

**MINISTRY OF CITY PLANNING, WATER SUPPLY AND HIGHER EDUCATION**

**Galle Group Water Supply Scheme**

**Water Safety Plan (WSP)**

**Revision No.02 Dated 05/01/2019**

****

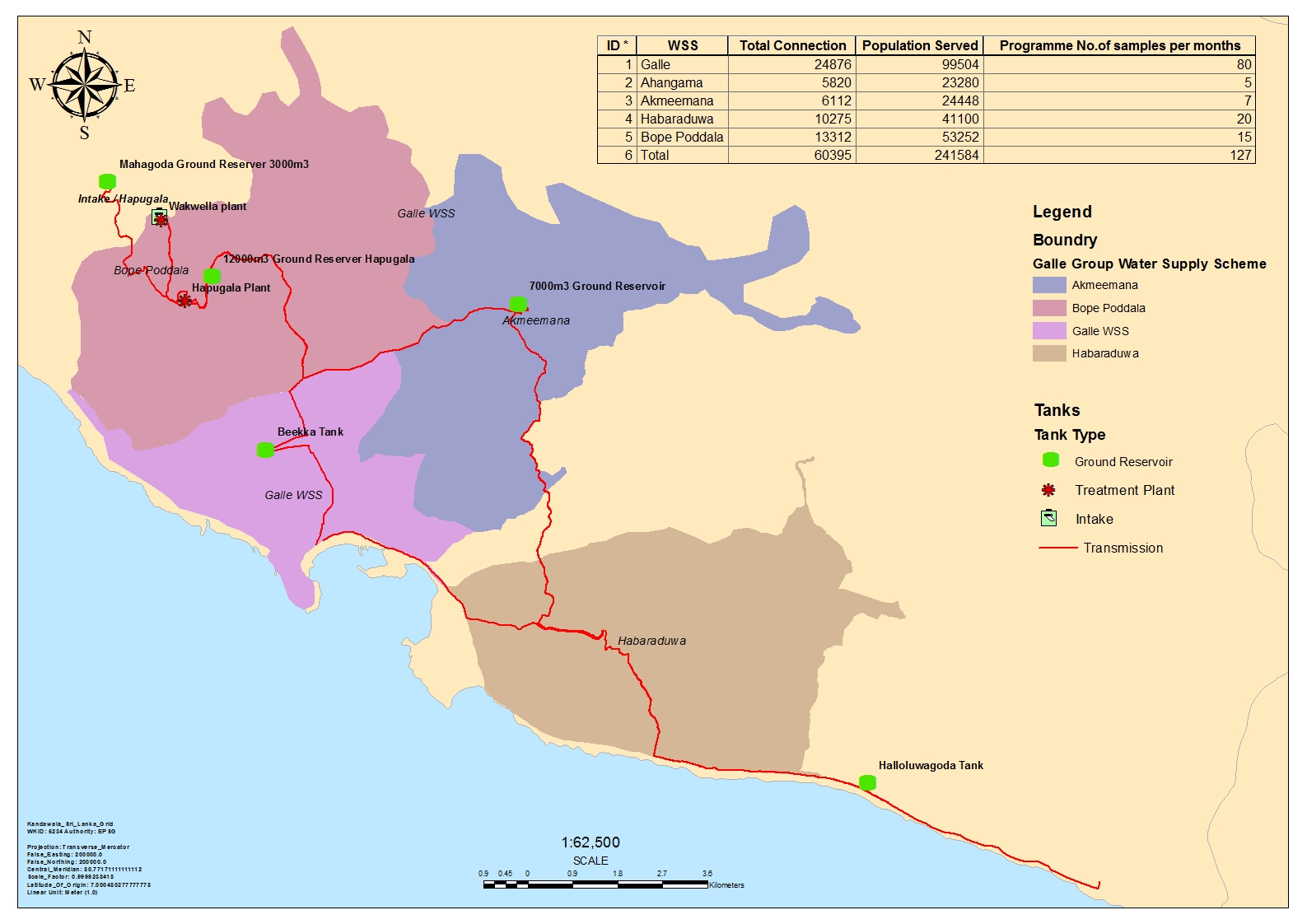
a TP

Hapugala TP

Wakwella TP

***Managing Drinking – Water Quality From***

***Catchment to Consumer***

**Key Map of Galle Group WSS**

**Overview of the WSP:**

“Managing drinking-water quality through the use of a comprehensive risk assessment and risk management approach that encompasses all steps in water supply from catchment to Consumer”

**Aim of the WSP for Galle Group WSS:**

“To consistently ensure the safety and acceptability of the drinking water supply in Galle Group WSS area”

**Development and Implementation of WSP is based on following 11 modules**

**Module 1 :** Assemble the WSP team

**Module 2 :** Describe the water supply system

**Module 3 :** Identify hazards and hazardous events and assess the risks

**Module 4 :** Determine and validate control measures, reassess and prioritize

The risks

**Module 5 :** Develop, implement and maintain an improvement/upgrade plan

**Module 6 :** Deﬁne monitoring of the control measures

**Module 7 :** Verify the effectiveness of the WSP

**Module 8 :** Prepare management procedures

**Module 9 :** Develop supporting programs

**Module 10 :** Plan and carry out periodic review of the WSP

**Module 11 :** Revise the WSP following an incident

**Abbreviations**

NWSDB / NWS&DB – National Water Supply Drainage Board WSP – Water Safety Plan

WHO – World Health Organization

SLS – Sri Lanka Standard

SOP – Standard Operation Procedure

WSS – Water Supply Scheme

WTP – Water Treatment Plant

UDA – Urban Development Authority

RDA – Road Development Authority

NGO – Non Government Organization

O&M – Operation and Maintenance

MOH – Medical Officer of Health

DS – Divisional Secretariat

DSD – Divisional Secretariat Division

GND \_ Grama Niladari Division

PHI – Public Health Inspector

RSC(S) – Regional Support Centre (Southern)

DGM – Deputy General Manager

AGM – Assistant General Manager

RM – Regional Manager

AE – Area Engineer

ME – Mechanical Engineer

EE – Electrical Engineer

TP – Treatment Plant

TBD – To Be Discussed

CO – Commercial Officer

PAC – Powder Activated Carbon

CBO – Community Based Organization

TOC – Total Organic Carbon

PVC – Poly Vinyl Chloride

PE – Poly Ethylene

RCL – Residual Chlorine Limit

OIC –Officer-in-Charge

PT – Plant Technician

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**Document Summary**

This page records the changes made to the document since its inception. Every time a revision is made to the document.

|  |  |
| --- | --- |
| **Rev 1:** 03-08-2016 | **WSP team**( Team strength, documentation, stake holders coordination)  **System Description** (Schematics on flow of water from catchment to consumer, intended uses and users , information on distribution system and consumer practices, description of TP specially dosing mechanism of Alum, pre chlorination and sampling points)  **Risk assessment and Hazard table** (categorizing seniority, hazardous events such as hazard related to water browser in case of water shortage, lack of storage facilities at household level at poor houses), Validation of control measures  **Improvement plan** ( Link between risk assessment process and improvement plan, action, responsible party, cost, funding source , using of WSP as a management tool  **Operational Monitoring** ( Critical limits for water quality, link between operational monitoring parameter and control measures, responsible parties)  **Verification (**Compliance monitoring by independent party and operational monitoring, communication between NWSDB staff and health sector, Planning for compliance monitoring), monitoring and planning of consumer satisfaction, internal auditing by Steering Committee) |
| **Rev 2:** 01-09-2018 (Conducted Galle & Greater Galle WSP external informal audit with participation of WSPAU team at 01stSep, 2019., According their instruction we updated our document dated 05,01,2019. | **WSP team**( Advisory team, Implementing team and Stakeholder team lists are updated )  **System Description** (Function of the organization, General statistics of Galle, Flow diagrams are modified, Intended uses and users , information on distribution system, consumer practices and no. of tested samples in distribution.  **Risk assessment and Hazard table** (Methodology of risk assessment, Categorizing, Determination and validation of CM, Prioritization of hazardous events according to the residual risk rate.  **Improvement plan (**Link between risk assessment process and improvement plan, action, responsible party, cost, funding source , using of WSP as a management tool  **Management Procedures** ( updating of SOPs and assure  availability at the field, Emergency response planning)  **Review of WSP** (WSP review schedule is updating) Incident response plan added |

* + 1. **INTRODUCTION**

**1.1 Background**

Water is a challengeable natural resource for many countries and studies predicted that the world will face water dilemma in 2025-2030, if not consumed in sustainable way. Moreover, population growth, climate change, and industrialization are critical factors that impact on the water sector and ultimately result in freshwater shortage and continued water pollution.

There is no such thing as naturally pure water. In nature, all water contains some impurities. As water flows in streams, sits in lakes, and filters through layers of soil and rock in the ground, it dissolves or absorbs the substances that it touches. Some of these substances are harmless. In fact, some people prefer mineral water precisely because minerals give it an appealing taste. However, at certain levels, minerals, just like man-made chemicals, are considered contaminants that can make water unpalatable or even unsafe. The water quality in Sri Lanka varies place to place due to its elevation, Rock type, Sociological factors, Rain, Region, Agricultural and Farming habits etc. This quality variation is sometime leads to act as risk to its consumers. Bad quality of the water may cause people sick. These may be unknown or unknown chronic and acute diseases. As an example chronic kidney failure in North Central Province is a disaster for Sri Lankan society today. The cause of the disease is still unknown and it under debate. Many studies are being carried out to find the cause of the disease. Some studies shows it’s due to high fluoride concentration in ground water and other studies shows it’s due to agrochemical introduced heavy metals such as Arsenic and Cadmium.

Waterborne diseases remain one of the major health concerns in the world. Diarrheal diseases, which are largely derived from contaminated water and inadequate sanitation. Endemic and epidemic disease derived from unsafe water supply affects all nations. In addition to microbial risk to drinking water safety may also be compromised by chemical and radiological constituents. The safe drinking water is a fundamental right of people who living in all over the earth. As a developing country, Sri Lanka still needs to create and add further improvements to ensure safeguard water to consumers. Therefore as a representative of Sri Lankan Government, National Water Supply and drainage Board (NWSDB) has an enormous responsibility to provide safe and sound drinking water to its consumers. By intending to meet aforesaid liability, NWSDB is inculcating the water safety plan (WSP) to its system. WSP is model which comprises and asses the multi-disciplinary operating units of its entire system. This WSP covers the water sources, conveyance system, water treatment, pumps and reservoir, and the distribution network up to its customers.

The task is tedious and complicated since NWSDB does not manage the watershed that acts as the main source of its water supply. And different governmental bodies have legal authority to control the actions going on the catchment. Therefore contribution through aforesaid bodies is vital to succeed objectives of WSP.

**1.2 Justification of Development of This Water Safety Plan**

WSP process is an integral part of the ongoing day-to-day operation, maintenance and management of water supply intending to the continuous provision of safe drinking-water to consumers. Some of the discovered key advantages that could be able to obtain by us are elaborated bellow;

* A WSP gives us a better understanding of our water supply system. In particular, we will better understand the risks that may affect water quality and health in our community.
* A WSP improves the day-to-day management and operation of our water supply. Overtime, the WSP process will lead to consistently safer water.
* A WSP encourages a team-based approach. It brings together all those who share responsibility for, interest in and knowledge of the community water supply, including authorities such as the local health or water supply office. This increases local cooperation and communication among community members.
* The WSP process involves community members, leading to improved hygiene awareness within the community.
* A WSP recognizes that even small and simple improvements are better than none.

Several tasks to develop and implement a WSP stated in WHO 2012 and mentioned bellow.

* 1. **1.3 Main Risks in the System**

Current major issues in Galle Group WSS are;

* + 1. **Inadequate water treatment capacity of the system**

Wackwella Treatment Plant Started in 1976.Treatement capacity of Wackwella Treatment plant was increased in 1999.New Treatment plant called Hapugala started in 2005. But existing treatment capacity is not enough to cater the present water demand. The Galle urban area has highly developing. Hence unavailability of adequate drinking water facility is highly affected to consumers.

Pumping hours have to be limited due to the low level of Treated water sump

* + 1. **Distribution pipe system that has smaller diameter pipes**

The most of the distribution pipes of Galle Municipal area very old Diameters of the pipes are not enough to carry the present demand in Galle Group Water Supply Scheme. Hence, the pipes system can’t be fed water to the consumers who are living at the ends of the pipe lines & especially to the consumers in high elevated areas. As, the available water quantity is limited water cannot be distributed to all areas simultaneously. As such, network control is adopted to distribute water to elevated areas at least night times.

* + 1. **Increase of Non-Revenue Water Quantity**

NRW is very high figuring 24-30 % due to old distribution and transmission mains in Galle area (ex. 25.4 km length of aged in the transmission line Ginthota to Mihiripanna)

* + 1. **Less attention for catchment protection**

## Many pollutants are released in to the catchment from home gardens and Tea Rubber cultivations. Industrial development and intensive agriculture courses for non-point and point source pollution. If there were adequate legal mechanisms and institutions to prevent water resources degradation it if fail to control the legal activities in reservation of the water bodies. Existing regulatory mechanisms to protect stream reservation covered all aspects including eviction of encroachers. However, there are serious deficiencies in implementation of such regulations such as the lack of coordination among institutions, procedural lapses, political interference, and less enthusiasm of state employees to implement rules and regulations.

Ginganga catchment is very bigger it spread about 116 Km away from Galle and Greater Galle treatment plants intake point to initial point of Gongala Hills, hence it is too difficult to monitor together. As this reason Hazard identification process was carried out both side of the Ginganga river bank about two kilometers away from intake point as a initial stage, however all length of the catchment will be selected and completed step by step to over it.

NWSDB has taken several short term and Long term measures to mitigate above major issues. Summary of the actions taken to address above risks are summarized in Table 1.1.

*Table 1.1: Summary of the actions taken to address the risks in Galle Group WSS*

|  |  |  |  |
| --- | --- | --- | --- |
| **No** | **Actions taken** | **Current status** | **Outcomes** |
| ***Short Term Actions*** |
| 1 | Raw water pumping capacity increased 200cum per hour by activating Amugoda Intake. | Completed | Increased he production capacity of the Wakkwella T.P.by 2500 cum per day |
| 2 | Wackwella –Beeka Transmission main divert to Mahagoda Sump | Completed | Increased the service hours by 3hrs of the Greater Galle WSS. |
| 3 | Modification of inlet arrangement at Beekka Sump | Completed | In creased flow rate by 120 cum per hour to Beekka sump. |
| 4 | Conducted study visit in to the Gingaga around the intake area to identify major risks & hazards, with participation of relevant stake holders. | Implementation stage | Enhance and regulating the cleaning program of the floating debries at Wakkwella bridge across the Gingaga. |
| 5 | Pipe Relaying at Habaraduwa WSS. | Tender calling stage | Reduce NRW and Enhance customer satisfaction |
| 6. | Arrange night leak survey and contract for leak repairs in Galle municipal area. | Tender calling stage | Reduce NRW and Enhance customer satisfaction |
|  | **Long term actions** |  |  |
| 1 | Implementation of Greater Galle Stage–III water supply project. | Evaluation  stage | Assure 24 hours the water supply to every consumers. |

## 

## 1.4 Main considerations for the WSP

The World Health Organization’s guide line for drinking water quality, aims to protect public health. Adaption of WSP can be identified as the key approach to ensure this goal. WSP is the most effective mean of consistently ensuring the safety of drinking water supply, through the use of a comprehensive risk assessment and risk management approach that encompasses all steps in water supply from catchment to consumer. This WSP is dynamic and practical.

WSP approach of WHO Guide Lines (2004) is a preventive management framework for safe drinking water that consists with 11 learning modules.

### 1.4.1 Water Quality Standards

Sri Lanka Standard SLS) 2013: 614 Part 1 and Part 2, health based targets (based on the evaluation of health concerns) set as the internal water quality standard for NWSDB and it is interested to comply with WHO Water Quality Standard and American Standard, EPA standers for Drinking Water and NWSDB’s focus is to follow the limits whichever the lowest.

Table 1.2: Standard for Water Quality – Physical Requirement

|  |  |  |  |
| --- | --- | --- | --- |
| **Item** | **Characteristic** | **Requirement** | **Method of Test** |
| 1 | Color | 15 | APHA 2120 B |
| 2 | Odor | Unobjectionable | Sensory evaluation |
| 3 | Taste | Unobjectionable | Sensory evaluation |
| 4 | Turbidity | 2 | APHA 2310 B |

*Table 1.3: Standard for Water Quality – Chemical Requirement*

|  |  |  |  |
| --- | --- | --- | --- |
| **Item** | **Characteristic** | **Requirement (mg/l) Max.** | **Method of Test** |
| 1 | pH | 6.5 – 8.5 | APHA 4500- H B |
| 2 | Chloride (as Cl) | 250 | APHA 4500 – Cl B |
| 3 | Free residual Chlorine (as Cl) | 1 | APHA 4500 – Cl G |
| 4 | Alkalinity  (total as CaCO3) | 200 | APHA 2320 – B |
| 5 | Free Ammonia | 0.06 | - |
| 6 | Albuminoidal Ammonia | 0.15 | - |
| 7 | Nitrate (as NO3) | 50 | ALHA 4500 – NO3 E |
| 8 | Nitrite (as NO2) | 3 | ALHA 4500 – NO3 B |
| 9 | Fluoride | 1 | APHA 4500 – F C |
| 10 | Total Phosphate | 2 | APHA 4500 – P C |
| 11 | Total Dissolved Solids | 500 | APHA 2540 – C |
| 12 | Total Hardness | 250 | APHA 2340 – C |
| 13 | Total Iron | 0.3 | APHA 3500 – Fe B |
| 14 | Sulphate | 250 | APHA 4500 – SO4 E |
| 15 | Oil and Grease | 0.2 | APHA 5520 B |
| 16 | Calcium | 100 | APHA 3500 – Ca B |
| 17 | Magnesium | 30 | APHA 3500 – Mg B |
| 18 | Sodium | 200 | APHA 3111B |
| 19 | Manganese | 0.1 | APHA 3111B |

*Table 1.4: Standard for Water Quality – Bacteriological Requirement*

|  |  |  |
| --- | --- | --- |
| Type of Bacteria | SLS 614:2013 (Part II) | |
| Pipe born Water | Well Water |
| # Total Coli form bacteria present in 100ml | <3 | <10 |
| # E. Coli present in 100ml | Nil | Nil |

**Key Reference Material for the WSP**

* Bartram J, Corrales L, Davison A, Deere D, Drury D, Gordon B, Howard G, Rinehold A, Stevens M. 2009. Water safety plan manual: step-by-step risk management for drinkingwater suppliers. World Health Organization. Geneva, 2009.Available at[http://www.wsportal.org/ibis/water-safety-portal/eng/home.](http://www.wsportal.org/ibis/water-safety-portal/eng/home)
* The Participant’s Handbook and course notes of a WSP Training conducted at Berjaya Hotel, Mount Lavania from 22/02 to 26/02 of 2016.
* Urban water safety planning capacity training Power point handouts for participants DRINKING WATER INSPECTORATE guardians of drinking water quality[http://www.sswm.info](http://www.sswm.info/)/sites/default/files/reference\_attachments
* Large Water System Emergency Response Plan Outline: Guidance to Assist Community Water Systems in Complying with the Public Health Security and Bioterrorism Preparedness and Response Act of 2002 [www.epa.gov/safewater/watersecurity/pubs/erp-long](http://www.epa.gov/safewater/watersecurity/pubs/erp-long)
* Water Quality Standards -Sri Lanka Standard (SLS), health based targets (based on the evaluation of health concerns)

Below environmental policy tools on catchment management for prevent pollution was referenced.

