GIS Data Collection & Implementation Plan

The Harrisburg Authority (THA)

By: Herbert, Rowland and Grubic, Inc.

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I. Introduction

Herbert, Rowland, & Grubic, Inc. (HRG) is pleased to submit this Data Collection and Implementation Plan (Plan) relative to development of the Geographic Information System (GIS) for the Harrisburg Water, Sanitary, Storm, and Combined Sewer Systems. This document presents HRG’s recommended project approach, defines roles and responsibilities, and discusses project costs and financing options for The Harrisburg Authority (THA).

THA desires to develop a GIS in order to inventory, manage, maintain, analyze and assist with modeling its water system and sanitary and combined sewer system. THA also wishes to enhance emergency response capabilities for the systems in the future. The GIS will allow THA to take a proactive approach to repairs, assist with scheduled and preventative maintenance, and increase operation efficiencies. It will also increase the accuracy of Pennsylvania One-Call mark outs. The major objectives of the GIS project are listed below.

**Key GIS Objectives:**
- Designate THA’s water and sewer facilities and the City of Harrisburg’s sewer and storm facilities.
- Locate water and sewer facilities.
- Assess condition of sanitary, combined, and storm sewer facilities.
- Data collection and integration into the GIS.
- Implement asset management system.
- Correlate condition of sewer facilities with sinkhole locations.

II. Background

In the past, multiple attempts have been made to establish a GIS for the water and sanitary sewer facilities in the City of Harrisburg (COH). Previous GIS initiatives have lost traction and an accurate, up-to-date GIS does not currently exist. Therefore, THA has expressed interest in developing a new GIS in order to inventory, manage, maintain, analyze and model its water system (water system), and also enhance emergency response capabilities for the system in the future.

THA has also decided to include data collection of the sanitary, combined, and storm sewer utilities as well due to the increasing occurrence of collapses and sinkholes, regulatory requirements, and for the same reasons identified for the water system.

The need for a new and accurate GIS system is justified by several reasons, including the following:

On April 18, 2011 a contractor caused a break in a 36-inch water main on HARSCO property in downtown Harrisburg. The COH did not have complete or accurate mapping of the water system in this area which led to extended shutdown and repair times. This incident stressed the need for accurate mapping of the water system for inventory, maintenance and emergency purposes.
In accordance with U.S. Environmental Protection Agency (EPA) requirements, THA must update its Combined Sewer Overflow (CSO) Long Term Control Plan (LTCP). EPA has issued comments to THA requiring verification and validation of the hydraulic model used to create the original LTCP. The data collection and location proposed for the sewer collection and conveyance system will enable THA to address EPA comments as they relate to the model. Development of accurate surface contours would enable surface runoff calculations as they affect the combined sewer system. Additionally, THA needs to map and collect detailed information on regulator chambers, interceptors, trunk sewers, and certain areas of the sewer collection system to better implement EPA’s Nine Minimum Controls for CSOs.

HRG has developed Capital Improvement Plans (CIPs) for the water and sanitary sewer conveyance systems. Data collection and location of these systems has been incorporated into the CIPs at the request of THA for implementation within the next five years (by 2018).

THA is evaluating the feasibility of implementing a storm water utility whereby customers would be charged a fee for runoff resulting from impervious surfaces. The storm water utility would provide a separate funding source to assist with necessary storm facility improvements. Detailed base mapping, including such layers as orthophotography and impervious surfaces (buildings, roads, driveways, parking lots, sidewalks, etc.) will be required to perform the necessary calculations for runoff analysis, implementation of the storm water management planning and practices and potential fee determination.

The COH has a municipal separate storm sewer system (MS4) in a portion of the City, and this MS4 is therefore subject to the requirements of the Pennsylvania Department of Environmental Protection’s MS4 Program. In order to meet the requirements of the MS4 Program, the separate storm sewer system needs to be included in this data collection, mapping, and overall GIS development effort.

The water and sewer systems date back to the late 1800s and much of the water and sewer facilities have aged beyond their useful life expectancy. Leaking water and sewer mains have washed away surrounding soil and caused underground sinkholes to develop throughout the COH. Road depressions have formed over many of the sinkholes and in some areas there has been complete pavement and ground collapse. These sinkholes affect the quality of life for COH residents by creating potentially hazardous and inconvenient travel conditions as well as posing health concerns when water and sanitary sewer service are not available.

III. Work Performed to Date

Project Understanding/Geodatabase Requirements Document

HRG completed a final draft of the Geographic Information System (GIS) Geodatabase Requirements Document & Generalized Implementation Plan (Implementation Plan) in September 2011. The Implementation Plan discussed creation of THA’s utility geodatabase structure, hardware and software requirements, field data collection and input, and general management of the GIS. The Implementation Plan contains critical steps for THA to properly manage and maintain the GIS of the water and sewer systems.
Data Review
Based on correspondence with THA and COH staff, there are many hard copy drawings, maps, files, etc. as well as GIS mapping layers previously developed by the COH and various engineering companies that portray the water and the sanitary, combined, and storm sewer systems. HRG has reviewed the existing GIS datasets for the water and the sanitary, storm and combined sewers and the corresponding existing hard copy design or record drawings. Although some of these documents are outdated and often incomplete, they are still potential resources of valuable data to be incorporated into the systems for the new GIS. They will also be used as a guide to assist in the field location of the water and the sanitary, storm, and combined sewer facilities by the survey professionals and the subsurface utility engineering (SUE) company[s].

Pilot Project
In order to provide insight into the full-scale GIS project requirements and budget, a pilot project was performed in a section of the COH. Over the course of several months in 2012, COH staff marked the location of water and sewer facilities in the pilot area. Utility mark out was performed by referencing hard files and personal knowledge. HRG then performed Global Positioning System (GPS) data collection and populated the GIS pilot geodatabase.

Once completed, the newly mapped facilities were compared to the existing GIS mapping to verify accuracy. Previous GIS mapping did not match actual field conditions, proving that previous mapping efforts are neither accurate nor complete, and therefore insufficient for THA’s needs. It was also determined that due to the required efforts necessary to complete the mark outs City-wide, COH staff would not be able to devote the time necessary to complete this task efficiently and accurately. Based on these results, it was recommended that THA contract with a professional SUE company to locate and mark out the water and sewer systems to be collected via GPS and conventional survey methods for incorporation into the GIS.

Consultation with SUE Companies
HRG met with several reputable SUE companies during 2012 to discuss data collection options and technologies specific for both water and sewer facilities. The meetings provided important details and insight into the available technologies associated with underground utility locating, along with the estimated efforts, results and estimated costs associated with each technology. This information was presented to THA and final data information needs and accuracy results were determined. The results are being incorporated into the request for proposals (RFP) being developed for the selection of the specialized SUE companies for this project. Detailed roles and responsibilities of the SUE companies are presented in Section XIII – Project Approach.

Silver Jackets
The Silver Jackets is a state level program that brings together local, state and federal agencies to address Pennsylvania’s flood risk management priorities. The ultimate goal for the Silver Jackets program is to develop a flood hazard mitigation tool to inform the general public, local officials, and emergency managers of risk associated with flood hazard.
Orthophotography Flight Development
On October 24, 2012, THA entered into a contract with T3 Global Strategies to complete the development of low level, high resolution orthophotography for the areas pertaining to the primary water transmission main from the DeHart Dam and the water and sewer service areas of THA and the COH. The flight was performed in November 2012 and final mapping is being processed.

THA authorized T3 Global Strategies to commence with Phase 2 – Mapping of Impervious Surfaces on January 24, 2013.

