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PART I

SQUAXIN ISLAND DEPARTMENT OF COMMUNITY DEVELOPMENT TRIP REPORT

INTRODUCTION

Michelle Rook 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 the Squaxin Island Department of Community Development (SIDCD) on June 14-15, 2004. The SIDCD administers the housing program for the Squaxin Island Tribe. The site visit provided technical assistance to the SIDCD in assessing mold and moisture conditions in housing units. This report summarizes activities and issues addressed while on site. A detailed analysis of findings and recommendations is found in PART II: Squaxin Island Department of Community Development Technical Housing Assessment Report: Examining Mold and Moisture Conditions of Homes for the Squaxin Island Tribe.

BACKGROUND INFORMATION

The Squaxin Island Community is located in Kamilche, in Mason County and west central Washington, near the state capital of Olympia. The annual precipitation averages 50.79 inches. The snowfall averages 16.7 inches. The annual maximum temperature averages 59.8° F and the annual minimum temperature averages 39.5° F. Approximately 740 Native Americans are enrolled in the Squaxin Island Tribe. The housing department maintains 21 Low Rent and 53 Mutual Help units of Tribal housing.

The assessment team responded to a request from the Northwest Office of Native American Programs to assess site and housing conditions contributing to mold and moisture problems in the Squaxin Island Community. Penni Giles, Housing Executive Director, requested technical assistance to address mold and moisture conditions. Liz Kuntz, staff of SIDCD and Tulley Krugger, staff of the maintenance department, accompanied the team.

The assessment team visited nine homes, ranging in age from twenty-seven to two years old. All homes had crawl spaces.

Following the assessment, the team provided a one and a half hour training session to Ms. Giles, Ms. Kuntz, Lisa Peters, the staff of SIDCD, and Mr. Krugger.

Day 1: Sunday: June 13, 2004

A travel day.
Day 2: Monday: June 14, 2004

The assessment team arrived at SIDCD Monday morning to meet with Ms. Giles and Ms. Kuntz, discuss the day’s activities, outline the team’s role while on the Reservation, and address the housing department’s concerns regarding the site visit. The housing staff selected several units for inspection. One was in the Low Rent program; the other eight in the Mutual Help program. Following the meeting, the assessment team, guided by Ms. Kuntz, inspected seven homes in the Squaxin Island Community.

Day 3: Tuesday: June 15, 2004

On Tuesday morning the assessment team, accompanied by Ms. Kuntz and Mr. Krugger inspected two more homes.

Digital photographs were taken to record conditions in all nine homes. The inspection process also involved visual assessments of both interior and exterior conditions. PART II: Squaxin Island DCD Technical Housing Assessment Report: Examining Mold and Moisture Conditions of Homes for the Squaxin Island Tribe provides a detailed analysis of findings and recommendations for the homes investigated.

FINDINGS

An overview of findings and recommendations for the site visit follows. PART II: Squaxin Island Department of Community Development Technical Housing Assessment Report: Examining Mold and Moisture Conditions of Homes for the Squaxin Island Tribe provides a more detailed discussion and analysis of the findings.

SQUAXIN ISLAND COMMUNITY

One of the homes had significant mold. The only community-wide problem found during the site inspections was the lack of window and door flashing. While there was little evidence of problems at most sites, this may change in the future.

MOLD TESTING

The assessment team agrees that if there is mold inside a building, it should be cleaned up. Generally, identifying the species of mold growing in a residence is unnecessary. No baseline exists for acceptable or unacceptable mold concentrations in a home. This message concurs with other federal agencies and experts as documented below. Attachment 1 is a copy of The Measurement Problem Regarding Mold.

The Bemidji Area Indian Health Service Office of Environmental Health and Engineering, Environmental Health Services Section (BAIHS EHSS), Guidelines on Assessment and Remediation of Fungi in Indoor Environments, takes this position on testing:

   Consistent with Center for Disease Control (CDC) and Environmental Protection Agency, BAIHS EHSS does not recommend testing as the first
response to an indoor air quality concern. Instead, careful detailed visual inspection and recognition of moldy odors should be used to find problems needing correction. Efforts should focus on areas where there are signs of moisture or high humidity or where moisture problems are suspected. The investigation goals should be to locate indoor mold growth to determine how to correct the moisture problem and remove contamination safely and effectively.

*The Adverse Human Health Effects Associated with Molds in the Indoor Environment* by the American College of Occupational and Environmental Medicine, states that to successfully remediate mold and moisture conditions, the water and moisture sources must be identified and corrected.

Mold spores are present in all indoor environments and cannot be eliminated from them. Normal building materials and furnishing provide ample nutrition for many species of molds, but they can grow and amplify indoors only when there is an adequate supply of moisture. Where mold grows indoors, there is an inappropriate source of water and moisture that must be identified and corrected before remediation of the mold colonization can succeed. Mold growth in the home, school, or office environment should not be tolerated because mold physically destroys the building materials on which it grows, mold growth is unsightly and may produce offensive odors and mold is likely to sensitize and produce allergic responses in allergic individuals. Except for persons with severely impaired immune systems, indoor mold is not a source of fungal infections. Current scientific evidence does not support the proposition that human health has been adversely affected by inhaled mycotoxins in home, school, or office environment.

*BAIHS EHSS Guidelines on Assessment and Remediation of Fungi in Indoor Environments* discusses the limitations of testing as follows:

Mold testing only provides a snap-shot estimate for a single point in time and a single location. How well the test represents other locations and times is uncertain since the amounts and types of mold in the environment are always changing. Furthermore, there is no basis for setting a baseline of acceptable or unacceptable mold concentrations. The variability can be especially large for airborne molds, with significant changes occurring over the course of hours or less. Caution must also be used in interpreting surface testing results, since mold growth or deposition may not be uniform over an area and may increase or decrease as time passes. Unless many samples are taken over a period of time and the investigator has been mindful of building operations and activities during the testing, the results might not be very representative of typical conditions; in addition, tests reflecting typical conditions may also miss evidence of problems that only occur infrequently (water leaks during rain storms).
Mold testing is often expensive. Money spent on unnecessary or poorly done testing, reduces the amount of money available for remediation and repairs. The following websites and references provide further information on mold remediation and testing:

**Indoor Air Quality:**

**Ball State University Indoor Environment Notebook** - General resource on a number of topics related to indoor air quality.
http://publish.bsu.edu/ien/archives/archive_list.htm (will open a new browser window)

**Mold:**

**EPA** - Mold Remediation in Schools and Commercial Buildings
http://www.epa.gov/iaq/molds/index.html (will open a new browser window)

**New York City Department of Health Bureau of Environmental & Occupational Disease Epidemiology** - Guidelines on Assessment and Remediation of Fungi in Indoor Environments http://www.ci.nyc.ny.us/html/doh/html/epi/moldrpt1.html (will open a new browser window)

**References:**

*Guidelines on Assessment and Remediation of Fungi in Indoor Environments* by Bemidji Area Indian Health Service Office of Environmental Health and Engineering, Environmental Health Services Section.


