# APPENDIX C:

# PHOTOGRAPHS OF EXISTING CONDITIONS IN SELECTED AREAS OF STUDY

**Figure 1:** Living room fireplace, view southwest. The three areas of concern regarding the fireplace are the foundation, the chimney and the cast stone mural. (Photo credit: Chattel Architecture, 2009)

**Figure 2:** A ground penetrating radar device was used on the surface of the cast stone mural in an effort to determine how it is attached to the chimney, view south.
(Photo credit: Chattel Architecture, 2009)

**Figure 3:** Detail photo of testing along the surface of the mural.
(Photo credit: Chattel Architecture, 2009)

**Figure 4:** Although some metal ties were identified within the mural, there was not the expected pattern of anchors at each stone corner. However these tests are inconclusive as the ground penetrating radar only detects ferrous metals.
(Photo credit: Chattel Architecture 2009)

**Figure 5:** Detail of cast stone mural during testing, view southeast.
(Photo credit: Chattel Architecture, 2009)

**Figure 6:** Detail of uppermost portion of the mural where it attaches to the fireplace, view southwest. The Northridge Earthquake caused structural damage to the mural which has shifted up to 1/8 inch.
(Photo credit: Chattel Architecture 2009)

**Figure 7:** The living room fireplace chimney as it appears from the roof, view south-east.
(Photo credit: Chattel Architecture, 2009)

**Figure 8:** Detail of living room fireplace chimney, view southwest. It is difficult to determine the actual size of the unreinforced masonry chimney as it is enclosed within a wood frame.
(Photo credit: Chattel Architecture, 2009)

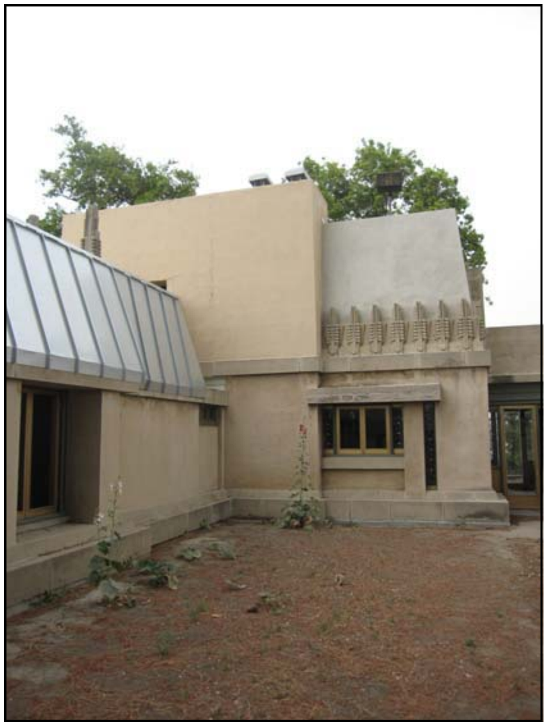

**Figure 9:** Child's Room and Master bedroom chimney block from ground level, view south-east.
(Photo credit: Chattel Architecture, 2009)

**Figure 10:** Child's Room and Master bedroom chimney block, view southeast. Cracks occur where the hidden chimney joins the building.
(Photo credit: Chattel Architecture, 2009)

**Figure 11:** Porch roof covered with temporary tarp, view northwest.
(Photo credit: Chattel Architecture, 2009)

**Figure 12:** Water testing being conducted on porch roof, view southwest. Note the metal covering was removed from the upper portion of the roof to perform testing.
(Photo credit: Chattel Architecture, 2009)

**Figure 13:** Porch roof during water testing, view southwest.
(Photo credit: Chattel Architecture, 2009)

**Figure 14:** Detail of porch roof during water testing, view southwest.
(Photo credit: Chattel Architecture, 2009)

**Figure 15:** A portion of the patio roof tile was removed to inspect for damage.
(Photo credit: Chattel Architecture, 2009)

**Figure 16:** Detail of large cracks on porch ceiling, view south.
(Photo credit: Chattel Architecture, 2009)

**Figure 17:** Interior view of porch window openings, view northwest. This particular area within the Gallery has a significant amount of water leakage.
(Photo credit: Chattel Architecture, 2009)

**Figure 18:** Gallery roof, view west.
(Photo credit: Chattel Architecture, 2009)

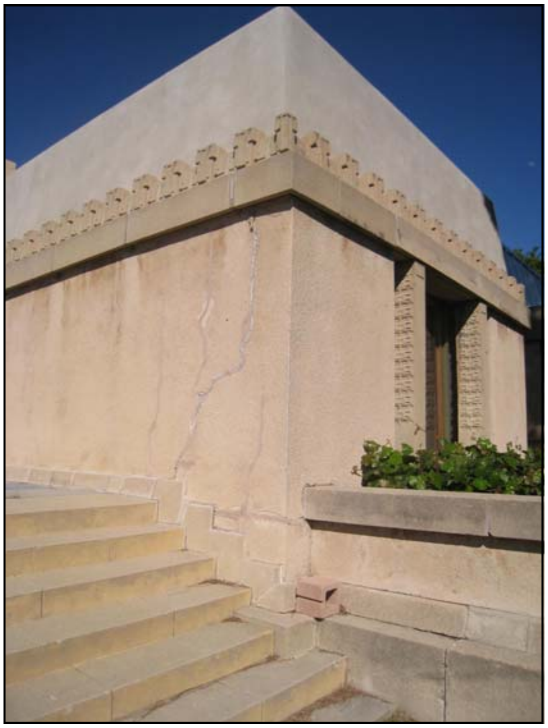

**Figure 19:** Library exterior wall, view northeast.
(Photo credit: Chattel Architecture, 2009)

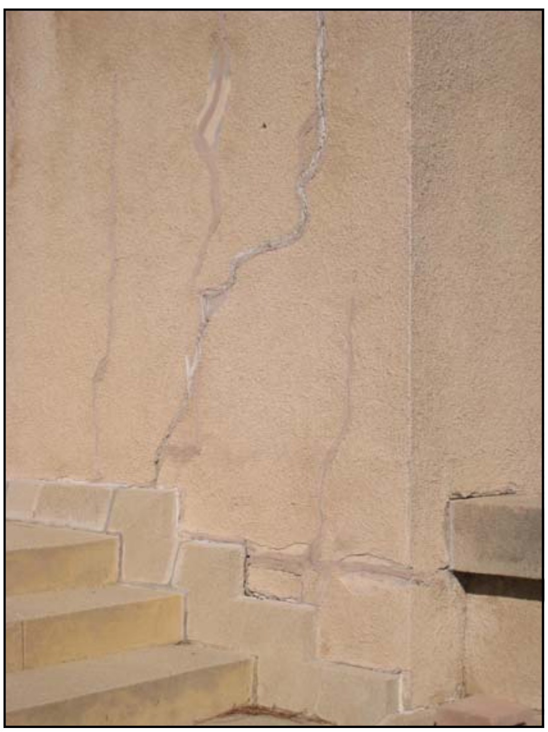

**Figure 20:** Detail of crack along library exterior wall.
(Photo credit: Chattel Architecture, 2009)

**Figure 21:** Sunroom wall, view west.
(Photo credit: Chattel Architecture, 2009)

**Figure 22:** Detail photo of crack along east wall in sunroom.
(Photo credit: Chattel Architecture, 2009)

**Figure 23:** Patio wall on south side of Hollyhock House, view east. The large pine tree has started to lift up the wall foundation.
(Photo credit: Chattel Architecture, 2009)

