SOP for GNSS Observation in Order to Determine Latitude, Longitude & Ellipsoidal Height and subsequently use of Geoid Model for National Hydrology Project.

The coordinates obtained from GPS/GNSS observations are burdened with many errors like Satellite Clock and orbit error, Ionospheric delay and Topospheric delay, Receiver Noise, Multipath and Receiver Clock error. Due the above errors the coordinates obtained are inaccurate and needs to be corrected before use.

To minimize the effect of these errors the GPS/GNSS data of observation points needs to be processed with reference to some known reference stations whose coordinates are accurately known to us.

The reference stations are of two types

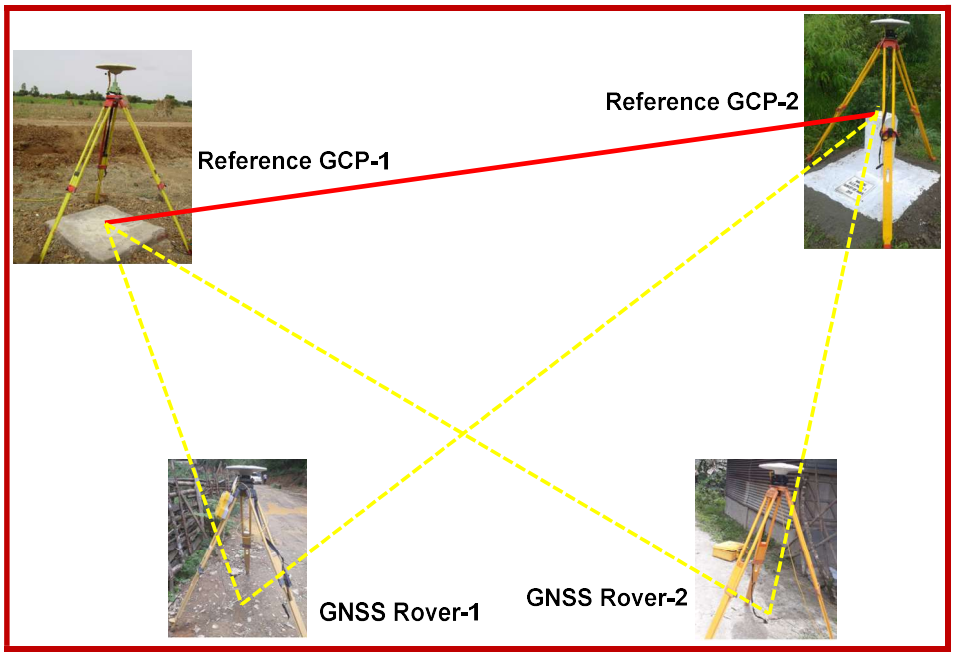
1. **CORS Network established by SOI: Active Network of Reference Stations**
2. **SOI GCPs: Passive Network of Reference Stations**

1. CORS Network established by SOI: Active Network of Reference Stations

- Continuously Operating Reference Stations CORS are geodetic quality GNSS receivers and antennas that are permanently installed at a Reference Station (RS) having very accurately pre-determined coordinates.
- These Reference Stations collect GNSS data continuously, and transmit data via Internet to a central server (Control & Processing Centre).
- **The incoming data is processed at the server to generate corrections which are made available to users over the Internet in real-time in order to get the accurate coordinates.**
- **To get accurate coordinates using the CORS network is known as Network Real Time Kinematic (NRTK) survey technique.**
- **To avail the facility of NRTK survey users needs to have a RTK enabled GNSS receiver with internet connectivity.**
- Different brand receivers are available in the market. The Standard Operating Procedure (SOP) to carry out NRTK survey is different for different brand receivers.
- At present SOI is using **Trimble R8s** GNSS receiver for NRTK survey. The SOP to carry out NRTK survey using **Trimble R8s GNSS receiver given in Annexure 'A'**.

2. SOI GCPs: Passive Network of Reference Stations

- The states where CORS network is not available, the SOI GCPs can be used as reference stations to get the accurate latitude longitude and ellipsoidal height of the survey points.
- The SOI has established Ground Control Point (GCP) Library of about 2500 Ground Control Points in the entire country and derived their coordinates (Latitude, Longitude and Ellipsoidal Height) with high accuracy. These GCPs define the Horizontal datum of the country and can be used for various surveying, mapping and developmental activities. These GCPs has cement concrete structure/Monumentation and can be located on the ground by their description which is available with SOI. **These GCPs are passive reference stations.**
- To get the accurate coordinates of survey points for any surveying and mapping activity the GPS/GNSS observation of survey points needs to be carried out for 1 to 2 hours with reference to SOI GCPs in static and relative/differential mode. The GPS/GNSS data thus collected needs to be processed with reference to SOI GCPs in order to derive the accurate coordinates (Latitude, Longitude and Ellipsoidal Height) of new survey points.
- The coordinates of reference GCPs which is required during the post processing can be obtained from SOI as per departmental policy.
- In this process at least two Observers with two GNSS receivers needs to occupy the Reference GCPs falling in the area of work and one or more observers needs to occupy the new survey points with 1 to 2 hours common observation duration.



- This technique is known as static survey technique and require the at least three GNSS receivers. More receivers will increase the progress of the work.
- The static survey requires:
    - 1 to 2 hours GNSS Data collection using GNSS receiver

    - GNSS data downloading from the receiver to a computer having GNSS data processing software and finally
    - GNSS data Processing using software
- The SOP for GNSS data collection in static mode using a **Trimble R8s GNSS** receiver and downloading to a computer is given in **Annexure 'B'**.
- The SOP for GNSS data processing using Trimble Business Center (TBC) software is given in **Annexure 'C'**.
- The output of NRTK as well as static survey is accurate Latitude, Longitude and ellipsoidal heights.
- **In order to get Orthometric Height of survey points, the Latitude, Longitude and Ellipsoidal heights of survey points can be supplied to SOI. The SOI use the Geoid model and convert the ellipsoidal heights into Orthometric Heights.**
- **The SOPs as mentioned above are given in Annexure 'A', 'B' and 'C'.**