**Future Housing Department Actions**

The Squaxin Island DCD staff was very organized and helpful during the site visit. The housing staff was knowledgeable and appeared committed to providing their residents with quality housing. Much of the discussion between the team and the housing department confirmed that the steps the housing department has taken in the past were appropriate. It appeared that the capabilities of the housing department were sufficient to meet the needs of the community.
Attachment 1
APPENDIX C: LIMITATIONS OF MOLD SAMPLING

The Measurement Problem Regarding Mold
By William B. Rose, Research Architect
Building Research Council/School of Architecture
University of Illinois, Urbana-Champaign

When complaints of mold problems occur, two courses of action are appropriate: 1) visually assess the site, remove the mold, and correct the conditions that led to the mold and 2) contact health professionals for allergy or respiratory problems. The proper action is to discover sites of mold growth. Where this approach has been used, the outcome has been, in every case, improvement of indoor environment conditions (though the improvements may take time) and improvement of health conditions. This is the recommended approach for dealing with mold problems in housing in Indian areas.

Techniques for sampling biological aerosols were developed for industrial and agricultural settings. They were designed to help industrial hygienists determine the safety of workplaces and other environments. The value of their work was evident in determining the causes of the Legionella outbreak of 20 years ago, and in sampling for biological warfare agents at present. Sampling produces counts of mold material from samples taken in the air or on surfaces. It may determine the number of viable spores in a sample from the air or a surface. And it may be used to identify genus and species of mold found in the sample.

Neither of the two recognized guidelines for mold remediation, the NYC Department of Health’s Guidelines on Assessment and Remediation of Fungi in Indoor Environments and the USEPA’s Mold Remediation in Schools and Commercial Buildings, calls for environmental sampling for routine mold problems. Both guidelines discourage environmental sampling in most cases. This opinion is summarized on the CDC website:

Generally, it is not necessary to identify the species of mold growing in a residence, and CDC does not recommend routine sampling for molds. Current evidence indicates that allergies are the type of diseases most often associated with molds. Since the susceptibility of individuals can vary greatly either because of the amount or type of mold, sampling and culturing are not reliable in determining health risk . . . reliable sampling for mold can be expensive, and standards for judging what is and what is not an acceptable or tolerable quantity of mold have not been established.

In general, the use of mold sampling must be discouraged. There are several reasons for this. First, aside from allergic effects, the health outcomes of mold in homes, schools or offices have not been established. Second, given those circumstances, there is no basis for setting a baseline of acceptable or unacceptable mold concentrations. Third, the internal repeatability of mold sampling results has not been shown in the literature. Fourth, weaknesses in the visual assessment protocols have not been demonstrated.
Mold sampling has been done in residential settings, leading to conclusions about the presence of mold, about the presence of individual species of mold, and about high concentrations of mold in some locations. However, much of the information provided by sampling is already known from common sense. The following are some facts about mold in indoor environments that are known even before measurements are taken:

1. Mold is everywhere. The outdoor air contains rather high concentrations of mold spores, which are naturally occurring. By contrast, most building interiors contain lower concentrations, though the concentrations indoors and outdoors vary over time. Indoor air comes from the outdoors. If the indoor is cleaner than the outdoors, something served as a filter, accumulating mold, dust and airborne material over time. Some commercial buildings have filtration systems designed to clean air as it passes from outdoors to indoors. But in most buildings, the outdoor air infiltrates through cracks and cavities in the building envelope as it travels indoors. If the indoor air is cleaner, then the building envelope acts like a filter. Therefore, when a sample of indoor air is taken, mold spores will be found. The conclusion “This building has mold” can be made of all buildings.

2. Dust, dirt, mold spores and other particulates accumulate in building cavities over time. There is no passive cleaning process for building cavities to match this cumulative process. Because the walls and roofs filter outdoor air as it moves indoors, all building cavities must be considered as sites with high concentrations of mold spores and other airborne material.

3. Evidence indicates that where proper conditions are in place, sooner or later the species that typically inhabit such spaces will arrive. *Stachybotrys* is known to inhabit pulpy cellulose materials that are maintained at a high water activity level. With the right quantity of water, the paper facing of gypsum products generally shows the growth of *Stachybotrys*. Where the appropriate conditions are maintained for a long enough time, *Stachybotrys* and other species appear and grow. “Wet it, and they will come.”

4. It is logically impossible to prove a negative statement. There are no tests that allow one to draw the conclusion that absolutely no mold spores representing a species are to be found in a space. Even if a test should turn up no spores of a given species that does not provide conclusive evidence of the total absence of that species from the interior space. And conditions may change from one hour to another. So a finding in a room or building of any given species, including *Stachybotrys*, should not be considered exceptional. The absence of a species from a space can be determined statistically to a pre-selected degree of confidence, requiring several tests.

What, then, remains to be discovered through mold measurement? It is already determined, for all buildings, that mold is contained in the air, that any species may be found in the air or on the surface, and that high concentrations of mold are contained in the cavity. If a tenant or occupant complains about living conditions, it is clear that any unit that occupant will move to will have mold in the air, will have all common species of
mold in the air or on surfaces, and will have high concentrations of mold in the building cavities. It is wrong to presume that buildings are sterile simply by virtue of their never having been measured.

Measurements of mold are not useful if the purpose of the measurement is to determine any or all of the following:

1) if the building has mold,
2) if a certain species, say, *Stachybotrys*, is present, or
3) if the building cavities have high concentrations.

For the measurement criteria above, no measurements should be made, as the results will be dismissed as being of no use.

Possible Occasions for Mold Measurement

After the effective implementation of visual assessment and remediation of mold as described above and conditions of mold are suspected to still exist, it is possible (though unlikely) that a visual assessment will overlook a cause of distress. If that happens, one strong possibility is that the distress is not related to mold in the first place. However, in the case where a mold problem has not been accurately identified and remediated through visual assessment, three scenarios are often suggested as possible occasions for mold measurement:

1. Active mold growth is usually accompanied by amplification, the strong increase in mold of one or two species out of proportion to the background taxa.
2. Mold may have an odd source, such as air conditioning ductwork, and may be present in the building only when that source contributes to the space, or
3. An investigator may use a fixed level as a measure of acceptability or cleanliness (though it bears repetition: there are not exposure limits set by any authorities).

In each of these cases, mold measurement may be able to provide some insight.

The statistics of mold measurement

For mold measurement to provide insight, or to provide material for decision-making, the results of mold testing must be statistically significant. One measurement is never statistically significant. Understanding the notion of statistical significance requires understanding error and bias.

Two samples of the same space will never provide the same results. There is always some spread (or precision error) in the data. The mold sampling industry generally fails to make public their estimates of the precision error in their sampling methods. It would be good to know, for the same equipment, same operator, same laboratory, same technician, what the estimate of the error would be. That information is not presently available.
addition to precision error, there are many other factors that tend to bias the results one way or another. These include the following:

1. Time of the day (ascomycetes tend to release spores in the afternoon, basidiomycetes in the morning)
2. Season (lower during winter)
3. Snow cover (greatly reduces outdoor concentrations)
4. Sampling technique (lowest with culturable samples, medium with impactors, highest with PCR)
5. Variations over space (highest, usually, in basements and crawl spaces)
6. Variations by surface (highest near carpets)
7. Disturbance (greatly higher with scuffing and fluffing of carpets, etc.)
8. Variations by wetness (higher concentrations on wetter materials)
9. Laboratory
10. Technician

It is evident that achieving statistically significant results requires considerable care, in addition to thoroughly accounting for variables. All proposals for mold study that involve sampling must contain information that describes:

1. The yardstick, or baseline values, that will be used for interpretation,
2. The variables that are accounted for in the study,
3. The error estimate associated with those variables,
4. The confidence interval to be used (95% confidence in the results is recommended),
5. How the study will deliver that level of confidence.