**Figure 24:** Detail photo showing proximity of tree to patio wall.
(Photo credit: Chattel Architecture, 2009)

**Figure 25:** Patio wall showing large crack, view northwest. The tree's proximity to Hollyhock house also poses a threat should the tree fall.
(Photo credit: Chattel Architecture, 2009)

**Figure 26:** Detail of crack along patio wall.
(Photo credit: Chattel Architecture, 2009)

**Figure 27:** Round fountain east of Hollyhock House, view southeast.
(Photo credit: Chattel Architecture, 2009)

**Figure 28:** Garage building north of Hollyhock house, view northeast.
(Photo credit: Chattel Architecture, 2009)

**Figure 29:** Interior of garage building, view southwest. The automobile area roof consists of a wood truss system which has been retrofitted with a horizontal steel truss.
(Photo credit: Chattel Architecture, 2009)

**Figure 30:** Detail showing the steel truss system anchoring walls in the automobile area, view west.
(Photo credit: Chattel Architecture, 2009)

**Figure 31:** A plywood shear wall has been constructed between the automobile area and living quarters, view east.
(Photo credit: Chattel Architecture, 2009)

**Figure 32:** Interior of garage living quarters, view southeast. (Photo credit: Chattel Architecture, 2009)

**Figure 33:** Garage living quarters, view northeast.
(Photo credit: Chattel Architecture, 2009)

**Figure 34:** Interior of garage living quarters, view northeast. It is likely that the existing historic concrete material would have to be covered to conform with existing code requirements.
(Photo credit: Chattel Architecture, 2009)

# APPENDIX D:

# STRUCTURAL REPORT


**Hollyhock House, Barnsdall Park**
**Los Angeles**
**Supplemental Structural Historic Report**

Prepared for

**LSA Associates and Chattel Architecture**
**Riverside, California**

Submitted by

**Melvyn Green and Associates**
**Structural Engineers**

July, 2009/(Rev.. October 2009)

**Hollyhock House, Barnsdall Park**
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July, 2009/(Rev. October, 2009)

Melvyn Green and Associates, Inc. 21311 Hawthorne Blvd., Suite 230, Torrance, CA 90503

# Table of Contents

# Scope and Intent

### Introduction

The Hollyhock House, designed by Frank Lloyd Wright, was constructed between 1919 and 1921. It is an important landmark building with visitors from all over the world visiting the site.

A historic structure report was prepared in 1992. This report served as a guideline for restoration work on the building. However, the building was damaged in the 1994 Northridge earthquake. After the 1994 Northridge earthquake, repairs were made to many areas of the building. Partial seismic retrofit was undertaken by connecting the roof to the walls of the structure. Not all damage was repaired and the building has not been completely retrofitted to current unreinforced masonry standards.

In the years since the original historic structure report was prepared, a number of other issues have come to light that may have an impact on the building. The Northridge Earthquake was mentioned earlier, but a number of natural phenomena also play role in the building's deterioration over time. These include such as  ground settlement, invasive tree roots, and water infiltration through the roof assembly.

In support of the Supplemental Historic Structures Report for the Hollyhock House at Barnsdall Park, Melvyn Green and Associates, Structural Engineers has developed this structural report on selected areas of the building

This report is intended to provide input to the Supplemental Historic Structure Report on focused structural issues. A floor plan of the building follows this introduction to show the area discussed.

### Limitations

This report is based on records, inspections, and previous plans. Work is limited to visible areas. Removals to permit inspection were limited to a small area of the porch roof tile. The tile is a later alteration and is not considered historic material.

## Methodology

### Overview

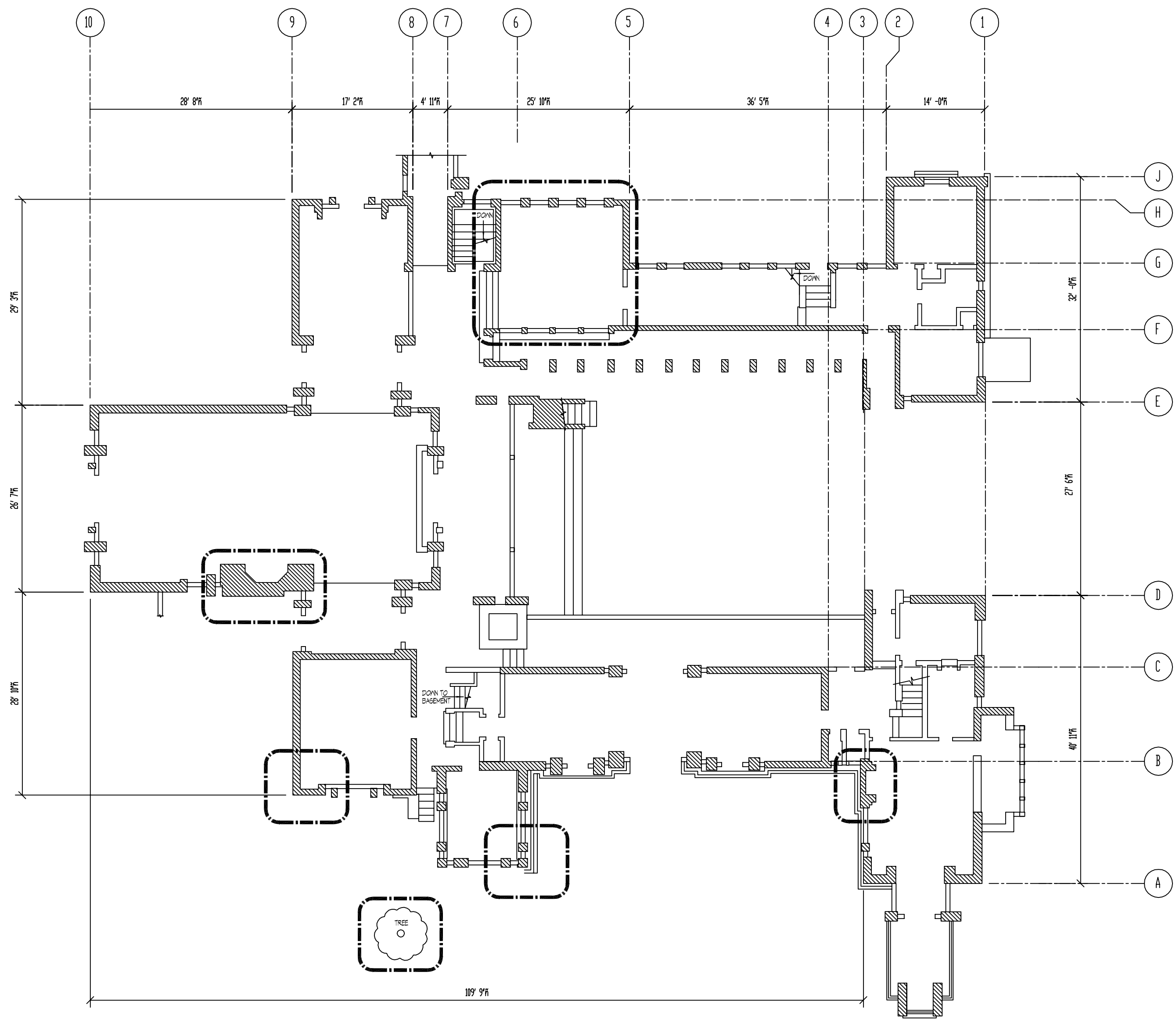
All areas of the building were inspected to observe the current conditions. Selected removal of roof tile finish was done on the porch roof to determine the substrate and framing. Waterproofing was also inspected.

