(FOR OFFICAL USE ONLY)

सत्यमेव जयते

HAND BOOK FOR HYDRO-METEOROLOGICAL OBSERVATIONS

Ministry of Jal Shakti
Department of Water Resources, River Development and Ganga Rejuvenation
Central Water Commission
Planning and Development (P&D) Organization
River Data Compilation-2 Directorate

June, 2020

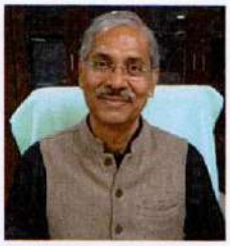
Cover page:
Confluence of River Alaknanda and Bhagirathi (Deoprayag)
Photograph courtesy by Tanya Shanker

FOR OFFICIAL USE ONLY

HANDBOOK FOR HYDRO METEOROLOGICAL OBSERVATIONS

River Data Compilation-2 Directorate
Planning and Development (P&D) Organisation
Central Water Commission

We Proudly Celebrate the 75th Anniversary of Central Water Commission and on this occasion brings this "**Handbook for Hydro-Meteorological Observations**"



Member (River Management), Central Water Commission
& Ex-Officio Additional Secretary to the GoI,
Department of Water Resources,
River Development and Ganga Rejuvenation

PREFACE

The need for conservation of water cannot be over emphasised. Quantity of water needs to be estimated accurately for proper planning and its management. Since 1945, CWC is committed for assessment, planning and management of surface water endowed to this great country.

Flood forecasting activities for all the Major Rivers in India is being carried out by Central Water Commission (CWC) for many years. Proper water level measurement at all the gauge sites is necessary for accurate flood forecast. During monsoon season, frequency of observation of gauge increased to 24X7, so that accurate forecasts are formulated.

This Manual is having 7 chapters for providing guidance to CWC officers and staff posted in field formations for proper and uniform observations. It is hoped, that the procedures, described in the manual, will be followed in letter and spirit, which will be the first step for creating reliable hydrological data base.

I appreciate the commendable efforts put by Shri Ravi Shanker,Chief Engineer (P&D) for bringing out the updated version of Handbook for Hydro Meteorological Observations. Efforts put in by the officers of River Data Directorate-2 and Shri Rajesh Kumar, Director(RDC-1); Shri Ram Jeet Verma, Superintending Engineer (Planning Circle, Faridabad); Shri Mayank Suhirid, Dy. Director (Monitoring, Faridabad); Shri Rakesh Kumar Gupta, Dy. Director (RDC-2); Shri Anjani Kumar Mishra, Executive Engineer, (LGBO); Shri Rohit Gupta, Assistant Director (RDC-2); Apoorva Raj, AssistantDirector (RMCD) are also appreciated.

(R.K. Sinha)
Member (RM Wing)

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

आपो हि ष्ठा मयोभुवस्था न ऊर्जे दधातन ।
महे रणाथ चक्षसे ॥

O Water, because of your presence, the Atmosphere is so refreshing, and imparts us with vigour and strength. We revere you who gladden us by your Pure essence.
(Apah Suktam Rigveda)

CHAPTER 1

HYDRO-METEOROLOGICAL OBSERVATION NETWORK DESIGN CONCEPT& GUIDELINES

The National water resources are limited & unevenly distributed resulting in seasonal abundance, and even devastating floods in some areas, while large tracts in other regions are persistently drought affected. The above situations have been compounded with the apprehended Climate change, which calls for data collection on large scale to carryout climate change studies to help, find possible sustainable solutions. This erratic occurrence necessitates precise hydrological observations in rivers for the optimum planning of water resources projects and their subsequent operations.

Availability and accessibility of hydrological information is the basic requirement for development and management of water resources. Water scarcity is fast becoming a critical issue and climate change impacts will further intensify the water related problems spatially and temporally in India. The need of the hour is to develop, manage, update, and maintain a centralized national level water resources information system and provide standardized data and value added services to all stake holders for its management and sustainable development.

Following activities are required in this regard:

(a) Measurement of hydro-meteorological parameters in rivers at selected place, time and frequency involving quantity and quality with desired accuracy.
(b) Compilation and tabulation of hydrological data.
(c) Data scrutiny, processing and publication.

1.1 OBJECTIVES OF STREAM FLOW OBSERVATION

Hydro-Meteorological data observation is a scientific way for collection of flow data at a specific location along the river including selected meteorological parameters. The reliability of the data is an important attribute for assessing the water resources in terms of quantity, quality and distribution in time and space.

In general hydro-meteorological data is observed for following purposes:

(a) Assessment of basin wise water availability and management
(b) Planning and design of water resources projects
(c) Formulating National Water Policy
(d) Study of climate change
(e) Flood forecast
(f) Flood mitigation
(g) Flood Inundation Mapping
(h) Reservoir inflow forecasting
(i) Water quality assessment
(j) Sediment assessment
(k) Morphological studies
(l) Assessment of navigational potential for inland waterways
(m) Resolving inter-state or international water disputes

(n) Study of the effect of nature and human interference on surface water availability and its distribution
(o) Research purposes
(p) Estimation of periodical flow distribution during various seasons

1.2 HYDRO-METEOROLOGICAL OBSERVATION NETWORK

The network of stream flow observations is purpose-based on requirements such as for water resources assessment and its distribution, flood forecasting & flood management, pollution control and environmental management, river behaviour and other hydrological studies. Each hydrological station has to offer some relevant and useful information individually and/ or collectively with other stations. Hydrological network optimization is a slow and evolutionary process, starting with a minimum number of stations, and increasing gradually (as necessary) until an optimum network is attained. An optimum network is achieved when the amount and quality of data collected and information processed is economically justifiable and it meets the users' needs. Hydro-meteorological observation network in a basin depends on:

(a) Purpose or objective
(b) Terrain or Physiographic region in the basin

As per the WMO Guidelines, minimum hydro-meteorological stations density should be as follows:

S. NO		Minimum density (area in km^2 per station)					
	Physiographic Region	*Precipitation Station*			*Stream flow Measurement Station*		
		Non-recording	**Recording**	**Evaporation Station**	**Stream flow Station**	**Sediment discharge and sedimentation**	**Water Temperature (Water Quality Station)**
1.	Coastal	900	9,000	50,000	2,750	18,300	55,000
2.	Mountainous	250	2,500	50,000	1,000	6,700	20,000
3.	Interior Plains	575	5,750	50,000	1,875	12,500	37,500
4.	Hilly/ Undulating	575	5,750	50,000	1,875	12,500	47,500
5.	Small islands	25	2520	50,000	300	2,000	6,000
6.	Polar/arid	10,000	100,000	100,000	20,000	200,000	200,000

1.3 CLASSIFICATION OF HYDROLOGICAL OBSERVATION STATIONS

A stream flow observation station may be of any of the following *three* types:

(a) Primary stations or Key gauging stations or Principal stations - Maintained on long term basis to generate representative flow series

(b) Secondary stations or Short duration stations - Period enough to establish the flow characteristics of the river or stream.

(c) Special purpose stations or Specific purpose stations or project stations or temporary stations - Discontinued when the purpose is served after fulfilment of legal agreement between co-basin states.

Note: The primary as well as the secondary stations many times serves as special purpose stations.

1.4 GENERAL GUIDELINES FOR FIXING LOCATION OF HYDROLOGICAL OBSERVATION STATION AND DESIGN OF HYDROLOGICAL OBSERVATION (HO) NETWORKS

(a) For rivers flowing across the plains before delta region, a station should be established at the point where the river normally divides itself into branches before joining the sea or a lake should invariably be chosen as terminal station for that particular river.

(b) In case of mountain rivers, stations should be created at u/s of the confluence in the minor tributary; and, below the confluence of a major tributary or at the outflow point of a lake.

(c) In case of large rivers:

i) The distance between two stations on the same river should not be more than 60 Km.
ii) The drainage area between the stations should be more than ten percent.

(d) Small independent rivers which flow directly into the sea should have at least one station as near to the confluence with the sea as possible.

(e) There should be at least one station on all international/ inter-state rivers as close to the border / boundary as possible.

(f) The network should be designed in such a manner as to ensure that all distinct hydrological area is adequately covered.

(g) The Network Design and establishment needs should be reviewed periodically.

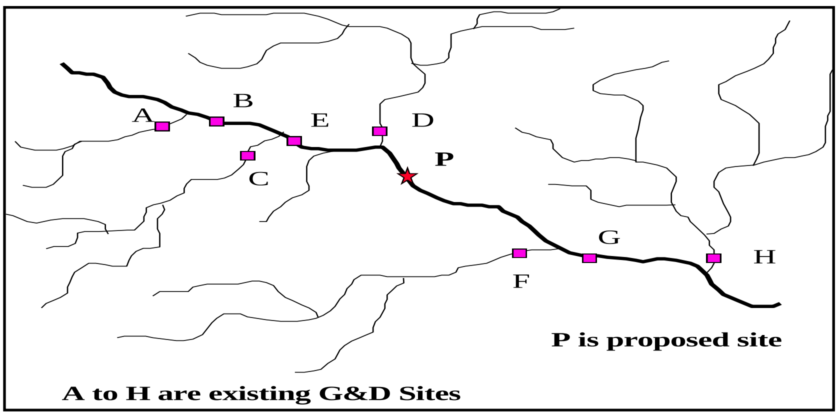


Figure 1: Typical Sketch of a River Basin-HO Network

Some additional points for consideration before selection of a gauging site are as follows:

(a) There should be minimum number of channels & minimum width in plain area.

(b) The flood plain should be avoided entirely or should be minimum possible.

(c) Station should be far away from any bend or natural or artificial obstruction.

(d) The river flow should be as close as possible normal to that of the prevailing wind direction.

(e) The locations with possibilities of vortex formation or return flow should be avoided.

(f) As far as possible, station should be free from aquatic growth, trees and obstructions.

(g) The station should be away from the backwater zone caused by any structure on the river

(h) The site should be sufficiently away from the disturbances caused by rapids and falls etc.

1.4.1 HYDRO-METEOROLOGICAL PARAMETERS FOR OBSERVATIONS

Following hydro-meteorological parameters are generally measured depending upon the purpose of observation:

(a) River water level
(b) River discharge or flow
(c) River Cross Section
(d) Suspended sediment/silt in river.
(e) Rainfall and other weather parameters
(f) Water quality consisting of many different parameters.

The above activities involve selection of site/station on the river, design of network for a basin or river system, type of methodology to be used at the station, selection of suitable equipment and technology for observation of different parameters, tabulation-calculation-compilation of observations made, scrutiny-validation-publication of data. All of the above activities have been described in detail in the following chapters.

CHAPTER 2

ESTABLISHING HYDRO-METEOROLOGICAL OBSERVATIONSITES

2.1 CRITERIA FOR SELECTION OF SITE

A thorough reconnaissance by an experienced Engineer is mandatory before finalisation of any hydrological observation site. The reconnaissance survey should be preceded by study of the area using Geographical Information System (GIS) and topographical maps of the area.

The reconnaissance should generally be undertaken during fair weather (summer/winter), when the reach is fairly exposed for visual inspection. In selecting a hydrological observation site, the following criteria should be adopted as far as possible.

1. The river bank and bed should be reasonably straight and stable both upstream and downstream of the gauge line for a distance of at least 4 times the normal width of the river during high flood or 1 kilometre whichever is less

2. The river in this reach should not show any signs of progressive aggradations or degradation.

3. Ideally, the water level should have no slope from bank to bank along the section at the gauge site. However, in case of slope is observed then gauges should be fixed on both the banks on the cross-section line and mean of the two gauges taken as the gauge reading.

4. The riverbed should not have reverse slope, i.e., slope against the current, in this reach and should be free from pools and rapids.

5. The water level in the reach should not preferably be affected by backwater effect from any structure or river confluences.

6. The orientation of the reach should be such that the direction of flow is as closely as possible normal to that of the prevailing wind.

7. Sites at which there is tendency for the formation of vortices, return flow or local disturbances should be avoided.

8. When gauge site situated near a confluence, its minimum distance upstream from the confluence point on either of the streams should be such that the backwater or disturbances due to floods in the other stream would not affect the gauge even if the stream on which the gauge is fixed is running low.

9. Water level at the gauge site should not be affected on account of a falling

curve obtained over a weir crest or immediately below a constricted bridge. It is recommended that when the gauge is located downstream of a structure, a minimum distance between the gauge and the structure should be kept 3 times the width of the section at high flood level in case of smaller streams. In case of big rivers length of 0.5 – 1.0 km below a weir or a bridge may be considered adequate for obtaining normal conditions.

10 The site should be free from aquatic growth which is likely to interface with the gauge measurement.

11 When gauges are observed from railway bridges, it is to ensure that sufficient free board is available even at very high floods. While installing such gauges it is necessary to locate these at points where highest water level will be obtained at the bridge during the passage of flood.

12. The site should be such that water flows in a single channel throughout the year and does not over flow banks. If bank spills are unavoidable these should be limited to minimum width and have as uniform depth as possible. Where a single channel is not available, as in case of braided rivers two or more channels satisfying these conditions should be used.

13. The site chosen should be easily accessible and should have clear and dependable approach at all times of the year. It is preferable to locate a site in the vicinity of an all-weather road which does not get submerged during floods. The site should be free from bushes, trees & other obstructions.

2.1.1 SITE OFFICE

The site office should be established for each site. The requirement of space varies depending upon the parameter to be observed at the site. The general criteria for site office are as follows:

(a) The site office whether rented or its own should be closely located near the actual site where observation is to be made.

(b) Site office as well as site should have proper approach road or path.

(c) It should be accessible throughout the year, even in extreme condition.

(d) Each site office should have proper sign board (written in bilingual) installed at appropriate location. Template of sign board is given at Annexure-I

(e) It should be maintained properly including cleanliness of toilets daily and whitewashing of building at least once in a three year.

The salient features of the site (in bilingual) including purpose of opening of site initially and present utility, Map of the site and photograph (A0 size) should be displayed at the site office. Various Historical records such as HFL, Highest Discharge, Maximum Sediment, Maximum Rainfall, Temperature and other parameter depending upon the parameter observed should be included in the salient features. Template of salient feature is given at Annexure-II.

2.1.1.1 SITE OFFICE EQUIPMENT/INSTRUMENT

Depending upon the parameter observed at the site, the following minimum equipment/instrument should be made available at the siteas given at Annexure-III.

2.1.2 BENCH MARK

(a) The Musto Type Bench Mark (MTBM) at each site on standard bank should be established as per the drawing attached at Annexure-IV.

(b) The Bench Mark should be established at sufficiently high level (at least 0.5 m above the HFL).

(c) The date of connection of Bench Mark from the nearby available Survey of India (Location should be mentioned) site office should be established for each site.

(d) The Reduced Level w.r.t mean sea level should be clearly written on the MTBM.

(e) D-type Temporary Bench Mark (D-TBM) at other bank should also be established at each site at appropriate location (above HFL).

(f) Temporary Bench Mark (TBM) should also be established near upstream and downstream centre line above HFL on Standard Bank Side.

2.1.3 ZERO OF GAUGES

The gauge observations to be fully useful should be convertible into Reduced Levels (RL*)* above or below mean sea level which is the common datum internationally adopted. To enable this, the zero mark on the gauge must be connected with the *RL.* In fixing: a gauge zero, the following requirements have to be satisfied.

(a) The zero of the gauge should be fixed below the lowest recorded water level and it should be in meter only.

(b) After installation of a gauge, its zero should be connected to the nearest GTS bench mark and reduced level with respect to the mean sea level determined, checked and entered into the record.

(c) The circuit should be closed preferably on another nearest GTS bench mark. The reduction of levels should be made in the office by the Sub-Divisional Officer.

(d) Once the zero of the gauge is fixed and recorded, it should not be changed except under special circumstances. If the old gauge is changed and replaced, its zero value should be retained the same by properly fixing and adjusting it.

(e) When a permanent GTS bench mark is more than 3 km away from the gauge, (i.e. when there is no Musto type bench mark available)a new permanent bench mark in a safe position should be established for reference near the gauge site.

(f) A reference mark on the structure to which gauge is fixed should be made. Reduced level of the reference mark should be obtained independently by levelling and recorded. This can be used for easily and quickly verifying the correctness of the gauge.

(g) In case of temporary gauges, if these are moved with the shifting of the low water channel during dry season or any other reason, care should be taken to see that the zeros of gauges are accurately correlated.

2.1.4 GAUGE LINE/CENTRE LINE

(a) The river bank and bed should be reasonably straight and stable both upstream and downstream of the gauge line/centre line for a distance of at least 4 times the normal width of the river during high flood or 1 kilometre whichever is less.

(b) Centre line should be normal to direction of current of the river.

(c) The river in this reach should not have either show any signs of progressive aggradations or degradation.

(d) Ideally the water level will have no slope from bank to bank along the section at the gauge site. However, in case of slope is observed then gauges should be fixed on both the banks on the cross-section line and mean of the two gauges taken as the gauge reading.

(e) The river bed should not have reverse slope, i.e., slope against the current, in this reach and should be free from pools and rapids.

(f) The water level in the reach should not preferably be affected by backwater effect from any structure or river confluences.

(g) The orientation of the reach should be such that the direction of flow is as closely as possible normal to that of the prevailing wind.

(h) Sites at which there is tendency for the formation of vortices, return flow or local disturbances should be avoided.

(i) When gauge site is situated near a confluence, its minimum distance upstream from the confluence point on either of the streams should be such that the backwater or disturbances due to floods in the other stream would not affect the gauge even if the stream on which the gauge is fixed is running low.

(j) Water level at the gauge site should not be affected on account of a falling curve obtained over a weir crest or immediately below a constricted bridge. It is recommended that when the gauge is located downstream of a structure, a minimum distance between the gauge and the structure should be kept 3 times the width of the section at high flood level in case of smaller streams.

In case of big rivers length of 0.5 – 1.0 km below a weir or a bridge may be considered adequate for obtaining normal conditions.

(k) The site should be free from aquatic growth which is likely to interfere with the gauge measurement.

(l) When gauges are observed from railway bridges, it is to ensure that sufficient free board is available even at very high floods. While installing such gauges it is necessary to locate these at points where highest water level will be obtained at the bridge during the passage of flood.

(m) The site should be such that water flows in a single channel throughout the year and does not over flow banks. If bank spills are unavoidable these should be limited to minimum width and have as uniform a depth as possible. Where a single channel is not available, as in case of braided rivers two or more channels satisfying these conditions should be used.

(n) Target post should be installed at centre line above HFL on the both bank of river and connected with zero of gauge. Painting of Target Post should be done every year before onset of monsoon.

(o) If discharge is observed at the site, then upstream gauge line 500m upstream of the centre line and downstream gauge line 500m downstream of the centre line should also be established.

(p) Gauge post should be upto minimum water level possible in the river and should be erected with minimum overlapping height of approx 30 cm.

(q) The Reduce level of all the gauge post should be fixed with MTBM.

(r) After fixing the gauge post, water level of the river should be measured manually and verified with auto level.

2.2 RIVER CROSS- SECTION

(a) The river cross section at Gauge Line/Centre Line, Upstream and Downstream Gauge Line at all site shall be taken twice once after monsoon between November to December and another before monsoon between April to May.

(b) Cross Section should cover HFL or top level of embankment/firm bank on both banks.

(c) Both Pre-monsoon and Post–monsoon X-Section should be plotted on a single overlapping graph.

(d) X-Section data for each site shall be entered in eSWIS immediately by the Sub-Divisional Officer under his/her jurisdiction.

CHAPTER 3

RIVER STAGE OBSERVATION

3.1 INTRODUCTION

In any Engineering field, the observation, compilation and validation of data is the most important aspect which lays the foundation of further activities. The measurement of water level or stage at a gauging station is perhaps the most fundamental activity in hydrology. Field practice and frequency of observation should match with the data needs and the available instruments. The greatest frequency of observation is required when the level (and discharge) is changing rapidly, especially during the monsoon season.

Manual observation by staff gauge will remain as the sole means of observation at many stations in the years to come. They will also continue to be used at all stations to check the operation of recording equipment at intervals, as a back-up in the event of instrument failure and in conjunction with discharge measurements for stage-discharge determination.

The water levels are normally recorded using:

(a) Staff gauges (RCC Post/Wooden post cut to edges).
(b) Stations with Radar/Pressure sensor (Digital Water level Recorders)

3.2 STAFF GAUGES

(a) The gauge observer will read the water level at an external staff gauge located directly in the river, and record to the nearest 1 mm where the water has little surface fluctuation. Where the water level is unstable due to wind action or turbulence, the observer will assess the mean level by noting the level fluctuation over a period of approximately 30 seconds and take the mean (average) of the normal range. Any gauge maintained inside of a stilling well should not be used as the primary water level measurement gauge. Observation will be made by making the closest possible approach to the gauge in the river consistent with safety. Where the staff gauge is likely to become too distant for accurate gauge readings during rising flood levels, a simple pair of binoculars may be provided.

(b) The frequency may also be used to record the maximum and minimum water level during the day in addition to hourly levels, is such additional data is available. In rapidly changing flows, the maximum level may exceed the highest recorded hourly level, when it occurs between the hourly observations. Similarly, the minimum level may be lower than the lowest hourly level.

(c) The gauge reader is required to maintain good time keeping and the hourly observation will not fall more than 5 minutes before or after the hourly observation time.

(d) The observer will note on the form whether the gauge is the only gauge, the main gauge, or a supplementary gauge, or gauges, for assessing surface water slope. A separate form will be used for each supplementary gauge in use. It is important that each gauge is clearly identified on the form. For supplementary gauges the observer will note whether the gauge is upstream or downstream from the main gauge. Where supplementary gauges exist and are some distance apart, the upstream gauge will be read first and the downstream gauge as soon thereafter as is consistent with safety.

(e) During period of low flow or where the station is equipped with a reliable automatic or digital method of recording, the observer will take readings three times daily at 0800, 1300 and 1800 hours and record on the standard form covering a period of one month per form. Where an internal gauge exists in a stilling well it will be read once daily at 0800 and recorded.

(f) When the gauge observer reads the gauge at other, non-standard times, he must ensure that the actual time of reading is recorded.

(g) When the gauge observer is unable to visit the station due to sickness or other reason, he will in no instance attempt to estimate or interpolate the missing value(s) but will leave the space blank or note “M” and record in “Remarks” the reason for the missing record.

(h) The observer will ensure that there is a direct connection between the flowing water surface and the gauge. After flood siltation he will, if necessary, remove sandbars or dig a trench from the gauge to free water. A shovel will be provided for this purpose. The channel to the gauges may require renewal on a daily basis.

(i) The observer will note in “Remarks” all those occurrences, which may influence the level as observed at the gauges and especially those, which may affect the level-discharge relationship. The time/date and location of occurrences will be noted. The following occurrences in particular should be noted:

- i) Damage or destruction of gauges due to flood or other cause
- ii) Scouring and lowering of the river bed level either at the gauges or at the control site
- iii) Construction of bunds downstream to raise water level for abstraction or diversion
- iv) Extraction of sand or gravel from the river channel
- v) Blockage or partial blockage of the channel by floating or other debris in flood.
- vi) Significant weed growth in the channel or on the weir and its subsequent removal.

(j) The observer will record the level at which flow ceases and the pool of water at the gauges becomes static. Where the river level falls below the level of the lowest gauge but flow continues, for example due to scouring of the bed at the station, the observer will attempt to continue the observations. In such occasions, the observer will measure downward form the datum of the gauges and record it as a negative stage i.e. he will measure the distance from the zero on the gauge to the water surface. For example, if the distance from the gauge zero to the water surface is 0.15 m, then the gauge reading should be recorded as -0.15 m. as soon as possible, the engineer in charge will re-survey the station and reinstall the gauges with a new datum, ensuring that survey details and the change in datum are fully documented in the station record.

3.2.1 ACCURACY OF GAUGE OBSERVATION

When gauge observations are made for use with a gauge-discharge curve or for any other purpose except for measurement of slope, the gauge should be read and recorded correct to 3 cm after averaging several readings. During flood season due to turbulence and wave motion this accuracy is sufficient. In non-flood season it would generally be possible to observe the gauge correct to 5 mm and also when gauge observation are meant for calculating slope, they should be read corrected to 5 mm. Hence the least count or minimum reading of staff gauge should be 5 mm. The Automatic water level recorder and recording type of gauges have least count of the range of 1 mm or less.

3.2.2 FREQUENCY OF GAUGE OBSERVATION

The frequency of gauge observation primarily depends on the purpose for which gauge observation is to be made. The characteristics of the river are also important factors in determining the frequency of gauge observations.

During non-monsoon period the gauge observation can be done three times a day at uniform interval because the river flows are generally very low and discharge fluctuations are small. During monsoon season the river rises and fluctuations & disturbances are more and data of water levels are more important for recording HFL and for flood forecasting purpose. Hence, during monsoon period gauge observation at every hour is recommended. For flashy rivers the fluctuation in water level are more sudden, which necessitates gauge observations at shorter interval.

When gauge observation is made in connection with discharge measurement, the gauge is observed both at the time of beginning and at the end of discharge measurement. If the difference in the two gauges is less than 5 cm, the mean value is adopted in discharge computations. If the change in stage is more than 5 cm, the gauges should be observed more frequently at an interval of half an hour or even less. When gauge observation is done for discharge observation by area-slope method, the gauges are generally installed at the centre, upstream & at downstream for measurement of water level for calculating the slope.

3.2.3 CHECKING OF GAUGES

In order to ensure accuracy of gauge observations periodical checking of gauges are essential. All gauges should be inspected and checked every year at least twice, once before and once after the flood season. During the checking the useful tools must be taken. Checking of gauge would mainly concern with the condition of the gauge along with accessories and its zero level. It is necessary to check up the levels with reference to the reference benchmarks and reference points.
For checking the staff gauges, reduced levels of the top of each section of the gauge should be checked. Reduced levels (RL) obtained by using the recorded zero of gauges should be compared against the reduced levels obtained by levelling. If an

error beyond the least count for a gauge is revealed, the zero of gauge or position of any section of the gauge should evidently require correction. In gauges intermediate divisions should be verified for their correctness using a steel tape or level.

3.2.4 RECORD OF GAUGES

For proper maintenance of gauge records standard forms are being utilized. For recording the gauge readings, the standard river data forms (RD Forms) RD-3 & RD-4 are used. RD-3 form is used for recording daily three times gauge observations at 8:00, 13:00 & 18:00 hrs. RD-4 form is being used during the monsoon season for recording hourly gauge readings.

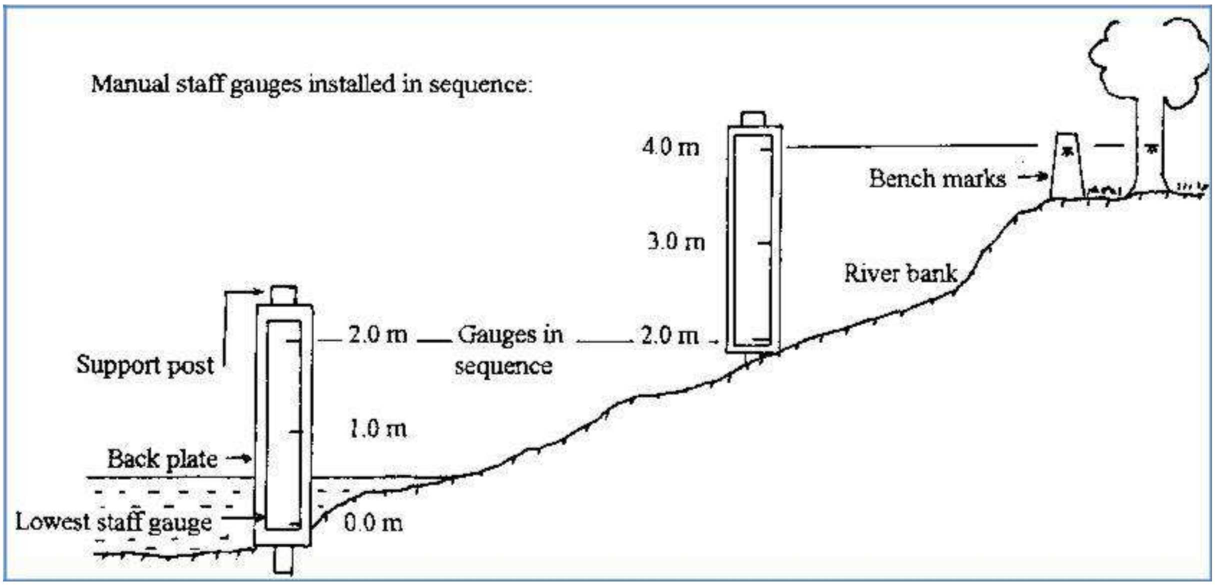


Figure 2: Manual Staff Gauge

3.3 Digital WATER LEVEL RECORDERS

Digital Water Level Recorders (DWLR"s) take a variety of forms but have in common the ability to measure and register the water level at a specified interval in digital storage on a data logger. The sensor may take the form of float-operated shaft encoder, a pressure transducer or Radar measurement. Data loggers for water level measurement nowadays have the capability to store the data and facility to retrieve it using USB drive and also transmit the data using GPRS system or satellite based to a predefined location(s).

The methods of setting up and checking DWLR"s depend upon the type of logger and sensor and on software specific to a logger type. Visual checking of the performance of the DWLR is possible through on-site display into the logger. Periodical checking involves following steps:

(a) Read the reference staff gauge.

(b) Check the Permanent termination block for deposition of silt and remove the silt if required so as to make it free upto the nozzle level (bubbler type DWLR).

(c) Check that the logger clock is within acceptable time accuracy.

(d) Check the current water level recorded by the DWLR with that of staff Gauge.

(e) Download the logger data, either the full stored contents or the data since last download, as required.

(f) Clean the solar panel from dust or debris.

(g) Check for breakage of HDPE pipe.

(h) Check the battery condition as provided in the data logger display unit.

(i) Notice any change in the alignment of antenna of the transmitter and inform the Engineer-in-charge accordingly.

(j) Visually inspect the alignment of the Radar.

(k) Check that the cables and electrical connections are not damaged or loosened.

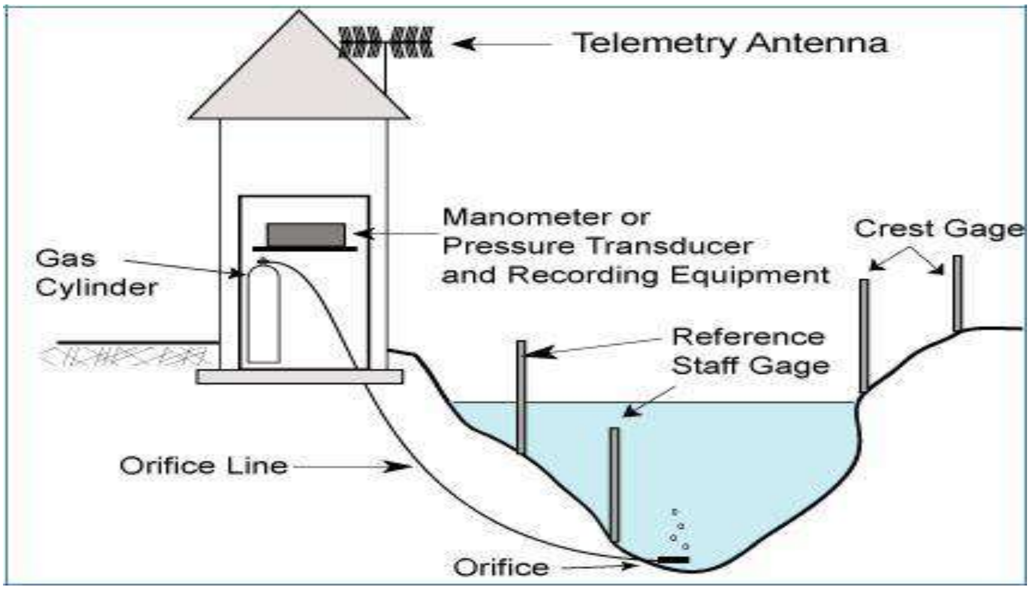


Figure 3: Bubbler type telemetry DWLR

Figure 4: RADAR type Water Level Sensor

CHAPTER 4

DISCHARGE OBSERVATION

Stream/River flow measurement involves determination of total volume of water passing through the cross-section of a stream in a measured interval of time. Water discharge in rivers and streams is usually expressed in cubic meters per second (cumec) or cubic feet per second (cusec).

There are various methods for the measurement of discharge, which can be classified into two categories, namely:

(a) Direct methods
(b) Indirect methods.

<table>
<tr><th>Direct Methods</th><th>Indirect Methods</th></tr>
<tr><td>1. Area-Velocity Method using Current Meter

i) By Wading
ii) By Boat or Catamaran or Motor launch
iii) From Bridge
iv) From a Cable-way</td><td rowspan="2">i) Slope-Area Method
ii) Stage-Discharge Relation
iii) Discharge Estimation at Hydraulic Structures</td></tr>
<tr><td>2. Other Methods

i) Float Method
ii) Ultrasonic Method (ADCP)
iii) Colour velocity Method</td></tr>
</table>

4.1 AREA VELOCITY METHOD USING CURRENT METER

Discharge Measurement by the Area-Velocity method is the most accurate one and is adopted by various agencies in India for regular discharge observations. In this method, observations of depths and velocities are required to be made in a number of segments along the section.

In this the river section is divided into a number of compartments depending upon the degree of accuracy required. The width and mean depth of each compartment is measured to determine its cross-sectional area. The mean velocity in the compartment is measured by a water current meter. The discharge through each compartment is the product of its cross-sectional area and mean velocity. The discharge of the whole section is obtained by the addition of all such compartmental discharges.

4.1.1 EQUIPMENT USED FOR DISCHARGE MEASUREMENT

The equipment used at CWC Gauging Stations can be grouped into three categories as indicated below:

Equipments for measurement of velocity	Equipments for measurement of depth	Miscellaneous Equipments
(a) Current meters & Accessories (b) Protractor	(a) Wading Rod (b) Sounding rod (c) Echo Sounder	(a) Stop Watch/ CM Counter (b) Fish Weight (c) Battery box with Earphone (d) Thermo-meters (e) Navigational Equipment (f) Life Saving Devices (g) Dumpy/Auto Level (h) Prismatic Compass (i) Screw drivers and spanners set (j) Knife

4.1.1.1CURRENT METERS & ACCESSORIES

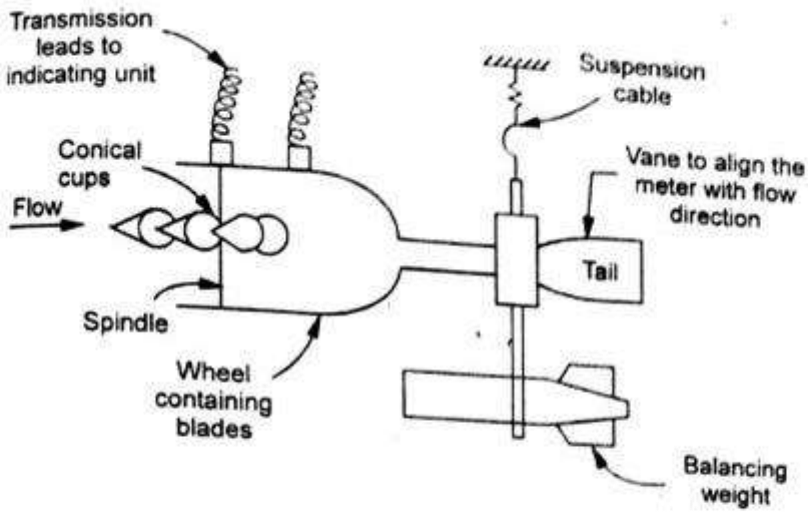


Figure 5: Cup type Current meter

Current Meters (CM) are used to measure velocities at selected verticals along the discharge section. They are broadly classified as vertical axis cup type meters and horizontal axis screw or propeller type current meters. Vertical axis cup type current meters are widely used at sites. Sometime few current meters of propeller type called Neyrpic current meters also used.

They are used at sites where velocity is high in the order of 3.5 m/Sec and above. Pigmy current meter is used when the velocity of flow is very less.

Figure 6: Current Meter

Figure 7: Current Meter While Taking Discharge Measurement

The accessories include

(a) suspension equipment
(b) headphones
(c) electronic counters
(d) battery

The current meters are rated in the rating tank in the recognised Institutions such as IITs etc. After current meter is calibrated in a tank, a statistical rating curve is prepared to enable direct reading of velocity while using the current meter during field observations.

The curve approximately takes the form of a straight line with equation $V = aR + b$ where V is the velocity and R the revolutions per second. A rated current meter should be used for total 180 days or for 90 working days or 300 hours before its rating period expires. International Organisation for Standardization specifies this period to be 100 working hours.

Whenever a current meter is being replaced, it should be compared with the freshly rated current meter on last three days. If the difference in discharges observed by the two meters go beyond 5% a third current meter should be brought in for comparison and confirmation of the values. If the Current meter being used is damaged due to some reason then the comparison may not be done as this will give wrong information.

The current meters are tested daily for spin before starting and after completing the discharge observations. If the spin is below 40 Sec the current meter should be discarded and a fresh current meter obtained. The spin should not be adjusted by movement of screws, spindle and pivot. It must be remembered that the discharge is a direct function of the observed velocities.

In order to ensure that the observed velocities are correct, it should be handled carefully always in the wooden box and oil them daily before and after discharge observations for free rotation of spindle. A rating chart also be supplied along with the current meter to enable to deduce velocities from the observed values of revolutions of the current meter rotor and time taken. This rating chart must be preserved in a good file for any later reference.

4.1.1.2 WADING ROD

It is a metallic rod circular in section and is of 1.5 M length with a base plate at the bottom. The length of the rod (1.5M) is composed of 3 pieces of each 0.5M in length. The pieces can be detached when not in use and packed up in the wooden box supplied. The wading rod is graduated in lengths of 1 cm so as to know the depth at which the current meter is lowered.

