

INDOOR ENVIRONMENTAL QUALITY EVALUATION

**SMITH RESIDENCE
514 PRECIOUS, VILLAS AT FORTUNA
SAN ANTONIO, TEXAS**

Prepared for

**SAN ANTONIO HOUSING AUTHORITY
SAN ANTONIO, TEXAS**

by

ETC INFORMATION SERVICES, LLC

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Project No. 7A-020
May 16, 2007

Mr. Timothy Alcott
San Antonio Housing Authority
1315 N. Elmendorf
San Antonio, Texas 78207

**Re: Indoor Environmental Quality Evaluation
Smith Residence 514 Precious, San Antonio, Texas**

Dear Mr. Alcott:

A copy of the report for the investigation of the referenced property is being forwarded to you for your information and necessary action. This report is part of a more comprehensive report on ten properties in the Villas at Fortuna, Blueridge, and Sunflower subdivisions. The comprehensive report should be used for a full introduction, discussion of field operations, and discussion.

We will be happy to answer any questions concerning this report. It has been a pleasure working with you on this important assignment. We look forward to being of continuing service to you.

Sincerely,

ETC INFORMATION SERVICES, LLC

Donald J. Schaezler, Ph.D., P.E., CIH
President

1.0 INTRODUCTION AND BACKGROUND

1.1 Purpose of the Evaluation

The subject residence was evaluated for indoor environmental quality conditions April 18, 2007. The purposes of the evaluation were as follows:

- To interview residents about their complaints with respect to water damage, mold, health symptoms, and other indoor environmental issues
- To collect indoor air samples for identification and enumeration of airborne fungal spores and culturable fungi
- To collect indoor air samples for enumeration of fiber glass and other mineral fibers, pollen, skin cell fragments, and other particles
- To measure indoor air quality with respect to common chemical and physical parameters
- To evaluate apparent sources of water damage and visible mold in the residence
- To document areas with excess moisture content in building materials
- To assess, in a preliminary manner, the condition and performance of the HVAC system
- If necessary, to recommend remediation, including preparation of a Mold Remediation Protocol

The investigations were performed at a screening level and were designed to obtain information on the overall condition of the residence. They were not intended to be in-depth investigations of all potential conditions that affect the indoor environment.

The investigations were conducted by Donald J. Schaezler, Ph.D., P.E., CIH, with assistance from other ETC staff. Dr. Schaezler is a licensed Mold Assessment Consultant (MAC), a licensed professional engineer (P.E.), and a Certified Industrial Hygienist (CIH).

1.2 Subject Residence

The subject residence was in the Villas at Fortuna subdivision. The residence was apparently built by KB Homes in about 2000. It has been leased to the Smith family but is owned by SAHA. Over the past several years, the residents in similar homes had complained to SAHA and KB about a variety of structural and indoor environmental issues. These complaints have triggered investigations by several consultants, including this report.

2.0 FIELD OPERATIONS

2.1 Description of Residence

The subject residence is approximately seven years old and is a single-family dwelling located in west San Antonio, between West Commerce and Culebra Road, near St. Mary's University. It appears to have a reinforced concrete foundation, Hardiplank® siding external wall finish, conventional wood framing, and a complex hip and gable roof with composition shingles. It is a two-story structure with five bedrooms, two bathrooms, one half-bath, Kitchen, Dining Room, Living Room, Utility Closet, and an attached one-car Garage. The layout of the subject residence is shown schematically in Figure 4.

The residence had carpeting in the Living Room, the Dining Room, the bedrooms, and the hallways. It had vinyl flooring in the Entry, Kitchen, bathrooms, and the Utility Closet. Interior finishes were typically textured and painted gypsum board.

There is a single, central HVAC system of split design. The condenser unit (CU) is outside on a concrete pad. The air handler unit (AHU) is in a hallway closet near the Hall Bathroom on the second floor. Return air is routed through a grille in the lower closet door and up through a supporting platform to the AHU. The AHU has a return air filter, evaporator coil, blower, and electric heating unit. Supply air is routed up to the Attic through a ductboard plenum. Flexible runouts are attached to that plenum. There are chases for ductwork to reach the first floor ceilings. The return air plenum is shared by a low profile hot water heater, which sits in an overflow pan. The ceiling penetration in the HVAC Closet is sealed with aluminum foil duct tape. There were small openings to a chase behind the AHU and, probably, to the attic behind the supply air plenum.

