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HTETCO Installation of Light Fixtures

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SECTION 1: INTRODUCTION

The intent of this technical paper is to provide the reader with the basic information to understand what goes into completing a commercial electrical estimate as it relates to the installation of exterior light pole fixtures. Many factors must be considered when estimating the cost of installing light pole fixtures, some of which include the supporting means, voltage, lighting controls, soil type, NEC (National Electrical Code), OSHA (occupational Safety and Health Administration) and the AHJ (Authority Having Jurisdiction). All of these factors and more must be considered by the estimator when completing a cost estimate.

The author will identify and describe the tasks that are required in completing a cost estimate to install exterior light pole fixtures from an electrical subcontractor's point of view. This estimate will be based on a lump sum contract, with the assumption that the CD's (construction documents) have been completed by an electrical PE (Professional Engineer) and are complete and accurate to the best of their knowledge. The estimate will be an itemized breakdown indicating direct and indirect costs associated with the installation of exterior light pole fixtures.

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DIVISION: 26 00 00 Electrical

Sub-Divisions

26 56 00 Exterior Lighting

SECTION 2: TYPES AND METHODS OF MEASUREMENTS

Methods and measurements are based on the type of material being accounted for. Below are examples of the methods and measurements that will be utilized in this estimate.

Each (EA): Each is taken-off by counting the individual item(s). For example, if there are (2) type P2 light fixtures shown on the drawings, the estimator would mark those two type P2 light fixtures on the drawings and list the count on the take-off sheet. Examples of each are as follows:

- Light Fixtures (heads)
- Light Poles
- Ground Rod

Linear Foot (LF): Linear foot measurements are typically taken-off by scaling the drawings with an architectural or engineering scale. This task can also be completed by using a rolling measuring device, or with computer software. Regardless of which method is used, the estimator must verify that the scale listed on the drawing(s) is correct. Examples of linear foot measurements are as follows:

- Wire (per thousand (M) basis)
- Conduit (per hundred (C) basis)
- Rebar
- Sono Tube

Cubic Yard (CY): In order to determine the cubic yardage required, the estimator must determine the volume. The estimator multiplies the LF length by LF width and by LF depth to calculate the volume of a ductbank or trench. Note that since these three measurements are calculated in feet, the estimator must divide the cubic feet (CF) by 27 to obtain the cubic yards (CY), as there are 27 cubic feet in 1 cubic yard. Examples of cubic yard measurements are as follows:

- Excavated Soils
- Concrete
- Backfill Material (sand, stone, soil, etc.)
- Waste/Haul Away Material

SECTION 3: PROJECT SPECIFIC FACTORS TO CONSIDER

Small Quantities vs. Large Quantities

The amount of material required for the project can have an impact on buying power. For exterior light poles that require a concrete pole base, a small load fee may apply from the concrete supplier if the contractor isn't purchasing a full load of concrete (based on the concrete truck's rated capacity). Incurring a cost such as this will increase the cubic yardage cost of the concrete. The amount of light fixtures and poles purchased can also change the unit cost of the fixtures and poles. If a large enough order (quantity) of light fixtures and poles are ordered, the unit cost is typically reduced.

Geographical location

Knowing the soil types is crucial to ensuring an accurate estimate when installing exterior pole bases. If a geotechnical report has been completed and included in the bid documents, this report must be reviewed to understand the soil type(s) that exist at the job site, specifically where the pole lights are to be installed. If a geotechnical report has not been completed and the site is unclassified, it is up to the contractor to make their own judgment of the soil type (in addition to soil differences).

Labor can vary widely from region to region. Some regions heavily favor labor unions; whereas other regions are open to merit (non-union) contractors. Labor availability is another issue that contractors are currently struggling with. Fewer people are getting into the construction industry than years past, which makes manning projects with skilled labor a struggle for many contractors. Contractors must know the availability of labor prior to submitting a bid on the project. _ do

Seasonal Effect on Work

Seasonal work can have an effect on the project in a variety of ways. Cold weather not only makes the ground harder and more difficult to excavate or auger, it also reduces the labor efficiency. Special precautions must be followed when installing concrete in extreme heat, cold and rainy conditions. The season can also have an effect on the projects schedule, depending on the type of project. One of the more common seasonal schedule effects involves public school projects. Many schools complete upgrades and renovations in the summer when students are on break. These schedules are typically accelerated and compressed to ensure the work is completed prior to students returning for the following school year.