The wading rods are used to suspend the current meters for observation of velocities by wading in low depths say up to 1 m, or more if possible. The current meters are suspended by means of a suspension rod and clamp bolts. A separate wading rod of 8 mm diameter rod is also used for lowering of pygmy Current Meter at depth below which the cup type CM cannot be used.

Figure 8: Wading Rod

4.1.1.3 PROTRACTOR

It is not always possible to select a measurement section, which is at right angles to the direction of flow, especially in the case of bridge measurement. In other cases, flow across part of the section may approach it at an oblique angle. It is necessary to obtain the component of velocity normal to the cross section. Propeller type meters on rod, held firmly at right angles to the cross section will measure the component velocity in such oblique flows and do not need correction.

However, cup-type meters and propeller meters on cable suspension align themselves directly into the current and require correction by multiplying the measured velocity by the cosine of the angle between the current direction and the normal direction. With a simple protractor on the Current Meter Measurement Note Sheet, the cosine of the angle can be read directly.

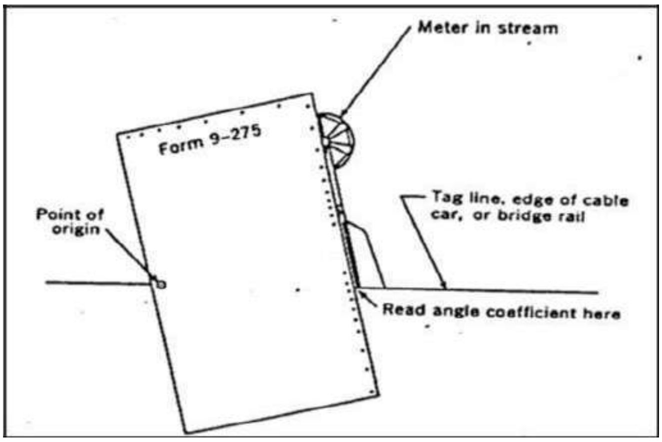


Figure 9: Using the protractor on the gauging form to determine oblique angle of flow

4.1.1.4 SOUNDING ROD

These are circular or oval in section and are 3m in height. They are graduated to read nearest to a centimetre with a base plate at the bottom. They are used to measure depths (In case depth is not more than 3m) at the selected verticals. However, bamboo sounding rods can be used to measure depths upto 6m. Marking on the bamboo should be truly vertical and along the body of the bamboo.

4.1.1.5 ECHO-SOUNDER

Echo Sounders are used to measure large depths in floods when the length of the sounding rod becomes insufficient to measure depth and could not be held vertical due to high velocity. Echo sounder is an accurate and rapid instrument for measuring and recording depth.

The conventional method of sounding line may introduce error on account of three sources:

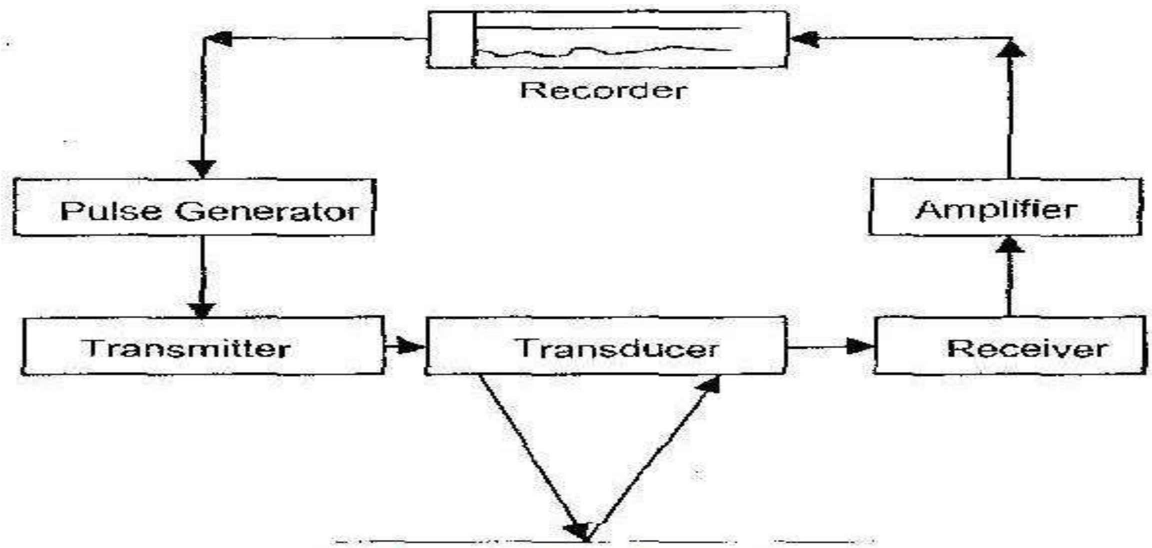
(a) Deflection of the line due to the current

(b) Error in judging when the line becomes truly plumb

(c) The bottom weight may sink in the bed depending on the bed material.

These errors are obviated by use of an echo sounder. As the name suggests, the echo sounder works on the principle of sending out a pressure wave for a very short duration, receiving back the echo, that is the reflected wave, and measuring and translating the interval of time between start of the sound impulse and receiving of the return echo in terms of depth of flow.

The depths observed by Echo Sounders are prone to errors and hence should invariably be compared with the depths observed by sounding rod in low floods when both can be conveniently used to ascertain its accuracy. No air bubble should be present on the transducer face, which causes progressive deterioration of waves and instrument's depth indicating capability.



Working of Echo-Sounder

Figure 10: Echo Sounder

4.1.1.6 STOP WATCH/ CM COUNTER

In gauging stations, it is used to count the time taken for a number of revolutions of the current meter rotor. It is also used for noting time in float observations and in sediment analysis. Now counter with facility to pre-set time/ revolutions are being commonly used.

Figure 11: Current meter counter

4.1.1.7 FISH WEIGHT

Weights in the shape of a fish are added to the sounding link (sounding link is a wire with a suspension rod at the bottom to suspend the fish weight and used to measure depth) or cable to keep reasonably vertical during measurement velocity and depth in rivers with sufficiently high velocity. The weights are in different sizes and weight according to the size. Heavy fish-weights are used for high velocities. The following formula may be useful guidance when choosing weights for different velocities.

Fish weight in Kg = 5 (Max Depth x Max Velocity) (IS 4073-1967)

Where depth is in m and velocity is in m/s.

Figure 12: Fish Weight

4.1.1.8 THERMO-METERS

Each of the station is also supplied with the thermometers to measure temperature of river water at 0800 hours daily. In addition to the above, temperature of river water is also observed before starting discharge observations and after completing discharge observations.

4.1.1.9 NAVIGATIONAL EQUIPMENT

In order to observe velocities and depths at selected verticals along a discharge section, sites are provided with navigational equipment such as wooden/ FRP/ steel boat /launch of sufficient size and buoyancy, with a cable way/ O.B. Engine of sufficient horse power (25 to 90 HP) and persons sufficient numbers to position the boat. In the case of Bridge sites, no such equipment would be necessary for movement since observations are conducted from bridge using a bridge outfit. This equipment must be kept in good condition and painted neatly. They must be washed daily to remove mud and stains.

4.1.1.10 LIFE SAVING DEVICES

As the officials will be going out into the river by boats there is always a certain amount of risk due to certain short-comings like failure of O.B. Engine and unforeseen conditions like sudden rise of water. Precautionary steps have to be taken for such unforeseen eventualities. For that purpose, gauging stations are supplied with Life Jackets and Life-buoys (Life Saving Devices).

Every person must normally wear the Life Jacket and enter the boat so that in the case of any mishap, the person shall still be afloat and be saved by the other. In case the person did not wear the Life Jacket and had fallen into the river, someone must throw the Life buoy to him so that the drowning person can catch hold of it and float away to the bank safely.

4.1.1.11 AUTO LEVEL OR DUMPY LEVEL

An Auto Level or Dumpy level is a levelling instrument and it is also supplied to all the sites to check the levels of all the gauge values periodically for correctness of the values. The level should also be tested for permanent adjustments on every 1st day of the month.

Figure: 13: Auto Level

4.1.1.12 PRISMATIC COMPASS

Gauging Stations are also supplied with a prismatic compass for measurement of angles and direction to accurately position the boats and power launches on a particular RD's and other measurements.

Figure 14: Prismatic Compass

4.1.1.13 SEGMENTATION OF AREA OF CROSS-SECTION

For discharge measurement, observations of depths and velocities are required to be made in a number of segments along the section. Fixing of the number and position of segments is known as segmentation. Method of segmentation presumes that measurement of depth and mean velocity made on any vertical gives a true average of these values within half the widths of adjoining segments on either side of a vertical. The segmentation & the width of segments are taken as per the following:

Sl.No	Description of channel	Number Of observations Verticals	Maximum width of Segment in Meters
(1)	Channel not exceeding 15 m or where its bed changes abruptly	15	1.5
(2)	Channel with width of waterway from 15 to 90 m	15	6
(3)	Channel with width of waterway from 90 to 180 m	15	15
(4)	Channel with width of waterway from greater than 180 m	25	-

The segmentation is also made in such a way that not more than 10% of the total discharge passes through each compartment and preferably not more than 4% variation exists between the discharges through any two adjacent compartments and in fixing segments, equal spacing of verticals should be preferred wherever possible.

Although the verticals are spaced at equal distances (Common width), there shall have the common width. The triangular area correction at both the ends should be deducted to get the final corrected area. The formula used for first RD is:

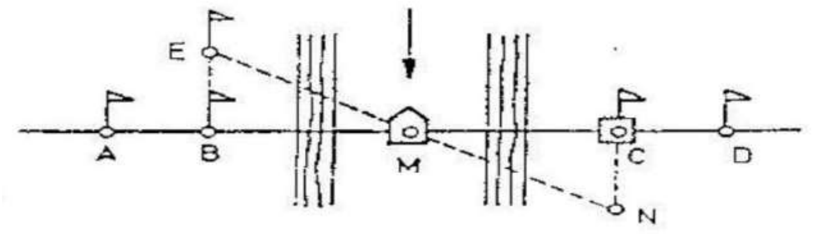
$$area\ correction = \left(common\ width - \frac{1}{2} the\ sum\ of segments\ on\ either\ side\ of first\ RD\ in\ water\right) * \frac{1}{2} depth\ at\ that\ RD * uncovered\ width * depth\ at\ the\ first\ RD\ of\ observation$$

4.1.1.14 MARKING OF SEGMENTS

Where the width of channel permits, the width of each compartment is measured by direct means, i.e., some steel tape/wire suitable marked pendants. Where the channel is too wide, the distance would be measured by optical or electronic distance meters or by any of the usual surveying methods.

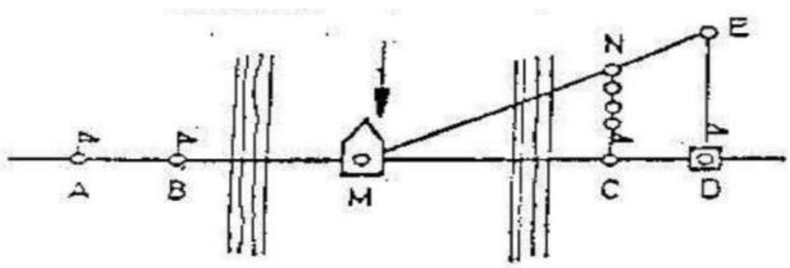
After deciding on the number of segments in which the cross-sectional area is to be divided, it is necessary to mark these on the section line to facilitate correct positioning of the sounding line and current meter on different verticals. For this the most popular method is the pivot point method. When the discharge observation are proposed to be made from a bridge, segments are marked directly on the bridge parapet, railing or structural members.

When wire rope is used for segmentation then on the rope, tags, pendants or tally marks are attached to indicate every vertical on which observations are to be made. Depth and velocity measurements are made by wading or from boat at these verticals.



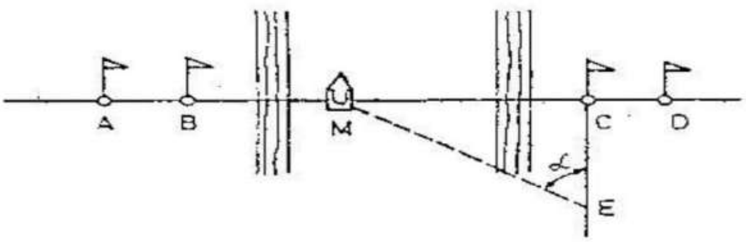
$$MC = \frac{CN \times BC}{BE + CN}$$

Figure 15: Measurement of cross section –Projection from opposite bank



$$MD = \frac{DE \times CD}{DE - CN}$$

Figure16: Measurement of cross section –Projection from One bank



$$MC = CE \tan \alpha$$

Figure17: Measurement of cross section–Angular Method

PIVOT POINT METHOD

When river is wide and land is available the pivot point method is the most suitable method for marking the segments. In this method, as shown in the Figure below distance AP is approximately half the width of the river and PD is about one-fifth of AP. On a line DD", points are marked at fixed intervals depending on the width between the selected verticals. The boat moving on the line AA" can be fixed in the selected vertical by lining up with points P and E1, E2, E3 etc. A second set of pivot points on the other bank can also be used, if required.

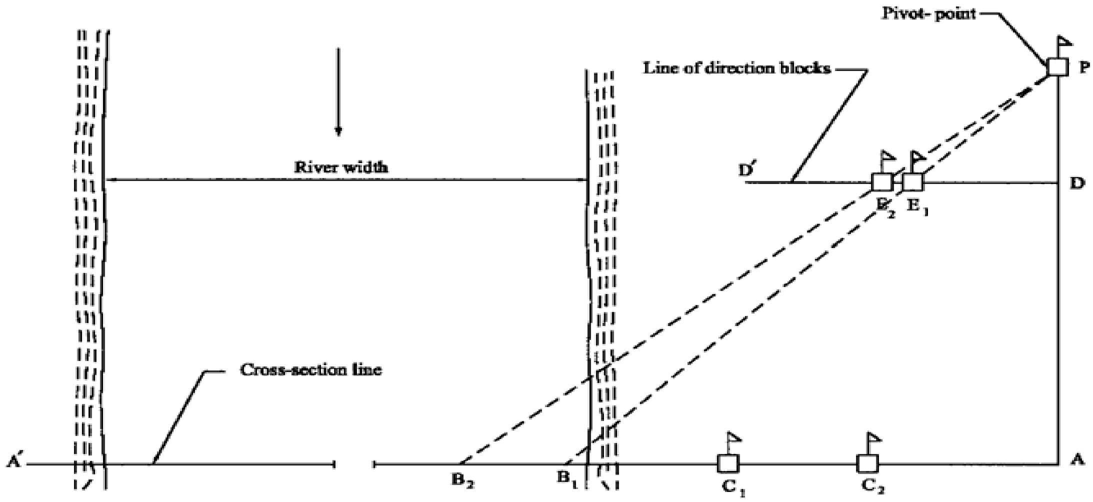


Figure18: Pivot Point Method

4.1.1.15 MEASUREMENT OF DEPTH

Measurement of depth and velocity by current meter are generally made in successive operations. The measurement of depth can be taken by using wading rods, sounding rod, log line or echo sounder.

Wading Rod is used when velocities are low (1 m/s) and depths are small up to 1 m,wading observations using wading rod suspension can be made. If depth of flow permits, these rods may be used when observations are made from a boat or from a channel crossing. The rod is generally upto 3 m in length with arrangement to attach the current meter and a detachable base plate to prevent its sinking in the bed.

Sounding *Rods* are circular or oval in section and are 3m or more in height. They are graduated to read nearest to a centimetre with a base plate at the bottom. They are used to measure depths at the selected verticals. However, bamboo sounding rods can be used to measure depths upto 6m. Marking on the bamboo should be truly vertical and along the body of the bamboo.

Eco-Sounder is used to measure large depths in floods. When the length of the sounding rods becomes insufficient to measure depths and could not be held vertical due to high velocity. An accurate and rapid, method of measuring and recording depths is by means of an echo sounder.

When a sounding rod or sounding line is used at least two readings are taken at each vertical and the mean adopted for calculations. When the difference between the two readings is more than 5% of the large value, in which case two further readings should be taken.

If these are within 5%, they should be accepted for the measurement and the two earlier readings discarded. If they are again different by more than 5%, no further readings should be taken, but the average of all four should be adopted for measurement.

When an echo-sounder is used, the average of several readings should preferably always be taken at each point, but regular calibrations or the instrument are required under the same conditions of salinity and temperatures of the water.

4.1.1.16 MEASUREMENT OF VELOCITY

The velocity is measured by means of cup type or propeller type current meter. The current meter should be held in the desired position in any vertical by means of a wading rod in case of shallow channels or by suspending it from a cable or rod from bridge, trolley or boat in the case of deeper channels.

After a current meter is placed at a selected point in the vertical, it is permitted to become adjusted to the current for at least a period of half a minute before the reading of the current is started. For low velocity of 0.3 m/s or less, this time should not be less than 2minutes. The length of time taken for each measurement shall be not less than 120 seconds or 150 revolutions of the meter, whichever is earlier, in order to eliminate the pulsating effect of the current.

Velocity is measured at all the selected verticals where, and at the same time, depth is measured. Velocity is not uniformly distributed from the surface to the bed at any vertical. It is approximately found to be maximum at 0.2 depth and minimum at the bed level. It is also found by vertical velocity distribution (VVD) experiments that the mean velocity occurs between 0.58d to 0.62d approximately and is equal to 0.89 times the surface velocity at the vertical.

This is normally accepted and hence, velocities are measured at 0.6 depths by current meter. However, experiments should also be conducted on vertical distribution of velocity to verify the assumptions. After the depth at a vertical is observed either by a sounding rod or Echo-sounder, the current meter is lowered to 0.6 depth to measure the mean velocity at the vertical by counting the time taken for the current meter rotor for a number of revolutions. The greater the number of revolutions counted the more accurate value of the velocity we get.

Sometimes it may not be possible to lower the current meter to 0.6 depth, especially at bridge sites in high floods. In that case surface velocity is observed and later converted to mean velocity by multiplying with the factor 0.89. Many times the current is not normal to the discharge section and hence correction is necessary for obliquity by measuring the angle of the current to the discharge section. This correction must be deducted from observed mean velocities to get final corrected velocities normal to gauge line.

4.1.1.17 CURRENT METER MEASUREMENTS BY WADING

A measuring tape or tag line is stretched across the river at right angles to the direction of flow. The position of successive verticals used for depth and velocity are located by horizontal measurements from a reference point on the bank. The position of the operator is important to ensure that the operator’s body does not affect the flow pattern at or approaching the current meter. The best position is to stand facing one or other of the banks, downstream from the meter and at arm’s length from it. The rod is kept vertical throughout the measurement and meter parallel to the direction of flow.

4.1.1.18 CURRENT METER MEASUREMENTS FROM BOATS & POWER LAUNCHES

When wading observation are not possible and a bridge in the vicinity is also not available, depth and velocity observations are made using boat or power launch.

Depth are measured using sounding rods etc and the distance above the water surface should be subtracted from the depth measurement and corrected depth used for proper placing of the current meter. When the boat is correctly brought at the vertical, it is anchored or operated in position by using a stay line cable. If the current is too fast and a power launch is used, its speed is adjusted so that it remains reasonably steady against the current.

When current meter observations are made, the meter must remain steady. This implies that the boat from which the meter is suspended must also remain stable in position. If any movement of the boat takes place, velocities recorded by the meter will not be accurate. This is because the current meter then records velocities of the current relative to the moving boat. These velocities are less than the actual velocity.

Anchorages are used to keep boat stationery while launches can be made stationery on their engine power. Sometimes in high velocities a boat even anchored or a launch even at full speed begins to drift downstream. The drift velocities in such cases have to be found and added to the velocity recorded from the meter to obtain correct velocity of the current as per the following formula: -

$$V_p = 0.064 + 0.98\, V_b + 0.98\, V_d$$

Where Vp = true velocity in meters per second

Vb = velocity in meter per second, observed at the point with the boat drifting

Vd= drift velocity in meters per second

$$V_d = \frac{\text{Drift in meters}}{\text{120 seconds (period of observation)}}$$

Personal safety is an important consideration in boat gauging, and velocity of flow in relation to the power of the boat will limit the conditions under which gauging is possible. All members of the crew should wear life jackets. There should be one member specially assigned to the task of propelling, controlling and positioning of the boat.

Moving Boat method is useful in the cases when:

(a) The river is too wide and the discharge measurement by conventional method is impractical/tedious and costly.

(b) The site is very remote without the Normal facilities required by the usual method.

(c) The facilities at the site are inundated or inaccessible during floods.

(d) The site is situated in a tidal reach where it may be necessary to observe the discharge not only frequently but continually throughout the tidal cycle.

(e) The flow at the site is very unsteady and should be observed as quickly as possible

4.1.1.19 CURRENT METER MEASUREMENTS FROM CABLEWAYS

Cableways are normally used when the depth of flow is too deep for wading, when wading in a speedy current is considered dangerous or when the measuring section is too wide to string a tag line or tape across it. The operating procedure depends on the type of cableway, whether it is an unmanned instrument carriage controlled from the bank by means of a winch, or a manned personnel carriage or cable car which travels across the river to make the observations.

In the case of unmanned cableway, the operator on the bank is able to move the current meter and sounding weight and to place the current meter at the desired point in the river by means of distance and depth counters on the winch. The electrical pulses from the current meter are returned through a coaxial suspension cable and registered on a revolution counter.

The manned cableway is provided with a support for a gauging reel, a guide pulley for the suspension cable and a protector for reading the vertical angle of the suspension cable. The procedure involved is as follows:

(a) Identify and record the water edge (RB or LB) in relation to a permanent initial point on the bank by means of a tag line or by the use of painted marks on the track cable, used for spacing the observation verticals.

(b) Lower the current meter at the first vertical until the bottom of the weight just touches the water surface and set the depth counter to zero.

(c) Lower the current meter assembly until the weight touches the bed, read the counter and record as depth.

(d) Raise the meter back to the surface and place the meter axis at the water surface and zero the depth counter again. Calculate 0.6 D etc. and lower the meter to the required position.

(e) When river is speedy and deep and the suspension cable suffers drag, measure the angle that the meter suspension makes with the vertical using a protector, as a basis for correcting the soundings to obtain the correct depth.

(f) Measure the velocity at the selected depths in the verticals.

(g) Raise the current meter occasionally for inspecting floating debris or weed in the river for cleaning the current meter.

4.1.1.20 CURRENT METER MEASUREMENTS FROM BRIDGES

When a river cannot be waded, suitable bridges may be used for current meter measurements. The advantage of this is that in this there is saving in initial cost of erecting a cable way or purchase boats etc. Its site is accessible at all times of the year. During heavy flow, rivers which spill enormously over miles beyond the banks pose a difficult problem in stream gauging than a bridge under such conditions provide excellent site for gauging where all the river discharge is confined and flows only through the bridge openings.

At the same time, it also has dis-advantages like-usually ideal conditions will not be obtained at bridge site for stream gauging. The bridge may not be normal to the flow; bridge piers offer obstructions and may cause non-uniform and turbulent flow to occur which is unfavourable if accurate discharge observations are to be made.

When current meter is lowered from the downstream of the bridge (which is more convenient) unseen floating debris might get entangled with the current meter. On the other hand, if the upstream of the bridge is used the drag causes the current meter to be hidden under the bridge deck. As such, measurements are usually made from the downstream parapet and not from the upstream side of the bridge. By lowering the rod twice, first till base plate touches surface of water and then till bed, depth of water in the river is calculated.

For road bridges care must be taken to ensure that road traffic does not endanger the gauging team or other road users. For higher bridges and for greater depths, the current meter and weight are suspended on a cable controlled by gauging reel mounted on a bridge derrick or bridge outfit.

Wet Line & Dry Line Corrections are used when suspending the current meter in deep water, as it is carried downstream before the weight touches the bottom. The length of cable paid out is more than the true depth. In order to obtain the corrected depth, dry line and wet line corrections, which are function of vertical angle α, are applied to the observed depth, where the angle α is measured by a fixed protector.

WET LINE CORRECTION

When measurements are made by suspending the current meter in deep swift water, it is carried downstream before the weight touches the bottom . The length of cable paid out is more than the true depth. In order to obtain the corrected depth, dry air line and wet line corrections, which are functions of the vertical angle p, are applied to the observed depth, where the angle p is measured by a fixed protractor.

The recommended routine procedure is as follows:

(a) Measure the vertical distance from the guide pulley on the gauging reel to the water surface using the reel counter. This is (ab) the "air-line" depth.
(b) Place the bottom of the weight at the water surface and set the depth counter on the gauging reel to read zero.
(c) Lower the weight to the bed. Read the sounded depth (ce) and the vertical angle of the cable on the protractor.
(d) The air-line correction (cd) is air-line depth (ab) * (sec p - 1).
(e) Calculate the wet line length as (sounded depth - air line correction) (de = ce - cd)
(f) The wet line correction for given angle p is shown in Table below. The correction is applied to wet line depth.

Vertical Angle	Correction (%)	Vertical Angle	Correction (%)
4^0 (0.07 rad)	0.0	18^0 (0.31 rad)	1.64
6^0 (0.10 rad)	0.1	20^0 (0.35 rad)	2.04
8^0 (0.14 rad)	0.3	22^0 (0.38 rad)	2.48
10^0 (0.17 rad)	0.5	24^0 (0.42 rad)	2.96
12^0 (0.21 rad)	0.7	26^0 (0.45 rad)	3.50
14^0 (0.24 rad)	0.9	28^0 (0.49 rad)	4.08
16^0 (0.28 rad)	1.2	30^0 (0.52 rad)	4.72

Note: Wetline depth minus wet line correction is true depth of water.

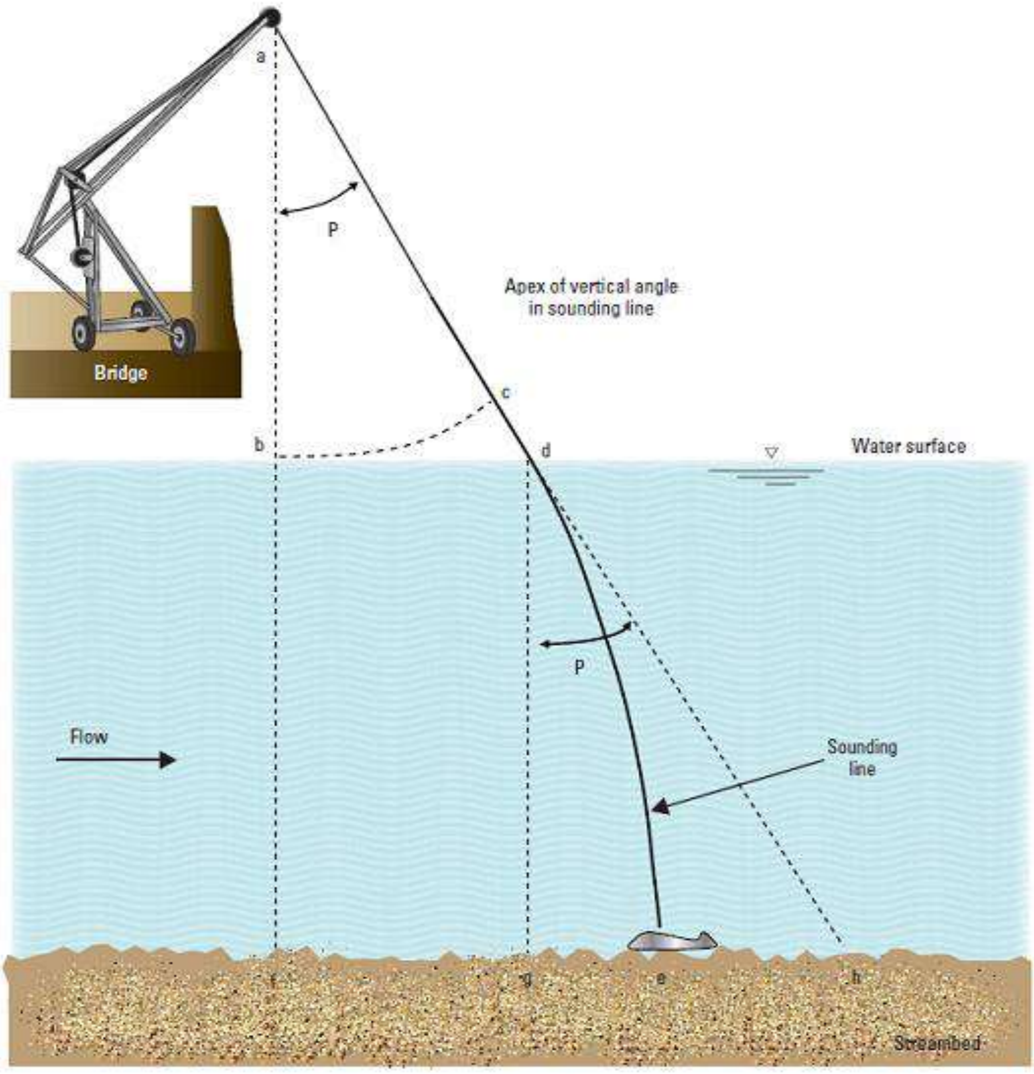


Figure 19: Wetline Correction

4.1.1.21 LIMITATIONS AND PRECAUTIONS IN CURRENT METER OBSERVATIONS

(a) The current meter should not be used beyond the range of velocity for which it has been calibrated.

(b) Errors may arise if the flow is unsteady and if material in suspension interferes with the rotation of the current meter.

(c) If the flow is unsteady, the time for the observation of velocity should be as short as possible otherwise, it will lead to a corresponding decrease in accuracy.

(d) The distance of the axis of the current meter from the side or the bed of the channel shall be not less than 0.75 times the diameter of the propeller or 0.2m, whichever is greater. The distance of the current meter from the side of the boat should, in no case, be less than the distance between the gauging section and the upstream end of the boat.

(e) For depth of water less than one meter, the current meter observation may be made with the help of wading rods, wherever the velocity of flow would permit such measurement.

(f) Usually, current meter is calibrated in laboratory by dragging it in still water, but it is used in flowing water with turbulence. This introduces certain amount of error, which, however, may be ignored.

(g) If the flow is oblique the angle between the direction of the flow and the section line is measured by a float attached to cotton or nylon cord and a protractor/sextant. The component of the velocity normal to the section line is obtained by multiplying the observed velocity by the sine of this angle. For ready use and computation, a modified velocity table is prepared and used during the observation.

(h) If the boat or motor launch drifts during the discharge observation, the drift should be measured carefully and correction to the observed velocity should be made.

The assumption that the mean velocity is given by measurement at 0.6 depth or by taking mean of the velocities observed at 0.2 and 0.8 depths is based on a parabolic velocity distribution. This is not always correct. This assumption needs to be verified occasionally by the velocity distribution method and a suitable coefficient applied, if necessary.

COMPUTATION OF DISCHARGE

The river section is divided into a number of compartments depending upon the degree of accuracy required. The width and mean depth of each compartment is measured to determine its cross-sectional area. The mean velocity in the compartment is measured by a water current meter.

The discharge through each compartment is the product of its cross-sectional area and mean velocity. There are numerous methods of calculating discharge. The one followed by CWC is the “Mid-Section Method”. In this method the depths and the velocities observed at all the verticals are first multiplied and such products summed up and finally multiplied by the common width of the segments. It is given as follows: -

DEPTH VELOCITY INTEGRATION METHOD (MID-SECTION METHOD)

The discharge in the stream is calculated by the summation

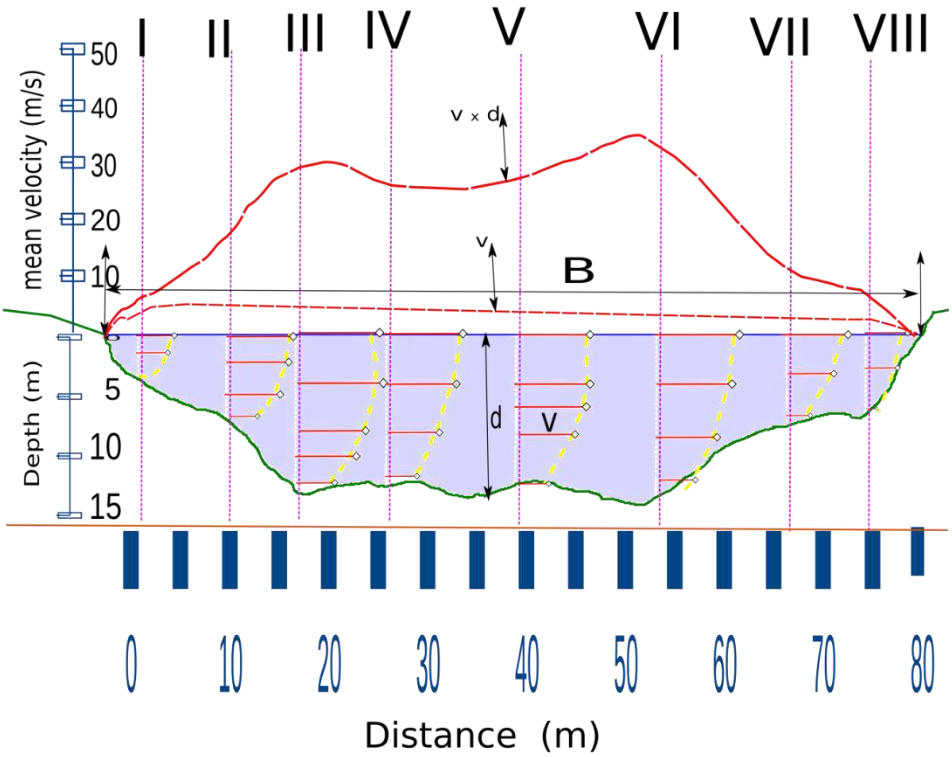
Qm = ∑di bi vi

Where Qm = Calculated Discharge

bi = Width of i^{th} Segment

di = Depth of i^{th} Segment

vi = Mean Velocity in i^{th} Segment



$$Q = \sum^{B} \bar{v} d \, \Delta B$$

COMPUTATION OF DISCHARGE FROM CURRENT METER MEASUREMENTS DEPTH VELOCITY INTEGRATION METHOD

Arithmetical Method (*Mean-Section method)*

q (Segment) = (V1+V2)/2 x (d1 + d2)/2 x b

WhereV1 = mean velocity at segment 1

— V2 = Mean velocity at segment 2

d1 = depth at segment 1
d2 = depth at segment 2

b = horizontal distance between the two segments

The total discharge is obtained by adding the discharge from each segment.

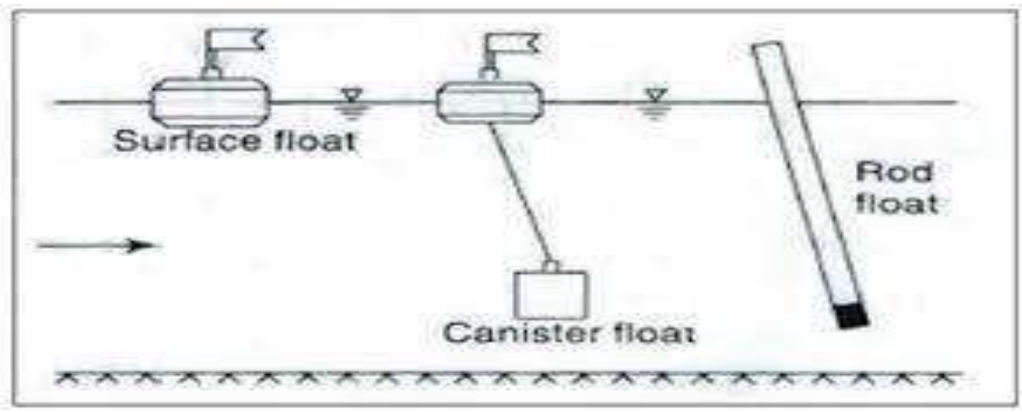
4.2 AREA-VELOCITY METHOD USING FLOAT

4.2.1 SCOPE

During very high floods it may not be possible to venture into the river by boat to observe velocities by current meters. In such circumstances, it is advisable to follow the float observations. The methods of float (surface) observations is designed and have to be adopted as the regular method for daily observations for those sites which are not too wide and where the current meter observations cannot be taken for want of powered navigational equipment, not possible to venture into the river due to high flood, etc.

4.2.2 Type of float

In view of the difficulty in recovery of floats, the floats should be inexpensive and made of the locally available material like jungle wood, bamboo etc., in high floods, floating debris in the river may be used as a float



4.2.3 NO. OF FLOATS

The number of floats will depend on the width of the river and the convenience of observations and shall vary from 8 to 15 inclusive of the two floats to be thrown 5 to 10 M away from the water edge on either side of the river. Keeping the end floats comparatively nearer to water edges is very essential.

4.2.4 FLOAT RUN

The float run shall start from 100m upstream of the station gauge and shall end 100m downstream of the station gauge. The distance could be reduced if there are practical difficulties of keeping this distance as 200m. But in any case the minimum distance between the upper and lower sections should be such that duration of float movement is not less than 40 seconds.

For marking the float run, wooden poles or flags should be erected along both the upper and lower section lines of the float run on both the banks. The float shall be released from a boat or thrown from a bank at a minimum of 15m to 20m above the upper cross-section so that the float attains the velocity of the flow before reaching the upper cross-section. In case of those sites where railway bridges are available, the floats could be thrown from such bridges.

4.2.5 MEASUREMENT OF VELOCITY

For the purpose of discharge calculations, the position of float on the station gauge has to be known. The path of the float shall be determined by angular measurement from a known reference point when the float passes the upper and lower cross section lines. This can be achieved by any of the following two semi graphical methods, which involve the use of compass or Theodolite on one of the banks.