* Regulatory tools
  + General Manger’s circular No A 09/2016 dated 07th September 2016 on Preparation of WSPs for the Water Supply Schemes maintained by the NWSDB
  + Strengthening pollution prevention laws & legislations. e.g.: Gazette No 1905/16 – 2015 March 11 (National policy for water sources, Their catchment and reservation protection & conservation In Sri Lanka)
  + Declaration of source protection zone and legal power to water supplier or responsible institute for pollution Monitoring in catchment area
* Finance – base -tools

Introduce a penalty scheme for polluters by applying soft environmental lows like “Polluter pays principle” as a finance base environmental policy tool to water pollutions control.

Case study: Industrial wastewater effluent program Lagunadebay <http://www.gwp.org/en/ToolBox/CASE-STUDIES/Asia/Philippines-Establishing-an-Industrial-Wastewater-Effluent>

* Information -base–tool
  + Awareness by using different media

* + 1. **WSP TEAM**

## History of the team development

Since the water safety plan deals with catchment to consumer approach of water safety, NWS&DB along could not guarantee a proper implementation and execution of WSP. Hence three teams were formed in 2014 to coordinate with WSP development, monitoring and implementation.

Hence, teams were assembled for the preparation of the WSP for Galle and Greater Galle Water Supply Schemes (WSSs).

According to workshop training and WSP manual, Water safety plan team for Galle group WSS was assembled to deal with catchment to consumer approach of water safety. It consists of following three main WSP teams.

* + - **WSP Advisory Committee** : To coordinate WSP preparation, Guidance of WSP implementing team and conducting internal informal audit
    - **WSP Implementation team:** Providing leader ship, Train and work together with others on systems or communication and documentation.
    - **Stake holder team:** To represent institutes which are involving and have authority in catchment management program and end uses.

  2. **WSP team members, roles and responsibilities**
     1. **Advisory Committee**
     2. *Table 2.1: WSP* Advisory Committee

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **No** | **Name** | **Title** | **Role in Team** | **Contact information** |
| 1 | M.K.A.J.M. Wijesingha | DGM  (Southern) | * Overall supervision of WSP * Progress reporting to   Head Office,   * Supporting to conduct internal informal Auditing * Technical guidance and assist to Implement WSP * Advisor | 077-2984120 |
| 2 | Primal Jinadasa | AGM(S) | * Calling for all meetings in RSC level to monitor WSP’ progress. * Technical guidance for operation team. * Advisor for technical developments. | 071-4407147 |
| 3 | K.K.N. Dias | M (O&M)  Galle | * Meetings and field inspection coordinating among teams, * Improvement of treatment process. | 077-7520065 |
| 4 | E.A. Edirisinghe | Chief Chemist (S/E) | * Advisor for Guidance on Water quality issues and improvement. | 077-2984170 |
| 5 | R.W.K. Ranasingha | CE (Cons) | * Advisor for Guidance on major construction activities. | 077-7800152 |
|  | Bandula Wijesingha | CE (M&E) | * Advisor for Guidance on M&E issues and improvement. | 0719333191 |
| 6 | D.M.C.S. Kumari | CE (P&C) | * Advisor and assist tender document preparation and minor construction activities. | 0714469662 |
| 7 | P.N.G. Pathirana | CE(P&D) | * Reporting progress to DGM of the WSP, and provide technical guidance on managing WSP, | 071-4233445 |

**Implementation Team**

*Table 2.2: Assembling the WSP Implementing Team*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **No** | **Name** | **Section** | **Title** | **Expertise** | **Role in Team** | **Contact Information** |
| 01. | K.K.N. Dias | Regional Office, Galle | Manager  (O&M) | Operation and Maintenance | -Team Leader-coordinating among teams  - Advisor for implementation | 0777520065 |
| 02. | J. P.B. Jayasooriya | Regional Managers Office | Area Engineer | Operation and Maintenance/ Management | -Technical guidance and supports to Operation and Maintenance of plant, Storages, transmission and distribution,  -Interact consumer relationship  -Coordinator with stakeholders | 077-3766468  091-2241152 |
| 03. | Nadeesha thilakarathne | Regional Laboratory | Chemist | Water Quality Management | Specialist for Water Quality maintaining  Treatment process monitoring and controlling  -Supervision of water quality surveillance program from catchment to end user | 077-1595263 |
| 04. | K..L. Dediyagala | Regional Managers Office | ME | Mechanical and preventive maintenance | -Mechanical related technical assistance | 071-4438635 |
| 05. | P.D.N.Kumudu Kumari | Regional Managers Office | EE | Electrical and preventive maintenance | - Electrical related technical assistance | 071-838879 |
| 06. | L.G.Dulan | Regional Managers Office | Sociologist | Social Relationship | -Organizing awareness programs  and meetings.  -Resource person for awareness programs  -Team mobilization  -Conducting consumer satisfaction surveys. | 077-7883842 |
| 07. | H.R.Ajith | Hapugala WTP | OIC (WTP) | Operation and Maintenance | -Operation and Maintenance of WTP (monitoring, recording, reporting) | 0715345690 |
| 08. | T.P.N.P.Liyanage | Wakwella WTP | OIC (WTP) | Operation and Maintenance | -Operation and Maintenance of WTP (monitoring, recording, reporting) | 0773711339 |
| 09. | H.K.A.G. Jayasekara | Galle WSS | OIC | Operation and Maintenance | -Operation and Maintenance of WSS (monitoring, recording, reporting  -Handling consumer grievances. | 071-8042350 |
| 10. | P. Mahawaththa | Ahangama WSS | OIC | Operation and Maintenance | -Operation and Maintenance of WSS(monitoring, recording, reporting)  -Handling consumer grievances | 071-8212157 |
| 11. | H.V. Kumudini | Akmeemana WSS | OIC | Operation and Maintenance | -Operation and Maintenance of WSS(monitoring, recording, reporting)  -Handling consumer grievances | 071-8042350 |
| 12. | R.H.D. Chandana | Habaraduwa WSS | OIC | Operation and Maintenance | -Operation and Maintenance of WSS(monitoring, recording, reporting)  -Handling consumer grievances | 070-2081555 |
| 13. | S.Gallearachchi | Bope Poddala WSS | OIC | Operation and Maintenance | -Operation and Maintenance of WSS(monitoring, recording, reporting)  -Handling consumer grievances | 071-4466395 |
| 14. | L.S.K. Mandalawaththa | Regional Managers Office | E.A | Coordination of rural water supply sectors. | -Coordinating with the stake holders and updating stakeholder list | 071-8477578 |
| 15. | A.S.Hettiarachchi | Regional Managers Office | E.A | Coordination &  Documentation | -Coordinating with stakeholders  -Preparing and updating improvement plan | 071-8054015 |
| 16. | P.H.D. Nishantha | Regional Office Galle | Engineering Assistant (E.A.) | Electrical Operation | -Operation and Maintenance of Electrical component at Treatment plants | 071-5345778 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **No** | **Name** | **Section** | **Title** | **Expertise** | **Role in Team** | **Contact Information** |
| 17. | Manoj De Silva | Regional Office Galle | Engineering Assistant (E.A.) | Mechanical Operation | Operation and Maintenance of Mechanical components at TPs | 0777-601012 |
| 18. | Nimal Karunarathna | Regional Office Galle | Engineering Assistant (E.A.) | Mechanical Operation | -Operation and Maintenance of Mechanical components at TPs and Vehicles | 071-4004424 |
| 19. | P.Sooriyaaachchi | Galle WSS | Engineering Assistant | Operation and Maintenance | -Operation and Maintenance of distribution system, reporting,  - Estimates preparation. | 077-0430821 |
| 20. | B D Nilanga | Wakwella TP | Engineering Assistant | Operation and Maintenance | -Water treatment process member, Recording surveillances at the plant. | 077-3901813 |
| 21. | L.D. Wickramasinghe | Hapugala TP | Plant Technician | Operation and Maintenance | -Maintain the Water quality recommended standards.  -Incident reporting in TP &Catchment. | 077-3796132 |
| 22. | P.K.S.Piyadarshana | Hapugala TP | Plant Technician | Operation and Maintenance | -Maintain the Water quality recommended standards.  -Incident reporting in TP &Catchment | 077-9929682 |
| 23. | J.P.M. Chathuranga | Hapugala TP | Plant Technician | Operation and Maintenance | -Maintain the Water quality recommended standards.  -Incident reporting in TP &Catchment | 071-9078486 |
| 24. | N. Lankageewa | Wakwella TP | Plant Technician | Operation and Maintenance | -Maintain the Water quality recommended standards.  -Incident reporting in TP &Catchment | 077-6309756 |
| 25. | D. L. Epa | Wakwella TP | Plant Technician | Operation and Maintenance | -Maintain the Water quality recommended standards.  -Incident reporting in TP &Catchment | 071-8212650 |
| 26. | M.H.S.K. Jayalath | Wakwella TP | Plant Technician | Operation and Maintenance | - Maintain the Water quality recommended standards.  -Incident reporting in TP &Catchment | 071-8324197 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **No** | **Name** | **Section** | **Title** | **Expertise** | **Role in Team** | **Contact Information** |
| 27. | I.A. Nihal | Wakwella TP | Pump Operator | Operation and Maintenance | -Operating pumps according to SOPs  -Conducting P&M schedule correctly.  -Incident reporting in TP | 0772681123 |
| 28. | T.G. Gunathilaka | Hapugala TP | Pump Operator | Operation and Maintenance | -Operating pumps according to SOPs  -Conducting P&M schedule correctly.  -Incident reporting in TP | 0718831249 |
| 29. | H.K.A.Anura | Habaraduwa WSS | Pipe Fitter | Operation and Maintenance | -Repairing pipelines and laying works.  - Incident reporting after repairing. | 071-303218 |
| 30. | A.K.P.Ruwan Sampath | Wakwella TP | Lab assistant | Water quality analysis | Water quality analysis and monitoring | 0773859191 |

* 1. **Stakeholders**
     1. **Identification of Stakeholders for the WSP of Galle Group WSS**
     2. Officers from other relevant organizations and stake holders were selected for involve in catchment management program.

*Table 2.3: Stakeholder details (as at 01/10/2019)*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Stakeholder Name** | **Role of the team** | **Stake holder point contact** | **Interaction mechanism** | **Contact Information** |
| District Secretary | Coordinator of Water Quality Surveillance Team, WSP Stake holder team &  Integrated water resource management | District Secretary Office, Galle | Scheduled Meetings | Mr. Somarathna Vidanapathirana 091 – 2222233  071 – 8030551 |
| Divisional Secretaries | Coordinator for catchment Protection programs and awareness programs for communities in relevant DS | Divisional Secretary Office, Galle | Scheduled Meetings/  Inspection | Ms.Himali Rathnaweera  091 – 2234238 |
| Divisional Secretaries | Coordinator for catchment Protection programs and awareness programs for communities in relevant DS | Divisional Secretary Office, Akmeemana | Scheduled Meetings/  Inspection | Ms.  Pushpika ThushariJagoda  071 – 8130386 |
| Divisional Secretaries | Coordinator for catchment Protection programs and awareness programs for communities in relevant DS | Divisional Secretary Office, Baddegama | Scheduled Meetings/  Inspection | Ms.  I Himali Rathnaweera  071 – 8409604 |
| Member of Environmental Unit, OIC (Police) | Involve to catchment Protection programs and legal activities in catchment & unauthorized water usage | Police Station, Galle | Scheduled Meetings/  Inspection | Mr. Galappaththi  071 – 8051272 |
| Senior Superintend of Police | Legal activities in catchment, distribution & unauthorized water usage | Police Station, Galle | Scheduled Meetings | Mr. Anurudda Bandara  071 – 859 1452 |
| Head Quarters Inspector of Police Galle | Involve to catchment Protection programs and Legal activities in catchment, distribution & unauthorized water usage | Police Station, Galle | Scheduled Meetings/  Inspection | Mr. J.L Ajith Kumara  071 – 8591455 |
| OIC (Police) | Involve to catchment Protection programs and Legal activities in catchment, distribution & unauthorized water usage | Police Station, Poddala | Scheduled Meetings/  Inspection | Mr. P.N.B Magedaragama  071 – 8591462 |
| OIC(Police) | Involve to catchment Protection programs and Legal activities in catchment, distribution & unauthorized water usage | Police Station, Baddegma | Scheduled Meetings/  Inspection | Mr. Wasanth Disanayake  071 – 8591480 |
| OIC(CWSD) | Coordinator for RWS to Involve in catchment Protection programs& monitoring the RWS bulk supply | Community Water Supply Department | Scheduled Meetings/  Inspection | Mr. Lalith  071 – 8042186 |
| Regional Epidemiologist | Public Awareness , Involve to catchment Protection programs & Coordinator for  water quality surveillance | RDHS, Galle. | Scheduled Meetings/  Inspection | Dr. Wenura  0773103422 |
| MOH | Public Awareness , Involve to catchment Protection programs & Coordinator for  water quality surveillance | Health Department | Scheduled Meetings/  Inspection | Dr. Lasantha Abekoon  071 – 4423543 |
| dss  Senior PHI | Public Awareness , Involve to catchment Protection programs & Coordinator for  water quality surveillance | MOH Office, Gale | Scheduled Meetings/  Inspection | N. Samaraweera  0712399936 |
| Director | Public Awareness , Involve to catchment Protection by coordinating farmer organizations & other  authorities& flood control | Irrigation Department, Galle | Scheduled Meetings/  Inspection | Mr. LS Sooriyabandara 091-2234301  071-8014758 |
| DFO | Public Awareness & Involve  to catchment management programs | Forest Department | Scheduled Meetings/  Inspection | Mr. Mohal Heenatigala  071 – 1863348 |
| Agricultural Inspector | Coordinator for farmer organizations to Involve in catchment Protection  Programs | Agricultural Department | Scheduled Meetings/  Inspection | LabuduwaMrs. H K J Sandamali  071 – 0893221 |
| Assistant Commissioner of Agrarian Service | Coordinator for farmer organizations to Involve in catchment Protection  programs& legal activities | Agrarian Service Department | Scheduled Meetings | Mr.AnuradhaDharmasena 041 – 2222115  071 – 8718555 |
| Director Southern Province | Coordinators for make legal frame work for pollution control ,Public Awareness &  Involve to catchment Protection | Environmental Authority | Scheduled Meetings/  Inspection | Mr. SusanthaWedage  071 – 685 9643 |
| Assistant Director | Coordinators for land use in catchment management programs& demarcation of  buffer zone in river | Land use Department | Scheduled Meetings/  Inspection | H M Chandrasena  091 – 2232975  071 – 4423530 |
| Commissioner | P Public Awareness & Involve to catchment Protection | Local Government | Scheduled Meetings | Mr. RanilWickramasekara 041 – 2222346  071 – 8114482 |
| Chairman | Involve to catchment protection program | Farmer Organizations | Scheduled Meetings/  Inspection | Mr. Sirilala  071 – 808 1535 |
| Director | Involve to catchment protection program | Urban Development Authority  (UDA) | Scheduled Meetings/  Inspection | Mr. K H M W Aberathna  071-8349579 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| General Manager | Oil Contamination Control at Oil spill | Marine Environmental Protection  Authority | | Scheduled Meetings/  Inspection | | Dr. P.B. Teney Pradeep Kumara 011 – 461 5960 | |
| Zonal Director of Education | Implementing school awareness program of Hygiene& catchment  protection | | Educational Department | | Scheduled Meetings/  Inspection | | Ms.S.P Chandrawathi  091-2234768  071-6893412 | |
| Regional Manager | Cont Controlling Unauthorized sand mining, | | Geological  Survey & Mine Bureau | | Scheduled Meetings/  Inspection | | Mr. K V Jagath  077-3538292  041 – 223 6765 | |
| Assistant Director | Identif Identifying & Controlling land slides | | National Building Research  Organization | | Scheduled Meetings/  Inspection | | Mr E R Bandula  071 – 8627038  077 – 7831054 | |
| Assistant Director | Support for emergency situations | | Disaster management Centre Divisional Secretary  Office, Galle | | Scheduled Meetings/  Inspection | | MrP.P.B.K Rathnayaka.  091-4976244  091-2226315  077-3957873 | |
| Executive Engineer | Support for the emergency pipe burst and other road related activities | | Road Development Authority | | Scheduled Meetings/  Inspection | | Mr.Vipula Karunarathna  0718287769 | |
| Secretary | Support for the catchment protection and public interaction | | Ginganga mitiyawatha ha janajeewitha Surakeeme Viyaparaya (Non-Government Organization) | | Scheduled Meetings/  Inspection | | P. Mahaliyana  0774830478 | |
| Administrative officer of GS | Coordinator for catchment Protection programs and awareness programs for communities in relevant GNDs | | Divisional Secretary  Office, Galle | | Scheduled Meetings/  Inspection | | D.L. Dayalal de Silva  0718406729 | |
| Administrative officer of GS | Coordinator for catchment Protection programs and awareness programs for communities in relevant GNDs | | Divisional Secretary  Office, Habaraduwa | | Scheduled Meetings/  Inspection | | S. Dasanayaka  0714476073 | |
| Administrative officer of GS | Coordinator for catchment Protection programs and awareness programs for communities in relevant GNDs | | Divisional Secretary  Office, Bope poddala | | Scheduled Meetings/  Inspection | | Saman Kumara  0716323856 | |

* + 1. **SYSTEM DESCRIPTION**
  1. **3.1 General Information**

National Water Supply & Drainage Board has its beginning as a sub department under the Public Works Department with responsibility for the water supply and drainage system of Sri Lanka. From 1965, it functioned as a division under various ministries until January 1975 when it was converted to Statutory Board by an Act of Parliament. Hence now, the National Water Supply & Drainage Board is a statutory board established under National Water Supply & Drainage Board Act No. 2 of 1974. An addendum was introduced to the initial act by the National Water Supply & Drainage Board Amendment Act No. 13 of 1992.

Safe drinking water access is one of the most important criteria in millennium development goals target 7.C.Around 80% of the population in Sri Lanka has access to the safe drinking water of which 30% (in 2010) is through piped water supply system of the NWSDB. National Water Supply & Drainage Board being the principal water supplying authority in Sri Lanka has a responsibility to supply drinking water.

* + 1. **3.2 Vision of the Organization**

To be the most prestigious utility organization in Sri Lanka through technological and service excellence.

* + 1. **3.3 Mission of the Organization**

Serve the nation by providing sustainable water and sanitation solutions ensuring total user satisfaction.

