Standard Engineering Practices Section 8
Underground Residential Distribution

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Standard Engineering Practice Section 8

Underground Residential Distribution

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1. Scope of the Standard

The purpose of SEP 8 Underground Residential Distribution is to provide general planning guidelines, background information, and design constraints for medium and large subdivisions contained within urban areas. As a set of general guidelines the SEP 8 is not intended to restrict designers to only those scenarios contained within this document, but aid in the design process.

2. Glossary

Buried Joint Use Agreement (Joint Use) – An agreement between SaskPower and Telecommunication Companies in the Province of Saskatchewan that provides a joint use path and/or pedestals where it is advantageous for all joint use partners. The agreement can be found on the SaskPower Employee Information Network.

CLF – Current Limiting Fuse.

Codes and Symbols – Refer to CSM B-02 for applicable codes and symbols.

Cold load pickup – The condition that takes place when a distribution circuit is re-energized following an extended outage of that circuit. Cold load pickup is a composite of two conditions: inrush and loss of load diversity.

CSM – Construction Standards Manual.

Directive – Corporate policies within the Customer Service Business Administration Manual.

Diversity Factor – Diversity refers to the percentage of independently controlled, cyclic loads that may be energized at any given time during normal circuit operation – 1 of 2 would be 50% diversity.

ESR – Electric Service Requirements.

Inductive Coordination Agreement – An agreement between SaskPower and SaskTel outlining mitigation practices for locations where both parties share the service area (parallel lines) in order to limit interference from power lines on telecommunication equipment. The agreement can be found in the Technical Services and Research Library, SaskPower Employee Information Network (EIN).

Load Factor – Ratio of average demand to peak demand.

Load Fused - The fuse(s) is sized accordingly to the specific amount of load on the cable or line.

Loop Feed – An alternate or backup power source to a transformer or group of transformers.

SEP – "Standard Engineering Practices" are SaskPower Engineering specifications and guidelines.

System Improvement – SaskPower system upgrades, facility replacements, internally preferred routing or construction methods not charged to a customer. System Improvement is covered fully by Directive 97-05.

URD – Underground Residential Distribution.

3. Basic Principles of URD

3.1. General Subdivision Considerations

Addition of new load to the three phase distribution system requires analysis of system power quality, ongoing operating and maintenance activities, and distribution infrastructure required to tie the load into the feeder/substation system. Larger loads will have greater impact on the system, but residential subdivisions are a good example of how small loads can have a dramatic effect on the three phase distribution system.

In residential subdivisions individual loads are small, varying from 1.5 kVA to 15 kVA per customer depending on the time of the day, but overall the subdivision may present a significant load to the system. Subdivision developments can vary from 5 to 1000 lots, and are typically constructed and energized in phases sometimes taking several years. System planning is required to ensure the subdivision load can be accommodated and the system can be properly operated and maintained.

Residential subdivision load can be approximated as a large single phase load. A small 5 lot subdivision will have an expected diversified load of 28 kVA; meanwhile for a 1000 lot subdivision the expected diversified load is 4000 kVA (refer to Table 4-3). Adding 28 kVA to a single phase system will not have a huge impact – it only results in 2 A of primary current at 14.4 kV. Adding 4000 kVA results in 278 A of primary current at 14.4 kV which would cause load imbalance on the three phase system and cause potential reliability and voltage issues.

The design process will determine the capacity of the single phase system, and allocate load based on subdivision staging. Design considerations will include: load limits for 14.4 kV cables, future cable faults, and potential for three phase loads within the subdivision. **Proper design will require the developer or municipality's subdivision layout –** referred to as a concept plan.

3.2. Subdivision Concept Plans

Subdivision developments in large urban centres typically have a concept plan available from the developer or municipality. A concept plan outlines the proposed subdivision details such as:

- Major roadways (collector streets and arterial roads) and anticipated traffic flows
- Minor streets and lot layouts
- Locations of schools, parks, and green space

- Locations of commercial and institutional parcels of land
- Sewer and water trunk lines and other existing infrastructure (fire hydrants, storm catch basins, water valves and connections, manholes, etc.)
- Landscaping plans (i.e. trees)
- Location of driveways
- Municipal buffers (berms, boulevard space and use, etc.)
- Walkout basements – due to swales and grading

Concept plans are not always finalized at the time of design, and are subject to change by the developer, but they provide the basis for an electrical plan. Major roadway layout is important for subdivision design as schools, commercial areas, high density mixed use, and sewage lift stations are usually placed on arterial roads; therefore, they are ideal for planning three phase (including feeder) routes. Smaller developments may not have a concept plan containing the level of detail outlined above, but they require less complex electrical design for servicing. A simple lot plan may be all that is required.

3.3. Subdivision Design

Subdivision design can be broken into four main areas as outlined below:

1. Electrical Design
    - Distribution issues
    - Maximum load (kVA) per phase
    - Maximum load (kVA) per lot
    - Allowed voltage drop
    - URD load fuse protection
    - Normal open points
    - Phase balancing

2. Physical Layout and Construction
    - Transformer and pedestal placement
    - Street light requirements
    - Voltage drop distances
    - Underground routing of primary and secondary cable
    - Temporary and permanent loop feeds
    - Accessibility for operating staff
    - Facility offsets from property lines
    - Easement requirements
    - Conduit use

3. Joint Use
    - Telecommunication cables in the same trench
    - Shared pedestals
    - Location of SaskEnergy facilities
    - Four-party trenching with SaskEnergy

4. Other
    - Operating concerns
    - Feeder mapping
    - Fault indicators

4. Electrical Design

The basic design of URD consists of three phase 25 kV primary feeders divided out into either three phase primary 25 kV loops or single phase primary 14.4 kV loops. The loops consist of primary cable daisy-chained between transformers. Three phase 25 kV loops will contain transformation appropriate to commercial/industrial business requirements within the subdivision; meanwhile, single phase 14.4 kV loops contain residential transformers with 120/240 V secondary. The 120/240 V secondary system is also daisy-chained from pedestal to pedestal, with individual consumer services fed from the pedestals. Figure 4-1 and Figure 4-2 are examples of primary and secondary distribution. Both temporary and permanent loops are required for new URD and are not considered system improvement. Note that secondary will not be looped.

