LAC COURTE OREILLES TRIP REPORT
Assessment of Mold and Moisture Conditions

Final Report

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INTRODUCTION

Kate Brown from the Building Research Council (BRC) at the University of Illinois Urbana-Champaign and Robert Nemeth from Magna Systems, Inc. conducted a site visit at Lac Courte Oreilles Housing Department (LCOHD) on April 28- May 1, 2003. The LCOHA administers the housing program for the Lac Courte Oreilles Tribe. The assessment team provided technical assistance to the housing authority in assessing mold and moisture condition in housing units. This report summarizes activities and issues addressed while on site. A detailed analysis of the findings and recommendations is found in PART II: Technical Housing Assessment Report: Examining Mold and Moisture Conditions of Homes on the Lac Courte Oreilles Reservation.

BACKGROUND INFORMATION

The Lac Courte Oreilles Reservation is located in Burnett, Washburn, and Sawyer Counties in Northwest Wisconsin. The area is home to hundreds of lakes, miles of rivers, and thousands of acres of rolling forestland. The average annual precipitation is 32.12 inches. The average annual snowfall is 50.6 inches. The average maximum temperature is 54.3 °F and the average minimum temperature is 33.5° F. Approximately 1,032 Native Americans reside on the Lac Courte Oreilles Reservation. The housing authority maintains 315 Low Rent homes and 125 Mutual Help homes for the Tribe.

Lorene Wielgot, Executive Director of the Lac Courte Oreilles Housing Department, requested technical assistance and training on mold and moisture problems impacting Low Rent homes on the reservation. Of the fourteen homes visited, the team could not enter two homes. In another home, the occupants were unavailable for an interview. The eleven investigated homes located on the reservation were stick built and modular with two, three, or four bedrooms. Six of these homes were built over crawl spaces, five other homes were built with basements, and one home was built with half a basement and half a crawl space. The primary sources of heat were propane, gas and wood. The homes ranged in age from sixteen to thirty-two years old.

Day 1: Monday, April 28, 2003

Monday was a travel day to the reservation.

Day 2: Tuesday, April 29, 2003

On Tuesday morning, the assessment team met with Lorene Wielgot, Executive Director, Ron Gokey, Maintenance Supervisor, and Dick Reese, Northern Native American Health Alliance Environmental Health Services Officer, to discuss the on-site assessment process, mold and moisture issues the housing authority has been handling, and the site visit schedule.
Dick Reese and Ron Gokey accompanied the assessment team during the morning inspections. The team visited six Low Rent homes at the Dry Town Lane and South Reserve Subdivisions. Four of these were inspected. Digital photographs recorded the conditions at each inspection site. The inspection process involved visual assessments of both interior and exterior conditions, measurements of relative humidity, and discussion with available residents. *PART II: Technical Housing Assessment Report: Examining Mold and Moisture Conditions of Homes on the Lac Courte Oreilles Reservation* provides a detailed analysis of findings and recommendations for the investigated homes.

**Day 3: Wednesday, April 30, 2003**

On Wednesday, the assessment team inspected seven Low Rent homes at the Poppletown Subdivision. Digital photographs were taken at each site. The inspection process involved visual assessments of both interior and exterior conditions, measurements of relative humidity, and discussion with residents when available. *PART II: Technical Housing Assessment Report: Examining Mold and Moisture Conditions of Homes on Lac Courte Oreilles Reservation* provides a detailed analysis of findings and recommendations for the investigated homes on the Reservation.

**Day 4: Thursday, May 1, 2003**

On Tuesday morning, the assessment team inspected one home, then provided technical assistance and training for housing authority staff. The sixteen participants included inspectors, carpenters, maintenance staff, resident service staff, and administrative staff. The two hour training session addressed the issues identified on the Lac Courte Oreilles Reservation. Issues included mold and moisture conditions noted from the inspections, potential causes for these problems, and recommendations and ideas for educating occupants. The following topics were discussed:

- What Mold Needs to Grow
- Definition of Moisture Loads and Identification of Sources of Moisture
- Impact of Building Construction and Design on Moisture Sources
- Findings on the Reservation and Strategies to Solve the Problems
- Occupants Issues
- Crawl Spaces and Basements

**FINDINGS**

An overview of findings and recommendations follows, while *PART II: Technical Housing Assessment Report* provides a more detailed discussion and analysis of the findings.

**Lac Courte Oreilles Reservation**

Principal findings from the site inspections include:

1. Rainwater Management. Nine inspected houses had site drainage problems.
2. All homes had problems with the roof drainage system (gutters, downspouts, leaders, and splashblocks). These problems can result in foundation wetness and elevated moisture levels in housing. Four inspected homes had damp crawl spaces or basements and eight of the homes inspected had wet basements or crawl spaces.

PROGRAMMATIC RECOMMENDATIONS

A particular challenge to all housing authorities is the development of a prompt and effective service delivery system addressing mold and moisture conditions. This requires a partnership between the housing authority and residents. 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, which results in significant mold contamination that could have been avoided. Some strategies include the following:

1. Require attendance at annual homeowner/renter clinics as part of the annual recertification process. Provide instruction on home maintenance issues such as identifying and repairing leaks and maintaining gutters.

2. During the annual recertification process, ask occupants to complete a survey based on Housing Quality Standards (HQS) with additional questions on mold and moisture conditions in their homes. Complete the survey further engages residents in their own home maintenance. Furthermore, the survey responses provide additional information to the housing authority on unreported problems, especially leaks and inoperable fans that might contribute to an unsafe, unhealthy home environment.
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Section 2: Lac Courte Oreille Indian Community Housing

Section 3: Findings

Section 4: Technical Discussion and Recommendations

Appendix A: Housing Survey Summary Site Visit Report

Appendix B: Housing Assessment Results
EXECUTIVE SUMMARY

The site assessment team inspected fourteen homes of Lac Courte Oreille Indian Community for moisture and mold conditions. The seven principal findings include:

1. Exterior site drainage and rainwater management was a problem in ten of the fourteen residences. Many of the sites were flat with no slope away from the foundation. Twelve houses were missing roof drainage systems (gutters, downspouts, leaders, etc.), a condition that can place a tremendous moisture load on the foundation and the house. One house had gutters but no downspouts and another house had gutters and downspouts that emptied right next to the house.

2. In several instances vapor barriers covered only a portion of the crawl space. This allowed ground moisture to freely dissipate into the structure above. In some cases the wet conditions promoted mold growth.

3. Winter moisture condensation caused mold growth at three houses. Visible mold grew in bedroom closets, at the wall/ceiling junctures of exterior walls and at the base of exterior walls.

4. Poor or non-operable bathroom exhaust ventilation systems were noted during the inspections at Lac Courte Oreilles Indian Community housing. Poor bathroom exhaust ventilation can result in a significant interior moisture loads which can increase mold growth.

5. All fourteen homes had propane or natural gas central heating systems. Several systems had interior or exterior wood stoves tied into the HVAC system.

6. Maintenance issues contributed to mold and moisture conditions. Plumbing leaks were evident in six of the fourteen houses.

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

Kate Brown from the Building Research Council and Robert Nemeth from Magna
Systems conducted a site visit at Lac Courte Oreilles Indian Community on April 28-May
1, 2003. The site visit provided technical assistance to the Lac Courte Oreilles Indian
Community Housing Department in assessing mold and moisture condition in housing
units. This report summarizes activities and issues addressed while on site. A detailed
analysis on the findings and recommendations is found in PART II: Technical Housing
Assessment Report: Examining Mold and Moisture Conditions of Homes on the Lac
Courte Oreilles Indian Community.

The Lac Courte Oreilles Reservation is located in Burnett, Washburn, and Sawyer
Counties in Northwest Wisconsin. The area is home to hundreds of lakes, miles of rivers,
and thousands of acres of rolling forestland. The average annual precipitation is 32.12
inches. The average annual snowfall is 50.6 inches. The average maximum temperature
is 54.3 ° F and the average minimum temperature is 33.5° F. Approximately 1,032
Native Americans reside on the Lac Courte Oreilles Reservation. The housing authority
maintains 315 Low Rent homes and 125 Mutual Help homes for the Tribe.

The assessment team investigated fourteen homes located in the Indian Community. A
variety of house styles were examined, including some on crawl spaces and others with
basements. All homes had a natural gas or propane central heating system and several
had wood stoves coupled to the system. The homes ranged from two years to over 34
years old.

SECTION 1 - METHODOLOGY

Visual Inspection

Housing inspections consisted primarily of visual assessment of mold and moisture
conditions. The assessment team used forms developed for the Chicago Mold and
Moisture Project, a HUD Healthy Homes Program, organized for a room-by-room
inspection. The team recorded information for all rooms inspected for water damage and
evidence of mold. Additionally, the team inspected the plumbing, localized ventilation,
water entry and other moisture source issues in kitchens, bathrooms, basements, crawl
spaces, utility rooms and attics.

The exterior of the houses were inspected for rain water/snow melt management
including site grading, roof condition and gutter system.

Whenever possible, the team interviewed residents to gather history on moisture
problems, plumbing leaks, winter condensation, health issues, number of occupants and
other useful information.

Digital photographs visually recorded notable conditions at each home.
Measurements

Floor framing moisture content (MC) readings were taken at several residences. Due to the storage capacity of wood, moisture content measurements provide information on wetness in the recent past, from three weeks to a month. Moisture content readings can range from 5%, indicating a very dry reading, to 30%, indicating a very wet reading.

The results of the mold and moisture assessments were compiled on a spreadsheet, with broad categories of common moisture problems noted. This data is presented in the table of Appendix A in this report. The findings from individual house inspections are presented in Appendix B.

