



PDHonline Course L166W (4 PDH)

Global Positioning System (Live Webinar)

Instructor: John C. Huang, Ph.D., PE

2020

PDH Online | PDH Center

5272 Meadow Estates Drive
Fairfax, VA 22030-6658
Phone: 703-988-0088
www.PDHonline.com

An Approved Continuing Education Provider

GPS Data Collection Guidelines

Prepared by the Standards & Data Coordination Work Group
of the NYS GIS Coordination Program

Last Updated: April 2007

Executive Summary

Purpose

The goal of this document is to provide a means of quality control and [accuracy](#) documentation of Geographic Information System (GIS) data sets created with Global Positioning System ([GPS](#)) technology.

These [GPS](#) data collection guidelines seek to accomplish the following objectives:

- (1) Establish methodology for collecting GPS data for use in a GIS;
- (2) Provide guidelines for reporting [metadata](#) about GPS collected data and methods/means used to collect such data;
- (3) Supply GPS users with definitions of GPS terms and abbreviations; and
- (4) Eliminate or reduce known and potential systematic errors.

This document was developed by the GPS Standards Subcommittee within the Standards & Data Coordination Work Group of the NYS GIS Coordination Program (www.nysgis.state.ny.us). A large amount of material and formatting for this document was obtained and used with permission from the "VT GPS Guidelines" document, written by the Vermont Center for Geographic Information's Technical Advisory Committee, led by Mike Brouillette.

(http://www.vcgi.org/techres/standards/partiii_section_I.doc)

While these guidelines are generally intended to improve the quality of GPS-collected data, following these guidelines does not guarantee that any suggested combination of hardware and methods will insure a prescribed [accuracy](#). Myriad factors influence GPS data quality—many of them not under the direct control of the user. Guidelines alone cannot substitute for experience and judgment in the field. Specifications should balance the needs for [accuracy](#) against the resources available for the project.

The user of these guidelines should understand that GPS technology is rapidly changing. Users of this document require training and a base knowledge of GPS software and hardware. The present version (April 2007) of this document may not be applicable in the future. This document will be reviewed and updated as necessary.

In February 2006, the NYS GIS Coordination Program, through the NYS Office of Cyber Security & Critical Infrastructure Coordination (CSCIC), presented a three hour workshop introducing GIS practitioners to the basic concepts, functionality, [accuracy](#) issues and processes of data collection via GPS, demonstrating the integration of GPS data into a GIS, and illustrating how positional error within GPS data may affect the results of a GIS project. Additionally, a DVD of this workshop was created and may be of interest to the readers of this document. This DVD is available upon request from the NYS GIS Clearinghouse.

The following guidelines were compiled by the Standards & Data Coordination Work Group and have been approved by the NYS GIS Coordinating Body.

Survey, Professional Licensure and Use of GPS

The Global Positioning System (GPS) and Geographic Information Systems (GIS) have been a great benefit to all levels of government. These two technologies have and will continue to change the way governments manage land records, infrastructure, emergency response, and planning, to name a few. Many of these GIS data layers are built and maintained by GIS consultants or government employees.

Some decisions, regulations, ordinances, and law enforcement require government officials to base their decision on information, data, or maps provided by State Licensed Professionals.

Licensed Land Surveyors commonly use Survey Grade GPS when performing boundary and topographic surveys. Through the New York State Education Law the State of New York governs the Profession of Land Surveying which this document will not address.

Users should familiarize themselves with and adhere to New York State Education Laws 7203 and 7209, which define the professions of engineering and land surveying as well as set guidelines. In the interest of public health and safety, 7203 and 7209 set standards, respectively, by stating ¹:

“The practice of the profession of land surveying is defined as practicing that branch of the engineering profession and applied mathematics which includes the measuring and plotting of the dimensions and areas of any portion of the earth, including all naturally placed and man- or machine-made structures and objects thereon, the lengths and directions of boundary lines, the contour of the surface and the application of rules and regulations in accordance with local requirements incidental to subdivisions for the correct determination, description, conveying and recording thereof or for the establishment or reestablishment thereof.”

AND

“No official of this state, or of any city, county, town or village therein, charged with the enforcement of laws, ordinances or regulations shall accept or approve any plans or specifications that are not stamped”.

More information about these New York State Education laws can be found online at <http://www.op.nysed.gov/pefaq.htm>.

¹ “NYS Education Law, Article 14,” 23 Jan. 2007 <<http://www.op.nysed.gov/article145.htm>>

TABLE OF CONTENTS

I.	EXPLANATION OF GEOGRAPHIC INFORMATION SYSTEMS AND GLOBAL POSITIONING SYSTEMS	6
A.	Geographic Information System	6
B.	Global Positioning System	6
II.	CATEGORIES OF GPS RECEIVERS	8
A.	Recreational Grade	8
B.	Mapping Grade	8
C.	Survey or High Accuracy Grade	8
D.	Categories of GPS Receiver Comparison Table	9
III.	SOURCES OF ERROR	10
A.	Multipath	10
B.	Atmosphere	10
C.	Distance from Base Station	11
D.	Selective Availability (SA)	11
E.	Noise	11
IV.	DATA COLLECTION AND PROCESSING METHODOLOGY	11
A.	Mission Planning	11
1.	Satellite Availability & Known Outages	11
2.	Position Dilution of Precision (PDOP)	12
3.	Local Obstructions of the Sky	12
4.	GPS Data Dictionary Design	12
B.	GPS Receiver Configuration	12
1.	PDOP Values	13
2.	Signal to Noise Ratio (SNR) Mask	13

3.	Elevation Mask	13
4.	Data Collection Rate (Sync Rate)	13
5.	Datum.....	13
6.	Projection.....	13
7.	Units of Measure.....	14
C.	GPS Data Download and Processing.....	15
D.	Quality Control	15
E.	Data Collection.....	16
1.	GPS Receiver Antenna.....	16
2.	Prohibit Data Dictionary Editing.....	16
3.	Data Download.....	16
4.	Post-Processing.....	16
5.	Base Station	17
V.	CHOOSING THE RIGHT TOOL FOR THE JOB.....	17
VI.	METADATA GUIDELINES	19
	Appendix A - Glossary of Useful Terms	20
	Appendix B - Useful GPS and Related Websites	30
	Appendix C - Map of New York State UTM (Universal Transverse Mercator) Zones.....	31
	Appendix D - Map of New York State Plane Zones.....	32
	Appendix E - Map of NYSDOT CORS Stations	33
	Appendix F - National and Cooperative CORS Map of New York State	34
	Appendix G - United States Coast Guard Differential GPS Coverage of New York State	35
	Appendix H - Sample of a Blank Metadata Form.....	36
	Appendix I - Sample of a Completed Metadata Form.....	37

I. EXPLANATION OF GEOGRAPHIC INFORMATION SYSTEMS AND GLOBAL POSITIONING SYSTEMS

A. Geographic Information System

In its simplest form, a Geographic Information System (GIS) is an electronic map used to display data based on its geographic location; in its more complex form, it becomes a powerful analytical tool with millions of pieces of data that are related geographically and can be displayed in a format that allows the user to make the inter-relationships between the data visually understandable.²

B. Global Positioning System

The Global Positioning System (GPS) consists of a constellation of 24 satellites that orbit the earth twice a day (making one revolution approximately every 12 hours) at an altitude of approximately 12,000 miles. The GPS satellite navigation system was initiated by the U.S. Department of Defense in the 1970's for military purposes. When the system is at full operational capacity, there are 24 operational satellites. This number changes periodically as satellites are commissioned (put into operation) and decommissioned (removed from operation). At the time of this writing, 31 satellites were in orbit. These satellites broadcast radio signals, containing satellite position and precise time data, twenty-four hours a day. These signals enable anyone with a GPS receiver to determine a geographic location.

The GPS system consists of three distinct segments: the space segment, the ground segment and the user segment.³ The space segment, known as the NAVigation Satellite Timing And Ranging ([NAVSTAR](#)) constellation, consists of the GPS satellites which transmit signals on two phase modulated frequencies ([L1](#) - 1575.42 MHz and [L2](#) - 1227.60 MHz). These transmissions are carefully controlled by highly stable atomic clocks inside the satellites. The satellites also transmit a navigation message that contains, among other things, orbital data for computing the positions of all satellites. The ground segment, also called the control segment, consists of a Master Control Station located near Colorado Springs, Colorado, and several monitoring stations located around the world. The purpose of the control segment is to monitor satellite transmissions continuously, to predict the satellite [ephemeris](#), to calibrate satellite clocks, and to update the navigation message periodically. The user segment simply stands for the total GPS user community. The user will typically observe and record the transmissions of several satellites and will apply solution algorithms to obtain position, velocity, and time.

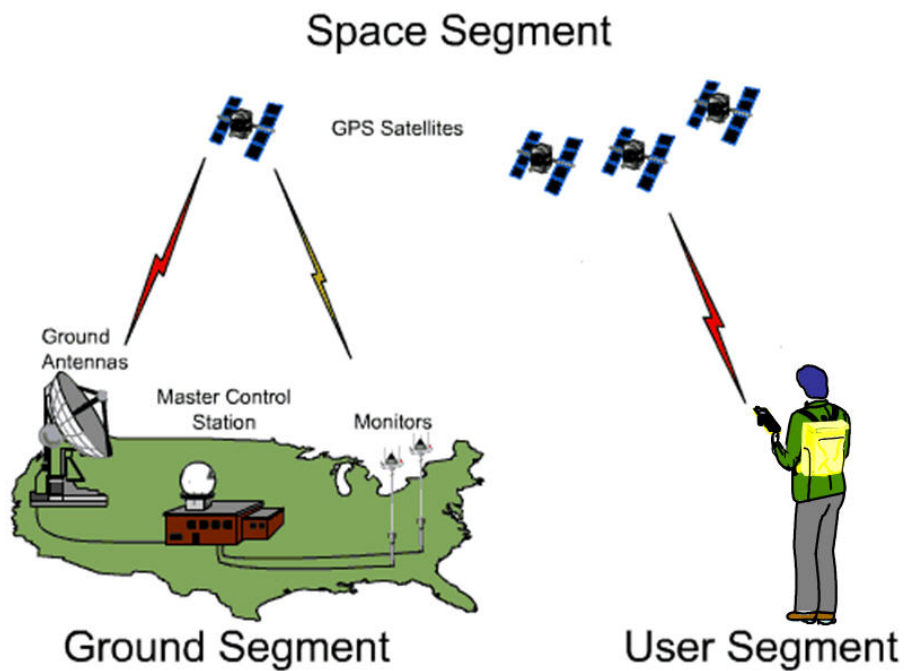
Two signals are broadcast continuously by each satellite, one for use by the military, the other for civilian use. The latter is referred to as Standard Positioning Service. The basis of GPS technology is precise information about time and position. To determine a horizontal location on earth, signals from at least three satellites are required. A minimum of four satellite signals are needed for determination of vertical position.

