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Section 1. TECHNICAL REQUIREMENTS

1.1. INTRODUCTION

The Contractor shall employ methods for the development of the digital data sets consistent with the requirements and specifications described in this Attachment. This section is organized as follows:

- Source document descriptions
- City of Philadelphia base map data
- System features to be converted
- Digitizing specifications
- Problem resolution process
- Tiling scheme
- Quality control and assurance requirements

This section of the RFP provides the technical information required by the Contractor to develop a comprehensive technical approach to the development of the citywide PGW GIS data. **Samples of all source materials described herein will be made available to the interested firms upon signing a confidentiality agreement.**

1.2. SOURCE DOCUMENT DESCRIPTIONS

PGW’s primary source for the gas mains and pressure force system data for the GIS conversion will be confined to its AutoCAD Detailed Main Maps (DMMs) that show all gas facilities at a 1” = 30’ scale and the AutoCAD General Main Maps (GMMs) at a 1” = 300’ scale. The GMMs will be used to show the extent of the cathodic protection systems only.

The DMMs are indexed on a citywide basis to the GMMs, with each GMM containing 100 DMMs. Some GMMs may contain less than 100 DMMs because of the GMM grid extends beyond the limit of the city of Philadelphia. There are approximately 6,300 DMMs and 100 GMMs.

Digital samples of the AutoCAD files will be provided in support of the Contractors proposal preparation and will be available at the mandatory pre-bid meeting.

The DMM and GMM drawings were originally developed in the 1960’s from aerial photography tied into the 10 individual survey districts of the city of Philadelphia at that time. Originally developed on Mylar, the drawings were later converted to AutoCAD. PGW has maintained these drawings to reflect repairs, replacement, new construction, and changes in curb lines since they were developed. The drawings were also updated to reflect the NAD 83 datum.

The Contractor will not be required to search secondary sources of data. Any issues or searches for missing data will be identified through the problem resolution process and will be resolved by PGW staff. It is not envisioned that any field survey work will be required to complete the data conversion effort.
PGW also has an ArcGIS 10.0 database that was developed from the AutoCAD DMM files to support PGW’s GL Noble main prioritization risk model. The model, which consists of pipe segments, material, year installed, pressure, and depth, has not been adjusted to the City base maps.

1.3. Digital Base Map Data

The city of Philadelphia planimetric base map will be used as the project base map. The base map includes a variety of features that have been developed and referenced to the Pennsylvania state plane coordinate system (south zone, 5151), in the North American Datum of 1983 (NAD83). Vertical coordinates were generated in North American Datum of 1988 (NAVD88) and were later converted to “City of Philadelphia” datum. City of Philadelphia datum differs from NAVD88 by -4.63 feet and from national geodetic vertical datum of 1929 (NGVD29) by -5.71 feet. All coverages are designed to be displayed and plotted at a scale of 1:2400.

It is anticipated that curb-lines in the AutoCAD drawings will not coincide with curb-lines on the digital base map. For areas where the two do not coincide the Contractor will be required to place the facility positions using distances and angles of piping as shown in the AutoCAD drawings. The annotated distances between pipes and curb-lines on the DMMs are known to be very accurate. The curb and building lines on the AutoCAD are not to be converted.

A sample of the base map and data dictionary will be provided with the sample AutoCAD drawings.

1.4. System Features to Be Converted

All gas features on the DMM AutoCAD drawings as well as the Gas Services and Gas Meters not on the AutoCAD Drawings but described, measured and location referenced to Curb Lines and Building Lines in an Oracle Database will be converted to the Gas Distribution geodatabase using the current ESRI Utility and Pipeline Model for 10.2 – this includes active and abandoned facilities. Abandoned facilities have only been captured since 1985, when mylar system drawings were moved to AutoCAD. The curb and building lines on the AutoCAD are not to be converted.