## Testing

Testing, shown in photos 1 and 2, was conducted to determine whether there is, and the type, of physical connection between the fireplace mural to the fireplace structure.

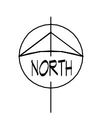
Photo 1. Living room fireplace showing testing in progress.

Photo 2. Living room fireplace. Each piece of blue tape shows a reading of metal.




# FIRST FLOOR PLAN

SCALE: 1/8" = 1'-0"




| LEGEND | |
|---|---|
| ▨ | INDICATES EXISTING HOLLOW CLAY TILE (HCT) WALL |
| ▭ | INDICATES EXISTING STUD WALL |

# Specific Areas of Investigation

## Introduction

The following areas of investigation each have specific factors to be considered that might potentially effect the building structurally.  Each is described by reviewing the issue or concern followed by a description of the structure in the area. A presentation of rehabilitation methods and options is next presented.

## Living Room Fireplace

### Issue

The Living Room fireplace is a massive structure of considerable historic importance. There are concerns about the fireplace foundation and chimney from a safety side. There is also concern about the mural constructed on the face of the fireplace. The fireplace is located on gridline D on the building plan. Photo 3 shows the mural and testing in progress.

The concern in regard to the foundation is that its embedment into the soil is shallow, perhaps about 12 inches. All the soil on the site has moderate bearing values. Some areas may have been filled without compaction. The bedrock is several feet below the ground surface. The result is less than adequate support for a heavy structure such as the fireplace. This may result in settlement of the foundation, which may be unequal across the width of the fireplace.

The second issue is the chimney, shown in photo 4. It is constructed of unreinforced masonry. Chimneys of this type have collapsed in past earthquakes. The movement of the chimney in the 1994 Northridge earthquake resulted in a horizontal crack in the stucco enclosure near the roof line on the building's exterior The Northridge earthquake also affected the decorative stone mural above the firebox in the building's interior.

The cast stone towards the west side of the fireplace shifted during the earthquake. The differential movement varies to a maximum of about 1/8 inch. The differential movement is greatest on the west end of the fireplace.

### Structure Description

The Living Room fireplace is a large structure located on the south wall of the living room. On the living room side there is a mural constructed of large cast stone blocks. The cast stone extends from the floor to the ceiling. The chimney appears as a 12 foot wide by 3 foot 6 inch deep massing at the roof level, matching the size of the fireplace on the interior. In reality, however, the structure observed on the roof is a stucco finished wood structure with a "normal" size chimney inside.

### Options

Foundation

The foundation for the chimney is founded about 12 to 18 inches into original soils. Under current standards, there is inadequate bearing for the fireplace. The soil could settle differentially under the load of the fireplace in a future earthquake.

The solution would be to improve the fireplace foundation. There are several options to consider.

One option is to construct a caisson pile system beneath the existing fireplace foundation and extend it into bedrock. A concrete grade beam would connect the caissons together and transfer the fireplace weight to the caissons.

Another option would be to improve the soil under the foundation. This involves the injection of a cement mix to strengthen the soil and, in effect, create a "soil-cement" foundation. This solution would greatly improve the support for the fireplace and significantly reduce the potential for settlement.

A third option is a "do nothing" option. This option would permit the fireplace foundation to settle in future earthquakes. There is no way to tell whether in a future earthquake, similar to the Northridge earthquake, would result in more significant damage, or localized collapse, of the fireplace.

The soil-cement option may be the least intrusive of the options. In any of the fireplace underpinning options, construction access will be required under the building.

Chimney

The fireplace chimney acts as a cantilever above the roof. The exact size of the brick chimney is unknown however, since it is enclosed within a wood structure to give the appearance of a chimney larger than it is.

The mitigation measure for this is to remove the portion of the brick chimney above the roof and skylight and to construct a new chimney comprised of metal studs. The new chimney would remain within the existing wood enclosure so there would be no visible impact on the building.

Other options that were considered would be to physically brace the chimney back to the roof within the wood enclosure if there is sufficient room, or to actually brace it back above the roof.

Another solution that was considered is to "center core" into the chimney. However, this solution would also require horizontal ties to hold the vertical bars in place. It is not feasible to install the ties as it would require disassembly of the chimney. While this is an approach to retrofit , this option is not practical.

Cast Stone Mural

The cast stone mural above the fireplace is not a monolithic slab; instead, it is comprised of a series of individual blocks placed together to create a surface that is monolithic in appearance.

The blocks that create the mural are attached to the fireplace structure itself. Typically, in installations such as this, attachment is accomplished with metal connectors of galvanized steel, bronze, or other material. Such connectors are usually located near the corners on the top and bottom of the individual stones. These are usually referred to as veneer ties.

The test program by Smith Emery Laboratories, which used ground penetrating radar devices, found some existing metal ties. This is seen in the following photographs. The test results did not find the expected pattern of anchors at each corner. Some lines indicated metal, and only one horizontal line showed a pattern. It is possible that the anchors from the stone to the fireplace are non-ferrous material and do not show up on the test devices. At this point the tests are non-conclusive. Any other test method would require destructive investigation.

Photo 3. Living room fireplace showing tape where testing indicates metal is present

Photo 4. Living room fireplace from roof. Note vertical crack where fireplace and wood extension join.

## Child's Room Fireplace

### Issue

The Child's Room fireplace, located on the first floor, has a two story chimney is shown in photo 5. It includes two flues, one for the first floor and one for the second floor fireplaces. The chimney is similar to that in the Living Room, in that it is enclosed in a wood structure to increase it visual appearance. In the 1994 Northridge earthquake, a vertical crack occurred on the exterior. It appears to be along the line between the brick and the wood portions of the chimney. Since the earthquake was in the direction of the long side of the chimney, it did not sustain the rocking type damage that the Living Room fireplace sustained.