² "NYS Office for Technology – Policy," 20 Dec. 2006 <http://www.oft.state.ny.us/policy/tp_9618.htm>

³ Alfred Leick, *GPS Satellite Surveying*, Second Edition (1995), 60

GPS receivers calculate the distance to each satellite by measuring the time interval between the transmission and the reception of a satellite signal. Once the distance measurements of at least three satellites are known, the method of trilateration can be used to determine the position of the GPS receiver. GPS can be used worldwide, 24 hours a day and in all types of weather. While positional [accuracy](#) can be very high, it does vary, depending on the type of GPS receiver, field techniques used, [post-processing](#) of data, and error from various sources.⁴ For further information, reference Section **III** about [SOURCES OF ERROR](#) and Section **IV** about [DATA COLLECTION & PROCESSING METHODOLOGY](#).

C. Illustration of the Three GPS System Segments⁵



⁴ “North Carolina - Statewide Global Positioning System (GPS) Data Collection and Documentation Standards, Version 3,” 20 Dec. 2006, <<http://cgia.cgia.state.nc.us/gicc/>>

⁵ “GPS Control Segments.” 20 Dec. 2006, <http://www.mitrecaasd.org/proj_images/satnav/segment.gif>

II. CATEGORIES OF GPS RECEIVERS

A. Recreational Grade

[Accuracy](#) within five to twenty meters. These GPS receivers usually do not have the ability to "[post-process](#)" collected data, but usually have the ability to perform [real time correction](#) using [Wide Area Augmentation System \(WAAS\)](#). GPS receivers can be used to navigate to a specific area and/or compile uncorrected GPS data, using associated third party software to convert the collected data directly into GIS supported data formats.

B. Mapping Grade

[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.⁶ 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.

C. 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.

⁶ Depending upon the model, corrections may occur as broadcast real time adjustments (WAAS or Coast Guard Beacon) or by post processing.

D. Categories of GPS Receiver Comparison Table

RECREATIONAL GRADE	MAPPING GRADE	SURVEY GRADE
Primary Uses		
<ul style="list-style-type: none"> Navigation; hunting; fishing; camping; backpacking; hiking; data collection 	<ul style="list-style-type: none"> Resource mapping; navigation; GIS data collection 	<ul style="list-style-type: none"> resource mapping; site mapping; land surveying; navigation; vertical measurement
Horizontal Data Accuracy		
<ul style="list-style-type: none"> 5 to 20 meter 	<ul style="list-style-type: none"> Submeter to 5 meter (real-time or post-processing correction) 	<ul style="list-style-type: none"> Centimeter level (<i>real-time OR post-processed corrections, with a survey control network</i>)
Vertical Data Accuracy		
<ul style="list-style-type: none"> Not used to collect vertical data 	<ul style="list-style-type: none"> 2 to 15 meter (<i>2 to 3 times less accurate than horizontal data</i>) 	<ul style="list-style-type: none"> < 2 cm (<i>real-time correction</i>) < 1 cm (<i>post-processed corrections with a survey control network</i>)
Differential Correction Options		
<ul style="list-style-type: none"> Most do not have post-processing capabilities Real-time correction (WAAS) in most GPS receivers 	<ul style="list-style-type: none"> Post-processing in all GPS receivers Most have real-time capabilities (WAAS and/or USCG beacon additional add on) 	<ul style="list-style-type: none"> Real-time in some GPS receivers Additional post-processing to improve accuracy is in all GPS receivers
Type of Features Collected		
<ul style="list-style-type: none"> points ⁷ 	<ul style="list-style-type: none"> points, lines and polygons 	<ul style="list-style-type: none"> points, lines and polygons
Option to Load Custom Data Dictionary with Feature Attributes		
<ul style="list-style-type: none"> unavailable at this time 	<ul style="list-style-type: none"> all GPS receivers 	<ul style="list-style-type: none"> all GPS receivers
Option to Load Custom Coordinate Systems, Projections, Datums/Spheroids		
<ul style="list-style-type: none"> some GPS receivers 	<ul style="list-style-type: none"> all GPS receivers 	<ul style="list-style-type: none"> all GPS receivers
Training Requirements		
<ul style="list-style-type: none"> minimal 	<ul style="list-style-type: none"> moderate 	<ul style="list-style-type: none"> advanced
Metadata (capability to generate metadata or extract metadata from GPS receiver type)		
<ul style="list-style-type: none"> minimal 	<ul style="list-style-type: none"> moderate 	<ul style="list-style-type: none"> advanced
Cost (circa 2006)		
<ul style="list-style-type: none"> \$200 to \$500 	<ul style="list-style-type: none"> \$2,500 to \$12,000 	<ul style="list-style-type: none"> \$5,000 to \$50,000

⁷ Additional software needed to generate lines and polygons

III. SOURCES OF ERROR

In order to effectively gather precise/accurate data, it is necessary to understand potential sources of error that can affect GPS data quality.

A. [Multipath](#)

Errors caused by reflected GPS signals arriving at the GPS receiver, typically as a result of nearby structures or other reflective surfaces (e.g. buildings, water). Signals traveling longer paths produce higher (erroneous) pseudorange estimates and, consequently, positioning errors.

The user should be aware that [multipath](#) errors are not detectable or correctable with recreational grade GPS receivers. Some mapping grade GPS receivers as well as most or all survey grade GPS receivers have antennas and software capable of minimizing [multipath](#) signals.

B. Atmosphere

GPS signals can experience some delays while traveling through the atmosphere. Common atmospheric conditions that can affect GPS signals include tropospheric delays and ionospheric delays.

Tropospheric delays have the capability of introducing a minimum of 1 meter variance. The troposphere is the lower part (from ground level to 13 km) of the atmosphere that experiences the changes in temperature, pressure, and humidity associated with weather changes. Complex models of tropospheric delay require estimates or measurements of these parameters.⁸ See [Elevation Mask](#) in section **IV.B.3** for related information.

Unmodeled ionospheric delays have the potential to introduce significant (i.e. >10 meter) positional error. The ionosphere is the layer of the earth's atmosphere generally ranging from 50 km to 500 km above the earth's surface. During periods of heightened solar activity, charged particles (ions) in the ionosphere impede GPS signal transmission. Specific phenomena that do affect the GPS signal quality include periods of high solar activity (e.g. solar flares). Approximately 50% of this delay is compensated for by the ionospheric model transmitted in the GPS signal. The balance must be resolved through [differential correction](#).⁹

Weather conditions, including cloud cover and precipitation, generally do not affect the GPS receivers' (hardware) capability of collecting accurate data. However, cold temperatures near and below freezing could affect the GPS receiver LCD screen and battery life.

⁸ "Global Positioning System Overview," 20 Dec. 2006 <<http://www.colorado.edu/geography/gcraft/notes/gps/gps.html>>

⁹ Alfred Leick, *GPS Satellite Surveying*, Second Edition (1995), 303

C. Distance from [Base Station](#)

While [differential correction](#) will increase the quality of the data, [accuracy](#) is degraded slightly as the distance from the [base station](#) increases. Users should use the nearest [base station](#) to where the data is being collected. With the implementation of the NYS [CORS](#) Base Station Network (see [Appendix E](#)) across the State, the density of [base stations](#) is increasing. This network should be sufficient to provide [differential correction](#) for GIS users in most situations.

D. [Selective Availability \(SA\)](#)

[SA](#) is the intentional degradation of the GPS signals by the Department of Defense (DOD) to limit [accuracy](#) for non-U.S. military and government users. The potential error due to SA is between 30 to 100 meters.¹⁰ SA is presently turned off, but the DOD reserves the right to turn it back on at any time and in specific geographic theaters.

E. Noise

Noise error is the distortion of the satellite signal prior to reaching the GPS receiver and/or additional signal “piggybacking” onto the GPS satellite signal. All three grades of GPS receivers are capable of suffering from noise error. The amount of error due to noise cannot be determined. Reference Section **IV.B.2** for further information about [Signal to Noise Ratio](#).

IV. DATA COLLECTION AND PROCESSING METHODOLOGY

Methodology refers to the techniques a user should apply prior to and while collecting data with a GPS receiver. It should be noted that not all of these options are applicable to all recreational grade GPS receivers.

A. Mission Planning

For the purpose of this document, Mission Planning is a broad overview of planning a project to establish what the purpose is, what the data will be used for and who will be using them. All these factors will help determine the proper equipment and methods to be used.

1. Satellite Availability & Known Outages

Before collecting data, the user should be aware of the theoretical satellite availability. Most GPS software has the ability to provide a theoretical estimate of satellite availability at a certain geographic location, on a certain day, at a specific point in time. This information is often displayed in a variety of methods, including graphs, charts and diagrams, such as a skyplot which displays the satellite constellation over a location.

