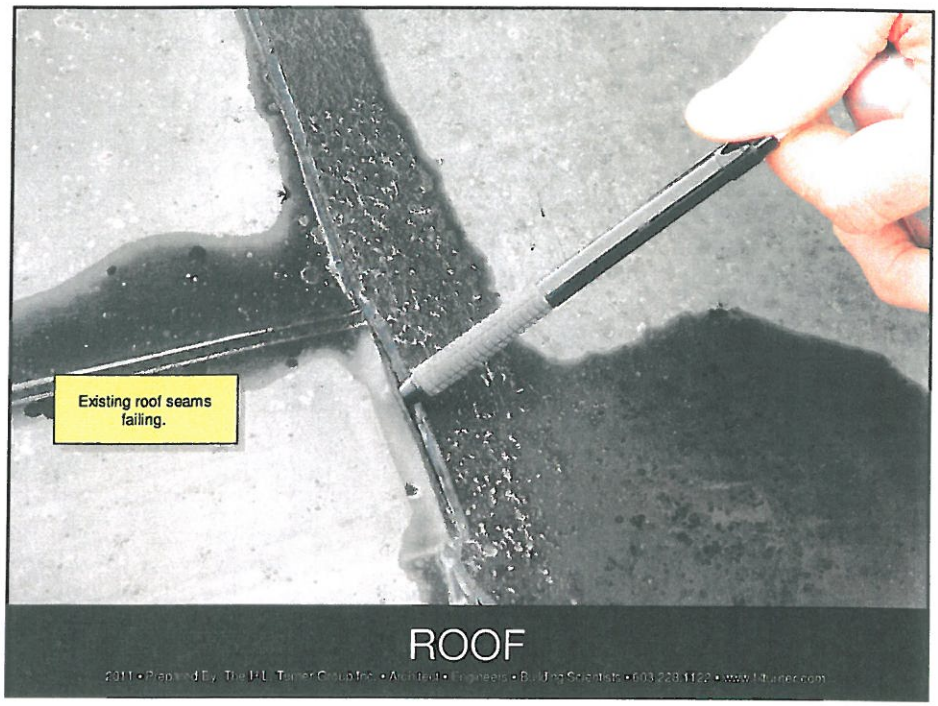
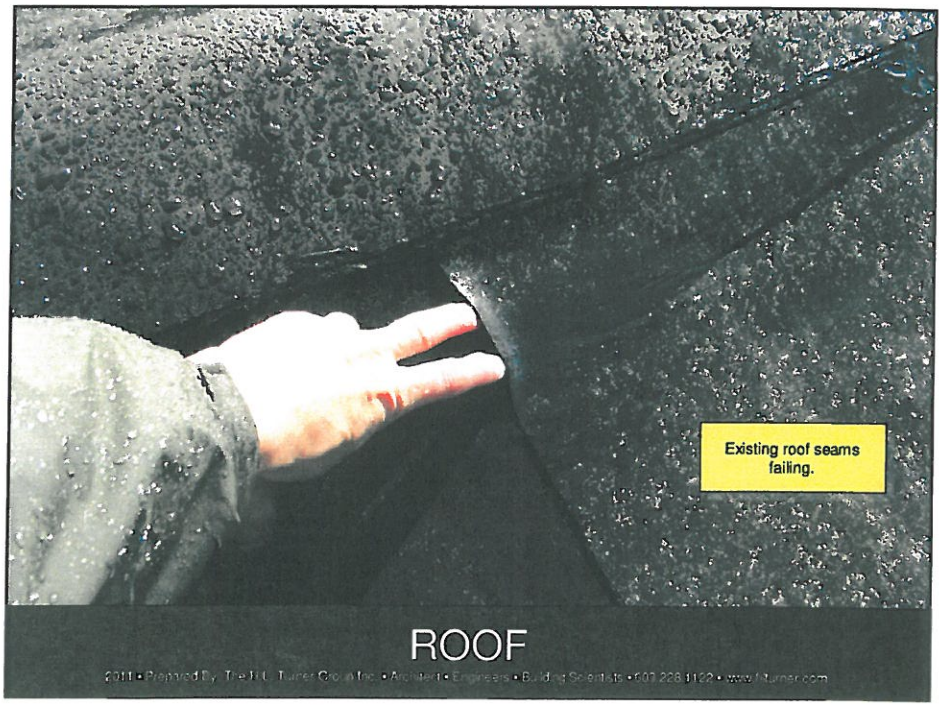
Appendix C

- Photos of the Barrington Town Offices

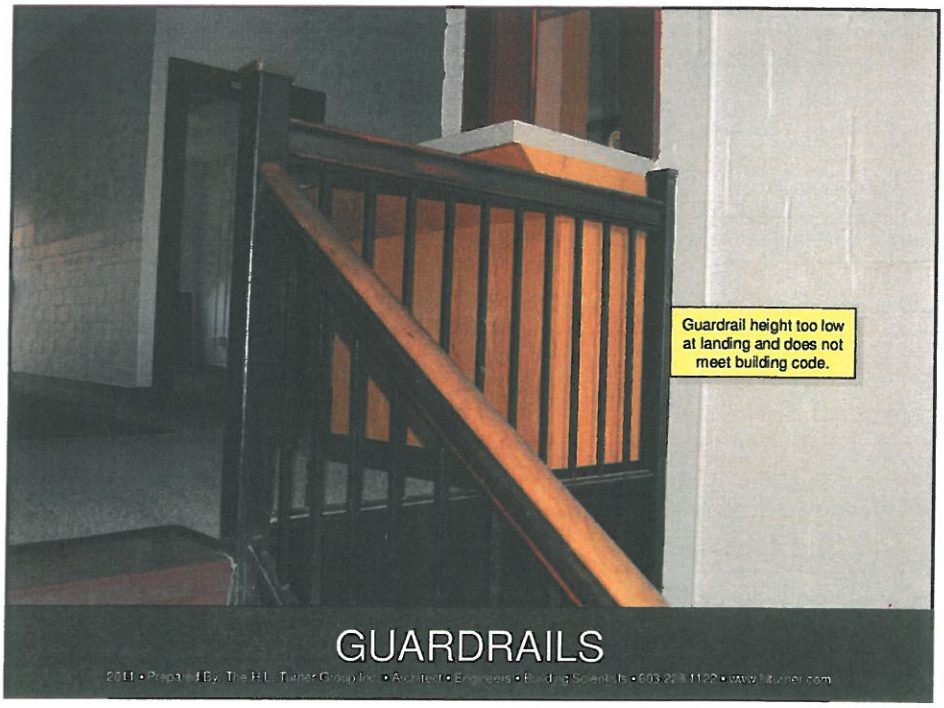

Rain water ponding on existing flat roof due to clogged drain and raised roof drain.
ROOF


Slope to roof drain not adequate. Roof drain higher then area around the drain.
ROOF


Existing roof seams failing.
ROOF

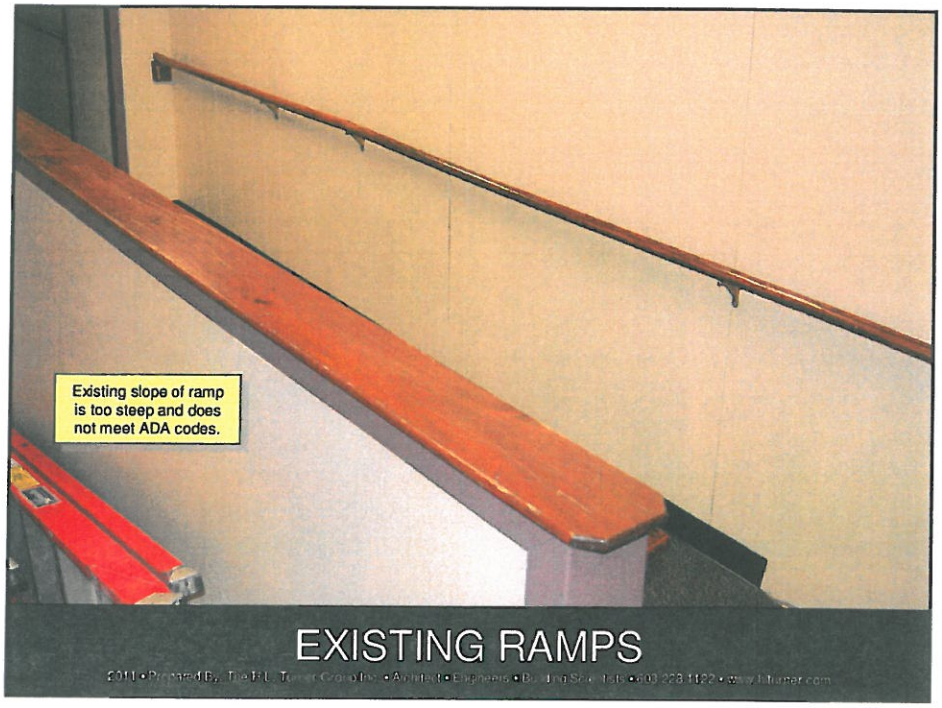

Existing roof seams failing.
ROOF

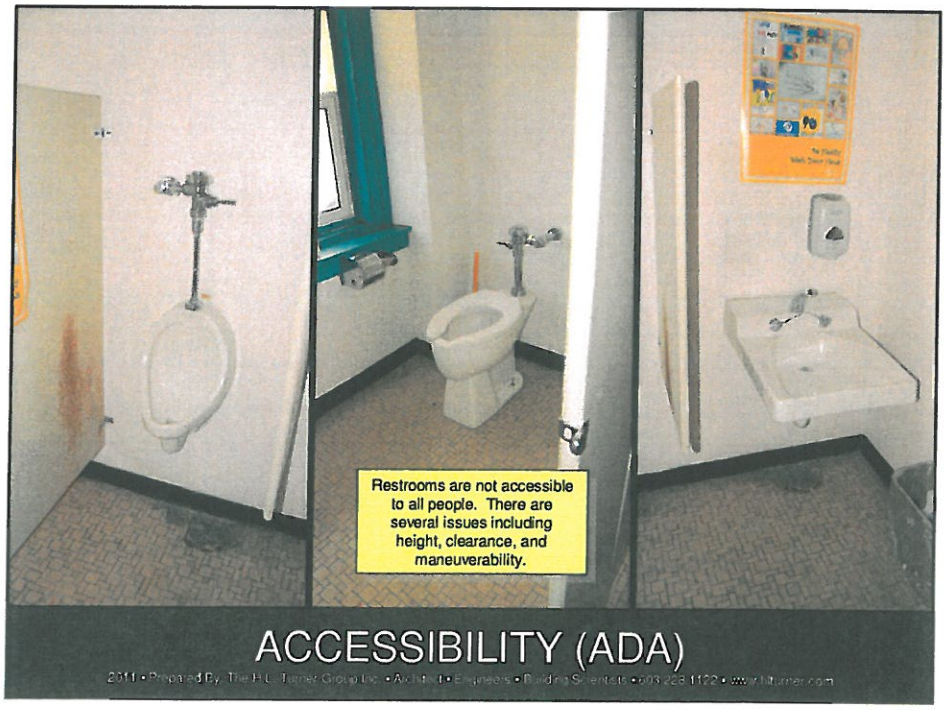

Handrails do not extend past landing as required by building code.
HANDRAILS

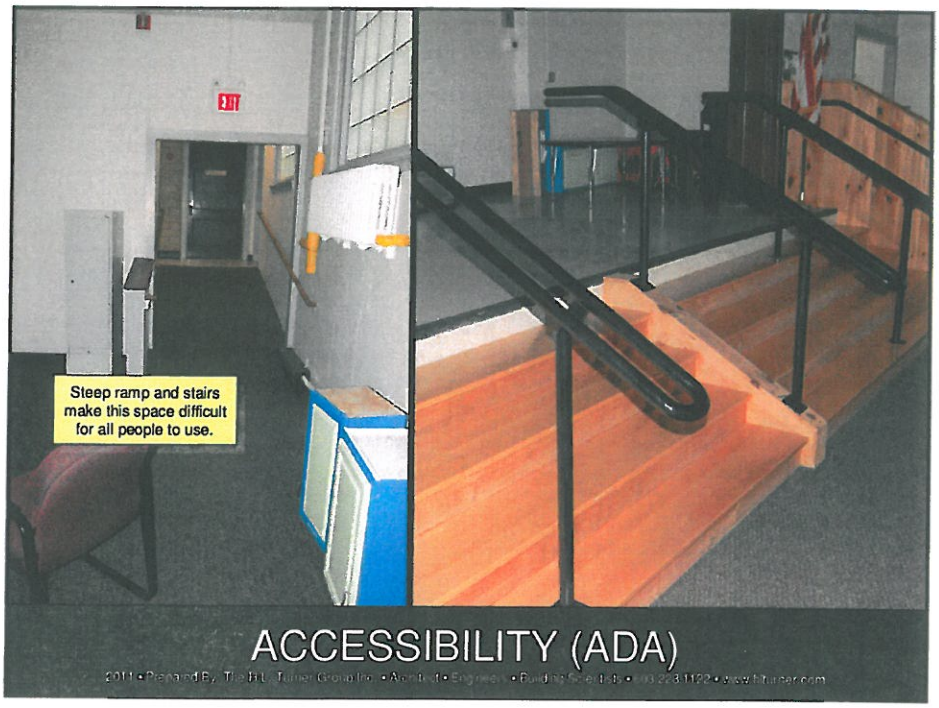

Guardrail height too low at landing and does not meet building code.
GUARDRAILS

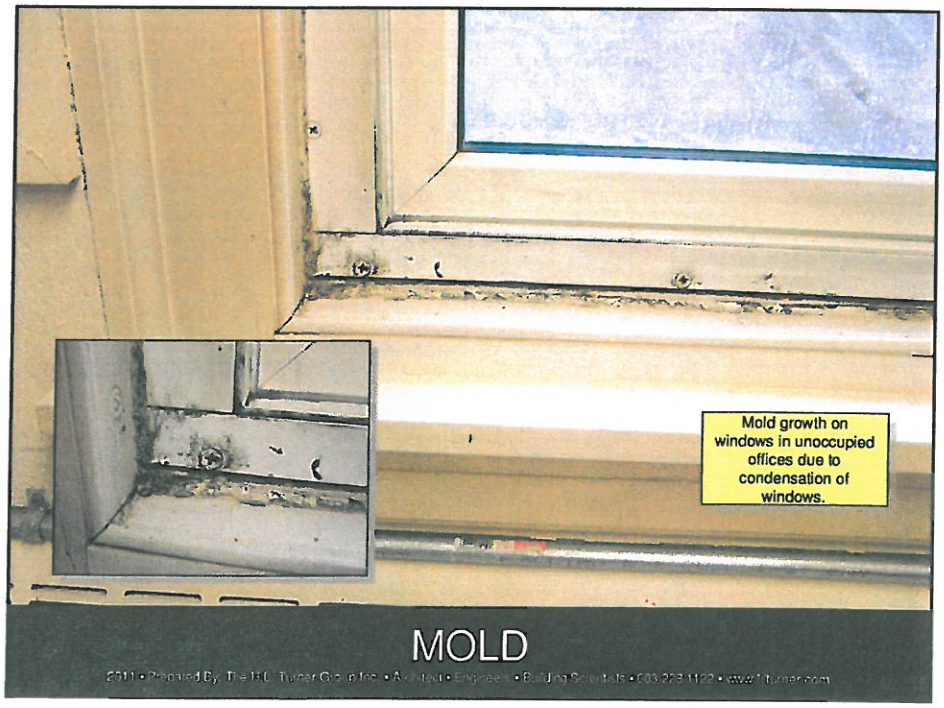

Stair not enclosed and does not meet building and life safety codes.
FIRE RATING

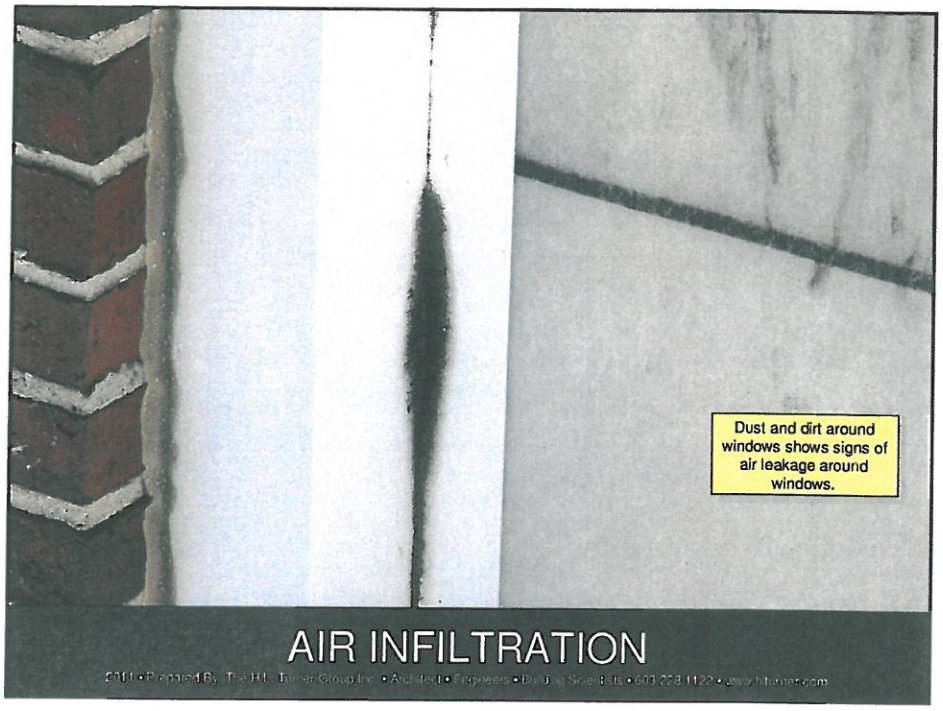

Stairs make this entrance inaccessible for all visitors.
ACCESSIBILITY (ADA)