Method-I: In this method the Theodolite or the prismatic compass is kept on bank at a convenient location on the station gauge line. In case of Theodolite, the zero angle should be made to coincide with the station gauge line, and in case of prismatic compass the bearing of the station gauge line should be noted. The moment the float is released, the Theodolite or the prismatic compass is brought in line with the float and the float is followed. The moment the float crosses the upper/upstream line, a person stationed there gives a whistle. The angle that is recorded by the instrument with the station gauge line section is noted.

The float is continued to be followed till it again crosses the lower/ downstream line when another whistle is given by another person standing along that section. This angle with the station gauge line is also noted. This is repeated for each float. A sketch is then prepared showing the upper and the lower section lines as well as the station gauge and the location of the instrument. The angles observed by the instrument are then plotted as shown inFigure-20 and the points “A” and “B” at which the float has crossed the upper and the lower cross-sections are thus obtained. The points “A” and “B” are joined to intersect the station gauge at “C”. The location of “C” gives the RD at which the velocity indicated by the float is applicable. The location of water edges shall be obtained by actual measurement.

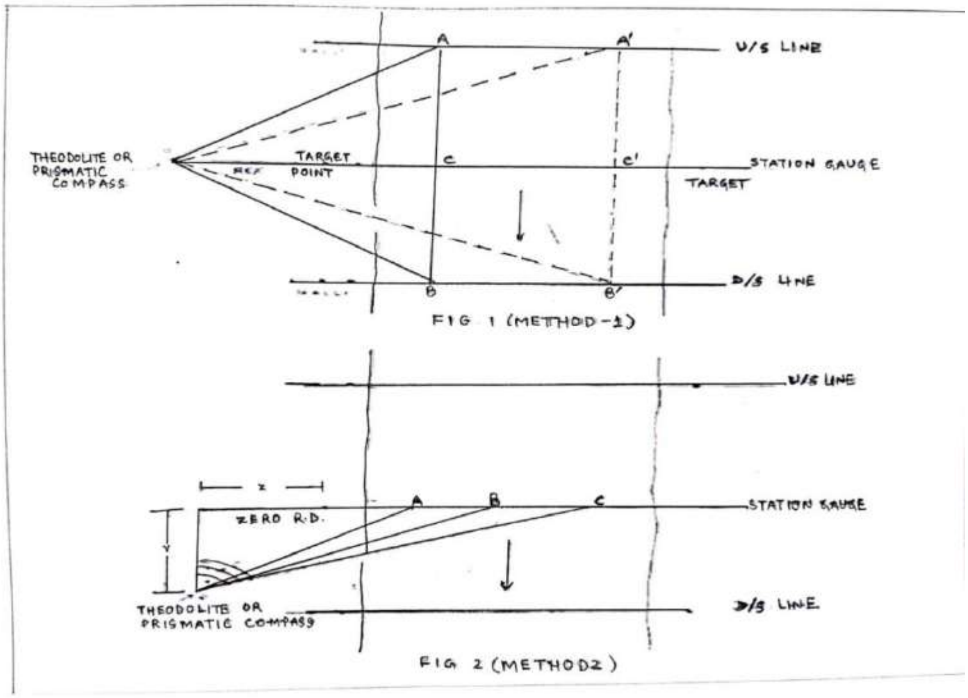


Figure 20: Angular Measurement using Theodolite

Method II: In this method, the theodolite or the prismatic compass is kept on a bank at a convenient point either upstream or downstream of the station gauge line, say at a distance of about 100 to 200 m from the point where the instrument has been kept, a line perpendicular to the station gauge line is set out and the bearing noted in case of prismatic compass and in case of theodolite, the zero angle made same as this perpendicular line.

The float is followed by the instrument as in case of Method I. However, an extra person is required at the station gauge line to give signal when the float crosses the station gauge section. The angle to be measured by the observer shall only be one angle i.e., at the time the float crosses the station gauge line. No angles needed to be measured when the float crosses the upstream or downstream section. Then as shown in Figure18 above, a sketch is prepared to show the location of station gauge line and the position of the instrument.

The angles measured by the instrument with respect of the perpendicular to the station gauge line are plotted so as to give the points “A” “B”, “C” etc., on the station gauge giving the RD at which the float has crossed the station gauge section. The water edges are in this case also measured by actual measurement. The time at which the float crosses the upper and lower cross-section lines shall be noted. This shall be repeated with the floats at various positions along the width of the river from one bank to the other. The velocity (surface) of flow of water shall be determined by dividing the distance between the upper and lower cross section by the time taken. This gives the velocity of the float normal to the station gauge section at the RD at which it has crossed the station gauge.

4.2.6 DEPTH MEASUREMENTS

The RDs depth shall be taken from the latest available cross section for the station gauge line. By cross-section here means the plot of the underwater portion based on the actual depths.

4.2.7 METHOD OF CALCULATIONS

The RDs at which the velocities have been observed are first marked on a straight line drawn to scale on a graph sheet representing the station gauge line cross section. The corresponding velocities are then plotted normal to this line to a convenient scale and these values are then joined to form a horizontal velocity distribution curve across the station gauge line. The depths at various RDs (at equal intervals) are determined from the cross sections. The velocities at these RDs are obtained from the velocity distribution curve mentioned above. Knowing the velocity and depth, the discharge could be worked out as in case of current meter observations.

4.3 DISCHARGE ESTIMATION BY AREA-SLOPE METHOD

In this method, discharge is worked out by multiplying cross-sectional area by average velocity of the whole stream which is found indirectly, using one of the open channel flow formulae. The method lacks accuracy since both, area as well as velocity, can be determined only approximately. Generally, area of cross-section measured during dry weather season has to be adopted in computation of flood discharge. However, there may be some differences in dry weather and flood sections of a river unless the bed is rocky. In alluvial rivers variation in section in narrow reaches can be considerable.

Assessment of the proper value of the coefficient in an open channel flow is another limitation in this method. Similarly, accurate data of river slope may not many times precisely available. Due to these limitations discharge estimated by Area-Slope method can at best be approximate and cannot be accepted at par with discharge measured by current-meter observations. When width of the river is more than 60m, it is necessary that gauges on both the banks be installed and the mean gauge value is used in slope calculations.

4.3.1 AREA

It is desirable to observe the flood sections for calculating the cross-section area but in case, if it is not possible then area of cross-section measured during dry weather season has to be adopted for computation of flood discharge. In such cases it is likely that changes which have occurred in river bed in the intervening period might affect the result.

4.3.2 VELOCITY

The velocity is deduced indirectly by observing the slope of water surface and using Manning's formula:

$$V = (1/n)(R^{2/3} S^{1/2}) \text{ m/sec}$$

Where:

V= Velocity in meter/sec

R= Hydraulic mean radius = A/P (Area of the Discharge Section/Wetted perimeter of the discharge section).

(Wetted Perimeter is some time taken as water width itself for simplicity)

S= Slope of water surface per meter.(It is calculated by observing the gauge readings of the U/s Section and D/s section)

n = Rugosity Co-efficient.(This should be based on the actual value determined previously by Area-Velocity method for the same Water level).

4.4 DISCHARGE ESTIMATION FROM STAGE-DISCHARGE RELATION

When it is not possible to observe discharge daily on considerations of expenditure or during flood stages, discharges are computed from a stage discharge curve (Rating curve) developed on the basis of stage discharge data earlier observed.
The rating curve should be prepared from actual observations spread over the whole range of flow at the site. Where it is not possible to observe the discharge in extraordinary high floods the rating curve is extrapolated for estimation of the high flood discharge. The method normally used in the field is to plot the rating curve on a log-log paper and then extrapolation of it for the high stage required.

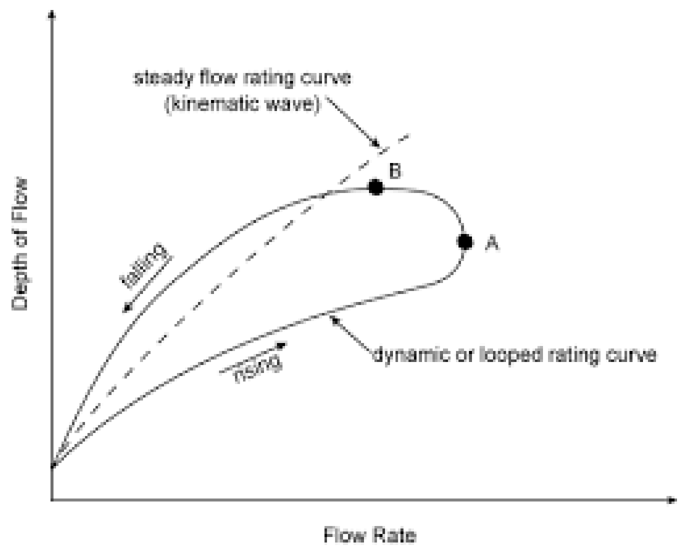


Figure 21: Typical Stage Discharge Curve

4.5 SPECIAL METHODS OF DISCHARGE MEASUREMENT

4.5.1 DISCHARGE MEASUREMENT USING ADCP

In recent years, advancement in technology has allowed us to make discharge measurements by use of an Acoustic Doppler Current Profiler (ADCP). An ADCP uses the principles of the Doppler Effect to measure the velocity of water. The Doppler Effect is the phenomenon we experience when passed by a car or train that is sounding its horn. As the car or train passes, the sound of the horn seems to drop in frequency.

The ADCP uses the Doppler Effect to determine water velocity by sending a sound pulse into the water and measuring the change in frequency of that sound pulse reflected back to the ADCP by sediment or other particulates being transported in the water. Due to the Doppler Effect, sound waves bounced back from a particle moving away from the profiler have a slightly lowered frequency when they return.

Particles moving toward the instrument send back higher frequency waves. The difference in frequency between the waves the profiler sends out and the waves it receives is called the Doppler shift. The change in frequency, or Doppler Shift, that is measured by the ADCP is translated into water velocity. Sound waves that hit particles far from the profiler take longer to come back than waves that strike close by measuring the time it takes for the waves to bounce back and the Doppler shift, the profiler can measure current speed at many different depths with each series of pulses.

Figure 22: ADCP (Courtesy: B&BBO, CWC)

Particles moving toward the instrument send back higher frequency waves. The difference in frequency between the waves the profiler sends out and the waves it receives is called the Doppler shift. The change in frequency, or Doppler Shift, that is measured by the ADCP is translated into water velocity. Sound waves that hit particles far from the profiler take longer to come back than waves that strike close by measuring the time it takes for the waves to bounce back and the Doppler shift, the profiler can measure current speed at many different depths with each series of pulses.

The sound is transmitted into the water from a transducer to the bottom of the river and receives return signals throughout the entire depth. The ADCP also uses acoustics to measure water depth by measuring the travel time of a pulse of sound to reach the river bottom and back to the ADCP.

To make the discharge measurement, the ADCP is mounted onto a boat with its acoustic beams directed into the water from the water surface. The ADCP is then guided across the surface of the river to obtain measurements of velocity and depth across the channel. The river-bottom tracking capability of the ADCP acoustic beams or a Global Positioning System (GPS) is used to track the progress of the ADCP across the channel and provide channel-width measurements.

Using the depth and width measurements for calculating the area and the velocity measurements, the discharge is computed by the ADCP using discharge = area × velocity, similar to the conventional current-meter method.

The ADCP has proven to be beneficial to stream gauging in several ways. The use of ADCPs has reduced the time it takes to make a discharge measurement. The ADCP allows discharge measurements to be made in some flooding conditions that were not previously possible. The ADCP provides a detailed profile of water velocity and direction for the majority of a cross section instead of just at point locations with a mechanical current meter; this improves the discharge measurement accuracy.

A number of ADCP's of RDI make has been deployed at many of the CWC Hydrological Observation stations. The models presently in use are RDI Workhorse and the more recent one called River Ray. The Workhorse model is to be fixed on an OBE propelled boat with some anchoring arrangement, whereas the River Ray which consists of trimaran has to be towed with help of the boat and communication between the laptop and ADCP can be done using Bluetooth.

Figure 23: Rio Grande Work Horse ADCP

4.5.1.1 SALIENT FEATURES OF RIO GRANDE WORK HORSE ADCP

The Rio Grande Work Horse ADCP has several operating modes, which can be selected via the laptop. The selection of the most appropriate operating mode is dependent on site conditions. The selection of operating modes is referred to briefly in the following paragraphs. However, for detail the users should refer to the manufacturer's user manual.

The Work Horse 600 kHz and 1200 kHz, has four operating modes i.e. modes 1, 4, 5 and 8. A comparison of these different operating modes which has been taken from the manufacturer's user manual is contained in Table.1
The major site constraint on the use of the ADCP is the channel depth

(a) Operating mode 1 only functions in depths greater than 1.0 m;
(b) Operating mode 4 only functions in depths greater than 3 m;
(c) Operating mode 5 only functions in depths greater than 1.25 m;
(d) Operating mode 8 only operates in depths greater than 0.8 m

Table 1: User manual for different operating modes for Work Horse

	Mode 1	Mode 4	Mode 5	Mode 8
Minimum recommended cell size	0.10 m 0.20 m	0.25 m 0.50 m	0.10 m 0.20 m	0.10 m 0.20 m
Single ping standard Deviation (min. cell size)	0.6 m/s 0.5 m/s	0.13 m/s 0.13 m/s	0.01 m/s 0.01 m/s(at 0.5 m/s flow velocity)	0.15 m/s 0. 1 m/s(at 1.0 m/s flow velocity)
Minimum depth of water	1.0 m 1.20 m	2.5 m 3.0 m	2.0 m 2.0 m	1.0 m 1.0 m
Maximum range (Mode 5&8 for <50 cm/s flow velocity)	20 m 50 m	20 m 60 m	4 m 8 m	4 m 8 m
Maximum relative velocity	10 m/s 10 m/s	10 m/s 10 m/s	1 m/s 1 m/s	1 m/s 2 m/s
Typical application	Very fast water of all depths. Rough and dynamic situations. Good in streams too fast or deep for modes 5 & 8, and not deep enough or too rough for mode 4	General purpose for most streams more than 3 m deep	Slow, shallow water with low shear and turbulence conditions	Shallow streams with velocities < 2 m/s and with high shear (rough bed and /or turbulence. Works where mode 5 does not work well).

i) Maximum range depends on water temperature and depth cell size. Use BBSETUP to compute the maximum range for a particular ADCP set-up and water temperature. The standard deviation of modes 5 & 8 varies with water velocity, boat speed, bed form roughness, channel depth and turbulence. Reference should be made to the ADCP for further discussion on these modes.

ii) The Figures in normal type are for the 1200 kHz system and those in italics for the 600 kHz system.

iii) Table showing comparison of performance of RDI 1200 kHz and 600 kHz ADCPs, both with transducers at 0.25 m deep & blank set to 0.30

However, it is recommended that the effective depth should be greater than 1.5 m for at least 95% of the cross-section.

NOTE: The depth is actually the effective depth i.e. the position from the transducers to the bed of the river. Therefore, if the transducers are positioned 0.3 m below the surface, then an actual depth of 1.5 + 0.3 m = 1.8 m is required.

Another major site consideration is flow velocity:

(a) Mode 8 can accurately measure flow velocities greater than 0.06 m/s.

(b) Modes 1 & 4 can measure velocities up to 10 m/s;

(c) Modes 5 and 8 can only measure velocities up to 1 and 2 m/s respectively;

(d) The uncertainties in Mode 1 velocity readings are significantly higher than other modes.

Table 2: Velocity and Depth Constraints

	Velocity - v (m/s)					
Depth (m)	v < 0.04	0.06 > v > 0.04	0.05 > v > 0.06	1.0 > v > 0.05	2.0 > v > 1.0	10 > v > 2.0
< 1.0	none	none	none	none	none	none
1 < d < 1.5	none	none	mode 8	mode 8	mode 1	mode 1
1.5 < d < 3.0	*	mode 5	mode 5	mode 5	mode 1	mode 1
3.0 < d < 4.0	*	mode 5	mode 5	mode 4	mode 4	mode 4
D > 4.0	none	none	none	mode 4	mode 4	mode 4

** Minimum water velocity in mode 5 at these depths has not been ascertained*

4.5.1.2 DEPLOYMENT OF ADCP

The ADCP should be deployed from an outboard motor propelled boat, which has been specially adapted for the task. The boat should be of a shallow draft type, preferably not greater than 0.5 m when laden with the equipment and the required number of operatives. Also, the boat should be relatively flat bottomed, stable and easily manoeuvred.

The ADCP should be fixed to the boat by means of a mounting arrangement. It should be possible to fit the mounting arrangement to any boat. This arrangement should be such that the ADCP transducers can be raised and lowered to different positions below the water surface in 0.1 m increments from 0.1 to 1.0 m. A rigging facility is required to prevent the ADCP to lean back during (fast) sailing. The rigging should be such that when the ADCP impacts with anything solid it can give way and swivel to the surface. An adequate shelter should be provided on the boat to protect the operator and laptop PC from sun and rain. A rigid working table should be provided on which to place the laptop PC and field data forms. However the latest model of ADCP's are mounted on floating trimaran, which are towed by the Outboard motor propelled boat using strong and flexible synthetic rope which is anchored to the boat. In such type of ADCP's on trimaran the communication between the laptop and the ADCP is carried out using Bluetooth connectivity.

ADCPs can be deployed in self-contained and real-time mode. The latter is preferred since anomalies and problems with the data being collected can be spotted immediately by means of the laptop. In some situations, it might be necessary to operate the equipment in self-contained mode, i.e. without a laptop PC connected but recording data in internal memory. The ADCP should be fitted with such memory then. A PC is required anyway to set-up the ADCP before and to retrieve the collected data after the deployment.

4.5.1.3 OPERATING SET-UP

Prior to commencing a measurement various set up parameters must entered into the ADCP via the PC lap top and deck box. The appropriate operating mode must be selected. Certain deployment parameters can be set within each operating model Bin size (size of each depth cell measured) Blanking distance ADCP depth (depth of transducers below the surface).

The time between "pings " can also be set-up. Experience has shown that if the time is set to continuous (the default setting) interference can possibly occur between consecutive sets of pings. The manufacturers have therefore recommended that the time be set to a small amount, say 0.025 milli-seconds. Even though the third point above is set when the ADCP is bolted onto the boat but is not required in case of latest models installed on trimaran. The bin, blanking and transducer depth depend on the water depth and channel conditions. No data is collected less than one bin from the bottom. No data is collected less than the sum of all three parameters from the water surface. Water velocities in these upper and lower regions of the profile are estimated. The literature on the ADCP states that a minimum of two depth cells must produce good velocity data to give accurate flow measurements.

There are certain rules to note:

(a) Always ensure that the depth specified in the deployment file is the depth at which the transducers are set (ignore for trimaran installed ADCP);

(b) Never use a blank of less than 0.2 m. It has shown that this will result in erroneous velocities being recorded in the top bin;

(c) In turbulent or high velocities ensure that the transducer depth is sufficient to be below the level of aeration (at least 0.3 m); and in case of trimaran the ADCP should not jump above the river surface in air.

(d) When reading the data make sure the configuration file has the same parameter values as the deployment file;

(e) Make a note of the width of the channel between the end of the ADCP traverse and the bank. If this distance is significantly large relative to the overall width it can be used to adjust the calculated flow. This should not be a problem if the site is carefully selected i.e. avoid shallow water.

Table 3: Settings appropriate for an RDI

Channel conditions	Mode	Bin (m)	Blank (m)	Transducer depth
Low Velocity shallow channel	5	0.1	0.2	0.1
Shallow channel	8	0.1	0.2	0.1
Shallow channels, high velocities	1	0.1	0.2	0.3
Channels 1.5 -3.0	5(v<2.0 m/s)	0.1	0.2	0.2
Channels>3.0	1(v<2.0 m/s)	0.1	0.2	0.3
		0.5(<10 m)	0.5	0.5
Channels>3.0 deep	4	1.0(>10 m)	0.5	0.5

4.5.1.4 MEASUREMENT RUNS

Once the ADCP has been set-up the measurement of traverses can be commenced. When in real-time mode the run can start immediately. However, operating the ADCP in self-contained (remote) mode the cable from the laptop to the ADCP has to be disconnected prior to starting in case of Rio Grande Work Horse. A dummy connector has to be placed on the ADCP plug socket to avoid damage of the electrical contacts by water and dirt.

Even though the boat can traverse the river following an irregular path it is recommended that as much as possible the boat traverses the river at right angles to the flow / banks. The boat speed should be as slow as reasonably possible while at the same time being sufficient to maintain a steady, smooth on-line course. The course should be kept stable and, if needed, only gradual changes are permitted. This speed should be low enough to take at least several minutes to complete a full traverse. On wide channels the speed over the ground may be increased to about the average flow velocity.

It is recommended that at least four traverses are made i.e. across and back twice and the calculated discharges compared for consistency and repeatability for each run. If bottom-tracking errors occurred in any calculated discharge or the calculated discharge deviates by more than 5% from the average of the calculated discharges, the traverse should be set apart and another 2 traverses should be made. For the estimation of the discharge, the unmeasured flow should be estimated by the provided software; the observer should enter his estimates for the distance to the start and end banks. Both the top and bottom layers should be automatically extrapolated by software applying the standard power fit method.

It is recommended that the boat pauses (remains stationary while collecting data) in a fixed position at the start and end of each traverse for a period of 30 - 60 seconds since this can assist with the final interpretation and processing of the data. The start and stop of movement should be extremely gradual to avoid bottom-tracking failure.

4.5.2 COLOUR VELOCITY METHOD/ RADIO-TRACER

There are other methods also in vague with a limited field of application under special circumstances. Their use is not recommended when more reliable method like area-velocity method with a current meter is possible. It is therefore used only for approximate estimation and is economically feasible in case of very small streams. In this method, discharge is computed from observed area of cross-section and velocity measured by using a suitable colouring matter. Fluorscein, a red powder, when dissolved in slightly alkaline water produces an easily distinguishable greenish colour even if in very dilute solution. Any other red or green aniline dye can also be used. Can of the colouring matter is quickly emptied and exact time of travel of the cloud of the dye to a downstream station on the stream is measured by a stop watch. Distance between the point of introduction of the dye and its detection should be sufficiently long depending on the velocity of the water since longer time of travel would yield greater accuracy in observation. Distance travelled divided by the time of travel gives the average velocity of the current.

4.6 RECORD OF DISCHARGE

For proper maintenance and recording the discharge values, the standard river data forms (RD Forms) RD-1 & RD-2 are used. RD-1 form is used for recording daily discharge observations at 8:00 hrs. RD-2 form is being used for the summary record of observed discharge for 10 daily.

Depending upon the IT resources available at the site, the RD forms shall be uploaded on eSWIS immediately. Otherwise, not later than one month, at the Sub-division / Division office, the recorded gauge & discharge in the RD forms should be entered into the e-SWIS online data entry system for storage, retrieval and dissemination purposes and further processing for preparing year books etc.

CHAPTER 5

SUSPENDED SEDIMENT OBSERVATION AND ANALYSIS

5.1 Introduction

Knowledge of sediment passing in a stream is essential in the solution of variety of problems associated with flow in rivers. Existing theories and empirical formulae for computation of transport give values that are un-verified for areas for which they have to be applied. These can be continued where specific data for verification is not available, due to various constraints. Actual data gathering help in better verification, and lead to better problem solving and designs of water use facilities.

The quantity of sediment passing a section can be determined either directly or indirectly. The direct method aims at determining the weight or volume of sediment passing a section in a period of time. Indirect methods aim at measuring the concentration of sediment flowing in the moving water. This approach needs the measurement of sediment concentrations, the cross sections areas and velocities.

This will also need looking at the sediment being transported as wash load, and bed load. Bed load measurement, though very important for unstable river channels, may not have much relevance for peninsular rivers. The use of empirical methods for bed load estimation may remain within desired accuracy ranges.

Observation of suspended particle load is alongside discharge measurements are economically justified in terms of extra financial and manpower requirements. Important information needed in respect of sediment is particle size distributions for design of sediment exclusion arrangements etc,

Briefly, the objectives of sediment measurements are listed below:

(a) Estimation of sediment inflow into reservoirs at the planning and design stage - by estimating the suspended load and bed loads separately.

(b) Studies for river training and river regimes – data may have to be gathered by mounting intensive gathering drill for short periods

(c) Evaluation of catchment erosion and identifying conservation measure.

(d) Estimation of regime widths and scour depths for barrages bridges from bed material analysis

DEFINITIONS

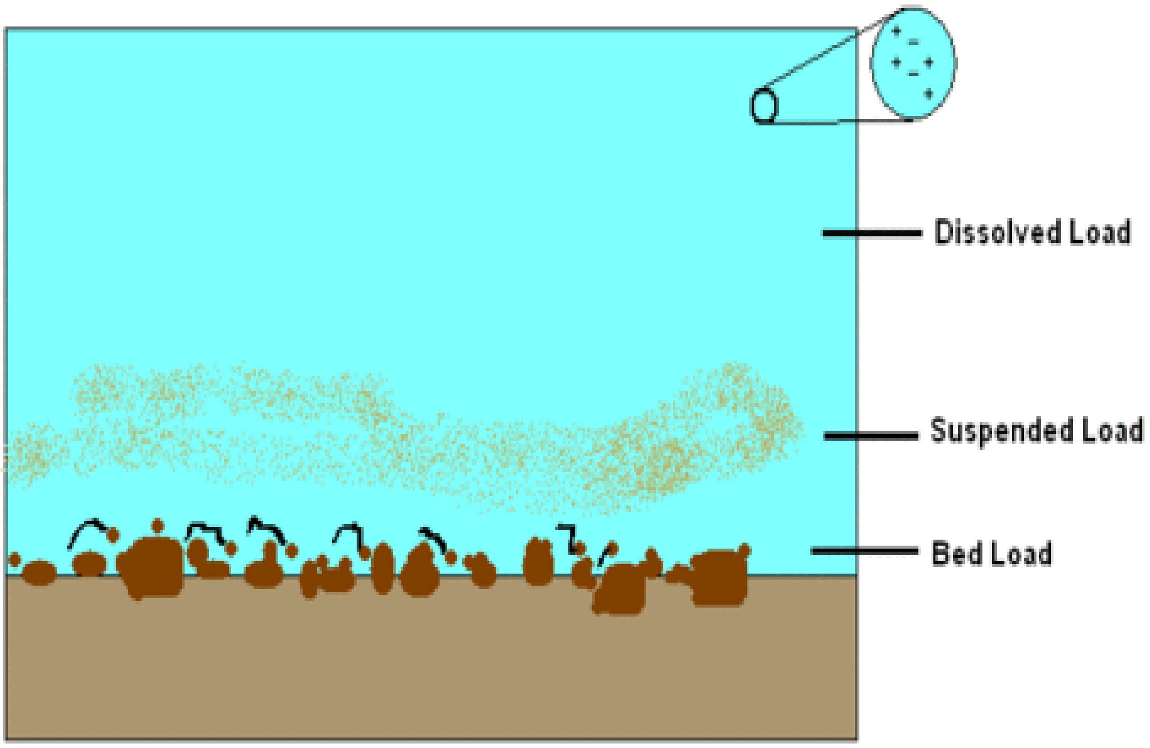
- **SEDIMENT TRANSPORT**: Movement of solids transported in any way by a flowing liquid. It is the sum of the suspended load transported and the bed load transported.

- **TOTAL LOAD**: the total load comprises bed load and suspended load, the latter including wash load.

- **BED MATERIAL**: Material, the particles of which are found in appreciable quantities in that part of the bed affected by transport.

- **BED MATERIAL LOAD**: Part of the total sediment transported which consists of the bed material and whose rate of movement is governed by the transporting capacity of the channel.

- **SUSPENDED LOAD**: That part of the total sediment transported which is maintained in suspension by turbulence in the flowing water for considerable periods of time without contact with the stream bed. It moves with practically the same velocity as that of the flowing water. It is generally expressed in mass or volume per unit of time.



- **BED LOAD**: Sediment in almost continuous contact with the bed, carried forward by rolling, sliding or hopping.

- **WASH LOAD**: The part of the suspended load that is composed of particle sizes smaller than those found in appreciable quantities in the bed material. It is near permanent suspension and, therefore, is transported through the stream without deposition. The discharge of the wash load through a reach depends only on the rate with which the particles become available in the catchment and not to the transport capacity of the flow. It is generally expressed in mass or volume of the suspension.

Thus Sediment is fragmented material derived from the physical and chemical disintegration of rocks present on earth's crust. Such particles may range from boulders to particles of colloidal sizes. Their shapes, influenced by constituent minerals, may range from angular to round.

Once particles are detached from their resting-place they may be transported by gravity, wind, water or by a combination of these agents. Where the transporting agent is water the transported material is "Fluvial sediment" and the process of detaching the particles and setting them in motion is called "Erosion".

Erosion may be sheet erosion where the finer grains are detached and moved by rain drops, splash and sheet flow. Further transport is in water flowing in channels. Due to topography of the catchment, sheet flow does not occur continuously over large areas, but quickly concentrates into small rills or channels and streams, which grow in size as each joins the other. Within the channels the flowing water erodes the material in the bank or in the bed till the stream is "loaded".

EFFECTS OF SEDIMENT IN RIVERS

(a) Land erosion
(b) Floods and meandering
(c) Degradation, aggradations and local scour
(d) Silting of reservoirs
(e) Navigation obstructions
(f) Hydro Power plant operation

SITE SELECTION CRITERIA FOR SEDIMENT SITES

(a) The measuring site should be in the middle of a channel stretch that should be straight over a distance at least 6 times the width at bank full flow and be of uniform cross section and slope.

(b) In stable channels (poised alluvial bed or rock substratum) flow directions for all points on any vertical across the width should be as much as possible parallel to one another and at right angles to the measurement section and this at all stages.

(c) In large alluvial sand bed rivers with formation of migrating shoals, the cross-section for gauging flow and sediment should be adapted continuously to the changing morphology, possibly also during the flood hydrograph.

(d) The bed and margins of the channels should be stable and well defined at all stages of flow.
(e) The curves of the distribution of velocities over depth and width should be regular (in the vertical and horizontal planes of measurement.

(f) Conditions at the section and in its vicinity should also be such as to preclude changes taking place in the velocity distribution during the period of measurement.

(g) Sites displaying vortices, reverse flow or dead water should be avoided, especially when associated with structures in the streambed or with bed rock outcrops.

(h) The measurement section should be clearly visible across its width and unobstructed by trees, aquatic growth or other obstacles.

(i) The depth of water at the section should be sufficient at all stages to provide for the effective immersion of the instruments, whichever is to be used.

(j) The site should have easy access at all times, for all necessary measurement equipment.

(k) The section should be sited away from pumps, sluices and outfalls, if their operation during a measurement is likely to create flow conditions not enough close to uniform flow.

(l) Sites should be avoided where there is converging or diverging flow.

(m) In those instances where it is necessary to make measurements in the vicinity of a bridge, it is preferable that the measuring site be upstream of the bridge. Although in special cases and where accumulation of logs or debris is liable to occur it is acceptable for the flow-measuring site be downstream of the bridge, sediment should preferably be sampled at another location. Particular care should be taken in determining the velocity distribution when bridge apertures are surcharged.

(n) It may, at certain states of river flow or level, prove necessary to carry out sediment measurements on sections other than that selected for the station. This is quite acceptable if there are no substantial ungauged flow and sediment losses or gains to the river in the intervening reach and so long as all measurements are related to levels recorded at the principal reference section

TYPE OF SAMPLER

- **Bottle type sampler (e.g. Punjab sampler)**

To be used only if suspended sediment does not contain significant proportions of medium and coarse fractions.

Figure 24: Punjab Type Sampler

- **Light-weight streamlined, fixed-volume point sampler or depth-integrated sampler (e.g. US DH-48)**

To be used when suspended sediment contains more than 5 % medium + coarse fractions and when the sediment concentration of the sample is higher than 100 g/m^3.

- **Heavy-weight streamlined, fixed-volume point sampler or depth-integrated sampler (e.g. US P- 61 or US P-63)**

To be used when suspended sediment contains more than 5 % medium + coarse fractions and when the sediment concentration of the sample is higher than 100 g/m^3.

5.2 SUSPENDED SEDIMENT SAMPLING METHOD

SINGLE VERTICAL SAMPLING

- Objective: to obtain a sample that represents the mean discharge-weighted suspended - sediment concentration in the vertical being sampled at the time of sample collection.

- Method: depending on flow conditions and Particle size of suspended sediment transported, four types of situations can be distinguished

- Low velocity (v< 0.5 m/s)
  - At these velocities, little or no sand would be in suspension, and distribution of the sediment is relatively uniform over the cross-section. In shallow streams, the sample may be collected by submerging by hand an open-mouth bottle into the stream. The bottle should be filled by moving it from the surface to the streambed and back, or at 0.6 of the depth. If the stream is not wadable, use weighted bottle type sampler. The samples are not discharge-weighted.

- High velocity (0.5 m/s = v < 3.5 m/s), depth = 4.5 m

  Use standard depth-integrating samplers. The transit rate used during raising has to be different from the one used in lowering, but both rates must be constant in order to obtain a velocity or discharge-weighted sample. For streams that transport heavy loads of sand, at least two complete depth integrations of the sample vertical should be made as close as possible in time.

- High velocity (0.5 m/s = v < 3.5 m/s), depth >4.5m

  It is possible to use depth-integrating samplers only with special precautions. In principle, point integrating samplers should be utilised.

- Very high velocities (v = 3.5 m/s)

  Only surface or dip sampling is recommended.

THE EQUAL-DISCHARGE-INCREMENT METHOD (EDI)

With the EDI method, samples are obtained from the centroids of equal discharge increments. It requires some previous knowledge of the distribution of the stream flow in the cross-section. If this is already known, the method saves time and labour, as fewer verticals are required.

The flow distribution across the channel should therefore be determined prior to sampling. A minimum of four and maximum of nine verticals should be used when applying the EDI procedure. The method assumes that the sample collected at the centroid represents the mean concentration of the subsection. The cumulative discharge distribution is used to determine the location of the centroids (of equal increments of discharge).

The most widely utilised principle for suspended load measurement is to determine the concentration of sediments in river water. Samplers of different types and makes are available on the market, but CWC uses point sampler known as Punjab type Bottle sampler. A point-integrating sampler is equipped with a device for opening and closing the sampler nozzle or mouth - for controlling the sampling time. In CWC, the methods and instruments for suspended load measurements have been kept as simple as possible:

(a) The samples are taken generally from each vertical at which the velocity measurements are taken.

(b) The number of composite samples taken has to be as small as possible depending upon the river characteristics and specific requirements, if any.

(c) The sampling has to be done at one level only (0.6 of the depth).

(d) Punjab type bottle sampler is used at all stations of CWC.

5.2.1 PUNJAB BOTTLE SAMPLER

The sampler is appropriate for rivers with suspended load almost exclusively composed of wash load, with no or little coarse and medium particle size fractions. Principal advantages, limitations of bottle samplers are as given under:

(a) Bottle samplers are very simple and easy to use; they can be appropriate for operation in rivers containing only wash load in suspension, the coarse and medium particle size fractions being very limited in concentration.

(b) The Punjab bottle sampler was designed in India in 1935 for slow flowing, shallow rivers and canals, and does not work efficiently at large depths.

(c) The Punjab-type bottle sampler does not work efficiently at high velocities, mainly due to the difficulty to keep it vertical, also when suspended or hung from a line with a fish-weight.

(d) The water does not enter the bottle with the velocity and direction of the surrounding stream velocity (not iso-kinetic sampling).

Figure 25: Measurement using Sediment Sampler

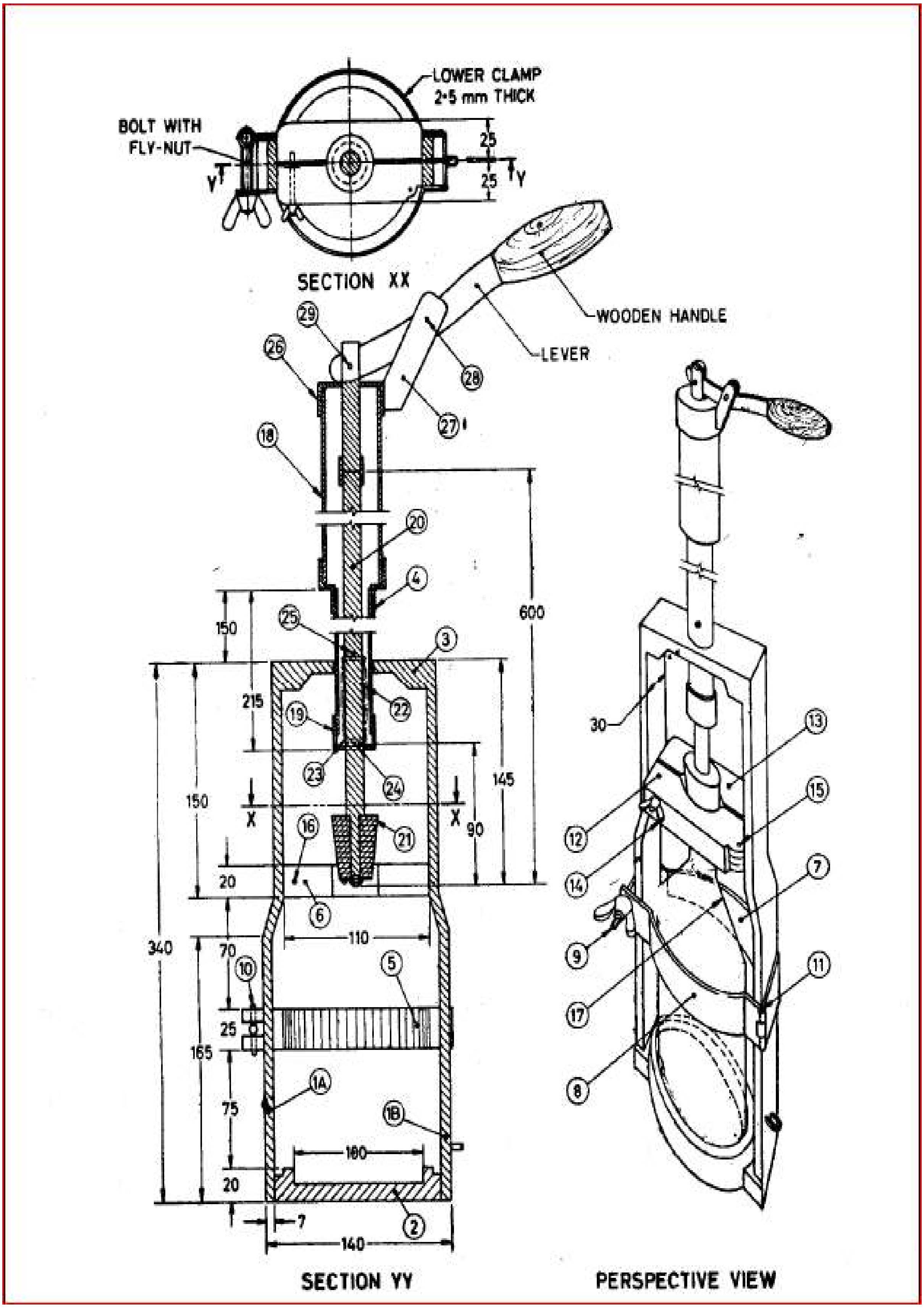


Figure 26: Sketch of components of Punjab Type Bottle Silt Sampler

Part No.	Nomenclature	Part No.	Nomenclature
1A	Vertical Side	15	Pin
1B		16	Hole (Threaded)
2	Base Plate	17	Bottle
3	Elbow Clamp	18	Pipe Extension
4	Lower Pipe Spring Cylinder	19	Half Socket
*5	Lower Clamp	20	Rod
*6	Upper Clamp	21	Cork
7	Semi-circular Shaped Strip	22	Spring Strong Coiled
8	Semi-circular Shaped Strip	23	Washer
9	Bolt	24	Rivet
10	Pin	25	Screws
11	Pin	26	Half Socket
12	Rectangular piece	27	Elbow Shaped Flat Plates
13	Rectangular piece	28	Pin
14	Fly-Nut Headed Screw	29	Bolt

* for the sake of convenience details 5 and 6 have been numbered, which comprise of several smaller details which have also been numbered.

