A Survey of Problem Homes of the Environmentally Hypersensitive

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NOTE: LE RÉSUMÉ EN FRANÇAIS SUIT IMMÉDIATEMENT LE RÉSUMÉ EN ANGLAIS.

Acknowledgments

The Project Team is indebted to the families who opened their doors (and their closets) to the investigators and let them poke into their private lives. As well, we wish to thank Dr. Virginia Salares of CMHC for her insight and knowledge of the needs of the hypersensitive person and her effort and involvement as the Project Co-ordinator.

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Foreword

This report combines the results of a survey of fifteen problem homes submitted by Drerup-Armstrong Limited and a post-survey analysis by the project manager.

The occupant survey and investigation checklists used in the field tests are purposely not included in this report and are not published anywhere else. These materials are part of the Indoor Air Quality training program for residential IAQ investigators, which was developed as a consequence of this survey.

Abstract

Fifteen houses suspected of causing or aggravating health problems of the occupants were investigated for indoor air quality problems, using an inspection protocol developed for this purpose. The primary objective of the field investigations was to test the inspection protocol; the secondary objective was to determine the types of indoor air quality problems in these houses. This study demonstrated the feasibility of conducting indoor air quality investigations of houses using the inspection protocol. It also identified a need for a formal program to train suitably qualified candidates to become residential indoor air quality investigators.

Executive Summary

This survey dealt with field testing an inspection protocol on houses suspected of causing or aggravating symptoms of the occupants. The primary purpose of this survey was to evaluate the method of investigating the indoor air quality of houses using the protocol. The draft protocol had been previously applied to the investigation of homes of environmentally hypersensitive individuals who were experiencing difficulties with the indoor air quality (IAQ) of their homes.

Fifteen houses in three regions across Canada were selected. The owners were identified through the support groups of the environmentally hypersensitive and through physicians who specialize in environmental medicine. Two survey teams based in Ontario and Nova Scotia carried out the survey. The members of the team had expertise in building science, indoor air quality inspections and housing for the environmentally hypersensitive. Eleven of the fifteen houses were investigated by one team member. Three houses were subjected to duplicate investigations by two team members working independently. The data gathered from two of the houses were reviewed by an external reviewer.

The survey provided an indication of the types of problems encountered in the homes. Mold and moisture were found to be the predominant problem in nine houses, while five houses had predominantly chemical contamination. One house had both types of contaminants. The moldy houses were older houses (15 to 154 years); while three of the houses with chemical contaminants were new (under ten years old).

Sources of chemical contamination were identified. Pets in many of the homes and lack of ventilation were found to contribute to poor indoor air quality. In six houses, the contamination problems were severe enough to cause adverse reactions; and in one case, the investigation had to be discontinued.

The inspection checklists, which are part of the protocol, were found by the survey team to be too detailed. Improvements in the format and removal of irrelevant information was suggested. As a data-gathering tool, the occupant and inspector checklists proved to be comprehensive, and the expert reviewer analyzing the data arrived at similar recommendations to those found by the investigators.

In one of the houses investigated, different concerns were identified by the two investigators inspecting the same house. In other cases, similar conclusions about the house were obtained by the two investigators, but the prioritization of remedial actions appeared to be influenced by the investigators' personal sensitivities.

A need for the formal training of the investigators was identified. Such training would ensure consistent and comprehensive inspections of homes. The training would also address health issues as a result of possible exposure of the investigator to toxic contaminants.

The protocol used in this survey is intentionally withheld from publication. It will be made available to those who participate in the training program for IAQ investigators.

RÉSUMÉ

L'enquête visait à éprouver un protocole d'inspection dans des maisons soupçonnées de faire ressortir ou d'aggraver les symptômes chez les occupants. Son objectif premier consistait à évaluer la méthode d'investigation de la qualité de l'air intérieur des maisons à l'aide du protocole. Le protocole provisoire avait déjà servi lors de l'investigation de maisons de personnes hypersensibles aux polluants environnementaux affectées par la qualité de l'air ambiant.

Quinze maisons réparties dans trois régions du Canada ont été retenues. Les propriétaires ont été identifiés grâce à l'intervention de groupes de soutien des personnes hypersensibles et de spécialistes en médecine environnementale. Deux équipes établies en Ontario et en Nouvelle-Écosse ont mené l'enquête. Les membres de l'équipe possédaient de l'expertise dans les domaines de la science du bâtiment, de la vérification de la qualité de l'air intérieur et du logement des personnes hypersensibles. Onze des quinze maisons ont été soumises à l'investigation d'un membre de l'équipe. Trois maisons ont fait l'objet d'investigations en double menées indépendamment par deux membres de l'équipe. Les données recueillies dans deux des maisons ont été scrutées par un examinateur de l'extérieur.

L'enquête a donné une indication des types de problèmes relevés dans les maisons. Neuf d'entre elles, a-t-on découvert, accusaient surtout des problèmes d'humidité et de moisissure, alors que cinq maisons attestaient d'une contamination chimique prédominante. Une maison recelait les deux types de contaminants. La moisissure se retrouvait dans les vieilles maisons (datant de 15 à 154 ans) alors que trois maisons neuves (moins de dix ans d'existence) comportaient des contaminants chimiques.

Les sources de contamination chimique ont été identifiées. On a ainsi découvert que les animaux domestiques présents dans bien des maisons et le manque de ventilation nuisaient à la qualité de l'air. Dans six maisons, la contamination était telle qu'elle suscitait des réactions défavorables, même que dans un cas il a fallu interrompre l'investigation.

L'équipe chargée de l'enquête a trouvé les listes d'inspection faisait partie intégrante du protocole trop détaillées et ainsi proposé des améliorations et la suppression de l'information non pertinente. Comme outils de collecte de données, les listes destinées à l'occupant et à l'inspecteur se sont révélées complètes; l'expert examinateur qui a analysé les données est arrivé à des recommandations analogues à celles des investigateurs.

Dans l'une des maisons à l'étude, différents motifs de préoccupation ont été soulevés par les deux investigateurs distincts ayant procédé à son inspection. Dans d'autres cas, les deux investigateurs ont tiré des conclusions semblables à propos de la maison, mais l'ordre de priorité des mesures correctives a semblé être dicté par la propre sensibilité de l'investigateur.

La nécessité de dispenser une formation spécifique aux investigateurs a été cernée. Une telle formation garantirait des inspections uniformes et complètes des maisons. Elle permettrait aussi de régler la question des risques pour la santé par suite de l'exposition possible de l'investigateur à des contaminants toxiques.

Le fait de ne pas divulguer le protocole utilisé lors de l'enquête est intentionnel de notre part. Il sera, par contre, mis à la disposition des participants au programme de formation des investigateurs en matière de qualité de l'air intérieur.

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1.0 Introduction

This project is one of several projects initiated by Canada Mortgage and Housing Corporation (CMHC) to help environmentally hypersensitive individuals solve their specialized housing problems. Numerous requests directed to CMHC by people seeking assistance in dealing with a variety of indoor air problems in homes resulted in a draft inspection protocol. This draft protocol is intended for use in investigating houses suspected of causing or aggravating health problems of the occupants. The draft protocol, however, required further development and testing.

The present study involves developing the inspection protocol and testing it in a number of problem homes in different regions of the country. By applying it in actual case studies, the ease of using it would be evaluated. This report documents and presents the results of the field investigations.

The draft inspection protocol

The purpose of the protocol is to determine if a house has an indoor air quality (IAQ) problem and to identify the types of contaminants and their sources. The protocol enables investigators to determine the predominant contaminant type, differentiating between mold and chemical contaminants. It does not positively identify and quantify specific contaminants. The actual inspection consists of a walk-through. Visual observations combined with some sensory perception are the primary methods of contaminant characterization and source identification. Sensory perception is limited to odour detection upon entry. Objective observations of the materials, furnishings and equipment in the house, their condition, the presence of mold growth, air movement inside and outside the house, and how the house is being used are collected. In addition, further information on the indoor air quality problem and the health of the occupants is gathered from the occupant through a detailed questionnaire completed prior to the investigator's arrival.

The scope of the survey

Although the protocol can be used to investigate houses with an urgent IAQ problem, which require immediate action, the present study focuses on problems of a chronic or long-standing nature. Houses of environmentally hypersensitive individuals, on which to test the protocol, were selected. Many hypersensitive individuals are known to be experiencing difficulties in their own homes, and they are anxious to find solutions.

Fifteen houses in various regions of Canada were chosen. Four of the houses were visited by two different project team members. Two houses were further evaluated by two external reviewers.

The investigating team

Although significant inroads have been made into the investigation of indoor air quality problems and their relation to health, IAQ inspections are still as much of an art as a science. It takes a knowledgeable and trained person to identify the problems and potential solutions. Causal relationships are difficult to establish. The inspection protocol, therefore, assumes the investigator is skilled in understanding the inter-relationships of building components, mechanical systems, air flow characteristics, sources of biological and chemical pollutants and has some understanding of the health effects of pollutants.

Two, on-site survey teams were chosen for the work — one, in Ontario and one, in Nova Scotia. Using the two teams minimized travel costs, used individuals familiar with

regional differences, and included professionals representing varied disciplines, including engineering, building science, environmental health and housing for the environmentally hypersensitive. All of these factors contributed to a rigorous test of the protocol, while providing valuable documentation on specific houses.

2.0 Objectives

The prime objective of this project was to field test the protocol for investigating problem houses of the environmentally hypersensitive person. More specifically, the objectives of the project were to:

- develop the survey forms
- identify fifteen houses that met the definition of "sick" houses (as defined in the protocol) and apply the protocol to investigate them;
- identify the problems in these homes and identify common patterns, if any;
- suggest how each home can be remediated; and
- evaluate the protocol for comprehensive.

The ultimate goal was to develop a functional tool for qualified IAQ investigators to use inspecting problem homes.

3.0 Methodology

The project was undertaken as a series of tasks:

Task 1 Develop List of "Sick" Houses for Survey

The houses for the survey were identified by contacting various individuals who were familiar with the issues and needs of environmentally hypersensitive individuals, including: personal contacts of the Team Members in different regions, Allergy and Environmental Health Association and related organizations and associations, practitioners in environmental health, and the Regional and National offices of CMHC. A letter and poster were sent to the following doctors and other professionals working in the environmental health field.

Environmental Health Contacts:

Allergy and Environmental Health Association, Ottawa, Toronto

Dr. Lynn Marshall
Oakhill, Ontario

Dr. Nabil El-Maraghi
Barrie, Ontario

Dr. Jozef Krop
Mississauga, Ontario

Dr. Philip Bright
Waterloo, Ontario

Dr. Marian Zazula
Mississauga, Ontario

Ms. Lynda Brooks
Kanata, Ontario

Dr. John Molot
Ottawa, Ontario

Dr. Donald L. Bastedo
Kitchener, Ontario

Dr. Libusa Gilka
Nepean, Ontario

Dr. John MacLennan
Dundas, Ontario

Dr. William Vanhoogenhuize
Niagara Falls, Ontario

Dr. Gerald Ross
Halifax, Nova Scotia

Mr. Bruce Small
Goodwood, Ontario

Task 2 Develop Data Gathering Forms, Report Sheets and Other Materials Required to Assist in Consistent Survey Information

In order to ensure the complete and consistent inspection of each of the survey homes and to aid the subsequent evaluation process, the data gathering forms and other project materials from earlier protocol development were modified. The Project Team assisted in developing a complete set of inspection checklists and forms for this project.

The materials used for the project included: Survey of Problem Homes House Inspection Checklist, Occupant Survey, Preliminary and Post Survey House Overviews, Map and Plan Pages, Summary Sheets Including Suggested Remedial Action.

Task 3 CMHC Meeting to Finalize List of Homes to be Surveyed

A preliminary meeting was held to confirm the list of houses for the survey and to finalize the proposed methodology for the project. The selection criteria for the houses included:

- Necessity, Urgency of Problem as Perceived by Occupant
- Commitment on Part of Occupant
- Interest:
  - variety
  - severity
  - potential for learning
- Representative Problems
- Number of People Affected / Multiple Problems
- Occupant had Seen Physician
- Location
- Renter / Owner
- Willing to Initiate Remedial Measures

Prior to identifying the list of 'sick' houses to be surveyed, however, it was necessary to determine the total number of houses to be surveyed under the research project. Taking into consideration the budget and objectives of the project, the decision was made to investigate a total of 15 different houses—five in Nova Scotia and ten in Ontario. A further decision was made to have the first three houses investigated by two different investigators. One house in Nova Scotia was inspected by the two team members from that area and two houses were inspected in Ontario by two team members from Ontario—on the same day, but independently of each other. This was done to test the repeatability of the survey—Did the protocol lead different investigators to identify the same contaminants and problems?

The following section (4.0) contains a list of the homes surveyed and the preliminary reasons for selecting the homes.

Task 4 Initial Contact of Occupants

The house occupants were contacted to:

- Screen whether their house was a candidate for the survey (Did the house meet the definition of "sick", as defined in the protocol?).
- Explain the CMHC initiative and obtain agreement to survey the house.
- Develop a preliminary house profile documenting general problems.
- Explain the CMHC liability waiver.
- Set-up an appointment for the on-site survey.

During the initial contact, the investigator explained to the occupant that the purpose of the visit was to apply an untested protocol to the building in question and that they would not make any specific recommendations to the occupants.

Task 5 Conduct On-Site Surveys

As mentioned under Task 3, each of the first three homes surveyed was investigated independently by two inspectors. After conducting these initial investigations using the Inspection Checklist and other materials, the investigators submitted their comments related to the procedure. Minor revisions were made to the protocol documentation.

The 11 further investigations were carried out by single investigators.

Task 6 Investigators Compile Survey Documents

Under this sixth task, the investigators compiled the collected data, recorded their on-site visits and evaluated their observations for each house. Suggestions for the remediation of the houses were also noted.

Recommendations were not made to the occupants by the investigators. The investigators reported the results of the survey to the Project Team and included suggestions for remediation in those cases where no immediate life-safety issues arose. These recommendations are included in Section 5.0 of this report. In situations where a potentially dangerous health or safety issue was observed, the Project Officer was immediately informed. It was the responsibility of CMHC to then inform the occupant.

Task 7 Independent Review by Healthy Housing Experts

As a further evaluation of the protocol, the complete results of two of the house investigations (NS01A and NS05) were sent to two independent reviewers. The purpose of the independent review was to determine whether an expert could analyze the occupant survey, the observations made by the investigator, and photographs of the house to confidently evaluate the house without actually visiting it. The investigators' recommendations were not sent to the reviewers. The reviewers were asked to:

- evaluate patterns, if any;
- provide suggestions for rehabilitation of the houses; and
- provide commentary on the completeness of the protocol.