Adjacent Stakeholder Discussions
As part of the GIS development, coordination with outlying municipalities has been discussed. An initial meeting will be held with representatives from other utility providers and surrounding municipalities served by THA or COH water, sewer, or storm systems. They will be presented with the opportunity to team with THA and have the coordination portions of their utility system(s) collected during this project.

THA Front Street Interceptor Investigation
The COH discovered two pipes that were thought to be abandoned discharging wastewater into the Susquehanna River near South Street. Through dye testing of the Front Street Interceptor it was discovered that the Front Street Interceptor was leaking and these pipes provided a conduit for the wastewater to be discharged into the river. The COH subsequently plugged these pipes and the COH and THA authorized HRG to perform an investigation of the Front Street Interceptor to find the leak. The COH had determined through dye testing that the leak was occurring in the Interceptor somewhere between South Street and Pine Street, a 760 foot long section.

A local sewer services contractor was first brought in to conduct a CCTV investigation of the Interceptor to locate the leak. This investigation while the Interceptor was kept in service and the CCTV investigation did not find any defects above the water level. Since no defects were discovered above the water level, an investigation below the water level needed to be conducted. This investigation could occur through the use of sonar equipment while the Interceptor was kept in service.

Granite XP Technologies, the contracting division of Cues, Inc., was brought in to conduct the sonar investigation. Granite XP Technologies also performed a CCTV inspection while on site. A number of defects, such as interceptor wall loss and holes in the interceptor wall, were observed during the sonar inspection that were not observed during the CCTV inspection. The sonar inspection noted a hole in the interceptor wall on the Susquehanna River side of the Interceptor at station 1+70 downstream of the South Street manhole. This is the same location as the two pipes that were leaking into the river.

THA Strategy Meetings
GIS Strategy Workshop meetings were held on November 2 and 8, 2012 with representatives of THA, the COH including the Bureau of Water and Bureau of Sewerage, HRG and CDM Smith. Data collection alternatives were discussed and prioritized, as well as associated costs. At these
meetings, THA chose to pursue the following general options, which are discussed in greater detail later in this Plan:

**Water Facilities:**
- Water System Distribution System - Location
- Water System Transmission Mains - Location

**Sanitary Sewer Facilities:**
- Interceptor and Force Main - Location, CCTV, Laser, Sonar with Advanced Manhole Scanning
- Collection System - Location with Accurate Mapping Probe, CCTV with Advanced Manhole Scanning

**IV. Utility Designation & Location Technology**

New and emerging technologies allow for the cost effective collection and depiction of existing utility information. This convergence of technologies and systematic use of the data derived from these technologies is known as subsurface utility engineering (SUE). A key component of SUE is affixing an attribute to utility information that denotes the quality of that information. The American Society of Civil Engineers (ASCE) developed a standard guideline for affixing that attribute – Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data (ASCE 38-02). This standard guideline will be utilized for this project, and classifies the quality of the subsurface utility data into the following four levels:

**Utility Quality Level D** – Information derived from existing records or oral recollections.

**Utility Quality Level C** – Information obtained by surveying and plotting visible above-ground utility features and by using professional judgment in correlating this information to Quality Level D information.

**Utility Quality Level B** – Information obtained through the application of appropriate surface geophysical methods to determine the existence and approximate horizontal position of subsurface utilities. This also includes performing Utility Quality Level C work. Quality level B data should be reproducible by surface geophysics at any point of their depiction. This information is surveyed to applicable tolerances defined by the project and reduced onto plan documents. The term “designation” used throughout this Plan refers to ASCE Utility Quality Level (UQL) B.

**Utility Quality Level A** – Precise horizontal and vertical location of utilities obtained by the actual exposure (or verification of previously exposed and surveyed utilities) and subsequent measurement of subsurface utilities, usually at a specific point. Minimally intrusive excavation equipment is typically used to minimize the potential for utility damage. This also includes performing Utility Quality Level B work. A precise horizontal and vertical location, as well as other utility attributes, is collected and shown on plan documents. Accuracy is typically set to 15 mm vertical and to applicable horizontal survey and mapping accuracy as defined or expected by
the project owner. The term “location” used throughout this Plan refers to ASCE Utility Quality Level (UQL) A.

A variety of surface geophysical technology will be used for designation and location of the water and sanitary, storm, and combined sewer systems. The following are brief descriptions of potential technologies that may be used during the location process. Each of the utility location techniques described below has been assigned an ASCE Quality Level.

**Acoustic/Radar Technology (Utility Quality Level B)**
This is a new technology in which acoustic waves are sent into the ground much like ground penetrating radar. The return signals are received and interpreted. Multiple traces are recorded at regular intervals and the results are combined to give the location of the target utility line. This technology can be used to find the majority of pipes regardless of pipe material and is not affected by varying soil conditions.

**Acoustic Locating (Utility Quality Level B)**
This technique uses vibrating or “thumping” the target line at a valve or fire hydrant location and then using powerful microphones located along the ground surface to amplify these sounds and transmit them up to a receiver/filtering device. By placing the microphone in various locations along the ground surface, the user can find the loudest signal and accurately locate the line. In some circumstances, the sound of the water moving through the pipe can be heard using these microphones.

**Sonde/Push Rods (Utility Quality Level B)**
This technology consists of two instruments where an electromagnetic field is created around a sonde which is a transmitter. The sonde is placed into the pipeline and an electromagnetic receiver is used to locate the electromagnetic field as the sonde travels through the pipe. The sonde can be attached to an inspection camera, a rod, or pulled through with rope installed in the pipe.

**Electromagnetic Locating (Utility Quality Level B)**
Electromagnetic (EM) locating, a.k.a. conductive locating, is a technology in which an electromagnetic signal is introduced onto a metallic conductor by a transmitter. The signal travels along the conductor and can be detected by a receiver that is matched to the transmitter. This is a common method used in the SUE industry. By utilizing a wide variety of signal frequencies and power settings, a competent user can accurately locate metallic underground utility lines or tracer wires accompanying nonmetallic utilities.

Inductive locating involves the same equipment, but is utilized when the transmitter cannot be directly connected to the target utility line. This method involves high frequencies that are sent into the ground which then “jump” to the underground line. This technology can be used to find pipe materials that are typically difficult to find such as reinforced concrete pipe.

**Ferro-magnetic Location (Utility Quality Level B)**
This method is similar to a metal detector except that this equipment is much more powerful than the consumer models and is tuned specifically to ferromagnetic (FM) materials. These
locators may be used to find valve boxes, manhole covers and other metallic structures that have been buried or overlaid with pavement.

**Ground-Penetrating Radar (GPR) (Utility Quality Level B)**
This technique utilizes a built-in transmitter used to send a high frequency signal into the ground. This signal reflects off the utility line and the receiver picks up these reflections. A pattern of returns will show a noticeable soil disturbance in the location of a utility line. This method does not require the target to be metallic and can find clay and concrete pipe. Success of the technology is affected by the makeup of the soil. GPR is typically successful in sandy conditions, but is limited in soil with dirty fill or dense, clay soils. One limitation of the GPR is depth; the deeper the target utility, the larger it must be to be detected.

**Vacuum Excavation (Utility Quality Level A)**
Vacuum excavation involves use of high pressure air or water to break up the ground and powerful vacuums to extract the soils and expose utility lines. This is a preferred method of excavation because it virtually eliminates the possibility of damaging the utility during the exposure process. Furthermore, it allows the user to precisely determine the location of the target facility. When used with keyholing, it provides a method of exposure under streets that is minimally evasive.