Special Conditions Related to Installing Light Fixtures

Exterior pole light fixtures and their associated circuitry are subject to coordination with new and/or existing utilities (electrical, telecommunication, natural gas, domestic water, sanitary, etc.) that may exist underground. The project may require the contractor to intercept, extend, abandon or protect the existing utilities. It's important to reference the civil drawings, as the existing utilities are typically shown on them, however there is normally a note on the drawings indicating that the contractor is responsible to field verify all existing utilities prior to excavating. Prior to putting a shovel in the ground, the contractor should contact an underground utility locator and have them mark the locations of any existing underground utilities near the area of work.

Accessibility and transporting issues are a common occurrence with exterior light pole fixtures. Prior to light pole delivery, the contractor should verify that there is a clear path for the transporting vehicle to reach the delivery site. In addition, the contractor needs to ensure there is enough clearance for the light pole to be rigged into place.

Special attention must be given to the light fixture itself, especially the installation method required by the manufacturer. Light poles are typically mounted on a concrete pole base with anchor bolts that are supplied by the pole manufacturer. These anchor bolts must be installed based on the template provided by the pole manufacturer to ensure the holes in the light poles flange align with the anchor bolts that are cast in the concrete pole base.

Lighting controls must be closely coordinated with the light fixtures they are controlling. One method to control exterior pole lights is through a time clock and lighting contactor. The time clock needs to be set based on when the client wants the lights to be on and off. Once the time clock is set, it will send signals to the lighting contactor for when to turn the lights on and off.

The specifications must be thoroughly reviewed to determine the type of raceway and conductors that are allowed to be utilized. This can have a huge effect on the overall cost, as there are multiple raceways and conductor types that can be utilized for exterior pole lights. The cheapest method is to direct bury UF cable without a raceway. This method is typically seen in residential applications and is rarely seen in commercial applications. A common commercial application is to utilize schedule 40 PVC conduit containing THHN wire. The ground would be excavated, and the conduit would be installed in the trench. Once all conduits are installed, the trench is backfilled and tamped for compaction. The wire is pulled through the conduit after all conduit connections to the light poles and upstream equipment, such as panelboards are made. Even though this is one of the more common methods for installing the circuitry for exterior pole lights, the specifications can cause subtle changes which increase the cost. An example of this would be changing schedule 40 PVC conduit to schedule 80 PVC conduit.

Local Jurisdiction

The physical location of the project as it relates to the AHJ is of the utmost importance. Jurisdictions generally have different rules and regulations that must be followed. In addition, jurisdictions adopt different versions of the NEC. For example, one jurisdiction could be running off the 2008 NEC, and another could be running off the most recent

2017 NEC. Generally speaking, the more recent NEC contains more stringent rules which could lead to additional cost. In some cases, the timing of light fixtures may need to be coordinated with the surrounding properties in the event a local ordinance dictates when exterior light fixtures can be on. There could also be local ordinances which state the guidelines on light pollution. If it's or it is determined that the exterior light poles are creating light pollution, the contractor may be required to install a shield to reduce light pollution, or even change the fixture head on the pole.

SECTION 4: OVERVIEW OF COSTS

Labor costs are calculated on a per-hour basis and encompass the hourly wage rate of the employee, along with the fringe benefits provided to that employee. These cost combined are commonly referred to as the "fully loaded rate." A standard work week is based on a 40 hour work week during a normal shift between the hours of 6AM and 5PM. If the work is to be performed off hours (after 5PM or before 6AM), a labor premium is usually applied. Labor cost could also be affected by prevailing wage rates, commonly referred to as "scale", which are typically mandated on public projects. Specifically, The Davis-Bacon Act of 1931 is mandated when a project is funded by Federal Government funds in excess of $2,000.00.

