Kimley»Horn

February 2, 2015

Ms. Marjorie Ferrer
Executive Director
Delray Beach Downtown Development Authority
85 SE 4th Ave, Suite 108
Delray Beach, FL 33483

RE: ***Delray Beach DDA Christmas Tree Evaluation***

Ms. Ferrer:

Kimley-Horn and Associates, Inc. ("Kimley-Horn") is pleased to submit this report to Delray Beach Downtown Development Authority ("Delray Beach DDA") for the preliminary structural evaluation of the steel frame of the 100 foot tall steel framed Christmas tree that the DDA displays over the holidays at Old School Square.

BACKGROUND AND PURPOSE

The tree structure was purchased from a previous owner. A concrete ring foundation was constructed as the base for the tree's structural frame in Old School Square, where it has been erected and displayed for over 20 years.

Annually, as the tree is removed, repairs are conducted to the frame, primarily to repair welds, replace rusting elements, and re-paint damaged areas. Once repaired, the frame is stacked and stored until the following holiday season.

Concerns have arisen regarding the structural integrity of the frame, and the cost of the current level of repairs. The DDA requested that Kimley-Horn conduct a non-destructive assessment of the condition of the frame, and provide actions for changes in how the tree is handled, repaired and stored.

INVESTIGATION AND OBSERVATIONS

The tree had already been erected for the 2014 -2015 holiday season at the time we were contacted. In addition to our initial site visit to understand the DDA's concerns on December 10, 2014, two additional site visits were conducted as part of our investigation on January 9, 2015 and on January 23, 2015.

Representative photographs taken during all three visits are included in Appendix A.

On January 9 2015, the primary purpose of the site visit was to observe and measure the tree structure as it was being dismantled. A meeting was held on site in which I had the opportunity to speak and interview Mr. Les Hensley from Eagle Metal Products. His company has been erecting and repairing the tree frame for many years.

The follow-up visit on January 23, 2015 was a review of the frame storage site conditions once the frame was disassembled, stacked and stored.

General observations

The following summarizes the framing characteristics of the structure based on the site visits, as well as a review of the plans provided to us by the City:

- The tree frame structure is composed primarily of welded square hollow tubular steel frame sections. Each frame consists of approximately 4 welded panels. There are a total of 548 frames.
- The entire frame (100 feet tall) is anchored by expansion bolts into the concrete foundation ring once assembled.
- The frame sections are assembled into polygonal "rings" by bolting the vertical legs at the edges of each frame together.
- The rings are stacked on top of each other and bolted together vertically through pre-drilled bolt holes in the upper and lower horizontal members to create "sections".
- The tree frame is subdivided into 5 sections, each of which consists of 8 "ring" frames.
- The steel frames have an exterior paint coating but no interior protection.
- The frames are stored outdoors, with no protection. Frames are partially connected when stored, with some of the bolts left in place.
- The vertical legs of the frames do not have drain holes into the horizontal members.
- The greenery and electrical lights that create the tree are zip- or wire-tied to the frame.

A copy of the plans of the tree frame is included in Appendix B for reference.

Overall condition of the frames:

During the second visit, when the tree was being disassembled, all of the sections were visible. The following was noted:

- The uppermost sections of the frames were reported to have recently re-fabricated in part and were visually determined to be in good condition.
- The lowest section was also noted to be in better condition than the majority of the frames that were stacked on site.
- Significant corrosion was noted in the frames that have not been recently restored. The majority of the corrosive distress was near the bolt hole locations and frame corners.
- The fasteners (bolts, nuts and washers) exhibited varying degrees of corrosion and weathering.
- There is extensive internal corrosion of the tubular members of the frames.

Refer to the captions of the photographs in Appendix A for additional information.

Existing Repair protocol:

Les Hensley (the President of Eagle Metals) reported that his company has been responsible for patching and repairing the tree frame on an annual basis. Repairs are done to the most severely affected areas, up to a maximum annual budgeted amount.

Typically, repairs consist of partial replacement of one or more legs of the frames and replacement of some of the bolt assemblies. In the past, they have tried to systematically review and upgrade the frames on a section by section basis. The uppermost section (tree top) has been nearly completely re-built. The lower (ground) section was re-furbished a few years ago.

Repairs also include touch up painting areas scratched from the chains that handle the frames during erection of the tree structure.

From a scheduling perspective, the repairs are performed shortly after the tree is removed from the site, preferably before delivery to the storage area.

There is no inventory or log of the repairs performed to date.

Existing Storage Location:

During the interview, Mr. Hensley expressed concern about the storage location and lack of protection of the frames during the summer rainy season.

The partially connected frames are transported and stacked in the back of the Public Works yard facility in an area that used to have a framed canopy. The frame is still visible, but the tarp is no longer in place. The condition of the canopy frame indicates that the tarp has been missing for several years. The overall plan size of the framed canopy is approximately 20 feet by 30 feet.

Frames are stored without any particular order. No inventory markings were noted on the frames.

The frames are placed directly on the pavement, with some frames connected with bolted fasteners still in place.

The orientation in which the frames are stacked (horizontally) allows rainwater to enter the bolt holes in the vertical legs, where it gets trapped because the vertical legs do not have drains. The only openings in the vertical legs are the bolt holes.

RECOMMENDATIONS

The overall condition of the tree frames is fair, with some sections in good condition, and some frames exhibiting extreme deterioration in localized areas.

The primary cause of the deterioration of the frame is due to the existing frame configuration that does not allow for proper ventilation/drying of the interior of the tubular members. Water gets trapped inside the tubular members.

Based on the observed conditions, the following incremental improvements are recommended:

1. Drill drain holes in the closed vertical leg sections of the frames to prevent trapping water.
2. Replace all fastener components (bolts, washers and nuts) with non-corrosive galvanized or stainless steel assemblies.
3. Consider using washers with neoprene to seal the holes when the frame is erected in place to minimize water intrusion.
4. Store all frames completely detached from each other.
5. Develop a rack system for storage that holds the frames vertical, elevated off the floor, thereby minimizing trapped water intrusion.
6. Continue to remove any loose rust and patch, weld or replace severely corroded sections as needed.
7. New sections should be galvanized and left bare (no paint) for better tracking and monitoring of the effectiveness of the repairs.
8. Create an inventory tracking log sheet to number the sections and track the repairs.
9. Construct or install an insulated closed shed-type structure for storage and protection of the frames.

Discussion about treatment of the interior of the tubular members was not pursued because in their current configuration, the tubes are not connected.

Replacing all the frames would be best served by a re-design, not just a re-construction, utilizing open steel sections. The cost of a re-constructed frame would be very expensive, and would have to be phased to utilize the existing frames that have been re-built and are in better condition.

As frames are reconstructed, consideration should be given to replacing frames, not just partial members. These new frames should be fabricated and galvanized with no sealed/ hidden compartments.

CONCLUSIONS

The overall condition of the tree frames is fair, with some sections in good (re-furbished) condition, and some frames exhibiting extreme deterioration in localized areas. The current repair protocol is maintaining the tree structure, but is not preventing further deterioration.

In order to achieve long term improvement, changes with regards to fasteners and storage need to be implemented very quickly as outlined in the recommendations section.

Once a proper storage solution is achieved, the next incremental improvement is to develop a phased replacement plan. Utilizing the repair tracking log, the focus should shift to inspecting and rating every frame to prioritize replacements by frame number and location.

If applied systematically, this would lead to a replacement plan that would slowly create complete new rings of the tree's framing system.

Our recommendations require an additional upfront investment for storage and fasteners, in addition to the on-going maintenance. The second investment is to conduct the inspection and develop the prioritization replacement schedule. Once those two steps are completed, a systematic annual approach to restoring the structural integrity of the tree can be achieved.

CLOSURE

The opinions and conclusions expressed in this report are based on a review of the noted material, the limited investigation described above, as well as my education, training, and experience as a licensed, professional engineer, and have been reached within a reasonable degree of engineering probability. These opinions and conclusions are based on the information currently available to me and may be amended or supplemented should new information become available.

This report has been prepared in accordance with the applicable professional standard of care. No other warranties or guarantees, express or implied, are made or intended. This report has been prepared solely for the Client for the purpose stated herein and should not be relied upon by any other party or for any other purpose. Any reliance on this report by any party other than the Client shall be without liability to Kimley-Horn or its employees.

Please call me at (561) 845-0665 if you have any questions.

