ON-STREET ELECTRIC VEHICLE CHARGING FROM LIGHT POLES

Feasibility study identifying possibilities for light-pole charging in Vancouver

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Executive Summary

The City of Vancouver set a goal to become the greenest city in the world by 2020. To achieve this objective it developed the Greenest City Action plan with ten main actions which included securing international reputation as a mecca of green enterprise; eliminating Vancouver's dependence on fossil fuels; and, breathing the cleanest air of any major city, amongst others (Neville, 2014). Increasing the electric vehicle charging infrastructure aligns directly with these three important actions.

To continue with the city's increasing EV adoption, access to home charging is considered essential. But that option is not available for many Vancouverites that do not have access to off-street parking. In addition to the Greenest City Goals, and in conjunction with the Climate Emergency Response, the City of Vancouver (the "City"), as one of its accelerated actions to respond to the Climate Emergency, is developing "a neighborhood charging strategy for vehicles and electric bikes, with a focus on providing charging in areas of the city where residents do not have access to off-street home charging. Possible locations include on-street, such as light-pole charging (City of Vancouver, 2019). This report presents the feasibility study of installing EV supply equipment (EVSE) on streetlight poles located near Vancouverites' homes that do not have access to off-street parking.

The Feasibility Study for On-Street Electric Vehicle Charging from Light Poles has three main objectives:

1. Review what other cities have done regarding streetlight poles charging stations, to understand what has worked and what has not.
2. Analyze the current status of the electrical infrastructure of the streetlight system, to identify the main barriers for installing EVSE on these poles.
3. Identify possible locations for installing EVSE on streetlight poles pilot projects, as well as the main technical and policy barriers.

For the first objective, various cities that are implementing a pilot project or that already have these type of charging stations as part of their EV charging infrastructure were studied. The main conclusion was that all of the cities took advantage of the capacity that became available once they started changing their streetlight to LED lighting.

The study focused on four main areas which have the highest density of RS and RT zoned parcels without access to off-street parking ("garage orphans"). These areas are:

- Between Ontario and Fraser & between 16th Avenue and 33th Avenue
- Between Fraser and Knight & between Broadway and 33th Avenue
- Between Commercial and Victoria & between East Hastings and Grandview Highway
- Between Alma and Trafalgar & between Point Grey Road and Broadway

For the second objective, analyzing the current status of the electrical infrastructure of the streetlight system, six service panels were selected based mainly on their locations and load capacity. An analysis of its conditions was made to identify the possible modifications that have to

be done to the electrical installations of those panels to install the EVSE. There were three main challenges identified.

1. The agreement with BC Hydro, regarding the way the City pays the light pole electricity consumption, is a major concern.
2. The grounding system of the modified light poles with the EVSE has to be verified.
3. According to the voltage drop results, for the implementation of the EV charging stations the size of the conductors has to be increased, to take advantage of all the capacity available in the panel.

For the third objective, Identify possible locations for installing EVSE on streetlight poles pilot projects, three Scenarios were defined to analyze the installation costs of the EVSE.

- Scenario 1: One charging station with maximum capacity
- Scenario 2: Maximum number of charging points
- Scenario 3: Minimum modifications to the existing electrical infrastructure

A cost was estimated for the six panels and the three scenarios.

- Scenario 3 has the lowest installation costs. The average installation cost was $37,685 CAD including the lighting fixtures replacement and $14,585 CAD without the lighting fixture replacement.
- This solution provided a Level 2 slow charger that went from 1.8 kW to 4.6 kW, depending on the service panel.
- The highest costs identified were associated with the lighting fixtures replacement (to LED) and the civil works, trenching for the replacement of conduit.
- One of the six panels analyzed was not feasible for Scenario 3 because its existing installations did not comply with the voltage drop requirements.

Overall, the most feasible scenario is Scenario 3. Not only for the installation costs but also because it does not replace any cable. This reduces significantly the risk of damaging existing infrastructure while pulling cable or replacing conduit.

Another important conclusion is that the pilot projects should be implemented in parallel with the lighting fixture upgrading program (LED conversion) and the bonding correction program to reduce significantly the installation costs.

Finally, the pilot projects must include the service panel replacement for a service panel with a certified meter in it. The use of metering in the charging station or the smart cables, with an in-line smart meter, are not yet approved and could take a significant amount of time to be approved.

1 Introduction

The City of Vancouver set a goal to become the greenest city in the world by 2020. To achieve this objective it developed the Greenest City Action plan with ten main actions which included securing international reputation as a mecca of green enterprise; eliminating Vancouver's dependence on fossil fuels; and, breathing the cleanest air of any major city, amongst others (Neville, 2014). Increasing the electric vehicle charging infrastructure aligns directly with these three important actions.

Vancouver is ideally situated to be the electric-vehicle capital of the world. Since around 93 percent of its electricity comes from hydropower, Electric vehicles (EV) in this part of the world would truly be fueled by renewable energy (Smith, 2019).

To continue with the city's increasing EV adoption, access to home charging is considered essential. But that option is not available for many Vancouverites that do not have access to off-street parking. In addition to the Greenest City Goals, and in conjunction with the Climate Emergency Response[1], the City of Vancouver (the "City"), as one of its accelerated actions to respond to the Climate Emergency, is developing "a neighborhood charging strategy for vehicles and electric bikes, with a focus on providing charging in areas of the city where residents do not have access to off-street home charging. Possible locations include on-street, such as light-pole charging; and lower-use parking areas, such as parks and schools, particularly where overnight access is possible" (City of Vancouver, 2019). This report presents the feasibility study of installing EV supply equipment (EVSE) on streetlight poles located near Vancouverites' homes that do not have access to off-street parking.

The Feasibility Study for On-Street Electric Vehicle Charging from Light Poles has three main objectives:

4. Review what other cities have done regarding streetlight poles charging stations, to understand what has worked and what has not.
5. Analyze the current status of the electrical infrastructure of the streetlight system, to identify the main barriers for installing EVSE on these poles.
6. Identify possible locations for installing EVSE on streetlight poles pilot projects, as well as the main technical and policy barriers.

An overview of the report is presented below.

(1) A background, identifying what other cities have done in relation with streetlight poles EVSEs and their lessons learned.
(2) The definition of the area of focus, explaining the methodology used to define it.

[1] Vancouver City Council unanimously approved a motion recognizing the climate emergency that the planet faces; acknowledging that Vancouver needs to do more to reduce carbon pollution in response to that emergency; to limit global warming to 1.5°C (according to the target of the Paris agreement). The City set six (6) "Big Moves" with 53 Accelerated Actions intended to direct staff to pursue the City's key opportunities to meet the objective of limiting warming to 1.5°C (City of Vancouver, 2019).

(3) An analysis of the current status of the electrical infrastructure, identifying the main technical challenges the project will be facing. The analysis will focus mainly on the capacity of the equipment that will feed the EVSE, using load and voltage drop calculations.
(4) A technology review, showing the main features, such as nominal power capacities, demand management, metering and billing, as well as the certifications to be able to work in Canada.
(5) An assessment of the different modifications that have to be made to the existing electrical infrastructure to be able to install the EVSE in the light poles.
(6) An evaluation of additional factors to consider such as metering and billing, as well as the option of leveraging from other projects and programs.
(7) A cost analysis of the modifications that have to be done to the existing infrastructure to be able to install the EVSE on the light poles.
(8) An analysis of all the results obtained and the conclusions.

2 Background

The City implemented an initiative called *Charge & Go Vancouver: Plug-In Electric Vehicle Charging Infrastructure Field Test* (Charge & Go) from 2011-2014, which was composed of five sub-projects. These were Residential Charging, Work Charging, Fleet Charging, Public Charging, and Intelligent Micro-Grid Charging. Across the five sub-projects, 111 EVSEs were deployed. These charging stations were installed at a total of 38 sites throughout the City which included: multi-unit residential buildings, community centers, hospitals, shopping malls, fleet locations and on-street (curbside) locations. The mean cost of installation varied depending on the type of site. It could cost from $5,800 for a parkade EVSE to $57,000 for a curbside EVSE (Neville, 2014). As a complement to this initiative, the City is evaluating the option of installing EVSE in streetlight poles, to address a demographic that is not being addressed by Charge & Go at lower deployment cost.

Pole-mounted Electric Vehicle (EV) chargers installed on existing infrastructure such as light poles have been a great solution for expanding electric vehicle infrastructure in cities. While this solution has several pros and cons, it is a cost-effective way to encourage electric vehicle adoption and reduce greenhouse gas emissions coming from private vehicles. Some of the pros and cons are shown below (W X Y architecture + urban design and Barretto Bay Strategies, 2018).

Table 1. Advantages and disadvantages of Streetlight EV charging stations (W X Y architecture + urban design and Barretto Bay Strategies, 2018).

Advantages	Disadvantages
+ Reduced clutter and sidewalk footprint, potential for more installations + Can be installed at flexible heights + Low installation cost if the power to the light pole is sufficient (trenching can be timed with planned streetlight upgrades)	– Installations are limited to existing pole locations, light pole standards, and further suitability assessments – May give the impression of impermanence – May affect the pole integrity

Installing an EV charging station in an existing lighting circuit is allowed by the Canadian Electrical Code. It states in section 86-300(2) "*electric vehicle supply equipment shall be permitted to be supplied from a branch circuit supplying another load(s), provided that control equipment prevents* *simultaneous operation of the electric vehicle supply equipment with other circuit loads such that the calculated demand of the circuit is not exceeded*" (Canadian Electrical Code, Part I - Safety Standard for Electrical Installations, 2015). The other loads would be lighting and the circuit protection will be sized to allow the simultaneous operation.

The objective of this section is to review several projects other cities have executed, or are in the process of executing, in terms of the implementation of electric vehicle charging stations in light poles. As a result, this section will try to illustrate what has worked for other cities and what has not.

2.1 Cities implementing EV charging stations in street lighting

Although many cities that have implemented On-Street Electric Vehicle Charging from Light Poles, this report will only focus on certain cities that illustrate the different options the City of Vancouver could implement. This section is going to emphasize on the location of the charging stations, which takes into account the customer it is addressing; the technology used; and the costs associated with its implementation.

2.1.1 London, United Kingdom

The City of London is a pioneer in this type of EVSEs. They retrofitted the first lighting pole in 2016 and now they have over 300. This initiative is part of their Go-ultra Low City Scheme which plans to implement 1,125 charging points in lamppost by 2020 (electrive, 2018).

The reason why this application has been successful is because in London, 78 percent of households do not have off-street parking (Auto Express, 2018). There is a growing demand for charging facilities due to the increasing number of EVs in the streets. Also, most of the EV owners are not able to charge their vehicles at their homes. For this reason, retrofitting the street lamps with charging technology allow them to charge their vehicles closer to their houses (electrek, 2017).

London implemented their solution by installing simple sockets in the light poles and demanding the user to buy a smart cable to charge their EV, as shown in Figure 1. The company that implemented this solution is called Ubitricity, which were the developers of the smart cable. The smart cable has a built-in electricity metering system. The simplicity of Ubitricity's solution allows the implementation of charging stations without having to do invasive infrastructure work like digging up sidewalks or installing unsightly, standalone charging bays. This reduces the costs of the city's initial investment. Also, this setup allows drivers with this type of cable to plug-in and charge their EVs anywhere there is a socket (Curbed, 2017).

Figure 1. London’s simple socket solution with Ubitricity cable (electrive, 2018)

The first lighting poles retrofitted had a capacity of 3 kW and the newest ones can charge up to 7.7 kW (Auto Express, 2018).

The City of London reduced significantly their initial investment for the retrofit of the poles because no metering device was installed. The City had to change their lighting fixture from High-Pressure Sodium (HPS) to LED to have an extra capacity for the charging station, but other than that the modifications were minor. According to (Times, 2018), the cost per charging point is about €1,500 ($2,300 CAD), which can take as little as 30 minutes to install assuming that all the necessary cabling is in place and excavation is not required to install new conduit and/or wiring. That compares well with the regular public chargers currently in use, which can cost more than €10,000 ($15,000 CAD) to install. It is important to mention that the single-phase voltage of England is 230V which makes easier the implementation of level 2 chargers.

Regarding the costs for the user, they pay 15p ($0.26 CAD) per kWh, which is fairly in line with electricity rates in the region. Also, they have to buy a £7.99 ($14 CAD) per month subscription to get that price and the smart cable that costs £199 ($340 CAD). There is another option that does not include the subscription fee, but they have to pay 19p ($0.32 CAD) per kWh and the cable will cost £299 ($510 CAD) (electrek, 2017).

Initially, Ubitricity was the only company implementing the charging stations on the streetlight poles. They were the first EV charging company to gain regulatory approval for working in the UK with unmetered power outlet (simple socket). Ubitricity implemented a MobileCharging system which allows them to charge the customer and pay the electric utility directly. Before they were able to implement their solution they had to get Electric vehicle conductive charging system certification (EN 61851-1), metering certification (EN 61851-1/3) and the approval of the grid operator (Ubitricity, 2019). Currently, there are more companies with similar technologies doing it, like Char.gy.

2.1.2 Los Angeles, United States of America

The City of Los Angeles started replacing all of its old sodium-vapor streetlights with smart LED versions that use less energy. This program started in 2009. As a result, economic savings and excess power were produced. For this reason, the city started investing in new electric vehicle charging stations attached to the streetlight poles (Techrepublic, 2016). Los Angeles began a program in 2016 to install EV charging stations to street light poles. By June of that year, they had installed 3 charging points, and their plan was to have 30 by the end of the year (Wired, 2016). Navigant Research estimates that over 250 charging stations are now deployed throughout Los Angeles' street light infrastructure (Navigant Research, 2018).

The location of the charging stations depends mainly on traffic patterns. The city looks for areas with heavy vehicle traffic, as well as neighborhoods that may be underserved in terms of charging infrastructure or overlooked by private sector charging companies. Also, some locations come from requests from the city residents. Each station costs the city $5,000 to $7,000 USD ($6,800 CAD to $9,500 CAD) (The Eastsider, 2018).

Charging a vehicle from the light pole EV charging station costs from $1 per hour to $3 per hour ($1.35 CAD to $4.06 CAD per hour), depending on where you are. After downloading an app to a mobile phone, the driver scans in the station number to start the process. A white plug mounted high on the pole is released and later retracts once the vehicle is recharged. It is important to mention that all public charging stations are level 2 (The Eastsider, 2018).

Figure 2. Lighting pole charging station in Los Angeles (Wired, 2016)

2.1.3 New York City, United States of America

Nearly a third of greenhouse gas emissions of New York City come from transportation, with private vehicles contributing 90 percent of these emissions (Government Technology, 2018). As a measure to reduce this number the New York City NYCx Climate Action Challenge was created. The German company Ubitricity won this Challenge for its technology that transforms existing light poles into EV charging stations. This solution will help the city's target of having 20 percent of new motor vehicle registrations be electric by 2025 (Smart Cities World, 2018).

New York City will use the simple socket installation in the light poles and demand the user to buy a smart cable, as was done in London (see section 2.1.1). The city finished their first test installation in June 2018, and now they are implementing a pilot project, to evaluate the feasibility of the solution. They are only going to install Level 2 charging stations and one of the challenges for New York pilot's design team will be upgrading the power supply to participating streetlamps from the standard 110 volts to 240 volts (Government Technology, 2018).

The pilot project consist of installing Ubitricity's simple socket charging stations in their facilities to charge The City of New York's fleet of EVs. They already bought 100 chargers from Ubitricity and they are waiting for the UL certifications to be issued to start the implementation (Roberton, 2019).

Currently, the City of New York pays the electric utility company, Con Edison, for the operation of each street light installed a fixed rate, because is a fixed load on the system. For this reason, the light pole electrical infrastructure does not have any metering devices. One of the major challenges the City will face, is defining a new agreement with the Utility Company that includes the variable load of the charging stations. One of the solutions they are considering implementing is installing an individual meter on each pole (Roberton, 2019).

2.1.4 Toronto, Canada

One of the largest sources of GHG emissions in Toronto is internal combustion engine vehicles. The City has stated that approximately one-third of the emissions are from private vehicles. The City has also indicated that the transition to EVs is one of the primary actions from the City's plan to achieve the 2050 goal of reducing emissions by 80%. Toronto Hydro is supporting the transition to electric vehicles by increasing the availability of charging stations for electric vehicles to the residents of Toronto. Projects to install on-street charging stations throughout the City began in 2017. The Residential on-Street project has been designed to offer charging stations in areas where residents are not able to install charging stations in their homes. Specifically, the areas targeted through this project are streets where residents rely upon only on-street parking (Toronto Hydro, 2018).

The City of Toronto and Toronto Hydro are developing a pilot project that consists on the implementation of 11 Residential on-street Electric Vehicle (EV) charging stations using the existing infrastructure of the street light poles in residential permit parking areas. It is important to mention that is a joint work between these two large organizations because the owners and operators of the lighting infrastructure of the city are Toronto Hydro, while The City of Toronto is the one in charge of managing the parking permits in the residential areas (Capano, 2019).

The fact that Toronto Hydro owns and manages the street lighting system of the city made them responsible for assuming the cost of the retrofit required to adapt the lighting poles to charging stations. One of the most important criteria they had to take into account for selecting the location of the stations, besides the capacity, was that it should have enough space between the curb and the sidewalk for the snow clearing machinery to operate properly. Also, they wanted that the cable of the charging stations was retractable and that increased the size of the enclosure for the charging stations. Another element to take into account, which affects the capacity requirement of the different lighting circuits, is that all of the 11 charging stations are Level 2 (Capano, 2019).

The cost for the use of the charging stations is being defined by Toronto Hydro since they will be the ones in charge of the implementation, operation and maintenance of the charging stations. However, there is a 60 CAD fine users have to pay if they are parked where an EV charging station is located and are not actively charging their vehicle (Capano, 2019).

The biggest challenge the City of Toronto has faced so far is defining the ground rules for Toronto Hydro to implement the project. Another important challenge they have faced is the escalation of this solution to more residential areas of the city (Capano, 2019).

2.1.5 New Westminster, Canada

The BC Institute of Technology (BCIT) and the City of New Westminster created a partnership for a pilot project that consists of installing 15 Electric Vehicle Charging Stations using the streetlight infrastructure. This project is specifically designed to allow residents that do not have access to off-street parking ("Garage Orphans") (New Westminister Record, 2017).

During the design of the project, they encountered many challenges. One of them was that most of the lighting fixtures of the city were not LED and the residential areas that had updated the street lighting with LED fixtures had off-street parking. Another technical issue they encountered was that most of the lighting fixtures were controlled by a photocell, so they were only allowed to measure the load during the night. A positive aspect that helped the city in the project was that most of the streetlights are fed at 240V and some at 208V, which is useful considering that a core project requirement was to install level 2 EVSE (Howey, 2018).

Other considerations were taken into account for the selection of the locations. First, the City of New Westminster surveyed over 310 residents to validate the need for more EV charging stations. Also, for the locations, they had to consider only light poles on the correct side of the sidewalk. This means the closest side to the street. The EVSE installed on the light poles located on the opposite side of the street would become a tripping hazard for the pedestrians walking on those sidewalks. Additionally, they considered the location of the parking meters relative to the light poles. There are some scenarios were the parking meters and the EVSE on the lighting poles might not be aligned, as shown in Figure 3 (Howey, 2018).

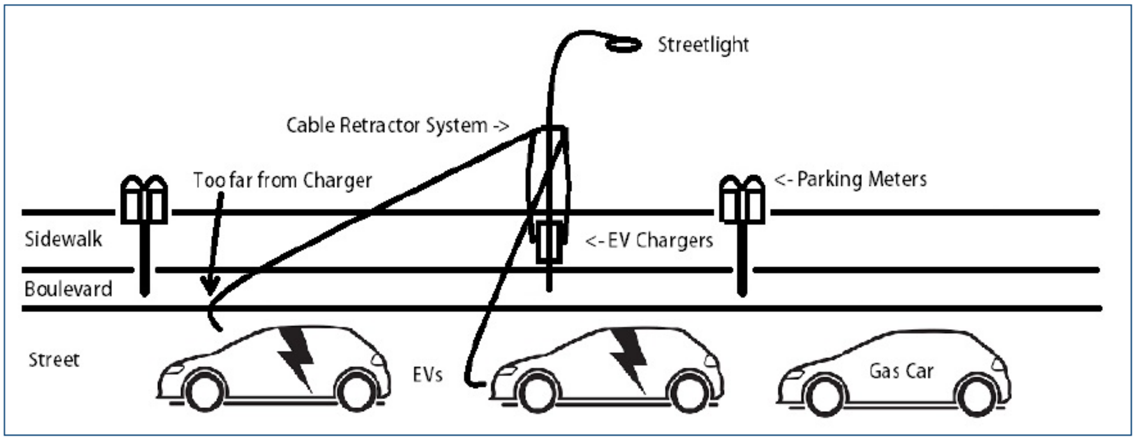

Figure 3. Parking Meter Considerations –Problematic Meter Placement (Howey, 2018)

In the implementation of their project, the City of New Westminster included a demand management system in some of their charging stations. Using this configuration, if only one vehicle was connected it could be charged with 40 Amps. When two vehicles were connected each one of them would receive 20 Amps. If the two vehicles were connected at night (when the streetlights were on) each vehicle would receive 16 Amps (Carmichael, 2019).

The brands of EV charging stations installed were Flo and Clipper Creek, with an average cost of 4000 CAD per charging point. Besides the demand management functionalities, the charging stations also included a cable management feature to reduce tripping hazards (Carmichael, 2019).

New Westminster allows users to charge their car for a defined number of hours, in some locations is two hours and in others is one hour. If they surpass this time they are subject to a fine. Regarding the cost of using the installations, for this pilot project is being free, the user only pays for the parking (around 2 CAD per hour) (New Westminister Record, 2017), (Carmichael, 2019).

2.1.6 Other cities

Other cities like Seattle, Lancaster, Sydney, Philadelphia, Miami, Chicago, Berlin, amongst others are exploring similar alternatives to increase the Electric Vehicle adoption and reduce GHG emissions from private transport.

2.2 Key findings of other cities light-pole charging projects

The main findings identified in the projects/programs were divided in the two categories, technical and non-technical.

2.2.1 Technical findings

- All the reviewed pilot projects and programs are implementing only level 2 charging stations.
- The major challenge has been finding the lighting poles that comply with the technical requirements. In the U.S., of 5,000,000 street and parking lights, only 5% of these have the right conditions to implement electrical vehicle charging stations using existing infrastructure (Charged, 2016).

- Most streetlight poles use High-Pressure Sodium or Metal Halide lighting fixtures. Upgrading them to LED reduces the electrical load by at least 50%, which makes the light poles more suitable for installing electric vehicle charging stations.
- Most of the streetlights are controlled by photocells and timers located in a service panel board, which means that the lighting poles are only energized at night. In order to host EV charging stations, each lighting pole has to have an independent control so it can be energized 24 hours a day 7 days a week.
- The lighting infrastructure of most of the cities is quite old and for that reason, its technical information is not available. Also, some cities have found that the electrical installations are deteriorated (conductors without proper insulation, broken conduits, etc.). This has made many cities discard certain locations that would be potentially useful for the users.
- Some of the cities are taking advantage of the retrofits that telecommunications companies are doing to the light poles. These companies are adding antennas to increase the mobility coverage and by doing this they are modifying the lighting poles to be energized 24 hours a day, 7 days a week, which is also a requirement for the electric vehicle charging stations. Moreover, during that retrofit, they are adding electric capacity to support these stations.
- There is a wide variety of EV charging stations suppliers that can adapt to the project requirements.

2.2.2 Non-technical findings

- Most projects are focused on residential areas where the residents do not have access to off-street parking. Several projects were also implemented in parking lots close to high-density residential areas, like community centers.
- Most projects limit the user to charge their cars only for a defined duration. Going over that time period the users are subject to a fine.
- All of the projects charge the users a fee for charging their vehicles, except for the City of New Westminster in which the service is currently free. The user only pays for the parking.

3 Area of focus

As mentioned previously, the main objective of this project is to increase Electric Vehicle adoption by providing a charging solution for Vancouverites who do not have access to off-street parking. This study used the information gathered by the Curbside EV Charging Pilot Program to identify the areas of focus.

The Curbside EV Charging Pilot Project identified all the RS and RT zoned parcels that did not have access to off-street parking (“garage orphans”). From 1,991 acknowledged homes, 1,179 were RS and 814 were RT. Off-street parking is defined by the prevalence of a garage, carport or driveway where a vehicle can be stored on private property off public streets. When the program started, over 57 Vancouverites enquired about the program, showing interest for it. From these, only 25 qualified for the program.

In addition to not having access to off-street parking, the program took into account other criteria. The hierarchy decision criteria for assessing enquiries/applications are shown below.

1. The applicant is the owner of the suite
2. It is a residential building in RS/RT zones, generally with less than 5 units

3. There is no other public EV charging station within 50 m
4. They are a garage orphans
5. There is no lane or access to a lane
6. The property does not have a garage or space to accommodate a garage on-site.

    a. If there is a laneway, there is off-street parking that could be used
    b. Any new-build multi-family will have off-street parking so should not qualify unless it is stratified and someone else owns the parking spot
    c. Validate if multi-family unit is stratified and if stratified owner has an assigned parking spot, only 1 installation per Strata Corporation.
    d. If not a new build with multiple suites then there still likely is some off-street parking that is shared so they do not qualify

7. Their garage is too small – only in extenuating circumstances and the City's Engineering department has to review.
8. They are willing to make it a public asset

Other than being the property owner, the above criteria align with the objectives of the feasibility study. For this reason, the data collected in the Curbside EV Charging Pilot Project was used. Consequently, the areas with the highest density of garage orphans and the highest number of enquiries were selected as the area of focus. In Figure 4 the garage orphans, enquiries and the selected areas of focus are shown.

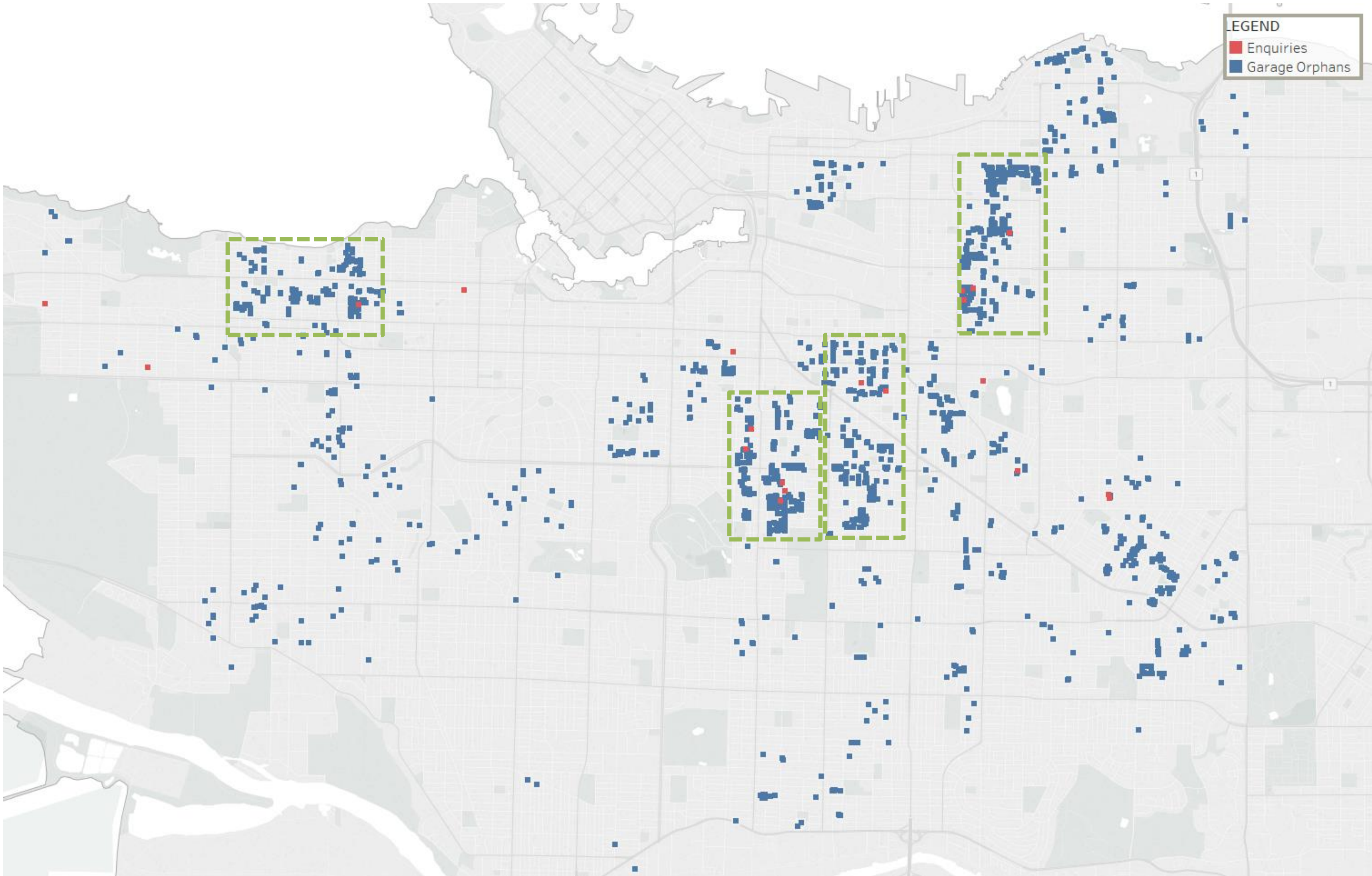

Figure 4. Location of garage orphans and enquiries.

As it can be seen from Figure 4, the areas selected are located between the following streets and avenues:

- Between Ontario and Fraser & between 16th Avenue and 33th Avenue
- Between Fraser and Knight & between Broadway and 33th Avenue
- Between Commercial and Victoria & between East Hastings and Grandview Highway
- Between Alma and Trafalgar & between Point Grey Road and Broadway

The areas selected were only for the purpose of this feasibility study. However, this does not mean there could be other areas with a huge potential to install EV charging stations in the curbside. Areas such as 30-year-old low rise buildings could also have potential for these type of application.

4 Current electrical infrastructure

Once the areas of focus were identified, the next step was to select the location of light poles that would have the EVSE. To accomplish that objective defining the service panel was the priority. To define them the following steps were followed:

1. Review the inventory of the City’s electrical light pole infrastructure.
2. Understand the physical status of the existing infrastructure.
3. Filtering the existing service panels that could be more suitable for the project.
4. Analyzing the load capacity of the panels pre-selected.
5. Calculating the voltage drop on the light poles of the panels selected.

4.1 Inventory of electrical light pole infrastructure

The City has 56,347 lighting fixtures fed by 1,288 electric panels over approximately 2,600 km of underground installations, composed mainly by rigid steel conduit (2” diameter), rigid PVC conduit (2” diameter), polyethylene conduit (1” diameter), direct buried cable and direct buried korduct that were installed over the last 90 years[2].

Before analysing the available capacity of the system it is important to know the overall distribution of the different elements that constitute the electrical infrastructure of the street light system.

4.1.1 Light pole distribution

The City’s 56,346 lighting fixtures are divided into four categories. The largest one is Street Lighting[3], which is the main interest of the project. The second-biggest category is Lane Lighting. This corresponds to the light poles located in the lane roads. The Park Lighting[4] category corresponds to the lighting fixtures in charge of lighting the green areas, pedestrian roads, tennis courts, basketball courts, etc. The last category, named as “other”, corresponds to additional lighting such as the ones located in some of the parking lots of community centers, the outdoor lighting of City Hall, the floodlighting of Cambie street, amongst others. The following figures show a representation of the distribution by the number of luminaires, as well as by power consumption.

[2] Information obtained through the City’s Engineering platform Hansen.
[3] In the City’s Engineering platform Hansen is referred to as OrnamentalStLtg.
[4] Park’s Lighting is not owned nor maintained by the City, with specific exceptions.

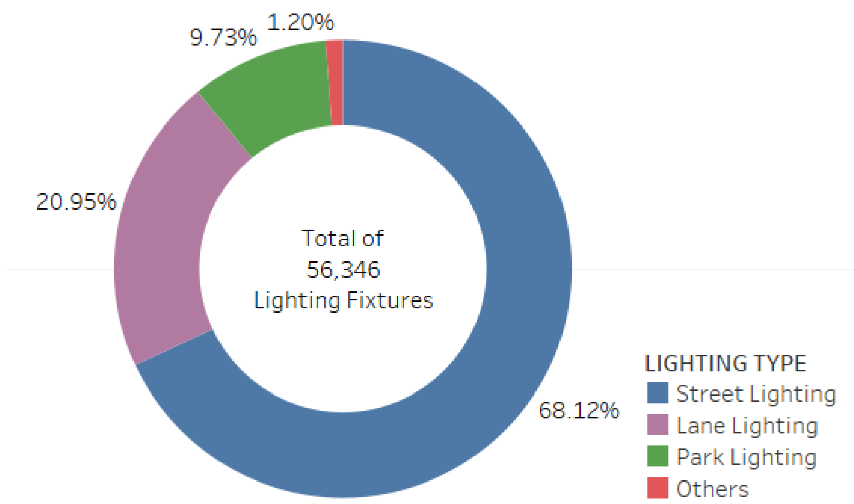

Figure 5. Distribution of types of lighting in the City of Vancouver.

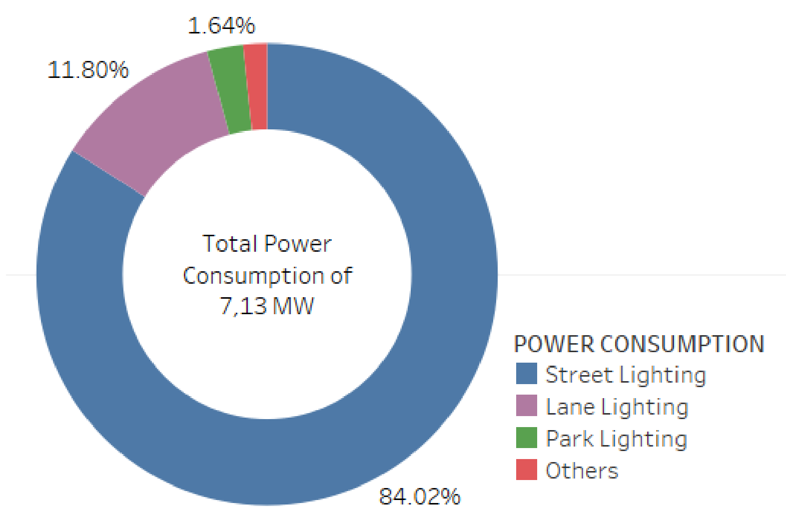

Figure 6. Distribution of power consumption per type of lighting in the City of Vancouver.

Table 2. Distribution of types of lighting in the City of Vancouver

Lighting Type	Quantity of Lighting Fixtures	Total Power Consumption (W)
Street Lighting	38,383	5,994,079
Lane Lighting	11,804	842,074
Park Lighting	5,483	180,608
Others	676	116,991

The figures above show that the largest amount of lighting fixtures, as well as the highest power, corresponds to the Street Lighting.

After analyzing the distribution of the different lighting fixtures of the City, the focus was directed only on the Street Lighting which corresponds to the streetlight poles. For this reason, an analysis of the different types of lighting fixtures the streetlight poles have was made.

The following graphs illustrate the distribution of the Street Lighting by type of lighting fixture. The lighting fixtures types are High Pressure Sodium (HPS), Light Emitting Diode (LED), Metal Halide (MH), Incandescent lamps, Induction Lamps, Compact Fluorescent Lamps (CFL) and Not Identified, which means lamps with no specification in the database.

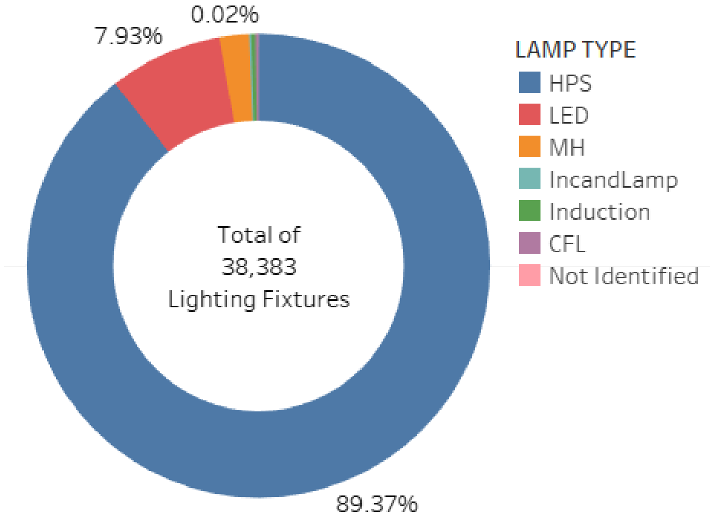

Figure 7. Lighting fixture distribution of the Street Lighting.

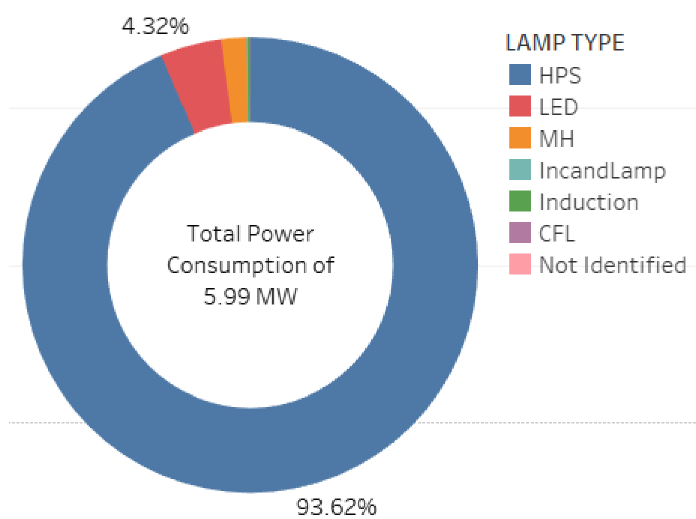

Figure 8. Lighting fixture distribution by power consumption of the Street Lighting

Table 3. Lighting fixture distribution of the Street Lighting.

Lighting Type	Quantity of Lighting Fixtures	Total Power Consumption (W)
High Pressure Sodium (HPS)	34,303	5,611,599

Lighting Type	Quantity of Lighting Fixtures	Total Power Consumption (W)
Light Emitting Diode (LED)	3,043	258,745
Metal Halide (MH)	789	104,415
Incandescent lamps	108	8,820
Induction Lamps	76	1,916
Compact Fluorescent Lamps (CFL)	56	8,253
Not Identified	8	331

As evidenced in the graphs above, the largest amount of lighting fixtures, as well as the highest power consumption, corresponds to the High Pressure Sodium lights, followed by LED, Metal Halide and Incandescent Lamps. This means that just by replacing all the High Pressure Sodium lights for LED the capacity of the streetlight electrical system would increase by 2.8 MW. This could represent over 840 level 2 EV charging stations (assuming 3.3 kW per charging point) or over 2,500 level 1 EV charging stations (assuming 1.1 kW per charging point).

4.1.2 Electrical service panels

As mentioned above, the City has 1,288 electric panels divided into service panels and kiosks. The following charts present the distribution between service panels and kiosks. The service panels are usually mounted on BC Hydro's wood poles, while the kiosks are pad mounted. The kiosks have larger enclosures and besides containing a panel, they can contain metering devices, while most of the service panels do not.

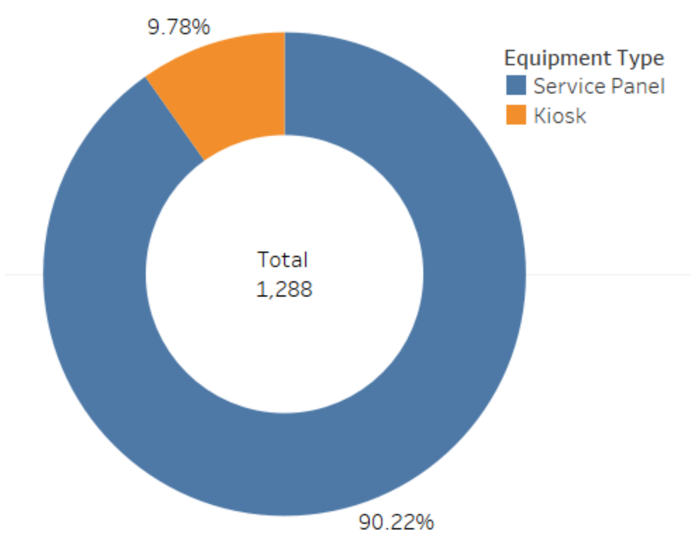

Figure 9. Service panels and kiosks distribution.

A crucial aspect for the project are the panels that have been updated and the ones that have not. Most of the panels were installed several decades ago, where the safety regulations governing the installation of the panelboards was different. Today's regulations are more strict requiring the bonding of all the metallic elements; stipulating the type of conductors used (no direct buried korduct is allowed, which has asbestos); specifying the type of conduit for each application; the overcurrent protections used as well as all the electrical components of the have to be CSA approved. Besides this fact, some of the electrical installations are in bad condition, due to corrosion of their materials and ageing components, turning them into a possible hazard. For this reason, the City has been updating the service panels. This update not only includes changing the panel but in some cases, their underground installations had also been renewed.

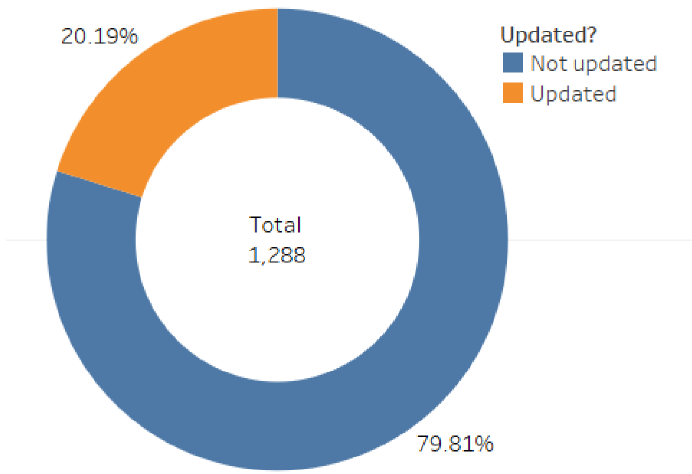

Figure 10. Updated and not updated panels distribution.

Finally, another important statistic for the project is the panels that are metered. This means the panels that have a Measurement Canada certified meter inside their enclosure.