SECTION 2 – LAC COURTE OREILLES INDIAN COMMUNITY HOUSING

The LCOHD is responsible for 440 assisted housing units. The assessment team examined fourteen housing units for mold and moisture. These units do not represent a typical cross-section of the units under their management since they were not based on a random sample.

All the site-built homes were older wood-framed houses on crawl spaces or basements.

SECTION 3 – FINDINGS

The assessment team found visible mold growth in all but one of the fourteen inspected houses. In some cases, mold contamination was slight and generally limited to bathrooms. In other cases, mold contamination was more extensive and present throughout the house. Mold contamination is always associated with moisture problems. Nine general findings based on the inspection follow.

3.1 Exterior Site Drainage and Rainwater Management

Good site drainage and rainwater management is essential to maintaining dry foundations and houses. Site drainage was poor at nine of the fourteen homes. Many sites were flat with no slope away from the foundation. However, the grade dropped close to most of these homes, which provided good potential for conducting water away from the homes. Additionally, thirteen houses had no roof drainage systems (gutters, downspouts, leaders, etc.), a condition that can place a tremendous moisture load on the foundation and the house.

Over the entry doors, several homes had short gutter sections without downspouts. These short gutter sections allowed water to drain out the ends of the gutter and splash over entry steps, decks, and the ground adjacent to the structure saturating the siding. This uncontrolled drainage caused extensive damage in almost every home. Damage extended beyond deteriorated siding and included rotted rim-joists and sills. In this situation, the short gutter sections did more damage than good by concentrating the runoff.
Concentrated runoff deposited immediately adjacent to the foundation can also exacerbate basement or crawl space moisture problems.

Section 4.1 provides a detailed discussion of site drainage and rainwater management.

3.2 Elevation of House Above Grade

All inspected homes were built close to grade; most were no more than one course of block above grade. Placing the structure this close to grade has contributed to several moisture related problems. When the siding is only eight to ten inches above grade, roof rainwater that drains on the ground splashes up onto the siding and saturates it. The composite fiberboard that was used as siding is not particularly moisture resistant, and the bottom edge of the siding is especially susceptible to water absorption.

Snow accumulation adjacent to a home provides another source of moisture. As snow accumulates against the siding, the warmer siding absorbs moisture. Ten homes had damaged siding. The bottom portion of the siding was the most deteriorated area since this area was exposed to more moisture than areas higher on the wall.

With only one course of block showing above grade, the bottom of crawl spaces vents sit right on grade. Soil washed into some crawl spaces through the bottom of the vents.

3.3 Crawl Spaces and Basements

Site drainage and rainwater management problems contributed to damp crawl space problems. Plumbing leaks, HVAC condensation drainage into the crawl space, and condensation on cold water supply lines all contributed to wet crawl spaces. None of the homes with crawl spaces had an effective vapor barrier, allowing ground moisture to dissipate up into the structure. In some cases, the wet conditions promoted mold growth.

Plumbing leaks contributed to damaged subfloors in several residences. Fortunately, the damage did not appear to have compromised the structural integrity of the plywood. However, left unchecked, the leaks could eventually result in safety problems. Wet crawl spaces are a source of excess moisture load in houses. See Section 4.2 for a discussion of crawl space design and construction.

Three of the five inspected homes with basements had mold. Although poor rainwater management was the primary contributor to moisture, plumbing leaks, condensation on cold water lines, and clothes dryers venting to the interior exacerbated the moisture load. The only house without mold was a recently rebuilt home. However, the potential for mold growth at this home is high due to an inadequate gutter system.

3.4 Winter Moisture Condensation

Winter moisture condensation caused mold in three homes. Mold growth was visible in bedroom closets, at the wall/ceiling junctures of exterior walls and at the base of exterior
walls. Condensation occurs when moisture-laden air comes in contact with a building surface that is chilled below the dew point of the air. This problem indicates a combination of two factors:

- High wintertime moisture load (relative humidity)
- Lower than desired interior temperature.

Lowering the moisture load and/or insulating or heating surfaces to prevent cold surface temperatures can treat the problem. Section 4.3 discusses condensation issues. The following three findings concern the condensation problem.

3.5 **Bathrooms and Bathroom Exhaust Ventilation**

Lack of functioning or poorly operating bathroom fans raised significant issues in the inspected houses. Bathrooms experience high moisture loads and often develop localized mold problems. Bathroom ventilation can reduce interior moisture load. All the bathrooms had operable exhaust fans. However, one fan was not used because it smelled like it was about to ignite; another was not used because of an occupant’s bad experience with a fan that caught on fire, and several seemed to make noise but moved very little air.

Active and previous plumbing problems were identified in six of the fourteen houses. Lack of cleaning and maintenance caused mold problems in bathrooms at seven houses.

Section 4.4 discusses bathrooms and localized exhaust ventilation.

3.6 **Overcrowded Conditions**

Overcrowding is a fairly common problem in Indian housing and should be mentioned here. Overcrowding increases the moisture level from human sources, and contributes to elevated interior moisture loads that can lead to mold contamination from condensation problems. Discussion of human moisture sources can be found in Section 4.5.

3.7 **Heating Method and Heat Distribution**

All fourteen homes used propane or natural gas central heating systems. Several systems had interior or exterior wood stoves tied into the HVAC system. Heating method and heat distribution play a vital role in preventing wintertime mold and moisture problems. Warm air should be evenly distributed throughout the home. Remote bedrooms often have problems because they can be colder than the rest of the residence, causing water vapor condensation on cold exterior walls, particularly in closets. Uninsulated heating ducts in proximity to crawl spaces vents exacerbated the problem. Cold air from the crawl space vent cooled the heated air before it entered the living space.

Heating systems are discussed in Section 4.6.
3.8 Maintenance Issues

Several maintenance issues contribute to mold and moisture conditions.

- Plumbing and/or bathroom fixture leaks were identified in six houses. Three homes had tub surrounds with holes, which allowed water into the wall, or compromised caulk joints where the surround meets the tub. Two other homes featured leaks in drain lines. Maintaining plumbing in proper working order is a high priority maintenance item. Plumbing leaks that persist for months or even years can lead to severe structural damage and mold problems.

- One house had a non-functional bathroom fan, five had fans that barely worked and the rest had marginally working fans. Bathing produces an excess amount of moisture that must be removed from the home. Typically, bathrooms show the first signs of mold growth because of the recurring high moisture load in these spaces. Maintenance of bathroom fans and replacement of broken fans should be high on the priority list.

- Occupant attention to cleanliness and clutter can reduce mold problems. In bathrooms and other wet areas, regular maintenance cleaning could keep mold conditions under control. The presence of clutter in closets and on exterior walls contributed to mold growth by increasing condensation problems when sufficient moisture is present. Maintenance issues are discussed in Section 4.7.

3.9 Lifestyle

Certain housekeeping habits contributed to mold growth on the interior of the structures. Clothes covering heating vents, overstuffed closets, over accumulation of trash, covering windows with heavy drapery, unrepaired leaks, and inadequate cleaning regimes can all contribute to mold growth. Modifying occupant lifestyles will be as important as solving technical problems. In general, most mold problems can be remediated, however, without addressing occupant lifestyle at the same time, many mold problems will rapidly resurface.

SECTION 4 - TECHNICAL DISCUSSIONS AND RECOMMENDATIONS

The following discussions and recommendations are based on the nine general findings identified during the site visit to the Lac Courte Oreilles Reservation.

4.1 Site Drainage and Rainwater Management

Site Drainage

The roof of a building should be designed and built so that the rain landing on the roof moves out to the edge of the roof. As rain falls on a soil surface, some 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. Houses that allow water to accumulate in the soil in contact
with the foundation will develop moisture problems. The best way to prevent mold and
moisture problems in houses is to ensure that rainwater moves off the roof, across the site
and off the property. In a well-managed property, the soil in contact with the foundation
is the driest soil on the site following a rainstorm. Houses with dry foundations
(basements, crawl spaces and slabs) are usually dry houses. Two general rules and some
specific guidelines to keep the foundation dry by keeping the soil next to the foundation
dry:

1. The first general rule is concentration – the greatest concentration of water causes
the worst damage. A valley on a roof acts like a funnel, with the greatest
concentration of water at the base of the valley. Gutters also act like funnels that
collect water from the edge of the roof and direct it to the downspouts. On the
land, valleys and swales act like collectors or funnels that concentrate the water
on the site. Water management design that makes use of funnels (such as valleys,
gutters or swales) requires maintenance to ensure the funnels work as intended.
Water damage occurs where a valley, gutter or swale is blocked.

2. The second general rule is the ground roof rule - treat the soil surface as if it were
a low-slope roof surface. Pitch the ground 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. Do not allow areas to remain
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, fill them
  with dirt, and tamp the fill material to prevent future settling. Use enough of the
  fill material so drainage occurs away from the foundation.

- If the house has no gutters, then the base of the soil around the house has to act as
  a gutter. The ground surface should prevent splash back onto the siding of the
  house and should have enough pitch to effectively move water away from the
  house.

- Good tamping or compaction of the backfill is very helpful in keeping water on
  the surface where it can be managed by slope. Soil at the outside corners of the
  foundation, where the downspouts are usually found, should always be tamped so
  the corners will not collapse inward.
• Bushes and other plantings can help with drainage if their root balls soak up a lot of water. They can be planted strategically near downspouts so that downspout extenders are less likely to be kicked off or removed during lawn mowing.

Rain Water 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.

• As part of a 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 and not on the uphill side. In areas with a moderate amount of trees, consider large gutters and downspouts where 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.

