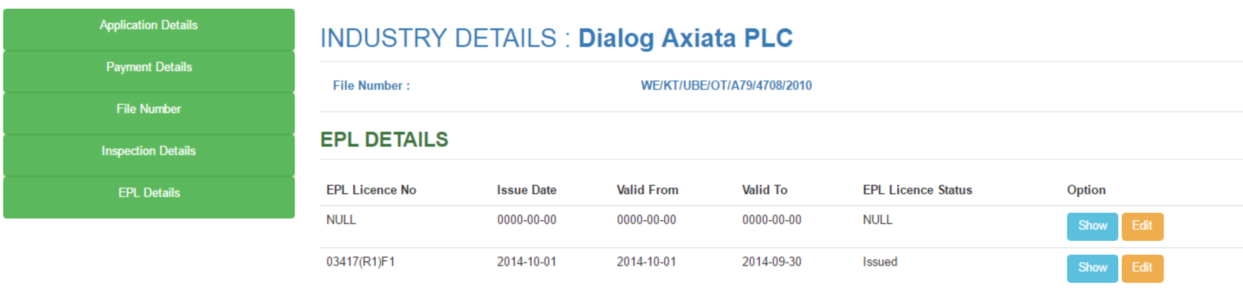


Figure 46 – EPL details Interface

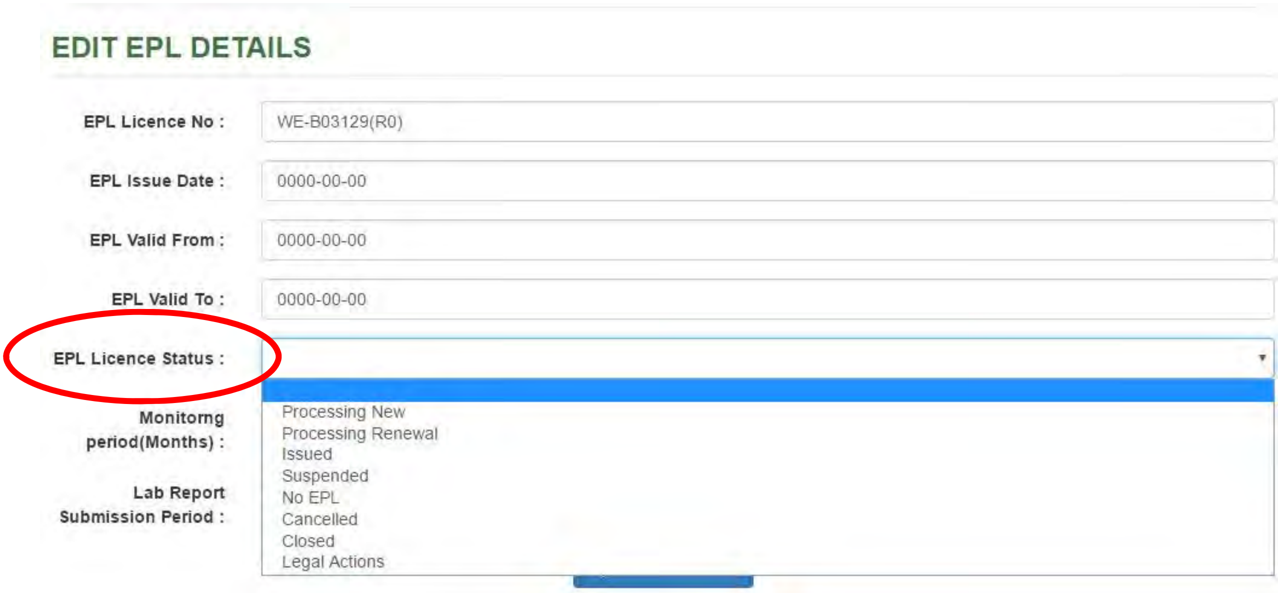


Figure 47 – View EPL details Interface

5. Search Industry

When you receive new EPL /Renewal EPL application, let's start to register industry information.

- Select "Search Industry" icon in Menu Options (Refer Figure 48).
- It displays "List of Industries Interface" (Refer Figure 49).

Figure 48 – Home Page Interface

- If user want to search any Industry,
  - o Select location (by selecting Province code, District code, LA code), or
  - o Select sector, EPL category (A,B,C), or Category Number, or
  - o Enter Industry ID that were provided registered company, or
  - o Enter Industry Name(Full name), or
  - o Enter the file number.
  - o Click "Search" button.
  - o Display search results in Industry details section.

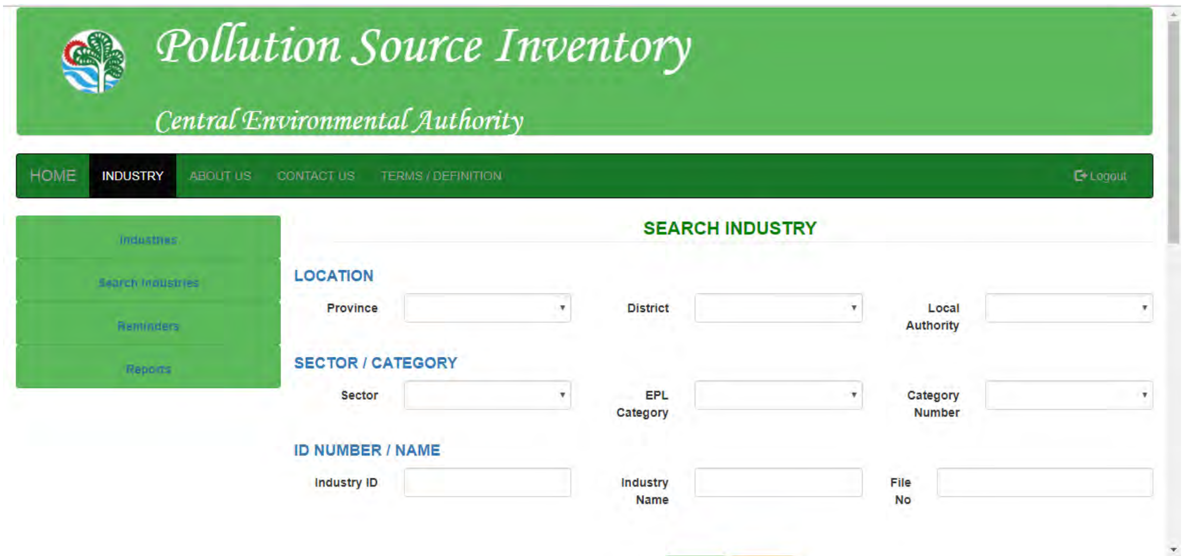


Figure 49 –Search Industry Interface

- If you enter the specific condition, such as Western Province, Colombo, Food Sector and Category A, then click "Search" button (Refer Figure 50).
- It displays the number and the list of Industries in your condition. (Refer Figure 51).

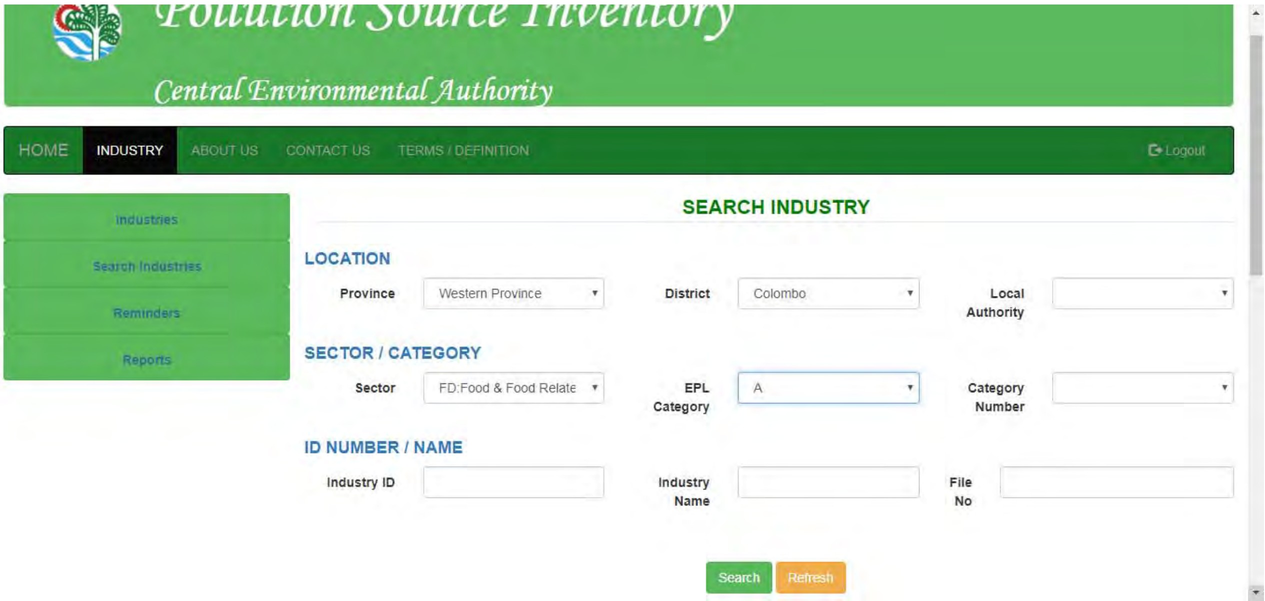
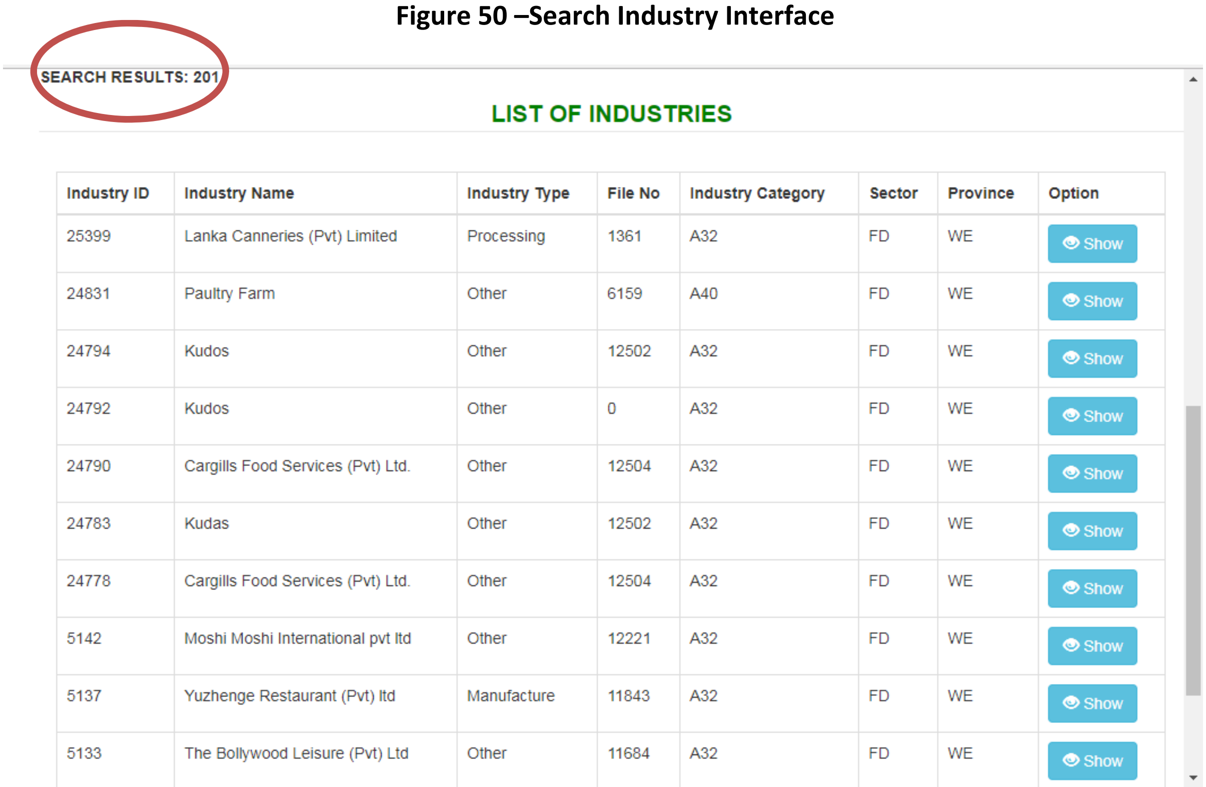


Figure 50 –Search Industry Interface



SEARCH RESULTS: 201

LIST OF INDUSTRIES

Industry ID	Industry Name	Industry Type	File No	Industry Category	Sector	Province	Option
25399	Lanka Canneries (Pvt) Limited	Processing	1361	A32	FD	WE	Show
24831	Paultry Farm	Other	6159	A40	FD	WE	Show
24794	Kudos	Other	12502	A32	FD	WE	Show
24792	Kudos	Other	0	A32	FD	WE	Show
24790	Cargills Food Services (Pvt) Ltd.	Other	12504	A32	FD	WE	Show
24783	Kudas	Other	12502	A32	FD	WE	Show
24778	Cargills Food Services (Pvt) Ltd.	Other	12504	A32	FD	WE	Show
5142	Moshi Moshi International pvt ltd	Other	12221	A32	FD	WE	Show
5137	Yuzhenge Restaurant (Pvt) ltd	Manufacture	11843	A32	FD	WE	Show
5133	The Bollywood Leisure (Pvt) Ltd	Other	11684	A32	FD	WE	Show

Figure 51 –Result of Search Industry

6. Environmental Monitoring

When you receive analytical report from EPL holder, input the monitoring data to "Environmental Monitoring".

- Select the industry. (Refer Chapter5. Search Industry)
- Display Environmental Monitoring Interface (Refer Figure52).
- Enter "year".
- Sellect "Monitoring type" by pulldown menu (Analytical report by EPL holder, Monitoring by authority).
- Sellect "Discharged Point" by pulldown menu (In land surface water, Land for irrigation purpose, Marine Coastal Areas, Public Sewers with Central Treatment Plant, Drinking water).
- Sellect "Tolence limit" by pulldown menu (Standard I, II, III….).
- Click "Next" button to go to next page.

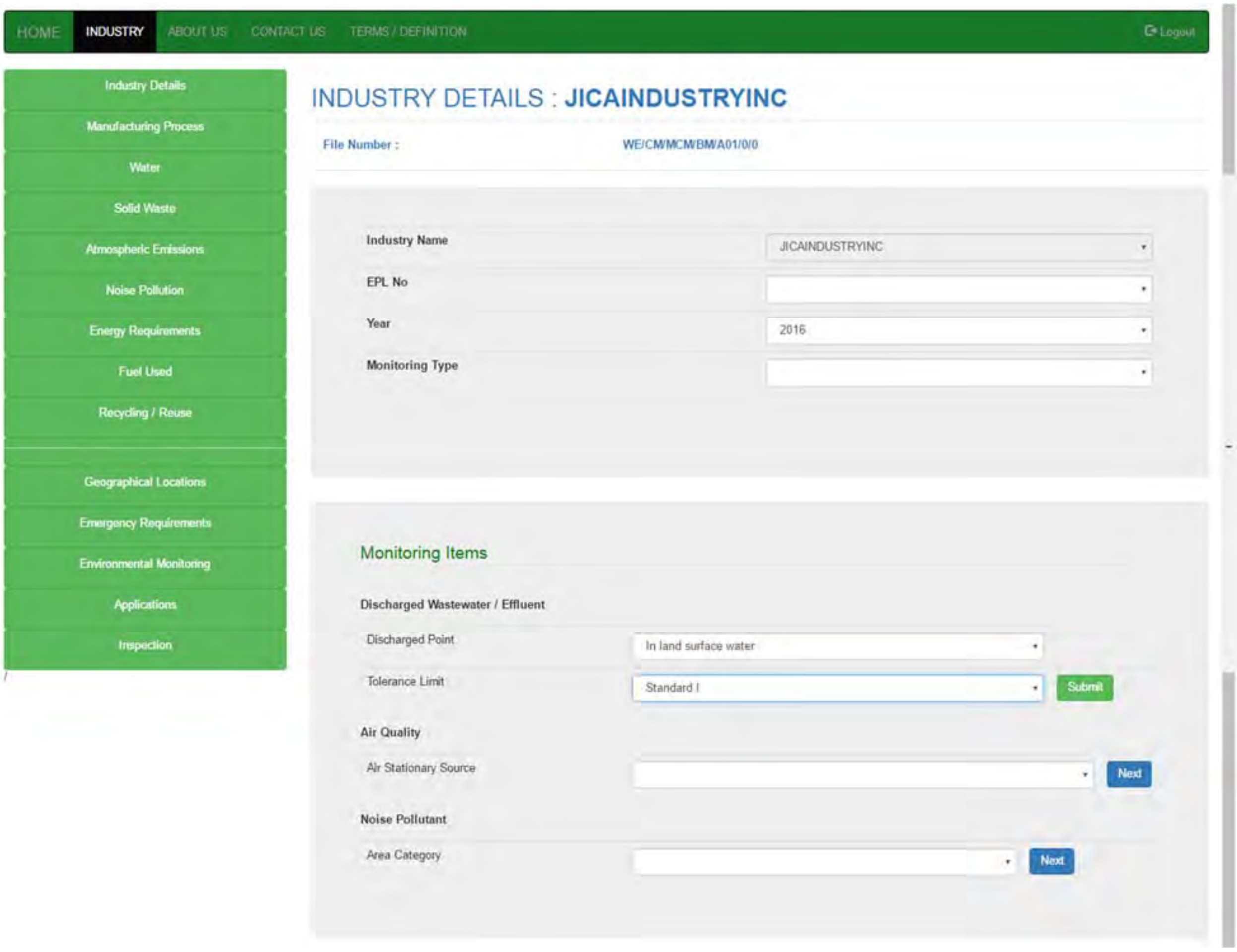


Figure 52 – Environmental Monitoring Interface

- Display Environmental Monitoring input page (Refer Figure 53).
- Enter details and Click “Save” button.
- Display saved data at the top of the page.

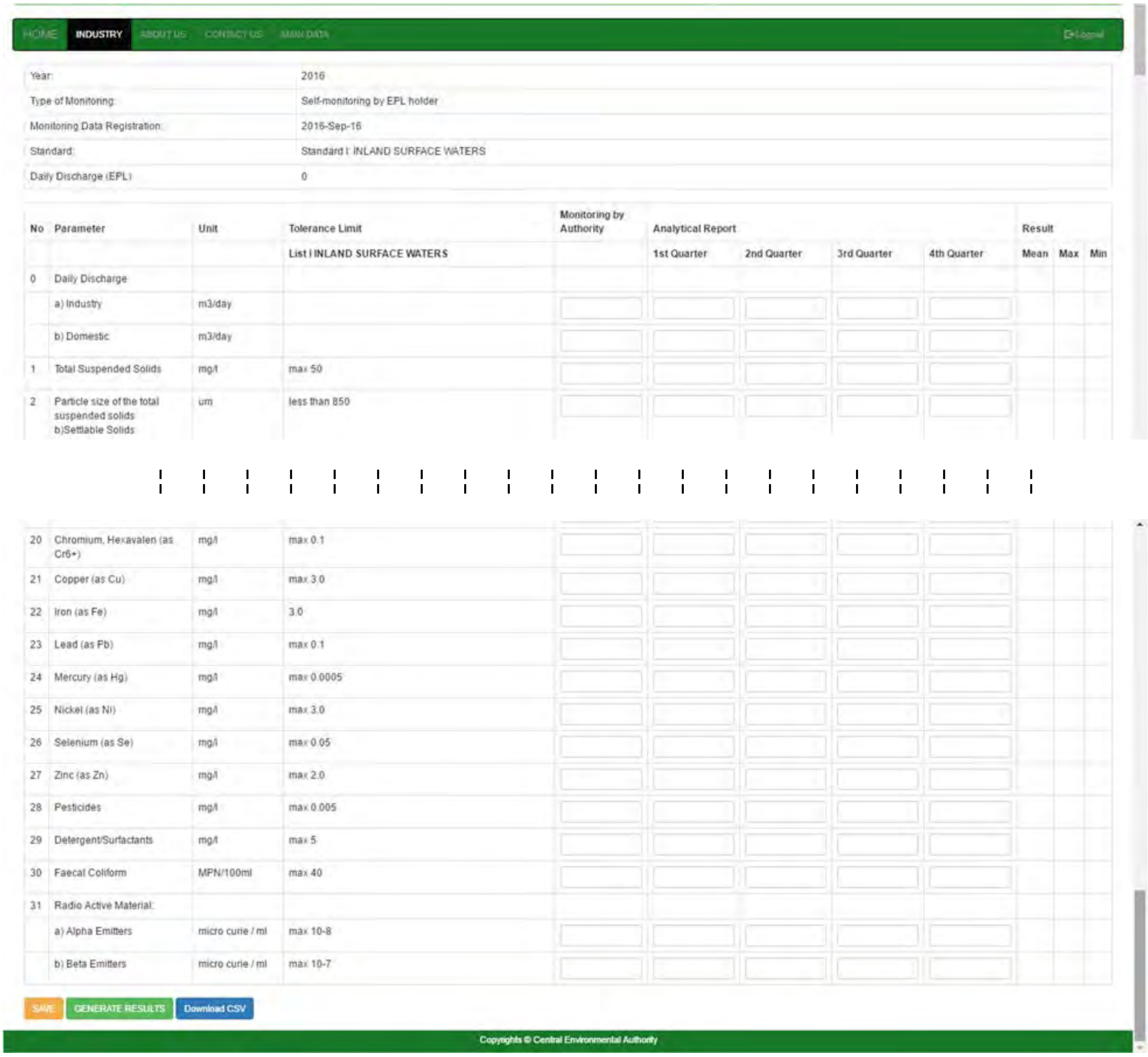


Figure 53 – Environmental Monitoring Input page

Appendix

Terms/ Definition

<EPL Category>

Category A

No.	Type of Activity	Sector Code	Category No. of List A	Waste Water Discharge
1	Chemical & Petrochemical	**CH**	1-22	1-2,4-5, 7-14,18-20
2	Textile & Leather	**TL**	23-29	23-29
3	Food and Food Related Food Industry	**FD**	30-42	30-35,37-40
4	Metal Industry	**BM**	43-46	43-44
5	Machinery & Equipment	**ME**	47	-
6	Mineral & Mineral Product	**MP**	48-56	49-50,52,56
7	Waste Disposal/Waste water/Water Treatment	**SZ**	57-63	57,59-60
8	Timber &Wood	**TW**	64-65	64
9	Lodging & Health Services	**SL**	66-68	66-68
10	Transport Related Services	**TR**	69-72	70-71
11	Power	**SP**	73	73
12	Paper & Printing	**PP**	74-75	74-75
13	Telecommunication Towers	**TC**	79	-
14	Other Activities	**OT**	76-78,80	76-78,80

Category B

No.	Type of Activity	Sector Code	Category No. of List B	Waste Water Discharge
1	Chemical & Petrochemical	**CH**	1-6	1,6
2	Textile & Leather	**TL**	7-13	7-8,10
3	Food and Food Related Food Industry	**FD**	14-21	14-17,19
4	Machinery & Equipment	**ME**	22,31	-
5	Mineral & Mineral Product	**MP**	23-25	23
6	Waste Disposal/Waste water/Water Treatment	**SZ**	26-28	26
7	Lodging & Health Services	**SL**	29	29
8	Transport Related Services	**TR**	30,32	32
9	Other Activities	**OT**	33	33

Category C

No.	Type of Activity	Sector Code	Category No. of List C
1	Chemical & Petrochemical	**CH**	1-2
2	Food and Food Related Food Industry	**FD**	3-10
3	Machinery & Equipment	**ME**	22,24
4	Mineral & Mineral Product	**MP**	11-17
5	Timber &Wood	**TW**	18-19
6	Lodging & Health Services	**SL**	20
7	Transport Related Services	**TR**	21,23
8	Paper & Printing	**PP**	25

<Area Code>

Provincial code	District code	LA code	LA name
WE	CM	MCM	Colombo M. C.
WE	CM	MDM	Dehiwela-Mt. Lavinia M. C.
WE	CM	MJK	Sri Jayawardeanapura Kotte M. C.
WE	CM	MMW	Moratuwa U. C.
WE	CM	PHO	Homagama P. S.
WE	CM	MKD	Kaduwela M.C.
WE	CM	PKM	Kotikawatta-Mullariyawa P. S.
WE	CM	UKB	Kesbewa U.C.
WE	CM	PSW	Seethawaka P. S.
WE	CM	UAV	Seetawakapura(Avissawella) U. C.
WE	CM	UKL	Kolonnawa U. C.
WE	CM	UMA	Maharagama U. C.
WE	CM	UBO	Boralesgamuwa U.C.
WE	GQ	MGQ	Gampaha M. C.
WE	GQ	MNE	Negambo M. C.
WE	GQ	PAT	Attanagalla P. S.
WE	GQ	PBB	Biyagama P. S.
WE	GQ	PDI	Divulapitiya P.S.
WE	GQ	PDM	Dompe P. S.
WE	GQ	PGQ	Gampaha P. S.
WE	GQ	PJE	Ja-ela P. S.
WE	GQ	PKE	Kelaniya P. S.
WE	GQ	PKT	Katana P. S.
WE	GQ	PME	Meerigama P. S.
WE	GQ	PMH	Mahara P. S.
WE	GQ	PMN	Minuwangoda P. S.
WE	GQ	PWN	Wattala P. S.
WE	GQ	UJE	Ja-ela U. C.
WE	GQ	UKS	Katunayake-Seeduwa U. C.
WE	GQ	UMG	Minuwangoda U.C.
WE	GQ	UPG	Paliyagoda U. C.
WE	GQ	UWM	Wattala-Mabola U. C.
WE	KT	PAG	Agalawatta P. S.
WE	KT	UBE	Beruwala U. C.
WE	KT	PBG	Bandaragama P. S.
WE	KT	PBU	Bulatsinghela P. S.
WE	KT	PDO	Dodangoda P. S.
WE	KT	PHR	Horana P.S.
WE	KT	PKA	Kalutara P. S.
WE	KT	PMG	Matugama P. S.
WE	KT	PPA	Panadura P. S.
WE	KT	PWA	Walallawita P. S.
WE	KT	PBE	Beruwela P. S.
WE	KT	UHR	Horana U. C.
WE	KT	UKT	Kalutara U. C.
WE	KT	UPD	Panadura U. C.
WE	KT	PPC	Palindanuwara P.S
WE	KT	PMA	Madurawala P.S.

Provincial code	District code	LA code	LA name
SU	GL	MGL	Galle M. C.
SU	GL	PAD	Ambalangoda P. S.
SU	GL	PAN	Akmeemana P. S.
SU	GL	PBM	Baddegama P. S.
SU	GL	PBP	Bope-Poddala P. S.
SU	GL	PBT	Bentota P. S.
SU	GL	PBY	Balapitiya P. S.
SU	GL	PHD	Habaraduwa P. S.
SU	GL	UHW	Hikkaduwa U. C.
SU	GL	PKI	Karandeniya P. S.
SU	GL	PLP	Elpitiya P. S.
SU	GL	PNG	Nagoda P. S.
SU	GL	PNM	Niyagama P. S.
SU	GL	PNW	Neluwa P. S.
SU	GL	PTW	Tawalama P. S.
SU	GL	PYK	Yakkalamulla P. S.
SU	GL	UAM	Ambaalngoda U. C.
SU	GL	PWJ	Weliwita Divithura P.S.
SU	GL	PID	Imaduwa P.S.
SU	GL	PGJ	Rajgama P.S
SU	MR	MMR	Matara M. C.
SU	MR	PAR	Akuressa P. S.
SU	MR	PDK	Dikwella P. S.
SU	MR	PDV	Devinuwara P. S.
SU	MR	PHM	Hakmana P. S.
SU	MR	PKB	Kamburupitiya P. S.
SU	MR	PKP	Kotapola P. S.
SU	MR	PLI	Malimbada P. S.
SU	MR	PML	Mulatiyana P. S.
SU	MR	PMM	Matara P. S.
SU	MR	PPG	Pasgoda P. S.
SU	MR	PTI	Tihagoda P. S.
SU	MR	PWG	Weligama P. S.
SU	MR	UWE	Weligama U. C.
SU	MR	PRO	Kirinda Puhulwella P.S.
SU	MR	PPZ	Pitabeddara P.S.
SU	MR	PAI	Athuraliya P.S.
SU	HB	PAL	Ambalantota P. S.
SU	HB	PAS	Agunakolapalassa P. S.
SU	HB	PBH	Beliatta P. S.
SU	HB	PHT	Hambantota P. S.
SU	HB	PLU	Lunugamwehera P. S.
SU	HB	PTA	Tangalla P. S.
SU	HB	PTN	Katuwana P. S.
SU	HB	PTS	Tissamaharama P. S.
SU	HB	PWT	Weeraketiya P. S.
SU	HB	MHB	Hambantota M. C.
SU	HB	UTG	Tangalla U. C.
SU	HB	PSU	Suriyawewa P.S.

Provincial code	District code	LA code	LA name
EA	TC	PGR	Gomarankadawala P. S
EA	TC	PKG	Kinniya P.S
EA	TC	PKJ	Kantale P. S
EA	TC	PKX	Kuchchiweli P. S
EA	TC	PMB	Morawewa P. S
EA	TC	PTT	Muttur P. S
EA	TC	PSE	Seruwila P. S
EA	TC	PSI	Padavi Siripura P. S
EA	TC	PTL	Trincomalee Town & Gravets P. S
EA	TC	PTM	Tamapalakamam (Thambalagamuwa)P. S
EA	TC	PWX	Verugal P.S.
EA	TC	UKG	Kinniya U.C
EA	TC	UTC	Trincomalee U.C
EA	AP	PAE	Alayadwembu P. S
EA	AP	PAF	Addalachchinai P. S
EA	AP	PDA	Damana P. S
EA	AP	PDH	Dehiattakandiya P. S
EA	AP	MKK	Kalmunei M.C
EA	AP	PLH	Luhugala P. S
EA	AP	PMO	Maha Oya P. S
EA	AP	PNO	Namalan Oya P. S
EA	AP	PNP	Nindavur Pattu P. S
EA	AP	PPI	Padiyathalawa P. S
EA	AP	PPV	Potuwil P. S
EA	AP	PSM	Samanthurai P. S
EA	AP	PTK	Thirukovil P. S
EA	AP	PUH	Uhana P. S
EA	AP	UAP	Ampara U. C
EA	AP	PRF	Kareithive P.S
EA	AP	PNV	Naveethanweli P.S
EA	AP	MAK	Akkaraipattu M.C
EA	AP	PAP	Akkaraipattu P.S
EA	AP	PIK	Irakkamam P.S
EA	BC	MBC	Batticaloa M. C
EA	BC	PAU	Erauvrpattu P. S
EA	BC	UEV	Erauvr U.C
EA	BC	PKC	Koraleipattu West P. S
EA	BC	PKQ	Korale Pattu P. S
EA	BC	PKV	Korale Pattu North P. S
EA	BC	UKW	Kaththankudi U.C
EA	BC	PMC	Manmunai West P. S
EA	BC	PBJ	Manmunaipattu P. S
EA	BC	PMQ	Manmunai South West P. S
EA	BC	PMV	Manmunai South & Eruwilpattu P. S
EA	BC	PPR	Porative Pattu P. S

Provincial code	District code	LA code	LA name
UV	BD	MBD	Badulla M. C.
UV	BD	PBN	Bandarawela P. S.
UV	BD	PBW	Badulla P. S.
UV	BD	PGI	Meegahakiula P. S.
UV	BD	PHB	Haldemulla P. S.
UV	BD	PHE	Hali-Ella P. S.
UV	BD	PHU	Haputale P. S.
UV	BD	PHY	Mahiyanganaya P. S.
UV	BD	PLL	Ella P. S.
UV	BD	PNY	Kandeketiya P. S.
UV	BD	PRE	Redimaliyadda P. S.
UV	BD	PRT	Soranatota P. S.
UV	BD	PSA	Passara P. S.
UV	BD	PUW	Uva-Paranagama P. S.
UV	BD	PWB	Welimada P. S.
UV	BD	MBW	Bandarawela M. C.
UV	BD	UHT	Haputale U. C.
UV	BD	PLG	Lunugala P.S
UV	MG	PBC	Bibile P. S.
UV	MG	PBF	Buttala P. S.
UV	MG	PBK	Badalkumbura P. S.
UV	MG	PDG	Medagama P. S.
UV	MG	PDU	Madulla P. S.
UV	MG	PNR	Monaragala P. S.
UV	MG	PSY	Siybalanduwa P. S.
UV	MG	PTR	Kataragama P. S.
UV	MG	PTV	Tanamalwila P. S.
UV	MG	PVL	Wellawaya P. S.

Provincial code	District code	LA code	LA name
CE	KY	MKY	Kandy M. C.
CE	KY	PAK	Akurana P. S.
CE	KY	PGK	Ganga Ihala Korale P. S.
CE	KY	PHA	Harispattuwa P. S.
CE	KY	PKN	Kandy Gravets & Gangawata Korale P.S.
CE	KY	PKU	Kundasale P. S.
CE	KY	PMD	Meda Dumbara P. S.
CE	KY	PMI	Minipe P. S.
CE	KY	PPD	Pathdumbara P. S.
CE	KY	PPH	Pathhewaheta P. S.
CE	KY	PPJ	Pujapitiya P. S.
CE	KY	PPK	Pasbagekorale (Rambukpitiya) P. S.
CE	KY	PPW	Panwila P. S.
CE	KY	PTU	Thumpane P. S.
CE	KY	PUD	Udadumbara P. S.
CE	KY	PUN	Udunuwara P. S.
CE	KY	PUP	Uda Palatha P. S.
CE	KY	PYA	Yatinuwara P. S.
CE	KY	UGM	Gampola U. C.
CE	KY	UKD	Kadugannawa U. C.
CE	KY	UNP	Nawalapitiya U. C.
CE	KY	UWG	Wattegama U. C.
CE	MT	MMT	Matale M. C.
CE	MT	PAB	Abanganga Korale P. S.
CE	MT	PDB	Dambulla P. S.
CE	MT	PGL	Galewela P. S.
CE	MT	PLA	Laggala & Palegama P. S.
CE	MT	PMT	Matale P. S.
CE	MT	PNU	Naula P. S.
CE	MT	PPP	Pallepola P. S.
CE	MT	PRA	Rattota P. S.
CE	MT	PUK	Ukuwela P. S.
CE	MT	PWI	Wilgamuwa P. S.
CE	MT	PYT	Yatawatta P. S.
CE	MT	MDB	Dambulla M.C.
CE	NW	MNW	Nuwara Eliya M. C.
CE	NW	PAW	Abagamuwa P. S.
CE	NW	PHK	Hanguranketha P. S.
CE	NW	PKH	Kotmale P. S.
CE	NW	PNA	Nuwara Eliya P. S.
CE	NW	PWL	Walapane P. S.
CE	NW	UHD	Hatton-Dikoya U. C.
CE	NW	UTL	Talawakele-Lindula U. C.

Provincial code	District code	LA code	LA name
NC	AD	MAD	Anuradapura M. C.
NC	AD	PBA	Kabithigollawa P. S.
NC	AD	PEP	Epalogama P. S.
NC	AD	PGE	Galenbidunuwewa P. S.
NC	AD	PGN	Galnewa P. S.
NC	AD	PHG	Kahatagasdigiliya P. S.
NC	AD	PMU	Medawachchiya P. S.
NC	AD	PMX	Mihintale P. S.
NC	AD	PNB	Nuwaragampalatha East P. S.
NC	AD	PNC	Nochchiyagama P. S.
NC	AD	PNJ	Nuwaragampalatha Central P.S.
NC	AD	PPB	Palagala P. S.
NC	AD	PPO	Horawpathana P. S.
NC	AD	PDW	Talawa P. S.
NC	AD	PPY	Padaviya P. S.
NC	AD	PRJ	Rajanganaya P. S.
NC	AD	PRK	Kekirawa P. S.
NC	AD	PRM	Rambewa P. S.
NC	AD	PTE	Thiruppane P. S.
NC	PO	PAH	Elahera P. S.
NC	PO	PDL	Dimbulagala P. S.
NC	PO	PDR	Medirigiriya P. S.
NC	PO	PHI	Hingurakgoda P. S.
NC	PO	PLE	Lankapura P. S.
NC	PO	PTD	Thamankaduwa P. S.
NC	PO	PWH	Welikanda P.S.

Provincial code	District code	LA code	LA name
SA	RN	MRN	Ratnapura M. C.
SA	RN	UAB	Embilipitiya U.C.
SA	RN	PAM	Embilipitiya P. S.
SA	RN	PAY	Ayagama P. S.
SA	RN	PBL	Balangoda P. S.
SA	RN	PEH	Ehaliyagoda P. S.
SA	RN	PIM	Ibulpe P. S.
SA	RN	PKL	Kalawana P. S.
SA	RN	PKO	Kolonna P. S.
SA	RN	PKR	Kuruwita P. S.
SA	RN	PNI	Niwithigala P. S.
SA	RN	PPL	Pelmadulla P. S.
SA	RN	PRN	Ratnapura P. S.
SA	RN	PWE	Waligapola P. S.
SA	RN	UBG	Balangoda U. C.
SA	RN	PGD	Godakawela P.S.
SA	RN	PHC	Kahawatta P.S.
SA	KE	PDF	Dehiowita P. S.
SA	KE	PDY	Deraniyagala P. S.
SA	KE	PGC	Kegalle P. S.
SA	KE	PGM	Galigamuwa P. S.
SA	KE	PRB	Rambukkana P. S.
SA	KE	PRL	Ruwanwella P. S.
SA	KE	PRY	Aranayake P. S.
SA	KE	PWV	Warakapola P. S.
SA	KE	PWZ	Mawanella P. S.
SA	KE	PVI	Yatiyantota P. S.
SA	KE	UKE	Kegalle U. C.
SA	KE	PBD	Bulathkohupitiya P.S.

Provincial code	District code	LA code	LA name
NO	JA	MJA	Jaffna M. C
NO	JA	UPP	Point Pedro U.C
NO	JA	UCK	Chawakachcheri U.C
NO	JA	UVV	Velvettithurai U.C
NO	JA	PCK	Chawakachcheri P.S
NO	JA	PDT	Delft P.S
NO	JA	PKY	Kayts P.S
NO	JA	PNL	Nallur P.S
NO	JA	PPU	Point Pedro P.S
NO	JA	PWK	Vadamarachchi South West P.S
NO	JA	PNQ	Valikaman East P.S
NO	JA	PVW	Valikaman North P.S
NO	JA	PWS	Valikaman South P.S
NO	JA	PWM	Valikaman South west P.S
NO	JA	PWW	Valikaman West P.S
NO	JA	PWY	Velanai P.S
NO	JA	PRH	Karainagar P.S
NO	MN	UMN	Mannar U.C
NO	MN	PMW	Manthai West P.S
NO	MN	PMS	Musali P.S
NO	MN	PNN	Nanattan P.S
NO	MN	PMR	Mannar P.S
NO	VA	UVA	Vavuniya U.C
NO	VA	PWU	Vavuniya North P.S
NO	VA	PWP	Vavuniya South(Sinhala) P.S
NO	VA	PWD	Vavuniya South(Tamil) P.S
NO	VA	PWC	Venkalacheddikulam P.S
NO	MU	PMY	Manthai East P.S
NO	MU	PMP	Maritimepatttu
NO	MU	PTY	Tunukkai P.S
NO	MU	PPT	Puthukkudiyiruppu P.S
NO	KN	PRC	Karachchi P.S
NO	KN	PCH	Pachchilaipalli P.S
NO	KN	PKK	Punakari P.S

Provincial code	District code	LA code	LA name
NW	KG	MKG	Kurunegala M. C.
NW	KG	PAC	Allauwa P. S.
NW	KG	PBI	Bingiriya P. S.
NW	KG	PDP	Panduwasnuwara P. S.
NW	KG	PEB	Ibbagamuwa P. S.
NW	KG	PGA	Galgamuwa P. S.
NW	KG	PGB	Giribawa P. S.
NW	KG	PGH	Polgahawela P. S.
NW	KG	PKZ	Kobeiganay P. S.
NW	KG	PLY	Kuliyapitiya P. S.
NW	KG	PMK	Mahawa P. S.
NW	KG	PMZ	Mawathagama P. S.
NW	KG	PNE	Kurunegala P. S.
NW	KG	PNF	Pannala P. S.
NW	KG	PNK	Nikeweratiya P. S.
NW	KG	PPM	Polpithigama P. S.
NW	KG	PRD	Redigama P. S.
NW	KG	PWO	Wariyapola P. S.
NW	KG	UKP	Kuliyapitiya U. C.
NW	KG	PUB	Udubaddawa P.S
NW	KG	PKS	Narammala P.S
NW	PX	PAA	Arachchikattuwa P. S.
NW	PX	PHL	Chilaw P. S.
NW	PX	PLT	Kalpitiya P. S.
NW	PX	PND	Anamaduwa P. S.
NW	PX	PNH	Nawagaththegama P. S.
NW	PX	PNT	Nathtandiya P. S.
NW	PX	PRW	Karuwalagaswewa P. S.
NW	PX	PUT	Puttalam P. S.
NW	PX	PVN	Wennappuwa P. S.
NW	PX	PWQ	Wanathawilluwa P. S.
NW	PX	UCH	Chilaw U. C.
NW	PX	UPX	Puttalam U. C.

Appendix D
Flowchart for PSI data registration

Stage \ Person	Industry	CEA Office
a. EPL Application	- Submit EPL application form with supplemental documents	a) Confirm a form and supplemental documents. b) Decide **"Application number"**.
b. Pre-Evaluation of the Application		a) Evaluate a form and documents and determine the inspection fee. b) Access PSI system and register PSI information on "**New Industry**". c) Check "**Pollution check list"** in "**Industry detail"** page. d) Submit EPL application form with printed "**Industry detail"** page, including "**Pollution check list".**
c. Determination and payment of inspection fee	- Pay Inspection fee	
d. Field Inspection		a) Conduct field inspection. b) Confirm the information of the application.
e. Inspection Report with Recommendation	- Conduct additional pollution control measure and report to CEA	a) Prepare Inspection report with recommendation. a) Confirm the information submitted by industry. b) Edit the PSI data c) Register "**Inspection details"**in PSI system
f. EPL Issuing	- Confirm EPL condition	a) Decide EPL condition b) Issue EPL with No. c) Enter information on "**EPL Detail**" in PSI system
g. Start Operation	- Conduct environmental monitoring	

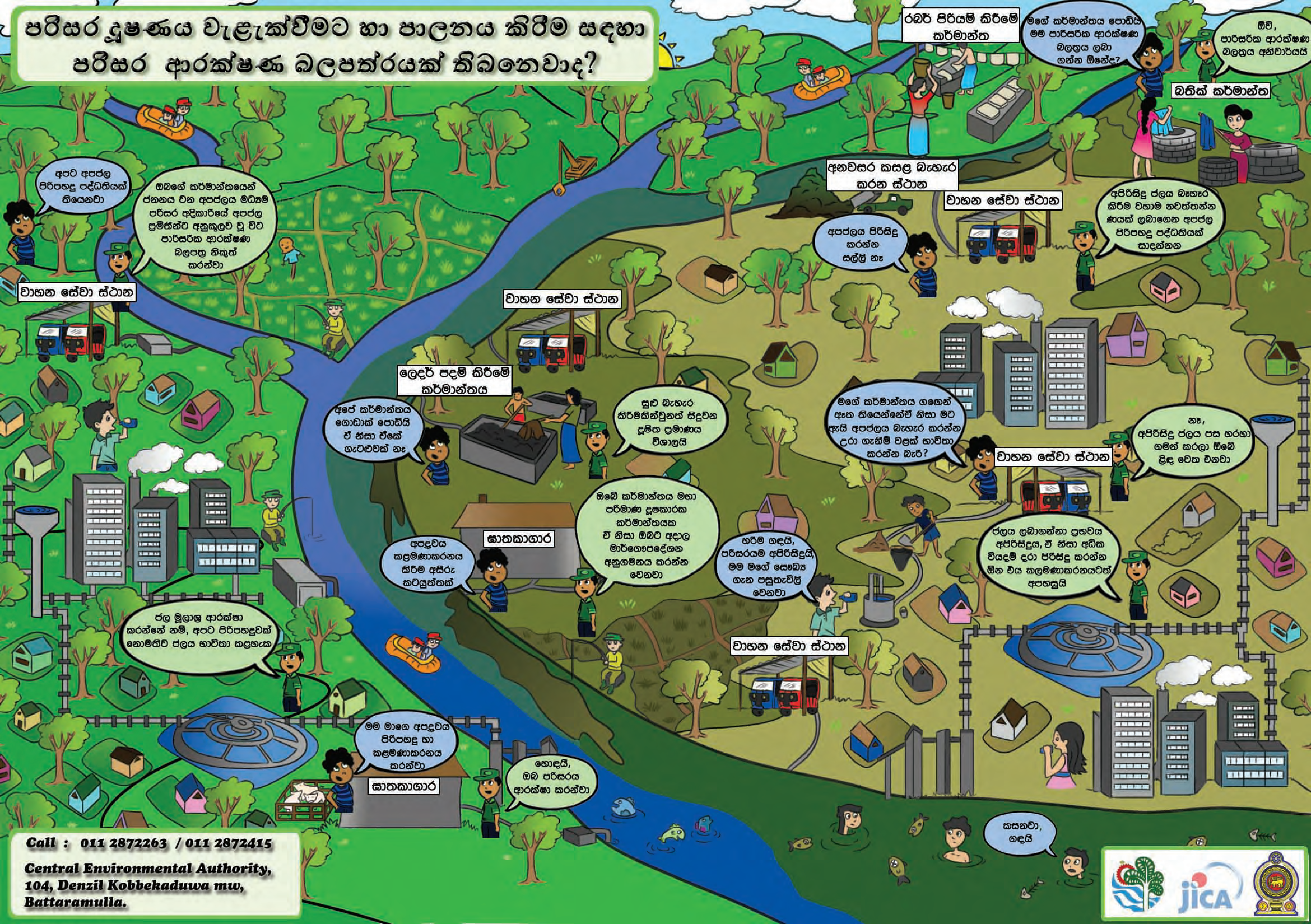
* Priority items are "Industry Detail including Pollution check list" and "EPL detail"

付属資料 20　EPL 宣材

Do you have a valid Environmental Protection Licence (EPL) ? To prevent, control and manage pollution.

Call : 011 2872263 / 011 2872415

Central Environmental Authority, 104, Denzil Kobbekaduwa mw, Battaramulla.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කසනවා, ගඳයි
Call : 011 2872263 / 011 2872415
Central Environmental Authority,
104, Denzil Kobbekaduwa mw,
Battaramulla.

வலுவான சுற்றாடல் பாதுகாப்பு உரிமம் (சு.பா.உ) உள்ளதா? மாசுபடுதலை தடுக்க, கட்டுப்படுத்த மற்றும் முகாமைசெய்ய.

Call : 011 2872263 / 011 2872415

Central Environmental Authority,
104, Denzil Kobbekaduwa mw,
Battaramulla.

付属資料 21　EPL 促進ガイドライン

Promotion
for
Environmental Protection Guideline

October 2017

Central Environmental Authority

JICA Expert Team

Table of Contents

1. INTRODUCTION

1.1. Purposes of the Guideline

The purpose of this guideline is to guide Local Authorities (LAs) to manage and Environmental Protection License (EPL) with the regulation on environmental protection and quality gazetted under the National Environmental Act (NEA).

The guideline addresses on providing contents and functions of the EPL, standardized inspection procedures to check compliance of industries categorized as "C". And also it is aimed to address the benefit and violation on the EPL holders under the NEA.

The EPL covers not only wastewater pollution but also air pollution, noise pollution, vibration and solid waste. Wastewater pollution, while, is specially indicated.

1.2. Need for Environmental Protection

1.2.1. Benefits from (Value of) Environment

We and all living things depend on the environment and nature to exist. The environment and nature provide us with the air that we breathe to survive, the water that we drink and use to grow our food, and the land on which to grow our food and other crops and derive other materials for building our homes and other man-made structures.

1.2.2. Terms of Impacts of Pollution

"*pollution*" means any direct or indirect alternation of the physical, thermal, chemical, biological, or radioactive properties of any part of the environment by the discharge, emission, or the deposit of wastes so as to affect any beneficial use adversely or to cause a condition which is hazardous or potentially hazardous to public health, safety, or welfare, or to animals, birds, wildlife, aquatic life, or to plants of every description;

"*beneficial use*" means a use of the environment or any portion of the environment that is conducive to public benefit, welfare, safety, or health and which requires protection from the effects of waste, discharges, emissions and deposits;

"*waste*" includes any matter prescribed to be waste and any matter, whether liquid, solid, gaseous, or radioactive, which is discharged, emitted, or deposited in the environment in such volume, constituency or manner as to cause an alteration of the environment.

1.2.3. Need for Pollution Control

Bodies of water, such as lakes and rivers, have a natural ability to clean itself. This capacity to clean itself is called its assimilative capacity. In the past, the amount of pollutants discharged to our lakes and rivers were within their assimilative capacity; hence, the quality of the water in the lakes and rivers did not grow worse. With continuing industrialization, development, and population growth, indiscriminate discharge of untreated wastewater increased well beyond the assimilative capacity of the receiving bodies of water. As a result, their water quality deteriorated, posing great threats and risks to public health and causing significant welfare losses. The threats to public health arise from toxic or hazardous contaminants and from pathogens and other disease vectors. Welfare losses include loss or reduction in subsistence (food supply), recreation, economic, and tourism opportunities, aesthetic values, cost of clean up, not only of routine pollution but also of catastrophic environmental accidents such as oil spills and fish kills.

Pollution control is necessary to protect public health and welfare, and to prevent or reduce damage to public and private property. Water quality standards define the minimum conditions necessary to assure the suitability of water for its designated purpose, use or classification and the protection of public health and welfare.

1.3. Environmental Management

1.3.1. Legal Basis on The EPL

National Environmental Act No. 47 of 1980 as amended by Act. No. 56 of 1988 indicates its purpose:

> for the protection, management and enhancement of the environment, for the regulation, maintenance and control of the quality of the environment; for the prevention, abatement and control of pollution

Main responsible government body is the CEA; the CEA has responsible to address and promote the EPL to the industries. The CEA derives power to investigate and inspect from the following sections of the NEA:

Art. 10 (1) (c) to undertake surveys and investigations as to the causes, nature, extent and prevention of pollution and to assist and co-operate with other persons or bodies carrying out similar surveys or investigations;

Art. 10 (1) (g) to undertake investigations and **inspections** to ensure compliance with this Act and to investigate complaints relating to non-compliance with any of its provisions;

Some of the important provisions of the NEA regarding the EPL procedure, wastewater, and inspection are as follows:

Section 23 A (1), (2) (a) and (b):

Section 23 G, 23 H;

Section 24 A, (1) (2) and (3)

1.3.2. Environmental Protection License (EPL)

The EPL system is a one of the key tools for regulating wastewater (and other pollutive) discharges from industries or establishments engaged in prescribed activities. It is decreed under the Act No. 47 of 1980 under the NEA as amended by Act. No. 56 of 1988 and Act No. 53 of 2000. The EPL system requires those engaged in prescribed activities to apply for and obtain the concerned license and to comply with environmental standards and criteria.

The important regulations that come under the EPL procedure are:

Gazette notification No. 1533/16 dated 25/1/2008: listing out the prescribed activities which the EPL is required.

Gazette notification No. 1534/18 dated 1/2/2008: listing down the EPL regulations and the tolerance limit of the discharged wastewater.

1.3.3. Mandate of Local Authorities

The EPL for any prescribed activities categorized as "A", "B" and "C". Those categorizations are according to the type of sector and scale of production activity. Under parts "A" and "B" in the Gazette Notification No. 1533/16 of 25.01.2008 has to be obtained from the CEA Provincial or District Officers.

As of them, category "A" and "B" shall be managed by the CEA. On the other hand, cite law or order as basis for: "EPL for prescribed activities under part "C" (see Appendix A) have to be obtained from respective Local Authorities (Municipal Council / Urban Council / Pradeshiya Sabha) where the prescribed activities are located. The powers of the CEA with regard to issue EPL have been delegated to the Local Authorities."

2. ENVIRONMENTAL PROTECTION LICENSE (EPL) SYSTEM

2.1. Environmental Protection License (EPL)

The EPL is a license that is required to be obtained by the NEA for prescribed activities which involve or results in discharging, depositing or emitting waste into the environment causing pollution. All industries, companies, establishments, or facilities which discharge effluent, dispose of solid wastes, emit smoke, gases, fumes, or vapour, or generate noise into the environment shall comply with the standards and criteria published under the National Environmental Act and its provisions.

The EPL system encourages the industries or establishments engaged in the prescribed activities to perform or operate in an environmentally friendly and sustainable manner.

2.2. Acquisition of Environmental Protection License (EPL)

2.2.1. Prescribed Activities

Gazette notification No. 1533/16 dated 25/1/2008 is listing out total of 138 industries / activities as prescribed activities under parts "A", "B", and "C". As of them, 25 industries / activities are under part "C" which application shall be under LAs.

Note: Any prescribed activities which is registered under section 17 of the Act of the Board of Investment of Sri Lanka (BOI), has to be obtained EPL from BOI situated in No. 1768.

Also prescribed activity which is situated in the North Western Province has to be obtained EPL from the North Western Province Environmental Authority (NWPEA) situated at Maligawa, Kurunagala. They have different procedure from mentioned here.

2.2.2. New Environmental Protection License (EPL)

2.2.2.1. Requirements

Application forms could be downloaded from the CEA Website or obtained from the CEA regional / district offices. Both are free of charge.

Necessary relevant documents, which shall be attached in and EPL application, are:

- Certification for Registration of the Business (If the activity is registered)
- Trade licence or receipt, building plan, certificate of conformity, no objection letter. Those are issued by the LAs. And any other documents requested by the responsible LAs.
- Survey plan of the land. If the land concerned is state owned, authorization to release the land for the particular purpose.
- Sketch premises condition such as road map to the land / site with the main landmarks form the nearest town.

2.2.2.2. Processing of EPL Application

Application procedure for new issuing EPL is described as below:

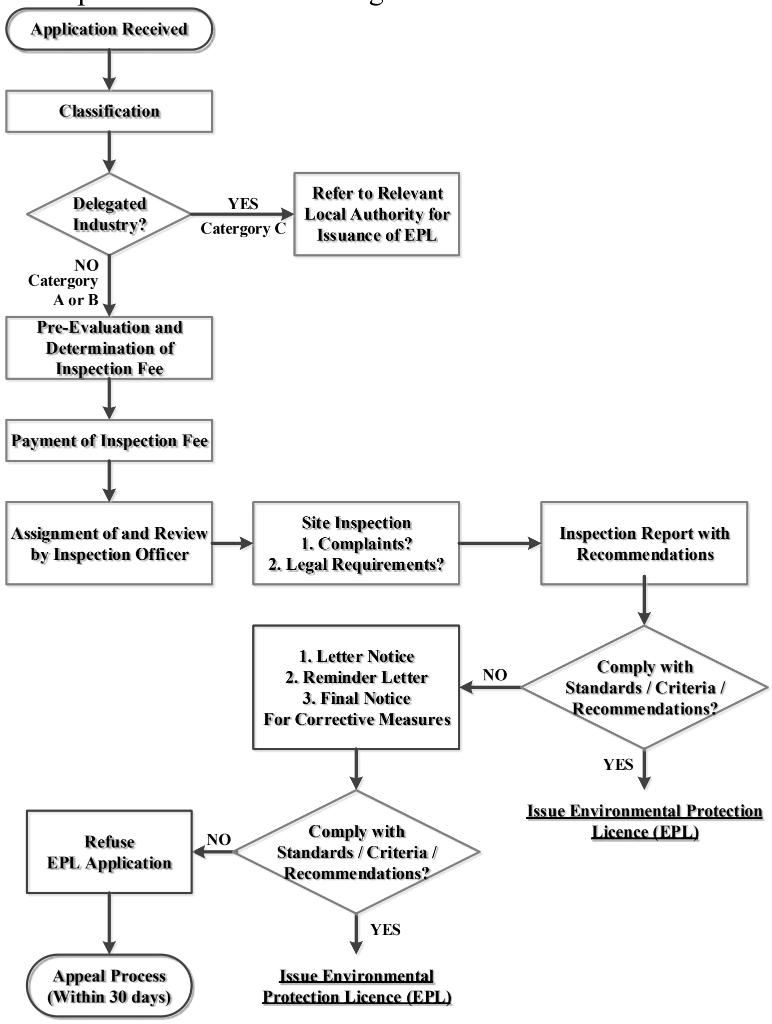


Figure1.1 Procedure of New Application of the EPL

Submission of application forms

The applicant shall submit an application form with relevant documents to the EPL issuing Authority by one month before of commencement of operation.

If applications contain incorrect information, not satisfactory filed or required documents are not attached; the applications are rejected and the applicant will be noticed rejection. However when the application is re-submitted making all the corrections it will be accepted again for processing.

Payment for EPL Application

The EPL application fee including the inspection fee would be decided by the EPL issuing Authority based on the details furnished by the industrialist, and refer to the cases decided by the relevant Provincial / District office of the CEA.

Normally the

- Minimum amount of the inspection fee is RS. 3,000.00 + applicable Government taxes.
- Maximum amount is Rs. 10,000.00 + applicable Government taxes.

- For special activities inspection fees could vary subjected to the decision of the Board of Directors.

Inspection

Inspecting officers or relevant licensing authorities will carry out the field inspection. Usually the inspection will be carried out within fourteen (14) from the date of payment of the inspection fee. However, according to the urgency of the need, changes may be made to this schedule.

Although the inspecting officers have the right to enter in to the premises, the industrialists have the authority to enquire the identity of the inspecting officers before permitting them into their premises.

Note: Inspection Procedure specially related on the wastewater pollution could be referred by "Inspection Guideline for Water Quality Section, 2017"

Compliance of the EPL

Compliance of the EPL would be judged by the EPL issuing authority based on the results of field inspection.

If wastewater as wells as emission, nose/ vibration, waste generated from any activity does not satisfy the stipulated standards and criteria under the NEA, the issue of EPL should be refused. And then the refusal letter will be sent to the applicant under the signature of the authorized officer.

Payment of EPL fee and validity period

For the EPL fee for the activities under part "C" is Rs. 4,000.00 + applicable Government taxes, the validity is maximum validity period is three years form the date of issue. Further details on this could be obtained from the Gazette Notification No. 1534/18 dated 01.02.2008.

Note: For the activities in part "A", maximum validity period of an EPL is one year form the date of issue, and the EPL fee is Rs. 7,500.00 + applicable Government taxes.

For the activities in part "B" maximum validity period of an EPL is three years form the date of issue and the EPL fee is Rs. 6,000.00 + applicable Government taxes.

2.2.2.3. Obligations of EPL Holder

Obligations before applying the EPL:

The most highlighted obligation of the industries is to compensate their pollution to affect environment. This should be based on "PPP: Principal Pollution payment".

Obligations during holding EPL:

Once they apply EPL (So they are called EPL Holder), the industries shall secure the following obligations:

- To prior notify any changes or expansion related to prescribed activities and/or condition of EPL issuing before those proposals are made.
- To take action to dispose, discharge or emit waste to conform to the standards and criteria stipulated in the NEA.

- To take action to submit application on time for next renewal of the EPL.
- To comply with any instructions, conditions given by the LAs (EPL issuing Authority).
- To submit analytical reports as requested by the LAs.
- To permit inspectors authorized the LAs to enter into the industrial premises for inspection.

2.2.2.4. Benefit of EPL Holder

The most important benefit on complying EPL could be to encourage environmental protection and sustainably development of Sri Lanka. For the other, the followings are expected:

- To perform as stakeholder in protecting the environment by controlling the pollution to a minimal level.
- Be eligible to apply for loans from the banks to carry out further improvements to the industry and process.
- To encourage to proceed towards the international obligations (such as ISO certification) as he fulfils national requirements to control pollution.
- To avoid / protect any objections from the neighbourhood and/or public through taking action to reduce the environmental pollution.
- Be legally protected.

2.2.3. Renewal of Environmental Protection License (EPL)

Application procedure for new issuing EPL is described as below:

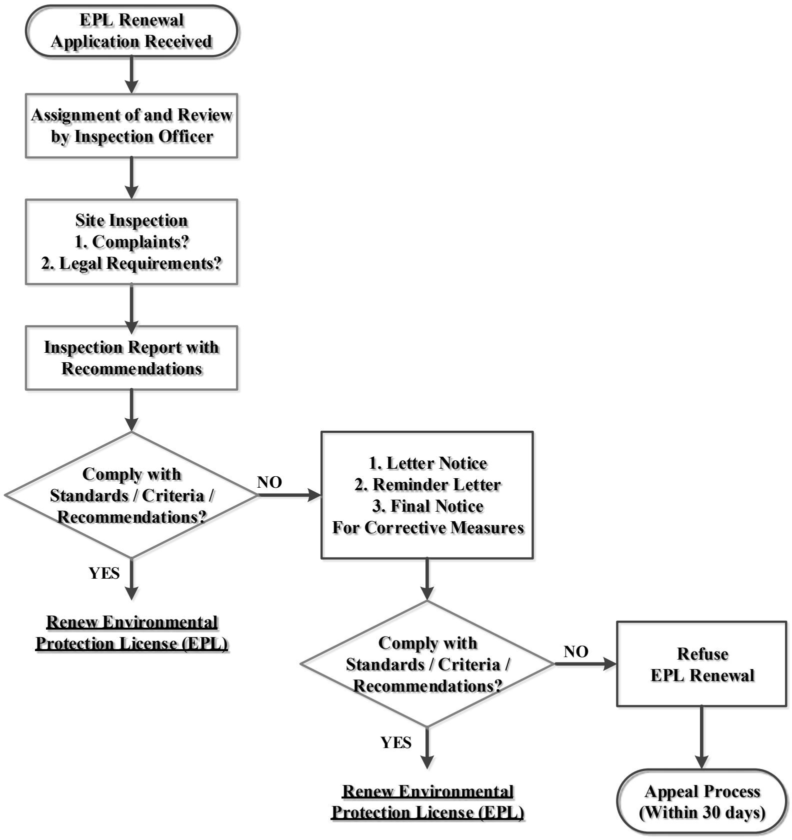


Figure1.2 Procedure of Renewal of the EPL

Submission of renewal application forms

The EPL application shall be renewed in maximum three years for part "C". The EPL holders, applicant, shall submit the application forms:

- before three months prior to the date of expiry of the EPL.
- before one month effecting any changes, alternations or extensions to the activity.