The width of the fireplace is oriented in a the north south direction along gridline 3 in the plan view. The mass of the chimney resulted in lateral movement causing

Photo 5. Child's Room fireplace. Shows vertical crack at joint of hidden chimney and building.

some minor cracks in the wall adjacent to the fireplace.

### Structure Description

The Child's Room fireplace is smaller than that of the Living Room. The surface of the fireplace has some tile work on the mantle.

No investigation of the foundation or of the chimney has been conducted. The chimney is not accessible as it is enclosed with wood walls similar to the condition previously described in this report regarding the living room fireplace. It is safe to assume that the chimney is constructed of unreinforced brick masonry. The chimney for the Child's Room fireplace is much taller than the living room chimney.

**Mitigation**

The chimney needs to be braced or partially reconstructed. It has a larger mass than the living room fireplace chimney as it is a two story chimney.

Bracing is required at both the second floor and the roof lines. (It is possible that there are strap ties at the second floor, but it would require destructive investigation to determine this.)

The two options are to reconstruct the chimney from the top of the firebox or from the second floor. It does not seem possible to only reconstruct the portion above the roof in this location as was suggested for the living room fireplace.

The foundation of the Child's Room fireplace chimney should be underpinned in a manner similar to the recommendations for the living room fireplace.

## Conservatory Wall

### Issue

A vertical crack occurs in the east wall of the Conservatory, gridline 6, located about 4 feet to the north of the south wall. The crack extends from the floor/foundation to the underside of the window. The crack has been noted for a number of years and was discussed in the original Historic Structure Report on the Hollyhock House.

### Structural Description

The building's exterior walls are constructed on a continuous concrete foundation. The foundation is not considered to be deep. The foundation only extends about 12 inches into undisturbed soil.

Previous photos, probably taken during the City's remodeling of the building in the mid-20th Century, showed that the room was extended southward several feet, probably during the original, 1921, construction. The foundation for the entire building is concrete but this extension was with brick. Also the wall of this extension was brick up to the underside of the window, compared to the use of hollow clay tile for all of the building's exterior walls.

### Options to Solve the Problem

Cracks usually occur between different materials. In this case, the main factor is differential settlement between the two sections of foundation. (Why this occurs on the east wall, and not the west, is unknown.) A second factor is that the earthquake likely caused some widening of the crack.

## Outer Terrace Wall at Location of Mature Tree

### Description of the Issue

The roots of the large pine tree on the south side of the building near the Conservatory is lifting up the garden walls in the area. This has resulted in both vertical and horizontal displacement of the walls, vertical cracks in the wall, and the potential for the wall to collapse. There is the future possibility for loss of the historic wall, plus the small chance that it could collapse on a visitor when someone leans against it.

Another factor is the trunk of the tree. It is close enough to damage the building.

If the tree fell in a wind storm the uplifting roots would do significant damage to the building.

### Structural Description

The wall is constructed of hollow clay tile on a concrete foundation. Its height varies from 5 feet to 6 feet.

### Options to Solve the Problem

Remove the tree and root system. Plant a new tree further from the building. Investigate how many more years the tree can be expected to live. Removal would be the preferred option since it protects the structure. A new tree would replace the lost shade in a few years.

Trim back the tree. Trimming the tree would reduce the chance of it toppling in a wind storm. It would not relieve the issue of the roots.

Rebuild the wall and provide for continued root growth. In this option the foundation of the wall would be constructed as a reinforced concrete beam. The beam would be under and over the existing root and provided with an opening that would permit some growth of the root. Ultimately, the root would continue to grow and the problem would reoccur.

## Porch Roof

### Description of the Issue

The roof to the east of the living room was added after the building's original construction. The roof surface is a tile finish, probably designed to be walked upon.

It has been a source of water leakage into the building for many years. There is also a preservation debate on whether it should be removed as part of a restoration project.

Calculations indicate that the total allocable dead plus live load is 41 pounds per square foot. The dead load is 30 pounds per square foot (psf) leaving about 11 psf for live load. The minimum roof live load is 20 psf. Only occasional foot traffic should be permitted on the roof. Public use would require a 100 psf live load.

### Structure

This roof section consists of 2 x 8 joists spaced 16 inches on center. On top of the joists is a layer of plywood. A layer of concrete with wire reinforcing was cast on the plywood as the base for the tile. A finish surface of tile is placed over the cement base. A cement plaster soffit is supported under the joists. The connection of the joists to the cast stone concrete on top of the wall has not been determined.

The sheathing in the area observed was deteriorated and delaminating. The waterproof membrane also appeared to be deteriorated.

### Options to Solve the Problem

The framing of this building is light. In this case, the joists are subject to a heavier than normal dead load. Calculations indicate possible excessive deflection under dead load. Wood also has a tendency to "relax" over the years and deflect more than anticipated.

If it is decided to retain the deck, it may be possible to add an additional joist between the existing joists. A new layer of plywood should be installed. The concrete substrate for the tile could be sloped to provide positive drainage away from the building into the yard.

Photo 6. Tile deck showing inspection opening. Note rotted plywood pieces.

## Dining Room Roof

### Description of the Issue

Ponding on the roof of the dining room has resulted in some rain water leakage.

### Describe the Structure

The dining room roof is flat. With the minor deflection of the roof rafters this leads to areas of ponding.

### Options to Solve the Problem

The roof covering should be removed and some “ripped” sloped pieces of 2 x material should be installed to provide roof slope and drainage. Another layer of plywood would be placed on these ripped joists and covered with a new roof covering. The system should be shallow enough to not be visible from below.

## Library Exterior Wall

### Description of the Issue

At the southwest corner of the library is a vertical crack. This was thought to be a result of the earthquake. However, it appears that there may be settlement at that corner of the library.

### Describe the Structure

This section of the building consists of a continuous concrete foundation with hollow clay tile. It is unknown if there is any foundation failure, such as a cracked footing or settlement, in this area.

### Options to Solve the Problem

One solution is to underpin this corner of the building with concrete. The concrete should extend down to competent material.

In addition, the installation of horizontal stainless rods at the 1/3 points of the walls height should be considered.

## Garage Building

### Description of the Issue

The garage may be placed in public use rather than continuing its use as storage. It is an unreinforced masonry structure and must comply with the Division 88 seismic retrofit provisions.

### Describe the Structure

The Hollyhock Garage is constructed on a continuous concrete foundation which supports hollow clay tile walls. The roof structure consists of wood trusses over the automobile area. Over the living area, the roof is constructed with conventional rafters and ceiling joists.

The FEMA repair work brought this building into full compliance with the Los Angeles Building Code Division 88. The retrofit work consisted of the installation of a horizontal steel truss to act as a diaphragm. The walls are anchored and braced by the horizontal truss system. In the living quarters, the walls are anchored to the plywood or to the straight board-sheathed diaphragm. Between the garage and living quarters there are drag elements to distribute the load and to tie the two halves of the building together.

