GOVERNMENT OF INDIA
CENTRAL WATER COMMISSION
CENTRAL TRAINING UNIT

HYDROLOGY PROJECT

TRAINING OF TRAINERS
IN
HYDROMETRY

HOW TO INVESTIGATE AND SELECT HYDROLGOCIAL OBSERVATIONS STATION

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1. MODULE CONTEXT

This module is one of the category "Design and Construction of hydrological obersvation stations" under Surface Water Hydrology. The Training Module is meant for Supervisor/SDO/Assistant Engineer/Assistant Executive Engineer/Deputy Executive Engineer. No prior training is need before proceeding :

Module	Code	Subject Contents
1. How to investigate and Select Hydrological Observation Station		– Describes the criteria and categories of HO stations – Develops skills on Investigation and Selecion

2. MODULE PROFILE

Title	:	How to undertake Investigation for Site Selection
Target Group	:	Supervisor/SDO/AE/AEE/DE E/Deputy Engineer
Duration	:	90 minutes
Objectives	:	After training, the officers would be able to – Describe the criteria and categories of HO Stations – Develop skills on Investigation and Selection of HO sites
Key Concepts	:	– Designing of Hydrological Observation station network – Density of hydrological observation station network – Classification of hydrological observation stations – Criteria of hydrological observation stations – Criteria for selection of hydrological observation sites
Training methods	:	Demonstration, discussion, exercise & quiz
Training aids	:	Overhead Projector, Overhead sheets, Flip chart, toposheets for exercise
Handout	:	Main text and Annexure

4. SUGGESTIONS FOR EVALUATION

Q.1. List out the considerations for designing of Hydrological Observation Station networks for large rivers originating in the mountains.

Q.2. Classify the H.O.Stations

A.1.

i) The first Hydrological Observation Station may be located at a point where water leaves the mountainsous reach and enters the plain land.

ii) Subsequent stations established at the sites where significant changes in the volume of flow are noticed like below the confluence of a major tributary.

iii) Other stations may be needed to provide information on water loss from the channel by evaporation, infiltration, utilisation of irrigation, power generation industrial and other domestic needs.

A.2. Depending on the purpose, the HO stations could be classified into three types namely:

i) Primary Stations - which are maintained on long term basis to generate representative flow series of the river systems. ii) Secondary Stations - short duration stations operated for a period enough to establish the flow characteristics of the river or stream and iii) Special Purpose Stations - temporary stations for specific purpose and are discontinued when the purpose is served.

INTRUCTORS NOTE

HOW TO UNDERTAKE INVESTIGATION FOR SITE SELECTION

1. 0 Introduction

Water is a major component of the natural environment inherited by the humanity and is a basic need for the sustenance of life. Apart from drinking and other domestic uses of the human and livestock population, it is required in large quantities for many other purposes like industrial use, irrigation, hydro-power generation, navigation, recreation etc. Water is a renewable resource, but this does not mean that it is plentiful and could be wasted away to flow into the deep seas. With the rapid growth in population and advancement of civilisation, the demand for water has tremendously increased over the past few decades. This has led to a situation where water would be a scarce resource unless its wastage is prevented and is properly harnessed and managed for distribution to various essential and developmental purposes.

India is of course, rich in it over all surface water resources as it is bestowed with many a perennial and other natural rivers, but they are not evenly distributed. The precipitation pattern is also erratic with its uneven distribution over vast tracts of the country and seasonal variations. Thus a need arises for proper coordination between the availability and utilisation of water. In order to effectively plan and manage the water of various river basins. It is highly essential to have a through knowledge of its availability both in quantity and quality at various places along the river course. Central Water Commission (CWC), being the premier technical organisation in the development of water resources of the country, has undertaken this work in a big way by establishing hydrological observation stations at various places along the courses of all the important rivers and their tributaries. The State Governments of Andhra Pradesh, Assam, Bihar, Haryana, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Tamil Nadu, Uttar Pradesh and West Bengal are also engaged in hydrological observations for limited purposes.

