MILLE LACS RESERVATION TRIP REPORT
Assessment of Mold and Moisture Conditions

Addendum to Final Report

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ADDENDUM: SECTION 5 – DISCUSSION OF COMMON PROBLEMS

5.1 Site Drainage

When rain falls on a building site, where should the water go? The roof should be designed and built so that the water that lands on the roof moves out to the edge of the roof. When rain falls on a soil surface, some of it will percolate downward through the soil—more in sandy soils and less in clayey soils. The water that does not percolate downward will move along the soil surface following the slope, out to the downhill edge of the site. The best way to prevent mold and moisture problems in houses is to make sure that rainwater moves off the roof, across the site, and off the property. The houses that have problems are the houses that allow water to accumulate in the soil in contact with the foundation. The soil in contact with the foundation should, in a well-managed property, be the driest soil on the site following a rainstorm. Houses with dry foundations (basements, crawl spaces and slabs) are usually dry houses. Keeping the foundation dry is the key to a good indoor environment in most houses. To keep the foundation dry, keep the soil dry that is next to the foundation.

Keeping the soil touching the foundation dry involves a few general rules, together with some specific guidelines.

The first general rule is the rule of concentration - damage is worse where greater quantities of water are concentrated. A valley on a roof acts like a funnel, with the greatest concentration of water at the base of the valley. Gutters act like funnels that collect water from the edge of the roof and concentrate it in the downspout. On the land, valleys and swales act like collectors or funnels that concentrate the water on the site. If the water management design makes use of funnels (such as valleys, gutters or swales) then they require maintenance to make sure they work as they are intended. Damage is worst where a valley, gutter or swale is blocked.

The second general rule is the ground-roof rule - treat the soil surface as if it were a low-slope roof surface. Pitch the surface away from the house - the steeper the pitch, the better the drainage. Imagine all the water moving to the low edge of the site, and imagine how best to get it there. Avoid areas near the building that can act as water collectors.

Specific site drainage guidelines include:

- The house should be built on a crown, not in a hole. If there is sufficient exposed foundation, site grading at the house can be improved. If the house hugs the ground, improvements at the foundation are more difficult. There should be a minimum of eight inches of exposed foundation between the ground and the beginning of the siding.

- Identify localized dips and holes immediately adjacent to the foundation and fill with dirt. Tamp the fill material to prevent future settling. Provide sufficient fill material such that drainage occurs away from the foundation.
• If the house has no gutters, then the base of the soil around the house has to serve as a gutter itself. It should have a surface that helps prevent splash back onto the siding of the house. It should be designed with pitch so that it effectively moves water away from the house.

• Good tamping or compaction of the backfill is very helpful because it helps keep water up on the surface where it can be managed by slope. Soil at the outside corners of the foundation, where the downspouts are usually found, can always be tamped because the corner will never collapse inward.

• Bushes and other plantings may be very helpful, especially if their root balls soak up a lot of water. Also they can be planted strategically near downspouts so that the downspout extenders are less likely to be kicked off or removed during lawn mowing.

5.2 Rain Water/Snow Melt Management

Rain water and snow melt from the roof should be collected and distributed away from the foundation with a gutter system. Flashings around chimneys and vents should be watertight.

• Include waterproofing underlayment at the eaves and in valleys as part of re-roofing to help prevent water damage caused by ice dams.

• Gutters can be an effective rain water/snow management system. Pitch the gutters to the downspout. Short gutters may be hung level. In hip roof houses, consider using downspouts only on the downhill side not on the uphill side. In areas with a moderate amount of trees, consider large gutters and downspouts where leaves and debris can be flushed more easily. Make sure the gutters hangers are solid so that they keep the gutter from sagging.

• Downspouts should be secured to the house. They should never be undersized, and some oversizing never hurts. Fasten elbows and straight sections together with pop rivets—screws that project into the downspout can lead to clogging.

• At the base of the downspout, the water has to be directed away from the foundation of the building. It should be directed out past the backfill onto the undisturbed soil, which may be 3’ to 5’ out from the edge of the house. If it is allowed to dump water close to the foundation, into the backfill, it will concentrate the water next to the foundation—precisely the wrong place for the water to be. The traditional way to discharge the water away from the house involves using downspout extenders (sections of straight downspout) or splash blocks. Both of these are often disturbed when lawns get mowed. A notched section of downspout that is hinged to the elbow at the base of the downspout, as is currently used by MLRHA, can solve this problem. The soil at the base of the downspout should be sloped away from the house at a
minimum of 5% slope. Six inches of fall in the first 10’ away from the house gives a 5% slope.

