Raba Kistner

Engineering • Testing • Environmental • Facilities • Infrastructure

RESIDENTIAL DISTRESS STUDY

FOR

432 PRECIOUS DRIVE
SAN ANTONIO, TEXAS

Austin, TX
Brownsville, TX
Dallas, TX
El Paso, TX
Houston, TX
McAllen, TX
México
San Antonio, TX

Raba Kistner

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Project No. ASR08-043-00
June 12, 2008

Mr. Edward Pape
San Antonio Housing Authority Task Force
459 Precious Drive
San Antonio, Texas 78237

RE: Consulting Engineering Services
Residential Distress Study
432 Precious Drive
San Antonio, Texas

Dear Mr. Pape:

Raba-Kistner Consultants, Inc. (R-K) is pleased to submit this report of engineering services provided for the above referenced project. It is our understanding that this work is being performed to assess the general condition of the above referenced home and to indentify conditions that are influencing the performance of this residence and its foundation. To accomplish this objective we made visual observations of the structural condition of the building frame and foundation and measured relative floor elevations. This report presents our observations and findings in accordance with our approved scope of work presented in **R-K** proposal No. PSR08-079-00, dated May 16, 2008.

INFORMATION REVIEW

Prior to our on-site observation, **R-K** was provided with the following information:

- Architectural Floor Plans and Elevations, MEP Drawings, and Roof Structural Drawings prepared by Bartholomew & Company of San Antonio, Texas, dated February 28, 2002.
- Structural Foundation Drawings prepared by South Texas Engineering of San Antonio, Texas, dated September 11, 2000.
- Geotechnical Engineering Study prepared by Nova Consulting Group, Inc. of San Antonio, Texas, dated September 30, 1999.
- 79-G Letter For Earthwork Fill Evaluation Villas of Fortuna Subdivision Lots 1 Thru 17 and Lots 1 Thru 27 San Antonio, Texas prepared by Integrated Testing and Engineering Company of San Antonio, L.P., (InTEC), dated October 27, 2000.

LIMITATIONS

The information provided in this document is directed to San Antonio Housing Authority Task Force (Client), and may not contain information for others and/or for other uses. Construction documents were provided to us by our Client prior to our site visit; however, a complete set of the "as-built" construction drawings was not available. Some of our observations were limited

due to building finishes, room contents, etc. Additional conditions may exist or may have existed at the time of our observations. This report includes observation information as obtained by **R-K** and from various other sources. Our comments and opinions are based upon that data. If information provided by others is incorrect, or if additional information becomes available, **R-K** may need to revise the comments and opinions presented in this document.

BACKGROUND INFORMATION

On Thursday, May 29, 2008, a meeting was held at the subject residence between Mr. and Mrs. Cintron, homeowners, and Ignacio Vivanco, E.I.T. of **R-K.** On the basis of the discussion held during the meeting, we have been provided with the following information:

- The homeowners took occupancy of this residence sometime in the year 2000.
- Mr. Cintron indicated that in the year 2004 he had to shave the edges of the door panels in the bedrooms as they could not open or close freely.
- In 2005 the homeowner repaired cracks within the sheetrock covered partitions in Bedroom 2, located on the right back corner of the residence, and on the back wall of the living room.
- In 2007, KB Home repaired an approximately 4 foot long ceiling crack that extended from the kitchen entrance, across the hallway, to the interior garage wall.
- Mr. Cintron indicated that the door at the main entrance of the home was adjusted 4 times by KB Home. Later it was replaced by the Client, and since then it has been adjusted 2 times.
- The homeowner also indicated that the Client has replaced the air conditioning unit, some windows, and the front and side doors of the residence. At the owner's request the water heater was not replaced.
- The homeowner stated that he has not experienced problems with plumbing leaks.

GENERAL INFORMATION

All directional descriptions of the home assume the viewer is facing the front of the residence. The structure generally faces west. The home is a single family, single story wood frame dwelling supported on a reinforced concrete beam and slab-on-ground foundation. The wood frame of the home is covered with a fiber cement siding system on all sides. The wall framing is supporting a wood roof framing system with a composition shingle roof covering. The framing of the perimeter walls consists of standard pressure treated 2x4 wood studs spaced about 16-inches on center. The roof framing system consists of prefabricated wood trusses spaced about 24-inches on center. At the time of our visit, the slab on ground did not have a floor cover, with the exception of the laundry room, which is covered with a vinyl tile system. The garage is located on the right side of the residence. Views of the outside of the residence as it exists today are shown on Photographs 1 through 5 included in Attachment B of this report.