2.0 Hydrological Observations - a definition

Hydrological observations could be broadly defined as the scientific way for collection of flow data at a specific location along the river. The reliability of the data is an important attribute for assessing the water resources in terms of quantity, quality, distribution in time and space and its potential for planning and development of projects to meet different water demands.

The observations at various hydrological stations of the Central Water Commission mainly include the gauge, discharge, suspended sediment, bed material and water quality.

2.1 Necessity and importance of hydrological observations

As stressed in the National Water Policy, water is one of the most crucial elements in developmental planning. The prime requisite for resource planning is a well developed information system. It is therefore necessary to establish a network of hydrological observation stations on various rivers and their tributaries to create a reliable data base and information system.

Resource planning in the case of water has to be done for a hydrological unit such as a drainage basin as a whole or a sub basin. All individual developmental projects and proposals need to be formulated and considered within the framework of an overall plan for a basin or sub basin, so as to make the best possible combination of the available options. In view of this, the hydrological observations at various locations along the river course are important to assess the water availability and to prepare comprehensive plans for its conservation, utilisation and overall management. Hydrological data is the basic input for planning and framing of project proposals for successful implementation. The main purposes for which the hydrological observation data can be used are given below:

- ✓ Assessment of water availability in a basin
- ✓ Estimation of periodical flow distribution during various seasons
- ✓ Estimation of suspended sediment load and bed sediment load
- ✓ Determination of water quality and its possible changes either naturally or under the influence of extraneous agencies
- ✓ Proper utilisation of water resources for various purposes
- ✓ Formulation of flood forecasts for dissemination to the people living in flood zones
- ✓ Better water management
- ✓ Resolving inter-state or international water disputes
- ✓ Study of the river morphological aspects
- ✓ Study of the effect of nature and human interference on surface water availability and its distribution.
- ✓ Other miscellaneous purposes including research.

3.0 Design of hydrological observation station networks

A hydrological network is a network of hydrometeorological stations in a river basin which provides data commonly required by the hydrologists for assessment of river system. The data should enable accurate estimation of the principal characteristics of the hydrological regime of the river basin. The network requirement is greatly influenced by the precipitation pattern in basin catchment and the purpose for which the data is required. The three major uses of the data are planning, management(including forecasting) and research. Planning usually requires extensive data with a long time data base. Management requires less data but on real time basis. The research requires high quality intensive data. Design of optimum network must therefore be based on quantified objectives wherever possible.

The selection of hydrological observation sites or stations forming the basic network may be carried out in following manner-

Primarily, a station is to be planned at a point on the main river where the mean discharge attains its maximum value.

For rivers flowing across the plains, this site is usually in the downstream part of the river, immediately upstream of the point where the river normally divides itself into branches before joining the sea or a lake.

In case of mountain rivers, it is the point where water leaves the mountainous reach and enters the plain land.

Subsequent stations are established at the sites where significant changes in the volume of flow are noticed viz. below the confluence of a major tributary or at the outflow point of a lake etc.

In case, a suitable location is not available below the confluence , the sites can be located above the confluence ,preferably on the tributary. While establishing sites at the downstream of confluence, care is taken to ensure that no other small stream joins the main river so as to avoid erroneous assessment of the contribution of the tributary to the main river.

In case of large rivers originating in the mountains, though the major contribution is from upper regions of the basin, several stations may have to be located in the downstream stretch of the river. Such stations are intended to provide an inventory of water loss from the channel by evaporation , infiltration and by way of utilisation for irrigation, power generation, industrial use and other domestic needs.

The distance between two stations on the same river may vary from 30 to several 100 kilometers, depending on the volume of the flow.

The drainage area computed from origin upto two consecutive observation sites on a large river should preferably differ by more than ten percent so that the difference in quantities of flow at the two stations is significant. The station should be of hydrological significance for determining the flow contribution from a typical catchment and in such a situation, these norms could be suitably relaxed.

The above mentioned criteria are applicable to a river basin having a large area and well developed stream system.

