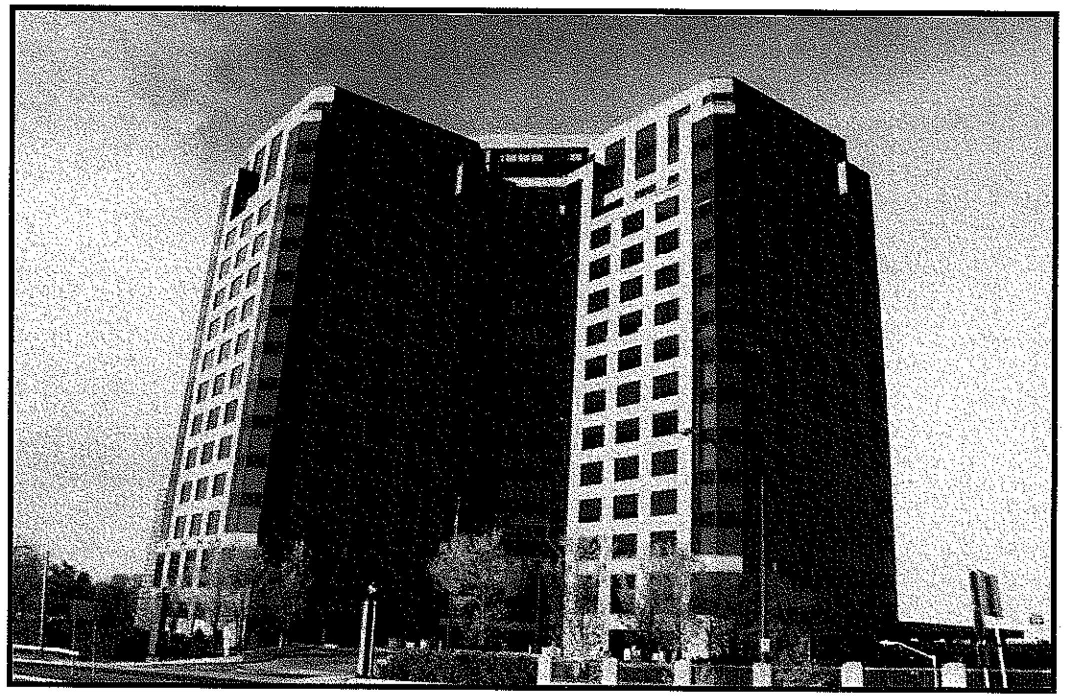
STUDY FOR DRAINAGE PLANE
25 Sigourney Street
Hartford, Connecticut

PROJECT NO. BI-2B-033 I



STATE OF CONNECTICUT
Department of Public Works
State Office Building
165 Capitol Avenue
Hartford, CT 06106

Prepared By:
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Two Broadway
Hamden, Connecticut 06518

Date:
July 21, 2006

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EXECUTIVE SUMMARY

On a building of this height, type of construction and age, there will always be some on-going scheduled maintenance which needs to be performed. Even so, the building is in generally sound and good condition. The life expectancy of the exterior facing materials used on an office building of this type is typically fifty-plus years, i.e. aluminum, brick, glazing, etc. Therefore, the materials on this building should last another twenty years or more with proper maintenance and a long-range repair plan.

Option A:
In lieu of opening the wall to apply an internal barrier, a new finish system can be applied to the exterior brick veneer. The exterior panels will act as the primary rain screen and the brick as the drainage plane behind creating the some redundancy. The panels come in various types of finishes and materials such as aluminum, stone and tile. This option will be less disruptive to the occupants. It also provides an opportunity to create a new appearance for the exterior of the building.

Option B:
We do not find the system noted in the report as adding a barrier within the drainage plane by accessing from the interior a viable option. This system will be too disruptive to the point of requiring the relocation of some, if not all, the tenants while the work is being performed. Methodology of performing this option is also questioned.

Option C:
Currently there are couple of areas which appear to be presenting problems. These include the flashing above the entrance curtain wall, flashing of the main roof parapet where it ties into the curtain wall, and some minor masonry repairs. Minimum recommend repairs for these areas would include, but are not limited to:

- Remove and replace any damaged or defective masonry
- Replace any defective sealant joints (The useful life expectancy of sealant is generally five to eight years)
- Tend to flashing defects at roof scuppers
- Cut back existing main roof parapet a minimum of 12 inches to allow for proper flashing into adjacent curtain wall
- Remove and install new cap flashing above entry, curtain wall, with proper drainage slope.
- Apply a breathable waterproof coating to the brick and periodically reapply every three to five years as recommended by manufacturer

Option D:
To apply an air and vapor barrier within the internal drainage plane is a complex and disruptive procedure. This can be accomplished by removing the brick veneer and applying a barrier to the surface of the masonry backup. It is important to flash the perimeters of window frames and seal all openings. Make sure that masonry ties used to reattach the brick veneer are self-sealing and air tight.

In addition to the options noted above, enclosing the 27 terraces with garden type aluminum frame windows would eliminate the flat roof areas and any problem associated with them. This would require some interior finish work and modifications to the existing mechanical system.

Associated costs:

• Option A - add rainscreen system	$7,286,186.00
• Option B - reconstruct inside out & add barrier	$ (unknown *)
• Option C - maintain existing	$ 534,249.00

- Option D - remove / replace exterior brick & add barrier $7,823,060.00
- Enclose terraces $2,530,250.00

(*) additional information about the procedure is required before an estimate can be provided

This report is **not intended for construction** and was prepared for the sole use of the Owner, The State of Connecticut, in connection with the study of the drainage plane of 25 Sigourney Street, Hartford, Connecticut. Any reprints or copies of this report without the written consent of the Architect, or Owner is unlawful. The parking garage is not part of this report.

Respectfully submitted,

Martin A. Benassi, AIA
Architect

END OF SECTION

INTRODUCTION

PREAMBLE

On March 23, 2006, Martin A. Benassi, AIA - Architect received written authorization to investigate and prepare a study of the drainage plane at 25 Sigourney Street, Hartford, Connecticut. Excluded from this report is the semi-detached parking garage and its emergency stairwell. The intent of this study is to determine the best method of design direction for the drainage plane for both interior or exterior with several alternatives, and to review and explore the balconies (a.k.a. terraces) and provide options as to their impact on the water intrusion issue. Toward this end, several site visits were made to document existing conditions using photographs and sketches, some of which are included in this study under the appropriate appendix. Site visits and meetings were made on:

Date	Present	Remarks
February 28, 2006	Martin Benassi, AIA Marguerite E Petersen, AIA Robert Cody, DPW Manuel Becerra, PE, RPA, DPW Donna Baisley, DPW Ward Ponticelli, DPW	To review general scope of work.
May 2, 2006	Marguerite E Petersen, AIA Nathan Cyr, Building Mgmt. Dennis Stevenson, Building Mgmt.	To photograph and document existing conditions.
May 17, 2006	Marguerite E Petersen, AIA Matt, Kelly Enterprises Mario, Kelly Enterprises	To photograph and document existing conditions via rig on west side of building

DATA COLLECTION

A partial set of original construction drawings dated May 1, 1985, was retained for evaluation and reference. The building was called the Xerox Centre then. Architect of Record was Welton Becket Associates, Architects, 200 Madison Avenue, New York, New York. The full set of drawings included Architectural, Structural, Mechanical, and Electrical as follows:

Consultants listed included:

Architectural	Mechanical
Brennan Beer Gorman 515 Madison Avenue New York, NY 10022 212-888-7663	Burton and Van Houten, Inc 10 North Main Street West Hartford, CT 06107 860-236-2365
Structural	**Landscape**
Lev Zetlin Associates 641 Avenue of the Americas New York, New York 10011 212-741-1300	CR 3 Inc. 571 Hopmeadow Street Simsbury, CT 06070 860-658-1988

We retained the following sheets for evaluation and reference:

A - 22	North & East Building Elevations
A - 23	South & West Building Elevations
A - 24	Building Sections
A - 25	Building Sections
A - 28	Roof Details
A - 29	Exterior Greenhouse Elevations & Details
A - 30	Greenhouse Sections & Details
A - 31	Typical Tower Window Wall Elevation, Section & Details
A - 32	Typical Tower Curtain Wall Elevation & Details
A - 33	Penthouse Elevation & Sections, Roof Details
A - 34	Exterior Terrace Details
A - 35	Typical Exterior Masonry Wall Sections & Details
A - 36	Brick Details

Additional drawings reviewed:

Roof Coping & Masonry Repairs, Hoffmann Architects, September 11, 1998

Exterior Repairs - Building Envelope, Hoffmann Architects, December 17, 2001

Roof Replacement and Entry Plaza Repairs, Hoffmann Architects, December 12, 2002

Reports reviewed:

Inspections, reports, etc., as posted on DPW website.

HVAC / IAQ Building Evaluation, prepared by Turner Building Science, LLC, 27 Locke Road, New Hampshire, dated December 2005.

Infrared Inspection Report, testing performed by Monroe Infrared Technology, Kennebunk, Maine, prepared by Turner Building Science, LLC, 27 Locke Road, New Hampshire, dated October 10, 2005.

Roof Coping and Masonry Repairs Survey prepared by Hoffmann Architects, 432 Washington Avenue, North Haven, Connecticut, dated June 7, 1996.

Building Envelope Survey prepared by Martin A. Benassi, AIA - Architect, Two Broadway, Hamden, Connecticut, dated May 15, 1998.

Building Condition Survey - Xerox Centre, prepared by Hoffmann Architects, 432 Washington Avenue, North Haven, Connecticut, dated September 30, 1992.

Property Inspection Report For Aetna Life and Casualty, prepared by Cherichetti Incorporated, 28 School Street, East Granby, Connecticut, dated March 16, 1987

SAMPLES

Samples of brick, mortar, and sealant were retained for in-house evaluation.

FORMAT

This survey is organized into four sections: Introduction, Observations, Evaluations, Recommendations. Activities are listed by a two-digit code followed by a broad scope heading, generally identifying the subject being discussed in accordance with the Construction Specification Institute (CSI) 16 Division format.

This report is **not for construction** and was prepared for the sole use by the State of Connecticut, Department of Public Works (DPW). Any reprint or copies of this report without the written consent of the Architect or DPW is unlawful.

END OF SECTION

OBSERVATIONS

01 GENERAL

Original construction drawings indicate the building is approximately 20 years old and was originally named the Xerox Centre. The State of Connecticut assumed control of the building in the early 1990's. The structure is 20 stories high (15 stories + penthouse + 4 parking), with a total roof elevation of approximately 200 feet above the main entrance level. The penthouse (20th floor) contains mechanical rooms as well as office space.

The building is predominantly used for offices, with a total floor area of approximately 410,000 net square feet (of office space). There is a semi-detached multilevel concrete parking structure with its own emergency stairwell. Both parking garage and stairwell are excluded from this report. There are two terraces located on the mezzanine (5th floor), 12 terraces on the 17th floor, and 13 terraces on the 19th floor, for a total of 27 terraces.

The building is constructed of a reinforced concrete infrastructure with a masonry cavity wall veneer. A portion of the parking garage concrete slabs are post tensioned. Glass and aluminum curtain wall system is located at the corners of the office building and over the front entrance/greenhouse.

The upper floor terraces are narrow in depth (less than 4 feet) surrounded by a brick parapet topped with a precast coping. A painted metal railing is attached to the parapet. Centered on the narrow depth of the terrace are safety line tie-back anchors mounted into the concrete deck. The balconies, at least on the upper floors, do not appear to be used except to open the sliding doors for occasional supplemental ventilation.