Existing slope of ramp is too steep and does not meet ADA codes.
EXISTING RAMPS

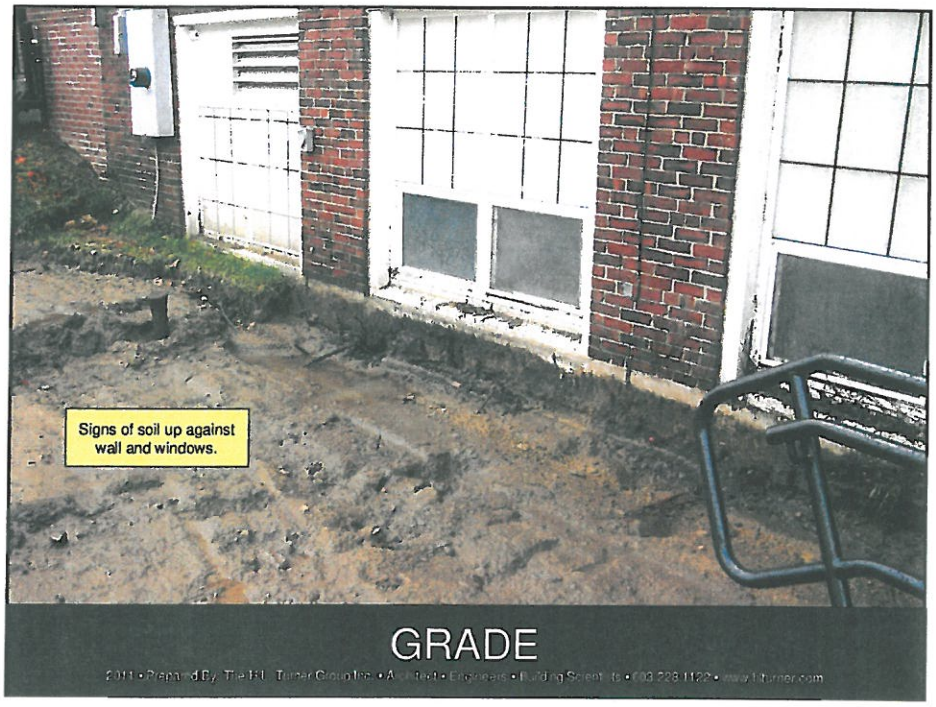

Restrooms are not accessible to all people. There are several issues including height, clearance, and maneuverability.
ACCESSIBILITY (ADA)

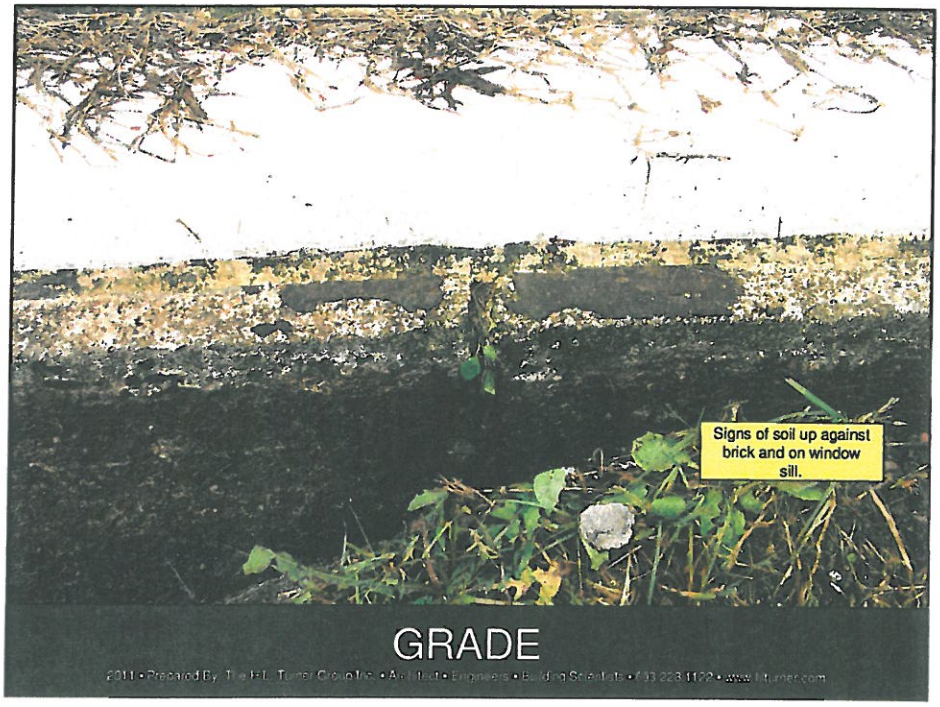

Steep ramp and stairs make this space difficult for all people to use.
ACCESSIBILITY (ADA)

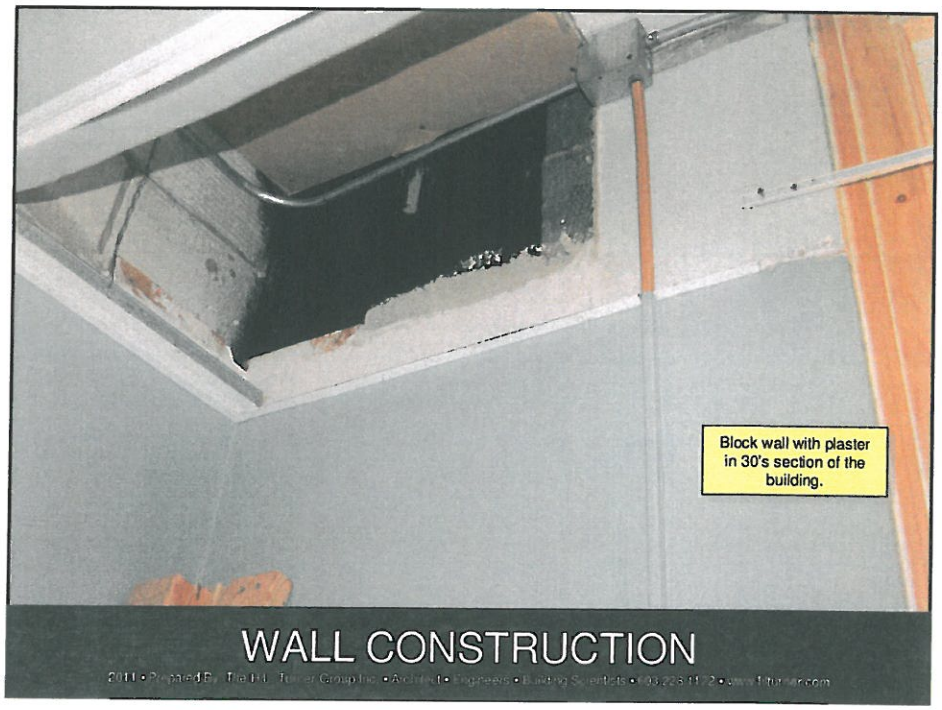

Mold growth on windows in unoccupied offices due to condensation of windows.
MOLD

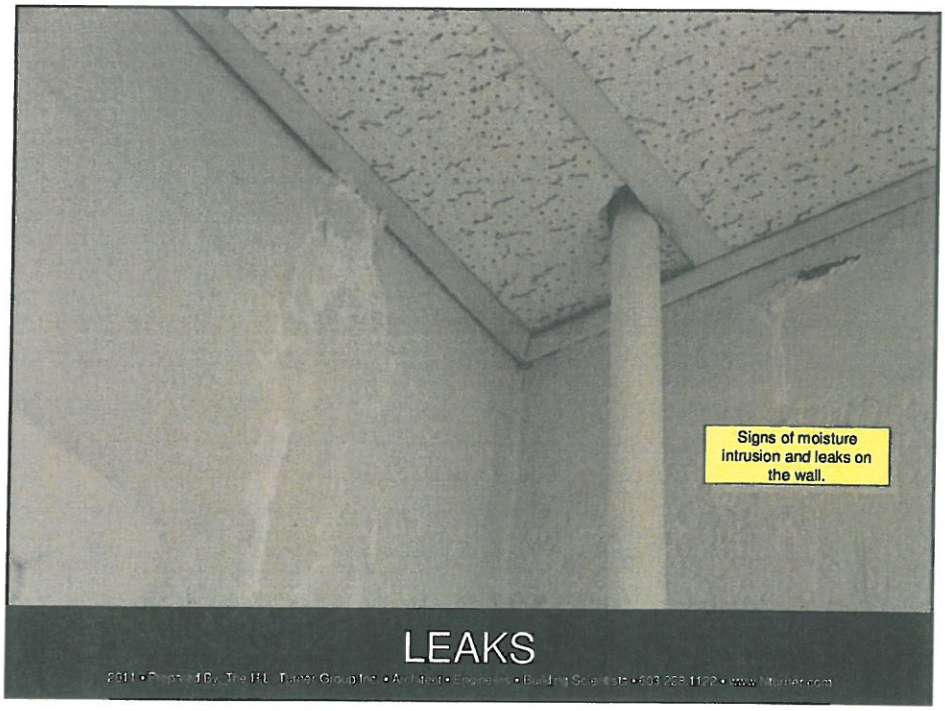

Dust and dirt around windows shows signs of air leakage around windows.
AIR INFILTRATION