A different approach is to be adopted in the case of small independent rivers which flow directly into the sea, as in the case of west flowing rivers of Kerala and some east flowing rivers of Tamilnadu. In such cases, the first hydrological observation station is to be established on a stream that is typically of the region and then further stations could be added to the network so as to widely cover the area. In no case, the stream having low flow in the area should be avoided for inclusion in the network. Absence of a station on a low flow stream may lead to wrong conclusions on the water potential of the area, if evaluated on the basis of the flow in the high flow streams. Thus, great care is to be exercised in designing the network to ensure that all distinct hydrological area are adequately covered.

The gauging network after design and establishment needs review from time to time. The developments that take place in the basin like construction of new irrigation / hydro-electric projects and industrialisation of the area may warrant addition or closure of the sites. Often the river reaches are polluted due to the discharge of affluents from industries. A need may also arise to establish a few temporary stations to monitor the quality of water in the river.

4.0 Density of hydrological observation station networks

The recommendations of the WMO (World Meteorological Organisation) on the density of hydrological network for regions with different physiographic features are reproduced in the Table below.

The table gives only the general minimum network requirements and the actual selection of stream gauging stations may be done keeping in view the current and perspective planning, and requirement of data for various other purposes.

Table
Minimum density of hydrological stations network

Type of Region	**Range of norms for minimum network (area in sq.km. for one station)**	**Range of provisional norms tolerated in different conditions * (area in sq.km. for one station)**
1. Flat regions of temperate mediterranean and tropical zones.	1,000 - 2,500	3,000 - 10,000
2. Mountainous regions of temperate, mediterranean and tropical zones	300 - 1,000	1,000 - 5,000 ++
Small mountainous islands with very irregular precipitation & very densestreams	140 -300	
3. Arid and polar zones **	5,000 - 20,000+	

* Last figure of the range should be tolerated only for exceptionally difficult conditions

** Great deserts are not included

\+ Depending on feasibility

++ Under very difficult conditions this may be extended upto 10,000 sq. km

5.0 Classification of hydrological observation stations

The main criteria for classification of a site for hydrological observation will be the purpose for which it is established . Depending on the purpose , the hydrological observation station could be classified into three types :

1) Primary stations — These are also termed as key gauging stations, principal stations or bench mark stations and are maintained on long term basis to generate representative flow series of the river system.

2) Secondary stations — These are essentially short duration stations intended to be operated only for such a length of

period as is enough to establish the flow characteristics of the river or stream .

3) Special purpose stations — These are also termed as specific purpose stations or project stations or temporary stations meant for projects and are discontinued when the purpose is served. The purpose could vary from design, management and operation of the project tomonitoring and fulfillment of legal agreement between co-basin states. The primary as well as the secondary stations also many a times serve as special purpose stations.

6.0 Criteria for selection of hydrological observation sites

Before taking up field reconnaissance survey for selection of a hydrological observation site, a careful study of the toposheets of larger scale covering the river basin on which the site is to be established is essential. This study provides useful information regarding the river morphology and makes the field reconnaissance survey easier for final selection of site. While selecting the site following points are to be kept in view :

1) The river bank should be steep and straight for fairly long distance.
2) The site should be free from backwater effect from any existing, ongoing or future
structures or from flow of the main river or tributary.
3) The site shall be accessible in all seasons round the year.

After preliminary studies with the help of toposheets, a field reconnaissance survey is to be conducted. It is desirable that such reconnaissance survey shall be conducted by an officer not below the rank of Executive Engineer and preferably in the non-monsoon season, when the river is better exposed for observation. As the hydraulic conditions and river characteristics vary considerably from non-monsoon to monsoon season, observations in both the seasons would facilitate correct decision on the suitability of the site. When the establishment of site cannot wait that long, the suitability of the site for hydrological observation could be decided after single inspection assisted by toposheet studies and other relevant field investigations including measurements of width, depth, velocity and direction of flow etc.

During the field inspection, it is to be ascertained whether :

- The reach upstream and downstream of the proposed station gauge are straight and uniform
- The cross section is stable and the banks are high enough to contain the floods
- The reach is free from rock outcrops, weed growth and pools
- The flow is normal to the cross section
- The flow is in single or multiple channels

- ☛ Any dam / weir / bridge is situated near the site and its possible effect on the flow measurements

The information on the historical high flood level (by local enquiry and / or by examining the available landmarks) etc. also requires to be collected during the inspection. A detailed checklist for selection of hydrological observation site is given in Annex-1.