Material costs are based on the type of material, and its quantity. Wire and cable is a common material to have a waste factor applied and must be accounted for when calculating its cost. Copper (wire and cable) and PVC (conduit and boxes) prices must be checked regularly, as these costs can fluctuate greatly over time. Many electrical material suppliers have weekly pricing sheets which provide updated cost of commonly used items such as conduit and wire for estimating purposes. When it comes time to buy these materials, a formal quote request should be sent to the supplier. Light fixtures and their associated controls should also be sent to suppliers for a quote. The contractor should send the light fixture schedule, details and specifications, along with their associated quantities to the lighting supplier. Depending on the material being purchased, additional freight charges may apply and must be accounted for in the estimate. If the order is large enough (size varies by supplier), the freight is usually included, however it may be FOB (freight on board) to the shipping point. Contractors usually request the anchor bolts for exterior pole lights early, which could also result in additional freight cost.

Equipment costs are based on their duration of usage, or time rented. If the equipment is owned by the contractor, the contractor must come up with an hourly, daily, weekly and/or monthly cost for the equipment to be utilized. This cost should factor the wear and tear cost of the equipment, along with any maintenance (oil changes, belts, fuel, etc.) associated with the equipment. If the equipment is rented, a quote must be obtained from an equipment rental supplier. Delivery fees usually apply to rentals, and fuel costs are the responsibility of the contractor.

Indirect costs apply to each project, and must be captured in the estimate. Executives, project managers, estimators and administration staff are all examples of indirect cost that need to be captured in each project. This cost is usually based on a nominal percentage of the contract cost, based on an annual revenue projection.

Request for proposals should be sent to all subcontractors for any work that will not be performed by the contractors own forces. Excavating is a common service that is subcontracted by an electrical contractor. The excavating subcontractor typically augers pole bases, trenches ditches for ductbanks and circuitry, backfills and compacts soil. A clear scope of work must be transmitted to the excavating subcontractor to ensure a complete an accurate proposal is received.

Once all cost has been calculated, a determination must be made in regards to mark-ups, or profit. Many factors come into play when deciding on what mark-up to apply to a project. The strength and competition of the market is one factor to consider. When the economy is in a recession, contractors bid projects at or near cost, and even sometimes below cost just to keep the doors open. When contractors are busier, this typically allows the profit margins to rise. The projects schedule must also be analyzed to ensure it works with the contractor's current back log and future plans. If the project conflicts or interferes with the contractor's current schedule, the contractor may want to increase the profit margin to make the challenging project worth the trouble. The difficulty (or ease) of the project can also play into the decision making of mark-up percentages. As the projects difficulty increases, additional risk is being taken on by the contractor. One way to mitigate risk is to increase the profit-margin. Projects that tend to be less complex usually have lower mark-ups.

SECTION 5: SPECIAL RISK CONSIDERATION

As mentioned in section 3, there are many variables and risk when installing light fixtures. Exterior pole light fixtures that are being replaced at an occupied and operational parking lot come with thier own set of unique challenges. The estimator must first determine if the pole light fixture(s) are easily accessible. If the pole light fixtures aren't, how will the electrician access the pole light fixtures for replacement? Vehicles are a common obstruction to access pole light fixtures, and the estimator must determine who is responsible for barricading the area off, as this could result in additional cost if it's the contractor's responsibility. Whenever possible, the estimator should always visit the job site, especially when it's a renovation or repair/replace project to fully understand the scope of work.

Another commonly overlooked risk consideration is the lead time of the pole light fixture(s). If this is a custom order, the lead time of the fixtures could increase, which could have a negative impact on the schedule. This could result in delays to the project which could potentially expose the contractor to damages. It's always recommended to request the lead time of the light fixtures when requesting quotations from vendors. It's the contractor's responsibility to inform the client of these lead times as soon as they are able to.

Prefabrication is a great method to reduce the contractor's risk. If the pole base cages can be assembled in a controlled environment such as the contractor's shop, the contractor can manage the quality and efficiency of the work. In addition, light fixture's heads can be pre-installed on the light poles in the same type environment. By doing this, the contractor eliminates the amount of work fixture's that needs to be completed on the job site.

SECTION 6: RATIOS AND ANALYSIS

There are multiple ways to verify your final price for the installation of electrical work. The most reliable method to verify pricing is historical data. Historical data is generated by the contractor's own experience by recording the time it took to complete a task or tasks. This time is then compared to the estimate to determine if the rates used in estimating reflect the actual time to complete a task or tasks. Another option would be to cross reference published labor books such as RS Means or National Electrical Contractors Association (NECA) Manual of Labor Units. Keep in mind these books have labor adjustment charts that factor in items such as location.