Sampling campaigns that give numbers without giving statistical significance to those numbers are worse than worthless. They come at a financial and social cost and are very disruptive to the lives of individuals, families and tribes.

The range of concentrations often found in mold measurements is several orders of magnitude—sometimes several dozen spores or colony-forming-units (CFUs) per unit of mass or volume out to several million. Most guidance advises representing the distribution as lognormal; that is, if the data values are represented not as numbers with zeroes but as powers of ten, then the exponents occur in a normal distribution. This is quite helpful, as one of the tails of the distribution never drops below zero.

Let us presume that an environmental consultant hypothesizes that the airborne mold spore concentration in a room exceeds a certain value. Of course, the consultant would be obliged to cite the reference for the value selected. Taking a single sample gives a distinct reading for the sample but says nothing about the concentration in the room. A second sample, with a result different from the first, proves that a single sample cannot characterize the actual concentration. Also, clearly, the more samples that are taken, the more sure one can be that the mean of the measured values represents the actual value, and can be used in this comparison test.
Let us also presume that the confidence interval used is 0.05 ($\alpha = 0.05$). That means that 5% of the time the confidence in the veracity of the finding will be misguided. Nevertheless, many scientific and management findings use a 0.05 confidence interval. Tribal leaders or others who are entertaining proposals from environmental consultants might consider having a stated confidence interval at the time of the work proposal, perhaps of 5%.

Then standard statistics allows us to calculate the confidence interval. The result is usually expressed as a value $y \pm z$ ($\alpha = 0.05$). The value $y$ is the mean (average) of the sample values. The value $z$ is composed of the Standard Error (SE, equal to the standard deviation divided by square root of the count-1) times a factor called "student's-t" ($t$). This factor is commonly used in statistics when the number of samples is small; it is found in textbooks of statistics and as a common spreadsheet function. The value $z$ is equal to ($t$) * (SE).

An environmental consultant may wish to sample to determine if a certain species is present or not. Common species of mold should always be deemed to be present, but may be proved to be absent, if indeed they are absent, to any selected degree of confidence (never for certain).

Testing is expensive. So there is a strong tendency on the part of both consultants and clients to conduct testing without regard to the statistical significance. This practice should end, as the results cannot be used for decision-making. If testing is to be done at all, then the testing campaign must be designed to have the power to provide answers to the critical questions.

All mold testing must include a minimum of two samples per measurement site. Taking only one sample leaves the impression that the value is somehow elevated above error. With two samples per site, the issue of error is inescapable. In addition all mold testing should:

- State the question or hypothesis that is being answered or addressed through testing
- State the criteria (absolute or comparison) used to address the hypothesis
- State the proposed confidence level.
- List the errors and biases that are accounted for (or controlled for) in the testing.
- Calculate the margin of error.
- Report the findings with the margin of error.
- Attach statistical significance to the conclusions.

July, 2003
PART II

SQUAXIN ISLAND DEPARTMENT OF COMMUNITY DEVELOPMENT

TECHNICAL HOUSING ASSESSMENT REPORT

EXAMINING MOLD AND MOISTURE CONDITIONS IN HOMES OF THE SQUAXIN ISLAND TRIBE

Executive Summary

Introduction

Section 1: Methodology

Section 2: Squaxin Island Reservation 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 nine homes on the Squaxin Island Indian Reservation for moisture and mold conditions. The ten principal findings include:

1. Exterior site drainage and rainwater management was a potential problem in several residences. Four sites were relatively flat adjacent to the house with no slope away from the foundation. Gutter systems were compromised at seven homes.

2. Four vapor barriers covered only a portion of the crawl space, allowing ground moisture to freely dissipate into the structure above.

3. Three homes had visible mold growth at the wall/ceiling junctures at truss bearing points on exterior walls.

4. Seven poor and one inoperable bathroom exhaust ventilation systems were noted. Poor bathroom exhaust ventilation can result in significant interior moisture loads, increasing the potential for mold growth.

5. The lack of flashing above both doors and windows allowed water to infiltrate walls. Fortunately, roof overhangs provided some protection for those doors and windows not on the gable-end of the houses. Proper flashing of doors and windows is an important detail.

6. Several window units had lost their seal and required window replacement.

7. Three houses had recirculating kitchen exhaust fans that did not vent to the exterior.

8. Three attics could use more insulation. Also, the method of directing exhaust fan ducts towards a roof vent should be replaced with a direct connection between the vent and the duct.

9. Three inspected houses employed stressed-skin panels for the wall and roof system. The Squaxin Island Department of Community Development (SIDCD) should be commended for going beyond the status quo of frame construction and exploring alternative forms of construction methods. Properly executed and ventilated, stressed-skin panel construction can create very tight, comfortable and energy efficient structures.

10. The SIDCD should also be commended for:
    a. Very well installed vapor barriers in some houses.
    b. Well installed floor insulation between joists in some houses.
c. The use of high quality (Panasonic) ventilation fans.
d. The use of metal rather than plastic gutters.
e. The use of a subsurface drainage tile for disposal of rainwater.
f. The use of Hardieplank (or equivalent) siding versus vinyl siding.
g. The insulation of both warm and cold supply lines.
h. The use of flexible metal ductwork instead of plastic.

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

Michelle Rook from the BRC at the UIUC and Robert Nemeth from Magna Systems conducted a site visit at SIDCD on June 14-15, 2004. The SIDCD administers the housing program for the Squaxin Island Tribe. This report contains detailed analysis of the findings and recommendations for the homes on the Squaxin Island Reservation.

The Squaxin Island Reservation is located in Mason County in the State of Washington. Squaxin Island is located on the southwest end of Puget Sound. The eastern edge of Mason County is formed by Hood Canal and Case Inlet. The area also includes many lakes, streams, rivers, forests and islands. The average annual precipitation is 50.79 inches. The average annual snowfall is 16.7 inches. The average annual maximum temperature is 59.8° F and the average annual minimum temperature is 39.5° F. Approximately 740 Native Americans are enrolled in the Squaxin Island Tribe. The housing department maintains 21 Low Rent units and 53 Mutual Help units of tribal housing.

The assessment team investigated nine homes located on Tribal lands. All houses examined were ranch style on crawl spaces with concrete foundations. The primary sources of heat were:

- Electric baseboard heat in five homes.
- Woodstove heat in two homes.
- Electric forced air in one home.
- Hot water baseboard heat in one home.

The homes ranged in age from approximately two years to twenty-seven years old. All the homes were a ranch style design.

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 on water damage and evidence of mold for all rooms inspected. 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 systems.
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.

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 – SQUAXIN ISLAND RESERVATION HOUSING

The SIDCD maintains 21 Low Rent and 53 Mutual Help units of tribal housing. The assessment team examined nine housing units for mold and moisture selected by SIDCD. The homes were both 2x4 stick-built and stressed skin panels. All were ranch-style on crawl spaces with concrete foundations. These units do not represent a typical cross-section of the units under their management since their selection was not based on a random sample.