The GMMs will be used to indicate the extent of individual cathodic protection systems. The contractor should review the source material prior to converting the pilot area and make recommendations for additions to accommodate any important feature represented in the source materials that are missing from this preliminary design. The systems and anticipated objects to be included in the ESRI data model are shown in the following table. Attribute tables for each feature are included in Exhibit A. Abandoned facilities will be moved to their own feature classes (i.e. Abandoned Pipes or Abandoned Devices).
<table>
<thead>
<tr>
<th>System</th>
<th>Feature Class</th>
<th>Includes:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipes</td>
<td>Complex edge -Mains</td>
<td>Distribution main</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Transmission main</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Service (Large and HP services on DMMs ONLY)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Services (&lt; 2” and Not HP)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Point</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Repairs to Joints and Mains shown on DMMs</td>
</tr>
<tr>
<td>Line Feature – Yard Piping</td>
<td>Conduits</td>
<td></td>
</tr>
<tr>
<td>(not part of geometric</td>
<td></td>
<td>Control lines</td>
</tr>
<tr>
<td>network)</td>
<td></td>
<td>Underground fuel line (UP)</td>
</tr>
<tr>
<td>Cathodic Protection System</td>
<td>Non controllable simple junctions</td>
<td>Rectifiers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CP Test Points</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Anode Beds</td>
</tr>
<tr>
<td>Fittings</td>
<td>Simple junction - Non-controllable</td>
<td>Tees</td>
</tr>
<tr>
<td></td>
<td></td>
<td>End Caps</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Couplings</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Flanges</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bends/Ells</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Repair Sleeves</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Point Feature</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vent casing (posts for casing/ sleeves)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Simple junction - Controllable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stopper Fittings</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bag Holes</td>
</tr>
<tr>
<td>Gas Devices and Facilities</td>
<td>Simple junction - Controllable</td>
<td>Valves</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Regulators</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meters (To Be Placed At)</td>
</tr>
<tr>
<td>Point Feature</td>
<td>Drips</td>
<td>Traffic Boxes</td>
</tr>
<tr>
<td>---------------</td>
<td>-------</td>
<td>---------------</td>
</tr>
<tr>
<td>Casing (Line Feature)</td>
<td>Bridges, crossings, and where new pipe is put inside old.</td>
<td></td>
</tr>
<tr>
<td>Points features</td>
<td>Depth of cover/Direction of flow Miscellaneous Annotation (ex. Cautions about other infrastructure in area)</td>
<td></td>
</tr>
<tr>
<td>Dimension</td>
<td>Dimensioning line</td>
<td></td>
</tr>
<tr>
<td>Industrial Stations</td>
<td>Vault</td>
<td></td>
</tr>
<tr>
<td>Regulator Stations</td>
<td>Vault Above Ground structure</td>
<td></td>
</tr>
<tr>
<td>Simple Junction</td>
<td>Source of Gas Supply</td>
<td></td>
</tr>
<tr>
<td>Regulator Station</td>
<td>Point Regulator Station</td>
<td></td>
</tr>
</tbody>
</table>

**Digitizing Requirements**

Contractors must specify the methods that will be used to develop the required digital data from the DMM and GMM files. All vector and attribute data must conform to the following specifications:

- Projection/Coordination system – The ESRI geodatabase file developed during the project will be developed using the Pennsylvania state plane coordinate system (south zone, 5151), referenced to the 1983 North American Datum (NAD83).
- Positional Accuracy to Source – each system feature must be placed within one (1) foot of the location indicated by the dimensions shown on the DMMs relative to the
photogrammetrically derived digital curb line data. In areas where the curb line location shown of the source material and the photogrammetrically derived curb line location differ (i.e. where the street widths do not match) by more than three (3) feet, a problem resolution issue must be raised for resolution by PGW. The 3 foot standard will be verified during the pilot program.

- Relative Positional Accuracy – Facilities must be placed within one (1) foot, fitting to fitting, relative to one another as shown on the source. For example, all bends, jogs or deflections in the pipe paths must be digitized as shown on the source materials so as to ensure the features are placed within one (1) foot of the position indicated on the source material relative to the other features shown on the source material.

