STAKING OF BURIED PLANT

CONTENTS

1. GENERAL

1.1 This section is intended to provide REA borrowers, consulting engineers, contractors and other interested parties with technical information in the design and construction of REA borrowers' telephone systems. It discusses in particular considerations in the staking of buried plant.

1.2 Staking should be consistent with the construction proposed in the Area Coverage Design. It should be undertaken with the objective of constructing plant which conforms to REA standards of design and construction, is free from hazards, and is the most economical plant practicable.

1.3 The staking engineer should have at his disposal and be familiar with the following material:

The Approved Area Coverage Design (Including Maps) and any revisions.
List of signed subscribers giving map locations and grades of service.
Maps showing available right-of-way easements
REA Form 511, Telephone System Construction Contract
National Electrical Safety Code (Latest Edition)
National Electrical Code (Latest Edition)
Design and Construction Of Joint Buried Plant - Electric & Telephone
REA Telephone Engineering and Construction Manual Sections:

- 116 Plant Engineering and Record System
- 210 Telephone System Design Criteria - Engineering Time Periods
- 424 Design of Two-Wire Subscriber Loop Plant
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830 Electrical Protection Assembly Units
911 Station Carrier

REA Bulletin 380-1, Right-of-way and Title Procedures.

1.4 Staking personnel should attend the Pre-staking Conference and staking should conform to the agreements and requirements contained in the conference notes.

1.5 In order to reduce delay and expense caused by replacement of lost stakes, the owner may wish to publicize the staking operation. Figure 1 is a sample advertisement designed to inform the public about staking.

1.6 Staking of buried plant is considerably different than for aerial plant in many respects. Actually the staking of a buried plant project may better be termed as a layout of the project, and it may be subject to many minor routing modifications throughout the construction period.

1.7 Even though it is to the benefit of the staking engineer to be familiar with the material listed in paragraph 1.3 above, he and his crew are not usually expected to fully design the buried outside plant. He is expected to make field measurements of cable and wire lengths as well as miscellaneous unit lengths and locate terminal housings for loading, branch splices, subscriber terminations, etc. He also locates obstacles such as bridges, culverts and underground facilities of other utilities as discussed later. He verifies the side of the road or the general route which has been tentatively selected by the system design engineer and often discusses any difficulties noted in the proposed routing with the system design engineer before making any changes.

1.8 In the case of buried plant, more firm decisions should be made in the design stage and qualified resident engineers should be on the project during construction. The resident engineer should be capable of exercising good engineering judgement in making necessary changes during construction with full consideration given to all the factors in the design of the project.

2. PRE-STAKING ACTIVITIES

2.1 Before staking begins on each segment of the route the engineer should receive assurance from the owner that right-of-way easements, agreements and permits have been obtained, insofar as possible. Any suitable means, such as easements strip maps or utilization of ACD Detail Maps, to indicate the right-of-way conditions may be used for this purpose. Property owners desiring to wait until staking is performed, to observe the route to be taken, before granting an easement should be denoted, as well as the status of easements on other properties. The owner shall furnish a qualified person to accompany each staking crew for the purpose of negotiating with landowners or tenants with respect to such right-of-way authorizations and easements. The right-of-way man and the staking engineer should not, however, promise the property owner anything that would be unreasonable or impossible for the contractor to do. Any special precautions to be observed by the contractor should be noted on the staking sheets.

2.2 Staking should be scheduled so as to coordinate with other activities such as material deliveries, (when furnished by the borrower), central office equipment deliveries, connecting company plans, etc. Consideration should also be given to farming operations and seasonal conditions so as to reduce the necessity for replacement of stakes.

2.3 When sign-up activities indicate changes in subscriber estimates, the engineer should be informed and, if necessary, action taken to revise the initial design to ensure that construction will be adequate to meet subscriber demands. This may entail a major revision of the subscriber data and the design. Any design changes should be reflected in the staking of the project, but written approval for significant changes must be obtained from the owner and REA. Restaking is costly and can cause delays. It should be kept to a minimum. Close coordination between the owner and the engineer can be effective in keeping restaking to a minimum while meeting service demands.

2.4 Stake only lines shown in the approved Area Coverage Design except for minor changes dictated by field conditions. The engineer should inform his staking crews of any routes, leads or service connections which for any reason are not to be constructed.

2.5 Give careful consideration to the right-of-way obtained on each parcel of land on which lines are to be staked. If the right-of-way is not satisfactory from a construction standpoint because of poor routing, hazardous conditions, heavy clearing, rock, swampy soil, lawns, insufficient room for the plow train, etc., the engineer should discuss the conditions with the owner so that an attempt can be made to either procure additional right-of-way or to relocate the proposed section of line in a more satisfactory location.

2.6 When the owner is required to submit engineering information as a prerequisite for procuring a permit, license, franchise, or authorization from public bodies or private corporations in connection with proposed construction, the staking engineer shall obtain the necessary field data for the engineer to prepare the required information and drawings for the owner. Examples of staking that may involve application for permits are as follows:

a. Operating plowing equipment on and adjacent to roads and highways.
b. Crossings of highways.
c. Crossings of navigable streams.
d. Railroad crossings.
e. Joint use of trenches with another utility.
f. Crossings of buried facilities of other utilities.
g. Crossings of land owned or controlled by public bodies.
h. Location of terminal housings on public right-of-way.

3. NATIONAL ELECTRICAL SAFETY CODE

3.1 It is very important that the staking engineer know and understand the requirements set forth in the National Electrical Safety Code (NESC) for telephone system outside plant construction as well as the requirements of the particular locality where staking is performed.

3.11 Some localities have requirements for telephone buried plant which are more stringent than the latest edition of the NESC. The more stringent requirements must be observed. For states where no requirements are established, the provisions of the latest edition of the NESC shall be followed.

3.2 The portion of the NESC that the staking engineer is particularly concerned with is Part 2 which deals with the construction and maintenance of overhead and underground lines. NESC rules are not intended to serve as a basis for designing or staking telephone plant. The rules should be considered as the minimum standards that must be met if the plant is to withstand the mechanical loads and stresses to which it will be subjected, be reasonably protected from the possible effects of electrical disturbances, and be relatively free from hazards to the general public and to persons maintaining the facilities.