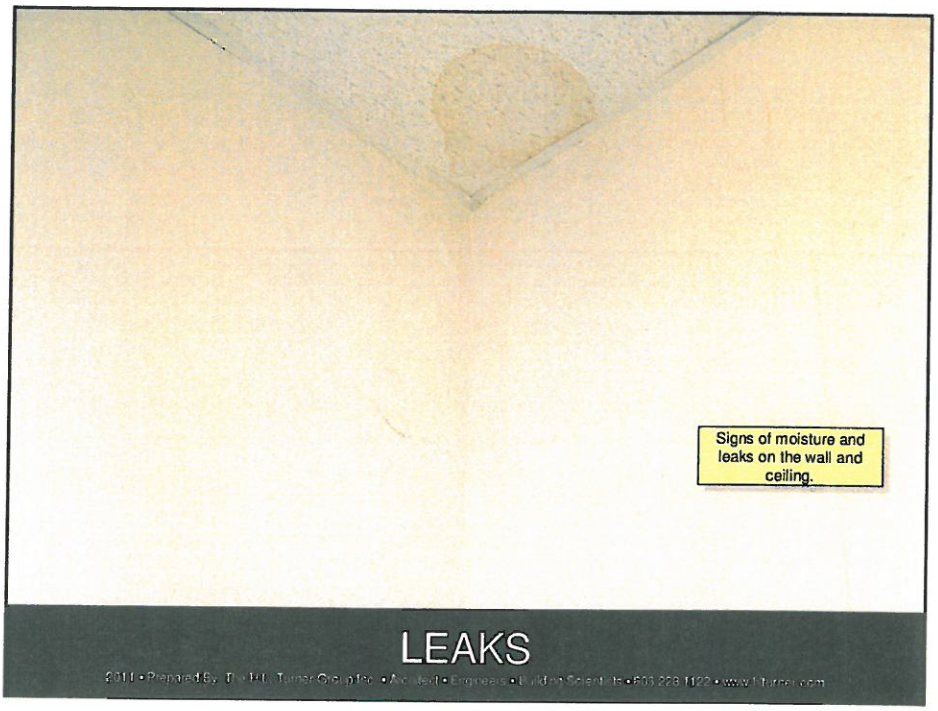

Insects have moved into window frames.
INSECTS

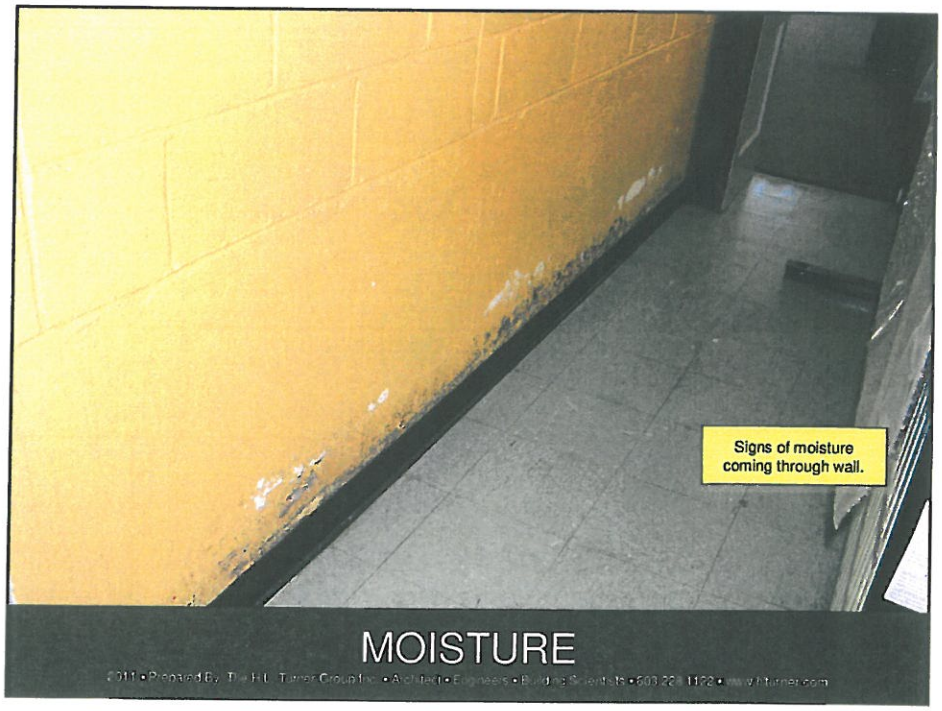

Signs of soil up against wall and windows.
GRADE

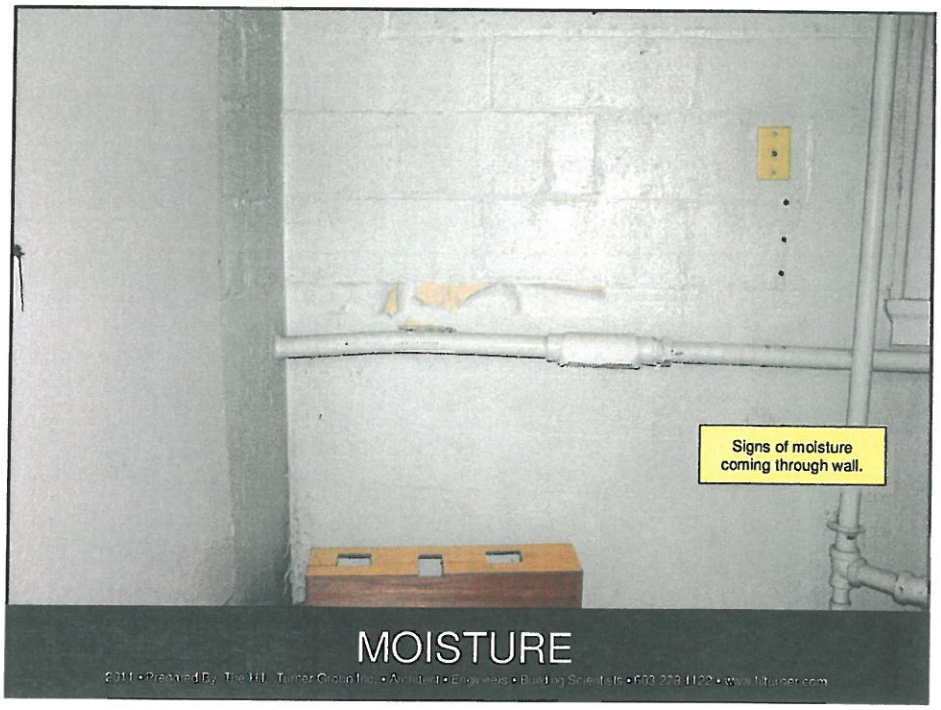

Signs of soil up against brick and on window sill.
GRADE

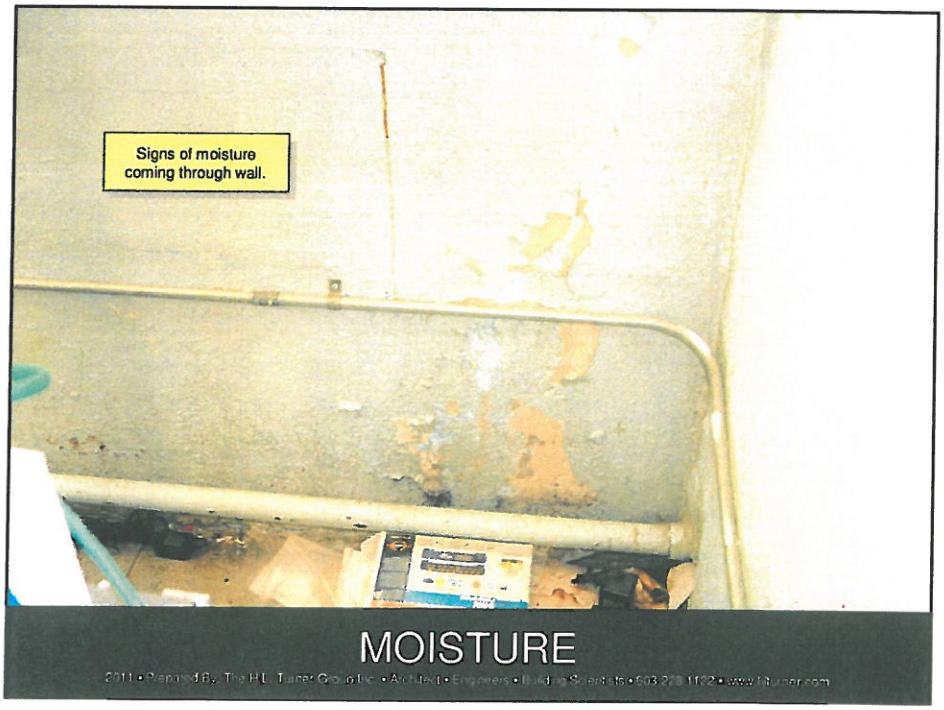

Block wall with plaster in 30's section of the building.
WALL CONSTRUCTION

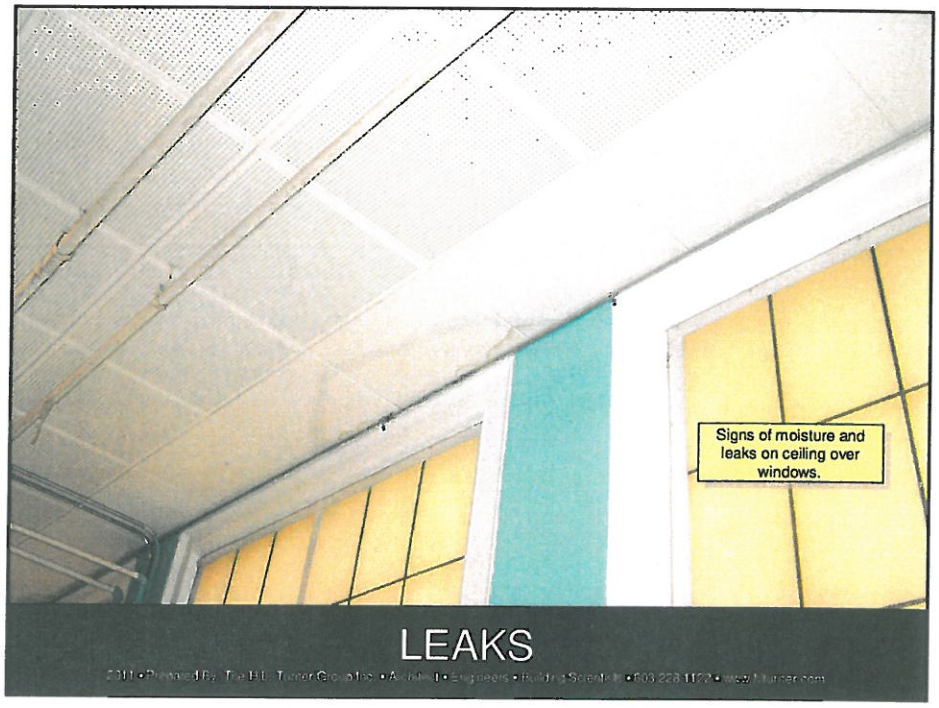

Signs of moisture intrusion and leaks on the wall.
LEAKS

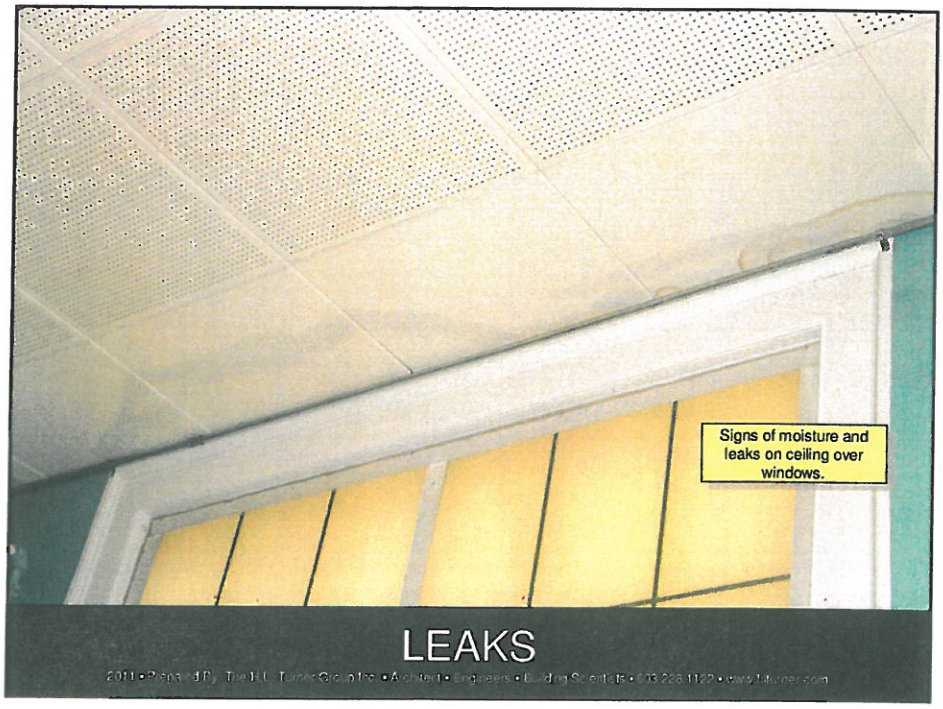

Signs of moisture and leaks on the wall and ceiling.
LEAKS

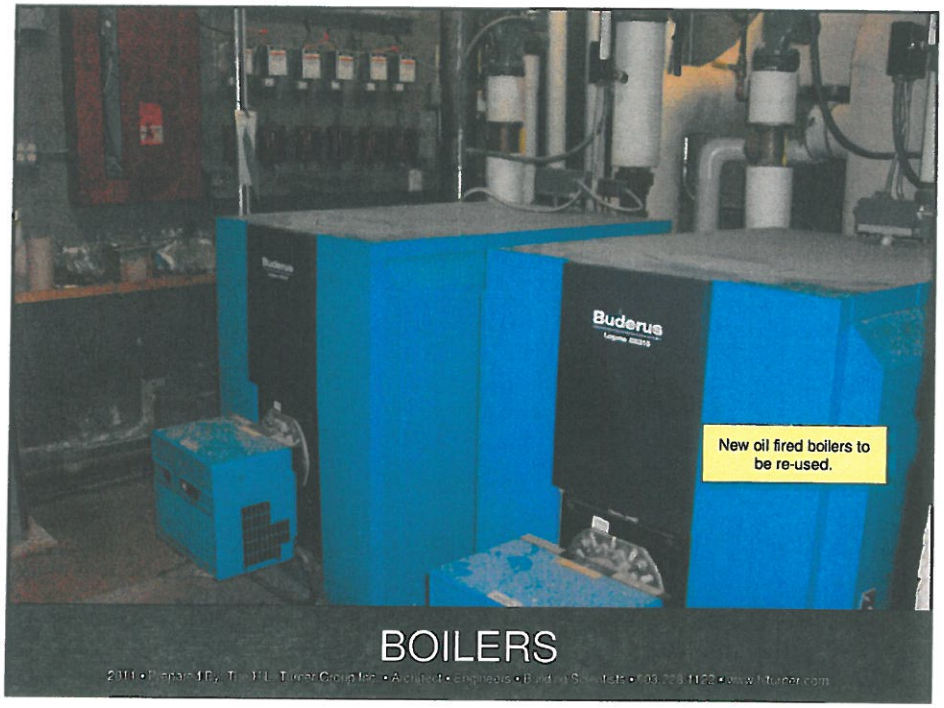

Signs of moisture coming through wall.
MOISTURE


Signs of moisture coming through wall.
MOISTURE

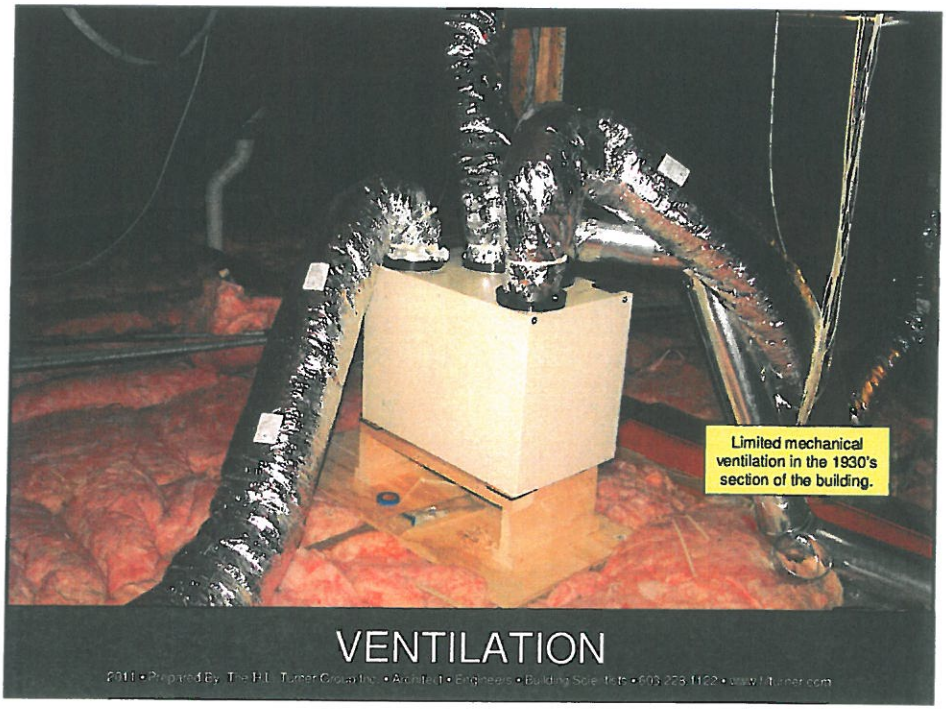

Signs of moisture coming through wall.
MOISTURE


Signs of moisture and leaks on ceiling over windows.
LEAKS

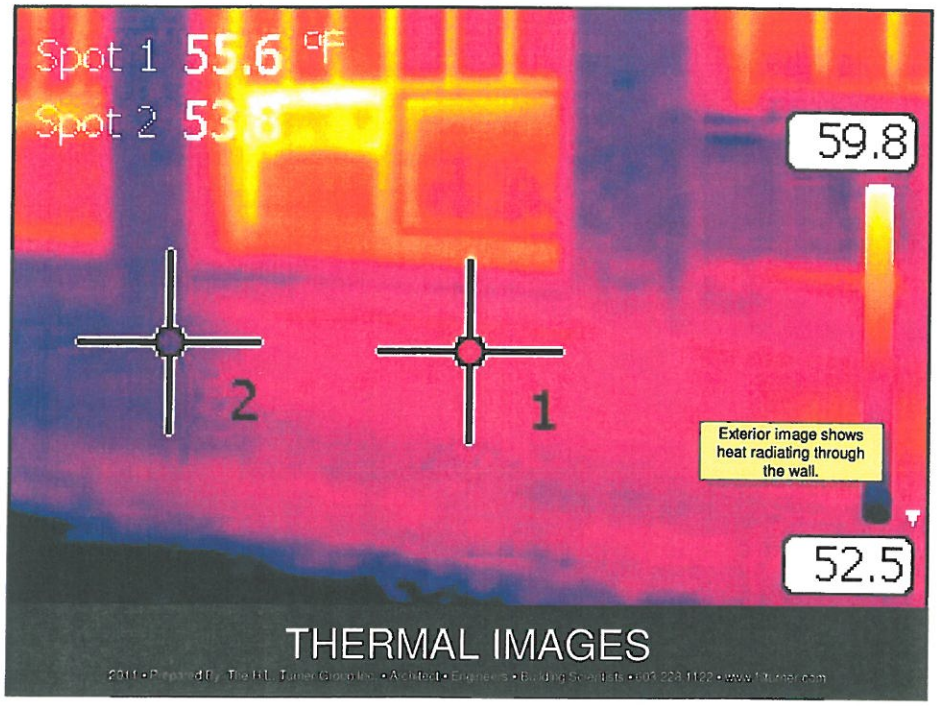

