LAC VIEUX DESERT TRIP REPORT
Assessment of Mold and Moisture Conditions

Final Report

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**Background Information**

The Lac Vieux Desert Reservation is located in Gogebic County in the upper peninsula of the State of Michigan. The winter climate consists of cold temperatures and heavy snowfall. The reservation has many lakes, streams, and rivers, along with wetlands and marshes. Tribal staff reported high water tables due to their location, which have contributed to mold and moisture conditions. There are about 1,000 residents living on the reservation, the housing authority manages the Low Rent.

**Day 1**

December 1, 2002

Today was a travel day to the reservation.

**Day 2**

Monday, December 2, 2002

Before beginning inspections, we attended the Lac Vieux Desert Housing Authority. During the tour, our inspectors were Dana Kuilman, Acting Division Director for Housing Services, and Carolyn Garcia, Rhinelander District Service Division Director. Inspections were conducted at the Child Development Center, and the initial meeting was held with Tony Lane, LVD Housing Director. Inspections were completed at two housing authority offices, where the schedule for the day’s activities was reviewed.

The inspectors examined 14 properties, consisting of properties of three houses. A fourth residence was not possible the inspection. In the afternoon, the team inspected the LVD Child Development Center, which reviewed a history of mold and moisture problems. The team has reviewed previous work to determine the presence of the problems and what can be done to resolve the issues. Digital photographs were taken in each unit to record conditions. The inspection process involved visual assessment of both interior and exterior conditions, moisture content readings of walls, and floor framing members in basements. All photos and discussion are consistent with available resources.

The Lac Vieux Desert Technical Housing Assessment Report includes a detailed analysis of findings and recommendations for the properties inspected at the Lac Vieux Desert Reservation.
INTRODUCTION

Jeff Gordon from the Building Research Council (BRC) at the University of Illinois Urbana-Champaign, and Robert Nemeth of Magna Systems, conducted a site visit at the Lac Vieux Desert Reservation on December 1-2, 2002. The purpose of the site visit was to provide technical assistance to the Lac Vieux Desert Housing Authority in assessing mold and moisture conditions in housing units. This is a summary report of activities and issues addressed while on site. A detailed analysis of the findings and recommendations is found in the attached report, entitled: Technical Housing Assessment Report: Examining Mold and Moisture Conditions of Homes and the Child Development Center on the Lac Vieux Desert Reservation.

BACKGROUND INFORMATION

The Lac Vieux Desert Reservation is located in Gogebic County in the upper peninsula of the State of Michigan. The winter climate consists of cold temperatures and heavy snowfall. The region has many lakes, streams, and rivers along with wetlands and marshes. Tribal staff reported high water tables. This type of topography can contribute to mold and moisture conditions. There are about 118 Native Americans residing on the reservation. The housing authority maintains 35 Low Rent units.

Day 1: Sunday, December 1, 2002

The first day was a travel day to the reservation.

Day 2: Monday, December 2, 2002

Monday involved inspections of properties on the Lac Vieux Desert (LVD) Reservation. Joining the team on the inspections were Diana Kuklinski, Acting Division Director for Bemidji Environmental Health Services; Carolyn Garcia, Rhindelands District Service Unit Environmental Health Officer; and Casey Crump Rhinelander District Environmental Health Officer, Indian Native Health Service. A brief initial meeting was held with Tony Labine, LVD Housing Director, at the housing authority office, where the schedule for the day’s activities was reviewed.

The morning’s activities consisted of inspections of three houses. A fourth residence was not available for inspection. In the afternoon, the team inspected the LVD Child Development Center. This facility has a history of mold and moisture problems. The team first reviewed previous work performed to address the problems, then examined the building for current moisture and mold issues. Digital photographs were taken at each site to record conditions. The inspection process involved visual assessment of both interior and exterior conditions, moisture content readings of wood floor framing members in basements or crawl spaces and discussion with available residents. The attached Technical Housing Assessment Report provides a detailed analysis of findings and recommendations for the properties inspected at the Lac Vieux Desert Reservation.
FINDINGS

An overview of findings and recommendations for the LVD site visit follows:

1. The Lac Vieux Desert Housing Authority appears to be exceptional at responding promptly to complaints and problems regarding mold and moisture. The houses inspected had only past mold and moisture complaints.

2. Site drainage and rainwater management could be improved at all of the properties. Though these conditions were not creating problems at the time of the inspections, there were reports of foundation flooding during the rainy months.

3. One house showed signs of condensation events at the wall/ceiling junction on the north side, though mold growth was not associated with the problem at the time of inspection. Improvements could be made to the insulation details in this area to prevent this problem.

4. Ice damming was a problem at one house, and potentially at the LVD Child Development Center. Insulation improvements, air sealing between the living space and the attic, and attic ventilation can all be helpful in preventing this problem common in the snowy northern climates.

5. Descriptions of past water intrusion and mold problems at the LVD Child Development Center indicated serious chronic conditions. It appears that the efforts to remediate those conditions have been successful, particularly relating to site drainage, roof repair, and rainwater management. Only one dormant mold growth was identified related to a past plumbing leak. Additional measures on site drainage and rainwater management are advised, as well as a detailed roof inspection to prevent future ice damming.