NOTE: Part numbers are given inside circles
All dimensions are in milimeters

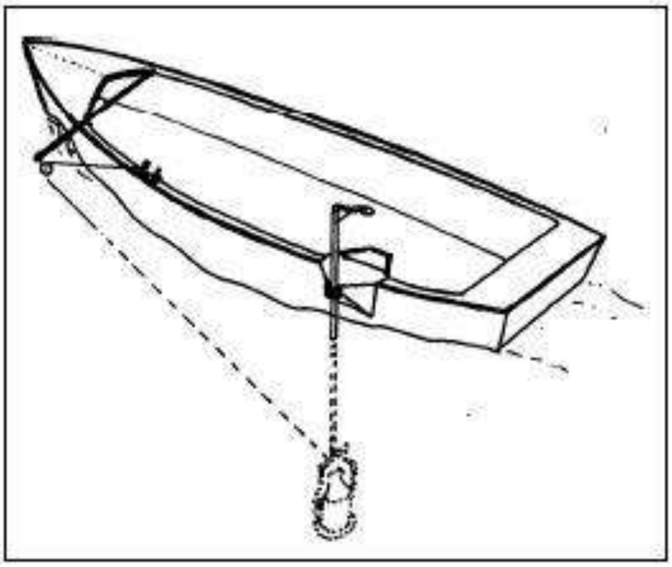


Figure 27: Boat mounted Silt sampler

5.2.2 INSTRUCTIONS FOR USE OF PUNJAB SAMPLER

PRECAUTIONS WHILE SAMPLING - FOR ALL THE BOTTLE SAMPLERS

(a) The sampler must be kept vertical while sampling.
(b) The mouth of the bottle must be opened only when the instrument has reached the required depth, not earlier.
(c) The bottle should not leak; leakage would result in a catch before the actual sampling starts.
(d) The mouth must be kept open with a sufficient water passage and for a minimum time span so as to fill enough, though overfilling should be avoided.
(e) The exact volume of the collected sediment sample must be measured and recorded.

Checks before sampling:

Sampling Bottle

(a) A metallic bottle, if deformed (out of shape) or damaged (especially its mouth) has to be replaced by a spare one.
(b) A glass bottle, if breached, has to be replaced by a spare one.

Bottle cork

(a) Must close tightly to avoid leaking.
(b) May never be painted.
(c) Damaged corks must be replaced.
(d) Cork must be suitably tapered to enter 0.5 to 1 cm in bottle mouth.
(e) Eventually, rub smoothly lower end of cork with emery paper if cork does not enter far enough into the bottle mouth.

Bottle holder (frame)

(a) Clamps at neck and mid-portion may not be damaged and should hold tightly the bottle with the cork seating perfectly axial in the mouth.
(b) Fly nuts for locking must operate easily; they should be replaced if they don't lock gently.
(c) Socket thread may not be damaged.

Pipe, rod, spring and lever

(a) Brass rod and pipe may not be bent.
(b) Spring must be checked and dead springs replaced.

Sampler leakage

(a) The sampler must be tested for possible leakage by holding it tightly closed under water for 5 minutes and collected sample needs to be less than 5 cc.
(b) In case of leakage, do not try to repair on the spot and use spare sampler.

During sampling, instructions and precautions

In general:

(a) The sampler must be oriented with the vertical frame perpendicular to the flow so that it does not disturb the flow at the mouth.
(b) The time required to fill the sampling bottle must be checked by trial and error, so that sampled volume would total between 80 and 90 % of the bottle volume (i.e. 0.4 l to 0.45 l for a 0.5 l bottle).
(c) Samples from partially or fully filled bottles must be rejected and a new sample taken.
(d) Sampler should never touch the stream bed.
(e) The distance between sampler bottom and the streambed must always be larger than 20 cm.

When sampling from a survey vessel:

(a) If flow permits, the survey vessel should be kept stationary to hold the sampler Vertical.
(b) In high flows, use a hull - fitting and a line for keeping the sampler vertical.
(c) In flows too strong for keeping the sampler vertical, drifting from the vessel may be allowed exceptionally to reduce the drag on the sampler as to keep it vertical, this should only be attempted if sampling can be performed in the selected vertical. (This procedure should be first tested in presence of the Assistant Research Officer.

When sampling while wading

(a) During sampling, keep the bottle upstream and well in front of you.
(b) Avoid sampling when the product of flow velocity (in m/s) with depth (in m) exceeds one (1).

When sampling from a bridge

(a) The bottle sampler should not be used if it cannot be kept vertical in the flow.
(b) When flow is too strong for measuring at 60% of the depth (0.6 d), a water surface sample may be taken, but with the bottle mouth at least 0.5 m under water.
(c) Operation of the bottle sampler with a fish weight should be avoided if this is not specifically designed to contain the bottle.
(d) When operated with a suitable fish, the drift angle measured at the protractor should not exceed 15 degrees.

After sampling, instructions and precautions

(a) Reject the sample if there is any floating debris hanging to the sampler or trapped between bottle mouth and cork.
(b) The sample must be collected carefully, without spilling any water.
(c) The volume of the collected sample must be measured precisely before rinsing, even if sediment remains in the bottle, to be rinsed later with clean water.
(d) If water or sediment is spilled during collection of sample, this must be rejected and a new sample taken.
(e) The rinsing water with its sediment must be added to the collected sample.

5.3 SEDIMENT ANALYSIS

PREPERATORY WORK-

(a) All equipment to be used in analysis must be cleaned thoroughly before use.
(b) Porcelain dish must be pre-weighed.
(c) Filter paper must be dried pre-weighed and kept in desiccators.
(d) 5% potash alum solution may be prepared as given under:

- Dissolve 25 gm of dry Potash Alum in 400 ml of water.
- Add 12ml of concentrated Sulphuric Acid: mix well.

- Make up the volume to 500ml with clean water.

The sediment analysis methods used for the sediment samples collected using samplers are described below:

(a) Analysis using sieves and a hydrometer for Coarse (C), Medium(M) and Fine (F) fractions
(b) Dry sieving for the medium and coarse fractions.
(c) Hydrometer analysis

The suspended loads are measured only for the percentage of coarse, medium and fine grades. The choice of the method and equipment needed for determining sediment particle size distributions would depend on:

(a) The kind in information requested. What do we want to know? for what purpose?
(b)
(c) The skills of the personnel in the laboratory.
(d) The need for particle size analysis of the complete sample, or only of part of it (e.g. do we need the size distribution of the sand/silt/clay fractions?)
(e) The number of samples to be analysed per day.
(f) The sample volumes.
(g) The kind of "size" needed.

5.3.1 ANALYSIS FOR ESTIMATION OF COARSE (PARTICLE SIZE 0.2MM DIA AND ABOVE) AND MEDIUM GRADE (PARTICLE SIZE 0.075 TO 0.2MM DIA) FRACTIONS

From the samples of water and sediment mixture collected in the enamelled buckets normally about 5 litres, the same is allowed to settle for about 30 minute. The supernatant water is carefully decanted off. The residue is passed into a numbered beaker for further analysis of coarse and medium fractions of sediment.

Each sample in the beaker is then passed through a IS – 212 micron sieve placed over a beaker marked upto 10 cm height. The sediment retained by the sieve is washed thoroughly with a jet of clean water till all the coarse grade particles are separated and particles of medium and fine-grained size have passed through, into the beaker.

The particles retained by the sieve after washing and removing organic matter are transferred to silt measuring tubes. Its volume in cubic centimetres (cc) is noted after tapping on a rubber pad. This can later be expressed as cubic centimetres per litre.

The sediment and water passing IS – 212-micron sieve collected in the beaker is made up upto 10-cm height. The mixture is stirred in for a few seconds and allowed to stand for the required interval of time given in table below, according to the temperature of water in the beaker. Time taken for particles above 0.075 mm to fall through 10 cm column of water at different temperature:

Table 4: Time taken for particles above 0.075 mm to fall through 10 cm column of water at different temperature

Water temp. in ° Celsius	Time of fall for particles of0.075 mm to fall 10 cm in seconds
5	31
6 - 10	28.5
11 - 15	25
16 - 20	22
21 - 25	20
26 – 30	18
31 - 35	16.5

The supernatant water is poured off. This process of separation of medium grade sediment by decantation of supernatant liquid, followed by filling the beaker upto the marked height is repeated, till the supernatant water is rendered clear. The medium grade sediment settled in beaker after the final washing and decantation process is transferred to a measuring tube and the volume is measured in cc as in the earlier case.

The material is also washed down on to a pre-weighed filter paper, initially drained of all water, and then subjected to drying in an oven. It is allowed to cool in desiccators and then weighed along with the collected dried sediment for obtaining its weight. This gives the concentration of medium fraction in gm per litre. The concentrations together with the observed water level and discharge are put in the "Record of suspended sediment summary data. The results are presented in metric tonnes per day.

5.3.2 ESTIMATION OF FINE-GRAINED FRACTION OF SEDIMENT

5.3.2.1 HYDROMETER METHOD

The fine grained sediment fraction can be estimated with the help of a sensitive calibrated hydrometer (see Figure28). A hydrometer calibrated initially in distilled water is to be used.

The hydrometer is to be placed for about five minutes in a separate sample of sediment and water to allow it to attain the water temperature. This helps also to eliminate effect of temperature change due to sudden placing of the hydrometer. The hydrometer is then taken out of the sample water. The water is stirred vigorously to put the sediment entirely into suspension and later poured into a double jacket metallic cylinder. The hydrometer is then immersed into the water in the cylinder and stopwatch started simultaneously. The level of immersion of the hydrometer in the cylinder is read after lapse of time intervals given in table below, depending on water temperature in the cylinder

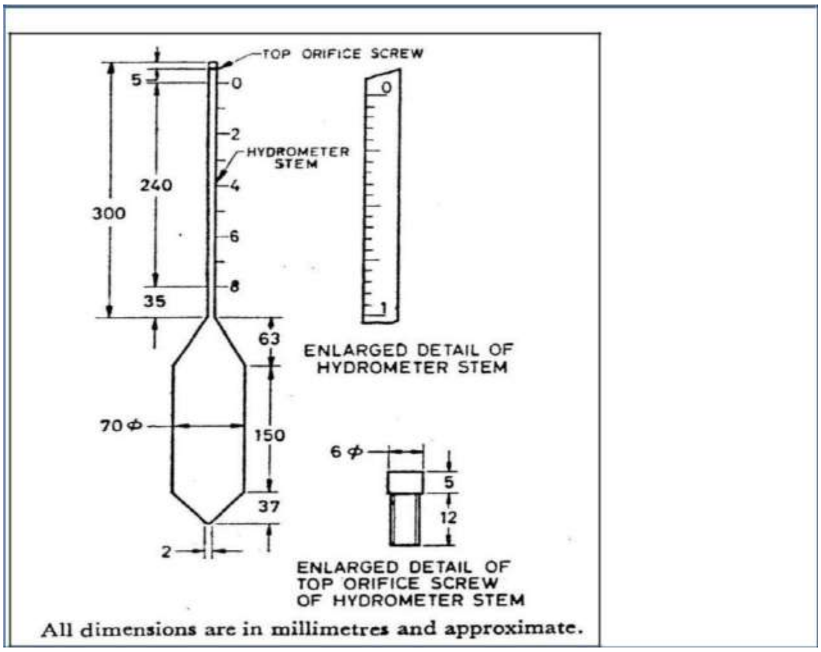


Figure 28: Hydrometer

Table 5: A time interval after which hydrometer is to be read

Water temperature ° Celsius	Time interval in seconds after which hydrometer to be read
5	105
6 – 10	100
11– 15	87
16– 20	77
21– 25	70
26– 30	63
31– 35	58

The time interval after which hydrometer is to be read for estimating fine sediment, versus water temperatures:

The point upto which the hydrometer is immersed can be used to derive the concentration of fine grained material and dissolved material in gm per litre as given below:

$$F + D = (R1 - R)\ K$$

Where:

F = Concentration of fine sediment in gm per litre
D = Concentration of dissolved material in gm per litre
R1 = Hydrometer reading taken in the cylinder water

R = Hydrometer reading in distilled water at the same Temperature
K = Factor for the hydrometer for converting to value in gm per litre

Next filter the water containing the sediment through filter paper and take readings of hydrometer in filtered river water for obtaining the concentration of dissolved material as below:

Thus: D = (r1 – r) K
Where: r1 = Hydrometer reading for the filtered water
r =Hydrometer reading in distilled water
For arriving at value of F = (F+D) – D is to be evaluated in gm per litre

PRECAUTIONS

(a) The water sample should be at room temperature.
(b) The hydrometer should be kept immersed in the water sample for about 5 minutes so that it attains the water temperature.
(c) The water sample should be thoroughly stirred before pouring into the jacket cylinder.
(d) No air bubbles should be sticking to the hydrometer stem and hydrometer should not touch the cylinder sides.

5.3.2.2 Filtering Process

The sample available after removing the Coarse and medium sediment is put on a pre-weighed filter paper and the water is allowed to completely drain off through the filter paper, which may take 12 to 24 hours depending upon the fineness of the silt and its quantity. After the water is completely drained out, the filter paper containing the fine sediment is put inside the oven with temperature such that the water gets evaporated without causing damage to the filter paper.

After the sample gets completely dried up, it is removed from the oven. The dried up sample (filter paper with fine sediment) is weighed on a physical balance or electronic balance.

The difference between weight of the empty filter paper and filter paper with fine sediment provides the weight of the fine sediment in gram/milligram. The same is converted based on the discharge of the river on the particular day in metric tonnes per day

PRECAUTIONS

(a) The empty filter paper should be completely dried before weighing.
(b) The water sample should be thoroughly stirred before pouring into the filter paper so that no fine sediment remains stuck to the beaker or container.
(c) The filter paper with sediment should be completely dried up without any traces of water on the filter paper and in the sediment.
(d) The filter paper with dried sediment should be weighed at the earliest after removal from oven as the filter paper may absorb atmospheric moisture if left open for a long time.

Equipment for sediment sampling at sediment laboratory is given at **Annexure V**

शं नो देवीरभिष्टय आपो भवन्तु पीतये ।
शं योरभि स्रवन्तु नः ॥४॥

O Water, may the auspicious divinity which is wished for be present in you when we drink (water).
May the auspiciousness which supports you, flow to us.

CHAPTER 6

METEOROLOGICAL OBSERVATIONS

6.1 INTRODUCTION

The water available in our rivers, lakes, reservoirs and below the ground is received through precipitation in various forms i.e. rain, snow, hail etc. A number of other atmospheric factors also play an important role in precipitation and availability of waters, both on the surface and below the ground.

A good understanding of such meteorological parameters is very important for proper assessment of available water resources over a short or longer period and for devising measures to overcome the extreme effects of hydrological phenomenon such as floods and droughts. The important meteorological parameters are also observed by CWC at selected stations. The details of observation methodology of such parameters are described below.

6.2. RAINFALL

6.2.1 RAINFALL MEASUREMENT BY STANDARD RAIN GAUGE (SRG)

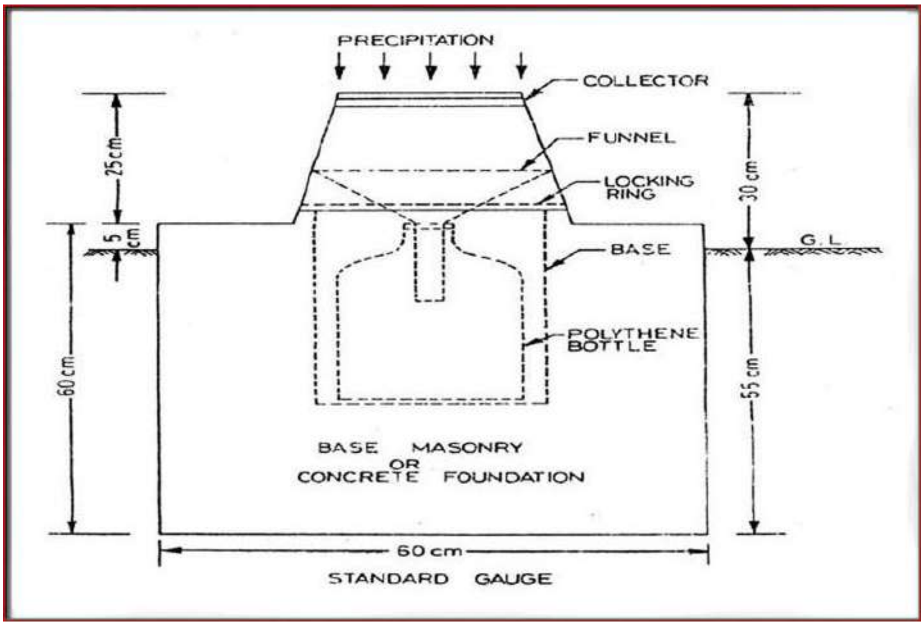


Fig 29: Standard Rain Gauge

The amount of rainfall at a station in a specified period is measured as the depth to which it would cover a flat surface. The measurement of this is made by a standard rain gauge, which in India is made of Fibre Glass Reinforced Polyester (FRP) and shown in Figure. 29

6.2.1.1 INSTALLATION OF STANDARD RAIN GAUGE

The amount of precipitation collected by a rain gauge depends on its exposure and special care be taken into consideration in selecting a suitable site.

(a) The gauge shall be placed on level ground not upon a slope or terrace and never on a wall or roof.

(b) On no account the rain gauge shall be placed on a slope such that the ground falls away steeply on the side of the prevailing wind.

(c) The distance between the rain gauge and the nearest object should generally be four times the height of the object, but never shall be less than twice the height of the object.

(d) Great care shall be taken at mountain and coastal stations that the gauges are not unduly exposed to the sweep of the wind. A belt of trees or a wall on the side of the prevailing wind at a distance, preferably four times its own height but exceeding at least twice its height, shall form an efficient shelter.

(e) The rain gauge shall be fixed on a masonry or concrete foundation 600 mm x 600 mm x 600 mm on a level ground surface (Figure 30).

(f) The base of the gauge shall be cemented so that the rim of the gauge is horizontal and exactly 300 mm above the ground level.

(g) In flood prone areas the level of rain gauge should be kept at least 300 mm above the HFL.

(h) A sketch showing the various objects with their height and distance from the rain gauge should be prepared and kept in the records.

(i) A fence should be erected around the rain gauge to protect it from stray cattle etc. The fence height should be such that it is not more than half the distance of the fence from the gauge.

(j) The rain gauge should be kept locked.

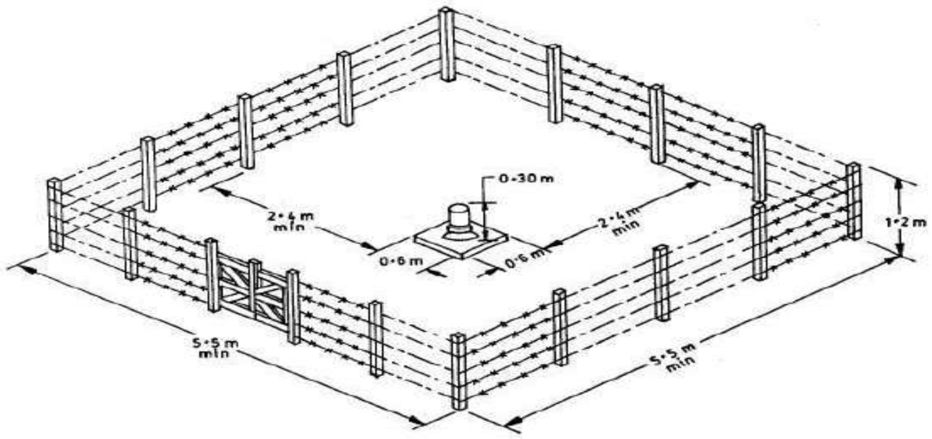


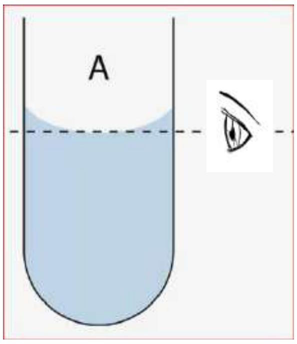
Figure 30: Fencing for Standard Rain Gauge (SRG)

6.2.1.2 MEASUREMENT OF RAINFALL BY SRG

The rain falling into the funnel collects in the bottle kept inside the base and is measured by a measure glass. The measurement is made daily at 0830 hrs IST in the morning and 1730 hrs in the evening or any suitable interval in between as decided by the Department. The following procedure is used for measurement of rainfall:

(a) Remove the funnel of the rain gauge and take out the polythene bottle. Place the measure glass in an empty basin and slowly pour the rainwater from the receiver (polythene bottle) into the measure glass to avoid spilling. If by chance, any rainwater is spilled into the basin, add it to the rainwater in the measure glass before arriving at the total amount collected.

(b) While reading the measure glass, hold it upright or place it on a horizontal surface. Bring the eye to the level of the rainwater in the measure glass and note the graduation (scale) reading of the lower level of the curved surface of water. The reading is recorded in mm to one decimal place.



(c) If the rainfall is more than 20 mm (for the 200 cm2 gauge), the measurement should be taken in two or more instalments depending upon the amount of rainfall.

(d) After the first measurement, the rainfall amount is checked by re-measurement before the rainwater is thrown away.

(e) During heavy rain, check the rain gauge at hourly intervals to avoid overflow. If necessary, take out the rainwater in a separate bottle, securely corked for measurement at the time of observation.

(f) All rainfall observations are made at 0830 hrs IST daily. The amount recorded at 0830 hrs is the rainfall of the preceding 24 hours ending at 0830 hrs of the observation day (Today's date). In other words, the rainfall of the day is the total rainfall collected in the rain gauge from 0830 hrs IST of previous day to 0830 hrs IST of the day and is recorded (entered) against today's date.

(g) If there is no rain, enter 0.0 (Note: The column should not be left blank or"-0should not be used for indicating "00 rainfall) and if the rain is below 0.1 mm, enter "t" (trace) in the prescribed form and also in the Register. Daily rainfall data, recorded on the prescribed form, is sent to the controlling office daily as per the arrangement fixed for the field station.

6.2.1.3 ROUTINE MAINTENANCE SRG

The following routine inspection and maintenance procedures should be used to ensure that the gauge continues to provide accurate records.

(a) The collector (funnel) of the rain gauge should be inspected for blockage with dirt/dry leaves etc and cleared if necessary.

(b) The collector, receiving bottle and the base should be checked for leakage. If leakage is found, immediate repair / replacement is to be undertaken.

(c) While replacing the collector on the base, it should be ensured that the two locking rings are engaged properly.

(d) The enclosure should be kept clean. No shrubs or plants be allowed to grow near the instrument as they will affect exposure conditions and the catch.

(e) A spare measure glass should invariably be kept at the field station and sufficient number of glass bottles with cork for closure should be kept in case of emergency (when both the measuring cylinder breaks down).

6.2.2 RAINFALL MEASUREMENT BY AUTOGRAPHIC RAIN GAUGE (ARG)

The autographic (siphon type) rain gauge enables automatic, continuous measurement and recording of precipitation. This type of rain gauge consists of a receptacle to collect precipitation and a measuring part to measure and record its amount. The measuring part consists of a float with a recording pen attached, a storage tank with a siphon to drain a fixed amount of water, and a clock-driven drum.

Rainwater gathered by the receptacle is led from the rain receiver to the storage tank through an adjustment vessel. As a result, a float in the storage tank moves upward. A recording pen is connected to the float. When rainwater in the storage tank reaches a level equivalent to a fixed amount, it is drained by the siphon.

This procedure is repeated as long as rainfall continues, and the pen repeats traces from zero to the maximum on the recording paper. When the rainfall stops, the pen traces a horizontal line. The photograph and different components of autographic (Siphon type) rain gauge is shown in Figure 31.

Figure 31: Natural siphon recording rain gauge

6.2.2.1 METHOD OF OBSERVATION

The traced mark on the recording paper is read to measure the amount of precipitation. For one-hour precipitation, for example, intersection points at the two consecutive hour lines and the tracing of precipitation are read. The one-hour amount is calculated from the difference between the two readings. The siphon operates when the pen reaches the maximum position on the recording chart. During heavy rain, however, it may start this action before the amount of precipitation reaches the predetermined level because of the wet interior. As the top of the tracing mark in such cases will not indicate the maximum level, the amount should be calculated as the sum of the readings for the top of the mark. A typical autographic rain chart is depicted in Figure 31

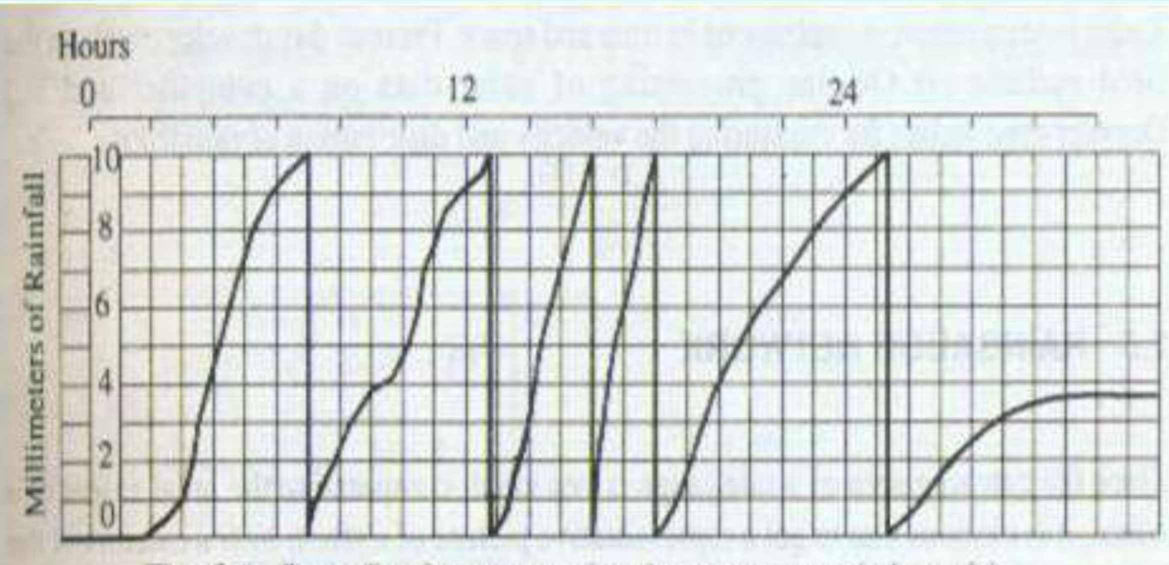


Fig. 2.6 Recording from a natural syphon–type gauge (schematic)

Figure 32: Autographic rainfall chart

6.2.2.2 INSTRUMENT SETTING, OPERATIONS AND TABULATION

Instrument Setting

(a) Wrap a chart on the clock drum taking care that the corresponding horizontal lines on the overlapping portions are coincident and that the bottom of the chart touches the flange. Fix the chart in place with the spring clip. The essential components of Autographic (siphon type) rain gauge are shown in Figure25.

(b) Replace the cover and pour water into the tube leading to the float chamber till the water begins to siphon. The pen should come down to the zero line on the chart after all the water is siphoned.

(c) Next, measure out the equivalent of 10 mm of rainfall in a measure glass and pour this water gently into the receiver as before, and the pen should touch the 10 mm line of the chart. If it does not, loosen the set-screw fixing the collar in the lid and slightly raise the collar by turning it till the correct range is obtained on the chart.

Operations

(a) The chart is changed at 0830 hrs IST daily in the morning. First remove the previous day chart and put the fresh chart on the clock drum and set the instrument as explained at “A” above.

(b) Put sufficient ink in the pen, wind the clock and set the pen to the correct time. To set the correct time, turn the clock drum slowly from left to right until the pen indicates the correct time. Give a time mark on the chart by gently tapping the pen. The instrument is now set for recording.

Tabulation

(a) Tabulate hourly rainfall values from the “removed“ autographic chart and make entries as per perform supplied. The autographic chart gives a continuous record of rainfall during the past 24 hours on a daily basis.

(b) If SRG and ARG are installed side by side, it is expected that the total rainfall recorded during the past 24 hours by both the rain gauges should agree. In case of any discrepancy, the rainfall amount recorded by the SRG is taken to be correct.

(c) Despatches tabulated perform to the Controlling Office on monthly basis or as prescribed.

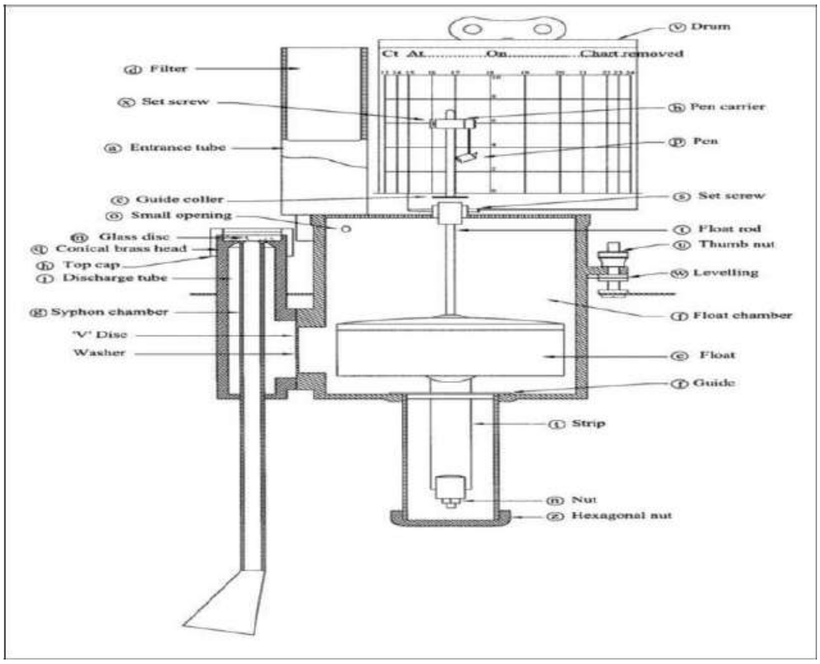


Figure 33: Showing essential component of Autographic Rain Gauge

6.2.2.3 ROUTINE MAINTENANCE OF ARG

The rain gauge should be regularly checked for dirt and debris in the funnel. In the rainy season, the wire-gauge filter should be cleaned once a week or immediately after a thunderstorm or dust storm. The inside of the glass disc should be kept clean. This is very necessary for proper siphoning. For cleaning the receiver, the float and the funnel, proceed as follows:

(a) Lift off the cover, remove the chart drum and the three thumb nuts. Remove the three small screws and washers, who hold the receiver lid in place. Gently lift the float from the chamber.

(b) To clean the float chamber, lift it off the base, flush it out with water after unscrewing the hexagonal nut.

(c) To clean the siphon tube, unscrew the top cap and see if the fibre gasket is in good condition. Then remove the glass disc and lift off the conical brass head with a bent pin. Clean the siphon tube. After cleaning, reassemble the parts carefully.

(d) Next, the halite washer between the float chamber and siphon is checked. The chamber should be replaced, if it leaks at this joint.

(e) The time of siphoning should be checked occasionally, to see whether the outlet tube is choked. The time taken for this should be 15 to 20 seconds.

(f) Special ink is used in the pen to obtain a thin and fine trace on the chart. During summer, a minute drop of glycerine may be added to reduce evaporation of the ink from the nib. The tip of the nib is kept clean with methylated spirit.

(g) Minor leaks or cracks in the body of the rain gauge can be sealed by using adhesive material.

The following are typical problems, which arise and cause the instrument to become out of adjustment. The listed actions may be used to correct.

(a) Incorrect siphoning: the float may not go up to the 10 mm mark but siphoning takes place.

Actions:

i) Check and adjust the levelling of the float chamber using a spirit level.

ii) Reduce the friction by rubbing the float rod with a lead pencil.

iii) Check whether the threaded collar is limiting the movement of the float. If so, raise the collar slightly after loosening the set-screw.

(b) Unstable zero: when no rain, the trace on the chart is not. along the zero line

Actions:

i) Check the alignment of the drum

ii) Check the wrapping of the chart on the drum. If a fault appears in the drum, it should be replaced.

(c) *Prolonged siphoning: siphon tube is partly blocked.*

Action:

i) To clear the siphon tube, unscrew the top cap (h), remove the fibre gasket, glass disc and then lift off the conical brass head (q) with a bentpin. Clear the tube by pushing a piece of soft wire through it. Clean and replace the conical brass head and glass disc. Change the fibre washers, if necessary.

(d) *Gradual fall of pen: either due to a leak in the float chamber or the pen arm is loose on the float rod.*

Actions:

i) For the leak at the joint of the float chamber and siphon chamber, the hallite washers between them should be replaced.
ii) Tighten the pen arm properly on the float rod.

(e) *Siphoning occurs after more than 10 mm of rain occurs: this happens if the float develops a leak.*

Action:

i) Float is to be replaced.

f) *During the period of heavy rainfall siphoning may be triggered before the pen reaches the 10 mm line.*

Actions:

i) Assume that each siphon represents 10 mm of rain.
ii) Keep the observatory enclosure locked, clean and fencing intact.

6.2.3 RAINFALL MEASUREMENT BY TIPPING BUCKET RAIN GAUGE (TBR)

The principle of this type of recording gauge is very simple. A light metal container is divided into two compartments and is balanced in unstable equilibrium about a horizontal axis. In its normal position the container rests against one of two stops, which prevents, it from tipping completely. The rain is led from a conventional collecting funnel into the uppermost compartment.

After a predetermined amount of rain has fallen, the bucket becomes unstable in its present position and tips over to its other position of rest. The compartments of the container are so shaped that the water can now flow out of the lower one and leave it empty. Meanwhile, the rain falls into the newly positioned upper compartment.

The movement of the bucket, as it tips over, is used to operate a relay contact and produce a record that consists of discontinuous steps. The amount of rain which causes the bucket to tip should not be greater than 0.2 millimetres.

The main advantage of this type of instrument is that it has an electronic pulse output and can be recorded at a distance or for simultaneous recording of rainfall and river stage on a water stage recorder. Its disadvantages are:

a) The bucket takes a small but finite time to tip, and during the first half of its motion, the rain is being fed into the compartment already containing the calculated amount of rainfall. This error is appreciable only in heavy rainfall.

b) With the usual design of the bucket, the exposed water surface is relatively large. Thus, significant evaporation losses can occur in hot regions. This will be most appreciable in light rains; and because of the discontinuous nature of the record, the instrument readings may not be satisfactory for use in light drizzle or very light rain. The time of beginning and ending of rainfall cannot be determined accurately.

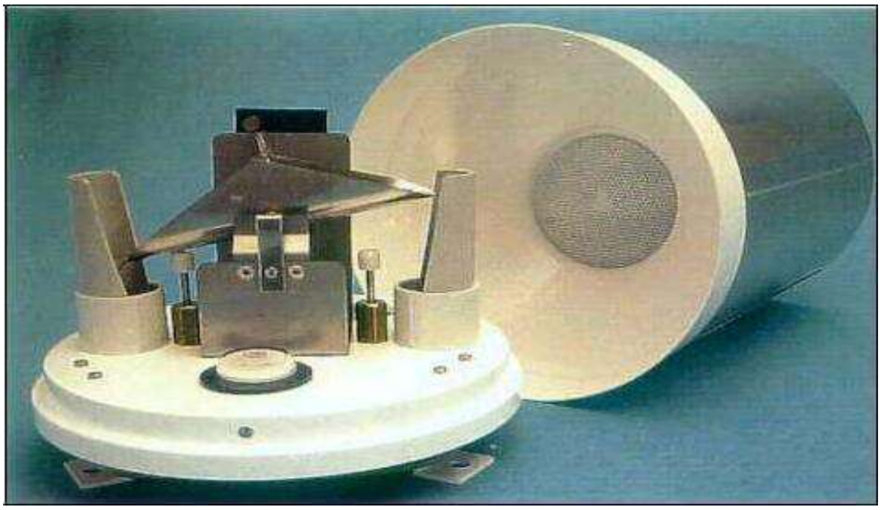


Figure 34: Tipping Bucket rain gauge

The Tipping Bucket rain gauge is a widely used for recording rainfall amounts and intensities in remote and unattended places. Once the TBR is installed and calibrated, it is ready for use.