4. NATIONAL ELECTRICAL CODE

4.1 The purpose of the National Electrical Code (NEC) is the safe-guarding of persons from electrical shock and protection of buildings from fire hazards arising from the use of electricity for light, heat, power, radio and signalling. The NEC contains basic minimum provisions for installation on subscribers' premises and are necessary for safety.

4.2 Chapter 8 "Communication Systems" Article 800 "Communication Circuits" discusses minimum conductor insulation requirements and station grounding. The requirements set forth in the NEC shall be followed unless local requirements are more stringent in which case they shall be followed.

5. OUTSIDE PLANT ASSEMBLY UNITS

5.1 The general buried plant design represented by the approved area coverage design must be translated by the engineer into a specific design in sufficient detail to enable a contractor to build the plant. To facilitate this, an "assembly unit" has been devised for each component of outside plant. By specifying the appropriate type, quantity and location of

assembly units on the staking sheets, the engineer indicates the complete physical outside plant as contemplated in the Area Coverage Design (ACD). The detailed descriptions of all buried plant assembly units are given in REA Form 511.

5.2 In addition to designating component parts of the outside plant on the staking sheets, all other information necessary for the contractor to construct the plant should be included on the staking sheets. Examples of this type of information are given in Figure 3.

6. STAKING

6.01 The route and outside plant assembly units are recorded on the staking sheets. An example of a typical staking sheet designed for this purpose is given in Figure 2. Other forms of staking sheets designed to present similar information may also be used.

6.02 The staking engineer should begin the staking using the information given on the ACD map. He should make a reconnaissance of the area checking such items as the following:

a. Status of easements.
b. Terrain.
c. Location of establishments and terminal housings.
d. Natural control points.
e. Plowing location as determined by fences, roads and right-of-way easements.
f. Obstacles for the plow train.

6.03 Control points are those where plant must be either located or avoided, or where special units are necessary or special precautions must be taken. They are also points which represent permanent landmarks or cause changes in routing. Some typical conditions which may determine control points are as follows:

a. Street, alley and highway intersections.
b. Rivers, drainage ditches and canals.
c. Angles and corners in highways and roads.
d. Farm driveways and field entrances.
e. Railroad right-of-way.
f. Buried facilities of other utilities.
g. Junctions between cable and wire.
h. Junctions with branch cables.
i. Terminal housing locations.
j. Subscribers' premises.
k. Trees.
l. Right-of-way restrictions.
m. Outcropping rock.
n. Buried splices.

6.04 Terminal housings should be placed along buried cable and wire leads at the following locations:

a. At signed subscriber distribution points and within a reasonable service distance to all prospective subscribers.
b. At junctions with lateral runs of cable and wire including possible future extensions.
c. At aerial inserts, if it is necessary to splice the cable or wire. (Ready-access enclosures may also be used for splicing to aerial cable inserts.)
d. At cable or wire loading points for initial or ultimate loading.

Direct burial splice cases may also be used at the above locations. These splice cases are to be specified by their unit designations.

6.05 The data that will be necessary to record on the finished staking sheet may be recorded in a notebook or on a staking sheet as the route is being traveled. This rough field data may then be neatly recorded on the finished preconstruction staking sheet back at the field or home office. Information that will be necessary for construction is recorded on one set of staking sheets. Information pertaining to removal of existing plant is recorded on a duplicate but separate set of staking sheets.

6.06 The type of information to be included on the staking sheets is that which is necessary to prepare the plans and specifications as well as to construct the outside plant. The staking sheets should be prepared so that they may be used as permanent plant records, although it may be necessary to modify them and add additional information during the construction of the project.

6.07 After the subscriber data is brought up-to-date on a map, the actual route that the plow is to take is selected and recorded while considering all physical obstructions that might affect the construction along the route. The actual sizing of the cables for the cable plant layout, line assignments, and the proper size terminal housings may be performed in the engineer's office from notes and measurements taken during the field staking.

6.08 Low cost plowing is obtainable where wire or cable can be plowed in along road shoulders or backslopes of roads and highways, or directly in the roadbed if it is not hard surfaced. Plowing across private right-of-way in rural areas having fences, or where land is cultivated to excessive depths by power machinery generally may not appear to be economical; however, experience has shown that road work causes more outages in buried plant than do farm operations. Therefore, the use of private right-of-way should receive primary consideration.

6.09 Permission should be obtained from road and highway authorities at locations where public right-of-way is to be used. Future possible highway improvements such as road widening should be considered in staking the plant. Future road work can result in costly telephone plant rearrangements. This is another reason for utilizing private right-of-way. The plow route should be selected so as to minimize property damage from the heavy equipment used in the plow train.

6.10 Investigations should also be made to locate other buried facilities such as main water, gas, sewer, power, telephone and oil lines. Maps locating as many of these facilities as possible should be obtained. These facilities should be indicated on the staking sheets, where possible, to warn the contractor of there presence. Predesignated Areas should be established on system detail maps if numerous underground facilities exist and the "BJT" units staked. A recommended procedure to be followed when the exact location of pipelines cannot be pinpointed is discussed in paragraph 9.33.

6.11 The cable routing should be marked on the staking sheet by reference to natural or manmade landmarks so as to facilitate the plowing and future location of the cable.

6.12 All forms of construction other than plowing should be avoided where possible.

6.13 Highway crossings must be discussed with road authorities. The route of plowing should be planned to cross the road as necessary to serve subscribers without the use of aerial construction if possible. Such crossings, if made by plowing, should be by cutting diagonally across the road. Since road crossings are often undesirable and expensive, the engineer should select the side of the paved road for general routing of the wire or cable which will result in the fewest crossings. If numerous crossings are necessary, plowing on both sides of the road may be the most economical choice.

6.14 Following the discussions with the highway officials and the visual inspection of a route, the staking engineer can verify the preliminary entries on the ACD maps or staking sheets to show the control points evident from the inspection.

