A METHODOLOGY FOR ESTIMATING CONSTRUCTION UNIT BID PRICES

A Record of Study

by

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ABSTRACT

The internship company does not have a standard procedure for preparing an engineer's estimate of probable construction cost document (engineer's estimate) for municipal projects. Every project manager employs a methodology that is a slightly different variation of the historical data approach. The internship objective was to develop a construction unit price estimation model that provides more accurate results than the company's existing unit price estimation methodology for the City of Fort Worth construction projects.

To accomplish the internship objective several tasks were conducted, including; gathering City of Fort Worth construction projects bid tabulation data (including all bids) for the past three years; developing three construction item unit price databases using the data collected; conducting statistical analyses using the unit price databases; developing tables and graphs showing the construction cost items and their appropriate estimated unit prices to be used by the project managers in their cost estimates; developing an approach to apply construction unit costs which adjusts for unique project characteristics; developing guidelines for using the developed tables and graphs to estimate unit prices for municipal projects; using one recent project to compare the company's existing unit price estimation methodology and the new developed model with actual unit bid prices; and developing guidelines for updating the unit price database, tables, and graphs.

The study made use of both normal and log-normal distributions to model the unit bid price data collected from the City of Fort Worth. The factors that are perceived to influence a contractor's unit bid price for a given item were identified and given a degree of impact on the project by the project managers. The factor that had the highest impact on the unit bid prices was discovered to be item quantity. The unit price estimating methodology presented in this study generated a better fit than the internship company's original method for predicting the actual average unit bid prices for the one case study the methodology was applied.

DEDICATION

Dedicated to my family for their love and unwavering support.

ACKNOWLEDGEMENTS

I would like to thank my father, Dr. Oktay Erbatur, and mother Dr. Gaye Erbatur for always expecting the best from me and providing the love and support for me to be my best.

A big thank you goes to my wonderful wife, Kamaron Erbatur, for being so patient with me during this long process. Without your invaluable input and assistance, I could not have completed this study.

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NOMENCLATURE

COFW	City of Fort Worth
TxDOT	Texas Department of Transportation
UPD	Unit Price Database
QVS	Quantity Value Score
POU	Probability of Underrun

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CHAPTER I

INTRODUCTION

This record of study is being submitted in partial fulfillment of the requirements for the degree of Doctor of Engineering. The goal of this Chapter is to provide information regarding the internship site, the internship objectives, the literature review and the methodology.

The internship company, LOPEZGARCIA GROUP (LGGROUP), was an engineering company with a staff of more than 250 professionals that provided services in the areas of civil, environmental, electrical, mechanical, structural and geotechnical engineering; environmental, planning and cultural resources studies; conventional and GPS surveying; and construction management and observation. Headquartered in Dallas, Texas, LGGROUP had additional offices in Fort Worth, Austin, Houston and Amarillo, Texas. The internship location was LGGROUP's Fort Worth office at Water Gardens Place 100 E. 15th Street Suite 200, Fort Worth, Texas 76102. The company was acquired by URS in 2009 after the internship period was complete.

The work accomplished during the internship with LGGROUP included the engineering of numerous municipal projects, including paving and drainage improvement projects, water distribution master plan development, and drainage basin studies. The municipalities worked with included the City of Fort Worth, the City of Watauga, and the City of Corsicana.

The Doctor of Engineering – Graduate Program Manual states that the student should apply the knowledge gained from technical training in making a significant contribution of practical concern to the intern's employer. Following this guidance and falling back on the training received from the Construction Engineering and Management program at the Civil Engineering Department of Texas A&M University, an area of practice in need of improvement was identified within the company.

Educational Background

During the internship period, the basic principles of construction engineering and management as taught in CVEN 641, Construction Engineering Systems, and CVEN 668, Advanced EPC Project Development were routinely utilized. In fact, the idea for the main internship objective, developing a construction unit price estimating model, originated from the knowledge obtained from these two courses. Because of the knowledge background that was provided by the Doctorate of Engineering Program, the author was able to contribute positively to the internship company.

The different cost estimating methods described in several of the courses in the construction engineering and management curriculum enabled the author to develop a unit bid price estimating methodology. Risk identification and management concepts discussed in CVEN 644, Project Risk Management, CVEN 641, and CVEN 689 Project Development Process enabled the author to utilize the concept of probability of under-run and generate a probabilistic unit price estimation methodology.

The skills obtained from STAT 601, Statistical Analysis, and STAT 608, Least Squares and Regression Analysis, and INEN 667, Engineering Economy, were utilized extensively while developing the unit bid price database and generating probability of occurrence curves for each cost item. Furthermore, the knowledge base developed from taking these two courses was utilized to test the unit bid price estimation model against the existing estimating methodology employed by the internship company. During the internship period, the basic principles of construction engineering and management as taught in CVEN 641, Construction Engineering Systems and CVEN 668, Advanced EPC Project Development were routinely utilized.

Internship Background

LGGROUP was an engineering, environmental, and surveying company that concentrated in transportation, municipal infrastructure, commercial development, and surveying. It was a Minority and Woman Owned Business (MWBE) that generated a large amount of its business by providing engineering and surveying services as a subconsultant to other companies to fulfill the federal and/or municipal MWBE percent contribution. The Fort Worth office primarily concentrated on transportation and municipal projects, and the internship was focused on municipal clients including the City of Fort Worth, the City of Corsicana, and the City of Watauga.

Typically, municipal projects begin with the municipality selecting the engineering company based on their statement of qualifications. After a company is selected to perform the work, scope and fee negotiations begin to determine the project’s overall cost; both engineering and construction.

Municipalities typically use one of two methods to determine the engineering fees. The first method assumes that the engineering fee is a straight percentage of the estimated construction cost. The second method involves the estimation of engineering labor man-hours for designing improvements, preparing construction plans and specifications, and sometimes providing construction administration services. Municipalities tend to choose whichever method they believe gives them the lowest cost, but can use either method or a combination of both at their discretion.

The selected engineering company prepares an engineer’s estimate of probable construction cost based on the anticipated infrastructure improvements. A preliminary quantity take-off is prepared based on conceptual plans using aerial photography for the approximate distances, and the unit prices are input by the engineering company’s project manager to prepare the cost estimate. Negotiations between the municipality and the engineering company tend to concentrate on the unit prices selected to prepare the estimate of probable construction cost rather than the quantities themselves.

Throughout the internship period at LGGROUP it was observed that the Company does not have a standard procedure for preparing an engineer’s estimate of probable construction cost. Each project manager employs a methodology that is a slightly different variation of the historical data approach. This involves identifying the project manager’s past projects that are similar in scope to the current project and averaging the unit bid prices used by the Contractors on those projects for each cost item to determine the unit prices to be used for the current estimate. In addition, the project managers adjust the unit bid price averages based on ENR data. If the project manager does not have historical data on some of the cost items, they coordinate with other project managers within the company to utilize their data from past projects. Since these items tend to occur infrequently, there is limited data, and the data that is available is often out-of-date.

Generating an accurate estimate of probable construction cost during the early stages of a municipal project is crucial because municipalities frequently use the consulting company's construction cost estimates to set up construction budgets. If a project ends up costing more than the estimated figure, municipalities may not have enough funding to complete their project. Also, the consulting firm's engineering fees are usually calculated as a percentage of the estimated total construction cost, which is standard practice in the municipal engineering market. As a result, there is a need to improve the accuracy of the construction cost estimates and standardize the cost estimating procedures.

In general, the LGGROUP project managers perform two main tasks while preparing an engineer's cost estimate:

- Preparing a quantity take-off.
- Estimating unit prices for each construction cost item

Preparing a quantity take-off is a relatively straightforward task and the existing methodology employed by the LGGROUP project managers' yields satisfactory results. A quantity take-off includes all construction cost items necessary to complete the desired improvements based on standard construction plans, specifications, and contract with the municipality of interest. Normally the quantity take-off consists of overlaying the conceptual plans on aerial photography to determine the approximate lengths of travel, and the project manager uses their experience with similar projects to determine what bid items will be needed for the construction project. During the internship period the quantity take-offs that were prepared by LGGROUP were never challenged by the Contractors. There has not been any addendums to change the bid quantity for an item during the bidding phase, and there has not been a change order to adjust an item quantity after a project was awarded. Preparing a quantity take-off will not be a part of the scope for this record of study.

Estimating unit prices for each construction cost item is a complicated task, and the variation of the methodologies employed by the LGGROUP project managers during this task was apparent from the variation of estimated unit bid prices for similar construction pay items. To accomplish this task, the project managers in general make use of the following data:

- Bid tabulations from the project manager's own recent projects.
- Engineering judgment.
- Bid tabulations from other project managers' recent projects.
- TxDOT unit bid price database.
- Material prices obtained from vendors.

When estimating unit prices, the project managers tend to give the highest importance to the data obtained from their own recently let projects' bid tabulations. In general each project manager kept their own unit price. The project managers first calculate the average unit bid prices for each construction cost item from their previous projects. The average unit bid price is then adjusted using engineering judgment for project specific conditions and escalation. The adjusted unit price is used to determine the engineer's estimate for probable construction cost for that line item.

If a project manager does not have his/her own historical unit bid price data for a specific line item, they try to obtain unit bid price data from other project managers. Each project manager's historical unit bid price data is a compilation of the projects each project manager has been involved with that has let for bid. All bid data for municipal projects is a matter of public record and available to anyone that requests it. If the project manager is still missing necessary unit bid price data, he/she consults with TxDOT's unit bid price database. The project managers are usually reluctant to rely on unit bid price data obtained from TxDOT, because construction specifications for municipalities and TxDOT are rarely comparable; thus the unit bid price data obtained from TxDOT need to be adjusted to reflect the difference between the specifications. Unfortunately, performing this adjustment can take a significant amount of effort due to the fact that the project managers are usually only familiar with one or the other set of specifications, that is, they focus on either TxDOT projects or Municipal projects.

The last resort for obtaining unit price data is contacting a vendor for material prices and using a rule of thumb multiplier for labor and overhead costs (usually it is assumed that three times the material cost is equal to total installed cost). This technique is employed rather infrequently.

Internship Objective

The internship objective was to develop a construction unit price estimation model that provides more accurate results than the existing LGGROUP unit price estimation methodology for the City of Fort Worth construction projects. The main project tasks that were completed to accomplish the internship objective are listed below:

- Gather City of Fort Worth construction projects bid tabulation data (including all bids) for the past three years.
- Develop three (sanitary sewer, water, pavement and storm drainage) construction item unit price databases using the data collected. The cost items for the three types of construction improvement projects are separated into three databases to make it easier for project managers to find the cost items related to a type of project.
- Conduct statistical analyses using the unit price databases.
- Develop tables and graphs showing the construction cost items and their appropriate estimated unit prices to be used by the project managers in their cost estimates.
- Develop an approach to apply construction unit costs which adjusts for unique project characteristics.
- Develop guidelines for using the developed tables and graphs to estimate unit prices for LGGROUP projects.
- Using several recent projects, compare the existing LGGROUP unit price estimation methodology and the new developed model with actual unit bid prices.
- Develop a system for updating the unit price database, tables, and graphs.

The new unit price estimation model will bring together the relevant unit bid price data for City of Fort Worth municipal construction projects that have bid between 2003 and 2008 in one excel database. LGGROUP project managers will have readily available access to bid price data from projects that have been conducted by other consultants, instead of just having to rely on historical data based on only their own projects with the City. The new model will enable the project managers to adjust the estimated unit bid prices based on project specific conditions by utilizing the concept of probability of underrun.

Literature Review

The contract for a construction project is awarded to the bidder who submits the lowest bid price when competition is based on a lump-sum lowest bid method. In this method, the submission of offers that are unreasonably low is frequently observed. Awarding contracts to unreasonably low bidders often causes delays and results in poor quality construction. According to Crowley et al. [1], statistically, projects awarded to the lowest bids are more likely to experience excessive cost growth than are projects awarded to more reasonable bids. Furthermore, the inclusion of unreasonably low bid prices in a historical database may lead to inaccurate cost estimates for future projects. One approach for decreasing the impact of unreasonably low bid prices on the accuracy of the predicted unit prices is to use all the bids while preparing a cost estimate. This unit price estimation methodology developed in this study utilizes all the bids received in the generated unit price database.

Shane et al [2] have carried out a study which included an anthology and categorization of individual cost increase factors that were identified through an in-depth literature review. This categorization of 18 primary factors which impact the cost of all types of construction projects was verified by interviews with over 20 state highway agencies. Several of these 18 primary factors were used in this study to develop the decision making matrix. The factors that were applicable to this study were; engineering and project complexities, contract document conflicts, effects of inflation, and market conditions.

Anderson et al. [3] have identified two factors as the important inputs in developing accurate estimates, and they are historical data and market conditions. Historical data are generally used in two different forms, unit costs for bid items derived from recent projects and using historical data related to construction to determine the actual cost to the contractor. Unit costs derived from recent projects reflect bid pricing for items related to past projects that are relevant to the project being estimated. These costs are typically the installed cost of each bid item. The second form is a much more involved method that is completed by using historical data related to production rates and crew sizes, material pricing, and construction equipment pricing, which are marked up with contractor overhead and profit. Both forms of historical data need to be adjusted to reflect market conditions specific to the project [4]. This study only focuses on the first form of utilizing historical data for developing the unit price estimating methodology since this is the standard format for bid prices to be presented to municipalities and engineers.

In many unit price contracts, the competing construction contractors must bid the engineer`s estimated quantities even if they are incorrect [5]. One method to reduce unbalanced bid prices is for the agency to ensure that the bid quantities used in the engineer's estimate are as accurate as possible. When a project is sent to bid, municipalities typically send the engineer's take-off along with the construction plans and specifications to any interested bidders. The bidders submit their unit prices on the engineer's take-off to determine the total construction cost of the bid. Any mistakes or omissions by the engineer may lead the contractor to unbalance the bid prices to protect fixed costs and target profits on bid items that will underrun the quantity used in the engineer's estimate [6]. One assumption made in this study is that the higher the quality of the plans and specifications, the higher the bid quantity accuracy should be. Higher quality plans and specifications are generally assumed to lead to fewer change orders and conflicts in the field than lower quality plans and specifications.

There is a need for accurate predictions of bid prices of construction work. Many cost estimation models that adopt parametric methods have been developed. Approaches to cost estimation based on statistics [7, 8] and linear regression analysis [9–12] have been developed since the 1970s. Despite the development of various mathematical techniques, such as probabilistic simulation [13–18], neural network [19–23] and fuzzy logic [23,24] starting from mid-80s, very few have been used in practice, while the use of conventional (traditional) techniques was continued to be preferred [25–27]. The reason, it is suggested, may be due to many practicing estimators not being well-equipped enough to understand and use other, more elaborate, models [25]. One can also argue that there is little conclusive evidence of the superiority of any of the non-traditional models, with the demand for a move to a more scientific basis for forecasting coming mainly from academia, rather than practice [28, 29]. Cheung and Skitmore [30] declared that for new models to be used, practitioners will need to be convinced that the benefits will exceed the costs involved. This implies the need for a logical and systematic approach to performance measurement and model evaluation.

Maio et al [31] used data acquired from the Atkinson-Washington-Zachry joint venture on the Eastside Reservoir Project in California. The data was analyzed using BestFit software to obtain the parameters of the theoretical distribution functions that best described the field data set. The research validated previous warnings about the influence of the class interval decision on the selection of a distribution function when the chi-square fitting test is utilized.

In summary, the primary method for awarding municipal construction contracts is the lump sum lowest bid method. There are numerous factors that influence the contractors' choices of unit prices for this system, and some of these factors have been used in the decision-making matrix to help the engineer determine the probability of under- or overrun. Because of the prevalence of using the estimated construction costs to set up city budgets and engineering fees, there is a need to have a more accurate model for obtaining unit price data to be used in engineers' estimates. In addition, there is sufficient research available to determine which methods of unit cost estimating provide more reasonable information, such as theoretical distribution functions.

Methodology

The City of Fort Worth construction projects can be separated into three categories: *paving and drainage*, *water*, and *sanitary sewer*. This study focused on all three categories. For each type of project, a construction cost item unit price database was developed. The cost items included in the database are the major items that comprise 80% of the total project cost, and are repeatedly used in different projects. The cost items that are project specific such as metering stations, pump stations, and siphons were not part of this analysis, due to lack of sufficient historical cost data. The tasks that were undertaken during the study are shown below:

A) Identified the cost items to be included in the study.

1. For each type of project (paving and drainage, water, sewer), the cost items that generally account for 80% of the total project cost were identified. Three candidate projects were randomly selected, and the pay items were sorted by their ratio of contribution to the total category (water, sewer, paving) cost using a Pareto diagram (**Appendix C**).
2. Verified that the identified cost items are the ones that are repeatedly used in similar projects and that there is sufficient historical data. For the purposes of this study, any cost item that was included in at least 15 projects or 60 bids was assumed to provide sufficient historical data.

B) Developed a unit bid price database for each of the three project categories with the identified cost items (**Appendix H**).

C) Escalated the unit price database. Using Engineering News Record (ENR) construction cost index, the unit bid prices were adjusted to reflect their present day value.

D) Generated a probability of occurrence curve for each cost item. To develop a statistical model, it was assumed that the compiled unit bid price data for each cost item constituted a small sample from a larger imaginary population of unit bid prices. In other words, it was assumed that there are an infinite number of contractors bidding on projects; leading to an infinite number of bid prices for each cost item. The unit bid price data that was obtained would then represent a small sample of that population. Preliminary results indicated that lognormal distribution could be used to model the probability distribution for construction unit prices (**Appendix G**). As a result, lognormal distribution was used during this study to develop probability distribution functions.

   1. Developed histogram charts for each cost item to identify resemblance to lognormal distribution density curves (**Appendix B**).
   2. Performed an Anderson-Darling goodness of fit test to verify that the unit price data set for each cost item came from a lognormal distribution population (**Appendix G**).
   3. Used the maximum-likelihood method to compute the "meanlog" and "sdlog" parameters of the lognormal distribution.

4. The computed “meanlog” and “sdlog” parameters were used to generate probability of occurrence curves and tables for each cost item (**Appendix D**).

E) Developed a decision making matrix that provides guidance for the project manager to select an appropriate probability of underrun in order to estimate the unit price of a cost item given project specific characteristics.

1. Conducted a survey of the project managers at LGGROUP Fort Worth Municipal Department to identify and rank the factors (item quantity, market, scope definition, schedule, etc.) that influence unit bid prices of a municipal project.
2. Used the survey results to develop a working table that computes an appropriate probability of under run for each cost item, which is then used to estimate the unit bid price.

F) Developed guidelines to assist project managers in filling out the working table and instructions in how to use the computed probability of under run to estimate the unit bid price for a cost item.

G) Tested the unit price estimation model on projects that were recently sent out to bid and compared the new model’s accuracy for estimating actual unit bid prices with the accuracy of the existing LGGROUP methodology for estimating unit bid prices where accuracy is tested by the difference in actual bid price and estimated bid price.

1. Identified the candidate projects.

2. Determined the cost items that were utilized to test the guidelines.
3. Interviewed the project managers who were responsible for the candidate projects and helped them fill out the working table developed in Task E-2.
4. Determined the probability of underrun for each selected cost item using the working table.
5. Used the computed probability of underrun and the graphs and tables developed in Task D-4 to estimate the unit prices that were used in the final cost estimate.
6. Compared the two sets of estimated unit prices (existing methodology, new model) with the contractor's actual unit bid prices using the paired "t" test.

H) Developed guidelines for updating the unit price databases, tables, and graphs. Provided a preliminary schedule and man-hour estimates for conducting the updates.

Summary

The methodology used for this study consists of transforming the unit bid price data of City of Fort Worth construction projects from October 2004 until May 2008 into a more user-friendly database that can be updated as needed by LGGROUP to assist in producing more accurate engineering estimates. In addition, the study created a new way of approaching an engineer's estimate by adding several steps to the process, including a decision-making matrix that would assist in determining the probability of underrun and charting the association between that probability and the changes in unit prices for the bid items. Finally, the study also created guidelines for LGGROUP to use in updating the unit price databases, tables, and graphs to keep the information current. The process could be repeated for various public clients (i.e. TxDOT, other municipalities) in order to have unit bid price databases for their construction projects as well.

CHAPTER II

UNIT BID PRICE DATABASE DEVELOPMENT

The first step for developing the Unit Price Database (UPD) was to obtain all the historical data regarding the received bids for the City of Fort Worth construction projects. For each construction project, the City of Fort Worth requires that the contractors submit bid packages with the unit price for each construction item present in the project. After the bids are opened, the City and/or the Engineer develops an Excel spreadsheet called "Bid Tabulation" with all the detailed unit bid prices submitted by each contractor to check the accuracy of the bid packages submitted by the contractors. If there are no calculation mistakes, the lowest responsive bidder is awarded the project. The City keeps the resulting bid tabulation (aka. bid tab) in their server as a historical record. The City of Fort Worth bid tabs are public information, and therefore anybody can obtain a copy of the bid tabulations recorded. This is true of most municipalities and TxDOT actually keeps their bid tabs online at the following website http://www.dot.state.tx.us/business/contractors_consultants/bid_tabs.htm.

For this study, all 140 bid tabulations recorded between October 2004 and May 2008 were obtained from the City in Excel format; the digital files are provided in a CD in **Appendix A**. An excerpt from a typical bid tab is shown in Figure 2-1.

				S.J. Louis Construction of Texas Ltd.		Oscar Renda Contracting, Inc.		Circle C Construction	
Pay Item	Quantity	Unit	Description of Bid Item	Unit Price	Total Bid	Unit Price	Total Bid	Unit Price	Total Bid
SEWER IMPROVEMENTS									
1.	1412	LF	90" Sewer by Open Cut; All Depths	$ 534.00	$ 754,008.00	$ 380.00	$ 536,560.00	$ 460.00	$ 649,520.00
2.	2438	LF	72" Sewer by Open Cut; All Depths	$ 406.00	$ 989,828.00	$ 320.00	$ 780,160.00	$ 390.00	$ 950,820.00
3.	180	LF	60" by Open Cut; All Depths	$ 433.00	$ 77,940.00	$ 250.00	$ 45,000.00	$ 350.00	$ 63,000.00
4.	635	LF	60" Sewer by Other than Open Cut; All Depths	$ 670.00	$ 425,450.00	$ 1,200.00	$ 762,000.00	$ 1,050.00	$ 666,750.00
5.	585	LF	42" Sewer by Open Cut; All Depths	$ 335.00	$ 195,975.00	$ 200.00	$ 117,000.00	$ 260.00	$ 152,100.00

Figure 2-1. Example Excerpt from a Bid Tab

As seen in Figure 2-1, a typical City of Fort Worth bid tab provides data regarding the quantity, unit, unit price bid by each contractor, and total price of each pay item in a project. The variability in the unit costs from the table above is typical for most projects. Depending on market conditions, some contractors may not actually want the job but feel they have to bid in order to be considered for future projects from the city. In addition, there might be an error on the plans for a particular cost item that a contractor sees and identifies as a probable change order, so they adjust their unit prices to obtain the greatest return on the change order while still keeping their lump sum price competitive by lowering other items.

Depending on the project scope, a City of Fort Worth construction project can have water, sanitary sewer, and/or paving and drainage improvement pay items. Pay items associated with each category are grouped under the appropriate units; Unit I: water, Unit II: sanitary sewer, Unit III: paving and drainage (**Appendix A**). Depending on the project scope, one or more of these units may be present in any bid tab. Each City of Fort Worth construction project is unique and the scope varies greatly from project to project. Typically sanitary sewer, water, or paving and drainage improvements would each have between 15 and 40 cost items. A project that has sanitary sewer, water, and paving/drainage improvement aspects in its scope may easily have 100 cost items.

The second step in the UPD development was to decrease the number of cost items to be analyzed to a more manageable size for the purposes of this study. The main pay items that accounted for about 80% of the total cost for sanitary sewer, water, or paving improvements categories were identified. To accomplish this task, three typical candidate projects were randomly identified. The pay items in these candidate projects were sorted by the ratio of their contribution to the total category cost using a Pareto diagram. The identified pay items were further studied, and the items that were not repeatedly used in different projects were eliminated from consideration to be included in the UPD. A cost item was considered not repeatedly used if there were less than 12 occurrences of that item from the bid data. Unit bid price data related to project specific, non-recurring pay items were excluded from this study due to a lack of a sufficient number of data points for analysis. The pay items that account for 80% of the total cost and are repeatedly used in City of Fort Worth sanitary sewer, water, and/or paving projects are presented in Table 2-1.

The third step in the UPD development was to build the framework for the database. Microsoft Excel was selected as the software to house the database. Excel was chosen because of its widespread use amongst the engineers at LGGROUP and many other engineering companies. Furthermore, all of the original bid tabs obtained from the City of Fort Worth were already in Excel format.

Table 2-1. Pay Items Selected for UPD Development

Sanitary Sewer	Water	Paving
12-Inch Sanitary Sewer Pipe:All Depths	12-Inch PVC Water Pipe By Open Cut	6-Inch Reinforced Concrete Pavement
10-Inch Sanitary Sewer Pipe:All Depths	10-Inch PVC Water Pipe By Open Cut	6-Inch Reinforced Concrete Driveways
8-Inch Sanitary Sewer Pipe:All Depths	8-Inch PVC Water Pipe By Open Cut	Standard 4-Inch Concrete Sidewalk
6-Inch Sanitary Sewer Pipe:All Depths	6-Inch PVC Water Pipe By Open Cut	Unclassified Street Excavation
4-Inch Sanitary Sewer Pipe:All Depths	12-Inch Gate Valve w/Cast Iron Box & Lid	6-Inch Lime Stabilized Subgrade
Std. 4-feet Dia. Manhole to 6-feet Depth	8-Inch Gate Valve w/Cast Iron Box & Lid	Lime
4-feet Dia. Drop Manhole to 6-feet Depth	6-Inch Gate Valve w/Cast Iron Box & Lid	Temporary Asphalt Pavement Repair
Std. 5-feet Dia. Manhole to 6-feet Depth	Ductile Iron Fittings	Permanent Concrete Pavement Repair
	Standard Fire Hydrant Assembly	Permanent Asphalt Pavement Repair

Each bid tab essentially provides the same type of information, however the format of the spreadsheets differs depending on the source (consultant engineer or the City personnel) of the original data; therefore it was not possible to combine the separate spreadsheets using an automated (software based) procedure. Instead the data from each bid tab was manually entered into the database framework spreadsheet. The data collected includes the following (**Appendix A**):

- Project Number
- Number of Bidders
- Bid Date
- Contractor
- Pay Item
- Quantity
- Unit
- Unit Price
- Bid Rank (Lowest bid = 1)

The fourth step was to refine the database by adjusting the unit bid price data from each bid tab to reflect their present day value. Engineering News Record's (ENR) Construction Cost Index was used to adjust the data. For the purposes of this study, the present day was assumed to be December 2008. The database framework was set up to automatically adjust the unit bid prices given any date between October 2004 and present day, thus increasing the robustness of the database and decreasing the effort required to update the spreadsheet every year. The digital UPD excel file is provided in **Appendix H**.

Summary

The development of the UPD began with separating the cost items into one of three units; Unit 1 for water, Unit 2 for sanitary sewer, and Unit 3 for paving. Using three randomly selected projects from each category, the cost items that typically account for 80% of the total cost for water, sanitary sewer, and paving projects, respectively, were determined. From those items, the ones that occurred 12 times or less where excluded from the UPD since they did not have a large enough sample size for analysis. The items from each bid tab that met the criteria of typically contributing towards 80% of the total construction cost and occurring on at least 12 projects where then entered by hand into the Microsoft Excel UPD. The UPD was set up to automatically adjust the entered data to the present day value using the ENR Construction Cost Index.

CHAPTER III

STATISTICAL MODEL DEVELOPMENT

As part of the internship objectives, a statistical model was developed for each selected pay item. To develop a statistical model from the compiled unit bid price data, it can be assumed that each pay item constituted a small sample obtained from a larger imaginary population. The imaginary population can be described as being formed by an infinite number of contractors bidding on projects leading to an infinite number of bid prices for each pay item. The unit bid price data gathered in this study represent a smaller sample of that population.

In the internship proposal, it was stated that preliminary results indicated the log-normal probability distribution provided the best fit to model the unit bid price distribution for each pay item. However, further investigation showed that for some of the pay items, normal distribution was a better fit. This study made use of both normal and log-normal distribution to model the unit bid price data collected from the City of Fort Worth.

Developing Histogram Charts

The first step in developing statistical models was to develop histogram charts for each of the pay items. The generated histograms for each item are presented in **Appendix B**. The histograms for most of the pay items selected indicated a resemblance for log-normal probability distribution as shown in Figure 3-1.

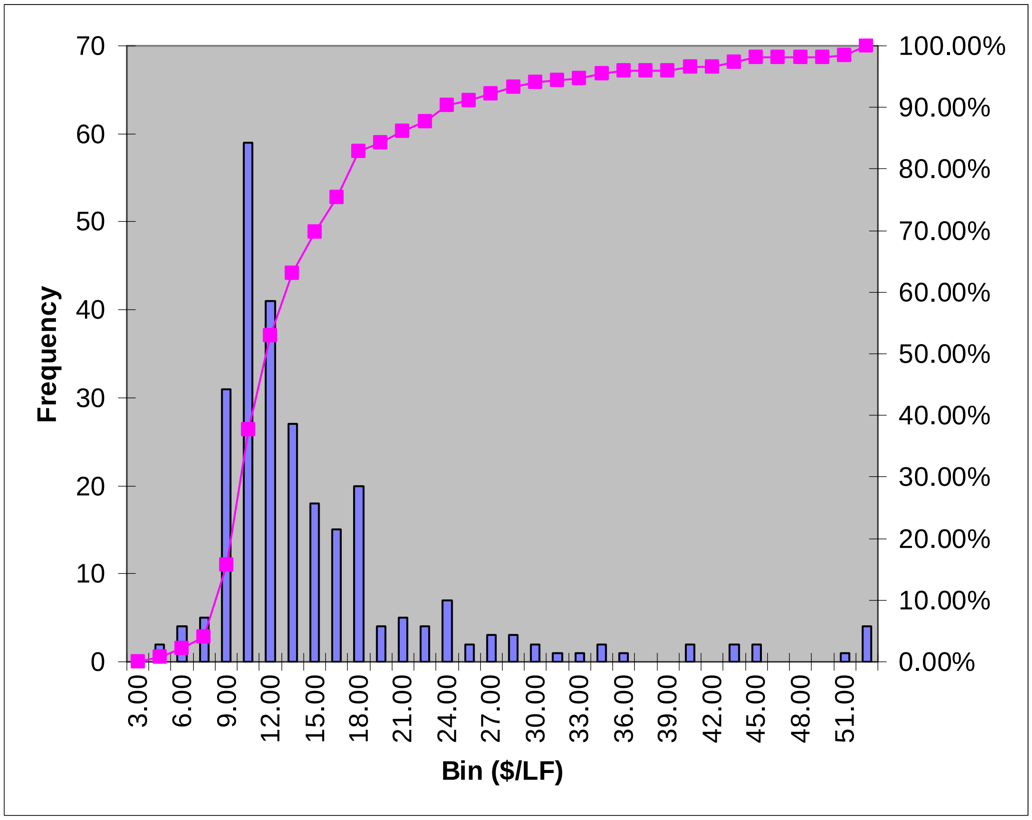


Figure 3-1. Temporary HMAC Pavement Repair Unit Price Data Histogram

On the other hand, some pay items such as the ones listed below indicated a resemblance for normal probability distribution:

- Lime for Stabilization
- All Size Gate Valves
- Ductile Iron Fittings (Figure 3-2)
- Sanitary Sewer Manholes

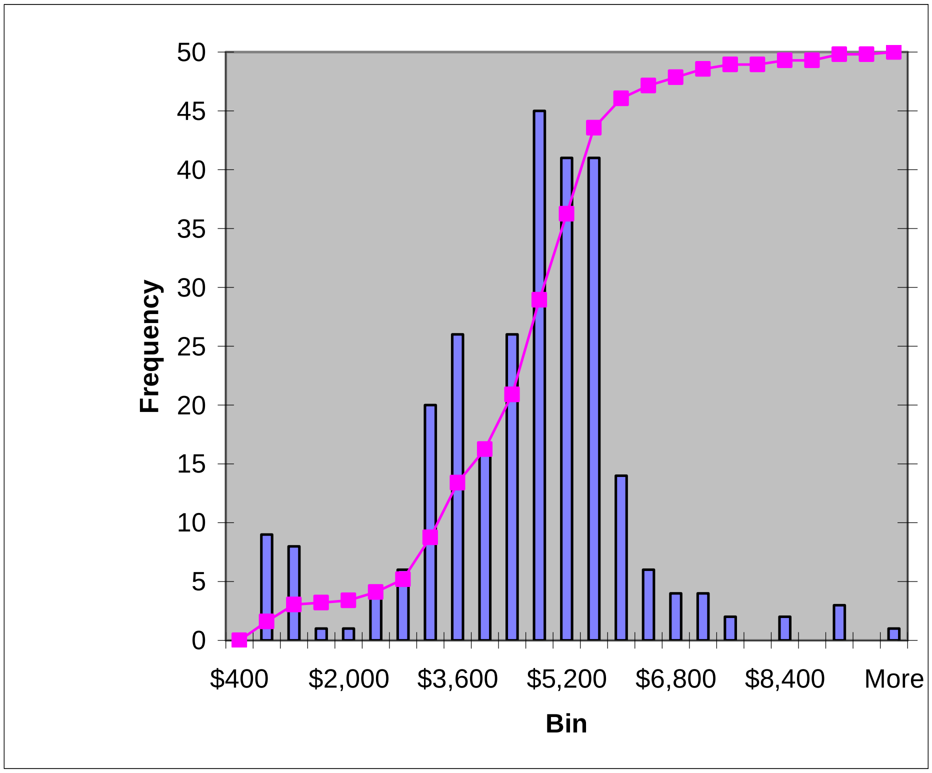


Figure 3-2. Ductile Iron Fittings Unit Price Data Histogram

Coefficient of Variation Effect

Since a small coefficient of variation typically leads to a more symmetrical probability density function, the data appears to be normally distributed. Conversely a larger coefficient of variation leads to an asymmetrical distribution that appears to be log-normal probability distributed. The items that have smaller coefficients of variation tend to be items that do not require much labor, and the items that have a lager coefficient of variation require more labor. In addition, the items with smaller coefficients of variation also have few suppliers in the area, so the cost to the contractors to obtain these items is relatively equal.

Developing Cumulative Probability Distribution Charts

The second step was to develop cumulative probability distribution charts for each of the cost items. To simplify the analysis, each cost item's unit price data with a histogram that resembled log-normal distribution was transformed by taking the natural logarithm of all the data points; thus making the transformed data set normally distributed. The mean and standard deviation of the transformed data set for each cost item was calculated. These values were used to develop cumulative probability distribution charts. All of these calculations were performed in Excel. A separate tab under each (paving, water, sanitary sewer) database was created for each pay item. An excerpt from the statistical analysis table for 12-Inch Water Line is presented in Table 3-1. The statistical analysis tables for all of the pay items are included in **Appendix C**.

Table 3-1. Excerpt from the 12-Inch WL Statistical Analysis Table

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$43.27	3.768	30	1.81%
$58.48	4.069	31	2.25%
$50.76	3.927	32	2.76%
$42.10	3.740	33	3.34%
$79.53	4.376	34	4.00%
$107.60	4.678	35	4.74%
$99.41	4.599	36	5.56%
$97.07	4.575	37	6.46%
$105.26	4.656	38	7.45%
$109.94	4.700	39	8.51%
$69.03	4.235	40	9.65%

Using the statistical analysis tables, cumulative probability distribution charts were developed for each of the cost items. The log-normal cumulative probability chart for 12-Inch water line is shown in Figure 3-3.

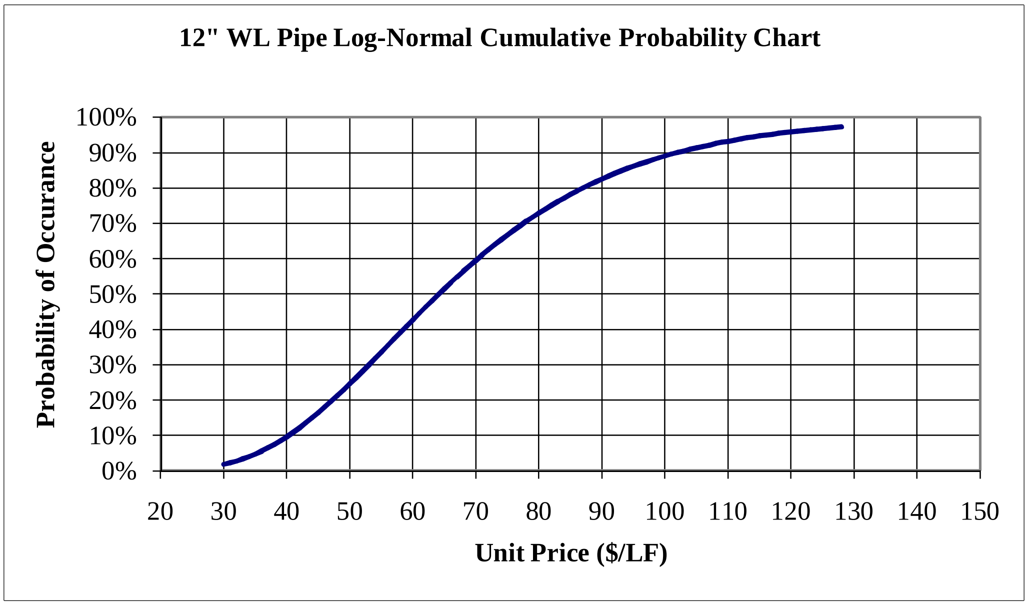


Figure 3-3. 12-Inch WL Unit Price Log-Normal Cumulative Probability Chart

The resulting probability of *underrun* vs. *estimated unit price* for the 12-Inch WL cost item is presented in Table 3-2. The generated probability charts and tables for all studied pay items are included in **Appendix D**.

Table 3-2. 12-Inch WL Probability of Underrun Table

Probability of Underrun	Estimated Unit Price ($/LF)
10%	40.30
20%	47.27
30%	53.03
40%	58.51
50%	64.14
60%	70.31
70%	77.57
80%	87.03
90%	102.09
98%	135.08

The quantity of each bid item was not dealt with during these calculations, but is addressed in a later section.

Summary

The first step in the statistical model development was to create a histogram of each cost item to determine if it was normally distributed or log-normally distributed. Typically a smaller coefficient in variation led to a normally distributed histogram, and a larger coefficient in variation led to a log-normal probability distributed items. The calculated mean and standard deviation for each cost item were used to create the cumulative probability distribution charts. A tab for each cost item was created in each database (paving, water, and sanitary sewer), and a chart for each was included in **Appendix D**.

CHAPTER IV

DECISION MAKING MATRIX DEVELOPMENT

A decision making matrix was developed to provide guidance for selecting an appropriate probability of under run for each analyzed construction cost item. Before a decision making matrix could be developed, the variables that are perceived to influence a contractor's unit bid price for a given item had to be identified and given a degree of impact on the project. The degree of impact for each variable is assigned an impact rate multiplier that allows each variable to have a different rate of impact on the unit bid prices. To accomplish these tasks, a list of variables from the literature review were selected and presented to the LGGROUP project managers.

Creating the Decision Making Matrix

Ogunlana and Thorpe [32] present several variables that may affect estimating accuracy in their paper. The variables presented by Ogunlana and Thorpe are discussed below:

- *Type of Project:* The type of construction (i.e. a water line construction versus a storm sewer and road reconstruction) in addition to the complexity of the work, the known versus unknown variables (i.e. underground conditions), the number of potential stakeholders involved, and conflicting utilities all may lead to changes in the unit bid prices.

- *Size of Project:* The size of the project was related to the item quantities since larger project would typically have larger quantities of the items that make up 80 percent of the total construction cost. Item quantity is inversely related to the unit bid price for that item [32].
- *Geographical Location of Project:* Since this study focused on the City of Fort Worth only, this variable does not apply and was excluded from further discussion.
- *Number of Bidders:* The number of bidders is typically inversely related to the unit bid prices. "Also, the statistics of bid distribution ensure that low bids are more likely as the number of bidders increases." [32] Although the contractors can not know the exact number of bidders an advertised project would generate before the bid documents are opened, they do know the interest the project receives from other contractors before they submit their bids because any interested parties who procure a project set of plans and specifications must sign a list that is public information. This competition is reflected in the average number of bidders for each project.
- *State of the Market:* Current market condition was assessed as the recent national and/or state wide status of the construction industry. "The view in the construction literature is that contractors will be willing to undertake less attractive projects, sometimes at a loss, in periods of low market activity. Conversely, tender levels are expected to rise and competition become more lax in periods of boom." [32]

- *Level of Information Available:* This was analyzed as the quality of the plans and specifications which can be measured as the ease or difficulty a project could be constructed as detailed in the plans and specifications. It was assumed that a good clear set of plans and specifications would enable the contractor to have a better understanding of the project, thus lowering the unit bid price. Conversely, a lower quality set of plans and specifications would cause a contractor to add more than required contingency to their cost estimates; thus raising the unit bid price. [32]
- *Ability of the Estimator:* Since this variable is not an area that the engineer has any input on or ability to determine, it was not a measurable variable and eliminated from this study.
- *Project Duration:* Project schedule has an inverse relationship with unit bid prices. If a project is advertised with a shorter than normal construction duration, traditionally the received unit bid prices tend to be higher. A short construction duration would force the contractor to increase the project workforce and this increase in workforce size often results in decreased productivity, thus forcing the contractor to increase his/her unit bid prices to compensate for the loss of productivity. Moreover, if a project has a longer than normal allowed construction duration, the contractor would have the flexibility to move crews between projects, thus decreasing his/her overall operating expenses. The contractor would have the means to lower his/her unit bid prices due to this decrease in expenses. [32]

These variables were compiled to create the survey forms found in **Appendix E**. The LGGROUP project managers were asked to complete the surveys to determine the variable impact as detailed in the following section. At this time, the project managers were also able to identify any additional variables they felt should be added to the surveys.

Variable Impact Determination

Upon receipt of the survey forms, each project manager was asked to estimate the impact on the unit bid price by those variables previously identified and included on the survey form. The project managers surveyed total approximately 150 years of experience working in the City of Fort Worth on the types of projects included in this project. The surveys by the 5 project managers are presented in **Appendix E**. The results of the survey are summarized in Table 4-1.

In general, the majority of the variables received similar impact ratings from the project managers, with the exception of the *item quantity* and *current market conditions*, which one project manager disagreed on. The project manager that did not think the *item quantity* and *current market conditions* affected the unit bid price had the least amount of experience in the City of Fort Worth (2 years). Because the project managers surveyed represent a large number of years of experience and types of projects, the overall classification ignored the lone outlier and focused on the majority's opinion. Based on the results of the survey, the factors potentially affecting unit bid prices were categorized into three classification groups regarding their perceived impact on a construction item unit bid price; high impact, medium impact, and low impact as shown in Table 4-1.

Table 4-1. Summary of Survey Results

Variables	No Impact	Low Impact	Medium Impact	High Impact	Overall Classification
Item Quantity		1		4	High
Project Simplicity		1	2	2	Medium
Current Market Condition	1			4	High
Quality of the Plans/Specs			5		Medium
Project Duration			3	2	Medium/High
Number of bidders	1		2	2	Medium

Item quantity and *current market condition* were estimated to have high impacts on the corresponding unit bid prices. *Project duration* was identified to have a medium/high impact; *project simplicity*, *quality of plans/ specs*, and n*umber of bidders* were determined to have medium impacts on the corresponding unit bid prices.

Impact Rate Multiplier Development

To quantify the rate of impact each variable has on the unit bid price, a numerical impact rate multiplier was assigned to each variable based on the rating classification. Each impact rating identified by the project managers had a corresponding numerical multiplier assigned to it as presented in Table 4-2.

Table 4-2. Impact Rate Multipliers

Variables	Impact Rate	Multiplier
Item Quantity	High	4
Project Simplicity	Medium	2
Current Market Condition	High	4
Quality of Plans & Specs	Medium	2
Project Duration	Medium/High	3
Competition (# of bidders)	Medium	2

Using the variables and the impact rate multipliers, a decision making matrix was developed for selecting the appropriate probability of under run in order to estimate the unit bid price for a construction item as shown in Table 4-3.

Table 4-3. Blank Decision Making Matrix for Selecting Probability of Under-run

Project Related Variables	Multiplier	Variable Rating	Variable Score (Multiplier x Variable Rating)
Project Simplicity	2		
Current Market Condition	4		
Quality of Plans & Specs	2		
Project Duration	3		
Competition (# of bidders)	2		
Total			
Suggested Probability of Underrun			

Determining Probability of Underrun with the Decision Making Matrix

For each construction item, the project managers should fill out the form presented in Table 4-3 to determine the appropriate *probability of underrun* given the project related variables and item quantity adjustment. *Item quantity* was separated from other variables because all of the remaining variables would have the same score for a given project. In other words, *project simplicity*, *current market condition*, *quality of plans/specs*, *project duration*, and *competition* have the same scores for each construction item in a project. However, the score for the *item quantity adjustment* can vary for each cost item within the project. With this format, the project managers only have to fill out one base form for each project and enter the *item quantity adjustment* for each cost item.

Each variable that has an impact on the unit bid price of a pay item as defined in this study has an inverse relationship with the unit bid price; for example, a lower *quality of plans/specs* should yield a higher unit bid price, or a higher *rate of competition* should yield a lower unit bid price.

Variable Rating Determination

The next column in the decision making matrix is the variable rating. The values for the variable ratings where determined by analyzing the applicable pay items from the *Improvements for Martha and Malinda Project.* The conceptual design report [33] that was submitted to the City before the design effort commenced is presented in **Appendix F**. The report outlines all the infrastructure problems in the project area and how LGGROUP planned to address the issues with the design improvements.

This project was selected because it presented several advantages over other candidate projects, the most important being that the project scope contained improvements for water, sanitary sewer, and paving and drainage. Therefore a large number of cost items that were in the Unit Price Database were also included in the bid package for the Martha and Malinda project. In addition, the project was similar in characteristic to a typical City of Fort Worth project in that the main scope was to provide infrastructure improvements to an older part of the City. Since the older parts of the City tend to have more infrastructure problems, the City generally spends more public works' funds in those areas.

The variable rating determination process is summarized as a flowchart in Figure 4-1.

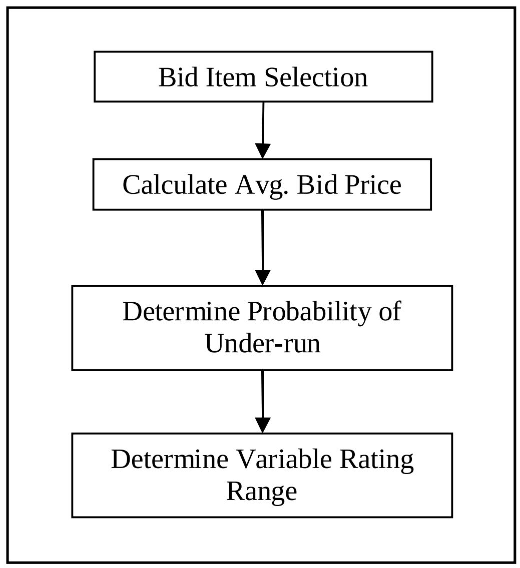


Figure 4-1. Variable Rating Determination Process Flowchart

The first task for determining the variable rating range was to identify the Martha and Malinda cost items that were included in the UPD. The second step in the process was to calculate the average bid price for each selected cost item. The third step was determining the probability of underrun for each selected pay item that corresponded to the calculated average bid price using the probability charts and tables that were included in **Appendix D**. For example, the average bid price for 8” PVC Water Pipe in the Martha and Malinda project is $41.83. Based on the probability charts and tables that are included in Appendix D, this corresponds to an average bid probability of underrun of 55%. The result of this analysis is summarized in Table 4-4.

Table 4-4. Variable Rating Determination Analysis Summary

Description of Item	Units	Quantity	Conatser	McClendon	JLB	Stabile& Winn	Avg. Bid Price	Avg. Bid Prob. Underrun
			UNIT COST	UNIT COST	UNIT COST	UNIT COST	UNIT COST	
8" PVC Water Pipe	LF	1,132	$36.00	$41.00	$46.30	$44.00	$41.83	55%
10" PVC Water Pipe	LF	1,785	$40.00	$62.00	$67.65	$65.00	$58.66	75%
Temp. Asph. Pavm. Repair	LF	3,450	$9.00	$12.00	$13.50	$12.00	$11.63	40%
4" PVC SS Pipe	LF	1,075	$35.00	$14.00	$15.95	$13.00	$19.49	30%
8" PVC SS Pipe	LF	1,075	$50.00	$51.00	$55.50	$53.00	$52.38	55%
Std. 4' Dia. SSMH (0-6')	EA	16	$1,600.00	$3,100.00	$3,370.00	$3,500.00	$2,892.50	75%
Unclassified Street Excavation	CY	3,668	$12.50	$17.00	$16.35	$20.00	$16.46	40%
Lime for Subgrade (30 Lbs./SY)	TN	173	$110.00	$87.50	$104.00	$110.00	$102.88	15%
6" Lime Stabilized Subgrade	SY	11,523	$3.00	$1.75	$2.26	$1.75	$2.19	20%
6" Reinforced Conc. Pavm.	SY	10,096	$32.50	$23.50	$28.21	$31.09	$28.83	25%
6" Reinforced Conc. Drive	SF	7,151	$6.00	$5.00	$5.34	$5.50	$5.46	30%
Cast Iron/Ductile Iron Fittings	TN	4	$3,000.00	$4,000.00	$4,500.00	$4,600.00	$4,025.00	40%
Std. 4' Dia. Drop SSMH (0-6')	EA	4	$2,000.00	$5,100.00	$5,600.00	$5,800.00	$4,625.00	70%
6" PVC SS Pipe	LF	170	$40.00	$49.00	$53.00	$51.00	$48.25	55%
Standard Fire Hydrant	EA	2	$1,600.00	$2,500.00	$2,800.00	$2,800.00	$2,425.00	70%
12" PVC Water Pipe	LF	60	$45.00	$75.00	$77.50	$76.00	$68.38	60%
Perm. Asph. Pavm. Repair	LF	35	$60.00	$70.00	$79.00	$70.00	$69.75	80%

A histogram showing the calculated average bid probability of underrun (POU) values is presented as Figure 4-2. As shown in Figure 4-2, the calculated POU values were within the 15-80 percent range, with an average POU value of 50 percent.

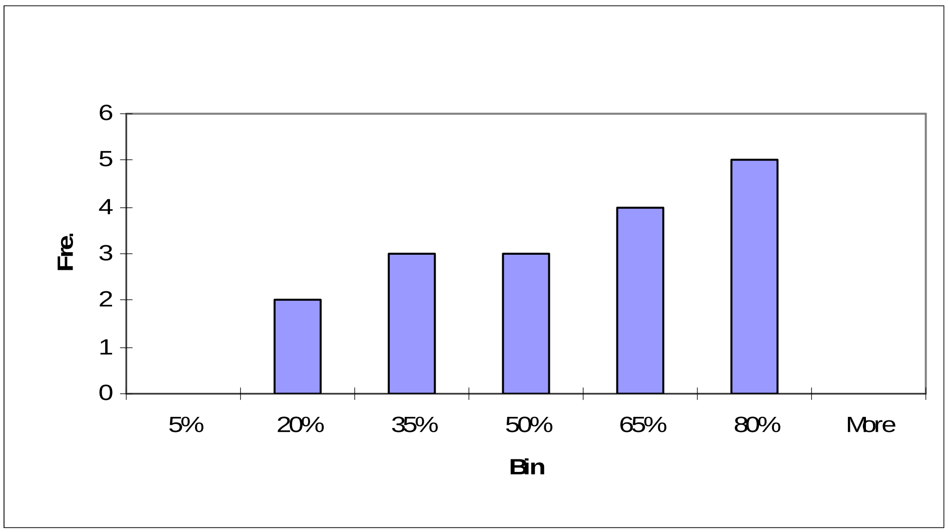


Figure 4-2. Martha & Malinda Calculated POU Histogram

After analyzing the Martha and Malinda project, the variables ratings for each project related variable were determined to be:

- Low = 15
- Medium = 20
- High = 25

Therefore, the project manager rates each project related variable by entering a variable rating where low=15, medium=20, and high=25 depending on the project characteristics. For example, a project with a good set of “Plans and Specifications” would have a variable rating of “high=25” in the decision making matrix.

In order to use the Decision Making Matrix (Table 4-3) to determine the probability of underrun, the project manager must determine the variable rating (high, medium, or low) for each project related variable and enter it into the table. The variable score is then determined by multiplying the variable rating by the multiplier for each project related variable. Then, the *suggested probability of underrun* is calculated by dividing 130 by the total variable scores. The suggested *probability of underrun* is calculated before quantity adjustment, so that in the worst case scenario where each variable is assigned a low quantity adjustment score, *the probability of underrun* would be 75 percent. On the other hand, if all the variables are assigned a high quantity adjustment score, the *probability of underrun* would be 35 percent. The range of the probability of underrun varies by 20 percent from an average of 55 percent based on the difference in bid prices determined by the quantity variable rating which is discussed in further detail in the following section.

Decision Making Matrix Quantity Adjustment

The first step in determining the quantity adjustment was to estimate the quantity variable rating for each selected bid item. The quantity variable rating categorizes the quantity of each bid item into a high, average, or low range. As previously mentioned, the quantity of each bid item has a high impact on the bid price [32]. The objective of this step was to quantify the impact of the bid item quantity on the bid price. The data stored in the UPD was used in the quantity variable rating analysis.

Estimate Quantity Variable Rating

As part of the quantity variable rating analysis, bid item quantity scatter plot graphs for each cost item were developed using Excel. As an example, the scatter plot for “6-Inch Concrete Driveway” is provided in Figure 4-3.

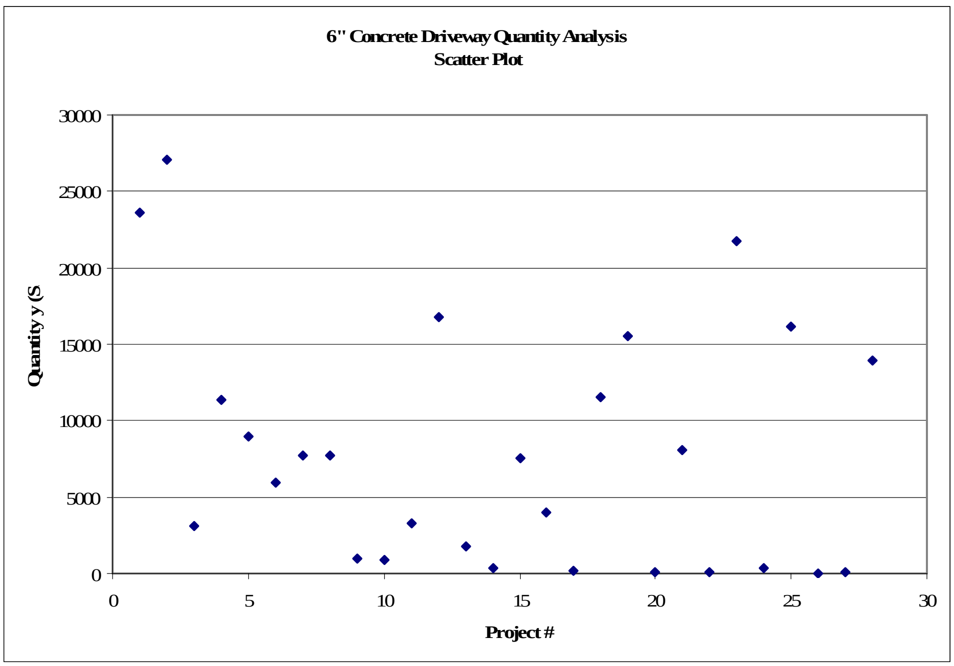


Figure 4-3. 6-Inch Concrete Quantity vs. Project Scatter Plot

A review of the scatter plots and histograms generated for each cost item revealed that the probability distribution that best resembled the bid quantity probability distribution was normal distribution. A cumulative normal distribution function was generated for each cost item in order to determine the high, average, and low quantity ranges. The normal cumulative distribution curve for 6-inch Concrete is shown in

Figure 4-4. The scatter plots and the log-normal cumulative distribution curves for each cost item are provided in **Appendix G**.

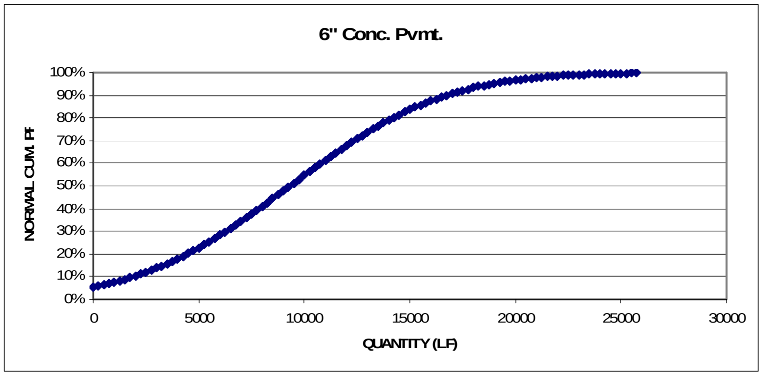


Figure 4-4. 6-Inch Concrete Normal Cumulative Distribution Curve

For the purposes of this study, a low quantity range was defined as any amount that would fall between 0 to 20 percent cumulative probability of occurrence. Quantities higher than 60 percent cumulative probability would be categorized as high. Quantities that fall in between 20 to 60 percent cumulative probability are labeled as average quantities. The results of the quantity analysis are summarized in Table 4-5.

Table 4-5. Quantity Analysis Results Matrix

Description of Item	Units	Low	Average	High
PVC SS Combined	L.F.	0-110	110-750	750+
Std. SSMH Combined Sizes	Each	0-3	3-9	9+
6" Concrete Pavement	S.Y.	0-4000	4000-9000	9000+
6" Concrete Driveway	S.F.	0-400	400-4300	4300+
4" Concrete Sidewalk	S.F.	0-800	800-7100	7100
Unclassified Street Excavation	C.Y.	0-600	600-2500	2500+
6" Lime Stabilization	S.Y.	0-5600	5600-11000	11000+
Lime for Subgrade Stabilization	Ton	0-90	90-170	170+
Temporary Asphalt Pavement Repair	L.F.	0-1000	1000-3600	3600+
Permanent Asphalt Pavement Repair	L.F.	0-80	80-600	600+
Permanent Concrete Pavement Repair	S.Y.	0-80	80-450	450+
PVC WL Combined	L.F.	0-75	75-1800	1800+
Cast Iron/Ductile Iron Fittings	Ton	0-1	1-4	4+
Standard Fire Hydrant (3'-6" Depth)	Each	0-2	2-6	6+

Calibrating the Decision Making Matrix Quantity Adjustment

Again, the Improvements for Martha and Malinda Lane Project was used to calibrate the decision making matrix for the quantity adjustment. As previously stated, this project presented several advantages over other candidate projects in that in included many pay items from the Unit Price Database and represented a typical project from the City of Fort Worth for infrastructure improvements.

Using Table 4-5, a Quantity Value Score (QVS) of 1, 2, or 3 was assigned to each bid item. A QVS of 1 was assigned to a bid item with lower than usual quantity amount, whereas a QVS of 3 was assigned to items with higher than usual amounts bid. A QVS of 2 was assigned to items that had quantities that were perceived to have an average quantity amount. The results of the analysis are presented in Table 4-6.

Table 4-6. Martha and Malinda Cost Items QVS Analysis

DESCRIPTION OF ITEM	UNITS	QTY	Avg. Bid Price	Avg. Bid POU	QVS
8" PVC Water Pipe	LF	1,132	$41.83	55%	2
10" PVC Water Pipe	LF	1,785	$58.66	75%	2
Temp. Asph. Pavm. Repair	LF	3,450	$11.63	40%	3
4" PVC SS Pipe	LF	1,075	$19.49	30%	3
8" PVC SS Pipe	LF	1,075	$52.38	55%	3
Std. 4' Dia. SSMH (0-6')	EA	16	$2,892.50	75%	3
Unclassified Street Excavation	CY	3,668	$16.46	40%	3
Lime for Subgrade (30 Lbs./SY)	TN	173	$102.88	15%	3
6" Lime Stabilized Subgrade	SY	11,523	$2.19	20%	3
6" Reinforced Conc. Pavm.	SY	10,096	$28.83	25%	3
6" Reinforced Conc. Drive	SF	7,151	$5.46	30%	3
Cast Iron/Ductile Iron Fittings	TN	4	$4,025.00	40%	2
Std. 4' Dia. Drop SSMH (0-6')	EA	4	$4,625.00	70%	1
6" PVC SS Pipe	LF	170	$48.25	55%	2
Standard Fire Hydrant	EA	2	$2,425.00	70%	2
12" PVC Water Pipe	LF	60	$68.38	60%	1
Perm. Asph. Pavm. Repair	LF	35	$69.75	80%	1

Determine Correlation between Probability of Underrun and Quantity Variable Rating

The final step in the matrix calibration process was to determine if there would be a correlation between Probability of Underrun (POU) and the QVS for the selected bid items. A scatter plot graph of QVR versus POU for the Martha and Malinda Project bid items is presented in Figure 4-5.

