BURNS & McDONNELL

PROGRAM LEVEL COST FORECAST AND SCHEDULE MODEL

SUBMITTED TO

THE PEOPLES GAS LIGHT AND COKE COMPANY

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1.0 INTRODUCTION

Burns & McDonnell was retained by The Peoples Gas Light and Coke Company (Peoples Gas) to develop a cost forecast and schedule model for the remaining accelerated infrastructure replacement program, also generalized as the Accelerated Main replacement Program (AMRP).

1.1 BACKGROUND

Peoples Gas is held by WEC Energy Group, Inc. since July 2015 and has been undertaking a long-term project involving upgrading its gas transmission and distribution systems which began in 2011. The program involves installation of high pressure (HP) and medium pressure (MP) mains, services and meters, as well as retirement of low pressure (LP) and MP 2-inch to 48-inch diameter piping made of various materials. Until 2014, engineering, planning and construction were prioritized based on the potential for leaks in the system. Since 2014, prioritization has been changed to a neighborhood approach, using the 228 neighborhoods established by City of Chicago as a basis. As of June 2015 the following progress has been made:

TABLE 1-1 AMRP Progress

Component	Program Total	Actual Program to Date
MP mains to install (miles)	3,462	597
HP mains to install (miles)	40	9
Services	309,760	50,872
Meters	520,609	101,381
Mains to be retired (miles)	2,359	311

The purpose of the forecast and modeling is to provide additional information to WEC leadership with respect to the cost and schedule of the AMRP. The scope of this assignment was to create an editable / updateable model that can be utilized by in-house Peoples Gas staff to support the ability to track and trend future program activities and costs.

This Report summarizes the process involved in creating the cost and schedule models developed by Burns & McDonnell, and presents model outputs for two scenarios described within.

1.2 OVERVIEW

Burns & McDonnell commenced an iterative process for developing the models at the neighborhood-level with the understanding that this level of detail is appropriate for the purpose of the effort but also understanding that there are several actual phases within each neighborhood. Model development included the following activities:

- Interview representatives from several involved company departments including Accounting, Engineering, Construction Planning, Construction, and Executive Management;
- Obtain and review several sources of data and information about past, current and future capital projects involving the AMRP (HP mains, MP mains, services and meters in the 228 neighborhoods along with restoration and abandonment) as well as Public Improvement (PI) projects, System Improvement (SI) projects and System Expansion (SE) projects;
- Develop a Work Breakdown Structure (WBS) for each "project" which are defined as the remaining 201 neighborhoods and the eight HP main projects needed to facilitate replacements in certain neighborhoods;
- Develop cost "drivers" and schedule "drivers" that impact the models. Assign factors to them;
- Develop models for a 2030 and 2040 completion, respectively; and
- Populate the cost forecast and schedule models with the factors, using unit costs, historical AMRP durations, and considering uncertainties / efficiencies to assign a cost range.

1.3 REPORT ORGANIZATION

Section 1 – Introduction – discusses background information, objectives of the effort and a general overview of the scope of the schedule and cost models.

Section 2 – Summary of Information and Data Collection – presents a summary of meetings conducted with Peoples Gas representing executive management, engineering, accounting, construction planning and construction. Also the sources of data reviewed and data used in the models is summarized.

Section 3 – Cost Data Used in Model – summarizes the purpose of the cost model, overall assumptions, key inputs, and drivers, factors and worksheets used in the model as well as the models to complete work in 2030 and 2040.

Section 4 –Schedule Model – summarizes the purpose of the schedule model, overall assumptions, key inputs, and drivers, factors and worksheets used in the model as well as the models to complete work in 2030 and 2040.

Section 5 – Cost and Schedule Model Analysis and Reports –graphically presents the specific models for the two scenarios and the ranges of the models.

Section 6 – Recommendations – presents a risk assessment and program recommendations specific to the SOW.

Appendix A and B will include the model outputs for 2030 and 2040. Appendix C includes a summary of the neighborhoods and Peoples Gas Districts.

1.4 MODEL SUMMARY

In September 2015 Burns and McDonnell Engineering Company (Burns & McDonnell) was retained by The Peoples Gas Light and Coke Company (Peoples Gas) to produce an independent Program Level Cost Forecast and Schedule Model for the remaining portion of their Accelerated Main Replacement Program (AMRP). The purpose of the exercise was to establish a series of cost and schedule models to aid in the management of the program moving forward. The Burns & McDonnell team reviewed existing data that was made available, and conducted numerous interviews with Peoples Gas staff to obtain an understanding of the AMRP to date, and the future direction of the program. Using this data and information, Burns & McDonnell developed two specific schedule models with associated cost forecasts:

- A model ending in 2030 (2030 Model)
- A model ending in 2040 (2040 Model)

The development of the two models included implementing the following tasks:

- Meet with Peoples Gas staff and gather pertinent historical data and remaining program scope
- Identify factors driving the cost forecast model and influencing the schedule
- Establish key requirements and goals for the models
- Develop construction cost forecasts at a neighborhood level
- Develop program level cost and schedule models
- Train Peoples Gas staff to utilize the models

COST FORECAST AND SCHEDULE MODEL

The above two models were developed using Excel and Primavera P6. A Work Breakdown Structure (WBS) which are consistence for both models, include:

- Program Costs Forecast inclusive of engineering, permitting, program management (Including overheads)
- Construction Costs Forecast inclusive of materials and installing medium pressure (MP) and high pressure (HP) mains, main retirement, gas services, meters, and restoration
- Miscellaneous costs forecast inclusive of public improvement related to AMRP

It was determined that an intermediate to preliminary level Program Cost Forecast and Schedule Model would be developed with a deterministic model using historical and lessons-learned data from PGL's AMRP. Current industry data would not accurately reflect the labor or geographical conditions found in this setting.

Recent construction cost project actuals and as-built quantities were used to determine unit rates as part of the scenarios for each of the two models. Program level costs were annualized and applied accordingly in each model. Due to time constraints of this exercise, a comprehensive risk analysis was not implemented. Cost risks were addressed with contingency assigned to all the major items. Contingency and escalation costs have a significant impact to the overall program cost.

TEMPLATE WORK BREAKDOWN STRUCTUIRE (WBS)	
WBS Code	WBS Name
Peoples Gas Model	Peoples Gas AMRP - Rev 0
Peoples Gas Model 0	Other Capital Project Planning
Peoples Gas Model 0.1	Public Improvement
Peoples Gas Model 0.2	System Improvement
Peoples Gas Model 0.3	System Expansion
Peoples Gas Model 1	Program Level Activities
Peoples Gas Model 1.1	Engineering
Peoples Gas Model 1.2	Escalation
Peoples Gas Model 1.3	Contingency
Peoples Gas Model 1.4	Program Management
Peoples Gas Model 2	High Pressure Mains
Peoples Gas Model 2.1	HP NW Extension w Gate Stn
Peoples Gas Model 2.2	HP NE Extension
Peoples Gas Model 2.3	HP Lower NE Connection
Peoples Gas Model 2.4	HP Extension from 73rd
Peoples Gas Model 2.5	HP SE Connection
Peoples Gas Model 2.6	HP Lower Central Connection w Gate Stn
Peoples Gas Model 2.7	HP SW Gate Station
Peoples Gas Model 2.8	HP Upper Central Connection
Peoples Gas Model 3	Neighborhood Project Level
Peoples Gas Model 3.000	AMRP EFFICIENCIES GAIN FROM PI/SI
Peoples Gas Model 3.MTR	2015 Meter Carryover
Peoples Gas Model 3.001	N001-Albany Park
Peoples Gas Model 3.002	N002-Altgeld Gardens
Peoples Gas Model 3.003	N003-Andersonville
Peoples Gas Model 3.004	N004-Arcadia Terrace

FACTORS identified that are incorporated into the cost and schedule models include:	**CONSTRAINTS** that influenced the schedule:
▪ Pipe Category (HP vs MP) ▪ Installation Distance ▪ Installation Location (Parkway, Sidewalk, Street, Alley) ▪ Installation Method (Open Cut, Directional Bore, Main Insertion) ▪ Pipe Diameter ▪ Pipe Material (Steel or Plastic) ▪ Crossings (Hydro and Railroad) ▪ Restoration (Per Length of Installation and Impacted Intersections) ▪ Program Management & Overhead Costs ▪ Escalation ▪ Contingency	▪ Annual Meter Installation ▪ Production Rates ▪ High Pressure Main Sequencing ▪ High Pressure Vault Dependence ▪ Neighborhood UMRI Rating ▪ Normal Seasonal Constraints ▪ Current System Constraints, ▪ City of Chicago Moratoriums
COST: PROGRAM LEVEL DRIVERS	**COST:** PROJECT LEVEL DRIVERS
▪ Engineering ▪ Construction ▪ Escalation ▪ Program Management	▪ Install ▪ Restore ▪ Retire ▪ Services ▪ Meters

The year of completion for the AMRP within the models were 2030 and 2040. All schedules were driven by actual production rates from the current AMRP used to determine execution parameters and constraints.

SUMMARY OF RESULTS

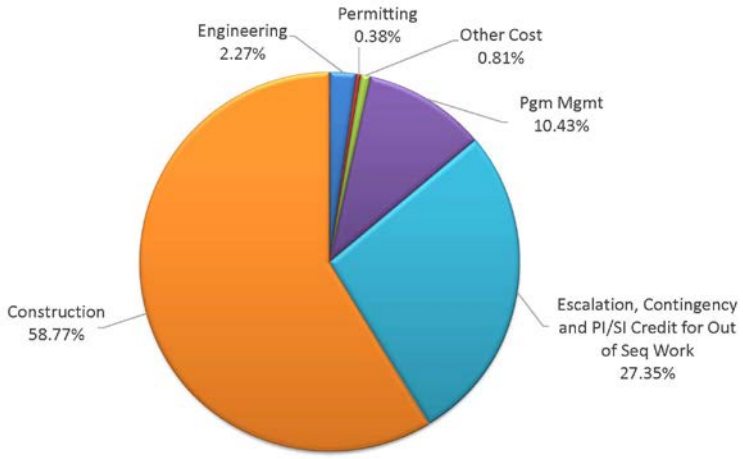
The scenarios for each of the models has been developed from historical AMRP program performance and assumptions to develop a series of cost forecast and schedule models to be used to measure future program performance. Additionally, ranges in the cost forecasts for each model are shown to indicate varying program performance scenarios. These were developed by introducing variances of major cost drivers that could be influenced by efficiencies in program performance to establish a deterministic range of possible results.