Payment for EPL Application

Inspection fee is obtained only when the applications for the first EPL is submitted. Therefore it is not necessary to pay the inspection fee for the EPL renewal. However if the applicant fails to submit the renewal application on time, the applicant has to submit a fresh EPL application. In this case payment shall be obtained.

Inspection

Inspection for renewal of EPL is generally undertaken by the same EPL issuing Authority who was received and inspected for new EPL application.

Inspection for renewal of EPL shall be conducted by two months before expiration of EPL.

Compliance of Renewal EPL

Compliance of the renewal EPL would be also judged by the same EPL issuing authority based on the results of field inspection. If the following improper conditions are resulted in, the EPL renewal shall be suspended or cancelled.

- Any violation, non-compliance of standards and criteria are found in the process.
- The receiving environment has been altered or changed due to natural factors of otherwise since EPL issuing.
- Continued discharge, deposit or emission of waste into the environment affects any beneficial use of the environment adversely.
- Discharge, deposit or emission of waste into the environment affects the sustainability of the surrounding environment.

Under Section 23 A of NEA, before issuing an order of suspension or cancellation of an EPL, the EPL issuing authority may give the holder of the EPL an opportunity to show cause why such order should not be issued.

Note: The difference between suspension and cancellation of EPL:

The EPL is suspended when the waste generated due to the activity does not conform to the standards and criteria, but this situation could be rectified and the quality of waste could be brought back to the stipulated standards and criteria. In this case, suspended EPL can be reactivated again through satisfying the standards / criteria by EPL holder's taking action.

While in case the quality of the waste exceeds and does not conform to these standards and criteria, the EPL will be cancelled. The applicant has to submit a fresh application in this regard and obtain a new EPL.

Appealing procedure

In case formal objection is raised from an EPL applicant against refusal of the EPL and/or the EPL holder is aggrieved by the suspension or cancellation of EPL; they can proceed an appeal in writing to the Secretary of the Ministry in-charge of the subject of Environment. This appeal has to be made within thirty days from the date of notifications of such decision. And the appeal is heard by the secretary. All the parties concerned will participate in the hearing of the appeal, and the decision of the secretary is the final and conclusive.

2.2.4. Violation and Penalty

If the EPL holders violate regulatory requirement under the NEA such as operation of prescribed activities without valid EPL, their waste as well as pollution do not satisfy the standards and criteria stipulated based on the NEA, and any other offense punishable under the NEA; they should be penalized. On conviction the offender is liable to a fine not less than Rs. 10,000/= or to a term of imprisonment not less than one year or both such fine and imprisonment.

If a convict continues to carry on such activity without obtaining an EPL, the Director General or any officer authorized by the Director General could request for a closure order from the court.

2.3. Promoting EPL Acquisition

2.3.1. Information and Education (Communication)

The promotion of EPL compliance mainly targets on the small scale enterprises (SMEs) which mostly operate activities categorized as "C".

Typical promotion tools are summarized as below:

Table 2.1 Typical Promotion Tools and Their Advantages and Disadvantages

Types of Promotion Materials	Advantage	Disadvantage
Video production	Able to show visually, so target can imagine by themselves; Able to use many occasions	Costing, Taking a time for production, Targets need to watch
Workshop/ Meeting	Directly communicate with targets; deep explanation/ discussion can be made; not so costing	Not many people can be reached by one time
Environmental Education	Able to take roots environmental awareness in target's mind; synergy effect of ordinary subjects taught in schools	Long-term commitment is necessary
Training/ Lecture	Directly communicate to targets; delivery not only practice, also theory of the matter	Targets need to make time to participate, costing (depend on programs)
Activities/ Excursion	Able to lead actual practices/ behaviour changes to participants; Big impact to participants	Continuous implementation is necessary; Targets need to make time to participate, costing (depend on activities/ excursion);
Contest	Getting a prize can be incentives for targets to participate; not so costing	Continuous implementation is necessary
Event	Able to reach many people; able to involve many organizations;	Costing; Big burden for preparation
Leaflet	Able to reach many people; not costing; Able to use in many places/occasions	Low impact to targets; tend to be disposed; difficult to trace receivers' feedbacks.
Website	Many people can contact; much information: visual materials, documents, can be uploaded.	Costing (in case of outsourcing); frequent information updates is necessary; usually difficult to reach elderly people

Promotion materials are prepared by the CEA in the forms of posters, booklets and guideline as below:

Table 2.2 Examples of Promotion Materials Established by the CEA

Name of Materials	Target Audiences	Topics
Poster	SMEs, LAs	Awareness raising of the EPL
Brochure	SMEs, LAs	Awareness raising of the EPL
Promotion Guideline	LAs	EPL system with inspection, awareness to the SMEs
Sector Guideline	CEA, LAs, SMEs	Technical guideline for specific industrial sectors

2.3.2. Enforcement and Implementation by Local Authorities

Detection of issues to be directed for enforcement could be mostly through inspection to the prescribed activities. Therefore inspection shall properly be undertaken. CEA has established

Inspection Guideline to address the inspection procedures[1]. It is strictly promoted for inspection officers in the any EPL issuing authorities to take action of inspection based on this guideline.

[1] It is especially for wastewater pollution control.

Appendix

Appendix A: List of Prescribed Activities in The part “C”

Appendix B: Details of Contact Information

Contact Details:

Central Environmental Authority
Head Office
No. 104, Denzil Kobbekaduwa mawatha “Parisara Pisaya”
Battaramulla

Telephone

General: (011) 2872263
2872278, 2872415,
2872419, 2873447-9,
2873451, 2888999

Mr. K. H. Muthukuda Arachchi
Deputy Director General
(Environmental. Pollution Control)
TP: (011) 2873453

Dr. R. M. S. K. Rathnayake
Director
(Environmental. Pollution Control)
TP: (011) 2873452

No.	Provincial / District Offices	Officer In-charge	Address	Contact
1	Western Provincial Office	Mr. H.S Premachandra Director	Central Environmental Authority Provincial Office, Western Province No. 104, Denzil Kobbekaduwa Mawatha,	011-4856187 011-2862831
2	Gampaha District Office	Mr.M.M.C.S.K. Malwana Director	Central Environmental Authority Gampaha District Office, No.50, Minuwangoda Road, Gampaha.	033-2232201/2
3	Kalutara District Office	Mrs.H.D.Chandrika Assistant Director	Central Environmental Authority Kalutara District Office, No. 233/3, Central Junction, Nagoda, Kalutara	034-2221420
4	Central Provincial Office	Mr. K.P Welikannage Director	Central Environmental Authority, Central Provincial Office Polgolla Dam Site, Polgolla	081-7877277
5	Matale District Office	Mr. M.M.A.I Janka Assistant Director	Central Environmental Authority Matale District Office No. 10A, Malwatta Road, Matale	0662231205
6	Nuwara Eliya District Office	Mr. R.M.K. Bandara Officer in-Charge	Central Environmental Authority Nuwara Eliya District Office, District Secretariat, Nuwara Eliya	052-2223311
7	Southern Provincial Office	Mr. W Susantha Director	Central Environmental Authority Southern Provincial Office, 361/189, Egal Park, Dangedara, Galle	091-7877277
8	Matara District Office	Mr. G. Sunil Assistant Director	Central Environmental Authority Matara District Office, No. 64/1, Fransis Samaraweera Mawatha, Gabada Street, Hakmana Road, Matara.	041-7877277
9	Hambantora District Office	Mr. G.L Samarathunga Asst.Director	Central Environmental Authority Hambantora District Office, No. 45, Weerakatiya Road, Tangalle	047-2241599

10	Sabaragamuwa Provincial Office	Mr. K.G.T.N Kiriella Director	Central Environmental Authority Sabaragamuwa Provincial Office, No.582/2, New Town, Rathnapura	045-2226984
11	Kegalle District Office	Mr. R.M.S.B Rathnayake Assistant Director	Central Environmental Authority Kegalle District Office, No. 54/7. Albert Senavirathna Mawatha, Kegalle	035-7877277
12	Eastern Provincial Office		Central Environmental Authority Eastern Provincial Office, No 05, Priyantha Mawatha, Kantale	026-2234488
13	Ampara District Office	Mr. Gohulan (Officer in Charge)	Central Environmental Authority Ampara District Office, 1st lane, Ampara	063-7877277
14	Batticloa District Office.	Mr. S. Udayarajan Officer in charge	Central Environmental Authority Batticloa District Office, No. 344/5, Chandra Lane, Trinco Road, Batticoloa.	065-2227522
15	North Central Provincial Office	Mr. R.M.G Anura Assistant Director	Central Environmental Authority North Central Provincial Office, No.388/40, Harishchandra Mawatha, Anuradhapura.	025-2225999
16	Uva Provincial Office	Mr. N.S Gamage Director	Central Environmental Authority Uva Provincial Office, No.179, Kappatipola Road, Badulla	055-7877277
17	Monaragala District Office	Mr. K.G.S. Rukshan Officer in Charge	Central Environmental Authority Monaragala District Office, No.11, Mile post, Monaragala Road, Buttala.	055-2273963
18	Northern Provincial Office	Mr. M.A.C Najeeb Director	Central Environmental Authority Northern Provincial Office, Kachcheri, Jaffna.	021-7877277
19	North Western Provincial Office	Ms. N. G. Senavirathna Director	Central Environmental Authority, North Western Provincial Office, No. 162, Negambo Road, Kurunegala.	037-7877277

20	Killinochchi District Office	Mr. T. Suboharan Assistant Director	Central Environmental Authority Killinochchi District Office, No.29, Uthayangar Kanakapuram Road, Killinochchi	021-2285548
21	Polonnaruwa District Office	Mr. Y.K.M.C.G Senavirathna	Central Environmental Authority Polonnaruwa District Office, No.474, 28Mile Post, Polonnaruwa	027-2227376
22	Vavunia District Office	Mr. G.A.L Balasooriya Officer in Charge	Central Environmental Authority Vavunia District Office, 49/17, Kovil Road, Kurumankaduwa,Vavunia	024-2220611
23	Mannar District Office	Mrs. H. Rajeshwaran Officer in Charge	Central Environmental Authority Mannar District Office, Old Library Building, main Street, Mannar.	023-2251606
24	Mullativu District Office.	Mr. P Thuvarahan Officer in Charge	Central Environmental Authority Mulliativu District Office, Mulliativu Muslim Vidyalaya Road, Vannakulam, Mullaithivu	021-2290224
25	Puttalam District Office.	Mr. D.N.K Dissanayaka Assistant Director	Central Environmental Authority Puttalam District Office, No.155/A, In front of Buddhist Center, Colombo Road, Puttalam	032-2267241

Our aim in requiring industries / activities to obtain an Environmental Protection Licence is to ensure that industries / activities which are an essential part of the development process may operate without causing undue adverse effects to the receiving environment or human health

付属資料 22　セクターガイドライン（繊維加工事業）

Industrial Pollution Control Guideline
for
Textile

December 2017

Central Environmental Authority

JICA Expert Team

Industrial Pollution Control Guidelines
TEXTILE PROCESSING INDUSTRY

Table of Contents

1. INTRODUCTION

1.1 Rationale

This industrial pollution control guideline for textile processing industry was prepared under the Project for Monitoring of the Water Quality of Major Water Bodies in the Democratic Socialist Republic of Sri Lanka.
The rapid industrialization in Sri Lanka has created many environmental problems over past decades. The water pollution is a significant issue when considering the human health, existence of biota and the beneficial uses of natural resources.

The Central Environmental Authority (CEA) is the lead agency in the implementation & enforcement of the National Environmental Act No 47 of 1980 which introduced to enhance environmental management & pollution control. Therefore improved approaches in managing the environment is a pre requisite with the rapid industrialization, urbanization and increasing threaten to the natural resources.

The CEA has requested technical & financial assistance from the Japan International Cooperation Agency (JICA) which consist of following out puts with a special focus on the Kelani River.

1. Introduction of water body categorization & gazetting of ambient water quality standards.
2. Capacity development of lab staff and strengthening of main Laboratory.
3. Strengthen enforcement capacity of inspecting officers establishment of pollution source inventory.
4. Introduction of Information Management System related to water quality monitoring etc.

under No. 03 above industrial pollution control guidelines were prepared for three (03) industry types which were prioritized during a need assessment.

This Textile Processing Industry guideline is a review of the Industrial Pollution Control Guideline No 06 published in 1992. Main aim of Preparation of this guideline is to provide information and guidance to Enforcement Officers on industry specific technical information, pollution sources, characteristics and waste treatment methods.

Introduction of proposed effluent discharge standards and stationary source emission standards (to be gazetted) were also considered in the guidelines.

1.2 Textile & Garments

Sri Lanka's apparel export industry is the most significant and dynamic contributor for Sri Lanka's economy. The industry has grown over the last three decades and has become the number one foreign exchange earner and the largest single employer in the manufacturing industry.

Today, the garment industry occupies a pre-eminent position in Sri Lanka, producing high quality garments combined with an industry which is flexible and uniquely capable in servicing leading international brands such as Victoria's Secret, Gap, Nike, etc. A wide range of apparel for men, women, girls, boys, children and babies in the categories of fashion-wear, sport wear, etc. is manufactured and exported.

The textile as well as garment industry has recorded substantial growth levels over the past four decades and is currently the country's leading export, accounting for approximately 45 percent of total exports, and it provides about 33 percent of the manufacturing employment in the country. This industry, which is entirely privately owned, has been successful in the international market. Sri Lanka's apparel exports were $4.8 billion in 2016.[1]

According to the CEA data base; ....of large scale textile manufacturing industries are distributed mainly in Colombo & Gampaha districts including export processing zones in Biyagama, Katunayake , Avissawella. In the gazette notification No. 1533/16 dated 2008.02.25 the textile industry is mentioned as high polluting industry which needs to obtain an Environmental Protection License under the National Environmental Act No 47 of 1980.

2. TEXTILE MILLING AND PRODUCTION

2.1 Dry Processes

2.1.1 Spinning

Spinning refers to the process of twisting together of fiber to form yarn or thread which includes preparatory steps such as cleaning of the fibers to remove dirt, impurities, and contaminants; carding to produce an even and aligned mass of fibers; twisting to form the yarn; and winding of the yarn in to spools. Natural fibers may come from natural vegetable (cotton, sisal) or animal (wool, silk) sources while synthetic fibers are man-made. In general, natural fibers tend to be short while synthetic fibers may be produced in very long lengths.

Spinning is a dry process; although, certain materials, such as sizing agents may be added to improve strength, abrasion resistance, and texture of fibers and to reduce friction. The fibers may also be treated with anti-statics and lubricants, especially synthetic fibers, for trouble-free spinning.

2.1.2 Weaving and Knitting

Weaving is a method of producing cloth or fabric by interlacing two (2) sets of yarns or threads at right angles. Knitting is another method of producing cloth or fabric by creating multiple, interconnected loops of yarn from continuous lengths of yarns or threads.

Both weaving and knitting are dry processes which do not generate wastewater discharges. However, the yarn may be treated with sizing agents, antiseptics, penetrants, softeners, and other necessary additives.

2.2 Wet Processes

2.2.1 Pre-Treatment

The unfinished (meaning not yet bleached or dyed) woven or knitted cloth or fabric (also called "*greige*") is pre-treated to remove dirt, natural or added impurities, sizing agents, and other treatment chemicals used during spinning and weaving or knitting.

[1] www.export.gov., 2017

Pre-treatment involves desizing, scouring, bleaching, mercerizing (mainly for cotton yarn and fabric), and washing.

Desizing involves impregnating the yarn or fabric with the desizing agent, allowing the desizing agent to degrade or dissolve the sizing from the fabric, and finally washing off the contaminants. Desizing agents include enzymes, oxidizing chemicals, acids, detergents, and water.

Scouring is used to remove (natural or added) oils and waxes and other impurities from the yarn or fabric to render it more hydrophilic or water-absorbent and cleaner. Scouring involves a high temperature and use of chemicals such as caustic soda (sodium hydroxide), detergents, and surfactants. Fabric or yarn made of certain types of fibers like wool may require the use of solvents.

Bleaching is the process by which color (and possibly, also odor and other impurities) is removed from the fabric or yarn to whiten it. Bleaching allows dyeing with lighter colors and a more even color dispersion. Bleaching uses strong oxidizing agents (usually for natural fibers) or reducing agents (usually for synthetic fibers). Optical whiteners or brightening agents may be applied afterwards to further enhance the white brightness.

Mercerizing is the process of treating cellulosic fiber (usually, cotton but also applied on hemp and linen though less frequently) with caustic soda (sodium hydroxide) to cause the fibers to swell and increase luster and the surface area of the fibers and thereby, their affinity to dyes and color fastness.

At the end of the pre-treatment stage (or in between individual process steps), the yarn or fabric is thoroughly cleaned by washing water and detergents and/or surfactants to get rid of the pre-treatment agents applied and contaminants removed in the pre-treatment stage.

2.2.2 Conventional Dyeing

Dyeing is the process of imparting color to yarn or fabric by the application of dyes. Dyes are dissolved, usually in water, to form a liquor or dye bath. The yarn or fabric is immersed in the dye bath. The dye molecule attaches to the surface of the fibers by physical absorption or by chemical bonding. As the yarn or fabric remains soaked in the dye bath, the dye penetrates deeper into the fibers and eventually align with and become fixed to the long fiber molecules. The best dyes do not lose color from washing or exposure to light. Ideally, all the dye molecules attach firmly to the fibers. In reality, a fraction of the dyes in the dye bath will not fix on (attach to or bind with) the fibers and becomes part of the effluent of the dyeing process where the dyes impart color of the wastewater.

There are many types of dyes –direct, acid, basic, disperse, mordant, and vat dyes. Natural dyes come from sources such as flowers, fruits, and other plant parts or from insects and animals or from minerals. Synthetic dyes are man-made.

Aside from the dyes, other chemicals such as acids, alkali, and salts are used to enhance the effect of the dyes and to fix them more firmly to the fibers.

There are several methods of dyeing depending on the materials to be dyed and the dyes use. Yarn or fabric may be dyed in batches or continuously; although, batch dyeing is more common. Whole, finished garments may also be dyed but this is not a common practice.

After dyeing, the yarn or fabric is rinsed and neutralized, then washed with detergents. Finishing formulations such as softeners may be applied to obtain desired characteristics of the finished yarn or fabric. The yarn or fabric is then spun and heat dried to produce the finished dyed yarn or fabric.

2.3 Textile Printing

Unlike conventional dyeing which imparts only a single color on the whole mass of yarn or fabric, *textile printing* or *textile printing* can impart multiple colors at several local sites and with specific designs or patterns. Textile printing is usually to done on fabric rather than on yarn. In textile printing, the dyes are applied using rollers, blocks or plates, and/or silk screen or stencils with the desired designs or patterns. Fixing agents or mordants may be applied before, during, or after the designs or patterns are printed on the fabric, depending on the printing methods and dyes used.

Preparation of the printing rollers, blocks or plates, and/or silk screen or stencils with the desired designs or patterns is a process separate from the actual textile printing but may be done in the same textile mill. Preparation of rollers often involves use of corrosive and hazardous chemicals to etch the pattern or design on the rollers. Fabrication of the rollers such as by photoengraving generates wastewater.

2.4 Garment Washing

2.4.1 Regular Washing

The production of ready-to-wear garments and apparels is a major sub-sector of the the Sri Lanka textile industry. Production of garments, apparel, and other finished textile goods uses dyed fabric and yarn as raw material. While the garments or apparels are not dyed before, during, or after sewing, the sewn garments are washed, treated with softeners and other agent, dried, pressed, and packed. This is similar to laundry operation but typically on a much larger scale and with limited but similar types of garments. Regular washing removes dirt and other contaminants. The wastewater or effluent from regular washing of garments contains dirt, soaps or detergents, fabric softeners, and sometimes, dyes washed off from the fabric.

2.4.2 Stone Washing, Acid Washing

Stone washing is a process to impart a worn out look on new garments and/or to soften and make more flexible stiff fabrics such as denims and canvas. The new garments are placed in large, horizontal washing machines with pumice stones which batter the fabric to soften and upbraid the fabric. In addition to the detergents, the used wash water contains fine pumice or stone powder.

Acid washing is a variation of stone washing in which chlorine solution is added to intensify the whitening or worn out appearance. Despite the name, it does not involve the use of acids.

As an alternative or supplement to pumice and chlorine solution, enzymes are also used to obtain the desired worn out look. The use of enzymes reduces the amount of water used in the stone washing process as well as the suspended solids (such as pumice powder) and other contaminants (upbraided fibers and dyes).

3. WASTE WATER GENERATION

3.1 Wastewater

3.1.1 Wet Processes -Washing, Bleaching, Dyeing, and Finishing Operations

Spinning, weaving, and knitting are basically "dry" processes which do not generate liquid discharges or wastewater. However, a protective, adhesive coating (sizing) is usually applied on the spun yarn surface in preparation for weaving or knitting in order to improve weaving or knitting efficiency.

For many types of fabric, especially cotton, the fabric or cloth is singed to remove loose fibers thereby reducing pilling and tendency to soil and improving surface texture and dye bonding. Although singeing is technically part of the finishing operations, it does not generate any wastewater. On the other hand, large quantities of wastewater are generated in the washing, bleaching, dyeing, and finishing operations with practically each step generating wastewater or effluent.

3.1.2 Wastewater Sources in Conventional Dyeing

To prepare yarn or cloth for use in making garments and other textile products, it is washed to remove impurities, bleached to remove undesirable color, dyed to the desired color, and finished by washing and applying various formulations to obtain the desired quality.

A schematic process flow diagram of the pre-treatment stage showing the steps that generate wastewater or effluent is presented in Figure 1 below .

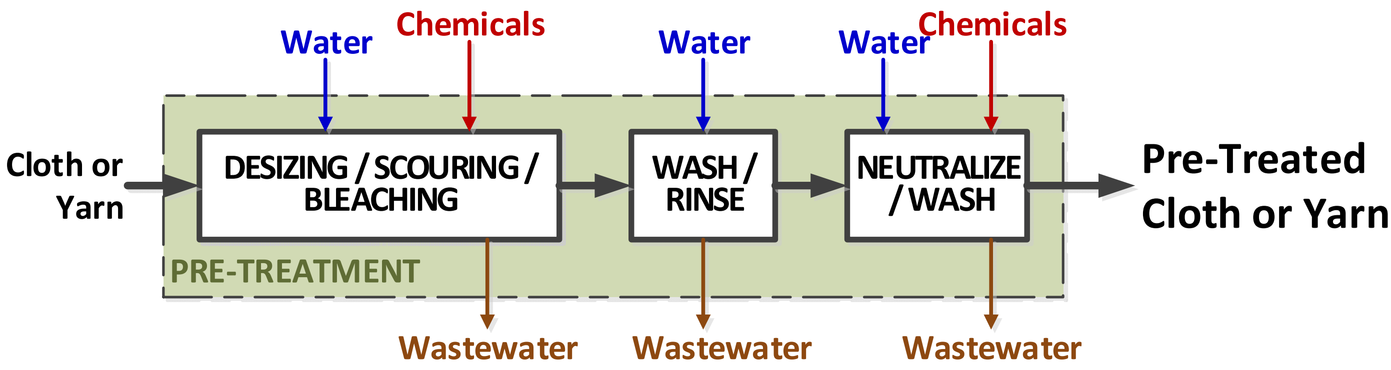


Figure 1 **Schematic Process Flow Diagram of Pre-Treatment Stage**

Many textile mills operate on a batch basis. This means that many of the process steps are performed in the same vat or tank. Referring to the schematic process flow diagram of the pre-treatment stage, the process steps desizing, scouring, and/or bleaching and subsequent wash and rinse and/or neutralize and rinse may be done in a single vat or tank. Wastewater may be discharged during and after each process step.

The schematic process flow diagram of the dyeing and finishing stage showing the steps that generate wastewater or effluent is presented in Figure 2 below .

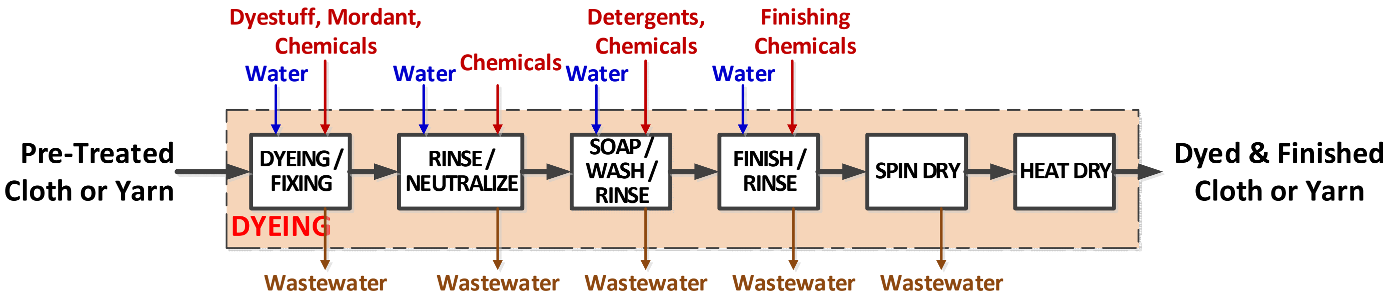


Figure 2 **Schematic Process Flow Diagram of Dyeing and Finishing Stage**

As with the pre-treatment stage, the process steps in the dyeing and finishing stage, actual dyeing and fixing of dyes, rinsing and neutralization of the chemicals used in dyeing, washing with soap, detergents and/or other formulations, and applying finishing chemicals and rinsing may also be done in a single vat or tank. Wastewater may be discharged during and after each process step.

In case some or all of the process steps are done in separate vats or tanks, the wet yarn or fabric will drip liquid or wastewater dragged out of the first vat or tank while it is transported to the next vat or tank. Floor drains on the route between vats or tanks should collect and convey the drag out wastewater to the effluent treatment plant.

In the dyeing and finishing stage, spin drying and heat drying are done in other equipment. The transport of the wet dyed and finished fabric or yarn will often result in drips, spills, and leaks on the floor on the route to the spin dyers. This wastewater stream on the floor should be collected and treated prior to discharge. Transport of the spin dried fabric or yarn is not likely to generate wastewater.

While drain water from spin dryers may be directed to canals, spills and leaks frequently occur on the floor of the spin dryer section. Hence, floor drains should collect the wastewater for conveyance to the effluent / wastewater treatment plant.

For continuous processes, the drains from vats or tanks are often closed pipes routed directly to drainage canals or pipes which may not always be readily visible. The sewer or piping plan for the wastewater or effluent streams is needed to identify the routes of these sources of wastewater or effluent.

Often overlooked sources of wastewater associated with dyeing are the dye preparation room and laboratory. While the dye preparation room is usually kept dry, highly concentrated dye solutions and rinse or wash water may be disposed of from this room. Likewise, the laboratory may discharge relatively small amounts of wastewater which may be highly contaminated. In both cases, the sewer drains serving the dye preparation room and the laboratory should be connected to the industrial wastewater sewer system to ensure that the wastewater discharged from these sources are properly treated prior to disposal.

3.1.3 Wastewater Sources in Textile Printing

In terms of wastewater sources, the main difference of textile printing from conventional dyeing is the addition of the preparation of the printing rollers, blocks or plates, and/or silk screen or stencils with the desired designs or patterns to the dyeing process. While this is a distinct process from the dyeing process itself, preparation of rollers, plates, and others is often done in the same textile mill. The type and sources of wastewater in the preparation of the rollers, plates, silk screen, and/or stencils depend on what material they are being made of and how they are made.

The schematic process flow diagram of the textile printing and finishing stage showing the steps that generate wastewater or effluent is presented inFigure 3 below.

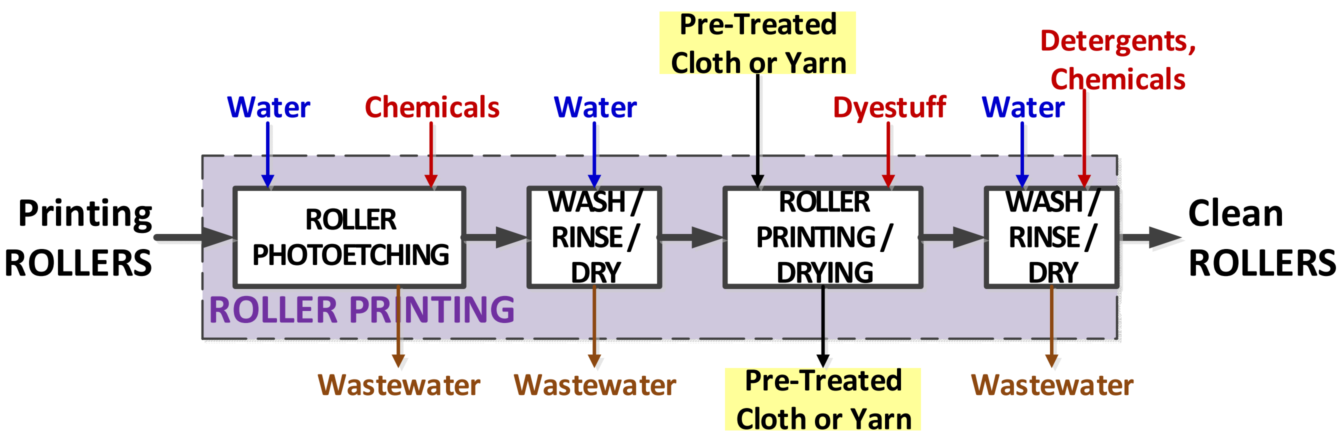


Figure 3Schematic Process Flow Diagram of Textile Printing and Finishing

In the case of print rollers or plates, many are fabricated using photoengraving techniques which etch designs on a (usually copper) substrate (roller or plate). The roller or plate is first coated with a photo resist and then exposed to strong light shining through a pattern or screen with the prepared design or image. Areas exposed to light harden. A solvent then washes away soft photo resist from the unexposed area, to uncover the pattern or design on bare metal (substrate). The plate or roller is then bathed in (or sprayed with) the etching solution to create the pattern or design on the plate. The plate or roller is then washed to remove the photo resist and etching solutions and then dried. The roller or plate is now ready to use for textile printing. After completion of a production run, the plates or rollers are cleaned, sanded, and re-used to create new designs and patterns.

Textile printing is more often a continuous and mechanized rather than batch and manual process. As such, it generates less wastewater. The dyes used are often thickened to minimize spreading due to absorption and/or capillary action. If multiple colors or dyes are to be printed, multiple rollers or plates are also used, one for each color or dye.

After designs or patterns are printed, the fabric is dried and the printed dye or color is cured and set or fixed by steam or hot air. The dyed fabric is then washed and finished similarly to conventionally dyed fabric.

3.1.4 Characteristics of Wastewater from Textile Dyeing and Finishing

*N.B.*The following data on the characteristics of wastewater from textile dyeing and finishing are derived from Philippine textile industry. The data have to be validated to determine if they are applicable to the Sri Lanka textile industry.

Table 1 Specific Wastewater Generation Rates in Dyeing and Finishing

Quantity:	
o Average:	125 liters/kg cloth or yarn
o Maximum:	160 liters/kg cloth or yarn
o Minimum:	60 liters/kg cloth or yarn
o Benchmark:	60 liters/kg cloth or yarn
Quality:	
o Average:	35 gm BOD5/kg cloth or yarn
o Maximum:	>60 gm BOD5/kg cloth or yarn
o Minimum:	15 gm BOD5/kg cloth or yarn

Table 2 Significant Pollution Parameters in Dyeing and Finishing Wastewater

- Color
- pH
- 5-day Biochemical Oxygen Demand (BOD5)
- Chemical Oxygen Demand (COD)
- Total Suspended Solids (TSS)
- Heavy Metals:
  - Lead
  - Chromium
  - Copper (e.g., roller printing)
- Salinity / Electroconductivity

3.1.5 Wastewater Sources in Garment Washing

Regular Washing: Washing of (sewn, ready-to-wear) garments is similar to typical laundry operations except for the larger, industrial scale. The main source of wastewater from garments washing is the washing machine. Washing with detergents, rinsing, draining, treatment with softeners and other property enhancers, and spin drying usually takes place in the same machine. These washing machines drain wastewater directly to the drainage canals or sewer pipes leading to the effluent treatment plant. Spills and leaks rarely occur in garments washing operations.

Stone washing makes use of pumice to obtain the worn out look and to soften garments. Hence, wastewater from stone washing contains pumice solids in addition to the detergents and fibers. Due to their density, the pumice solids tend to settle in the wastewater canals and pipes.

Acid washing adds chlorine (not acid) solution to the pumice in stone washing to achieve an even whiter and more worn out appearance. The wastewater from acid washing may contain residual chlorine and chlorination by-products in addition to the usual contaminants present in wastewater from stone washing.

If enzymes are used to supplement or replace pumice and chlorine, excess enzymes will end up in the wastewater. However, use of enzymes will reduce the volume of wastewater generated and contaminants in the wastewater such as pumice solids and fibers.

3.1.6 Characteristics of Wastewater from Garment Washing

*N.B.*The following data on the characteristics of wastewater from garments washing are derived from Philippine textile industry. The data have to be validated to determine if they are applicable to the Sri Lanka textile industry.

Table 3 Specific Wastewater Generation Rates in Garments Washing

Quantity:	
o Average:	55 liters/kg laundry
o Maximum:	80 liters/kg laundry
o Minimum:	25 liters/kg laundry
o Benchmark:	20 liters/kg laundry
Quality:	
o Average:	15 gm BOD5/kg laundry
o Maximum:	30 gm BOD5/kg laundry
o Minimum:	10 gm BOD5/kg laundry

Table 4 Significant Pollution Parameters in Garments Washing

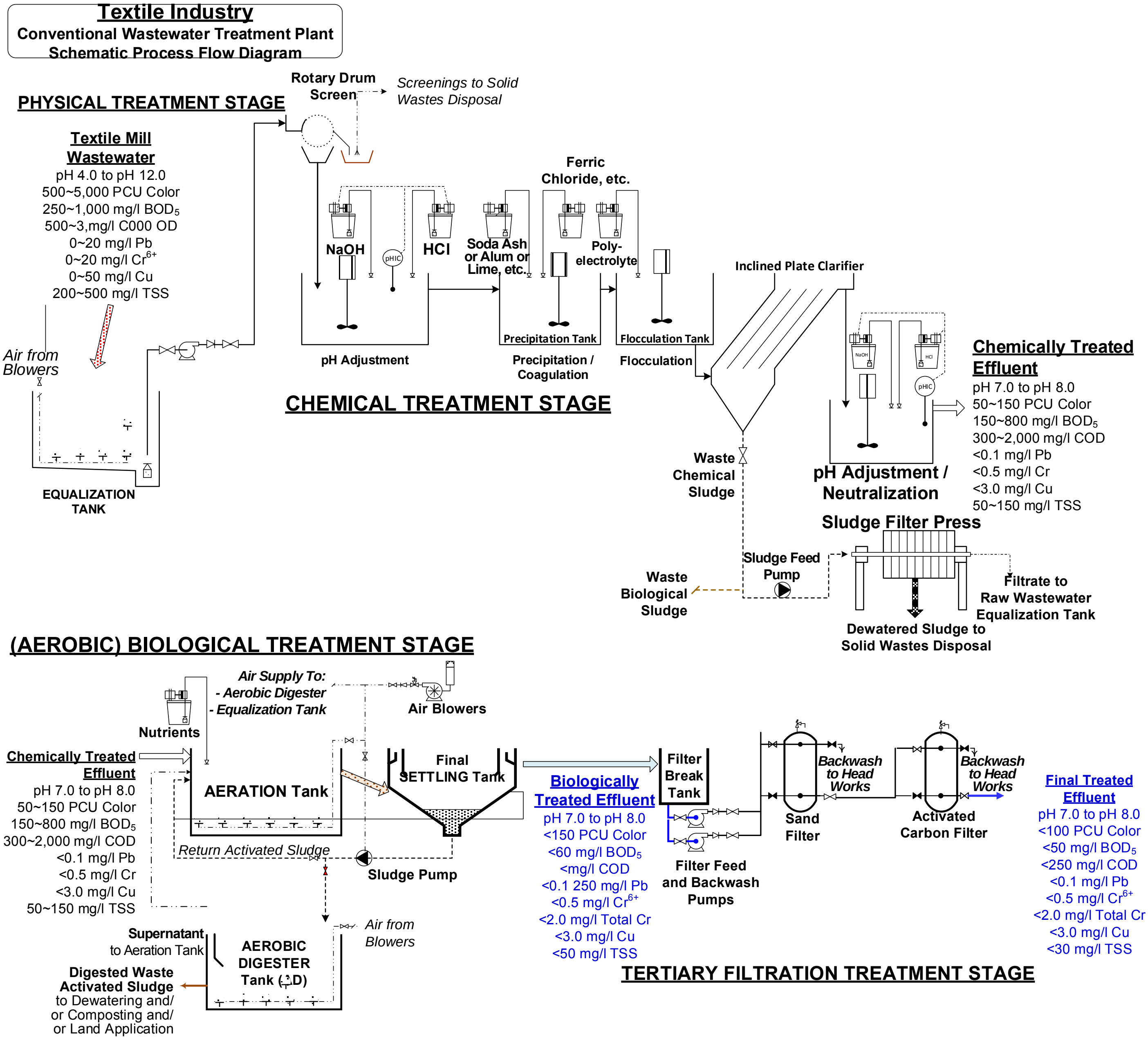
- Color
- pH
- 5-day Biochemical Oxygen Demand (BOD5)
- Chemical Oxygen Demand (COD)
- Total Suspended Solids (TSS)
- Chlorination By-Products
- Salinity / Electroconductivity

4. WASTEWATER TREATMENT

4.1 Introduction

Considering the wide variety of significant pollution parameters in textile industry wastewater, its treatment requires several types of treatment processes. The schematic process flow diagram shown in Figure 4 shows a comprehensive range of conventional treatment processes suitable for textile industry wastewater.

Figure 4 Conventional Treatment Plant for Textile Industry Wastewater



4.2 Physical Treatment Processes

Physical treatment processes rely on physical properties of contaminants to effect treatment. Physical treatment processes are best suited for the removal of discrete solids from water because they are effective and very economical, especially in terms of cost per unit quantity of pollutant removed.

4.2.1 Equalization

Treatment of wastewater from textile mills depends on the types of yarns or fabrics, dyes, and finishing chemicals used. Textile mills rarely process only a single type of fabric or yarn and dye with a single dye of specific color. In fact, the type of yarn or fabric and the colors and types of dye can vary on a batch by batch or production line by production line. Hence, the wastewater or effluent treatment plant must be able to effectively treat highly variable volumes of wastewater with varying characteristics. It is, therefore, important to equalize the volume and characteristics of the textile mill wastewater to be treated in order to minimize the variations in quantity and quality. The first treatment process of a wastewater or effluent treatment plants of textile mills should be equalization.

The working capacity of the equalization tank may be determined from the instantaneous flow rates and flow patterns. In the absence of reliable, actual flow rate data, the working capacity of the equalization tank should be equal to the average flow if feasible. Alternatively, the working volume of the equalization tank may be based on the total volume of wastewater if the largest tanks of each production line are simultaneously dumped.

Due to the high degree of contamination and the presence of suspended solids, the equalization tank is usually aerated to minimize putrefaction of the organic pollutants which causes odor problems. Aeration also serves to mix the contents of the equalization tank to attain uniform conditions.

4.2.2 Screening

Wastewater from the textile industry contains suspended solids which may interfere with the operation or function of downstream treatment units. Special concern are the fibers which tend to form strings which wrap around equipment. Rotary drum screens are the most appropriate type even though mesh type screen have higher capture efficiency because rotary drum screens are less prone to blinding or plugging from strings and are self-cleaning. Alternatively, static hyperbolic screens are also reasonably effective and more resistant to blinding than mesh screens. Unlike rotary drum screens, static screens need to be manually scraped for effective removal of screened solids.

The size of screening equipment is based on the flow rate, size of openings, and solids load. The effectiveness or degree of removal of solids is also dependent on these factors and varies considerably from less than 30% to more than 70%.

4.2.3 Flotation

Most of the fibers are light weight, dissolved air flotation (DAF) or other forms of flotation can be effective in fine fibers and other solids not removed by screening. Apart from the conventional method of dissolving compressed air in re circulated clarified water, dissolved air mixture may be formed by cavitation. Cavitation air flotation simplifies the dissolved air system by replacing the recirculation pump, air compressor, air-water mixing tank, and pressure reducing and flow control valves with a single mixer-like cavitation air flotation unit. Since DAF systems are expensive and chemical treatment can remove the fine fibers and suspended solids, the flotation is not usually appropriate or cost effective for the treatment of textile industry wastewater.

Flotation systems typical include dosing of coagulating agents to promote agglomeration of the fibers and suspended solids. The size of the flotation area is dependent on the instantaneous feed flow rate which is usually the pump flow rate and rise rate of the solids. The rise rate for DAF systems is typically 3-5 m/hr. Flotation can remove more than 80% of suspended solids and approximately 30-50% of BOD.

4.3 Chemical Treatment Processes

4.3.1 Conventional Chemical Treatment

Chemical treatment processes rely on (usually, inorganic) chemical reactions to remove or destroy pollutants. For wastewater from the textile industry, chemical treatment is used to remove or reduce color, suspended solids, and dissolved pollutants through neutralization, precipitation, coagulation, and oxidation-reduction reactions. Treatment of the wastewater with chemicals will cause the precipitation or coagulation of pollutants, agglomeration of suspended solids and precipitates.

Neutralization, precipitation, and coagulation may take place in separate reaction tanks or simultaneously in a single reactor tank. Flocculation normally takes place in a separate reaction tank. After precipitation, coagulation, and flocculation, the pollutants, now in floc form, are separated by gravity sedimentation in conventional settling tanks or clarifiers or in inclined, parallel plate or tube settlers. The sludge which now contains the pollutants removed from the wastewater is discharged and dewatered prior to ultimate disposal as solid wastes.

Chemical treatment can be very effective in removing or reducing inorganic pollutants including toxic heavy metals (such as copper, chromium, and lead), color (natural and synthetic) dyes, and suspended solids but has a lesser effect on BOD and COD.

While there are many chemicals used in wastewater treatment, the most common include alum, ferric chlorides and other iron salts, lime, caustic soda, hydrochloric acid, and sulfuric acid. Polyelectrolytes are used as flocculant aids. Due to the numerous possible combinations of fibers, yarns, fabrics, dyes, softeners, finishing formulations, and dyeing methods, the correct types and combinations of treatment chemicals, including polyelectrolytes, and their optimum dosages are best determined by conducting jar tests on the actual wastewater streams.

Even when there is an adequately large equalization tank, the types and combinations of chemical that are effective in treating the wastewater may vary frequently. It is, therefore, necessary to have several chemical dosing systems. With experience and the use of simple jar testing techniques, the wastewater treatment plant operator can effectively and successfully attain compliance with effluent standards by adjusting chemical dosing regimens if multiple chemical dosing systems are provided.

Conventional chemical treatment can remove as much as 90% of suspended solids and approximately 30-50% of BOD or COD.

4.3.2 Electrocoagulation

An electrocoagulation reactor consists of an anode of aluminum and a cathode of an inert material, most commonly, iron, across which is applied a direct current voltage. The aluminum metal in the anode dissolves as aluminum cations while the cathode, hydroxide is formed. These react with pollutants to form precipitates which are removed by settling. Hydrogen gas is also formed at the cathode. The fine bubbles of hydrogen gas can attach to suspended solids particles to float them out. Electrocoagulation is more effective than conventional chemical treatment methods especially in removing difficult to treat contaminants such as emulsified oil, hydrocarbon solvents, and heavy metals. In addition, electrocoagulation produces much less sludge than conventional chemical treatment. Although still relatively more expensive, it may be suitable for specific applications in the treatment of wastewater from the textile industry.

4.4 Biological Treatment Processes

4.4.1 Activated Sludge Process

Biological treatment processes make use of living organisms (mostly microorganisms) to effect treatment.The *activated sludge* treatment process is an aerobic, suspended-growth system. Itis, by far, the most common biological treatment process because of its high BOD reduction efficiency, stability, reliability, and ease of operation.

The activated sludge treatment process consists of an aeration tank and a (final or secondary) settling tank. Wastewater flows into the aeration tank where biologically active sludge recycled from the (final or secondary) settling tank is mixed with the influent wastewater. The activated sludge microorganisms consume the organic pollutants (measured as BOD_5) which serve as their food or substrate, and convert them to harmless carbon dioxide, water, and additional cell mass. An aeration system provides the oxygen required for the degradation of the organic pollutants and the mixing energy to keep the activated sludge flocs in suspension.

Activated sludge treatment process can reduce BOD by 90-95%, suspended solids by 80-90%, and oil by 50-80%.

While many factors affect the performance of an activated sludge treatment system, one of the most important is the ratio of food (BOD) to microorganism or food to mass (F:M) ratio. A food to mass (F:M) ratio of 0.05 – 0.15 kg BOD5/day/kg microorganisms will consistently producetreated effluent BOD_5 concentrations below 20 - 30 mg/l and effluent suspended solids concentrations below 30 – 50 mg/l.

4.4.2 Alternative Aerobic Biological Treatment Processes

Alternative aerobic biological treatment processes include sequencing batch reactors (SBR), trickling filters, rotating biological contactors (RBC), and membrane bioreactors (MBR).

Sequencing batch reactors(SBR) are a variation of the conventional activated sludge system. Treatment takes place in a single tank, unlike the two-tank arrangement of the conventional activated sludge system. Treatment is undertaken in batches going through the different stages of filling, aeration / reaction, settling or solids separation, and discharge or decanting of the treated effluent. Provisions have to be made to accommodate the influent wastewater during the different stages (except filling). In most cases, a holding or equalization tank is used or a twin tank arrangement is provided wherein one tank cycles through the treatment while the other reactor tank accumulates the influent raw wastewater. SBRs attain similar treatment efficiencies as activated sludge treatment plants. Although they can be operated manually, SBRs usually require automation and motorized or pneumatically operated valves. SBRs consume more energy than activated sludge treatment plants of the same capacity.

Trickling filters are a form of attached growth or fixed film biological treatment systems. In fixed film processes, microorganisms that consume the organic material (food or BOD) grow as *slime* on fixed media. As the wastewater flows over the slime or biomass, (soluble) organic wastes are adsorbed and consumed by the microorganisms. Oxygen from air diffuses through the thin layer of wastewater to the microorganisms. As the slime layer builds up, clumps slough off or detach from the media. The material that sloughs off, called *humus*, flows with the wastewater and is separated from the treated wastewater in the secondary clarifier or settling tank. The main advantage of trickling filters (and other fixed film treatment systems) is their low operating costs.

Rotating biological contactors (RBC) are another type of attached growth biological treatment with a low operating energy consumption. In contrast to trickling filters where the media do not move, the media in RBCs are disc-like and rotate around a shaft. The rotation alternately exposes the slime layer to the food (organic wastes) when submerged and oxygen when exposed to the air to effect treatment.

It is important to note that attached growth treatment processes, such as trickling filters are more effective on soluble organic pollutants and less so on particulate or suspended solid pollutants. For this reason, trickling filters need primary clarifiers or similar pre-treatment units to be effective. The presence of fibers which can form strings in the wastewater from the textile industry can contribute to clogging of the trickling filter media or the RBC discs. Properly sized and operated, attached growth treatment systems can attain BOD reduction efficiencies of 80-90%. The suspended solids concentrations of the treated effluent of attached growth treatment processes like trickling filters are higher than those of the effluent of suspended growth treatment processes like activated sludge process.

Membrane bioreactors (MBR) are aerobic, suspended growth treatment systems similar to activated sludge treatment plants where the secondary clarifier or settling tank is replaced with a (semi-permeable) membrane such as ultrafiltration or microfiltration membranes which are installed in the aeration tank. This system eliminates the secondary settling tank resulting in a more compact system. The membrane is also several degrees more effective in remove suspended solids (mainly the activated sludge flocs) than settling tanks to produce very low suspended solids concentrations in the effluent. The membrane system also allows the retention of higher concentrations of biomass or activated sludge, further improving BOD reduction efficiencies.

MBRs can produce effluents with less than 10 mg/l BOD5 and less than 10 mg/l TSS (total suspended solids). Depending on the type and material of the membrane, it may also be able to remove some type of color dyestuff. As such, the treated effluent of MBRs may be suitable to re-use in the textile mill.

The membranes in MBRs are sensitive to plugging by stringy solids such as those present in wastewater from the textile industry. Hence, effective primary treatment to remove suspended solids is necessary if MBRs are to be used in treating wastewater from the textile industry.

The membranes in MBRs are sensitive to fouling from mineral and biological deposits which reduce flux and increases the pressure required to maintain the desired flux. This results in higher energy requirements to operate and the need for frequent cleaning. As a result, MBRs are costly operate than the more conventional biological treatment systems as well as being more costly to construct.

4.4.3 Anaerobic Treatment

Anaerobic treatment is generally applied on high BOD strength wastewater and organic sludges. Anaerobic processes take place in the absence of oxygen. In biochemical reactions, oxygen generally acts as electron receptor in the process of extracting energy from the organic material. In the absence of free oxygen, other chemical species such as nitrates and sulfates can serve as oxygen donors in *anoxic* reactions. In the absence of even such oxygen donors, other compounds, generally complex organic compounds, serve as electron receptors.

One great advantage of anaerobic treatment systems is the low energy consumption, or in many cases, net energy yield (from the methane gas generated). Their disadvantage is the much slower reaction rates which generally translates to longer reaction (holding) times and larger tanks.

In general, anaerobic treatment processes are cost effective when the influent BOD concentration is 2,000-3,000 mg/l or higher. Anaerobic treatment processes can attain BOD reduction efficiencies of 75-90%. However, sue to the high BOD concentration of the influent, the effluent of anaerobic treatment systems need polishing treatment (usually by aerobic processes) to attain compliance with discharge standards.

The biochemical oxygen demand (BOD) of raw wastewater from textile industry very rarely exceeds 2,000 mg/l even when processing natural fiber such as silk and wool. As such, anaerobic treatment systems are rarely used in treating wastewater from the textile industry.

4.5 Tertiary Treatment Processes

4.5.1 Ultrafiltration

Sometimes, primary treatment (physical and chemical treatment processes) and secondary treatment (biological treatment processes) may be inadequate to attain full compliance with discharge standards, especially for color when treating wastewater from textile industry. To further improve effluent quality to attain compliance, tertiary treatment methods may be used.

Depending on the type of membrane and type of dyes, ultrafiltration with or without chemical pre-treatment (for precipitation and coagulation) may suffice to remove color and residual pollutants. Like MBRs which use membranes, the product water of ultrafiltration is of very high quality (very low color, BOD, etc.). Thus, one advantage of ultrafiltration is the possibility of re-using treated effluent in the textile mill. However, because of the low cost of water supply and the current abundance of water, using ultrafiltration to enable reuse of the product water may not be financially viable.

The retentate or reject from ultrafiltration contains the pollutants that were removed from the feed water. Since the pollutants are concentrated in the retentate, it needs to be treated. If the wastewater or effluent treatment plant includes a chemical treatment stage, the retentate is best returned to the chemical treatment stage for further treatment.

4.5.2 Activated Carbon Filtration

Activated carbon filtration is a simpler and less costly method of removing color from secondary effluent of treatment plants for wastewater fromthe textile industry. Tertiary filtration consists of a sand filter and an activated carbon filter. The sand filter removes residual suspended solids (from secondary treatment) to prevent plugging of the downstream activated carbon media which would reduce its adsorption and treatment capacity. The activated carbon filter removes the color particles as well as some organic matter and inorganic substances. In some cases, activated carbon adsorption may also further reduce residual heavy metal concentration.

The adsorptive ability and capacity of activated carbon is dependent on the raw material from which it is made as well as the type of color bodies (dyes) present in the wastewater being treated. These are best determined by adsorption (isotherm) tests on actual wastewater samples.

4.5.3 Chemical Decolorization

A simpler method for removing or reducing residual color from textile industry treated effluent is treatment with strong oxidizing agents. Decolorization by chemical oxidation only requires a chemical solution metering system and is easier to install and operate. In many cases, chlorination using sodium or calcium hypochlorite solution will suffice to reduce color to attain compliance. Alternatively, hydrogen peroxide may also be used. The effectiveness of these oxidizing agents and their optimal dosages are best determined by jar tests on the actual effluent to be treated.

5 AIR POLLUTION, NOISE, VIBRATION AND SOLID WASTE DISPOSAL

5.1 Air Pollution

Gaseous emissions generated by textile industry can be categorized as ;
1) Emissions released from boiler / stacks.
The gaseous emission released from boilers / stacks with inadequate height may cause problems of stagnating the emissions in the lower levels. The bio mass boilers used for heat production may generate bottom ash and fly ash which may cause health hazards and nuisance if they are not properly disposed of in an environmentally friendly manner.

2) Vapours from organic solvents by printing & dyeing processes, and dust & fibre released from dry processes may have adverse effects on the health of the factory workers due to inadequate ventilation.

These pollution problems could be mitigated by relatively simple measures and by maintenance of equipments and good housekeeping practises.

The exposure to dust and vapour can be reduced by installation of better ventilation and suction equipment in the dyeing and printing sections. The ventilated air should be treated by dust collectors before emission into the air. The gases, collected by the suction equipment should be treated by wet scrubbers, and subsequently be emitted into the air by a stack of sufficient height.

It is adopted as a general rule for that the stack height shall not be less than 20 meters except for the combustion sources with gross heat input less than 0.620MW.

5.2 Noise & Vibration Pollution

Excessive noise and vibration generated from machineries in the spinning & weaving sections may affect the workers health causing hearing problems. Noise problems could be solved by modernizing the machinery, installation of vibrating machinery on ....and enclosing certain areas by sound proof materials.
At the initial stage during siting the industrial activity, noise generating activities can be arranged considering the likely impacts to workers as well as neighbouring areas.

Also the workers should be provided with protective equipments for the improvement of occupational safety &health.

5.3 Solid Waste disposal

Solid waste generated from textile industry is basically fabrics and their accessories, food waste, paper, polythene & plastic may be generated from various activities associated with the production process.

The solid waste originate from spinning and weaving processes are called "cotton waste", which consist of pieces of yarn and cloth. Generally the cotton waste is graded in the mill. The cotton waste with little dust is sold for domestic purposes. Considerable quantities of packing materials such as cardboard, polythene etc. may originate from the textile mills as solid waste.

Incineration of solid waste (i.e cotton waste with dust and packing materials) is normally practised in the textile mills. In some textile mills these solid wastes together with firewood or saw dust are used in fire wood boilers.However it is not suggestible in using it for open burnt because it could generate nuisance to the surroundings. Some artificial fiber is made from chemicals such as polyester, which incineration causes toxic gases, carbon monoxide, chlorine, etc. The table below lists major artificial fibers and toxics generated.

Name of artificial fiber	Possible toxics generated
Cellulose	Carbon monoxide, methane, acetaldehyde
Rayon	Carbon monoxide, methane
Polyester	Carbon monoxide, methane, ethylene, acetylene
Nylon	Carbon monoxide, methane, Ammonia
Acrylic	Carbon monoxide, methane, Ammonia, hydrogen cyanide
Vinylon	Carbon monoxide, methane, acetaldehyde, benzene

Textile sludge, which will be generated in the wastewater treatment process, may have a variable composition and normally contains high organic matter, N, P, K and micronutrients. Additionally, dyes, heavy metals and pathogenic microorganisms may also present.

In many textile and garment factories the solid wastes are collected by private contractors in order to be disposed of at official disposal sites, operated and controlled by the Authorities. The local authorities are responsible for collection and disposal of solid waste in their jurisdiction area. Therefore the solid waste are collected by the municipal services or brought by the house holds to temporary collection sites. These waste could be disposed off as municipal waste or the usable items could be reused or recycled.

It is responsible for textile factories to make proper contract with private waste collector/dispose firms. Details on waste collection and disposal rules shall be clarified through municipal council, urban council or from Pradeshiya Sabha.

Recycling or reusing of remnant is also suggestible. It will be secondly used for quilting for construction, transportation of materials, heat-retention or cold storage.

5.3.1. Chemical Waste

Large variety of chemicals such as solvents, dyes, pigments etc. are used in textile processing industry. Therefore special attention should be paid in handling , storage and disposing of such chemical and chemical contaminated waste. The wastewater treatment plant sludge which is contaminated with chemicals may dried to reduce the volume and could be stored in a separate storage area with a cemented floor,

6. WASTE MANAGEMENT & CLEANER PRODUCTION

6.1 Introduction

Waste management in industrial activities aims environmentally sustainable management. It could contribute to both reducing pollution and saving operation cost from viewpoints of considering production and or wastewater treatment processes. This concept also targets more efficient production methods by saving energy and raw materials and reducing emissions to air, water and soil.

Additional advantages of the application of cleaner production processes are the reduction of safety hazards and the improvement of occupational health. Therefore, initial investments aimed at pollution control become more cost effective.

The production of waste from the textile processing operations can be prevented or reduced by numerous different measures. It is mainly suggested to contribute “waste minimization”, “energy saving” and “substitution to least pollution materials”.

6.2 Waste Minimization

Waste minimization could be by control of volume of raw materials and/or consumption of water, e.g., recovery / reuse of materials, etc.

- **Recovery of sizing agents**
  Recovery of Carboxy Methyl Cellulose (CMC), a synthetic sizing agent from spent sizing solutions is carried out successfully in textile processing plants.
  Recovery of glucose from wastewater from starch desizing may also be a possibility to reduce the organic waste load from textile processing.

- **Reduction of the water use**
  The water use for washing, as carried out after various process steps, can be reduced by applying counter current washing. ln this process less polluted washing waters are re-used for washing. The use of water for dyeing and printing can be reduced by modifying the processes to some extent.

- **Reduce use of chemicals for dyeing and printing**
  The use of dyeing and printing chemicals can be reduced by various methods for process optimization, e.g. reduction of the dye bath volume and application of computerized systems for mixing and addition. Dye stuffs and printing pastes can be reused in some cases (only for dark colours).

6.3 Substitution of Materials

Such measures include replacement of toxic process chemicals by less harmful chemicals, process modifications and good housekeeping practices.

- Replacement of hypochlorite by hydrogen peroxide
  Hypochlorite (NaOCI) used for bleaching, can be replaced by hydrogen peroxide (H2O2) for most bleaching operations. Hypochlorite has to be used only when a very high degree of whiteness is required and for bleaching of some types of artificial fibres.

- Use of synthetic detergents instead of soaps
  The organic waste load from textile processing can be reduced significantly by using synthetic detergents instead of natural oil based soaps. The use of synthetic detergents is now applied widely in the textile industry.

- Substitution of toxic carriers
  ln a number of dyeing techniques carriers have to be used in order to establish an adequate dye uptake by the cloth. Most carriers are complex organic compounds, including black listed substances, such as di- and trichlorobenzene. Usually mixtures of different carriers are applied. Most carriers are hard to biodegrade and toxic to some extent.

6.4 Energy Saving

Large amounts of energy, including electricity and fuel oil for steam production, are used in textile mills. There are numerous possibilities to reduce energy consumption, including intensive control of electricity consumption (good housekeeping) and heat recovery from the boilers for steam production

6.5 Cleaner Production

Cleaner production is a preventive, company-specific environmental protection initiative which intends to minimize waste and emissions and maximize product output.

By analyzing the flow of materials and energy in a company, options could be identified to minimize waste and emissions out of industrial processes through source reduction strategies. Improvements of organization and technology can be suggested for better choices in use of materials and energy, and to avoid waste, waste water generation, and gaseous emissions, and also waste heat and noise.

In a textile industry followings options can be incorporated in to the process to encourage cleaner production:

- Process Optimization
  - Reduce Liquor Ratio (in Jigger / Vats)
  - Change from Overflow Rinsing
    - Batch or Stepwise Rinsing
    - Continuous Counter current Rinsing
  - Replace Chlorinated Solvent Carriers
  - Use hot Water for Rinsing
  - Improve Hydro extractors (Spin Dryers)
- Substitution
  - Biodegradable Detergents
  - High Fixation Efficiency and Non-Toxic Dyestuff
  - Mineral instead of Organic Acids
  - Hydrogen Peroxide instead of Chlorine Products
- Recycling and Re-Use
  - LAST Rinse as FIRST Rinse in Next Batch
  - Re-USE of Alkali (Mercerization) after Filtration
- Cleaner Technology
  - Continuous Rinsing instead of Batch Rinsing
  - Computerized Color Matching

7. DISCHARGE AND EMISSIONS STANDARDS

Refer to Appendix

8. REFERENCES

Appendix A: Typical Harmful parameters

a) *Colour-* Colour is an important measurement for aesthetic purposes affecting the appearance and taste of the water. Colour in water may result from coloured organic substances or natural metallic ions such as iron, manganese and copper. Colour causing organic substances are of particular concern due to their potential for disinfection by-product formation when they are combined with chlorine.

