GPS COLLECTION FOR AS-BUILT SUBMISSION FOR PUBLIC-PRIVATE PARTNERSHIP PROJECTS

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INTRODUCTION

The use of the Global Positioning System (GPS) for accurately and efficiently storing feature locations and attributes has become a widely accepted method for collecting GIS data. With many now having the ability to use this technology to collect GIS data, it is recommended that the West Virginia American Water Company (WVAWC) Geographic Information System (GIS) adopts GPS data collection recommendations to insure data quality and consistency. This document provides recommendations for collecting GPS data for WVAWC.

The recommendations in this manual will assist the GIS Team to meet the mission objectives set down by the American Water (AMWATER) and WVAWC leadership teams in an efficient and consistent manner. The objectives are as follows:

- Incorporate GPS technology into WVAW as a tool for use.
- Accurately locate WVAW assets to promote efficiency and reduce costs.

This manual is developed and maintained by the WVAWC GIS Team and is subject to review and modification on an annual basis. The annual review is necessary to verify that the manual is up-to-date with any changes or additions to the mission objectives of the GIS Program to meet the business needs of WVAWC.

GPS SETTINGS AND FIELD PROCEDURES

This section will outline the established the minimum recommendations used throughout the GPS Program to meet the mission objectives. These recommendations have been developed to:

- Maintain quality control of GPS processes and products
- Establish data organization and naming conventions to ensure GIS Team members can easily identify data and projects in an efficient manner
- Ensure that GIS and mapping processes can be continued uninterrupted and are completed on established schedules

GPS RECEIVERS

The GPS Program requires common elements in the GPS Collection process to ensure accuracy and consistency across the GIS environment. Field staff should have a thorough understanding of GPS basic concepts and receiver operation. GPS fieldwork should be performed by staff that has had training in GPS and/or GIS or has a surveying or mapping background. The staff should also have familiarity with the types of features that are to be located, and should be able to recognize/interpret features in the field.

1) RECEIVER TYPES

To ensure that the appropriate type of GPS receiver is matched to the mapping application, an understanding of receiver capabilities and limitations is suggested. There are three classes of GPS receivers:

- Commercial Grade: Garmin, TomTom and cellular phones are able to collect GPS coordinates. Their accuracy is most of the time dependent on cellular coverage. This varies depending on the number of towers and signal strength in the area of work.
- Mapping Grade: These have an accuracy from sub-meter to five meters. These GPS receivers have the ability to log raw GPS data, enabling these GPS-collected data to be post-processed utilizing desktop GPS software and allowing locations to be refined or corrected to a higher level of precision than inherent in the raw data. This category of GPS receiver also has the ability to communicate with a base station, store attributes of features, use a data dictionary and upload data from the GPS device to a PC.
- Survey or High Accuracy Grade: These include instruments with associated software that can achieve one-centimeter relative accuracy. These are used by land surveyors primarily for boundary, topographic, and geodetic surveys, photogrammetry, and other activities requiring high accuracy. Specialized training is needed to use this equipment.

2) GPS RECEIVERS REQUIREMENTS

The minimum requirements set by WVAWC GIS Team are as follows:

- The GPS receiver used to collect data should be of Mapping Grade or better.
- It should receive Sub-Meter or better accuracy, using either real time or post processed differential corrections.
- Operate in a 3D Mode where the receiver requires signals from a minimum of four satellites to determine a 3D (latitude, longitude, and elevation) location.
- The device should allow the storage of position fixes for feature that are being mapped or connect to a device that allows this storage such as smartphone or tablet. The storage device should have enough data storage capacity for a typical day's worth of data collection.
- The device should be user configurable for critical settings, including DOP, SNR, elevation mask, and logging rate.
- Produce and export data in a format compatible with the base station data used to perform the differential corrections or have the capability to receive real-time corrections from the base station.

3) SUGGESTED GPS RECEIVERS SETTINGS

The GPS Program requires a receiver's critical parameter settings to be set to a minimum standard. Experienced professionals with knowledge of how a GPS device works and how to change the device's settings should become familiar with this information.