The building management company reported there are 48 interior areas which have the finishes removed, based on areas of potential water infiltration as noted in the Infrared Investigation Report by MIT for Turner Building Science, LLC. Finishes will be installed after exterior sealant repairs have been completed by Kelly Enterprises, Inc., who has recently been performing repairs to defective sealant joints (photos # 9, 10, and 11). Their rig is on site, and they have been going over the side of the building to accomplish the work.

The building no longer uses roof top window washing rigs. The rooftop concrete pad used by the rig was removed during the 2003 reroofing project, and safety line tie back anchors were installed as part of that project.

03 CONCRETE

Structural framing members are cast-in-place, reinforced concrete beams and columns.

04 MASONRY

The building facade is typically constructed of a masonry cavity wall comprised of a standard sized, non-glazed, iron spot, low absorption, cored brick (Belden Brick #470-479) on the exterior with a 2- to 2½-inch air space cavity behind. Within the cavity is 1-inch rigid insulation board adhered to a 6-inch CMU (concrete masonry unit) inner wall.

The penthouse (20th floor/ main roof) parapet walls are constructed of a CMU interior with an exterior brick veneer on both sides. Dennis Stevenson, building maintenance engineer, reported the entire wythe of brick on the interior of the parapets was replaced, and select sections of brick replaced on the exterior of the parapet during the roof coping and masonry repairs project completed in January 2000. This is opposite of what is shown on the parapet repair details (1998). The penthouse and terrace parapets are solid masonry with no air space cavity.

On the north elevation of the building, there is evidence of efflorescence on the outside face of the 19th floor terrace parapet walls. Crazing and cracks are evident in the corresponding brick (photo #1). On the west elevation of the building, there is evidence of efflorescence on the outside face of the 17th floor terrace parapet walls (photo #7). It is impossible to tell if the efflorescence is from an old leak which has been fixed and the staining has not washed off or an active leak.

Between one end of the main roof parapet (above the main entrance) and the face of the glazed curtain wall, is a clearance of only 1½ inches wide (by +/-16 inches deep), which is too narrow to be properly flashed and made watertight. The lower segment of the parapet end abuts the wall below the window. The sealant is excessive on the narrow, horizontal top of this lower segment (photo #2). There is a reoccurring leak in this vicinity on the floor below.

The new membrane flashing under the new coping stones appears to have been installed on top of the metal through-wall flashing instead of below as detailed (1998).

Coping bed joints of mortar were deteriorating in places and in other places had been patched with sealant.

Flashings above the galvanized lintels, which span across the masonry openings for the windows, cannot be seen. There is no drip edge exposed. The brick has been factory formed so its face overhangs the toe of the lintel. The horizontal space between the lintel toe and the backside of the brick "leg" is filled with mortar. The adjacent metal drip edge, installed during recent masonry repairs, is visible (photo #8).

07 THERMAL AND MOISTURE PROTECTION

The roofing system observed was an IRMA (inverted roofing membrane assembly). Listing from the top down, it consisted of: river stone ballast, underlayment mat, rigid extruded polystyrene type insulation, drainage composite, and black MBR (modified bitumen roofing) membrane with a granulated cap sheet. The membrane ran vertically up the inside of the parapet approximately 18 inches. The drawings show a continuous termination bar and sealant along its top edge, which could not be seen due to the overlapping metal counter-flashing. There was stainless steel counter-flashing protecting the top edge of the membrane. Strip sealant and a tooled bead of sealant ran along the top edge of the metal flashing. The mortar in the joint above showed signs of cracking in some locations. Weep holes with a honeycomb insert are located above one joint above the flashing.

A strong air flow was felt exiting some of the weeps on the interior side of the main roof parapet, as also was felt from the plumbing vent stacks penetrating the roof.

The coping cap was a tinted cast stone with stainless steel through-wall (according to the drawings) flashing. The joint between the flashing and the underside of the coping was pointed with mortar in most cases, but was patched with sealant in other areas. The terrace parapets were viewed as similar in materials.

Sealant between the coping stones, as well as where the coping stones abutted brick walls, was showing signs of adhesive failure (photo #3).

Noted around the penthouse wall were many areas of crudely applied sealant, which highlighted areas of previously repaired leaks.

Lightning protection cable, with air terminals approximately every 12 feet, was anchored with clamps fastened to the top of the coping.

There was a double-wide path of square concrete walkway pavers encircling the roof (resting on the rigid insulation) directly adjacent to the base of the parapet.

The overflow scuppers through the main roof parapet were created by core drilling a 5½-inch opening near the base of the parapet and installing a stainless steel through-wall sleeve with flanges extending onto each brick face. A target patch of granulated MBR was heat sealed around the opening and onto the MBR cap flashing which had been run vertically partially up the inside of the parapet. In some locations, the membrane did not appear to have completely sealed itself to the sleeve flange. In another location, the corner of the target patch was not adhered (photo #4). It is our understanding that the flashing has been repaired since our initial site visit.

Metal fabricated penetration pockets were filled with pourable sealer which did not have a crown; and some, more than others, retained varying amounts of water. One pocket had bits of insulation, ballast, and underlayment mat embedded in the sealer.

Observed were a couple of different types of sealant throughout the building - the sealant installed during the last construction project and the current repair project, and other sealant applied.

Record drawings of terrace details (1998) indicate an existing concrete deck with cementitious fill, fluid-applied waterproofing, 2-ply rubberized asphalt membrane, drainage composite, and loose laid lightweight concrete pavers. During onsite observation, it was noted an approximately 2-inch width around the perimeter edge of the terrace deck sloped toward the base of the wall and away from the drain, thereby retaining water.

A concrete curb raises the terrace door sill above the roof line by approximately 5 inches. Flashings ran up the curb and under the door sill. Kelly Enterprises has recently installed additional copper flashing under the terrace doors, and the maintenance staff reported the former associated leaks have stopped.

08 WINDOWS AND DOORS

The curtain wall system along the front entrance and building corners is an extruded anodized aluminum frame, insulated tinted glass secured with drive-in gaskets and a snap-on cover trim. The system is called out as Vistawall 2600 on the 2001 drawings.

Metal cap flashing above the main entrance curtain wall assembly pitches incorrectly back toward the building facade and retains water as a gutter would, as evidenced by the moss growth. This condition has been referenced as a problem in previous survey reports as far back as 1996 - 10 years ago. Leaks appear be a problem as evidenced by the excessive amount of sealant applied at the intersection of the cap flashing and brick (photo #5). A reoccurring leak on the 19th floor is potentially related to this condition.

The bands of windows are similar in construction and detail to the glazed curtain wall assembly. They are called out as Vistawall 4400 in the 2001 drawings.

As observed up-close from the rig, every joint and seam in the aluminum window framing was coated with sealant. The glazing gaskets were replaced and coated with sealant per the 2001 drawings for repairs.

15 MECHANICAL

The top surface of a sheet metal hood over one of the mechanical vents on the main roof, as well as the top of adjacent rooftop ductwork, was dented and retained water (photo #6).

END OF SECTION

EVALUATIONS

GENERAL

In its 20-year life, 25 Sigourney Street has been plagued with water infiltration problems. Listed on the DPW website, there are no less than 65 reports, inspections, evaluations, assessments, letters, etc., related to the matter; and the listing is limited to the past 7 years. Earlier documentation is not posted. There also have been three major construction projects since 1999. These projects included terrace reroofing; roof coping and masonry repairs; exterior repairs (including windows); roof replacement (penthouse and main); and limited entry plaza repairs. As of May 12, 2006, there are only three reported leaks. Kelly Enterprises is on site as this report is being written, tending to sealant repairs on the building's exterior. Having zero leaks, regardless of the possible extremes of weather and the resulting adverse conditions, is an unrealistic expectation for any building of this size.

In the 1970's, the cost of energy was cheap. Office buildings were built with lighting for an entire floor regulated by a "single" switch. Then came the oil embargo 1973-1974, the cost of energy rose, and the term "energy efficiency" became the new buzz word.

25 Sigourney was built a decade later using typical construction methods and budding energy efficiency techniques of that era. There wasn't redundancy in the exterior rain-penetration control detailing - no "belt-and-suspenders" approach should the first line of defense fail. At present, an on-going in-depth examination of the exterior on a regular basis is required to attempt to keep the building watertight. To date, this kind of scrutiny hasn't totally prevented leaks simply due to the original inherent construction methodology of a single line of defense.

Some of the current building problems can be found described in the Property Inspection Report for Aetna Life and Casualty, dated March 16, 1987. At that date, the building wasn't quite complete, and already concerns were arising. As noted in the report, "*Items that may be significant problems over the life of the building or result in substantial limitations include: .....the exterior caulking joints are much wider in many places than is indicated on the plans. This could result in decreased caulking life, and in increased costs to maintain and repair over the life of the building.*" Also in the report, "*.... balconies are so narrow as to be of little use.....because they are over occupied space, provide an increased opportunity for leakage into the spaces below.*"

The one item not listed in the report as a cause of concern, in relationship to water intrusion, was the masonry brick veneer. It was accepted as being constructed to the standards and methodology of the time.

Today, there is an improved comprehensive view resulting from extensive research and development concerning integrating materials and methods of construction, building systems, energy efficiency, health environments, etc. The construction industry is more technical and scientific; and the consumer is wiser and more health conscious today.

The "new" vocabulary words of the construction industry today are: drainage plane, rainscreen, vapor barrier, and air barrier.

A drainage plane is a surface, and therefore a path, which water follows by means of gravity. In order for the water to free flow, there needs to be airspace in front of the plane. If surfaces are touching, then the potential for capillary action takes place, which can over ride gravity; and moisture can travel in all directions.

The primary drainage planes of the building would be the exterior surfaces of the brick, glass, and roof. The secondary drainage plane, in the case of 25 Sigourney, would be the backside of the brick, or possibly the face of the rigid insulation which is adhered to the face of the inner CMU wall. (See

Appendix B, page 1.)

The problem with the building's existing secondary drainage plane is two-fold. First, there are areas of the original construction where there isn't an air space cavity (terrace and penthouse parapets), or the air space is minimal; and second, it is assumed the existing rigid insulation panels did not have ship lapped vertical joints (or tongue and groove) and horizontal joints flashed to provide a continuous surface. Without the joints in the insulation detailed as mentioned, there would be discontinuities in the secondary drainage plane, allowing water to potentially pass into the CMU in the form of liquid or solar driven water vapor (as when the brick gets wet during a rainstorm and then is warmed by the sun).

Another similar name used in the industry is "rainscreen", which is an outer panel, a ventilated cavity (with connection to the outside air), and an inner skin. A rainscreen system is pressure equalized - the joints are open allowing pressure equalization in driving rain conditions to be instantaneous. Pressure inside the cavity is equal to pressure outside, thus precipitation has no inclination to be driven into the cavity. The majority of the water is deflected off the outside face, and any penetrating water is disposed of through drainage. [1] (See Appendix B, page 2.)

Critical features of the rainscreen principle are: an exterior barrier (rainscreen) containing protected openings which permit the passage of air, but not water; a confined cavity behind the rainscreen in which air pressure is essentially the same as the external air pressure; insulation fixed to the outer surface of the interior wall system, if provided in design; an interior barrier (wall) which substantially limits the passage of air and water vapor. It must be an engineered system with certified testing results by an recognized independent laboratory. Also, the structural integrity of the brick veneer must be evaluated by a structural engineer (for wind, seismic, etc.), and dew point calculations performed and evaluated.

The pressure equalization in the cavity behind the exterior wythe is the major difference between a rainscreen wall and a drainage plane system. A pressure-equalized rainscreen wall provides the best means of resisting water penetration. If the cavity space is at the same air pressure as the exterior (as a result of air flow through [high] vent openings and [low] weep holes), the only moisture which will reach the cavity space is due to gravity flow and capillary action. The provision of an airtight barrier is also extremely important [2] (See Appendix B, page 3.)