For industrial manufacturing, largely pulp and paper and textile industries, colour is often measured in the wastewater for removal purposes and effluent monitoring. Dyes and coloured organic substances are used extensively to add colour to various different substrates in the manufacturing process. The wastewater stream from these processes can contain a high level of colour which, if discharged untreated, can cause environmental problems, problems for downstream drinking water facilities, or wastewater treatment issues for wastes discharged to the sewer system.

b) *pH* - Most biochemical reactions that maintain life or promote growth whether in unicellular organisms or more complex life forms are pH dependent. For unicellular organisms, the pH of the surrounding environment has an immediate and direct effect on the intracellular reactions. Most microorganisms can survive only within a narrow pH range. For higher life forms such as fishes and aquatic plants, a wider pH range is acceptable, but pH condition below 6.8 or above 8.4 can be lethal. Fishes and other motile life forms may have sufficient mobility to avoid such non-neutral water conditions, but for aquatic plants the non-neutral pH conditions are fatal. In any case, non-neutral waters are not suitable for the propagation of fishes and other aquatic resources.

c) *Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) –* Biochemical oxygen demand (BOD) is a measure of the oxygen required by microorganisms to decompose and stabilize the organic (and biodegradable) matter in the water sample, through biochemical reactions. Organic matter is usually not toxic or harmful in itself. It can serve as food directly for some higher life forms and types of organisms, and a wide variety of microorganisms.

Microorganisms naturally present in water decompose organic matter. In the course of decomposing the organic matter, the aerobic bacteria (those requiring the presence of oxygen to survive) need oxygen to "burn" the food. They obtain this oxygen from that dissolved in the water. The dissolved oxygen concentration then falls below a level that fishes need to survive and the fishes are killed by asphyxiation. A high Biochemical *Oxygen Demand* causes a rapid decrease in the dissolved oxygen (D.O.) levels to the point where fish kills can occur due to lack of oxygen.

d) *Turbidity and Suspended Solids* - Turbidity is also a measure of the interference to the transmission of light through water. It is caused by the presence of fine solids that remain suspended in the water. The effect of turbidity is similar to that of color in inhibiting photosynthesis. The presence of suspended solids causes turbidity.

Suspended solids have another effect distinct from turbidity. The insoluble solids may settle to the bottom of the receiving water body. The settled solids may decompose, and change the ecological balance at the bottom, or they may cover the bottom to the extent of preventing photosynthetic activity by plants at the bottom or prevent access to the bottom biota by the bottom grazing fishes.

e) *Chlorination* - Chlorine or chlorination agents are used by many wastewater treatment plants in order to disinfect effluent prior to its discharge into the receiving environment. Effluent wastewaters are disinfected to protect downstream municipal water supplies, recreational waters and shellfish-growing areas from bacterial contamination and other agents causing waterborne disease.

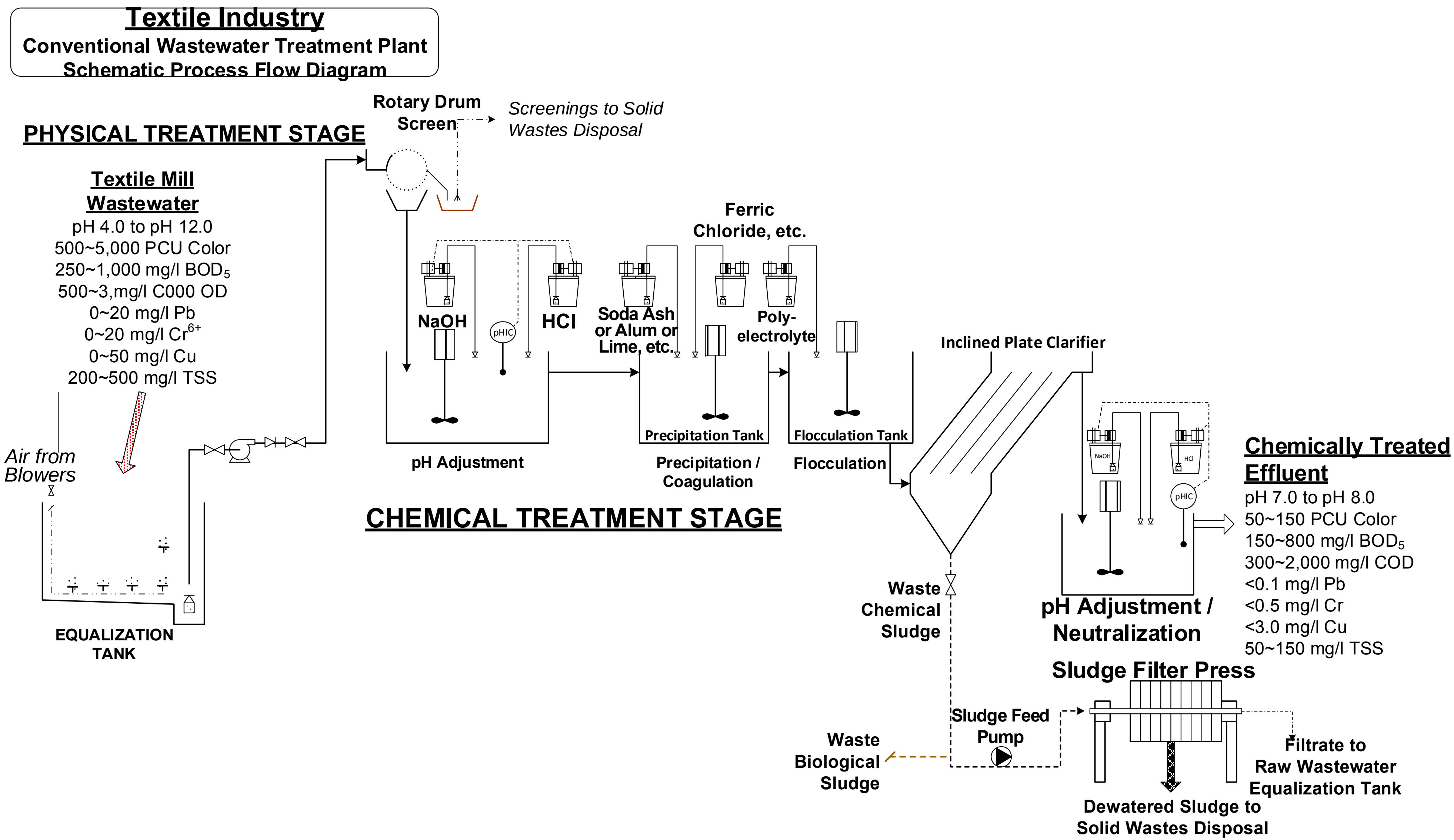
f) *Heavy metals (Pb, Cr and Cu)*–Those heavy metal pollution from textile industries will be by dyeing ,contained in paintings, e.g.

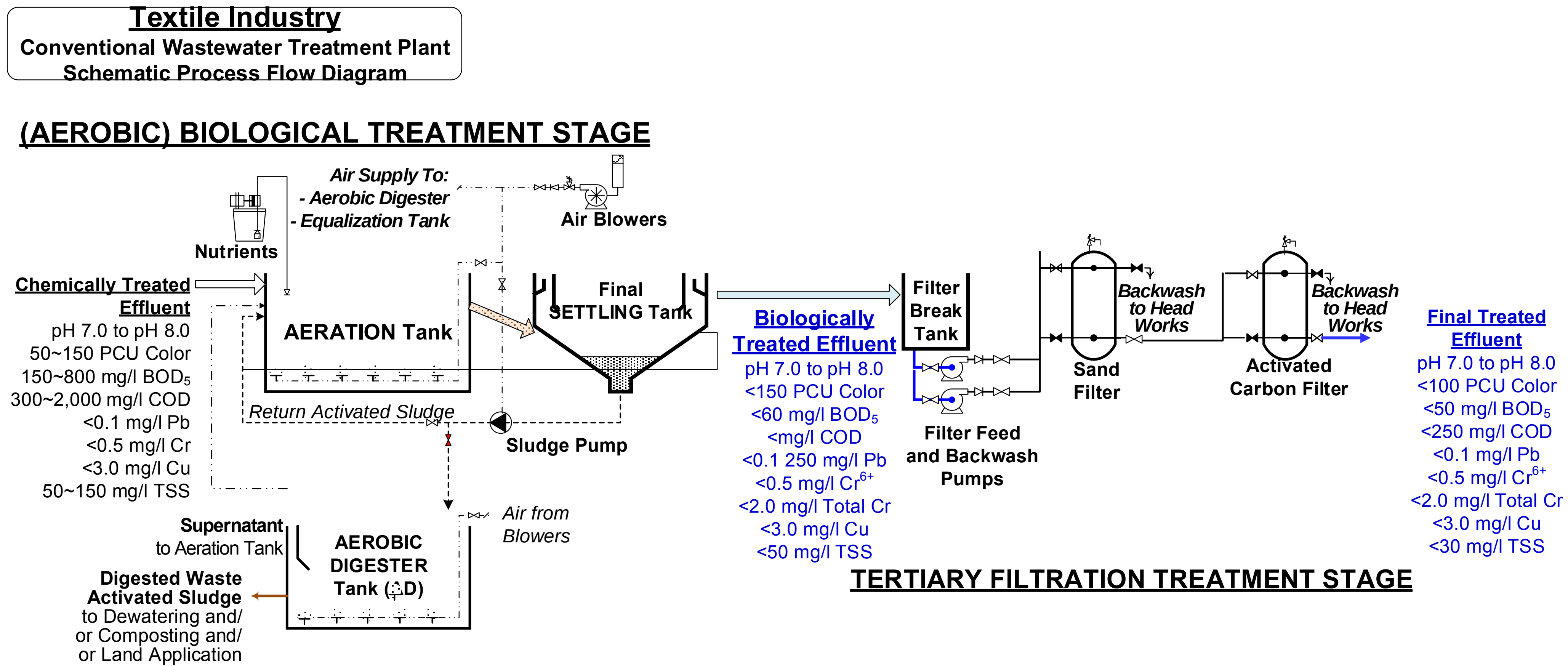
Lead is a nonessentialelement and is potentially hazardous to most forms of life and can be bio-accumulated bybenthic bacteria, fresh water plants, invertebrates and fish. Enhanced levels of lead can lead to thedisruption of the biosynthesis of hemoglobin and anemia, a rise in blood pressure, kidney damage.

Chromium is a transition element of sub-group VIA, and it can assume the oxidation states 0(chromium hexa-carbonyl) and I to VI. The most critical health problem could be affected by chromium hexavalent (Cr^{6+}) which causes irritation to thenose, stomach upsets and ulcers,skin ulcers, etc.

Cupper is one of the essential nutrients, while high doses can cause stomachand intestinal pain, damages the liver and kidney, or cause anemia. In contain of copper could degrade taste of drinking water.

Appendix:**Schematic Process Flow Diagram of Conventional Wastewater Treatment Plant for Textile Industry Wastewater**




Textile Industry
Conventional Wastewater Treatment Plant
Schematic Process Flow Diagram
(AEROBIC) BIOLOGICAL TREATMENT STAGE
Air Supply To:
- Aerobic Digester
- Equalization Tank
Air Blowers
Nutrients
Chemically Treated Effluent
pH 7.0 to pH 8.0
50~150 PCU Color
150~800 mg/l BOD_5
300~2,000 mg/l COD
<0.1 mg/l Pb
<0.5 mg/l Cr
<3.0 mg/l Cu
50~150 mg/l TSS
AERATION Tank
Final SETTLING Tank
Return Activated Sludge
Sludge Pump
Biologically Treated Effluent
pH 7.0 to pH 8.0
<150 PCU Color
<60 mg/l BOD_5
<mg/l COD
<0.1 250 mg/l Pb
<0.5 mg/l Cr^{6+}
<2.0 mg/l Total Cr
<3.0 mg/l Cu
<50 mg/l TSS
Filter Break Tank
Filter Feed and Backwash Pumps
Sand Filter
Backwash to Head Works
Activated Carbon Filter
Backwash to Head Works
Final Treated Effluent
pH 7.0 to pH 8.0
<100 PCU Color
<50 mg/l BOD_5
<250 mg/l COD
<0.1 mg/l Pb
<0.5 mg/l Cr^{6+}
<2.0 mg/l Total Cr
<3.0 mg/l Cu
<30 mg/l TSS
TERTIARY FILTRATION TREATMENT STAGE
Supernatant to Aeration Tank
AEROBIC DIGESTER Tank (AD)
Air from Blowers
Digested Waste Activated Sludge to Dewatering and/ or Composting and/ or Land Application

付属資料 23　セクターガイドライン（屠殺事業）

Industrial Pollution Control Guidelines
SLAUGHTERHOUSE and MEAT PACKING INDUSTRY

Table of Contents

1. INTRODUCTION

1.1 Rationale

This industrial (water) pollution control guideline for the slaughterhouse and meat packing industry was prepared under the Project for Monitoring of the Water Quality of Major Water Bodies in the Democratic Socialist Republic of Sri Lanka to enhance the enforcement capacity of environmental officers of the Central Environment Authority (CEA) by providing industry specific technical information on (water) pollution sources, characteristics, and treatment methods in the slaughterhouse and meat packing industry.

1.2 Livestock Industry

Industry Sector Contribution to Sri Lanka Economy
Value of Industry Sector Output
% Share of GDP (Gross Domestic Product)
Employment Generated (Direct and Indirect)

1.3 Slaughterhouses

Number and size or capacity of slaughterhouses
Range of sizes and/or scale

2. SLAUGHTERHOUSE AND MEAT PACKING OPERATIONS

The following descriptions apply to mechanized, line-type slaughterhouse (or abattoir) and meat packing operations. They do not apply to manual or booth type slaughterhouse and meat packing operations.

2.1 Slaughtering

2.1.1 Reception and Lairage

Live hogs (pigs) are received and may be temporarily kept at the lairage (holding and resting area before slaughtering). The lairage may be provided with slotted floors through which solid and liquid waste as well as wash water pass into a digester pit. The hogs are washed in the reception area or lairage prior to further processing. Delivery trucks or vans may also be washed in the reception area or at a separate place.

Water used to wash the hogs (and trucks) and liquid animal wastes constitute the main wastewater stream from the reception and/or lairage area. The lairage pit may also be a source of wastewater. The wastewater from this area contains solid animal wastes, feed stuff, mud, and dirt. The suspended solids and organic matter (measured as BOD and COD) contents of this wastewater stream is high due to the presence of animal wastes.

2.1.2 Stunning and Sticking

Slaughtering starts with stunning of the hogs (to avoid disruptive behavior among others). The stunned hogs are then hooked up to shackles of a conveyor system or a hoist followed by sticking and bleeding to drain the blood. Blood is collected and processed into blood meal.

The stunning and bleeding area is usually washed only at the start and end of the slaughterhouse operations. The wastewater from the stunning and bleeding area contains blood, feeds, and dirt.

2.1.3 Scalding and Dehairing

The carcass (of the pig) is then scalded in a hot water bath to loosen the hair before it passes through the dehairing machine. After dehairing, the carcass may be singed with blow torches and polished to remove any remaining fine hair.

Wastewater from the scalding and dehairing area comes from overflow from the scalding tanks, water dragged out with the carcass, and spray water from the dehairing machines. It contains hair, blood, and pieces of meat.

2.1.4 Evisceration

The carcass is then slit open for evisceration. The offal and internal organs are removed from the carcass for separate processing. The carcass is then washed, ready for release to customers or for further processing in the meat packing plant. If refrigeration is needed, the carcass may be rapidly cooled (blast chilling) prior to storage in freezers before shipment to customers.

Wastewater from the evisceration area comes from water used to wash the carcass. It contains hair, blood, and pieces of meat.

2.2 Meat Packing

2.2.1 Meat Packing

If the carcass is not shipped to customers as whole or half carcass, the bones are removed and the carcass is carved into specific meat cuts, washed as needed, then packed, and placed in cold storage, ready to shipment to customers.

Wastewater from the meat packing area comes from washing of the cut meat and general cleaning for sanitation to maintain hygienic conditions.

2.2.2 Offal Processing

The offal is segregated into white and red offal and washed, processed, and stored separately. Paunch manure is removed and dumped into a pit or digester. The liver, kidney, heart, and other valuable parts are also washed and packed prior to cold storage and sale.

Wastewater from the offal processing and packing area comes from washing of the cut meat and general cleaning for sanitation to maintain hygienic conditions.

3. WASTE GENERATION

3.1 Wastewater

3.1.1 Wastewater Sources

The wastewater sources in a slaughterhouse and meat packing plant are the following:

a. Reception, Lairage, and Truck Washing Areas (*Please refer to Figure 1, below*) and Desludging of Pit under Lairage

b. Mechanized Slaughterhouse and Meat Packing Plant, combined wastewater streams from the following sections or stages (*Please refer to Figure 1, below*):
   - Hanging, Stunning, and Sticking Section (*Please refer to Figure 1, below*)
   - Scalding, Dehairing, and Singeing Section (*Please refer to Figure 1, below*)
   - Evisceration and Dressing Section (*Please refer to Figure 1, below*)
   - Splitting, Washing, Carving / Cutting / Deboning, Weighing, Grading, and Packing Section of the Meat Packing and Offal Processing Lines (*Please refer also to Figure 2 and Figure 3, below*).

c. Blowdown from the following:
   - Cooling Tower (for air conditioning and refrigeration)
   - Boiler (for steam and hot water supply)
   - Water (Supply) Treatment Plant

d. (Biological and Chemical) Laboratory

e. Cleaning and sanitation of processing facilities, utensils, tools, and equipment before and after production run.

Wastewater streams from the reception, lairage, and truck washing areas, the slaughterhouse and meat packing plant, and the laboratories are combined before conveyance to the wastewater or effluent treatment plant.

Blowdown from the cooling towers, boilers, and water supply treatment plant are usually deemed clean enough to comply with the discharge standards; hence, these streams are not treated.

Figure 1 Schematic Process Flow Diagram of Slaughtering

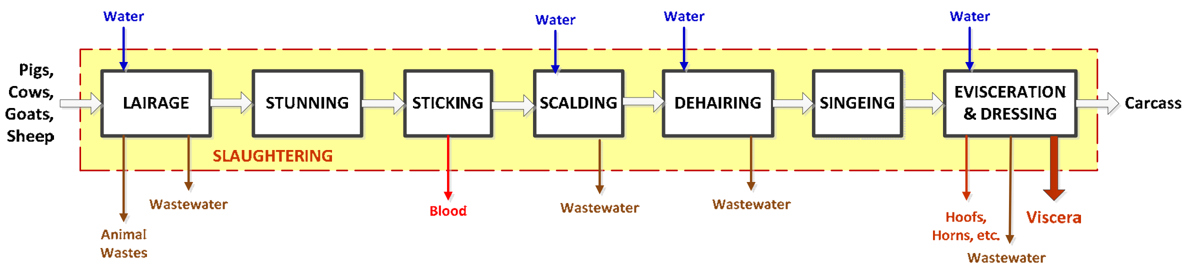


Figure 2 Schematic Process Flow Diagram of Meat Packing

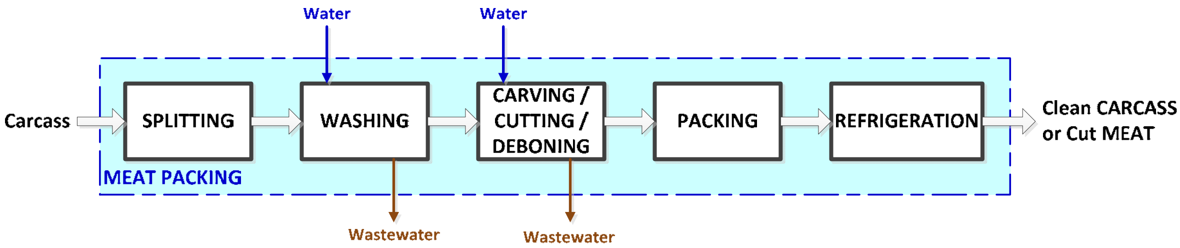
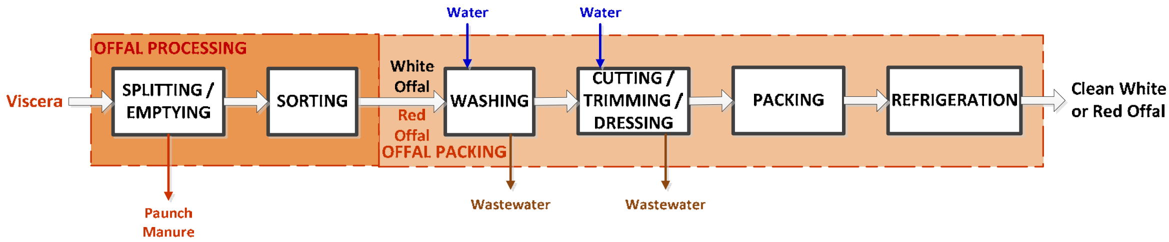


Figure 3 Schematic Process Flow Diagram of Offal Processing



3.1.2 Wastewater Characteristics

N.B. The following data on the characteristics of wastewater from slaughterhouse and meat packing are derived from Philippine (hog or pig) livestock industry. The data have to be validated to determine if they are applicable to the Sri Lanka livestock industry.

Table 1 Specific Wastewater Generation Rates

- **Quantity:**
  - **Average:** **390 Liters per Head (mostly Hogs)**
  - **Maximum:** **1,300 Liters per Head (mostly Cows)**
  - **Minimum:** **230 Liters per Head (mostly Hogs)**
  - **Benchmark:** **200 Liters per Head (mostly Hogs)**
- **Quality:**
  - **Average:** **1,500 gm BOD_5 per Head (mostly Hogs)**
  - **Maximum:** **2,700 gm BOD_5 per Head (mostly Cows)**
  - **Minimum:** **700 gm BOD_5 per Head (mostly Hogs)**
  - **Benchmark:** **200 Liters per Head (mostly Hogs)**

Table 2 Significant Pollution Parameters in Slaughterhouse and Meat Packing Operations

- **pH**
- **5-day Biochemical Oxygen Demand (BOD_5)**
- **Chemical Oxygen Demand (COD)**
- **Total Suspended Solids (TSS)**
- **Oil & Grease**
- **Fecal Coliform**

3.1.3 Effects of Water Pollution

Water pollution is any change in the water that makes it unsuitable for its intended use. A *pollutant* is, therefore, any agent that causes undesirable change. *Wastewater* is any water that is contaminated or polluted so that it is no longer suitable for its intended purpose, be it for drinking, swimming, washing, raising of fishes, or any other legitimate purpose.

Water pollution affects us in many ways. The harmful effects of the various forms of water pollution include:

a) *pH* - Most biochemical reactions that maintain life or promote growth whether in unicellular organisms or more complex life forms are pH dependent. For unicellular organisms, the pH of the surrounding environment has an immediate and direct effect on the intracellular reactions. Most microorganisms can survive only within a narrow pH range. For higher life forms such as fishes and aquatic plants, a wider pH range is acceptable, but pH condition below 6.8 or above 8.4 can be lethal. Fishes and other motile life forms may have sufficient mobility to avoid such non-neutral water conditions, but for aquatic plants the non-neutral pH conditions are fatal. In any case, non-neutral waters are not suitable for the propagation of fishes and other aquatic resources.

b) *Biochemical Oxygen Demand (BOD)* and *Chemical Oxygen Demand (COD)* – Biochemical oxygen demand (BOD) is a measure of the oxygen required by microorganisms to decompose and stabilize the organic (and biodegradable) matter in the water sample, through biochemical reactions. Organic matter is usually not toxic or harmful in itself. It can serve as food directly for some higher life forms and types of organisms, and a wide variety of microorganisms.

   Microorganisms naturally present in water decompose organic matter. In the course of decomposing the organic matter, the aerobic bacteria (those requiring the presence of oxygen to survive) need oxygen to "burn" the food. They obtain this oxygen from that dissolved in the water. The dissolved oxygen concentration then falls below a level that fishes need to survive and the fishes are killed by asphyxiation. A high Biochemical *Oxygen Demand* causes a rapid decrease in the dissolved oxygen (D.O.) levels to the point where fish kills can occur due to lack of oxygen.

c) *Turbidity* and *Suspended Solids* - Turbidity is also a measure of the interference to the transmission of light through water. It is caused by the presence of fine solids that remain suspended in the water. The effect of turbidity is similar to that of color in inhibiting photosynthesis. The presence of suspended solids causes turbidity.

   Suspended solids have another effect distinct from turbidity. The insoluble solids may settle to the bottom of the receiving water body. The settled solids may decompose, and change the ecological balance at the bottom, or they may cover the bottom to the extent of preventing photosynthetic activity by plants at the bottom or prevent access to the bottom biota by the bottom grazing fishes.

d) *Oil and Grease* – Fats, oil, and grease (FOG) can coat the cell walls and surfaces of plants and animals. In excessive amounts such as in oil spills, the coating of oil can kill fishes and birds. At much lower concentrations, fats, oil, and grease cause the formation of grease mud balls which do not settle.. In biological wastewater treatment, such as in activated sludge treatment systems, oily or greasy substances tend to coat the activated sludge flocs, limiting the diffusion of oxygen, enzymes, and food into the cells and upsetting and inhibiting the treatment process.

e) *Total and Fecal Coliforms* - Wastes from human and/or animal origin may also contain pathogens (disease causing organisms including those causing cholera, polio, typhoid, and hepatitis) from people who are sick and/or carriers of disease. It is necessary to destroy these pathogens or render them inactive so that they will not cause infections and spread diseases on those exposed to wastewater (or sewage) contaminated with these pathogens.

   Coliform (total and/or fecal) counts are used as indicators of contamination of water with wastes from human or animal origin and potential presence of pathogens. While most coliforms are not pathogenic, they are present in very large numbers in human and animal wastes and are easier to detect. In contrast, it is more difficult and expensive to detect the presence and determine the quantity of each potential pathogen in water, which are far fewer in number. Hence, coliforms are used as "*indicators*" of contamination by human and/or animal wastes and potential presence of pathogens.

3.2 Gaseous Emissions

3.3 Solid Wastes

4. WASTE MANAGEMENT

4.1 Waste Minimization

- **Re-Use Treated Effluent for Washing:**
  - **Trucks and Crates**
  - **Livestock and Lairage**
- **Optimize Scalding Water Temperature**
- **Use High Pressure Washers for Cleaning**
- **Use Trays and Suitable Containers for:**
  - **Collection of Blood**
  - **Transport of Carcass, Viscera, Offal**
- **Provide Workers with Continuing Training and Skills Enhancement**

4.2 Cleaner Production

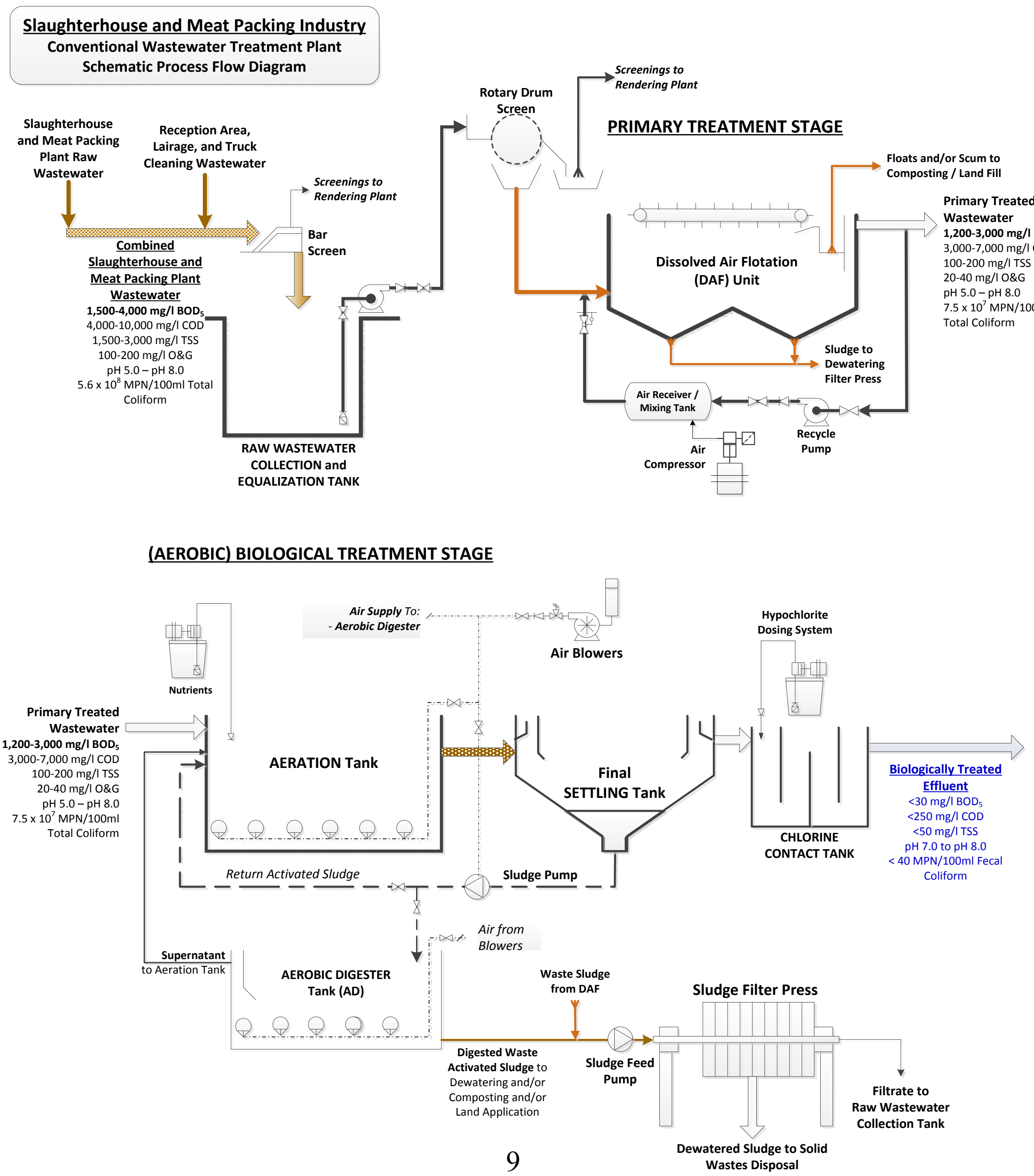
4.3 Green Productivity

5. WASTEWATER TREATMENT

5.1 Introduction

The contaminants in wastewater from slaughterhouse and meat packing industry are mainly organic matter amenable to biological treatment processes. The slaughterhouse and meat packing wastewater also contains solids and oil & grease which can interfere with or inhibit biological treatment. The slaughterhouse and meat packing wastewater needs to undergo primary treatment to ensure effective biological treatment that will produce effluents complying with the standards for discharge of industrial effluents. The schematic process flow diagram shown in *Figure 4,below* shows a range of conventional treatment processes suitable for slaughterhouse and meat packing and packing industry wastewater.

Figure 4 Conventional Treatment Plant for Slaughterhouse and Meat Packing Industry Wastewater



5.2 Physical Treatment Processes

Physical treatment processes rely on physical properties of contaminants to effect treatment. Physical treatment processes are best suited for the removal of discrete solids from water because they are effective and very economical, especially in terms of cost per unit quantity of pollutant removed.

5.2.1 Flow Equalization

Slaughterhouse and meat packing plants typically start operations at night and finish in the early morning so that the carcasses and packed meat products can be brought to the market or sales outlet in the early morning. During the day time, operation is minimal if at all. If it is desired to size and operate the wastewater or effluent treatment plant on a 24 hour per day basis, it is necessary to retain in a retention or equalization tank the wastewater generated during the shorter operating hours. This will allow the wastewater to be fed to wastewater or effluent treatment plant at the 24 hour average daily flow rate. This arrangement will reduce the sizes of the treatment units. If a retention or equalization tank is not feasible, the treatment units should be sized in accordance with the peak or pump flow rate.

The working capacity of the retention or equalization tank may be determined from the instantaneous flow rates and flow patterns. In the absence of reliable, actual flow rate data, the working capacity of the equalization tank should be equal to the average daily flow rate, if feasible, or at least 80% of the average daily flow rate.

Due to the high concentration of organic matter, fats, oil, & grease, and the presence of suspended organic matter solids, the retention or equalization tank is usually aerated to minimize putrefaction of the organic pollutants which causes odor problems. Aeration also serves to mix the contents of the equalization tank to attain uniform conditions.

5.2.2 Screening

Although the dehairing equipment is provided with screens to capture most of the feathers and large solids prior to discharge, the slaughterhouse and meat packing plant wastewater may still contain fine hair, (paunch) manure, undigested feeds, bits of meat, and other solids. These suspended solids may interfere with the operation or function of downstream treatment units or increase the pollution load. Of special concern are the hair and bits of skin and meat which tend to form strings which wrap around equipment. Rotary drum screens are the most appropriate type even though mesh type screen have higher capture efficiency. Rotary drum screens are less prone to blinding or plugging from strings and are self-cleaning. Alternatively, static hyperbolic screens with slotted openings are also reasonably effective and more resistant to blinding than mesh screens. Unlike rotary drum screens, static screens are not self-cleaning and thus, need to be manually scraped for effective removal of screened solids. Screenings from slaughterhouse and meat packing wastewater are best processed in a rendering plant to recover the fat and protein value of the screened solids.

As a safety precaution, the raw wastewater canal should be provided with bar screens to remove large solids such as hoofs and horns which may inadvertently be dumped in the wastewater drainage system.

The size of screening equipment is based on the flow rate, size of openings, and solids load. The effectiveness or degree of removal of solids is also dependent on these factors and varies considerably from less than 30% to more than 70%.

5.2.3 Flotation (Oil and Grease Removal)

The use of hot water for scalding extracts some amount of fats to the extent that the fat content in the wastewater may inhibit biological treatment processes. For slaughterhouse and meat packing wastewater, dissolved air flotation (DAF) is required to effectively remove fats, fine hair, and other solids not caught by screening to a level that is no longer inhibitory to biological treatment processes. Other forms of flotation (plain or induced by fine air bubbles) may be inadequate in lowering the concentration of fats, oil, and grease (FOG) to a level that is no longer inhibitory to biological treatment processes. Aside from the conventional method of dissolving compressed air in recirculated clarified water, dissolved air mixture may be formed by cavitation. Cavitation air flotation simplifies the dissolved air system by replacing the recirculation pump, air compressor, air-water mixing tank, and pressure reducing and flow control valves with a single mixer-like cavitation air flotation unit.

Flotation systems typically include dosing of coagulating agents to promote agglomeration of the fats, feathers, and suspended solids into flocs. The size of the flotation area is dependent on the instantaneous feed flow rate which is usually the pump flow rate and rise rate of the solids. The rise rate of flocs in DAF systems is typically 3-5 m/hr. Flotation can remove more than 80% of suspended solids and approximately 30-50% of BOD.

5.3 Biological Treatment Processes

5.3.1 Activated Sludge Process

Biological treatment processes make use of living organisms (mostly microorganisms) to effect treatment. The *activated sludge* treatment process is an aerobic, suspended-growth system. It is, by far, the most common biological treatment process because of its high BOD reduction efficiency, stability, reliability, and ease of operation.

The activated sludge treatment process consists of an aeration tank and a (final or secondary) settling tank. Wastewater flows into the aeration tank where biologically active sludge recycled from the (final or secondary) settling tank is mixed with the influent wastewater. The activated sludge microorganisms consume the organic pollutants (measured as BOD_5) which serve as their food or substrate, and convert them to harmless carbon dioxide, water, and additional cell mass. An aeration system provides the oxygen required for the degradation of the organic pollutants and the mixing energy to keep the activated sludge flocs in suspension.

Activated sludge treatment process can reduce BOD by 90-95%, suspended solids by 80-90%, and oil by 50-80%.

While many factors affect the performance of an activated sludge treatment system, one of the most important is the ratio of food (BOD) to microorganism or food to mass (F:M) ratio. A food to mass (F:M) ratio of 0.05 – 0.15 kg BOD5/day/kg microorganisms will consistently produce treated effluent BOD_5 concentrations below 20 - 30 mg/l and effluent suspended solids concentrations below 30 – 50 mg/l.

5.3.2 Alternative Aerobic Biological Treatment Processes

Alternative aerobic biological treatment processes include sequencing batch reactors (SBR), trickling filters, rotating biological contactors (RBC), and membrane bioreactors (MBR).

Sequencing batch reactors (SBR) are a variation of the conventional activated sludge system. Treatment takes place in a single tank, unlike the two-tank arrangement of the conventional activated sludge system. Treatment is undertaken in batches going through the different stages of filling, aeration / reaction, settling or solids separation, and discharge or decanting of the treated effluent. Provisions have to be made to accommodate the influent wastewater during the different stages (except filling). In most cases, a holding or equalization tank is used or a twin tank arrangement is provided wherein one tank cycles through the treatment while the other reactor tank accumulates the influent raw wastewater. SBRs attain similar treatment efficiencies as activated sludge treatment plants. Although they can be operated manually, SBRs usually require automation and motorized or pneumatically operated valves. SBRs consume more energy than activated sludge treatment plants of the same capacity.

Trickling filters are a form of attached growth or fixed film biological treatment systems. In fixed film processes, microorganisms that consume the organic material (food or BOD) grow as *slime* on fixed media. As the wastewater flows over the slime or biomass, (soluble) organic wastes are adsorbed and consumed by the microorganisms. Oxygen from air diffuses through the thin layer of wastewater to the microorganisms. As the slime layer builds up, clumps slough off or detach from the media. The material that sloughs off, called *humus*, flows with the wastewater and is separated from the treated wastewater in the secondary clarifier or settling tank. The main advantage of trickling filters (and other fixed film treatment systems) is their low operating costs.

Rotating biological contactors (RBC) are another type of attached growth biological treatment with low operating energy consumption. In contrast to trickling filters where the media do not move, the media in RBCs are disc-like and rotate around a shaft. The rotation alternately exposes the slime layer to the food (organic wastes) when submerged and oxygen when exposed to the air to effect treatment.

It is important to note that attached growth treatment processes, such as trickling filters are more effective on soluble organic pollutants and less so on particulate or suspended solid pollutants. For this reason, trickling filters need primary clarifiers or similar pre-treatment units to be effective. The presence of hair, skin, meat, and other solids which can form strings in the wastewater from the slaughterhouse and meat packing industry can contribute to clogging of the trickling filter media or the RBC discs. Properly sized and operated, attached growth treatment systems can attain

BOD reduction efficiencies of 80-90%. The suspended solids concentrations of the treated effluent of attached growth treatment processes like trickling filters are often higher than those of the effluent of suspended growth treatment processes like activated sludge process.

Membrane bioreactors (MBR) are aerobic, suspended growth treatment systems similar to activated sludge treatment plants where the secondary clarifier or settling tank is replaced with a (semi-permeable) membrane such as ultrafiltration or microfiltration membranes which are usually installed in the aeration tank. This system eliminates the secondary settling tank resulting in a more compact system. The membrane is also several times more effective in removing suspended solids (mainly the activated sludge flocs) than settling tanks to produce very low suspended solids concentrations in the effluent. The membrane system also allows the retention of higher concentrations of biomass or activated sludge, further improving BOD reduction efficiencies.

MBRs can produce effluents with less than 10 mg/l BOD_5 and less than 10 mg/l TSS (total suspended solids). As such, the treated effluent of MBRs may be suitable to re-use in washing crates and trucks and the reception area.

The membranes in MBRs are sensitive to plugging by stringy solids such as those present in wastewater from the slaughterhouse and meat packing industry. Hence, effective primary treatment to remove suspended solids is necessary if MBRs are to be used in treating wastewater from the slaughterhouse and meat packing industry.

The membranes in MBRs are sensitive to fouling from mineral and biological deposits which reduce flux and increases the pressure required to maintain the desired flux. This results in higher energy requirements to operate and the need for frequent cleaning. As a result, MBRs are more costly operate than the more conventional biological treatment systems as well as being more costly to construct.

5.3.3 Anaerobic Treatment

Anaerobic treatment is generally applied on high BOD strength wastewater and organic sludges. Anaerobic processes take place in the absence of oxygen. In biochemical reactions, oxygen generally acts as electron receptor in the process of extracting energy from the organic material. In the absence of free oxygen, other chemical species such as nitrates and sulfates can serve as oxygen donors in *anoxic* reactions. In the absence of even such oxygen donors, other compounds, generally complex organic compounds, serve as electron receptors.

One great advantage of anaerobic treatment systems is the low energy consumption, or in many cases, net energy yield (from the methane gas generated). Their disadvantage is the much slower reaction rates which generally translates to longer reaction (holding) times and larger tanks.

In general, anaerobic treatment processes are cost effective when the influent BOD concentration is 2,000-3,000 mg/l or higher. Anaerobic treatment processes can attain BOD reduction efficiencies of 75-90%. However, due to the high BOD concentration of the influent, the effluent of anaerobic treatment systems need polishing treatment (usually by aerobic processes) to attain compliance with discharge standards.

The biochemical oxygen demand (BOD) of raw wastewater from slaughterhouse and meat packing industry may or may not exceed 2,000 mg/l after primary treatment (screening and flotation). Dissolved air flotation is required to reduce fats, oil, and grease concentration to below inhibitory limits. Hence, the use of anaerobic treatment systems in treating wastewater from the slaughterhouse and meat packing industry should be considered on a case to case basis.

5.4 Tertiary Treatment Processes

5.4.1 Post Disinfection

Coliform count is an indirect measurement of the possible contamination of wastewater with wastes from animal or human sources. If these animal or human sources of wastes are sick and/or carry pathogens (disease causing organisms), exposure to the wastewater may cause people or animals to get sick. While aerobic biological treatment processes such as the activated sludge process can attain 3-log (1,000 times) coliform reduction, the concentration of coliforms (total and/or fecal) in the influent raw wastewater can be very high. Thus, the effluent of biological treatment needs to be disinfected to prevent the spread of contagious diseases.

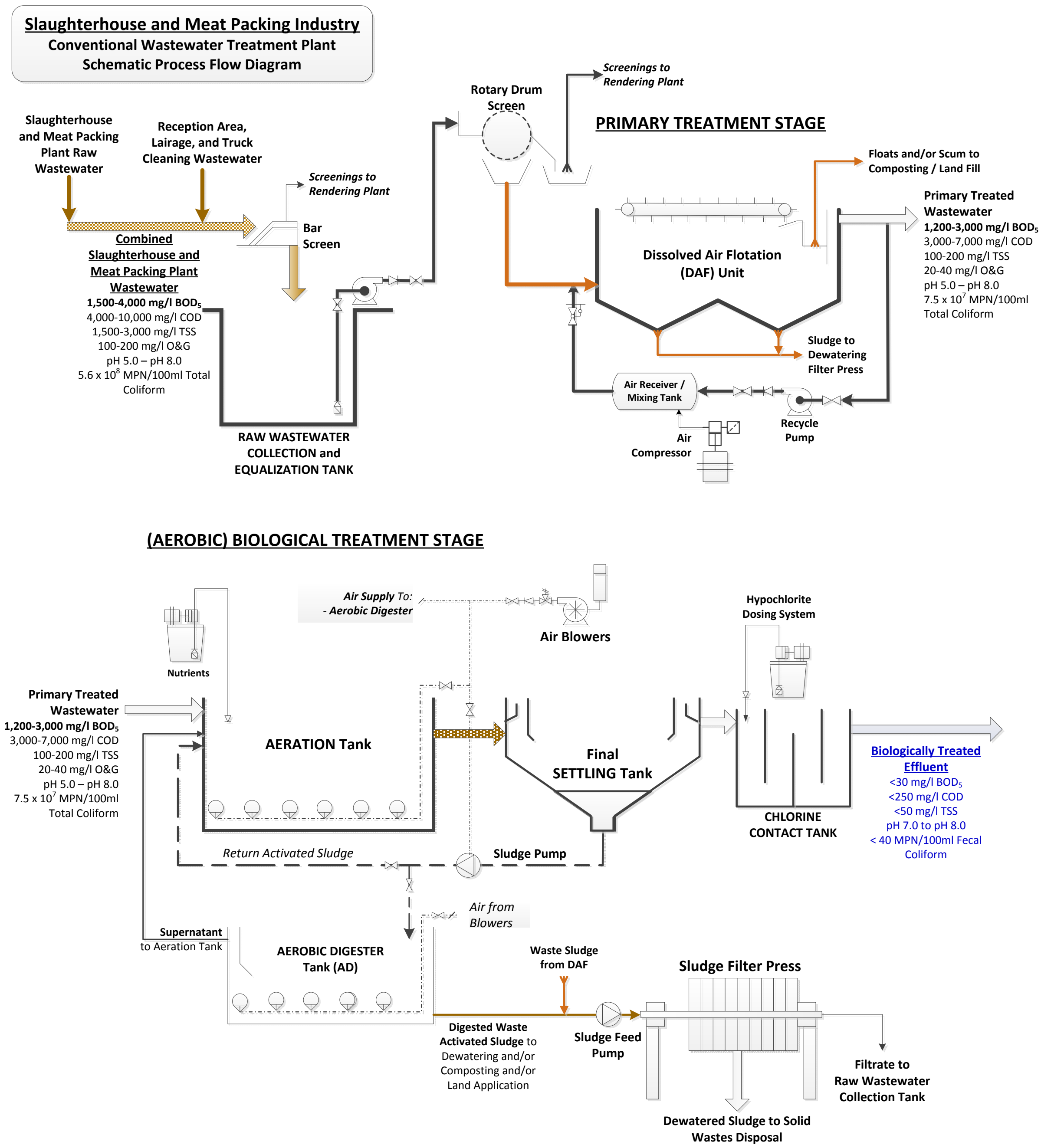
The effluent of the biological treatment (activated sludge process) may be treated with hypochlorite solution at approximately 10 ppm available chlorine dosage to ensure destruction and/or inactivation of pathogens and coliforms which may be present in wastewater from animal and/or human sources. The clarified effluent flows to a chlorine contact tank providing at least 30 minutes of contact time at average flow and equipped with baffles or other device to promote mixing of the chlorine solution with the clarified (activated sludge process) effluent. The chlorine dosage may be increased to ensure consistent compliance with the statutory limits for coliforms.

6. AIR POLLUTION CONTROL AND SOLID WASTES DISPOSAL

7. DISCHARGE AND EMISSIONS STANDARDS

8. REFERENCES

9. APPENDIX: SCHEMATIC PROCESS FLOW DIAGRAM OF CONVENTIONAL WASTEWATER TREATMENT PLANT FOR SLAUGHTERHOUSE AND MEAT PACKING INDUSTRY WASTEWATER



付属資料 24　セクターガイドライン（鶏肉処理事業）

Industrial Pollution Control Guidelines
POULTRY PROCESSING (DRESSING)INDUSTRY

Table of Contents

1. INTRODUCTION

1.1 Rationale

This industrial pollution control guideline for poultry processing industry was prepared under the Project for Monitoring of the Water Quality of Major Water Bodies in the Democratic Socialist Republic of Sri Lanka.
The rapid industrialization in Sri Lanka has created many environmental problems over past decades. The water pollution is a significant issue when considering the human health, existence of biota and the beneficial uses of natural resources.

The Central Environmental Authority (CEA) is the lead agency in the implementation & enforcement of the National Environmental Act No 47 of 1980 which introduced to enhance environmental management & pollution control. Therefore improved approaches in managing the environment is a pre requisite with the rapid industrialization, urbanization and increasing threaten to the natural resources.

The CEA has requested technical & financial assistance from the Japan International Cooperation Agency (JICA) which consist of following out puts with a special focus on the Kelani River.

1. Introduction of water body categorization & gazetting of ambient water quality standards.
2. Capacity development of lab staff and strengthening of main Laboratory.
3. Strengthen enforcement capacity of inspecting officers establishment of pollution source inventory.
4. Introduction of Information Management System related to water quality monitoring etc.

under No. 03 above industrial pollution control guidelines were prepared for three (03) industry types which were prioritized during a need assessment.

The main aim of Preparation of this guideline is to provide information and guidance to Enforcement Officers on industry specific technical information, pollution sources, characteristics and waste treatment methods.

Introduction of proposed effluent discharge standards and stationary source emission standards (to be gazetted) were also considered in the guidelines.

1.2 Poultry Processing Industry

Poultry industry in Sri Lanka has shown a phenomenal growth over the recent past contributing 0.35% to GDP in 2016 which is more than 50% of the total contribution of Sri Lankan live stock sector. As a result, poultry products have become essential food items in Sri Lankan menus.

Current meat consumption habits are slowly changing from fresh and frozen meat towards processed meat products which attributed to the nutritional awareness and changing socio-economic status of the people.

Sri Lankan processed meat industry produces a variety of meat products under three main categories; comminuted meat products (sausage, luncheon meats, and hot dogs), cured meat products (bacon and ham), and formed meat products (nuggets, meat fingers, drumsticks etc). In addition, most of the meat processing factories now prepare marinated meat products which have become popular among the consumers during the past decade.

According to the CEA data base; ....of large scale poultry processing industries are distributed mainly in ....districts. It is evident that this industry sector generates large amount of wastewater of which contains considerable amount of organic pollutants. In the gazette notification No. 1533/16 dated 2008.02.25 .... is mentioned as high polluting industry which needs to obtain an Environmental Protection License under the National Environmental Act No 47 of 1980.

2. POULTRY PROCESSING (DRESSING)OPERATIONS

The following descriptions apply to mechanized poultry processing (dressing) operations. They do not apply to manual poultry processing (dressing) operations.

2.1 Slaughtering

2.1.1 Transport and Reception

Live chicken are hauled from the (poultry) farms and delivered to the poultry processing (dressing) plant or facility in crates or modules consisting of stacks of open top crates. At the reception area of the poultry processing (dressing) plant, the live chicken are unloaded (manually or automatically) from the crates and loaded on the conveyor system of the processing plant.

The empty crates (and modules) are washed, either manually or in automatic washing machines. Used wash water from crate washing contains chicken droppings, feathers, and miscellaneous dirt or mud from the farm or roads. The cleaned crates are loaded back to the trucks.

2.1.2 Hanging, Stunning, and Killing

The live chickens (birds) are hanged on shackles connected to an overhead conveyor system. The chickens are stunned while their heads are partially immersed in a water bath. The chickens are then killed / slaughtered by cutting the neck. Blood drains from the dead chickens through the neck cut and may be collected for various uses.

Drips and spills from the water bath generate a small amount of wastewater at this process stage.

2.1.3 De feathering and Trimming

After the chickens are fully bled, they are immersed in hot water (scalding) in order to loosen the feathers for easier plucking. The scalded chickens are then conveyed through the mechanized pluckers or pickers where a combination flexible fingers and water spray jets gently remove the feathers without bruising the meat. Special mechanisms remove feathers from hard to reach areas such as the joints.

After removal of feathers, the head and trachea are removed. This is followed by the cutting of the hock (leg joint) and unloading of the legs (which were previously hanged on the shackles). The chickens then proceed to the evisceration stage.

Wastewater from this process stage comes from the scalding and water used to spray on the chickens and to wash the tools, shackles, and other implements and parts of the conveyor and processing equipment. The wastewater from this area contains feathers, dirt (droppings, feed, etc.),and blood from the chickens.

2.1.4 Evisceration and Dressing

At the evisceration stage, a vent is first cut in the posterior portion of the chicken and opened. An eviscerating spoon or fork removes the intestines and other internal organs. The gizzard andcropper are also removed and the neck is broken.

The giblets (gizzard, heart, and liver and sometimes, also part of the neck) are collected and sorted on the sorting tables, either for inclusion in the whole chicken package or for separate packing.

After evisceration, the chicken carcasses are subjected to final inspection. Residues are removed by suction. Then, the chicken carcasses are washed inside and outside for a final time before being unloaded to the packing stage.

The vent cutting units, eviscerating spoons and/or forks, shackles, and other processing equipment and implements are cleaned by water spray jets. The various wash water streams constitute the wastewater from this process stage and may containsome blood,chicken flesh, fine feathers, and other residues.

2.2 Weighing, Grading, and Packing

2.2.1 Whole Chicken Packing

The whole chicken carcasses are chilled in cold water baths or in air chillers. The chilled whole chicken carcasses are then weighed, graded, sorted, and finally packed, with or without the giblets package.

Wastewater from the whole chicken packing section comes mainly from drippings, leaks, and overflow and drained water from the water chillers. This wastewater stream contains mostly residues.

2.2.2 Cut Chicken Packing

Depending on the market demand, the chilled chicken carcasses are cut up into various portions such as halves or quarters, breast, wings, legs, thigh, and drumsticks. The various cuts are then weighed, graded, and sorted prior to packing.

Aside from the wastewater stream from the water chillers, wastewater from the cut chicken packing section comes from drippings, leaks, and wash water for the cutting tools. This wastewater stream contains mostly blood, chicken flesh, and residues.

2.2.3 Giblets Packing

The giblets are usually chilled in separate chillers from the whole or cut chicken lines. The various parts are then weighed, graded, and sorted prior to packing. The giblets packs may be incorporated in the whole chicken package or sold separately.

Aside from the wastewater stream from the giblets chillers, wastewater from the giblets packing section comes from drippings, leaks, and wash water for the sorting tables. This wastewater stream contains mostly blood, chicken flesh, and residues.

2.2.4 Refrigeration and Freezing

After packing, the packs of whole chickens, cut portions, and giblets are then refrigerated (especially if to be sold fresh) and/or frozen, either in blast or conventional freezers.

The refrigeration and freezing stage does not normally generate any wastewater except when defrosted for cleaning and maintenance.

3. WASTE WATER GENERATION

3.1 Wastewater

3.1.1 Wastewater Sources

The wastewater sources in a poultry processing (dressing) plant are the following:

a. Reception and Crate (and Trucks) Washing Areas (*Please refer to Figure 1 below*)
b. Integrated Poultry Processing Plant, combined wastewater streams from the following sections or stages (*Please refer also to Figure 1,below*):
    - Hanging, Stunning, and Killing Section (*Please refer also to Figure 1, below*)
    - Defeathering and Trimming Section (*Please refer also to Figure1, below*)
    - Evisceration and Dressing Section (*Please refer also to Figure 1,below*)
    - Weighing, Grading, and Packing Section (*Please refer also to Figure 2, Figure 3, and Figure 4, below).*
c. Blowdown from the following:
    - Cooling Tower (for air conditioning and refrigeration)
    - Boiler
    - Water (Supply) Treatment Plant
d. (Biological and Chemical) Laboratory
e. Cleaning and sanitation of processing facilities, utensils, tools, and equipment before and after production run.

Wastewater streams from the reception and crate washing areas, the integrated poultry processing (dressing) plant, and the laboratories are combined before conveyance to the wastewater or effluent treatment plant.

Blowdown from the cooling towers, boilers, and water supply treatment plant are usually deemed clean enough to comply with the discharge standards; hence, these streams are not treated.

Figure 1 <u>Schematic Process Flow Diagram of Poultry Processing (Dressing)</u>

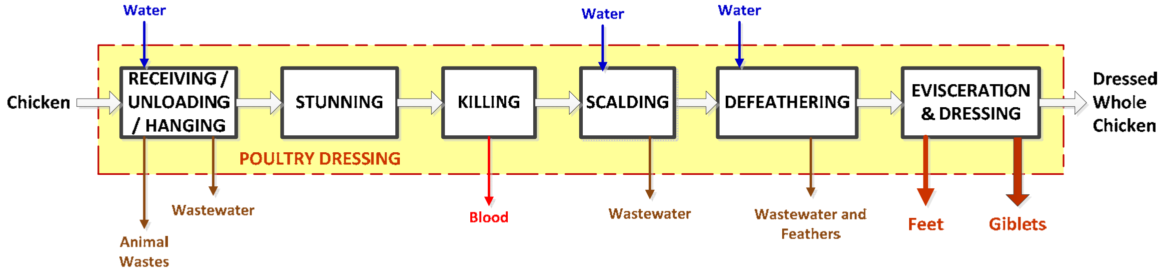


Figure 2 <u>Schematic Process Flow Diagram of Whole Chicken Packing</u>

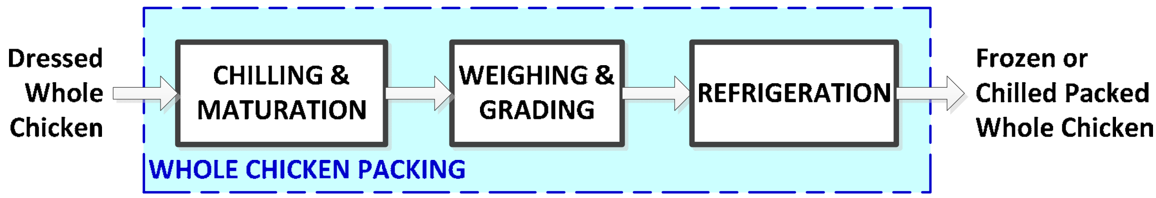


Figure 3 <u>Schematic Process Flow Diagram of Cut Chicken Packing</u>

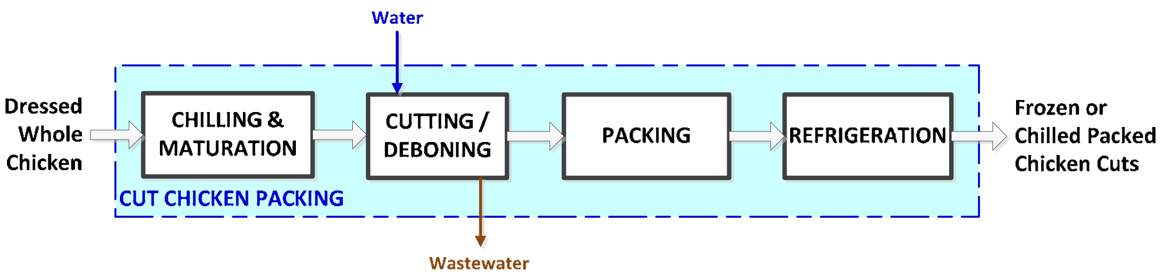
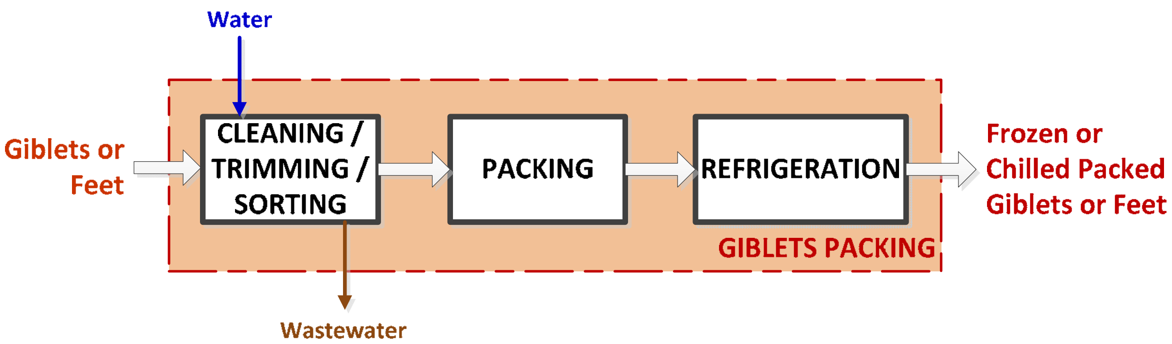


Figure 4 <u>Schematic Process Flow Diagram of Giblets Packing</u>



3.1.2 Wastewater Characteristics

N.B. The following data on the characteristics of wastewater from poultry processing (dressing) are derived from Philippine livestock industry. The data have to be validated to determine if they are applicable to the Sri Lanka livestock industry.

Table 1 Specific Wastewater Generation Rates

- **Quantity:**
  - **Average: 23 Liters per Chicken**
  - **Maximum: 33 Liters per Chicken**
  - **Minimum: 18 Liters per Chicken**
  - **Benchmark: 10 Liters per Chicken**
- **Quality:**
  - **Average: 30 gm BOD_5 per Chicken**
  - **Maximum: 55 gm BOD_5 per Chicken**
  - **Minimum: 15 gm BOD_5 per Chicken**
  - **Benchmark: 10 gm BOD_5 per Chicken**

  - **Average: 20 gm TSS per Chicken**
  - **Maximum: 40 gm TSS per Chicken**
  - **Minimum: 10 gm TSS per Chicken**
  - **Benchmark: 10 gm TSS per Chicken**

  - **Average: 2.0 gm Oil & Grease per Chicken**
  - **Maximum: 4.0 gm Oil & Grease per Chicken**
  - **Minimum: 0.4 gm Oil & Grease per Chicken**
  - **Benchmark: 0.3 gm Oil & Grease per Chicken**

Table 2 Significant Pollution Parameters in Poultry Processing (Dressing) and Packing Operations

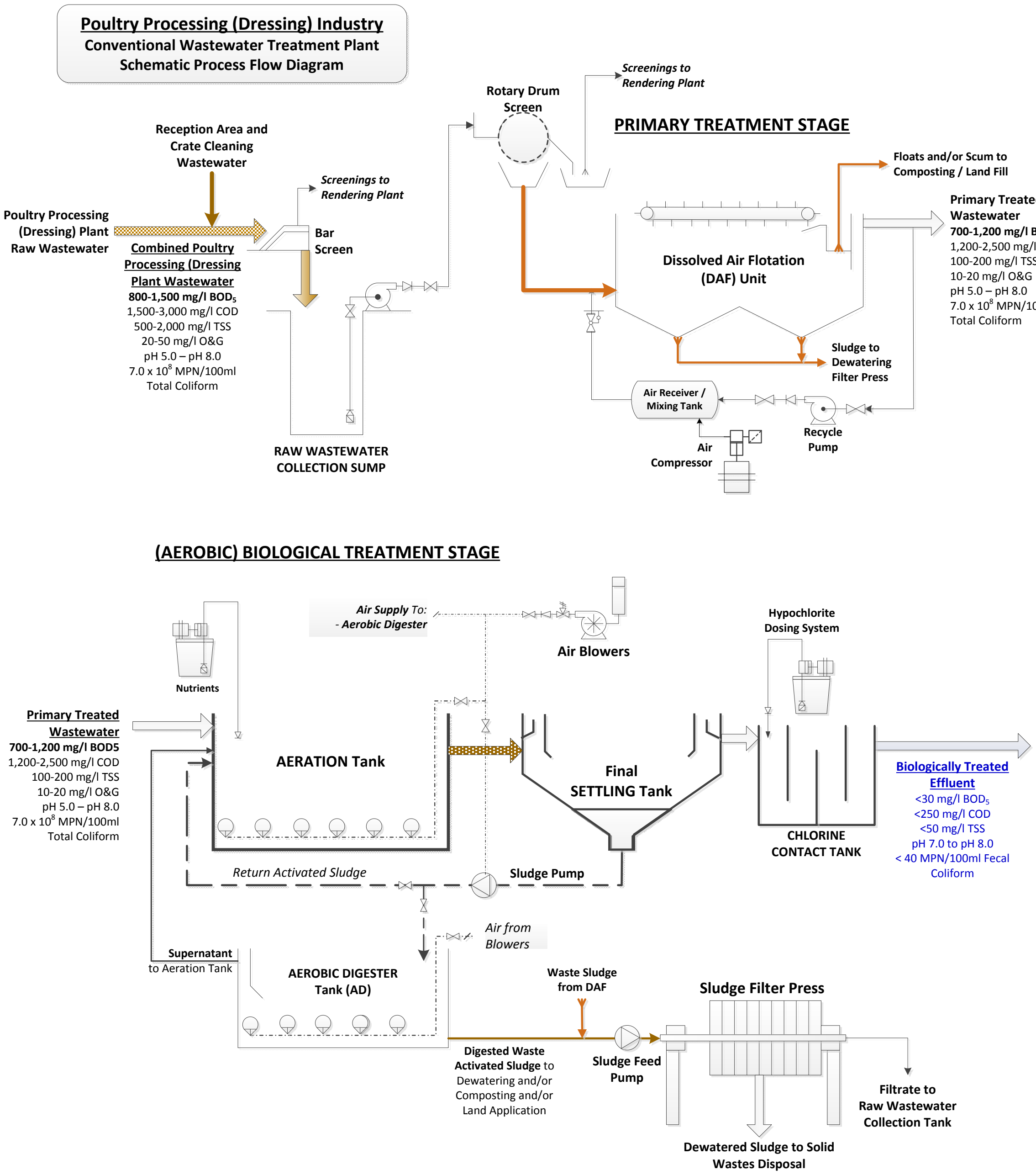
- **pH**
- **5-day Biochemical Oxygen Demand (BOD_5)**
- **Chemical Oxygen Demand (COD)**
- **Total Suspended Solids (TSS)**
- **Oil & Grease**
- **Fecal Coliform**

4. WASTEWATER TREATMENT

4.1 Introduction

The contaminants in wastewater from poultry processing (dressing) industry are mainly organic matter amenable to biological treatment processes. The poultry processing (dressing) wastewater also contains solids and oil & grease which can interfere with or inhibit biological treatment. The poultry processing (dressing) wastewater needs to undergo primary treatment to ensure effective biological treatment that will produce effluents complying with the standards for discharge of industrial effluents. The schematic process flow diagram shown in Figure 5 below shows a range of conventional treatment processes suitable for poultry processing (dressing) and packing industry wastewater.