A plywood shear wall was constructed on the wall between the garage and living quarters and extends from the foundation to the roof. Independent supports were placed below the steel beams over the garage openings.

### Options to Solve the Problem

There should be no additional structural construction work required.

Photo 7. Garage interior showing steel for seismic retrofit.

# Appendices

Typical masonry veneer anchor details.

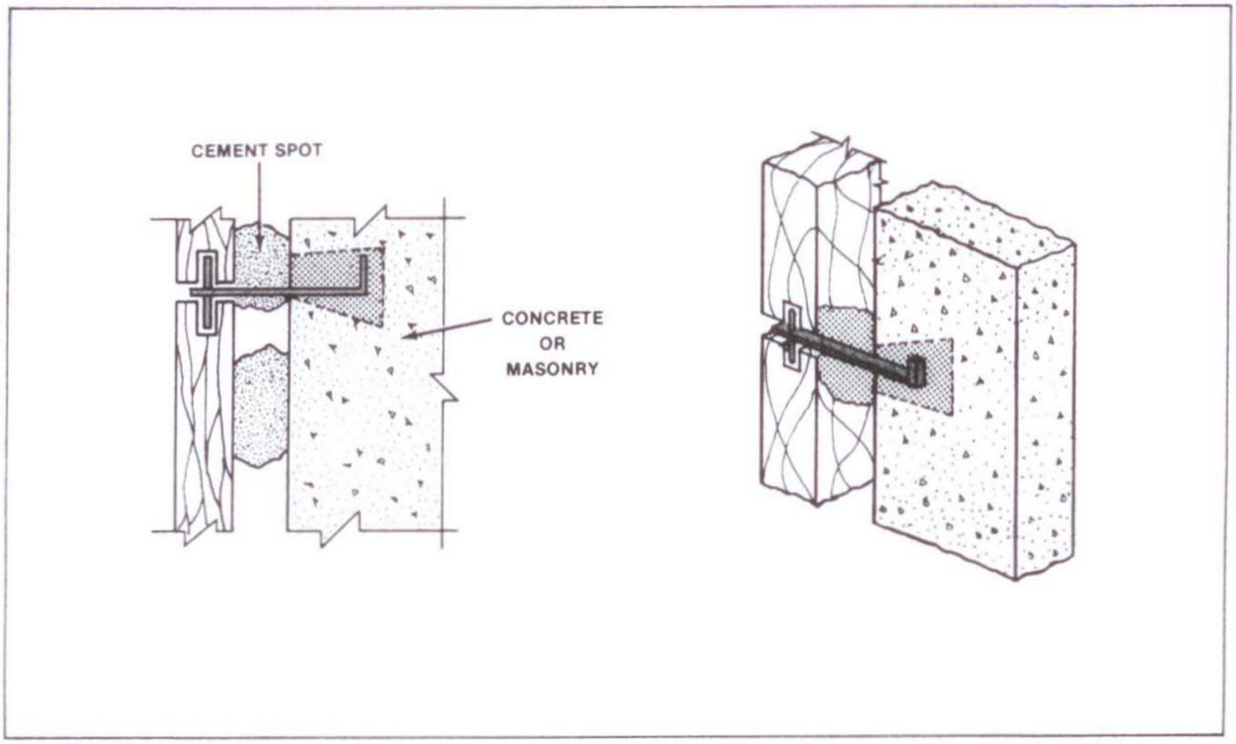



**Figure 4–4**
L-strap anchor with dowel.

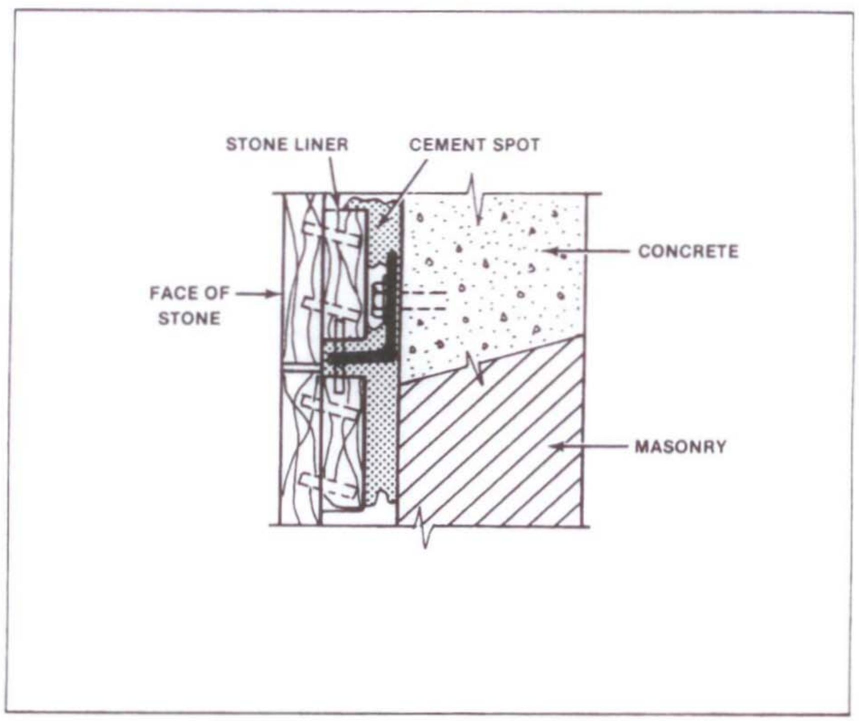



**Figure 4–6**
L-strap anchor with dowel and liners.

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Voice (310) 792 9252 - Fax (310) 792 8092 - E mail mgreen @mgreenassoc.com www.mgreenassoc.com

# APPENDIX E:

# FORENSIC WATER INFILTRATION TESTING REPORT

# INDEPENDENT ROOFING CONSULTANTS

**Roofing & Waterproofing Solutions**


| Dublin Office | Santa Ana Office | Las Vegas Office |
|---|---|---|
| 6955 Sierra Court, Suite 203 | 1761 E. Garry Avenue, Suite 100 | 3175 E. Warm Springs Rd., Suite 121 |
| Dublin, CA 94568 | Santa Ana, California 92705 | Las Vegas, Nevada 89120 |
| (925) 829-5030 T | (949) 476-8626 T | (702) 795-8020 T |
| (925) 829-5032 F | (949) 476-9810 F | (702) 795-2271 F |


June 17, 2009

Mr. Curt Duke
LSA Associates, Inc.
1500 Iowa Avenue, Suite 200
Riverside, CA 92507

Reference: Facility Survey (Roofing and Waterproofing Areas of Concern)
Hollyhock House at Barnsdall Art Park
Los Angeles, California
IRC Project No.: 17847.00

Dear Mr. Duke:

## 1.00 ABSTRACT

1.01 A Survey of the roofing and waterproofing areas of concern was conducted at the above referenced project on April 22 and 23, 2009. Additionally, further investigation was conducted on June 3 and 4, 2009, to better understand the hidden conditions at and near a glazed tile roof area. The main purpose of this inspection was:

- Examination of reported roof leak locations.
- Assessment of the current general overall roofing and waterproofing conditions.
- Identification of detrimental roofing and waterproofing conditions.
- Estimation of the remaining roofing and waterproofing service life capabilities.
- To provide recommendations based upon the roof conditions found.

