Hawaiian Electric

The information found in this document are general guidelines that may be used to aid in the preparation of your service request proposal. Please be advised that depending on the specific needs and actual conditions of your project, Hawaiian Electric may require your design to comply with different specifications including specifications that include more stringent requirements than those included in these design specification guidelines. For further guidance and clarification on the actual specifications that will apply to your particular project, please refer to instructions issued by Hawaiian Electric's Planner or Engineer who is assigned to your particular (Project/Review Request/…). Additionally, please be advised that Hawaiian Electric reserves the right to require additional modifications to any approved design if it is determined during actual construction that additional modifications must be made to address certain field conditions that were not detected or Hawaiian Electric was unaware of during the design review process.

# GUIDE FOR APPLICATION OF CONDUITS

## I. GENERAL

A. This guide is intended to aid Company personnel in the application of conduits for the installation of underground primary distribution, secondary distribution, and secondary service cables in various areas on our system. The sketches also indicate the applications of conduits in residential, commercial and residential condominium service areas.

B. Consult with Engineering Department personnel for conduit requirements for transmission and subtransmission cables.
1. Depending on the type of cable, transmission cables are to be installed in steel pipes or concrete encased conduits in all locations.
2. Subtransmission cables are to be installed in concrete encased conduits in all locations.

C. It can be noted that several alternative methods of installation for a given situation are contained in this guide. It is expected that these methods should cover most of the underground installations on our system.

D. All of the Company's underground installations shall be constructed in accordance with the Company's Standards, including this Guide. The Company's Underground Standards comply, at a minimum, with all applicable regulations, including the PUC's General Order No. 10 and the National Electrical Safety Code, which are primarily concerned with safety. However, in many cases the requirements of the Company's Standards are more stringent than these regulations since their scope encompasses many other concerns in addition to safety, including reliability, operation, maintenance, experience, and best industry practices.

E. The Company's ductlines are to be designed and constructed in accordance with our standards, including the following:
1. Std. 30-1006 Duct Line Applications
2. Std. 30-1015 Typical Duct Encasement Details
3. Std. 30-1020 Duct Roll Sections
4. Std. 30-1025 Conduit and Duct Sealing Details
5. Std. 30-1030 Plastic Ducts - Special Installation Details
6. Std. 30-1035 Plastic Ducts - Installation Details

F. All conduit ends shall be sealed per HECO Std. 30-1025 - Conduit and Duct Sealing Details

G. Direct buried cables will not be allowed on the Company's distribution system.

H. Conduit installations on the HECO system are to be limited to the following types: PVC 40 - Polyvinyl Chloride, Schedule 40 Conduits
PVC 80 - Polyvinyl Chloride, Schedule 80 Conduits

These conduits shall meet the requirements of NEMA Standards Publication No. TC-2, latest revision, and HECO Specification M7001, latest revision.

I. Conduits shall not switch between PVC 40 and PVC 80 in mid-span. The conduit type must be continuous between handholes or manholes.

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## II. DEFINITIONS

A. Commercial Area - Areas where services are per Rule No. 1, "Commercial Services," in the HECO Rules and Rate Schedules and Service Installation Manual.

B. Residential Area - Areas where services are per Rule No. 1, "Residential Services," in the HECO Rules and Rate Schedules and Service Installation Manual.

C. Transmission Cables
1. HECO - 138 KV and above
2. MECO - 69, 34.5, and 23 KV
3. HELCO - 69 KV

D. Subtransmission Cables
1. HECO - 46 KV
2. HELCO - 34.5 KV

E. Primary Distribution Cables - 1 KV and above but below subtransmission and transmission.

F. Secondary Distribution Cables - Below 1 KV and connected to two or more service cables.

G. Secondary Service Cables - Below 1 KV and connected to the terminals of the service equipment.

H. Concrete Encasement: See Details.
Concrete Cover - For one, two or three ducts in a duct bank, the ducts may be laid on a smooth trench bottom and covered with concrete to ensure a 3" concrete coverage on the top and sides.
Concrete Envelope - For four or more ducts in a duct bank, the ducts shall be completely encased (top, sides, and bottom) in a 3" concrete envelope.

I. The terms - Conduits, Ducts and Pipes - are used interchangably in this guide.

J. Non-encased Conduits (Direct Buried Conduits) - Conduits that are not concrete encased and shall be cushioned in Type B backfill as specified in the details. Non-encased conduits shall not be stacked vertically. If conduits must be installed in a vertical arrangement, they shall be concrete encased.

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## III. COMMERCIAL AREAS

### A. Primary Distibution Cables

1. Roads - Schedule 40 PVC conduits in a 3" concrete encasement shall be installed in all areas subject to vehicular traffic. See definition for "Concrete Encasement."

2. Easements - Schedule 40 PVC conduits in a 3" concrete encasement shall be required in all easement areas. See definition for "Concrete Encasement".

3. Sidewalk Areas (With and Without Concrete Sidewalks) - Schedule 40 PVC conduits in a 3" concrete encasement shall be installed in the sidewalk areas. See definition for "Concrete Encasement."

4. Customer's Property - For all primary service cables to vaults and pad mounted transformers for the customer's service in commercial areas:

   a. Schedule 40 PVC conduits in a 3" concrete encasement shall be installed in these areas. See definition for "Concrete Encasement."

   b. Conduit runs under building slabs shall be concrete encased and reinforced with steel bars. See Std. 30-1030, Plastic Ducts - Special Installation Details.

5. For three phase primary distribution circuits, the Schedule 40 PVC conduits shall be installed in a 3" concrete envelope. See Detail on sheet 9.