• Direct the water at the base of the downspout away from the foundation of the building (Figure 1). 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 allowed to dump close to the foundation and into the backfill, the water will concentrate next to the foundation—precisely the wrong place for water to be. The traditional way to discharge water away from the house involves the use of downspout extenders (sections of straight downspout) or splash blocks. However, both of these are often disturbed when lawns are mowed. A better alternative is to 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

Figure 1: To deposit downspout water well away from the foundation, consider using a hinged extender. It can pivot up and out of the way when the lawn is being mowed.
of fall in the first 10’ away from the house gives a 5% slope.

- 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.

- An example of a gutter guard system is the *PermFlow Gutter Guard System* (Figure 2). This system costs about $4.50 per 3’ section and is designed for a 5” K style gutter (8’ sections are sold to contractors). Similar systems such as the *Waterfall Gutter Guard* are available (Figure 3).

### 4.2 Crawl Space Design

Moisture entry and evaporation from foundation sources are major contributors to the moisture load in a house. Because they are rarely visited or inspected and problems go unaddressed, crawl spaces are particularly notorious for leading to foundation moisture problems. When moisture entry is acute, framing and subflooring can deteriorate and support mold. The following points relate to crawl spaces in general, regardless of thermal boundary:

- Crawl spaces should have easy access and good lighting to enable regular inspections. There should be sufficient headroom to allow for reasonable ease of movement and ability to perform repairs and improvements.

- Water in crawl spaces typically comes from poor rainwater management outdoors, plumbing leaks, air conditioner condensate or water softener discharge. Poor rainwater management is by far the leading source of water in crawl spaces.

- Crawl spaces should be covered with a ground material: a slab of concrete, 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.

- Crawl spaces should be insulated. There are two ways to insulate a crawl space, depending on where the thermal boundary is to be established. The thermal boundary is the building section that separates conditioned space from outside conditions. Insulation can either be placed on the crawl space walls (placing the crawl space inside the thermal boundary) or in the floor of the house (placing the crawl space outside the thermal boundary). If the crawl space contains
The inspected crawl spaces violated several of these points. Many crawl spaces had no vapor barriers covering the base of the crawl space and were marginally insulated. The crawl spaces were wet from poor rainwater management and ground moisture. Existing crawl spaces should have a vapor barrier installed and rainwater management improvements made to the exterior through site grading and roof drainage systems.

The following discussion on new crawl space design is provided to clarify principles, and to serve as a guide for future construction.

First 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 (Figure 4) and that the crawl space is part of the conditioned space. In this case, it is not desirable to provide crawl space ventilation, which is analogous to opening a window in a heated room. If insulation is placed in the floor above the crawl space, then the floor is the thermal boundary, and ventilation can be installed. Mechanicals (plumbing, ductwork) should be inside the thermal boundary in all cases.
Crawl Space Walls Are the Thermal Boundary

The crawl space is unvented. It shows an exterior insulation system that allows a shallower frost wall, although the foundation wall may be insulated in 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.

The crawl space is designed as a stubby basement that is conditioned as a result of ductwork, or in some cases, furnaces being located there. As unvented crawl spaces are not usually allowed by most codes, it may be necessary to add closeable vents in order to obtain a building permit.

Floor above the Crawl Space is the Thermal Boundary

Figure 5 shows a well-vented crawl space where the subfloor of the home serves as the thermal boundary. 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 at floor level and run into the crawl space.

Water service piping should be insulated with electric heating tape. Generous venting is required in the foundation walls, with the vents installed 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.

4.3 Winter Condensation Problems

Condensation occurs when moisture-laden air comes in contact with a building surface that is chilled below the dew point of the air. When this happens, the moisture content of

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the materials at the location increases, often up to saturation, and mold grows on the surfaces. This problem indicates a combination of two factors:

1. A house with a high wintertime moisture load (relative humidity), and
2. Areas of the building that are below the desired interior temperature.

Two approaches could address this problem:

1. Identify the moisture sources that contribute to the elevated humidity in the house and reduce or eliminate these moisture sources.
2. Identify the cause of the chilled surface and add insulation or airflow improvements to reduce or eliminate the chilling of the surface.

Identifying and reducing moisture sources to lower relative humidity in the winter should be the first step. Moisture sources can include:

- Foundation moisture sources, i.e. wet basements and crawl spaces
- Bathroom moisture sources due to lack of effective localized ventilation
- Human moisture sources resulting from overcrowding.

Several of these moisture sources were identified in the Lac Courte Oreilles inspected houses that had experienced condensation problems. These moisture sources are related to other issues discussed individually in the report, including site drainage and rainwater management (Section 4.1.), crawl space design (Section 4.2.), bathrooms (Section 4.4.), and overcrowding (Section 4.5.). Minimizing these moisture sources is discussed in each respective section.

Especially in cases involving overcrowding in weather-tight houses, adding whole house ventilation can reduce the moisture load in the house. Ventilation should be considered after all of the other moisture sources have been addressed.

Maintaining surface temperatures above the dew point temperature is the second approach. Moisture source control should always be considered first, because the lower the relative humidity, the lower the temperature that is tolerable within the home. However, the problem can occur at a reasonable interior humidity if there is a specific construction flaw that allows a surface to get chilled in the winter.

A common condition contributing to winter condensation and mold problems occurs in closets on an exterior wall. The design and use of closets collaborate to make this condition common, specifically:

- Lack of heat supplied to closets and closed closet doors
- Lack of airflow in closets, which could distribute heat to the closet exterior surface
- Closet clutter that prevents airflow and heat reaching the closet's exterior walls
- Clothes hanging against the wall act as insulation and lower the temperature of the wall

Furthermore, a relatively cold room also contributes to mold growth, thus ensuring that the exterior wall of the closet does not get chilled will prevent this mold growth. Closets should not be cluttered and residents should maintain some distance between the clothes and the exterior wall. Closet doors should be louvered and the room kept at a comfortable temperature. Exterior walls should also be insulated. Again, the moisture load in the house should be kept at a minimum.

The exterior wall/ceiling junctures on exterior walls often experiences chilling and subsequent condensation and mold contamination. This problem often occurs in northern climates in older ranch-style homes with low-pitched roofs. It was found in Lac Courte Oreilles housing, as well.

Three reasons why the exterior wall/ceiling juncture gets cold are (Figure 6):

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 may prevent slow-moving currents of warm air from reaching into the corners.
Dark spots occur on interior surfaces that are chilled due to poor insulation. In new construction, use a raised-heel truss and carefully insulation at the wall-roof joints. It is difficult to adequately insulate the exterior edge of the attic, especially in homes with low-pitch roofs. With batt insulation, special pusher sticks may be used to push 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 homes consider retrofitting the wall-roof joint (Figure 7). 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, followed by 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, organizations, and 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 major drawback. Designs without attic ventilation may improve the performance of the eave area. Most designs without ventilation rely upon the verified airtight 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/documents/pdf1999/tenwo99a.pdf.

The retrofit described above is designed to keep the wall/ceiling juncture warm and eliminate the condensation site. These efforts to lower the moisture load in the house and reduce the relative humidity also help prevent wintertime mold and moisture problems.
4.4 Bathroom Mold Problems

Many home mold and moisture problems occur in bathrooms due to the present and use of much water. Keeping bathrooms dry depends on care in several areas:

1. Bathroom plumbing should not leak. There should be no leaks in either the water supply system or the drain-waste-vent (DWV) system. All plumbing leaks should be fixed promptly. Some hard to detect leaks at the toilet flange or at a shower drain require careful inspection.

2. Bathroom users should use shower curtains so that all the shower water does not splash outside the tub. Toilet users should not wet the areas around the toilet. Surfaces in the bathroom should be selected and installed to keep water away from drywall and other materials that may permit mold to grow. Wipe up spills promptly and clean dirty and discolored spots. Correct the water problems that may have led to the spotting. Damaged drywall should be removed and replaced. Keeping surfaces clean and dry is primarily the responsibility of the residents of a house.

3. Some rooms are naturally 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 for reducing the moisture load in a house. 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.

4. Not only bathroom and kitchen exhaust fans, but also clothes dryers should 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. If the vent discharges through the roof, make sure the vent has an effective check valve to prevent wind blowing back through the vent.

5. Bathroom exhaust fans should exhaust between 50 and 70 cubic feet per minute (CFM). The effectiveness of exhaust fans depends 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 than ribbed ductwork. Round, smooth sheet metal ductwork is recommended for all types of exhaust ventilation. Generally, the larger the duct, with the fewest bends.
or elbows, and the shortest duct run, is preferred. A dirty intake grille will also greatly increase resistance and reduce airflow.

6. Noisy exhaust fans are not likely to be used, so exhaust fans with a low sone rating should be selected. To ensure they are used, consider:

- Exhaust fan hard-wired to the bathroom light, and/or
- Exhaust fan on a timer, to extend moisture dilution time after showering.

A good system features both of these features. The fan is hard-wired to the light, but also runs for a programmed period following bathroom use. (Available from Energy Federation Incorporated, [www.efi.org](http://www.efi.org), Fan/Light Time Delay Switch). Residents should be encouraged to always use the bathroom exhaust vent.

### 4.5 Human Moisture Sources

Human occupation naturally produces moisture in buildings. Humans are similar to internal combustion engines, and respiration, the act of breathing, produces considerable moisture. Other human activities and preferences also produce moisture:

- Showering
- Cooking
- Cleaning
- Drying laundry indoors
- Accidental spills
- House plants
- Firewood storage
- The use of humidifiers and vaporizers

All of these moisture producing activities contribute to the moisture load in a house.