The independent reviews were provided by:

- John Bower, The Healthy House Institute—an Indiana-based designer, builder writer and consultant specializing in non-toxic housing construction and author of The Healthy House
- Greg Allen, Allen Associates—a Toronto-based engineer whose work in the area of residential building science included the engineering of the Codocile Project.[1]

[1] This Healthy House, built in Toronto, was a winning design in CMHC's Healthy Housing Design Competition in 1992.

Task 8 Draft Report and Final Report

The investigation reports received from the survey teams were compiled into a draft report. The information was presented in a format that provides easy comparison of the data. The final report was prepared after the draft report has been reviewed by CMHC.

4.0 The Homes Surveyed

The following table lists each of the homes surveyed under the protocol and identifies their location by town and province. The reasons for investigating each house are briefly documented and the investigator responsible for the investigation is identified. It should be noted that, in addition to the reasons listed below, at least one of the occupants of each house has been diagnosed with a health-related problem.

Table 4.1

Listing of the Homes Surveyed

House ID	*Location*	*Reasons for Investigation*	*Investigator*
NS01A	Bedford, Nova Scotia	- all occupants have allergies - recent renovations undertaken - smell from attached garage - treated foundation	J. Feigin
NS01B	Bedford, Nova Scotia	see NS01A	R. Barrett
NS02	Blockhouse, Nova Scotia	- 1 occupant sensitive - 1 occupant slightly sensitive - dizziness, fatigue - basement wet in early spring - old house	J. Feigin
NS03	Whycocomagh, Nova Scotia	- asthma, etc. - water leakage - house is over 40 years old	J. Feigin
NS04	Halifax, Nova Scotia	- slab-on-grade - 2 occupants are sensitive - bathrooms problem area	R. Barrett
NS05	Nova Scotia	- house 150 years old - fire 8 years ago - bothered by electric and magnetic fields - well in basement - earth floor	R. Barrett
ON00	Metcalfe, Ontario	- new house, less than 2 years old - occupant started feeling sick shortly after moving in - better away/in house symptoms return	O. Drerup
ON01A	Mississauga, Ontario	- lived in home 10 years - both people affected - have environmental illness - feel better outside home - problems seasonal	O. Drerup
ON01B	Mississauga, Ontario	see ON01A	E. Lowans
ON02	Kanata, Ontario	- new townhouse - stripped floors - lived there 41/2 yrs—sick for 4 yrs	O. Drerup

House ID	*Location*	*Reasons for Investigation*	*Investigator*
ON03	Ottawa, Ontario	- apartment in old home - environmental hypersensitivities - heating system makes situation worse	O. Drerup
ON04	Gloucester, Ontario	- house now 8 yrs old - problem began when moved in (house was new)	O. Drerup
ON05	Ottawa, Ontario	- one occupant—environmental illness - some family members also affected - problems developed shortly after building addition to house - Ontario Ministry of Housing requested assessment of house	O. Drerup
ON06A	Coe Hill, Ontario	- committed to remediation - all occupants environmental illness - urgency—occupied less than 1 year	E. Lowans
ON06B	Coe Hill, Ontario	see ON06B	R. Van Vliet
ON07	Toronto, Ontario	- one occupant (allergies) - bothered by gas furnace - feels worse in winter - feels worse in basement - vacuuming and cleaning trigger symptoms	E. Lowans
ON08	Ontario	- occupant allergies to mold & insects - 154 year old house in rural area - wood stove removed 1991 & health improved - bothered by cleaning	E. Lowans
ON09	Unionville, Ontario	- both occupants affected - willing to remediate - symptoms worse in winter - house built on filled swamp	E. Lowans

The following section presents a detailed documentation of each house and its occupants as gathered by the investigator.

5.0 Summaries of the Investigation Reports

HOUSE SUMMARY: NS01A

OCCUPANT SURVEY:

Occupants, bothered with smells, have problems with foods, inhalants, chemicals, scented products, molds and car exhaust smells.

30-year old house: bungalow with split entry and garage below living space, has a baseboard hydronic oil-fired heating system, whole-house ventilation (runs 24 hours), no kitchen fan, odours linger after cooking, basement used for storage, occupant in house 15 years, observed increase in problems in early 1980s when basement remodelling began.

House undergoing renovation since late 1970s. New furnace, fireplace, and chimney installed recently, also central vac and whole-house fan, 8 ft addition to front of garage 3 years ago.

Survey Date and Conditions: 30 August 1993, PM

PHOTOGRAPH:

INVESTIGATOR'S OBSERVATIONS:

GENERAL:

- 8 rooms/areas were surveyed - basement, kitchen, living room, bathroom, master bedroom, bedroom 2 (upstairs), study, and bedroom 3(downstairs)
- foil air barrier possible in kitchen; paper-backed batts in good condition in kitchen, living, bath, master bedroom, bed 2 and study, no air barrier

- very musty closets in basement, master bed and study
- some black around window in basement and living room

BASEMENT:
- in good condition, no drain, no trap, no sump, no flooding
- Styrofoam SM under unpainted concrete floor
- 1 couch, 2 chairs with synthetic filling
- variety of equipment and supplies stored in basement
- musty, smells like cardboard, minor amount of white fuzzy mold
- poor air circulation
- walls finished except in mechanical room
- bedroom downstairs
- area rugs in family room (wool) and bedroom (synthetic) over parquet flooring

KITCHEN:
- no-wax vinyl floor in kitchen
- small amount of vinyl in cupboard doors
- dishwasher
- spice smell in kitchen closet

BATHROOM:
- ceramic tiles in bath downstairs and foyer
- sheet wall panelling cracked in corner
- Varethane plastic finish on walls
- plastic paint on ceiling

LIVING ROOM:
- brick fireplace
- large leather couch strong—smell of tanning process
- vinyl wall paper
- synthetic-filled chairs and couch
- smells like tar
- synthetic area rug

BEDROOM:
- cracked plaster on north wall corner in master bedroom

MECHANICAL:
- hydronic baseboard heating supplied by oil-fired boiler in basement, living, bathroom, bedroom 1 & 2, and study
- portable fan (working condition)
- ventilation system: 20% fresh air supply, no heat recovery, filter changed less than once per year, long flex duct

EXTERIOR:
- cedar wood shingles on exterior walls, asphalt shingle roof
- north side of the house in shade most of the day, cool air circulation on this side, moisture, green algae visible on wall
- door to attached garage not sufficiently weather stripped to isolate garage from rest of house. Concrete garage floor with floor drain. Walls concrete half way up, then drywall.
- oil tank stored in garage, no signs of leakage. Strong moisture, damp, dusty smell in garage.
- old brass drain pipe on west wall from upper house. Shows signs of leakage and mold—should be investigated.

Investigator developed breathing problem and dizziness in living room and bath. Also disorientation in basement.

INVESTIGATOR'S SUGGESTED REMEDIAL ACTIONS:

- Move location of intake for ventilation system to an area with better air movement away from heavy vegetation.
- Increase ventilation in house.
- Ensure garage is sealed from rest of house.

FURTHER SUGGESTIONS FROM THE PROJECT TEAM:

Dehumidify basement.

Completely seal garage below the living space from the living space.

Ensure ventilation system is working adequately, may require moving air intake. Replace flex duct with smooth duct work (because of resistance to air flow and potential odours from plastic ducts—especially supply). Ventilation system could be improved by installing a unit with heat recovery and ducting to deliver fresh air where it is needed (living room and bedrooms) and removing stale air at points where it is created (kitchen, bathroom, basement, closets).

Stop remodelling and let pollutants from renovations be removed from house by ventilation system.

Suggest use of fragrance-free products—some unscented products are not fragrance-free but may contain a masking scent.

Remove all stored items that are sources of odours in workshop and garage and determine source of contamination.

COMMENTS FROM JOHN BOWER (Expert Reviewer):

Primary Issue: Problem related to a combination of small exposures to a wide variety of synthetic or odourous household products and furnishings. Notes poor separation of garage from house and general smell of laundry soap in house.

Secondary Issue: Mild to moderate excess humidity problem resulting in microbial growth. Localized areas of high humidity: room over garage, long showers, closed drapes, musty smells (closets), coastal climate, etc. Air filter may remove some microbials but probably not synthetic odours.

Third Issue: Ventilation system may not be operating properly—over ventilating one area and under ventilating another.

Comment: Inspector identified quite a few odours that were helpful in diagnosing the problem—but still had to base conclusions on deductive reasoning and past experience.

Comment: Mold and VOC testing not very useful—sensitive people often react to "normal" concentrations.

Suggested Remediation: Switch all household cleaning and maintenance products to low-tox products formulated for sensitive people. Walls, ceilings and floors may need cleaning with a low-tox cleaner to remove residual odours absorbed by surfaces. Air-seal garage and workshop from living space—if can't properly air seal, remove all odourous products. Use a high efficiency dehumidifier to reduce indoor humidities.

No specific comments about this house were provided by Greg Allen.

HOUSE SUMMARY: NS01B

OCCUPANT SURVEY:

Occupants, bothered with smells, have problems with foods, inhalants, chemicals, scented products, molds and car exhaust smells.

30 year old house: bungalow with split entry and garage below living space, has a baseboard hydronic oil-fired heating system, whole house ventilation (runs 24 hours), no kitchen fan, odours linger after cooking, basement used for storage, occupant in house 15 years, observed increase in problems in early 1980s when basement remodelling began

House undergoing renovation since late 1970s. New furnace, fireplace and chimney installed recently, also central vac and whole house fan, 8 ft addition to front of garage 3 years ago.

Survey Date and Conditions: 30 August 1993, 8:04 AM, 10°C, 34% RH (outside)

PHOTOGRAPH:

INVESTIGATOR'S OBSERVATIONS:

GENERAL:

- 12 rooms/areas were surveyed in total- basement bedroom, kitchen, living room, upper bath, master bedroom, hall/entrance, second bedroom, office, and four additional basement areas - furnace room, lower bath, family room, and workshop
- latex mesh under most rugs
- closets contained particle board, bedroom closets had smell of detergent, fabric softener
- garage and workshop were very bad, but smell could not be identified

ENTRY SMELL: - homeowner forgot to mention not to cook to the rest of the family. Cooked fish sticks for breakfast - slight smell still in kitchen. Slight smell of personal care products. 2nd day - chemical smell noticed—same as smell in garage

BASEMENT:
- floor drain—hole drilled in floor, slight crack, dry
- insulation—floor SM, wall partial

KITCHEN:
- cabinet doors made of veneer plywood, cabinets made of softwood plywood, hardwood plywood, softwood, painted but not all edges sealed
- spice smell in kitchen closet
- slight mold behind kitchen sink

BATHROOM:
- Varethane on bathroom wall and ceiling
- scented products
- slight mold, seal gone around sink

LIVING ROOM:
- some furniture with particle board

MASTER BED:
- water bed with original sheets
- master closet contamination from garage

BEDROOM 2:
- appeared to have contamination from garage

OFFICE:
- strong chemical smell in office closet
- strong smell of paper and forms
- electronics

FAMILY ROOM:
- different strong smell to rest of house—possible sources: books, clutter, sources

GARAGE & WORKSHOP:
- gas and oil smells
- poor weather stripping on door

MECHANICAL:
- portable air cleaner in one room (no ventilation supply to bedrooms)

EXTERIOR:
- cedar wood shingles on exterior walls, asphalt shingle roof
- decks
- oil tank supply line near the front door
- slight moldy smell on NW side
- leaves and lawn clipping pile

Physical effects of investigation on inspector: Investigator developed slight headache which became progressively worse during inspection. Had to return on a second day to complete inspection.

INVESTIGATOR'S SUGGESTED REMEDIAL ACTIONS:

- Remove items from work shop and garage to determine whether it is the materials or contaminated concrete that are causing the problem in this area.
- Negatively pressurize garage and/or completely seal from house.
- Install ventilation system supplies to bedrooms and exhausts from kitchen and basement.
- Change use of scented products.
- Keep door to furnace room closed.
- Large amount of particleboard in closets may warrant formaldehyde test.

FURTHER SUGGESTIONS FROM PROJECT TEAM:

—see NS01A for main listing of further suggestions

Seal all pressed wood products with appropriate sealer.

Re-evaluate use of waterbeds (due to odours from rubber, possible mold growth, electromagnetic fields).

HOUSE SUMMARY: NS02

OCCUPANT SURVEY:

Occupants bothered by asthma and allergies, have problems with foods, trees, molds and new products. Occupants feel worse in spring, winter and fall.

Very old house (over 70 years): 2 storey with cement basement, previously used a wood stove for heating but now have furnace and ducted heating system, odours linger after cooking, wood varnish smell in bathroom and hallway at all times, wallpapering and floors refinished 5 years ago, basement used to store firewood and basement is damp.

Survey Date and Conditions: 6 October 1993, 2 PM, 18°C, 61% RH

PHOTOGRAPH:

INVESTIGATOR'S OBSERVATIONS:

GENERAL:

- 6 rooms surveyed in total - basement, kitchen, living room, bathroom, bedroom and den
- natural fibres in drapes
- double-hung single-glazed windows with wood frames—old, cold, fair condition
- incandescent lighting
- some walls are plaster and others are wallboard, no vapour barrier, air barrier (poly)
- some unvented closets on exterior walls
- moldy, musty, earthy, mildew

ENTRY SMELL:
- mildew smell on entering house
- living room mold-musty smell that became a chemical odour when in room

BASEMENT:
- open well and sump in basement (sump not automatic)
- firewood stored in basement
- painted concrete wall with flat paint
- damp, cold
- food stored on shelves in boxes—apples
- basement floods occasionally (1 - 2 times a year) well or sump pump overflows,
- walls/floor not insulated, no vapour barrier, concrete floor in good condition
- fuzzy white mold growth on floor
- fibrous dust
- may have asbestos
- sealed combustion woodstove in basement
- new fixed windows—cold to touch, poor lighting

KITCHEN:
- softwood plywood cabinets
- hard vinyl floor tiles—lifting
- no exhaust fan, some cleaning products

BATHROOM:
- hard vinyl floor
- oil finish on wood veneer wall paneling—cool feeling
- plywood underlay
- pine strip panelling on ceiling—oil paint finish
- no exhaust fan

LIVING ROOM:
- cold floor, fir wood
- vinyl/vinyl coated wall paper, cold wall
- wood fireplace with doors
- chairs in living room wood frame, synthetic covering

BEDROOM:
- portable air cleaner with HEPA & charcoal filter

DEN:
- unheated, contains books

MECHANICAL:
- electric and wood systems, no fresh air supply
- all supply ducts are unused, a wood furnace is presently being installed and some of the duct work will be used
- no air conditioner, portable humidifier or dehumidifier

ATTIC:
- soffits are packed with insulation
- blown glass-fibre insulation, gable vents

EXTERIOR:
- house located in small valley surrounded by large pine trees
- radon possible, should be tested
- no down spouts or gutters
- trees just cut—considerable amount of brush and old building remains
- no garage

Physical Effects of Investigation on Inspector: developed a stuffed-up nose and dizziness in kitchen, living room. Disoriented in living room. Symptoms better in bath and bedroom.