The United States Coast Guard maintains a website that generates a digest of known or forecasted GPS satellite outages. This digest is called the Notice

¹⁰ “Global Positioning System Overview,” 20 Dec. 2006 <<http://www.colorado.edu/geography/gcraft/notes/gps/gps.html#SA>>

Advisory to [NAVSTAR](#) Users (NANU) and lists the times when specific GPS satellites will be unstable or not available for use. This information can be used in the mission planning utility when considering which satellites will be available on a specific day. For information about how to subscribe to the NANU email list, visit the following webpage:
http://www.navcen.uscg.gov/gps/gps_news_090905.htm

2. [Position Dilution of Precision \(PDOP\)](#)

The user should plan their data collection at times when there is optimum satellite availability (four or more) and when the satellites are in an appropriate configuration to produce an acceptable (lower) [PDOP](#) value. Data collection can be planned to exclude poor (higher) [PDOP](#) times. [PDOP](#) values should be reviewed daily as satellite geometry changes constantly. Most GPS desktop software has the capability of providing graphics indicating the number of satellites available over the course of a day at a specific location as well as the [PDOP](#) values.

3. Local Obstructions of the Sky

The user should consider performing field reconnaissance in advance of data collection to identify local obstructions of the sky, including urban canyon, forest canopy, etc., that can affect results. Reference Vermont's GPS Guidelines (section III - GPS Accuracy Considerations) for further information about collecting data in difficult conditions:
http://www.vcgi.org/techres/standards/partiii_section_I.doc

4. GPS [Data Dictionary](#) Design

A [data dictionary](#) is very important and should be designed for specific projects and/or specific data types being collected (e.g. cataloging tree species type for environmental projects, the cataloging of pipe size for infrastructure mapping projects). Most project planning software has the capability to help the user construct a data collection schema, which, through the use of rules, allows the user to control which features types can be mapped (i.e. points, lines, and polygons) as well as the attribute values for those features. A well-planned [data dictionary](#) will seamlessly develop GIS layers and help to provide consistency in the data collection process for multiple users. The user should take into consideration that a well-planned [data dictionary](#) will increase efficiency in both the field and office and permit higher level GIS analytical operations.

B. GPS Receiver Configuration

It is recommended that the following values be set on the GPS receiver prior to field data collection. These values are subject to the [accuracy](#) requirements of specific projects. The values below may be modified depending on GPS receiver model. Additionally, the user should consult the manufacturers' guidelines for optimal GPS receiver configuration recommendations.

1. [PDOP](#) Values

It is the generally accepted standard that the GPS receiver be set to collect data at a [PDOP](#) level of 6 or less. [PDOP](#) levels higher than 6 can result in reduced positional [accuracy](#) and less reliable data. For some GPS receivers, this value can be set and the user should consult the manufacturers' guidelines.

2. [Signal to Noise Ratio](#) (SNR) Mask

Setting the value of the [SNR](#) mask higher will help minimize noise error. Varies from GPS receiver manufacturer; each manufacturer has their own recommendations; user must refer to their specific user manual.

3. [Elevation Mask](#)

It is recommended setting the GPS receiver's [elevation mask](#) to 15°. This is the default angle to minimize the amount of atmosphere through which the satellite signal has to travel. This also helps to ensure that a roving GPS receiver is tracking a subset of the satellites that the [base station](#) is tracking. Reference Section **III.B** for related information about [Tropospheric delays](#).

4. Data Collection Rate (Sync Rate)

It is recommended to collect point data at a 1-second interval, and to collect polygon and line data at a 5-second interval. However, to maximize the potential [accuracy](#), the user should collect point data at the same data collection interval as the [base station](#). Data collection rates will be dependent upon several factors developed in mission planning.

5. [Datum](#)

GPS receivers are designed to collect GPS positions relative to the [WGS-84 datum](#), however the user has the option of designating into which datum the data will be displayed. Users must have an understanding of the [datum](#) in which the GIS project is developed.

For most GIS applications, the [WGS-84 datum](#) is similar to the NAD-83 datum, however NAD-27 is significantly different from the NAD-83 datum. Most manufacturers allow the user the option of *displaying* the data being collected in most [datums](#). Various software exists that allow for the [transformation](#) of data from one datum to another. Refer to [Appendix B](#) for more information on [datum transformation](#).

6. [Projection](#)

It is recommended that data being collected with GPS be displayed on the GPS receiver in the [UTM](#) or [New York State Plane](#) projections:

[UTM Zone 17 North](#)

[UTM Zone 18 North / Zone 18 Extended](#)

[UTM Zone 19 North](#)

[State Plane New York West](#)
[State Plane New York Central](#)
[State Plane New York East](#)
[State Plane New York Long Island](#)
US National Grid (USNG)

Users should have an understanding of the [projection](#) the data are being collected in and the [projection](#) in which the GIS project is in. GPS receivers are designed to collect data and perform [real-time correction](#) in an unprojected geographic coordinate system ([latitude/longitude](#)). Most manufacturers allow the user the option of displaying the data being collected on the GPS receiver in most [projections](#).

The term “Zone 18 Extended” is a mathematical extension of UTM Zone 18 into neighboring UTM Zones 17 and 19 within New York State. Considerable error can be introduced by using Zone 18 in the East or West of New York State.

The US National Grid system (USNG) is a standard for mapping applications at scales of approximately 1:1,000,000 and larger. The USNG is an alpha-numeric grid reference system that presents the Universal Transverse Mercator (UTM) coordinate system at various levels of [precision](#).¹¹

Refer to Appendices [C](#) and [D](#) for maps of the [UTM](#) and [State Plane](#) Zones.

The recommended [Datum](#) and Coordinate System standards for New York State are listed on the GIS Recommended Standards webpage on the NYS GIS Clearinghouse.¹²

7. Units of Measure

Users should be aware of the units of measure that are commonly used with each [projection](#). The [UTM projections](#) are always published in meters; the [State Plane projections](#) can be published in US Survey Feet or meters. Users should also be aware of the International Foot unit of measurement which is different than the more commonly used US Survey Feet.

Users should have an understanding of the units of measure in which the data can be displayed on the GPS receiver. Some manufacturers allow the user the option of displaying the data being collected in different units of measure (e.g. US Survey Feet, International Feet, Miles, Meters, etc.).

¹¹ GPS Pathfinder® Office 3.10, copyright © 1996-2005, Trimble Navigation Limited.

¹² “GIS Recommended Standards,” 20 Dec. 2006

<http://www.nysgis.state.ny.us/coordinationprogram/workgroups/wg_1/related/standards/index.html>

When collecting data with a GPS receiver, the geographic location is represented as a coordinate pair (e.g. 42.8123N, 75.8066W). The positional coordinate pair can be displayed in some common formats:

Latitude/Longitude - Degrees/Minutes/Seconds (DMS)

A [latitude](#) or [longitude](#) might be written as 43° 5' 20", where the single quotation (') represents minutes and the double-quotation symbol (") represents seconds.

Latitude/Longitude - Decimal Degrees (DD)

The same coordinate would be written as 43.088889°.

Latitude/Longitude - Degrees and decimal minutes

The same coordinate would be written as 43° 5.333333'.

UTM 18 extended North (meters)

The same coordinate would be written as (4740283N, 434057E).

State Plane New York Central (US feet)

The same pair would be written as (312608N, 313525E).

US National Grid

The same pair would be written as (18T WN 7125315437)

Conversion of a coordinate pair between any of these three formats can be performed with a relatively easy formula found within existing tools. Additionally, calculators and mathematical formulas on the Internet allow translation of one coordinate pair (i.e. [latitude/longitude](#)) in any of these formats into another format for that same location. Refer to [Appendix B](#) for a list of useful websites.

C. GPS Data Download and Processing

The data download process varies by GPS receiver manufacturer so the user should refer to their specific user manual for instructions.

D. Quality Control

Data should be reviewed to determine if procedures established during mission planning were followed.

High resolution orthophotos, such as those available through the New York Statewide Digital Orthoimagery Program (NYSODP), can be used to determine if there are gross errors (i.e. does not meet the [accuracy](#) standards defined in mission planning of a project) in the GPS data by comparing the GPS data positions to the high resolution orthoimagery. It may be necessary to recollect data if the original data do not meet project needs. NYSODP has been producing orthoimagery since 2001 with high-resolution orthoimagery available statewide outside New York City for viewing and

downloading.¹³ More information about the New York State Digital Orthoimagery (DOI) Program can be found at the following webpage:
<http://www.nysgis.state.ny.us/gateway/orthoprogram/index.cfm>

After conducting quality control and if your positional requirements are not met, it may be necessary to recollect the data.

E. Data Collection

1. GPS Receiver Antenna

In order to minimize loss of GPS satellite lock, users should, whenever practicable, orient the GPS antenna skyward; and in the case of handheld GPS receivers avoid signal blockage by their upper body and head. In addition, when recording the location of tall features (e.g. trees, utility poles) it is a good practice to approach the feature from the south, positioning the GPS receiver antenna on the south side of the feature. This recommendation is due to the fact that, in the northern hemisphere, GPS satellites are not present in the northern sky except at very high elevations above the [horizon](#) (i.e. > 70 degrees).

2. Prohibit [Data Dictionary](#) Editing

It is recommended to prohibit the editing of the [data dictionary](#) in the field in order to ensure uniformity in the data attributes being collected.

3. Data Download

It is recommended to download the collected data from the GPS receiver to a local computer as soon as possible after returning from the field to minimize the risk of losing the data on the GPS receiver due to battery failure, inability to store additional data or overwriting existing data.

4. Post-Processing

It is recommended that users employ [post-processed differential correction](#) as part of their GPS data management workflow as soon as practicable after downloading data from a field device. Three key benefits to adhering to this approach are:

- Rapid identification of reference stations that are out of service or are experiencing communication interruptions

- Avoidance of encountering a condition where reference station files are no longer available because they have been deleted from the provider's server

¹³ "NYS GIS Clearinghouse - Digital Orthoimagery Program," 12 February 2007
<<http://www.nysgis.state.ny.us/gateway/orthoprogram/index.cfm>>

- Compliance with a standardized workflow procedure that delivers data in its final form swiftly, allowing for archiving of raw field and intermediate data files, and promoting streamlined and simplified file management

5. Base Station

The user should determine the quality of the [base station](#) being used. It is recommended for the novice GPS user that only NOAA/NGS published [base stations](#) be used.¹⁴ Advanced GPS users may have the ability to establish their own [base station](#) and should consult the manufacturers' guidelines for their specific hardware for instructions.