Sincerely,

KIMLEY-HORN AND ASSOCIATES, INC.
CA 00000696

Angelina G. Fairchild, P.E.
FL License #43958

Attachments:

Appendix A – Representative Photographs from Site Visits
Appendix B – Tree Plans Provided by City

Kimley»Horn

APPENDIX A

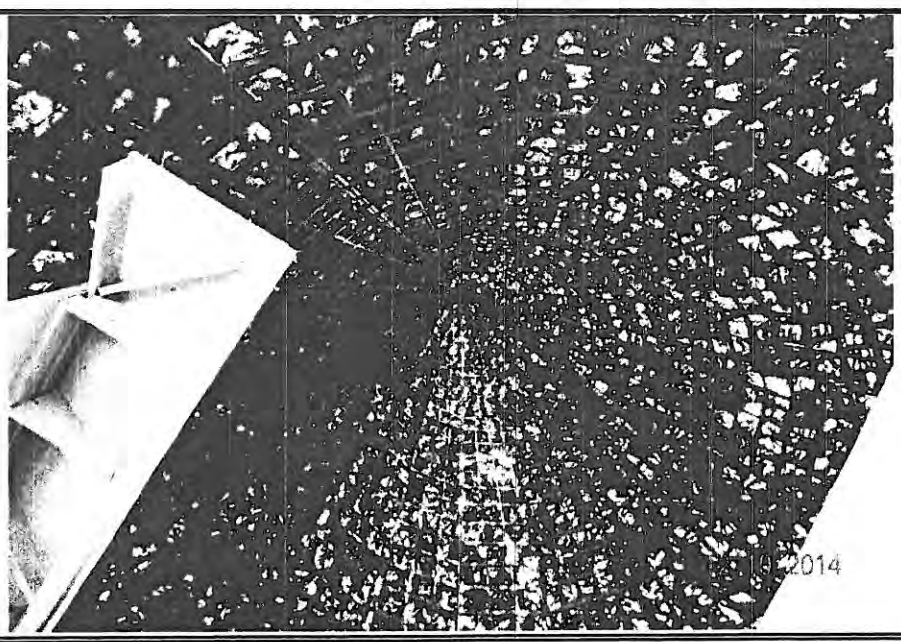
Representative photographs from site visits

Kimley»Horn
KHA Job No.: 144999000

Delray Beach DDA Christmas Tree Frame

Photograph Sheet

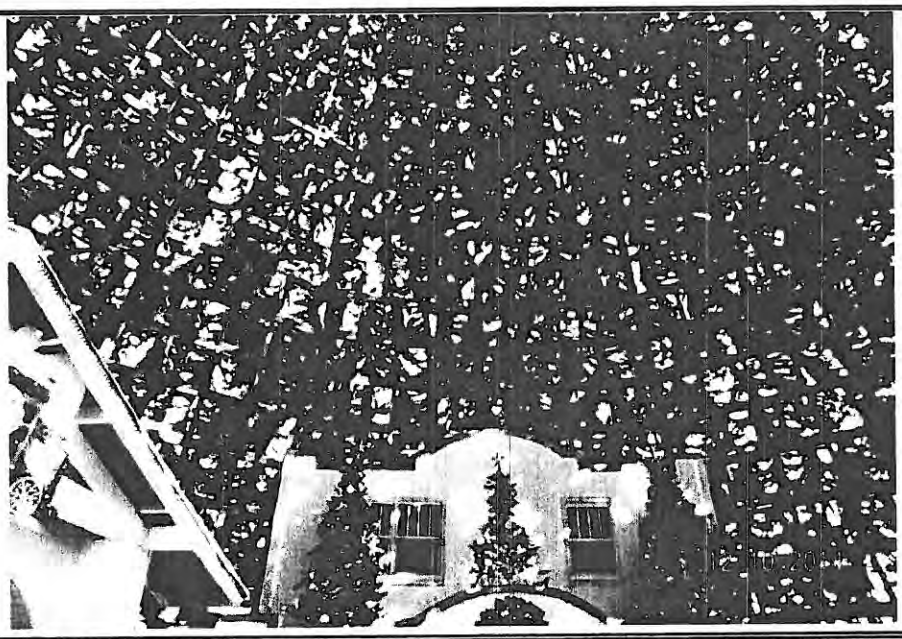
Photo No. 1



Remarks: View of tree frame from within while in place for display.

Location: TREE IN PLACE

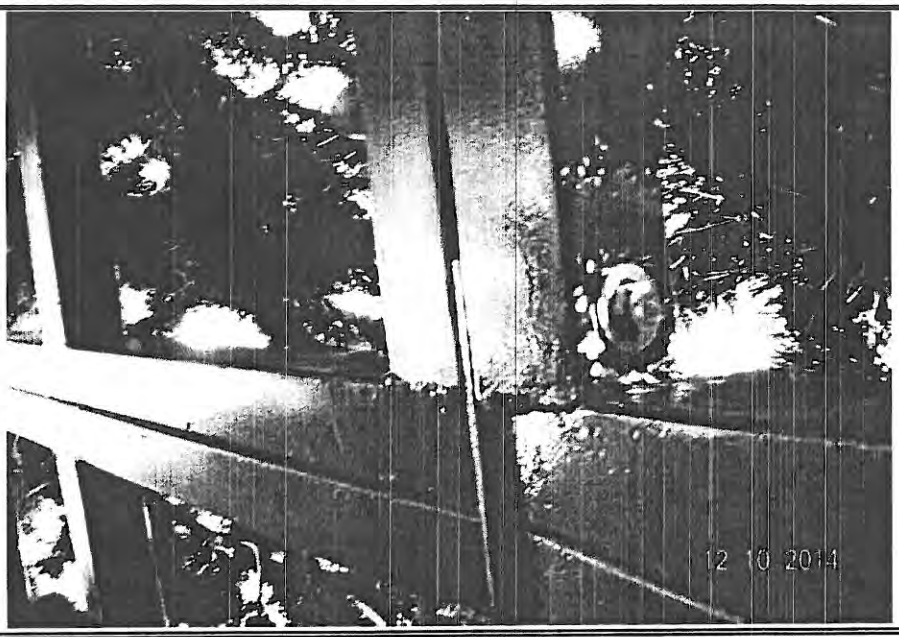
Photo No. 2



Remarks: Closer view of tree frame from within while in place for display. Note frames tapering with tree height.

Location: TREE IN PLACE

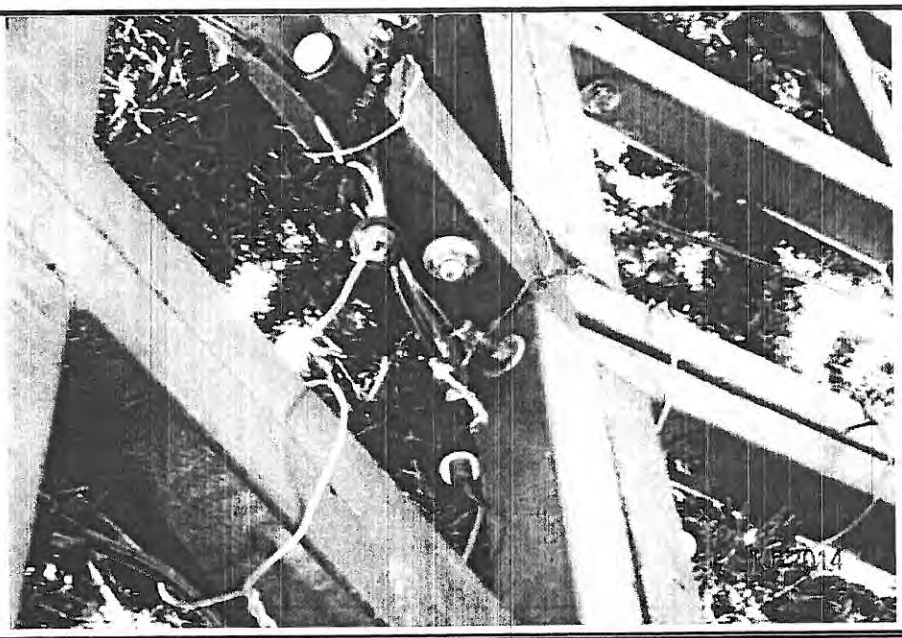
Photo No. 3



Remarks: Close-up view of tree frame connection from within while in place for display.

Location: TREE IN PLACE

Photo No. 4



Remarks: Close-up view of attachment of teree greenery and lighting from within while in place for display. Note corrosion of bolted connections.

Location: TREE IN PLACE

Photo No. 5

Remarks: View of tree section on site during removal. This section was reportedly recently refurbished.

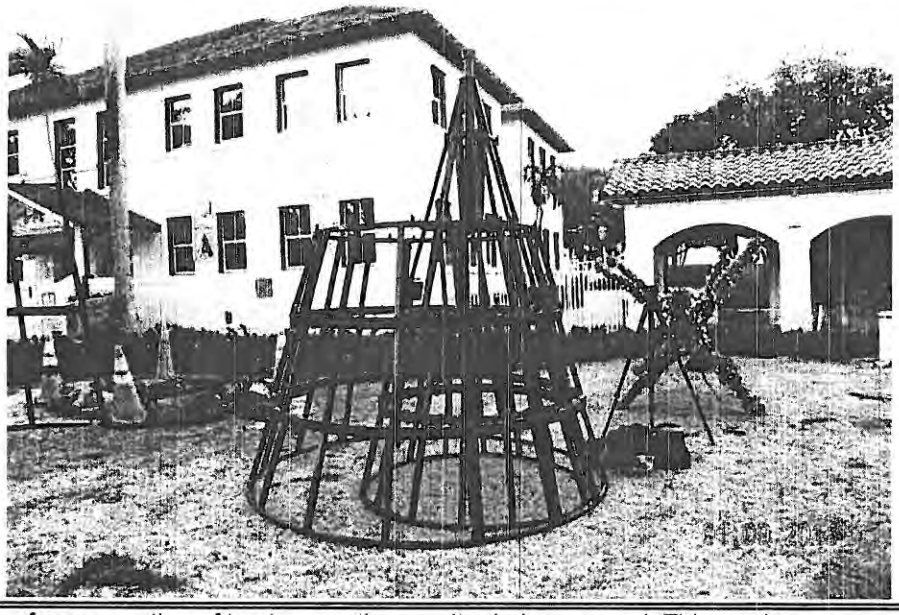
Location: TREE BEING DISASSEMBLED

Photo No. 6

Remarks: View of lowest tree section on site during removal. This section was reportedly recently refurbished.