Inspector's Thoughts on Primary Problem in House:

- vinyl wallpaper on wall in living room (mold present when similar wallpaper removed from wall in entrance hall)

Inspector's Thoughts on Secondary Problems in House:

- damp environment encasing house; slope behind house drains into basement—occasionally floods
- large pile of rotting lumber (old torn-down building) metres away from house—source of mold and fungal growth

INVESTIGATOR'S RECOMMENDATIONS:

- Increase ventilation.
- Maintain heat at a higher level (70 - 75°F).
- Remove vinyl wallpaper from wall in living room.
- Remove remains of torn-down building.
- Use rocks or french drains to stop water from entering the basement.
- Install central vacuum system vented to the outside (lower priority).
- Test house for bacterial and fungal growth, and for radon (lowest priority—remediate mold problem first).

FURTHER SUGGESTIONS FROM PROJECT TEAM:

From its history of flooding, this house appears to have a moisture problem. Visual and odour observations indicate presence of molds. The control of moisture in the basement, therefore, is a top priority. Water should be led away from the foundation by draining to a lower point, upgrading the sump pump (automatic with a cover) and installing eavestrough. Once drainage is improved, clean basement walls and floors to remove molds. The whole house and furnishings may also require cleaning.

Use a dehumidifier in the basement to assist in controlling moisture levels.

Install an exhaust fan in the kitchen. In the bathroom, an exhaust fan or an exhaust vent as part of an heat recovery ventilation system could be installed. An HRV should only be considered after making the house air tight. The cost effectiveness these measures should be addressed.

Remove firewood from basement.

Seal sources of moisture and provide adequate ventilation to house.

HOUSE SUMMARY: NS03

OCCUPANT SURVEY:

One occupant chronically bothered by asthma, has allergies, lung disease and is very sensitive to molds. She has been treated by a doctor and has had sinus surgery. Previously a smoker who had tuberculosis when younger.

Single family house: single storey with basement located on an Indian Reserve. Ventilation system installed three years ago—has had little effect on the occupant's problems.

House is left vacant for periods during the summer. Because house is very close to Trans-Canada Highway, it is difficult to leave windows open.

Survey Date and Conditions: 4 October 1993, 10 AM, 14°C

PHOTOGRAPH:

INVESTIGATOR'S OBSERVATIONS:

GENERAL:

- 6 rooms were surveyed - basement, kitchen, living room, bathroom, bedroom and 2nd bedroom.
- overall impression of stale air and mustiness with little air movement.
- HRV doesn't appear to be working right.
- walls in basement, kitchen, living room painted within last 3 months.
- house additions over ground. Much of the first floor is not on basement.
- home within 15 metres of Trans Canada Highway. Highway noise levels high.

BASEMENT:
- full, concrete block
- no floor drain
- does not flood
- no stored items
- carpet with foam backing in fair condition
- portable dehumidifier, black mold in drip pan
- supply duct very close to washer and dryer area. A lot of dust, mold, moisture in this area.
- basement sealed from ground floor by interior door. When shut, air circulation is minimal, when open, air circulated is of poor quality.

KITCHEN:
- smells musty, food odours
- plywood, enclosed shelves and cupboards
- exhaust fan, not working, vented outside

BATHROOM:
- moldy ,damp smell
- soft vinyl floor tiles, glued, in good condition
- natural linoleum, glued in good condition
- working exhaust fan

LIVING ROOM:
- carpet in good condition, with foam under pad

BEDROOMS:
- roof leak
- soft vinyl tiles, glued, in good condition
- natural linoleum, glued in good condition

ATTIC:
- vermiculite and eel grass (seaweed) insulation

MECHANICAL:
- basement return duct plugged (kitchen). Two supply ducts not hooked up. One return register to kitchen not hooked up—therefore only one functioning return air duct to furnace
- forced air, oil heating
- HRV installed over two years ago. No service since then including filter changes and cleaning. Little air being supplied or exhausted from the machine (while in maximum supply mode).
- HRV is exhausting air from ground floor living space and supplying fresh air in the basement.

EXTERIOR:
- down spout not connected at kitchen
- stone, exterior sheathing. Cement and rock facing on west side with some cracking.
- brick chimney, needs cleaning
- potential for introducing contaminants (truck emissions) through air intakes
- exterior oil tank smells
- site is partially shaded with growth against building
- unattached garage
- wood siding in good condition
- low slope roof with asphalt shingles in fair condition
- peeling blistering paint
- mold on north and south walls

Physical Effects of Investigation on Inspector: developed stopped up nose in basement and living room. Also breathing problem and itchy skin in basement.

INVESTIGATOR'S SUGGESTED REMEDIAL ACTIONS:

- Service the HRV and check flows in and out of machine. Re-route HRV supply air duct from basement to back bedroom. The return air duct should be located in the living room in order to deliver fresh air to the area of greatest need.
- Clean exterior fuel tank area around fill area.
- Seal floor, walls and sealing.
- Use liquid laundry products in laundry.
- Clean dehumidifier regularly.
- Install central vacuum system, vented to outside.
- When roof is replaced, use metal or wood, do not recommend asphalt shingles.
- Plantings on the border on the property with the highway would have a positive effect in reducing traffic noise.

FURTHER SUGGESTIONS FROM PROJECT TEAM:

Repair roof leak. Connect downspout at kitchen.

Make exhaust fan in kitchen operable.

Remove carpets in basement. Consider replacing the carpet in living room with hardwood floor or rigid vinyl tiles (not sheathing).

Improve air circulation outside the house to prevent mold growth on walls.

HOUSE SUMMARY: NS04

OCCUPANT SURVEY:

Occupants have problems with weeds, grasses, tree molds, pest and herbicides, scented products and vapours from oil furnace.

Relatively new house (1-5 years): two floors with no basement, has a hydronic heating system, has an HRV ("air exchanger-every 2 hours"), no kitchen or bathroom fans, odours linger.

Occupant uses unscented fabric softener sheets.

Survey Date and Conditions: 6 October 1993, 10:00 AM, 12°C, 32% RH

PHOTOGRAPH:

INVESTIGATOR'S OBSERVATIONS:

GENERAL:

- 8 rooms/areas were surveyed - basement (incl. Laundry, hobby room, mechanical systems room), kitchen, living room, bath, bed 1, dining, spare bed, and bed 2.
- fiberglass batt insulation in attic
- strong fragrance throughout area
- generally ventilation seems to be good (except kitchen). All rooms have ventilation connected.
- carpets in all rooms except kitchen and bath.

ENTRY SMELL: - slight smell of smoke (wood smoke or other burning).

UTILITY:
- no basement: house is slab-on-grade
- possible contamination from some of the hobby supplies in laundry
- laundry has exposed softwood plywood shelves and particle board table
- Mechanical room- Concrete floor, cracks, fresh air supply through hole cut in door to basement(sic) den, unfinished drywall, floor drain has water in it, slight smell of furnace

KITCHEN:
- humid
- no apparent air movement—suspect exhaust fan is not vented
- no leaks under sink. Stored cleaning products under sink-not too fragrant. No mold visible.
- fridge evaporation pan looks well marked but no sign of water. Lots of lint buildup.
- Cupboards - hardwood plywood, counter-particle board
- particle board table, plywood chairs, and hardwood plywood cupboards

LIVING ROOM: - softwood exposed shelves, hardwood plywood tables and cupboards

BATH: - finished particle board shelves and hardwood plywood cupboards

BEDROOMS:
- slight source of scented products
- Bed 1 has softwood exposed shelves and hardwood plywood tables, chairs, and cupboards. Spare bedroom has particle board exposed shelves and hardwood tables and plywood chairs. Bedroom 2 has medium density fiberboard tables and cupboards.
- spare drain trap (unused and unfilled)

DINING ROOM:
- humid
- hardwood plywood enclosed shelves, tables and chairs.

MECHANICAL:
- vent cut in mechanical room door
- chimney side vented (not sealed tightly)
- medium efficiency oil-fired boiler, hydronic system, leak from water pipes (heat),
- metal flex duct (metal pipe some areas). Plastic flex duct too. Flex duct often long, and partially collapsed in some locations. No access to filters, filter condition unknown. Drainage tube—not connected.
- no air cleaner

EXTERIOR:
- front grade slopes away from house. Back slopes toward house.
- site is partial shade south west, sunny/east
- no garage
- slab on grade foundation
- Slight mold on soffit
- dryer vents near air intakes (potential for introducing contaminants). Air exhausts under deck next to dryer vents.

OTHER: - main floor apartment in house is a source of scented products

INVESTIGATOR'S SUGGESTED REMEDIAL ACTIONS:

- Extra drain trap in bathroom should be filled with water or sealed or a back check valve installed.
- Better seal side-mounted furnace exhaust to prevent exhaust fumes from getting in around cracks.
- Fix leak in furnace hot water piping.

- Shut off HRV when clothes dryer is on to prevent dryer exhaust from circulating through house.
- Check for possible back drafts from the furnace due to pressure imbalances from prevailing winds.
- Check filters, balancing and flows of the HRV.
- Separate dryer exhaust from HRV intake.
- Use less scented products/make it a requirement for the main floor rental unit.

FURTHER SUGGESTIONS FROM THE PROJECT TEAM:

Increase air exchange, especially removal from kitchen and bathroom and at same time do not depressurize house (hard to do with hydronic heating system). Ensure adequate air supply to furnace and determine why furnace backdrafts.

Seal particle board and plywood furniture with sealant.

Remove carpets and replace with hard flooring (carpets hold odours).

Improve grading—may be potential source of problems in future.

HOUSE SUMMARY: NS05

OCCUPANT SURVEY:

Occupants have environmental illness and sensitivities, Epstein-Barr virus and chronic fatigue, allergies to molds, food, pollen, dust mites and sensitivities to chemicals and new materials. Occupy second floor of house—parents occupy main floor.

Very old house: 2 floors with an unheated basement, basement windows boarded up, musty smell when enter house, humidify in winter, dehumidify in summer, no kitchen or bathroom fans, house had extensive fire in 1985

Survey Date and Condition: 14 October 1993, 8:00 PM, 7.2°C, 46% RH

PHOTOGRAPH:

INVESTIGATOR'S OBSERVATIONS:

GENERAL:

- investigation undertaken as two sections:
  1) 7 rooms upstairs & basement: basement, kitchen, living, bath, bed 1, hall, bed 2, back bed
  2) 5 rooms on the main floor: kitchen, living, bath, master bed, and hall—occupied by parents
- paper-backed fibreglass insulation in outer wall exposed at floor in kitchen, bedroom 1, hall (upper floor)
- all walls were in poor to fair condition
- air barrier: exterior "Scoutam" paper on bed 1, kitchen, bathroom, hall, bed 2, and back bed
- windows: mainly operable double glazed, some single glazed; some casement, awning, single hung; all in good condition; sealing and finishing around windows missing in many rooms—insulation exposed

ENTRY SMELL:
- Strong smell(chemical odour) in bedroom
- mold and wood odour in back bedroom, also room much cooler

Section 1: (Upper Floor Apartment and Basement)

BASEMENT:
- full basement, window wells blocked off
- masonry and stone walls
- half of house has concrete wall formed on outside of original masonry wall at full height
- earth floor
- open well
- penetrations are below grade, some sealed with concrete patch, some not
- large number of penetrations between basement and main floor of house
- oil tank stored inside—slight leakage
- items stored on skids

KITCHEN:
- under floor: painted plywood, not painted in hard to get at areas on square edge boards
- walls and ceiling: drywall sheets put up and painted, cracks filled after (not painted yet); some veneer lauan panelling on wall, one wall foiled
- Varola pine around window
- stripped softwood panel door, softwood cupboards

BATHROOM:
- under floor: painted plywood, not painted in hard to get at areas on square edge boards
- walls and ceiling: drywall installed, cracks filled, no paint; some veneer lauan panelling on exterior wall and 1 other wall
- shelves: painted pine and particleboard
- hot water tank in bathroom

HALL:
- under floor: untreated plywood
- walls and ceiling: drywall installed, cracks filled, no paint, some veneer lauan panelling on exterior wall and 1 other wall
- bureaus: hardwood and hardwood veneer
- freezer, boxes and metal filing cabinets, jackets & miscellaneous items

BEDROOMS:
- back bed: location fire
- floor bed 1,2: unfinished waferboard on unfinished square edge boards
- floor back bed: 1/2 board painted, 1/2 softwood boards unfinished—signs of past mold on boards
- walls and ceiling bed 1, back: drywall sheets put up and painted, cracks filled after (not painted yet)
- walls bed 2, back: 1 x 4 square edged pine, bed 2-stained, back-unfinished
- ceiling bed 2: finished wood strips over joints
- back bed: stripped softwood panel door
- closets bed 1: painted/paper veneer lauan panelling on walls, pine built in cabinets and hardwood dresser; bed 2: unfinished built-in pine closet
- bed 1: particleboard TV stand, hardwood plywood table, pine shelving, softwood pine
- bed 2: stuffed animals, stereo, clothes

MECHANICAL:
- electric baseboard heaters in every room except kitchen
- portable dehumidifier in hall

Section 2: (Main Floor Apartment)

KITCHEN:
- under floor: 1/4" plywood over 3/4" square edge boards
- walls: arborite glued on drywall, small amount of pine (nailed) and hardwood veneer plywood (varethane) with styrofoam behind
- hardwood ply cupboards, aspenite, a small amount of particleboard
- water from a spring in Weymouth (Jones bottling plant was there—does better)
- washer/dryer—ok, use dryer sheets.