An all weather accessible site located in a straight uniform reach free from weeds, rock outcrop, pools and back water effect with stable non-overflowing banks and withflow confined to single channel normal to the selected cross-section of measurement would generally form an ideal site for hydrological observation.

6.1 Bureau of Indian Standards (BIS) criteria for selection of hydrological observation sites:

The ideal requirements for a good gauging site as enunciated in IS 1192-1981 "Velocity - Area methods for measurement of flow of water in open channels" are given below. The accuracy of measurement of discharge by velocity area method is increased if the site is selected considering these aspects.

- ➡ The channel shall be straight and its cross section is well defined.
- ➡ The conditions of flow do not change within the period of measurement.
- ➡ The observation verticals at all points are parallel to one another and at right angles to the measuring cross section.
- ➡ The velocity contours (iso-vels) are regular in the vertical and horizontal planes on which they are measured.

The site selected should comply, as far as possible, with the following essential requirements:

a) The reach of the open channel at the gauging site shall be straight and of uniform cross section and slope, as far as possible, in order to avoid irregularities in velocity distribution. The length of the reach need not be more than 1600 m and should not be less than 400m. When the length of the straight channel is restricted, it is recommended for currentmeter measurements and the straight length upstream of the measuring cross section should be twice that on the downstream.

(Note: In case of artificial channel, the minimum length of straight reach should preferably be such as to give a drop in water level of 0.06 m. or the minimum length should be equal to four times the width of the channel, which ever is larger.)

b) The depth of water in the selected reach shall be sufficient to provide for the effective immersion of either the current meters or floats, whichever are to be used.

c) When near a confluence, the site, if located on a tributary shall be sufficiently upstream preferably beyond the backwater effect; and if located on the main stream, upstream or downstream of the confluence it shall be beyond the disturbances due to the tributary.

d) The site should be easily accessible at all times of the year.

In addition to the requirements specified above, the following points shall be taken into consideration as desirable requirements in the selection of the gauging site.

i. The flow should be confined in a single channel and there should be no overflow as far as possible. Where this is not possible, the site in which minimum number of channels exist and the flood plain has minimum width should be preferred.

ii. Where these requirements cannot be met (for instance- when in alluvial rivers the river bed is changing during the period of measurement, or when, under flood conditions, the river is not confined to a single channel in embankments), a gauging site shall be chosen such that the bed change and/or overflow is minimum. Floodplain, if cannot be avoided, shall be of minimum width, as smooth as possible, with a distinct channel, and clear of bushes and trees. The flow in the over bank or floodplain section (s) shall be measured separately and added, treating the whole as a composite section.

iii. The site shall be remote from any bend or natural or artificial obstruction if disturbances of the flow is likely to be caused thereby.

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

v. Sites at which there is a tendency for the formation of vortex or development of return flow shall be avoided.

vi. The site should, as far as possible, be free from trees and obstructions which may interfere with flow and clear vision during observation.

vii. The site shall be free from aquatic growth which is likely to interfere with the measurement of depth and the current meter reading.

viii. The site shall be away from the back water zone caused by any structure on the river.

ix. The site should be sufficiently away from the disturbance caused by rapids and falls. etc.

6.2 World Meteorological Organisation (WMO) criteria for selection of site

The following are the WMO recommendations for selection of a site :

I. The general course of the stream should be straight for about 100M upstream and downstream from the site.

II. No flow bypasses the site as subsurface flow.

III. The stream bed is not subject to scour and fill and .....

IV. The banks are permanent and high enough to contain floods.

V. Unchanging natural controls are present in the form of a bedrock outcrop or other ruffle for low flow and a channel constriction for high flow.

VI. Small pool is present upstream from the control at extremely low stages to ensure a recording of stage at extremely low flow and to avoid high velocities

VII. A satisfactory reach for measuring discharge at all stages is available within reasonable proximity of the gauge site. It is not necessary for low and high flows to be measured at the same cross section.