For the purpose of clarification, vapor retarders control transmission of water vapor, and air retarders limit the amount of air flow. A vapor retarder always serves as an air retarder, but an air retarder may or may not perform as a vapor retarder. Vapor retarders are normally placed on the warm side of the insulation in the wall assembly. Air retarders have no specific position. Walls designed with rigid insulation on the exterior side of the air retarder can be designed so that the second (partial vapor retarder) barrier is at a temperature above the dew point, so condensation problems can be eliminated. [3] If a vapor or air retarder is added, the window and door jambs and sills must also be wrapped with the membrane, with all joints properly sealed. All brick tie penetrations should be self-sealing.

Rigid board insulation in the pressure-equalized cavity is only effective if it is adhered tightly to the cavity side of the CMU by the use of fasteners or full adhesion. If the insulation boards are adhered using the common method of dabs of adhesive, then air will circulate behind and lessen the effect of the insulation capacity as well as the quality of the pressure equalization of the cavity.

A continuous additional drainage plane ("second skin") and vapor barrier, along with the repairs of problem areas mentioned in the Observation section of this report, will improve the general control of the building's rain-penetration. A better option would be to include a pressure-equalized cavity, as well. (See Appendix B, page 4.)

In order to provide a vapor-impermeable, continuous drainage plane to the face of the existing

CMU, the existing exterior brick would have to be removed to gain access; or another option would be to remove the entire perimeter interior gypsum wall board, metal studs, and CMU wall, then replace them (with enhancements) from the air space cavity back to the interior again. Turner Building Science mentions the latter approach in their report dated December 2005. A phone call to President/CEO, William A. Turner, M.S., P.E., provided information confirming this procedure has been done, but he added he has is no written information on the technique.

Also at issue is the fact the existing air space cavity is only 2-2 ½" wide total, and contains 1-inch thick rigid insulation. Installing a thicker insulation (with proper seam detailing) would improve energy efficiency; but the Brick Institute of America recommends a 1-inch minimum clear air space cavity in a brick veneer wall, and prefers more.

[1,2,3] Brick Institute of America (BIA) Technical Notes, 27 - Brick Masonry Rain Screen Walls

END OF SECTION

RECOMMENDATIONS

GENERAL

There has been a conscientious effort to reduce/stop the leaks over the years with increasing success.

RECOMMENDATIONS

We recommend:

Option A:

Cladding the brick on the building with a new engineered and tested waterproof rainscreen system which is pressure equalized and includes insulation. Structural integrity of the brick veneer must be evaluated by a structural engineer, based on the system selected, and dew point calculations performed and evaluated. **Adding new siding to the facade of the building will have a dramatic change to the structure's overall appearance.** (See Appendix B, pages 5, 6, and 7).

Disadvantages:
- Possible difficult detailing at intersections of curtain walls
- Life expectancy of rainscreen finish or material varies greatly with product chosen (coated metal pans to terra cotta panels, etc.).
- High cost

Advantages:
- Has been installed in Canada and Europe for many years - track record
- Work performed from the exterior
- Building gets a "second skin" (a.k.a. rainscreen)
- Gain a watertight interior drainage plane
- Gain an air/vapor barrier
- Can add additional insulation

Option B: (Based on Turner Building Science's report, dated December 2005).

Removing the interior perimeter gypsum board and metal stud walls along with the 6-inch CMU backup wall (and attached insulation), and rebuilding (with enhancements such as vapor and air barrier) in reverse, without removing the brick exterior. The brick veneer must be properly reanchored back to the substrate, and supported during the work.

Disadvantages:
- An extremely disruptive procedure and nearly impossible to perfect.
- Option based on suggestion in Turner's report dated December 2005. No written information is available on the procedure. Therefore, the exact methodology is unknown.
- Very high cost

Advantages:
- Gain a watertight interior drainage plane
- Gain an air/vapor barrier
- Can add additional insulation

Option C:

Monitor and repair leaks on a regular basis. This would include, but is not limited to; remove and replace any damaged or defective masonry; cut back existing main roof parapet a minimum of 12 inches to allow for proper flashing into adjacent curtain wall; remove and install new cap flashing above entry curtain wall, with proper drainage slope, and apply a breathable waterproof coating to the brick and periodically renew as recommended by manufacturer. The coating can be spray applied and should be reapplied every three to five years, based on the manufacturer's specifications.

Disadvantages:
- Will require ongoing maintenance and observation

Advantages:
- Less disruptive than other options
- Least cost

Option D:

Remove brick veneer to allow for installation of air/vapor barrier to interior surface and reconstruct brick wall with all related flashing, insulation, brick ties, and sealant.

Disadvantages:
- Cost associated with removing and replacing the brick veneer
- Sound and dust will be disruptive to occupants
- Repeating work which has already been performed and appears to be working

Advantages:
- Gain a watertight interior drainage plane
- Gain an air/vapor barrier

Combine with Options A, B, C, and D:

Enclose the unused terraces (which would eliminate 27 roofs of varying sizes) with greenhouse-type enclosures. (See detail drawing SK-3 and elevations).

Disadvantages:
- Readjustment of mechanical system for possible increased heat / cooling / ventilation loads. (Remove existing sliding door wall - optional).
- Eliminates existing safety line tie back anchors. Contractor will need to use remaining anchors on main roof for access to side of building.
- Disruption to associated offices / spaces, if performed during normal office working hours.

Advantages:
- Eliminates 27 flat roofs
- Eliminates associated internal drains and their maintenance
- Gain additional interior usable rental space

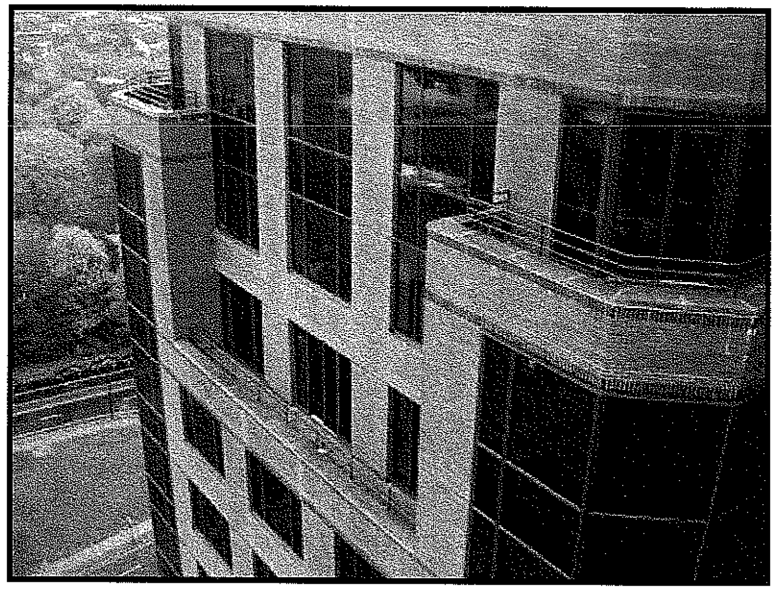
Additional recommendations:

Schedule periodic preventative maintenance (minimum twice a year - suggest spring and fall) with a record keeping system of checklists, marked-up location drawings, and a time table of required tasks.

All new detailing to have a "belt-and-suspenders" redundancy whenever possible. Note that whenever sealing the building with an air / vapor barrier and making the interior spaces more airtight, the mechanical system must be evaluated and properly maintained.

All construction documents should be prepared by an Architect or Engineer, specializing in this type of work. Full time representation on site during construction by the design firm is also recommended.

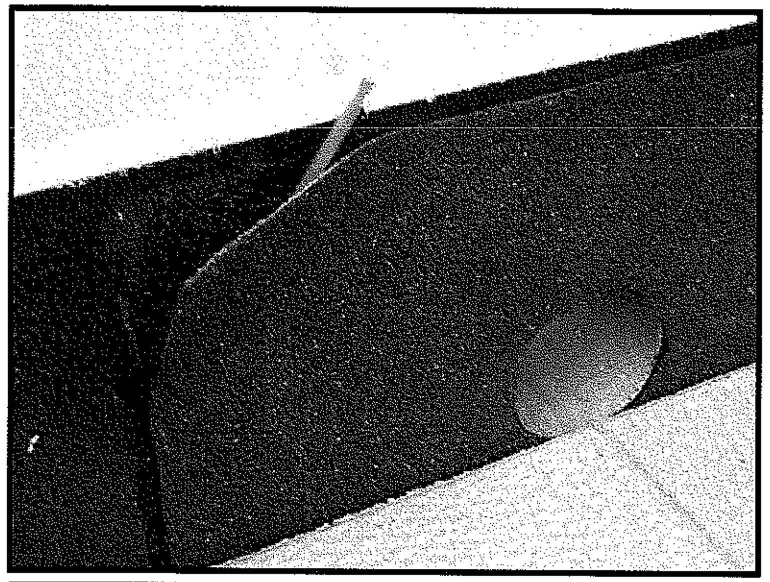
END OF SECTION



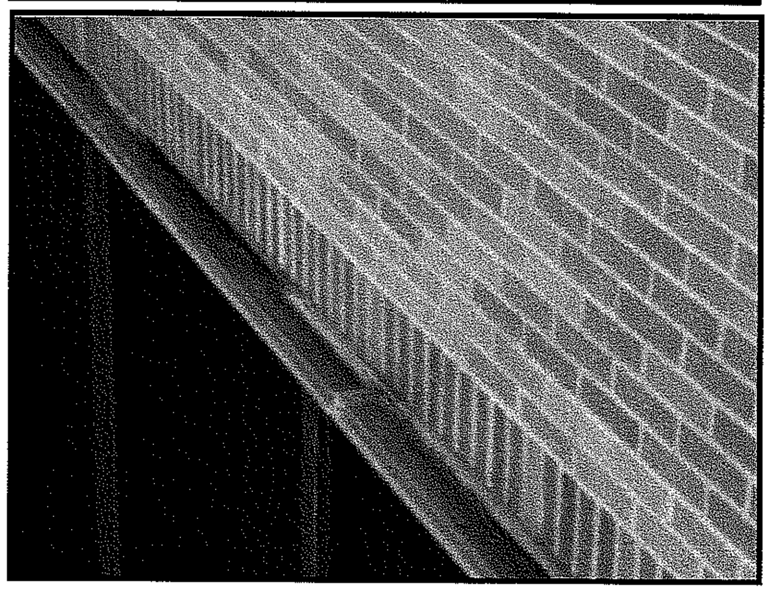
#1 North elevation. Note efflorescence and cracked brick at corner of both terraces.

#2 Bad detailing of junction of parapet end to window. Note excessive quantity of sealant used in an attempt to make watertight.

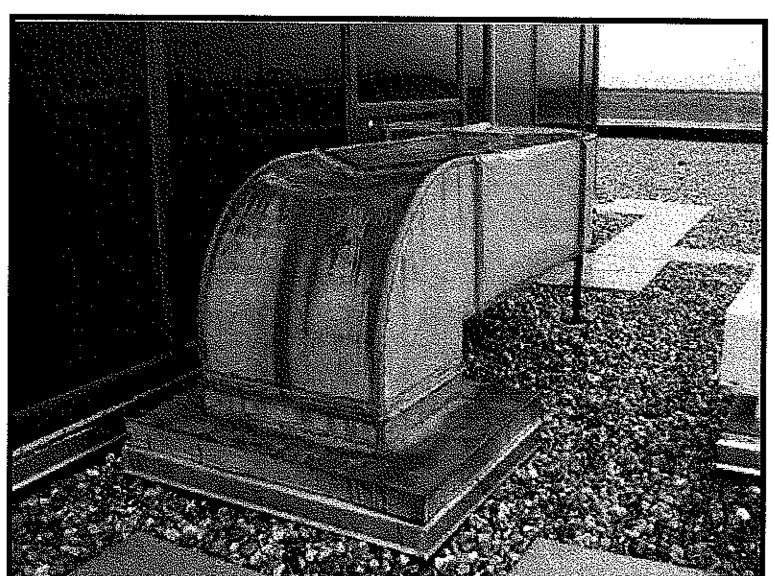
#3 Adhesive failure between sealant and coping stone.