SECTION 3 – FINDINGS

The assessment team found visible mold growth in eight of the nine inspected houses. Mold contamination ranged from slight, limited to windows, to moderate, 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 five of the nine homes. Four sites were flat with no slope away from the foundation. One site sloped toward the house, but leveled off just before the foundation. However, the grade dropped close to most of these homes, which provided good potential for conducting water away from the homes. Additionally, three sites had depressions near the foundations.

Most houses had compromised roof drainage systems, a condition that can place a tremendous moisture load on the foundation and the house. Seven houses were missing leaders, one house was missing downspouts, three houses had crushed downspouts and two houses had poorly maintained gutters (Figures 1 & 2). One very positive aspect of the gutter systems was the subsurface drainage system. Rather than surface draining downspouts, the
downspouts emptied into a subsurface tile system which is typically much more robust
than leaders and splash blocks which oftentimes get disconnected and damaged.

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. 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, rainwater that drains from the roof onto the ground splashes onto the
siding and saturates it.

Snow accumulation adjacent to a home provides another source of moisture. As snow
accumulates against the siding, the warmer siding absorbs moisture.

The crawl space vents were placed in the top course of masonry blocks
which were at grade. In some instances, the vents were so low to the
ground that water and debris could wash into the crawl space (Figure 3).

3.3 Crawl Spaces

Several crawl spaces had a well-installed vapor barrier and insulation between the
floor joists. In most cases, they used the good practice of insulating both the hot and
cold water supply lines. Former and active plumbing leaks were identified in a couple
crawl spaces.

In the crawl spaces where the vapor barrier did not cover the entire floor, the exposed soil was damp, causing mold on any clutter, such as cardboard, stored there.

In some instances insulation had fallen out from between the floor joists. This increased energy consumption and decreased occupant comfort. It also allowed cold spots to develop on the floor where water could condense and cause problems.

3.4 Winter Moisture Condensation

Winter moisture condensation caused mold in two homes. Mold growth was visible 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 (temperature at which dew begins to form or vapor
condenses into a liquid) of the air. This problem results from a combination of two
factors:
• High wintertime moisture load (relative humidity).
• Lower than desired interior temperature.

Lowering the moisture load and warming the 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

The lack of functioning or poorly operating bathroom fans raised significant issues. Bathrooms experience high moisture loads and often develop localized mold problems. However, bathroom ventilation can reduce interior moisture loads. Seven bathrooms had exhaust fans that moved very little air and one bathroom had an inoperable exhaust fan.

Section 4.4 discusses bathrooms and localized exhaust ventilation.

3.6 Overcrowded Conditions

High occupancy rates are a fairly common occurrence in Native American housing. 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

One home had an electric forced-air central heating system; two homes had woodstove heat and one home had propane-stove heat. Heating methods 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 home, causing water vapor condensation on cold exterior walls, particularly in closets.

Five inspected homes had electric baseboard heat, which unevenly distributed heat throughout the house. This heating system does not promote air circulation and can contribute to conditions conducive to mold growth.

Two houses used wood stoves as their primary heat source. Wood stoves are a point heat source without a heat distribution system that can lead to chilled surfaces in the rooms.
furthest from the heat source, contributing to condensation-based mold contamination.

Heating systems are discussed in Section 4.7.

3.8 Maintenance Issues

The Squaxin Island Reservation had very few maintenance issues that contribute to mold and moisture conditions.

- One house had an inoperable bathroom fan; all other tested fans barely operating. Bathing produces large amounts 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. Maintenance and replacement of bathroom fans should be a high priority.

- Occupant attention to cleanliness and clutter can reduce mold problems. In bathrooms and other wet areas, regular 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 was present. Maintenance issues are discussed in Section 4.8.

3.9 Lifestyle

Certain housekeeping habits contributed to mold growth on the interior of the structures. Clothes covering heating vents, overstuffed closets, accumulation of trash, windows covered with heavy drapery, unrepaired leaks, and inadequate cleaning regimes can all contribute to mold growth. Modifying occupant lifestyles is 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 Squaxin Island Reservation.

4.1 Site Drainage and Rainwater Management

Site Drainage

The roof of a building should be designed and built so that rain moves 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 are:

1. Concentration – high concentrations of water cause 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. Frequently water damage occurs where a valley, gutter or swale is blocked.

2. 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 significant foundation exposure, site grading should 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 flows away from the foundation.

- If the house has no gutters, then the base of the soil around the house will 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 help with drainage if their root balls soak up much water. Plant them strategically near downspouts so that downspout extenders are
• less likely to be kicked off or removed during lawn mowing (Figure 7).

**Rainwater Management**

Rainwater 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. For houses situated on a sloping lot, make sure gutters on the high side of the lot drain to the side of the structure and not against the foundation. 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, or screws that project into the downspout can lead to clogging.

• Draining downspouts can be discharged onto the surface of the earth, or into a subsurface drainage tile system. Each system has its advantages and disadvantages. One advantage of the subsurface drainage system is that once installed it is difficult to damage, whereas the surface drainage system is much more vulnerable to damage. A disadvantage of the subsurface system is that if it does get clogged or damaged, it is difficult to repair, whereas the surface drainage system is easy to inspect and repair.

• If a subsurface drainage system is employed, make sure that it drains properly. Ideally it should be run away from the house and open to daylight at the end. The open end should be covered with a heavy screen to keep rodents and debris out of the pipe.
• If a surface drainage system is used, direct the water at the base of the downspout away from the foundation of the building. Water should be directed 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 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 8). 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 also available (Figure 9).

4.2 Crawl Space Design

Moisture entry and evaporation from foundation sources can be 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 or high-efficiency furnace condensate, water softener discharge, or groundwater sources. 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 in 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 mechanical systems (plumbing, ductwork), the space should be inside the thermal boundary.

A couple crawl spaces had incomplete vapor barriers covering the base of the crawl space and were missing sections of insulation. Where exposed, the soil was damp.

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 10) 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 11 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

![Figure 11: Crawl space with thermal boundary at the floor system](image-url)
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 the materials at the location increases, often up to saturation, and mold growth begins on the surfaces. This problem is a result of a combination of two factors:

1. A house has a high wintertime moisture load (relative humidity).
2. Areas of the building 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 Squaxin Island 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 4.5), and overcrowding (Section 4.6). Ways to minimize these moisture sources are 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.

Another approach is to maintain surface temperatures above the dew point temperature. However, moisture source control should always be considered first, because the lower the relative humidity, the lower the temperature that is tolerable within the home. Nevertheless, 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 creates this common condition, characterized by:

- A lack of heat supplied to closets and closed closet doors

- A lack of airflow to distribute heat to the exterior surface of the closet.

- Closet clutter that prevents airflow and heat from reaching the closet’s exterior walls

- Clothes hanging against the wall act as insulation and lower the temperature of the wall

Since a relatively cold room contributes to mold growth, ensuring that the exterior wall of the closet does not get chilled is a good preventative measure. 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 often experience chilling and subsequent condensation and mold contamination, especially in northern climates in older ranch-style homes with low-pitched roofs. This condition was found in some of the older Squaxin Island housing.

Exterior wall/ceiling junctures gets cold for the following reasons (Figure 12):

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 insulate the wall-roof joints. 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 13). 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. 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/pdf/99/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 Insulate & Air Seal Attic Hatches

A non-air sealed attic hatch is a type of bypass or alternate space through which air can pass (Figure 14). Mold can condense on access hatch blocking if not air-sealed. The hatches should be air-sealed with weatherstripping or gasket as shown in Figure 14. Latches should be installed to lock the hatches in place and provide positive closure.