The Utility Closet included connections for a washer and a dryer. The dryer exhausted to a vent stack in a wall cavity, and the vent stack continued through the roof.

For simplicity of discussion in this report, Precious is assumed to run north-south. The Smith residence is at the end of the north cul-de-sac and is assumed to face south. Directional references, such as front, right, rear, and left will refer to an observer facing the front of the house from the street.

2.2 Observations

1. The residents were home during the investigation.
2. Mrs. Smith related that, in the past, the rear half of the Living Room had flooded from rain water intrusion at the back door. The door had been reinstalled, and problems have not recurred.
3. There was little damage evident at the back door at the door trim or threshold.

4. The Living Room tackboards were stained farther from the door.
5. The base cabinet under the Kitchen sink had water damage and surficial mold growth from leaks through the counter above.
6. There was mold growth on the left and rear windows in the Living Room.
7. There was minor water damage on the lower wall and trim near the head of the tub in the Master Bathroom.
8. The base cabinet in Bathroom 2 had damage to the left side. There may have been a liquid spill inside the cabinet that affected it.
9. The exhaust air vent in the Bathroom 2 ceiling was clogged with dust.
10. The return air plenum was dusty.
11. The return air filter was a standard, low efficiency filter. It had a significant buildup of dust.
12. The evaporator coils were extremely dirty. They were largely covered with debris and dry scum.

Areas with water damage and mold growth are summarized in Table 2, along with other characterizations of investigation results.

2.3 Field Measurements

2.3.1 Moisture Content

Moisture measurements were made for wood, sheetrock, and concrete surfaces in areas with visible or potential water damage with Delmhorst and Tramex moisture instruments. Measurements were also taken in background areas for comparison. Excess moisture was found in the quarter round at the floor near the tub in the Master Bathroom.

2.3.2 Air Quality

During the survey, the indoor area was investigated by measuring general indoor air quality parameters to determine the potential for chemical and physical problems. Temperature, relative humidity, carbon dioxide, and carbon monoxide were measured using a Vulcain Safety Palm field instrument. Results are summarized in Table 3. Key points are discussed below.

1. The indoor temperature was colder than is normal in most houses.
2. The indoor relative humidity and dew point were satisfactory.
3. Carbon dioxide values were satisfactory.
4. Carbon monoxide values were zero.

2.3.3 Thermal performance of Heating, Ventilation, and Air-Conditioning System (HVAC)

During the survey, the thermal performance of the HVAC system was evaluated by measuring temperature of supply air and return air in the system, using a laser-focused infrared thermometer. The Smith residence had good thermal performance, based on the temperature difference alone. However, the air flow may be reduced below normal because of the clogged coils, and the temperature difference may be artificially high. The results are summarized in Table 4.

2.4 Sampling

The emphasis of the sampling program was to evaluate indoor air quality. The blower in the AHU was turned on before sampling. Samples were collected from three locations, at the return air grille, in the Living Room, and in the Master Bedroom near the Master Bathroom.

2.5 Photographs

Photographs of the subject residence are available for review.

3.0 RESULTS AND DISCUSSION

All sample results are included in the comprehensive report. The results are summarized in the tables and are discussed in this section for comparison purposes.

3.1 Fungi in Air

Three sets of indoor air samples and one outdoor air sample was collected for the house. One set of indoor air samples was collected from near the return air grille, one set was collected from the Master Bedroom near the Master Bathroom, and a third was collected from the Living room. Indoor air samples were collected for indirect evidence of water damage and mold amplification and to evaluate potential exposures to occupants of the house.

Outdoor air samples from the neighborhood were used for all houses in that neighborhood on that day.

Samples were collected for total bioaerosols, using Allergenco D cassettes, which are slit impaction samplers. Sampling was at 15 liters per minute for five minutes. The slides in the cassettes were interpreted microscopically by Aerotech and were analyzed for total bioaerosols. Results of analyses are summarized in Table 5.