- Keeping cutters clean in wooded areas can be a maintenance issue. A gutter guard system can help keep debris out of the gutter, thus minimizing maintenance, while allowing water to drain into the gutter.

Two such gutter guard systems are the *PermFlow Gutter Guard System* and the *WaterFall Gutter Guard System*. These systems cost about $4.50 per 3’ section and are designed for a 5” K style gutter (8’ sections are sold to contractors).

5.3 Crawl Space Design

The thermal boundary is the building section that separates conditioned space from outside conditions. A clear distinction should be made whether the crawl space walls or the floor above the crawl space is the thermal boundary for a home. Insulation on the foundation walls indicates that the foundation walls form the thermal boundary. Crawl space vents indicate that the floor above the crawl space is the thermal boundary. Crawl space vents indicate that the floor above the crawl space is the thermal boundary.

Both of the above conditions were found in the inspected homes. Crawl space walls were insulated with either 2” (R10) or 4” (R20) extruded polystyrene foam, the latter being integral to the ICF system. Both insulation levels indicate the foundation walls form the thermal boundary. However, some of these crawl spaces were vented. If the crawl spaces are to be vented, then the floors above the crawl spaces should be insulated and air sealed with all mechanicals (ductwork, plumbing) above the insulation.

The mechanicals are currently exposed in the crawl spaces. Depending upon where the thermal boundary is located, one of two strategies may be employed. It is our recommendation that the crawl space foundation walls be the thermal boundary given the current conditions found in the homes.
Crawl Space Walls is the Thermal Boundary

The crawl space is unvented (Figure 29). It shows an exterior insulation system that allows a shallower frost wall, although the foundation wall may be insulated down to the footing, either on the inside or outside of the foundation wall. The drawing also shows a concrete pad sloped to a sump pump. Should water get into the crawl space, it can be drained and pumped from the crawl space. The concrete pad serves as a ground cover that can be cleaned and is more durable than a polyethylene ground cover.

In essence, the crawl space is designed as a stubby basement that is conditioned as a result of ductwork being located there. The ductwork had open supply and return registers in some cases. As unvented crawl spaces are not yet allowed by most codes, it may be necessary to add closeable vents to obtain a building permit.

- Floor Above the Crawl Space is the Thermal Boundary

A detail showing a well-vented crawl space is shown in Figure 30. The “bellyboard” membrane seals the home from the crawl space. A small drain to discharge any leaks or overflows from the bathroom and kitchen may be added. No ductwork or piping should be run in the crawl space, except for services. Water service piping should be insulated with electric heating tape. Generous venting is required in the foundation walls, with the vents held well off the ground. Vents installed according to code can only deal with small
amounts of moisture. Consequently, it is essential to include a continuous and sealed ground cover to ensure that water drains away from the crawl space.

![Figure 30](image)

The following points relate to crawl spaces in general, regardless of thermal boundary.

- Crawl spaces should have easy access and good lighting so as to enable regular inspections.
- Return air grilles should be sealed.
- Water in crawl spaces typically comes from poor rainwater management outdoors, plumbing leaks, air conditioner condensate or water softener discharge.
- Cover the ground surface with a ground material: a concrete slab, a polyethylene sheet or other vapor-proof material. The ground cover must be sealed to the foundation walls. All joints and seams must also be sealed. The ground cover must also be sealed to foundation piers interior to the crawl space.

### 5.4 Bathroom and Kitchen Exhaust Fans

Several rooms in a house are natural moisture sources simply by the nature of their function. Showers are taken in bathrooms resulting in 100% humidity in that room.
Kitchens are used for cooking and cleaning. In laundries, clothes dryers must remove large quantities of water from wet clothes. By removing moisture at the source in these areas, exhaust ventilation serves as a source control strategy. Exhaust ventilation dilutes the moisture and places the room in a negative pressure, thus limiting the spread of moisture to the rest of the house until most of the moisture has been removed to the outside.

Bathroom exhaust fans, kitchen exhaust fans and clothes dryers should always vent to the outside rather than into the living space. Venting to the basement, crawl space and attic can lead to moisture problems occurring in these areas. For this reason, localized exhaust ventilation requires ductwork.