TOTAL PROGRAM COST	New Management Target Case (Billions)	Contingency Case Higher Restoration Costs (Billions)	Pre-Acquisition Path (Billions)
2030	$6.83	$8.33	$9.41
2040	$7.81	$9.69	$10.96
	▪ 75% PI/Si Out of Sequence Work Credit ▪ 14% Efficiency in Contractor Labor ▪ 7.5% Construction Contingency ▪ 80% Installation Efficiency (All MP & HP) ▪ 75% Program Management Efficiency ▪ 40% Reduction in Restoration Cost	▪ 60% PI/Si Out of Sequence Work Credit ▪ 90% Installation Efficiency (All MP & HP) ▪ 85 % Program Management Efficiency ▪ 10% Reduction in Restoration Cost	**Base Assumptions:** Actual Program Cost to Date = $932.0M **Consisting of:** AMRP Construction to Date = $805.4M, Program Costs/Overheads/Etc. = $126.6M ▪ PI/SI Out of Sequence Work Credit = 50% ▪ Engineering Escalation = 2.10% ▪ Contractor Labor Escalation = 3.50% ▪ PGL Labor Escalation = 3.15% ▪ Material, Plastic Pipe Escalation = 1.54% ▪ Material, Steel Pipe Escalation = 3.00% ▪ Permit Escalation = 5.0% ▪ Engineering Contingency = 10% ▪ Construction Contingency = 10% ▪ Meter Installation Contingency = 10% ▪ Permit Contingency = 10% ▪ Program Management Contingency = 10% ▪ Other Program Cost Contingency = 10% ▪ Quantities and Sequencing per Neighborhood Assignments ▪ Unit Prices are Per Historical Data and Industry Standards ▪ Production Rates are Per Historical Data and Industry Standards

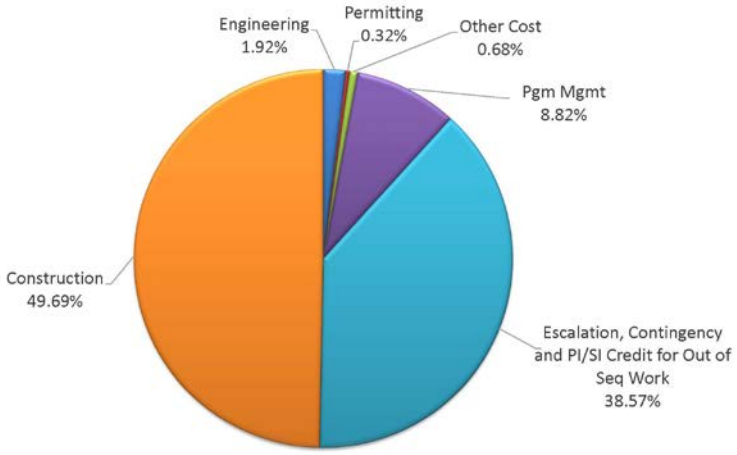
SUMMARY OF RESULTS OVERALL COST BREAKDOWN

Breaking down the overall cost into percentages of total program cost and comparing complexity can indicate possible areas of opportunity. Below is a breakdown of cost by percentage of the two models:

2030 MODEL



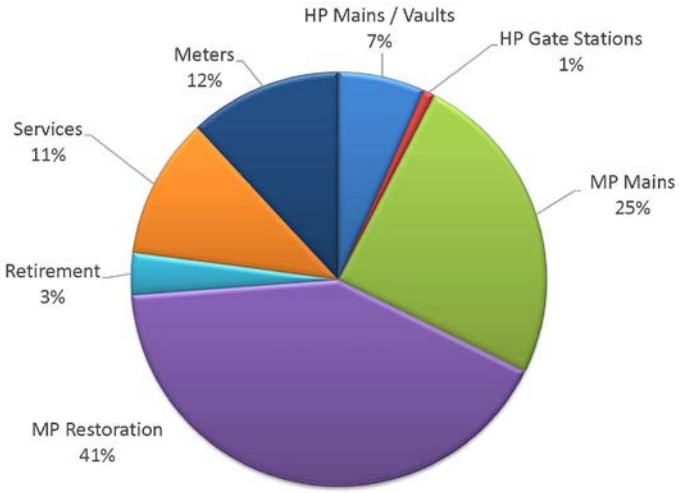
2040 MODEL



SUMMARY OF RESULTS CONSTRUCTION COST BREAKDOWN

The graphics above illustrate the overall budget broken down into the major cost centers. As you note, the largest spend is the actual construction budget. The graph to the right breaks down the construction budget into major categories of the AMRP work.

2030 / 2040 MODEL



CONCLUSION RECOMMENDATIONS

These versions of the cost and schedule models will be a dynamic element in the program moving forward. As major program decisions are redefined, a version of one of these models will transition into a strong baseline. The information collected, summarized, and analyzed against a baseline will provide insight to planning and coordination while aiding in sound management decisions moving forward.

Burns & McDonnell will be transitioning these models over to Peoples Gas staff in the next few weeks. As Peoples Gas continues to restructure the program the following items should be considered:

EXECUTIVE GROUP	PROGRAM GROUP	CONSTRUCTION GROUP
▪ Expand the current Risk Strategies at the Program Level as well as the Project Level. ▪ Annual review of Escalation and Contingency budgets. ▪ Continue to Review and Refresh program processes and procedures from Planning to Construction Close Out.	▪ Revisit the current model schedule with all stakeholders and confirm the 2016 schedule. ▪ Reduce the number of cost centers residing at the program level. ▪ Engage all departments involved to optimize the schedule. Adopt a scheduling strategy that looks forward three to five years. ▪ Commit to truing up the model on a defined schedule. ▪ Annual revisit all major cost centers budgets.	▪ Revise methods of capturing actual data so that it is aligned with the processes of the program / projects. ▪ Expand the detail and accuracy of the model's WBS to manage actual construction activities. ▪ Expedite the project close out process at year end so that model costs and schedules can be updated prior to the next year's starts. ▪ Explore alternate construction contract terms and conditions.

2.0 SUMMARY OF INFORMATION AND DATA COLLECTION

Several meetings and interviews were conducted to ascertain various processes and to provide general overviews from the perspective of Accounting, Executive Management, Engineering, Procurement, Project Construction Planning and Construction. In some cases, follow-up meetings occurred. In addition, several sources of data were provided by Peoples Gas.

2.1 SUMMARY OF DATA SOURCES

Peoples Gas provided various data and documents that can be generally categorized as follows:

- HP and neighborhood MP project cost data;
- Unit pricing for cast iron and plastic pipe and fittings;
- Capital Overhead cost data;
- As-built data from Portage Park, South Austin, South Shore and Beverly;
- Project rankings;
- Neighborhood and Chicago ward maps;
- Data regarding railroad crossings, hydro crossings, intersections and aprons;
- Data regarding meter density and meter pricing;
- Main retirement data;
- Permit costs and categories; and,
- Others.

Construction cost data sources are presented in Table 2-1:

TABLE 2-1 Cost Data Sources

Scope Component	Source
Main Distance to Install per Diameter	Derived from existing infrastructure per neighborhood
Distance per Install Type / Locations	Determined from as-built and contractor bid~~s~~ scopes on a neighborhood category basis
Main Retire	Existing infrastructure per neighborhood
Services	Derived from existing infrastructure per neighborhood
Meters	Derived from existing infrastructure per neighborhood

The sources of unit costs for each component are presented in Table 2-2:

TABLE 2-2 Unit Cost Data Sources	
Unit Cost Component	**Source**
Install Costs (per foot) per diameter, type/location	Actuals, As-Built and Cost Estimating Template
Restore Costs (per foot) Per type/location	Actuals, As-Built and Cost Estimating Template
Restore Costs (each) • Intersections • Apron	Cost Estimating Template/ Historical Cost Analysis
Services (each)	Cost Estimating Template/ Historical Cost Analysis & Actuals/ Contractor Bid Scopes
Meters (each)	Actuals/ As-Built

3.0 COST DATA USED IN MODELS

The program forecast model is comprised of the construction cost forecast component and the program cost forecast component. The cost models were developed from data provided by Peoples Gas.

The construction cost forecast is comprised of two components:

- MP costs forecast per neighborhood
- HP cost forecast

The construction cost forecast applies to present day costs per neighborhood and HP project for construction activities. Program costs such as program management, program supplies and engineering are not included in the construction cost forecast but are included in the program cost forecast component.

3.1. MEDIUM PRESSURE COSTS PER NEIGHBORHOOD

MP costs per neighborhood are broken into MP main installation, MP restoration, retirement services and meter components. The following process was implemented to assess costs per neighborhood.

1. A cost sensitivity analysis was performed on the available data to establish the drivers of cost (See Section 3.1.1).
    a. Assessed per linear foot costs; and
    b. Assessed per unit costs for cost drivers.
2. Costs were established using actual costs from recent work and as-built installation data.
    a. Per linear foot costs for MP main installation and restoration were derived from actual costs and as-built data;
        i. Developed ratios between main cost drivers;
        ii. Developed linear foot scope quantities in cost driver categories; and
        iii. Used actual and as-built information and established driver quantities to assign linear feet of main costs.
    b. Per linear foot costs for MP pipe retirement and unit costs for services were both derived; and
    c. Costs for intersections, aprons, meters, railroad crossings and hydro crossings were provided by People Gas.
3. Costs were applied to the project scope per neighborhood to calculate neighborhood costs broken out by component.
    a. Neighborhood categories were used to differentiate between areas of Chicago;
    b. Costs were applied to scope; and
    c. The summation of all costs was used to establish overall neighborhood component costs.

3.1.1 CONSTRUCTION COST SENSITIVITY ANALYSIS

In order to establish the unit costs per construction component, the cost drivers must first be identified. A sensitivity analysis was performed on the Cost Estimate Template that follows. The Cost Estimate Template provides cost information per linear foot of pipe and break out quantities for intersections and aprons. In addition to the Cost Estimate Template, cost drivers were established for retirement, services, and meters. The drivers of cost, and not the actual costs in the Cost Estimate Template were used in the cost forecast model. The cost was calculated with actual project costs and as-built installation data. Only the variation between cost drivers was used in the cost forecast. The results of drivers found in the cost sensitivity analysis are shown in Table 3-1.