Position Mode	All position fixes should be determined with 4 or more satellites. 2D fixes (using only 3 satellites) are not acceptable. 3D positions generated from 2D fixes supplemented with user-entered elevations are also not acceptable.
Elevation Mask	15 degrees above horizon.
PDOP Mask	Max PDOP >= 8

PDOP refers to the quality of horizontal (HDOP) and vertical (VDOP) measurements (latitude, longitude and altitude).	A low DOP value represents a good satellite configuration, whereas a higher value represents a poor satellite configuration. 1 This PDOP provides the highest possible confidence in data accuracy and is used for the applications that demand the highest level of precision. 2-3 In this range, the positional measurements are accurate enough for all but the most sensitive applications. 4-6 This is the minimum level for mapping applications and for making business decisions. 7-8 Here, positional measurements could be used, but a better configuration of satellites is suggested.
Signal to Noise Ratio Mask (SNR)	If this parameter setting exists, set it to 39.0
Minimum Positions for Point Features	If this parameter setting exists, it should be set at a minimum that would allow the GPS data collected to the Sub-Meter standard or the accuracy specified for the dataset. Solutions based on a single fix are not acceptable.
Logging Intervals	Intervals for point features will be 1 second. Intervals for line and area features depend on the velocity at which the receiver will be traveling and the nature of the feature and the operating environment. Under normal circumstances (i.e., when the user is walking with the receiver) the interval for line and area features will be set to 1 second.
Logging of DOP	If the receiver allows, this parameter setting will be set to allow the logging of DOP data along with position fixes.

WEATHER CONSIDERATIONS

Attempt to keep the GPS unit and antennas dry during wet weather, fog and humid days. The buildup of moisture can cause signal blockage/attenuate. ***Do not*** operate during storms that may produce lightning. Dense fog can also cause blocked signal or reflection.

Atmospheric and solar phenomena can drastically effect signals from the GNSS. These can include solar flares, solar radio burst, and coronal mass ejections. These phenomena are predictable and rarely affect the signals above the continental United States. The most drastic effect of these types of incidents are errors with WAAS leading to inaccuracies mostly in elevation of up to 200 feet.

GPS COLLECTION PROCESSES

Purpose: This section will outline the various procedures, processes, guidelines, and references to supporting documents used within the GIS program to meet the recommendations detailed in the previous section. The procedures will describe who, what, and when of how recommendations are met while the processes will present guidelines on how to complete basic tasks that meet the established recommendations.

FIELD DATA COLLECTION OBJECTS

The GPS Program function is to collect assets installed in the WVAWC network. The following are the recommendations for what objects GPS coordinates should be collected for and the attributes that are required to be collected with each.

1) MAJOR ASSETS

Major Asset construction projects include tanks, booster stations, PRVs, reservoirs, wells, treatment plants etc… These assets are major capital expenditures and GPS coordinates should be collected at specific points for each asset.

Asset	Collection Point	Notes
Intakes	at intake point.	Can be adjusted or laser offset.
Treatment Plants	at finished water sample point.	
Tanks	at center point of the tank.	This can be done during construction or later by taking three offsets and determining the central point.
Dams and Reservoirs	at any point at top of dam.	Work with Districts on locations
PRV	on top of PRV opening.	
Booster Station	at main connection.	Work with districts if need inside building.

2) HYDRANTS AND HYDRANT VALVES

The importance of collecting accurate hydrant and hydrant valve location is vital not only to the company but to public safety.

Asset	Collection Point	Notes
Hydrants	at hydrant.	Set bipod on either side of the hydrant. Angle the central pole until the receiver is above the central valve.

Hydrant Valves	at the valve if visible.	Place central pole point on the covers, on either side of the “T” in WATER or directly on the central nut. Figure 1 below.

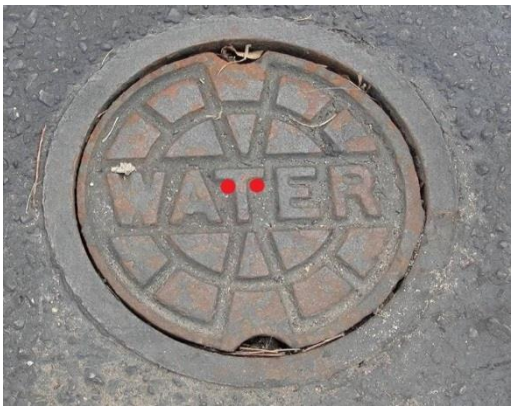

Figure 1. The red dots show the standard locations for position of the central pole point.

3) VALVES

The importance of collecting accurate valve locations helps Operations workers to quickly and efficiently do their jobs. Time spent searching for valve can waste valuable time and in the event of leaks Non-Revenue Water loss.

Asset	Collection Point	Notes
Valves (All valve types)	at the valve.	Place central pole point on the covers, on either side of the “T” in WATER or directly on the central nut. Figure 1 above.
Air – Release Valves	at the valve.	Take on top of valve or valve cover if partially buried. If above ground, use the angle method to place receiver over valve.
Blow-off Valves	at the valve.	Take on top of valve or valve cover if partially buried. If above ground, use the angle method to place receiver over valve.
Tapping Valve	Above tapping valve at main.	When tying over or installing new services the tapping valve should be collected when possible.