#4 Through wall scupper in main roof parapet. Poor adhesion of target patch.



#5 Window cap flashing sloping incorrectly toward building. Note moss along sealant indicating water retention.

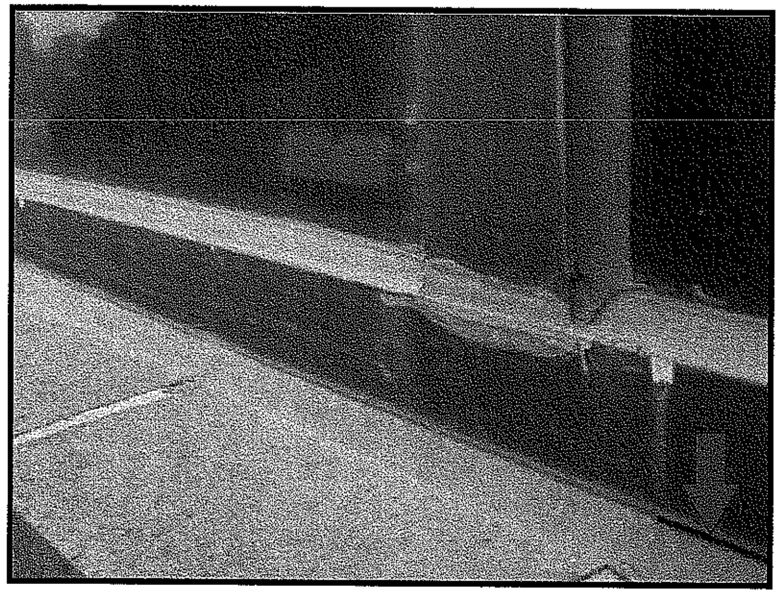


#6 Note water ponding in dented top surface of duct.

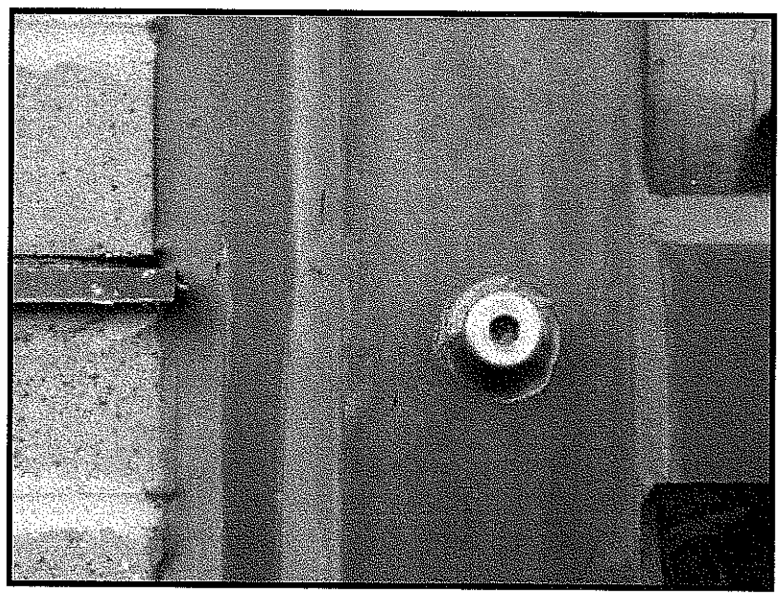
#7 Typical terrace curtain wall condition. Note efflorescence along face of terrace.

#8 New metal drip edge installed during recent masonry repair.

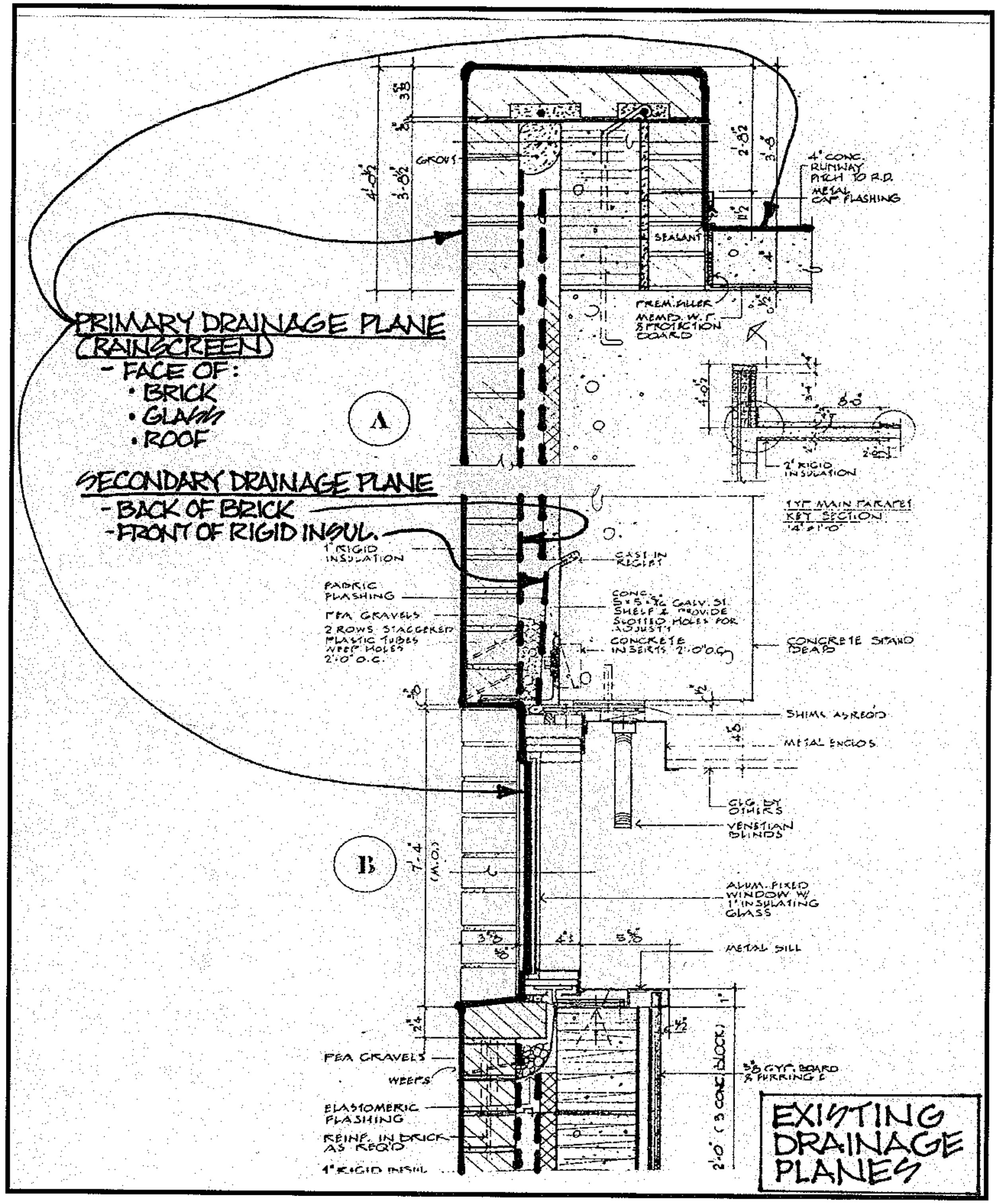
#9 Sealant repairs being performed at junction of curtain wall to masonry.



#10 View of curtain wall sill. Note gap in sealant along base.

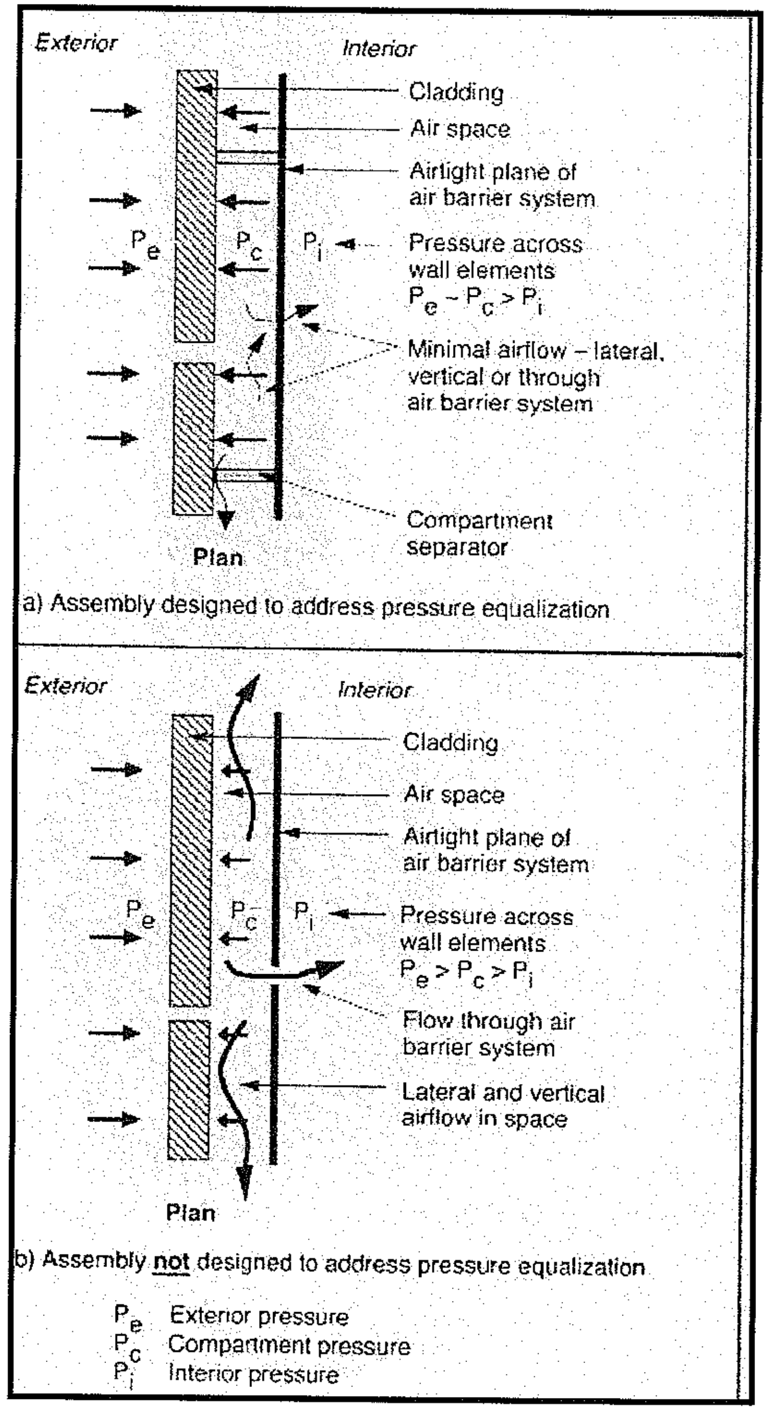


#11 Closeup view of curtain wall belt securement. Contractor applying sealant around securement.