BATHROOM:
- walls: arborite on drywall (glued) and backer board
- ceiling joints covered by 1 x 4s (stained)
- closets: painted plywood shelves, particleboard cupboards
- slight black on window above tub, mold on corners of tub
- large number of shoes on the back of 1 door is quite potent, scented products
- past leak from toilet —has been fixed

LIVING ROOM:
- 3/4" plywood over 3/4" square edge boards
- walls: wood similar to cedar but not same
- seems to be getting moisture coming up from basement
- particleboard enclosed shelves and cupboards, hardwood ply cupboards, hardwood tables and chairs
- TV and microwave, plates on wall near ceiling
- many soft cushions

HALL:
- seems to be getting moisture coming up from basement (occupant complained of "rotten smell that comes from somewhere around the staircase in the centre of the house in really hot, wet weather")
- exposed and enclosed particleboard shelves, softwood tables
- lots of pictures on the wall, coat rack, fabric door to master bed

MASTER BED:
- ceiling: slight stain from past toilet overflow upstairs
- particleboard enclosed shelves and cupboards
- portable humidifier, TV

ATTIC:
- very difficult to check for materials stored in the attic
- light watermark near chimney—repaired
- no vents, but 1 window in each dormer is an operable casement
- lots of flies at windows
- smelled stale—some bat droppings, suspect small holes in chimney flashing
- roof rafters pegged not nailed

MECHANICAL:
- oil-fired forced-air high efficiency heating system with electronic ignition
- ducts: metal and metal flex; returns metal piping, not sealed.
- plumbing: separate gray and black water
- passive electrostatic filter; filters changed every 2 months
- many ducts and pipes—not easy to seal basement from main floor

EXTERIOR:
- smelled diesel fumes on deck at 10:48
- ground slopes away on west & north, level on south & east
- no down spouts or gutters
- site has slight shade
- siding: wood shingles in good condition, slight peeling paint in some sections; if old original shingles, lead is a potential problem
- roof: asphalt shingles in fair condition—lichen & moss growth on north side
- metal chimney has cap, masonry chimney has no cap
- foundation in good condition for type
- basement windows covered over with plywood
- no air intakes or exhausts

Inspector's Thoughts on Primary Problem in House:

- basement is a major source of moisture and mold

INVESTIGATOR'S RECOMMENDATIONS:

Top Priority

- Determine whether basement can be isolated from rest of house or whether walls, floor and well can be covered and sealed. If this can't be done, all other improvements will be limited.

  Possible solutions:
  - cover and seal well in basement (vent to outside?)
  - seal basement floor (pour a concrete floor or put down poly and cover with sand to prevent puncture)—*other investigators were concerned this would create a moisture sink and lead to increase in mold*
  - seal all basement walls and penetrations

Second Priority

- Seal exposed floors (use low emission sealant or foil vapour barrier). Test back bedroom floor with a vapour barrier on the floor to ensure there is not going to be a moisture problem if sealed.
- Install trim and seal to wall
- Stop using fabric softener sheets
- Switch to less scented products—especially in bedroom #2 and lower bathroom
- Check upper toilet for possible leak
- Seal any exposed particle board (for example backs of furniture)
- Clean up bat droppings (use caution—possibility of contracting histoplasmosis), identify entry routes and seal.
- Move oil tank to outside

Third Priority

- Paint walls and ceilings with low emission sealer
- Paint/seal all exposed wood trim and closets
- If moisture is not a problem, seal the floor in the back bedroom
- Ventilate bathroom

Fourth Priority

- Inspect north roof, moss will accelerate decay of shingles

FURTHER SUGGESTIONS FROM PROJECT TEAM:

Find out what was done as a result of fire in house: Was it fumigated? Was a fire sealant used?

If feasible, the occupants should move to another home or replace the structure—with fire damage and age and condition of structure it will be very expensive to markedly improve the indoor environment in the existing building.

If moving is not an option:

- Isolate basement from house or upgrade basement by heating and stopping leaks and dampness, provide adequate controlled air exchange. Concrete ledge at main floor header may be causing significant moisture movement to basement area.
- If isolate basement, slightly pressurize house (unless potential for problems with moisture in wall cavities). Weather seal all penetrations and seal building envelope but ensure moisture is not being trapped in envelope.
- Monitor to determine whether humidification really required during winter.
- Dehumidify during warm months.

COMMENTS FROM JOHN BOWER (Expert Reviewer):

Primary Issue: Excessive indoor moisture is resulting in an abundance of microbial growth and subsequent air contamination. Sources include: drying clothes indoors, showering, coastal climate, etc. Moisture enters through basement during winter and from inappropriate use of humidifier and is absorbed by unfinished drywall, unfinished wood, soft furnishings, rugs, draperies, etc.—provides homes for microbials such as mold, mildew and dust mites. Poor sealing of house indicates probability of condensation in walls. High humidity in summer result of coastal climate, moisture release from absorbent materials and lack of operation of furnace fan (acts like exhaust fan in winter).

Secondary Issue: Manufactured wood products releasing formaldehyde into air. Outgassing more pronounced when indoor humidities high.

Comment: Survey did not do a good job of identifying the problems—conclusions based on deductive reasoning and past experience.

Comment: Mold and VOC testing not very useful—sensitive people often react to "normal" concentrations.

Comment: Radon testing should be done, could also evaluate for lead paint and combustion spillage.

Suggested Remediation: Completing the house (painting unfinished drywall, trim, etc.), reducing indoor humidities (install local exhaust fans and high efficiency dehumidifier), maintain warmer temperatures in all rooms including closets. Also tighten house as much as possible and install central ventilation system (if cost effective), remove any manufactured wood products containing formaldehyde.

No specific comments about this house were provided by Greg Allen.

COMMENTS FROM V. SALARES (Project Manager) REGARDING RADON TESTING:

Radon Testing in All Homes: The protocol used in this survey does not place emphasis on radon testing as much as is done in the United states. In some situations, radon testing may be necessary. However, requests from homeowners who believe their house may be aggravating their symptoms are more likely to be affected by pollutants other than radon. Radon, as well as lead or asbestos, require long-term exposures (years)before the health effects will become manifest. Other pollutants (CO, molds, formaldehyde, other VOCs) will exert their effects over a shorter time. Some of these pollutants are perceived by sensitive occupants—in contrast to radon which is odourless. If these pollutants are present, the homeowner will likely be affected by these first rather than radon. The mitigation procedures for moisture entering the basement and ventilation to control molds and other pollutants will also be effective in reducing indoor radon concentrations.

Radon testing would be indicated in the following situations: the area is known to have high radon concentrations; cracks in the foundation suggest possible soil gas entry; rocks or massive stone structures are in the basement; soil is exposed; or the basement area is used as living space.

HOUSE SUMMARY: ON00

OCCUPANT SURVEY:

House inspection undertaken be fore survey available for use.

New house: Large executive home built by owner/builder and sold to occupant on a large rural lot adjacent to a golf course and a farm (potential exposure to pesticides and fertilizers). Has a wing with indoor pool and wing with two-car garage and living space above it.

Survey Date and Conditions: Spring 1993, PM, sunny

PHOTOGRAPH:

INVESTIGATOR'S OBSERVATIONS:

GENERAL:

- 10 rooms/areas were surveyed in total - living/dining, kitchen, master bedroom, master bath, basement, mechanical, pool, bed 1 & 2.
- large quantities of carpet, all new
- vapour barrier installed throughout building—continuity is questionable

ENTRY SMELL: - chlorine with very high humidity

BASEMENT:
- flooded several times, appears to be built below the water table
- dampish
- contains finished space including family room, den, wine storage
- exit with door to pool level directly from basement

KITCHEN:
- extensive counters made of particle board
- aspenite subfloor covered in sheet flooring

BATHROOMS: - clean, fans

LIVING ROOM:
- cathedral ceiling
- entry to pool area through a door via open spiral staircase

BEDROOMS:
- two located above garage are inaccessible to main house mechanical system
- heated by electric resistance radiant panels
- foam underpad and carpet

MASTER SUITE
- cathedral ceiling with significant moisture damage at eaves
- wall-to-wall carpet
- adjoining bathroom has tile floor
- heated by forced-air furnace in mechanical room

ATTIC:
- primarily cathedral ceilings
- some rooms have drop ceilings

MECHANICAL:
- main mechanical system located in basement of main building and immediately adjacent to pool room
- dry-a-tron (large exhaust fan used for pool area space conditioning) is located in mechanical room; dry-a-tron exhausts to exterior; duct work of dry-a-tron leaks into mechanical room when mechanical room depressurized
- forced-air electric furnace has leaky ductwork. When operating, depressurizes mechanical room and causes significant amount of cross-leakage with dry-a-tron ductwork
- sump located in mechanical room operating almost continuously in spring months to remove large volumes of water

POOL:
- interior swimming pool uncovered
- measured humidity in pool area: 68% RH
- cedar finish on interior walls and ceiling
- one area of pool is carpeted

GARAGE:
- cars, chain saws, gasoline and other petrochemicals in storage
- ceiling of garage is floor of bedroom wing and is not air tight

EXTERIOR:
- very high water table
- close proximity to golf course and farm yard
- no significant plantings near house

INVESTIGATOR'S SUGGESTED REMEDIAL ACTIONS:

Problem: Moisture and chemicals from pool of primary concern. Moisture may cause mold and high levels of moisture enhances off-gassing of building materials.

Temporary Remedial Action: Remove automobiles and petrochemicals from garage. Remove carpet from bedroom wing above garage. Occupy bedroom wing because furthest from pool, above ground, ability to obtain cross ventilation and separation from main mechanical system. Avoid using radiant heating because of promotion of off-gassing from building materials and EMF.

This does, however place the occupants closer the petrochemical residue and should be seen as a temporary measure.

Further Remedial Action: Reduce humidity levels in building by covering pool when not in use; cover sump. Remove carpet from all areas of building. Seal subfloor with no-toxic sealer and make good floor finish. Wash basement to eliminate mold growth. Improve mechanical systems and eliminate duct leakage. Investigate and rectify moisture problems in master bedroom ceiling. Install a ventilation system. Isolate pool area from rest of house ventilate and slightly depressurize the room.

FURTHER COMMENTS OF THE PROJECT TEAM:

Seal all possible leakage points where moisture and gases from the pool area could enter the house.

The water quality and ambient air quality at the site may be adversely affected by the proximity of the golf course and the frequent applications of pesticide.

HOUSE SUMMARY: ON01A

OCCUPANT SURVEY:

Occupants affected by hypersensitive rhinitis, headaches, itchy skin, dryness and allergies, have problems with molds, dust, trees, grasses, ragweed and tobacco smoke.

18 year old house: side-split bungalow with slab at entry level and a full basement under building, construction of house "poor", new windows 8 years ago, replaced all broadloom & carpets (due to high level of mold), replaced combustion gas furnace (with 85 - 90% efficient unit), replaced roof (leaked, had resulted in mold in wall), installed new A/C, retiled bathroom, installed HRV (not happy with it), removed mold from exterior wall space, insulated basement, painted ceiling in LR and family room with oil-based paint. Over last 8 years made extensive effort to remove all sources of mold and improve ventilation. Two to 3 humidifiers used during winter because of occupant feeling dry.

Survey Date and Conditions: 21 July 1993, 3:00 PM

PHOTOGRAPH:

INVESTIGATOR'S OBSERVATIONS:

GENERAL:

- 6 rooms surveyed in total - basement, kitchen, living room, bathroom, bedroom and 2nd bedroom
- house located at bottom of hill with all neighbours lots draining over it. Ground does not slope away from house, lawn watered frequently, suspicion of high level of interior moisture. Although occupants did not find house damp in summer months, removed dramatic amounts of water through A/C and dehumidifier.

- synthetic throw rugs in all rooms except kitchen
- triple-glazed aluminum side-slider windows throughout house, with hollow core wood doors

ENTRY SMELL:
- damp, moldy, musty, earthy and fruity

ENTRY:
- tiles glued on cement slab at entry
- adjacent to garage which shares same slab

BASEMENT:
- during summer months, 2 to 3 litres of water removed from dehumidifier in basement per day in addition to a central air conditioning system working full time
- saturated placemat under pet dishes on floor—indicated a very high level of capillary rise of moisture
- cold cellar at rear of basement smelled powerfully of mold (not visible); supply ducting of forced-air furnace passed through ceiling of cold room prior to delivery to living space above
- wall structure: 2 x 2 with ply or tar impregnated fibreboard, fibreglass, drywall
- plumbing pipes partially wrapped with foam

KITCHEN:
- musty
- range hood
- soft vinyl tiles in good condition
- standing water in fridge evaporation pan

BATHROOMS:
- ceramic tile set in glue
- exhaust fans in each bathroom

LIVING ROOM:
- oak parquet glued flooring

MECHANICAL:
- forced-air, induced-draft, electronic ignition gas furnace
- air conditioning
- HRV
- humidifier
- media air cleaner with high efficiency matrix filter. Filter is changed every 6 months.

EXTERIOR:
- flowers including lilies, snapdragons, hollyhocks, dahlias, roses, planted against house and well watered
- soffits are aluminum, hip roof, average pitch, chimney is lined, zero clearance.
- venting: six roof vents, clean; some soffit vents, partially blocked.

Inspector's Thoughts on Primary Problem in House:

- capillary rise of soil moisture, coupled with a high level of air leakage and an over conditioned interior

INVESTIGATOR'S SUGGESTED REMEDIAL ACTIONS:

- Tear out everything in basement, wash entire basement and especially back storage space using proper mold cleaning techniques and products.
- Install proper dampproof course.
- Reinsulate floor and walls.
- Ensure all mechanicals working properly.
- Re-landscape to remove moisture from foundation.

FURTHER SUGGESTIONS FROM THE PROJECT TEAM:

Ensure HRV operating properly and allow house to stabilize.

Ducting of exhaust air for the house could be improved to facilitate removal of moisture and pollutants at their sources.

Carefully control sources of moisture in house.

POSTSCRIPT AFTER SURVEY:

This house was tested for molds and was found to be contaminated with *Stachybotyrs atra*, a known noxious mold. The basement was stripped and cleaned with bleach along with the rest of the house. The furnishings were removed and cleaned prior to being brought back into the house. Re-testing after the clean up indicated that the contaminating mold had been eliminated.

HOUSE SUMMARY: ON01B

OCCUPANT SURVEY:

Occupants affected by hypersensitive rhinitis, headaches, itchy skin, dryness and allergies, have problems with molds, dust, trees, grasses, ragweed and tobacco smoke.

18 year old house: side-split bungalow with slab at entry level and a full basement under building, construction of house "poor", new windows 8 years ago, replaced all broadloom & carpets (due to high level of mold), replaced combustion gas furnace (with 85 - 90% efficient unit), replaced roof (leaked, had resulted in mold in wall), installed new A/C, retiled bathroom, installed HRV (not happy with it), removed mold from exterior wall space, insulated basement, painted ceiling in LR and family room with oil-based paint. Over last 8 years made extensive effort to remove all sources of mold and improve ventilation. Two to 3 humidifiers used during winter because of occupant feeling dry.