Attic hatches should be insulated to a minimum of R38 but no less than R19. A lightweight attic hatch may be cut from damaged insulated foam core doors. The door has an R-value around 7. Batt or rigid insulation may be attached to the back of the door panel to achieve the desired R-value. The door panel is pre-finished, lightweight and requires no additional painting.

4.5 Bathroom Mold Problems

Many home mold and moisture problems occur in bathrooms due to the presence and use of 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. Promptly fix all plumbing leaks. Some hard to detect leaks at the toilet flange or at a shower drain require careful inspection and may only be obvious from the crawl space or the basement below.

2. Bathroom users should use shower curtains so that 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. Promptly wipe up spills 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 natural moisture sources due to the nature of their function. Showers result in 100% humidity in bathrooms. Kitchens cooking and cleaning causes high humidity. 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, attic, or crawl 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, larger ducts with fewer bends or elbows, and the shortest run, are 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:

- An exhaust fan hard-wired to the bathroom light.
- An exhaust fan on a timer, to extend moisture dilution time after showering.

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

4.6 Human Moisture Sources

Human occupation also 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 these moisture producing activities contribute to the moisture load in a house.

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, the moisture burden increases. Each person participates in moisture-producing activities (breathing, cooking, washing, etc.) increasing 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) provides fresh air in homes during the winter. This fresh, dry, winter air 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 with 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, maximizing 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, the existing fan and ductwork can be augmented with a connecting duct to the exterior and controls 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.

4.7 Heating Systems and Moisture Control

In winter, heating systems provide occupant comfort. Heating systems also impact winter moisture problems in these ways:
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.

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.

The electric baseboard heat used at several reservations as a primary heating source is not advisable. The only advantage of electric heat is its low first-cost. Unless the Reservation has negotiated a very low electric rate with the local utility, electric heat is expensive and does not promote air circulation like a forced air unit. Poor air circulation could contribute to future mold problems.

4.8 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. If not repaired quickly, a minor water infiltration problem with a small potential for mold can turn into a major contamination site. Unfortunately, water, roof and plumbing leaks, often go unreported and unattended. These 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 to identify problematic moisture conditions.
- Encourage residents to report moisture problems.
- Respond promptly to 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 pump system desired, installation, and disposal of water

**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

**4.9 Remodel & New Construction Recommendations**

The following are some recommendations for rehabilitation and new construction projects for the Squaxin Island Indian Community Housing Authority.

**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 preferred approach to maintaining a dry basement or crawl space. 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 to consider when selecting the siding for a structure. Consider performance (maintainability, durability, repairability, permeability, etc.), aesthetics, first-cost, and life-cycle-cost. Frequently, the selection of siding is based on 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. Investing a little more initially can result in significant savings later. Conduct a life-cycle-cost analysis to justify the selection process. The fiber cement composite siding currently being used should serve the Squaxin Island Tribe well.

• Wall and ceiling envelope options
Three inspected houses had stressed-skin panel walls and roofs. The SIDCD should be commended for going beyond the status quo of frame construction. Using stressed skin panels can result in very tight constriction. From an energy and occupant comfort standpoint this is good. Residents won’t have to spend as much money to stay warm in the winter and cool in the summer. However, ventilation in tight buildings is critical. Moisture can build up rapidly in tight buildings and must be diluted to maintain a healthy environment. Air-to-Air heat exchangers are and ideal compliment to tightly constructed buildings. Mold inspectors have examined several new buildings that were built to very tight standards that are already exhibiting mold problems because of insufficient ventilation. As the adage goes, “Build tight, ventilate right”.

On the Interior of the House:

- Toilet tank condensation problems

One common problem identified in much Indian housing is mold and the deterioration of drywall behind toilet tanks. Due to the condensation on the outer surface of the toilet tank, the adjacent wall area 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 two ways to mitigate this problem:

1. Install a toilet with an insulated tank, resulting in higher toilet tank surface temperatures and thus less surface condensation.

2. 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 homes had water supply pipes in the basement or crawl spaces that were dripping 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

Only one home 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.

- Drainage of Condensate

One of the by-products from high-efficiency furnaces is water. During winter months, when the furnace runs frequently, these units produce a significant amount of water. This water should be conducted into a drain or to the sump pit from where it can then be pumped to the exterior. The same applies to condensate from running an air-conditioner.
## SUMMARY SITE VISIT REPORT

**DATE:** June 14-15, 2004

### Squaxin Island Reservation

#### Appendix B: Site Visit Summary

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<th>Inspection Number</th>
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<th>Address</th>
<th>Program</th>
<th>Building Age</th>
<th>Occupancy</th>
<th>Foundation Type</th>
<th>Model and Framing Type</th>
<th>Heat Type (Primary Listed First)</th>
<th>Site Drainage Problems</th>
<th>Outer System Problems</th>
<th>Wet Basement or Crawlspace Problems</th>
<th>Plumbing Problems</th>
<th>Bathroom Problems</th>
<th>BR Exhaust Ventilation Problems</th>
<th>K Exhaust Ventilation Problems</th>
<th>Dryer Vent Problems</th>
<th>Exterior wall vandalism problems</th>
<th>Attic Problems</th>
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<td>MH</td>
<td>Feb-82</td>
<td>3A:5C</td>
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<td>Stressed Skin Panels</td>
<td>Electric Baseboard</td>
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<td>Yes</td>
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<td>MH</td>
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**Notes:**
- **MH = Mutual Help**
- **TK = Turnkey/ Rent to Own**
- **LR = Low Rent**
- **N/A** = No electricity to unit during visit
- **N/A** = Owner Not Present
- **N/A** = Did Not View

**Legend:**
- No electricity to unit during visit
- Owner Not Present
- Did Not View

**Contact:**
- Building Research Council

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31
Inspection Number: 1-1  
Address: 480 SE T-Peeksin Lane  
Model Type: Ranch  
Foundation: Concrete crawl space  
Construction: Stress Skin Panels  
Heat Type: Electric Baseboard  
Bedrooms: 3  
Occupancy: 4 Adults and 2 Teens  
Age: 13 Years  

Mold and Moisture Conditions: Mold was present on all windows (Figure 2).

Site Drainage and Rainwater Management: The front yard was relatively flat, sloped away from the house. The remainder of the site had good drainage away from the house. Gutters were poorly maintained and were growing vegetation (Figure 3). One downspout was crushed. Leaders and splash blocks were missing.

Foundation Conditions: The house rested on a concrete crawl space foundation. Crawl space vents were at grade.

Crawl Space Condition: The crawl space was dry with a vapor barrier. Floor joists and pipes were insulated. The dryer vent duct was sagging, torn and leaking into the crawl space (Figure 4).

Exterior Conditions: Some moss was present on the roof. All windows and doors were installed without head flashing (Figure 5). No soffit or ridge vent was present over the house due stressed-skin-panel roof construction. Continuous soffit venting was present over the garage since this area was constructed with trusses.
**Bathroom:** The toilet was securely fastened to the floor. The bath fan, operated by a separate switch, exhausted little air, since the grill was covered with lint (Figure 6).