EXTERIOR OBSERVATIONS

While walking around the residence, the following observations were noted:

- The ground surface grading around the home is generally good along the front and fair along the left and back sides. Surface grading along the right side of the home is relatively flat.
- We noted a separation between the soil and the perimeter grade beam along the right side of the home as shown on Photographs 6 and 7 of Attachment B.
- There are two medium size trees in the front yard, located about 15-feet from the front, exterior kitchen wall.
- The water heater temperature/pressure relief (T/P R) drain line and the heating, ventilation, and air-conditioning (HVAC) condensate drain line empty adjacent to the left exterior concrete grade beam as shown on Photographs 8 and 9 in Attachment B. We encountered some standing water in this area.
- We noted only one gutter and one downspout along the roof eaves of this residence. This gutter collects rainwater from the left half of the garage roof and the front porch, and redirects the runoff to the downspout located on the left-front corner of the garage. The downspout, in turn drains the rainwater directly onto the concrete walkway as shown on Photograph 10 of Attachment B.
- The sanitary sewer drain cleanout could not be located during our site visit.

INTERIOR OBSERVATIONS

Our observations of the interior of this residence are summarized below:

- We noted a significant transverse crack in the concrete floor slab, located in the living room. This crack, extends from left-to-right across the floor slab, and was measured to be approximately 9-1/2 ft long (where visible) and approximately 1/8-inch wide in some locations as shown on Photographs 11, 12, and 13 of Attachment B. For ease of reference, this crack is also shown in red on Figures 1, 2, and 3 of Attachment A.
- Other cracks were noted in the concrete floor slab within bedrooms 2 and 3, as well as along the hallway. In general, these cracks varied in thickness from hairline to about 1/16-inch wide as shown on Photographs 14 through 16 of Attachment B.
- We did not note any cracks on the sheetrock covered partition walls or ceilings.

RELATIVE FLOOR ELEVATIONS AND CONTOURS

On Friday, May 16, 2008, Mr. Brandon Koropsak, Graduate Engineer with **R-K** was present at the Cintron residence to obtain relative floor elevations of the concrete floor slab. These relative floor elevations were determined using elevation measuring equipment placed at various locations on the floor surface throughout the residence. Presented on Figure 2 of Attachment A are the relative floor elevation measurement values to the nearest hundredth of an inch. However, we view the accuracy to be more on the order of about 1/4-inch. The relative floor

elevation measurements were tied to a temporary reference benchmark located on the concrete slab under the porch, near the main entrance of the home. To facilitate the relative floor elevation survey and for the purposes of this report an arbitrary value of 100 inches has been assigned to the lowest point surveyed within the home, excluding the garage area. All other floor elevation measurements used in producing the drawing are relative to this assigned value of 100 inches.

Presented on Figure 3 are the relative floor elevation contours corresponding to the elevation measurements presented on Figure 2. Contour lines are presented in 1/4-inch intervals. The contour lines are approximate and are intended to demonstrate overall floor slope patterns, and may not represent actual floor surface elevations along the entire length of the different contour lines.

From Figure 2, the maximum relative floor elevation measurement within the building footprint was found to be about 101-1/2 inches recorded around the left half portion of the kitchen. The lowest measurement within the building footprint was measured along the back right corner of the master bedroom at about 100 inches. The maximum floor differential between the highest and lowest elevations is about 1-1/2 inches within about a 24 foot distance. This equates to an overall floor slope of about 1/2 percent. In general, the overall elevation profile of the building is observed to be sloping from front to back. Larger floor slopes spanning shorter distances were noted between the utility closet and the master bedroom walk-in closet. In general, these slopes were measured to range from about 1 percent to 1-1/4 percent. A review of the elevations measured within the living room, particularly along the 1/8-inch wide crack, indicates that the crack is relatively flat along its length.

SOILS INFORMATION

Our experience with soils in this area and information from the *Geologic Atlas of Texas, San Antonio Sheet*, indicates that this site is naturally underlain by fluviatile terrace deposits which are stream bed deposits typically consisting of clays, sands, silts, and gravels. Such deposits can contain point bars, cutbanks, oxbows, and abandoned channel segments associated with variations in stream bed activity. As a result, soil profiles in terrace deposit areas may vary greatly over relatively short distances. Key geotechnical engineering concerns for development supported on this formation are the expansive nature of the clays, the consistency or relative density of the deposits, and the absence/presence as well as thickness of potentially water-bearing gravels.

On the basis of the information provided in the geotechnical report prepared by Nova Consulting Group, Inc., it is our understanding that the soils conditions encountered within this subdivision consist of undocumented fill materials comprised of highly plastic, tan and brown clay soils with gravel, that range in thickness from about 1 foot to 6 feet. In general, we understand that the thickness of the fill materials generally increased across the site from south to north, Fortuna Street to Zarzamora Creek, respectively. These fill materials are underlain by hard, dark gray to gray to tan and gray, highly plastic natural clay soils. Further, we understand that the Potential Vertical Rise (PVR) values calculated for this area ranged between 5 to 6-inches.