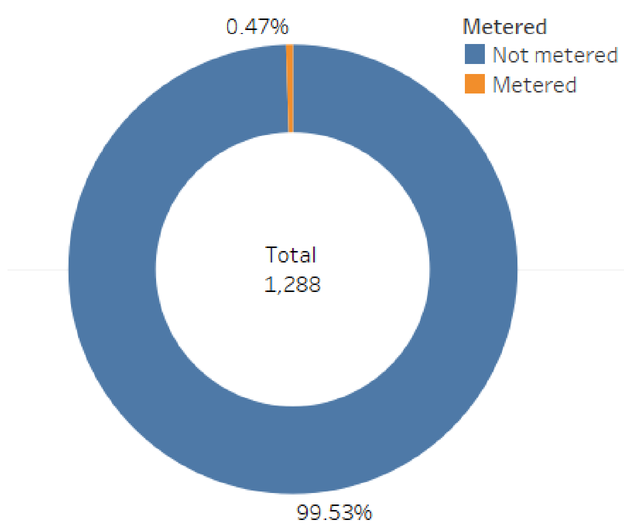

Figure 11. Metered and not metered panels distribution

As shown in the previous charts, the amount of kiosk in the city is significantly smaller than the service panels. The same phenomenon occurs with metered and unmetered on a higher scale. On the other hand, the updated panels are almost one-quarter of the total number of panels which means is likely to use several of those for the project. It is important to take into account that these updated panels, besides supplying energy to streetlight, can also feed traffic lights and tree lights (in specific months of the year).

4.2 Overview of the physical status of the infrastructure

Meetings with City Streets and Electrical Design Branch staff, conducted on May 22 and June 18 of 2019, identified several major concerns regarding the current status of the streetlight electrical infrastructure. The first and most important concern is that many of the conductors in charge of feeding the light poles have deteriorated insulation that is a hazard to pedestrians because it energizes the metal poles. Currently, the light poles are only energized at night; they operate with photocells located in the service panel that is in charge of feeding them. The problem would become larger, and more dangerous because, for the operation of the EVSE on the light poles, they have to be energized the 24 hours of the day. This would energize the metallic light poles during the day increases the probability of a pedestrian touching it and receiving an electrical discharge.

This previous problem shows another big issue with the electrical system of the streetlight poles, which is the grounding of all of its elements. If the light poles had a proper bonding (connection with a common grounding system) this problem would not exist. This means that the project must include the correction of the bonding of all the light poles intervened by the installation of the charging stations. It is worthy to mention the City has a budget for this correction and the Engineering department is currently fixing this hazard.

Another important issue that has to be taken into account is the fact that most of the metallic conduit is corroded and is impossible to reuse. This means that if a new wire is required, either because it is necessary to increase the size of the conductor (to increase capacity) or to add a phase (to get 240V), new conduit would need to be installed. This means digging through the sidewalk or street to install new duct banks.

An additional concern identified by the City's Engineering department is that all the service panels are located on wood poles. According to new BC Hydro regulations, no service panel is allowed on wood poles. This means that if the project requires changing the panel it has to be located on a metal pole, a pedestal or a kiosk. The replacement of the service panels would depend on the metering requirements of the utility company.

Also, all the electrical installations from 41st Avenue to the south and from Victoria Street to the east are direct-buried. Direct-buried conductors present two significant barriers to adding a light-pole charging point. The first one is the uncertainty of the location of those cables. If a failure occurs it could be difficult to troubleshoot it. They were installed a long time ago and they could have moved during this period. Second, modifying or changing a conductor would require changing the whole underground installation, incurring in higher investment costs.

Finally, the last concern identified was that the service panels do not have a metering device. Currently, the City pays the utility company (BC Hydro) a fixed rate per each streetlight on service. The energy consumption and the power required to feed all the City's light poles is predictable. An estimate of the time they are operating per day (is an estimate because they operate with a photocell) can be calculated and the power of each lighting fixture is known. If the charging stations are installed, this fixed rate will no longer apply to the City's streetlight because the charging stations will add a variable consumption. The City cannot assure the time they will be operating and for this reason, it is mandatory to install a metering system.

4.3 Service panel selection

Once the areas of interest were identified, the following step was to select the service panels that are going to feed the streetlight pole charging stations. Because the City has 1,288 service panels, a meeting was scheduled with a designer from Electrical Street Design Branch, on July 2, 2019. In this meeting, the designer gave additional criteria to facilitate the selection of the electric panels. Also, some solutions to the possible barriers for the implementation were discussed, such as the metering options.

The information from the service panels was obtained using Hansen service panels' database, VanMap, and the Street Lighting Mapbook. This last resource is a set of drawings which contain all the information of the different panels, light poles, lighting fixtures, conduits and junction boxes. It was updated on February 13, 2009.

The first filter made was selecting the updated panels. These panels are identified because they have the letter U or M at the beginning of their Panel Name. U stands for unmetered and M for metered. All the panels have a four digit number for example, U6239WFBLR and 6722WF. The first one starts with a U (updated panel) and the second one start with the four digit number (non-updated panel). This step narrowed the search to 261 panels. Selecting these panels assures that the panel and outputs are in good condition. Selecting only updated panels will help in the pilot project phase by saving a significant amount of money and time of implementation. Also, these panels have a higher capacity than the old ones, 100 A two-pole main breaker to 60 A two-pole main breaker, respectively.

Once the updated panels were selected the quantity was narrowed by focusing on the ones that were located in the area of interest for the project. Discarding all the panels that were placed outside these areas the number of panels was reduced to 27. None of these panels were metered.

From these 27, 10 panels were selected. Three of these panels were discarded because they have not been installed yet, their status is pending installation. Four more panels were discarded because, although they were located in the area of interest, the light poles they were feeding were not. Two were discarded because they only feed light poles located on main roads. Two panels were discarded because the light poles were located on the wrong side of the sidewalk (see Figure 13). Three more panels were discarded because most of their circuits and outputs were direct-buried. The last three panels were discarded because there was no information of their conduit installation neither in VanMap nor in the Street Lighting Mapbook. A process diagram of how the selection of the service panel was made is shown in Figure 12.

Figure 12. Steps for the selection of the service panels.

Figure 13. Light pole on the wrong side of the sidewalk.

Finally, the service panels selected are shown in Table 4.

Table 4. Service panels selected.

Panel name	Location	Voltage	Light poles fed
U5438SFBLR	400 to 499 E 22nd Avenue	240/480V	39
U6134LEBLR	1100 to 1199 E 18th Avenue	120/240V	17
U6333WEBLR	1300 to 1399 E 17th Avenue	120/240V	11
U5848CFBLR	800 to 899 Durward Avenue	240/480V	43
U5743VFBLR	4300 to 4399 Fraser Street	240/480V	53
U5245PFBLR	4500 to 4599 Main Street	240/480V	33
U6135TFBLR	1100 to 1199 E 19TH Avenue	240/480V	66
U5534SFBLR	500 to 599 E 18TH Avenue	240/480V	42

Panel name	Location	Voltage	Light poles fed
U5342NFBLR	4200 to 4299 Sophia Street	240/480V	26
U6239WFBLR	3900 to 3999 Inverness Street	240/480V	28

None of the service panel selected (Table 4) using the criteria shown in Figure 12 were located in the following areas of focus:

- Between Commercial and Victoria & between East Hastings and Grandview Highway
- Between Alma and Trafalgar & between Point Grey Road and Broadway

Also, all the service panels selected are mounted in wood poles.

4.4 Load capacity

The load calculation considered the following assumptions:

- Balanced distribution of the lighting fixtures per circuit.
- Power factor of the High Pressure Sodium (HPS) lighting is 87%.
- Power factor of the Metal Halide (MH) lighting is 90%.
- Power factor of the LED lighting is 97%.
- The service panels U6134LEBLR and U6333WEBLR fed the light poles at 120 V; this assumption was based on the distribution of the conductors showed in Street Lighting Mapbook.
- The power consumption of the LED lighting was selected using a quick reference conversion table of the City's Electrical Design Branch.
- All service panels are fed using a single-phase three-wire configuration (split-phase). This means two circuits share a neutral, i.e. circuit 1 and 2 share the neutral.

The following tables present a summary of the load calculations. The current consumption corresponds to the power consumption with the current lighting fixtures. The future consumption corresponds to the consumption that results from replacing all the HPS lighting by LED lighting. Capacity gain is the difference between these two consumptions.

Table 5. Capacity gain in U5438SFBLR service panel.

	Current Consumption (kVA)	Future Consumption (kVA)	Capacity Gain (kVA)
Circuit 1	1.95	0.86	1.09
Circuit 2	1.95	0.86	1.09
Circuit 3	1.84	0.80	1.04
Circuit 4	1.55	0.67	0.88
Total capacity gain			**4.11**

Table 6. Capacity gain in U6134LEBLR service panel.

	Current Consumption (kVA)	Future Consumption (kVA)	Capacity Gain (kVA)
Circuit 1	0.52	0.22	0.29
Circuit 2	0.52	0.22	0.29
Circuit 3	1.03	0.45	0.59
Circuit 4	0.86	0.37	0.49
Total capacity gain			**1.67**

Table 7. Capacity gain in U6333WEBLR service panel.

	Current Consumption (kVA)	Future Consumption (kVA)	Capacity Gain (kVA)
Circuit 1	0.52	0.22	0.29
Circuit 2	0.52	0.22	0.29
Circuit 3	0.52	0.22	0.29
Circuit 4	0.34	0.15	0.20
Total capacity gain			**1.08**

Table 8. Capacity gain in U5848CFBLR service panel.

	Current Consumption (kVA)	Future Consumption (kVA)	Capacity Gain (kVA)
Circuit 1	0.69	0.30	0.39
Circuit 2	0.52	0.22	0.29
Circuit 3	1.15	0.47	0.68
Circuit 4	1.26	0.53	0.73
Circuit 5	1.90	0.75	1.14
Circuit 6	1.61	0.62	0.99
Circuit 7	2.97	0.72	2.25
Circuit 8	2.74	0.64	2.10
Total capacity gain			**8.58**

Table 9. Capacity gain in U5743VFBLR service panel.

	Current Consumption (kVA)	Future Consumption (kVA)	Capacity Gain (kVA)
Circuit 1	1.21	0.52	0.69
Circuit 2	1.03	0.45	0.59
Circuit 3	2.53	0.98	1.55
Circuit 4	2.53	0.98	1.55
Circuit 5	2.07	0.80	1.27

	Current Consumption (kVA)	Future Consumption (kVA)	Capacity Gain (kVA)
Circuit 6	2.07	0.80	1.27
Total capacity gain			**6.93**

Table 10. Capacity gain in U5245PFBLR service panel.

	Current Consumption (kVA)	Future Consumption (kVA)	Capacity Gain (kVA)
Circuit 1	0.86	0.37	0.49
Circuit 2	0.69	0.30	0.39
Circuit 3	2.76	1.06	1.69
Circuit 4	2.76	1.06	1.69
Total capacity gain			**4.27**

Table 11. Capacity gain in U6135TFBLR service panel.

	Current Consumption (kVA)	Future Consumption (kVA)	Capacity Gain (kVA)
Circuit 1	1.72	0.74	0.98
Circuit 2	1.55	0.67	0.88
Circuit 3	1.72	0.80	0.93
Circuit 4	1.72	0.80	0.93
Circuit 5	1.44	0.66	0.77
Circuit 6	1.44	0.66	0.77
Circuit 7	1.95	0.89	1.07
Circuit 8	1.67	0.75	0.91
Circuit 9	1.61	0.71	0.90
Circuit 10	1.61	0.71	0.90
Total capacity gain			**9.04**

Table 12. Capacity gain in U5534SFBLR service panel.

	Current Consumption (kVA)	Future Consumption (kVA)	Capacity Gain (kVA)
Circuit 1	1.67	0.71	0.96
Circuit 2	1.55	0.67	0.88
Circuit 3	2.07	0.89	1.18
Circuit 4	1.90	0.82	1.08
Total capacity gain			**4.10**

Table 13. Capacity gain in U5342NFBLR service panel.

	Current Consumption (kVA)	Future Consumption (kVA)	Capacity Gain (kVA)
Circuit 1	0.98	0.43	0.55
Circuit 2	0.86	0.30	0.57
Circuit 3	1.38	0.59	0.79
Circuit 4	1.38	0.59	0.79
Total capacity gain			**2.68**

Table 14. Capacity gain in U6239WFBLR service panel.

	Current Consumption (kVA)	Future Consumption (kVA)	Capacity Gain (kVA)
Circuit 1	2.18	0.95	1.23
Circuit 2	2.82	1.20	1.61
Total capacity gain			**2.58**

After reviewing the available capacity and the capacity gain it can be seen that U5848CFBLR (with 8.6 kVA), U5743VFBLR (with 6.9 kVA) and U6135TFBLR (9.0 kVA) service panels have a larger capacity gain. This is because they feed the highest number of luminaries.

Also, it is important to mention that at least two of the circuits of these panels supply energy to streetlight poles in charge of lighting main roads. U5848CFBLR feeds 33rd East Avenue, U5743VFBLR feeds Fraser Street and U6135TFBLR feeds Kingsway.

Last but not least, the three panels selected have spare circuit breakers according to the Street Lighting Mapbook, which means it can have extra capacity.

Appendix A – Load calculations presents the load calculations in detail.

4.5 Voltage drop calculations

To identify the modifications that have to be done to the existing infrastructure, the voltage drop has to be calculated. The voltage drop calculations were only made for the circuits that are not feeding streetlight poles in main roads because the project would not be adding load (charging infrastructure) to these circuits. For now, it is assumed that pilot projects will only add load to the circuits feeding the light poles of residential areas not located on main roads.

In the following tables, the voltage drop per luminaire will be presented. The following assumptions were considered:

- The distribution of the light poles per circuit was taking into account the conductors per conduit. It can be seen in the appendix, section 12.2.
- The power consumption of the LED lighting was selected using a quick reference conversion table of the City's Electrical Design Branch.

- All service panels are fed using a single-phase three-wire configuration (split-phase). This means two circuits share a neutral. For the three panels analyzed circuit 1 and 2 share the same neutral which mean that if the load is balanced in the two circuits the current through the neutral is zero.

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To comply with the Canadian Electrical Code the voltage drop has to be below 3%.

Table 15. Voltage drop for service panel U5848CFBLR.

Pole	Current voltage drop	Future voltage drop
Circuit 1		
P1-A	0.55%	0.26%
P3-A	0.73%	0.35%
P5-A	0.89%	0.42%
P7-A	1.25%	0.59%
Circuit 2		
P2-B	0.12%	0.06%
P4-B	0.44%	0.21%
P6-B	0.62%	0.29%

Table 16. Voltage drop for service panel U5743VFBLR

Pole	Current voltage drop	Future voltage drop
Circuit 1		
P1-A	0.04%	0.02%
P3-A	0.85%	0.41%
P5-A	1.70%	0.81%
P7-A	2.13%	1.01%
P9-A	2.48%	1.18%
P11-A	2.79%	1.33%
P13-A	2.10%	1.00%
Circuit 2		
P2-B	0.41%	0.19%
P4-B	1.20%	0.57%
P6-B	1.89%	0.90%
P8-B	2.18%	1.03%
P10-B	2.35%	1.11%
P12-B	2.08%	0.99%

Table 17. Voltage drop for service panel U6135TFBLR.

Pole	Current voltage drop	Future voltage drop
Circuit 1		
P1-A	1.47%	0.70%

Pole	Current voltage drop	Future voltage drop
P3-A	2.31%	1.10%
P5-A	3.05%	1.45%
P7-A	3.26%	1.55%
P9-A	3.39%	1.61%
P11-A	3.34%	1.59%
P13-A	1.70%	0.81%
P15-A	1.99%	0.94%
P17-A	2.21%	1.05%
P19-A	2.56%	1.22%
Circuit 2		
P2-B	2.19%	1.04%
P4-B	2.82%	1.34%
P6-B	3.43%	1.63%
P8-B	3.63%	1.72%
P10-B	3.92%	1.86%
P12-B	3.44%	1.64%
P14-B	1.59%	0.75%
P16-B	2.05%	0.97%
P18-B	1.99%	0.94%

Table 15, Table 16 and Table 17 show that two of the three panels analysed do not comply with the 3% of voltage drop accepted for branch circuits, as defined in the Canadian Electrical Code. Of the circuits analysed in the three panels, all of them are wired using cable 12 AWG.

Appendix B – Voltage drop calculations presents the voltage drop calculations of the three panels selected in detail.

4.6 Additional service panels

Three additional service panels were selected to be analysed because some of the focus areas were not being addressed. The criteria for the selection of these panels were their location. The panels selected were:

- **U2722VFLR**, located in the area of Kitsilano. This panel was discarded because it did not comply with the requirement presented in section 4.3, Figure 12, although it is an updated panel. Also, most of the wiring that feeds to the light poles are in 10 AWG which will reduce the voltage drop.
- **6722WF,** located between Commercial and Victoria Drive with 6th East Avenue. This panel was not selected initially because has not been updated. However, it was selected as an additional panel because two of its circuits feed the streetlight poles from Commercial Drive, which means that once the lighting fixtures are upgraded to LED the available power capacity will significantly increase.
- **5441UF,** located between Prince Edward and Balkan Street with 26th East Avenue. This panel was selected because of the high density of "garage orphans" near it.

4.6.1 Load capacity and voltage drop calculations

The load calculation considered the same assumptions stated in section 4.4:

- Balanced distribution of the lighting fixtures per circuit.
- Power factor of the High Pressure Sodium (HPS) lighting is 87%.
- Power factor of the LED lighting is 97%.
- The power consumption of the LED lighting was selected using a quick reference conversion table of the City's Electrical Design Branch.
- All service panels are fed using a single-phase three-wire configuration (split-phase). This means two circuits share a neutral, i.e. circuit 1 and 2 share the neutral.

The following tables present a summary of the load calculations. The current consumption corresponds to the power consumption with the current lighting fixtures. The future consumption corresponds to the consumption that results from replacing all the HPS lighting by LED lighting. Capacity gain is the difference between these two consumptions.

Table 18. Capacity gain in U2722VFLR service panel.

	Current Consumption (kVA)	Future Consumption (kVA)	Capacity Gain (kVA)
Circuit 1	2.64	1.05	1.60
Circuit 2	2.53	1.01	1.52
Total capacity gain			**3.12**

Table 19. Capacity gain in 6722WF service panel.

	Current Consumption (kVA)	Future Consumption (kVA)	Capacity Gain (kVA)
Circuit 1	0.98	0.39	0.59
Circuit 2	0.86	0.37	0.49
Circuit 3	0.98	0.41	0.57
Circuit 4	0.90	0.38	0.52
Circuit 5	2.48	1.05	1.43
Circuit 6	2.68	1.14	1.54
Total capacity gain			**5.14**

Table 20. Capacity gain in 5441UF service panel.

	Current Consumption (kVA)	Future Consumption (kVA)	Capacity Gain (kVA)
Circuit 1	1.03	0.45	0.59
Circuit 2	1.03	0.45	0.59
Circuit 3	1.03	0.45	0.59
Circuit 4	0.86	0.37	0.49

	Current Consumption (kVA)	Future Consumption (kVA)	Capacity Gain (kVA)
Total capacity gain			2.26

For the voltage drop calculation of the additional panels, the same assumptions as the ones stated in section 4.5 were considered:

- The distribution of the light poles per circuit was taking into account the conductors per conduit. Refer to the Appendix, section 12.4.
- The power consumption of the LED lighting was selected using a quick reference conversion table of the City's Electrical Design Branch.
- All service panels are fed using a single-phase three-wire configuration (split-phase). This means two circuits share a neutral. For the three panels analyzed circuit 1 and 2 share the same neutral which mean that if the load is balanced in the two circuits the current through the neutral is zero.

The following tables present the voltage drop per luminaire. To comply with the Canadian Electrical Code the voltage drop has to be below 3%.

Table 21. Voltage drop for service panel U2722VFLR.

Pole	Current voltage drop	Future voltage drop
Circuit 1		
P1-A	0.13%	0.06%
P3-A	0.43%	0.20%
P5-A	0.63%	0.30%
P7-A	0.58%	0.27%
Circuit 2		
P2-B	0.25%	0.12%
P4-B	0.39%	0.19%
P6-B	0.43%	0.20%

Table 22. Voltage drop for service panel 6722WF.

Pole	Current voltage drop	Future voltage drop
Circuit 1		
P1-A	0.34%	0.16%
P3-A	0.66%	0.30%
P5-A	1.04%	0.46%
P7-A	0.65%	0.31%
P9-A	0.85%	0.40%
Circuit 2		
P2-B	0.35%	0.17%
P4-B	0.53%	0.25%
P6-B	0.73%	0.35%

Pole	Current voltage drop	Future voltage drop
P8-B	1.11%	0.53%
P10-B	1.40%	0.67%

Table 23. Voltage drop for service panel 5441UF.

Pole	Current voltage drop	Future voltage drop
Circuit 1		
P1-A	0.22%	0.11%
P3-A	0.33%	0.16%
P5-A	0.34%	0.16%
P7-A	0.94%	0.45%
P9-A	1.17%	0.56%
P11-A	1.29%	0.61%
Circuit 2		
P2-B	0.53%	0.25%
P4-B	0.63%	0.30%
P6-B	0.65%	0.31%
P8-B	1.22%	0.58%
P10-B	1.40%	0.67%
P12-B	1.73%	0.82%
Circuit 3		
P13-C	0.39%	0.18%
P15-C	0.68%	0.32%
P17-C	0.92%	0.43%
P19-C	1.11%	0.52%
P21-C	1.08%	0.51%
P23-C	1.35%	0.64%
Circuit 4		
P14-D	0.53%	0.25%
P16-D	0.88%	0.41%
P18-D	1.14%	0.54%
P20-D	1.46%	0.69%
P22-D	1.20%	0.56%

Appendix C – Load calculations of additional service panels presents the load calculations in detail. Appendix D – Voltage drop calculations of additional service panels presents the voltage drop calculations of the panels in detail.

4.7 Selected Service Panels

The service panels selected are shown in Figure 14.

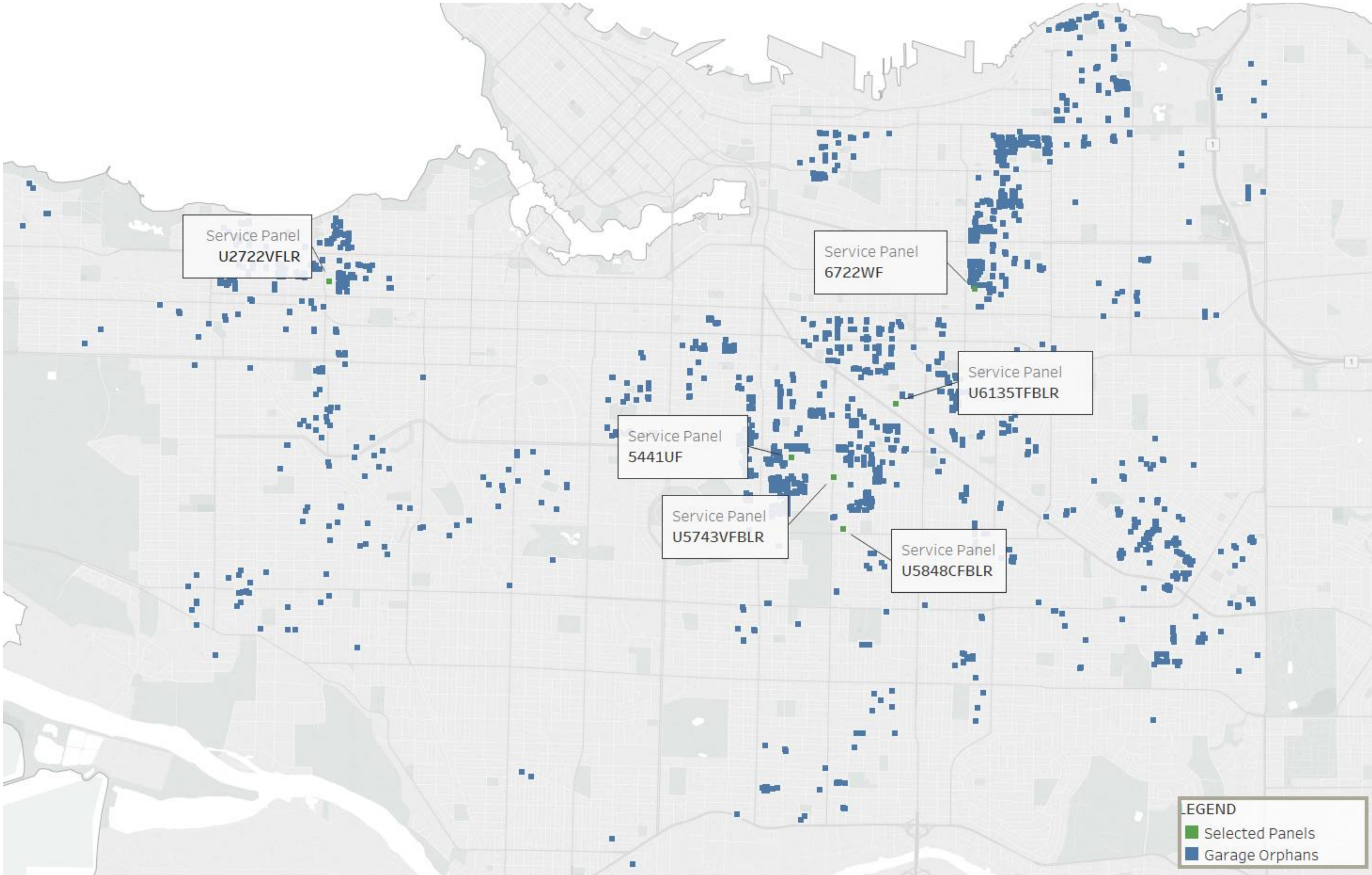

Figure 14. Location of selected service panels.

4.8 Findings and challenges of the current electrical infrastructure

The main findings identified were:

- Most of the lighting fixtures are HPS which means that if changed to LED the streetlight electrical infrastructure could increase its capacity over 2.8 MW.
- None of the existing kiosks were suitable for the implementation of the EV charging stations due to their location.
- The six panels selected have a service voltage of 240/480 V, single-phase, 3 wire connection.
- The service panels that can provide the highest power capacity are the ones located near the main roads. There are two reasons why this happens.

    (1) The high amount of lighting fixtures these circuits feed.
    (2) The power of the lighting fixtures in charge of lighting the main roads. While the residential streetlight poles usually have a 150 W HPS lamp, the light poles of the main roads have 200W or 250 W HPS lamps. Retrofitting them to LED will make more capacity available.

- The installation of EV charging stations has to be as close as possible to the services panel reducing the voltage drop. Although with the upgrading to LED lighting the voltage drop is mitigated, the power consumption of the EVSE will increase it significantly.
- For most of the service panels, the power capacity of the EVSE will not be a concern because the updated service panels have a capacity of over 38.4 kVA (80% of the 100 A main breaker).
- The voltage drop and the ampacity of the existing conductors will be the major factors limiting the capacity of the charging infrastructure. Most of the circuits are wired with 12 AWG conductors.

The main challenges identified were:

4. The agreement with BC Hydro, regarding the way the City pays the light pole electricity consumption, is a major concern. The problem is not the change in the electricity rate the City is currently paying; the problem is that with the implementation of the EV charging station from the light poles a metering device has to be installed in the service panel and/or in the light poles. This issue can be solved in three different ways:

    a) The use of a smart EV charging cable with the metering included in it. This has to be approved by BC Hydro and could have certain implications on the supplier of the cable because it would require a Measurement Canada (MC) metering certification as well as a CSA certification, among other technical requirements.
    b) The implementation of EV charging stations with the metering device included in their enclosure. As well as the previous solution, it has to be approved by BC Hydro and MC metering certification, and CSA certification.
    c) The replacement of the service panels for kiosks or pole-mounted panels (in metallic poles) which have a certified metering device approved by the MC and BC Hydro. This cannot be implemented in the existing service panels because they have to be removed from the wooden poles to comply with BC Hydro's new

regulations if modified. In this solution, the City would have to assume a higher cost because it would have to incur in the installation of the new kiosks/panels.

5. The grounding system of the modified light poles with the EVSE has to be verified. In some cases, installing the bonding of the poles where the ECVS will be located would be enough, but in some others, the problem could affect the light poles downstream of the ones with the EVSE installed. For this reason, a special focus has to be considered to the poles that belong to the circuits.
6. According to the voltage drop results, it can be seen that for the implementation of the EV charging stations the size of the conductors should be increased. It may only be required to change the first two segments of the circuits. If the conduit of those cable segments is polyethylene, it could most likely be reused and just pull the new conductor through the conduit. On the other hand, if the conduit of those segments is a rigid metal conduit, it is most likely that the whole underground installation has to be replaced incurring in additional costs.

5 Technology review

Taking into account that the purpose of this project is to provide electric vehicle charging solutions to Vancouverites that do not have off-street parking, the technology review is focused only on level 1 and 2 charging stations.

The following table shows the typical electrical characteristics the electrical circuits feeding the EV charging stations must have. This information was taken from (Hydro Québec, 2015).

Table 24. Technical characteristics of level 1 and level 2 charging stations

Parameter	Level 1	Level 2
Voltage	120 V	208 or 240 V
Current type	AC	AC
Useful power	1.4 kW	7.2 kW
Maximum power output	1.9 kW	19.2 kW
Maximum current	12 A or 16 A	Up to 80 A
Protection	15 A[5] or 20 A	From 20 A to 100 A[6]
Type of Protection	1-pole breaker	1-pole breaker
Connector	J1772	J1772

Most of the EV can travel between 34 to 38 kilometres per hour of charge from a level 2 charger (7.7 kW). On the other hand, if charged by a level 1 charger (1.4 kW) that distance reduces to 6 kilometers per hour. It is important to clarify that the power of the level 2 charger can be varied and with this the range per hour of charge will also vary. The minimum amperage that can be provided is 6 Amps. A current lower than this will not be enough for the onboard charger of the EV

[5] A 15-A breaker is permitted only if the outlet is not dedicated to E V charging; otherwise, a 20-A breaker is required (see Section 86 of the Code).
[6] For 90 A to 100 A circuit breakers it's a requirement to have a disconnect switch near the charging station.

to start charging the battery (Guinn, 2018). A typical commute for a Vancouverite is between 10 to 30 kilometers round-trip per day (City of Vancouver, 2015), which is around 8 kWh per day (City of Vancouver, 2016). This means that a Vancouverite needs to charge its EV a little over an hour with a level 2 charger, while with a Level 1 would be around five hours.

From the cities currently using EV charging stations on street lighting, three EV charging solutions were chosen and a fourth one was selected due to its potential for future installations. Ubitricity which has been successful in London, England; Char.gy which also has deployed various EVSE in London; Flo which is a Canadian company and was used on New Westminster's pilot project; and Plugzio which is a Vancouver start-up with an innovative solution of level 1 charging stations.

5.1 Ubitricity

Ubitricity is a Berlin-based startup founded in 2008 which has developed a unique mobile metering technology for smart AC electric vehicle charging, on-street and off-street. This solution allows councils and real estate owners, to benefit from significantly lower charging infrastructure costs (Ubitricity, 2019), by transferring part of this cost to the users. The user needs to buy the smart cable, which has an in-line smart meter if it wants to access the Ubitricity network of EVSE. The council or real state owners have to install Ubitricity's SimpleSocket, which is a power outlet with no metering device included. However, this socket has an authentication system which communicates with the SmartCable to allow the charging.

Figure 15 Ubitricity Smart Cable (Ubitricity, 2019).

The main features of this technology are (Ubitricity, 2019):

- **Authorization / Power Release**
  The SmartCable initiates user authorization via mobile communication to the backend system and enables the SimpleSocket to begin charging.
- **Charging at Conventional Charging Stations**

SmartCable can be used like conventional charging cables at all conventional, standard-compliant charging stations. Although, the billing conditions of the other supplier will apply.

- Consumption Metering
  The SmartCable is equipped with a MID-certified[7] electricity meter for measuring energy consumption.
- Automated Billing
  The amount of energy consumed is billed to the user of the SmartCable. Transaction data is provided online.
- Data Transfer
  All consumption data is transferred to the backend system via mobile communication in a secure manner. If a mobile connection is not available at the time of charging, offline authorization is enabled. Transaction data is stored temporarily and transmitted to the back-end once a connection can be established.
- Data Security / Cryptography
  Certificate-based authentication is made possible by using a public key infrastructure (PKI) and encrypted communication.
- Remote Charging Control
  Mobile Metering allows for remote control of charging processes, enabling future smart grid integration and energy storage.

The technical information on this technology is presented below. Only the two single-phase SmartCable variants are presented. The SimpleSocket can limit the amount of current to assure the simultaneous operation of EVSE and street lighting.

Table 25. Technical characteristics of Ubitricity's solution (Ubitricity, 2019)

SmartCable Variants	20 A, 1-ph	32 A, 1-ph
On-board Plug Connector	Type 2 or Type 1 EN 62196-1/2	
Charging Power (1)	Max. 4.6 kW (230 V, 1-ph, 20 A)	Max. 7.4 kW (230 V, 1-ph, 32 A)
Weight	2.35 kg	3.3 kg
Materials and Dimensions	Dimensions of measuring unit: 270 x 89 x 56 mm (H x W x D) Material: PC clear; Protection class: IP 55 Cable length: 5.5 m	
Infrastructure-Based Plug Connector	Type 2 EN 62196-1/2	
Charging Mode	Mode 3 EN 61851-1	
Standard	EN 61851-1:2011	
MID meter	According to EN 50470-1/3	
SimpleSocket Plug Connection	Type 2 EN 62196-1/2 with interlock	

(1) The maximum capacity may be reduced due to conditions on the grid connection side.

7 Complies with the Electricity Metering Equipment (a.c.) Standard (EN 50470-1/3) from the European Committee for Electrotechnical Standardization.

If the City decides to implement this solution the manufacturer has to adapt its technology to Canadian standards. They would have to modify its device to operate at 60 Hz, as well as for 240V, among other technical requirements.

5.2 Char.gy

Char.gy is London-based (UK) startup founded in 2016 to solve residential electric vehicle charging for people without off-street parking. In late 2017 they install their first public charge point in Richmond, UK. Their solution consists of a compact charger that can be attached to existing lampposts or as a stand-alone or satellite bollard (Char.gy, 2019). In this technology the user has to connect its own cable to the charging station.

Figure 16. Char.gy's EV charging solution (Char.gy, 2019).

The main features of this technology are (Char.gy, 2019):

- **Multiple street wiring configurations**
  Dedicated cut-outs at 25A or 32A and shared 25A supplies.
- **Demand management**
  Various patented ways of managing supply bottlenecks and peak demand on the grid.
- **Physically secure**
  The charging station has a full metal enclosure which makes them weatherproof and waterproof. In addition, they have a unique metal embossed URL, hence, they cannot be vandalized or removed. Also, they have tamper-proof access.
- **Cable lock feature**
  The charging cable is locked in until the car owner releases it. It cannot be removed by anyone else.
- **Anti-graffiti paint**
  Designed to minimize any alteration of appearance.
- **Remote monitoring**

The user can track and monitor each device to maximize uptime.

Table 26. Technical characteristics of Char.gy's solution (Char.gy, 2019)

Parameter	Description
Infrastructure-Based Socket	Standard Type 2 (BS EN 62196-2)
Charging Power [(1)]	Up to 7.7 kW (230 V, 1-ph, 40 A)
IP Enclosure rating	IP55 as per IEC 60529:1989
Standard	EN 61851Parts 1 & 22
MID meter	ELEXON certified BSCP520 Measured Central Management System

[(1)] The maximum capacity may be reduced due to conditions on the grid connection side.

If the City decides to implement this solution the manufacturer has to adapt its technology to Canadian standards. They would have to modify its device to operate at 60 Hz, as well as for 240V.

5.3 Flo

Flo is a Canadian-wide charging station network that was founded in 2011 by AddEnergie. AddEnergie develops level 2 and level 3 charging stations in Quebec. Overall, FLO's charging stations are designed for roads, businesses and homes across the country and this network provides charging stations that are equipped with a SAE J1772 connector. By 2016, more than 2000 FLO charging stations were installed. The network aims to deploy another 10,000 smart-charging stations by 2020 (ChargeHub, 2019).

Flo has several charging station options but the one selected for this technology review is their newest product in the market and is called CoRe+. It can be pole-mounted as well as a single or double charging point.

Figure 17. Flo's EV charging solution (FLO, 2019)

The main features of this technology are (FLO, 2019):

- Power Sharing technology
  Greatly reduce installation cost by sharing the remaining incremental capacity of an existing electrical infrastructure.
- Power Limiting technology
  Add multiple charging stations to an existing installation while minimizing the light-pole circuit's peak power demand through:
  - Fixed limit
  - Scheduled limitations
- Smart Charging Solution
  Complete remote management capabilities. Also, enhances the user experience delivering real-time updates and notifications to drivers.
- Physical features

The enclosure is made from a thick and sturdy cast aluminum casing. It has a flexible 25-foot cable with a cable management system.

Table 27. Technical characteristics of Flo's technology (FLO, 2019)

Parameter	Description
Enclosure	Aluminum casing - NEMA 4X
Charging connector	SAE J1772
Cable	7.62 m / 25´ Ultra Flex
Charging Power	1.2 kW to 7.2 kW (208 VAC or 240 VAC)
Output current	6 A to 30 A (maximum configurable by software)
Integrated GFCI	20 mA, auto reset (3 attempts at 15-minute intervals)
Weight	9.5 kg / 21 lb
Communication interface	ZigBee - IEEE 802.15.4 meshed network
Certifications	CSA certified for Canada and United States Complies with UL 2594, UL 2231-1, UL 2231-2
EMC compliance	CAN - ICES-3 (A) / NMB-3 (A)

5.4 Plugzio

Plugzio is a Vancouver-based start-up who developed a consumption monitored outlet that automatically bills the user who authenticates it. The device is OFF by default and only starts the flow of electricity when the user activates it on a mobile phone. Plugzio bills the user and pays the owner, which could be the City if this technology is selected (Plugzio, 2019).

Currently, this technology only has an indoor application but they are working on an outdoor version of their product which will be available shortly. Plugzio has two products; Plugzio Cellular which comes with a built-in sim card and does not require any additional devices to operate; and Plugzio Wifi which requires a reliable Wi-Fi connection at all times. For this study, the technology review will use Plugzio Cellular.

Figure 18. Plugzio's EV charging solution (Plugzio, 2019)

The following table shows its technical features.

Table 28. Technical characteristics of Plugzio's technology (Plugzio, 2019).

Parameter	Description
Type	Smart Receptacle
Operating Voltage	120V AC
Wide Voltage Range	100V to 130V
Max Current	15 A
Max power output	1.8 kW
Dimensions	Depth: 44mm; Height: 125mm; Width: 125mm
Certifications	CSA StandardSPE-1000

Most of the light poles are fed by a 240/480 V service feeder. However, BC Hydro is replacing all the service feeders to 347/600 V three-phase or 120/240 V. For this reason, Plugzio technology could be a possible solution for future installations.

5.5 Technology comparison

The four technologies reviewed were compared in the following categories:

- **Operating voltage:** Currently, the electrical infrastructure of the Streetlight poles have two operating voltage levels: 120/240 V and 240/480 V. Depending on the service panels selected, this could be a constraint.
- **Charging power range:** The maximum and minimum power the charging station can provide. Taking into account that the installation is going to be in existing infrastructure, the more flexible the charging station is, the more suitable for the project it will be.
- **Demand Management:** Is the charging station able to vary its power output dynamically depending on the specific charging conditions. For example, if there is a vehicle charging when the sunset occurs and the streetlight is turned on, does the charging station has the capacity to reduce its power output to allow the service panel to provide the required power to the lighting fixtures.
- **Measurement Canada Certification:** Vancouver's utility company requires this certification to approve the installation of any variable power consumption equipment in its electrical grid, such as an EV charging station.
- **CSA certification:** Any electrical equipment installed in Canada has to have a CSA certification. Otherwise, it cannot be used until this certification is issued.
- **Cost:** The estimated cost of the installation.

Table 29. Technology comparison.

Parameter	Ubitricity	Char.gy	Flo	Plugzio
Operating voltage (charging level)	230V	230V	208 or 240V	120V
Charging power range	Up to 7.4 kW(1) (Level 2)	Up to 7.7 kW(1) (Level 2)	Up to 7.2 kW(1) (Level 2)	1.8 kW (Level 1)
Demand management	No	Yes	Yes	No

Parameter	Ubitricity	Char.gy	Flo	Plugzio
Measurement Canada Certification	No	No	No	No
CSA Certification	No	No	Yes	Yes
Cost	~2,300 CAD	No info	~4,000 CAD	~650 CAD(2)

(1) The power output may be reduced depending on the available capacity. The minimum current is 6 A.
(2) The cost presented is the price of the indoor device with 30% (150 CAD) installation costs. The actual price of the outdoor model will be more expensive because the enclosure will have to be NEMA 3R or above to be weatherproof, increasing its price.

Table 29 shows a comparison of some of the possible technologies that could be used in the implementation of the pilot projects. None of the alternatives analyzed has the Measurement Canada certification which is one of the major barriers of the light pole EVSE. Nevertheless, all the technologies analysed have a metering device which is accountable for billing the user.

Regarding the costs, Plugzio solution is the cheapest one. However, it is the only level one option and the majority of the service panels do not have 120 V available. This is also reflected in the maximum power output. Also, this version of the device lacks the feature to limit the current output which is a requirement by the Canadian Electrical Code to assure simultaneous operation of the EVSE and the street light.

Finally, Flo's technology is the most expensive one. Nonetheless, it has the demand management feature that could allow the user to have a faster charge if used during the day. This will not be possible with Ubitricity's or Plugzio's technologies; the user will have to charge their vehicle always at the same capacity.

6 Technical requirements

To identify the modifications that have to be made to the six service panels selected, and its circuits, load scenarios have to be defined. They were defined taking into account the capacity that becomes available once all the lighting fixtures of a service panel are upgraded to LED lighting.

- **Scenario 1:** One charging station with maximum capacity
    - *Scenario 1-1*: Streetlights on
    - *Scenario 1-2*: Streetlights off
- **Scenario 2:** Maximum number of charging points
    - *Scenario 1-1*: Streetlights on
    - *Scenario 1-2*: Streetlights off
- **Scenario 3**: Minimum modifications to the existing electrical infrastructure

For this analysis, the charging station used was the Flo - CoRe+. The specifications of this device are shown in section 5.3. This technology has a minimum current output of 6 A, and a maximum of 30 A. In terms of power output for scenarios 2 and 3 the minimum power output used was 1.7 kW, which corresponds to 7.3 A at 240V. Taking into account that the minimum current required by an EV's onboard charger to operate is 6 A, a security factor of 20% was taken (1.3 A). on the other hand, the maximum power output considered was 7.2 kW, which corresponds to 30 A at 240 V.

6.1 Modification to existing infrastructure

Charging stations were added to the load calculation presented in sections 4.4 and 4.6.1. Also, cable sizing calculations were made to identify the modifications that had to be made to the existing infrastructure to operate properly. Table 30 shows these modifications.

The load calculations were used to define the maximum capacity of the charging stations and the number of charging points for each scenario. Also, these calculations were used to validate the size of the overcurrent protection and to define the new size, in the case, it was required. As mention in section 4.8, the maximum capacity of the service panels is 38.4 kVA, which corresponds to 80% of the capacity of its main protection (100 A).