It is recommended to utilize a single reference station for all project specific [post-processed differential correction](#) activities, with the exception of projects that cover a large area (e.g. several thousand square miles) or long (30 miles or more) "strand" or linear mapping projects. This technique will promote data registration uniformity by inducing identical systematic errors (if any) across the full breadth of your data sets. In addition, [metadata](#) documentation will be simplified and [differential correction](#) parameters will be homogeneous across the entire project data set.

V. CHOOSING THE RIGHT TOOL FOR THE JOB

Based on the parameters established in mission planning, the user should choose a GPS receiver that meets or exceeds those requirements. Resources (e.g. staff, hardware, software) must also be sufficient to support the use and maintenance of the selected data collection tool. Therefore, choosing the right GPS receiver for a specific project requires serious consideration of the following:¹⁵

- Identify and use existing data collection procedures or standards.
- Anticipate use of the feature location and attribute data to be collected.
- Project data [accuracy](#) requirements for the data to be collected.
- Available resources to support data collection and processing activities.
- Type, number, and other characteristics of features to be located.
- Characteristics (e.g., rural vs. urban, remote vs. nearby) of the data collection site.
- Identify and use existing feature location or attribute data.
- Type of feature attribute data to be collected
- How the features to be located will be represented (i.e., as points, lines, or polygons).

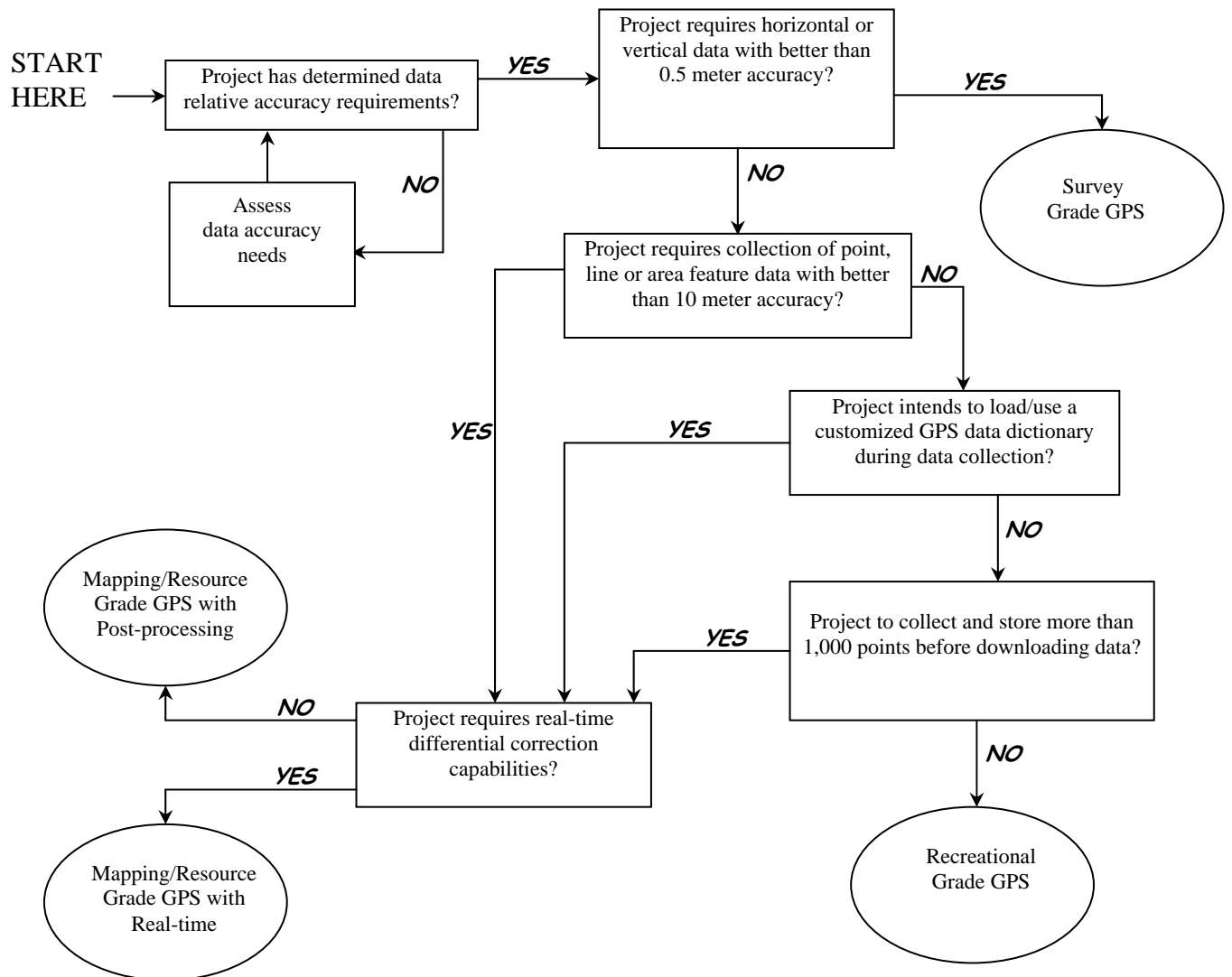
¹⁴ "CORS Data," 20 Dec. 2006 <<http://www.ngs.noaa.gov/CORS/Data.html>>

¹⁵ "Vermont Center for Geographic Information VT GPS Guidelines," 20 Dec. 2006 <http://www.vcgi.org/techres/standards/partiii_section_1.doc>

A. Decision Tree

The decision tree is intended to help users select an appropriate GPS receiver grade particular to their GPS data collection project. This is only a general guide, however, and you must also consider several other factors as noted above before making your final choice!

16



¹⁶ "WI-DNR. Comparing GPS Tools," - <<http://www.dnr.state.wi.us/maps/gis/gps.html>>

VI. METADATA GUIDELINES

Simply defined, [metadata](#) is “data about data”, or information that describes the characteristics of a GIS data set. In describing a GIS data set, [metadata](#) usually provides information about its content and origins; it may also be used to track the updates, corrections or changes to a data set. In addition, [metadata](#) should also contain distribution information, which explains how a potential user can acquire the data set.

[Metadata](#), created and updated according to the Federal Geographic Data Committee (FGDC)¹⁷ standards is important and valuable. [Metadata](#) should accompany all data collected with GPS as it:

- Maintains the value of the data set over time;
- Preserves the data description (e.g. origin, format, use, purpose.)
- Allows users to search for and use existing geospatial data and contributed to an NSDI Clearinghouse (such as the NYS GIS Clearinghouse).

¹⁷ “Content Standard for Digital Geospatial Metadata,” 20 Dec. 2006 <<http://www.fgdc.gov/standards/projects/FGDC-standards-projects/metadata/base-metadata>>

Appendix A - Glossary of Useful Terms

Accuracy

The degree of conformity with a standard or accepted value. Accuracy relates to the quality of the result, and is distinguished from precision which relates to the quality of the operation by which the result is obtained.

Autonomous Positioning

The least precise form of positioning that a GPS receiver can produce. The position fix is calculated in real time from satellite data alone. Autonomous positions are generally accurate to within 10 meters.

Base Station

A base station is comprised of a GPS antenna and GPS receiver positioned at a known location specifically to collect data for differential correction. The purpose of the base station is to provide reference data for performing differential correction on data collected in the field. Base data need to be collected at the same time as you collect data with a GPS rover receiver. A base station can be a permanent installation that collects base data for provision to multiple users, or a GPS rover receiver that you temporarily locate on known coordinates for the duration of a specific project or datalogging session.

Bluetooth

A wireless technology capable of using short-range radio technology for Internet and mobile devices, aimed at simplifying communications among them. Some GPS receivers use Bluetooth to communicate with the datalogger.

Carrier Phase

The difference between the carrier signal generated by the internal oscillator of a roving GPS receiver and the carrier signal emitted from a particular GPS satellite.

Coarse/Acquisition (C/A) Code

A pseudorandom noise code (PRN) modulated onto a L1 signal which helps the GPS receiver to compute the distance from each satellite. Specifically, the difference between the pseudorandom number code generated by the GPS rover software and the pseudorandom number code coming in from the satellite is used to quickly compute the distance to a satellite and therefore calculate your position.

CORS (Continuously Operating Reference) Station

A network of GPS base stations coordinated by the National Geodetic Survey for the purpose of providing GPS reference data to permit end users to perform post-processed differential correction of GPS data collected with roving GPS receivers. Reference data are typically acquired via direct download from the Internet.

Data Dictionary / Feature Library

A term used to describe the schema, or structure, that defines the relationship between features and their descriptive attributes that will be located in the field with a professional GPS receiver. This description typically includes feature name(s), data type classification (point, line, or polygon), attribute names, attribute types, and attribute values. After being created on a PC, a data dictionary is transferred to a GPS datalogger and used when collecting data in the field.

Data Message

A message included in the GPS signal, which reports a satellite's location, clock correction, and health. It includes information on other satellites' health and their approximate positions.

Datum

A mathematical model of the earth's surface. World geodetic datums are typically defined by the size and shape of an ellipsoid and the relationship between the center of the ellipsoid and the center of the earth. Because the earth is not a perfect ellipsoid, any single datum will provide a better model in some locations than others. Therefore, various datums have been established to suit particular regions. For example, maps in the United States are often based on the North American datum of 1927 (NAD-27) or 1983 (NAD-83). All GPS coordinates are based on the WGS-84 datum surface.

Datum Transformation

A mathematical calculation that converts the coordinates of a position in one datum to coordinates in terms of another datum. Two types of datum transformations are supported by most professional grade GPS data collection and management software: three parameter and seven parameter. A datum transformation is used when the GPS results are required in terms of a local datum.

[Declination](#)

See magnetic declination.