A review of the 79-G Letter prepared by InTEC, revealed that 108 field density (compaction) tests were performed throughout the subdivision as part of the site grading activities prior to the construction of the residences. According to the density test reports performed within the lots located in close proximity to the subject residence, compaction tests were performed on the native subgrade soils as well as two lifts of fill materials placed on top of the subgrade soils. Assuming that the fill materials were placed in 6-inch to 8-inch lifts, then only about 1 foot of the fill materials was tested.

Characteristics of Expansive Soils

The clay soils that exist beneath the home are considered to be highly expansive soils. Expansive soils are clay soils that exhibit volume changes with changes in soil water content. Expansive soils shrink or reduce their volume when they lose water (damp to dry) and swell or increase their volume when they gain water (moist to wet).

Expansive soils are often identified by the Atterberg Limits laboratory test. The most common Atterberg Limits test provides two arbitrarily chosen soil values, the Liquid Limit and Plastic Limit, which have been correlated with many aspects of soil behavior. The Liquid Limit is the water content of the soil mass at which clay begins to act as a viscous liquid. The Plastic Limit is the water content of the soil mass at which a clay soil begins to break apart and loses its ability to deform without breaking into pieces. The numerical difference between the Liquid Limit and Plastic Limit is known as the Plasticity Index. Generally, the shrink/swell potential of a clay soil increases as the Plasticity Index increases. Therefore, clay soils with relatively large Plasticity Indices generally exhibit greater shrink/swell behavior than clay soils with relatively small Plasticity Indices.

Since the shrinking and swelling behavior of the clay soils depends on changes in soil moisture, satisfactory long-term performance of a foundation is affected by conditions that can affect soil water content. Conditions include climate, vegetation, plumbing leaks, irrigation, and site drainage. The most frequently encountered semi-arid climates (climates where periods of rainfall are followed by extended periods without rainfall) are more susceptible to shrink/swell behavior than climates that tend to remain either wet or dry. This is particularly true of this site, where the clay soils have pulled away from the foundation along the right side of the home.

In addition, the type and extent of vegetation affects the water content of the soil since some types of trees, shrubs, and grasses require more moisture than others. The extent to which the vegetation is watered (or not watered) also directly affects soil moisture conditions, as do the surface drainage conditions around a foundation.

COMMENTS

The distress conditions observed throughout the residence appear to be a result of soil-related movements that have occurred over time and have affected the performance of the foundation system. On the basis of our visual observations it appears that poor drainage conditions, inconsistent watering of the landscaped areas along the perimeter of the home, and changes in seasonal moisture content have contributed to soil-related movements of the native clay soils. Possible plumbing leaks beneath the foundation may also be contributing to the movements.

On the basis of the information provided in the geotechnical report prepared by Nova Consulting Group, Inc., it is our understanding that the soils conditions encountered within this subdivision consist of undocumented fill materials comprised of highly plastic clay soils with gravel that range in thickness from about 1 foot to 6 feet. In general, we understand that the thickness of the fill materials generally increased across the site from south to north, Fortuna Street to Zarzamora Creek, respectively. These fill materials are underlain by highly plastic natural clay soils. Further, the fill materials and native clay soils exhibit PVR values ranging between 5 to 6-inches. The relative floor elevation survey indicates that the largest measured floor differential across the entire home is approximately 1-1/2 inch. Assuming that the foundation system was perfectly level when it was constructed, this differential has not exceeded the estimated PVR values provided in the original geotechnical report. However, if the current conditions are not addressed, additional movements may occur which could adversely affect the structural performance of the home.

A review of the density test reports and the 79-G letter prepared by InTEC, revealed that at most only about 1 foot of the fill materials was tested during the site grading activities performed within the residential lots located in close proximity to the subject residence. On the basis of the soils information provided to us, we do not have enough information to render an opinion if there are any other causes for the movements observed within the home. At this time we recommend that a geotechnical investigation be performed for this home to gather current soils information and to assess the condition of the fill materials and the native clay soils placed beneath the foundation.

As stated earlier, there are two medium size trees located about 15-feet from the front exterior wall of the kitchen. Trees and other large plants can remove water from the soils beneath the foundation via their root systems. The reduction of water content in expansive soils can cause shrinkage in the soils resulting in reduced support and downward movement of the foundation in the vicinity of the tree(s). The roots of trees generally extend past the extents of their drip lines (canopies). It is believed that some species of trees growing closer to the building than 1-1/2 times their ultimate height can affect the building foundation. We believe that these trees could have contributed to the differential movement of the foundation near this area.

With the exception of the gutter and downspout, located along the roof eave on the left side of the garage, runoff from the roof valley and the roof eaves falls onto the ground surface and may tend to pond on this low lying area. Water that ponds within this area will likely soak into the soils located adjacent to the perimeter grade beam and could possibly gain access to soils beneath the home.