The cable sizing calculations were used to define if certain conductors had to be changed for larger ones to comply with the Canadian Electrical Code requirements. Unlike the previous calculations made in section 4.5 and 4.6.1, these calculations verified the following requirements:

- Maximum allowable ampacities according to table 2 of the Canadian Electrical Code.
- Maximum voltages drop of 3% for branch circuits.
- Maximum 40% of the cross-sectional area of a conduit can be occupied.

Finally, the cable sizing calculation also identified the type of conduit. If a cable did not comply with the Canadian Electrical Code it has to be replaced, or if it is currently installed in a Rigid Metal conduit, the conduit has to be replaced. If the cable segment is in Poly conduit it can be reused.
Table 30 shows the modifications that have to be made to the existing electrical infrastructure to install the EV charging stations in the streetlight poles. In the third column, the number of charging stations and their power capacities is shown. The information presented in this column also includes the code of the pole where the EVSE has to be installed. The code is defined according to the pole distribution used for the voltage drop calculations (see Appendix B and D). The fourth column exposes the works that have to be performed to the existing infrastructure..

Almost all of the scenarios in all of the service panels require the replacement of one or two circuit breakers. This happens because most of the circuits have 15 A overcurrent protection, which is suitable for lighting but not for an EVSE. Also, in scenarios 1 and 2 a cable segment must be replaced to support the new capacity. This cable replacement is due to two reasons:

1. Does not comply with the 3% voltage drop requirement.
2. The conductor does not have the ampacity required by the EVSE.

In some of these cases, the conduit also requires a replacement. The conduit replacement occurs for two reasons:

1. The cables that need replacement is in Rigid Metal Conduit.
2. The cables that to be replaced are N2 AWG or larger. This size requires a minimum diameter of 1 ¼”.

Appendix E – Load calculations per load scenario shows the load calculations per scenario.
Appendix F – Cable sizing calculations per load scenario shows the cable sizing per scenario.

Table 30. Modifications required to install the EVSE in the light poles selected.

Services Panels	Scenarios	Description	Modifications
Panel 1 U-33rd U5848CFBLR	Scenario 1-1	• 2 EVSE on P2-B of 7.2 kW	• 1 Single-phase circuit breaker of 80A. • Replacement of N12 AWG for a N4, in 7 m of rigid conduit and 16 m of poly conduit. The rigid conduit is a road crossing. • Replacement of 14x150 W HPS for LED. • Replacement of 21x200 W HPS for LED. • Replacement of 4x250 W HPS for LED. • Replacement of 4x1000 W MH for LED.
	Scenario 1-2	• 2 EVSE on P2-B of 7.2 kW	• 1 Single-phase circuit breaker of 80A. • Replacement of N12 AWG for a N4, in 7 m of rigid conduit and 16 m of poly conduit. The rigid conduit is a road crossing. • Replacement of 14x150 W HPS for LED. • Replacement of 21x200 W HPS for LED. • Replacement of 4x250 W HPS for LED. • Replacement of 4x1000 W MH for LED.
	Scenario 2-1	• 2 EVSE on P1-A of 2.7 kW • 2 EVSE on P2-B of 2.7 kW • 2 EVSE on P3-A of 2.7 kW • 2 EVSE on P4-B of 2.7 kW • 2 EVSE on P5-A of 2.7 kW • 2 EVSE on P6-B of 2.7 kW	• 2 Single-phase circuit breaker of 100A. • Replacement of N12 AWG for a N1/0, in 275 m new 1.5” conduit must be included (diameter of conduit) and 26 m are in road crossing (26 m shared with other installation). • Replacement of N12 AWG for a N2, in 80 m new 1.5” conduit must be included (diameter of conduit) and 26 m are in road crossing (26 m shared with other installation). • Replacement of N12 AWG for a N6, in 20 m of rigid conduit and 37 m of poly conduit. The rigid conduit is a road crossing. • Replacement of 14x150 W HPS for LED. • Replacement of 21x200 W HPS for LED. • Replacement of 4x250 W HPS for LED. • Replacement of 4x1000 W MH for LED.
	Scenario 2-2	• 2 EVSE on P1-A of 3.1 kW • 2 EVSE on P2-B of 3.1 kW • 2 EVSE on P3-A of 3.1 kW	• 2 Single-phase circuit breaker of 90A. • `Replacement of N12 AWG for a N1/0, in 190 m new 1.5” conduit must be included (diameter of conduit).

Services Panels	Scenarios	Description	Modifications
		• 2 EVSE on P4-B of 3.1 kW • 2 EVSE on P5-A of 3.1 kW • 2 EVSE on P6-B of 3.1 kW	• Replacement of N12 AWG for a N4, in 10 m of rigid conduit and 37 m of poly conduit. The rigid conduit is a road crossing. • Replacement of N12 AWG for a N10, in 60 m of rigid conduit (10 m of the conduit is a road crossing). • Replacement of 14x150 W HPS for LED. • Replacement of 21x200 W HPS for LED. • Replacement of 4x250 W HPS for LED. • Replacement of 4x1000 W MH for LED.
	Scenario 3	• 1 EVSE on P1-A of 3.8 kW	• 1 Single-phase circuit breaker of 30A. • Replacement of 14x150 W HPS for LED. • Replacement of 21x200 W HPS for LED. • Replacement of 4x250 W HPS for LED. • Replacement of 4x1000 W MH for LED.
Panel 2 U-Fraser U5743VFBLR	Scenario 1-1	• 2 EVSE on P2-B of 7.2 kW	• 1 Single-phase circuit breaker of 80A. • Replacement of N12 AWG for a N4, in 38 m of poly conduit • Replacement of 13x150 W HPS for LED. • Replacement of 40x200 W HPS for LED.
	Scenario 1-2	• 2 EVSE on P2-B of 7.2 kW	• 1 Single-phase circuit breaker of 80A. • Replacement of N12 AWG for a N4, in 38 m of poly conduit • Replacement of 13x150 W HPS for LED. • Replacement of 40x200 W HPS for LED.
	Scenario 2-1	• 2 EVSE on P1-A of 4.1 kW • 2 EVSE on P2-B of 4.1 kW • 2 EVSE on P3-A of 4.1 kW • 2 EVSE on P4-B of 4.1 kW	• 2 Single-phase circuit breaker of 100A. • Replacement of N12 AWG for a N1/0, in 38 m new 1.5” conduit must be included (diameter of conduit). • Replacement of N12 AWG for a N2, in 165 m new 1.5” conduit must be included (diameter of conduit). • Replacement of N12 AWG for a N8, in 20 m of rigid conduit and 20 m of poly conduit. The rigid conduit is a road crossing. • Replacement of 13x150 W HPS for LED. • Replacement of 40x200 W HPS for LED.
	Scenario 2-2	• 2 EVSE on P1-A of 4.6 kW • 2 EVSE on P2-B of 4.6 kW	• 2 Single-phase circuit breaker of 100A.

Services Panels	Scenarios	Description	Modifications
		• 2 EVSE on P3-A of 4.6 kW • 2 EVSE on P4-B of 4.6 kW	• Replacement of N12 AWG for a N1/0, in 130 m new 1.5” conduit must be included (diameter of conduit). • Replacement of N12 AWG for a N2, in 76 m new 1.5” conduit must be included (diameter of conduit). • Replacement of N12 AWG for a N8, in 20 m of rigid conduit and 20 m of poly conduit. The rigid conduit is a road crossing. • Replacement of 13x150 W HPS for LED. • Replacement of 40x200 W HPS for LED.
	Scenario 3	• 2 EVSE on P1-A of 2.2 kW • 1 EVSE on P2-B of 2.1 kW	• 1 Single-phase circuit breaker of 30A. • 1 Single-phase circuit breaker of 20A. • Replacement of 13x150 W HPS for LED. • Replacement of 40x200 W HPS for LED.
Panel 3 U-Kingsway U6135TFBLR	Scenario 1-1	• 2 EVSE on P1-A of 7.2 kW	• 1 Single-phase circuit breaker of 90A. • Replacement of N12 AWG for a N2/0, in 165 m new 2” conduit must be included (diameter of conduit) and 10 m are in road crossing (shared with other installation). • Replacement of N12 AWG for a N4, in 10 m of poly conduit. • Replacement of 19x150 W HPS for LED. • Replacement of 6x200 W HPS for LED. • Replacement of 41x250 W HPS for LED.
	Scenario 1-2	• 2 EVSE on P1-A of 7.2 kW	• 1 Single-phase circuit breaker of 90A. • Replacement of N12 AWG for a N3/0, in 165 m new 2” conduit must be included (diameter of conduit) and 10 m are in road crossing (shared with other installation). • Replacement of N12 AWG for a N2, in 10 m new 1.5” conduit must be included (diameter of conduit). • Replacement of 19x150 W HPS for LED. • Replacement of 6x200 W HPS for LED. • Replacement of 41x250 W HPS for LED.
	Scenario 2-1	• 1 EVSE on P1-A of 3.7 kW • 2 EVSE on P2-B of 3.7 kW • 2 EVSE on P3-A of 3.7 kW	• 2 Single-phase circuit breaker of 90A.

Services Panels	Scenarios	Description	Modifications
		• 2 EVSE on P4-B of 3.7 kW • 1 EVSE on P5-A of 3.7 kW	• Replacement of N12 AWG for a N3/0, in 80 m new 2” conduit must be included (diameter of conduit) and 10 m are in road crossing (shared with other installation). • Replacement of N12 AWG for a N2/0, in 260 m new 2” conduit must be included (diameter of conduit) and 12 m are in road crossing (shared with other installation). • Replacement of N12 AWG for a N1/0, in 76 m new 1.5” conduit must be included (diameter of conduit) and 10 m are in road crossing (shared with other installation). • Replacement of N12 AWG for a N2, in 170 m new 1.5” conduit must be included (diameter of conduit) and 30 m are in road crossing. • Replacement of N12 AWG for a N4, in 12 m of rigid conduit. The rigid conduit is a road crossing. • Replacement of N12 AWG for a N8, in 10 m of poly conduit. • Replacement of 19x150 W HPS for LED. • Replacement of 6x200 W HPS for LED. • Replacement of 41x250 W HPS for LED.
	Scenario 2-2	• 1 EVSE on P1-A of 4.3 kW • 2 EVSE on P2-B of 4.3 kW • 2 EVSE on P3-A of 4.3 kW • 2 EVSE on P4-B of 4.3 kW • 1 EVSE on P5-A of 4.3 kW	• 2 Single-phase circuit breaker of 90A. • Replacement of N12 AWG for a N4/0, in 410 m new 2” conduit must be included (diameter of conduit) and 25 m are in road crossing (shared with other installation). • Replacement of N12 AWG for a N3/0, in 165 m new 2” conduit must be included (diameter of conduit) and 24 m are in road crossing (shared with other installation). • Replacement of N12 AWG for a N4, in 12 m of rigid conduit and 10 m of poly conduit. The rigid conduit is a road crossing. • Replacement of 19x150 W HPS for LED. • Replacement of 6x200 W HPS for LED. • Replacement of 41x250 W HPS for LED.
	Scenario 3	• Not Feasible	•
Panel 4	Scenario 1-1	• 2 EVSE on P1-A of 7.2 kW	• 1 Single-phase circuit breaker of 90A.

Services Panels	Scenarios	Description	Modifications
U-Kitsilano U2722VFLR			• Replacement of N10 AWG for a N4, in 10 m of rigid conduit and 25 m of poly conduit. The rigid conduit is a road crossing. • Replacement of 1x100 W HPS for LED. • Replacement of 8x150 W HPS for LED. • Replacement of 16x200 W HPS for LED.
	Scenario 1-2	• 2 EVSE on P1-A of 7.2 kW	• 1 Single-phase circuit breaker of 80A. • Replacement of N10 AWG for a N4, in 10 m of rigid conduit and 25 m of poly conduit. The rigid conduit is a road crossing. • Replacement of 1x100 W HPS for LED. • Replacement of 8x150 W HPS for LED. • Replacement of 16x200 W HPS for LED.
	Scenario 2-1	• 2 EVSE on P1-A of 4.3 kW • 2 EVSE on P2-B of 4.3 kW • 2 EVSE on P3-A of 4.3 kW • 2 EVSE on P4-B of 4.3 kW	• 2 Single-phase circuit breaker of 100A. • Replacement of N10 AWG for a N1/0, in 125 m new 1.5" conduit must be included (diameter of conduit) and 20 m are in road crossing (shared with other installation). • Replacement of N10 AWG for a N2, in 120 m new 1.5" conduit must be included (diameter of conduit) and 10 m are in road crossing (shared with other installation). • Replacement of N10 AWG for a N4, in 10 m of rigid conduit. • Replacement of N10 AWG for a N8, in 10 m of rigid conduit and 10 m of poly conduit. The rigid conduit is a road crossing. • Replacement of 1x100 W HPS for LED. • Replacement of 8x150 W HPS for LED. • Replacement of 16x200 W HPS for LED.
	Scenario 2-2	• 2 EVSE on P1-A of 4.6 kW • 2 EVSE on P2-B of 4.6 kW • 2 EVSE on P3-A of 4.6 kW • 2 EVSE on P4-B of 4.6 kW	• 2 Single-phase circuit breaker of 100A. • Replacement of N10 AWG for a N1/0, in 170 m new 1.5" conduit must be included (diameter of conduit) and 20 m are in road crossing (10 m shared with other installation). • Replacement of N10 AWG for a N2, in 91 m new 1.5" conduit must be included (diameter of conduit). • Replacement of N10 AWG for a N8, in 10 m of rigid conduit and 10 m of poly conduit. The rigid conduit is a road crossing.

Services Panels	Scenarios	Description	Modifications
			• Replacement of 1x100 W HPS for LED. • Replacement of 8x150 W HPS for LED. • Replacement of 16x200 W HPS for LED.
	Scenario 3	• 2 EVSE on P1-A of 2.3 kW • 2 EVSE on P2-B of 2.3 kW	• 2 Single-phase circuit breaker of 30A. • Replacement of 1x100 W HPS for LED. • Replacement of 8x150 W HPS for LED. • Replacement of 16x200 W HPS for LED
Panel 5 Commercial 6722WF	Scenario 1-1	• 2 EVSE on P1-A of 7.2 kW	• 1 Single-phase circuit breaker of 80A. • Replacement of N12 AWG for a N2, in 50 m new 1.5” conduit must be included (diameter of conduit). • Replacement of N12 AWG for a N4, in 20 m of poly conduit. • Replacement of 26x70 W HPS for LED. • Replacement of 16x150 W HPS for LED. • Replacement of 14x250 W HPS for LED.
	Scenario 1-2	• 2 EVSE on P1-A of 7.2 kW	• 1 Single-phase circuit breaker of 80A. • Replacement of N12 AWG for a N2, in 50 m new 1.5” conduit must be included (diameter of conduit). • Replacement of N12 AWG for a N4, in 20 m of poly conduit. • Replacement of 26x70 W HPS for LED. • Replacement of 16x150 W HPS for LED. • Replacement of 14x250 W HPS for LED.
	Scenario 2-1	• 2 EVSE on P1-A of 2.7 kW • 2 EVSE on P2-B of 2.7 kW • 2 EVSE on P3-A of 2.7 kW • 2 EVSE on P6-B of 2.7 kW • 2 EVSE on P7-A of 2.7 kW • 2 EVSE on P8-B of 2.7 kW	• 2 Single-phase circuit breaker of 90A. • Replacement of N12 AWG for a N1/0, in 240 m new 1.5” conduit must be included (diameter of conduit). • Replacement of N12 AWG for a N2, in 320 m new 1.5” conduit must be included (diameter of conduit) (170 m shared with other installation). • Replacement of N12 AWG for a N4, in 88 m of poly conduit. • Replacement of N12 AWG for a N6, in 11 m of rigid conduit. The rigid conduit is a road crossing. • Replacement of N12 AWG for a N10, in 20 m of rigid conduit and 20 m of poly conduit. The rigid conduit is a road crossing. • Replacement of 26x70 W HPS for LED.

Services Panels	Scenarios	Description	Modifications
			• Replacement of 16x150 W HPS for LED. • Replacement of 14x250 W HPS for LED.
	Scenario 2-2	• 2 EVSE on P1-A of 3.1 kW • 2 EVSE on P2-B of 3.1 kW • 2 EVSE on P3-A of 3.1 kW • 2 EVSE on P6-B of 3.1 kW • 2 EVSE on P7-A of 3.1 kW • 2 EVSE on P8-B of 3.1 kW	• 2 Single-phase circuit breaker of 100A. • Replacement of N12 AWG for a N2/0, in 130 m new 2” conduit must be included (diameter of conduit). • Replacement of N12 AWG for a N1/0, in 240 m new 1.5” conduit must be included (diameter of conduit). • Replacement of N12 AWG for a N2, in 320 m new 1.5” conduit must be included (diameter of conduit) (170 m shared with other installation). • Replacement of N12 AWG for a N4, in 100 m of poly conduit. • Replacement of N12 AWG for a N10, in 20 m of rigid conduit and 20 m of poly conduit. The rigid conduit is a road crossing. • Replacement of 26x70 W HPS for LED. • Replacement of 16x150 W HPS for LED. • Replacement of 14x250 W HPS for LED.
	Scenario 3	• 1 EVSE on P1-A of 1.8 kW	• Replacement of 26x70 W HPS for LED. • Replacement of 16x150 W HPS for LED. • Replacement of 14x250 W HPS for LED.
Panel 6 Main 5441UF	Scenario 1-1	• 2 EVSE on P13-C of 7.2 kW	• 1 Single-phase circuit breaker of 80A. • Replacement of N8 AWG for a N1/0, in 100 m new 1.5” conduit must be included (diameter of conduit). • Replacement of N12 AWG for a N4, in 15 m of rigid conduit. The rigid conduit is a road crossing. • Replacement of 2 junction boxes. • Replacement of 23x150 W HPS for LED.
	Scenario 1-2	• 2 EVSE on P13-C of 7.2 kW	• 1 Single-phase circuit breaker of 80A. • Replacement of N8 AWG for a N1/0, in 100 m new 1.5” conduit must be included (diameter of conduit). • Replacement of N12 AWG for a N4, in 15 m of rigid conduit. The rigid conduit is a road crossing. • Replacement of 2 junction boxes. • Replacement of 23x150 W HPS for LED.

Services Panels	Scenarios	Description	Modifications
	Scenario 2-1	• 2 EVSE on P1-A of 4.4 kW • 2 EVSE on P2-B of 4.4 kW • 2 EVSE on P13-C of 4.4 kW • 2 EVSE on P14-D of 4.4 kW	• 4 Single-phase circuit breaker of 50A. • Replacement of N8 AWG for a N1/0, in 151 m new 1.5” conduit must be included (diameter of conduit) and 15 m are in road crossing. • Replacement of N8 AWG for a N2, in 100 m new 1.5” conduit must be included (diameter of conduit). • Replacement of N12 AWG for a N2, in 120 m new 1.5” conduit must be included (diameter of conduit) and 15 m are in road crossing. • Replacement of N12 AWG for a N4, in 15 m of rigid conduit and 50 m of poly conduit. • Replacement of N12 AWG for a N6, in 15 m of rigid conduit. The rigid conduit is a road crossing. • Replacement of 2 junction boxes. • Replacement of 23x150 W HPS for LED.
	Scenario 2-2	• 2 EVSE on P1-A of 4.6 kW • 2 EVSE on P2-B of 4.6 kW • 2 EVSE on P13-C of 4.6 kW • 2 EVSE on P14-D of 4.6 kW	• 4 Single-phase circuit breaker of 50A. • Replacement of N8 AWG for a N1/0, in 151 m new 1.5” conduit must be included (diameter of conduit) and 15 m are in road crossing. • Replacement of N8 AWG for a N2, in 100 m new 1.5” conduit must be included (diameter of conduit). • Replacement of N12 AWG for a N2, in 120 m new 1.5” conduit must be included (diameter of conduit) and 15 m are in road crossing. • Replacement of N12 AWG for a N4, in 15 m of rigid conduit and 50 m of poly conduit. • Replacement of N12 AWG for a N6, in 15 m of rigid conduit. The rigid conduit is a road crossing. • Replacement of 2 junction boxes. • Replacement of 23x150 W HPS for LED.
	Scenario 3	• 1 EVSE on P13-C of 2.3 kW	• Replacement of 23x150 W HPS for LED.

Scenario 2 requires the highest number of modifications, which means the highest implementation costs. There are two reasons why this may happen:

1. Installing two charging stations in the same circuit will increase the voltage drop for the farthest light poles making mandatory to increase the size of the first cable segments of the circuit. This size increase can lead to an increase in the conduit size.
2. Using two separate circuits double de modifications that have to be made to the existing electrical infrastructure.

On the other hand, as expected, the least number of modifications are in scenario 3. Besides upgrading the lighting fixtures to LED, the only additional modification would be increasing the capacity of the circuit breaker, which has a low cost.

The information presented in Table 30 is an approximation of what would need to be done to install the EVSE in the light poles. Detailed inspections and design would have to be done before the implementation of pilot projects.

7 Additional Considerations

Two main factors could affect the installation of EV charging stations on streetlight poles. The main one, which has been mention earlier (section 4) is the metering required by the electrical utility company BC Hydro for billing purposes.

The second major factor is the opportunities the project could have by leveraging on existing City's programs to reduce its costs.

7.1 Metering and billing requirements

Currently, BC Hydro supplies the electricity to the City's street lighting for a fixed rate. This fixed rate is because the City belongs to the unmetered category of the Public Area Ornamental Street Lighting, Rate Schedule 1702, (British Columbia Hydro and Power Authority, 2019). The City pays a fixed monthly fee per watt of lighting in service, which includes the lighting fixture and its ballast. Installing EV charging stations in the light poles would imply two major changes to be considered:

- First, the City would have to add a metering device to measure the energy consumption of the EV charging stations.
- Second, a change in the tariffs the City is currently paying for the lighting fixtures. This would only apply to the lighting fixtures that belong to the service panel where the charging station will be implemented.

In the following sections, these two major changes will be discussed in detail.

7.1.1 Metering Infrastructure

In section 4.2 the concern for the metering was stated. The City has to install a metering device to measure the energy consumed by each charging station for billing purposes. In section 4.8 three possible solutions were mentioned. BC Hydro has to review each installation and approve it in order to allow the new charging stations to operate.

BC Hydro's installation approval process consists of reviewing the equipment to be installed as well as the overall installation. For that process the client, in this case, the City would have to submit all the performance and safety certifications of the EVSE as well as the detailed design drawings of the installation to be reviewed. Because is a metering device for billing purposes it has to have a Measurement Canada (MC) Certification. The MC certification process can take from 6 months to 18 months. This timeframe depends on many factors: if the manufacturer already has other products certified and knows the process this could help it to get the certification faster, as well as if it already has other Canadian certifications, like CSA.

The three solutions proposed to overcome the metering barrier are the following:

1. Smart Cable with an in-line smart meter
   This solution is based on the technology developed by Ubitricity. Ubitricity's SmartCable has all the certifications required for metering energy as well as for billing in the UK. However, they have no experience of working in Canada. To implement this solution the company would have to get the MC and CSA certifications. This process could take over 18 months, plus the BC Hydro's approval process, which would add a significant time delay for the implementation of the pilot project.

2. Charging station with an in-line smart meter
   This solution is based on the technology developed by Flo. To implement this solution the company would have to get the MC Certification as well as the CSA certification associated with their application. However, this is a Canadian company which knows the Canadian market an already has a CSA certification as well as other Canadian certifications such as the ICES-3 (A) / NMB-3 (A). This could reduce significantly the time the MC Certification process takes, decreasing the time delay for the implementation of the pilot project.

3. Replace the service panels with metered service panels
   This solution would require replacing all the service panels for kiosks or pole-mounted panels (in metallic poles) with a metering device. The advantage of this solution has is that the meters used in this application already have the MC Certification, CSA certification and other Canadian certifications. This could accelerate BC Hydro's approval process, which could be less than a month.

If the only possible solution would be the third one, the City will still have to incur in the costs associated with the charging equipment which could be either the smart cable with an in-line smart meter or charging station with an in-line smart meter. For this reason, solutions the first and second solutions would make the installation of charging stations on streetlight poles more feasible by reducing the costs.

Another fact to consider is that currently, BC Hydro owns the infrastructure from the meter upstream. They are in charge of its maintenance and operation. Implementing the first or second solutions would involve adding subservice metering. This means that BC Hydro would neither own nor maintain the infrastructure upstream the new meter.

7.1.2 *Tariffs*

Depending on the solution chosen, from the ones presented in the previous section, the rates paid by the City may change. Currently, the City is paying according to the unmetered Rate Schedule 1702 (Public Area Ornamental Street Lighting) which is 4.03 cents per watt per month (3.77 cents with a 6.85% increase effective April 2019) (British Columbia Hydro and Power Authority, 2019). If the solution 1 or 2 is approved by BC Hydro, the Rate Schedule 1702 would be maintained for the City's street lighting. The charging stations on the light poles would be billed separately, using Rate Schedule 1300 (Small general service under 35 kW) which consist on a basic charge of 38.95 cents per day plus 13.39 cents per kWh (these charges include the 6.85% increase effective since April 2019).

If the first and second solutions are not approved by BC Hydro, the third option would be the only solution. This alternative would change the fixed unmetered rate paid for the lighting to the Rate Schedule 1300 for the whole service. The following tables show the variation of what would be paid for lighting if the rate is changed. The calculations were done using all the lighting fixtures of the six service panels selected.

Table 31 shows what the City currently pays for the streetlighting of the service panels analyzed in this feasibility study, which in total they feed 240 lighting fixtures. Table 32 shows what the City would pay for the same number of lighting fixtures if its fixed rate is changed. The difference between these two rates is $6 CAD.

Table 31. Current lighting expense with Rate Schedule 1702.

Description	Value
Rate per Watt per month	$0.0403
Number of 70W lighting fixtures	26
Number of 100W lighting fixtures	1
Number of 150W lighting fixtures	93
Number of 200W lighting fixtures	83
Number of 250W lighting fixtures	59
Number of 1000W lighting fixtures	4
Total monthly expense (CAD)	**$2,063**

Table 32. Lighting expense with Rate Schedule 1300.

Description	Value
Basic charge per day	$0.3895
Energy Charge (CAD/kWh)	$0.1339
Days per month	30
Hours of operation per day	10
Number of 70W lighting fixtures	26
Number of 100W lighting fixtures	1
Number of 150W lighting fixtures	93
Number of 200W lighting fixtures	83
Number of 250W lighting fixtures	59

Description	Value
Number of 1000W lighting fixtures	4
Total power (W)	51,220
Total energy (kWh)	15,366
Total monthly expense (CAD)	**$2,069**

Although the results presented in the tables above is an estimate that could vary depending on the hours the lights are on, which depends on the month of the year, they show that the variation between one rate and the other is minimal.

7.2 Leveraging existing projects

To reduce the initial investment costs of the installation of EVSE on streetlight poles it could leverage certain projects and programs the City or other external stakeholders are executing or planning to execute in the future.

One of the highest expenditures of turning the light poles into EVSE is replacing all the lighting fixtures of the service panel feeding the EVSE for LED lighting. The City will start in 2021 a program which consists of the replacement of the existing lighting fixtures of street poles for LED lighting. Although the actual program that will upgrade the lighting fixtures starts in two years the Streets Branch have already started replacing some lighting fixtures on the main roads.

Also, telecommunication companies like Telus and Shaw are investing a significant amount of capital in retrofitting the existing street poles with smart poles to provide better connectivity to mobile phone users. During this retrofitting, they are not only installing LED lighting but also changing the overall electrical infrastructure to provide a higher capacity. This available capacity could be used for the installation of new charging stations. Unfortunately, the areas of Vancouver in which these companies are currently focusing on are not the same as the ones the City wants to focus on. However, in near futures, these areas of focus could align.

Finally, one of the concerns identified with the existing electrical infrastructure was the lack of a proper bonding between metallic elements of the electrical systems, as mentioned in section 4.2. Currently, the City has a program in which it is fixing this hazard. The installation of the EVSE could leverage in this program. If the City prioritizes the Streetlight service panels and circuits in which the charging station will be installed it could help reduce the costs of the pilot project making it more feasible, as well as the future charging stations from light poles.

8 Cost analysis

Once defined the modifications that had to be made to the existing electrical infrastructure to install the EVSE (section 6.1), an estimate of the cost associated with those activities was calculated. The cost estimates were done for the six selected service panels and for each load scenario.

The costs presented in the following tables are divided into two main categories, direct costs and indirect costs. The direct costs are the ones directly associated with the retrofitting of the existing infrastructure. These costs contain replacing the existing lighting fixture for LED; the installation of the new service panels (panels with metering on new metallic poles); the cable and conduit; the labor costs; the special equipment costs (such as the aerial truck for the replacement of the lighting fixtures); the civil works (trenching and installing the new conduit); the taxes; and the miscellaneous contingency (which refer to a contingency fund the lighting replacement, cable and conduit and the service panel).

The most expensive items are the civil works, the lighting fixtures replacement and the labour costs. Each one of these varies depending on the specific scenario and panel.

The second category is the indirect costs. These costs are the COV overhead expenses; a contingency fund (for civil works, labour and equipment); and an electrical permit fee that has to be paid to BC Hydro for any electrical work that involves this utility. To replace the service panel BC Hydro has to interrupt the circuit feeding it to execute this work.

The costs presented below do not take into account the cost of the charging station which could be $4,000 CAD if the Flo technology was selected or $2,500 CAD if the Ubitricity technology was selected.

Table 33. Cost estimates service panel U5848CFBLR.

	Scenario 1-1	Scenario 1-2	Scenario 2-1	Scenario 2-2	Scenario 3
Direct costs					
Lighting fixture replacement	$12,165	$12,165	$12,165	$12,165	$12,165
Service panel (includes installation of the pole)	$6,514	$6,514	$6,514	$6,514	$6,514
Cable and conduit	$69	$69	$4,811	$2,765	$0
Labor	$7,204	$7,204	$6,484	$6,484	$5,763
Equipment cost	$1,075	$1,075	$922	$922	$768
Taxes	$1,890	$1,890	$2,459	$2,213	$1,881
Miscellaneous Contingency	$1,764	$1,764	$2,295	$2,066	$1,756
Civil works (Excavations with pipe laying)	$6,000	$6,000	$69,200	$60,000	$0
Total direct cost	**$36,681**	**$36,681**	**$104,849**	**$93,128**	**$28,848**
Indirect costs					
COV charge (Project overhead-15% of direct cost)	$5,502	$5,502	$15,727	$13,969	$4,327
Contingency fund (labor, equipment and civil works)	$3,456	$3,456	$15,921	$14,081	$1,906
Electrical Permit Fee	$1,000	$1,000	$1,104	$1,052	$948
Total indirect cost	**$9,958**	**$9,958**	**$32,752**	**$29,102**	**$7,181**
Total Cost	**$46,639**	**$46,639**	**$137,601**	**$122,231**	**$36,029**

Table 34. Cost estimates service panel U5743VFBLR.

	Scenario 1-1	Scenario 1-2	Scenario 2-1	Scenario 2-2	Scenari o 3
Direct costs					
Lighting fixture replacement	$14,955	$14,955	$14,955	$14,955	$14,955
Service panel (includes installation of the pole)	$6,514	$6,514	$6,514	$6,514	$6,514
Cable and conduit	$141	$76	$2,753	$2,715	$0
Labor	$6,484	$6,484	$6,484	$6,484	$5,763
Equipment cost	$922	$922	$922	$922	$768
Taxes	$2,233	$2,225	$2,547	$2,542	$2,216
Miscellaneous Contingency	$2,084	$2,077	$2,377	$2,373	$2,069
Civil works (Excavations with pipe laying)	$0	$0	$52,600	$53,200	$0
Total direct cost	**$33,333**	**$33,253**	**$89,150**	**$89,703**	**$32,285**
Indirect costs					
COV charge (Project overhead-15% of direct cost)	$5,000	$4,988	$13,373	$13,456	$4,843
Contingency fund (labor, equipment and civil works)	$2,081	$2,081	$12,601	$12,721	$1,906
Electrical Permit Fee	$1,052	$1,052	$1,104	$1,104	$1,026
Total indirect cost	**$8,133**	**$8,121**	**$27,078**	**$27,281**	**$7,775**
Total Cost	**$41,466**	**$41,373**	**$116,228**	**$116,984**	**$40,060**

Table 35. Cost estimates service panel U6135TFBLR.

	Scenario 1-1	Scenario 1-2	Scenario 2-1	Scenario 2-2
Direct costs				
Lighting fixture replacement	$18,522	$18,522	$18,522	$18,522
Service panel (includes installation of the pole)	$6,514	$6,514	$6,514	$6,514
Cable and conduit	$2,216	$2,399	$7,677	$8,202
Labor	$7,204	$7,204	$7,204	$7,204
Equipment cost	$1,075	$1,075	$1,075	$1,075
Taxes	$2,910	$2,932	$3,566	$3,629
Miscellaneous Contingency	$2,716	$2,737	$3,328	$3,387
Civil works (Excavations with pipe laying)	$37,000	$39,000	$90,000	$90,000
Total direct cost	**$78,158**	**$80,383**	**$137,886**	**$138,533**
Indirect costs				
COV charge (Project overhead-15% of direct cost)	$11,724	$12,057	$20,683	$20,780
Contingency fund (labor, equipment and civil works)	$9,656	$10,056	$20,256	$20,256
Electrical Permit Fee	$1,208	$1,234	$1,364	$1,364

	Scenario 1-1	Scenario 1-2	Scenario 2-1	Scenario 2-2
Total indirect cost	$22,588	$23,347	$42,303	$42,400
Total Cost	$100,745	$103,730	$180,189	$180,933

Table 36. Cost estimates service panel U2722VFLR.

	Scenario 1-1	Scenario 1-2	Scenario 2-1	Scenario 2-2	Scenario 3
Direct costs					
Lighting fixture replacement	$6,931	$6,931	$6,931	$6,931	$6,931
Service panel (includes installation of the pole)	$6,514	$6,514	$6,514	$6,514	$6,514
Cable and conduit	$93	$93	$3,219	$3,392	$0
Labor	$5,043	$5,043	$5,043	$5,043	$5,043
Equipment cost	$768	$768	$768	$768	$768
Taxes	$1,265	$1,265	$1,640	$1,660	$1,253
Miscellaneous Contingency	$1,180	$1,180	$1,530	$1,550	$1,170
Civil works (Excavations with pipe laying)	$6,000	$6,000	$37,400	$37,400	$0
Total direct cost	**$27,793**	**$27,793**	**$63,044**	**$63,258**	**$21,679**
Indirect costs					
COV charge (Project overhead-15% of direct cost)	$4,169	$4,169	$9,457	$9,489	$3,252
Contingency fund (labor, equipment and civil works)	$2,962	$2,962	$9,242	$9,242	$1,762
Electrical Permit Fee	$792	$792	$870	$896	$792
Total indirect cost	**$7,923**	**$7,923**	**$19,569**	**$19,627**	**$5,806**
Total Cost	$35,716	$35,716	$82,613	$82,885	$27,485

Table 37. Cost estimates service panel 6722WF.

	Scenario 1-1	Scenario 1-2	Scenario 2-1	Scenario 2-2	Scenario 3
Direct costs					
Lighting fixture replacement	$12,782	$12,782	$12,782	$12,782	$12,782
Service panel (includes installation of the pole)	$6,514	$6,514	$6,514	$6,514	$6,514
Cable and conduit	$1,124	$1,124	$7,903	$9,316	$0
Labor	$6,484	$6,484	$6,484	$6,484	$6,484
Equipment cost	$768	$768	$768	$768	$768
Taxes	$2,090	$2,090	$2,904	$3,073	$1,956
Miscellaneous Contingency	$1,951	$1,951	$2,710	$2,869	$1,825
Civil works (Excavations with pipe laying)	$12,000	$12,000	$96,600	$96,600	$0

	Scenario 1-1	Scenario 1-2	Scenario 2-1	Scenario 2-2	Scenario 3
Total direct cost	**$43,713**	**$43,713**	**$136,665**	**$138,406**	**$30,328**
Indirect costs					
COV charge (Project overhead-15% of direct cost)	$6,557	$6,557	$20,500	$20,761	$4,549
Contingency fund (labor, equipment and civil works)	$4,450	$4,450	$21,370	$21,370	$2,050
Electrical Permit Fee	$1,026	$1,026	$1,182	$1,234	$974
Total indirect cost	**$12,033**	**$12,033**	**$43,052**	**$43,365**	**$7,574**
Total Cost	**$55,746**	**$55,746**	**$179,717**	**$181,771**	**$37,902**

Table 38. Cost estimates service panel 5441UF.

	Scenario 1-1	Scenario 1-2	Scenario 2-1	Scenario 2-2	Scenario 3
Direct costs					
Lighting fixture replacement	$5,865	$5,865	$5,865	$5,865	$5,865
Service panel (includes installation of the pole)	$6,514	$6,514	$6,514	$6,514	$6,514
Cable and conduit	$1,712	$1,712	$5,454	$5,454	$0
Labor	$5,763	$5,763	$5,763	$5,763	$5,763
Equipment cost	$768	$768	$768	$768	$768
Taxes	$1,331	$1,331	$1,780	$1,780	$1,125
Miscellaneous Contingency	$1,242	$1,242	$1,661	$1,661	$1,050
Civil works (Excavations with pipe laying)	$11,000	$11,000	$69,600	$69,600	$0
Total direct cost	**$34,196**	**$34,196**	**$97,405**	**$97,405**	**$21,086**
Indirect costs					
COV charge (Project overhead-15% of direct cost)	$5,129	$5,129	$14,611	$14,611	$3,163
Contingency fund (labor, equipment and civil works)	$4,106	$4,106	$15,826	$15,826	$1,906
Electrical Permit Fee	$818	$818	$922	$922	$792
Total indirect cost	**$10,054**	**$10,054**	**$31,359**	**$31,359**	**$5,861**
Total Cost	**$44,249**	**$44,249**	**$128,765**	**$128,765**	**$26,947**

Table 39. Estimated cost related with charging capacity.

Services Panels	Scenarios	EV Charging Capacity	Investment Cost
Panel 1 U-33rd U5848CFBLR	Scenario 1-1	14.4 kW	$ 46,639
	Scenario 1-2	14.4 kW	$ 46,639
	Scenario 2-1	32.4 kW	$ 137,601

Services Panels	Scenarios	EV Charging Capacity	Investment Cost
	Scenario 2-2	38.4 kW	$ 122,231
	Scenario 3	3.8 kW	$ 36,029
Panel 2 U-Fraser U5743VFBLR	Scenario 1-1	14.4 kW	$ 41,466
	Scenario 1-2	14.4 kW	$ 41,373
	Scenario 2-1	32.8 kW	$ 116,228
	Scenario 2-2	36.8 kW	$ 116,984
	Scenario 3	6.5 kW	$ 40,060
Panel 3 U-Kingsway U6135TFBLR	Scenario 1-1	14.4 kW	$ 100,745
	Scenario 1-2	14.4 kW	$ 103,730
	Scenario 2-1	29.6 kW	$ 180,189
	Scenario 2-2	34.4 kW	$ 180,933
	Scenario 3	Not Feasible	
Panel 4 U-Kitsilano U2722VFLR	Scenario 1-1	14.4 kW	$ 35,716
	Scenario 1-2	14.4 kW	$ 35,716
	Scenario 2-1	34.4 kW	$ 82,613
	Scenario 2-2	36.8 kW	$ 82,885
	Scenario 3	9.1 kW	$ 27,485
Panel 5 Commercial 6722WF	Scenario 1-1	14.4 kW	$ 55,746
	Scenario 1-2	14.4 kW	$ 55,746
	Scenario 2-1	32.4 kW	$ 179,717
	Scenario 2-2	37.2 kW	$ 181,771
	Scenario 3	1.8 kW	$ 37,902
Panel 6 Main 5441UF	Scenario 1-1	14.4 kW	$ 44,249
	Scenario 1-2	14.4 kW	$ 44,249
	Scenario 2-1	35.2 kW	$ 128,765
	Scenario 2-2	36.8 kW	$ 128,765
	Scenario 3	2.3 kW	$ 26,947

The tables presented above show a great variation between different service panels. The one that requires the least investment to adapt its infrastructure for the charging stations is the one located in Kitsilano (U2722VFLR), followed by the one located near Main Street (5441UF).

The most expensive one was the one located near Kingsway (U6135TFBLR). The reason why this happens is because the existing infrastructure of this panel is not complying with the voltage drop requirements defined in the Canadian Electrical Code. When a new load is added the voltage drop increases and to correct it the cabling has to be replaced by larger conductors.

Another reason for this high cost is because the closest light poles to the panel are located on the other side of the road. When the streetlight infrastructure was first installed the used rigid metal conduit for every road crossing and replacing the conductors of those poles require a civil work. An excavation for a road crossing three times more expensive than for installing conduit in a sidewalk or boulevard.

Moreover, in most cases the higher the capacity the higher the cost. Following this statement, Scenario 2 for most of the service panels has the highest investment costs. On the other hand, Scenario 3 has the lowest investment costs.

Finally, the tables presented above show that the highest costs are associated with the civil works and the lighting fixtures replacement. Not all the service panels require civil work, but all the lighting fixtures have to be replaced. Not only for the capacity that will become available but for the functionality of allowing the light poles to be energized 24/7 (24 hours, 7 days per week).

9 Discussion

To implement a pilot project Scenario 3 (Minimum modifications to the existing electrical infrastructure) would be the most suitable one. Having the lowest investment gives it a strong advantage over the other scenarios. Also, taking into account that for this study level 1 charging stations were being considered as an option, the low power capacity is not going to be an issue. The idea of the pilot project is to allow Vancouverites that do not have access to off-street parking the opportunity the charge their vehicles near their homes. So having a slow EVSEs where they can connect their vehicles when they arrive from work and disconnect it the next day when they are going back to work complies with the purpose of the project.

Another important advantage of selecting Scenario 3 for the pilot project is that the only modification to the electrical infrastructure will be the replacement of the service panel. No cable will be pulled in an existing conduit, which was one of the major concerns of the City's Streets and Electrical Design Branch staff because of the uncertainty of what is installed underground. By selecting this load scenario the City is avoiding the risk of damaging existing infrastructure while pulling cable or replacing conduit.

Table 40. Investment cost of Scenario 3.

Service Panel	U5848CFBLR	U5743VFBLR	U2722VFLR	6722WF	5441UF
Direct costs					
Lighting fixture replacement	$12,165	$14,955	$6,931	$12,782	$5,865
Service panel (includes installation of the pole)	$6,514	$6,514	$6,514	$6,514	$6,514
Labor	$5,763	$5,763	$5,043	$6,484	$5,763
Equipment cost	$768	$768	$768	$768	$768
Taxes	$1,881	$2,216	$1,253	$1,956	$1,125
Miscellaneous Contingency	$1,756	$2,069	$1,170	$1,825	$1,050
Total direct cost	**$28,848**	**$32,285**	**$21,679**	**30,328**	**$21,086**
Indirect costs					
COV charge (Project overhead-15% of direct cost)	$4,327	$4,843	$3,252	$4,549	$3,163
Contingency fund (labor, equipment and civil works)	$1,906	$1,906	$1,762	$2,050	$1,906
Electrical Permit Fee	$948	$1,026	$792	$974	$792

Service Panel	U5848CFBLR	U5743VFBLR	U2722VFLR	6722WF	5441UF
Total indirect cost	$7,181	$7,775	$5,806	$7,574	$5,861
Charging Station	$4,000	$4,000	$4,000	$4,000	$4,000
Total Cost	**$40,029**	**$44,060**	**$31,485**	**$41,902**	**$30,947**

Upgrading the existing lighting (mainly HPS) for LED lighting is one of the highest costs for the implementation of the pilot project. However, this is the most important activity that has to be done for the project to be feasible. With this replacement not only the power capacity for the EV charging station will become available, but also the functionality for the streetlight to be energized during the day (24/7). Nevertheless, as mentioned in section 7.2 if the project could leverage from the City's upgrading to LED lighting program, the investments costs would be reduced significantly, as shown in the table below.

