"TCL1"

Development of the Default Conduit and Pit Placement Ratios Used in the TEA Model

Background

The TEA Model applies input ratios in respect of conduit placement activities. The following describes, in summary form, the process undertaken to determine appropriate ratios for breakout and reinstatement activities for use in the Model.

As set out in *TEA Model Documentation* (page 48), the TEA model requires a number of input ratios to be applied to trench lengths. These ratios apply to:

- Breakout (the breaking open of the surface cover to obtain access to the ground beneath for the purpose of digging trenches), the cost of which depends on whether this activity is carried out in the following ground surfaces:
    - Pavement less than 75mm thick
    - Pavement between 75 and 150mm thick
    - Pavement between 150 and 200mm thick
    - Brick or concrete pavers
- Placement (the digging of trenches or boring of tunnels to house underground conduit), the costs of which depend on whether this activity involves:
    - Excavation on the side of a road
    - Excavation on a road
    - Directional boring under nature strips, footpaths and driveways
    - Directional boring under roads
    - Trenches provided by other parties (developers of new estates)
- Reinstatement (the replacement of the surface cover over the trench once it has been back filled), the cost of which depends on whether this activity is carried out in the following ground surfaces:
    - Unreinforced concrete (of three different thicknesses)
    - Reinforced concrete (of three different thicknesses)
    - Asphalt (of three different thicknesses)
    - Brick or concrete pavers
    - Turf (grass)

- Kerbing (guttering)

The placement, breakout and reinstatement ratios used in the model were determined through a series of meetings between, and analysis conducted by, numerous subject matter experts. Representatives of Telstra's' engineering department and the modelling team conducted several meetings to come to a consensus on the appropriate factors for use in the TEA model. In addition to their extensive knowledge of Telstra's network and service territory, the team relied on the following types of data and analysis to derive the default values in the TEA model. In particular the team:

- Reviewed maps to ascertain the proportion of each of the density groups that would be classified as industrial, high rise residential or major commercial (i.e. developed urban or market areas):

- Used an analysis of average lot sizes in each density group to ascertain the proportion of the service area that was constructed prior to the time when nature strips became standard in designing roadways:;

- Reviewed numerous network planning maps for typical serving areas that would fall into each density classification used in the model to estimate the types, quantity and sizes of different driveways, roads and footpaths a company would encounter when replacing the network;

- Used the lot size analysis to estimate what proportion of the average lot frontage would be traversed by driveways and footpaths; and

- Estimated, based on standard block sizes, the proportion of a total cable run that would need to traverse existing streets and roads.

Based on their expert knowledge and the supporting analysis the team determined the placement factors used in the model.

The result of these analyses and deliberations is the set of placement, restoration and breakout parametres that are used to derive the composite trenching costs in the TEA model. Ratios have been determined separately for the following categories of placement, restoration and breakout activities:

- The types of placement activities (i.e. trench turf, trench and restore asphalt and concrete and bore) required in placing distribution pits, manholes and conduit runs in each of the density categories;

- The types of placement activities required in placing main pits and conduit runs in each of the density categories; and

- The thickness of the concrete and asphalt surfaces that would be encountered in constructing a new network.

The same basic types of placement activities are required for placing pits, manholes and conduit in similar geographical areas. The conduit and the pits and manholes are all placed in the same right of ways so the conditions for placing each are similar.

Following is a synopsis of the analysis and rationale underlying the development of the default factors used to calculate composite placement costs in the TEA model.

Provided with this discussion paper are several attachments that illustrate the deliberation process used in compiling these factors.

Ratios for the types of placement used in constructing distribution pits and conduit runs in the distribution network

The group first identified the types of placement activities that would be required in replacing the existing Telstra distribution network in Band 2 exchanges:

- Trenching through turf;
- Trenching through roadways;
- Trenching through or under footpaths;
- Boring under roads; and
- Boring under footpaths.

These categories match the placement activity categories found in the current Access and Associated Services (A&AS) contracts between Telstra and its contractors. Consequently, the ratios can be applied to the construction prices that are contained in these contracts.