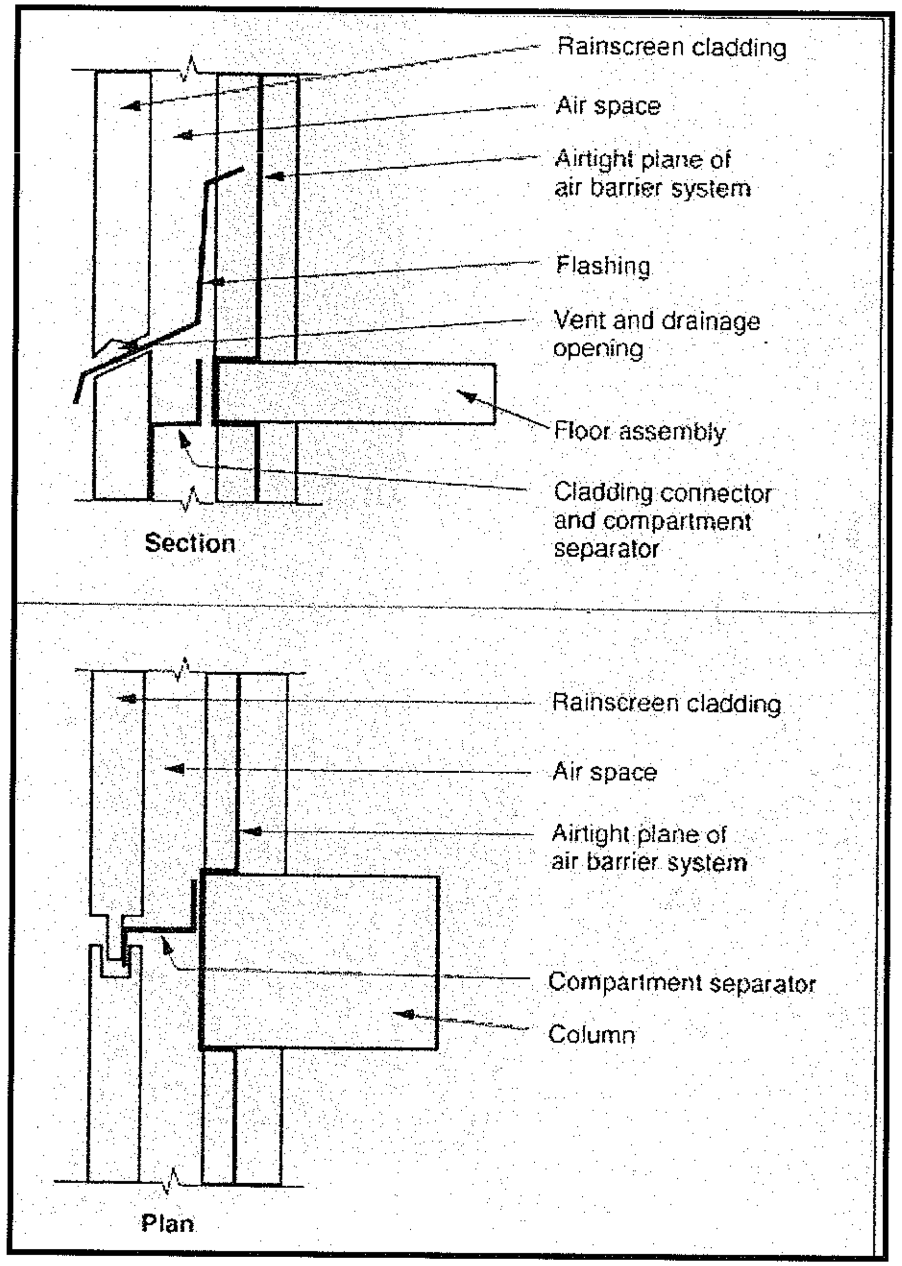
Existing Drainage Planes[1]

[1] Window Detail 5/A35; Original Drawings by Welton Becket Associate Architects



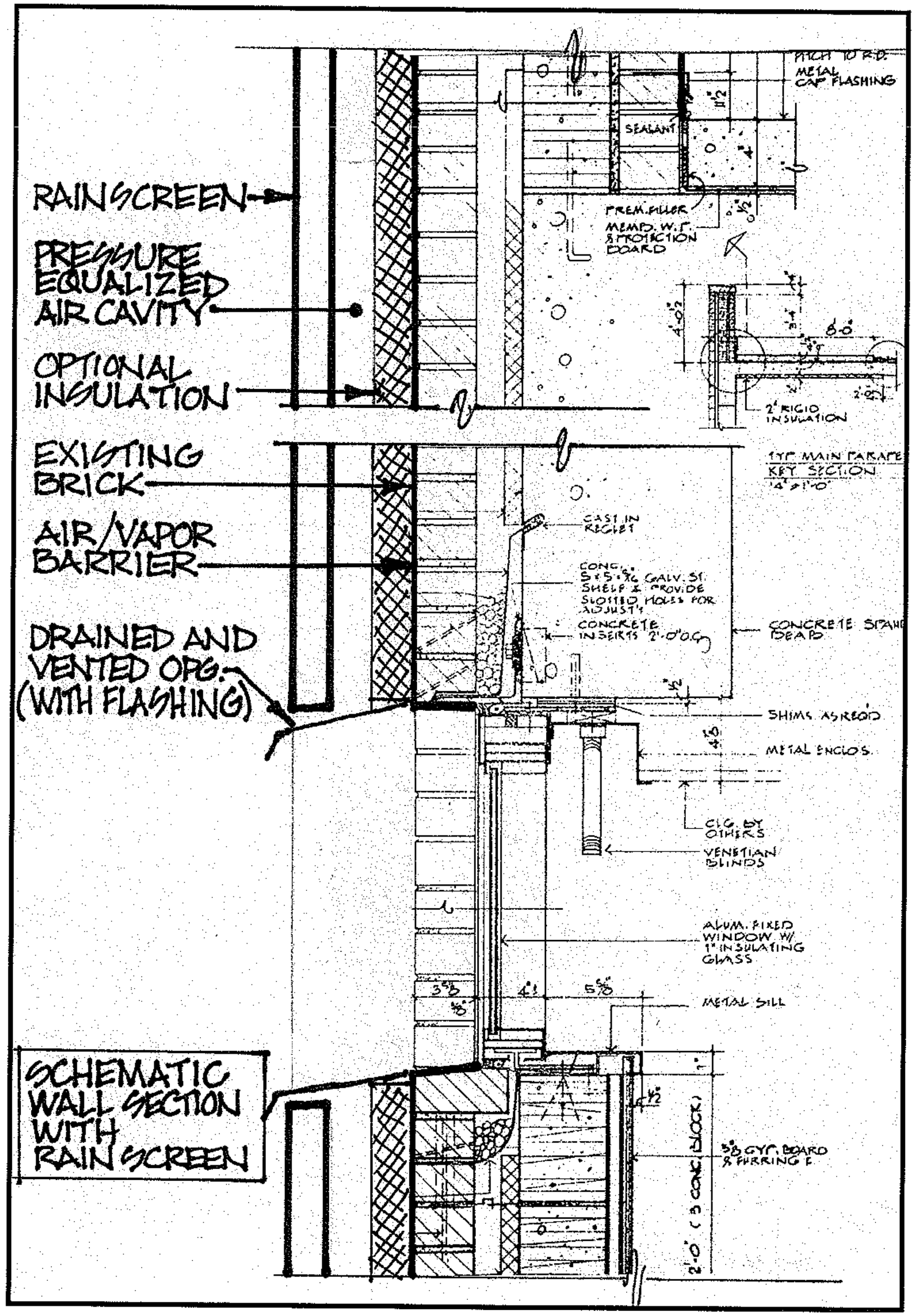
Air flows through and within rainscreen wall assemblies.[2]

[2] National Research Council Canada, *Evolution of Wall Design for Controlling Rain Penetration.*



Open rainscreen wall - pressure equalized [2]

[2] National Research Council Canada, *Evolution of Wall Design for Controlling Rain Penetration.*



Schematic Wall Section with Rainscreen[3]

[3] Window Detail 5/A35; Original Drawings by Welton Becket Associate Architects

Metal panel rain screen.

STONESCREEN
natural stone rainscreen systems

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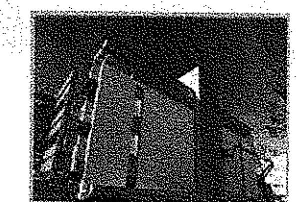
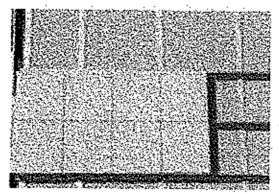
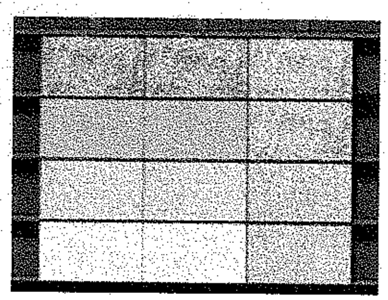
Click HERE to Download Stonescreen technical specification pdf

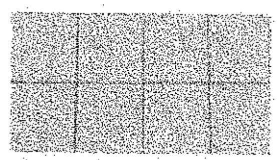
Stonescreen is a high performance curtain walling system specially designed to be faced with natural stone and incorporate standard or bespoke windows, shades, louvres etc.
Stonescreen combines the benefits and elegance of natural stone with the energy efficiency of a high performance curtain wall.


Oxford Chemistry lab.

Stonescreen is a double skin rainscreen construction. Natural stone rainscreen cladding with back up wall integral to the system. Drained, thermally broken and back ventilated. The curtain wall forms the inner weatherproof and insulating skin. It is formed using thermally broken extruded aluminium mullions which are bolted to the face of the primary structure. Composite insulation panels are fitted into the aluminium frame with gasket seals to front and rear of panels. Any moisture penetrating the front seal is drained and expelled through weep holes. Horizontal extruded aluminium transoms are fitted to the mullions to which natural stone cladding panels are fixed.


Granite panels installed.