Figure 5 Conventional Treatment Plant for Poultry Processing (Dressing) and Packing Industry Wastewater



4.2 Physical Treatment Processes

Physical treatment processes rely on physical properties of contaminants to effect treatment. Physical treatment processes are best suited for the removal of discrete solids from water because they are effective and very economical, especially in terms of cost per unit quantity of pollutant removed.

4.2.1 Screening

Although the de feathering equipment is provided with screens to capture most of the feathers and large solids prior to discharge, the poultry processing (dressing) plant wastewater may still contain fine feathers, chicken manure, undigested feeds, fine pebbles and other solids. These suspended solids may interfere with the operation or function of downstream treatment units or increase the pollution load. Of special concern are the fine feathers, skin, and meat which tend to form strings which wrap around equipment. Rotary drum screens are the most appropriate type even though mesh type screen have higher capture efficiency. Rotary drum screens are less prone to blinding or plugging from strings and are self-cleaning. Alternatively, static hyperbolic screens with slotted openings are also reasonably effective and more resistant to blinding than mesh screens. Unlike rotary drum screens, static screens are not self-cleaning and thus, need to be manually scraped for effective removal of screened solids. Screenings from poultry processing (dressing) wastewater are best processed in a rendering plant to recover the fat and protein value of the screened solids.

The size of screening equipment is based on the flow rate, size of openings, and solids load. The effectiveness or degree of removal of solids is also dependent on these factors and varies considerably from less than 30% to more than 70%.

4.2.2 Flotation (Oil and Grease Removal)

Although chickens have relatively lower fat content than other meat sources, the use of hot water for scalding extracts some amount of fats to the extent that the fat content in the wastewater may inhibit biological treatment processes. Dissolved air flotation (DAF) or other forms of flotation(plain or induced by fine air bubbles) can be effective in removing fats, fine feathers, and other solids not caught by screening. Aside from the conventional method of dissolving compressed air in recirculated clarified water, dissolved air mixture may be formed by cavitation. Cavitation air flotation simplifies the dissolved air system by replacing the recirculation pump, air compressor, air-water mixing tank, and pressure reducing and flow control valves with a single mixer-like cavitation air flotation unit.Since DAF systems are expensive, flotation is not usually appropriate or cost effective for the treatment of poultry processing (dressing) industry wastewater.

Flotation systems typically include dosing of coagulating agents to promote agglomeration of the fats, feathers, and suspended solids into flocs. The size of the flotation area is dependent on the instantaneous feed flow rate which is usually the pump flow rate and rise rate of the solids. The rise rate of flocs in DAF systems is typically 3-5 m/hr. Flotation can remove more than 80% of suspended solids and approximately 30-50% of BOD.

4.3 Biological Treatment Processes

4.3.1 Activated Sludge Process

Biological treatment processes make use of living organisms (mostly microorganisms) to effect treatment. The *activated sludge* treatment process is an aerobic, suspended-growth system. Itis, by far, the most common biological treatment process because of its high BOD reduction efficiency, stability, reliability, and ease of operation.

The activated sludge treatment process consists of an aeration tank and a (final or secondary) settling tank. Wastewater flows into the aeration tank where biologically active sludge recycled from the (final or secondary) settling tank is mixed with the influent wastewater. The activated sludge microorganisms consume the organic pollutants (measured as BOD_5 and COD) which serve as their food or substrate, and convert them to harmless carbon dioxide, water, and additional cell mass. An aeration system provides the oxygen required for the degradation of the organic pollutants and the mixing energy to keep the activated sludge flocs in suspension.

Activated sludge treatment process can reduce BOD by over 90-95%, suspended solids by 80-90%, and fats, oil, & grease (FOG) by 50-80%.

While many factors affect the performance of an activated sludge treatment system, one of the most important is the ratio of food (BOD) to microorganism or food to mass (F:M) ratio. A food to mass (F:M) ratio of 0.05 – 0.15 kg BOD5/day/kg microorganisms will consistently produce treated effluent BOD_5 concentrations below 20 - 30 mg/l and effluent suspended solids concentrations below 30 – 50 mg/l.

4.3.2 Alternative Aerobic Biological Treatment Processes

Alternative aerobic biological treatment processes include sequencing batch reactors (SBR), trickling filters, rotating biological contactors (RBC), and membrane bioreactors (MBR).

Sequencing batch reactors(SBR) are a variation of the conventional activated sludge system. Treatment takes place in a single tank, unlike the two-tank arrangement of the conventional activated sludge system. Treatment is undertaken in batches going through the different stages of filling, aeration / reaction, settling or solids separation, and discharge or decanting of the treated effluent. Provisions have to be made to accommodate the influent wastewater during the different stages (except filling). In most cases, a holding or equalization tank is used or a twin tank arrangement is provided wherein one tank cycles through the treatment while the other reactor tank accumulates the influent raw wastewater. SBRs attain similar treatment efficiencies as activated sludge treatment plants. Although they can be operated manually, SBRs usually require automation and motorized or pneumatically operated valves. SBRs consume more energy overall than activated sludge treatment plants of the same capacity.

Trickling filters are a form of attached growth or fixed film, aerobic biological treatment systems. In fixed film processes, microorganisms that consume the organic material (food or BOD) grow as *slime* on fixed media. As the wastewater flows over the slime or biomass, (soluble) organic wastes are adsorbed and consumed by the microorganisms. Oxygen from air diffuses through the thin layer of wastewater to the microorganisms. As the slime layer builds up, clumps slough off or detach from the media. The material that sloughs off, called *humus*, flows with the wastewater and is separated from the treated wastewater in the secondary clarifier or settling tank (or filter). The main advantage of trickling filters (and other fixed film treatment systems) is their low operating costs.

Rotating biological contactors (RBC) are another type of attached growth biological treatment with low operating energy consumption. In contrast to trickling filters wherein the media do not move, the media in RBCs are discspartially submerged in the wastewater that rotate around a shaft. The rotation alternately exposes the slime layer to the food (organic wastes) when submerged and oxygen when exposed to the air to effect treatment.

It is important to note that attached growth treatment processes, such as trickling filters are more effective on soluble organic pollutants and less so on particulate or suspended solid pollutants. For this reason, trickling filters need primary clarifiers or similar pre-treatment units to be effective. The presence of feathers and other solids which can form strings in the wastewater from the poultry processing (dressing) industry can contribute to clogging of the trickling filter media or the RBC discs. Properly sized and operated, attached growth treatment systems can attain BOD reduction efficiencies of 80-90%. The suspended solids concentrations of the treated effluent of attached growth treatment processes like trickling filters are often higher than those of the effluent of suspended growth treatment processes like activated sludge process.

Membrane bioreactors (MBR) are aerobic, suspended growth treatment systems similar to activated sludge treatment plants where the secondary clarifier or settling tank is replaced with a (semi-permeable) membrane such as ultrafiltration or microfiltration membranes which are usually installed in the aeration tank. This system eliminates the secondary settling tank resulting in a more compact system. The membrane is also several times more effective in removing suspended solids (mainly the activated sludge flocs) than settling tanks to produce very low suspended solids concentrations in the effluent. The membrane system also allows the retention of higher concentrations of biomass or activated sludge, further improving BOD reduction efficiencies.

MBRs can produce effluents with less than 10 mg/l BOD_5 and less than 10 mg/l TSS (total suspended solids).As such, the treated effluent of MBRs may be suitable to re-use in washing crates and trucks and the reception area.

The membranes in MBRs are sensitive to plugging by stringy solids such as those present in wastewater from the poultry processing (dressing) industry. Hence, effective primary treatment to remove suspended solids is necessary if MBRs are to be used in treating wastewater from the poultry processing (dressing) industry.

The membranes in MBRs are sensitive to fouling from mineral and biological deposits which reduce flux and increases the pressure required to maintain the desired flux. This results in higher energy requirements to operate and the need for frequent cleaning. As a result, MBRs are more costly operate than the more conventional biological treatment systems as well as being more costly to construct.

4.3.3 Anaerobic Treatment

Anaerobic treatment is generally applied on high BOD strength wastewater and organic sludges. Anaerobic processes take place in the absence of oxygen. In biochemical reactions, oxygen generally acts as electron receptor in the process of extracting energy from the organic material. In the absence of free oxygen, other chemical species such as nitrates and sulfates can serve as oxygen donors in *anoxic* reactions. In the absence of even such oxygen donors, other compounds, generally complex organic compounds, serve as electron receptors.

One great advantage of anaerobic treatment systems is the low energy consumption, or in many cases, net energy yield (from the methane gas generated). Their disadvantage is the much slower reaction rates which generally translates to longer reaction (holding) times and larger tanks.

In general, anaerobic treatment processes are cost effective when the influent BOD concentration is 2,000-3,000 mg/l or higher. Anaerobic treatment processes can attain BOD reduction efficiencies of more than 75-90%. However, due to the high BOD concentration of the influent, the effluent of anaerobic treatment systems need polishing treatment (usually by aerobic processes) to attain compliance with discharge standards.

The biochemical oxygen demand (BOD) of raw wastewater from poultry processing (dressing) very rarely exceeds 2,000 mg/l. As such, anaerobic treatment systems are rarely used in treating wastewater from the poultry processing (dressing) industry. It is, however, technically feasible to use a simple anaerobic digester as pre-treatment prior to aerobic treatment. A hydraulic retention time of one (1) day can reduce BOD and COD concentrations by 15-20%. An anaerobic digester also removes fats, oils, and grease (FOG) due to the long retention period. Thus, anaerobic digesters may replace the flotation stage. Since suspended solids may settle in the anaerobic digester tank, settled sludge and the floating scum layer of fats and solids need to be regularly removed for proper disposal.

Anaerobic digesters produce methane gas. The gas should be properly vented to avoid risks of fire or explosion.

4.4 Tertiary Treatment Processes

4.4.1 Post Disinfection

Coliform count is an indirect measurement of the possible contamination of wastewater with wastes from animal or human sources. If these animal or human sources of wastes are sick and/or carry pathogens (disease causing organisms), exposure to the wastewater may cause people or animals to get sick. While aerobic biological treatment processes such as the activated sludge process can attain 3-log (1,000 times) coliform reduction, the concentration of coliforms (total and/or fecal) in the influent raw wastewater can be very high. Thus, the effluent of biological treatment needs to be disinfected to prevent the spread of contagious diseases.

The effluent of the biological treatment (activated sludge process) may be treated with hypochlorite solution at approximately 10 ppm available chlorine dosage to ensure destruction and/or inactivation of pathogens and coliforms which may be present in wastewater from animal and/or human sources. The clarified effluent flows to a chlorine contact tank providing at least 30 minutes of contact time at average flow and equipped with baffles or other device to promote mixing of the chlorine solution with the clarified (activated sludge process) effluent. The chlorine dosage may be increased to ensure consistent compliance with the statutory limits for coliforms.

5.0 Air Pollution, Noise, Vibration & Solid Waste Disposal

5.1 Air Pollution

Air emission issues of concern in this sector are mainly associated with odor. Process odor sources include scalding, live bird handling, wastewater treatment, and rendering. Other sources of odors include by-products, blood collection tanks, manure piles, and fat traps.
Recommended measures to prevent the generation of odor emissions include: · Maintenance of clean live bird handling areas by removing fecal matter and dead birds on a daily basis; · Emptying and cleaning fat traps frequently; · Reducing the inventory of raw carcasses, waste, and byproducts and minimizing any storage to short periods of time in a cold, closed, well-ventilated area. Dead birds, waste, and byproducts should not be stored in open spaces, where possible; · Sealing off animal by-products during transport and transporting blood in insulated containers to reduce temperature increase; · Where feasible,

installation of rendering equipment in enclosed buildings operated under negative air pressure. Recommended measures to control odor emissions include: · Use of exhaust stack heights from rendering and smoking processes.

If the facility is in close proximity to residential areas, the use of wet scrubbers to remove odor emissions should be considered. Wet scrubbers are used to remove odors with a high affinity to water, such as ammonia emitted during the rendering process.

Generally such odour could be reduced by deodorization devices. The following table describes major deodorization devices:

Table X **<u>Types of Deodorization Methods</u>**

Types of deodorization	Methods	Advantages	Disadvantages
Combustion	Direct burning or burning with catalyst	Applicable for most of odour Applicable for high concentration odour	Costly
Biological deodorization	Natural deodorizationby bacteria	Environmentally friend	Need control of growth condition of bacteria
Activated charcoal filter	Deodorization by biological and chemical functions of charcoal filter	Easy to handle and maintain.	

Ozone oxidation	Contact oxidation with ozone	No chemical Comact space	High concentration of ozone is harmful.
Photo-catalyst	Oxidation by ultraviolet ray with titanium oxide as a catalyst	Useful for persistent odour	Need maintenance to remove dust oily materials

5.2 Noise & Vibration Pollution

Noise and vibration exposure may result from proximity to noisy machinery such as compressors, automatic packing machinery, condensers, ventilation units, and pressurized air, among other sources.

Recommendations for noise management are ;

5.3 Solid Waste disposal

Major solid waste generated from poultry processing is sorts of waste such as dead body, bone, organs. Those could be used for composting for agricultural purposes, feed for animals, etc. Composting is expected to generate benefit on selling to farmland.

The domestic waste can be source of infectious diseases by decomposition, therefore those shall be properly sealed, and taken out to waste collection companies or composition process.

Chemical Hazards

Exposure to chemicals (including gases and vapours) typically involves chemical-handling activities related to cleaning operations and disinfection of process areas, in addition to the maintenance of heating (thermal oils) and cooling systems (ammonia). Recommended measures to prevent and control

6. 0 WASTE MANAGEMENT & CLEANER PRODUCTION

Waste management in industrial activities aims environmentally sustainable management. It could contribute to both reducing pollution and saving operation cost from viewpoints of considering production and or wastewater treatment processes. This concept also targets more efficient production methods by saving energy and raw materials and reducing emissions to air, water and soil.

Cleaner production is a preventive, company-specific environmental protection initiative which intends to minimize waste and emissions and maximize product output.

By analyzing the flow of materials and energy in a company, options could be identified to minimize waste and emissions out of industrial processes through source reduction strategies. Improvements of organization and technology can be suggested for better choices in use of materials and energy, and to avoid waste, waste water generation, and gaseous emissions, and also waste heat and noise.

Poultry processing facilities use energy to heat water and produce steam for process applications, cleaning purposes, and for the operation of mechanical and electrical equipment, refrigeration, and air compressors.

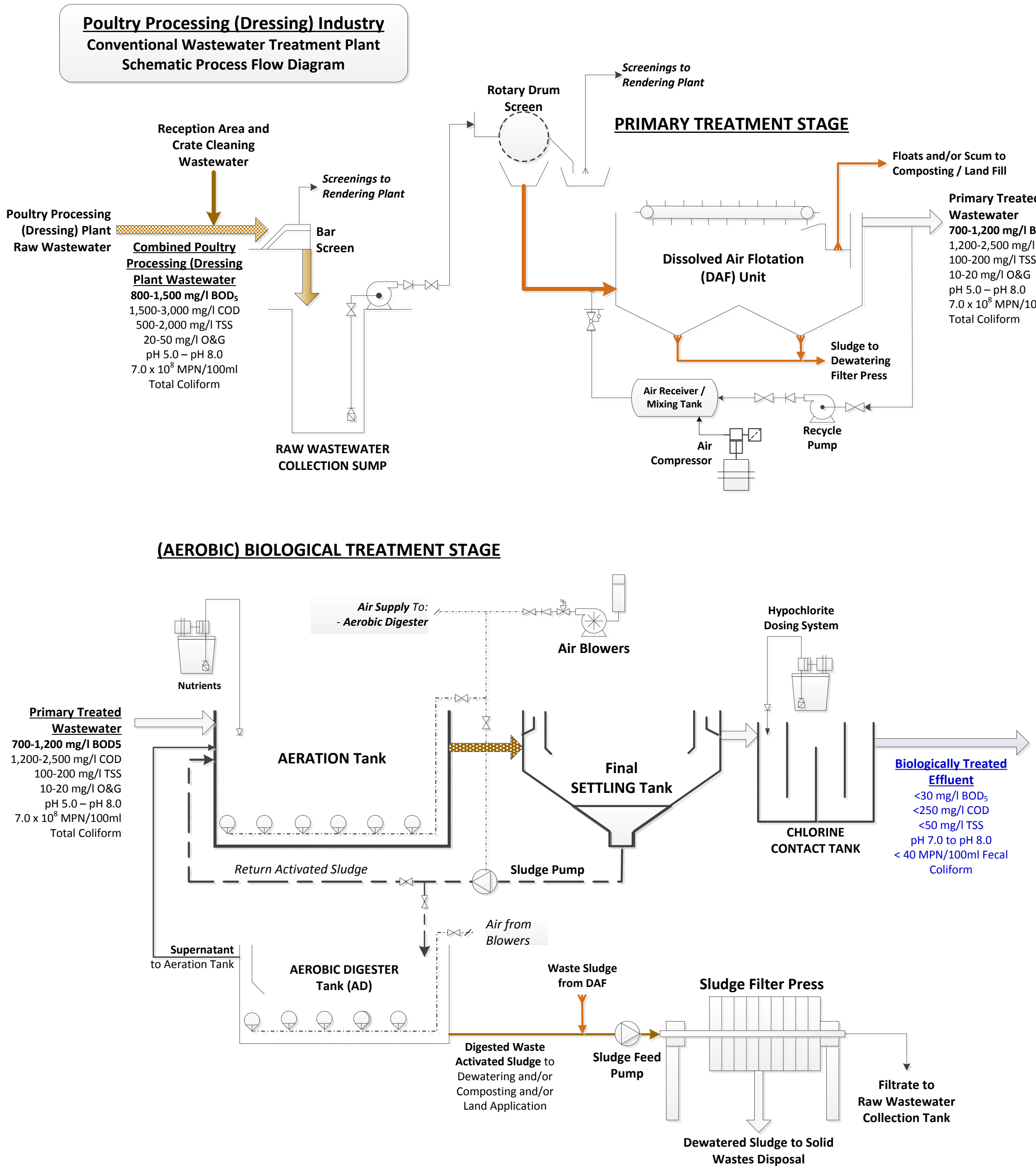
6.1 Waste Minimization

- **Re-Use Treated Effluent for Washing:**
  - **Trucks and Crates**
- **Optimize Scalding Water Temperature**
- **Use Trays and Suitable Containers for:**
  - **Collection of Blood**
  - **Transport of Chicken and Giblets**
- **Provide Workers with Continuing Training and Skills Enhancement**

5. DISCHARGE AND EMISSIONS STANDARDS

6. REFERENCES

7. APPENDIX: SCHEMATIC PROCESS FLOW DIAGRAM OF CONVENTIONAL WASTEWATER TREATMENT PLANT FOR POULTRY DRESSINGINDUSTRY WASTEWATER



付属資料 25　州コードと業種コード

Table 1 Provincial and District Code in RKB

Provincial codes	District Codes	
CE - Central Province,	KY – Kandy	KE – Kegalle
EA - Eastern Province	MT – Matale	RN – Ratnapura
NC - North Central	AP – Ampara	GL – Galle
NO - Northern	BC – Batticaloa	HB – Hambantota
SA - Sabaragamuwa	TC – Trincomalee	MR – Monaragala
SU - Southern	AD – Anuradhapura	CM – Colombo
WE - Western	PO – Polonnaruwa	GQ – Gampaha
UV - Uva	MU – Mulative	KT – Kalutara

Source : JICA Team

Table 2 Sector Code of industries in List "A"

	Type of Activities	Code	List A
1	Chemical & Petrochemical	CH	1-22
2	Textile & Leather	TL	23-29
3	Food and Food Related Food Industry	FD	30-42
4	Metal Industry	BM	43-46
5	Machinery & Equipment	ME	47
6	Mineral & Mineral Product	MP	48-56
7	Waste Disposal/ Waste water/ Water Treatment	SZ	57-63
8	Timber & Wood	TW	64-65
9	Lodgings & Health Services	SL	66-68
10	Transport Related Services	TR	69-72
11	Power	SP	73
12	Paper & Printing	PP	74-75
13	Telecommunication Towers	TC	79
14	Other Activities	OT	76-78, 80

Source : R & D Unit, CEA

付属資料 26 情報管理ガイドライン

Draft

GUIDELINE
ON
INFORMATION MANAGEMENT
IN CEA

Date 1st August 2017

Central Environmental Authority

ABBREVIATION

Abbreviations	Original
MMDE	Ministry of Mahaweli Development and Environment
CEA	Central Environmental Authority
EPC	Environmental Control Pollution Division
EMA	Environmental Management and Assessment Division
EEA	Environmental Education & Awareness Division
EIA	Environmental Impact Assessment Unit
NRM	Natural Resources Management Unit
R&D	Research and Development Unit
IT	Information Technology
GSMB	Geological Survey and Mines Bureau
NWS & DB	National Water Supply and Drainage Board
BOI	Board of Investment of Sri Lanka
EPL	Environmental Protection Licence
PSI	Pollution Source Inventory
GIS	Geographic Information System
SHP	Shapefile
IMS	Information Management System
DB	Database
DBMS	Database Management System
DG	Director General
CSV	Comma Separated Value

EXPLANATION OF SPECIFIC TERMS

Terms	Explanation
Hardware	the machines, and other physical components of a computer or other electronic gadget or system
Software	the programs and other operating information used by a computer.
Malware	A software that will damage or disable computer systems, software and configuration

TABLE OF CONTENTS

Chapter 1. SUMMARY OF INFORMATION MANAGEMENT

The guidelines summarize the activities from collection of data to updating of the website on the environmental information handled by CEA and the environment-related organizations. Simultaneously, it includes the policy for preparing an environmental report for each river basin in Sri Lanka.

1.1 FLOWCHART OF INFORMATION MANAGEMENT

The flow chart of the activity outlined in this guideline is shown in Figure 1.1.

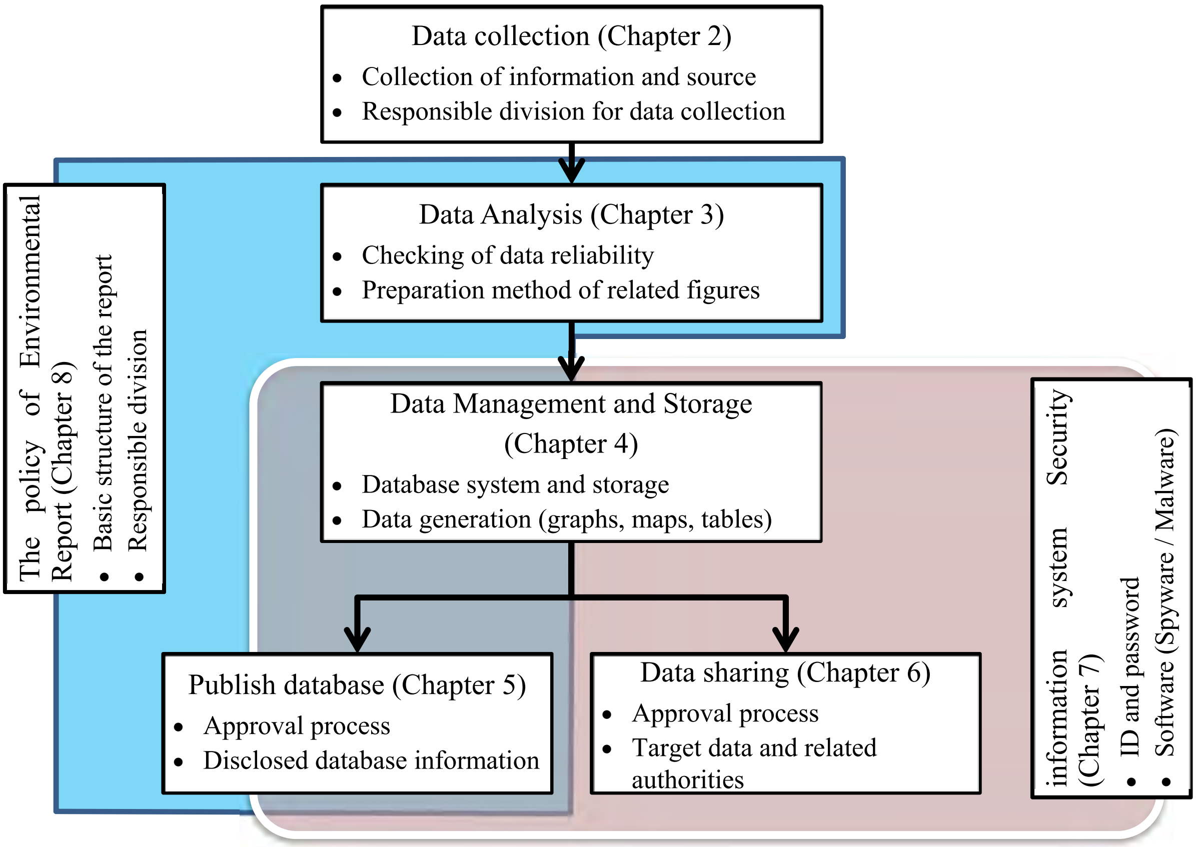


Figure 1.1 Flowchart of publishing on environmental information

1.2 DATA COLLECTION (CHAPTER 2)

CEA produces significant environmental information that other related agencies, ministries and private sector would identify as critical in their operations. Similarly, CEA collects information from related agencies for internal analysis. This chapter describes the collection of data from CEA relevant divisions and related agencies. CEA manages this information and stores in a database. The database system is designed in such a way it combines all the data, removes duplicates and checks updates to provide an output such as maps, charts.

However, this guideline does not limit the number of parameters or category items of CEA. This is based on series of discussion with the working group 4 and considering the only available data of CEA. It is recommended to summarize information on the public sector environmental education activities, etc. as necessary.

1.3 DATA ANALYSIS (CHAPTER 3)

It is necessary to recognize that the water quality monitoring data is the result of analyzing the environmental water sampled at a specific date and time and a specific place.

In the evaluation of water quality data, not only the reliability of the analytical institution and the validity of the analytical method but also whether the water sampling is being appropriately implemented. Furthermore, it is important to compare and examine from a viewpoint of whether representative the river environment at the sampling site.

In chapter 3, the basic relationship is explained between water quality items and the factors that affect water quality.

1.4 DATA MANAGEMENT AND STORAGE (CHAPTER 4)

In chapter 4, data collected are stored in an organized folder system. It is consolidated to create required visual outputs such as maps, charts, and tables. This chapter is particularly for internal use of CEA. It is important to have a centralized information management system in order to avoid duplication of work and inconsistencies within the CEA. As a basic policy, the collected data will be provided to the users (CEA internal employees, management, related agencies, and public) as necessary. It is specified in this report the frequency of data updating and consolidating

1.5 PUBLISH DATABASE (CHAPTER 5)

This chapter provides the internal guideline of publishing information to privately or publicly. It is necessary to organize the data, separate sensitive information and disclose to the public. There are some parameters with only CEA staff can only view and with limited to CEA staff only. The basic procedure for information disclosure is expounded and discussed in this section.

1.6 DATA SHARING (CHAPTER 6)

In the data handled in these guidelines, data obtained from related ministries and agencies and processed information such as graphing are included. Chapter 6 shows the scope and method of data sharing with related organizations in all of these collected data. The data sharing is focused on relationship to public sectors.

1.7 SECURITY ON INFORMATION SYSTEM (CHAPTER 7)

Cyber security is essential in information management system. The environmental database holds sensitive information of related agencies and private organizations which can be stolen or exposed to the public. This chapter describes the additional information security measures to be implemented by CEA.

1.8 THE POLICY OF ENVIRONMENTAL REPORT (CHAPTER 8)

It is recommended that environmental information gathered be prepared as an environmental report. The Environmental Report can be regarded not only as an accurate presentation to the citizens but also as an awareness activity. In addition, through this report, it can be used for the transition of the environment where we live and to widely disseminate environmental conservation activities that CEA is working on.

In this guideline, we describe the basic policy for environmental report preparation. The environmental report can pick up additional topics from time to time, then the guideline will only introduce the basic composition.

Chapter 2. DATA COLLECTION

2.1 OVERVIEW OF DATA COLLECTION

Data collection is the beginning of the Information Management System (IMS). It consists of two parts: 1) Parameter list collection and 2) Consolidation. The planning office is responsible for consolidating the data from different sources listed in Table 2-1.

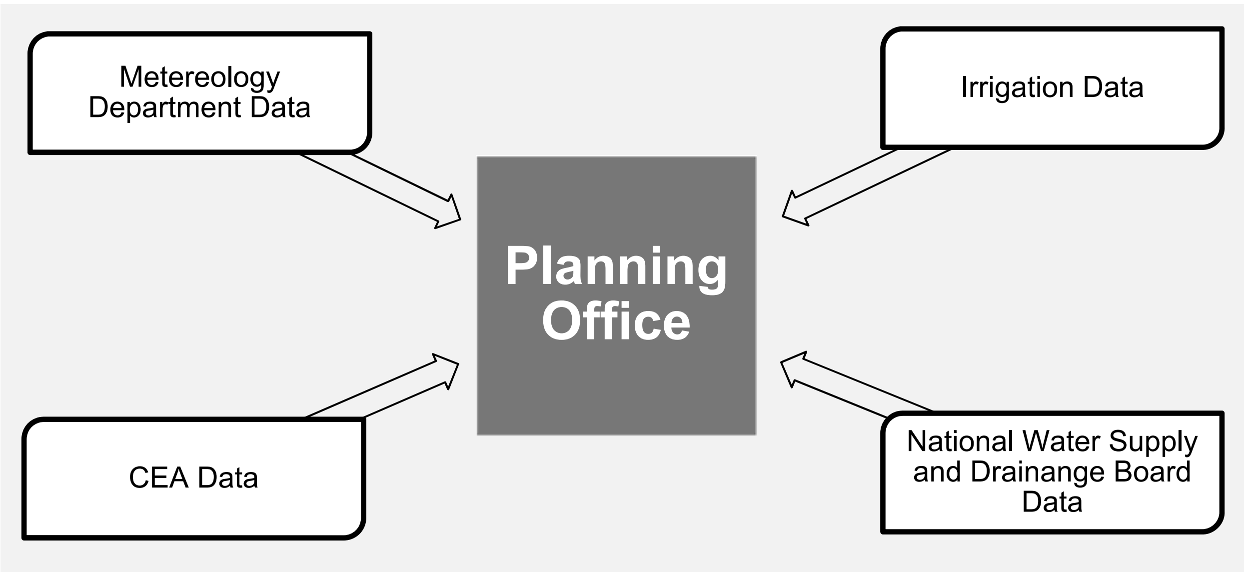


Figure 2.1 Data from other CEA division and other related agencies will be collected by Planning Office for data collection part of the information management system

2.2 ORGANIZATION OF DATA COLLECTION

Table 2-1 shows the summary of information included in the current information management system. Important information such as data type (file extension) and source data. A detailed information for each category item is explained in Section 2-2 and the subsequent pages.

Table 2-1 Organization of Data Collection

No	Category	Items	Data type	Data Source
1	2.2 Basic data	GIS Data	Shapefile	Agricultural Planning Survey Department Department of Census and Statistics Forest Department Department of Wildlife Conservation NBRO
3		Water Source for Drinking Water	Excel / Word	NWS&DB
4		Categorization		Laboratory
5	2.3 Monitoring data	Temperature Data	Excel	Meteorological Department
6		Rainfall	Excel	Meteorological Department
7		Water Level / Flow Rate	Excel	Irrigation Department
8		Ambient Water Monitoring	Excel	CEA Laboratory
9		Environmental Accident	Excel	EPC
10	2.4 Pollution source information	EPL / PSI	CSV data	CEA/ BOI
11		Compliance Monitoring	CSV data	CEA/ BOI
12		Complaints	Excel	CEA/ BOI
13		Industrial Zone	Information	CEA/ BOI
14		EIA Projects	Word	CEA/ BOI
15	2.5 Other activity in river basin	Sand Mining	Excel	GSMB
16		Gem Mining	Excel	NGJA
17	2.6 Awareness	Education, Seminars, and Training	Excel / Word	CEA

2.3 BASIC INFORMATION

(1) GIS Data

- **Summary of the Data:** Geographic Information System (GIS) is that captures, stores, manages and analyzes spatial data. It is commonly used to visualize the location with multiple layers such as administrative boundary, land use, population density and industry locations. These data can be managed by a GIS Software.

- **Purpose and Usage:** GIS data is used to display visually on the map the following layers: administration (showing provincial, district, local authority, DSD, and GND), roads, streamlines, industry location, water intake points, water monitoring points, etc.

No	Layer Name	File type	Data Source	Obtain procedure	Note
1	Kelani DSD (Admin)	SHP	CEA R&D Division	Request letter to CEA R&D Division Request letter to CEA R&D Division **for the Pop Housing, request letter to Department of Census	
2	Kelani_GND (Admin)	SHP			
3	Kelani_Province (Admin)	SHP			
4	Kelani Subbasin	SHP			
5	Kelani_SandMining	SHP			
6	Kelani_LU	SHP			

No	Layer Name	File type	Data Source	Obtain procedure	Note
7	Kelani_PopHousing	SHP		and Statistics	
8	Kelani_Reservoirs	SHP			
9	Kelani_Roads	SHP			
10	Kelani_SandMining	SHP	GSMB	Request letter to GSMB	
11	Kelani_WaterSampling CEA	SHP	CEA Laboratory	Request letter to CEA Laboratory	
12	Kelani_WatershedBND	SHP	CEA R&D Division	Request letter to CEA R&D Division	
13	Kelani_HydroMet	SHP			
14	Kelani_WBIntake	SHP	Water Board	Request letter to NWS&DB	
15	Kelani_Irrigation	SHP	CEA R&D Division	Request letter to CEA R&D Request letter to Irrigation Department	Location data taken from Irrigation Department website

(2) Water source for drinking water

- **Summary of the Data:** Water source is one of information of water use on (2) sec. 2.2. The information of drinking water source is critical information for river management.
- Purpose and Usage: Drinking water source is an important information needed to compare actual environmental conditions and the water source itself.

No	Layer / Table Name	File type	Source of data	Obtain procedure	Note
1	GIS Information: Design and Output Capacity	Excel File	NWS&DB	Request a letter to NWS&DB	
2	Monthly surface monitoring	Excel Word	NWS&DB	Request a letter to NWS&DB	

(3) Categorization

- **Summary of the Data:** Water Categorization are set up to river basin based on the Water quality categorization in line with water quality standard. The categorization will set on each sub-basin in river basin based on the major water use. Therefore, the data is summarized to list of sub-basin and designated category or as a map colored to categized.
- **Purpose and Usage:** The designated category is indicated to target values of water quality parameters in the sub-basin. The government can used the target values to evaluate with monitoring data.

No	Layer / Table Name	File type	Source of data	Obtain procedure	Note
1	Categorization	Excel File GIS map	EPL R&D Unit	Request letter to CEA R&D	

2.4 MONITORING DATA

(1) Temperature Data

- **Summary of the Data:** The temperature data from the Department of Meteorology is a collective district temperature measured monthly.
- **Purpose and Usage:** The data has an impact on the biological and chemical characteristics of surface water. It is important to closely monitor the temperature data to detect irregularities of water quality or characteristic.

No	Layer / Table Name	File type	Source of data	Obtain procedure	Note
1	GIS Information: Location Data	SHP	CEA R&D	Send request letter to CEA R&D Division	
2	Monthly Temperature Data (Minimum values)	Excel	Department of Meteorology	Send request letter to Meteorology Department; Request data from their IT department and purchase information (within the river basin boundary)	
2	Monthly Temperature Data (Maximum values)	Excel	Department of Meteorology	Send request letter to Meteorology Department; Request data from their IT department and purchase information (within the river basin boundary)	

(2) Rainfall

- **Summary of the Data:** A monthly rainfall data is provided by the Department of Meteorology per district.
- **Purpose and Usage:** The map that is generated from this data is important to identify which areas in the river basin are mostly wet or mostly dry in a year. This can help identify which part of the river basin manifests irregularities which can be a trigger for further observation of the area.

No	Layer / Table Name	File type	Source of data	Obtain procedure	Note
1	GIS Information: Location Data	SHP	CEA R&D	Send request letter to CEA R&D Division	
2	Monthly Rainfall	Excel	Department of Meteorology	Send request letter to Meteorology	

No	Layer / Table Name	File type	Source of data	Obtain procedure	Note
	Data			Department; Request data from their IT department and purchase information (within the river basin boundary)	

(3) Water Level / Flow Rate

- **Summary of the Data**: The Irrigation Department provides the water level and flow rate data of all major river basins in Sri Lanka. The data is displayed on the irrigation department website real time information publicly.

- **Purpose and Usage:** It is important to check if the water level and the flow rate are within the acceptable values. This information can be a basis of pollution presence in an isolated portion of the river.

No	Layer / Table Name	File type	Source of data	Obtain procedure	Note
1	GIS Information: Location Data	SHP	CEA R&D	Send request letter to CEA R&D Division	
2	Monthly Minimum, Maximum values of Water Level	Excel	Department of Irrigation	Send request letter to the Irrigation Department	
3	Monthly Flow Rate	PDF / Hard Copy Excel	Department of Irrigation	Send request letter to the Irrigation Department	

(4) Ambient Water Monitoring

- **Summary of the Data:** This information is monitored by the CEA Laboratory for monthly inspections. This data is taken from the water sampling location on the river basin and the officer retrieves parameter list such as pH, TSS, BOD, COD, etc.

- **Purpose and Usage:** The information is used to monitor the water quality of the river basin. It validates the cleanliness of the river in the presence of pollution-generating industries and human activities that can affect the quality of the river.

No	Layer / Table Name	File type	Source of data	Obtain procedure	Note
1	GIS Information: Location Data	SHP	CEA R&D	Send request letter to CEA R&D Division	
2	Water Sampling Locations	Excel	CEA Laboratory	Send request letter to the CEA Laboratory	

(5) Environmental Accident

- **Summary of the Data:** These are accidents identified as harmful to the environment. Reports of industries or infrastructures that concern the river basin are vital to record and identify the frequency of similar cases that can damage the environment.

- **Purpose and Usage:** Monitoring of environmental accidents occurring in the country should be stored in a database to analyze patterns of frequent accidents, location of accidents and industry-related accidents.

No	Layer / Table Name	File type	Source of data	Obtain procedure	Note
1	Environmental Accident - Year - Type of Accident - Location	Excel	EPC	Send request letter to EPC Division	

2.5 POLLUTION SOURCE INFORMATION

(1) EPL / PSI

- **Summary of the Data:** The EPL / PSI information contains information about the pollution-generating industries. These contains basic information from the industries, industry sector, location, type of pollution generated and environmental monitoring.

- **Purpose and Usage:** Getting all the up-to-date information from the industries can give an overview of an area according to pollution generated, industry sector or category and location.

No	Layer / Table Name	File type	Source of data	Obtain procedure	Note
1	Industry Basic Information (Location, Category, Sector, Nature of Industry, Contact)	Excel	PSI Database	Send request letter to CEA IT Unit	
2	Industry – Pollution Checklist	Excel	PSI Database	Send request letter to CEA IT Unit	
3	Industry Waste Water Effluent	Excel	PSI Database	Send request letter to CEA IT Unit	

(2) Compliance Monitoring

- **Summary of the Data:** CEA Officers visit industries for EPL application, renewal of application or investigation to assess the environmental standard compliance.

- **Purpose and Usage:** Inspection data is used to validate the number of industries that comply to the CEA standards.

No	Layer / Table Name	File type	Source of data	Obtain procedure	Note
1	Inspection Details: Inspection date, Officer Name, Inspection Status, Reason	Excel	PSI Database IT Unit	Send request letter to CEA IT Unit Send request letter to EPC Division	

(3) Complaints

- **Summary of the Data:** Complaint data is collected from CEA Complaint Unit database. Complaints are filed by the public about their area via phone calls, emails, etc. This information provides location-based complain and determine which area receives most complains and the type of complain.

- **Purpose and Usage:** This information can be used in planning and inspection.

No	Layer / Table Name	File type	Source of data	Obtain procedure	Note
1	Complaint Details: Complaint details ID Source ID District ID Refer date En pollution date Cmb province Complaint local authority Person received nature action date upload date final date ins date year	Excel / CSV	Complaint Database Complaint Unit	Send request letter to CEA IT Unit	

(4) Industrial Zone

- **Summary of the Data:** Industrial Zone is set as specific area with central treatment facility. Therefore, the effluent standard are regulate the discharge from zone through central treatment facility. The zone data is handle on as address or map images.

- **Purpose and Usage:** These data are used to idetify the distribution of magor pollutants source.

No	Layer / Table Name	File type	Source of data	Obtain procedure	Note
1	Industrial zone	Word GIS jpeg images	Ministry of industry and commerce and BOI	Sent to letter to Ministry of industry and commerce, or Obtain web site on BOI	

(5) Wastewater treatment facility

- **Summary of the Data:** CEA Officers visit industries for EPL application, renewal of application or investigation to assess the environmental standard compliance.
- **Purpose and Usage:** Inspection data is used to validate the number of industries that comply to the CEA standards.

No	Layer / Table Name	File type	Source of data	Obtain procedure	Note
1	Inspection Details: Inspection date, Officer Name, Inspection Status, Reason	Excel	PSI Database IT Unit	Send request letter to CEA IT Unit Send request letter to EPC Division	

(6) EIA Projects

- **Summary of the Data:** EIA information is collected from the CEA EIA Division Annual report. This is a list of industries applied for EIA and status (approved or rejected).
- **Purpose and Usage:** This data is used by CEA to identify industries that generate pollution in specific areas. The location of these industries may have a negative or positive effect on the environmental condition.

No	Layer / Table Name	File type	Source of data	Obtain procedure	Note
1	EIA Project Annual Report	Word/Excel	EIA	Send request letter to CEA EIA Unit	

2.6 OTHER ACTIVITY IN RIVER BASIN

(1) Sand Mining

- **Summary of the Data:** Sand mining data is a list of government sanction industries. This information overlaid with other information such as water quality in the river, complaint data and PSI data, can assess if an area has the potential to damage the environmental resources.

- **Purpose and Usage:** This type of information detects presence of potential environmental degradation in one location.

No	Layer / Table Name	File type	Source of data	Obtain procedure	Note
1	Sand Mining	Excel	GSMB	Send request letter to GSMB	

(2) Gem Mining

- **Summary of the Data:** Similar to Sand Mining, Gem Mining is a list of government sanction industries. This information overlaid with other information such as water quality in the river, complaint data and PSI data, can assess if an area has the potential to damage the environmental resources.

- **Purpose and Usage:** These types of industries have possibility to affect the quality of environmental condition of an area such as the water condition. It is important that these locations are closely monitored by the CEA to ensure environmental condition is livable.

No	Layer / Table Name	File type	Source of data	Obtain procedure	Note
1	Gem Mining Condition	Excel	GSMB	Send request letter to GSMB and NGJA	

2.7 AWARENESS

(1) Education, Training, and Seminar

- **Summary of the Data:** These are CEA efforts to inform the public about environmental practices and conditions of the country. It is important to conduct these awareness campaigns to let the public know the CEA projects as well.

- **Purpose and Usage:** The purpose of collecting this information is to recognize CEA efforts to publicly disseminate information about the importance of a healthy living environment and to assess which type of awareness should be conducted in an area and for each set of people.

No	Layer / Table Name	File type	Source of data	Obtain procedure	Note
1	Environmental Trainings etc.	Excel, Word	CEA EEA	Send internal memo to CEA and request for this type of information Particularly in EEA	

Chapter 3. DATA ANALYSIS

3.1 CHECK RELIABILITY OF COLLECTED DATA

Reliability of the collected data is depended on the source department. For this reason, it is difficult to confirm the reliability after collecting data, but you can check Careless miss including input error etc. In particular, it is necessary to sufficiently confirm the data to be disclosed. Here is shown a confirmation example of collected monitoring data.

3.2 RELATIONSHIP AMONG WATER QUALITY PARAMETERS

This method is a data analysis method for observation data such as river water. Normally, a certain correlation is often obtained between observation items, for example, both COD and BOD observe organic pollution indices, so if the same water source/observation point is used, it shows a certain correlation regardless of environmental water or factory wastewater. Also, if it is river water in the tide zone, most of EC originates from sea water content, so it shows a high correlation between EC – Cl^-.

Besides this, chlorophyll-a is an indicator of algae, it produces DO by photosynthesis during the day time, and it consumes DO by breathing at night, while at the same time it raises pH by discharging carbon dioxide. It is important to understand the bio-chemical changes and to confirm the observation results.

(1) COMPARISON OF LAST YEAR

It is also important to compare observation data with past results. The factory wastewater has almost the same wastewater concentration and amount unless the product type and supply amount are changed, or if the treatment facility is changed. Even in river water shows seasonal changes, if there is no change in the pollution source, the same tendency will be shown every year. Therefore, if there is a significant change compared with the past data, it is important to investigate the factor and to confirmation of input errors etc.

3.3 DOUBLE CHECK SYSTEM

After confirming the reliability of collected data, each department shown in Table 2-1 shows the summary of information included in the current information management system. Important information such as data type (file extension) and source data. A detailed information for each category item is explained in Section 2-2 and the subsequent pages.

Table 2-1 creates charts for information disclosure. Also, the created chart is performed the double check by staff who is different from the creator, such as whether is using wrong data or whether is selecting easy-to-see graph/color.

Chapter 4. DATA MANAGEMENT AND STORAGE

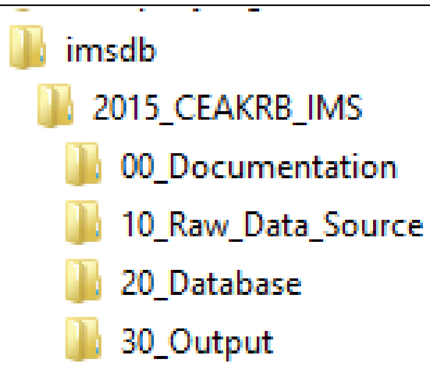
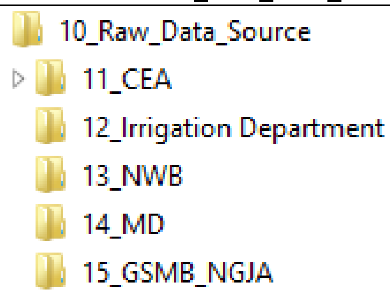
4.1 DATA MANAGEMENT

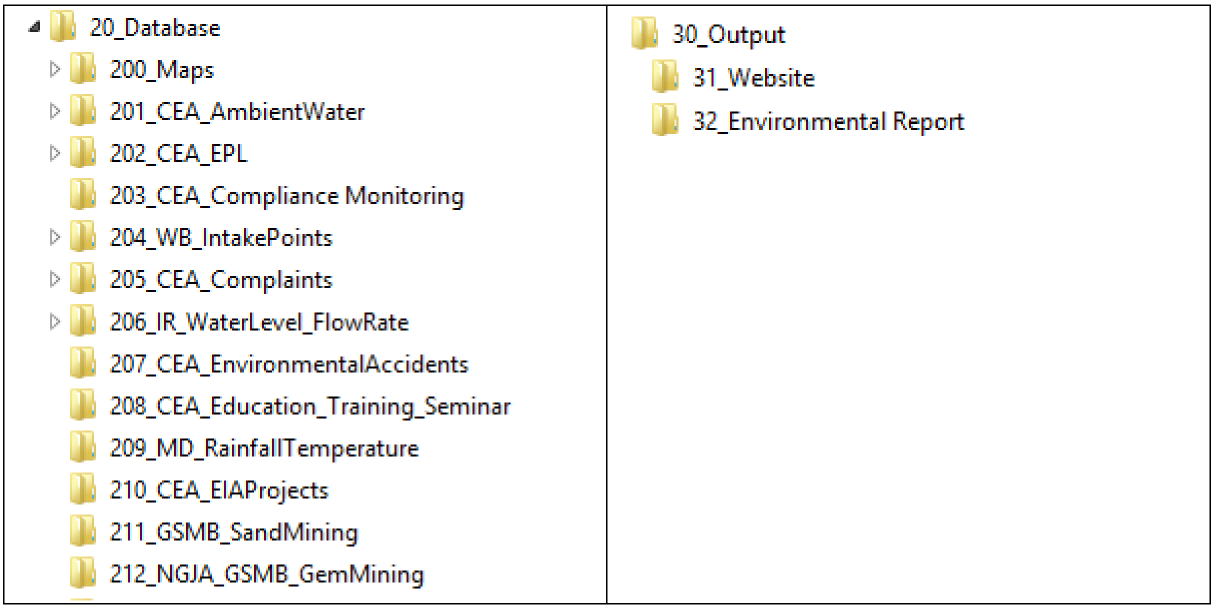
Once the data is collected and consolidated, the responsible unit will hand over the data to the next responsible unit for the second step in the database management.

No	Responsibility	Division
1	Data Collection	Planning Unit
1.1	Data validation	
1.2	Prepare and send request letters of memos to the related agencies and CEA unit	
1.3	Collection / Follow up the data from all sources of data	
1.4	Hand over to database management responsible unit	
2	Database Management	
2.1	Preparation of Tables and Charts	IT Unit
2.2	Preparation of Maps	R&D
2.3	Update website	IT Unit
2.4	Environmental Report Output Preparation	IT Unit / R&D
2.5	Backup	IT Unit

4.1.1 FOLDER SYSTEM

The files collected will be strictly stored in the folder system below:

<table>
<tr><th colspan="2">Main Folder</th></tr>
<tr><td colspan="2">
</td></tr>
<tr><th>00_Documentation</th><th>10_Raw_Data_Source</th></tr>
<tr><td>00_ParameterList
Step 1_Collection.xlsx
Step 2_Database Management.docx
Step 3_Data Upload and Environmental Report.docx
01_ HardwareSoftwareChecklist.docx
02_ DataRequestLog.xlsx
03_ Timeline.xlsx</td><td>
</td></tr>
<tr><th>20_Database</th><th>30_Output</th></tr>
</table>



4.1.2 00_DOCUMENTATION

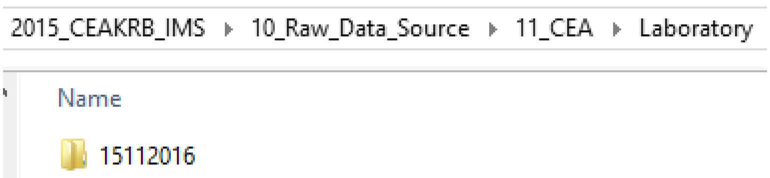
This folder contains the documentation of handling the database step by step.

1. Parameter List
2. Collection
3. Database Administration
4. Data Upload and Environmental Report
5. HardwareSoftwareChecklist.docx
6. DataRequestLog.xlsx
7. Timeline.xlsx

4.1.3 10_RAW_DATA_SOURCE

This contains the information collected from sources. Naming conventions are not strict because these are collected format from the sources. However, it is important to take note of the date it was collected. Make a folder and rename it as [Date Collected].

Example:



FOLDER SYSTEM		
11_CEA		
	Complaint	
	EIA	
	EPC	
	IT Unit	

	Laboratory	
	R&D Division	
12_Irrigation Department		
	Irrigation-WaterLevel.xlsx	
	20161025	
		Kelani 2015 - 2016 Jun discharges.xlsx
		Irrigation Data.pdf
13_NWB		
	Kelani river intakes & GPS_Mod.xls	
	Labugama Kalatuwa Capacity.docx	
	RWQ_2015_2016_Intake_Kalani river	
		RWQ_KALAINI RIVER_2015
		RWQ_KALANI_RIVER_2016
	SHP	
	WB_GPS.csv	
14_MD		
	colombo t min.xls	
	colombo tm max.xls	
	rf.xls	
15_GSMB_NGJA		
	Mineral Data including river sand data Islandwide.xls	

*** data as of 2016

4.1.4 20_DATABASE

The folders inside 20_Database is organized according to Source and Type of Information.

2	0	0	_	M	A	P	S
1	2	3	4	5	6	7	8

2	0	1	_	C	E	A	_	E	P	L
1	2	3	4	5	6	7	8	9	10	11

Guide:

Number	Description
1 – 2	Folder name (20_Database)
3	Folder Number
4	Separator
5 – 7 or 8	Source / MAPS (because it has multiple source)
8	Separator
9 – 11	Type of Information

No	Main Folder	Files / Folders	Files/Folders	Description/ Sub Folders
1	200_Maps			Maps from multiple sources (R&D, MD, IR, etc.)
		00_SHP	Kelani_District Kelani_DSD Kelani_GND Kelani_FlowRateMeasuringLoc_ID Kelani_GSMB_SandMining Kelani_Hydro Kelani_HydroMetNetwork_MD Kelani_Industry Kelani_IR_MeasuringLocation Kelani_LU Kelani_PopHousing Kelani_Province Kelani_Reservoirs Kelani_Subbasin Kelani_WaterSamplingLoc Kelani_WB_IntakePoints	
		01_LYR	Kelani_District.lyr Kelani_DSD.lyr Kelani_MD_HydroMet.lyr Kelani_Sand Mining.lyr Kelani_WaterSamplingLoc.lyr	Layer files used for Symbology
		02_Scripts	DDPExport.py IMS SCRIPT.tbx	ConvertCSVtoSHP DDPtoJPEG ExportToSHP_CSV Rainfall_Generate Script SelectKelaniOnly ****Description**** Scripts are used for automating multiple commands in ArcGIS.

No	Main Folder	Files / Folders	Files/Folders	Description/ Sub Folders
		03_RASTER	Apr Aug Dec Feb Jan Jul Jun Mar May Nov Oct Sep	Raster files
1.1		10_JPG	201_CEA_AmbientWater_KRB.jpg 201_CEA_AmbientWater_KRB_O76001.jpg 201_CEA_AmbientWater_KRB_O76002.jpg 201_CEA_AmbientWater_KRB_O76003.jpg 201_CEA_AmbientWater_KRB_O76004.jpg 201_CEA_AmbientWater_KRB_O76005.jpg 201_CEA_AmbientWater_KRB_O76006.jpg 201_CEA_AmbientWater_KRB_O76007.jpg 201_CEA_AmbientWater_KRB_O76008.jpg 201_CEA_AmbientWater_KRB_O76009.jpg 201_CEA_AmbientWater_KRB_O76010.jpg 201_CEA_AmbientWater_KRB_O76011.jpg 201_CEA_AmbientWater_KRB_O76012.jpg 201_CEA_AmbientWater_KRB_O76013.jpg 201_CEA_AmbientWater_KRB_O76014.jpg 201_CEA_AmbientWater_KRB_O76015.jpg 201_CEA_AmbientWater_KRB_O76016.jpg 201_CEA_AmbientWater_KRB_O76017.jpg 203_WB_IntakePoints_KRB.jpg 203_WB_IntakePoints_KRB_WB01.jpg 203_WB_IntakePoints_KRB_WB02.jpg 203_WB_IntakePoints_KRB_WB03.jpg	Output from Maps in JPEG format

No	Main Folder	Files / Folders	Files/Folders	Description/ Sub Folders
			203_WB_IntakePoints_KRB_WB04.jpg 203_WB_IntakePoints_KRB_WB05.jpg 203_WB_IntakePoints_KRB_WB06.jpg 203_WB_IntakePoints_KRB_WB07.jpg 203_WB_IntakePoints_KRB_WB08.jpg 203_WB_IntakePoints_KRB_WB09.jpg 203_WB_IntakePoints_KRB_WB10.jpg 203_WB_IntakePoints_KRB_WB11.jpg 203_WB_IntakePoints_KRB_WB12.jpg 203_WB_IntakePoints_KRB_WB13.jpg 203_WB_IntakePoints_KRB_WB14.jpg 203_WB_IntakePoints_KRB_WB15.jpg 206_IR_WaterLevel_KRB.jpg 209_MD_RainfallTemperature_KRB.jpg 209_MD_Rainfall_KRB 1.jpg 209_MD_Rainfall_KRB 2.jpg 209_MD_Rainfall_KRB 3.jpg 209_MD_Rainfall_KRB 4.jpg 211_GSMB_SandMining.jpg	
1.2		20_PDF		Output maps in PDF format
1.3		201_CEA_AmbientWater_KRB.mxd		Map work document for editing
1.4		201_CEA_AmbientWater_KRB_DDP.mxd		Map work document for editing
		202_CEA_EPLPSIReport_KRB.mxd		Map work document for editing
		203_WB_IntakePoints_KRB.mxd		Map work document for editing
		203_WB_IntakePoints_KRB_DDP.mxd		Map work document for editing
		206_IR_WaterLevel_KRB.mxd		Map work document for editing
		209_MD_Rainfall_KRB.mxd		Map work document for editing
		209_MD_Temperature_KRB.mxd		Map work document for editing
		211_GSMB_SandMining.mxd		Map work document for editing
2	201_CEA_AmbientWater			Water Sampling Location data
		Charts	[StationID]_[Chart Number]	All exported charts
		01_KRB.xlsm		Template Format
3	202_CEA_EPL			EPL / PSI Data

No	Main Folder	Files / Folders	Files/Folders	Description/ Sub Folders
		00_CSV		Raw file taken from the PSI System server c/o IT Unit
			epl_report_2015.csv	
			psi_report_2015.csv	
		01_RB Location Data		Selected data within the selected River Basin
			104_CEA_EPLReport_KRB.csv	
			104_CEA_PSIReport_KRB.csv	
			EPLIndustry.shp	
			KRB_EPLIndustry.shp	
			KRB_PSIIndustry.shp	
			PSIIndustry.shp	
		02_RB Table		River basin table
			104_CEA_EPLReport_KRB.csv	
			104_CEA_PSIReport_KRB.csv	
		00_Template_Charts.xlsm		
		03_Charts		Output charts from the 00_Template_Charts
			Charts	
				EPLR_Indu.png
				EPLR_Indu_RB.png
				EPLR_Sec.png
				EPLR_Sec_RB.png
				EPLR_Sec_RB_A.png
				EPLR_Sec_RB_B.png
				PSIR_Air_A.png
				PSIR_Air_RB_A.png
				PSIR_SW_A.png
				PSIR_SW_RB_A.png
				PSIR_WW_A.png
				PSIR_WW_RB_A.png
			PDF	
				102_CEA_EPLReport_Industry.pdf

No	Main Folder	Files / Folders	Files/Folders	Description/ Sub Folders
				102_CEA_EPLReport_Sector.pdf
				103_CEA_PSIReport_Air.pdf
				104_CEA_EPLReport_KRB_Industry.pdf
				104_CEA_EPLReport_KRB_Sector.pdf
				104_CEA_PSIReport_KRB_Air.pdf
				104_CEA_PSIReport_KRB_Noise.pdf
				104_CEA_PSIReport_KRB_SW.pdf
				104_CEA_PSIReport_KRB_WW.pdf
			Tables	
				102_CEA_EPLReport_Annual.xlsx
				103_CEA_PSIReport_Annual.xlsx
				104_CEA_EPLReport_KRB_Annual.xlsx
				104_CEA_PSIReport_KRB_Annual.xlsx
4	203_CEA_Compliance			Data from Inspection report in PSI System
5	204_WB_IntakePoints			Water board data
		Charts		Charts generated from the XLSM template
			WB_AMB_01.png	
			WB_AMB_02.png	
			WB_AMB_03.png	
			WB_AVS_01.png	
			WB_AVS_02.png	
			WB_AVS_03.png	
			WB_DHW_01.png	
			WB_DHW_02.png	
			WB_DHW_03.png	
			WB_GNG_01.png	
			WB_GNG_02.png	
			WB_GNG_03.png	
			WB_HRT_01.png	
			WB_HRT_02.png	
			WB_HRT_03.png	

No	Main Folder	Files / Folders	Files/Folders	Description/ Sub Folders
			WB_KRB_01.png	
			WB_KRB_02.png	
			WB_KRB_03.png	
			WB_KSG_01.png	
			WB_KSG_02.png	
			WB_KSG_03.png	
			WB_MRN_01.png	
			WB_MRN_02.png	
			WB_MRN_03.png	
			WB_MSK_01.png	
			WB_MSK_02.png	
			WB_MSK_03.png	
			WB_PGD_01.png	
			WB_PGD_02.png	
			WB_PGD_03.png	
			WB_RWN_01.png	
			WB_RWN_02.png	
			WB_RWN_03.png	
		Tables	RWQ_KALAINI _RIVER_2015	Raw data from Water Board
				01.Ginigathhena,Hatton,Maskeliya
				02.KRB
				03.Pugoda
				04.Dehiowita,Ruwanwella
				06
				07.Moronthota
		01_KRB_WB.xlsm		
6	205_CEA_Complaints			
		Tables		
			105_Complaints_Pollution.xls	
			105_Complaints_Source_WP.xls	
		Allcomplain_sinhala.xlsx		

No	Main Folder	Files / Folders	Files/Folders	Description/ Sub Folders
7	206_IR_WaterLevel_Flow Rate			
		Source	Irrigation Data.pdf Kelani 2015 - 2016 Jun discharges.xlsx	
		Irrigation-WL_FR_Template.xlsm		
8	207_CEA_EnvironmentalA ccidents	EAccidents_Template.xlsm		
9	208_CEA_Education_Train ing_Seminar	CEA_Awareness_Template.xlsm		
10	209_MD_RainfallTemperat ure			
		MD_Temperature.xlsm		
		MD_Rainfall_Template.xlsm		
		Source	colombo t min.xls colombo t max.xls rf.xls	
		RainfallData.csv		
		Temperature.csv		
11	210_CEA_EIAProjects			
		EIATemplate.xlsm		
		Source	ANNUAL REPORT 2015.doc EIA and IEE projects.pdf	
12	211_GSMB_SandMining	Kelani_GSMB_SandMining.xls		
13	212_GSMB_GemMining	********NO DATA AVAILABLE IN KELANI RIVER JUST ONE AVAILABLE*******		

4.1.5 30_OUTPUT

No	Folder	Folder	Description
1	31_Website	00_StateOfKelani	No content
		01_LandUse	Kelani River Basin Land Use
		02_Admin BND	Administrative Boundaries
		03_Subbasin	KRB Sub basin
		04_Industrial Zone	KRB Industrial Zone
		05_AgroEco Zone	Agro Ecological Zone
		06_Intake with Treatment Facility	Water Board Data (Intake with Treatment Facility)
		07_WaterLevel	Irrigation Department data (Water Level)
		10_Weather	No content
		11_Temperature	Meteorological Department (Temperature)
		12_Rainfall	Meteorological Department (Rainfall)
		20_Water Quality	No Content
		21_WQStandard	Water Quality Standard (CEA Laboratory) Reference
		22_LatestWQInfo	Water Quality Standard (CEA Laboratory) Monthly
		23_PastWQInfo	Water Quality Standard (CEA Laboratory) Annual
		30_EPL Condition	EPL Condition (PSI System)
		30_PSI Condition	EPL Condition (EPL System)
		40_HydroPower	Hydropower in KRB
		50_Mining	KRB Sand and Gem Mining
		60_Download	Download Page
2	32_Environmental Report		

4.2 DATA STORAGE

(1) HARDWARE REQUIREMENTS

Hardware requirements for the IMS are:

1) Desktop Computer – Local storage of IMS during data preparation. Software requirements should be installed.
2) Physical Server – The IT Unit has provided a server not only for data storage of the IMS but also for the PSI System.