6.15 The owner and engineer should agree on the type of stakes to be used as well as the methods of installing and marking the stakes. Where it is probable that there will be difficulty in finding stakes at a later date, the stake location should be indicated by driving a four-foot building lath adjacent to the stake or by providing some other suitable marker. Where the stakes are located on private right-of-way so as to be invisible from the road because of brush, trees or crops, a suitable marker (such as a strip of bright colored cloth or plastic marking tape tied on the fence) should be provided so that the location of the stake will be indicated from the road. Where permitted by highway authorities, a colored stripe could be painted on the edge of the pavement to show the approximate location of the stake. It will also be helpful to place appropriate notes on the staking sheets.

6.16 The staking engineer proceeds along a route, showing the following information (some of which may be done in the engineer's home office) on the sheets:

a. Location and type of the terminal housings and poles, if any.
b. The distances in feet from the plow line to each terminal housing or pole.

c. The distances in feet along the plow route between lateral trenches to terminal housings or poles. This distance should be chained or wheeled. The sequential foot markings on the buried cable or wire will be used to determine the actual quantities of wire and cable for the final inventory. The lengths on the staking sheets will be revised accordingly at that time, and be reflected on the "as built" sheets.
d. The lengths in feet of service wires from terminal housing to subscriber's premises.
e. Terminal housing numbers.
f. Cable or wire size and gauge.
g. Tentative load point location.
h. Miscellaneous units ("BM" units).
i. Type of station protection.
j. Special considerations such as obstructions, increased depths, minor route deviations, easement restrictions, etc.

6.17 A stake should be used to show the location of the following:

1. All terminal housings.
2. Control danger points such as underground utilities, culverts, etc.
3. Poles and anchors for aerial inserts.
4. Miscellaneous units such as split metal guards and warning signs.

The route and terminal housing and pole number should be marked on the stake so as to be legible at the time of construction.

6.18 The acceptable measuring techniques that may be used in staking buried plant are:

1. Wheel
2. Chain
3. Stadia rod

6.181 Chaining will be the method of measurement generally used on private right-of-way and in congested urban areas. Caution must be used to avoid the most common chaining errors, which are: Dropping or adding a complete chain length, reversing the chain so that the wrong figure is read, and not holding the end of the chain even with the chaining pin.

6.182 Since measurements are intended to represent the length of the telephone plant, they should be made along the contour of the ground for buried plant. When gullies or sharp breaks in the terrain are encountered, the chain should be held approximately parallel to the route the cable is expected to take when installed.

6.183 A properly used footmeter mounted on a vehicle will meet telephone engineering precision standards. Measuring with a footmeter permits measurements to be easily checked, which should result in fewer major errors than chaining. A footmeter should be calibrated at least once a day over a measured 1000' distance, and it should not be used in situations where the wheels may slip, such as in mud, snow, or loose gravel, or on steep slopes.

6.184 A hand-pushed, wheel-type footmeter will also meet telephone engineering precision standards when used over level ground.

6.185 The stadia rod is a relatively accurate and fast means of measuring distance when there are no obstructions in the line of vision and the terrain is flat between the transit and rod. It may be used to good advantage for measuring distances across bodies of water, etc.

6.186 Measurements for cable 400 pair and larger (or any cable which is unusually expensive or difficult to obtain) should be made twice, preferably by two different people. A re-measurement of distances on existing records may be considered the second measurement, if the records agree with the new measurement. This is particularly important in the case of any cables ordered a specific length for placing in conduit systems, since an additional piece of cable cannot be spliced on if the cable is too short.

6.187 More buried cable length is required to reach between two points than the measurements along the contour of the earth would indicate, because of the slack in the cable when it is placed. In chaining for cross-country toll cables, it is customary to drop 6" in each 200' chain to allow for this. Consideration of this $\frac{1}{4}$ of 1% difference between measurements and cable length is probably not justified in buried exchange cable measurements because route changes in buried exchange plant during construction will generally result in small changes in nearly all measurements.

6.188 Generally the only practical way to make measurements cross-country is by means of chaining. A two-man crew will generally be used, with two vehicles. At the beginning of each cross-country section, one of the vehicles is moved to a road ahead so that it may be used to leapfrog the second vehicle ahead.

6.189 Recommended Measurement Techniques: Listed below are the measurement techniques that are recommended for most situations. Distances between load points should always be checked, even though this is not listed below.

	Orignial Measurement	Check Measurement
Urban Areas:		
Conduit Systems	Chain	Chain
Underground cable	Chain	Chain or existing records
Large or unusual cables	Chain	Chain, meter, or use existing records
OTHER PLANT		
Rural Areas:		
Large or unusual cables	Chain	Chain, meter, or use existing records
All other plant except one circuit Leads		
Along roads	Meter	Meter or use existing records
Private R/W	Chain	Not required
One circuit leads		
Along roads	Meter	Not required
Private R/W	Chain	Not required
New Drops, Urban or Rural		
Aerial	Chain or meter between drop poles. Step or estimate span to house, ± 10%.	Chain or use push footmeter during final inventory.
Buried	Step or estimate ± 10%.	Use sequential marking during final inventory.

Note: Footmeters should be calibrated frequently and used in accordance with the manufacturers recommendations.

6.19 Terminal housings should be specified within a reasonable service distance from those potential subscribers who, in the judgement of the engineer and the owner, can be expected to take service within the five-year forecast period. If the potential subscribers shown on the ACD were selected arbitrarly, a closer review is needed at the time of staking. Terminal housings should be specified at junction points from which future extensions may be run even though not required in the initial construction. The size of the terminal housing shall be large enough to accommodate the future branch cable. Future loading requirements should also be taken into account in sizing terminal housings. Pole mounted terminal housings or riser guards should be specified at junctions of buried plant and aerial plant. Terminal housings mounted on stub poles should be specified where additional mechanical strength is required.

6.20 The major portion of a buried plant staking sheet is devoted to a sketch of the cable or wire to show the general route of the buried plant and the location of the terminal housings and other related units. Horizontal distances, along the plow lines between the terminal housings and all other control points are to be shown. This will include all intersections. The measured

length of the trench from the plow line to the terminal housing shall be shown on the staking sheet. The vertical footage inside the terminal housing should be included on the staking sheet but may be revised during construction because of the different heights of terminal housings manufactured by various manufacturers.