* + 1. **3.4 Principles and Values of the Organization**
       - Commitment to total customer needs
       - Motivation of staff towards creativity to achieve organizational objectives
       - Maintain Ethics and Professionalism in all activities
       - Facilitate for Prevention of Environmental Degradation
       - Positive contribution to National Economic Growth respecting Government Policy initiatives
       - Work as a Team with Honesty, Integrity and Transparency
    2. **3.5 Functions of the Organization**
* Primary Functions
  + Identification of the “unnerved”, especially those prone to health problems
  + Preliminary Investigations, Planning, Design and Construction of Water Supply and projects.
  + Sewerage Projects with local funds and donor assistance. Study all possible options & carry out feasibility studies, Comprehensive analysis (including social economic impact, environmental impact, health aspects, etc.) cost estimation & Environmental Impact Assessment of such projects
  + Operation and maintenance of Water Supply and Sewerage Schemes to provide satisfactory service to customers
  + Billing and Collection through affordable tariff setting
* Secondary Functions
  + Human Resource Planning and Development
  + Research & Development for service improvement utilizing innovative techniques
  + Budgeting and Financial Control
  + Publicity and Consumer awareness program on effective use of water and reduction of non-revenue water
  + Corporate Planning and Strategic Management
  + Laboratory Services for quality monitoring and control
  + Overall responsibility to monitor the drinking water quality of the people of the country and to provide Technical Assistance to Community Based Organizations, Local Authorities, State Agencies and Private/ Public Sector Institutions on their water supply and sanitation facilities.
  + Consultancy Services on water supply &sanitation
  + Project formulation and Management
  + Coordination with sector actors and stakeholders
    1. **3.6 General Statistics of Galle Region**

Table 3.1 depicts the general statistics of Galle Region which is having thirteen (13) water supply Schemes, four full treatment plants, eight (8) partial treatment plant and **110,663** service connections(as at 16 /01/2019).

* + 1. **3.7 General Statistics of Galle Group WSS**

Table 3.3 depicts the general statistics of Galle Group WSS (as at 2019-01-16) which is having 5 WSSs, Two full treatment plants and 61,331 service connections.

*Table 3.1: General Statistics of Galle Region (as at 2019-01-16)*

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Scheme** | **Domestic** | **Non Domestic** | **Stand Post** | | **Total Connection** | **No of Staff** | **Staff per 1000 Connection** | **Population Served** |
| **(M.I.S.)** | **Active** |
|  | (Nos;) | (Nos;) | (Nos;) | (Nos;) | (Nos;) | (Nos;) |
| Wackwella T.P | NR | NR | NR | NR | NR | 16 | NR | NR |
| Hapugala T.P | NR | NR | NR | NR | NR | 06 | NR | NR |
| Galle WSS | 22008 | 3223 | 22 | 22 | 25253 | 30 | 02 | 99,504 |
| Ambalangoda WSS | 15,434 | 1,375 | 14 | 14 | 16823 | 21 | 02 | 66,840 |
| Baddegama WSS | 2219 | 316 | 04 | 04 | 2539 | 13 | 06 | 9,880 |
| BopePoddala WSS | 12851 | 905 | 03 | 03 | 13759 | 17 | 02 | 53,252 |
| Habaraduwa WSS | 9197 | 1212 | 0 | 0 | 10409 | 16 | 02 | 41,100 |
| BalapitiyaWSS | 8118 | 674 | 01 | 01 | 8793 | 06 | 01 | 34,768 |
| Pitigala WSS | 309 | 106 | 03 | 03 | 418 | 01 | 03 | 1,648 |
| Hikkaduwa WSS | 17782 | 1330 | 36 | 36 | 19148 | 20 | 01 | 75,784 |
| Ahangama WSS | 5269 | 656 | 01 | 01 | 5197 | 08 | 02 | 23,280 |
| Elpitiya WSS | 1495 | 402 | 0 | 0 | 1897 | 09 | 05 | 7,200 |
| Akmeemana WSS | 5961 | 275 | 0 | 0 | 6236 | 15 | 03 | 24,448 |
| Udugama WSS | 163 | 28 | 0 | 0 | 191 | 01 | 06 | 756 |
| **Total Galle Group WSS** | **100806** | **10502** | **84** | | **110663** | **179** | **35** | **438,460** |

* + 1. **3.8 Intended Users and Uses**

The Galle Group WSS covers water intended for human consumption which is defined as water intended for drinking, cooking, food preparation, food production and washing and bathing. Main water users are as follows,

*Table 3.2: Use of water by intended users*

|  |  |
| --- | --- |
| **Intended Use** | **Intended Users** |
| The water supplied is intended for domestic use includes water that is used in the home every day, including wate**r** for normal household purposes, such as drinking, food preparation, bathing, washing clothes and dishes, flushing toilets, and watering lawns and gardens  Industrially and commercially, water is used for Shipping, drinking, food preparation, flushing and food processing and swimming pools and fire fighting for emergencies. | Water is provided to the general population in following categories.   * + - * Domestic       * Schools       * Government Quarters       * Government Institutes       * Police/Army/ Navy       * Hospitals       * Commercial (Super markets   bakeries, etc.)   * + - * Tourist Hotels       * Religious       * Bulk supply to CBO &Local   Authorities, stand posts.  The intended consumers do not include those who are signiﬁcantly immune compromised or industries with special water quality needs. These groups are advised to provide additional  points-of-use treatment. |

*Table 3.3: Intended Users of Galle Group WSS and Their Consumption (As at 2019-01-16)*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Scheme** | **Domestic** | | **Schools** | | **Government**  **Quarters** | | **Government Institutes** | | **Police/Army** | | **Hospitals** | | **Commercial** | | **Hotels** | | **Religious** | | **Stand Posts** | | **Bulk to CBOs and Pradesiya Saba** | | **Total Connection** |
|  | Connection | Consumption(m3) | Connection | Consumption(m3) | Connection | Consumption(m3) | Connection | Consumption(m3) | Connection | Consumption(m3) | Connection | Consumption(m3) | Connection | Consumption(m3) | Connection | Consumption(m3) | Connection | Consumption(m3) | Connection | Consumption(m3) | Connection | Consumption(m3) |
| **Galle WSS** | 22008 | 376523 | 56 | 11505 | 276 | 3197 | 145 | 27272 | 12 | 3054 | 7 | 36786 | 2337 | 72997 | 10 | 4610 | 142 | 8153 | 22 | 669 | 1 | 0 | 25253 |
| **Ahangama WSS** | 5269 | 73919 | 17 | 784 | 14 | 60 | 21 | 434 | 2 | 4265 | 1 | 0 | 284 | 10963 | 47 | 5774 | 34 | 1523 | 1 | 0 | 1 | 0 | 5936 |
| **Akmeemana WSS** | 5961 | 87856 | 12 | 1122 | 6 | 79 | 20 | 1352 | 0 | 0 | 0 | 0 | 143 | 5514 | 0 | 0 | 22 | 850 | 0 | 0 | 3 | 1656 | 6236 |
| **Habaraduwa WSS** | 9197 | 132133 | 22 | 1602 | 16 | 118 | 26 | 1448 | 0 | 0 | 4 | 758 | 616 | 31495 | 204 | 10889 | 64 | 3580 | 0 | 0 | 2 | 2354 | 10409 |
| **Bope-Poddala WSS** | 12851 | 188262 | 19 | 1504 | 76 | 976 | 42 | 11109 | 0 | 0 | 0 | 0 | 317 | 6868 | 1 | 33 | 51 | 2769 | 3 | 0 | 0 | 0 | 13497 |
| **Total** | 55286 | 858963 | 126 | 16517 | 379 | 4430 | 254 | 41605 | 14 | 7319 | 12 | 37544 | 3697 | 127837 | 262 | 21306 | 313 | 16875 | 26 | 669 | 7 | 4010 | **61331** |

* + 1. **3.9 Testing facilities**

Wackwella and Hapugala treatment plant have testing facility for Jar testing, turbidity, pH, electrical conductivity, color, residual chlorine, residual aluminum under daily water quality monitoring. Regional laboratory collect samples for full chemical and bacteriological test from treatment plant, Raw water from intake and distribution twice a month as compiling SLS requirement. Heavy metals are tested quarterly per year by central laboratory.

**3.10 Source of water: Catchment and extraction from source**

## 3.10.1 Source of Water: Catchment and Extraction from Source

For the preparation of Galle and Greater Galle Water Safety Plan, the both river sides of Ginganga was selected about 2.0 km away from Wakwella intake, as an initial stage.

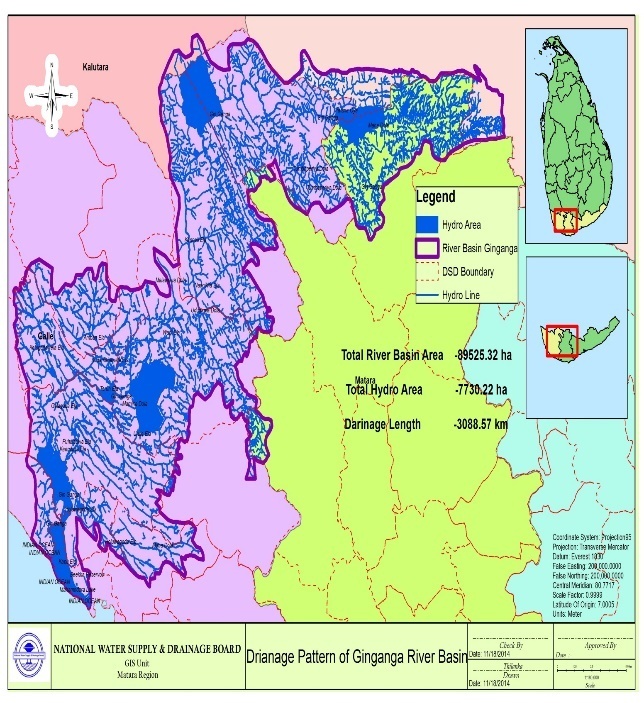
This survey carried out along both side of the river from Wakwella intake to left side- up to Ginemellagaha and right side- up to Balagoda covering two Grama Niladhari divisions named as Horagampita area and wakwella area.

According to the land act of Sri Lanka, 60M distance from the centre of the water sources in both sides (Left and right banks) should be protected as river reservation. But the selected catchment area of the Ginganga, (both left and right banks) (**Fig: 3.3)** reservations has been used for human settlements, sand mining, etc. and now became as a highly sensitive area due to the encroachments and the pollutions.

Considering of the all above river affected activities and water quality problems we focus our attention to implement WSP for the Galle and Greater Galle water Supply System to overcome such problems. The Galle and Greater Galle water supply system catchment affected activities were identified with our WSP stakeholders and national Water Supply & Drainage Board (NWSDB) relevant WSP officers.

The identified problems will be overcome as follows and supply of safety, enough water for the general public by using Galle and Greater Galle **Safety Plan.**

* Maintain raw water quality of the Galle and Greater Galle water intake (Ginganga) with in the SLS 722 limits and prevent further deterioration of the raw water quality.
* Further increase of treated water quality in water treatment plants
* Prevent water shortage in drought periods
* Mitigate to enter of the pollution lord in to catchment from the present pollution effected points.
* Aware the stakeholders of the catchment about scarcity and value of water as well as water related disease and health effects.
* Aware the stake holders of the catchment about comprehensive catchment management plan
* Aware the consumers to conserve and wise use of pipe borne water



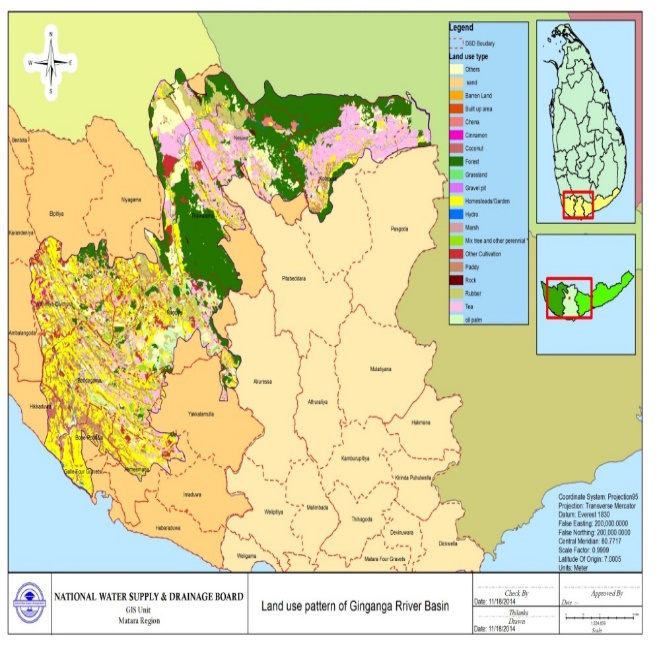
***Fig 3.2*** *Drainage pattern Ginganga River Basin*

***Fig: 3.1****Catchment close to water intake*

### 3.11.2 Land Use Pattern

Home garden is the major land use type in the river basin and it contributes 45% of the total basin area. The Land Use Pattern is shown in Table 3.4

*Table 3.4: Approximate Land Use Pattern of Gin Ganga Basin*

******

***Fig 3.3****Approximate Land Use Pattern of Gin ganga Basin*

Further details could refer pertaining to Gin ganga basin with following maps as the Reference WSP/Mapping.

WSP/Mapping/River Basin/GND – Grama Niladhari Divisions (GNDs) of Gin ganga Basin

WSP/Mapping/River Basin/Population – Population Distribution Pattern of Gin ganga Basin

WSP/Mapping/River\_Basin/Factories – Factories and Hospitals located at Gin ganga Basin

**3.11 Flow Diagram**

**3.11.1 Flow Diagram for Galle W.S.S.**

**Galle MC Area**

**G.R. Beekke**

**Treated water transmission**

**Clear water sump**

**Clear water sump**

**Sand Filtration**

**Intermittent process**

**Downstream of the river**

**Transport Steps**

**Storage Step**

**Aeration**

**Pumping/**

**Intake Screeners**

**Catchment**

**intermittent process**

**Continuous process**

**Continuous process**

**3.11.2 Flow Diagram for G.G. W.S.S.**

**Aeration**

**Hikkaduwa**

**Bope Poddala**

**Ahangama**

**Habaraduwa**

**Akmeemana**

**Pumping/**

**Intake**

**Sludge**

**Treated Water Pumping**

**Treated Water Pumping**

**Storage**

**Sand filtration**

**Raw Water**

**Catchment**

**Intermittent process**

**Continuous process**

**Transport Step**

**Storage Step**

## Treatment Plants

The above two plants are conventional water treatment plants. They consist of Corus and fine screening at the intake, cascade aeration, rapid mixer, clari flocculators, rapid sand filters, storage tanks and disinfection unit. In these two plants, for the flocculation, Alum (aluminium sulphate) is used as coagulant. 3.0% Alum solution is prepared by dissolving 300 kg of Alum in 10.0m3 water. For disinfection gas chlorination units are currently using. Other than that bleaching solution is used also in case of emergency. It has Backwash system with electro-mechanical equipment and relies mostly on hydraulic properties of water to backwash its filters and on gravity to convey raw water from the source, into the plant and out into the distribution system.

Jar test, pH, Turbidity, conductivity, Residual Chlorine (RCL) measurements are taking daily

**3.13.1 Water Treatment Processor Galle WSS - Wakwella Treatment Plant**

The capacity of wakwella water treatment plant is 32,000m3 /day. Treated water pumps in to a Beekke reservoir and distribute within the service area, 6 km away from the Treatment Plant and then distributed using a distribution system of approximately 175 km. Treated water pumps are generally operate manually in response to level of water storage tower. Galle water supply system is covered Galle Municipal area.

**3.13.2 Raw water Intake – Wakwella**

The raw water is drowning from the Ginganga with intake wire in place. The intake well is provided with a level transmitter, which will provide level in the river before the intake weir. The water from the river comes to the intake chamber, from where the water is transferred to the cascade aerator.

**3.13.3 Cascade Aerator –Wakwella**

Raw water is pumped to the top chamber of a cascade aerator from where it cascades down through several steps, and then into an inlet chamber at the water treatment plant, which has been connected to the mixing chamber.

The cascade aerator is located at a level 11.5 MSL. The natural level drop of the ground may be utilised in constructing the aerator. Manually operated valves have been provided on each outlet pipe from the aerator to the mixing chamber for isolation and maintenance purposes.

During this aeration, oxidation of iron will occur along with degassing of CO2 to some extent.

Lime solution is done at the top of the aerator (1 steps).the purpose of lime dosing in raw water at cascade aerator is to control the degassing of CO2 gas, which otherwise would cause increase in pH of inlet water.

### 

### 3.13.4 Distribution Chamber (Flash Mixer) –Wakwella

There are two nos. of distribution chamber to distribute raw water to two clarifiers. Alum solution dosing is done into the mixing chamber (the inlet weir to the clarifier).The purpose of alum solution dosing is to enable coagulation in the water, so that the fine suspended particles in the water coagulate and form bigger flocks enabling faster settling of these flocks in clarifier.

Each distribution chamber is provide with a gate followed by a weir to ensure that some water is always available in the chamber for chlorine and Alum to get mixed before the water is fed to the clarifier.

### 

### 3.13.5 Clariflocculator–Wakwella

This unit combines mixing, flocculation and sedimentation into a single structural unit. The clari flocculator is composed of 4 no. of mixers and 1 no of side driving scraper. The mixer rotates slowly and helps to flocculate solid. The mixers can be adjusted 0-100% by inverter of local panel depending on the flocculation condition. And there are two number of the sludge drain valves each clarifier and the initial setting of sludge drain in 3 minutes every 2 hrs. However,timer can adjust duration of the sludge drain time. The drawn off sludge is directed to a collection tank by gravity, and from here it is pumped to the river

### 

### 3.13.6 Filtration–Wakwella

The water from the clarifiers will be filtered in a set of 8 filters and constant rate type, which are gravity-operated, homogeneous grain size sand filters washed with air and water at the same time.

The filter plant includes two rows of 4 filters.

Backwashing is carried out with backwash pumps, obtaining water from the clear water sump. The highest filtration level maintain according to the filter head loss and back washing system is started, which is controlled by means of the water level in each filter and backwashing is then run for a pre-set time period. Thus the head of water above the sand level of the filter will increase during the filtration cycle until backwashing is required.

### 3.13.7 Clear water reservoir–Wakwella

Filtered water is directed to the 02 nos. of clear water reservoirs in a ground storage tank and disinfection process is carried out. The back wash water requirement is obtaining from the clear water reservoirs. The capacity of each tank is 882 m3.

This tanks are provide sufficient contact time for disinfection as well as being the backwash storage tank. Operational storage is also being provided in the tank. This is being used to provide a reserve of water to meet daily peak demands for treated water and also to compensate for small daily imbalances between works inflow and works outflow.

Treated water pumps are generally operate manually in response to level signals from remote water storage tower and the reservoirs unless otherwise stated. Treated water pumps are generally sized to meet peak daily water demands in each distribution system.

The treated water is pumped by 4no. of high lift (H/L) pumps to the Beekke service reservoir. There are three transmission lines to be pumped to beekke service reservoir from wakwella clear water tank. Two of them, one is 400mm dia. coated steel pipes and other one is 400mm dia DI pipes. The length of each pipes line is 5.825 kilometers. The other transmission pipe line is 500mm dia. HDPE pipes. The length of this pipeline is approximately 8 km.