Table 41. Investment cost of Scenario 3 without lighting upgrading.

Service Panel	U5848CFBLR	U5743VFBLR	U2722VFLR	6722WF	5441UF
Direct costs					
Service panel (includes installation of the pole)	$6,514	$6,514	$6,514	$6,514	$6,514
Labor	$1,153	$1,153	$1,153	$1,153	$1,153
Taxes	$422	$422	$422	$422	$422
Miscellaneous Contingency	$394	$394	$394	$394	$394
Total direct cost	$9,250	$9,250	$9,250	$9,250	$9,250
Indirect costs					
COV charge (Project overhead-15% of direct cost)	$1,272	$1,272	$1,272	$1,272	$1,272
Contingency fund (labor, equipment and civil works)	$831	$831	$831	$831	$831
Total indirect cost	**$2,103**	**$2,103**	**$2,103**	**$2,103**	**$2,103**
Charging Station	$4,000	$4,000	$4,000	$4,000	$4,000
Total Cost	**$14,585**	**$14,585**	**$14,585**	**$14,585**	**$14,585**

Once the cost associated with the lighting fixture replacement is covered by another program, the investment for the pilot project is significantly reduced. The equipment costs are eliminated because there is no need to use an Aerial Truck. Finally, labour costs are reduced because the only activities required are replacing the service panels and installing the charging station. The replacement of the 25 to 53 lighting fixtures is covered by another project with another budget.

Furthermore, there are two more elements whose costs could be reduced, and both of them are related to the metering and billing requirements (section 7.1). If BC Hydro approves the use of the charging station meter, or the smart cable meter, for billing the City for the energy consumption of the light pole charging stations the cost of the service panel replacement would be eliminated. With this done the only cost would be changing the circuit breaker of the service panel and installing the charging station in the pole with its additional protection. So the final cost would be basically the charging station. The cost estimates shown in Table 41 are using Flo's charging station but if the technology used for the implementation of the charging station is Ubitricity's SimpleSocket the cost could be reduced even more.

The use of a demand management functionalities in the charging stations could help increase the charging power during the day (when the street lighting is off). Note that this function refers to dynamic demand management. The charging stations must have a load management system that limits the current output to be able to operate simultaneously with the street lighting, as per the Canadian Electrical Code. For Scenario 3 (fewer modifications required in the electrical infrastructure), the charging capabilities with the streetlight off would be as follows:

Table 42. Scenario 3 with and without demand management.

Service Panel	Poles	Charging power without demand management	Charging power with demand management
U5848CFBLR	P2-B	4.4 kW	4.6 kW(1)
U5743VFBLR	P1-A and P2-B	4.4 kW and 2.1 kW	4.6 kW and 4.6 kW(1)
U2722VFLR	P1-A and P2-B	4.6 kW and 4.6 kW	6.3 kW and 4.7 kW(2)
6722WF	P1-A	1.85 kW	1.95 kW(2)
5441UF	P13-C	2.3 kW	2.45 kW(2)

(1) Value limited by the cable ampacity.
(2) Value limited by the voltage drop.

Table 42 shows that although demand management could be a good option for service panels U5743VFBLR and U2722VFLR because the power capacity is increased, for service panels U5848CFBLR, 6722WF and 5441UF it would be an unnecessary investment because the capacity increase is minimal. Note that a charging station without the demand management functionality is cheaper than the one considered in this study.

It can be concluded that any of these five options could be used for a pilot project. However, if the possibility of leveraging from the LED replacing program is not possible, due to their low investment costs, the most suitable service panels would be U2722VFLR and 5441UF. These two service panels are shown in green in Figure 19.

Finally, considering the overall power capacity the service panels, (38.4 kVA) installing a standalone EVSE on the curbside using a dedicated circuit could be a feasible option. The main activities would be the installation of a dedicated circuit from the service panel in the lane road to the nearest curb; and the installation of the EVSE. This alternative is not analyzed in detail since it is not part of the scope of this study.

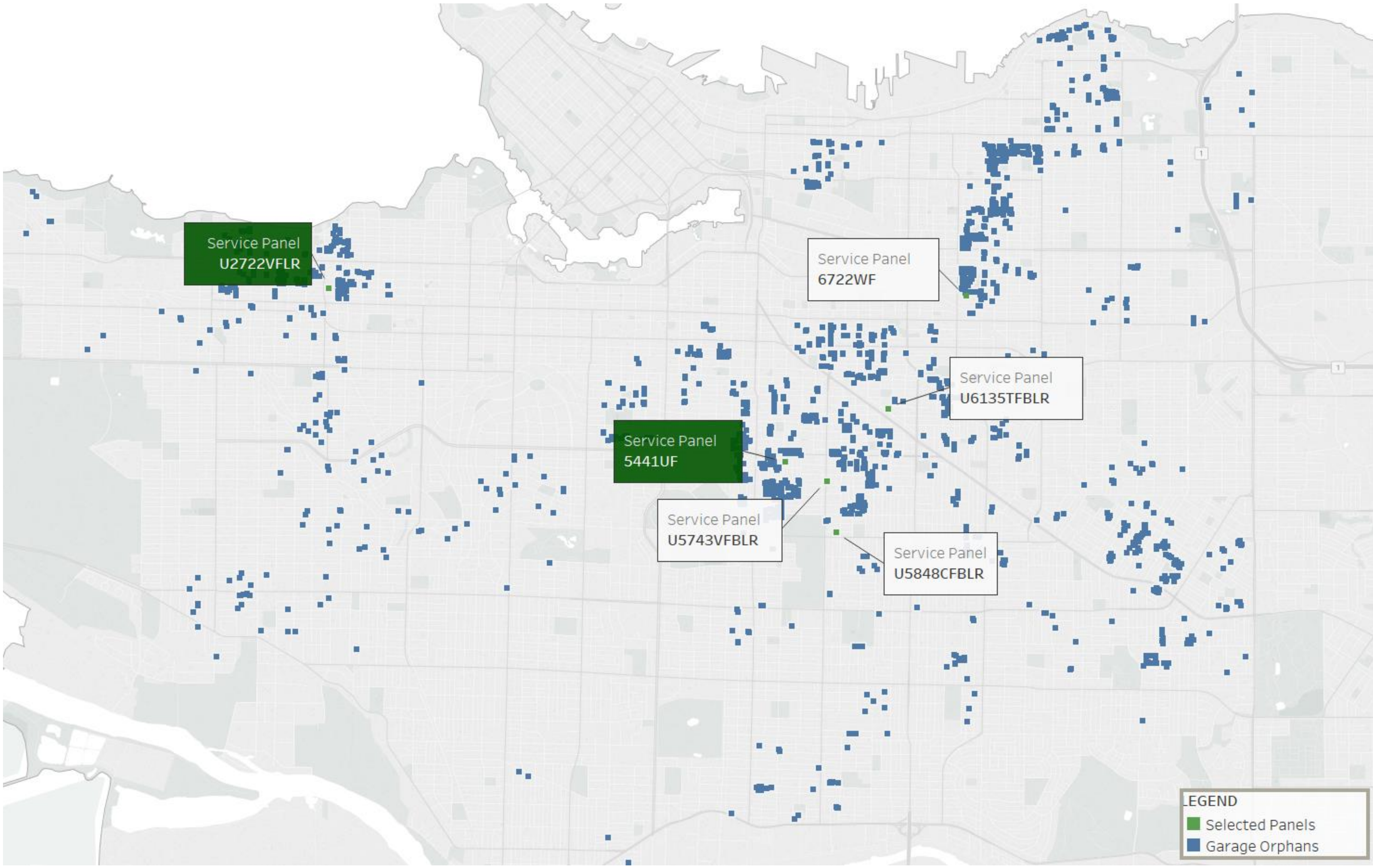

Figure 19. Most feasible service panels.

10 Findings and Conclusions

The main findings and conclusions of the Feasibility Study Identifying Possibilities for Light-Pole Charging in Vancouver are:

10.1 Cost analysis findings

- Scenario 3 (Fewer modifications in the infrastructure) has the lowest installation costs. This scenario provides a slow charging level 2 EVSE.
    - Average implementation costs with lighting fixtures replacement: $37,685 CAD.
    - Average implementation cost without lighting fixture replacement: $14,585 CAD.
- Scenario 2 (Maximum number of EVSE) has the highest installation costs. This is because most of the circuits would require a cable and conduit replacement.
    - Average implementation costs with lighting fixtures replacement: $140,557 CAD.
    - Average implementation cost without lighting fixture replacement: $118,859 CAD.
- The highest costs identified are associated with the civil works, trenching for the replacement of conduit, followed by lighting fixtures replacement (to LED).

10.2 Pilot project conclusions

- Pilot projects should be implemented in parallel with the lighting fixture upgrading program (LED conversion) and the bonding correction program to reduce significantly the installation costs.
- Five optimal service panels were identified for pilots projects. These panels are:
    - U5848CFBLR
    - U5743VFBLR
    - U2722VFLR
    - 6722WF
    - 5441UF
- The most feasible scenario is Scenario 3 (Fewer modifications in the infrastructure). Not only for the costs but also because its not going to replace any cable. This reduces the risk of damaging existing infrastructure while pulling cable or replacing conduit.
- Using a EVSE with demand management capabilities will allow the users to have faster charging capacity during the day (streetlights off) and slower charging capacity during the night (streetlights on).
- The pilot projects must include the service panel replacement for a service panel with a certified meter in it. The use of metering in the charging station or in the smart cable is not yet approved and could take a significant amount of time to be approved. For this reason, the service panels selected based only on their location (see section 4.6) had better results than selected for their technical capabilities (see section 4.3).
- An alternative of installing a standalone EVSE on the curbside using a dedicated circuit from the services panels mentioned above is an option that could be studied. The panels have enough capacity to support several charging points. This option could have higher costs due to the civil work required it would not need the replacement of the lighting fixtures.

- The energy consumption costs for the streetlighting fed by the service panels selected for the pilot project would increase due to the change in the Electric Tariff Schedule Rate (British Columbia Hydro and Power Authority, 2019).
- The calculations and budgets presented in this report are estimates based on the information obtained in drawings and meetings with the City's Streets and Electrical Design Branch staff. Before the pilot projects are implemented detailed inspections, calculations and designs have to be performed.

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12 Appendix

12.1 Appendix A – Load calculations

In the following show the load calculation made for the selected service panels (Table 4). The following assumptions were considered for the calculations:

- Balanced distribution of the lighting fixtures per circuit.
- Power factor of the High Pressure Sodium (HPS) lighting is 87%.
- Power factor of the Metal Halide (MH) lighting is 90%.
- Power factor of the LED lighting is 97%.
- The service panels U6134LEBLR and U6333WEBLR fed the light poles at 120 V; this assumption was based on the distribution of the conductors showed in Street Lighting Mapbook.
- The power consumption of the LED lighting was selected using a quick reference conversion table of the City's Electrical Design Branch.

Table 43 to Table 52 show the existing loads of the selected panels. Table 53 to Table 62 show the load if all the lighting fixtures fed by the service panel were changed to LED.

Table 43. U5438SFBLR with existing lighting fixtures.

	# Lamps	Type of Lamps	Power of Lamps (W)	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	8	HPS	150	1.95	240	8.14	15
	2	HPS	250				
Circuit 2	8	HPS	150	1.95	240	8.14	15
	2	HPS	250				
Circuit 3	9	HPS	150	1.84	240	7.66	15
	1	HPS	250				
Circuit 4	9	HPS	150	1.55	240	6.47	15
	0	HPS	250				

Table 44. U6134LEBLR with existing lighting fixtures.

	# Lamps	Type of Lamps	Power of Lamps (W)	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	3	HPS	150	0.52	120	4.31	15
Circuit 2	3	HPS	150	0.52	120	4.31	15
Circuit 3	6	HPS	150	1.03	120	8.62	20
Circuit 4	5	HPS	150	0.86	120	7.18	20

Table 45. U6333WEBLR with existing lighting fixtures.

	# Lamps	Type of Lamps	Power of Lamps (W)	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	3	HPS	150	0.52	120	4.31	15
Circuit 2	3	HPS	150	0.52	120	4.31	15
Circuit 3	3	HPS	150	0.52	120	4.31	15
Circuit 4	2	HPS	150	0.34	120	2.87	15

Table 46. U5848CFBLR with existing lighting fixtures.

	# Lamps	Type of Lamps	Power of Lamps (W)	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	4	HPS	150	0.69	240	2.87	15
Circuit 2	3	HPS	150	0.52	240	2.16	15
Circuit 3	1	HPS	150	1.15	240	4.79	15
	3	HPS	200				
	1	HPS	250				
Circuit 4	3	HPS	200	1.26	240	5.27	15
	2	HPS	250				
Circuit 5	7	HPS	200	1.90	240	7.90	20
	1	HPS	250				
Circuit 6	7	HPS	200	1.61	240	6.70	20
Circuit 7	3	HPS	150	2.97	240	12.37	20
	1	HPS	200				
	2	MH	1000				
Circuit 8	3	HPS	150	2.74	240	11.41	20
	2	MH	1000				

Table 47. U5743VFBLR with existing lighting fixtures.

	# Lamps	Type of Lamps	Power of Lamps (W)	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	7	HPS	150	1.21	240	5.03	15
Circuit 2	6	HPS	150	1.03	240	4.31	15
Circuit 3	11	HPS	200	2.53	240	10.54	30
Circuit 4	11	HPS	200	2.53	240	10.54	30
Circuit 5	9	HPS	200	2.07	240	8.62	30
Circuit 6	9	HPS	200	2.07	240	8.62	30

Table 48. U5245PFBLR with existing lighting fixtures.

	# Lamps	Type of Lamps	Power of Lamps (W)	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	5	HPS	150	0.86	240	3.59	15

	# Lamps	Type of Lamps	Power of Lamps (W)	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
	0	HPS	200				
Circuit 2	4	HPS	150	0.69	240	2.87	15
	0	HPS	200				
Circuit 3	0	HPS	150	2.76	240	11.49	30
	12	HPS	200				
Circuit 4	0	HPS	150	2.76	240	11.49	30
	12	HPS	200				

Table 49. U6135TFBLR with existing lighting fixtures.

	# Lamps	Type of Lamps	Power of Lamps (W)	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	10	HPS	150	1.72	240	7.18	15
Circuit 2	9	HPS	150	1.55	240	6.47	15
Circuit 3	6	HPS	250	1.72	240	7.18	20
Circuit 4	6	HPS	250	1.72	240	7.18	20
Circuit 5	5	HPS	250	1.44	240	5.99	20
Circuit 6	5	HPS	250	1.44	240	5.99	20
Circuit 7	1	HPS	200	1.95	240	8.14	20
	6	HPS	250				
Circuit 8	1	HPS	200	1.67	240	6.94	20
	5	HPS	250				
Circuit 9	2	HPS	200	1.61	240	6.70	20
	4	HPS	250				
Circuit 10	2	HPS	200	1.61	240	6.70	20
	4	HPS	250				

Table 50. U5534SFBLR with existing lighting fixtures.

	# Lamps	Type of Lamps	Power of Lamps (W)	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	1	HPS	100	1.67	240	6.94	20
	9	HPS	150				
Circuit 2	9	HPS	150	1.55	240	6.47	20
Circuit 3	12	HPS	150	2.07	240	8.62	20
Circuit 4	11	HPS	150	1.90	240	7.90	20

Table 51. U5342NFBLR with existing lighting fixtures.

	# Lamps	Type of Lamps	Power of Lamps (W)	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	4	HPS	150	0.98	240	4.07	15

	# Lamps	Type of Lamps	Power of Lamps (W)	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
	1	HPS	250				
Circuit 2	5	HPS	150	0.86	240	3.59	15
Circuit 3	8	HPS	150	1.38	240	5.75	15
Circuit 4	8	HPS	150	1.38	240	5.75	15

Table 52. U6239WFBLR with existing lighting fixtures.

	# Lamps	Type of Lamps	Power of Lamps (W)	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	11	HPS	150	2.18	240	9.10	15
	1	HPS	250				
Circuit 2	15	HPS	150	2.82	240	11.73	15
	1	HPS	200				

Table 53. U5438SFBLR with LED lighting fixtures.

	# Lamps	Type of Lamps	Power of Lamps (W)	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	8	LED	72	0.86	240	3.58	15
	2	LED	129				
Circuit 2	8	LED	72	0.86	240	3.58	15
	2	LED	129				
Circuit 3	9	LED	72	0.80	240	3.34	15
	1	LED	129				
Circuit 4	9	LED	72	0.67	240	2.78	15
	0	LED	129				

Table 54. U6134LEBLR with LED lighting fixtures.

	# Lamps	Type of Lamps	Power of Lamps (W)	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	3	LED	72	0.22	120	1.86	15
Circuit 2	3	LED	72	0.22	120	1.86	15
Circuit 3	6	LED	72	0.45	120	3.71	20
Circuit 4	5	LED	72	0.37	120	3.09	20

Table 55. U6333WEBLR LED lighting fixtures.

	# Lamps	Type of Lamps	Power of Lamps (W)	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	3	LED	72	0.22	120	1.86	15
Circuit 2	3	LED	72	0.22	120	1.86	15
Circuit 3	3	LED	72	0.22	120	1.86	15

	# Lamps	Type of Lamps	Power of Lamps (W)	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 4	2	LED	72	0.15	120	1.24	15

Table 56. U5848CFBLR LED lighting fixtures.

	# Lamps	Type of Lamps	Power of Lamps (W)	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	4	LED	72	0.30	240	1.24	15
Circuit 2	3	LED	72	0.22	240	0.93	15
Circuit 3	1	LED	72	0.47	240	1.97	15
	3	LED	86				
	1	LED	129				
Circuit 4	3	LED	86	0.53	240	2.22	15
	2	LED	129				
Circuit 5	7	LED	86	0.75	240	3.14	20
	1	LED	129				
Circuit 6	7	LED	86	0.62	240	2.59	20
Circuit 7	3	LED	72	0.72	240	3.02	20
	1	LED	86				
	2	LED	200				
Circuit 8	3	LED	72	0.64	240	2.65	20
	2	LED	200				

Table 57. U5743VFBLR with LED lighting fixtures.

	# Lamps	Type of Lamps	Power of Lamps (W)	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	6	LED	72	0.52	240	2.16	15
Circuit 2	6	LED	72	0.45	240	1.86	15
Circuit 3	11	LED	86	0.98	240	4.06	30
Circuit 4	11	LED	86	0.98	240	4.06	30
Circuit 5	9	LED	86	0.80	240	3.32	30
Circuit 6	9	LED	86	0.80	240	3.32	30

Table 58. U5245PFBLR with LED lighting fixtures.

	# Lamps	Type of Lamps	Power of Lamps (W)	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	5	LED	72	0.37	240	1.55	15
	0	LED	86				
Circuit 2	4	LED	72	0.30	240	1.24	15
	0	LED	86				
Circuit 3	0	LED	72	1.06	240	4.43	30

	# Lamps	Type of Lamps	Power of Lamps (W)	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
	12	LED	86				
Circuit 4	0	LED	72	1.06	240	4.43	30
	12	LED	86				

Table 59. U6135TFBLR with LED lighting fixtures.

	# Lamps	Type of Lamps	Power of Lamps (W)	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	10	LED	72	0.74	240	3.09	15
Circuit 2	9	LED	72	0.67	240	2.78	15
Circuit 3	6	LED	129	0.80	240	3.32	20
Circuit 4	6	LED	129	0.80	240	3.32	20
Circuit 5	5	LED	129	0.66	240	2.77	20
Circuit 6	5	LED	129	0.66	240	2.77	20
Circuit 7	1	LED	86	0.89	240	3.69	20
	6	LED	129				
Circuit 8	1	LED	86	0.75	240	3.14	20
	5	LED	129				
Circuit 9	2	LED	86	0.71	240	2.96	20
	4	LED	129				
Circuit 10	2	LED	86	0.71	240	2.96	20
	4	LED	129				

Table 60. U5534SFBLR with LED lighting fixtures.

	# Lamps	Type of Lamps	Power of Lamps (W)	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	1	LED	39	0.71	240	2.95	20
	9	LED	72				
Circuit 2	9	LED	72	0.67	240	2.78	20
Circuit 3	12	LED	72	0.89	240	3.71	20
Circuit 4	11	LED	72	0.82	240	3.40	20

Table 61. U5342NFBLR with LED lighting fixtures.

	# Lamps	Type of Lamps	Power of Lamps (W)	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	4	LED	72	0.43	240	1.79	15
	1	LED	129				
Circuit 2	4	LED	72	0.30	240	1.24	15
Circuit 3	8	LED	72	0.59	240	2.47	15
Circuit 4	8	LED	72	0.59	240	2.47	15

Table 62. U6239WFBLR with LED lighting fixtures.

	# Lamps	Type of Lamps	Power of Lamps (W)	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	11	LED	72	0.95	240	3.96	15
	1	LED	129				
Circuit 2	15	LED	72	1.20	240	5.01	15
	1	LED	86				

12.2 Appendix B – Voltage drop calculations

The following figures show the distribution of the light poles per circuit. The acronyms used for coding the elements were, JB for Junction Box and P for pole. Regarding the coding of the poles, they are referred to as PX-A or PX-B, where the X corresponds to the number of the pole, the A corresponds to circuit 1 and B to circuit 2.

Additionally, below the distribution figures, the voltage drop calculations are presented for the current status as well as for the future status.

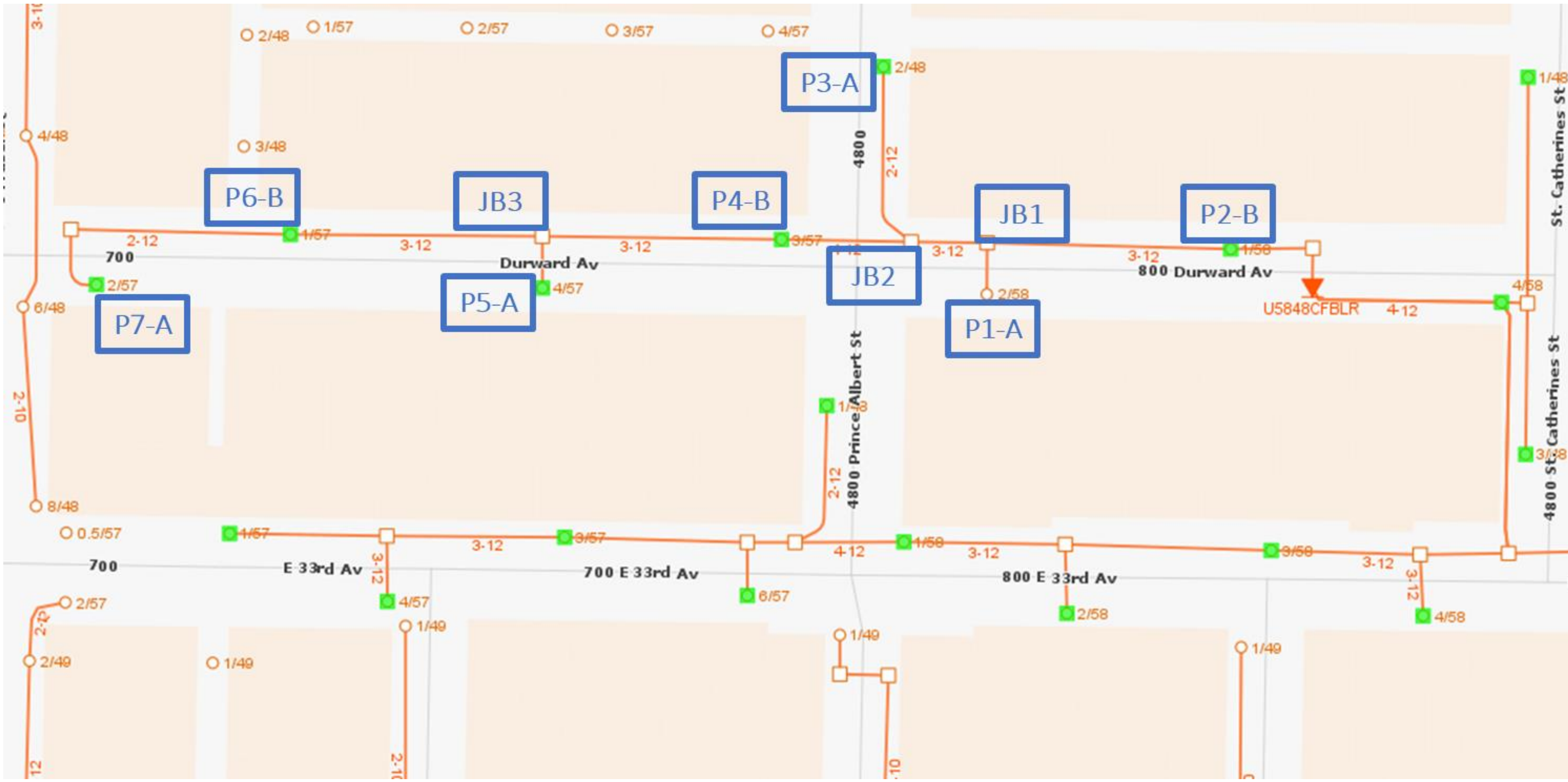

Figure 20. Circuit distribution of service panel U5848CFBLR.

Figure 21. Circuit distribution of service panel U5743VFBLR

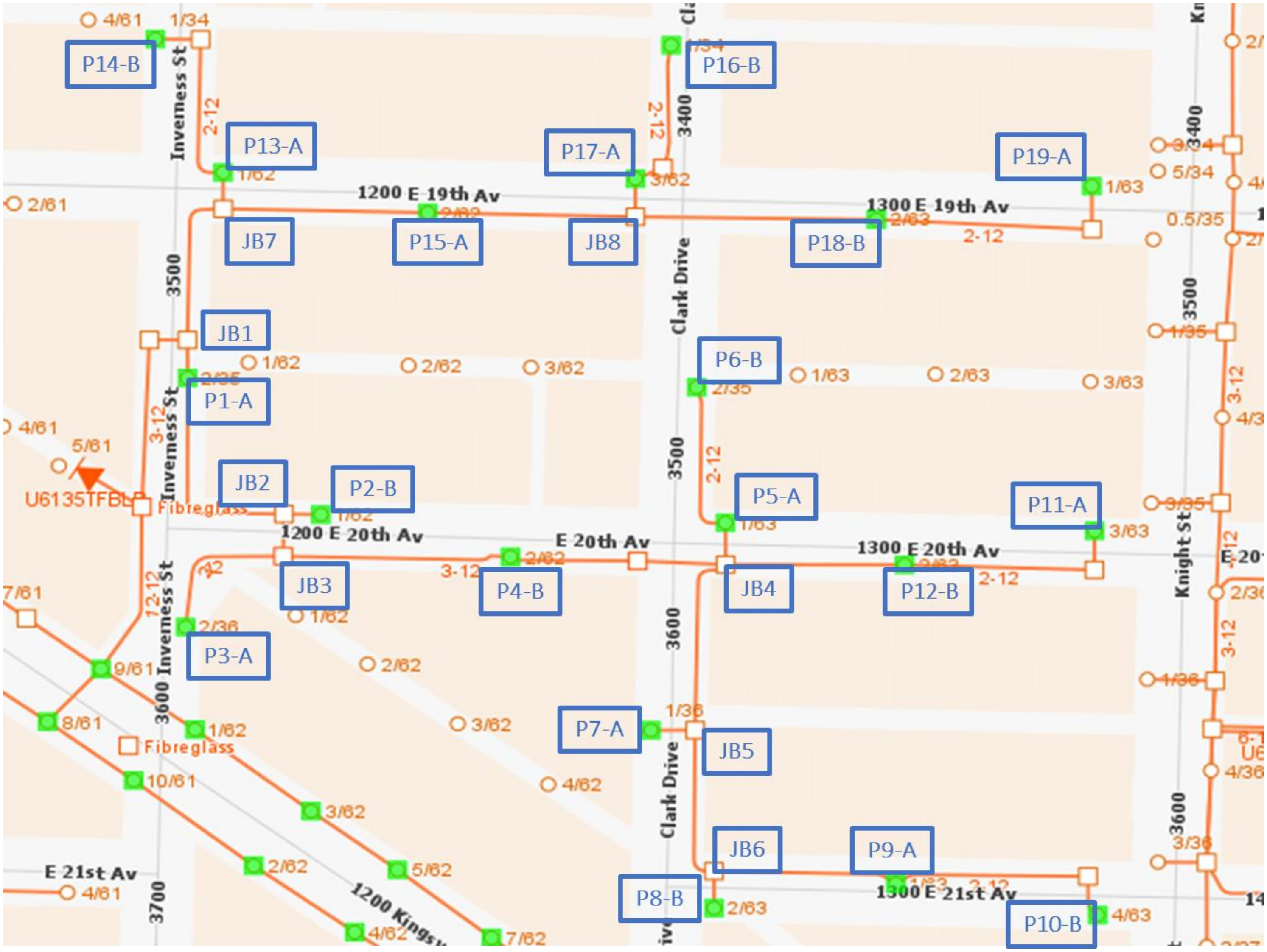

Figure 22. Circuit distribution of service panel U6135TFBLR.

Table 63. Voltage drop calculation for current U5848CFBLR.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Gauge of grounding (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal
SERVICE PANEL	JB1	1-PHASE	0.60	0.69	240	1	2.87	87%	72.00	2 x (12)	12 AWG	25	0.51%	0.51%	6.73	0.22	YES
JB1	P1-A	1-PHASE	0.15	0.17	240	1	0.72	87%	10.00	2 x (12)	12 AWG	25	0.04%	0.55%	6.73	0.22	YES
JB1	JB2	1-PHASE	0.45	0.52	240	1	2.16	87%	15.00	2 x (12)	12 AWG	25	0.08%	0.59%	6.73	0.22	YES
JB2	P3-A	1-PHASE	0.15	0.17	240	1	0.72	87%	37.00	2 x (12)	12 AWG	25	0.13%	0.73%	6.73	0.22	YES
JB2	JB3	1-PHASE	0.30	0.34	240	1	1.44	87%	74.00	2 x (12)	12 AWG	25	0.26%	0.86%	6.73	0.22	YES
JB3	P5-A	1-PHASE	0.15	0.17	240	1	0.72	87%	10.00	2 x (12)	12 AWG	25	0.04%	0.89%	6.73	0.22	YES
JB3	P7-A	1-PHASE	0.15	0.17	240	1	0.72	87%	109.00	2 x (12)	12 AWG	25	0.39%	1.25%	6.73	0.22	YES
SERVICE PANEL	P2-B	1-PHASE	0.45	0.52	240	1	2.16	87%	23.00	2 x (12)	12 AWG	25	0.12%	0.12%	6.73	0.22	YES
P2-B	P4-B	1-PHASE	0.30	0.34	240	1	1.44	87%	90.00	2 x (12)	12 AWG	25	0.32%	0.44%	6.73	0.22	YES
P4-B	P6-B	1-PHASE	0.15	0.17	240	1	0.72	87%	98.00	2 x (12)	12 AWG	25	0.17%	0.62%	6.73	0.22	YES

Table 64. Voltage drop calculation for future U5848CFBLR.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES								
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Gauge of grounding (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal
SERVICE PANEL	JB1	1-PHASE	0.29	0.30	240	1	1.24	97%	72.00	2 x (12)	12 AWG	25	0.24%	0.24%	6.73	0.22	YES
JB1	P1-A	1-PHASE	0.07	0.07	240	1	0.31	97%	10.00	2 x (12)	12 AWG	25	0.02%	0.26%	6.73	0.22	YES
JB1	JB2	1-PHASE	0.22	0.22	240	1	0.93	97%	15.00	2 x (12)	12 AWG	25	0.04%	0.28%	6.73	0.22	YES
JB2	P3-A	1-PHASE	0.07	0.07	240	1	0.31	97%	37.00	2 x (12)	12 AWG	25	0.06%	0.35%	6.73	0.22	YES
JB2	JB3	1-PHASE	0.14	0.15	240	1	0.62	97%	74.00	2 x (12)	12 AWG	25	0.13%	0.41%	6.73	0.22	YES
JB3	P5-A	1-PHASE	0.07	0.07	240	1	0.31	97%	10.00	2 x (12)	12 AWG	25	0.02%	0.42%	6.73	0.22	YES
JB3	P7-A	1-PHASE	0.07	0.07	240	1	0.31	97%	109.00	2 x (12)	12 AWG	25	0.18%	0.59%	6.73	0.22	YES
SERVICE PANEL	P2-B	1-PHASE	0.22	0.22	240	1	0.93	97%	23.00	2 x (12)	12 AWG	25	0.06%	0.06%	6.73	0.22	YES
P2-B	P4-B	1-PHASE	0.14	0.15	240	1	0.62	97%	90.00	2 x (12)	12 AWG	25	0.15%	0.21%	6.73	0.22	YES
P4-B	P6-B	1-PHASE	0.07	0.07	240	1	0.31	97%	98.00	2 x (12)	12 AWG	25	0.08%	0.29%	6.73	0.22	YES

Table 65. Voltage drop calculation for current U5743VFBLR.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Gauge of grounding (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal
SERVICE PANEL	P1-A	1-PHASE	0.15	0.17	240	1	0.72	87%	10.00	2 x (12)	12 AWG	25	0.04%	0.04%	6.73	0.22	YES
SERVICE PANEL	JB1	1-PHASE	0.90	1.03	240	1	4.31	87%	76.00	2 x (12)	12 AWG	25	0.81%	0.81%	6.73	0.22	YES
JB1	P3-A	1-PHASE	0.15	0.17	240	1	0.72	87%	11.00	2 x (12)	12 AWG	25	0.04%	0.85%	6.73	0.22	YES
JB1	JB2	1-PHASE	0.75	0.862	240	1	3.59	87%	95.00	2 x (12)	12 AWG	25	0.85%	1.66%	6.73	0.22	YES
JB2	P5-A	1-PHASE	0.15	0.17	240	1	0.72	87%	11.00	2 x (12)	12 AWG	25	0.04%	1.70%	6.73	0.22	YES
JB2	P6-B	1-PHASE	0.60	0.69	240	1	2.87	87%	43.00	2 x (12)	12 AWG	25	0.31%	2.01%	6.73	0.22	YES
P6-B	P7-A	1-PHASE	0.45	0.52	240	1	2.16	87%	22.00	2 x (12)	12 AWG	25	0.12%	2.13%	6.73	0.22	YES
P7-A	P9-A	1-PHASE	0.30	0.34	240	1	1.44	87%	99.00	2 x (12)	12 AWG	25	0.35%	2.48%	6.73	0.22	YES
P9-A	P11-A	1-PHASE	0.15	0.17	240	1	0.72	87%	114.00	2 x (12)	12 AWG	25	0.31%	2.79%	6.73	0.22	YES
P6-B	P13-A	1-PHASE	0.15	0.17	240	1	0.72	87%	51.00	2 x (12)	12 AWG	25	0.09%	2.10%	6.73	0.22	YES
SERVICE PANEL	P2-B	1-PHASE	0.90	1.03	240	1	4.31	87%	38.00	2 x (12)	12 AWG	25	0.41%	0.41%	6.73	0.22	YES
P2-B	P4-B	1-PHASE	0.75	0.86	240	1	3.59	87%	89.00	2 x (12)	12 AWG	25	0.79%	1.20%	6.73	0.22	YES
P4-B	P6-B	1-PHASE	0.60	0.69	240	1	2.87	87%	97.00	2 x (12)	12 AWG	25	0.69%	1.89%	6.73	0.22	YES
P6-B	JB3	1-PHASE	0.30	0.34	240	1	1.44	87%	70.00	2 x (12)	12 AWG	25	0.25%	2.14%	6.73	0.22	YES
JB3	P8-B	1-PHASE	0.15	0.17	240	1	0.72	87%	9.00	2 x (12)	12 AWG	25	0.03%	2.18%	6.73	0.22	YES

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Gauge of grounding (AWG o kcmil)	Conductor Ampacity	Voltage Drop		R	X	Voltage Drop Comply?
													Nominal (%)	Accumulated (%)	ohm/km	ohm/km	Nominal
JB3	P10-B	1-PHASE	0.15	0.17	240	1	0.72	87%	113.00	2 x (12)	12 AWG	25	0.20%	2.35%	6.73	0.22	YES
P6-B	P12-B	1-PHASE	0.15	0.17	240	1	0.72	87%	77.00	2 x (12)	12 AWG	25	0.18%	2.08%	6.73	0.22	YES

Table 66. Voltage drop calculation for future U5743VFBLR.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Gauge of grounding (AWG o kcmil)	Conductor Ampacity	Voltage Drop		R	X	Voltage Drop Comply?
													Nominal (%)	Accumulated (%)	ohm/km	ohm/km	Nominal
SERVICE PANEL	P1-A	1-PHASE	0.07	0.07	240	1	0.31	97%	10.00	2 x (12)	12 AWG	25	0.02%	0.02%	6.73	0.22	YES
SERVICE PANEL	JB1	1-PHASE	0.43	0.45	240	1	1.86	97%	76.00	2 x (12)	12 AWG	25	0.39%	0.39%	6.73	0.22	YES
JB1	P3-A	1-PHASE	0.07	0.07	240	1	0.31	97%	11.00	2 x (12)	12 AWG	25	0.02%	0.41%	6.73	0.22	YES
JB1	JB2	1-PHASE	0.36	0.37	240	1	1.55	97%	95.00	2 x (12)	12 AWG	25	0.40%	0.79%	6.73	0.22	YES
JB2	P5-A	1-PHASE	0.07	0.07	240	1	0.31	97%	11.00	2 x (12)	12 AWG	25	0.02%	0.81%	6.73	0.22	YES
JB2	P6-B	1-PHASE	0.29	0.30	240	1	1.24	97%	43.00	2 x (12)	12 AWG	25	0.15%	0.95%	6.73	0.22	YES
P6-B	P7-A	1-PHASE	0.22	0.22	240	1	0.93	97%	22.00	2 x (12)	12 AWG	25	0.06%	1.01%	6.73	0.22	YES

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Gauge of grounding (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal
P7-A	P9-A	1-PHASE	0.14	0.15	240	1	0.62	97%	99.00	2 x (12)	12 AWG	25	0.17%	1.18%	6.73	0.22	YES
P9-A	P11-A	1-PHASE	0.07	0.07	240	1	0.31	97%	114.00	2 x (12)	12 AWG	25	0.15%	1.33%	6.73	0.22	YES
P6-B	P13-A	1-PHASE	0.07	0.07	240	1	0.31	97%	51.00	2 x (12)	12 AWG	25	0.04%	1.00%	6.73	0.22	YES
SERVICE PANEL	P2-B	1-PHASE	0.43	0.45	240	1	1.86	97%	38.00	2 x (12)	12 AWG	25	0.19%	0.19%	6.73	0.22	YES
P2-B	P4-B	1-PHASE	0.36	0.37	240	1	1.55	97%	89.00	2 x (12)	12 AWG	25	0.38%	0.57%	6.73	0.22	YES
P4-B	P6-B	1-PHASE	0.29	0.30	240	1	1.24	97%	97.00	2 x (12)	12 AWG	25	0.33%	0.90%	6.73	0.22	YES
P6-B	JB3	1-PHASE	0.14	0.15	240	1	0.62	97%	70.00	2 x (12)	12 AWG	25	0.12%	1.02%	6.73	0.22	YES
JB3	P8-B	1-PHASE	0.07	0.07	240	1	0.31	97%	9.00	2 x (12)	12 AWG	25	0.02%	1.03%	6.73	0.22	YES
JB3	P10-B	1-PHASE	0.07	0.07	240	1	0.31	97%	113.00	2 x (12)	12 AWG	25	0.10%	1.11%	6.73	0.22	YES
P6-B	P12-B	1-PHASE	0.07	0.07	240	1	0.31	97%	77.00	2 x (12)	12 AWG	25	0.09%	0.99%	6.73	0.22	YES

Table 67. Voltage drop calculation for current U6135TFBLR.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Gauge of grounding (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal
SERVICE PANEL	JB1	1-PHASE	1.50	1.72	240	1	7.18	87%	76.00	2 x (12)	12 AWG	25	1.36%	1.36%	6.73	0.22	YES
JB1	P1-A	1-PHASE	0.90	1.03	240	1	4.31	87%	11.00	2 x (12)	12 AWG	25	0.12%	1.47%	6.73	0.22	YES
P1-A	JB3	1-PHASE	0.75	0.86	240	1	3.59	87%	76.00	2 x (12)	12 AWG	25	0.68%	2.15%	6.73	0.22	YES
JB3	P3-A	1-PHASE	0.15	0.17	240	1	0.72	87%	43.00	2 x (12)	12 AWG	25	0.15%	2.31%	6.73	0.22	YES
JB3	JB4	1-PHASE	0.60	0.69	240	1	2.87	87%	122.00	2 x (12)	12 AWG	25	0.87%	3.02%	6.73	0.22	NO
JB4	P5-A	1-PHASE	0.15	0.17	240	1	0.72	87%	12.00	2 x (12)	12 AWG	25	0.02%	3.05%	6.73	0.22	NO
JB4	JB5	1-PHASE	0.30	0.34	240	1	1.44	87%	53.00	2 x (12)	12 AWG	25	0.19%	3.21%	6.73	0.22	NO
JB5	P7-A	1-PHASE	0.15	0.17	240	1	0.72	87%	12.00	2 x (12)	12 AWG	25	0.04%	3.26%	6.73	0.22	NO
JB5	P9-A	1-PHASE	0.15	0.17	240	1	0.72	87%	96.00	2 x (12)	12 AWG	25	0.17%	3.39%	6.73	0.22	NO
JB4	P11-A	1-PHASE	0.15	0.17	240	1	0.72	87%	112.00	2 x (12)	12 AWG	25	0.31%	3.34%	6.73	0.22	NO
JB1	JB7	1-PHASE	0.60	0.69	240	1	2.87	87%	46.00	2 x (12)	12 AWG	25	0.33%	1.69%	6.73	0.22	YES
JB7	P13-A	1-PHASE	0.15	0.17	240	1	0.72	87%	10.00	2 x (12)	12 AWG	25	0.02%	1.70%	6.73	0.22	YES
JB7	P15-A	1-PHASE	0.45	0.52	240	1	2.16	87%	56.00	2 x (12)	12 AWG	25	0.30%	1.99%	6.73	0.22	YES
P15-A	JB8	1-PHASE	0.30	0.34	240	1	1.44	87%	57.00	2 x (12)	12 AWG	25	0.20%	2.19%	6.73	0.22	YES
JB8	P17-A	1-PHASE	0.15	0.17	240	1	0.72	87%	11.00	2 x (12)	12 AWG	25	0.02%	2.21%	6.73	0.22	YES
JB8	P19-A	1-PHASE	0.15	0.17	240	1	0.72	87%	137.00	2 x (12)	12 AWG	25	0.37%	2.56%	6.73	0.22	YES