ESAs are allocated to one of five density zones based on the average number of SIOs per square km in the ESA. The relevant densities for each density zone are set out in Attachment 3.

The guiding principle for selecting placement ratios for use in the TEA Model is to minimise costs. In each instance the least cost placing activity available for placing plant in any given environment has been selected. The two caveats to this principle being that the placement activity being employed must conform to Telstra's best practice efficient engineering principles and guidelines and any applicable governmental regulations and standards. Hence, the use of the least cost open trench through turf construction approach is adopted whenever environmental considerations allow (i.e. the conduit does not traverse a concrete drive, footpath or road). Similarly, when given the option of trenching through or boring under a road or footpath the more economical boring option is selected.

Using this basic principle, each of the density zones has been analysed to estimate the percentage of time that roads, footpaths or driveways necessitate the used of cut and restore trenching or boring placement techniques. This was done using a three step process;

1. Estimate, by density category, the percentage of the total area that would be characterized as being primarily major commercial, high rise residential and/or industrial areas where the footpath or parking area extends from the roadway to the building (in those areas, breakout and reinstatement of the footpath or other concrete/asphalt surface cover will be necessary).

2. Estimate the percentage of the remaining residential areas that lie in areas that were constructed prior to the time when nature strips became prevalent in road and footpath construction (in those areas, breakout and

reinstatement of the footpath or other concrete/asphalt surface cover will be necessary).

3. Use the lot size characteristics of each density zone to determine the portion of the nature strips for a normal distribution block that would be traversed by footpaths, drives and roads (this breakout and reinstatement will be necessary notwithstanding that in these areas most of the trenching will be in the turf nature strip).

Actual density, average lot sizes and average lot frontage calculations were used to facilitate the analysis in each of the steps identified above. Judgement is required when analysing the average lot and lot frontage amounts. Generally in any given area, the lot sizes and frontages will be similar on most streets. In older areas the standard lot frontages may be 10 to 15 metres compared to 20 to 25 metres in newer neighbourhoods. However, the average lot frontage size for any group of new and old areas could fall in the 10 to 15 metre range or the 20 to 25 metre range depending on the mix of new and old neighbourhoods in the ESA. Thus, when comparing lot sizes it is important to recognize that an average lot size that falls in the small lot range is only an indicator of the relative mix of the types of lots in the area and not indicative that the whole area can be categorized as having a single set of lot characteristics.

Step 1: the proportion of each density zone which is major commercial

The first step in the process is identification of the proportion of each density group that is classified as high rise residential, industrial or major commercial. The objective is to identify those commercial areas, especially those with older high rise apartments, hotels, shops and factories, where a driveway or footpath extends from the roadway to the front of the building. In these areas, cut and restore of asphalt or concrete footpath or boring under the footpath is the only option available for placing new conduit facilities. Based on the customer density, the team concluded that virtually all areas categorized as density group one fall into this classification. With a density of over 4000 customers per kilometre, virtually all of these areas are comprised of multitenant buildings or densely packed commercial or industrial areas or complexes.

The proportion of each of the other density areas (i.e. 2 through 5) that fall into this category has been estimated based upon the average customer density and lot sizes in the areas. In all cases a very small proportion of the total area is assumed to be comprised of these major commercial areas. The approximate proportion of the area categorised as major commercial for the other four density categories runs from a high of 10 to 15 percent in density group 2 to a low of 0 to 2 percent for density group five. The assumed percentage of occurrence for each density group is identified in the following chart:

Comercial and Industrial as Approximate % of the Total Area

	Maximum	Minimum
Density Group 2	15%	10%
Density Group 3	12%	8%
Density Group 4	8%	3%
Density Group 5	2%	0%

Step 2: areas without nature strips

The second step in the process is the identification of residential areas constructed prior to the time when nature strips became prevalent in road construction. Many older neighbourhoods were designed without nature strips running down every road. These are usually older areas around the city centre. Without nature strips, cut and restore footpaths or boring needs to be employed in constructing new conduit lines.