6.21 In addition to knowledge of the outside plant units and the project area, the staking engineer must be familiar with the capabilities, size and weight of the plowing and trenching equipment generally used by contractors. This will aid him in the selection of the proper route and construction units required.

6.22 Terminal housings for buried wire or cable on highway right-of-way should be placed as close to the fence line as possible to provide maximum protection to the housings from traffic, road and farm equipment, and farm animals. If it is impossible, due to the absence of fences or to planned highway widening programs, to place the terminal housing in a reasonably protected location; the engineer should consider appropriate methods of guarding against damage if the housing will be exposed to road or farm machinery, farm animals, or other hazards. Such methods may include the use of stub poles, orange colored fiberglass terminal housings or buried splices. Long stub poles may be used in high vegetation. Consideration may also be given to mounting the terminal housing high on a stub pole with a riser guard to protect the cable for the desired height. This may be used to advantage in areas subject to flooding and heavy snow. A disadvantage to this type of construction is that the bottom of the housing does not match the shape of the riser guard which could permit the entrance of birds and insects.

6.23 Terminal housing and pole numbering should be in accordance with REA TE & CM 116, "Plant Engineering and Record System." Terminal housings and poles inserted in intermediate locations during construction (such as for reel end splices and cable repairs) should be assigned the number of the previous pole or terminal housing with a fractional number or supplemental letter. This will prevent the need for altering the numbering scheme on a staking sheet and central office area circuit schematic. All terminal housings should be marked with the appropriate cable, loading point, route and terminal housing number. For example, the number D4K7A would designate the first terminal housing (A) between terminal housing 7 and 8 after the fourth loading point on lateral route K off the main cable lead D.

6.24 When the field work has been completed by the staking crews and the necessary entries on the field staking sheets are completed, he may turn the sheets over to an office engineer for preparation in final form and insertion of other data so the sheets can be released for use in the preparation of the "Plans and Specifications".

6.25 The cable sizes, gauges and loading points must be determined, based on the requirements given in other sections of this manual. This information is then inserted on the staking sheets with the proper terminal housing assembly units. (The location of terminal housings for loading have been approximately located in the field and will be accurately placed based on the sequential length markings during construction.) Various sections of the REA TE & CM provide information necessary for the determination of the transmission and signalling requirements for trunks and subscribers as to cable gauges, loading, and the number of pairs required based on the design criteria. The load point locations and permissible deviations should be verified at this time by adding the footages shown on the sheets turned in by the staking engineer.

6.26 In computations made to locate loading points the engineer adds to the in-line plowed lengths the lengths which are trenched from the plow line to terminal housing or pole, plus an amount representing the vertical runs in the terminal housing or on poles.

6.27 To meet transmission objectives, especially with respect to maintaining the proper end sections beyond the last loading point, particular care must be exercised in assigning those subscribers to be served from a given circuit. A thorough explanation of bridge taps and excessive end sections and their effect on transmission is given in REA TE & CM-424.

6.28 The locations determined for loading coil terminal housings in the office following the field staking, may indicate places where a terminal housing for service connections can be combined with the loading coil locations. The reverse (moving the load point) is not desirable because of the precision required in locating loading coils.

6.29 No loading coils are to be specified for cable pairs intended to be used with trunk or subscriber carrier.

6.30 In some instances a cable dedicated to carrier use will be required. This means that no subscriber or physical trunk circuits will be in the cable. This is a requirement to minimize impulse noise interference on carrier circuits which may be used for high speed data transmission. Where such a dedicated cable is specified there are to be no appearances of the cable pairs except where carrier repeaters are located or where reel end splices are made. An exception is where the trunk route is so long that the order wire pair used in maintaining the trunk cable carrier system requires loading, in which case loading coils for one pair in the cable are specified.

7. TERMINAL HOUSING SELECTION

7.1 The installed cost of terminal housings represents approximately 4.5% of the total installed cost of buried outside plant. The terminal housing costs, therefore, represent a very minor portion of the overall investment. Yet these housings are used to protect the relatively expensive cable plant at above ground appearances. The installed buried cable represents approximately 81.5% of the installed cost of buried plant. Terminal housings should be selected to allow sufficient room for splicing, loading, and terminating the initial cable installation as well as for ease of maintenance. All manufacturers of terminal housings design their product to contain minimum specified components. They are designed for splicing, loading or looping in and out various size cables but will not necessarily be large enough to perform all three functions for a given size cable. The recommended capabilities of all terminal housings are given in Figure 4. This data should be studied so as to select the proper size housing.

7.2 One objective in the selection of terminal housings is to have them as small and as inconspicuous as possible so as to preserve the natural beauty of the countryside. There are, however, instances where it may be desired to have attention called to their presence. This may be done by mounting housings on tall stub poles or using orange colored fiberglass housings.

7.3 Frost conditions have been causing problems with buried plant in the northern area of the country. Because of these problems, all buried construction in the northern area should use prudent construction practices. If possible, all cable and wire should be located on private right-of-way. If private right-of-way is not available, cable and wire should be buried on public right-of-way as deep as possible and located so as to receive the benefits of grass and snow cover to minimize frost problems. Where heaving is a persistent problem, pole mounted terminal housings may be used to advantage.

8. TERMINAL BLOCKS

8.1 Moisture inside buried plant terminal housings should never be a problem if sealed splicing connectors are used for connecting service wire drops instead of terminal blocks. Terminal blocks may be satisfactory immediately after cutover with new plant but as insects, moisture, dust and corrosion products accumulate on the terminal block's surface, the plant may become noisy. Every effort should be made to seal buried plant completely by avoiding the use of terminal blocks.

9. CROSSINGS

9.1 Railroad Crossings

9.11 The NESC specifies minimum vertical and horizontal clearances for aerial and underground railroad crossings, as well as minimum strength requirements for poles, conductors, anchors and guys, and maximum crossing spans. The Association of American Railroads "Specification for Communication Lines Crossing the Tracks of Railroads" is reproduced in REA TE & CM-617.

9.12 Some railroads may have specifications which differ from the NESC and REA TE & CM-617. Therefore, before design and staking work is undertaken railroad officials should be consulted regarding their crossing requirements. The more stringent requirements should be followed.