Location: TREE BEING DISASSEMBLED

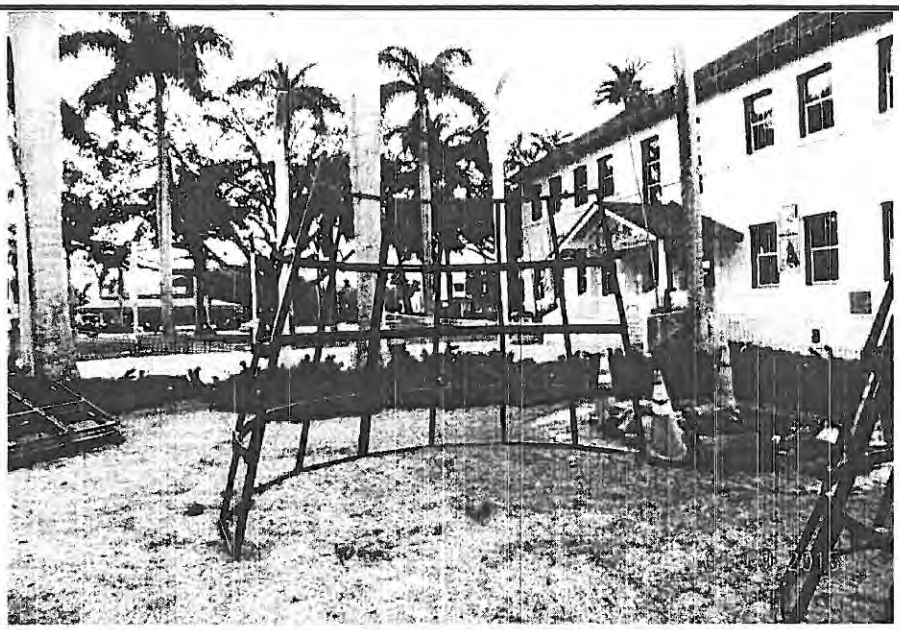
Photo No. 7



Remarks: View of upper portion of top tree section on site during removal. This section was recently refurbished.

Location: TREE BEING DISASSEMBLED

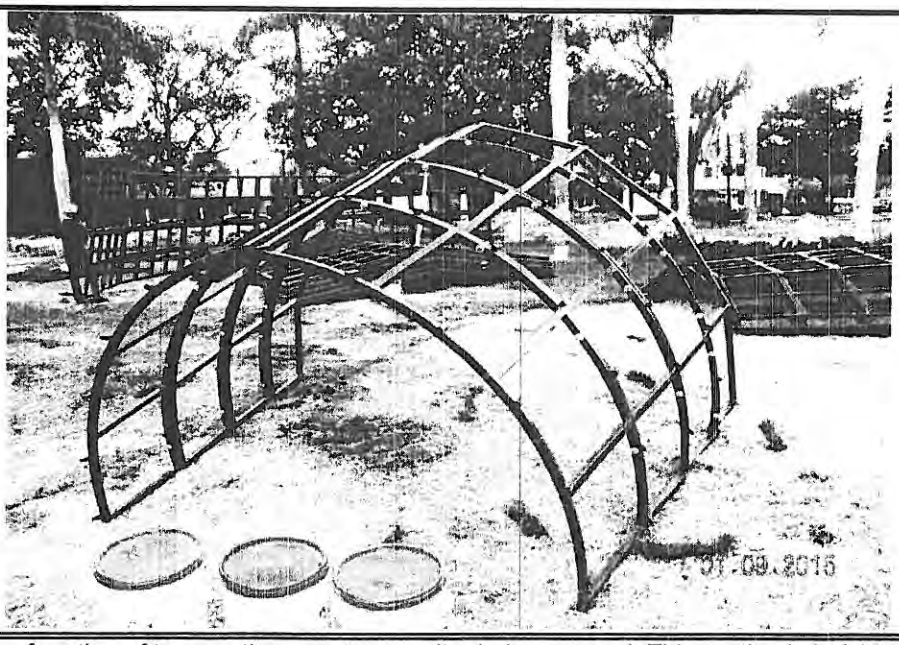
Photo No. 8



Remarks: View of lower portion of top tree section on site during removal. This section is in fairly good condition.

Location: TREE BEING DISASSEMBLED

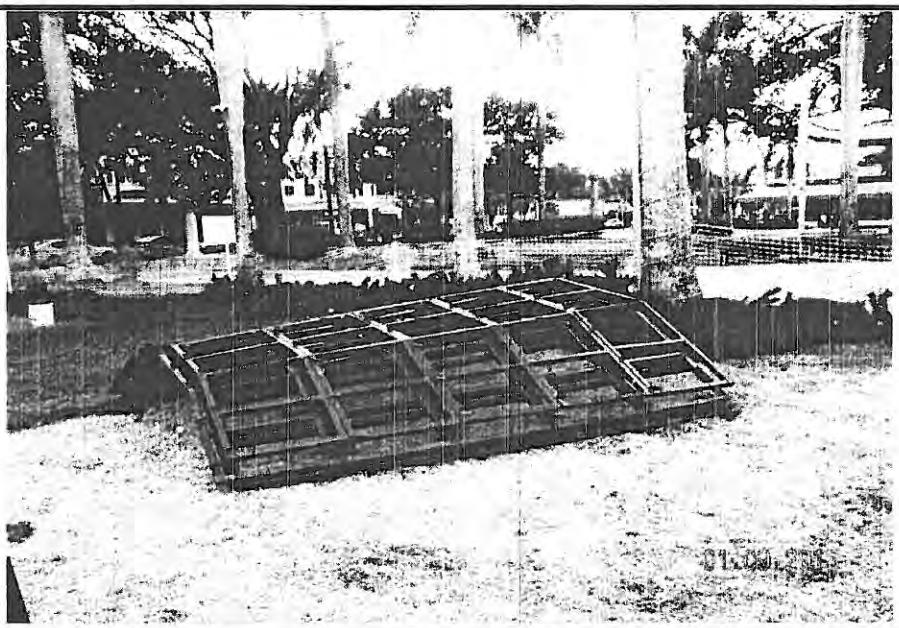
Photo No. 9



Remarks: View of portion of tree section near top on site during removal. This section is in fairly good condition.

Location: TREE BEING DISASSEMBLED

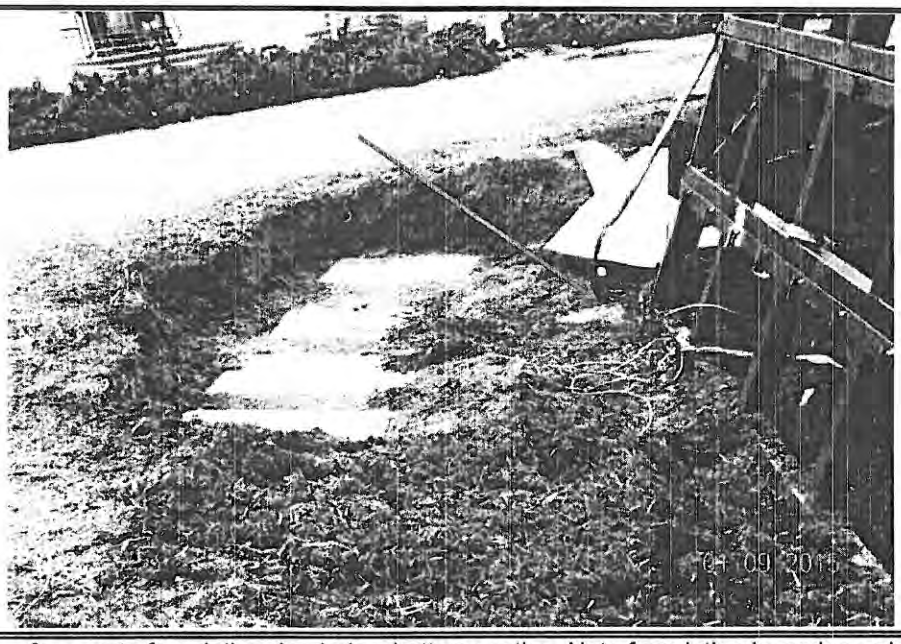
Photo No. 10



Remarks: View of stacked portion of tree section near top on site during removal. This section is in fairly good condition.

Location: TREE BEING DISASSEMBLED

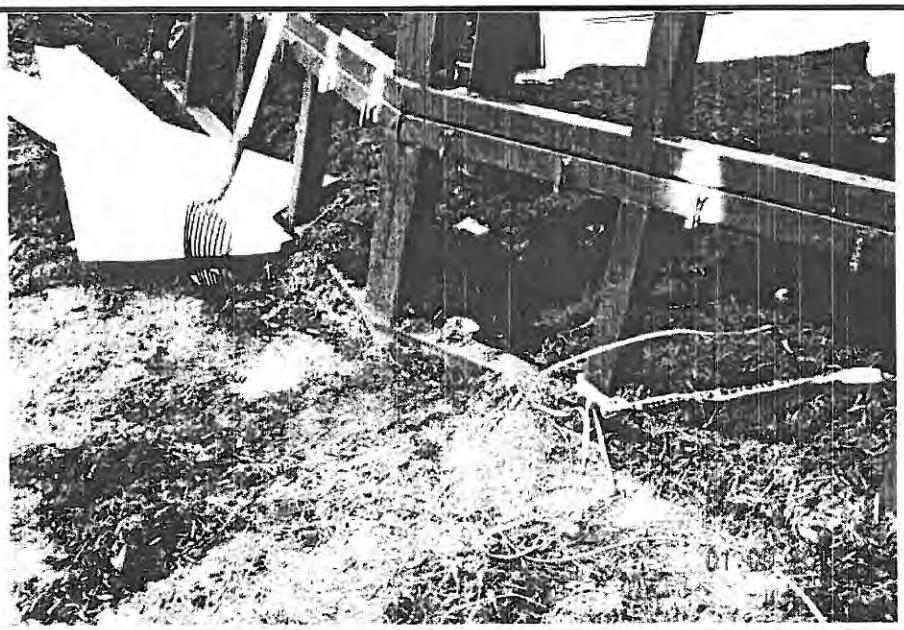
Photo No. 11



Remarks: View of concrete foundation ring below bottom section. Note foundation is sunken relative to grade.