TABLE 3-1 Summary of Cost Drivers

Activity	Driver
Install	Distance Diameter RR Crossings Hydro Crossings
Restore	Distance Install Type Install Location Impacted Intersections Impacted Driveway Aprons
Retire	Distance Diameter
Services	Services
Meters	Meters

3.1.2 COST DRIVERS FOR MEDIUM PRESSURE MAIN PER LINEAR FOOT

Drivers associated with MP installation and restoration were developed using the Cost Estimate Template presented below. This template includes installation and restoration costs per linear foot of main. The purpose of the Cost Estimate Template was to provide relatively accurate variances between costs for various install types and install locations, as opposed to being a source of actual costs.

The costs within the template were sorted by diameter, location (parkway, sidewalk, street or alley) and installation type (directional bore, open cut or main insertion). A summary of the location/type acronyms used in the model are included in Table 3-2. The Cost Estimate Template unit costs provided by Peoples Gas for use in the model are shown in Table 3-3.

TABLE 3-2 Main Installation Type Acronyms		
Acronym	Installation Method	**Included in Cost Estimate Template**
ALOC	Alley Open Cut	yes
STOC	Street Open Cut	yes
SWOC	Sidewalk Open Cut	yes
PWOC	Parkway Open Cut	yes
STMI	Street Main Insertion	no
SWDB	Sidewalk Directional Bore	yes
PWDB	Parkway Directional Bore	yes

TABLE 3-3 Cost Estimate Template-MP Main per Linear Foot						
Size (inches)	**ALOC**	**STOC**	**SWOC**	**PWOC**	**SWDB**	**PWDB**
2	$ 282.09	$ 197.37	$ 85.46	$ 40.36	$ 44.22	$ 32.32
4	$ 284.35	$ 199.63	$ 87.72	$ 42.62	$ 42.57	$ 30.67
6	$ 293.26	$ 208.54	$ 96.63	$ 51.53	$ 54.65	$ 42.75
8	$ 301.28	$ 216.56	$ 104.65	$ 59.55	$ 68.74	$ 56.84
12	$ 329.13	$ 258.28	$ 126.48	$ 84.51		
18	$ 343.07	$ 272.22	$ 140.42	$ 98.45		
24		$ 556.25				

3.1.3 STREET MAIN INSERTION ESTIMATE

Street Main Insertion (STMI) is another installation method used in certain circumstances. For some neighborhoods, STMI can make up a significant percent of installation. For example, in the bid scope for South Shore, Phase 16 included 165 linear feet of 12 inch STMI out of a total 1,865 linear feet of 12 inch main installed. STMI in the example is 9% of the scope.

The Cost Estimate Template presented above in Table 3-3 does not include pricing for STMI, but pipe material and installation costs for an 18 inch main insertion were provided by Peoples Gas. STMI was assumed to be equivalent to a pipe material and installation cost for a directional bore method of installation. The 18 inch main insertion pipe material and installation cost was charted along with the 2 inch to 12 inch directional bore pipe material and installation cost, and the relationship is essentially linear. Therefore, the 2 inch through 12 inch pipe directional bore installation costs was assumed to be equivalent to STMI pipe costs. This trend line was extrapolated to estimate the 24 inch pipe cost for main insertion. Table 3-4 presents the main insertion pipe material and installation cost versus directional bore material and installation cost.

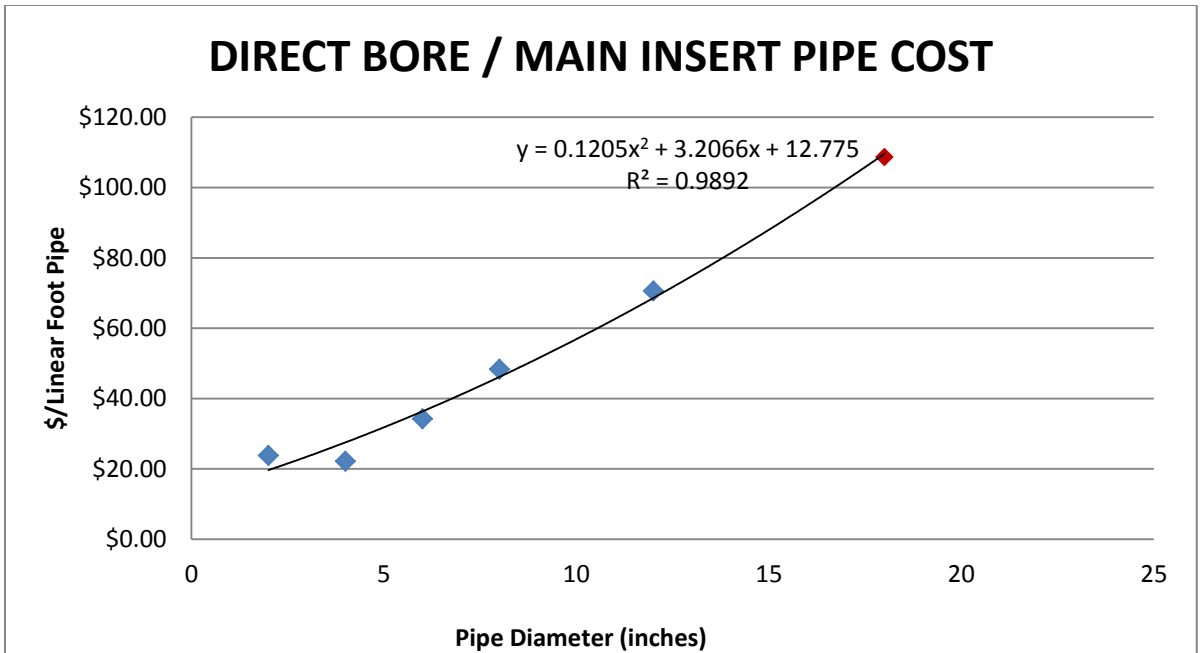


Table 3-4 Relationship Between Direct Bore and Main Insertion

Costs beyond the pipe material and installation costs were calculated based on the directional bore lengths and bore hole size associated with parkway and sidewalk directional bores. Costs for asphalt and pavement were assigned based on the street open cut values. The overall unit cost (per foot) is presented in table 3-5, which is an update to Table 3-3, by including the STMI costs.

TABLE 3-5 Cost Estimate Template MP Main per Linear Foot with STMI

Pipe	Installation Method						
Size	ALOC	STOC	SWOC	PWOC	STMI*	SWDB	PWDB
2	$ 282.09	$ 197.37	$ 85.46	$ 40.36	$ 68.07	$ 44.22	$ 32.32
4	$ 284.35	$ 199.63	$ 87.72	$ 42.62	$ 66.42	$ 42.57	$ 30.67
6	$ 293.26	$ 208.54	$ 96.63	$ 51.53	$ 78.50	$ 54.65	$ 42.75
8	$ 301.28	$ 216.56	$ 104.65	$ 59.55	$ 92.59	$ 68.74	$ 56.84
12	$ 329.13	$ 258.28	$ 126.48	$ 84.51	$ 121.25		
18	$ 343.07	$ 272.22	$ 140.42	$ 98.45	$ 160.99		
24		$ 556.25			$ 216.11		

*STMI Estimated

Unit costs provided in the Cost Estimate Template were separated into installation and restoration categories using the total unit costs provided in the Cost Estimate Template. Table 3-6 presents the distribution of costs associated with installation versus restoration. Costs for installation and restoration categories are presented in Table 3-7 and 3-8, respectively.

TABLE 3-6 Main Install and Restore Categories		
Cost Category	**Install Cost**	**Restore Cost**
Pipe	x	
Pavement Removal	x	
Post-Installation Sewer Insp.	x	
Sand Backfill and Disposal	x	
1-1/2" Grinding & Resurfacing		x
Topsoil		x
Sod		x
8" Alley Pavement		x
12" Base		x
Sidewalk		x

TABLE 3-7 MP Main Price/LF Installation Cost							
Size (Inches)	**ALOC**	**STOC**	**SWOC**	**PWOC**	**STMI**	**SWDB**	**PWDB**
2	$ 60.17	$ 60.17	$ 30.97	$ 30.97	$ 37.71	$ 31.38	$ 31.38
4	$ 62.43	$ 62.43	$ 33.23	$ 33.23	$ 36.06	$ 29.73	$ 29.73
6	$ 71.34	$ 71.34	$ 42.14	$ 42.14	$ 48.14	$ 41.81	$ 41.81
8	$ 79.36	$ 79.36	$ 50.16	$ 50.16	$ 62.23	$ 55.90	$ 55.90
12	$ 107.21	$ 107.21	$ 71.99	$ 71.99	$ 86.80		
18	$ 121.15	$ 121.15	$ 85.93	$ 85.93	$ 126.55		
24		$ 343.39			$ 178.55		

TABLE 3-8 MP Main Price/LF Restoration Cost							
Size (inches)	**ALOC**	**STOC**	**SWOC**	**PWOC**	**STMI**	**SWDB**	**PWDB**
2	$ 221.92	$ 137.20	$ 54.49	$ 9.39	$ 30.36	$ 12.84	$ 0.94
4	$ 221.92	$ 137.20	$ 54.49	$ 9.39	$ 30.36	$ 12.84	$ 0.94
6	$ 221.92	$ 137.20	$ 54.49	$ 9.39	$ 30.36	$ 12.84	$ 0.94
8	$ 221.92	$ 137.20	$ 54.49	$ 9.39	$ 30.36	$ 12.84	$ 0.94
12	$ 221.92	$ 151.07	$ 54.49	$ 12.52	$ 34.45		
18	$ 221.92	$ 151.07	$ 54.49	$ 12.52	$ 34.45		
24		$ 212.86			$ 37.56		

If the installation and restoration costs are combined, some trends become apparent in the cost data. One trend is the effect of diameter on cost although the drivers of cost are more apparent when installation and restoration costs are separated. The driver of installation cost per linear foot is primarily diameter, and to a lesser extent, whether the installation is in the parkway/sidewalk or street/alley. The driver of restoration cost per linear foot is primarily

location and installation type (i.e. street open cut). To a lesser extent, pipe diameter over 8 inches affects cost. Tables 3-9, 3-10 and 3-11 present the total construction cost per linear foot and the break out costs per linear foot of installation and restoration.