SECTION 7: MISCELLANEOUS

The light fixtures are typically described on a light fixture schedule shown on the drawings generated by the electrical engineer and/or lighting consultant. Depending on the type of project, the fixture schedule may only show one manufacturer/model of light fixture. This is common of a prescribed specification. The fixture schedule could also show a basis of design (BOD) fixture along with multiple approved alternate light fixture manufacturers/models. This method is a mixture of a prescribed and performance specification. This is important to note for multiple reasons. If the fixture schedule only lists one manufacturer/model per fixture type, and there are no notes on the schedule or elsewhere in the construction documents that allow alternate manufacturers/models, than the contractor must provide the specified light fixture for the project. Generally speaking, this is more expensive than a project that allows multiple manufacturers/models of light fixtures.

In some instances, the client may request value engineering (VE) options for the light fixtures, which can vary widely. When it comes to light fixture VE options, there are typically two routes to take. The first is to stick with the same type of fixtures (aesthetics, performance, etc.), but utilize an alternate manufacturer to reduce the cost of the fixture. The second is to stray away from the aesthetics aspect but still try to obtain similar performance. This option is typically the most cost effective value engineering solution for light fixtures.

The drawings may also provide details and schedules for how the light fixtures are to be controlled. In a site lighting application it's common to see details showing lighting contactors, time clocks and photocells. The details indicate how to properly wire the system, and the schedules shows how the controls are to be programmed.