6.2.3.1 STANDARD MEASUREMENT PRACTICE FOR TBR

The TBR is equipped with a data logger, which automatically stores the number of tipping per unit of time or the timings of each tipping. The data stored in the data logger is either transmitted through satellite or GPRS based telemetry system at the required location.

Else the logger can be read out using data downloading device at any point of time or interval. The functioning of the equipment is to be checked as per instructions of the supplier on routine basis.

6.2.3.2 ROUTINE MAINTENANCE OF TBR

Maintenance of TBR should be carried out in accordance with the instructions supplied with the equipment.

a) The collector should be kept clear of obstructions and it should be gently cleaned for dust and debris without disturbing the tipping bucket switch. This should be carried out on regular interval basis.
b) If the bucket does not tip, it is probably sticking on its bearings.

c) If the bucket does tip but the counter reading fails to advance, the trouble may be due to a faulty counter or switch. These defects should be rectified by only an expert mechanic.

6.3 MAXIMUM& MINIMUM ATMOSPHERIC TEMPERATURE

The maximum and minimum atmospheric temperature plays a vital role in various natural processes including the hydrological cycle.

The Maximum / Minimum thermometer records the highest and lowest atmospheric temperatures seen by the thermometer between settings. A "U" shape tube holds a clear liquid and columns of mercury.

As the temperature increases, the liquid expands forcing the mercury up the maximum scale. When the temperature falls, the liquid contracts and the mercury follows it back up the minimum scale. Small glass and wire floats called limit markers are pushed to the temperature limits by the two sides of the mercury column.

The markers are held in position by a magnet in the back of the case and the maximum / minimum temperatures are read at the bottom point of the markers. A setting magnet will easily reset both scales so you can take periodic readings without worrying about recording the wrong information.

The current or immediate temperature can always be read at the top of the mercury column as in a single tube thermometer. One limb of the thermometer reads the maximum temperature while the other limb is used to read the minimum temperature. The range of the thermometer should be between -35°C to +55°C with minimum readable graduation as 0.5°C.

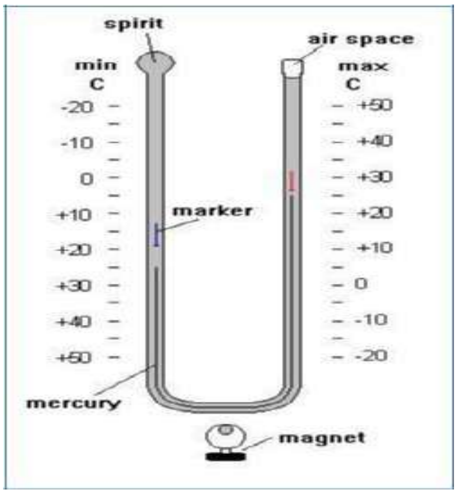


Figure 35:Maximum-Minimum Atmospheric temperature thermometer

It is important to note that the minimum scale is inverted with the lower temperatures above the higher. The observed should become accustomed to reading this "upside down" scale, for which some care may be required to get accurate readings

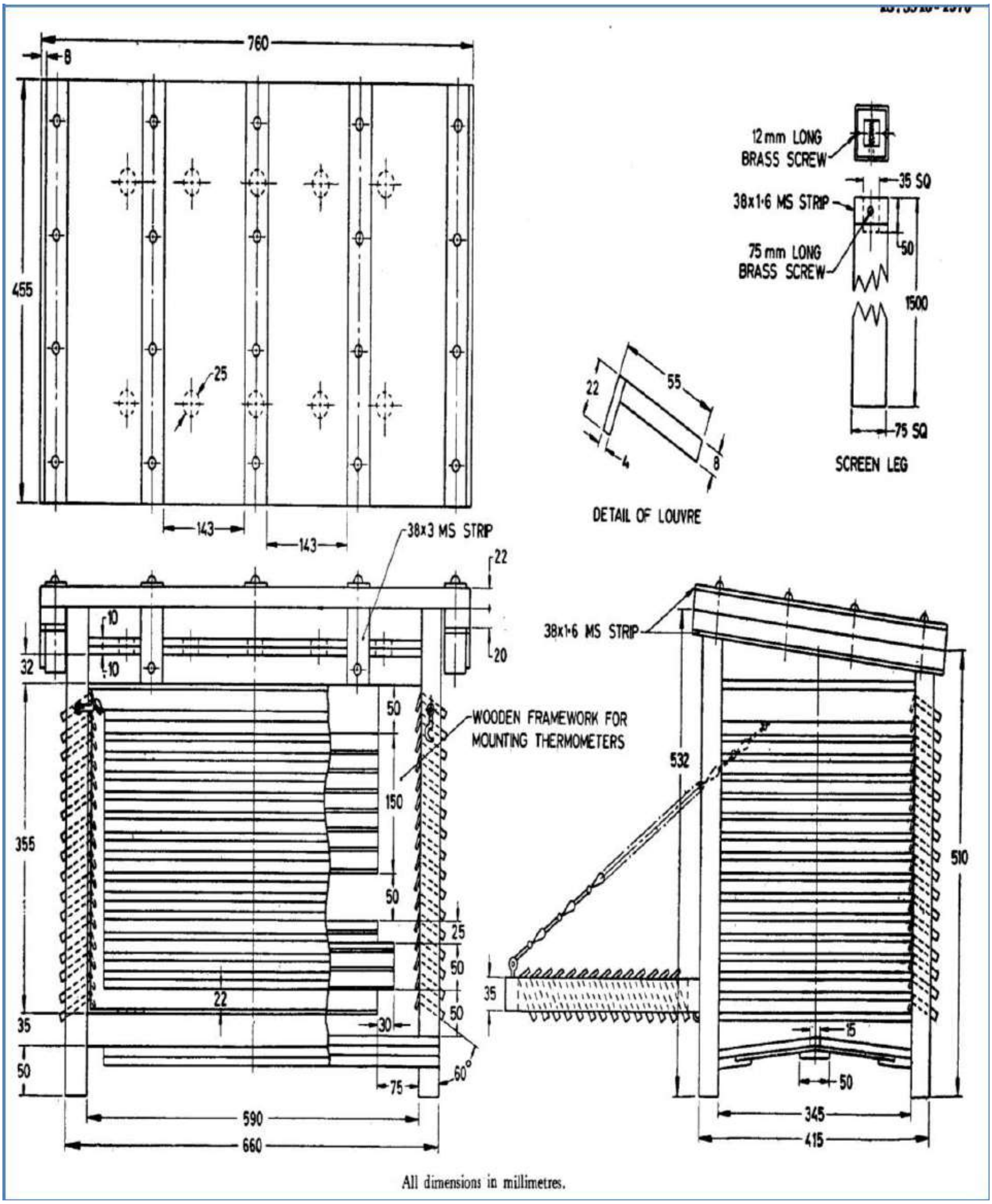


Figure 36: Typical small size Stevenson's screen

6.3.1 STEVENSON'S SCREEN

In order to record the correct atmospheric temperature, the thermometer should be exposed to the atmosphere and should not be kept indoors in a room or shelter. However placing the thermometer under the open sky would render it to direct exposure of sun, wind, dust, rain, snow, hail etc which will provide erroneous readings.

In order to have ambient atmospheric conditions, free from any disturbance, the thermometers are placed inside a wooden enclosure, with proper arrangement for hanging/clamping the thermometer.

The above enclosure is known as Stevensons screen and is made up of wood with spaces in between the wooden louvers for proper circulation of the air. A typical Stevenson's screen (small) sketch for housing max/min thermometers as per BIS standard is shown below with dimensions.

6.4 EVAPORATION

Under natural conditions, the rate of evaporation, or the amount of water turned to aqueous vapour in a given time, is a function of the following meteorological factors:

a) Solar and sky radiation
b) The vapour pressure deficit of the atmosphere surrounding the evaporating surface water
c) The flow of air past the evaporating surface
d) The air temperature which controls the temperature of the liquid and also determines the upper limit of the vapour pressure deficit.

Measurement of evaporation from a free water surface provides a value which could be used as an expression of the integrated effect of all these meteorological factors.

The pan Evaporo-meter used for measurement of evaporation consists of a cylindrical reservoir of fixed diameter and depth, filled with water to a few centimetres below the rim. A fixed-point gauge in a stilling well serves to indicate the level of water in the pan.

A calibrated measuring cylinder is used to add or remove water at each observation to bring the water level to the fixed point. The cross-sectional area of the measuring cylinder is such that, the number of millimetres of water added from the measuring cylinder divided by 100 gives the amount of water in millimetres which has evaporated from the pan during a given interval of time.

The reservoir is covered with wire-mesh netting to protect it from birds, animals or flying debris. The pan used for evaporation measurement is the US "Class A" evaporation pan which rests on a carefully levelled, wooden base and is often enclosed by a fence. Evaporation is measured daily as the depth of water (in mm/cm) evaporates from the pan.

As per BIS Standard, a typical Pan Evaporo-meter should be in circular shape made up of Copper and having arrangement for clamping thermometer and should have a fixed gauge inside a stilling well made up of brass to observe the water level in the Pan (Figure37). A measuring cylinder made up of either acrylic plastic or brass is used to add water to the Pan Evaporo-meter (Figure38)

6.4.1 PROCEDURE FOR MEASUREMENT OF EVAPORATION

To calculate the evaporation it is necessary to measure the rainfall and the water level in the pan at the same time.

a) *Read the rain gauge every day at 8:30 hrs to get the past 24 hours cumulative rainfall.*

b) *Class A Pan Evaporo-meter reading*

   i) Take the measuring cylinder and fill it completely with water and start pouring the water slowly in the Pan Evaporo-meter and keep a tab on the fixed point gauge. Stop pouring the water as soon as the water level in the Pan touches the top of the fixed point gauge.

   ii) Observe/measure the amount of water (in mm) poured into the Pan Evaporo-meter.

   iii) The actual evaporation during the past 24 hours is the amount of water (mm) added to the Pan Evaporo-meter + the rainfall (mm) occurred during the past 24 hours.

Case B: Water level in the pan is above the fixed-point gauge:

i) Take the measuring cylinder and start removing the water using the measuring cylinder till the water level touches the fixed point gauge.

ii) Observe/measure the amount of water (in mm) taken out into the Pan Evaporo-meter.

iii) The actual evaporation during the past 24 hours is the amount of water (mm) removed from the Pan Evaporo-meter - the rainfall (mm) occurred during the past 24 hours.

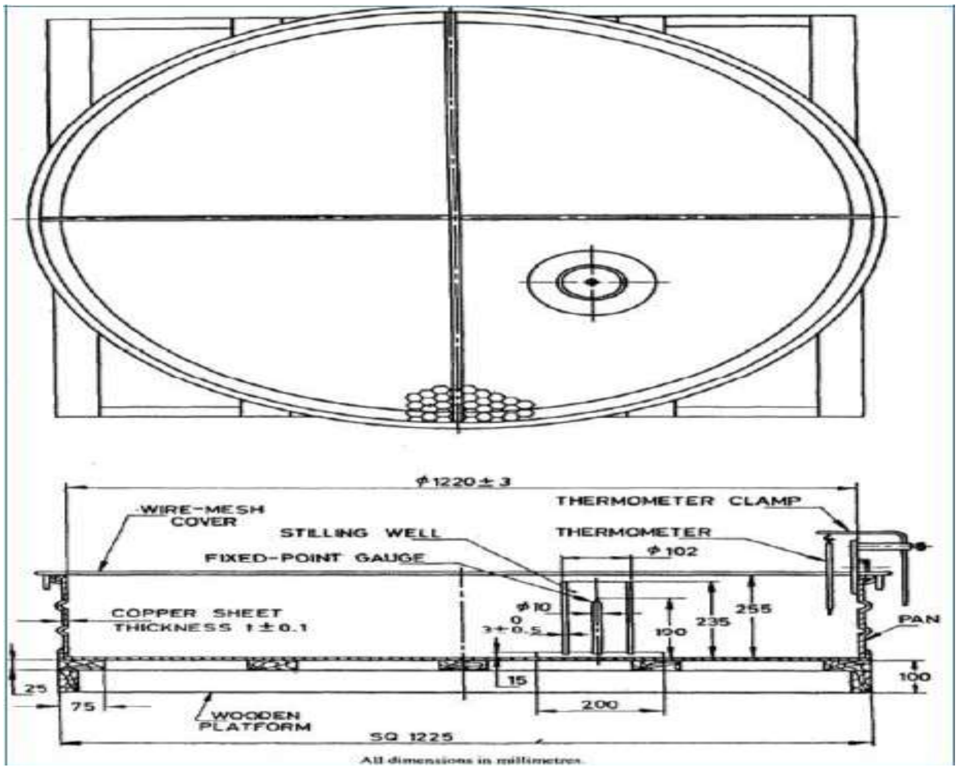


Figure 37: Pan Evaporimeter

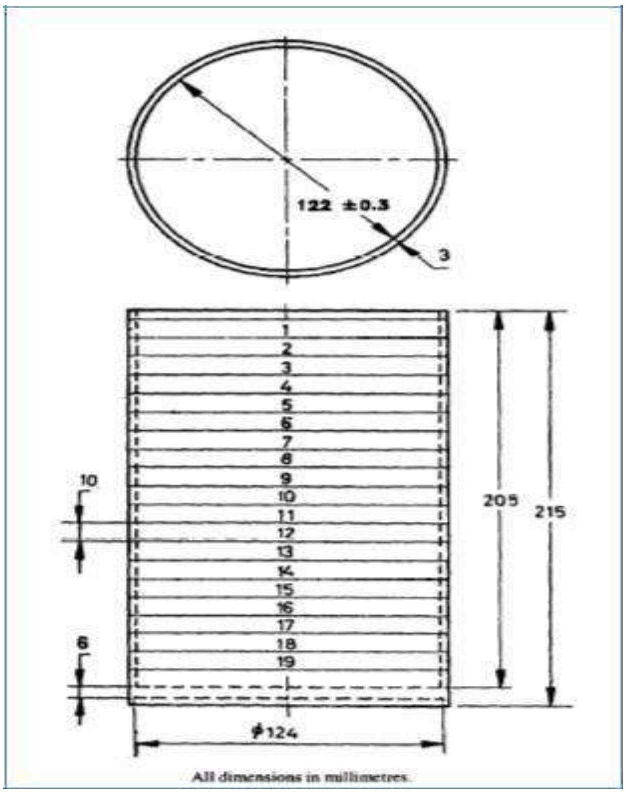


Figure 38: Measuring Cylinder (Acrylic Plastic)

CHAPTER 7

STANDARD RECORD DATA (RD) FORMS AND CHECK LIST

7.1 STANDARD RD FORMS AT THE HYDROLOGICAL OBSERVATION

RD 1 Form: Daily Discharge Data

RD 2 Form: Ten Daily Discharge data

RD 3 Form: Daily Gauge Reading

RD 4 Form: Daily Hourly Flood levels

RD 5 Form: Record of Ground Water Level

RD 6 Form: Record of Rainfall

7.2 STANDARD FORMS AT THE SILT/SEDIMENT OBSERVATION

RD 7 Form: Record of Suspended Sediment Analysis
RD 8 Form: Detail of Suspended Sediment For 10 Days
RD 9 Form: Abstract of Suspended Sediment Load Data
RD 10 Form: Mean Diameter of Sediment Particles (Diameter below 0.6 mm, %< 5)
RD 11 Form: Mean Diameter of Sediment Particles (Diameter below 0.6 mm %> 5)
RD 12 Form: Analysis of Bed Material
RD 13 Form: Vertical velocity and sediment distribution

7.3 STANDARD FORMS FOR WATER QUALITY OBSERVATION

RD 14 Form: Physical & chemical specialities of River/well water sampler
RD 15 Form: Result of Dissolved & Biochemical Oxygen Demand
RD 16 Form: Inspection Report

These forms are given at **Annexure-VI**

7.4 CHECK LISTS OF HYDRO-METEOROLOGICAL SITES

7.4.1 CHECK LIST FOR GAUGE SITE

a) All the gauges to be overlapped in increasing order about 30 cm.

b) Painting and marking should be done as per norms at least once before monsoon each year.

c) H.F.L & Last Year HFL should be marked at least three places on Both Bank at appropriate locations.

d) D-Type BM should be at the adjacent of site.

e) Permanent adjustment should be done at least once in a month.

f) Zero RL of gauge should be checked during inspection of site by higher officers.

g) At least two temporary gauges with painting and marking should be kept for emergency.

h) Pre & Post Cross section should be taken before monsoon and post monsoon and platted on proper graph.

i) Gauge dairy should be maintained properly.

j) All the Permanent Gauges RL should be checked at least once in a month.

k) All the equipment accessories should be kept in good working condition.

l) Site office should be at proper approach Road.

m) When gauge site situated near a confluence, its minimum distance upstream from the confluence point on either of the streams should be such that the backwater or disturbances due to floods in the other stream would not affect the gauge site in other stream even in if the stream is flowing on which the gauge is fixed is running low.

n) Three SWA should be posted at the gauge site during monsoon season to record hourly gauge.

o) Last temporary or permanent gauge should be installed in the flowing River to read minimum gauge.

p) Site Office Board should be fixed adjacent of D-Type BM/or at proper location.

q) Umbrella, and Torch, and life jacket and lifebuoy should be available at the site.

r) D-Type BM should be checked from MTBM at least before Monsoon.

s) Silent features of the sites board should be kept inside the site office.

t) All Gauge Site Should have invariably metrological observation parameters like Rainfall (through ORG), Maximum and Minimum temperature.

u) Daily Gauge and Rain fall data and temperature should be recorded properly and submitted to sub-division in timely.

v) Water level at the gauge site should not be affected on account of a falling curve obtained over a weir crest or immediately below a constricted bridge. It is recommended that when the gauge is located downstream of a structure, a minimum distance between the gauge and the structure should be kept 3 times the width of the section at high flood level in case of smaller streams. In case of big rivers length of 0.5 – 1.0 km below a weir or a bridge may be considered adequate for obtaining normal conditions.

w) The site should be free from aquatic growth which is likely to interface with the gauge measurement.

x) All observed data should be entered in eSWIS software immediately.

7.4.2 CHECK LIST FOR DISCHARGE SITE

i) All the check list as listed for Gauge site should be read as part of Discharge site also.

ii) All necessary equipments as listed below area should be available:

Equipment for measurement of velocity

a. Current meters & Accessories, b. Wading Rod, c. Protractor

Equipment for measurement of depth
a. Sounding rod, b. Echo Sounder

Miscellaneous equipment
a. Stop Watch/ CM Counter, b. Fish Weight, c. Battery box with Earphone d. Thermo-meters e. Navigational Equipment, f. Life Saving Devices, g. Auto Level, h. Prismatic Compass, i. Screw drivers and spanners set, j. Knife

iii) Discharge site should have Gauges installed at CG Line, US side (500 m from CG) and DS (500M down from CG).Preferably the river reaches in this section should be normal to flow. This may be kept in mind while selecting the site for discharge observation.

iv) Divide the area of cross section into number of strips. River Segmentation: Strip width < 1/15 to 1/20 of the width of river, Minimum section 15(for small river) to 25 (for large river)

v) Find the area of each strip and mean velocity.

vi) Discharge in each strip < 10% of total discharge.

vii) Difference in velocity between adjacent strip should not be more than 20%.

viii) Vertical Velocity Distribution Experiment should be done once in a month to calculate the point of average velocity. Normally it occurs at 0.56d to 0.63d.

ix) Normally Velocity Area Method should be used for Direct Discharge Observation.

x) Pivot Point /Stadia Method is used for fixing position of boat at particular RD for making observation.

xi) The discharge observation measured should be done for each strip at each RD at 0.6d depth for shallow and medium depth rivers. For deep rivers it should be observed at two point i.e. at 0.2d and at 0.8d. Average of both velocity should be taken for segment discharge computation.

xii) If Surface level velocity is observed then it should be Multiplied by 0.89 so it's give the Mean velocity.

xiii) In lower water level small Peg is fixed for marking the RD Point in a Channel. Pigmy Type current meter should be used for measurement of low discharges.

xiv) The Revolution of CM should be measured twice at a particular RD Point. Average of both value is taken for velocity computation.

xv) The Proper Fish Wt. should be used for high Flow discharge observation.

xvi) The CM spin should be examined daily before start the discharge observation. If and day spin is less than 75, it should be sent to lab for recalibration. A rated current meter should have spin between 75 to 115 as per BIS. A rated current meter should be used for 90 days continuous use or 300 hrs or 180 day, whichever is earliest.

xvii) The CM should be properly fixed with wadding Rod and for good result Wt. is adjusted for horizontal balancing.

xviii) Eco sounder should be used for recording depth in large and deep rivers.

xix) River flow slope and other flow parameters such as Manning's 'n", wetted perimeters etc should be calculated daily from the observed flow.

xx) Different Curves such as Stage/Water Level(G) Vs Q, Q Vs n, G Vs n etc should be plotted for each year flow data and displayed in the site office. Proper record should be maintained.

xxi) The corner water width is actual measured for end correction of area and discharge calculation.

xxii) If the flow is oblique i.e. not normal to the flow, oblique angle correction must be applied in velocity computation.

xxiii) If observation is carried out from the bridge using current meter then, Dry line, Wet Line correction must be applied in depth calculation. For lowering the current meter into the river, Boat Outfit/Bridge Outfit should be used.

xxiv) As far as possible this method should be avoided.

xxv) The Natural & Balloon float should be used for Float observation work. Compass should be used for checking float direction. C/G, U/S, D/S line Gauges is Checked for Straight line alignment.

xxvi) The discharge observation work using bridge outfit, RD should be marked on the top of the parapet of bridge span by equal Interval of the Span between the Piers and discharge is measured at each span. Pier correction must be applied.

xxvii) Temporary Gauge Post should be fixed at Bridge Site and it should be connected to main Gauge at CG line.

xxviii) If Rope and Pendent is used using Winch Machine through Cable, Sag correction should be applied for calculating the width. If cable Trolley is being used, it should be used and maintained properly.

xxix) All safety Precaution is Measured during the discharge observation.

xxx) If Slope-Area method is being used for computing discharge in extreme/high flow condition, where direct method is not possible, then slope should be properly observed between US and DS Gauges. If the river has Cross Slope also then mean Gauge of both Gauge (Left and Right bank gauge) should be observed. Manning 'n' should be judiciously chosen from using G Vs n and S Vs n curve from the observed data.

xxxi) All Hydrological Graph Reg- Discharge vs. Area, velocity, Manning, Slope and Stage vs. Area, velocity, Manning, Slope and Monthly Bar Chart, Ten Daily Bar Chart, Hydrograph, S/D Curve Monsoon and Non-Monsoon displayed in office.

7.4.3 Check List for Sediment Observation Site

a) The checklist for Gauge and Discharge should invariably be part of the Silt observation.

b) Vertical Silt Distribution Curve should be plotted each month for ascertaining the depth at which silt samples are to be taken.

c) The silt sample is collected at each RD at 0.6 water depth in one litre bottle using Punjab Type Silt Sampler at the time of discharge measurement.

d) Sites displaying vortices, reverse flow or dead water should be avoided, especially when associated with structures in the streambed or with bed rock outcrops.

e) The measurement section should be clearly visible across its width and unobstructed by trees, aquatic growth or other obstacles.

f) The depth of water at the section should be sufficient at all stages to provide for the effective immersion of the instruments, whichever is to be used.

g) The site should have easy access at all times, for all necessary measurement equipment.

h) The section should be sited away from pumps, sluices and outfalls, if their operation during a measurement is likely to create flow conditions not enough close to uniform flow.

i) Sites should be avoided where there is converging or diverging flow.

j) In those instances where it is necessary to make measurements in the vicinity of a bridge, it is preferable that the measuring site be upstream of the bridge. Although in special cases and where accumulation of logs or debris is liable to occur it is acceptable for the flow-measuring site be downstream of the bridge, sediment should preferably be sampled at another location.

k) Light-weight streamlined, fixed-volume point sampler or depth-integrated sampler (e.g. US DH-48) should be used when suspended sediment contains more than 5 % medium + coarse fractions and when the sediment concentration of the sample is higher than 100 g/m^3.

l) The Punjab-type bottle sampler does not work efficiently at high velocities.

m) All equipment to be used in analysis must be cleaned thoroughly before use
   a. Porcelain dish must be pre-weighed.

n) Filter paper must be dried pre-weighed and kept in desiccators.

o) Sampling and Analysis procedures must be followed strictly as mentioned in the guidelines.

p) All the analyzed results must be properly recorded and entered immediately in eSWIS.

7.4.4 Check List for Bed Material Site

The Bed Material Survey sample should be collected one from at ¼ distance from water edge, another at middle of river and third at ¾ water width location using appropriate Bed Material sampler. These samples should be immediately transported to divisional laboratories for analysis once before pre-monsoon and another after the monsoon.

7.4.5 Check List for Water Quality Site

a) Water Samples should be collected from the River at ¼,½, ¾ distance from water edge below 30 cm from surface.
b) Basic parameters (06) as mentioned for Level-I labs should be analyzed at the site itself. The results after analysis may be immediately entered in eSWIS
c) After fixing DO samples, the sample should be sent to Divisional WQ lab for further analysis.

Check List for Snowfall Site

a) Snow Fall is measured every day at8.00AM.
b) The snow gauge is kept in Vertical Position.
c) The Snow is collected in a Beaker and after heating it is converted into water equivalent which shows the snow fall at a site on a particular day.

ANNEXURES

Annexure-I

Site office Sign Board

NOTE: The usual practice of painting signboard on ordinary MS sheet may be dispensed with. New sign board shall be fluorescent in nature and in conformity with standards being followed in other Government Organizations like NHAI OR Airport Authority of India etc.

Annexure-II

SALIENT FEATURE OF SITE

स्थल की मुख्य विशेषताएँ

Name Of Site/ स्थल का नाम -------------Name of River-/ नदी का नाम -------

Code / कोड -------------Type of site/ स्थल का प्रकार--------

Division / मण्डल ----------------   Sub division / उप मण्डल -----------------

Location/ स्थिति ------Village / गाँव -----------District / जिला

Date of Opening of Gauge / गेज प्रारम्भ होने की तिथि ----

Date Of Opening Of Discharge/ निस्सरण प्रारम्भ होने की तिथि ---

Date Of Opening Of Silt / गाद प्रारम्भ होने की तिथि ----

Date Of Opening Of Water Quality / जल गुणवत्ता प्रारम्भ होने की तिथि ---

Zero R.L. Of Gauge / गेज का शून्य सापेक्ष ताल -----

Value of M.T.B.M. / मस्टों बेंच मार्क का मान -------

Value Of D.Type B.M / डी-टाइप बेंच मार्क का मान .—

500m U/s T.B.M Value/ 500मी0 ऊपर अस्थायी बेंच मार्क का मान ---

500m D/s T.B.M Value / 500मी0 नीचे अस्थायी बेंच मार्क का मान---

Latitude/ अक्षांश -----

Longitude/ देशांतर ---

H.F.L.Value / हिस्टॉरिकल बाढ़ स्तर-------------Year /वर्ष-----------

Last Year H.F.L / पिछले वर्ष का अधिकतम जल स्तर -------------Year/वर्ष

Maximum Discharge / अधिकतम निस्सरण --------------Year/ वर्ष-----

Maximum Rain fall /अधिकतम वर्षा स्तर ----------------------Year/ वर्ष----

Maximum Temperature / अधिकतम तापमान ------ ----Year / वर्ष --------------

Purpose of site initially / प्रारंभिक उद्देश्य --------

Present Purpose / वर्तमान उद्देश्य ----------------

Annexure-III

Site Office Equipment/Instrument

Gauge Site		
Sl. No.	**Particulars**	**Quantity**
1	Metallic Tape 30 m	01
2	Auto Level with accessories & staff	01
3	Gauge Post	10
4	Target Poles	04
	Ordinary Rain Gauge with measuring cylinder	01
5	Maximum and Minimum Thermometer (Digital)	01
6	Dry Wet Thermometer	01
7	Life Buoy	05
8	Life Jackets	05
9	Raincoat	03
10	Umbrella	02
11	Torch	02
12	Gum Boot	03
13	Bucket	02
14	Carpentry Tool set	01
15	Water Filter	01
16	Calculator	01
17	Stevenson's Screen	01
18	Table	02
19	Chair	05
20	Wireless with accessories	01
21	Maintenance free battery	02
22	Petromax/Light Arrangement	01
Consumables		
Paints, Painting Brushes, Data forms and stationary etc.		

Gauge and Discharge Site		
Sl. No.	**Particulars**	**Quantity**
1	Current Meter with accessories	02
2	Pigmy Current meter with accessories	01
3	Digital Counter	02
4	Fish Weight – 10 kg	02
5	Fish Weight – 25 kg	02
6	Sounding Weight- 10 kg	02
7	Sounding Weight- 25 kg	02
8	Metallic Tape 30 m long	01

9	Auto Level with accessories & staff	01
10	Gauge Post	30
11	Target Poles	05
12	Ordinary Rain Gauge with measuring cylinder	01
13	Maximum Minimum Thermometer (Digital)	01
14	Dry Wet Thermometer	01
15	River Temperature Thermometer	01
16	Boat with accessories	01
17	OB Engine with accessories (Capacity 25 HP/45 HP/90 HP depending upon max. River current)	01
18	Sisal/Nylon/Jute Rope- 50 m each	02
19	Life Buoy	08
20	Life Jacket	08
21	Ranging Rods	06
22	Raincoat	08
23	Umbrella	0**5**
24	Torch	03
25	Gum Boot pairs	08
26	Bucket	03
27	Carpentry Tool set	01
28	Water Filter	01
29	Scientific Calculator	01
30	Stop Watch	01
31	Eco-Sounder	01
32	Boat Outfit	01
33	Bridge Outfit	01
34	Stevenson's Screen	01
35	Table	03
36	Chair	08
37	Petromax/Light Arrangement	01
38	Wireless with accessories	01
39	Maintenance free battery	02
Consumables		
	Paints, Painting Brushes, Data forms and stationary etc.	

Gauge, Discharge & Water Quality Site

Sl. No.	Particulars	Quantity
1	Current Meter with accessories	02
2	Pigmy Current meter with accessories	01
3	Digital Counter	02
4	Fish Weight – 10 kg	02
5	Fish Weight – 25 kg	02
6	Sounding Weight- 10 kg	02

7	Sounding Weight- 25 kg	02
8	Metallic Tape 30 m long	01
9	Auto Level with accessories & staff	01
10	Gauge Post	30
11	Target Poles	05
12	Ordinary Rain Gauge with measuring cylinder	01
13	Maximum Minimum Thermometer (Digital)	01
14	Dry Wet Thermometer	01
15	River Temperature Thermometer	01
16	Boat with accessories	01
17	O B Engine with accessories (Capacity 25 HP/45 HP/90 HP depending upon max. River current)	01
18	Sisal/Nylon/Jute Rope- 50 m each	02
19	Life Buoy	08
20	Life Jacket	08
21	Ranging Rods	06
22	Raincoat	08
23	Umbrella	05
24	Torch	03
25	Gum Boot pairs	08
26	Bucket	03
27	Carpentry Tool set	01
28	Water Filter	01
29	Scientific Calculator	01
30	Stop Watch	01
31	Eco-Sounder	01
32	Boat Outfit	01
33	Bridge Outfit	01
34	Stevenson’s Screen	01
35	Table	03
36	Chair	08
37	Petromax/Light Arrangement	01
38	Wireless with accessories	01
39	Maintenance free battery	02
40	Conductivity Meter	01
41	DO meter	01
42	pH meter	01
44	DO Sampler	01
Consumables		
1	Paints, Painting Brushes, Data forms and stationary etc.	
2	Filter Paper, Chemicals, Glass Wares etc.	

Gauge, Discharge, Silt Water Quality Site		
Sl. No.	**Particulars**	**Quantity**
1	Current Meter with accessories	02
2	Pigmy Current meter with accessories	01
3	Digital Counter	02
4	Fish Weight – 10 kg	02
5	Fish Weight – 25 kg	02
6	Sounding Weight- 10 kg	02
7	Sounding Weight- 25 kg	02
8	Metallic Tape 30 m long	01
9	Auto Level with accessories & staff	01
10	Gauge Post	30
11	Target Poles	05
12	Ordinary Rain Gauge with measuring cylinder	01
13	Maximum Minimum Thermometer (Digital)	01
14	Dry Wet Thermometer	01
15	River Temperature Thermometer	01
16	Boat with accessories	01
17	O B Engine with accessories (Capacity 25 HP/45 HP/90 HP depending upon max. River current)	01
18	Sisal/Nylon/Jute Rope- 50 m each	02
19	Life Buoy	08
20	Life Jacket	08
21	Ranging Rods	06
22	Raincoat	08
23	Umbrella	0**5**
24	Torch	03
25	Gum Boot pairs	08
26	Bucket	03
27	Carpentry Tool set	01
28	Water Filter	01
29	Scientific Calculator	01
30	Stop Watch	01
31	Eco-Sounder	01
32	Boat Outfit	01
33	Bridge Outfit	01
34	Stevenson's Screen	01
35	Table	03
36	Chair	08
37	Petromax/Light Arrangement	01
38	Wireless with accessories	01
39	Maintenance free battery	02

40	Conductivity Meter	01
41	DO meter	01
42	pH meter	01
43	Wireless with accessories	01
44	DO Sampler	01
45	Silt Sampler	01
46	Sieves set	01
47	Oven	01
48	Electronic balance	01
49	Enamel Bucket & Mug	01
50	Desiccators	01
51	Gas Stove	01
Consumables		
1	Paints, Painting Brushes, Data forms and stationary etc.	
2	Filter Paper, Chemicals, Glass Wares etc.	

Annexure-IV

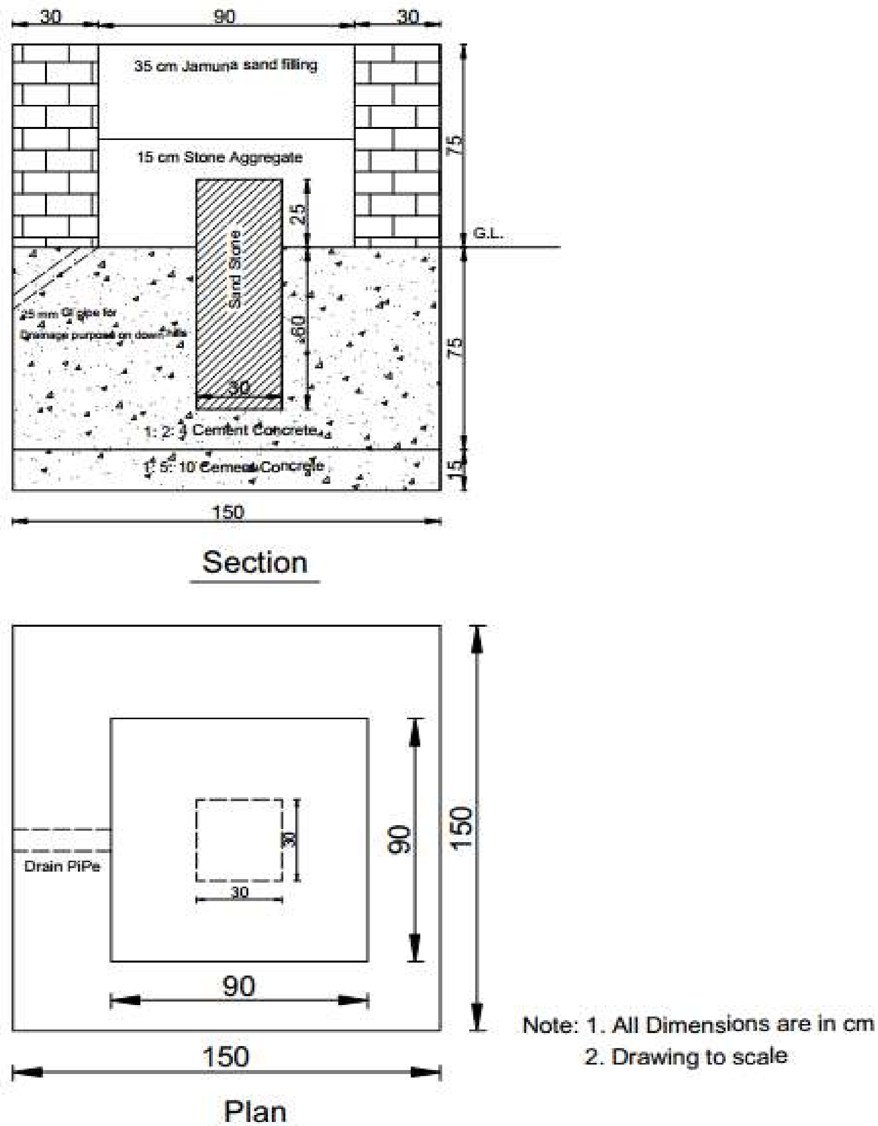


Fig: Musto Type Bench Mark

Annexure-V

EQUIPMENT FOR SEDIMENT SAMPLING AND SEDIMENT LABORATORY

S. No.	Equipment
1	Bottle type Samplers
2	Metallic 1 Litre bottle
3	Metallic Conical Flask
4	Metallic Beaker 500 ml.
5	Double Jacketed cylinder
6	Filtering apparatus
7	Hydrometer
8	Set of 3 sieves
9	Oven
10	Other Sundry items
11	Analytical Balance
12	Enamel or Stainless steel (SS) trough
13	Buckets S S or Enamel
14	Bowls 500 ml
15	Tripod stand
16	Pipette stand
17	Beakers glass 500 ml
18	Measuring cylinders 1 lit.
19	Desiccator 20 cms dia
20	Funnel glass 100 cms
21	Pipette glass 100 ml
22	Porcelain basin 10 cms
23	Thermometer 110 deg C
24	Bottle glass 500 ml
25	Rubber Corks assorted
26	Filter Paper assorted
27	Pressure rubber tubing
28	Glass tubing assorted
29	Glass marking pencil
30	Watch glass 10 cm dia

के.ज.आ./ आर.डी.-1

भारत सरकार

केन्द्रीय जल आयोग

दैनिक निस्सरण आँकड़े

प्रेक्षण न...