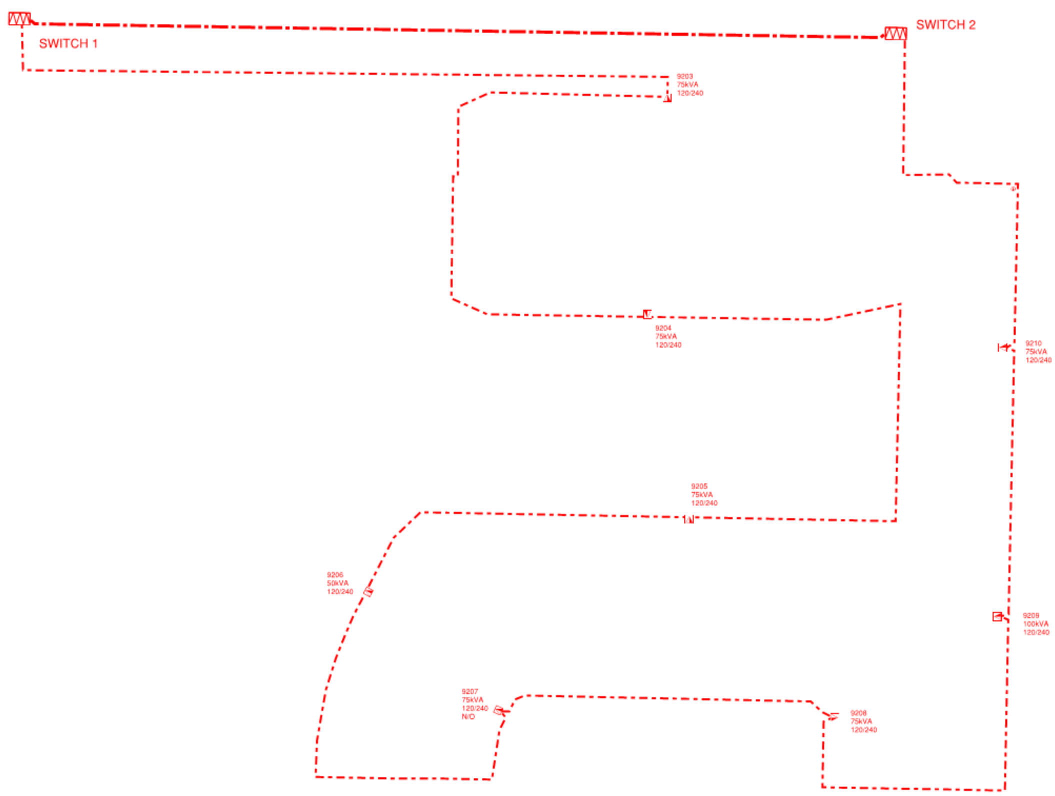

Figure 4-1: Primary Schematic

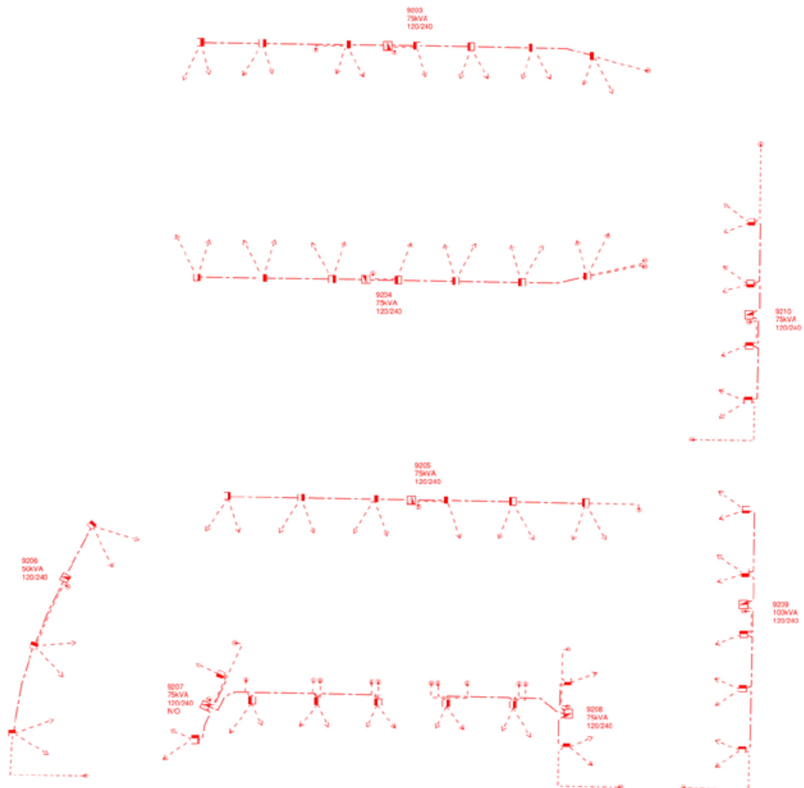

Figure 4-2: Secondary Schematic

Three phase feeders are the backbone of any distribution system, and require additional consideration when designed. Important issues to consider are:

- System capacity – the feeder and substation must be capable of providing the additional load required by the subdivision
- Power quality – acceptable voltage limits must be maintained at minimum and maximum loading conditions. Phase current balancing must be considered in order to comply with the Inductive Coordination Agreement, and to maintain balanced loading and power factors between phases.
- Line protection – breaker and recloser placement must provide adequate reach and recloser-fuse coordination.
- Reliability – additional reclosers or fuses may be added to limit feeder exposure to faults. Loop feeds and alternate feed capability from another substation must be considered.
- Operating/Maintenance – switches, transformers, and fuses installed in accessible locations (roads, lanes, right-of-ways, etc.), with loadbreak switches at key locations.

All of the above must be considered when designing residential subdivisions and the facilities required to connect them to the existing distribution system.

4.1. Protection and System Loading

URD systems are typically *load fused*, a protection scheme where the load fuse clears a fault prior to upstream protection operating. Load fusing is used because URD is a cable system and cable system faults are not usually temporary. There is no value in a trip and reclose occurring on the overhead system if the fault on the URD can be cleared via a fuse. The reclose could damage the cable further, and would expose more customers to the fault.

As mentioned previously, URD systems can be approximated as a large single phase load. The designer must limit the size of the largest single phase load added to the three phase system. Single phase loads that are too large can cause the following:

- Phase current imbalance under normal operating conditions
- Severe phase current imbalance under abnormal/contingency conditions (ie: when alternating the URD from one substation to another after an unplanned outage)
- Protection coordination problems (ie: tap-off fuse too large to coordinate with an upstream device)
- Recloser ground trip problems (ie: a fuse trip on a large URD could unbalance the three phase system such that a substation breaker operates due to a 51R (residual overcurrent protection or the series recloser trips)
- Recloser/breaker trips when restoring service because of cold load pickup
- Overloading the feed through bushings on the padmount transformers

Typical URD fusing consists of a 65T at all tap-offs from the feeder. A 65T fuse can handle up to 200% of its rating, or 130 A, at 14.4 kV = 1872 kVA. The 65T must be able to feed the entire URD, even if the URD is loop-fed, and account for cold load pickup. Accounting for cold load pickup, the maximum connected kVA that can be served by a 65T is 1872 kVA/1.6 = **1170 kVA** (or 81 A at 14.4 kV). These results are derived from Equation 1 below:

$$\boldsymbol{Maximum\ Connected\ kVA\ Allowed} = \frac{\boldsymbol{Fuse\ Rating\ x\ Voltage\ (kV)}}{\boldsymbol{Cold\ Load\ Pickup\ Factor\ (1.6)}} \quad (1)$$

Load capability for common fuse sizes are contained in Table 4-1 below:

Fuse Size	Maximum Connected kVA	Initial Design kVA
20T	360	288
40T	720	576
65T	1170	936

Table 4-1: Fuse Loading (Including Cold Load Pickup)

81 A represents the maximum steady state connected load allowed on a 65T, which can be considered the ultimate load of the URD. The worst case cold load pickup factor can be applied following a lengthy outage and the 65T will not blow (i.e.: 1.6 x 81 A = 130 A). When load diversity is restored, the peak load reduces to 81 A.

A single phase tap with 81 A of load is significant; however, the load would normally be split in half due to the normal open (N/O) point. In most cases the URD will not be fed from only one end. A general guideline is to design the URD so that the maximum load is no more than 100% of the nominal rating of the fuse (65 A for a 65T). Most URDs are not planned and built entirely in a 1-2 year period. Often developments take years to be fully constructed, and over that time development plans may be modified. Lot sizes and density may change causing higher than expected loads. Therefore, design current is 65 A, not 81 A, allowing for future load growth and unexpected load additions to the URD.

Refer to SEP 5 for complete details on system protection for urban feeders.

4.2. Transformers, Pedestals, and Switching Cubicles

Transformers, pedestals, and switching cubicles are placed according to lot layout plans provided in the overall subdivision concept plan. Placement must account for transformer loading (refer to section 4.2.1), cable voltage drop (section 4.3), non-SaskPower infrastructure, and easement requirements.

4.2.1. Transformer Types

The maximum fault level on the URD will dictate the appropriate transformer type. All transformers must have a CLF to be installed in a URD system. Note the common ‘78’ series transformers do not have a CLF, and are not to be used in URD systems. Note CSM C-26-02.01 outlines requirements for padmount transformer placement near various structures.

Refer to CSM B-08-XX for detailed transformation information.

4.2.2. Transformer Loading

SaskPower supplied padmount transformers can be loaded to 144% of the nameplate rating for a 4 hour period at 40 °C ambient temperature after being loaded for the previous 12 hours at an average load of 75% of rating without significant loss of life to the winding insulation. The large oil reservoir in the transformer tank slows the temperature rise and allows the transformer to be subjected to overload conditions for a fixed amount of time. Ambient temperature significantly affects the cooling process, such that in winter conditions the transformer can be loaded to 200% of the nameplate rating.

Loading the transformer beyond the nameplate rating will result in a larger voltage drop across the transformer windings, as shown in Table 4-2 below:

Transformer Loading	Voltage Drop
75%	1.34%
100%	1.78%
144%	2.6%
160%	2.9%
200%	3.6%

Table 4-2: Transformer Winding Voltage Drop

URD design must make economical use of all transformers by reducing no-load transformer losses. A general rule of thumb is to design for 100% (nameplate rating) transformer loading under peak steady state conditions.

Transformer loading forms the basis for determining the number of URD lots per transformer. The transformer must accommodate peak load while supplying acceptable voltage at all customer meters. Table 4-3 provides maximum expected diversified loading based on historical residential load studies. Note diversity factor increases as the number of lots increases, and becomes a significant factor with more than four lots.

Number of Residential Customers	Diversified Demand (kVA)	Expected Current (A)	Number of Residential Customers	Diversified Demand (kVA)	Expected Current (A)
1	10	42	13	57	238
2	15	63	14	62	258
3	20	83	15	65	271
4	**24***	**100**	16	68	283
5	28	117	17	70	292
6	34	142	**18**	**74***	**308**
7	38	158	19	77	321
8	43	179	20	80	333
9	48	200	21	83	346
10	**50***	**208**	22	86	358
11	53	221	23	89	371
12	56	233	**24**	**92***	**383**

Table 4-3: Transformer Loading Diversified Demand (60 Minute Average) Measured Data

* Note that items in bold correspond to available padmount transformer sizes (25, 50, 75, and 100 kVA)

A transformer can serve a specific number of lots at peak load, but that does not ensure acceptable voltage at all delivery points (meter socket). The ‘kVA per lot’ criterion is based on 60 minute average demand measured over several years as part of a residential load study in Regina. 60 minute average demand is used because transformer heating is not instantaneous. As load increases it can take several hours for the transformer to heat (transformers can be loaded to 200% of the nameplate rating for one hour in 40 °C ambient without damage).