PROGRAMMATIC RECOMMENDATIONS

A particular challenge to all housing authorities is the development of a service-delivery system to effectively address mold and moisture conditions in a prompt fashion. This requires a partnership between the housing authority and tenants. A system could include training for the maintenance staff on how to implement the technical recommendations and training for residents on their roles and responsibilities as renters and homeowners. In many cases, moisture problems develop but go unreported and unrepaired, resulting in significant mold contamination that could have been avoided. Some strategies follow:

1. Require attendance at annual homeowner/renter clinics as part of the annual recertification process. These clinics would provide instruction on home maintenance topics, such as identifying and repairing leaks and gutter maintenance could be presented.

2. During the annual recertification process, have occupants complete a survey based on Housing Quality Standards (HQS), with additional questions on mold and moisture conditions in their homes. Having the resident complete the survey further engages them in their own home maintenance. Furthermore, the survey responses will provide additional information to the housing authority on any unreported problems (especially leaks and inoperable fans) that may contribute to an unsafe, unhealthy home environment.
TECHNICAL HOUSING ASSESSMENT REPORT

EXAMINING MOLD AND MOISTURE CONDITIONS OF HOMES AND THE CHILD DEVELOPMENT CENTER ON THE LAC VIEUX DESERT RESERVATION

Executive Summary

Introduction

Section 1: Methodology

Section 2: Findings, Recommendations, and Discussion
  2.1. Maintenance Management
  2.2. Exterior Site Drainage and Rainwater Management
  2.3. Wall/Ceiling Junction on Exterior Walls
  2.4. Ice Damming

Section 3: Child Development Center

Appendix A: Site Visit Summary Form

Appendix B: Housing Survey Results
EXECUTIVE SUMMARY

On December 2, 2002, the Building Research Council and Magna Systems conducted a site visit to the Lac Vieux Desert Reservation Housing Authority was conducted by the. The purpose of the visit was to investigate mold and moisture conditions in housing units and the Child Development Center. Building Research Council staff member, Jeffrey Gordon, and Magna Systems’ staff member, Robert Nemeth, conducted this investigation. A total of three housing units (two rentals and one private residence) were inspected in the morning of the site visit. Housing inspections consisted primarily of visual assessment of mold and moisture conditions. In the afternoon the inspection team examined the Child Development Center at the Lac Vieux Desert Reservation, a facility with a history of mold contamination problems. No serious mold problems were identified in the houses. The following are the principal findings from the site visit:

1. A housing authority’s best defense against mold and moisture problems is an effective maintenance department. The houses that were inspected had previously reported moisture and mold problems. In each case, the moisture source problem had already been addressed, and the mold contamination remediated. The LVD Housing Authority maintenance program has been proactive and effective in addressing mold and moisture problems.

2. All three residences inspected, as well as the LVD Child Development Center, had site drainage and rainwater management issues. Site drainage and rainwater management are critical to maintaining a dry foundation, which is critical for maintaining a dry, mold-free house.

3. One of the houses inspected showed signs of condensation and staining at the wall/ceiling junction along the north elevation, though mold growth was not apparent at this site. This is a very common problem in older ranch-style homes with low-pitched roofs located in northern climates.

4. The private residence had ice damming potential, with one ice dam having formed below a roof valley. Ice damming potential was also an issue at the Child Development Center. This is a common problem in northern climates.

5. The LVD Child Development Center had suffered previous water damage and mold contamination resulting from roof leaks, site drainage, and rainwater management problems. Renovation efforts successfully addressed these problems. Additional site drainage and rainwater management repairs should be considered on the north and east elevations. Only one site of mold contamination was identified; this was a dormant mold site behind a baseboard, associated with a pre-existing or past plumbing problem. Maintaining, and possibly improving, the roof drainage system, along with efforts to identify and address potential ice damming problems, will be central to preventing water intrusion in the future.

The report provides technical recommendations and discussions focusing on these problem categories. Appendix A includes a summary of findings from the inspections. Appendix B provides a detailed assessment of each home.
INTRODUCTION

The on-site inspection team responded to a request from the Eastern/Woodlands Office of Native American Programs and the Lac Vieux Desert (LVD) Housing Authority to assess physical site and structural conditions contributing to mold and moisture problems on the LVD Reservation. The team inspected a total of four buildings; three of the properties were inspected during the morning of the site visit. Two of the houses were rentals owned by the LVD Housing Authority, and one house was a privately owned residence. The fourth home was not available for inspection. The selection of the homes were made on the basis of known mold problems having occurred in the past.

On the afternoon of the site visit, the Child Development Center on the LVD Reservation was inspected. This large facility had a recent history of moisture and mold problems. The Team’s inspection focused on the effectiveness of recent improvements intended to address the moisture problems, and on the current conditions that could contribute to ongoing moisture and mold problems. The inspection was lead by Carolyn Garcia, IHS staff member responsible for the LVD region. The builder principally involved in the diagnosis, recommendations, and repairs that addressed the previous mold and moisture conditions was also participated in the inspection.

For the purposes of this report, the three residences are discussed together in the body of the report. Individual write-ups of each house are contained in Appendix B. The Child Development Center merits a separate section in the body of the report.