नदी...................स्थल....................कोड सं0 ....दिनांक ....समय ....बजे से ....बजे तक

नदी पार करने की विधि - पैदल / पुल / नाव / नाव - इंजन / केबल-नाव / केबल / नदी तट नियंत्रित केबल / केबल - ट्रॉली/..............................

वेग अवलोकन की विधि - फ्लोट (तरणिका) / करेंट मीटर / स्लोप एरिया / विलयन विधि / ए डी सी पी ....

निस्सरण स्थल का स्थान : A) स्थायी स्थल ....

B) अस्थायी स्थल ....

स्थायी स्थल की दूरी ....

अनुप्रवाह / प्रतिप्रवाह ....

गहराई मापने का यंत्र - वेडिंग रॉड / धातु की रील / ईको साउंडर / क्रॉस - सेक्शन द्वारा / ....

प्रयुक्त भार की मात्रा किलोग्राम..

जल अवस्था काफी साफ ....

सामान्यतया गदला...

बहुत गदला ....

नदी जल का ताप (से0ग्रे0)...

औसत जल तल (मानक तट)..मी0

वायुमंडलीय ताप -अधिकतम...(°से0ग्रे0)...न्यूनतम...(°से0ग्रे0)

मौसम की दशा..

नदी प्रवाह के साथ वायु की दिशा ....

वायु की शक्ति: अति मंद/ मंद / प्रबल / अति प्रबल .... वर्षा की मात्रा ....

वायु का वेग कि० मी०/घ० ....

<u>करेंट मीटर का अवलोकन</u>

मीटर न० एवं मेक....................................समीकरण......................अंशांकन की तिथि....................................... अंशांकन चक्रण (स्पिन).................से.

माप से पहले चक्रण.............................से. माप के बाद चक्रण................................ से

प्रथम प्रयोग तिथि.......................... दिनों की संख्या जब से प्रयोग मे है...

मीटर निलंबन की विधि ....

मीटर के साथ उपयोग किए गए भार की मात्रा ....

प्रेक्षित वेग 0.6 डी / सतह ..../.........................तरणिका (फ्लोट) विवरण.. तरणिका चाल की दूरी.......................मी.

तरणिका दूरी हेतु प्रयोग चिन्ह ....

गेज सूचना

शून्य सापेक्ष तल (जी.टी.एस) .... (मी0)

गेज	स्थायी			अस्थायी		
	बायाँ तट	दायाँ तट	औसत	बायाँ तट	दायाँ तट	औसत
प्रारम्भिक						
अंतिम						
औसत						

खंड संख्या	काट पर सापेक्ष दूरी (आर.डी.)	जल की गहराई (मी.)	उध्र्वाधर कोण (वी.एंगल) (°)	एयर लाइन गहराई (मी.)	एयर लाइन करेक्शन (मी.)	वेट लाइन करेक्शन (मी.)	कूल संशुद्धि (मी.) (6+7)	जल की संशुद्ध गहराई (मी.)	गहराई मे अंतर (मी.)	तल मे वृद्धि (मी.)	काट क्षेत्रफल (मी.^{2})	काट क्षेत्रफल संशुद्धि	संशुद्ध क्षेत्रफल	समय	मीटर परिक्रमण	परिकलित वेग	औसत वेग (मी./से.)	काट से धारा का कोण (डिग्री)	संशोधित औसत वेग (मी./से.)	अपवहन दूरी (मी.)	समय अपवहन (से0)	अपवहन संशोधन	अंतिम औसत वेग	खंड निस्सरण (मी.^{3}/से.)	टिप्पणी
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26

परिकलित आँकड़े	सतह की चौड़ाई (मी.)	भीगा परिमाप (मी.)	क्षेत्रफल (मी^{2})	क्षेत्रफल में संशोधन (मी^{2})	संशुद्ध क्षेत्रफल (मी^{2})	कुल निस्सरण (मी^{3}/से.)	निस्सरण में संशोधन (मी^{3}/से.)	संशुद्ध निस्सरण (मी^{3}/से.)

औसत ढाल मापन					
स्तर के अवलोकन का स्थान	दाये किनारे का विवरण		बाएं किनारे का विवरण		औसत रीडिंग
	मध्य गेज लाइन से दुरी	स्तर रीडिंग	मध्य गेज लाइन से दुरी	स्तर रीडिंग	
अनुप्रवाह गेज लाइन:					
मध्य गेज लाइन:					
प्रतिप्रवाह गेज लाइन:					
ढाल :	मीटर मे कमी		दूरी		
औसत ढाल :					

मुख्य आँकड़े
1. V = औसत वेग Q/A=
2. V(max)= अधिकतम बिन्दु वेग =
3. R = जलीय औसत गहराई = A/P =
4. C (चेजी) = $V/\sqrt{RS}$ =
5. N (मैनिंग) = $R^{1/6}/C$ =
6. औसत गहराई = A/W =
7. जहाँ W = जल की सतह की चौड़ाई

अन्य सूचनाये

1.नदी तल के लक्षण

2. खुरदुरेपन की श्रेणी जिसमे यह आता है।

3.प्रत्येक माह अथवा प्रत्येक परिवर्तन की दशा मे नदी के सामान्य प्रवाह की दशा, स्थायी व अस्थायी गेज की स्थिति तथा मध्यरेखा से उनकी दूरी समेत अन्य स्थायी चिन्हो को दर्शाता हुआ स्थल के 500 मीटर प्रति प्रवाह व 500 मीटर अनुप्रवाह तक के नदी की आकृति का एक मुक्त हस्तचित्र बना लेना चाहिए ।

प्रेषक के हस्ताक्षर
नाम
पद

निरीक्षणकर्ता अधिकारी के हस्ताक्षर
नाम
पद

सूचना:

1. 0.6 गहराई पर जो वेग है वही सामान्यतया औसत वेग (स्तम्भ 18) होगा। जहां सतह वेग से औसत वेग का परिणाम निकाला जाय वहां प्रयोग में लाये गए गुणांक को अभ्युक्ति -स्तम्भ में लिख देना चाहिये। जब तक विशेष रूप से प्रमाणित न हो तब तक गुणांक 0.89 को ही प्रयोग में लाना चाहिए।
2. यदि कोई अपवहन (ड्रिफ्ट) न हो तो स्तम्भ 23 में शून्य दर्शाना चाहिये । इस स्तम्भ को कभी रिक्त नहीं छोड़ना चाहिये ।
3. क्षेत्रफल संशुद्धि = असमान छौर खंडो के क्षेत्रफल संशुद्धि का योग = ½ x (जल सतह से पिछले/ अगले RD की सुखी दूरी) x छोर उर्धवार्धर पर गहराई

के.ज.आ./ आर.डी.-2

भारत सरकार

केन्द्रीय जल आयोग

दैनिक निस्सरण आँकड़े

माह...............................20........... के दौरान प्रथम/द्वितीय/तृतीय दस दिनों के निस्सरण प्रेक्षण का दस दिवसीय विवरण

नदी..स्थल..कोड सं0..

निस्सरण स्थल की स्थिति ....

खंडीकरण (सेगमेन्टेशन) की विधि ....

गहराई किस से नापी गई / प्रयुक्त भार ....

0.6 गहराई / सतह पर वेग प्रेक्षण किससे किया गया...

निस्सरण प्रेक्षण की विधि ....

मानक गेज बायें/दायें तट पर है..

गेज का शून्य सापेछ तल(जी0टी0एस0)...

जांच की पिछली तिथि..

दिन	समय	अवलोकन संख्या	औसत गेज (मी.)	समुद्र तल के संदर्भ में ty स्तर (मी.)	निस्सरण (क्यू) (मी.^{3}/से.))	अवलोकन /संगणित	क्षेत्रफल	सतह की ढाल	शीर्ष चौड़ाई	भीगा परिमाप	जल विज्ञान त्रिज्या	वेग	मैनिंग	ढाल	गिरना / घटना	क्रॉसिंग की विधि	वेग का प्रकार	नं. वर्टिकल / फ्लोट	अधिकतम बिन्दु वेग	मौसम की स्थिति	हवा का वेग	हवा की दिशा, धारा प्रवाह के संदर्भ में	टिप्पणी
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

टिप्पणी :-

1. वास्तविक प्रेक्षित निस्सरण को लाल स्याही से लिखा जाये ।

2. संगणित निस्सरण को काली स्याही से लिखा जाये ।

प्रेषक के हस्ताक्षर
नाम
पद

उपमंडलीय अभियंता के हस्ताक्षर
उपमंड

अधिशासी अभियंता
……………………………… मंडल
केन्द्रीय जल आयोग
……………………………. …………………………..

के. ज. आ. आर.डी.-3

भारत सरकार

केंद्रीय जल आयोग

माह..................20............. के दौरान दैनिक गेज पाठयांक का विवरण

नदी...स्थल.....................................कोड सं...............................

शून्य सापेक्ष तल(जी.टी.एस.).. स्थल की प्रकृति

दिनांक	**मध्य रेखा पर गेज पाठयांक (मी.)**			**जल तल (मी.)**			नदी जल का तापमान (से. ग्रे.)	वायुमण्डलीय तापमान (से. ग्रे.)		
	08:00 बजे	13:00 बजे	18:00 बजे	08:00 बजे	13:00 बजे	18:00 बजे		अधिकतम (से. ग्रे.)	न्यूनतम (से. ग्रे.)	
1	2	3	4	5	6	7	8	9	10	11

प्रेषक के हस्ताक्षर
नाम
पद

उपमंडलीय अभियंता के हस्ताक्षर
उपमंडल ……………..

अधिशासी अभियंता
मंडल ...…………
केंद्रीय जल आयोग

के. ज. आ. /आर. डी.-4

भारत सरकार

केंद्रीय जल आयोग

माह..................20......... के दौरान प्रथम/द्वितीय/तृतीय दस दिनों के घंटेवार बाढ़ जलतल का दस दिवसीय विवरण

नदी..स्थल..कोड सं..........................गेज का शुन्य सापेक्षतल(जी. टी. एस.) ....

दिनांक	जलतल(मी.)																										निरीक्षणकर्ता अधिकारी की टिप्पणी
	बजे (घण्टे)																										
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	अधिकतम	न्यूनतम.	

माह के दौरान अधिकतम जलतल.. मीटर ....

वर्ष के दौरान अधिकतम जलतल .... मीटर

कभी भी रिकॉर्ड किया गया अधिकतम जलतल तथा घटित होने की तिथि.....................

प्रेषक के हस्ताक्षर

नाम

पद

उपमंडलीय अभियंता के हस्ताक्षर

उपमंडल

अधिशासी अभियंता

मंडल ....

केंद्रीय जल आयोग

के. ज. आ. /आर. डी.-5

भारत सरकार

केंद्रीय जल आयोग

माह.................20............. के भूजल का अभिलेख

नदी...स्थल..कोड सं..........................

कुएं की स्थिति (गाँव)......................... मध्य रेखा से अनुमानित दूरी.....................…

कुआं किस उपयोग में आ रहा है...

कुएं के शीर्ष पर निर्देश बिंदु की ऊंचाई..

कुएं के चारो ओर भूमि सतह की औसत ऊंचाई...

कुएं के तल (बेड) की औसत ऊंचाई..

कुएं के भूविज्ञानिय लक्षण..

दिनांक	**निर्देश (रेफ़ेन्स) बिंदु से नीचे की गहराई**		**कुएं में जलतल की ऊंचाई**		**कुएं के जल का तापमान(से.ग्रे.)**		**माप की अवस्था**	**टिपण्णी**
	0500 बजे	0800 बजे	0500 बजे	0800 बजे	0500 बजे	0800 बजे		
1	2	3	4	5	6	7	8	9

मासिक औसत जल तल

1- निम्नलिखित विवरण के अनुसार स्तंभ 8 में उपयुक्त चिन्ह भरें ।
   (a) पिछले माप से भारी अवक्षेपण (वर्षा और या हिम)
   (b) पिछले माप से संतुलित (माडरेट) अवक्षेपण (वर्षा और/या हिम)
   (c) पिछले माप से मामूली या शून्य अवक्षेपण (वर्षा और / या हिम)
2- जल से प्राय: भरे गर्त, तालाब और खाई
3- प्राय: सूखे गर्त तालाब और खाई।
4- क्या ज़मीन जमी हुई है।
5- क्या कुएं में सतह का जल बहकर गया है।
6- यदि कुआं उपयोग में है तो टिप्पणी के स्तंभ में माप तथा प्रयोग की समाप्ति के बीच समय अंतराल घंटों में दर्शाया जाये ।
7- यदि पास के किसी कुएं का पानी पंप से निकला जाये तो टिप्पणी के स्तंभ में इस की दूरी पंप करने की अवधि तथा अनुमानित निस्सरण का उल्लेख करें।

प्रेषक के हस्ताक्षर	उपमंडलीय अभियंता के हस्ताक्षर	अधिशासी अभियंता
नाम	उपमंडल	मंडल ....
पद		केंद्रीय जल आयोग
		....................../ ....

के. ज. आ. /आर. डी.-6

भारत सरकार

केंद्रीय जल आयोग

माह.................20.......... के वर्षा का अभिलेख

नदी ....स्थल ....कोड सं ....

वर्षा मापी का प्रकार: साधारण / स्वतः अभिलेखी ………………………………………………………….

दिनांक	**पिछले दिन 20:30 बजे हुई वर्षा (मिमी)**	**08:30 बजे हुई वर्षा (मिमी)**	**पूरे दिन में हुई कुल वर्षा (मिमी)**	**माह के लिए संचयी वर्षा (मिमी)**	**वर्ष के लिए संचयी वर्षा (मिमी)**	**टिप्पणी**
1	2	3	4	5	6	7
योग						

वर्ष में हुई कुल वर्षा

1- पिछले माह के अंत तक …………………………………………………………………….मिमी

2- चालू माह के अंत तक ………………………………………………………………..……. मिमी

3- चालू माह में वर्षा के दिनों की संख्या ………………………………………………………….

प्रेषक के हस्ताक्षर
नाम
पद

उपमंडलीय अभियंता के हस्ताक्षर
उपमंडल ……………………….

अधिशासी अभियंता
मंडल……………………………….
केंद्रीय जल आयोग

के. ज. आ. /आर. डी.-7

भारत सरकार

केंद्रीय जल आयोग

दैनिक निलम्बित तलछट विश्लेषण का अभिलेख

नदी................................स्थल.........................स्थलकोड सं..................................दिनांक..

प्रतिचयन काट.....................................गेज रेखा /पुल/अस्थाई काट……………………………………………… समय......................से..........................तक

प्रतिचयन की विधि लांच/रज्जू मार्ग/आउट बोर्ड इंजन सहित या रहितनाव/पैदल(वैडिंग से)... नदी जल का रंग ....

प्रयोग में लाये गये तलछट सेंप्लर की किस्म.. नदी जल का ताप………………………..मौसम...

प्रतिचयन का अभिलेख										तलछठ विश्लेषण												
										स्थूल तल छट 0.2 मिमी.से ऊपर						मध्य तल छट 0.2 मिमी..से नीचे व 0.075 मिमी. से ऊपर						
क्र.	प्रतिचयन की अनुभाग की सापेक्ष की दूरी	जल की गहराई (मी.)	प्रतिचयन गहराई (मी.)	वेग (मी./से.)	नमूना बोतलों की सं.	समूह सं.	संयुक्त नमूनो का आयतन (ली.)	समूह निस्सारण (मी³/से.)	समूह अपवाह 1000 (हे.मी.)	डिश सं.	खाली डिश का भार (ग्रा.)	डिश+शुष्क तलछट का भार (ग्रा.)	तलछट का भार (ग्रा.)	सांद्रता (ग्रा./ली.)	भार (टन/दिन)	डिस सं.	खाली डिश का भार (ग्रा.)	डिश+शुष्क तलछट का भार (ग्रा.)	तलछट का भार (ग्रा.)	सांद्रता (ग्रा./ली.)	भार (टन/दिन)	अभियुक्तियाँ
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	योग																					
	औसत																					
	भारित सांद्रता																					

$$\text{भारित माध्य सांद्रता(ग्रा./ली.)} = \frac{\text{कुल भार (टन/दिन)}}{\text{(अपवाह)} \times 10^4}$$

सूक्ष्म तलछठ					
सूक्ष्म तलछठ की सांद्रता (.075मिमी.से कम)		घुलित पदार्थ		गेज एवं निस्सारण	
				विवरण	मिट्रिक इकाई
फिल्टर पेपर का भार(ग्रा.)		खाली डिश की भार (ग्रा.)		प्रारम्भ मेन गेज	
				अंत में गेज	
फिल्टर पेपर + शुष्क तलछट का भार (ग्रा।)		खाली डिश + घुलित पदार्थ का भार(ग्रा.)		माध्य गेज	
				शून्य सापेक्ष तल.	
तलछट का भार (ग्रा.)		घुलित पदार्थ का भार(ग्रा.)		माध्य जल तल	
				निस्सारण	
सांद्रता (ग्रा./ली.)		सांद्रता (ग्रा./ली.)		अपवाह प्रतिदिन	
				माध्य वेग	
भार (टन/दिन)		सांद्रता (पी.पी.एम.मे)			

तलछट का सार

	कोटि	सांद्रता(ग्रा./ली)	भार (टन/दिन)	
	स्थूल			
	मध्यम			
	सूक्ष्म			
	योग			

प्रेषक के हस्ताक्षर | सहायक अनु.अधिकारी/अनुसंधान अधिकारी | अधिशासी अभियंता

नाम.. | .... मंडल | .... मंडल

पद...

के. ज. आ./ आर.डी.-**8**

भारत सरकार

केन्द्रीय जल आयोग

……………………..…माह के दौरान प्रथम /द्वितीय/ तृतीय दस दिवस के लिए निलंबित तलछट का दस दिवसीय विवरण

स्थल……………………………………………………………………………… कोड सं॰…………………………………………………………………………………………

नदी ……………………………………………………. स्थल शैल और / या मिट्टी की किस्म……………………………………………

मण्डल………………………………………………………………………… उपमण्डल…………………………………………………………………………………

गेज का शून्य सापेक्ष तल ……

दिनांक	स्थूल तलछट की सांद्रता (ग्रां/ ली.)							योग	माध्य	मध्यम तलछट की सांद्रता (ग्रां/ ली.)							योग	माध्य	सूक्ष्म तलछट की सांद्रता (ग्रां/ ली.)	घुलित पदार्थ की (सांद्रता ग्रां/ ली.)	माध्य वेग (मी/से.)
	I	II	III	IV	V	VI	VII			I	II	III	IV	V	VI	VII					
योग																					
माध्य																					
मासिक योग																					
मासिक औसत																					

दैनिक निलंबित तलछट का भार

दिनांक	माध्य जलस्तर(मी.)	निस्सरण (मी.^{3}/से.)	अपवाह (हे.मी.∗10)	स्थूल तलछट		मध्यम तलछट		सूक्ष्म तलछट		कुल तलछट		अभ्युक्तियां
				ग्रा./ली.	टन/दिन	ग्रा./ली.	टन/दिन	ग्रा./ली.	टन/दिन	ग्रा./ली.	टन/दिन	
1	2	3	4	5	6	7	8	9	10	11	12	13
योग												
माध्य												
मासिक योग												
मासिक औसत												

प्रेषक के हस्ताक्षर................................

नाम...

पद.......................................

सहायक अनुसंधान अधिकारी/अनुसंधान अधिकारी

.......................मंडल

............................./……………………

अधिशासी अभियंता

.......................मंडल

............................/………………

के.ज.आ./आर. डी.-9

भारत सरकार

केन्द्रीय जल आयोग

वर्ष................................ का निलंबित तलछट भार आंकड़ों का सार

नदी.................................. स्थल.............................. कोड सं0............................

अनुप्रस्थ काठ/Cross Section...................................

स्थल का प्रकारअथवा मिट्टी की किस्म.................................. गेज (जी.टी.एस.) का शुन्य सापेक्ष ताल.........................मी०

माह	निस्सरण (मी.^{3}/से.)	तलछट भार टन																		प्रति चयन की रीति	अभियुक्ति
		(अपवाह (हे० मी.X10)		स्थूल				मध्यम				सूक्ष्म				योग					
	मध्य मान	योग	मध्य मान	योग	मध्य मान	आरोही /योग	मध्य मान	योग	मध्य मान	आरोही योग	मध्य मान	योग	मध्य मान	आरोही योग	मध्य मान	योग	मध्य मान	आरोही योग	मध्य मान		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22

प्रेषक के हस्ताक्षर　　　　सहायकअनुसंधान अधिकारी　　　　अधिशासी अभियंता

नाम...　　　　............ मंडल....................　　　　.................. मंडल....................

पद..　　　　..................../............................

के. ज. आ. /आर. डी.-10

भारतसरकार

केन्द्रीय जल आयोग

तलछट कणों का औसत व्यास

(0.6 मिमी. व्यास से कम.)

आवश्यक :-यह प्रपत्र अकेला तभी प्रयुक्त करना चाहिए जबकि 0.6 मिमी. से कम व्यास वाले कणों का प्रतिशत 5.0 से कम अथवा समान हो अन्यथा 5.0 प्रतिशत से अधिक होने पर प्रपत्र सी. डब्लूसी/आर.डी. II प्रयुक्त करना चाहिए।

नदी..............................गाद मापी में जल का ताप..

स्थल ....कोड सं०.............क्षेत्र नमूना सं. ....

प्रतिचयन की तिथि ....प्रयोगशाला नमूना सं ....

विश्लेषण की तिथि.....................................

प्रायोगिक मान				अन्तर्वेशित मान			
व्यास मिमी. में	वास्तविक आयतन घन सेमी. में	भार से वास्तविक प्रतिशत	संकलन प्रतिशत	व्यास मिमी. में.	संकलन पाठ्याँक (=S)	वितरण मान प्रतिशत	अंकित औसत व्यास मिमी.
				0.06			
				0.08			0.07
				0.10			0.09
				0.12			0.11
				0.14			0.13
				0.16			0.15
				0.18			0.17
				0.20			0.19
				0.22			0.21
				0.24			0.23
				0.26			0.25
				0.28			0.27
				0.30			0.29
				0.32			0.31
				0.34			0.33
				0.36			0.35
				0.38			0.37

				0.40			0.39
				0.42			0.41
				0.44			0.43
				0.46			0.45
				0.48			0.47
				0.50			0.49
				0.52			0.51
				0.54			0.53
				0.56			0.55
				0.58			0.57
				0.60			0.59
योग							

छनी हुई मात्रा =

0.6 से कम मात्रा/ =

आरंभिक भार W1

(गाद मापी में =

रखे गये भाग का)) = W2

अंतिम भार =

हानि = (W1-W2)

%0.6 मि.मी. से ज्यादा. = (वाई/Y) 1.'S' कॉलम का योग = (T)

%0.2-0.6 मि.मी. = 2. 0.61+0.0019(Y) =

%0.7-0.2 मि.मी. = 3.0.0002 T =

%0.7 मि.मी.से कम = (पी/P) 4.0.0004 P =

50% व्यास = 5. औसत व्यास =

=(2)-(1)-(4)

विश्लेषक के हस्ताक्षर सहायक अनुसंधान अधिकारी अधिशाषी अभियंता

नाम जल गुणवत्ता अनुसंधान प्रयोगशाला लेवल-2/ ....मंडल

पद

..........................मंडल

के. ज. आ. /आर. डी.-11

भारत सरकार

केन्द्रीय जल आयोग

तलछट कणों का औसत व्यास

(0.6 मिमी. व्यास से कम)

आवश्यक :-

यह प्रपत्र CWC/RD-10 परिशिष्ट की तरह प्रयुक्त करना चाहिए जब 0.6 मि.मी. से ज्यादा व्यास वाले कणों का प्रतिशत 5.0 से अधिक हो/ योग वक्र को संकुचित पैमाने और साधारण पैमाने दोनों पर खींचा जाना चाहिए.

नदी............................ अनुप्रस्थ काट. .... R.D....................

स्थल ....कोड सं०........... क्षेत्र सं ....

प्रयोगशाला नमूना सं. ....

Experimental Values		Interpolated Values						Result of Slope Analysis		
व्यास (मिमी.)	योग प्रतिशतता	व्यास (मिमी.)	योग रीडिंग (=S)	वितरण मूल्य प्रतिशत	व्यास (मिमी.)	योग रीडिंग (=s)	वितरण मूल्यप्रतिशत	छिद्र (मि.मी.)	ठहरी हुई मात्रा (ग्रा.)	ठहरी मात्रा का प्रतिशत/%
0.1		0.1								
0.2		0.2								
0.3		0.3								
0.4		0.4								
0.5		0.5								
0.6		0.6								
1.0		0.7								
1.5		0.8								
2.0		0.9								
2.5		1.0								
3.0		1.1								
3.5		1.2								
4.0		1.3								
4.8		1.4								
		1.5								
		1.6								
		1.7								
		1.8								
		1.9						4.8		
		2.0						4.0		

		2.1							3.5		
		2.2							3.0		
		2.3							2.5		
		2.4							2.0		
		2.5							1.5		
		2.6							1.0		
		2.7							0.6		
		2.8							0.6 से गुज़रना		
		2.9									
		3.0									
		3.1							योग		
		3.2									
		3.3									
		3.4									
		3.5									
		3.6									
		3.7									
		3.8									
		3.9									
		4.0									
		4.1									
		4.2									
		4.3									
		4.4									
		4.5									
		4.6									
		4.7									
		4.8									

1. 'S' कॉलम का योग (=T) =
2. अधिकतम व्यास (=A) =
3. 0.0001 T (=B) =
4. औसत व्यास (=A-B) =

विश्लेषक के हस्ताक्षर सहायक अनुसंधान अधिकारी/अनुसंधान अधिकारी के (हस्ताक्षर) अधिशासी अभियन्ता

नाम ....मंडल

पद

के. ज. आ. /आर. डी.-12

भारत सरकार

केन्द्रीय जल आयोग

तल पदार्थो के विश्लेषण परिणाम

नदी...................................... स्थल................................. कोड संख्या .... प्रेक्षण काट (**प्रति प्रवाह/अनुप्रवाह/केन्द्रीय रेखा**)-------

क्रमांक	संग्रह की तारीख	प्रयोगशाला संख्या	एकत्रित किये गए नमूनों की तारीख											नदी के सामान्य आकडे								अभियुक्ति
			सापेक्ष दूरी	शुष्क तल का सापेक्ष स्तर	तल का सापेक्ष स्तर	प्रति चयन गहराई का जल स्तर (जी.टी.इस.)	जल की गहराई (मी.)	चौड़ाई (मी.)	वेग (मी./से.)	निस्सारण (मी3/से.)	तल पदार्थ संरचना			भीगा परिमाप (मी०)	जलीय औसत गहराई (मी०)	औसत वेग (मी./से.)	सतह जल ढाल	निस्सारण (मी3/से.)	तलपदार्थ संरचना			
											अधिकतम आकर	न्यूनतम आकर (मिमी.)	औसत आकर (मिमी.)						अधिकतम आकर (मि.मी.)	न्यूनतम आकर (मि.मी.)	औसत आकर (मि.मी.)	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23

सहायक/विश्लेषक के हस्ताक्षर
नाम
पद

सहायक अनुसंधान अधिकारी/अनुसंधान अधिकारी के हस्ताक्षर
नाम

अधिशासी अभियन्ता के हस्ताक्षर
.... मंडल
....

के. ज. आ. / आर. डी.-13

भारत सरकार

केन्द्रीय जल आयोग

ऊर्ध्वाधर वेग तथा तलछट वितरण प्रयोग/ Vertical Velocity and Sediment Distribution Experiment

नदी.............................. स्थल.............................. कोडसं ....

दिनांक.............................. समय..............................बजेसे..............................बजेतक

प्रयोग सं...................काट एवं सापेक्ष की दूरी. ....जल की गहराई.....................

जल स्तर प्रारम्भ............ अंत........................ औसत.....................निस्सरण..............................

			स्थूल तलछट		मध्यम तलछट		
प्रतिचयन बिंदु	प्रतिचयन गहराई	वेग (सी/से)	योग (ग्रा.)	सांद्रता (ग्रा/ली)	योग(ग्रा.)	सांद्रता (ग्रा/ली)	अभ्युक्तियाँ
1	2	3	4	5	6	7	8
सतह							
0.1 D							
0.2 D							
0.3 D							
0.4 D							
0.5 D							
0.6 D							
0.7 D							
0.8 D							
0.9 D							
योग							
माध्य							
अधिकतम							
न्युनतम							

टिप्पणी

योग- सभी निर्धारित गहराइयों का योग+जल सतह पर मान का1/2

माध्य: $\frac{\text{योग}}{10}$

सारांश

1.ग्राफिय समाकलन विधि से प्राप्त मध्यवेग (V)…………………………..मी./से

2. मध्यवेग (V) जल सतह के नीचे..........................गहराई पर प्राप्त हुआ।

3. सतह वेग से मध्यवेग का अनुपात................

4. 0.6 गहराई पर वेग से माध्यवेग का अनुपात।

5. ग्राफ़िय समाकन विधि द्वारा प्राप्त मध्य तलछट सांद्रता:-

(i) स्थूल तल छट..

(ii) मध्यम तलछट..

6. मध्य तलछट सांद्रता प्राप्त हुई:

(i) स्थूल तलछट..

(ii) मध्यम तलछट ....

7. 0.6 गहराई पर प्राप्त सांद्रता से मध्य तलछट सांद्रता का अनुपात................

(i) स्थूल तलछट..

(ii) मध्यम तलछट..

प्रेषक के हस्ताक्षर	उपमंडल अधिकारी	अधिशाषी अभियंता
नाम	उपमंडल	................मंडल
पद		

के. ज. आ./ आर.डी.-14

भारत सरकार

केन्द्रीय जल आयोग

नदी/कुंआ जल भौतिक और रासायनिक विशिष्टता

प्रदूषण अध्ययन केन्द्रीय रेखा तथा कुंआ

प्रदूषण अध्ययन कुंआ एवं केन्द्रीय रेखा पर एकत्र किये जाने वाले प्रतिचयन के लिए													पीएच	चालकता	कुंआ का जल स्तर	कुंआ का आधार तल	केन्द्रीय रेखा से कुंआ की दूरी	प्रती चयन बिंदु की गहराई	नदी का औसत जलस्तर	नमूना प्राप्ति का दिनांक
क्रमांक	प्रयोगशाला संख्या	नदी	स्थल	स्थिति	दिनांक	समय	मौसम	जल का रंग	जल का गंध	तापमान	निस्सरण मी.^{3}/से	आयतन (ली.)								
				प्रतिप्रवाह																
				अनुप्रवाह																
				केन्द्रीय रेखा																
				कुंआ																

ष्ठ अनुसंधान सहायक / कनिष्ठ अभियंता/गेज सहायक के हस्ताक्षर

निस्सरण स्थल का नाम

के. ज. आ./ आर.डी.-15

भारत सरकार

केन्द्रीय जल आयोग

.... मंडल ....

नदी जल नमूनो के धूलित ऑक्सीज़न एवं जैव ऑक्सीज़न मांग पर हुए प्रयोग के परिणाम

नदी.. स्थल... कोड सं. ....

घुलित ऑक्सीज़न एवं जैव ऑक्सीज़न मांग आँकड़ो के लिए प्रयुक्त सेंप्लर का प्रकार....................... / क्या सेंप्लर कार्य करने की दशा में हैं.........................

क्रमांक	प्रयोगशाला संख्या	नमूना संग्रह का दिनाँक	समय घंटे में	स्थान	नदी जल का ताप	सापेक्ष दूरी	नमूना मंडल प्रयोगशाला भेजने की दिनाँक	निस्सरण (मी.^{3}/से.)	गहराई (मी.)	वेग (मी./से.)	प्रतिचयन गहराई	मानकीकरण के लिए प्रयुक्त पोटेशियम डाइक्रोमेट और सोडियम हाइपो सल्फेट विलयनों की सांद्रता	घुलित ऑक्सीज़न एवं जैव ऑक्सीज़न मांग(mg/l)								
													मानकीकरण की दिनाँक	स्थल पर	ऊष्मा यान से पूर्व	ऊष्मा यन से पश्चात	तनुता स. यदि हो	मिग्रा./ ली.	टन / दिन	(बी. ओ. डी. बोतल न.)	अभ्युक्तिया
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22

प्रेषक के हस्ताक्षर　　　सहायक अनुसंधान अधिकारी/ अनुसंधान अधिकारी　　　अधिशाषी अभियंता

नाम..

पद...　　　................... मंडल　　.　　　................. मंडल

के. ज. आ./ आर.डी.-16

भारत सरकार

केन्द्रीय जल आयोग

निरीक्षण प्रतिवेदन

(कृपया कोई मद खाली न छोड़े। प्रपत्र को पूरी तरह भरें तथा लागू न होने वाले मदो के सामने लागु नही लिखे)

नदी....................................स्थल..................................... कोड सं...................दिनांक.......................................

1- वर्तमान निरीक्षण की अवधि से.......................................तक.......................................
:द्वारा

2- स्थल का पिछला निरीक्षण कब और किसने किया ?

I. गेज एवं निस्सरण प्रेक्षण

3- प्रयोगरत नौसंचालन उपकरणों नाव / ओ. बी. इंजन / जेट बोट इत्यादि के प्रकार एवं उनकी स्थिति:

4- बताये की क्या पर्याप्त संख्या में लाइफबॉय , लाइफ जैकेट , डाइ दिए गए हैं?

5- इंजन यदि हो तो उस का प्रकार व उसकी स्थितिः

6- इंजन के कुल चलन घंटे:

7- गीयर तेल बदलने की तिथि

8- लागबुक तथा तेल की खपत सत्यापित करे

9- निम्न्लिखित की स्थिति तथा निष्पादन क्षमता का उल्लेख करें:

(a) विराम घड़ी

(b) गहराई मापीदंड

(c) वेडिंग रॉड

(d) निलंबन उपकरण

(e) फीता

(f) अन्य वैज्ञानिक व गणितीय उपकरण

10- तल मापन कार्य

(a) तल सं.

(b) स्थायी समयोजन की जांच करें तथा परिणाम बतायें

(c) गेज के शुन्य तल की जांच करे. तथा परिणाम बतायें

11- क्या आस-पास में मानक बेंचमार्क सुलभ हैं?

12- स्थल के बेंचमार्क की मस्टो टाइप बेंचमार्क से पिछली बार कब जांच की गयी।

13- नदी गेज (लकड़ी / कंक्रीट / स्टील / इनामल प्लेट / ऊर्ध्वाधर / आनत / स्थायी / अस्थायी इत्यादि के प्रकार तथा उनकी स्थिति

14- स्थल पर नदी की स्थिति बतायें (चैनल की संख्या , प्रबल प्रवाह की दशायें , तटों का अधिपत्य , नदी की आकारिकी , अपरदन की समस्याऐं यदि कोई हो , इत्यादि

15- खंडीकरण की विधि का उल्लेख करें

16- यदि कीलक बिंदु विन्यास है तो क्या इस की शुद्धता की जांच की गयी हैं ? यदि हाँ तो कब और किस के द्वारा?

17- क्या केबुल मार्ग या क्रेडिल हैं ? यदि हाँ तो वह किस दशा में है?

18- धारा वेगमापी की संख्या , उसकी बनावट तथा उसका अंशांकन समीकरण.

19- सामान्य दशा (कृपया बतायें कि क्या धारा वेगमापी तथा इसके साथ सभी उपकरण बिना किसी क्षति के ठीक ढंग से काम कर रहे हैं)

20- क्या प्रेक्षक उसे दक्षता से चला सकता है?

21- पिछली बार उस का अंशांकन कब हुआ था?

22- प्रयोग से पूर्व व पश्चात चक्रण स्पिन की जांच करें तथा परिणाम लिखें:

23- जांच मीटर की संख्या , बनावट एवं इसका अंशांकन समीकरण:

24- निरीक्षण के दौरान अगर दोनों मीटरों से पूर्ण संयुक्त प्रेक्षण किया गया हो तो परिणाम लिखें तथा दोनों निस्सरण प्रेक्षण संलग्न करें:

25- दोनों परिणामो के बीच अंतर का संभावित कारण तथा सुझाये गये उपाय:

26- विगत दस दिनों के दैनिक गेज, निस्सरणव 'सेट' 'एस' तथा 'एन' (मैनिंग) के मान का विवरण संलग्न करें तथा आंकड़ों पर टिप्पणी के साथ अंतर, यदि हो, तो विस्तृत कारण बतायें:

II. क्षेत्र तलछट प्रेक्षण एवं विश्लेषण

27- प्रयोग में लाये गए निलंबित सैम्पलर का प्रकार एवं इसकी दशा:

28- क्या नमूने 0.6 डी से लिए जाते हैं? यदि नहीं तो प्रतिचयन बिंदु का उल्लेख करें तथा निर्धारित मानक के अनुसार नमूनों के इकट्ठा न करने का कारण बतायें:

29- नमूनों को नाव में रखने तथा इन्हें प्रयोगशाला ले जाने की व्यवस्था बतायें:

30- प्रेक्षक के साथ संयुक्त प्रेक्षण करें तथा परिणाम लिखें:

31- स्थल से गाद प्रयोगशाला के बीच की दूरी।

32- क्या प्रयोगशाला को साफ़-सुथरा एवं समुचित दशा में रखा जाता है?