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Gauge of grounding (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal
SERVICE PANEL	JB1	1-PHASE	1.35	1.55	240	1	6.47	87%	76.00	2 x (12)	12 AWG	25	1.22%	1.22%	6.73	0.22	YES
JB1	JB2	1-PHASE	0.90	1.03	240	1	4.31	87%	87.00	2 x (12)	12 AWG	25	0.93%	2.15%	6.73	0.22	YES
JB2	P2-B	1-PHASE	0.15	0.17	240	1	0.72	87%	10.00	2 x (12)	12 AWG	25	0.04%	2.19%	6.73	0.22	YES
JB2	P4-B	1-PHASE	0.75	0.86	240	1	3.59	87%	75.00	2 x (12)	12 AWG	25	0.67%	2.82%	6.73	0.22	YES
P4-B	JB4	1-PHASE	0.60	0.69	240	1	2.87	87%	59.00	2 x (12)	12 AWG	25	0.42%	3.24%	6.73	0.22	NO
JB4	P6-B	1-PHASE	0.15	0.17	240	1	0.72	87%	57.00	2 x (12)	12 AWG	25	0.18%	3.43%	6.73	0.22	NO
JB4	JB6	1-PHASE	0.30	0.34	240	1	1.44	87%	98.00	2 x (12)	12 AWG	25	0.35%	3.59%	6.73	0.22	NO
JB6	P8-B	1-PHASE	0.15	0.17	240	1	0.72	87%	10.00	2 x (12)	12 AWG	25	0.04%	3.63%	6.73	0.22	NO
JB6	P10-B	1-PHASE	0.15	0.17	240	1	0.72	87%	116.00	2 x (12)	12 AWG	25	0.32%	3.92%	6.73	0.22	NO
JB4	P12-B	1-PHASE	0.15	0.17	240	1	0.72	87%	112.00	2 x (12)	12 AWG	25	0.20%	3.44%	6.73	0.22	NO
JB1	JB7	1-PHASE	0.45	0.52	240	1	2.16	87%	46.00	2 x (12)	12 AWG	25	0.25%	1.47%	6.73	0.22	YES
JB7	P14-B	1-PHASE	0.15	0.17	240	1	0.72	87%	66.00	2 x (12)	12 AWG	25	0.12%	1.59%	6.73	0.22	YES
JB7	JB8	1-PHASE	0.30	0.34	240	1	1.44	87%	113.00	2 x (12)	12 AWG	25	0.40%	1.87%	6.73	0.22	YES
JB8	P16-B	1-PHASE	0.15	0.17	240	1	0.72	87%	55.00	2 x (12)	12 AWG	25	0.18%	2.05%	6.73	0.22	YES
JB8	P18-B	1-PHASE	0.15	0.17	240	1	0.72	87%	66.00	2 x (12)	12 AWG	25	0.12%	1.99%	6.73	0.22	YES

Table 68. Voltage drop calculation for future U6135TFBLR.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Gauge of grounding (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal
SERVICE PANEL	JB1	1-PHASE	0.72	0.74	240	1	3.09	97%	76.00	2 x (12)	12 AWG	25	0.64%	0.64%	6.73	0.22	YES
JB1	P1-A	1-PHASE	0.43	0.45	240	1	1.86	97%	11.00	2 x (12)	12 AWG	25	0.06%	0.70%	6.73	0.22	YES
P1-A	JB3	1-PHASE	0.36	0.37	240	1	1.55	97%	76.00	2 x (12)	12 AWG	25	0.32%	1.02%	6.73	0.22	YES
JB3	P3-A	1-PHASE	0.07	0.07	240	1	0.31	97%	43.00	2 x (12)	12 AWG	25	0.07%	1.10%	6.73	0.22	YES
JB3	JB4	1-PHASE	0.29	0.30	240	1	1.24	97%	122.00	2 x (12)	12 AWG	25	0.41%	1.44%	6.73	0.22	YES
JB4	P5-A	1-PHASE	0.07	0.07	240	1	0.31	97%	12.00	2 x (12)	12 AWG	25	0.01%	1.45%	6.73	0.22	YES
JB4	JB5	1-PHASE	0.14	0.15	240	1	0.62	97%	53.00	2 x (12)	12 AWG	25	0.09%	1.53%	6.73	0.22	YES
JB5	P7-A	1-PHASE	0.07	0.07	240	1	0.31	97%	12.00	2 x (12)	12 AWG	25	0.02%	1.55%	6.73	0.22	YES
JB5	P9-A	1-PHASE	0.07	0.07	240	1	0.31	97%	96.00	2 x (12)	12 AWG	25	0.08%	1.61%	6.73	0.22	YES
JB4	P11-A	1-PHASE	0.07	0.07	240	1	0.31	97%	112.00	2 x (12)	12 AWG	25	0.15%	1.59%	6.73	0.22	YES
JB1	JB7	1-PHASE	0.29	0.30	240	1	1.24	97%	46.00	2 x (12)	12 AWG	25	0.16%	0.80%	6.73	0.22	YES
JB7	P13-A	1-PHASE	0.07	0.07	240	1	0.31	97%	10.00	2 x (12)	12 AWG	25	0.01%	0.81%	6.73	0.22	YES
JB7	P15-A	1-PHASE	0.22	0.22	240	1	0.93	97%	56.00	2 x (12)	12 AWG	25	0.14%	0.94%	6.73	0.22	YES
P15-A	JB8	1-PHASE	0.14	0.15	240	1	0.62	97%	57.00	2 x (12)	12 AWG	25	0.10%	1.04%	6.73	0.22	YES
JB8	P17-A	1-PHASE	0.07	0.07	240	1	0.31	97%	11.00	2 x (12)	12 AWG	25	0.01%	1.05%	6.73	0.22	YES
JB8	P19-A	1-PHASE	0.07	0.07	240	1	0.31	97%	137.00	2 x (12)	12 AWG	25	0.18%	1.22%	6.73	0.22	YES

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							
ORIGIN	DESTINATION						Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Gauge of grounding (AWG o kcmil)	Conductor Ampacity	Voltage Drop		R	X	Voltage Drop Comply?
			kW	kVA									Nominal (%)	Accumulated (%)	ohm/km	ohm/km	Nominal
SERVICE PANEL	JB1	1-PHASE	0.65	0.67	240	1	2.78	97%	76.00	2 x (12)	12 AWG	25	0.58%	0.58%	6.73	0.22	YES
JB1	JB2	1-PHASE	0.43	0.45	240	1	1.86	97%	87.00	2 x (12)	12 AWG	25	0.44%	1.02%	6.73	0.22	YES
JB2	P2-B	1-PHASE	0.07	0.07	240	1	0.31	97%	10.00	2 x (12)	12 AWG	25	0.02%	1.04%	6.73	0.22	YES
JB2	P4-B	1-PHASE	0.36	0.37	240	1	1.55	97%	75.00	2 x (12)	12 AWG	25	0.32%	1.34%	6.73	0.22	YES
P4-B	JB4	1-PHASE	0.29	0.30	240	1	1.24	97%	59.00	2 x (12)	12 AWG	25	0.20%	1.54%	6.73	0.22	YES
JB4	P6-B	1-PHASE	0.07	0.07	240	1	0.31	97%	57.00	2 x (12)	12 AWG	25	0.09%	1.63%	6.73	0.22	YES
JB4	JB6	1-PHASE	0.14	0.15	240	1	0.62	97%	98.00	2 x (12)	12 AWG	25	0.17%	1.71%	6.73	0.22	YES
JB6	P8-B	1-PHASE	0.07	0.07	240	1	0.31	97%	10.00	2 x (12)	12 AWG	25	0.02%	1.72%	6.73	0.22	YES
JB6	P10-B	1-PHASE	0.07	0.07	240	1	0.31	97%	116.00	2 x (12)	12 AWG	25	0.15%	1.86%	6.73	0.22	YES
JB4	P12-B	1-PHASE	0.07	0.07	240	1	0.31	97%	112.00	2 x (12)	12 AWG	25	0.10%	1.64%	6.73	0.22	YES
JB1	JB7	1-PHASE	0.22	0.22	240	1	0.93	97%	46.00	2 x (12)	12 AWG	25	0.12%	0.70%	6.73	0.22	YES
JB7	P14-B	1-PHASE	0.07	0.07	240	1	0.31	97%	66.00	2 x (12)	12 AWG	25	0.06%	0.75%	6.73	0.22	YES
JB7	JB8	1-PHASE	0.14	0.15	240	1	0.62	97%	113.00	2 x (12)	12 AWG	25	0.19%	0.89%	6.73	0.22	YES
JB8	P16-B	1-PHASE	0.07	0.07	240	1	0.31	97%	55.00	2 x (12)	12 AWG	25	0.08%	0.97%	6.73	0.22	YES
JB8	P18-B	1-PHASE	0.07	0.07	240	1	0.31	97%	66.00	2 x (12)	12 AWG	25	0.06%	0.94%	6.73	0.22	YES

12.3 Appendix C – Load calculations of additional service panels

In the following show the load calculation made for the additional service panels (U2722VFLR, 6722WF, and 5441UF). The following assumptions were considered for the calculations:

- Balanced distribution of the lighting fixtures per circuit.
- Power factor of the High Pressure Sodium (HPS) lighting is 87%.
- Power factor of the LED lighting is 97%.
- The power consumption of the LED lighting was selected using a quick reference conversion table of the City's Electrical Design Branch.

Table 69, Table 70, and Table 71 show the existing loads of the additional panels. Table 72, Table 73, and

	# Lamps	Type of Lamps	Power of Lamps (W)	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	4	LED	72	0.39	240	1.61	15
	1	LED	86				
Circuit 2	5	LED	72	0.37	240	1.55	15
	0	LED	86				
Circuit 3	5	LED	27	0.41	240	1.69	35
	0	LED	72				
	2	LED	129				
Circuit 4	4	LED	27	0.38	240	1.57	35
	0	LED	72				
	2	LED	129				
Circuit 5	8	LED	27	1.05	240	4.38	35
	4	LED	72				
	4	LED	129				
Circuit 6	9	LED	27	1.14	240	4.74	35
	3	LED	72				
	5	LED	129				

Table 74 show the load if all the lighting fixtures fed by the service panel were changed to LED.

Table 69. U2722VFLR with existing lighting fixtures.

	# Lamps	Type of Lamps	Power of Lamps (W)	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	1	HPS	100	2.64	240	11.02	15
	4	HPS	150				
	8	HPS	200				
Circuit 2	0	HPS	100	2.53	240	10.54	15
	4	HPS	150				

	# Lamps	Type of Lamps	Power of Lamps (W)	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
	8	HPS	200				

Table 70. 6722WF with existing lighting fixtures.

	# Lamps	Type of Lamps	Power of Lamps (W)	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	4	HPS	150	0.98	240	4.07	15
	1	HPS	250				
Circuit 2	5	HPS	150	0.86	240	3.59	15
	0	HPS	200				
Circuit 3	5	HPS	70	0.98	240	4.07	35
	0	HPS	150				
	2	HPS	250				
Circuit 4	4	HPS	70	0.90	240	3.74	35
	0	HPS	150				
	2	HPS	250				
Circuit 5	8	HPS	70	2.48	240	10.34	35
	4	HPS	150				
	4	HPS	250				
Circuit 6	9	HPS	70	2.68	240	11.16	35
	3	HPS	150				
	5	HPS	250				

Table 71. 5441UF with existing lighting fixtures.

	# Lamps	Type of Lamps	Power of Lamps (W)	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	6	HPS	150	87%	1.03	240	4.31
Circuit 2	6	HPS	150	87%	1.03	240	4.31
Circuit 3	6	HPS	150	87%	1.03	240	4.31
Circuit 4	5	HPS	150	87%	0.86	240	3.59

Table 72. U2722VFLR with LED lighting fixtures.

	# Lamps	Type of Lamps	Power of Lamps (W)	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	1	LED	39	1.05	240	4.36	15
	4	LED	72				
	8	LED	86				
Circuit 2	0	LED	39	1.01	240	4.19	15
	4	LED	72				

	# Lamps	Type of Lamps	Power of Lamps (W)	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
	8	LED	86				

Table 73. 6722WF with LED lighting fixtures.

	# Lamps	Type of Lamps	Power of Lamps (W)	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	4	LED	72	0.39	240	1.61	15
	1	LED	86				
Circuit 2	5	LED	72	0.37	240	1.55	15
	0	LED	86				
Circuit 3	5	LED	27	0.41	240	1.69	35
	0	LED	72				
	2	LED	129				
Circuit 4	4	LED	27	0.38	240	1.57	35
	0	LED	72				
	2	LED	129				
Circuit 5	8	LED	27	1.05	240	4.38	35
	4	LED	72				
	4	LED	129				
Circuit 6	9	LED	27	1.14	240	4.74	35
	3	LED	72				
	5	LED	129				

Table 74. 5441UF LED lighting fixtures.

	# Lamps	Type of Lamps	Power of Lamps (W)	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	6	LED	72	97%	0.45	240	1.86
Circuit 2	6	LED	72	97%	0.45	240	1.86
Circuit 3	6	LED	72	97%	0.45	240	1.86
Circuit 4	5	LED	72	97%	0.37	240	1.55

12.4 Appendix D – Voltage drop calculations of additional service panels

The following figures show the distribution of the light poles per circuit. The acronyms used for coding the elements were, JB for Junction Box and P for pole. Regarding the coding of the poles, they are referred to as PX-A, PX-B, PX-C, or PX-D where the X corresponds to the number of the pole, the A corresponds to circuit 1, B to circuit 2, C to circuit 3, and C to circuit 4.

Additionally, below the distribution figures, the voltage drop calculations are presented for the current status as well as for the future status.

Figure 23. Circuit distribution of service panel U2722VFLR.

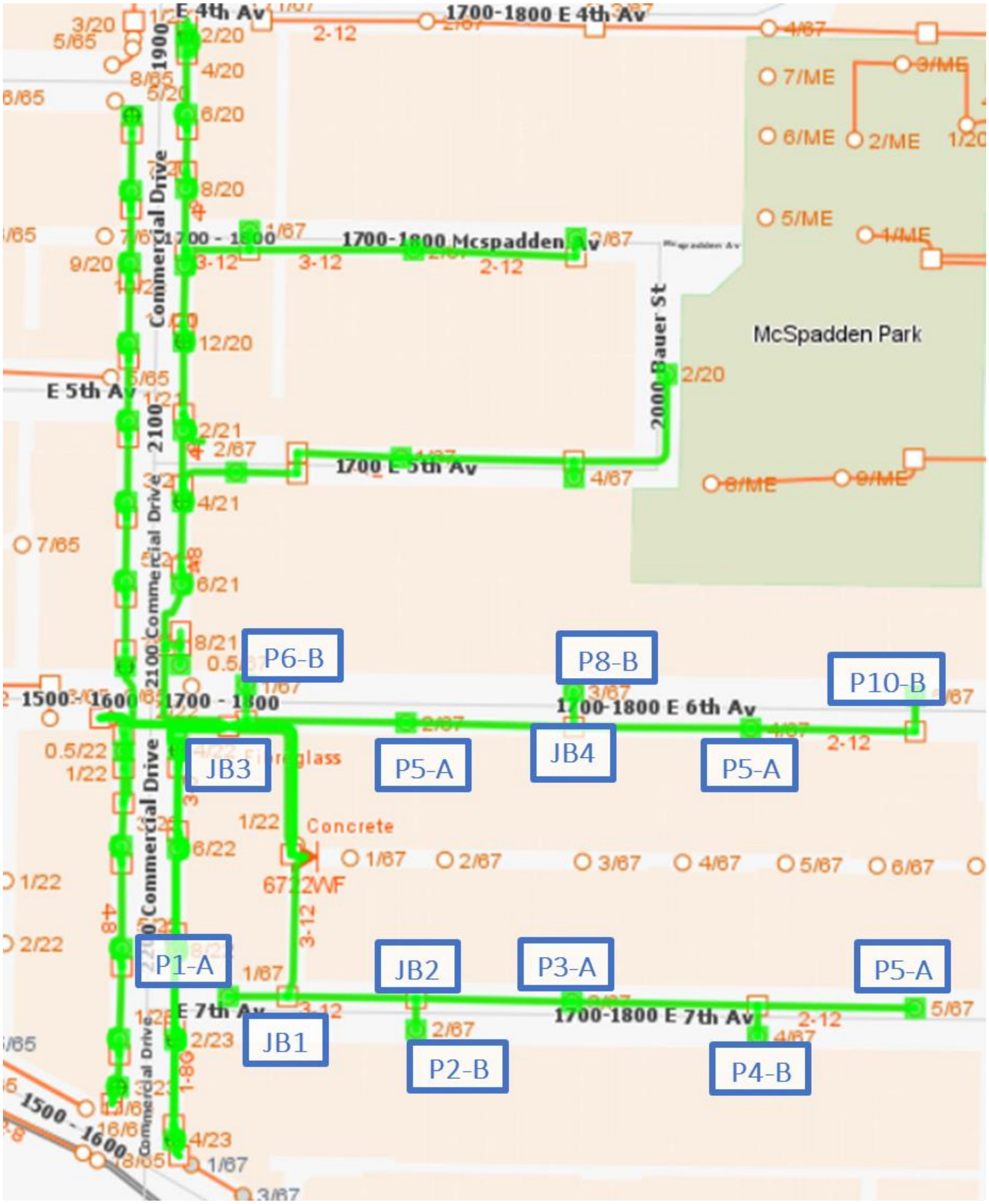

Figure 24. Circuit distribution of service panel 6722WF.

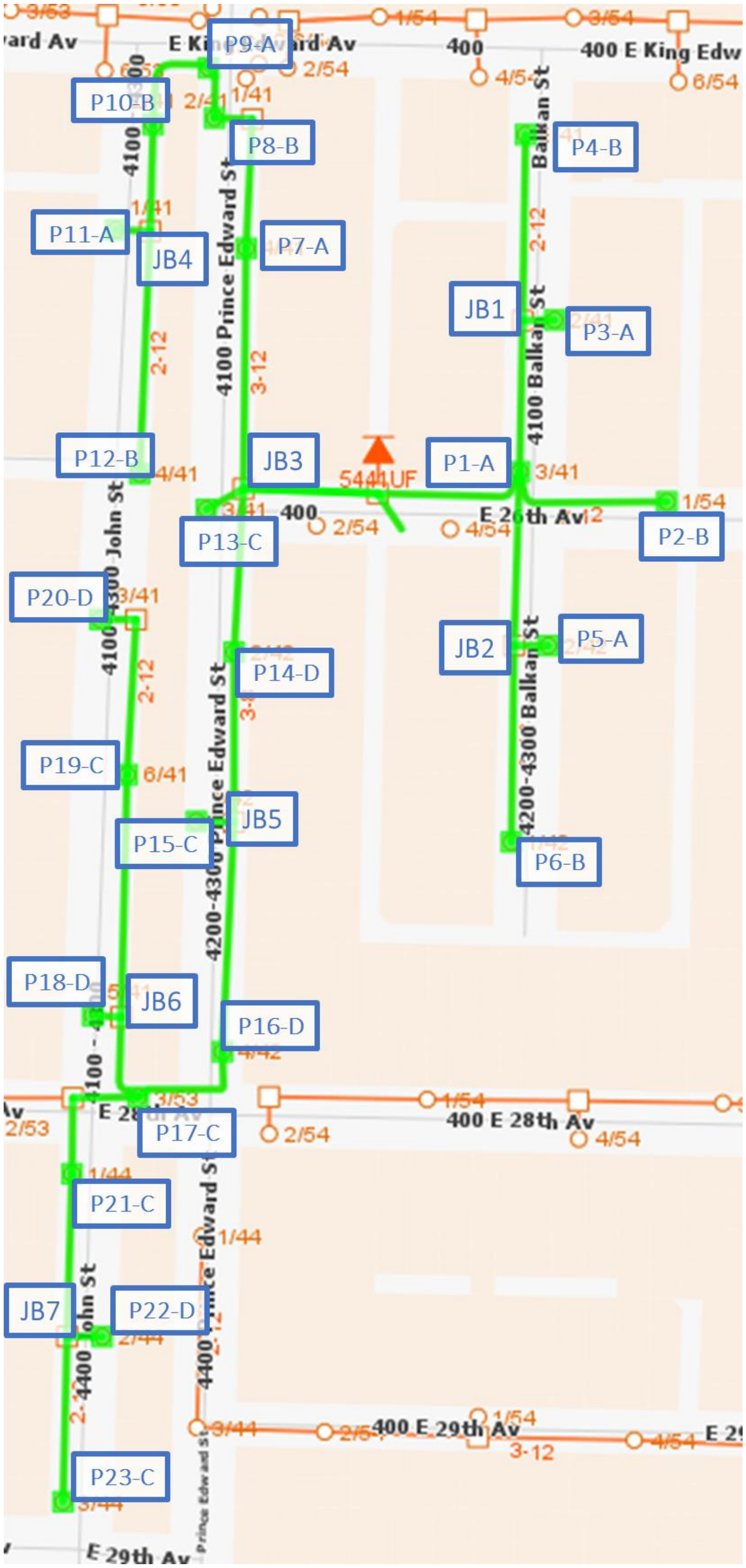

Figure 25. Circuit distribution of service panel 5441UF.

Table 75. Voltage drop calculation for current U2722VFLR.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Gauge of grounding (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal
SERVICE PANEL	JB1	1-PHASE	0.60	0.69	240	1	2.87	87%	26.00	2 x (10)	12 AWG	35	0.12%	0.12%	4.23	0.21	YES
JB1	P1-A	1-PHASE	0.15	0.17	240	1	0.72	87%	6.00	2 x (10)	12 AWG	35	0.01%	0.13%	4.23	0.21	YES
JB1	P3-A	1-PHASE	0.45	0.52	240	1	2.16	87%	91.00	2 x (10)	12 AWG	35	0.31%	0.43%	4.23	0.21	YES
P3-A	P5-A	1-PHASE	0.15	0.17	240	1	0.72	87%	56.00	2 x (12)	12 AWG	25	0.20%	0.63%	6.73	0.22	YES
P3-A	P7-A	1-PHASE	0.15	0.17	240	1	0.72	87%	90.00	2 x (10)	12 AWG	35	0.15%	0.58%	4.23	0.21	YES
SERVICE PANEL	JB2	1-PHASE	0.45	0.52	240	1	2.16	87%	67.00	2 x (10)	12 AWG	35	0.23%	0.23%	4.23	0.21	YES
JB2	P2-B	1-PHASE	0.15	0.17	240	1	0.72	87%	9.00	2 x (10)	12 AWG	35	0.02%	0.25%	4.23	0.21	YES
JB2	JB3	1-PHASE	0.30	0.34	240	1	1.44	87%	57.00	2 x (10)	12 AWG	35	0.13%	0.36%	4.23	0.21	YES
JB3	P4-B	1-PHASE	0.15	0.17	240	1	0.72	87%	17.00	2 x (10)	12 AWG	35	0.04%	0.39%	4.23	0.21	YES
JB3	P6-B	1-PHASE	0.15	0.17	240	1	0.72	87%	63.00	2 x (10)	12 AWG	35	0.07%	0.43%	4.23	0.21	YES

Table 76. Voltage drop calculation for future U2722VFLR.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Gauge of grounding (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal
SERVICE PANEL	JB1	1-PHASE	0.29	0.30	240	1	1.24	97%	26.00	2 x (10)	12 AWG	35	0.06%	0.06%	4.23	0.21	YES
JB1	P1-A	1-PHASE	0.07	0.07	240	1	0.31	97%	6.00	2 x (10)	12 AWG	35	0.01%	0.06%	4.23	0.21	YES
JB1	P3-A	1-PHASE	0.22	0.22	240	1	0.93	97%	91.00	2 x (10)	12 AWG	35	0.15%	0.20%	4.23	0.21	YES
P3-A	P5-A	1-PHASE	0.07	0.07	240	1	0.31	97%	56.00	2 x (12)	12 AWG	25	0.10%	0.30%	6.73	0.22	YES
P3-A	P7-A	1-PHASE	0.07	0.07	240	1	0.31	97%	90.00	2 x (10)	12 AWG	35	0.07%	0.27%	4.23	0.21	YES
SERVICE PANEL	JB2	1-PHASE	0.22	0.22	240	1	0.93	97%	67.00	2 x (10)	12 AWG	35	0.11%	0.11%	4.23	0.21	YES
JB2	P2-B	1-PHASE	0.07	0.07	240	1	0.31	97%	9.00	2 x (10)	12 AWG	35	0.01%	0.12%	4.23	0.21	YES
JB2	JB3	1-PHASE	0.14	0.15	240	1	0.62	97%	57.00	2 x (10)	12 AWG	35	0.06%	0.17%	4.23	0.21	YES
JB3	P4-B	1-PHASE	0.07	0.07	240	1	0.31	97%	17.00	2 x (10)	12 AWG	35	0.02%	0.19%	4.23	0.21	YES
JB3	P6-B	1-PHASE	0.07	0.07	240	1	0.31	97%	63.00	2 x (10)	12 AWG	35	0.03%	0.20%	4.23	0.21	YES

Table 77. Voltage drop calculation for current 6722WF.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							
ORIGIN	DESTINATION						Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Gauge of grounding (AWG o kcmil)	Conductor Ampacity	Voltage Drop		R	X	Voltage Drop Comply?
			kW	kVA									Nominal (%)	Accumulated (%)	ohm/km	ohm/km	Nominal
SERVICE PANEL	JB1	1-PHASE	0.50	0.57	240	1	2.39	87%	46.00	2 x (12)	12 AWG	25	0.27%	0.27%	6.73	0.22	YES
JB1	P1-A	1-PHASE	0.15	0.17	240	1	0.72	87%	19.00	2 x (12)	12 AWG	25	0.07%	0.34%	6.73	0.22	YES
JB1	P3-A	1-PHASE	0.35	0.40	240	1	1.68	87%	92.00	2 x (12)	12 AWG	25	0.38%	0.66%	6.73	0.22	YES
P3-A	P5-A	1-PHASE	0.20	0.23	240	1	0.96	87%	111.00	2 x (12)	12 AWG	25	0.38%	1.04%	6.73	0.22	YES
SERVICE PANEL	JB2	1-PHASE	0.30	0.34	240	1	1.44	87%	88.00	2 x (12)	12 AWG	25	0.31%	0.31%	6.73	0.22	YES
JB2	P2-B	1-PHASE	0.15	0.17	240	1	0.72	87%	10.00	2 x (12)	12 AWG	25	0.04%	0.35%	6.73	0.22	YES
JB2	P4-B	1-PHASE	0.15	0.17	240	1	0.72	87%	121.00	2 x (12)	12 AWG	25	0.22%	0.53%	6.73	0.22	YES
SERVICE PANEL	P7-A	1-PHASE	0.30	0.34	240	1	1.44	87%	181.00	2 x (12)	12 AWG	25	0.65%	0.65%	6.73	0.22	YES
P7-A	P9-A	1-PHASE	0.15	0.17	240	1	0.72	87%	112.00	2 x (12)	12 AWG	25	0.20%	0.85%	6.73	0.22	YES
SERVICE PANEL	JB3	1-PHASE	0.45	0.52	240	1	2.16	87%	129.00	2 x (12)	12 AWG	25	0.69%	0.69%	6.73	0.22	YES
JB3	P6-B	1-PHASE	0.15	0.17	240	1	0.72	87%	11.00	2 x (12)	12 AWG	25	0.04%	0.73%	6.73	0.22	YES
JB3	JB4	1-PHASE	0.30	0.34	240	1	1.44	87%	106.00	2 x (12)	12 AWG	25	0.38%	1.07%	6.73	0.22	YES
JB4	P8-B	1-PHASE	0.15	0.17	240	1	0.72	87%	11.00	2 x (12)	12 AWG	25	0.04%	1.11%	6.73	0.22	YES
JB4	P10-B	1-PHASE	0.15	0.17	240	1	0.72	87%	122.00	2 x (12)	12 AWG	25	0.33%	1.40%	6.73	0.22	YES

Table 78. Voltage drop calculation for future 6722WF.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Gauge of grounding (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal
SERVICE PANEL	JB1	1-PHASE	0.23	0.24	240	1	0.99	97%	46.00	2 x (12)	12 AWG	25	0.12%	0.12%	6.73	0.22	YES
JB1	P1-A	1-PHASE	0.07	0.07	240	1	0.31	97%	19.00	2 x (12)	12 AWG	25	0.03%	0.16%	6.73	0.22	YES
JB1	P3-A	1-PHASE	0.16	0.16	240	1	0.68	97%	92.00	2 x (12)	12 AWG	25	0.17%	0.30%	6.73	0.22	YES
P3-A	P5-A	1-PHASE	0.09	0.09	240	1	0.37	97%	111.00	2 x (12)	12 AWG	25	0.16%	0.46%	6.73	0.22	YES
SERVICE PANEL	JB2	1-PHASE	0.14	0.15	240	1	0.62	97%	88.00	2 x (12)	12 AWG	25	0.15%	0.15%	6.73	0.22	YES
JB2	P2-B	1-PHASE	0.07	0.07	240	1	0.31	97%	10.00	2 x (12)	12 AWG	25	0.02%	0.17%	6.73	0.22	YES
JB2	P4-B	1-PHASE	0.07	0.07	240	1	0.31	97%	121.00	2 x (12)	12 AWG	25	0.10%	0.25%	6.73	0.22	YES
SERVICE PANEL	P7-A	1-PHASE	0.14	0.15	240	1	0.62	97%	181.00	2 x (12)	12 AWG	25	0.31%	0.31%	6.73	0.22	YES
P7-A	P9-A	1-PHASE	0.07	0.07	240	1	0.31	97%	112.00	2 x (12)	12 AWG	25	0.10%	0.40%	6.73	0.22	YES
SERVICE PANEL	JB3	1-PHASE	0.22	0.22	240	1	0.93	97%	129.00	2 x (12)	12 AWG	25	0.33%	0.33%	6.73	0.22	YES
JB3	P6-B	1-PHASE	0.07	0.07	240	1	0.31	97%	11.00	2 x (12)	12 AWG	25	0.02%	0.35%	6.73	0.22	YES
JB3	JB4	1-PHASE	0.14	0.15	240	1	0.62	97%	106.00	2 x (12)	12 AWG	25	0.18%	0.51%	6.73	0.22	YES
JB4	P8-B	1-PHASE	0.07	0.07	240	1	0.31	97%	11.00	2 x (12)	12 AWG	25	0.02%	0.53%	6.73	0.22	YES
JB4	P10-B	1-PHASE	0.07	0.07	240	1	0.31	97%	122.00	2 x (12)	12 AWG	25	0.16%	0.67%	6.73	0.22	YES

Table 79. Voltage drop calculation for current 5441UF.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							
													Voltage Drop		R	X	Voltage Drop Comply?
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Gauge of grounding (AWG o kcmil)	Conductor Ampacity	Nominal (%)	Accumulated (%)	ohm/km	ohm/km	Nominal
SERVICE PANEL	P1-A	1-PHASE	0.30	0.34	240	1	1.44	87%	63.00	2 x (12)	12 AWG	25	0.22%	0.22%	6.73	0.22	YES
P1-A	P3-A	1-PHASE	0.15	0.17	240	1	0.72	87%	58.00	2 x (12)	12 AWG	25	0.10%	0.33%	6.73	0.22	YES
P1-A	P5-A	1-PHASE	0.15	0.17	240	1	0.72	87%	66.00	2 x (12)	12 AWG	25	0.12%	0.34%	6.73	0.22	YES
SERVICE PANEL	P1	1-PHASE	0.45	0.52	240	1	2.16	87%	63.00	2 x (12)	12 AWG	25	0.34%	0.34%	6.73	0.22	YES
P1	P2-B	1-PHASE	0.15	0.17	240	1	0.72	87%	53.00	2 x (12)	12 AWG	25	0.19%	0.53%	6.73	0.22	YES
P1	P4-B	1-PHASE	0.15	0.17	240	1	0.72	87%	107.00	2 x (12)	12 AWG	25	0.29%	0.63%	6.73	0.22	YES
P1	P6-B	1-PHASE	0.15	0.17	240	1	0.72	87%	117.00	2 x (12)	12 AWG	25	0.32%	0.65%	6.73	0.22	YES
SERVICE PANEL	P7-A	1-PHASE	0.45	0.52	240	1	2.16	87%	175.00	2 x (12)	12 AWG	25	0.94%	0.94%	6.73	0.22	YES
P7-A	P9-A	1-PHASE	0.30	0.34	240	1	1.44	87%	66.00	2 x (12)	12 AWG	25	0.24%	1.17%	6.73	0.22	YES
P9-A	P11-A	1-PHASE	0.15	0.17	240	1	0.72	87%	68.00	2 x (12)	12 AWG	25	0.12%	1.29%	6.73	0.22	YES
SERVICE PANEL	P8-B	1-PHASE	0.45	0.52	240	1	2.16	87%	228.00	2 x (12)	12 AWG	25	1.22%	1.22%	6.73	0.22	YES
P8-B	P10-B	1-PHASE	0.30	0.34	240	1	1.44	87%	50.00	2 x (12)	12 AWG	25	0.18%	1.40%	6.73	0.22	YES
P10-B	P12-B	1-PHASE	0.15	0.17	240	1	0.72	87%	110.00	2 x (12)	12 AWG	25	0.33%	1.73%	6.73	0.22	YES
SERVICE PANEL	JB3	1-PHASE	0.75	0.86	240	1	3.59	87%	99.00	2 x (8)	12 AWG	50	0.35%	0.35%	2.56	0.21	YES

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Gauge of grounding (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal
JB3	P13-C	1-PHASE	0.15	0.17	240	1	0.72	87%	13.00	2 x (12)	12 AWG	25	0.05%	0.39%	6.73	0.22	YES
JB3	JB5	1-PHASE	0.60	0.69	240	1	2.87	87%	105.00	2 x (8)	12 AWG	50	0.29%	0.64%	2.56	0.21	YES
JB5	P15-C	1-PHASE	0.15	0.17	240	1	0.72	87%	11.00	2 x (12)	12 AWG	25	0.04%	0.68%	6.73	0.22	YES
JB5	P16	1-PHASE	0.45	0.52	240	1	2.16	87%	72.00	2 x (8)	12 AWG	50	0.15%	0.79%	2.56	0.21	YES
P16	P17-C	1-PHASE	0.45	0.52	240	1	2.16	87%	39.00	2 x (10)	12 AWG	35	0.13%	0.92%	4.23	0.21	YES
P17-C	P19-C	1-PHASE	0.15	0.17	240	1	0.72	87%	105.00	2 x (12)	12 AWG	25	0.19%	1.11%	6.73	0.22	YES
P17-C	P21-C	1-PHASE	0.30	0.34	240	1	1.44	87%	44.00	2 x (12)	12 AWG	25	0.16%	1.08%	6.73	0.22	YES
P21-C	P23-C	1-PHASE	0.15	0.17	240	1	0.72	87%	104.00	2 x (12)	12 AWG	25	0.27%	1.35%	6.73	0.22	YES
SERVICE PANEL	P14-D	1-PHASE	0.75	0.86	240	1	3.59	87%	151.00	2 x (8)	12 AWG	50	0.53%	0.53%	2.56	0.21	YES
P14-D	P16-D	1-PHASE	0.60	0.69	240	1	2.87	87%	126.00	2 x (8)	12 AWG	50	0.35%	0.88%	2.56	0.21	YES
P16-D	P17	1-PHASE	0.45	0.52	240	1	2.16	87%	39.00	2 x (10)	12 AWG	35	0.13%	1.01%	4.23	0.21	YES
P17	JB6	1-PHASE	0.30	0.34	240	1	1.44	87%	28.00	2 x (12)	12 AWG	25	0.10%	1.11%	6.73	0.22	YES
JB6	P18-D	1-PHASE	0.15	0.17	240	1	0.72	87%	9.00	2 x (12)	12 AWG	25	0.03%	1.14%	6.73	0.22	YES
JB6	P20-D	1-PHASE	0.15	0.17	240	1	0.72	87%	137.00	2 x (12)	12 AWG	25	0.35%	1.46%	6.73	0.22	YES
P17	P22-D	1-PHASE	0.15	0.17	240	1	0.72	87%	107.00	2 x (12)	12 AWG	25	0.19%	1.20%	6.73	0.22	YES

Table 80. Voltage drop calculation for future 5441UF.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Gauge of grounding (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal
SERVICE PANEL	P1-A	1-PHASE	0.14	0.15	240	1	0.62	97%	63.00	2 x (12)	12 AWG	25	0.11%	0.11%	6.73	0.22	YES
P1-A	P3-A	1-PHASE	0.07	0.07	240	1	0.31	97%	58.00	2 x (12)	12 AWG	25	0.05%	0.16%	6.73	0.22	YES
P1-A	P5-A	1-PHASE	0.07	0.07	240	1	0.31	97%	66.00	2 x (12)	12 AWG	25	0.06%	0.16%	6.73	0.22	YES
SERVICE PANEL	P1	1-PHASE	0.22	0.22	240	1	0.93	97%	63.00	2 x (12)	12 AWG	25	0.16%	0.16%	6.73	0.22	YES
P1	P2-B	1-PHASE	0.07	0.07	240	1	0.31	97%	53.00	2 x (12)	12 AWG	25	0.09%	0.25%	6.73	0.22	YES
P1	P4-B	1-PHASE	0.07	0.07	240	1	0.31	97%	107.00	2 x (12)	12 AWG	25	0.14%	0.30%	6.73	0.22	YES
P1	P6-B	1-PHASE	0.07	0.07	240	1	0.31	97%	117.00	2 x (12)	12 AWG	25	0.15%	0.31%	6.73	0.22	YES
SERVICE PANEL	P7-A	1-PHASE	0.22	0.22	240	1	0.93	97%	175.00	2 x (12)	12 AWG	25	0.45%	0.45%	6.73	0.22	YES
P7-A	P9-A	1-PHASE	0.14	0.15	240	1	0.62	97%	66.00	2 x (12)	12 AWG	25	0.11%	0.56%	6.73	0.22	YES
P9-A	P11-A	1-PHASE	0.07	0.07	240	1	0.31	97%	68.00	2 x (12)	12 AWG	25	0.06%	0.61%	6.73	0.22	YES
SERVICE PANEL	P8-B	1-PHASE	0.22	0.22	240	1	0.93	97%	228.00	2 x (12)	12 AWG	25	0.58%	0.58%	6.73	0.22	YES
P8-B	P10-B	1-PHASE	0.14	0.15	240	1	0.62	97%	50.00	2 x (12)	12 AWG	25	0.08%	0.67%	6.73	0.22	YES
P10-B	P12-B	1-PHASE	0.07	0.07	240	1	0.31	97%	110.00	2 x (12)	12 AWG	25	0.16%	0.82%	6.73	0.22	YES
SERVICE PANEL	JB3	1-PHASE	0.36	0.37	240	1	1.55	97%	99.00	2 x (8)	12 AWG	50	0.16%	0.16%	2.56	0.21	YES

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Gauge of grounding (AWG o kcmil)	Conductor Ampacity	Voltage Drop		R	X	Voltage Drop Comply?
													Nominal (%)	Accumulated (%)	ohm/km	ohm/km	Nominal
JB3	P13-C	1-PHASE	0.07	0.07	240	1	0.31	97%	13.00	2 x (12)	12 AWG	25	0.02%	0.18%	6.73	0.22	YES
JB3	JB5	1-PHASE	0.29	0.30	240	1	1.24	97%	105.00	2 x (8)	12 AWG	50	0.14%	0.30%	2.56	0.21	YES
JB5	P15-C	1-PHASE	0.07	0.07	240	1	0.31	97%	11.00	2 x (12)	12 AWG	25	0.02%	0.32%	6.73	0.22	YES
JB5	P16	1-PHASE	0.22	0.22	240	1	0.93	97%	72.00	2 x (8)	12 AWG	50	0.07%	0.37%	2.56	0.21	YES
P16	P17-C	1-PHASE	0.22	0.22	240	1	0.93	97%	39.00	2 x (10)	12 AWG	35	0.06%	0.43%	4.23	0.21	YES
P17-C	P19-C	1-PHASE	0.07	0.07	240	1	0.31	97%	105.00	2 x (12)	12 AWG	25	0.09%	0.52%	6.73	0.22	YES
P17-C	P21-C	1-PHASE	0.14	0.15	240	1	0.62	97%	44.00	2 x (12)	12 AWG	25	0.07%	0.51%	6.73	0.22	YES
P21-C	P23-C	1-PHASE	0.07	0.07	240	1	0.31	97%	104.00	2 x (12)	12 AWG	25	0.13%	0.64%	6.73	0.22	YES
SERVICE PANEL	P14-D	1-PHASE	0.36	0.37	240	1	1.55	97%	151.00	2 x (8)	12 AWG	50	0.25%	0.25%	2.56	0.21	YES
P14-D	P16-D	1-PHASE	0.29	0.30	240	1	1.24	97%	126.00	2 x (8)	12 AWG	50	0.16%	0.41%	2.56	0.21	YES
P16-D	P17	1-PHASE	0.22	0.22	240	1	0.93	97%	39.00	2 x (10)	12 AWG	35	0.06%	0.47%	4.23	0.21	YES
P17	JB6	1-PHASE	0.14	0.15	240	1	0.62	97%	28.00	2 x (12)	12 AWG	25	0.05%	0.52%	6.73	0.22	YES
JB6	P18-D	1-PHASE	0.07	0.07	240	1	0.31	97%	9.00	2 x (12)	12 AWG	25	0.02%	0.54%	6.73	0.22	YES
JB6	P20-D	1-PHASE	0.07	0.07	240	1	0.31	97%	137.00	2 x (12)	12 AWG	25	0.17%	0.69%	6.73	0.22	YES
P17	P22-D	1-PHASE	0.07	0.07	240	1	0.31	97%	107.00	2 x (12)	12 AWG	25	0.09%	0.56%	6.73	0.22	YES

12.5 Appendix E – Load calculations per load scenario

The following tables show the load calculation per service panel to identify the maximum capacity of the charging stations as well as the size of the overcurrent protection of the circuits that feed them.

12.5.1 Service panel U5848CFBLR

Table 81. Service panel U5848CFBLR Scenario 1-1.