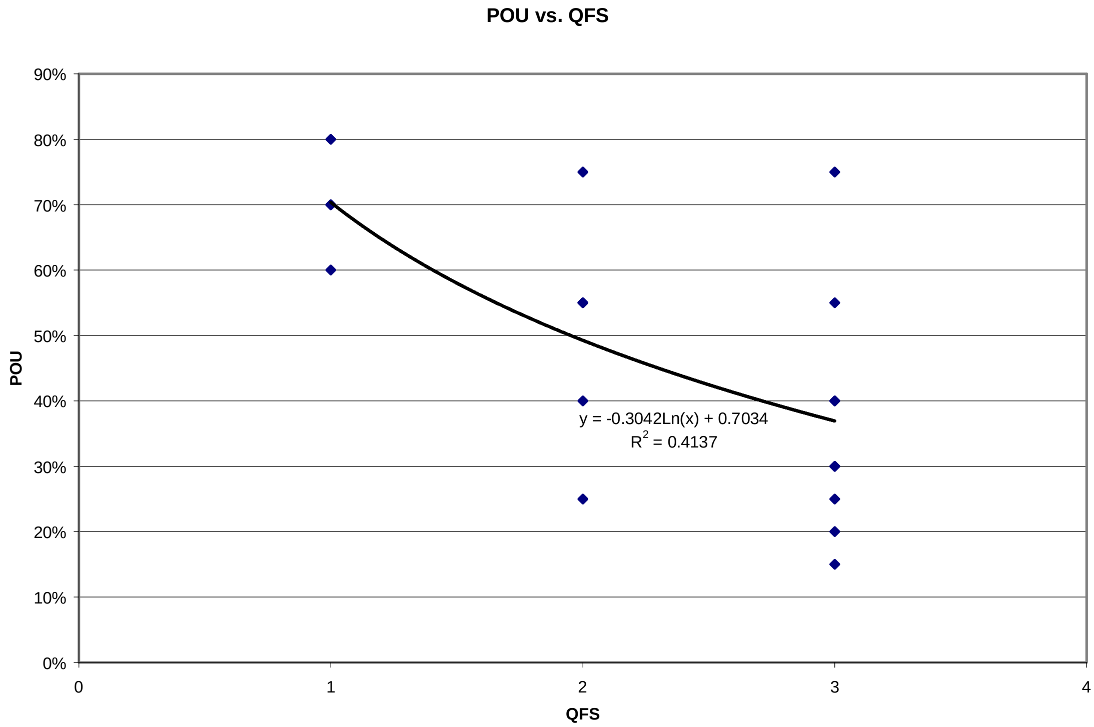


Figure 4-5. POU vs. QVS Scatter Plot

As shown in Figure 4-5, there is a negative correlation between POU and QVS. As indicated by the logarithmic best fit equation, a low or high quantity amount compared to an average quantity for a bid item, results in about a 20 percent difference in bid prices. As a result, the POU calculated by a Project Manager using the decision making matrix can be adjusted up to 20 percent depending on the bid item quantity. This 20 percent variance influenced the decisions made previously in regards to the variable rating determination such that the range of probability of underrun was contained within the 35-75 percent range.

Summary

The decision making matrix was developed to provide the project managers with a tool to determine the probability of underrun for a project based on several variables determined to have an impact on the bid prices for construction projects. These variables were determined based on literature review and work experience. In addition, the project managers used their experience to determine the rate of impact each variable would have on the probability of under-run, and these impact rates were included in the decision making matrix. The Unit Price Database was used to determine the Quantity Variable Rating for each cost item in the UPD. The decision making matrix was then applied to the *Improvements to Martha and Malinda Lane Project* to calibrate the values chosen in order to have a range for the probability of underrun between 35 and 75 percent.

CHAPTER V

UNIT PRICE ESTIMATION MODEL APPLICATION

This Chapter discusses the application of the unit price estimation model to an actual project and comparing the results with the current estimating methods utilized at LGGROUP. The project that was selected as the case study is called, "Rosedale Street Improvements." The project consists of water and sanitary sewer improvements. The first step in the application process is filling out the decision making matrix, and this process was already discussed in Chapter IV. The second step is to compare the engineer's original unit price estimate with the estimated unit prices from this methodology and also with the actual average bid prices.

Completing the Rosedale Street Improvements Decision Making Matrix

The project manager in charge of the Rosedale Project was asked to fill out the decision making matrix in Excel so an acceptable probability of underrun could be estimated for each cost item. The filled out decision making matrix for this project is shown in Table 5-1.

The suggested POU before the quantity adjustment for the Rosedale Project was calculated to be 55%. Depending on the quantity adjustment, the POU for a bid item can be 35, 55, or 75 percent. The Rosedale Project cost items that were included in the developed Unit Price Database, their respective quantity factor scores, and selected probability of underrun values are listed in Table 5-2.

Table 5-1. Rosedale Filled Out Decision Making Matrix

Project Related Factors	Multiplier	Factor Score	Multiplier x Factor Score
Project Simplicity	2	15	30
Current Market Condition	4	20	80
Quality of Plans & Specs	2	20	40
Project Duration	3	15	45
Competition (# of bidders)	2	20	40
Total			**235**
Suggested Probability of Underrun (POU)	**55%**		

Table 5-2. Selected Bid Items, QFS, POU for the Rosedale Project

DESCRIPTION OF ITEM	UNITS	QTY	QFS	POU
6" PVC Water Pipe(All Depths)	LF	100	2	55%
8" PVC Water Pipe(All Depths)	LF	1,284	2	55%
12" PVC Water Pipe (All Depths)	LF	4,850	3	35%
Permanent Asphalt Pavement Repair	LF	7,164	3	35%
Permanent Concrete Pavement Repair	LF	432	2	55%
4" PVC SS Pipe for Service Lines (All Depths)	LF	170	2	55%
6" PVC SS Pipe for Service Lines (All Depths)	LF	35	2	55%
8" PVC SS Pipe (All Depths)	LF	1,367	2	55%
Std. 4' Dia. SSMH (0-6')	EA	9	2	55%
Cast Iron/Ductile Iron Fittings	TN	17	3	35%
Standard Fire Hydrant (3'-6" Depth)	EA	5	2	55%
6" Gate Valve and Box	EA	6	2	55%
8" Gate Valve and Box	EA	8	2	55%
12" Gate Valve and Box	EA	18	3	35%

Rosedale Unit Bid Price Estimation

Using the unit bid price tables that were included in **Appendix D**, the unit bid price for the selected cost items were calculated. The estimated unit bid prices are presented in Table 5-3.

Table 5-3. Estimated Unit Bid Prices for the Rosedale Project

DESCRIPTION OF ITEM	UNITS	POU	Est.UP
6" PVC Water Pipe(All Depths)	LF	55%	$36.62
8" PVC Water Pipe(All Depths)	LF	55%	$40.90
12" PVC Water Pipe (All Depths)	LF	35%	$55.75
Permanent Asphalt Pavement Repair	LF	35%	$42.36
Permanent Concrete Pavement Repair	LF	55%	$71.54
4" PVC SS Pipe for Service Lines (All Depths)	LF	55%	$28.94
6" PVC SS Pipe for Service Lines (All Depths)	LF	55%	$48.43
8" PVC SS Pipe (All Depths)	LF	55%	$52.73
Std. 4' Dia. SSMH (0-6')	EA	55%	$2,559.95
Cast Iron/Ductile Iron Fittings	TN	35%	$3,823.32
Standard Fire Hydrant (3'-6" Depth)	EA	55%	$2,234.00
6" Gate Valve and Box	EA	55%	$778.68
8" Gate Valve and Box	EA	55%	$1,008.20
12" Gate Valve and Box	EA	35%	$1,591.40

Original Engineer's and UPD Methodology Estimate Comparison

One of the Internship Objectives was to compare LGGROUP's cost estimation methodology with the UPD Methodology developed during this study. As explained in Chapter 1, there was no universal methodology employed by the project managers at LGGROUP to estimate unit prices.

When estimating unit prices, the project managers tend to give the highest importance to the data obtained from their own recently let projects' bid tabulations. The project managers first calculate the average unit bid prices for each construction cost item from their previous projects. The average unit bid price is then adjusted using engineering judgment for project specific conditions and escalation. The adjusted unit price is used to determine the engineer's estimate for probable construction cost for that line item. The Engineer's estimate for the Rosedale Project was prepared as described above.

A comparison of the estimated unit bid prices, actual average bid prices, and the engineer's original unit price estimates are presented in Table 5-4.

Table 5-4. Comparison of Estimated and Actual Unit Bid Prices

DESCRIPTION OF ITEM	UNITS	Estimated Unit Price	Actual Avg. Bid	Engineer's Estimate
6" PVC Water Pipe(All Depths)	LF	$36.62	$69.67	$50.00
8" PVC Water Pipe(All Depths)	LF	$40.90	$86.33	$75.00
12" PVC Water Pipe (All Depths)	LF	$55.75	$118.33	$90.00
Permanent Asphalt Pavement Repair	LF	$42.36	$38.67	$50.00
Permanent Concrete Pavement Repair	LF	$71.54	$48.33	$75.00
4" PVC SS Pipe for Service Lines (All Depths)	LF	$28.94	$54.00	$20.00
6" PVC SS Pipe for Service Lines (All Depths)	LF	$48.43	$88.67	$40.00
8" PVC SS Pipe (All Depths)	LF	$52.73	$97.00	$50.00
Std. 4' Dia. SSMH (0-6')	EA	$2,559.95	$2,033.33	$2,500.00
Cast Iron/Ductile Iron Fittings	TN	$3,823.32	$3,916.67	$5,000.00
Standard Fire Hydrant (3'-6" Depth)	EA	$2,234.00	$2,233.33	$2,500.00
6" Gate Valve and Box	EA	$778.68	$733.33	$750.00
8" Gate Valve and Box	EA	$1,008.20	$933.33	$1,000.00
12" Gate Valve and Box	EA	$1,591.40	$1,533.33	$2,000.00

Chi-Square Goodness of Fit test was utilized to compare the two unit price estimation methodologies as shown in Tables 5-5 and 5-6.

Table 5-5. Chi-Square Subtotals for UPD – Actual Average Bid

DESCRIPTION OF ITEM	UNITS	Estimated Unit Price E	Actual Avg. Bid A	Difference A - E	Square of Difference (A-E)^2	Chi-squ subtotal (A-E)^2/E
6" PVC Water Pipe	LF	$36.62	$69.67	33.05	1,092.30	29.83
8" PVC Water Pipe	LF	$40.90	$86.33	45.43	2,063.88	50.46
12" PVC Water Pipe	LF	$55.75	$118.33	62.58	3,916.26	70.25
Asphalt Pvmt. Rep.	LF	$42.36	$38.67	-3.69	13.62	0.32
Concrete Pvmt. Rep.	LF	$71.54	$48.33	-23.21	538.70	7.53
4" PVC SS Pipe	LF	$28.94	$54.00	25.06	628.00	21.70
6" PVC SS Pipe	LF	$48.43	$88.67	40.24	1,619.26	33.44
8" PVC SS Pipe	LF	$52.73	$97.00	44.27	1,959.83	37.17
Std. 4' Dia. SSMH	EA	$2,559.95	$2,033.33	-526.62	277,328.62	108.33
Cast/Ductile Iron Fittings	TN	$3,823.32	$3,916.67	93.35	8,714.22	2.28
Standard Fire Hydrant	EA	$2,234.00	$2,233.33	-0.67	0.45	0.00
6" Gate Valve and Box	EA	$778.68	$733.33	-45.35	2,056.62	2.64
8" Gate Valve and Box	EA	$1,008.20	$933.33	-74.87	5,605.52	5.56
12" Gate Valve and Box	EA	$1,591.40	$1,533.33	-58.07	3,372.12	2.12
Total						**371.62**

Table 5-6. Chi-Square Subtotals for Engineer's Estimate – Actual Average Bid

DESCRIPTION OF ITEM	UNITS	Engineer's Estimate Unit Price E	Actual Avg. Bid A	Difference A - E	Square of Difference (A-E)^2	Chi-squ subtotal (A-E)^2/E
6" PVC Water Pipe	LF	$50.00	$69.67	19.67	386.91	7.74
8" PVC Water Pipe	LF	$75.00	$86.33	11.33	128.37	1.71
12" PVC Water Pipe	LF	$90.00	$118.33	28.33	802.59	8.92
Asphalt Pvmt. Rep.	LF	$50.00	$38.67	-11.33	128.37	2.57
Concrete Pvmt. Rep.	LF	$75.00	$48.33	-26.67	711.29	9.48
4" PVC SS Pipe	LF	$20.00	$54.00	34.00	1,156.00	57.80
6" PVC SS Pipe	LF	$40.00	$88.67	48.67	2,368.77	59.22
8" PVC SS Pipe	LF	$50.00	$97.00	47.00	2,209.00	44.18
Std. 4' Dia. SSMH	EA	$2,500.00	$2,033.33	-466.67	217,780.89	87.11
Cast/Ductile Iron Fittings	TN	$5,000.00	$3,916.67	-1,083.33	1,173,603.89	234.72
Standard Fire Hydrant	EA	$2,500.00	$2,233.33	-266.67	71,112.89	28.45
6" Gate Valve and Box	EA	$750.00	$733.33	-16.67	277.89	0.37
8" Gate Valve and Box	EA	$1,000.00	$933.33	-66.67	4,444.89	4.44
12" Gate Valve and Box	EA	$2,000.00	$1,533.33	-466.67	217,780.89	108.89
Total						**655.60**

The chi-square subtotals for the two data sets were computed as shown in Table 5-7. As can be seen in Table 5-7, the UPD methodology yielded a lower total chi-square value than the original engineer's estimate method. The lower total chi-square value indicates that the UPD methodology generated an overall more accurate estimate than the original method for predicting the actual average unit bid prices for the Rosedale Project.

Table 5-7. Chi-Square Subtotals Comparison

DESCRIPTION OF ITEM	UNITS	Chi-sq subtotal UPD Estimate	Chi-sq subtotal Eng. Estimate
6" PVC Water Pipe	LF	29.83	7.74
8" PVC Water Pipe	LF	50.46	1.71
12" PVC Water Pipe	LF	70.25	8.92
Permanent Asphalt Pavement Repair	LF	0.32	2.57
Permanent Concrete Pavement Repair	LF	7.53	9.48
4" PVC SS Pipe	LF	21.70	57.80
6" PVC SS Pipe	LF	33.44	59.22
8" PVC SS Pipe	LF	37.17	44.18
Std. 4' Dia. SSMH (0-6')	EA	108.33	87.11
Cast Iron/Ductile Iron Fittings	TN	2.28	234.72
Standard Fire Hydrant (3'-6" Depth)	EA	0.00	28.45
6" Gate Valve and Box	EA	2.64	0.37
8" Gate Valve and Box	EA	5.56	4.44
12" Gate Valve and Box	EA	2.12	108.89
Total		**371.62**	**655.60**
Mean		**26.54**	**46.83**
Standard Deviation		**32.01**	**64.27**

It is important to note that neither of the methodologies resulted in a statistically acceptable fit, due to the high chi-square subtotal amount. Given the degree of freedom of 13, and the calculated probability of 0.05, the Chi Square total value should be less than 5.892 for the fit to the be statistically significant. The total Chi Square value for either of the methodologies is significantly higher than a statistically acceptable level. An interesting point to note is that except for the sanitary sewer manhole line item, the largest contributors to the chi-square subtotal and hence the cost items that were predicted with the largest error were PVC water and sanitary sewer lines. The sudden rise in petroleum prices at that time may be the culprit behind the increase in PVC pipe prices.

One of the main reasons, the UPD methodology fell short in this case study may be due to the unexpectedly sharp rise in petroleum prices (Figure 5-1) shortly before the Rosedale project was bid. The project was bid around the fall of 2008, which was coincidentally soon after the US oil prices peaked. The sudden increase in PVC pipe prices were not yet reflected in the UPD, since the database was developed before the increase in the recent months. This is one of the reasons a project manager should always have the ability to modify the estimated unit prices to be used in a cost estimate.

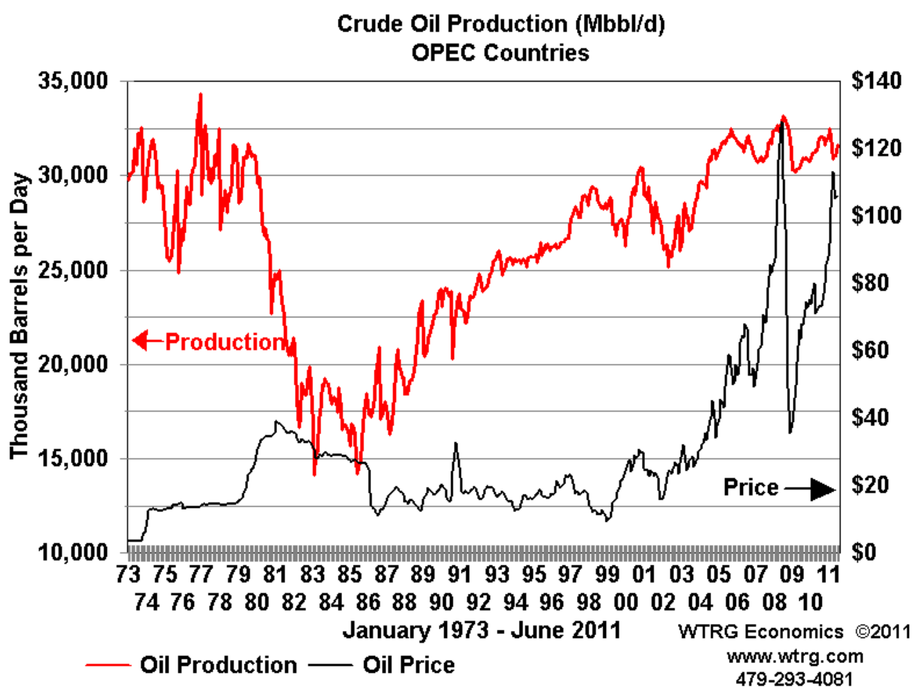


Figure 5-1. Crude Oil Price (Dollars/Barrel)

Summary

The comparison between the Engineer's estimate of unit bid prices and the unit bid prices determined with this methodology for the "Rosedale Street Improvements" indicated that, although neither estimate produced a statistically acceptable fit, the unit prices determine with this methodology did produce a more accurate estimate. With a few exceptions that can mainly be attributed to unexpected changes in the supply costs, the unit prices obtained from UPD fell within statistically acceptable ranges. Because the UPD is developed from historical data, the project engineer should always have the ability to modify the estimated unit prices to account for sudden changes in any of the variables that contribute to the overall unit bid prices.

CHAPTER VI

GUIDELINES FOR UPDATING THE UNIT PRICE ESTIMATION MODEL

As was demonstrated in the previous chapter, the UPD methodology is only as good as the quality of the database. If the data stored in the UPD does not include the most recent unit price data, the resulting estimated unit price may not accurately predict the actual unit bid prices. As a result, it is imperative that the UPD be updated at least bi-annually. This Chapter provides guidelines for updating the UPD. The main tasks that need to be conducted for updating the UPD are shown in a flowchart format in Figure 6-1.

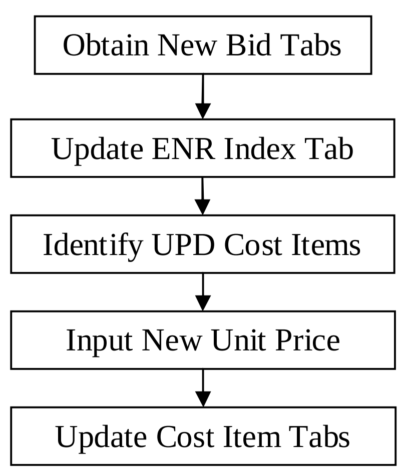


Figure 6-1. UPD Update Flowchart

The first task for updating the UPD is to contact the City of Fort Worth, and obtain the bid tabs for the projects that were let since the last time the UPD was updated. The second task is to update the "ENR Index" tab in the UPD spreadsheets with the latest ENR construction cost index data. Also, at this stage, the user should enter the current date at the top of each UPD spreadsheet. The current date will be used for adjusting the unit bid prices for time value of money. The third task is to identify the UPD cost items that are included in the new projects. After the cost items are identified, the new unit price data for all the identified cost items will be entered into the main excel tab containing the raw unit price data. To illustrate the process of entering the data, a portion of the Water UPD excel spreadsheet is shown in Figure 6-2. As an example, the following list will detail the process of entering new unit price data for standard fire hydrant assembly in the appropriate UPD spreadsheet columns.

1. Column A: Enter "W" for water project improvements. (If the cost item was related to paving improvements, it would be necessary to enter "P". "S" should be entered for sanitary sewer improvements.)
2. Column B: Enter the project number for the bid tab.
3. Column C: Enter the number of bidders.
4. Column D: Input bid opening date.
5. Column E: Input Contractor name.
6. Column F: Enter cost item description.
7. Column G: Enter the bid quantity for the line item.
8. Column H: Input unit of measurement for the bid item.

9. Column I: Enter unit bid price.
10. Column J: Input Contractor’s bid ranking.
11. Columns K and L: The project bid year and month are automatically generated when date is entered in Column 4.
12. Columns M, N, O: Previous, current, and ENR adjustment factor are automatically generated after the project date is entered and the ENR index tab is updated.
13. Column P: The adjusted unit price is computed by the spreadsheet.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Analysis Item	**Project**	**# of Bidders**	**Date**	**Contractor**	**Item**	**Quantity**	**Unit**	**Unit Price**	**OveralL Bid Rank (Low:1)**	**Year**	**Month**	**Previous ENR Index**	**Current ENR Index**	**ENR Adj. Factor**	**Adjusted Unit Price**
W	041118-3706	4	Nov-04	AOC	Std. Fire Hydrant Assembly	18	EA	$1,600.00	1	2004	11	7,311.63	8,551.32	1.17	$1,871.28
W	041118-3706	4	Nov-04	SHUC Inc.	Std. Fire Hydrant Assembly	18	EA	$1,576.00	2	2004	11	7,311.63	8,551.32	1.17	$1,843.21
W	041118-3706	4	Nov-04	Burns Const.	Std. Fire Hydrant Assembly	18	EA	$1,600.00	3	2004	11	7,311.63	8,551.32	1.17	$1,871.28
W	041118-3706	4	Nov-04	Cleburne	Std. Fire Hydrant Assembly	18	EA	$1,850.00	4	Year	Month	7,311.63	8,551.32	1.17	$2,163.67
W	041202-3910	4	Dec-04	McClendon	Std. Fire Hydrant Assembly	4	EA	$1,600.00	1	2004	12	7,308.30	8,551.32	1.17	$1,872.13
W	041202-3910	4	Dec-04	Stabile&Winn	Std. Fire Hydrant Assembly	4	EA	$1,700.00	2	2004	12	7,308.30	8,551.32	1.17	$1,989.14
W	041202-3910	4	Dec-04	JLB	Std. Fire Hydrant Assembly	4	EA	$1,750.00	3	2004	12	7,308.30	8,551.32	1.17	$2,047.65
W	041202-3910	4	Dec-04	Jackson	Std. Fire Hydrant Assembly	4	EA	$1,400.00	4	Year	Month	7,308.30	8,551.32	1.17	$1,638.12
W	050127-4060	5	Jan-05	Tri-Tech	Std. Fire Hydrant Assembly	6	EA	$2,000.00	1	2005	1	7,297.24	8,551.32	1.17	$2,343.71
W	050127-4060	5	Jan-05	Circle C	Std. Fire Hydrant Assembly	6	EA	$2,000.00	2	2005	1	7,297.24	8,551.32	1.17	$2,343.71
W	050127-4060	5	Jan-05	Conatser	Std. Fire Hydrant Assembly	6	EA	$1,800.00	3	2005	1	7,297.24	8,551.32	1.17	$2,109.34
W	050127-4060	5	Jan-05	Jackson	Std. Fire Hydrant Assembly	6	EA	$1,500.00	4	2005	1	7,297.24	8,551.32	1.17	$1,757.79
W	050127-4060	5	Jan-05	AUI	Std. Fire Hydrant Assembly	6	EA	$2,200.00	5	Year	Month	7,297.24	8,551.32	1.17	$2,578.08
W	050217-3599	4	Feb-05	Conatser	Std. Fire Hydrant Assembly	14	EA	$1,400.00	1	2005	2	7,297.58	8,551.32	1.17	$1,640.52
W	050217-3599	4	Feb-05	Tri-Tech	Std. Fire Hydrant Assembly	14	EA	$1,800.00	2	2005	2	7,297.58	8,551.32	1.17	$2,109.24
W	050217-3599	4	Feb-05	SYB	Std. Fire Hydrant Assembly	14	EA	$1,750.00	3	2005	2	7,297.58	8,551.32	1.17	$2,050.65

Figure 6-2. UPD Raw Data Tab

The last step in updating the UPD is updating the individual cost item tabs in the spreadsheet. To illustrate the process of entering the data, a portion of the "Fire Hydrant Assembly" UPD cost item tab excel spreadsheet is shown in Figure 6-3.

1	2	3	4	5	6
Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**	**Estimated Unit Price ($/LF)**	**Probability of Under-run**
$1,871.28	7.534	1500	2.90%	$1,693	10%
$1,843.21	7.519	1520	3.37%	$1,777	15%
$1,871.28	7.534	1540	3.90%	$1,846	20%
$2,163.67	7.680	1560	4.49%	$1,908	25%
$1,872.13	7.535	1580	5.13%	$1,965	30%
$1,989.14	7.595	1600	5.84%	$2,020	35%
$2,047.65	7.624	1620	6.61%	$2,073	40%
$1,638.12	7.401	1640	7.45%	$2,126	45%
$2,343.71	7.759	1660	8.36%	$2,179	50%
$2,343.71	7.759	1680	9.33%	$2,234	55%
$2,109.34	7.654	1700	10.37%	$2,291	60%
$1,757.79	7.472	1720	11.48%	$2,351	65%
$2,578.08	7.855	1740	12.66%	$2,416	70%
$1,640.52	7.403	1760	13.91%	$2,489	75%
$2,109.24	7.654	1780	15.22%	$2,572	80%
$2,050.65	7.626	1800	16.59%	$2,673	85%
$2,109.24	7.654	1820	18.03%	$2,805	90%
$1,930.52	7.566	1840	19.52%	$3,013	95%

Figure 6-3. UPD Cost Item Tab

The only columns that need to be updated with the new data are columns 1 and 2. Column 1 references the adjusted unit bid price calculated in the previous step; therefore the only thing that needs to be completed in the Cost Item Tab is to scroll to the last row of columns 1 and 2 and copy those two columns, so that the latest unit price data would be referenced to the Cost Item Tab. The spreadsheet is designed to automatically re-calculate column 5, Estimated Unit Price.

Summary

It is important to update the Unit Price Database on a regular basis in order to provide the most recent and most accurate information for the unit price determination. It is suggested that the UPD be updated at least bi-annually by contacting the City of Fort Worth to obtain all bid items from projects let since the last update of the UPD. This information should then be entered into the UPD as described above in order to provide the most complete information for the Project Manager's the use for their estimates.

CHAPTER VII

SUMMARY

This record of study is being submitted in partial fulfillment of the requirements for the degree of Doctor of Engineering. The internship company, LOPEZGARCIA GROUP, was an engineering company with a staff of more than 250 professionals that provided services in the areas of civil, environmental, electrical, mechanical, structural and geotechnical engineering; environmental, planning and cultural resources studies; conventional and GPS surveying; and construction management and observation. The company was acquired by URS in 2009.

Throughout the time at LGGROUP it was observed that the Company does not have a standard procedure for preparing an engineer's estimate of probable construction cost document (engineer's estimate) for municipal projects. Every project manager employs a methodology that is a slightly different variation of the historical data approach.

Generating an accurate estimate of construction cost during the early stages of a municipal project is crucial because municipalities frequently use the consulting company's construction cost estimates to set up construction budgets. If a project ends up costing more than the estimated figure, municipalities have to scramble to find additional funding to complete their project. Also, the consulting firm's engineering fees are usually calculated as a percentage of the estimated total construction cost. As a result, there was a need to improve the accuracy of LGGROUP's construction cost estimates and standardize the cost estimating procedures.

The internship objective was to develop a construction unit price estimation model that provides more accurate results than the existing LGGROUP unit price estimation methodology for the City of Fort Worth construction projects.

To accomplish the internship objective several tasks were conducted including: gathering City of Fort Worth construction projects bid tabulation data (including all bids) for the past three years; developing three construction item unit price databases using the data collected; conducting statistical analyses using the unit price databases; developing tables and graphs showing the construction cost items and their appropriate estimated unit prices to be used by the project managers in their cost estimates; developing an approach to apply construction unit costs which adjusts for unique project characteristics; developing guidelines for using the developed tables and graphs to estimate unit prices for LGGROUP projects; using one recent project to compare the existing LGGROUP unit price estimation methodology and the new developed model with actual unit bid prices; and developing guidelines for updating the unit price database, tables, and graphs.

The unit price estimating methodology presented in this study generated a better fit than the original method for predicting the actual average unit bid prices for the one case study where the methodology was applied. Unfortunately, at the time the study was conducted, there were no other LGGROUP projects that would have been suitable for testing the methodology. To validate the statistical model and the decision making matrix, further study is needed. The methodology presented in this study should be tested using other case studies. Based on the results of the case studies, the decision making matrix can be modified, so the unit price estimation methodology yields statistically significant results. The methodology presented in this is record of study is a step in the right direction, however further research is necessary to validate it.

Ideas for future studies in this topic include: determining the effect of sudden rise in petroleum prices on unit bid prices; identifying the impact of the economic recession on the unit bid prices; and estimating the impact of variation in construction specifications on the unit bid prices.

REFERENCES

[1] Crowley, LG and Hancher, DE. Risk assessment of competitive procurement. Journal of Construction Engineering and Management, 1995; 121(2):230–237.

[2] Shane, JS, Molenaar, KR, Anderson, SD, and Schexnayder, CJ. Construction project cost escalation factors, Journal of Management in Engineering, 2009; 25: 221-229.

[3] Anderson, SD, Molenaar, KR, and Schexnayder, CJ. "The Guidebook: Guidance for Cost Estimating and Management During Planning, Programming, and Preconstruction," NCHRP Report 574, National Cooperative Highway Research Program, Transportation Research Board, National Research Council, National Academy Press, 2007.

[4] Anderson, SD, Damnjanovic, I, Nejat, A, and Ramesh, S. Synthesis on Construction Unit Cost Development. Technical Report 0-6023-1, Texas Transportation Institute, The Texas A&M University System, 2009

[5] Schexnayder, CJ and Mayo, R. 2004 Construction management fundamentals, New York: McGraw-Hill, p. 282–283.

[6] Gransberg, DD and Riemer, C. Impact of inaccurate engineer's estimated quantities on unit price contracts. Journal of Construction Engineering and Management, 2009; 135(11): 1138-1145

[7] Wilson, AJ. Experiments in probabilistic cost modelling. In: Brandon PS, editor. Building cost techniques; new direction. London: E& FN Spon; 1982. p. 169–180.

[8] Singh, S. Cost model for reinforced concrete beam and slab structures in building. Journal of Construction Engineering and Management, 1990; 116(1):54–67.

[9] Kouskoulas, V, Koehn, E. Predesign cost estimation function for building. Journal of the Construction Division, 1974; December: 589–604.

[10] McCaffer, R. Some analysis of the use of regression as an estimating tool. Quantity Surveyor, 1975; 32:81–86.

[11] Khosrowshahi, F, Kaka, AP. Estimation of project total cost and duration for housing projects in the UK. Building and Environment, 1996; 31(4):373–383.

[12] Skitmore, RM, Thomas, NgS. Forecast models for actual construction time and cost. Building and Environment, 2003; 38(8):1075–1083.

[13] Southwell, J. “Building cost forecasting”. Selected Papers on a systematic approach to forecasting building costs, presented to the Quantity Surveyors (Research and Information) Committee, Royal Institution of Chartered Surveyors; 1971.

[14] Mathur, K, editor. A probabilistic planning model. Building cost techniques: new directions. London: E & FN Spon; 1982.

[15] Pitt, T. The identification and use of spend units in the financial monitoring and control of construction projects. In: Brandon PS, editor. Building cost techniques—new directions. London: E & F N Spon; 1982. p. 255–62.

[16] Bennett, J, Omerod, RN. Simulation applied to construction projects. Construction Management and Economics, 1984; 2:225–63.

[17] Chau, KW. Monte Carlo simulation of construction costs using subjective data. Construction Management and Economics, 1995; 13:369–83.

[18] Chau, KW. The validity of the triangular distribution assumption in Monte Carlo simulation of construction costs: empirical evidence from Hong Kong. Construction Management and Economics, 1995; 13:15–21.

[19] Li, H. Neural networks for construction cost estimation. Building Research and Information, 1995; 23(5):279–84.

[20] Adeli, H, Wu, M. Regularization neural network for construction cost estimation. Journal of Construction Engineering and Management, 1998; 24(1):18–24.

[21] Bode, J. Neural networks for cost estimation. Cost Engineering, 1998; 40(1):25–30.

[22] Emsley, MW, Lowe, DJ, Duff AR, Harding A, Hickson A. Data modelling and the application of a neural network approach to the prediction of total construction costs. Construction Management and Economics, 2002; 20(6):465–72.

[23] Kim, GH, Yoon, JE, An, SH, Cho, HH, and Kang, KI. Neural network model incorporating a genetic algorithm in estimating construction costs. Building and Environment, 2004; 39(11):1330–40.

[24] Lu, Q. Cost estimation based on theory of fuzzy sets and prediction techniques: an expert system approach. Construction Contracting in China, Department of Civil and Structural Engineering, Hong Kong Polytechnic, 1988; p. 113–25.

[25] Fortune, C and Lees, M. The relative performance of new and traditional cost models in strategic advice and clients. RICS Research Paper Series Volume 2, Number 2. The Royal Institution of Chartered Surveyors, 1996.

[26] Fortune, C and Hinks, J. Strategic building project price forecasting models in use: paradigm shift postponed. Journal of Financial Management of Property and Construction, 1998; 3(1):3–26.

[27] Bowen, PA and Edwards, PJ. Building cost planning and cost information management in South Africa. International Journal of Procurement, 1998; 16–25.

[28] Bowen, PA and Edwards, PJ. Cost modelling and price forecasting: practice and theory in perspective. Construction Management and Economics, 1985; 3:199–215.

[29] Raftery, J. The state of cost/price modelling in the construction industry: a multicriteria approach. In: Brandon PS, editor. Building cost modelling and computers. London: E & F N Spon, 1987; p.49–71.

[30] Cheung, FKT and Skitmore, M. Building and Environment, 2006; 41, 1973–1990

[31] Maio, C, Schexnayder, CJ, Knutson, K and Weber, S. J Probability distribution functions for construction simulation. Journal of Construction Engineering and Management, 2000; 126: 285-292.

[32] Ogunlana and Thorpe, The Nature of Estimating Accuracy: Developing Correct Associations. Building and Environment, 1991; Vol. 26, No. 2, pp. 77-86.

[33] Lewis, B. 2005 Conceptual Design Report for 2004 CIP CONTRACT No. 17 Pavement Reconstruction and Water and Sanitary Sewer Main Replacement for Martha Lane (Milam Street to Barron Lane), Malinda Lane N. (Jenson Road to Malinda Lane S.) and Malinda Lane S. (Jenson Road to Malinda Lane N.) D.O.E. No. 4879

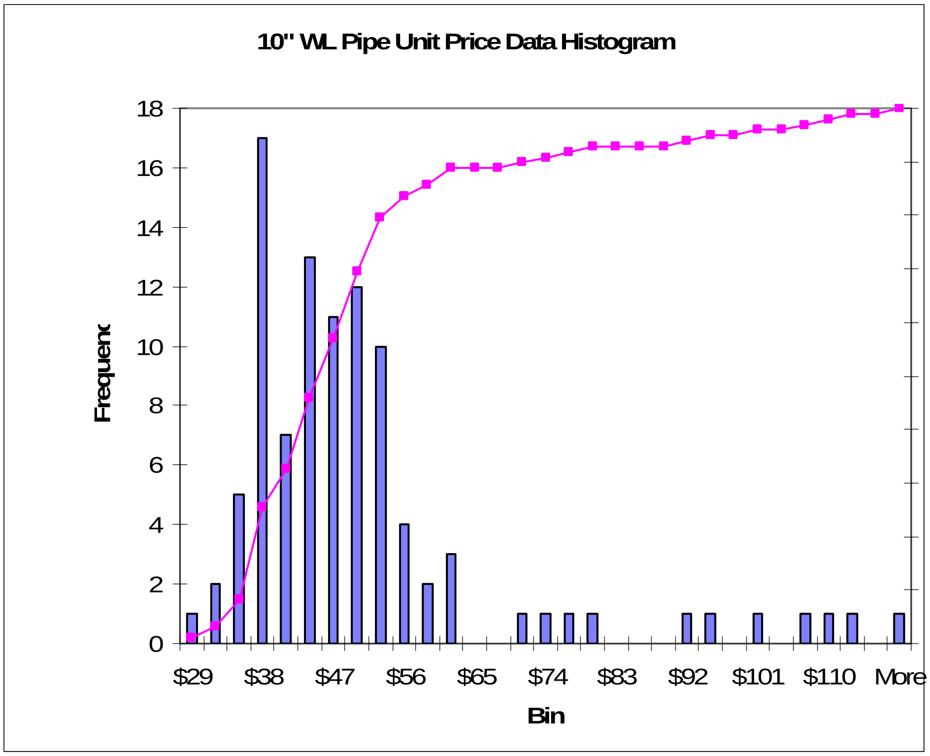
APPENDIX A

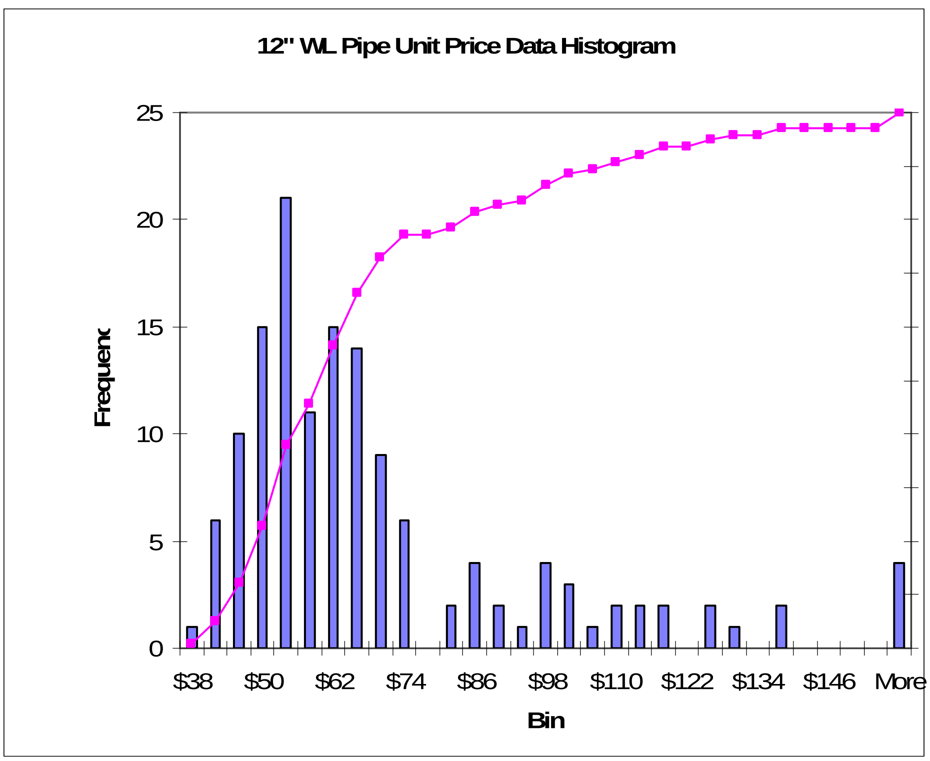
COFW DIGITAL BID TABS

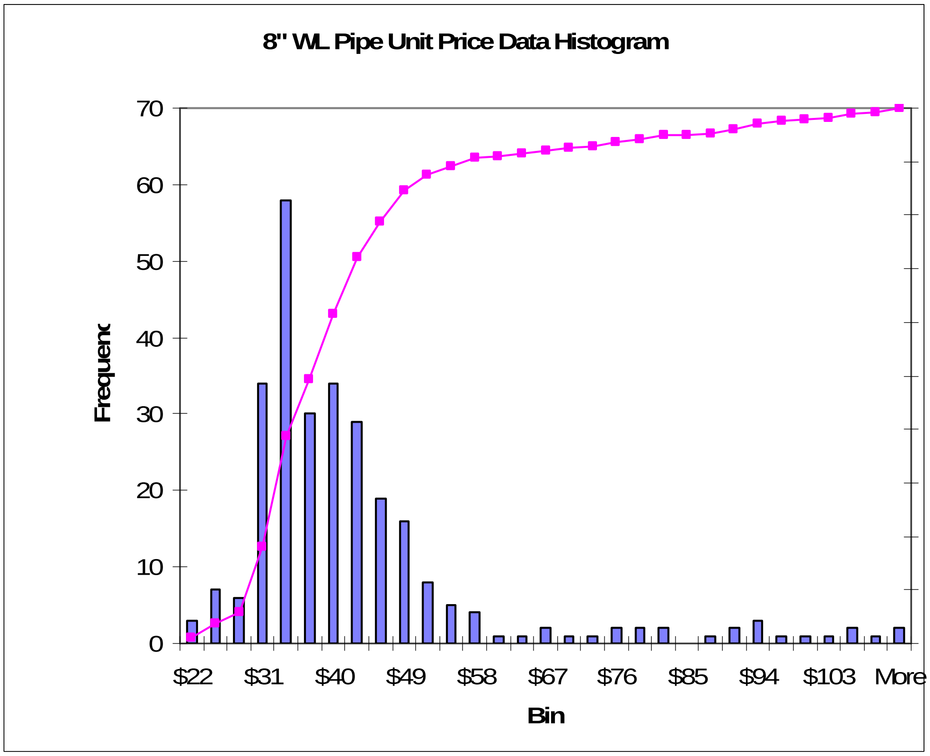
Appendix A - Fort Worth Bid Tabs.zip

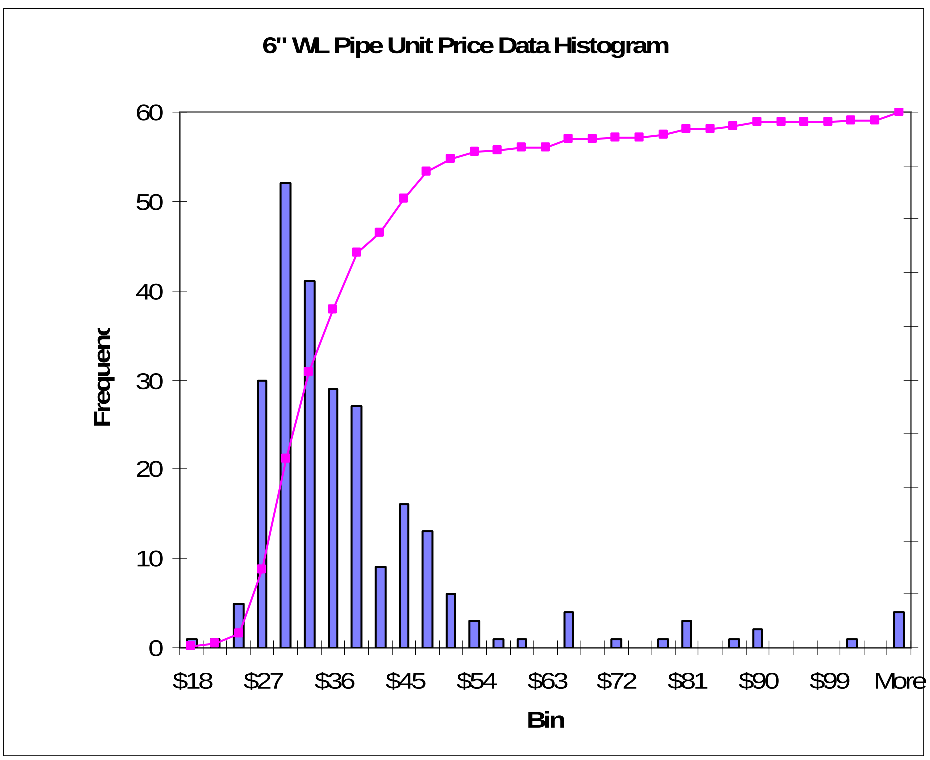
APPENDIX B

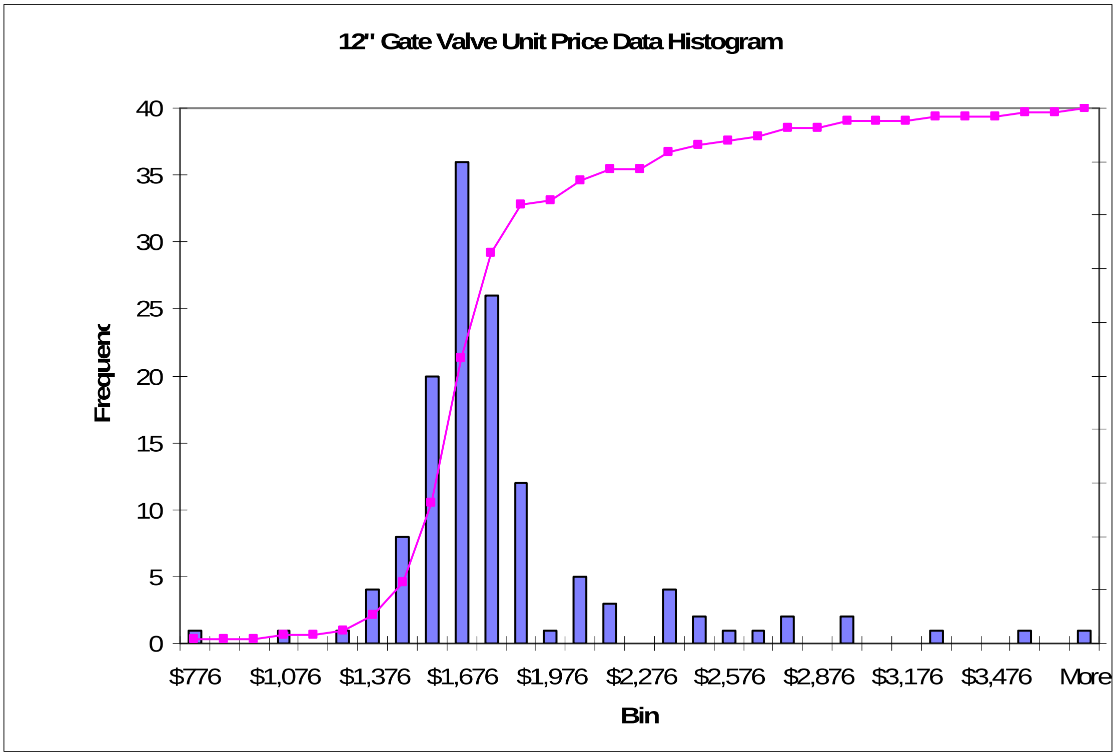
COST ITEM HISTOGRAMS

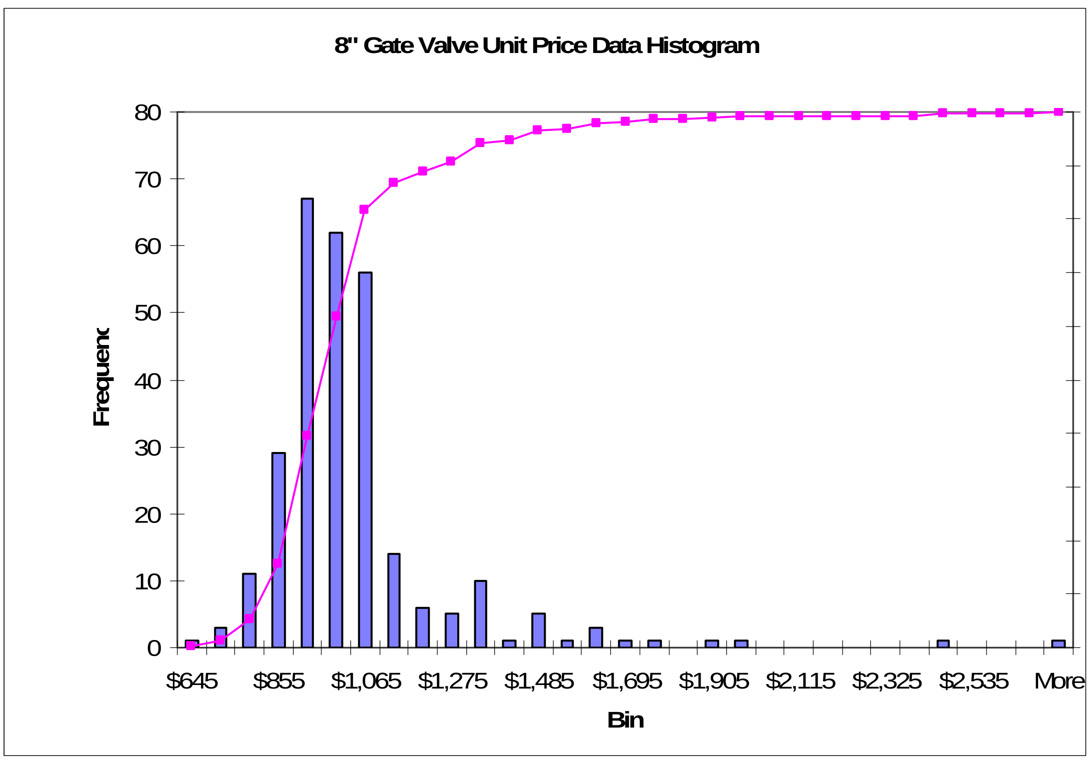

10" WL Pipe Unit Price Data Histogram
Frequenc
18
16
14
12
10
8
6
4
2
0
$29
$38
$47
$56
$65
$74
$83
$92
$101
$110
More
Bin

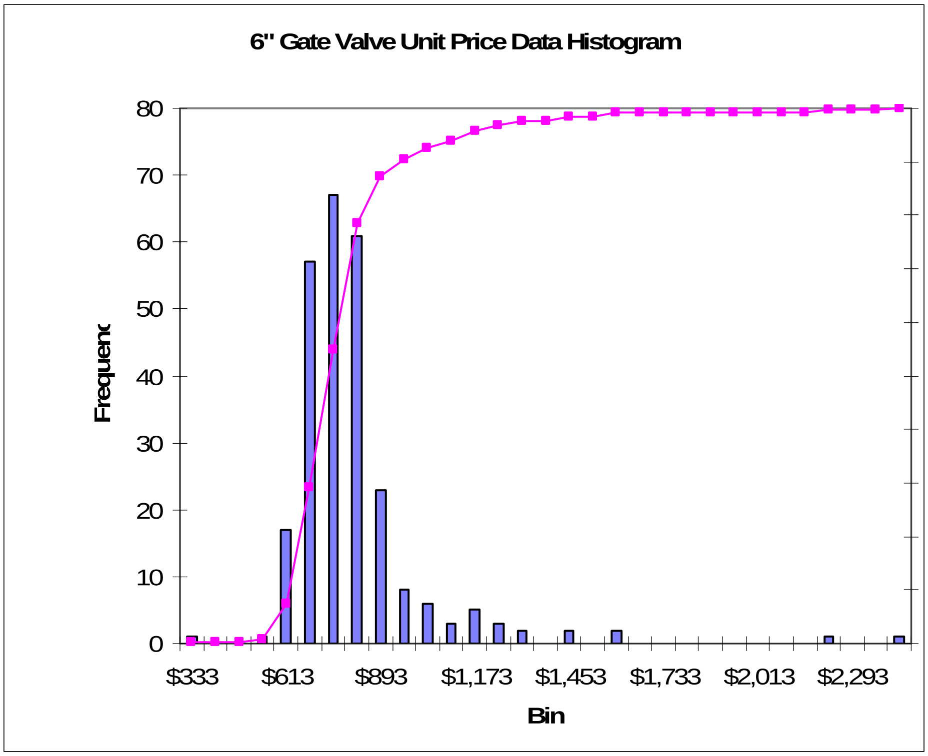

12" WL Pipe Unit Price Data Histogram
Frequenc
25
20
15
10
5
0
$38
$50
$62
$74
$86
$98
$110
$122
$134
$146
More
Bin

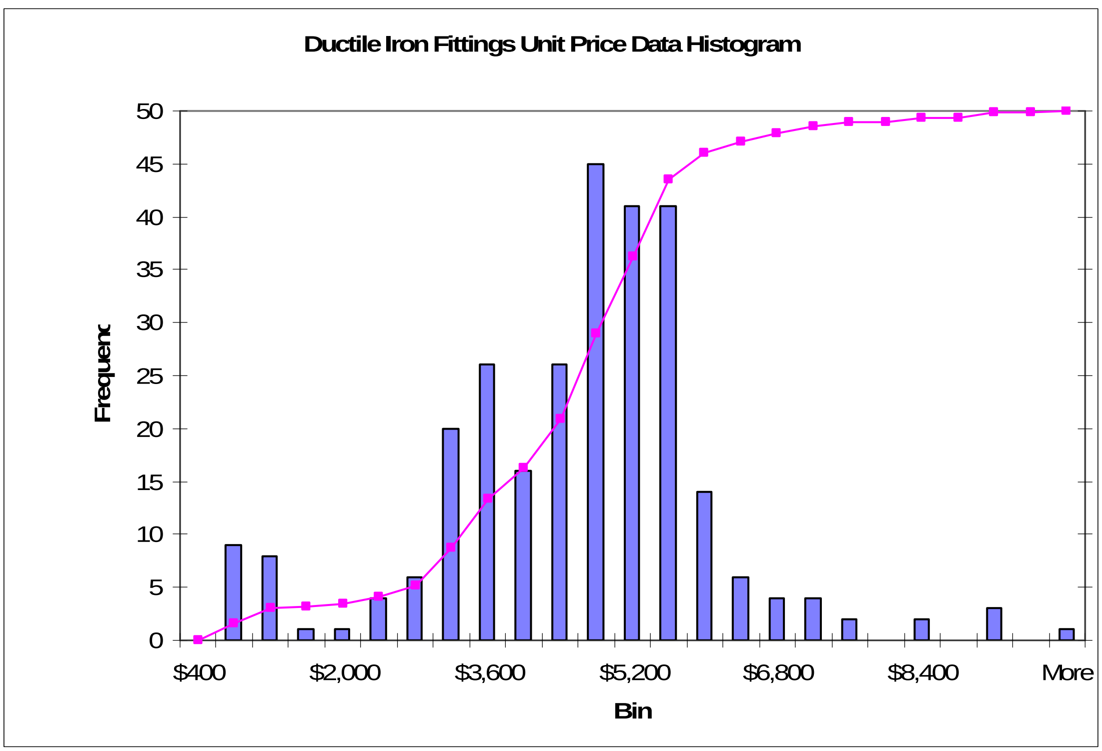

8" WL Pipe Unit Price Data Histogram
70
60
50
40
30
20
10
0
Frequenc
$22
$31
$40
$49
$58
$67
$76
$85
$94
$103
More
Bin

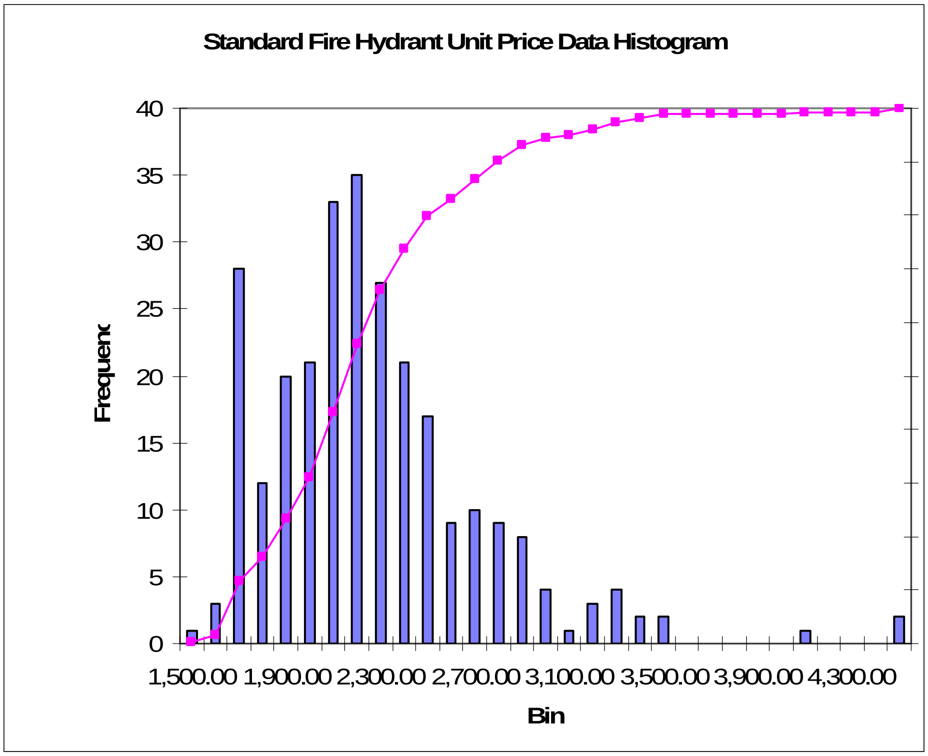

6" WL Pipe Unit Price Data Histogram
60
50
40
30
20
10
0
Frequenc
$18
$27
$36
$45
$54
$63
$72
$81
$90
$99
More
Bin

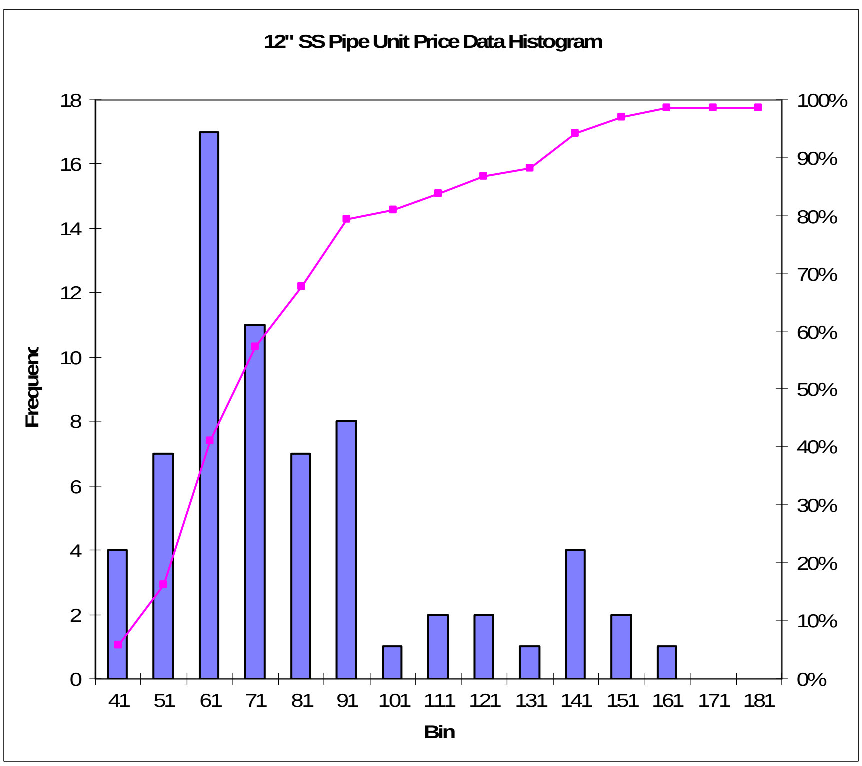

12" Gate Valve Unit Price Data Histogram
40
35
30
25
20
15
10
5
0
Frequenc
$776
$1,076
$1,376
$1,676
$1,976
$2,276
$2,576
$2,876
$3,176
$3,476
More
Bin

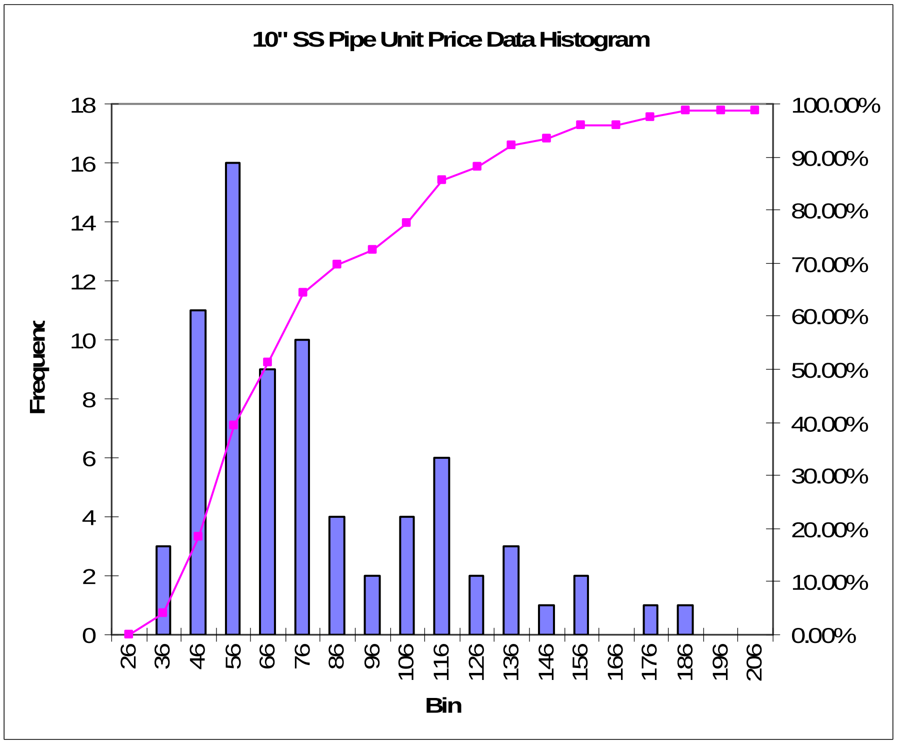

8" Gate Valve Unit Price Data Histogram
80
70
60
50
40
30
20
10
0
Frequenc
$645
$855
$1,065
$1,275
$1,485
$1,695
$1,905
$2,115
$2,325
$2,535
More
Bin