Differential Correction

The process of correcting GPS data collected on a rover with data collected simultaneously at a base station. Because it is on a known location, any errors in data collected at the base station can be measured, and the necessary corrections applied to the rover data. Differential correction can be done in real time, or after the data has been collected by post processing.

Dilution of Precision (DOP)

An indicator of the quality of a GPS position, which takes account of each satellite's location relative to the other satellites in the constellation, and their geometry in relation to the GPS receiver. A low DOP value indicates a higher probability of accuracy.

Standard DOPs for GPS applications are:

PDOP - Position (three coordinates)

HDOP - Horizontal (two horizontal coordinates)

VDOP - Vertical (height only)

TDOP - Time (clock offset only)

Dual-frequency (GPS) Receiver

A type of GPS receiver that uses both L1 and L2 signals from GPS satellites. A dual-frequency GPS receiver can compute more precise position fixes over longer distances and under more adverse conditions by compensating for ionospheric delays.

Earth Centered, Earth Fixed (ECEF)

A Cartesian coordinate system used by the WGS-84 reference frame. The center of the system is at the earth's center of mass. The z axis is coincident with the mean rotational axis of the earth, the x axis passes through 0°N and 0°E, the y axis is perpendicular to the plane of the x and z axes.

EGNOS (European Geostationary Navigation Overlay Service)

A satellite-based augmentation system (SBAS) that provides a differential correction service for GPS users in Europe. EGNOS is the European equivalent of WAAS, which is available in the United States.

Elevation Mask

The angle above and relative to the horizon, below which your GPS rover will not track satellites. It is normally set to 15° to avoid interference problems caused by buildings and trees and multipath errors and avoid the rover GPS receiver using a GPS satellite that the base station is not tracking.

Ellipsoid

An ellipsoid is the three-dimensional shape that is used as the basis for mathematically modeling the earth's surface. The ellipsoid is defined by the lengths of the minor and major axes. The earth's minor axis is the polar axis and the major axis is the equatorial axis.

Ephemeris

The current satellite position predictions that are transmitted from a GPS satellite in the NAVDATA message.

Epoch

The measurement interval of a GPS receiver.

Geoid

A mathematical surface of constant gravitational potential that approximates sea level (See Mean Sea Level, below). Or, the equipotential surface of the Earth's gravity field which best fits, in a least squares sense, global mean sea level.

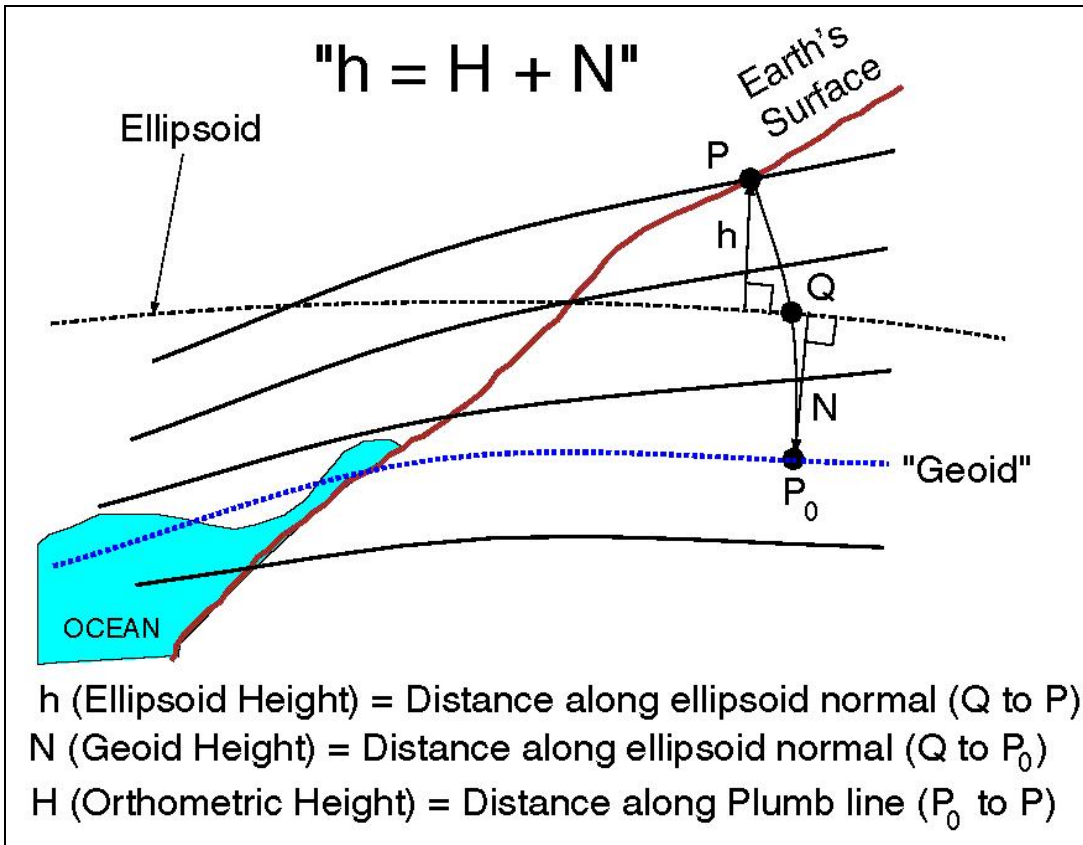


Image Source: National Geodetic Survey

Global Positioning System (GPS)

The generic term used to describe the satellite-based timing and positioning system operated by the United States Department of Defense (DoD).

Grid North

The meridian of any particular grid that is referenced to true north.

Height Above Ellipsoid (HAE)

Distance (h) above the reference ellipsoid. HAE is always measured orthogonal to the ellipsoidal surface. Three dimensional GPS positions reference HAE. Recreational grade GPS receivers calculate approximate orthometric height (elevation) for the user.

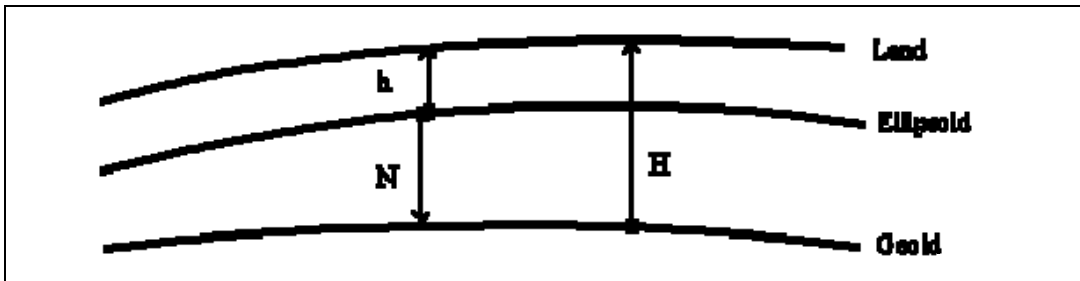


Image Source: National Geodetic Survey

Horizon

The line at which the earth and sky seem to meet for any particular observer.

Horizontal Dilution of Precision (HDOP)

See DOP.

L1

The primary L-band carrier used by GPS satellites to transmit satellite data. The frequency is 1575.42 MHz. It is modulated by C/A code, P-code and a 50 bit/second navigation message.

L2

The secondary L-band carrier used by GPS satellites to transmit satellite data. The frequency is 1227.6 MHz. It is modulated by P-code and a 50 bit/second navigation message.

Latitude

An angular measurement made from the center of the earth to north or south of the equator. It comprises the north/south component of the latitude/longitude coordinate system, which is used in GPS data collection. Traditionally, north is considered positive, and south is considered negative. Example: 43° south of the equator may be expressed as either unsigned (-43°) or signed (43° S)

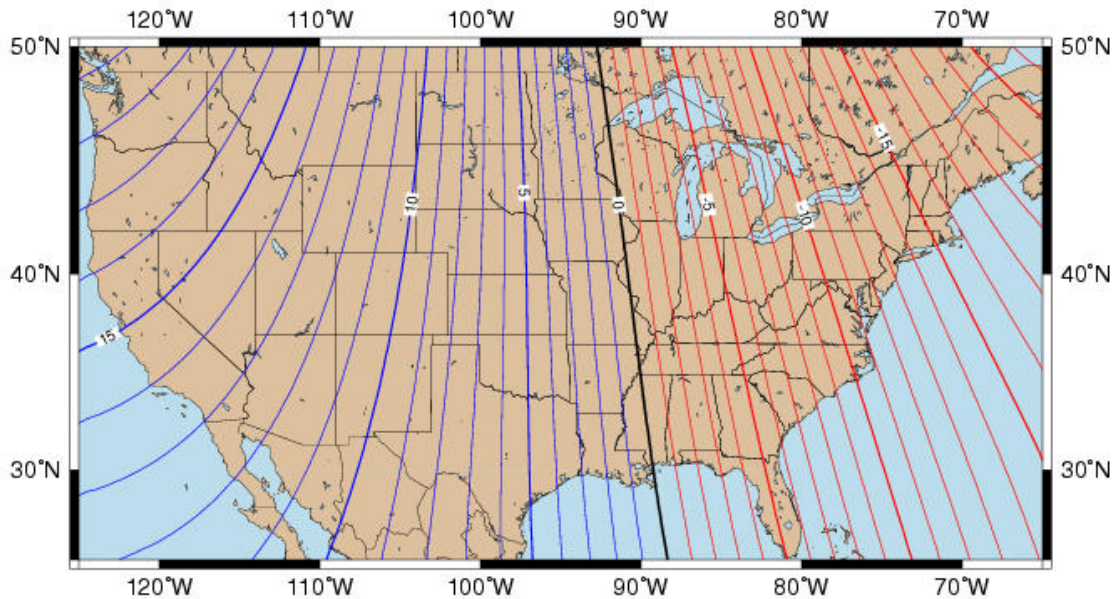
Longitude

An angular measurement made from the center of the earth to the east or west of the Greenwich meridian (London, England). It comprises the east/west component of the latitude/longitude coordinate system, which is used in GPS data collection. Traditionally, east is considered positive, and west is considered negative. Example: 74° west of the Greenwich meridian may be expressed as either unsigned (-74°) or signed (74° W)

Magnetic Declination

The local angular difference between magnetic and true north. Declination is expressed as a positive or negative angle, and varies by location and over time. In New York State, declination values range from approximately -10 degrees in western Chautauqua County to -15 degrees in northeastern Clinton County.