Signs of moisture and leaks on ceiling over windows.
LEAKS

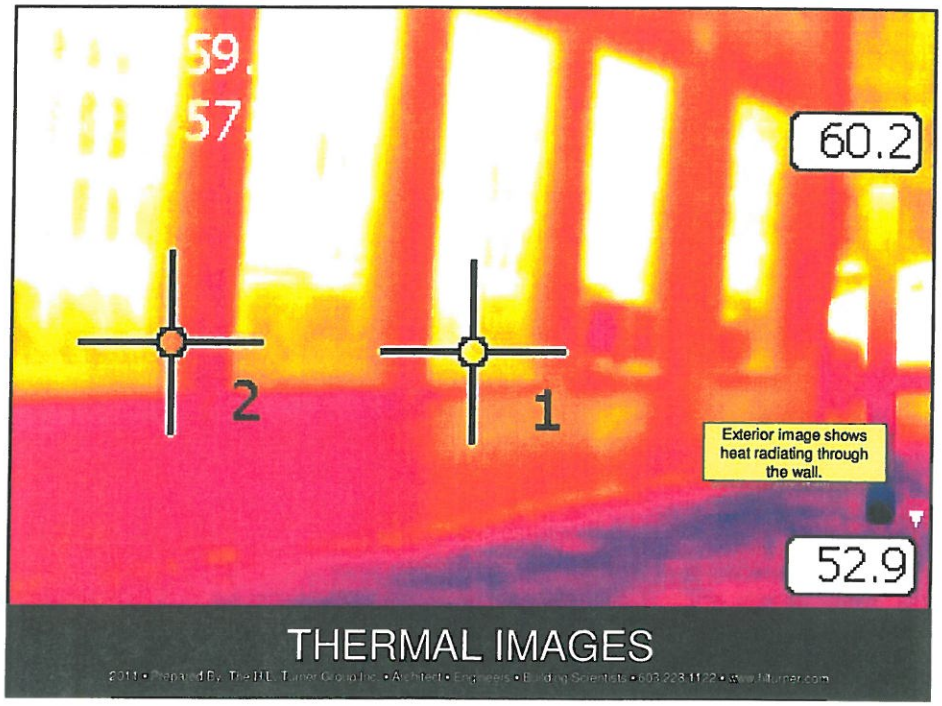


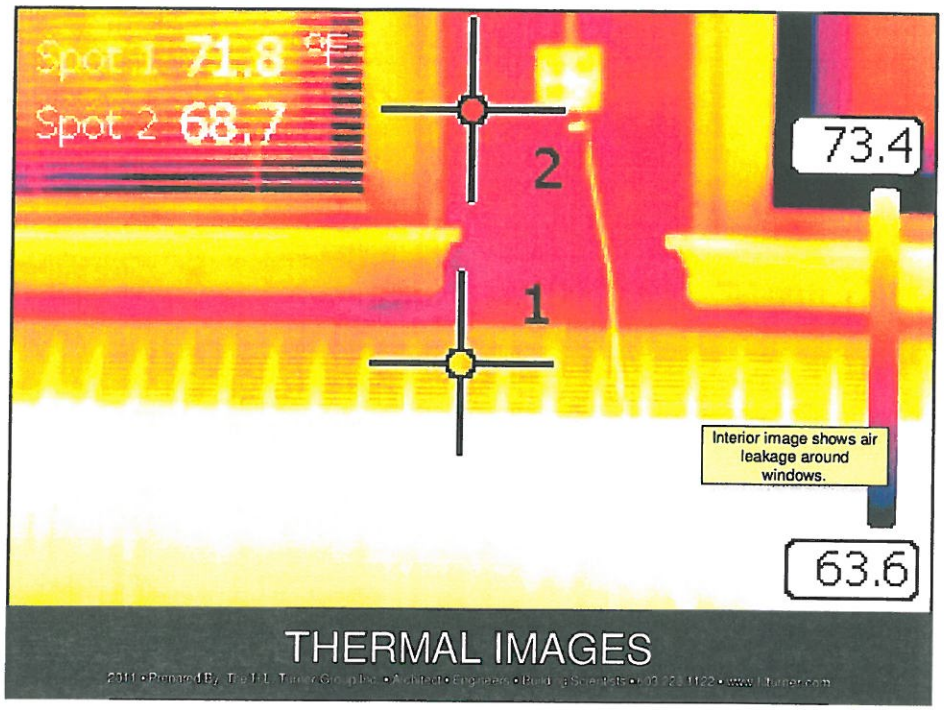
BOILERS

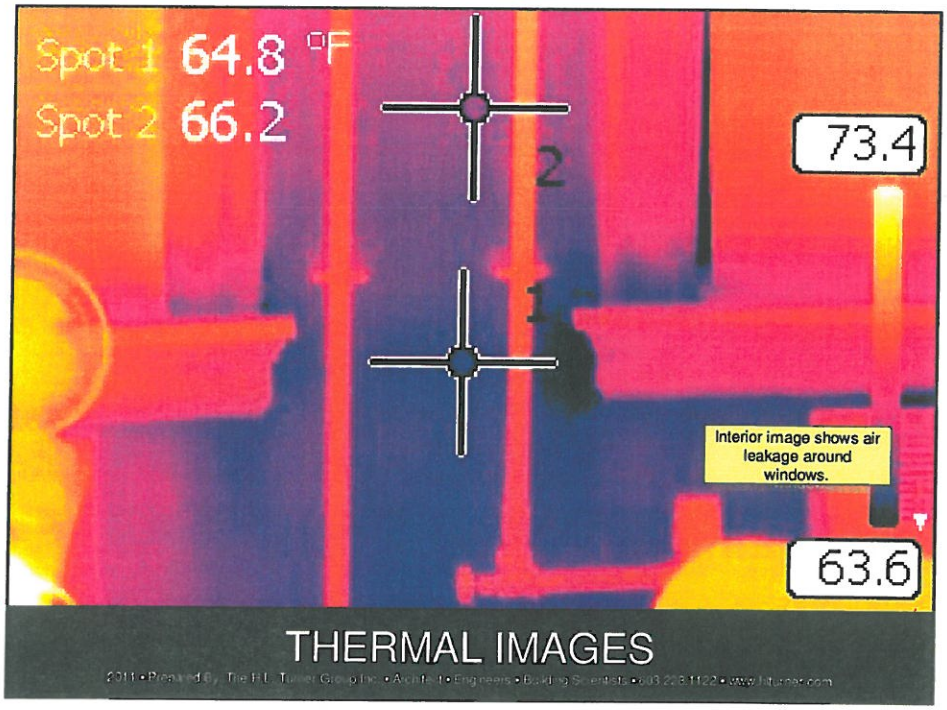


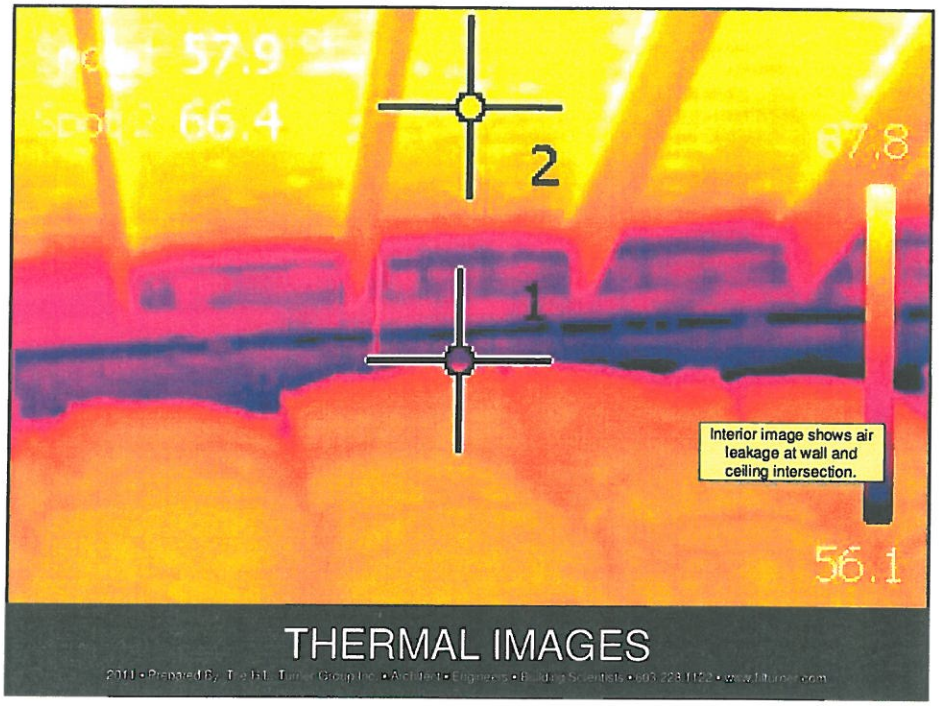
VENTILATION

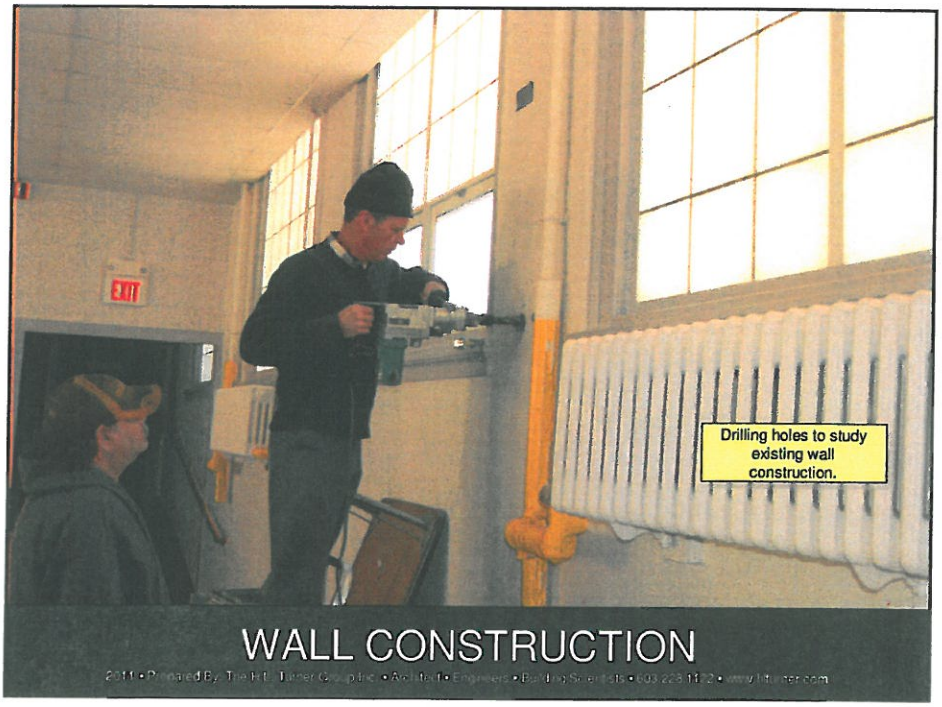

Spot 1 55.6 °F
Spot 2 53.8
59.8
2
1
Exterior image shows heat radiating through the wall.
52.5
THERMAL IMAGES


59.
57.
60.2
2
1
Exterior image shows heat radiating through the wall.
52.9
THERMAL IMAGES

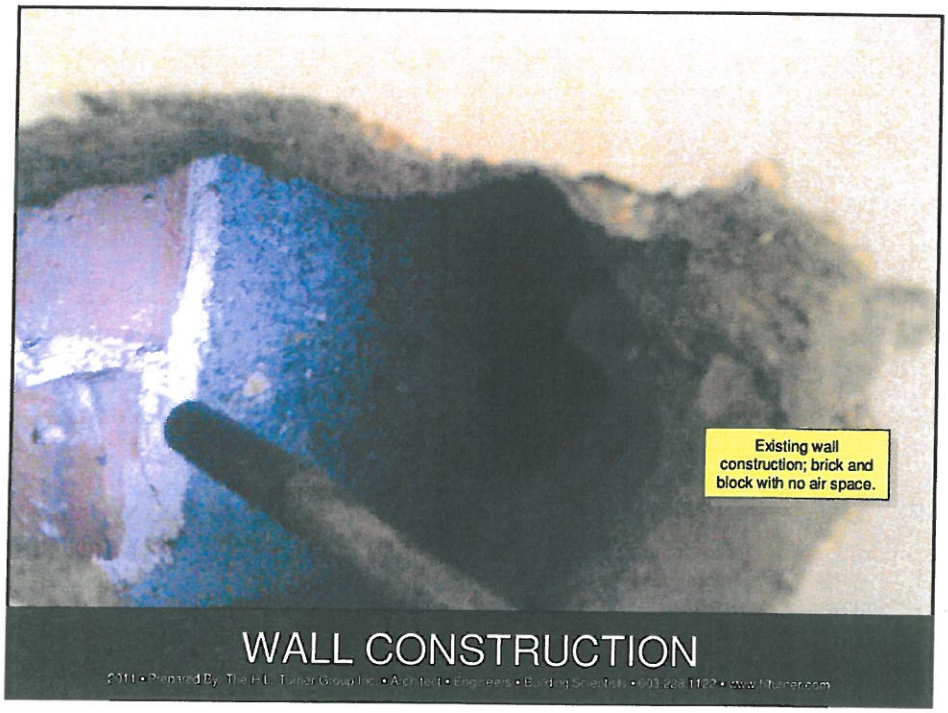

Spot 1 71.8 °F
Spot 2 68.7
2
1
73.4
Interior image shows air leakage around windows.
63.6
THERMAL IMAGES

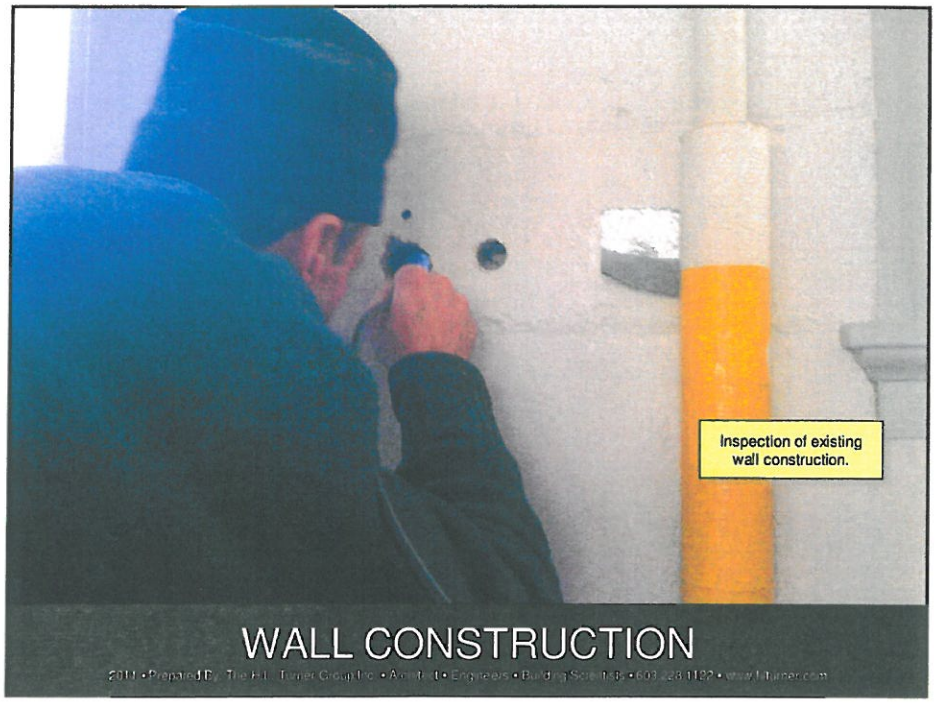

Spot 1 64.8 °F
Spot 2 66.2
2
1
73.4
Interior image shows air leakage around windows.
63.6
THERMAL IMAGES

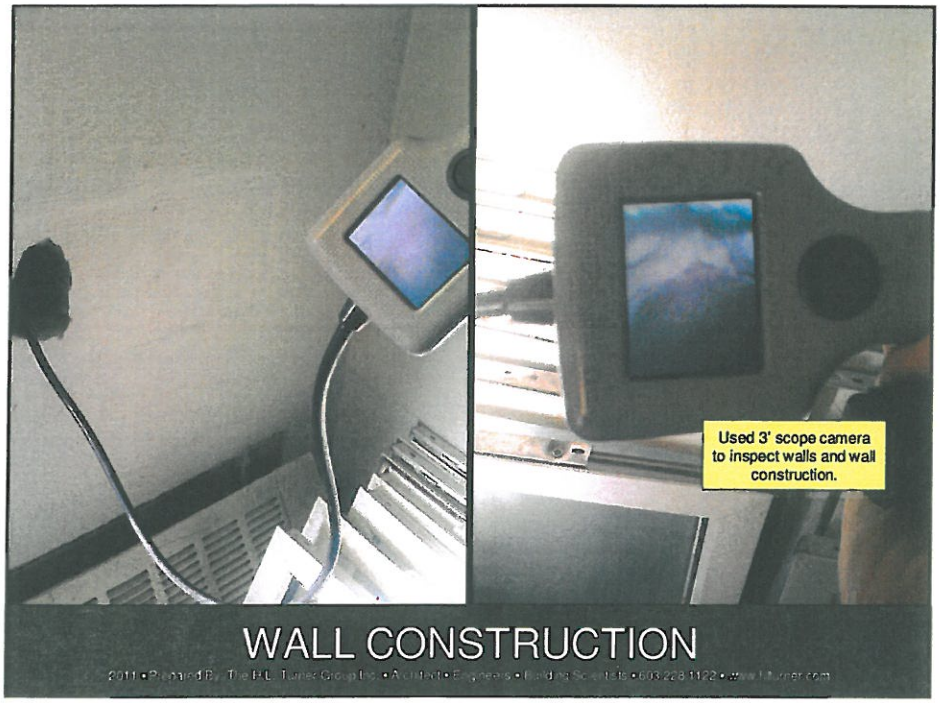

57.9
66.4
2
1
67.8
Interior image shows air leakage at wall and ceiling intersection.
56.1
THERMAL IMAGES