Annex -1

Checklist for selection of hydrological observation sites

1. Location information :

a Name of stream — Sub basin / Basin

b Name of site — Latitude / Longitude

2. Network design considerations :

a. Catchment area of the stream at the proposed site.

b. Total length of the stream along its longest course from origin to the proposed site.

c. Total catchment area of existing key G&D site (ref.sketch) immediately up stream of proposed site expressed as a % of (a) above.

d. Total catchment area of existing key G&D site (ref.sketch) immediately downstream of proposed site expressed as a % of (a) above.

e. Distance along the stream from the origin along the longest course to the existing key G&D site immediately upstream of proposed site expressed as a % of (b)

f. Distance along the stream from the origin along the longest course to the existing key G&D site immediately downstream of proposed site expressed as a % of (b)

g. 1) % of catchment area which is tapped by existing storage reservoirs on the upstream side.

11) % of catchment area which is tapped by existing and proposed reservoirs.

h. % of catchment area which is tapped by existing storage reservoirs as well as diversion works.

i % of catchment area which is tapped by existing and proposed storage and diversion works.

j Is the site also going to be of special use for :

i) Flood forecasting

ii) Water supply/water quality for a nearby town

iii) Obtaining records of flow at administrative /political boundary.

iv) Planning of a large proposed water development project in future.

3. Detailed location consideration :

a. Is the site going to be submerged/affected by a future project.

b. Is there any quarrying activity or dumping activity at or near downstream area which can change the low flow regime from year to year.

c. Whether the river has a straight reach ? If so :

i) Length of straight reach u/s and d/s of proposed site.

ii) Its full width at the proposed site.

d. Whether the reach upstream and downstream of the site in the reach mentioned in (c) above is fairly uniform.

e. Whether the cross-section is uniform ? If so the length of uniform cross section. Whether river banks are stable and high enough to contain the maximum flood ? If the maximum flood is likely to over flow the banks for how many days in a year ?

f. Whether the reach is free from rock out crop, weeds , pools, trees etc.

4. Hydrological regime consideration

(I) Low flow regime

a. Is the site likely to have a deep pool which will reduce the velocity and make it difficult to measure low flows.

b. If answer to (a) above is yes, is it possible to have a nearby site as a temporary low flow site ?

c. Does the flow take place in a single channel or in multiple channels

d. Does the flow take place on a wide and shallow stretch, where proper depth measurement and flow computation would be difficult.

e. In such a case are there possibilities of training low flow by temporary work .

II) High flow regime

a. Is there any rock outcrop or rapid bed fall or an ungated hydraulic structure etc, downstream section of the site which will act as a "Control" in floods and lead to a good and unique stage-discharge relation during floods.

b. Does the river have a stable downstream section for a few kilometers which can provide a friction control leading to a unique stage-discharge relation during floods.

c. Is the stage discharge relation likely to be affected due to the following :

(i) Floods in another channel meeting downstream of the proposed site

(ii) A downstream reservoir existing or proposed Submergence / backwater of which can reach the proposed site.

(iii) Gate operation at gated hydraulic structure on the downstream (existing or proposed)

d. If during high floods it is found difficult to take observations by the normal means due to high velocity, non functioning of cableway or boats etc. Is a high level bridge available nearby for alternate bridge observations.

5. River hydraulic consideration

a. The site, if situated downstream of a bridge or any structure, is at a distance of at least there times the width of the river.

b. Is any flow normal to the cross section of the river ?

c. Is any dam/weir situated near the site ? If so, what are its likely effects on the flows.

d. The stream is perennial or seasonal. If seasonal what is the duration of flow ?