### B. Secondary Distribution and Service Cables

1. Roads - Schedule 40 PVC conduits in a 3" concrete encasement shall be installed in all areas subject to vehicular traffic. See definition for "Concrete Encasement."

2. Easements - Schedule 40 PVC conduits in a 3" concrete encasement shall be required in all easement areas. See definition for "Concrete Encasement".

3. Sidewalk Areas (With and Without Concrete Sidewalks) - Schedule 40 PVC conduits in a 3" concrete encasement shall be installed in these areas. See definition for "Concrete Encasement."

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4. Customer's Property - For all secondary services to customers in commercial areas.

   a. Schedule 40 PVC conduits in a 3" concrete encasement shall be specified. See definition for "Concrete Encasement".

   b. Conduit runs under building slabs shall be concrete encased and reinforced with steel bars. See Std. 30-1030, Plastic Ducts - Special Installation Details.

C. Manholes, Handholes or Boxes

1. Cast-in-place manholes and handholes, constructed in accordance with HECO standards, or precast/pre-fabricated manholes and handholes, approved for use by HECO, shall be required for all primary distribution cable splice connections.

2. Cast-in-place, precast or pre-fabricated handholes or boxes, approved for use by HECO, shall be installed for all secondary cable connections and service loops.

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## IV RESIDENTIAL AREAS

### A. Primary Distribution Cables

1. Roads - Schedule 40 PVC conduits in a 3" concrete encasement shall be installed under the roads and all areas subject to vehicular traffic in residential areas. See definition for "Concrete Encasement,"

2. Easements - Schedule 40 PVC conduits in a 3" concrete encasement shall be required in all easement areas. This category includes cases where it is necessary to install primary distribution cables between two lots and cases where the primary distribution cables have to be installed in undeveloped areas to riser poles. See definition for "Concrete Encasement".

3. Sidewalk Areas With Concrete Sidewalks - Primary distribution cables under concrete sidewalks shall be installed in:
   a. Schedule 40 PVC conduits in a 3" concrete encasement. See definition for "Concrete Encasement".
   b. As an alternative, non-encased Schedule 80 PVC conduits with a minimum 24" cover may also be utilized.
   c. Multiple conduit installations where the conduits are arranged vertically shall be installed in a concrete envelope. See Detail, Sheet 9.

4. Sidewalk Areas Without Concrete Sidewalks - Primary distibution cables in sidewalk areas without concrete sidewalks shall be installed in Schedule 40 PVC conduits in a 3" concrete encasement. See definition for "Concrete Encasement".

5. For the installation of primary distribution underground three phase feeder cables in 4" or larger conduits through a subdivision, Schedule 40 PVC conduits shall be installed in a 3" concrete envelope. See Detail on Sheet 9.

### B. Secondary Distribution and Service Cables

1. Roads - Schedule 40 PVC conduits in a 3" concrete encasement shall be installed under the roads and all areas subject to vehicular traffic in residential areas. See definition for "Concrete Encasement,"

2. Easements - Schedule 40 PVC conduits in a 3" concrete encasement shall be required in all easement areas. See definition for "Concrete Encasement". Primarily, this category includes cases where it is necessary to install secondary cables between two lots and in undeveloped areas.

3. Concrete Sidewalks - Secondary distribution cables under concrete sidewalks shall be installed in:
   a. Schedule 40 PVC conduits in a 3" concrete encasement. See definition for "Concrete Encasement".
   b. As an alternative, non-encased Schedule 40 PVC conduits with a minimum 18" cover may also be utilized to house secondary distribution cables.
   c. Multiple conduit installations where the conduits are arranged vertically shall be installed in a concrete envelope. See Detail, Sheet 9.

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4. Sidewalk Areas without Concrete Sidewalk
   a. Schedule 40 PVC conduits with a 3" concrete encasement shall be installed for the secondary distribution cables in the sidewalk area without concrete sidewalk. See definition for "Concrete Encasement".
   b. As an alternative, non-encased Schedule 80 PVC conduits with a minimum 18" cover may also be utilized to house secondary distribution cables.
   c. As a second alternative, non-encased Schedule 40 PVC pipes with a minimum 2'-0" cover may also be used. However, conduits/pipes crossing driveways must be in a 3" concrete encasement.

5. Customer's Property - For all secondary services to customers in residential areas, any one of the following types of construction may be specified:
   a. Schedule 40 PVC conduits in a 3" concrete encasement shall be specified. See definition for "Concrete Encasement".
   b. As an alternative, non-encased Schedule 40 PVC conduits with a minimum 18" cover may be specified for all areas not subject to vehicular traffic.
   c. Conduits under driveways and in parking areas must be in a 3" concrete encasement.
   d. As an alternative, Schedule 80 conduits non-encased with a minimum of 18" cover may be specified under driveways and in parking areas.
   e. Conduit runs under building slabs shall be concrete encased and reinforced with steel bars. See Std. 30-1030, Plastic Ducts - Special Installation Details.

C. Manholes, Handholes or Boxes

1. Cast-in-place manholes and handholes, constructed in accordance with HECO standards, or precast/pre-fabricated manholes and handholes, approved for use by HECO, shall be required for all primary distribution cable splice connections.

2. Cast-in-place, precast or pre-fabricated handholes or boxes, approved for use by HECO, shall be installed for all secondary cable connections and service loops.

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## V CONDOMINIUM - RESIDENTIAL

In condominium or similar areas where two or more structures require electric services on a common property and where it is necessary to install primary and secondary cables along private roadways, walkways and parking areas with easements, the following types of construction shall be specified:

### A. Primary Cables

1. Roads or Parking Area - Schedule 40 PVC conduits in a 3" concrete encasement, shall be installed under the roads and areas subject to vehicular traffic, including parking. See definition for "Concrete Encasement."