**Kitchen:** The kitchen had an electric stove with a recirculating range hood.

**Interior Conditions:** The interior was very well kept and in excellent condition.

**Attic:** The attic above the house and garage was not viewed.

**Occupant Notes:** The four adult and three children occupants all suffer from allergies. It was unexpected to find occupants complaining about mold in a house that was very clean and well kept. This suggests the inhabitants may be hypersensitive to mold. Testing for specific allergies may be in order.

**Discussion/Recommendations:**

On the exterior:

1. Resolve all gutter problems.
   a. Clean out the gutters.
   b. Replace crushed downspouts.
   c. Install splash-blocks at all downspout locations.

2. Install head flashing on all windows and doors. The current method, a bead of caulk, to keep water out of the walls should never be the primary method.

On the Interior:

1. Clean the bathroom fan intake grill. Bathrooms can contribute significant amounts of moisture to the interior. Exhausting this moisture laden air to the exterior is important.

2. Replace the recirculating fan in the kitchen with a unit that exhausts to the exterior.

3. Replace the damaged dryer vent duct with metal ducting.

4. Add ventilation to the attic.

5. Residents use a hygrometer (an instrument used to measure the moisture content or the humidity of air) to monitor interior moisture levels. Run the dehumidifier to reduce interior moisture levels exceeding 40%, thus reducing the instances of mold.
Appendix B-Squaxin Island DCD Technical Housing Assessment Report

Inspection Number: 1-2  
Address: 391 SE Klah-Che-Min Drive  
Model Type: Ranch  
Foundation: Concrete crawl space  
Construction: 2 x 4 Wood Frame  
Heat Type: Propane Stove (Primary) and Hot Water Baseboard  
Bedrooms: 4  
Occupancy: 2 Adults  
Age: 22 Years

Mold and Moisture Conditions: Mold was present on windows.

Site Drainage and Rainwater Management: The site drained away from the house, but with depressions adjacent to the foundation. Gutters were maintained and downspouts, some of which were crushed, drained into a sub grade tile system (Figure 2).

Foundation Conditions: The house rested on a concrete crawl space foundation. Crawl space vents were at grade.

Crawl Space Condition: The crawl space was dry with a vapor barrier. Floor joists and pipes were insulated. Several sections of floor insulation had fallen from between the joists rested on the floor of the crawl space (Figure 3 & 4). One large skeleton was present (Figure 5). The hatch to the crawl space was insulated.
Exterior Conditions: All windows and doors were installed without flashing. Carpenter ant infestation had compromised a carport post (Figure 6). The dryer vent on the exterior of the house was missing louvers (Figure 7).

Bathroom: The toilet was securely fastened to the floor. It had been replaced after a leak was discovered. A sink leak was also fixed and dormant. The bath fan, operated by a separate switch, exhausted with low efficacy through the attic (Figure 8).

Kitchen: The propane stove had a range hood exhausting to the outside.

Interior Conditions: The interior of the unit was in excellent condition.

Attic: The center section of the attic was in need of more insulation. It appeared that someone had been working in the attic, moved the insulation off to the sides, and had not replaced it (Figure 9). Roof sheathing was in good condition. The bathroom exhaust fan vent was kinked and disconnected from the housing. The hose was not connected well and was leaking. The kitchen exhaust fan vent was hanging away from the roof vent, and the screen had been pushed aside. A family of birds had set up residence in the attic. All three fan ducts were ‘close’ to jacks.

Occupant Notes: Two adults lived in the home.

Discussion/Recommendations:

On the Exterior:

1. Install flashing on all windows and doors.

2. Fix crushed downspout.
3. Replace louvered dryer vent.

4. Fill and reseed depressions next to the foundation (Figure 10).

5. Fix rotting column at carport.

On the Interior:

1. Clean bathroom fan.

2. Add insulation to attic.

3. In the attic, replace attic vent screen and remove bird family.

4. In the attic, repair exhaust fan ducts and properly vent them to the exterior.

5. In the crawl space, replace floor joist insulation that has fallen from between the joists.
Appendix B—Squaxin Island DCD Technical Housing Assessment Report

Inspection Number: 1-3
Address: 60 SE Steh-Chass Place
Model Type: Ranch
Foundation: Concrete crawl space
Construction: 2 x 4 Wood Frame
Heat Type: Electric Baseboard
Bedrooms: 4
Occupancy: 3 Adults and 5 Children
Age: 22 Years

Mold and Moisture Conditions: Mold was present in all rooms.

Site Drainage and Rainwater Management: The site had good drainage away from the house, but depressions were present near the foundation. Gutters were satisfactorily maintained and downspouts were tiled. Some downspouts were crushed or missing (Figure 2).

Foundation Conditions: The house rested on a concrete crawl space foundation. Crawl space vents were at grade.

Crawl Space Condition: The crawl space was not dry and the vapor barrier was compromised (Figure 3). Floor joists and pipes were insulated. Several sections of insulation had fallen and become saturated. One section of insulation had fallen off the supply pipe and water was present on one of the waste pipes. There was evidence of a plumbing leak and visible mold. Clutter was present and cardboard was molding.

Exterior Conditions: All windows and doors were installed without flashing allowing for possible mold growth (Figure 4). Fasteners holding the vent screen for the dryer were missing leaving the screen hanging and not covering the dryer vent. Moss was present on roof, and roof was in questionable condition. The stovepipe for a former wood stove had been removed and there was evidence of a leak where the ceiling had been patched (Figure 5). The gable vent was loose.
Bathroom: The toilet was securely fastened to the floor. Mold was present around the toilet next to the tub (Figure 6). The bath fan, which is operated by a separate switch, exhausted with low efficacy. The drywall above the shower in the master bath, which five occupants used, was moldy (Figure 7).

Kitchen: The electric stove had a range hood exhausting to the outside.

Interior Conditions: The interior of the unit showed mold at truss bearing points, bathrooms, windows, and stovepipe closure. The occupant states that the front window leaks. Also, a leak had occurred behind the washer when the hose came out of the drain. A roof leak also occurred when the stovepipe was removed.

Attic: The attic had six inches of insulation. All three fan ducts were ‘close’ to jacks. Daylight was visible where ridge vent sections butted together (Figure 8).

Occupant Notes: All young occupants have asthma. Adult occupants recently began to experience problems of wheezing and were prescribed inhalers.

Discussion/Recommendations:

On the Exterior:

1. Install flashing on all windows and doors.
2. Replace missing and crushed downspout.
3. Fill and reseed depressions next to the foundation.
4. Fix rotting column at carport.
5. Repair ridge vent
On the Interior:

1. Clean the bathroom fan.

2. Add insulation to the attic.

3. In the attic, repair exhaust fan ducts and properly vent them to the exterior.

4. In the crawl space, repair vapor barrier and waste pipe leak.

5. Replace floor joist insulation that has fallen from between the joists.

6. Remove clutter and cardboard in crawl space

High occupancy, poorly working exhaust fans, and moisture from the crawl space all contribute to the high interior moisture load. All drywall with mold should be thoroughly cleaned with soap and water. Some of the drywall may be compromised to the point that it needs to be replaced. Consider replacing drywall window jamb returns with a more durable product, such as wood, tile, or a solid material that will not mold as easily as drywall.
Inspection Number: 1-4  
Address: 361 SE T-Peeksin Lane  
Model Type: Ranch  
Foundation: Concrete crawl space  
Construction: Stress Skin Panels  
Heat Type: Electric Baseboard  
Bedrooms: 3  
Occupancy: 2 Adults and 1 Child  
Age: 13 Years

Mold and Moisture Conditions:  
Mold was present on windows and sliding glass door (Figure 2). Condensation was present between the panes glass of the bay window.