OPINIONS

On the basis of our observations / measurements, measured relative floor elevations, and our knowledge of beam and slab-on-ground floating foundations founded on expansive clay soils, it is our opinion that:

- The distress conditions observed at this home appear to be a result of soil-related movements. These movements are likely a result of a combination of

variations in climatic conditions, vegetation effects, surface grading conditions around the home and possible plumbing leaks. However, additional soils information is required to confirm this assumption and develop recommendations to improve the performance of the foundation.

- At the moment, the foundation supporting the home appears to be structurally adequate. It has cracked and deflected in response to the movement of the native expansive clay soils.
- At this time we do not know enough information about the underlying soil conditions to render an opinion if there are any other causes for the distress conditions observed within the home.

RECOMMENDATIONS

At this time **R-K** recommends the following:

- The plumbing lines beneath the home should be tested for leaks. If the systems leak, the exact leak locations should be determined and repairs made.
- Irrigation needs be controlled within a 10-foot zone around the perimeter of the home. The moisture content of the clay soils should be maintained at a uniform condition. The ground within this area should not be allowed to become dry to the point where the ground cracks and pulls away from the foundation. This is particularly true of this residence where these conditions were noted along the right side of the foundation. Water should also not be allowed to pond adjacent to the foundation such that it is allowed to soak into the ground. The homeowner should be made aware of the importance to maintain the ground areas adjacent to the foundation such that there are not areas that are over watered or under watered.
- In order to help control the effects of surface water around the home, all roof drain water should be collected and redirected to drain to the street located along the front of the house. Roof gutters and downspouts should be installed and connected to buried drain piping. We recommend using Schedule 40 PVC drain piping because it is more durable and less susceptible to cracking and damage. All connections should be water tight. Care should be taken to install enough downspouts so the gutters do not overflow during heavy rainfall. The gutter subcontractor will design the gutters to handle the roof runoff. Additional runs of drain line should be installed as needed to carry the water from the downspouts to the front of the home.
- Discharge from the HVAC condensate drain line should also be routed to drain at least 10 feet from the perimeter of the foundation.
- A geotechnical investigation should be performed for this home to assess the conditions of the underlying soils beneath and along the perimeter of the home and to gain a better understanding of how these soils are influencing the performance of the foundation. This should include performing one interior and two exterior exploratory soil borings down to depths of about 15-feet or refusal, whichever occurs first, as well as conducting laboratory tests on the soil samples recovered from the borings to assess the moisture content, plasticity, and

strength characteristics of these soils. The data obtained from these tests, along with the information presented in this report, will be used to develop recommendations to improve the performance of the foundation.

- A concrete core sample should be obtained from the significant crack located in the living room floor slab to assess the depth of the crack and the condition of the concrete.
- Excavations along the perimeter of the exterior grade beam should also be performed to observe and document the depth of the grade beam and its condition. At this time, we recommend that a minimum of two excavations be performed. Once the excavations and soil borings have been completed and the results of the field and laboratory tests analyzed, additional recommendations may need to be provided.

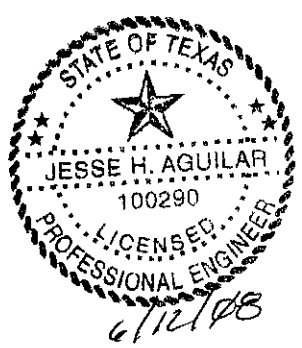
We appreciate the opportunity to be of service to you on this project. Should you have any questions about the information presented in this report, or if we may be of additional service, please call.

Very truly yours,

RABA-KISTNER CONSULTANTS, INC.

Ignacio Vivanco, E.I.T.
Project Consultant

Jesse H. Aguilar, P.E.
Project Engineer



IV/JHA/jg

Attachments: (A) Figures 1 through 3
(B) Photographs

Copies Submitted: Above (2)