6" Gate Valve Unit Price Data Histogram
Frequenc
80
70
60
50
40
30
20
10
0
$333
$613
$893
$1,173
$1,453
$1,733
$2,013
$2,293
Bin

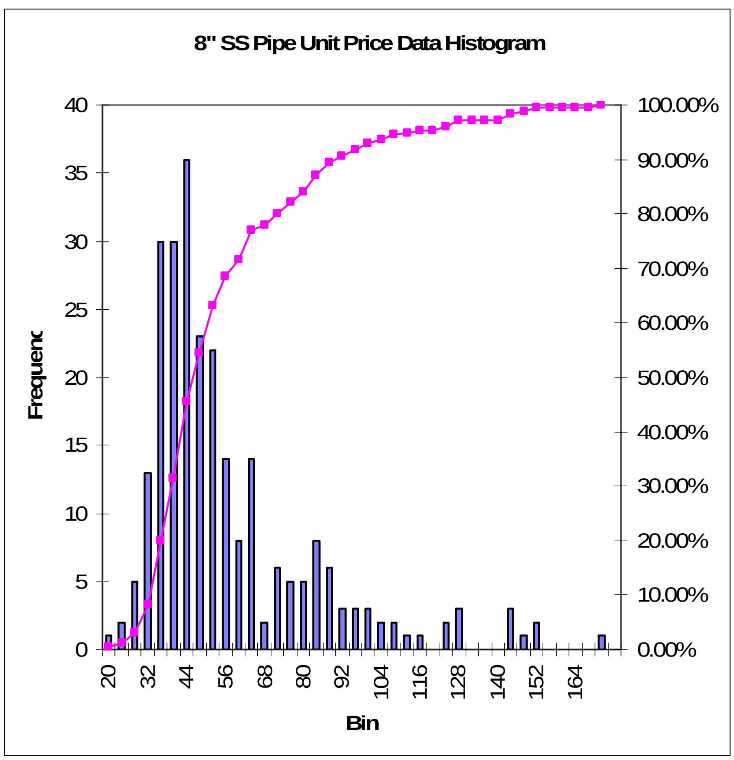

Ductile Iron Fittings Unit Price Data Histogram
Frequenc
50
45
40
35
30
25
20
15
10
5
0
$400
$2,000
$3,600
$5,200
$6,800
$8,400
More
Bin


Standard Fire Hydrant Unit Price Data Histogram
40
35
30
25
20
15
10
5
0
Frequenc
1,500.00 1,900.00 2,300.00 2,700.00 3,100.00 3,500.00 3,900.00 4,300.00
Bin

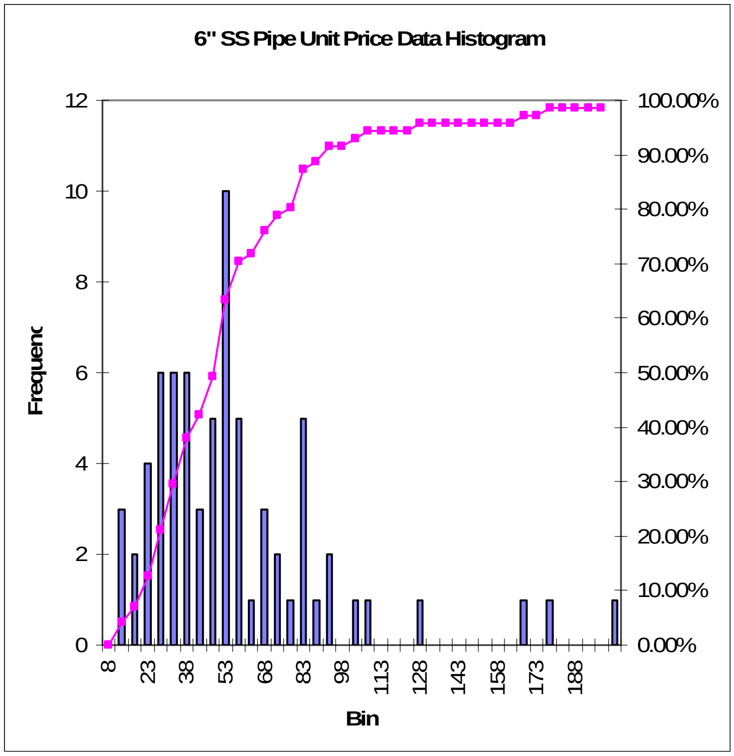

12" SS Pipe Unit Price Data Histogram
18
16
14
12
10
8
6
4
2
0
Frequenc
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
41 51 61 71 81 91 101 111 121 131 141 151 161 171 181
Bin

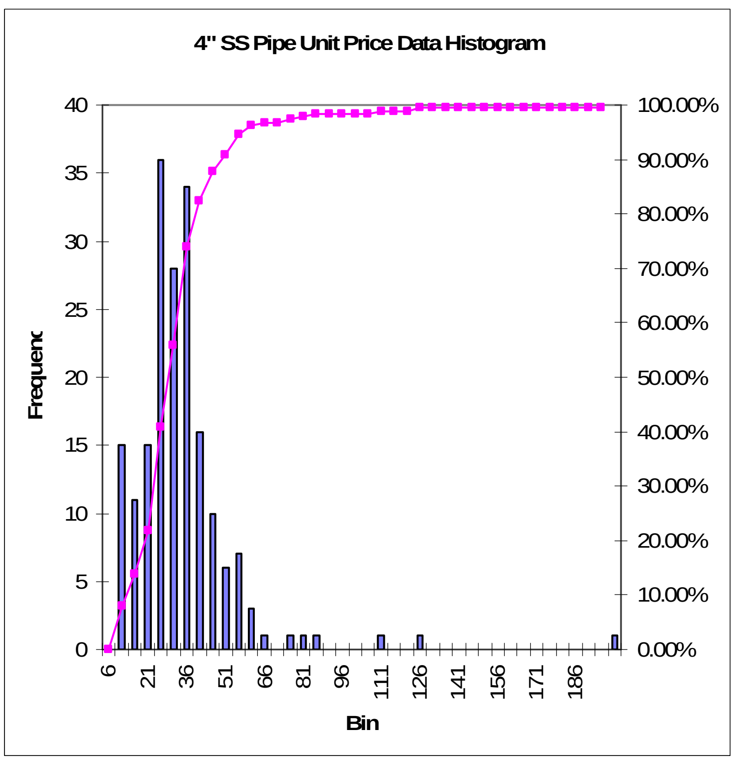


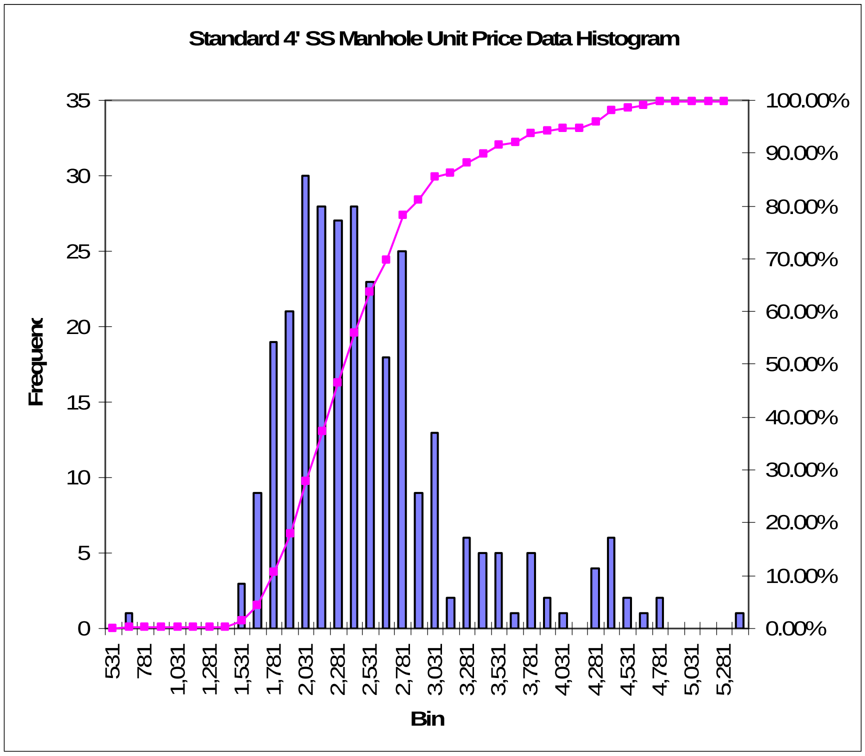
10" SS Pipe Unit Price Data Histogram
18
16
14
12
10
8
6
4
2
0
Frequenc
100.00%
90.00%
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
26
36
46
56
66
76
86
96
106
116
126
136
146
156
166
176
186
196
206
Bin

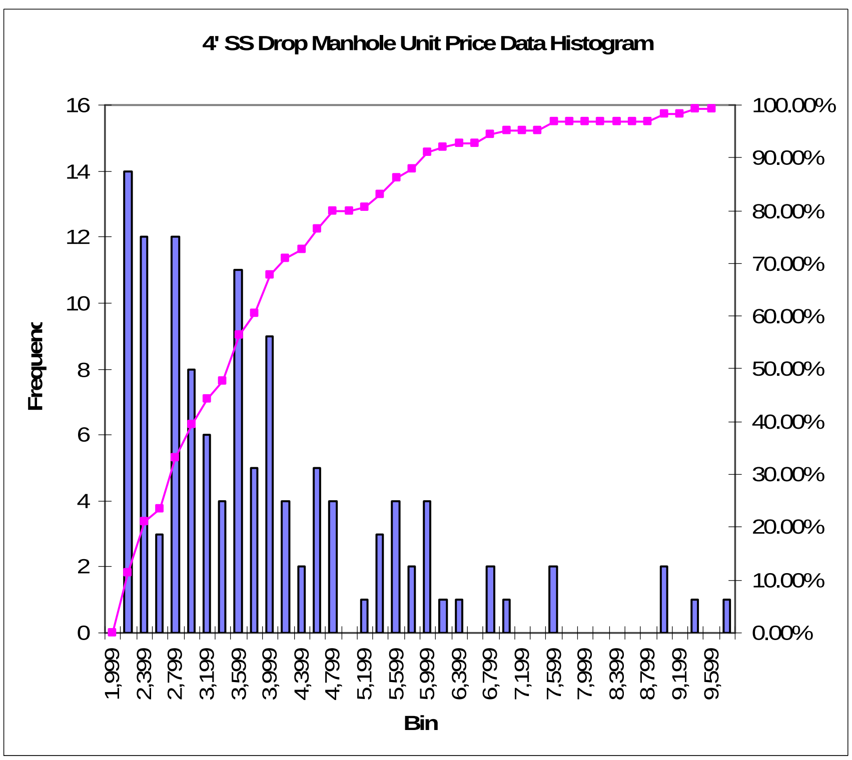


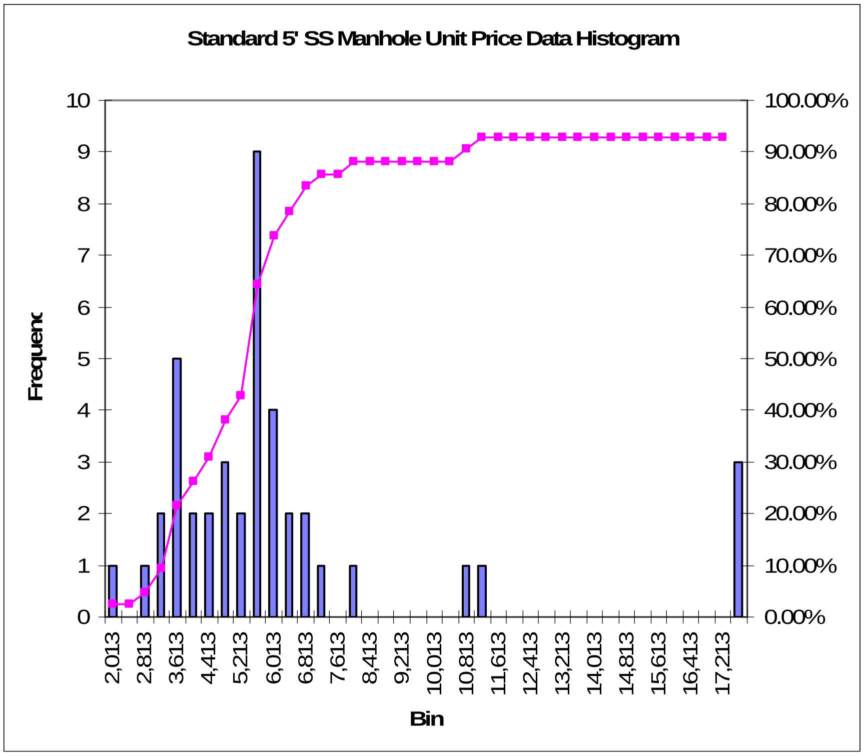
8" SS Pipe Unit Price Data Histogram
40
35
30
25
20
15
10
5
0
Frequenc
100.00%
90.00%
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
20
32
44
56
68
80
92
104
116
128
140
152
164
Bin

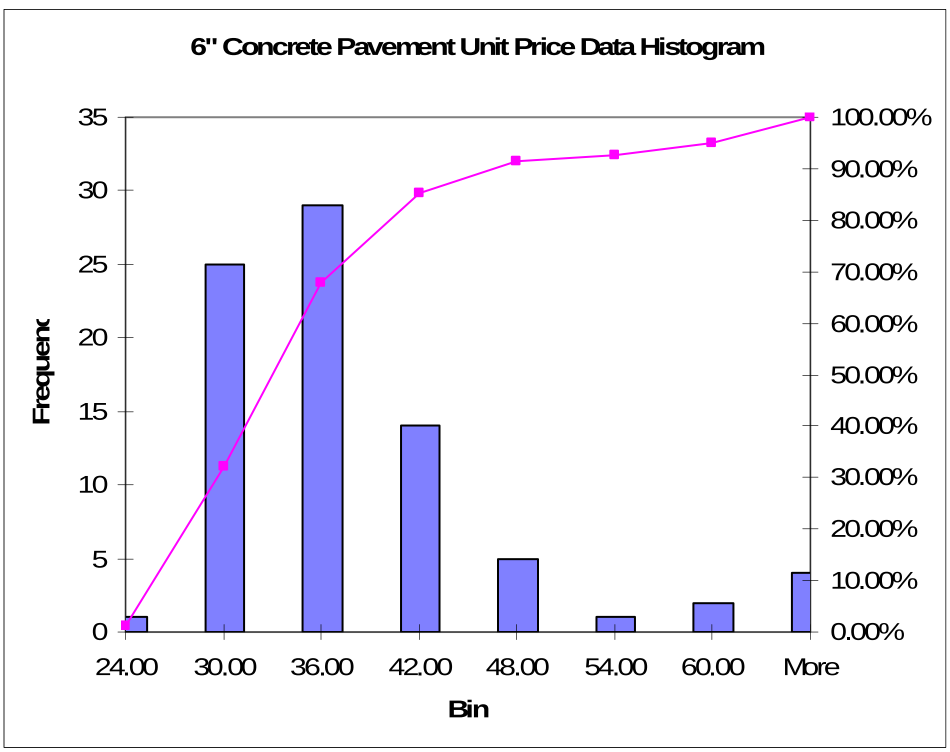

6" SS Pipe Unit Price Data Histogram
Frequenc
0
2
4
6
8
10
12
0.00%
10.00%
20.00%
30.00%
40.00%
50.00%
60.00%
70.00%
80.00%
90.00%
100.00%
8
23
38
53
68
83
98
113
128
143
158
173
188
Bin

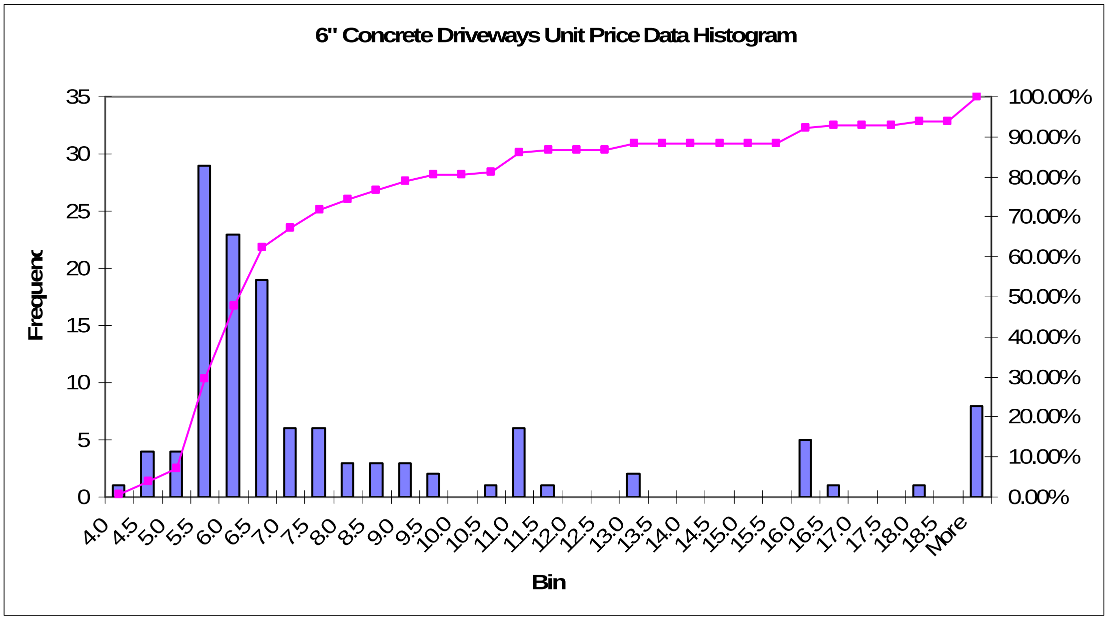

4" SS Pipe Unit Price Data Histogram
Frequenc
0
5
10
15
20
25
30
35
40
0.00%
10.00%
20.00%
30.00%
40.00%
50.00%
60.00%
70.00%
80.00%
90.00%
100.00%
6
21
36
51
66
81
96
111
126
141
156
171
186
Bin

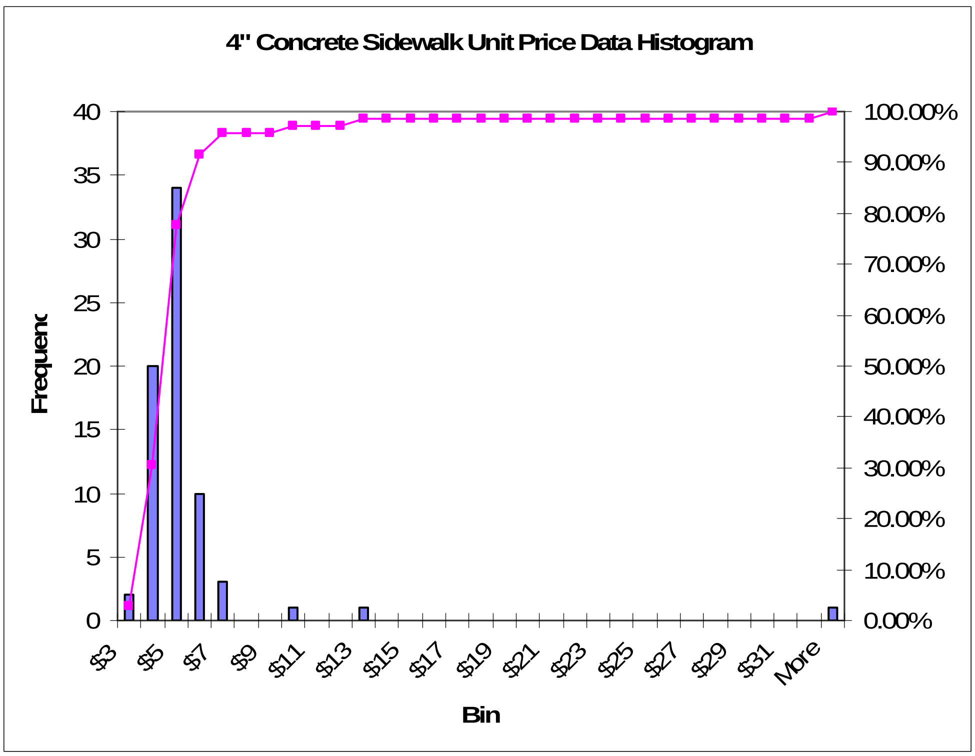

Standard 4' SS Manhole Unit Price Data Histogram
35
30
25
20
15
10
5
0
Frequenc
100.00%
90.00%
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
531
781
1,031
1,281
1,531
1,781
2,031
2,281
2,531
2,781
3,031
3,281
3,531
3,781
4,031
4,281
4,531
4,781
5,031
5,281
Bin

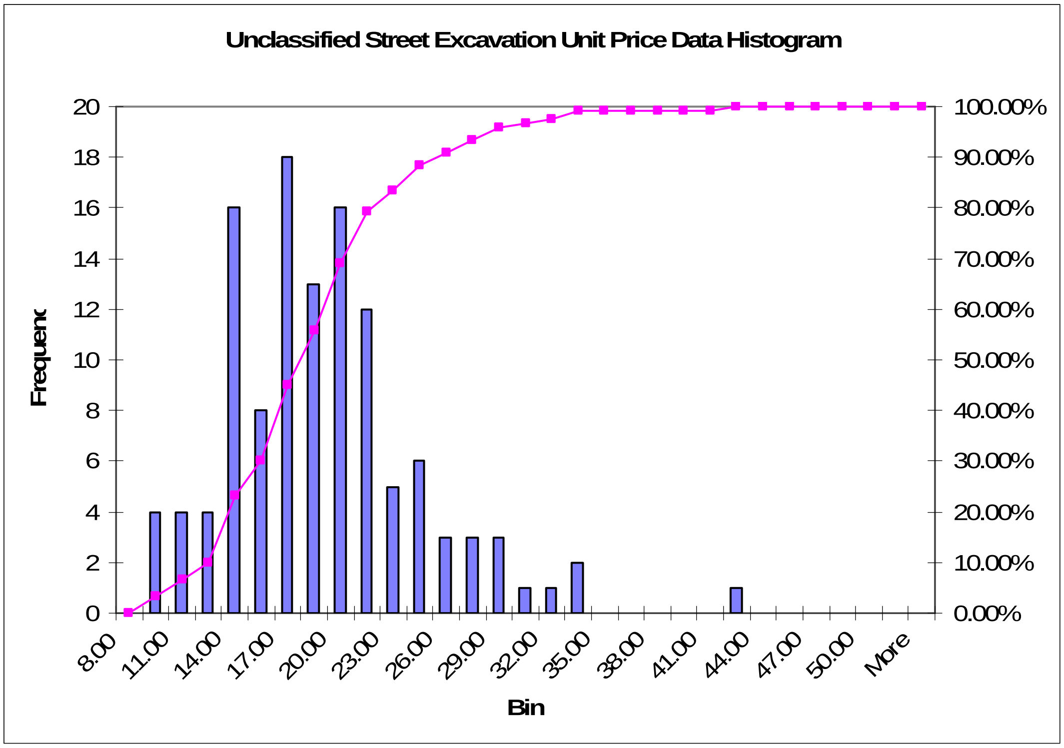

4' SS Drop Manhole Unit Price Data Histogram
16
14
12
10
8
6
4
2
0
Frequenc
100.00%
90.00%
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
1,999
2,399
2,799
3,199
3,599
3,999
4,399
4,799
5,199
5,599
5,999
6,399
6,799
7,199
7,599
7,999
8,399
8,799
9,199
9,599
Bin

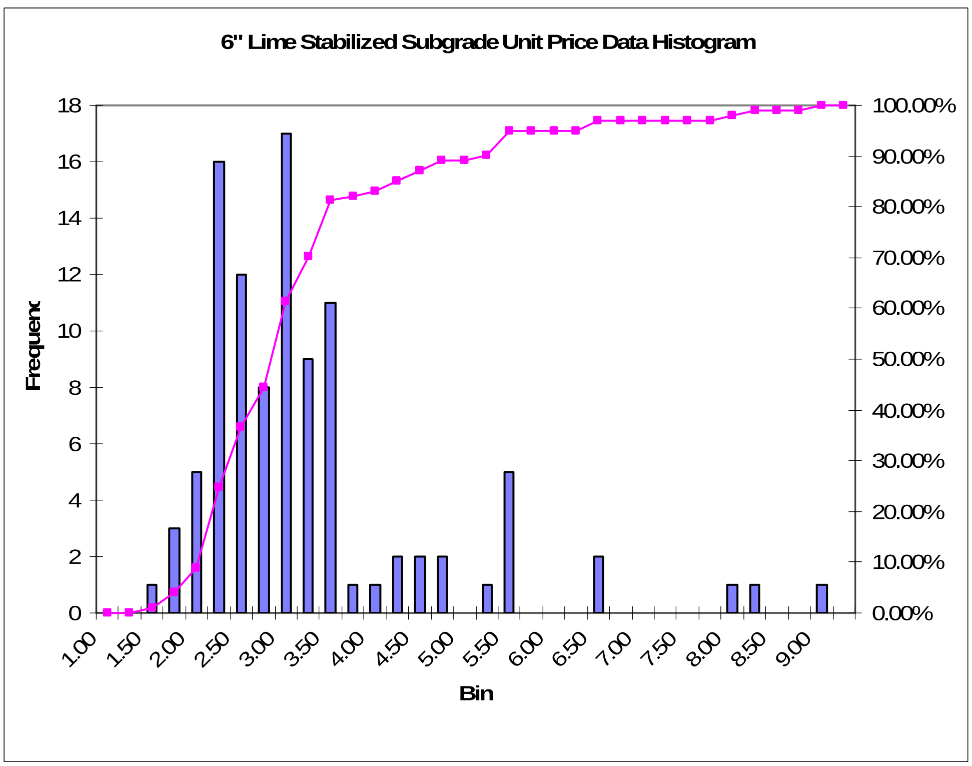

Standard 5' SS Manhole Unit Price Data Histogram
Frequenc
Bin
0
1
2
3
4
5
6
7
8
9
10
0.00%
10.00%
20.00%
30.00%
40.00%
50.00%
60.00%
70.00%
80.00%
90.00%
100.00%
2,013
2,813
3,613
4,413
5,213
6,013
6,813
7,613
8,413
9,213
10,013
10,813
11,613
12,413
13,213
14,013
14,813
15,613
16,413
17,213


6" Concrete Pavement Unit Price Data Histogram
Frequenc
Bin
0
5
10
15
20
25
30
35
0.00%
10.00%
20.00%
30.00%
40.00%
50.00%
60.00%
70.00%
80.00%
90.00%
100.00%
24.00
30.00
36.00
42.00
48.00
54.00
60.00
More


6" Concrete Driveways Unit Price Data Histogram
Frequenc
35
30
25
20
15
10
5
0
100.00%
90.00%
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
10.0
10.5
11.0
11.5
12.0
12.5
13.0
13.5
14.0
14.5
15.0
15.5
16.0
16.5
17.0
17.5
18.0
18.5
More
Bin


4" Concrete Sidewalk Unit Price Data Histogram
Frequenc
40
35
30
25
20
15
10
5
0
100.00%
90.00%
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
$3
$5
$7
$9
$11
$13
$15
$17
$19
$21
$23
$25
$27
$29
$31
More
Bin


Unclassified Street Excavation Unit Price Data Histogram
Frequenc
Bin
0
2
4
6
8
10
12
14
16
18
20
0.00%
10.00%
20.00%
30.00%
40.00%
50.00%
60.00%
70.00%
80.00%
90.00%
100.00%
8.00
11.00
14.00
17.00
20.00
23.00
26.00
29.00
32.00
35.00
38.00
41.00
44.00
47.00
50.00
More


6" Lime Stabilized Subgrade Unit Price Data Histogram
Frequenc
Bin
0
2
4
6
8
10
12
14
16
18
0.00%
10.00%
20.00%
30.00%
40.00%
50.00%
60.00%
70.00%
80.00%
90.00%
100.00%
1.00
1.50
2.00
2.50
3.00
3.50
4.00
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6.00
6.50
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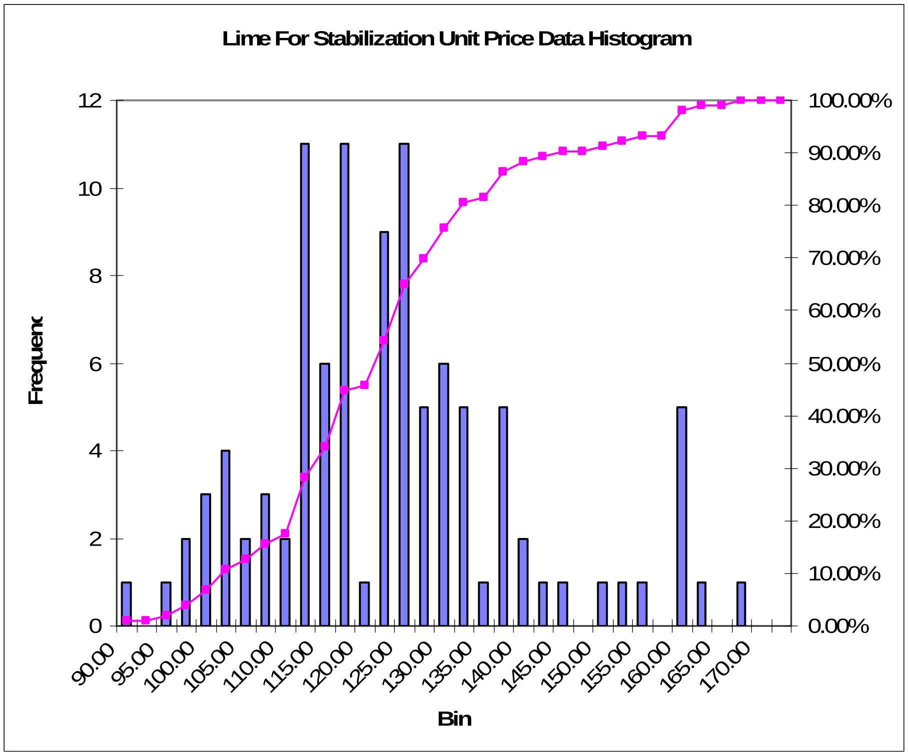
7.50
8.00
8.50
9.00



Lime For Stabilization Unit Price Data Histogram
Frequenc
Bin
0
2
4
6
8
10
12
0.00%
10.00%
20.00%
30.00%
40.00%
50.00%
60.00%
70.00%
80.00%
90.00%
100.00%
90.00
95.00
100.00
105.00
110.00
115.00
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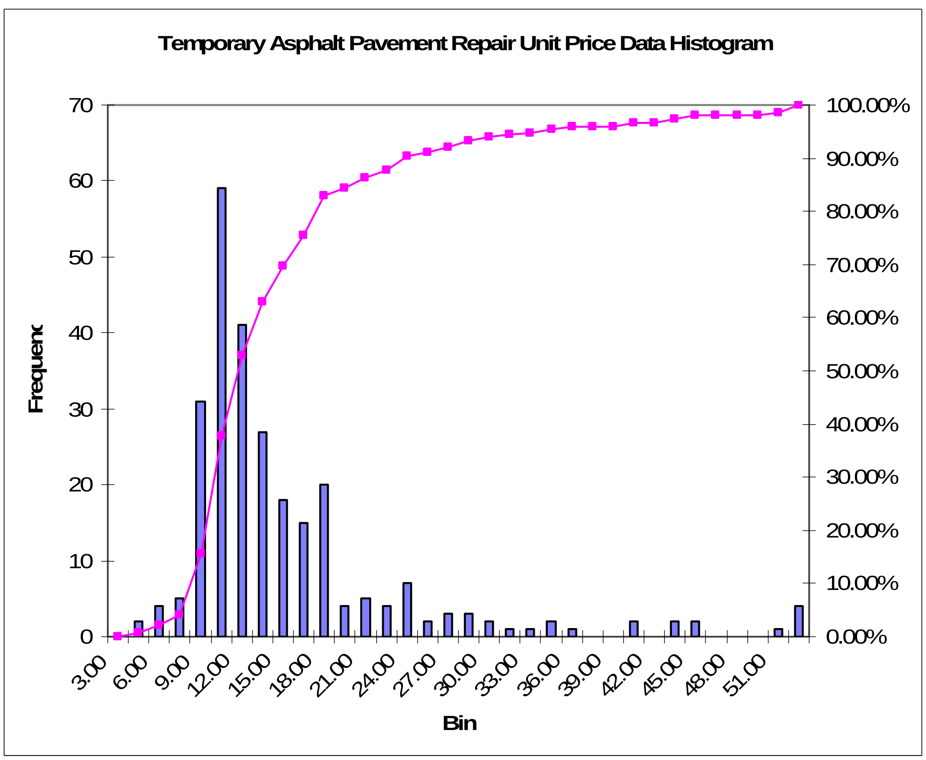
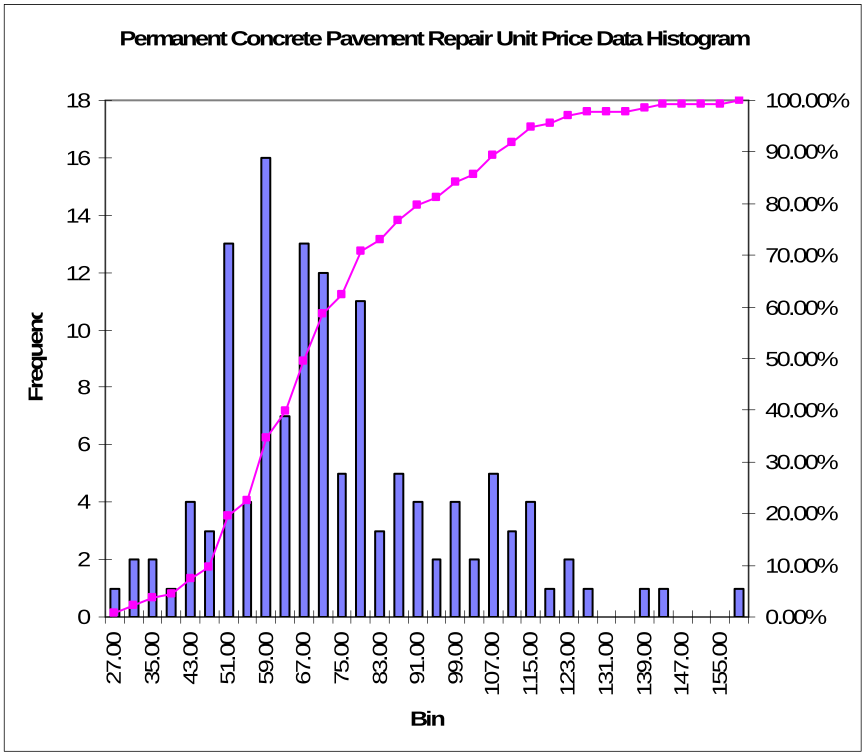
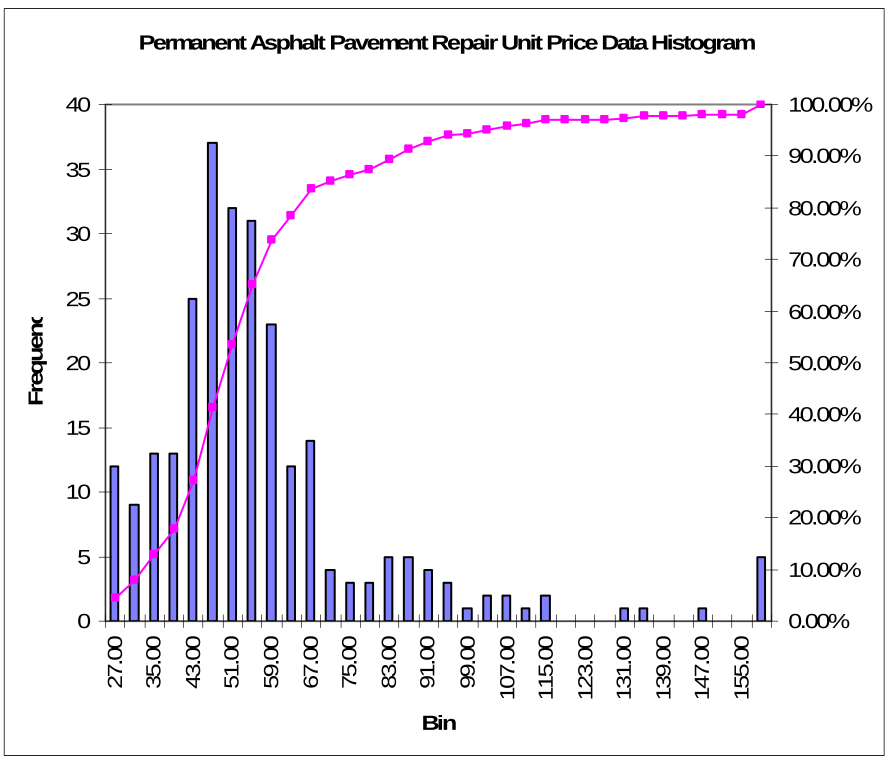
160.00
165.00
170.00



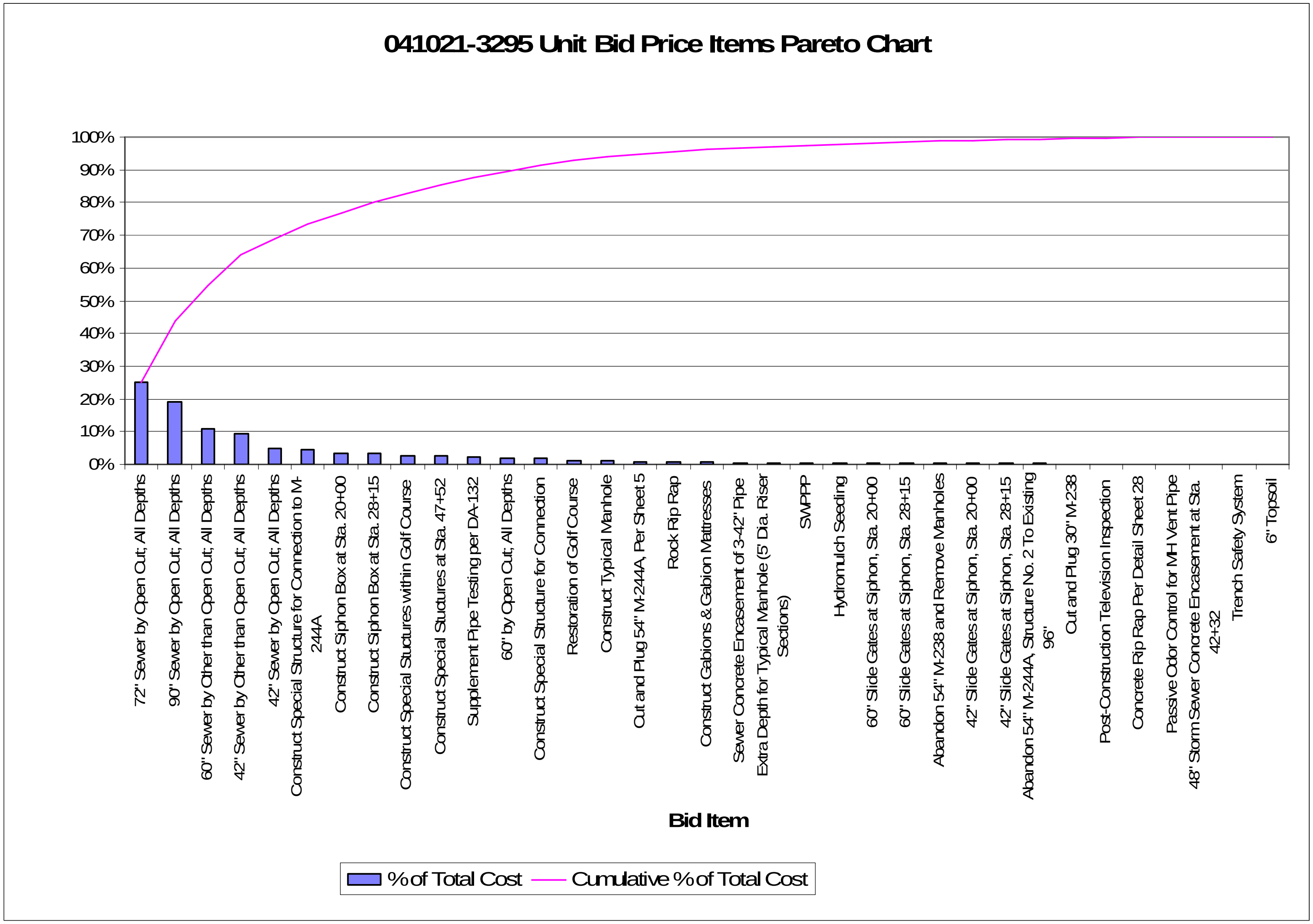
Temporary Asphalt Pavement Repair Unit Price Data Histogram
Frequenc
Bin
0
10
20
30
40
50
60
70
0.00%
10.00%
20.00%
30.00%
40.00%
50.00%
60.00%
70.00%
80.00%
90.00%
100.00%
3.00
6.00
9.00
12.00
15.00
18.00
21.00
24.00
27.00
30.00
33.00
36.00
39.00
42.00
45.00
48.00
51.00


Permanent Concrete Pavement Repair Unit Price Data Histogram
Frequenc
Bin
0
2
4
6
8
10
12
14
16
18
0.00%
10.00%
20.00%
30.00%
40.00%
50.00%
60.00%
70.00%
80.00%
90.00%
100.00%
27.00
35.00
43.00
51.00
59.00
67.00
75.00
83.00
91.00
99.00
107.00
115.00
123.00
131.00
139.00
147.00
155.00


Permanent Asphalt Pavement Repair Unit Price Data Histogram
Frequenc
Bin
0
5
10
15
20
25
30
35
40
0.00%
10.00%
20.00%
30.00%
40.00%
50.00%
60.00%
70.00%
80.00%
90.00%
100.00%
27.00
35.00
43.00
51.00
59.00
67.00
75.00
83.00
91.00
99.00
107.00
115.00
123.00
131.00
139.00
147.00
155.00

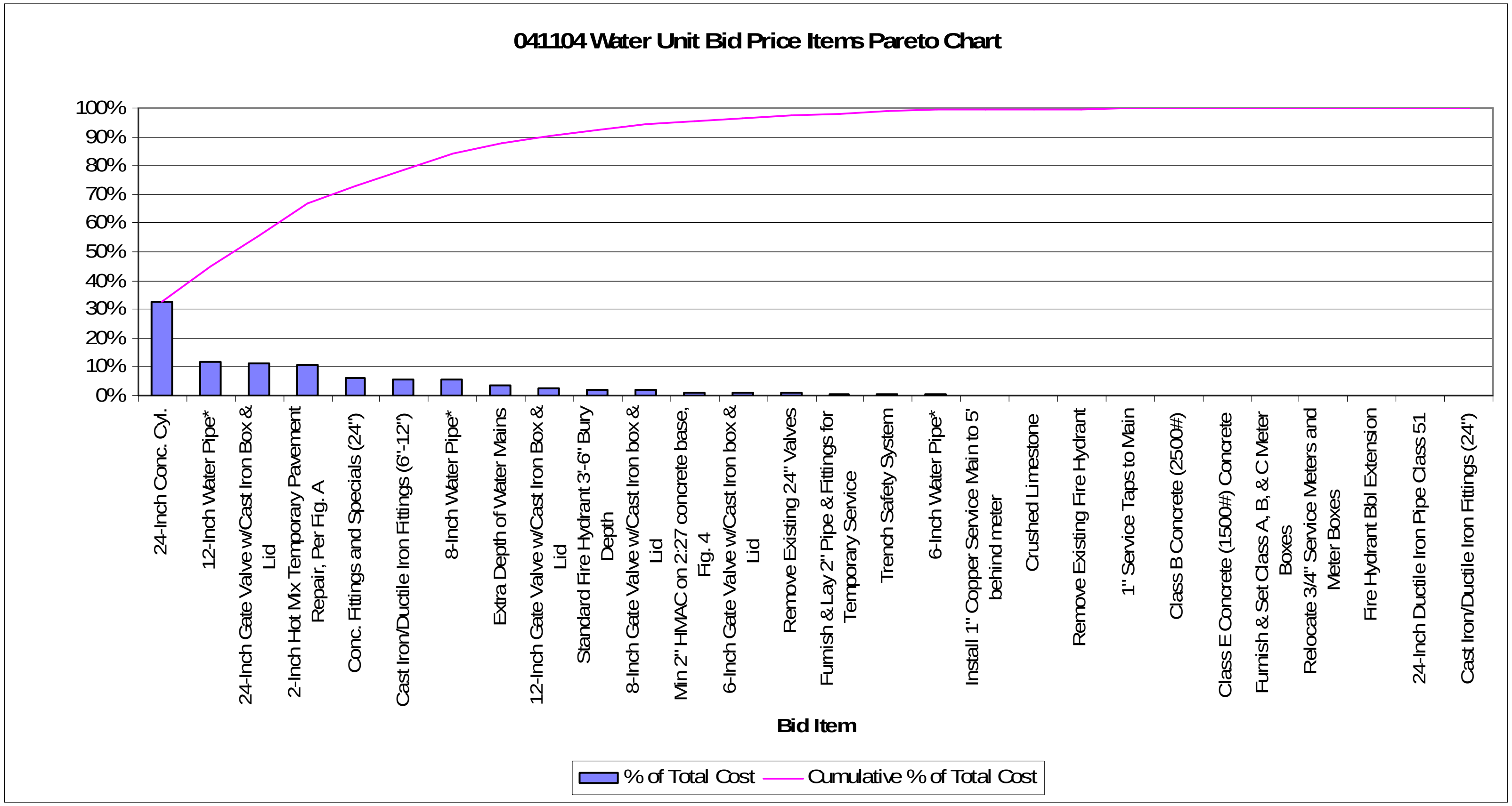
APPENDIX C

COST ITEM STATISTICAL ANALYSIS TABLES

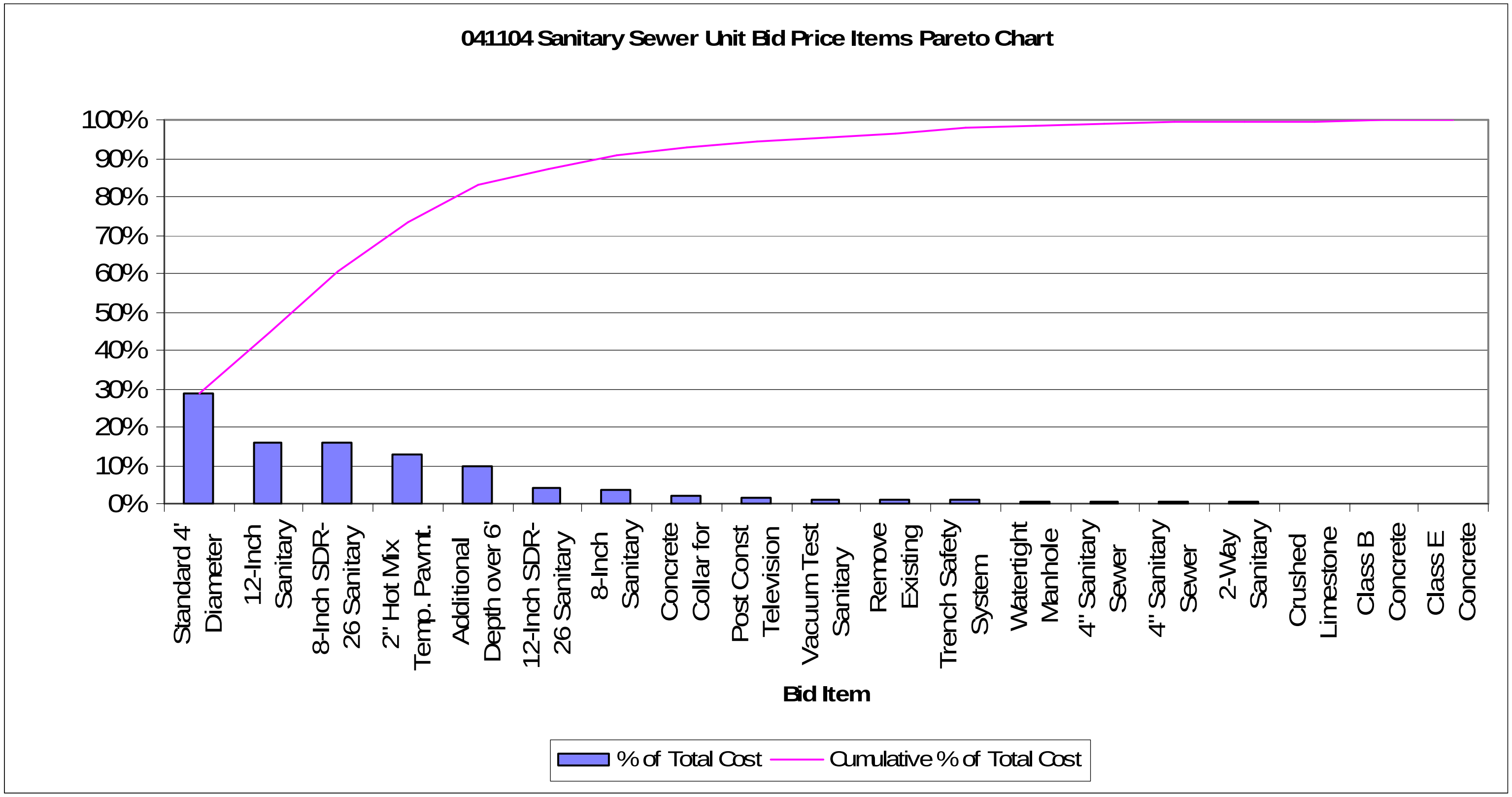

041021-3295 Unit Bid Price Items Pareto Chart
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
72" Sewer by Open Cut; All Depths
90" Sewer by Open Cut; All Depths
60" Sewer by Other than Open Cut; All Depths
42" Sewer by Other than Open Cut; All Depths
42" Sewer by Open Cut; All Depths
Construct Special Structure for Connection to M-244A
Construct Siphon Box at Sta. 20+00
Construct Siphon Box at Sta. 28+15
Construct Special Stuctures within Golf Course
Construct Special Stuctures at Sta. 47+52
Supplement Pipe Testing per DA-132
60" by Open Cut; All Depths
Construct Special Structure for Connection
Restoration of Golf Course
Construct Typical Manhole
Cut and Plug 54" M-244A, Per Sheet 5
Rock Rip Rap
Construct Gabions & Gabion Mattresses
Sewer Concrete Encasement of 3-42" Pipe
Extra Depth for Typical Manhole (5' Dia. Riser Sections)
SWPPP
Hydromulch Seeding
60" Slide Gates at Siphon, Sta. 20+00
60" Slide Gates at Siphon, Sta. 28+15
Abandon 54" M-238 and Remove Manholes
42" Slide Gates at Siphon, Sta. 20+00
42" Slide Gates at Siphon, Sta. 28+15
Abandon 54" M-244A, Structure No. 2 To Existing 96"
Cut and Plug 30" M-238
Post-Construction Television Inspection
Concrete Rip Rap Per Detail Sheet 28
Passive Odor Control for MH Vent Pipe
48" Storm Sewer Concrete Encasement at Sta. 42+32
Trench Safety System
6" Topsoil
Bid Item
% of Total Cost
Cumulative % of Total Cost

Project # 041021-3295				Low Bidder			
Pay Item	Quantity	Unit	Description of Bid Item	Unit Price	Total Bid	% of Total Cost	Cum.% of Total Cost
			SEWER IMPROVEMENTS				
2.	2438	LF	72" Sewer by Open Cut; All Depths	$ 406.00	$ 989,828.00	25%	25%
1.	1412	LF	90" Sewer by Open Cut; All Depths	$ 534.00	$ 754,008.00	19%	44%
2.	635	LF	60" Sewer by Other than Open Cut; All Depths	$ 670.00	$ 425,450.00	11%	55%
3.	635	LF	42" Sewer by Other than Open Cut; All Depths	$ 575.00	$ 365,125.00	9%	64%
4.	585	LF	42" Sewer by Open Cut; All Depths	$ 335.00	$ 195,975.00	5%	69%
5.	1	LS	Construct Special Structure for Connection to M-244A	$185,000.00	$ 185,000.00	5%	73%
9.	1	LS	Construct Siphon Box at Sta. 20+00	$135,000.00	$ 135,000.00	3%	77%
10.	1	LS	Construct Siphon Box at Sta. 28+15	$130,000.00	$ 130,000.00	3%	80%
11.	1	LS	Construct Special Stuctures within Golf Course	$105,000.00	$ 105,000.00	3%	83%
11.	1	LS	Construct Special Stuctures at Sta. 47+52	$100,000.00	$ 100,000.00	3%	85%
35.	1	LS	Supplement Pipe Testing per DA-132	$ 90,000.00	$ 90,000.00	2%	88%
3.	180	LF	60" by Open Cut; All Depths	$ 433.00	$ 77,940.00	2%	90%
4.	1	LS	Construct Special Structure for Connection	$ 75,000.00	$ 75,000.00	2%	91%
5.	1	LS	Restoration of Golf Course	$ 50,000.00	$ 50,000.00	1%	93%
6.	5	EA	Construct Typical Manhole	$ 9,500.00	$ 47,500.00	1%	94%
7.	10	EA	Cut and Plug 54" M-244A, Per Sheet 5	$ 3,500.00	$ 35,000.00	1%	95%
8.	794	SY	Rock Rip Rap	$ 39.00	$ 30,966.00	1%	96%
9.	290	SY	Construct Gabions & Gabion Mattresses	$ 80.00	$ 23,200.00	1%	96%
10.	135	LF	Sewer Concrete Encasement of 3-42" Pipe	$ 150.00	$ 20,250.00	1%	97%
11.	65	VF	Extra Depth for Typical Manhole (5' Dia. Riser Sections)	$ 300.00	$ 19,500.00	0%	97%
12.	1	LS	SWPPP	$ 15,000.00	$ 15,000.00	0%	98%
13.	4030	LF	Hydromulch Seeding	$ 3.50	$ 14,105.00	0%	98%
14.	1	EA	60" Slide Gates at Siphon, Sta. 20+00	$ 11,500.00	$ 11,500.00	0%	98%
15.	1	EA	60" Slide Gates at Siphon, Sta. 28+15	$ 11,500.00	$ 11,500.00	0%	98%
16.	1	LS	Abandon 54" M-238 and Remove Manholes	$ 10,000.00	$ 10,000.00	0%	99%
17.	1	EA	42" Slide Gates at Siphon, Sta. 20+00	$ 9,000.00	$ 9,000.00	0%	99%
18.	1	EA	42" Slide Gates at Siphon, Sta. 28+15	$ 9,000.00	$ 9,000.00	0%	99%
19.	1	LS	Abandon 54" M-244A, Structure No. 2 To Existing 96"	$ 8,000.00	$ 8,000.00	0%	99%
20.	2	EA	Cut and Plug 30" M-238	$ 3,500.00	$ 7,000.00	0%	100%
21.	5885	LF	Post-Construction Television Inspection	$ 1.00	$ 5,885.00	0%	100%
22.	110	SY	Concrete Rip Rap Per Detail Sheet 28	$ 50.00	$ 5,500.00	0%	100%
23.	5	EA	Passive Odor Control for MH Vent Pipe	$ 1,100.00	$ 5,500.00	0%	100%
24.	20	LF	48" Storm Sewer Concrete Encasement at Sta. 42+32	$ 44.00	$ 880.00	0%	100%
25.	4363	LF	Trench Safety System	$ 0.01	$ 43.63	0%	100%
26.	4030	SY	6" Topsoil	$ 0.01	$ 40.30	0%	100%
			TOTAL BID		**$3,967,695.93**		
			Submitted Bid if Different				

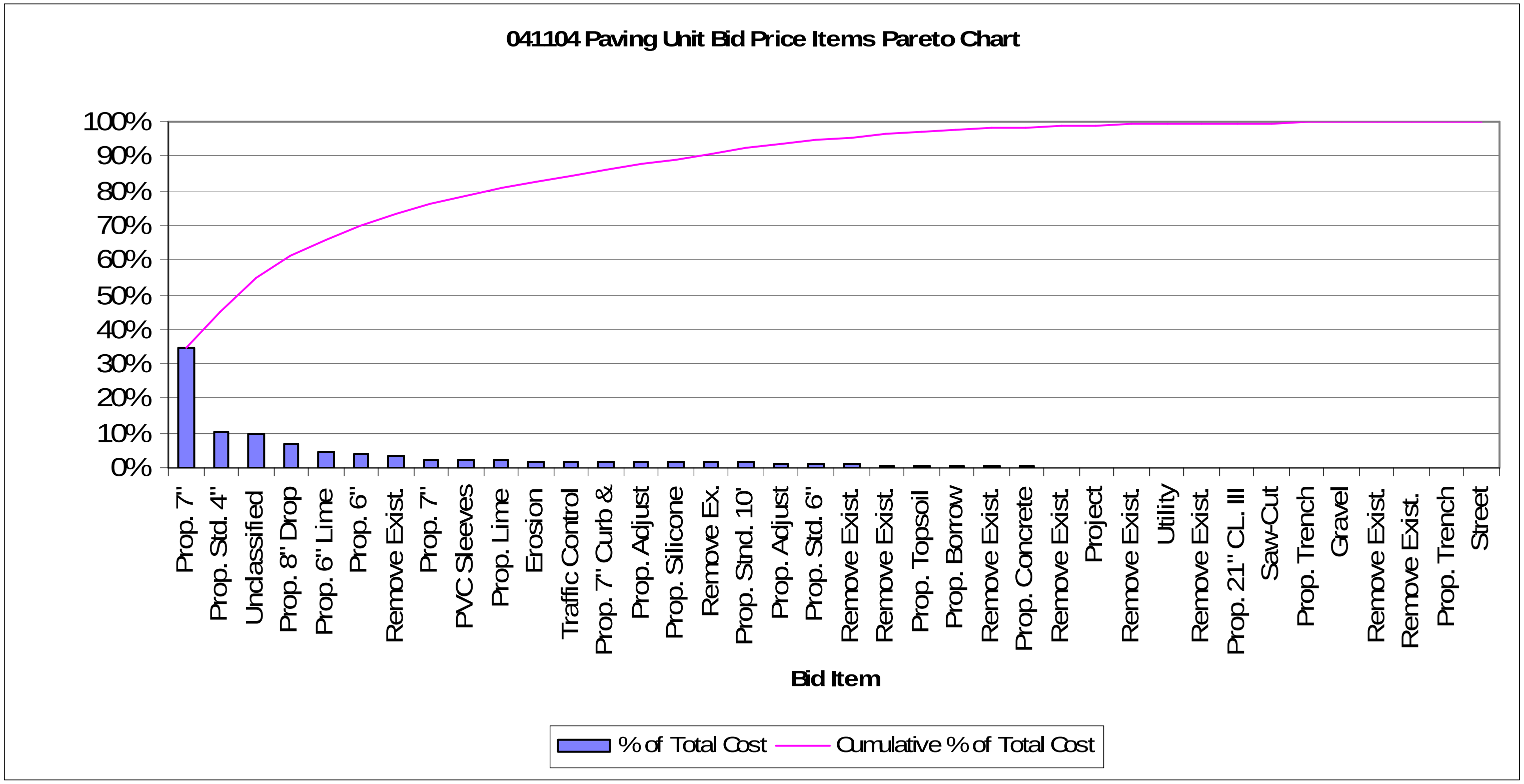
Note: Pay items highlighted are selected for UPD development


041104 Water Unit Bid Price Items Pareto Chart
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
24-Inch Conc. Cyl.
12-Inch Water Pipe*
24-Inch Gate Valve w/Cast Iron Box & Lid
2-Inch Hot Mix Temporary Pavement Repair, Per Fig. A
Conc. Fittings and Specials (24")
Cast Iron/Ductile Iron Fittings (6"-12")
8-Inch Water Pipe*
Extra Depth of Water Mains
12-Inch Gate Valve w/Cast Iron Box & Lid
Standard Fire Hydrant 3'-6" Bury Depth
8-Inch Gate Valve w/Cast Iron box & Lid
Min 2" HMAC on 2:27 concrete base, Fig. 4
6-Inch Gate Valve w/Cast Iron box & Lid
Remove Existing 24" Valves
Furnish & Lay 2" Pipe & Fittings for Temporary Service
Trench Safety System
6-Inch Water Pipe*
Install 1" Copper Service Main to 5' behind meter
Crushed Limestone
Remove Existing Fire Hydrant
1" Service Taps to Main
Class B Concrete (2500#)
Class E Concrete (1500#) Concrete
Furnish & Set Class A, B, & C Meter Boxes
Relocate 3/4" Service Meters and Meter Boxes
Fire Hydrant Bbl Extension
24-Inch Ductile Iron Pipe Class 51
Cast Iron/Ductile Iron Fittings (24")
Bid Item
% of Total Cost
Cumulative % of Total Cost