Survey Date and Conditions: 21 July 1993, 3:00 PM, hot and sunny

PHOTOGRAPH:

INVESTIGATOR'S OBSERVATIONS:

GENERAL:

- Inspection sequence indicated: entry, basement, living, kitchen, bath, bed 1, bed 2, bed 3, exterior, roof.
- painted concrete behind lower level floor/walls, plywood upper subfloors
- house has a range of windows, single, double and triple glazed

ENTRY SMELL: - mold and pet odours in entry hall and landing

BASEMENT:
- half of basement finished with a rec room and bathroom
- air barrier installed in new basement walls
- smell of book mold in basement
- rec room smells stuffy
- watermarks around plumbing drain from kitchen and bath drain
- A/C pipes wrapped with rubber (neoprene)
- DHW pipes wrapped with polyethylene
- fibres pet [fur?]
- sill plate boxed in with styrofoam/foam
- laundry wall made of plywood and vinyl tile
- basement cupboard has a paint smell

KITCHEN:
- pantry smells of mold
- imitation brick sheathing on walls
- kitchen exhaust fan vented outside
- microwave

LIVING ROOM:
- pet and carpet smell
- large synthetic throw rug
- wallpaper on walls

DINING ROOM:
- synthetic cut carpet

BATHROOM:
- smells of soap
- powered exhaust fan in each bathroom

BEDROOMS:
- pets sleep on bedroom rugs

ATTIC:
- attic hatch in hall, insulated with 1" styrofoam
- truss roof: underside of 3/8" sheathing has lots of moisture damage/rusted nails
- approximately 6" of blown fibreglass with a few loose batts, insulation is disturbed
- vents: 4 roof vents in house + 2 in garage—one garage roof vent open to garage, one open to sealed mini attic over the entrance
- all but 2 soffit vents blocked with insulation
- no soffit intake—new continuous soffit vent added but no through ventilation provided therefore cosmetic only.

MECHANICAL:
- medium efficiency gas forced-air furnace (used to backdraft)
- HRV supplies fresh air to return air duct; HRV intake is to one side of plenum and HRV exhaust is from other side of it, therefore HRV only works if furnace fan is on
- ducts last cleaned 1.5 years ago
- furnace humidifier and portable humidifier, dehumidifier
- use air conditioner
- electric DHW
- air cleaner, filter changed every 6 months

EXTERIOR:
- grade slopes toward house at back and one side.
- down spouts: only 2 for whole house—inadequate
- gutters: upper gutters discharge to garage shingles—floods wall joint and damages shingles. Gutters have 1" accumulation of sand
- minor vegetation against building, few smelly flowers, 1 25' maple in front
- garage to house: aluminum siding with some brick, caulking of aluminum siding failed

EXTERIOR *con't* - no drip caps on windows—mold entry to aluminum siding

Note:
- failed caulking (material incompatibility/movement)
- improper down spout installation
- improper flashing —all lead to water damage and may result in mold growth

- cementitious foundation coating above grade, foundation may contain joint cracks at poured section joints
- metal chimney ok, roof exhaust flashing and chimney flashing failed, 3/8" roof sheathing can't hold nails.
- air intakes 8' off ground, no filter, air exhausts next to laundry.

Physical Effects of Investigation on Inspector: Rhinitis - pets/mold. "probably pets 1st, mold 2nd for me in this house."

Inspector's Thoughts on Primary Problem in House:

- improper installation of soffit, flashing, down spouts and insulation
- negative drainage to clay soil
- improper caulking
- water damage incident in attic
- moisture accumulation in finished basement

Inspector's Thoughts on Secondary Problems in House:

- pets; mold; carpets
- improper HRV installation
- use of contaminated materials—attic, walls, basement floors and walls, books, furniture

INVESTIGATOR'S SUGGESTED REMEDIAL ACTIONS:

Primary

- Gut basement—clean completely and seal walls (before rebuild).
- Remove carpets.
- Repair flashing.
- Add down spouts at rear of house and change all to ground discharge.
- Open attic above entrance and repair water damaged insulation, etc.
- Open up soffit vents.
- Repair grade.

Secondary

- Add drip caps to windows.
- Prime aluminum siding joints and use high modulus of elasticity caulk.
- Move TV to first floor and avoid use of basement.

FURTHER SUGGESTIONS FROM THE PROJECT TEAM:

—see ON01A Investigation for listing of suggestions and comments.

HOUSE SUMMARY: ON02

OCCUPANT SURVEY:

Occupant handicapped by environment, has emphysema, asthma, heart condition; on oxygen, has 100 yd walking limit, can't climb. Petroleum, alcohol, rubber, soaps, rugs, exhaust fumes, animals, dust, cosmetics, sprays, etc cause severe breathing problems. Has trouble finding products that are alcohol free, petroleum free, scent & perfume free, and are true soaps and detergents.

New town house (less than 5 years old): suburban near rural, 2 storey with dry basement, has removed broadloom (currently living on subfloor) and wood floor to be installed, ventilation system to be installed.

Survey Date and Conditions: 5 October 1993, 3:30 PM

PHOTOGRAPH:

INVESTIGATOR'S OBSERVATIONS:

GENERAL:

- 9 rooms/areas were surveyed in total - living, dining, front, kitchen, powder, bed-master, bed 1&2, baths-upper floor.
- closest neighbor—attached at both sides
- building not well constructed
- ductwork installation—poor workmanship
- central vacuum exhausts dust particles into ducts
- airtightness poor at sill plates
- substantial amount of formaldehyde-based glue and materials in building
- building filled with particle board material—this impression is heightened by removal of carpets and exposed OSB covered with a coat of white paint
- significant amount of sawdust composite-board furniture
- carpets still in place on stairs
- unusual layout with garage building into front hall
- recent repainting of main and upper floor walls and ceiling with low VOC paints
- windows installed in 1988, includes swiggle-strip thermal break

ENTRY SMELL: - chemical, wooden

BASEMENT:
- fully insulated basement walls—fibreglass and styrofoam (type unspecified)
- stored items on floor, on shelves, on skids, in boxes
- dry

KITCHEN:
- vinyl sheet flooring in good condition in nook and kitchen
- fan over kitchen stove ineffective

BATHROOMS: - each has a fan

MECHANICAL:
- gas forced-air furnace —electronic ignition
- gas domestic hot water—pilot light

INVESTIGATOR'S SUGGESTED REMEDIAL ACTIONS:

- Seal subfloor and lay down hardwood flooring.
- Properly vent central vacuum system to outside.
- Install HRV and ensure operating properly.
- Check combustion appliances functioning properly and consider installing sealed combustion units in future.

FURTHER SUGGESTIONS OF THE PROJECT TEAM:

Consider replacing sawdust composite-board furniture with hardwood furniture—if not feasible this furniture should be sealed.

HOUSE SUMMARY: ON03

OCCUPANT SURVEY:

Occupant diagnosed with multiple chemical sensitivities and may have candida (taking medication). Allergies to food, petrochemicals, all solvents, new materials. Feels better outside and when away. Sensitive to chemical odours which are stronger when its hot.

Old house: occupant rents main floor of a 3 storey with basement, has problem with rug and underpad in one room and new vinyl sheet flooring and cooking. Works at home on computer. Occupant could smell perfume on walls from previous occupant. Occupant feels electric stove is breaking down chemically.

Planned improvements include: removing all rugs and underpads, refinishing wood floor with water-based, low-VOC finish, remove or seal new linoleum, repaint with low-odour latex paint, replace stove

Survey Date and Conditions: 4 August 1993, 4:30 PM, weather: broken cloud, light breeze

PHOTOGRAPH:

INVESTIGATOR'S OBSERVATIONS:

GENERAL:

- 6 rooms were surveyed in total - kitchen, bed 1, west front room, west back room, bath, laundry
- one bedroom apartment in an older home
- house in good condition
- oak parquet throughout older portion of apartment
- vinyl sheet flooring on parquet on 3/8 plywood in newer portion of apartment
- foam underpad in west side front and back rooms very poor and very smelly (laid over parquet flooring)
- true plaster on walls in kitchen, bedroom, west side front and back room
- windows: bay window in front room. Window in front, back, bath, and laundry are casement and fixed. Glass may be low-E. Excellent replacement windows.

ENTRY SMELL:
- very strong smell of underpad
- moldy, musty, chemical and plastic

BASEMENT:
- water trap is dry (potential air infiltration)
- basement walls completely insulated with exposed foam from floor to ceiling *NOTE building code infraction—see recommendations*

KITCHEN:
- range hood

BATHROOM:
- black mold
- tiles in bath, lifting and cracked
- fan, not well ventilated

LIVING ROOM:
- used as bedroom and office, contains computer

LAUNDRY:
- rattan throw rug in laundry
- walls appear stained from interior

MECHANICAL:
- baseboard electric throughout

EXTERIOR:
- solid brick building, may be double wythe

INVESTIGATOR'S SUGGESTED REMEDIAL ACTIONS

- Cover exposed insulation in basement to meet Building Code.
- Remove underpads and carpets from apartment.
- Consider repainting with low VOC interior paints, after washing to remove molds and fragrances from walls and ceilings.
- Replace kitchen stove.
- Consider installing through-the-wall ventilation systems.

FURTHER SUGGESTIONS OF THE PROJECT TEAM:

To completely remove fragrances from wall, must seal wall of block absorbed with VOCs and then paint with low VOC paint.

HOUSE SUMMARY: ON04

OCCUPANT SURVEY:

Occupant has allergies, chronic fatigue syndrome and candida, bothered by mold, dust, candida and ethanol, window cleaning chemicals, and boarder's after shave lotion. Occupant has been bothered by house since 1984 (moved in when house new). Feels better in summer and worse in fall.

10 year old house: two storey detached, located in suburban development, some renovation between 1987 and 1992. Occupant doesn't know if renovation had negative impact on health. House is dry in winter—use humidifier, water condenses on windows, basement floods through window when rains. Basement humid and damp in summer, many stored items in basement.

Survey Date and Conditions: 21 January 1994, 4:30 PM, weather: broken cloud, light breeze

PHOTOGRAPH:

INVESTIGATOR'S OBSERVATIONS:

GENERAL:

- 9 rooms/areas were surveyed in total - family, office, hall, main floor, master bed, bed 1, bed 2, bath, and kitchen
- large quantities of fabric, lots of synthetics—curtains, carpet, upholstery
- lots of particle board products and materials, aspenite subfloor
- long pile carpet is 9 years old
- water marked plaster in family room, office, & hall located in basement

- occupant not pleased with windows—have air leakage, don't slide. All tracks were replaced 2 years ago with vinyl tracks

ENTRY SMELL: - no noticeable smells, investigator noted "has natural gas heat and DHW", pet odour not indicated but "has dog"

BASEMENT:
- water enters basement through window well, evidence of moisture damage on basement walls
- conditions exist for mold problems but no evidence of it
- finished basement, "sonoflex" ceiling tile, recessed lighting
- may be condensation on poured concrete walls

BATHROOM: - powder room fan working, no other fans work

KITCHEN: - vinyl sheet goods glued to floor, discoloured by sunshine

MECHANICAL:
- forced-air natural gas heating with a standing pilot light, gas water heater with a standing pilot light
- exterior fresh air supplied to the return duct of furnace
- dryer located in mechanical room 1 metre from furnace
- empty dehumidifier every second day in summer
- filters changed every month in furnace

EXTERIOR:
- vinyl siding with brick front, zero clearance chimney with a brick chase
- good slope away from house
- attached garage
- dryer exhaust at front. Kitchen exhaust blows to rear of garage
- tar foundation coating

INVESTIGATOR'S SUGGESTED REMEDIAL ACTIONS:

- Remove any sources of fragrance.
- Remove synthetic carpet and other synthetic fabrics.
- Concern about basement—may be a good environment for mold and biological growth. Stripping basement to ensure quality of dampproof course and vapour barrier would be desirable, however, unlikely due to existing investment and level of finish. Could address problem by installing ventilation system and intentionally depressurizing basement with appropriate concern for backdrafting and soil gas entry.

Further Concerns:

1. Exterior fresh air supplied to the return duct of furnace. This is probably pressurizing the basement and contributing to moisture problems, however, it is also probably preventing furnace backdrafting.
2. Concern regarding close proximity of dryer (in mechanical room 1 metre from furnace) to cause significant backdrafting of furnace and DHW should airtightness of building envelope be improved

FURTHER SUGGESTIONS OF THE PROJECT TEAM:

Seal the subfloor and install hard flooring where particle board subfloor is currently covered in carpeting.

HOUSE SUMMARY: ON05

OCCUPANT SURVEY:

One occupant has problems including: environmental illness, food intolerances, allergies to molds, migraines, and other problems. Some other members of the family are affected but to a lesser degree. Respondent feels better outside except bothered by pollen, fertilizers, temperature inversions, auto exhaust. Lived in house more than 11 years, first bothered by house in 1988.

Older house (1950s): split level with basement in urban area on busy road near school, modified sashless slider windows, cedar off-gases 11:00 to 3:00 during sunny days. Occupant works out of home. "Son and husband are complete do-it-yourselfers and do all projects (building renovation in the house)". Renovation: basement finished 1988, and kitchen 1991 both had negative impact on how occupant felt. Ensuite bathroom renovation in 1989 improved how occupant felt. House dry in winter—occasionally use humidifier, water occasionally condenses on windows. Basement has flooded four times, water comes through kitchen wall in heavy rain. Items stored in basement smell moldy—many items stored there and daughter's bedroom in basement.

Planned improvements include: identify and removing pollution sources

Survey Date and Conditions: 20 February 1994, 3:00 PM, melting snow with light rain

PHOTOGRAPH:

INVESTIGATOR'S OBSERVATIONS:

GENERAL:

- 8 rooms/areas were surveyed in total - living/dining, kitchen, master bedroom, master bath, basement, laundry, exercise, bed 1 & 2.