ATTACHMENT A

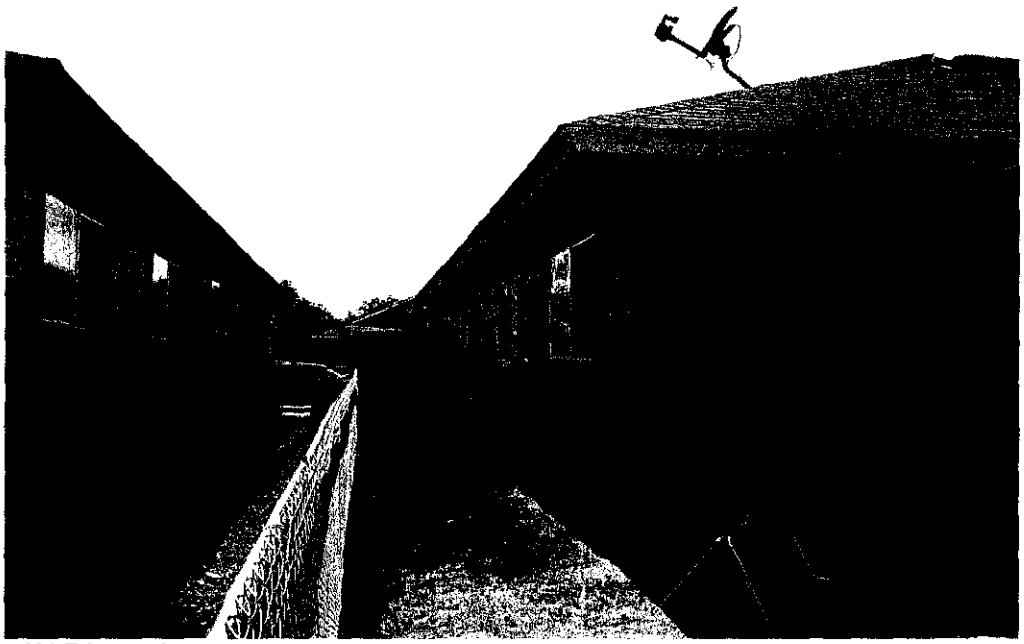
ATTACHMENT B

PHOTOGRAPH 1
GENERAL VIEW OF THE FRONT OF THE HOME.

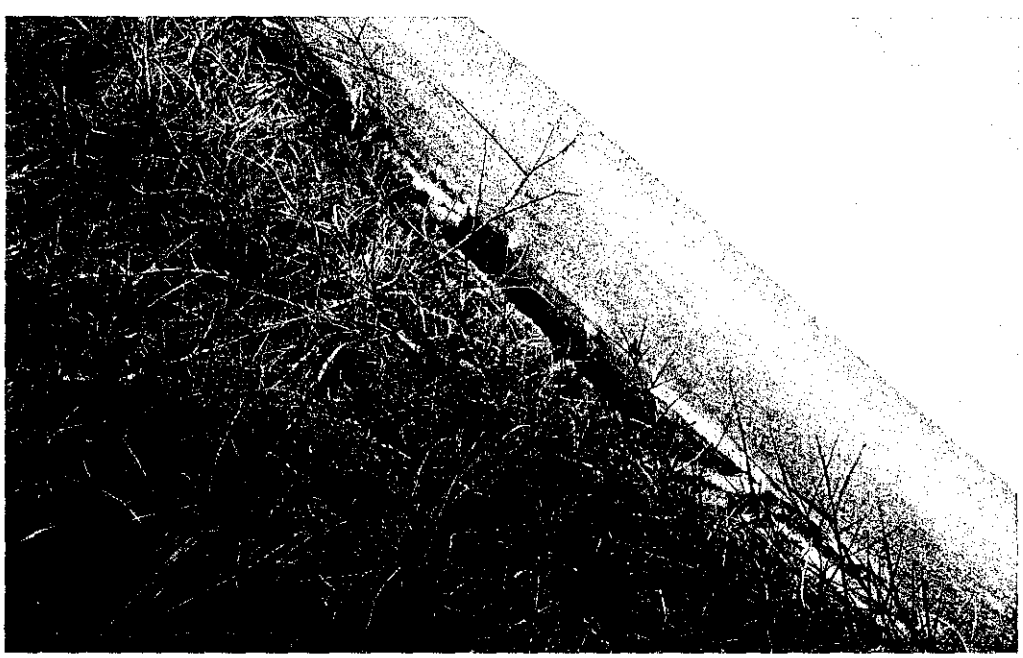
PHOTOGRAPH 2
GENERAL VIEW OF THE RIGHT FRONT CORNER OF THE HOME.

PHOTOGRAPH 3
GENERAL VIEW OF THE LEFT SIDE OF THE HOME.

PHOTOGRAPH 4
GENERAL VIEW OF THE BACK OF THE HOME.



PHOTOGRAPH 5
GENERAL VIEW OF THE RIGHT SIDE OF THE HOME.