However, human moisture sources alone do not produce enough moisture to cause winter condensation and mold problems in the winter. Two circumstances under which human moisture sources may create mold problems include:

1. **Overcrowding.** When the number of residents living in a house exceeds the expected capacity of the house, the moisture burden increases. Each person participates in the moisture-producing activities (breathing, cooking, washing, etc.) to increase the moisture load. If the number of people living in the home doubles the set capacity of a house, the moisture load from human sources also doubles.

2. **Weather-tight construction.** In the absence of a mechanical ventilation system, natural infiltration (air leakage) is the source of fresh air in homes during the winter. It is this fresh, dry, winter air that dilutes the moisture in the interior air and helps keep relative humidity under control. The amount of infiltration (the air
change rate) that occurs in a house varies depending on the house. Some houses are naturally leaky, while others are more airtight. A particularly tight house may exhibit high relative humidity in the winter, which could lead to moisture and mold problems.

When a house is both overcrowded and has a low air change rate, an excessive moisture load can occur and maximize the potential for localized condensation and mold growth.

If winter condensation problems occur in a crowded house, all other sources of moisture should be identified and minimized. If the problems persist, then the house should be tested for its relative tightness or leakiness using a blower door test. Agencies responsible for performing low-income weatherization usually have the equipment and expertise to perform this test and can confirm whether the air change is too low for the size of a house and its number of residents. If this proves to be the case, then consideration should be given to providing additional ventilation for the house. This can be accomplished in any number of ways. Installing a good bathroom exhaust fan on a humidistat control might accomplish the goal. If the house has a central forced-air heating system, then the existing fan and ductwork can be augmented with a connecting duct to the exterior and controls added to provide fresh air circulation. The services of a mechanical engineer with experience in residential ventilation systems would be valuable when addressing a problem of this kind.

4.6 Heating Systems and Moisture Control

In winter, heating systems provide occupant comfort. Heating systems also impact winter moisture problems in several ways. Two critical ways follow:

1. The heating system is a major determinant of the temperature of interior surfaces. If heat is inadequate or poorly distributed, some wall and ceiling surfaces may be chilled near or below the dew point temperature leading to condensation problems. Occupants play a role in this if they close off rooms, cover supply ducts, block airflow to exterior walls, or adjust the thermostat too low.

2. With the exception of electric heat, most heating systems depend on the combustion of fuels. A major byproduct of combustion is water vapor. If a combustion appliance is improperly vented, or not vented at all, then the heating system can contribute significant amounts of moisture into the interior air.

With regard to the first issue, central heating systems are preferred over stationary, single source heating systems, such as propane space heaters and wood stoves. Central heating systems feature ductwork that supply heated air (or heated water to radiators in hydronic systems) to all the major living spaces of the house. A properly designed and functioning heating plant and distribution system keeps all the rooms warm. This minimizes the potential for chilled surfaces, which are potential condensation and mold contamination sites.
Economic reasons sometimes cause residents to limit the heating of spaces such as bedrooms. Although this is understandable, it can also contribute to chilled exterior surfaces and result in condensation and mold growth.

If a house uses a single, stationary heat source like a wood stove or propane heater, the heat distribution in the house is dramatically affected. The room with the heating appliance will be warm (and even hot) while the rooms furthest from the heat source will be cold. The potential for chilled surfaces and mold problems rises dramatically in the cold rooms. The areas with the greatest potential for condensation problems are closets on exterior walls and at the wall/ceiling junction on exterior walls. If the rooms are particularly cold and the indoor relative humidity is high, condensation can occur most anywhere on exterior walls and ceilings.

With regard to the second issue, any appliance that burns a fuel, such as gas, fuel oil, or wood, produces moisture. Generally, for every molecule of fuel consumed, two molecules of water vapor are produced. If the combustion gases are not well ventilated to the outside of a home, the appliance can contribute large quantities of moisture into the indoor air. The excessive moisture load in the air can be a major contributor to winter moisture problems in the home.

4.7 Maintenance Issues

Many moisture problems and consequent mold contamination result from deferred maintenance. If water infiltration problems from plumbing, roofing, or foundation sources linger, a small problem can turn into a large problem. A minor water infiltration problem with a small potential for mold can turn into a major contamination site, if not repaired quickly. Unfortunately water leakages often go unreported and unattended. Roof and plumbing leaks should be attended to promptly.

A housing authority’s best defense against mold and moisture complaints is its maintenance department. A good proactive maintenance program guards against mold and moisture problems by including the following procedures:

- Perform regular inspections of properties to identify problematic moisture conditions.
- Encourage residents to report moisture problems.
- Respond promptly to identified and reported moisture problems to prevent excessive mold contamination.

Clearly, a prompt response implies a partnership between tenants and the housing authority. Residents must promptly report mold and moisture problems, and maintenance staff must promptly respond to the residents’ reports. If either party defers in their responsibility, the list of deferred maintenance items will grow, and small moisture and mold problems will turn into major problems with possibly severe mold contamination.
Maintenance staff should be trained in the following items to assist in solving and eliminating moisture and mold problems.

**General**

- What is mold
- What causes mold
- Other Indoor Air Quality (IAQ) problems
- Sources of moisture
- Moisture assessment procedures

**Exterior**

- Site drainage
- Maintenance of roof drainage systems (gutters, downspouts, etc.)
- Paving adjacent to homes
- Repair of roofs and roof flashings

**Foundations**

- Crawl space design issues
- Sump pumps

**Attics**

- Attic bypasses
- Attic hatches
- Attic ventilation
- Insulation
- Wall/ceiling junctures

**Mechanical**

- Bathroom and kitchen exhaust fans
- Venting exhaust fans to the exterior
- Plumbing leaks
- Humidifiers
- Unvented appliances

**Mold Remediation**

- Clean-up
- When to call for outside help
At the same time, occupants should be aware of their crucial role in preventing mold and moisture problems. A number of occupant issues bear directly on the causes and severity of moisture and mold problems. Occupants should receive training on the following topics to assist in solving and eliminating moisture and mold problems in their homes.

- What is mold and what causes it
- Use of exhaust fans
- Regular bathroom cleaning
- Avoidance of clutter in critical locations (exterior walls of closets, etc.)
- General housekeeping
- Use of crawl spaces
- Gutter and downspout maintenance
- Difference between plumbing leaks and water condensation on pipes
- Use of sump pumps
- Humidifiers and dehumidifiers

4.8 Remodel & New Construction Recommendations

The following are some recommendations for rehabilitation and new construction projects for the Lac Courte Oreilles Indian Community Housing Department.

On the Exterior of the House

- **Siting & elevation of house.**
  See Section 4.1 - Site Drainage and Rainwater Management

- **Gutter and drainage systems.**
  See Section 4.1 - Site Drainage and Rainwater Management

- **Foundation waterproofing and drainage for new construction.**
  Keeping soil dry next to a foundation is the preferable approach for maintaining a dry basement or crawl spaces. However, there are occasions where this may not be possible and a good second line of defense is to use a high quality waterproofing membrane on the exterior face of the foundation wall. There are many towel or spray applied products on the market. Once applied, these products create a monolithic and highly flexible membrane with crack-bridging properties (e.g. www.appliedtechnologies.com, or www.carlisle-ccw.com). These membranes should be protected with either a geotextile covering (e.g. http://www.deltams.com/deltadrain/) or rigid insulation (e.g. DOW Styrofoam Perimate) before backfilling.

In addition to carefully waterproofing foundation walls, installing drain tile at the base of the foundation wall is necessary to dispose of water that has drained down the face of the wall. Usually this tile is connected to the sump pit, or if possible, run to daylight.
Properly sealing and draining crawl spaces or basement foundation walls is as important as properly installing shingles on a roof. Unfortunately, foundation walls are frequently not provided the same attention that roofs are. Roofs are visible and everyone understands that a leaky roof will result in a host of problems. On the other hand, foundations are below grade and not visible, and thus do not appear to be as important as roofs. However, this belief is incorrect. It does not matter whether moisture comes from above or below. All unwanted moisture should be kept outside the building structure. Although foundation leakage may not result in obvious water spots on the ceiling such as from a roof leak, water from a foundation leak can cause structural damage, contribute to mold growth, and compromise habitable spaces. The importance of properly sealing and draining foundations cannot be overemphasized.

- **Siding options for new construction and remodel projects.**
  There are several criteria that should be considered when selecting the siding for a structure. Performance (maintainability, durability, repairability, permeability, etc.), aesthetics, first-cost, and life-cycle-cost should all be considered. Frequently the selection of siding is based on one factor; lowest first-cost. This is unfortunate because basing decisions solely on first cost precludes all the other criteria that should also be considered in the selection process. The housing authority should carefully scrutinize siding options and not base selection solely on first-cost. Durability of siding should be an important factor in the selection process. Spending a little more up-front can result in significant savings later. A life-cycle-cost analysis should be conducted to justify the selection process. High quality, heavy gauge, insulated vinyl siding, or fiber cement composite siding (http://www.jameshardie.com/), are some of the siding options that should be considered.

**On the Interior of the House:**

- **Toilet tank condensation problems**
  One common problem identified in all Indian housing is mold and the deterioration of drywall behind toilet tanks. Due to condensation on the outer surface of the toilet tank, the wall area next to it is often wet. Since the wet wall behind the toilet tank is difficult to clean, due to limited access, mold grows and the wall deteriorates.