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	4	LED	72	97%	0.30	240	1.24	15
Circuit 2	3	LED	72	97%	15.07	240	62.78	80
	2	EVSE	7200	97%				
Circuit 3	1	LED	72	97%	0.47	240	1.97	15
	3	LED	86	97%				
	1	LED	129	97%				
Circuit 4	3	LED	86	97%	0.53	240	2.22	15
	2	LED	129	97%				
Circuit 5	7	LED	86	97%	0.75	240	3.14	20
	1	LED	129	97%				
Circuit 6	7	LED	86	97%	0.62	240	2.59	20
Circuit 7	3	LED	72	97%	0.72	240	3.02	20
	1	LED	86	97%				
	2	LED	200	97%				
Circuit 8	3	LED	72	97%	0.64	240	2.65	20
	2	LED	200	97%				
Total Load Phase A					2.25	240	9.36	100
Total Load Phase B					16.86	240	70.23	100

Table 82. Service panel U5848CFBLR Scenario 1-2.

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	0	LED	72	97%	0.00	240	0.00	15
Circuit 2	0	LED	72	97%	14.85	240	61.86	80
	2	EVSE	7200	97%				
Circuit 3	0	LED	72	97%	0.00	240	0.00	15
	0	LED	86	97%				
	0	LED	129	97%				
Circuit 4	0	LED	86	97%	0.00	240	0.00	15

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
	0	LED	129	97%				
Circuit 5	0	LED	86	97%	0.00	240	0.00	20
	0	LED	129	97%				
Circuit 6	0	LED	86	97%	0.00	240	0.00	20
Circuit 7	0	LED	72	97%	0.00	240	0.00	20
	0	LED	86	97%				
	0	LED	200	97%				
Circuit 8	0	LED	72	97%	0.00	240	0.00	20
	0	LED	200	97%				
				Total Load Phase A	**0.00**	**240**	**0.00**	**100**
				Total Load Phase B	**14.85**	**240**	**61.86**	**100**

Table 83. Service panel U5848CFBLR Scenario 2-1.

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	4	LED	72	97%	17.00	240	70.82	90
	6	EVSE	2700	97%				
Circuit 2	3	LED	72	97%	16.92	240	70.52	90
	6	EVSE	2700	97%				
Circuit 3	1	LED	72	97%	0.47	240	1.97	15
	3	LED	86	97%				
	1	LED	129	97%				
Circuit 4	3	LED	86	97%	0.53	240	2.22	15
	2	LED	129	97%				
Circuit 5	7	LED	86	97%	0.75	240	3.14	20
	1	LED	129	97%				
Circuit 6	7	LED	86	97%	0.62	240	2.59	20
Circuit 7	3	LED	72	97%	0.72	240	3.02	20
	1	LED	86	97%				
	2	LED	200	97%				
Circuit 8	3	LED	72	97%	0.64	240	2.65	20
	2	LED	200	97%				
				Total Load Phase A	**18.95**	**240**	**78.95**	**100**
				Total Load Phase B	**18.71**	**240**	**77.96**	**100**

Table 84. Service panel U5848CFBLR Scenario 2-2.

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	0	LED	72	97%	19.18	240	79.90	100
	6	EVSE	3100	97%				
Circuit 2	0	LED	72	97%	19.18	240	79.90	100
	6	EVSE	3100	97%				
Circuit 3	0	LED	72	97%	0.00	240	0.00	15
	0	LED	86	97%				
	0	LED	129	97%				
Circuit 4	0	LED	86	97%	0.00	240	0.00	15
	0	LED	129	97%				
Circuit 5	0	LED	86	97%	0.00	240	0.00	20
	0	LED	129	97%				
Circuit 6	0	LED	86	97%	0.00	240	0.00	20
Circuit 7	0	LED	72	97%	0.00	240	0.00	20
	0	LED	86	97%				
	0	LED	200	97%				
Circuit 8	0	LED	72	97%	0.00	240	0.00	20
	0	LED	200	97%				
Total Load Phase A					19.18	240	79.90	100
Total Load Phase B					19.18	240	79.90	100

Table 85. Service panel U5848CFBLR Scenario 3.

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	4	LED	72	97%	0.30	240	1.24	15
Circuit 2	3	LED	72	97%	2.49	240	10.38	15
	1	EVSE	2200	97%				
Circuit 3	1	LED	72	97%	0.47	240	1.97	15
	3	LED	86	97%				
	1	LED	129	97%				
Circuit 4	3	LED	86	97%	0.53	240	2.22	15
	2	LED	129	97%				
Circuit 5	7	LED	86	97%	0.75	240	3.14	20
	1	LED	129	97%				
Circuit 6	7	LED	86	97%	0.62	240	2.59	20
Circuit 7	3	LED	72	97%	0.72	240	3.02	20
	1	LED	86	97%				

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
	2	LED	200	97%				
Circuit 8	3	LED	72	97%	0.64	240	2.65	20
	2	LED	200	97%				
				Total Load Phase A	2.25	240	9.36	100
				Total Load Phase B	4.28	240	17.83	100

12.5.2 Service panel U5743VFBLR

Table 86. Service panel U5743VFBLR Scenario 1-1.

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	7	LED	72	97%	0.52	240	2.16	15
	0	EVSE	7200	97%				
Circuit 2	6	LED	72	97%	15.29	240	63.71	80
	2	EVSE	7200	97%				
Circuit 3	11	LED	86	97%	0.98	240	4.06	30
Circuit 4	11	LED	86	97%	0.98	240	4.06	30
Circuit 5	9	LED	86	97%	0.80	240	3.32	30
Circuit 6	9	LED	86	97%	0.80	240	3.32	30
				Total Load Phase A	2.29	240	9.55	100
				Total Load Phase B	17.06	240	71.10	100

Table 87. Service panel U5743VFBLR Scenario 1-2.

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	0	LED	72	97%	0.00	240	0.00	15
	0	EVSE	7200	97%				
Circuit 2	0	LED	72	97%	14.85	240	61.86	80
	2	EVSE	7200	97%				
Circuit 3	0	LED	86	97%	0.00	240	0.00	30
Circuit 4	0	LED	86	97%	0.00	240	0.00	30
Circuit 5	0	LED	86	97%	0.00	240	0.00	30
Circuit 6	0	LED	86	97%	0.00	240	0.00	30
				Total Load Phase A	0.00	240	0.00	100
				Total Load Phase B	14.85	240	61.86	100

Table 88. Service panel U5743VFBLR Scenario 2-1.

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	7	LED	72	97%	17.43	240	72.61	100
	4	EVSE	4100	97%				
Circuit 2	6	LED	72	97%	17.35	240	72.30	100
	4	EVSE	4100	97%				
Circuit 3	11	LED	86	97%	0.98	240	4.06	30
Circuit 4	11	LED	86	97%	0.98	240	4.06	30
Circuit 5	9	LED	86	97%	0.80	240	3.32	30
Circuit 6	9	LED	86	97%	0.80	240	3.32	30
Total Load Phase A					19.20	240	80.00	100
Total Load Phase B					19.13	240	79.69	100

Table 89. Service panel U5743VFBLR Scenario 2-2.

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	0	LED	72	97%	18.97	240	79.04	100
	4	EVSE	4600	97%				
Circuit 2	0	LED	72	97%	18.97	240	79.04	100
	4	EVSE	4600	97%				
Circuit 3	0	LED	86	97%	0.00	240	0.00	30
Circuit 4	0	LED	86	97%	0.00	240	0.00	30
Circuit 5	0	LED	86	97%	0.00	240	0.00	30
Circuit 6	0	LED	86	97%	0.00	240	0.00	30
Total Load Phase A					18.97	240	79.04	100
Total Load Phase B					18.97	240	79.04	100

Table 90. Service panel U5743VFBLR Scenario 3.

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	7	LED	72	97%	5.06	240	21.07	30
	2	EVSE	2200	97%				
Circuit 2	6	LED	72	97%	2.61	240	10.88	15
	1	EVSE	2100	97%				
Circuit 3	11	LED	86	97%	0.98	240	4.06	30
Circuit 4	11	LED	86	97%	0.98	240	4.06	30
Circuit 5	9	LED	86	97%	0.80	240	3.32	30
Circuit 6	9	LED	86	97%	0.80	240	3.32	30

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
				Total Load Phase A	6.83	240	28.45	100
				Total Load Phase B	4.38	240	18.26	100

12.5.3 Service panel U6135TFBLR

Table 91. Service panel U6135TFBLR Scenario 1-1.

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	10	LED	72	97%	15.59	240	64.95	15
	2	EVSE	7200	97%				
Circuit 2	9	LED	72	97%	15.51	240	64.64	90
	2	EVSE	7200	97%				
Circuit 3	6	LED	129	97%	0.80	240	3.32	20
Circuit 4	6	LED	129	97%	0.80	240	3.32	20
Circuit 5	5	LED	129	97%	0.66	240	2.77	20
Circuit 6	5	LED	129	97%	0.66	240	2.77	20
Circuit 7	1	LED	86	97%	0.89	240	3.69	20
	6	LED	129	97%				
Circuit 8	1	LED	86	97%	0.75	240	3.14	20
	5	LED	129	97%				
Circuit 9	2	LED	86	97%	0.71	240	2.96	20
	4	LED	129	97%				
Circuit 10	2	LED	86	97%	0.71	240	2.96	20
	4	LED	129	97%				
				Total Load Phase A	18.65	240	77.69	100
				Total Load Phase B	18.44	240	76.83	100

Table 92. Service panel U6135TFBLR Scenario 1-2.

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	0	LED	72	97%	0.00	240	0.00	15
	0	EVSE	7200	97%				
Circuit 2	0	LED	72	97%	14.85	240	61.86	90
	2	EVSE	7200	97%				
Circuit 3	0	LED	129	97%	0.00	240	0.00	20
Circuit 4	0	LED	129	97%	0.00	240	0.00	20

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 5	0	LED	129	97%	0.00	240	0.00	20
Circuit 6	0	LED	129	97%	0.00	240	0.00	20
Circuit 7	0	LED	86	97%	0.00	240	0.00	20
	0	LED	129	97%				
Circuit 8	0	LED	86	97%	0.00	240	0.00	20
	0	LED	129	97%				
Circuit 9	0	LED	86	97%	0.00	240	0.00	20
	0	LED	129	97%				
Circuit 10	0	LED	86	97%	0.00	240	0.00	20
	0	LED	129	97%				
Total Load Phase A					**0.00**	**240**	**0.00**	**100**
Total Load Phase B					**14.85**	**240**	**61.86**	**100**

Table 93. Service panel U6135TFBLR Scenario 2-1.

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	10	LED	72	97%	16.00	240	66.67	90
	4	EVSE	3700	97%				
Circuit 2	9	LED	72	97%	15.93	240	66.36	90
	4	EVSE	3700	97%				
Circuit 3	6	LED	129	97%	0.80	240	3.32	20
Circuit 4	6	LED	129	97%	0.80	240	3.32	20
Circuit 5	5	LED	129	97%	0.66	240	2.77	20
Circuit 6	5	LED	129	97%	0.66	240	2.77	20
Circuit 7	1	LED	86	97%	0.89	240	3.69	20
	6	LED	129	97%				
Circuit 8	1	LED	86	97%	0.75	240	3.14	20
	5	LED	129	97%				
Circuit 9	2	LED	86	97%	0.71	240	2.96	20
	4	LED	129	97%				
Circuit 10	2	LED	86	97%	0.71	240	2.96	20
	4	LED	129	97%				
Total Load Phase A					19.06	240	79.41	100
Total Load Phase B					18.85	240	78.55	100

Table 94. Service panel U6135TFBLR Scenario 2-2.

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	0	LED	72	97%	17.73	240	73.88	100
	4	EVSE	4300	97%				
Circuit 2	0	LED	72	97%	17.73	240	73.88	100
	4	EVSE	4300	97%				
Circuit 3	0	LED	129	97%	0.00	240	0.00	20
Circuit 4	0	LED	129	97%	0.00	240	0.00	20
Circuit 5	0	LED	129	97%	0.00	240	0.00	20
Circuit 6	0	LED	129	97%	0.00	240	0.00	20
Circuit 7	0	LED	86	97%	0.00	240	0.00	20
	0	LED	129	97%				
Circuit 8	0	LED	86	97%	0.00	240	0.00	20
	0	LED	129	97%				
Circuit 9	0	LED	86	97%	0.00	240	0.00	20
	0	LED	129	97%				
Circuit 10	0	LED	86	97%	0.00	240	0.00	20
	0	LED	129	97%				
				Total Load Phase A	17.73	240	73.88	100
				Total Load Phase B	17.73	240	73.88	100

12.5.4 Service panel U2722VFLR

Table 95. Service panel U2722VFLR Scenario 1-1

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	1	LED	39	97%	15.89	240	66.22	90
	4	LED	72	97%				
	8	LED	86	97%				
	2	EVCE	7200	97%				
Circuit 2	0	LED	39	97%	1.01	240	4.19	15
	4	LED	72	97%				
	8	LED	86	97%				
	0	EVCE	3030	97%				
				Total Load Phase A	15.89	240	66.22	100
				Total Load Phase B	1.01	240	4.19	100

Table 96. Service panel U2722VFLR Scenario 1-2.

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	0	LED	39	97%	14.85	240	61.86	80
	0	LED	72	97%				
	0	LED	86	97%				
	2	EVCE	7200	97%				
Circuit 2	0	LED	39	97%	0.00	240	0.00	15
	0	LED	72	97%				
	0	LED	86	97%				
	0	EVCE	5020	97%				
Total Load Phase A					14.85	240	61.86	100
Total Load Phase B					0.00	240	0.00	100

Table 97. Service panel U2722VFLR Scenario 2-1.

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	1	LED	39	97%	18.78	240	78.24	100
	4	LED	72	97%				
	8	LED	86	97%				
	4	EVCE	4300	97%				
Circuit 2	0	LED	39	97%	18.74	240	78.08	100
	4	LED	72	97%				
	8	LED	86	97%				
	4	EVCE	4300	97%				
Total Load Phase A					18.78	240	78.24	100
Total Load Phase B					18.74	240	78.08	100

Table 98. Service panel U2722VFLR Scenario 2-2.

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	0	LED	39	97%	18.97	240	79.04	100
	0	LED	72	97%				

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
	0	LED	86	97%				
	4	EVCE	4600	97%				
Circuit 2	0	LED	39	97%	18.97	240	79.04	100
	0	LED	72	97%				
	0	LED	86	97%				
	4	EVCE	4600	97%				
Total Load Phase A					18.97	240	79.04	100
Total Load Phase B					18.97	240	79.04	100

Table 99. Service panel U2722VFLR Scenario 3.

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	1	LED	39	97%	5.74	240	23.90	30
	4	LED	72	97%				
	8	LED	86	97%				
	2	EVCE	2275	97%				
Circuit 2	0	LED	39	97%	5.70	240	23.74	30
	4	LED	72	97%				
	8	LED	86	97%				
	2	EVCE	2275	97%				
Total Load Phase A					5.74	240	23.90	100
Total Load Phase B					5.70	240	23.74	100

12.5.5 Service panel 6722WF

Table 100. Service panel 6722WF Scenario 1-1.

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	4	LED	72	97%	15.23	240	63.46	80
	1	LED	86	97%				
	2	EVSE	7200	97%				

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 2	5	LED	72	97%	0.37	240	1.55	15
	0	LED	86	97%				
	0	EVSE	4540	97%				
Circuit 3	5	LED	27	97%	0.41	240	1.69	35
	0	LED	72	97%				
	2	LED	129	97%				
Circuit 4	4	LED	27	97%	0.38	240	1.57	35
	0	LED	72	97%				
	2	LED	129	97%				
Circuit 5	8	LED	27	97%	1.05	240	4.38	35
	4	LED	72	97%				
	4	LED	129	97%				
Circuit 6	9	LED	27	97%	1.14	240	4.74	35
	3	LED	72	97%				
	5	LED	129	97%				
Total Load Phase A					16.69	240	69.53	100
Total Load Phase B					1.89	240	7.86	100

Table 101. Service panel 6722WF Scenario 1-2.

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	0	LED	72	97%	14.85	240	61.86	80
	0	LED	86	97%				
	2	EVSE	7200	97%				
Circuit 2	0	LED	72	97%	0.00	240	0.00	15
	0	LED	86	97%				
	0	EVSE	7200	97%				
Circuit 3	0	LED	27	97%	0.00	240	0.00	35
	0	LED	72	97%				
	0	LED	129	97%				
Circuit 4	0	LED	27	97%	0.00	240	0.00	35
	0	LED	72	97%				
	0	LED	129	97%				
Circuit 5	0	LED	27	97%	0.00	240	0.00	35
	0	LED	72	97%				

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
	0	LED	129	97%				
Circuit 6	0	LED	27	97%	0.00	240	0.00	35
	0	LED	72	97%				
	0	LED	129	97%				
Total Load Phase A					14.85	240	61.86	100
Total Load Phase B					0.00	240	0.00	100

Table 102. Service panel 6722WF Scenario 2-1.

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	4	LED	72	97%	17.09	240	71.19	90
	1	LED	86	97%				
	6	EVSE	2700	97%				
Circuit 2	5	LED	72	97%	17.07	240	71.13	90
	0	LED	86	97%				
	6	EVSE	2700	97%				
Circuit 3	5	LED	27	97%	0.41	240	1.69	35
	0	LED	72	97%				
	2	LED	129	97%				
Circuit 4	4	LED	27	97%	0.38	240	1.57	35
	0	LED	72	97%				
	2	LED	129	97%				
Circuit 5	8	LED	27	97%	1.05	240	4.38	35
	4	LED	72	97%				
	4	LED	129	97%				
Circuit 6	9	LED	27	97%	1.14	240	4.74	35
	3	LED	72	97%				
	5	LED	129	97%				
Total Load Phase A					18.54	240	77.26	100
Total Load Phase B					18.59	240	77.45	100

Table 103. Service panel 6722WF Scenario 2-2.

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	0	LED	72	97%	19.18	240	79.90	100
	0	LED	86	97%				
	6	EVSE	3100	97%				
Circuit 2	0	LED	72	97%	19.18	240	79.90	100
	0	LED	86	97%				
	6	EVSE	3100	97%				
Circuit 3	0	LED	27	97%	0.00	240	0.00	35
	0	LED	72	97%				
	0	LED	129	97%				
Circuit 4	0	LED	27	97%	0.00	240	0.00	35
	0	LED	72	97%				
	0	LED	129	97%				
Circuit 5	0	LED	27	97%	0.00	240	0.00	35
	0	LED	72	97%				
	0	LED	129	97%				
Circuit 6	0	LED	27	97%	0.00	240	0.00	35
	0	LED	72	97%				
	0	LED	129	97%				
Total Load Phase A					19.18	240	79.90	100
Total Load Phase B					19.18	240	79.90	100

Table 104. Service panel 6722WF Scenario 3.

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	4	LED	72	97%	2.29	240	9.55	15
	1	LED	86	97%				
	1	EVSE	1850	97%				
Circuit 2	5	LED	72	97%	0.37	240	1.55	15
	0	LED	86	97%				
	0	EVSE	4540	97%				
Circuit 3	5	LED	27	97%	0.41	240	1.69	35
	0	LED	72	97%				
	2	LED	129	97%				
Circuit 4	4	LED	27	97%	0.38	240	1.57	35

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
	0	LED	72	97%				
	2	LED	129	97%				
Circuit 5	8	LED	27	97%	1.05	240	4.38	35
	4	LED	72	97%				
	4	LED	129	97%				
Circuit 6	9	LED	27	97%	1.14	240	4.74	35
	3	LED	72	97%				
	5	LED	129	97%				
Total Load Phase A					3.75	240	15.62	100
Total Load Phase B					1.89	240	7.86	100

12.5.6 Service panel 5441UF

Table 105. Service panel 5441UF Scenario 1-1.

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	6	LED	72	97%	0.45	240	1.86	15
Circuit 2	6	LED	72	97%	0.45	240	1.86	15
Circuit 3	6	LED	72	97%	15.29	240	63.71	80
	2	EVSE	7200	97%				
Circuit 4	5	LED	72	97%	0.37	240	1.55	15
Total Load Phase A					15.74	240	65.57	100
Total Load Phase B					0.82	240	3.40	100

Table 106. Service panel 5441UF Scenario 1-2.

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	0	LED	72	97%	0.00	240	0.00	15
Circuit 2	0	LED	72	97%	0.00	240	0.00	15
Circuit 3	0	LED	72	97%	14.85	240	61.86	80
	2	EVSE	7200	97%				
Circuit 4	0	LED	72	97%	0.00	240	0.00	15
Total Load Phase A					14.85	240	61.86	100
Total Load Phase B					0.00	240	0.00	100

Table 107. Service panel 5441UF Scenario 2-1.

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	6	LED	72	97%	9.52	240	39.66	50
	2	EVSE	4400	97%				
Circuit 2	6	LED	72	97%	9.52	240	39.66	50
	2	EVSE	4400	97%				
Circuit 3	6	LED	72	97%	9.52	240	39.66	50
	2	EVSE	4400	97%				
Circuit 4	5	LED	72	97%	9.44	240	39.35	50
	2	EVSE	4400	97%				
Total Load Phase A					19.04	240	79.31	100
Total Load Phase B					18.96	240	79.00	100

Table 108. Service panel 5441UF Scenario 2-2.

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	0	LED	72	97%	9.48	240	39.52	50
	2	EVSE	4600	97%				
Circuit 2	0	LED	72	97%	9.48	240	39.52	50
	2	EVSE	4600	97%				
Circuit 3	0	LED	72	97%	9.48	240	39.52	50
	2	EVSE	4600	97%				
Circuit 4	0	LED	72	97%	9.48	240	39.52	50
	2	EVSE	4600	97%				
Total Load Phase A					18.97	240	79.04	100
Total Load Phase B					18.97	240	79.04	100

Table 109. Service panel 5441UF Scenario 3.

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
Circuit 1	6	LED	72	97%	0.45	240	1.86	15
Circuit 2	6	LED	72	97%	0.45	240	1.86	15
Circuit 3	6	LED	72	97%	2.82	240	11.74	15

	# Lamps	Type of Lamps	Power of Lamps (W)	Power Factor	Total Power (kVA)	Voltage (V)	Current (A)	Circuit Breaker (A)
	1	EVSE	2300	97%				
Circuit 4	5	LED	72	97%	0.37	240	1.55	15
				Total Load Phase A	**3.26**	**240**	**13.59**	**100**
				Total Load Phase B	**0.82**	**240**	**3.40**	**100**

12.6 Appendix F – Cable sizing calculations per load scenario

The following tables show the cable sizing calculations per service panel to identify if certain conductors have to be changed for larger ones to comply with the Canadian Electrical Code requirements. Unlike the previous calculations made in section 4.5 and 4.6.1, these calculations verified the following requirements:

- Maximum allowable ampacities according to table 2 of the Canadian Electrical Code.
- Maximum voltages drop of 3% for branch circuits.
- Maximum 40% of the cross-sectional area of a conduit can be occupied.

Finally, the cable sizing calculation also identified the type of conduit. If a cable did not complied with Canadian Electrical Code and has to be replaced, if it is installed in a Rigid Metal conduit, the conduit has to be replaced. On the other hand, if the cable segment is in Poly conduit it can be reused.

12.6.1 Service panel U5848CFBLR

Table 110. Service panel U5848CFBLR Scenario 1-1.

CIRCUIT ORIGIN	CIRCUIT DESTINATION	TYPE OF CIRCUIT	POWER kW	POWER kVA	VOLTAGE	CONDUCTORS PER PHASE	CURRENT Nominal (A)	POWER FACTOR Nominal (%)	DISTANCE (m)	CABLES Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	CONDUIT Number of Conduits	Size in	Occupation %	Occupation Comply?
SERVICE PANEL	JB1	1-PHASE	0.29	0.30	240	1	1.24	97%	72.00	2 x (12)	25	0.24%	0.24%	6.73	0.22	YES	1	x 1	7.76%	YES
JB1	P1-A	1-PHASE	0.07	0.07	240	1	0.31	97%	10.00	2 x (12)	25	0.02%	0.26%	6.73	0.22	YES	1	x 1	7.76%	YES
JB1	JB2	1-PHASE	0.22	0.22	240	1	0.93	97%	15.00	2 x (12)	25	0.04%	0.28%	6.73	0.22	YES	1	x 1	7.76%	YES
JB2	P3-A	1-PHASE	0.07	0.07	240	1	0.31	97%	37.00	2 x (12)	25	0.06%	0.35%	6.73	0.22	YES	1	x 1	7.76%	YES
JB2	JB3	1-PHASE	0.14	0.15	240	1	0.62	97%	74.00	2 x (12)	25	0.13%	0.41%	6.73	0.22	YES	1	x 1	7.76%	YES
JB3	P5-A	1-PHASE	0.07	0.07	240	1	0.31	97%	10.00	2 x (12)	25	0.02%	0.42%	6.73	0.22	YES	1	x 1	7.76%	YES
JB3	P7-A	1-PHASE	0.07	0.07	240	1	0.31	97%	109.00	2 x (12)	25	0.18%	0.59%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	P2-B	1-PHASE	14.62	15.07	240	1	62.78	97%	23.00	2 x (4)	85	1.29%	1.29%	1.05	0.20	YES	1	x 1	38.94%	YES
P2-B	P4-B	1-PHASE	0.14	0.15	240	1	0.62	97%	90.00	2 x (12)	25	0.15%	1.44%	6.73	0.22	YES	1	x 1	7.76%	YES
P4-B	P6-B	1-PHASE	0.07	0.07	240	1	0.31	97%	98.00	2 x (12)	25	0.08%	1.52%	6.73	0.22	YES	1	x 1	7.76%	YES

Table 111. Service panel U5848CFBLR Scenario 1-2.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT				
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	Number of Conduits	Size	in	Occupation %	Occupation Comply?
SERVICE PANEL	JB1	1-PHASE	0.00	0.00	240	1	0.00	97%	72.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x	1	7.76%	YES
JB1	P1-A	1-PHASE	0.00	0.00	240	1	0.00	97%	10.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x	1	7.76%	YES
JB1	JB2	1-PHASE	0.00	0.00	240	1	0.00	97%	15.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x	1	7.76%	YES
JB2	P3-A	1-PHASE	0.00	0.00	240	1	0.00	97%	37.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x	1	7.76%	YES
JB2	JB3	1-PHASE	0.00	0.00	240	1	0.00	97%	74.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x	1	7.76%	YES
JB3	P5-A	1-PHASE	0.00	0.00	240	1	0.00	97%	10.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x	1	7.76%	YES
JB3	P7-A	1-PHASE	0.00	0.00	240	1	0.00	97%	109.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x	1	7.76%	YES
SERVICE PANEL	P2-B	1-PHASE	14.40	14.85	240	1	61.86	97%	23.00	2 x (4)	85	1.27%	1.27%	1.05	0.20	YES	1	x	1	38.94%	YES
P2-B	P4-B	1-PHASE	0.00	0.00	240	1	0.00	97%	90.00	2 x (12)	25	0.00%	1.27%	6.73	0.22	YES	1	x	1	7.76%	YES
P4-B	P6-B	1-PHASE	0.00	0.00	240	1	0.00	97%	98.00	2 x (12)	25	0.00%	1.27%	6.73	0.22	YES	1	x	1	7.76%	YES

Table 112. Service panel U5848CFBLR Scenario 2-1.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT			
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	Number of Conduits	Size in	Occupation %	Occupation Comply?
SERVICE PANEL	JB1	1-PHASE	16.49	17.00	240	1	70.82	97%	72.00	2 x (1/0)	150	1.55%	1.55%	0.39	0.18	YES	1	x 1	85.32%	NO
JB1	P1-A	1-PHASE	5.47	5.64	240	1	23.51	97%	10.00	2 x (6)	65	0.33%	1.88%	1.67	0.21	YES	1	x 1	24.61%	YES
JB1	JB2	1-PHASE	11.02	11.36	240	1	47.32	97%	15.00	2 x (1/0)	150	0.21%	1.76%	0.39	0.18	YES	1	x 1	85.32%	NO
JB2	P3-A	1-PHASE	5.47	5.64	240	1	23.51	97%	37.00	2 x (6)	65	1.21%	2.97%	1.67	0.21	YES	1	x 1	24.61%	YES
JB2	JB3	1-PHASE	5.54	5.72	240	1	23.81	97%	74.00	2 x (2)	115	0.88%	2.64%	0.66	0.19	YES	1	x 1	53.98%	NO
JB3	P5-A	1-PHASE	5.47	5.64	240	1	23.51	97%	10.00	2 x (6)	65	0.33%	2.97%	1.67	0.21	YES	1	x 1	24.61%	YES
JB3	P7-A	1-PHASE	0.07	0.07	240	1	0.31	97%	109.00	2 x (12)	25	0.18%	2.83%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	P2-B	1-PHASE	16.42	16.92	240	1	70.52	97%	23.00	2 x (1/0)	150	0.51%	0.51%	0.39	0.18	YES	1	x 1	85.32%	NO
P2-B	P4-B	1-PHASE	10.94	11.28	240	1	47.01	97%	90.00	2 x (1/0)	150	1.34%	1.85%	0.39	0.18	YES	1	x 1	85.32%	NO
P4-B	P6-B	1-PHASE	5.47	5.64	240	1	23.51	97%	98.00	2 x (1/0)	150	0.73%	2.57%	0.39	0.18	YES	1	x 1	85.32%	NO

Table 113. Service panel U5848CFBLR Scenario 2-2.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT			
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	Number of Conduits	Size in	Occupation %	Occupation Comply?
SERVICE PANEL	JB1	1-PHASE	18.67	19.25	240	1	80.21	97%	72.00	2 x (2/0)	175	1.74%	1.74%	0.33	0.18	YES	1	x 1	101.92%	NO
JB1	P1-A	1-PHASE	6.27	6.47	240	1	26.94	97%	10.00	2 x (10)	35	0.93%	2.67%	4.23	0.21	YES	1	x 1	11.30%	YES
JB1	JB2	1-PHASE	12.40	12.78	240	1	53.26	97%	15.00	2 x (1/0)	150	0.28%	2.02%	0.39	0.18	YES	1	x 1	85.32%	NO
JB2	P3-A	1-PHASE	6.20	6.39	240	1	26.63	97%	37.00	2 x (4)	85	0.88%	2.90%	1.05	0.20	YES	1	x 1	38.94%	YES
JB2	JB3	1-PHASE	6.20	6.39	240	1	26.63	97%	74.00	2 x (1/0)	150	0.69%	2.72%	0.39	0.18	YES	1	x 1	85.32%	NO
JB3	P5-A	1-PHASE	6.20	6.39	240	1	26.63	97%	10.00	2 x (4)	85	0.24%	2.95%	1.05	0.20	YES	1	x 1	38.94%	YES
JB3	P7-A	1-PHASE	0.00	0.00	240	1	0.00	97%	109.00	2 x (12)	25	0.00%	2.72%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	P2-B	1-PHASE	18.60	19.18	240	1	79.90	97%	23.00	2 x (2/0)	175	0.55%	0.55%	0.33	0.18	YES	1	x 1	101.92%	NO
P2-B	P4-B	1-PHASE	12.40	12.78	240	1	53.26	97%	90.00	2 x (2/0)	175	1.45%	2.00%	0.33	0.18	YES	1	x 1	101.92%	NO
P4-B	P6-B	1-PHASE	6.20	6.39	240	1	26.63	97%	98.00	2 x (1/0)	150	0.92%	2.92%	0.39	0.18	YES	1	x 1	85.32%	NO

Table 114. Service panel U5848CFBLR Scenario 3.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT			
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	Number of Conduits	Size in	Occupation %	Occupation Comply?
SERVICE PANEL	JB1	1-PHASE	0.29	0.30	240	1	1.24	97%	72.00	2 x (12)	25	0.24%	0.24%	6.73	0.22	YES	1	x 1	7.76%	YES
JB1	P1-A	1-PHASE	0.07	0.07	240	1	0.31	97%	10.00	2 x (12)	25	0.02%	0.26%	6.73	0.22	YES	1	x 1	7.76%	YES
JB1	JB2	1-PHASE	0.22	0.22	240	1	0.93	97%	15.00	2 x (12)	25	0.04%	0.28%	6.73	0.22	YES	1	x 1	7.76%	YES
JB2	P3-A	1-PHASE	0.07	0.07	240	1	0.31	97%	37.00	2 x (12)	25	0.06%	0.35%	6.73	0.22	YES	1	x 1	7.76%	YES
JB2	JB3	1-PHASE	0.14	0.15	240	1	0.62	97%	74.00	2 x (12)	25	0.13%	0.41%	6.73	0.22	YES	1	x 1	7.76%	YES
JB3	P5-A	1-PHASE	0.07	0.07	240	1	0.31	97%	10.00	2 x (12)	25	0.02%	0.42%	6.73	0.22	YES	1	x 1	7.76%	YES
JB3	P7-A	1-PHASE	0.07	0.07	240	1	0.31	97%	109.00	2 x (12)	25	0.18%	0.59%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	P2-B	1-PHASE	4.62	4.76	240	1	19.83	97%	23.00	2 x (12)	25	2.44%	2.44%	6.73	0.22	YES	1	x 1	7.76%	YES
P2-B	P4-B	1-PHASE	0.14	0.15	240	1	0.62	97%	90.00	2 x (12)	25	0.15%	2.60%	6.73	0.22	YES	1	x 1	7.76%	YES
P4-B	P6-B	1-PHASE	0.07	0.07	240	1	0.31	97%	98.00	2 x (12)	25	0.08%	2.68%	6.73	0.22	YES	1	x 1	7.76%	YES

12.6.2 *Service panel U5743VFBLR*

Table 115. Service panel U5743VFBLR Scenario 1-1.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT			
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	Number of Conduits	Size in	Occupation %	Occupation Comply?
SERVICE PANEL	P1-A	1-PHASE	0.07	0.07	240	1	0.31	97%	10.00	2 x (12)	25	0.02%	0.02%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	JB1	1-PHASE	0.43	0.45	240	1	1.86	97%	76.00	2 x (12)	25	0.39%	0.39%	6.73	0.22	YES	1	x 1	7.76%	YES
JB1	P3-A	1-PHASE	0.07	0.07	240	1	0.31	97%	11.00	2 x (12)	25	0.02%	0.41%	6.73	0.22	YES	1	x 1	7.76%	YES
JB1	JB2	1-PHASE	0.36	0.37	240	1	1.55	97%	95.00	2 x (12)	25	0.40%	0.79%	6.73	0.22	YES	1	x 1	7.76%	YES
JB2	P5-A	1-PHASE	0.07	0.07	240	1	0.31	97%	11.00	2 x (12)	25	0.02%	0.81%	6.73	0.22	YES	1	x 1	7.76%	YES
JB2	P6-B	1-PHASE	0.29	0.30	240	1	1.24	97%	43.00	2 x (12)	25	0.15%	0.95%	6.73	0.22	YES	1	x 1	7.76%	YES
P6-B	P7-A	1-PHASE	0.22	0.22	240	1	0.93	97%	22.00	2 x (12)	25	0.06%	1.01%	6.73	0.22	YES	1	x 1	7.76%	YES
P7-A	P9-A	1-PHASE	0.14	0.15	240	1	0.62	97%	99.00	2 x (12)	25	0.17%	1.18%	6.73	0.22	YES	1	x 1	7.76%	YES
P9-A	P11-A	1-PHASE	0.07	0.07	240	1	0.31	97%	114.00	2 x (12)	25	0.15%	1.33%	6.73	0.22	YES	1	x 1	7.76%	YES
P6-B	P13-A	1-PHASE	0.07	0.07	240	1	0.31	97%	51.00	2 x (12)	25	0.04%	1.00%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	P2-B	1-PHASE	14.83	15.29	240	1	63.71	97%	38.00	2 x (4)	85	1.96%	1.96%	1.05	0.20	YES	1	x 1	38.94%	YES
P2-B	P4-B	1-PHASE	0.36	0.37	240	1	1.55	97%	89.00	2 x (12)	25	0.38%	2.34%	6.73	0.22	YES	1	x 1	7.76%	YES
P4-B	P6-B	1-PHASE	0.29	0.30	240	1	1.24	97%	97.00	2 x (12)	25	0.33%	2.67%	6.73	0.22	YES	1	x 1	7.76%	YES
P6-B	JB3	1-PHASE	0.14	0.15	240	1	0.62	97%	70.00	2 x (12)	25	0.12%	2.79%	6.73	0.22	YES	1	x 1	7.76%	YES
JB3	P8-B	1-PHASE	0.07	0.07	240	1	0.31	97%	9.00	2 x (12)	25	0.02%	2.80%	6.73	0.22	YES	1	x 1	7.76%	YES

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT			
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	Number of Conduits	Size in	Occupation %	Occupation Comply?
JB3	P10-B	1-PHASE	0.07	0.07	240	1	0.31	97%	113.00	2 x (12)	25	0.10%	2.89%	6.73	0.22	YES	1	x 1	7.76%	YES
P6-B	P12-B	1-PHASE	0.07	0.07	240	1	0.31	97%	77.00	2 x (12)	25	0.09%	2.76%	6.73	0.22	YES	1	x 1	7.76%	YES

Table 116. Service panel U5743VFBLR Scenario 1-2.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT			
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	Number of Conduits	Size in	Occupation %	Occupation Comply?
SERVICE PANEL	P1-A	1-PHASE	0.00	0.00	240	1	0.00	97%	10.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	JB1	1-PHASE	0.00	0.00	240	1	0.00	97%	76.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
JB1	P3-A	1-PHASE	0.00	0.00	240	1	0.00	97%	11.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
JB1	JB2	1-PHASE	0.00	0.00	240	1	0.00	97%	95.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
JB2	P5-A	1-PHASE	0.00	0.00	240	1	0.00	97%	11.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
JB2	P6-B	1-PHASE	0.00	0.00	240	1	0.00	97%	43.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
P6-B	P7-A	1-PHASE	0.00	0.00	240	1	0.00	97%	22.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
P7-A	P9-A	1-PHASE	0.00	0.00	240	1	0.00	97%	99.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
P9-A	P11-A	1-PHASE	0.00	0.00	240	1	0.00	97%	114.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT				
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	Number of Conduits	Size in		Occupation %	Occupation Comply?
P6-B	P13-A	1-PHASE	0.00	0.00	240	1	0.00	97%	51.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x	1	7.76%	YES
SERVICE PANEL	P2-B	1-PHASE	14.40	14.85	240	1	61.86	97%	38.00	2 x (4)	85	2.09%	2.09%	1.05	0.20	YES	1	x	1	38.94%	YES
P2-B	P4-B	1-PHASE	0.00	0.00	240	1	0.00	97%	89.00	2 x (12)	25	0.00%	2.09%	6.73	0.22	YES	1	x	1	7.76%	YES
P4-B	P6-B	1-PHASE	0.00	0.00	240	1	0.00	97%	97.00	2 x (12)	25	0.00%	2.09%	6.73	0.22	YES	1	x	1	7.76%	YES
P6-B	JB3	1-PHASE	0.00	0.00	240	1	0.00	97%	70.00	2 x (12)	25	0.00%	2.09%	6.73	0.22	YES	1	x	1	7.76%	YES
JB3	P8-B	1-PHASE	0.00	0.00	240	1	0.00	97%	9.00	2 x (12)	25	0.00%	2.09%	6.73	0.22	YES	1	x	1	7.76%	YES
JB3	P10-B	1-PHASE	0.00	0.00	240	1	0.00	97%	113.00	2 x (12)	25	0.00%	2.09%	6.73	0.22	YES	1	x	1	7.76%	YES
P6-B	P12-B	1-PHASE	0.00	0.00	240	1	0.00	97%	77.00	2 x (12)	25	0.00%	2.09%	6.73	0.22	YES	1	x	1	7.76%	YES

Table 117. Service panel U5743VFBLR Scenario 2-1.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT				
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	Number of Conduits	Size in		Occupation %	Occupation Comply?
SERVICE PANEL	P1-A	1-PHASE	8.27	8.53	240	1	35.53	97%	10.00	2 x (8)	50	0.75%	0.75%	2.56	0.21	YES	1	x	1	18.29%	YES
SERVICE PANEL	JB1	1-PHASE	8.63	8.90	240	1	37.08	97%	76.00	2 x (2)	115	1.23%	1.23%	0.66	0.19	YES	1	x	1	53.98%	NO
JB1	P3-A	1-PHASE	8.27	8.53	240	1	35.53	97%	11.00	2 x (8)	50	0.83%	2.05%	2.56	0.21	YES	1	x	1	18.29%	YES

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT			
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	Number of Conduits	Size in	Occupation %	Occupation Comply?
JB1	JB2	1-PHASE	0.36	0.37	240	1	1.55	97%	95.00	2 x (12)	25	0.40%	1.63%	6.73	0.22	YES	1	x 1	7.76%	YES
JB2	P5-A	1-PHASE	0.07	0.07	240	1	0.31	97%	11.00	2 x (12)	25	0.02%	1.65%	6.73	0.22	YES	1	x 1	7.76%	YES
JB2	P6-B	1-PHASE	0.29	0.30	240	1	1.24	97%	43.00	2 x (12)	25	0.15%	1.79%	6.73	0.22	YES	1	x 1	7.76%	YES
P6-B	P7-A	1-PHASE	0.22	0.22	240	1	0.93	97%	22.00	2 x (12)	25	0.06%	1.85%	6.73	0.22	YES	1	x 1	7.76%	YES
P7-A	P9-A	1-PHASE	0.14	0.15	240	1	0.62	97%	99.00	2 x (12)	25	0.17%	2.02%	6.73	0.22	YES	1	x 1	7.76%	YES
P9-A	P11-A	1-PHASE	0.07	0.07	240	1	0.31	97%	114.00	2 x (12)	25	0.15%	2.17%	6.73	0.22	YES	1	x 1	7.76%	YES
P6-B	P13-A	1-PHASE	0.07	0.07	240	1	0.31	97%	51.00	2 x (12)	25	0.04%	1.84%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	P2-B	1-PHASE	16.83	17.35	240	1	72.30	97%	38.00	2 x (1/0)	150	0.77%	0.77%	0.39	0.18	YES	1	x 1	85.32%	NO
P2-B	P4-B	1-PHASE	8.56	8.82	240	1	36.77	97%	89.00	2 x (2)	115	1.50%	2.27%	0.66	0.19	YES	1	x 1	53.98%	NO
P4-B	P6-B	1-PHASE	0.29	0.30	240	1	1.24	97%	97.00	2 x (12)	25	0.33%	2.60%	6.73	0.22	YES	1	x 1	7.76%	YES
P6-B	JB3	1-PHASE	0.14	0.15	240	1	0.62	97%	70.00	2 x (12)	25	0.12%	2.72%	6.73	0.22	YES	1	x 1	7.76%	YES
JB3	P8-B	1-PHASE	0.07	0.07	240	1	0.31	97%	9.00	2 x (12)	25	0.02%	2.73%	6.73	0.22	YES	1	x 1	7.76%	YES
JB3	P10-B	1-PHASE	0.07	0.07	240	1	0.31	97%	113.00	2 x (12)	25	0.10%	2.81%	6.73	0.22	YES	1	x 1	7.76%	YES
P6-B	P12-B	1-PHASE	0.07	0.07	240	1	0.31	97%	77.00	2 x (12)	25	0.09%	2.68%	6.73	0.22	YES	1	x 1	7.76%	YES