SECTION 1: METHODOLOGY

Housing inspections consisted primarily of visual assessment of mold and moisture conditions. Assessment forms developed for the Chicago Mold and Moisture Project, a HUD Healthy Homes program, were used to record information. The assessment forms are organized for a room-by-room inspection. All rooms were examined for water damage and evidence of mold. The assessment of kitchens, bathrooms, basements, and attics included additional inspections relating to plumbing, ventilation, and water entry issues. The exterior of the houses were inspected for rainwater management, including site grading, roof condition, and the gutter system.

Whenever possible, residents were interviewed to gather history on moisture problems, flooding, winter condensation problems, and other useful information that could be offered.

In selected basements and crawl spaces, moisture content measurements were taken of floor framing members. Because of the storage capacity of wood, moisture content measurements provide information on foundation and basement wetness during the past three weeks to a month. Moisture content readings can range from 5%, indicating a very dry reading, to 30%, indicating a very wet reading.

Digital photographs were taken at each house to visually record notable conditions.
SECTION 2: FINDINGS

The three houses inspected constitute a small sample upon which to base findings. An insufficient number of houses were visited to draw conclusions about common problems that affect this reservation. Most of the moisture conditions identified pertained only to one of the three houses. However, based on visits to several other northern reservations, some of the conditions identified are very common for housing in the northern Midwest climate. With this in mind, the following discussion provides an analysis of and makes recommendations for three common problems that were identified in one or more of the LVD residences. Those three conditions include:

- Exterior site drainage and rainwater management
- Wall/Ceiling junctions on exterior walls
- Ice damming

It is hoped that these discussions and recommendations will serve to assist the LVD Housing Authority in addressing future moisture problems that may arise.

Prior to the discussion of technical issues, an assessment of the LVD Housing Authority’s Maintenance Program merits discussion.

2.1. Maintenance Management

Many moisture problems, and the resulting mold contamination, are the result of deferred maintenance. Any situation with a water leak should be addressed promptly. Lingering water infiltration problems from plumbing, roofing, or foundation sources can turn a small problem into a large one. The potential for mold can turn into a major contamination site. While this fact seems obvious, it is remarkable how often water leakage can go unreported and unattended.

A housing authority’s best defense against mold and moisture complaints is its maintenance department. A good maintenance program should be proactive regarding mold and moisture problems, and include the following:

- Perform regular inspections of properties to identify problem moisture conditions
- Encourage reporting of moisture problems from residents
- Respond promptly to identified and reported moisture problems to prevent excessive mold contamination

Through site visits to several reservation housing authorities, BRC inspection teams have had the opportunity to observe, at least in a secondhand way, the effectiveness of housing authorities’ maintenance programs. It should be noted that the maintenance program at LVD appears to be first-rate. The houses that were inspected had previous moisture and mold problems. In each case, the source of the moisture problem had already been addressed and the mold contamination remediated. Indeed, while some improvements to moisture performance are noted in the findings, there were no active mold problems identified during the visit. This is a significant finding. The LVD Housing Authority
should be complimented for their efforts in operating a maintenance program that effectively deals with maintenance problems.

### 2.2. Exterior Site Drainage and Rainwater Management

All three residences inspected on the LVD site visit, as well as the LVD Child Development Center, had site drainage and rainwater management issues. Site drainage and rainwater management are critical to maintaining a dry foundation, which in turn is critical for maintaining a dry, mold-free house.

#### 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 is moved out to the edge of the roof. The same is true of a building site. When rain falls on a soil surface, some of it will percolate downward through the soil—more in sandy soils and less in clay soils. The water that does not percolate downward should 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 and across the site and off the property. The houses that have problems often allow water to accumulate in the soil that is in contact with the foundation. The soil that is 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 that touches the foundation dry involves a few general rules, together with some specific guidelines.

#### General Rules for Dry Foundations

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

- 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. If there is not sufficient exposed foundation to achieve sufficient pitch away from the house, gutters may be required.

- 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 comer 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.

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 gutter 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 and 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), also known as leaders and splash blocks. Both of these are often disturbed when lawns get mowed (Figure 1).

  Instead, use a notched section of downspout that is hinged to the elbow at the base of the downspout. 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 (Figure 1).

- If the grading of the site allows, downspouts can also discharge into drain tile that run to daylight at a drainage ditch, swale, or hillside on or adjoining the site. This is a preferred method, as it avoids the maintenance problems associated with leaders that often get broken or go missing, thus leading to concentration of rainwater at one point of the foundation. There must be sufficient grade on the site to ensure proper pitch to the drain tile (minimum 1/8" fall/foot of run), as well as an outlet for free flowing rainwater.

- Keeping gutters 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.
One such gutter guard system is the *PermFlow Gutter Guard System* (Figure 2). There are several similar systems on the market that offer a variety of gutter sizes and shapes. These systems cost about $4.50 per 3’ section and are designed for a 5” K style gutter (8’ sections are sold to contractors).

### 2.3. Wall/Ceiling Junction on Exterior Walls

One of the houses inspected (E-23943) showed signs of condensation and staining at the wall/ceiling junction along the north elevation. No mold growth was apparent at this site, and the source of the staining was not identified. This is a very common problem in northern climates in older ranch-style homes with low-pitched roofs.