Older neighbourhoods are generally characterised as having smaller houses and accompanying lots. For this reason, lot frontage is the predominant factor in determining the percentage of each density group that falls into this classification. Areas with average lot frontages of less than 15 metres are considered to fall into this classification. Average lot areas are calculated using the maximum and minimum customer per square kilometre for each of the density zones. Lot frontages are estimated calculated using two types of lot configurations: 1) lots that are twice as deep as they are wide, and 2) lots that are three times as deep as they are wide. The calculation is made by dividing one square kilometre by the average number of SIOs per square Kilometre for the density zone.

Attachment 1 identifies the calculated average lot frontages for each of the density groups. As discussed above, lot frontage calculations for Density Group 1 are meaningless since these tend to be densely populated commercial and high-rise residential areas. As for the other density categories, the average lot frontage for Density Group 2 areas is in general less than 15 metres across. As a result slightly more than 50 percent of the total population of houses in this density group is classified as being built prior to deployment of the modern road design which includes nature strips. For the remaining density groups, it is estimated that less than 50 percent of the customers' residences fall into this classification. The proportion of the residences ranges from approximately 40 percent for density group 3 to approximately 1 percent in density group 5.

Step 3: concrete/asphalt that traverses nature strips

The final step in the process is determining the placement ratios for residential areas constructed subsequent to the standard use of nature strips in road construction. It is assumed that all such areas have nature strips where new conduit facilities can be located. Normal trenching without extensive restoration is the predominant placement method employed in these areas. More expensive cut and restore or boring options are only used when crossing streets, footpaths and drives.

Driveways

The standard lot widths in Attachment 1 are the basis for determining the proportion of the length of a standard block that is bisected by drives. The number of drives in a standard block is identified by dividing a standard block length (i.e. 160 to 200 metres depending on the density group) by the maximum and minimum average lot widths for each density group.

The total width of drives in a block is determined by applying the average drive width (assumed as 3 metres) to the number of drives on the average block. This amount is then used to develop the proportion of the block length that is traversed by drives. Attachment 2 identifies these calculations for each density group. Note that in some instances, the minimum or maximum average lot frontage is less than 15 metres. The placement ratios derived from these lot sizes is ignored in the calculation of the composite placement ratios for these density groups because lot frontages of less than 15 metres are assigned to the previous category (i.e. older neighbourhoods). As shown on attachment 2, the proportion of a block-long nature strip that is assumed to be traversed by drives ranges from 18 to 20 percent for Density Group 2 to 1 to 10 percent for Density Group 5.

Roads

The standard block length (160 to 200m) is also used to estimate the proportion of the standard cable run that requires boring or cut and restoring roads and footpaths. Appendix A, B and C of the Streetworks Code (attached to this filing) are used to indentify the minimum width for arterial, collector and sub-collector roads and their associated footpaths of 64, 19 and 16 metres, respectively. Using these street widths and the average block length we are able to estimate that 7 to 12 percent of an average conduit run is placed under roadways depending on the density group. The calculation of these amounts is also identified in Attachment 2. Note that in deriving the estimates very little weight was given to the width of arterial streets.

Total proportion of concrete/asphalt

The proportion of area of each density group that requires cut and restore or boring for conduit placement is derived by combining the results of the three analyses. Attachment 3 depicts the process employed to derive the actual default ratios used in the model. As can be seen on these sheets, the ratios derived are within the ranges that result from applying the processes discussed above.

As stated previously, where feasible, boring is the preferred method for placing conduits under streets and drives. For small conduit configurations, boring is the least cost option for placing conduit under a road or drive. Over 99% of the total distribution conduit in the network design produced by the TEA model consists of a single 50 or 100 mm conduit. In placing conduit in normal terrain, the TEA model assumes simple trenching through turf (i.e. no cut and restoring of concrete or asphalt) are employed over 53% of the time. Boring is assumed to be used in 93% of the instances when simple trenching can not be employed. The more expensive cut and restore options are employed for only 3% of the lines placed in normal terrain. Note that boring cannot be used when placing conduit in rocky terrain.