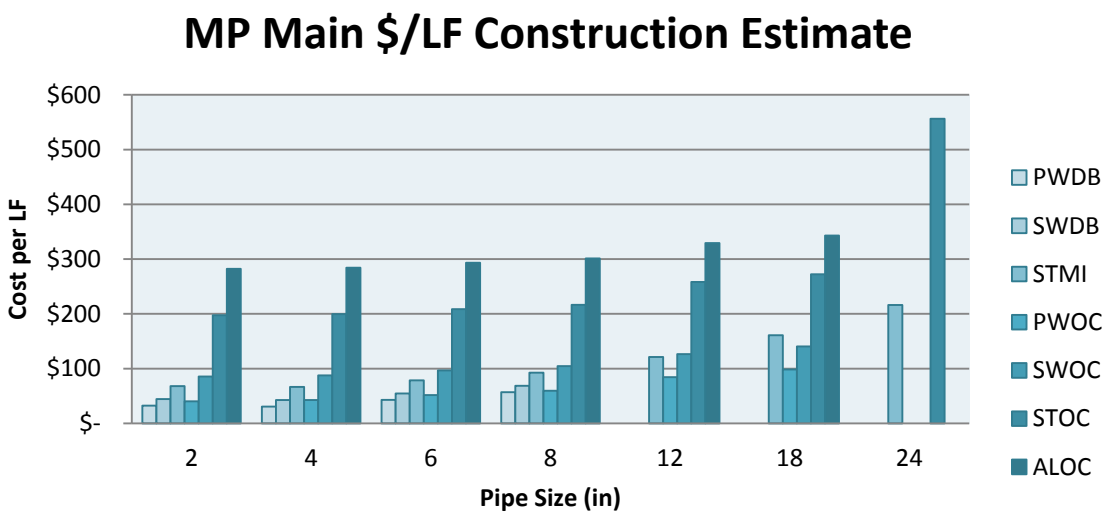


Table 3-9 MP Main Construction Versus Pipe Size

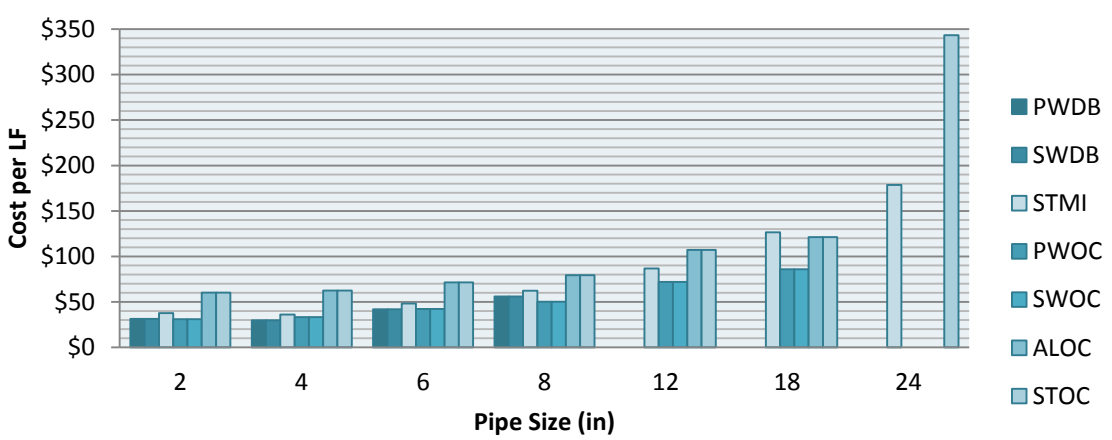


Table 3-10 MP Main Installation versus Cost per LF

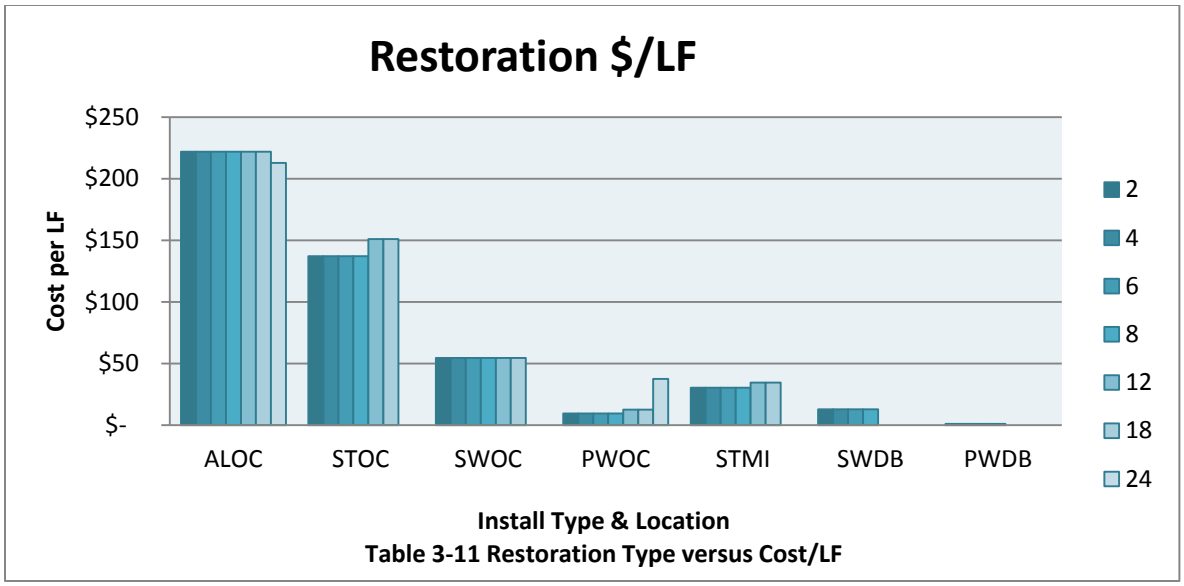


Table 3-11 Restoration Type versus Cost/LF

3.1.4 COST DRIVERS FOR MAIN RETIREMENT PER LINEAR FOOT

No drivers were apparent from the estimate template, actuals, as-builts, bids and other data available to analyze retirement costs. Using the bid scopes and actuals for the three residential projects available, the average cost per linear foot was estimated. Within the available data, the retirement of pipe based on diameter and use of flowable fill to plug ends could not be evaluated. Based on conversations with Peoples Gas Engineering, using flowable fill to retire large diameter (larger than 8 inches) pipe is not currently common practice, but is expected to be required sometime in the near future. The cost forecast model allows for this cost to be captured should that requirement occur.

3.1.5 COST DRIVERS PER UNIT

The costs associated with meters, services, intersections, aprons, railroad crossings, and hydro crossings were made available in the form of unit costs.

3.1.5.1 METERS

Cost data is not tracked at a level that can accurately assess the drivers associated with meters. Building type, type of meter, and where meter is installed is noted by Peoples Gas Engineering to assign a difference on meter cost, but project information was not available at this time to support this data. Meter quantity per building type per neighborhood was not available at this time.

3.1.5.2 SERVICES

Similar to retirement costs, service costs were established by using the actuals and bid scopes. The bid scopes list services by unit. The average price per service for the neighborhood data that was available was used in the model. There are no apparent drivers from the data available. It is probable that drivers such as whether the service line crosses the road has an effect on costs, but this cannot be established based on the available data.

3.1.5.3 RESTORATION UNIT COSTS- INTERSECTIONS AND APRONS

Intersections and aprons are a unit cost driver for restoration. Intersection and apron costs are broken out separately from the per linear foot costs in the Cost Estimate Template. Intersections are driven by intersection type: whether the intersection is a full intersection or a tee intersection. Apron costs are only driven by quantity.

3.1.5.4 INSTALLATION UNIT COSTS- RAILROAD AND HYDRO CROSSINGS

Railroad and hydro crossings were categorized as installation unit costs. Although rail and hydro crossings include restoration costs as part of the total cost, the quantity of restoration is much less than the installation costs. Without detailed cost information, all railroad and hydro crossing costs were assumed to be applied as installation unit costs. The rail and hydro crossing costs are a driver of the overall installation costs.

3.1.6 COST FOR MAIN PER LINEAR FOOT

The cost of main per linear foot was calculated using actual cost information for three neighborhoods that are almost complete, and comparing it to the as-built documents and bid scopes for the same phases completed. This top-down approach to cost estimating increases the accuracy of the cost forecast because it is comprehensive of all costs. A bottoms-up estimate cannot include unknown or unrealized costs.

3.1.7 COST DRIVER RATIOS

The variation in cost drivers was used to extract the per linear foot rate from the overall actual cost. Although the rates provided in the Cost Estimate Template are not used to avoid a bottom-up estimate which may exclude detailed costs, the variation between the cost drivers is used. The method used to illustrate variation between drivers was to place the costs by driver within the Cost Estimate Template into a ratio (or weighted) format.

The most common cost driver was assigned a unit of 1 in the ratio table. Based on the as-built and bid scopes for the residential projects that were provided to Burns & McDonnell (Portage Park, South Austin, South Shore, and Beverly), the most common installation type by driver was 2-inch parkway directional bore (PWDB) as shown in Table 4-12. Therefore, the 2-inch PWDB is set to a unit of 1, and the costs of other drivers are related to it by using a ratio. Table 3-13 provides the ratios in terms of 2-inch PWDB.