High relative humidity and cold surfaces can lead to mold growth. If a surface approaches the dew point temperature based on the relative humidity, water will condense, be quickly absorbed by the material, and raise the moisture content of the surface. At some point, the moisture content can be sufficient to promote mold growth. This process often occurs at the wall/ceiling junction on exterior walls.

There are at least three reasons why the exterior wall/ceiling juncture gets cold:

1. Cold wind may enter through soffit vents and pass through the porous insulation material, degrading its thermal performance.
2. The insulation may have been poorly installed resulting in reduced amounts of insulation in the corner.
3. The geometry of the corner usually means that slow-moving currents of warm air may not be able to reach into the corners (Figure 3).

Dark spots occur where the interior surfaces are the coldest. They occur there because that is the hardest place to insulate effectively. In new construction, use a raised-heel truss and make sure the insulation installer pays special attention to the wall-roof joint. Anyone who has tried to insulate an attic knows that it is difficult to carefully insulate the
exterior edge of the attic, especially in homes with low-pitch roofs. With batt insulation, special pusher sticks may be used to get the insulation out to the edge. With loose fill insulation, the outside edge should be prepared correctly so that it is packed with insulation.

In existing construction consider using a retrofit as shown in Figure 4. The work is done from the outside. Remove the soffit material. Install a fiberglass baffle in each cavity space. Push the existing insulation back up against the sheathing or the baffle. Blow in new cellulose insulation, or pack in fiberglass insulation, into the cavity. Then install pre-cut rectangles of rigid foam insulation to block air flow. (If blowing in loose-fill insulation, the rigid foam insulation should be installed first, and blown insulation second). Use spray-applied foam insulation to keep the rigid rectangle in place. Replace the soffit. If the attic is ventilated, make sure that nothing blocks the baffles.

Many individuals and organizations (including model codes) stress the importance of attic ventilation. While it has some benefits, it also has some drawbacks. Wind washing of insulation at the edge is one of the major drawbacks. Designs without attic ventilation may improve the performance of the eave area, and most designs without ventilation rely upon the verified airtightness of the ceiling plane for good moisture performance. For more information about the benefits and drawbacks of attic ventilation see “Issues Related to the Venting of Attics and Cathedral Ceilings” at [http://www.fpl.fs.fed.us/documnts/pdf1999/tenwo99a.pdf](http://www.fpl.fs.fed.us/documnts/pdf1999/tenwo99a.pdf).

The retrofit presented is designed to keep the wall/ceiling juncture warm, and eliminate the condensation site. Lowering the moisture load in the house and reducing the relative humidity, also helps prevent wintertime mold and moisture problems.
2.4. Ice Damming

The private residence had ice damming potential, with one ice dam having formed below a roof valley. Up north, especially when the temperature drops below freezing following a snowstorm, many buildings have problems with ice dams. Ice dams show up as large icicle formations on the outside of the building, and can result in water leaking and staining at the exterior wall and ceilings inside.

The problem begins with an attic that is too hot. The excess heat in the attic melts the snow above and the melted snow refreezes at the eaves. When refrozen ice builds up at the eaves, the continued melting above the ice dam can cause saturation of the snow with melted water. That water may have a hydraulic head that can allow it to back up under shingles, and perhaps back up behind a joint in the underlayment, then ultimately through a joint in the sheathing. If it manages to find those joints, it can drip, sometimes in considerable quantities, down onto the insulation, the top plate, and the topside of the vapor barrier, if there is one. From there it may find its way to stain the ceiling drywall. Mold growth on the interior and in the building cavities can occur.

Most attics are designed to be cold during winter, with insulation on the floor of the attic. If the attic has a good amount of insulation (R-30 or R-38), no ductwork in the attic and no gaping openings in the ceiling, then the likelihood of ice damming should be small. Additional security can come with attic ventilation and by the use of waterproofing underlayment, such as an ice and water shield. If waterproofing underlayment is used it should cover any area where ice dams may form—three to six feet up from the wall plate and three to six feet on either side of a roofing valley.

If the building suffers from ice damming, look for:

- Insufficient attic insulation. R-30 or R-38 (10 to 12 inches deep) is recommended for cold climates.
- Openings in the ceiling that let indoor heat escape into the attic. Potential openings include spaces around mechanical chases, electrical wiring, chimneys, vent pipes, and wall partitions in balloon-framed construction.
- Mechanical equipment or ductwork that allows heat to escape. Ductwork should be well insulated if it runs through an unheated attic space.

Attic ventilation is fine and will help address an ice damming problem, but ventilation should be used only after the insulation, openings and mechanical equipment are addressed. In northern climates, reroofing with waterproofing underlayment at the eaves is always a good idea.

SECTION 3: LVD CHILD DEVELOPMENT CENTER

On the afternoon of December 2, 2002, the team inspected the Child Development Center at Lac Vieux Desert. The building houses a Head Start Program, day care facilities, and other social service programs. This large facility has a recent history of
moisture and mold problems. The inspection focused on the effectiveness of recent improvements intended to address the moisture problems, and on the current conditions that could contribute to on-going moisture and mold problems.