(2) SOFTWARE REQUIREMENTS

The software requirements for the IMS are:

1) ArcGIS – This is Geographic Information Software used to create, edit and analyze spatial data.
2) MS Office (MS Access extension) – Microsoft Excel and Microsoft Access shall be used in this project in generating charts and tables for the website and environmental report.
3) Windows Operating System

(3) ARCHIVING DATA

Data archive or backup refers to creating a copy on another computer or creating a restoration point on the OS to avoid data loss due to accident or security breach. In Windows OS, creating restoration point should be done annually to prevent data deletion or corruption. For yearly update, archive the previous year's data to another folder for distinction.

4.3 UPDATING / CREATING NEW DBMS FOR OTHER RIVER BASINS IN SRI LANKA

In the IMSDB Folder, a template folder system shall be populated with data. Each year, the database administrator will have fresh folder without content to recreate the previous year's data. Some data, especially the website may need more technical skills for updating and creating but templates are already provided and additional code can be added.

4.4 UPDATE SCHEDULE OF THE DATA

Necessary data have to update on annually, and storage to the unified database following to below schedule. As a general process of updating information, 1) check the update schedule for each information source, 2) prepare request letter for information sharing, etc. in accordance with information update schedule, 3) perform actual data collection activities, 4) Create a new Chart with the collected data, 5) Upload the updated information to the Web site, and concurrently 6) create an environmental report.

Table 4-1 Update schedule

Activity	XX	XY											XZ
	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
1) Check the updated data to each source														
2) Start to data collection procedure														
3) Data collection/ up-date														
4) Output preparation														
5) Upload to web-site														
6) Prepare annual report														

Chapter 5. PUBLISH DATABASE

5.1 APPROVAL PROCESS OF PUBLISHING INFORMATION

Regarding collected environment-related data and prepared charts, please obtain approval of information disclosure by the following procedure that can disclose information. In particular, please consult with concerning department about data from out of CEA, and relevant data on the factory.

(1) INFORMATION BY CEA

After prepared a publishing data, show the draft images of chart etc. with web images, obtain a permission from D.G. of CEA.

(2) INFORMATION BY OUTSIDE OF CEA

Information disclosure of data on the outside of CEA is basically limited to display on the CEA website. Also, even on display on the web, we will process it into a chart, summary, etc. so that specific numerical values will not come out. It is advisable to avoid displaying the collected data directly in tabular form.

When showing information of outside of the CEA on the CEA website, it is necessary to show the concrete display example to the data source organization and obtain permission to disclose the information and obtain DG's permission on the CEA website.

5.2 PREPARATION OF PUBLISH DATABASE AND FIGURES/ CHARTS

After confirming the reliability of collected data according to in Cap.3, prepare the necessary chart and text.

(1) Data that can download

Data that can be downloaded is limited. Currently, we can download only the monitoring data of the Kelani River. For other data, it is limited to display on the website.

Download of water quality data of Kelani River is made into PDF file to prevent data alteration. Downloading in the form of excel, word, CSV etc. is not allowed.

(2) Data that shows only

Most information is limited to display only on the website. However, in order to update the information every year, it is required to create the chart or table. Basically, a drawing will update information according to past case. For some charts, you can create a chart of the same type as currently viewing by using the master file managed by IT Unit. The charts that can be created with the master file are as follows. For other information without this master file, you need to create it in consultation with the responsible division.

Table 5-1 Master file and available charts

No	Parameter	Input	Type	Output	Public	CEA/Agencies	Remarks
1	Ambient Water						
1.1		CSV	Chart	Selected Parameter Each Location Annual	x	x	
1.2			Chart	Parameter Each Location Annual / Category Standard	x	x	
2	EPL / PSI	CSV	Chart	No of EPL Application Received (Year)	x		
			Chart	No of EPL Application Received (Year) in KRB	x		
			Chart	No of EPL Application Received (Year) by Sector	x		
			Chart	No of EPL Application Received (Year) by Sector in KRB	x		
			Table	No of EPL Application Received (Year)	x		
			Table	No of EPL Application Received (Year) in KRB	x		
			Table	No of EPL Application Received (Year) by Sector	x		
			Table	No of EPL Application Received (Year) by Sector in KRB	x		
			Chart	No of Category A that emits Air Pollution	x		
			Chart	No of Category A that emits Air Pollution in KRB	x		
			Chart	No of Category A that emits A	x		
			Chart	No of Category A that generates solid waste	x		
			Chart	No of Category A that generates solid waste in KRB	x		
			Chart	No of Category A that generates waste water	x		
			Chart	No of Category A that generates waste water in KRB	x		
3	Complaints	Excel	Table	Number of Complaints for each type		x	
			Table	Number of Complaints from each Source		x	

No	Parameter	Input	Type	Output	Public	CEA/Agencies	Remarks
4	Water Board Intake Points	Excel /Word	Chart	Water board selected parameters each location	x		
			Map	Water board each sampling location KRB	x		
			Map	Water board sampling location in Kelani River Basin	x		
6	Water Level / Flow Rate	Excel / PDF	Map	Water level each sampling location (Mean, Min, Max)	x		
			Chart	Flow rate	x		
7	Environmental Accident	Excel	Table	Environmental Accidents	x		
8	Education / Training / Seminar	Excel	Table	Awareness Program	x		
9	Rainfall /Temperature Data	Excel	Map	Hydro meteorological stations in Kelani River Basin	x		
			Chart	Monthly temperature (min, ave, max)	x		
			Map	Rainfall Data	x		
10	EIA Projects	Word	Table	EIA Projects approved		x	
11	GIS Data	SHP				x	
12	Sand Mining	Excel	Map	Sand mining location (According to Type of Mineral)		x	
13	Gem Mining	Excel	Map	Location		x	

No	Parameter	Input	Type	Output	Public	CEA/Agencies	Remarks

Chapter 6. DATA SHARING

Data sharing, unlike information disclosure, is information sharing within the relevant administrative organizations. This guideline shows the scope of current information sharing. However, since policies on data handling may change according to the times, it is desirable to consult with concerned departments and related organizations, if data management rules are suspected.

6.1 AUTHORITY/ DEPARTMENT THAT CAN BE SHARING THE DATA

#	Category	Items	Data source	Sharable organizations	Note
1	Basic data	GIS Data		CEA, BOI, NWS&DB, ID, MoIC	
2		Water use		CEA, BOI, NWS&DB, ID, MoIC	
3		Water source for drinking water		CEA, BOI, NWS&DB, ID, MoIC	
4		Categorization		CEA, BOI, NWS&DB, ID, MoIC	
5	Monitoring data	Temperature Data		CEA, BOI, NWS&DB, ID, MoIC	
6		Rainfall		CEA, BOI, NWS&DB, ID, MoIC	
7		Water Level / Flow Rate		CEA, BOI, NWS&DB, ID, MoIC	
8		Ambient Water monitoring		CEA, BOI, NWS&DB, ID, MoIC	
9		Environmental Accident		CEA, BOI, NWS&DB, ID, MoIC	
10	Pollution source information	EPL / PSI	CEA/ BOI	CEA, BOI, NWS&DB, ID, MoIC	
11		Inspection	CEA/ BOI	CEA, BOI, NWS&DB, ID, MoIC	
12		Complaints	CEA/ BOI	CEA, BOI, NWS&DB, ID, MoIC	
13		Industrial Zone	CEA/ BOI	CEA, BOI, NWS&DB, ID, MoIC	
14		Wastewater treatment facility	CEA/ BOI	CEA, BOI, NWS&DB, ID, MoIC	
15		EIA Projects	CEA/ BOI	CEA, BOI, NWS&DB, ID, MoIC	
16	Other activity in river basin	Sand Mining		CEA, BOI, NWS&DB, NGJA, GSMB, ID, MoIC	
17		Gem Mining		CEA, BOI, NWS&DB, NGJA, GSMB, ID, MoIC	
18	Awareness	Education, Training, and Awareness	CEA	CEA, BOI, NWS&DB, ID, MoIC	

Chapter 7. SECURITY ON INFORMATION SYSTEM

7.1 KEY ISSUES OF DATA SECURITY

(1) Unauthorized Access to the Information System of Non-CEA Affiliated Organization / Group

The Information Management System is secured inside the physical server / desktop in CEA. External attackers can still access the system to steal data and damage the system without proper security protocol. Physical measures are advised such as installation of anti-virus software and malware and close monitoring of users with full control and access to the information system.

(2) Unofficial Distribution of Information by CEA Staff

CEA Staff has access to the information stored inside the database. Some have authorization to get a soft / hard copy of the information. Security issue is triggered when staff share the information to public or private sector unofficially without proper permission from management. Safety is reduced by limiting the access rights to the information and moral conduct of staff.

(3) Accidental Information Sharing

Undisclosed information is kept privately and can only be shared with authorized agencies and divisions only. Negligence of handling this type of information such as accidentally sending e-mail to the wrong recipient, losing USB or stealing office laptop with sensitive information. The safety management for this type of risk is primary to establish internal rules of information management methods and ensure that staff members act accordingly to these rules.

(4) Information Technology Policy of Information Management in CEA

New IT policy should be established together with the new information management system in CEA. This is to ensure information security and proper handling of information within the CEA and related agencies.

7.2 GENERAL SECURITY FOR DATA STORAGE COMPUTER AND SERVER

(1) Software Security System Specifications

These are some additional security measures to ensure no information will not leaked publicly and virus and malware protection. First line of defence is password protection.

No	Security Protocol	Server Windows 2008	Windows 10
1	Password Authentication	x	x
2	User Account Control	x	x
3	Backup and recovery	x	x
4	Malware Protection	x	x

Password Authentication – the first line of defence of system access. The system will require a user name and a password and verify the credentials.

User Account Control - the process of authorizing users, groups, and computers to access objects on the network by using permissions, user rights, and object auditing.

Backup and File Recovery – Windows has a backup and restore functionality. It creates a restore point in case there is a problem in the system, files have been deleted or system malfunction. It will automatically go back to the restoration point configured by the user.

Malware Protection – these are software installed in a system that prevents outside (internet) malicious intrusions to the system and database.

(2) Hardware and Software Maintenance

The division in charge should check the hardware and software annually to prevent its deterioration. The table below shows the activities to be conducted for maintenance.

No	Hardware	Software
1	Place in a cool and dry place.	Scan system errors
2	Keep away from direct sunlight	Regular Defragment
3	Keep liquids away from the computer	Malware protection updated and always on
4	All cables should be working and untangled	Check Disk usage
5	Defective cables should be replaced	Backup files monthly / annually
6	Should be dust-free	Update OS
7	Check computer / server component if working	Change Authentication Annually

(3) Systematic Information Dissemination and Collection

The division in charge should be able to properly document the ministry, unit or individual person that from the database. It will monitor the number of organization or people that has the copy of the data. This will also track unofficial data used by other agencies without approval from the CEA higher management. The following record should be logged:

1. **No** - Request number
2. **Ministry** - Name of ministry
3. **Division** - Name of division
4. **Name** - Name of person requested
5. **Date Requested** - Date requested
6. **Data Needed** - Description of needed data from the database
7. **Purpose** - Purpose of request
8. **Format** - Format needed (Table, PDF, Image, etc)
9. **Data Given** - Date given by division in charge

Chapter 8. THE POLICY OF ENVIRONMENTAL REPORT

8.1 PURPOSE OF ENVIRONMENTAL REPORT

The Environmental Report is prepared to publicize the actual condition of the water environment in Sri Lanka to the public widely. Even say a simply the water environment, it is not only river water quality, its flow rate and water use situation, in addition to the activities of CEA to maintain and improve the water environment, etc. should also be included in the report.

There are 103 major river basins in Sri Lanka, and not enough observations are implemented in all watersheds. Also, since the workload in creating the Annual Environmental Report is also great, CEA should carefully consider the target river basin to be created, the renewal year, etc.

8.2 BASIC STRUCTURE OF ENVIRONMENTAL REPORT

Basically, the composition of the environmental report shall include the topics in the table below. However, there is a possibility that sufficient data cannot be gathered depending on the monitoring situation of each target river basin, so the composition is judged each time.

Table 8-1 Basic Composition of Environmental Report

Chapter	Contents	Note
Map etc		It shows a map etc. of the target basin
Chapter 1 State of the Target River Basin	1.1 Summary of Target River and the Basin 1.2 Population and the density on each LA/ DSD 1.3 Water Use 1.4 Land Use 1.5 Specific Zone 1.6 Gem and Sand Mining 1.7 Rainfall data 1.8 Temperature data 1.9 Flowrate data	It shows basic information of the target basin.
Chapter 2 Water Quality of the Target River	2.1 Ambient Water Quality Standard 2.2 Water Quality Objectives (Classification) in river basin 2.3 Monitoring point 2.4 Monitoring results	It shows water quality of the target basin.
Chapter 3 Industrial Information	3.1 EPL System and Management 3.2 Industrial information on each LA 3.3 Inspection Work 3.4 Compliance of industry 3.5 Others	Indicates industrial information which is one source of pollution in the target river basin., and inspection result etc.,
Chapter 4 Waste management	4.1 4.2	
Chapter 5 Other Activities		It shows CEA activities in the target basin.
Chapter 6 Challenges and Recommendation		Present environmental conservation issues and recommendations in the target watershed.

End of Document

Appendix-1 Hardware and Software Maintenance Checklist

CHECKLIST

No	SOFTWARE	Check
1	Scan for system errors	
2	Regular Defragment of drive	
3	Malware protection updated and always on	
4	Check Disk usage	
5	Backup files monthly / annually	
6	Update Operating System / Software Update	
7	Change Authentication Annually	

No	HARDWARE	Check
1	Place in a cool and dry place.	
2	Keep away from direct sunlight	
3	Keep liquids away from the computer	
4	All cables should be working and untangled	
5	Defective cables should be replaced	
6	Wipe dust with dry cloth	
7	Check computer / server component if working	

Appendix-2 Data request log sheet

No	Ministry	Division	Name	Date Requested	Data Needed	Purpose	Format	Data Given
1								
2								
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Appendix-3 Database Collection Timeline

APPENDIX 4. DATABASE COLLECTION AND MANAGEMENT TIMELINE

		20xx	20xx												20xx
No		**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**
1	GIS Data														
2	Water Source for Drinking Water														
3	Categorization														
4	Temperature Data														
5	Rainfall														
6	Water Level / Flow Rate														
7	Ambient Water Monitoring														
8	Environmental Accident														
9	EPL / PSI														
10	Compliance Monitoring														
11	Complaints														
12	Industrial Zone														
13	EIA Projects														
14	Sand Mining														
15	Gem Mining														
16	Education, Seminars, and Training														

Notes:

TIMELINE		
		Database Collection
1st week of the month		1.1 Check the required data for the database
2nd week of the month		1.2 Prepare and send request letters and memos to data source
First week of the month; Weekly Follow up		1.3 Collection / Follow up data from all sources
1st week of the month		1.4 Hand over data to database management responsible unit
		Database Management
2nd week of the month		2.1 Prepare Maps
2nd week of the month		2.2 Prepare tables and charts
3rd Week of month		2.3 Update website
4th Week of the month		2.4 Environmental Report Preparation
4th Week of the month		2.6 Backup

Appendix-4 Parameter List

No	Parameter	Input	Type	Output	Public	CEA/ Agencies	Remarks
1	**Ambient Water**						
1.1		CSV	Chart	Selected Parameter Each Location Annual	x	x	
1.2			Chart	Parameter Each Location Annual / Category Standard	x	x	
2	**EPL / PSI**	CSV	Chart	No of EPL Application Received (Year)	x		
			Chart	No of EPL Application Received (Year) in KRB	x		
			Chart	No of EPL Application Received (Year) by Sector	x		
			Chart	No of EPL Application Received (Year) by Sector in KRB	x		
			Table	No of EPL Application Received (Year)	x		
			Table	No of EPL Application Received (Year) in KRB	x		
			Table	No of EPL Application Received (Year) by Sector	x		
			Table	No of EPL Application Received (Year) by Sector in KRB	x		
			Chart	No of Category A that emits Air Pollution	x		
			Chart	No of Category A that emits Air Pollution in KRB	x		
			Chart	No of Category A that emits A	x		
			Chart	No of Category A that generates solid waste	x		
			Chart	No of Category A that generates solid waste in KRB	x		
			Chart	No of Category A that generates waste water	x		
			Chart	No of Category A that generates waste water in KRB	x		
3	**Complaints**	Excel	Table	Number of Complaints for each type		x	
			Table	Number of Complaints from each Source		x	
4	**Water Board Intake Points**	Excel /Word	Chart	Water board selected parameters each location	x		
			Map	Water board each sampling location KRB	x		
			Map	Water board sampling location in Kelani River Basin	x		
6	**Water Level / Flow Rate**	Excel / PDF	Map	Water level each sampling location (Mean, Min, Max)	x		
			Chart	Flow rate	x		
7	**Environmental Accident**	Excel	Table	Environmental Accidents	x		
8	**Education / Training / Seminar**	Excel	Table	Awareness Program	x		
9	**Rainfall /Temperature Data**	Excel	Map	Hydro meteorological stations in Kelani River Basin	x		
			Chart	Monthly temperature (min, ave, max)	x		
			Map	Rainfall Data	x		
10	**EIA Projects**	Word	Table	EIA Projects approved		x	
11	**GIS Data**	SHP				x	
12	**Sand Mining**	Excel	Map	Sand mining location (According to Type of Mineral)		x	
13	**Gem Mining**	Excel	Map	Location		x	

Appendix-5 Step 1 Collection

Name	
Date	
Division	

		Data Collection							Database Management										Website Update			
No	Parameter	Check data	Prepare Request Letter / Memo	Send Letter / Memo	Date Sent	Collected Date	Format	Collected From	Collect Data from RU	Organize Files and Folders	Prepare Template	Import to MS Access	Import to MS Excel	Generate Charts	Generate Tables		Update Map Folder	Generate Maps		Rename Charts	Rename Images	Rename Documents	Edit Code

Appendix-6 Step 2 Database Administration

STEP 2. DATABASE ADMINISTRATION

Information Management System Documentation

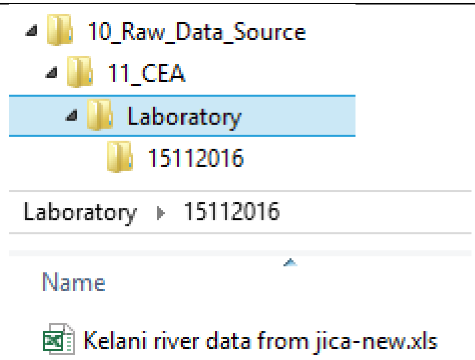
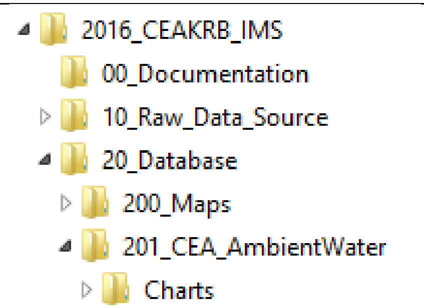
JICA

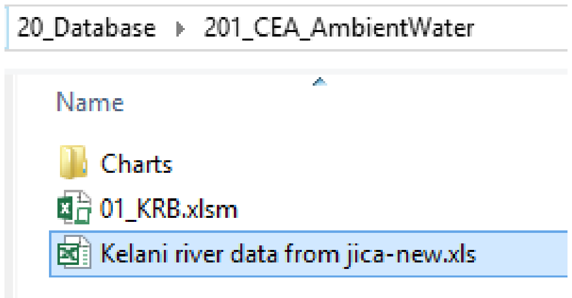
12/1/17

I. Introduction

This document will show the step by step procedure that will help serve as a guideline for the administrator/s in preparation of the necessary output for the website and environmental report.

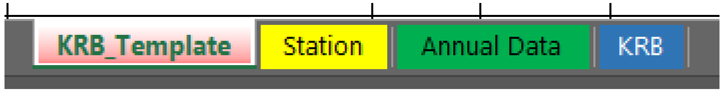
II. Database Administration

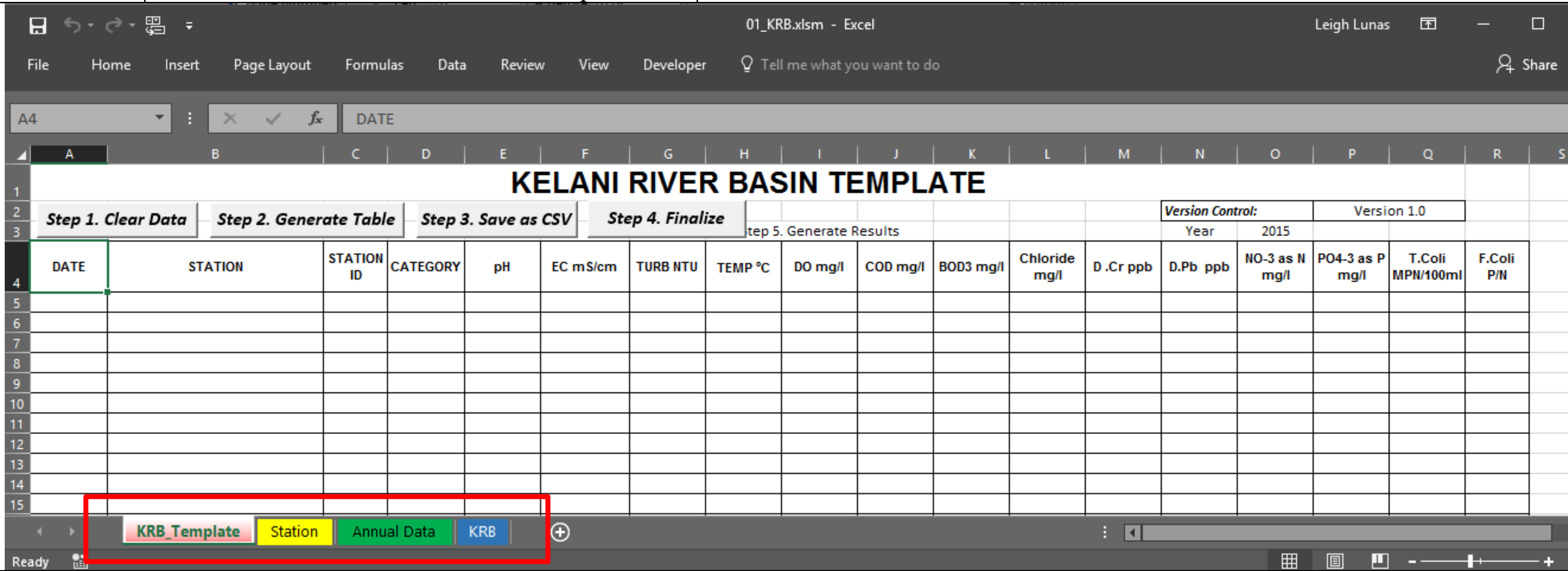
No	Parameter	Main Task	Screen Shot
1	Ambient Water	1.1 From database collection, copy the file to assigned folder in 10_Raw_Data_Source \\2016_CEAKRB_IMS\10_Raw_Data_Source\11_CEA\Laboratory\15112016	
		1.2 COPY the excel file to assigned folder in 20_Database	



1.3 Open in MS Excel 01_KRB.xlsm
- It is a Macro Excel Book
- KRB means “Kelani River Basin”
- Check the Tab Sheets
- Activated Tab should be “KRB Template”

Tab Sheets





1.4 There are Buttons available:
STEP 1. Clear Data
STEP 2. Generate Table

		STEP 3. Save as CSV STEP 4. Finalize	Step 3. Save as CSV · Step 4. Finalize
		1.5 Check "STATION" Tab Sheet and check the stations available in Kelani River Basin. Check the correct **CATEGORY**	(see Station sheet below)
		1.6 Change the **YEAR** accordingly	

Sampling Location	StationID	Category
Parawalathanna Bridge	O76016	A
Karawanella Bridge	O76015	B
Anguruwella Bridge	O76014	A
Malibada, Nakkawita	O76017	B
Thalduwa Bridge	O76012	A
Seethawaka Ferry	O76013	A
Pugoda Intake	O76010	A
Hanwella Bridge	O76008	A
Kaduwela Bridge	O76005	A
Welivita bridge	O76003	D
Victoriya Bridge (Japan Friendship)	O76001	D
Pugoda Ela	O76011	A
Wak Oya Bridge	O76009	A
Pussali Oya	O76007	B
Maha Ela Bridge	O76006	B
Raggahawatte Ela	O76004	A
Kolonnawa Ela	O76002	C
New Bridge Peliyagoda		

KRB_Template | Station | Annual Data | KRB

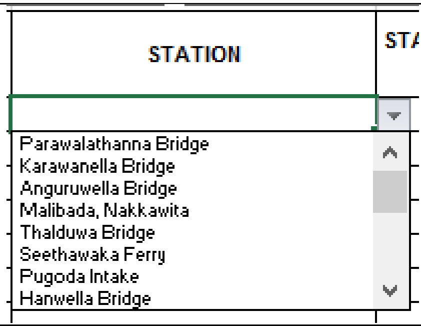
KELANI RIVER BASIN TEMPLATE

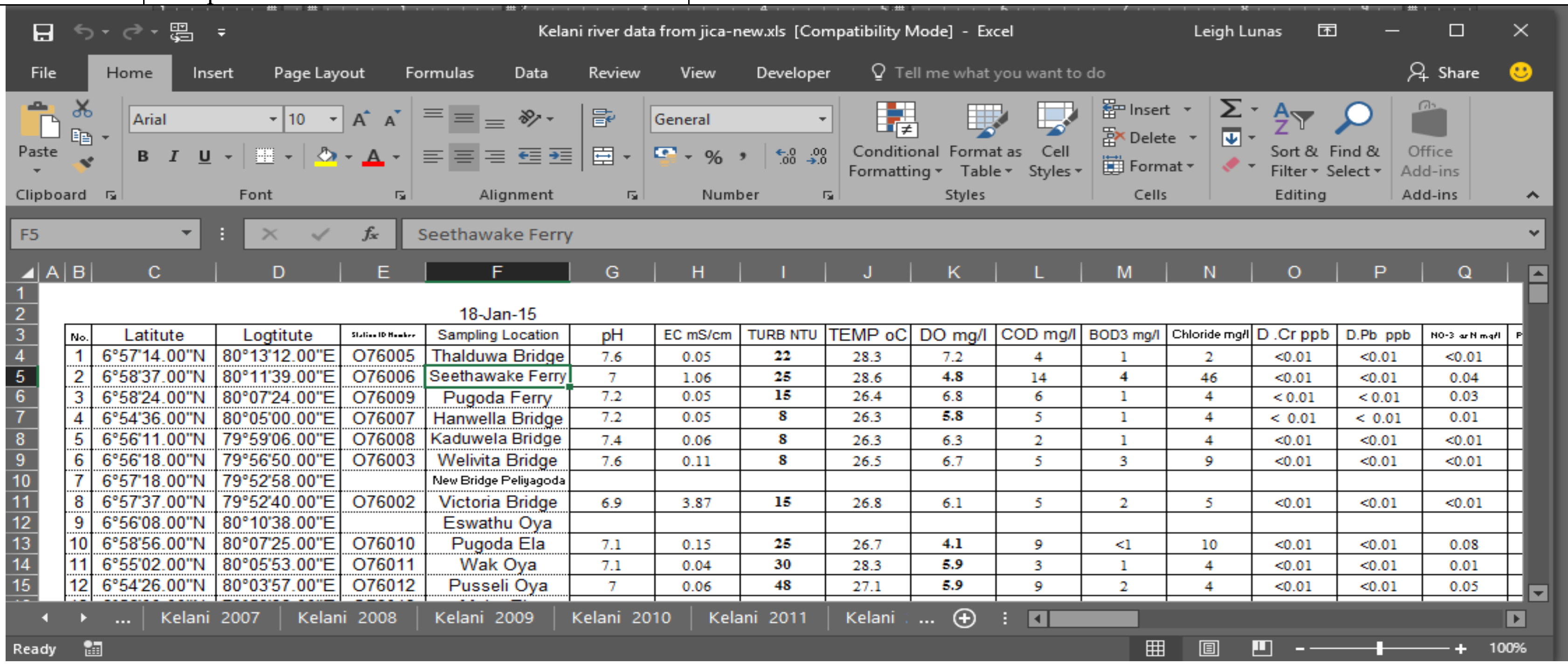
Step 1. Clear Data | Step 2. Generate Table | Step 3. Save as CSV | Step 4. Finalize | Step 5. Generate Results

Version Control: Version 1.0

Year: 2015

DATE	STATION	STATION ID	CATEGORY	pH	EC mS/cm	TURB NTU	TEMP °C	DO mg/l	COD mg/l	BOD3 mg/l	Chloride mg/l	D .Cr ppb	D.Pb ppb	NO-3 as N mg/l	PO4-3 as P mg/l	T.Coli MPN/100ml	F.Coli P/N
18-Jan-15	Thalduwa Bridge	O76012	A	7.6	0.05	22	28.3	7.2	4	1	2	0.01	0.01	0.01	0.02	1400	800
18-Jan-15	Seethawaka Ferry	O76013	A	7	1.06	25	28.6	4.8	14	4	46	0.01	0.01	0.04	1	2800	1700
18-Jan-15	Pugoda Intake	O76010	A	7.2	0.05	15	26.4	6.8	6	1	4	0.01	0.01	0.03	0.02	2200	1300
18-Jan-15	Hanwella Bridge	O76008	A	7.2	0.05	8	26.3	5.8	5	1	4	0.01	0.01	0.01	0.02	2400	1300
18-Jan-15	Kaduwela Bridge	O76005	A	7.4	0.06	8	26.3	6.3	2	1	4	0.01	0.01	0.01	0.04	5000	2400
18-Jan-15	Welivita Bridge	O76003		7.6	0.11	8	26.5	6.7	5	3	9	0.01	0.01	0.01	0.15	5000	1300
18-Jan-15	New Bridge Peliyagoda	0	0														
18-Jan-15	Victoriya Bridge (Japan Friendship)	O76001		6.9	3.87	15	26.8	6.1	5	2	5	0.01	0.01	0.01	0.1	3000	1300
18-Jan-15	Eswathu Oya	0	0														

		1.7 Back in KRB_Template Tab, If you click a record under "Station" column, a list of station encoded in "Station" Tab. *** Make sure all the encoded have the same name. **Ex. Thalduwa – Thalduwa = correct!** **Thalduwa – Thaldwaa = wrong!**	
		1.8 Open in MS Excel original ambient water data. In the 01_KRB file, click **Step 1. Clear** Data to remove existing data from the "KRB Template".	



	Step 1. Clear Data		
		1.9 Copy paste according to Header **Original** = Template **Sampling Location** = Station **pH** = pH **EC mS/cm** = EC mS/cm **TURB NTU** = TURB NTU **TEMP oC** = TEMP oC **DO mg/l** = DO mg/l **COD mg/l** = COD mg/l **BOD3 mg/l** = BOD3 mg/l **Chloride mg/l** = Chloride mg/l **D .Cr ppb** = D .Cr ppb **D.Pb ppb** = D.Pb ppb **NO-3 as N mg/l** = NO-3 as N mg/l **PO4-3 as P mg/l** = PO4-3 as P mg/l **T.Coli MPN/100ml** = T.Coli MPN/100ml **F.Coli P/N** = F.Coli P/N ** Get the Date per record	

KELANI RIVER BASIN TEMPLATE

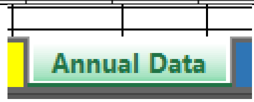
Step 1. Clear Data | Step 2. Generate Table | Step 3. Save as CSV | Step 4. Finalize | Step 5. Generate Results

Version Control: Version 1.0

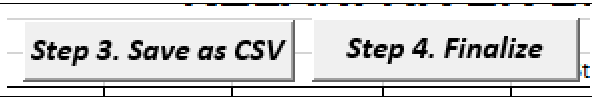
Year 2015

DATE	STATION	STATION ID	CATEGORY	pH	EC mS/cm	TURB NTU	TEMP °C	DO mg/l	COD mg/l	BOD3 mg/l	Chloride mg/l	D .Cr ppb	D.Pb ppb	NO-3 as N mg/l	PO4-3 as P mg/l	T.Coli MPN/100ml	F.Col P/N
18-Jan-15	Thalduwa Bridge	O76012	A	7.6	0.05	22	28.3	7.2	4	1	2	0.01	0.01	0.01	0.02	1400	800
18-Jan-15	Seethawaka Ferry	O76013	A	7	1.06	25	28.6	4.8	14	4	46	0.01	0.01	0.04	1	2800	1700
18-Jan-15	Pugoda Intake	O76010	A	7.2	0.05	15	26.4	6.8	6	1	4	0.01	0.01	0.03	0.02	2200	1300
18-Jan-15	Hanwella Bridge	O76008	A	7.2	0.05	8	26.3	5.8	5	1	4	0.01	0.01	0.01	0.02	2400	1300
18-Jan-15	Kaduwela Bridge	O76005	A	7.4	0.06	8	26.3	6.3	2	1	4	0.01	0.01	0.01	0.04	5000	2400
18-Jan-15	Welivita Bridge	O76003		7.6	0.11	8	26.5	6.7	5	3	9	0.01	0.01	0.01	0.15	5000	1300
18-Jan-15	New Bridge Peliyagoda	0	0														
18-Jan-15	Victoriya Bridge (Japan Friendship)	O76001		6.9	3.87	15	26.8	6.1	5	2	5	0.01	0.01	0.01	0.1	3000	1300
18-Jan-15	Eswathu Oya	0	0														
18-Jan-15	Pugoda Ela	O76011	A	7.1	0.15	25	26.7	4.1	9	1	10	0.01	0.01	0.08	0.03	≥16000	5000
18-Jan-15	Wak Oya Bridge	O76009	A	7.1	0.04	30	28.3	5.9	3	1	4	0.01	0.01	0.01	0.09	16000	2400
18-Jan-15	Pussali Oya	O76007	B	7	0.06	48	27.1	5.9	9	2	4	0.01	0.01	0.05	0.05	9000	1300
18-Jan-15	Maha Ela Bridge	O76006	B	6.9	0.12	19	27.4	4.4	11	2	16	0.01	0.01	0.02	0.09	9000	500
18-Jan-15	Raggahawatte Ela	O76004	A	7.2	0.34	16	27.9	4.9	13	2	32	0.01	0.01	0.05	0.89	9000	1700
8-Feb-15	Thalduwa Bridge	O76012	A	7.7	0.04	158	28.3	5.8	14	1	2	0.01	0.01	0.01	0.06	9000	2400

2.0 Click button “Step 2. Generate Table” to generate table in “Annual Data” Tab

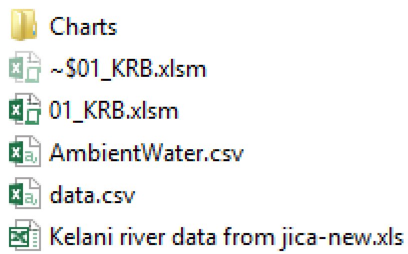


2.1 Click button “Step 3. Save as CSV” to save annual data as CSV file and “Step 4. Finalize”

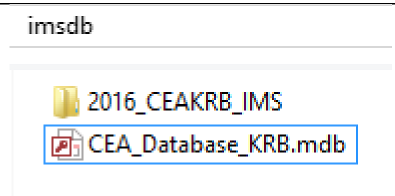
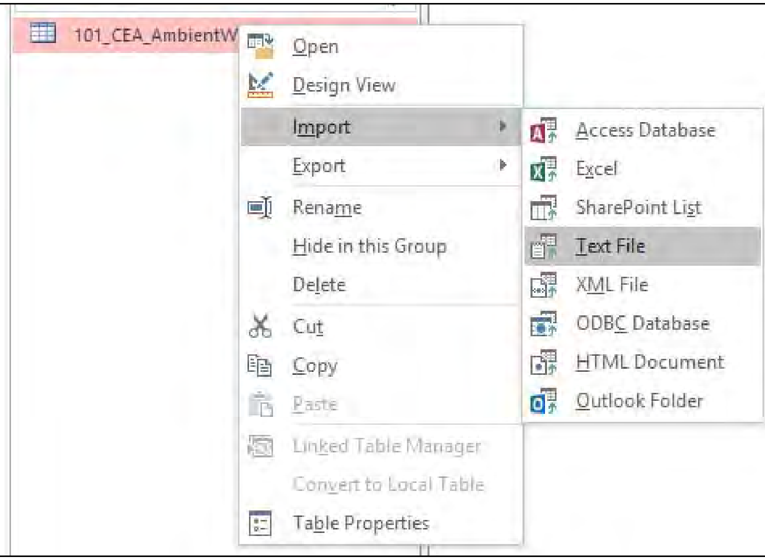


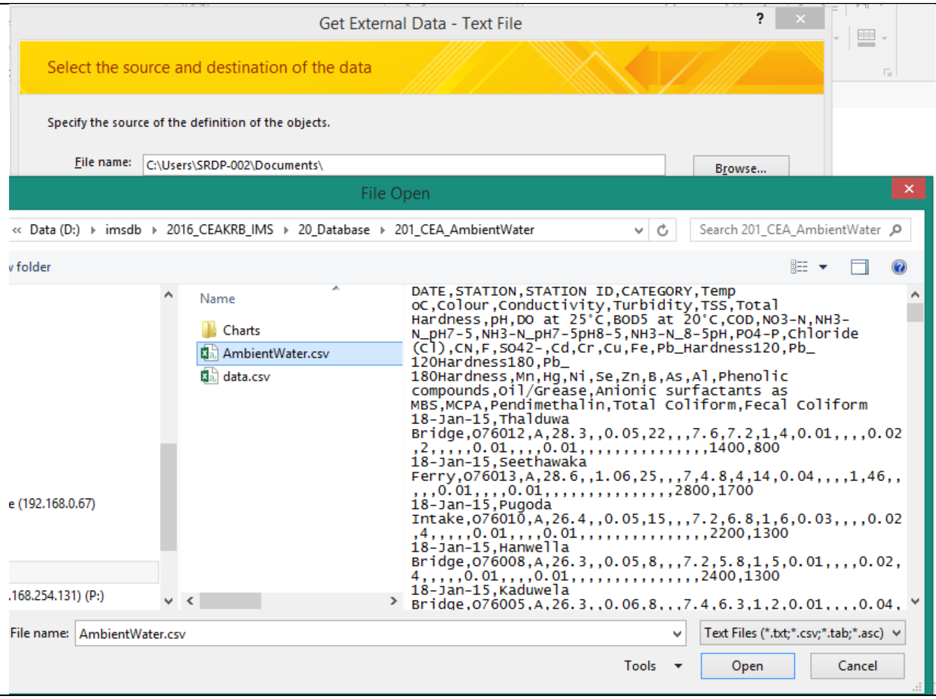
2.2 Check the folder again. You will see two additional data
data.csv and AmbientWater.csv

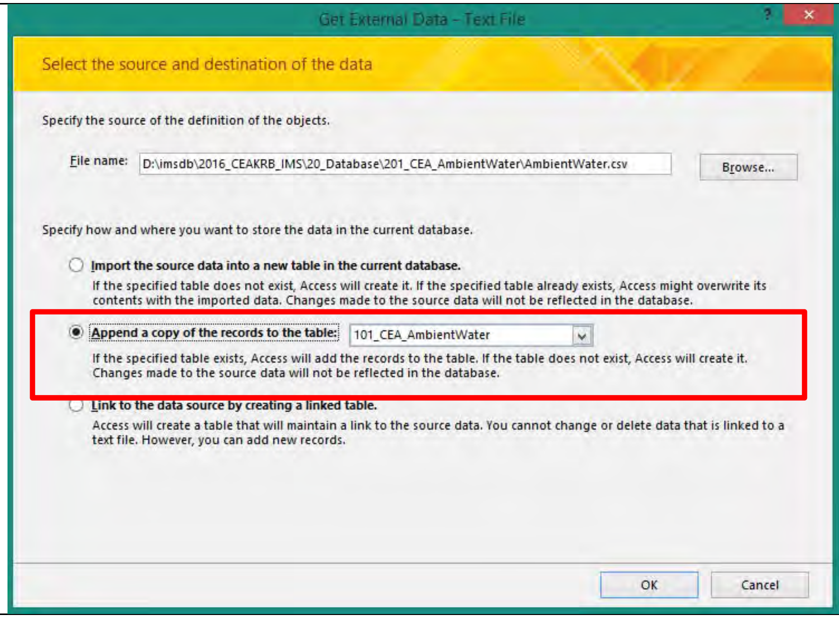
Then **SAVE 01_KRB.xlsm**

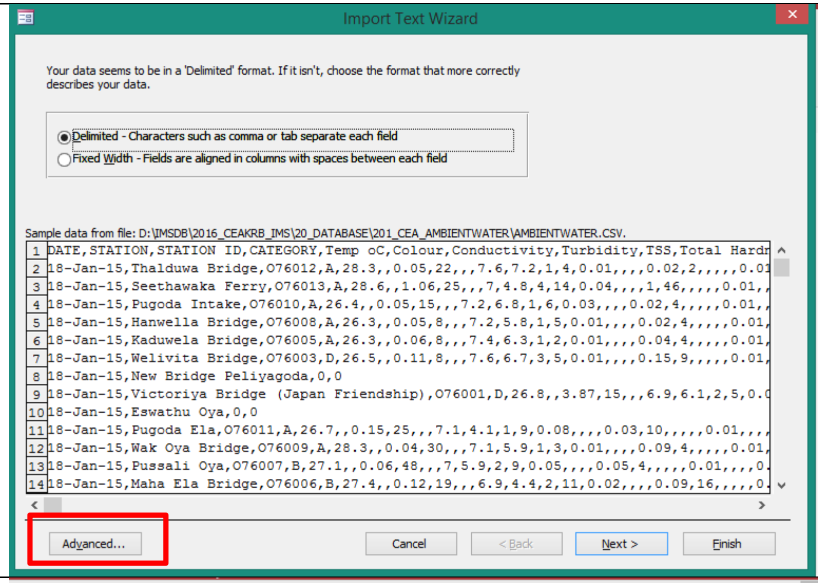


2.3 Open MS Access database located here:

<table>
<tr><td></td><td></td><td>
</td><td></td></tr>
<tr><td></td><td></td><td>2.4 Import data. Right click on the table 101_CEA_AmbientWater and select import
- select text file
- locate AmbientWater.csv</td><td>
</td></tr>
</table>

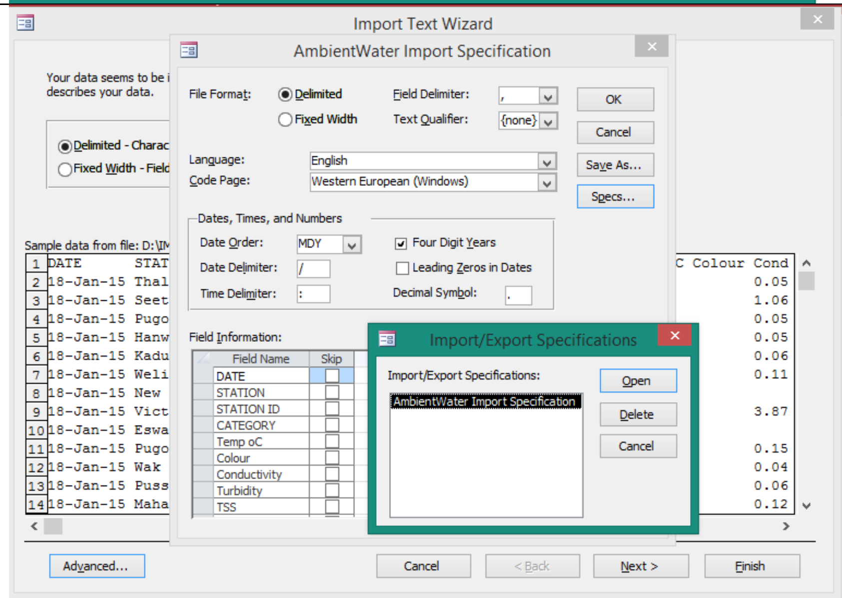
			Get External Data - Text File
Select the source and destination of the data
Specify the source of the definition of the objects.
File name: C:\Users\SRDP-002\Documents\
Browse...
File Open
Data (D:) imsdb 2016_CEAKRB_IMS 20_Database 201_CEA_AmbientWater
Search 201_CEA_AmbientWater
Name
Charts
AmbientWater.csv
data.csv
File name: AmbientWater.csv
Text Files (*.txt;*.csv;*.tab;*.asc)
Tools
Open
Cancel

<table>
<tr><td></td><td></td><td>2.4 Append a copy of the records to the table
- select 101_CEA_AmbientWater</td><td>
</td></tr>
<tr><td></td><td></td><td></td><td>Click Advanced</td></tr>
</table>

<table>
<tr>
<td></td>
<td></td>
<td></td>
<td>
</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.5 Select SPECS then Import/Expect Specifications: AmbientWater_ImportSpecification

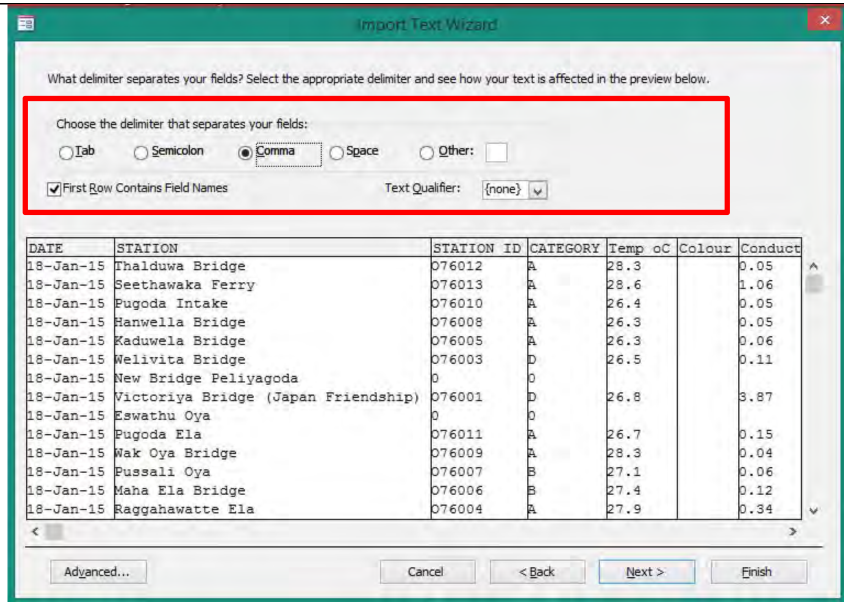
Click OPEN

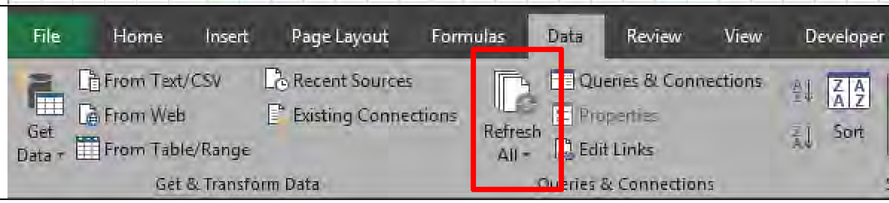
Click OK

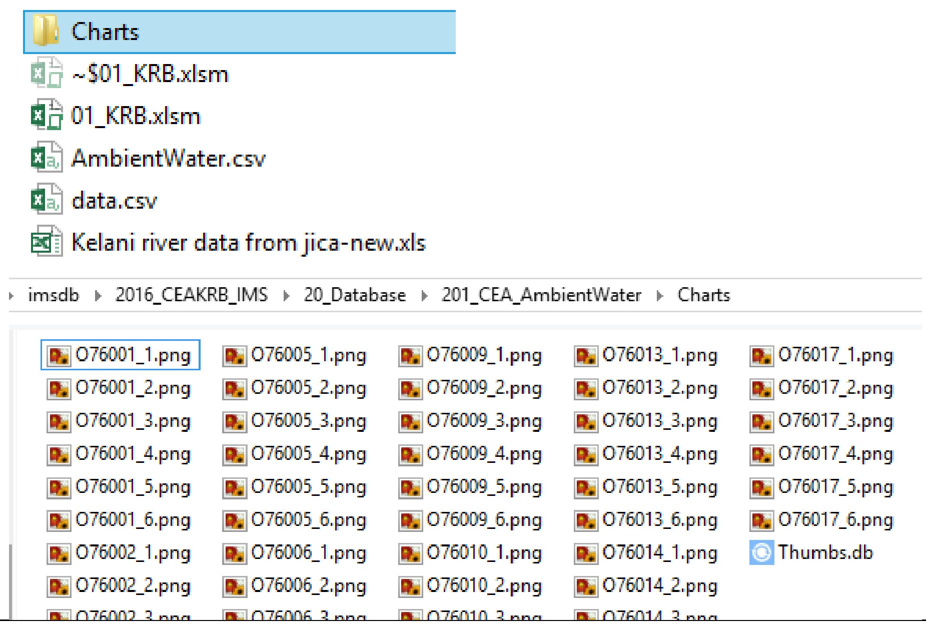
Click NEXT.</td>
<td>
</td>
</tr>
</table>

<table>
<tr><td></td><td></td><td>2.6 Import Text Wizard. Make sure First Row Contains Field Names should be checked and delimiter should be Comma

Click Next.

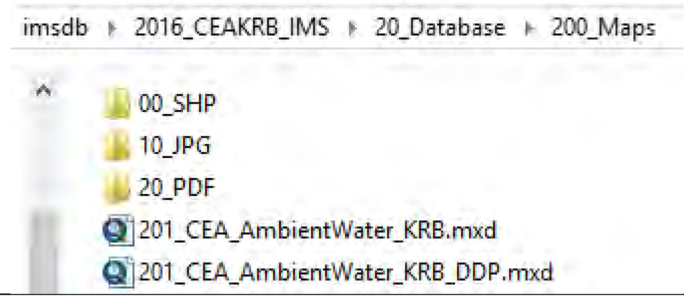
Click Finish.</td><td>
</td></tr>
<tr><td></td><td></td><td>2.7 Open 01_KRB.xlsm again and click “KRB” Tab.

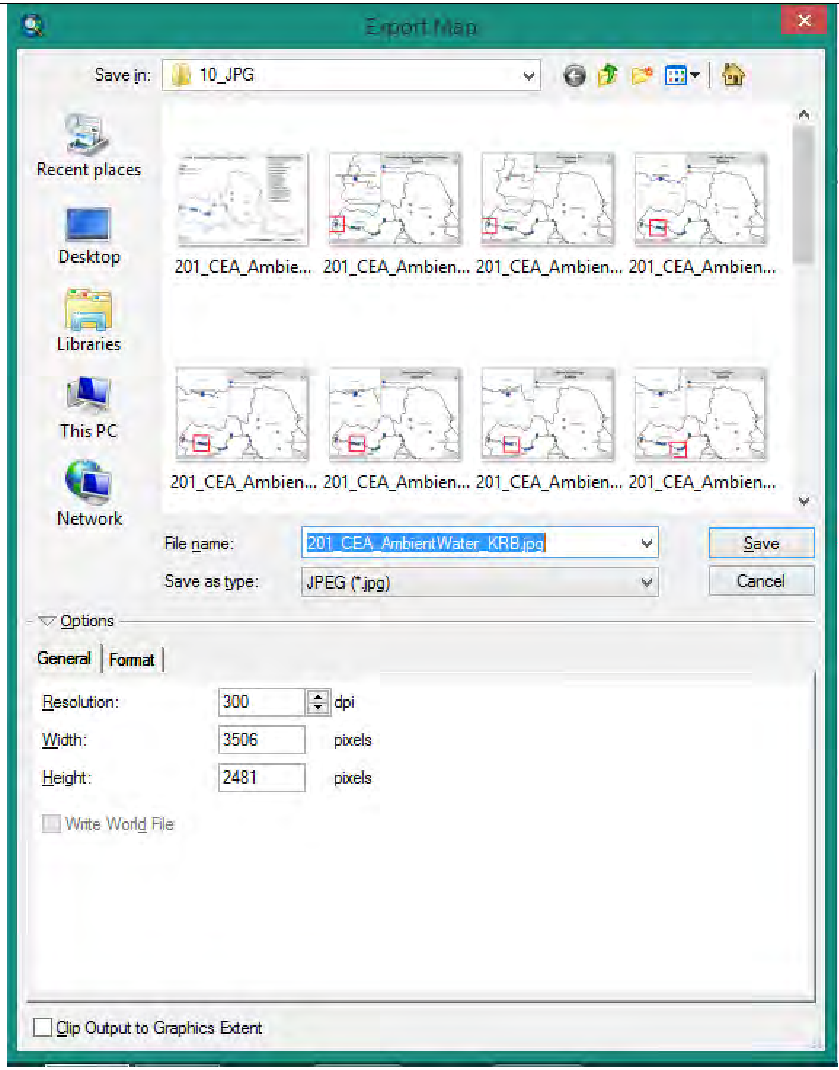
Charts are already prepared for exporting.</td><td>
</td></tr>
<tr><td></td><td></td><td>2.8 Refresh all
Go to DATA tab then click Refresh All</td><td>
</td></tr>
</table>

		2.9 Click **Export Charts** Button Automatically, all the charts will be generated in the folder CHARTS. File name is [StationID]_[Chart Number].	
		3.0 Files are ready for Website and Environmental Report.	
	2.0 EPL PSI Data		

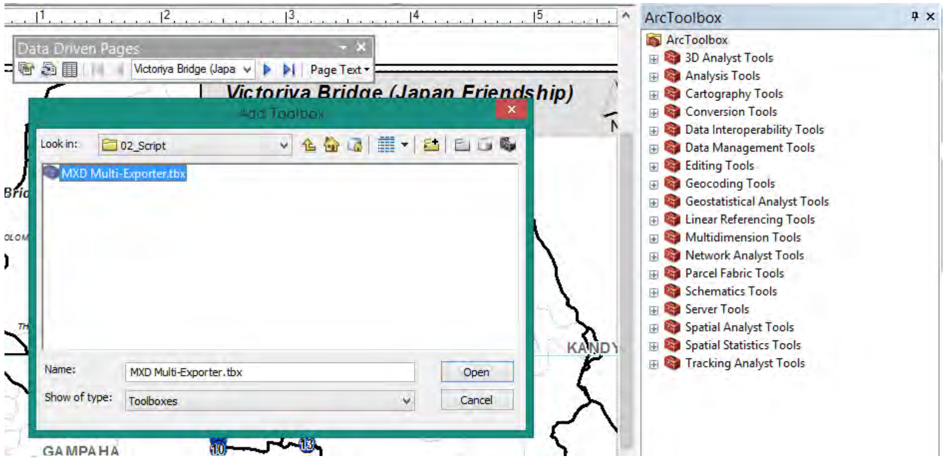
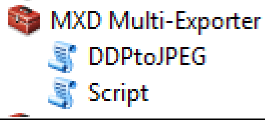
III. Map Preparation

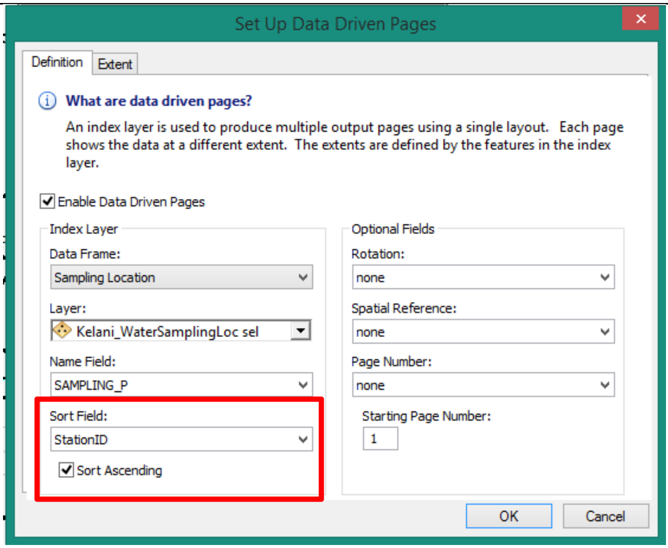
No	Task	Screenshot

1	Location: //2016_CEAKRB_IMS/20_Database/200_Maps	
2	**FOLDER / FILE**	**DESCRIPTION**
	00_SHP	Contains all the shapefiles
	01_LYR	Contains layers file to standardize the symbology for each shapefile
	10_JPG	Contains output in JPG format
	20_PDF	Contains output in PDF format
	201_CEA_AmbientWater_KRB.mxd	Website – Water quality monthly
	201_CEA_AmbientWater_KRB_DDP.mxd	Website – Water quality monthly each station
3	If there are new SHP, replace the SHP inside the 00_SHP folder.	
4	Open MXD file of the map you want to update. The shapefile is already updated. Just save the file accordingly.	
5	**Exporting Map (One by One)** 201_CEA_AmbientWater_KRB.mxd	Go to File -> Export Map ->



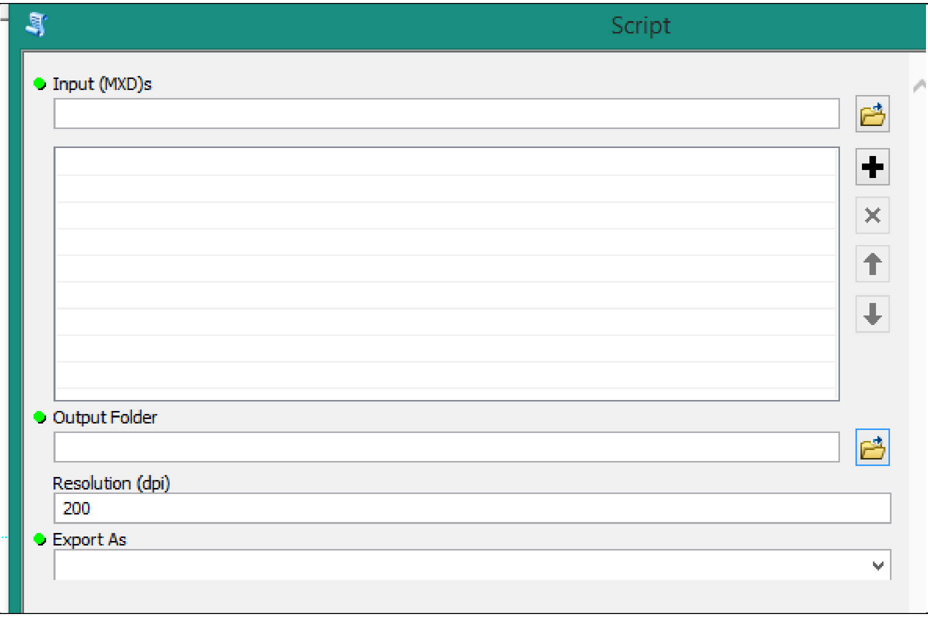
Save here:
\\imsdb\2016_CEAKRB_IMS\20_Database\200_Maps\10_JPG

6	**Exporting Map (Multiple Data)**	Add Toolbox:  
6.1	**DDP to JPEG:** - For Data Driven Pages Export MXD File – MXD Source ex. “201_CEA_AmbientWater_KRB_DDP.mxd File Name – Name of Output ex. “201_CEA_AmbientWater_KRB_” DDPSortingField – name of field for sorting in DDP	



DPI = Dots Per Inch (Resolution) ex. 300

<table>
<tr>
<td>6.2</td>
<td>Script (Multiple MXD printing)

Input (MXD)s – import MXDs for printing
Output Folder – Store in //10_JPG
Resolution (dpi) – Dots Per Inch
Export As – JPG or PNG or PDF</td>
<td>
</td>
</tr>
</table>

Appendix-7 Step 3 Data Upload and Environmental Report

STEP 3. DATA UPLOAD AND ENVIRONMENTAL REPORT

Information Management System Documentation

JICA

12/1/17

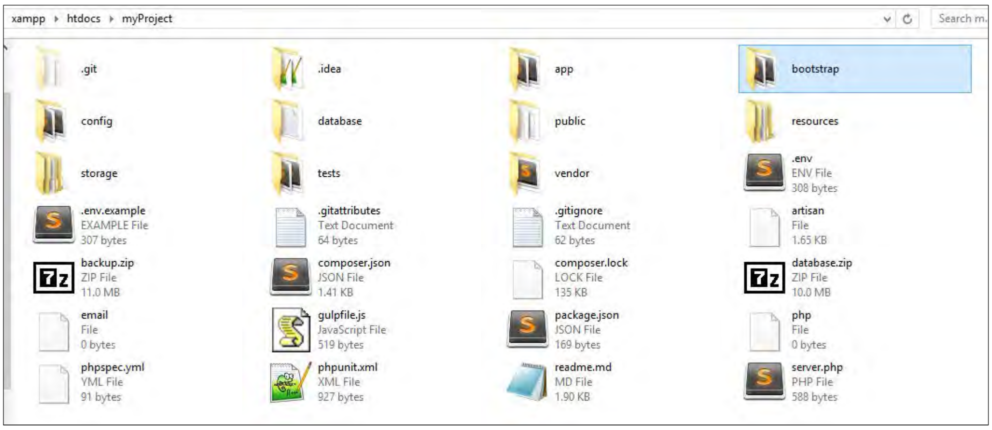
I. Introduction

This document will show the step by step procedure that will help serve as a guideline for the administrator/s in preparation of the necessary output for the website and environmental report.