- Completeness – Both the location and descriptive attributes about each of the required features must be developed where shown on the source material. All missing or unknown feature attributes shall be clearly indicated using approved codes and must be brought to the attention of PGW during the data preparation phase of the conversion.

- Edgematching – All data delivered must be seamless and subsequent data deliverables must match seamlessly along each boundary.

- Topology – All data must be developed with the correct system topology whereby edges, and junctions “snap” correctly to one another and no “dangles” or “overshooting” arcs will be allowed. All system features represented as points must lie directly on and “snapped” to the edge features where applicable.

- Line Quality – Within curvilinear line segments comprised of multiple vertices, each vertex must be placed no closer than 1 foot from another vertex and no further than 4 feet from the last vertex to ensure visual smoothness. No zero-length line segments, hooks or jags will be accepted. Lines that are shown on the source materials to be straight shall be digitized using only two points to represent the beginning and ending of the line. Extraneous vertices will not be allowed and no customized line types will be accepted without prior approval by PGW.

- Annotation – capture of existing annotation, as specified in Table 1.1 will be required and must be included in the GIS data deliveries. Annotation on feature attributes will not be required.

- Feature duplication – No duplication of features will be allowed.

- Completeness – All features depicted on the DMMs must be captured. On the GMMs the extent of the corrosion control systems and the CP System numbers that are depicted must be captured.

Data deliverables will be reviewed by PGW for conformance with the above specifications using both electronic and manual review methods during PGW’s Quality Assurance process.
1.5. **Problem Resolution**

PGW and the contractor will establish protocols for identifying, tracking and resolving questions and problems that arise during each step of the conversion process. The Contractor will develop problem resolution forms to be used during each section of the proposed process. The specific design of the forms will be developed during the pilot conversion phase of the project and will be transferred from the Contractor to PGW and back to track each anomaly or question. The Contractor will be required to deliver the completed resolution forms with each delivery group.

1.6. **Grid Scheme and Pilot Conversion Areas**

Throughout the conversion process, the existing DMM and GMM grids will be used to define the data deliverables and track the progress of the data conversion effort.

The Pilot Area for the project will be comprised of three (3) General Main Maps (GMMs) encompassing nine (9) Detail Main Maps (DMMs) each. The pilot areas will cover separate areas with the system and will contain, to the best of PGW’s knowledge, all features present in the system to be converted. The areas have been selected by PGW and a map of the areas can be found in Exhibit B.

1.7. **Quality Control and Quality Assurance Requirements**

The Contractor will develop specific quality control and quality assurance processes to trap and correct errors resulting from erroneous digitizing or incorrect attribute data entry. The Contractor’s response to this RFP shall include well-defined data review processes that will provide a 100% check on all data, both spatial and attribute. These processes may include, but should not be limited to, review for the following items:

- Complete adherence to all database design specifications listed in Section 1.4
- Adherence to the digitizing specifications described in Section 1.5
- Correct entry of all feature attribute data.
- Correct spatial position of each GIS system feature (edges, junctions, points)
- Capture of all available features and attributes

Each data delivered to PGW will be subject to a set of Quality Assurance checks to determine if the data meet acceptable levels. The process will use the American National Standards Institute (ANSI) Z1.4-1993 random sampling standards to ensure that the data meets a minimum acceptable quality level (AQL) of 1.0 (99% accuracy by statistical sampling methods) when compared back to the original source materials. This process will include the random selection of a number of attributes contained in the GIS features to be reviewed based on statistically determined sample size for the number of total attributes in each data set delivery.
Each set of digital data delivered will undergo a 100% check of each attribute in the random sample. Each attribute found to be in error will be noted and the final number of errors in each sample will be reviewed against the ANSI tables to determine the level of acceptance or rejection for the delivery. All delivery groups will be categorized as follows:

1. **REJECTED:** Should the number of errors found by PGW during the statistical review exceed the maximum number of allowable errors, PGW will discontinue review of the delivery group and return it to the contractor as REJECTED. The Contractor must then subject the delivery group to a 100% quality control and corrections cycle prior to resubmittal to PGW. PGW also reserves the right to REJECT any delivery group based on a cursory review if the overall quality is deemed unacceptable by PGW. The Contractor may be subject to penalties, based on the final contract, for submittals that are successively rejected.