EXIT
Drilling holes to study existing wall construction.
WALL CONSTRUCTION


Inspection of existing wall construction.
WALL CONSTRUCTION


Existing wall construction; brick and block with no air space.
WALL CONSTRUCTION


Inspection of existing wall construction.
WALL CONSTRUCTION


Used 3' scope camera to inspect walls and wall construction.
WALL CONSTRUCTION

Appendix D

- Costs

DRAFT

Renovated Town Offices ~ Barrington, NH

Architect's Opinion of Cost

Updated: 01.09.11

			Opinion of Cost	Comments
CONSTRUCTION:				
Building:				
Structural	$11	5,100	$58,500	New sloped roof (does not include seismic upgrades)
Architectural	$77	18,800	$1,448,953	Includes ADA upgrades, new ext wall system, new finishes, building code upgrades, demo
Mechanical	$28	18,800	$526,400	New Ventalation System
Radiant Floor	$4	18,800	$75,200	Radiant floor add
Plumbing				Fixtures in Architectural
Fire Protection	$3	18,800	$56,400	
Electrical	$4.50	18,800	$84,600	Range from $85k-$95k (Adjusted)
Communications				In electrical numbers
Subtotal:	$120		$2,250,053	
Site:				
Civil			$70,000	Range from $85k-$115k (Adjusted)
Subtotal:	$123		$2,320,053	
Construction (General Requirements)	10%		$232,005	
Construction (Overhead & Profit)	15%		$348,008	
SUBTOTAL CONSTRUCTION:	$154		**$2,900,066**	**Construction Contract Only**
ANCILLARY COSTS:				
Architectural/Engineering	7.5%		$217,505	Design, Bid Documents
Construction Administration	2.0%		$58,001	Construction Oversight
Construction Testing			$3,000	Soils, concrete, steel, etc. quality control
Commissioning			$25,000	Confirmation that all systems are fully functional under all conditions
Utility Charges			$0	Transformers, primaries, etc. (none known at this time)
Bond Counsel			$10,000	Preparation to sell public bond. Number verified by town.
Moving and Storage			$0	Done by town
Clerk-of-the-works			$30,000	Owner's Representative (Possibly not needed)
Printing / Plotting			$7,000	Construction drawings
Miscellaneous Expenses			$10,000	Misc Expenses (non-construction related)
Additonal Mold Testing			$18,000	To determine location of mold
Records Cleaning / Replacement			$0	Done by town
SUBTOTAL ANCILLARY:			**$378,506**	**Associated "Soft" Costs**
FURNISHINGS/EQUIPMENT:				
Furniture	20	$4,000	$80,000	Allowance to replace loose furniture and technology equipment
Generator			$70,000	For Critical Systems Only (Not Full Building)
			$150,000	
CONTINGENCY:	9.50%		**$311,464**	Unencumbered for unexpected costs
TOTAL PROJECT BUDGET	$199		**$3,740,036**	**Opinion of Cost**
	$/sf 18,800 sf			Total Building SF

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Renovated Town Offices (Minimal) ~ Barrington, NH

Architect's Opinion of Cost

Updated: 12.28.10

			Opinion of Cost	Comments
CONSTRUCTION:				
Building:				
Structural	$0	5,100	$0	None (does not include seismic upgrades)
Architectural	$67	18,800	$1,257,335	Includes ADA upgrades, new ext wall system, patch & repair, building code upgrades, demo
Mechanical	$28	18,800	$526,400	Included displacement vent
Radiant Floor	$0	18,800	$0	Radiant floor add
Plumbing				Fixtures in Architectural
Fire Protection	$3	18,800	$56,400	
Electrical	$4	18,800	$80,000	Range from $85k-$95k
Communications				In electrical numbers
Subtotal:	$102		$1,920,135	
Site:				
Civil			$20,000	Range from $85k-$115k
Subtotal:	$103		$1,940,135	
Construction (General Requirements)	10%		$194,014	
Construction (Overhead & Profit)	15%		$291,020	
SUBTOTAL CONSTRUCTION:	$129		**$2,425,169**	**Construction Contract Only**
ANCILLARY COSTS:				
Architectural/Engineering	7.5%		$181,888	Design, Bid Documents
Construction Administration	2.0%		$48,503	Construction Oversight
Construction Testing			$3,000	Soils, concrete, steel, etc. quality control
Commissioning			$40,000	Confirmation that all systems are fully functional under all conditions
Utility Charges			$0	Transformers, primaries, etc. (none known at this time)
Bond Counsel			$10,000	Preparation to sell public bond. Number verified by town.
Moving and Storage			$0	Done by town
Clerk-of-the-works			$0	Owner's Representative (Possibly not needed)
Printing / Plotting			$7,000	Construction drawings
Miscellaneous Expenses			$10,000	Misc Expenses (non-construction related)
SUBTOTAL ANCILLARY:			**$300,391**	**Associated "Soft" Costs**
FURNISHINGS/EQUIPMENT:				
Furniture	20	$2,000	$40,000	Allowance 50% New / 50% Reused (Loose furniture and technology equipment)
Generator			$0	For Critical Systems Only (Not Full Building)
			$40,000	
CONTINGENCY:	10%		**$272,556**	Unencumbered for unexpected costs (10%)
TOTAL PROJECT BUDGET	$162		**$3,038,116**	**Opinion of Cost**
	$/sf 18,800 sf			Total Building SF

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Renovated Town Offices ~ Barrington, NH

Architect's Opinion of Cost

Updated: 01.04.11

			Opinion of Cost	Comments
CONSTRUCTION:				
Building:				
Structural	$11	5,100	$58,500	New sloped roof (does not include seismic upgrades)
Architectural	$90	13,700	$1,231,935	Includes ADA upgrades, new ext wall system, new finishes, building code upgrades, demo
Demo	$15	5,100	$74,175	
Mechanical	$32	13,700	$438,400	
Radiant Floor	$4	13,700	$54,800	Radiant floor add
Plumbing				Fixtures in Architectural
Fire Protection	$4	13,700	$47,950	
Electrical	$6	13,700	$85,000	Range from $85k-$95k
Communications				In electrical numbers
Subtotal:	$145		$1,990,760	
Site:				
Civil			$100,000	Range from $85k-$115k
Subtotal:	$153		$2,090,760	
Construction (General Requirements)	10%		$209,076	
Construction (Overhead & Profit)	15%		$313,614	
SUBTOTAL CONSTRUCTION:	$191		**$2,613,450**	**Construction Contract Only**
ANCILLARY COSTS:				
Architectural/Engineering	7.5%		$196,009	Design, Bid Documents
Construction Administration	2.0%		$52,269	Construction Oversight
Construction Testing			$3,000	Soils, concrete, steel, etc. quality control
Commissioning			$40,000	Confirmation that all systems are fully functional under all conditions
Utility Charges			$0	Transformers, primaries, etc. (none known at this time)
Bond Counsel			$10,000	Preparation to sell public bond. Number verified by town.
Moving and Storage			$0	Done by town
Clerk-of-the-works			$30,000	Owner's Representative (Possibly not needed)
Printing / Plotting			$7,000	Construction drawings
Miscellaneous Expenses			$10,000	Misc Expenses (non-construction related)
SUBTOTAL ANCILLARY:			**$348,278**	**Associated "Soft" Costs**
FURNISHINGS/EQUIPMENT:				
Furniture	20	$4,000	$80,000	Allowance to replace loose furniture and technology equipment
Generator			$70,000	For Critical Systems Only (Not Full Building)
			$150,000	
CONTINGENCY:	10%		**$296,173**	Unencumbered for unexpected costs (10%)
TOTAL PROJECT BUDGET	$249		**$3,407,901**	**Opinion of Cost**
$/sf	13,700 sf			Total Building SF

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New Town Offices (10,000 sf with basement) ~ Barrington, NH

Architect's Opinion of Cost

Updated: 12.28.10

DRAFT

			Opinion of Cost	Comments
CONSTRUCTION:				
Building:				
Structural	$35	10,000	$350,000	
Architectural	$77	10,000	$770,000	Brick with mtl stud backup
Elevator	$12	10,000	$120,000	
Mechanical	$30	10,000	$300,000	
Plumbing	$14	10,000	$140,000	
Fire Protection	$6	10,000	$60,000	
Electrical & Communications	$22	10,000	$220,000	
Subtotal:	$196		$1,960,000	
Site:				
Civil			$340,000	Includes: site prep, building excavation, final grading, road, parking, utilities, walkways (showing Clark-Goodwill Site / Add $60,000 for Rt 125 Site)
Off site improvements			$0	None known at this time
Subtotal:	$230		$2,300,000	
Construction (General Requirements)	10%		$230,000	
Construction (Overhead & Profit)	15%		$345,000	
SUBTOTAL CONSTRUCTION:	$288		**$2,875,000**	**Construction Contract Only**
ANCILLARY COSTS:				
Architectural/Engineering	6.5%		$186,875	Design, Bid Documents
Construction Administration	2.0%		$57,500	Construction Oversight
Construction Testing			$6,000	Soils, concrete, steel, etc. quality control
Commissioning			$20,000	Confirmation that all systems are fully functional under all conditions
Utility Charges			$20,000	Transformers, primaries, etc. (verify)
Bond Counsel			$10,000	Preparation to sell public bond. Number verified by town.
Moving and Storage			$0	Done by town
Clerk-of-the-works			$30,000	Owner's Representative (Possibly not needed)
Printing / Plotting			$7,000	Construction drawings
Miscellaneous Expenses			$10,000	Misc Expenses (non-construction related)
Land Acquisition			$0	Varies depending on chosen site
Sale Price of Existing Structure			$0	Unknown at this time
Site Survey & Design Testing			$10,000	Survey, test pits, soils, etc.
SUBTOTAL ANCILLARY:			**$357,375**	**Associated "Soft" Costs**
FURNISHINGS/EQUIPMENT:				
Furniture	20	$2,000	$40,000	Allowance 50% New / 50% Reused (Loose furniture and technology equipment)
Generator			$70,000	For Critical Systems Only (Not Full Building)
			$110,000	
CONTINGENCY:	10%		**$334,238**	Unencumbered for unexpected costs (10%)
TOTAL PROJECT BUDGET	$361		**$3,606,613**	**Opinion of Cost**
$/sf	10,000 sf			Total Building sf

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New Town Offices (11,500 sf Slab on Grade) ~ Barrington, NH

Architect's Opinion of Cost

Updated: 12.28.10

DRAFT

			Opinion of Cost	Comments
CONSTRUCTION:				
Building:				
Structural	$28	11,500	$322,000	
Architectural	$65	11,500	$747,500	Brick with mtl stud backup (No Elev)
Mechanical	$26	11,500	$299,000	
Plumbing	$12	11,500	$138,000	
Fire Protection	$4	11,500	$46,000	
Electrical Communications	$21	11,500	$241,500	
Subtotal:	$156		$1,794,000	
Site:				
Civil			$320,000	Includes: site prep, building excavation, final grading, road, parking, utilities, walkways (showing Clark-Goodwill Site / Add $60,000 for Rt 125 Site)
Off site improvements			$0	None known at this time
Subtotal:	$184		$2,114,000	
Construction (General Requirements)	10%		$211,400	
Construction (Overhead & Profit)	15%		$317,100	
SUBTOTAL CONSTRUCTION:	$230		**$2,642,500**	**Construction Contract Only**
ANCILLARY COSTS:				
Architectural/Engineering	6.5%		$171,763	Design, Bid Documents
Construction Administration	2.0%		$52,850	Construction Oversight
Construction Testing			$6,000	Soils, concrete, steel, etc. quality control
Commissioning			$20,000	Confirmation that all systems are fully functional under all conditions
Utility Charges			$20,000	Transformers, primaries, etc. (verify)
Bond Counsel			$10,000	Preparation to sell public bond. Number verified by town.
Moving and Storage			$0	Done by town
Clerk-of-the-works			$30,000	Owner's Representative (Possibly not needed)
Printing / Plotting			$7,000	Construction drawings
Miscellaneous Expenses			$10,000	Misc Expenses (non-construction related)
Land Acquisition			$0	Varies depending on chosen site
Sale Price of Existing Structure			$0	Unknown at this time
Site Survey & Design Testing			$10,000	Survey, test pits, soils, etc.
SUBTOTAL ANCILLARY:			**$337,613**	**Associated "Soft" Costs**
FURNISHINGS/EQUIPMENT:				
Furniture	20	$2,000	$40,000	Allowance 50% New / 50% Reused (Loose furniture and technology equipment)
Generator			$70,000	For Critical Systems Only (Not Full Building)
			$110,000	
CONTINGENCY:	10%		**$309,011**	Unencumbered for unexpected costs (10%)
TOTAL PROJECT BUDGET	$289		**$3,329,124**	**Opinion of Cost**
	$/sf 11,500 sf			Total Building sf

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New Town Offices (8.5k \+ Basement 4k Fin 4.5k Unfin) ~ Barrington, NH

Architect's Opinion of Cost

Updated: 12.28.10

DRAFT

			Opinion of Cost	Comments
CONSTRUCTION:				
Building:				
Structural	$30	12,500	$375,000	
Architectural	$80	12,500	$1,000,000	Brick with mtl stud backup (Includes Elev.)
Mechanical	$26	12,500	$325,000	
Plumbing	$10	12,500	$125,000	
Fire Protection	$4	12,500	$50,000	
Electrical & Communications	$19	12,500	$237,500	
Subtotal:	$169		$2,112,500	
Site:				
Civil			$340,000	Includes: site prep, building excavation, final grading, road, parking, utilities, walkways (showing Clark-Goodwill Site / Add $60,000 for Rt 125 Site)
Off site improvements			$0	None known at this time
Subtotal:	$196		$2,452,500	
Construction (General Requirements)	10%		$245,250	
Construction (Overhead & Profit)	15%		$367,875	
SUBTOTAL CONSTRUCTION:	$245		**$3,065,625**	**Construction Contract Only**
ANCILLARY COSTS:				
Architectural/Engineering	6.5%		$199,266	Design, Bid Documents
Construction Administration	2.0%		$61,313	Construction Oversight
Construction Testing			$6,000	Soils, concrete, steel, etc. quality control
Commissioning			$20,000	Confirmation that all systems are fully functional under all conditions
Utility Charges			$20,000	Transformers, primaries, etc. (verify)
Bond Counsel			$10,000	Preparation to sell public bond. Number verified by town.
Moving and Storage			$0	Done by town
Clerk-of-the-works			$30,000	Owner's Representative (Possibly not needed)
Printing / Plotting			$7,000	Construction drawings
Miscellaneous Expenses			$10,000	Misc Expenses (non-construction related)
Land Acquisition			$0	Varies depending on chosen site
Sale Price of Existing Structure			$0	Unknown at this time
Site Survey & Design Testing			$10,000	Survey, test pits, soils, etc.
SUBTOTAL ANCILLARY:			**$373,578**	**Associated "Soft" Costs**
FURNISHINGS/EQUIPMENT:				
Furniture	20	$2,000	$40,000	Allowance 50% New / 50% Reused (Loose furniture and technology equipment)
Generator			$70,000	For Critical Systems Only (Not Full Building)
			$110,000	
CONTINGENCY:	10%		**$354,920**	Unencumbered for unexpected costs (10%)
TOTAL PROJECT BUDGET	$307		**$3,834,123**	**Opinion of Cost**
$/sf	12,500 sf			Total Building sf

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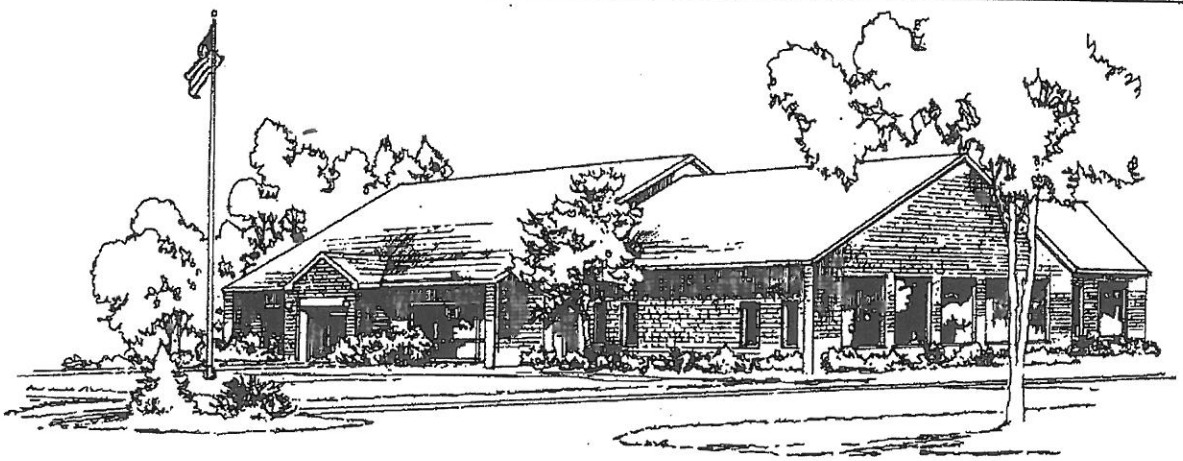

Costs per square foot of floor area

Exterior Wall	S.F. Area / L.F. Perimeter	3000 / 200	5000 / 250	7500 / 300	10000 / 350	15000 / 450	20000 / 500	25000 / 550	30000 / 600	40000 / 700
Face Brick with Concrete Block Back-up	Steel Joists	151.55	145.40	138.45	132.30	129.90	126.45	121.85	119.85	118.65
	Wood Joists	149.75	143.55	136.30	130.05	127.55	124.00	119.25	117.25	116.00
Stone with Concrete Block Back-up	Steel Joists	154.20	147.90	140.60	134.20	131.65	128.05	123.25	121.15	119.90
	Wood Joists	152.40	145.95	138.45	131.90	129.30	125.65	120.65	118.50	117.25
Brick Veneer	Wood Frame	141.10	135.35	128.85	123.25	121.05	117.80	113.60	111.70	110.65
E.I.F.S.	Wood Frame	129.35	124.30	118.95	114.40	112.50	109.65	106.20	104.65	103.70
Perimeter Adj., Add or Deduct	Per 100 L.F.	15.20	11.65	9.50	8.05	6.90	5.40	4.35	3.65	3.15
Story Hgt. Adj., Add or Deduct	Per 1 Ft.	2.80	2.55	2.20	1.90	1.80	1.65	1.50	1.35	1.30

For Basement, add $28.70 per square foot of basement area

The above costs were calculated using the basic specifications shown on the facing page. These costs should be adjusted where necessary for design alternatives and owner's requirements. Reported completed project costs, for this type of structure, range from $86.30 to $227.00 per S.F.