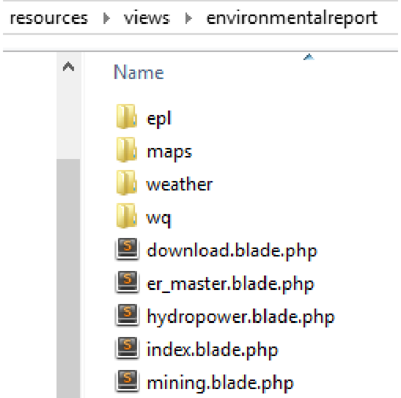
II. Folder System

Environmental Reporting is under the PSI System Web Framework:

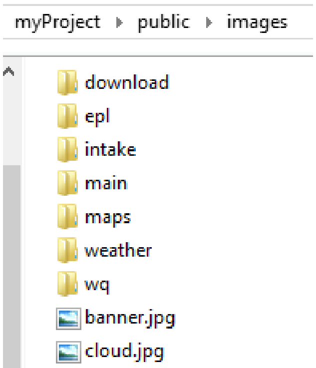
1. //xamp/htdocs/myProject



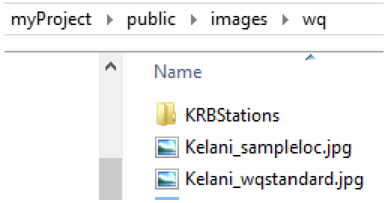
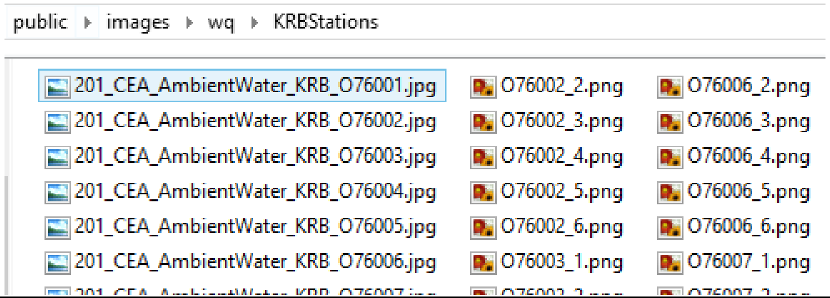
2. The scripts are located in //xampp/htdocs/myProject/resources/views



3. Images are located in ///htdocs/myProject/public/images



III. Uploading Information

No	Parameter	Main Task	Screen Shot
1	Ambient Water	Update the images	 
		Update Texts	**Water Quality Monthly** <div class="tab-pane" id="n" style = "padding:0px"> **##BUTTONS##** <center> <div class="container"> <div class="btn-group col-sm-12" role="group" aria-label="..."> <button type="button" class="btn btn-default active col-sm-4" data-toggle="collapse" data- target="#map13">**Map Location**</button> <button type="button" class="btn btn-warning col-sm-4" data-toggle="collapse" data-target="#graphs13">**Graphs**</button> </center> **##MAP##** <div id="map13" class="col-sm-12" style = "padding:0px"> <img src="/images/wq/KRBStations/201_CEA_AmbientWater_KRB_O76013.jpg" class = "img-responsive img" style = "padding:1px"> </div> **##GRAPHS##** <div class="col-sm-12 collapse" id="graphs13"> <div class = "row">

			<div class="col-sm-6" style = "padding:1px"> <img src="/images/wq/KRBStations/O76013_1.png" class = "img-responsive img"> </div> <div class="col-sm-6" style = "padding:1px"> <img src="/images/wq/KRBStations/O76013_2.png" class = "img-responsive img"> </div> </div> <div class = "row"> <div class="col-sm-6" style = "padding:1px"> <img src="/images/wq/KRBStations/O76013_3.png" class = "img-responsive img"> </div> <div class="col-sm-6" style = "padding:1px"> <img src="/images/wq/KRBStations/O76013_4.png" class = "img-responsive img"> </div> </div> <div class = "row"> <div class="col-sm-6" style = "padding:1px"> <img src="/images/wq/KRBStations/O76013_5.png" class = "img-responsive img"> </div> <div class="col-sm-6" style = "padding:1px"> <img src="/images/wq/KRBStations/O76013_6.png" class = "img-responsive img"> </div> </div> </div> </div>
			Water Quality Yearly

Appendix-1 Hardware and Software Maintenance Checklist

CHECKLIST

No	SOFTWARE	Check
1	Scan for system errors	
2	Regular Defragment of drive	
3	Malware protection updated and always on	
4	Check Disk usage	
5	Backup files monthly / annually	
6	Update Operating System / Software Update	
7	Change Authentication Annually	

No	HARDWARE	Check
1	Place in a cool and dry place.	
2	Keep away from direct sunlight	
3	Keep liquids away from the computer	
4	All cables should be working and untangled	
5	Defective cables should be replaced	
6	Wipe dust with dry cloth	
7	Check computer / server component if working	

Appendix-2 Data request log sheet

No	Ministry	Division	Name	Date Requested	Data Needed	Purpose	Format	Data Given
1								
2								
3								
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Appendix-3 Database Collection Timeline

APPENDIX 3. DATABASE COLLECTION AND MANAGEMENT TIMELINE

		20xx	20xx												20xx
No		**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**
1	GIS Data														
2	Water Source for Drinking Water														
3	Categorization														
4	Temperature Data														
5	Rainfall														
6	Water Level / Flow Rate														
7	Ambient Water Monitoring														
8	Environmental Accident														
9	EPL / PSI														
10	Compliance Monitoring														
11	Complaints														
12	Industrial Zone														
13	EIA Projects														
14	Sand Mining														
15	Gem Mining														
16	Education, Seminars, and Training														

Notes:

TIMELINE		
		Database Collection
1st week of the month		1.1 Check the required data for the database
2nd week of the month		1.2 Prepare and send request letters and memos to data source
First week of the month; Weekly Follow up		1.3 Collection / Follow up data from all sources
1st week of the month		1.4 Hand over data to database management responsible unit
		Database Management
2nd week of the month		2.1 Prepare Maps
2nd week of the month		2.2 Prepare tables and charts
3rd Week of month		2.3 Update website
4th Week of the month		2.4 Environmental Report Preparation
4th Week of the month		2.6 Backup

Appendix-4 Parameter List

No	Parameter	Input	Type	Output	Public	CEA/ Agencies	Remarks
1	**Ambient Water**						
1.1		CSV	Chart	Selected Parameter Each Location Annual	x	x	
1.2			Chart	Parameter Each Location Annual / Category Standard	x	x	
2	**EPL / PSI**	CSV	Chart	No of EPL Application Received (Year)	x		
			Chart	No of EPL Application Received (Year) in KRB	x		
			Chart	No of EPL Application Received (Year) by Sector	x		
			Chart	No of EPL Application Received (Year) by Sector in KRB	x		
			Table	No of EPL Application Received (Year)	x		
			Table	No of EPL Application Received (Year) in KRB	x		
			Table	No of EPL Application Received (Year) by Sector	x		
			Table	No of EPL Application Received (Year) by Sector in KRB	x		
			Chart	No of Category A that emits Air Pollution	x		
			Chart	No of Category A that emits Air Pollution in KRB	x		
			Chart	No of Category A that emits A	x		
			Chart	No of Category A that generates solid waste	x		
			Chart	No of Category A that generates solid waste in KRB	x		
			Chart	No of Category A that generates waste water	x		
			Chart	No of Category A that generates waste water in KRB	x		
3	**Complaints**	Excel	Table	Number of Complaints for each type		x	
			Table	Number of Complaints from each Source		x	
4	**Water Board Intake Points**	Excel /Word	Chart	Water board selected parameters each location	x		
			Map	Water board each sampling location KRB	x		
			Map	Water board sampling location in Kelani River Basin	x		
6	**Water Level / Flow Rate**	Excel / PDF	Map	Water level each sampling location (Mean, Min, Max)	x		
			Chart	Flow rate	x		
7	**Environmental Accident**	Excel	Table	Environmental Accidents	x		
8	**Education / Training / Seminar**	Excel	Table	Awareness Program	x		
9	**Rainfall /Temperature Data**	Excel	Map	Hydro meteorological stations in Kelani River Basin	x		
			Chart	Monthly temperature (min, ave, max)	x		
			Map	Rainfall Data	x		
10	**EIA Projects**	Word	Table	EIA Projects approved		x	
11	**GIS Data**	SHP				x	
12	**Sand Mining**	Excel	Map	Sand mining location (According to Type of Mineral)		x	
13	**Gem Mining**	Excel	Map	Location		x	

Appendix-5 Step 1 Collection

Name	
Date	
Division	

		Data Collection							**Database Management**											**Website Update**			
No	**Parameter**	**Check data**	**Prepare Request Letter / Memo**	**Send Letter / Memo**	**Date Sent**	**Collected Date**	**Format**	**Collected From**	**Collect Data from RU**	**Organize Files and Folders**	**Prepare Template**	**Import to MS Access**	**Import to MS Excel**	**Generate Charts**	**Generate Tables**		**Update Map Folder**	**Generate Maps**		**Rename Charts**	**Rename Images**	**Rename Documents**	**Edit Code**

Appendix-6 Step 2 Database Administration

STEP 2. DATABASE ADMINISTRATION

Information Management System Documentation

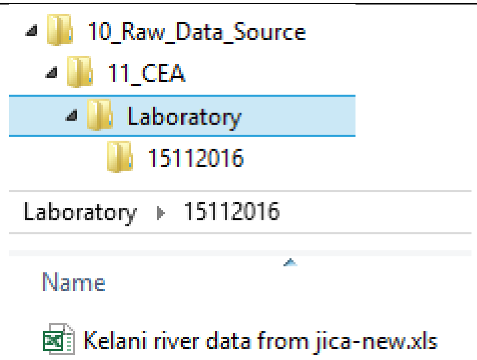
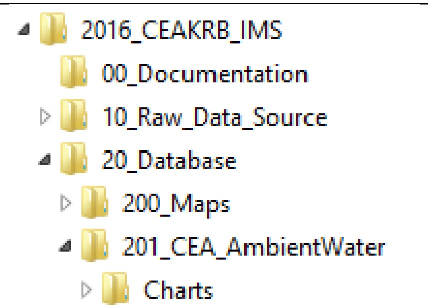
JICA

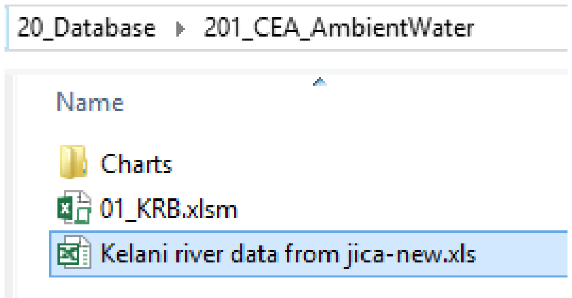
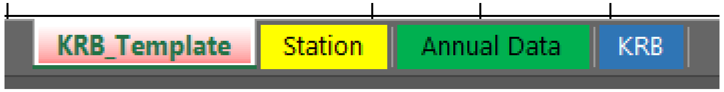
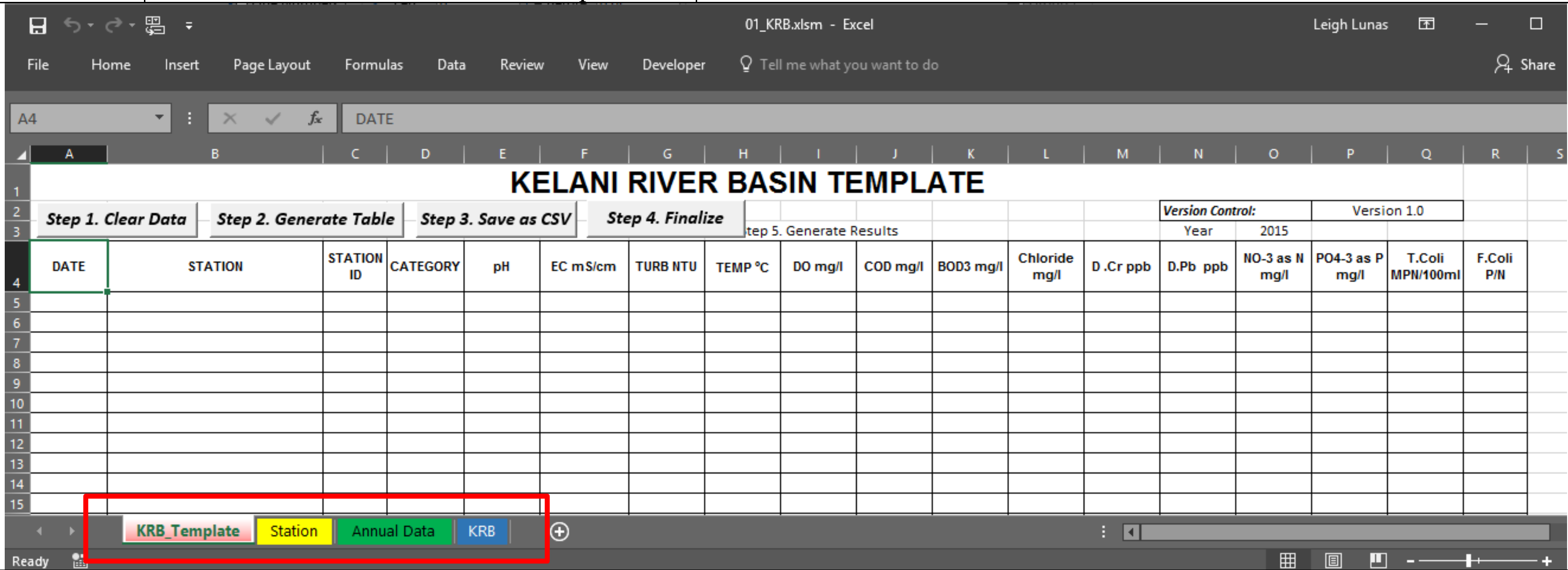
12/1/17

I. Introduction

This document will show the step by step procedure that will help serve as a guideline for the administrator/s in preparation of the necessary output for the website and environmental report.

II. Database Administration

No	Parameter	Main Task	Screen Shot
1	Ambient Water	1.1 From database collection, copy the file to assigned folder in 10_Raw_Data_Source \\2016_CEAKRB_IMS\10_Raw_Data_Source\11_CEA\Laboratory\15112016	
		1.2 COPY the excel file to assigned folder in 20_Database	

<table>
<tr><td></td><td></td><td></td><td>
</td></tr>
<tr><td></td><td></td><td>1.3 Open in MS Excel 01_KRB.xlsm
- It is a Macro Excel Book
- KRB means “Kelani River Basin”
- Check the Tab Sheets
- Activated Tab should be “KRB Template”</td><td>Tab Sheets

</td></tr>
<tr><td></td><td colspan="3">
</td></tr>
<tr><td></td><td></td><td>1.4 There are Buttons available:
STEP 1. Clear Data
STEP 2. Generate Table</td><td>
</td></tr>
</table>

STEP 3. Save as CSV
STEP 4. Finalize

Step 3. Save as CSV | Step 4. Finalize

1.5 Check “STATION” Tab Sheet and check the stations available in Kelani River Basin. Check the correct **CATEGORY**

Sampling Location	StationID	Category
Parawalathanna Bridge	O76016	A
Karawanella Bridge	O76015	B
Anguruwella Bridge	O76014	A
Malibada, Nakkawita	O76017	B
Thalduwa Bridge	O76012	A
Seethawaka Ferry	O76013	A
Pugoda Intake	O76010	A
Hanwella Bridge	O76008	A
Kaduwela Bridge	O76005	A
Welivita bridge	O76003	D
Victoriya Bridge (Japan Friendship)	O76001	D
Pugoda Ela	O76011	A
Wak Oya Bridge	O76009	A
Pussali Oya	O76007	B
Maha Ela Bridge	O76006	B
Raggahawatte Ela	O76004	A
Kolonnawa Ela	O76002	C
New Bridge Peliyagoda		

KRB_Template | Station | Annual Data | KRB

1.6 Change the **YEAR** accordingly

KELANI RIVER BASIN TEMPLATE

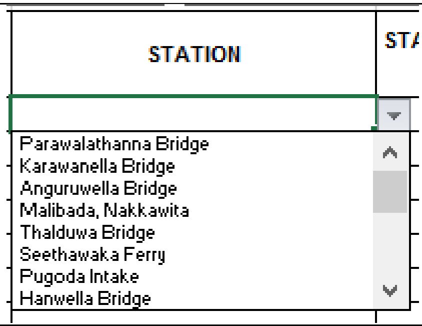
Step 1. Clear Data | Step 2. Generate Table | Step 3. Save as CSV | Step 4. Finalize | Step 5. Generate Results

Version Control: Version 1.0
Year: 2015

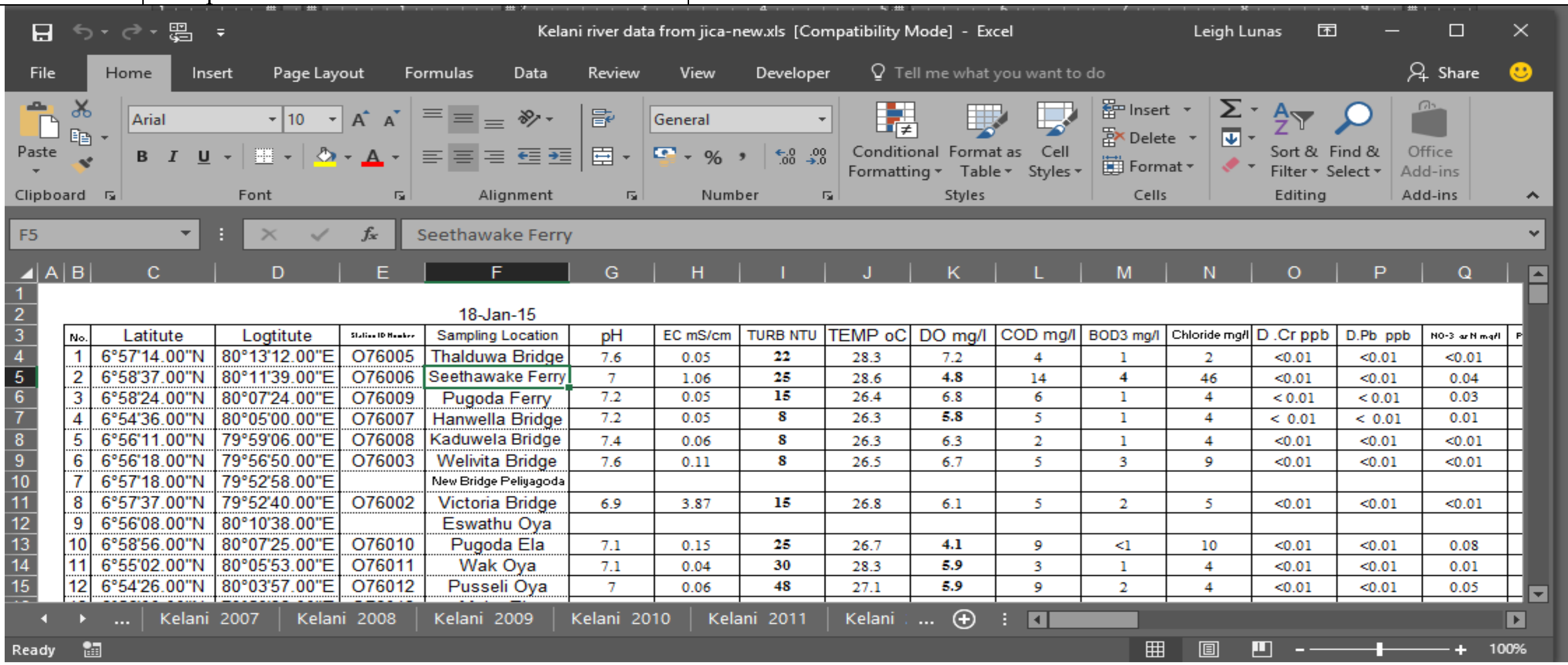
DATE	STATION	STATION ID	CATEGORY	pH	EC mS/cm	TURB NTU	TEMP °C	DO mg/l	COD mg/l	BOD3 mg/l	Chloride mg/l	D .Cr ppb	D.Pb ppb	NO-3 as N mg/l	PO4-3 as P mg/l	T.Coli MPN/100ml	F.Coli P/N
18-Jan-15	Thalduwa Bridge	O76012	A	7.6	0.05	22	28.3	7.2	4	1	2	0.01	0.01	0.01	0.02	1400	800
18-Jan-15	Seethawaka Ferry	O76013	A	7	1.06	25	28.6	4.8	14	4	46	0.01	0.01	0.04	1	2800	1700
18-Jan-15	Pugoda Intake	O76010	A	7.2	0.05	15	26.4	6.8	6	1	4	0.01	0.01	0.03	0.02	2200	1300
18-Jan-15	Hanwella Bridge	O76008	A	7.2	0.05	8	26.3	5.8	5	1	4	0.01	0.01	0.01	0.02	2400	1300
18-Jan-15	Kaduwela Bridge	O76005	A	7.4	0.06	8	26.3	6.3	2	1	4	0.01	0.01	0.01	0.04	5000	2400
18-Jan-15	Welivita Bridge	O76003		7.6	0.11	8	26.5	6.7	5	3	9	0.01	0.01	0.01	0.15	5000	1300
18-Jan-15	New Bridge Peliyagoda	0	0														
18-Jan-15	Victoriya Bridge (Japan Friendship)	O76001		6.9	3.87	15	26.8	6.1	5	2	5	0.01	0.01	0.01	0.1	3000	1300
18-Jan-15	Eswathu Oya	0	0														

1.7 Back in KRB_Template Tab,
If you click a record under "Station" column, a list of station encoded in "Station" Tab.

*** Make sure all the encoded have the same name.
Ex. Thalduwa – Thalduwa = correct!
Thalduwa – Thaldwaa = wrong!



1.8 Open in MS Excel original ambient water data. In the 01_KRB file, click **Step 1. Clear** Data to remove existing data from the "KRB Template".



18-Jan-15

No.	Latitute	Logtitute	Station ID Number	Sampling Location	pH	EC mS/cm	TURB NTU	TEMP oC	DO mg/l	COD mg/l	BOD3 mg/l	Chloride mg/l	D .Cr ppb	D.Pb ppb	NO-3 ar N mg/l
1	6°57'14.00"N	80°13'12.00"E	O76005	Thalduwa Bridge	7.6	0.05	**22**	28.3	7.2	4	1	2	<0.01	<0.01	<0.01
2	6°58'37.00"N	80°11'39.00"E	O76006	Seethawake Ferry	7	1.06	**25**	28.6	**4.8**	14	**4**	46	<0.01	<0.01	0.04
3	6°58'24.00"N	80°07'24.00"E	O76009	Pugoda Ferry	7.2	0.05	**15**	26.4	6.8	6	1	4	< 0.01	< 0.01	0.03
4	6°54'36.00"N	80°05'00.00"E	O76007	Hanwella Bridge	7.2	0.05	**8**	26.3	**5.8**	5	1	4	< 0.01	< 0.01	0.01
5	6°56'11.00"N	79°59'06.00"E	O76008	Kaduwela Bridge	7.4	0.06	**8**	26.3	6.3	2	1	4	<0.01	<0.01	<0.01
6	6°56'18.00"N	79°56'50.00"E	O76003	Welivita Bridge	7.6	0.11	**8**	26.5	6.7	5	3	9	<0.01	<0.01	<0.01
7	6°57'18.00"N	79°52'58.00"E		New Bridge Peliyagoda											
8	6°57'37.00"N	79°52'40.00"E	O76002	Victoria Bridge	6.9	3.87	**15**	26.8	6.1	5	2	5	<0.01	<0.01	<0.01
9	6°56'08.00"N	80°10'38.00"E		Eswathu Oya											
10	6°58'56.00"N	80°07'25.00"E	O76010	Pugoda Ela	7.1	0.15	**25**	26.7	**4.1**	9	<1	10	<0.01	<0.01	0.08
11	6°55'02.00"N	80°05'53.00"E	O76011	Wak Oya	7.1	0.04	**30**	28.3	**5.9**	3	1	4	<0.01	<0.01	0.01
12	6°54'26.00"N	80°03'57.00"E	O76012	Pusseli Oya	7	0.06	**48**	27.1	**5.9**	9	2	4	<0.01	<0.01	0.05

	Step 1. Clear Data		
		1.9 Copy paste according to Header **Original** = Template **Sampling Location** = Station **pH** = pH **EC mS/cm** = EC mS/cm **TURB NTU** = TURB NTU **TEMP oC** = TEMP oC **DO mg/l** = DO mg/l **COD mg/l** = COD mg/l **BOD3 mg/l** = BOD3 mg/l **Chloride mg/l** = Chloride mg/l **D .Cr ppb** = D .Cr ppb **D.Pb ppb** = D.Pb ppb **NO-3 as N mg/l** = NO-3 as N mg/l **PO4-3 as P mg/l** = PO4-3 as P mg/l **T.Coli MPN/100ml** = T.Coli MPN/100ml **F.Coli P/N** = F.Coli P/N ** Get the Date per record	

KELANI RIVER BASIN TEMPLATE

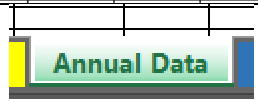
Step 1. Clear Data | Step 2. Generate Table | Step 3. Save as CSV | Step 4. Finalize | Step 5. Generate Results

Version Control: Version 1.0

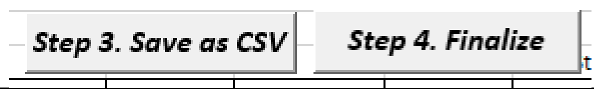
Year 2015

DATE	STATION	STATION ID	CATEGORY	pH	EC mS/cm	TURB NTU	TEMP °C	DO mg/l	COD mg/l	BOD3 mg/l	Chloride mg/l	D .Cr ppb	D.Pb ppb	NO-3 as N mg/l	PO4-3 as P mg/l	T.Coli MPN/100ml	F.Col P/N
18-Jan-15	Thalduwa Bridge	O76012	A	7.6	0.05	22	28.3	7.2	4	1	2	0.01	0.01	0.01	0.02	1400	800
18-Jan-15	Seethawaka Ferry	O76013	A	7	1.06	25	28.6	4.8	14	4	46	0.01	0.01	0.04	1	2800	1700
18-Jan-15	Pugoda Intake	O76010	A	7.2	0.05	15	26.4	6.8	6	1	4	0.01	0.01	0.03	0.02	2200	1300
18-Jan-15	Hanwella Bridge	O76008	A	7.2	0.05	8	26.3	5.8	5	1	4	0.01	0.01	0.01	0.02	2400	1300
18-Jan-15	Kaduwela Bridge	O76005	A	7.4	0.06	8	26.3	6.3	2	1	4	0.01	0.01	0.01	0.04	5000	2400
18-Jan-15	Welivita Bridge	O76003		7.6	0.11	8	26.5	6.7	5	3	9	0.01	0.01	0.01	0.15	5000	1300
18-Jan-15	New Bridge Peliyagoda	0	0														
18-Jan-15	Victoriya Bridge (Japan Friendship)	O76001		6.9	3.87	15	26.8	6.1	5	2	5	0.01	0.01	0.01	0.1	3000	1300
18-Jan-15	Eswathu Oya	0	0														
18-Jan-15	Pugoda Ela	O76011	A	7.1	0.15	25	26.7	4.1	9	1	10	0.01	0.01	0.08	0.03	≥16000	5000
18-Jan-15	Wak Oya Bridge	O76009	A	7.1	0.04	30	28.3	5.9	3	1	4	0.01	0.01	0.01	0.09	16000	2400
18-Jan-15	Pussali Oya	O76007	B	7	0.06	48	27.1	5.9	9	2	4	0.01	0.01	0.05	0.05	9000	1300
18-Jan-15	Maha Ela Bridge	O76006	B	6.9	0.12	19	27.4	4.4	11	2	16	0.01	0.01	0.02	0.09	9000	500
18-Jan-15	Raggahawatte Ela	O76004	A	7.2	0.34	16	27.9	4.9	13	2	32	0.01	0.01	0.05	0.89	9000	1700
8-Feb-15	Thalduwa Bridge	O76012	A	7.7	0.04	158	28.3	5.8	14	1	2	0.01	0.01	0.01	0.06	9000	2400

2.0 Click button "Step 2. Generate Table" to generate table in "Annual Data" Tab

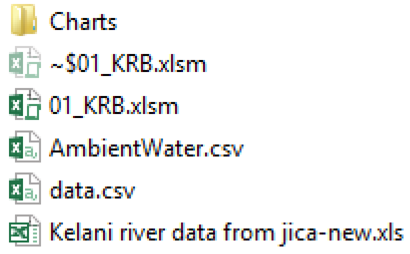


2.1 Click button "Step 3. Save as CSV" to save annual data as CSV file and "Step 4. Finalize"

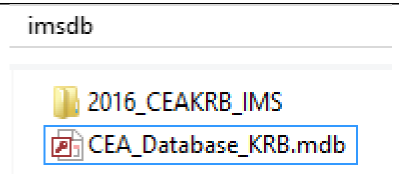
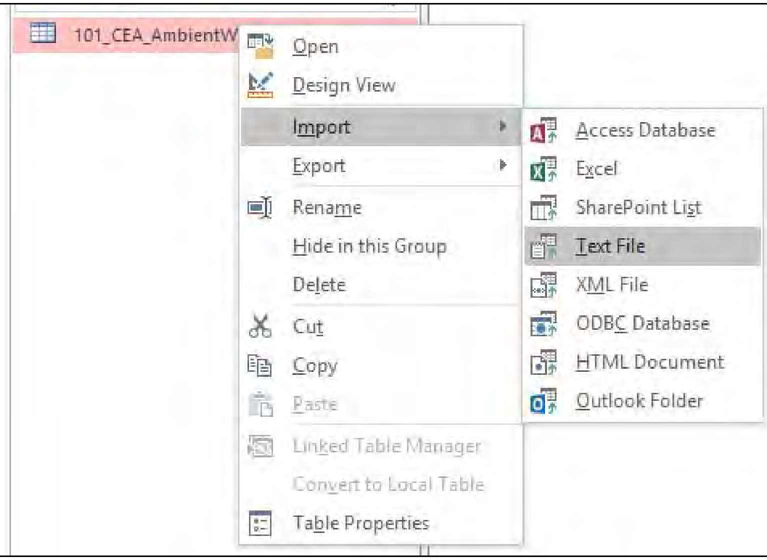


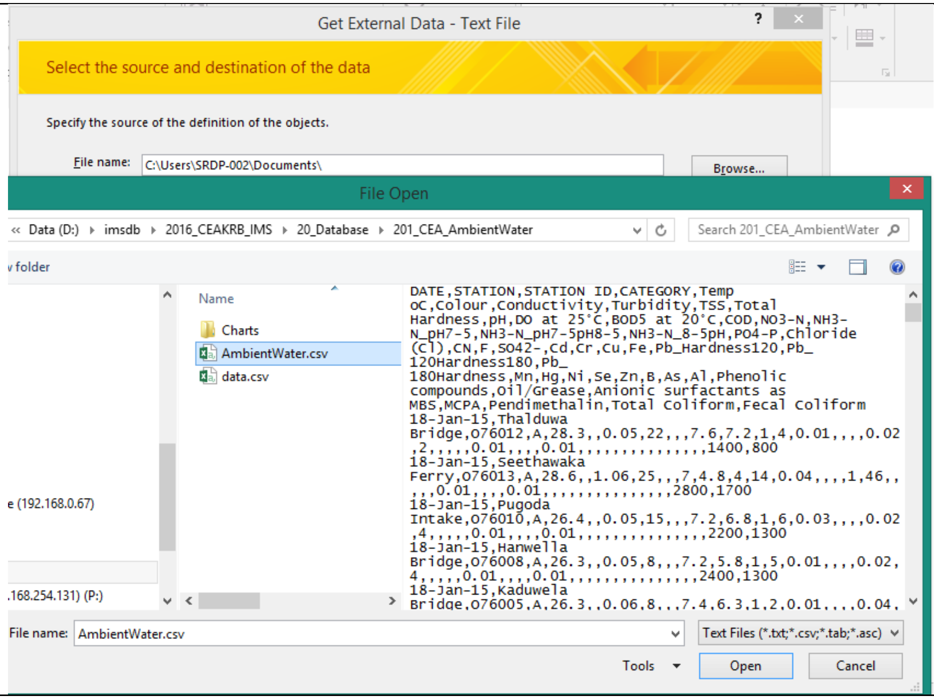
2.2 Check the folder again. You will see two additional data
data.csv and AmbientWater.csv

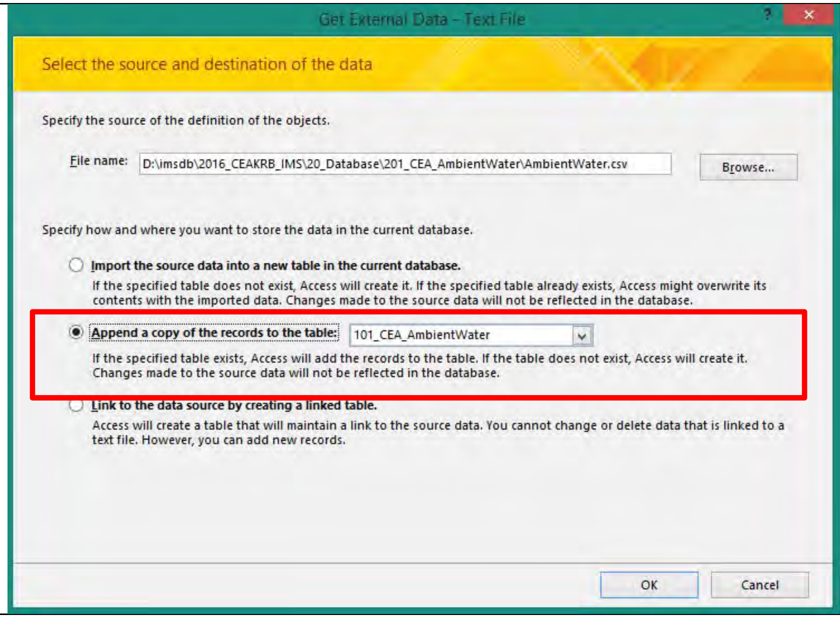
Then **SAVE 01_KRB.xlsm**

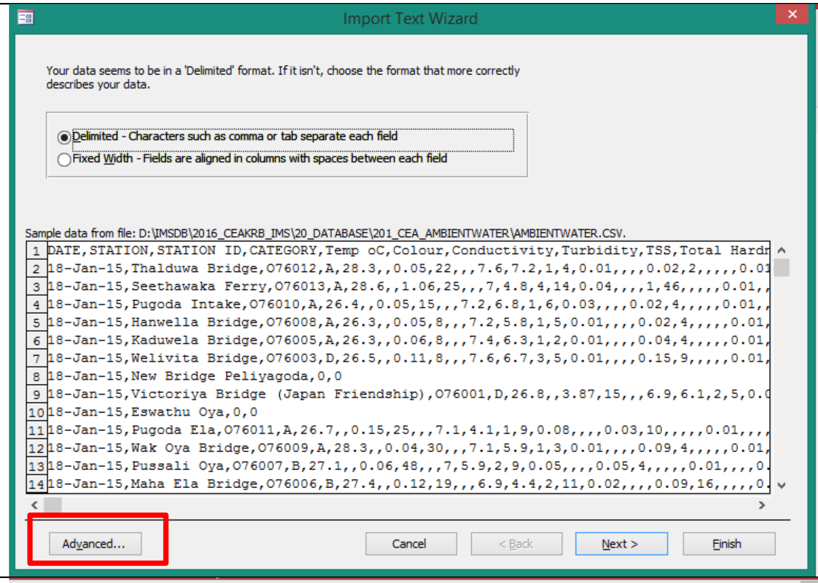


2.3 Open MS Access database located here:

<table>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td>2.4 Import data. Right click on the table 101_CEA_AmbientWater and select import
- select text file
- locate AmbientWater.csv</td><td></td></tr>
</table>

<table>
<tr><td></td><td></td><td></td><td>
</td></tr>
</table>

		2.4 Append a copy of the records to the table - select 101_CEA_AmbientWater	
			Click Advanced

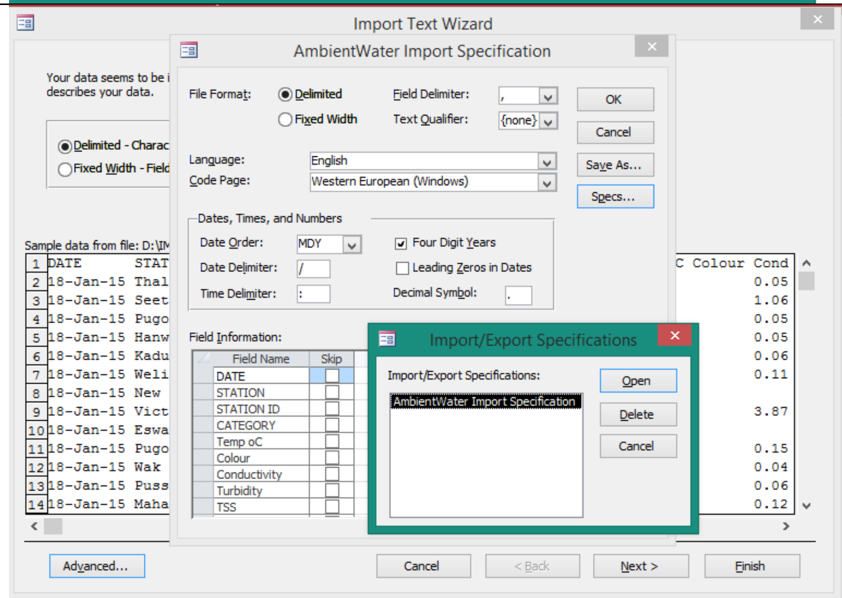


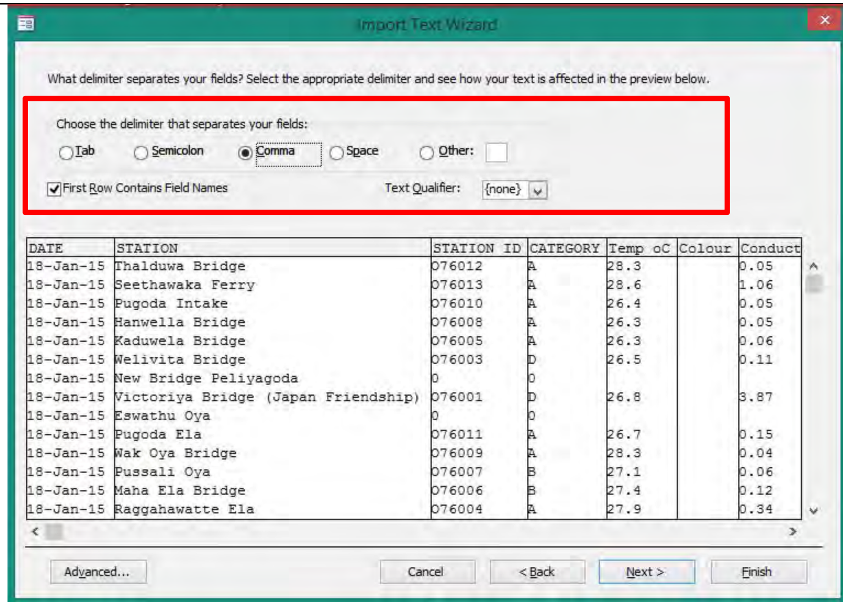
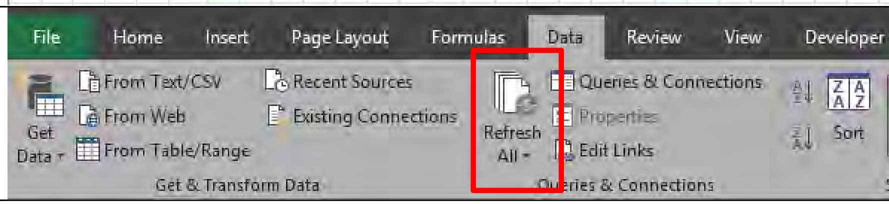
2.5 Select SPECS then Import/Expect Specifications: **AmbientWater_ImportSpecification**

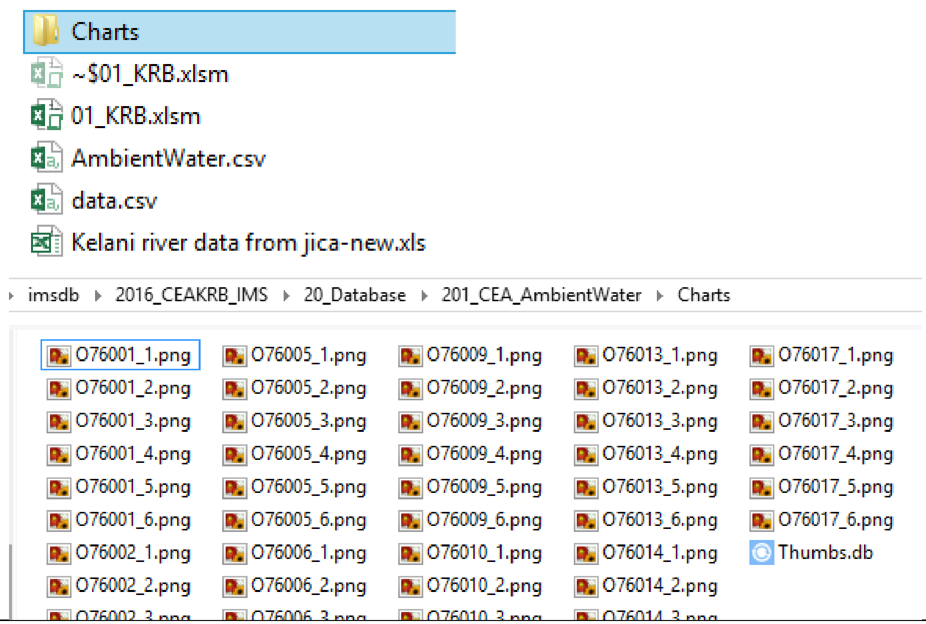
Click OPEN

Click OK

Click NEXT.

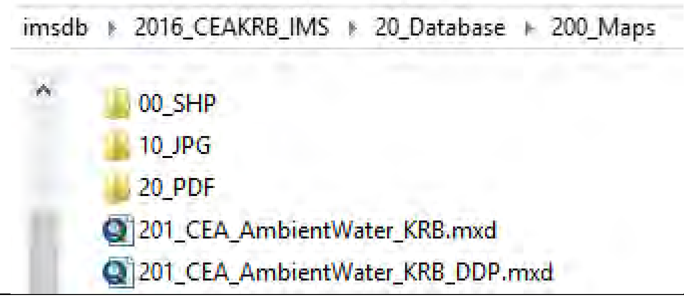


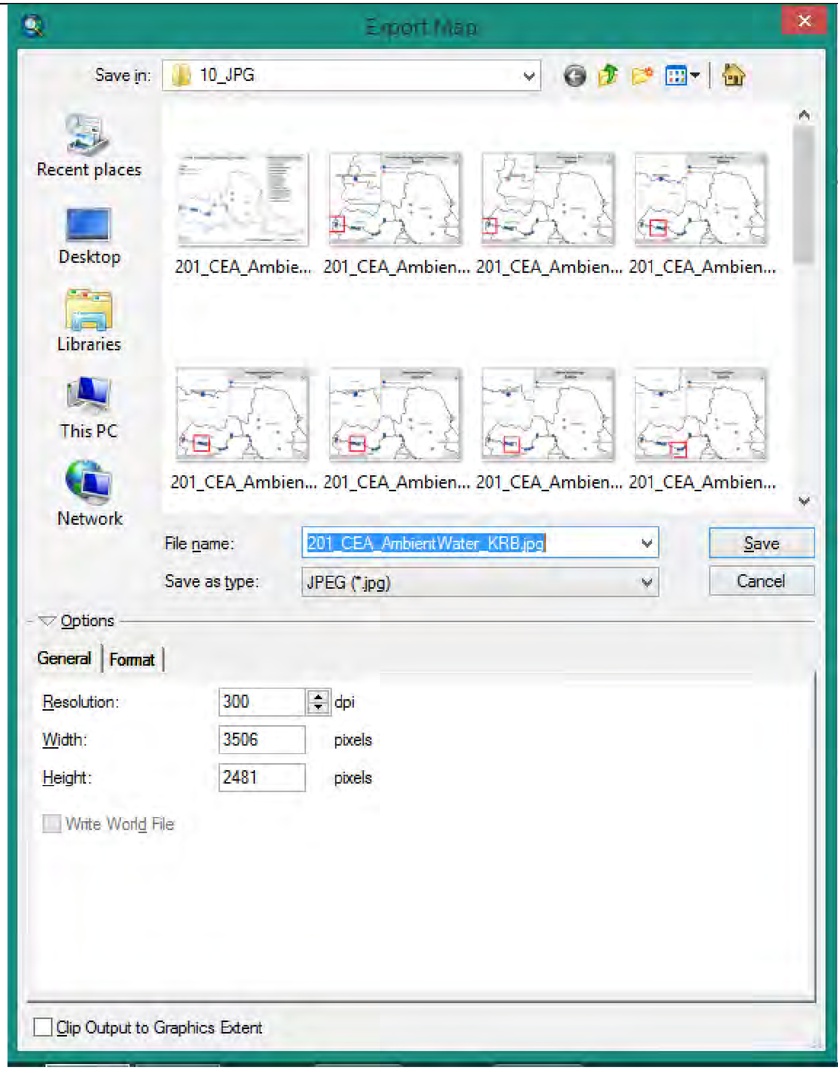
		2.6 Import Text Wizard. Make sure First Row Contains Field Names should be checked and delimiter should be Comma Click Next. Click Finish.	
		2.7 Open 01_KRB.xlsm again and click "KRB" Tab. Charts are already prepared for exporting.	
		2.8 Refresh all Go to DATA tab then click Refresh All	

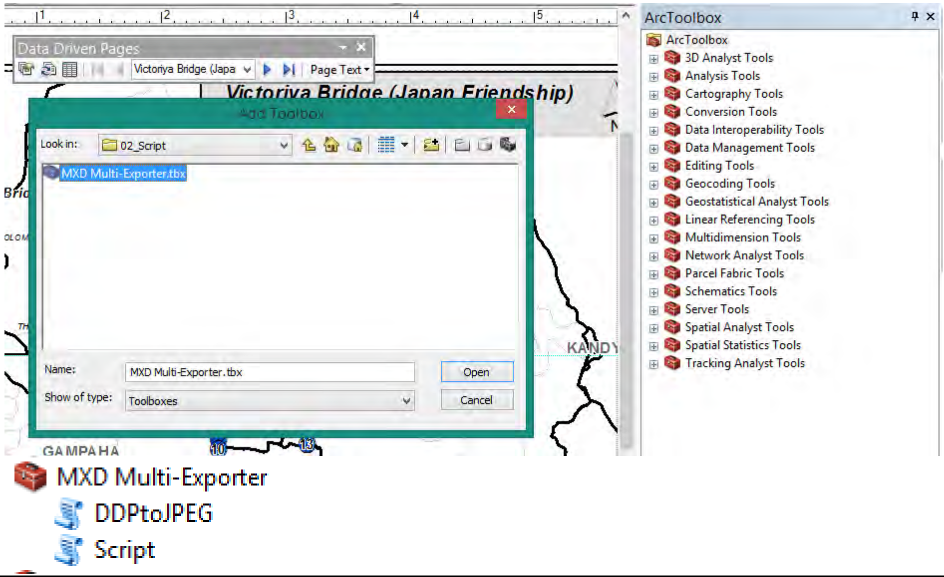
		2.9 Click **Export Charts** Button Automatically, all the charts will be generated in the folder CHARTS. File name is [StationID]_[Chart Number].	
		3.0 Files are ready for Website and Environmental Report.	
	2.0 EPL PSI Data		

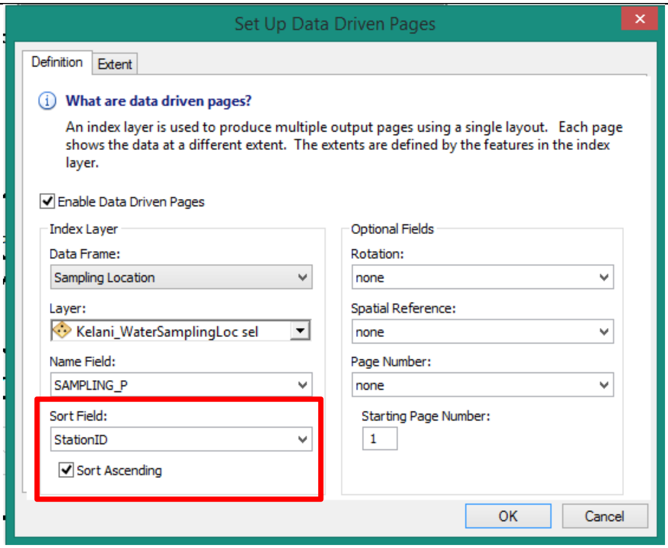
III. Map Preparation

No	Task	Screenshot

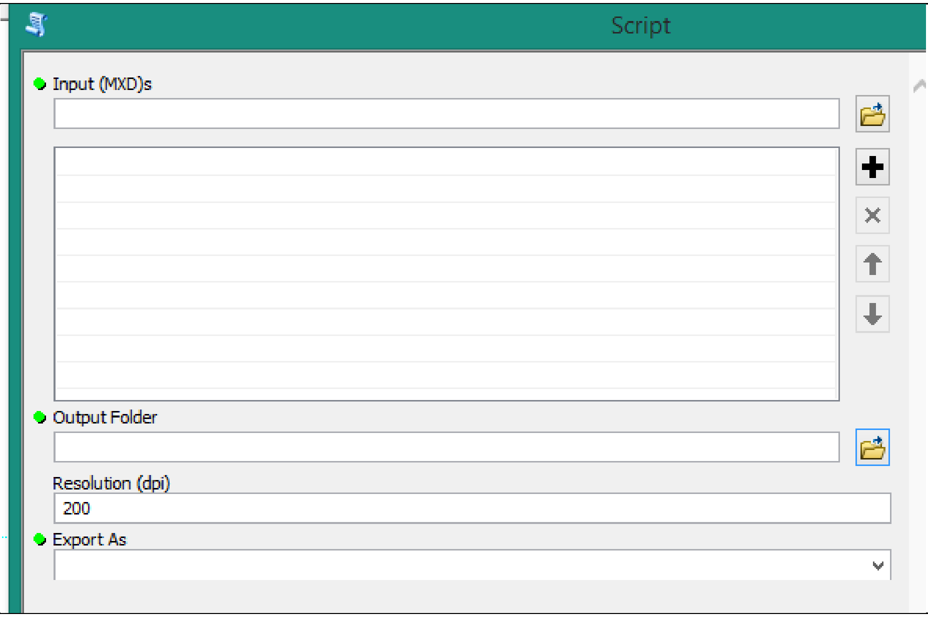
1	Location: //2016_CEAKRB_IMS/20_Database/200_Maps	
2	**FOLDER / FILE**	**DESCRIPTION**
	00_SHP	Contains all the shapefiles
	01_LYR	Contains layers file to standardize the symbology for each shapefile
	10_JPG	Contains output in JPG format
	20_PDF	Contains output in PDF format
	201_CEA_AmbientWater_KRB.mxd	Website – Water quality monthly
	201_CEA_AmbientWater_KRB_DDP.mxd	Website – Water quality monthly each station
3	If there are new SHP, replace the SHP inside the 00_SHP folder.	
4	Open MXD file of the map you want to update. The shapefile is already updated. Just save the file accordingly.	
5	**Exporting Map (One by One)** 201_CEA_AmbientWater_KRB.mxd	Go to File -> Export Map ->

		 Save here: \\imsdb\2016_CEAKRB_IMS\20_Database\200_Maps\10_JPG

6	**Exporting Map (Multiple Data)**	Add Toolbox: 
6.1	**DDP to JPEG:** - For Data Driven Pages Export MXD File – MXD Source ex. “201_CEA_AmbientWater_KRB_DDP.mxd File Name – Name of Output ex. “201_CEA_AmbientWater_KRB_” DDPSortingField – name of field for sorting in DDP	

<table>
<tr>
<td></td>
<td>

DPI = Dots Per Inch (Resolution) ex. 300</td>
<td></td>
</tr>
</table>

6.2	**Script (Multiple MXD printing)** Input (MXD)s – import MXDs for printing Output Folder – Store in //10_JPG Resolution (dpi) – Dots Per Inch Export As – JPG or PNG or PDF	

Appendix-7 Step 3 Data Upload and Environmental Report

STEP 3. DATA UPLOAD AND ENVIRONMENTAL REPORT

Information Management System Documentation

JICA

12/1/17

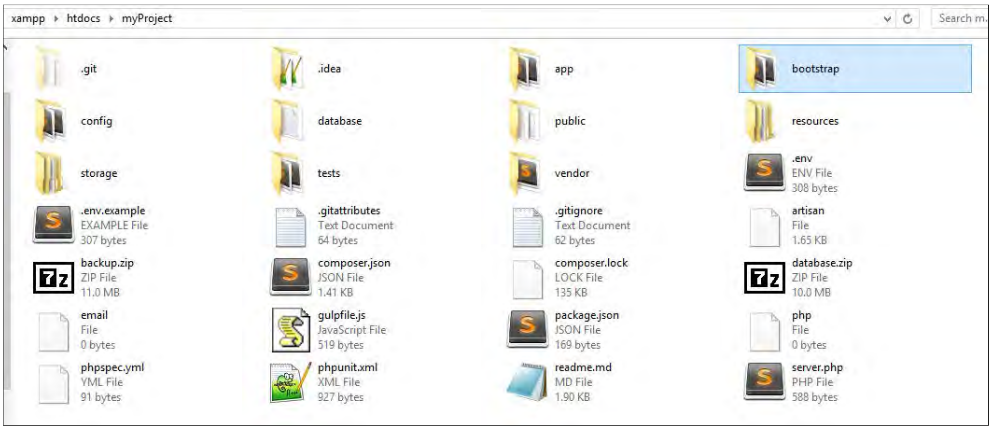
I. Introduction

This document will show the step by step procedure that will help serve as a guideline for the administrator/s in preparation of the necessary output for the website and environmental report.

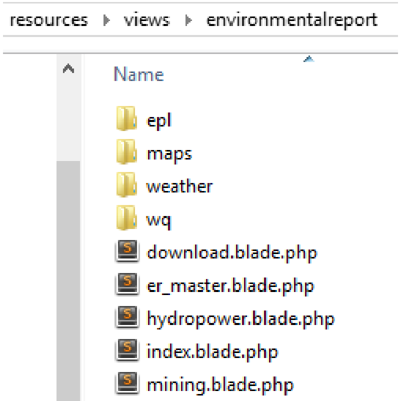
II. Folder System

Environmental Reporting is under the PSI System Web Framework:

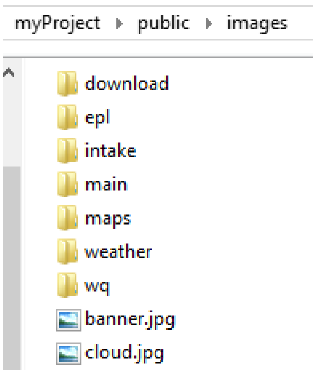
1. //xamp/htdocs/myProject



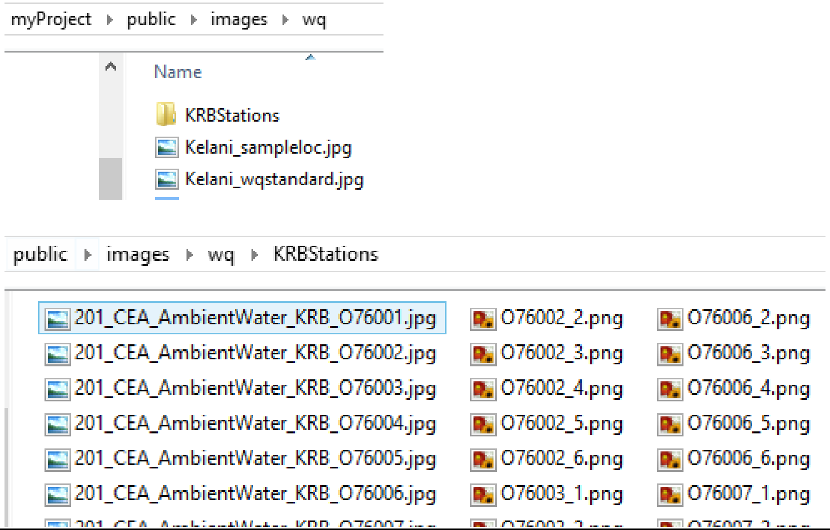
2. The scripts are located in //xampp/htdocs/myProject/resources/views



3. Images are located in ///htdocs/myProject/public/images



III. Uploading Information

No	Parameter	Main Task	Screen Shot
1	Ambient Water	Update the images	
		Update Texts	**Water Quality Monthly** <div class="tab-pane" id="n" style = "padding:0px"> **##BUTTONS##** <center> <div class="container"> <div class="btn-group col-sm-12" role="group" aria-label="..."> <button type="button" class="btn btn-default active col-sm-4" data-toggle="collapse" data- target="#map13">**Map Location**</button> <button type="button" class="btn btn-warning col-sm-4" data-toggle="collapse" data-target="#graphs13">**Graphs**</button> </center> **##MAP##** <div id="map13" class="col-sm-12" style = "padding:0px"> <img src="/images/wq/KRBStations/201_CEA_AmbientWater_KRB_O76013.jpg" class = "img-responsive img" style = "padding:1px"> </div> **##GRAPHS##** <div class="col-sm-12 collapse" id="graphs13"> <div class = "row">

			<div class="col-sm-6" style = "padding:1px"> <img src="/images/wq/KRBStations/O76013_1.png" class = "img-responsive img"> </div> <div class="col-sm-6" style = "padding:1px"> <img src="/images/wq/KRBStations/O76013_2.png" class = "img-responsive img"> </div> </div> <div class = "row"> <div class="col-sm-6" style = "padding:1px"> <img src="/images/wq/KRBStations/O76013_3.png" class = "img-responsive img"> </div> <div class="col-sm-6" style = "padding:1px"> <img src="/images/wq/KRBStations/O76013_4.png" class = "img-responsive img"> </div> </div> <div class = "row"> <div class="col-sm-6" style = "padding:1px"> <img src="/images/wq/KRBStations/O76013_5.png" class = "img-responsive img"> </div> <div class="col-sm-6" style = "padding:1px"> <img src="/images/wq/KRBStations/O76013_6.png" class = "img-responsive img"> </div> </div> </div> </div>
			Water Quality Yearly

付属資料 27　環境白書—ケラニ川流域—

ENVIRONMENTAL REPORT

State of the Kalani River Basin 2017

Central Environmental Authority
Ministry of Mahaweli Development and Environment

Message from Chairman

Quality of life depends directly or indirectly on the goods and services supplied by the environment. In the primitive societies mankind lived in state of symbiosis with the environment. Historical records reveal the reasons for emergence of civilization around the rivers. Water requirement for cultivation, animal husbandry, and consumption, availability of fertile soil deposited on river banks, as a means of transport, has been the important resources.