2. **ACCEPTED WITH EDITS:** Delivery groups that are found to pass the statistical review but contain errors will be returned to the Contractor as ACCEPTED WITH EDITS. The Contractor must then correct all errors found and resubmit the delivery group. All corrections will be subject to a 100% review by PGW.

3. **ACCEPTED:** Delivery groups that meet the specifications set forth in the final scope of services contract and contain no errors (all errors from an ACCEPTED WITH EDITS ratings have been corrected) will be ACCEPTED by PGW. PGW will not review an invoice for a delivery group unit it has been ACCEPTED by PGW’s delivery group review and acceptance process.

The rework required to process the edits will not be allowed to affect the Contractor’s production schedule and must be completed per the schedule set forth by the Contractor in their response to this RFP and the final scope of services agreed upon by both the Contractor and PGW. PGW will perform the statistical review of each data delivery and return all comments to the Contractor within 30 working days of its initial delivery for the appropriate corrective action based on the number of errors found.

### 1.8 MAINTENANCE REQUIREMENTS

The Contractor will be required to maintain PGW’s geodatabase until final acceptance. PGW will forward to the vendor the field sketches (or modified DMMs) for any mains replaced or constructed in the grids that have been accepted.

PGW currently replaces 30 miles of main per year and installs 4 to 5 miles of new main. PGW normally updates its DMMs with 1200 field sketches per year.

### 1.9 ASSET AS-BUILT SOLUTION REQUIREMENTS

The contractor is required prepare and present a viable, cost effective and efficient process to gather new or revised asset data for use in the geodatabase being delivered under this RFP. The as-built information will need to included, but not be limited to, mains, services and meter locations along with all data stored on barcodes.
SECTION 2 PROJECT DELIVERABLES

The specific project deliverables are summarized below. The deliverables are organized by project phase and the proposed schedule shall include anticipated dates of delivery for each. Payment of invoices for the work performed during the project will be based on PGW’s acceptance below, as described in Section 3, Acceptance Criteria and Process.

2.1. PROJECT INITIATION AND MANAGEMENT

Initial Management Meeting – A meeting of management teams for both PGW and the Contractor will be held to outline the project, introduce staff and review the project milestones.

Draft Conversion Work Plan – A detailed draft conversion Work Plan, based directly on the Contractor’s proposal, will be delivered after the Initial Management Meeting is held.

Kickoff Workshop – The Contractor will hold a kickoff workshop attended by key members of the Contractor and PGW staff to review and discuss the draft conversion Work Plan.

Status Meetings – The Contractor will hold status meetings with PGW on a monthly basis throughout the project with the PGW Steering Committee.

Status Reports – The Contractor will deliver monthly status reports to the PGW Steering Committee. The reports will be required to list the major project milestones achieved during that month, the status of the project to date relative to the production schedule, a list of major conversion issues and the modifications made to address them. The reports must include a summary of the information contained in the problem resolution forms returned to PGW for that month.

2.2. PILOT CONVERSION PHASE

Preliminary Pilot Data Set – This data set will consist of the Pilot areas defined in Section 1.7. Each set of Pilot area data must conform to the format described in the Technical Requirements and the deliverables will consist of the following:

- A set of “scrub” errata lists (delivered to PGW for review prior to beginning digital conversion of the data)
- Copies of all problem resolution forms generated for the pilot area data.
- Draft document that defines the structure and coding contained in each field of the GIS database file developed.
- DMM template for recreating PGW AutoCAD plot.
Final Pilot Data Set – This data set will consist of the same data as in the Preliminary Pilot data set but will be modified based on PGW’s comments and will consist of the following:

- Final, modified geodatabase files in the format described in the Technical Requirements
- Draft review comment forms containing the original edit mark-ups from all PGW reviews performed on the Preliminary Pilot Data Set.