### 3.13.8 Chemical dosing

The chemical buildings are comprises of three independent sections for alum, lime and chlorine preparation and dosing facilities unless otherwise stated. An electrically operated overhead crane shall be provided in the alum and lime storage area for transporting bags of chemicals. Another electrically operated overhead crane shall be provided in the chlorine container storage area for lifting of chlorine tonners.

A proper ventilation system has been provided in the chlorination area with adequate air outlet and inlet provisions. A water bath is used in case of a leakage of chlorine gas from a cylinder at Wakwella Treatment Plant. A neutralization unit has been established at Hapugala Treatment Plant in case of leakage of chlorine gas.

**3.13.9 Chemical feeding for coagulation and pH correction**

Chemicals are used in this system for coagulation and pH correction. Suggested chemicals are alum and lime. The feeding system is take place according to mechanical manner/ or manually. Chemical preparation tanks are used for preparation of chemicals. The strength of the alum and lime solutions are 3% and 1%.

Chemical dosing requirements for coagulation and flocculation will be determined at least daily by laboratory analysis of raw water quality and the appropriate dosing rates set manually.

The reagents used for the water treatment are as follows:

Chlorine for pre chlorination and post disinfection

Alum for coagulation

* Hydrated lime for flocculation and final neutralization

Chemicals plants have been designed for delivery, handling, storage, transfer, solution preparation/dilution and dosing.

#### 3.13.10 Pre Chlorination

In order to algae and germs it is considered to be necessary to dose 1.0-1.5mg/l – during the seasonal algae bloom.Dosing is done sedimentation step before entering filters using a submerged perforated piping system.Chlorine is available locally and delivered as liquid 900kg drums.

#### 3.13.11 Post chlorination

To be dosed at inlet to clean water tank. Retention time to be secured by installation of baffles in clean water tank.

### 

### 3.13.12 Alum-dosing

Alum dosing is done at the mixing chamber. Alum blocks will be transferred from the storage area into the dosing room where alum-dosing tanks are constructed. Each tank has a compartment with a perforated floor/grit, where alum blocks can be added. The blocks are dissolved by service water, which is mixed by a top mounted mixer to obtain a homogeneous solution.

#### 3.13.13 Lime-dosing

Dosed at the inlet to the clarifloculation and to clean water reservoir as final pH-adjustment.

**3.13.14 Hapugala Treatment Plant**

The raw water extracted from wakwella intake pumps into the Hapugala Treatment Plant situated about 2.6 km away from wakwella. The capacity of Hapugala Treatment plant is 32000m3/ Day. Treated water pumps into the Batuwantudawa service reservoir away from the treatment plant. Then treated water pumps into the 3 major reservoirs within the service area and then distributed using a distribution system of approximately 938.5.kms.

Treated water pumps are generally operated manually in response to level from water storage reservoirs and the reservoirs unless otherwise stated. Treated water pumps are generally sized to meet peak daily water demands in each distribution system. Greater Galle water Supply system is covered Akmeemana, Bope-Poddala, Habaraduwa, Ahangama and a part of Hikkaduwa water supply schemes.

**3.13.15 Raw water Intake Hapugala**

The raw water is also drowning from the Ginganga with intake wire in place. The intake well is provided with a level transmitter, which will provide level in the river before the intake weir. The water from the river comes to the intake chamber, from where the water is transferred to the Hapugala TP by 600 mm pumping main, 2.8 km away from the wakwella intake.

**3.13.16 Cascade Aerator – Hapugala**

Raw water is pumped to the top chamber of a cascade aerator from where it cascades down through several steps, and then into an inlet chamber at the water treatment plant, which has been connected to the mixing chamber. During this aeration, oxidation of iron will occur along with degassing of CO2 to some extent.

Lime solution is done at the top of the aerator (1 steps).the purpose of lime dosing in raw water at cascade aerator is to control the degassing of CO2 gas, which otherwise would cause increase in pH of inlet water.

Design criteria are mentioned as follows;

Design flow - 1467 m3/h

No of steps - 06

Height of each step - 0.5m

Width of each step - 8m

### 3.13.17 Distribution Chamber (Flash Mixer) –Hapugala

There are two nos. of distribution chamber to distribute raw water to two clarifiers.Alum solution dosing is done into the mixing chamber (the inlet weir to the clarifier).The purpose of alum solution dosing is to enable coagulation in the water, so that the fine suspended particles in the water coagulate and form bigger flocks enabling faster settling of these flocs in clarifier. Each distribution chamber is provide with a gate followed by a weir to ensure that some water is always available in the chamber for Alum to get mixed before the water is fed to the Clarifier.

### Clariflocculator - Hapugala

The flow of raw water from the aerator after passing through the flash mixing chamber is equally distributed at the attached flow splitter and lead into two identical centri-floc clarifiers.

This unit combines mixing, flocculation and sedimentation into a single structural unit. The clariflocculator is composed of 4 no. of mixers and 1 no of side driving scraper. The mixer rotates slowly and helps to flocculate solid. The mixers can be adjusted 0-100% by inverter of local panel depending on the flocculation condition. And there are two number of the sludge drain valves each clarifier and the initial setting of sludge drain in 3 minutes every 2 hrs. However the sludge drain time duration can be adjusted by timer.

Flow rate - 35200 m3/Day

No of clarifier - 02

Flow through each clarifier - 733.33m3/Hour

Volume of flocculation chamber - 480.5 m3

Volume of sedimentation compartment - 1961.14m3

Retention time - 9627.43 Sec.

The drawn off sludge is directed to a collection tank by gravity, and from here it is pumped to the sludge beds.

### 

### 3.13.19 Filtration –Hapugala

The water from the clarifiers will be filtered in a set of 8 Rapid sand filters and constant rate type, which are gravity-operated, homogeneous grain size sand filters washed with air and water at the same time.

The filter plant includes two rows of 4 filters.

Flow rate - 33,440 m3/Day

No of filters - 08

Length of each unit - 7.2 m

Effective width of each unit - 4.25 m

Bed area of each unit - 3.60 m2

Flow through each filter unit - 174.17 m3/hour

Filtration Rate - 5.69 m/hr

Backwashing is carried out with backwash pumps, obtaining water from the clear water sump. The highest filtration level maintain according to the filter head loss and back washing system is started, which is controlled by means of the water level in each filter and backwashing is then run for a pre-set time period. Thus the head of water above the sand level of the filter will increase during the filtration cycle until backwashing is required.

### 3.13.20 Clear water reservoir –Hapugala

Filtered water is directed to a clear water reservoir in a ground storage tank and disinfection process is carried out. The back wash water requirement is obtaining from the clear water reservoir. The capacity of tank is 3000 m3.

This tank are provide sufficient contact time for disinfection as well as being the backwash storage tank. Operational storage is also being provided in the tank. This is being used to provide a reserve of water to meet daily peak demands for treated water and also to compensate for small daily imbalances between works inflow and works outflow.

Treated water pumps are generally operate manually and pumps form Hapugala Treatment Plant to Batuwatudawa Reservoir (12,000 m3) and Mahagogoda Reservoir (3000 m3). Treated water pumps are generally sized to meet peak daily water demands in each distribution system.

### 

### 3.13.21 Sludge treatment Hapugala

Sludge is generated from two different sources, from the clarifier and settling tank of the Hapugala drinking water treatment plant. Sludge is extracted from the bottom of the settling tank and then transferred to the sludge drying beds by pumps

No of sludge drying bed - 06

Length of each drying bed - 10.40 m

Width of each drying bed - 10.35 m

Depth of each drying bed - 1.8 m

### Chemical dosing

In here, a neutralization unit has been established at Hapugala Treatment Plant in case of leakage of chlorine gas.

* + 1. **Chemical feeding for coagulation and pH correction**

Chemical feeding for coagulation and pH correction is same as Wakwella TP.

## 3.14 Distribution System

## Treated Water of Wackwella & Hapugala Treatment Plants distributed among 13 no. of water supply systems. Capacity of each treatment plant is 32,000 m3/day.

## Here in under the Galle group water safety plan, we consider below mention water supply systems.

## Galle WSS

## Ahangama WSS

## Akmeemana WSS

## Habaraduwa WSS

## Pope Poddala WSS

## Galle WSS

## Treated water from Wackwella treatment plant pumped to Beekka ground reservoir of 9000m3 capacity. This water distribute to Galle WSS

## Belongs to Four Gravets Divisional Secretariat Division

## Covers 44 no. of Grama Niladari Divisions

## Approximate population is 112,000

* 25,253 service connections (as at 16/01/2019)
* Distribution lines are under the road carriage way
* More time taken for leak repairing because of very old (more than 40 yrs) pipes in the distribution system.
* Average of 3.5 bar pressure is maintained high pressure area in the system & average 0.3 bar pressure is maintained low pressure area in the system
* Majority of the customers collected the water in the storage tank
* Water quality monitoring of the system is done twice per month (Reference File: Water Quality Analysis Report Folder – WSP/WQA)

Ahangama WSS

## Treated water from Hapugala treatment plant pumped to Hapugala ground reservoir of 12,000m3 capacity and then pumped to the Koulhena ground reservoir of 7,000m3 capacity. Then pumped to the Halloluwagoda ground reservoir of 7,000m3 capacity. This water distribute to Ahangama WSS

## Belongs to Habaraduwa Divisional Secretariat Division

## Covers 33 no. of Grama Niladari Divisions

## Approximate population is 34,604

* 5,936 service connections
* There is intermittent supply been established
* Distribution lines are under the road carriage way
* More leaks happen in Galle & Matara Main road
* Average of 6 bar pressure is maintained high pressure area in the system & average 0.5 bar pressure is maintained low pressure area in the system
* Majority of the customers collected the water in the storage tank
* Water quality monitoring of the system is done twice per month (Reference File: Water Quality Analysis Report Folder – WSP/WQA)

## Akmeemana WSS

## Treated water from Hapugala treatment plant pumped to Hapugala ground reservoir of 12,000m3 capacity and then pumped to the Koulhena ground reservoir of 7,000m3 capacity. This water distribute in Akmeemana WSS

## Belongs to Akmeemana Divisional Secretariat Division

## Covers 53 nos Grama Niladari Divisions

## Approximate population is 69,580

* 6,236 service connections
* There is intermittent supply been established
* Distribution lines are under the road carriage way
* Average of 4.2 bar pressure is maintained high pressure area in the system & average 0.02 bar pressure is maintained low pressure area in the system
* Majority of the customers collected the water in the storage tank
* Water quality monitoring of the system is done twice per month (Reference File: Water Quality Analysis Report Folder – WSP/WQA)

## Habaraduwa WSS

## Treated water from Hapugala treatment plant pumped to Hapugala ground reservoir of 12,000m3 capacity and then pumped to the Koulhena ground reservoir of 7,000m3 capacity. This water distribute in Habaraduwa WSS

## Belongs to Habaraduwa,Imaduwa & Akmeemana Divisional Secretariat Division

## Covers 64 nos Grama Niladari Divisions

## Approximate population is 82,000

* 10,409 service connections
* There is intermittent supply been established
* Distribution lines are under the road carriage way
* More leaks happen in Galle & Matara Main road
* Average of 5.5 bar pressure is maintained high pressure area in the system & average 0.2 bar pressure is maintained low pressure area in the system
* Majority of the customers collected the water in the storage tank
* Water quality monitoring of the system is done twice per month (Reference File: Water Quality Analysis Report Folder – WSP/WQA)

## Pobe Poddala WSS

## Treated water from Hapugala treatment plant pumping to Hapugala ground reservoir capacity of 12,000m3. This water distribute to Habaraduwa, Akmeemana, Ahangama, Bope Poddala WSSs.

## Belongs to Bope Boddala,Four Gravets of Galle & Baddegama Divisional Secretariat Division

## Covers 55 nos Grama Niladari Divisions

## Approximate population is 73,875

* 13,497 service connections
* There is intermittent supply been established
* Distribution lines are under the road carriage way
* More leaks happen in Galle gintota Main road
* Average of 2 bar pressure is maintained in the system
* Majority of the customers collected the water in the storage tank
* Water quality monitoring of the system is done twice per month (Reference File: Water Quality Analysis Report Folder – WSP/WQA)

**3.15. Water uses**

**3.15.1. Current water uses**

Drinking, preparation of food, Personal hygiene, Cloth washing, uses in hotels and restaurants, domestic livestock, fish market ,Hospital Schools industries quantity.

* + 1. **House hold collection and storage practices.**
       - Some high elevated areas are provided Bowser supplies by NWS&DB and feed in to distribution line and private Browsers are in operation those who use water board water and water from other sources.
       - Storage tanks, Pots and barrels are used as storage containers.

**House hold treatment**

* + - * + Use house hold filters
      1. **Water transported**

The water supply scheme has high demand over the supply and some issues in line diameters low pressure zones has identified (refer low pressure zone map).It has a water cut schedule for most of the area and Bowser supply has practiced to established Bowser points in hilly areas. If get consumer complain Bowser supply carried out free of charge. Private Bowser services also supply water from our Bowser points and other sources to some areas in some occasions.

* + 1. **3.16 Operational monitoring of distribution**
       1. **Delivery point water quality testing**

Sample collection and tested by NWSDB regional lab as according to satisfying SLS target minimum number of samples from distribution.(Table3.6)

*Table 3.5: Number of samples tested in distribution*

|  |  |  |  |
| --- | --- | --- | --- |
| **WSS** | **Total Connection** | **Population Served** | **Program number of samples per month** |
| Galle | 25253 | 99504 | 80 |
| Ahangama | 5936 | 23280 | 5 |
| Akmeemana | 6236 | 24448 | 7 |
| Habaraduwa | 10409 | 41100 | 20 |
| Bobe - Poddala | 13497 | 53252 | 15 |
| **Total** | **61,331** | **241,584** | **127** |

**3.17 Sample points of distribution**

Refer map of sample points of Galle group water supply scheme.

* 1. **3.18 Water Quality Required**

Sri Lanka Standard (SLS) 2013: 614 Part 1 and Part 2. Set as the internal water quality standard for NWSDB and it is interested to comply with WHO Water Quality Standard and American Standard, EPA standers for Drinking Water and NWSDB’s focus is to follow the limits whichever the lowest.

* + 1. **3.18.1 Standard for Water Quality – Physical Requirement**

*Table 3.6: Standard for Water Quality*

|  |  |  |  |
| --- | --- | --- | --- |
| **Item** | **Characteristic** | **Requirement** | **Method of Test** |
| **1** | Color | 15 | APHA 2120 B |
| **2** | Odor | Unobjectionable | Sensory  evaluation |
| **3** | Taste | Unobjectionable | Sensory  evaluation |
| **4** | Turbidity | 2 | APHA 2310 B |

*Table 3.7: Standard for Water Quality - Chemical Requirement*

|  |  |  |  |
| --- | --- | --- | --- |
| **Item** | **Characteristic** | **Requirement (mg/l)**  **Max.** | **Method of Test** |
| **1** | pH | 6.5 – 8.5 | APHA 4500- H B |
| **2** | Chloride (as Cl) | 250 | APHA 4500 – Cl B |
| **3** | Free residual Chlorine (as Cl) | 1.0 | APHA 4500 – Cl G |
| **4** | Alkalinity (total as CaCO3) | 200 | APHA 2320 – B |
| **5** | Free Ammonia | 0.06 | - |
| **6** | Albuminoidal Ammonia | 0.15 | - |
| **7** | Nitrate (as NO3) | 50 | ALHA 4500 –  NO3 E |
| **8** | Nitrite (as NO2) | 3 | ALHA 4500 –  NO3 B |
| **9** | Fluoride | 1 | APHA 4500 – F C |
| **10** | Total Phosphate | 2 | APHA 4500 – P |
| **11**   |  |  |  |  | | --- | --- | --- | --- | | **12** | Total Hardness | 250 | APHA 2340 – C | | **13** | Total Iron | 0.3 | APHA 3500 – Fe B | | **14** | Sulphate | 250 | APHA 4500 – SO4 E | | **15** | Oil and Grease | 0.2 | APHA 5520 B | | **16** | Calcium | 100 | APHA 3500 – Ca  B | | **17** | Magnesium | 30 | APHA 3500 –  Mg B | | **18** | Sodium | 200 | APHA 3111B | | **19** | Manganese | 0.1 | APHA 3111B | | Total Dissolved Solids | 500 | APHA 2540 – C |

* + 1. **3.18.2 Bacteriological requirement**

*Table 3.8: Standard for Water Quality – Bacteriological Requirement*

|  |  |  |
| --- | --- | --- |
| **Type of Bacteria** | **SLS 614:2013 (Part II)** | |
| **Pipe born Water** | **Well Water** |
| # Total Coli form bacteria  present in 100ml | <3 | <10 |
| # E. Coli present in 100ml | Nil | Nil |

* + - * E. coli or thermo tolerant coli form bacteria shall not be detectable in any 100 ml sample.
      * Total coli form bacteria shall not exceed 3 in any 100 ml sample. Total coli form bacteria shall not be detectable in 100ml of any two consecutive samples.
      * In the case of large supplies, where sufficient samples are examined total coli form bacteria shall not be present in 95 percent of samples taken throughout any 12 month period. In the remaining 5 percent sample total coliform bacteria shall not exceed 10 per 100ml.

    2. **3.18.3 Heavy metal requirement**

*Table 3.9: Standard for water quality - Heavy metal Requirement*

|  |  |  |  |
| --- | --- | --- | --- |
| **No** | **Characteristic** | **Limit mg/l (maximum)** | **Referee method** |
| **1** | Arsenic (as As) | 0.01 | APHA 3114C |
| **2** | Cadmium (as Cd) | 0.003 | APHA 3113B |
| **3** | Chromium (as Cr) | 0.05 | APHA 3114C |
| **4** | Cyanide (as CN) | 0.05 | APHA (4500-CN C; EPA 335.4) |
| **5** | Lead (as Pb) | 0.01 | APHA 3113B |
| **6** | Mercury (as Hg) | 0.001 | APHA 3111B |
| **7** | Selenium (as Se) | 0.01 | APHA 3114C |

**3.18.4 Pesticide requirement**

*Table 3.10: standards for pesticide*

|  |  |  |  |
| --- | --- | --- | --- |
| **No** | **Pesticide** | **Method** | **Limit of Determination**  **(μg /L)** |
|
| **1** | Aldrin | EPA-8081 B | 10 |
| **2** | Captan | EPA-8081 B | 10 |
| **3** | Carbofuran | EPA-8081 B | 10 |
| **4** | Carbosulfan | EPA-8081 B | 10 |
| **5** | Chloropyrifos | EPA-8081 B | 10 |
| **6** | Diazinon | EPA-8081 B | 10 |
| **7** | Dieldrin | EPA-8081 B | 10 |
| **8** | Endosulfan | EPA-8081 B | 10 |
| **9** | Etofenprox | EPA-8081 B | 10 |
| **10** | Hexachlorobenzen | EPA-8081 B | 10 |
| **11** | Mancozeb | EPA-8081 B | 10 |
| **12** | Melathion | EPA-8081 B | 10 |
| **13** | Parathion | EPA-8081 B | 10 |
| **14** | Profenofos | EPA-8081 B | 10 |

*Table 3.11: Average water quality achieved of Galle Group water supply scheme.* **(**As at 2018 December) Drinking Water Targets in GGWSS

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Treatment Plant** | | **Distribution** | | | | |
| **Parameter** | **Wakwella Treatment**  **plant** | **Hapugala Treatment plant** | **Galle** | **Bopepoddala** | **Ahangama** | **Akmeemana** | **Habaraduwa** |
| Turbidity/ NTU | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |
| Conductivity/ µS/cm | <70 | <70 | <70 | <70 | <70 | <70 | <70 |
| Colour/ pt/Co | <10 | <10 | <10 | <10 | <10 | <10 | <10 |
| RCl/ ppm | 1 | 1 | >0.2 | >0.2 | >0.2 | >0.2 | >0.2 |

**4. Risk assessments, hazard table and existing control measures**

The next step is to assess the risk associated with each identified hazard. There are two aspects to assessing the risk. The first is the likelihood of the hazard or hazardous event occurring, taking into account existing catchment controls and treatment processes and controls, and it could be described qualitatively in terms such as almost certain, likely, moderate, and unlikely or rarely or by a quantitative scoring method. The second is the severity of the consequences of the hazard should it occur, particularly the effect on human health and meeting health based standards and indicator parameter values. Again this assessment could be described qualitatively in terms such as catastrophic, major, moderate, minor or insignificant or by a quantitative scoring method. The risk associated

With each hazard is a combination of the likelihood of occurrence and the severity of the consequences. The risks can then be ranked in priority for action, but not all will require attention because some will be very small*.(DWI – A brief guide to drinking water safety plans October 2005)*

**4.1 Risk Assessment Methodology**

Semi Quantitative Risk Matrix was developed by frequency of occurring of the particular hazard event and the severity of the particular hazard event was measured considering the following guideline.