**Keyholing (Utility Quality Level A)** - This process utilizes core drills to cut through pavement so that utility lines can be exposed. The core created can be replaced after the exposure leaving the area virtually undisturbed. Because the core is round, there is less chance of chipping or other problems associated with saw cutting.

**Designation and Location Technology for Water System:**
- Acoustic/Radar Technology
- Acoustic
- Electro-magnetic locating
- Ferro-magnetic Location
- GPR
- Vacuum Excavation
- Keyholing

**Designation and Location Technology for Sanitary, Combined, and Storm Sewer Systems:**
- Acoustic/Radar Technology
- Acoustic
- Sonde/Push Rods
- Electro-magnetic locating
- Ferro-magnetic Location
- GPR
- Vacuum Excavation
- Keyholing
Sinkhole Location Technology:
Preliminary research into sinkhole location technology indicates two technologies are available through the use of non-destructive geophysical techniques. These are microgravity and ground penetrating radar (GPR). Microgravity can be used to detect areas of mass deficiency below the survey area, and GPR can be utilized to detect very shallow targets (i.e. possible voids directly under the road within 3 to 4 feet of the roadway surface). Microgravity profiling is based upon the principle that the observed value of the earth’s gravitational acceleration at any measurement station is a function of the vertical distribution of mass beneath that station, with corrections for specific areas. That is, gravity is measurably stronger at a station underlain directly by dense bedrock than at a station underlain by a void or a significant thickness of unconsolidated (i.e. less dense) sediments. GPR has been previously described.

V. Data Collection Technology
A combination of different data collection technology will be used for the sanitary and combined sewer systems. The following are the potential data collection technologies, accompanied with brief descriptions that are intended to be utilized for this project.

Digital CCTV Pipe Inspection Equipment – Digital Closed Circuit Television (CCTV) pipe inspection equipment systems produce a continuous hemispherical scan of the condition of pipe or manholes. This camera can operate at a constant speed without the need to stop or pan and tilt. The unit is capable of running through multiple manholes, reducing staging requirements and increasing data collection efficiency. The camera system takes numerous digital still photos which are merged to create one large video of the pipe. The recorded information is then processed at the office for observations and defects. Digital CCTV sewer inspection equipment is available from Cues, Inc., Redzone Robotics, RapidView, LLC.- IBAK, and Envirosight. Each manufacturer gears their equipment system to different pipe size segments. Cues, Inc. for example provide a front facing camera only but can inspect 6” to 60” diameter pipe. Redzone Robotics has both a front and rear facing camera but can inspect 8” to 12” diameter pipes.

Analog CCTV Pipe Inspection Equipment – Analog CCTV pipe inspection equipment systems rely upon an operator to guide the camera system through the pipe, and pan and tilt the camera to inspect the pipe. The operator completes a report of the observations and defects as the camera advances through the pipe. The unit is capable of running through multiple manholes, reducing staging requirements and increasing data collection efficiency. The operator provides an analog video recording of their inspection. There are a variety of analog CCTV sewer inspection equipment manufacturers as this technology has existed for a number of years.

Digital Optical Manhole Scanner - Digital optical manhole scanners consists of a modular equipment skid which has a winch and telescopic arm to raise and lower the optical scanner in the manhole. The optical scanner consists of a top and bottom mounted hemispherical digital cameras. Similar to the Digital CCTV pipe inspection equipment systems, the result is a complete 360 degree digital view of the manhole. The manhole scanner can also export a 3-D geometric model of the structure providing accurate structure dimensions and allows for analysis of structural defects. The recorded information is processed at the office for observations and
defects enabling the field collection crew to minimize the amount of time spent collecting the
data. The Digital Optical Manhole Scanner is available from Rapidview, LLC. - IBAK. Redzone Robotics also produces similar technology, but it is not capable of producing the 3-D geometric model.

Gyroscope Mapping Probe – The Accurate Mapping Probe (AMP) is a gyroscopically operated device that records XYZ positional data at the rate of 800 times per second and can be placed within a pipeline or conduit. Based on its onboard data acquisition storage capability the AMP is not connected to a data or power cable, enabling the AMP to map long and deep pipelines or conduits. Positional data obtained by the AMP is processed in the field and exported into GIS or CAD file format of plan and profile views. Ranges of size provided through different models are 1.5 inch to 58 inch diameters. This product is currently offered only by Cues Mapping Services, a division of Cues, Inc.

Pole-Mounted Camera – The pole-mounted camera consists of a battery operated camera and light assembly with multiple wireless color monitors that is mounted on a retractable pole and designed for manhole and pipe inspection. One benefit of this camera is that all inspections can be made from the surface; no manned entry is required. The newest version of this camera uses haloptic technology which yields superior illumination and increases pipe inspection range. The camera has zoom capabilities to inspect upstream and downstream pipe at a manhole. Video and camera stills can be recorded on an internal hard drive. The pole-mounted camera is limited by the straightness of the pipe and the pipe size; the larger the pipe diameter the further the camera is able to see. The pole-mounted camera with haloptic technology is currently only offered by Envirosight, LLC. Other manufacturers offer pole-mounted cameras but lack the haloptic technology.

Laser Profiling – This technology uses CCTV crawlers or floats to hold a laser assembly that projects a laser ring on the internal surface of the pipe and uses software to create an image of the internal pipe dimensions and check pipe ovality. Cracks and other physical defects can be examined using the accompanying software. Laser diodes can also be added to CCTV crawlers and floats. The laser diodes are used to measure the size of cracks or separated joints. This technology is available from a number of manufacturers.

Sonar – Sonar technology provides an underwater condition assessment of the internal pipe conditions. This technology is generally used in pipelines 24” in diameter and larger. The sonar technology has the ability to provide a visual profile, profile comparison, and dimension data of significant items or defects below the water level in the pipe. Using sonar software, a circle overlay is projected, sized, and moved anywhere within the image to check for pipe erosion or to gauge wall thickness. Accurate measurements can be made between any two points within the sonar image. Debris level, size of blockages, grease levels, defects and other conditions can be quantified. In partially charged lines, sonar can be combined with CCTV to provide a simultaneous composite image of the pipe both above and below the waterline.

Two different sonar systems are available; one for submerged pipelines and another for semi-submerged pipelines. Both systems provide real time cross-sectional views of the pipe by utilizing high resolution/short range sonar. For semi-submerged pipelines, the non-submerged portion of
the pipe is displayed on the video monitor as a standard video image. This technology is offered by Cues and Red Zone Robotics.

**RFID** – Radio Frequency Identification (RFID) technology, commonly used in the form of marker balls, is a system for traditionally un-locatable utilities. Once the utility is exposed (vacuum excavation or dig up), a marker ball is placed directly over the utility line and buried. The marker ball creates a signal that can be picked up by a locating receiver. In addition, through RFID technology, the marker ball can be programmed to relay up to seven fields of information to the receiver. These fields can be designed to meet the specific needs of the utility owner. Fields could include items such as date of placement, depth, material, type of repair, etc. RFID marker balls may be placed over a bend in the pipe, a change in pipe size or material, or strictly to assist in facility location.

**Visual Inspections from Surface** – Visual inspections, hand sketches and digital pictures of all visible features from the surface (i.e. without entry into the structure). Sketches of utility conflicts at vacuum excavation locations can be useful to determine the proximity of surrounding utilities.

**V-Depth Tool** – This technology allows the user to acquire highly accurate (+/- 3mm) pipe invert elevations from the manhole rim. The tool itself combines a laser distance finding device with a builders angle device that fits into a bracket and is mounted to the manhole frame. This tool increases the accuracy of the pipe invert elevations.