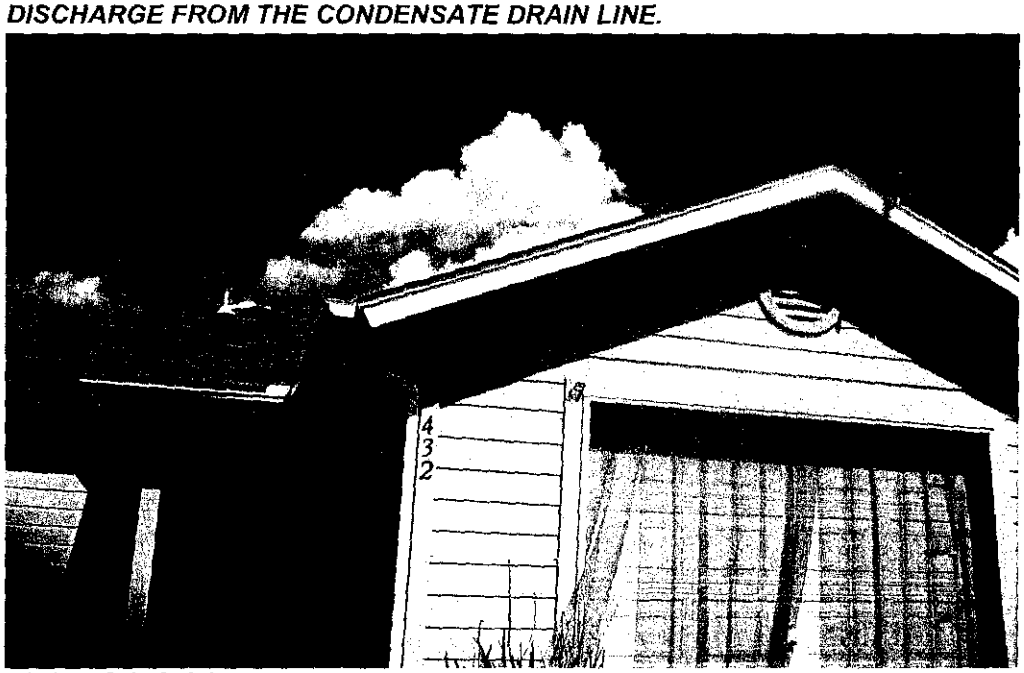


PHOTOGRAPH 6
GENERAL VIEW OF DRYING SOIL CONDITIONS ALONG THE PERIMETER GRADE BEAM LOCATED ALONG THE RIGHT SIDE OF THE HOME.

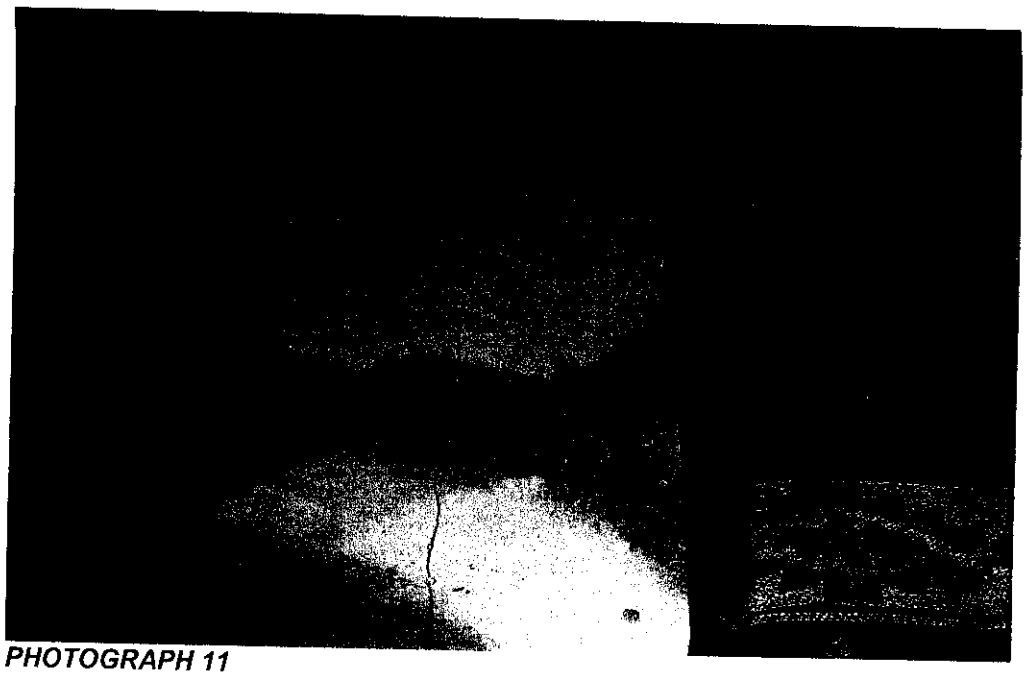
PHOTOGRAPH 7
CLOSE-UP VIEW OF DRYING SOIL CONDITIONS ALONG THE PERIMETER GRADE BEAM LOCATED ALONG THE RIGHT SIDE OF THE HOME.

PHOTOGRAPH 8
GENERAL VIEW OF THE CONDENSATE DRAIN LINE AND T/P R DRAIN PIPING LOCATED AT THE PERIMETER GRADE BEAM ALONG THE LEFT SIDE OF THE HOME.