Sri Lanka is a country endowed with many natural resources, among which, the availability of 103 rivers can be considered as assets beyond validation. Kelani River is one of the main rivers, that is considered economically and environmentally important, as the main source of drinking water supply to Colombo and Metropolitan area, for commercial crops and paddy cultivation, and in generation of hydroelectric powers. With the present development status of the country and due to industrialization and increase of population of the river basin area, the threat imposed on the river cannot of disregarded.

As the chairman of Central Environmental Authority, I extend my sincere thanks for tasks performed by CEA officials on preparation of the report on the "Status of Kelani River basin-2017".

I also wish to convey my gratitude to the Government of Japan for the support extended , making this effort a success.

A comprehensive study on the current status of the Kelani in and adopting necessary precautionary steps has been identified as a task of national importance. With the technical corporation and financial support of JICA, the CEA initiated the study on Kelani River.

Chairman
"Parisara Piyasa" Central Environmental Authority
No. 104, Denzilkobbekaduwa Mawatha,Battaramulla

Message from Director General

Pollution of environment naturally occurs by means of outflow of high concentration of heavy metals from minor changes in acidification, or increase in turbidity as influence of ashes from volcanic eruption etc. But Sri Lanka is much fortunate to have very less in such type of pollution, compared to other countries in the globe. But, pollution and destruction of environment due to anthropogenic activities, is very common in Sri Lanka.

CEA as the state institution responsible for conservation and management of the environment, continues to make consistent efforts to provide a clean environment.

Although the environment has a self-cleaning or purifying capacity, it is conspicuous that, it's being exceeded due to high population concentrations , in the Colombo metropolitan areas. When the main water bodies are concerned, pollution is aggravated by discharge of untreated industrial effluents and, by domestic waste waters. Regulating and monitoring of discharge of waste water is carried out by the CEA, by means of issuance of Environmental Protection Licence, under the provision of the National Environmental Act. Reverse of contaminated environment to its original state requires labour and high cost. But it is the duty of each citizen to , protect and conserve the environment, for the next generation.

The Central Environmental Authority initiated a project on " Water Environmental System and Administrative Management" with the assistance of JICA,and a pilot study of Kelani river basin, as the Kelani river is the main source of drinking water to Colombo metropolitan area. Categorization of water bodies as an evaluation method of river water quality, is addressed, as first time in Sri Lanka, by carrying-out continues study incollaboration with other and stakeholder institutions, and specially with the team of experts of the JICA.

The findings of the study, is produced as the "Environmental Report- the state of Kelani River Basin", the outcome of the strenuous effort of the study, and hope it will immensely help in planning, managing and quality assurance of all activities related to the Kelani River.

Mr. P.B Hemantha Jayasinghe
Director General
"Parisara Piyasa", Central Environmental Authority
No. 104, Denzilkobbekaduwa, Mawatha,Battaramulla

List of Abbreviation

The Abbreviation	Original Word
Al	Aluminium
As	Arsenic
B	Boron
BM	Metal Industry
BOD	Biochemical Oxygen Demand
BOI	Board of Investment
Cd	Cadmium
CEA	Central Environmental Authority
CH	Chemical & Petrochemical
Cl	Chloride
CN	Cyanide
COD	Chemical Oxygen Demand
Cr	Chromium
Cu	Cupper
DO	Dissolved Oxygen
EC	Electric Conductivity
EPL	Environmental Protection License
F	Fluoride
FD	Food and Food Related Food Industry
Fe	Iron
GS & MB	Geological Survey and Mines Bureau
Hg	Mercury
KRB	Kelani River Basin
MBAS	Methylene Blue Active Substance
MCPA	4-chloro-2-methylphenoxyacetic acid or (4-chloro-2-methylphenoxy) acetic acid
ME	Machinery & Equipment
Mn	Manganese
MP	Mineral & Mineral Product
NEA	National Environmental Act
NH_3-N	Nitrogen as Ammonia
Ni	Nickel
NO_3^--N	Nitrogen as Nitrate
NWS&DB	National Water Supply & Drainage Board
OT	Other Activities
Pb	Lead
pH	Power of Hydrogen or potential Hydrogen
PO_4^{3-}-P	Phosphate as Phosphorus
PP	Paper & Printing
R&D Unit	Research and Development Unit
Se	Selenium
SL	Lodgings & Health Services

The Abbreviation	Original Word
SO_4^{2-}	Sulphate
SP	Power
SZ	Waste Disposal/ Waste water/ Water Treatment
TB	Turbidity
TC	Telecommunication Towers
TH	Total Hardness (as CaCO3)
TL	Textile & Leather
TR	Transport Related Services
TSS	Total Suspended Solid
TW	Timber & Wood
Zn	Zinc

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Chapter 1 State of the Kelani River Basin

1.1 Introduction

Kelani River which is 145 km in length, is the 4th longest river among the 103 major rivers of Sri Lanka. Total area of the Kelani River Basin (KBR) is 2,321 km^2. The two main tributaries of the river at upper reaches are the Kehelgamu Oya and Maskeli Oya. Other tributaries which connect at the lower reaches are Wee Oya, Gurugoda Oya, and Seethawaka Ganga. Average flow rate of the river in the dry season is 20-25 m^3/s and 800-1500 m^3/s in the Monsoon Season. The upstream area flows mostly through tea plantations and at downstream areas through highly polluted urban area of Western Province, which is clustered with industries.

Kelani River is considered as nationally important source of water, as it is the main supplier of drinking water to the Colombo Metropolitan area. Most of the water intakes of the National Water Supply & Drainage Board (NWS&DB), the responsible agency for supplying potable water, are located at the downstream area of the Kelani River. In addition, Kelani river is used for fisheries, transport, disposal of waste water, sand mining and for generation of hydroelectricity.

Hence, maintaining, regulating and monitoring of the river water quality, is of utmost importance.

Pollution of water at upstream areas, are due to agricultural run-offs from the tea fields, but in contrast, high contaminations occur at downstream areas by urban run- offs, industrial discharges, and leachates of haphazardly disposed solid waste.

Flood risk in the Colombo City and sub-urban areas, during monsoon, which lie in the lower flood plain of the river, and saline intrusion which has impacts on the quality of the drinking water supply, are the major concerns with reference to the Kelani River.

1.2 Populationand distribution

The Kelani river basin is spreads over an area of 2,321 $km^2$and in 3 provinces namely, the Western(34%), Sabaragamuwa (47%), and Central (19%) which consists of 7 Districts. Figure 1.1 shows the administrative boundaries of the five districts. Total Number of Divisions in the five Districts are 34 and the details are given in the Table 1.1. Local Authorities within the Divisions includes Urban Councils, Pradeshiya Sabha, and Municipal Councils.

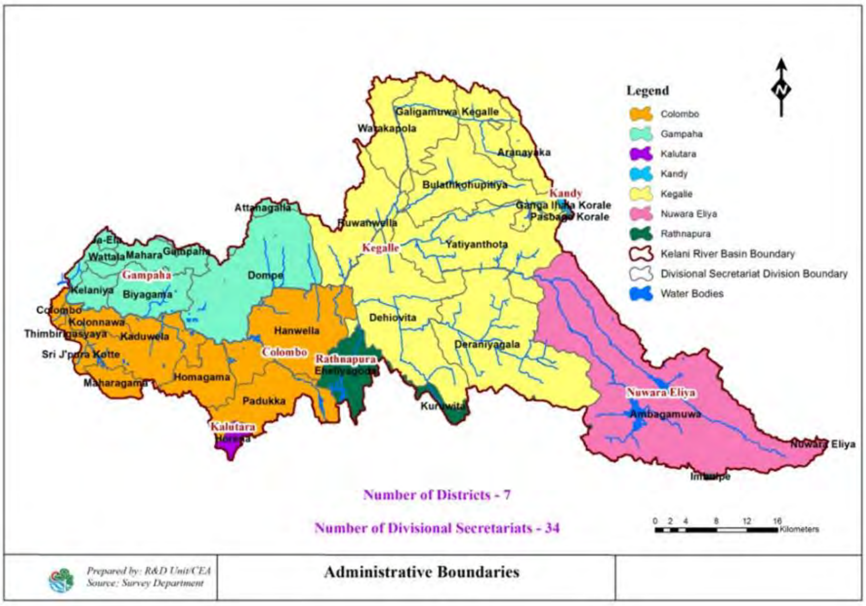


Figure 1.1 Local authority boundary in Kelani river basin

Table 1.1 Area on Kelani river basin

	Province	District	DSD Name		Area (km^2)
1	Western	Gampaha	1	Attanagalla	7
2			2	Biyagama	60
3			3	Dompe	175
4			4	Gampaha	3
5			5	Ja-Ela	6
6			6	Kelaniya	22
7			7	Mahara	48
8			8	Wattala	15
9		Colombo	1	Colombo	8
10			2	Hanwella	146
11			3	Homagama	51
12			4	Kaduwela	88
13			5	Kolonnawa	26
14			6	Maharagama	23
15			7	Padukka	85
16			8	Sri Jayawardanapura Kotte	11
17			9	Thimbirigasyaya	3
18		Kalutara	1	Horana	11
19	Sabaragamuwa	Kegalle	1	Aranayaka	34
20			2	Bulathkohupitiya	128
21			3	Dehiovita	192
22			4	Deraniyagala	218
23			5	Galigamuwa	73
24			6	Kegalle	53
25			7	Ruwanwella	102
26			8	Warakapola	52
27			9	Yatiyanthota	178
28		Rathnapura	1	Eheliyagoda	56
29			2	Imbulpe	1
30			3	Kuruwita	12
31	Central	Kandy	1	Ganga Ihala Korale	2
32			2	Pasbage Korale	1
33		Nuwara Eliya	1	Ambagamuwa	427
34			2	Nuwara Eliya	3
				Total	**2321**

According to statistical data, population of the KRB is 5 million in 2016, and is in the trend of increasing due to urbanization and migration from rural areas to the Colombo metropolitan area for employment. Distribution of population over the 7 administrative Districts is given in the Figure 1.2.

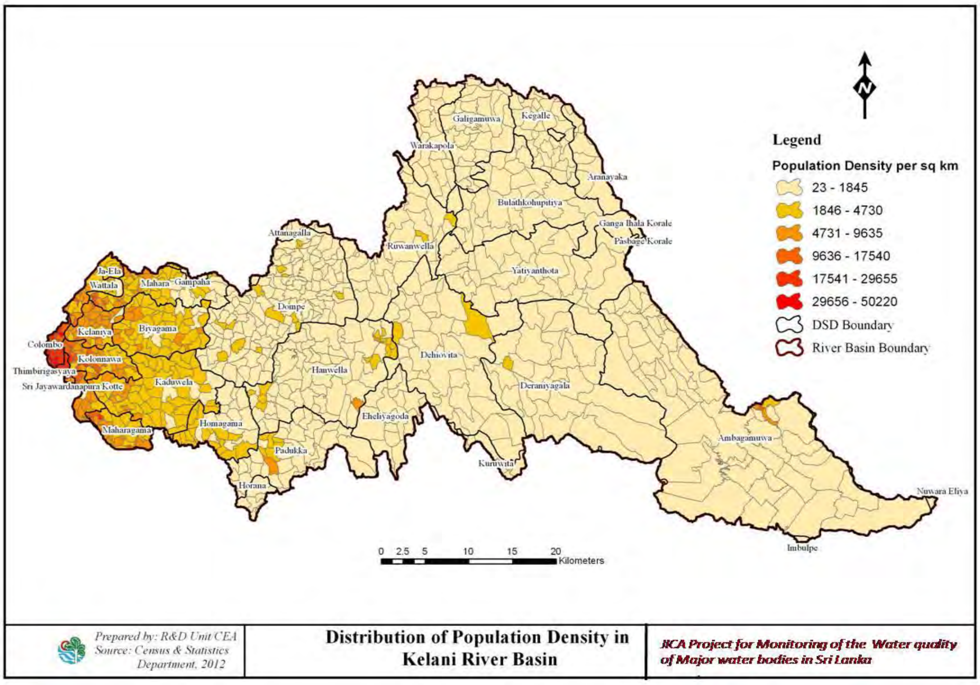


Figure 1.2 Population Density and distribution in Kelani RiverBasin

1.3 Water Use

1.3.1 Supply of potable Water.

Currently in Sri Lanka, the average consumption of water per person is 140 l/day. But the average water usage is expected to be increased with the industrial and economic growth.

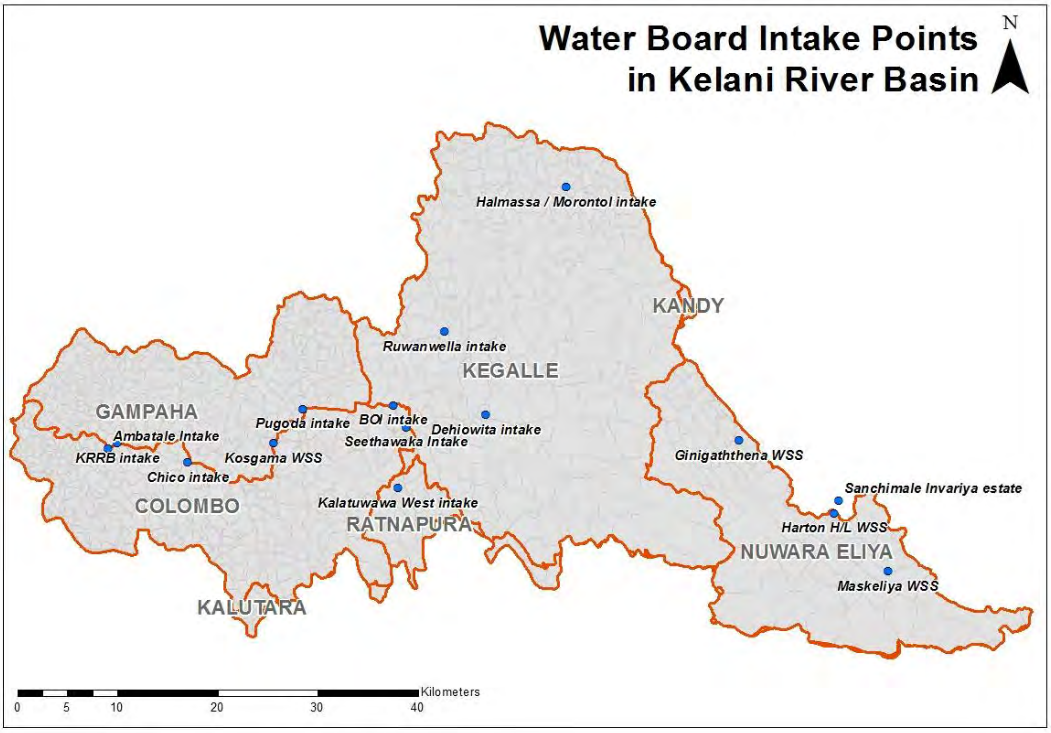
The National Water Supply & Drainage Board (NWS&DB) is the responsible agency for supply of potable water to the nation. Currently total capacity of water supplied by the NWS&DB is 860,ooo m^3/ day.

There are 15 Water treatment facilities of the NWS&DB, including intake points located within the Kelani river basin, of which the details are given in Table 1.2 Designated capacity of the water treatment plants located within the KRB is given in the Table 1.2.

Bits of Knowledges

Generally, one person requires the around 140L/day water amount. Present maximum water supply capacity is around 860,000m3/day. This suppling capacity is cover on 5.7million people as use 140L/day on one person.

Let's use carefully Water and save it!



Source: NWS&DB

Figure 1.3 Intake point in Kelani river Basin

Table 1.2 Treatment plant in Kelani river basin

ID	Name of Purification plant	Designed Capacity (m^3/day)	Remarks
1	Ginigathhena	3,500	
2	Sanchimale	1,200	
3	Invariya Estate Otteryesta	2,000	
4	Mahaneluwa / Maskeliya Oya	2,500	
5	Ambatale Intake	540,000	
6	BOI intake	9,950	
7	Seetha Vidyalaya intake (Seethawaka)	3,500	
8	Chico intake	8000-10000	
9	Kosgama intake	2,750	
10	KRRB intake	180,000	
11	Pugoda intake	500	Package plant
		3,000	Kirindiwela
		3,000	Ranpokunugama
12	Ruwanwella intake (Thotupola)	2,500	
13	Kalatuwawa West intake	91,000	
14	Dehiowita intake (Kelani Tribute)	2,500	

Source: NWS&DB

1.3.2 Generation of Hydro Electricity

The Kelani River is considered as an economically important water resource, with respect to the generation of hydro electrical power. Main tributaries of the Kelani River, the Kehelgamu Oya and the Maskeli Oya contribute largel to hydro electricity generation of Sri Lanka. Castlereigh, Noraten, Maskeliya, Canyon and Laxapana reservoirs, are constructed across the main tributaries for hydropower generation.

According to the source of Ministry of power and energy, there are many mini hydropower plants, located within the Kelani River basin, of which the details are given in the Table 1.3.

Table 1.3 Situation of Mini-Hydropower plant in Kelani river basin

	Stage	Number of project	Electric power (MW)
1	Commissioned Projects	36	65.36
2	Energy Permit Issued Projects	21	27.35
3	Provisional Approval Issued Projects	18	37.68
4	Pre-Processing Stage	73	77.04

Source: Ministry of Power & Energy

1.3.3 Irrigation and Agriculture

Water of the Kelani River at upstream areas are being used for agricultural purposes of major economically important crops plantations such as tea and rubber. In the downstream areas irrigating Paddy cultivation is practiced with water through anicuts built across the tributaries such as Seethawaka Ganga and Wee Oya during both cultivation seasons Maha and Yala.

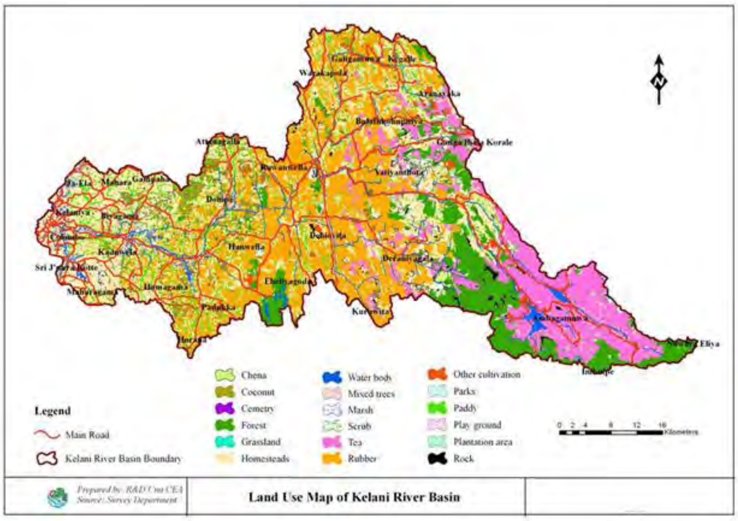
There is a tea field in the upstream area, and middle to downstream area were to using for paddy and Rubber filed. These areas will use a lot of water. Regarding rice cultivation is conduct on double cropping in particular, it has been drawn water throughout year around and it is one of the major water uses.

1.4 Land Use

1.4.1 Agro Ecological Zone

Agro ecological zones of the KRB are identified based on the distribution of soil types, land use, latitude, temperature and rainfall distribution.

The Kelani river starts from the wet-zone of up country and flows through the wet-zone mid country, and wet –zone low country. Within these zones, the basin is subdivided into 10 agro-ecological regions' staring from the central hills towards the coastal areas. Land use of Kelani River Basin and Agro ecological zones of KRB is given in the Figure 1.4, Table 1.4 and Figure 1.5 respectively.



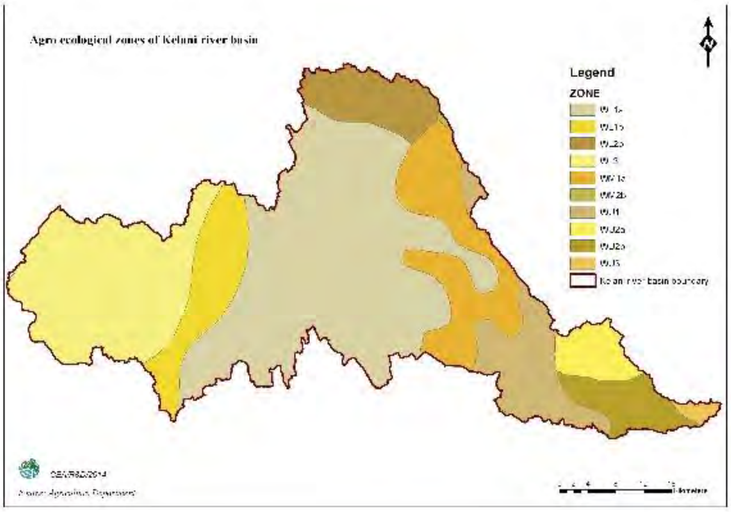
Source: R & D Unit, CEA

Figure 1.4 Land use- Kelani River Basin

Table 1.4 Land use type in Kelani River Basin

No	Type	Area (km^2)	Area %
1	Park	0.1	0.00%
2	Plantation Area	0.1	0.01%
3	Cemetry	0.8	0.03%
4	Play ground	1.3	0.05%
5	Grassland	2.0	0.09%
6	Non agricultural land	3.7	0.16%
7	Chena	16.4	0.71%
8	Rock	18.6	0.80%
9	Marsh	23.6	1.02%
10	Other cultivation	39.2	1.69%
11	Water bodies	48.2	2.07%
12	Scrub	68.1	2.93%
13	Coconut	70.4	3.03%
14	Paddy	149.5	6.44%
15	Forest	237.4	10.23%
16	Tea	300.2	12.93%
17	Home garden	646.7	27.86%
18	Rubber	695.2	29.94%
	Total area	**2321.5**	

Source: R & D Unit, CEA



Source: R & D Unit, CEA

Figure 1.5 Agro-ecological zones of Kelani river Basin

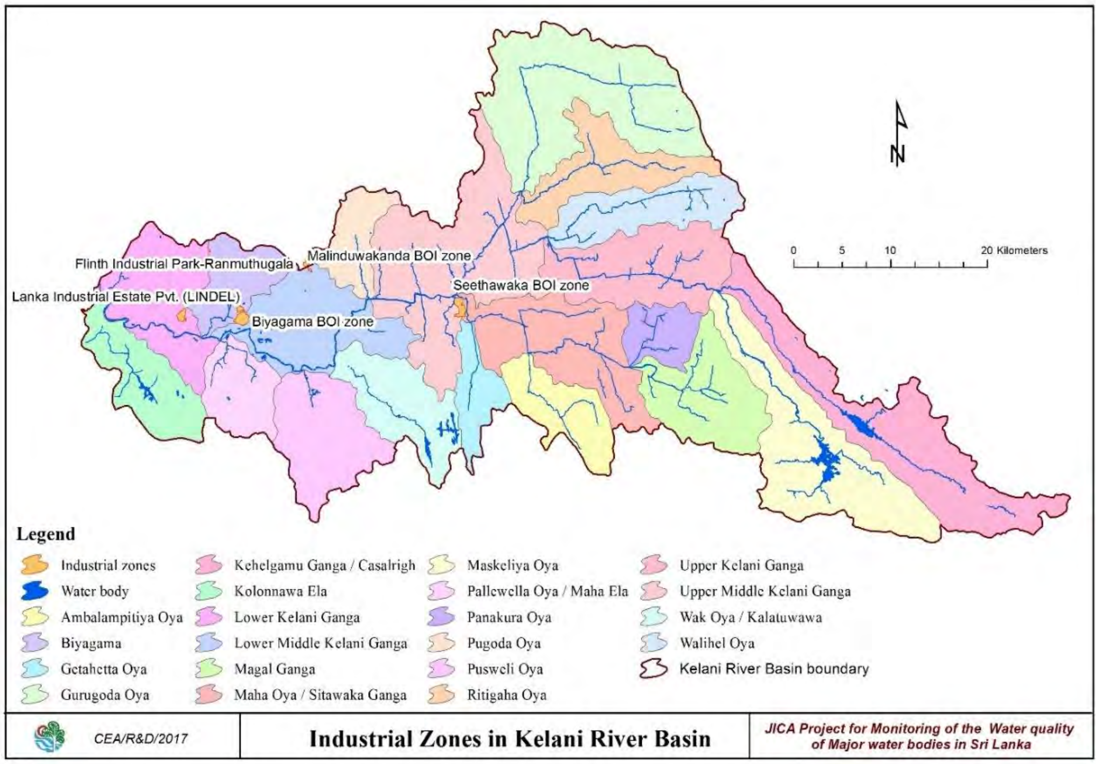
Climatic conditions of the agro ecological zones and terrain types of the KRB are given in the Table 1.5 below

Table 1.5 Climate conditions in agro-ecological zones

#	Zone name	Agro-ecological region (AER)	Terrain	75% Expectancy value of Annual Rainfall (mm)	Area (Km^2)	Area (%)
1	WL1a	Wet Zone Low Country	Rolling, undulating &Hilly	> 3,200	907	39.08
2	WL1b	Wet Zone Low Country	Undulating & Rolling	> 2,800	172	7.41
3	WL2b	Wet Zone Low Country	Steeply dissected, Rolling & Undulating	> 2,200	137	5.90
4	WL3	Wet Zone Low Country	Rolling & undulating	> 1,700	461	19.86
5	WM1a	Wet Zone Mid Country	Mountainous, Steeply dissected, Hilly & Rolling	> 3,300	268	11.55
6	WM2b	Wet Zone Mid Country	Steeply, Hilly & Rolling	> 1,800	2	0.08
7	WU1	Wet Zone Up Country	Mountainous, Steeply dissected, Hilly & Rolling	> 3,100	187	8.06
8	WU2a	Wet Zone Up Country	Steeply dissected, Hilly & Rolling	> 2,400	75	3.23
9	WU2b	Wet Zone Up Country	Mountainous, Steeply dissected, Hilly & Rolling	> 2,200	94	4.18
10	WU3	Wet Zone Up Country	Hilly & Rolling	> 1,800	15	0.65
Total					**2,321**	

Source: R & D Unit, CEA

1.4.2 Industrial Zone



Source: R & D Unit, CEA

Figure 1.6 Industrial zones of Kelani river Basin

In Sri Lanka, there are 14 Industrial Estates, within which most of local and foreign invested industries are located. Within the KRB itself, there are 5 Industrial Estates or zones which are managed by the Board of Investment of Sri Lanka(BOI). The Figure 1.6 shows the location of the said Industrial zones located within the KRB.

Although high quantity of industrial waste water is being generated by different type of industries located within these industrial Estates, the waste load on the Kelani River is controlled to acceptable levels, as these Industrial Estates are equipped with common waste- water treatment facilities (Industrial information is widely discussed under Chapter 3).

1.5 Extraction of minerals.

Extraction of minerals such as sand gravel, and mining of Gemstones is very common in the Kelani river basin and also within the Kelani riverbed.

Excessive mining of sand is directly affected to the natural equilibrium of the riverine eco system. Sand mining, without determining the actual sand budget, and using topographic, water quality, and hydraulic information cause negative impacts mainly on the water quality, and on the aquatic and riparian ecosystems. Deepening the river, lowering the river bed, sea water intrusion, drop of water table, increase in channel slope, change of velocity of river flow, and collapse of river banks can be listed as physical impacts.

Kelani river is the main source of supplying potable water to the Colombo Metropolitan area. Short term increase of the parameters such as turbidity, suspended solids, and chemical or fuel spills eventually increase the cost of water treatment and influence the downstream users abstracting water for domestic purposes.

In Sri Lanka, the Geological Survey and Mines Bureau (GS & MB) established under the Mineral Act No. 33 of 1993, holds the responsibility of issuance of permits for mining of minerals. At present there are about 134 permitted sand mining locations and one Gem mining location within the Kelani River basin. Total amount of sand extracted from this area is approximately, 4,415 m^3 per year. Sand mining locations located within the KRB, are depicted in the Figure 1.7 below.

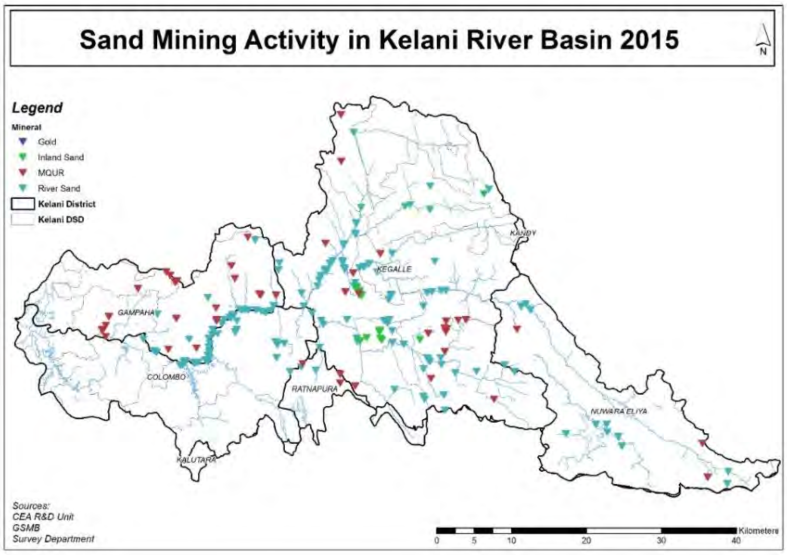


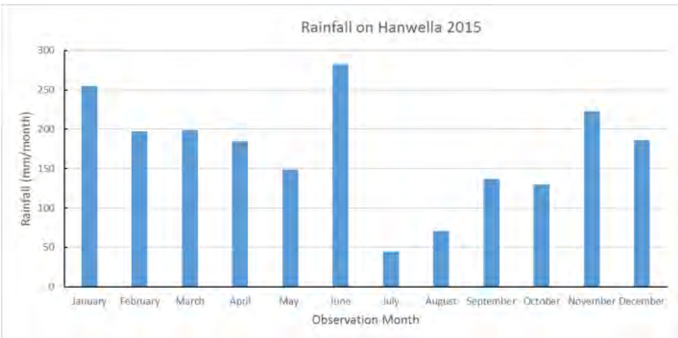
Figure 1.7 Sand Mining Location

1.6 Weather Condition in Kelani River Basin

1.6.1 Rainfall

Rainfall of KRB is a very important factor and it contributes largely to the maintenance of the volume of water in the river.

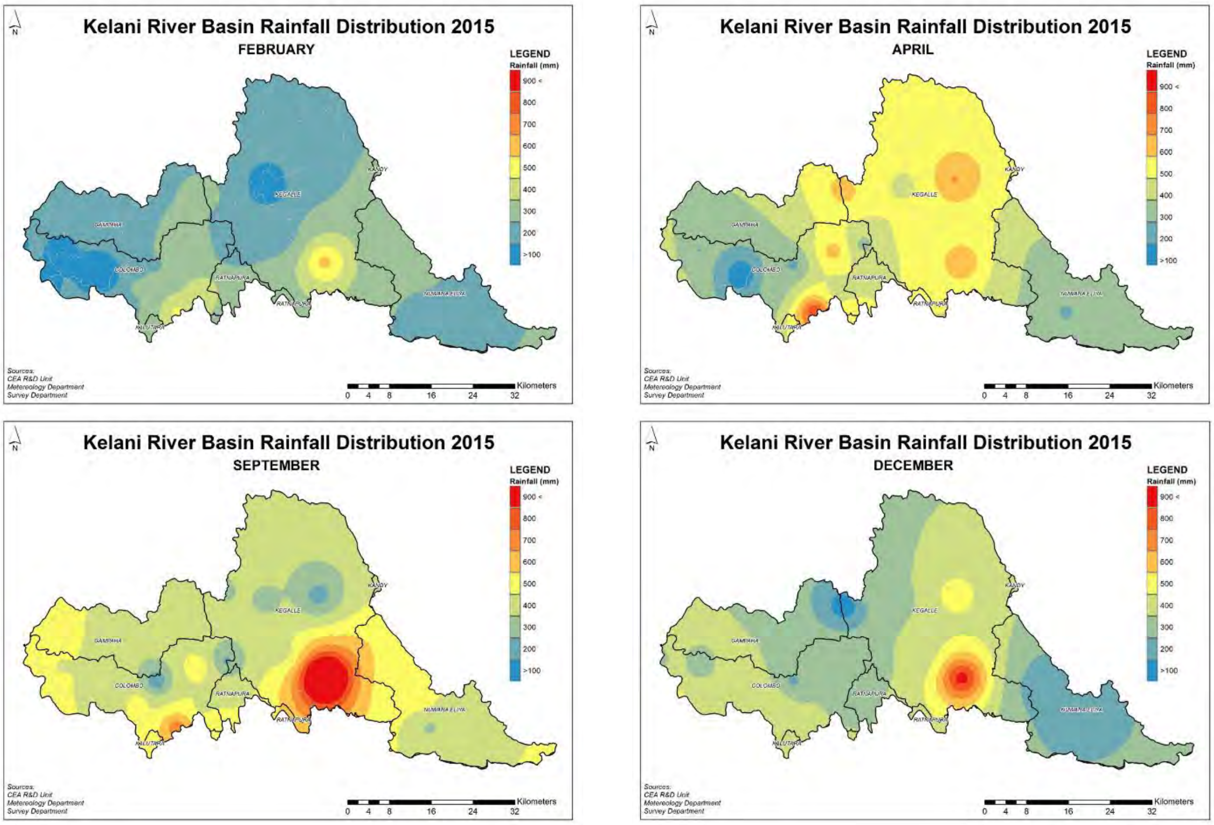
The average rainfall amount per year is around 300mm/year in the Kelani river basin. There



Source: Metrological Department

Figure 1.8 Monthly average rainfall at Hanwella

are 25 rainfall monitoring stations, within the KRB, managed by the Meteorological department. The Figure 1.8 shows the monthly average rainfall at Hanwella. Distribution of rainfall within the KRB in the months of February, April, September and December is given in the Figure 1.9 respectively. Maliboda area is recorded as the area with high rainfall, and the highest during the year 2015 is recorded at "Dabar Estate" and has been 7,877mm/year.

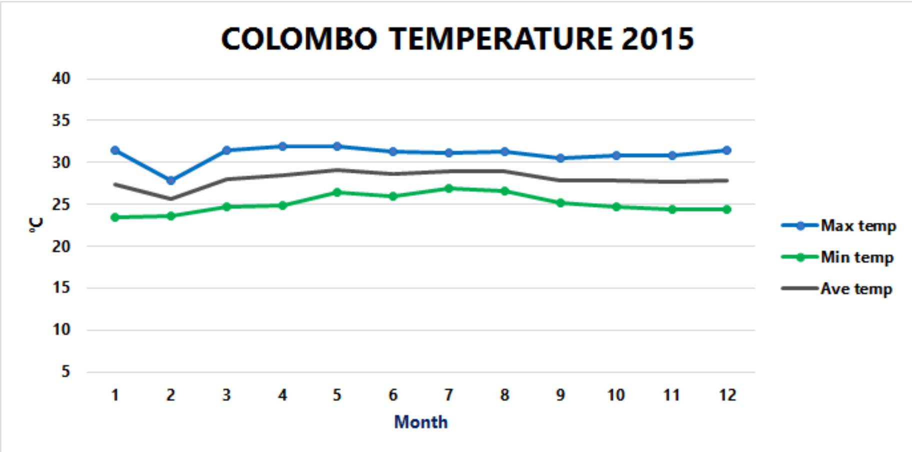


Source: Metrological Department

Figure 1.9 Seasonable Distribution of rainfall in Kelani river basin

1.6.2 Temperature

Annual temperature within the KRB does not show drastic variation and lies within the range of 26^{o}C – 20^{o}C. The Figure 1.10 depicts the annual average temperature variation in the Colombo district.



Source: Metrological Department

Figure 1.10 Seasonable change of temperature in Colombo

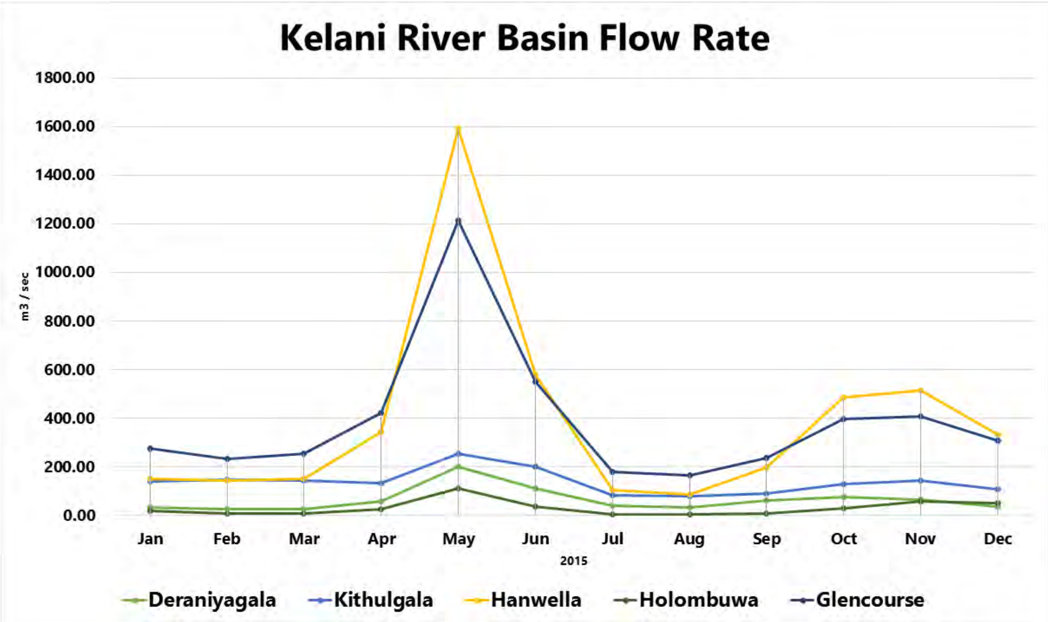
1.7 Hydrology

The total catchment area of the Kelani river is around 2,321 km^2. The catchment are structured 20 Sub-watershed based on Main tributaries of the Kelani river can be listed in Table 1.6. There are lot of small tributaries which feed the Kelani river.

Table 1.6 Sub Watershed in Kelani river basin

#	Name of Sub Watershed	#	Name of Sub Watershed
1	Kolonnawa Ela	11	Kehelgamu Ganga/ Casalrigh
2	Pallewella Oya/ Maha Ela	12	Upper Kelani Ganga
3	Pusweli Oya	13	Walihel Oya
4	Wak Oya/ Kalutuwawa	14	Ritigaha Oya
5	Getahetta Oya	15	Gurugoda Oya
6	Ambalampitiya Oya	16	Upper Middle Kelani Ganga
7	Maha Oya/ Sitawaka Ganga	17	Pugoda Oya
8	Pankura Oya	18	Lower Middle Kelani Ganga
9	Magal Ganga	19	Biyagama
10	Maskeliya Oya	20	Lower Kelani Ganga

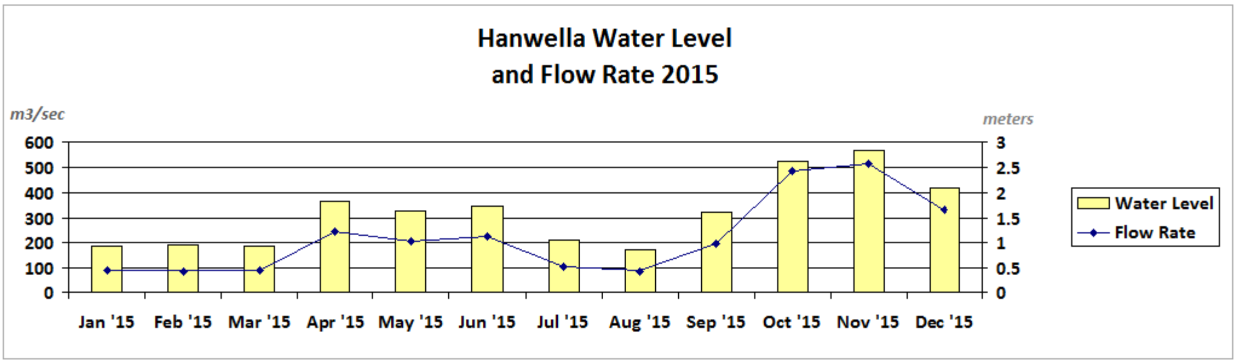
Source: R & D Unit, CEA



Source: Irrigation Department

Figure 1.11 Flow rates of Kelani River

The Figure 1.11 above shows the average annual flow rates at five locations of the Kelani River, namely, Deraniyagala, Kithulgala, Hanwella, Holombuwa and Glencourse. According to the graph, it's clear that the flow rates during the months, January- March and July-August is comparatively low, in the dry period.



Source: Irrigation Department

Figure 1.12 Water level change at Hanwella in Kelani river

Water Levels and the flow rate variations at Hanwella in 2015 is given by the Figure 1.12 above.

Chapter 2 Water Quality of the Kelani River

2.1 Ambient Water Quality Standard

River water quality is influenced to various factors as naturally derived substances, drainage from factories or business activities, discharge from pastures such as livestock, and drainage from each household. Although Industrial wastewater discharged to the kelani river is regulated by effluent standards specified, by *National Environment Act No 47 of 1988 and its amendment*, the impact of domestic and other wastewater is not fully managed. The standards of river water quality provide valuable clues of the quality of water, the level of contamination and relevant causes etc. Hence, the standards for river water quality is crucial in environmental conservation.

However, there were no such water quality standards established in Sri Lanka until 2015 except the proposed standard prepared by DHV consultancies in 1992. Hence, a joint project was initiated with the collaboration of Japan International Cooperation Agency (JICA) in order to establish standards of river water quality (a project for 3 years from 2015 to 2018), which is the one of the objectives of the project. As a result, a set of parameters and criteria of standards of river water quality for each six categories were established, depending on the particular water usage. The ambient water quality standards are shown in the Annex 1.

Ambient Water Quality Standard was categorized as six (6) categories, i.e. 1) Category A; Water source for simple treatment, 2) Category B; Bathing and contact recreational water, 3) Category C; Fish and Aquatic Life Water, 4) Category D; Water source for general treatment, 5) Category E; Irrigation & Agriculture and 6) Category F; Minimum Water Quality. The categories show water quality objectives including regulated criteria values of monitoring parameters.

Table 2.1 Categories and their description

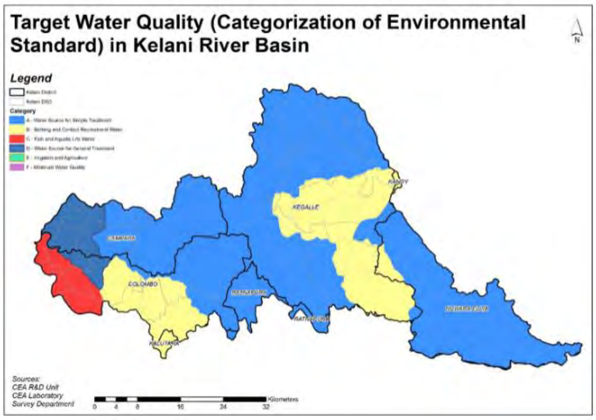
Category	Description
Category A: Water source for partial treatment	For waters whose waterbodies remain uninhabited or otherwise protected, and which require only approved partial treatment process commonly adopting simple physical treatment and disinfection process to meet the National Drinking Water Quality Standards. The values are also consonant with the Sri Lanka Standard 722:1985 on Tolerance Limits for Inland Surface waters used as raw water for public water supply. These waters shall also include pristine water with outstanding quality that may be found within national park and other protected areas.
Category B: Bathing and contact recreational water	For primary and secondary contact recreational activities such as swimming and diving. The use of waters does not include daily bathing and drinking purposes without appropriate treatment process.
Category C: Fish and Aquatic Life	For commercial and municipal fishing waters which are widely used for fishing purpose by local fisher folk and other water bodies which are locally

Category	Description
Water	known or identified as habitats of fishes or other aquatic products being consumed by humans or are being used for the propagation of such.
Category D: Water source for general treatment	For waters whose quality requires with full treatment process commonly adopting normal physical and chemical treatment accompanied by disinfection as designated by NWS&DB in order to meet the national Drinking Water Quality Standards.
Category E: Irrigation & Agriculture	For compatible agricultural uses (irrigation, livestock watering, etc.) and other uses.
Category F: Minimum Water Quality	This would include those used for navigational purposes, etc.

Source: CEA cooperate with JICA Team

2.2 Water Quality Objectives (Classification) in Kelani river basin

The CEA implemented a trial operation in 2016 to establish the Ambient Water Quality Standard. The Kelani river basin was divided into 14 small basins, the kelani river was divided into 14 small river basins depending on the water usage and land use pattern for the implementation of ambient water quality standards. classification. These small watersheds were designated the water classification based on purpose of water use. Each sub-basin has one reference monitoring point specified. The classified water objectives is shown in Figure 2.1.

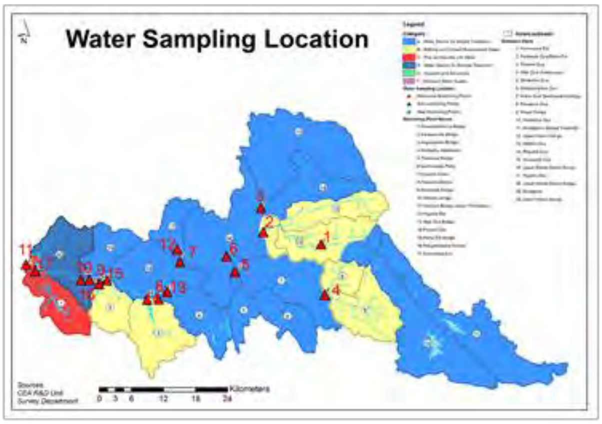


Source: R&D Unit, CEA

Figure 2.1 Categorization and District

2.3 Water Quality Monitoring points

CEA has monitored the water quality of the Kelani river over the past 10 years. There were 12 water quality monitoring points starting from Seethawaka to Japan Friendship Bridge. After establishing the water quality standards shown in Section 2.1, CEA has added additional 5 monitoring points making up to 17 points in total for the Kelani river.



Source: R&D Unit, CEA

Figure 2.2 Monitoring point and sub- basin

These monitoring points are using /used as reference monitoring points to compare with criteria values of water quality standard in each classified sub-basin. Currently, CEA have total of 17 monitoring points against 14 sub-basins. Among them, three monitoring points are used as sub-monitoring points, and measuring water quality.

2.4 Evaluation Methodology

Normally, the monitoring result is evaluated by the average annual value. However, high toxicity parameter is evaluated by the maximum value of annual results. Therefore, in items with high toxicity, even if it exceeds the standard value once a year, will be strictly evaluated as "not achieved the environmental guideline

Table 2.2 Evaluation methodology of each parameters

Class		Parameters	Evaluation method
1	Parameters that may gave significant health effects to humans	1. CN 2. F 3. Cd 4. Cr 5. Pb 6. Hg 7. Se 8. B 9. As 10. Phenol compound 11. NO_3-N 12. MCPA 13. Pendimethalin	Since the parameters of the first group are highly toxic, they are compared with the water quality guideline value using the maximum value of each year's monitoring result and evaluated.
2	Other important parameters	1. Colour 2. Conductivity 3. Turbidity 4. TSS 5. Total Hardness (as $CaCO_3$) 6. pH 7. DO at 25°C 8. BOD5 at 20°C 9. COD 10. PO_4-P 11. Chloride (Cl-) 12. SO_4^{2-} 13. Cu 14. Fe 15. NH_3-N 16. Mn 17. Ni 18. Zn 19. Al 20. Oil & Grease 21. Anionic surfactants as MBAS 22. Total Coliform 23. Fecal Coliform	The parameters of the second group are evaluated by comparing the annual average value of monitoring results with the water quality guideline value.

Source; CEA with JICA Team

2.5 Monitoring results

The annual average value or the observed maximum value for each parameter of 17 observation points in 2017 are shown below.

Table 2.3 Monitoring results of Kelani river on 2017

Ambient Water Standard			General parameters								Nutrient			Other	Metal							Micro Organism	
Location name	Setting category	Temperature	Conductivity	Turbidity	TSS	Total Hardness	pH	DO	BOD_5	COD	NO_3-N	NH_3-N	PO_4-P	Chloride (Cl)	Cd	Cr	Fe	Pb	Mn	Zn	As	Total Coliform	Fecal Coliform
		℃	μS/cm	NTU	mg/l	mg/l	-	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	μg/l	μg/l	μg/l	μg/l	μg/l	μg/l	μg/l	MPN/100ml	MPN/100ml
Parawalathanna Bridge	A	25.3	44	12	15	23	7.3	7.6	2	8	0.49	0.30	0.04	5	10	40	803	10	-	25	N.D.	4,000	1,325
Karawanella Bridge	B	25.8	40	7	6	22	7.1	7.2	2	7	0.51	0.15	0.03	4	10	10	385	10	-	35	N.D.	6,800	3,633
Anguruwella Bridge	A	27.6	51	9	10	23	7.1	7.0	2	7	0.59	0.21	0.02	4	10	20	626	10	-	20	N.D.	7,017	3,570
Nakkavita Bridge	B	26.7	24	4	7	15	7.2	7.7	2	7	0.66	0.09	0.02	3	10	20	570	10	-	60	N.D.	5,700	3,288
Thalduwa Bridge	A	27.0	43	7	6	20	7.4	7.3	2	7	0.53	0.27	0.02	6	10	10	413	10	-	10	N.D.	7,844	3,517
Seethawaka Ferry	-	28.5	454	49	14	54	7.1	6.0	2	14	0.85	2.13	0.03	24	10	20	536	10	-	24	N.D.	7,040	1,660
Pugoda Ela	A	27.6	338	69	13	38	7.2	5.5	1	18	0.66	1.50	0.02	20	10	10	1,159	10	-	18	N.D.	8,136	2,512
Pugoda Ferry	A	27.1	53	26	8	23	7.1	6.8	1	9	0.48	0.76	0.03	6	10	20	429	10	-	17	N.D.	5,225	3,060
Wak Oya	A	27.5	47	17	4	25	6.4	6.7	2	12	0.59	0.20	0.07	6	10	10	657	10	-	19	N.D.	8,510	2,241
Hanwella Bridge	-	26.8	46	48	11	24	7.4	6.8	2	11	0.87	0.22	0.03	4	10	40	491	10	-	20	N.D.	4,766	1,423
Pusseli Oya	B	27.8	56	40	10	32	7.0	5.8	2	9	0.61	0.63	0.02	7	10	60	760	10	-	20	N.D.	7,022	3,018
Kaduwela bridge	A	27.4	53	21	7	27	7.3	6.8	2	10	0.60	0.36	0.01	5	10	20	508	10	-	10	N.D.	8,004	1,970
Maha Ela	B	28.0	118	88	19	57	7.0	3.9	4	16	0.67	1.19	0.06	11	10	10	1,760	10	-	74	N.D.	6,830	3,772
Raggahawatte Ela	A	27.6	591	46	12	86	7.0	2.6	3	19	3.62	1.83	0.04	49	10	10	1,112	10	-	22	N.D.	11,413	3,210
Welibita bridge	D	27.4	72	21	8	28	7.4	6.9	2	10	0.65	0.32	0.04	19	10	10	586	10	-	13	N.D.	9,278	2,835
Kolonnawa Ela	C	27.9	2,411	65	13	252	7.4	2.9	8	35	0.55	6.38	0.19	748	10	10	1,713	10	-	26	N.D.	8,850	5,061
Japan Friendship Bridge	-	27.3	2,841	32	11	325	7.5	6.6	3	17	0.77	2.60	0.07	716	10	10	575	10		20	N.D.	9,583	5,510

Source; Laboratory Service, CEA

2.5.1 Attainment condition (Evaluation)

The summary of attainment condition on reference monitoring points in 2017 is follows;

Table 2.4 Attainment condition on 2017

#	Reference monitoring point	Applied category	Attainment condition
1	Parawalathanna Bridge	A	Turbidity and Fecal coliform are not achieved
2	Karawanella Bridge	B	Turbidity and Fecal coliform are not achieved
3	Anguruwella Bridge	A	Turbidity and Fecal coliform are not achieved
4	Nakkavita Bridge	B	Turbidity and Fecal coliform are not achieved
5	Thalduwa Bridge	A	Turbidity and Fecal coliform are not achieved
6	Pugoda Ela	A	Turbidity, DO, COD,Fe and Fecal coliform are not achieved
7	Pugoda Ferry	A	Turbidity and Fecal coliform are not achieved

#	Reference monitoring point	Applied category	Attainment condition
8	Wak Oya	A	Turbidity,COD and Fecal coliform are not achieved
9	Pusseli Oya	B	Turbidity and Fecal coliform are not achieved
10	Kaduwela bridge	A	Turbidity and Fecal coliform are not achieved
11	Maha Ela	B	Turbidity,DO, COD,and Fecal coliform are not achieved
12	Raggahawatte Ela	A	Turbidity,DO,COD,Fe,Total coliform and Fecal coliform are not achieved
13	Welivita bridge	D	All achieved
14	Kolonnawa Ela	C	DO, COD and BOD are not achieved

Source; CEA with JICA Team

In the upstream area, Fecal Coliform and Turbidity are exceeding the guideline value, but the other parameters maintain roughly good water quality.

In addition, in the downstream area, excessive amounts of organic pollution lead to increase in COD and BOD_5 values. Especially the excess of BOD is slight, but the number of excess COD is increasing. BOD can detect easily decomposable organic substances and COD can observe many organic substances. From this, it is assumed that the improvement of the BOD-COD ratio is increasingly difficult to decompose organic pollutants, and the influence of factory wastewater that is coming out to the downstream area.

Coliform and Turbidity exceeded in almost areas from the upstream to the downstream area in the kelani river basin. Coliform may increase due to the wastewater from livestock or surrounding households. In households around rivers it is necessary to handle the drainage system properly.

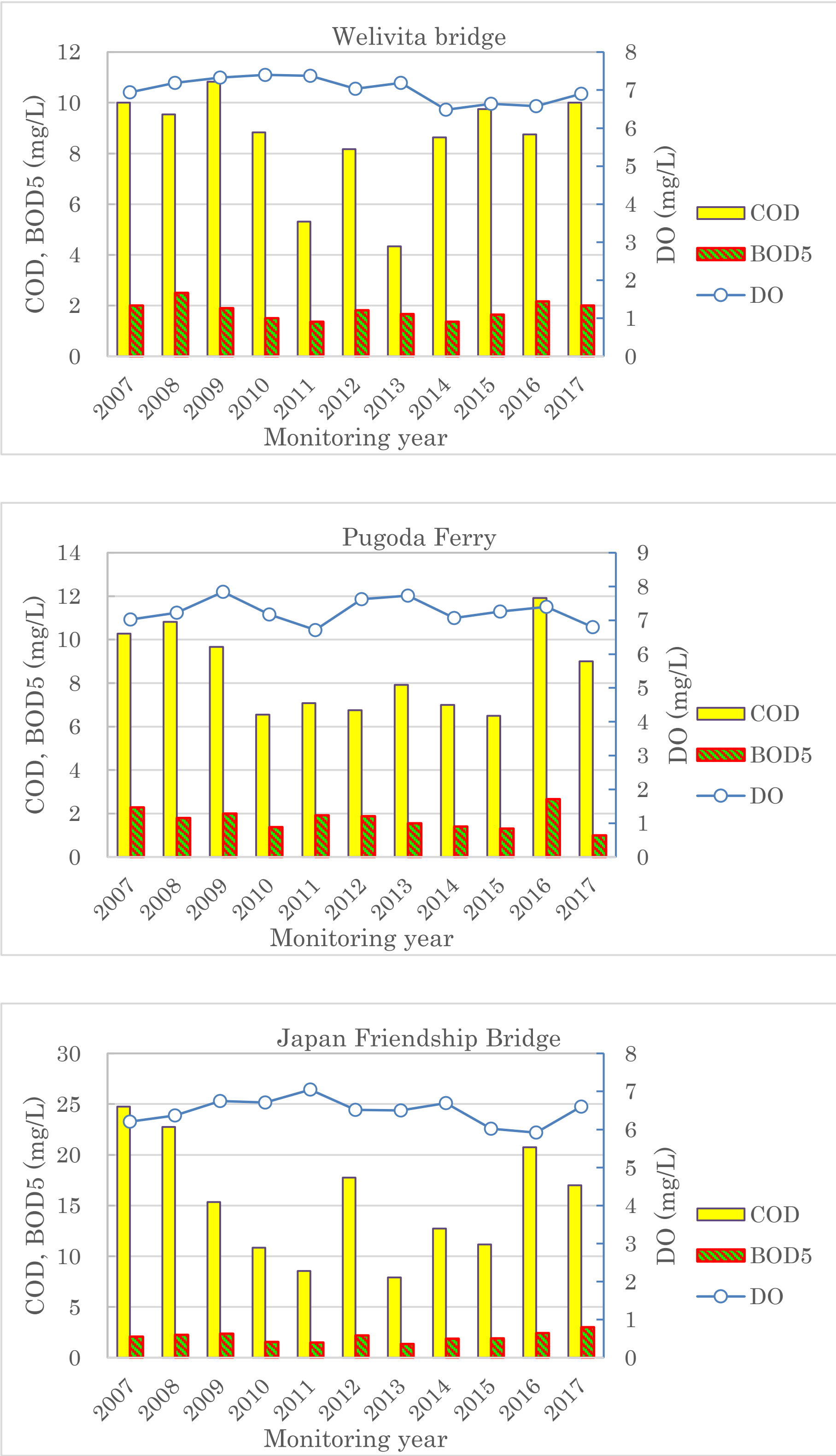
Turbidity has exceeded the guideline value at many points from the upstream to the downstream area. This seems to have a large influence by the surrounding soil quality, waste water from industries etc. It is difficult to improve this condition immediately. Turbidity is not thought to cause health damage, but when used as drinking water it is not desirable because it increases the processing load at the water treatment plant.

From upstream to downstream the iron concentration is in the accepted level except in Pugoda Ela and Raggahawatta Ela. This may be due to sudden discharge of industrial effluent to the river only in some months of the year.

When considering chromium concentration, it may give significant health effect to human; so it is compared with the water quality guideline value using the maximum value of each year's monitoring result and evaluated. In some locations in the upstream and downstream of Kelani river Cr concentration is little high when comparing to last year values. This may be due to chromium contaminated industrial discharges like paint industries.

2.5.2 Trend of WQ

In Kelani River, there are currently 17 regular monitoring points. At 12 sites in the downstream area from Sheethawaka in the middle watershed in Kelani river basin are observed continually over the past 11years. Figure 2.3 show the change of organic pollution index of Pugoda Ferry (Category A), Wellivita bridge (Category D), Japan Friendship Bridge (No Category) in Kelani River. These 3 locations, the BOD level has not changed significantly during the 11 years observation. The annual average value of BOD is 3 mg/L or less, which achieves the guideline value of category A. The DO level also meets the guideline value of category A in the same way. On the other hand, COD tends to exceed 10 mg/L.



Source: Laboratory service, CEA

Figure 2.3 Trend of Water quality in Kelani river

Chapter 3 Industrial Information

3.1 Distribution of Industries within Kelani River Basin

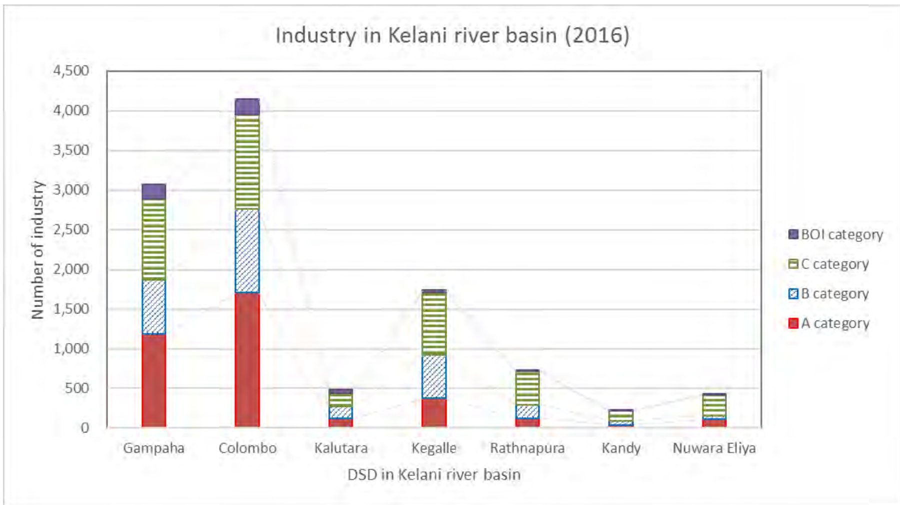
Availability of water for the production processes, and flowing water source for discharge of treated industrial effluent is important in selecting sites for industrial activities. There are around 10,000 industrial activities located within the KRB. Local industries as well as industries privileged by the facilities of the Board of Investment (BOI) of Sri Lanka are located in this area, due to availability of few BOI Industrial Estates within the KRB.Colombo and Gampaha districts of Sri Lanka is recorded as the areas which are highly industrialized, due to close proximity to the airport, harbor and to, Colombo, which is also the economical hub. and the capitals city. According to the data of CEA, nearly 10, 1000 small, medium and large scale industries are recorded in the Western Province. These industries fall into different categories. They include Chemical & Petrochemical, food and beverages, mineral s and allied products, and transport related industries. These industries highly contribute to the economy of the country. On the other hand, control of environmental pollution is a challenge to regulatory authorities.

Information on the industrial activities in each District in the Kelani River Basin is given at the Table 3.1. Many industrial activities are concentrated in downstream areas such as Gampaha and Colombo districts, while in upstream areas such as Kandy, and Nuwaraeliya, comparatively low concentrations are recorded (Figure 3.1). The Map in the Figure 3.2 depicts the distribution of industries within the Kelani River Basin.