1.02 As a part of this service, on April 22, 2009, we met with the House Curator, Mr. Jeffrey Herr. Mr. Herr informed us of the main areas of concern, which included several water entry locations. We also discussed the history of the project with Mr. Herr. Several parties were present on April 23, 2009 and on June 3, 2009, which fulfilled the team meeting portion of our service. During the meetings, we completed some investigative core sampling and water testing to further add to the information in this report. The core samples we extracted were each repaired using appropriate and compatible materials with existing materials. Removal also occurred by others during the investigative portion of the meetings.

1.03 The project was found to consist of a house that is registered as a historical landmark. The house includes multiple roof sections over which built-up roofing, elastomeric waterproofing or glazed tile surfaces were found.

1.04 The following report is based upon the inspection of visible items. No interior, structural or other evaluation is provided.

## 2.00 PROJECT INFORMATION:

**Roof Areas:**

| | |
|---|---|
| **Built-up Roofing (Gravel):** | 1,119 Square Feet |
| **Built-up Roofing (Cap Sheet):** | 1,462 Square Feet |
| **Waterproofing (Elastomeric Deck Coating):** | 3,027 Square Feet |
| **Waterproofing (Under Glazed Tile):** | 425 Square Feet |

| | |
|---|---|
| **Building Type:** | Historical House |
| **Number of Stories:** | 1 Story |
| **Roof Access:** | Stairs |

**Date Installed:**

All roof sections were reportedly replaced in 2002 with the exception of the waterproofing under the glazed tile, which was reportedly installed in 1970.

**Roof System Descriptions:**

**Built-up Roofing (Gravel):** The gravel surfaced roof sections were found to consist of the gravel surfacing embedded into asphalt over four (4) plies of fiberglass felt, each installed into asphalt over a fiberglass base sheet. The base sheet was found mechanically attached into a plywood substrate through a rosin sheet.

**Built-up Roofing (Cap Sheet)**: The cap sheet surfaced roof sections were found to consist of the mineral surfaced fiberglass cap sheet over three (3) plies of fiberglass felt, each installed into asphalt over a fiberglass base sheet. The base sheet was found mechanically attached into a plywood substrate through a rosin sheet.

**Waterproofing (Elastomeric Deck Coating)**: The elastomeric deck coating system appeared to consist of a urethane traffic coating system installed to the plywood roof substrate. There appeared to have been two base coat layers, a top coat layer into which sand was embedded and another top coat layer over the sand.

**Waterproofing (Under Glazed Tile)**: At the main glazed tile location, a cap sheet surfaced, organic reinforced built-up roof system was found installed over a plywood substrate. A 2-inch thick mortar bed was found over the built-up roofing waterproofing system. The glazed tile over the mortar bed was approximately ½ inches thick.

## 3.00 SPECIFIC FIELD OBSERVATIONS

3.01 Reported Leaks:

A. Leak Area #1:

1. This leak was reported above an interior door frame. The interior door is to the west of the courtyard. Plastic was draped beneath this area to catch water.

2. The roof location above this leak location was identified as the junction between the main green, glazed tile waterproof deck and the wall with the art stone of the upper roof area.

3. A clear coating was found on the surface of the tiles.

4. Cracks were noted through areas of the tiles.

5. At the wall and beneath the art stone, a sheet metal flashing was found extending onto the tile, like a counterflashing. This sheet metal flashing was sealed to the surface of the tiles with urethane coating materials that were reinforced with fabric.

The coating over the metal counterflashing did not extend behind the exposed surfaces.

6. Joints in the metal flashing were sealed where exposed. These seals were not found to extend beneath the art stones. Open joints occur in this flashing beneath the art stones.

7. The metal beneath the art stones was not removed during this investigation. The surfaces of the buried galvanized metal were not found waterproofed. Rust was developing in some locations and was already of serious concern.

8. The drain and overflow drain on the upper roof area were water tested (April 23, 2009 water testing) near this leak location for over an hour without any water entry confirmed. During this water test, the primary drain was the main focus of the test. While the primary drain was being tested, some water exited the overflow drain. Also drips could be heard in the wall during the initial phases of this test. These drips could have been associated with the water getting into the overflow drain. No water was found inside the building due to the testing of the drains.

9. Water testing of the wall above and onto the art stones (June 3, 2009 water testing) revealed that water flows out of the weep holes, located at the mortar joints between the art stones, long after the water testing was stopped. The wall itself remains wet for a long time after water testing.

10. When the wall was tested and masking provided over the glazed tile at the exposed portion of the counterflashing, leaks were simulated below. One leak occurred to the left of the interior door, as one enters the building from the glass sliding doors. The other leak was to the right of the interior door. The leak to the left of the door appears to be due to an open joint in the counterflashing metal. The leak to the right of the door occurs at the corner of the glazed tile deck above, and is speculated to be caused by openings in the transition metal installation.

11. The leak at the interior door was not simulated during the water testing, even after a strip of glazed tile, approximately a foot wide, was water tested in addition to the water testing of the wall. It is noted that a small crack in the tile materials to the left of the interior door below was not within this test location and would be the most likely location for the water entry to occur at the interior door.

B. Leak Area #2:

1. Stains at ceiling cracks in the walkway adjacent to Leak Area #1 were manifested at this reported leak location.

2. The roof above this location occurs at the green, glazed tile. The tile materials were cracked above the leak area. The cracks in the tile were in a similar location to the cracks in the ceiling, however, did not line up precisely.

3. The cracks in the tile surfacing were particularly wide open at a grout joint nearby the leak area.

4. Water testing of the cracks in the tile (April 23, 2009 water testing) allowed water intrusion to occur within 5 minutes. This water entry appears to simulate the water entry reported. We were prepared to test the tile flashing at the base of the wall to the upper roof at Leak Area #1; however, due to the amount of water entering we could not further water test the tile area and separate the results until the June 3, 2009 water testing when masking off of the glazed tile with plastic was organized.

5. The glazed tile deck area was cut open by others. We observed this opening on June 4, 2009. The plywood was completely deteriorated beneath the roofing materials at this location.

C. Leak Area #3:

1. In the corner of the ceiling to the north of Leak Area #1, another leak was reported. At this location, ceiling damages were noted. Small cracks and stains in the ceiling were also visible.

2. The roof location occurs where a stair assembly exists. At the base around the stair planter walls, the flashing flanges are not sealed nor stripped-in properly with the elastomeric deck coating system, and the flashing was installed like a counterflashing.