33- प्रयोगशाला के समस्त उपकरणों की जांच करें तथा उन पर अपनी टिप्पणी दें

(a) भौतिक तुला

(b) रासायनिक तुला

(c) पी. एच. मीटर

(d) बाट

(e) अन्य उपकरण

34- क्या प्रयोगशाला पूर्णतः सज्जित है? यदि नहीं तो वांछित उपकरण का उल्लेख करें।

35- क्या कोई विशेष प्रयोग किया गया? यदि हां, तो किये गये प्रयोग की प्रकृति एवं संख्या का उल्लेख करें तथा सुधार हेतु अपने सुझाव दें

36- क्या स्थल पर ताल-भार सर्वेक्षण कियागया? यदि हां तो इसकी स्थिति बताते हुए माह में इकट्ठा किये गये नमूनों के संख्या का उल्लेख करें।

37- क्या तलभार सैम्पलर ठीक ढंग से कार्य कर रहा है?

III. जल गुणवत्ता कार्य:

38- प्रतिचयन काट की संख्या एवं उनकी अवस्थिति:

39- प्रत्येक काट से एकत्रित नमूनों की संख्या तथा प्रतिचयन की वास्तविक स्थिति (चौड़ाई व गहराई के अनुसार)

40- स्थल पर किये गये परीक्षणों की संख्या तथा उन पर निरीक्षणकर्ता अधिकारी की टिप्पणी

41- मंडल / परिमंडल प्रयोगशाला को भेजे गये नमूनों की संख्या तथा उनके उद्देश्य

IV वर्षामापी

42- वर्षा मापी के प्रकार एवं उनकी स्थिति

43- क्या वर्षा मापी निर्धारित मापदंडो के अनुसार लगाये गये हैं? (कृपया बतायें की क्या स्थल बाधा रहित है?)

44- स्वतः अभिलेखी वर्षा मापी के कार्य की जांच करें

V बेतार केन्द्र

45- स्थल का प्रयोगरत बेतार सेट का प्रकार एवं दशा

46- भवन तथा उसके परिसर की दशा

47- प्रयुक्त बैट्री की दशा

48- यदि जेनेरेटर हो तो उसकी दशा

49- मस्तूल (मास्ट व एन्टीना की दशा)

VI सामान्य

50- क्या पिछले निरिक्षण प्रति वेदन में इंगित निर्देशों का पूर्णतः पालन किया गया है?

51- क्या कनि०अभी०अनु०संहा०संगत प्रपत्र में आंकड़े भरकर मुश्तैदी के साथ नियमित भेजते हैं? विलम्ब होने पर क्या कार्यवाही की गयी?

52- स्थल पर रखे जाने वाले सभी अभिलेखों (उपस्थिति पंजिका समेत) की जांच करें तथा यदि कोई कमी हो तो उल्लेख करें।

53- सामान्य अभ्युक्तियां एवं सुझाव:

कनिष्ट अभियंता के हस्ताक्षर	अनुसंधान सहायक के हस्ताक्षर	जांचकर्ता के हस्ताक्षर
नाम	नाम	नाम
पद	पद	पद
दिनांक	दिनांक	दिनांक

CWC/RD-1

Government of India
Central Water Commission
Daily Discharge Data

Observation No……

River………………..Site……………….. Code No. ……………. Date………………..Time from…………….to………..

Mode of Crossing:- By Wading/ Bridge/ Boat/ Boat with OBE/ Boat With IBE/Boat with Cable Way/ Cable Way/Bank Operated Cable Way/Cable Way with trolley...............

Method of Velocity Observation:-Floats/ Current Meter/Slope Area/Dilution Method/ Floats with Respect to RDs/ ADCP…………………………..

Location of Discharge Site: A) Permanent Site...

B) Temporary Site..

Distance of Permanent Site ....

U/S/ D/S/ ....

Depth measured with:- Wading Rod/Sounding Pole/Metallic Reel/ Echo Sounder/Cross Section…………………………………………….

Sounding weight used: (Kg/Lb)………..

Condition of Water Fairly Clear……..

Ordinary Silty…………………………………………………………………………………………………..

Intensely Silty...

River Water Temperature (^oC)………..

Mean Water Level (Standard Bank)……………………………………………………………………………………………….Meter

Atmospheric Temperature - Max…………………………………..^oC... Min……………………………………...…..^oC

Weather Condition……

Direction of Wind w.r.t. stream flow………..

Strength of Wind: Very Slight / Slight / Strong / Very Strong………………………………………….

Velocity of Wind: Km / Hr …… Rainfall ……………………………………………….

Current Meter Observation

Meter No. and make……………………………Equation…………………………………Date of last Rating……………………………………………………Rated Spin ………………………..

Spin Before Measurement……….

Spin After Measurement……….

Date of first use …………………………………………. No. of days used ……………………………………….

Method of Suspending Meter: ……………………………………………………………………………………………….

Weight used with meter: ………………………………………………………………………………………….

Observed velocity at 0.6 D / Surface…………/……………..Float details……………………Float travel distance……………..Float travel distance marked with ……………………….

Gauge Information

Zero RL (GTS) …………………… m

Gauge	Permanent			Temporary		
	Left Bank	Right Bank	Average	Left Bank	Right Bank	Average
Beginning						
End						
Mean						

SECTION NO.	RD OF SECTION (m)	WATER DEPTH (m)	VERTICAL ANGLE (Deg.)	AIRLINE DEPTH (m)	AIRLINE CORRECTION(m)	WETLINE CORRECTION (m)	(6+7)Total Correction(m)	CORRECTED WAT ER DEPTH (m)	DIFF. IN DEPTH (m)	INCREASE IN BED (m)	AREA of SECTION (m^2)	C/s area correction	(12-13) NET AREA	TIME (sec)	No. OF REV. OF CM	CALCULATED VELOCITY	MEAN VELOCITY (m/s)	ANGLE OBLQ	CORR. MEAN VELOCITY(m/s)	DRIFT DISTANCE (m)	TIME DRIFT (S)	DRIFT CORRECTION	FINAL MEAN VELOCITY	DISCH SECTION (m3/s)	REMARKS
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26

Computed Data	Top Width (m):	Wetted Perimeter (m):	Area (m^2):	Area correction (m^2):	Net Area (m^2):	Discharge (m^3/sec):	Discharge correction (m^3/sec):	Net Discharge (m^3/sec):

Slope Measurement						Main data
Location of Level Observations	Right Bank Details		Left Bank Details		Mean Reading	1. Average velocity, V = Q/A =
	Distance from CGL	Level Reading	Distance from CGL	Level Reading		2. Max. velocity, V(max) =
U/S Gauge Line:						3. Hydraulic mean depth, R = A/P =
Central Gauge Line:						4. Chezy, $C=V/(RS)^{0.5}$ =
D/S Gauge Line:						5. Mannings, $N=R^{1/6}/C$ =
Slope:	Fall in meters:			Distance:		6. Average Depth = A/W =
Mean Slope:						7. Where W=width of water surface

Other information

1.Characteristic of river bed ……………………..

2. Class of roughness under which it falls……………………………………………………………………………………………….

3. Every month or on each change a free hand sketch should be made of the configuration of the river, 500m upstream and downstream of the discharge site, Showing direction of general flow of the river and position of permanent and temporary gauges and other permanent mark and their distance from the C.L. Section.

Signature of Observer
Name
Designation

Signature of inspecting officer
Name
Designation

Note:-

1 Mean velocity (Cl. No. 18) will generally be velocity at 0.6 Depth. Where mean velocity is deducted from surface velocity, the co-efficient employed should be noted I remarks column. Unless proven specially, the co-efficient should be taken as 0.89.

2 If no drift occurs, it has to be shown as NIL in column No. 23, the column is never to be left blank.

3 Sum of area corrections due to unequal segments. Correction for each unequal segment=½ X (Dry distance of preceding/succeeding R.D. from water edge)X depth at the end Vertical.

CWC/RD-2

Government of India

Central Water Commission

Daily Discharge Data

Month……………………………..20……….

Statement Showing details of First/ Second/ Third Ten Daily Discharge Observation

River……………………………………………………… Site…………………………………………………. Code…………………………………………………….

Position of Discharge Site…….
Method of Segmentation……….
Sounding taken with/weight used…….
Velocity observed by…………………………………………………………………………………….at 0.6 depth/surface
Mode of discharge observation……….

Standard Gauge on Right/Left Bank……….
R.L. of Zero of Gauge (G.T.S.)…….
Date of its last checking…….

DAY	TIME	OBSERAVATION No.	MEAN GAUGE (m)	Water Level w.r.t. M.S.L. (m)	DISCHARGE (Q) (m^3/s)	Observed/Computed	AREA (A)	SURFACE SLOPE (S)	TOP WIDTH	WETTED PERIMETER	HYDROLIC RADIUS	VELOCITY	MANNING COEFFICIENT	GRADIENT	FALL	MODE CROSSING	METHOD VELOCITY	No. VERTICAL/FLOAT	VELOCITY MAX	WEATHER CONDITION	WIND VELOCITY	WIND DIR w.r.t. FLOW	REMARKS
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

Remarks :-

1. Actual observed discharges to be entered in red ink.
2. Tabular discharges to be entered in black ink.

Signature of Observer
Name
Designation

Signature of SDE
Sub- Division

Executive Engineer
………………… ..……………… Division
Central Water Commission
…………………………./ ………………………….

CWC/RD-3

Government of India
Central Water Commission

Month..................20............Statement showing Daily Gauge Reading

River..Site......................................Code No................................

Zero of Gauge (G.T.S.)... Type of Site

Date	**Gauge reading at C/G Line (m)**			**Water Level (m)**			River Water Temperature (°C)	Atmospheric Temperature(°C)		**Remarks of Inspecting Officer**
	0800 Hrs	1300 Hrs	1800 Hrs	0800 Hrs	1300 Hrs	1800 Hrs		Max.(° C)	Min.(° C)	
1	2	3	4	5	6	7	8	9	10	11

Signature of Observer
Name

Signature of SDE
Sub-Division

Executive Engineer
Division /Designation
Central Water Commission

CWC/RD-4

Government of India

Central Water Commission

Month..................20.........

Statement showing details of First/Second/Third Ten Daily Hourly Flood Level

River.......................... Site.............. ..Code.......... Zero of Gauge (G.T.S.) ………………

Date	Water Level (m)																										Remarks of Inspecting Officer
	Hours																										
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Max.	Min.	

…………………………………………………Highest Water Level during the month …………………… m.

Highest Water Level during the year ……………………………………… (m)

Ever Recorded Highest Water Level and Date of occurrence…………………

Signature of Observer Signature of SDE Executive Engineer

Name Sub-Division …………... ...…………. Division

Designation Central Water Commission

CWC/RD-5
Government of India
Central Water Commission

Month..................20.... Record of Ground Water Level

River..Site..Code No.........................
Location of well(Village)…………………… Approximate Distance from Central Line…………………..…
Purpose for which well is used……………………………………………………………………..
Elevation of reference point on the top of the well……………………………………………..
Average Elevation of the well…………………………………………………………………….………
Elevation of the bed of well…………………………………………………….………………….
Geological features of the well……………………………………………………………..……………

Date	**Depth Below Reference Point**		**Elevation of Water level in the well**		**Temperature of Well Water (ºC)**		**Condition of measurement**	**Remarks**
	0500 Hrs	0800 Hrs	0500 Hrs	0800 Hrs	0500 Hrs	0800 Hrs		
1	2	3	4	5	6	7	8	9

Monthly Average Water Level

1- Enter approximate symbol in column ‘8’ according to the following description:-
   (a) Heavy precipitation (Rain and/or Snow) since last measurement.
   (b) Moderate precipitation (Rain and/or Snow) since last measurement.
   (c) Slight or no precipitation (Rain and/or Snow) since last measurement.
2- Pond, ditches and depressions nearly filled with water.
3- Pond, ditches and depressions nearly dried up.
4- The ground is frozen.
5- Surface water may be have flowed into the well.
6- If the well has been in use, indicate the time interval (in hours) between the cessation of use are measurement in remarks column.
7- If pumping takes place in a nearly well indicate its distance, duration of pumping and approximate discharge in the remarks column.

Signature of Observer	Signature of SDE	अधिशासी अभियंता / Executive Engineer
Name	Sub-Division	...………. Division
Designation		Central Water Commission

CWC/RD-6

Government of India
Central Water Commission
Month.................20.........Record of Rainfall

River... Site................................... Code...
Type of Rain gauge: Ordinary/ Self-recording………………….…………………………………….

Date	Rainfall at 20:30 hrs (mm) on the previous day	Rainfall at 08:30 hrs (mm)	Total Rainfall during the day (mm)	Cumulative Rainfall till date for the month (mm)	Cumulative Rainfall for the year (mm)	Remarks
1	2	3	4	5	6	7
Total						

Total annual rainfall

1- Till the end of previous month………………………………………………………………… mm
2- Till the end of current month…………………………………………………………..……mm.
3- Number of rainy days during the current month……………………………………………………..

Signature of Observer
Name
Designation

Signature of SDE
Sub-Division

Executive Engineer
...………. Division
Central Water Commission

CWC/R.D.-7

Govt of India

Central Water Commission

Daily Record of Suspended Sediment Analysis

River................................Site...............................Site Code No.............................Date.......................................

Sampling section.............................Gauge Line/Bridge/Temporary Section………………………………….

......................................Time...From..to.................................

Mode of sampling/Launch/Ropeway/Boat with or without O.B.E/Bridge/Wading..

River Water Colour..

Type of Suspended sediment sampler used..

Temp of River Water…………………………………………………….... Weather...

Sampling Record										Sediment Analysis												
No.	R.D.on sampling Section	Water Depth(M)	Sampling Depth (M)	Velocity(m)/s	No.of Sampling bottels	Group No.	Volume of composite Samples	Group Discharge M³/s	Group Run off 103 (Hect M)	Coarse Sediment Above 0.2 mm						Medium sediment bellow 0.2 mm and above 0.075 mm						
										Dish No.	Weight of empty dish(gm)	Weight of dish + dry sediment	Weight of Sediment(g)	Concentration(g/l)	Load (Tons/Day)	Dish No.	Weight of empty dish(gm)	Weight of dish + dry sediment	Weight of Sediment(g)	Concentration(g/l)	Load (Tons/Day)	Remarks
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	Total																					
	Average																					
	Weighted Concentration																					

$$\text{Weighted mean concentration(g/l)} = \frac{\text{Total Load (Tones/day)}}{(\text{Run off})\times 10^{4}}$$

Fine Sediment

Concentration of Fine Sediment (bellow0.075 mm)	
Weight of Filter Paper (gm)	
Weight of Filter Paper + Dry Sediment	
Weight of Sediment	
Concentration(gm/l)	
Load (Tons/Day)	

Dissolved Solid	
Weight of Empty Dish(gram)	
Weight of Empty dish+ Dissolved solid (Gm)	
Weight of Dissolved Solid(gm)	
Concentration(g/l)	
Concentration (PPM)	

Gauge and Discharge	
Details	M.K.S.Unit
Initial Gauge	
Final gauge	
Average Gauge	
Zero R.L.	
Average Water level	
Discharge	
Run Off Per Day	
Average Velocity	

	Grade	Concentration(g/l)	Load (Tons/Day)	
	Coarse			
	Medium			
	Fine			
	Total			

Signature of Observer

Name...

Designation...

Asstt. Research Officer

.... Division

....

Executive Engineer

.... Division

CWC/RD-8
GOVT.OF INDIA
CENTRAL WATER COMMISSION

During the Month of...details of suspended sediment for the First/Second/Third 10 days

Site.. Code No..

River .... Rock and or soil type at Site..

division... Sub-Division..

Zero reduced level of gauge ....

Date	Concentration of Medium sediment (g/l)							Total	Average	Concentration of Medium sediment (g/l)							Total	Average	Concentration of fine sediment (g/l)	Concentration of Dissolved solid g/l	Average Velocity (m/s)
	I	II	III	IV	V	VI	VII			I	II	III	IV	V	VI	VII					
Total																					
Average																					
Monthly Total																					
Monthly Avg																					

Weight of Daily Suspended Sediment

Date	M.W.L	Discharge in m^3/s	Run Off in 10^3 Hect. M	Coarse sediment		Medium Sediment		Fine Sediment		Total Sediment		Remarks
				gram/lit	Tons/Day	gram/lit	Tons/Day	gram/lit	Tons/Day	gram/lit	Tons/Day	
1	2	3	4	5	6	7	8	9	10	11	12	13
Total												
Monthly. Total												
Monthly. Avg												
Monthly. Avg												

Signature of observer................................

Name..

Designation.......................................

Asstt. Research Officer/Research Officer
..................………… Division
.........................……………………

Executive Engineer
...................…………. Division
.........................……………

CWC/RD-9

Government of India

Central Water Commission

Year…………………………..

ABSTRACT OF SUSPENDED SEDIMENT LOAD DATA FOR THE YEAR

River…………………………….. Site………………………… Code No………………………..

Cross Section………………….…………..

Rock and Soil type at site……………………………… Zero R.L. of Gauge (G.T.S.)……………………..m.

Month	Discharge (m^3/s)	Sediment Load in Tons																		Mode of sampling	Remarks
		(Runoff Ha. mx10)		Coarse				Medium				Fine				Total					
	Mean	Total	Mean	Total	Mean	Progressive Total	Mean	Total	Mean	Progressive Total	Mean	Total	Mean	Progressive Total	Mean	Total	Mean	Progressive Total	Mean		
1	2	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23

Signature of Observer　　　　Asstt. Research Officer　　　　Executive Engineer

Name...　　　　.............................. Division　　　　........................ Division

Designation...　　　　...

CWC/RD-10

Government of India

Central Water Commission

MEAN DIAMETER OF SEDIMENT PARTICLES

Below 0.6 mm. dia.)

IMPORTANT :-This Form is to be used alone when the percentage of particles above 0.6 mm is less than or equal to 5.0 and with Form CWC/RD-11 if the percentage exceeds 5.0.

River..............................Temperature of water in Siltometer…………………………………...

Site …………………Code No………….Field Sample No. ……………………………………

Date of Sampling ……………………………………………………Laboratory Sample No. ....

Date of Analysis ……………………………….

EXPERIMENTAL VALUES				-INTERPOLATED VALUES			
Diameter in mm.	Actual Volume (C.C.)	Actual Percentage by Weight	Summation Percentage	Diameter in mm.	Summation Reading (=S)	Distribution Value Percentages	Mean Diameters Plotted mm.
				0.06			
				0.08			0.07
				0.10			0.09
				0.12			0.11
				0.14			0.13
				0.16			0.15
				0.18			0.17
				0.20			0.19
				0.22			0.21
				0.24			0.23
				0.26			0.25
				0.28			0.27
				0.30			0.29
				0.32			0.31
				0.34			0.33
				0.36			0.35
				0.38			0.37
				0.40			0.39

				0.42			0.41
				0.44			0.43
				0.46			0.45
				0.48			0.47
				0.50			0.49
				0.52			0.51
				0.54			0.53
				0.56			0.55
				0.58			0.57
				0.60			0.59
TOTAL							

Quantity Sieved =

Quantity below 0.6 =

Initial Weight W1
of portion put in =
Siltometer) = W2
Final Weight =

Loss = (W_1-W_2)

% above 0.6 mm. = (Y) 1. Total of 'S' Column = (T)

% 0.2-0.6 mm. = 2. 0.61+0.0019(Y) =

% 0.2-0.6 mm. = 3 0.0002 T =

% below 0.06 mm = (P) 0.0004 P =

50% Diameter = 5. Mean Diameter =
=(2)-(1)-(4)

Signature of Analyst Assistant Research Officer Executive Engineer

Name ………………………………………….Division

Designation Water Quality Research Laboratory-2

……………………..…………………..Division

CWC/RD-11

Government of India

Central Water Commission

MEAN DIAMETER OF SEDIMENT PARTICLES

(Below 0.6 mm dia.)

IMPORTANT: -

This form is to be used as a supplement to Form No. CWC/RD-10 and only when the percentage of particles above 0.6 mm exceed 5.0. The summation curve in a case is to be drawn on a compressed scale as well as on ordinary scale.

River………………………… Cross Section No. ………………. R.D………………..

Site ………………….Code No………… Field No. ……………………………….

Laboratory Sample No. ………………….

Experimental Values		**Interpolated Values**						**Result of Slope Analysis**		
Diameter in mm	Summation Percentage	Diameter in mm	Summation Reading (=S)	Distribution Value Percentage	Diameter in mm	) Summation Reading (=S)	Distribution Value Percentage	Aperture in mm	Quantity retained gms.	Retained Percentage
0.1		0.1								
0.2		0.2								
0.3		0.3								
0.4		0.4								
0.5		0.5								
0.6		0.6								
1.0		0.7								
1.5		0.8								
2.0		0.9								
2.5		1.0								

3.0		1.1								
3.5		1.2								
4.0		1.3								
4.8		1.4								
		1.5								
		1.6								
		1.7								
		1.8								
		1.9						4.8		
		2.0						4.0		
		2.1						3.5		
		2.2						3.0		
		2.3						2.5		
		2.4						2.0		
		2.5						1.5		
		2.6						1.0		
		2.7						0.6		
		2.8						Passing0.6		
		2.9								
		3.0								
		3.1						Total		
		3.2								
		3.3								
		3.4								
		3.5								
		3.6								
		3.7								
		3.8								
		3.9								
		4.0								
		4.1								
		4.2								

		4.3					
		4.4					
		4.5					
		4.6					
		4.7					
		4.8					

1. Total of 'S' column (=T) =
2. Highest Diameter + 0.05 (=A) =
3. 0.0001 T (=B) =
4. Mean Diameter (=A-B) =

Signature of Analysis

Name

Designation

Signature of A.R.O./R.O.

Executive Engineer

…………………………………………Division

CWC/RD-12

Government of India

Central Water Commission

RESULTS OF ANALYSIS OF BED MATERIAL

River……………….…………….. **Site………….……………… Code No.** **………………………** **Observation Section (CL/US/DS)……………………………**

Sl.No.	Date of Collection	Lab. No.	Date of the Sample Collected											General data of the River								Remarks
			R. D.	R.L. of Dry Bed	R.L. of Bed Level	W.L.(GTS) of the sampling depth(m)	Depth of Water (m)	Width (m)	Velocity (m/s)	Discharge (m3/s)	Bed Material Composition			Wetted perimeter (m)	Hydraulic mean depth (m)	Mean Velocity (m/s)	Surface Water Slope	Discharge(m3/s)	Bed Material Composition			
											Max Size (mm)	Min. Size (mm)	Mean. Size (mm)						Max. Size(mm)	Min. Size(mm)	Mean. Size(mm)	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23

Signature of Lab Assistant/Analysist

Name…………………………..

Designation

Signature of A.R.O./R.O.

Name…………………………..

Signature of Executive Engineer

……………………………………………………………Division

………………………………………………………………………………………….

CWC/RD-13

Government of India

CENTRAL WATER COMMISSION

Vertical Velocity and Sediment Distribution Experiment

River............................. Site............................. Code No. ....

Date.............................Time From.............................To.............................

Experiment No.................Section and R.D. ....Water Depth....................

Water Level Beginning......... End.......................Mean....................Discharge.............................

			Coarse Sediment		Medium Sediment		
Sampling point	Sampling depth	Velocity (m/s)	Total(g)	Concentration (g/l)	Total(g)	Concentration (g/l)	Remarks
1	2	3	4	5	6	7	8
Surface							
0.1 D							
0.2 D							
0.3 D							
0.4 D							
0.5 D							
0.6 D							
0.7 D							
0.8 D							
0.9 D							
Total							
Mean							
Max.							
Min.							

Note-

Total- Sum of values at all decs-depth+1/2 the value of water surface

Mean: $\frac{\text{Total}}{10}$

Summary:

1. Mean velocity by graphical integrative method (V)…………………………...m/s
2. Mean velocity (V) /occurred at...........................depth below water surface.
3. Ratio of mean velocity(V) to the surface velocity................
4. Ratio of mean velocity to velocity at 0.6 depth.
5. Mean sediment concentration by graphical integration method: -

(i)Coarse sediment..

(ii)Medium sediment ....

6.Mean Sediment concentration occurred at:

(i)Coarse sediment..

(ii)Medium sediment ....

7. Ratio of mean sediment concentration to sediment concentration at 0.6 depth................

(i) Coarse sediment..

(i) Medium sediment..

Signature of Observer	Signature S.D.E.	Executive Engineer
Name Designation	Sub Division	……………..................Division

C.W.C/ R.D.-14
Government of India
Central Water Commission

Physical & Chemical Specialties of River/Well Water Samples
Pollution Study of Well & River at Central Line

Pollution Study of Well & River Water Samples collected at C/L													pH	Conductivity mho/cm	Water Level in well	Datum Level of Well	Distance of well from C/L	Depth of sampling Point	Mean Water Level of the river	Date of receipt
Sl. No	Lab Sample No.	River	Site	Situation	Date	Time	Weather	Water Color	Odor of Water	Temp in degree C	Discharge in m3/sec	Volume in Lit.								
				U/S																
				D/S																
				C/L																
				Well																

Signature of Senior Research Asstt/Junior Engineer/
Gauge Asstt

Name of Discharge Site

C.W.C/ R.D.-15
Government of India
Central Water Commission

………………. DIVISION……………….

RESULT OF DISSOLVED OXYZEN AND BIO-CHEMICAL OXYGEN DEMAND EXPERIMENT

River……………………………………………………………. Site……………………….………………… Code No. ………………………….………………………………

Type of Sampler used for collecting data for Dissolved Oxygen / B.D.O. Experiment……………. Is sampler in working order………..

Sl. No.	Lab.No.	Date of sampling collection	Time in HRs.	Situation	River Water Temp. in degree	R.D.	Date of sending samples to divisional Lab.	Discharge in m^3 / sec	Depth in m	Velocity in m/sec	Sampling Depth	Strength of Potassium Dichromate and Sodium Hydrosulphate for standardization	Dissolved Oxygen / Biochemical Oxygen Demand (mg/litre)								
													Date of Standardization	on site	Before Heat Boat	After heat boat	concentration if any	(mg/l)	(ton/day)	(BOD Bottle no.)	Remarks
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22

Signature of Observer

Name.. Asstt. Research Officer/Research Officer Executive Engineer

Post.. ....Division . ... Division

CWC/RD-16

Government of India
Central Water Commission

INSPECTION REPORT

(Please do not leave any item blank. Fill up the form completely indicating N.A. against items not applicable)

River....................................Site...................................... Code....................Date.......................................

1- From.......................................To.......................................
Period of present inspection:
By

2- When was this site last inspected and by whom?

I. GAUGE AND DISCHARGE OBSERVATION

3- Type of navigational equipment (Boat/Motor Launch/OBE/Jet Boat etc.) in use and its condition

4- Mention if sufficient number f life buoys, life jackets, oars etc. are provided.

5- Type of engine, if any and its condition.

6- Total running hours of the engine.

7- Date of change of gear oil.

8- Verify log book and fuel consumption.

9- Comment on condition and performance of the following.

(a) Stop Watch

(b) Sounding rod

(c) Wading rod

(d) Suspension equipment

(e) Tape

(f)Other scientific and mathematical instruments

10- Leveling operation-

(a) Level No.

(b) Check permanent adjustment and state the result.
(c) Check zero level of the gauge and state the result

11- Is there standard bench mark available within easy reach?

12- When the site B.M. was last checked with Musto type B.M.?

13- Type of river Gauges (wooden/concrete/steel/enamel plate/vertical/inclined/permanent/temporary etc.) and their condition.

14- Describe the river condition at site (Please indicate the number of channels, prevailing flow conditions including overflow of banks, river morphology, erosion problems, if any, etc.)

15- Describe method of segmentation

16- If pivot-point lay out is existing, has it been checked for the correctness? If yes, when and by whom?

17- If a cable way or cradle exists? Indicate its condition.

18- No. of current meter, make and its rating equation.

19- General condition (please indicate if the current meter and its accessories are in working condition without any damages)

20- Can the observer handle it efficiently?

21- When was it last re-rated?

22- Check spin before and after use and record result.

23- No. of check meter, make and its rating equation.

24- Mention the result of complete joint observation with both meters and record result if done during the inspection and enclose both discharge observations.

25- Possible reasons for the difference in two results and remedies suggested.

26- Submit a statement of daily gauge, discharge and value of ‘c’ ‘s’ and ‘n’ (manning) for the last ten days and comment on the data with detailed reasons for variation, if any.

II. FIELD SEDIMENT OBSERVATION AND ANALYSIS.

27- Type of suspended sampler used and its condition.

28- Whether the samples are connected from 0.6 D? if not, state the sampling point and reason for non-collection of samples according to the prescribed norms.

29- Describe the arrangement for keeping the samples in the boat and the carriage of samples to the laboratory.

30- Make joint observation with the observer and record results.

31- Distance between the site and silt laboratory.

32- Is the laboratory kept neat and in proper order?

33- Check all the instruments in the lab and give your comments, if any.

(a) Physical balance

(b) Chemical balance

(c) Meter

(d)Weights

(d) Other instruments

34- Is laboratory fully equipped? If not, mention the apparatus required.

35- Has any special experiment been conducted? If so, state the nature and number of experiments conducted and suggestions for improvement, if any.

36- Has bed-material survey been conducted at the site? If so, state position and number of samples collected during the month.

37- Is the bed material sampler in working order?

III. WATER QUALITY WORK

38- Number of sampling sections and their location.

39- Number of samples collected from each section and exact position of sampling (width-wise and depth-wise)

40- No. of tests conducted at site and the comments of the inspecting officer thereon.

41- Number of samples sent to Division/Circle laboratory and purpose thereof.

IV RAIN GAUGE

42- Type of rain gauges and their conditions.

43- Whether the rain gauges are installed as per prescribed norms (please indicate if the site is free from obstructions.)

44- Check the working of the self-recording rain gauge.

V WIRELESS STATION

45- Mention the type and condition of wireless et at site.

46- Mention the condition of the building and its surroundings.

47- Condition of the battery in use.

48- Condition of the generator, if any.

49- Condition of the mast and antenna.

VI GENERAL

50- Have the points noted in the last inspection report fully attended?

51- Have the data in relevant formats been sent by the JE/RA promptly and regularly? Please indicate the action taken in cases of delay.

52- Examine all records maintained at site (including attendance register) and point out shortcomings.

53- General remarks and suggestions.

Signature of Junior Engineer	Signature of Asst Research	Signature of inspecting officer
Name	Name	Name
Designation	Designation	Designation
Date	Date	Date

STANDARD OPERATING PROCEDURE FOR GAUGE & DISCHARGE OBSERVATION

दैनिक गेज (G) अवलोकन के लिए मानक संचालन प्रक्रिया

चरण 1. गेज पर्यवेक्षक को 07:55 बजे तक अवलोकन गेज तक पहुंच जाना चाहिए।

चरण 2. गेज पोस्ट को ऊर्ध्वाधरता (verticality) और स्थिरता (stability) के लिए जाँचना चाहिए।

चरण 3. गेज पर्यवेक्षक नदी में स्थित गेज पर जल स्तर को पढ़ेगा , और निकटतम 1 मिमी तक रिकॉर्ड करेगा। जहां पानी का स्तर अस्थिर है, पर्यवेक्षक लगभग 30 सेकंड की अवधि में स्तर के उतार-चढ़ाव को ध्यान में रखते हुए औसत स्तर का आकलन करेगा ।

चरण 4. गेज की रिपोर्टिंग शून्य सापेक्ष तल (R.L.) को जोड़ने के बाद की जानी चाहिए। यदि गेज रीडिंग 7.560 m है और शून्य सापेक्ष तल ("गेज ऑफ़ जीरो") 63.00m है तो जल स्तर 70.560m बताया जाना चाहिए। कोई भी मुद्दा जो जल स्तर माप कार्य को प्रभावित कर सकता है , उसे टिप्पणी कॉलम में सूचित किया जाना चाहिए- जैसे बाढ़, क्षति, खरपतवार की वृद्धि, निर्माण कार्य आदि

चरण 5. गेज पर्यवेक्षक प्रतिदिन तीन बार 0800, 1300 और 1800 घंटों में रीडिंग लेगा।

चरण 6. मानसून के मौसम के दौरान गेज को हर घंटे पढ़ना चाहिए और तुरंत ई-स्विस (e-SWIS) में दर्ज करना चाहिए तथा कंट्रोल रूम को भेजना चाहिए।

चरण 7. केवल वास्तविक अवलोकन डेटा दर्ज किया जाना चाहिए। जिन दिनों डेटा नहीं लिया गया उस अवधि के लिए रिक्त स्थान छोड़ा जाए। तथा टिप्पणी कॉलम में कारणों को दर्ज किया जाए।

चरण 8. प्रत्येक साइट के सभी डेटा को उप-मंडल अधिकारी द्वारा तुरंत eSWIS में दर्ज किया जाएगा।

चरण 9. गेज की नियमित आधार पर MTBM के साथ जाँच की जानी चाहिए।

डिस्चार्ज (D) के लिए मानक संचालन प्रक्रिया

- ए. डी. सी. पी. (ADCP)
- करंटमीटर द्वारा
- स्लोप एरिया विधि द्वारा
- वेडिंग द्वारा
- फ्लोट द्वारा

<u>दैनिक निस्सरण प्रेक्षण (Daily Discharge Observation) के लिए मानक संचालन प्रक्रिया (D)</u>

<u>ए. डी. सी. पी (ADCP) द्वारा</u>

चरण 1. हाइड्रोलॉजिकल अवलोकन के लिए आवश्यक कर्मचारी नदी के किनारे प्रातः 08:25 बजे तक मौसम संबंधी डेटा संग्रह करने के बाद अवश्य पहुँच जाऐंगें।

चरण 2. डिस्चार्ज अवलोकन सुबह 08:30 बजे से शुरू होना चाहिए।

चरण 3. गेजों (u/s और d/s गेज भी) की ऊर्ध्वाधरता और स्थिरता की हर दिन जाँच की जाएगी। बाढ़ से पहले और बाद में सभी गेजों की कम से कम एक वर्ष में दो बार MTBM के साथ जाँच की जाएगी। अस्थायी गेजों को निकटतम बेंचमार्क के साथ नियमित रूप से जांचा जाना चाहिए।

चरण 4. ब्लूटूथ के माध्यम से लैपटॉप , ADCP और GPS इंस्ट्रूमेंट्स की आपसी कनेक्टिविटी को पहले ही चेक कर लेना चाहिए। ADCP को फाइबर बॉडी में मजबूती से जोड़ा जाना चाहिए और इसे नाव से सुरक्षित रूप से बांधने के बाद हीं पानी की सतह पर तैराना चाहिए। सुबह 8:30 बजे ADCP चालू हो जाना चाहिए।

चरण 5. एडीसीपी के मामले में, यह सुनिश्चित करना होगा कि यह पानी की सतह को लगातार छूता रहे।

चरण 6. नाव ले जाने से पहले ADCP सॉफ्टवेयर (जैसे WinRiver- II इत्यादि) में साइट का नाम, कोड, तिथि, गेज जैसी जानकारी भरनी चाहिए।

चरण 7. शुरूआत में नदी के किनारे से लेकर फाइबर बॉडी तक की दूरी को सॉफ्टवेयर में एंड करेक्शन के रूप में मापा और भरा जाना चाहिए।

चरण 8. नाव को सेंट्रल गेज लाइन पर नदी के एक किनारे से दूसरे तक सीधी रेखा में ले जाना चाहिए। अगर सेंट्रल गेज रेखा पर नदी के आर-पार जाना संभव नहीं है तो U/S गेज लाइन या D/S गेज लाइन जहां भी एक सीधा चैनल नाव खेने के लिए उपलब्ध है, उसे चुना जा सकता है।

चरण 9. दूसरे छोर पर , फिर से नदी के किनारे से फाइबर बॉडी तक की दूरी को सॉफ्टवेयर में एंड करेक्शन के रूप में मापा और भरा जाना चाहिए।

चरण 10. नाव को पहले छोर पर फिर से सीधी रेखा में लाया जाता है।

चरण 11. पहले छोर पर आने के बाद WinRiver सॉफ्टवेयर में ADCP डिस्चार्ज माप प्रक्रिया "END" बटन पर क्लिक करके बंद कर दी जाती है। औसत डिस्चार्ज लैपटॉप में माप लिया जाता है और सहेजा जाता है।

चरण 12. स्टेज-डिस्चार्ज कर्व को साल में कम से कम एक बार नियमित रूप से अपडेट किया जाएगा और साइट ऑफिस में चिपकाया जाएगा।

चरण 13. मानसून और गैर मानसून से पहले नदी के क्रॉस सेक्शन को नापना चाहिए और साइट ऑफिस में चिपकाना चाहिए।

चरण 14. साइट पर नापे गए सभी डेटा को तुरंत eSWIS में दर्ज किया जाएगा।

दैनिक निस्सरण प्रेक्षण (Daily Discharge Observation) के लिए मानक संचालन प्रक्रिया (D)

करंटमीटर द्वारा

चरण 1. हर क्रॉस सेक्शन पर, गहराई (d) को पहले मापा जाना चाहिए।

चरण 2. उसके बाद, प्रत्येक क्रॉस सेक्शन पर 0.6d पर करेंट-मीटर को नीचे किया जाना चाहिए और डेटा को लेने से पहले कम से कम 30 सेकंड के लिए करेंट-मीटर को स्थिर करना चाहिए।