Location: TREE BEING DISASSEMBLED

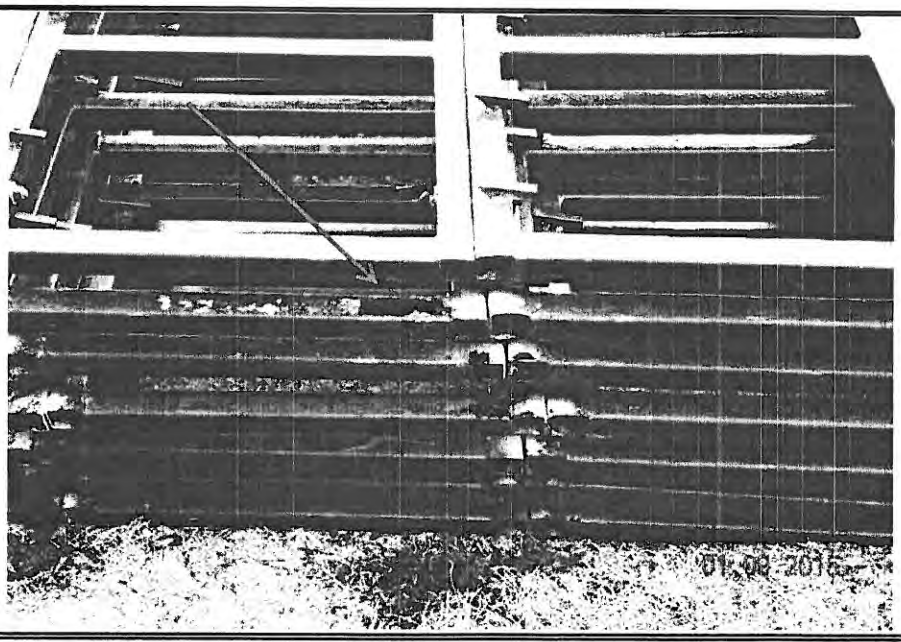
Photo No. 12



Remarks: Close up view of foundation area indicated by red arrow in Photo 11 above.

Location: TREE BEING DISASSEMBLED

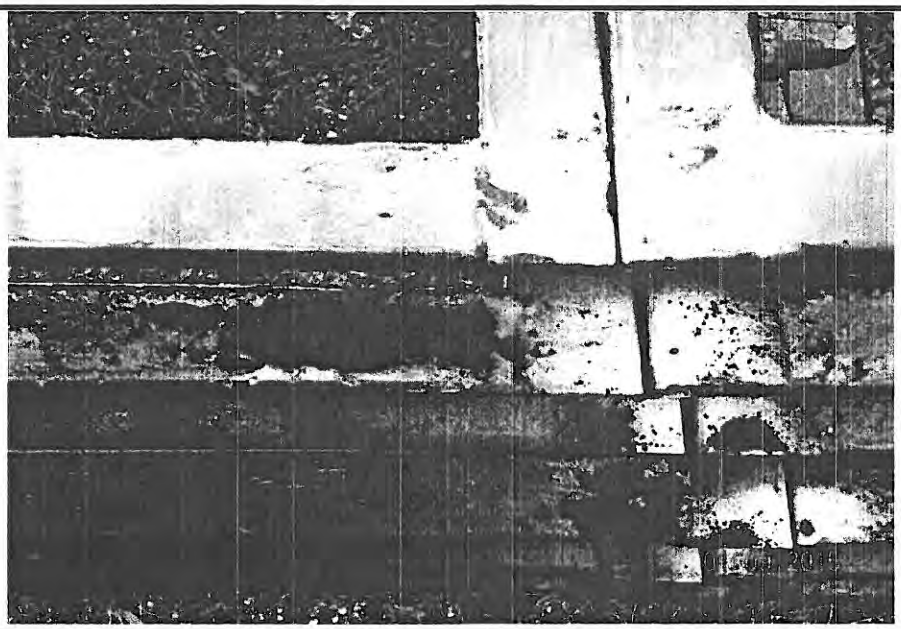
Photo No. 13



Remarks: View of end of frames stacked on site. Note corrosion near connections.

Location: TREE BEING DISASSEMBLED

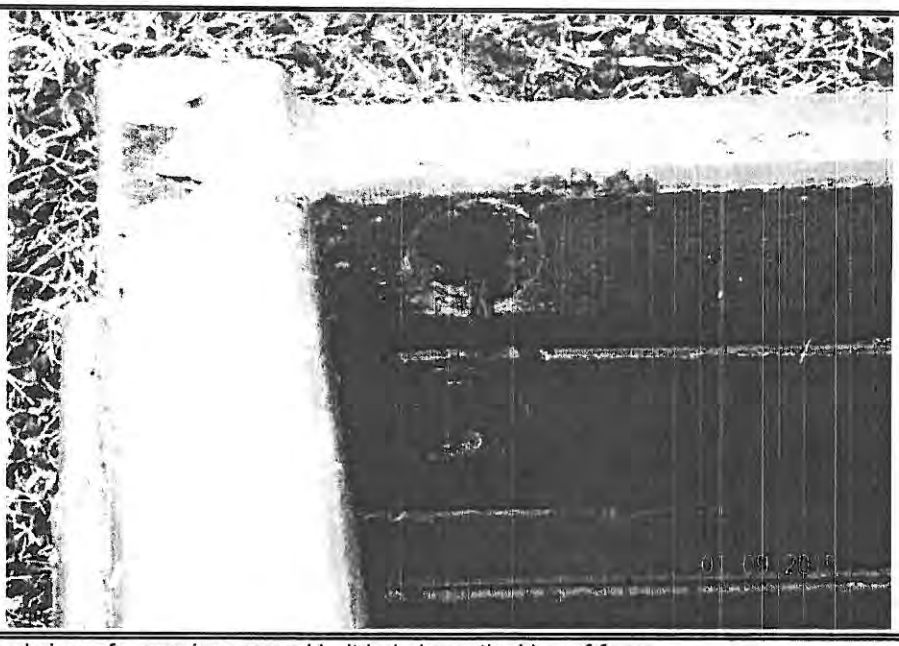
Photo No. 14



Remarks: Close-up view of corroded connection points indicated by red arrow in Photo 13 above.

Location: TREE BEING DISASSEMBLED

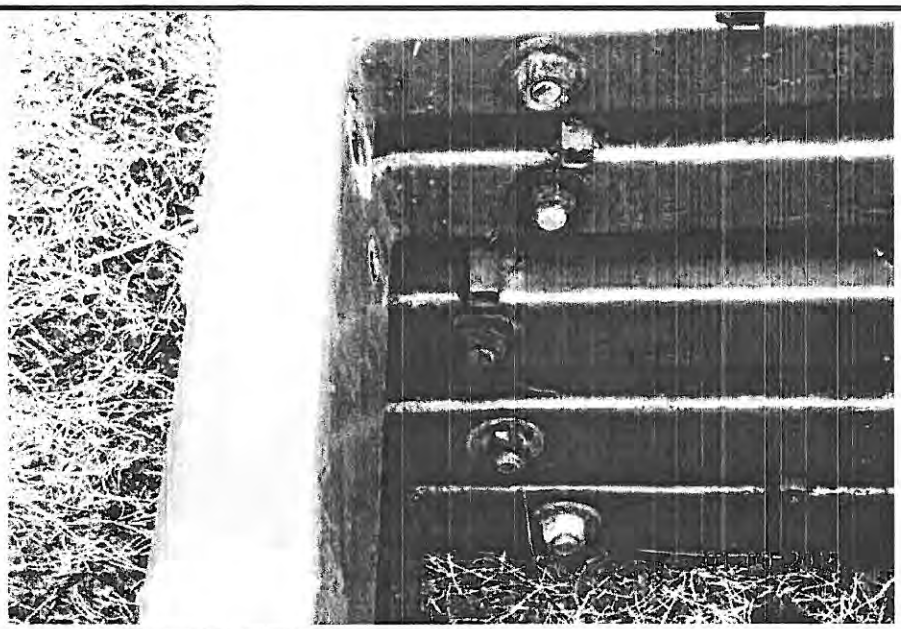
Photo No. 15



Remarks: Typical view of corrosion around bolt hole in vertical leg of frame.

Location: TREE BEING DISASSEMBLED

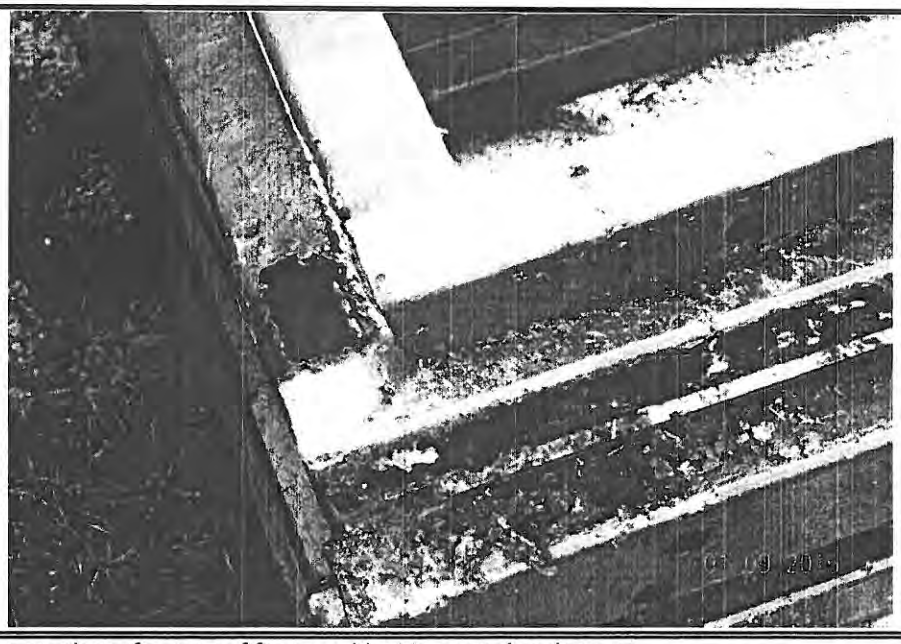
Photo No. 16



Remarks: Typical view of corroded fasteners.