Site Drainage and Rainwater Management: The site was relatively flat, but sloped away from the house. Depressions were present near the foundation. Gutters were satisfactorily maintained, but one of the downspouts was disconnected from the subsurface drainage system (Figure 3).

Foundation Conditions: The house rested on a concrete crawl space foundation. Crawl space vents were at grade.

Crawl Space Condition: The crawl space was dry and a vapor barrier was present. The floor joists were well insulated. Water supply pipes were not visible. A new metal dryer vent duct replaced the abandoned plastic duct.

Exterior Conditions: All windows and doors were installed without flashing (Figure 4). Some mold was present on the siding. No soffit or ridge vent was present over the house since it had a stressed skin panel roof. A continuous soffit vent was present over the trussed garage.

Bathroom: The toilet was securely fastened to the floor. The bath fan, which is operated by a separate switch, had a very dirty intake grill and exhausted with low efficacy (Figure 5).
Caulk joint at base of tub to flooring was compromised (Figure 6).

**Kitchen:** The kitchen had an electric stove with a recirculating range hood.

**Interior Conditions:** The interior of the unit was in excellent condition. There were minor instances of dirt and possibly mold buildup in the tracks of the window frames and some pane deterioration between panes of glass.

**Attic:** The attic was not viewed. The attic over the house was not vented; this was a stressed-skin panel house.

**Occupant Notes:** The occupants were not present during inspection.

**Discussion/Recommendations:**

On the Exterior:

1. Install flashing on all windows and doors.
2. Reconnect gutter to drain tile.
3. Fill in depressions around the foundation and reseed.

On the Interior:

1. Replace the recirculating fan in the kitchen with a unit that exhausts to the exterior.
2. Replace bay window (condensation between panes).
3. Clean bathroom fan intake grill.
4. Clean, dry, and recaulk joint at base of tub.
5. The dirt and mold in the window tracks can be cleaned with soap and water. Some of the cleaning may require q-tips or toothpicks to get into the corners.
Appendix B-Squaxin Island DCD Technical Housing Assessment Report

Inspection Number: 1-5
Address: 80 SE Qua-Ta-Sat Circle
Model Type: Ranch
Foundation: Concrete crawl space
Construction: 2 x 4 Wood Frame
Heat Type: Electric Baseboard
Bedrooms: 3
Occupancy: 4 Adults
Age: 27 Years

Mold and Moisture Conditions:
Mold was present on windows (Figure 2 & 3), at truss bearing points, behind beds along exterior walls in the bedroom (Figures 4 & 5), and in the bathroom.

Site Drainage and Rainwater Management: The front yard sloped toward the house, but leveled out just in front of the house (Figure 6). The remainder of the site had good drainage away from the house, but depressions were present near the foundations. Gutters were poorly maintained and were growing vegetation. Leaders and splash blocks were missing.

Foundation Conditions: The house rested on a concrete crawl space foundation. Crawl space vents were at grade.

Crawl Space Condition: The crawl space was not viewed.

Exterior Conditions: Thick moss was present on the roof (Figure 7).

Bathroom: The toilet was securely fastened to the floor. The bath fan, which is operated by a separate switch, exhausted with low efficacy. The caulk joint at the base of the tub was compromised.
**Kitchen:** The kitchen had an electric stove with a range hood exhausting to the outside.

**Interior Conditions:** Mold was present at truss bearing points and behind beds along exterior walls.

**Attic:** The attic was not viewed.

**Occupant Notes:** The owner was not present.

**Discussion/Recommendations:**

On the Exterior:

1. Install flashing on all windows and doors.

2. Replace leaders and splash blocks.

3. Fill and reseed depressions next to the foundation.

4. Clean vegetation from the gutters and the moss from the roof. Examine the attic for sheathing deterioration from the heavy moss buildup.

On the Interior:

1. Clean the bathroom fan.

2. Repair the tub base caulk joint.

3. Replace windows that have a compromised window seal.

4. Inspect the attic. Based on the incidence of wall to ceiling mold, the perimeter of the attic probably needs more insulation.

The interior mold was due to many factors. The high interior moisture load resulted from poorly operating bath fans, building occupants, and possibly from the uninvestigated crawl space. In addition, the primary heating method, electric baseboards, did not produce significant air circulation, particularly with all of the personal belongings in the house. A thorough cleaning with soap and water and a dehumidifier may keep mold in check. However, the plethora of personal belongings stacked against exterior walls stymied air circulation and created environments conducive to mold growth.
Inspection Number: 1-6  
Address: 90 SE Ko-Pul Loop  
Model Type: Ranch  
Foundation: Concrete crawl space  
Construction: 2 x 4 Wood Frame  
Heat Type: Electric Forced Air and Wood Stove  
Bedrooms: 3  
Occupancy: 2 Adults and 1 Child  
Age: 2 Years  

Mold and Moisture Conditions: Unknown spots were present on the walls and smoke detector.

Site Drainage and Rainwater Management: The front and side yards had good drainage away from the house. The rear yard was flat. Depressions were present along the driveway. Gutters were satisfactorily maintained. Leaders and splash blocks were missing. Two downspouts were emptying onto the driveway (Figure 2).

Foundation Conditions: The house rested on a concrete crawl space foundation. Crawl space vents were at grade (Figure 3).

Crawl Space Condition: The crawl space was dry. The vapor barrier was not continuous, and the exposed soil was damp. Floor joists were insulated. Pipes were not visible.

Exterior Conditions: All windows and doors were installed without flashing (Figure 4). The attic ventilation was achieved through perforated soffit material, though one section was loose.

Bathroom: The toilet was securely fastened to the floor. The bath fan, which was operated by a separate switch, was inoperable because the electricity to the house was turned off.

Kitchen: The kitchen had an electric stove with a range hood exhausting to the outside.

Interior Conditions: The interior of the unit was in good condition, but a strong animal odor was present.

Attic: The attic was not viewed.

Occupant Notes: Two adults and one child lived in the home. One occupant was present.
Discussion/Recommendations:

On the Exterior

1. Install flashing on all windows and doors. The missing flashing was probably the worst problem at this residence. Water behind the window and door trim could migrate into the wall system and eventually cause problems.

2. Install leaders and splash blocks on the ends of the downspouts.

3. Fix the soffit material that was loose (Figure 5).

On the interior

1. In the crawl space, properly install the vapor barrier (Figure 6).

2. Inform the residents that the strong animal odor, if allowed to persist, can saturate building finishes and materials, becoming very difficult to get rid of.

3. Some small rust-colored spots from an unknown source on the walls and ceilings were present throughout the residence.
Inspection Number: 1-7  
Address: 181 SE Klah-Che-Min Drive  
Model Type: Ranch  
Foundation: Concrete crawl space  
Construction: 2 x 4 Wood Frame  
Heat Type: Wood Stove and Electric Baseboard  
Bedrooms: 3  
Occupancy: 2 Adults  
Age: 22 Years

Figure 1: 181 SE Klah-Che-Min Drive

Mold and Moisture Conditions: Mold was present at the base of the wall in the hot water heater closet (Figure 2). Bleach was used to clean the mold.

Site Drainage and Rainwater Management: The site drained away from the house.