Note the use of 167kVA transformers should be avoided for servicing single family lots. This gives SaskPower an option in the event that a 100kVA gets overloaded. 167kVA transformers can be utilized for single service (800A) or on multifamily parcels.

4.2.3. Switching Cubicles

The use of switching cubicles is generally left to the discretion of the designer. Dead front remote operated (capabilities exist but may not be active) switching cubicles are to be used in Saskatoon and Regina. This ensures the two largest urban centers will be distribution automation capable in the future. Outside of Saskatoon and Regina dead front devices are preferred, but not mandatory. Note live front switches are still an acceptable option in all areas as necessary. The designer should consider material availability, access for operating personnel, easement requirements, switching requirements, and necessity for remote operation when selecting the appropriate switching cubicle.

Refer to CSM B-26-79 for switching cubicle installation details.

4.3. Voltage Drop

The 'kVA per lot' criteria used for transformer sizing cannot be applied directly to voltage drop. Transformer sizing is based on peak 60 minute average demand; however, voltage drop has a faster response to load, so a 5 minute average demand is used.

Number of Residential Customers	Diversified Demand (kVA)	Expected Current (A)	Number of Residential Customers	Diversified Demand (kVA)	Expected Current (A)
1	15	63	13	57	238
2	20	83	14	62	258
3	**24***	**100**	15	65	271
4	28	117	16	68	283
5	35	146	17	70	292
6	42	175	**18**	**74***	**308**
7	44	183	19	77	321
8	46	192	20	80	333
9	48	200	21	83	346
10	**50***	**208**	22	86	358
11	53	221	23	89	371
12	56	233	**24**	**92***	**383**

Table 4-4: Transformer Loading Diversified Demand (5 Minute Average) Measured Data

* Note that items in bold correspond to available padmount transformer sizes (25, 50, 75, and 100 kVA)

The maximum permissible voltage drop at the above loading conditions (refer to Appendix 1: Voltage Drop Calculations) is as follows:

Secondary Cable 3.5%
Service Cable 1.5%

Power Factor 95% (based on historical data)

As per ESR Section 3.2.3.3, under normal operating conditions, steady state voltage at the customer's point of delivery shall be between 91.6% and 104.2% of nominal. The aim of the designer should be to keep the total voltage drop below the 5% total listed above.

An exception is made for multifamily services where the transformer is dedicated and located on the customer property in near proximity to the metering location. In this case the design is only required to keep the total voltage drop for the service cables below 5%.

4.4. Primary Cable

4.4.1. Single Phase Primary Cable

The standard single phase URD cable is direct buried #1 AlXLPEcJ (Aluminum cross-linked polyethylene concentric neutral jacketed). Refer to CSM C-26-04.06 for ampacity of direct buried or cable in conduit. The cable can handle the maximum contingency load on a 65T fuse.

Standard URD design practice requires that an empty 2” HDPE (High Density Polyethylene) conduit be installed between transformers, take-off structures, and/or switching cubicles for use in future cable replacement projects. As such, the maximum ampacity of the cable will be reduced when installed in conduit. The designer must be aware of those locations where the cable is in conduit when designing the URD system.

4.4.2. Three Phase Primary Cable

The standard three phase URD feeder cable is direct buried 3x 500 AlXLPEcJ. Refer to CSM C-26-04.06 for ampacity of direct buried or cable in conduit. The standard three phase distribution loop cable for servicing is direct buried 3x 4/0 AlXLPEcJ or 3x #1 AlXLPEcJ. Refer to CSM C-26-04.06 for ampacity of direct buried or cable in conduit. The cable can handle the maximum contingency load on a 65T fuse (#1 AlXLPEcJ) or 100T fuse (4/0 AlXLPEcJ).

Standard URD design practice requires an empty 5” Schedule 40 PVC (polyvinyl chloride) conduit be installed between transformers, take-off structures, and/or switching cubicles for use in future cable replacement projects. As such, the maximum ampacity of the cable(s) will be reduced installed in conduit. The Designer must be aware of those locations where the cable is in conduit when designing the URD system.

4.4.3. Conduit

4.4.3.1. Types of Conduit

SaskPower currently uses two standard types of conduit.

1) PVC (polyvinyl chloride)
2) HDPE (high-density polyethylene)

There were two other types of conduit used in the past. These conduits may be exposed or accessed in new designs.

1) Cobraduct (PVC)
2) Fibreglass duct (FRE)

These conduit are no longer being stocked, but if required, it may be possible to special order these older conduits on an as-required bases. If a requirement comes up where the old conduit needs to be spliced on to a new type of conduit, contact the Standards Department as a supplier may be able to custom make an adapter.

4.4.3.2. Sizes of Conduit

SaskPower has standardized on and stocks the following sizes:

1) PVC is available in 4” and 5” – Schedule 40, bell-and-spigot construction, 20’ lengths.
2) HDPE is available in 2” and 5” – Smooth body, continuous reel, red in colour.

4.4.3.3. Uses of Conduit

1) 4” PVC conduit is typically used in substation applications and in concrete duct formations.

2) 5” PVC conduit shall be installed in urban applications along the entire three phase primary cable route. Typically the conduit is installed as a spare and the cable is direct buried. The 5” conduit can accommodate up to three 750MCM primary cables.

3) 2” HDPE conduit shall be installed in the following urban applications. With both of the following situations, the conduit is installed as a spare and the cable is direct buried.
    - Along the entire single phase primary cable route from apparatus to apparatus or pole to apparatus.

4) 5” HDPE conduit shall be used only in directional boring applications. 5” HDPE is not to be used in an open trench, as it is difficult to handle. The conduit has a memory and will tend to either curl up or snap back to its original shape.

4.4.3.4. Conduit Design Considerations

Things to consider during when selecting conduit for your design:

- The future expansion of an area.
- Future cable replacement due to the direct buried cables age or failure.
- The future need for a capacity upgrade to an area.
- Installing multiple spare conduits in the trench in an early phase of a subdivision in order to accommodate the future requirements of the next phases.
- Will the future loads be single or three phase.
- Access and ability for the future pulling of the cable(s) in the spare conduit.
- The number of bends required in your conduit design. *CSA recommendation is four maximum bends without a pull box.
- The need for pull boxes.
- It is required to install a spare 5” conduit, capped at both ends across all road crossings.
- Concrete encased as per CSM.
- There may be more reasons, and each situation has to be looked at individually to determine not only the size of conduit, but also the number of them being installed.

At this time, we do not install conduit for secondary as a standard design. However, if conditions warrant, the option is available (ie: rocky terrain or an area that may become inaccessible in the future).

Construction Standards Manual references

- B-14-100 Series – Duct Formations
- C-26-04.14 – Cable Pulling Tensions and Max Pull Lengths
- B-14-65 – Conductor Depth of Cover
- C-26-04.06 – Primary XLPE Cable Ampacities

4.5. Secondary and Service Cables

4.5.1. Secondary Cable

The standard secondary cable is direct buried 2x 500+500 AlPEJ (aluminum polyethylene jacketed) rated for 640A (refer to CSM C-26-04.13) in residential applications. The secondary cable runs from transformer to pedestal and between pedestals.

4.5.2. Service Cable

The standard service cable from pedestal to meter socket is typically 2x 1/0+1/0 AlPEJ; however, alternate cabling may be used to accommodate larger service sizes or to address voltage drop concerns. Note that 4/0 cable can be terminated in a standard 200A meter socket, but 350MCM and 500MCM cannot.

4.6. Grounding

All single phase padmount transformers will have a ground grid as per CSM B-33-XX. Pedestals require a service pedestal ground grid (refer to CSM B-33-34). Refer to CSM B-33-XX for grounding requirements for all three phase equipment.

4.7. Roadway Lighting

Refer to SEP 4 Roadway Lighting Design Guide, which provides guidelines and information required to design roadway lighting systems.

Note that the City of Saskatoon and the City of Swift Current are responsible for all roadway lighting design, engineering, and construction within their municipal boundaries. SaskPower is responsible for providing a meter point for street lights in these cities when requested, and the designer will have to work with the developer and/or city to determine the appropriate meter location(s).

SaskPower may provide a meter point for roadway lighting at customer request. For instance, where the customer installs and maintains lighting (Department of Highways, University of Saskatchewan, multi-unit parking lots, etc.).