Final Conversion Work Plan – The Contractor will deliver the final, revised work plan containing all PGW comments and modifications based on the conversion of the Pilot Area data set.

2.3. PRODUCTION PHASE

Draft Data Delivery – The Contractor will develop and deliver data in multiple phases after acceptance of the Pilot Area Data Set by PGW. Each delivery area will consist of an area comprised of a set number of PGW DMM tile areas as defined in the tiling scheme described in the Technical Requirements, Section 1.7. Data will be considered to be in the draft format until such time as the data successfully pass the ANSI quality assurance tests and are labeled as “ACCEPTED” by PGW. Each data delivery in each phase will consist of the following:

- A set of “scrub” errata lists (delivered to PGW for review prior to beginning digital conversion of the data for each production phase).
- Geodatabase as described in Technical Requirements
- Copies of all problem resolution forms for the delivery area
- Copies of all PGW review comment forms

2.4. GEODATABASE MAINTENANCE

- Any scrubbed documentation that is required
- Revised geodatabase
- Copies of any PGW review comment forms

2.5. ASSET AS-BUILT SOLUTION

- As described in Section 1.9

2.6. PROJECT FINALIZATION

- Finalization Report – the Contractor will develop a finalization report for the project that will include the following:
• The Final Conversion Work Plan document containing any required modifications made to the conversion process after the pilot phase.
• Final document describing the design and format of the geodatabase.

2.7. DELIVERABLE FORMATS

All deliverables will be delivered to PGW via FTP / SFTP. The geodatabase will be delivered in ArcGIS 10.21. All documents will be delivered in both bound paper and digital Microsoft Word format and all errata lists will be delivered in Microsoft Access format on CD or DVD ROM along with a bound paper printout of each. All deliverables will include a cover/transmittal letter containing an itemized list of the hardcopy and digital files contained in the delivery.
SECTION 3  ACCEPTANCE CRITERIA AND PROCESS

3.1. ACCEPTANCE CRITERIA

Throughout the project each of the deliverables described in Section 2 will be evaluated by PGW against a specific set of acceptance criteria. Each deliverable product from the Contractor will be required to meet the minimum criteria described below and PGW reserves the sole right to approve or reject each deliverable either in part or as a whole. The Contractor may invoice PGW for work performed as described below.

Should a deliverable be deemed unacceptable, PGW reserves the right to suspend further production until such time as the Contractor can demonstrate that the problem(s) have been corrected.

3.1.1 PROJECT INITIATION DELIVERABLES

The Initial Management Meeting, Kickoff Workshop and Draft Conversion Work Plan will be grouped together to comprise the project initiation deliverable. The meeting and workshop will be reviewed by each PGW staff member in attendance for the following criteria:

- The clarity of the presentations given
- Provide a complete, thorough review of the proposed conversion process
- Attendance by key Contractor staff

The Draft Conversion Work Plan will be reviewed for the following criteria:

- Compliance with the work plan format requirements set forth in this RFP
- Completeness of the description of the number and type of conversion processes to be performed relative to the conversion requirements set forth in this RFP
- Adequate and clear description of each individual conversion process, including the applicable quality control processes
- Adequate description of the draft and final deliverables

Should the meeting or workshop fail to meet the criteria described above, PGW reserves the right to require additional meetings or workshops (without additional compensation) prior to returning the work plan review comments to the Contractor for correction. Once the meetings, workshop and work plan are approved by PGW the Contractor may invoice for the work performed up to that point in a single invoice based on the payment schedule agreed upon by PGW and Contractor within the final contract.

3.1.2 PILOT CONVERSION DELIVERABLES

The Preliminary Pilot Data Set will comprise the first digital GIS data deliverable and will be reviewed against the requirements outlined in this RFP for the following:
• Adherence to the required database design and deliverable format
• Correct projection and coordinate system
• Positional accuracy of the digital features
• Completeness of both the physical features and the attribute data compared to the original source materials
• Correctness of attribute data to source materials
• Seamless edgematching and correct feature topology
• Line quality and errors in digitizing (dangles and overshoots)
• Annotation
• Adequate plotting template for recreating AutoCAD DMMs plots

The Final Pilot Data Set will be reviewed to ensure that all corrections requested by PGW were made. PGW will also perform a statistical Quality Assurance review of the data to ensure that the required level of quality has been met.