Common additives

Description	Unit	$ Cost
Directory Boards, Plastic, glass covered		
30" x 20"	Each	595
36" x 48"	Each	1450
Aluminum, 24" x 18"	Each	600
36" x 24"	Each	675
48" x 32"	Each	980
48" x 60"	Each	2025
Emergency Lighting, 25 watt, battery operated		
Lead battery	Each	282
Nickel cadmium	Each	805
Flagpoles, Complete		
Aluminum, 20' high	Each	1650
40' high	Each	3475
70' high	Each	10,100
Fiberglass, 23' high	Each	1775
39'-5" high	Each	3325
59' high	Each	8225
Safe, Office type, 1 hour rating		
30" x 18" x 18"	Each	2400
60" x 36" x 18", double door	Each	8750

Description	Unit	$ Cost
Smoke Detectors		
Ceiling type	Each	187
Duct type	Each	480
Vault Front, Door & frame		
1 Hour test, 32" x 78"	Opening	5175
2 Hour test, 32" door	Opening	5600
40" door	Opening	6400
4 Hour test, 32" door	Opening	6075
40" door	Opening	7125
Time lock movement; two movement	Each	1850

Important: See the Reference Section for Location Factors

We have calculated projected operating costs for a new building and for a renovation of the existing town hall building. At 10,000 square feet plus a full basement, the new building would have substantially less occupied space than the existing building. Over 8,000 square feet of space in the renovation would be occupied by entities (Recreation Department and School District) that would not be accommodated in the new building, and the total building-to-building cost comparison reflects that difference.

There are many imponderables in the projection of costs, but most would affect both the new building and renovation scenarios proportionally, maintaining the validity of the comparison between the two.

Assumptions & Factors

Factor	Existing Building	Renovated Building	New Building	Notes
Building Area (s.f.)	18,800	18,800	10,000	New building to include full basement
Configuration	Elongated, 2 stories		1 story	
Roof insulation	R30 & R 7.5	R40	R40	
Wall insulation	R4	R25+	R25+	
Windows	Substantial air infiltration	New		
Lighting	T8 fluorescent	New lamps	T8 fluorescent	
Heating	Oil fired boilers, 85% efficiency			
A/C	13 window units	Central A/C	Central A/C	
Cleaning/ maintenance staff	2	2	1	Current staff of four serves all town buildings
Capital renewal: MEP&FFE				Annual allowance based on overall average of 20-year useful life; costs can be applied to repair or replacement.
Inflation				An annual inflation factor of 2.5% has been used for all lines except for cleaning and maintenance (staff), for which a 4% factor has been used.

Present Value

Based on an annual inflation rate of 2.5%, the present value of the 20-year projected operating costs detailed on the next page are:

- Renovated building: $2,632,570
- New Building: $1,890,464

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20-year Projection of Building-Related Operating Costs, Renovated Building

	1	2	3	4	5	6	7	8	9	10
Electricity	$12,460	$12,772	$13,091	$13,418	$13,754	$14,097	$14,450	$14,811	$15,181	$15,561
Heating oil	$11,790	$12,085	$12,387	$12,697	$13,014	$13,339	$13,673	$14,015	$14,365	$14,724
Clean / Maint	$24,750	$25,740	$26,770	$27,840	$28,954	$30,112	$31,317	$32,569	$33,872	$35,227
Trash	$1,000	$1,025	$1,051	$1,077	$1,104	$1,131	$1,160	$1,189	$1,218	$1,249
Capital renewal	$81,149	$83,178	$85,257	$87,388	$89,573	$91,812	$94,108	$96,460	$98,872	$101,344
Total	$131,150	$134,801	$138,558	$142,424	$146,403	$150,499	$154,714	$159,052	$163,518	$168,114

	11	12	13	14	15	16	17	18	19	20	Total
Elect	$15,950	$16,349	$16,757	$17,176	$17,606	$18,046	$18,497	$18,959	$19,433	$19,919	$318,286
Heating	$15,092	$15,470	$15,856	$16,253	$16,659	$17,075	$17,502	$17,940	$18,388	$18,848	$301,172
Cln / Mnt	$36,636	$38,101	$39,626	$41,211	$42,859	$44,573	$46,356	$48,211	$50,139	$52,145	$737,007
Trash	$1,280	$1,312	$1,345	$1,379	$1,413	$1,448	$1,485	$1,522	$1,560	$1,599	$25,545
Capital	$103,877	$106,474	$109,136	$111,865	$114,661	$117,528	$120,466	$123,477	$126,564	$129,729	$2,072,918
Total	$172,846	$177,718	$182,733	$187,896	$193,213	$198,687	$204,323	$210,127	$216,104	$222,259	$3,455,138

20-year Projection of Building-Related Operating Costs, New Building

	1	2	3	4	5	6	7	8	9	10
Electricity	$6,563	$6,727	$6,895	$7,067	$7,244	$7,425	$7,610	$7,801	$7,996	$8,196
Heating oil	$6,790	$6,960	$7,134	$7,312	$7,495	$7,682	$7,874	$8,071	$8,273	$8,480
Cleaning / Maint	$12,375	$12,870	$13,385	$13,920	$14,477	$15,056	$15,658	$16,285	$16,936	$17,613
Trash	$750	$769	$788	$808	$828	$849	$870	$892	$914	$937
Capital renewal	$68,520	$70,233	$71,989	$73,788	$75,633	$77,524	$79,462	$81,448	$83,485	$85,572
Total	$94,998	$97,560	$100,193	$102,899	$105,681	$108,542	$111,482	$114,504	$117,612	$120,807

	11	12	13	14	15	16	17	18	19	20	Total
Elect	$8,401	$8,611	$8,826	$9,046	$9,273	$9,504	$9,742	$9,986	$10,235	$10,491	$167,637
Heating	$8,692	$8,909	$9,132	$9,360	$9,594	$9,834	$10,080	$10,332	$10,590	$10,855	$173,448
Cln / Mnt	$18,318	$19,051	$19,813	$20,605	$21,429	$22,287	$23,178	$24,105	$25,069	$26,072	$368,504
Trash	$960	$984	$1,009	$1,034	$1,060	$1,086	$1,113	$1,141	$1,170	$1,199	$19,158
Capital	$87,711	$89,904	$92,151	$94,455	$96,817	$99,237	$101,718	$104,261	$106,867	$109,539	$1,750,312
Total	$124,092	$127,470	$130,943	$134,515	$138,188	$141,964	$145,848	$149,843	$153,951	$158,176	$2,479,270

Appendix E

- Cleaning Procedures for Mold

From the University of Hawaii.

PROCEDURES FOR CLEANING MOLD ON BOOKS

1. Locate areas within the library that contain moldy books.
2. Place several clean book carts (wiped down with a commercial disinfectant) outside of the library, away from public traffic.
   (Note: The commercial disinfectant used to wipe down books should be tested to ensure that it does not damage the books and must be approved for use by the library's Director. We recommend using Simple Green-D which is a water-based cleaner/disinfectant solution.)
3. Leave a container of disinfectant, paper towels and trash bags with the book carts.
4. Have other carts ready to load the moldy books from the shelves.
5. When handling contaminated books, workers must wear protective gear. This includes wearing long sleeve shirt or other protective coat over street clothing, particulate dust mask (i.e. N95 particulate) and vinyl examination gloves. Unprotected indiv iduals may aggravate or develop allergic sensitivities to the mold spores.
6. Unload the moldy books from the shelves and place them on the book carts to be taken outside for cleaning. Cleaning must be conducted away from air intakes, other building openings and public areas.
7. HEPA vacuum moldy books by covering the following areas: outside front and back covers, joints between the covers, spine, text block and inside back and front covers. A soft-bristled brush may be used for stubborn growth.
   (Note: When the user experiences a noticeable operating resistance when using the HEPA vacuum, the HEPA filter for the vacuum cleaner should be checked and replaced if it appears to be overloaded. The used filters must be removed, misted with water, p laced in a zip lock bag or sealed trash bag and disposed of in a dumpster.)
8. Place clean book on a disinfected book cart.
9. Once cleaning of books are completed, book carts that were holding moldy books must be cleaned with disinfectant and paper towels.
10. Once the books have been cleaned and before reshelving, the floors and shelf areas must be cleaned and disinfected. The shelves and flooring must be cleaned with disinfectant and paper towels. All paper towels used in steps 9 and 10 must be discarde d in a trash bag for disposal.
11. the exterior of the HEPA vacuum cleaner must be wiped down with disinfectant.
12. Worker must remove protective coat, eye protection, dust mask, and gloves outside. Wash hands with soap and hot water after completing the

cleaning session.

13. Keep a record of where the problem areas are and note the time and day when the cleaning took place for future reference.
14. Institute a preventative cleaning program to address the continuing mold problem in the library. Books must be given to a quick wipe down with an appropriate disinfectant solution before re-shelving.

Personal Protective Equipment:

- long sleeved shirt and long pants or protective coat
- disposal gloves (non-powdered)- avoid using latex gloves since some individuals maybe allergic to latex
- dust mask
- eye protection (chemical goggles)

Supplies Needed:

- commercial disinfectant (i.e.Simple Green-D, Lysol, diluted bleach, etc.)
- paper towels
- trash bag
- duct tape
- HEPA vacuum
- soft-bristled brush
- soap
- sponge/rags

3.8 Emergency Salvage of Moldy Books and Paper

Beth Lindblom Patkus
Preservation Consultant
Walpole, MA

Introduction

Most librarians and archivists have seen the effects of mold on paper materials, but many have never experienced an active mold outbreak. Dealing with such an outbreak (large or small) can be overwhelming. This leaflet provides some basic information about mold and outlines the steps that need to be taken to stop mold growth and begin to salvage collections.

Please note that the actions recommended here are basic stabilization techniques to be undertaken in-house for small to moderate outbreaks. The complexities of dealing with a large number of wet and moldy materials will usually require outside assistance, and some suggestions for dealing with a major mold outbreak, appear at the end of this leaflet. In all cases, a conservator or preservation professional should be consulted if any questions arise or if further treatment is necessary.

What is Mold?

Mold and mildew are generic terms that refer to various types of fungi, microorganisms that depend on other organisms for sustenance. There are over 100,000 known species of fungi. The great variety of species means that patterns of mold growth and the activity of mold in a particular situation can be unpredictable, but it is possible to make some broad generalizations about the behavior of mold.

Mold propagates by disseminating large numbers of spores, which become airborne, travel to new locations, and (under the right conditions) germinate. When spores germinate, they sprout hair-like webs known as mycelium (visible mold); these in turn produce more spore sacs, which ripen and burst, starting the cycle again. Molds excrete enzymes that allow them to digest organic materials such as paper and book bindings, altering and weakening those materials. In addition, many molds contain colored substances that can stain paper, cloth, or leather. It is also important to realize that mold can be dangerous to people and in some cases can pose a major health hazard. Mold outbreaks should never be ignored or left to "go away on their own."

Why Does Mold Grow?

To germinate (become active), spores require a favorable environment. If favorable conditions are not present, the spores remain inactive (dormant); in this state they can do little damage.

The most important factor in mold growth is the presence of moisture, most commonly in the air, but also in the object on which the mold is growing. Moisture in the air is measured as relative humidity (RH). In general, the higher the RH the more readily mold will grow. If the RH is over 70% for an extended period of time, mold growth is almost inevitable. It is important to remember, however, that it is possible for some species of mold to grow at lower RH as well. If collections have become wet as the result of a water disaster, this increases their susceptibility to mold growth. Other factors that will contribute to mold growth in the presence of moisture are high temperature, stagnant air, and darkness.

Mold spores, active or dormant, are everywhere. It is not possible to create an atmosphere free of spores. They exist in every room, on every object in the collection, and on every person entering the collection area. The only wholly dependable control strategy is to keep the humidity and temperature moderate so the spores remain dormant, keep collections as clean as possible, and prevent the introduction of new active mold colonies.

Basic Principles of Salvage

Reduce the humidity: As noted above, moisture initiates mold growth. Reducing the humidity is essential to stopping the mold growth.

Do not turn up the heat: This will not help to dry out collections and storage areas. Additional heat in the presence of moisture will cause the mold to grow faster.

If collections are wet, dry or freeze them: Mold will normally grow on wet materials in about 48 hours (sometimes sooner). If you know you cannot get the affected material dry within 48 hours, it is best to freeze it. This will not kill the mold, but it will stop further growth until you have a chance to dry and clean the material.

Consider the health risks: A few mold species are toxic to people, and many molds are powerful sensitizers. Exposure to mold can lead to debilitating allergy even among people not prone to allergies. Everyone who works with moldy objects must be properly protected.

Avoid "quick and easy" cures: "Quick cures" that you may have heard about (such as spraying Lysol on objects or cleaning them with bleach) may cause additional damage to items or be toxic to people; they are also often ineffective. In the past, mold-infested collections were often treated with fumigants. Ethylene oxide (ETO) will kill active mold and mold spores; other chemicals that have been used are less effective. All of these chemicals can have adverse effects on both collections and people, and none of them will keep the mold from recurring.

Step-by-Step Salvage

This section provides specific steps for responding to a small or moderate mold outbreak. While the steps are

humbered for convenience, they may not be carried out in exactly this order, and some of these activities will occur simultaneously.