**Previous Mold and Moisture Issues**

Originally a casino, the facility has had several additions. As a result, the building ended up with a hodgepodge of roofs. Most critically, a section of flat roof was in one place on the south elevation with no less than three gabled roofs draining onto its surface. This was a recipe for continuous water infiltration and mold problems, as was reported to be the case. To address this problem, a new gabled roof was built over the entire back of the building, enclosing the flat roof and the two adjoining gable roofs. This solution appears to have proven effective in eliminating roof leakage and corresponding mold contamination through the central portion of the building.

One outcome of this solution was to virtually triple the rainwater runoff that occurred on both the east and west elevations. Site grading and rainwater management at these locations was not adequate to prevent water intrusion and mold contamination on these elevations. Reported descriptions of conditions indicated major water damage and mold growth, particularly at the base of the west wall.

At the time of the inspection, repairs and modifications had been made to address the mold and moisture problems at these locations. On the west elevation, repairs included:

- Reconstruction of the eave to provide greater overhang from the building
- Installation of water shield membrane at the eave
- Installation of a gutter system
- Site grading and exterior concrete installation to direct rainwater away from the foundation
- Removal of mold contaminated drywall and framing, and the installation of new interior finishes with greater moisture resistance (Figure 6).

Similar, but less extensive, repairs were performed on the east elevation. These repairs provided a remedy for the mold problems resulting from exterior grading and rainwater management. The measures taken were appropriate and appeared to be effective at the time of inspection.
Current Mold and Moisture Problems

The building was inspected for current mold and moisture problems. Active moisture and mold contamination sites were not visible on interior surfaces.

One location of dormant mold was pointed out behind a baseboard on an interior wall in one of the childcare rooms. Upon clearing the wall of shelving and removing the baseboard, a mold site approximately 3” by 10” was observed. The area was dry and the mold dormant. In the closet on the opposite side of the wall, directly adjacent to the mold site, was a floor-mounted mop sink. It was clear that the moisture supporting the mold had been due to the mop sink, either from splashup from use of the sink, or from a leaking supply or drain line serving the basin. The sink is currently unused, and the mold contamination no longer active. This area should be cleaned with a detergent to remove the dormant mold growth.

Staff members pointed out other areas of the facility where they occasionally sensed a moldy smell. Inspection of these sites did not reveal visible mold growth, and there were no moldy smells apparent at the time of the inspection.

Potential moisture problems that were noted primarily relate to site drainage and rainwater management. They include:

1. The gutter system on the new roof at both the east and west elevations may prove to be undersized. These are large roofs and the installed gutters are designed for smaller, residential use. Observation of the gutters in a heavy rainstorm will confirm whether or not these gutters are effective in keeping up with rainwater removal. If not, larger, commercial grade gutters should be sized and installed for the surface area of roof to be drained.

2. The downspouts on the new gutter system do not channel the water away from the facility. It is understood that vehicle traffic around the back of the building makes the design and discharge of the downspouts problematic. However, leaders that divert the gathered rainwater onto a slope away from the building should be installed and protected from damage.

3. Site grading and drainage on the east elevation should be improved. Of particular
concern is the area of the valley where the new roof intersects the original building (Figure 7). Valleys are always problematic because of the concentrated amount of rainwater they handle. In this case, the valley is in close proximity to an entry door of one of the childcare rooms, and is a location where staff members reported occasional moldy smells. It is critical that the roof drainage system works in this location, and that the site drainage is effective in moving rainwater away from the building at this location.

4. There is almost no overhang, and no roof drainage system along the front, north elevation (Figure 8). The grade on this elevation is fairly flat, and in some locations pitches slightly toward the building. There are several unsealed penetrations in the metal siding. All of these factors can contribute to water infiltration and damage. One area of water damage had recently been repaired. A comprehensive renovation addressing all of these problems would be a wise preventative maintenance measure. Regrading toward the street, sealing of penetrations, and the design and installation of gutters, downspouts and leaders that divert rainwater around the building should be done.

5. Based on the formation of icicles along the east and west elevation, there were signs of potential ice damming (Figure 9). Ice damming can lead to serious water infiltration into ceiling and wall cavities. See Section 2.4 for a discussion of this condition. In this case, efforts to reduce ice damming potential should focus on reducing vagrant heat loss into the new attic space, rather than additional ventilation. To the extent that ventilation brings the attic temperature closer to the outside temperature, ventilation does help in reducing the potential for ice damming. However a large exhaust fan located in the south wall of the attic puts the attic under negative pressure (Figure 10). The attic draws air in from various sources, in this case preferably from the gable vent in the opposite wall. It can also, however, draw air through bypasses in the ceiling plane of the building, which will draw warm air into the attic and lead to snow melting off of the roof and ice damming at the eaves. At the time of the inspection, the attic temperature was 29 degrees F, while the outside temperature was 12 degrees F. Clearly, some heat loss is occurring into the attic.
6. A comprehensive survey of the attic would identify ceiling bypasses and insulation voids that could be sealed. Specific concerns include:

   a. Heat loss from the two mechanical rooms in the attic. These rooms should be well insulated, and virtually air tight with respect to the attic.
   b. Bypasses associated with electrical and mechanical chases penetrating the ceiling, including recessed lighting. If recessed lighting is in contact with insulation, it needs to be IC rated and gasketed.
   c. Insulation voids and lapses at the ceiling that allow for conductive heat loss.
   d. Provide additional insulation to the heating ducts.