The effectiveness of exhaust fans is based on the power of the exhaust fan, length and type of exhaust duct and cleanliness of the fan grille. When there is excessive resistance in the ductwork, the exhaust fan motor may not be powerful enough to vent sufficient airflow through the duct. The longer the duct length, the greater the static pressure in the duct and the less air flow through the duct. Turns and bends in the ductwork also increase the static pressure and reduce flow. Similarly, a smooth duct provides less resistance and improved flow over ribbed ductwork. For all types of exhaust ventilation, using round, smooth sheet metal ductwork is recommended. A dirty intake grille will also greatly increase resistance and reduce airflow.

Fan capacity is typically listed at 0.10" and 0.25" of static pressure. Bathroom exhaust fans should provide a minimum ventilation rate of 70 CFM at 0.25" of static pressure. Selecting a fan capacity at 0.10" static pressure is appropriate only if the exhaust duct is smooth, straight (no more than one elbow) and less than 15' in length. For example, a bathroom fan with an exhaust ventilation rate of 90 CFM or 100 CFM (at 0.10") may have to be selected to obtain 70 CFM at 0.25" of static pressure if there are numerous elbows, the exhaust duct is ribbed and the length is over 15’. Fan performance curves should be reviewed to determine ventilation rates at 0.25".

Range hoods should be replaced whenever possible with venting to the outside mandatory. The hoods should have a minimum exhaust capacity of 150 CFM. Under no circumstances should recirculating fans be installed in place of the existing range hoods.

5.5 Dryer Vents

Dryer vents should be smooth-surfaced rigid duct. Non-combustible flexible metal duct approved for dryer venting may also be used. Duct joints shall be in the direction of airflow. Ducts should not be fastened with screws or fasteners that extend into the duct. The length of the duct run should be minimized, especially with flexible metal duct. Flexible metal duct should be installed without dips or sags. Dryer vents extending through non-conditioned spaces should be insulated.

Minimum duct diameter should be 4" and length should not exceed 25’ from the dryer outlet to the termination point. If duct length is greater than 25’, a 5” diameter duct should be used.
Dryer vent caps should have a backdraft damper that closes when the dryer is not being used. Insect screens or small wire cages should not be installed over the vent cap.

5.6 Heat Recovery Ventilation Systems

In cold winter climates, excess airborne water vapor (relative humidity) can be considered a pollutant with the potential for contributing to mold contamination. The purpose of an HRV is to provide fresh outdoor air for dilution of pollutants and improved indoor air quality. In the process of bringing fresh air into a building, and exhausting stale air from the building, an HRV passes the two airstreams simultaneously through a heat recovery core, thus recapturing some of the heat (estimated between 50% and 80%) that would otherwise be exhausted with the stale air. Mechanical ventilation augments the natural infiltration of outside air that occurs in buildings. In tight buildings with limited natural infiltration, mechanical ventilation can serve an important role in the dilution of airborne water vapor, and thus reduce the potential for interior mold contamination.

For most effective operation, a mechanical ventilation system should supply fresh air to all the main living spaces, such as bedrooms, living, dining and family rooms. The distribution should be designed to ensure mixing of the fresh air and provide balancing of the distribution system. Exhaust should remove air from spaces in which moisture and odor are generated, generally kitchens, bathrooms and utility rooms.

The HRV systems in the new homes are properly designed. HRV’s that have been added to existing home may utilize the existing forced air distribution system or may have their own duct system for supplying and returning air. Systems utilizing the existing ductwork provide air to all of the living spaces but may benefit by adding exhaust ports in the bathroom and kitchen (current exhaust is near the kitchen/dining area). Systems that utilize a separate duct system have one supply register and one return register, each located around the corner from each other. In such a system, air is short circuiting the home and is not being circulated around the home (Figure 31). Consideration should be given to modifying these systems to provide air to all of the living spaces.

5.7 Occupant Items

A number of occupant items were identified that can cause moisture and mold problems. Occupants should be trained in the following items to assist in solving and eliminating moisture and mold problems in their homes.

- what is mold and what causes it
- importance of maintaining gutter system
- use of exhaust fans

Figure 31— Supply and return air registers located around the corner from each other.
• use of crawl spaces and storage of items in them
• use of rugs in below grade living spaces
• changing furnace filters
• operation of HRV’s
• difference between plumbing leaks and water condensing on pipes
• inspection of sump pumps
• ductwork