Various stone samples

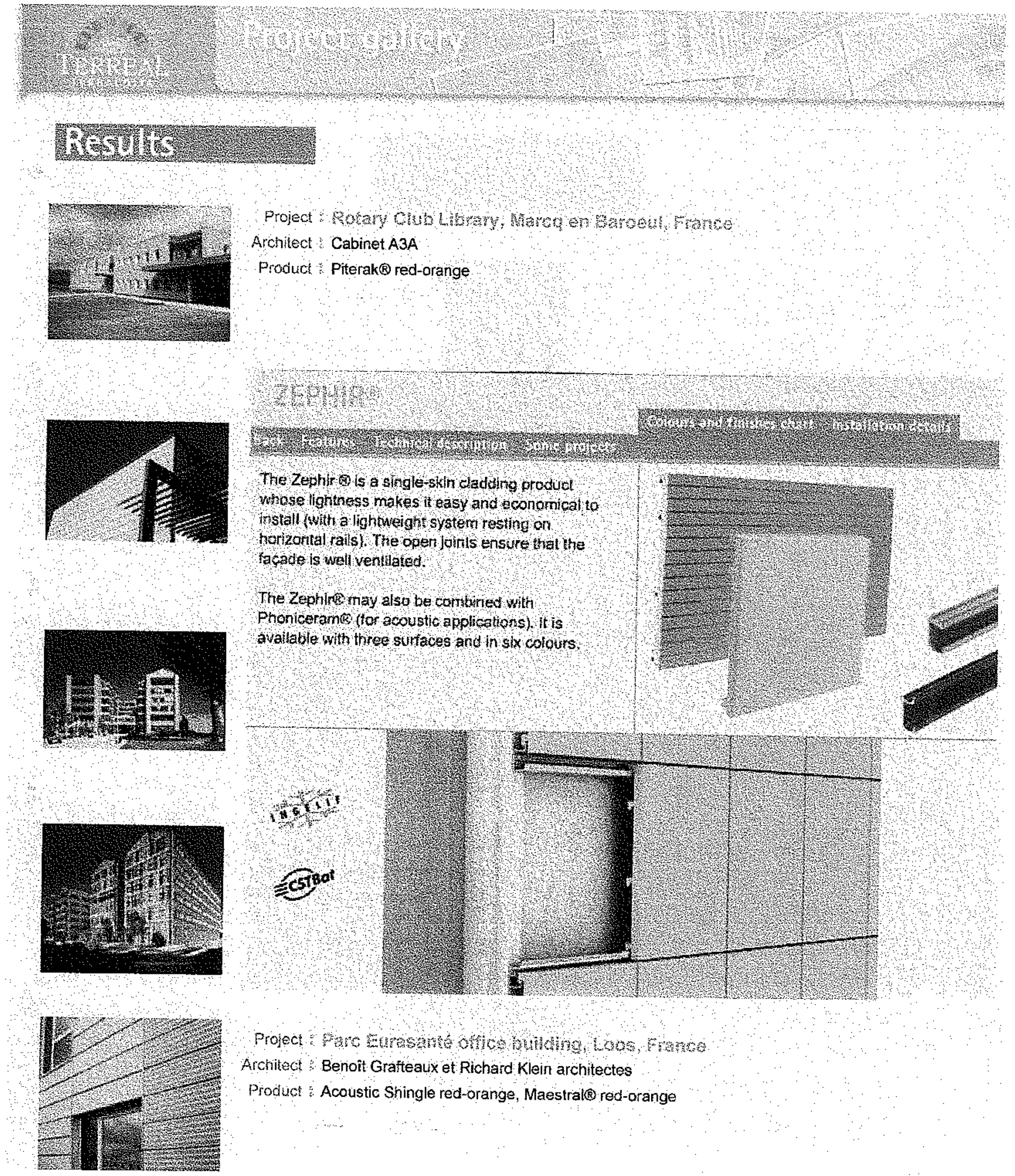

Granite Stonescreen sample.

A 38mm air cavity is maintained between the rear face of stone cladding and the front face of the curtain wall composite panels, which enables ventilation of the cavity.
Typical stone panel thickness would be 30 or 40mm thick depending on durability of particular stone used and dimensions of panels.


Internal features.

[Go to top of page]

Stone panel rain screen.



Terra Cotta panel rain screen.

Martin A. Benassi AIA		COST ESTIMATE - Appendix C				Design Phase
Architect		DPW #BI-2B-033-I				
Drainage Plane Study - 25 Sigourney Street		Date: July 21, 2006				Page 1 of 5
DIV.	PRINCIPAL TRADE ITEM AND ITEM DESCRIPTION	UNIT	QTY	UNIT PRICE	ITEM PRICE	SELECTED ITEM COST
	GENERAL					
	bonding, insurance, general administrative	unit	1	$150,000.00	$150,000.00	
	scaffolding, swing stagging rental and equip.	mo	4	$6,000.00	$24,000.00	
	site foreman, supervision	mo	4	$11,000.00	$44,000.00	
						$218,000.00
	OPTION A - add rainscreen system					
*	add alum. rainscreen system with all related flashing	sf	107,100	$45.00	$4,819,500.00	
	additional rigid insulation 1 inch thick	sf	107,100	$0.80	$85,680.00	
						$4,905,180.00
	SUB-TOTAL					$5,123,180.00
	city cost index	0.094				$481,578.92
	soft costs include A/E, CA, & DPW, etc.	0.30**				$1,681,427.68
	TOTAL:					$7,286,186.60
*	terracotta rainscreen system, et. al = $65/SF		107,100	$65.00	$6,961,500.00	
	stone rainscreen system, et. al = $75/SF		107,100	$75.00	$8,032,500.00	
**	Based on total value of a larger project size.					

Some of the dollar figures used were calculated based on information obtained from the 2006 Building Construction Cost Data, published by Robert Snow Means Company, Inc. Kingston, Massachussetts. Additional figures were obtained from similar active projects with inflation and geographical percentages included and manufacturer's pricing. The final dollar amount shown is for guidance only and is a "ball park" figure. An assumption is made that all repair work will be performed under one contract and not spaced out over a period of time. The amount does not include any Architectural / Engineering fess or contingencies. Total dollar amount to be adjusted if work is to be performed during off hours or on weekends.

Martin A. Benassi AIA		COST ESTIMATE - Appendix C				Design Phase
Architect		DPW #BI-2B-033-I				
Drainage Plane Study - 25 Sigourney Street		Date: July 21, 2006				Page 2 of 5
DIV.	PRINCIPAL TRADE ITEM AND ITEM DESCRIPTION	UNIT	QTY	UNIT PRICE	ITEM PRICE	SELECTED ITEM COST
	GENERAL					
	bonding, insurance, general administrative	unit	1	$150,000.00	$150,000.00	
	scaffolding, swing stagging rental and equip.	mo	4	$6,000.00	$24,000.00	
	site foreman, supervision	mo	4	$11,000.00	$44,000.00	
						$218,000.00
	OPTION B - reconstruct inside out, add barrier					
	demo & reconstruct interior gyp bd/metal partitions	sf	107,100	***	#VALUE!	
	demo CMU walls/rigid insul & reconstruct	sf	107,100	***	#VALUE!	
	install barrier on exterior side of new CMU	sf	107,100	***	#VALUE!	
	miscellaneous interior finishes	u	1		$0.00	
	sealant	u	1	$15,000.00	$15,000.00	
						#VALUE!
	SUB-TOTAL					#VALUE!
	city cost index	0.094				#VALUE!
	soft costs include A/E, CA, & DPW, etc.	0.300				#VALUE!
	TOTAL:					#VALUE!
***	additional information required on proceedure to estimate cost.					

Some of the dollar figures used were calculated based on information obtained from the 2006 Building Construction Cost Data, published by Robert Snow Means Company, Inc. Kingston, Massachussetts. Additional figures were obtained from similar active projects with inflation and geographical percentages included and manufacturer's pricing. The final dollar amount shown is for guidance only and is a "ball park" figure. An assumption is made that all repair work will be performed under one contract and not spaced out over a period of time. The amount does not include any Architectural / Engineering fess or contingencies. Total dollar amount to be adjusted if work is to be performed during off hours or on weekends.

Martin A. Benassi AIA	COST ESTIMATE - Appendix C				Design Phase
Architect	DPW #BI-2B-033-I					
Drainage Plane Study - 25 Sigourney Street	Date: July 21, 2006				Page 3 of 5

DIV.	PRINCIPAL TRADE ITEM AND ITEM DESCRIPTION	UNIT	QTY	UNIT PRICE	ITEM PRICE	SELECTED ITEM COST
	GENERAL					
	bonding, insurance, general administrative	unit	1	$98,000.00	$98,000.00	
	scaffolding, swing stagging rental and equip.	mo	2	$6,000.00	$12,000.00	
	site foreman, supervision	mo	2	$11,000.00	$22,000.00	
						$132,000.00
	OPTION C - maintain existing					
	cut back existing parapet to allow for flashing at wall	u	2	$6,000.00	$12,000.00	
	new flashing at curtain wall above entry	lf	40	$450.00	$18,000.00	
	miscellaneous brick repointing / replacement	sf	1,000	$45.00	$45,000.00	
	sealant	u	1	$8,000.00	$8,000.00	
	breathable waterproof coating (ev 3-5 yrs)	sf	107,100	$1.50	$160,650.00	
						$243,650.00
	SUB-TOTAL					$375,650.00
	city cost index	0.094				$35,311.10
	soft costs include A/E, CA, & DPW, etc.	0.35**				$123,288.33
	TOTAL:					$534,249.43
**	Based on total value of a smaller project size.					

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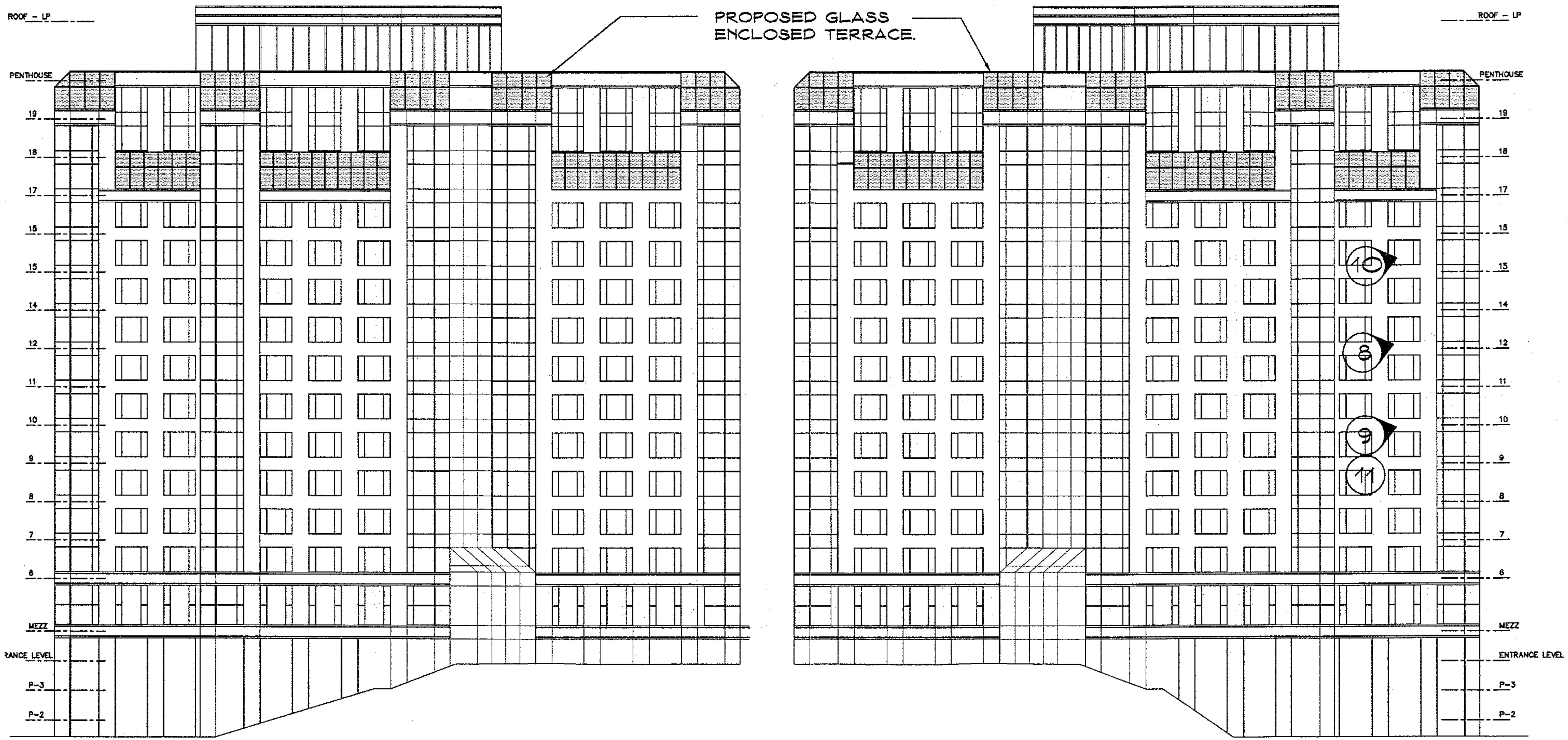
Martin A. Benassi AIA		COST ESTIMATE - Appendix C				Design Phase
Architect		DPW #BI-2B-033-I				
Drainage Plane Study - 25 Sigourney Street		Date: July 21, 2006				Page 4 of 5
DIV.	PRINCIPAL TRADE ITEM AND ITEM DESCRIPTION	UNIT	QTY	UNIT PRICE	ITEM PRICE	SELECTED ITEM COST
	GENERAL					
	bonding, insurance, general administrative	unit	1	$150,000.00	$150,000.00	
	scaffolding, swing stagging rental and equip.	mo	4	$6,000.00	$24,000.00	
	site foreman, supervision	mo	4	$11,000.00	$44,000.00	
						$218,000.00
	OPTION D - rem/replace brick & add barrier					
	remove and replace brick veneer	sf	107,100	$45.00	$4,819,500.00	
	remove & replace rigid insulation	sf	107,100	$1.25	$133,875.00	
	install barier on exterior of existing CMU	sf	107,100	$3.00	$321,300.00	
	sealant	u	1	$8,000.00	$8,000.00	
						$5,282,675.00
	SUB-TOTAL					$5,500,675.00
	city cost index	0.094				$517,063.45
	soft costs include A/E, CA, & DPW, etc.	0.30**				$1,805,321.54
	TOTAL:					$7,823,059.99
**	Based on total value of a larger project size.					