2. Sidewalk Areas With Concrete Sidewalks or Walkways - Primary distribution cables under concrete sidewalks shall be installed in:
   a. Schedule 40 PVC conduits in a 3" concrete encasement. See definition for "Concrete Encasement".
   b. As an alternative, non-encased Schedule 80 PVC conduits with a minimum 24" cover may also be utilized.
   c. Multiple conduit installations where the conduits are arranged vertically shall be installed in a concrete envelope. See Detail, Sheet 9.

3. Unpaved or Grass Areas - Schedule 40 PVC conduits with 3" concrete encasement shall be utilized. See definition for "Concrete Encasement".

4. For the installation of primary distribution three phase feeder cables in 4" or larger conduits through a condominium area, Schedule 40 PVC conduits shall be installed in a 3" concrete envelope. See Detail on sheet 9.

### B. Secondary Distribution Cables

1. Roads or Parking Area - Schedule 40 PVC conduits in a 3" concrete encasement shall be installed under the roads and areas subject to vehicular traffic, including parking. See definition for "Concrete Encasement".

2. Concrete or Paved Sidewalks or Walkways
   a. Schedule 40 PVC conduits with a 3" concrete encasement may be installed for secondary distribution cables in these areas. See definition for "Concrete Encasement".
   b. As an alternative, non-encased Schedule 40 PVC conduits with a minimum 18" cover may be used to house secondary distribution cables under concrete sidewalks.
   c. Multiple conduit installations where the conduits are arranged vertically shall be installed in a concrete envelope. See Detail, Sheet 9.

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3. Unpaved or Grass Areas
   a. Schedule 40 PVC conduits with 3" concrete encasement shall be specified for the secondary distribution cables in these areas. See definition for "Concrete Encasement".
   b. As an alternative, non-encased Schedule 80 PVC conduits with a minimum 18" cover may be used to house secondary distribution cables under unpaved or grass areas. However, conduits in driveways must be in a 3" concrete encasement.
   c. As a second alternative, non-encased Schedule 40 PVC conduits with a minimum 2'-0" cover may be used. However, conduits in driveways must be in a 3" concrete encasement.
   d. Multiple conduit installations where the conduits are arranged vertically shall be installed in a concrete envelope.

C. Services

1. Schedule 40 PVC conduits with 3" concrete encasement shall be required to house the service cables with 18" cover. See definition for "Concrete Encasement".
2. As an alternative, non-encased Schedule 40 PVC conduits with a minimum 18" cover may be used to house service cables for all areas not subject to vehicular traffic. However, conduits in driveway and parking areas must be in 3" concrete encasement.
3. Multiple conduit installations where the conduits are arranged vertically shall be installed in a concrete envelope.
4. Service runs under building slabs shall be in conduits and shall be encased in concrete and reinforced with steel bars. See Std. 30-1030, Plastic Ducts - Special Installation Details.

D. Manholes, Handholes or Boxes

1. Cast-in-place manholes and handholes, constructed in accordance with HECO standards, or precast/pre-fabricated manholes and handholes, approved for use by HECO, shall be required for all primary distribution cable splice connections.
2. Cast-in-place, precast or pre-fabricated handholes or boxes, approved for use by HECO, shall be installed for all secondary cable connections and service loops.

## VI GALVANIZED IRON CONDUITS

A. Galvanized iron conduits may be used for short runs, approximately 15 feet, under driveways or sidewalks for service cable to an individual residence.

B. Galvanized iron conduits shall not be utilized for extensive runs (over about 15 feet) in residential, commercial or condominium areas except for special applications. Consult with Technical Services Division for these applications.

C. Both ends of all conduit runs composed of galvanized iron conduits shall be securely grounded.

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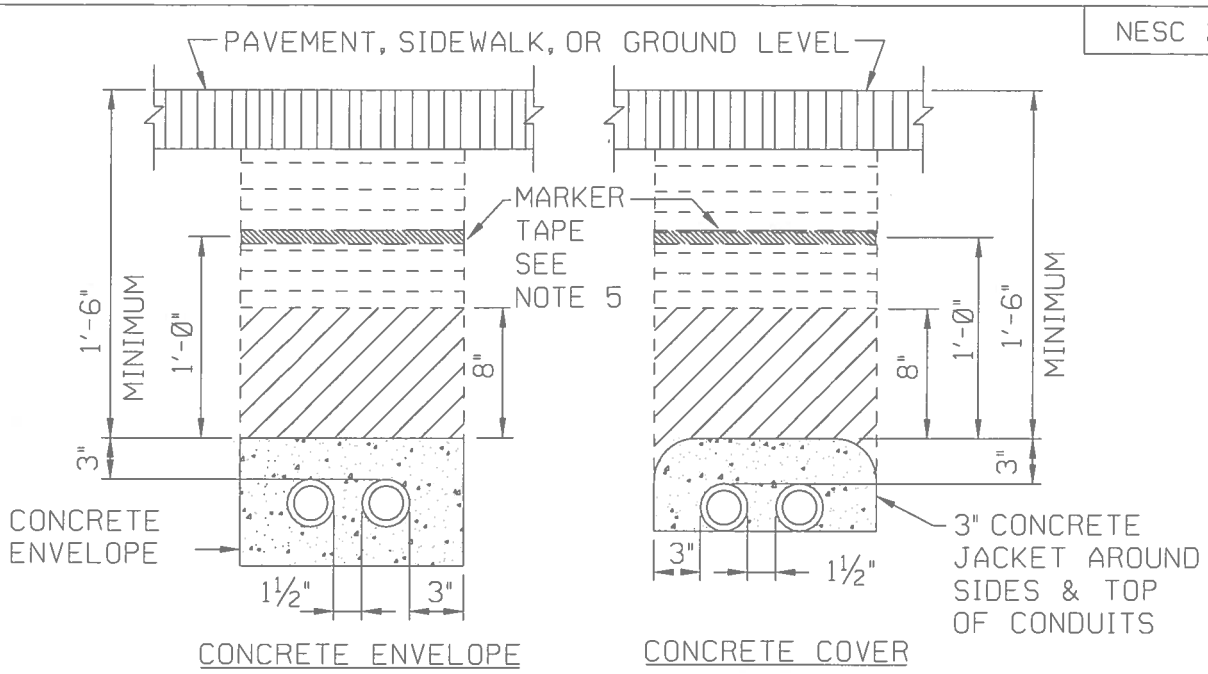