5. Layout and Construction

The following describes layout requirements for URD systems. Construction mapping will be required to have the following (at a minimum), and all maps will be required to comply with the Distribution Engineering Mapping Standard:

- Trench line locations and offsets
- Primary and secondary schematics
- Equipment locations and sizes
- Easement map
- Key map

Refer to CSM B-02-XX for symbol orientations.

5.1. Urban Transformer and Pedestal Locations – Rear Lot with no Lane

Transformers should be located on the ends of blocks in the corner of the lots for easy access for operating staff. Ideal designs have the transformer outside of the customer's fence so operating staff do not have to access the transformer thru the yard. If the block is too long a second run of 2x 500+500 AlPEJ secondary may be used rather than installing a transformer mid-block. Refer to Figure 5-1.

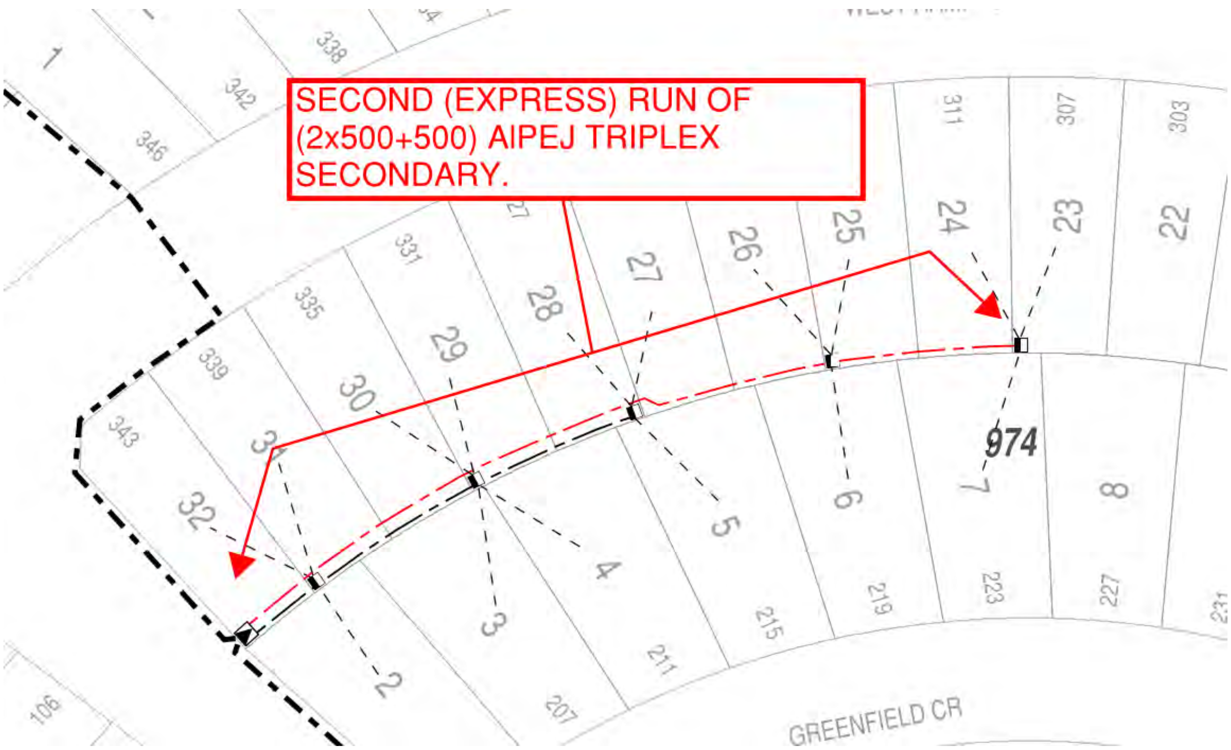

Figure 5-1: Rear Lot with No Lane – Transformer Layout

If the block is such that a second run of 2x 500+500 AlPEJ does not meet minimum voltage requirements, another transformer must be placed in the center of the block. If the transformer is placed at the back of the lot, a 4.5 m wide access route (as per CSM B-14-50) to the transformer should be obtained if possible. If the transformer is placed at the front of the lot, a minimum 2 m side lot easement would be sufficient to install primary to the transformer. Refer to Figure 5-2, Figure 5-3 and 5-10.

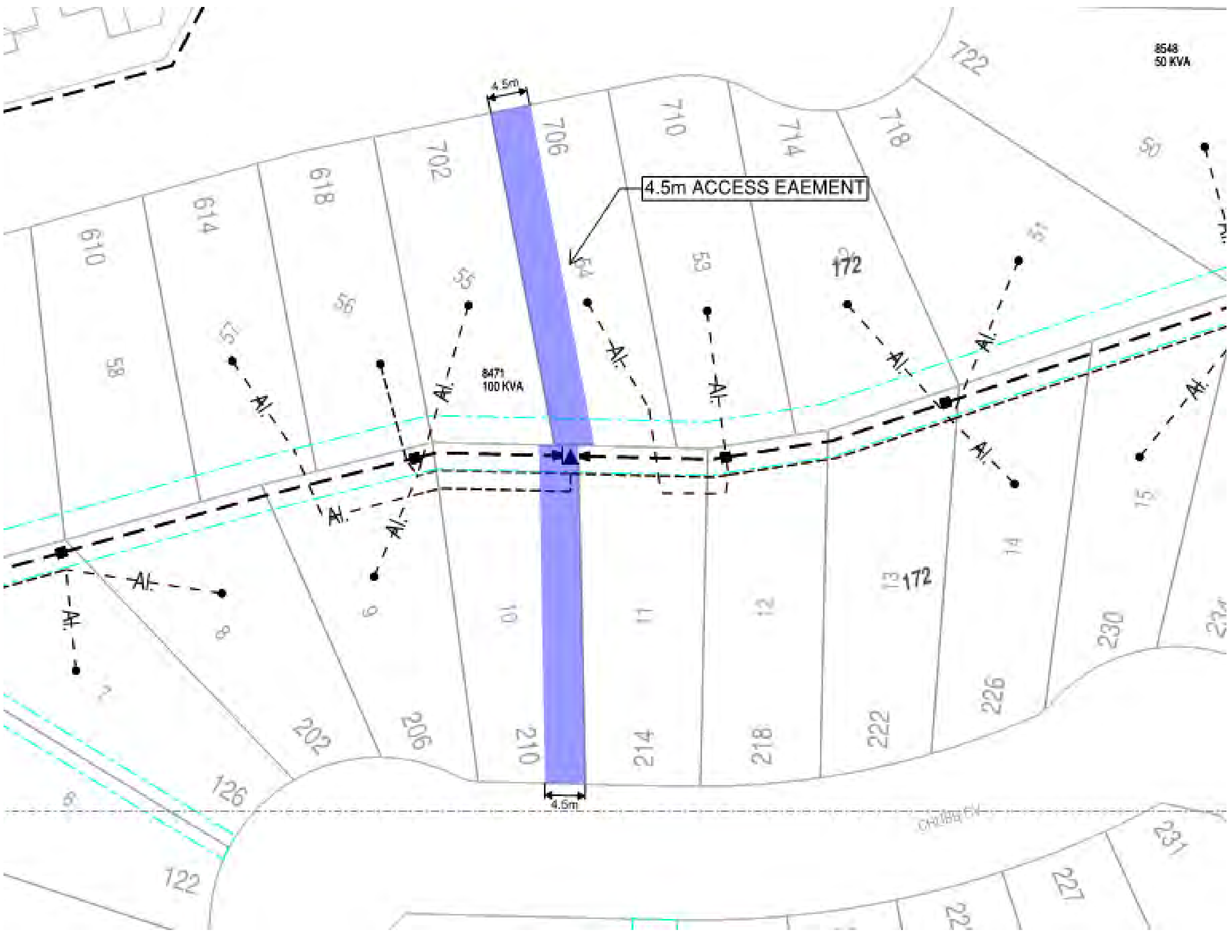

Figure 5-2: Rear Lot with No Lane – Side Lot Easement Example 1

Figure 5-3: Rear Lot with No Lane – Side Lot Easement Example 2

Pedestals are normally supplied with three eight-hole termination blocks (cookies), allowing for two main feeds (2x 500+500 AlPEJ) and four services (2x 1/0+1/0 AlPEJ). Note that more than four services from a pedestal is permitted in special circumstances, but is not standard design practice. Maximum is 5 services to leave room for expansion. Refer to Figure 5-4.