6. Inspection and other facilities consideration

a. Name of village/town nearby and its distance from the site

b. Extent of facilities like living and office accommodation on hire, basic market, medical facilities. P&T office, school etc, available nearby.

c. Whether the site is approachable throughout the year. Is it approachable by jeep ?

d. Distance to nearest town, railway station and means of communication thereon.

e. Location of nearest town inspection bungalow/rest House.

f. Whether Govt. and or private land on lease would be available for construction of semi permanent sheds.

g. Whether land is available for construction of cable towers

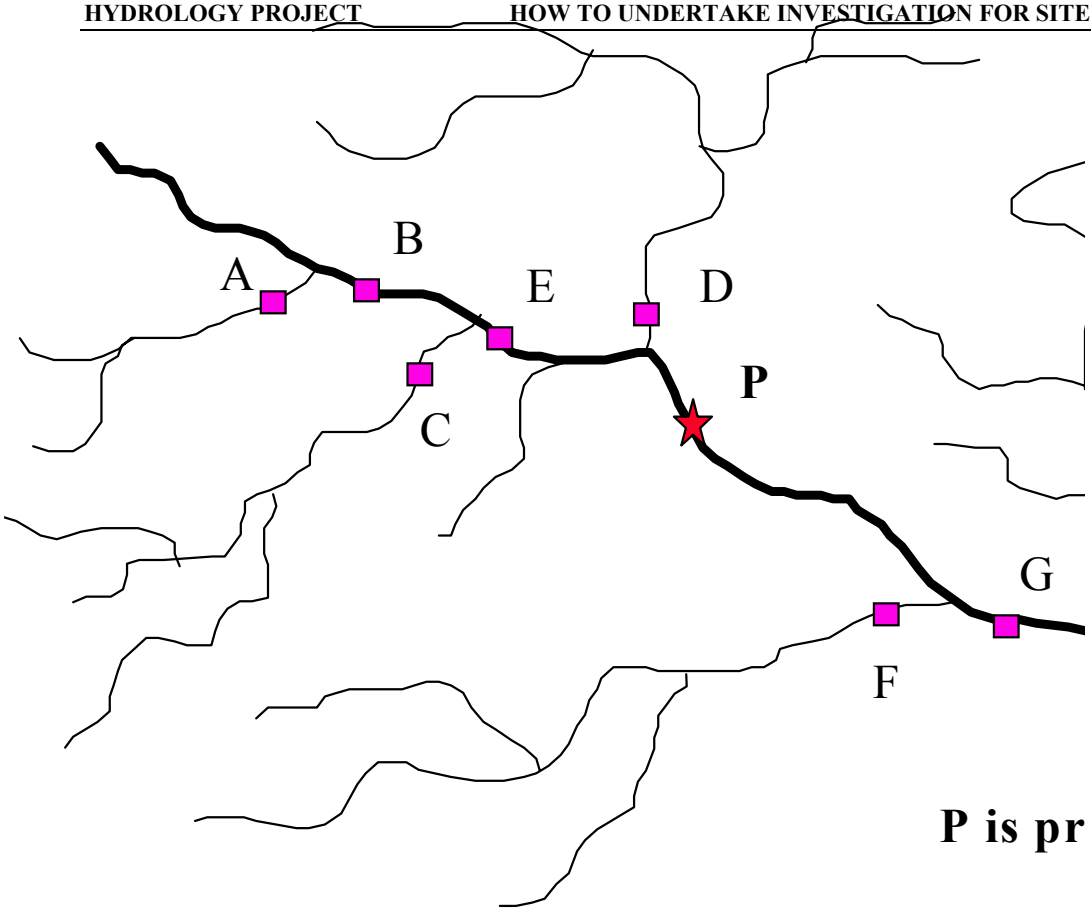
7. Miscellaneous considerations :

a. Whether any wireless station or G&D station of state Govt./other gencies exist nearby and if so its status.
b. Whether any industries exist nearby, which can pollute the river water.
c. How far is the nearest GTS Benchmark available .
d. Maximum velocity range and the category of site :

i) Boat and cable way
ii) Boat with O.B.engine or
iii) Motor launch

e. Requirement of equipment and T&P and note comments about their availability.

f. Requirement of staff and comments about their availability.



A to H are existing G&D Sites

Sketch of a river basin to elucidate items 2c to 2f

In the above sketch A, B, C, D, E, F, G and H are existing G&D Sites.