Samples were also collected for culturable fungi, using a single stage Anderson-type impactor with potato dextrose agar plates. Sampling was at 28.3 liters per minute for three minutes. The plates were then reassembled, sealed with tape, and shipped to Aerotech for incubation and interpretation. Results of analyses are summarized in Table 6.

1. Outdoor air had typical levels of total fungal spores, dominated by *Cladosporium* and *Bipolaris/Drechslera*.
2. Indoor air in the Smith residence had low levels of total fungal spores, relative to outdoor air, in the Master Bedroom and at the return air upstairs.
3. Indoor air in the Living Room had high levels of total fungal spores, dominated by *Aspergillus/Penicillium*-like spores.
4. Outdoor had typical levels of culturable fungi, dominated by *Cladosporium*.
5. Indoor air in the Smith residence had low levels of culturable fungi, relative to outdoor air, in the Master Bedroom and at the return air upstairs.
6. Indoor air in the Living Room had relatively high levels of culturable fungi, dominated by *Cladosporium* but with a significant proportion of *Aspergillus* species.
7. These results indicate that there are likely sources of *Aspergillus* growth that are affecting the indoor environment.

3.2 Swab Samples

Surface samples were taken with sterile swabs. These samples were analyzed by microscopic examination and by culturing. Results of analyses are summarized in Tables 7 and 8.

3.2.1 Evaporator Coil Samples

Evaporator coils are cold during operation of the air-conditioning system, and condensation typically occurs. Dust accumulation typically occurs on coils because of the small dimensions of the finned coils. Dust accumulation is exacerbated if return air filtering is poor. If dust has accumulated on the coils, fungal amplification of cold-tolerant microorganisms may take place. Evaporator coils may then be a source of microbial matter in the indoor environment.

1. The evaporator coils were extremely laden with debris.
2. The coils had moderate levels of total fungal spores, dominated by *Cladosporium*. Yeast and bacteria were also reported.
3. The coils had high levels of culturable fungi, dominated by *Fusarium*.

3.2.2 Window Sill

Window sills at the left and rear of the Living Room were significantly impacted by mold growth. The growth appeared to be primarily on dirt accumulated on the window frame.

1. There were very high levels of total fungal spores, almost all of which were *Cladosporium*.
2. Yeast and bacteria were also reported.
3. There were also high levels of culturable fungi, dominated by *Cladosporium* with a significant proportion of *Alternaria*.

3.3 Fibers and Other Particles in Air Samples

The Allergenco D slides were evaluated by Aerotech for the presence of fibers and particles of potential interest other than fungal spores and mycelial fragments. The fibers found were compared specifically to attic insulation. The results are summarized in Table 5. Compared to samples collected from other houses, there were low concentrations of fibers in the three samples. There were high levels of skin fragments in two of the three indoor air samples.

3.4 Sources of Water Damage

Based on field observations and measurements, apparent sources of water causing damages at the subject residence include the following:

1. Rain water intrusion at the back door. This source may have already been eliminated.
2. Condensation at windows
3. Possible rain water intrusion at windows
4. Dirty evaporator coils

4.0 CONCLUSIONS

1. The Smith residence had satisfactory relative humidity during the preliminary investigation.
2. The house had inadequate filtration within the air handler unit (AHU), and the evaporator coils were extremely dirty, indicating that poor filtration has affected the AHU.
3. The residence had evidence of water damage and significant mold growth at windows and tackboards in the Living Room. The damage to the tackboards probably reflects old rain water intrusion at the back door. The damage at the windows is consistent with condensation that would occur during cold weather, exacerbated by some rain water intrusion.
4. Rain water intrusion occurred in the past at the back door, but repairs have been made that have prevented recent intrusion.
5. Some mold growth was present on the wall under the Kitchen sink, due to leaks through the counter above.
6. The cleanliness of the AHU system was poor. This was especially true for the evaporator coils
7. There were elevated levels of *Aspergillus/Penicillium*-like spores and culturable *Aspergillus* in indoor air samples.
8. There were elevated levels of culturable fungi on the evaporator coils, dominated by *Fusarium*.
9. There were low concentrations of fibers in the three samples. There were high levels of skin fragments in two of the three indoor air samples.
10. The Smith residence should be remediated to eliminate the sources of fungal growth in the residence and the AHU.