**VI. Field Data Collection**

HRG will utilize high precision GPS technologies, capable of obtaining survey grade accuracies to plus or minus 5 centimeters, to perform infrastructure data collection of the defined water and sanitary, storm, and combined sewer system features.

HRG will reference the local Virtual Reference System (VRS) maintained and operated by Keystone Precision and known as KeyNet for field data feature collection. This VRS is the latest in technology and removes HRG personnel from the confines of conventional Real-Time Kinematic (RTK) GPS positioning, which must rely on a base station GPS receiver at a secure location, coupled with the rover GPS receiver that is used for feature positioning. Instead, through accessing the VRS, field members simply rely on a rover receiver and connect to the VRS via a wireless phone. This adds efficiency to an already highly accurate, highly efficient RTK methodology.

In order to verify that the data points collected via RTK GPS methods meet the defined plus or minus 5 centimeter accuracy range, HRG will re-observe a representative sample of points for comparing one-percent of the collected features. The vertical difference between first and second observations will be reported by the Root Mean Square Error (RMSE) of the sample.

In areas where GPS technologies are unavailable to be utilized, alternative data collection methods such as code-based GPS, heads-up digitizing and/or conventional survey may be used for feature data collection as available and applicable. The data collection method performed
will be attributed within the coordinating GIS layer stored within THA’s GIS database, and the achieved accuracies will be reported accordingly.

The THA selected SUE company(s) will be responsible for designation and marking all water system features. HRG will utilize the above described methods to collect the designation markings, the above ground features, and utility location at the vacuum excavated pits. It is estimated that the SUE company(s) will require approximately two weeks advance start before HRG begins field collection. This will allow the SUE company(s) to stay ahead of HRG’s crews and keep the data collection process moving steadily. It is assumed that once the SUE company(s) begin designation, they will continue working without interruption until either their contract is completed or they are directed by THA to stop work.

While collecting water system features, HRG will use the same above described methods to collect the above ground sanitary and storm sewer features.

VII. Data Processing/Geodatabase Population

A motive for developing a GIS is to be able to make informed and correct decisions in an efficient and timely manner. As with the development of any GIS, the most important, and inevitably the most expensive part of designing and implementing such a system is data. The same rule applies to GIS data that applies to any type of database, spreadsheet, etc., “garbage in, garbage out”. In other words, the end user can only analyze, interpret and make decisions based on the quality of the information provided. Thus, better information and data will afford the ability for better analysis and decision making.

THA will utilize ESRI’s software solutions as its selected GIS platform. HRG is currently working with ESRI’s staff to assist with the selection and integration of the software applications required to meet the existing and future needs/requirements of THA.

Based on the requirements, outcome expectations and future plans for the utility GIS system, a high precision inventory of the systems’ assets and accurate attribute collection/input for those features is necessary. In order to obtain the high standards set for this project, various processes, collection and verification techniques, and partnerships have been discussed.

There is extensive hard copy information stored in various locations that define the water, sanitary, storm, and combined sewer utility systems. Even though these documents are incomplete, they provide historically significant information that is vital to the development of the new GIS. The many documents, books, plan sets and index cards can be used as a starting point for system development and provide future clarifications to end users.

An important issue that has been mentioned many times, along with the fact that these datasets are incomplete, is the ability by end users to access and find the information when required, and the ability to do so in an efficient manner. It is recommended that through this project, and into the future, digital scans and copies be developed of the existing system plan sets and future system update plan sets. Scanning existing documents will help preserve the historical hard copy documentation composing the system. Digital plans provide the ability to link useful
existing hardcopy information within the GIS to the newly collected and verified assets allowing for quick retrieval for reference as required.

In addition to hard copy plans, the existing GIS information previously developed through other past projects is a beneficial source of data. This data will help create the base for field verification and system understanding and provide a “roadmap” for enhancing, updating, collecting and developing the utility system(s) with the high precision technologies.

HRG will utilize ESRI’s ArcGIS Version 10.1 desktop software to process the field collected information and begin populating THA’s predefined utility systems geodatabase which was previously drafted as part of this project. As the systems are collected, HRG will use the existing historic systems exhibits, as provided by THA, to connect the features and create the initial sewer network(s). HRG will utilize mobile GIS technologies to conduct data verification, input, and updates while in the field, as applicable.

Generalized data processing and database population procedures will include:

1. Data collected via GPS technologies will be checked/processed through procedures built into the Trimble Business Center (TBC) software. TBC allows the processor to complete a desktop review of the field collected features, observe calculated accuracies and flag potential anomalies that may need further investigation or re-observation.

2. After the data has been processed and verified through TBC, the final point location coordinates and their represented coded feature ID and description value (i.e., FH = Fire Hydrant) are exported as CSV and/or shapefiles from TBC for import into the GIS database.

3. Using ESRI desktop technologies, final points features will be imported into THA’s utility geodatabase within their corresponding predefined feature classes (i.e., Water Valves, Fire Hydrants, Manholes, etc.). Features that are located, but unable to be collected via GPS, will be input directly into the representative data layer via heads-up digitizing while referencing orthophotography.

4. HRG, using ESRI desktop technologies and referencing various available sources of information (i.e., water main data points designation by the SUE company(s) and collected by HRG, and the existing historic water and sewer system exhibits, as provided by THA) will connect the collected above ground utility point features developing the water and sewer main line work.

5. Referencing the provided historic water and sewer system exhibits, HRG will input attribute information for the water pipe sizes and types and sewer pipe and manhole sizes and type, as available and applicable, into the geodatabase.

6. Each feature input into the geodatabase will have its data collection / development method populated as an attribute stored within the features direct attribute table.
7. Metadata (data about the data) will be developed and incorporated for each GIS layer populated within THA’s predefined geodatabase.

8. QA/QC processing will be conducted by reexamining and cross-checking the provided references with the populated information for a representative sample of features within each feature class populated within the geodatabase.

VIII. GIS QA/QC

A Quality Assurance/Quality Control (QA/QC) Plan outlines the processes and procedures that will be performed to ensure that existing and future data integration into the GIS is correct and meets the pre-determined required accuracy levels. The plan covers aspects integral to the success of the project in both the initial creation and continuing maintenance of the GIS. This plan will be developed based upon project needs and will be implemented and updated during the duration of the data collection and GIS development.

A documented QA/QC plan will be delivered to THA for review and implementation to use in maintaining and updating its GIS in the future. QA/QC practices will be conducted by HRG and be required and documented by any other third parties involved in the GIS implementation or data collection processes.

IX. Administration and Training

THA will be the administrative authority for the final GIS. Staffing requirements to meet the needs of THA’s implemented GIS were discussed in the GIS Geodatabase Requirements Document & Generalized Implementation Plan prepared by HRG in September 2011 and have been reiterated in this Plan. It is anticipated that at least one full-time GIS professional is planned to be hired by THA. This staff member will maintain the GIS, follow the requirements of the QA/QC plan, and assist with the ongoing implementation and expansion of the GIS. THA is currently evaluating the requirements of the potential position including a timeframe for hiring of this individual. It is anticipated that THA will hire its first GIS professional between March and December 2013.