- lots of snow accumulation but does not appear to be a drainage problem
- suspect high leakage through potlights in ceiling—high level of infiltration and exfiltration through building envelope
- storing remains of relative's estate in basement including upholstered furniture and carpet
- garage renovation connected main house to basement
- according to occupant: house used to be much better place before renovation
- smell of exterior grade caulking and cedar siding used in addition entered building easily through wall
- street quiet during inspection (Sunday) although bus route. Occupant complained of exhaust entering house through sashless sliders and high levels of dust from road. Traffic was moderate to busy. Air quality was better than average during inspection.
- presumed wall structure: wood frame 2 x 4 with brick veneer. Likely tarpaper (1950's construction), fibre insulation, plaster interior. No air or vapour barriers.
- plywood subfloor throughout, painted in exercise room at back of garage
- over 200 lights in house. Constructed in 50's by an electrical contractor for self

ENTRY SMELL:
- lower levels are somewhat chemical
- inspection day very pleasant and the house was aired out. Very "fresh" on upper floors

BASEMENT:
- basement not connected to house originally
- occupant complained of mold in basement
- lots of stuff stored in basement including chemicals, renovation materials, stored furniture
- plumbing problem caused basement to fill several inches deep once
- vapour barrier only in new construction
- some metal track with moisture damage from overflowed sink
- wall structure--2 x 4 brick and stone veneer, OK for rot and damage
- stuff (books) brought up from basement moldy
- significant route for contaminant entry from garage to basement under the floor of the laundry room

KITCHEN:
- thin-set mortar tile floor
- new drywall installed when kitchen renovated
- addition is sided in cedar facing south which heats up during day and off gases into home as a result of high infiltration
- 300 cfm fan in kitchen ceiling installed to remove cooking odours
- down draft range disconnected because of wood smoke from outside and oven smoke not properly exhausted
- very clean—use borax powder
- water filter: charcoal and aqua pure

BATHROOMS:
- master bath painted and sealed with crystal aire
- tile floors
- fans in each bathroom
- bathrooms very clean

LIVING ROOM:
- occupant complains about foam living room furniture
- oak floor recently refinished
- large fixed windows (1/2 inch airspace thermopane) with sashless sliders below
- stone fireplace feature wall

BEDROOMS
- upper (bedroom) floor is covered in pile carpet with chip foam underpad
- bed 1 has portable electric heater (moldy—was in basement)

ATTIC:
- two attics very difficult to access. Daughter's clothing required removal

LAUNDRY:
- built into one bay of original two car garage
- platform frame floor laid on top of original garage slab
- water leaks into this area through original garage door location
- fumes and moisture circulates under floor into existing house
- vinyl floor has moisture damage at door
- humidity in laundry room causing blistering and peeling of paint

MECHANICAL:
- high efficiency, seal combustion boiler is to be installed
- several fans in living and kitchen
- four window-mounted air conditioners (potential for mold)
- portable humidifier in occasional use
- dehumidifier runs all summer. Quantity removed unknown but high—drains to floor drain
- several portable air cleaners

EXTERIOR:
- air exhausts intentionally blocked
- neighbour at back of lot very close (6 metres)
- air intake and kitchen exhaust and exhaust of baths and kitchen all go through roof
- two layers of asphalt shingles on roof, masonry chimney, gutters OK
- not much growing against building
- kitchen addition has cedar siding, rest of building covered in brick with stone features
- outdoor carpet on steps saturated (potential for mold)
- water seal on cedar

INVESTIGATOR'S SUGGESTED REMEDIAL ACTIONS:

- Replace backdrafting furnace with a new high efficiency boiler.
- Solution to high air infiltration: properly seal all potlights and penetrations of ceiling (ensure insulation not touching potlights—could cause fire); improve air tightness of windows.
- Remove to external storage all chemicals, renovation materials, and furniture stored in home.
- Remove carpet and underpad on bedroom level.
- Install exterior quality doors between laundry room and house (2 locations: at stairs and at exercise room).
- Install a ventilation system.

FURTHER SUGGESTIONS OF THE PROJECT TEAM:

Repair source of garage leak

When renovating, occupants should use hard finishes and architecture that permits optimal air movement.

HOUSE SUMMARY: ON06A

OCCUPANT SURVEY:

All occupants have environmental illness, intolerances, allergies to molds, javex, soap, smoke, rotting wood, react to perfume, plastics, glues, paints. Feel better outside except have phobias and anxiety. Problems observed immediately when moved in. Occupied less than one year.

New house: construction started in 1980 but gutted and rebuilt in 1990 by owner/builder and sold to current occupant, storey and a half, situated in a rural area in a damp bush, stream in spring, basement flooded in spring. Have pets. Pests: mice in basement, bats in attic.

Planned improvements include: grading site.

Survey Date and Conditions: 27 JULY 1993, 11:00 AM, damp drizzle

PHOTOGRAPH:

PHOTOGRAPH UNAVAILABLE

INVESTIGATOR'S OBSERVATIONS:

GENERAL:

- main floor platform consists of an original cabin platform with an extended platform added
- looped rubber backed carpet on plywood, moldy, soil-build up, smells
- subfloors—not tongue and groove and some joists inadequately supported; 12" OC—some gaps to upstairs
- exterior walls: hardboard paneling with a composite with vinyl coat, discontinuous poly, 3.5" glass fibre batts between 2x4" studs, two layers 0.5" tentest, 0.25" exterior hardboard siding. Above 8' mark walls appear to be 2.5" thick and are of indeterminate construction. Condensation on inside of exterior wall board and batts. Rug in wall.

- no baseboards—masking tape
- cathedral ceiling areas are not vented, may not have a continuous air/vapour barrier and has an unsealed (T-bar) surface
- ceiling fan controls heat and contaminant distribution
- plumbing and wiring penetrations not sealed—septic gas enters dwelling due to improper piping and stack installation
- windows: front window 6x6 homemade thermopane without a frame,—minor black around glass edges, no seals, no weather stripping, no ext/int caulk. Other windows single pane and not all operable. Natural lighting low due to trees.

ENTRY SMELL: - cooking

BASEMENT:
- on solid rock—slopes approximately 30° from back to front
- floor solid rock with water pools, walls mortared to rock
- front and part of side walls—mortared round stone
- back and part of side walls—2x8 pressured treated wood framing
- 1" styrofoam covers most walls. Log posts set into stone walls
- rock wool behind joists. 2x6 joists, posts wet
- outside door-barnboard, unpainted, sill flat to dirt
- no overhang, not caulked, weather stripped
- first impression very moldy, air movement from basement to first floor is substantial
- water filter in basement—cartridge sediment etc changed, black
- particle board subfloor ceiling, water damaged (delamination, grey mold)
- no ventilation except 1 partially opened window. Wet floor, no drainage
- mice in basement

Comment: *"walls are probably not structurally safe and are water saturated, therefore they should be replaced as necessary upon structural inspection.*

NOTE: The structural integrity of the building frame should not be assumed. Work should proceed with unusual caution and an extra degree of support when wall sections are removed. "

KITCHEN:
- washer, dryer, fridge, freeze
- no exhaust fan
- circuit breaker at base of mast, 6" from fridge, no cover, maybe 100 amp
- was propane pipe, disconnected
- fridge evaporation pan inaccessible; heat sink clean; electric hot plate;
- countertop: post formed, stainless steel sink, laminate cupboards

BATHROOM:
- no exhaust fan
- alum/wood jalousie window, two pane
- vanity-chemical smells
- penetrations not sealed
- vinyl tub enclosure-cracked; steel tub
- floor: plywood on chipboard

LOFT :
- fly carcasses
- smells moldy behind panelling, no vapour barrier
- windows not sealed to wall, "wet" (winter), windows painted shut
- 1 oil-filled radiator
- attic has fibreglass batts on poly on dropped fibreglass-vinyl

ATTIC:
- flying bats in attic
- no access to underside of roof
- no vents into attic-continuous soffit vent but no gable or peak—can't tell if open

MECHANICAL:
- electric baseboards: turned to lowest, some not operable
- woodstove: low efficiency, plate, no door gasket, cracked fire brick, metal floor guard, wall guard of light gauge, no insulation—occupant commented on backdrafting
- chimney: 2 wall black steel, no flashing installed, substantial build-up of creosote on wall and ground, floor and wall shields inadequate and unsafe *NOTE building code infraction see recommendations*
- dehumidifier in basement—don't use

EXTERIOR:
- hardboard siding
- tree directly over chimney and trees down hill/down wind of chimney
- chimney cut into overhang, not flashed; creosote buildup on eaves trough, siding and ground—creosote flakes on ground 1.5" deep
- wood windows; small drip caps not extended over ends, side flashing not caulked
- metal roof, aluminum soffit and fascia; metal roof not straight—water can penetrate under overlap joints, does not overhang but flashing; some eaves trough—not adequate
- no vents at peak, no gable, continuous vent soffit.
- foundation not all on granite; tar coating of foundation
- compost pile away from house

INSPECTOR'S COMMENTS

"The site is inherently damp and therefore even a new home designed for sensitive people would not necessarily be satisfactory in this location. The building does not conform to Code or to standard building practice. Although the building can be substantially improved, the consultants stress adequate improvements will be expensive and are not likely to be fully satisfactory. Reconstruction will be extensive and would necessitate the billetting of the clients off site for approximately two months. The work entails additional health and safety risks to the contractors over standard work and requires specialized knowledge and/or supervision. The extent of the remediation work will result in significant use of new materials which may affect the occupants when they return. The significance of the mold problem may be masking the probable effects of the particulate and volatile contaminants (fibreglass and combustion). Dry walling and replacing insulation will contribute most to this load."

INVESTIGATOR'S SUGGESTED REMEDIAL ACTIONS:

Numbered actions indicate priorities as identified by investigator

Basement: Note comment under Basement above

1. - Replace wood walls with block and seal with cementitious waterproofing; excavate exterior and install a french drain around perimeter; also advise surface ditching approximately 15 feet above wall.
2. - Repair ceiling joists as necessary; seal penetrations with polyurethane foam and appropriate silicone caulk. Check cedar logs for integrity of material, fastenings, load bearing capacity and support bearing surfaces. Coat or replace and coat underside of main floor subfloor with a water borne sealant
3. - Install six inches of washed gravel with a heavy poly barrier and a slab—requires two levels and a knee wall; treat walls with cementitious coating; waterproof floor with coating to be determined; test and mitigate for Radon, if necessary
4. - Insulate either walls or ceiling of basement with styrofoam SM or equivalent or rockwool depending on satisfactory performance of moisture and water control methods
   - Repair plumbing drain pipes
   - Raise door threshold above grade

Main Floor and Loft:

5. - Determine bracing/tie in of roof /wall structure before any work is started on building
6. - Bring woodstove chimney installation up to Code, add gaskets to woodstove if required

7. - Remove carpeting, repair subfloor to ensure air and water vapour tight
   - Inspect integrity of poly/insulation in wall cavity—repair as needed
8. - Provide roof ventilation, air/vapour barrier and sealed surface for cathedral ceiling and hung ceiling
9. - Seal all wall and ceiling penetrations, including around windows
10. - Replace T-bar ceiling with drywall or sealed panels
    - Make all windows operable
    - Seal underside of kitchen and bathroom counter tops
    - Repair/replace electric baseboard heaters

Exterior:

11. - Remove tree(s) adjacent to chimney to reduce down drafts and
12. - Remove metal roof, straighten, strap and ventilate
13. - Install and extend eaves trough around house, move and replace down spout
    - Install proper drip caps on all windows and doors
    - Check tentest and insulation for biological contamination, replace with rockwool as necessary
    - Repair deck railing at front door

FURTHER SUGGESTIONS OF THE PROJECT TEAM:

One of the investigators of this building, a trained fire fighter, identified a definite fire hazard with the creosote on the chimney —this must be rectified immediately.

Put cover on circuit breaker at base of mast in kitchen and inspect all electrical installations for Code violations.

In the view of the two investigators who visited this home, the structural viability of this building is questionable. The solutions suggested must be undertaken keeping in mind that the structure may not be sound. These concerns have been communicated to the Project Officer at CMHC and the Project Team assumes no liability.

HOUSE SUMMARY: ON06B

OCCUPANT SURVEY:

All occupants have environmental illness, intolerances, allergies to molds, javex, soap, smoke, punky wood, react to perfume, plastics, glues, paints. Feel better outside except phobias, anxiety. Occupants had symptoms before moving into this building and problems were observed immediately when moved in. Occupied less than one year.

House: Construction started in 1980 but gutted and rebuilt in 1990 by amateur owner/builder and sold to current occupant; storey and a half, situated in a rural area in a damp bush area on a side of a steep bedrock hill with run off going to building, stream in spring, basement flooded in spring. Have pets. Pests: mice in basement, bats in attic.

Planned improvements include: grading site, draining away from building

Survey Date and Conditions: 27 JULY 1993, 11:00 AM, damp drizzle, 24°C, 67% RH

PHOTOGRAPH:

PHOTOGRAPH UNAVAILABLE

INVESTIGATOR'S OBSERVATIONS:

GENERAL:

- 7 rooms/areas were surveyed in total - basement, living, sewing, bath, kitchen, loft, bedroom.
- tree cover prevents air circulation
- windows: mix, single hung, mostly wood framed, home made; several low grade single pane windows (frost in winter and water damage); rain caps suspicious
- synthetic woven carpet throughout main floor and loft in poor condition and moisture damaged

ENTRY SMELL:
- stuffy fabric combined with moisture; moldy, musty, damp, dusty, earthy

BASEMENT:
- entry into basement: pine door—wet; pressure treated (PT) casing on cement, air leakage, no weather stripping
- PT window frame, insulated glass, wood frame good condition (dry)
- exterior wall: half stone and half plywood, half pillars on earth mounds
- basement wet all the time
- wood posts in poured cement or cement attached
- standing water on bedrock-no drainage; exposed earth, portion of floor covered by wood—soaking wet
- blue-brown spores, advanced wood rot in entire basement; evidence of slugs and mice
- partial covering of 1" blue styrofoam, not sealed

MAIN FLOOR
- wall structure--hardboard siding-1/4", 2 layers 1/2" tar coated wall board, no drip cap (basement gets wet)
- floor: major structural problems—damp, spongy, dusty, greasy, sticky, blue mold

KITCHEN:
- beamed ceiling with stucco in between, no paint
- hot plates, large toaster oven
- activated carbon water filter, reported to have been recently changed

BATHROOM:
- ceiling: factory finished 2 x 4 sheets on steel track (hung ceiling)
- bath window: aluminum awning type
- baseboard heater

LIVING ROOM:
- ceiling fan with light in living room
- ceiling: factory finished 2 x 4 sheets on steel track (hung ceiling)
- window: awning-no-opening thermopane picture window with wood frame

LOFT:
- hardboard composite walls in both upstairs rooms-vinyl covered
- one vinyl slider window in bedroom
- oil-filled portable electric heater in bedroom
- closet in bedroom over full and stuffed with plastic tote boxes (gassing off?)—many stored items of stuffy nature

MECHANICAL:
- dehumidifier used in basement to no avail
- woodstove and electric baseboard
- oil-filled portable electric heater in bedroom (loft)

EXTERIOR:
- no gutters on west side
- foundation backsplash—wet
- minor weed growth; major maple, oak foliage growth over house (makes canopy over house; debris/brush piles—moderate
- exterior sheathing: composite hardboard with baked-on enamel in good condition
- doors: steel, poly insulation X2
- steps: PT wood—wet
- roof: some leakage on north side; bend in roof, improper installation, no flashing at roof angle; soffits: aluminum
- chimney: ***Definite fire hazard***—metal, creosote on outside everywhere; no flashing on chimney
- vents: soffits only; 1 1/2" ABS vent pipe on exterior of building (strongly suspect plugs up in winter due to condensation)
- air exhausts—none except perhaps steel ridge cap
- foundation coating—none; tar on PT plywood
- deck--green, discoloured brown PT in average shape

Physical effects of investigation on inspector: Sore throat, nausea and dizziness as result of inspection.