SECTION 8: SAMPLE PLAN AND TAKEOFF

Figure 1

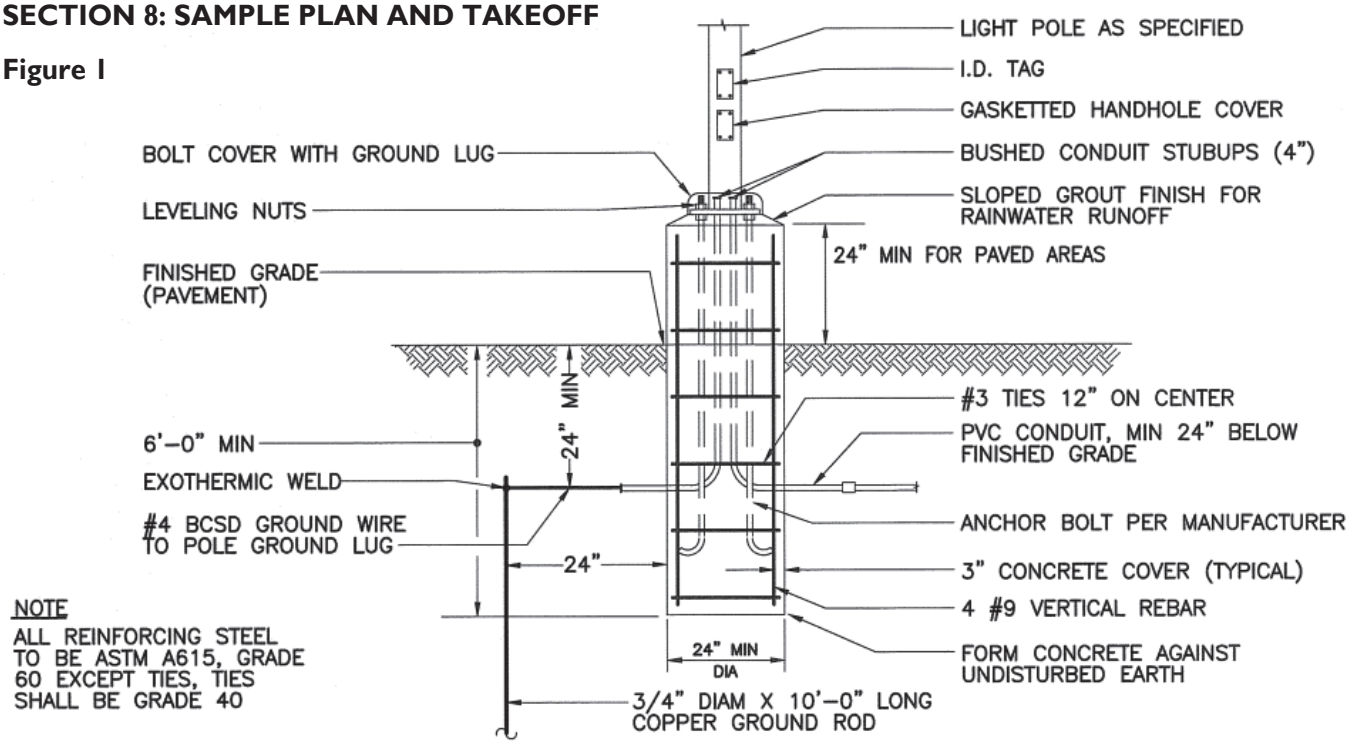

Figure 1 details an exterior pole light with a concrete pole base mounted in-grade. As shown in figure 1, there are a lot of items that go into building a concrete pole base for an exterior light pole fixture. This detail indicates the pole base is to be 24" minimum in diameter, of which a minimum of 6' must be installed below grade, with a minimum of 24" installed above grade for paved areas. The top of this pole base is also to have a sloped grout finish to allow rainwater to runoff. This detail also shows there is to be 4 #9 reinforcement bars (rebar) and #3 ties at 12" on center (OC) to strengthen the concrete pole base. There's a note to the bottom left indicating the requirements that the rebar must meet for this pole base. The rebar that makes up this reinforcement is commonly known in the electrical industry as the "cage". In addition, the detail shows PVC conduit entering the pole base at a minimum of 24" below finished grade to allow the conductors to enter the light pole. There's another PVC conduit shown which allows the #4 ground wire to connect the light poles ground lug (if available) to the ¾" diameter x 10' long copper clad ground rod via an exothermic weld. The detail also shows the anchor bolts, which are provided by the light pole manufacture. Above the pole base is the light pole, which doesn't give many details. The fixture schedule must be referenced for more information on the light pole.

Figure 2

LED FULL CUTOFF EXTERIOR AREA FIXTURE WITH IES TYPE II ASYMMETRIC DISTRIBUTION, EXTRUDED AND DIE CAST ALUMINUM HOUSING, INTEGRAL ARM, DECORATIVE STRUT, POWDERCOAT PAINT, UL WET LOCATION AND IP66	LITHONIA	MRT1-LED-42C-350-30K-SR2-MVOLT	277	49	LED ARRAY, 3000K, 4235 LUMENS B1-U0-G1
14 FT STRAIGHT SQUARE STEEL POLE FINISHED TO MATCH FIXTURE	LITHONIA	SSS-12-4C			

Figure2 (shown above) is a portion of the light fixture schedule, specifically the pole light that corresponds to the pole base as shown in figure 1. "P2" is the type, or fixture designation that the electrical engineer gave the light fixture to differentiate it on the drawings from the other light fixtures. The second column provides a brief description of the light fixture in two parts. The first description informs us that the fixture (pole head) is an LED full cut off exterior fixture with IES type II distribution (the way light is disbursed), has an aluminum housing with an integral arm and decorative strut. The fixture is also to have a powder coat finish that is UL listed for wet locations and has an IP66 rating. The second description is for the pole to support the fixture head, which is 14' tall and is straight square steel to match the powder coat finish of the fixture (pole head). The third and fourth column states the manufacturer and the associated model/catalog numbers for the light fixture and pole. The fifth column states the light fixture voltage (277V), and the sixth column shows 49 input watts. The last column shown provides information on the lamping

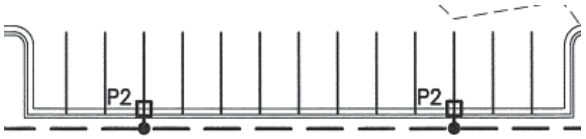

Figure 3

Figure 3 (shown above) shows two type P2 light fixtures in a parking lot. This sketch is only a portion of the entire site plan. Even though it isn't shown, each of these light fixtures is connected to the same circuit and is fed out of an existing lighting panel board inside of the building. These light fixtures are shown to be installed behind the curb line along the parking spaces. For the purpose of this estimate, we will assume that only these two light fixtures are on the circuit, and the total linear circuit length is 200'.