चरण 3. पुल के एक ओर से एक बिंदु चुना जाता है जिसे 0 RD माना जाता है। पुल पर "0 RD" से टेप से माप कर खंड (segment) बनाया जाता है। यह ध्यान दिया जाना चाहिए कि नदी की चौड़ाई 180 मीटर से कम है तो कम से कम 15 खंड होने चाहिए। और नदी की चौड़ाई 180 मीटर से अधिक है तो कम से कम 24 खंड होने चाहिए। यदि कोई पुल नहीं है , तो खंड तार या रस्सी का उपयोग करके तैयार किया जाना चाहिए।

चरण 4. डिस्चार्ज नापने से पहले गेज (नदी का जल-स्तर) नोट किया जाता है।

चरण 5. हर सेगमेंट की गहराई या तो रस्सी और वजन या इको साउंडर या नाव से साउंडिंग रॉड द्वारा मीटर में नापी जाती है।

चरण 6. करेंट मीटर डिजिटल काउंटर से अपने संबंधित बिंदुओं (+ और -) पर केबल या लचीले तार द्वारा जोड़ा जाता है और 0.6d की गहराई पर पानी में लटकाया जाता है।

चरण 7. रेटिंग चार्ट से वेग प्राप्त करने के लिए , डिजिटल काउंटर का घूमना इस तरह तय किया जाता है ताकि समय 30 सेकंड से 70 सेकंड के बीच बना रहे।

चरण 8. करेंट मीटर रेटिंग चार्ट से मिलान कर वेग m/s में प्राप्त किया जाता है। इस तरह प्रत्येक खंड में गहराई और वेग नापा जाता है।

चरण 9. डिस्चार्ज नापना ख़त्म होने के बाद गेज रीडिंग को पुन: नोट किया जाता है और करेंट मीटर के स्पिन को चेक किया जाता है। काम शुरू होने से पहले भी करेंट मीटर के स्पिन की जांच की जाती है। यह रेटेड स्पिन से ±10% से अधिक नहीं होनी चाहिए और इसे 90 कार्य दिवसों के बाद री-रेटिंग के लिए भेजा जाना चाहिए। ("कुल 180 दिनों / 90 कार्य दिवसों / 300 घंटे के उपयोग के बाद" में से जो भी पहले हो)

चरण 10. गहराई X वेग की गिनती हर सेगमेंट के लिए की जाती है।

चरण 11. उत्पादों को आम सेगमेंट में गुणा करके कुल डिस्चार्ज प्राप्त किया जाता है।

चरण 12. वास्तविक क्षेत्र और डिस्चार्ज को "एरिया एंड डिस्चार्ज का एंड करेक्शन" करके प्राप्त किया जाता है।

चरण 13. स्टेज-डिस्चार्ज कर्व को साल में कम से कम एक बार नियमित रूप से अपडेट किया जाएगा और साइट ऑफिस में चिपकाया जाएगा।

चरण 14. मानसून और गैर मानसून से पहले नदी के क्रॉस सेक्शन को नापना चाहिए और साइट ऑफिस में चिपकाना चाहिए।

चरण 15. साइट पर नापे गए सभी डेटा को तुरंत eSWIS में दर्ज किया जाएगा।

दैनिक निस्सरण प्रेक्षण (Daily Discharge Observation) के लिए मानक संचालन प्रक्रिया (D)

स्लोप एरिया विधि द्वारा

चरण 1. सबसे पहले स्लोप की गणना ऑटो लेवल या U/S या D/S गेज के माध्यम से की जाती है।

चरण 2. क्षेत्र की गणना C / S चार्ट के माध्यम से की जाती है।

चरण 3. N का मान रिवर-बेड स्तर के आधार पर निर्धारित किया जाता है।

चरण 4. डिस्चार्ज की गणना के लिए मैनिंग फॉर्मूला का उपयोग किया जाता है।

सूत्रः

$$Q = \frac{1}{N} x\, R^{\frac{2}{3}}\, x\, S^{\frac{1}{2}}\, x\, A$$

जहाँ

Q -> निस्सरण

N -> मैनिंग अचल (Manning's constant)

R -> हाइड्रोलिक मीन गहराई = ए / पी, जहां पी -> गीला परिधि

S -> स्लोप

A -> क्षेत्र (cross-section area)

दैनिक निस्सरण प्रेक्षण (Daily Discharge Observation) के लिए मानक संचालन प्रक्रिया (D)

वेडिंग द्वारा

चरण 1. नदी के एक छोर से दूसरे छोर तक एक तार ताना जाता है।

चरण 2. नदी की चौड़ाई के आधार पर खंड (segment) बनाए जाते हैं।

चरण 3. प्रत्येक खंड में गहराई (d) वैडिंग रॉड द्वारा मापा जाता है।

चरण 4. प्रत्येक खंड में 0.6d गहराई पर वेग (v) को नापा जाता है और गहराई (d) से गुणा किया जाता है। (v x d)

नोट: यह प्रक्रिया करेंट-मीटर से निस्सरण नापने के समान है। सिर्फ गहराई नापने के लिए वेडिंग रॉड का इस्तेमाल होता है।

दैनिक निस्सरण प्रेक्षण (Daily Discharge Observation) के लिए मानक संचालन प्रक्रिया (D)

फ्लोट द्वारा

चरण 1. नदी पर केंद्रीय गेज रेखा (central gauge line) से लंबवत दिशा में कम्पास को U / S की तरफ 50 या 100 मीटर पर खड़ा किया जाता है।

चरण 2. 100 मीटर u/s से लकड़ी का फ्लोट फेंका जाता है।

चरण 3. स्टॉपवॉच से लकड़ी का फ्लोट फेंकने का समय नोट कर लिया जाता है।

चरण 4. वेग (v) की गणना दूरी को समय से भाग करके की जाती है और औसत वेग की गणना 0.89 से गुणा कर की जाती है।

चरण 5. जब फ्लोट केंद्र रेखा से गुज रता है तो कोण को कम्पास में नोट किया जाता है। कोणीय विधि के माध्यम से RD (= 100 स्पर्शज्या ∅ , =100 tan∅) की गणना की जाती है।

चरण 6. इस प्रकार फ्लोट को विभिन्न बिंदुओं पर फेंक कर के वेग (v) और RD निर्धारित किया जाता है।

चरण 7. आरडी बनाम वेग (RD vs v) का ग्राफ बनाएं। ग्राफ की मदद से, प्रत्येक 10, 20, 30 मीटर आरडी पर, वेग को प्रक्षेप के माध्यम से निर्धारित किया जाता है।

चरण 8. क्रॉस सेक्शन के माध्यम से, क्षेत्र की गणना की जाती है।

चरण 9. डिस्चार्ज वेग और क्षेत्र को गुणा करके निकाला जाता है।

तलछट के लिए मानक संचालन प्रक्रिया

चरण 1. पंजाब टाइप बॉटल सैंपलर को किसी भी लीकेज या खराबी के लिए साइट ऑफिस से बाहर जाने से पहले चेक कर लेना चाहिए।

चरण 2. प्रत्येक ऊर्ध्वाधर से नमूना को 0.6 गहराई से एकत्र किया जाना चाहिए।

चरण 3. एकत्र किए गए नमूने की मात्रा को बोतल की मात्रा के साथ जांचना चाहिए और यह बोतल की मात्रा के 80% से 90% के बीच होना चाहिए। आंशिक रूप से भरी हुई बोतल के मामले में नमूना को अस्वीकार कर दिया जाना चाहिए और फिर से एकत्र किया जाना चाहिए।

चरण 4. 5 L पानी को ऊपर एकत्रित नमूना से अलग करना है।

चरण 5. यह अलग किया हुआ पानी अब 100 एवं 200 माइक्रोन छलनी से छाना जाता है।

चरण 6. 100 माइक्रोन छलनी और 200 माइक्रोन छलनी का उपयोग क्रमशः मध्यम गाद और मोटे गाद को छानने के लिए किया जाता है।

चरण 7. दो खाली पोर्सलिन डिशेज का वजन उपलब्ध तराजू का उपयोग करके नोट किया जाता है।

चरण 8. अब छलनी वाले सिल्ट (मोटे और मध्यम) को इन दोनों पोर्सलिन डिशेज में अलग-अलग रखा जाता है।

चरण 9. पोर्सलिन डिशेज अब ओवन में सूखाए जाते हैं।

चरण 10. सूखे बर्तन फिर तौले जाते हैं। खाली बर्तनों का वजन इस वजन से घटाया जाता है।

चरण 11. गाद (मोटे / मध्यम) की सांद्रता प्राप्त करने के लिए 5 से विभाजित किया जाता है।

चरण 12. फिटकरी को बचे हुए पानी में घोलने के बाद छोड़ दिया जाता है और 24 घंटे के लिए रखा जाता है।

चरण 13. अगले दिन एक सूखे फिल्टर पेपर का वजन नापा और नोट किया जाता है।

चरण 14. तल पर की गाद को विचलित किए बिना साफ पानी धीरे-धीरे गिराया जाता है।

चरण 15. बर्तन के नीचे की गाद को फिल्टर पेपर पर धीरे-धीरे धोया जाता है।

चरण 16. आगे फिल्टर पेपर को सुखाया और तौला जाता है और खाली सूखे फिल्टर पेपर का वजन इससे घटाया जाता है और प्राप्त माप को 5 से विभाजित किया जाता है। इस प्रकार सूक्ष्म गाद की सांद्रता ग्राम / लीटर में प्राप्त किया जाता है।

गाद का भार "टन प्रति दिन" में प्राप्त करने के लिए डिस्चार्ज को 0.00864 से गुणा किया जाता है और इसलिए रन ऑफ प्राप्त होता है।

सूत्रः

सिल्ट लोड = डिस्चार्ज x 0.00864 x सांद्रता x 10000

जहाँ,

सिल्ट लोड ton/day में है।

निस्सरण m^3/s में है।

सांद्रता g/L में है।

स्तर-1 की प्रयोगशाला में सैम्पलिंग व पैरामीटर परीक्षण से संबंधित सामान्य सूचनाएँ

सैम्पलिंग की विधि:- प्रयोगशाला में सभी पैरामीटेरों का परीक्षण करने के लिए प्रायः तीन प्रकार के जल नमूनों के बोतलों की जरूरत होती है जिसमें से:

- सामान्य पैरामीटर के परीक्षण के लिए 1000 मिलीलीटर की प्लास्टिक की बोतल।।
- घुलित आक्सीजन (डी.ओ.) के परीक्षण के लिए 300 मिलीलीटर की काँच की तीन डी. ओ. बोतल ।
- सूक्ष्म जैविकी परीक्षण के लिए कांच की 125 मिलीलीटर की सूक्ष्मजैविकी बोतल।

तीनों प्रकार की बोतलों में सैंपलिंग करने की विधि निम्न प्रकार है।

1. सामान्य पैरामीटर (कैटायन्स, एनायन्स एवं अन्य रासायनिक पैरामीटर) के परीक्षण हेतु

- इस नमूने के लिए नदी की चौड़ाई का 1/4, 1/2 तथा 3/4 भाग पर जायें।
- सतह से 30 सेंटीमीटर नीचे से अलग-अलग सैम्पल एकत्र किया जाए।
- फिर तीनों को एक बाल्टी में मिलाकर एक कम्पोजिट सैम्पल तैयार किया जाए।
- इस कम्पोजिट सैम्पल से 1000 मिलीलीटर की प्लास्टिक की बोतल भरकर प्रयोगशाला में भेजे।
- इस सैम्पल से प्रयोगशाला में सामान्य पैरामीटर किये जाते है।

2. डी.ओ. एवं बी.ओ.डी. परीक्षण हेतु-

- यह नमूना नदी के मध्य भाग पर सतह से 30 सेन्टीगीटर नीचे से तीन डी. ओ. बोतल में एकत्र करे।
- ध्यान रहे इन तीनों बोतलों में कोई वायु का बुलबुला नहीं होना चाहिए। इसकी जाँच हेतु बोतल को उल्टा करके देखें।
- इसमें से एक बोतल से डी. ओ. का परीक्षण साईट (insitu) पर ही करें।
- यदि नहीं कर सकते तो उसमे 1 मिली $MnSO_4$ तथा 1 मिली. Alkall iodide azide डाल दें। (f i xat i on of DO)
- अन्य दो डी. ओ. बोतलों में कुछ भी न मिलाएं।
- अब इन तीनों बोतलों को आइस बाक्स में बर्फ के साथ (4°c) रखकर प्रयोगशाला में भेजे।

3. सूक्ष्म जैविकी (फीकल एवं टोटल कोलीफार्म) परीक्षण हेतु

- इस नमूने को नदी के मध्य भाग पर सतह से 30 सेन्टीमीटर नीचे से एकत्र करें।
- इस बोतल का लगभग 25% भाग खाली रखें।
- इस सूक्ष्मजीवी बोतल को एल्यूमिनियम की फ़्वाइल में लपेट दे।
- इसके बाद सूक्ष्मजीवी बोतल को आइस बॉक्स में बर्फ के साथ (4°c) रखकर प्रयोगशाला में भेजें।

उपरोक्त जल नमूना प्रत्येक माह के प्रथम कार्य दिवस पर बेस, फ़्लक्स व ट्रेन्ड स्थलों पर तथा 11 व 21 तारीख को केवल फ्लक्स स्थल पर एकत्र किये जायेंगे।

स्तर-1 की प्रयोगशाला के पैरामीटर परीक्षण करने की विधि

साईट पर स्थित स्तर-1 की प्रयोगशाला में निम्नलिखित 6 पैरामीटर का विश्लेषण किया जाता है।

- रंग, गंध, तापमान, पीएच, विद्युत चालकता (ई.सी.) व घुलित आक्सीजन (सी.ओ.)

1. **रंग**:-100 मिलीलीटर के काँच के बीकर में नमूना लेकर ध्यान से देखेंगे और रंग की जाँच कर लेंगे।
2. **गंध**:- उपरोक्त बीकर के जल को सूंघे तथा गंध की पहचान करेंगे।
3. **तापमान**- उपरोक्त बीकर के जल में थर्मामीटर को डुबोकर कुछ देर तक रोके तथा फिर तापमान देख लें।
4. **पी. एच:**
   - सर्वप्रथम कांच के बीकर में 100 मिलीलीटर जल नमूना लें।
   - फिर पी. एच. मीटर का स्विच ऑन करके बीकर में डुबायें।
   - पी. एच. मीटर की स्क्रीन पर देखें जब स्क्रीन पर ब्लिंक होना बन्द हो जाये तो उस वैल्यू को नोट कर लें यही पी. एच. वैल्यू है।
   - पी. एच. मीटर को स्विच ऑफ करके रख दें।
5. **विद्युत चालकता (ई.सी.):**
   - सर्वप्रथम कांच के बीकर में 100 मिलीलीटर जल नमूना लें।
   - फिर ई.सी. मीटर का स्विच ऑन करके बीकर में डुबाये।
   - ई सी मीटर की स्क्रीन पर देखें जब स्क्रीन पर ब्लिंक होना बन्द हो जाये तो उस वैल्यू को नोट करले यही ई. सी. वैल्यु है।
   - ई सी. मीटर को स्विच ऑफ करके रख दें।
6. **घुलित ऑक्सीजन (डी.ओ.):**
   - सर्वप्रथम डी ओ. बोतल के कैप को खोलकर 1 मिली. $MnSO_4$ तथा 1 मिली. Alkali iodide azide solution मिलायेगें।
   - फिर उसके कैप को बन्द करके अच्छे से हिलाये जिससे कि पूरे नमूने में केमिकल मिल जाये और उसमें किस्टल बनते हुए नजर आयेंगे।
   - उसके पश्चात कैप को खोलकर 1 मिली. H_2SO_4 मिलायें और कैप बन्द करे और अच्छे से हिलायें जिससे कि क्रिस्टल उसमें घुल जायेंगे।
   - अब इसके बाद मेजरिंग सिलेंडर से 100 मिली. इस विलयन को लेंगे तथा कोनिकल फ्लास्क में डालेंगे।
   - अब इसमें 4-5 बूंद स्टार्च डालेंगे जिससे विलयन का रंग गहरा नीला हो जायेगा।
   - पिर ब्यूरेट में सोडियम थायोसल्फेट (0.025N) भरेंगे।
   - अब कोनिकल फ्लास्क के गहरे नीले रंग के विलयन में व्यूरेट से बूंद-बूँद कर सोडियम थायो सल्फेट को गिरायेंगे जब तक कि विलयन रंगहीन न हो जाये।
   - फिर व्यूरेट से जितना मिली. सोडियम थायो सल्फेट खर्च हुआ है उतना नोट कर ले।
   - Sodium thiosulphate के Normality पे निर्भर करने वाले फैक्टर से गुणा करें, घलित ऑक्सीजन (डी.ओ.) की मात्रा मिलीग्राम/लीटर में प्राप्त हो जायेगी।

Standard Operating Procedure for Daily Gauge (G) Observation

STEP 1. The Gauge observer should reach the observation gauge by **07:55 AM**.

STEP 2. The gauge post should be checked for verticality and stability.

STEP 3. The gauge observer will read the water level at an external staff gauge located directly in the river, and record to the nearest 1 mm. Where the water level is unstable, the observer will assess the mean level by noting the level fluctuation over a period **of approximately 30 seconds** and take the mean average.

STEP 4. The reporting of gauge should be done after adding the reduced level (R.L) of gauge. For e.g. If gauge reading is 7.560m and "zero of gauge" is 63.00m then water level should be reported as 70.560m. Any issue which can affect the water level measurement work should be reported in remarks column. For e.g. Scouring, flood damage, weed growth etc.

STEP 5. The gauge observer will take readings three times daily **at 0800, 1300 and 1800 hours**.

STEP 6. During monsoon season, hourly readings should be taken and communicated as soon as possible.

STEP 7. Only actual observed data should be recorded. Blank space may be left for unrecorded period with reasons recorded in remarks.

STEP 8. All data for each site shall be entered in eSWIS immediately by the Sub-Divisional Officer under his/her jurisdiction.

STEP 9. The gauge posts should be checked with MTBM on regular basis.

STANDARD OPERATING PROCEDURE FOR DISCHARGE (D) OBSERVATION

- **By ADCP**
- **By Current-meter**
- **By Slope Area Method**
- **By wading**
- **By Float**

Standard Operating Procedure for Daily Discharge (D) Observation by ADCP

STEP 1. The staff required for hydrological observation shall be present at the bank of the river **by 08:25AM** after completing the meteorological data collection exercise, if any.

STEP 2. The discharge observation should commence **by 08:30AM**.

STEP 3. The verticality and stability of U/s and D/s gauges shall be checked on every day. All the gauges shall be checked with MTBM twice in a year before and after floods. The temporary gauge posts should be checked routinely with nearest benchmark.

STEP 4. The connectivity of laptop, ADCP and GPS instruments through Bluetooth should be checked beforehand.

THE ADCP should be firmly attached in fiber body and floated on the water surface after securely tying it with boat and switched on by 8:30 AM.

STEP 5. In case of ADCP, it has to be ensured that it touches the water surface continuously.

STEP 6. The details of site like Name of site, code, date, Gauge should be filled up and checked in the ADCP software (like WinRiver-II etc.) before moving the boat.

STEP 7. The distance from the river edge to fiber body should be measured and filled up as End Correction in the software.

STEP 8. The boat should be moved in straight line on Central gauge line from one bank of the river (single channel) to other. The u/s gauge line or d/s gauge line may be chosen, wherever single channel is available for rowing the boat.

STEP 9. At the other end, again the distance from river edge to fiber body should be measured for end correction.

STEP 10. Boat is brought back to first bank in straight line again.

STEP 11. At the first bank, WinRiver Software ADCP discharge measurement process is stopped by clicking on "END" button. The Average discharge is noted, printed and saved in the laptop.

STEP 12. Stage-Discharge curve shall be updated regularly at least once in a year and pasted in site office.

STEP 13. Before monsoon and non monsoon proper cross section should be taken and pasted in site office.

STEP 14. All observed data for site shall be entered in eSWIS immediately.

Standard Operating Procedure for Daily Discharge (D) Observation by Current-meter:

STEP 1. On every cross section, depth (d) should be measured first.

STEP 2. After that, on every cross section at 0.6 of the depth (0.6 d), the current-meter should be lowered and allowed to stabilize **for at least 30 seconds** before taking observations.

STEP 3. A point is chosen from the Left Side of the bridge where 0 (zero) RD is undertaken. Segments are drawn on the bridge using measurement tape from "0 (zero) RD". It should be noted that there must be at least 15 segments, if the River Width is less than 180m and 24 segments if the River Width is more than 180m. If there is no bridge, the segment is drawn using wire or rope.

STEP 4. Before discharge, water level is noted.

STEP 5. The depth for every segment in meter is obtained either by rope and weight or Eco Sounder or Sounding Rod from the boat.

STEP 6. The current meter is connected to digital counter by cable or flexible wire on their respective points (+ and -) and is hung in water at the depth of 0.6 d.

STEP 7. To obtain velocity from the Rating Chart, Revolution is fixed on Digital counter such that the time must be maintained between 30 sec to 70 sec.

STEP 8. The velocity of the matching point (before the time below the current meter rating chart to Revolution) is obtained in m/sec. In this way at each segment the depth and velocity are obtained.

STEP 9. Gauge reading is noted just after the discharge ends and the current meter's spin is checked. The spin of the current meter is also checked before the work starts. It must not be more than **± 10% of Rated Spin** and it must be sent for **Re-rating** after 90 working days. (Earliest of total 180 days / 90 working days / 300 hours of use)

STEP 10. The counting of **Depth X Velocity** is done for every segment.

STEP 11. The total discharge is obtained by multiplying the products to common segment.

STEP 12. The genuine **Area** and **Discharge** are obtained by doing the **End Correction** of **Area** and **Discharge.**

STEP 13. Stage-Discharge curve shall be updated regularly at least once in a year and pasted in site office.

STEP 14. Before monsoon and non monsoon proper cross section should be taken and pasted in site office.

STEP 15. All observed data for site shall be entered in eSWIS immediately.

Standard Operating Procedure for Daily Discharge (D) Observation by Slope Area Method

STEP 1. Firstly slope is calculated through auto level or through U/S or D/S gauge.

STEP 2. Area is calculated through C/S chart.

STEP 3. Value of N is determined on the basis of bed level.

STEP 4. Manning formula is used to calculate the discharge.

Formula:

$$Q = \frac{1}{N} x\, R^{\frac{2}{3}}\, x\, S^{\frac{1}{2}}\, x\, A$$

Where, Q -> Discharge
N -> Manning's Constant
R -> Hydraulic Mean Depth = A/P, where P -> wetted perimeter
S -> Slope
A -> Area

Standard Operating Procedure for Daily Discharge (D) Observation by Wading

STEP 1. A wire is fixed from one end of river to other.

STEP 2. On the basis of width , segements are created.

STEP 3. At each segment depth (d) is measured by wading rod.

STEP 4. At each segment, at 0.6d depth, velocity (v) is determined and multiplied with depth. (v x d)

Note: This procedure is similar to the measurement of discharge through current-meter. Only depth is measured through wading-rod.

Standard Operating Procedure for Daily Discharge (D) Observation by Float

STEP 1. From centre line of river in perpendicular direction compass is erected at 50 or 100 m at U/S side.

STEP 2. From 100m U/S wooden float is thrown.

STEP 3. The time is noted in stopwatch when the wooden float is thrown.

STEP 4. Velocity is calculated by dividing the distance with time and mean velocity is 0.89 of calculated velocity.

STEP 5. When the float is passed through centre line then angle is noted in compass. Through angular method, RD (=100 tan ǿ) is calculated.

STEP 6. In this way, at different points by throwing float, velocity and RD is determined.

STEP 7. Draw graph of RD versus velocity. With help of graph, at every 10, 20, 30m RD, velocity is determined through interpolation.

STEP 8. Through cross section, area is calculated.

STEP 9. By multiplying area with velocity discharge is calculated.

Standard Operating Procedure for Sediment

STEP 1. The Punjab type bottle sampler should be checked before moving out from site office for any leakage or defects.

STEP 2. From each vertical, sample should be collected from 0.6 of the depth.

STEP 3. The volume of collected sample should be checked with the volume of bottle and it should be between 80% to 90% of the bottle volume. In case of partially filled bottle, the sample should be rejected and collected again.

STEP 4. 5 L of water is to be separated from the above collected sample water.

STEP 5. This separated water is now sieved by 100-200 micron sieve.

STEP 6. 100 micron sieve and 200 micron sieve are used to sieve medium silt and coarse silt respectively.

STEP 7. The weight of two empty porcelain dishes is noted using the available weighing instrument.

STEP 8. Now the sieved silts (Coarse and medium) are kept separately in these two porcelain dishes.

STEP 9. The porcelain dishes are now dried in oven.

STEP 10. Dried porcelain dishes are then weighed. The weight of the empty porcelain dishes is subtracted from this weight.

STEP 11. Further the silt (Coarse/Medium) is divided by 5 to obtain the concentration.

STEP 12. Alum is dissolved in the remaining water (left after sieving) and is kept for 24 hours undisturbed.

STEP 13. The next day a dried filter paper is weighed and the measurement is noted down.

STEP 14. The clear water is dropped slowly without disturbing the silt at bottom.

STEP 15. The silt in the bottom of the vessel is washed slowly on the filter paper.

STEP 16. Further the filter paper is dried and weighed and the weight of the empty dried filter paper is subtracted from it and the obtained measurement is divided by 5. Thus the Concentration of fine silt is obtained in gm/L.

To obtain the Load of the silt (ton per day), Discharge is multiplied by 0.00864 and so the Run Off is obtained.

Formula:

$$Silt\ Load = Discharge\ x\ 0.00864\ x\ Concentration\ x\ 10000$$

Where,

Silt Load is in Ton per day.
Discharge is in m^3/s.
Concentration is in g/L.

General Instructions for Sampling and Parameters analysis at Level-1 Laboratory

Sampling Process: Following 3 Types of water sample bottles are required for analyzing all the parameters:

1. 1000 mL plastic bottle for general parameter
2. Three DO glass bottles of 300 mL for DO analysis
3. 125 mL bacteriological bottle for bacteriological analysis

Sampling Methods for these 3 types of bottles are as follow:

1. For the testing of General Parameter (Cations, Anions & Other Chemical Parameters)
    - For this sample, river water may be divided into 3 parts: ¼, ½, and ¾ across X- section
    - Sample should be collected from 30 cm below the surface water on all three sections.
    - A composite sample is prepared by mixing these three samples in a bucket.
    - This composite sample is filled in 1000 mL bottle to be sent to laboratory.
    - General Parameters are analyzed in laboratory using this sample.

2. For DO and BOD test
    - This sample is collected from middle portion of river water at the depth of 30 cm in 3 DO bottles.
    - Precautions must be taken so that no air bubble should be there in all 3 bottles.
    - In situ test of DO should be done at site for one of the bottle.
    - If the test of DO is not done, add 1 mL of $MnSO_4$ and 1 mL of Alkali iodide azide solution to fix the DO.
    - Do not add anything in other two bottles.
    - Keep these three bottles at 4 ^oC in an ice box and sent to laboratory.

3. For bacteriological (Fecal coliform & Total coliform) analysis
    - This sample is collected from middle portion of river water at the depth of 30 cm.
    - One fourth (25%) of sample bottle must be kept empty.
    - This bacteriological bottle should be covered using aluminum foil.
    - Keep this bacteriological bottle at 4 ^oC in an ice box and sent to laboratory.

Above Water sample must be collected on 1^{st} working day of the month for trend, base and flux stations and on 11^{th} & 21^{st} of month for only flux stations.

Method for Parameters analysis at Level-1 Laboratory

Following 6 parameters are tested in level-1 laboratory at site:

- Color, Odour, Temperature, pH, EC, and DO

1. **Color**: Sample should be taken in a glass beaker of 100 mL and color is decided by looking at the sample carefully

2. **Odour**: Smell the above beaker water and recognize the odour.

3. **Temperature**: Thermometer is dipped in above beaker water for few minutes and note down the temperature.

4. **pH**:

- First of all take the water sample in a glass beaker.
- Switch on the pH meter and dip it in this beaker.
- Note down the pH value shown in pH meter screen.
- Switch off the pH meter and keep aside.

5. **Electrical Conductivity** (EC):

- First of all take the water sample in a glass beaker.
- Switch on the EC meter and dip it in this beaker.
- Note down the EC value shown in EC meter screen.
- Switch off the EC meter and keep aside.

6. **Dissolved Oxygen** (DO):

- First of all open the DO Bottle and add 1 mL of $MnSO_4$ and 1 mL of Alkali iodide-azide solution.
- Close the cap of bottle and mix it well. Crystals will be visible in bottle.
- After that open the bottle and add 1 mL of H2SO4 and mix it well to dissolve the crystals.
- Measure the 100 mL of this solution using a measuring cylinder and keep it in a clean conical flask.
- Add few drops of starch in it so that color of the solution turns blue.
- Take the sodium thiosulphate solution (0.025 N) in a burette.
- Add this sodium thiosulphate solution from burette to the blue colored solution of conical flask drop by drop till the blue color disappears.
- Note down the used volume (mL) of sodium thiosulphate solution from burette.
- To calculate the DO value (mg/L) multiply the above volume (mL) of sodium thio sulphate solution from the factor depending on Normality of sodium thiosulphate.

LIST OF CHARTS, REGISTERS & MAPS TO BE DISPLAYED AT THE SITE OFFICE

Gauge Site (G)

1. Basin Map.
2. Jurisdiction Map.
3. Site Plan.
4. General Information/ Hydro Meteorological/ Salient Features.
5. Inspection register of officers.
6. Pre-monsoon v/s. Post-monsoon cross section of river.
7. Superimposed cross section of river for the past 5 years.
8. Daily Max. Min. Temperature chart.
9. Organogram showing posts at site like JE/Observers/ SWA.
10. Catchments map with project.
11. Minimum and Maximum Water Level (5 Years, 10 Years).
12. Rainfall Chart.

Gauge-WQ Site (GQ)

1. Basin Map.
2. Jurisdiction Map.
3. Site Plan.
4. General Information/ Hydro Meteorological/ Salient Features.
5. Inspection registers of officers.
6. Pre-monsoon v/s. Post-monsoon cross section of river.
7. Superimposed cross section of river for the past 5 years.
8. Daily Max. Min. Temperature chart.
9. Organogram showing posts at site like JE/Observers/ SWA.
10. Catchments map with project.
11. Minimum and Maximum Water Level (5 Years, 10 Years).
12. Rainfall Chart.
13. Water Quality Parameters (quartile Box-whisker chart).

Gauge-Discharge Site (GD)

1. Basin Map.
2. Jurisdiction Map.
3. Site Plan.
4. General Information/ Hydro Meteorological/ Salient Features.
5. Inspection register of officers.
6. S-D curve of current season.
7. S-D curve (Superimposed) for 5 years.
8. Stage v/s Area (c/s), mean Velocity, 'N' Slope (current season).
9. Discharge v/s Area (c/s), mean Velocity, 'N' Stope (current season).
10. Bar chart of ten daily flows.
11. Bar chart of monthly flows.
12. Bar chart of Annual flows since inception of site.
13. Pre-monsoon v/s. Post-monsoon cross section of river.
14. Superimposed cross section of river for the past 5 years.
15. Daily Max. Min. Temperature chart.
16. Stage-Duration of flow chart.
17. Current meter Calibration register
18. Vertical velocity distribution (V.V.D) Experiment chart.
19. Organogram showing posts at site like JE/Observers/ SWA.
20. Catchments map with project.
21. Flood Hydrograph of recent monsoon.
22. Minimum and Maximum Water Level (5 Years, 10 Years).
23. Rainfall Chart.

Gauge-Discharge-WQ Site

1. Basin Map.
2. Jurisdiction Map.
3. Site Plan.
4. General Information/ Hydro Meteorological/ Salient Features.
5. Inspection register of officers.
6. S-D curve of current season.
7. S-D curve (Superimposed) for 5 years.
8. Stage & Discharge hydrographs.
9. Stage v/s. Area, mean Velocity, 'N' Slope (current season).
10. Discharge v/s. Area, mean Velocity, 'N' Stope (current season).
11. Bar chart of ten daily flows.
12. Bar chart of monthly flows.
13. Bar chart of Annual flows since inception of site.
14. Pre-monsoon v/s. Post-monsoon cross section of river.
15. Superimposed cross section of river for the past 5 years.
16. Daily Max. Min. Temperature chart.
17. Stage-Duration of flow chart.
18. Current meter Calibration chart.
19. Vertical velocity distribution (V.V.D)Experiment chart.
20. Organogram showing posts at site like JE/Observers/ SWA.
21. Catchments map with project.
22. Flood Hydrograph of recent monsoon.
23. Minimum and Maximum Water Level (5 Years, 10 Years)
24. Rainfall Chart
25. Water Quality Parameters

Gauge-Discharge-Sediment Site (GDS)

1. Basin Map.

2. Jurisdiction Map.

3. Site Plan.

4. General Information/ Hydro Meteorological/ Salient Features.

5. Inspection register of officers.

6. S-D curve of current season.

7. S-D curve (Superimposed) for 5 years.

8. Stage & Discharge hydrographs.

9. Stage v/s. Area, mean Velocity, 'N' Slope (current season).

10. Discharge v/s. Area, mean Velocity, 'N' Stope (current season).

11. Bar chart of ten daily flows.

12. Bar chart of monthly flows.

13. Bar chart of Annual flows since inception of site.

14. Pre-monsoon v/s. Post-monsoon cross section of river.

15. Superimposed cross section of river for the past 5 years.

16. Daily Max. Min. Temperature chart.

17. Stage-Duration of flow chart.

18. Bar chart - Annual sediment load.

19. Discharge v/s. Sediment load graph (season-wise).

20. Current meter Calibration chart.

21. Vertical velocity distribution (V.V.D),Vertical sediment distribution(V.S.D) Experiment chart.

22. Organogram showing posts at site like JE/Observers/ SWA.

23. Catchments map with project.

24. Flood Hydrograph of recent monsoon.

25. Minimum and Maximum Water Level (5 Years, 10 Years)

26. Rainfall Chart

Gauge-Discharge-Sediment-WQ Site (GDSQ)

1. Basin Map.
2. Jurisdiction Map.
3. Site Plan.
4. General Information/ Hydro Meteorological/ Salient Features.
5. Inspection register of officers.
6. S-D curve of current season.
7. S-D curve (Superimposed) for 5 years.
8. Stage & Discharge hydrographs.
9. Stage vis. Area, mean Velocity, 'N' Slope (current season).
10. Discharge v/s. Area, mean Velocity, 'N' Stope (current season).
11. Bar chart of ten daily flows.
12. Bar chart or monthly flows.
13. Bar chart of Annual flows since inception of site.
14. Pre-monsoon v/s. Post-monsoon cross section of river.
15. Superimposed cross section of river for the past 5 years.
16. Daily Max. Min. Temperature chart.
17. Stage-Duration of flow chart.
18. Bar chart - Annual sediment load.
19. Discharge v/s. Sediment load graph (season-wise).
20. Current meter Calibration chart.
21. Vertical velocity distribution (V.V.D) , Vertical sediment distribution (V.S.D) Experiment chart.
22. Organogram showing posts at site like JE/Observers/ SWA.
23. Catchments map with project.
24. Flood Hydrograph of recent monsoon.
25. Minimum and Maximum Water Level (5 Years, 10 Years).
26. Rainfall Chart.
27. Water Quality Parameters.

References

1. "Stream Gauging", By MG Hiranandani & SV Chitale.

2. World Meteorological Organisation, Guide to Hydrological Practices, WMO No. 168, 2008.

3. **BIS Codes**:

i. BIS 4896 (2002)- Installation of Rain gauge (Non-recording type) and measurement of rain.

ii. BIS 5225:1992, Meteorology- Rain gauge Non-recording type specification.

iii. BIS 4987: 1994 (Reaffirmed 2004)- Recommendations for establishing network of Rain gauge Stations.

iv. BIS 4890: 1968, Methods of measurement of suspended sediment in Rivers.

4. **Manuals prepared under Hydrology Project-Phase-I:**

i. Hydro-Meteorology, Volume-3, Field Manual Part-I, Network Design and site selection.

ii. Hydro-Meteorology, Volume-3, Field Manual Part-III ARG or TBR O&M.

iii. Hydro-Meteorology, Volume-3, SRG O&M.

iv. Hydro-Meteorology, Volume-3, Field Manual- Part-IV, Field inspections, Maintenance and calibrations.

v. Hydrometry, Volume-4, Design Manual.

vi. Hydrometry, Volume-4, Reference Manual.

vii. Hydrometry, Volume-4, Field Manual Part-II, River Stage Observation.

viii. Hydrometry Volume-4, Field Manual Part-III, Float Measurements.

ix. Hydrometry Volume-4, Field Manual Part-IV, Current meter gauging.

x. Hydrometry Volume-4, Field Manual Part-V, Field applications of ADCP.

xi. Hydrometry Volume-4, Field Manual Part-VI, Slope-Area method.

xii. Sediment Transport Measurement, Volume-5, Design Manual.

xiii. Sediment Transport Measurement, Volume-5, Field Manual.

xiv. Sediment Transport Measurement, Volume-5,Reference Manual.

Any suggestions and views are welcomed and can be sent on rdc2dte-cwc@gov.in .These may be incorporated in future editions of this book.

NOTES

NOTES

NOTES

NOTES

Shri R.K. Sinha, Member (River Management), CWC, New Delhi

Shri Ravi Shanker, Chief Engineer (Planning & Development), CWC, New Delhi

Shri Rajesh Kumar, Director (River Data Compilation -1 Dte), CWC, New Delhi

Shri Pankaj Kumar Sharma, Director(River Data Compilation -2 Dte), CWC, New Delhi

Shri Rakesh Kumar Gupta, Deputy Director (River Data Compilation -2 Dte), CWC, New Delhi

REPORT PREPARATION DONE BY

Shri Rohit Gupta, Assistant Director, RDC-2 Directorate, CWC, New Delhi

Courtesy:CSRO