Location: TREE BEING DISASSEMBLED

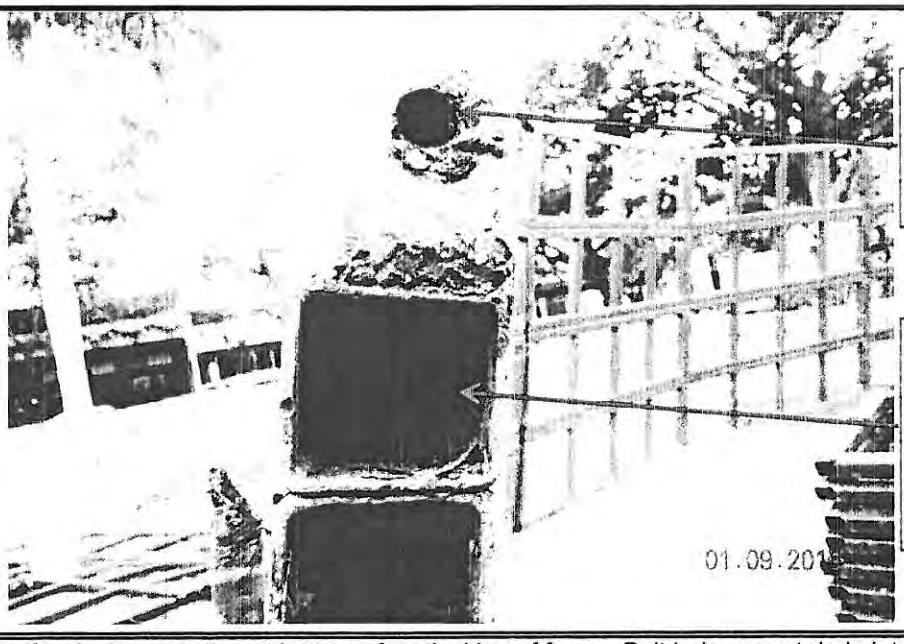
Photo No. 17



Remarks: Close-up view of corner of frame subject to corrosion damage.

Location: TREE BEING DISASSEMBLED

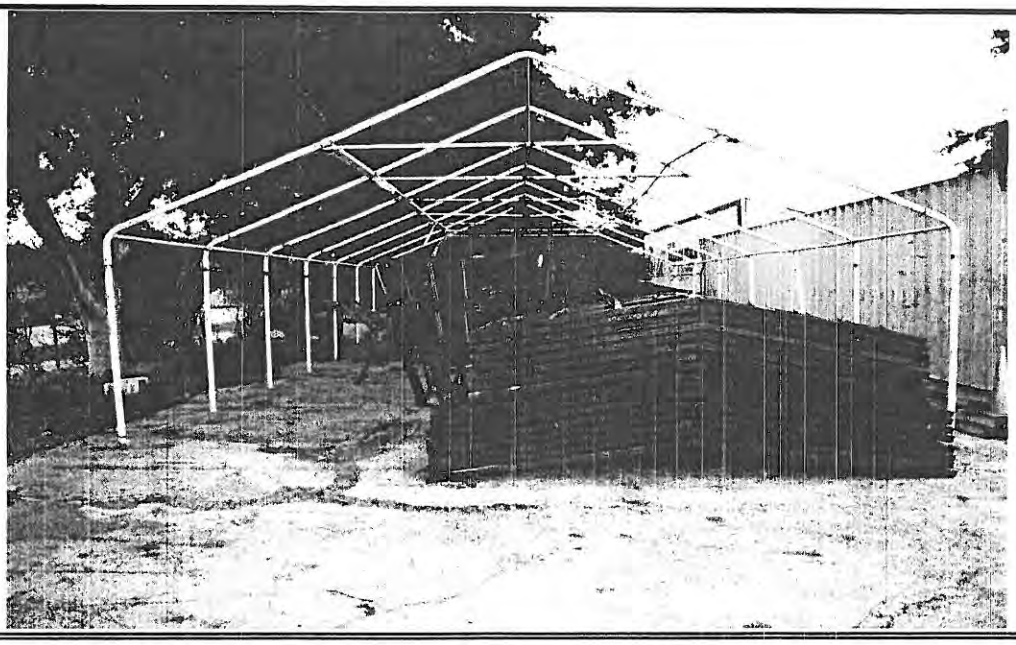
Photo No. 18



Remarks: View of typical connection at bottom of vertical leg of frame. Bolt hole cannot drain into horizontal leg.

Location: TREE BEING DISASSEMBLED

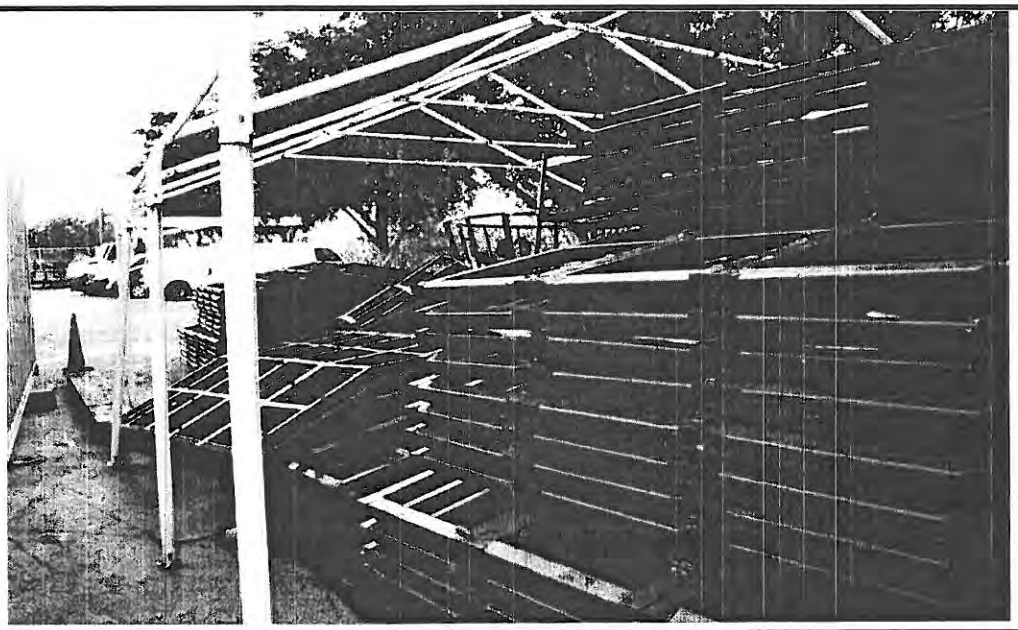
Photo No. 19



Remarks:

Location: TREE STORAGE

Photo No. 20



Remarks:

Location: TREE STORAGE

Kimley»Horn

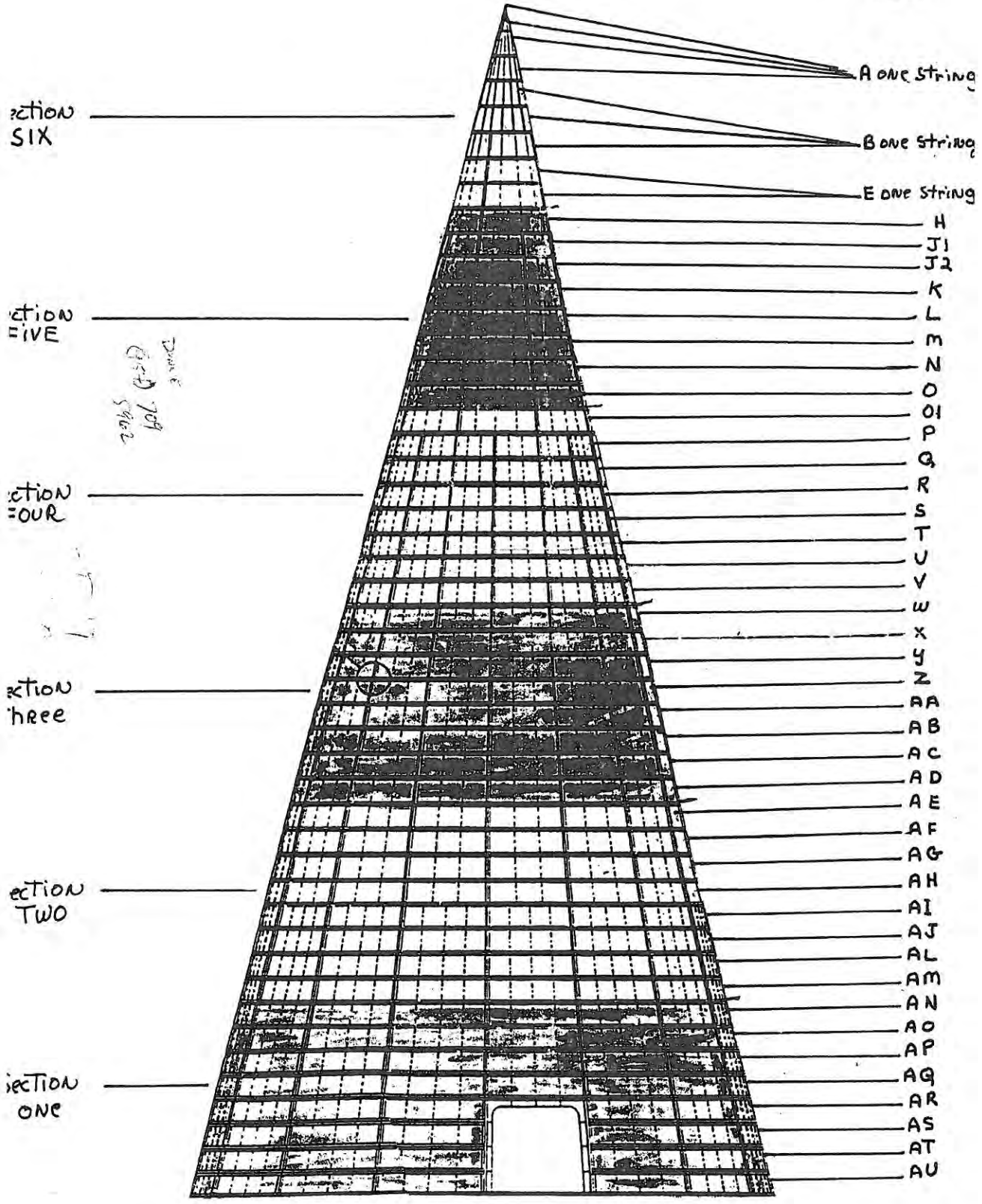
APPENDIX B

Tree Plans provided by City

Delray Beach Christmas Tree 1999

ELECTRIC

* STAR has its own three ctr's



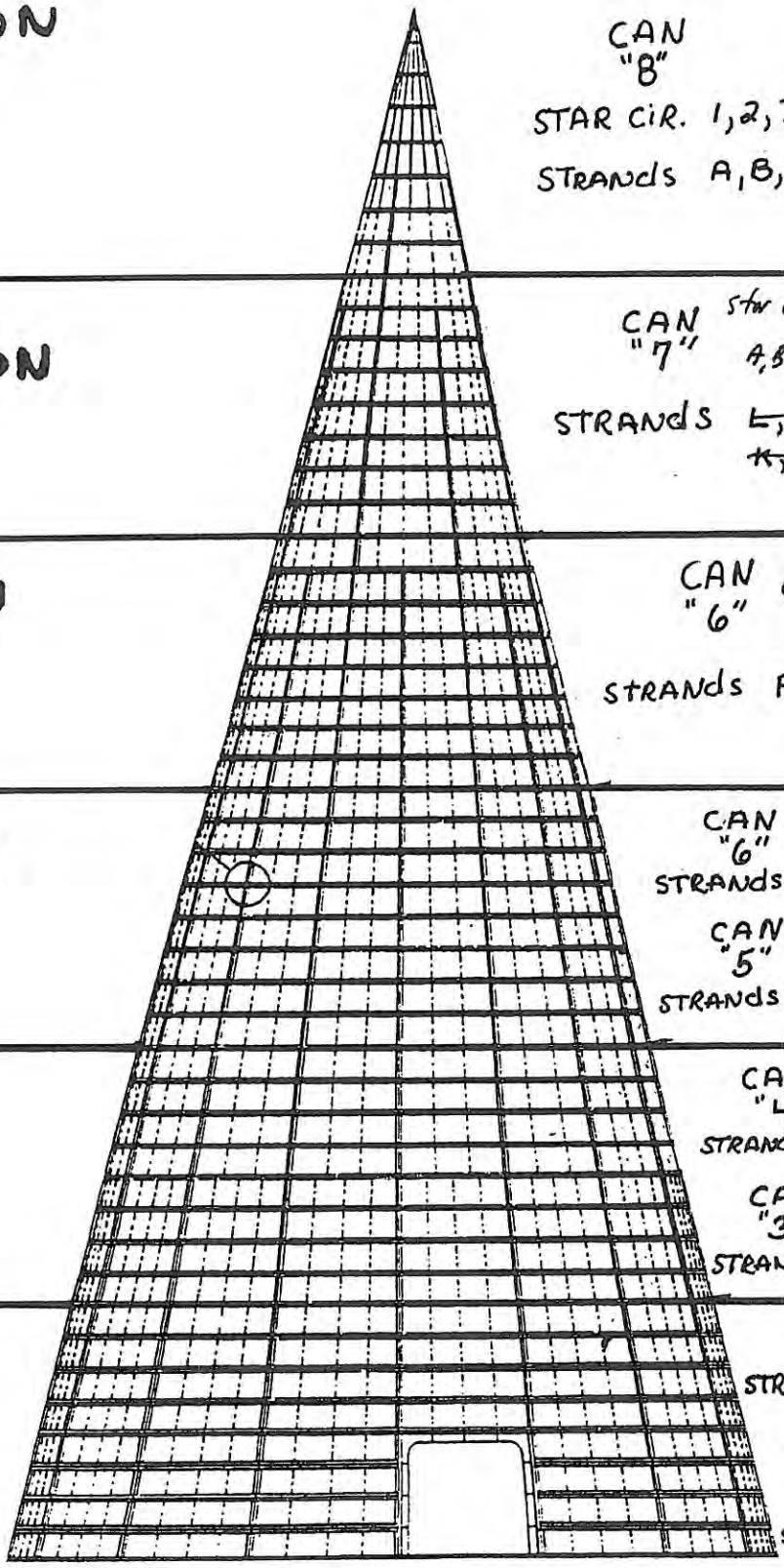
2 "or
3 1/8
YELLOW
9000
lbs
RED
BASE
48
ORANGE
1 st
39
13 000
lbs
BLUE
23 6
$300
lbs
WHITE
1st
15 6
5 1/4
9 to
TOT
lbs
LESS LBS

Gigan end of Park yr ant.

STORAGE CANS

Delray Beach Christmas Tree

ELECTRIC



Section "6"

CAN "8"

STAR CIR. 1, 2, 3

STRANDS A, B, E, H

Section "5"

CAN "7" star circuits 1, 2, 3

A, B, E, H

STRANDS ~~L, M, N, O, O1~~ ~~K, J1, J2~~

Section "4"

CAN "6" C, M, N, O, K, J1, J2

STRANDS P, Q, R, S, ~~T, U, V~~

Section "3"

CAN "6" Y, U, T

STRANDS. W, X

CAN "5"

STRANDS y, z, ~~AA, AB, AC AD~~

Section "2"

CAN "4" AA, AB, AC AD

STRANDS ~~AB~~, AF, AE

CAN "3"

STRANDS AL, AJ, AI, AH, AG

Section "1"

CAN "2"

STRANDS AQ, AP, AO, AN AM

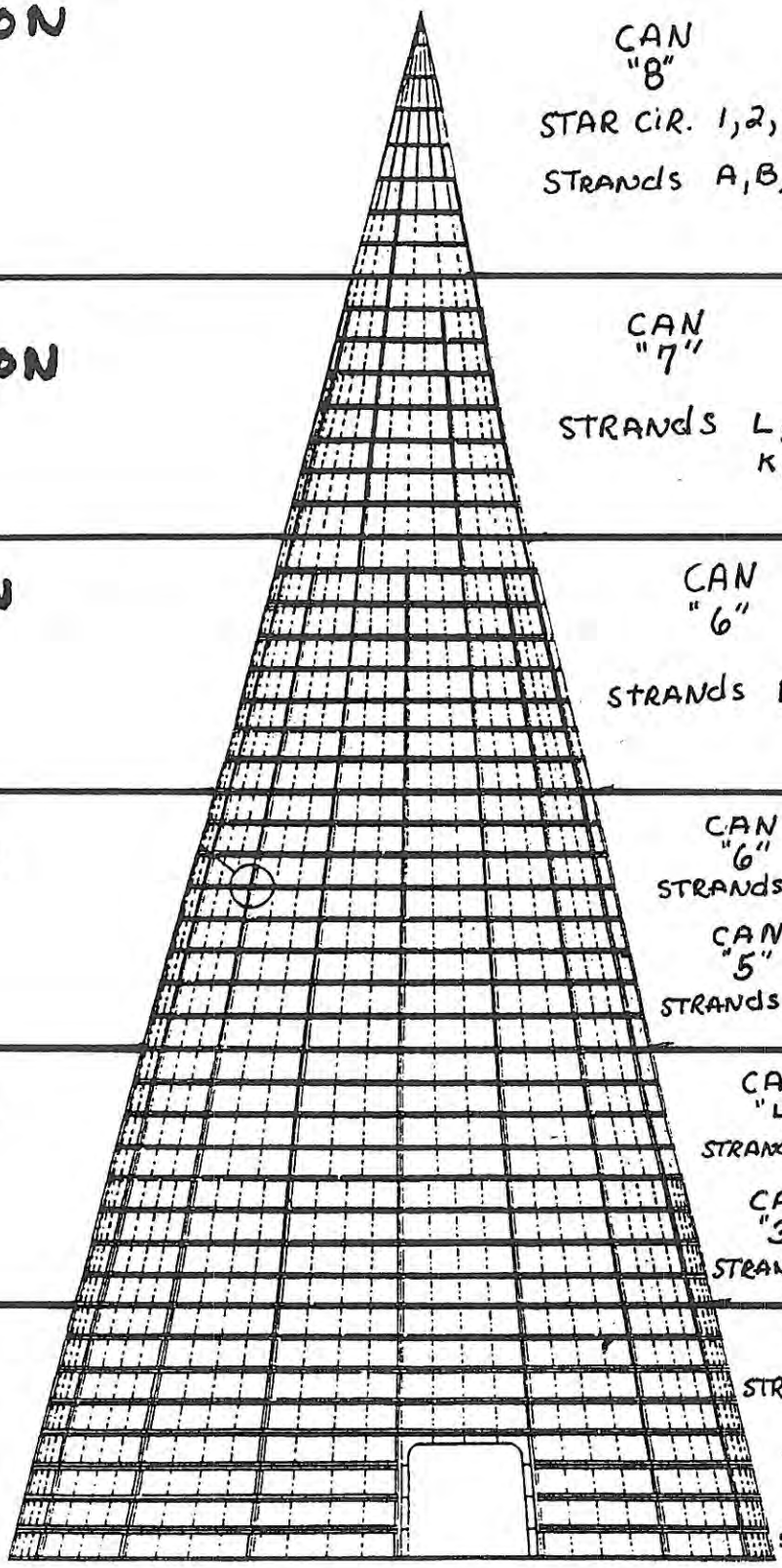
CAN "1"