5.0 RECOMMENDATIONS

1. A technically competent HVAC contractor should evaluate the Smith residence for the size of the HVAC equipment, the capacity of the blower, the size of the plenums, the size and orientation of the ductwork, the size of the registers, the connections of all supply air components, the sealing of the HVAC Closet and return air plenum, the cleanliness of the system and the need for cleaning, the thermal performance of the system, the balance of the supply air system, the operation of the thermostat, the level of refrigerant in the system, and other aspects of the design and operation of the system. All deficiencies should be corrected, including cleaning of the evaporator coils outside of the house.
2. The Smith residence should use high performance pleated return air filters, rated as MERV 8 or better.
3. Deficiencies in installation of doors and windows should be corrected as necessary.
4. During the evaluation of the HVAC system and investigation of door and window installations, the Mold Assessment Consultant should evaluate the condition of the system with respect to mold contamination.
5. Because of the visible water damage and mold growth, and the elevated levels of fungi in the indoor air and on the evaporator coils, the Smith residence should be remediated. Remediation may require that the residents move from the house for a period of time. Following remediation, including post remediation verification (clearance), the residents should be able to reoccupy their home.
6. Mold contamination likely affects areas with more than 25 contiguous square feet. Therefore, the mold remediation work must follow the Texas Mold Assessment and Remediation Rules (TMARR). A Mold Remediation Protocol is being prepared for the work recommended above.
7. All penetrations of the ceilings (such as peripheral edges of supply air ducts and vents and exhaust fans) and chases (such as at the HVAC closet) should be sealed.
8. Improperly finished sheetrock/shower-surround junctions should be properly repaired.
9. Following remediation and other repairs, the residence should be thoroughly cleaned. HEPA-vacuuming of all surfaces and HEPA-vacuuming plus hot water extraction of upholstery and carpeting by a professional cleaning company may be very useful to reduce the inventory of dust in the house. Together with use of high performance return air filters, this should help to correct the dust problems. Badly soiled carpet and carpet in poor physical condition should be replaced.

Indoor Environmental Evaluation – Smith Residence – 514 Precious

TABLE 1 – SUMMARY OF RESIDENCE CHARACTERISTICS

No.	Street	Resident	Owner	Yr. Built	SF	Stories	Garage	Floor Plan	Subdivision	Date Investigated
514	Precious	Smith, Missy	SAHA	2000	690(1)/1000(2)	2	1.5-car	IV	Villas at Fortuna	4/18

TABLE 2 – SUMMARY OF MOLD GROWTH, WATER DAMAGE AND MOISTURE CONTENT

No.	Street	Resident	Visible Mold Growth	Visible Water Damage	High Moisture Content
514	Precious	Smith, Missy	LR windows LR tackboards Kitchen cabinet-wall under sink	LR windows LR tackboards Kitchen cabinet	Master Bedroom lower wall near head of tub (slight)

Yellow-highlighted boxes indicate conditions that may be significant in evaluation of indoor environmental issues.

Table 3 - Summary of Air Quality Measurements

Location	Temp °F	RH %	CO ₂ Ppmv	CO Ppmv	Dew Point °F
April 18, 2007					
Outside Air	67.4	51	438	0	48
Inside Air					
514 Precious (Smith) K	69.8	56	1069	0	52.5
514 Precious (Smith) RA	63.8	55	1188	0	47

Yellow-highlighted boxes indicate conditions that may be significant in evaluation of indoor environmental issues.

TABLE 4 – SUMMARY OF HVAC SYSTEM OPERATION AND SPECIAL CONDITONS

No.	Street	Resident	AC Operation	AHU Cleanliness	Dew Point	IAQ CO ₂ /CO	No. Occupants	Pets	Comments
514	Precious	Smith, Missy	Good ΔT= 17-19°	Dust in return air plenum Extremely dirty coils	52.5	1188/0	Ca. 5		

Yellow-highlighted boxes indicate conditions that may be significant in evaluation of indoor environmental issues.