  There are a couple of ways to mitigate this problem. One is to install a toilet with an insulated tank. The insulation results in higher toilet tank surface temperatures and thus less surface condensation. The other option is to supply both hot and cold water to the toilet through a mixing valve. The increased water temperature inside the tank will result in less surface condensation. The supply of hot and cold water through a mixing valve has been implemented at a couple of Indian housing communities with positive results.
- **Insulate all plumbing supply lines.**
  The temperature of water supplied to Indian housing in the northern tier of the United States is very cold. Many of the examined homes had water supply pipes in the basement or crawl spaces that were dripping liquid water due to condensation on their surface. This condensation can contribute a significant amount of water to the interior moisture load. All hot and cold supply piping should be insulated; the hot water lines for energy conservation, the cold water lines to eliminate condensation.

- **Ceiling finishes.**
  Many of the inspected homes had mold growing at the wall to ceiling junction. Cleanup of this mold is very difficult, if not impossible, if the ceiling has a rough textured finish. It is highly recommended that ceilings be finished with a smooth or a skip-trowel finish in lieu of a rough popcorn finish.
### SUMMARY SITE VISIT REPORT

**DATE:** April 28-May 1, 2003

| A | B | C | D | E | F | G | H | I | K | L | M | N | O | P | Q | R | S | T | V |
| 1 | **Inspection Number** | **Address** | **HUD Program** | **Building Age** | **Occupancy** | **Foundation Type** | **Model and Framing Type** | **Heat Type** | **Site Drainage Problems** | **Gutter System Problems** | **Leaks from Exterior** | **Basement or Crawlspace** | **Plumbing Problems** | **Bathroom Problems** | **Exhaust Ventilation** | **Exterior Wall/Ceiling problems** | **Attic Problems** | **Visible Mold (Column #)** |
| 2 | **Number** | **Address** | **Block Concrete** | **2 X 4 Ranch** | **Propane** | **Yes** | **Yes** | **No** | **Damp** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** | **No** | **13,15,17** |
| 3 | 1-1 | South Reserve | LR | 32 | 3 | Block Concrete | 2 X 4 Ranch | Propane | Yes | Yes | No | Damp | Yes | Yes | Yes | Yes | No | 13,15,17 |
| 4 | 1-2 | 14367 W Sand Lane | LR | 24 | 3 | Block Concrete | 2 X 4 Ranch | Outside Wood/Propane | Yes | Yes | Yes | No | No | Yes | Recirc Fan in Kitchen | Yes | No | 13,15,17 |
| 5 | 1-3 | Six Mile | LR | 23 | Occupants not Home | Block Concrete | 2 X 4 Ranch | Yes | INTERIOR | NOT INSPECTED |
| 6 | 1-4 | 12840 N. Dry Town Lane | LR | 16 | 3 | 1/2 Block Concrete | 1/2 Crawlspace | Split-Level/Shoe House | Inside Wood/Gas | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | No | 13,15 |
| 7 | 1-5 | 9316 N. Dry Town Lane | LR | 16 | 5 | Block Concrete | 2 X 4 Ranch | Interior Wood/Propane | Yes | Yes | Yes | Yes | No | No | Recirc Fan in Kitchen | No | No | 13 |
| 8 | 1-6 | Round Lake | LR | 32 | Occupants not Home | Unknown | 2 X 4 Ranch | Unknown | Yes | INTERIOR | NOT INSPECTED |
| 9 | 2-1 | 9360 N. Poppletown Lane | LR | 18 | 3 | Crawl Space | Modular Ranch | Gas | No | Yes | Yes | No | Yes | Yes | No | Yes | No | No | 15 |
| 10 | 2-2 | 13366 W Poppletown Lane | LR | 18 | Occupants Available for Interview | Crawl Space | Modular Ranch | Propane | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | No | 13 |
| 11 | 2-3 | 9393 N. Bass Lake | LR | 18 | 4 | Crawl Space | Modular Ranch | Gas | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | 15,17 |
| 12 | 2-4 | 13367 W Poppletown Lane | LR | 18 | 4 | Crawl Space | Modular Ranch | Propane | Yes | Yes | Yes | Yes | Yes | No | No | No | No | No | 15 |
| 13 | 2-5 | 13355 W Poppletown Lane | LR | 18 | 4 | Crawl Space | Modular Ranch | Gas | Yes | Yes | Yes | Not Inspected | Yes | Not Inspected | Yes | No | No | No | 13,15 |
| 14 | 2-6 | 13362 W Poppletown Lane | LR | 18 | 5 | Basement | Modular Ranch | Gas | Yes | Yes | Yes | No | Yes | No | No | No | No | No | 13,15,17 |
| 15 | 2-7 | 13316 W Poppletown Lane | LR | 18 | 2 | Crawl Space | Modular Ranch | Propane | No | Yes | Yes | Damp | Yes | Yes | No | No | No | 13,15 |
| 16 | 3-1 | 13512 W Highway B | MH | 20 | 3 | Block Concrete | 2 X 4 Ranch | Outside Wood/Propane | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes | No | 13,15,17 |

**Building Research Council**

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Appendix B-Lac Courte Oreilles Technical Housing Assessment Report

Inspection Number: 1-1
Address: South Reserve
Model Type: Ranch
Foundation: Block Concrete Basement
Construction: 2 x 4 Wood Frame
Heat Type: Propane
Bedrooms: 3
Occupancy: 3 total, 2 adults and 1 child
Age: 32 Years

Mold and Moisture Conditions: Mold was present at the wall to ceiling junctions in the bathroom, in closets (Figure 2), on windowsills and in the basement.

Rainwater Management: The site was relatively flat. Only short sections of gutters were present over the front and back doors. The depressions next to the foundation were probably due to animal activity.

Exterior Wall/Ceiling Junction: The mold at the wall to ceiling junctions coincided with where the trusses rested on the top plate and condensation occurred (Figure 3).

Bathroom: Mold growth was evident at the perimeter of the bathtub where it joined the wall surface (Figure 4). The plastic soap dish, which was molded into the tub surround, was cracked with a hole in it (Figure 5). The bath fan cover was missing and, although the motor functioned, it did not move much air well (Figure 6).
**Interior Conditions:** Several windows had mold growth at the bottom of the glass and on the lower sash portion (Figure 7). One bedroom closet exterior wall had extensive mold. The attic hatch had mold growing on one corner (Figure 8).

**Basement:** Several problems were identified in the basement.

1. The disconnected dryer vent was venting directly into the basement (Figure 9).
2. The washing machine drain emptied into the floor drain rather than the building waste system (Figure 10).
3. Mold grew on the block walls (Figure 11).
4. The basement floor carpet and clutter provided food for mold growth (Figure 12).

**Attic Conditions:**
The attic sheathing was dry, there was approximately twelve inches of insulation, and baffles along the perimeter were evident between trusses. The vent for the bath fan was not evident however it could very well have been buried beneath the insulation.

**Occupant Notes:** Two adults and one child had resided in the home since 1991. There were two smokers. The only reported health problems were colds.
**Recommendations:**

**On the exterior of the house:**

1. Reshingle the house since shingles are missing (Figure 13).

2. Install gutters on both the house front and back and drain away from the foundation.

3. Fill in the depressions next to the foundation and reseed grass.

**In the basement:**

1. Reconnect the dryer vent to the exterior jack.

2. Drain the washing machine plumbing into the waste line for the house rather than into the floor drain.

3. Install a dehumidifier to dry out the basement.

4. Wash all the walls and floor with soap and water.

5. Clean up the clutter to reduce mold food sources.

**Inside the residence:**

1. Clean all visible mold with soap and water.

2. Lightly sand all window sashes and sills, then reseal with two coats of polyurethane.

3. Remove and replace bathtub surround. Clean up interior wall cavities and reinsulate, if necessary.

4. Remove and replace the bath fan with a high quality unit. Install a light switch that also activates the fan with an adjustable timer.

5. Install a kitchen fan that vents to the exterior.

6. Keep clothes and other possessions away from exterior closet walls.

**In the attic:**

1. Add more insulation to the attic hatch top and weather-strip the perimeter.
2. Add more insulation along the trusses’ perimeters.

3. Vent the bath fan to the exterior, preferably through the roof instead of the soffit. Since the vented air has the potential of migrating into adjacent soffit vents, it may travel back into the attic.
**Appendix B**

**Lac Courte Oreilles**

**Technical Housing Assessment Report**

April 28-May 1, 2003

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**Inspection Number:** 1-2  
**Address:** 14387 W Sand Lane  
**Model Type:** Ranch  
**Foundation:** Block Concrete Basement  
**Construction:** 2 x 4 Wood Frame  
**Heat Type:** Outside Wood Stove with Propane as back-up  
**Bedrooms:** 3  
**Occupancy:** 3 total; 2 adults and 1 child  
**Age:** 24 years

**Mold and Moisture Conditions:** Mold was in the bathroom and basement.

**Rainwater Management:** The site was relatively flat for about ten feet adjacent to the house, but then sloped away from the site. Gutters were present, but there were no downspouts (Figure 2). The end-caps were left off the gutters letting water pour out the gutter ends, causing depressions where the gutters emptied onto the ground next to the foundation.

**Bathroom:** Extensive mold growth grew in the bathroom on the ceiling and walls above the bathtub (Figure 3). The bath fan worked but did not move much air. The vanity base cabinet was badly deteriorated by moisture damage (Figure 4).

**Basement:** The home had a water pressure tank in the basement and the area surrounding the tank had mold stains (Figure 5). On the wall opposite the pressure tank, there was a window to the exterior with...
Appendix B-Lac Courte Oreilles Technical Housing Assessment Report

kitchen water supply lines above. A wet spot was on the windowsill from a leak in the supply plumbing (Figure 6).