3. Sealant at the copper planter box cover was found open above this area.

4. In the vicinity of this leak, a drain outlet exists.

D. Leak Area #4:

1. Leakage was reported at a ceiling corner below the southwest corner of the main green, glazed tile section.

2. The overflow outlet occurs in this area, and this leak is in line with the wall junction between the glazed tile and the wall to the upper roof.

E. Leak Area #5:

1. This reported leak occurs beneath the acrylic skylight panels to the south of the courtyard. The sealant joints at the edges of these panels all appear open.

F. Leak Area #6:

1. Leakage was reported at the interior lintels of the window openings at the south exposure of the house. It is noted that a junction occurs between the work from 2002 and the original walls at this general area. This item did not appear to be a roofing item.

G. **Built-up Roofing - Observations:**

1. The built-up roof test samples were visually evaluated. The asphalt layers in the sample cuts appeared to be of a good thickness. The asphalt still held the cuts together cohesively.

   Only the initial signs of the asphalt becoming brittle were noted in the cap sheet sample cut. At the sample cuts, the underlying plywood appeared to be relatively new and it was suspected that the plywood was installed at the time the roof systems were installed.

2. Significant granule loss had occurred from the surface of the cap sheet surfaced roof areas.

3. At various wall junctions, the roofing is counterflashed by the wall systems in a hidden manner. The wall components cover the roofing to a relatively low elevation.

4. At the top of low roof section perimeter walls, the roofing terminates on the top surface of the wall with a fabric reinforced roof cement seal. Openings were developing along isolated areas of this seal.

5. Isolated edge-to-wall transition seals appeared open.

6. Around one of the sump box drains on a gravel surfaced roof section, cap sheet strip-in occurs. The cap sheet strip-in was loose around the sheet metal sump box.

7. At a wall drain, the roof membrane was also loose.

8. Typically, the overflow drain clamping rings were taller than 2 inches above the roof's surface. Overflow drainage is required to be 2 inches above the primary roof drain elevation.

9. Two heat vent pipes were without a sheet metal storm collar. Seals generally dry out around heat vent pipes. The seals appeared intact at the time of this inspection at these two pipes.

10. The top edge seal joints at pipe flashings were typically open.

11. Loose base flashing laps were identified.

12. A membrane blister was visible in a ponding area on one of the upper roof areas.

13. Debris accumulations around some of the drains were of concern. Debris covered drain areas in at least three locations.

14. One of the heat vent pipes was crooked. The caps on crooked heat vent pipes do not shed water properly and can result in water intrusion.

15. Isolated buckles in the cap sheet application were noted.

16. Evidence that ponding occurs was identified. Dirt accumulations were found at areas where ponding was suspected. In some cases, the walkpad material appears to cause ponding, however, there are low roof areas that exist without slope to drain.

H. **Waterproofing (Elastomeric Deck Coating) - Observations**:

1. The thickness of the elastomeric deck coating was found to be good at the sample cut location. The base coats were found to be approximately 60 mils thick. A substantial amount of the aggregate in the surfacing layers appeared worn away, however, embedded aggregate still existed, as seen at the test sample cross section.

2. A high deck nail was removed at the sample cut location. The nail removed had a ringed shank.

3. Numerous high nail punctures through the waterproofing system were identified. The underlying plywood was deteriorated at the high fastener at the test sample location. No roof leakage was reported at this location.

4. Proper waterproofing strip-in was found missing at three specific locations where flanged metal flashings return onto the roof deck. These flanges include the two locations above Leak Area #3, and a door threshold pan flashing on the opposite side of the house.

5. Debris accumulations were typical on the waterproofed deck coating.

6. Several isolated splits were found through the waterproofing membrane. The splits appeared to occur over joints in the plywood substrate.

7. A couple of spots were found where cuts occurred into the waterproofing membrane.

8. Ponding areas also appeared to exist on the waterproof deck areas, due to accumulations of dirt noted. At one area in particular, a waterproof deck area on the north side of the house, the ponding appears to be severe.

## I. Waterproofing (Under Glazed Tile) - Observations:

1. The built-up roofing material beneath the main glazed tile deck area was found open at the test sample location. The roofing material layers were easily separated and the asphalt layers were found brittle. The underlying plywood was completely deteriorated.

2. There were two tile roof areas. No leaks were reported below the small tile deck area on the southeast corner of the building. It is unknown if the waterproofing and substrate materials are different between the separate tile roof areas.

3. On both glazed tile roof areas, there were visible cracks in the tile materials.

4. During water testing, there were times when the tile roof area was flooded. Numerous locations occurred below, where water was dripping. Locations included light fixtures and cracks in the ceiling.

5. The drainage from the main glazed tile area is in one corner of this deck. The drainage from this corner occurs through a scupper flashing and into a sheet metal box drain. The box drain also services the adjacent coated waterproofed deck through a small channel gutter. The channel is between the glazed tile and a large copper cover. Joints between the gutter and the copper cover are open, and in the event that this drainage becomes blocked, could allow water entry.

J. **Roof and Waterproofing Related Items - Observations:**

1. Sealant joint material was found open in several areas of this project related to the roofing and waterproofing. Sealant joints were typically open at clerestory window sills, door sills and at the edges of the sheet metal planter covers.

2. Chimney flue flashing flanges were not sealed.

3. Tree branches were overhanging the roof line. Where this occurs, abrasion damages to the roof could occur. Abrasion damage had started at one location noted.

4. Severe wall cracks were visible in the stucco materials.

5. Wood access stairs exist to and from the various roof elevations. The access stairs covered some roof areas from observations during this inspection.

6. The wall work from 2002 construction on the house seemed to occur from top of structure down. There is a clear location where lower walls below the roof areas are original. Wall waterproofing below newer to original transition seems to be a source of water intrusion. One such example would be at Leak Area #6.

## 4.00 CONCLUSIONS AND RECOMMENDATIONS

### 4.01 Built-up Roofing- Conclusions/Recommendations:

A. Contrary to the performance of waterproofing systems on this project, the built-up roofing systems were found to be performing well and are estimated to have a remaining service life in excess of 10 years (10+ years). Our primary recommendation for the built-up roofs is to complete maintenance repairs to address each of the observations on the built-up roof areas, however, additional items should be considered, including the following:

1. Because of the hidden flashing methods used, proper roof replacement will eventually require removal and reinstallation of wall elements. In an effort to extend the roof's service life so as not to incur the substantial costs associated with a proper roof replacement, the installation of

a white reflective coating should be considered over the cap sheet surfaced roof areas. On this project, the coating would seem to be cost effective, even if used in a precautionary manner. Costs of coating may require recoating at approximate 5 to 7 year intervals and could entail special procedures in low spots. Substantial extension of roof service life could result from a well maintained reflective coating.