TABLE 5 – SUMMARY OF AIRBORNE AND AHU PARTICLES

No.	Street	Resident	Sample Location	Total Fungal Spores	Unusual Spore Counts	Mycelial Fragments	Fiber Count	Skin Cell Fragments	Fiber-glass	Pollen	AHU
April 18, 2007											
Outdoor Air Samples – Villas at Fortuna											
463	Precious	Ynman	OA-front	1413	Cl>Asc>Bas	27	27	40	<13	520	
514	Precious	Smith	OA-front	2,840	Cl>Bi>Alt>Cur	133	27	227	<13	360	
Indoor Air Samples – Villas at Fortuna											
514	Precious	Smith	Return Air	627	Cl>Bi>Cur	67	627	2,693	<13	53	Coils: low levels Cl ¹
514	Precious	Smith	LR	2,467	As/Pn>Cl>Alt>Bi 773 As/Pn	360	933	3,747	13	107	
514	Precious	Smith	MBR	467	Cl>Bi>Alt>Cur	27	693	4,040	13	53	

Yellow-highlighted boxes indicate conditions that may be significant in evaluation of indoor environmental issues.

¹ Yeast and bacteria observed.

Alt denotes *Alternaria*. As/Pn denotes *Aspergillus/Penicillium*-like spores. Asc denotes Ascospores. Bas denotes Basidiospores. Bi denotes *Bipolaris/Drechslera*. Cl denotes *Cladosporium*. Sm denotes Smuts/Myxomycetes/*Periconia*. A>B, C denotes that type A is more numerous than type B, which in turn has the same numbers as type C.

TABLE 6 – SUMMARY OF AIRBORNE CULTURABLE FUNGI AND AHU SAMPLES

No.	Street	Resident	Sample Location	Total Fungi	Distribution Unusual Counts	Return Air Filter	Supply Air Plenum
April 18, 2007							
Outdoor Samples – Villas at Fortuna							
463	Precious	Ynman	OA-front	776	StH		
514	Precious	Smith	OA-front	1,024	Cl>Bi>StH>Alt		
Indoor Air Samples – Villa at Fortuna							
514	Precious	Smith	Return Air	71	StH	Coils: high levels <i>Fusarium</i>	
514	Precious	Smith	LR	776	Cl>As>Alt As 106		
514	Precious	Smith	MBR	47	StH		

Yellow-highlighted boxes indicate conditions that may be significant in evaluation of indoor environmental issues.

**Table 7
Swab Samples
Identification of Fungal Spores – Major Genera
Method S001**

Ref. No.	Description of Swab Samples	Concentration, Cts/cm ² (%)					
		<i>Alternaria</i>	<i>Aspergillus/ Penicillium</i> -like spores	Basidio-spores	<i>Cladosporium</i>	Total fungal spores	Mycelial Fragments
SB-6-S ¹	Smith LR Window ²	966 (<1)	ND	ND	349,600 (100)	350,566	8,740
SB-7-S ¹	Evap Coil, Smith ¹	276 (4)	ND	ND	5,934 (96)	6,211	13,662

Yellow-highlighted boxes indicate conditions that may be significant in evaluation of indoor environmental issues.

¹ Yeast and bacteria observed on swab samples.

Table 8
Swab Samples
Identification of Cultural Fungi – Major Genera
Method S002

Ref. No.	Description of Swab Samples	Concentration, CFU/cm ² (%)						
		<i>Aspergillus</i> species	<i>Aureobasidium</i>	<i>Cladosporium</i>	<i>Penicillium</i> Species	<i>Fusarium</i>	Sterile Hyphae	Total fungi
SB-6-S	Smith LR Window			27,000 (70)			2,610 (7)	38,300
SB-7-S	Evap Coil, Smith					12,800 (83)	2,560 (17)	15,400

Yellow-highlighted boxes indicate conditions that may be significant in evaluation of indoor environmental issues.

¹ Yeast numbers were also high on the swab sample.

