

OBJECTIVE

The Transportation Division wishes to upgrade its surveying, mapping and data collection capabilities. Global positioning systems (GPS) represent the latest technology available for this purpose. This technology will reduce the total inspection time Transportation Division inspection forces spend locating and inspecting sanitary sewer structures by eliminating up to two “visits” to each structure. Secondary benefits include the ability to map, survey, stake out and set control monuments more cost effectively.

EXPLANATION

In 2002 Transportation located and inspected 972 sanitary sewer structures and 188,841 linear feet (35.8 miles) of sewer lines for the Department of Utilities (Utilities). Utilities requires that these structures are located in the “state plane coordinate system”, (GEOID99, Ohio South Zone) and North American Vertical Datum 1988 (NAVD 88). Utilities then inputs these horizontal and vertical positions, along with any information related to the sewer lines between these structures, into their Geographic Information Systems (GIS). Tolerances for these positions are ± 0.5 feet in the horizontal plane and ± 0.1 feet in the vertical plane.

To obtain these positions Transportation is currently using a Topcon electronic theodolite (transit and electronic measuring device) and a hand held data collector to locate these structures in the horizontal plane (state plane coordinates) then an automatic level is used to locate the same structures in the vertical plane (NAVD 88). Control points are provided by the consultant.

The method used by Transportation to obtain the data requires three visits to each structure/position. One visit to obtain the horizontal position, a second visit to obtain the vertical position and finally a third visit to visually inspect the interior of the structure (two visits to obtain the position and one visit for the inspection.)

Use of Global Positioning Systems (GPS) will eliminate the need for up to two of these visits. The location of the structure can be mapped at the same time as the inspection. Also, GPS can be operated by one person.

GPS is a group of satellites (currently 24) orbiting 11,000 \pm miles above the earth. Each satellite sends out a radio signal at a known wavelength and time so precise that the distance to each satellite can be measured to less than 0.01 feet. Positions are obtained by calculating the distance to a minimum of six satellites signals. With a horizontal tolerance of ± 0.02 feet and a vertical tolerance of ± 0.05 feet. These tolerances are obtained by using a base station (over a known point) to supply continuous correcting information to a “rover” that is collecting new data. This process of using a base station and rover is called Real-time Kinematic or RTK. RTK provides precise positioning correction information at speeds up to 20 times per second.

Three persons are required by OSHA for visual inspections (a manhole is a confined space). Locations can be obtained on the first trip to the structure for inspection. Re-inspections of those structures would leave GPS equipment free for other uses. In 2002 only 7% of the sanitary sewer jobs inspected were approved on the first inspection.

One person could map, survey, stake out and set horizontal control monuments. Almost any object on the face of the earth can be located using GPS. Precise locations of existing utilities such as storm water facilities, water facilities, including fire hydrants, electric facilities, fiber optic lines, traffic control devices, ADA Curb Ramps, parking meters, etc. are easily obtained. Any position collected, along with descriptive data can be downloaded easily into the City’s GIS. Developers and planners use GIS to best utilize the land within the City.

Use of GPS would also give Transportation the ability to set horizontal control monuments as required of the City Engineer in the Columbus City Codes, 1959 (CC3123.16(b)) where monumentation is currently lacking.

COST ANALYSIS

Current Method (line of sight location and inspection)

| | | | | | | | | |
|--|---|------------------------------|---|---------------------------------|---|----------------------------------|---|------------------|
| # Sanitary MH <u>inspected 2002</u> | X | visits / <u>structure</u> | X | time spent <u>each visit</u> | X | # of personnel <u>on crew</u> | = | <u>man hours</u> |
| 972 | | 3 | | .25 hrs (15 minutes) | | 3 | = | 2187 |

RTK GPS (collect location data from satellites during inspection)

| | | | | | | | | |
|--|---|------------------------------|---|---------------------------------|---|----------------------------------|---|------------------|
| # Sanitary MH <u>inspected 2002</u> | X | visits / <u>structure</u> | X | time spent <u>each visit</u> | X | # of personnel <u>on crew</u> | = | <u>man hours</u> |
| 972 | | 1 | | .25 hrs | | 3 | = | 729 |

| | | | | | | | |
|-------------------------|---|------------------------|---|------------------------|---|-----------------------|-------------|
| 3 person <u>crew</u> | = | Eng. <u>Assoc I</u> | + | Eng. <u>Aide II</u> | + | Eng. <u>Aide I</u> | (as billed) |
| \$108.00 | | \$36.00 | | \$36.00 | | \$36.00 | |

| | | | | |
|---------------------------|---|------------------------------|---|--------------------|
| Man hours <u>saved</u> | X | \$/ person <u>on crew</u> | = | <u>\$saved</u> |
| 1458 | | \$36.00 | | \$52,488.00 |

Equipment Costs (see attached)

Three RTK packages (all necessary equipment and training) were obtained. We have ranked these packages by precision, ease of use, reliability, local support and cost.

- Topcon HiPer + Legacy GPS System (L1, L2, & Glonass) – E GGD, 1Hz RTK (Anderson Instrument & Supply Co.) **\$44,129.00**
(Uses Russian Satellite constellation [GLONASS] in addition to U.S. satellites)
- Trimble Navigation GPS Total Station 5700 – 5800 Bundle (Ellerbusch) \$45,036.60
- Topcon HiPer GD, 1Hz RTK (Anderson Instrument & Supply Co.) \$36,110.00

Conclusion

Using the Topcon HiPer + Legacy System the Transportation Division can accurately locate existing and new sanitary sewer structures in less time in both the horizontal and vertical planes. Also, Transportation can establish horizontal control, where this control is currently lacking.

The use of this system will save the City almost \$9,000.00 in its first year of use if it is used only as a tool to locate sanitary sewer structures. There are many other cost savings and benefits.