The Modified Conversion Work Plan will be reviewed by PGW to ensure that any modifications to the conversion processes necessitated by the pilot conversion are documented. The Contractor may invoice for Preliminary Pilot Data Set, Final Pilot Data Set and the Modified Conversion Work Plan separately based on approval by PGW.

3.1.3 PRODUCTION DELIVERABLES

The data delivery set for each of the production phases agreed upon by PGW and Contractor and set forth in the final scope of services contract will be reviewed for the following:

• Adherence to the required database design and deliverable format
• Correct projection and coordinate system
• Positional accuracy of the digital features
• Completeness of both the physical features and the attribute data
• Correctness of attribute data to source materials
• Seamless edgematching and correct feature topology
• Line quality and errors in digitizing (dangles and overshoots)
• Annotation

PGW will perform the statistical Quality Assurance review of the data to ensure that the correct level of quality has been met and will accept or reject the data based on the process described in Section 2.

The Contractor may invoice separately for each of the data delivery phases pending approval of the data by PGW. Data must be labeled as ACCEPTED by PGW prior to invoices being generated.
3.1.4 Geodatabase Maintenance

PGW will review the previously approved grids where mains were replaced or new mains installed for conformance of the revised data with acceptance criteria listed in Section 3.1.3.

3.1.5 Project Finalization

PGW will review the Finalization Report for content and completeness relative to the requirements of Sections 1 and 2. The Contractor will invoice PGW for the Project Finalization deliverables and the last GIS data delivery set on the same invoice.

3.2. Acceptance Process

The Conversion Work Plan and Finalization Report deliverables will be reviewed by PGW staff members for appropriate content as per both the technical requirements set forth in Section 1 and the final scope of services agreed upon by PGW and Contractor.

The draft GIS data deliverables will undergo a set of Quality Assurance checks utilizing the ANSI standard random sampling standards described in this RFP. Each set of digital GIS data delivered will be reviewed and labeled as REJECTED, ACCEPTED WITH EDITS or ACCEPTED. Data that are labeled as REJECTED will be returned to the Contractor for a thorough reworking and re-review. Data that are labeled as ACCEPTED WITH EDITS will be returned to the Contractor for correction of specific errors and re-review. Once a data set is labeled ACCEPTED no further action by the Contractor will be required for that data set.

If a data delivery set is rejected initially or found to require edits after two successive Quality Assurance reviews by PGW, the data set will be returned to the Contractor for careful re-review, correction and resubmission to PGW. PGW will then use a more stringent, tightened level of sampling standard on that data delivery set as well as the next set of data delivered in order to ensure that the proper corrective action has been taken by the Contractor.

3.3. Payment Criteria

Payment will be authorized on a deliverable by deliverable basis based on the delivery groups described in Section 2 – Project Deliverables. The final payment schedule will be determined during contract negotiations once a Contractor has been selected. Payment will only be authorized for data deliverables that are categorized as ACCEPTED. Data deliverables that are categorized as REJECTED or ACCEPTED WITH EDITS may not be invoiced until the data are modified, re-reviewed by PGW and found to be ACCEPTED.
EXHIBIT A

1. Geodatabase Summary Objects
   A. Pipes
   B. Flow Control Devices
   C. Inline Devices
   D. Connected Devices
   E. Structures
   F. Cathodic Protection Devices

2. Examples
   A. Symbol examples
   B. Tee / Crosses
   C. Abandoned Facilities
   D. Services
   E. Underground House Piping
   F. Excess Flow Valves
   G. Location Measures
   H. Cathodic Protection Details
   I. Special Notes
   J. “A” Drawings
   K. Details
   L. Regulator Stations
   M. Step-Down Regulators

EXHIBIT B
1. Pilot Conversion Phase Map