Some of the dollar figures used were calculated based on information obtained from the 2006 Building Construction Cost Data, published by Robert Snow Means Company, Inc. Kingston, Massachussetts. Additional figures were obtained from similar active projects with inflation and geographical percentages included and manufacturer's pricing. The final dollar amount shown is for guidance only and is a "ball park" figure. An assumption is made that all repair work will be performed under one contract and not spaced out over a period of time. The amount does not include any Architectural / Engineering fess or contingencies. Total dollar amount to be adjusted if work is to be performed during off hours or on weekends.

Martin A. Benassi AIA		COST ESTIMATE - Appendix C				Design Phase
Architect		DPW #BI-2B-033-I				
Drainage Plane Study - 25 Sigourney Street		Date: July 21, 2006				Page 5 of 5
DIV.	PRINCIPAL TRADE ITEM AND ITEM DESCRIPTION	UNIT	QTY	UNIT PRICE	ITEM PRICE	SELECTED ITEM COST
	GENERAL					
	bonding, insurance, general administrative	unit	1	$98,000.00	$98,000.00	
	scaffolding, swing stagging rental and equip.	mo	4	$2,000.00	$8,000.00	
	site foreman, supervision	mo	4	$11,000.00	$44,000.00	
						$150,000.00
	ADDITIONAL ITEMS - enclose terraces					
	enclose terraces with greenhouse windows	sf	10,000	$110.00	$1,100,000.00	
	remove existing safety line tie back anchors	u	50	$250.00	$12,500.00	
	remove sliding doors and adjacent glazing (optional)	u	27	$4,500.00	$121,500.00	
	remove existing railings	lf	746	$35.00	$26,110.00	
	miscellaneous interior finishes and trim	u	27	$12,000.00	$324,000.00	
	revise mechanical system	u	1	$45,000.00	$45,000.00	
						$1,629,110.00
	SUB-TOTAL					$1,779,110.00
	city cost index	0.094				$167,236.34
	soft costs include A/E, CA, & DPW, etc.	0.30**				$583,903.90
	TOTAL:					$2,530,250.24
**	Based on total value of a smaller project size.					

Some of the dollar figures used were calculated based on information obtained from the 2006 Building Construction Cost Data, published by Robert Snow Means Company, Inc. Kingston, Massachussetts. Additional figures were obtained from similar active projects with inflation and geographical percentages included and manufacturer's pricing. The final dollar amount shown is for guidance only and is a "ball park" figure. An assumption is made that all repair work will be performed under one contract and not spaced out over a period of time. The amount does not include any Architectural / Engineering fess or contingencies. Total dollar amount to be adjusted if work is to be performed during off hours or on weekends.

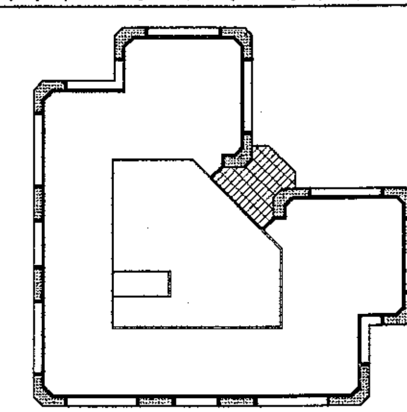


EAST ELEVATION

NORTH ELEVATION

SCALE: 1/32" = 1'-0"

(#) PHOTOS - SEE APPENDIX A



KEY PLAN

NORTH

Drawing Title
APPENDIX D
ELEVATIONS

STATE OF CONNECTICUT
DEPARTMENT OF PUBLIC WORKS

REVISIONS

Mark	Date	Description

Drawing Prepared By
MARTIN A. BENASSI, A.I.A., ARCHITECT
TWO BROADWAY
HAMDEN, CONNECTICUT 06518

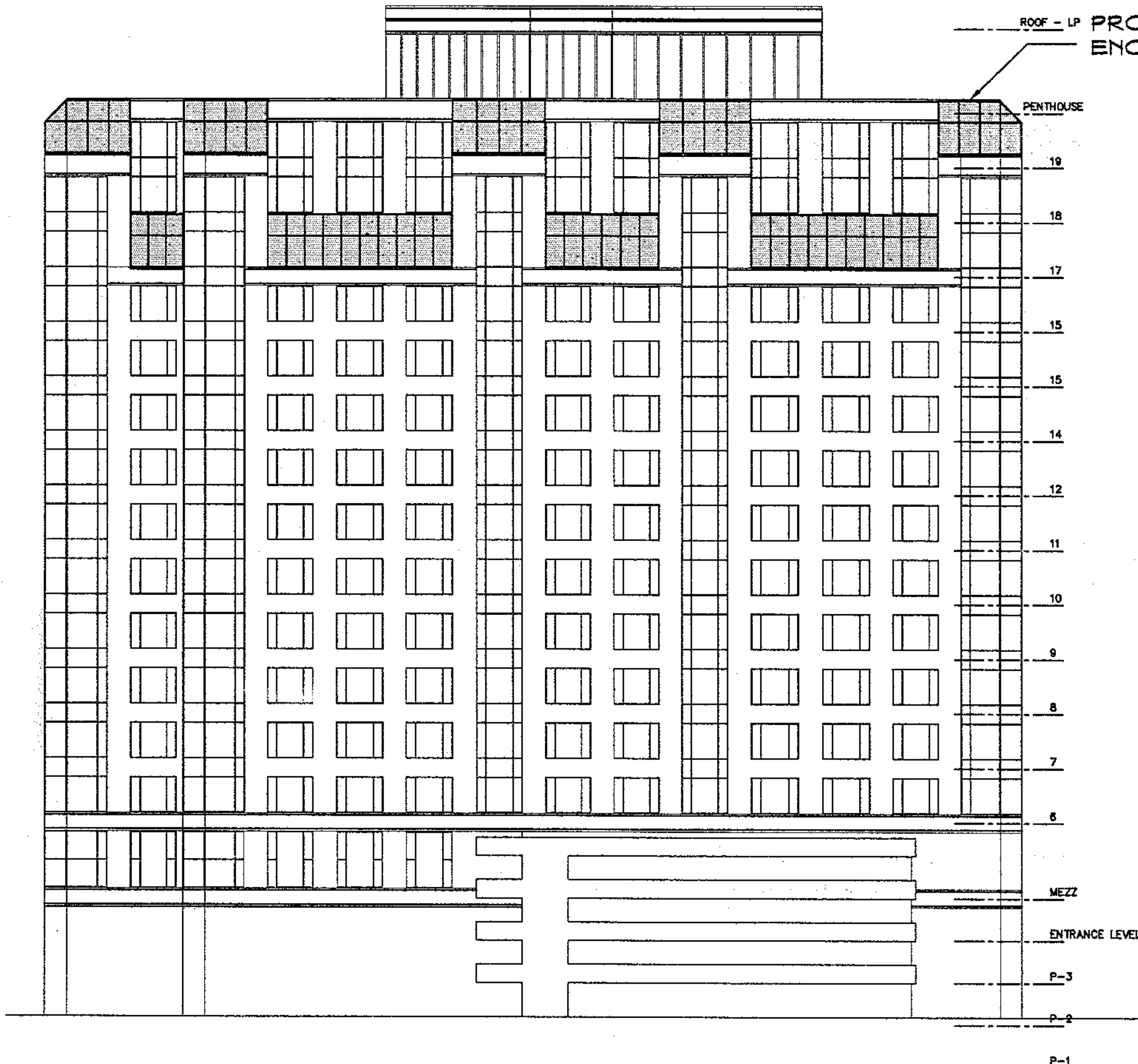
Date: 7/21/06
Scale: AS NOTED
Drawn By: MEP
Approved By: MAB

