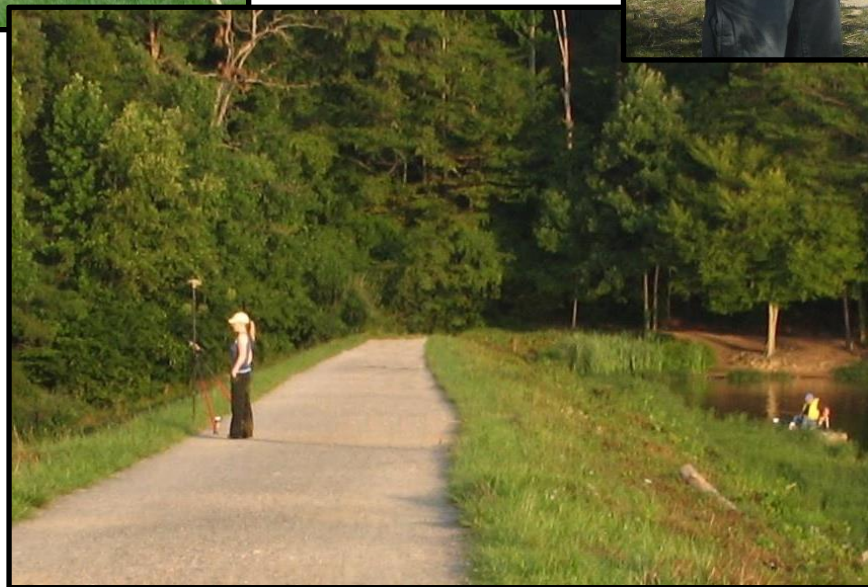
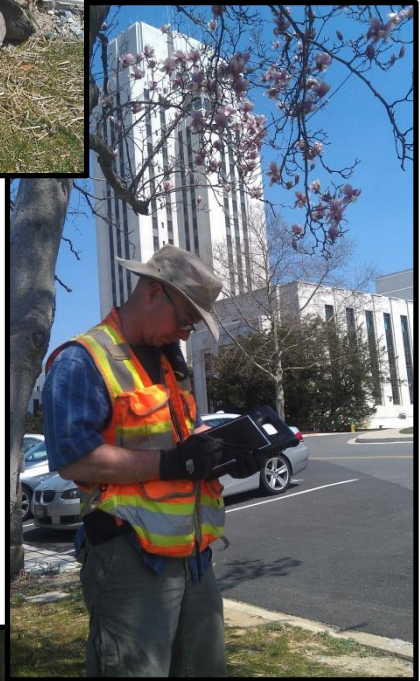


PRECISION SURVEYING FOR STORM DRAINAGE USING ARCGIS



INTRODUCTION

For more than a decade GIS has been increasingly used by municipalities for storm water inventory and management. Large scale digital elevation models and sub-meter asset collection were adequate in detecting illicit discharge, modeling large watershed runoff and assessing capacity. More recently GIS has become a predominant tool for the design professional with the ability to model open and closed systems from subdivision to regional watersheds.

Thoth Land Surveying Professionals, Inc. (Thoth) understands the requirements of design professionals, the fundamentals of high accuracy data collection and how to collect and integrate that data into a GIS feature set that is design ready for the engineer.



FEDERAL AND MUNICIPAL TRENDS

Maryland and Virginia in partnership with the Environmental protection agency are currently undertaking GIS Storm water modeling projects to comply with the “Chesapeake Bay Protection and Restoration Executive Order (E.O. 13508) to restore native oyster habitat and populations in 20 tributaries by 2025” and Executive Order (E.O. 13514) Federal Leadership In Environmental, Energy, And Economic Performance. These are just two recent initiatives requiring design grade GIS storm water modeling for the analysis, planning and design of storm water discharge.