Project # 041104-trinity bluff				Low Bidder			
Pay Item	Quantity	Unit	Description of Bid Item	Unit Price	Total Bid	% of Total Cost	Cum.% of Total Cost
UNIT I - WATER BASE BID							
5.	1234	LF	24-Inch Conc. Cyl.	$ 94.00	$ 115,996.00	33%	33%
3.	1142	LF	12-Inch Water Pipe*	$ 37.00	$ 42,254.00	12%	45%
9.	2	EA	24-Inch Gate Valve w/Cast Iron Box & Lid	$ 19,700.00	$ 39,400.00	11%	56%
27.	3190	LF	2-Inch Hot Mix Temporary Pavement Repair, Per Fig. A	$ 12.00	$ 38,280.00	11%	67%
10.	1	LS	Conc. Fittings and Specials (24")	$ 22,100.00	$ 22,100.00	6%	73%
11.	5	TONS	Cast Iron/Ductile Iron Fittings (6"-12")	$ 4,050.00	$ 20,250.00	6%	79%
2.	720	LF	8-Inch Water Pipe*	$ 28.00	$ 20,160.00	6%	84%
26.	2376	LF	Extra Depth of Water Mains	$ 5.00	$ 11,880.00	3%	88%
8.	6	EA	12-Inch Gate Valve w/Cast Iron Box & Lid	$ 1,500.00	$ 9,000.00	3%	90%
13.	5	EA	Standard Fire Hydrant 3'-6" Bury Depth	$ 1,600.00	$ 8,000.00	2%	92%
7.	9	EA	8-Inch Gate Valve w/Cast Iron box & Lid	$ 750.00	$ 6,750.00	2%	94%
28.	125	LF	Min 2" HMAC on 2:27 concrete base, Fig. 4	$ 31.00	$ 3,875.00	1%	95%
6.	6	EA	6-Inch Gate Valve w/Cast Iron box & Lid	$ 600.00	$ 3,600.00	1%	96%
16.	2	EA	Remove Existing 24" Valves	$ 1,700.00	$ 3,400.00	1%	97%
21.	1	LS	Furnish & Lay 2" Pipe & Fittings for Temporary Service	$ 2,500.00	$ 2,500.00	1%	98%
25.	2376	LF	Trench Safety System	$ 1.00	$ 2,376.00	1%	99%
1.	90	LF	6-Inch Water Pipe*	$ 24.00	$ 2,160.00	1%	99%
18.	30	LF	Install 1" Copper Service Main to 5' behind meter	$ 15.00	$ 450.00	0%	99%
22.	90	CY	Crushed Limestone	$ 5.00	$ 450.00	0%	100%
15.	2	EA	Remove Existing Fire Hydrant	$ 150.00	$ 300.00	0%	100%
17.	1	EA	1" Service Taps to Main	$ 290.00	$ 290.00	0%	100%
23.	40	CY	Class B Concrete (2500#)	$ 5.00	$ 200.00	0%	100%
24.	40	CY	Class E Concrete (1500#) Concrete	$ 5.00	$ 200.00	0%	100%
20.	1	EA	Furnish & Set Class A, B, & C Meter Boxes	$ 160.00	$ 160.00	0%	100%
19.	1	EA	Relocate 3/4" Service Meters and Meter Boxes	$ 150.00	$ 150.00	0%	100%
14.	5	LF	Fire Hydrant Bbl Extension	$ 12.00	$ 60.00	0%	100%
4.	1234	LF	24-Inch Ductile Iron Pipe Class 51	$ -	$ -	0%	100%
12.	7	Tons	Cast Iron/Ductile Iron Fittings (24")	$ -	$ -	0%	100%
			UNIT I - WATER SUBTOTAL AMOUNT BASE BID		**$ 354,241.00**		


041104 Sanitary Sewer Unit Bid Price Items Pareto Chart
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Standard 4' Diameter
12-Inch Sanitary
8-Inch SDR-26 Sanitary
2" Hot Mix Temp. Pavmt.
Additional Depth over 6'
12-Inch SDR-26 Sanitary
8-Inch Sanitary
Concrete Collar for
Post Const Television
Vacuum Test Sanitary
Remove Existing
Trench Safety System
Watertight Manhole
4" Sanitary Sewer
4" Sanitary Sewer
2-Way Sanitary
Crushed Limestone
Class B Concrete
Class E Concrete
Bid Item
% of Total Cost
Cumulative % of Total Cost

Pay Item	Quantity	Unit	Description of Bid Item	Unit Price	Total Bid	% of Total Cost	Cum.% of Total Cost
UNIT IB - SANITARY SEWER							
5	12	EA	Standard 4' Diameter Manhole to 6' Depth	$ 1,700.00	$ 20,400.00	29%	29%
4	284	LF	12-Inch Sanitary Sewer Pipe	$ 40.00	$ 11,360.00	16%	45%
1	320	LF	8-Inch SDR- 26 Sanitary Sewer Pipe	$ 35.00	$ 11,200.00	16%	60%
17	750	LF	2" Hot Mix Temp. Pavmt. Rep., Per Fig. A	$ 12.00	$ 9,000.00	13%	73%
6	42	LF	Additional Depth over 6' of Standard 4' Diameter Manhole	$ 165.00	$ 6,930.00	10%	83%
2	65	LF	12-Inch SDR-26 Sanitary Sewer Pipe	$ 46.00	$ 2,990.00	4%	87%
3	84	LF	8-Inch Sanitary Sewer Pipe*, 8 Ft. - 10 Ft. Trench Depth	$ 32.00	$ 2,688.00	4%	91%
7	6	EA	Concrete Collar for Manhole, Per Fig. 121	$ 250.00	$ 1,500.00	2%	93%
18	752	LF	Post Const Television Inspection of Sanitary Sewer Lines	$ 1.25	$ 940.00	1%	94%
19	12	EA	Vacuum Test Sanitary Sewer Manholes	$ 75.00	$ 900.00	1%	96%
9	4	EA	Remove Existing Sewer Manhole	$ 200.00	$ 800.00	1%	97%
16	752	LF	Trench Safety System	$ 1.00	$ 752.00	1%	98%
8	12	EA	Watertight Manhole Inserts	$ 38.00	$ 456.00	1%	98%
11	20	LF	4" Sanitary Sewer Service Line Replacement w/ SDR26	$ 20.00	$ 400.00	1%	99%
10	1	EA	4" Sanitary Sewer Service Tap	$ 230.00	$ 230.00	0%	99%
12	1		2-Way Sanitary Sewer Service Cleanout	$ 183.00	$ 183.00	0%	100%
13	30	CY	Crushed Limestone	$ 5.00	$ 150.00	0%	100%
14	20	CY	Class B Concrete (2500#)	$ 5.00	$ 100.00	0%	100%
15	20	CY	Class E Concrete (1500#)	$ 5.00	$ 100.00	0%	100%
			UNIT IB - SANITARY SEWER SUBTOTAL AMOUNT BID		**$ 71,079.00**		



041104 Paving Unit Bid Price Items Pareto Chart
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Prop. 7"
Prop. Std. 4"
Unclassified
Prop. 8" Drop
Prop. 6" Lime
Prop. 6"
Remove Exist.
Prop. 7"
PVC Sleeves
Prop. Lime
Erosion
Traffic Control
Prop. 7" Curb &
Prop. Adjust
Prop. Silicone
Remove Ex.
Prop. Stnd. 10'
Prop. Adjust
Prop. Std. 6"
Remove Exist.
Remove Exist.
Prop. Topsoil
Prop. Borrow
Remove Exist.
Prop. Concrete
Remove Exist.
Project
Remove Exist.
Utility
Remove Exist.
Prop. 21" CL. III
Saw-Cut
Prop. Trench
Gravel
Remove Exist.
Remove Exist.
Prop. Trench
Street
Bid Item
% of Total Cost
Cumulative % of Total Cost

Pay Item	Quantity	Unit	Description of Bid Item	Unit Price	Total Bid	% of Total Cost	Cum.% of Total Cost
UNIT II - PAVING							
27	4450	SY.	Prop. 7" Concrete Pavement	$ 24.50	$ 109,025.00	35%	35%
20	9106	SF.	Prop. Std. 4" Conc. Sidewalk, Leadwalk, Wheelchair Ramp	$ 3.65	$ 33,236.90	11%	45%
37	2100	CY.	Unclassified Street Excavation	$ 14.50	$ 30,450.00	10%	55%
28	543	SY.	Prop. 8" Drop Slab Reinf.Concrete Pavement W/3.5" HMA(	$ 38.65	$ 20,986.95	7%	61%
23	5855	SY.	Prop. 6" Lime Stabilized Subgrade @ 30 lbs./s.y.	$ 2.50	$ 14,637.50	5%	66%
30	525	SY.	Prop. 6" H.M.A.C. Pavement	$ 24.00	$ 12,600.00	4%	70%
11.	2405	SY.	Remove Exist. 10" Conc. Base	$ 4.50	$ 10,822.50	3%	74%
19.	2685	LF.	Prop. 7" Attached Curb	$ 3.00	$ 8,055.00	3%	76%
36.	263	L.F.	PVC Sleeves (4-4" PVC and 1-8" PVC In Trench)	$ 30.00	$ 7,890.00	3%	79%
24.	88	TN.	Prop. Lime	$ 80.00	$ 7,040.00	2%	81%
3.	1	LS.	Erosion Control Plan	$ 6,000.00	$ 6,000.00	2%	83%
38.	1	LS.	Traffic Control	$ 5,500.00	$ 5,500.00	2%	85%
18.	334	LF.	Prop. 7" Curb & 18" Gutter	$ 15.00	$ 5,010.00	2%	86%
34.	14	EA.	Prop. Adjust Manhole	$ 350.00	$ 4,900.00	2%	88%
29.	6110	LF.	Prop. Silicone Joint Sealant	$ 0.79	$ 4,826.90	2%	89%
6.	4810	SF.	Remove Ex. Sidewalk, Leadwalk, Steps, Wheelchair	$ 1.00	$ 4,810.00	2%	91%
17.	2	EA.	Prop. Stnd. 10' Inlet	$ 2,400.00	$ 4,800.00	2%	92%
33.	21	EA.	Prop. Adjust Water Valve Box	$ 200.00	$ 4,200.00	1%	94%
21.	740	SF.	Prop. Std. 6" Conc. Driveway	$ 4.40	$ 3,256.00	1%	95%
9.	2868	SF.	Remove Exist. Conc. Driveway	$ 1.00	$ 2,868.00	1%	96%
4.	1513	LF.	Remove Exist. Curb & Gutter	$ 1.75	$ 2,647.75	1%	96%
32.	250	CY.	Prop. Topsoil	$ 9.00	$ 2,250.00	1%	97%
22.	225	CY.	Prop. Borrow Material	$ 8.25	$ 1,856.25	1%	98%
12.	1	EA.	Remove Exist. 10' Inlet	$ 1,400.00	$ 1,400.00	0%	98%
25.	174	LF.	Prop. Concrete Street Header	$ 6.00	$ 1,044.00	0%	98%
8.	910	SF.	Remove Exist. Asphalt Driveway	$ 1.00	$ 910.00	0%	99%
2.	4	EA.	Project Designation Signs	$ 200.00	$ 800.00	0%	99%
5.	456	LF.	Remove Exist. Standup Curb	$ 1.50	$ 684.00	0%	99%
1.	1	LS.	Utility Adjustment	$ 500.00	$ 500.00	0%	99%
7.	350	SF.	Remove Exist. Brick Pavers	$ 1.00	$ 350.00	0%	99%
14.	4	LF.	Prop. 21" CL. III R.C.P.	$ 82.00	$ 328.00	0%	100%
26.	215	LF.	Saw-Cut Existing Asphalt Pavement	$ 1.50	$ 322.50	0%	100%
16.	1	LS.	Prop. Trench Excavation & Backfill/Perm. Pavg. Repair	$ 300.00	$ 300.00	0%	100%
31.	5	CY.	Gravel Transition for Driveways	$ 57.00	$ 285.00	0%	100%
13.	4	LF.	Remove Exist. 21" R.C.P.	$ 40.00	$ 160.00	0%	100%
10.	155	SF.	Remove Exist. Conc. Valley Gutter	$ 1.00	$ 155.00	0%	100%
15.	4	LF.	Prop. Trench Safety	$ 25.00	$ 100.00	0%	100%
35.	1	LS.	Street Luminaire Package - Deleted			0%	100%
			UNIT II - PAVING TOTAL AMOUNT BID		**$ 315,007.25**		
Note: Pay items highlighted are selected for UPD development							

12-INCH PVC WATER PIPE BY OPEN CUT

Mean LN(Y)= 4.161

Std. Dev. LN(Y)= 0.363

Increment= 1

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$43.27	3.768	30	1.81%
$58.48	4.069	31	2.25%
$50.76	3.927	32	2.76%
$42.10	3.740	33	3.34%
$79.53	4.376	34	4.00%
$107.60	4.678	35	4.74%
$99.41	4.599	36	5.56%
$97.07	4.575	37	6.46%
$105.26	4.656	38	7.45%
$109.94	4.700	39	8.51%
$69.03	4.235	40	9.65%
$58.50	4.069	41	10.86%
$65.52	4.182	42	12.15%
$117.00	4.762	43	13.51%
$38.03	3.638	44	14.94%
$39.90	3.686	45	16.42%
$52.65	3.964	46	17.97%
$55.80	4.022	47	19.56%
$58.13	4.063	48	21.21%
$59.29	4.082	49	22.89%
$57.79	4.057	50	24.61%
$41.76	3.732	51	26.37%
$37.68	3.629	52	28.14%
$57.79	4.057	53	29.94%
$41.03	3.714	54	31.76%
$52.02	3.952	55	33.58%
$71.67	4.272	56	35.41%
$53.30	3.976	57	37.24%
$58.97	4.077	58	39.07%
$60.48	4.102	59	40.89%
$58.97	4.077	60	42.70%
$62.37	4.133	61	44.50%
$54.44	3.997	62	46.27%

12-INCH PVC WATER PIPE BY OPEN CUT
Mean LN(Y)= 4.161
Std. Dev. LN(Y)= 0.363
Increment= 1

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$68.04	4.220	63	48.03%
$60.11	4.096	64	49.76%
$55.57	4.018	65	51.47%
$88.46	4.483	66	53.14%
$62.62	4.137	67	54.79%
$100.64	4.612	68	56.40%
$93.94	4.543	69	57.98%
$111.83	4.717	70	59.53%
$123.01	4.812	71	61.03%
$42.42	3.748	72	62.50%
$55.82	4.022	73	63.94%
$52.47	3.960	74	65.33%
$53.58	3.981	75	66.69%
$64.75	4.170	76	68.01%
$72.56	4.284	77	69.28%
$110.52	4.705	78	70.52%
$57.85	4.058	79	71.72%
$194.63	5.271	80	72.88%
$199.08	5.294	81	74.01%
$289.16	5.667	82	75.09%
$55.01	4.007	83	76.14%
$47.78	3.867	84	77.15%
$58.89	4.076	85	78.13%
$68.90	4.233	86	79.07%
$58.34	4.066	87	79.97%
$69.45	4.241	88	80.84%
$63.38	4.149	89	81.68%
$82.28	4.410	90	82.49%
$46.70	3.844	91	83.26%
$61.15	4.113	92	84.00%
$43.63	3.776	93	84.72%
$51.15	3.935	94	85.40%
$46.70	3.844	95	86.06%
$53.31	3.976	96	86.69%
$46.65	3.843	97	87.30%
$57.75	4.056	98	87.88%
$49.98	3.912	99	88.43%

12-INCH PVC WATER PIPE BY OPEN CUT
Mean LN(Y)= **4.161**
Std. Dev. LN(Y)= **0.363**
Increment= 1

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$49.13	3.895	100	88.96%
$52.20	3.955	101	89.47%
$53.60	3.982	102	89.96%
$66.45	4.196	103	90.42%
$50.94	3.931	104	90.87%
$59.80	4.091	105	91.29%
$53.16	3.973	106	91.70%
$64.23	4.163	107	92.09%
$99.67	4.602	108	92.46%
$54.24	3.993	109	92.82%
$52.07	3.953	110	93.15%
$62.92	4.142	111	93.48%
$97.64	4.581	112	93.79%
$72.17	4.279	113	94.08%
$96.95	4.574	114	94.36%
$134.65	4.903	115	94.63%
$136.80	4.919	116	94.89%
$117.48	4.766	117	95.13%
$85.44	4.448	118	95.36%
$176.22	5.172	119	95.58%
$42.49	3.749	120	95.79%
$44.62	3.798	121	96.00%
$48.87	3.889	122	96.19%
$48.87	3.889	123	96.37%
$47.80	3.867	124	96.54%
$64.27	4.163	125	96.71%
$50.74	3.927	126	96.87%
$44.39	3.793	127	97.02%
$44.39	3.793	128	97.16%
$40.17	3.693		
$58.14	4.063		
$65.53	4.183		
$69.60	4.243		
$50.09	3.914		
$72.13	4.278		
$82.25	4.410		
$58.00	4.060		

12-INCH PVC WATER PIPE BY OPEN CUT

Mean LN(Y)= 4.161

Std. Dev. LN(Y)= 0.363

Increment= 1

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$97.02	4.575		
$127.60	4.849		
$63.27	4.147		
$66.59	4.199		
$68.55	4.227		
$46.40	3.837		
$50.62	3.924		
$50.62	3.924		
$42.18	3.742		
$60.11	4.096		
$43.24	3.767		
$52.73	3.965		
$55.89	4.023		
$70.65	4.258		
$52.73	3.965		
$47.25	3.856		
$89.60	4.495		
$65.35	4.180		
$84.33	4.435		
$124.38	4.823		
$63.03	4.144		
$39.92	3.687		
$47.27	3.856		
$63.03	4.144		
$47.27	3.856		
$66.18	4.192		
$51.47	3.941		
$73.53	4.298		
$47.27	3.856		
$81.94	4.406		
$47.27	3.856		
$51.47	3.941		
$63.03	4.144		

10-INCH PVC WATER PIPE BY OPEN CUT
Mean LN(Y)= 3.849
Std. Dev. LN(Y)= 0.295
Increment= 1

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$36.57	3.599	25	1.63%
$35.10	3.558	26	2.25%
$36.27	3.591	27	3.03%
$47.97	3.871	28	3.98%
$46.50	3.840	29	5.11%
$48.83	3.888	30	6.44%
$48.83	3.888	31	7.96%
$50.86	3.929	32	9.68%
$35.06	3.557	33	11.59%
$31.21	3.441	34	13.69%
$53.17	3.974	35	15.96%
$36.41	3.595	36	18.39%
$39.30	3.671	37	20.96%
$69.35	4.239	38	23.66%
$38.14	3.641	39	26.46%
$35.83	3.579	40	29.35%
$55.48	4.016	41	32.30%
$36.99	3.611	42	35.28%
$35.83	3.579	43	38.29%
$49.24	3.897	44	41.30%
$42.77	3.756	45	44.29%
$47.39	3.858	46	47.25%
$53.75	3.984	47	50.15%
$72.59	4.285	48	53.00%
$35.72	3.576	49	55.77%
$34.57	3.543	50	58.46%
$35.95	3.582	51	61.06%
$49.90	3.910	52	63.56%
$51.03	3.932	53	65.96%
$51.29	3.938	54	68.26%
$36.18	3.589	55	70.44%
$31.66	3.455	56	72.52%
$35.05	3.557	57	74.48%
$39.58	3.678	58	76.34%

10-INCH PVC WATER PIPE BY OPEN CUT

Mean LN(Y)= 3.849

Std. Dev. LN(Y)= 0.295

Increment= 1

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$56.42	4.033	59	78.09%
$38.90	3.661	60	79.74%
$57.95	4.060	61	81.28%
$59.27	4.082	62	82.73%
$39.14	3.667	63	84.08%
$45.85	3.825	64	85.34%
$42.49	3.749	65	86.52%
$59.27	4.082	66	87.61%
$44.73	3.801	67	88.62%
$50.32	3.918	68	89.56%
$78.28	4.360	69	90.43%
$109.59	4.697	70	91.23%
$100.64	4.612	71	91.97%
$111.83	4.717	72	92.66%
$41.38	3.723	73	93.29%
$39.14	3.667	74	93.87%
$44.73	3.801	75	94.40%
$28.24	3.341	76	94.89%
$35.47	3.569	77	95.34%
$43.54	3.774	78	95.75%
$43.54	3.774	79	96.13%
$50.23	3.917	80	96.47%
$35.72	3.576	81	96.79%
$46.89	3.848	82	97.08%
$41.30	3.721	83	97.34%
$45.77	3.824	84	97.58%
$51.35	3.939	85	97.80%
$61.40	4.117	86	98.00%
$91.54	4.517	87	98.18%
$49.27	3.897	88	98.35%
$51.67	3.945	89	98.50%
$33.34	3.507	90	98.64%
$46.67	3.843	91	98.76%
$48.89	3.890	92	98.88%
$47.00	3.850	93	98.98%
$122.23	4.806	94	99.07%

10-INCH PVC WATER PIPE BY OPEN CUT

Mean LN(Y)= **3.849**

Std. Dev. LN(Y)= **0.295**

Increment= 1

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$55.60	4.018		
$41.14	3.717		
$44.48	3.795		
$50.04	3.913		
$37.29	3.619		
$44.48	3.795		
$38.92	3.661		
$47.73	3.866		
$47.73	3.866		
$52.07	3.953		
$92.21	4.524		
$34.73	3.548		
$43.41	3.771		
$41.89	3.735		
$43.41	3.771		
$36.79	3.605		
$41.24	3.719		
$45.45	3.817		
$34.88	3.552		
$50.74	3.927		
$34.88	3.552		
$42.28	3.744		
$105.70	4.661		
$37.82	3.633		
$75.63	4.326		
$42.02	3.738		
$45.17	3.810		
$47.27	3.856		

8-Inch Water Pipe*
Mean LN(Y)= 3.671
Std. Dev. LN(Y)= 0.317
Increment= 1

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$32.75	3.489	20	1.66%
$37.43	3.622	21	2.41%
$38.77	3.658	22	3.37%
$31.58	3.452	23	4.57%
$104.09	4.645	24	6.00%
$91.22	4.513	25	7.70%
$26.90	3.292	26	9.64%
$29.24	3.375	27	11.84%
$30.41	3.415	28	14.26%
$37.43	3.622	29	16.90%
$26.90	3.292	30	19.73%
$32.75	3.489	31	22.72%
$31.30	3.444	32	25.85%
$29.25	3.376	33	29.08%
$30.42	3.415	34	32.39%
$37.44	3.623	35	35.73%
$30.42	3.415	36	39.10%
$28.08	3.335	37	42.45%
$34.63	3.545	38	45.76%
$29.30	3.377	39	49.02%
$41.60	3.728	40	52.20%
$46.87	3.847	41	55.29%
$42.19	3.742	42	58.27%
$39.84	3.685	43	61.14%
$29.30	3.377	44	63.89%
$38.67	3.655	45	66.51%
$57.42	4.050	46	68.99%
$48.04	3.872	47	71.34%
$56.16	4.028	48	73.55%
$35.10	3.558	49	75.64%
$46.80	3.846	50	77.59%
$105.30	4.657	51	79.41%
$45.34	3.814	52	81.11%
$46.50	3.840	53	82.69%

8-Inch Water Pipe*
Mean LN(Y)= 3.671
Std. Dev. LN(Y)= 0.317
Increment= 1

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$47.67	3.864	54	84.15%
$46.50	3.840	55	85.51%
$48.83	3.888	56	86.76%
$48.83	3.888	57	87.92%
$40.46	3.700	58	88.99%
$28.90	3.364	59	89.97%
$22.18	3.099	60	90.87%
$30.05	3.403	61	91.69%
$29.76	3.393	62	92.45%
$30.05	3.403	63	93.14%
$39.30	3.671	64	93.77%
$28.90	3.364	65	94.35%
$41.61	3.728	66	94.88%
$34.68	3.546	67	95.36%
$31.21	3.441	68	95.79%
$30.05	3.403	69	96.19%
$43.92	3.782	70	96.55%
$36.99	3.611	71	96.88%
$41.61	3.728	72	97.18%
$41.61	3.728	73	97.45%
$42.67	3.754	74	97.69%
$53.05	3.971	75	97.91%
$40.36	3.698	76	98.11%
$40.36	3.698	77	98.29%
$28.83	3.361	78	98.46%
$53.05	3.971	79	98.61%
$26.50	3.277	80	98.74%
$29.96	3.400	81	98.86%
$28.81	3.361	82	98.97%
$29.73	3.392	83	99.07%
$47.63	3.863	84	99.16%
$47.63	3.863	85	99.25%
$43.67	3.777	86	99.32%
$29.49	3.384	87	99.39%
$28.98	3.366	88	99.44%
$33.17	3.502	89	99.50%

8-Inch Water Pipe*
Mean LN(Y)= 3.671
Std. Dev. LN(Y)= 0.317
Increment= 1

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$38.56	3.652		
$30.62	3.422		
$39.69	3.681		
$31.19	3.440		
$40.28	3.696		
$43.09	3.763		
$40.83	3.709		
$38.56	3.652		
$56.70	4.038		
$51.03	3.932		
$46.50	3.839		
$45.36	3.815		
$22.62	3.119		
$21.48	3.067		
$21.48	3.067		
$26.01	3.258		
$23.07	3.138		
$31.32	3.444		
$24.88	3.214		
$23.26	3.147		
$32.09	3.469		
$38.02	3.638		
$38.02	3.638		
$45.85	3.825		
$37.28	3.619		
$41.38	3.723		
$55.91	4.024		
$72.69	4.286		
$89.46	4.494		
$106.24	4.666		
$29.08	3.370		
$22.37	3.108		
$35.78	3.578		
$21.92	3.087		
$24.15	3.184		
$32.43	3.479		

8-Inch Water Pipe*
Mean LN(Y)= 3.671
Std. Dev. LN(Y)= 0.317
Increment= 1

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$38.02	3.638		
$46.97	3.849		
$89.46	4.494		
$76.04	4.331		
$75.77	4.328		
$35.72	3.576		
$31.26	3.442		
$41.30	3.721		
$33.49	3.511		
$36.84	3.607		
$52.47	3.960		
$31.26	3.442		
$41.30	3.721		
$33.49	3.511		
$37.95	3.636		
$41.86	3.734		
$42.42	3.748		
$33.49	3.511		
$42.24	3.743		
$36.84	3.607		
$31.26	3.442		
$33.49	3.511		
$39.07	3.665		
$39.07	3.665		
$45.77	3.824		
$33.49	3.511		
$32.37	3.477		
$31.26	3.442		
$43.54	3.774		
$36.84	3.607		
$39.07	3.665		
$42.42	3.748		
$41.71	3.731		
$32.24	3.473		
$32.24	3.473		
$36.13	3.587		

8-Inch Water Pipe*
Mean LN(Y)= 3.671
Std. Dev. LN(Y)= 0.317
Increment= 1

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$37.80	3.632		
$41.13	3.717		
$41.13	3.717		
$42.25	3.744		
$45.96	3.828		
$34.19	3.532		
$41.70	3.730		
$41.14	3.717		
$43.36	3.770		
$40.03	3.690		
$37.80	3.632		
$53.37	3.977		
$41.14	3.717		
$33.36	3.507		
$31.69	3.456		
$37.80	3.632		
$33.36	3.507		
$31.97	3.465		
$33.36	3.507		
$34.47	3.540		
$32.21	3.472		
$35.54	3.571		
$35.54	3.571		
$35.54	3.571		
$36.49	3.597		
$33.32	3.506		
$38.32	3.646		
$36.65	3.601		
$43.09	3.763		
$43.87	3.781		
$49.98	3.912		
$33.32	3.506		
$38.87	3.660		
$37.76	3.631		
$33.16	3.501		
$36.65	3.601		

8-Inch Water Pipe*
Mean LN(Y)= 3.671
Std. Dev. LN(Y)= 0.317
Increment= 1

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$44.42	3.794		
$45.54	3.818		
$32.21	3.472		
$47.76	3.866		
$51.09	3.934		
$37.65	3.628		
$27.69	3.321		
$44.30	3.791		
$50.94	3.931		
$44.30	3.791		
$45.56	3.819		
$46.65	3.843		
$48.82	3.888		
$65.09	4.176		
$75.67	4.326		
$87.56	4.472		
$97.29	4.578		
$91.88	4.521		
$118.91	4.778		
$64.86	4.172		
$30.93	3.432		
$39.61	3.679		
$31.47	3.449		
$31.47	3.449		
$33.37	3.508		
$39.07	3.665		
$43.41	3.771		
$45.58	3.819		
$63.02	4.143		
$51.70	3.946		
$91.56	4.517		
$80.79	4.392		
$121.72	4.802		
$96.12	4.566		
$79.03	4.370		
$101.46	4.620		

8-Inch Water Pipe*
Mean LN(Y)= 3.671
Std. Dev. LN(Y)= 0.317
Increment= 1

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$33.99	3.526		
$38.24	3.644		
$32.93	3.494		
$33.99	3.526		
$38.24	3.644		
$49.93	3.911		
$28.54	3.351		
$29.07	3.370		
$30.65	3.423		
$30.12	3.405		
$31.71	3.457		
$41.22	3.719		
$31.69	3.456		
$38.56	3.652		
$34.12	3.530		
$33.81	3.521		
$31.69	3.456		
$39.09	3.666		
$30.16	3.407		
$28.47	3.349		
$32.69	3.487		
$36.91	3.608		
$32.69	3.487		
$27.42	3.311		
$31.64	3.454		
$30.21	3.408		
$36.91	3.608		
$29.00	3.367		
$30.53	3.419		
$34.27	3.534		
$31.64	3.454		
$36.91	3.608		
$35.85	3.579		
$31.64	3.454		
$37.65	3.628		
$35.12	3.559		

8-Inch Water Pipe*
Mean LN(Y)= 3.671
Std. Dev. LN(Y)= 0.317
Increment= 1

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$36.91	3.608		
$36.91	3.608		
$42.16	3.742		
$47.43	3.859		
$68.52	4.227		
$30.57	3.420		
$32.68	3.487		
$39.00	3.664		
$33.73	3.518		
$32.68	3.487		
$34.79	3.549		
$38.69	3.655		
$52.70	3.965		
$50.60	3.924		
$78.00	4.357		
$60.08	4.096		
$33.61	3.515		
$29.41	3.381		
$32.56	3.483		
$31.51	3.450		
$31.51	3.450		
$33.61	3.515		
$33.61	3.515		
$51.47	3.941		
$33.61	3.515		
$42.02	3.738		
$36.77	3.605		
$34.93	3.553		
$32.56	3.483		

6-INCH WATER PIPE
Mean LN(Y)= **3.560**
Std. Dev. LN(Y)= **0.324**
Increment= 1

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$24.56	3.201	16	0.75%
$25.73	3.248	17	1.24%
$28.65	3.355	18	1.93%
$28.07	3.335	19	2.86%
$29.25	3.376	20	4.07%
$26.91	3.293	21	5.56%
$28.08	3.335	22	7.37%
$44.46	3.795	23	9.49%
$23.40	3.153	24	11.90%
$36.27	3.591	25	14.60%
$50.31	3.918	26	17.55%
$25.58	3.242	27	20.73%
$25.58	3.242	28	24.08%
$25.58	3.242	29	27.59%
$32.55	3.483	30	31.19%
$48.83	3.888	31	34.86%
$44.18	3.788	32	38.55%
$45.34	3.814	33	42.23%
$34.88	3.552	34	45.87%
$34.88	3.552	35	49.44%
$38.37	3.647	36	52.90%
$35.83	3.579	37	56.26%
$25.43	3.236	38	59.48%
$17.05	2.836	39	62.56%
$25.43	3.236	40	65.48%
$27.16	3.302	41	68.25%
$27.74	3.323	42	70.85%
$38.14	3.641	43	73.30%
$40.36	3.698	44	75.58%
$57.66	4.055	45	77.71%
$46.13	3.831	46	79.68%
$46.13	3.831	47	81.50%
$23.07	3.138	48	83.19%
$48.44	3.880	49	84.74%

6-INCH WATER PIPE
Mean LN(Y)= 3.560
Std. Dev. LN(Y)= 0.324
Increment= 1

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$43.78	3.779	50	86.17%
$27.65	3.320	51	87.47%
$26.50	3.277	52	88.67%
$27.65	3.320	53	89.76%
$43.09	3.763	54	90.75%
$45.36	3.815	55	91.66%
$37.55	3.626	56	92.48%
$28.35	3.345	57	93.22%
$28.98	3.366	58	93.90%
$32.89	3.493	59	94.51%
$32.89	3.493	60	95.06%
$28.35	3.345	61	95.56%
$37.42	3.622	62	96.02%
$29.49	3.384	63	96.42%
$35.76	3.577	64	96.79%
$37.42	3.622	65	97.12%
$46.04	3.830	66	97.41%
$31.75	3.458	67	97.68%
$47.63	3.863	68	97.92%
$36.29	3.592	69	98.14%
$36.29	3.592	70	98.33%
$40.83	3.709	71	98.50%
$21.66	3.076	72	98.66%
$26.84	3.290	73	98.80%
$32.43	3.479	74	98.93%
$24.60	3.203	75	99.04%
$39.14	3.667	76	99.14%
$31.64	3.454	77	99.23%
$33.55	3.513	78	99.31%
$50.32	3.918	79	99.38%
$63.74	4.155	80	99.45%
$89.46	4.494	81	99.50%
$100.64	4.612	82	99.56%
$29.02	3.368	83	99.60%
$25.68	3.246	84	99.64%
$33.49	3.511	85	99.68%

6-INCH WATER PIPE

Mean LN(Y)= **3.560**

Std. Dev. LN(Y)= **0.324**

Increment= 1

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$26.79	3.288		
$29.02	3.368		
$45.77	3.824		
$26.79	3.288		
$33.49	3.511		
$26.79	3.288		
$33.49	3.511		
$36.84	3.607		
$39.07	3.665		
$45.77	3.824		
$36.48	3.597		
$29.02	3.368		
$25.68	3.246		
$29.02	3.368		
$33.49	3.511		
$43.54	3.774		
$33.49	3.511		
$29.02	3.368		
$29.02	3.368		
$25.68	3.246		
$29.02	3.368		
$31.26	3.442		
$32.37	3.477		
$45.77	3.824		
$36.27	3.591		
$25.57	3.241		
$26.68	3.284		
$30.57	3.420		
$31.13	3.438		
$35.58	3.572		
$31.13	3.438		
$37.80	3.632		
$42.15	3.741		
$29.01	3.367		
$42.78	3.756		
$20.00	2.996		

6-INCH WATER PIPE
Mean LN(Y)= **3.560**
Std. Dev. LN(Y)= **0.324**
Increment= 1

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$33.34	3.507		
$35.56	3.571		
$31.39	3.447		
$108.90	4.690		
$38.92	3.661		
$32.25	3.473		
$37.80	3.632		
$35.58	3.572		
$32.25	3.473		
$51.15	3.935		
$33.36	3.507		
$30.02	3.402		
$27.80	3.325		
$33.36	3.507		
$33.36	3.507		
$27.71	3.322		
$30.02	3.402		
$28.91	3.364		
$31.10	3.437		
$33.32	3.506		
$32.21	3.472		
$32.21	3.472		
$31.92	3.463		
$26.65	3.283		
$35.54	3.571		
$33.32	3.506		
$33.32	3.506		
$55.53	4.017		
$36.65	3.601		
$31.10	3.437		
$33.32	3.506		
$33.32	3.506		
$28.38	3.346		
$28.88	3.363		
$33.32	3.506		
$36.65	3.601		

6-INCH WATER PIPE
Mean LN(Y)= 3.560
Std. Dev. LN(Y)= 0.324
Increment= 1

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$25.54	3.240		
$36.65	3.601		
$33.32	3.506		
$53.16	3.973		
$38.76	3.657		
$27.69	3.321		
$26.58	3.280		
$44.30	3.791		
$45.41	3.816		
$88.60	4.484		
$33.22	3.503		
$26.58	3.280		
$40.98	3.713		
$39.32	3.672		
$43.19	3.766		
$42.31	3.745		
$28.21	3.340		
$32.55	3.483		
$75.94	4.330		
$30.39	3.414		
$36.90	3.608		
$30.39	3.414		
$27.13	3.301		
$29.95	3.400		
$36.90	3.608		
$37.98	3.637		
$37.98	3.637		
$49.92	3.910		
$50.63	3.924		
$86.17	4.456		
$64.63	4.169		
$115.26	4.747		
$80.10	4.383		
$79.03	4.370		
$64.08	4.160		
$31.87	3.462		

6-INCH WATER PIPE
Mean LN(Y)= 3.560
Std. Dev. LN(Y)= 0.324
Increment= 1

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$36.12	3.587		
$29.75	3.393		
$27.62	3.319		
$37.18	3.616		
$47.80	3.867		
$24.31	3.191		
$25.37	3.234		
$27.48	3.314		
$27.48	3.314		
$29.60	3.388		
$39.11	3.666		
$27.47	3.313		
$34.86	3.551		
$28.00	3.332		
$31.69	3.456		
$41.20	3.718		
$29.58	3.387		
$26.89	3.292		
$25.31	3.231		
$29.53	3.385		
$31.64	3.454		
$47.45	3.860		
$47.45	3.860		
$31.64	3.454		
$34.80	3.550		
$42.18	3.742		
$28.47	3.349		
$70.65	4.258		
$147.64	4.995		
$24.25	3.189		
$28.47	3.349		
$24.25	3.189		
$31.64	3.454		
$27.42	3.311		
$28.84	3.362		
$32.69	3.487		

6-INCH WATER PIPE

Mean LN(Y)=	**3.560**		
Std. Dev. LN(Y)=	**0.324**		
	Increment=	1	

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$31.64	3.454		
$31.64	3.454		
$30.58	3.420		
$27.42	3.311		
$29.53	3.385		
$28.05	3.334		
$31.64	3.454		
$42.18	3.742		
$39.02	3.664		
$42.18	3.742		
$23.64	3.163		
$31.62	3.454		
$158.11	5.063		
$64.83	4.172		
$28.46	3.349		
$28.46	3.349		
$37.95	3.636		
$31.62	3.454		
$36.89	3.608		
$28.46	3.349		
$30.04	3.403		
$42.16	3.742		
$44.27	3.790		
$78.00	4.357		
$42.16	3.742		
$29.41	3.381		
$23.11	3.140		
$27.31	3.307		
$31.51	3.450		
$29.41	3.381		
$31.51	3.450		
$25.21	3.227		
$52.52	3.961		
$31.51	3.450		
$36.77	3.605		
$33.61	3.515		

6-INCH WATER PIPE

Mean LN(Y)= **3.560**

Std. Dev. LN(Y)= **0.324**

Increment= 1

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$28.36	3.345		
$31.51	3.450		

12-Inch Gate Valve with Cast Iron Box & Lid

Mean LN(Y)= **7.452** **Mean (Y)=** **$1,763.75**

Std. Dev. LN(Y)= **0.207** **Std. Dev. (Y)=** **$421.00**

Increment= 25

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.	Normal Dist. Cum. Prob.
$1,520.42	7.327	1000	0.43%	3.48%
$1,403.46	7.247	1025	0.61%	3.97%
$1,444.86	7.276	1050	0.84%	4.50%
$1,733.84	7.458	1075	1.13%	5.09%
$1,733.84	7.458	1100	1.51%	5.74%
$1,502.66	7.315	1125	1.97%	6.46%
$1,755.02	7.470	1150	2.54%	7.24%
$1,462.51	7.288	1175	3.22%	8.10%
$1,521.01	7.327	1200	4.02%	9.03%
$1,743.89	7.464	1225	4.96%	10.03%
$1,685.76	7.430	1250	6.04%	11.12%
$1,743.89	7.464	1275	7.28%	12.28%
$2,311.78	7.746	1300	8.66%	13.53%
$1,661.93	7.416	1325	10.21%	14.87%
$1,618.25	7.389	1350	11.91%	16.29%
$1,444.86	7.276	1375	13.77%	17.79%
$1,589.35	7.371	1400	15.77%	19.38%
$1,733.84	7.458	1425	17.92%	21.05%
$1,849.43	7.523	1450	20.20%	22.81%
$1,644.40	7.405	1475	22.60%	24.64%
$1,701.11	7.439	1500	25.12%	26.55%
$2,537.11	7.839	1525	27.72%	28.53%
$1,701.11	7.439	1550	30.41%	30.58%
$1,814.51	7.504	1575	33.17%	32.70%

12-Inch Gate Valve with Cast Iron Box & Lid

Mean LN(Y)=	**7.452**	**Mean (Y)=**	**$1,763.75**
Std. Dev. LN(Y)=	**0.207**	**Std. Dev. (Y)=**	**$421.00**

Increment= 25

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**	**Normal Dist. Cum. Prob.**
$1,871.22	7.534	1600	35.97%	34.87%
$1,417.59	7.257	1625	38.80%	37.09%
$1,247.48	7.129	1650	41.65%	39.35%
$2,891.88	7.970	1675	44.51%	41.65%
$2,041.33	7.621	1700	47.34%	43.98%
$1,453.76	7.282	1725	50.15%	46.33%
$1,341.93	7.202	1750	52.92%	48.70%
$2,404.30	7.785	1775	55.64%	51.07%
$1,677.42	7.425	1800	58.29%	53.43%
$1,677.42	7.425	1825	60.87%	55.78%
$1,562.85	7.354	1850	63.37%	58.12%
$1,786.11	7.488	1875	65.78%	60.42%
$1,451.21	7.280	1900	68.09%	62.69%
$1,709.08	7.444	1925	70.31%	64.91%
$1,562.85	7.354	1950	72.43%	67.09%
$1,507.03	7.318	1975	74.45%	69.21%
$1,674.48	7.423	2000	76.36%	71.27%
$1,618.66	7.389	2025	78.17%	73.26%
$1,668.25	7.420	2050	79.87%	75.17%
$3,558.93	8.177	2075	81.48%	77.01%
$1,668.25	7.420	2100	82.98%	78.78%
$1,666.84	7.419	2125	84.39%	80.46%
$1,555.71	7.350	2150	85.70%	82.06%
$1,777.96	7.483	2175	86.92%	83.57%
$1,555.71	7.350	2200	88.06%	85.00%
$1,555.71	7.350	2225	89.11%	86.34%
$2,889.18	7.969	2250	90.09%	87.60%
$1,684.53	7.429	2275	90.99%	88.77%
$1,556.66	7.350	2300	91.81%	89.86%
$1,667.85	7.419	2325	92.57%	90.88%
$1,667.85	7.419	2350	93.27%	91.81%
$2,001.42	7.602	2375	93.91%	92.67%
$1,779.04	7.484	2400	94.50%	93.46%
$1,667.85	7.419	2425	95.03%	94.19%
$1,776.99	7.483	2450	95.52%	94.85%
$1,665.93	7.418	2475	95.96%	95.44%
$1,665.93	7.418	2500	96.37%	95.98%

12-Inch Gate Valve with Cast Iron Box & Lid

Mean LN(Y)=	**7.452**	**Mean (Y)=**	**$1,763.75**
Std. Dev. LN(Y)=	**0.207**	**Std. Dev. (Y)=**	**$421.00**

Increment= 25

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.	Normal Dist. Cum. Prob.
$1,554.87	7.349	2525	96.73%	96.47%
$1,682.50	7.428	2550	97.07%	96.91%
$1,443.81	7.275	2575	97.37%	97.30%
$1,550.49	7.346	2600	97.64%	97.65%
$1,605.86	7.381	2625	97.89%	97.96%
$1,328.99	7.192	2650	98.11%	98.24%
$2,159.61	7.678	2675	98.31%	98.48%
$1,993.49	7.598	2700	98.49%	98.69%
$1,661.24	7.415	2725	98.65%	98.88%
$775.24	6.653	2750	98.79%	99.04%
$1,735.75	7.459	2775	98.92%	99.18%
$1,681.51	7.427	2800	99.04%	99.31%
$1,627.27	7.395			
$2,712.11	7.905			
$2,692.96	7.898			
$3,770.15	8.235			
$1,615.78	7.388			
$2,369.81	7.771			
$1,601.96	7.379			
$1,601.96	7.379			
$1,708.75	7.444			
$1,889.87	7.544			
$1,593.48	7.374			
$1,593.48	7.374			
$1,593.48	7.374			
$1,593.48	7.374			
$1,859.06	7.528			
$1,374.12	7.226			
$1,479.82	7.300			
$1,769.44	7.478			
$1,585.52	7.369			
$1,479.82	7.300			
$2,325.43	7.752			
$1,792.73	7.491			
$1,529.09	7.332			
$1,581.82	7.366			
$1,581.82	7.366			

12-Inch Gate Valve with Cast Iron Box & Lid

Mean LN(Y)=	**7.452**	**Mean (Y)=**	**$1,763.75**
Std. Dev. LN(Y)=	**0.207**	**Std. Dev. (Y)=**	**$421.00**

Increment= 25

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.	Normal Dist. Cum. Prob.
$1,476.37	7.297			
$1,845.46	7.520			
$1,054.55	6.961			
$1,529.09	7.332			
$1,608.18	7.383			
$1,740.00	7.462			
$1,581.82	7.366			
$1,476.37	7.297			
$2,109.09	7.654			
$2,056.37	7.629			
$2,320.00	7.749			
$2,109.09	7.654			
$1,687.27	7.431			
$3,269.10	8.092			
$1,476.37	7.297			
$1,581.82	7.366			
$1,634.55	7.399			
$1,581.82	7.366			
$1,370.91	7.223			
$1,687.27	7.431			
$1,581.82	7.366			
$1,581.82	7.366			
$1,681.11	7.427			
$1,581.15	7.366			
$2,635.25	7.877			
$1,581.15	7.366			
$2,002.79	7.602			
$1,680.72	7.427			
$1,838.29	7.517			
$1,744.80	7.464			
$1,680.72	7.427			
$1,575.68	7.362			
$1,680.72	7.427			
$1,838.29	7.517			
$2,416.04	7.790			

8-Inch Gate Valve with Cast Iron Box and Lid

Mean LN(Y)=	**6.893**	**Mean (Y)=**	**$1,004.26**
Std. Dev. LN(Y)=	**0.184**	**Std. Dev. (Y)=**	**$230.48**

Increment= 15

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**	**Normal Dist. Cum. Prob.**
$923.94	6.829	500	0.01%	1.43%
$795.29	6.679	515	0.02%	1.69%
$994.12	6.902	530	0.04%	1.98%
$994.12	6.902	545	0.07%	2.32%
$760.21	6.634	560	0.11%	2.70%
$701.73	6.554	575	0.17%	3.13%
$936.07	6.842	590	0.27%	3.61%
$994.57	6.902	605	0.40%	4.16%
$1,017.97	6.926	620	0.60%	4.77%
$820.30	6.710	635	0.85%	5.46%
$878.89	6.779	650	1.20%	6.21%
$1,171.86	7.066	665	1.64%	7.05%
$937.49	6.843	680	2.20%	7.97%
$1,171.86	7.066	695	2.91%	8.98%
$1,464.82	7.289	710	3.76%	10.09%
$849.60	6.745	725	4.79%	11.28%
$644.52	6.469	740	6.01%	12.58%
$1,307.79	7.176	755	7.42%	13.97%
$878.89	6.779	770	9.04%	15.47%
$878.85	6.779	785	10.87%	17.07%
$703.08	6.555	800	12.91%	18.77%
$937.44	6.843	815	15.16%	20.58%
$878.85	6.779	830	17.60%	22.48%
$819.01	6.708	845	20.23%	24.48%
$877.51	6.777	860	23.03%	26.57%
$936.01	6.842	875	25.98%	28.75%
$1,287.01	7.160	890	29.06%	31.00%
$1,046.33	6.953	905	32.25%	33.34%
$901.01	6.804	920	35.51%	35.73%
$1,046.33	6.953	935	38.83%	38.19%
$1,155.89	7.053	950	42.18%	40.69%
$831.24	6.723	965	45.53%	43.24%
$866.92	6.765	980	48.87%	45.81%
$809.12	6.696	995	52.16%	48.40%
$982.51	6.890	1010	55.38%	50.99%
$982.51	6.890	1025	58.53%	53.59%

8-Inch Gate Valve with Cast Iron Box and Lid

Mean LN(Y)=	**6.893**	**Mean (Y)=**	**$1,004.26**
Std. Dev. LN(Y)=	**0.184**	**Std. Dev. (Y)=**	**$230.48**

Increment= 15

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.	Normal Dist. Cum. Prob.
$982.51	6.890	1040	61.57%	56.16%
$1,155.89	7.053	1055	64.51%	58.71%
$809.12	6.696	1070	67.32%	61.23%
$1,618.25	7.389	1085	70.00%	63.70%
$809.12	6.696	1100	72.54%	66.11%
$1,040.30	6.947	1115	74.94%	68.46%
$1,250.57	7.131	1130	77.19%	70.73%
$809.12	6.696	1145	79.29%	72.93%
$809.12	6.696	1160	81.26%	75.04%
$866.92	6.765	1175	83.08%	77.06%
$749.61	6.620	1190	84.76%	78.98%
$2,421.83	7.792	1205	86.30%	80.81%
$922.60	6.827	1220	87.72%	82.54%
$1,037.93	6.945	1235	89.02%	84.16%
$922.60	6.827	1250	90.20%	85.68%
$1,960.53	7.581	1265	91.28%	87.10%
$921.78	6.826	1280	92.25%	88.42%
$806.56	6.693	1295	93.13%	89.64%
$864.17	6.762	1310	93.92%	90.77%
$864.17	6.762	1325	94.63%	91.80%
$963.96	6.871	1340	95.26%	92.74%
$1,134.07	7.034	1355	95.83%	93.60%
$1,531.96	7.334	1370	96.34%	94.37%
$1,020.66	6.928	1385	96.79%	95.07%
$986.64	6.894	1400	97.19%	95.70%
$963.96	6.871	1415	97.54%	96.26%
$963.96	6.871	1430	97.85%	96.76%
$1,020.66	6.928	1445	98.13%	97.21%
$1,077.37	6.982	1460	98.37%	97.60%
$1,009.32	6.917	1475	98.58%	97.94%
$801.14	6.686	1490	98.77%	98.25%
$1,020.66	6.928	1505	98.93%	98.51%
$1,088.71	6.993	1520	99.07%	98.74%
$1,077.37	6.982	1535	99.20%	98.94%
$963.96	6.871	1550	99.31%	99.11%
$907.26	6.810	1565	99.40%	99.25%
$963.96	6.871	1580	99.49%	99.38%
$1,247.48	7.129			

8-Inch Gate Valve with Cast Iron Box and Lid

Mean LN(Y)=	**6.893**	**Mean (Y)=**	**$1,004.26**
Std. Dev. LN(Y)=	**0.184**	**Std. Dev. (Y)=**	**$230.48**

Increment= 15

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.	Normal Dist. Cum. Prob.
$938.53	6.844			
$706.72	6.561			
$848.06	6.743			
$881.99	6.782			
$995.06	6.903			
$773.44	6.651			
$1,047.08	6.954			
$997.92	6.906			
$920.34	6.825			
$950.54	6.857			
$894.62	6.796			
$796.21	6.680			
$950.54	6.857			
$838.71	6.732			
$1,006.45	6.914			
$1,453.76	7.282			
$1,006.45	6.914			
$1,006.45	6.914			
$782.79	6.663			
$1,453.76	7.282			
$978.49	6.886			
$866.66	6.765			
$906.90	6.810			
$955.01	6.862			
$812.99	6.701			
$1,341.93	7.202			
$1,230.10	7.115			
$894.62	6.796			
$782.79	6.663			
$893.05	6.795			
$893.05	6.795			
$1,004.69	6.912			
$781.42	6.661			
$893.05	6.795			
$1,423.31	7.261			
$837.24	6.730			
$1,032.59	6.940			
$893.05	6.795			

8-Inch Gate Valve with Cast Iron Box and Lid

Mean LN(Y)=	**6.893**	**Mean (Y)=**	**$1,004.26**
Std. Dev. LN(Y)=	**0.184**	**Std. Dev. (Y)=**	**$230.48**

Increment= 15

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.	Normal Dist. Cum. Prob.
$977.89	6.885			
$948.87	6.855			
$781.42	6.661			
$837.24	6.730			
$948.87	6.855			
$1,004.69	6.912			
$893.05	6.795			
$837.24	6.730			
$781.42	6.661			
$893.05	6.795			
$893.05	6.795			
$837.24	6.730			
$923.20	6.828			
$893.05	6.795			
$1,004.69	6.912			
$781.42	6.661			
$893.05	6.795			
$837.24	6.730			
$948.87	6.855			
$1,112.16	7.014			
$1,890.68	7.545			
$889.73	6.791			
$944.99	6.851			
$975.01	6.882			
$944.99	6.851			
$778.23	6.657			
$1,083.96	6.988			
$944.99	6.851			
$834.93	6.727			
$778.23	6.657			
$1,056.17	6.962			
$888.98	6.790			
$833.42	6.726			
$1,000.10	6.908			
$888.98	6.790			
$911.20	6.815			
$1,555.71	7.350			
$1,223.09	7.109			

8-Inch Gate Valve with Cast Iron Box and Lid

Mean LN(Y)=	**6.893**	**Mean (Y)=**	**$1,004.26**
Std. Dev. LN(Y)=	**0.184**	**Std. Dev. (Y)=**	**$230.48**

Increment= 15

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.	Normal Dist. Cum. Prob.
$1,312.04	7.179			
$1,111.90	7.014			
$1,000.71	6.908			
$1,056.31	6.963			
$889.52	6.791			
$1,049.63	6.956			
$991.82	6.900			
$889.52	6.791			
$945.12	6.851			
$833.93	6.726			
$1,056.31	6.963			
$1,000.71	6.908			
$889.52	6.791			
$944.03	6.850			
$944.03	6.850			
$944.03	6.850			
$888.50	6.790			
$970.50	6.878			
$888.50	6.790			
$944.03	6.850			
$999.56	6.907			
$1,021.77	6.929			
$1,221.68	7.108			
$1,332.74	7.195			
$932.92	6.838			
$888.50	6.790			
$944.03	6.850			
$944.03	6.850			
$888.50	6.790			
$1,055.09	6.961			
$944.03	6.850			
$944.03	6.850			
$1,110.62	7.013			
$988.45	6.896			
$996.74	6.904			
$1,328.99	7.192			
$1,107.49	7.010			
$1,328.99	7.192			

8-Inch Gate Valve with Cast Iron Box and Lid

Mean LN(Y)=	**6.893**	**Mean (Y)=**	**$1,004.26**
Std. Dev. LN(Y)=	**0.184**	**Std. Dev. (Y)=**	**$230.48**

Increment= 15

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.	Normal Dist. Cum. Prob.
$1,107.49	7.010			
$1,084.84	6.989			
$976.36	6.884			
$976.36	6.884			
$1,301.81	7.172			
$976.73	6.884			
$976.73	6.884			
$976.73	6.884			
$868.20	6.766			
$913.78	6.818			
$922.46	6.827			
$976.73	6.884			
$976.73	6.884			
$1,716.88	7.448			
$1,400.34	7.244			
$1,615.78	7.388			
$1,077.19	6.982			
$1,292.62	7.164			
$1,014.57	6.922			
$907.78	6.811			
$1,067.97	6.974			
$1,062.32	6.968			
$902.97	6.806			
$849.86	6.745			
$902.97	6.806			
$902.97	6.806			
$1,035.76	6.943			
$845.61	6.740			
$819.19	6.708			
$1,003.11	6.911			
$1,004.16	6.912			
$951.31	6.858			
$1,057.02	6.963			
$897.99	6.800			
$950.82	6.857			
$892.71	6.794			
$897.99	6.800			
$950.82	6.857			

8-Inch Gate Valve with Cast Iron Box and Lid

Mean LN(Y)=	**6.893**	**Mean (Y)=**	**$1,004.26**
Std. Dev. LN(Y)=	**0.184**	**Std. Dev. (Y)=**	**$230.48**

Increment= 15

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.	Normal Dist. Cum. Prob.
$1,135.70	7.035			
$1,044.00	6.951			
$1,054.55	6.961			
$1,054.55	6.961			
$949.09	6.856			
$1,001.82	6.910			
$1,054.55	6.961			
$950.15	6.857			
$1,001.82	6.910			
$896.36	6.798			
$843.64	6.738			
$887.93	6.789			
$949.09	6.856			
$949.09	6.856			
$896.36	6.798			
$1,054.55	6.961			
$1,054.55	6.961			
$1,687.27	7.431			
$1,054.55	6.961			
$949.09	6.856			
$2,805.09	7.939			
$843.64	6.738			
$896.36	6.798			
$896.36	6.798			
$896.36	6.798			
$896.36	6.798			
$975.46	6.883			
$948.69	6.855			
$1,054.10	6.960			
$1,054.10	6.960			
$1,054.10	6.960			
$1,001.39	6.909			
$1,001.39	6.909			
$895.98	6.798			
$922.34	6.827			
$895.98	6.798			
$1,343.98	7.203			
$948.69	6.855			

8-Inch Gate Valve with Cast Iron Box and Lid

Mean LN(Y)=	**6.893**	**Mean (Y)=**	**$1,004.26**
Std. Dev. LN(Y)=	**0.184**	**Std. Dev. (Y)=**	**$230.48**

Increment= 15

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.	Normal Dist. Cum. Prob.
$1,054.10	6.960			
$895.98	6.798			
$1,159.51	7.056			
$997.93	6.906			
$997.93	6.906			
$1,015.79	6.923			
$945.41	6.852			
$892.88	6.794			
$892.88	6.794			
$1,071.46	6.977			
$1,418.11	7.257			
$892.88	6.794			
$945.41	6.852			
$997.93	6.906			
$1,050.45	6.957			
$908.64	6.812			

6-Inch Gate Valve with Cast Iron Box and Lid

Mean LN(Y)=	**6.631**	**Mean (Y)=**	**$777.98**
Std. Dev. LN(Y)=	**0.211**	**Std. Dev. (Y)=**	**$213.55**

Increment= 15

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.	Normal Dist. Cum. Prob.
$761.67	6.636	350	0.01%	2.25%
$585.90	6.373	365	0.03%	2.66%
$703.08	6.555	380	0.05%	3.12%
$644.49	6.468	395	0.10%	3.65%
$573.31	6.351	410	0.18%	4.24%
$760.51	6.634	425	0.31%	4.92%
$585.01	6.372	440	0.50%	5.67%
$643.51	6.467	455	0.78%	6.52%

6-Inch Gate Valve with Cast Iron Box and Lid

Mean LN(Y)=	**6.631**	**Mean (Y)=**	**$777.98**
Std. Dev. LN(Y)=	**0.211**	**Std. Dev. (Y)=**	**$213.55**

Increment= 15

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.	Normal Dist. Cum. Prob.
$760.51	6.634	470	1.18%	7.46%
$555.76	6.320	485	1.72%	8.50%
$643.51	6.467	500	2.43%	9.65%
$755.69	6.628	515	3.35%	10.91%
$755.69	6.628	530	4.50%	12.28%
$697.56	6.548	545	5.90%	13.76%
$924.71	6.829	560	7.56%	15.37%
$627.96	6.442	575	9.51%	17.09%
$751.33	6.622	590	11.74%	18.94%
$549.05	6.308	605	14.25%	20.90%
$751.33	6.622	620	17.02%	22.97%
$751.33	6.622	635	20.04%	25.16%
$722.43	6.583	650	23.29%	27.45%
$924.71	6.829	665	26.71%	29.84%
$693.53	6.542	680	30.30%	32.32%
$1,271.48	7.148	695	34.00%	34.88%
$577.95	6.359	710	37.77%	37.51%
$751.33	6.622	725	41.59%	40.20%
$866.92	6.765	740	45.40%	42.94%
$577.95	6.359	755	49.18%	45.72%
$577.95	6.359	770	52.89%	48.51%
$577.95	6.359	785	56.51%	51.31%
$634.29	6.453	800	60.01%	54.11%
$2,191.18	7.692	815	63.36%	56.88%
$691.95	6.540	830	66.56%	59.62%
$749.61	6.620	845	69.59%	62.32%
$807.28	6.694	860	72.44%	64.95%
$1,037.93	6.945	875	75.10%	67.52%
$691.34	6.539	890	77.58%	70.01%
$576.11	6.356	905	79.88%	72.40%
$633.72	6.452	920	81.99%	74.70%
$622.20	6.433	935	83.93%	76.89%
$793.85	6.677	950	85.70%	78.97%
$1,020.66	6.928	965	87.31%	80.94%
$1,218.13	7.105	980	88.77%	82.79%

6-Inch Gate Valve with Cast Iron Box and Lid

Mean LN(Y)=	**6.631**	**Mean (Y)=**	**$777.98**
Std. Dev. LN(Y)=	**0.211**	**Std. Dev. (Y)=**	**$213.55**

Increment= 15

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.	Normal Dist. Cum. Prob.
$680.44	6.523	995	90.08%	84.53%
$686.11	6.531	1010	91.26%	86.14%
$680.44	6.523	1025	92.32%	87.63%
$708.79	6.564	1040	93.26%	89.01%
$680.44	6.523	1055	94.10%	90.27%
$793.85	6.677	1070	94.85%	91.43%
$703.12	6.556	1085	95.51%	92.47%
$595.39	6.389	1100	96.09%	93.42%
$680.44	6.523	1115	96.60%	94.27%
$759.83	6.633	1130	97.05%	95.04%
$765.50	6.641	1145	97.45%	95.72%
$850.55	6.746	1160	97.79%	96.32%
$623.74	6.436	1175	98.09%	96.85%
$737.15	6.603	1190	98.36%	97.32%
$907.26	6.810	1205	98.58%	97.72%
$723.27	6.584	1220	98.78%	98.08%
$730.23	6.593	1235	98.95%	98.38%
$698.92	6.550	1250	99.10%	98.65%
$643.01	6.466	1265	99.23%	98.87%
$611.70	6.416	1280	99.34%	99.06%
$726.88	6.589	1295	99.44%	99.23%
$615.05	6.422	1310	99.52%	99.36%
$894.62	6.796	1325	99.59%	99.48%
$1,090.32	6.994	1340	99.65%	99.58%
$782.79	6.663	1355	99.70%	99.66%
$782.79	6.663	1370	99.74%	99.72%
$669.79	6.507	1385	99.78%	99.78%
$669.79	6.507	1400	99.82%	99.82%
$781.42	6.661	1415	99.84%	99.86%
$558.16	6.325	1430	99.87%	99.89%
$669.79	6.507			
$1,116.32	7.018			
$725.61	6.587			
$781.42	6.661			
$502.34	6.219			