CONCRETE ENVELOPE  CONCRETE COVER

CONCRETE ENCASEMENT

NOTE:

FOR THREE PHASE, PRIMARY DISTRIBUTION UNDERGROUND CIRCUITS IN ALL AREAS, THE SCHEDULE 40 PVC CONDUITS SHALL BE INSTALLED IN A 3" CONCRETE ENVELOPE.

| | | | | | | | |
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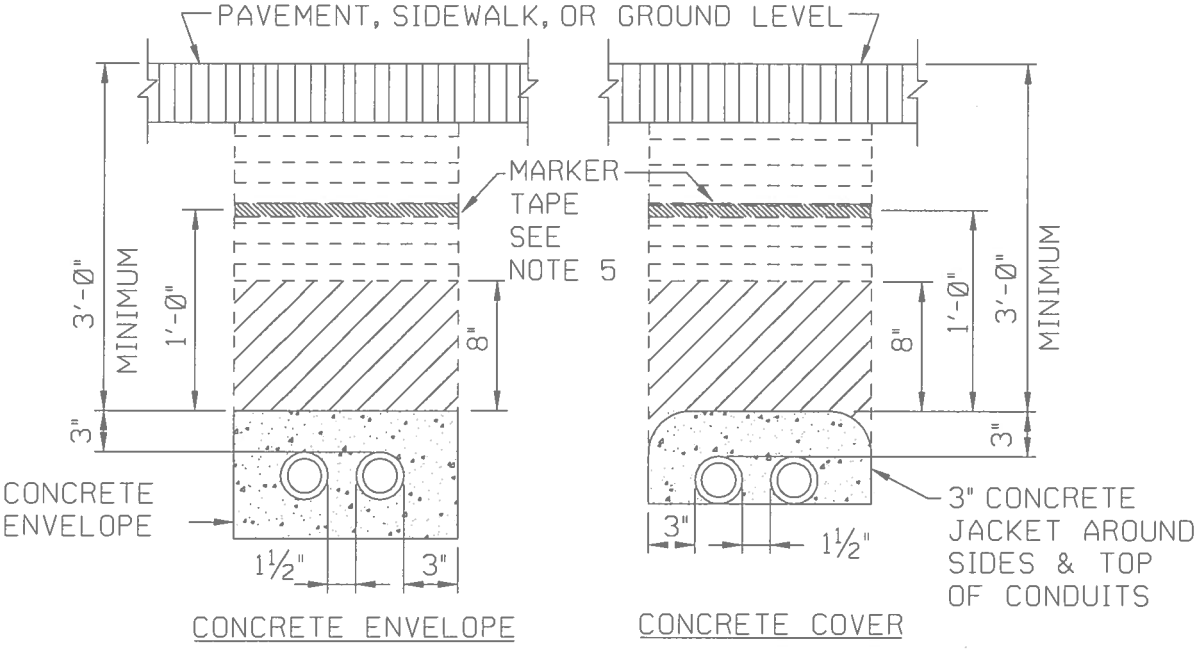
| III A3 | III B3 | IV A3a | IV B2 | IV B5a | V A3 | V B3d | |
| III A4a | III B4a | IV A4 | IV B3a | IV B5c | V B2a | V C1 | |
| | | | | | V B2c | V C3 | |

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CONCRETE ENCASEMENT

NOTE:

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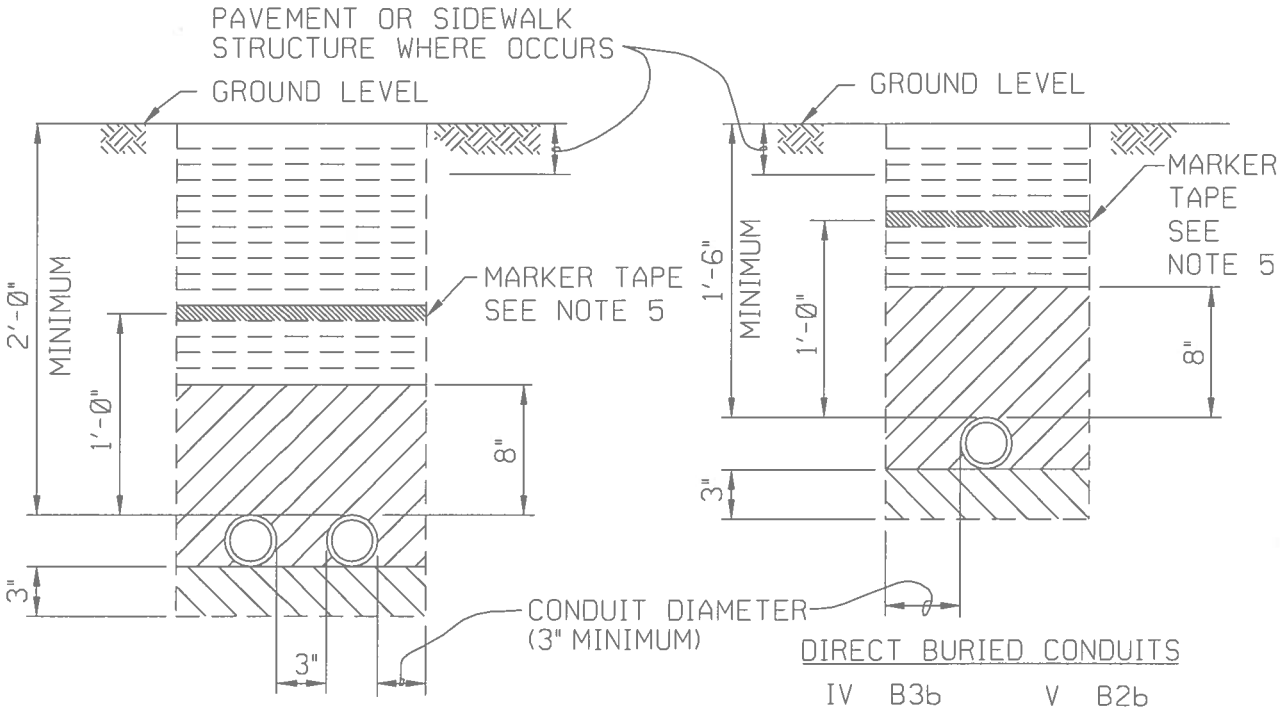


DIRECT BURIED CONDUITS

| | | | |
|---|---|---|---|
| IV | A3b | V | A2b |
| IV | B4c | V | B3c |

DIRECT BURIED CONDUITS

| | | | |
|---|---|---|---|
| IV | B3b | V | B2b |
| IV | B4b | V | B3b |
| IV | B5b | V | C2 |
| IV | B5d | | |

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NOTES:

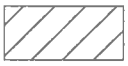
1. BACKFILL SHALL BE MADE WITH SUITABLE MATERIAL SPECIFIED OR AS APPROVED BY HECO INSPECTOR. SUCH MATERIAL SHALL BE AS DESCRIBED BELOW. NO BRUSH, TRASH, GRASS, OR ORGANIC MATERIAL SHALL BE PLACED IN ANY BACKFILL.

2. IF THE NORMAL MATERIAL IN THE BOTTOM OF THE TRENCH IS NOT TYPE "B", AN ADDITIONAL 3" SHALL BE EXCAVATED AND THE TYPE "B" BACKFILL SHALL BE PROVIDED.

3. CONCRETE NOTES:
   A) CONCRETE STRENGTH - 2500PSI IN 28 DAYS
   B) MAXIMUM AGGREGATE FOR DUCTLINE CONCRETE - 3/4"

4. BACKFILL
   a. PREFERRED BACKFILL

TYPE "A" - EITHER MATERIAL CONFORMING TO THE REQUIREMENTS OF THE CITY AND COUNTY OF HONOLULU STANDARD SPECIFICATION FOR PUBLIC WORKS CONSTRUCTION, DATED SEPTEMBER 1986, SECTION 16 - "BORROW", OR NATIVE SOIL MATERIAL WHICH DOES NOT CONTAIN MORE THAN 50% GRAVEL, AND ALSO, DOES NOT CONTAIN HARD LUMPS OF EARTH 3 INCHES IN GREATEST DIMENSION, ROCKS LARGER THAN 3 INCHES IN LARGEST DIMENSION, HIGHLY PLASTIC CLAY, POORLY-GRADED SAND AND GRAVEL (CLASSIFIED AS SP AND GP USING THE UNITED SOIL CLASSIFICATION SYSTEM), ORGANICS, DEBRIS, OR OTHER UNSUITABLE OR DELETERIOUS MATERIALS.



TYPE "B" - SELECT GRANULAR MATERIAL PASSING A ONE (1) INCH SIEVE SUCH AS THREE-QUARTER (3/4) INCH AGGREGATE BASE COURSE GRAVEL, S4C OR MATERIAL THAT IS FREE OF ORGANICS, DEBRIS OR HIGHLY-PLASTIC CLAY AND MEETS THE FOLLOWING GRADATION:

| SLEEVE SIZE | PERCENT PASSING BY WEIGHT |
|---|---|
| 1" | 100 |
| 3/4" | 90 - 100 |
| NO. 4 | 35 - 100 |
| NO. 40 | 10 - 30 |
| NO. 200 | 3 - 15 |

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b. Alternative Backfill

(1) A controlled Fluidized Thermal Backfill (FTB) may be placed around the the conduits in lieu of the Type A and Type B Backfill material. FTB is to be placed as a slurry around and above the conduits and, when properly formulated and mixed, will solidify into a uniform, efficient heat conducting medium that will provide structural support and mechanical protection for the buried conduits.

(2) The FTB shall be composed of fine to coarse natural aggregate, cement and water as specified.
The mix proportions to yield approximately 1 cu. Yd. of FTB are given below:

Course Aggregate (Crushed Basalt #67) - 1550 pounds/cu. Yd.
Medium Aggregate (Manufactured Concrete Sand) - 1300 pounds/cu. Yd.
Fine Aggregate (Maui Dunes Sand) - 500 pounds/cu. Yd.
Cement (Normal Portland Cement Type 1) - 150 pounds/cu.Yd.
Water - 52 gallons

No substitutions of materials is permitted without HECO engineer's approval.