**Attic Conditions:**
The attic had approximately twelve inches of insulation and baffles along the perimeter between trusses. The vent for the bath fan was not evident; however, it could have been buried beneath the insulation. There was a wet area between the truss and sheathing adjacent to the chimney.

**Occupants Notes:** Two adults and one child had lived in the home for twelve years. There was one smoker in the household. One occupant had reported allergies.

**Recommendations:**
On the exterior of the house:

1. Fill in the depressions next to the foundation and reseed with grass.
2. Place end-caps on the gutters and install downspouts and splash blocks.
3. Repair deteriorated siding at the wall base.

In the basement:

1. Fix leaking kitchen supply line.
2. Clean pressure tank and surrounding walls with soap and water.
3. Install a dehumidifier in the basement.

Inside the residence:

1. Clean up bathroom mold with soap and water. Replace drywall if necessary.
2. Replace the deteriorated bath vanity.

In the attic:

1. Vent the bath fan to the exterior, preferably through the roof not out the soffit.
2. The wet area at the truss and sheathing junction is due to leaking flashing. Fix the chimney flashing.
Appendix B-Lac Courte Oreilles Technical Housing Assessment Report

Inspection Number: 1-3
Address: Six Mile
Model Type: Ranch
Foundation: Block Concrete Basement
Construction: 2 x 4 Wood Frame
Heat Type: Unknown
Bedrooms: Unknown
Occupancy: Occupants not home
Age: 23

Note: Occupants were not home, so the home was not inspected. The following notes are based on an exterior inspection only.

Mold and Moisture Conditions: Mildew was present on the exterior siding on the home’s north side.

Site Drainage and Rainwater Management: The house front had a gutter, but it was damaged where a valley emptied into it. The rear of the house had no gutter and a clear drip-line had formed beneath the overhang (Figure 2).

Occupant Notes: The occupants were not home or available for an interview.

Discussion/Recommendations:

1. Use soap and water to clean the mildew off the siding on the north side of the house.
2. Fix the gutter to the right of the front house door.
3. Install a gutter system along the back of the house.
4. Repair deteriorated siding.
Inspection Number: 1-4  
Address: 12840 N. Dry Town Lane  
Model Type: Split-Level (Shoe House)  
Foundation: ½ Concrete Block Basement and ½ Crawl Space  
Construction: 2 x 4 Wood Frame  
Heat Type: Gas and Wood Stove as back-up  
Bedrooms: 3  
Occupancy: 3 adults  
Age: 16 Years  

Mold and Moisture Conditions: Mold was on a downstairs bedroom wall (Figure 2). Mold was on an upstairs hallway closet ceiling (Figure 3). The occupants reported flooding problems in a downstairs bedroom.

Site Drainage and Rainwater Management: There were no gutters on the house and the site was relatively flat.

Foundation Conditions: A portion of the foundation was a deep crawl space and the remainder formed the lower walls of a bedroom, bathroom, and mechanical room partially below grade. A soil depression had formed next to the back house foundation.

Exterior Conditions: The siding was in good condition except for the dried out and separated caulk joints between the siding and corner boards (Figure 4).

Bathroom: The upstairs toilet was not securely fastened to the floor. Some visible mold was on the upstairs bathroom ceiling (Figure 5).

Kitchen: The kitchen sink drain had a minor leak. The stove exhaust fan was a recirculating unit.
**Lower Level Bedroom and Mechanical Space:** The lower level bedroom and its closet had mold. The bedroom wall-to-wall carpet could not be pulled up, but probably had mold beneath.

The clothes dryer vent in the mechanical room was disconnected and exhausted to the interior (Figure 6).

**Attic:** The blown-in insulation looked sufficient. The inspector could not identify where the upstairs bathroom fan vented.

**Occupant Notes:** Three adults have lived in the home since 1984. There was one smoker in the household. Some family members reported allergies. Two grandchildren visited often. The house had burned down and was rebuilt ten years earlier.

**Discussion/Recommendations:**

1. The primary moisture source in the lower level was probably due to a poor rainwater management system. A substantial amount of water drained from the roof surfaces next to the front door saturating the foundation at the lower level bedroom/closet area. Proper installation of gutters could alleviate the lower level mold problems.

2. Remove mold damaged materials, clean all surfaces, dry the area, and reinstall new materials in the lower level bedroom/closet area after an exterior rainwater management system is installed.

3. Fix the deteriorated concrete front door step (as a safety issue).

4. Reconnect dryer vent to the exterior jack.

5. Fix the leaking kitchen sink drain.

6. Since gaps between siding and corner boards allow air and moisture into the wall system, scrape all gaps clean and recaulk with a high-quality silicone caulk.

7. Venting of the upstairs bathroom fan needs further investigation. The fan could be venting into the insulation, causing mold on the bathroom ceiling, rather than through a roof jack as it should be.

8. Wood stacked against the exterior of the house should be moved away from the siding to allow air circulation and keep vermin away from the house base (Figure 7).
Inspection Number: 1-5
Address: 9316 N. Dry Town Lane
Model Type: Ranch
Foundation: Block Concrete Basement
Construction: 2 x 4 Wood Frame
Heat Type: Gas and Wood Stove as back-up
Bedrooms: 3
Occupancy: 5 total: 2 adults and 3 children
Age: 16 Years

Mold and Moisture Conditions: Mold was present on basement walls.

Site Drainage and Rainwater Management: There were no gutters. Roof run off was splashing on the ground and over the lower portion of the siding causing it to deteriorate (Figure 2).

Foundation Conditions: The occupants reported occasional flooding in the basement. Visible mold was noted on the foundation wall (Figure 3). The dryer vented to the basement (Figure 4).

Bathroom: No mold was present in the bathroom.

Kitchen: The only problem with the kitchen was a recirculating exhaust fan.

Bedrooms and Living Space: The bedrooms and living areas had no mold.

Attic: Approximately ten to twelve inches of blown-in insulation was in the attic. Everything appeared dry and there was no mold.

Occupant Notes: Five occupants, two adults and three children have lived in the home three years. One reported smoker and one two-year-old child with allergies are among the occupants.

Discussion/Recommendations:

1. Install gutters and downspouts so they dispose rain and snow melt away from the house.

2. Replace badly deteriorated siding after a water management system is installed.
3. Reconnect dryer vent to the exterior wall jack.

4. Clean all basement wall and floor surfaces with soap and water, allow to dry and then paint with a masonry sealant.

5. Install a dehumidifier in the basement.

6. Remove all food sources for mold in the basement. The carpet on the basement floor had visible mold growth and should be removed (Figure 5).

Figure 5: Mold on carpet in basement
Inspection Number: 1-6
Address: Round Lake
Model Type: Ranch
Foundation: Unknown
Construction: 2 x 4 Wood Frame
Heat Type: Unknown
Bedrooms: Unknown
Occupancy: Occupants not home
Age: 32 Years

Note: Unable to inspect home interior due to occupants unavailability. The following notes are based on an exterior inspection only.

Mold and Moisture Conditions: No mildew was evident on the exterior siding.

Site Drainage and Rainwater Management: No rainwater management system was present. A clear drip line was visible along the base of the house where the roof shed water at the front and back of the house.

Occupant Notes: The occupants unavailable for an interview.

Discussion/Recommendations:

1. Install gutters and downspouts that dispose of water away from the house.

2. A leaky faucet at the back of the house ran continuously and had formed a puddle immediately adjacent to the house. The faucet should be repaired.

3. A gap between the brick and window frame on the front of the house was noted. Gaps such as this allow water and air infiltration into the wall and accelerate the deterioration of the wall system. The gap should be sealed.
Inspection Number: 2-1
Address: 9360 N. Poppletown Lane
Model Type: Ranch
Foundation: Crawl Space
Construction: Modular
Heat Type: Gas
Bedrooms: 3
Occupancy: 3 adults
Age: 18 Years

Mold and Moisture Conditions: Mold was on the bedroom closet lower wall (Figure 2). Visible mold grew on the wall behind the toilet due to toilet tank condensation (Figure 3). Sewer problems and bath backup had occurred within the last three years. Condensation was visible on the back bedroom and kitchen windows (Figure 4).

Site Drainage and Rainwater Management: Site grading was good, but there were no gutters. Some depressions were around the house perimeter from animal activity (Figure 5).

Foundation Conditions: Some puddles were on the vapor barrier top. About 80% of the crawl space insulation had fallen out of the floor structure (Figure 6).
The crawl space vents were at grade and dirt flowed into the crawl space (Figure 7). The condensate line from the high-efficiency furnace was disconnected and drained into the crawl space (Figure 8). Poor rainwater management and repeated soaking of the band joist had caused it to rot through in a couple areas (Figure 9).

**Exterior Conditions:** The home exterior was in poor condition. The siding and windows were badly deteriorated. The deteriorated siding resulted from a poor or nonexistent rainwater management system.

**Bathroom:** The bathroom fan was operational but did not move much air.

**Kitchen:** No mold was in the kitchen. The kitchen had a recirculating exhaust fan.

**Bedrooms and Living Space:** Mold was growing on the wall in one of the bedroom closets. The dryer was disconnected and vented into the interior of the home (Figure 10).

**Attic:** There was no mold in the attic. Insulation levels looked good.

**Occupant Notes:** Three adult smokers with reported health problems of allergies, asthma, and heart issues had lived in the home for one year.

**Discussion/Recommendations:**
On the exterior of the house:

1. Install a rainwater management system and drain away from the house.

2. Replace siding, windows and rotted band joist. The deterioration is due mainly to an absent rainwater management system.
3. Construct small area wells around the crawl space vents.