For a conduit configuration consisting of two or more conduits (less than 1 % of all distribution conduits) boring is not a network approved option so it is not used in the model.

Ratios for the types of placement used in constructing main pits, manholes and conduit runs in the main network

The list of placement activities used to determine the ratios for placing main conduit is the same as that used for placing distribution conduit:

- Trenching through turf;
- Trenching through roadways;
- Trenching through or under footpaths;
- Boring under roads; and
- Boring under footpaths.

The same guiding principles used in developing the distribution ratios are used to derive the main placement ratios used in the model. The objective is to minimize costs while adhering to Telstra's best practice engineering principles and guidelines and any applicable governmental regulations and standards.

Unlike the distribution ratios analysis, the main ratios do not vary between density groups. The panel of expert network engineers determined that in the main network the size of the conduit configuration is more relevant to the methods employed to place the conduits than customer density, because unlike the distribution network, where virtually all the conduit configurations consist of a single conduit, the main routes frequently employ larger conduit configurations. In addition, main conduits tend to run along major roads and are generally located in the more densely populated portions of exchanges. It was also determined that the probability of the need to use cut and restore or boring conduit placement options increased as:

- The conduit run approached the exchange; and

- The size of the conduit configuration increased.

Exchanges are generally located in centralised commercial areas where there is less opportunity to place conduit using simple trenching options. In densely populated commercial areas, footpaths often extend from the street to the building, requiring the use of placement options that include cut and restoring concrete or boring placement techniques. As the main conduit run moves away from the exchange it begins to pass through less densely populated areas where the opportunity of placing the conduit in a nature strip using simple trenching techniques is more prevalent. In addition, the newer areas where nature strips are more prevalent, are also located farther from the city centres and hence the exchanges. For both these reasons, it was determined that distance from the exchange and the size of the conduit are the most relevant factors in determining the types of placement activities that may be deployed.

The size of a conduit configuration impacts whether it can be placed in the nature strip. As shown on Appendix A, B and C of the Streetworks Code attached to this submission, very little area is allotted for telecommunications conduit in the standard street arrangement. On sub-collector roads the telephone easement is only 0.3 metres wide. Once a conduit configuration exceeds a total number of 6 conduits, there is not enough room in the telephony easement to place the conduit and leave an appropriate distance between the telephone facilities and the facilities of other service authorities such as gas, water and electric companies. Hence, conduit configurations of more than six conduits are generally always placed beneath the footpath.

Conduit size is also an excellent indicator of how far a section of a cable run is from the exchange building, because a main cable run will require fewer conduits as it extends out to the farther reaches of the serving area. Since, as explained previously, large conduit runs will often not fit into the telecommunications easement in the nature strip and they are an indication that the run is approaching the city centre, the size of the main conduit configuration is the best predictor of the probability of being able to place main conduit runs in nature strips using simple trenching techniques. Consequently, the size of main conduit runs is used to determine the proportion of the various trenching and boring options that are required.

The following three step process is used to determine the placement ratios for the various sizes of main conduit configurations.

- It is assumed that all large conduit configurations (i.e. 8 or more conduits) are placed under the road or footpath requiring the cutting and restoration of the road or footpath surface;

- It is assumed that small main conduit configurations (i.e. 1 or 2 conduits) are placed in nature strips requiring the use of the more expensive cut and restore or boring placement techniques (to cross roads and driveways) in a proportion that is similar to the proportions derived for small distribution conduits discussed above; and

- It is assumed that medium sized conduit runs (i.e. 4 to 6 conduits) would not have the same opportunity to be place in nature strips as the smaller configurations.

As stated above, large conduit configurations can seldom fit into the telecommunications easement in nature strips. In addition, these large conduit configurations are generally required in densely populated city centres around the exchanges. For these reasons it is assumed that the large conduit configurations are always located beneath a road or footpath.