INVESTIGATOR'S SUGGESTED REMEDIAL ACTIONS:

- Serious potential structural and health problems are associated with the building, it would be difficult to justify the amount of repairs necessary to bring the building up to an acceptable state. It should be replaced.

FURTHER SUGGESTIONS OF THE PROJECT TEAM:

One of the investigators of this building, a trained fire fighter, identified a definite fire hazard with the creosote on the chimney —this must be rectified immediately.

Put cover on circuit breaker at base of mast in kitchen and inspect all electrical installations for Code violations.

In the view of the two investigators who visited this home, the structural viability of this building is questionable. The solutions suggested must be undertaken keeping in mind that the structure may not be sound. These concerns have been communicated to the Project Officer at CMHC and the Project Team assumes no liability.

HOUSE SUMMARY: ON07

OCCUPANT SURVEY:

House occupied by one person, affected by sugar, additives, grains, moldy places, new materials. Feels better outside, bothered by gas furnace, feels worse in winter, feels worse in basement. Feels better in summer—away from house. Vacuuming and cleaning trigger symptoms.

Old house: approximately 60 years old, semidetached two storey with basement, large urban area near busy road. Gas furnace not used—uses portable oil-filled radiators for heat. Drop ceiling in bathroom hole exhausts to flat joist space, old original windows. Basement has flooded and roof leaks, middle bedroom ceiling collapsed from water damage. Uses dehumidifier in basement. Occupant lived in house 11 years—bothered by house since first moved in. Occupant rarely vacuums house. Recent renovations include: removal of carpet and refinish floors.

Planned improvements include: add central vacuum system; install exhaust fan in bathroom

Survey Date and Conditions: 12 November 1993, 12:00 noon, moderate overcast, warm fall day

PHOTOGRAPH:

INVESTIGATOR'S OBSERVATIONS:

GENERAL:

- 7 rooms/areas were surveyed in total - basement, living, kitchen, bed 1, bath, bed 2, bed 3
- double brick walls, no air or vapour barrier, feel cold
- windows: storm windows in basement, living, bed 1/2 and bath; frame or sill feel ok in basement, living room, kitchen, and bed 1

ENTRY SMELL:
- slightly stale—substantial improvement over last visit

BASEMENT:
- strong smell of mold
- sealed clean out, open trap
- some gypsum plaster on walls; some polystyrene behind walls and exposed polystyrene insulation in basement
- floor feels cold and damp
- washer, dryer
- dust accumulation, dirty, earthy, moldy, musty, damp

KITCHEN:
- recently renovated ceiling
- fridge motor, evaporation pan, heat sink dirty
- water filter—distiller

BATHROOM:
- recently renovated ceiling
- mold visible behind cabinet
- tile on tub wall
- old gravity exhaust but no pipe to roof

LIVING ROOM:
- floor recently refinished
- new paint on walls
- has old furniture, sauna, carpets on stairs, file cabinets, art materials, bookcases

BEDROOMS
- master bedroom over verandah, dusty
- middle bedroom recently painted
- back bedroom—strong smell of wood, stale, paint discoloured, built-in plywood bed frame
- oak floors in bedrooms—2 good, 1 fair condition

ATTIC:
- attic hatch sealed—partial attic, roof flat
- fibreglass batt insulation in both flat roof space and attic; batts were water damaged in the flat section due to long term leak
- flat roof not vented
- static bathroom vent discharges into the roof cavity (powered unit previously vented into cavity but has been removed)
- batt insulation and ceilings water damaged—some repaired

MECHANICALS:
- low efficiency gas furnace not used—uses portable electric heaters, radiator type
- air filter used for 6 months—may be overloaded and contaminated
- A/C used in summer, uses fan of furnace
- dehumidifier with drain tube

EXTERIOR:
- sheathing is wood shingles/asphalt shingles/double brick
- wood windows, some deterioration; sills rotten
- asphalt shingles to wall back-cedar side top 1/2
- mostly flat roof, average pitch in front; asphalt shingles on front roof, tar on back roof; flat roof no overhang (6" from wall, 0" over fascia)
- paved area between units
- one down spout to sub drain, 1 to lawn
- 1 roof vent, no soffit vents
- front porch closed in at bottom
- no lawn—interlock and ground cover
- brick chimney
- air exhaust clogged with lint

Physical effects of investigation on inspector: Itchy chin in all rooms; teeth (ache?); headache in beds 2 & 3.

Inspector's Thoughts on Primary Problem in House:

- moldy basement, packed with junk
- moldy flat roof cavity, no vents, vapour barrier
- low light levels
- residual odours from previous tenancy still noticeable after many years

Inspector's Thoughts on Secondary Problem in House:

- lifestyle—although much recovered from last visit, still unable to tackle a full cleanup; two sons have moved out—considerably lessening the emotional and physical load

Inspector's NOTE:

Without the furnace being used, no air is being exhausted from the basement, therefore, even though the electric heat was better for the occupant, the increased mold and moisture in the basement is a countervailing factor. This same phenomenon is noticeable where condensing (sealed combustion) gas furnaces have replaced older units and where furnaces have been changed to sealed combustion units but the domestic hot water has not been changed. This also results in an increase in backdrafting.

INVESTIGATOR'S SUGGESTED REMEDIAL ACTIONS:

Primary:

- Clean out basement and discard unused stored ; add back check valve to drain; cement over dirt section; paint floor and walls with waterproof coatings; shut off gas; tape duct joints.
- Weatherize building.
- Ventilate attic.
- Install central vacuum system—occupant can't vacuum due to exposure, therefore, house dust becomes a major contaminant.

Secondary:

- Replace flat roof with peaked roof.

Occupant had already undertaken some remedial work after an earlier investigation by the same inspector. Inspector noted: House was much better after 1) boys moved out, 2) floors stripped and coated, 3) walls painted. Paint on walls had dried to no odour level, however when room left unheated and closed, odour was apparent upon entry. Occupant has improved nutrition.

Occupant was using sheet metal on basement as a geomagnetic barrier—condensation was occurring below.

FURTHER SUGGESTIONS OF THE PROJECT TEAM:

A major clean up would benefit the occupant. House should be thoroughly cleaned for molds. After fixing the basement and making the house airtight, a ventilation system could be considered.

HOUSE SUMMARY: ON08

OCCUPANT SURVEY:

Occupant has allergies to molds, insects. Feels better outside, bothered by cleaning, winter, when wet and closed areas (closets), kitchen worse. Lived in house 26 years. Occupant has noticed improvement in health since removing woodstove.

154 year old house: rural area near farms, 1 1/2-storey with basement, vertical plank and batten construction, settling, water damage in roof, old linoleum floors, dense cedar brush against house, woodstove removed in 1991, forced-air electric furnace with electric baseboards in kitchen, furnace filter changed once a year, burning dust odour when furnace turns on, cover windows with poly in winter, use heat pump to cool in summer, sump pump

Survey Date and Conditions: 27 September 1993, 10:00 AM, clear, calm and dry

PHOTOGRAPH:

INVESTIGATOR'S OBSERVATIONS:

GENERAL:

- 6 rooms/areas were surveyed in total - kitchen, living, bed, bath, upstairs, basement
- floor/subfloor: pine planks laid on joists
- wall sandwich: 2 x 12 vertical fir planks and 1 x 3 fir battens; covered clapboard, insulbrick, aluminum clapboard and some cedar shingles, some new board and batten (pine) installed under CMHC RRAP
- windows: 3 'x 4', single glazed; frame, sill feel ok; wood storms—all rooms except basement
- overall impression of natural lighting—dark, few windows, heavy cedar foliage

- pests: evidence of mice/flies/spiders/chipmunk
- barn smelled of rotting hay

ENTRY SMELL:
- moldy, musty, damp, earthy, wood smell and soap smell
- cupboards: soap smell
- cedar log furniture: cedar smell

BASEMENT:
- mold, damp, dirt (floor) smell, dusty
- floor: half unpainted concrete and half dirt—fair condition
- half height basement: rubble foundation wall and dirt crawl space—feels damp, cold, spongy, dusty
- basement window well filled in rotten—wet
- sill plate rotten, missing in some places—open to outside

KITCHEN:
- moldy, dusty, entry walk off mat: dog smell
- pine 1/2 log (slab) on walls and wainscot

BATHROOM:
- fragrant, soap smell
- walls: plaster on fir boards
- no exhaust fan

LIVING ROOM:
- walls: plaster on fir boards, painted and wall paper—discoloured, blistered, peeling, faded and water marked
- painted plaster ceiling discoloured and water marked
- ceiling fan and free standing fan

BEDROOM:
- musty
- walls: plaster on fir boards, painted—discoloured, blistered, peeling, faded and water marked

UPSTAIRS:
- musty, dusty, wood smell
- 2 x 4 spruce partitions with lauan mahogany sheet panelling
- polyethylene vapour barrier—poor condition

ATTIC:
- all rough wood wall boards—watermarked top and bottom
- attic hatch: unsealed board
- insulation: old, white rockwool (mineral wool)
- gable vent may be blocked; vents probably blocked

MECHANICAL:
- wood stove removed in 1992
- forced air electric air-to-air heat pump
- chimney: deteriorated, creosote stained—leak to indoor air quality
- portable electric heater in kitchen (supplementary)
- electronic air cleaner—not working
- chlorinated polyvinyl chloride (CPVC) plumbing pipe

EXTERIOR:
- slopes away from house but sill plate is buried
- down spout extended and ditched away from house
- gutters: clogged with heavy foliage—no maintenance; lawn not cut—long; heavy cedar and natural grape vines growing on or against building, also maple and spruce trees; site: shady
- sheathing: some new board and batten, mostly aluminum clapboard, some old insulbrick
- stone steps
- roof: old layer of cedar shingles covered in steel, starting to rust, nails popping—not all sealed—some holes (siliconed); watermarks indicating roof leakage; rotten soffits
- windows ok; exterior sills rotten; exterior paint peeled on frames of windows
- rubble foundation in fair condition

EXTERIOR *con't*
- exterior of kitchen-- no foundation, log on grade 2 sides, north side—poured sill, fell over, open
- two chimneys: brick; heavy creosote—several fires; cracked, smells
- old paint
- no tile/drain
- decaying, unattached garage

Physical effects of investigation on inspector: mild asthma, stuffed up nose (caused by mold and house dust?)

Inspector's Thoughts on Primary Problem in House:

- mold dominant problem
- exposed wood second problem
- cedar trees
- house dust, clogged furnace filters
- rotting sill plate on grade with no drains
- no or failed eaves trough (just added new)

Food allergies may be a significant underlying problem. Occupant has improved significantly since RRAP repairs (primarily air sealing and removal of woodstove)

Inspector's Thoughts on Secondary Problem in House:

- no vapour barrier/weather seal from unvented basement crawl space
- no basement tile or drain
- roof needs to be replaced, upstairs walls need to be replaced

INVESTIGATOR'S SUGGESTED REMEDIAL ACTIONS:

Primary:

- Ventilate basement (to reduce mold).
- Replace upstairs walls.
- Remove cedar hedge.
- Replace sill plate, however, this will be very difficult since vertical plank walls.

Secondary:

- The house is 156 years old and of unusual construction. It would be difficult to restore without lifting and a installing a foundation. Covering the entire dirt floor with polyethylene is not feasible.

FURTHER SUGGESTIONS OF THE PROJECT TEAM:

Seal crawl space from rest of house.

Remove molds in basement using proper procedures. Lime wash wooden beams in basement.

HOUSE SUMMARY: ON09

OCCUPANT SURVEY:

Both occupants bothered by house, have candidiasis, allergies to dust, molds, and new materials. Feel better outside, bothered more in winter; one occupant bothered more in summer. Family room specifically causes difficulties. Lived in house 8 years, have a dog. Hobbies include carpentry, woodworking, painting, photography and others.

26 year old house: 1 1/2-storey with basement and crawl space, located in suburban area near rural area on filled swamp land near pond, renovations include sun room, removal of wall, new bathroom and kitchen, new vinyl-framed windows, new carpet 8 years ago. 25 year old forced-air gas furnace, course washable furnace filter cleaned every 6 weeks, natural gas heated DHW, electric heated hot tub, air conditioning, central humidifier. Basement damp in summer, efflorescence on wall. Have used pesticide to kill ants—affected by use of herbicides.

Survey Date and Conditions: 14 January 1994, 8:30 AM, cold and dry winter day

PHOTOGRAPH:

INVESTIGATOR'S OBSERVATIONS:

GENERAL:

- 12 rooms/areas were surveyed in total - kitchen, living, dining, bath, bedrooms 1 to 4, basement, workshop, sun room, family
- wall/ceiling junction is darkened—moisture trap—throughout top floor
- windows: most double glazed side sliders, triple glazed fixed in sun room; all clear but 2; most PVC frame, some aluminum. Minor amount of black around glass edges and mold on frame of a couple of second floor windows; some frost on panes but -20°C; Frame/sill felt minor damp on a couple

- woven synthetic carpet in living, dining, bed 1, bed 4, basement, family rooms with latex underpad in fair to poor condition—all smell of pet damage

ENTRY SMELL:
- no distinguishable smells on entry—dog/mold/hot tub/carpet
- pool chemicals (bromine) from hot tub

BASEMENT:
- mold smell
- finished office (strapped and panelled with prefinished mahogany), unfinished workroom and crawl space
- hardwood, sawdust and paint smell in workroom
- concrete dust in crawl space
- exposed insulation in basement—joist cavity ends
- water trap is failed—backdrafting air into hole
- sill plate not sealed—no cap
- hollow block walls in basement

KITCHEN:
- renovated in 1986 and problems started
- ceiling-mounted exhaust fan discharges to attic
- fridge tray no cleaned

BATHROOM:
- exhaust fan

LIVING/DINING:
- pet odours

SUN ROOM:
- moldy, earthy smell; bromine smell from hot tub
- hot tub located in sun room—has cover
- loaded with plants-open to rest of house
- floor: cement pavers over limestone fines and styrofoam
- ceiling: unsealed polyethylene vapour retarder
- exposed pressure treated wood window frames
- portable electric heater, ceiling fan

FAMILY ROOM:
- fireplace—poor draw—wood smell/creosote

ATTIC:
- all wall/ceiling corners darkened—moisture damage
- several roof vents into attic; some new
- soffit vents: new, aluminum—add-on, no provision for transfer so inadequate air movement
- vents possibly blocked by insulation, definitely - covered by new soffit
- ceiling-mounted kitchen stove exhaust: vents into attic, seldom used but constant leakage

MECHANICAL:
- low efficiency, forced-air gas furnace
- air return duct for main floor only
- drum humidifier on furnace

EXTERIOR:
- minor growth against building; mix of few flowers
- flat slope with down spouts onto ground
- attached double garage
- no drip caps on windows
- aluminum exterior sheathing
- low slope roof with asphalt shingles in fair condition
- trim in fair condition; soffits ok
- brick chimney and cap ok
- foundation coat-old tar
- wood for woodstove piled near house

Physical effects of investigation on inspector: minor pet effects, minor wood dust

Inspector's Thoughts on Primary Problem in House:

- renovations apparently led to sensitizing exposures (urethane)
- high water table and flat lot—soil moisture content and organic content may be very high
- moisture damage in wall cavities and, therefore, probably substantial (possibly quite toxic) biological contamination—probably infiltrates bedrooms in particular via unsealed baseboards, trim, outlets, etc.
- soil and sewer gas enters through basement floor drain
- vinyl window frames probably off gassing in summer
- stored and used volatiles (paints, etc.) and wood dust in basement permeates house
- installation of new soffits has covered old vents—restricting ventilation
- existing floor in sun room permits soil gas and biologicals to enter home, also contains molds from plants and bromine from hot tub
- mechanical system appliances probably backdraft to some extent
- bedding contaminated
- lifestyle factors: hobby exposure—failure to wear adequate filter and protective clothing; pet exposure

Inspector's Thoughts on Secondary Problem in House:

- no vapour barrier/weather seal from unvented basement crawl space

INVESTIGATOR'S SUGGESTED REMEDIAL ACTIONS:

Primary:

- Seal all wall penetrations including sill plate areas and all ceiling penetrations (attic hatch, pot lights).
- Install mechanical backcheck valve in basement floor drain.
- Provide adequate soffit ventilation.
- Check and, if necessary, seal wall/attic barrier between garage and house.
- Isolate sunroom from rest of house by replacing common window, weather stripping door, adding sweep and keeping door closed; also seal pressure treated wood and reduce mold growth by covering soil with sphagnum moss or charcoal.
- Vent kitchen exhaust to outside.
- Mechanically vent workroom to outside.
- Use mid-efficiency pleated poly/cotton-type filter in furnace.
- Use particulate mask and protective clothing when vacuuming and woodworking.
- Shampoo pets regularly and use treatments to allergenicity.