P is the proposed location
O is the origin of the stream

Item 2(c) $\frac{\text{C.A. upto E + C.A. upto D}}{\text{C.A. upto P}}$

Item 2(d) $\frac{\text{C.A. upto G}}{\text{C.A. upto P}} \times 100$

Item 2(e) $\frac{\text{Length from O to E}}{\text{Length from O to P}} \times 100$

Item 2 (f) $\frac{\text{Length from O to G}}{\text{Length from O to F}} \times 100$

C.A.: Catchment Area

OVERHEAD SHEETS

HYDROLOGICAL OBSERVATIONS - DEFINITION

HYDROLOGICAL OBSERVATIONS ARE DEFINED AS THE SCIENTIFIC WAY OF COLLECTION OF DATA ON VARIOUS PARAMETERS OF STREAM FLOW AT VARIOUS LOCATIONS

THE PARAMETERS COULD BE WATER LEVELS, DISCHARGES, SUSPENDED SEDIMENTS, BED MATERIAL, WATER QUALITY etc.,.

USE OF STREAM FLOW DATA

- ASSESSEMENT OF WATER AVAILABILITY
- FLOW DISTRIBUTION IN VARIOUS SEASONS
- ESTIMATION OF SUSPENDED SEDIMENT AND BED MATERIAL LOADS
- DETERMINATION OF WATER QUALITY
- FORMULATION OF FLOOD FORECASTING
- RESOLVING WATER DISPUTES
- STUDY OF RIVER MORPHOLOGICAL ASPECTS

CLASSIFICATION OF HYDROLOGICAL OBSERVATION STATIONS

H.O.STATIONS

PRIMARY STATIONS	SECONDARY STATIONS	SPECIAL PURPOSE STATIONS
KEY STATIONS ESTABLISHED TO OBTAIN DATA ON LONG TERM BASIS	ESTABLISHED TO OBTAIN DATA ON SHORT TERM BASIS	(i) PROJECT STATIONS (PROPOSED OR EXISTING) (ii) DUE TO LEGAL REQRT. (iii) WATER QUALITY etc.,.

DENSITY OF H.O STATION NETWORKS

TYPE OF REGION	NORMS (area in sq km/ station)	IN DIFFICULT CONDITIONS
1. FLAT REGIONS OF TEMPERATE MEDITERRANIAN & TROPICAL ZONES	1000 to 2500	3000 to 10000
2. MOUNTAIN REGIONS OF TEMPERATE MEDITERRANIAN & TROPICAL ZONES	300 to 1000	1000 to 5000
3. SMALL MOUNTAIN ISLANDS WITH DENSE STREAMS & IRREGULAR PRECTPITATION	140 to 300	
4. ARID & POLAR ZONES	5000 to 20000	

IMPORTANT POINTS FOR DESIGN OF H.O. NETWORKS

- ✓ AT A LOCATION OF MAX. DISCHARGE
- ✓ IN THE d/s PORTION OF THE RIVER
- ✓ IN MOUNTAINS - AT A POINT WHERE THE RIVER LEAVES MOUNATINS AND ENTERS PLAINS
- ✓ AT LOCATIONS WHERE SIGNIFICANT CHANGES IN VOLUME OF WATER ARE EXPECTED

IMPORTANT POINTS (contd.)

- ✓ **DISTANCE BETWEEN TWO STATIONS IS MORE THAN 30 KMs**
- ✓ **CATCHMENT AREA OF TWO CONSECUTIVE SITES SHOULD DIFFER BY MORE THAN 10%**
- ✓ **AVOID REDUNDANT SITES**
- ✓ **REVIEW, REVIEW & REVIEW**

CRITERIA FOR SELECTION OF H.O. STATIONS

- THE CHANNEL SHOULD BE STRAIGHT & UNIFORM (> 400 m)
- DEPTH OF WATER SHOULD BE SUFFICIENT TO IMMERSE CURRENTMETER
- FREE FROM BACK WATER EFFECT
- EASILY ACCESSIBLE THROUGHOUT THE YEAR

CRITERIA (contd.)