STRANDS AV, AT, AS AR

STORAGE CANS

Delray Beach Christmas Tree

ELECTRIC



Section "6"

CAN "8"
STAR CIR. 1, 2, 3
STRANDS A, B, E, H

Section "5"

CAN "7"
STRANDS L, M, N, O, O1
K, J1, J2

Section "4"

CAN "6"
STRANDS P, Q, R, S, T, U, V

Section "3"

CAN "6"
STRANDS. W, X
CAN "5"
STRANDS Y, Z, AA, AB, AC
AD

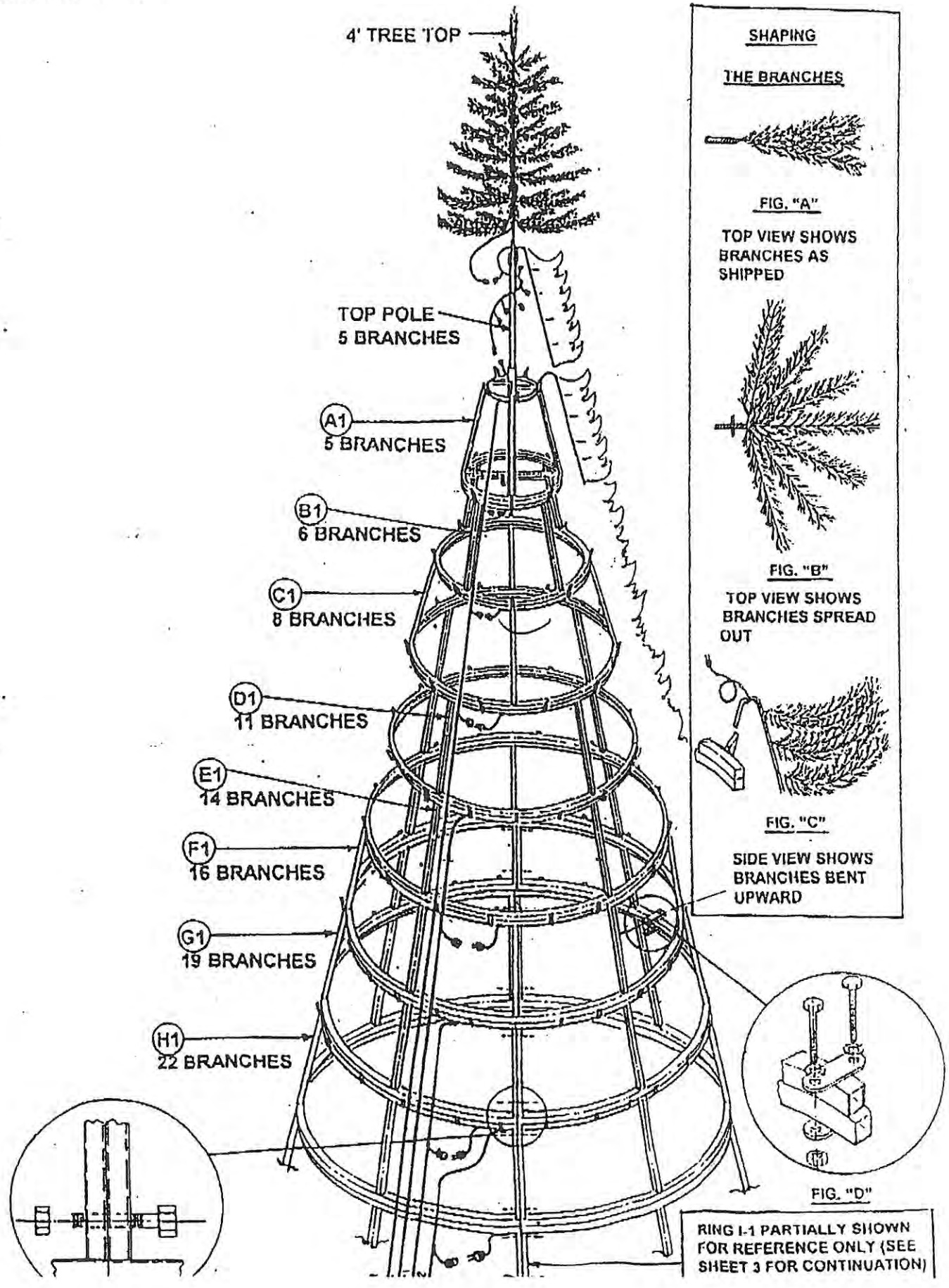
Section "2"

CAN "4"
STRANDS AG, AF, AE
CAN "3"
STRANDS AL, AJ, AI, AH

Section "1"

CAN "2"
STRANDS AQ, AP, AO, AN
AM
CAN "1"
STRANDS AV, AT, AS
AR

SHEET 2 OF 4


4' TREE TOP
TOP POLE
5 BRANCHES
A1
5 BRANCHES
B1
6 BRANCHES
C1
8 BRANCHES
D1
11 BRANCHES
E1
14 BRANCHES
F1
16 BRANCHES
G1
19 BRANCHES
H1
22 BRANCHES
SHAPING
THE BRANCHES
FIG. "A"
TOP VIEW SHOWS BRANCHES AS SHIPPED
FIG. "B"
TOP VIEW SHOWS BRANCHES SPREAD OUT
FIG. "C"
SIDE VIEW SHOWS BRANCHES BENT UPWARD
FIG. "D"
RING I-1 PARTIALLY SHOWN FOR REFERENCE ONLY (SEE SHEET 3 FOR CONTINUATION)