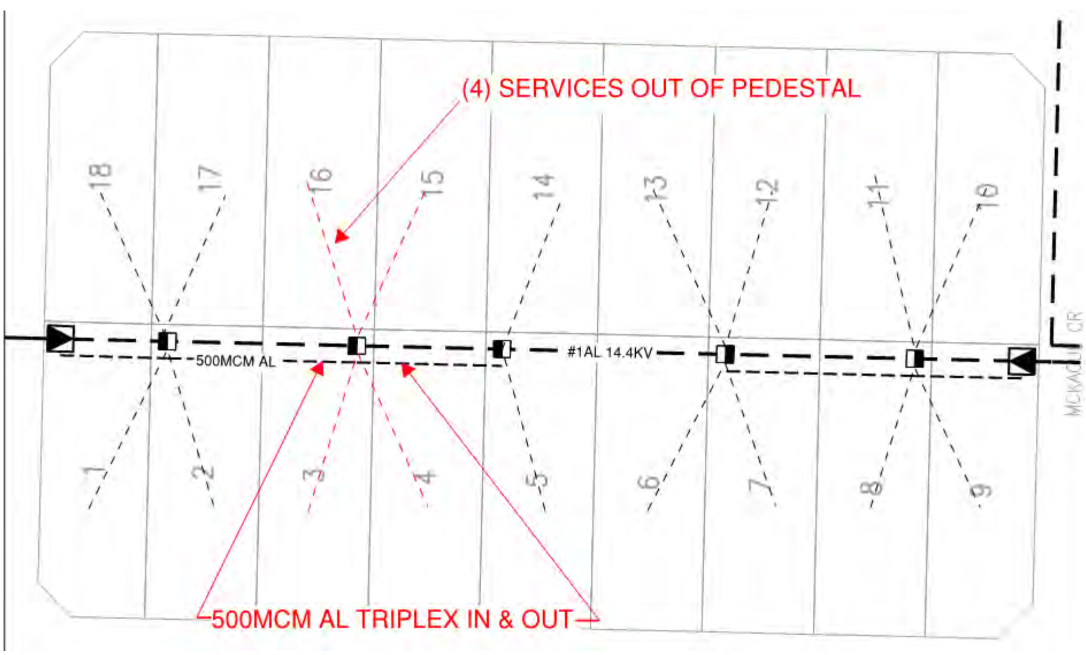

Figure 5-4: Rear Lot with No Lane – Pedestal Layout

When the rear lot lines do not match up, service stubs can be used as shown in Figure 5-5.

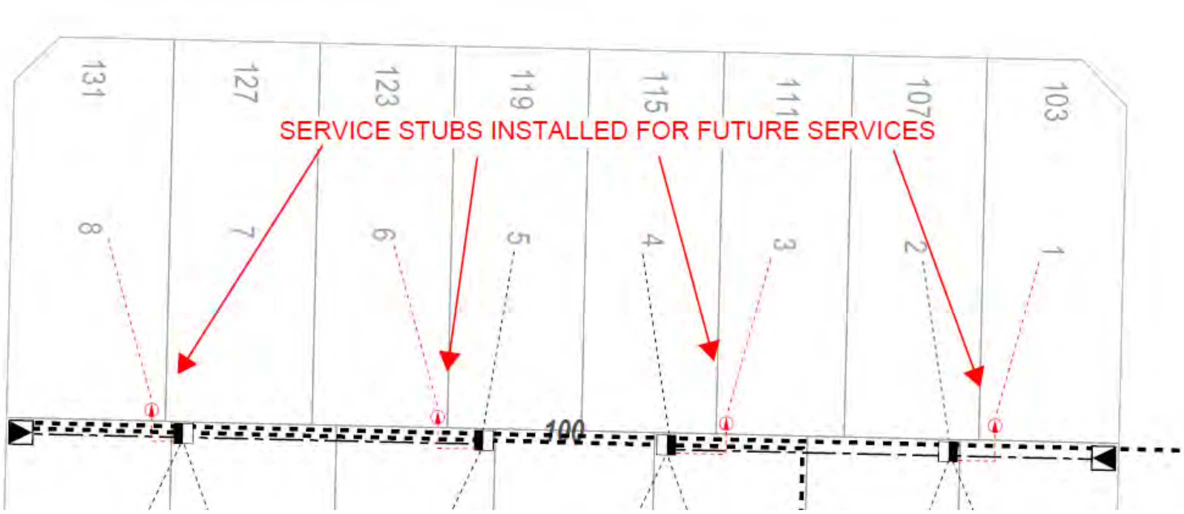

Figure 5-5: Rear Lot with No Lane – Pedestal Layout for Staggered Lots

5.2. Urban Transformer and Pedestal Locations – Rear Lane Lots

Transformers and pedestals should be located on private property where possible to avoid vehicle traffic in the alley. They should be located completely in one lot where lot size exceeds 10 m. Refer to Figure 5-6.

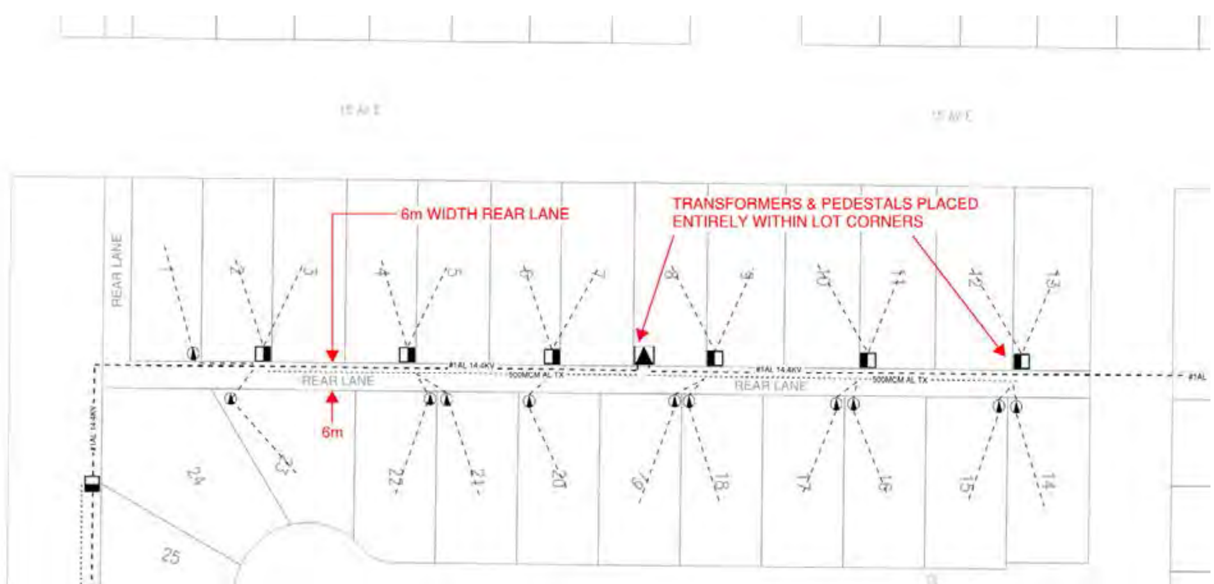

Figure 5-6: Rear Lane Lots – Transformer Layout

When lot sizes are less than 10 m, pedestals and transformers should straddle the lot lines, so each lot has room for a garage. If necessary, transformers can be placed entirely in the corner of a larger lot that will not contain a pedestal. The placement of pedestals and transformers should be coordinated with the developer. Options may include:

- trench lines, pedestals, and transformers all in the property
- transformers only in the property
- pedestals and transformers only in the property with the trench in the lane
- any other working arrangement

Note the property pin should not be covered. Refer to Figure 5-7 and Figure 5-8. Service cables should be run across the lane, just inside the lot, to a service stub. (refer to CSM B-30-21). Note for Turnkey Subdivision service stub details refer to CSM B-14-59.