GIS STORM FEATURE DATA SETS

Existing Mapping Grade Data

The majority of existing GIS data is often an integration of high altitude photogrammetry and LIDAR, CAD files and mapping grade GPS inventory with sub-meter horizontal locations. Occasionally this data will have a vertical element though the method of collection, statement of accuracy and datum of data is often missing or ambiguous. Mapping grade storm features have typically been useful for inventory and planning purposes, but do not meet the rigors for engineering analysis and design.

Industry Methods of Collection

GIS Field Data Collection is almost completely based on GPS collection which employs correction techniques such as WAAS/SBAS (Satellite based corrections), post-processing or Real Time Networks (RTN). Although most GIS/GPS collection methods are sub-meter, even RTN often considered “survey grade” still lacks the vertical accuracy necessary for storm water collection. According to the National Geodetic Survey, under “ideal conditions” vertical accuracies range between 6-9cms and reliable accuracies of 4cms can only be obtained by 2 one minute collections 4 hours apart (to ensure different satellite geometry). Take into consideration the East Coast rarely offers “ideal conditions” due to the fact that phase based (survey grade GPS) will not work under tree canopy, it becomes necessary to also use more conventional methods of collection such as total station location.

SURVEY GRADE GIS DATA

At Thoth we have designed and implemented tools and techniques for the capture of design grade data to be collected inside ArcGIS and the SDSFIE Data Model. Furthermore, as experts in measurement, Thoth uses techniques that guarantee reliable high-accuracy and verifiable data is collected and provided to the client through a simple workflow consisting of:

- Establishment of High Order Geodetic Control Project Control
- Reconnaissance of existing storm structures
- 3D Location of Storm Structures

- Creation of 3D Pipe Network in the Field
- Review and Delivery of ArcGIS 10 SDSFIE Geodatabase

Establishment of High Order Geodetic Project Control

All projects begin with the establishment of high order horizontal and vertical control. Thoth establishes a primary control network consisting of a minimum of three 36"x6" concrete monuments and a secondary network of 18"x1/2" rebar and caps. Horizontal and Vertical Control are initially established using Dual Frequency Static GPS techniques providing sub centimeter horizontal and vertical accuracies less than 2 centimeters. Vertical control is then localized using digital differential leveling to provide final accuracies less than 3mms.



Reconnaissance of Existing Storm Structures

Thoth works with the client and other stake-holders to collect all legacy data of the existing storm network. All data is converted and imported into an ArcGIS Geodatabase and then a field reconnaissance of existing structures is conducted with a GPS enabled ruggedized laptop running ArcGIS with real-time Bing Map display using 4g connectivity.

3D Location of Storm Structures

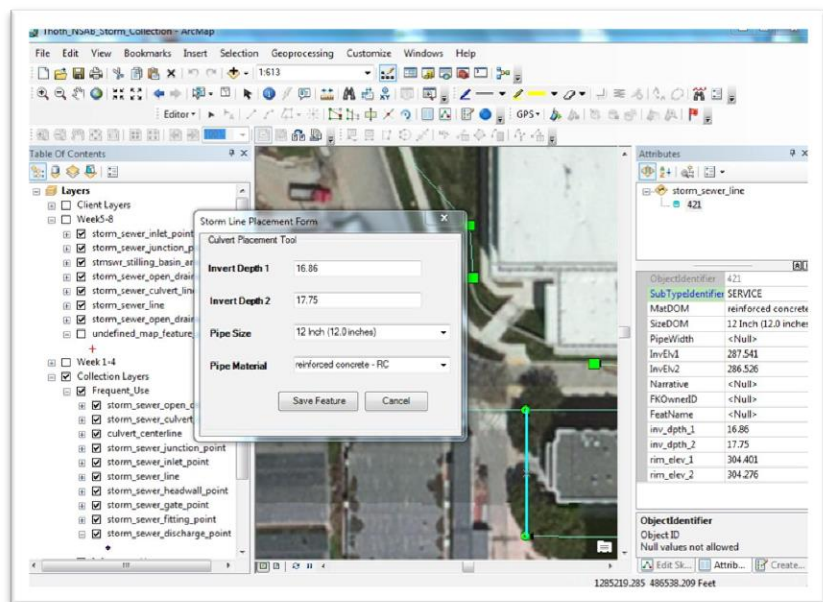
Storm Structures are located from the primary and secondary control using RTK GPS and conventional robotic total station techniques. All locations are collected via traverse between primary or secondary control and are then analyzed and adjusted in StarNET least squares software and imported into the SDSFIE Geodatabase as 3D features via ESRI's ArcCatalog table to feature class function.