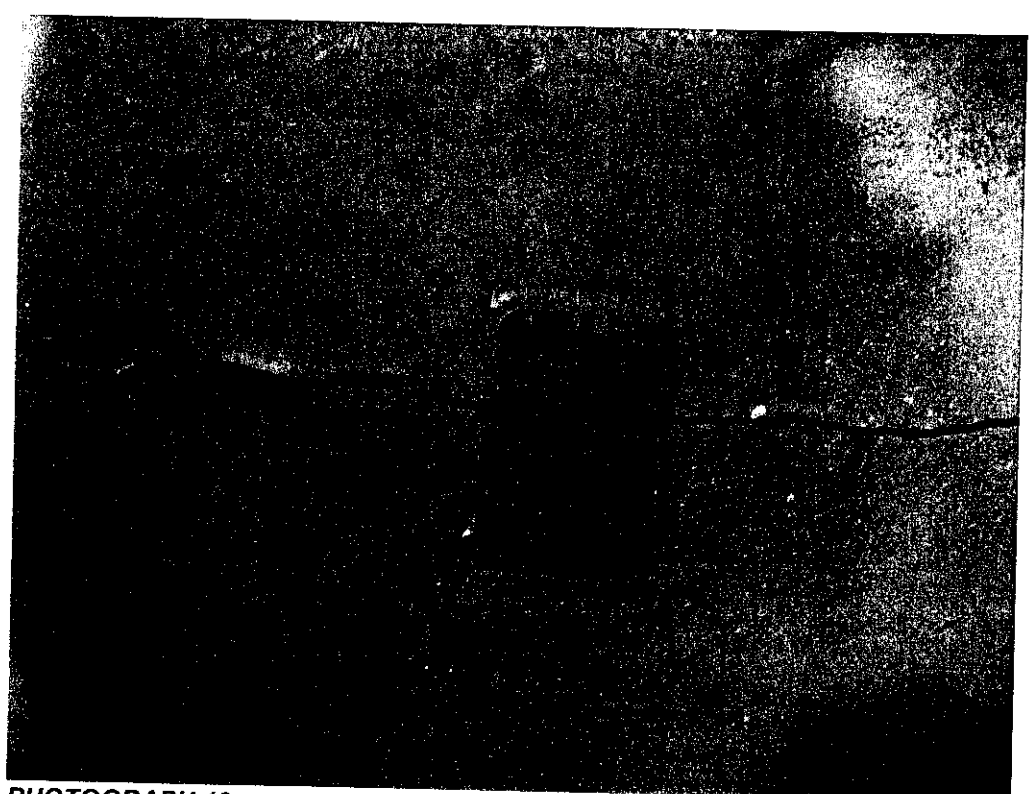
PHOTOGRAPH 9
CLOSE-UP VIEW OF THE WET SOIL CONDITIONS ASSOCIATED WITH THE DISCHARGE FROM THE CONDENSATE DRAIN LINE.



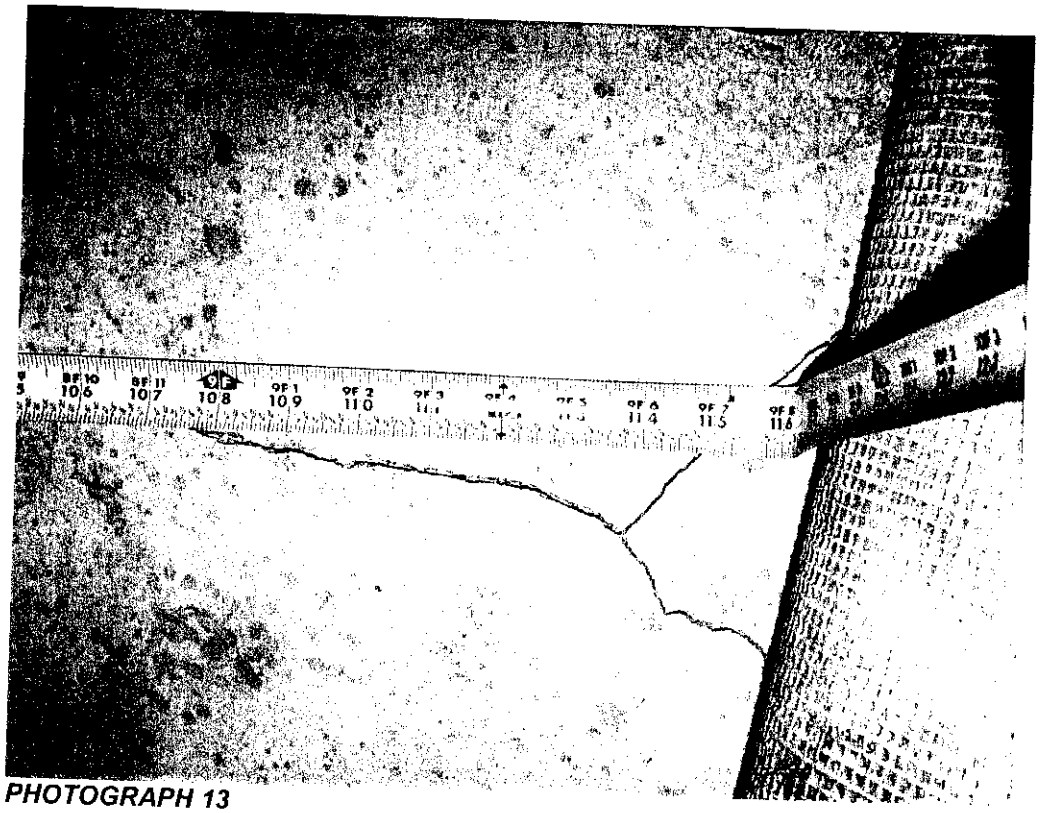
PHOTOGRAPH 10
CLOSE-UP VIEW OF THE GUTTER AND DOWNSPOUT LOCATED ALONG THE FRONT WALKWAY.