6-Inch Gate Valve with Cast Iron Box and Lid

Mean LN(Y)=	**6.631**	**Mean (Y)=**	**$777.98**
Std. Dev. LN(Y)=	**0.211**	**Std. Dev. (Y)=**	**$213.55**

Increment= 15

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.	Normal Dist. Cum. Prob.
$785.89	6.667			
$725.61	6.587			
$558.16	6.325			
$613.97	6.420			
$725.61	6.587			
$781.42	6.661			
$669.79	6.507			
$725.61	6.587			
$558.16	6.325			
$669.79	6.507			
$669.79	6.507			
$725.61	6.587			
$731.19	6.595			
$669.79	6.507			
$781.42	6.661			
$558.16	6.325			
$669.79	6.507			
$613.97	6.420			
$725.61	6.587			
$889.73	6.791			
$1,557.03	7.351			
$667.30	6.503			
$694.85	6.544			
$778.23	6.657			
$694.85	6.544			
$889.41	6.791			
$1,000.58	6.908			
$667.05	6.503			
$644.82	6.469			
$667.05	6.503			
$722.64	6.583			
$666.73	6.502			
$722.30	6.582			
$777.86	6.657			
$666.73	6.502			

6-Inch Gate Valve with Cast Iron Box and Lid

Mean LN(Y)=	**6.631**	**Mean (Y)=**	**$777.98**
Std. Dev. LN(Y)=	**0.211**	**Std. Dev. (Y)=**	**$213.55**

Increment= 15

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**	**Normal Dist. Cum. Prob.**
$666.73	6.502			
$1,222.35	7.109			
$1,111.90	7.014			
$1,178.62	7.072			
$889.52	6.791			
$778.33	6.657			
$833.93	6.726			
$667.14	6.503			
$771.66	6.649			
$772.77	6.650			
$678.26	6.520			
$833.93	6.726			
$722.74	6.583			
$722.74	6.583			
$667.14	6.503			
$667.14	6.503			
$677.48	6.518			
$777.43	6.656			
$683.03	6.527			
$666.37	6.502			
$729.68	6.593			
$666.37	6.502			
$777.43	6.656			
$777.43	6.656			
$799.65	6.684			
$1,110.62	7.013			
$999.56	6.907			
$666.37	6.502			
$666.37	6.502			
$832.97	6.725			
$721.90	6.582			
$666.37	6.502			
$832.97	6.725			
$721.90	6.582			
$721.90	6.582			

6-Inch Gate Valve with Cast Iron Box and Lid

Mean LN(Y)=	**6.631**	**Mean (Y)=**	**$777.98**
Std. Dev. LN(Y)=	**0.211**	**Std. Dev. (Y)=**	**$213.55**

Increment= 15

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.	Normal Dist. Cum. Prob.
$777.43	6.656			
$744.12	6.612			
$609.12	6.412			
$719.87	6.579			
$775.24	6.653			
$664.50	6.499			
$719.87	6.579			
$775.24	6.653			
$332.25	5.806			
$808.47	6.695			
$1,107.49	7.010			
$885.99	6.787			
$1,107.49	7.010			
$775.24	6.653			
$922.12	6.827			
$759.39	6.633			
$867.88	6.766			
$867.88	6.766			
$759.68	6.633			
$705.41	6.559			
$759.68	6.633			
$651.15	6.479			
$685.88	6.531			
$813.94	6.702			
$868.20	6.766			
$759.68	6.633			
$1,395.64	7.241			
$969.47	6.877			
$1,400.34	7.244			
$861.75	6.759			
$969.47	6.877			
$800.98	6.686			
$694.18	6.543			
$854.38	6.750			
$743.63	6.612			

6-Inch Gate Valve with Cast Iron Box and Lid

Mean LN(Y)=	**6.631**	**Mean (Y)=**	**$777.98**
Std. Dev. LN(Y)=	**0.211**	**Std. Dev. (Y)=**	**$213.55**

Increment= 15

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**	**Normal Dist. Cum. Prob.**
$796.74	6.681			
$637.39	6.457			
$637.39	6.457			
$796.74	6.681			
$796.74	6.681			
$634.21	6.452			
$739.91	6.607			
$895.29	6.797			
$739.91	6.607			
$845.61	6.740			
$687.06	6.532			
$686.70	6.532			
$686.70	6.532			
$697.27	6.547			
$792.35	6.675			
$686.70	6.532			
$818.76	6.708			
$790.91	6.673			
$843.64	6.738			
$790.91	6.673			
$843.64	6.738			
$738.18	6.604			
$711.82	6.568			
$632.73	6.450			
$664.36	6.499			
$790.91	6.673			
$790.91	6.673			
$738.18	6.604			
$1,001.82	6.910			
$843.64	6.738			
$712.87	6.569			
$750.84	6.621			
$790.91	6.673			
$711.82	6.568			
$749.78	6.620			

6-Inch Gate Valve with Cast Iron Box and Lid

Mean LN(Y)=	**6.631**	**Mean (Y)=**	**$777.98**
Std. Dev. LN(Y)=	**0.211**	**Std. Dev. (Y)=**	**$213.55**

Increment= 15

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.	Normal Dist. Cum. Prob.
$817.27	6.706			
$632.73	6.450			
$790.91	6.673			
$949.09	6.856			
$790.91	6.673			
$1,581.82	7.366			
$843.64	6.738			
$664.36	6.499			
$2,573.09	7.853			
$632.73	6.450			
$685.46	6.530			
$738.18	6.604			
$674.91	6.515			
$790.91	6.673			
$685.46	6.530			
$685.46	6.530			
$896.36	6.798			
$635.63	6.455			
$843.28	6.737			
$774.76	6.653			
$790.57	6.673			
$790.57	6.673			
$685.16	6.530			
$643.00	6.466			
$1,054.10	6.960			
$843.28	6.737			
$632.46	6.450			
$685.16	6.530			
$843.28	6.737			
$787.84	6.669			
$735.32	6.600			
$801.49	6.686			
$761.58	6.635			
$787.84	6.669			
$630.27	6.446			

6-Inch Gate Valve with Cast Iron Box and Lid

Mean LN(Y)=	**6.631**	**Mean (Y)=**	**$777.98**
Std. Dev. LN(Y)=	**0.211**	**Std. Dev. (Y)=**	**$213.55**

Increment= 15

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.	Normal Dist. Cum. Prob.
$816.20	6.705			
$1,260.54	7.139			
$787.84	6.669			
$682.79	6.526			
$735.32	6.600			
$793.09	6.676			
$685.95	6.531			

Ductile Iron Fittings

Mean LN(Y)=	**8.301**	**Mean (Y)=**	**$4,419.48**
Std. Dev. LN(Y)=	**0.508**	**Std. Dev. (Y)=**	**$1,547.18**

Increment= 50

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.	Normal Dist. Cum. Prob.
$4,736.68	8.463	1000	0.31%	1.35%
$3,508.65	8.163	1050	0.41%	1.47%
$5,344.85	8.584	1100	0.53%	1.60%
$5,262.98	8.568	1150	0.68%	1.73%
$5,029.07	8.523	1200	0.86%	1.87%
$4,678.20	8.451	1250	1.06%	2.03%
$4,093.43	8.317	1300	1.30%	2.19%
$4,983.45	8.514	1350	1.57%	2.36%
$4,970.59	8.511	1400	1.88%	2.55%
$4,912.11	8.499	1450	2.22%	2.75%
$3,508.65	8.163	1500	2.59%	2.96%
$4,678.20	8.451	1550	3.01%	3.18%
$4,797.34	8.476	1600	3.46%	3.42%
$5,031.36	8.523	1650	3.95%	3.67%
$5,212.72	8.559	1700	4.48%	3.94%
$5,148.37	8.546	1750	5.04%	4.22%
$4,797.34	8.476	1800	5.65%	4.52%

Ductile Iron Fittings

Mean LN(Y)=	**8.301**	**Mean (Y)=**	**$4,419.48**
Std. Dev. LN(Y)=	**0.508**	**Std. Dev. (Y)=**	**$1,547.18**

Increment= 50

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.	Normal Dist. Cum. Prob.
$5,031.36	8.523	1850	6.29%	4.84%
$5,212.72	8.559	1900	6.96%	5.17%
$4,101.50	8.319	1950	7.67%	5.52%
$3,515.57	8.165	2000	8.41%	5.89%
$4,687.43	8.453	2050	9.19%	6.28%
$5,273.36	8.570	2100	10.00%	6.69%
$2,695.27	7.899	2150	10.83%	7.12%
$2,925.03	7.981	2200	11.70%	7.57%
$2,808.03	7.940	2250	12.59%	8.04%
$5,850.06	8.674	2300	13.51%	8.54%
$4,650.38	8.445	2350	14.45%	9.05%
$5,231.67	8.562	2400	15.41%	9.59%
$5,231.67	8.562	2450	16.40%	10.15%
$3,467.67	8.151	2500	17.40%	10.74%
$4,925.25	8.502	2550	18.42%	11.35%
$4,161.21	8.334	2600	19.45%	11.98%
$5,895.05	8.682	2650	20.50%	12.64%
$4,970.33	8.511	2700	21.56%	13.32%
$2,889.73	7.969	2750	22.64%	14.03%
$5,779.46	8.662	2800	23.72%	14.76%
$2,542.96	7.841	2850	24.81%	15.52%
$3,467.67	8.151	2900	25.90%	16.30%
$3,467.67	8.151	2950	27.00%	17.11%
$6,935.35	8.844	3000	28.11%	17.95%
$4,623.57	8.439	3050	29.22%	18.80%
$4,276.80	8.361	3100	30.32%	19.69%
$4,496.42	8.411	3150	31.43%	20.60%
$5,779.46	8.662	3200	32.54%	21.53%
$6,357.40	8.757	3250	33.65%	22.49%
$5,189.63	8.554	3300	34.75%	23.47%
$4,613.00	8.437	3350	35.85%	24.47%
$4,036.38	8.303	3400	36.95%	25.50%
$8,072.76	8.996	3450	38.04%	26.55%
$3,459.75	8.149	3500	39.12%	27.62%
$4,613.00	8.437	3550	40.20%	28.71%
$5,761.13	8.659	3600	41.26%	29.82%
$4,608.90	8.436	3650	42.32%	30.95%
$4,839.35	8.485	3700	43.38%	32.10%

Ductile Iron Fittings

Mean LN(Y)=	**8.301**	**Mean (Y)=**	**$4,419.48**
Std. Dev. LN(Y)=	**0.508**	**Std. Dev. (Y)=**	**$1,547.18**

Increment= 50

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.	Normal Dist. Cum. Prob.
$4,954.57	8.508	3750	44.42%	33.26%
$5,670.35	8.643	3800	45.45%	34.44%
$5,670.35	8.643	3850	46.47%	35.64%
$5,316.52	8.579	3900	47.48%	36.85%
$4,989.91	8.515	3950	48.48%	38.08%
$5,018.26	8.521	4000	49.47%	39.31%
$4,763.09	8.469	4050	50.44%	40.56%
$3,629.02	8.197	4100	51.40%	41.82%
$4,989.91	8.515	4150	52.36%	43.09%
$5,103.32	8.538	4200	53.29%	44.36%
$5,126.00	8.542	4250	54.22%	45.64%
$3,685.73	8.212	4300	55.13%	46.92%
$6,804.42	8.825	4350	56.03%	48.21%
$4,309.47	8.369	4400	56.92%	49.50%
$4,536.28	8.420	4450	57.79%	50.79%
$3,402.21	8.132	4500	58.65%	52.08%
$6,010.57	8.701	4550	59.49%	53.36%
$4,082.65	8.315	4600	60.32%	54.64%
$4,989.91	8.515	4650	61.14%	55.92%
$3,279.18	8.095	4700	61.95%	57.19%
$3,392.26	8.129	4750	62.74%	58.46%
$5,088.39	8.535	4800	63.51%	59.71%
$3,799.33	8.243	4850	64.28%	60.96%
$4,466.47	8.404	4900	65.03%	62.19%
$1,967.51	7.585	4950	65.76%	63.42%
$4,805.70	8.478	5000	66.49%	64.62%
$2,464.54	7.810	5050	67.20%	65.82%
$4,763.86	8.469	5100	67.90%	67.00%
$5,032.25	8.524	5150	68.58%	68.16%
$5,255.90	8.567	5200	69.25%	69.30%
$4,584.94	8.431	5250	69.91%	70.43%
$2,795.69	7.936	5300	70.56%	71.54%
$5,703.21	8.649	5350	71.19%	72.62%
$3,354.83	8.118	5400	71.81%	73.69%
$5,032.25	8.524	5450	72.42%	74.73%
$782.79	6.663	5500	73.02%	75.75%
$6,709.66	8.811	5550	73.61%	76.75%
$4,945.02	8.506	5600	74.18%	77.73%

Ductile Iron Fittings

Mean LN(Y)=	**8.301**	**Mean (Y)=**	**$4,419.48**
Std. Dev. LN(Y)=	**0.508**	**Std. Dev. (Y)=**	**$1,547.18**

Increment= 50

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.	Normal Dist. Cum. Prob.
$5,043.43	8.526	5650	74.74%	78.68%
$4,846.61	8.486	5700	75.29%	79.61%
$2,236.55	7.713	5750	75.83%	80.51%
$5,591.39	8.629	5800	76.36%	81.39%
$5,579.64	8.627	5850	76.88%	82.24%
$5,581.59	8.627	5900	77.39%	83.07%
$5,581.59	8.627	5950	77.88%	83.87%
$6,474.64	8.776	6000	78.37%	84.65%
$2,232.64	7.711	6050	78.84%	85.40%
$2,567.53	7.851	6100	79.31%	86.13%
$6,139.75	8.723	6150	79.77%	86.83%
$3,348.95	8.116	6200	80.21%	87.51%
$558.16	6.325	6250	80.65%	88.16%
$5,581.59	8.627	6300	81.08%	88.79%
$4,863.80	8.490	6350	81.50%	89.39%
$5,023.43	8.522	6400	81.90%	89.97%
$3,907.11	8.271	6450	82.31%	90.53%
$1,116.32	7.018	6500	82.70%	91.06%
$4,018.74	8.299	6550	83.08%	91.57%
$558.16	6.325	6600	83.46%	92.06%
$5,581.59	8.627	6650	83.82%	92.53%
$3,348.95	8.116	6700	84.18%	92.98%
$5,023.43	8.522	6750	84.53%	93.40%
$5,581.59	8.627	6800	84.87%	93.81%
$4,465.27	8.404	6850	85.21%	94.19%
$3,348.95	8.116	6900	85.54%	94.56%
$4,852.63	8.487	6950	85.86%	94.90%
$5,581.59	8.627	7000	86.17%	95.23%
$558.16	6.325	7050	86.48%	95.55%
$2,232.64	7.711	7100	86.78%	95.84%
$4,465.27	8.404	7150	87.07%	96.12%
$446.53	6.102	7200	87.36%	96.38%
$3,348.95	8.116	7250	87.64%	96.63%
$4,448.66	8.400	7300	87.91%	96.87%
$7,006.64	8.855	7350	88.18%	97.09%
$4,448.66	8.400	7400	88.44%	97.30%
$5,336.43	8.582	7450	88.70%	97.49%
$5,565.45	8.624	7500	88.95%	97.68%

Ductile Iron Fittings

Mean LN(Y)=	**8.301**	**Mean (Y)=**	**$4,419.48**
Std. Dev. LN(Y)=	**0.508**	**Std. Dev. (Y)=**	**$1,547.18**

Increment= 50

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.	Normal Dist. Cum. Prob.
$5,002.90	8.518	7550	89.20%	97.85%
$5,558.78	8.623	7600	89.43%	98.01%
$4,891.73	8.495	7650	89.67%	98.16%
$1,111.76	7.014	7700	89.90%	98.30%
$4,530.41	8.419	7750	90.12%	98.43%
$4,335.85	8.375	7800	90.34%	98.56%
$3,335.27	8.112	7850	90.55%	98.67%
$5,000.51	8.517	7900	90.76%	98.78%
$3,333.67	8.112	7950	90.97%	98.88%
$555.61	6.320	8000	91.16%	98.97%
$5,556.12	8.623	8050	91.36%	99.05%
$4,667.14	8.448	8100	91.55%	99.13%
$8,889.80	9.093	8150	91.74%	99.20%
$5,114.75	8.540	8200	91.92%	99.27%
$5,559.51	8.623	8250	92.10%	99.34%
$5,559.51	8.623	8300	92.27%	99.39%
$4,447.60	8.400	8350	92.44%	99.45%
$5,337.13	8.582	8400	92.61%	99.50%
$5,003.55	8.518	8450	92.77%	99.54%
$5,312.66	8.578	8500	92.93%	99.58%
$4,935.73	8.504	8550	93.08%	99.62%
$4,336.41	8.375	8600	93.23%	99.66%
$3,335.70	8.112	8650	93.38%	99.69%
$5,559.51	8.623	8700	93.52%	
$4,447.60	8.400	8750	93.67%	
$5,559.51	8.623	8800	93.80%	
$4,447.60	8.400	8850	93.94%	
$4,442.48	8.399	8900	94.07%	
$2,776.55	7.929	8950	94.20%	
$1,110.62	7.013	9000	94.33%	
$4,442.48	8.399	9050	94.45%	
$4,153.72	8.332	9100	94.57%	
$5,553.10	8.622	9150	94.69%	
$5,553.10	8.622	9200	94.80%	
$5,219.91	8.560	9250	94.92%	
$5,242.13	8.564	9300	95.03%	
$6,108.41	8.717	9350	95.13%	
$555.31	6.320	9400	95.24%	

Ductile Iron Fittings

Mean LN(Y)=	**8.301**	**Mean (Y)=**	**$4,419.48**
Std. Dev. LN(Y)=	**0.508**	**Std. Dev. (Y)=**	**$1,547.18**

Increment= 50

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.	Normal Dist. Cum. Prob.
$4,664.60	8.448	9450	95.34%	
$5,553.10	8.622	9500	95.44%	
$3,331.86	8.111	9550	95.54%	
$4,997.79	8.517	9600	95.64%	
$5,553.10	8.622	9650	95.73%	
$3,887.17	8.265	9700	95.82%	
$4,997.79	8.517	9750	95.91%	
$4,331.42	8.374	9800	96.00%	
$5,997.35	8.699	9850	96.08%	
$5,553.10	8.622	9900	96.17%	
$2,214.98	7.703	9950	96.25%	
$4,429.97	8.396	10000	96.33%	
$3,322.48	8.108	10050	96.41%	
$5,537.46	8.619	10100	96.48%	
$3,100.98	8.039	10150	96.56%	
$5,537.46	8.619	10200	96.63%	
$1,107.49	7.010	10250	96.70%	
$3,876.22	8.263	10300	96.77%	
$5,537.46	8.619	10350	96.84%	
$4,817.59	8.480	10400	96.91%	
$6,091.20	8.715	10450	96.97%	
$5,758.96	8.659	10500	97.04%	
$8,858.42	9.089	10550	97.10%	
$8,858.42	9.089	10600	97.16%	
$7,197.47	8.881	10650	97.22%	
$3,211.18	8.074	10700	97.28%	
$4,881.80	8.493	10750	97.34%	
$5,966.65	8.694	10800	97.39%	
$5,424.22	8.599	10850	97.45%	
$5,858.16	8.676	10900	97.50%	
$3,364.28	8.121	10950	97.55%	
$3,038.70	8.019	11000	97.60%	
$3,798.38	8.242	11050	97.65%	
$1,085.25	6.990	11100	97.70%	
$3,201.49	8.071	11150	97.75%	
$3,255.75	8.088	11200	97.80%	
$6,678.55	8.807	11250	97.84%	
$4,308.74	8.368	11300	97.89%	

Ductile Iron Fittings

Mean LN(Y)=	**8.301**	**Mean (Y)=**	**$4,419.48**
Std. Dev. LN(Y)=	**0.508**	**Std. Dev. (Y)=**	**$1,547.18**

Increment= 50

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.	Normal Dist. Cum. Prob.
$4,308.74	8.368	11350	97.93%	
$7,540.30	8.928	11400	97.97%	
$1,334.96	7.197	11450	98.01%	
$8,009.78	8.988	11500	98.06%	
$3,203.91	8.072	11550	98.10%	
$2,868.27	7.961	11600	98.13%	
$3,186.97	8.067	11650	98.17%	
$5,311.61	8.578	11700	98.21%	
$4,780.45	8.472	11750	98.25%	
$3,186.97	8.067	11800	98.28%	
$6,639.51	8.801	11850	98.32%	
$4,331.50	8.374	11900	98.35%	
$4,542.80	8.421	11950	98.39%	
$4,437.15	8.398	12000	98.42%	
$3,169.39	8.061	12050	98.45%	
$5,493.62	8.611	12100	98.48%	
$6,296.53	8.748	12150	98.51%	
$527.27	6.268	12200	98.54%	
$5,272.73	8.570	12250	98.57%	
$3,163.64	8.059	12300	98.60%	
$3,163.64	8.059			
$4,218.19	8.347			
$4,745.46	8.465			
$3,690.91	8.214			
$4,429.10	8.396			
$4,178.11	8.338			
$4,397.46	8.389			
$3,163.64	8.059			
$4,481.82	8.408			
$4,719.10	8.459			
$4,481.82	8.408			
$5,061.82	8.529			
$3,163.64	8.059			
$3,163.64	8.059			
$4,429.10	8.396			
$3,163.64	8.059			
$4,745.46	8.465			
$4,007.28	8.296			

Ductile Iron Fittings

Mean LN(Y)=	**8.301**	**Mean (Y)=**	**$4,419.48**
Std. Dev. LN(Y)=	**0.508**	**Std. Dev. (Y)=**	**$1,547.18**

Increment= 50

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.	Normal Dist. Cum. Prob.
$3,690.91	8.214			
$3,901.82	8.269			
$2,952.73	7.990			
$3,928.19	8.276			
$3,690.91	8.214			
$527.27	6.268			
$1,054.55	6.961			
$4,218.19	8.347			
$5,869.08	8.677			
$3,689.34	8.213			
$4,005.57	8.295			
$4,427.21	8.396			
$4,743.44	8.465			
$4,437.75	8.398			
$4,216.39	8.347			
$3,689.34	8.213			
$1,054.10	6.960			
$3,162.29	8.059			
$12,485.79	9.432			
$3,689.34	8.213			
$4,216.39	8.347			
$7,378.69	8.906			
$3,794.75	8.241			
$4,411.90	8.392			
$4,727.03	8.461			
$4,052.64	8.307			
$5,042.17	8.526			
$3,361.45	8.120			
$3,046.31	8.022			
$4,359.38	8.380			
$1,050.45	6.957			
$3,151.36	8.056			
$3,151.36	8.056			
$4,727.03	8.461			
$5,672.44	8.643			
$4,306.85	8.368			

Fire Hydrant
Mean LN(Y)= 7.687
Std. Dev. LN(Y)= 0.197
Increment= 20

1	2	3	4
Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$1,871.28	7.534	1500	2.90%
$1,843.21	7.519	1520	3.37%
$1,871.28	7.534	1540	3.90%
$2,163.67	7.680	1560	4.49%
$1,872.13	7.535	1580	5.13%
$1,989.14	7.595	1600	5.84%
$2,047.65	7.624	1620	6.61%
$1,638.12	7.401	1640	7.45%
$2,343.71	7.759	1660	8.36%
$2,343.71	7.759	1680	9.33%
$2,109.34	7.654	1700	10.37%
$1,757.79	7.472	1720	11.48%
$2,578.08	7.855	1740	12.66%
$1,640.52	7.403	1760	13.91%
$2,109.24	7.654	1780	15.22%
$2,050.65	7.626	1800	16.59%
$2,109.24	7.654	1820	18.03%
$1,930.52	7.566	1840	19.52%
$1,872.02	7.535	1860	21.07%
$1,872.02	7.535	1880	22.67%
$2,340.02	7.758	1900	24.32%
$1,872.02	7.535	1920	26.02%
$1,638.02	7.401	1940	27.75%
$2,106.02	7.653	1960	29.52%
$2,325.19	7.752	1980	31.32%
$2,092.67	7.646	2000	33.15%
$2,557.71	7.847	2020	35.01%
$2,658.55	7.886	2040	36.88%
$1,821.69	7.508	2060	38.76%
$2,022.81	7.612	2080	40.65%
$1,965.02	7.583	2100	42.54%
$1,965.02	7.583	2120	44.44%
$1,965.02	7.583	2140	46.33%
$1,849.43	7.523	2160	48.20%
$2,311.78	7.746	2180	50.07%
$1,733.84	7.458	2200	51.92%
$2,311.78	7.746	2220	53.75%
$1,676.04	7.424	2240	55.55%

Fire Hydrant
Mean LN(Y)= **7.687**
Std. Dev. LN(Y)= **0.197**
Increment= 20

1	**2**	**3**	**4**
Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$2,196.19	7.694	2260	57.33%
$2,138.40	7.668	2280	59.07%
$1,618.25	7.389	2300	60.79%
$2,311.78	7.746	2320	62.46%
$2,080.60	7.640	2340	64.10%
$2,075.85	7.638	2360	65.71%
$4,958.98	8.509	2380	67.27%
$1,729.88	7.456	2400	68.78%
$2,075.85	7.638	2420	70.26%
$1,729.88	7.456	2440	71.69%
$2,883.13	7.967	2460	73.08%
$1,843.56	7.519	2480	74.42%
$1,728.34	7.455	2500	75.71%
$2,189.23	7.691	2520	76.96%
$2,229.56	7.710	2540	78.16%
$2,041.33	7.621	2560	79.31%
$2,268.14	7.727	2580	80.42%
$2,965.40	7.995	2600	81.49%
$2,154.73	7.675	2620	82.51%
$2,211.44	7.701	2640	83.49%
$2,154.73	7.675	2660	84.42%
$1,927.92	7.564	2680	85.31%
$2,041.33	7.621	2700	86.16%
$2,154.73	7.675	2720	86.97%
$2,075.35	7.638	2740	87.74%
$1,757.81	7.472	2760	88.48%
$2,268.14	7.727	2780	89.17%
$2,041.33	7.621	2800	89.83%
$2,835.18	7.950	2820	90.46%
$2,494.95	7.822	2840	91.06%
$2,835.18	7.950	2860	91.62%
$2,098.03	7.649	2880	92.15%
$3,402.21	8.132	2900	92.65%
$2,713.81	7.906	2920	93.13%
$2,204.97	7.698	2940	93.57%
$2,261.51	7.724	2960	93.99%
$2,798.61	7.937	2980	94.39%
$2,114.51	7.657	3000	94.76%

Fire Hydrant
Mean LN(Y)= 7.687
Std. Dev. LN(Y)= 0.197
Increment= 20

1	2	3	4
Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$2,826.88	7.947	3020	95.12%
$2,261.51	7.724	3040	95.45%
$2,268.77	7.727	3060	95.75%
$2,111.31	7.655	3080	96.05%
$2,068.81	7.635	3100	96.32%
$2,012.90	7.607	3120	96.57%
$1,617.03	7.388	3140	96.81%
$2,012.90	7.607	3160	97.04%
$1,677.42	7.425	3180	97.25%
$1,677.42	7.425	3200	97.44%
$2,907.52	7.975	3220	97.62%
$1,677.42	7.425	3240	97.79%
$2,795.69	7.936	3260	97.95%
$2,683.87	7.895	3280	98.10%
$2,236.55	7.713	3300	98.24%
$1,901.07	7.550	3320	98.37%
$2,795.69	7.936	3340	98.49%
$1,983.38	7.593	3360	98.60%
$2,232.64	7.711	3380	98.71%
$1,674.48	7.423	3400	98.80%
$2,567.53	7.851	3420	98.89%
$2,232.64	7.711	3440	98.98%
$2,567.53	7.851	3460	99.05%
$3,348.95	8.116		
$1,674.48	7.423		
$2,277.29	7.731		
$2,009.37	7.606		
$2,586.51	7.858		
$2,065.19	7.633		
$1,562.85	7.354		
$1,674.48	7.423		
$2,065.19	7.633		
$2,455.90	7.806		
$2,009.37	7.606		
$1,674.48	7.423		
$2,232.64	7.711		
$1,786.11	7.488		
$2,455.90	7.806		

Fire Hydrant

Mean LN(Y)= **7.687**

Std. Dev. LN(Y)= **0.197**

Increment= 20

1	**2**	**3**	**4**
Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$1,674.48	7.423		
$1,922.30	7.561		
$2,009.37	7.606		
$2,455.90	7.806		
$2,232.64	7.711		
$2,455.90	7.806		
$1,786.11	7.488		
$2,009.37	7.606		
$3,336.49	8.113		
$4,003.79	8.295		
$1,668.25	7.420		
$3,112.92	8.043		
$2,031.18	7.616		
$1,945.57	7.573		
$3,112.92	8.043		
$3,112.92	8.043		
$1,889.99	7.544		
$1,663.19	7.416		
$1,645.40	7.406		
$2,001.16	7.601		
$1,611.28	7.385		
$1,666.84	7.419		
$2,222.45	7.706		
$2,000.20	7.601		
$2,155.78	7.676		
$3,444.80	8.145		
$2,557.37	7.847		
$2,890.94	7.969		
$2,001.42	7.602		
$2,347.22	7.761		
$2,162.65	7.679		
$1,890.23	7.544		
$1,667.85	7.419		
$1,779.04	7.484		
$2,001.42	7.602		
$2,112.61	7.656		
$2,446.18	7.802		
$2,054.65	7.628		

Fire Hydrant
Mean LN(Y)= 7.687
Std. Dev. LN(Y)= 0.197
Increment= 20

1	2	3	4
Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$1,665.93	7.418		
$1,888.05	7.543		
$2,221.24	7.706		
$2,266.36	7.726		
$1,776.99	7.483		
$2,498.90	7.824		
$2,443.36	7.801		
$2,465.58	7.810		
$3,054.21	8.024		
$2,443.36	7.801		
$1,888.05	7.543		
$2,554.43	7.846		
$1,776.99	7.483		
$1,999.12	7.600		
$2,110.18	7.655		
$2,554.43	7.846		
$2,554.43	7.846		
$1,999.12	7.600		
$2,998.67	8.006		
$2,721.02	7.909		
$1,993.49	7.598		
$1,661.24	7.415		
$1,661.24	7.415		
$1,993.49	7.598		
$1,993.49	7.598		
$2,768.73	7.926		
$1,107.49	7.010		
$1,882.74	7.540		
$2,879.48	7.965		
$2,436.48	7.798		
$2,990.23	8.003		
$2,436.48	7.798		
$2,495.14	7.822		
$2,006.96	7.604		
$2,169.69	7.682		
$2,278.17	7.731		
$2,387.55	7.778		
$2,279.03	7.732		

Fire Hydrant
Mean LN(Y)= 7.687
Std. Dev. LN(Y)= 0.197

Increment= 20

1	2	3	4
Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$1,953.45	7.577		
$1,844.93	7.520		
$2,284.45	7.734		
$1,627.88	7.395		
$2,170.51	7.683		
$2,713.14	7.906		
$3,255.77	8.088		
$5,601.36	8.631		
$2,692.96	7.898		
$3,231.56	8.081		
$3,231.56	8.081		
$2,349.54	7.762		
$2,669.93	7.890		
$2,135.94	7.667		
$2,655.80	7.885		
$1,752.83	7.469		
$2,124.64	7.661		
$2,337.11	7.757		
$1,699.72	7.438		
$3,213.52	8.075		
$2,114.03	7.656		
$2,431.14	7.796		
$2,787.35	7.933		
$2,114.03	7.656		
$1,691.23	7.433		
$2,114.03	7.656		
$2,218.58	7.705		
$2,324.22	7.751		
$2,218.58	7.705		
$1,690.34	7.433		
$2,112.93	7.656		
$2,789.07	7.933		
$2,109.09	7.654		
$1,581.82	7.366		
$2,003.64	7.603		
$1,950.91	7.576		
$1,898.18	7.549		
$1,845.46	7.520		

Fire Hydrant
Mean LN(Y)= **7.687**
Std. Dev. LN(Y)= **0.197**
Increment= 20

1	2	3	4
Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$2,636.37	7.877		
$2,320.00	7.749		
$2,215.60	7.703		
$2,330.55	7.754		
$1,950.91	7.576		
$2,320.00	7.749		
$2,442.33	7.801		
$2,320.00	7.749		
$1,898.18	7.549		
$1,950.91	7.576		
$2,003.64	7.603		
$2,109.09	7.654		
$2,109.09	7.654		
$2,130.18	7.664		
$1,581.82	7.366		
$2,109.09	7.654		
$2,109.09	7.654		
$2,320.00	7.749		
$2,083.12	7.642		
$2,319.02	7.749		
$2,213.61	7.702		
$2,477.13	7.815		
$2,319.02	7.749		
$2,213.61	7.702		
$2,319.02	7.749		
$1,897.38	7.548		
$2,002.79	7.602		
$2,002.79	7.602		
$2,861.88	7.959		
$2,635.25	7.877		
$2,108.20	7.654		
$2,635.25	7.877		
$2,846.07	7.954		
$2,205.95	7.699		
$1,943.34	7.572		
$2,624.03	7.872		
$2,100.90	7.650		
$2,100.90	7.650		

Fire Hydrant
Mean LN(Y)= 7.687
Std. Dev. LN(Y)= 0.197
Increment= 20

1	2	3	4
Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$1,995.86	7.599		
$2,626.13	7.873		
$1,890.81	7.545		
$1,680.72	7.427		
$2,310.99	7.745		
$2,416.04	7.790		
$2,158.68	7.677		
$2,240.61	7.715		

12" Sanitary Sewer:All Depths
Increment= 2

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$46.78	3.845	30	1.50%
$61.99	4.127	32	2.24%
$47.83	3.868	34	3.20%
$46.78	3.845	36	4.40%
$99.41	4.599	38	5.84%
$102.92	4.634	40	7.53%
$58.59	4.071	42	9.46%
$38.38	3.647	44	11.62%
$58.59	4.071	46	13.99%
$87.89	4.476	48	16.55%
$64.45	4.166	50	19.28%
$62.49	4.135	52	22.13%
$53.94	3.988	54	25.10%
$64.35	4.164	56	28.14%
$46.80	3.846	58	31.24%
$56.16	4.028	60	34.36%
$70.20	4.251	62	37.49%
$57.66	4.055	64	40.60%
$86.49	4.460	66	43.67%
$78.42	4.362	68	46.69%
$87.65	4.473	70	49.63%
$42.49	3.749	72	52.50%
$134.19	4.899	74	55.27%
$134.19	4.899	76	57.95%

12" Sanitary Sewer:All Depths

Increment= 2

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$111.83	4.717	78	60.52%
$64.86	4.172	80	62.99%
$42.23	3.743	82	65.34%
$53.34	3.977	84	67.58%
$66.67	4.200	86	69.71%
$72.23	4.280	88	71.73%
$137.79	4.926	90	73.63%
$73.34	4.295	92	75.43%
$64.49	4.167	94	77.13%
$57.26	4.048	96	78.72%
$72.27	4.280	98	80.22%
$38.52	3.651	100	81.62%
$144.38	4.972	102	82.93%
$155.49	5.047	104	84.16%
$88.85	4.487	106	85.31%
$56.64	4.037	108	86.37%
$47.76	3.866	110	87.37%
$61.08	4.112	112	88.30%
$41.06	3.715	114	89.16%
$53.31	3.976	116	89.97%
$31.01	3.434	118	90.71%
$55.37	4.014	120	91.41%
$66.45	4.196	122	92.05%
$62.02	4.127	124	92.64%
$39.87	3.686	126	93.20%
$60.91	4.109	128	93.71%
$110.75	4.707	130	94.18%
$52.97	3.970	132	94.62%
$54.05	3.990	134	95.03%
$52.97	3.970	136	95.41%
$83.23	4.422	138	95.75%
$56.21	4.029	140	96.08%
$59.69	4.089	142	96.37%
$58.60	4.071	144	96.65%
$75.43	4.323	146	96.90%
$150.81	5.016	148	97.14%
$80.79	4.392	150	97.35%
$183.12	5.210	152	97.55%
$135.73	4.911	154	97.74%
$89.85	4.498	156	97.91%
$85.62	4.450	158	98.07%

12" Sanitary Sewer:All Depths

Increment= 2

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$73.99	4.304	160	98.21%
$89.85	4.498	162	98.35%
$120.50	4.792	164	98.47%
$128.96	4.859	166	98.59%
		168	98.70%
		170	98.79%
Mean LN(Y)=	**4.252**	172	98.88%
Std. Dev. LN(Y)=	**0.3918885**	174	98.97%

10" Sanitary Sewer:All Depths
Mean LN(Y)= 4.228
Std. Dev. LN(Y)= 0.4564

Increment= 2

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$52.73	3.965	30	3.49%
$71.48	4.269	32	4.73%
$79.68	4.378	34	6.20%
$82.03	4.407	36	7.88%
$57.81	4.057	38	9.77%
$49.73	3.907	40	11.86%
$58.50	4.069	42	14.11%
$40.95	3.712	44	16.52%
$44.46	3.795	46	19.05%
$64.35	4.164	48	21.69%
$47.97	3.871	50	24.40%
$46.80	3.846	52	27.18%
$70.20	4.251	54	29.99%
$117.00	4.762	56	32.81%
$42.12	3.741	58	35.64%
$26.33	3.271	60	38.44%
$53.82	3.986	62	41.22%
$67.43	4.211	64	43.94%
$133.70	4.896	66	46.61%
$82.54	4.413	68	49.22%
$129.05	4.860	70	51.75%
$75.13	4.319	72	54.21%
$75.13	4.319	74	56.58%

10" Sanitary Sewer:All Depths
Mean LN(Y)= 4.228
Std. Dev. LN(Y)= 0.4564

Increment= 2

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$69.35	4.239	76	58.87%
$57.79	4.057	78	61.06%
$54.33	3.995	80	63.17%
$47.97	3.871	82	65.19%
$96.52	4.570	84	67.13%
$90.16	4.502	86	68.97%
$104.03	4.645	88	70.72%
$92.26	4.525	90	72.39%
$62.28	4.132	92	73.98%
$115.33	4.748	94	75.48%
$69.20	4.237	96	76.91%
$98.03	4.585	98	78.26%
$115.33	4.748	100	79.54%
$54.20	3.993	102	80.75%
$80.73	4.391	104	81.89%
$69.20	4.237	106	82.97%
$138.39	4.930	108	83.99%
$36.90	3.608	110	84.95%
$111.83	4.717	112	85.85%
$117.42	4.766	114	86.70%
$111.83	4.717	116	87.50%
$60.39	4.101	118	88.26%
$167.45	5.121	120	88.97%
$39.07	3.665	122	89.64%
$31.26	3.442	124	90.26%
$55.82	4.022	126	90.85%
$66.98	4.204	128	91.41%
$50.23	3.917	130	91.93%
$223.26	5.408	132	92.42%
$36.91	3.608	134	92.88%
$48.92	3.890	136	93.31%
$47.81	3.867	138	93.71%
$46.70	3.844	140	94.09%
$38.36	3.647	142	94.45%
$35.44	3.568	144	94.78%
$111.06	4.710	146	95.10%
$149.93	5.010	148	95.39%

10" Sanitary Sewer:All Depths
Mean LN(Y)= 4.228
Std. Dev. LN(Y)= 0.4564

Increment= 2

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$155.49	5.047	150	95.67%
$110.75	4.707	152	95.93%
$68.66	4.229	154	96.18%
$132.90	4.890	156	96.40%
$182.74	5.208	158	96.62%
$39.65	3.680	160	96.82%
$53.16	3.973	162	97.01%
$60.91	4.109	164	97.19%
$59.80	4.091	166	97.36%
$44.30	3.791	168	97.51%
$65.34	4.180	170	97.66%
$99.67	4.602	172	97.80%
$43.24	3.767	174	97.93%
$49.72	3.906	176	98.05%
$49.45	3.901	178	98.16%
$54.05	3.990	180	98.27%
$45.40	3.816	182	98.37%

8" Sanitary Sewer
Mean LN(Y)= 3.914
Std. Dev. LN(Y)= 0.407692

Increment= 1

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$40.93	3.712	20	1.21%
$58.48	4.069	21	1.65%
$41.23	3.719	22	2.18%
$39.76	3.683	23	2.81%
$121.63	4.801	24	3.55%
$95.90	4.563	25	4.41%
$58.48	4.069	26	5.38%
$86.55	4.461	27	6.47%
$31.59	3.453	28	7.68%
$26.91	3.293	29	9.00%

8" Sanitary Sewer

Mean LN(Y)=	**3.914**
Std. Dev. LN(Y)=	**0.407692**

Increment= 1

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$28.08	3.335	30	10.42%
$47.97	3.871	31	11.95%
$50.43	3.921	32	13.58%
$21.06	3.047	33	15.29%
$47.97	3.871	34	17.08%
$52.65	3.964	35	18.95%
$36.27	3.591	36	20.88%
$115.83	4.752	37	22.86%
$36.27	3.591	38	24.89%
$37.44	3.623	39	26.95%
$76.05	4.331	40	29.04%
$40.95	3.712	41	31.15%
$37.44	3.623	42	33.27%
$24.10	3.182	43	35.39%
$46.80	3.846	44	37.51%
$59.29	4.082	45	39.62%
$127.89	4.851	46	41.71%
$90.68	4.507	47	43.78%
$126.72	4.842	48	45.82%
$75.13	4.319	49	47.83%
$69.35	4.239	50	49.80%
$63.57	4.152	51	51.74%
$38.14	3.641	52	53.64%
$38.14	3.641	53	55.49%
$43.92	3.782	54	57.29%
$56.64	4.037	55	59.05%
$77.44	4.350	56	60.76%
$48.55	3.883	57	62.42%
$46.13	3.831	58	64.03%
$57.66	4.055	59	65.58%
$80.73	4.391	60	67.09%
$63.43	4.150	61	68.54%
$69.20	4.237	62	69.94%
$92.26	4.525	63	71.29%
$51.90	3.949	64	72.60%
$80.73	4.391	65	73.85%
$61.12	4.113	66	75.05%

8" Sanitary Sewer
Mean LN(Y)= **3.914**
Std. Dev. LN(Y)= **0.407692**

Increment= 1

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$84.19	4.433	67	76.21%
$23.75	3.167	68	77.32%
$33.92	3.524	69	78.38%
$29.40	3.381	70	79.40%
$29.40	3.381	71	80.38%
$34.37	3.537	72	81.31%
$28.27	3.342	73	82.21%
$35.62	3.573	74	83.06%
$32.43	3.479	75	83.88%
$61.51	4.119	76	84.66%
$87.23	4.468	77	85.41%
$106.24	4.666	78	86.12%
$55.91	4.024	79	86.80%
$31.31	3.444	80	87.45%
$44.73	3.801	81	88.07%
$83.87	4.429	82	88.66%
$57.59	4.053	83	89.22%
$140.12	4.943	84	89.75%
$43.82	3.780	85	90.26%
$35.72	3.576	86	90.75%
$50.23	3.917	87	91.21%
$27.91	3.329	88	91.65%
$42.42	3.748	89	92.06%
$33.49	3.511	90	92.46%
$49.12	3.894	91	92.84%
$42.42	3.748	92	93.20%
$50.23	3.917	93	93.54%
$37.95	3.636	94	93.86%
$33.74	3.519	95	94.17%
$55.82	4.022	96	94.47%
$39.07	3.665	97	94.74%
$44.65	3.799	98	95.01%
$46.89	3.848	99	95.26%
$41.30	3.721	100	95.50%
$50.23	3.917	101	95.73%
$31.26	3.442	102	95.94%
$33.49	3.511	103	96.15%

8" Sanitary Sewer
Mean LN(Y)= 3.914
Std. Dev. LN(Y)= 0.407692

Increment= 1

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$33.49	3.511	104	96.34%
$44.65	3.799	105	96.52%
$39.07	3.665	106	96.70%
$48.00	3.871	107	96.86%
$46.89	3.848	108	97.02%
$33.49	3.511	109	97.17%
$41.12	3.716	110	97.31%
$38.89	3.661	111	97.45%
$35.56	3.571	112	97.58%
$41.12	3.716	113	97.70%
$100.01	4.605	114	97.81%
$140.01	4.942	115	97.92%
$49.48	3.902	116	98.03%
$44.48	3.795	117	98.13%
$60.04	4.095	118	98.22%
$46.70	3.844	119	98.31%
$45.59	3.820	120	98.39%
$42.25	3.744	121	98.47%
$41.03	3.714	122	98.55%
$30.02	3.402	123	98.62%
$51.15	3.935	124	98.69%
$40.03	3.690	125	98.75%
$37.80	3.632	126	98.82%
$32.45	3.480	127	98.87%
$40.03	3.690	128	98.93%
$42.25	3.744	129	98.98%
$39.43	3.674	130	99.03%
$37.76	3.631	131	99.08%
$44.31	3.791	132	99.13%
$45.54	3.818	133	99.17%
$55.53	4.017	134	99.21%
$32.96	3.495	135	99.25%
$99.96	4.605		
$142.16	4.957		
$76.63	4.339		
$46.65	3.843		
$41.09	3.716		

8" Sanitary Sewer

Mean LN(Y)=	**3.914**
Std. Dev. LN(Y)=	**0.407692**

Increment= 1

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$49.98	3.912		
$35.02	3.556		
$44.42	3.794		
$51.09	3.934		
$48.87	3.889		
$37.76	3.631		
$51.09	3.934		
$53.31	3.976		
$68.86	4.232		
$64.42	4.165		
$61.08	4.112		
$149.93	5.010		
$99.67	4.602		
$68.66	4.229		
$121.82	4.803		
$171.66	5.146		
$37.21	3.617		
$49.84	3.909		
$44.30	3.791		
$48.73	3.886		
$39.87	3.686		
$63.13	4.145		
$99.67	4.602		
$68.66	4.229		
$33.22	3.503		
$42.08	3.740		
$50.94	3.931		
$70.88	4.261		
$38.91	3.661		
$43.24	3.767		
$47.83	3.868		
$52.97	3.970		
$41.08	3.715		
$62.16	4.130		
$83.23	4.422		
$91.88	4.521		
$83.23	4.422		

8" Sanitary Sewer

Mean LN(Y)=	**3.914**
Std. Dev. LN(Y)=	**0.407692**

Increment= 1

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$108.10	4.683		
$150.25	5.012		
$35.81	3.578		
$44.50	3.795		
$43.41	3.771		
$27.13	3.301		
$35.43	3.568		
$32.56	3.483		
$54.26	3.994		
$49.92	3.910		
$73.80	4.301		
$45.24	3.812		
$53.86	3.986		
$102.33	4.628		
$126.03	4.837		
$144.18	4.971		
$81.17	4.396		
$85.44	4.448		
$26.56	3.279		
$42.49	3.749		
$36.12	3.587		
$48.87	3.889		
$42.49	3.749		
$84.99	4.442		
$73.99	4.304		
$82.45	4.412		
$52.85	3.967		
$60.25	4.099		
$61.31	4.116		
$93.02	4.533		
$40.17	3.693		
$33.82	3.521		
$30.65	3.423		
$31.71	3.457		
$42.28	3.744		
$52.85	3.967		
$41.20	3.718		

8" Sanitary Sewer
Mean LN(Y)= **3.914**
Std. Dev. LN(Y)= **0.407692**

Increment= 1

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$49.65	3.905		
$44.69	3.800		
$42.26	3.744		
$63.39	4.149		
$42.26	3.744		
$61.16	4.114		
$50.09	3.914		
$64.33	4.164		
$63.27	4.147		
$56.95	4.042		
$73.82	4.302		
$33.75	3.519		
$30.58	3.420		
$33.75	3.519		
$32.43	3.479		
$42.18	3.742		
$40.07	3.691		
$42.18	3.742		
$45.35	3.814		
$36.91	3.608		
$42.18	3.742		
$37.96	3.637		
$33.75	3.519		
$40.07	3.691		
$37.38	3.621		
$42.18	3.742		
$32.69	3.487		
$52.70	3.965		
$79.06	4.370		
$81.17	4.396		
$31.62	3.454		
$33.73	3.518		
$40.06	3.690		
$37.95	3.636		
$28.46	3.349		
$37.95	3.636		
$37.95	3.636		

8" Sanitary Sewer
Mean LN(Y)= 3.914
Std. Dev. LN(Y)= 0.407692

Increment= 1

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$79.06	4.370		
$52.70	3.965		
$91.71	4.519		
$84.33	4.435		
$52.52	3.961		
$32.56	3.483		
$42.02	3.738		
$105.05	4.654		
$42.02	3.738		
$63.03	4.144		
$19.96	2.994		
$57.77	4.057		
$33.61	3.515		
$34.14	3.530		
$37.82	3.633		
$33.61	3.515		
$33.61	3.515		
$46.22	3.833		
$72.48	4.283		
$53.57	3.981		
$36.77	3.605		
$51.47	3.941		
$39.92	3.687		
$36.56	3.599		
$37.82	3.633		

6" Sanitary Sewer

Mean LN(Y)=	**3.800**
Std. Dev. LN(Y)=	**0.640549**
Increment=	2

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$46.87	3.847	12	2.01%
$48.05	3.872	14	3.50%
$46.87	3.847	16	5.44%
$64.45	4.166	18	7.79%
$103.12	4.636	20	10.47%
$19.89	2.990	22	13.43%
$35.10	3.558	24	16.59%
$35.10	3.558	26	19.90%
$52.65	3.964	28	23.28%
$35.10	3.558	30	26.70%
$19.89	2.990	32	30.11%
$46.80	3.846	34	33.49%
$61.07	4.112	36	36.79%
$8.07	2.088	38	40.02%
$9.22	2.221	40	43.14%
$8.68	2.161	42	46.15%
$20.35	3.013	44	49.04%
$28.27	3.342	46	51.81%
$16.96	2.831	48	54.45%
$24.88	3.214	50	56.97%
$27.25	3.305	52	59.36%
$24.82	3.212	54	61.63%
$28.27	3.342	56	63.78%
$27.96	3.331	58	65.81%
$55.91	4.024	60	67.73%
$80.52	4.388	62	69.54%
$100.64	4.612	64	71.26%
$51.44	3.940	66	72.87%
$55.53	4.017	68	74.39%
$26.65	3.283	70	75.83%
$31.10	3.437	72	77.18%
$222.12	5.403	74	78.45%
$77.52	4.351	76	79.65%
$63.13	4.145	78	80.78%
$166.12	5.113	80	81.84%
$177.20	5.177	82	82.84%

6" Sanitary Sewer
Mean LN(Y)= 3.800
Std. Dev. LN(Y)= 0.640549

Increment= 2

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$27.69	3.321	84	83.78%
$28.79	3.360	86	84.67%
$49.84	3.909	88	85.50%
$35.44	3.568	90	86.28%
$52.05	3.952	92	87.02%
$33.22	3.503	94	87.72%
$22.15	3.098	96	88.37%
$43.41	3.771	98	88.99%
$48.84	3.888	100	89.57%
$38.53	3.651	102	90.12%
$52.78	3.966	104	90.64%
$48.47	3.881	106	91.13%
$91.56	4.517	108	91.59%
$124.95	4.828	110	92.02%
$90.78	4.508	112	92.43%
$79.03	4.370	114	92.82%
$69.42	4.240	116	93.18%
$53.91	3.987	118	93.52%
$80.33	4.386	120	93.85%
$47.57	3.862	122	94.16%
$57.08	4.044	124	94.45%
$51.79	3.947	126	94.72%
$84.56	4.437	128	94.98%
$63.25	4.147	130	95.23%
$79.06	4.370	132	95.46%
$36.89	3.608	134	95.68%
$70.62	4.257	136	95.89%
$42.02	3.738	138	96.08%
$29.41	3.381	140	96.27%
$38.87	3.660	142	96.45%
$78.78	4.367	144	96.61%
$31.51	3.450	146	96.77%
$57.77	4.057	148	96.92%
$17.86	2.882	150	97.07%
$52.52	3.961	152	97.20%

4" Sanitary Sewer
Mean LN(Y)= **3.294**
Std. Dev. LN(Y)= **0.564115**

Increment= 1

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$32.75	3.489	7	0.84%
$7.02	1.948	8	1.56%
$35.16	3.560	9	2.59%
$9.37	2.238	10	3.94%
$31.64	3.454	11	5.60%
$17.87	2.883	12	7.57%
$35.15	3.560	13	9.80%
$41.01	3.714	14	12.27%
$18.72	2.930	15	14.94%
$29.25	3.376	16	17.76%
$29.25	3.376	17	20.69%
$40.95	3.712	18	23.70%
$29.25	3.376	19	26.76%
$18.72	2.930	20	29.83%
$40.95	3.712	21	32.90%
$34.88	3.552	22	35.93%
$58.13	4.063	23	38.92%
$24.41	3.195	24	41.84%
$52.32	3.957	25	44.69%
$46.50	3.840	26	47.45%
$11.56	2.447	27	50.11%
$34.68	3.546	28	52.68%
$38.14	3.641	29	55.15%
$32.36	3.477	30	57.52%
$30.05	3.403	31	59.78%
$32.36	3.477	32	61.94%
$33.52	3.512	33	64.00%
$11.56	2.447	34	65.96%
$32.36	3.477	35	67.83%
$55.31	4.013	36	69.60%
$6.91	1.933	37	71.27%
$8.07	2.088	38	72.86%
$7.43	2.006	39	74.37%
$21.55	3.070	40	75.79%
$20.92	3.041	41	77.14%

4" Sanitary Sewer
Mean LN(Y)= **3.294**
Std. Dev. LN(Y)= **0.564115**

Increment= 1

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$24.38	3.194	42	78.41%
$34.02	3.527	43	79.61%
$24.56	3.201	44	80.74%
$27.91	3.329	45	81.82%
$27.91	3.329	46	82.83%
$37.95	3.636	47	83.78%
$29.02	3.368	48	84.68%
$30.14	3.406	49	85.53%
$36.84	3.607	50	86.33%
$30.32	3.412	51	87.08%
$27.91	3.329	52	87.79%
$22.33	3.106	53	88.46%
$33.49	3.511	54	89.09%
$26.79	3.288	55	89.69%
$37.95	3.636	56	90.25%
$20.09	3.000	57	90.78%
$27.91	3.329	58	91.28%
$23.44	3.155	59	91.75%
$22.33	3.106	60	92.20%
$27.91	3.329	61	92.61%
$22.33	3.106	62	93.01%
$11.16	2.413	63	93.38%
$37.95	3.636	64	93.73%
$30.04	3.403	65	94.06%
$38.36	3.647	66	94.38%
$33.36	3.507	67	94.67%
$38.92	3.661	68	94.95%
$23.35	3.151	69	95.22%
$27.80	3.325	70	95.46%
$33.36	3.507	71	95.70%
$26.69	3.284	72	95.92%
$29.88	3.397	73	96.13%
$24.46	3.197	74	96.33%
$11.12	2.409	75	96.52%
$33.32	3.506	76	96.69%

4" Sanitary Sewer
Mean LN(Y)= **3.294**
Std. Dev. LN(Y)= **0.564115**

Increment= 1

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$31.10	3.437	77	96.86%
$30.88	3.430	78	97.02%
$37.76	3.631	79	97.17%
$38.87	3.660	80	97.31%
$23.32	3.149	81	97.44%
$11.11	2.408	82	97.57%
$38.87	3.660	83	97.69%
$17.96	2.888	84	97.80%
$24.43	3.196	85	97.91%
$27.77	3.324	86	98.01%
$12.22	2.503		
$52.20	3.955		
$11.11	2.408		
$9.88	2.291		
$44.42	3.794		
$22.21	3.101		
$28.88	3.363		
$277.66	5.626		
$49.84	3.909		
$58.70	4.072		
$110.75	4.707		
$31.01	3.434		
$24.92	3.216		
$26.58	3.280		
$44.30	3.791		
$29.90	3.398		
$49.84	3.909		
$22.15	3.098		
$22.15	3.098		
$22.15	3.098		
$13.29	2.587		
$35.44	3.568		
$32.12	3.469		
$55.37	4.014		
$37.83	3.633		

4" Sanitary Sewer
Mean LN(Y)= 3.294
Std. Dev. LN(Y)= 0.564115

Increment= 1

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$9.73	2.275		
$43.24	3.767		
$63.78	4.155		
$21.62	3.074		
$51.89	3.949		
$7.60	2.028		
$17.36	2.854		
$19.86	2.989		
$33.64	3.516		
$6.84	1.922		
$27.13	3.301		
$43.09	3.763		
$43.09	3.763		
$80.79	4.392		
$123.88	4.819		
$50.19	3.916		
$72.62	4.285		
$58.74	4.073		
$10.62	2.363		
$31.87	3.462		
$20.18	3.005		
$10.62	2.363		
$31.87	3.462		
$84.99	4.442		
$20.08	3.000		
$19.03	2.946		
$42.28	3.744		
$44.39	3.793		
$31.71	3.457		
$25.37	3.234		
$22.19	3.099		
$24.30	3.190		
$22.19	3.099		
$36.98	3.610		
$42.26	3.744		

4" Sanitary Sewer

Mean LN(Y)= **3.294**

Std. Dev. LN(Y)= **0.564115**

Increment= 1

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$36.98	3.610		
$21.09	3.049		
$21.09	3.049		
$31.64	3.454		
$21.09	3.049		
$52.73	3.965		
$31.64	3.454		
$23.20	3.144		
$27.42	3.311		
$47.45	3.860		
$26.36	3.272		
$34.80	3.550		
$50.62	3.924		
$21.09	3.049		
$22.20	3.100		
$26.36	3.272		
$6.33	1.845		
$31.64	3.454		
$7.38	1.999		
$7.91	2.068		
$11.60	2.451		
$7.86	2.061		
$31.64	3.454		
$31.64	3.454		
$18.97	2.943		
$17.92	2.886		
$23.19	3.144		
$31.62	3.454		
$25.30	3.231		
$24.24	3.188		
$29.51	3.385		
$52.70	3.965		
$31.62	3.454		
$31.62	3.454		
$27.41	3.311		

4" Sanitary Sewer
Mean LN(Y)= 3.294
Std. Dev. LN(Y)= 0.564115

Increment= 1

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$17.86	2.882		
$23.11	3.140		
$23.11	3.140		
$24.16	3.185		
$31.51	3.450		
$11.55	2.447		
$42.02	3.738		
$36.77	3.605		
$31.51	3.450		
$18.91	2.940		
$12.08	2.492		
$21.01	3.045		
$23.11	3.140		

4' Diameter Manhole
Mean LN(Y)= 7.777 **Mean (Y)= $2,472.48**
Std. Dev. LN(Y)= 0.266399 **Std. Dev. (Y)= 696.1222693**

Increment= 25

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**	**Normal Dist. Cum. Prob.**
$1,988.24	7.595	1000	0.06%	1.72%
$1,871.28	7.534	1025	0.08%	1.88%
$2,227.99	7.709	1050	0.10%	2.05%
$2,222.15	7.706	1075	0.14%	2.23%
$2,339.10	7.758	1100	0.18%	2.43%
$2,602.25	7.864	1125	0.24%	2.65%
$1,637.37	7.401	1150	0.31%	2.87%
$2,689.97	7.897	1175	0.39%	3.12%
$2,929.64	7.983	1200	0.50%	3.38%
$1,417.95	7.257	1225	0.62%	3.66%
$2,109.24	7.654	1250	0.76%	3.95%
$1,734.27	7.458	1275	0.94%	4.27%
$1,757.70	7.472	1300	1.13%	4.61%

4' Diameter Manhole

Mean LN(Y)=	**7.777**	**Mean (Y)=**	**$2,472.48**
Std. Dev. LN(Y)=	**0.266399**	**Std. Dev. (Y)=**	**696.1222693**

Increment= 25

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**	**Normal Dist. Cum. Prob.**
$3,222.46	8.078	1325	1.37%	4.96%
$1,872.13	7.535	1350	1.63%	5.34%
$1,989.14	7.595	1375	1.93%	5.74%
$2,047.65	7.624	1400	2.27%	6.17%
$1,638.12	7.401	1425	2.66%	6.62%
$2,929.64	7.983	1450	3.08%	7.09%
$1,417.95	7.257	1475	3.56%	7.59%
$2,460.90	7.808	1500	4.08%	8.12%
$2,812.46	7.942	1525	4.66%	8.67%
$1,757.79	7.472	1550	5.28%	9.26%
$1,757.70	7.472	1575	5.96%	9.87%
$2,460.78	7.808	1600	6.69%	10.50%
$2,929.51	7.983	1625	7.48%	11.17%
$2,812.33	7.942	1650	8.33%	11.87%
$1,784.27	7.487	1675	9.22%	12.60%
$2,691.03	7.898	1700	10.18%	13.36%
$2,925.03	7.981	1725	11.19%	14.15%
$1,872.02	7.535	1750	12.25%	14.97%
$2,644.23	7.880	1775	13.36%	15.82%
$4,446.04	8.400	1800	14.53%	16.70%
$2,106.02	7.653	1825	15.74%	17.62%
$2,164.52	7.680	1850	17.00%	18.56%
$2,106.02	7.653	1875	18.31%	19.54%
$2,340.02	7.758	1900	19.66%	20.54%
$1,579.52	7.365	1925	21.04%	21.58%
$1,638.02	7.401	1950	22.47%	22.65%
$2,340.02	7.758	1975	23.93%	23.74%
$2,092.67	7.646	2000	25.42%	24.87%
$2,325.19	7.752	2025	26.94%	26.02%
$2,732.10	7.913	2050	28.48%	27.20%
$1,918.28	7.559	2075	30.04%	28.40%
$2,325.19	7.752	2100	31.62%	29.63%
$2,557.71	7.847	2125	33.22%	30.88%
$2,732.10	7.913	2150	34.83%	32.16%
$2,557.71	7.847	2175	36.45%	33.46%
$2,325.19	7.752	2200	38.07%	34.77%
$2,282.89	7.733	2225	39.70%	36.11%
$1,733.84	7.458	2250	41.32%	37.46%