9.13 A detailed crossing layout is often necessary for submission to the railroad officials for approval and for inclusion in the crossing agreement.

9.2 Road and Highway Crossings.

9.21 State and local road and highway officials should be consulted concerning permissible methods of crossing roads and highways. Methods available for such crossings are:

a. Diagonal plowing across roads.
b. Pushing pipe under roads.
c. Boring under roads.
d. Breaking through pavement.
e. Aerial inserts.

Units applicable to the above methods appear in REA Form 511. Meeting with the road and highway officials should result in the most acceptable method. Agreements should be reached concerning the procedures to be used in both cutting and restoring the pavement. Such procedures are to be made available to the bidding contractors to assist them in preparing their proposals. Any local regulations concerning the cutting and repair of private roads, lanes and driveways should also be called to the attention of all contractors prior to their submission of bids.

9.22 Existing conduit under roads and highways, as well as across bridges, should be used where available. Lengths of low cost plastic conduit may be placed along with the cable where the road or highway is opened. This will facilitate future reinforcement.

9.3 Pipe Line Crossings

9.31 Crossing of pipelines and facilities of other utilities should be done in the most economical manner. This would involve placing the cable or wire by plowing directly over these facilities. If sufficient depth cannot be obtained, it may be necessary to place split galvanized steel cable guards over the cable or wire at the crossing, or to cut and resplice the cable to achieve greater depth.

9.32 Some pipe line companies require that telephone cable or wire be placed a fixed distance below the pipeline. This may require cutting the cable, trenching, splicing and installing a buried splice enclosure or a terminal housing. If the work performed is not for his own convenience, the contractor should be paid for all units necessary for all crossings which are required and not specifically included in units already specified. This applies to all crossings of railroads, roads, highways, bridges, pipelines, etc. It is the responsibility of the engineer to determine the most advantageous and economical method to use. It is the responsibility of the contractor to avoid damaging facilities which he crosses and to restore them and their contents if damaged.

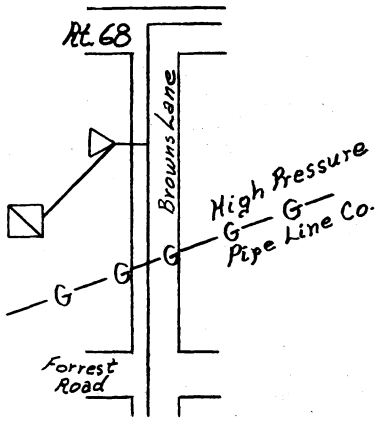
9.33 In view of the great hazard to life and property that may result if a pipe line, particularly a high pressure gas line, is damaged while placing buried telephone plant, it is important to use engineering and construction techniques that will reduce the possibility of damage to a minimum. This can be accomplished by:

1. The engineer shall obtain and provide to the contractor all reasonably available information. The engineer shall send a map showing the proposed construction to each pipe line company in the area, requesting that any pipe line locations in the construction area be shown on the maps.

2. The contractor shall be responsible for notifying the pipe line company when work in the vicinity of pipe lines is to be carried out, and shall do this work only when a representative of the pipe line company is present for the purpose of locating the pipe lines.

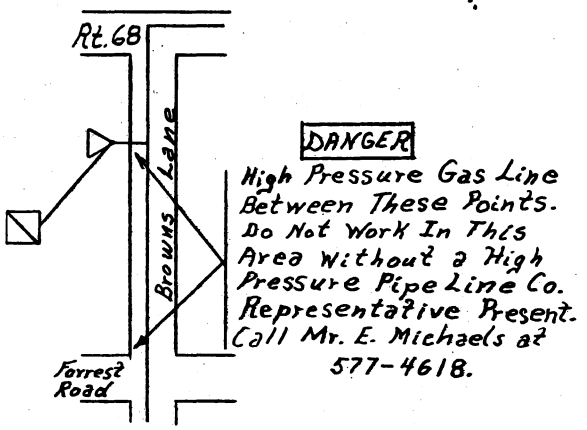
3. The contractor shall bury plant across a pipe line only when it has been exposed by hand digging or other means approved by the pipe line company representative.

9.331 Since a pipe line can be located definitely only by exposing it to view, the staking engineer should avoid being the cause of accidents by showing pipe lines improperly on staking sheets. When there is some doubt as to its exact location, the correct and incorrect methods are shown below:



WRONG

The contractor may think that the pipe line is halfway between the road intersection and the subscriber. Since the drawing is not to scale, this may result in plowing through the pipe line.



RIGHT

The contractor must necessarily get a pipe line representative on the job before entering the danger area.

10. STATION INSTALLATIONS

10.1 Station installations include the staking of buried service wire assembly units, station protector assembly units, station wiring units, and station telephone set assemblies.

10.2 Where the objectives of safety and electrical protection conflict with the objectives of appearance and economy, the decision should always favor safety and protection.

10.3 The buried service wire should be staked to conform with a station protector location which will facilitate connections to the telephone set and which, at the same time, will ensure interconnection between the telephone, power and water pipe grounds. More details in staking buried service and station installations are given in TE & CM 701.

11. ELECTRICAL PROTECTION

11.1 The staking engineer should be provided with the detailed protective measures to be employed which have been decided upon in the system design. The 800 series of the REA TE & CM include details regarding applicable protection practices.

11.2 In order to minimize the possibility of conflict with or interference from power distribution systems, crossings of power and communication systems should be minimized. Where joint trenching or plowing of power and telephone conductors is contemplated, the provisions of the REA publication "Design and Construction of Joint Buried Plant - Electric and Telephone" should be followed.

11.3 Auxiliary protection of buried wire or cable against direct contact with power conductors is not required. Station installations connected by buried wire from aerial extensions may require auxiliary protection as prescribed in appropriate sections of the TE & CM.

11.4 It is important that the staking engineer understand the difference in the objectives of station protection as compared to plant protection. Plant protection is primarily concerned with balancing the cost of maintaining unprotected plant and the value of service interruption against the cost of applying and maintaining protective devices which will reduce or eliminate this plant maintenance. Station protection is concerned with the personal safety of the subscriber, protection of his premises against fire and protection of the station equipment and wiring against damage and circuit outage. Adequate protection of persons and premises must be provided at all station installations.