Magnetic Declination for the U.S. 2004



Mercator Projection

Contours of Declination of the Earth's magnetic field. Contours are expressed in degrees. Contour Interval: 1 Degree (Positive declinations in blue, negative in red)

Produced by NOAA's National Geophysical Data Center (NGDC), Boulder, Colorado

<http://www.ngdc.noaa.gov>

Based on the International Geomagnetic Reference Field (IGRF), Epoch 2000 updated to December 31, 2004

The IGRF is developed by the International Association of Geomagnetism and Aeronomy (IAGA). Division V

Image Source: National Oceanic and Atmospheric Administration (NOAA)

Magnetic North

The direction of the north-seeking end of a magnetic compass needle, not subject to transient or local disturbance (*Definitions of Surveying Terms Prepared by a joint committee of the American Congress on Surveying and Mapping and the American Society of Civil Engineers 1978*)

Map Projection

A defined method of transforming positions defined on an ellipsoid to a map grid; for example, the Transverse Mercator and Parallel Lambert projections.

Mean Sea Level (MSL)

The average height of the surface of the sea at a tide station for all stages of the tide over a 19-year period, usually determined from hourly height readings measured from a fixed predetermined reference level.

Metadata

Simply defined, metadata is “data about data”, or which information which describes the characteristics of a GIS data set. In describing a GIS data set, metadata usually provides information about its content and origins; it may also be used to track the updates, corrections or changes to a data set. In addition, metadata should also contain distribution information, which explains how a potential user can acquire the data set.

[Minimum Elevation](#)

See Elevation Mask

Multipath

Interference, similar to *ghosts* on a television screen, which occurs when GPS signals arrive at an antenna after traversing different paths. The signal traversing the longer path will yield a larger pseudorange estimate and increase positional error. Multipath occurs when GPS signals reflect off a surface before reaching the GPS antenna.

NAVDATA

The Navigation Message broadcast by each GPS satellite on both the L1 and L2 transmitters. This message contains system time, clock correction parameters, ionospheric delay model parameters, and the satellite vehicle’s ephemeris and health. A GPS receiver uses this information to process GPS signals and thus obtain user position and velocity.

NAVigation Satellite Timing And Ranging (NAVSTAR) System

The formal name given to the United States Department of Defense’s navigation and timing system comprised of GPS satellites, monitoring stations, and Master Control Station.

P-Code

The precise code transmitted by the GPS satellites. Each satellite has a unique code that is modulated onto both the L1 and L2 carrier waves. The P-code is replaced by a Y-code when Anti-Spoofing is active.

PDOP Mask

The highest level of PDOP that will allow the GPS receiver to compute a fix. For example, if the PDOP Mask is set to (6), the GPS receiver will not record a location when the PDOP exceeds (6).

Position Dilution of Precision (PDOP)

A unitless figure of merit expressing the relationship between the error in user position and the error in satellite position. Values considered *good* for positioning are small, such as 3. Values greater than 7 are considered *poor*. PDOP is related to horizontal and vertical DOP by the following formula: $PDOP^2 = HDOP^2 + VDOP^2$. *See also* DOP.

Postprocessing (Differential Correction)

The processing of satellite data after it has been collected in order to eliminate error. This involves using PC software to compare data from the rover to data collected at the base station. Because the base station is on a known location, systematic errors can be determined and removed from the rover data.

Precision

A measure of the repeatability or uniformity of a measurement. Precision relates to the quality of the operation by which the result is obtained, and is distinguished from accuracy which relates to the quality of the result. In order to comply with a specific standard, accuracy results must meet the minimum while complying with the precision required. Obtaining suitable accuracy results without complying with the precision is not acceptable to meet the standards.

Pseudorandom Noise or Number (PRN)

A signal that carries a code that appears to be randomly distributed like noise, but can be exactly reproduced. PRN codes have a low auto-correlation value for all delays or lags, except when they are exactly coincident. Each NAVSTAR satellite has its own unique PRN code.

Radio Technical Commission for Maritime Services (RTCM)

A commission established to define a differential data link for real-time differential correction of roving GPS receivers. There are two types of RTCM differential correction messages. Most modern GPS receivers use the newer Type 2.2 RTCM protocol.

Real Time (Differential Correction)

The processing of satellite data as it is being collected in order to eliminate error. This involves using software to compare data from the rover to data collected at the base station. Because the base station is a known location, systematic errors can be determined and removed from the rover data as it is being logged. This correction is not instantaneous and adequate time on station should be planned for accurate readings. Users should consult the manufacturers' guidelines for their specific hardware for recommended time on station. Two free systems offering real time differential correction capabilities include the United States Coast Guard (USCG) beacon system and the WAAS system. The USCG beacon system has a greater accuracy than WAAS and is more reliable. *See Time on Station.*

[Reference Station](#)

See Base station.

Root Mean Square (RMS)

An expression of the accuracy of a point measurement. It is the radius of the error circle, within which approximately 68% of position fixes are to be found. RMS is typically expressed in distance units of feet or meters.

Rover/Roving (GPS) Receiver

Any mobile GPS receiver and data collector used for determining location in the field. A roving GPS receiver's position can be differentially corrected relative to a stationary base GPS receiver.

RTK (Real-Time Kinematic)

A real-time differential GPS method that uses carrier phase measurements for greater accuracy. RTK measurements typically yield relative horizontal accuracy of approximately one centimeter.

SBAS (Satellite Based Augmentation System)

The generic term that refers to differential GPS applied to a wide area, such as an entire continent. WAAS and EGNOS are examples of SBAS networks, and are comprised of a series of reference stations that generate GPS corrections which are broadcast to GPS rovers via geostationary satellites.

Selective Availability (SA)

The artificial and deliberate degradation of GPS satellite signals by the United States Department of Defense. Selective Availability was implemented in order to enhance national security, but was turned off on May 10, 2000 due to the presence of several sources of various differential correction (DGPS) messages, which rendered SA obsolete. The SA bias on each satellite signal is different, and so the resulting position solution is a function of the combined SA bias from each satellite used in the navigation solution. Because SA is a changing bias with low frequency terms in excess of a few hours, position solutions or individual satellite vehicle pseudo-ranges cannot be effectively averaged over periods shorter than a few hours. Differential corrections must be updated at a rate less than the correlation time of SA (and other bias errors).¹⁸

Signal-to-Noise Ratio (SNR)

The signal strength of a satellite is a measure of the information content of the signal, relative to the signal's noise. The typical SNR of a satellite at 30° elevation is between 47 and 50 dBHz. The quality of a GPS position is degraded if the SNR of one or more satellites in the constellation falls below 39. This value is used to determine whether the signal strength of a satellite is sufficient for that satellite to be used by the GPS receiver. If a satellite's SNR is below the configured minimum SNR, that satellite is not used to compute positions.

SV

Satellite Vehicle or Space Vehicle, referring to the actual GPS satellite.

[Time Dilution of Precision \(TDOP\)](#)

See DOP.

Time on Station

The amount of time needed to be at a location in order to accurately collect an X,Y value per the project requirements.

True North

A term used to define 1) an astronomic meridian; 2) a geodetic meridian; 3) the direction of north from magnetic north corrected for declination; 4) the meridional direction assumed in a survey description; 5) the cardinal directions run in the Public Land Survey. Since the term is subject to several interpretations it should not be used (*Definitions of Surveying Terms Prepared by a joint committee of the American Congress on Surveying and Mapping and the American Society of Civil Engineers 1978*)

¹⁸ "Global Positioning System Overview," 20 Dec. 2006 <<http://www.colorado.edu/geography/gcraft/notes/gps/gps.html#SA>>

Vertical Dilution of Precision (VDOP)

See DOP.

VRS (Virtual Reference Station)

A VRS system consists of GPS hardware, software, and communication links. It uses data from a network of base stations to provide corrections to each rover that are more accurate than corrections from a single base station. To start using VRS corrections, the rover sends its position to the VRS server. The VRS server uses the base station data to model systematic errors (such as ionospheric noise) at the rover position. It then sends RTCM correction messages back to the rover.

WAAS (Wide Area Augmentation System)

WAAS was established by the Federal Aviation Administration (FAA) for flight and approach navigation for civil aviation. WAAS improves the accuracy and availability of the basic GPS signals over its coverage area, which includes the continental United States and outlying parts of Canada and Mexico. The WAAS system provides correction data for visible satellites. Corrections are computed from ground station observations and then uploaded to two geostationary satellites. This data is then broadcast on the L1 frequency, and is tracked using a channel on the GPS receiver, exactly like a GPS satellite.

Waypoint

A geographical point that, unlike a feature, holds no attribute information beyond a name and location. Typically, waypoints are used to denote objects or locations of primary interest, such as a survey mark. Waypoints are most often used for navigation.

WGS-84

World Geodetic System (1984), the mathematical ellipsoid used by GPS since 1984. *See also* Ellipsoid.