It is assumed that the placement of small conduit configuration in the main network will be similar to the placement of small distribution conduit configurations. In general small main conduits traverse areas similar to those traversed by small distribution conduits. Although there is a potential that distribution conduits, especially those in the less densely populated areas, have a significantly greater opportunity to be placed in areas that had fewer drives and roads, applying approximately the same placement ratios to both distribution and main networks is a conservative (i.e. cost minimising) assumption. Consequently, we assume that simple trenching techniques with no cut and restore asphalt can be employed 56% of the time when placing small main conduit configurations. This is 3% more than 53% of the time simple trenching through turf is employed in the distribution network. The percentages of simple trenching for main conduit are slightly higher than the ratios for distribution conduit because the estimates were done at different times. In hindsight, a 53% estimate is probably more appropriate for small main conduit configurations.

Medium sized main conduit configurations were assumed to be in areas closer to the city centre than the small configurations so it was determined that the opportunity to avoid cut and restore placement techniques would be reduced.

Ratios for the thickness of the concrete and asphalt surfaces that would be encountered in constructing a new network

The contract cost for breakout and reinstatement varies based on the thickness of the concrete or asphalt being removed. In order to derive an average cost, the panel had to determine proportions of occurrence for each thickness of concrete and asphalt identified in the contracts. The following chart identifies the various concrete and asphalt surfaces for which there are separate costs in the AS&S Contracts. Next to the description of the types of concrete and asphalt that may need to be replaced are the percentages of occurrence used in the model:

Proportion of Occurrence for Various Thicknesses Concrete and Asphalt

Description	Distribution	Main
Concrete (< 75 mm thick)	70%	70%
Concrete (75 to 100 mm thick)	0%	0%
Concrete (Over 100 mm thick)	0%	0%
Reinforced (< 75 mm thick)	30%	30%
Reinforced (75 to 100 mm thick)	0%	0%
Reinforced (100 to 150mm thick)	0%	0%
Total	100%	100%
Asphalt (25 mm thick)	0%	0%
Asphalt (50 mm thick)	100%	100%
Asphalt (75 mm thick)	0%	0%
Total	100%	100%

In establishing the concrete placement ratios, the team decided to err on the conservative side and assume that all the concrete that would need to be restored would be < 75 millimetres thick. It was also assumed that only 30 percent of the concrete would be reinforced. Again the team felt this was a conservative assumption.

In determining the asphalt restoration ratios the team considered that most asphalt surface breakout and reinstatement will be paid for at the 50mm rate. Of the remainder, it seems likely that the amount of asphalt charged at the 25mm rate will be approximately the same as that charged at the 75mm rate. Therefore, it has been assumed that all asphalt breakout and reinstatement will be paid for at the 50mm rate, which represents a reasonable average. The same ratios were used for both concrete and asphalt main and distribution restoration.

Calculation of the average Lot Frontages by Density Group (Metres)

	Density Group 1	Density Group 2	Density Group 3	Density Group 4	Density Group 5
Customers / Kilometre (max)	n/a	3,999	1,599	799	399
Customers / Kilometre (min)	4,000	1,600	800	400	n/a
Usable Area (min)		75%	75%	75%	75%
Usable Area (max)		90%	90%	90%	90%
Average Lot Size (min)		187.5	469.0	938.7	1,879.7
Average Lot Size (max)		562.5	1,125.0	2,250.0	2,255.6
Lot Frontage 1x2 (Min)	n/a	9.7	15.3	21.7	30.7
Lot Frontage 1x2 (Max)	n/a	16.8	23.7	33.5	33.6
Average	n/a	13.2	19.5	27.6	32.1
Lot Frontage 1x3 (Min)	n/a	7.9	12.5	17.7	25.0
Lot Frontage 1x3 (Max)	n/a	13.7	19.4	27.4	27.4
Average	n/a	10.8	15.9	22.5	26.2

Development of the Proportion of a Standard Block that is Streets, Drives and Footpaths