4' Diameter Manhole

Mean LN(Y)=	**7.777**	**Mean (Y)=**	**$2,472.48**
Std. Dev. LN(Y)=	**0.266399**	**Std. Dev. (Y)=**	**696.1222693**

Increment= 25

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.	Normal Dist. Cum. Prob.
$3,467.67	8.151	2275	42.94%	38.83%
$1,965.02	7.583	2300	44.56%	40.22%
$3,005.32	8.008	2325	46.17%	41.61%
$2,542.96	7.841	2350	47.77%	43.02%
$1,560.45	7.353	2375	49.35%	44.43%
$2,658.55	7.886	2400	50.92%	45.85%
$1,849.43	7.523	2425	52.47%	47.28%
$2,191.18	7.692	2450	54.00%	48.71%
$4,497.68	8.411	2475	55.51%	50.14%
$2,306.50	7.743	2500	56.99%	51.58%
$3,113.78	8.044	2525	58.46%	53.01%
$2,883.13	7.967	2550	59.89%	54.43%
$3,459.75	8.149	2575	61.30%	55.85%
$1,845.20	7.520	2600	62.68%	57.27%
$3,459.75	8.149	2625	64.03%	58.67%
$2,306.50	7.743	2650	65.36%	60.06%
$2,421.83	7.792	2675	66.65%	61.44%
$2,304.45	7.743	2700	67.91%	62.81%
$2,304.45	7.743	2725	69.14%	64.16%
$2,419.67	7.791	2750	70.33%	65.49%
$2,477.91	7.815	2775	71.50%	66.81%
$2,154.73	7.675	2800	72.63%	68.10%
$2,154.73	7.675	2825	73.73%	69.37%
$2,041.33	7.621	2850	74.80%	70.62%
$2,268.14	7.727	2875	75.83%	71.84%
$2,114.51	7.657	2900	76.83%	73.04%
$1,583.05	7.367	2925	77.80%	74.22%
$1,922.28	7.561	2950	78.74%	75.36%
$2,612.04	7.868	2975	79.65%	76.48%
$2,080.59	7.640	3000	80.53%	77.57%
$1,667.86	7.419	3025	81.37%	78.63%
$2,171.05	7.683	3050	82.19%	79.66%
$1,789.24	7.490	3075	82.98%	80.66%
$1,677.42	7.425	3100	83.74%	81.63%
$3,019.35	8.013	3125	84.47%	82.57%
$1,901.07	7.550	3150	85.17%	83.48%
$2,236.55	7.713	3175	85.85%	84.36%
$2,583.22	7.857	3200	86.50%	85.20%

4' Diameter Manhole

Mean LN(Y)=	**7.777**	**Mean (Y)=**	**$2,472.48**
Std. Dev. LN(Y)=	**0.266399**	**Std. Dev. (Y)=**	**696.1222693**

Increment= 25

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**	**Normal Dist. Cum. Prob.**
$1,856.34	7.526	3225	87.12%	86.02%
$3,354.83	8.118	3250	87.72%	86.80%
$2,683.87	7.895	3275	88.29%	87.55%
$2,795.69	7.936	3300	88.85%	88.27%
$2,012.90	7.607	3325	89.37%	88.97%
$1,453.76	7.282	3350	89.88%	89.63%
$2,236.55	7.713	3375	90.37%	90.26%
$3,913.97	8.272	3400	90.83%	90.86%
$2,068.81	7.635	3425	91.28%	91.44%
$4,361.28	8.381	3450	91.70%	91.99%
$2,232.64	7.711	3475	92.11%	92.51%
$2,009.37	7.606	3500	92.50%	93.00%
$2,567.53	7.851	3525	92.87%	93.47%
$3,683.85	8.212	3550	93.22%	93.92%
$4,242.01	8.353	3575	93.56%	94.34%
$4,576.90	8.429	3600	93.88%	94.74%
$1,674.48	7.423	3625	94.19%	95.11%
$3,014.06	8.011	3650	94.48%	95.46%
$2,009.37	7.606	3675	94.76%	95.80%
$2,511.72	7.829	3700	95.03%	96.11%
$2,455.90	7.806	3725	95.28%	96.40%
$2,121.00	7.660	3750	95.53%	96.68%
$1,953.56	7.577	3775	95.76%	96.93%
$2,065.19	7.633	3800	95.98%	97.17%
$2,567.53	7.851	3825	96.19%	97.40%
$1,786.11	7.488	3850	96.38%	97.61%
$2,232.64	7.711	3875	96.57%	97.80%
$2,455.90	7.806	3900	96.75%	97.99%
$2,232.64	7.711	3925	96.92%	98.15%
$2,790.80	7.934	3950	97.08%	98.31%
$1,674.48	7.423	3975	97.24%	98.46%
$2,232.64	7.711	4000	97.38%	98.59%
$1,786.11	7.488	4025	97.52%	98.71%
$2,232.64	7.711	4050	97.65%	98.83%
$2,455.90	7.806	4075	97.78%	98.93%
$2,790.80	7.934	4100	97.90%	99.03%
$2,009.37	7.606	4125	98.01%	99.12%
$2,009.37	7.606			

4' Diameter Manhole

Mean LN(Y)=	**7.777**	**Mean (Y)=**	**$2,472.48**
Std. Dev. LN(Y)=	**0.266399**	**Std. Dev. (Y)=**	**696.1222693**

Increment= 25

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**	**Normal Dist. Cum. Prob.**
$2,780.41	7.930			
$4,671.09	8.449			
$2,780.41	7.930			
$2,000.20	7.601			
$1,833.52	7.514			
$2,555.82	7.846			
$1,777.96	7.483			
$2,000.20	7.601			
$4,222.65	8.348			
$3,335.70	8.112			
$3,891.65	8.267			
$3,113.32	8.043			
$2,446.18	7.802			
$2,668.56	7.889			
$2,223.80	7.707			
$2,717.49	7.907			
$2,198.23	7.695			
$1,912.47	7.556			
$1,667.85	7.419			
$1,890.23	7.544			
$2,112.61	7.656			
$2,001.42	7.602			
$2,779.75	7.930			
$2,110.18	7.655			
$1,665.93	7.418			
$2,221.24	7.706			
$2,443.36	7.801			
$2,344.52	7.760			
$1,999.12	7.600			
$2,498.90	7.824			
$2,665.49	7.888			
$2,654.38	7.884			
$3,165.27	8.060			
$2,776.55	7.929			
$2,221.24	7.706			
$1,665.93	7.418			
$2,221.24	7.706			
$2,998.67	8.006			

4' Diameter Manhole

Mean LN(Y)=	**7.777**	**Mean (Y)=**	**$2,472.48**
Std. Dev. LN(Y)=	**0.266399**	**Std. Dev. (Y)=**	**696.1222693**

Increment= 25

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**	**Normal Dist. Cum. Prob.**
$1,999.12	7.600			
$2,776.55	7.929			
$1,776.99	7.483			
$2,054.65	7.628			
$1,999.12	7.600			
$2,554.43	7.846			
$2,776.55	7.929			
$1,999.12	7.600			
$3,220.80	8.077			
$2,965.36	7.995			
$1,776.99	7.483			
$1,999.12	7.600			
$2,443.36	7.801			
$3,331.86	8.111			
$1,771.99	7.480			
$4,263.84	8.358			
$3,433.22	8.141			
$2,657.98	7.885			
$2,990.23	8.003			
$2,436.48	7.798			
$1,661.24	7.415			
$1,993.49	7.598			
$2,104.23	7.652			
$2,768.73	7.926			
$1,661.24	7.415			
$2,657.98	7.885			
$2,879.48	7.965			
$2,547.23	7.843			
$2,990.23	8.003			
$2,436.48	7.798			
$3,459.09	8.149			
$2,378.13	7.774			
$3,188.85	8.067			
$4,756.25	8.467			
$4,323.87	8.372			
$1,945.74	7.573			
$2,378.13	7.774			
$1,621.45	7.391			

4' Diameter Manhole

Mean LN(Y)=	**7.777**	**Mean (Y)=**	**$2,472.48**
Std. Dev. LN(Y)=	**0.266399**	**Std. Dev. (Y)=**	**696.1222693**

Increment= 25

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**	**Normal Dist. Cum. Prob.**
$2,702.42	7.902			
$4,323.87	8.372			
$2,702.42	7.902			
$2,387.55	7.778			
$2,279.03	7.732			
$1,844.93	7.520			
$2,387.55	7.778			
$2,284.45	7.734			
$1,627.88	7.395			
$2,713.14	7.906			
$2,713.14	7.906			
$2,821.67	7.945			
$3,770.15	8.235			
$4,308.74	8.368			
$4,308.74	8.368			
$4,201.02	8.343			
$2,349.54	7.762			
$2,456.33	7.806			
$1,708.75	7.444			
$3,718.13	8.221			
$1,912.18	7.556			
$531.16	6.275			
$4,333.76	8.374			
$5,285.08	8.573			
$2,642.54	7.879			
$3,593.85	8.187			
$3,382.45	8.126			
$2,959.64	7.993			
$1,902.63	7.551			
$2,431.14	7.796			
$2,378.29	7.774			
$2,325.43	7.752			
$2,114.03	7.656			
$1,796.93	7.494			
$2,324.22	7.751			
$2,429.87	7.796			
$2,334.79	7.756			
$1,954.46	7.578			

4' Diameter Manhole

Mean LN(Y)=	**7.777**	**Mean (Y)=**	**$2,472.48**
Std. Dev. LN(Y)=	**0.266399**	**Std. Dev. (Y)=**	**696.1222693**

Increment= 25

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**	**Normal Dist. Cum. Prob.**
$3,169.39	8.061			
$2,933.80	7.984			
$2,098.55	7.649			
$2,109.09	7.654			
$2,267.28	7.726			
$2,636.37	7.877			
$2,109.09	7.654			
$2,320.00	7.749			
$2,109.09	7.654			
$2,109.09	7.654			
$3,163.64	8.059			
$2,636.37	7.877			
$3,901.82	8.269			
$2,214.55	7.703			
$2,320.00	7.749			
$2,271.49	7.728			
$2,277.82	7.731			
$2,214.55	7.703			
$2,372.73	7.772			
$2,499.28	7.824			
$2,372.73	7.772			
$1,581.82	7.366			
$2,425.46	7.794			
$1,898.18	7.549			
$2,003.64	7.603			
$2,003.64	7.603			
$2,003.64	7.603			
$1,950.91	7.576			
$2,003.64	7.603			
$2,635.25	7.877			
$3,373.11	8.124			
$2,898.77	7.972			
$2,529.84	7.836			
$2,498.21	7.823			
$2,582.54	7.857			
$2,424.43	7.793			
$2,002.79	7.602			
$1,897.38	7.548			

4' Diameter Manhole

Mean LN(Y)=	**7.777**	**Mean (Y)=**	**$2,472.48**
Std. Dev. LN(Y)=	**0.266399**	**Std. Dev. (Y)=**	**696.1222693**

Increment= 25

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**	**Normal Dist. Cum. Prob.**
$2,224.15	7.707			
$1,897.38	7.548			
$2,740.66	7.916			
$2,108.20	7.654			
$2,740.66	7.916			
$2,310.99	7.745			
$1,890.81	7.545			
$2,256.37	7.722			
$2,100.90	7.650			
$2,100.90	7.650			
$1,890.81	7.545			
$3,676.58	8.210			
$3,676.58	8.210			
$2,100.90	7.650			
$2,100.90	7.650			
$2,205.95	7.699			
$2,731.18	7.912			
$2,310.99	7.745			

4' Diameter Drop Manhole

Mean LN(Y)=	**8.167**	**Mean (Y)=**	**$3,820.07**
Std. Dev. LN(Y)=	**0.390124**	**Std. Dev. (Y)=**	**1692.618882**

Increment = 50

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**	**Normal Dist. Cum. Prob.**
$2,105.19	7.652	1300	0.53%	6.83%
$4,678.20	8.451	1350	0.70%	7.22%
$3,515.57	8.165	1400	0.90%	7.64%
$2,009.73	7.606	1450	1.14%	8.07%
$2,343.60	7.759	1500	1.43%	8.52%
$2,794.75	7.935	1550	1.76%	8.99%
$2,343.60	7.759	1600	2.15%	9.48%
$5,273.11	8.570	1650	2.59%	9.99%

4' Diameter Drop Manhole

Mean LN(Y)=	**8.167**	**Mean (Y)=**	**$3,820.07**
Std. Dev. LN(Y)=	**0.390124**	**Std. Dev. (Y)=**	**1692.618882**

Increment = 50

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**	**Normal Dist. Cum. Prob.**
$3,515.57	8.165	1700	3.09%	10.52%
$2,009.73	7.606	1750	3.64%	11.07%
$3,281.20	8.096	1800	4.25%	11.63%
$3,984.31	8.290	1850	4.93%	12.22%
$3,164.01	8.060	1900	5.67%	12.83%
$2,929.51	7.983	1950	6.47%	13.46%
$5,976.19	8.696	2000	7.33%	14.11%
$3,515.41	8.165	2050	8.25%	14.78%
$3,515.41	8.165	2100	9.23%	15.48%
$3,931.24	8.277	2150	10.27%	16.19%
$2,574.02	7.853	2200	11.36%	16.92%
$2,925.03	7.981	2250	12.51%	17.68%
$3,510.03	8.163	2300	13.71%	18.46%
$4,069.08	8.311	2350	14.95%	19.26%
$3,022.74	8.014	2400	16.24%	20.07%
$5,812.97	8.668	2450	17.58%	20.91%
$3,604.04	8.190	2500	18.95%	21.77%
$3,720.30	8.222	2550	20.35%	22.65%
$4,650.38	8.445	2600	21.79%	23.55%
$6,161.75	8.726	2650	23.25%	24.47%
$4,417.86	8.393	2700	24.74%	25.41%
$2,906.48	7.975	2750	26.25%	26.36%
$4,219.00	8.347	2800	27.78%	27.34%
$2,311.78	7.746	2850	29.32%	28.33%
$4,045.62	8.305	2900	30.87%	29.34%
$3,583.26	8.184	2950	32.43%	30.36%
$4,161.21	8.334	3000	34.00%	31.40%
$3,467.67	8.151	3050	35.56%	32.46%
$4,768.05	8.470	3100	37.13%	33.53%
$9,247.13	9.132	3150	38.69%	34.61%
$2,138.40	7.668	3200	40.24%	35.71%
$2,075.85	7.638	3250	41.79%	36.81%
$8,995.36	9.104	3300	43.32%	37.93%
$2,652.48	7.883	3350	44.84%	39.06%
$5,074.30	8.532	3400	46.35%	40.20%
$3,459.75	8.149	3450	47.84%	41.35%
$4,036.38	8.303	3500	49.31%	42.50%

4' Diameter Drop Manhole

Mean LN(Y)=	**8.167**	**Mean (Y)=**	**$3,820.07**
Std. Dev. LN(Y)=	**0.390124**	**Std. Dev. (Y)=**	**1692.618882**

Increment = 50

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**	**Normal Dist. Cum. Prob.**
$2,075.85	7.638	3550	50.76%	43.66%
$4,613.00	8.437	3600	52.19%	44.83%
$2,883.13	7.967	3650	53.59%	46.00%
$3,921.05	8.274	3700	54.98%	47.17%
$3,456.68	8.148	3750	56.33%	48.35%
$2,650.12	7.882	3800	57.67%	49.53%
$2,765.34	7.925	3850	58.98%	50.71%
$2,849.59	7.955	3900	60.26%	51.88%
$3,907.11	8.271	3950	61.51%	53.06%
$2,009.37	7.606	4000	62.74%	54.23%
$3,348.95	8.116	4050	63.94%	55.40%
$3,795.48	8.242	4100	65.11%	56.57%
$2,455.90	7.806	4150	66.25%	57.73%
$6,697.91	8.810	4200	67.36%	58.88%
$4,448.66	8.400	4250	68.45%	60.03%
$11,010.43	9.307	4300	69.51%	61.16%
$4,448.66	8.400	4350	70.54%	62.29%
$5,781.89	8.662	4400	71.54%	63.41%
$6,671.41	8.806	4450	72.51%	64.51%
$2,890.94	7.969	4500	73.46%	65.60%
$3,613.68	8.192	4550	74.38%	66.69%
$2,906.51	7.975	4600	75.27%	67.75%
$2,223.80	7.707	4650	76.14%	68.80%
$2,057.02	7.629	4700	76.98%	69.84%
$2,223.80	7.707	4750	77.80%	70.86%
$2,779.75	7.930	4800	78.59%	71.87%
$2,223.80	7.707	4850	79.35%	72.86%
$5,559.51	8.623	4900	80.10%	73.83%
$3,109.74	8.042	4950	80.82%	74.78%
$1,999.12	7.600	5000	81.51%	75.71%
$2,554.43	7.846	5050	82.18%	76.63%
$4,442.48	8.399	5100	82.83%	77.52%
$2,677.71	7.893	5150	83.46%	78.40%
$2,332.30	7.755	5200	84.07%	79.25%
$3,553.98	8.176	5250	84.66%	80.09%
$2,221.24	7.706	5300	85.23%	80.90%
$2,776.55	7.929	5350	85.78%	81.70%

4' Diameter Drop Manhole

Mean LN(Y)=	**8.167**	**Mean (Y)=**	**$3,820.07**
Std. Dev. LN(Y)=	**0.390124**	**Std. Dev. (Y)=**	**1692.618882**

Increment = 50

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**	**Normal Dist. Cum. Prob.**
$3,887.17	8.265	5400	86.31%	82.47%
$3,887.17	8.265	5450	86.82%	83.22%
$5,330.98	8.581	5500	87.31%	83.95%
$2,998.67	8.006	5550	87.79%	84.66%
$6,330.54	8.753	5600	88.25%	85.35%
$5,886.29	8.680	5650	88.69%	86.02%
$2,221.24	7.706	5700	89.12%	86.66%
$2,221.24	7.706	5750	89.53%	87.29%
$3,109.74	8.042	5800	89.93%	87.89%
$5,553.10	8.622	5850	90.31%	88.48%
$2,768.73	7.926	5900	90.68%	89.04%
$5,792.18	8.664	5950	91.03%	89.59%
$5,869.71	8.678	6000	91.37%	90.11%
$3,100.98	8.039	6050	91.70%	90.62%
$3,986.97	8.291	6100	92.02%	91.10%
$3,986.97	8.291	6150	92.33%	91.57%
$3,433.22	8.141	6200	92.62%	92.01%
$4,208.47	8.345	6250	92.91%	92.44%
$3,876.22	8.263	6300	93.18%	92.86%
$2,161.93	7.679	6350	93.44%	93.25%
$5,404.83	8.595	6400	93.69%	93.63%
$1,999.79	7.601	6450	93.94%	93.99%
$4,431.96	8.397	6500	94.17%	94.33%
$5,404.83	8.595	6550	94.40%	94.66%
$3,242.90	8.084	6600	94.61%	94.97%
$8,940.64	9.098	6650	94.82%	95.27%
$5,385.93	8.592	6700	95.02%	95.56%
$7,540.30	8.928	6750	95.22%	95.83%
$7,540.30	8.928	6800	95.40%	96.08%
$3,203.91	8.072	6850	95.58%	96.33%
$2,669.93	7.890	6900	95.75%	96.56%
$2,135.94	7.667	6950	95.92%	96.78%
$3,197.47	8.070	7000	96.07%	96.99%
$2,642.54	7.879	7050	96.23%	97.18%
$2,114.03	7.656	7100	96.37%	97.37%
$2,642.54	7.879	7150	96.51%	97.54%
$2,114.03	7.656	7200	96.65%	97.71%

4' Diameter Drop Manhole

Mean LN(Y)=	**8.167**	**Mean (Y)=**	**$3,820.07**
Std. Dev. LN(Y)=	**0.390124**	**Std. Dev. (Y)=**	**1692.618882**

Increment = 50

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.	Normal Dist. Cum. Prob.
$2,325.43	7.752	7250	96.78%	97.86%
$2,319.02	7.749	7300	96.90%	98.01%
$3,794.75	8.241	7350	97.02%	98.15%
$2,740.66	7.916	7400	97.14%	98.28%
$6,851.64	8.832	7450	97.25%	98.40%

5' Diameter Manhole

Mean LN(Y)=	**8.606**	**Mean (Y)=**	**$6,379.24**
Std. Dev. LN(Y)=	**0.509193**	**Std. Dev. (Y)=**	**4625.3526**

Increment= 300

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.	Normal Dist. Cum. Prob.
$11,110.35	9.316	1300	0.24%	13.61%
$10,525.59	9.262	1600	0.79%	15.07%
$21,635.94	9.982	1900	1.90%	16.64%
$4,687.43	8.453	2200	3.69%	18.31%
$3,164.01	8.060	2500	6.22%	20.08%
$6,210.55	8.734	2800	9.45%	21.95%
$3,269.33	8.092	3100	13.27%	23.92%
$4,101.31	8.319	3400	17.55%	25.98%
$5,859.01	8.676	3700	22.17%	28.12%
$19,933.50	9.900	4000	26.98%	30.35%
$6,913.35	8.841	4300	31.87%	32.65%
$23,044.50	10.045	4600	36.73%	35.02%
$2,012.90	7.607	4900	41.50%	37.46%
$3,913.97	8.272	5200	46.09%	39.94%
$5,591.39	8.629	5500	50.48%	42.46%
$4,236.03	8.351	5800	54.63%	45.02%
$5,144.07	8.546	6100	58.53%	47.59%
$4,687.43	8.453	6400	62.16%	50.18%

5' Diameter Manhole

Mean LN(Y)=	**8.606**	**Mean (Y)=**	**$6,379.24**
Std. Dev. LN(Y)=	**0.509193**	**Std. Dev. (Y)=**	**4625.3526**

Increment= 300

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**	**Normal Dist. Cum. Prob.**
$3,164.01	8.060	6700	65.53%	52.76%
$3,281.20	8.096	7000	68.64%	55.34%
$3,984.31	8.290	7300	71.50%	57.89%
$5,507.73	8.614	7600	74.12%	60.41%
$3,348.95	8.116	7900	76.52%	62.88%
$5,581.59	8.627	8200	78.71%	65.31%
$5,916.49	8.685	8500	80.70%	67.67%
$4,911.80	8.499	8800	82.51%	69.96%
$6,139.75	8.723	9100	84.16%	72.18%
$5,581.59	8.627	9400	85.65%	74.32%
$5,581.59	8.627	9700	87.00%	76.36%
$5,581.59	8.627	10000	88.22%	78.31%
$4,775.67	8.471	10300	89.33%	80.17%
$5,553.10	8.622	10600	90.33%	81.93%
$2,776.55	7.929	10900	91.24%	83.58%
$5,775.22	8.661	11200	92.05%	85.14%
$5,553.10	8.622	11500	92.79%	86.59%
$5,869.71	8.678	11800	93.46%	87.94%
$3,322.48	8.108	12100	94.07%	89.19%
$6,644.95	8.802	12400	94.61%	90.35%
$6,644.95	8.802	12700	95.11%	91.41%
$5,315.96	8.578	13000	95.56%	92.38%
$7,752.44	8.956	13300	95.96%	93.27%
$3,322.48	8.108	13600	96.33%	94.08%

6" Reinforced Concrete Pavement
Mean LN(Y)= 3.528
Std. Dev. LN(Y)= 0.247

Increment= 1

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$28.08	3.335	18	0.49%
$23.99	3.177	19	0.90%
$29.33	3.379	20	1.55%
$35.03	3.556	21	2.51%
$26.91	3.293	22	3.83%
$25.91	3.254	23	5.59%
$33.02	3.497	24	7.81%
$29.96	3.400	25	10.52%
$25.35	3.233	26	13.71%
$26.55	3.279	27	17.35%
$32.60	3.484	28	21.38%
$25.77	3.249	29	25.75%
$37.13	3.614	30	30.38%
$24.95	3.217	31	35.17%
$29.49	3.384	32	40.05%
$33.17	3.502	33	44.93%
$26.08	3.261	34	49.74%
$38.96	3.662	35	54.42%
$38.22	3.643	36	58.91%
$24.71	3.207	37	63.17%
$31.10	3.437	38	67.16%
$26.01	3.258	39	70.87%
$28.27	3.342	40	74.29%
$31.66	3.455	41	77.41%
$31.10	3.437	42	80.23%
$30.07	3.403	43	82.77%
$25.68	3.246	44	85.05%
$26.57	3.280	45	87.07%
$28.69	3.357	46	88.85%
$24.56	3.201	47	90.42%
$31.02	3.435	48	91.79%
$39.07	3.665	49	92.98%
$27.80	3.325	50	94.02%
$37.07	3.613	51	94.92%
$45.35	3.815	52	95.69%
$28.35	3.345	53	96.35%
$31.76	3.458	54	96.91%
$31.69	3.456	55	97.40%

6" Reinforced Concrete Pavement
Mean LN(Y)= 3.528
Std. Dev. LN(Y)= 0.247

Increment= 1

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$35.80	3.578	56	97.81%
$27.77	3.324	57	98.16%
$34.38	3.538	58	98.45%
$32.72	3.488	59	98.70%
$33.87	3.523	60	98.91%
$35.54	3.571	61	99.09%
$35.54	3.571	62	99.24%
$34.98	3.555	63	99.37%
$33.32	3.506	64	99.47%
$28.95	3.366	65	99.56%
$36.02	3.584		
$31.01	3.434		
$44.23	3.789		
$29.90	3.398		
$32.67	3.486		
$48.73	3.886		
$54.94	4.006		
$73.25	4.294		
$80.79	4.392		
$57.09	4.045		
$42.49	3.749		
$44.62	3.798		
$66.93	4.204		
$27.66	3.320		
$27.47	3.313		
$31.63	3.454		
$43.32	3.769		
$34.86	3.551		
$64.39	4.165		
$33.46	3.510		
$32.69	3.487		
$36.85	3.607		
$40.07	3.691		
$28.94	3.365		
$36.39	3.594		
$31.64	3.454		
$35.33	3.565		
$38.75	3.657		

6" Reinforced Concrete Pavement
Mean LN(Y)= 3.528
Std. Dev. LN(Y)= 0.247

Increment= 1

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$31.64	3.454		
$38.52	3.651		
$36.07	3.585		
$35.17	3.560		
$40.07	3.691		
$36.91	3.608		

6" Reinforced Concrete Driveways
Mean LN(Y)= 1.965
Std. Dev. LN(Y)= 0.494

Increment= 0.5

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$5.47	1.700	1.5	0.08%
$5.76	1.751	2	0.50%
$5.19	1.646	2.5	1.68%
$5.29	1.666	3	3.97%
$5.10	1.630	3.5	7.46%
$5.68	1.737	4	12.06%
$5.67	1.735	4.5	17.53%
$5.10	1.630	5	23.57%
$5.10	1.630	5.5	29.91%
$5.39	1.684	6	36.29%
$5.66	1.733	6.5	42.52%
$5.67	1.735	7	48.46%
$5.02	1.614	7.5	54.03%
$5.47	1.699	8	59.17%
$5.02	1.614	8.5	63.86%
$6.14	1.815	9	68.10%
$5.58	1.719	9.5	71.90%
$5.02	1.614	10	75.29%
$5.84	1.764	10.5	78.31%
$5.70	1.741	11	80.97%
$5.56	1.716	11.5	83.32%

6" Reinforced Concrete Driveways
Mean LN(Y)= 1.965
Std. Dev. LN(Y)= 0.494

Increment= 0.5

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$7.23	1.978	12	85.38%
$6.12	1.811	12.5	87.20%
$5.56	1.716	13	88.79%
$5.89	1.774	13.5	90.18%
$5.50	1.704	14	91.39%
$5.55	1.714	14.5	92.46%
$5.88	1.771	15	93.38%
$5.00	1.609	15.5	94.20%
$4.44	1.491	16	94.91%
$6.39	1.854	16.5	95.53%
$6.66	1.897	17	96.07%
$9.44	2.245	17.5	96.54%
$6.66	1.897	18	96.96%
$6.29	1.840	18.5	97.32%
$7.40	2.002	19	97.64%
$5.55	1.714	19.5	97.91%
$6.14	1.815	20	98.16%
$5.18	1.645	20.5	98.37%
$5.32	1.671	21	98.56%
$6.09	1.807	21.5	98.73%
$6.64	1.894	22	98.87%
$5.26	1.660	22.5	99.00%
$8.86	2.182	23	99.11%
$5.43	1.691	23.5	99.21%
$6.51	1.874	24	99.30%
$5.70	1.740	24.5	99.38%
$5.43	1.691	25	99.45%
$5.43	1.691		
$6.51	1.874		
$8.71	2.164		
$1.09	0.085		
$6.53	1.877		
$10.23	2.325		
$8.71	2.164		
$5.34	1.675		
$16.02	2.774		
$10.68	2.368		
$9.03	2.201		
$6.37	1.852		

6" Reinforced Concrete Driveways
Mean LN(Y)= 1.965
Std. Dev. LN(Y)= 0.494

Increment= 0.5

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$6.37	1.852		
$4.23	1.442		
$6.34	1.847		
$10.57	2.358		
$7.13	1.965		
$7.40	2.001		
$7.93	2.070		
$7.40	2.001		
$11.10	2.407		
$10.57	2.358		
$8.46	2.135		
$6.34	1.847		
$6.34	1.847		
$5.28	1.664		
$5.81	1.760		
$4.75	1.559		
$6.34	1.847		
$5.28	1.664		
$4.86	1.581		
$4.62	1.530		
$5.27	1.663		
$6.33	1.845		
$6.33	1.845		
$6.33	1.845		
$7.38	1.999		
$7.91	2.068		
$10.55	2.356		
$12.65	2.538		
$15.82	2.761		
$7.91	2.068		
$12.65	2.538		
$5.80	1.758		
$5.27	1.663		
$5.80	1.758		
$4.22	1.439		
$21.09	3.049		
$22.20	3.100		
$21.09	3.049		
$17.93	2.886		

6" Reinforced Concrete Driveways
Mean LN(Y)= 1.965
Std. Dev. LN(Y)= 0.494

Increment= 0.5

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$10.55	2.356		
$5.27	1.663		
$5.69	1.740		
$5.27	1.663		
$5.02	1.613		
$6.33	1.845		
$8.44	2.133		
$18.98	2.943		
$26.36	3.272		
$15.82	2.761		
$6.33	1.845		
$30.58	3.420		
$5.80	1.758		
$5.27	1.663		
$5.27	1.663		
$5.86	1.769		
$4.22	1.439		
$5.80	1.758		
$15.81	2.761		
$28.46	3.349		
$57.98	4.060		
$15.81	2.761		
$15.81	2.761		
$8.43	2.132		
$10.54	2.355		
$5.78	1.754		
$6.30	1.841		
$5.25	1.659		
$6.16	1.817		
$5.25	1.659		

Prop. Std. 4" Conc. Sidewalk, Leadwalk, Wheelchair Ramps
Mean LN(Y)= 1.513
Std. Dev. LN(Y)= 0.377

Increment= 0.25

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$4.27	1.451	1.5	0.17%
$3.22	1.168	1.75	0.57%
$3.61	1.285	2	1.48%
$3.51	1.255	2.25	3.13%
$4.09	1.409	2.5	5.68%
$4.09	1.409	2.75	9.18%
$3.97	1.379	3	13.60%
$6.24	1.831	3.25	18.78%
$4.07	1.404	3.5	24.53%
$5.61	1.725	3.75	30.63%
$4.47	1.496	4	36.88%
$4.35	1.471	4.25	43.09%
$4.47	1.496	4.5	49.11%
$4.17	1.428	4.75	54.82%
$4.14	1.420	5	60.15%
$5.00	1.610	5.25	65.05%
$3.89	1.359	5.5	69.50%
$5.00	1.610	5.75	73.51%
$4.78	1.565	6	77.07%
$4.00	1.387	6.25	80.22%
$5.28	1.663	6.5	82.99%
$3.33	1.204	6.75	85.40%
$6.11	1.810	7	87.50%
$5.55	1.714	7.25	89.31%
$4.98	1.606	7.5	90.88%
$5.54	1.712	7.75	92.23%
$6.09	1.807	8	93.38%
$5.54	1.712	8.25	94.37%
$9.97	2.299	8.5	95.21%
$4.34	1.468	8.75	95.93%
$4.88	1.586	9	96.54%
$4.61	1.529	9.25	97.06%
$3.80	1.335	9.5	97.50%
$4.61	1.529	9.75	97.88%
$3.53	1.260	10	98.20%
$5.31	1.670	10.25	98.47%

Prop. Std. 4" Conc. Sidewalk, Leadwalk, Wheelchair Ramps
Mean LN(Y)= 1.513
Std. Dev. LN(Y)= 0.377

Increment= 0.25

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$3.72	1.313	10.5	98.70%
$4.78	1.565	10.75	98.90%
$4.23	1.441	11	99.06%
$4.23	1.441	11.25	99.20%
$3.93	1.369	11.5	99.32%
$2.64	0.971	11.75	99.42%
$4.23	1.441	12	99.51%
$4.23	1.441	12.25	99.58%
$3.90	1.361	12.5	99.64%
$4.22	1.439	12.75	99.69%
$4.22	1.439	13	99.74%
$3.69	1.306	13.25	99.78%
$4.75	1.557		
$4.75	1.557		
$4.38	1.476		
$3.94	1.372		
$3.43	1.232		
$4.75	1.557		
$3.80	1.334		
$4.01	1.388		
$4.75	1.557		
$3.16	1.152		
$3.43	1.232		
$3.16	1.152		
$5.27	1.663		
$3.91	1.364		
$3.43	1.232		
$4.75	1.557		
$5.27	1.662		
$12.65	2.538		
$52.70	3.965		
$2.89	1.061		
$4.20	1.436		
$4.20	1.436		
$4.04	1.397		
$4.20	1.436		

Unclassified Street Excavation

Mean LN(Y)=	**2.859**	**Mean (Y)=**	**$18.23**
Std. Dev. LN(Y)=	**0.298**	**Std. Dev. (Y)=**	**$5.56**

Increment= 0.5

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.	Normal Dist. Cum. Prob.
$16.96	2.831	9	1.31%	4.86%
$10.53	2.354	9.5	2.06%	5.84%
$8.65	2.158	10	3.08%	6.96%
$23.39	3.152	10.5	4.41%	8.24%
$16.37	2.796	11	6.08%	9.70%
$18.71	2.929	11.5	8.09%	11.33%
$17.55	2.865	12	10.45%	13.15%
$18.14	2.898	12.5	13.16%	15.17%
$14.04	2.642	13	16.17%	17.38%
$8.27	2.113	13.5	19.47%	19.78%
$17.55	2.865	14	23.01%	22.37%
$15.21	2.722	14.5	26.75%	25.15%
$19.31	2.960	15	30.62%	28.10%
$23.44	3.154	15.5	34.59%	31.21%
$12.89	2.556	16	38.60%	34.46%
$11.72	2.461	16.5	42.60%	37.82%
$28.12	3.337	17	46.56%	41.28%
$29.30	3.377	17.5	50.44%	44.81%
$19.59	2.975	18	54.21%	48.39%
$12.67	2.540	18.5	57.84%	51.97%
$13.83	2.627	19	61.31%	55.54%
$14.86	2.699	19.5	64.60%	59.06%
$18.15	2.898	20	67.71%	62.52%
$16.73	2.817	20.5	70.63%	65.87%
$15.88	2.765	21	73.35%	69.11%
$17.01	2.834	21.5	75.88%	72.20%
$18.15	2.898	22	78.22%	75.13%
$19.85	2.988	22.5	80.38%	77.89%
$18.29	2.906	23	82.36%	80.47%
$15.88	2.765	23.5	84.17%	82.85%
$16.19	2.784	24	85.82%	85.04%
$15.63	2.749	24.5	87.31%	87.04%
$15.63	2.749	25	88.67%	88.84%
$17.86	2.883	25.5	89.90%	90.45%
$15.63	2.749	26	91.00%	91.89%
$15.07	2.713	26.5	92.00%	93.16%
$23.91	3.174	27	92.89%	94.27%

Unclassified Street Excavation

Mean LN(Y)=	**2.859**	**Mean (Y)=**	**$18.23**
Std. Dev. LN(Y)=	**0.298**	**Std. Dev. (Y)=**	**$5.56**

Increment= 0.5

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**	**Normal Dist. Cum. Prob.**
$16.68	2.814	27.5	93.69%	95.23%
$22.24	3.102	28	94.41%	96.06%
$28.91	3.364	28.5	95.05%	96.76%
$20.01	2.996	29	95.62%	97.36%
$20.01	2.996	29.5	96.12%	97.87%
$17.35	2.853	30	96.57%	98.29%
$21.10	3.049	30.5	96.97%	98.63%
$19.99	2.995	31	97.33%	98.92%
$12.03	2.487	31.5	97.65%	99.15%
$10.00	2.302	32	97.92%	99.34%
$13.33	2.590	32.5	98.17%	99.49%
$13.33	2.590			
$20.55	3.023			
$12.22	2.503			
$16.66	2.813			
$19.16	2.953			
$24.92	3.216			
$22.15	3.098			
$24.36	3.193			
$12.74	2.544			
$18.83	2.935			
$14.65	2.685			
$21.71	3.078			
$13.02	2.567			
$11.94	2.480			
$19.15	2.953			
$10.85	2.384			
$13.02	2.567			
$32.56	3.483			
$17.57	2.866			
$18.31	2.908			
$32.32	3.476			
$21.54	3.070			
$28.01	3.332			
$21.25	3.056			
$14.87	2.700			
$22.31	3.105			

Unclassified Street Excavation

Mean LN(Y)=	**2.859**	**Mean (Y)=**	**$18.23**
Std. Dev. LN(Y)=	**0.298**	**Std. Dev. (Y)=**	**$5.56**

Increment= 0.5

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.	Normal Dist. Cum. Prob.
$19.02	2.945			
$17.43	2.858			
$19.22	2.956			
$12.68	2.540			
$12.68	2.540			
$9.35	2.235			
$19.16	2.953			
$21.09	3.049			
$25.84	3.252			
$12.65	2.538			
$24.25	3.189			
$21.09	3.049			
$26.36	3.272			
$23.66	3.164			
$12.65	2.538			
$16.87	2.826			
$15.55	2.744			
$21.09	3.049			
$14.76	2.692			
$12.65	2.538			
$12.65	2.538			
$42.18	3.742			
$8.44	2.133			
$26.36	3.272			
$26.36	3.272			
$25.31	3.231			
$21.09	3.049			
$21.09	3.049			
$14.61	2.681			
$16.05	2.776			
$12.65	2.538			
$21.09	3.049			
$31.62	3.454			
$21.08	3.048			
$15.81	2.761			
$18.97	2.943			
$18.97	2.943			

Unclassified Street Excavation

Mean LN(Y)=	**2.859**	**Mean (Y)=**	**$18.23**
Std. Dev. LN(Y)=	**0.298**	**Std. Dev. (Y)=**	**$5.56**

Increment= 0.5

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.	Normal Dist. Cum. Prob.
$19.50	2.970			
$10.54	2.355			
$18.97	2.943			
$17.39	2.856			
$16.87	2.825			
$15.76	2.757			
$18.91	2.940			
$15.76	2.757			
$12.79	2.549			
$15.76	2.757			

Prop. 6" Lime Stabilized Subgrade @ 30 lbs./s.y.

Mean LN(Y)=	**1.070**
Std. Dev. LN(Y)=	**0.355**

Increment= 0.1

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$2.92	1.073	1	0.13%
$2.63	0.968	1.1	0.30%
$2.34	0.850	1.2	0.63%
$2.34	0.850	1.3	1.15%
$4.68	1.543	1.4	1.95%
$3.51	1.255	1.5	3.08%
$2.34	0.850	1.6	4.57%
$2.93	1.073	1.7	6.46%
$2.11	0.745	1.8	8.75%
$2.40	0.875	1.9	11.43%
$4.32	1.463	2	14.46%
$2.88	1.058	2.1	17.81%
$1.73	0.547	2.2	21.43%
$2.42	0.884	2.3	25.25%

Prop. 6" Lime Stabilized Subgrade @ 30 lbs./s.y.
Mean LN(Y)= 1.070
Std. Dev. LN(Y)= 0.355

Increment= 0.1

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$1.70	0.531	2.4	29.23%
$2.43	0.887	2.5	33.29%
$2.84	1.042	2.6	37.39%
$4.54	1.512	2.7	41.48%
$2.84	1.042	2.8	45.51%
$3.35	1.208	2.9	49.44%
$2.51	0.919	3	53.24%
$5.00	1.610	3.1	56.89%
$1.81	0.593	3.2	60.37%
$2.09	0.738	3.3	63.67%
$3.39	1.221	3.4	66.77%
$2.49	0.911	3.5	69.68%
$1.87	0.624	3.6	72.39%
$2.83	1.039	3.7	74.91%
$2.32	0.841	3.8	77.24%
$2.79	1.026	3.9	79.38%
$3.35	1.209	4	81.35%
$2.23	0.803	4.1	83.16%
$2.23	0.803	4.2	84.81%
$2.23	0.803	4.3	86.31%
$4.47	1.496	4.4	87.68%
$2.78	1.022	4.5	88.92%
$2.51	0.921	4.6	90.05%
$2.78	1.022	4.7	91.07%
$2.78	1.022	4.8	91.99%
$1.95	0.666	4.9	92.82%
$3.89	1.359	5	93.56%
$2.50	0.917	5.1	94.23%
$3.33	1.204	5.2	94.84%
$2.78	1.021	5.3	95.38%
$2.55	0.938	5.4	95.87%
$4.22	1.440	5.5	96.31%
$2.50	0.916	5.6	96.70%
$2.67	0.980	5.7	97.05%
$2.78	1.021		
$3.33	1.204		
$1.94	0.665		

Prop. 6" Lime Stabilized Subgrade @ 30 lbs./s.y.
Mean LN(Y)= 1.070
Std. Dev. LN(Y)= 0.355

Increment= 0.1

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$3.05	1.117		
$3.43	1.233		
$3.05	1.114		
$2.77	1.018		
$8.86	2.182		
$7.75	2.048		
$2.06	0.724		
$2.01	0.697		
$2.44	0.893		
$3.26	1.180		
$2.06	0.724		
$3.26	1.180		
$5.39	1.684		
$5.39	1.684		
$6.46	1.866		
$8.08	2.089		
$5.31	1.670		
$3.19	1.159		
$2.12	0.754		
$1.69	0.525		
$3.17	1.154		
$2.50	0.918		
$6.34	1.847		
$5.28	1.664		
$3.43	1.234		
$2.48	0.908		
$1.85	0.613		
$2.64	0.969		
$3.43	1.232		
$4.22	1.439		
$2.11	0.746		
$2.00	0.695		
$2.91	1.068		
$3.16	1.152		
$2.11	0.746		
$2.86	1.050		
$3.43	1.232		

Prop. 6" Lime Stabilized Subgrade @ 30 lbs./s.y.
Mean LN(Y)= 1.070
Std. Dev. LN(Y)= 0.355

Increment= 0.1

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$5.27	1.663		
$3.16	1.152		
$2.11	0.746		
$2.11	0.746		
$2.48	0.908		
$2.93	1.076		
$3.16	1.152		
$3.16	1.152		
$3.15	1.148		
$1.42	0.349		
$2.10	0.742		
$2.86	1.050		
$2.10	0.742		

Proposed Lime
Mean LN(Y)= 4.789 **Mean (Y)= $121.64**
Std. Dev. LN(Y)= 0.163 **Std. Dev. (Y)= $17.72**

Increment= 1.5

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.	Normal Dist. Cum. Prob.
$93.56	4.539	90	3.84%	3.71%
$128.65	4.857	91.5	4.76%	4.45%
$116.96	4.762	93	5.83%	5.31%
$111.11	4.710	94.5	7.06%	6.29%
$128.65	4.857	96	8.46%	7.40%
$129.82	4.866	97.5	10.03%	8.66%
$105.31	4.657	99	11.77%	10.07%
$95.95	4.564	100.5	13.68%	11.65%
$111.16	4.711	102	15.77%	13.39%
$114.67	4.742	103.5	18.02%	15.31%

Proposed Lime

Mean LN(Y)=	**4.789**	**Mean (Y)=**	**$121.64**
Std. Dev. LN(Y)=	**0.163**	**Std. Dev. (Y)=**	**$17.72**

Increment= 1.5

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**	**Normal Dist. Cum. Prob.**
$126.74	4.842	105	20.42%	17.39%
$97.94	4.584	106.5	22.97%	19.65%
$103.70	4.642	108	25.64%	22.08%
$123.29	4.815	109.5	28.43%	24.67%
$113.41	4.731	111	31.32%	27.42%
$113.41	4.731	112.5	34.29%	30.31%
$102.07	4.626	114	37.31%	33.32%
$124.75	4.826	115.5	40.37%	36.45%
$113.41	4.731	117	43.46%	39.68%
$102.07	4.626	118.5	46.54%	42.97%
$117.41	4.766	120	49.61%	46.32%
$140.62	4.946	121.5	52.64%	49.69%
$107.42	4.677	123	55.61%	53.06%
$110.81	4.708	124.5	58.52%	56.41%
$113.08	4.728	126	61.36%	59.72%
$118.73	4.777	127.5	64.10%	62.95%
$124.38	4.823	129	66.73%	66.10%
$128.91	4.859	130.5	69.26%	69.14%
$124.38	4.823	132	71.67%	72.06%
$101.58	4.621	133.5	73.97%	74.83%
$117.21	4.764	135	76.14%	77.45%
$111.63	4.715	136.5	78.18%	79.91%
$96.00	4.564	138	80.10%	82.20%
$111.63	4.715	139.5	81.89%	84.32%
$139.54	4.938	141	83.56%	86.27%
$102.29	4.628	142.5	85.12%	88.04%
$120.35	4.790	144	86.55%	89.65%
$133.43	4.894	145.5	87.88%	91.09%
$111.19	4.711	147	89.10%	92.38%
$116.75	4.760	148.5	90.21%	93.52%
$127.87	4.851	150	91.23%	94.52%
$123.42	4.816	151.5	92.16%	95.40%
$111.06	4.710	153	93.01%	96.16%
$111.06	4.710	154.5	93.77%	96.81%
$122.17	4.805	156	94.47%	97.37%

Proposed Lime

Mean LN(Y)=	**4.789**	**Mean (Y)=**	**$121.64**
Std. Dev. LN(Y)=	**0.163**	**Std. Dev. (Y)=**	**$17.72**

Increment= 1.5

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**	**Normal Dist. Cum. Prob.**
$161.04	5.082	157.5	95.09%	97.85%
$116.62	4.759	159	95.65%	98.25%
$116.62	4.759	160.5	96.16%	98.58%
$104.40	4.648			
$122.17	4.805			
$122.17	4.805			
$116.62	4.759			
$99.67	4.602			
$110.75	4.707			
$99.67	4.602			
$158.37	5.065			
$143.97	4.970			
$108.53	4.687			
$108.53	4.687			
$113.95	4.736			
$122.63	4.809			
$122.63	4.809			
$151.94	5.023			
$106.23	4.666			
$159.35	5.071			
$116.86	4.761			
$116.21	4.755			
$126.78	4.842			
$124.66	4.826			
$42.26	3.744			
$137.34	4.922			
$165.86	5.111			
$123.38	4.815			
$121.27	4.798			
$137.09	4.921			
$158.18	5.064			
$137.09	4.921			
$116.00	4.754			
$111.78	4.717			
$126.55	4.841			

Proposed Lime

Mean LN(Y)=	**4.789**	**Mean (Y)=**	**$121.64**
Std. Dev. LN(Y)=	**0.163**	**Std. Dev. (Y)=**	**$17.72**

Increment= 1.5

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**	**Normal Dist. Cum. Prob.**
$158.18	5.064			
$131.82	4.881			
$123.38	4.815			
$121.27	4.798			
$137.09	4.921			
$94.91	4.553			
$131.82	4.881			
$126.55	4.841			
$116.00	4.754			
$127.60	4.849			
$158.18	5.064			
$131.82	4.881			
$121.22	4.798			
$124.38	4.823			
$131.76	4.881			
$147.57	4.994			
$131.76	4.881			
$111.73	4.716			
$138.09	4.928			
$120.80	4.794			
$136.56	4.917			
$126.05	4.837			
$153.37	5.033			
$121.85	4.803			

2" Hot Mix Temporary Pavement Repair over 6" Flexbase, Per Fig. A

Mean LN(Y)= **2.570**

Std. Dev. LN(Y)= **0.487**

Increment= 0.6

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$14.03	2.642	4	0.75%
$9.36	2.236	4.6	1.60%
$15.96	2.770	5.2	2.92%
$14.03	2.642	5.8	4.76%
$11.70	2.459	6.4	7.13%
$43.27	3.768	7	9.98%
$7.31	1.989	7.6	13.27%
$10.53	2.354	8.2	16.92%
$10.23	2.326	8.8	20.83%
$22.22	3.101	9.4	24.92%
$8.19	2.103	10	29.12%
$15.20	2.722	10.6	33.35%
$14.06	2.643	11.2	37.56%
$23.44	3.154	11.8	41.69%
$8.78	2.172	12.4	45.70%
$8.78	2.172	13	49.56%
$9.54	2.255	13.6	53.25%
$16.38	2.796	14.2	56.76%
$9.36	2.237	14.8	60.07%
$9.36	2.237	15.4	63.19%
$10.18	2.320	16	66.11%
$16.38	2.796	16.6	68.83%
$8.78	2.172	17.2	71.36%
$8.78	2.172	17.8	73.71%
$9.54	2.255	18.4	75.88%
$14.06	2.643	19	77.89%
$23.14	3.142	19.6	79.74%
$11.72	2.461	20.2	81.44%
$32.81	3.491	20.8	83.00%
$26.95	3.294	21.4	84.44%
$14.06	2.643	22	85.76%
$23.44	3.154	22.6	86.96%
$17.58	2.867	23.2	88.07%
$24.98	3.218	23.8	89.08%
$35.16	3.560	24.4	90.01%
$9.37	2.238	25	90.86%

2" Hot Mix Temporary Pavement Repair over 6" Flexbase, Per Fig. A
Mean LN(Y)= 2.570
Std. Dev. LN(Y)= 0.487

Increment= 0.6

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$16.41	2.798	25.6	91.63%
$17.58	2.867	26.2	92.34%
$14.06	2.643	26.8	92.99%
$19.80	2.986	27.4	93.58%
$6.98	1.942	28	94.12%
$18.60	2.923	28.6	94.61%
$30.23	3.409	29.2	95.06%
$13.95	2.636	29.8	95.47%
$5.20	1.649	30.4	95.85%
$10.40	2.342	31	96.19%
$16.18	2.784	31.6	96.51%
$11.56	2.447	32.2	96.80%
$10.40	2.342		
$11.56	2.447		
$17.34	2.853		
$3.47	1.243		
$9.25	2.224		
$11.56	2.447		
$23.70	3.165		
$16.18	2.784		
$20.23	3.007		
$11.56	2.447		
$15.03	2.710		
$12.71	2.543		
$5.78	1.754		
$9.25	2.224		
$13.87	2.630		
$23.70	3.165		
$24.85	3.213		
$20.23	3.007		
$16.76	2.819		
$23.12	3.141		
$12.71	2.543		
$17.28	2.850		
$9.79	2.282		
$9.79	2.282		
$10.54	2.355		
$8.51	2.141		

2" Hot Mix Temporary Pavement Repair over 6" Flexbase, Per Fig. A
Mean LN(Y)= 2.570
Std. Dev. LN(Y)= 0.487

Increment= 0.6

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$8.96	2.193		
$8.51	2.141		
$12.47	2.524		
$8.79	2.174		
$8.79	2.174		
$9.64	2.266		
$27.22	3.304		
$14.74	2.691		
$26.08	3.261		
$19.28	2.959		
$15.88	2.765		
$22.68	3.122		
$27.22	3.304		
$17.01	2.834		
$12.29	2.509		
$8.39	2.127		
$9.23	2.222		
$19.01	2.945		
$11.18	2.414		
$29.30	3.378		
$8.95	2.191		
$20.13	3.002		
$12.30	2.510		
$11.18	2.414		
$14.54	2.677		
$14.79	2.694		
$12.28	2.508		
$13.40	2.595		
$12.28	2.508		
$8.93	2.189		
$8.93	2.189		
$16.74	2.818		
$6.70	1.902		
$10.05	2.307		
$15.63	2.749		
$10.05	2.307		
$12.84	2.552		
$9.49	2.250		

2" Hot Mix Temporary Pavement Repair over 6" Flexbase, Per Fig. A
Mean LN(Y)= 2.570
Std. Dev. LN(Y)= 0.487

Increment= 0.6

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$14.51	2.675		
$17.44	2.859		
$10.05	2.307		
$13.40	2.595		
$10.05	2.307		
$11.16	2.413		
$17.86	2.883		
$16.74	2.818		
$10.05	2.307		
$10.05	2.307		
$11.16	2.413		
$10.05	2.307		
$12.28	2.508		
$13.40	2.595		
$27.91	3.329		
$29.82	3.395		
$8.89	2.185		
$8.89	2.185		
$8.89	2.185		
$10.01	2.303		
$3.06	1.118		
$16.68	2.814		
$12.23	2.504		
$12.07	2.491		
$50.20	3.916		
$16.68	2.814		
$18.90	2.939		
$12.23	2.504		
$10.56	2.357		
$11.12	2.409		
$16.68	2.814		
$11.79	2.467		
$10.01	2.303		
$11.67	2.457		
$10.01	2.303		
$13.34	2.591		
$15.73	2.756		
$20.01	2.996		

2" Hot Mix Temporary Pavement Repair over 6" Flexbase, Per Fig. A

Mean LN(Y)= 2.570

Std. Dev. LN(Y)= 0.487

Increment= 0.6

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$13.34	2.591		
$12.88	2.556		
$10.00	2.302		
$17.77	2.878		
$10.00	2.302		
$33.32	3.506		
$14.44	2.670		
$11.11	2.408		
$12.22	2.503		
$12.34	2.513		
$16.66	2.813		
$11.11	2.408		
$11.11	2.408		
$12.22	2.503		
$11.11	2.408		
$22.21	3.101		
$17.77	2.878		
$11.11	2.408		
$13.33	2.590		
$15.55	2.744		
$14.44	2.670		
$14.83	2.696		
$33.22	3.503		
$39.87	3.686		
$44.30	3.791		
$13.29	2.587		
$11.07	2.405		
$9.41	2.242		
$11.07	2.405		
$14.40	2.667		
$16.61	2.810		
$7.75	2.048		
$5.54	1.712		
$11.07	2.405		
$16.61	2.810		
$11.07	2.405		
$13.84	2.628		
$16.61	2.810		

2" Hot Mix Temporary Pavement Repair over 6" Flexbase, Per Fig. A
Mean LN(Y)= 2.570
Std. Dev. LN(Y)= 0.487

Increment= 0.6

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$11.94	2.480		
$10.85	2.384		
$10.85	2.384		
$11.94	2.480		
$11.45	2.438		
$9.77	2.279		
$10.85	2.384		
$16.28	2.790		
$10.85	2.384		
$13.06	2.570		
$43.54	3.774		
$81.64	4.402		
$52.25	3.956		
$217.69	5.383		
$5.31	1.670		
$9.56	2.258		
$9.56	2.258		
$8.50	2.140		
$9.56	2.258		
$15.67	2.752		
$9.51	2.253		
$9.51	2.253		
$9.51	2.253		
$12.68	2.540		
$40.17	3.693		
$8.46	2.135		
$8.45	2.134		
$8.45	2.134		
$8.90	2.186		
$9.51	2.252		
$17.96	2.888		
$7.92	2.070		
$10.02	2.304		
$9.49	2.250		
$9.49	2.250		
$9.49	2.250		
$14.76	2.692		
$8.44	2.133		

2" Hot Mix Temporary Pavement Repair over 6" Flexbase, Per Fig. A
Mean LN(Y)= **2.570**
Std. Dev. LN(Y)= **0.487**

Increment= 0.6

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$8.44	2.133		
$8.96	2.193		
$9.49	2.250		
$8.96	2.193		
$9.44	2.245		
$8.96	2.193		
$9.49	2.250		
$9.49	2.250		
$10.55	2.356		
$26.36	3.272		
$21.09	3.049		
$42.18	3.742		
$15.82	2.761		
$64.33	4.164		
$9.49	2.250		
$9.49	2.250		
$6.33	1.845		
$10.09	2.312		
$9.49	2.250		
$10.55	2.356		
$9.49	2.250		
$10.54	2.355		
$21.08	3.048		
$9.49	2.250		
$9.98	2.301		
$9.49	2.250		
$9.49	2.250		
$11.60	2.451		
$6.32	1.844		
$8.75	2.169		
$10.50	2.352		
$12.61	2.534		
$10.50	2.352		
$9.45	2.246		
$9.45	2.246		
$11.55	2.447		
$9.45	2.246		
$12.61	2.534		

2" Hot Mix Temporary Pavement Repair over 6" Flexbase, Per Fig. A
Mean LN(Y)= 2.570
Std. Dev. LN(Y)= 0.487

Increment= 0.6

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$9.45	2.246		
$10.50	2.352		
$10.50	2.352		
$14.76	2.692		
$8.40	2.129		

Permanent Reinforced Concrete pavement repair per Fig. 2000-2
Mean LN(Y)= 4.226
Std. Dev. LN(Y)= 0.350

Increment= 2

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$49.12	3.894	35	2.77%
$66.66	4.200	37	3.94%
$58.59	4.071	39	5.40%
$104.65	4.651	41	7.15%
$28.67	3.356	43	9.20%
$64.35	4.164	45	11.54%
$70.20	4.251	47	14.14%
$63.28	4.148	49	16.97%
$76.17	4.333	51	20.02%
$58.59	4.071	53	23.24%
$79.69	4.378	55	26.59%
$93.75	4.541	57	30.04%
$58.59	4.071	59	33.55%
$104.65	4.651	61	37.09%
$76.17	4.333	63	40.62%
$54.75	4.003	65	44.11%
$117.19	4.764	67	47.55%
$50.88	3.929	69	50.90%
$63.94	4.158	71	54.15%
$61.62	4.121	73	57.28%
$63.94	4.158	75	60.28%
$58.13	4.063	77	63.15%
$52.02	3.952	79	65.88%

Permanent Reinforced Concrete pavement repair per Fig. 2000-2
Mean LN(Y)= **4.226**
Std. Dev. LN(Y)= **0.350**

Increment= 2

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$68.20	4.222	81	68.46%
$60.11	4.096	83	70.89%
$72.82	4.288	85	73.18%
$75.13	4.319	87	75.32%
$75.13	4.319	89	77.32%
$89.00	4.489	91	79.19%
$32.29	3.475	93	80.93%
$69.20	4.237	95	82.53%
$74.96	4.317	97	84.02%
$108.41	4.686	99	85.40%
$113.41	4.731	101	86.67%
$119.08	4.780	103	87.84%
$113.41	4.731	105	88.91%
$113.41	4.731	107	89.90%
$66.91	4.203	109	90.80%
$69.18	4.237	111	91.63%
$111.14	4.711	113	92.39%
$45.36	3.815	115	93.08%
$56.70	4.038	117	93.71%
$38.22	3.643	119	94.29%
$120.21	4.789	121	94.81%
$49.20	3.896	123	95.29%
$64.86	4.172	125	95.73%
$98.41	4.589	127	96.12%
$42.49	3.749	129	96.48%
$76.04	4.331		
$50.23	3.917		
$44.65	3.799		
$44.65	3.799		
$53.58	3.981		
$139.54	4.938		
$83.72	4.428		
$70.33	4.253		
$50.74	3.927		
$40.19	3.694		
$62.51	4.135		
$50.23	3.917		

Permanent Reinforced Concrete pavement repair per Fig. 2000-2
Mean LN(Y)= 4.226
Std. Dev. LN(Y)= 0.350

Increment= 2

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$89.31	4.492		
$100.47	4.610		
$75.91	4.330		
$55.60	4.018		
$95.62	4.560		
$55.60	4.018		
$61.15	4.113		
$57.51	4.052		
$47.81	3.867		
$68.94	4.233		
$95.51	4.559		
$66.64	4.199		
$27.77	3.324		
$83.30	4.422		
$60.24	4.098		
$42.20	3.743		
$86.16	4.456		
$77.74	4.353		
$94.40	4.548		
$104.40	4.648		
$95.51	4.559		
$77.74	4.353		
$55.53	4.017		
$86.16	4.456		
$47.76	3.866		
$57.75	4.056		
$55.53	4.017		
$66.64	4.199		
$77.74	4.353		
$66.45	4.196		
$87.49	4.472		
$88.60	4.484		
$71.99	4.276		
$48.73	3.886		
$71.99	4.276		
$55.37	4.014		
$55.37	4.014		

Permanent Reinforced Concrete pavement repair per Fig. 2000-2
Mean LN(Y)= **4.226**
Std. Dev. LN(Y)= **0.350**