Table 3.1 Number of industry in Kelani river basin (2016)

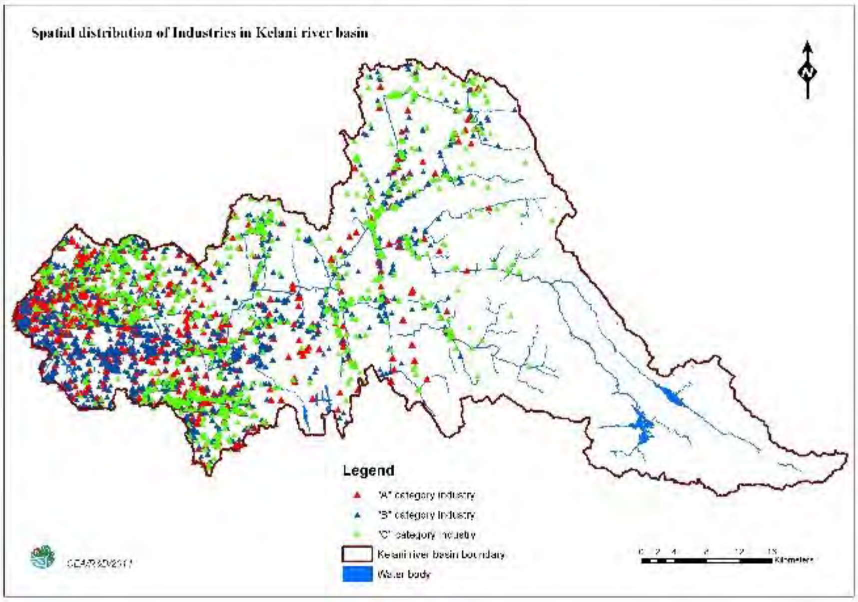
Province	District	Total Industry	A category	B category	C category	BOI category
Western	Gampaha	3,075	1,189	681	1,016	189
	Colombo	4,149	1,706	1,056	1,188	199
	Kalutara	486	117	153	169	47
Sabaragamuwa	Kegalle	1,736	374	542	795	25
	Rathnapura	720	127	167	419	7
Central	Kandy	220	42	51	123	4
	Nuwara Eliya	427	109	45	261	12
Total Industry in Kelani river basin		10,813	3,664	2,695	3,971	483

It is also revealed that Colombo and Gampaha districts representative large number of "A" category Industries. Detail description of distribution of Industries in each province of the KRB is depicted in the Table 3.1, Graphical encompass on the distribution of each type of Industries within each district located within the KRB is given at the Figure 3.2 below.



Source: R&D Unit, CEA

Figure 3.1 Distribution of industry in Kelani river basin



Source: R&D Unit, CEA

Figure 3.2 Distribution of industry in Kelani river basin

There are water intake points and treatment plants of the NWS&DB located in these highly industrialized areas of the KRB, hence proper wastewater management to maintain the quality of river water, is of prime important, and also a great challenge, to regulators, planners, and all relevant stakeholders. Industrial Pollution and Control.

3.1.1 Categorization of industries.

Under the provisions of the National Environmental Act (NEA), No.47 of 1980, as amended by Act No. 56 of 1987 and Act No.53 of 2000, pollution of water, air, and noise, is controlled by the issuance of the Environmental Protection License (EPL).

All industries which are required to obtain EPL are published in the Gazette Notification No.1533/16, dated 25.01.2008. Operating any industry or any carrying out of prescribed activity without a valid EPL is a punishable offence.

In the said Gazette Notification, industries are listed under "A", "B", and "C" categories based on the pollution load, as, high, medium and low, respectively.80 categories of industries are listed under the list "A", while 30 categories of industries are being listed out under the list "B". 33 categories of industries which are considered as low polluting, comes under thee under category "C".

Under the regulation, it is required to obtain the EPL for industrial categories "A" and "B", from the Central Environmental Authority. Currently, issuance of EPL and related duties are performed by the Provincial and District offices of the CEA.

Further, powers to issue EPL for low polluting industries under category "C" is delegated to the local authorities such as Urban Councils, Pradesheeya Sabhas, and Municipal Councils. Information on the type or categories of industries listed under the above Gazette Notification, the Codes according to the nature of each sectors, and the manner in which they are listed in the Gazette is given at the Table 3.2 below.

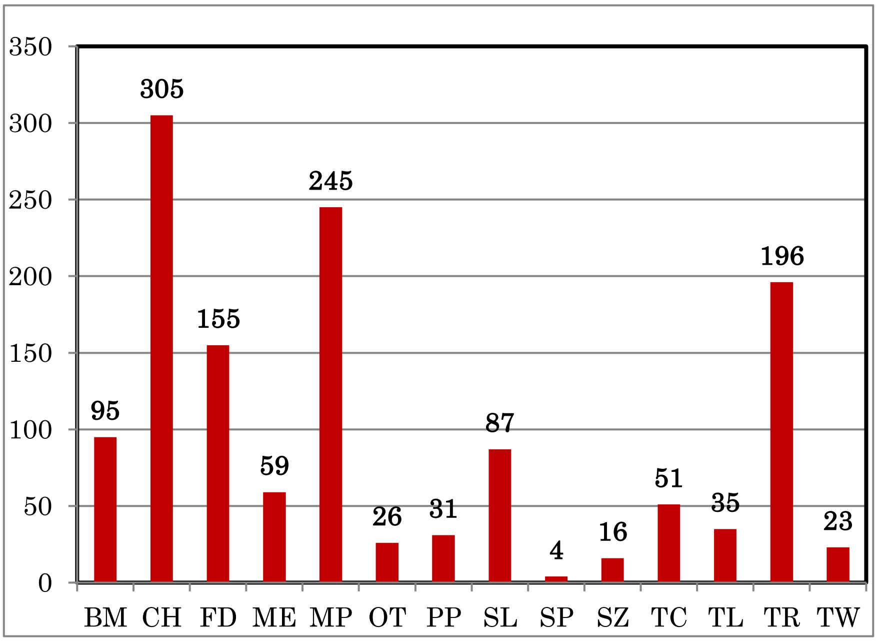
Table 3.2 Categories of industries in List "A"

	Type of Activities	Code	List A
1	Chemical & Petrochemical	CH	1-22
2	Textile & Leather	TL	23-29
3	Food and Food Related Food Industry	FD	30-42
4	Metal Industry	BM	43-46
5	Machinery & Equipment	ME	47
6	Mineral & Mineral Product	MP	48-56
7	Waste Disposal/ Waste water/ Water Treatment	SZ	57-63
8	Timber & Wood	TW	64-65
9	Lodgings & Health Services	SL	66-68
10	Transport Related Services	TR	69-72
11	Power	SP	73
12	Paper & Printing	PP	74-75
13	Telecommunication Towers	TC	79
14	Other Activities	OT	76-78, 80

Source: R&D Unit, CEA

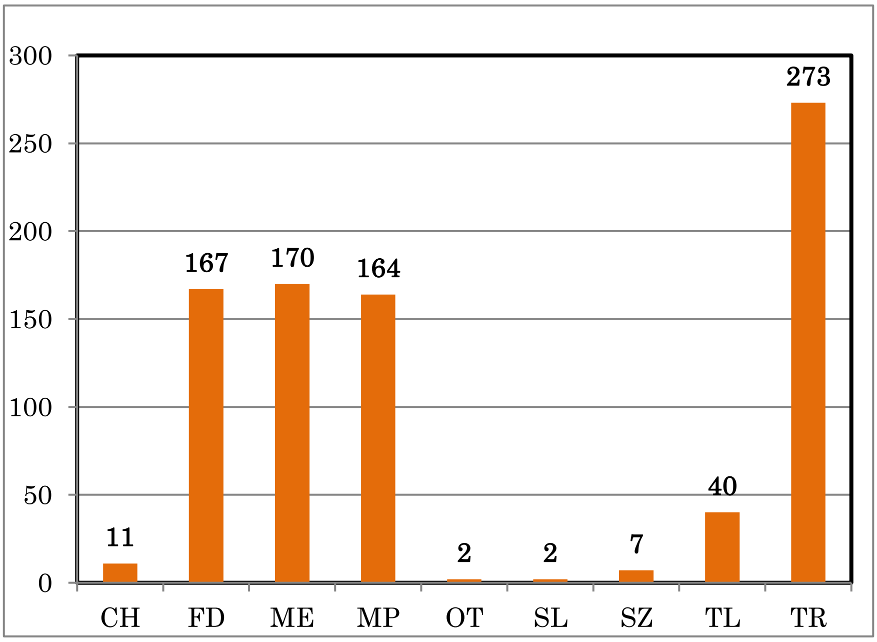
Data of the CEA reveals that category "A" industries, such as Chemical & Petrochemical (CH), Food and Related Food Industry (FD) and Transport Related

Services (TR), discharge large volume of industrial effluents. i.e. more than 10 m^3/day. Graphical representation of "A" category industries in sector wise, within the Kelani River Basin is given in the Figure 3.3. There are 305 Chemical &Petrochemical industries, 245 and, Mineral and mineral products industries, 196 Transport related services/ industries within the KRB.



Source: R&D Unit, CEA

Figure 3.3 Sector wise "A" category industry distribution in Kelani river basin

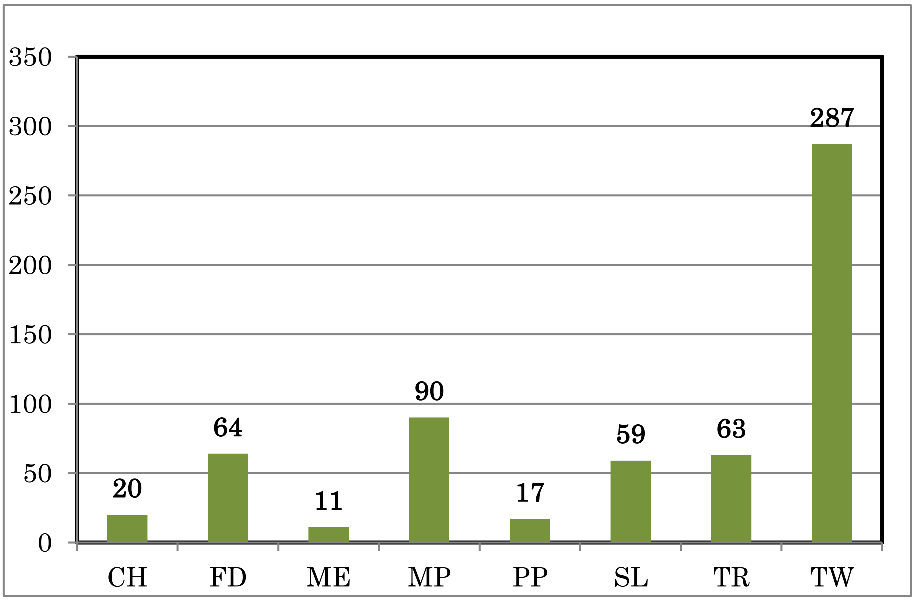


Source: R&D Unit, CEA

Figure 3.4 Sector wise "B" category industry distribution in Kelani river basin

"B" category industries in sector wise is given in the Figure 3.4 above. Within the KRB, Transport related services /industries are the highest, under the "B" category.

The Figure 3.5 shows the "C" category industries within the KRB in sector wise. Under "C'" category, Timber & Wood industries are the highest sectors.



Source: R&D Unit, CEA

Figure 3.5 Sector wise "C" category industry distribution in Kelani river basin

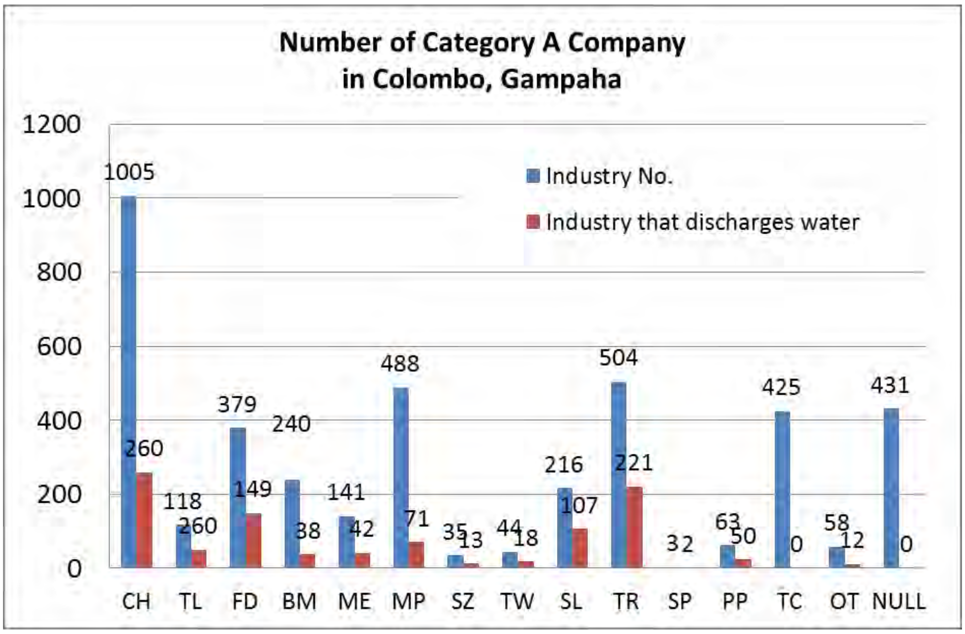
Table 3.3 "A" Category Industries generating waste water, and the Sectors –Colombo & Gampaha Districts.- 2016

Sector	CH	TL	FD	BM	ME	MP	SZ	TW	SL	TR	SP	PP	TC	OT	Total
Industry No. (A)															
Colombo	451	77	201	137	86	326	18	31	118	293	2	31	417	25	2213
Gampaha	554	41	178	103	55	162	17	13	98	211	1	32	8	33	1937
Industry discharge water (B)															
Colombo	154	39	91	22	30	45	9	14	66	143	2	13	0	9	637
Gampaha	106	11	58	16	12	26	4	4	41	78	0	11	0	3	370

Source: EPL system, CEA

All types of "A" category industries do not discharge wastewater. Comparison of all types of "A" category industries and the industries that generate waste water in Colombo and Gampaha Districts, according to the data of CEA, is given in the Table 3.3 above. According to the data of the Table 3.3, in Colombo and Gampaha districts, Chemical & Petrochemical sector industries that generate waste water, are high.

Comparison of total number of industries and the industries that discharge waste water within Colombo and Gampaha districts in sector wise are shown at the Figure 3.6.



Source: EPL system, CEA

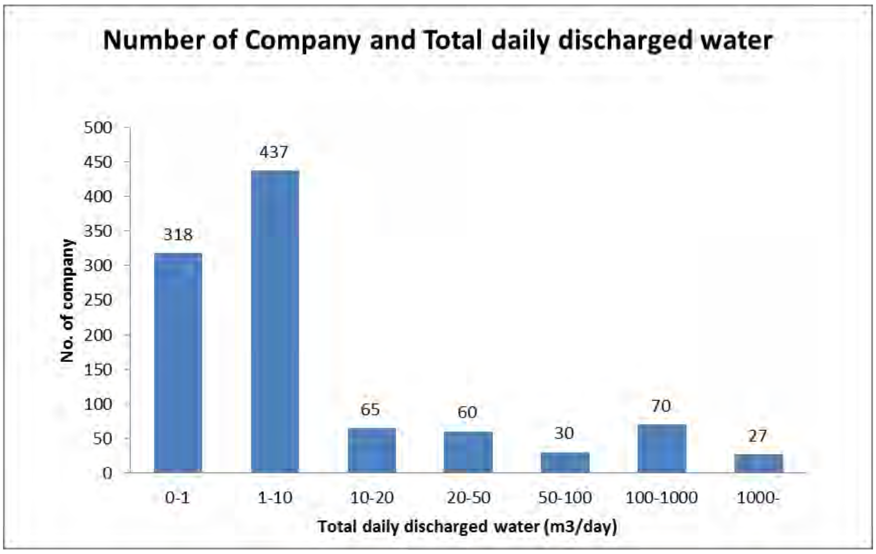
Figure 3.6 Number of Industries that discharge waste water in Colombo & Gampaha - in sector wise

Table 3.4 depicts the number of industries that discharge waste water, and the volumes (m^3/day), in both Colombo and Gampaha districts, according to the records of CEA. Approximately, 75% of industries discharge industrial effluents, less than 10m^3/day. However, nearly 10% of industries discharge more than 100 m^3/day of industrial effluents by their activities.

Table 3.4 Number of Industries and the Daily Discharge Water in KRB.

Daily Discharge Water (m^3/day)	Number of Industry
0-1	318
1-10	437
10-20	65
20-50	60
50-100	30
100-1000	70
1000-	27
Total	1007

Source: EPL system, CEA



Source: EPL system, CEA

Figure 3.7 Distribution of Daily Discharge Water in Colombo and Gampaha

The Figure 3.7 above shows the no of industries and volume daily discharge (m^3/day). According to data, No. of industries in KRB, discharge of waste water, in the range of 1-10 m^3/day, is comparatively high, and industries that discharge more than 1000 m^3/day is very few.

3.1.2 Pollution control

3.1.2.1 Environmental Protection License and Effluent Standards.

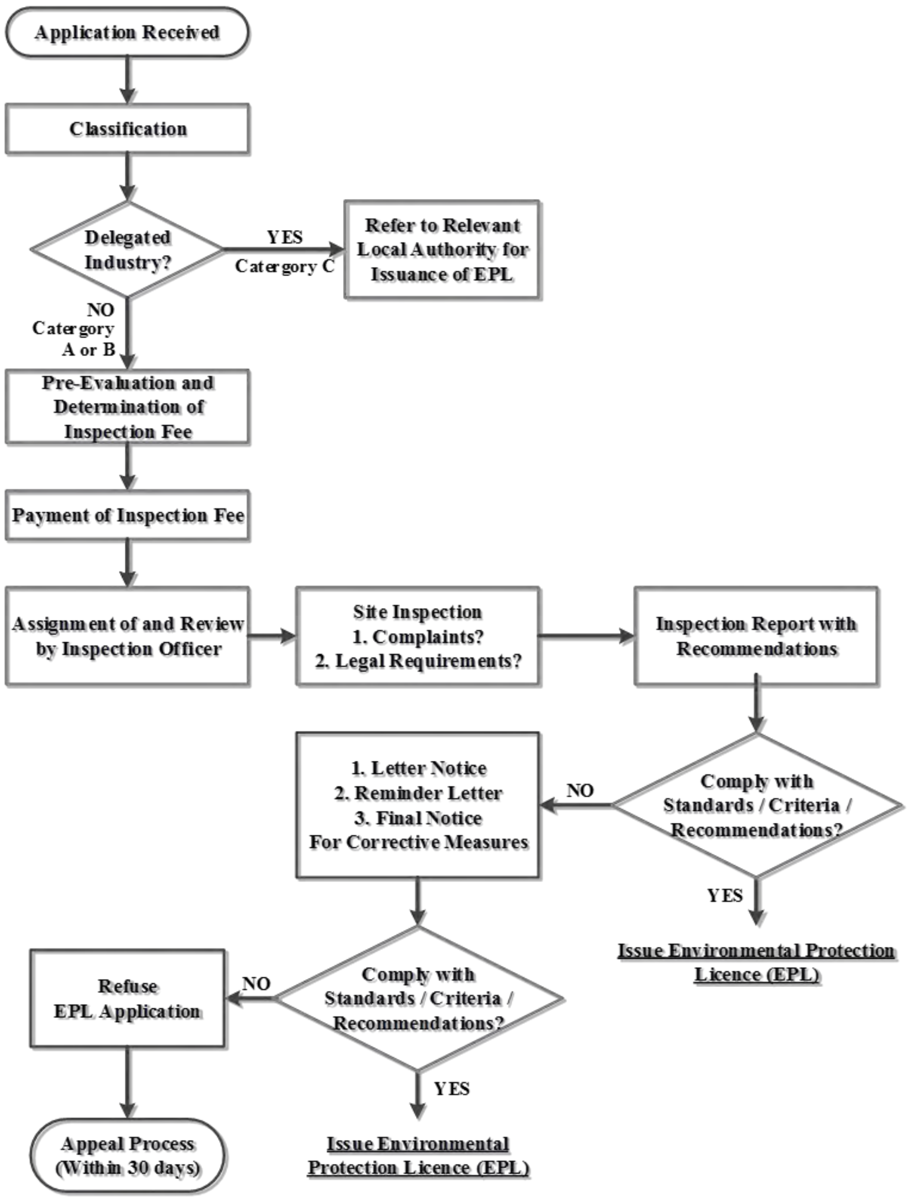
As described in the section 3.2.1 above, the Environmental Protection License (EPL) is the regulatory/legal tool adopted to control of environmental pollution, under the provisions of the National Environmental Act No: 47 of 1980 amended by Acts No 56 of 1988 and No 53 of 2000.

Industries and activities are required to operate with a valid EPL, which also needed to be renewed at the time of expire the validity of the License.

Moreover, as per Section 20.A of the Greater Colombo Economic Commission (Amendment) Act.No.49 of 1992, power to issuance of EPL to industries registered under section 17 (2) of the said Act, is vested with the Board of Investment, in consultation with, and the concurrence of the CEA.

Applications for obtaining EPL has to be submitted to the CEA, along with copies of the necessary supporting documents, to prove the land ownership, legal condition, etc.. Detailed information on the industry including, raw material types and requirement, production process, energy and water requirement, by products, waste quantities and quality (water, solid waste, emissions) is required to be disclosed by the industrialist.

Based on the observations at the time of inspecting the industry, issuance of EPL is decided. Quality of treated waste water, noise levels, emissions, and disposal methods of solid waste are taken into consideration, when deciding on issuance of an EPL. The procedure followed by the CEA, when granting approval for and EPL, is given in the Figure 3.8.



Source: CEA

Figure 3.8 Schematic diagram on the EPL Procedure.

At the instances, where the pollution control methods adopted by the developers are found inadequate, and the quality of treated waste water & noise levels, emissions, etc; or exceeding the tolerance limits of the Standards, the industrialists are guided to improve their systems, and a grace period is given them for making the improvements.

At the end of the grace period, quality of treated effluent, noise levels measured, and compared with the respective regulations and Standards, prepared under the provisions of the NEA (The Regulations – Annex-3 & Annex-4). Based on the results, the decision is taken on issuance of EPL to any particular industry or activity.

Conditions are stipulated in the EPLs to submit analytical reports on waste water, noise & vibrations levels, emissions reports on quarterly, or biannually basis, as and when required.

As per the provisions of the NEA, actions is taken on record of exceeding of any tolerance limit or level of the regulations. pH, BOD, COD, TSS, and oil& Grease levels are the commonly tested parameters of the treated waste water. Analytical reports on other parameters, specially on heavy metals are requested to test depending on the possibly of discharge with the effluents, due to availability of them in the raw materials used, by the industries concerned.

3.1.2.2 Renewal of EPL and Compliance monitoring

Compliance monitoring of industries, random sampling and analysis of waste water, is being carrying out by the officers of CEA, under the provisions of the NEA.

Renewal of the EPL is required to be continued by each industrialist or entrepreneur, as it is a requirement under the provisions of the NEA. Prior to the date of expiry of the EPL, entrepreneur has to take steps to submit an application for the purpose of renewal of existing EPL. After carrying out a site inspection, and obtaining reports on treated effluent, noises levels etc: when and where applicable, the officers of CEA proceeds in granting approval for renewal of the EPLs. Renewal of "A" Category EPLs is commenced on annual basis. In contrast, the EPLs of "B" and "C" categories are renewed once in three years. Compliance monitoring of the industries is being carried out according to a schedule.

3.1.2.3 Public complaints on Industrial Pollution.

CEA very often receives a number of complaints from individuals, NGOs, relevant stakeholder institutions, and other interested parties. A comprehensive database is maintained at the CEA on the complaints. Inspections on complaints are being carried out by the officers of CEA, and necessary actions are taken to resolve the issues, under the provisions of the NEA.

According to data of the CEA, detailed description of the complaints on the industrial pollution, in the KRB within the year 2016 is given at the Table 3.5. The Percentage of complaints in the Gampaha district is comparatively high. Kandy and Nuwara Eliya districts have very low percentage of complaints, compared to the other districts located within the KRB.

Table 3.5 Number of Complaints in Kelani river basin

Province	District	Number of Industry	Analysis on 2016	
			Total Number of Complaints	Ratio of total complain
Western	Gampaha	3,075	841	27.3%
	Colombo	4,149	336	8.1%
	Kalutara	486	28	5.8%
Sabaragamuwa	Kegalle	1,736	106	6.1%
	Rathnapura	720	8	1.1%
Central	Kandy	220	0	0%
	Nuwara Eliya	427	3	0.7%
Total in Kelani river basin		10,813	1,322	12.2%

Source: CEA

Total number of complaints received on industrial pollution and complaints on water pollution, within the all the districts of the KRB and total number of industries in each district (in 2015 and 2016) are tabulated in the Table 3.6.

In the Kalutara district in KRB, the complaint ratio related to water pollution is 21 to 32%, and it is high when compared to other areas. According to the comparison of the total number of complaints and the number of industries in 2016, the complaint ratio in Gampaha district is remarkably higher than that of the other districts. Thus, priority on compliance monitoring pertaining to water pollution in the Kalutara and Gampaha districts is needed for healthy maintenance of the quality of water of Kelani river.

Table 3.6 Comparison of number of Complaints in KRB

Province	District	Complaints on 2015		Complaints on 2016	
		Total complaints number	On water pollution	Total complaints number	On water pollution
Western	Gampaha	2,787	306 (11%)	841	125 (14.8%)
	Colombo	767	45 (5.8%)	336	40 (11.9%)
	Kalutara	156	34 (21.8%)	28	9 (32.1%)
Sabaragamuwa	Kegalle	190	25 (13.1%)	106	15 (14.1%)
	Rathnapura	24	1 (4.1%)	8	1 (12.5%)
Central	Kandy	0	0 (0%)	0	0 (0%)
	Nuwara Eliya	3	0 (0%)	3	1 (33.3%)
Total in Kelani river basin		3,927	411 (10.4%)	1,322	191 (14.4%)

Source: CEA

Chapter 4 Other Activities

4.1 Education program/Awareness

In order to maintain good water quality of the Kelani River, and for environmental conservation, it is much easier to take precautionary messures, thanimproving contaminated river water. However, water is abasic requirement, for washing, bathing, cooking etc.. These domestic wastewater are sometimes treatedat sewage treatment facilities, but there are many places where waste water is directly emitted into the environment. Therefore, CEA has conducted education awareness programs for secondary school students, other stakeholder agencies and the general public on environmental pollution control, and or river water management.

Table 4.1 Education program in 2014 - 2016

Name of Awareness Program	Event Year	Number of Participants	Participants Desc
Protection and Management of the environment and in daily life	2016	126	Power chief Engineer's office of Sri Lanka Railways
Protection and Management of the environment and in daily life	2014	38	Chief Mechanical Engineer's Office of Sri Lanka Railways - Rathmalana
Kelani River Basin Conservation and Management Project	2014	108	Grama Niladari, Economic Development Officers in Kelaniya DS Division
Kelani River Basin Conservation and Management Project	2014	58	Grama Niladari , Economic Officers, Agrarian Development Officers in Dompe DS Division
Awareness Program on Industrialists of Sand Mining "Hanwella and Kaduwela" DS Division	2014	100	Industrialists of Sand Mining "Hanwella and Kaduwela" DS Division

Source: CEA

Details of each education and awareness programs, organized and conducted by the CEA, with the years 2014-2016, is given in the Table 4.1 above, and is in the process of continuing of such programmes & events.

Chapter 5 Explanation of Technical Terms

EPL (Environmental Protection License)

Industries are classified under 3 lists i.e., List "A", "B" and "C" depending on their pollution potential. EPL is required for Industries to operate.

Effluent standard

It is regulated value when industry discharge their water to outside/ environment. The standard value regulates depend on the type of activity or discharge area.

Ambient Water Quality Standard

It is a target values of river water for conservation the environment or people's health. The target parameters are regulated depend on the major water use.

Categorization

The categorization is applied in river section based on major water use. The water use are categorized into 6 types of Water Source for Simple Treatment, Bathing and Contact Recreational Water, Fish and Aquatic Life Water, Water Source for General Treatment, Irrigation and Agriculture and Minimum Water Quality.

pH

It is an indicator of the degree of acidity and alkalinity. If pH is7, it is neutral. The lower than 7 is called acidic, the higher than 7 is called alkaline.

DO (Dissolved Oxygen)

It is the amount of oxygen dissolved necessary for living creatures in water. If the water is polluted, DO will be low.

BOD (Biochemical Oxygen Demand)

It is the amount of oxygen required when water pollutant is decomposed by microorganisms. It is an indicator of the water pollution of areas where microorganism activities are active like a river. If the water is polluted, BOD will be high

COD (Chemical Oxygen Demand)

It is the amount of oxygen required when the water pollutant is decomposed by the oxidizing agent. It is an indicator of the water pollution of areas closed watershed where microorganism activity is not active like a sea and the lake. If the water id polluted, COD will be high.

EC (Electric Conductivity)

It is an ease of passing electricity in water. If the water is polluted, EC will be high.

TSS (Total Suspended Solids)

It is the amount of solid floating in the water. If the water id polluted, TSS will be high.

Annex

Annex - 1 Ambient Water Quality Standard

	No.	Parameter	Unit	Category A: Water source for simple treatment	Category B: Bathing and contact recreational water	Category C: Fish and Aquatic Life Water	Category D: Water source for general treatment	Category E: Irrigation & Agriculture	Category F: Minimum Water Quality
General	1	Colour	PTmg/l	20	-	-	100	-	-
	2	Conductivity	μS/cm	-	-	-	-	700	-
	3	Turbidity	NTU	5	-	-		-	-
	4	TSS	mg/l	25	-	40	1500	2100	-
	5	Total Hardness (as CaCO3)	mg/l	250 des 600 max	-	-	-	-	-
	6	pH	-	6.0-8.5	6.0-9.0	6.0-8.5	6.0-9.0	6.0-8.5	5.5-9.0
	7	DO at 25°C	mg/l	6	5	5	4	3	3
	8	BOD5 at 20°C	mg/l	3	4	4	5	12	15
	9	COD	mg/l	10	10	15	30	-	40
Nutrient	10	NO_3.N	mg/l	10	10	10	10	-	10
	11	NH_3-N pH<7.5	mg/l	-	-	0.94	-	-	9.1
		pH7.5≦pH＜8.5		-	-	0.59	-	-	4.9
		8.5≦pH		-	-	0.22	-	-	1.6
	12	PO4-P	mg/l	0.7	0.7	0.4	0.7	-	-
Other	13	Chloride (Cl)	mg/l	250	-	-	250	600	-
	14	CN	mg/l	0.05	0.05	0.05	0.05	0.05	0.05
	15	F	mg/l	1.5	-	-	1.5	-	-
	16	SO42-	mg/l	250	-	-	250	1,000	-
Metal	17	Cd	μg/l	5	-	5	5	-	5
	18	Cr	μg/l	50	-	20	50	-	50
	19	Cu	μg/l	-	-	100	-	-	100
	20	Fe	μg/l	300 des 1,000 max	-	-	2000	-	-
	21	Pb Hardness<120	μg/l	50	-	2	-	-	-
		120≦Hardness＜180				3			
		180≦Hardness				4			
	22	Mn	μg/l	1,000	1,000	1,000	1,000	1,000	1,000
	23	Hg	μg/l	1	1	1	1	2	2
	24	Ni	μg/l	70	100	100	100	200	100
	25	Se	μg/l	10	10	5	10	-	-
	26	Zn	μg/l	1,000	-	100	1,000	2,000	24,000
	27	B	μg/l	-	-	-	-	500	-
	28	As	μg/l	50	50	50	50	50	50
	29	Al	μg/l	200	-	-	-	5,000	5,000
Organic Micro Pollutant	30	Phenolic compounds	μg/l	2	5	2	5	5	5
	31	Oil/Grease	μg/l	100	-	100	100	-	300
	32	Anionic surfactants as MBS	μg/l	1,000	1,000	1,000	1,000	1,000	1,000
	33	Pesticide and the metabodies	μg/l	note:1	-	-	note:1	-	-
Micro Organism	34	Total Coliform	MPN/ 100ml	10,000	10,000	-	10,000	-	-
	35	Fecal Coliform	MPN/ 100ml	500 des 1000 max	500 des 1000 max	-	-	-	-

Note:1 Psticeideand the metabpdies shall not exceed the guideline balues specified in WHO Guideline for Drinking Water Quality*. The analysis of pesticide residues shall be conducted preferably by an accredeted laboratory using internationallly established test methods.

* The latest edition should be used

NOTE: Tests for Pesticide residues may not be necessary for routine analysis and carried out only if required or requested.

Annex - 2 Industrial Category

Industrial category was categorized part A to part C based on the type and capacity of their activities that is designated in Gazette No. 1533/16 2008. In the Gazette, the category of part A have 80 industrial activities types. Therefore, Sector Code are can be used to gathering the similar activity to summarized in main document. Herewith attached the original industrial categories and the scale of the businesses that regulated intoGazette No. 1533/16 2008. If you would like to know detail of the regulation, please refer directly toGazette No. 1533/16 2008.

Table-1 Category "A"Industry

#	The Prescribed Activities for Which a License is Required
1.	Chemicals manufacturing or formulating or repacking industries.
2.	Soaps, detergents, softener or any other cleansing preparations manufacturing industries having a production capacity of 1,000 kilograms per day or more.
3.	Bulk petroleum liquid or liquefied petroleum gas storage or filling facilities having a total capacity of 150 or more metric tons excluding vehicle fuel filling stations.
4.	Industries involved in the use of fiberglass as a raw material where 10 or more workers are employed.
5.	Synthetic rubber, natural rubber manufacturing or processing or rubber based industries excluding industrieswhich manufacture less than 100 kilograms of ribbed smoke rubber sheets per day.
6.	Activated carbon or carbon black manufacturing industries or charcoal manufacturing industries having a production capacity one or more metric ton per batch.
7.	Industries involved in manufacturing extracting or formulating Ayurvedic, Indigenous medicinal products where25 or more workers are employed.
8.	Chemical fertilizer manufacturing, formulating, processing or repacking Industries.
9.	Pesticides, insecticides, fungicides and herbicides manufacturing, formulating or repacking industries.
10.	Oil (mineral oil or petroleum) refineries.
11.	Dye and dye intermediate manufacturing or formulating industries.
12	Paints (emulsion or enamel), inks, pigments, varnish, polish manufacturing or formulating industries.
13.	Petrochemical (basic or intermediates) manufacturing or formulating industries.
14.	Industrial gas manufacturing, processing or refilling industries.
15.	Asphalt processing plants.
16.	Industries involved in the manufacture of polymers or polymer based products (i.e. polyethylene, polyvinylchloride (PVC), polyurethane, polypropylene, polyester, nylon, polystyrene, resins, fiberglass or other manmade fibers etc.) or polymer or polymer based products, recycling industries.
17.	All types of tyres, tubes manufacturing or tyre retreading industries.
18.	Industries involved in manufacturing or reconditioning of batteries.
19.	Any industry involved in the use of asbestos fibres as a raw material.
20.	Industries involved in manufacturing, extracting or formulating pharmaceuticals or cosmetic products includingintermediates.
21.	Adhesives manufacturing industries excluding natural gums.
22.	Match sticks manufacturing industries and explosives manufacturing or formulating industries.
23.	Batik industries where 10 or more workers are employed.
24.	Textile processing (i.e. bleaching, dyeing, printing) industries or garment washing industries or textile sandblasting industries or commercial laundries where 10 or more workers are employed.
25.	Tanneries.

#	The Prescribed Activities for Which a License is Required
26.	Lather finishing industries having effluent generating operations.
27.	Jute processing industries.
28.	Industries involved in bleaching or dyeing of natural fibre or natural fibre based industries where 25 or moreworkers are employed.
29.	Power looms having 25 or more machines or power looms with sizing activities.
30.	Sugar manufacturing industries or sugar refineries.
31.	Fermentation industries (Distilleries, Breweries) or alcoholic beverages bottling plants or bottling plants havingbottle washing operations.
32.	Food manufacturing and processing industries including bakery products and confectioneries where 25 or moreworkers are employed.
33.	Abattoirs.
34.	Coconut oil or cinnamon oil extraction industries where 25 or more workers are employed.
35.	Plants or animal oil/fats extraction industries having production capacity of 10 litres or more per day excludingcoconut oil and cinnamon oil extraction industries.
36.	Instant tea or coffee processing industries.
37.	Non-alcoholic beverages manufacturing industries where 25 or more workers are employed.
38.	Desiccated coconut mills or coconut processing industries where 10 or more workers are employed.
39.	Rice mills having wet process and having a production capacity of 5,000 kilograms or more per day.
40.	All hatcheries or poultry farms having 2,500 or more birds or piggery, cattle, goats farms having animals 50 ormore or having rating* for mixed farming 2,500 or more.*Rating for Mixed Farming = No. of Birds + 50 x (No. of Pigs + No. of Cattle + No. of Goats)
41.	Animal feed manufacturing industries having a capacity of 25 or more metric tons per day.
42.	Cigarettes or other tobacco products manufacturing industries where 50 or more workers are employed.
43.	Industries involved in surface treatment of metal or plastic including electroplating, galvanizing and powdercoating industries.
44.	Iron and steel mills.
45.	Foundries with any type of furnaces.
46.	Non-ferrous metal processing industries including secondary process, smelting and recovery of metals.
47.	Metal fabricating industries or machinery, machinery parts or hardware items or electrical and electronic goodsand equipment manufacturing or assembling industries where 24 or more workers are employed. (Including latheworkshops, welding shops, spray painting industries).
48.	Cement industries (clinker grinding, manufacturing or repacking).
49.	Concrete batching plants having a production capacity of 50 or more cubic meters per day.
50.	Glass or glass based product manufacturing industries.
51.	Lime kilns having a production capacity of 20 or more metric tons per day.
52.	Ceramic industries where more than 25 or more workers are employed.
53.	Mechanized mining activities with multi bore hole blasting or single bore hole blasting activities with productioncapacity having 600 or more cubic meters per month.
54.	Crushing or processing of non-metallic minerals (i.e. limestone, dolomite, apatite.rock phosphate, sand stone,feldspar, quartz, ilmenite, rutile, zircon, mica, graphite, kaolin, etc) excluding lime shell and granite crushingactivities.
55.	Granite boulders making or processing industries (extracting, blasting, slicing, polishing).
56.	Granite crushing (Metal crushing) industries having a total production capacity of 25 or more cubic meters perday.
57.	Common wastewater (industrial or sewage) treatment plants.
58.	Incinerators having a feeding capacity of 5 or more metric tons per day.
59.	Water treatment plants having a treatment capacity of 10,000 or more cubic meters per day.
60.	Municipal solid waste and other solid waste composting plants having a capacity or 10 or more metric tons perday.

#	The Prescribed Activities for Which a License is Required
61.	Solid waste recovery/recycling or processing plants having a capacity of 10 or more metric tons per day.
62.	Soild waste disposal facility having a disposal capacity of 10 or more metric tons per day.
63.	All toxic and hazardous waste treatment facility or disposal facilities or recycling/recovering or storage facilities.
64.	Industries involved in chemical treatment and preservation of wood excluding Boron treatment.
65.	Saw mills having a milling capacity of 50 or more cubic meters per day or wood based industries where 25 or moreworkers are employed.
66.	Hotels, guest houses, rest houses having 20 or more rooms.
67.	Hostels and similar dwelling places where occupancy level is exceeding 200 or more.
68.	Health care service centres generating infectious wastes, including medical laboratories and research centres.
69.	Automobile or bicycle manufacturing or assembling industries.
70.	Vehicles service stations or container yards having vehicle service activities excluding three wheeler and motorcycles services and interior cleaning.
71.	Railway workshops or all bus depots having vehicle servicing activities.
72.	All vehicle emission testing centres.
73.	Electrical power generating utilities excluding standby generators and hydro or solar or wind power generation.
74.	Printing presses with lead smelting o newspaper printing or printing process which generates wastewater orcolour photographs processing centres.
75.	Paper and Pulp Industries or corrugated cartons manufacturing industries.
76.	Any industry where 200 or more workers per shift are employed.
77.	Industrial Estates approved under the part IVC of the National environmental Act including Katunayake andBiyagama Export processing Zones.
78.	Zoological gardens.
79.	Transmission towers providing facilities for telecommunication and boradcasting.
80.	Any industry not included above which discharges 10 or more cubic meters of wastewater per day or using toxicchemicals in its process.

Table-2 Category “B”Industry

#	The Prescribed Activities for Which a License is Required
1.	Soaps, detergents, softener or any other cleansing preparations manufacturing industries having a productioncapacity less than 1,000 kilograms per day.
2.	Bulk petroleum liquid storage facilities excluding filling stations or liquefied petroleum gas (LP Gas) storage or filling facilities having a total capacity less than 150 metric tons.
3.	Industries involved in the use of fibre glass as a raw material where less than 10 workers are employed.
4.	Ribbed smoke rubber sheet manufacturing industries having a production capacity of more than 50 kilogramsand less than 100 kilograms per day.
5.	Activated carbon or carbon black manufacturing industries or charcoal manufacturing industries having aproduction capacity less than one metric ton per batch.
6.	Industries involved in manufacturing, extracting or formulating Ayurvedic, indigenous medicinal products wheremore than 10 workers and less than 25 workers are employed.
7.	Batik industries where less than 10 workers are employed.
8.	Commercial laundries where less than 10 workers are employed.
9.	Leather finishing industries having dry process operations.
10.	Natural fibre based industries where less than 25 workers are employed excluding industries involved in bleachingor dyeing of natural fibre.
11.	Power looms having less than 25 machines.

#	The Prescribed Activities for Which a License is Required
12	Hand Looms or knitting or embroidery industry having more than 10 looms.
13.	Garment industries where 25 or more workers and less than 200 workers per shift are employed.
14.	Sugar cane based industries excluding sugar factories of sugar refineries.
15.	Food manufacturing and processing industries including bakery products and confectioneries where 5 or moreworkers and less than 25 workers are employed.
16.	Cinnamon oil extracting industry where less than 25 workers are employed.
17.	Rice mills having wet process with a production capacity of less than 5,000 kilograms per day.
18.	Grinding mills having production capacity of more than 1,000 kilograms per month.
19.	Poultry farms have 250 or more and less than 2,500 birds or piggery, cattle, goats farms having animals 5 or moreand less than 50 or having rating * for mixed farming 250 and less than 2,500. * Rating for Mixed Farming = No. of Birds + 50 x (No. of Pigs + No. of Cattle + No. Goats)
20.	Animals feed manufacturing industries, having a capacity of less than 25 metric tons per day.
21.	All ice manufacturing industries.
22.	Metal fabricating industries or machinery, machinery parts or hardware items or electrical and electronic goodsand equipment manufacturing or assembling industries where less than 25 workers are employed. (includinglathe workshop, welding shops, spray painting industries).
23.	Concrete batching plants having a capacity less than 50 cubic meters per day
24.	Single borehole blasting with industrial mining activities using explosives, having a production capacity of lessthan 600 cubic meters per month.
25.	Granite crushing (Metal crushing) industries having a total production capacity of less than 25 cubic meters perday excluding manual crushing operations using hand tools.
26.	Municipal solid waste and other solid waste composting plants (excluding household composting) having acapacity of less than 10 metric tons per day.
27.	Solid waste recovery/recycling or processing plants having a capacity of less than 10 metric tons per day.
28.	Solid waste disposal facilities a disposal capacity of less than 10 metric tons per day.
29.	Hostels and similar dwelling places where occupancy level or 25 or more boarders and less than 200 borders.
30.	Vehicle repairing and maintaining garages including spray painting or mobile air-conditioning activities.
31.	Recycling or recovering centres of refrigerants form air-conditioners or refrigerators.
32.	Three wheeler or motor cycle servicing activities or vehicle interior cleaning activities.
33.	Any industry not included above which discharges 3 or more and less than 10 cubic meters of industrialprocessing wastewater per day.

Table-3 Category “C”Industry

#	The Prescribed Activities for Which a License is Required
1.	All vehicle filling stations (liquid petroleum and liquefied petroleum gas).
2.	Manufacturing of candles where 10 or more workers are employed.
3.	Coconut oil extraction industries where 10 or more workers and less than 25 workers are employed.
4.	Non-alcoholic beverages manufacturing industries where 10 or more workers and less than 25 workers areemployed.
5.	Rice mills having dry process operations.
6.	Grinding mills having production capacity of less than 1,000 kilograms per month.
7.	Tobacco barns.
8.	Cinnamon fumigating industries with sulphur fumigation having capacity of 500 or more kilograms per batch.
9.	Edible salt packing and processing industries.

#	The Prescribed Activities for Which a License is Required
10.	Tea factories excluding instant tea processing.
11.	Concrete pre-cast industries.
12	Mechanized cement blocks manufacturing industries.
13.	Lime kilms having a production capacity of less than 20 metric tons per day.
14.	Plaster of Paris industries where less than 25 workers are employed.
15.	Lime shell crushing industries.
16.	Tile and brick kilms.
17.	Single borehole blasting with artisanary mining activities using explosives, having capacity of less than 600cubic meters per month.
18.	Saw mills having a milling capacity of less than 50 cubic meters per day or industries involved in Boron treatmentof wood or timber seasoning.
19.	Carpentry workshops which use multipurpose carpentry machine or wood based industries where more than 5 workers and less than 25 workers are employed.
20.	Residential hotels, guest houses, rest houses with 05 or more and less than 20 rooms.
21.	Vehicle repairing or maintaining garages excluding spray-painting or mobile air-conditioning activities.
22.	Repairing, maintaining or installation centres of refrigerators and air-conditioners.
23.	Container yards excluding where vehicle servicing activities are carried out.
24.	All electrical and electronic goods repairing centre where more than 10 workers are employed.
25.	Printing presses and later press machines excluding lead smelting.

Annex - 3 Tolerance Limit for the Discharge of industrial Waste in to Inland Surface Waters

This is an excerpt of one of the reference value of tolerance limit from Gazette No. 1534/18 2008. The tolerance limit is not only this table, there are 7 types tolerance limits shown in Table 2. If you would like to know all contents, please refer directly to Gazette No. 1534/18 2008.

Table-1 Tolerance Limit for the Discharge of industrial Waste in to Inland Surface Waters

No.	Parameters	Unit Type of limit	Tolerance limit values
01	Total suspended solids	mg/L, max.	50
02	Particle size of the total suspended solids	μ m, less than	850
03	pH at ambient temperature	--	6.0 - 8.5
04	Biochemical oxygen demand (BOD_5 in five days at 20℃ or BOD_3 in three days at 27 ℃)	mg/L, max.	30
05	Temperature of discharge	℃, max.	Shall no exceed 40 ℃ in any section of the stream within 15 m downstream from effluent outlet
06	Oil and greases	mg/L, max.	10
07	Phenolic compounds (as C_6H_5OH)	mg/L, max.	1
08	Chemical Oxygen demand (COD)	mg/L, max.	250
09	Colour	Wavelengthrange 436nm (Yellow range) 525 nm (Red range) 620 nm (Blue range)	Maximum spectral absorption coefficient 7 m^{-1} 5 m^{-1} 3 m^{-1}
10	Dissolved phosphate (as P)	mg/L, max.	5
11	Total kjeldahl nitrogen (as N)	mg/L, max.	150
12	Ammonia nitrogen (as N)	mg/L, max.	50
13	Cyanide (as CN)	mg/L, max.	0.2
14	Total residual chloride	mg/L, max.	1.0
15	Fluorides (as F)	mg/L, max.	2.0
16	Sulphide (as S)	mg/L, max.	2.0
17	Arsenic (as As)	mg/L, max.	0.2
18	Cadmium (as Cd)	mg/L, max.	0.1
19	Chromium, total (as Cr)	mg/L, max.	0.5
20	Chromium, Hexavalent (as Cr^{6+})	mg/L, max.	0.1
21	Copper (as Cu)	mg/L, max.	3.0
22	Iron (as Fe)	mg/L, max.	3.0
23	Lead (as Pb)	mg/L, max.	0.1
24	Mercury (as Hg)	mg/L, max.	0.0005
25	Nickel (as Ni)	mg/L, max.	3.0
26	Selenium (as Se)	mg/L, max.	0.05
27	Zinc (as Zn)	mg/L, max.	2.0
28	Pesticides	mg/L, max.	0.005

29	Detergents/ surfactants	mg/L, max.	5
30	Feacal coliform	MPN/100mL, max.	40
31	Radio Active Material; (a) Alpha emitters (b) Beta emitters	 micro curie/mL, max. micro curie/mL, max.	 10^{-8} 10^{-7}

Table-2 Type of Tolerance Limit

Type	Type of tolerance limit	Number of regulated parameters	Discharge area	Target industry
I	Tolerance limit for the discharge of industrial waste in to inland surface waters	31	Inland surface waters	All industry
II	Tolerance limit for industrial waste discharge on land for irrigation purpose	20	Land for irrigation purpose	All industry
III	Tolerance limit for industrial and domestic waste discharge into marine costal area	28	Marine coastal area	All industry and domestic waste
IV	Tolerance limit for waste from rubber factories being discharge into inland surface waters	8	Inland surface waters	Rubber industry
V	Tolerance limit for waste from textile industry being discharge into inland surface waters	15	Inland surface waters	Textile industry
VI	Tolerance limit for waste from being discharged from tanning industries	12	No designate	Tanning industry
VII	Tolerance limit for discharge of effluent into public sewers with central treatment plants	28	Public sewers with central treatment plants	All industry

Annex - 4 Permissible Noise Levels in Accordance with Noise Control Regulations

This is a summary of regulation of noise control. The regulation is described more details including the handling of background level of noise etc. If you would like to know all contents, please refer directly to National Environmental Act.

Maximum Permissible Noise Levels (as L_{Aeq} T) at Boundaries of the Land in which the noise source is located shall not exceed the limits set out below.

Area	L_{Aeq} T, DB(A)	
	Day Time	Night Time
Low Noise (Pradeshiya Sabha area)	55	45
Medium Noise (Municipal Council/ Urban Council area)	63*	50
High Noise (EPZZ of BOI & Industrial Estates approved under part IVC of the NEA)	70	60
Silent Zone (100 m from the boundary of a courthouse, hospital, public library, school, zoo, sacred areas and areas set apart for recreation or environmental purpose)	50	45

* Provided that the noise level should not exceed 60 DB (A) inside existing house, during day time.

Maximum Permissible Noise Levels at Boundaries of the Land in which the source of noise is lacated in L_{Aeq} T for construction activities.

Construction Activities

L_{Aeq} T, DB(A)	
Day Time	Night Time
55	45

Note 1;

"L_{Aeq}"means the equivalent continuous, A-weighted sound pressure determined over a time interval T (in DB)

"Day Time"means 06:00 hours to 18:00 hours, except for the purpose of constructions activities where it means 06:00 hours to 21:00 hours

"Night time"means 18:00 hours to 06:00 hours, except for the purpose of constructions activities where it means 21:00 hours to 06:00 hours

Annex - 5 SLS 614 2013 Specification for Portable Water

This is an excerpt of only the reference value of Portable water from SLS 614. If you would like to know all contents, please refer directly to SLS 614 2013.

Table-1 Physical and organoleptic requirement

SI No. (1)	Characteristics (2)	Requirement (3)	Method of test (4)
i)	Colour, Hazen Units, (max.)	15	APHA 2120B
ii)	Odour	Unobjectionable	Sensory evaluation
iii)	Taste	Unobjectionable	Sensory evaluation
iv)	Turbidity, NTU, (max)	2	APHA 2130B
v)	pH at 25℃±2℃	6.5 to 8.5	APHA 4500-H^+B

Table-2 Chemical requirement

SI No. (1)	Characteristics (2)	Requirement mg/L (maximum) (3)	Method of test	
			Referee method (4)	Alternative method (5)
i)	Aluminum (as Al)	0.2	APHA 3113B	---
ii)	Ammonia; Free ammonia (as NH_3) Albuminoid ammonia	 0.06 0.15	 Appendix A Appendix A	---
iii)	Anionic detergents (as MBAS)	0.2	APHA 5540 C	---
iv)	Calcium (as Ca)	100	APHA 3500 Ca B	---
v)	Chloride (as Cl^-)	250	APHA 4500 Cl B	APHA 4110 B
vi)	Chemical Oxygen Demand (COD)	10	APHA 5220 B	---
vii)	Copper (as Cu)	1.0	APHA 3111 B	ICP-MS (APHA 3125, EPA 200.8)
viii)	Fluoride (as F^-)	1.0	APHA 4500 F- C	APHA 4110 B
ix)	Free residual chloride	1	APHA 4500 Cl G	---
x)	Iron (as Fe)	0.3	APHA 3500 Fe B	APHA 3111 B
xi)	Magnesium (as Mg)	30	APHA 3500 Mg B	---
xii)	Manganese (as Mn)	0.1	APHA 3113 B	ICP-MS (APHA 3125, EPA 200.8)
xiii)	Nitrate (as NO_3^-)	50	APHA 4500 NO_3^-E	APHA 4110 B
xiv)	Nitrite (as NO_2^-)	3	APHA 4500 NO_2^- B	APHA 4110 B
xv)	Nickel (as Ni)	0.02	APHA 3113 B	ICP-MS (APHA 3125, EPA 200.8)
xvi)	Oil and grease	0.2	APHA 5520 B	---
xvii)	Phenolic compound (as C_6H_5OH)	0.001	APHA 5530 B & D	---
xviii)	Sodium (as Na)	200	APHA 3113 B	---
xix)	Sulphate (as SO_4^{2-})	250	APHA 4500 SO_4^{2-} E	APHA 4110 B
xx)	Total alkalinity (as $CaCO_3$)	200	APHA 2320 B	---
xxi)	Total dissolved solids, mg/L, (max)	500	APHA2540 C	---
xxii)	Total hardness (as Ca CO_3), mg/L, (max)	250	APHA2340 C	---
xxiii)	Total phosphate (as PO_4^{3-})	2.0	APHA 4500 PC	APHA 4110 B
xxiv)	Zinc (as Zn)	3.0	APHA 3111 B	---

Table-3 Limit for toxic substances

SI No. (1)	Characteristics (2)	Limit mg/L (maximum) (3)	Method of test	
			Referee method (4)	Alternative method (5)
i)	Arsenic (as As)	0.01	APHA 3114 C	ICP-MS (APHA 3125, EPA 200.8)
ii)	Cadmium (as Cd)	0.003	APHA 3113 B	ICP-MS (APHA 3125, EPA 200.8)
iii)	Chromium (as Cr)	0.05	APHA 3114 C	ICP-MS (APHA 3125, EPA 200.8)
iv)	Cyanide (as CN)	0.05	APHA (4500 CN C; EPA 335.4)	APHA 4500 CN G APHA 4500 CN H
v)	Lead (as Pb)	0.01	APHA 3113 B	ICP-MS (APHA 3125, EPA 200.8)
vi)	Mercury (as Hg)	0.001	APHA 3111 B	ICP-MS (APHA 3125, EPA 200.8)
vii)	Selenium (as Se)	0.01	APHA 3114 C	ICP-MS (APHA 3125, EPA 200.8)

Annex - 6 SLS 722 Tolerance Limit for Inland Surface Water used as Raw Water for Public Water Supply

This is an excerpt of only the tolerance limit for inland surface water source as public water supply from SLS 722. If you would like to know all contents, please refer directly to SLS 722 1985

Table-1 Tolerance Limit for Inland Surface Water used as Raw Water for Public Water Supply

Determinant		Tolerance limit	Method of test (Ref. to publication in clause 5 and SLS 614)	Technique of the method
1)	Coliform organisms (monthly average, most probable number (MPN) per 100ml)	Not more than 5000, with less than 5 percent of the samples with value 20,000, and less than 20 present samples with value 5,000	SLS 614 part 2	
2)	pH range at ambient temperature	6.0 to 9.0	1	Electrometry, by means of pH meter with glass electrocode (Reference Method)
			2	Colorimetory, winkler (azide modification method)
3)	Chloride (as Cl) mg/L, max.	1,200	1	Titrimetry- Silver nitrate method (Reference method)
			1	Titrimetry- Mercury nitrate method
4)	Nitrate (as N) mg/L, max.	10	1	Ultraviolet spectrophotometric method (Reference method)
			1	Colorimetry-
			2	Burcine method
			Appendix C of SLS 614 : Part1	Colorimetry- Phenol-disulfonic acid method
5)	Fluoride (as F) mg/L, max.	1.5	1	Selective ion electrocode method (Reference method)
			1	Colorimetry- Alizarin visual method
6)	Phenolic compound (as Phenolic OH) mg/L, max.	0.005	1	Colorimetry-chloroform extraction method
7)	Oils and grease, mg/L, max.	0.1	1	Gravimetry, liquid extraction with trichloro-trifluoro ethan
8)	Pesticide residue	As per WHO/ FAO requirement	1	Gas chromatography
9)	Arsenic (as As)	0.05	1	A. A. Spectrophotometric method
10)	Cyndie (as CN) mg/L, max.	0.05	1	Pyridine pyrazolone (or barbituric acid) colorimetric method
11)	Lead (as Pb) mg/L, max.	0.1	1, 2	Colorimetric (Dithizone) method (Reference method)
			1, 2	A. A. Spectrophotometric method

Determinant		Tolerance limit	Method of test (Ref. to publication in clause 5 and SLS 614)	Technique of the method
12)	Mercury (Total as Hg) mg/L, max.	0.001	1	A. A. Spectrophotometric method
13)	Selenium (as Se) mg/L, max.	0.05	1	A. A. Spectrophotometric method (Reference method)
14)	Chromium (as Cr) mg/L, max.	0.05	1	A. A. Spectrophotometric method (Reference method)
15)	DissolvedOxygen (DO) mg/L, max.	4	2	Azido modification method
16)	Biochemical oxygen demand (BOD) mg/L, max.	5	2	Incubation for 5 days at 20℃ (Reference method)
				Incubation for 3 days at ambient temperature (Routine method)
17)	Radioactive material			
a)	Alpha emitters μ c/mL, max.	10-9	1	Proportional or scintillation counter
b)	Beta emitters μ c/mL, max.	10-8	1	Proportional or scintillation counter

End

付属資料 28 要員計画

Annex 28 Assignment Record of JICA Team Members

#	Designation	Name	Organization	Schedule in Sri Lanka (dd/mm/yyyy)	Total period days (month)
1	Team Leader/ Water Environment Management	Dr. Yasuhiko Muramatsu	CTII	01/03/2015 - 28/03/2015 08/08/2015 - 24/09/2015 26/12/2015 - 22/02/2016 16/07/2016 - 60/08/2016 05/01/2017 - 04/03/2017 08/06/2017 - 01/07/2017 05/08/2017 - 27/08/2017 02/09/2017 - 01/10/2017 02/12/2017 - 28/12/2017 18/01/2018 - 17/02/2018	351 days (11.70)
2	Deputy Team Leader/ Environment Monitoring	Mr. Takashi Onuma	CTII	01/03/2015 - 28/03/2015 20/04/2015 - 18/07/2015 28/09/2015 - 28/11/2015 08/02/2016 - 09/04/2016 26/06/2016 - 23/07/2016 17/10/2016 - 17/12/2016 06/02/2017 - 06/04/2017 11/09/2017 - 23/11/2017 11/01/2018 - 24/02/2018	511 days (17.03)
3	Inspection 1	Mr. Kenichi Kuramoto	OCG	13/05/2015 - 11/06/2015 04/10/2015 - 28/11/2015 02/05/2016 - 02/07/2016 26/09/2016 - 24/11/2016 16/01/2017 - 11/02/2017 13/05/2017 - 24/05/2017 05/06/2017 - 08/07/2017 27/07/2017 - 10/08/2017 11/09/2017 - 21/09/2017	307 days (10.23)
4	Inspection 2	Mr. Manuel I. Gloria, Jr.	Affiliate of CTII*1	22/04/2015 - 10/06/2015 29/06/2015 - 05/09/2015 13/01/2016 - 12/02/2016 11/05/2016 - 10/06/2016 31/08/2016 - 30/09/2016 27/02/2017 - 07/04/2017 26/06/2017 - 12/08/2017	300 days (10.00)
5	Water Quality Analysis	Mr. Seiji Okano	CTII	20/04/2015 - 18/07/2015 16/11/2015 - 24/12/2015	129 days (4.30)
6	Water Quality Analysis	Mr. Michinori Mutsuda	Affiliate of OCG*2	26/06/2016 - 23/07/2016 12/09/2016 - 12/11/2016 0501/2017 - 04/02/2017 01/06/2017 - 19/08/2017	201 days (6.70)
7	Pollution Source Inventory	Ms. Eiko Watatsu	OCG	17/05/2015 - 13/06/2015 12/08/2015 - 06/10/2015 28/01/2016 - 03/03/2016 25/07/2016 - 02/08/2016 05/08/2016 - 17/09/2016 08/12/2016 23/04/2017 - 21/05/2017	203 days (6.77)

#	Designation	Name	Organization	Schedule in Sri Lanka (dd/mm/yyyy)	Total period days (month)
8	Information Management System	Ms. Trisha Leigh O. Lunas	Affiliate of CTII*3	07/06/2015 - 04/07/2015 18/10/2015 - 18/12/2015 29/05/2016 - 27/08/2016 17/10/206 - 17/12/2016 23/04/2017 - 10/05/2017 18/06/2017 - 02/08/2017 14/09/2017 - 06/10/2017	330 days (11.00)
Total		**8 experts**	**5 companies**	**01/03/2015 - 24/02/2018**	**2,332 days (77.73)**

CTII: CTI International Co., Ltd.

OCG: Oriental Consultants Global. Co., Ltd.

*1 : Aquatreat Environmental Systems Inc.

*2 : Techno Chubu Co., Ltd.

*3 : SRDP Consulting Inc.