PHOTOGRAPH 11
GENERAL VIEW OF THE APPROXIMATELY 1/8-INCH WIDE CRACK WITHIN THE LIVING ROOM.

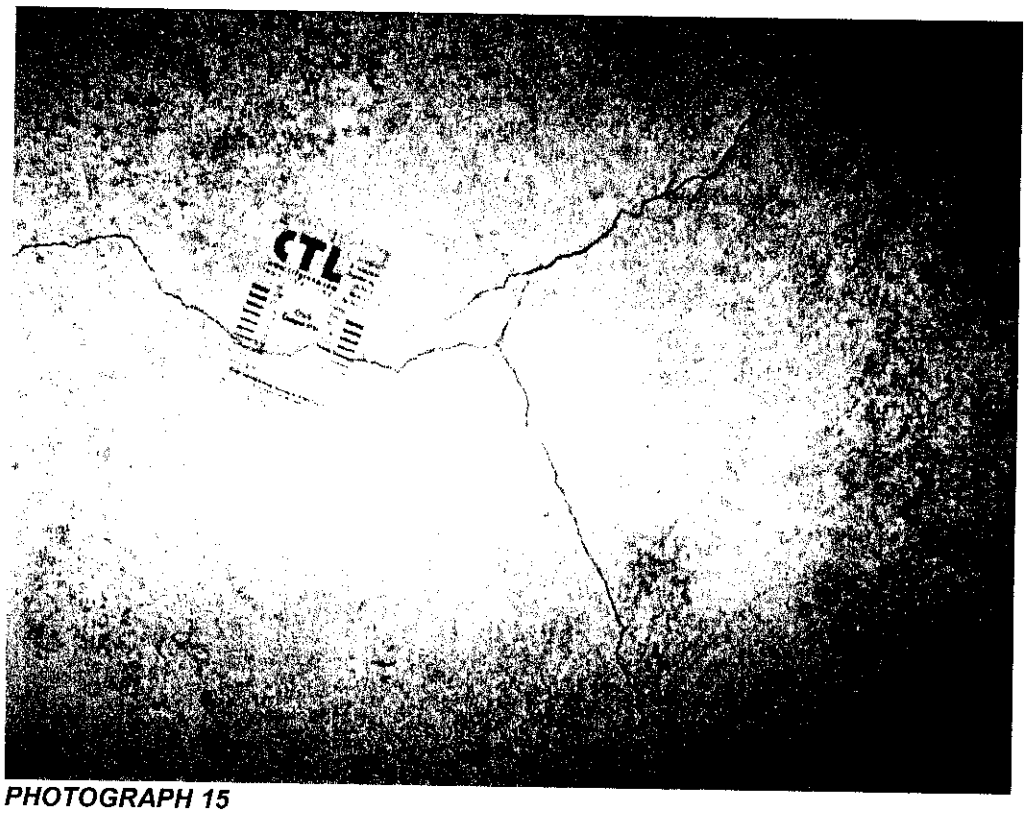


PHOTOGRAPH 12
CLOSE-UP VIEW OF THE LIVING ROOM CRACK SHOWN IN PHOTOGRAPH 11.



PHOTOGRAPH 13
CLOSE-UP VIEW OF THE LIVING ROOM CRACK SHOWN IN PHOTOGRAPHS 11 AND 12.

PHOTOGRAPH 14
GENERAL VIEW OF A TRANSVERSE CRACK WITHIN THE HALLWAY.



PHOTOGRAPH 15
CLOSE-UP VIEW OF A CRACK WITHIN THE CONCRETE FLOOR SLAB.

PHOTOGRAPH 16
GENERAL VIEW OF A CRACK WITHIN THE CONCRETE FLOOR SLAB.