With many roofs, the location of snow melting on the roof can be seen from the ground, and this observation will assist in identifying the location of heat loss. This would be apparent on this building as it pertains to heat loss from the mechanical rooms. Besides this heat source, however, and owing to the complex nature of this roof system, reading the pattern of snow melting will not be productive. While surveying the roof system for heat loss areas will be difficult, access holes in the old roofs have been prepared (Figure 11).

Without identifying ceiling bypasses and areas of heat loss, adding additional ventilation to the attic will not be effective. It would serve to place the attic under even greater negative pressure, and draw more warm interior air into the attic, probably making very little change in the temperature of the attic. It would be more effective to install additional passive vents (like the current gable vent) to the exterior, thus providing more cold makeup air for the exhaust fan.

**Reported Health Issues**

It is clear that the staff of the Child Development Center is concerned about the health implications of indoor air quality and specifically exposure to mold. Prior to the site inspection, a memorandum was circulated to the employees prompting individual lists of health related symptoms that had happened since their employment at the Center. The staff provided the BRC inspection team with copies of 21 responses to the memorandum. Common symptoms mentioned in the responses include headaches, respiratory problems, bronchitis, sinus infections, fatigue, nausea, and other allergic-type reactions.

The Assessment Team specializes in construction and building performance. The BRC's inspection of the facility (as with all of its work in this area) focused on the construction and performance of the building as it relates to the prevention of water damage. The
approach is based on the fact that mold contamination, in every case, results from elevated moisture loads and water damage. Reducing moisture loads and preventing water damage is crucial to preventing mold contamination.

The assessment team does not have expertise in medical diagnosis, and does not offer opinions on health symptoms and their causes. That is best left to the medical community.

There are known health impacts from mold exposure, though the science is far from complete in providing a full understanding of the extent and mechanics of these health impacts. A brief summary of health effects from mold include the following:

- Molds produce protein allergens that are capable of causing allergic reactions in people. An estimated 6-10% of the general population is sensitized to mold allergens. Around 15-20% of people prone to allergies (atopic) are sensitized to mold allergens. Typical allergic reactions (runny nose, sneezing, headaches, etc.) can result. For those sensitized, it is clear that mold plays a role in the exacerbation of asthma symptoms. A rare but more serious immune-related condition, hypersensitivity pneumonitis, may follow exposure (usually occupational) to very high concentrations of mold.

- Some molds produce toxic material known as “mycotoxins.” The health impacts of exposure to mycotoxins, as compared to allergic reactions, are less clear. Studies of relatively high dose exposures in agricultural, occupational, and food processing settings show a substantial relationship between mycotoxins and adverse health effects. Studies that examine exposure to mycotoxins in indoor air, however, are limited. There is some evidence that mycotoxin exposure in the indoor environment can result in adverse respiratory health, and there are case studies with association to non-specific symptoms (flu symptoms, sore throat, etc.) Some of the more publicized claims of toxic reaction to mold exposure are anecdotal, however, and are not yet supported by research results. The impact of mycotoxins on human health is currently a hotly debated topic both within and without the medical community.

The American College of Occupational and Environmental Medicine (ACOEM) has recently prepared an “Evidence Based Statement” entitled, *Adverse Human Health Effects Associated with Molds in the Indoor Environment* (www.acoem.org/guidelines). This paper provides a good overview on the current state of research into the known effects of mold on health. The paper states:

"The present alarm over human exposure to molds in the indoor environment derives from a belief that inhalation exposure to mycotoxins cause numerous and varied, but generally nonspecific symptoms. Current scientific evidence does not support the proposition that human health has been adversely affected by inhaled mycotoxins in the home, school, or office environment." (p.2)
In addition to mold, there are many other potential indoor pollutants that can cause or contribute to the allergenic and adverse health symptoms reported. Pesticides, VOCs (volatile organic compounds such as solvents, strong cleaners, degreasers, many others), bacteria, insects (dust mites and cockroaches), combustion gases, plants (pollen), and animals are some of the potential pollutants to the indoor air and settled dust within a building.

The site investigation did not disclose any severe mold or moisture problems, and concluded that the moisture conditions that led to previous mold contamination had been addressed. The Team could not evaluate precautions to protect the site from the spread of airborne mold material during the previous demolition, remediation, and construction programs. The Team’s investigation, however, was not a comprehensive examination of indoor environmental quality. It is beyond the Team’s scope and area of expertise to either suggest or refute that the reported symptoms by the staff members are caused by one or more indoor environmental agents, or to draw any conclusions on what those agents may be, whether mold or any other contaminant. Ultimately, this is a medical question. The ACOEM paper provides the following guidance in this regard:

“When patients associate health complaints with mold exposure, treating physicians should evaluate all possible diagnoses, including those unrelated to mold exposure, i.e., consider a complete appropriate differential diagnosis for the patient’s complaints. To the extent that signs and symptoms are consistent with immune-mediated disease, immune mechanisms should be investigated.” (p.7)
## Appendix A