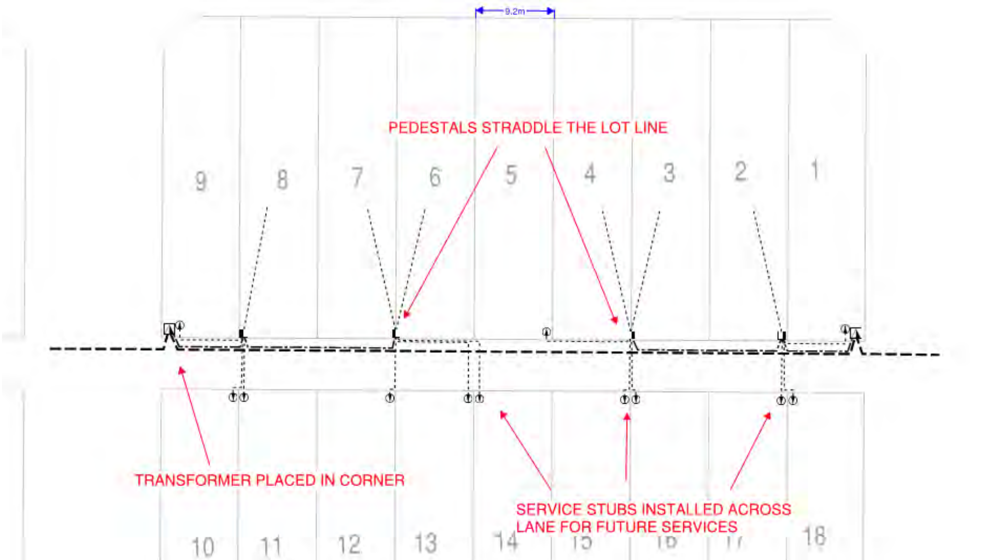

Figure 5-7: Rear Lane Lots – Lot Size Less Than 10 m

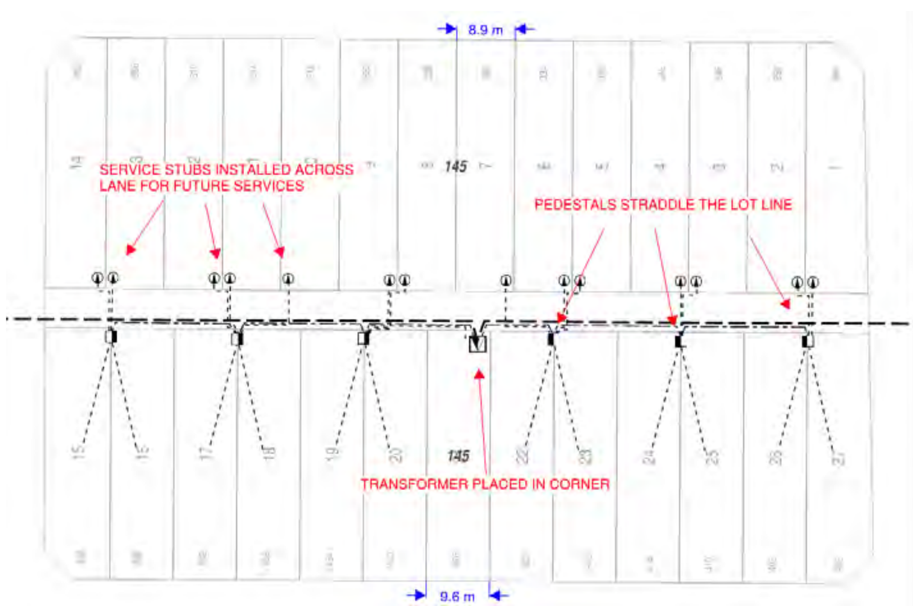

Figure 5-8: Rear Lane Lots – Lot Size Less Than 10 m with Staggered Lots

5.3. Urban Transformer and Pedestal Locations – Front Street

This section intentionally left blank. Front street distribution standards are currently being developed.

5.4. Easements

SaskPower minimum easement requirements are specified in SaskPower's *Acquisition of Land Rights for Electrical Facilities in Saskatchewan* (copies can be requested from the SaskPower Land Department). Separate easement drawings are required for complex projects, specifically subdivisions. Examples of separate easement drawings are provided below.

A 5 meter wide joint use easement is needed at the rear of the lots where the back of the lots butt up against the side of an adjoining lot. This provides adequate space for SaskPower, SaskEnergy, Telephone, and Cable TV facilities. Refer to CSM B-14-XX for facility placement in the shared easements. Two 3 m wide easements are needed at the rear of back to back lots, where SaskEnergy completely utilizes one 3 m easement on the opposite lot. Refer to CSM B-14-50 and Figure 5-9.

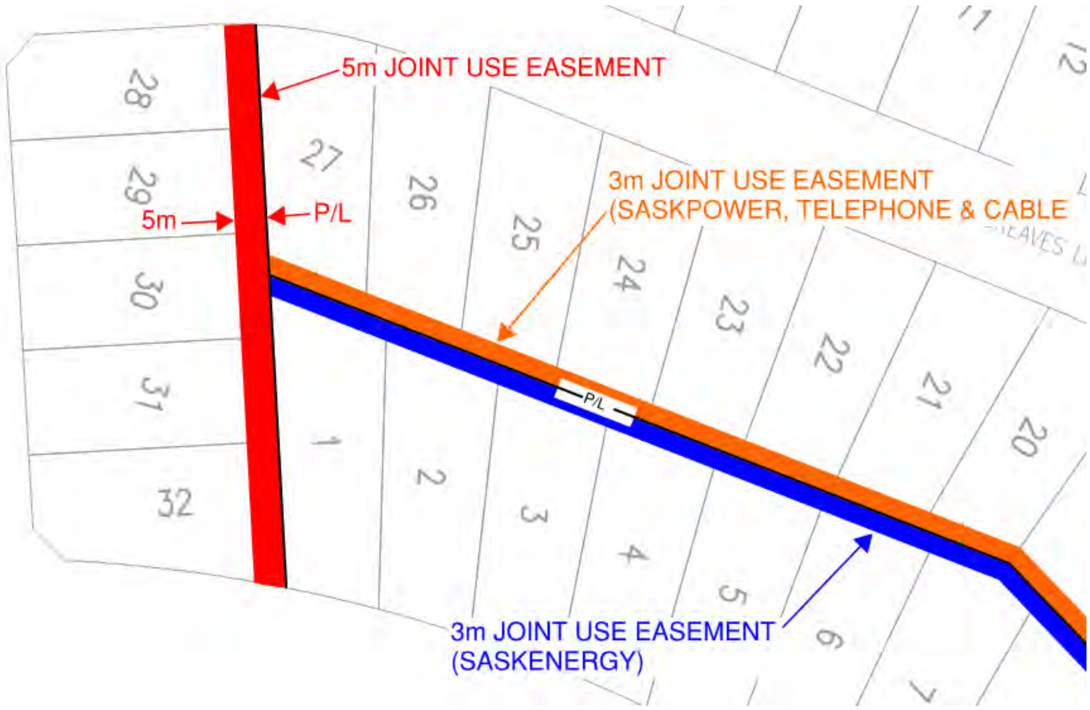

Figure 5-9: Typical Rear Lot Easements

A 2 m wide easement can be used along the side of a lot to allow cable access to the street (ex: primary cable or streetlight cable). Refer to Figure 5-10.

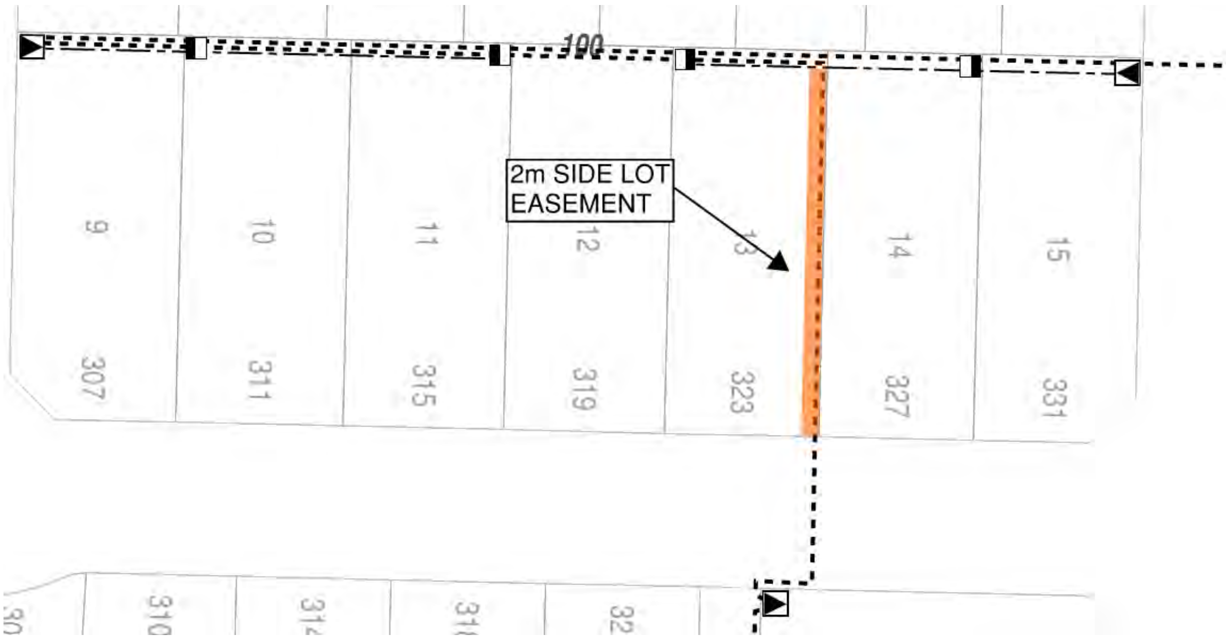

Figure 5-10: Typical Side Lot Easement

For rear lot construction with a rear lane, a 2 m wide easement may be required to place facilities on the back of the lots. Note these easements will need to be coordinated with the developer and local municipality. Where the main trench line is located in the rear lane, the transformers require a minimum 2 m x 2 m easement and the pedestals require a minimum 2.75 m x 2 m easement. Refer to Figure 5-11 and Figure 5-12.