At the request of THA, HRG will work with THA to further define the required GIS employee(s) and their title, roles, duties, etc. As THA’s GIS consultant, HRG will provide technical and administrative support and assist in the acquisition of the full-time staff member(s) as requested. HRG will continue to work with the newly hired staff member(s) during their orientation with THA’s GIS, work with THA staff to coordinate application development requirements, and assist with training associated with the implemented GIS. Also at THA’s request, HRG will provide continued technical and consulting support to THA and its GIS staff after the initial implementation processes. Specialty GIS services such as custom application development and/or performing system maintenance and updates will also be provided at THA’s request.
X. Future System Growth

The development of a highly accurate, GIS system for water, sanitary, storm and combined sewer systems is the base for other expansion possibilities into the future. Not only does it provide the accurate inventory of the existing system for maintenance, but this highly accurate and precise information initiates the ability to perform system(s) modeling for such things as existing system deficiency predictions and future expansion opportunities/capabilities.

Developing an enterprise based GIS database also allows the potential to put digital information into the hands of THA and COH staff in the field. Mobile applications, including web based applications and mobile mapping devices such as tablet PC’s and smart phones, can provide the reference and editing capabilities required to perform such tasks.

The enterprise level geodatabase sets the basis to open up community involvement with asset and work order management and emergency reporting, as well as establish the base for more precise communications with potential effected clients in times of crisis.

Another future application, which has been discussed with THA is the potential for the GIS to be tied to a billing system for water and sanitary sewer service.

XI. Asset Management

The development of an accurate GIS is the cornerstone to the development and implementation of an asset management system. Spatial data and other feature attribute information can be combined with an asset management database, providing the container and interface to store, maintain, retrieve and analyze related utility asset information, including the system’s feature physical attributes, maintenance records, condition assessment, associated photos and videos, scanned documents, documentation of customer complaints, etc.

The cost of a fully integrated asset management system can range into six figures plus, depending on the level of customization, user requirements/functionality and licensing. At THA’s request, HRG will provide assistance in evaluation and selection of an asset management system to meet all of THA’s needs.

There are numerous options for asset management software. It is recommended that various asset management software solutions be investigated in order to select the best fit for THA. If a standard asset management system will not meet THA’s needs, a custom system can be developed. When choosing the asset management system, various factors should be evaluated:

- Can the system meet all of THA’s needs and requirements?
- Compatibility with ESRI’s GIS software suite
- Compatibility with other software/databases that may be potentially linked to the GIS (i.e. billing, digital document management, etc.)
- Data migration processes and capabilities
- Desktop and Web-Enabled/Mobile Interfaces
- Proprietary data structures and information
THA’s staff and other project stakeholders should be involved with the process of selecting and implementing the asset management software that will best meet their needs. HRG staff will provide guidance and insight throughout this process and assist with the coordination of software demonstrations, follow-up discussions and final implementation. However, it is ultimately THA’s final decision to select which option will best fulfill their requirements. Recommended third-party asset management software include but are not limited to Cityworks, VUEWorks, CarteGraph, and Lucity.

THA staff has already previewed information provided by Cityworks and Lucity, and has been contacted in the past by CarteGraph. HRG will work with ESRI on this task and request their professional recommendation of the selection of an asset management solution. It is a requirement that selected solution integrate seamlessly with ESRI’s platform.

XII. Application Development

Custom Application Development can range from the development of simple database input forms, to custom tool set(s), to desktop and/or web based GIS interfaces, to fully integrated asset management systems. All custom applications do not have to be completed before or during initial implementation, some may not be determined until after a few months/years of use, but some will need to be developed before final original system installation.

One custom development task that needs to be addressed prior to final implementation includes WebGIS interface and application development. Along with discussions on developing custom WebGIS interfaces, the potential implementation of ESRI’s ArcGIS Online solution will be addressed.

Unlike desktop software from ESRI, server based applications, including internet based mapping applications, have limited out-of-the-box capabilities, thus, leaving the development of the look and functionality for the end user up to the host (THA). Along with the look and functionality requirements for the web application, a determination must also be made on what type of mobile device(s) may be required to access the application. Different operating systems require different web interface development platforms. (i.e. iOS for iPhone and iPad).

XIII. Project Approach

As previously discussed, the GIS will incorporate information on the water and sanitary, storm, and combined sewer systems. Several of the technologies described in this Plan are only offered by a limited number of companies. Therefore, the project will require issuance of multiple RFPs and contracts with multiple SUE companies to obtain the high quality level of information desired.
A. Water Facilities

THA owns the Harrisburg Water System which serves approximately 66,000 residents in the COH and portions of the Borough of Penbrook, and Susquehanna and Lower Paxton Townships. Via a 1990 management agreement, the COH’s Bureau of Water staff operates and maintains the water system.

It is estimated that THA’s water system consists of the following facilities:

- 250 miles of distribution main
- 23 miles of primary transmission main (DeHart Dam)
- 3 miles of secondary transmission main (Susquehanna River)
- 3,500 in-line water valves
- 20,800 water service lines
- 1,700 fire hydrants
- 3 finished water reservoirs
- 3 finished water pump stations
- 5 water system interconnects

The following project approach will be implemented for the water facilities.

Major Distribution System:

- SUE Utility Quality Level (UQL) B designation of the water distribution system (less the 20,800 water service lines). Designation of water service curb stops and/or water service lines will be performed.
- SUE UQL A location (vacuum excavation), investigation, and documentation at 250 points throughout the water distribution system.
- SUE company will install an RFID marker ball at each location point.
- HRG will perform field data collection of water distribution system marked out by SUE company.
- HRG will capture high precision surface locations of approximately 3,000 sanitary sewer manholes lids and 3,600 storm sewer inlets.

The required accuracy of UQL B designations will be +/- 6 inches from the centerline of the pipe in the horizontal direction. Vertical depth ranges may be provided when SUE designation equipment indicates an approximate depth. UQL A locations will result in high precision locations of the top of pipe via keyhole or vacuum excavation methods.

Roles and Responsibilities

SUE Company:

- Perform the tasks listed above.
- Provide necessary traffic controls to perform the work.
- Prepare and submit PennDOT Highway Occupancy Permits (HOP), local street cut permits, and any other permits required to perform the work.
- Coordinate with the COH, specifically any requirements to perform work close to the Capitol for security requirements surrounding the Capital building and other government buildings.
- Provide sketches at utility conflict locations.
- Provide QA/QC of data collected.
- Coordinate all work with HRG.

**HRG:**
- Perform the tasks listed above.
- In an effort to maximize data collection efforts, while collecting water feature data marked out by the SUE company, HRG will simultaneously collect high precision locations of all visible and accessible sanitary sewer manhole lids and storm sewer inlets. The sanitary sewer manhole lid locations are needed before the SUE company can perform detailed manhole data collection work.
- Provide overall project management and coordination.
- Provide SUE company coordination and contract administration on behalf of THA.
- Perform data processing/geodatabase population into the GIS and provide QA/QC of all data collected.
- Provide assistance with coordination between all parties involved in the work.

**THA:**
- Provide existing GIS mapping and/or record drawings to assist in location and designation of the water system.
- Responsible for any permit fees associated with necessary project permits.
- Payment of all project related costs.
- Notifying all property owners and assist in gaining access to any facilities located outside the public in right-of-way.
- Provide a numbering sequence for water feature identification.

**COH:**
- Provide existing GIS mapping and/or record drawings to assist in location and designation of the water system.
- Assist in access to facilities for data collection, such as, but not limited to, removing structure lids that the SUE company cannot remove.
- Provide a numbering sequence for water feature identification.
- Assist with security and public relations during completion of the work.
Primary Transmission Main (PTM)

The primary transmission main runs for 23 miles via gravity from the DeHart Dam, located in Rush Township, Dauphin County to the Doctor Robert E. Young Water Services Center (DREYWSC). Based on COH records drawings, the main was installed in the late 1930s and is recorded as a 42-inch diameter concrete pipe. Improvements to certain portions of the PTM in the COH limits have been made over the years. Based on drawings provided by the COH, it is estimated that there are approximately 50 air release valves installed along the 23 miles of the PTM. Concrete pillars were installed at each air release valve locations.