4. Fill in the depressions next to the foundation and reseed with grass.

In the crawl space:

1. Properly insulate the floor structure. The incorrectly installed fiberglass insulation had fallen onto the crawl space floor. Currently the only building component separating occupant inhabited spaces and outside cold air is a ¾” subfloor. This results in compromised occupant comfort and increased utility costs.

2. Repair the high efficiency condensate drain, which currently drains into the crawl space.

3. Properly install a vapor barrier (VB). The existing VB only covers a portion of the base of the crawl space and is not sealed to the perimeter or sheet-to-sheet.

Inside the residence:

1) Reconnect the dryer vent.

2) Clean bath fan grill and housing interior. Vent the bath fan to the exterior, preferably through the roof instead of the soffit.

3) Clean up bathroom mold with soap and water. Replace damaged drywall.

4) Clean all windows and sashes with soap and water, let them dry, lightly sand the sashes, and recoat them with polyurethane. When condensation reappears on the windows, either run a dehumidifier, or wipe dry and keep clean.
Inspection Number: 2-2  
Address: 13368 W. Poppletown Lane  
Model Type: Ranch  
Foundation: Crawl Space  
Construction: Modular  
Heat Type: Propane  
Bedrooms: 3  
Occupancy: Occupants unavailable for interview  
Age: 18 Years

Mold and Moisture Conditions: Some bedrooms were occupied, however, the spaces that were inspected did not have space had some mold.

Site Drainage and Rainwater Management: The site was relatively flat and two short sections of guttering were present above the doorways. There were no downspouts on either gutter section (Figure 2). Several depressions were next to the foundation.

Foundation Conditions: Several problems were uncovered in the crawl space:

1. The crawl space had a significant puddle beneath the bathroom due to a plumbing leak. Whenever someone took a shower and the water was running, a steady stream of water leaked into the crawl space.
2. The dryer vented into the crawl space (Figure 3).
3. Most of the insulation had fallen out from between the joists and was lying on the ground (Figure 4).
4. A large hole dug in the crawl space was full of occupant clutter (Figure 4).
5. There were only remnants of a vapor barrier.

6. The crawl space vents were located at grade.

**Bathroom:** The bathtub drain leaked, but no mold grew in the bathroom. The exhaust fan vented through the soffit (Figure 5).

**Kitchen:** A kitchen sink leak had been fixed. The kitchen had a recirculating fan.

**Bedrooms and Living Space:** The inspected common areas were free of mold.

**Attic:** The attic had about twelve inches of blown-in insulation and looked dry.

**Occupants Notes:** The occupants were unavailable for an interview.

**Discussion/Recommendations:**

On the exterior of the house:

1. Install a rainwater management system to drain remote.

2. Replace siding, windows and any rotted band joist. Install some type of rainwater management system.

3. Construct small area wells around crawl space vents.

4. Fill in depressions near foundation and reseed grass.

In the crawl space:

1. Properly insulate the floor structure. Currently the only building component separating occupant inhabited spaces and outside cold air is a ¾” subfloor. This resulted in compromised occupant comfort and increased utility costs.

2. Fill large crawl space hole and regrade to level floor.

3. Properly install a vapor barrier.

4. Reconnect the dryer vent.

Inside the residence:

1. Fix the bathroom plumbing leak.

1) Preferably vent the bath fan to the exterior through the roof, not out the soffit.
Appendix B-Lac Courte Oreilles Technical Housing Assessment Report

Inspection Number: 2-3  
Address: 9393 N. Bass Lake  
Model Type: Ranch  
Foundation: Crawl Space  
Construction: Modular  
Heat Type: Gas  
Bedrooms: 3  
Occupancy: 4 total, 1 adult and 3 children  
Age: 18 Years

Mold and Moisture Conditions: Mold grew on the back bedroom wall where it had been painted over previously (Figure 2). Mold had also grown beside and behind the toilet, even though it had been cleaned, and repainted. Mold grew on living room windowsills.

Site Drainage and Rainwater Management: The site was relatively flat and the only gutters on the house were two short sections above the doorways with no downspouts.

Foundation Conditions: The crawl space floor was partially covered with a vapor barrier (VB), on which there were a couple of puddles (Figure 3). Where the VB was missing, the soil was damp. Some clutter was present. Uninsulated metal supply-air ducts were proximate to open crawl space vents (Figure 4).

Bathroom: Mold had grown beside and behind the toilet, which had been cleaned and repainted. The rest of the bathroom looked fine.

Kitchen: There was no mold in the kitchen, and the kitchen exhaust fan was vented to the exterior.

Bedrooms and Living Space: Mold grew on the back bedroom wall, where it had been painted over.

A very healthy mold bloom grew on the bedroom closet exterior wall that

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backed-up to the front entry (Figure 5). Several windows had minor mold growth at the glass to sash interface and one of the thermopane windows had a compromised seal.

**Attic:** There was no mold in the attic. Insulation levels looked good.

**Occupant Notes:** One adult and three children (ages 11, 10, and 8 years) had lived in the home for eleven years. There was one smoker and no reported health problems.

**Discussion/Recommendations:**

On the exterior:

1. Install a rainwater management system and drain away from the house.

2. Replace siding, windows, and the rotted band joist.

In the crawl space:

1. Properly insulate the floor structure.

2. Insulate supply-air ductwork, particularly ductwork immediately adjacent to crawl space vents.

3. Properly install a vapor barrier. The existing VB only covers a portion of the base of the crawl space and is not sealed to the perimeter or sheet-to-sheet.

4. Remove all clutter and food sources for mold.

Inside the residence:

1) Remove and replace drywall compromised by mold on closet wall. Inspect interior of wall and clean if necessary before installing new drywall.

2) Clean all windows and sashes with soap and water, dry them, lightly sand the sashes, and recoat them with polyurethane. When condensation reappears on the windows, either run a dehumidifier, or wipe dry and keep clean.

3) Replace the windows with compromised seals.
Appendix B-Lac Courte Oreilles Technical Housing Assessment Report

Inspection Number: 2-4
Address: 13367 W. Poppletown Lane
Model Type: Ranch
Foundation: Crawl Space
Construction: Modular
Heat Type: Propane
Bedrooms: 3
Occupancy: 4 total, 3 adults and 1 teenager
Age: 18 Years

Mold and Moisture Conditions: The occupant reported roof leaks, living room flooding and window leaks. Mold grew in the bedrooms, on the windowsills and on the bedroom closet wall (Figure 2-4). The occupants had cleaned the mold but it came back.

Site Drainage and Rainwater Management: The site adjacent to the house was relatively flat, however a short distance from the house, the grade dropped. There was a short section of gutter above the front door which had no downspout.

Foundation Conditions: The crawl space floor was partially covered with a vapor barrier (VB), on which were a couple puddles. Where no VB was present, the soil was damp. Uninsulated metal supply-air ducts were proximate to open crawl space vents (Figure 5). Much of the insulation that was supposed to be between the joists had fallen to rest on the crawl space floor (Figure 6).
The dryer vent was disconnected from the exterior jack (Figure 7).

**Bathroom:** Mold was around and behind the bathroom toilet. The occupants did not use the bath fan because if allowed to run for any length of time, it began to smell like it was about to catch on fire.

**Kitchen:** The kitchen had some mold beneath the kitchen sink due to a minor drain leak.

**Bedrooms and Living Space:** Mold was in all bedrooms on several window sashes and wall surfaces. Occupant possessions cluttered most rooms.

**Attic:** The attic was sufficiently insulated and dry.

**Occupant Notes:** Three adults and one teenager had lived in the home for seventeen years with reported asthma, diabetes and allergies. One adult occupant had spinal arthritis, which limited her to movement around the home in a wheelchair.

**Discussion/Recommendations:**

On the exterior:

1. Install a rainwater management system and drain away from the house.

2. Replace deteriorated siding (Figure 8), windows, and rotted band joists.

3. Fix the metal fascia (Figure 9).

4. Reshingle the roof.

In the crawl space:

1. Properly insulate the floor structure.

2. Insulate supply-air ductwork, particularly ductwork immediately adjacent to crawl space vents.
3. Properly install a vapor barrier. The existing VB only covers a portion of the base of the crawl space and is not sealed to the perimeter or sheet-to-sheet.

4. Insulate cold and hot water pipes.

5. Reconnect dryer vent to exterior jack.

Inside the residence:

1. Mold on several wall surfaces appears to have compromised drywall to the point that it should be removed and replaced. Inspect interior of wall and clean if necessary before installing new drywall.

2. Clean all windows and sashes with soap and water, dry them, lightly sand the sashes, and recoat them with polyurethane. When condensation reappears on the windows, either run a dehumidifier, or wipe dry and keep clean.

3. Clean return-air grill and replace the filter (Figure 10).

4. Reconnect the dryer vent to the appliance (Figure 11).

5. Fix damaged ceiling areas after the home is reshimed.

6. Reduce clutter, particularly along the outside walls so air circulates better. Keep surfaces dry.

7. Fix kitchen sink leak.
Appendix B-Lac Courte Oreilles Technical Housing Assessment Report

Inspection Number: 2-5
Address: 13355 W. Poppletown Lane
Model Type: Ranch
Foundation: Concrete Block Crawl space
Construction: Modular
Heat Type: Gas
Bedrooms: 3
Occupancy: 4: 2 adults, 2 children
Age: 18 Years

Mold and Moisture Conditions:
There was some mold, but it was contained to the crawl space and bathroom.

Site Drainage and Rainwater Management: The site immediately adjacent to the house was flat, however a short distance away, the grade dropped. There was a short section of gutter above the front door which had no downspout.