1. Find out what is causing the mold growth. You need to know what is causing the problem so that additional mold on collections not yet affected can be avoided.
   - Look first for an obvious source of moisture, such as a water leak.
   - If there is no obvious source of moisture, use a monitoring instrument to measure the relative humidity in the affected area. If the humidity is elevated, there might be a problem with the HVAC (heating, ventilating, and air conditioning) system, or the area might be subject to higher humidity for another reason, such as having shelves placed against an outside wall. Mold might also develop in areas with poor air circulation or in areas where there is a lot of dust and dirt that might provide a food source for mold.
   - Initiate repairs or resolve the problem as soon as possible. If the problem cannot be resolved quickly, salvage the collections as directed below and develop a strategy for frequent monitoring of the area for additional mold growth.
2. Take steps to modify the environment so that it is no longer conducive to mold growth.
   - Mop up and/or use a wet-dry vacuum to remove any standing water. Bring in dehumidifiers, but be sure that a mechanism is in place to drain them periodically so they do not overflow. Bring in fans to circulate the air, and open the windows (unless the humidity is higher outside).
   - Your goal should be to reduce the relative humidity to 55% or lower. Temperature should be moderate, below 70°F. Get a monitoring instrument that can measure the relative humidity and temperature accurately, and record the measurements in a log several times a day. Do not rely on your own impression of climate conditions.
3. Implement safety precautions for staff and others working with moldy items.
   - A mycologist should be consulted to insure that no toxic mold species are present (a local hospital or university should be able to provide a reference). If toxic molds are present, DO NOT attempt to salvage materials yourself.
   - If there are no toxic molds present, collections can be salvaged in-house, but everyone working with the affected materials must wear disposable plastic gloves and clothing, and use a protective mask when working with moldy objects.
   - Use a respirator with a HEPA (high efficiency particulate) filter; pollen dust masks available in drug and hardware stores are not adequate. If you cannot use disposable clothing, be sure to leave dirty clothes in a designated area and wash them in hot water and bleach. Respirators should be wiped periodically with rubbing or denatured alcohol.
   - Be aware that some people cannot wear respirators. The respirator must fit well with good contact around the nose and mouth area. In addition, they make breathing somewhat difficult and can be problematic for people with asthma or heart conditions, or people who are pregnant. It is a good idea to consult your doctor before wearing a respirator to work with moldy materials.[1]
4. Isolate the affected items.
   - Quarantine items by removing them to a clean area with relative humidity below 45%, separate from the rest of the collection. Items should be transferred in sealed plastic bags to avoid transfer of mold to other items during the move, but they should not remain in the bags once in the clean area, since this will create a micro-environment that can foster further mold growth.
   - In the case of a large mold outbreak it may be impractical to move the items; in that case the area in which they are housed should be quarantined and sealed off from the rest of the building to the extent possible (remember that this includes shutting off air circulation from the affected area).
5. Begin to dry the materials. Your goal is to make the mold go dormant, so that it will appear dry and powdery rather than soft and fuzzy. This will allow you to remove the mold residue more easily.
   - Wet material should be dried in a cool, dry space with good air circulation. An air-conditioned space is the best for this purpose, but if that is impossible, use fans to circulate air (do not aim fans directly at objects, however, as this can damage materials and further scatter mold spores). Place paper toweling or unprinted newsprint (regular newspapers may transfer print to the wet objects) under the drying items to absorb moisture, and change this blotting material often. Air drying takes time and attention, since you must check drying materials often, and you must maintain cool, dry conditions and air circulation in the space.
   - Collections may also be dried outside in the sun (sunlight or ultraviolet light can cause some molds to become dormant). The outside humidity must be low. Be aware that the sun causes fading and other damage to paper-based collections, however. Materials should be monitored closely and left outside no more than an hour or so.
   - Special attention should be paid to framed objects (such as prints and drawings) and to the interior of the spines of books. A frame provides an ideal environment for mold; the back is dark, air does not circulate, and humidity can be trapped inside. Similarly, the interior of the spine of a book is particularly vulnerable to mold growth. Spines should be checked regularly during the drying process. Framed materials should be unframed immediately, and dried as above. If the item appears to be stuck to the glass in the frame, remove the backing materials from the frame and leave the item in the frame and attached to the glass. Place the framed item in a cool, dry space as described above, and consult a professional conservator.

6. If immediate drying is not possible, freeze the affected items.
   - If the item is small enough, it can be placed in the freezer compartment of a home refrigerator, with freezer paper loosely wrapped around it to prevent it from sticking to other items.
   - For items that are too big for a freezer compartment or for larger numbers of items, a commercial freezer may be necessary (grocery store, university food service, commercial cold storage facility, etc.). It is a good idea to make arrangements for commercial freezer storage before an emergency arises, since there may be restrictions on storing moldy items in a freezer that normally holds foodstuffs.
   - Once time and resources are available, frozen materials can be thawed and dried in small batches, or they can be freeze-dried or vacuum freeze-dried (with the exception of photographs, which should not be freeze-dried or vacuum freeze-dried).
7. Clean the affected items. ***Do not*** try to clean active mold (soft and fuzzy) yourself. This should be done only by a conservator, who will use a vacuum aspirator to avoid further embedding the mold into the paper. The following instructions apply only to inactive (dry and powdery) mold and materials that do NOT have artifactual value:**2**
   - Remove mold residue outdoors rather than in an enclosed space whenever possible. Be sure to wear protective gear (see above). If you must work indoors, use a fume hood with a filter that traps mold or in front of a fan, with the fan blowing contaminated air out a window. Close off the room from other areas of the building (including blocking the air circulation vents).
   - Vacuum the mold. Use a vacuum with a HEPA filter; this will contain the mold spores. A normal vacuum will simply exhaust the spores out into the air. You can also use a wet-dry commercial-strength vacuum if the tank is filled with a solution of a fungicide such as Lysol diluted according to the label instructions. A tube from the hose inlet should extend into the solution so that incoming spores are directed there.
   - Do not vacuum fragile items directly, since the suction can easily cause damage. Papers can be vacuumed through a plastic screen held down with weights. A brush attachment covered with cheesecloth or screening should be used for books to guard against loss of detached pieces. Boxes can be vacuumed directly. When disposing of vacuum bags or filters, seal them in plastic trash bags and remove them from the building.
   - It is also acceptable to clean off mold with a soft brush, but this must be done carefully. Once moldy material is dry and the residue appears powdery, take a soft, wide brush (such as a watercolor wash brush) and lightly brush the powdery mold off the surface of the item. This should be done outside or the mold should be brushed into a vacuum nozzle. Be careful not to rub the mold into the surface, since that will attach it permanently to paper fibers or the cover of a book.
8. Dry and thoroughly clean the room(s) where the mold outbreak occurred. You may do this yourself or hire a company to provide dehumidification and/or cleaning.
   - Vacuum shelves and floors with a wet-dry vacuum filled with a fungicide solution such as Lysol, then wipe them down with Lysol or a similar solution. Allow them to dry fully before returning any materials. If a musty odor lingers in the room, open containers of baking soda may help.
   - It is also a good idea to have the HVAC system components (heat-exchange coils, ductwork, etc.) cleaned and disinfected, particularly if you suspect they have caused the problem.
9. Return materials to the affected area. Do this ***only*** after the area has been thoroughly cleaned ***and*** the cause of the mold outbreak has been identified and dealt with.
10. Continue to monitor conditions and take steps to avoid additional mold growth.
    - Take daily readings of temperature and relative humidity, and be sure that the climate is moderate. It is particularly important to keep humidity below 55% to insure that mold will not reappear. Temperature should not exceed 70°F.
    - Check problem areas frequently to insure that there is no new mold growth. Be sure to examine the gutters of books near the endbands and inside the spines.
    - Keep areas where collections are stored and used as clean as possible, since dust and dirt are a source of spores, both active and dormant. Clean floors with a HEPA filter vacuum rather than sweeping, since sweeping scatters dust. House collections in protective enclosures whenever possible to keep them free of dust. Vacuum shelves and the tops of unboxed, shelved books, or clean them with a magnetic wiping cloth.
    - If funds permit, install a multi-stage particulate filtration system in the building or storage area.
    - Keep windows closed to prevent active spores from entering, and prohibit live plants in collection storage or use areas, since these are also a source of spores.
    - Quarantine new acquisitions for a few days, and check them carefully for signs of mold.
    - Avoid storing collections in potentially damp areas or in locations where water accidents are possible. Insure that regular maintenance is carried out on the building to reduce the chance of water emergencies.
    - Regularly inspect the HVAC system, which is a good breeding ground for mold. Regularly clean the heat exchange coils, drip pan, and ductwork. Change air filters frequently.
    - Prepare a disaster plan. This will prevent some accidents and provide strategies for dealing quickly and effectively with problems. Be sure that all employees are familiar with the plan.

Dealing with a Major Mold Outbreak

If a large portion of the collection is affected by the mold outbreak, if dangerous species of mold are present, or if the HVAC system and the building itself are also infected with mold, outside assistance will be needed. Particularly in the latter cases, it is essential to make sure that the building is safe for occupancy by staff. There

are a variety of companies experienced in working with cultural collections that can assist institutions with recovery.

Most of the disaster recovery companies that provide drying services will also clean surface mold off collections. Conservators or regional conservation centers provide treatment services for individual items with artifactual value.

There are also several disaster recovery companies that specialize in dehumidifying and cleaning of buildings. In the case of a severe infestation of mold and/or an infestation that poses serious health risks to staff, companies specializing in indoor air quality can help to insure that the building is safe for occupancy. In severe cases, fumigation of the affected area may be necessary. Due to the potential for damage, fumigants should not be used directly on or in the presence of collections unless there is no other choice. Fumigation should always be done by a licensed professional.

A list of service providers is given at the end of this leaflet. Be sure that the company you choose is familiar with the requirements of cultural collections. If you are not sure how to choose a service provider, always contact a conservator or preservation professional for advice.

Summary

Spores, active or dormant, are ubiquitous. Although it is impossible to get rid of all the spores, mold growth can be controlled. Most important for mold control is maintaining RH conditions below 55%, or, better, below 45%. Use of protective enclosures, meticulous housekeeping, monitoring of RH and temperature, and a watchful eye are also important. If resources allow, high-level filtration of storage areas, if not of the whole building, is recommended. Protecting library and archival collections from water accidents should be among the highest priorities for any institution. Wet collections must be immediately dried or stabilized by freezing. Moldy materials must be isolated, dried if wet, then cleaned using the strictest precautions.

GENERAL PROCEDURES FOR MOLD CLEANING

1. Identify where mold is present.
2. Inform building occupants where and when cleaning will take place. If possible try to conduct cleaning during off-hours, early morning, late afternoon or on weekends.
3. Assemble personal protective and cleaning equipment before proceeding with cleaning.

Personal Protective Equipment:

- long sleeved shirt and long pants or protective cloth covering
- disposable gloves (non-powdered) - avoid using latex gloves since some individuals maybe allergic to latex
- dust mask (N95 particulate)
- eye protection (chemical goggles)

Cleaning Supplies:

- HEPA Vacuum
- Commercial disinfectant (i.e. Simple Green -D, diluted bleach, Lysol, etc.)
- trash bags
- paper towels
- soft-bristled brush
- soap
- sponge/rags

4. Don personal protective equipment.
5. HEPA vacuum moldy areas and/or materials initially to remove loose dirt and mold.
   (Note: When the user experiences a noticeable operating resistance when using the HEPA vacuum, the HEPA filter for the vacuum cleaner should be checked and replace d if it appears to be overloaded. The used filters must be removed, misted with water, placed in a zip lock bag or sealed trash bag and disposed of in a dumpster.)
6. After HEPA vacuuming, use water and soap to remove mold using a sponge, rag and/or soft-bristled brush for stubborn growth.
7. Once mold has been cleaned, spray disinfectant on the cleaned surfaces (allow 10 minutes of contact time).
8. Wipe of disinfectant and thoroughly dry surface with paper towel.
9. The exterior clothing worn by workers should be vacuumed with the HEPA vacuum cleaner and placed in trash bags for laundering. If disposable coveralls such as tyvek suits are worn, these can disposed of as regular trash.
10. The exterior of the HEPA vacuum cleaner must be wiped down with disinfectant.
11. Worker must remove protective clothing, eye protection, dust mask and gloves outside. Wash hands with soap and hot water after completing the cleaning session. Disposable protective gear such as dust mask and gloves should be placed in trash bag and disposed of as regular trash. Eye protection (chemical goggles) must be cleaned and disinfected.
12. Keep a record of where the problem areas are and note the time of day when the cleaning took place for future reference.

PROCEDURES FOR CLEANING MOLD ON BOOKS

1. Locate areas within the library that contain moldy books.
2. Place several clean book carts (wiped down with a commercial disinfectant) outside of the library, away from public traffic. *(Note: The commercial disinfectant used to wipe down books should be tested to ensure that it does not damage the books and must be approved for use by the library's Director. We recommend using Simple Green-D which is a water-based cleaner/disinfectant solution.)*
3. Leave a container of disinfectant, paper towels and trash bags with the book carts.
4. Have other carts ready to load the moldy books from the shelves.
5. When handling contaminated books, workers must wear protective gear. This includes wearing long sleeve shirt or other protective coat over street clothing, particulate dust mask (i.e. N95 particulate) and vinyl examination gloves. Unprotected individuals may aggravate or develop allergic sensitivities to the mold spores.
6. Unload the moldy books from the shelves and place them on the book carts to be taken outside for cleaning. Cleaning must be conducted away from air intakes, other building openings and public areas.
7. HEPA vacuum moldy books by covering the following areas: outside front and back covers, joints between the covers, spine, text block and inside back and front covers. A soft-bristled brush may be used for stubborn growth. *(Note: When the user experiences a noticeable operating resistance when using the HEPA vacuum, the HEPA filter for the vacuum cleaner should be checked and replaced if it appears to be overloaded. The used filters must be removed, misted with water, p laced in a zip lock bag or sealed trash bag and disposed of in a dumpster.)*
8. Place clean book on a disinfected book cart.
9. Once cleaning of books are completed, book carts that were holding moldy books must be cleaned with disinfectant and paper towels.
10. Once the books have been cleaned and before reshelving, the floors and shelf areas must be cleaned and disinfected. The shelves and flooring must be cleaned with disinfectant and paper towels. All paper towels used in steps 9 and 10 must be discarded in a trash bag for disposal.
11. the exterior of the HEPA vacuum cleaner must be wiped down with disinfectant.
12. Worker must remove protective coat, eye protection, dust mask, and gloves outside. Wash hands with soap and hot water after completing the cleaning session.
13. Keep a record of where the problem areas are and note the time and day when the cleaning took place for future reference.
14. Institute a preventative cleaning program to address the continuing mold problem in the library. Books must be given to a quick wipe down with an appropriate disinfectant solution before re-shelving.

Personal Protective Equipment:

- long sleeved shirt and long pants or protective coat
- disposal gloves (non-powdered)- avoid using latex gloves since some individuals maybe allergic to latex
- dust mask
- eye protection (chemical goggles)

Supplies Needed:

- commercial disinfectant (i.e.Simple Green-D, Lysol, diluted bleach, etc.)
- paper towels
- trash bag
- duct tape
- HEPA vacuum
- soft-bristled brush
- soap
- sponge/rags

MOLD PREVENTION AND CONTROL TIPS FOR BUILDING OCCUPANTS

1. At least once a month, room surfaces such as desks, shelves, books, etc. should be wiped down with disinfectant (i.e. lysol).
2. Remove plants from the area, wet soil/plants and/or containers such as wicker baskets introduce moisture in the air and promotes fungal growth.
3. Maintain good housekeeping by not accumulating items which harbor spores/mold such as old books, journals/magazines, clothing, etc.
4. When water leaks or spills occur indoors- ACT QUICKLY. Call facilities to repair leak; and have them dry or replace damp material within 24-48 hours.
5. If ceiling tiles appear to be water-damaged or if a leak occurs, immediately call facilities to repair the leak and replace ceiling tiles.
6. When the air-conditioning system is in operation, keep all exterior doors and windows closed. If the temperature in an area is very cold, call facilities to have the temperature adjusted. Do not open exterior doors and/or windows because this will introduce higher humidity and moisture; and do not block supply air registers because this may cause some areas to have warmer temperatures and higher humidities.

CLEANING PROCEDURES FOR MOLD
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ABSTRACT

Successful cleaning of mold requires an understanding of the location of contamination and the reason why fungal growth initially occurred. In buildings with extensive moisture damage, the extent of hidden mold colonization is almost always greater than that which is readily visible in the occupied space. In buildings with extensive moisture damage it is generally necessary to open-up and inspect representative structural components in order to estimate the extent of mold growth to be removed by cleaning. Basic steps in mold cleaning include the physical removal of colonized materials, the removal of associated dusts and debris, the prevention of dusts and spores generated during clean-up from entering occupied or clean areas, and the use of appropriate protective equipment by knowledgeable clean-up workers. When surfaces are cleaned emphasis must be placed on thorough physical removal of dusts and mold residues rather than on use of microbiocidal agents. A clear pathway for data evaluation including an informed inspection should proceed any sampling performed in buildings including those undergoing cleaning. The limitations of the sampling methods should be understood (e.g., a negative air sampling result does not prove the absence of hidden growth in a wall cavity). The procedures used to clean mold are highly influenced by variables such as the kind of occupant (e.g., very conservative guidelines are used for cleaning of mold in health care centers), the kind of building (e.g., generally more wood framing is used in small residential buildings), or kinds of materials in a building (e.g., library and archival materials are difficult to clean). Special protocols are needed for mold cleaning in these different types of buildings. Finally, the ultimate success of mold cleaning is dependent upon prevention of leaks and dampness that can lead to new growth.

KEY WORDS: Cleaning, Fungi, Inspection, Mold, Renovation

INTRODUCTION

A problem building in the context of mold growth almost certainly means that chronic leaks or dampness conditions exist. Filamentous fungi will likely grow on biodegradable water-damaged or damp finishing and construction materials. The necessity for clean-up of mold in a building implies that extensive biodeterioration or growth has already occurred. Almost all mold contamination problems in buildings are caused by failure to keep infrastructure clean and dry, and/or by failure in the design, operation, and maintenance of building systems.