12. FINAL INVENTORY STAKING SHEETS

12.1 Final inventory staking sheets are usually made during construction by correcting the pre-construction staking sheets. Due to construction changes, the initial staking sheets may require some modifications, particularly in regard to cable lengths and load point locations. The resident engineer and contractor must agree on all the quantities and units appearing on the final inventory staking sheets. The corrected staking sheets are then neatly prepared in final form for permanent plant records.

12.2 The "as built" or final inventory staking sheets should provide the following information in complete detail:

a. An inventory of all Outside Plant units installed.
b. The physical location of the buried facilities.

12.3 These staking sheets should give a record of the amount of materials and their location in the field, and also provide the owner with a basis for a reliable schematic with which to locate the cable either for trouble shooting, upgrading, or coordinating with other utilities and construction activities that might occur in the future.

12.4 To facilitate future reinforcement which may be required on the project, the staking sheet should be corrected and marked with reasonable accuracy so the construction crew which does the reinforcing will know the approximate location of existing wire or cable. If a greater than normal depth has been specified to facilitate future reinforcing, the resident engineer should make certain that this depth is achieved during construction. For instance, a nominal cable depth of 36" may be used with the thought that additional cable may be placed at a nominal depth of 24" in the future.

12.5 The terminal housings, buried splices, cable length, etc., required for reel-end splicing and cable repairs should be so designated on the staking sheets to facilitate trouble-shooting later; but, should not be included in the final inventory for compensation purposes.

12.6 Figure 5 illustrates commonly used staking symbols. Figure 6 illustrates typical lengths of cable required for installation in the terminal housings.


STOP!!
PLEASE DON'T DISTURB ME
EVERY NEW STAKE YOU SEE MARKS THE ROUTE OF BURIED TELEPHONE CABLE THAT WILL BRING YOU IMPROVED MODERN DIAL SERVICE.
YOU HAVE A STAKE IN THIS
IT COST YOUR LOCAL TELEPHONE COMPANY $5.00 TO PUT ME HERE AND WILL COST THEM ALMOST AS MUCH TO PUT ME BACK!

FIGURE 1

STAKING SHEET & PLANT RECORD

COMPANY

REA TE & CM-642

ALL EASEMENTS HAVE BEEN SECURED, SIGNED:

SEC.	STAKED BY	REVISED	SHEET OF
TWP	DATE	REVISED	ROUTE NO.
RANGE	RELEASE DATE	INVENTORIED	MAP NO.
CO.	CONSTRUCTED	PROJECT NO.	EXCHANGE

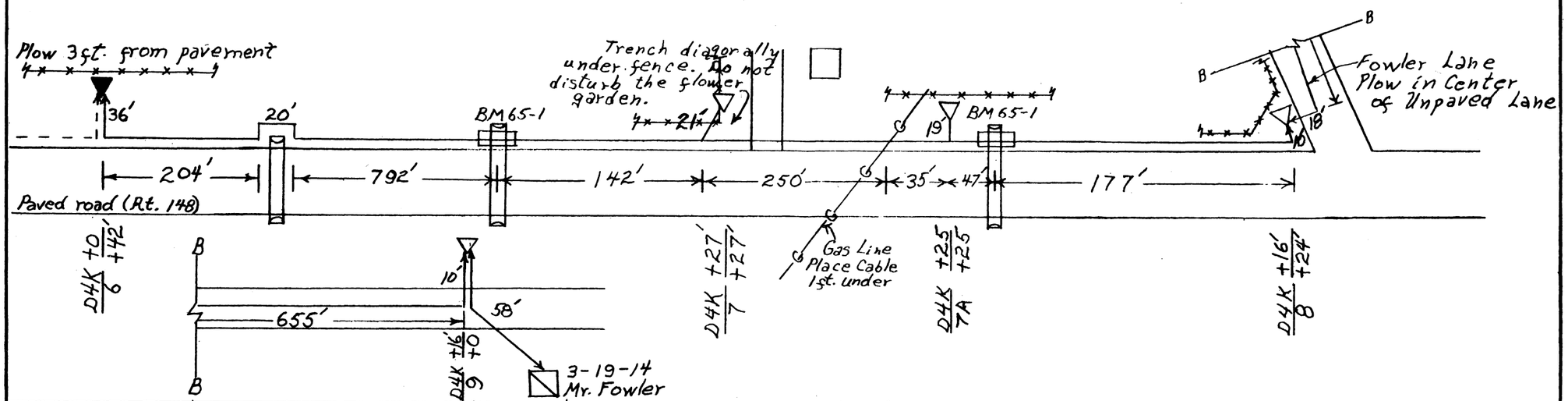
TERMINAL HOUSING NO.	POLE UNITS		BD		BJ		BW		BG		BKB	BM-UNITS					HC	P-UNITS				S-UNITS		SW	SUBSCRIBER NO. AND REMARKS					

FIGURE 2

STAKING SHEET & PLANT RECORD **COMPANY:** Ocean Telephone Co.