Creation of 3D Pipe Network in the Field

Specialized Invert Collection

Thoth contracted with a local machinist to specifically design a tool for storm and sanitary invert collection. The tool has an adjustable rocker arm that spans the rim of an open manhole and ensures center locations even when the manhole is inclined. The tool also houses the Fluke 424 D distance meter that automatically calculates the true vertical depth using slope distance and inclination.

Note: To provide an example of the error incurred when measuring sloped distances, a pipe invert at a depth of 15 feet and offset throat of 2' can provide as much as 1 foot of vertical error when measured to the opposite rim (due to the angle of the rod.)



Pipe Network Creation

Using a special GIS Tool developed by Thoth we are able to populate the attributes of the pipe and as well as place the true 3D location of the culvert using 3D snaps on the existing storm structure and calculating invert elevations on the fly. If no connecting structure is found or is not currently in the GIS, the feature line can be placed approximately with a zero elevation and the tool can be subsequently run

THOTH LAND SURVEYING

after the structure is located. Because the tablet is linked to online imagery and is GPS enabled, accidental errors such as collection on the wrong structure are eliminated.

Review and Delivery of ArcGIS 10 SDSFIE

Geodatabase

All data are collected in an ArcGIS 10.x using the latest version of SDSFIE. In coordination with the creation of Thoth's Storm Collection Tool, Thoth has added additional data fields including:

- *rim_elev_1* and *rim_elev_2* if not already available in the feature_class such as the *storm_sewer_inlet_point*. This field is populated directly by the z coordinate of the feature.
- *inv_dpth1* and *inv_dpth2* record the vertical distance from the rim to the pipe invert.
- *InvElv1* and *InvElv2* is a value automatically calculated by the tool using subtracting the *inv_dpth* from the *rim_elev*.

By storing these additional metadata fields with the feature-class, any questionable data values can easily be checked and verified for validity and recalculated should any error in values be discovered.



IN CLOSING

Thoth has worked diligently to produce the tools and techniques to provide our clients with the most accurate and reliable Storm Data collection possible. We welcome the opportunity to discuss your particular needs and help provide you with high quality GIS Storm Data in the future. We look forward to hearing from you.

Greg Pendleton, LS
greg@tlsurv.com
202 652-0184 ext 01
www.thothsurveying.com



Thoth Land Surveying Professionals, Inc. (THOTH) is a women-owned small business in the Washington D.C. Metropolitan region. Thoth provides geospatial mapping and design services in D.C., Maryland, Virginia and West Virginia.

SERVICES

- ⊕ Control Surveying
- ⊕ Boundary and ALTA
- ⊕ Design Base-mapping
- ⊕ Utility Designation
- ⊕ Construction Layout
- ⊕ 3D Scanning/Modeling
- ⊕ GIS / LIS
- ⊕ Monitoring Surveys
- ⊕ Aerial Surveying

LICENSES

- ⊕ DC (LS and Reg.)
- ⊕ Maryland
- ⊕ Virginia
- ⊕ West Virginia

CERTIFICATIONS

- ⊕ CCR and ORCA Reg.
- ⊕ HAZCOM 40 Hour
- ⊕ First Aid / CPR and Blood-borne Pathogens

Thoth is fully insured for errors and omissions, general liability workers compensation and commercial vehicle