**Risk Prioritization**

Prioritization matrix is used to Prioritize Management Of actions according to risk ratings.

*Table No. 4.1 Semi quantitative risk matrix*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Public Health** | | **Severity or Consequence** | | | | |
| **Catastrophic** Ratings 5 | **Major**  Rating 4 | **Moderate**  Rating 3 | **Minor**  Rating 2 | **Insignificant** Rating 1 |
| **Likely hood of Frequency** | **Almost certain** Ratings 5 | 25 | 20 | 15 | 10 | 5 |
| **Likely**  Ratings 4 | 20 | 16 | 12 | 8 | 4 |
| **Moderate** Ratings 3 | 15 | 12 | 9 | 6 | 3 |
| **Unlikely**  Ratings 2 | 10 | 8 | 6 | 4 | 2 |
| **Rare**  Ratings 1 | 5 | 4 | 3 | 2 | 1 |

*Table No. 4.2 Risk score pertaining to severity and likely hood*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Risk score** | **<6** | **6 - 9** | **10 – 15** | **>15** |
| **Risk rating** | **low** | **medium** | **high** | **very high** |

Based on the frequency index and the severity index of a particular hazard event the risk score of the event was calculated and the risk rates are as follows;

**Risk prioritization method**

**Prioritization matrix**

*Table No. 4.3 Risk rating pertaining to severity and Likely hood*

|  |  |
| --- | --- |
| **Risk Rating** | **Action** |
| **Low** | * **Manage using routine procedures, keep under review.** |
| **Medium** | * **Less priority action required; or** * **Action required, plan and prepare.** |
| **High** | * **Priority action required to mitigate hazard in short term.** |
| **Very High** | * **Urgent action required to mitigate and prevent hazard.** |

*Table No. 4.4 Description of likelihood or frequency.*

|  |  |  |
| --- | --- | --- |
| **Level** | **Descriptor** | **Description** |
| **1** | **Rare** | **Very uncommon event/ never happen but possible** |
| **2** | **Unlikely** | **The event may occur/ recorded in the history may happen annually or once in 1-2 years.** |
| **3** | **Moderate** | **The event has happened before and can probably occur again/ events that occur may monthly** |
| **4** | **Likely** | **The event happen periodically with shorter interval/ events that may occur weekly** |
| **5** | **Almost certain** | **Very common event/ events that take place daily** |

*Table No. 4.5 Description of severity or consequence.*

|  |  |  |
| --- | --- | --- |
| **Level** | **Descriptor** | **Description** |
| **1** | **Insignificant** | * **No potential to course harm to public health within a community** * **No disruption to normal operation.** |
| **2** | **Minor** | * **Potential course to irritation or discomfort** * **Manageable operation disruption.** |
| **3** | **Moderate** | * **Widespread aesthetic issues *(e.g. Fe, Mn, H2S, Zn, color, odor, taste, and turbidity)*. or long term non-compliance but potential to course illness.** * **Significant impact to normal operation but manageable.** |
| **4** | **Major** | * **Potential to course illness and hospitalization of people within the community** * **System significantly compromised, high level of monitoring is required.** * **Disruption to consumers.** |
| **5** | **Catastrophic** | * **Potential illness or acute toxicity (e.g. microbial, chemical organic constituents, i.e. pesticide, or inorganic constituents, i.e. CN).Potential to course death(s) within the community** * **Major impact for large population.** * **Complete system failure.** |

# 4.4 Determination and validation of control measures

Control measures are the activities, actions and processes applied to prevent or minimize the hazards occurring or hazards that can be occurred in the system, which can be effectively reduced the levels of hazards by minimizing their entry into the water supply system. These controlled measures are needed to apply at the point of contamination. All significant hazards in the system which identified during the hazard analysis need to be identified as being controlled or potentially controlled by mitigating or control measures.

Some hazards will not be effectively controlled with current control measure and risk is till high. Therefore residual **risks** in the system with existing controls should be **re- assessed** and mitigate with suitable control measures.

Next step of the Water Safety Plan is the Validation of Control Measures reassess and priorities the Risks

1. Control measure **for Catchment or 1st barrier** – effective catchment management, decreases the contamination of source water, amount of treatment and quantity of chemicals needed is then reduced. This may reduce the production of treatment bi – products and minimize operational costs and increase aesthetic values.
2. Control measures **for the treatment Plant or 2nd barrier** – If source water of very high quality may only require watershed protection and disinfection. Otherwise control measures may include many treatment steps. Water Treatment should be optimised to prevent microbial growth, corrosion of pipe materials and the formation of deposits.
3. Control measures **for the Distribution system or 3nd barrier** – Maintaining good water quality in the distribution system will depend on the design and operation of the system and on maintenance and survey procedures to prevent contamination and remove the accumulation of internal deposits.
4. Control **measures for the Consumer interface or 4nd barrier** – Treated water quality should be protected until use by the consumer with effective control measures.
   1. **Hazard / Risk table and existing controls**

**Table 4.6: Catchment**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Ref.No | Process step |  | Hazard type | R | Risk if there was no controls | | |  | Is this control measure capable of being effective? (column "notes" shows short  justification) | | | Risk with existing controls | | |  | Improvements | Improvement plan No |  |
| Hazardous event | L' hood | Severity | Risk score | Risk Class | Existing controls | L' hood | Severity | Risk score | Risk Class | Short title only | Notes |
| Yes | No | Not sure or some  what |
| **Intake** | S-01 | High turbidity (> 200 NTU) in raw water due to soil erosion. | Physical | 3 | 3 | 9 | Medium | N  1st barrier-Nil  2nd barrier-Coagulation, Flocculation and filtration | **√** |  |  | 1 | 3 | 3 | Low | Awareness program through catchment management program.  Maintain the buffer zone with special plantation. | WSP/ I / 01 |  |

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|  | S-02 | High color in raw water due to soil erosion at heavy rain | Physical, Chemical, | 3 | 3 | 9 | Medium | Nil |  | **√** |  | 3 | 3 | 9 | Medium | Awareness program through catchment management program.  Maintain the buffer zone with special plantation. | WSP/ I / 01 |  |

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|  | S-03 | Biological contamination in raw water due to surface runoff | Biological | 3 | 5 | 15 | High | 1st barrier-Nil  2nd barrier-  Chlorination at WTP | √ |  |  | 1 | 5 | 5 | Low | \*Implementation of demarcation of the river reservation  \*Awareness for public to prevent the source pollution | WSP/ I / 01,34,35,30 |  |
|  | S-04 | Contamination in raw water due to direct discharge of sewer in to river | Biological, Chemical | 5 | 5 | 25 | Very High | 1st barrier-Nil  2nd barrier-  Disinfection & RCL monitoring at TP effluent | √ |  |  | 1 | 5 | 5 | Low | \*Implementation of demarcation of the river reservation  \*Awareness for public to prevent the source pollution\*Identifying sewer discharge point as soon as possible | WSP/ I / 01,34,35,30 |  |
|  | S-05 | Agrochemical contamination in raw water due to surface runoff at rainy season | Chemical | 3 | 4 | 12 | High | Nil |  | √ |  | 3 | 4 | 12 | High | \*Implementation of demarcation of the river reservation  \*Awareness for public to prevent the source pollution  \*Aware a farmer organizations and farmers to mitigate their amount of use agro chemicals. | WSP/ I / 01,34,35,30 |  |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Ref No | Process step |  | Hazard type | Risk if there was no controls | | | |  | Is this control measure capable of being effective? (column "notes"  shows short justification) | | | Risk with existing controls | | |  | Improvements | Improvement plan No |  |
| Hazardous event | L'hood | Severity | Risk score | Risk Class | Existing controls | L'hood | Severity | Risk score | Risk Class | Short title only | Notes |
| Yes | No | Not sure or some  what |
|  | S-06 | Agrochemical contamination in raw water due to disposal of agrochemical containers | Chemical | 3 | 4 | 12 | High | Awareness by field offices of Agriculture Department to minimize the solid waste dumping in to the catchment |  |  | **√** | 3 | 4 | 12 | High | \*Awareness for public to prevent the source pollution | WSP/ I / 01,34,35,30 |  |
| S-07 | Chemical contamination in raw water due to industrial discharges by surface runoff at upper catchment | Chemical | 3 | 4 | 12 | High | EP Licensing procedure |  |  | **√** | 3 | 4 | 12 | High | \*Implementation of demarcation of the river reservation  \*Monitoring & Updating of the status of EPL | WSP/ I / 01,11,34,35,30 |  |
| S-08 | Contamination by pharmaceutical waste and radio-actives due to hospital discharges at upper catchment | Physical, Chemical, Radiological | 4 | 4 | 16 | Very High | Nil | **√** |  |  | 4 | 4 | 16 | Very High | Aware the hospital higher staff to implement wastes TP immediately. | WSP/ I / 01,34,35,30 |  |

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|  | S-09 | Biological contamination into raw water due to direct dump illegal solid waste discharge from meat shops. | Biological | 4 | 5 | 20 | Very High | 1st barrier- Maintaining regular reporting procedure by public  2nd barrier-  Disinfection & RCL monitoring at TP effluent | √ |  |  | 1 | 5 | 5 | Low | \*Awareness program for public to get a fully attention to prevent solid dumping.  \*Establish the protocol to aware PHIs.  \* Initiate the regularly following up program of Boucher shops by PHIs | WSP/ I / 01,34,35,30 |  |
| S-10 | Chemical contamination by untreated / partially treated hospital waste discharge in to water ways in catchments | physical, Chemical, Biological | 4 | 5 | 20 | Very High | 1st barrier-Nil  2nd barrier-  Disinfection & RCL monitoring at TP effluent | **√** |  |  | 2 | 5 | 10 | High | Aware the hospital higher staff to Renovate or implement waste TP immediately | WSP/ I / 01,34,35,30 |  |

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|  | S-11 | Biological organic waste in to raw water due to livestock of fatal animals in catchments by surface runoff | Chemical, Biological | 3 | 5 | 15 | High | 1st barrier- Maintaining regular reporting procedure by public  2nd barrier-  Disinfection & RCL monitoring at TP effluent | √ |  |  | 1 | 5 | 5 | Low |  |  |  |
| S-12 | Oil, grease, heavy metal &chemical contamination into raw water due to effluent discharge or runoff from service stations along the river | Physical, Chemical | 4 | 3 | 12 | High | EP Licensing procedure |  |  | √ | 4 | 3 | 12 | High | \*Implementation of demarcation of the river reservation  \*Monitoring & Updating of the status of EPL | WSP/ I / 01, 11,02 |  |
| S-13 | Chemical & physical Contamination of raw water due to discharge of by-product from palm oil processing factory at Nakiyadeniya | Chemical, Physical | 3 | 4 | 12 | High | EP Licensing procedure |  |  | √ | 2 | 4 | 8 | Medium | \*Awareness for public to prevent the source pollution  . | WSP/I/01,34,35,30 |  |

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|  | S-14 | Contamination raw water due to  Salinity intrusion enhancing by sand mining | Chemical, Physical | 3 | 2 | 6 | Medium | 1st barrier- Banned sand mining in to the river,  2nd barrier- Operation of the salinity barrier | √ |  |  | 1 | 4 | 4 | Low | \*Awareness program for public. | WSP/ I / 01,34,35,30 |  |
|  | S- 15 | Contamination in to raw water due to electrical waste dumping along the river side | Chemical, Physical | 3 | 4 | 12 | High | Nil |  | √ |  | 3 | 4 | 12 | High | \*Awareness for public to prevent the source pollution | WSP/ I / 01,34,35,30 |  |
|  | S-16 | Chemical contamination in raw water due to using high agro chemical dosage for homestead and tea gardens near river side | Chemical | 4 | 4 | 16 | Very high | Awareness by field offices of Agriculture Department to reduce over dose |  |  | √ | 3 | 4 | 12 | High | \*Awareness for public to prevent the source pollution  \*Implementation of demarcation of the river reservation | WSP/I/ 01,34,35,30 |  |
|  | S-17 | Contamination in raw water due to colliding fuel bowser when transporting near river sideway | Chemical, Physical | 1 | 4 | 4 | Low | Application of PAC | √ |  |  | 1 | 4 | 4 | Low |  |  |  |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | S-18 | Chemical, physical & biological contamination into raw water due to seepage of septic tanks along the river | Physical,  Chemical, Biological | 5 | 5 | 25 | Very High | 1st barrier-Nil  2nd barrier-  Disinfection & RCL monitoring at TP effluent | √ |  |  | 3 | 5 | 15 | High | \*Implementation of demarcation of the river reservation  \*Awareness for public to prevent the source pollution | WSP/ I / 01,11,30,34,35  WSP/ I / 01 |  |
| S19 | Contamination of raw water due to direct discharge of domestic waste water | Physical, Chemical, Biological | 5 | 5 | 25 | Very High | 1st barrier-Nil  2nd barrier-  Disinfection & RCL monitoring at TP effluent  Sedimentation  Filtration | √ |  |  | 3 | 5 | 15 | High | \*Awareness for public to prevent the source pollution &implementation of catchment management program | WSP/ I / 01,11,34,35, 30 |  |

**4.7 Treatment Plant**

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| Ref  No | Process step |  | Hazard type | Risk if there was no controls | | | |  | Is this control measure capable of being effective? (column "notes" shows short  justification ) | | | Risk with existing controls | | | | Improvements | Improvement plan No |  |
| Hazardous event | L' hood | Severity | Risk score | Risk Class | Existing controls | L'hood | Severity | Risk score | Risk Class | Short title only | Notes |
| Yes | No | Not sure or some what |
| **Intake** | T-01. | Increase of taste and odor due to accumulation of debris at screen(Hapugala & Wakwella TPs) | Physical, Biological | 3 | 5 | 15 | High | Regularly cleaning and inspection | √ |  |  | 1 | 5 | 5 | Low |  |  |  |
| T-02. | Contamination of raw water due to malfunctioning of screens at intake well (Hapugala & Wakwella TPs)s | Physical,  Biological | 2 | 5 | 10 | Medium | Regularly cleaning and inspection | √ |  |  | 1 | 5 | 5 | Low |  |  |  |

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|  | T - 03 | Low or no water in treatment plant due to power failures occurred in intake pump house at Hapugala TP | Physical | 2 | 4 | 8 | Medium | Generator | √ |  |  | 1 | 4 | 4 | Low |  |  |  |
| **Intake**  Intake | T-04. | Low or no water to the treatment plant due to power failures occurred in intake pump house at Wakwella TP | Physical | 2 | 4 | 8 | Medium | Nil |  | √ |  | 2 | 4 | 8 | Medium | \*Install a generator to minimize the damage | WSP/I/04 |  |
| T -05 | Low or no water to the treatment plant due to damage of impellers of intake pumps.(Hapugala & Wakwella TPs) | Physical | 2 | 3 | 6 | Medium | Immediately attend for corrective action | √ |  |  | 1 | 3 | 3 | Low |  |  |  |
| T-06. | Low capacity of intake pumps due to depreciation (Hapugala &Wakwella TPs) | Physical | 4 | 3 | 12 | High | Preventive maintenance | √ |  |  | 2 | 3 | 6 | Medium | Renovation of M&E equipment at particular intervals, Implementing preventive maintenance program properly. | WSP/I/12 |  |

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|  | T -07 | Increasing of salinity level of raw water due to improper operation of salinity barrier during drought period | Chemical | 2 | 3 | 6 | Medium | If the incident it happen the worker is assign that operation |  |  | √ | 2 | 3 | 6 | Medium | Assign the level system | WSP/I/03 |  |
|  | T - 08 | Increasing the turbidity in treated water due to malfunctioning of flow measurement meter | Physical, Biological | 2 | 3 | 6 | Medium | Preventive maintenance |  |  | √ | 2 | 3 | 6 | Medium | Purchase the new flow meter | WSP/I/05 |  |
|  | T - 09 | Low or no water in to the treatment plant due to damage of pumps because of malfunctioning of non-return valve (Hapugala&Wakwella TPs) | Chemical, Physical | 2 | 3 | 6 | Medium | Preventive maintenance |  |  | √ | 2 | 3 | 6 | Medium | Replace the non-return valve correctly. | WSP/I/12,21 |  |
|  | T - 10 | Increasing the turbidity of treated water due chemical dosing failure because of collect the raw water by different intake location ( Wakwella TP ) | Chemical, Physical | 2 | 3 | 6 | Medium | Nil |  | √ |  | 2 | 3 | 6 | Medium | Implement PMS.  Replacing damaged valves,  upgrade feeding system | WSP/I/12,21,26 |  |

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|  | T - 11 | Increasing turbidity in treated water due to improper chemical reaction because of unavailability of pre lime dosage (Wakwella & Hapugala TPs ) | Chemical, Physical | 2 | 3 | 6 | Medium | Nil |  | √ |  | 2 | 3 | 6 | Medium | Introduce the pre lime dosing system | WSP/I/20 |  |
|  | T-12 | Chemical toxic contamination of water due to algal formation of aerator (Hapugala & Wakwella TPs) | Chemical, Physical | 3 | 3 | 9 | Medium | Cleaning program |  |  | √ | 2 | 3 | 6 | Medium | Implementing preventive maintenance program properly | WSP/I/12 |  |
| **Aerator** | T- 13 | Insufficient aeration of raw water due to varies in raw water quality during heavy rain (Hapugala & TP) | Chemical, Physical | 3 | 3 | 9 | Medium  Medium | Pre-chlorination | √ |  |  | 1 | 3 | 3 | Low |  |  |  |