SHEET 3 OF 4

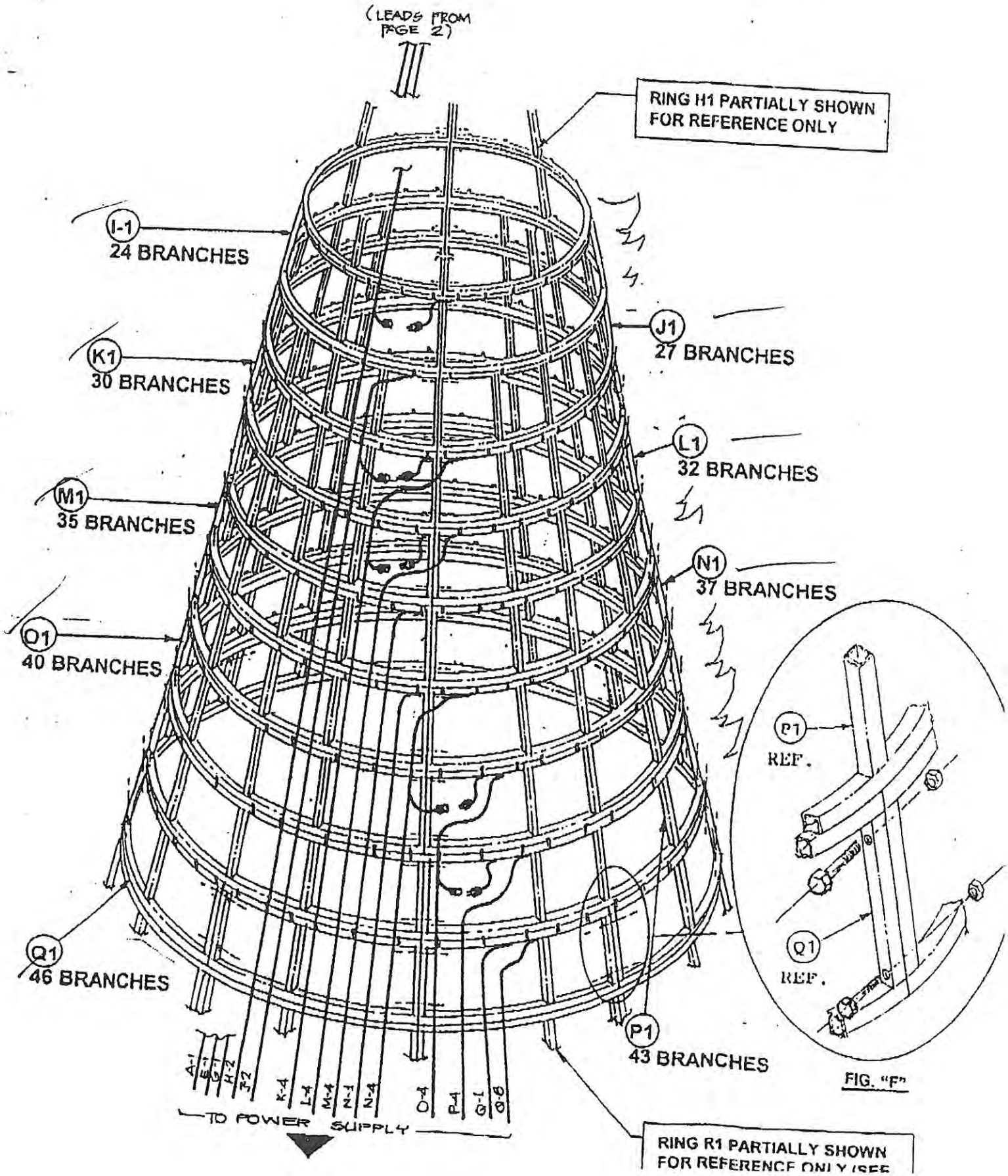
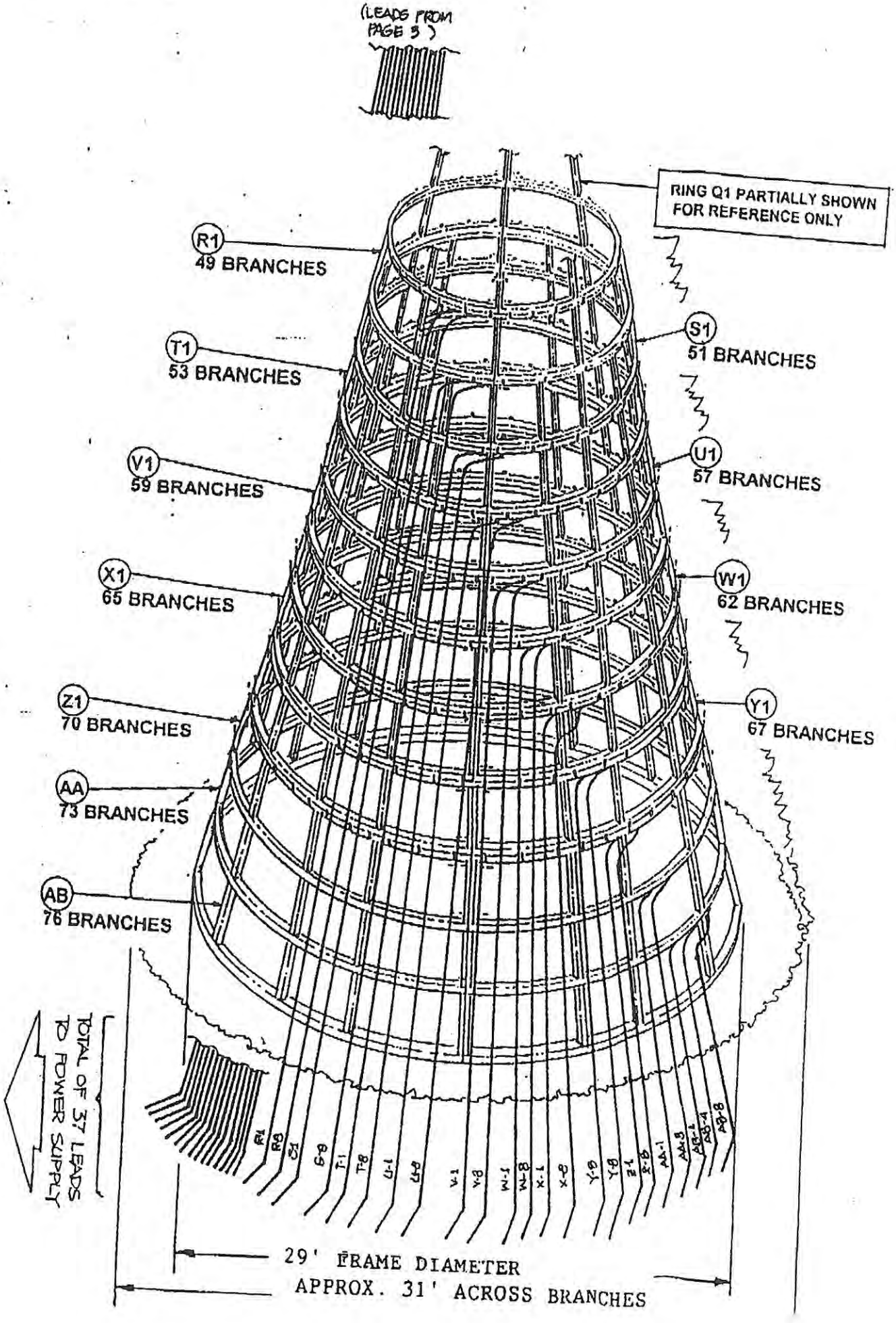


FIG. "F"


(LEADS FROM PAGE 3)
RING Q1 PARTIALLY SHOWN FOR REFERENCE ONLY
R1
49 BRANCHES
S1
51 BRANCHES
T1
53 BRANCHES
U1
57 BRANCHES
V1
59 BRANCHES
W1
62 BRANCHES
X1
65 BRANCHES
Y1
67 BRANCHES
Z1
70 BRANCHES
AA
73 BRANCHES
AB
76 BRANCHES
TOTAL OF 37 LEADS TO POWER SUPPLY
29' FRAME DIAMETER
APPROX. 31' ACROSS BRANCHES

Delray Beach Christmas Tree
HOUSE PANEL
120-208 V / 3P / 4W

CKT		CKT	
1	South Tree Recpt.	2	North Tree Rec.
3	South Tree Rec.	4	North Tree Rec.
5	South Tree Rec.	6	North Tree Rec.
7	SPARE	8	East Soda Rec.
9	Panel Rec.	10	West Rec.
11	SPARE	12	East Rec.
13	SPARE	14	SPARE
15	SPARE South Tree J Bx.	16	SPARE
17		18	
19		20	
21		22	
23		24	
25		26	
27		28	
29		30	
31		32	
33		34	
35		36	
37		38	
39		40	
41		42	

MEISNER ELECTRIC INC. (561) 278-8362

Delray Beach Christmas Tree

PANEL ONE

120-208 V 3P / 4W

CKT			CKT		
1	U	Sec 3 26" Tier	2	Y	22 Tier
3	V	Sec 3 25 "	4	Y	Sec 3 22 "
5	W	Sec 3 24 "	6	X	Sec 3 23 "
7	W	Sec 3 24 "	8	X	Sec 3 23 "
9	U	Sec 3 26 "	10	V	Sec 3 25 "
11	S	Sec 3 28 "	12	T	Sec 3 27 "
13	Q	Sec 3 30 "	14	R	Sec 3 29 "
15	O1	Sec 1 33 "	16	P	Sec 3 31 "
17	M	Sec 1 35 "	18	N	Sec 1 34 "
19	K	Sec 1 37 "	20	L	Sec 1 36 "
21	SPARE		22	J1	Sec 5 39 "
23	SPARE		24	H	40 "
25	E	Sec 5 41, 42 Tier	26	SPARE	
27	SPARE		28	SPARE	
29	A	Sec 1 46 47 48 Tier	30	B	Sec 4 42, 43, 44 Tier
31	STAR		32	R	29 "
33	T	Sec 3 27 Tier	34	SPARE	
35	S	Sec 3 28 "	36	J2	Sec 4 35 "
37	SPARE		38	O2	Sec 4 32 "
39			40		
41			42		

MEISNER ELECTRIC INC. (561) 278-8362

Delray Beach Christmas Tree

PANEL 2

120-208 V / 3P / 4W

CKT		CKT	
1	AI Sec 2 12 Tier	2	SPARE
3	AL Sec 2 12 "	4	AL Sec 2 10 Tier
5	AH Sec 2 13 "	6	SPARE
7	AH Sec 2 13 "	8	AJ Sec 2 11 Tier
9	AH Sec 2 13 "	10	AI Sec 2 12 "
11	AI Sec 2 12 "	12	AG Sec 2 14 "
13	AG Sec 2 14 "	14	AF Sec 2 15 "
15	AF Sec 2 15 "	16	AF Sec 2 15 "
17	AE Sec 2 16 "	18	AE Sec 2 16 "
19	AD Sec 2 17 "	20	AE Sec 2 16 "
21	AC Sec 2 18	22	AJ Sec 2 11 "
23	AB Sec 2 19	24	AJ Sec 2 11 "
25	AA Sec 2 20	26	AL Sec 2 10 "
27	AA 20	28	AL Sec 2 10 "
29	Z Sec 2 21	30	AB Sec 2 19 "
31	Z Sec 2 21	32	AI Sec 2 12 "
33	SPARE	34	SPARE
35	SPARE	36	SPARE
37	SPARE	38	SPARE
39	SPARE	40	SPARE
41	SPARE	42	SPARE

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Spare

Delray Beach Christmas Tree

PANEL THREE

120-208 V / 3P / 4W

CKT		CKT	
1	AV 1st TIER	2	AV Sec 1 1st TIER
3	AT 2 "	4	AV Sec 1 1 "
5	AS 3 "	6	AT Sec 1 2 "
7	AR 4 "	8	AT Sec 1 2 "
9	AQ 5 "	10	AS Sec 1 3 "
11	AP 6 "	12	AS Sec 1 3 "
13	AO 7 "	14	AR Sec 1 4 "
15	AN 8 "	16	AR Sec 1 4 "
17	AM 9 "	18	AQ Sec 1 5 "
19	SPARE	20	AQ Sec 1 5 "
21	SPARE	22	AP Sec 1 6"
23	SPARE	24	AP Sec 1 6 "
25	SPARE	26	AO 7 "
27	SPARE	28	AO 7 "
29	AM	30	AN 8 "
31	AM	32	AN 8 "
33	SPARE	34	SPARE
35	SPARE	36	
37		38	
39		40	
41		42	

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