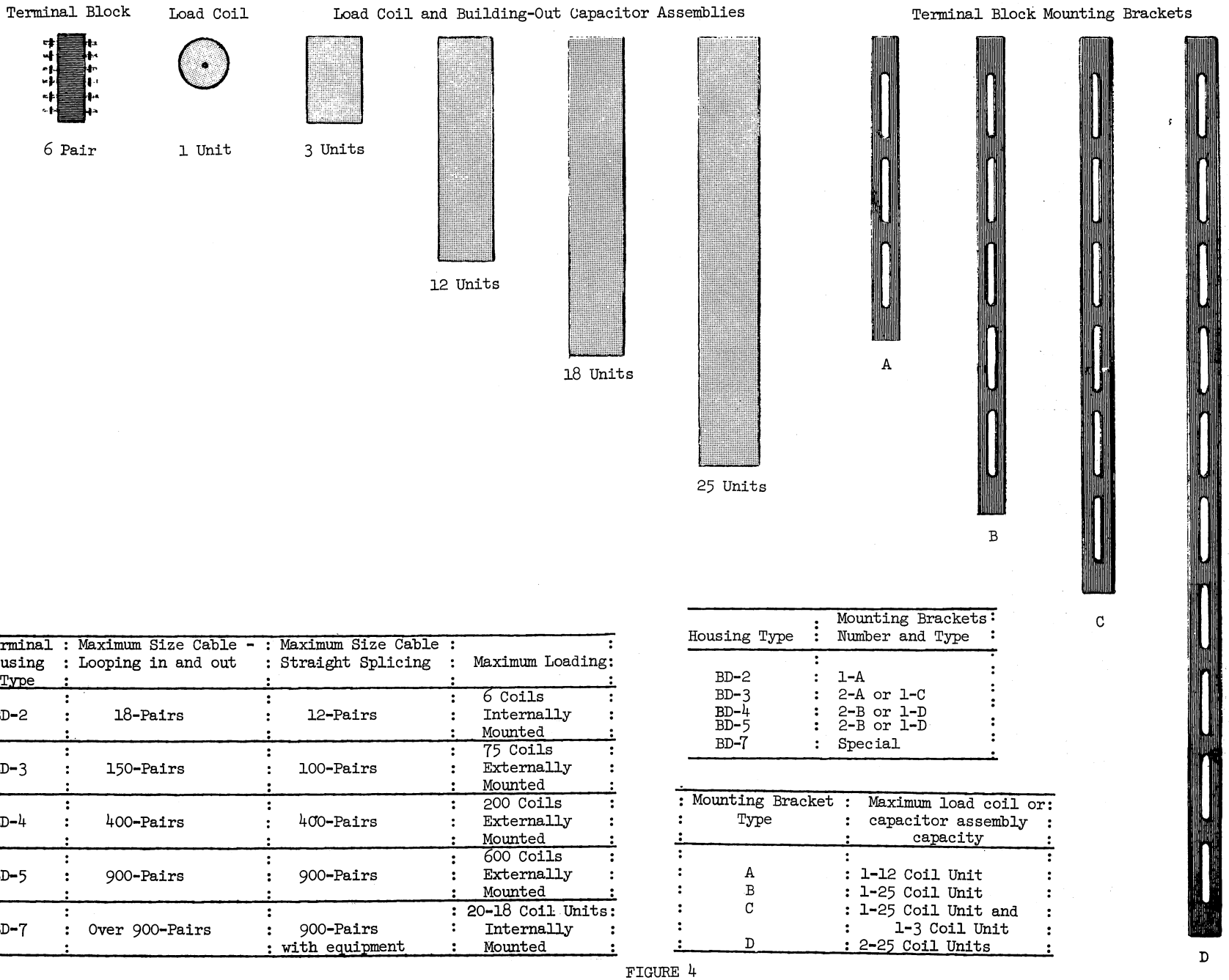
ALL EASEMENTS HAVE BEEN SECURED. SIGNED: George Cole 6/28/67

SEC. 19	STAKED BY R.A.	REVISED 9/25/67	SHEET 3 OF 3
TWP	DATE 7/8/67	REVISED	ROUTE NO. D4K
RANGE	RELEASE DATE 7/15/67	INVENTORIED 9/25/67	MAP NO. 3
CO.	CONSTRUCTED 9/25/67	PROJECT NO. N.J. 904	EXCHANGE Hickory Hill



TERMINAL HOUSING NO.	POLE UNITS	BD	BJ	BW	BG	BKB	BM-UNITS		HC	P-UNITS	S-UNITS	SW	SUBSCRIBER NO. AND REMARKS
		2	6-24	1-19		1-19	70	65-1	1	1-IAF	3	3	
D4K6							36		.12				
D4K7		1	1227				41	1					
D4K7A		1	337				19		.06				
D4K8		1	265				28	1	.06				
D4K9		1		695		58	10			1	1	1	3-19-14 Mr. Fowler
TOTAL		4	1829	695		58	134	2	.24	1	1	1	

FIGURE 3



Terminal Housing Type	Maximum Size Cable - Looping in and out	Maximum Size Cable Straight Splicing	Maximum Loading
BD-2	18-Pairs	12-Pairs	6 Coils Internally Mounted
BD-3	150-Pairs	100-Pairs	75 Coils Externally Mounted
BD-4	400-Pairs	400-Pairs	200 Coils Externally Mounted
BD-5	900-Pairs	900-Pairs	600 Coils Externally Mounted
BD-7	Over 900-Pairs	900-Pairs with equipment	20-18 Coil Units Internally Mounted

Housing Type	Mounting Brackets Number and Type
BD-2	1-A
BD-3	2-A or 1-C
BD-4	2-B or 1-D
BD-5	2-B or 1-D
BD-7	Special

Mounting Bracket Type	Maximum load coil or capacitor assembly capacity
A	1-12 Coil Unit
B	1-25 Coil Unit
C	1-25 Coil Unit and 1-3 Coil Unit
D	2-25 Coil Units