(3) The FTB is to be installed by pouring into the trench and completely filling all voids without causing excessive segregation. No vibration or compaction shall be used. The FTB may be pumped into place using conventional concrete pumps; however, this method shall be approved by the HECO engineer first as the flow requirements may have to be adjusted accordingly.

5. Electrical Warning Marker Tape is required above all non-encased conduits. For concrete encased conduits, marker tape is required for all conduit installations in the State Highway Right-of-Way. Place marker tape 1'-0" above conduits or encasement. Marker tape shall conform to HECO Spec. M0302.

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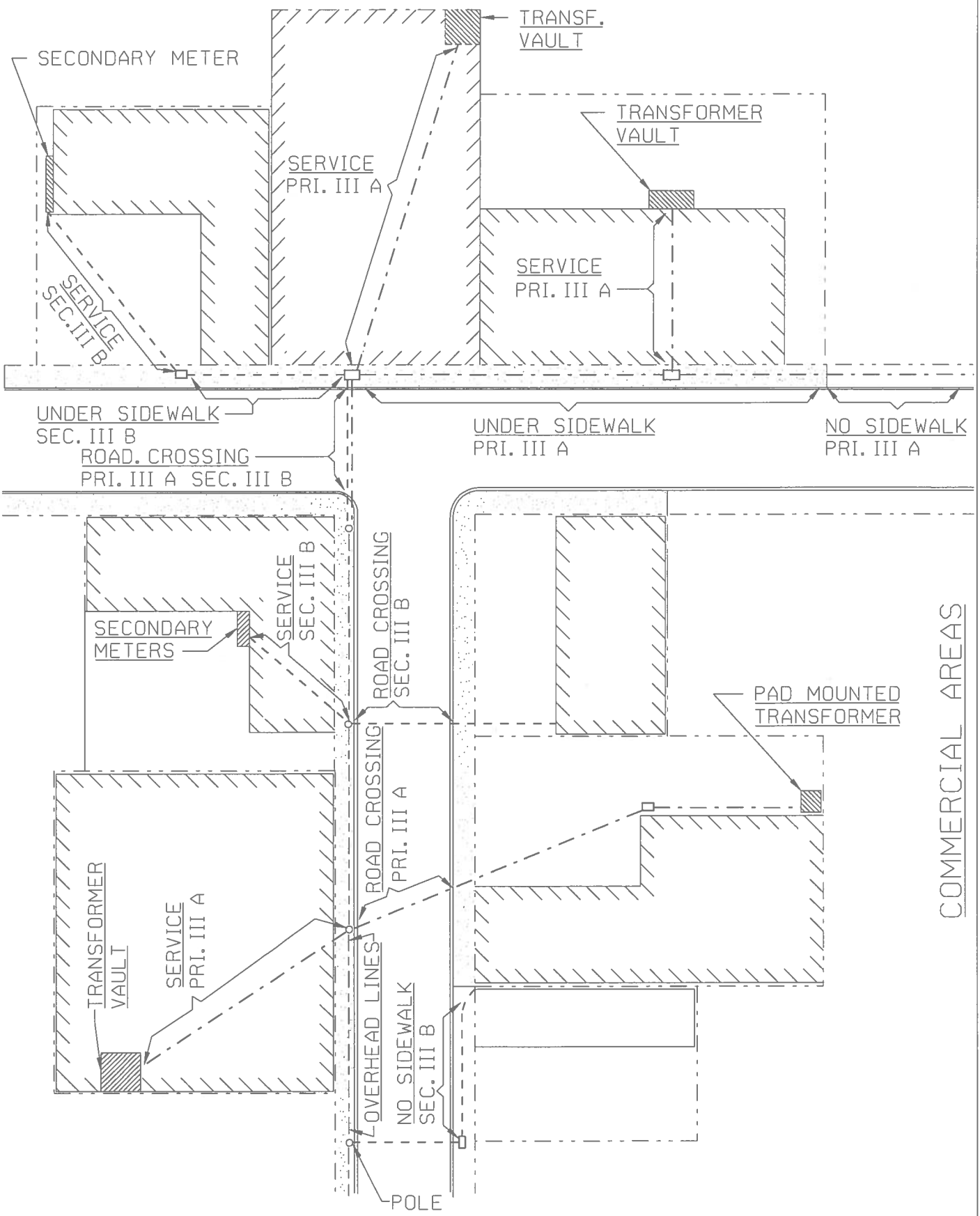