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|  | T - 14 | Increasing Iron &Mn levels of Water insufficient aeration due to bypass the aerator at Hapugala TP. | Chemical | 5 | 3 | 15 | High | Pre-chlorination | √ |  |  | 1 | 3 | 3 | Low |  |  |  |
| **Coagulation and flocculation** | T - 15 | Insufficient chemical dosage due to incorrect water quality testing (Jar test. (Hapugala & Wakwella TPs) |  | 2 | 4 | 8 | Medium | Doing the jar test accurately random testing for  Residue alum & turbidity of  sediment water | √ |  |  | 1 | 4 | 4 | Low |  |  |  |
|  | T-16 | Improper floc formation of Water due to Inaccurate chemical dosage because of malfunctioning of flow meter(Hapugala & Wakwella TPs) | Chemical,Physical Biological | 2 | 3 | 6 | Medium | periodically checking the flow | √ |  |  | 1 | 3 | 3 | Low | Installing new EMF meters for continuous flow measurement. | WSP/I/05 |  |
|  | T - 17 | Increasing of turbidity in water due to scaling the alum distribution line because of less preventive maintenance(Hapugala&Wakwella TPs) | Chemical, Physical Biological | 2 | 3 | 6 | Medium | Regular flushing program and standby pipe line | √ |  |  | 1 | 3 | 3 | Low |  |  |  |

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|  | T - 18 | Improper floc formation due to malfunctioning of flash mixer because of inadequate preventive maintenance(Hapugala&Wakwella TPs) | Chemical, Physical a | 3 | 3 | 9 | Medium | Regular preventive maintenance.  Maintaining spare parts. |  |  | √ | 2 | 3 | 6 | Medium | Follow the SOPs. | WSP/I/12 |  |
|  | T - 19 | Improper floc formation due to malfunctioning of pen stock because of inadequate preventive maintenance(Hapugala& Wakwella TPs) | Chemical, Physical | 3 | 3 | 9 | Medium | Regular preventive maintenance.  Maintaining spare parts. | √ |  |  | 2 | 3 | 6 | Medium | Follow the SOPs. | WSP/I/12 |  |
|  | T - 20 | Increasing turbidity in treated water due to improper sludge removal because of sludge valve not working properly (Hapugala&Wakwella TPs) | Chemical, Physical | 2 | 3 | 6 | Medium | Preventive and corrective maintenance | √ |  |  | 1 | 3 | 3 | Low |  |  |  |
|  | T - 21 | Increasing turbidity in treated water due to mixing flocks with water because of poor maintenance of outlet chamber (Hapugala&Wakwella TPs) | Chemical, Physical | 3 | 3 | 9 | Medium | Schedule the cleaning program properly | √ |  |  | 1 | 3 | 3 | Low |  |  |  |
|  | T - 22 | Increasing turbidity, taste and odor of treated water due to sludge accumulation at clarry flocculate because of malfunctioning of scraper (Hapugala&Wakwella TPs) | Chemical, Physical | 2 | 3 | 6 | Medium | Preventive maintenance | √ |  |  | 1 | 3 | 3 | Low |  |  |  |
|  | T - 23 | Increasing turbidity, of treated water due to cracking of filter bed (Hapugala&Wakwella TPs) | Chemical, Physical | 2 | 3 | 6 | Medium | Inspection and proper backwash | √ |  |  | 1 | 3 | 3 | Low |  |  |  |
|  | T - 24 | Increasing turbidity and color of treated water due to loss of filter media because of high backwash rate.(Hapugala&Wakwella TPs) | Physical | 2 | 3 | 6 | Medium | Follow the SOPs | √ |  |  | 1 | 3 | 3 | Low |  |  |  |
|  | T -25 | Increasing turbidity and color of treated water due to loss of filter media because of damaging filter nossol and post bottom. (Hapugala TP) | Physical , Biological | 2 | 3 | 6 | Medium | Nil |  | √ |  | 2 | 3 | 6 | Medium | Rehabilitation of filter beds | WSP/I/17 |  |
|  | T - 26 | Increasing turbidity of treated water due to over loading the filter because of malfunctioning of MOV valve. Hapugala TP) | Physical Biological | 2 | 3 | 6 | Medium | Preventive maintenance | √ |  |  | 1 | 3 | 3 | Low |  |  |  |
|  | T - 27 | Chemical toxic contamination of filtered water due to algal formation on filter wall /wall of sedimentation tank/ on flocculation | Chemical, Physical Biological | 3 | 5 | 15 | High | Intermediate chlorination if need. | √ |  |  | 1 | 5 | 5 | Low |  |  |  |
|  | T - 28 | Chlorine leakage to the environment due to poor quality Chlorinator system | Chemical | 2 | 5 | 10 | Medium | Nil |  | √ |  | 2 | 5 | 10 | Medium | Aware about chlorinator systems to workers.  Preventive maintenance system. | WSP/I/09,12 |  |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | T - 29 | Chlorine leakage to the environment due to poor maintenance of Chlorine lines | Chemical | 2 | 5 | 10 | Medium | Maintain standby copper pipe line | √ |  |  | 1 | 5 | 5 | Low |  |  |  |
|  | T - 30 | Release of chlorine gas to the environment due to defects in Chlorine cylinders (Hapugala TP ) | Chemical | 2 | 5 | 10 | Medium | Standby neutralization unit | √ |  |  | 1 | 5 | 5 | Low |  |  |  |
|  | T - 31 | Release of chlorine gas to the environment due to defects in Chlorine cylinders (Walwella TP ) | Chemical | 2 | 5 | 10 | Medium | Nil |  | √ |  | 2 | 5 | 10 | Medium | Establish the new neutralization unit | WSP/I/36 |  |
| **Filtration** | T - 32 | Poor disinfection due to interrupted power supply to the chlorinators ( Wakwella ) | Chemical, Biological | 2 | 5 | 10 | Medium | Shut down the plant |  |  | √ | 2 | 5 | 10 | Medium | Purchase the new generator | WSP/I/04 |  |
| T -33 | Poor disinfection due to interrupted power supply to the chlorinators ( Hapugala ) | Chemical, Biological | 2 | 5 | 10 | Medium | Generator | √ |  |  | 1 | 5 | 5 | Low |  |  |  |
| T - 34 | Contamination of treated water due to disinfection by products(Hapugala&Wakwella TPs) | Chemical, Biological | 2 | 3 | 6 | Medium | Cleaning the clear water sump |  |  | √ | 2 | 3 | 6 | Medium | Do the sample analysis and identifying the byproducts. Introduce PAC | WSP/I/02,06,,08 |  |

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|  | T- 35 | High RCL, residual Alum, turbidity, pH of treated water due to poor maintenance of laboratory /testing equipment (Hapugala & Wakwella TPs ) | Biological, Chemical, Physical | 2 | 5 | 10 | Medium | Standby equipment | √ |  |  | 1 | 5 | 5 | Low |  |  |  |
| T- 36 | High RCL, residual Alum, turbidity, pH of treated water due to improper calibration of laboratory/testing equipment ( Hapugala&Wakwella TPs ) | Biological, Chemical, Physical | 2 | 5 | 10 | Medium | Test again with standards | √ |  |  | 1 | 5 | 5 | Low |  |  |  |
| T- 37 | High/low dose of Alum, Lime and/or Cl due to poor maintenance of Lime, Alum, Cl pumps/panels ( Hapugala&Wakwella TPs ) | Biological, Chemical, Physical | 2 | 5 | 10 | Medium | Corrective action and regular measurements. | √ |  |  | 1 | 5 | 5 | Low |  |  |  |
| T- 38 | Contamination to treated water due to entry of animals in to the clear water sump through unprotected ventilation ( Hapugala&Wakwella TPs ) | Biological, Chemical, Physical | 3 | 5 | 15 | High | Regular visual inspection.  Protect the ventilate opening | √ |  |  | 1 | 5 | 5 | Low |  |  |  |

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| **pH correction** | T -39 | No RCL in treated water due to damage of chlorinator & unavailability of chlorine | Chemical  Biological | 3 | 5 | 15 | High | Installing a standby chlorinator with spares & maintaining an adequate stock | √ |  |  | 1 | 5 | 5 | Low |  |  |  |
| T- 40 | Low PH in treated water due to lime line clogging | Chemical | 3 | 3 | 9 | Medium | Alternative lime line for a old TP& following SOPs |  |  | √ | 2 | 3 | 6 | Medium | I Installing a standby lime line | WSP/I/20 |  |

**4.8 Distribution**

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| RefNo | Process step |  | Hazard type | Risk if there was no controls | | | |  | Is this control measure capable of being effective? (column "notes" shows short justification ) | | | Risk with existing controls | | | | Improvements | Improvement plan No |  |
| Hazardous event | L' hood | Severity | Risk score | Risk Class | Existing controls | L' hood | Severity | Risk score | Risk Class | Short title only | Notes |
| Yes | No | Not sure or some what |
|  | D - 01 | Low residual chlorine of drinking water in distribution systems due to high deposits in pipe lines | Physical, Chemical | 3 | 3 | 9 | Medium | Regular flushing program | √ |  |  | 1 | 3 | 3 | Low |  |  |  |
|  | D - 02 | Contamination of water into pipe lines due to pipe leakage/pipe burst | Physical, Chemical, Biological | 3 | 5 | 15 | High | maintain the RCL level up to 0.2ppm at the distribution end | √ |  |  | 1 | 5 | 5 | Low |  |  |  |

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|  | D – 03 | Contamination of water into pipe lines due to improper function of the valves | Chemical, Biological | 3 | 4 | 12 | High | Replacing the damaged valves | √ |  |  | 2 | 4 | 8 | Medium | Replacing the damaged valves | WSP/I 21 |  |
|  | D – 04 | Contamination of water into pipe lines due to improper valve operations | Chemical, Biological | 3 | 4 | 12 | High | Regular valve operation arrangement |  |  | √ | 2 | 4 | 8 | Medium | Installation of PSV + PR | WSP/I/15,14 |  |
|  | D -05 | Contamination water in pipe lines due to improper pipe repairing | Physical, Chemical, Biological | 3 | 5 | 15 | High | Wash out the line after repairing | √ |  |  | 2 | 5 | 10 | Medium | Awareness program for plumbers and workers | WSP/I/16 |  |
|  | D – 06 | Deposits in pipe lines due to irregular flushing practices | Physical, Biological | 2 | 5 | 10 | Medium | Regular flushing program | √ |  |  | 1 | 5 | 5 | Low |  |  |  |
|  | D – 07 | Corrosion/ Degradation of DI pipe lines due to pH variation | Physical, Chemical | 3 | 3 | 9 | Medium | Properly control pH level of treated water and regular monitoring | √ |  |  | 1 | 3 | 3 | Low |  |  |  |
|  | D – 08 | Increasing of turbidity (Iron - Mn deposit) due to intermittent supply | Physical, Chemical, Biological | 3 | 3 | 9 | Medium | Regular flushing program |  |  | √ | 2 | 3 | 6 | Medium | Reduction of intermittent supply | WSP/I/14 |  |
|  | D – 09 | Decrease of water flow in pipe lines due to blockages of pipe line by tree roots. | Physical, Chemical, Biological | 2 | 3 | 6 | Medium | Corrective action | √ |  |  | 1 | 3 | 3 | Low |  |  |  |
|  | D – 10 | Contamination of pipe water due to illegal connection |  | 4 | 4 | 16 | Very High | detection and disconnection program | √ |  |  | 2 | 4 | 8 | Medium | Reduction of intermittent suppl | WSP/I/14 |  |
|  | D – 11 | Interruptions to the supply due to poor quality pipe materials | Physical | 3 | 2 | 6 | Medium | Purchasing from pre-qualified suppliers. |  |  | √ | 2 | 2 | 4 | Low |  |  |  |
|  | D -12 | Increasing high turbidity and color of drinking water due to poor maintenance of service reservoirs. | Physical | 3 | 3 | 9 | Medium | Regular cleaning program | √ |  |  | 1 | 3 | 3 | Low |  |  |  |
|  | D -13 | Low flow and pipe pressure in pipe lines due to unplanned expansion of distribution system | Physical | 5 | 3 | 15 | High | Properly planned and analyzed expansions for future requests |  |  | √ | 3 | 3 | 9 | Medium | Analysis of system pressure | WSP/I/15,23,29 |  |
|  | D – 14 | Interruptions to the supply due to old leaky pipe lines | Chemical, Biological, Physical | 4 | 3 | 12 | High | Pipe line replacement |  |  | √ | 2 | 3 | 6 | Medium | Rehabilitation activities. | WSP/I/17 |  |
|  | D – 15 | Interruptions to the supply due to water leaks during RDA road improvements | Chemical, Biological, Physical l | 4 | 3 | 12 | High | Coordinate with RDA for minimize damages to pipe lines |  |  | √ | 1 | 3 | 3 | Low |  |  |  |

**4.9 Consumers**

Ref No

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Process step |  | Hazard type | Risk if there was no controls | | | |  | Is this control measure capable of being effective? (column "notes" shows short justification ) | | | Risk with existing controls | | | | Improvements | Improvement plan No |  |
| Hazardous event | L' hood | Severity | Risk score | Risk Class | Existing  controls | L' hood | Severity | Risk score | Risk Class | Short title only | Notes |
| Ye s | No | Not sure or some  what |
| **Consumer** | C-01 | Chemical, Physical, Bacteriological contamination due to poor plumbing practices and usage of poor quality materials. | Chemical, Physical, Biological | 4 | 5 | 20 | Very High | Do the training program for plumbers |  |  | √ | 3 | 5 | 15 | High | Consumer & School awareness program | WSP/I/16,32 |  |
| C-02 | Low RCL values in storage tanks due to long run. | Biological | 3 | 5 | 15 | High | nil |  | √ |  | 3 | 5 | 15 | High | Awareness program for consumers | WSP/I/18,31,32 |  |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | C-03 | No RCL values due to RCL decaying because of poor maintaining of storage tanks | Physical, Biological | 3 | 4 | 12 | High | Cleaning tanks |  |  | √ | 2 | 4 | 8 | Medium | Awareness programfor consumers | WSP/I/31 |  |
| C-04 | Chemical & Bacteriological contamination into drinking water due to poor hygiene practices in domestic purposes. | Chemical,  Biological | 4 | 5 | 20 | Very High | Awareness program |  |  | √ | 3 | 5 | 15 | High | Awareness with modern concepts or events for consumers | WSP/I/31,28 |  |
| C-05 | Chemical& Bacteriological contamination into drinking water due to poor practices of water containing materials | Chemical, Biological | 4 | 5 | 20 | Very High | Awareness program |  |  | √ | 3 | 5 | 15 | High | Awareness with modern concepts or events for consumers | WSP/I/31 |  |
| C-06 | Chemical, Physical, Bacteriological contamination of drinking water due to usage of alternative water sources (wells, springs, Rivers, Streams etc…) | Chemical,  Physical,  Biological | 3 | 5 | 15 | High | Awareness program |  |  | √ | 2 | 5 | 10 | Medium | Awareness program for consumers | WSP/I31 |  |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| C-07 | Contamination into drinking water pipe lines due to close laying sewerage lines & drinking water lines | Physical, Chemical, Biological | 3 | 5 | 15 | High | Plumbers training ` |  |  | √ | 2 | 5 | 10 | Medium | Consumer and School awareness | WSP/I/16,28 |  |
| C-08 | Contamination of drinking water due to using of un proper household filters for domestic purpose. | Physical, Chemical, Biological | 3 | 2 | 6 | Medium | Nil |  | √ |  | 3 | 2 | 6 | Medium | Awareness program for consumers | WSP/I/31 |  |

**Prioritization of hazardous event according to residual risk rate**

Table 4.10: Prioritization of hazardous event

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **No** | **Hazardous event** | **Risk without control (Raw risk rate)** | **Control Measure** | **Risk with control (residual risk rate)** |
| S-08 | Contamination by pharmaceutical waste and radio-actives due to hospital discharges at upper catchment | Very High | Nil | Very High |
| S – 10 | Chemical contamination by untreated / partially treated hospital waste discharge in to water ways in catchments | Very High | 1st barrier - Nil  2nd barrier - Disinfection & RCL monitoring at TP effluent | High |
| S – 16 | Chemical contamination in raw water due to using high agro chemical dosage for homestead and tea gardens near river side | Very High | Awareness by field offices of Agriculture Department to reduce over dose | High |
| S – 18 | Chemical, physical & biological contamination into raw water due to seepage of septic tanks along the river | Very High | 1st barrier-Nil  2nd barrier - Disinfection & RCL monitoring at TP effluent | High |
| S – 19 | Contamination of raw water due to direct discharge of domestic waste water | Very High | 1st barrier-Nil  2nd barrier - Disinfection & RCL monitoring at TP effluent  Sedimentation  Filtration | High |
| C – 01 | Chemical, Physical, Bacteriological contamination due to poor plumbing practices & materials domestically | Very High | Do the training program for plumbers | High |
| C – 04 | Chemical & Bacteriological contamination into drinking water due to poor hygiene practices in domestic purposes. | Very High | Awareness program | High |
| C – 05 | Chemical& Bacteriological contamination into drinking water due to poor practices of water containing materials | Very High | Awareness program | High |
| D-10 | Contamination of pipe water due to illegal connection | Very High | Detection and Disconnection program | Medium |
| s-04 | Contamination in raw water due to direct discharge of sewer in to river | Very High | 1st barrier-Nil.  2nd barrier-Disinfection & RCL monitoring at TP effluent | Low |
| S-09 | Biological contamination into raw water due to direct dump illegal solid waste discharge from meat shops. | Very High | 1st barrier- Maintaining regular reporting procedure by public  2nd barrier-Disinfection & RCL monitoring at TP effluent | Low |