Hydrant ID: The Hydrant ID is composed of the letter "H" for Hydrant and a number. The numbering for each project should restart with 1 and continue in sequence (2, 3, etc.).
Valve ID: The Valve ID is composed of a prefix "V" for Valve, "HV" for Hydrant Valve, or "BO" for Blow-Off and a number. The numbering for each project should restart with 1 and continue in sequence (2, 3, etc.).

This means that it is very important to fill in the Project ID field for each asset so we can be sure assets from other projects don't get confused when being processed by the GIS team.

4) FITTINGS

The importance of collecting accurate fitting locations helps locate bends and tees for quick and efficient repairs.

Asset	Collection Point	Notes
Tee	at the fitting	Place central pole or laser offset in the center of the fitting.
Bend	at the fitting	Place central pole or laser offset in the center of the fitting.
2-Way-Wye	at the center of wye.	Place central pole or laser offset in the center of the fitting.
3-Way-Wye	at the center of wye.	Place central pole or laser offset in the center of the fitting.
Tapping Sleeve	at the fitting	Place central pole or laser offset in the center of the fitting.
Reducer	at the fitting	Place central pole or laser offset in the center of the fitting.
Sleeve	at the fitting	Place central pole or laser offset in the center of the fitting.

5) MAINS AND LATERALS

The importance of collecting accurate main and lateral locations helps Operations workers to quickly and efficiently do their jobs and reduce the time leaks affect the customers.

Asset	Collection Point	Notes
Main	Top center of main if possible.	The point should be taking at the end of each 60 foot section of main. If the main is smaller than 60 feet then collect at the fitting that is attached to the end of that main.
Laterals	Not required to be GPS.	

FIELD DATA COLLECTION PROCESSES

This section discusses the GPS collection processes. These steps should be used as a guide to data format conventions, asset-naming conventions to be used to keep data consistent. To achieve the WVAWC GIS Unit's target accuracy, collected GPS data can be differentially corrected, either in real time or in a post process step. This method works with other collection methods but requires post processing to assure accuracy. Should download the Geodatabase each time to get the latest version. Notifications will be given when new versions are published.

a) Open the WVAW site at: https://amwater.com/wvaw/about-us/doing-business-with-us/engineers-contractors
b) Locate the link for PPP Projects.
c) Available to download are the instructions and two file geodatabases for GPS Points and Underground Utilities.
    - The device should connect to the free WV RTK Network to ensure differential accuracy.
    - Data should be entered into the file geodatabases including as many attributes as possible.
    - Each project should be entered into a separate File Geodatabase with a name related to the project or work order.
    - For each project the Geodatabase, the raw GPS data, the post processing GPS data and the Post processing results should also be provided.
    - The minimum GPS Data required is the GPS Coordinates and the Type of Asset (Valve, Hydrant, Fitting, Main, etc…)

POST PROCESSING AND SUBMISSION

POST PROCESSING METHODS

This section outlines how WVAWC acquires the GIS data used within the GIS program. It details what requirements need to be met for GPS acquired data, where WVAWC GIS data is sourced from. And when newly acquired data will be made available to the WVAWC GIS users.

1) NOAA SOURCED DATA

Post processing with OPUS (www.ngs.noaa.gov/OPUS) or equal software should be done on a weekly basis if needed.

2) 3rd PARTY SOURCED DATA

Data may be sourced from 3rd parties for certain projects. These sources could be from government regulators, GIS data warehouses, other utilities, or other sources. With the variety of GIS data sources it is impossible to apply a standard is met on accuracy and completeness of a dataset. With that in mind the following should be checked before implementing new data into the GIS system:

- Make sure the source of the data is a reputable source before putting any file on WVAWC systems.
- Ensure you have contact information for the authoritative source of the data.
- Ensure the data has a projected coordinate system established with it. If not, you will need to identify and establish the projection yourself (refer to this ESRI support article.)
- Review any supporting documentation that is part of the data (metadata, or accompanying Readme files etc.)

DATA DELIVERY METHODS

All coordinate data submitted should use West Virginia State Plane, South Zone, NAD83, US Foot (FIPS 4702) at sub-meter level accuracy or better. Coordinates are not to be obtained from AutoCAD, Google Earth or similar source.

- Data will be delivered by the contractor via physical (USB drive, external HD, CD/DVD media etc.) or electronic means (E-mail, FTP, etc.) on the date all other project deliverables are submitted to the Engineering Division.
- All deliverables are to be documented with proper naming conventions containing the following:
  - Engineering Company Name
  - Project Name
  - In-Service Date
  - Agreement number or Work Order number
  - Date the data was burned onto the disc(if on disc)
  - Designate disc as “Record Drawing”

RTK PROCESSING METHODS

Signing Up for the RTK Network

To access the State of West Virginia's free Real Time Network you can go to the WV Department of Transportation website here: http://www.cors.us/RegisterAccount.aspx

Create a free account. These accounts can be setup for each individual or a shared account for the company.