SECTION 9: SAMPLE TAKE-OFF

To calculate the concrete required for the pole bases, we need to know the area of the circle, as well as the volume in cubic yards. The pole base as shown in section 8, figure 1 has a 2' diameter and is 8' tall. The total concrete required per pole base is .93 cubic yard, but we will round up to 1 cubic yard per pole base (2 cubic yards total) for the estimate. The calculations for this are below:

- Area (SF) = Pi x (diameter/2) ^2
  - 3.14 x (2/2)^2 = 3.14
- Volume (CF) = Height x Area
  - b x 3.14 = 25.12
- Volume (CY) = Volume in cf / 27
  - 25.12 / 27 = .93

Conduit and circuitry calculations are based on linear feet. With these light fixtures being 277V, we will need 3 #10 AWG THHN wires (one hot, one neutral and one ground) to circuit the exterior pole light fixtures. We're utilizing #10 AWG THHN wire assuming there's a general note on the site lighting drawing (section 8, figure 3) stating that a minimum of #10 AWG THHN wire is require for all site lighting circuits, as this is a common note on drawings. Our total linear feet of conduit is 200' (excluding the conduit in the pole base); 200' x 3 wires = 600' of wire. We're including a 10% waste factor for wire, 600' x 10% = 660' of wire. We also have to account for the wire that runs inside of the pole to supply the fixture head with power. Our total vertical feet length for wire per pole is 18' (14' pole + 2' above grade pole base + 2' below grade pole base). 18' x 3 = 54', but again we will apply a 10% waste factor bringing the total vertical feet length to 59.4' (rounded to 60') per pole. Keep in mind we have two poles, so the total vertical feet length is 120' for this estimate. The total amount of #10 AWG THHN wire required for this estimate is 780' (660' + 120').

To calculate the excavating and backfilling required we will need three dimensions for the trench; depth, length and width. To obtain the depth we will reference figure 1 shown in section 8. This figure indicates that our conduit is to be a minimum of 2' below grade. Figure 3 in section 8 states that we have a 200' run (length). The last item required is width, which isn't shown in any of the figures in section 8. For estimating purposes, we will assume that the trench is 1' wide. To calculate the cubic yardage required to be excavated and backfilled we will multiply all three dimensions together (200' x 2' x 1'), then divide by 27. This gives us a total of 14.8 cubic yards, but we will round up to 15 cubic yards for this estimate. We intend to utilize all of the material that is excavated for backfill, however we will have some excavated material left over from the pole bases since those voids will be filled with concrete. With each pole base being 1 cubic yard of concrete, we must auger 1 cubic yard of material to make way for the concrete. The 2 total cubic yards of material that was removed for the pole bases (and won't be reused) must be stock piled, or hauled away from the site and will be calculated in the estimate.