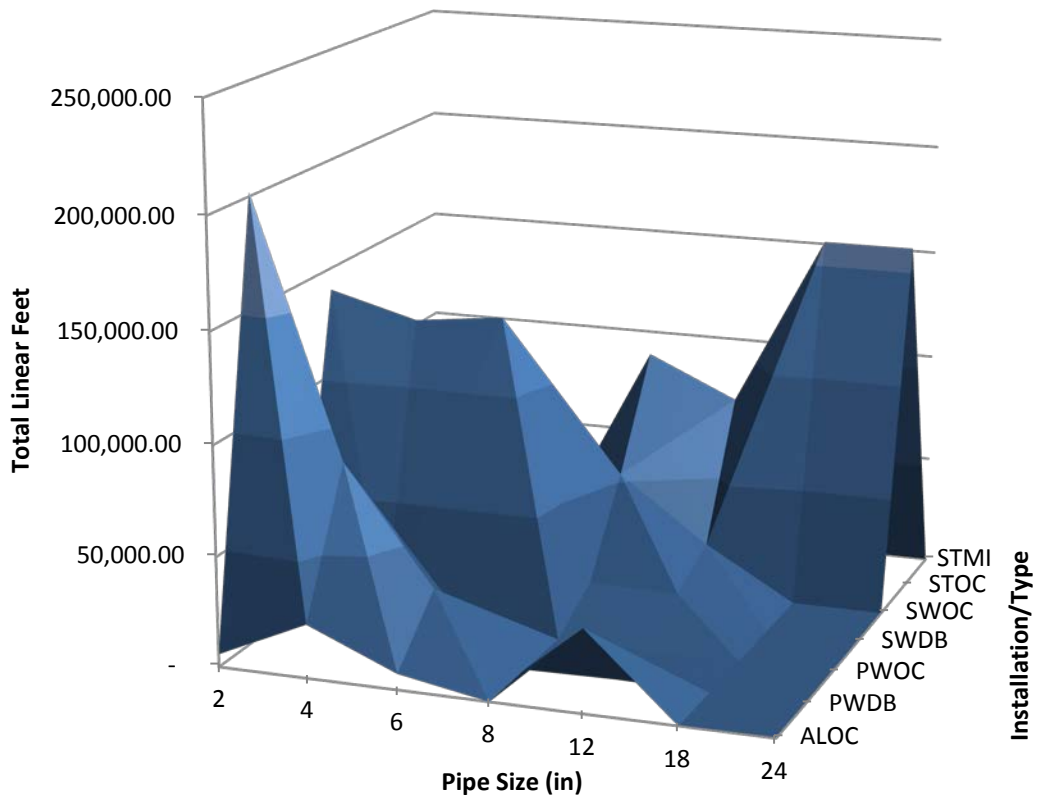


Table 3-12
Distribution of Pipe Diameter Versus Installation Type Compared to Parkway Directional Bore

TABLE 3-13 Install and restore cost factor in terms of PWDB							
	ALOC	**PWDB**	**PWOC**	**SWDB**	**SWOC**	**STOC**	**STMI**
2	8.73	1.00	1.25	1.37	2.64	6.11	1.20
4	8.80	0.95	1.32	1.32	2.71	6.18	1.15
6	9.07	1.32	1.59	1.69	2.99	6.45	1.53
8	9.32	1.76	1.84	2.13	3.24	6.70	1.98
12	10.18		2.61		3.91	7.99	2.77
16	10.33		2.76		4.06	8.14	4.03
18	10.62		3.05		4.34	8.42	5.69
24						17.21	-

3.1.8 DISTRIBUTION OF SCOPE INTO COST DRIVERS

Neighborhood main scope data was provided as linear footages by main diameter. Since location and installation type drive costs, the footages were sorted by diameter into the seven cost drivers. The as-built and bid scope data for the same four residential projects (Portage Park, South Austin, South Shore and Beverly) were used to distribute the diameters into the seven cost drivers. These neighborhoods are located in each of the three Peoples Gas shop districts: North, Central, and South.

The bid scopes by phase provide locations, and the as-built data provides installation type. The quantities in the bid scopes were assumed to match the as-built quantities. Then data was compared between the bid scopes and as-built to establish the distribution of each diameter into the seven categories. The assumptions listed below were made to assign the distribution for each of the three districts.

Assumptions Related to the Distribution of Scope into Cost Drivers include:

- All street installation is open cut.
- Alleys can be open cut or direct bore, but costs for each are the same. Alley open cut was assumed for all alley installations.
- Parkways and sidewalks are mostly direct bore for main diameters that are less than 4 inches.

Assumptions were derived from information provided by Peoples Gas Engineering and the Cost Estimate Template.

The distribution tables for each district are presented in Tables 3-14, 3-15 and 3-16. Most of the tables were created based on actual as-built data from neighborhoods. As more neighborhoods are completed and added to the distribution, the distribution of scope will change and accuracy will increase.

Table 3-14 North District Scope Distribution							
Installation	**Street Open Cut**	**Parkway Open Cut**	**Parkway DB**	**Sidewalk Open Cut**	**Sidewalk DB**	**Main Insertion**	**Alley Open Cut**
Diameter	**STOC**	**PWOC**	**PWDB**	**SWOC**	**SWDB**	**STMI**	**ALOC**
2	6%	0%	39%	0%	49%	0.00%	5%
4	4%	0%	35%	0%	45%	0.47%	15%
6	8%	0%	1%	16%	75%	0.00%	0%
8	100%	0%	0%	0%	0%	0.00%	0%
12	100%	0%	0%	0%	0%	0.00%	0%
18	100%	0%	0%	0%	0%	0.00%	0%
24	100%	0%	0%	0%	0%	0.00%	0%

Table 3-15 Central District Scope Distribution							
	Street Open Cut	**Parkway Open Cut**	**Parkway DB**	**Sidewalk Open Cut**	**Sidewalk DB**	**Main Insertion**	**Alley Open Cut**
Diameter	**STOC**	**PWOC**	**PWDB**	**SWOC**	**SWDB**	**STMI**	**ALOC**
2	4%	0%	61%	4%	31%	0.00%	0%
4	5%	0%	33%	0%	50%	0.00%	11%
6	6%	0%	16%	0%	72%	0.00%	6%
8	10%	0%	0%	83%	7%	0.00%	0%
12	13%	0%	0%	23%	0%	0.00%	64%
18	100%	0%	0%	0%	0%	0.00%	0%
24	100%	0%	0%	0%	0%	0.00%	0%

Table 3-16 South District Scope Distribution							
	Street Open Cut	**Parkway Open Cut**	**Parkway DB**	**Sidewalk Open Cut**	**Sidewalk DB**	**Main Insertion**	**Alley Open Cut**
Diameter	**STOC**	**PWOC**	**PWDB**	**SWOC**	**SWDB**	**STMI**	**ALOC**
2	7%	0%	52%	3%	36%	0.52%	1%
4	9%	0%	32%	0%	51%	0.36%	8%
6	12%	0%	17%	0%	67%	0.00%	3%
8	62%	0%	0%	30%	8%	0.00%	0%
12	50%	0%	0%	13%	8%	7.76%	20%
18	100%	0%	0%	0%	0%	0.00%	0%
24	100%	0%	0%	0%	0%	0.00%	0%

3.1.9 MAIN PRICE PER LINEAR FOOT

The cost per linear foot of main was assessed by extracting the cost from the actuals and as-builts/bid scopes. Only phases of the projects with matching actual costs and as-built data were used to assess the base cost per linear foot. In addition, phases with extenuating circumstances such as the South Shore railroad phases were purposely excluded so the exceptions would not skew the main cost per linear foot data. Costs of railroads were accounted for by unit quantity explained later.

Main price per linear foot was established using the following process:

1. Distribute as-built linear footages by diameter and neighborhood phase into seven drivers of cost using the distributions in Tables 3-14, 3-15 and 3-16 above.

2. Apply cost ratios to scope quantities to equate all diameters in terms of 2-inch PWDB.

3. The sum of the ratios by scope quantity values provides the total linear feet in terms of 2-inch PWDB.

4. The total cost of phases used (actuals) for each neighborhood also includes intersections and aprons within the cost. In order to determine the per linear foot costs, the costs of intersections were excluded from the unit cost determination as they are subsequently included in the cost forecast per intersection and apron.

5. The cost per intersection used was the costs provided in the Cost Estimate Template for full and tee intersections and confirmed by Peoples Gas Engineering. The total quantity of intersections impacted within each neighborhood was provided, but the project data did not include all phases of each neighborhood project. Therefore, a percent of phases provided verses the total was used to establish the quantity of intersections used. The intersections are then separated into full and tee intersections using the observation that 90 percent are full and 10 percent are tee intersections. Costs per intersection and quantities of each are used to establish total cost of the intersections per project.

6. The process for intersections was applied to aprons. Blocks per neighborhood were provided. The number of aprons was then calculated from the number of blocks. The number of aprons per block was established to be 2.95 through 3 point samples in each neighborhood. Aprons are only applied to the cost when open cut parkway or sidewalk footages are installed. The percent of open cut parkway and open cut sidewalk was estimated and taken as a percentage of the blocks. The total number of aprons is then calculated as percent of blocks in phases by the number of aprons per block by the percent of sidewalk or parkway open cut.

7. The costs of intersections and aprons are then removed from neighborhood actual costs used.

8. The total cost and footage normalized to 2-inch PWDB are then established. The total cost divided by the footage in terms of 2-inch PWDB is the cost per linear foot of 2-inch PWDB.

This process was completed for the three residential neighborhoods. The base cost is an average of the three neighborhoods. The costs for the other drivers can be determined by applying the associated cost ratio to the base cost. The costs determined are shown in Table 3-17 below.

Table 3-17 Install and restore cost per linear foot (FACTOR*BASE)

Pipe Diameter	ALOC	PWDB	PWOC	SWDB	SWOC	STOC	STMI
2	$ 474.45	$ 54.36	$ 67.88	$ 74.37	$ 143.74	$ 331.96	$ 65.31
4	$ 478.25	$ 51.58	$ 71.68	$ 71.60	$ 147.54	$ 335.76	$ 62.46
6	$ 493.23	$ 71.90	$ 86.67	$ 91.92	$ 162.52	$ 350.74	$ 83.38
8	$ 506.72	$ 95.60	$ 100.16	$ 115.61	$ 176.01	$ 364.23	$ 107.79
12	$ 553.56	$ -	$ 142.14	$ -	$ 212.73	$ 434.40	$ 150.36
16	$ 561.38	$ -	$ 149.95	$ -	$ 220.54	$ 442.22	$ 219.21
18	$ 577.01	$ -	$ 165.58	$ -	$ 236.17	$ 457.85	$ 309.29
24	$ -	$ -	$ -	$ -	$ -	$ 935.56	$ -

3.1.10 COST OF MAIN RETIREMENT PER LINEAR FOOT

The cost estimate associated with main retirement was developed as follows:

1. Obtain the linear feet removed from bid documents.
2. Utilize the total “Removal” costs obtained from actuals for mains only.
3. Calculated the cost per linear foot.
4. Calculate the average using three projects to yield the unit price for main retirement.