FIGURE 4

BURIED PLANT STAKING SYMBOLS

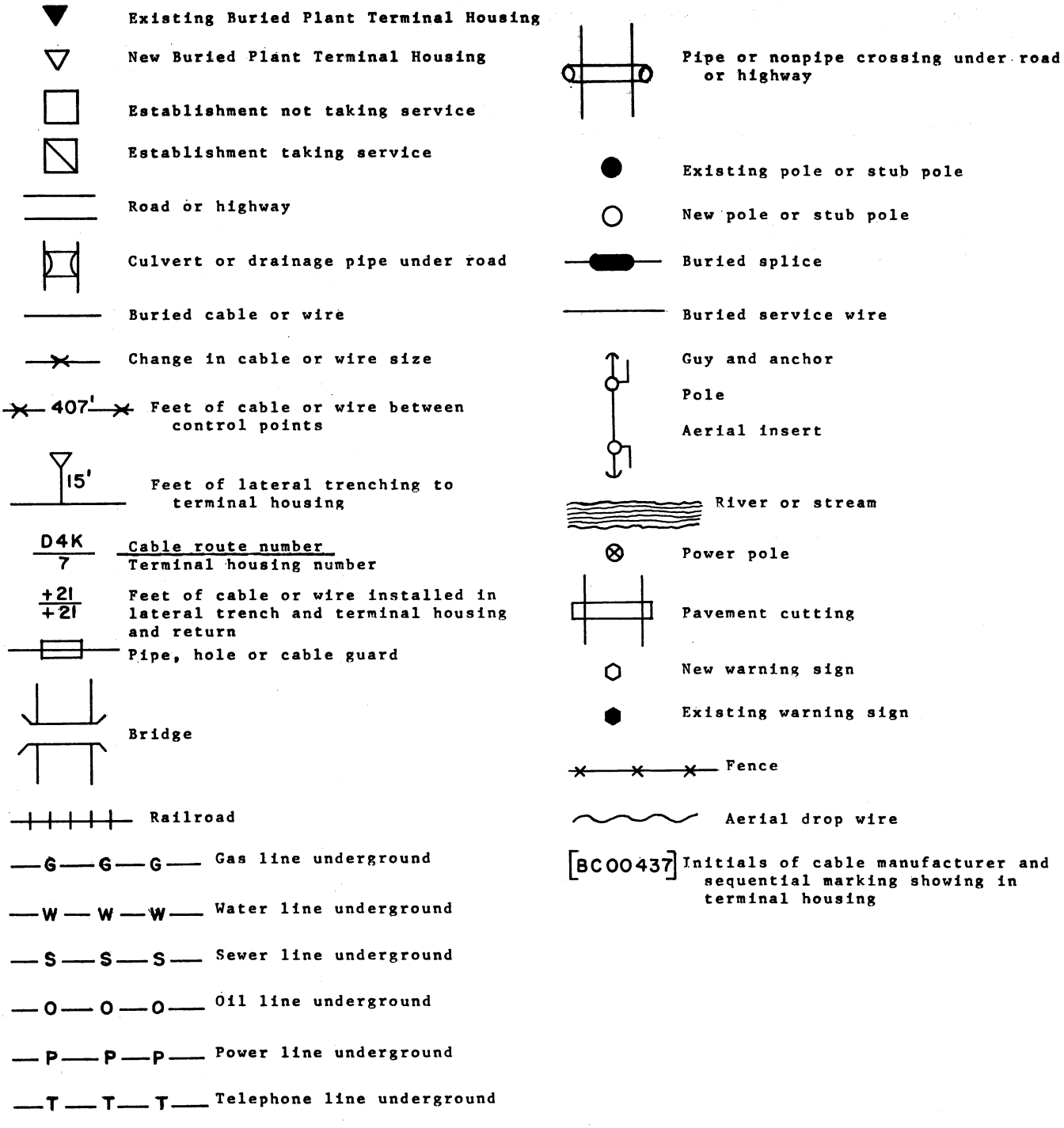
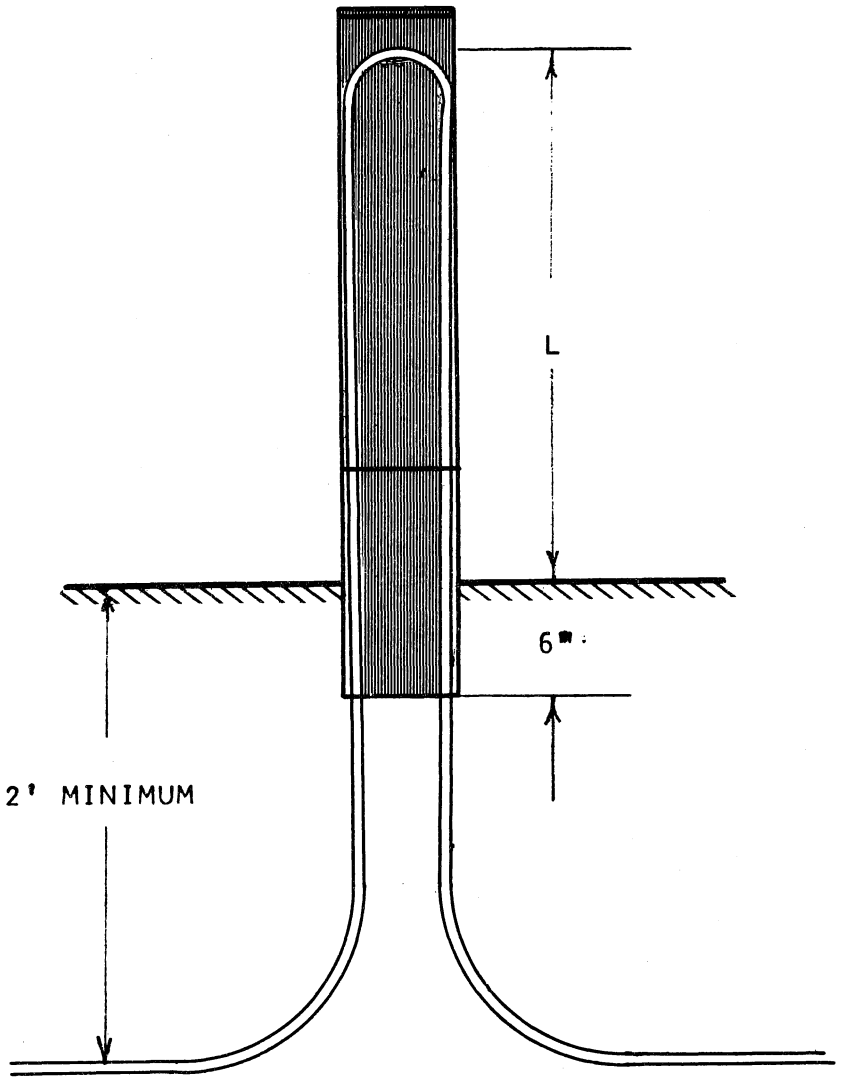


Figure 5

TYPICAL CABLE LOOPS AT
TERMINAL HOUSINGS



TYPE TERMINAL HOUSING	L	ADD FOR CABLE VERTICAL RUN	LOOP
BD2 AND BD2A	3'		12'
BD3 AND BD3A	3.5'	6'	12'
BD4 AND BD4A	4.5'	7'	14'
BD5 AND BD5A	4.5'	7'	14'
BD7	3'	7'	14'

FIGURE 6