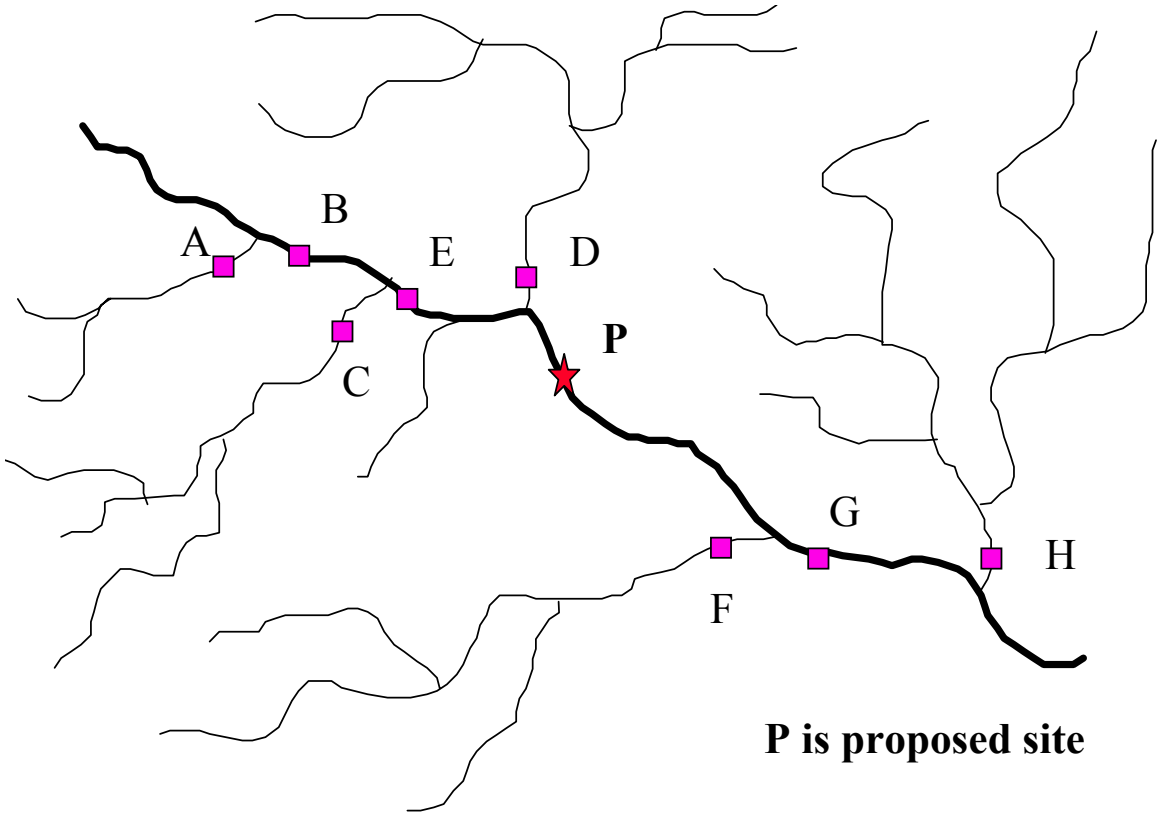
- CONFINED TO ONE CHANNEL
- FREE FROM OBSTRUCTIONS (NAURAL OR ARTIFICIAL)
- DIRECTION OF FLOW NORMAL TO WIND DIRECTION
- FREE FROM VORTEX CONDITIONS
- CLEAR VISION DURING OBSERVATIONS SHOULD BE POSSIBLE

CRITERIA (contd.)

- FREE FROM AQUATIC GROWTH
- SUFFICIENTLY FAR FROM FALLS
- BANKS ARE PERMENANT AND HIGH ENOUGH TO CONTAIN FLOODS
- NATURAL CONTROLS ARE PRESENT
- BED IS NOT SUBJECT TO SCOURING
- NO FLOW BYPASSES AS SUBSURFACE FLOW

CHECKLIST FOR SELECTION OF H.O.STATIONS

- LOCATION INFORMATION
- NETWORK DESIGN CONSIDERATION
- DETAILED LOCATION CONSIDERATION
- HYDROLOGICAL REGIME CONSIDERATION
- RIVER HYDRAULIC CONSIDERATION
- INSPECTION & OTHER FACILITIES
- MISCELLANEOUS



A to H are existing G&D Sites