3.1.11 SERVICE COST

The cost associated with gas services was determined by dividing the actual costs by the total services installed. No cost drivers were able to be established from the data provided. Service line length and quantity of meters served could be possible cost drivers but they were not used in the model because these factors could not be accounted for in the available data.

3.1.12 HISTORICAL AMRP COST DATA

Historical AMRP cost data was to be used for intersections, aprons, meters, railroad crossings and hydro crossings.

- Intersection costs presented in the Cost Estimate Template were used for full and tee intersections and were assumed accurate.
- Apron costs presented in the Cost Estimate Template were used in the cost model and assumed accurate.
- Meter costs were based on actuals and meter counting as provided by Peoples Gas.
- Railroad crossing costs were established as the average cost of the South Shore rail crossing installation. Railroad crossing costs do not include contingency in the base number. Also rail costs are only for one neighborhood and have the potential to vary based on neighborhood. At this time, cost drivers were not identified for railroad crossing costs.
- Hydro crossing costs were established as the average cost of three actual hydro crossing installations. Hydro crossing costs do not include contingency in the base number. At this time, cost drivers were not identified for the hydro crossings. Only one hydro crossing is included in the scope.

3.1.13 OVERALL MEDIUM PRESSURE COSTS

The scope per neighborhood that was provided by Peoples Gas was used to develop costs by neighborhood. Then neighborhood costs (per linear foot) were broken out by component, which include installation and restoration. Costs were then applied to the scope for the linear foot categories. Unit costs per category were then added to the linear foot costs to obtain the overall costs per category.

3.1.14 NEIGHBORHOOD CATEGORIES

The Peoples Gas MP pipe replacement program is distributed within three different shop districts (North, South, and Central) and the Central Business District. These four neighborhood categories are coded in Table 3-18.

Table 3-18 Neighborhood Category Abbreviations	
CB	Central Business District
CD	Central District
ND	North District
SD	South District

The Peoples Gas neighborhood map segregated by which of the four districts they are located in is presented in Appendix D. For split neighborhoods, the largest portion dictates which district the neighborhood is located. Each neighborhood category has its own scope distribution, intersection distribution, aprons per block, and scope factor. The Neighborhood Categories are located in the Scope Distribution tab of the Excel Model.

3.1.15 SCOPE DISTRIBUTION

The available as-built, bid scopes, and actual data provided related to the following projects:

- Portage Park, located in the North District (ND);
- South Austin, located in the Central District (CD);
- South Shore, located in the South District(SD) ; and
- Beverly, located in the SD (as-built and scopes only).

Engineering judgment was used to develop a scope distribution for the Central Business District (CB).

3.1.16 INTERSECTION DISTRIBUTION

The intersection distribution is designed to differentiate between full and tee intersections since the costs vary by type. Specific information on neighborhood full and tee intersections were not previously tracked. Therefore, an estimated distribution was set to 90% for full intersections and 10% for tee intersections for every neighborhood category. The intersection distribution can be altered in the future if data becomes available.

3.1.17 APRONS PER BLOCK

Aprons per block were placed into the neighborhood category so the model has the ability to change the aprons per block based on the neighborhood type. For instance, if the neighborhood type is highly residential, the aprons per block may increase because of a larger portion of driveways per block. Currently, the aprons per block described previously were used for all neighborhoods. The aprons per block can be altered in the future if more data becomes available.

3.1.18 SCOPE FACTOR

Based on the MP installation footages provided, the assumption provided by Peoples Gas Engineering is that 1.3 times the existing linear feet of pipe will be the quantity of new MP pipe to be installed. The scope factor is designed to give the user the ability to increase or decrease the 1.3 factor. Currently the model is set at a scope factor of 1which means that the data in the model is on an installation of 1.3 times the existing footage.

3.1.19 COSTS PER LINEAR FOOT

Costs were established by applying the costs found in the unit price tables from above to the scope by the drivers. As described previously, diameter drives the installation per linear foot cost and primarily location/type drive the restoration per linear foot cost.

3.1.20 INSTALLATION

The unit cost of installation is driven by pipe diameter. The scope data provided for each neighborhood already has linear footages per neighborhood broken up by diameter. Therefore the installation costs can be applied directly to the project scope by diameter. This is completed in the SCOPE MP tab of the EXCEL model.

3.1.21 RESTORATION

The unit cost of restoration is driven by location/type and to a lesser extent, diameter. The scope data provided for each neighborhood has linear footages per neighborhood broken out by diameter. However, the data to apply restoration cost per linear foot was broken out by location/type. To do this, the scope distributions located in the Neighborhood Categories are applied to the scope. This distributes the footages into each location/type category (e.g. STOC) by diameter.

To account for the variance in cost of pipe larger than 8 inches, the percent of large diameter pipe is tracked per location/type. The costs used are sorted between large (greater than 8 inches) and small diameter (8 inches and smaller) cost. The large diameter cost is applied to the portion of the location/type scope which is large diameter, and the small diameter cost is applied to the portion of the location/type scope which is small. This is completed in the SCOPE MP tab of the EXCEL model.

3.1.22 RETIREMENT

Variance in cost per linear feet of retirement was not able to be determined based on the information available. However, it is expected at some point in the future that details on flowable fill used for retiring large diameter pipes will be tracked. The current model applies the cost per linear foot of existing pipe to the footage of existing pipe. The footage of existing pipe is determined to be 0.77 (1/1.3) times the installation footage. Essentially, the assumed 1.3 factor applied to the existing footage to determine the new footage installed is removed. The scope factor is applied to the new footage quantity, so it is also divided out of equation so the retirement quantity will remain the same if the new footage quantity increases or decreases.

3.1.23 COSTS PER UNIT

Intersections, aprons, services, and meters are all cost per unit costs. These costs are computed by applying the cost per unit by the scope per neighborhood.

3.1.23.1 INTERSECTIONS

Intersections costs have historically varied dramatically. Therefore, a factor for intersection costs currently set at 1 is embedded in the intersection computation. If intersection costs change dramatically, this cost can be accounted for by adjusting the intersection cost factor.

3.1.23.2 MEDIUM PRESSURE COSTS

The neighborhood costs for each of the construction categories are summarized on the MP Cost tab. The construction categories are installation, restoration, retirement, services, and meters. Permitting is also included on this tab but is not considered construction category.

3.1.24 EQUATIONS

The costs were determined by adding all described costs in the cost per linear foot and cost per unit sections together. Equations per category include:

MP Main Installation	=	**Install Cost ($/LF) * Install Scope (LF)**
MP Main Restore	=	**Restore Cost ($/LF) * Restore Scope (LF)**
		+ Full Intersection Cost ($/EA) * Full Intersection Scope (EA) * *Intersection Factor*
		+ Tee Intersection Cost ($/EA) * Full Intersection Scope (EA) * *Intersection Factor*
		+ Apron Cost ($/EA) * Aprons Scope (EA)
Retirement =		**Retire Cost ($/LF) * Retire Scope (LF)**
Services =		**Service Cost ($/EA) * Service Scope (EA)**
Meter =		**Meter Cost ($/EA) * Meter Scope (EA)**

3.1.25 OTHER COSTS

Other costs include engineering and permitting. Permits were calculated by neighborhood because permit costs are a cost per block. The cost of permits per block was estimated to be $1,505.

3.2 HIGH PRESSURE COST FORECAST

The cost forecast for each proposed HP projects was completed and applies to the project scope quantities in unit rates provided by Peoples Gas Engineering. HP costs were broken out by HP main costs, HP vault cost, HP gate station costs, and Calumet Station costs.

3.2.1 HP MAIN

HP main was an estimated quantity using historical information to establish the cost per linear foot which resulted in an expected cost per linear foot of $10 million a mile.

3.2.2 VAULTS

Vault costs were estimated to be $775,000 per vault based on the average cost of vault installation.

3.2.3 GATE STATIONS

Gate stations were estimated to be $22 million based on a recent similar project.

4.0 SCHEDULE DATA USED IN MODELS

4.1 SCHEDULE MODEL NARRATIVES

The schedule models were developed from data provided by Peoples Gas. In addition, several assumptions were made and formulate the basis of the schedule models.

4.1.1 MODEL PURPOSE

Two models were created to evaluate AMRP production and spend requirements needed to make 2030 and 2040 completion timelines. The model does not provide a baseline program schedule or budget; it only validates the amount of work that can be accomplished within the model parameters and assumptions.

4.1.2 METHODS AND ASSUMPTIONS

The following information formulates the basis the assumptions associated with the schedule models. Crew members and sizes were based on productivity documents provided based on historical data:

- One contractor works within one neighborhood (to avoid scope conflicts);

- Each contractor has four crews – 2 open cut, 2 directional bore working on installation of MP main;
- Rates identified by the Contractor are for all respective crews per day (300 lineal foot [lf]/day for two crews performing open cut excavations);
- Each contractor has five service install crews; and
- Each contractor has nine restoration crews.

Install duration and restore duration are equal. (Due to high number of work orders within each neighborhood phase, work separation at the neighborhood level is not visible)

There are two gate stations in the system as follows:

- NW Station ($22MM spend): Starts in 2017 and ends in 2018; and
- SW Gate Station ($22MM spend): Starts and ends in 2019.

Vaults (new on existing HP mains and new on new HP mains);

- Costs for new vaults installed within new HP mains are included in the $10MM per mile estimate;
- HP main installation rate (two month install duration per mile); and
- New vaults installed on existing HP mains are included at $775k each;
- 2 month installation duration per vault;
- There are 16 new vaults to be installed on existing new HP mains, including:
    - X-N1, X-N2, X-N3, X-N4, X-N5
    - X-C1, X-C2, X-C3
    - X-S1, X-S2
    - 1F, 1G, 1H, 1I, 1J, 1K

General Methods and Assumptions:

- Remaining restoration will be completed before new installations take place.
- Vaults installed on existing new HP mains (listed above) were scheduled independently, based on neighborhood dependencies.
- Neighborhood ranking (UMRI Rank) was used to identify the highest neighborhood priorities which were scheduled first as budget was available.
- Installation constraints (dependencies) were applied per Peoples Gas direction.
- PI work provides a partial cost credit toward AMRP out of sequence work.
- Engineering, Program Management, and other total costs are based on the 2040 Model.
- No critical path is included.
- Escalation and contingency are calculated after schedules have been completed utilizing the time phased data from the models. Escalation & contingency are then applied to the schedule in stand-alone activities.
- Contingency is applied to the escalated cost for each year.