Project
STUDY FOR DRAINAGE PLANE

25 SIGOURNEY STREET
HARTFORD, CONNECTICUT

Project No. BI-2B-033 1

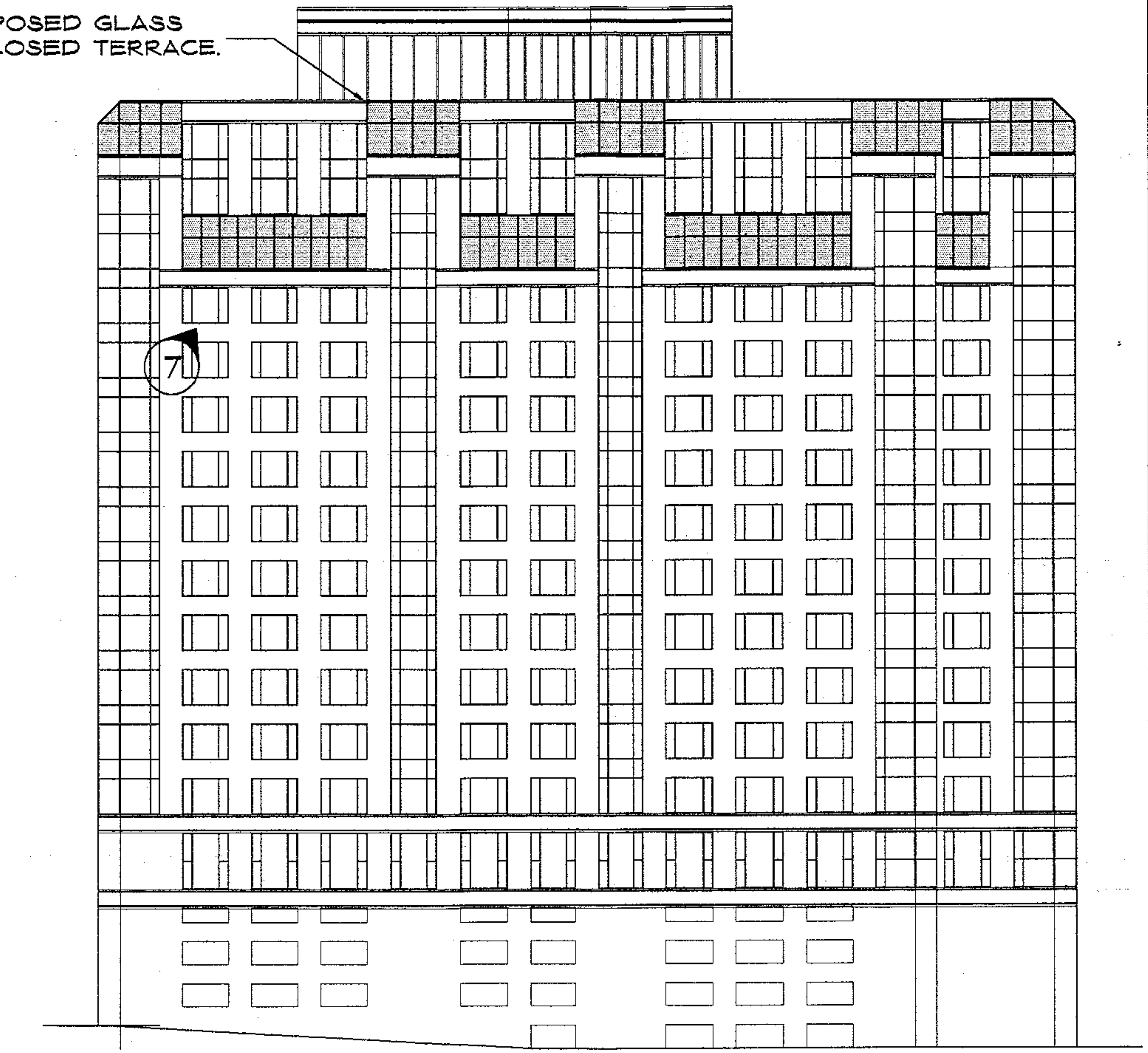
Drawing No. SK-1



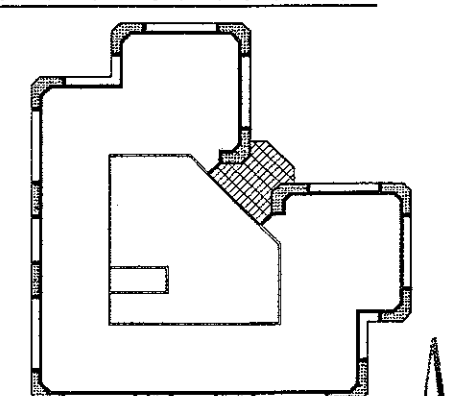
WEST ELEVATION

SCALE: 1/32" = 1'-0"

(#) PHOTOS - SEE APPENDIX A



SOUTH ELEVATION



KEY PLAN

NORTH

Drawing Title	STATE OF CONNECTICUT
APPENDIX D ELEVATIONS	DEPARTMENT OF PUBLIC WORKS

REVISIONS

Mark	Date	Description

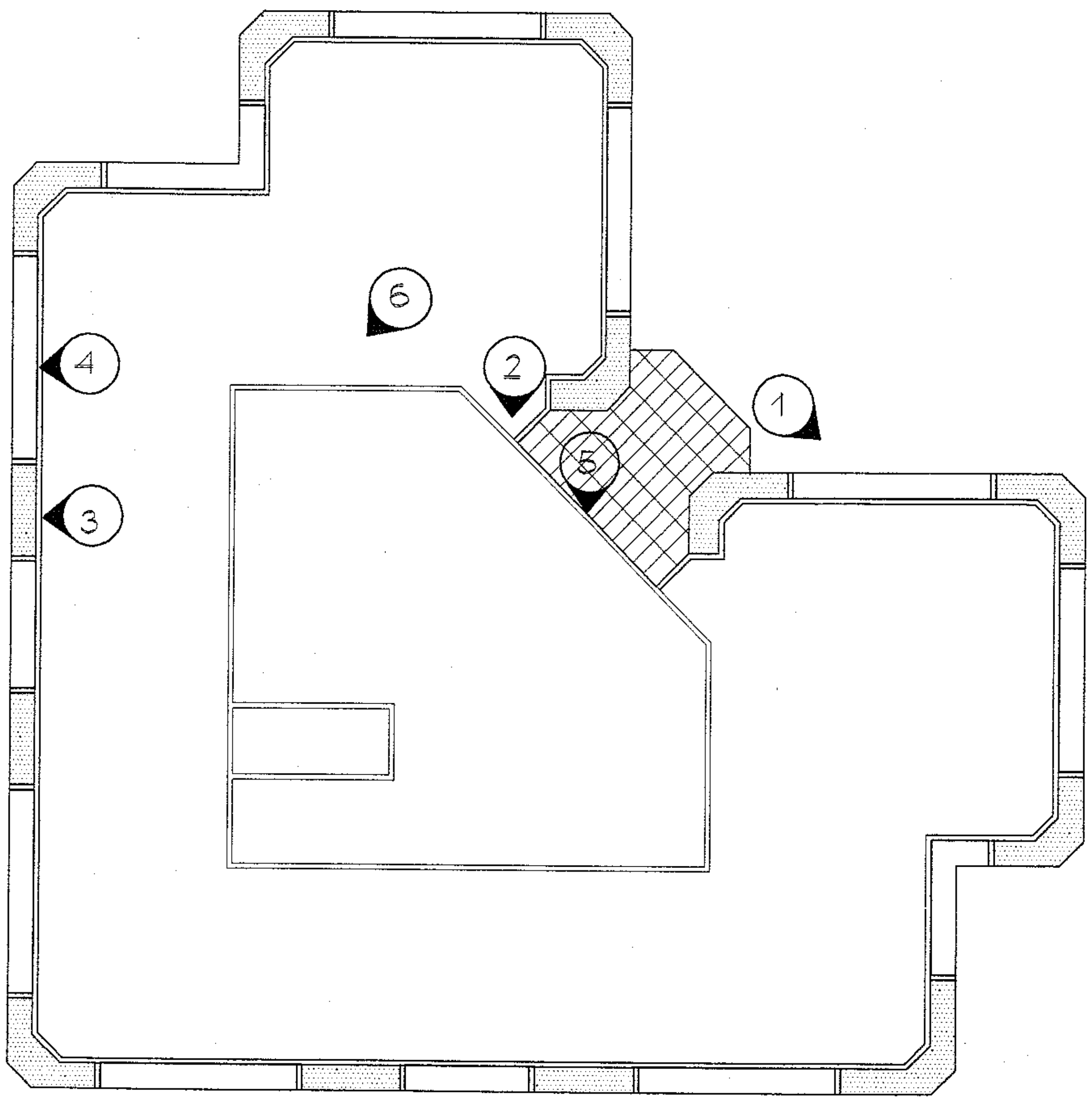
Drawing Prepared By: MARTIN A. BENASSI, A.I.A., ARCHITECT, TWO BROADWAY, HAMDEN, CONNECTICUT 06518

Project: STUDY FOR DRAINAGE PLANE, 25 SIGOURNEY STREET, HARTFORD, CONNECTICUT

Date	7/21/06
Scale	AS NOTED
Drawn By	MEP
Approved By	MAB
Drawing No.	SK-2

CAD No. SK-2

Project No. B1-26-033 1

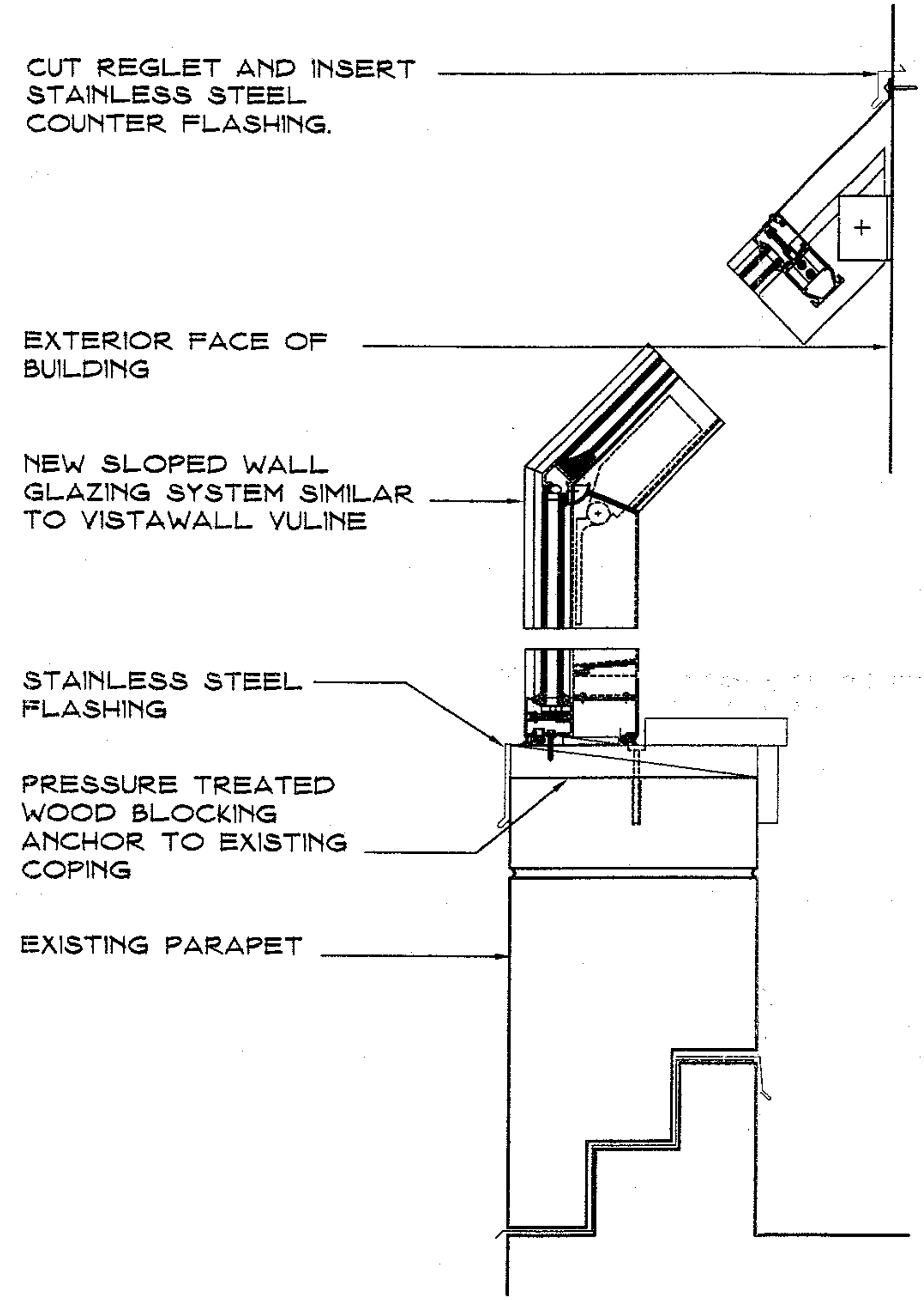


SCHEMATIC ROOF PLAN

SCALE: 1/32" = 1'-0"

NORTH

(#) PHOTOS - SEE APPENDIX A



TERRACE ENCLOSURE SECTION

SCALE: 1 1/2" = 1'-0"

Drawing Title: APPENDIX D ROOF PLAN

STATE OF CONNECTICUT
DEPARTMENT OF PUBLIC WORKS

REVISIONS

Mark	Date	Description

Drawing Prepared By: MARTIN A. BENASSI, A.I.A., ARCHITECT, TWO BROADWAY, HAMDEN, CONNECTICUT 06518

Project: STUDY FOR DRAINAGE PLANE, 25 SIGOURNEY STREET, HARTFORD, CONNECTICUT

Date: 7/21/06
Scale: AS NOTED
Drawn By: MEP
Approved By: MAB
Drawing No.: SK-3

CAD No. SK-3
Project No. BI-2B-033 1