**5. Improvement Plan**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |
| **No** | **Title of the Improvement Plan** | **Need for the IMP** | **Key Outcome of the IMP** | **Accountability** | **Timeline** | **Cost** | **Progress to 01/01/2019** |
| WSP/I/01 | Catchment development program & | \* Budget allocation and improve the water quality of the catchment, mitigate the hazard events | \*Reduce the risk from hazard producing introducing hazard controlling activities | DGM/WSP Advisory unit | Continuous | Refer file estimate no : WSP/IMP/Est01-01-Est 01-06 | Implementation & Planning |
| Identification of river reservation areas and Source protection zone | \* No identified river reservation and reservation monitoring program | \* Identification & Declare river reservation |  |
|  |  | \* Legislation & continuous monitoring program |  |
|  |  | \* Awareness catchment uses by water quality surveillance at DS Meeting. |  |
|  |  | \* Tree planting program |  |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | \* Green Farming awareness |  |  |  |  |
|  |  | \* Awareness programme about domestic sewer management for Local Authorities. |  |
| WSP/I/02 | Field Inspection for discussing environmental sustainability practices for minor scale industries (vehicle service stations ) close to river. | Budget allocation & improve the water quality of the catchment, mitigate the hazard events | Reduce the risk from hazard producing introducing hazard controlling activities | RM/WSP Committee | Continuous | Refer file estimate no : WSP/IMP/Est02 | Planning |
| WSP/I/03 | Establishing a water level monitoring system at inside Of the intake well | Budget allocation / To monitor quantity of debris on the screen | Reduce the risk fromClogging screens due to debris and identify right time to regular cleaning | ME, EA -Electrical / Mechanical | 2019 | Refer file estimate no : WSP/IMP/Est03 | Tender calling stage |
| WSP/I/04 | Install 2 nos generator | Low or no water in Wackwella treatment plant | Maintain the Continuous water supply | DGM (S) / AGM (S) /M (O&M) | 2020 | Refer file estimate no : WSP/IMP/Est04 | Planning |
|  |
| WSP/I/05 | Installing EMF meters | To get accurate flow measurement identifying real NRW figures. | Reduce NRW Values and enhance water supplying and new connection programme. | CE (M&E)/ AE | 2020 | Refer file estimate no : WSP/IMP/Est05 | Planning |
| WSP/I/06 | PAC introducing programme | System improvement to treat the TOC | Minimizing the Organic toxins and Byproduct | DGM | End 2020 | Refer file estimate no : WSP/IMP/Est06 | Planning |
| WSP/I/07 | Stock maintenance programme | If the newly received chemical is unacceptable, stock for continuous operation until received the acceptable chemical. | Maintaining the water quality without toxic chemical substance | DGM | End 2020 | TBD | Planning |
| WSP/I/08 | Disinfection system development programme | not adequate efficiency for existing water quality | Minimizing the DBP | DGM | End 2019 | TBD | Negotiating |
| WSP/I/09 | Chlorination safety programme | No idea about the risk level and severity of the damage is very high | Minimizing health risk of workers | RM | End 2019 | TBD | Planning |
| WSP/I/11 | Updating sample points on the map | Update sampling location Identification of frequency of low RCL points and areas | Conducting flushing programme and reduce the health risk | M (O&M) / AE | May of 2019 | O&M | Implementation |
|
|
| WSP/I/12 | Preparing of SOP and PMS | To reduce contamination and risk during the operation and maintenance. | * Following SOP s at leak repairs & and operation activities in standard manner and reduce the operation times and improve the quality of the work. * Follow PMS to reduce the failures. | AE / OIC | Feb of 2019 | Refer file estimate no : WSP/I/Est08 | SOP displaying work on progress.Training is to be planned. |
| WSP/I/13 | Reduce leaks and illegal connections | Budget allocation /To reduce contamination NRW reduction | Reduce in line contamination. | AGM (S) / M | End 2020 | Refer file estimate no : WSP/I/Est10 | Tender calling stage |
|  |  | (O&M) / AE / OIC |  |  |  |
|  |  |  | Enhance billing programme. |  |  |  |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| WSP/I/14 | Reduction of intermittent supply | To reduce contamination | Reduce Pipe burst and Illegal connections. | AGM (S) / M (O&M) | 2019 | Refer file estimate no : WSP/I/Est09 | Increased intake capacity by 3000m3 in Wackwella WTP |
|  |  |  |  |  |  | Completed. |
| WSP/I/15 | Plan to reduce low pressure | Budget allocation /To Maintain service level and reduce Health risk of consumers. | Enhance the service level. | DGM (S) / M (O&M) /AE | End 2020 | TBD | Planning |
| Zones and installation of PS+PRV | Fix the valve operation schedules. |  |  |
|  |  |  |  |
| WSP/I/16 | Awareness programmed for plumbers and workers | Budget allocation /Lack of knowledge and practices for correct operations and maintenance. | Control the contamination through the distributed water. | RM/AE | End 2019 | Refer file estimate no : WSP/I/Est11 | **Planned and implementing** |
| WSP/I/17 | Rehabilitation activities | Budget allocation /Supporting programme for operations and maintenance. | Enhancing the water quality and smooth operation. | RM | End 2019 | TBD | Planning |
|  | Reduce NRW. | Reducing O & M cost for leak and repairing. |
|  | Enhance customer satisfaction. |  |
| WSP/I/18 | Awareness program for customers | Budget allocation /Lack of awareness for safe water usage | Enhance the sanitation practices and optimizing the water usage. | RM | End 2019 | TBD | Planning |
| WSP/I/19 | Installation of Standby Chlorinator | Budget allocation /Prevent Cl2 accident and increasing disinfection efficiency | Enhancing the water quality and smooth operation prevent health risk of workers | RM | End of 2019 | Refer file estimate no : WSP/IMP/Est13 | Tender preparation stage |
| WSP/I/20 | Installation Pre lime Dosing system & Standby lime line in Wackwella treatment plant | Budget allocation /Prevent water quality issues such as high turbidity and PH adjustment. | Enhancing the water quality and smooth operation | RM | End of 2019 | Refer file estimate no : WSP/IMP/Est14 | Tender evaluation stage |
| WSP/I/21 | Replacing Damaged valves, regular valve operation arrangement | Prevent water quality issues and plant shutdown | Enhancing the water quality and smooth operation | RM | End of 2019 | Refer file estimate no : WSP/IMP/Est15 | Implementation |
| WSP/I/23 | Maintain pressure system & analysis before giving connections | Budget allocation /Reduce the interrupted service. | Enhancing supply level | DGM (S) / M (O&M) /AE | continuous | No special cost required | Implementation |
| WSP/I/25 | Supply of temporary floating boom for intake at Wackwella WTP | Risk Management | Risk Management at intake/improve raw water quality | DGM (S) / M (O&M) /AE | End of 2019 | TBD | Planning |
| WSP/I/26 | Replacement and upgrading of chemical feeding system at Wackwella WTP | Budget allocation/scope definition | Improve water quality/effective use of chemicals/mitigate inaccurate chemical dosing | DGM (S) / M (O&M) /AE/Eng.(M) | End of 2019 | Refer file estimate no : WSP/IMP/Est16 | Tender evaluation stage |
| WSP/I/27 | Supply of filter media to Wackwella WTP | Budget allocation by RH 2019 /water quality improvement | Improve water quality/enhance customer satisfaction | DGM (S) / M (O&M) /AE/Eng.(M) | End of 2019 | Refer file estimate no : WSP/IMP/Est17 | Tender Calling |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| WSP/I/28 | Upgrade the customer details into a GIS database | Budget allocation for human resource | Develop customer database | M (O&M) /AE | End of 2021 | Refer file estimate no : WSP/IMP/Est18 | Planning |
| And bilateral communication with consumers. |
| WSP/I/29 | Supply and installation of zone meters to Galle Region | Budget allocation/mapping network | Development of distribution system/reduce NRW/improve safety of water | DGM (S) / M (O&M) /AE/Eng.(M | Continuous | Refer file estimate no : WSP/IMP/Est19 | Planning |
| WSP/I/30 | Launched and continuing social media page in face book calling “Surakimu Gin Ganga” | Update environmental affected informations | Build the social group to protect the catchment | WSP Implementing team | Continuous | No special cost required | Implementing |
| Public awareness. |
| Reduce the illegal activities around the River. |
| WSP/I/31 | “Keep in Touch with your household and personal water containers” awareness programme distributing leaflet and poster for public | Budget allocation | Reduce the health impact on domestic water uses. | AGM (S) | Continuous | Refer file estimate no : WSP/IMP/Est20 | Planning |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| WSP/I/32 | Line up for water conservation- awareness programme (leaflet and seminar) | Budget allocation | Reduce the stress on water distribution system and production capacity. | WSP Advisory Unit | Continuous | Refer file estimate no : WSP/IMP/Est21 | Planning |
| Enhance the service level |
| WSP/I/34 | “Wenaswena Gin Ganga”school art competition. | Budget allocation | Public awareness through children/suggestion for protection and prevent illegal activities in GIN Gaga River | AGM (S) | Continuous | Refer file estimate no : WSP/IMP/Est23 | Planning |
| WSP/I/35 | TV documentary programme will be making through Gin ganga routine path | Budget allocation | Public awareness through environmental changes and aware of the mitigations. | AGM (S) | Continuous | Refer file estimate no : WSP/IMP/Est24 | Planning |
| WSP/I/36 | Installation of chlorine neutralization unit. | Budget allocation | Reduce the risk | DGM (S) | 2020 | Refer file estimate no : WSP/IMP/Est25 | Planning |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |

1. **Operational monitoring & corrective actions of control measures**

Planned, ongoing observations using checklists for visual on-site inspection and simple water quality measurements to assess whether a water supply is operating normally - that is, whether the control measures to prevent, remove or reduce contaminants are operating effectively (as planned). Operational monitoring of control measures enables timely detection of operational and water quality problems so that action can be taken prior to the supply of unsafe drinking water.

# Operation Monitoring and Corrective Actions

Hazard events which are controlled by an existing control measures are taken into consideration while developing the operation monitoring program. The objective of this operation monitoring and corrective action program is to dedicate the responsibility of the monitoring of the existing controls, define alert and critical limits of operational limits and describe the corrective action in a simple way.

*Table6.1: Operation Monitoring and Corrective Actions*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No** | **Hazardous event** | **Hazard Type** | **Existing Control** | **Operational limits** | | **Operational Monitoring of the control measure** | | | | | **Correction Action if the operational limits are exceeded** | | | | |
| **Alert** | **Critical** | **What will be monitored?** | **How will it be monitored?** | **Where will it be monitored?** | **Who will be monitored?** | **When is it monitored?** | **What action is to be taken?** | | **Who takes the action?** | **How quickly it is taken?** | **Who needs to be informed?** |
| T-01. | Increase of taste and odor due to accumulation of debris at screen(Hapugala&Wakwella TPs) | Physical, Microbiological | Regularly cleaning and inspection | Unobjectionable(U/B) | U/B | Odor | Manually | Intake | Plant technician(P.T) | Once in 2Hrs | Alert | Inspection | OIC | Immediately | AE |
| Critical | Plant shutdown | OIC | Immediately | AE |
| T-02. | Contamination of raw water due to malfunctioning of screens at intake well(Hapugala&Wakwella TPs)s | Physical, Chemical, Biological | regularly cleaning and inspection | Unobjectionable(U/B) | U/B | Odor | Manually | Aerator | P.T | Once in 2Hrs |  | Inspection | OIC | Immediately | AE |
| T - 03 | Low or no water to the treatment plant due to power failures occurred in intake pump house for HapugalaTP | Physical | Generator | Unobjectionable(U/B) | No flow | No flow | Manually | Aerator | P.T | Once in 2Hrs |  | Inspection | OIC | Immediately | AE |
| T - 05 | Low or no water to the treatment plant due to damage of impellers of intake pumps.(Hapugala&Wakwella TPs | Physical | Immediately attend for corrective action | No flow | No flow | Raw water flow | Flow meter | Intake | P.T | Once in 2Hrs |  | Inspection | OIC | Immediately | ME |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| T-06. | Low capacity of intake pumps due to depreciation (Hapugala&Wakwella TPs) | | Physical | Preventive maintenance | 1350M3/hr | 1000m3/hr | | | Raw water flow | | Flow meter | | Intake | | P.T | Regularly | |  | | informed to OIC | | OIC | | Immediately | | EE | |
| T -07 | Increasing of salinity level of raw water due to improper operation of salinity barrier during drought period | | Chemical | If the incident it happen the person is assign that operation | 100 | 250 | | | EC | | EC analyzer | | Aerator | | P.T | Regularly | |  | | informed to plant OIC | | OIC | | Immediately | | Chemist/AE | |
| T - 08 | Increasing the turbidity in treated water due to malfunctioning of flow measurement meter | | Chemical, biological | Preventive maintenance | 0.05 ppm | 2.0 ppm | | | Alum | | Test kit | | After Clarifloculator | | P.T | Daily | |  | | Inspection | | OIC | | Immediately | | Chimist | |
| T - 09 | Low or no water in to the treatment plant due to damage of pumps because of malfunctioning of non return valve (Hapugala&Wakwella TPs) | | Chemical, Physical | Preventive maintenance | No flow | No flow | | | Raw water flow | | Visual | | Aerator | | P.T | Daily | |  | | Inspection | | OIC | | Immediately | | ME | |
| T-13 | Chemical toxic contamination of water due to algal formation of aerator (Hapugala&Wakwella TPs) | Chemical and Physical | | Cleaning program | U/B | | U/B | Algal formation of the Wall | | Visually | | Aerator | | P.T | | | Daily | |  | | Inspection | | OIC | | Immediately | | Chemist | |
| T- 14 | Insufficient aeration of raw water due to change in raw water quality during heavy rain (Hapugala&Wakwella TPs) | Chemical, Physical | | Pre chlorination | 0.1 ppm | | 0.3 ppm | Mn/Iron | | Spectropotometer | | After filtration | | P.T | | | Daily | |  | | pH correction and Chlorination | | OIC | | Immediately | | Chemist | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No** | **Hazardous event** | **Hazard Type** | | **Existing Control** | **Operational limits** | | **Operational Monitoring of the control measure** | | | | | | **Correction Action if the operational limits are exceeded** | | | | |
| **Alert** | **Critical** | **What will be monitored?** | **How will it be monitored?** | **Where will it be monitored?** | **Who will be monitored?** | **When is it monitored?** | | **What action is to be taken?** | | **Who takes the action?** | **How quickly it is taken?** | **Who needs to be informed?** |
| T - 15 | Insufficient chemical dosage due to incorrect water quality testing (Jar test. (Hapugala&Wakwella TPs) | Chemical, Physical, Biological | | Doing the jar test accurately random testing for  R. Alum& turbidity of  sediment water | 1.0 NTU | 2.0 NTU | Turbidity | Turbidity meter | After Clarifloculator | P.T | Once in 2Hrs | |  | Repeat the Jar test | OIC | Immediately | Chemist |
| T-16 | Improper floc formation of Water due to Inaccurate chemical dosage because of malfunctioning of flow meter(Hapugala&Wakwella TPs) | Chemical, Physical and Biological | periodically checking the flow | | 0.05ppm | 2.0 ppm | Residual Alum | Test kit | After Clarifloculator | P.T | Once in 2Hrs | |  | Re check the flow manually | OIC | Immediately | Chemist |
| T - 17 | Increasing of turbidity of water due to scaling the alum distribution line because of less preventive maintenance(Hapugala&Wakwella TPs) | Chemical, Physical and Biological | Regular flushing program and standby pipe line | | 1.0 NTU | 2.0 NTU | Turbidity | Turbidity meter | After Clarifloculator | P.T | Once in 2Hrs |  | | Repeat the Jar test | OIC | Immediately | Chemist |
| T - 18 | Improper floc formation due to malfunctioning of flash mixer because of inadequate preventive maintenance(Hapugala&Wakwella TPs) | Chemical, Physical | Regular preventive maintenance. Maintaining spare parts | | 1.0 NTU | 2.0 NTU | Turbidity | Turbidity meter | After Clarifloculator | P.T | Once in 2Hrs |  | | Repeat the Jar test | OIC | Immediately | ME |
| T - 19 | Improper floc formation due to malfunctioning of penstock because of inadequate preventive maintenance (Hapugala&Wakwella TPs) | Chemical, Physical a | Regular preventive maintenance. Maintaining spare parts | | 1.0 NTU | 2.0 NTU | Turbidity | Turbidity meter | After Clarifloculator | P.T | Once in 2Hrs | |  | Repeat the Jar test | OIC | Immediately | ME |
| T-20 | Increasing turbidity in treated water due to improper sludge removal because of sludge valve not working properlyHapugala&Wakwella TPs) | Chemical, Physical a, Biological | Regular preventive maintenance | | 1.0 NTU | 2.0 NTU | Turbidity | Turbidity meter | After Clarifloculator | P.T | Once in 2Hrs |  | | Repeat the Jar test | OIC | Immediately | AE |
| T - 21 | Increasing turbidity due to improper chemical dosing because of less attention for water at recovery pit. Hapugala&Wakwella TPs) | Chemical, Physical a, Biological | Carried out jar test after back wash | | Required Strength | Low Strength | Strength of the Alum/Lime Solution | Hydrometer | Dosing point | P.T | Once in 2Hrs |  | | Repeat the Jar test | OIC | Immediately | Chemist |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No** | **Hazardous event** | **Hazard Type** | | **Existing Control** | | | **Operational limits** | | **Operational Monitoring of the control measure** | | | | | | | | | **Correction Action if the operational limits are exceeded** | | | | | |
| **Alert** | **Critical** | **What will be monitored?** | **How will it be monitored?** | **Where will it be monitored?** | | **Who will be monitored?** | | | **When is it monitored?** | | **What action is to be taken?** | | | **Who takes the action?** | **How quickly it is taken?** | **Who needs to be informed?** |
| T - 22 | Increasing turbidity in treated water due to mixing flocs with water because of poor maintenance of outlet chamberHapugala&Wakwella TPs) | Chemical, Physical a, Biological | | Schedule the cleaning program properly | | | 1.0 NTU | 2.0 NTU | Turbidity | Turbidity meter | After filtration | | P.T | | | Once in 2Hrs | |  | Backwashing | | P.T | Immediately | OIC |
| T - 23 | Increasing turbidity, taste and odor of treated water due to sludge accumulation at clarry flocculate because of malfunctioning of scraperHapugala&Wakwella TPs) | Chemical, Physical a, Biological | | Preventive maintenance | | | 1.0 NTU | 2.0 NTU | Turbidity | Turbidity meter | After filtration | | P.T | | | Once in 2Hrs | |  | Sludge removing | | P.T | Immediately | OIC |
| T - 24 | Increasing turbidity, of treated water due to cracking of filter bed Hapugala&Wakwella TPs) | Physical Biological | | Inspection and proper backwash | | | 1.0 NTU | 2.0 NTU | Turbidity | Turbidity meter | After filtration | | P.T | | | Once in 2Hrs | |  | Backwashing | | P.T | Immediately | OIC |
| T - 26 | Increasing turbidity and color of treated water due to loss of filter media because of high backwash rate.(Hapugala&Wakwella TPs) | | Physical Biological | | Follow the SOPs | 800 mm | | 600 mm | Height of the sand layer | Measuring | | Filter | | P.T | monthly | |  | | Re sanding | OIC | | Immediately | AE |
| T - 27 | Increasing turbidity of treated water due to over loading the filter because of malfunctioning of MOV valve. Hapugala TP) | | Physical Biological | | Preventive maintenance | 1.5 m | | 2.0 m | Water head | Measuring | | Filter | | P.T | Once in 2Hrs | |  | | Backwashing | P.T | | Immediately | OIC |
| T - 28 | Chemical toxic contamination of filtered water due to algal formation on filter wall /wall of sedimentation tank/ on flocculation | | Chemical, Physical and Biological | | Regular Cleaning | U/B | | U/B | Algal formation of the Wall | Visually | | Filter | | P.T | Daily | |  | | Inspection | OIC | | Immediately | Chemist |
| T - 29 | Chlorine leakage to the environment due to poor maintenance of Chlorine lines | | Chemical | | Maintain a standby line | U/B | | U/B | Smell | Physically | | Chlorine line | | P.T | Daily | |  | | Inspection | OIC | | Immediately | AE |
| T - 30 | Release of chlorine gas to the environment due to defects in Chlorine cylinders ( Hapugala TP ) | | Chemical | | Standby neutralization unit | U/B | | U/B | Smell | Physically | | Chlorine line | | P.T | Daily | |  | | Inspection | OIC | | Immediately | AE |
| T - 33 | Poor disinfection due to interrupted power supply to the chlorinators ( Wakwella ) | | Physical, Chemical, Biological | | Shut down the plant | 1.0 ppm | | 0.5 ppm | RCL | Test kit | | Clear water sump | | P.T | Daily | |  | | Wash out and Cleaning | OIC | | Immediately | AE |
| T -34 | Poor disinfection due to interrupted power supply to the chlorinators ( Hapugala ) | | Chemical, Biological | | Generator | 1.0 ppm | | 0.5 ppm | RCL | Test kit | | Clear water sump | | P.T | Daily | |  | | Wash out and Cleaning | OIC | | Immediately | AE |
| T - 35 | Contamination of treated water due to disinfection by products( Hapugala&Wakwella TPs) | | Chemical | | Cleaning the clear water sump | U/B | | U/B | TOC | Test kit | | Clear water sump | | Chemist | Once in three months | |  | | Inspection | AE | | Immediately | Manager |
| T- 37 | High RCl, residual Alum, turbidity, pH of treated water due to poor maintenance of laboratory /testing equipment ( Hapugala&Wakwella TPs ) | | Biological, Chemical, Physical | | repaired with limited budget. | Standards | |  | Relevant parameters | Testing | | Labortory | | P.T | Monthly | |  | | Repairing or replacing | Chemist | | Immediately | RM |
| T- 38 | High RCl, residual Alum, turbidity, pH of treated water due to improper calibration of laboratory/testing equipment ( Hapugala&Wakwella TPs ) | | Biological, Chemical, Physical | | retesting with standards | Standards | |  | Relavant parameters | Testing | | Labortory | | P.T | Monthly | |  | | Repairing or replacing | Chemist | | Immediately | RM |
| T- 39 | High/low dose of Alum, Lime and/or Cl due to poor maintenance of Lime, Alum, Cl pumps/panels ( Hapugala&Wakwella TPs ) | | Biological, Chemical, Physical | | Corrective action and regular measurements. | Required Strength | | Low Strength | Strength of the Alum/Lime Solution | Hydrometer | | Dosing point | | P.T | Once in 2Hrs | |  | | Repeat the Jar test | OIC | | Immediately | Chemist |
| T -41 | No RCL in treated water due to damage of chlorinator &unavailability of chlorine | | Biological | | Installing a standby chlorinator with spares &maintaining an adequate stock | 1.0 ppm | | 0.5 ppm | RCL | Test kit | | Clear water sump | | P.T | Daily | |  | | Wash out and Cleaning | OIC | | Immediately | AE |
| T -42 | Physical, chemical & bacteriological risk of treated water due to entry of animals in to the clear water sump through unprotected ventilation (Wakwella TP) | | Physical, Chemical &Bacteriologica | | Netting | Standards | |  | Relevant parameters | Testing | | Labortory | | P.T | Monthly | |  | | Repairing or replacing | Chemist | | Immediately | RM |
| T- 43 | Low PH in treated water due to lime line clogging | | Chemical | | Alternativelime line for old TP& following SOP | Standards | |  | Relavant parameters | Testing | | Labortory | | P.T | Monthly | |  | | Repairing or replacing | Chemist | | Immediately | RM |
| T-44 | Chemical or biological contamination into drinking water due to untreatable contaminant during treatment process. | | Chemical, Biological | | Regular flushing programme | 0.1-0.2 ppm | | <0.1 ppm | RCL | Test kit | | End of the Distribution | | OIC Distribution | Daily | |  | | Wash out and Cleaning | OIC Distribution | | Immediately | Chemist |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No** | **Hazardous event** | **Hazard Type** | **Existing Control** | **Operational limits** | | **Operational Monitoring of the control measure** | | | | | | | **Correction Action if the operational limits are exceeded** | | | | | | | |
| **Alert** | **Critical** | **What will be monitored?** | **How will it be monitored?** | **Where will it be monitored?** | **Who will be monitored?** | | **When is it monitored?** | | **What action is to be taken?** | | | **Who takes the action?** | | **How quickly it is taken?** | | **Who needs to be informed?** |
| D - 01 | Low residual chlorine of drinking water in distribution systems due to high deposits in pipe lines ( Hapugala&Wakwella TPs ) | Physical, Chemical | Regular flushing program | 0.1-0.2 ppm | <0.1 ppm | RCL | Test kit | End of the Distribution | OIC Distribution | After repairing | |  | | Repair/Wash out | OIC Distribution | | Immediately | | AE/Chemist | |
| D - 02 | Contamination of water into pipe lines due to pipe leakage/pipe burst ( Hapugala&Wakwella TPs ) | Physical, Chemical, Biological | Maintain the RCL level up to 0.2ppm at the distribution end | 0.1-0.2 ppm | <0.1 ppm | RCL | Test kit | End of the Distribution | OIC Distribution | After repairing | |  | | Repair/Wash out | OIC Distribution | | Immediately | | AE/Chemist | |
| D - 03 | Contamination of water into pipe lines due to improper function of the valves( Hapugala&Wakwella TPs ) | Physical, Chemical, Biological | Replacing the damaged valves | 0.1-0.2 ppm | <0.1 ppm | RCL | Test kit | End of the Distribution | OIC Distribution | Reported | |  | | Correct valve operation | OIC Distribution | | Immediately | | AE/Chemist | |
| D - 04 | Contamination of the water into pipe lines due to improper valve operations( Hapugala&Wakwella TPs ) | Physical, Chemical, Biological | Regular valve operation arrangement | 0.1-0.2 ppm | <0.1 ppm | RCL | Test kit | End of the Distribution | OIC Distribution | Reported | |  | | Wash out | OIC Distribution | | Immediately | | AE/Chemist | |
| D -05 | Contamination to the water in pipe lines due to improper pipe repairing ( Hapugala&Wakwella TPs ) | Physical, Chemical, Biological | Washed out the line after repairing | 0.1-0.2 ppm | <0.1 ppm | RCL | Test kit | End of the Distribution | OIC Distribution | Daily | |  | | Follow the SOP | OIC Distribution | | Immediately | | AE/Chemist | |
| D - 06 | Deposits in pipe lines due to irregular flushing practice | Physical, Biological | Regular flushing program | 0.1-0.2 ppm | <0.1 ppm | RCL | Test kit | End of the Distribution | OIC Distribution | Daily | |  | | Repair/Wash out | OIC Distribution | | Immediately | | AE/Chemist | |
| D - 07 | Corrosion/ Degradation of DI pipe lines due to pH variation | Physical, Chemical | Properly control pH level of treated water and regular monitoring | TBA | TBA | pH | pH meter | Clear water sump | P.T | Regularly | |  | | pH correction on Marble test | Chemist | | Immediately | | AE | |
| D - 08 | Increasing of turbidity (Iron - Mn deposit) due to intermittent supply | Physical, Chemical, Biological | Regular flushing program | 3 Hazen | 5 Hazen | Colour | Colour Neplerizer | Distribution | Chemist/EA Distribution | Reported | |  | | Flushing the Distribution | OIC | | Immediately | | AE | |
| D – 10 | Contamination of pipe water due to illegal connection | Physical, Chemical | Detection and disconnection program | 0.1-0.2 ppm | <0.1 ppm | RCL | Test kit | End of the Distribution | OIC Distribution | Daily | |  | | After Detect. | OIC Distribution | | Immediately | | AE/Chemist | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No** | **Hazardous event** | **Hazard Type** | **Existing Control** | **Operational limits** | | **Operational Monitoring of the control measure** | | | | | **Correction Action if the operational limits are exceeded** | | | | |
| **Alert** | **Critical** | **What will be monitored?** | **How will it be monitored?** | **Where will it be monitored?** | **Who will be monitored?** | **When is it monitored?** | **What action is to be taken?** | | **Who takes the action?** | **How quickly it is taken?** | **Who needs to be informed?** |
| D -13 | Increasing high turbidity and color of drinking water due to poor maintenance of service reservoirs | Physical | Regular cleaning program | 3 Hazen | 5 Hazen | Colour | ColourNezlerizer | Distribution | Chemist/EA Distribution | Reported |  | Flushing the Distribution | OIC | Immediately | AE |
| D -14 | Low flow and pipe pressure in pipe lines due to unplanned expansion of distribution system | Physical | Properly planned and analyzed expansions for future requests | Water supply 6 hrs | No water. | Complained | Water supply hrs | Distribution | EA Distribution | Reported |  | Valve controlled | OIC | Immediately | AE |
| D - 15 | Interruption to the supply due to old, leaky pipe line | Physical | Pipe line replacement | 25% NRW | 30% NRW | NRW | Analyzing | Distribution | OIC Distribution | Regularly |  | Inspection and Detection of illegalconnection | OIC | Immediately | AE |
| D - 16 | Interruptions to the supply due to water leaks during RDA road improvements | Physical | Coordination with RDA for minimize damages to pipe lines | 8 hrs | 24 hrs | Water supply | Physically | Distribution | OIC Distribution | Reported |  | Bowser supply | OIC Distribution | Immediately | AE |
| C-01 | Chemical, Physical, Bacteriological contamination due to poor plumbing practices & materials domestically | Chemical, Physical, Biological | Do the training program for plumbers | 0.1-0.2 ppm | <0.1 ppm | RCL | Test kit | End of the Distribution | OIC Distribution | Reported |  | Correct instruction for leak repair | OIC Distribution | Immediately | AE/Chemist |
| C-04 | No RCL values due to RCL decaying because of poor maintaining of storage tanks | Biological | Cleaning tanks | 0.1-0.2 ppm | <0.1 ppm | RCL | Test kit | End of the Distribution | OIC Distribution | Reported |  | Regular flushing | OIC Distribution | Immediately | AE/Chemist |
| C-05 | Chemical & Bacteriological contamination into drinking water due to poor hygiene practices in domestic purposes. | Chemical, Biological | Awareness program | 0.1-0.2 ppm | <0.1 ppm | RCL | Test kit | End of the Distribution | OIC Distribution | Reported |  | Introduce | OIC Distribution | Immediately | AE/Sociologist |
| C-07 | Chemical, Physical, Bacteriological contamination of drinking water due to usage of alternative water sources (wells, springs, Rivers, Streams etc…) | Chemical,  Physical,  Biological | Awareness program | TBD | TBD | No of patient due to water usage | OIC office | MOH | Chemist | Reported |  | Awareness | MOH/Chemist | Immediately | DGM |