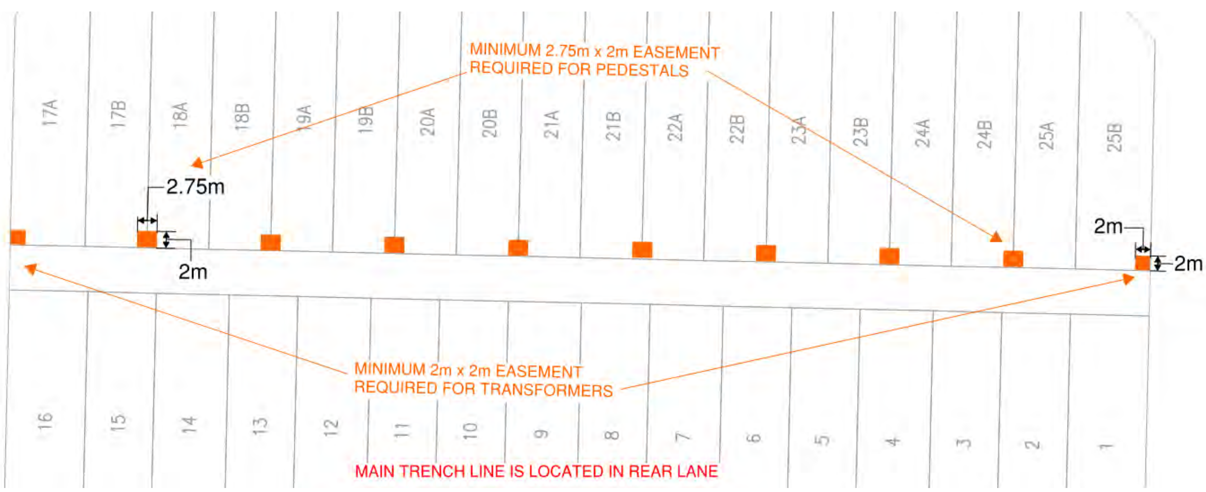

Figure 5-11: Rear Lane Lots – Pedestal Easements

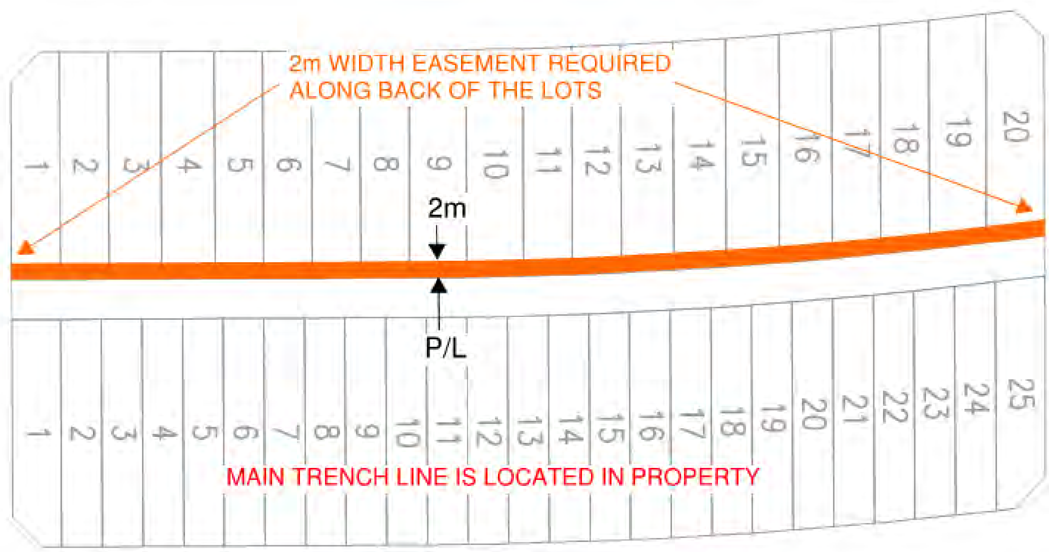

Figure 5-12: Rear Lane Lots – Primary Cable Located in Property

Offset allowances should be considered for developer fencing, concrete swales, and subdivision earth berms. Coordinate offsets with the developer and/or local municipality. Refer to Figure 5-13 and Figure 5-14.

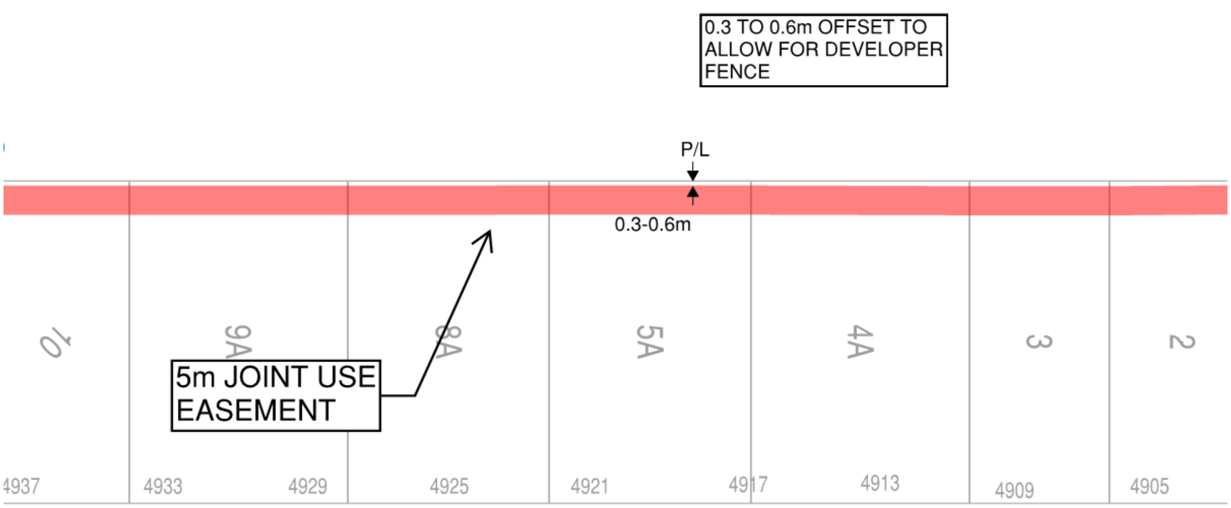

Figure 5-13: Easement Offset for Developer Fence (Example Only)

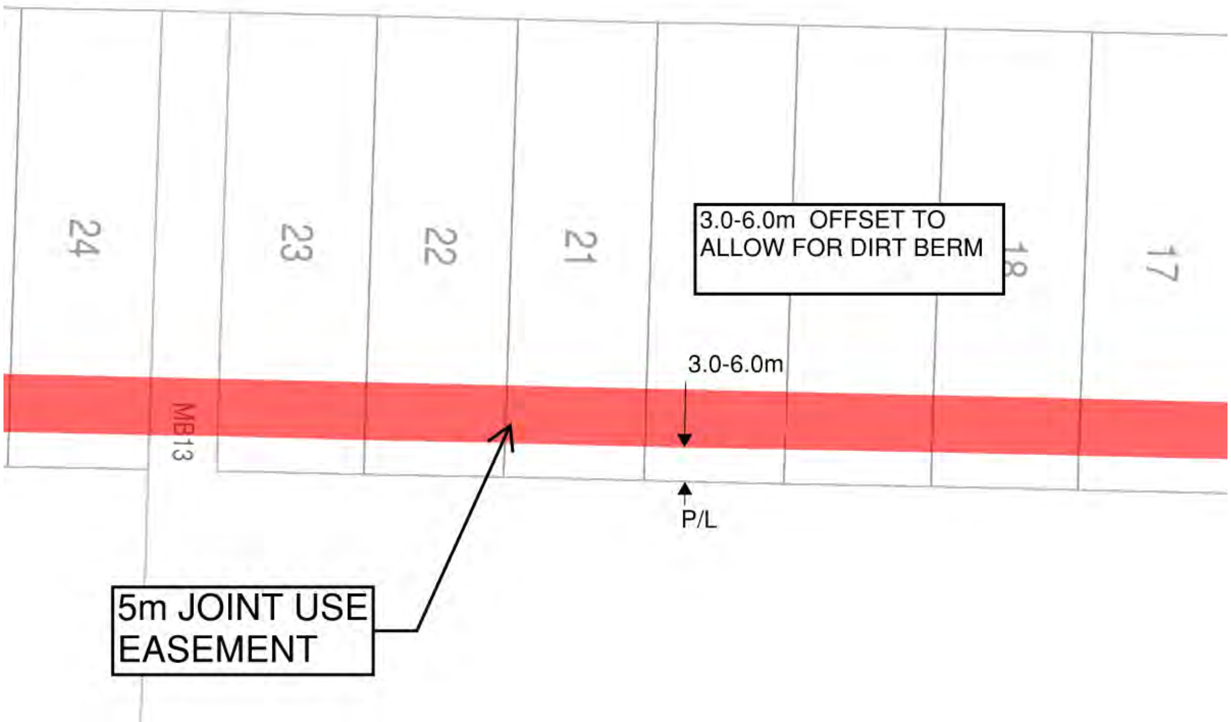

Figure 5-14: Easement Offset for Developer Berm (Example Only)

Three phase apparatus installed on modular vaults require a 6 m x 8 m easement due to the size of vault and ground grid. Three phase transformer easement requirements are determined by the size of the vault and ground grid (refer to CSM B-33-XX).