Increment= 2

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$81.95	4.406		
$71.99	4.276		
$33.22	3.503		
$65.12	4.176		
$59.69	4.089		
$65.12	4.176		
$108.53	4.687		
$62.84	4.141		
$54.26	3.994		
$70.75	4.259		
$136.06	4.913		
$108.85	4.690		
$81.64	4.402		
$272.12	5.606		
$26.70	3.285		
$69.42	4.240		
$58.74	4.073		
$106.23	4.666		
$69.05	4.235		
$100.92	4.614		
$41.22	3.719		
$50.21	3.916		
$50.74	3.927		
$47.57	3.862		
$47.57	3.862		
$63.42	4.150		
$78.04	4.357		
$78.04	4.357		
$126.55	4.841		
$83.31	4.423		
$58.00	4.060		
$68.55	4.227		
$57.98	4.060		
$68.52	4.227		
$68.52	4.227		
$105.41	4.658		

Permanent Asphalt Pavement Repair, per Fig. 2000-1
Mean LN(Y)= 3.919
Std. Dev. LN(Y)= 0.450

Increment= 2

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$46.78	3.845	20	2.00%
$70.17	4.251	22	3.28%
$52.73	3.965	24	4.97%
$85.14	4.444	26	7.08%
$40.69	3.706	28	9.59%
$58.13	4.063	30	12.47%
$46.50	3.840	32	15.66%
$113.35	4.731	34	19.11%
$28.83	3.361	36	22.76%
$51.90	3.949	38	26.55%
$46.13	3.831	40	30.41%
$46.13	3.831	42	34.31%
$55.07	4.009	44	38.18%
$99.49	4.600	46	42.00%
$33.32	3.506	48	45.73%
$55.53	4.017	50	49.34%
$49.98	3.912	52	52.81%
$27.77	3.324	54	56.14%
$33.32	3.506	56	59.30%
$36.53	3.598	58	62.30%
$48.35	3.878	60	65.12%
$51.57	3.943	62	67.78%
$48.35	3.878	64	70.27%
$60.94	4.110	66	72.59%
$64.45	4.166	68	74.76%
$82.03	4.407	70	76.77%
$65.62	4.184	72	78.64%
$82.03	4.407	74	80.37%
$52.73	3.965	76	81.96%
$85.14	4.444	78	83.44%
$52.73	3.965	80	84.80%
$32.18	3.471	82	86.06%
$66.80	4.202	84	87.21%
$37.50	3.624	86	88.27%
$48.04	3.872	88	89.25%
$46.87	3.847	90	90.14%

Permanent Asphalt Pavement Repair, per Fig. 2000-1
Mean LN(Y)= 3.919
Std. Dev. LN(Y)= 0.450

Increment= 2

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$42.18	3.742	92	90.97%
$40.37	3.698	94	91.72%
$46.80	3.846	96	92.41%
$40.95	3.712	98	93.04%
$52.65	3.964	100	93.62%
$52.65	3.964	102	94.16%
$40.48	3.701	104	94.64%
$65.52	4.182	106	95.09%
$40.69	3.706	108	95.50%
$58.13	4.063	110	95.87%
$46.50	3.840	112	96.21%
$113.35	4.731	114	96.52%
$17.34	2.853		
$38.14	3.641		
$39.30	3.671		
$40.46	3.700		
$42.77	3.756		
$52.02	3.952		
$30.05	3.403		
$57.79	4.057		
$69.35	4.239		
$161.82	5.087		
$86.69	4.462		
$75.13	4.319		
$46.81	3.846		
$231.18	5.443		
$127.15	4.845		
$52.02	3.952		
$74.96	4.317		
$57.66	4.055		
$23.07	3.138		
$132.62	4.888		
$51.90	3.949		
$57.66	4.055		
$28.83	3.361		
$51.90	3.949		
$46.13	3.831		

Permanent Asphalt Pavement Repair, per Fig. 2000-1

Mean LN(Y)= 3.919

Std. Dev. LN(Y)= 0.450

Increment= 2

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$46.13	3.831		
$38.02	3.638		
$31.11	3.438		
$31.11	3.438		
$33.41	3.509		
$56.70	4.038		
$60.11	4.096		
$56.70	4.038		
$90.73	4.508		
$45.36	3.815		
$45.36	3.815		
$48.77	3.887		
$88.46	4.483		
$43.09	3.763		
$53.87	3.987		
$47.63	3.863		
$45.36	3.815		
$38.56	3.652		
$88.46	4.483		
$69.18	4.237		
$56.31	4.031		
$39.14	3.667		
$50.32	3.918		
$42.49	3.749		
$38.02	3.638		
$34.55	3.543		
$46.89	3.848		
$44.65	3.799		
$46.89	3.848		
$44.65	3.799		
$44.65	3.799		
$35.72	3.576		
$50.23	3.917		
$61.40	4.117		
$50.23	3.917		
$45.77	3.824		
$49.85	3.909		

Permanent Asphalt Pavement Repair, per Fig. 2000-1
Mean LN(Y)= **3.919**
Std. Dev. LN(Y)= **0.450**

Increment= 2

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$27.91	3.329		
$49.12	3.894		
$44.65	3.799		
$55.82	4.022		
$46.89	3.848		
$44.65	3.799		
$50.23	3.917		
$40.19	3.694		
$48.00	3.871		
$27.91	3.329		
$61.40	4.117		
$55.82	4.022		
$48.00	3.871		
$59.51	4.086		
$83.41	4.424		
$155.70	5.048		
$83.41	4.424		
$38.89	3.661		
$22.22	3.101		
$66.67	4.200		
$44.45	3.794		
$75.56	4.325		
$146.68	4.988		
$27.80	3.325		
$31.13	3.438		
$66.71	4.200		
$38.92	3.661		
$33.36	3.507		
$50.04	3.913		
$38.92	3.661		
$41.14	3.717		
$40.03	3.690		
$42.25	3.744		
$26.39	3.273		
$55.53	4.017		
$44.42	3.794		
$77.74	4.353		

Permanent Asphalt Pavement Repair, per Fig. 2000-1
Mean LN(Y)= 3.919
Std. Dev. LN(Y)= 0.450

Increment= 2

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$33.32	3.506		
$63.31	4.148		
$44.42	3.794		
$27.77	3.324		
$33.32	3.506		
$55.53	4.017		
$55.53	4.017		
$25.54	3.240		
$66.64	4.199		
$62.19	4.130		
$60.91	4.109		
$66.45	4.196		
$110.75	4.707		
$60.91	4.109		
$49.06	3.893		
$38.76	3.657		
$50.94	3.931		
$44.30	3.791		
$50.94	3.931		
$55.37	4.014		
$22.15	3.098		
$44.30	3.791		
$38.76	3.657		
$54.27	3.994		
$71.99	4.276		
$55.37	4.014		
$43.24	3.767		
$59.45	4.085		
$64.86	4.172		
$54.05	3.990		
$54.05	3.990		
$48.64	3.885		
$59.69	4.089		
$54.26	3.994		
$54.26	3.994		
$46.67	3.843		
$57.14	4.045		

Permanent Asphalt Pavement Repair, per Fig. 2000-1
Mean LN(Y)= **3.919**
Std. Dev. LN(Y)= **0.450**

Increment= 2

Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$54.26	3.994		
$48.84	3.888		
$40.15	3.693		
$26.59	3.280		
$65.31	4.179		
$59.87	4.092		
$97.96	4.585		
$58.23	4.064		
$217.69	5.383		
$19.22	2.956		
$51.26	3.937		
$53.40	3.978		
$52.05	3.952		
$63.74	4.155		
$106.23	4.666		
$37.00	3.611		
$61.31	4.116		
$58.14	4.063		
$81.39	4.399		
$73.99	4.304		
$44.39	3.793		
$45.45	3.817		
$42.28	3.744		
$42.28	3.744		
$40.17	3.693		
$44.39	3.793		
$47.57	3.862		
$5.28	1.664		
$5.28	1.664		
$5.56	1.715		
$42.26	3.744		
$55.99	4.025		
$21.13	3.051		
$49.56	3.903		
$47.45	3.860		
$39.55	3.677		
$47.45	3.860		

Permanent Asphalt Pavement Repair, per Fig. 2000-1
Mean LN(Y)= 3.919
Std. Dev. LN(Y)= 0.450

Increment= 2

Adjusted Unit Price Data (Y)	LN(Y)	X	Log-Normal Dist. Cum. Prob.
$58.00	4.060		
$31.64	3.454		
$49.56	3.903		
$46.40	3.837		
$46.40	3.837		
$48.51	3.882		
$52.73	3.965		
$52.73	3.965		
$55.52	4.017		
$52.73	3.965		
$42.18	3.742		
$47.45	3.860		
$89.64	4.496		
$79.09	4.371		
$94.91	4.553		
$105.45	4.658		
$79.09	4.371		
$179.27	5.189		
$94.91	4.553		
$94.91	4.553		
$63.27	4.147		
$101.24	4.617		
$52.73	3.965		
$46.40	3.837		
$27.42	3.311		
$50.62	3.924		
$46.40	3.837		
$48.49	3.881		
$51.65	3.945		
$48.49	3.881		
$47.43	3.859		
$54.81	4.004		
$42.16	3.742		
$52.70	3.965		
$52.70	3.965		
$42.16	3.742		
$52.70	3.965		

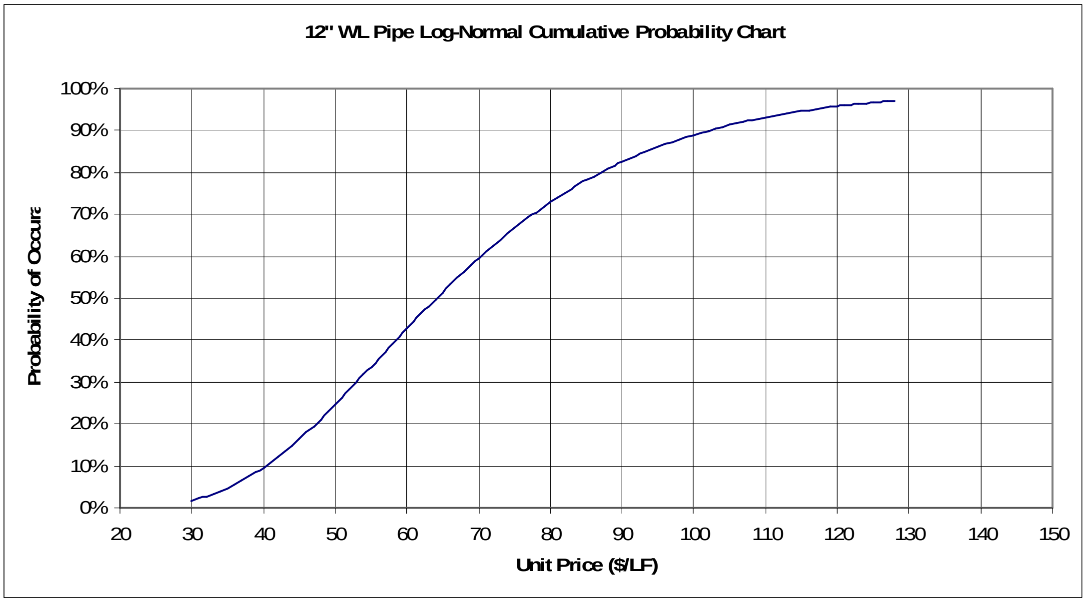
Permanent Asphalt Pavement Repair, per Fig. 2000-1
Mean LN(Y)= **3.919**
Std. Dev. LN(Y)= **0.450**

Increment= 2

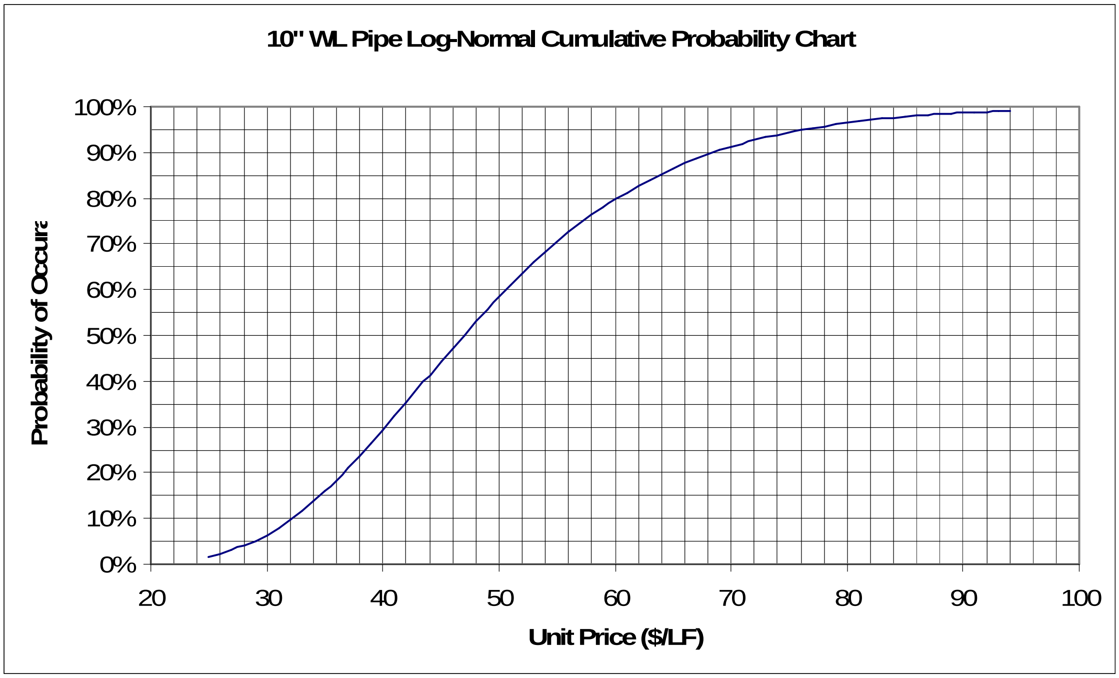
Adjusted Unit Price Data (Y)	**LN(Y)**	**X**	**Log-Normal Dist. Cum. Prob.**
$42.16	3.742		
$47.27	3.856		
$63.03	4.144		
$68.28	4.224		
$34.03	3.527		
$52.52	3.961		

APPENDIX D

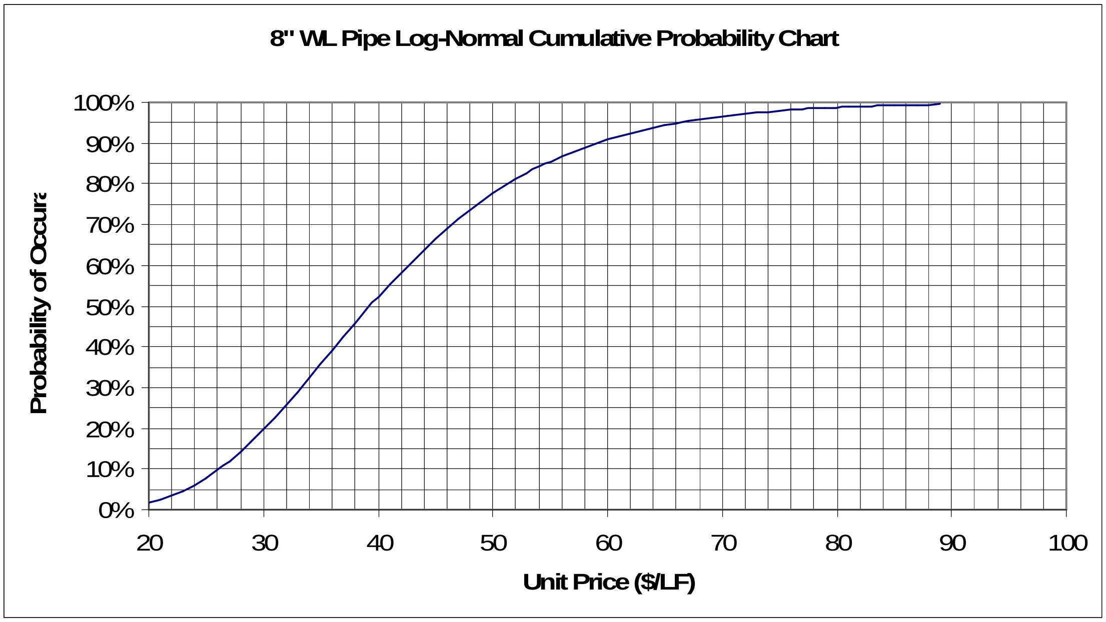
COST ITEM PROBABILITY CHARTS AND TABLES



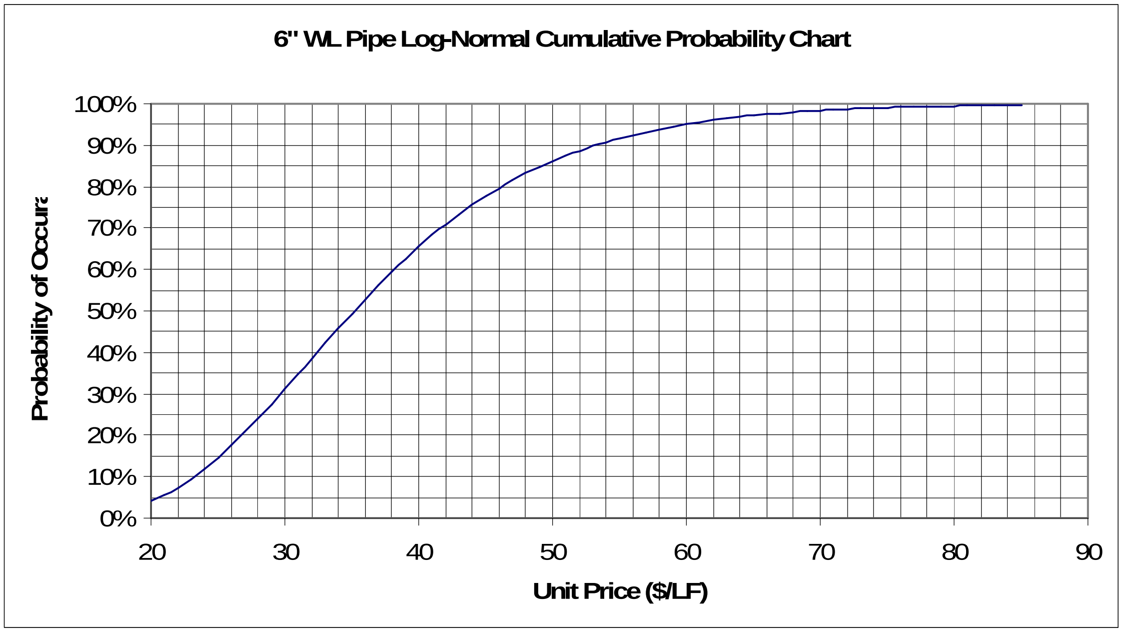
Estimated Unit Price ($/LF)	Probability of Under-run
40.30	10%
44.04	15%
47.27	20%
50.22	25%
53.03	30%
55.77	35%
58.51	40%
61.28	45%
64.14	50%
67.13	55%
70.31	60%
73.76	65%
77.57	70%
81.91	75%
87.03	80%
93.40	85%
102.09	90%
116.46	95%
135.08	98%



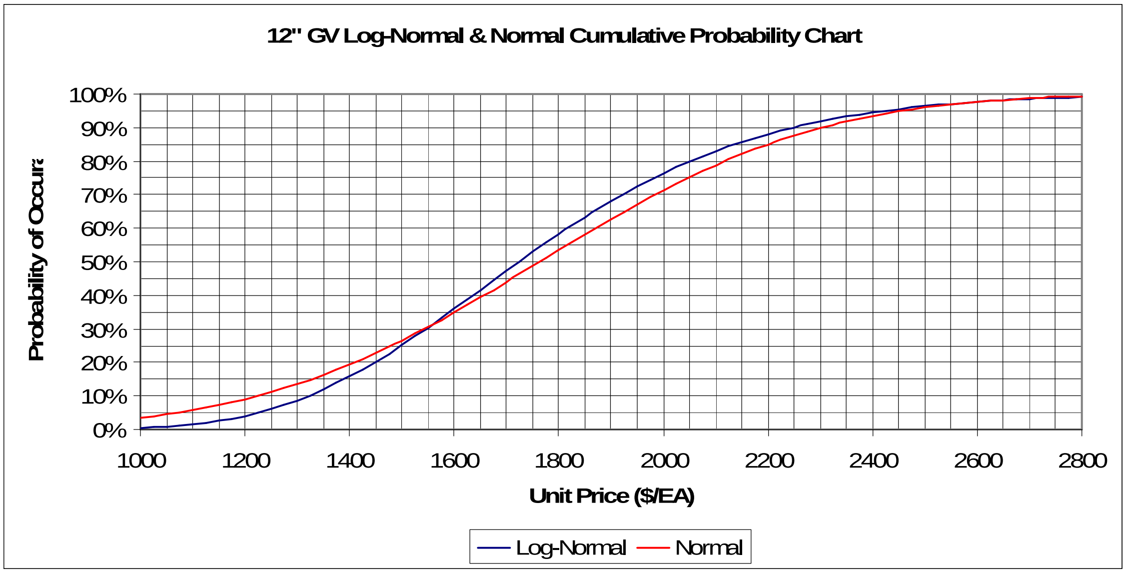
Estimated Unit Price ($/LF)	Probability of Under-run
$32	10%
$35	15%
$37	20%
$38	25%
$40	30%
$42	35%
$44	40%
$45	45%
$47	50%
$49	55%
$51	60%
$53	65%
$55	70%
$57	75%
$60	80%
$64	85%
$68	90%
$76	95%
$86	98%



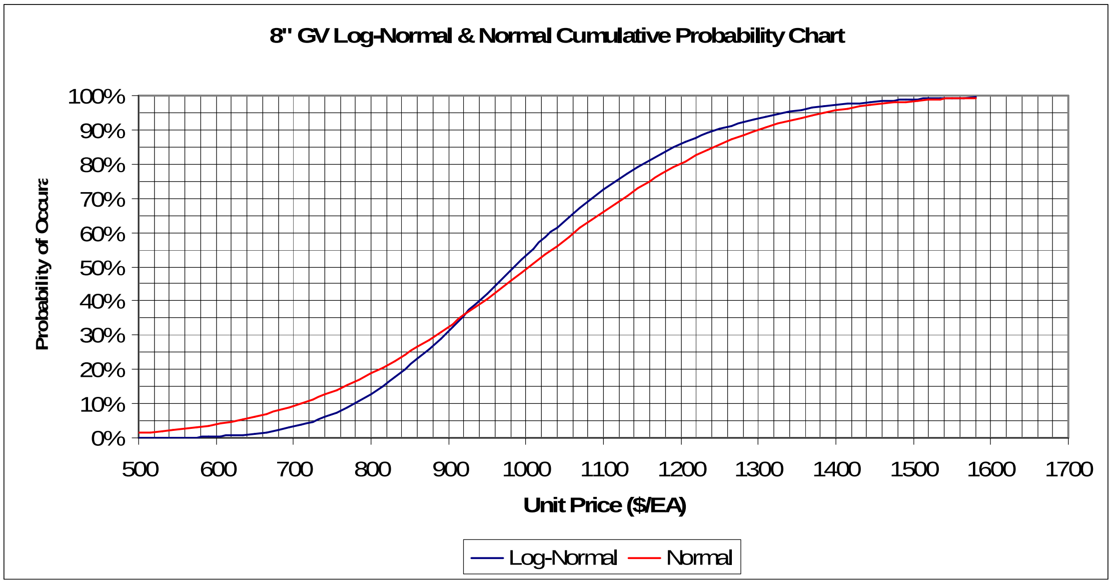
Estimated Unit Price ($/LF)	Probability of Under-run
26.17	10%
28.29	15%
30.09	20%
31.73	25%
33.28	30%
34.78	35%
36.27	40%
37.77	45%
39.31	50%
40.90	55%
42.60	60%
44.42	65%
46.42	70%
48.69	75%
51.34	80%
54.61	85%
59.03	90%
66.25	95%
75.43	98%



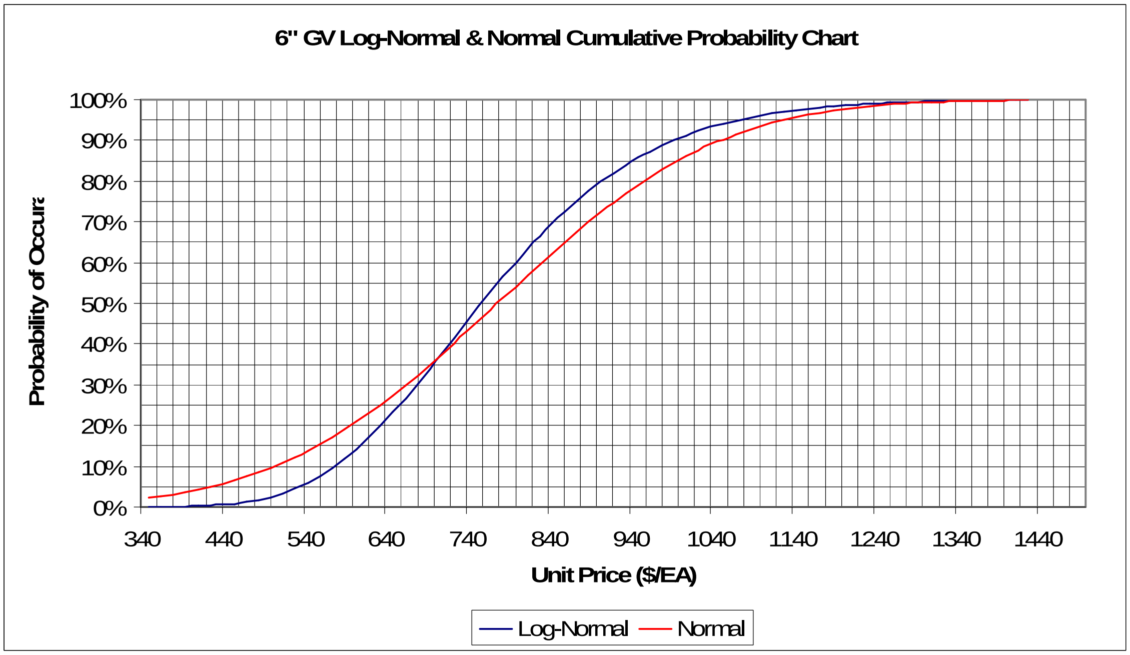
Estimated Unit Price ($/LF)	Probability of Under-run
23.22	10%
25.14	15%
26.78	20%
28.26	25%
29.67	30%
31.04	35%
32.39	40%
33.76	45%
35.16	50%
36.62	55%
38.17	60%
39.83	65%
41.66	70%
43.74	75%
46.17	80%
49.18	85%
53.24	90%
59.88	95%
68.35	98%



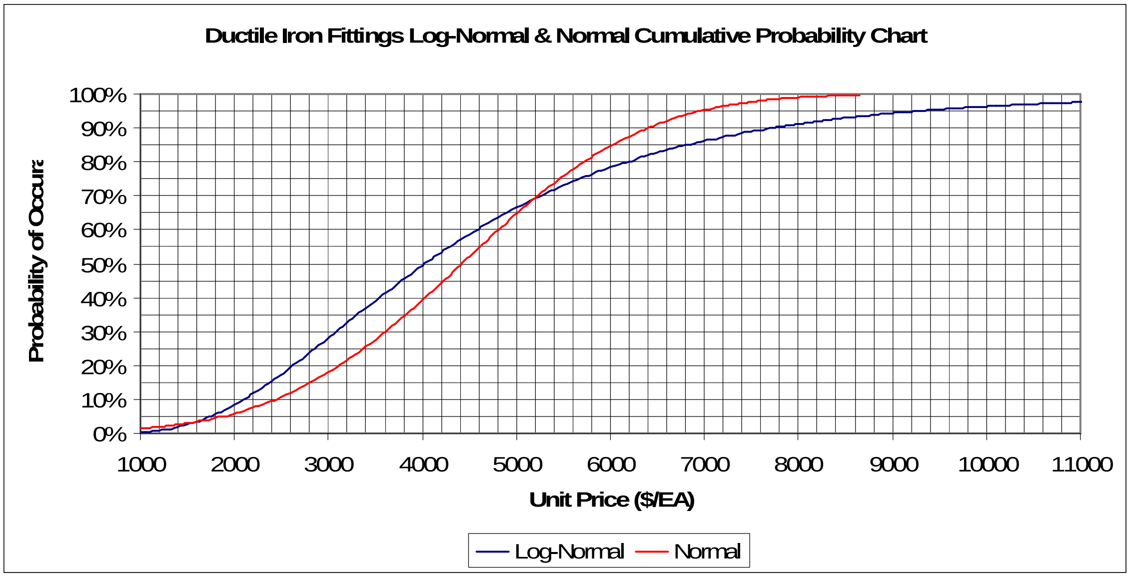
Log-Normal		Normal	
Estimated Unit Price ($/LF)	Probability of Under-run	Estimated Unit Price ($/LF)	Probability of Under-run
$1,321.76	10%	$1,224.22	10%
$1,390.61	15%	$1,327.41	15%
$1,447.87	20%	$1,409.43	20%
$1,498.88	25%	$1,479.79	25%
$1,546.21	30%	$1,542.98	30%
$1,591.40	35%	$1,601.53	35%
$1,635.51	40%	$1,657.09	40%
$1,679.35	45%	$1,710.84	45%
$1,723.63	50%	$1,763.75	50%
$1,769.09	55%	$1,816.65	55%
$1,816.51	60%	$1,870.41	60%
$1,866.85	65%	$1,925.97	65%
$1,921.42	70%	$1,984.52	70%
$1,982.09	75%	$2,047.71	75%
$2,051.92	80%	$2,118.07	80%
$2,136.42	85%	$2,200.08	85%
$2,247.70	90%	$2,303.28	90%
$2,423.38	95%	$2,456.23	95%



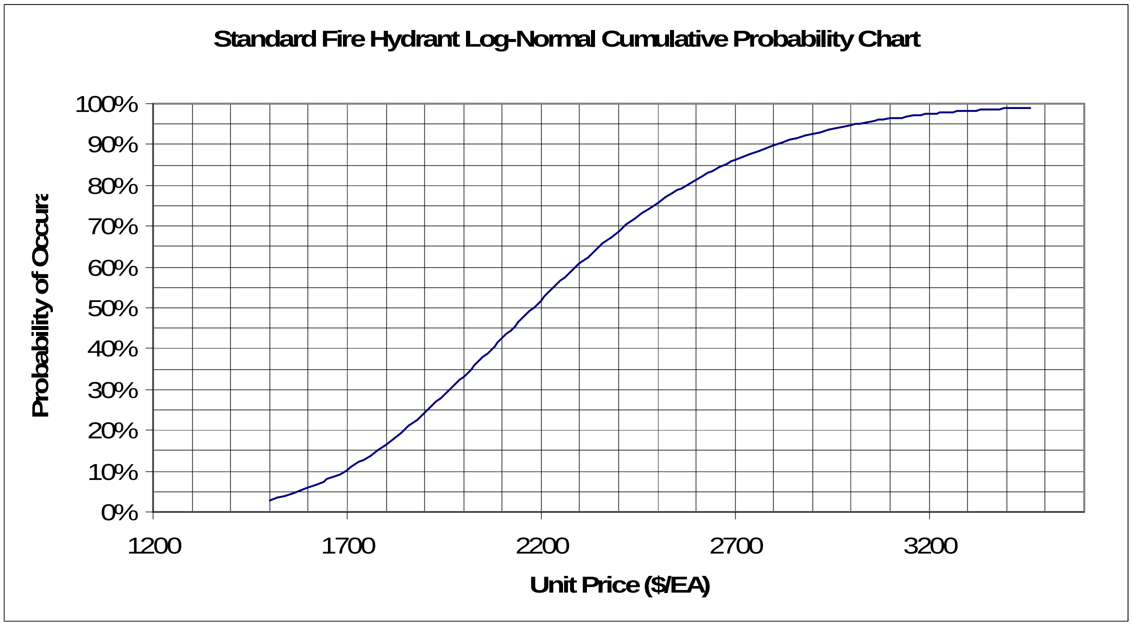
Log-Normal		Normal	
Estimated Unit Price ($/LF)	Probability of Under-run	Estimated Unit Price ($/LF)	Probability of Under-run
$778.07	10%	$708.88	10%
$814.00	15%	$765.38	15%
$843.72	20%	$810.28	20%
$870.09	25%	$848.80	25%
$894.47	30%	$883.39	30%
$917.67	35%	$915.45	35%
$940.24	40%	$945.87	40%
$962.61	45%	$975.29	45%
$985.14	50%	$1,004.26	50%
$1,008.20	55%	$1,033.22	55%
$1,032.19	60%	$1,062.65	60%
$1,057.58	65%	$1,093.07	65%
$1,085.01	70%	$1,125.12	70%
$1,115.41	75%	$1,159.71	75%
$1,150.27	80%	$1,198.23	80%
$1,192.28	85%	$1,243.13	85%
$1,247.32	90%	$1,299.63	90%
$1,333.61	95%	$1,383.36	95%



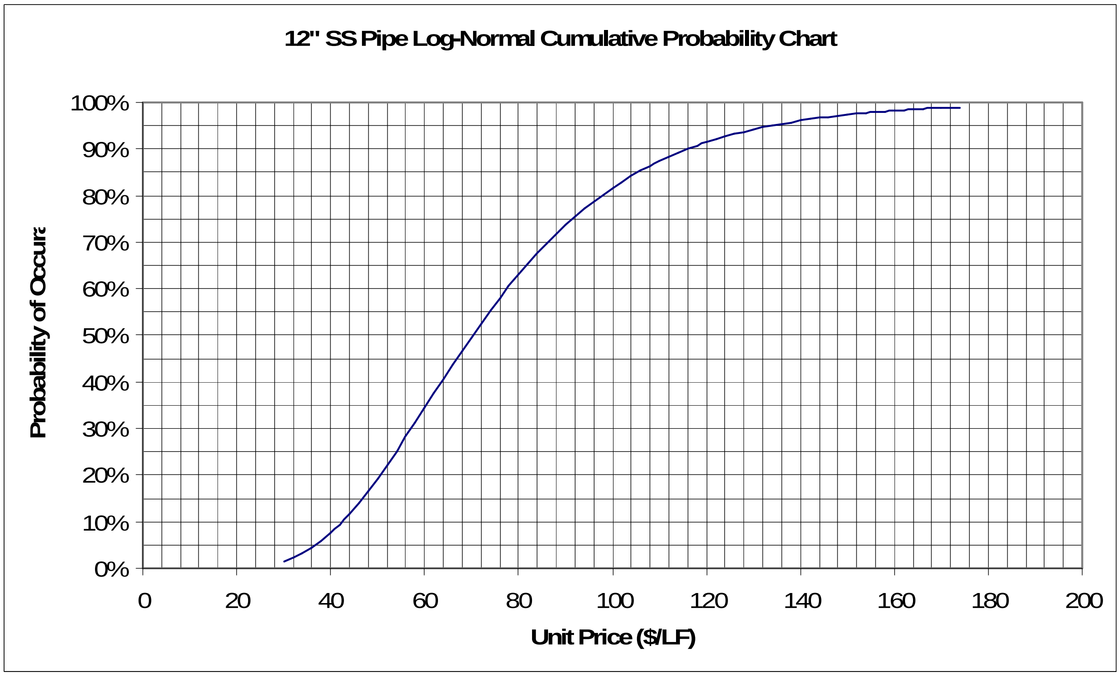
Log-Normal		Normal	
Estimated Unit Price ($/LF)	**Probability of Under-run**	**Estimated Unit Price ($/LF)**	**Probability of Under-run**
$578.45	10%	$504.30	10%
$609.19	15%	$556.65	15%
$634.79	20%	$598.25	20%
$657.60	25%	$633.94	25%
$678.78	30%	$665.99	30%
$699.01	35%	$695.69	35%
$718.77	40%	$723.87	40%
$738.42	45%	$751.14	45%
$758.29	50%	$777.98	50%
$778.68	55%	$804.81	55%
$799.97	60%	$832.08	60%
$822.59	65%	$860.26	65%
$847.11	70%	$889.96	70%
$874.40	75%	$922.01	75%
$905.82	80%	$957.70	80%
$943.87	85%	$999.30	85%
$994.03	90%	$1,051.65	90%
$1,073.31	95%	$1,129.23	95%



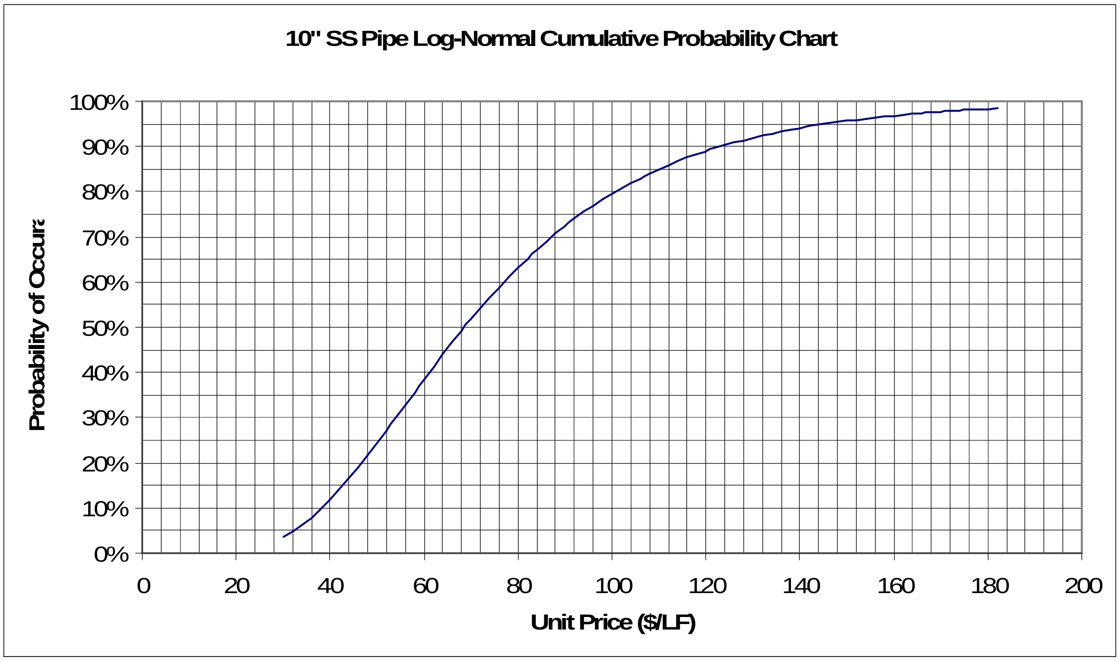
Log-Normal		Normal	
Estimated Unit Price ($/LF)	**Probability of Under-run**	**Estimated Unit Price ($/LF)**	**Probability of Under-run**
$2,100.14	10%	$2,436.69	10%
$2,378.65	15%	$2,815.93	15%
$2,626.12	20%	$3,117.34	20%
$2,858.85	25%	$3,375.92	25%
$3,085.37	30%	$3,608.14	30%
$3,311.27	35%	$3,823.32	35%
$3,540.89	40%	$4,027.50	40%
$3,778.21	45%	$4,225.06	45%
$4,027.28	50%	$4,419.48	50%
$4,292.78	55%	$4,613.90	55%
$4,580.48	60%	$4,811.45	60%
$4,898.13	65%	$5,015.64	65%
$5,256.75	70%	$5,230.82	70%
$5,673.26	75%	$5,463.03	75%
$6,176.03	80%	$5,721.61	80%
$6,818.57	85%	$6,023.02	85%
$7,722.83	90%	$6,402.26	90%
$9,288.30	95%	$6,964.36	95%



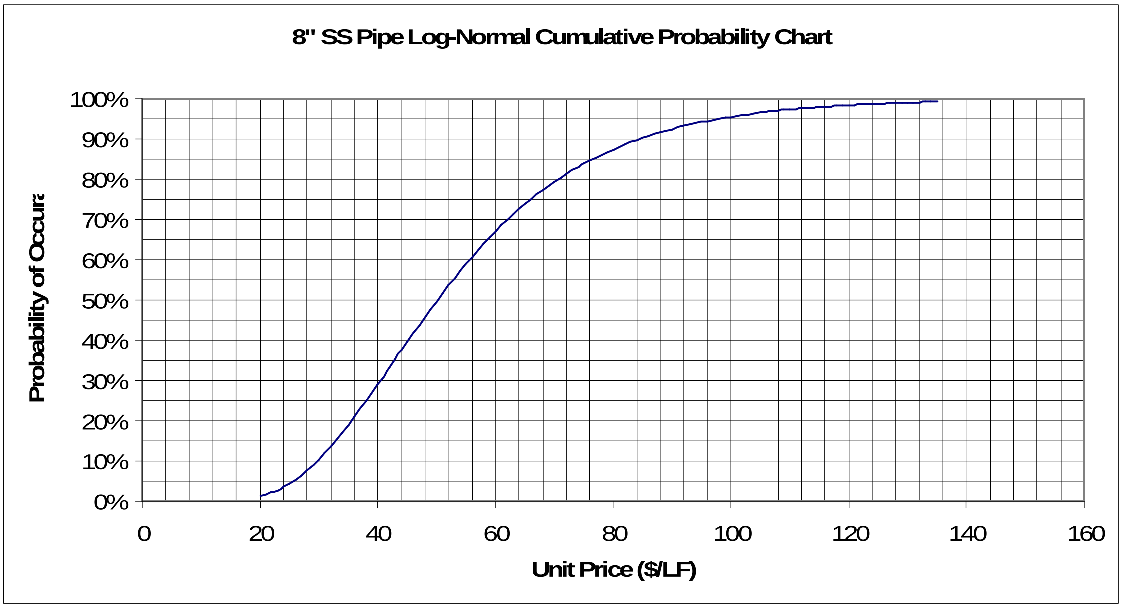
Estimated Unit Price ($/LF)	Probability of Under-run
$1,693	10%
$1,777	15%
$1,846	20%
$1,908	25%
$1,965	30%
$2,020	35%
$2,073	40%
$2,126	45%
$2,179	50%
$2,234	55%
$2,291	60%
$2,351	65%
$2,416	70%
$2,489	75%
$2,572	80%
$2,673	85%
$2,805	90%
$3,013	95%



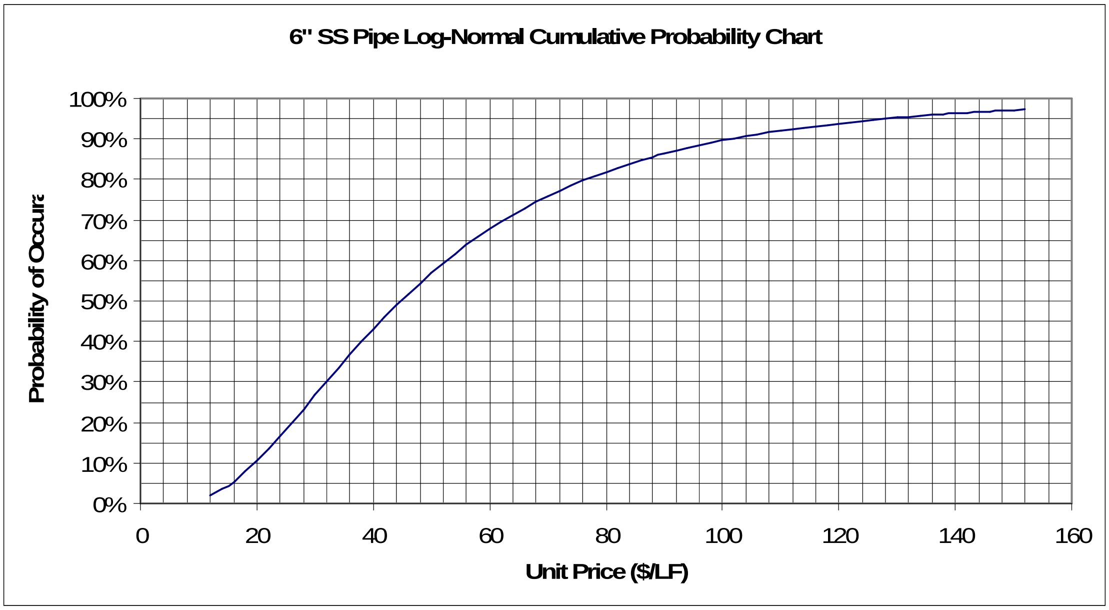
Estimated Unit Price ($/LF)	Probability of Under-run
$42.52	10%
$46.80	15%
$50.52	20%
$53.93	25%
$57.20	30%
$60.41	35%
$63.61	40%
$66.88	45%
$70.25	50%
$73.80	55%
$77.59	60%
$81.70	65%
$86.28	70%
$91.51	75%
$97.70	80%
$105.45	85%
$116.09	90%
$133.85	95%



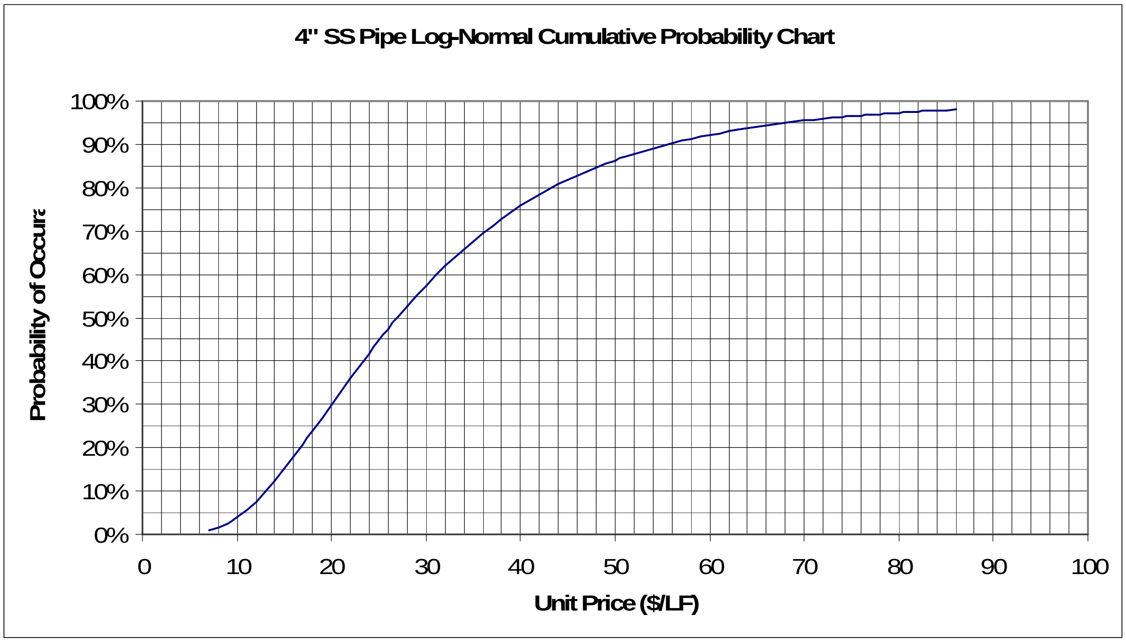
Estimated Unit Price ($/LF)	Probability of Under-run
$38.23	10%
$43.00	15%
$47.18	21%
$51.08	26%
$54.86	31%
$58.61	37%
$62.43	42%
$66.37	47%
$70.52	52%
$74.97	58%
$79.83	63%
$85.26	68%
$91.51	74%
$98.98	79%
$108.43	84%
$121.58	90%
$144.09	95%
$175.18	98%



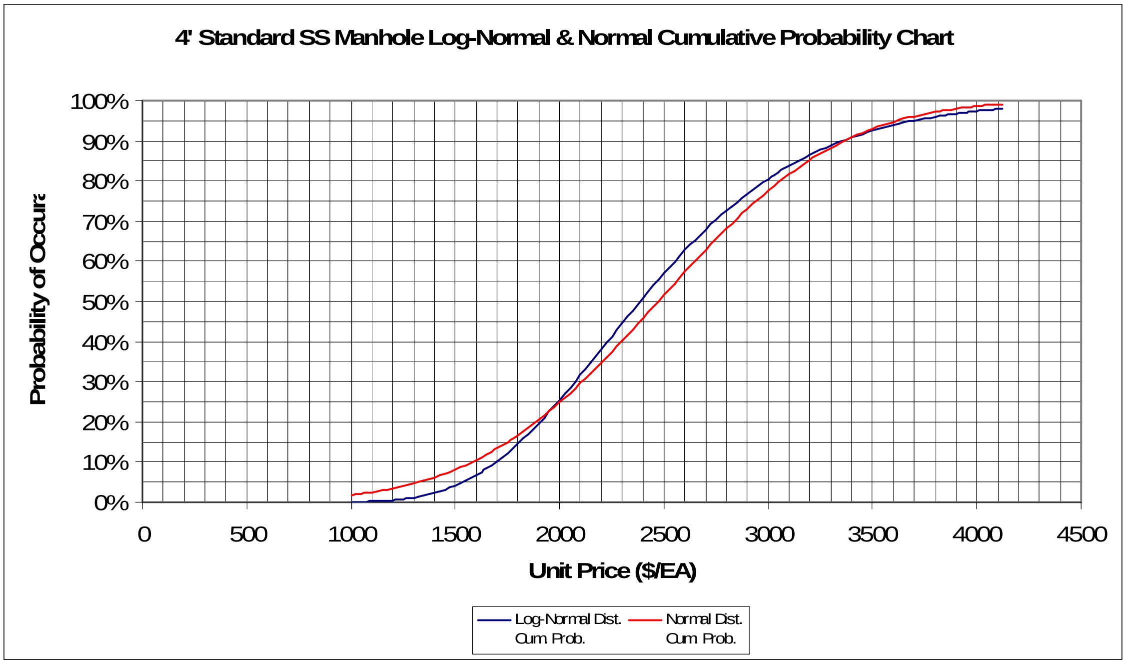
Estimated Unit Price ($/LF)	Probability of Under-run
$29.71	10%
$32.83	15%
$35.55	20%
$38.05	25%
$40.46	30%
$42.82	35%
$45.18	40%
$47.60	45%
$50.10	50%
$52.73	55%
$55.55	60%
$58.62	65%
$62.04	70%
$65.96	75%
$70.61	80%
$76.44	85%
$84.48	90%
$97.96	95%



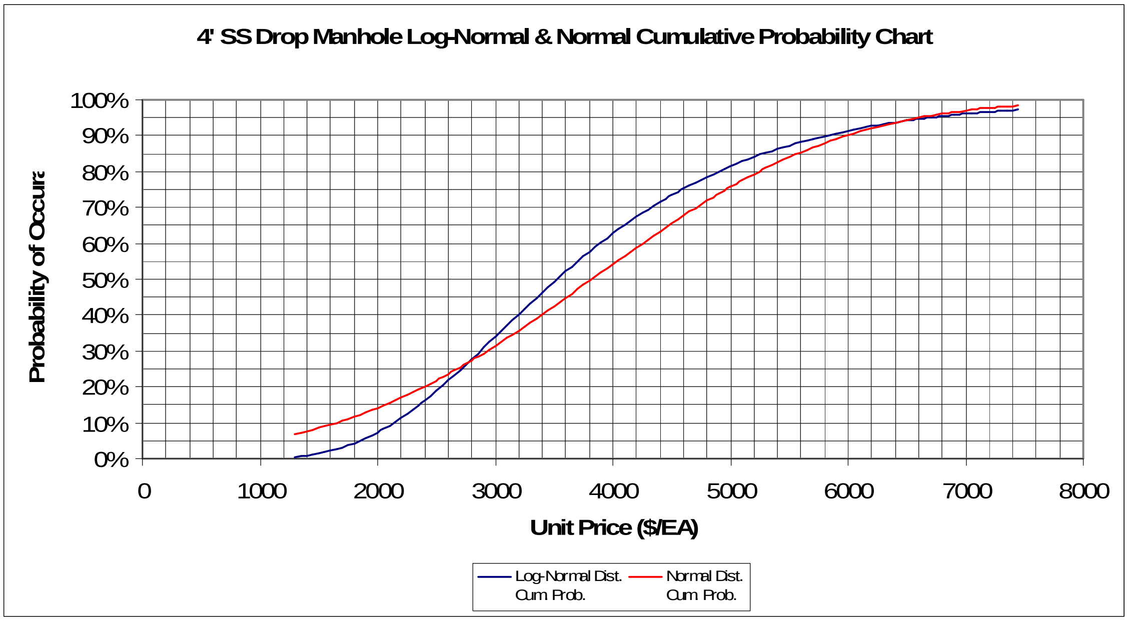
Estimated Unit Price ($/LF)	Probability of Under-run
$19.66	10%
$23.00	15%
$26.06	20%
$29.01	25%
$31.93	30%
$34.91	35%
$37.99	40%
$41.23	45%
$44.68	50%
$48.43	55%
$52.56	60%
$57.19	65%
$62.52	70%
$68.83	75%
$76.61	80%
$86.79	85%
$101.54	90%
$128.15	95%



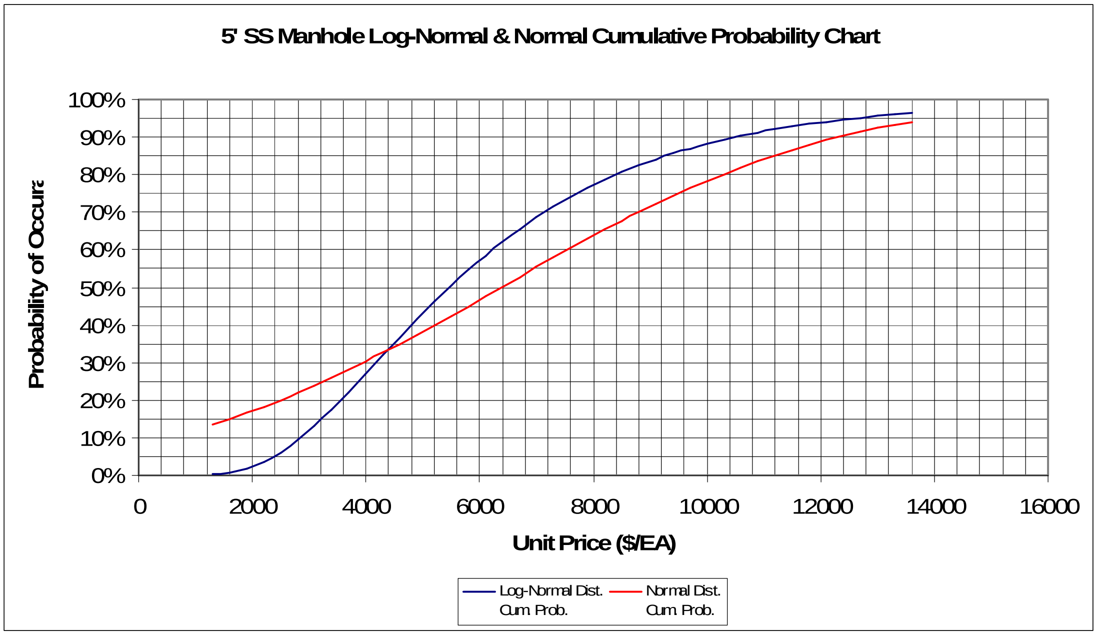
Estimated Unit Price ($/LF)	Probability of Under-run
$13.08	10%
$15.02	15%
$16.77	20%
$18.43	25%
$20.05	30%
$21.69	35%
$23.37	40%
$25.11	45%
$26.96	50%
$28.94	55%
$31.10	60%
$33.50	65%
$36.24	70%
$39.44	75%
$43.34	80%
$48.37	85%
$55.54	90%
$68.18	95%
$85.87	98%



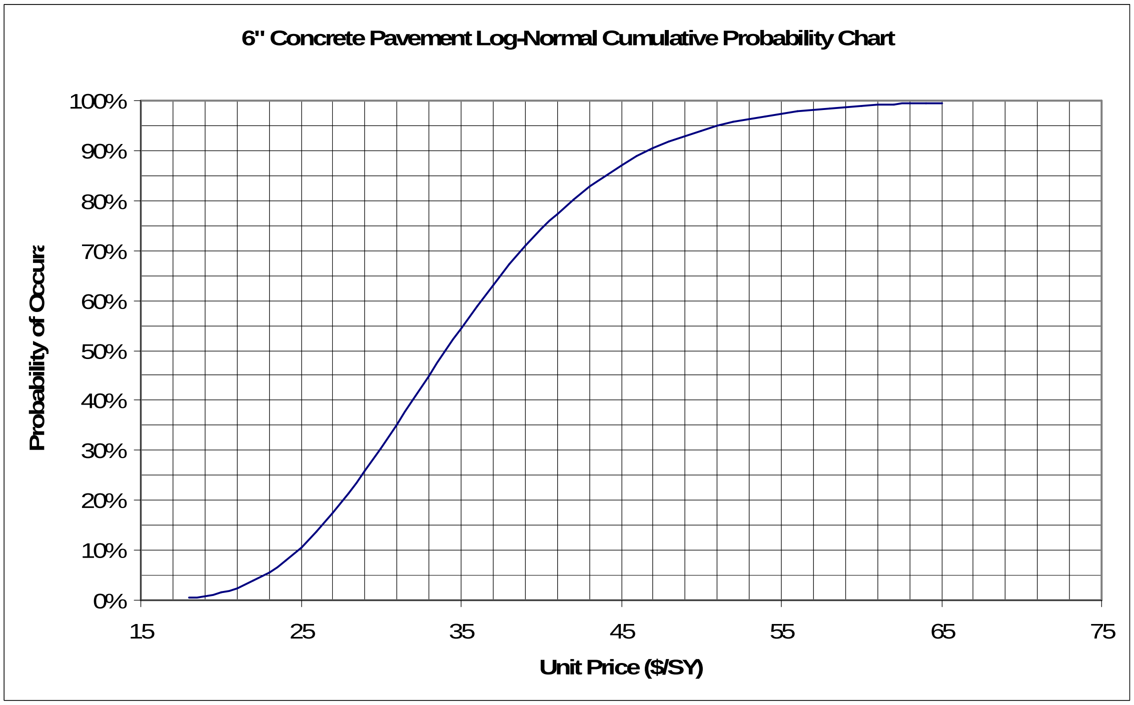
Log-Normal		Normal	
Estimated Unit Price ($/LF)	**Probability of Under-run**	**Estimated Unit Price ($/LF)**	**Probability of Under-run**
$1,695.44	10%	$1,580.36	10%
$1,809.84	15%	$1,750.99	15%
$1,906.25	20%	$1,886.61	20%
$1,993.04	25%	$2,002.95	25%
$2,074.35	30%	$2,107.43	30%
$2,152.64	35%	$2,204.25	35%
$2,229.67	40%	$2,296.12	40%
$2,306.82	45%	$2,385.00	45%
$2,385.35	50%	$2,472.48	50%
$2,466.55	55%	$2,559.95	55%
$2,551.90	60%	$2,648.84	60%
$2,643.21	65%	$2,740.71	65%
$2,742.98	70%	$2,837.53	70%
$2,854.88	75%	$2,942.01	75%
$2,984.86	80%	$3,058.35	80%
$3,143.86	85%	$3,193.96	85%
$3,356.00	90%	$3,364.59	90%
$3,697.04	95%	$3,617.50	95%



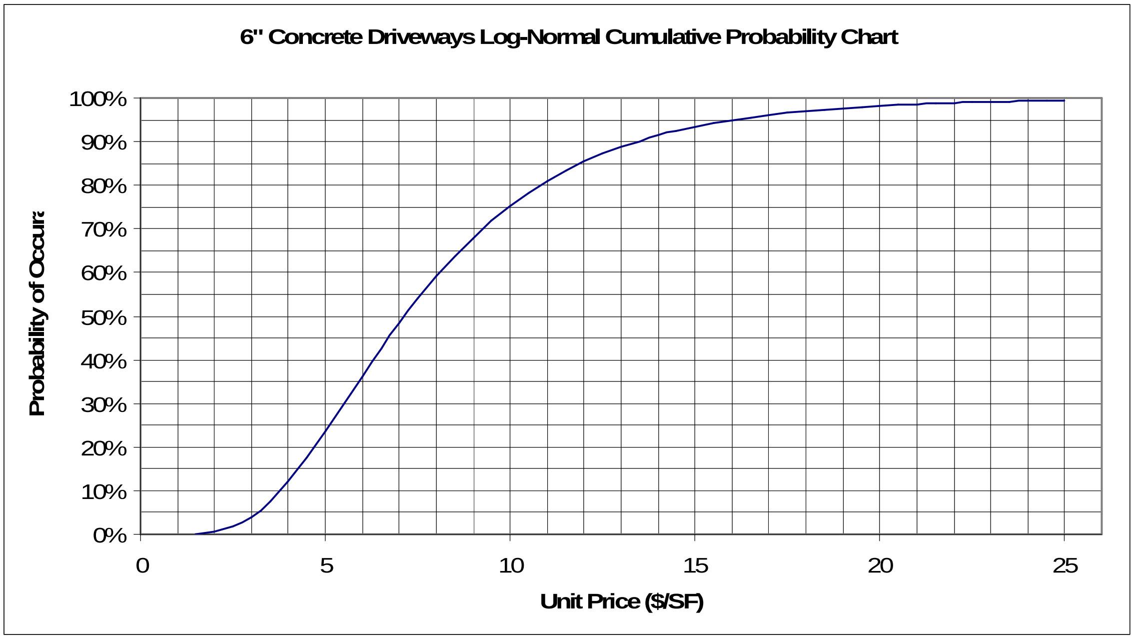
Log-Normal		Normal	
Estimated Unit Price ($/LF)	**Probability of Under-run**	**Estimated Unit Price ($/LF)**	**Probability of Under-run**
$2,137.39	10%	$1,650.89	10%
$2,351.87	15%	$2,065.79	15%
$2,537.58	20%	$2,395.53	20%
$2,708.55	25%	$2,678.42	25%
$2,871.88	30%	$2,932.46	30%
$3,032.01	35%	$3,167.87	35%
$3,192.20	40%	$3,391.25	40%
$3,355.24	45%	$3,607.38	45%
$3,523.83	50%	$3,820.07	50%
$3,700.88	55%	$4,032.77	55%
$3,889.90	60%	$4,248.89	60%
$4,095.42	65%	$4,472.27	65%
$4,323.77	70%	$4,707.68	70%
$4,584.50	75%	$4,961.73	75%
$4,893.38	80%	$5,244.62	80%
$5,279.78	85%	$5,574.36	85%
$5,809.60	90%	$5,989.25	90%
$6,694.22	95%	$6,604.18	95%
$7,851.96	98%	$7,296.29	98%