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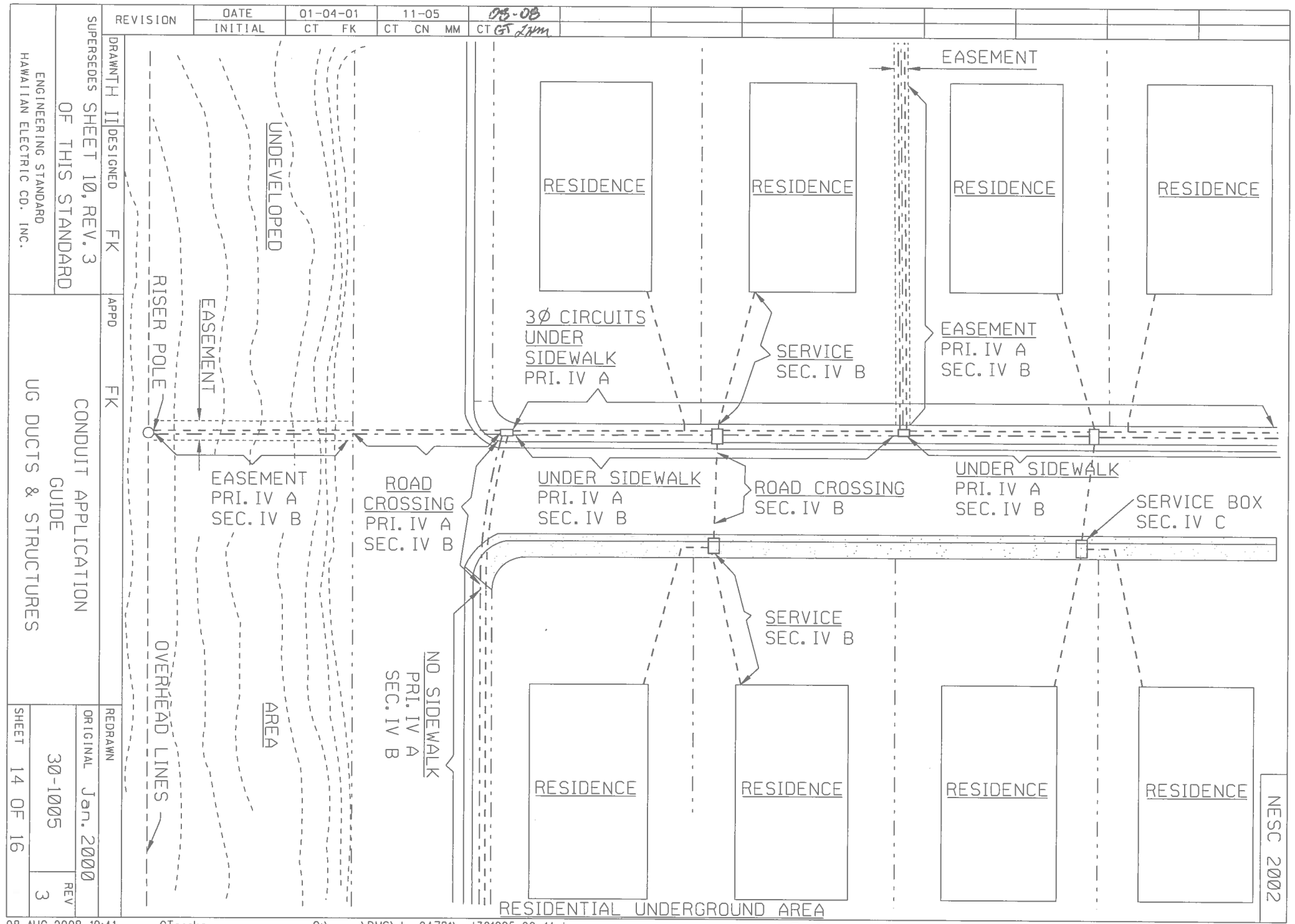
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EASEMENT
RESIDENCE
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3Ø CIRCUITS UNDER SIDEWALK PRI. IV A
SERVICE SEC. IV B
EASEMENT PRI. IV A SEC. IV B
EASEMENT PRI. IV A SEC. IV B
ROAD CROSSING PRI. IV A SEC. IV B
UNDER SIDEWALK PRI. IV A SEC. IV B
ROAD CROSSING SEC. IV B
UNDER SIDEWALK PRI. IV A SEC. IV B
SERVICE BOX SEC. IV C
SERVICE SEC. IV B
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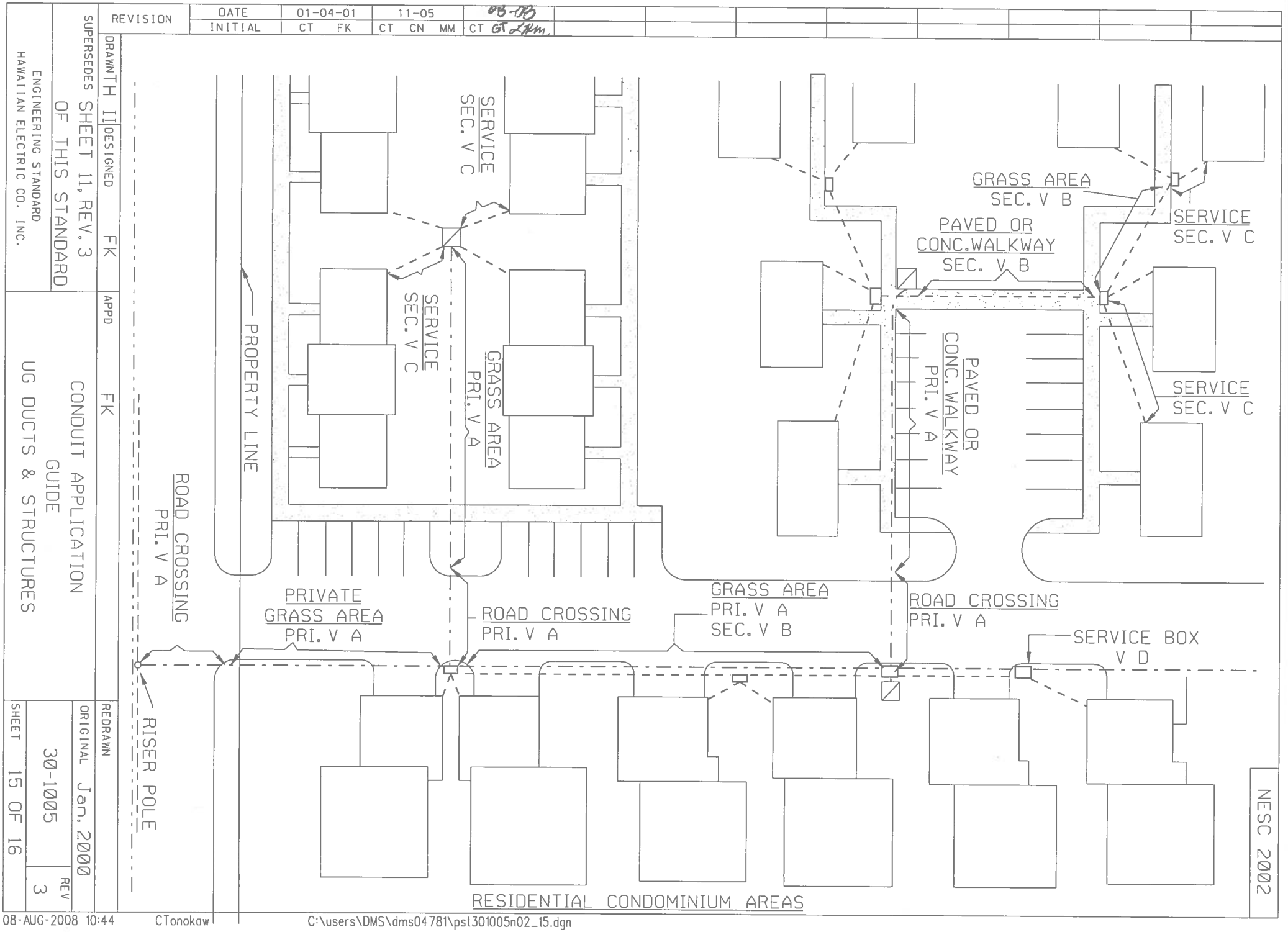