Foundation Conditions: The crawl space floor was partially covered with a vapor barrier (VB), on which were a couple puddles. Where no VB was present, the soil was damp. The puddles on top the vapor barrier were due to a broken water heater leaking on the floor and crawl space. Some of the insulation from between the joists had fallen to rest on the crawl space floor.

Bathroom: There was mold in the bathroom, primarily around and behind the toilet.

Kitchen: No mold grew in the kitchen but it had holes in drywall, missing drawers, etc.

Bedrooms and Living Space: The bedrooms and living spaces did not have any mold.

Attic: The attic was sufficiently insulated and dry.

Occupyant Notes: Two adults and two children had lived in the home since 1996. There were two smokers in the household.
Discussion/Recommendations:

On the exterior:

1. Install a rainwater management system and drain away from the house.
2. Replace deteriorated siding, windows, and rotted band joists.

In the crawl space:

1. Properly insulate the floor structure.
2. Properly install a vapor barrier. The existing VB only covers a portion of the base of the crawl space and is not sealed to the perimeter or sheet-to-sheet.
3. Insulate cold and hot water pipes.
4. Remove clutter.

Inside the residence:

1) Clean up the mold with soap and water.
2) Fix damaged drywall.
Appendix B-Lac Courte Oreilles Technical Housing Assessment Report

Inspection Number: 2-6
Address: 13362 W Poppletown Lane
Model Type: Ranch
Foundation: Concrete Block Basement
Construction: Modular
Heat Type: Gas
Bedrooms: 3
Occupancy: 5 total, 2 adults and 3 children
Age: 18 Years

Mold and Moisture Conditions: This home was recently rehabilitated for about $80,000 and did not have any mold.

Site Drainage and Rainwater Management: The site had the potential for good drainage. The home had gutters and downspouts but three of the four downspouts did not have leaders and splash blocks. Instead, the downspouts emptied immediately adjacent to the foundation wall (Figure 2). Water discharge from the three downspouts without leaders had already scoured holes in the ground adjacent to the foundation.

Foundation Conditions: The foundation walls were unpainted concrete block with evidence of moisture migration from the exterior in one corner that did not have a downspout leader. A plastic-covered hole in the concrete floor was assumed to be a sump pit, but no sump was present. The framing for the basement staircase walls rested on standard lumber that was embedded in the concrete floor (Figure 3). The HVAC unit was located in the basement and had an air exchanger system.

Bedrooms, Bathrooms, Kitchen and Living Space: None of these spaces had mold.

Attic: Not inspected.

Occupant Notes: Two adults and three children (ages 3, 4, and 8 years old) had lived in the home for one year. There were no reported health problems.

Discussion/Recommendations:

1. Install leaders on the downspout ends and drain away from the house or into a drain tile that drains away from the house. Drain tiles are much less susceptible to damage than leaders and splash blocks. This simple drainage problem can rapidly mature...
into a much more severe moisture problem if not addressed immediately. As is, the downspouts currently place a huge moisture load on the corners of the foundation whenever it rains.

2. In the basement, install a sump pump in the sump pit (Figure 4) and monitor the standard lumber that is embedded in the concrete floor for deterioration.

Mold and Moisture Conditions: Mold was noted around the windows and in the bathroom.

Site Drainage and Rainwater Management: A section of gutter was above the front door with no downspouts. Areas close to the house shaped down several feet away from the house and would provide good drainage if a rainwater management system were installed.

Exterior Condition: Soil and back material was shifting (Figure 2), the windows were in bad condition, and the siding needed replacing mostly due to the lack of rainwater management.

Foundation Condition: The crawl space had a vapor barrier over a portion of the floor and the uncovered portion had damp soil (Figure 3). The dryer vent duct was compromised allowing the dryer to vent into the crawl space (Figure 4). Mold was on the Kraft-faced insulation adjacent to a waste pipe (Figure 5).

Bathroom: The bathroom had very minor mold in an upper corner above the vanity (Figure 6). The bath exhaust fans had been disconnected because the occupants feared it might ignite and start a fire.
Inspection Number: 2-7
Address: 13316 W Poppletown Lane
Model Type: Ranch
Foundation: Crawl Space
Construction: Modular
Heat Type: Propane
Bedrooms: 3
Occupancy: 2 total, 1 adult and 1 child
Age: 18 Years

Mold and Moisture Conditions: Mold was noted around the windows and in the bathroom.

Site Drainage and Rainwater Management: A section of gutter was above the front door with no downspouts. Areas close to the home sloped down and away from the house and would provide good drainage if a rainwater management system were installed.

Exterior Conditions: Soffit and fascia material was missing (Figure 2), the windows were in bad condition, and the siding needed replacing mostly due to the lack of rainwater management.

Foundation Conditions: The crawl space had a vapor barrier over a portion of the floor and the uncovered portion had damp soil (Figure 3). The dryer vent duct was compromised allowing the dryer to vent into the crawl space (Figure 4). Mold was on the kraft-faced insulation adjacent to a waste pipe (Figure 5).

Bathroom: The bathroom had very minor mold in an upper corner above the vanity (Figure 6). The bath exhaust fans had been disconnected because the occupants feared it might ignite and start a fire.
as had happened in their other residence. The base of the vanity cabinet was missing.

**Kitchen:** No visible mold was in the kitchen. The range hood was covered with grease which leads one to suspect that the hood filter is likewise contaminated and probably clogged with grease (Figure 7).

**Bedrooms and Living Space:** These spaces had no mold. The return-air grill in the hallway was clogged with dust (Figure 8).

**Attic:** The attic was well insulated and dry.

**Occupants Notes:** One adult and one child resided in the home for fifteen years. There was one smoker in the household and one occupant had asthma and allergies.

**Discussion/Recommendations:**

On the exterior:

1. Fix the fascia and soffit.
2. Replace deteriorated siding, windows, and rotted band joists.
3. Install a rainwater management system and drain away from the house.

In the crawl space:

1. Properly install a vapor barrier. The existing VB only covers a portion of the base of the crawl space and is not sealed to the perimeter or sheet-to-sheet.
2. Insulate cold and hot water pipes.
3. Replace insulation that has fallen out from between the floor joists and strap all of the insulation so it will not fall out again.
4. Fix the dryer vent.

Inside the residence:

1. Clean up mold with soap and water.
2. Replace the bath fan with a high quality unit.

3. Fix the bath vanity.

4. Check filter on range exhaust hood and replace.

5. Clean return-air grill and furnace filter.
Appendix B-Lac Courte Oreilles Technical Housing Assessment Report

Inspection Number: 3-1
Address: 13512 W. Highway B
Model Type: Ranch
Foundation: Concrete Block Basement
Construction: 2 x 4 Wood Frame
Heat Type: Outside Wood Stove and Propane
Bedrooms: 3
Occupancy: 3 total, 2 adults and 1 child
Age: 20 Years

Mold and Moisture Conditions: Several areas had significant mold growth. A strong musty smell was evident throughout the home.

Site Drainage and Rainwater Management: The site was relatively flat. A gutter system and several downspouts with leaders that conducted water away from the house were present.

Basement: Several problems in the basement included:

1. Moisture wet the basement floor and the bottom of the basement walls. Mold grew on the wall bases (Figure 2).

2. The washing machine emptied into a large open-topped plastic garbage barrel. The sump pump then pumped it into the building’s waste system (Figure 3).

3. Basement clutter provided ample sources of food for mold to grow on (Figure 4).

Bathroom: The bathroom had several problems:

1. The toilet was very loose, rocking back-and-forth easily (Figure 5).
2. The vinyl flooring had extensive staining beneath and embedded in the surface (Figure 6).

3. The walls had mold growth and water staining due to moisture condensation on cold surfaces. The mold grew due to repeated wetting of the area near the toilet base from condensation on the supply line and toilet tank.

4. The air inlet slots in the bath exhaust fan cover were almost completely clogged with lint.

**Kitchen:** The kitchen sink had a bowl beneath the trap to capture the water from a plumbing leak (Figure 7).

**Bedrooms and Living Space:** The mudroom had mold on the ceiling and walls (Figure 8).

**Attic:** The attic hatch had no topside insulation and had mold growing on its bottom side (Figure 9). The attic itself was well insulated and appeared to have no moisture problems.

**Occupant Notes:** Two adults and one seven-year-old child had lived in the home for ten years with no reported health problems.

**Discussion/Recommendations:**

For the basement include:

1. Clear all clutter from the basement.

2. Remove moldy drywall and clean contaminated framing.

3. Run a dehumidifier to dry out any remaining moisture.
4. Drain washing machine into an enclosed container not an open garbage can.

5. Insulate the band joist with rigid insulation.

For the main level:

1. Clean up mold in back mudroom. Remove and replace any damaged wallboard.

2. Remove toilet and vinyl flooring. Inspect subfloor and repair as required. Install new flooring and reseat toilet.

3. Run a hot water line to the toilet and install a mixing valve to reduce condensation on the supply line and the toilet tank.

4. Clean bath fan exhaust cover and inspect and clean interior of fan housing. Reroute bath exhaust to a new roof-mounted exhaust jack instead of through the soffit.

5. Fix kitchen sink leak.

6. Fasten rigid insulation to top of attic hatch and weather-strip perimeter.

For the exterior include:

1. The stoop into the back mudroom sloped toward the house (Figure 10). Remove the stoop and recast to drain properly or raise the stoop by mudjacking.

2. Fix the gutter on the roof at the rear of the house.

3. Make all downspouts drain away from the house.

4. Place thick plastic beneath the rocks along the perimeter of the house and slope away from the house to decrease the moisture amount along the basement perimeter.

Figure 10: Stoop slopes toward the mudroom