Foundation Conditions: The house was on a concrete crawl space foundation with vents at grade.

Crawl Space Condition: The crawl space was dry although the vapor barrier was pushed aside and the soil was wet (Figure 3). The floor joists were insulated, but several sections of insulation had fallen to the floor. Cardboard boxes were used for storage (Figure 4).

Exterior Conditions: All windows and doors were installed without flashing.

Bathroom: The toilet was securely fastened to the floor. A sink leak was fixed and dormant. The bath fan which operated from a separate switch exhausted efficiently. The tub/shower trip lever was rusted and deteriorated (Figure 5), allowing water into the wall cavity. The hot water tank closet was directly behind this room. Evidence of previous condensation running down the walls was present.
Kitchen: The electric stove had a range hood exhausting to the outside. A sink leak was fixed and dormant.

Interior Conditions: The interior of the unit was in good condition.

Attic: The attic had eight inches of insulation that was somewhat packed down. A ridge vent was present. All vents looked good.

Occupant Notes: The occupant had a constant runny nose.

Discussion/Recommendations:

On the Exterior:

1. Install flashing on all windows and doors.

On the Interior:

1. Replace the fallen floor joist insulation sections.

2. Repair the vapor barrier.

3. Remove clutter from the crawl space. If crawl space is to be used as a storage space, store goods in airtight plastic containers.

4. Repair tub/shower toggle switch, then repair drywall in water heater closet.
Appendix B-Squaxin Island DCD Technical Housing Assessment Report

Inspection Number: 2-1
Address: 211 SE Klah-Che-Min Drive
Model Type: Ranch
Foundation: Concrete crawl space
Construction: 2 x 4 Wood Frame
Heat Type: Wood Stove (Primary) and Electric Baseboard
Bedrooms: 3
Occupancy: 2 Adults and 3 Children
Age: 22 Years

Mold and Moisture Conditions: Mold and dirt were present in window sash frames (Figure 2). The occupant stated that mold was also present at wall to ceiling junctions and at exterior corners however there was only minor evidence of it since she had just cleaned with peroxide.

Site Drainage and Rainwater Management: The site had good drainage away from the house. One of the gutters was improperly sloped, one downspout was missing, others were crushed, leaders and splash blocks were not present (Figure 3).

Foundation and Crawl Space Conditions: The house rested on a concrete crawl space foundation. A vapor barrier covered a portion of the floor. The remaining floor was exposed damp soil (Figure 4). The house floor was insulated with fiberglass insulation placed between the floor joists. Several sections of insulation had fallen out of place and rested on the crawl space floor. The dryer duct was disconnected (Figure 5) and vented to the crawl space. Supply pipes were insulated. There was evidence of a leak in the waste piping that was repaired with duct tape (Figure 6).
Exterior Conditions: All windows and doors were installed without flashing. There was some mildew present on the siding on the north side of the house. A large stack of firewood rested against the side of the house (Figure 7).

Bathroom: The toilet was securely fastened to the floor. The bath fan, which was operated by a separate switch, was inoperable. The seal between the vinyl flooring and the bathtub was compromised (Figure 8).

Kitchen: The electric stove had a range hood exhausting to the outside. A sink leak was fixed and dormant.

Interior Conditions: Mold was reoccurring every four months at truss bearing points in bedrooms. The occupant had concerns about repair work done after a fire in the bedroom exterior wall. The stovepipe and one of the bedroom windows leaked when it rained. The occupant tightened the washer hook-up after it leaked.

Attic: Birds had broken a vent screen and had set up residence in the well insulated attic. More insulation was needed around the bath fan and the connection of the exhaust duct through the roof was questionable (Figure 9).

Occitant Notes: Two adults and three children lived in the home. One child with asthma and one adult with frequent bronchitis and a runny nose awoke regularly with heavy chests and coughing.

Discussion/Recommendations:

This house had recently had a fire along one of the exterior walls. To make sure the fire was out; the fire department saturated the interior of the wall with water. The wall was supposedly left open for some time to let it dry out before rebuilding and enclosing it. Inspectors were not permitted to inspect the room that had experienced the fire or the laundry room.

On the Exterior

1. Install flashing on all windows and doors, an important detail that helps to keep water out of walls.
2. Replace crushed downspouts and missing leaders. Resolve improperly sloped gutter.

3. Move the stack of firewood away from the siding. Stacks of firewood can harbor carpenter ants and other unwanted rodents.

On the Interior

1. Repair or replace the bathroom fan.

2. Replace the floor joist insulation sections that have fallen from between the joists.

3. Install a vapor barrier completely covering all the soil and seal it to the perimeter and any interior penetrations. Exposed soil in the crawl space can contribute significantly to interior moisture loads.

4. Add insulation to the attic, particularly towards the perimeter of the house. Make sure that soffit ventilation in the attic is maintained.

5. Make sure the dryer is properly vented to the exterior.

6. Reseal the junction between the bathtub and vinyl flooring.

7. Replace the windows with damaged seals.

Functional bath fans used by residents, a properly vented dryer, and a well installed vapor barrier in the crawl space can significantly reduce interior moisture loads which can contribute to mold growth. If these repairs are instituted and there is still recurring mold growth, running a dehumidifier during wet periods may help to keep interior moisture loads to a level below that needed for mold to grow.
Appendix B-Squaxin Island DCD Technical Housing Assessment Report

Inspection Number: 2-2
Address: 430 SE T-Peekstin Lane
Model Type: Ranch
Foundation: Concrete crawl space
Construction: Stress Skin Panels
Heat Type: Electric Baseboard
Bedrooms: 3
Occupancy: 3 Adults and 1 Child
Age: 13 Years

Mold and Moisture Conditions: No mold was present.

Site Drainage and Rainwater Management: The site had good drainage away from the house. Gutters were satisfactorily maintained. Leaders and splash blocks were missing. One splashblock sloped toward the house (Figure 2).

Foundation Conditions: The house rested on a concrete crawl space foundation. Crawl space vents were at grade.

Crawl Space Condition: The crawl space was dry with a vapor barrier. Floor joists and pipes were insulated. Some insulation was missing and the plastic dryer duct was poorly installed, leaving it sagging (Figures 3 & 4).

Exterior Conditions: Some moss was present on the roof. All windows and doors were installed without flashing (Figure 5). No soffit or ridge vent was present over house. Continuous soffit vent present over garage only.

Bathroom: The toilet was securely fastened to the floor. The bath fan, which was operated by a separate switch, exhausted with low efficacy. The Master bath fan was missing.

Kitchen: The kitchen had an electric stove with a recirculating range hood (Figure 6). A whole-house exhaust fan was present and working.
**Interior Conditions:** The interior of the unit was in excellent condition.

**Attic:** The attic was in good condition, though not vented.

**Occupant Notes:** Three adults and one child lived in the home. Occupants were not present.

**Discussion/Recommendations:**

On the Exterior

1. Install flashing on all windows and doors.
2. Slope splash blocks to drain away from the house.

On the Interior

1. Clean the bathroom fan and replace the master bathroom fan (Figure 7).
2. Replace the recirculating fan in the kitchen with a unit that exhausts to the exterior (Figure 8).
3. Replace the windows that have a compromised seal (Figure 9).
4. In the crawl space, install floor insulation where missing.
5. Replace the sagging dryer duct with a metal duct.