	Minimum	DG 2	DG 3	DG 4	DG 5
Lot Frontage 1x2 (Min)	15.0	9.7	15.3	21.7	30.7
Lot Frontage 1x2 (Max)		16.8	23.7	33.5	33.6
Lot Frontage 1x3 (Min)		7.9	12.5	17.7	25.0
Lot Frontage 1x3 (Max)		13.7	19.4	27.4	27.4
Average Block Size	160	160	160	160	200
Width Street & Footpath (subcollector)	16	16	16	16	16
Width Street & Footpath (collector)	19	19	19	19	19
Width Street & Footpath (arterial)	64	64	64	64	64
Width of Standard Drive	3	3	3	3	3
Road % of Total Distance (subcollector)	9.1%	9.1%	9.1%	9.1%	7.4%
Road % of Total Distance (collector)	10.6%	10.6%	10.6%	10.6%	8.7%
Road % of Total Distance (arterial)	28.6%	28.6%	28.6%	28.6%	24.2%
Road % Used in Analysis (min)	9.0%	9.0%	9.0%	9.0%	7.0%
Road % Used in Analysis (max)	12.0%	12.0%	12.0%	12.0%	9.0%
# Lots (Drives) / Block 1x2 (max)	11	17	10	7	7
# Lots (Drives) / Block 1x2 (min)		10	7	5	6
# Lots (Drives) / Block 1x3 (max)		20	13	9	8
# Lots (Drives) / Block 1x3 (min)		12	8	6	7
Total Width Drives 1x2 (max)	32	50	31	22	20
Total Width Drives 1x2 (min)		29	20	14	18
Total Width Drives 1x3 (max)		61	38	27	24
Total Width Drives 1x3 (min)		35	25	18	22
Drives % of Total Distance 1x2 (max)	20%	31%	20%	14%	10%
Drives % of Total Distance 1x2 (min)		18%	13%	9%	9%
Drives % of Total Distance 1x3 (max)		38%	24%	17%	12%
Drives % of Total Distance 1x3 (min)		22%	15%	11%	11%
Drive % Used in Analysis (max)		18%	13%	9%	11%
Drive % Used in Analysis (min)		20%	20%	14%	10%