Table 118. Service panel U5743VFBLR Scenario 2-2.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT			
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	Number of Conduits	Size in	Occupation %	Occupation Comply?
SERVICE PANEL	P1-A	1-PHASE	9.20	9.48	240	1	39.52	97%	10.00	2 x (8)	50	0.83%	0.83%	2.56	0.21	YES	1	x 1	18.29%	YES
SERVICE PANEL	JB1	1-PHASE	9.20	9.48	240	1	39.52	97%	76.00	2 x (2)	115	1.72%	1.72%	0.66	0.19	YES	1	x 1	53.98%	NO
JB1	P3-A	1-PHASE	9.20	9.48	240	1	39.52	97%	11.00	2 x (8)	50	0.92%	2.64%	2.56	0.21	YES	1	x 1	18.29%	YES
JB1	JB2	1-PHASE	0.00	0.00	240	1	0.00	97%	95.00	2 x (12)	25	0.00%	1.72%	6.73	0.22	YES	1	x 1	7.76%	YES
JB2	P5-A	1-PHASE	0.00	0.00	240	1	0.00	97%	11.00	2 x (12)	25	0.00%	1.72%	6.73	0.22	YES	1	x 1	7.76%	YES
JB2	P6-B	1-PHASE	0.00	0.00	240	1	0.00	97%	43.00	2 x (12)	25	0.00%	1.72%	6.73	0.22	YES	1	x 1	7.76%	YES
P6-B	P7-A	1-PHASE	0.00	0.00	240	1	0.00	97%	22.00	2 x (12)	25	0.00%	1.72%	6.73	0.22	YES	1	x 1	7.76%	YES
P7-A	P9-A	1-PHASE	0.00	0.00	240	1	0.00	97%	99.00	2 x (12)	25	0.00%	1.72%	6.73	0.22	YES	1	x 1	7.76%	YES
P9-A	P11-A	1-PHASE	0.00	0.00	240	1	0.00	97%	114.00	2 x (12)	25	0.00%	1.72%	6.73	0.22	YES	1	x 1	7.76%	YES
P6-B	P13-A	1-PHASE	0.00	0.00	240	1	0.00	97%	51.00	2 x (12)	25	0.00%	1.72%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	P2-B	1-PHASE	18.40	18.97	240	1	79.04	97%	38.00	2 x (1/0)	150	1.06%	1.06%	0.39	0.18	YES	1	x 1	85.32%	NO
P2-B	P4-B	1-PHASE	9.20	9.48	240	1	39.52	97%	89.00	2 x (1/0)	150	1.24%	2.29%	0.39	0.18	YES	1	x 1	85.32%	NO
P4-B	P6-B	1-PHASE	0.00	0.00	240	1	0.00	97%	97.00	2 x (12)	25	0.00%	2.29%	6.73	0.22	YES	1	x 1	7.76%	YES
P6-B	JB3	1-PHASE	0.00	0.00	240	1	0.00	97%	70.00	2 x (12)	25	0.00%	2.29%	6.73	0.22	YES	1	x 1	7.76%	YES
JB3	P8-B	1-PHASE	0.00	0.00	240	1	0.00	97%	9.00	2 x (12)	25	0.00%	2.29%	6.73	0.22	YES	1	x 1	7.76%	YES
JB3	P10-B	1-PHASE	0.00	0.00	240	1	0.00	97%	113.00	2 x (12)	25	0.00%	2.29%	6.73	0.22	YES	1	x 1	7.76%	YES
P6-B	P12-B	1-PHASE	0.00	0.00	240	1	0.00	97%	77.00	2 x (12)	25	0.00%	2.29%	6.73	0.22	YES	1	x 1	7.76%	YES

Table 119. Service panel U5743VFBLR Scenario 3.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT				
ORIGIN	DESTINATION						Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop		R	X	Voltage Drop Comply?	Number of Conduits	Size		Occupation	Occupation Comply?
			kW	kVA								Nominal (%)	Accumulated (%)	ohm/km	ohm/km	Nominal		in		%	
SERVICE PANEL	P1-A	1-PHASE	4.47	4.61	240	1	19.21	97%	10.00	2 x (12)	25	1.05%	1.05%	6.73	0.22	YES	1	x	1	7.76%	YES
SERVICE PANEL	JB1	1-PHASE	0.43	0.45	240	1	1.86	97%	76.00	2 x (12)	25	0.39%	0.39%	6.73	0.22	YES	1	x	1	7.76%	YES
JB1	P3-A	1-PHASE	0.07	0.07	240	1	0.31	97%	11.00	2 x (12)	25	0.02%	0.41%	6.73	0.22	YES	1	x	1	7.76%	YES
JB1	JB2	1-PHASE	0.36	0.37	240	1	1.55	97%	95.00	2 x (12)	25	0.40%	0.79%	6.73	0.22	YES	1	x	1	7.76%	YES
JB2	P5-A	1-PHASE	0.07	0.07	240	1	0.31	97%	11.00	2 x (12)	25	0.02%	0.81%	6.73	0.22	YES	1	x	1	7.76%	YES
JB2	P6-B	1-PHASE	0.29	0.30	240	1	1.24	97%	43.00	2 x (12)	25	0.15%	0.95%	6.73	0.22	YES	1	x	1	7.76%	YES
P6-B	P7-A	1-PHASE	0.22	0.22	240	1	0.93	97%	22.00	2 x (12)	25	0.06%	1.01%	6.73	0.22	YES	1	x	1	7.76%	YES
P7-A	P9-A	1-PHASE	0.14	0.15	240	1	0.62	97%	99.00	2 x (12)	25	0.17%	1.18%	6.73	0.22	YES	1	x	1	7.76%	YES
P9-A	P11-A	1-PHASE	0.07	0.07	240	1	0.31	97%	114.00	2 x (12)	25	0.15%	1.33%	6.73	0.22	YES	1	x	1	7.76%	YES
P6-B	P13-A	1-PHASE	0.07	0.07	240	1	0.31	97%	51.00	2 x (12)	25	0.04%	1.00%	6.73	0.22	YES	1	x	1	7.76%	YES
SERVICE PANEL	P2-B	1-PHASE	2.53	2.61	240	1	10.88	97%	38.00	2 x (12)	25	2.07%	2.07%	6.73	0.22	YES	1	x	1	7.76%	YES
P2-B	P4-B	1-PHASE	0.36	0.37	240	1	1.55	97%	89.00	2 x (12)	25	0.38%	2.45%	6.73	0.22	YES	1	x	1	7.76%	YES
P4-B	P6-B	1-PHASE	0.29	0.30	240	1	1.24	97%	97.00	2 x (12)	25	0.33%	2.78%	6.73	0.22	YES	1	x	1	7.76%	YES
P6-B	JB3	1-PHASE	0.14	0.15	240	1	0.62	97%	70.00	2 x (12)	25	0.12%	2.90%	6.73	0.22	YES	1	x	1	7.76%	YES
JB3	P8-B	1-PHASE	0.07	0.07	240	1	0.31	97%	9.00	2 x (12)	25	0.02%	2.91%	6.73	0.22	YES	1	x	1	7.76%	YES
JB3	P10-B	1-PHASE	0.07	0.07	240	1	0.31	97%	113.00	2 x (12)	25	0.10%	2.99%	6.73	0.22	YES	1	x	1	7.76%	YES

CIRCUIT ORIGIN	CIRCUIT DESTINATION	TYPE OF CIRCUIT	POWER kW	POWER kVA	VOLTAGE	CONDUCTORS PER PHASE	CURRENT Nominal (A)	POWER FACTOR Nominal (%)	DISTANCE (m)	CABLES Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	CONDUIT Number of Conduits	Size in	Occupation %	Occupation Comply?
P6-B	P12-B	1-PHASE	0.07	0.07	240	1	0.31	97%	77.00	2 x (12)	25	0.09%	2.87%	6.73	0.22	YES	1	x 1	7.76%	YES

12.6.3 Service panel U6135TFBLR

Table 120. Service panel U6135TFBLR Scenario 1-1.

CIRCUIT ORIGIN	CIRCUIT DESTINATION	TYPE OF CIRCUIT	POWER kW	POWER kVA	VOLTAGE	CONDUCTORS PER PHASE	CURRENT Nominal (A)	POWER FACTOR Nominal (%)	DISTANCE (m)	CABLES Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	CONDUIT Number of Conduits	Size in	Occupation %	Occupation Comply?
SERVICE PANEL	JB1	1-PHASE	0.72	0.74	240	1	3.09	97%	76.00	2 x (12)	25	0.64%	0.64%	6.73	0.22	YES	1	x 1	7.76%	YES
JB1	P1-A	1-PHASE	0.43	0.45	240	1	1.86	97%	11.00	2 x (12)	25	0.06%	0.70%	6.73	0.22	YES	1	x 1	7.76%	YES
P1-A	JB3	1-PHASE	0.36	0.37	240	1	1.55	97%	76.00	2 x (12)	25	0.32%	1.02%	6.73	0.22	YES	1	x 1	7.76%	YES
JB3	P3-A	1-PHASE	0.07	0.07	240	1	0.31	97%	43.00	2 x (12)	25	0.07%	1.10%	6.73	0.22	YES	1	x 1	7.76%	YES
JB3	JB4	1-PHASE	0.29	0.30	240	1	1.24	97%	122.00	2 x (12)	25	0.41%	1.44%	6.73	0.22	YES	1	x 1	7.76%	YES
JB4	P5-A	1-PHASE	0.07	0.07	240	1	0.31	97%	12.00	2 x (12)	25	0.01%	1.45%	6.73	0.22	YES	1	x 1	7.76%	YES
JB4	JB5	1-PHASE	0.14	0.15	240	1	0.62	97%	53.00	2 x (12)	25	0.09%	1.53%	6.73	0.22	YES	1	x 1	7.76%	YES
JB5	P7-A	1-PHASE	0.07	0.07	240	1	0.31	97%	12.00	2 x (12)	25	0.02%	1.55%	6.73	0.22	YES	1	x 1	7.76%	YES
JB5	P9-A	1-PHASE	0.07	0.07	240	1	0.31	97%	96.00	2 x (12)	25	0.08%	1.61%	6.73	0.22	YES	1	x 1	7.76%	YES

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT			
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	Number of Conduits	Size in	Occupation %	Occupation Comply?
JB4	P11-A	1-PHASE	0.07	0.07	240	1	0.31	97%	112.00	2 x (12)	25	0.15%	1.59%	6.73	0.22	YES	1	x 1	7.76%	YES
JB1	JB7	1-PHASE	0.29	0.30	240	1	1.24	97%	46.00	2 x (12)	25	0.16%	0.80%	6.73	0.22	YES	1	x 1	7.76%	YES
JB7	P13-A	1-PHASE	0.07	0.07	240	1	0.31	97%	10.00	2 x (12)	25	0.01%	0.81%	6.73	0.22	YES	1	x 1	7.76%	YES
JB7	P15-A	1-PHASE	0.22	0.22	240	1	0.93	97%	56.00	2 x (12)	25	0.14%	0.94%	6.73	0.22	YES	1	x 1	7.76%	YES
P15-A	JB8	1-PHASE	0.14	0.15	240	1	0.62	97%	57.00	2 x (12)	25	0.10%	1.04%	6.73	0.22	YES	1	x 1	7.76%	YES
JB8	P17-A	1-PHASE	0.07	0.07	240	1	0.31	97%	11.00	2 x (12)	25	0.01%	1.05%	6.73	0.22	YES	1	x 1	7.76%	YES
JB8	P19-A	1-PHASE	0.07	0.07	240	1	0.31	97%	137.00	2 x (12)	25	0.18%	1.22%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	JB1	1-PHASE	15.05	15.51	240	1	64.64	97%	76.00	2 x (2/0)	175	0.90%	0.90%	0.33	0.18	YES	1	x 1	101.92%	NO
JB1	JB2	1-PHASE	14.83	15.29	240	1	63.71	97%	87.00	2 x (2/0)	175	1.23%	2.13%	0.33	0.18	YES	1	x 1	101.92%	NO
JB2	P2-B	1-PHASE	14.47	14.92	240	1	62.16	97%	10.00	2 x (4)	85	0.55%	2.69%	1.05	0.20	YES	1	x 1	38.94%	YES
JB2	P4-B	1-PHASE	0.36	0.37	240	1	1.55	97%	75.00	2 x (12)	25	0.32%	2.45%	6.73	0.22	YES	1	x 1	7.76%	YES
P4-B	JB4	1-PHASE	0.29	0.30	240	1	1.24	97%	59.00	2 x (12)	25	0.20%	2.65%	6.73	0.22	YES	1	x 1	7.76%	YES
JB4	P6-B	1-PHASE	0.07	0.07	240	1	0.31	97%	57.00	2 x (12)	25	0.09%	2.74%	6.73	0.22	YES	1	x 1	7.76%	YES
JB4	JB6	1-PHASE	0.14	0.15	240	1	0.62	97%	98.00	2 x (12)	25	0.17%	2.82%	6.73	0.22	YES	1	x 1	7.76%	YES
JB6	P8-B	1-PHASE	0.07	0.07	240	1	0.31	97%	10.00	2 x (12)	25	0.02%	2.83%	6.73	0.22	YES	1	x 1	7.76%	YES
JB6	P10-B	1-PHASE	0.07	0.07	240	1	0.31	97%	116.00	2 x (12)	25	0.15%	2.97%	6.73	0.22	YES	1	x 1	7.76%	YES
JB4	P12-B	1-PHASE	0.07	0.07	240	1	0.31	97%	112.00	2 x (12)	25	0.10%	2.75%	6.73	0.22	YES	1	x 1	7.76%	YES
JB1	JB7	1-PHASE	0.22	0.22	240	1	0.93	97%	46.00	2 x (12)	25	0.12%	1.02%	6.73	0.22	YES	1	x 1	7.76%	YES

CIRCUIT ORIGIN	CIRCUIT DESTINATION	TYPE OF CIRCUIT	POWER kW	POWER kVA	VOLTAGE	CONDUCTORS PER PHASE	CURRENT Nominal (A)	POWER FACTOR Nominal (%)	DISTANCE (m)	CABLES Gauge phases and / or neutral (AWG o kcmil)	CABLES Conductor Ampacity	CABLES Voltage Drop Nominal (%)	CABLES Voltage Drop Accumulated (%)	CABLES R ohm/km	CABLES X ohm/km	CABLES Voltage Drop Comply? Nominal	CONDUIT Number of Conduits	CONDUIT Size in	CONDUIT Occupation %	CONDUIT Occupation Comply?
JB7	P14-B	1-PHASE	0.07	0.07	240	1	0.31	97%	66.00	2 x (12)	25	0.06%	1.08%	6.73	0.22	YES	1	x 1	7.76%	YES
JB7	JB8	1-PHASE	0.14	0.15	240	1	0.62	97%	113.00	2 x (12)	25	0.19%	1.21%	6.73	0.22	YES	1	x 1	7.76%	YES
JB8	P16-B	1-PHASE	0.07	0.07	240	1	0.31	97%	55.00	2 x (12)	25	0.08%	1.30%	6.73	0.22	YES	1	x 1	7.76%	YES
JB8	P18-B	1-PHASE	0.07	0.07	240	1	0.31	97%	66.00	2 x (12)	25	0.06%	1.27%	6.73	0.22	YES	1	x 1	7.76%	YES

Table 121. Service panel U6135TFBLR Scenario 1-2.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT			
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	Number of Conduits	Size in	Occupation %	Occupation Comply?
SERVICE PANEL	JB1	1-PHASE	0.00	0.00	240	1	0.00	97%	76.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
JB1	P1-A	1-PHASE	0.00	0.00	240	1	0.00	97%	11.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
P1-A	JB3	1-PHASE	0.00	0.00	240	1	0.00	97%	76.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
JB3	P3-A	1-PHASE	0.00	0.00	240	1	0.00	97%	43.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
JB3	JB4	1-PHASE	0.00	0.00	240	1	0.00	97%	122.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
JB4	P5-A	1-PHASE	0.00	0.00	240	1	0.00	97%	12.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
JB4	JB5	1-PHASE	0.00	0.00	240	1	0.00	97%	53.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
JB5	P7-A	1-PHASE	0.00	0.00	240	1	0.00	97%	12.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
JB5	P9-A	1-PHASE	0.00	0.00	240	1	0.00	97%	96.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
JB4	P11-A	1-PHASE	0.00	0.00	240	1	0.00	97%	112.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
JB1	JB7	1-PHASE	0.00	0.00	240	1	0.00	97%	46.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
JB7	P13-A	1-PHASE	0.00	0.00	240	1	0.00	97%	10.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
JB7	P15-A	1-PHASE	0.00	0.00	240	1	0.00	97%	56.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
P15-A	JB8	1-PHASE	0.00	0.00	240	1	0.00	97%	57.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
JB8	P17-A	1-PHASE	0.00	0.00	240	1	0.00	97%	11.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
JB8	P19-A	1-PHASE	0.00	0.00	240	1	0.00	97%	137.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	JB1	1-PHASE	14.40	14.85	240	1	61.86	97%	76.00	2 x (3/0)	200	1.15%	1.15%	0.26	0.17	YES	1	x 1	122.45%	NO

CIRCUIT ORIGIN	CIRCUIT DESTINATION	TYPE OF CIRCUIT	POWER kW	POWER kVA	VOLTAGE	CONDUCTORS PER PHASE	CURRENT Nominal (A)	POWER FACTOR Nominal (%)	DISTANCE (m)	CABLES Gauge phases and / or neutral (AWG o kcmil)	CABLES Conductor Ampacity	CABLES Voltage Drop Nominal (%)	CABLES Voltage Drop Accumulated (%)	CABLES R ohm/km	CABLES X ohm/km	CABLES Voltage Drop Comply? Nominal	CONDUIT Number of Conduits	CONDUIT Size in	CONDUIT Occupation %	CONDUIT Occupation Comply?
JB1	JB2	1-PHASE	14.40	14.85	240	1	61.86	97%	87.00	2 x (3/0)	200	1.32%	2.48%	0.26	0.17	YES	1	x 1	122.45%	NO
JB2	P2-B	1-PHASE	14.40	14.85	240	1	61.86	97%	10.00	2 x (2)	115	0.35%	2.83%	0.66	0.19	YES	1	x 1	53.98%	NO
JB2	P4-B	1-PHASE	0.00	0.00	240	1	0.00	97%	75.00	2 x (12)	25	0.00%	2.48%	6.73	0.22	YES	1	x 1	7.76%	YES
P4-B	JB4	1-PHASE	0.00	0.00	240	1	0.00	97%	59.00	2 x (12)	25	0.00%	2.48%	6.73	0.22	YES	1	x 1	7.76%	YES
JB4	P6-B	1-PHASE	0.00	0.00	240	1	0.00	97%	57.00	2 x (12)	25	0.00%	2.48%	6.73	0.22	YES	1	x 1	7.76%	YES
JB4	JB6	1-PHASE	0.00	0.00	240	1	0.00	97%	98.00	2 x (12)	25	0.00%	2.48%	6.73	0.22	YES	1	x 1	7.76%	YES
JB6	P8-B	1-PHASE	0.00	0.00	240	1	0.00	97%	10.00	2 x (12)	25	0.00%	2.48%	6.73	0.22	YES	1	x 1	7.76%	YES
JB6	P10-B	1-PHASE	0.00	0.00	240	1	0.00	97%	116.00	2 x (12)	25	0.00%	2.48%	6.73	0.22	YES	1	x 1	7.76%	YES
JB4	P12-B	1-PHASE	0.00	0.00	240	1	0.00	97%	112.00	2 x (12)	25	0.00%	2.48%	6.73	0.22	YES	1	x 1	7.76%	YES
JB1	JB7	1-PHASE	0.00	0.00	240	1	0.00	97%	46.00	2 x (12)	25	0.00%	1.15%	6.73	0.22	YES	1	x 1	7.76%	YES
JB7	P14-B	1-PHASE	0.00	0.00	240	1	0.00	97%	66.00	2 x (12)	25	0.00%	1.15%	6.73	0.22	YES	1	x 1	7.76%	YES
JB7	JB8	1-PHASE	0.00	0.00	240	1	0.00	97%	113.00	2 x (12)	25	0.00%	1.15%	6.73	0.22	YES	1	x 1	7.76%	YES
JB8	P16-B	1-PHASE	0.00	0.00	240	1	0.00	97%	55.00	2 x (12)	25	0.00%	1.15%	6.73	0.22	YES	1	x 1	7.76%	YES
JB8	P18-B	1-PHASE	0.00	0.00	240	1	0.00	97%	66.00	2 x (12)	25	0.00%	1.15%	6.73	0.22	YES	1	x 1	7.76%	YES

Table 122. Service panel U6135TFBLR Scenario 2-1.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT			
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	Number of Conduits	Size in	Occupation %	Occupation Comply?
SERVICE PANEL	JB1	1-PHASE	15.52	16.00	240	1	66.67	97%	76.00	2 x (2/0)	175	0.88%	0.88%	0.33	0.18	YES	1	x 1	101.92%	NO
JB1	P1-A	1-PHASE	15.23	15.70	240	1	65.43	97%	11.00	2 x (2/0)	175	0.16%	1.05%	0.33	0.18	YES	1	x 1	101.92%	NO
P1-A	JB3	1-PHASE	11.46	11.81	240	1	49.23	97%	76.00	2 x (1/0)	150	0.99%	2.04%	0.39	0.18	YES	1	x 1	85.32%	NO
JB3	P3-A	1-PHASE	7.47	7.70	240	1	32.10	97%	43.00	2 x (2)	115	0.79%	2.83%	0.66	0.19	YES	1	x 1	53.98%	NO
JB3	JB4	1-PHASE	3.99	4.11	240	1	17.13	97%	122.00	2 x (2)	115	0.78%	2.82%	0.66	0.19	YES	1	x 1	53.98%	NO
JB4	P5-A	1-PHASE	3.77	3.89	240	1	16.20	97%	12.00	2 x (4)	85	0.16%	2.98%	1.05	0.20	YES	1	x 1	38.94%	YES
JB4	JB5	1-PHASE	0.14	0.15	240	1	0.62	97%	53.00	2 x (12)	25	0.09%	2.91%	6.73	0.22	YES	1	x 1	7.76%	YES
JB5	P7-A	1-PHASE	0.07	0.07	240	1	0.31	97%	12.00	2 x (12)	25	0.02%	2.93%	6.73	0.22	YES	1	x 1	7.76%	YES
JB5	P9-A	1-PHASE	0.07	0.07	240	1	0.31	97%	96.00	2 x (12)	25	0.08%	2.99%	6.73	0.22	YES	1	x 1	7.76%	YES
JB4	P11-A	1-PHASE	0.07	0.07	240	1	0.31	97%	112.00	2 x (12)	25	0.15%	2.97%	6.73	0.22	YES	1	x 1	7.76%	YES
JB1	JB7	1-PHASE	0.29	0.30	240	1	1.24	97%	46.00	2 x (12)	25	0.16%	1.04%	6.73	0.22	YES	1	x 1	7.76%	YES
JB7	P13-A	1-PHASE	0.07	0.07	240	1	0.31	97%	10.00	2 x (12)	25	0.01%	1.05%	6.73	0.22	YES	1	x 1	7.76%	YES
JB7	P15-A	1-PHASE	0.22	0.22	240	1	0.93	97%	56.00	2 x (12)	25	0.14%	1.18%	6.73	0.22	YES	1	x 1	7.76%	YES
P15-A	JB8	1-PHASE	0.14	0.15	240	1	0.62	97%	57.00	2 x (12)	25	0.10%	1.28%	6.73	0.22	YES	1	x 1	7.76%	YES
JB8	P17-A	1-PHASE	0.07	0.07	240	1	0.31	97%	11.00	2 x (12)	25	0.01%	1.29%	6.73	0.22	YES	1	x 1	7.76%	YES
JB8	P19-A	1-PHASE	0.07	0.07	240	1	0.31	97%	137.00	2 x (12)	25	0.18%	1.46%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	JB1	1-PHASE	15.45	15.93	240	1	66.36	97%	76.00	2 x (3/0)	200	0.66%	0.66%	0.26	0.17	YES	1	x 1	122.45%	NO

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT			
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	Number of Conduits	Size in	Occupation %	Occupation Comply?
JB1	JB2	1-PHASE	15.23	15.70	240	1	65.43	97%	87.00	2 x (2/0)	175	1.28%	1.93%	0.33	0.18	YES	1	x 1	101.92%	NO
JB2	P2-B	1-PHASE	7.47	7.70	240	1	32.10	97%	10.00	2 x (8)	50	0.68%	2.61%	2.56	0.21	YES	1	x 1	18.29%	YES
JB2	P4-B	1-PHASE	7.76	8.00	240	1	33.33	97%	75.00	2 x (2/0)	175	0.44%	2.37%	0.33	0.18	YES	1	x 1	101.92%	NO
P4-B	JB4	1-PHASE	0.29	0.30	240	1	1.24	97%	59.00	2 x (12)	25	0.20%	2.57%	6.73	0.22	YES	1	x 1	7.76%	YES
JB4	P6-B	1-PHASE	0.07	0.07	240	1	0.31	97%	57.00	2 x (12)	25	0.09%	2.66%	6.73	0.22	YES	1	x 1	7.76%	YES
JB4	JB6	1-PHASE	0.14	0.15	240	1	0.62	97%	98.00	2 x (12)	25	0.17%	2.74%	6.73	0.22	YES	1	x 1	7.76%	YES
JB6	P8-B	1-PHASE	0.07	0.07	240	1	0.31	97%	10.00	2 x (12)	25	0.02%	2.75%	6.73	0.22	YES	1	x 1	7.76%	YES
JB6	P10-B	1-PHASE	0.07	0.07	240	1	0.31	97%	116.00	2 x (12)	25	0.15%	2.89%	6.73	0.22	YES	1	x 1	7.76%	YES
JB4	P12-B	1-PHASE	0.07	0.07	240	1	0.31	97%	112.00	2 x (12)	25	0.10%	2.67%	6.73	0.22	YES	1	x 1	7.76%	YES
JB1	JB7	1-PHASE	0.22	0.22	240	1	0.93	97%	46.00	2 x (12)	25	0.12%	0.78%	6.73	0.22	YES	1	x 1	7.76%	YES
JB7	P14-B	1-PHASE	0.07	0.07	240	1	0.31	97%	66.00	2 x (12)	25	0.06%	0.83%	6.73	0.22	YES	1	x 1	7.76%	YES
JB7	JB8	1-PHASE	0.14	0.15	240	1	0.62	97%	113.00	2 x (12)	25	0.19%	0.97%	6.73	0.22	YES	1	x 1	7.76%	YES
JB8	P16-B	1-PHASE	0.07	0.07	240	1	0.31	97%	55.00	2 x (12)	25	0.08%	1.05%	6.73	0.22	YES	1	x 1	7.76%	YES
JB8	P18-B	1-PHASE	0.07	0.07	240	1	0.31	97%	66.00	2 x (12)	25	0.06%	1.02%	6.73	0.22	YES	1	x 1	7.76%	YES

Table 123. Service panel U6135TFBLR Scenario 2-2.

CIRCUIT ORIGIN	CIRCUIT DESTINATION	TYPE OF CIRCUIT	POWER kW	POWER kVA	VOLTAGE	CONDUCTORS PER PHASE	CURRENT Nominal (A)	POWER FACTOR Nominal (%)	DISTANCE (m)	CABLES Gauge phases and / or neutral (AWG o kcmil)	CABLES Conductor Ampacity	CABLES Voltage Drop Nominal (%)	CABLES Voltage Drop Accumulated (%)	CABLES R ohm/km	CABLES X ohm/km	CABLES Voltage Drop Comply? Nominal	CONDUIT Number of Conduits	CONDUIT Size in	CONDUIT Occupation %	CONDUIT Occupation Comply?
SERVICE PANEL	JB1	1-PHASE	17.20	17.73	240	1	73.88	97%	76.00	2 x (4/0)	230	1.12%	1.12%	0.21	0.17	YES	1	x 1	147.73%	NO
JB1	P1-A	1-PHASE	17.20	17.73	240	1	73.88	97%	11.00	2 x (4/0)	230	0.16%	1.28%	0.21	0.17	YES	1	x 1	147.73%	NO
P1-A	JB3	1-PHASE	12.90	13.30	240	1	55.41	97%	76.00	2 x (4/0)	230	0.84%	2.12%	0.21	0.17	YES	1	x 1	147.73%	NO
JB3	P3-A	1-PHASE	8.60	8.87	240	1	36.94	97%	43.00	2 x (3/0)	200	0.39%	2.51%	0.26	0.17	YES	1	x 1	122.45%	NO
JB3	JB4	1-PHASE	4.30	4.43	240	1	18.47	97%	122.00	2 x (3/0)	200	0.55%	2.68%	0.26	0.17	YES	1	x 1	122.45%	NO
JB4	P5-A	1-PHASE	4.30	4.43	240	1	18.47	97%	12.00	2 x (4)	85	0.20%	2.87%	1.05	0.20	YES	1	x 1	38.94%	YES
JB4	JB5	1-PHASE	0.00	0.00	240	1	0.00	97%	53.00	2 x (12)	25	0.00%	2.68%	6.73	0.22	YES	1	x 1	7.76%	YES
JB5	P7-A	1-PHASE	0.00	0.00	240	1	0.00	97%	12.00	2 x (12)	25	0.00%	2.68%	6.73	0.22	YES	1	x 1	7.76%	YES
JB5	P9-A	1-PHASE	0.00	0.00	240	1	0.00	97%	96.00	2 x (12)	25	0.00%	2.68%	6.73	0.22	YES	1	x 1	7.76%	YES
JB4	P11-A	1-PHASE	0.00	0.00	240	1	0.00	97%	112.00	2 x (12)	25	0.00%	2.68%	6.73	0.22	YES	1	x 1	7.76%	YES
JB1	JB7	1-PHASE	0.00	0.00	240	1	0.00	97%	46.00	2 x (12)	25	0.00%	1.12%	6.73	0.22	YES	1	x 1	7.76%	YES
JB7	P13-A	1-PHASE	0.00	0.00	240	1	0.00	97%	10.00	2 x (12)	25	0.00%	1.12%	6.73	0.22	YES	1	x 1	7.76%	YES
JB7	P15-A	1-PHASE	0.00	0.00	240	1	0.00	97%	56.00	2 x (12)	25	0.00%	1.12%	6.73	0.22	YES	1	x 1	7.76%	YES
P15-A	JB8	1-PHASE	0.00	0.00	240	1	0.00	97%	57.00	2 x (12)	25	0.00%	1.12%	6.73	0.22	YES	1	x 1	7.76%	YES
JB8	P17-A	1-PHASE	0.00	0.00	240	1	0.00	97%	11.00	2 x (12)	25	0.00%	1.12%	6.73	0.22	YES	1	x 1	7.76%	YES
JB8	P19-A	1-PHASE	0.00	0.00	240	1	0.00	97%	137.00	2 x (12)	25	0.00%	1.12%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	JB1	1-PHASE	17.20	17.73	240	1	73.88	97%	76.00	2 x (4/0)	230	1.12%	1.12%	0.21	0.17	YES	1	x 1	147.73%	NO

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT			
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	Number of Conduits	Size in	Occupation %	Occupation Comply?
JB1	JB2	1-PHASE	17.20	17.73	240	1	73.88	97%	87.00	2 x (4/0)	230	1.28%	2.40%	0.21	0.17	YES	1	x 1	147.73%	NO
JB2	P2-B	1-PHASE	8.60	8.87	240	1	36.94	97%	10.00	2 x (4)	85	0.33%	2.73%	1.05	0.20	YES	1	x 1	38.94%	YES
JB2	P4-B	1-PHASE	8.60	8.87	240	1	36.94	97%	75.00	2 x (4/0)	230	0.55%	2.96%	0.21	0.17	YES	1	x 1	147.73%	NO
P4-B	JB4	1-PHASE	0.00	0.00	240	1	0.00	97%	59.00	2 x (12)	25	0.00%	2.96%	6.73	0.22	YES	1	x 1	7.76%	YES
JB4	P6-B	1-PHASE	0.00	0.00	240	1	0.00	97%	57.00	2 x (12)	25	0.00%	2.96%	6.73	0.22	YES	1	x 1	7.76%	YES
JB4	JB6	1-PHASE	0.00	0.00	240	1	0.00	97%	98.00	2 x (12)	25	0.00%	2.96%	6.73	0.22	YES	1	x 1	7.76%	YES
JB6	P8-B	1-PHASE	0.00	0.00	240	1	0.00	97%	10.00	2 x (12)	25	0.00%	2.96%	6.73	0.22	YES	1	x 1	7.76%	YES
JB6	P10-B	1-PHASE	0.00	0.00	240	1	0.00	97%	116.00	2 x (12)	25	0.00%	2.96%	6.73	0.22	YES	1	x 1	7.76%	YES
JB4	P12-B	1-PHASE	0.00	0.00	240	1	0.00	97%	112.00	2 x (12)	25	0.00%	2.96%	6.73	0.22	YES	1	x 1	7.76%	YES
JB1	JB7	1-PHASE	0.00	0.00	240	1	0.00	97%	46.00	2 x (12)	25	0.00%	1.12%	6.73	0.22	YES	1	x 1	7.76%	YES
JB7	P14-B	1-PHASE	0.00	0.00	240	1	0.00	97%	66.00	2 x (12)	25	0.00%	1.12%	6.73	0.22	YES	1	x 1	7.76%	YES
JB7	JB8	1-PHASE	0.00	0.00	240	1	0.00	97%	113.00	2 x (12)	25	0.00%	1.12%	6.73	0.22	YES	1	x 1	7.76%	YES
JB8	P16-B	1-PHASE	0.00	0.00	240	1	0.00	97%	55.00	2 x (12)	25	0.00%	1.12%	6.73	0.22	YES	1	x 1	7.76%	YES
JB8	P18-B	1-PHASE	0.00	0.00	240	1	0.00	97%	66.00	2 x (12)	25	0.00%	1.12%	6.73	0.22	YES	1	x 1	7.76%	YES

12.6.4 Service panel U2722VFLR

Table 124. Service panel U2722VFLR Scenario 1-1

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT			
ORIGIN	DESTINATION						Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop		R	X	Voltage Drop Comply?	Number of Conduits	Size	Occupation	Occupation Comply?
			kW	kVA								Nominal (%)	Accumulated (%)	ohm/km	ohm/km	Nominal		in	%	
SERVICE PANEL	JB1	1-PHASE	14.69	15.14	240	1	63.09	97%	26.00	2 x (4)	85	1.41%	1.41%	1.05	0.20	YES	1	x 1	38.94%	YES
JB1	P1-A	1-PHASE	14.47	14.92	240	1	62.16	97%	6.00	2 x (4)	85	0.33%	1.74%	1.05	0.20	YES	1	x 1	38.94%	YES
JB1	P3-A	1-PHASE	0.22	0.22	240	1	0.93	97%	91.00	2 x (10)	35	0.15%	1.55%	4.23	0.21	YES	1	x 1	11.30%	YES
P3-A	P5-A	1-PHASE	0.07	0.07	240	1	0.31	97%	56.00	2 x (12)	25	0.10%	1.65%	6.73	0.22	YES	1	x 1	7.76%	YES
P3-A	P7-A	1-PHASE	0.07	0.07	240	1	0.31	97%	90.00	2 x (10)	35	0.07%	1.62%	4.23	0.21	YES	1	x 1	11.30%	YES
SERVICE PANEL	JB2	1-PHASE	0.22	0.22	240	1	0.93	97%	67.00	2 x (10)	35	0.11%	0.11%	4.23	0.21	YES	1	x 1	11.30%	YES
JB2	P2-B	1-PHASE	0.07	0.07	240	1	0.31	97%	9.00	2 x (10)	35	0.01%	0.12%	4.23	0.21	YES	1	x 1	11.30%	YES
JB2	JB3	1-PHASE	0.14	0.15	240	1	0.62	97%	57.00	2 x (10)	35	0.06%	0.17%	4.23	0.21	YES	1	x 1	11.30%	YES
JB3	P4-B	1-PHASE	0.07	0.07	240	1	0.31	97%	17.00	2 x (10)	35	0.02%	0.19%	4.23	0.21	YES	1	x 1	11.30%	YES
JB3	P6-B	1-PHASE	0.07	0.07	240	1	0.31	97%	63.00	2 x (10)	35	0.03%	0.20%	4.23	0.21	YES	1	x 1	11.30%	YES

Table 125. Service panel U2722VFLR Scenario 1-2.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT			
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	Number of Conduits	Size in	Occupation %	Occupation Comply?
SERVICE PANEL	JB1	1-PHASE	14.40	14.85	240	1	61.86	97%	26.00	2 x (4)	85	1.43%	1.43%	1.05	0.20	YES	1	x 1	38.94%	YES
JB1	P1-A	1-PHASE	14.40	14.85	240	1	61.86	97%	6.00	2 x (4)	85	0.33%	1.76%	1.05	0.20	YES	1	x 1	38.94%	YES
JB1	P3-A	1-PHASE	0.00	0.00	240	1	0.00	97%	91.00	2 x (10)	35	0.00%	1.43%	4.23	0.21	YES	1	x 1	11.30%	YES
P3-A	P5-A	1-PHASE	0.00	0.00	240	1	0.00	97%	56.00	2 x (12)	25	0.00%	1.43%	6.73	0.22	YES	1	x 1	7.76%	YES
P3-A	P7-A	1-PHASE	0.00	0.00	240	1	0.00	97%	90.00	2 x (10)	35	0.00%	1.43%	4.23	0.21	YES	1	x 1	11.30%	YES
SERVICE PANEL	JB2	1-PHASE	0.00	0.00	240	1	0.00	97%	67.00	2 x (10)	35	0.00%	0.00%	4.23	0.21	YES	1	x 1	11.30%	YES
JB2	P2-B	1-PHASE	0.00	0.00	240	1	0.00	97%	9.00	2 x (10)	35	0.00%	0.00%	4.23	0.21	YES	1	x 1	11.30%	YES
JB2	JB3	1-PHASE	0.00	0.00	240	1	0.00	97%	57.00	2 x (10)	35	0.00%	0.00%	4.23	0.21	YES	1	x 1	11.30%	YES
JB3	P4-B	1-PHASE	0.00	0.00	240	1	0.00	97%	17.00	2 x (10)	35	0.00%	0.00%	4.23	0.21	YES	1	x 1	11.30%	YES
JB3	P6-B	1-PHASE	0.00	0.00	240	1	0.00	97%	63.00	2 x (10)	35	0.00%	0.00%	4.23	0.21	YES	1	x 1	11.30%	YES

Table 126. Service panel U2722VFLR Scenario 2-1.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT			
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	Number of Conduits	Size in	Occupation %	Occupation Comply?
SERVICE PANEL	JB1	1-PHASE	17.49	18.03	240	1	75.12	97%	26.00	2 x (2)	115	1.06%	1.06%	0.66	0.19	YES	1	x 1	53.98%	NO
JB1	P1-A	1-PHASE	8.67	8.94	240	1	37.25	97%	6.00	2 x (8)	50	0.47%	1.53%	2.56	0.21	YES	1	x 1	18.29%	YES
JB1	P3-A	1-PHASE	8.82	9.09	240	1	37.87	97%	91.00	2 x (2)	115	1.83%	2.89%	0.66	0.19	YES	1	x 1	53.98%	NO
P3-A	P5-A	1-PHASE	0.07	0.07	240	1	0.31	97%	56.00	2 x (12)	25	0.10%	2.98%	6.73	0.22	YES	1	x 1	7.76%	YES
P3-A	P7-A	1-PHASE	0.07	0.07	240	1	0.31	97%	90.00	2 x (10)	35	0.07%	2.96%	4.23	0.21	YES	1	x 1	11.30%	YES
SERVICE PANEL	JB2	1-PHASE	17.42	17.95	240	1	74.81	97%	67.00	2 x (1/0)	150	1.66%	1.66%	0.39	0.18	YES	1	x 1	85.32%	NO
JB2	P2-B	1-PHASE	8.67	8.94	240	1	37.25	97%	9.00	2 x (8)	50	0.71%	2.36%	2.56	0.21	YES	1	x 1	18.29%	YES
JB2	JB3	1-PHASE	8.74	9.01	240	1	37.56	97%	57.00	2 x (1/0)	150	0.69%	2.35%	0.39	0.18	YES	1	x 1	85.32%	NO
JB3	P4-B	1-PHASE	8.67	8.94	240	1	37.25	97%	17.00	2 x (4)	85	0.56%	2.91%	1.05	0.20	YES	1	x 1	38.94%	YES
JB3	P6-B	1-PHASE	0.07	0.07	240	1	0.31	97%	63.00	2 x (10)	35	0.03%	2.38%	4.23	0.21	YES	1	x 1	11.30%	YES

Table 127. Service panel U2722VFLR Scenario 2-2.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT				
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	Number of Conduits	Size	in	Occupation %	Occupation Comply?
SERVICE PANEL	JB1	1-PHASE	18.40	18.97	240	1	79.04	97%	26.00	2 x (1/0)	150	0.72%	0.72%	0.39	0.18	YES	1	x	1	85.32%	NO
JB1	P1-A	1-PHASE	9.20	9.48	240	1	39.52	97%	6.00	2 x (8)	50	0.50%	1.22%	2.56	0.21	YES	1	x	1	18.29%	YES
JB1	P3-A	1-PHASE	9.20	9.48	240	1	39.52	97%	91.00	2 x (2)	115	2.06%	2.78%	0.66	0.19	YES	1	x	1	53.98%	NO
P3-A	P5-A	1-PHASE	0.00	0.00	240	1	0.00	97%	56.00	2 x (12)	25	0.00%	2.78%	6.73	0.22	YES	1	x	1	7.76%	YES
P3-A	P7-A	1-PHASE	0.00	0.00	240	1	0.00	97%	90.00	2 x (10)	35	0.00%	2.78%	4.23	0.21	YES	1	x	1	11.30%	YES
SERVICE PANEL	JB2	1-PHASE	18.40	18.97	240	1	79.04	97%	67.00	2 x (1/0)	150	1.86%	1.86%	0.39	0.18	YES	1	x	1	85.32%	NO
JB2	P2-B	1-PHASE	9.20	9.48	240	1	39.52	97%	9.00	2 x (8)	50	0.75%	2.61%	2.56	0.21	YES	1	x	1	18.29%	YES
JB2	JB3	1-PHASE	9.20	9.48	240	1	39.52	97%	57.00	2 x (1/0)	150	0.79%	2.65%	0.39	0.18	YES	1	x	1	85.32%	NO
JB3	P4-B	1-PHASE	9.20	9.48	240	1	39.52	97%	17.00	2 x (1/0)	150	0.24%	2.89%	0.39	0.18	YES	1	x	1	85.32%	NO
JB3	P6-B	1-PHASE	0.00	0.00	240	1	0.00	97%	63.00	2 x (10)	35	0.00%	2.65%	4.23	0.21	YES	1	x	1	11.30%	YES