Section One of the PTM:
The first 12 miles (approximate) of the PTM from the DeHart Dam to the intersection of State Route (SR) 0325 and SR 0225 is located in a heavily wooded area with limited access. The majority of the right of way (ROW) is not accessible and is overgrown with trees and other foliage. Therefore, it is not feasible for an SUE company to access the majority of this section of the PTM and perform designation and location of the PTM. Once detailed information on the PTM is incorporated into the GIS, THA can better plan to clear the ROW of the 12 miles of heavily wooded ROW and repair any potentially damaged concrete pillars. Once the ROW is cleared, the SUE company would then proceed with designation and location of this section of the PTM.

HRG proposes to locate the PTM through the ROW first by reproducing existing drawings electronically in Civil3D 2011 then performing sufficient preliminary data collection of the transmission main and geo-reference this information to assist in the location and collection of the remaining facilities along the transmission main corridor. The preliminary data collection will enable HRG to translate and apply the proper azimuthal rotation to the reproduced data thereby building added efficiency in the remaining collection of those appurtenances associated with the transmission main that were installed cross-country and believed to have been historically monumented.

Given the location of this section of the PTM, HRG proposes completing this work during the winter season when foliage is at its minimum and the ground is frozen, making access in the typically marshy areas easier.

Roles and Responsibilities

HRG:

- Perform the specified tasks listed above. Recover the concrete pillars at each air release valve.
- Mark out the structure, collect the location, a digital photo and general description of each air release valve.
• Perform data processing/geodatabase population into the GIS and provide QA/QC of all data collected.
• Provide assistance with coordination between all parties involved in the work.

THA:
• Provide existing GIS mapping and drawings to assist in designation of the air release valves and the 12 miles of the PTM.
• Assist in gaining access to any facilities in ROW or on private property.
• Provide a numbering sequence for water feature identification.

COH:
• Provide existing GIS mapping and drawings to assist in designation of the air release valves and the 12 miles of the PTM.
• Identify PTM access points.
• The DeHart Dam Supervisor will coordinate with HRG to provide any additional information that may be of assistance.
• Assist in removing structure lids that cannot be easily removed.
• Provide a numbering sequence for water feature identification.

Section Two of the PTM:
Approximately 11 miles of the PTM from the intersection of State Route 0325 and SR 0225 to the DREYWSC is primarily located in areas which can be accessed by the SUE company and their designation and location equipment. Therefore, this 11 mile portion of the PTM will be in the scope of work for the SUE company.

Major Tasks to be Performed:

• SUE UQL B designation of the 11 miles of the PTM.
• SUE UQL A location (vacuum excavation), investigation, and documentation at 11 points along the PTM.
• SUE company will install an RFID marker ball at each location point.
• HRG will perform field data collection of PTM marked out by SUE company.

The required accuracy of UQL B designations will be +/- 6 inches from the centerline of the pipe in the horizontal direction. Vertical depth ranges may be provided when SUE designation equipment indicates an approximate depth. UQL A locations will result in high precision locations of the top of pipe via keyhole or vacuum excavation methods.

Roles and Responsibilities:

SUE Company:
• Perform the tasks listed above.
• Provide necessary traffic controls to perform the work.
- Prepare and submit PennDOT Highway Occupancy Permits (HOP), local street cut permits, and any other permits required to perform the work.
- Coordinate all work with HRG.

**HRG:**
- Perform the specified tasks listed above.
- Provide overall project management and administration of SUE company contracts on behalf of THA.
- HRG will perform data processing/geodatabase population into the GIS and provide QA/QC of all data collected.
- HRG will provide assistance with coordination between all parties involved in the work.

**THA:**
- Provide existing GIS mapping and/or record drawings to assist in location and designation of the air release valves and the 11 miles of Section Two PTM.
- THA will be responsible for any permit fees.
- Payment of all project related cost.
- Assist in gaining access to any facilities in ROW or on private property.
- Provide a numbering sequence for water feature identification.

**COH:**
- Provide existing GIS mapping and/or record drawings to assist in location and designation of the air release valves and the 11 miles of Section Two of the PTM.
- The DeHart Dam Supervisor will coordinate with HRG to provide any additional information that may be of assistance.
- Assist in removing structure lids that the SUE company cannot remove.
- Provide a numbering sequence for water feature identification.

**Secondary Transmission Main (STM)**
The secondary transmission main (STM) begins at an intake near McCormick Island in the Susquehanna River, extends for 3 miles, and ends at the DREYWSC. Based on existing drawings, the STM is a 36-inch ductile iron pipe.

**Major Tasks to be Performed:**
- SUE UQL B designation of 3 miles of STM.
- SUE UQL A location (vacuum excavation), investigation, and documentation at a minimum of 3 points along the STM.
- SUE company to install an RFID marker ball at each location point.
- Confirm pipe material at each location point.
- HRG will perform field data collection of STM marked out by SUE company.
The required accuracy of UQL B designations will be +/- 6 inches from the centerline of the pipe in the horizontal direction. Vertical depth ranges may be provided when SUE designation equipment indicates an approximate depth. UQL A locations will result in high precision locations of the top of pipe via keyhole or vacuum excavation methods.

Roles and Responsibilities:

SUE Company:
- Perform the tasks listed above.
- Provide necessary traffic controls to perform the work.
- Prepare and submit PennDOT Highway Occupancy Permits (HOP), local street cut permits, and any other permits required to perform the work.
- Coordinate all work with HRG.

HRG:
- Perform the specified tasks listed above.
- Provide overall project management and administration of SUE company contracts on behalf of THA.
- HRG will perform data processing/geodatabase population into the GIS and provide QA/QC of all data collected.
- HRG will provide assistance with coordination between all parties involved in the work.

THA:
- Provide existing GIS mapping and/or record drawings to assist in location and designation of the air release valves and the 3 miles of STM.
- THA will be responsible for any permit fees.
- Payment of all project related cost.
- Assist in gaining access to any facilities in ROW or on private property.
- Provide a numbering sequence for water feature identification.

COH:
- Provide existing GIS mapping and/or record drawings to assist in location and designation of the air release valves and the 3 miles of STM.
- Assist in removing structure lids that the SUE company cannot remove.
- Provide a numbering sequence for water feature identification.
- Assist with security and public relations during completion of the work.

B. Sewer Facilities

The following project approach will be implemented for the sewer facilities.
Sanitary and Combined Sewer Collection System

The sanitary and combined sewer collection system is owned, operated and maintained by the COH. It consists of the following facilities:

- Approximately 134 miles of collection sewer
- Approximately 3,000 manholes
- Two Pump Stations on City Island and associated force main piping

Major Tasks to be Performed:

- SUE company will clean sanitary sewer collection system as necessary to perform investigation and data collection.
- SUE UQL B designation of approximately 134 miles of collection sewer via gyroscopic mapping probe.
- SUE UQL B designation of approximately 1.3 miles of force main piping from the City Island Pump Stations.
- SUE investigation and data collection of sanitary and combined sewer collection system via CCTV pipe inspection equipment.
- SUE investigation and data collection of 3,000 sanitary sewer manholes via digital optical manhole scanner and pole-mounted camera.
- SUE company to provide condition assessment, report, and all videos of the collection system and manholes.
- SUE company to provide plan and profile mapping of the collection system.