Itemized Take-Off

Description	Quantity	Unit	Material Unit Cost	Labor Unit Hours	Total Material	Total Hours
LIGHT FIXTURE TYPE P2 (HEAD)	2	EA	$ 500.00	2.5	$ 1,000.00	5
1" ELBOW 90 DEG - RMC - GALV	1	C	$ 698.00	62	$ 6.98	0.62
1" LOCKNUT - STEEL	1	C	$ 14.00	1	$ 0.14	0.01
1" BUSHING GRDG INSUL	4	C	$ 253.00	2	$ 10.12	0.08
1/2" CONDUIT - PVC40	20	C	$ 17.21	5.1	$ 3.44	1.02
1" CONDUIT - PVC40	220	C	$ 29.98	6.5	$ 65.96	14.3
1/2" ELBOW 90 DEG - PVC40	2	C	$ 36.00	25	$ 0.72	0.5
1" ELBOW 90 DEG - PVC40	2	C	$ 63.00	31	$ 1.26	0.62
1" ADAPTER MALE - PVC	1	C	$ 32.00	22	$ 0.32	0.22
1" ADAPTER FEM - PVC	2	C	$ 36.00	22	$ 0.72	0.44
PVC CEMENT STANDARD (16OZ)	1	EA	$ 22.35	1	$ 22.35	1
#10 THHN SOLID BLACK	780	M	$ 157.01	8.75	$ 122.47	6.83
# 4 BARE COPPER	30	M	$ 647.13	15	$ 19.41	0.45
#4 LUG	2	C	$ 91.00	56	$ 1.82	1.12
1/8" POLYTWINE	220	M	$ 4.47	6	$ 0.98	1.32
3/4"x 10' CU CLAD GRD ROD	2	EA	$ 19.42	2.5	$ 38.84	5
EXOTHERMAL WELD	2	EA	$ 15.00	0.5	$ 30.00	1
14' POLE SQUARE STRAIGHT	2	EA	$ 500.00	5	$ 1,000.00	10
ANCHOR BOLT TEMPLATE	2	EA	$ 5.00	1.2	$ 10.00	2.4
EXCAVATION (CUBIC YARD)	15	EA	$ -	0.25	$ -	3.75
BACKFILL (CUBIC YARD)	15	EA	$ -	0.5	$ -	7.5
WASTE / HAULAGE (CUBIC YARD)	2	EA	$ -	0.2	$ -	0.4
#9 RE-BAR (LIN FOOT)	64	C	$ 97.50	2	$ 62.40	1.28
CONCRETE 3000 LB (CU YARD)	2	EA	$ 200.00	0.25	$ 400.00	0.5
24" SONO TUBE (LIN FOOT)	4	EA	$ 23.90	0.5	$ 95.60	2
#3 RE-BAR TIE	12	EA	$ 2.50	0.25	$ 30.00	3
SETUP CONCRETE POUR - PER BASE	2	EA	$ -	0.25	$ -	0.5
POLE BASE AUGER SETUP	2	EA	$ -	0.5	$ -	1
POLE BASE AUGER 24" DIAM (LF)	12	EA	$ -	0.2	$ -	2.4
UNDERGROUND MARKING TAPE	200	M	$ 22.58	3	$ 4.52	0.6
Totals					$ 2,928.05	74.86

Total Material		$ 2,928.05
Sales Tax	6%	$ 175.68
Subtotal		**$ 3,103.73**
Total Hours		74.86
Labor Rate (per hour)		$ 40.00
Subtotal		**$ 2,994.40**
Equipment Rental (includes fuel & delivery)		$ 850.00
Subcontractors - Utility Marking		$ 250.00
Electrical Permit		$ 100.00
Subtotal		**$ 1,200.00**
Cost Subtotal		**$ 7,298.13**
Overhead	12.50%	$ 912.27
Subtotal		**$ 8,210.40**
Profit	5%	$ 410.52
Total		**$ 8,620.92**

SECTION 10: GLOSSARY

The Davis-Bacon Act of 1931: Established in 1931, it's a federal law that requires paying the local prevailing wages on public projects for laborers and mechanics when the project is funded or assisted by federal funds in excess of $2,000.00 (Wage and Hour Division, 2018).

Construction Specifications Institute (CSI) 2016 MasterFormat: A standard for organizing specifications and other written information for commercial and institutional building projects in the United States and Canada (MasterFormat, 2018).

Occupational Safety and Health Administration (OSHA): Established on December 29, 1970 OSHA's mission is to "assure safe and healthful working conditions for working men and women by setting and enforcing standard and by providing training, outreach, education and assistance" (UNITED STATES DEPARTMENT OF LABOR, 2018).

Authority Having Jurisdiction (AHJ): Per article 100 of the 2017 National Electrical Code, the term Authority Having Jurisdiction (AHJ) is defined as "An organization, office or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure" (Guidry, 2015).

National Electrical Code (NEC) 2017: Published by the National Fire Protection Association (NFPA), the NEC is a regionally adopted standard for the safe installation of electrical wiring and equipment in the United States (About the NEC, 2018).

PVC (Polyvinyl Chloride): Widely produced synthetic plaster polymer. In electrical applications PVC is used for conduits and boxes.

THHN (Thermoplastic High Heat-Resistant Nylon Coated): This is a specific type of insulation for electrical wire, and the most commonly used insulation type for wire on commercial projects.

Auger: A drill for boring holes. This is how material is excavated for exterior light pole bases.

Prefabrication: Building or assembling components in a shop or other controlled environment prior to it arriving on the job site for installation.