Appendix B - Useful GPS and Related Websites

GPS Basics

Federal Aviation Administration (FAA)

http://gps.faa.gov/GPSbasics/gps_basics.htm

Glossary of Terms

http://www.novatel.com/about_gps/glossary.htm

GPSInformation

<http://gpsinformation.net/>

National Space-Based Positioning, Navigation, and Timing (PNT) Executive Committee

<http://www.pnt.gov/>

NOAA's National Geodetic Survey (NGS)

<http://www.ngs.noaa.gov>

<http://www.ngs.noaa.gov/faq.shtml>

<http://www.ngs.noaa.gov/CORS/>

<http://www.ngs.noaa.gov/ims/CORS/viewer.html>

United State Coast Guard Navigation Center

<http://www.navcen.uscg.gov>

http://www.navcen.uscg.gov/gps/gps_news_090905.htm

United State Naval Observatory (USNO) GPS Operations

<http://tycho.usno.navy.mil/gps.html>

Coordinate Translation

<http://jeeep.com/details/coord/>

http://www.terra-server.com/tools/degrees_converter.asp

<http://www.fcc.gov/mb/audio/bickel/DDDMSS-decimal.html>

<http://life.csu.edu.au/geo/dms.html>

GPS Hardware and Software Providers

www.esri.com/software/arcgis/about/mobile.html

www.cmtinc.com

www.trimble.com

www.leica-geosystems.com

www.novatel.com

www.sokkia.com

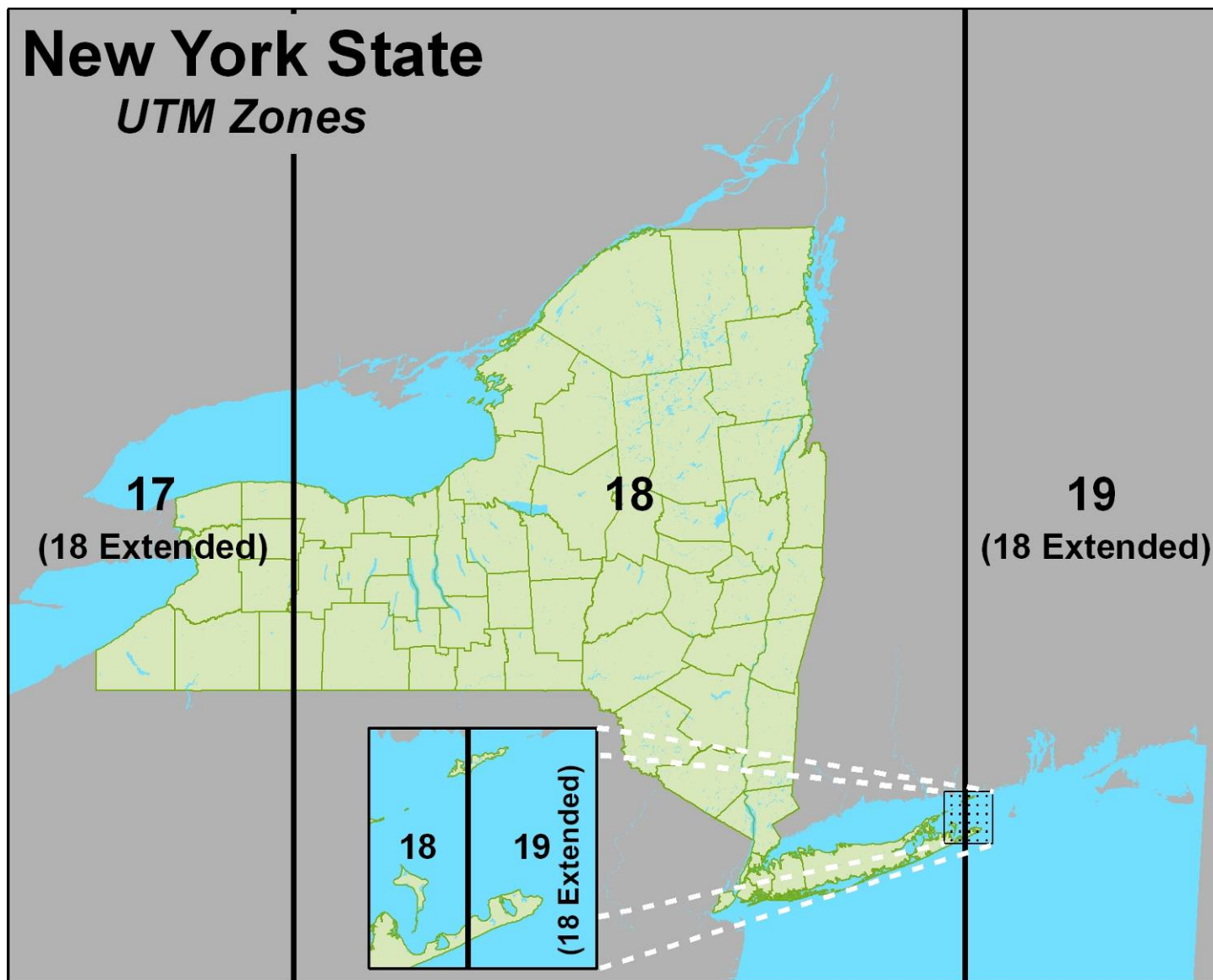
www.tds-way.com

www.thalesnavigation.com

United State Army Corps of Engineers Corpscon Datum Conversion Software

<http://crunch.tec.army.mil/software/corpscon/corpscon.html>

Appendix C - Map of New York State UTM (Universal Transverse Mercator) Zones



Appendix D - Map of New York State Plane Zones



Appendix E - Map of NYSDOT CORS Stations

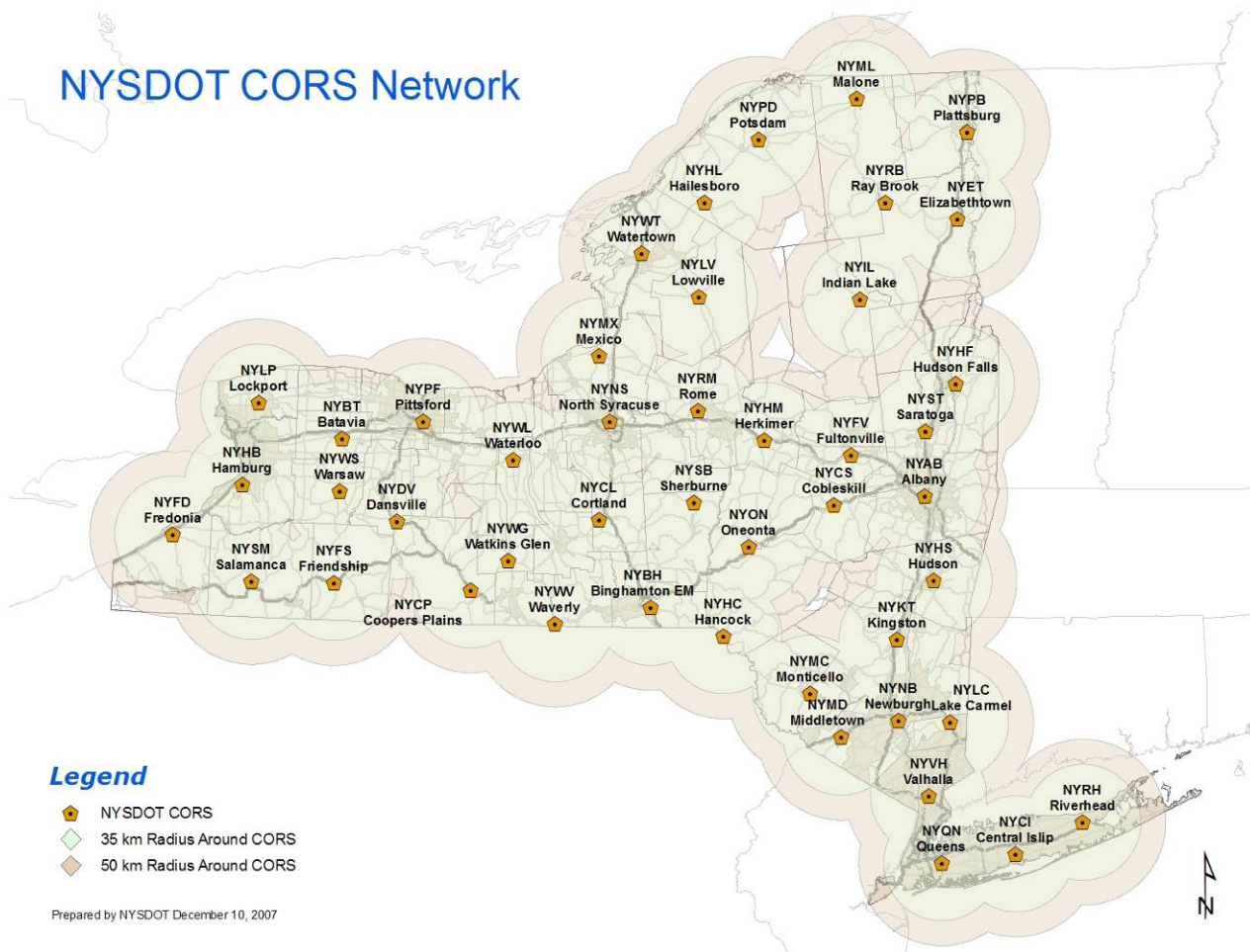
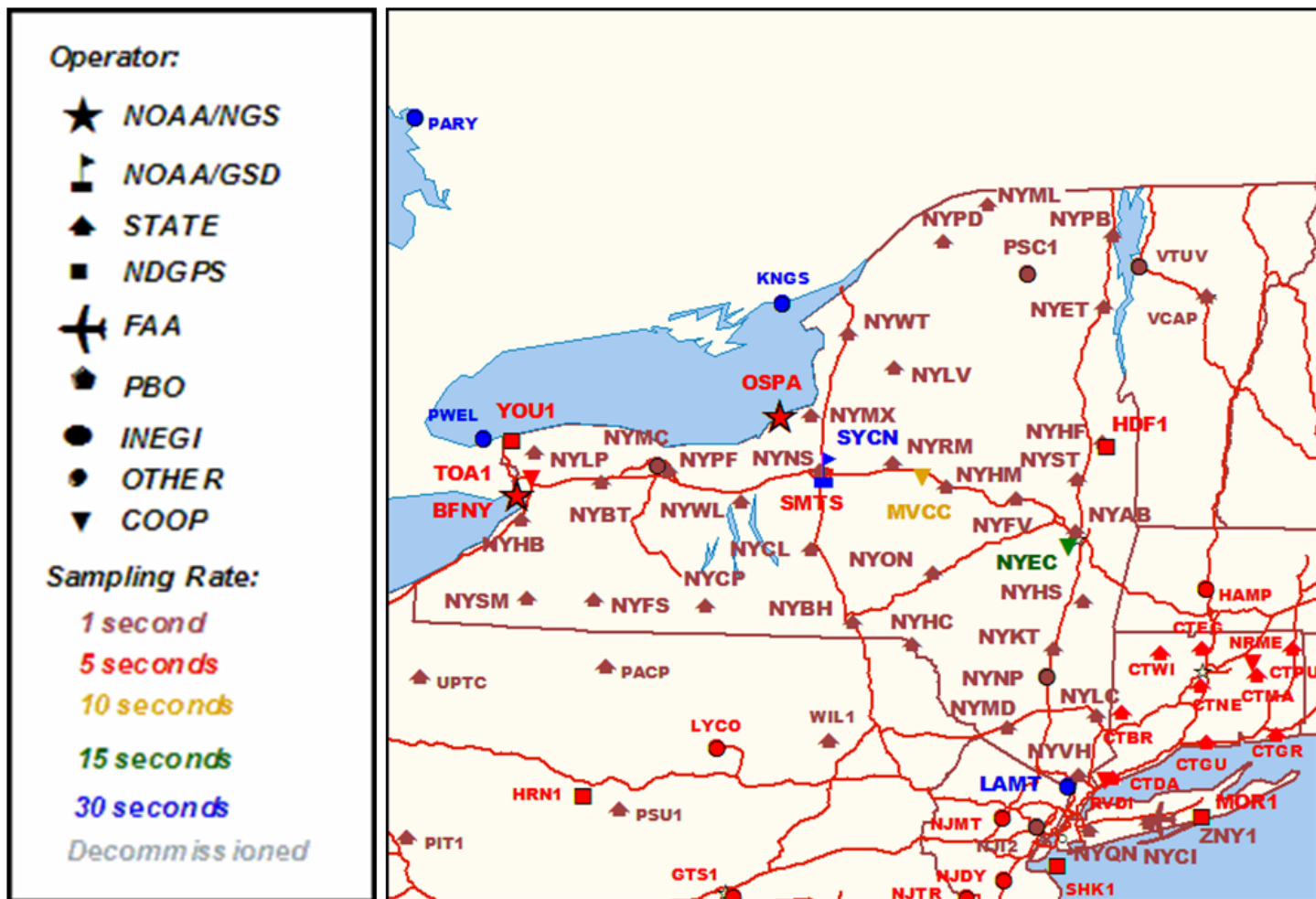