6. Servicing Multifamily Parcels

Multifamily parcels can be broken into four main areas as outlined below. Refer to the voltage drop section for a specific note on multifamily services.

6.1. Condo Sites

- Single title, one parcel, one owner
- Condo Association stewards the site, once operational
- Service as per ESR 2.1.4.2 – Maximum of two points of delivery per building
- Typical servicing arrangement
    - Customer splitter cabinet with customer main disconnect and meter stack(s)
    - ESR Figures 2-7 and 2-12
- Easements required for primary cables and transformers
- No easements required for service cables

6.2. Bareland Condo Sites

- The land around all building structures is held under one title
- Units are individually titled and owned
- Condo Association stewards the site once operational
- Service as per ESR 2.1.4.2 – Maximum of two points of delivery per building
- Typical servicing arrangements
    - 2 to 4 gang meter troughs – ESR Figure 2-7
    - Customer splitter cabinet with customer main disconnect and meter stack
- Easements required for primary cables, transformers and service cables

6.3. Row Housing Sites – Individually Titled Lots

- A separate title is registered for each unit and the land it sits on
- Service as per ESR 2.1.4.1.1
- Typical servicing arrangements
    - 100A or 200A meter socket for each unit – ESR Figures 2-1 and 2-3
    - Note, we are able to have more than two services to the same building because of fire separation between units and the land is subdivided into individual titles
    - Meters to be mounted on the back of the units or at the back of the garage
    - The garage is most likely, in order to avoid future service line encroachments
    - Service stubs locations would need to be confirmed with the developer and approved prior to any construction
- No easements required for the service cables, provided they remain on the titled lot they service

6.4. Granny Suites on top of Garages

- An additional service to the lot is acceptable.
- Service as per ESR 2.1.4.1.1
- Typical servicing arrangements
    - 100A or 200A meter socket mounted on or near the garage – ESR Figures 2-1 and 2-3
- No easements required for the service cables

6.5. Typical Service Conductor Sizing

- (**2x1/0+1/0**) AlPEJ Triplex for 200A single unit and 200A (2x100A meter sockets) duplex units
- (**2x4/0+4/0**) AlPEJ Triplex for 400A (4x100A meter sockets) four-plex units
- (**2x500+500**) AlPEJ to splitter cabinets for condo buildings and two story row housing
    - The number of runs will vary with the number of units and the length of the run

7. Rural Subdivisions

7.1. Primary Cable

The standard single phase RUD cable is direct buried #2 AlXLPEcJ (Aluminum cross-linked polyethylene concentric neutral jacketed). Refer to CSM C-26-04.06 for ampacity of direct buried cables.

7.2. Secondary and Service Cables

7.2.1. Secondary Cable

The standard secondary cable is direct buried (2x 500+500) AlPEJ (aluminum polyethylene jacketed) (refer to CSM C-26-04.13) for secondary cable runs from transformers to joint use pedestals and in between joint use pedestals.

7.2.2. Service Cables

The standard service cable from a joint use pedestal or transformer to free standing metering pedestal is typically (2x 350+350) AlPEJ; however, alternate cabling may be used where voltage drop is not a concern. Note that 350MCM cable (and smaller) can be terminated in a free standing metering pedestal, but 500MCM cannot.

7.3. Protection and System Loading

Refer to the Distribution Planning Guidelines and SEP 5.

7.4. Transformers, Pedestals, and Switching Cubicles

7.4.1. Transformer Loading

Subdivisions with urban lot density (0.25ac-1.00ac) follow tables 4-2 and 4-3. When lots exceed 1.00ac other criteria will need to be considered including: secondary distances, customer service distances, grading, lot shape, subdivision layout, house sizes, outbuilding allowances etc.

7.4.2. Free Standing and Joint Use Pedestals

As per ESR 2.1.4.1.2 free standing metering pedestal is the only option for servicing in a rural subdivision.

7.5. Rural Transformer and Pedestal Locations-0.25ac-1.00ac lots

Lots are more typical of urban residential style layouts. Front Street or rear lot distribution are the available options. Typically ~5m max offset for free standing pedestal from property line.

7.6. Rural Transformer and Pedestal Locations-1.00ac-10.00ac lots

These are very large lots. Front street distribution is typical for the primary route and transformer placement. Work with developer for offsets of free standing metering pedestals.

7.7. Easements

Standard 3m easement along cable route(s). SaskEnergy and SaskTel should be considered for joint use easements e.g. 5m joint use easement.

7.8. Vegetation

Developer shall be responsible to clear vegetation/debris along the cable route for the entire easement width, and at pedestal locations. Communicate this requirement to the developer, when applicable.

8. Turnkey Developments

Developers will have to apply the same guidelines and design principles as described in the previous sections when designing URD. There are two exceptions: turnkey developments are to utilize a 4-party joint easement and trench, and service posts are to be installed as described in the following sections.

8.1. Urban Transformer Locations, Pedestal Locations, and Easements – Turnkey Development Rear Lot with no Lane

1. Refer to Section 5.1 of this document for transformer and pedestal placements for rear lot distribution with no lane, and for design guidelines with regards to the secondary runs.
2. Temporary wooden service posts are to be installed at each lot to accommodate coiled up electrical and telecommunication cables and/or conduits. Overall layout and easement requirements are covered in CSM B-14-52. Note a reduced 4 m wide 4-party easement is used.
3. Service trench layout, service post, and metering details for 4-party trenching are covered in CSM B-14-59.
4. Trench layout and utility crossing details for 4-party trenches are covered in CSM B-14-66.

8.2. Urban Transformer Locations, Pedestal Locations, and Easements – Turnkey Development with Rear Lane Lots

1. Refer to Section 5.2 of this document for transformer and pedestal placements for rear lot distribution with no lane, and for design guidelines with regards to the secondary runs.

2. Temporary wooden service posts are to be installed at each lot to accommodate coiled up electrical and telecommunication cables and/or conduits. Overall layout and easement requirements are covered in CSM B-14-53.
3. Service trench layout, service post, and metering details for 4-party trenching are covered in CSM B-14-59.
4. Trench layout and utility crossing details for 4-party trenches are covered in CSM B-14-66.

Appendix 1: Voltage Drop Calculations

The approximate voltage drop in a conductor is defined by Equation 2 below. Note Equation 2 has an error of less than 0.1% for power factors near unity (typical for residential loads), and approaches zero as the power factor of the load equals that of the supply system.

$$\boldsymbol{V_D = I(R\cos\theta + X\sin\theta)} \tag{2}$$

Where: $V_D = Voltage\ drop\ in\ the\ conductor$

$I = Current\ in\ Amps\ in\ the\ conductor$

$\theta = Power\ factor\ angle$

$R = Resistance\ in\ Ohms\ at\ a\ specified\ conductor\ temperature$

$X = Reactance\ in\ Ohms\ at\ a\ specified\ conductor\ spacing$

Normalizing resistances (R and X) to Ohms/1000ft, and including the length of secondary (one way), results in Equation 3 below:

$$\boldsymbol{V_D = 2I\left(\frac{R}{1000}D\cos\theta + \frac{X}{1000}D\sin\theta\right)} \tag{3}$$

Where: $D = Length\ of\ secondary\ (one\ way)$

Calculating the voltage drop percentage for a 240 V system results in:

$$\%\boldsymbol{V_D} = \boldsymbol{\frac{V_D}{240} \times 100} \tag{4}$$

$$= \frac{1}{240}2I\left(\frac{R}{1000}D\cos\theta + \frac{X}{1000}D\sin\theta\right) \times 100$$

$$\%\boldsymbol{V_D} = \boldsymbol{\frac{1}{1200}ID(R\cos\theta + X\sin\theta)} \tag{5}$$