- Meter installation and retirement is by People Gas.
- The following projects are starting construction in 2016:
    - Beverly (UMRI #66)
    - Portage Park (UMRI #23)
    - South Austin (UMRI #154)
    - South Shore (UMRI #144)

2030/2040 Models:

- The 2030 and 2040 model meter installations are the same for the 2016 & 2017 years and the remainder is leveled to complete within the model year end.
- Engineering, Program Management and other total costs for the 2030 model are equal to the 2040 model totals and prorated to the shorter duration, assuming program management and engineering efforts will be elevated due to the compressed schedule.

4.1.3 SOFTWARE UTILIZED

The software used to develop the cost and schedule models includes:

- Oracle Primavera P6 Version 8.3 to develop the schedule/cost model.
- Microsoft Office Products to prepare reporting documents and analysis charts and graphs.

4.1.4 DESCRIPTION OF WORKSHEETS / LAYOUTS

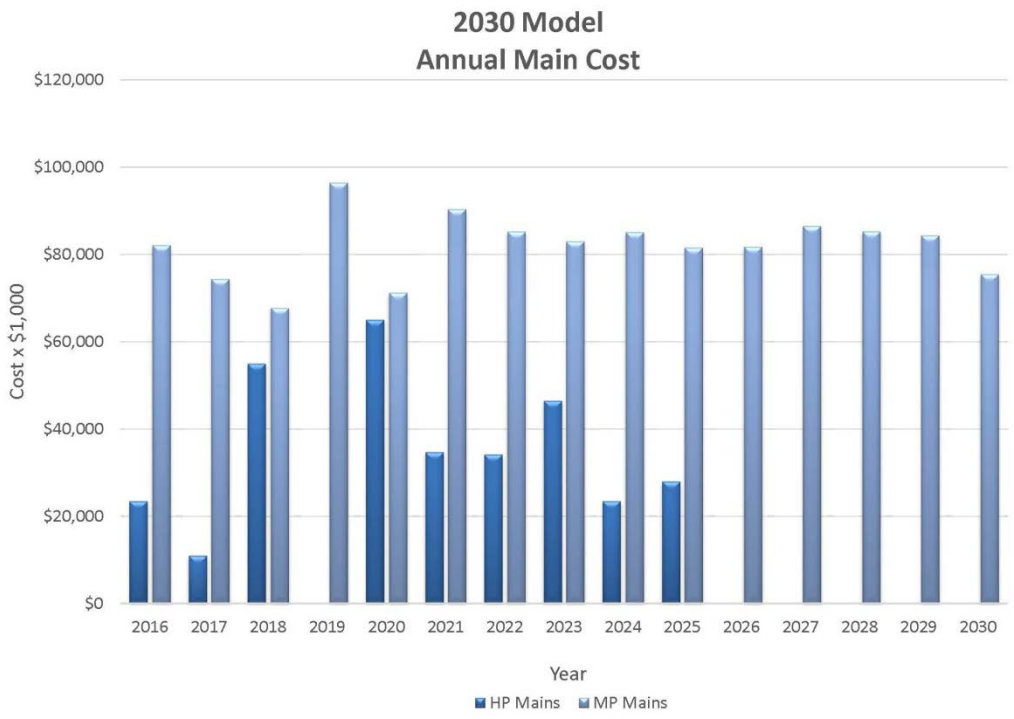
Appendix B and C provide 3 layouts for both the 2030 and the 2040 model, for total of 6 layouts. The layouts include:

- AMRP Three Year Look Ahead by Ranking for a 2030;
- AMRP All Neighborhood Start by Ranking for 2030;
- AMRP Model Resource Breakout for 2030;
- AMRP Three Year Look Ahead by Ranking for a 2040;
- AMRP All Neighborhood Start by Ranking for 2040; and
- AMRP Model Resource Breakout for 2040.

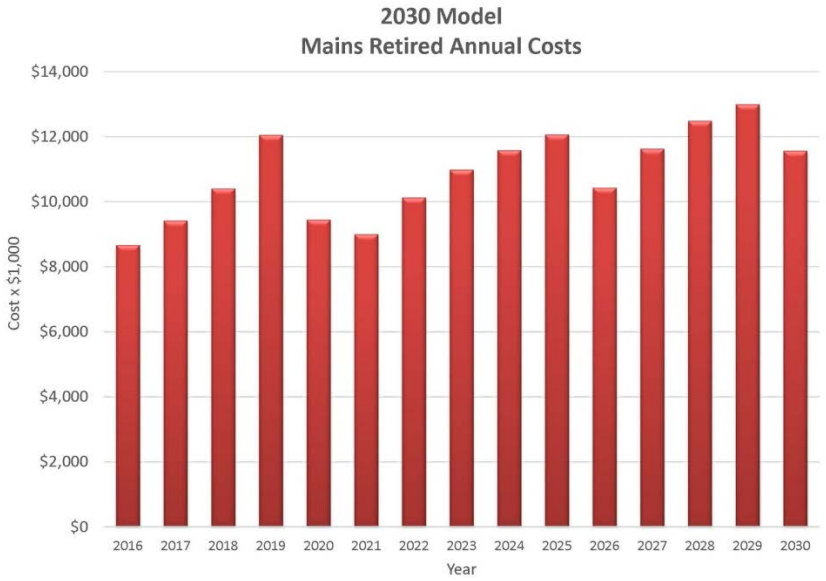
5.0 COST AND SCHEDULE MODEL ANALYSIS AND REPORTS