# Verification Procedure

*Table7.1: Verification Procedure*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No** | **Type of data collected** | | **Data Collected** | **Verification Monitoring plan** | | | | | |
| **What will be monitored?** | **How will it be monitored?** | **Where will it be monitored?** | **Who will be monitored?** | **When is it monitored?** | **Where the records are kept?** |
| 1 | Compliance monitoring | Catchment | SLS 722: 1983 | Water sample | Visually/ Equipment | Micro catchment | Chemist | Quarterly | AE (Galle) Office |
| Treatment process | pH, RCl, Turbidity, Residual Alum, Odor, Flow, Mn, Electrical Conductivity (EC) | Water sample in each component | Visually/ Equipment | Treatment plant | Plant tech. | Daily |
| Distribution | Turbidity, Color, RCl, E coli, Total Coliform | Water sample at the end point | Visually/ Equipment | Distribution | Chemist | Weekly |
| Consumer | Turbidity, Colour, RCL ,E coli, Total Coliform | Water sample from consumer tap | Visually/ Equipment | Consumer tap | Lab Assistant | Once in three months |  |
| 2 | Auditing | Internal | WSP Document verified data and SOPs | Effectiveness and accuracy of the WSP | Data Analyzing | Catchment to consumer | DGM | Annually |
| External | WSP Document,Verified data and SOP | Effectiveness and accuracy of the WSP | Data Analyzing | Catchment to consumer | Audit specialist | By Annually |

The objective of developing a verification procedure is to build a body of evidence that the produced water by the Galle WSG is compliant with SLS standard, to confirm whether the WSP is being implementing as suggested and to confirm the appropriateness of adopted operational limits.

There are three key features of the verification procedure as follows;

* Water (raw and treated) quality surveillance
* Auditing
* Customer surveys

# Management Procedures

Management Procedures are discussed basically under five (5) event categories as shown in

*Table8.1: Management Procedures*

|  |  |  |  |
| --- | --- | --- | --- |
| **No.** | **Event** | **Management Procedure** | **Reference** |
| 1 | Normal Operational Activities | Standard Operation Procedure | WSP/SOP |
| 2 | Regular Maintenance | Preventive Maintenance Schedule | WSP/PMS |
| 3 | Break Downs | Operation & Maintenance Manual | WSP/O&M Manual |
| 4 | Incidents | Corrective Maintenance Schedule | WSP/CMS |
| 5 | Emergencies | Emergency Response Plan | WSP/ERP |

# Supporting Program.

Operations that are essential for proper operation of control measures and still perform as indirect support to the water safety are identified in the supporting program.

*Table9.1: Supporting Program.*

|  |  |  |  |
| --- | --- | --- | --- |
| **No** | **Activity** | **Purpose** | **Examples** |
| 01 | Training & awareness. | * To aware activities of water safety plan, motivate for pollution prevention activities for catchment uses and aware consumer safety. | * Awareness program for catchment uses. At water quality surveillance meetings in DS &provincial secretary meeting/awareness program for consumer/handbill for consumers. |
| 02 | Preparing source protection zone (SPZ). | * Identification source protection zone. * Declaration source protection zone. * Legislation for involving pollution prevention activities in SPZ. | * Stake holder meetings for identification the SPZ & legislation preparation. * Map & demarcation the SPZ |
| 03 | Documentation of started operation procedures, standard preventive & corrective maintenance procedures $ time schedule. | * Upgrade efficiencies of treatment process & control contamination. | * SOP manual * Preventive maintenance & corrective manual & time table maintenance. * Time schedule. |
| 04 | Installing High tech lab facility to regional support center. | * To upgrade water testing facility. | * Upgrade testing facility of organic contaminants (pesticide), THM. etc. |
| 05 | Research & develop | * To identify treatment efficiency of contaminants to improve water quality. | * Research to treat agricultural persistent chemical |
| 06 | Financing WSP activities | * To introducing penalty scheme for polluters to cost for pollution. | * Prepare legislations for the penalty scheme by using international lows &principles ex: -polluters pay principle. |

# Review of WSP

Review of each component of WSP and WSP itself is discussed under this chapter.

*Table10.1: Review Schedule*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **No** | **Activity** | **Ref** | **Response** | **How Often?** | **Next Update on** | |
| **Next** | **After Next** |
| 1 | Contact detail update |  | WSP team | Monthly | 1-Jul-2019 | 1-Aug 2019 |
| 2 | Stakeholder list update |  | WSP team | Semi-annually | 1-Jun-2019 | 1-Jan-2020 |
| 3 | Catchment map update |  | Mapping section | Annually | 1-Jan-2020 | 1-Jan-2021 |
| 4 | Treatment process update |  | P&D section | Bi-annually | 1-Jan-2020 | 1-Jan-2022 |
| 5 | Distribution map update |  | Mapping section | Annually | 1-Jan-2020 | 1-Jan-2021 |
| 6 | Hazard table update |  | WSP team | Semi-annually | 1-Jun-2019 | 1-Jan-2020 |
| 7 | Control measure update |  | WSP team | Semi-annually | 1-Jan-2020 | 1-Jun-2021 |
| 8 | Improvement plan update |  | WSP team | Annually | 1-Nov-2019 | 1-Nov-2020 |
| 9 | Prioritizing improvement plan |  | WSP team | Annually | 1-Jan-2020 | 1-Jan-2021 |
| 10 | Operation monitoring update |  | WSP team | Annually | 30-Nov-2019 | 30-Nov-2020 |
| 11 | Corrective action plan update |  | WSP team | Annually | 1-Jan-2020 | 1-Jan-2021 |
| 12 | Verification procedure update |  | WSP team | Annually | 1-Jan-2020 | 1-Jan-2021 |
| 13 | Management procedure update |  | WSP team | Annually | 1-Jan-2020 | 1-Jan-2021 |
| 14 | Standard operation procedure update |  | WSP team | Annually | 1-Jan-2020 | 1-Jan-2021 |
| 15 | Preventive maintenance schedule |  | WSP team | Annually | 1-Jan-2020 | 1-Jan-2021 |
| 16 | Operation & maintenance manual |  | WSP team | Annually | 1-Jan-2020 | 1-Jan-2021 |
| 17 | Corrective maintenance schedule |  | WSP team | Annually | 1-Jan-2020 | 1-Jan-2021 |
| 18 | Emergency response plan update |  | WSP team | Annually | 1-Jan-2020 | 1-Jan-2021 |
| 19 | Supporting programme update |  | WSP team | Annually | 1-Jan-2020 | 1-Jan-2021 |
| 20 | Consumer list update |  | Commercial section | Annually | 15-Oct-2019 | 15-Oct-2020 |
| 21 | WSP document update |  | WSP team | Annually | 1-Jan-2020 | 1-Jan-2021 |

# Incident Response Plan

Incident response is planned in pre-incident stage. Once the incident occurs, emergency action plan is implemented followed by the recovery activities. It is assumed that after the recovery, again the cycle return to pre-incident stage and the emergency action plan to be updated using the lessons learned, i.e. the tacit knowledge turn into the documented knowledge.

*Figure11.1: Incident Cycle*

Pre Incident Planning (Figure 11.2)

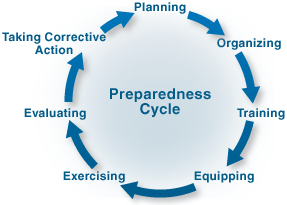
Emergency Response

Recovery Activity

Return to Pre Incident Planning

Pre-incident planning plays a vital part of emergency response. Emergency response plan is separately developed and discussed under management procedure in this report. Planning cycle is described in Figure11.2: Planning Cycle.

*Figure11.2: Planning Cycle*



And once the incident occur incident response can be attended through six main phases as follows;

Preparation (described in Figure11.2: Planning Cycle)

Identification

How to note the incident?

What tools to be used?

Communication Process

Classification (what kind of incident?)

Trace back

From where the incident is coming?

Where and how it is affecting the existing system?

What are the consequences?

Reaction

Is emergency response plan address the incident?

If ”no”, how communicate?

What options in the emergency response plan?

Which option is the best?

Communication Process

Post Mortem

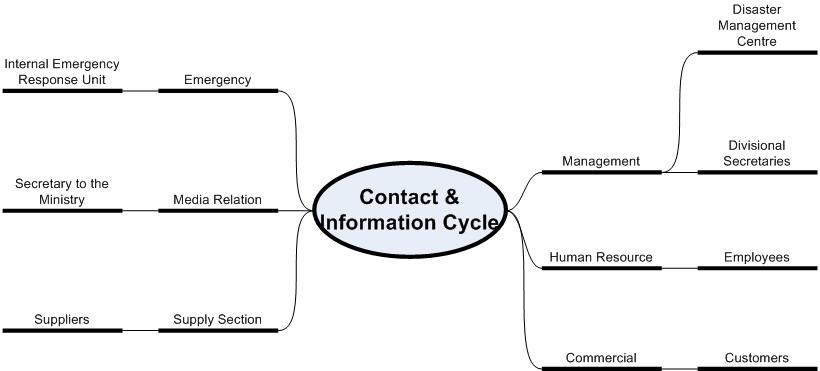
What was done?

What would be preventive measures?

How to control?

Communication cycle for incident response as follows;

*Figure11.3: Communication Cycle*



**MEASURES**