### Lac Vieux Desert Summary Table of Home Assessments

<table>
<thead>
<tr>
<th>Inspection Number</th>
<th>Address</th>
<th>Building Age (Years)</th>
<th>Occupancy</th>
<th>Model Type</th>
<th>Foundation Type</th>
<th>Framing Type</th>
<th>Heat Type</th>
<th>Basement Framing moisture content</th>
<th>Site Drainage Problems</th>
<th>Gutter System Problems</th>
<th>Leaks from Exterior</th>
<th>Wet Basement or Crawl Space</th>
<th>Plumbing Problems</th>
<th>Bathroom Problems</th>
<th>Exhaust Ventilation</th>
<th>Exterior Wall/Ceiling Problems</th>
<th>Attic Problems</th>
<th>Visible Mold</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1</td>
<td>E-23943</td>
<td>30</td>
<td>3</td>
<td>Frame-Ranch</td>
<td>Concrete Block/Crawl</td>
<td>Frame</td>
<td>Natural gas forced air</td>
<td>NA</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>NA</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>17</td>
</tr>
<tr>
<td>1-2</td>
<td>Unavailable</td>
<td>20</td>
<td>2</td>
<td>Frame-Ranch</td>
<td>Poured Concrete Basement</td>
<td>Frame</td>
<td>Natural gas forced air</td>
<td>5%</td>
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<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>1-3</td>
<td>E-23857</td>
<td>40</td>
<td>3</td>
<td>Log Ranch</td>
<td>Basement/Crawl</td>
<td>Log</td>
<td>Hydronic</td>
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<td>Yes</td>
<td>Yes</td>
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<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
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<td>15</td>
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<td>1-4</td>
<td>Child Development Center</td>
<td>Various</td>
<td>Various</td>
<td>Frame 2 story</td>
<td>Slab</td>
<td>Frame</td>
<td>Natural gas forced air</td>
<td>NA</td>
<td>Mostly Addressed</td>
<td>Yes</td>
<td>Old</td>
<td>NA</td>
<td>Yes, old</td>
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<td>NA</td>
<td>Old</td>
<td>Yes</td>
<td>14</td>
</tr>
</tbody>
</table>

December 1-6, 2002
**Inspection Number:** 1-1  
**Address:** E-23943  
**Model Type:** Frame Ranch  
**Age:** 30 years old  
**Bedrooms:** 2  
**Foundation:** Concrete Block Crawl Space  
**Heat Type:** Direct-vent gas, forced air distribution  
**Construction:** 2x4 wood frame  
**Attic:** Mineral wool insulation

**Mold and Moisture Conditions:**  
There was evidence of condensation on the north wall/ceiling interfaces throughout the entire house.

**Rainwater Management:** The site was relatively flat. There was no roof drainage system (gutters, downspouts, etc.). The house was built very low to the ground, to the extent that there was insufficient foundation height for installing crawl space vents in the concrete block area. Instead, crawl space vents were installed in the band joist (Figure 2). Often, the combination of a flat site and missing roof drainage in a house built so low to grade will lead to foundation wetness. In this case, the crawl space was not accessible, so the team could not determine whether there was excessive foundation wetness.

**Exterior Wall/Ceiling Junction:**  
There were indications of condensation events at the wall to ceiling junction along the north elevation. The condensation has led to staining in the living room, one bedroom, and the closets of these rooms (Figure 3). The occupant reported that these brown stains occurred periodically, and that they were frequently cleaned. The stains in...
the living room closet, where cleaning was least likely, were the most pronounced (Figure 4). While the moisture source appeared to be condensation, the deposit leading to the staining was not identified. The stains were not obviously mold, and based on color, could have been deposits of environmental tobacco smoke.

Bathroom: While there were no visible mold problems in the bathroom, there were two conditions that should be addressed:
- The bathroom exhaust fan was not functioning.
- The toilet was loose. Examination of the sub-flooring from the crawl space should indicate whether there was leakage around the toilet drain, and whether the toilet should be reinstalled with a new wax gasket.

Crawl Space Conditions: Crawl space access was from an adjoining shed structure. A significant amount of stored items blocked the crawl space making it inaccessible for inspection.

Attic: Attic sheathing appeared dry and free of mold contamination.

Occupant Issues: There were three occupants in the house. One of the occupants was a smoker. There were no reported health or respiratory problems.
Appendix B, Lac Vieux Desert Technical Report

**Inspection Number:** 1-2  
**Address:** Not Available  
**Model Type:** Frame Ranch  
**Age:** 20 years old  
**Bedrooms:** 3  
**Foundation:** Poured concrete basement  
**Heat Type:** Direct-vent gas, forced air distribution  
**Construction:** 2x4 wood frame  
**Attic:** Not accessible

**Mold and Moisture Conditions:** There was no evidence of mold contamination in the house. There were only minor moisture problems.

**Rainwater Management:** The site was relatively flat. There was no roof drainage system (gutters, downspouts, etc.). The house was built very low to the ground, with basement windows fully below grade (Figure 2). Often, the combination of a flat site and missing roof drainage in a house built so low to grade will lead to foundation wetness. At the time of inspection, this was not the case.