Table 128. Service panel U2722VFLR Scenario 3.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT			
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	Number of Conduits	Size in	Occupation %	Occupation Comply?
SERVICE PANEL	JB1	1-PHASE	4.84	4.99	240	1	20.78	97%	26.00	2 x (10)	35	1.81%	1.81%	4.23	0.21	YES	1	x 1	11.30%	YES
JB1	P1-A	1-PHASE	4.62	4.76	240	1	19.85	97%	6.00	2 x (10)	35	0.41%	2.22%	4.23	0.21	YES	1	x 1	11.30%	YES
JB1	P3-A	1-PHASE	0.22	0.22	240	1	0.93	97%	91.00	2 x (10)	35	0.15%	1.96%	4.23	0.21	YES	1	x 1	11.30%	YES
P3-A	P5-A	1-PHASE	0.07	0.07	240	1	0.31	97%	56.00	2 x (12)	25	0.10%	2.05%	6.73	0.22	YES	1	x 1	7.76%	YES
P3-A	P7-A	1-PHASE	0.07	0.07	240	1	0.31	97%	90.00	2 x (10)	35	0.07%	2.03%	4.23	0.21	YES	1	x 1	11.30%	YES
SERVICE PANEL	JB2	1-PHASE	4.77	4.91	240	1	20.47	97%	67.00	2 x (10)	35	2.37%	2.37%	4.23	0.21	YES	1	x 1	11.30%	YES
JB2	P2-B	1-PHASE	4.62	4.76	240	1	19.85	97%	9.00	2 x (10)	35	0.62%	2.99%	4.23	0.21	YES	1	x 1	11.30%	YES
JB2	JB3	1-PHASE	0.14	0.15	240	1	0.62	97%	57.00	2 x (10)	35	0.06%	2.43%	4.23	0.21	YES	1	x 1	11.30%	YES
JB3	P4-B	1-PHASE	0.07	0.07	240	1	0.31	97%	17.00	2 x (10)	35	0.02%	2.45%	4.23	0.21	YES	1	x 1	11.30%	YES
JB3	P6-B	1-PHASE	0.07	0.07	240	1	0.31	97%	63.00	2 x (10)	35	0.03%	2.47%	4.23	0.21	YES	1	x 1	11.30%	YES

12.6.5 Service panel 6722WF

Table 129. Service panel 6722WF Scenario 1-1.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT			
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	Number of Conduits	Size in	Occupation %	Occupation Comply?
SERVICE PANEL	JB1	1-PHASE	14.63	15.08	240	1	62.84	97%	46.00	2 x (2)	115	1.53%	1.53%	0.66	0.19	YES	1	x 1	53.98%	NO
JB1	P1-A	1-PHASE	14.47	14.92	240	1	62.16	97%	19.00	2 x (4)	85	1.05%	2.58%	1.05	0.20	YES	1	x 1	38.94%	YES
JB1	P3-A	1-PHASE	0.16	0.16	240	1	0.68	97%	92.00	2 x (12)	25	0.17%	1.70%	6.73	0.22	YES	1	x 1	7.76%	YES
P3-A	P5-A	1-PHASE	0.09	0.09	240	1	0.37	97%	111.00	2 x (12)	25	0.16%	1.86%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	JB2	1-PHASE	0.14	0.15	240	1	0.62	97%	88.00	2 x (12)	25	0.15%	0.15%	6.73	0.22	YES	1	x 1	7.76%	YES
JB2	P2-B	1-PHASE	0.07	0.07	240	1	0.31	97%	10.00	2 x (12)	25	0.02%	0.17%	6.73	0.22	YES	1	x 1	7.76%	YES
JB2	P4-B	1-PHASE	0.07	0.07	240	1	0.31	97%	121.00	2 x (12)	25	0.10%	0.25%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	P7-A	1-PHASE	0.14	0.15	240	1	0.62	97%	181.00	2 x (12)	25	0.31%	0.31%	6.73	0.22	YES	1	x 1	7.76%	YES
P7-A	P9-A	1-PHASE	0.07	0.07	240	1	0.31	97%	112.00	2 x (12)	25	0.10%	0.40%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	JB3	1-PHASE	0.22	0.22	240	1	0.93	97%	129.00	2 x (12)	25	0.33%	0.33%	6.73	0.22	YES	1	x 1	7.76%	YES
JB3	P6-B	1-PHASE	0.07	0.07	240	1	0.31	97%	11.00	2 x (12)	25	0.02%	0.35%	6.73	0.22	YES	1	x 1	7.76%	YES
JB3	JB4	1-PHASE	0.14	0.15	240	1	0.62	97%	106.00	2 x (12)	25	0.18%	0.51%	6.73	0.22	YES	1	x 1	7.76%	YES
JB4	P8-B	1-PHASE	0.07	0.07	240	1	0.31	97%	11.00	2 x (12)	25	0.02%	0.53%	6.73	0.22	YES	1	x 1	7.76%	YES
JB4	P10-B	1-PHASE	0.07	0.07	240	1	0.31	97%	122.00	2 x (12)	25	0.16%	0.67%	6.73	0.22	YES	1	x 1	7.76%	YES

Table 130. Service panel 6722WF Scenario 1-2.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT			
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	Number of Conduits	Size in	Occupation %	Occupation Comply?
SERVICE PANEL	JB1	1-PHASE	14.40	14.85	240	1	61.86	97%	46.00	2 x (2)	115	1.63%	1.63%	0.66	0.19	YES	1	x 1	53.98%	NO
JB1	P1-A	1-PHASE	14.40	14.85	240	1	61.86	97%	19.00	2 x (4)	85	1.05%	2.68%	1.05	0.20	YES	1	x 1	38.94%	YES
JB1	P3-A	1-PHASE	0.00	0.00	240	1	0.00	97%	92.00	2 x (12)	25	0.00%	1.63%	6.73	0.22	YES	1	x 1	7.76%	YES
P3-A	P5-A	1-PHASE	0.00	0.00	240	1	0.00	97%	111.00	2 x (12)	25	0.00%	1.63%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	JB2	1-PHASE	0.00	0.00	240	1	0.00	97%	88.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
JB2	P2-B	1-PHASE	0.00	0.00	240	1	0.00	97%	10.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
JB2	P4-B	1-PHASE	0.00	0.00	240	1	0.00	97%	121.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	P7-A	1-PHASE	0.00	0.00	240	1	0.00	97%	181.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
P7-A	P9-A	1-PHASE	0.00	0.00	240	1	0.00	97%	112.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	JB3	1-PHASE	0.00	0.00	240	1	0.00	97%	129.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
JB3	P6-B	1-PHASE	0.00	0.00	240	1	0.00	97%	11.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
JB3	JB4	1-PHASE	0.00	0.00	240	1	0.00	97%	106.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
JB4	P8-B	1-PHASE	0.00	0.00	240	1	0.00	97%	11.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
JB4	P10-B	1-PHASE	0.00	0.00	240	1	0.00	97%	122.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES

Table 131. Service panel 6722WF Scenario 2-1.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT			
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	Number of Conduits	Size in	Occupation %	Occupation Comply?
SERVICE PANEL	JB1	1-PHASE	11.03	11.37	240	1	47.38	97%	46.00	2 x (2)	115	1.12%	1.12%	0.66	0.19	YES	1	x 1	53.98%	NO
JB1	P1-A	1-PHASE	5.47	5.64	240	1	23.51	97%	19.00	2 x (10)	35	1.54%	2.67%	4.23	0.21	YES	1	x 1	11.30%	YES
JB1	P3-A	1-PHASE	5.56	5.73	240	1	23.87	97%	92.00	2 x (2)	115	1.09%	2.21%	0.66	0.19	YES	1	x 1	53.98%	NO
P3-A	P5-A	1-PHASE	0.09	0.09	240	1	0.37	97%	111.00	2 x (12)	25	0.16%	2.37%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	JB2	1-PHASE	5.54	5.72	240	1	23.81	97%	88.00	2 x (4)	85	1.72%	1.72%	1.05	0.20	YES	1	x 1	38.94%	YES
JB2	P2-B	1-PHASE	5.47	5.64	240	1	23.51	97%	10.00	2 x (10)	35	0.81%	2.53%	4.23	0.21	YES	1	x 1	11.30%	YES
JB2	P4-B	1-PHASE	0.07	0.07	240	1	0.31	97%	121.00	2 x (12)	25	0.10%	1.82%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	P7-A	1-PHASE	5.54	5.72	240	1	23.81	97%	181.00	2 x (2)	115	2.16%	2.16%	0.66	0.19	YES	1	x 1	53.98%	NO
P7-A	P9-A	1-PHASE	0.07	0.07	240	1	0.31	97%	112.00	2 x (12)	25	0.10%	2.25%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	JB3	1-PHASE	11.02	11.36	240	1	47.32	97%	129.00	2 x (1/0)	150	1.82%	1.82%	0.39	0.18	YES	1	x 1	85.32%	NO
JB3	P6-B	1-PHASE	5.47	5.64	240	1	23.51	97%	11.00	2 x (10)	35	0.89%	2.71%	4.23	0.21	YES	1	x 1	11.30%	YES
JB3	JB4	1-PHASE	5.54	5.72	240	1	23.81	97%	106.00	2 x (1/0)	150	0.71%	2.53%	0.39	0.18	YES	1	x 1	85.32%	NO
JB4	P8-B	1-PHASE	5.47	5.64	240	1	23.51	97%	11.00	2 x (6)	65	0.36%	2.89%	1.67	0.21	YES	1	x 1	24.61%	YES
JB4	P10-B	1-PHASE	0.07	0.07	240	1	0.31	97%	122.00	2 x (12)	25	0.16%	2.69%	6.73	0.22	YES	1	x 1	7.76%	YES

Table 132. Service panel 6722WF Scenario 2-2.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT			
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	Number of Conduits	Size in	Occupation %	Occupation Comply?
SERVICE PANEL	JB1	1-PHASE	10.80	11.13	240	1	46.39	97%	46.00	2 x (2)	115	1.22%	1.22%	0.66	0.19	YES	1	x 1	53.98%	NO
JB1	P1-A	1-PHASE	5.40	5.57	240	1	23.20	97%	19.00	2 x (10)	35	1.52%	2.75%	4.23	0.21	YES	1	x 1	11.30%	YES
JB1	P3-A	1-PHASE	5.40	5.57	240	1	23.20	97%	92.00	2 x (2)	115	1.22%	2.44%	0.66	0.19	YES	1	x 1	53.98%	NO
P3-A	P5-A	1-PHASE	0.00	0.00	240	1	0.00	97%	111.00	2 x (12)	25	0.00%	2.44%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	JB2	1-PHASE	5.40	5.57	240	1	23.20	97%	88.00	2 x (4)	85	1.82%	1.82%	1.05	0.20	YES	1	x 1	38.94%	YES
JB2	P2-B	1-PHASE	5.40	5.57	240	1	23.20	97%	10.00	2 x (10)	35	0.80%	2.62%	4.23	0.21	YES	1	x 1	11.30%	YES
JB2	P4-B	1-PHASE	0.00	0.00	240	1	0.00	97%	121.00	2 x (12)	25	0.00%	1.82%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	P7-A	1-PHASE	5.40	5.57	240	1	23.20	97%	181.00	2 x (2)	115	2.40%	2.40%	0.66	0.19	YES	1	x 1	53.98%	NO
P7-A	P9-A	1-PHASE	0.00	0.00	240	1	0.00	97%	112.00	2 x (12)	25	0.00%	2.40%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	JB3	1-PHASE	10.80	11.13	240	1	46.39	97%	129.00	2 x (2/0)	175	1.81%	1.81%	0.33	0.18	YES	1	x 1	101.92%	NO
JB3	P6-B	1-PHASE	5.40	5.57	240	1	23.20	97%	11.00	2 x (10)	35	0.88%	2.69%	4.23	0.21	YES	1	x 1	11.30%	YES
JB3	JB4	1-PHASE	5.40	5.57	240	1	23.20	97%	106.00	2 x (1/0)	150	0.86%	2.67%	0.39	0.18	YES	1	x 1	85.32%	NO
JB4	P8-B	1-PHASE	5.40	5.57	240	1	23.20	97%	11.00	2 x (4)	85	0.23%	2.90%	1.05	0.20	YES	1	x 1	38.94%	YES
JB4	P10-B	1-PHASE	0.00	0.00	240	1	0.00	97%	122.00	2 x (12)	25	0.00%	2.67%	6.73	0.22	YES	1	x 1	7.76%	YES

Table 133. Service panel 6722WF Scenario 3.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT			
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	Number of Conduits	Size in	Occupation %	Occupation Comply?
SERVICE PANEL	JB1	1-PHASE	2.08	2.14	240	1	8.93	97%	46.00	2 x (12)	25	2.13%	2.13%	6.73	0.22	YES	1	x 1	7.76%	YES
JB1	P1-A	1-PHASE	1.92	1.98	240	1	8.26	97%	19.00	2 x (12)	25	0.86%	2.99%	6.73	0.22	YES	1	x 1	7.76%	YES
JB1	P3-A	1-PHASE	0.16	0.16	240	1	0.68	97%	92.00	2 x (12)	25	0.17%	2.30%	6.73	0.22	YES	1	x 1	7.76%	YES
P3-A	P5-A	1-PHASE	0.09	0.09	240	1	0.37	97%	111.00	2 x (12)	25	0.16%	2.46%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	JB2	1-PHASE	0.14	0.15	240	1	0.62	97%	88.00	2 x (12)	25	0.15%	0.15%	6.73	0.22	YES	1	x 1	7.76%	YES
JB2	P2-B	1-PHASE	0.07	0.07	240	1	0.31	97%	10.00	2 x (12)	25	0.02%	0.17%	6.73	0.22	YES	1	x 1	7.76%	YES
JB2	P4-B	1-PHASE	0.07	0.07	240	1	0.31	97%	121.00	2 x (12)	25	0.10%	0.25%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	P7-A	1-PHASE	0.14	0.15	240	1	0.62	97%	181.00	2 x (12)	25	0.31%	0.31%	6.73	0.22	YES	1	x 1	7.76%	YES
P7-A	P9-A	1-PHASE	0.07	0.07	240	1	0.31	97%	112.00	2 x (12)	25	0.10%	0.40%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	JB3	1-PHASE	0.22	0.22	240	1	0.93	97%	129.00	2 x (12)	25	0.33%	0.33%	6.73	0.22	YES	1	x 1	7.76%	YES
JB3	P6-B	1-PHASE	0.07	0.07	240	1	0.31	97%	11.00	2 x (12)	25	0.02%	0.35%	6.73	0.22	YES	1	x 1	7.76%	YES
JB3	JB4	1-PHASE	0.14	0.15	240	1	0.62	97%	106.00	2 x (12)	25	0.18%	0.51%	6.73	0.22	YES	1	x 1	7.76%	YES
JB4	P8-B	1-PHASE	0.07	0.07	240	1	0.31	97%	11.00	2 x (12)	25	0.02%	0.53%	6.73	0.22	YES	1	x 1	7.76%	YES
JB4	P10-B	1-PHASE	0.07	0.07	240	1	0.31	97%	122.00	2 x (12)	25	0.16%	0.67%	6.73	0.22	YES	1	x 1	7.76%	YES

12.6.6 Service panel 5441UF

Table 134. Service panel 5441UF Scenario 1-1.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT				
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	Number of Conduits	Size in		Occupation %	Occupation Comply?
SERVICE PANEL	P1-A	1-PHASE	0.14	0.15	240	1	0.62	97%	63.00	2 x (12)	25	0.11%	0.11%	6.73	0.22	YES	1	x	1	7.76%	YES
P1-A	P3-A	1-PHASE	0.07	0.07	240	1	0.31	97%	58.00	2 x (12)	25	0.05%	0.16%	6.73	0.22	YES	1	x	1	7.76%	YES
P1-A	P5-A	1-PHASE	0.07	0.07	240	1	0.31	97%	66.00	2 x (12)	25	0.06%	0.16%	6.73	0.22	YES	1	x	1	7.76%	YES
SERVICE PANEL	P1	1-PHASE	0.22	0.22	240	1	0.93	97%	63.00	2 x (12)	25	0.16%	0.16%	6.73	0.22	YES	1	x	1	7.76%	YES
P1	P2-B	1-PHASE	0.07	0.07	240	1	0.31	97%	53.00	2 x (12)	25	0.09%	0.25%	6.73	0.22	YES	1	x	1	7.76%	YES
P1	P4-B	1-PHASE	0.07	0.07	240	1	0.31	97%	107.00	2 x (12)	25	0.14%	0.30%	6.73	0.22	YES	1	x	1	7.76%	YES
P1	P6-B	1-PHASE	0.07	0.07	240	1	0.31	97%	117.00	2 x (12)	25	0.15%	0.31%	6.73	0.22	YES	1	x	1	7.76%	YES
SERVICE PANEL	P7-A	1-PHASE	0.22	0.22	240	1	0.93	97%	175.00	2 x (12)	25	0.45%	0.45%	6.73	0.22	YES	1	x	1	7.76%	YES
P7-A	P9-A	1-PHASE	0.14	0.15	240	1	0.62	97%	66.00	2 x (12)	25	0.11%	0.56%	6.73	0.22	YES	1	x	1	7.76%	YES
P9-A	P11-A	1-PHASE	0.07	0.07	240	1	0.31	97%	68.00	2 x (12)	25	0.06%	0.61%	6.73	0.22	YES	1	x	1	7.76%	YES
SERVICE PANEL	P8-B	1-PHASE	0.22	0.22	240	1	0.93	97%	228.00	2 x (12)	25	0.58%	0.58%	6.73	0.22	YES	1	x	1	7.76%	YES
P8-B	P10-B	1-PHASE	0.14	0.15	240	1	0.62	97%	50.00	2 x (12)	25	0.08%	0.67%	6.73	0.22	YES	1	x	1	7.76%	YES
P10-B	P12-B	1-PHASE	0.07	0.07	240	1	0.31	97%	110.00	2 x (12)	25	0.16%	0.82%	6.73	0.22	YES	1	x	1	7.76%	YES
SERVICE PANEL	JB3	1-PHASE	14.76	15.22	240	1	63.40	97%	99.00	2 x (1/0)	150	2.05%	2.05%	0.39	0.18	YES	1	x	1	85.32%	NO
JB3	P13-C	1-PHASE	14.47	14.92	240	1	62.16	97%	13.00	2 x (4)	85	0.72%	2.77%	1.05	0.20	YES	1	x	1	38.94%	YES

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT			
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	Number of Conduits	Size in	Occupation %	Occupation Comply?
JB3	JB5	1-PHASE	0.29	0.30	240	1	1.24	97%	105.00	2 x (8)	50	0.14%	2.18%	2.56	0.21	YES	1	x 1	18.29%	YES
JB5	P15-C	1-PHASE	0.07	0.07	240	1	0.31	97%	11.00	2 x (12)	25	0.02%	2.20%	6.73	0.22	YES	1	x 1	7.76%	YES
JB5	P16	1-PHASE	0.22	0.22	240	1	0.93	97%	72.00	2 x (8)	50	0.07%	2.25%	2.56	0.21	YES	1	x 1	18.29%	YES
P16	P17-C	1-PHASE	0.22	0.22	240	1	0.93	97%	39.00	2 x (10)	35	0.06%	2.32%	4.23	0.21	YES	1	x 1	11.30%	YES
P17-C	P19-C	1-PHASE	0.07	0.07	240	1	0.31	97%	105.00	2 x (12)	25	0.09%	2.41%	6.73	0.22	YES	1	x 1	7.76%	YES
P17-C	P21-C	1-PHASE	0.14	0.15	240	1	0.62	97%	44.00	2 x (12)	25	0.07%	2.39%	6.73	0.22	YES	1	x 1	7.76%	YES
P21-C	P23-C	1-PHASE	0.07	0.07	240	1	0.31	97%	104.00	2 x (12)	25	0.13%	2.52%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	P14-D	1-PHASE	0.36	0.37	240	1	1.55	97%	151.00	2 x (8)	50	0.25%	0.25%	2.56	0.21	YES	1	x 1	18.29%	YES
P14-D	P16-D	1-PHASE	0.29	0.30	240	1	1.24	97%	126.00	2 x (8)	50	0.16%	0.41%	2.56	0.21	YES	1	x 1	18.29%	YES
P16-D	P17	1-PHASE	0.22	0.22	240	1	0.93	97%	39.00	2 x (10)	35	0.06%	0.47%	4.23	0.21	YES	1	x 1	11.30%	YES
P17	JB6	1-PHASE	0.14	0.15	240	1	0.62	97%	28.00	2 x (12)	25	0.05%	0.52%	6.73	0.22	YES	1	x 1	7.76%	YES
JB6	P18-D	1-PHASE	0.07	0.07	240	1	0.31	97%	9.00	2 x (12)	25	0.02%	0.54%	6.73	0.22	YES	1	x 1	7.76%	YES
JB6	P20-D	1-PHASE	0.07	0.07	240	1	0.31	97%	137.00	2 x (12)	25	0.17%	0.69%	6.73	0.22	YES	1	x 1	7.76%	YES
P17	P22-D	1-PHASE	0.07	0.07	240	1	0.31	97%	107.00	2 x (12)	25	0.09%	0.56%	6.73	0.22	YES	1	x 1	7.76%	YES

Table 135. Service panel 5441UF Scenario 1-2.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT			
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	Number of Conduits	Size in	Occupation %	Occupation Comply?
SERVICE PANEL	P1-A	1-PHASE	0.00	0.00	240	1	0.00	97%	63.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
P1-A	P3-A	1-PHASE	0.00	0.00	240	1	0.00	97%	58.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
P1-A	P5-A	1-PHASE	0.00	0.00	240	1	0.00	97%	66.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	P1	1-PHASE	0.00	0.00	240	1	0.00	97%	63.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
P1	P2-B	1-PHASE	0.00	0.00	240	1	0.00	97%	53.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
P1	P4-B	1-PHASE	0.00	0.00	240	1	0.00	97%	107.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
P1	P6-B	1-PHASE	0.00	0.00	240	1	0.00	97%	117.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	P7-A	1-PHASE	0.00	0.00	240	1	0.00	97%	175.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
P7-A	P9-A	1-PHASE	0.00	0.00	240	1	0.00	97%	66.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
P9-A	P11-A	1-PHASE	0.00	0.00	240	1	0.00	97%	68.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	P8-B	1-PHASE	0.00	0.00	240	1	0.00	97%	228.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
P8-B	P10-B	1-PHASE	0.00	0.00	240	1	0.00	97%	50.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
P10-B	P12-B	1-PHASE	0.00	0.00	240	1	0.00	97%	110.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	JB3	1-PHASE	14.40	14.85	240	1	61.86	97%	99.00	2 x (1/0)	150	1.99%	1.99%	0.39	0.18	YES	1	x 1	85.32%	NO
JB3	P13-C	1-PHASE	14.40	14.85	240	1	61.86	97%	13.00	2 x (4)	85	0.72%	2.71%	1.05	0.20	YES	1	x 1	38.94%	YES

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT			
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	Number of Conduits	Size in	Occupation %	Occupation Comply?
JB3	JB5	1-PHASE	0.00	0.00	240	1	0.00	97%	105.00	2 x (8)	50	0.00%	1.99%	2.56	0.21	YES	1	x 1	18.29%	YES
JB5	P15-C	1-PHASE	0.00	0.00	240	1	0.00	97%	11.00	2 x (12)	25	0.00%	1.99%	6.73	0.22	YES	1	x 1	7.76%	YES
JB5	P16	1-PHASE	0.00	0.00	240	1	0.00	97%	72.00	2 x (8)	50	0.00%	1.99%	2.56	0.21	YES	1	x 1	18.29%	YES
P16	P17-C	1-PHASE	0.00	0.00	240	1	0.00	97%	39.00	2 x (10)	35	0.00%	1.99%	4.23	0.21	YES	1	x 1	11.30%	YES
P17-C	P19-C	1-PHASE	0.00	0.00	240	1	0.00	97%	105.00	2 x (12)	25	0.00%	1.99%	6.73	0.22	YES	1	x 1	7.76%	YES
P17-C	P21-C	1-PHASE	0.00	0.00	240	1	0.00	97%	44.00	2 x (12)	25	0.00%	1.99%	6.73	0.22	YES	1	x 1	7.76%	YES
P21-C	P23-C	1-PHASE	0.00	0.00	240	1	0.00	97%	104.00	2 x (12)	25	0.00%	1.99%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	P14-D	1-PHASE	0.00	0.00	240	1	0.00	97%	151.00	2 x (8)	50	0.00%	0.00%	2.56	0.21	YES	1	x 1	18.29%	YES
P14-D	P16-D	1-PHASE	0.00	0.00	240	1	0.00	97%	126.00	2 x (8)	50	0.00%	0.00%	2.56	0.21	YES	1	x 1	18.29%	YES
P16-D	P17	1-PHASE	0.00	0.00	240	1	0.00	97%	39.00	2 x (10)	35	0.00%	0.00%	4.23	0.21	YES	1	x 1	11.30%	YES
P17	JB6	1-PHASE	0.00	0.00	240	1	0.00	97%	28.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
JB6	P18-D	1-PHASE	0.00	0.00	240	1	0.00	97%	9.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
JB6	P20-D	1-PHASE	0.00	0.00	240	1	0.00	97%	137.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
P17	P22-D	1-PHASE	0.00	0.00	240	1	0.00	97%	107.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES

Table 136. Service panel 5441UF Scenario 2-1.

CIRCUIT: ORIGIN	CIRCUIT: DESTINATION	TYPE OF CIRCUIT	POWER kW	POWER kVA	VOLTAGE	CONDUCTORS PER PHASE	CURRENT Nominal (A)	POWER FACTOR Nominal (%)	DISTANCE (m)	CABLES: Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	CONDUIT: Number of Conduits		Size in	Occupation %	Occupation Comply?
SERVICE PANEL	P1-A	1-PHASE	8.94	9.22	240	1	38.42	97%	63.00	2 x (4)	85	2.05%	2.05%	1.05	0.20	YES	1	x	1	38.94%	YES
P1-A	P3-A	1-PHASE	0.07	0.07	240	1	0.31	97%	58.00	2 x (12)	25	0.05%	2.10%	6.73	0.22	YES	1	x	1	7.76%	YES
P1-A	P5-A	1-PHASE	0.07	0.07	240	1	0.31	97%	66.00	2 x (12)	25	0.06%	2.11%	6.73	0.22	YES	1	x	1	7.76%	YES
SERVICE PANEL	P1	1-PHASE	9.02	9.29	240	1	38.73	97%	63.00	2 x (2)	115	1.24%	1.24%	0.66	0.19	YES	1	x	1	53.98%	NO
P1	P2-B	1-PHASE	8.87	9.15	240	1	38.11	97%	53.00	2 x (2)	115	1.16%	2.39%	0.66	0.19	YES	1	x	1	53.98%	NO
P1	P4-B	1-PHASE	0.07	0.07	240	1	0.31	97%	107.00	2 x (12)	25	0.14%	1.37%	6.73	0.22	YES	1	x	1	7.76%	YES
P1	P6-B	1-PHASE	0.07	0.07	240	1	0.31	97%	117.00	2 x (12)	25	0.15%	1.39%	6.73	0.22	YES	1	x	1	7.76%	YES
SERVICE PANEL	P7-A	1-PHASE	0.22	0.22	240	1	0.93	97%	175.00	2 x (12)	25	0.45%	0.45%	6.73	0.22	YES	1	x	1	7.76%	YES
P7-A	P9-A	1-PHASE	0.14	0.15	240	1	0.62	97%	66.00	2 x (12)	25	0.11%	0.56%	6.73	0.22	YES	1	x	1	7.76%	YES
P9-A	P11-A	1-PHASE	0.07	0.07	240	1	0.31	97%	68.00	2 x (12)	25	0.06%	0.61%	6.73	0.22	YES	1	x	1	7.76%	YES
SERVICE PANEL	P8-B	1-PHASE	0.22	0.22	240	1	0.93	97%	228.00	2 x (12)	25	0.58%	0.58%	6.73	0.22	YES	1	x	1	7.76%	YES
P8-B	P10-B	1-PHASE	0.14	0.15	240	1	0.62	97%	50.00	2 x (12)	25	0.08%	0.67%	6.73	0.22	YES	1	x	1	7.76%	YES
P10-B	P12-B	1-PHASE	0.07	0.07	240	1	0.31	97%	110.00	2 x (12)	25	0.16%	0.82%	6.73	0.22	YES	1	x	1	7.76%	YES
SERVICE PANEL	JB3	1-PHASE	9.16	9.44	240	1	39.35	97%	99.00	2 x (2)	115	2.07%	2.07%	0.66	0.19	YES	1	x	1	53.98%	NO
JB3	P13-C	1-PHASE	8.87	9.15	240	1	38.11	97%	13.00	2 x (6)	65	0.69%	2.76%	1.67	0.21	YES	1	x	1	24.61%	YES

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT			
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	Number of Conduits	Size in	Occupation %	Occupation Comply?
JB3	JB5	1-PHASE	0.29	0.30	240	1	1.24	97%	105.00	2 x (8)	50	0.14%	2.20%	2.56	0.21	YES	1	x 1	18.29%	YES
JB5	P15-C	1-PHASE	0.07	0.07	240	1	0.31	97%	11.00	2 x (12)	25	0.02%	2.22%	6.73	0.22	YES	1	x 1	7.76%	YES
JB5	P16	1-PHASE	0.22	0.22	240	1	0.93	97%	72.00	2 x (8)	50	0.07%	2.27%	2.56	0.21	YES	1	x 1	18.29%	YES
P16	P17-C	1-PHASE	0.22	0.22	240	1	0.93	97%	39.00	2 x (10)	35	0.06%	2.34%	4.23	0.21	YES	1	x 1	11.30%	YES
P17-C	P19-C	1-PHASE	0.07	0.07	240	1	0.31	97%	105.00	2 x (12)	25	0.09%	2.43%	6.73	0.22	YES	1	x 1	7.76%	YES
P17-C	P21-C	1-PHASE	0.14	0.15	240	1	0.62	97%	44.00	2 x (12)	25	0.07%	2.41%	6.73	0.22	YES	1	x 1	7.76%	YES
P21-C	P23-C	1-PHASE	0.07	0.07	240	1	0.31	97%	104.00	2 x (12)	25	0.13%	2.54%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	P14-D	1-PHASE	9.16	9.44	240	1	39.35	97%	151.00	2 x (1/0)	150	1.84%	1.84%	0.39	0.18	YES	1	x 1	85.32%	NO
P14-D	P16-D	1-PHASE	0.29	0.30	240	1	1.24	97%	126.00	2 x (8)	50	0.16%	2.01%	2.56	0.21	YES	1	x 1	18.29%	YES
P16-D	P17	1-PHASE	0.22	0.22	240	1	0.93	97%	39.00	2 x (10)	35	0.06%	2.07%	4.23	0.21	YES	1	x 1	11.30%	YES
P17	JB6	1-PHASE	0.14	0.15	240	1	0.62	97%	28.00	2 x (12)	25	0.05%	2.12%	6.73	0.22	YES	1	x 1	7.76%	YES
JB6	P18-D	1-PHASE	0.07	0.07	240	1	0.31	97%	9.00	2 x (12)	25	0.02%	2.13%	6.73	0.22	YES	1	x 1	7.76%	YES
JB6	P20-D	1-PHASE	0.07	0.07	240	1	0.31	97%	137.00	2 x (12)	25	0.17%	2.28%	6.73	0.22	YES	1	x 1	7.76%	YES
P17	P22-D	1-PHASE	0.07	0.07	240	1	0.31	97%	107.00	2 x (12)	25	0.09%	2.16%	6.73	0.22	YES	1	x 1	7.76%	YES

Table 137. Service panel 5441UF Scenario 2-2.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT			
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	Number of Conduits	Size in	Occupation %	Occupation Comply?
SERVICE PANEL	P1-A	1-PHASE	9.20	9.48	240	1	39.52	97%	63.00	2 x (4)	85	2.22%	2.22%	1.05	0.20	YES	1	x 1	38.94%	YES
P1-A	P3-A	1-PHASE	0.00	0.00	240	1	0.00	97%	58.00	2 x (12)	25	0.00%	2.22%	6.73	0.22	YES	1	x 1	7.76%	YES
P1-A	P5-A	1-PHASE	0.00	0.00	240	1	0.00	97%	66.00	2 x (12)	25	0.00%	2.22%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	P1	1-PHASE	9.20	9.48	240	1	39.52	97%	63.00	2 x (2)	115	1.42%	1.42%	0.66	0.19	YES	1	x 1	53.98%	NO
P1	P2-B	1-PHASE	9.20	9.48	240	1	39.52	97%	53.00	2 x (2)	115	1.20%	2.62%	0.66	0.19	YES	1	x 1	53.98%	NO
P1	P4-B	1-PHASE	0.00	0.00	240	1	0.00	97%	107.00	2 x (12)	25	0.00%	1.42%	6.73	0.22	YES	1	x 1	7.76%	YES
P1	P6-B	1-PHASE	0.00	0.00	240	1	0.00	97%	117.00	2 x (12)	25	0.00%	1.42%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	P7-A	1-PHASE	0.00	0.00	240	1	0.00	97%	175.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
P7-A	P9-A	1-PHASE	0.00	0.00	240	1	0.00	97%	66.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
P9-A	P11-A	1-PHASE	0.00	0.00	240	1	0.00	97%	68.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	P8-B	1-PHASE	0.00	0.00	240	1	0.00	97%	228.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
P8-B	P10-B	1-PHASE	0.00	0.00	240	1	0.00	97%	50.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
P10-B	P12-B	1-PHASE	0.00	0.00	240	1	0.00	97%	110.00	2 x (12)	25	0.00%	0.00%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	JB3	1-PHASE	9.20	9.48	240	1	39.52	97%	99.00	2 x (2)	115	2.24%	2.24%	0.66	0.19	YES	1	x 1	53.98%	NO
JB3	P13-C	1-PHASE	9.20	9.48	240	1	39.52	97%	13.00	2 x (6)	65	0.72%	2.95%	1.67	0.21	YES	1	x 1	24.61%	YES

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT				
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	Number of Conduits	Size in		Occupation %	Occupation Comply?
JB3	JB5	1-PHASE	0.00	0.00	240	1	0.00	97%	105.00	2 x (8)	50	0.00%	2.24%	2.56	0.21	YES	1	x	1	18.29%	YES
JB5	P15-C	1-PHASE	0.00	0.00	240	1	0.00	97%	11.00	2 x (12)	25	0.00%	2.24%	6.73	0.22	YES	1	x	1	7.76%	YES
JB5	P16	1-PHASE	0.00	0.00	240	1	0.00	97%	72.00	2 x (8)	50	0.00%	2.24%	2.56	0.21	YES	1	x	1	18.29%	YES
P16	P17-C	1-PHASE	0.00	0.00	240	1	0.00	97%	39.00	2 x (10)	35	0.00%	2.24%	4.23	0.21	YES	1	x	1	11.30%	YES
P17-C	P19-C	1-PHASE	0.00	0.00	240	1	0.00	97%	105.00	2 x (12)	25	0.00%	2.24%	6.73	0.22	YES	1	x	1	7.76%	YES
P17-C	P21-C	1-PHASE	0.00	0.00	240	1	0.00	97%	44.00	2 x (12)	25	0.00%	2.24%	6.73	0.22	YES	1	x	1	7.76%	YES
P21-C	P23-C	1-PHASE	0.00	0.00	240	1	0.00	97%	104.00	2 x (12)	25	0.00%	2.24%	6.73	0.22	YES	1	x	1	7.76%	YES
SERVICE PANEL	P14-D	1-PHASE	9.20	9.48	240	1	39.52	97%	151.00	2 x (1/0)	150	2.10%	2.10%	0.39	0.18	YES	1	x	1	85.32%	NO
P14-D	P16-D	1-PHASE	0.00	0.00	240	1	0.00	97%	126.00	2 x (8)	50	0.00%	2.10%	2.56	0.21	YES	1	x	1	18.29%	YES
P16-D	P17	1-PHASE	0.00	0.00	240	1	0.00	97%	39.00	2 x (10)	35	0.00%	2.10%	4.23	0.21	YES	1	x	1	11.30%	YES
P17	JB6	1-PHASE	0.00	0.00	240	1	0.00	97%	28.00	2 x (12)	25	0.00%	2.10%	6.73	0.22	YES	1	x	1	7.76%	YES
JB6	P18-D	1-PHASE	0.00	0.00	240	1	0.00	97%	9.00	2 x (12)	25	0.00%	2.10%	6.73	0.22	YES	1	x	1	7.76%	YES
JB6	P20-D	1-PHASE	0.00	0.00	240	1	0.00	97%	137.00	2 x (12)	25	0.00%	2.10%	6.73	0.22	YES	1	x	1	7.76%	YES
P17	P22-D	1-PHASE	0.00	0.00	240	1	0.00	97%	107.00	2 x (12)	25	0.00%	2.10%	6.73	0.22	YES	1	x	1	7.76%	YES

Table 138. Service panel 5441UF Scenario 3.

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT			
ORIGIN	DESTINATION		kW	kVA			Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop Nominal (%)	Voltage Drop Accumulated (%)	R ohm/km	X ohm/km	Voltage Drop Comply? Nominal	Number of Conduits	Size in	Occupation %	Occupation Comply?
SERVICE PANEL	P1-A	1-PHASE	0.14	0.15	240	1	0.62	97%	63.00	2 x (12)	25	0.11%	0.11%	6.73	0.22	YES	1	x 1	7.76%	YES
P1-A	P3-A	1-PHASE	0.07	0.07	240	1	0.31	97%	58.00	2 x (12)	25	0.05%	0.16%	6.73	0.22	YES	1	x 1	7.76%	YES
P1-A	P5-A	1-PHASE	0.07	0.07	240	1	0.31	97%	66.00	2 x (12)	25	0.06%	0.16%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	P1	1-PHASE	0.22	0.22	240	1	0.93	97%	63.00	2 x (12)	25	0.16%	0.16%	6.73	0.22	YES	1	x 1	7.76%	YES
P1	P2-B	1-PHASE	0.07	0.07	240	1	0.31	97%	53.00	2 x (12)	25	0.09%	0.25%	6.73	0.22	YES	1	x 1	7.76%	YES
P1	P4-B	1-PHASE	0.07	0.07	240	1	0.31	97%	107.00	2 x (12)	25	0.14%	0.30%	6.73	0.22	YES	1	x 1	7.76%	YES
P1	P6-B	1-PHASE	0.07	0.07	240	1	0.31	97%	117.00	2 x (12)	25	0.15%	0.31%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	P7-A	1-PHASE	0.22	0.22	240	1	0.93	97%	175.00	2 x (12)	25	0.45%	0.45%	6.73	0.22	YES	1	x 1	7.76%	YES
P7-A	P9-A	1-PHASE	0.14	0.15	240	1	0.62	97%	66.00	2 x (12)	25	0.11%	0.56%	6.73	0.22	YES	1	x 1	7.76%	YES
P9-A	P11-A	1-PHASE	0.07	0.07	240	1	0.31	97%	68.00	2 x (12)	25	0.06%	0.61%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	P8-B	1-PHASE	0.22	0.22	240	1	0.93	97%	228.00	2 x (12)	25	0.58%	0.58%	6.73	0.22	YES	1	x 1	7.76%	YES
P8-B	P10-B	1-PHASE	0.14	0.15	240	1	0.62	97%	50.00	2 x (12)	25	0.08%	0.67%	6.73	0.22	YES	1	x 1	7.76%	YES
P10-B	P12-B	1-PHASE	0.07	0.07	240	1	0.31	97%	110.00	2 x (12)	25	0.16%	0.82%	6.73	0.22	YES	1	x 1	7.76%	YES
SERVICE PANEL	JB3	1-PHASE	2.66	2.74	240	1	11.43	97%	99.00	2 x (8)	50	2.23%	2.23%	2.56	0.21	YES	1	x 1	18.29%	YES

CIRCUIT		TYPE OF CIRCUIT	POWER		VOLTAGE	CONDUCTORS PER PHASE	CURRENT	POWER FACTOR	DISTANCE (m)	CABLES							CONDUIT				
ORIGIN	DESTINATION						Nominal (A)	Nominal (%)		Gauge phases and / or neutral (AWG o kcmil)	Conductor Ampacity	Voltage Drop		R	X	Voltage Drop Comply?	Number of Conduits	Size		Occupation	Occupation Comply?
			kW	kVA								Nominal (%)	Accumulated (%)	ohm/km	ohm/km	Nominal		in		%	
JB3	P13-C	1-PHASE	2.37	2.45	240	1	10.19	97%	13.00	2 x (12)	25	0.73%	2.95%	6.73	0.22	YES	1	x	1	7.76%	YES
JB3	JB5	1-PHASE	0.29	0.30	240	1	1.24	97%	105.00	2 x (8)	50	0.14%	2.37%	2.56	0.21	YES	1	x	1	18.29%	YES
JB5	P15-C	1-PHASE	0.07	0.07	240	1	0.31	97%	11.00	2 x (12)	25	0.02%	2.38%	6.73	0.22	YES	1	x	1	7.76%	YES
JB5	P16	1-PHASE	0.22	0.22	240	1	0.93	97%	72.00	2 x (8)	50	0.07%	2.44%	2.56	0.21	YES	1	x	1	18.29%	YES
P16	P17-C	1-PHASE	0.22	0.22	240	1	0.93	97%	39.00	2 x (10)	35	0.06%	2.50%	4.23	0.21	YES	1	x	1	11.30%	YES
P17-C	P19-C	1-PHASE	0.07	0.07	240	1	0.31	97%	105.00	2 x (12)	25	0.09%	2.59%	6.73	0.22	YES	1	x	1	7.76%	YES
P17-C	P21-C	1-PHASE	0.14	0.15	240	1	0.62	97%	44.00	2 x (12)	25	0.07%	2.57%	6.73	0.22	YES	1	x	1	7.76%	YES
P21-C	P23-C	1-PHASE	0.07	0.07	240	1	0.31	97%	104.00	2 x (12)	25	0.13%	2.70%	6.73	0.22	YES	1	x	1	7.76%	YES
SERVICE PANEL	P14-D	1-PHASE	0.36	0.37	240	1	1.55	97%	151.00	2 x (8)	50	0.25%	0.25%	2.56	0.21	YES	1	x	1	18.29%	YES
P14-D	P16-D	1-PHASE	0.29	0.30	240	1	1.24	97%	126.00	2 x (8)	50	0.16%	0.41%	2.56	0.21	YES	1	x	1	18.29%	YES
P16-D	P17	1-PHASE	0.22	0.22	240	1	0.93	97%	39.00	2 x (10)	35	0.06%	0.47%	4.23	0.21	YES	1	x	1	11.30%	YES
P17	JB6	1-PHASE	0.14	0.15	240	1	0.62	97%	28.00	2 x (12)	25	0.05%	0.52%	6.73	0.22	YES	1	x	1	7.76%	YES
JB6	P18-D	1-PHASE	0.07	0.07	240	1	0.31	97%	9.00	2 x (12)	25	0.02%	0.54%	6.73	0.22	YES	1	x	1	7.76%	YES
JB6	P20-D	1-PHASE	0.07	0.07	240	1	0.31	97%	137.00	2 x (12)	25	0.17%	0.69%	6.73	0.22	YES	1	x	1	7.76%	YES
P17	P22-D	1-PHASE	0.07	0.07	240	1	0.31	97%	107.00	2 x (12)	25	0.09%	0.56%	6.73	0.22	YES	1	x	1	7.76%	YES