5.1 MODEL COMPLETE BY 2030

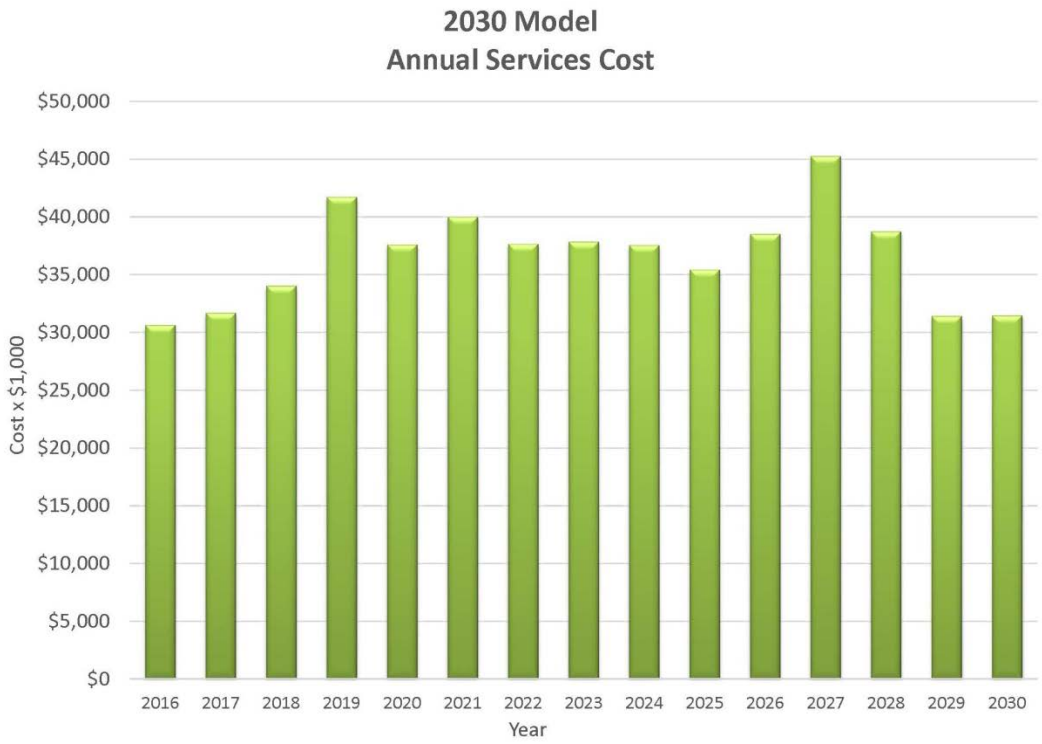
5.1.1 MILES OF MAIN INSTALLED



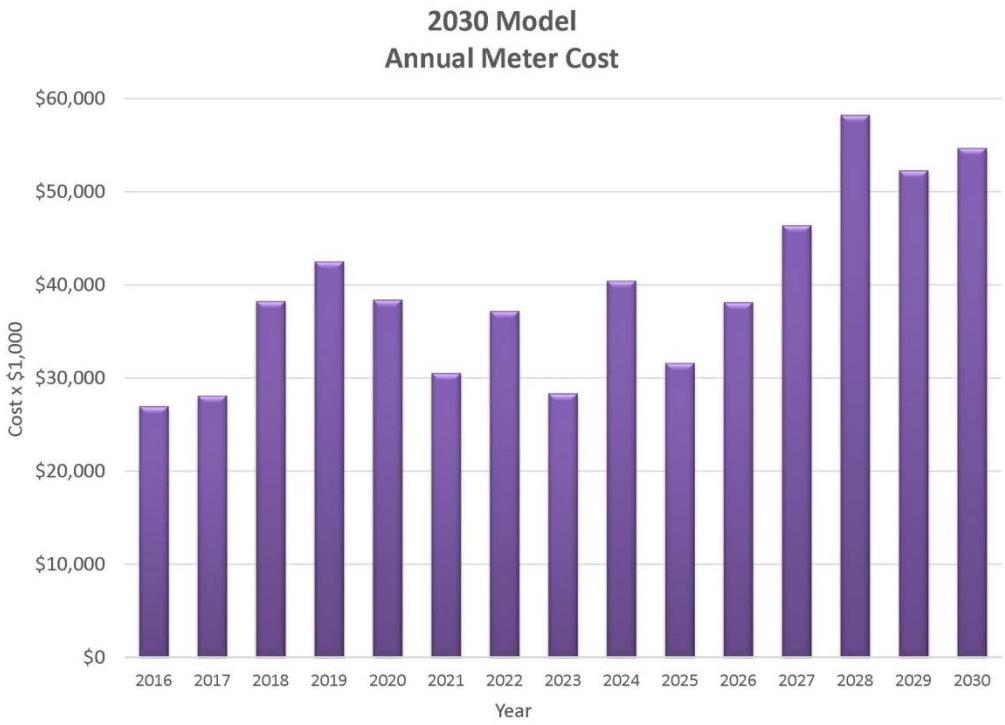
5.1.2 MILES OF MAIN RETIRED



5.1.3 SERVICES INSTALLED

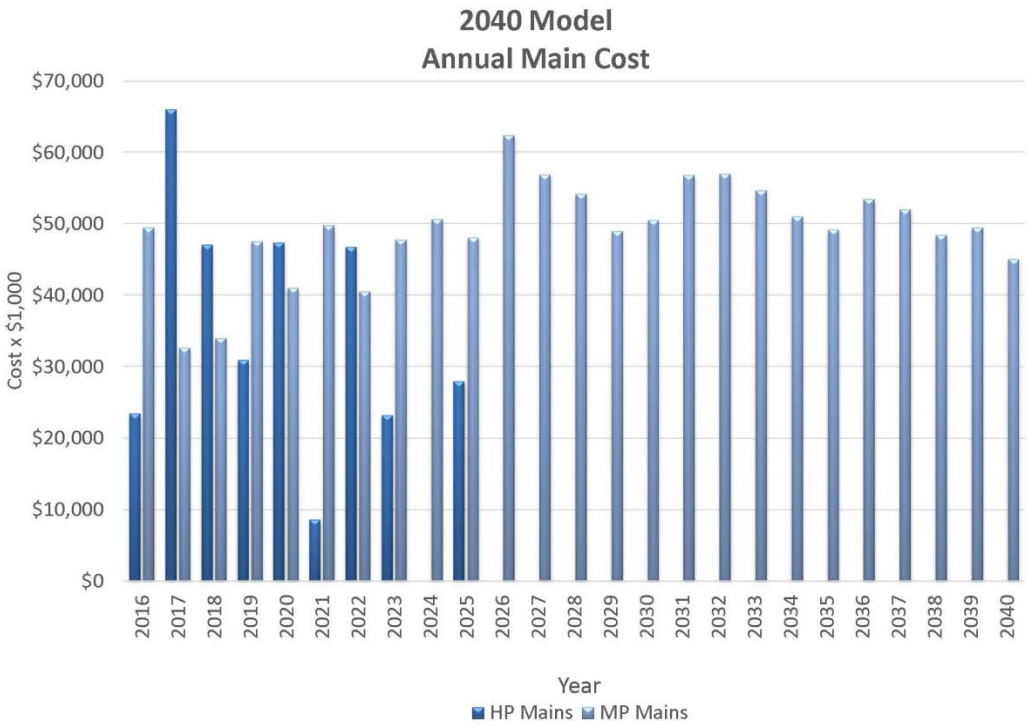


5.1.4 METERS INSTALLED

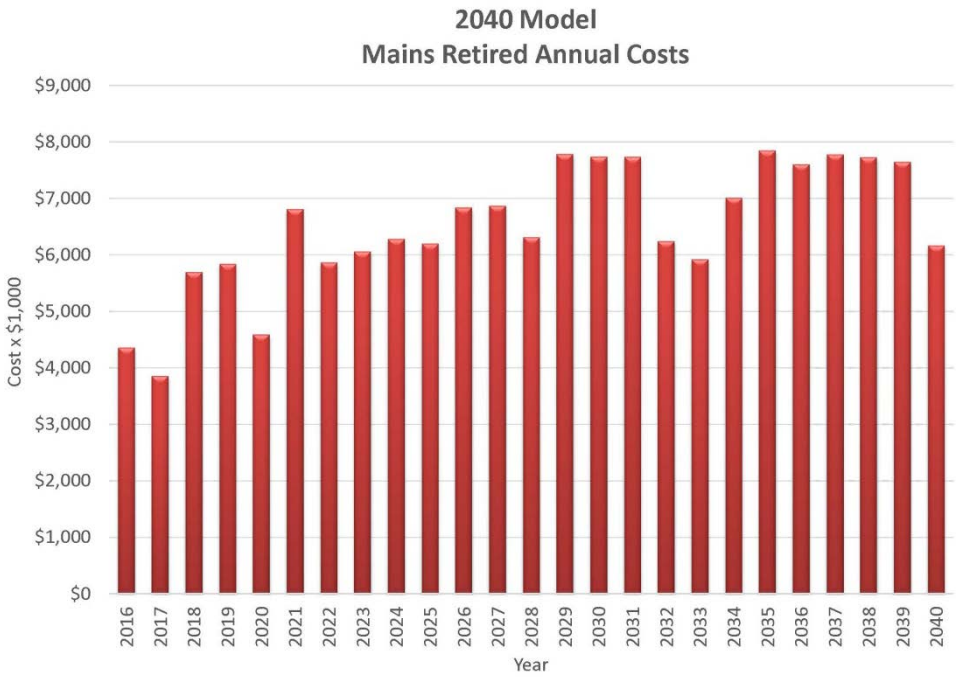


5.2 Model Complete by 2040

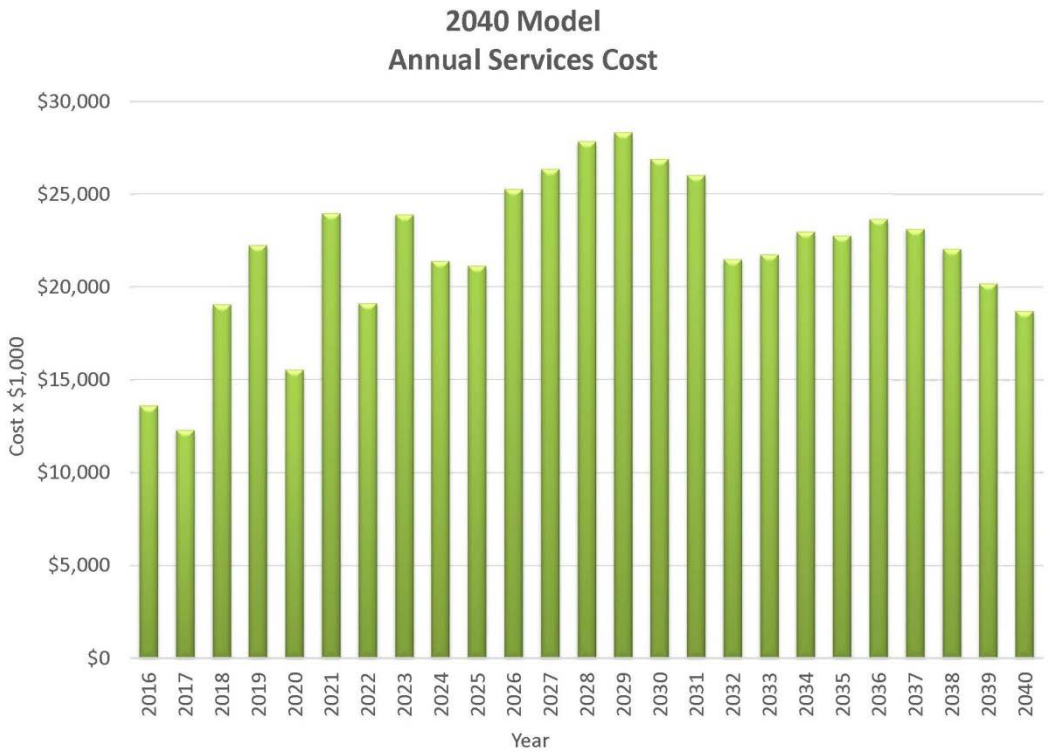
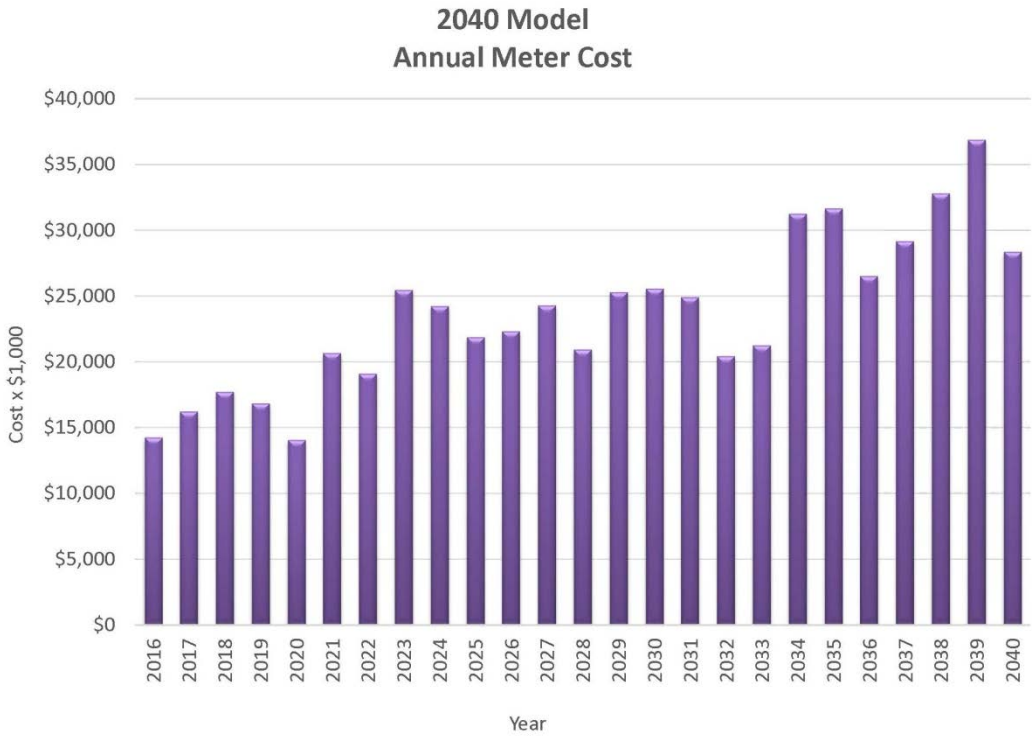
5.2.1 MILES OF MAIN INSTALLED



5.2.2 MILES OF MAIN RETIRED



5.2.3 SERVICES INSTALLED



5.2.4 METERS INSTALLED