2. Measures to reduce or eliminate ponding water could be considered. Such measures are typically more successful during roof replacement and may not be realistic on this project at this time. Typical ways ponding areas are reduced or eliminated would be the installation of additional drains and/or the installation of tapered roof crickets. Due to the existing low elevations at the flashing areas, cricket installations are not anticipated as feasible. Installation of new drains, with drain lines could be considered if locations can be identified for such work.

3. One specific method to assist with drainage in some areas on these roof sections would be to cut gaps into the walkpad layout to allow drainage. Walkpads block drainage at some areas.

## 4.02 Waterproofing (Elastomeric Deck Coating) - Conclusions / Recommendations:

A. The current performance of the elastomeric deck coating is of serious concern. The installation appears proper. The plywood substrate was found attached with ring shank nails, which is also proper, and the system thickness was considered good, but splits were found developing, and ring shank nails appear to be backing out, causing punctures through the waterproofing system. We note that excessive building and substrate movement could cause these types of deficiencies. Other signs of building movement noted included cracked stucco walls.

B. Options to address areas of concern would include:

1. At minimum, extensive immediate repairs of the waterproofing deck coating is necessary. Repairs would address each of the individual observations regarding the

deck coating installations. Repaired items could recur in the case that items are caused by excessive building movement.

2. The installation of additional coating and surfacing layers should be considered after the repairs of all individual items. Similar coating and surfacing maintenance should be anticipated on a 5 to 7 year schedule.

3. The replacement of the waterproofing system is a possible solution, in lieu of the above two options.

   Any exposed, surface applied system will require similar maintenance as the existing (i.e. recoating/resurfacing every 5 to 7 years).

   Long term solutions can only be considered with the use of a protected system. Protected systems could consist of an overburden such as mortar bed and tile, or with removable pavers. Many waterproofing options exist for protected waterproofing installations; however, we would recommend a 215 mils thick reinforced hot rubberized asphalt waterproofing system for this project. This waterproofing system should be able to perform in excess of 20 years and we would expect it to perform much longer.

4. Drainage concerns also occur on the waterproof deck areas. The installation of new drains should be explored to reduce or eliminate ponding conditions.

4.03 **Waterproofing (Under Glazed Tile) - Conclusions/Recommendations:**

A. The waterproofing observed under the main glazed tile roof section was in a failed condition. From the construction noted, the leakage below should occur very close to leak openings because there are few surfaces that will allow the water to travel once it has breached the waterproofing layer. Numerous leaks observed during the water testing thus indicate system failure. It is noted that system failure has also resulted in deteriorated substrate materials and other possible project ramifications. Because of the extent of damage and deterioration noted, recommended work for this area should occur immediately.

B. Once a substrate for waterproofing/roofing is provided, we suggest using a similar long term solution as discussed above. Our recommendation would be the installation of a 215 mils thick reinforced hot rubberized asphalt waterproofing system for this project.

C. Specific to the waterproofing at the glazed tile areas, we believe that the following recommendations are important to successful remediation work:

1. The removal of the art stone adjacent to this roof section is recommended to access the flashing areas.

2. The removal of the existing sheet metal flashing behind the art stone is necessary to tie-in a new flashing at the waterproofing elevation. Tie-in should occur in the stucco wall above where the sheet metal reglet is located.

3. Stainless steel flashings are recommended to prevent the rust that is occurring on the existing flashing.

4. Waterproofing of the sheet metal flashings is also an option that should occur, whether stainless steel is used or not.

5. Additional drainage for this section and adjacent sections should be considered.

D. **Roof and Waterproofing Related Items – Conclusions and Recommendations:**

1. Replacement of existing sealant or installation of sealant at joints where none exists is recommended.

2. Tree branches must be trimmed off of the roof to prevent abrasion damages and to reduce leaf debris.

3. Wall waterproofing started in 2002 should continue to include original wall areas that have not been addressed. This is necessary to solve wall related leakage. One recommendation would be to use a breathable air barrier system. The air barrier system should be selected based upon compatibility with existing materials.

## 5.00 BUDGETARY CONSIDERATIONS

5.01 The anticipated budget figures for the above discussion items would be as follows:

A. Built-up Roofs:

| | | |
|---|---|---|
| 1. | Immediate roof maintenance repairs: | $5,000.00 |
| 2. | Protective coating application over cap sheet surfaced roofs: | $3,500.00 |
| 3. | Unit cost per roof drain (does not include costs other than for new drain assembly and roofing tie-in): | $5,000.00 |

B. Waterproofing (Elastomeric Deck Coating):

| | | |
|---|---|---|
| 1. | Immediate roof maintenance repairs: | $9,200.00 |
| 2. | Application of new sand coat and top coat over sand coat: | $8,500.00 |
| 3. | Installation of new hot rubberized asphalt waterproofing system. Cost provided does not include demolition, installation of new overburden or removal and reinstallation of the art stones. | $25,000.00 |
| 4. | Unit cost per roof drain (does not include costs other than for new drain assembly and waterproofing tie-in): | $4,500.00 |

C. Waterproofing (Under Glazed Tile):

| | | |
|---|---|---|
| 1. | Installation of a new hot rubberized asphalt waterproofing system. Cost provided does not include demolition work, reconstruction of the roof substrate, installation of new overburden or the removal and reinstallation of the art stones: | $5,200.00 |

5.02 There are additional items related to the roof and waterproof work that were not explored as a part of the roofing and waterproofing budget estimations. Items that are not a part of the above budgets provided would include the following:

A. Budget figures provided assume good access and set up areas are allowed to complete the work and assume roofing and waterproofing work can be accomplished without multiple mobilizations. Additional costs would occur if access is restarted and/or work opportunities are limited.

B. Roofing and waterproofing related work by other trades than the waterproofing contractor, such as carpentry, stone work, concrete work, stucco work, etc. which may occur on this project, have not been included in the roofing/waterproofing budgets. Note that related costs indicated as excluded in our budget estimations, such as overburden installation, stone removal/reinstallation and stucco wall tie-in work could greatly increase costs for the waterproofing installation on this project.

C. Costs associated with asbestos containing materials (ACM) have not been included in this report. It is suggested to test the roofing membrane beneath the glazed tile, as this material is organic reinforced, which could potentially include ACM.

D. Budget costs are provided in today's dollars. Recent and rapid cost fluctuations have been experienced throughout the construction industry. Future fluctuations cannot be accounted for in this report.

E. Leak investigation and emergency repairs that cannot be anticipated as a result of this visual inspection have not been included in the roofing/waterproofing budgets provided.

The recipient of our report must have a thorough and complete understanding of the findings and recommendations prior to making any determinations as to taking action.

Thank you for using Independent Roofing Consultants as your roofing and waterproofing consultant. If you should have any questions regarding this report, please do not hesitate to call.

Sincerely,

*INDEPENDENT ROOFING CONSULTANTS*

*Chris Woolfolk*

Chris Woolfolk
Consultant

CW/dv

Enclosures