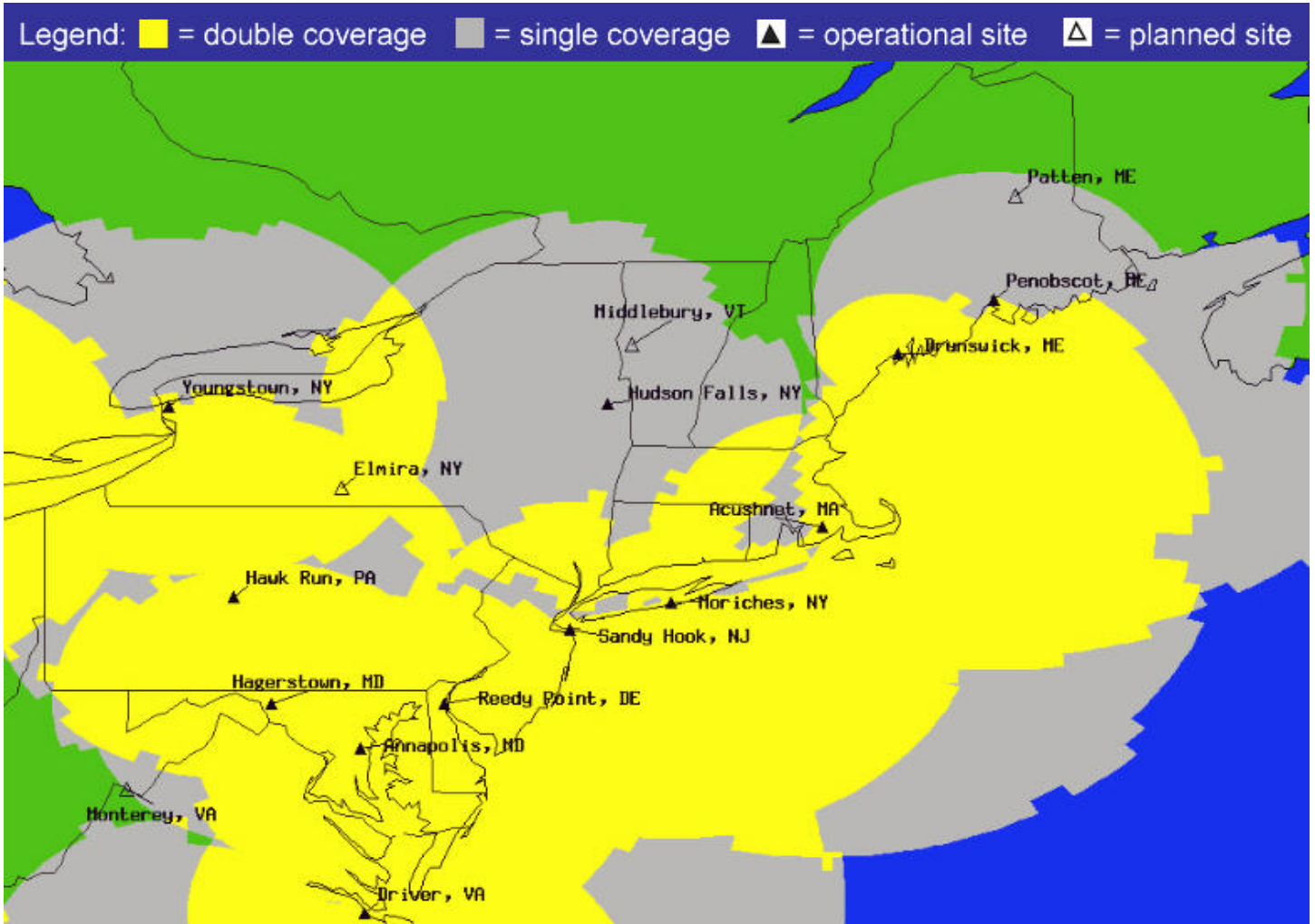
Image Source: New York State Department of Transportation (NYSDOT)

Appendix F - National and Cooperative CORS Map of New York State ¹⁹



¹⁹ "CORS selector map," 20 Dec. 2006 <<http://www.ngs.noaa.gov/CORS/Maps2005/ny.html>>

Appendix G - United States Coast Guard Differential GPS Coverage of New York State ²⁰



²⁰ USCG Navigation Center DGPC Coverage Page – New York,” 20 Dec. 2006
<<http://www.navcen.uscg.gov/dgps/coverage/NYork.htm>>

Appendix H - Sample of a Blank Metadata Form

Citation:

Contact information:

User name:

Organization:

Address:

Phone:

Email:

Description:

Abstract:

Purpose:

Supplemental Information: (information specific to either the GPS receiver or the data collected with GPS, as applicable)

GPS receiver model name/number:

Base Station:

PDOP:

Configurations of GPS receiver:

Coordinate system:

Datum:

Projection:

Units of measure:

Signal to Noise ratio:

Elevation mask:

Data logging rate:

Modifications: (made to data after it was collected and the GPS desktop software used to modify this data)

Time Period of Content:

Beginning Date:

Ending Date:

Currentness Reference:

Status:

Progress:

Maintenance and Update Frequency:

Keywords:

Theme:

Place:

Use Constraints:

Horizontal Positional Accuracy: (include manufacturer spec sheet from your GPS receiver)

Process Description:

Field conditions:

Weather:

Canopy:

Topography:

User defined attributes: (if using a data dictionary)

Attribute label:

Attribute description:

Appendix I - Sample of a Completed Metadata Form

Citation:

Contact information:

User name: John Smith

Organization: XYZ Company

Address: 123 Main Street, Hometown, NY 12345

Phone: 222-333-4444

Email: JohnSmith@XYZcompany.com

Description:

Abstract: This tree inventory data set contains the locations of hardwood trees within Main Park in Hometown, NY

Purpose: This data tree data set was compiled from July 21-26, 2006 in order to properly identify tree species type, approximate age, health and diameter of all of the hardwood trees currently growing with Main Park on Main Street in Hometown, NY. It was developed to be used as a management tool in conjunction with commercial GIS software, such as ArcView or MapInfo.

Supplemental Information:

GPS receiver model name/number: Trimble ProXR

Base Station: CORS, Hudson Falls, NY

PDOP: 5

Configurations of GPS receiver:

Coordinate system: UTM Zone 18 North

Datum: NAD83

Projection: UTM Zone 18 North

Units of measure: Feet

Signal to Noise ratio: NA

Elevation mask: 15°

Data logging rate: 5 seconds

Modifications:

Time Period of Content:

Beginning Date: July 21, 2006

Ending Date: July 26, 2006

Currentness Reference: July 28, 2006

Status:

Progress: Complete

Maintenance and Update Frequency: As needed

Keywords:

Theme: Hardwood

Theme: Trees

Theme: Inventory

Theme: Species

Place: Hometown

Use Constraints: None

Horizontal Positional Accuracy: 12 inches

Process Description: Data was collected, brought back into the office and downloaded onto a computer. A data dictionary was not used while in the field. Post-processed differential correction was applied to the data using the Hudson Falls CORS station with GPS desktop software. The resulting DBF file containing latitude and longitude (among other attribute information) was then exported.

Field conditions:

Weather: Cloudy

Canopy: None

Topography: Open field

User defined attributes: (if using a data dictionary)

Attribute label: LAT

Attribute description: Latitude

Attribute label: LON

Attribute description: Longitude

Attribute label: SPEC

Attribute description: Tree species type, common name

Attribute label: AGE

Attribute description: Approximate age of the tree

Attribute label: HEALTH

Attribute description: Description of the health of the tree

Attribute label: DIA

Attribute description: Trunk diameter 6 inches above the ground