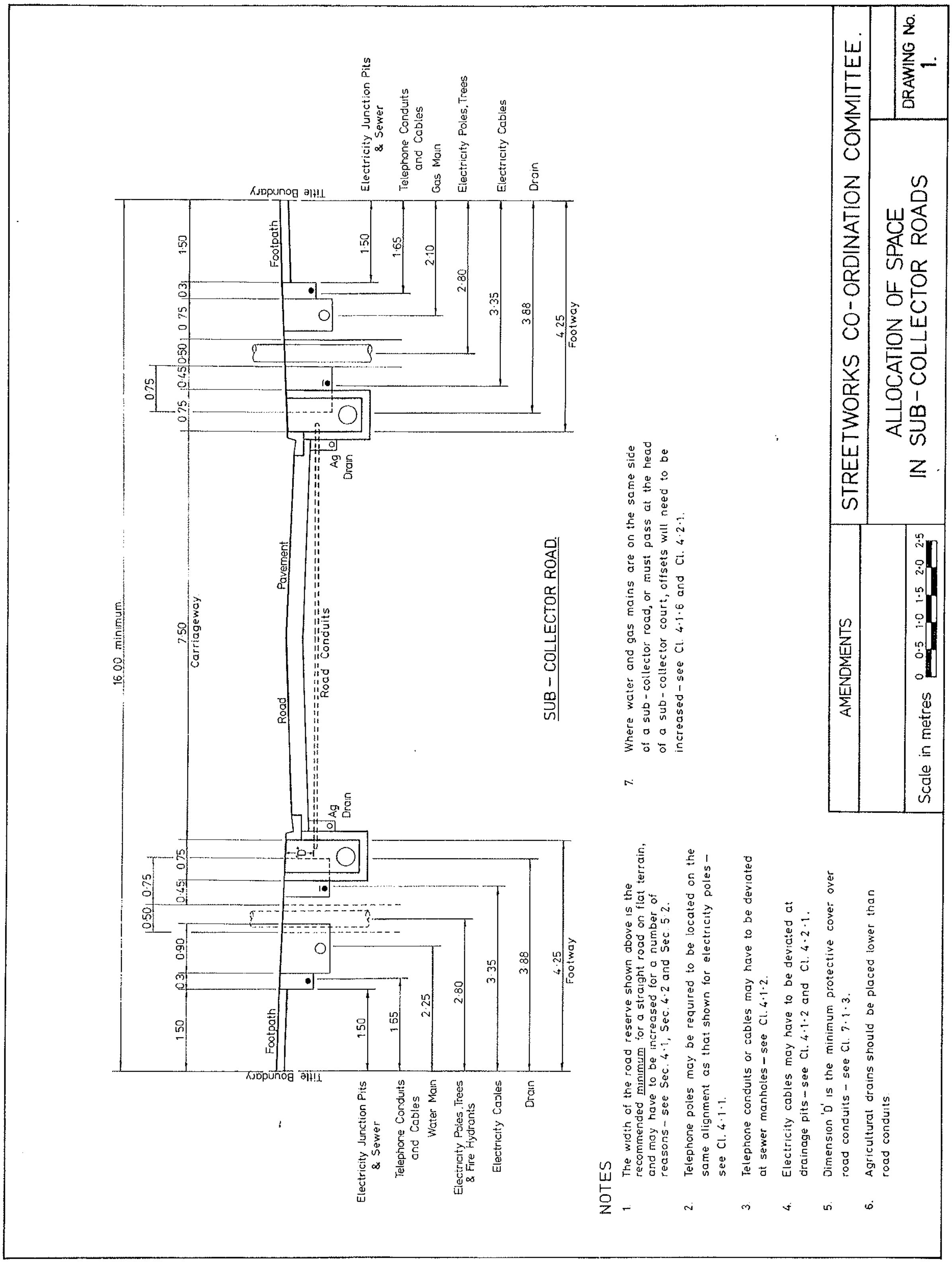
Attachment 3

Representation of the Development of the Distribution Conduit Placement Ratios used in the TEA model

	DG 1	DG 2	DG 3	DG 4	DG 5
Comercial and Industrial as % Area (min)	80%	10%	8%	3%	0%
Comercial and Industrial as % Area (max)	95%	15%	12%	8%	2%
% Area in Older Neighbourhoods (min)	10%	50%	30%	5%	2%
% Area in Older Neighbourhoods (max)	3%	70%	45%	15%	5%
Remainder of Area (%) (min)	10%	40%	62%	92%	98%
Remainder of Area (%) (max)	3%	15%	43%	77%	93%
Road % of Total Distance (min)	9.0%	9.0%	9.0%	9.0%	7%
Road % of Total Distance (max)	12.0%	12.0%	12.0%	12.0%	9%
Drives & Footpaths % of Total (min)	18%	18%	13%	9%	1%
Drives & Footpaths % of Total (min)	20%	20%	20%	14%	10%
Total Drives/Roads % Total (min)	3%	11%	14%	17%	8%
Total Drives/Roads % Total (min)	1%	5%	14%	20%	18%
Total Ratio for Cut & Restore/Bore (min)	93%	71%	52%	25%	10%
Total Ratio for Cut & Restore/Bore (max)	98%	90%	71%	43%	25%
Ratio Used in Model	95%	80%	60%	30%	15%