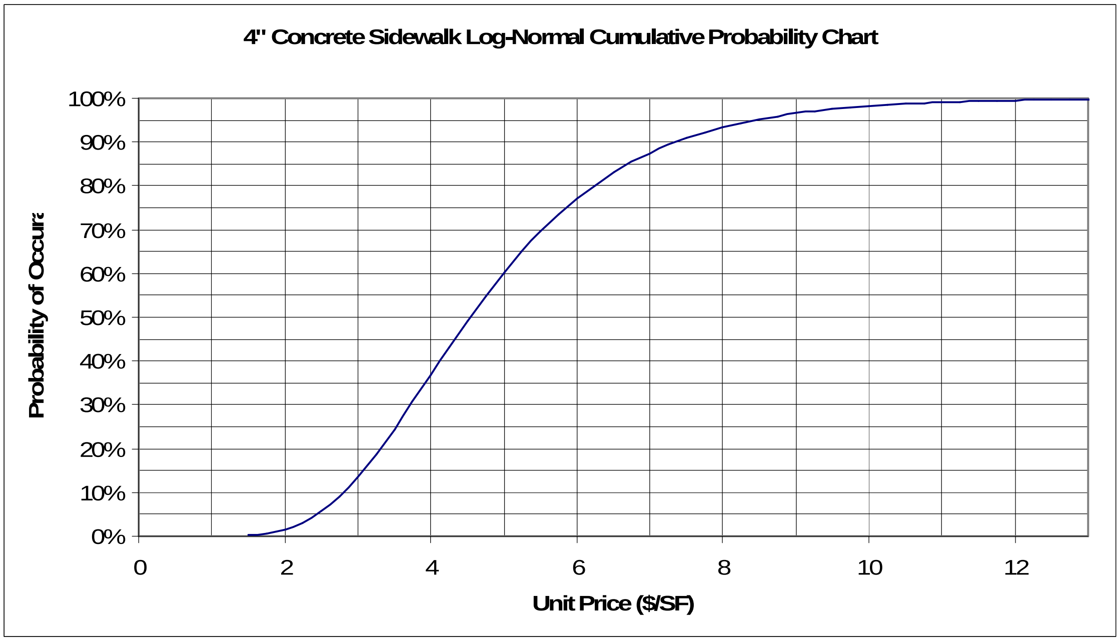
Log-Normal		Normal	
Estimated Unit Price ($/LF)	Probability of Under-run	Estimated Unit Price ($/LF)	Probability of Under-run
$2,846.41	10%	$451.61	10%
$3,224.80	15%	$1,585.37	15%
$3,561.09	20%	$2,486.44	20%
$3,877.42	25%	$3,259.48	25%
$4,185.37	30%	$3,953.70	30%
$4,492.52	35%	$4,596.99	35%
$4,804.79	40%	$5,207.42	40%
$5,127.56	45%	$5,798.01	45%
$5,466.37	50%	$6,379.24	50%
$5,827.58	55%	$6,960.46	55%
$6,219.06	60%	$7,551.05	60%
$6,651.34	65%	$8,161.48	65%
$7,139.46	70%	$8,804.77	70%
$7,706.48	75%	$9,498.99	75%
$8,391.03	80%	$10,272.03	80%
$9,266.08	85%	$11,173.10	85%
$10,497.88	90%	$12,306.86	90%
$12,631.13	95%	$13,987.26	95%
$15,554.82	98%	$15,878.55	98%



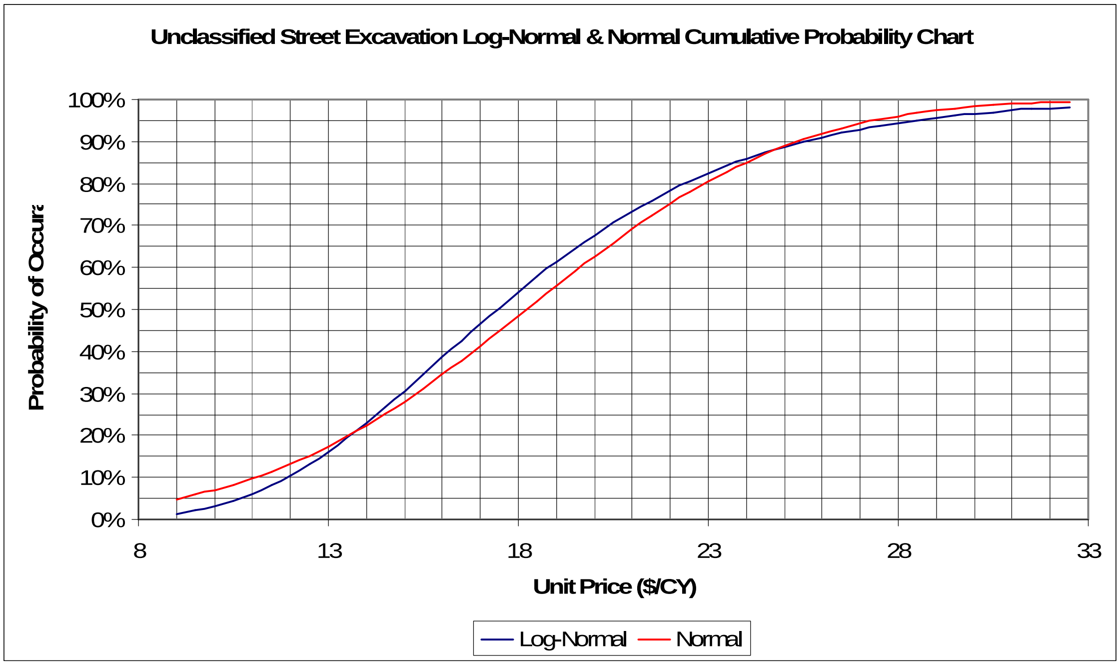
Estimated Unit Price ($/SY)	Probability of Under-run
$24.82	10%
$26.37	15%
$27.67	20%
$28.83	25%
$29.92	30%
$30.97	35%
$31.99	40%
$33.01	45%
$34.05	50%
$35.13	55%
$36.25	60%
$37.45	65%
$38.76	70%
$40.22	75%
$41.91	80%
$43.98	85%
$46.72	90%
$51.10	95%
$56.53	98%



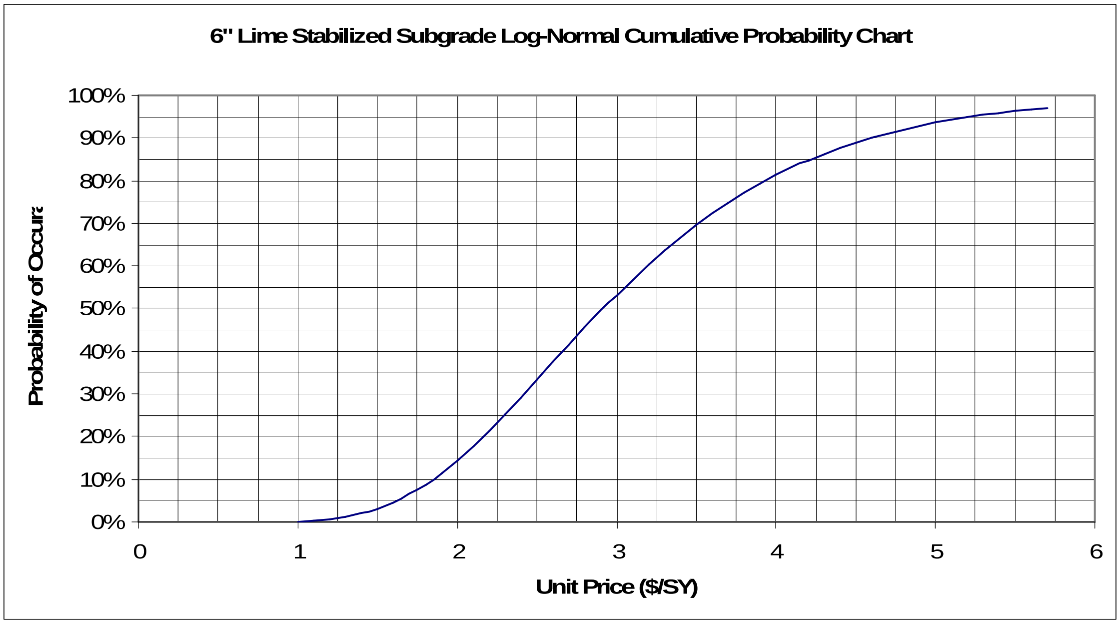
Estimated Unit Price ($/SF)	Probability of Under-run
$3.79	10%
$4.28	15%
$4.71	20%
$5.11	25%
$5.51	30%
$5.90	35%
$6.30	40%
$6.71	45%
$7.13	50%
$7.59	55%
$8.09	60%
$8.63	65%
$9.24	70%
$9.95	75%
$10.81	80%
$11.90	85%
$13.43	90%
$16.07	95%
$19.67	98%



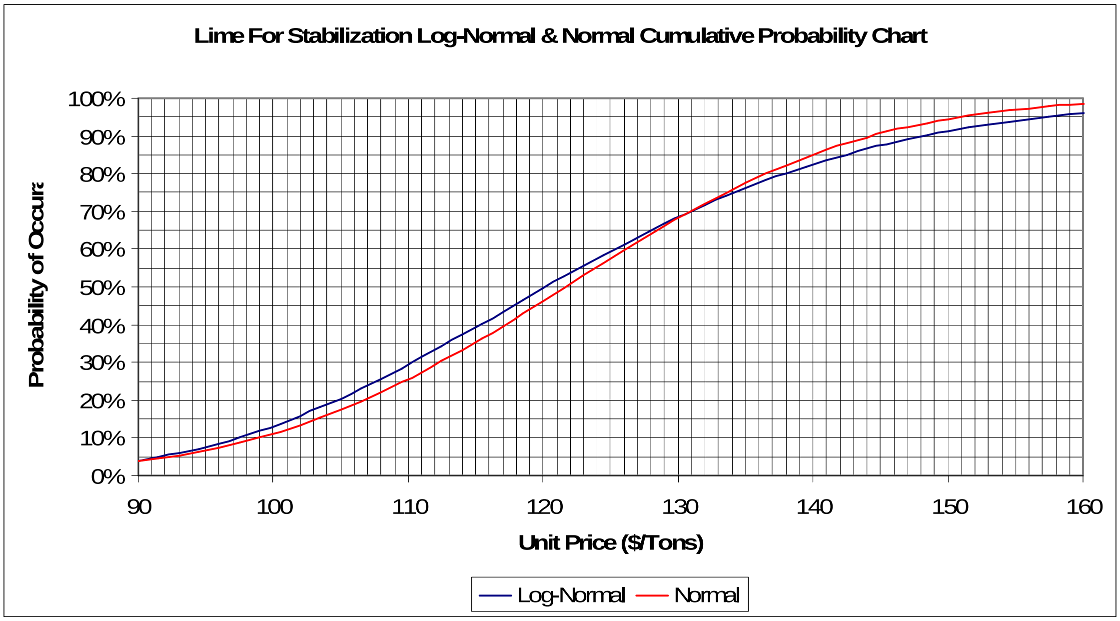
Estimated Unit Price ($/SF)	Probability of Under-run
$2.80	10%
$3.07	15%
$3.30	20%
$3.52	25%
$3.72	30%
$3.92	35%
$4.12	40%
$4.33	45%
$4.54	50%
$4.76	55%
$4.99	60%
$5.25	65%
$5.53	70%
$5.85	75%
$6.23	80%
$6.71	85%
$7.35	90%
$8.43	95%
$9.84	98%



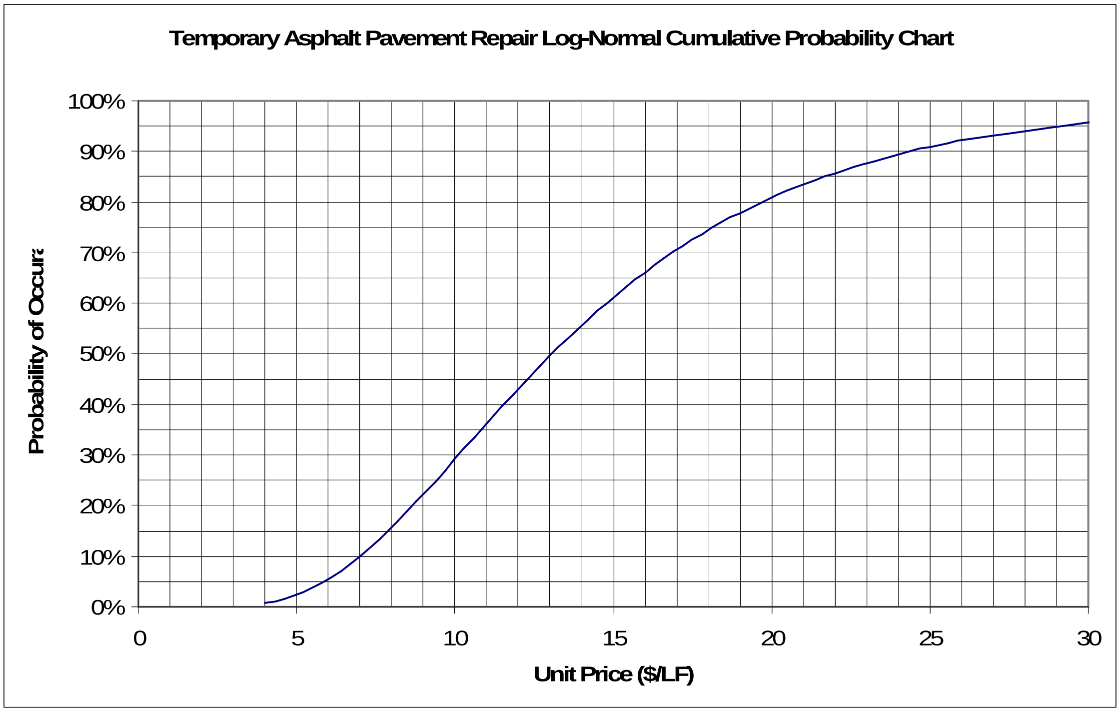
Log-Normal		Normal	
Estimated Unit Price ($/CY)	Probability of Under-run	Estimated Unit Price ($/CY)	Probability of Under-run
$11.91	10%	$11.10	10%
$12.81	15%	$12.46	15%
$13.58	20%	$13.54	20%
$14.27	25%	$14.47	25%
$14.92	30%	$15.31	30%
$15.55	35%	$16.08	35%
$16.17	40%	$16.82	40%
$16.80	45%	$17.53	45%
$17.44	50%	$18.23	50%
$18.11	55%	$18.92	55%
$18.81	60%	$19.63	60%
$19.56	65%	$20.37	65%
$20.39	70%	$21.14	70%
$21.32	75%	$21.98	75%
$22.41	80%	$22.91	80%
$23.75	85%	$23.99	85%
$25.54	90%	$25.35	90%
$28.46	95%	$27.37	95%
$32.15	98%	$29.65	98%



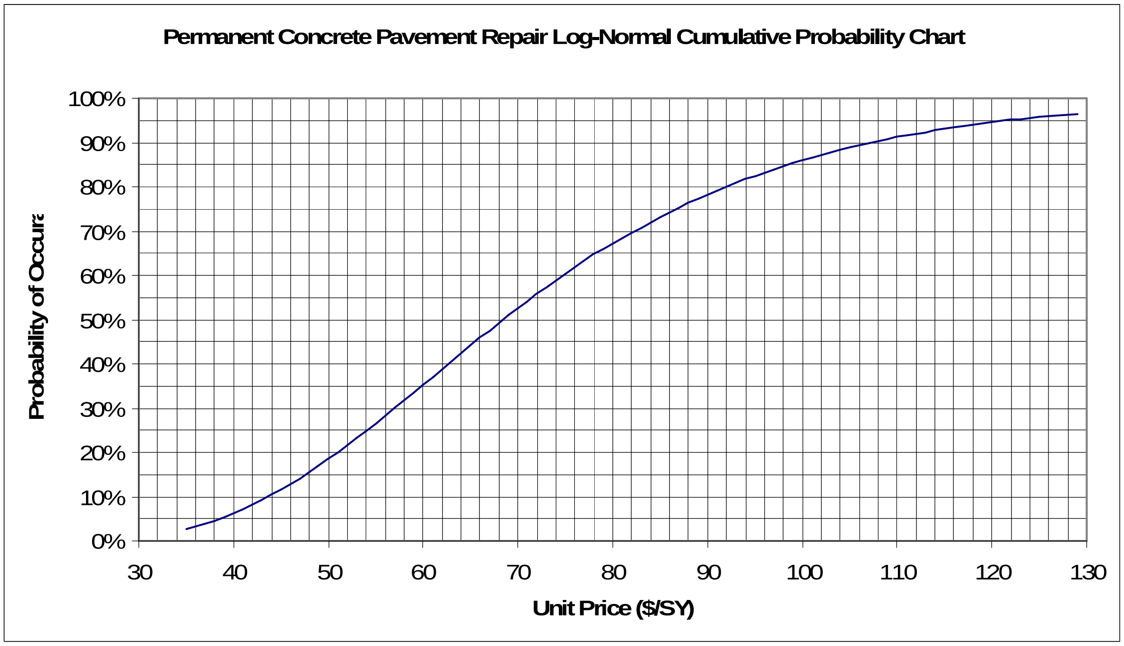
Estimated Unit Price ($/SY)	Probability of Under-run
$1.85	10%
$2.02	15%
$2.16	20%
$2.29	25%
$2.42	30%
$2.54	35%
$2.66	40%
$2.79	45%
$2.91	50%
$3.05	55%
$3.19	60%
$3.34	65%
$3.51	70%
$3.70	75%
$3.93	80%
$4.21	85%
$4.60	90%
$5.23	95%
$6.05	98%



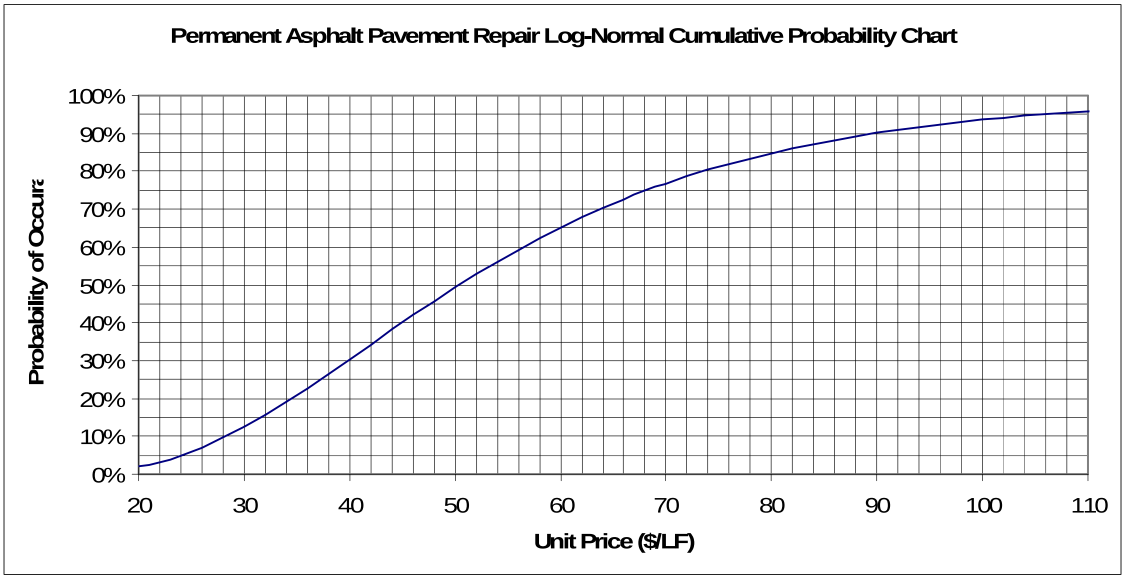
Log-Normal		Normal	
Estimated Unit Price ($/Tons)	Probability of Under-run	Estimated Unit Price ($/Tons)	Probability of Under-run
$97.48	10%	$98.92	10%
$101.46	15%	$103.27	15%
$104.75	20%	$106.72	20%
$107.65	25%	$109.68	25%
$110.32	30%	$112.34	30%
$112.86	35%	$114.81	35%
$115.32	40%	$117.15	40%
$117.75	45%	$119.41	45%
$120.19	50%	$121.64	50%
$122.69	55%	$123.87	55%
$125.28	60%	$126.13	60%
$128.01	65%	$128.47	65%
$130.95	70%	$130.93	70%
$134.20	75%	$133.59	75%
$137.92	80%	$136.56	80%
$142.38	85%	$140.01	85%
$148.20	90%	$144.35	90%
$157.27	95%	$150.79	95%
$168.14	98%	$158.04	98%



Estimated Unit Price ($/LF)	Probability of Under-run
$7.00	10%
$7.89	15%
$8.68	20%
$9.41	25%
$10.12	30%
$10.83	35%
$11.55	40%
$12.29	45%
$13.07	50%
$13.89	55%
$14.79	60%
$15.77	65%
$16.87	70%
$18.15	75%
$19.69	80%
$21.65	85%
$24.39	90%
$29.11	95%
$35.53	98%



Estimated Unit Price ($/SY)	Probability of Under-run
$43.71	10%
$47.63	15%
$50.99	20%
$54.06	25%
$56.98	30%
$59.82	35%
$62.65	40%
$65.51	45%
$68.46	50%
$71.54	55%
$74.81	60%
$78.34	65%
$82.25	70%
$86.69	75%
$91.91	80%
$98.40	85%
$107.22	90%
$121.76	95%



Estimated Unit Price ($/LF)	Probability of Under-run
$28.30	10%
$31.60	15%
$34.49	20%
$37.19	25%
$39.79	30%
$42.36	35%
$44.95	40%
$47.61	45%
$50.37	50%
$53.30	55%
$56.46	60%
$59.91	65%
$63.78	70%
$68.24	75%
$73.56	80%
$80.30	85%
$89.67	90%
$105.59	95%

APPENDIX E

SURVEY FORMS

DHC

Survey of Project Managers

In your opinion, how much of an impact do the following factors have on the unit bid price of a cost item (7" conc. pvmt., 5' MH, 16" SS, etc.) on a municipal construction project?

Please check the appropriate box below. If you think other factors should also be included, feel free to add at the bottom of the list. Thanks for your help.

Factors	No Impact	Low Impact	Medium Impact	High Impact
Item Quantity				X
Project Complexity				X
Current Market Condition				X
Quality of the Plans			X	
Quality of the Specifications			X	
Project Schedule				X
Project Owner			X	
Competition (# of bidders)				X

Theron

Survey of Project Managers

In your opion, how much of an impact do the following factors have on the unit bid price of a cost item (7" conc. pvmt., 5' MH, 16" SS, etc.) on a municipal construction project?

Please check the appropriate box below. If you think other factors should also be included, feel free to add at the bottom of the list. Thanks for your help.

Factors	No Impact	Low Impact	Medium Impact	High Impact
Item Quantity				✓
Project Complexity			✓	
Current Market Condition			✓ (crossed out)	✓
Quality of the Plans			✓	
Quality of the Specifications			✓	
Project Schedule			✓	
Project Owner		✓		
Competition (# of bidders)			✓	

RWA

Survey of Project Managers

In your opinion, how much of an impact do the following factors have on the unit bid price of a cost item (7" conc. pvmt., 5' MH, 16" SS, etc.) on a municipal construction project?

Please check the appropriate box below. If you think other factors should also be included, feel free to add at the bottom of the list. Thanks for your help.

Factors	No Impact	Low Impact	Medium Impact	High Impact
Item Quantity				X
Project Complexity			X	
Current Market Condition				X
Quality of the Plans			X	
Quality of the Specifications			X	
Project Schedule			X	
Project Owner		X		
Competition (# of bidders)			X	

Survey of Project Managers

In your opion, how much of an impact do the following factors have on the unit bid price of a cost item (7" conc. pvmt., 5' MH, 16" SS, etc.) on a municipal construction project?

Please check the appropriate box below. If you think other factors should also be included, feel free to add at the bottom of the list. Thanks for your help.

Factors	No Impact	Low Impact	Medium Impact	High Impact
Item Quantity				X
Project Complexity		←	X	
Current Market Condition				X
Quality of the Plans			X	
Quality of the Specifications			X	
Project Schedule			X	
Project Owner			X	
Competition (# of bidders)	X *			
CONSULTANT REPUTATION		X		

* DOES A CONTRACTOR KNOW HOW MANY PEOPLE HE IS GOING TO BE COMPETING WITH?

[signature]

5-20-08

L. Hamilton

Survey of Project Managers

In your opinion, how much of an impact do the following factors have on the unit bid price of a cost item (7" conc. pvmt., 5' MH, 16" SS, etc.) on a municipal construction project?

Please check the appropriate box below. If you think other factors should also be included, feel free to add at the bottom of the list. Thanks for your help.

Factors	No Impact	Low Impact	Medium Impact	High Impact
Item Quantity		✓		
Project Complexity				✓
Current Market Condition	✓			
Quality of the Plans			✓	
Quality of the Specifications			✓	
Project Schedule				✓
Project Owner		✓		
Competition (# of bidders)				✓

APPENDIX F

MARTHA & MALINDA CONCEPTUAL DESIGN REPORT

INTRODUCTION

LOPEZGARCIA GROUP (LGGROUP) is pleased to present this Conceptual Design Report for the:

2004 CIP CONTRACT No. 17
Pavement Reconstruction and Water and Sanitary Sewer Main Replacement for Martha Lane (Milam Street to Barron Lane), Malinda Lane N. (Jenson Road to Malinda Lane S.) and Malinda Lane S. (Jenson Road to Malinda Lane N.)
D.O.E. No. 4879

This report identifies the existing conditions of each of the design elements (Water, Sanitary Sewer, Paving and Drainage) contained within the identified project limits. Additionally, this report identifies proposed replacement techniques along with alignments and sizes for each design element.

The following design criteria have been typically utilized to develop this report:

Water Line Improvements

- Replace all existing water lines within the proposed paving limits.
- Replace all water mains with an 8” line (min.) or match existing.
- Verify adequate Fire Hydrant coverage/spacing (Add additional as needed).
- Replace all Service Lines (Main to Meter) along replacement limits with a 1” line (min.) or match existing.
- Provide an assessment tap to all vacant properties.
- Relocate existing meter boxes as necessary to accommodate new pavement widths and drive locations.

Sanitary Sewer Line Improvements

- Replace all existing sanitary sewer lines within the proposed paving limits.
- Replace all sanitary sewer mains with an 8” line (min.) or match existing.
- Verify adequate sanitary sewer manhole spacing.
- Replace all Service Lines (Main to Property Line) along replacement limits with a 4” line (min.) or match existing.
- Provide a service connection (Main to Property Line) to all vacant properties.
- Install a Two-way cleanout at property line for each property served.

Paving and Drainage Improvements

- Replace existing streets with 29’ back to back paving.

- Provide 7” curb w/18” gutter along limits of pavement replacement.
- Replace sidewalk only where existing is present.
- Replace existing drive entrances with 6” thick reinforced concrete to the property line (11’ wide min. for single drive, 18’ wide min. for double drive).
- Replace existing curb inlets within project limits.
- Identify storm drain improvements needed.

UNIT IA – WATER LINE IMPROVEMENTS

Martha Lane

The existing water line along the Martha Ln. pavement replacement limits consists of a 10” water line (material unknown). The portion of this line located from Shelman Tr. to the West was constructed around 1983 according to City records. Additionally, the portion of this existing 10” line located from Mims St. to the East was constructed around 1973 according to City records. The remaining existing 10” water line between Shelman Tr. and Mims St. appears to have been constructed sometime before 1973 (no specific dates available).

LGGROUP proposes to replace the existing 10” water main with a proposed 10” PVC water main. The City has not identified the need to increase the size of this line at this time. The proposed 10” PVC water line will be constructed at a minimum depth of 4’ along its entire replacement limits with the exception of crossings with other utilities where greater depths may be required. These other utilities include sanitary sewer mains, storm drain lines, gas mains, telephone lines and other private utilities.

There are approximately 23 properties that are served (connect to) the 10” main located within the replacement limits. The majority of these properties are located along the south side of the right-of-way as the northern properties are generally served by mains located within the connecting side-streets. Most all of the existing services located along the south property line consist of bullhead services located along the property lines between adjoining property owners. LGGROUP proposes to replace the existing Bullhead services with Bullhead services.

There are no existing Fire Hydrants that are connected to the existing 10” water main. Several of the lines from adjoining streets, however, have Fire Hydrants near Martha Ln. These Fire Hydrants provide adequate fire coverage for Martha Ln.

Every connecting street to Martha Ln. contains an existing water line

(6” to 12”) that LGGROUP proposes to replace beneath the proposed paving limits unless recently constructed.

Sheet 5 of the Conceptual Construction Plan Sheets further identifies the replacement limits and appurtenances associated with this water main.

Malinda Lane (North and South)

The existing water line along the Malinda Lane N. and Malinda Lane S. pavement replacement limits consists of a 6” water line (material unknown). The construction date of this line is unknown, but several of the properties served date back to the early 1960’s.

LGGROUP proposes to replace the existing 6” water main with a proposed 8” PVC water main, in accordance with current City of Fort Worth design criteria. The proposed 8” PVC water line will be constructed at a minimum depth of 4’ along its entire replacement limits with the exception of crossings with other utilities where greater depths may be required.

There are approximately 19 properties that are served (connect to) the 6” main located within the replacement limits. All of the existing services consist of ¾”-1” water meters. LGGROUP proposes to replace these existing services with 1” services (main to meter) with ¾”-1” meters to match existing.

There is one (1) existing Fire Hydrant connected to the existing 6” water main. This Fire Hydrant provides adequate fire coverage for the area and will be removed, salvaged and replaced as part of the water line improvements.

The existing connecting water line in Jenson Rd. is an 8” line that was constructed in 2001. The limits of this construction included the two (2) 8” valves located in Malinda Ln. N. and Malinda Ln. S. LGGROUP proposes to remove the existing 6” to 8” reducers identified in the CONTRACT STM 99 BB, D.O.E. No. 2670 construction drawings and connect directly to the existing 8” valves.

Sheet 6 of the Conceptual Construction Plan Sheets further identifies the replacement limits and appurtenances associated with this water main.

*The associated Construction Cost for Water Line Improvements along Martha Ln., Malinda Ln. N. and Malinda Ln. S. is **$238,312.80**. A detailed breakdown of* *the costs for each individual item is located in the Engineer's Opinion of Probable Construction Cost.*

UNIT IB – SANITARY SEWER LINE IMPROVEMENTS

Martha Lane

M-238 is an existing 18" main (material varies) that also serves as a trunk line for several smaller laterals located in adjoining streets. A large portion of this existing main is located outside of the Martha Ln. right-of-way within easements located on private property. In addition to replacing the existing 18" line with a proposed 18" PVC sanitary sewer main (SDR-26 where required), LGGROUP proposes to relocate this main north to within the Martha Ln. right-of-way, thus allowing the City to abandon the applicable existing easements. The City has not identified the need to increase the capacity of this main at this time.

There are approximately 25 service connections to the 18" main located within the replacement limits. The majority of these properties are located along the south side of the right-of-way as the northern properties are believed to be connected to the smaller laterals located in the connecting side-streets. There are no known or suspected services that exceed 4" in diameter.

Every connecting street to Martha Lane contains an existing sanitary sewer line (6" to 12") that LGGROUP proposes to replace beneath the proposed paving limits unless recently constructed. These lines include L-5617 (6"), L-5618 (6"), L-5619 (6"), L-5672 (6"), L-5673 (6"), L-5674 (6") and L-6263* (12").

M-238 along with all the connecting laterals along the Martha Ln. replacement limits are proposed to be installed by "Open-Cut".

Sheets 7-9 of the Conceptual Construction Plan Sheets further identify the replacement limits and appurtenances associated with the sanitary sewer main replacements along Martha Ln.

Malinda Lane (North and South)

L-3706 is an existing 6" lateral (clay pipe) that serves approximately 11 properties primarily located in Malinda Ln. S. Sta. 0+00 to Sta. 1+49 is located within an existing 20' easement. In order to reduce disturbance to private property, LGGROUP recommends that the City perform a TV inspection within these limits. This information will allow LGGROUP to determine what types of replacement “By Other than Open Cut” technologies are feasible. Additionally, this inspection will identify the presence and location(s) of any services that will need to be reconnected to the proposed line. The remaining portion of L-3706 is located within the street right-of-way. LGGROUP recommends that these portions be replaced by “Open-Cut” with 8” PVC (SDR-26 where required). There are no known or suspected services that exceed 4” in diameter. Additional sanitary sewer manholes will be required to allow for deflections necessary to replace this existing lateral.

L-3707 is an existing 6” lateral (clay pipe) that serves approximately 4 properties located in Malinda Ln. N. The entire replacement limit of L-3707 is located within the street right-of-way. LGGROUP recommends that this sanitary sewer lateral be replaced by “Open-Cut” with 8” PVC (SDR-26 where required). There are no known or suspected services that exceed 4” in diameter. An additional sanitary sewer manhole is proposed at Sta. 2+47 (End of Line) to provide access.

Sheets 10 and 11 of the Conceptual Construction Plan Sheets further identify the replacement limits and appurtenances associated with the sanitary sewer main replacements along Malinda Ln. N. and Malinda Ln. S.

*The associated Construction Cost for Sanitary Sewer Line Improvements along Martha Ln., Malinda Ln. N. and Malinda Ln. S. is **$404,954.00**. A detailed breakdown of the costs for each individual item is located in the Engineer’s Opinion of Probable Construction Cost.*

UNIT II – PAVING AND DRAINAGE IMPROVEMENTS

Martha Lane

The identified replacement limit for Martha Ln. is from the west curb return of Milam St. to +/- 250' east of Barron Ln. Martha Ln. is an existing 30' wide (Face-to-Face) asphalt roadway with concrete curb and gutter. Martha Ln. is a residential street within a 50' wide right-of-way. There are no existing sidewalks along the replacement limits identified. There are no existing mailboxes located within the right-of-way. Generally, there are very few private improvements located within the parkway with the exception of sprinkler systems and minor landscaping. There are no trees that are anticipated to be affected by construction activities. The construction of Martha Ln. dates back to the early 1950's.

LGGROUP proposes that Martha Ln. be reconstructed as a 28' wide roadway with a 7" integral concrete curb in compliance with the current City of Fort Worth roadway standards.

There are 28 drive entrances that will be affected by the reconstruction of Martha Ln. Several of these drives consist of exposed-aggregate concrete. LGGROUP proposes to replace these drives to the property line with 6" Conc. pavement in observance of City standard practice.

Connecting to Martha Ln. are 7 T-intersecting streets. All but one of these streets consists of asphalt pavement; Barron Ln. is an existing concrete street. These connecting streets will generally be replaced to their curb returns with a 28' face-to-face section, and then transitioned with a 3' to 10' HMAC strip to match existing grades. Barron Ln. will be saw-cut in order to tie directly into the existing paving.

Martha Ln. generally slopes from West to East at an average grade of 0.90%. Portions of Martha Ln. (Terbet Ln. to Barron Ln.), however, are extremely flat with grades as low as 0.10%. The current City of Fort Worth design criteria allows for a minimum of 0.50% longitudinal slope along the roadway. Though there is no known history of flooding in this area, LGGROUP proposes to investigate altering the existing pavement grades and possibly storm drain inlet locations to meet the City's current design criteria. There are 2-10' and 2-20' existing storm drain inlets that will be impacted by the street reconstruction. LGGROUP is currently only proposing to replace these inlets pending a more detailed analysis of the proposed paving grades.

Sheets 14-17 of the Conceptual Construction Plan Sheets further identify the replacement limits and proposed alignment of Martha Lane.

Malinda Lane (North and South)

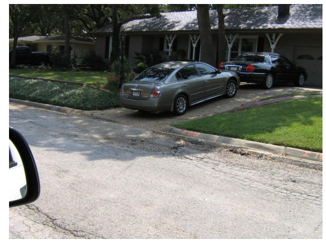
The identified replacement limit for Malinda Ln. N. is from Jenson Rd. to Malinda Ln. S. The identified replacement limit for Malinda Ln. S. is from Jenson Rd. to Malinda Ln. N. For all practical purposes, there is no defining separation where the two Malinda Lns. connect to one another. The Malinda Lns. are existing 30' wide (Face-to-Face) asphalt roadways with concrete curb and gutter. These are residential streets located within a 50' wide right-of-way. There are no existing sidewalks along either of the two roadways. There are no existing mailboxes located within the right-of-way. The construction of Malinda Ln. N. and Malinda Ln. S. dates back to the early 1950's.

Several lots have extensive private improvements located within the parkway. These improvements include railroad tie retaining walls, concrete steps, planters, landscaping etc.

In addition to private improvements, there are several trees located within the parkway that will need to be removed in order to facilitate construction of the new roadway(s).

LGGROUP proposes that Malinda Ln. N. and Malinda Ln. S. be constructed as a 28' wide roadway with a 7" integral concrete curb in compliance with the current City of Fort Worth roadway standards.

There are 17 drive entrances that will be affected by the reconstruction of Malinda Ln. N. and Malinda Ln. S. A few of these drives consist of exposed-aggregate concrete. LGGROUP proposes to replace these drives to the property line with 6” Conc. pavement in observance of City standard practice.



Additionally, several of the drive entrances along Malinda Ln. S. have excessive grades. LGGROUP proposes to investigate raising the existing street grade and/or increasing the existing curb split to attempt to alleviate this problem.

Malinda Ln. N. and Malinda Ln. S T-intersect into Jenson Rd. Jenson Rd. was reconstructed as an asphalt road in 2001. LGGROUP proposes to replace to the curb returns located on Jenson Rd. with a 2’ HMAC transition to match existing grades.

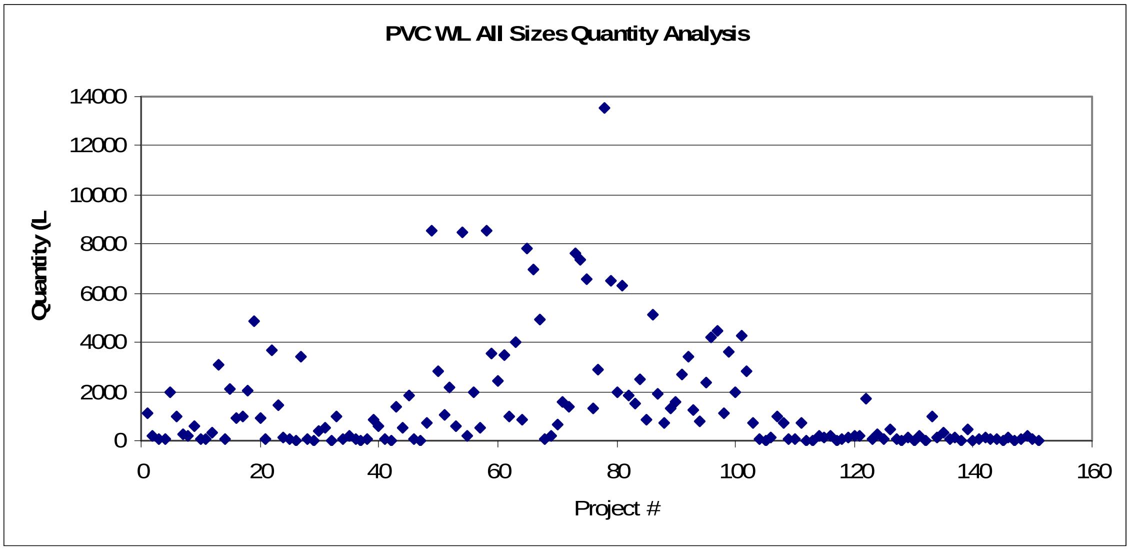
Malinda Ln. N. generally slopes towards a center sump at an average grade of 3.70% from Jenson Rd. and 2.50% from Malinda Ln. S. The sump is served by three (3) 10’ storm drain inlets. Malinda Ln. S. generally slopes from Jenson Rd. to Malinda Ln. N. at an average grade of 1.90%. Run-off from Malinda Ln. S. is carried to Malinda Ln. N. where it is picked up by the existing storm drain inlets. Though there is no known history of flooding in this area, LGGROUP proposes to investigate altering the existing pavement grades to address excessive drive entrance grades. There are 3-10’ existing storm drain inlets that will be impacted by the street reconstruction. LGGROUP is currently only proposing to replace these inlets pending a more detailed analysis of the proposed paving grades.

Sheets 18-20 of the Conceptual Construction Plan Sheets further identify the replacement limits and proposed alignment(s) for Malinda Ln. N. and Malinda Ln. S.

*The associated Construction Cost for Paving and Drainage Improvements along Martha Ln., Malinda Ln. N. and Malinda Ln. S. is **$502,009.75**. A detailed breakdown of the costs for each individual item is located in the Engineer’s Opinion of Probable Construction Cost.*

APPENDIX G

SCATTER PLOTS AND LOG-NORMAL CUMULATIVE DISTRIBUTION CURVES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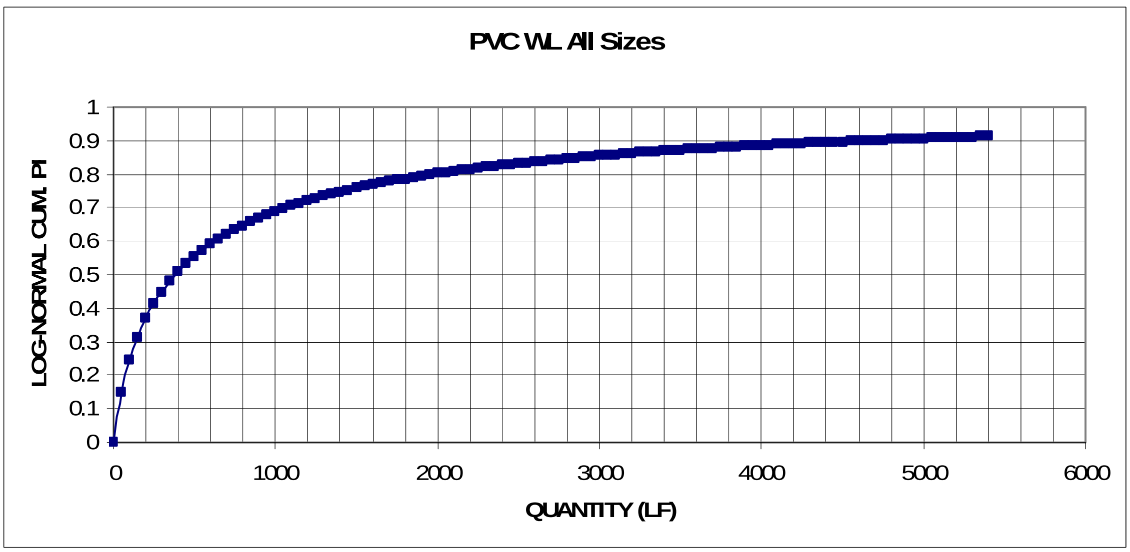
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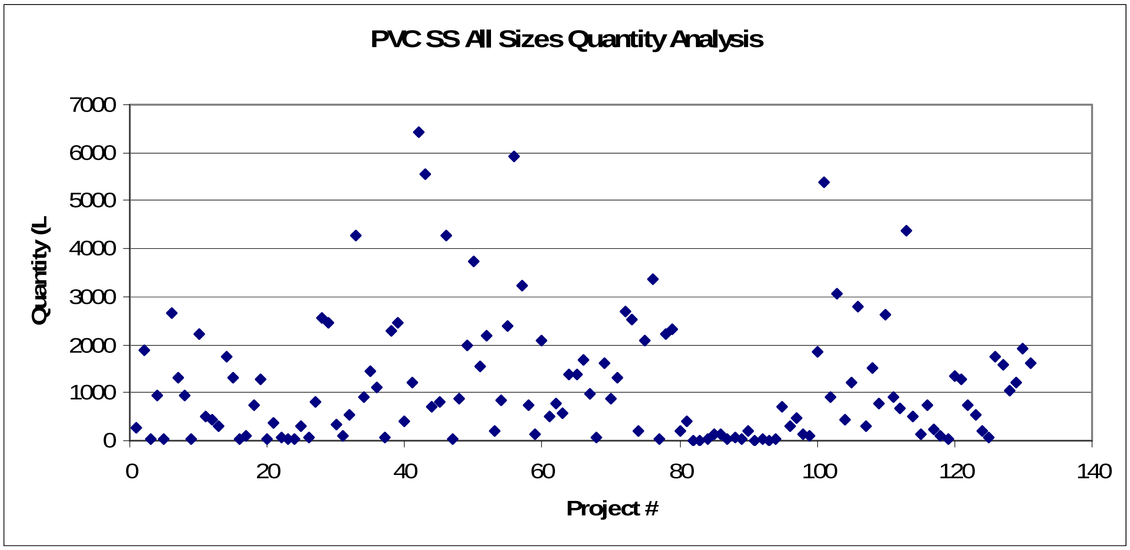

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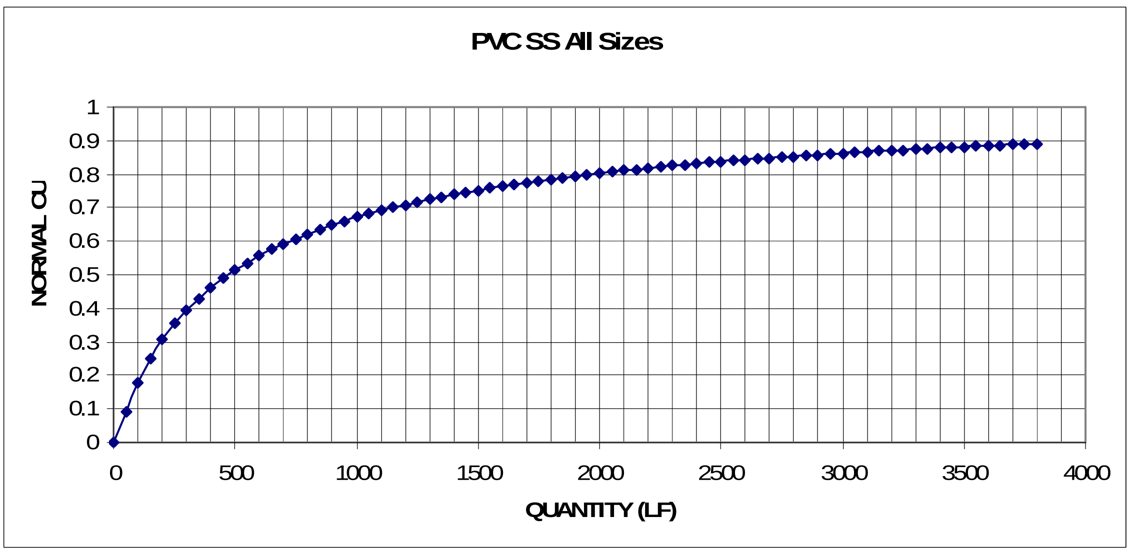

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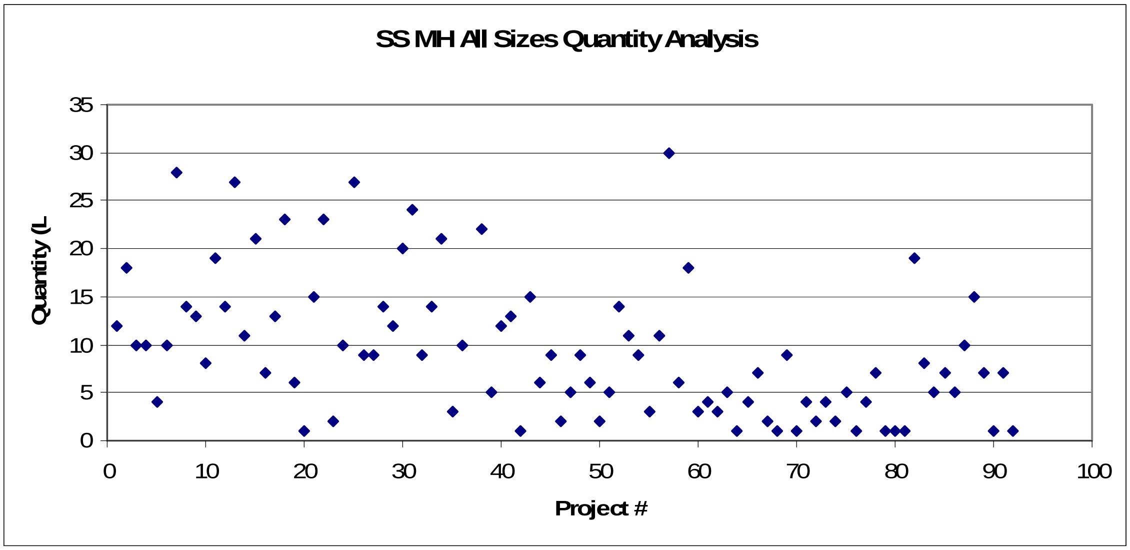
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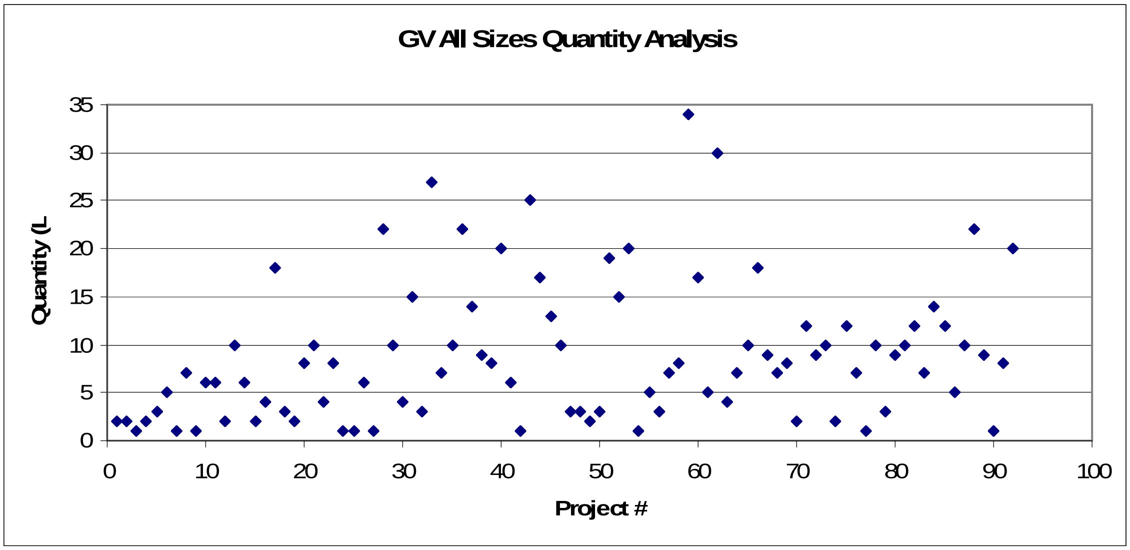
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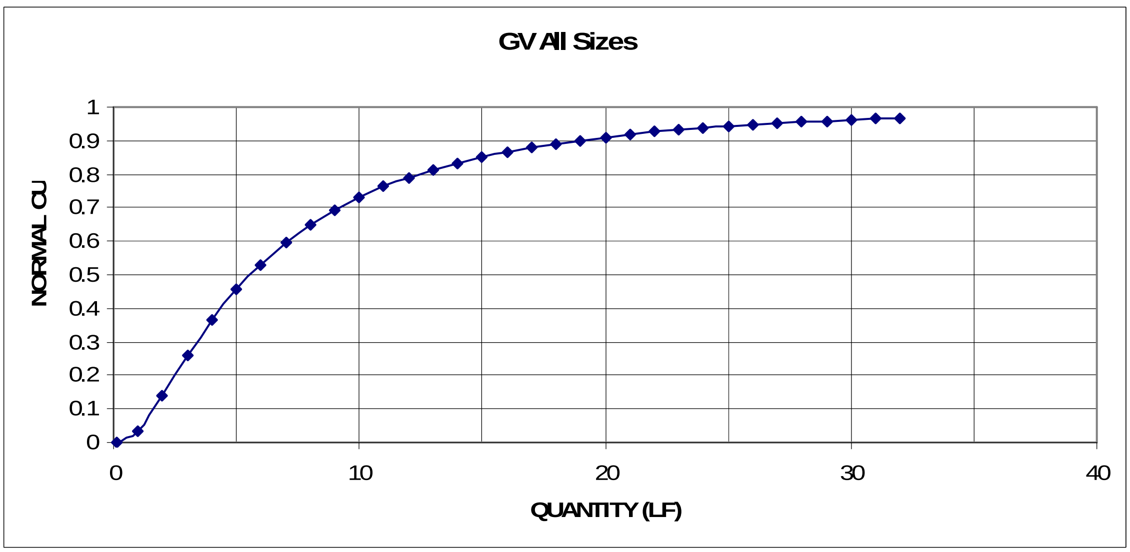
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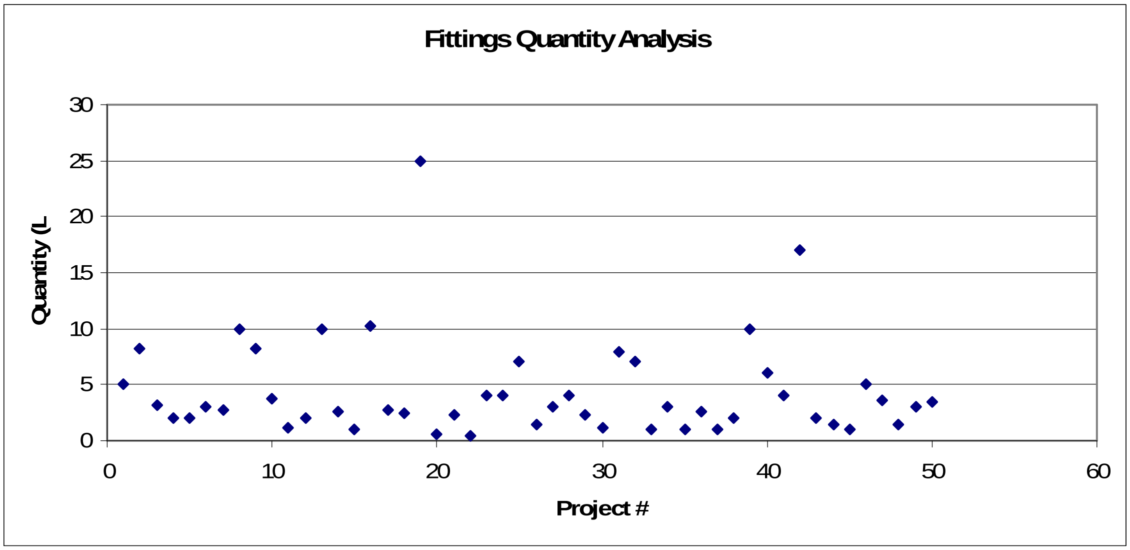
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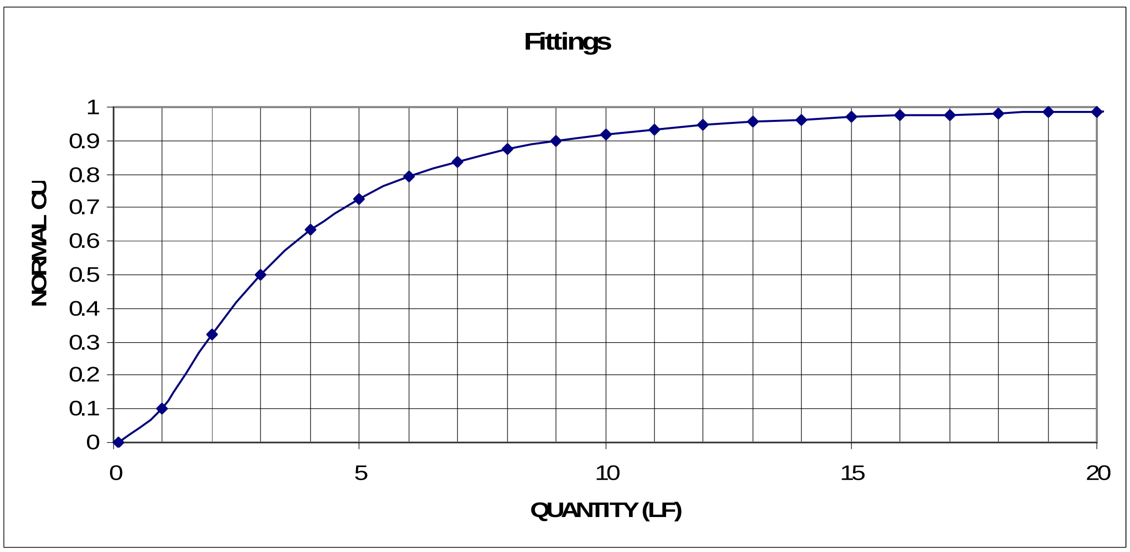
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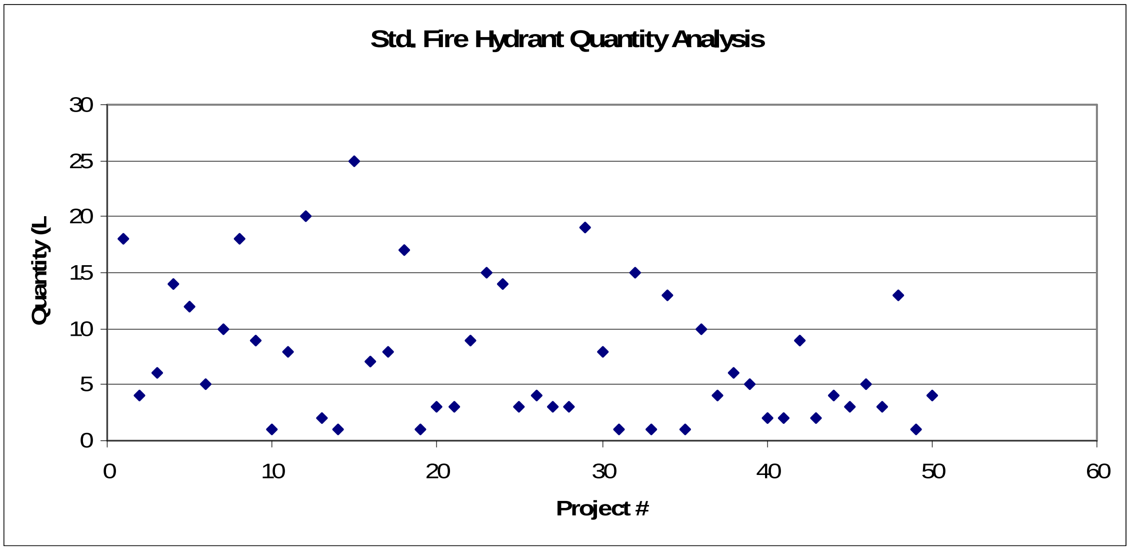
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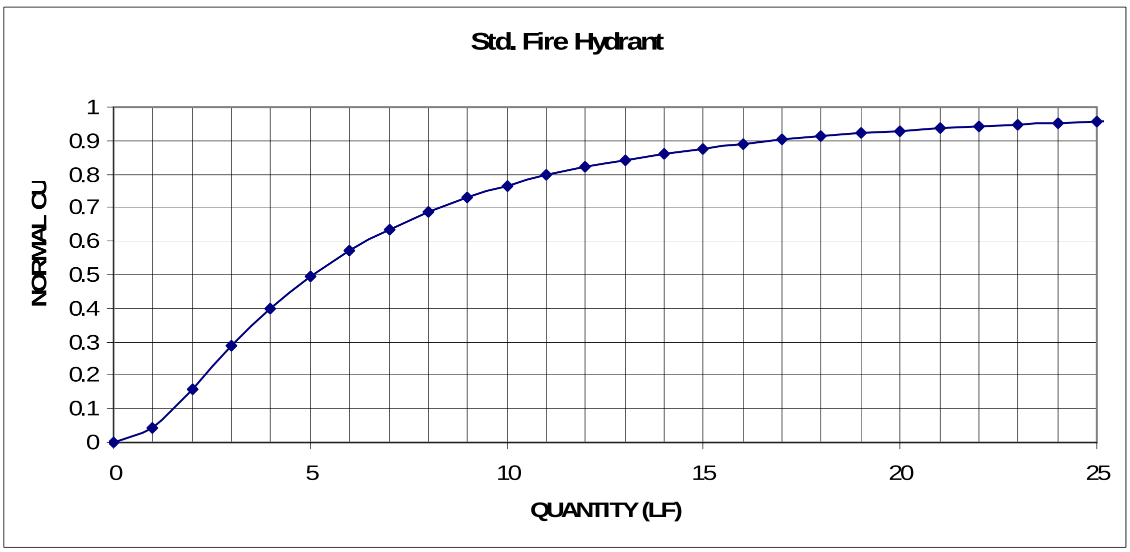
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APPENDIX H

DIGITAL UNIT PRICE DATABASE

Unit Price Database.zip