**Basement:** The basement was quite dry. Moisture content of floor joists measured 5%, indicating very dry conditions. There were two sump pumps in use, with the second pump dedicated to draining the washing machine. Resident indicated that the sump pumps were active in the spring, but that they worked well in removing water from the basement. The clothes dryer vent was not connected to the exterior (Figure 3). In houses with high moisture loads, clothes dryers should be vented to the exterior to remove excess moisture.

**Bathroom:** While there were no visible mold problems in the bathroom, the bathroom exhaust fan was not functioning.

**Kitchen:** The range hood in the kitchen did not vent to the exterior, but simply
recirculated air through a grease trap. With gas ranges (as in this case), an exterior vented range hood was recommended for moisture and indoor air quality.

**Occupant Issues:** There were two occupants in the house, one of which was a smoker. There were no reported health or respiratory problems.
Appendix B, Lac Vieux Desert Technical Report

**Inspection Number:** 1-3  
**Address:** E-23857  
**Model Type:** Frame Ranch  
**Age:** 40 years old  
**Bedrooms:** 2  
**Foundation:** Combined concrete block basement and crawl space  
**Heat Type:** Fuel oil, hydronic distribution  
**Construction:** Log framed  
**Attic:** Unvented, mineral wool insulation

**Mold and Moisture Conditions:**  
The house was very dry at the time of the inspection. A relative humidity of 29% was measured despite the use of two vaporizers in the house. Several windows were single-paned with open or missing storm windows, and it would be expected that severe condensation on the glass would be occurring given the cold outdoor temperatures. This was not the case, confirming the very dry conditions in the house. There was slight mold contamination in the bathroom due to splashup. There were reports of basement flooding following rainstorms. The house was in danger of ice damming during the winter, a condition that could lead to bulk water entry at the exterior walls. Serious roof leakage and moldy conditions in the attached, small, gable addition had recently been addressed. There was no smell or sign of mold in this area at the time of inspection.

**Rainwater Management:** The site was relatively flat on the elevation with the driveway. The opposite elevation sloped toward the house, draining a fairly large area to the foundation (Figure 2). There was no roof drainage system (gutters, downspouts, etc.). There were clear indications that roof drainage from the lack of gutters was creating depressions in the soil next to the foundation (Figure 3). The combination of the slope and missing roof drainage was the likely cause of the complaints of basement flooding following rainstorms. Regrading...
and/or installation of gutters, downspouts, and leaders could address the problem by diverting rainwater away from the foundation.

**Basement and Crawl Space:**
The basement and crawl space were dry at the time of inspection. There was an operating sump pump in use. The resident indicated that the basement flooded during rainstorms, and that a squeegee was used to manually move water toward the sump pump. The crawl space portion, which was accessed from the basement, was used as storage at the entry to the space. There was no vapor retarder in place in the crawl space.

**Bathroom:** The tub and shower surround was deteriorated and pulling away from the wall (Figure 4). This presented an ideal area for mold growth. The tracks for the sliding glass doors did not drain into the tub. When the doors were operated, trapped water splashed against the wall between the tub and toilet (Figure 5). This situation was leading to deterioration of the wall surfaces and possible mold growth. There was no exhaust ventilation in the bathroom. If exhaust ventilation were to be added, the exhaust should be vented outside the home, not into the attic.

**Roof and Attic:** A new metal roof had been installed over the asphalt shingle roof this past summer. It was noticed that no cricket had been installed at the chimney (Figure 6). Given the chimney’s location low on the roof, this is a potential leakage in the future. At the time of inspection, an ice dam was forming at the base of the valley where the addition joined the main structure (Figure 7). Ice dams will form when excess heat migrates to the attic from the...
living space, causing snow to melt from the roof and refreeze at the eave. Ice damming can lead to water entry at the exterior walls. A heat leakage site leading to snow melting could be seen on the roof of the main residence (Figure 8).

An examination of the attic found no roof ventilation and little insulation. There was about 3” of original mineral insulation in the attic. Both ventilation and insulation play a role in ice damming problems. To address the potential for ice damming at this property, the following steps should be taken:

1. The attic space should be closely inspected for open bypasses from the heated interior, particularly in the region of the affected roof valley. Bypasses include open partition walls, electrical and plumbing chases, and around the attic hatch. Warm air leakage from the interior was the principal cause of ice damming.

2. The insulation in the attic should be increased. The addition of 10”, R-30 fiberglass batts, or the equivalent in blown-in insulation, should be applied.

3. Install attic ventilation. Attic ventilation could serve to keep the roof deck colder, and thus would reduce ice-damming problems.

The ideal time to install attic ventilation would be when re-roofing a residence. Unfortunately, in this case, the house was re-roofed in the past year, and it will be difficult to retrofit soffit and ridge insulation. There appears to be little space in the soffit for the installation of vents. The best recommendation at this point would be to follow steps one and two initially and observe the results. This may take care of any ice damming problems. If problems persist, or if mold contamination is noted on roof sheathing, step three (attic ventilation) should be pursued.

Occupant Issues: There are three occupants in the house, none of whom are smokers. There was no reported health or respiratory problems.