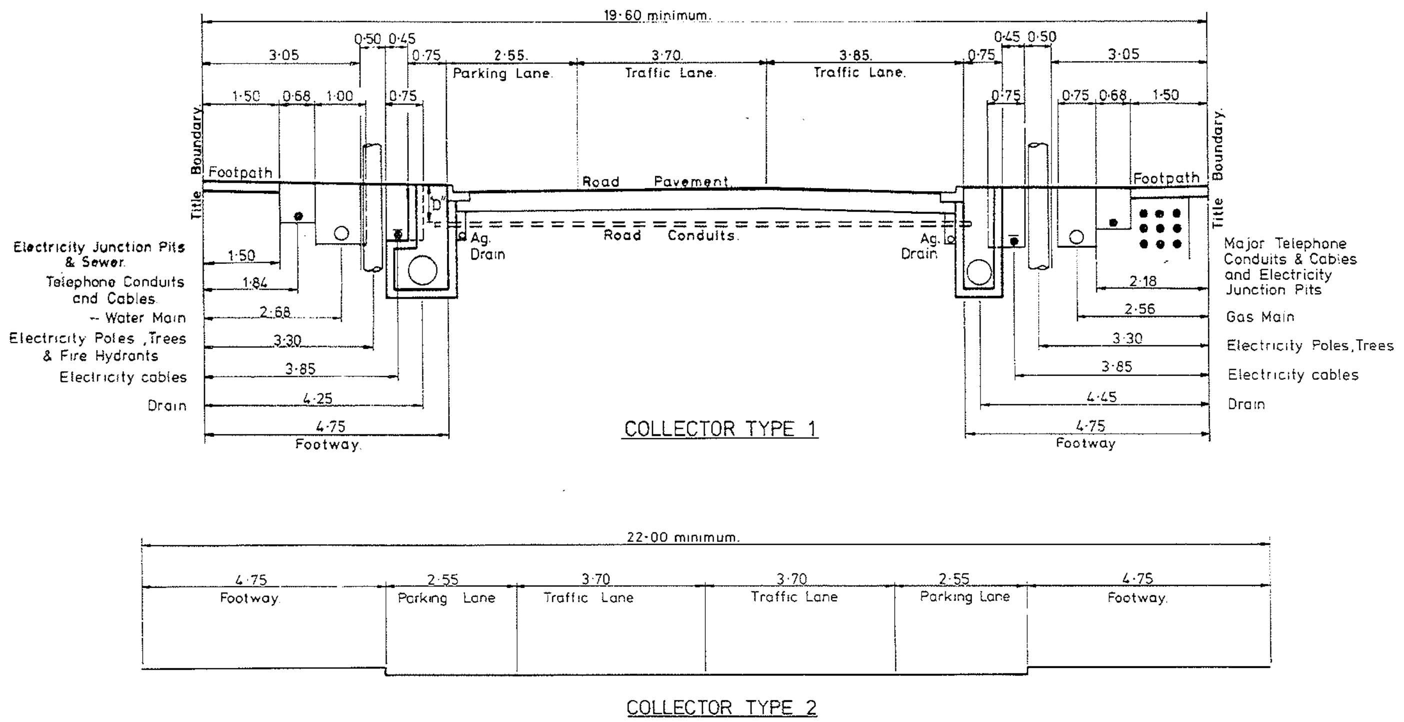
APPENDIX A

Allocation of Space in Sub-Collector Roads



APPENDIX B

Allocation of Space in Collector Roads



NOTES

1. The width of each road reserve shown above is the recommended minimum for a straight road on flat terrain, and may have to be increased for a number of reasons – see Sec. 4.1, Sec. 4.2 and Sec. 5.2.
2. Telephone poles may be required to be located on the same alignment as that shown for electricity poles – see Cl. 4.1.1.
3. Telephone conduits or cables may have to be deviated at sewer manholes – see Cl. 4.1.2.
4. Electricity cables may have to be deviated at drainage pits – see Cl. 4.1.2 and Cl. 4.2.1.
5. Dimension 'D' is the minimum protective cover over road conduits – see Cl. 7.1.3.
6. Agricultural drains should be placed lower than road conduits.
7. Intermittent parking could be allowed on each side of the collector road, Type 1.
8. The preferred location for electricity reticulation is on the low side of the road.
9. Wherever practicable, the route for high-voltage power lines should be located on the opposite side of the road to the major telephone conduit and cable route. In all such cases, negotiation is required between the electricity authority and telephone authority.

AMENDMENTS	STREETWORKS CO-ORDINATION COMMITTEE.	
	ALLOCATION OF SPACE IN COLLECTOR ROADS	DRAWING No. 2.
Scale in metres 0 1·0 2·0 3·0		

APPENDIX C

Allocation of Space in Arterial Roads