This paper describes cleaning procedures for mold beginning with a review of consensus documents. The importance of an informed inspection prior to cleaning or renovation is emphasized. General principles for removal of colonized materials as well as sampling as a component of the inspection process are reviewed.

Review of Consensus Publications

International workshop on health implications of fungi in indoor environments.
This workshop held in Baarn, the Netherlands in 1992 [1] presented recommendations with regard to cleaning and removal of fungal growth in buildings. It was agreed that the health risks

of biocides are not adequately understood and therefore biocides should be used only as a last option for controlling fungal growth indoors. In addition, the inhalation of fungal spores and other mycological byproducts should be avoided when handling contaminated materials.

NYC Stachybotrys Guidelines. A panel in 1993 in New York City discussed appropriate remediation actions when visible Stachybotrys chartarum growth occurs on interior surfaces [2]. It was recommended that materials visibly colonized by mold should be removed by persons using appropriate personal protective equipment including respirators and gloves. The use of containment barriers (plastic sheeting) and negative pressurization was recommended for removal of moldy materials with a surface area greater than about $3m^2$. Smaller amounts of moldy materials should be removed or cleaned by simpler methods. A proposed revision of the 1993 document has been widely discussed but not yet published. Some highlights of the proposed revision are (a) all fungi that may colonize interior surfaces, not just Stachybotrys chartarum must be considered during clean-up. The inspection process of the building for water damage and mold colonization is the most important step in designing remediation and clean-up strategies. Four size areas of mold colonization ($<1\ m^2$, $1\text{ -}3\ m^2$, $3\text{-}10\ m^2$, $>10\ m^2$) with more conservative containment strategies (proportional to area colonized) have been proposed.

Health Canada [3] Fungal Contamination Guide. Health Canada published a guide to assist investigators in managing fungal contamination issues in buildings. An appendix in the guide recommended the use of personal protective equipment by persons doing clean-up of moldy materials. For large-scale (colonized surfaces greater than about $10m^2$) clean-up operations, physical isolation and negative pressurization of the clean-up area from both the HVAC system and from the interior spaces was recommended. Evacuation of building occupants should also be considered in large-scale fungal remediations.

ISIAQ Task Force Report. A 1996 ISIAQ report [4] reviewed previous publications on fungal remediation and recommended additionally that soft porous materials that are visually colonized should be discarded [5]. Cleaning and remediation should not render interior surfaces sterile, but rather return the building to a condition where normal (background) kinds and concentrations of fungi occur.

ACGIH bioaerosols committee. The ACGIH 1999 publication [6] classifies the extent of fungal colonization in buildings as minimal, moderate, and extensive without assignment of numerical surface area guidelines. During clean-up plastic sheeting barriers and negative pressurization should be used to contain dusts when extensive colonization is removed.

The Building Inspection

Successful cleaning of mold requires an understanding of the location(s) of contamination and the reason(s) why fungal growth has occurred. The informed building inspection is central to the clean-up process. Components of the inspection process include identifying those building materials affected by both fungal growth and moisture damage. Literature on identification of moisture and fungal growth problems in buildings [4, 6-10] should be reviewed prior to the inspection process.

The location and extent of visible fungal colonization must be determined during the inspection [11, 12]. An inventory of visibly moldy interior surfaces should be made including the extent (m^2) and location of colonized materials. It should be realized that fungal micro-colonies invisible to the unaided human eye may extend outward for considerable distances (approximately 0.5m) from moldy materials such as paper fiber gypsum board [13]. The presence of mycelia or

fruiting structures as seen by direct microscopic examination (e.g., cellotape samples) verifies that visible contamination is of fungal origin [6, 14].

During the inspection it should be determined if materials that are highly susceptible to biodeterioration such as those containing amorphous cellulose are hidden in damp moist niches in building components. In moisture-damaged buildings, the extent of hidden colonization is almost always greater than that which is readily visible in the occupied space [15]. In buildings with substantial moisture damage it may be necessary to open-up and inspect floor, wall and ceiling structural components in order to estimate the extent of hidden mold growth. Precautions must be taken during destructive opening of building structural components to protect occupants and investigators from spores that may be aerosolized if hidden colonization is found. Demolition of structural components may be required to expose pockets of contamination (e.g., sewage contaminated water) for adequate cleaning and drying [16].

As an aid to finding locations of hidden mold growth a clear understanding of locations of moisture damage as well as reasons for the damage is necessary. Cleaning of the building will ultimately be ineffective if moisture problems persist. A moisture meter can be used to determine if some finishes and construction materials which appear superficially dry actually contain significant amounts of moisture [17]. Literature on condensation and dampness problems in building envelopes in hot humid or cold climate/seasons should be reviewed in order to understand the reasons for consequential mold growth [9, 10]. Moisture problems associated with below grade structures and the building foundation especially if biodegradable materials are used in construction (e.g., wood joists and framing) must be revealed during the inspection in order to plan a strategy for cleaning.

Principles for Mold Clean-up

Important components of mold cleaning are (a) the physical removal of colonized materials, (b) removal of settled dusts containing spores that may have previously been dispersed from moldy surfaces, (c) prevention of spores and dusts generated during clean-up from entering occupied or clean areas, and (d) use of appropriate personal protective equipment by clean-up workers.

Porous materials such as paper fiber gypsum board, ceiling tiles, insulation, wallpaper, carpet, pressed wood products etc., that are visually moldy should be discarded. Mold growth that may be present on non-porous surfaces such as sheet metal, ceramic tiles, glass, etc., is physically removed by cleaning. Tap water with detergents or surfactants should be effective for most cleanings of non-porous materials.

The method used to remove colonization on semi-porous materials such as wood framing depends on the degree to which fungi have penetrated the substrate. Lumber that is dry rotted or wet rotted [17] is discarded. Wood that is sound with the exception of colonization of the outer surface may be sanded, planed, refinished, and reused. The principle for reuse is the absence of hyphae and fruiting structures (over and above that normally present in sound wood) in the wood cells of the timber being salvaged.

The airborne concentration of spores can exceed 10^6/m? when moldy materials are disturbed [18-19]. Consequently those persons involved in clean-up activities must use personal protective equipment. The use of a N-95 respirator and gloves is adequate during the clean-up of minimal (small surface area) colonization [6]. For remediations involving extensive colonization the use of full body disposable protective clothing and P-100 respirators is essential.

The use of containment barriers, depressurizing techniques, and dust suppression methods during removal of moldy materials is required to prevent dissemination of spores into occupied or clean areas [20]. The extent of the surface colonized (minimal, moderate, extensive) in a room or in one area of a building is the most important factor to be considered with regard to selection of containment methodology or dust suppression methods [6]. When moldy materials are removed or cleaned the area where the clean-up is occurring should be depressurized (negative air machine for large scale containment; nozzle of a HEPA vacuum for source containment) so that the flow of air is always from clean areas into the location where cleaning is occurring. Additional factors important in determining the dust containment methods employed during a remediation include (a) the presence of highly susceptible occupants [21] and (b) the likelihood that hidden colonization may be uncovered within building components.

A principle common to guidelines on fungal remediation [2, 4, 6] is that building maintenance personnel with proper training can perform clean-up involving minimal and moderate surface area colonization. Interior surfaces with minimal fungal growth (e.g., 1 or 2 ceiling tiles, 0.1 or $0.2m^2$ paper fiber gypsum board) can be removed by properly trained persons wearing gloves and a respirator. The colonized or moldy surface can be covered with a sticky sheeting (sticky surface makes contact with colonized surface), removed in one piece, bagged, and discarded.

Any technique that reduces dust (spore) emission from the colonized surface should be considered during cleaning. Thus, application of an encapsulant to a colonized surface prior to removal may be useful. The application of a gentle water mist to colonized surfaces may be effective in dust suppression so long as hydrophobic spores are not dispersed into the air by impaction of droplets. Water mists and sprays, if used, must not wet sound infrastructure.

Spores from colonized surfaces in one area of a building may have been dispersed by air currents into areas of the building unaffected by moisture problems. A combination of damp wiping and HEPA vacuum cleaning should be adequate to remove dusts from non-porous surfaces. Professional judgment is required to determine if porous surfaces can be cleaned by HEPA vacuuming. Specific protocols have been recommended for dust removal from some porous materials such as carpet [5].

The objective of clean-up is to remove colonization and associated mold laden dusts, but not to sterilize or disinfect interior surfaces. As such the use of biocides and disinfectants is to kill cells during clean-up is unnecessary unless infection is perceived as a health concern. The use of biocides and disinfectants during cleaning may confound efforts to determine cleaning efficiency when clearance sampling is based on culture techniques [22]. The physical removal of moldy materials plus the removal of associated dusts by vacuum cleaning and damp wiping should be adequate for cleaning [4, 6] in most buildings. If disinfectants are used in the clean-up of moldy surfaces, it is essential during the final cleaning process to remove dead residues that may potentially be allergic or toxic [23].

Sampling and Mold Cleaning

Sampling for fungi during building evaluations has been reviewed elsewhere [6, 24, 25]. Sampling for fungi in buildings undergoing mold cleaning must be preceded by a clear evaluation pathway that outlines how analytical data will be interpreted. For example, when the objective of air sampling is to determine if exposure conditions after a clean-up in a building are "normal", the collection of samples at many locations and at various times indoors as well as concurrently in the outdoor air is minimally required for data interpretation. The collection of one or a few samples seldom characterizes environmental mycological conditions [6, 24].

Comparison of air sampling data obtained both before and after clean-up with the knowledge that moisture problems have been fixed and that visually moldy materials have been physically removed adds to the strength of possible data interpretations. Awareness of limitations in sampling and analytical methodology is always important in data interpretation. For example, if the objective of sampling is to determine if Stachybotrys is present, then exclusive use of culture based methods may overlook non-culturable spores detectable only by direct microscope methods (e.g., cellotape and spore trap sampling).

During building evaluations including those involving cleaning, the results of an informed inspection are of greater value than sampling results alone obtained without the benefit of inspection. Table 1 shows the results of sampling by spore trap in a room with a history of chronic water leaks around windows. While Cladosporium accounted for the vast majority of spores collected in the room, a few Stachybotrys spores were also detected. The data might be interpreted to indicate that fungal reservoirs were present somewhere in the building. Alternatively, some investigators might interpret the sampling data as indicative of a ? normal? situation because of a predominance of Cladosporium. Subsequent destructive opening of the building envelope around windows showed that about 50% of the surface area of the hidden construction materials (e.g. wall cavity side of paper fiber gypsum board, asphaltic building paper, etc.) were colonized by fungi including Stachybotrys and Chaetomium. The sampling results in Table 1 could thus be more clearly interpreted namely that the Stachybotrys found in the room air had likely originated from reservoirs within the envelope. In addition, cleaning of room surfaces alone can not fix the mold problem in the envelope.

Table 2 presents sampling data on culturable fungi present in settled dust in a home where water damaged furniture had been stored for several weeks. Some mold had grown on the stored furniture as well as on flooring material. Cleaning of floors with a household vacuum cleaner had occurred subsequent to removal of furniture. The dominating presence of non-phylloplane fungi such as Aspergillus versicolor in settled dust indicated that cleaning for mold was ineffective.

Air sampling for fungi can be used to assist in determining if microbial particulate is being effectively kept out of occupied space during clean-up. Table 3 presents sampling data collected during removal of approximately m^3 of moldy wallboard (mostly Stachybotrys) from a water damaged envelope wall. The concentration of Stachybotrys increased by several orders of magnitude within the containment when moldy wallboard was being removed from the envelope wall. It is significant that some Stachybotrys spores were entering the occupied space indicating a deficiency in containment procedures. This finding indicated that spores were not adequately being confined within the containment during clean-up.

Table 1. Airborne fungal spores in room with a history of chronic leaks around windows

Spore Type	Spores/m?
Cladosporium	2,900
Penicillium/ Aspergillus	650
Stachybotrys	70

Collected by spore trap with a flow rate of 0.01 m? /minute

Table 2. Culturable fungi in settled dust in house where water damaged furniture had been temporarily stored

Predominant species	Frequency (%)

Aspergillus versicolor	50
Penicillium citrinum	26
Cladosporium cladosporioides	4
Aspergillus niger	3
Aspergillus ustus	3
other species	14

Rank order frequency of species recovered on malt extract agar by dilution plating

Table 3. Airborne Stachybotrys spores inside and outside a containment during clean-up

Location	Stachybotrys	Total Spores
	(spores/m^3)	
Inside containment, moldy materials not being handled	340	2,700
Inside containment, during handling of moldy materials	69,000	70,000
Outside containment	15	400

CLEANING OF MOLD - SPECIAL SITUATIONS

Hospitals. For more than two decades it has been known that incidence of infection (aspergillosis) among immunosuppressed patients is reduced when air entering a building is filtered [26]. Epidemics of aspergillosis in immunocompromised patients have been associated with the presence of fungal growth on surfaces in HVAC systems and with dust emissions associated with soil excavation, new construction, and interior renovations [21, 27].

Very conservative guidelines have been recommended to control and prevent exposure of immunocompromised patients to essentially all culturable fungal spores [21]. Procedures such as the following are recommended during renovation and clean-up work in hospitals: (a) isolate and negatively pressurize the remediation/clean-up area; rigid floor to ceiling, critical barriers are used to isolate patient areas from potential sources of culturable fungi, (b) administrative procedures are used to prohibit tracking of dusts into patient areas, (c) high quality air (spores absent) is provided to highly susceptible patients by point of discharge filtration in supply air ductwork, and (d) patient rooms are positively pressurized relative to areas containing fungal colonization and dusts aerosolized during cleaning and renovation. The conservative actions used to reduce incidence of fungal infection among immunocompromised patients provide a framework for guidelines that may be necessary in clean-up situations when highly susceptible people may be present in non-medical facilities.

Books, Paper, and Archives. The clean-up of books, paper, and archives damaged by floods and dampness involves a combination of discarding moldy items, drying out of wet materials, and removal of settled dusts. Fungi can grow rapidly on many of these materials because of the adhesives, gums, starch, etc., often present in book jackets and bindings and also because of the presence of delignified cellulose substrate.

Because of the susceptibility of books, paper, and archives to biodeterioration, the drying of

water damaged or damp materials is of critical importance. Freeze drying of water soaked material can be used in restoration because low temperatures arrest fungal colonization and evaporation of water molecules (subliming) lowers available moisture so that growth can not recur [28, 29]. A goal of restoration is to lower the moisture content of paper to its normal range, 5 - 7%, [30] where fungal growth does not occur.

Several simple techniques are available for removing superficial colonization from valuable materials. Miniature aspirators capable of applying a gentle suction to surfaces by a pipette nozzle can be used to carefully remove spores [28]. A small vacuum cleaner can be used to remove spores where a fine screen is placed firmly over the fragile material being cleaned [28]. All cleaning activities involving manual removal of colonization should be performed by persons with adequate personal protective equipment and preferably in a biosafety cabinet.

The cleaning of library materials which are not visually colonized but which were stored in buildings with mold growth problems is a challenge because of the enormous amount of paper surface potentially involved. The following activities can be effective in cleaning dusty library materials that had been stored in a moldy environment: (a) Vacuum (HEPA instrument) the top, bottom, and sides of books and files to remove settled dusts. (b) Vacuum and damp wipe the surfaces of shelves, file cabinets, desks and other non-porous fixtures. The visual presence of dust on books and on non-porous surfaces (e.g., shelves) in the library indicates unsuccessful cleaning. (c) Fan the pages of the books, files, and other archives in the immediate vicinity of the suction orifice of a HEPA vacuum. The objective is to reduce the amount of dust present on surfaces of library materials.

Residences. As a general principle, it is recognized that people should not live in moldy homes [5]. Clean-up of fungal colonization in residences differs from that in most large buildings because of occupancy and construction reasons. Occupants may be present 24 hours a day, 7 days per week in homes. Occupants of residences may also be specially sensitive or susceptible to fungal exposure (e.g., persons with immunosuppression diseases).

Most residences are smaller in volume than commercial and public buildings. In comparison to a large office building, a residence has a greater ratio of envelope surface (roof, exterior walls, basement) to air volume. There is a greater envelope surface where moisture may enter from precipitation or from the soil. Fungal growth problems in residences are increased by the use of porous biodegradable materials in damp locations such as basements.

Residences differ from office buildings because of the greater use of wood framing and pressed wood products in the former. Consequently wood rot fungi are more likely to be present in a residence with persistent moisture problems. Cleaning of mold in residences is often logistically difficult because of problems with access to biodeteriorated wood structural members in crawl spaces and attics.

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