The required accuracy of UQL B designations will be +/- 6 inches from the centerline of the pipe in the horizontal direction. UQL A locations will provide an exact XYZ location of the top of pipe via keyhole or vacuum excavation methods.

Roles and Responsibilities:

SUE Company:

- Perform the tasks listed above.
- Using the XYZ of the sanitary sewer manhole lid gathered during the water SUE work, the sewer SUE company will provide invert elevations of all pipes entering and exiting the manholes.
- Provide necessary traffic controls to perform the work.
- Prepare and submit PennDOT Highway Occupancy Permits (HOP), local street cut permits, and any other permits required to perform the work.

HRG:

- Perform the specified tasks listed above.
- Provide overall project management and administration of SUE company contracts on behalf of THA.
- Perform data processing/geodatabase population into the GIS and provide QA/QC of all data collected.
• Provide assistance with coordination between all parties involved in the work.

THA:
• Provide existing GIS mapping and/or record drawings to assist in location and designation of the sanitary and combined sewer systems.
• THA will be responsible for any permit fees.
• Payment of all project related cost.
• Assist in gaining access to any facilities in ROW or on private property.
• Provide a numbering sequence for manhole identification.

COH:
• Provide existing GIS mapping and/or record drawings to assist in location and designation of the sanitary and combined sewer systems.
• Assist in removing manhole lids that the SUE company cannot remove.
• Provide a numbering sequence for manhole identification.
• Assist with security and public relations during completion of the work.

Sanitary Sewer Conveyance System
The sewer conveyance system is owned by THA. It consists of the following facilities:

• Front Street Interceptor
• Paxton Creek Interceptor
• Paxton Creek Relief Interceptor
• Asylum Run interceptor
• Hemlock Street Interceptor
• Spring Creek Interceptor
• Front Street Pumping Station and Force Main
• Spring Creek Pumping Station and Force Main
• 58 Combined Sewer Overflow (CSO) structures

Major Tasks to be Performed:
• SUE UQL B designation of the 63,400 feet of interceptor pipe.
• SUE UQL B designation of 7,000 feet of force main and any in-line valves.
• SUE UQL B designation of CSO outfall pipes from 58 interceptor structures.
• CDM Smith will collect detailed internal dimensions of the CSO Diversion Chambers including all critical elevations.
• SUE investigation and data collection of interceptors.
• SUE investigation and data collection of the interceptor manholes via digital optical manhole scanner and pole-mounted camera.
• SUE company to provide condition assessment, report, and all videos of the interceptors, manholes, and CSO structures.
• SUE company to provide plan and profile mapping of the conveyance system.

The required accuracy of UQL B designations will be +/- 6 inches from the centerline of the pipe in the horizontal direction.

Roles and Responsibilities:

SUE Company:
• Perform the tasks listed above.
• Using the XYZ of the sanitary sewer manhole lid gathered during the water SUE work, the sewer SUE company will provide invert elevations of all pipes entering and exiting the manholes.
• Provide necessary traffic controls to perform the work.
• Prepare and submit PennDOT Highway Occupancy Permits (HOP), local street cut permits, and any other permits required to perform the work.

HRG:
• Perform the specified tasks listed above.
• Provide overall project management including field supervision of SUE company.
• Perform data processing/geodatabase population into the GIS and provide QA/QC of all data collected.
• Provide assistance with coordination between all parties involved in the work.

CDM Smith:
• Via manned entry, CDM Smith will provide detailed sketches and dimensions, including all critical XYZ elevations, of the 58 CSOs structures including all critical information necessary for accurate modeling of the system to satisfy LTCP requirements.

THA:
• Provide existing GIS mapping and/or record drawings to assist in location and designation of the sanitary sewer conveyance system.
• THA will be responsible for any permit fees.
• Payment of all project related cost.
• Assist in gaining access to any facilities in ROW or on private property.
• Provide a numbering sequence for manhole identification.
CoH:
- Provide existing GIS mapping and/or record drawings to assist in location and designation of the sanitary sewer conveyance system.
- Assist in removing manhole lids that the SUE company cannot remove.
- Provide a numbering sequence for manhole identification.
- Assist with security and public relations during completion of the work.

C. Separate Storm Sewer System and Combined Sewer Inlets

The COH own the municipal separate storm sewer system (MS4) and the inlets connected to the combined sewer system in the City limits. Detailed attribute data collection and investigation for the MS4 storm sewer structures and inlets connected to the combined sewer system is not part of this Plan. The MS4 is approximately 30 miles in total length and there are approximately 3,600 inlets connected to the combined sewer system. Detailed data collection including pipe size and material, and investigation through CCTV pipe inspection equipment or pole-mounted cameras cannot be easily gathered due to hoods on the combined sewer inlet boxes which limit access to the storm sewer pipe. In addition, a number of inlets are filled with sediment and debris which restricts access to the storm sewer pipes. THA and the COH should discuss and consider whether they wish to perform SUE UQL B designation and data collection and investigation of the storm sewer system and inlets connected to the combined sewer system. Prior to proceeding a plan will have to be developed for cleaning of the inlets and removal and reinstallation of the hoods to allow this work to progress.

The following project approach will be implemented for the sewer facilities.

Major Tasks to be Performed:

- HRG will capture high precision surface locations of visible and accessible storm manholes and inlets as part of this project.

Roles and Responsibilities:

SUE Company:
- None at this time

HRG:
- Perform the specified tasks listed above.
- Perform data processing/geodatabase population into the GIS and provide QA/QC of all data collected.
- Provide assistance with coordination between all parties involved in the work.
THA:
- Provide existing GIS mapping and/or record drawings to assist in location and designation of the MS4 manholes and inlets connected to the combined sewer system.
- Payment for any permit fees.
- Payment of all project related cost.
- Assist in gaining access to any facilities in rights-of-way or on private property.
- Provide a numbering sequence for MS4 manhole and inlet identification.

COH:
- Provide existing GIS mapping and/or record drawings to assist in location and designation of the MS4 manholes and inlets connected to the combined sewer system.
- Provide a numbering sequence for MS4 manhole and inlet identification.
- Assist with security and public relations during completion of the work.

XIV. Project Schedule and Phasing
Data collection is planned to begin in the first quarter of 2013 with the first phase of the data collection work concentrating on the water system. Work on the sanitary, combined, and storm sewer facilities will generally need to be conducted in sequence with the first task being the completion of manhole inspections and the collection of invert elevations. The invert elevations are needed prior to the pipe inspections because they are required by the gyroscopic mapping probe to acquire the underground XYZ locations of the pipe. Once the invert elevations are collected, the detailed investigation and gyroscopic mapping of the pipes can proceed. The anticipated phasing and schedule for the project is provided below. A detailed schedule has been proposed for Phases 1 through 4. As the project progresses, detailed schedules will be further developed for subsequent phases.

Refer to the attached map for a delineation of Area 1 and Area 2.