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SERVICE SEC. V C
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PROPERTY LINE
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PRIVATE GRASS AREA PRI. V A
ROAD CROSSING PRI. V A
GRASS AREA PRI. V A SEC. V B
PAVED OR CONC. WALKWAY PRI. V A
GRASS AREA SEC. V B
PAVED OR CONC. WALKWAY SEC. V B
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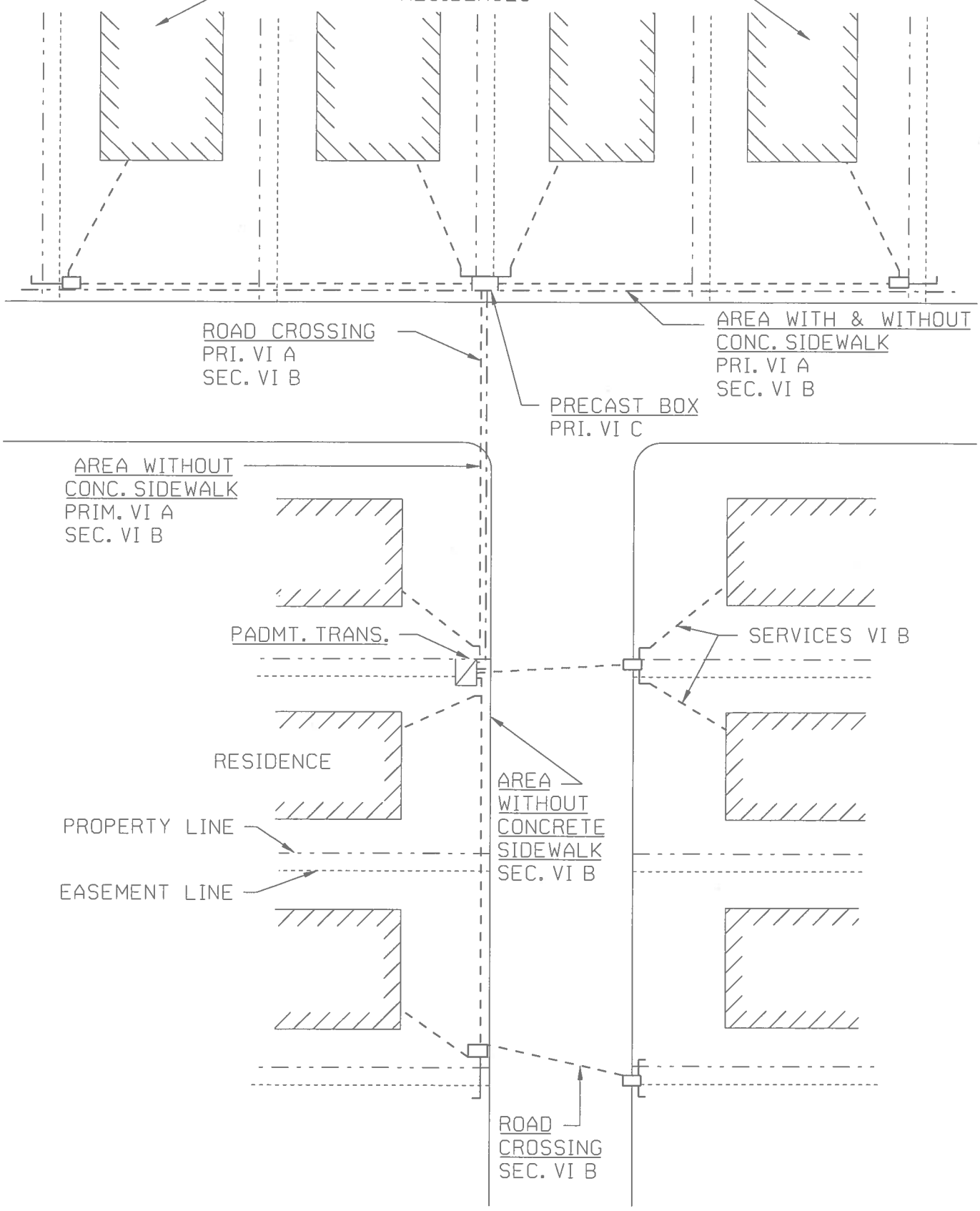


# ZERO LOT LINE RESIDENTIAL AREAS

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