Phase 1 – 2013
Water System – Area 1
- Issue RFP for Water System SUE: 2/12/13
- Receive Water System SUE Proposals: 2/25/13
- THA Authorization to Proceed with Water System SUE and Data Collection: 2/27/13
- Commence Water System Designation and Location: March 2013
- Commence GPS Field Data Collection for Water System Features: March 2013
- GIS Office Processing, QA/QC, & Upload to THA GIS: Ongoing
- Complete Water System Designation and Location: September 2013
- Complete GPS Field Data Collection: September 2013
Sanitary Sewer System – Area 1
• Commence Detailed Internal Dimensions Collection of the CSO Diversion Chambers including all critical elevations: April 2013
• Commence GPS Field Data Collection for Incidental/Conflicting Sanitary, Combined, and Storm Features: March 2013
• GIS Office Processing, QA/QC, & Upload to THA GIS: Ongoing
• Complete GPS Field Data Collection: September 2013

Software & Hardware
• ESRI GIS Selection, Procurement and Implementation: 2013
• Asset Management Software Evaluation and Selection: 2013
• Asset Management Implementation: 2013 and beyond
• Asset Management Population: Ongoing

Phase 2 – 2013/2014
Water System – Area 2 and Primary Transmission Main (PTM) and Secondary Transmission Main (STM)
• THA Authorization to Proceed with Water System, PTM, and STM SUE and Data Collection: June 5, 2013
• Commence Water System, PTM and STM Designation and Location: July 2013
• Commence GPS Field Data Collection for Water System, PTM and STM Features: August 2013
• GIS Office Processing, QA/QC, & Upload to THA GIS: Ongoing
• Complete Water System, PTM, and STM Designation and Location: April 2014
• Complete GPS Field Data Collection: April 2014

Sanitary Sewer System – Area 2 (Within COH)
• Commence GPS Field Data Collection for Incidental/Conflicting Sanitary, Combined, and Storm Features: August 2013
• GIS Office Processing, QA/QC, & Upload to THA GIS: Ongoing
• Complete GPS Field Data Collection: April 2014

Phase 3 – 2013/2014
Sanitary Sewer System - Combined and Separate Sewer Interceptors
• THA Authorization to Proceed with Combined and Separate Sewer Interceptor Investigation: June 5, 2013
• Issue RFP for Combined and Separate Sewer Interceptor Investigation: August 2013
• Receive Combined and Separate Sewer Interceptor Proposals: September 2013
• Commence Combined and Separate Sewer Interceptor Investigation: October 2013
• GIS Office Processing, QA/QC, & Upload to THA GIS: Ongoing
• Complete Combined Sewer Investigation: January 2014

Phase 4 – 2013/2014
Remaining Sewer System Above Ground Features
• THA Authorization to Proceed with Remaining Sewer System Above Ground Features Data Collection: June 5, 2013
• Commence GPS Field Data Collection for all Remaining Sewer System Above Ground Features: June 2013
• GIS Office Processing, QA/QC, & Upload to THA GIS: Ongoing
• Complete GPS Field Data Collection: April 2014

Phase 5 – 2014
Sanitary Sewer System – Critical Combined Sewer Trunk Lines and Collection Sewers needed for LTCP
• Issue RFP for Critical Combined Sewer Trunk Lines and Collection Sewers Investigation
• Receive Critical Combined Sewer Trunk Lines and Collection Sewers Proposals
• THA Authorization to Proceed with Critical Combined Sewer Trunk Lines and Collection Sewers Investigation
• Commence Critical Combined Sewer Trunk Lines and Collection Sewers Investigation
• Commence GPS Field Data Critical Combined Sewer Trunk Lines and Collection Sewers and other information as necessary for Long Term Control Plan Modeling effort
• GIS Office Processing, QA/QC, & Upload to THA GIS
• Complete Critical Combined Sewer Trunk Lines and Collection Sewers Investigation
• Complete GPS Field Data Collection

Phase 6 – 2014 to 2016
Sanitary Sewer System – Remaining Sanitary Sewers
• Issue RFP for Remaining Sanitary Sewers Investigation
• Receive Remaining Sanitary Sewers Proposals
• THA Authorization to Proceed with Remaining Sanitary Sewers Investigation
• Commence Remaining Sanitary Sewers Investigation
• Commence GPS Field Data Collection for Separate Sewer Interceptors
• GIS Office Processing, QA/QC, & Upload to THA GIS
• Complete Remaining Sanitary Sewers Investigation
• Complete GPS Field Data Collection

Phase 7 – To Be Determined
MS4 and Combined Sewer Inlets
• Issue RFP for MS4 and Combined Sewer Inlets Investigation
• Receive MS4 and Combined Sewer Inlets Proposals
• THA Authorization to Proceed with MS4 and Combined Sewer Inlets Investigation
• Commence MS4 and Combined Sewer Inlets Investigation
• Commence GPS Field Data Collection for MS4 and Combined Sewer Inlets
• GIS Office Processing, QA/QC, & Upload to THA GIS
• Complete MS4 and Combined Sewer Inlets Investigation
• Complete GPS Field Data Collection

The phasing and schedule of the project above has been prepared with consideration of the Long Term Control Plan efforts through discussions with CDM Smith. Based upon the negotiated Long Term Control Plan schedule, the phasing and schedule of this project may need to be revised.
XV. Cost and Financing

It is estimated that the entire GIS project will cost in the range of $8-10 MM. This includes project planning, software, hardware, THA staffing, system implementation, training and administration, feature asset designation, location and verification, field data collection, and office processing of the data for the water, sanitary and storm sewer systems. Attached to this Plan is the Project Phasing and Expenditures Spreadsheet that identifies an estimate of the expenditures for each phase and year, and a potential source of funding. THA has several options available to finance the project.

THA received a $5.668 MM PENNVEST loan in July 2011, of which approximately $2.37 MM is available to finance costs associated with the water system portion of the GIS project. These costs include SUE designation and location of the water system features. It will also fund the GPS field data collection of water and incidental/conflicting sanitary and storm water utilities, GIS development, hardware/software purchases, training, asset management software, THA staffing and other related costs. HRG will provide assistance with administering the PENNVEST funding.

Sanitary sewer system costs will primarily be financed through budgeted THA funds. In both 2012 and 2013, THA budgeted $800,000 per year for GIS development. In 2013, THA allocated $600,000 of the total $800,000 budgeted for costs associated with sanitary sewer collection system mapping and $200,000 for costs associated with the sewer conveyance system. For planning purposes, future budgets can be assumed in the same annual amount.

THA is currently pursuing financial assistance from the United States Army Corps of Engineers (USACE). The desired USACE funding would be $845,000 worth of Section 22 Assistance over a multi-year schedule. The USACE currently believes assistance may be available beginning in the late 2013 fiscal year, which ends September 30, 2013, with an initial $5,000 worth of Section 22 Assistance to designate the location of the sewer force mains and begin investigation of the CSO outfall pipes. If approved, USACE would require THA to provide $5,000 worth of matching assistance. It is currently anticipated for this amount to be allocated from THA’s annual “special projects” budget. HRG will provide assistance and coordination with the potential USACE financial assistance.
Mapping derived from data provided by ESRI, City of Harrisburg, PaMap and Dauphin County.

Water System Location Map
The Harrisburg Authority
Sheet 2 of 2
Harrisburg, PA

Estimated Limits of Water Service
Estimated Location of Primary Transmission Main
Estimated Location of Secondary Transmission Main

Dr. Robert E. Young
Water Services Center

Area 1
Area 2
### The Harrisburg Authority

**GIS Program**

**Updated Project Phasing & Expenditures**

**As of June 25, 2013**

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**Notes:**
1. TBA incurred an additional $267,500 of planning and mapping costs in years 2011 and 2012. The portion to be reimbursed through PENNVEST ($122,500) is shown in the above table. Previous work includes the following:
   - Project Understanding and Geodatabase Requirements Documentation
   - Physical Geodatabase Design
   - Pilot Project
   - Front Street Interceptor Work
   - T3 Phase 1 - Flight and Ortho Mapping

2. See Attached Description of Phases. Costs are based on footages provided by TBA and City staff and existing mapping.