Secondary:

- If carpets removed, wash and/or seal floors to remove absorbed latex odours—avoid latex in new carpets, rugs, underpad.
- Install central vacuum vented to the outside.
- Vacuum and seal crawl space floor and wall.
- Replace furnace with high efficiency, sealed combustion unit and seal all duct joints.
- Use barrier cloth on pillows and beds to control dust mites.
- Wash fireplace with muriatic acid (using caution) and seal with foil covered styrofoam to stop creosote and wood smoke infiltration.
- Seal crawl space from rest of house.

FURTHER SUGGESTIONS OF THE PROJECT TEAM:

Because of the extensive remedial measures, owners may want to have the house tested for molds first to determine the level of mold in the house and if any toxic molds are present.

Seal and isolate the crawl space from the rest of the house. Cover the dirt floor in the crawl space with polyethylene and anchor it with sand or gravel.

Control internal sources of moisture (plants, floor in sunroom, humidifier). Measure the relative humidity in the house before using the humidifier. Dehumidify the basement in the summer.

Give consideration to re-building the sunroom floor and installing a vapour barrier, cement slab and ceramic tile. The pressure-treated wood should be removed from the sunroom interior. Other disinfection methods (such as using UV light) should be explored for the hot tub in order to reduce the use of bromine gas.

After making the house air tight, a central ventilation system should be installed to provide outside air to the cold air return of the furnace and to exhaust air from the basement, workroom, kitchen, bathrooms and sunroom. Air should be made to move from the house to the sunroom and not the reverse.

6.0 Results of the Surveys

Significant amounts of data were collected over the course of this research project. In an attempt to assess the information and to identify any trends or patterns, the raw material was compiled into tables and summaries.

Table 6.1 presents the Summary of Observations/Potential Problems Identified in the Homes surveyed. These observations were obtained from the Investigators' Reports and Checklists compiled for each survey and from the Occupant Surveys prepared by the occupants of the houses prior to the investigator visiting the house. The list of observations is not compiled in any order of priority; however, it does correspond roughly to the organization of the checklist.

It is important to note that, when examining the contents of Table 6.1, only the items ***observed and noted*** by the investigators or ***identified*** in the occupant survey are included in the table. It is not a complete listing of what does or does not exist in the house.

For the three houses visited by two investigators, the observations of the investigators are presented independently (for example, the first house in Nova Scotia, 01, was visited twice, resulting in investigations 01A and 01B).

Table 6.2 contains a Summary of the Responses of the Occupant Surveys. Because one objective of the project was to test the protocol on a wide variety of houses in a broad range of situations, there were no observable trends. The only common element to the surveys were that the occupants were diagnosed with a health condition (one of the prerequisites for inclusion in the survey).

Table 6.1
Summary of Observations/Potential Problems Identified in Homes

	House ID	Nova Scotia (NS)						Ontario (ON)										
	Observation/Potential Problem	***01A***	***01B***	***02***	***03***	***04***	***05***	***01A***	***01B***	***02***	***03***	***04***	***05***	***06A***	***06B***	***07***	***08***	***09***
1	moldy, musty, damp when enter house	X		X	X		X	X	X		X			X	X	X	X	X
2	chemical smell when enter house		X			X	X			X	X	X	X					
3	still air/stale air/poor air exchange	X	X	X	X	X	X				X			X	X			
4	cooking odours, stale odours in kitchen				X	X								X	X			
5	condensation/signs of mold growth on windows		X			X	X						X					X
6	closets on exterior walls	X	X	X		X	X											
7	humid, musty, mold, leaks in bathroom		X	X			X							X	X			
8	musty smell, mold, dampness in basement/crawlspace	X	X	X			X	X	X					X	X	X	X	
9	storage of clothes, paper, furnishings, perishable food, garden items in basement	X	X	X			X			X		X	X					
10	cracks/leakage in basement floor or foundation			X	X	X	X											
11	well/cistern in basement			X			X											
12	humidifiers, dehumidifiers				X		X	X	X			X	X	X	X	X		X
13	smell/use of scented soaps, air fresheners, fragrances, fabric softener, etc.		X	X	X	X	X	X	X	X	X	X	X		X	X	X	
14	new furnishings, new carpet, new flooring, new paint or wall covering	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
15	particleboard/wood composite materials (flooring underlay, shelving, partitions, panelling, cupboards)	X	X		X	X	X			X								
16	unfinished wood products					X	X											
17	vinyl and synthetic floorings and underpads				X	X												
18	flaking, peeling paint in older homes (lead)		X								X		X				X	

House ID	Nova Scotia (NS)						Ontario (ON)										
Observation/Potential Problem	01A	01B	02	03	04	05	01A	01B	02	03	04	05	06A	06B	07	08	09
19 house dust under beds, furniture, basement, other areas			X	X		X						X				X	X
20 cracks in above grade walls					X												
21 exposed insulating products			X		X	X	X	X		X	X				X		X
22 storage of chemicals in house (cleaning products, paints, petroleum products etc)		X	X		X												
23 use of gas/propane appliances (DHW, space heaters, stoves furnaces)																	
24 fireplace/wood stove	X	X	X						X		X			X			X
25 storage of firewood inside			X											X			X
26 smell/leaking of fuel oil				X	X	X											
27 furnace exhaust fumes					X							X	X	X			
28 dirty filters/clogged ducts in furnace, air cleaner, HRV etc.				X	X												
29 poorly located air supply (dryer vents)		X		X	X			X									
30 potted plants						X					X			X			X
31 pets of present or previous owners	X	X	X			X	X	X	X		X					X	X
32 hobby materials	X	X			X		X	X	X			X	X	X	X		X
33 restricted air movement/exterior of house		X	X	X								X	X	X		X	
34 attached garage/unheated space with inadequate separations	X	X					X	X			X	X					X
35 poor exterior drainage				X	X												
36 evidence of pests (bats, insects)						X							X	X		X	
37 external contaminants (smoke, traffic fumes)				X	X	X											
38 temperature main level	-	-	18°C	22°C	22°C	22.5°C											
39 humidity main level	-	-	61%	63%	60%	35%											

Moisture levels: Winter dry? *Y/N*	N	N		Y	Y		Y	?	Y	Y	Y	N	N	Y	Y-slightly
Use humidifier? *Y/N*	N	N		N	Y		Y	?	N	Y	Y	N	N	fish tank	Y
Water condensation on windows? *Y/N*	Y	Y		Y	Y		N	Y-Ba	N	Y	Y-occa	Y	Y	N	N
Basement floods? *Y/N/?*	Y	Y		N	N		N	Y-pipe	?	Y	Y	Y	Y	Y	N
Summer damp & humid? *Y/N*	Y	N		N	Y		N	N	N	Y	Y	Y	Y	Y	Y
Use dehumidifier? *Y/N*	N	N		N	Y		Y+A/C	N	N	Y	Y	N	Y	N	Y
Fuzzy growth or discoloration on walls, floor, furniture in basement? earthy smell in basement? *Y/N/?*	Y	Y		N	N		N	N	old, small amount	N	Y	N	Y	Y	Y-slight
Hang laundry to dry indoors? *Y-year round Su, Sp, F, W*	Y	W		N	Y			?						?	
Pesticide Use: pest problems? *Y/N/?*	Y	Y		N	N		N	N	N	N	Y	Y	Y	Y	Y
Use chemical pest control products in house? *Y/N*	N	N		N	N		once	N	N	N	Y	N	3 yrs ago	N	Y
Use pest/weed control products outside house? *Y/N*	Y	N		N	N		Y	N	N	Y	N	N	N	N	N, in past
Neighbours use pest/weed control products? *Y/N/?*	?	?		Y	?		Y	?	N	Y	Y	N	N	Y	Y
Observed impact on feelings from chemical application *Y/N*	?	?		Y	?		Y	Y	Y	Y	Y		Y	Y	Y
Household & personal product Use:															
Cleaning: *B–bleach, L–Lysol, Mr–Mr Clean, C–cleanser, E–Endust, W–Windex, A–ammonia, T–tile & tub, D–deodorizer, S–carpet shampoo, F–floor wax, V–vinegar, Bs–baking soda, X–borax, O–other*	Mr, C, W, V, Bs	Bs, X, O		Bs, X, O	B, W, Bs, X, O		B, V, S	V, Bs, X	X, O	W, S, F, V, Bs	B, S, V, Bs, X	V, Bs, O	B, V, X,	Bs	T, S, V
Laundry: *S–scented detergent, U–unscented, L–liquid softener, F–sheet softener, B–bleach, X–borax, O–other*	U, F, B, O	X, O		U, F, X	U, F, B, X		U, L, B,	U	X, O	U, L (El)	U, B, X	O	O	O	S, F
Kitchen: *S–scented dish washing liquid, U–unscented dish washing liquid, D–scented dishwasher soap, N–unscented dishwasher soap, O–other*	S, D	S, U		U	O		O	U, V	O	S, D	S	O	B, V	O	S, D
Personal: *B–scented bath soap, P–perfume, S–scented lotion, H–hair spray, A–air freshener*	S, P			none	none		none	none	none	none	B		none	none	S
Vacuum house: *D–daily, B–biweekly, W–weekly, L–less*	W	W		B	B/W		D	W	L	W	B	W	L	no	L
Use: *P–portable vac, C–central, Cv–central vented outside*	Cv	P		P	P		P	P, C	P	C	P	P	P	none	P
Mattress: *F–foam, C–cotton, S–coil/spring, W–waterbed*	W	F/C		S	F							S			
Change bed: *D–daily, B–biweekly, W–weekly, L–less*	W	W		W	W		W	W	W	L	B	L	W	W	W
Vacuum mattress: *C–when changed, B–biannual, A–annual*	B	never		monthly	never		plastic	?	2 mon	never	never	never	never	never	B
Pillow: *F–feather, Fo–foam, C–cotton, P–spun polyester*	P	Fo		P	F										
Dry clean clothes? *F–frequently, O–occasionally, N–never*	O	O		N	N		N	N	N	O	N	N	N	N	O
Bring dry cleaned clothes directly into house? *Y/N*	Y	N		–	–		–	–	–	Y	N	–	–	–	Y
Fans: *K–kitchen, B–bathroom, W–whole house, O–other (number indicates hours of use per day)*	B<1, W-24	–		W-24	–		K, B<1, HRV						A/C *occasionally*	furnace	B, furnace-24, A/C
Odours linger after cooking? *Y/N*	Y	Y		Y	–										
Other odours linger in house? *Y/N*	N	Y		Y	–										
Furnace filters replaced/cleaned: *B–biannually, A–annually, N–never, Na–not applicable*	Na	new		Na	2 mon								N	A	6 weeks
Ducts cleaned: *A–annually, O–occasionally, N–never, Na*	N	new		Na	once										
Clean baseboard heaters: *W–weekly, M–monthly, A–annually, N–never, Na–not applicable*	W	W		M	M			Na					?	?	
Heating system maintenance: *A–annual, B–biennial, N–never*	A	new		A	A								N		
Open windows to provide ventilation? *Y/N*	Y	Y		Y	Y		Y								
If yes, which ones and when: *M–most, B–bedroom, K–kitchen, Ba–bathroom \ U–usually, O–occasionally \ Sp, Su, F, W*	M-U-Su B-U-W	M-U-Su		M-O-all year	M-U-all year										
Items stored in house: *P–paint, S–shoe polish, I–insecticide, A–aerosol fixative, E–engine oil, V–varnish, H–herbicide*	P, S, I, E, A, V, H	P, S		P	S		S	–	–	S	P, S, I, A, E, V	P	P, S	S, I	P, S, I, V
Stored in basement: *C–clothes, S–shoes, X–boxes, T–toys, M–mattress, E–sports equip, W–wood, F–firewood, N–newspaper, B–books, P–paper, R–rugs/carpet, O–other*	C, X, E, B, P	F, root veg.		no basem't	X& unknow n items		C, M, B	C, X, T, E, W, B	C, S, E	X, T, E, N, B, P, paint, insecticide	C, S, E, B, P, R, daughter's bedroom	none	X, T, E, W, B, P		C, X, E, N, B, P, R

Table 6.2

Summary of Responses to Occupant Survey

OBSERVATIONS	NS01	NS02	NS03	NS04	NS05	ON00	ON01	ON02	ON03	ON04	ON05	ON06	ON07	ON08	ON09
All occupants of house suffer? *Y/N*	N, 1/4	Y, 2/2		N, 2/4	N, 3/4		Y, 2/2	N, 1/2	Y, 1/1	N, 1/4	Y, 4/4	Y, 3/3	Y, 1/1	Y, 1/1	Y, 2/2
Symptoms: *A–allergies, E–emphysema, L–lethargy, H–hypoglycemia, S–smells, I–environmental illness, O-other*	S	A	A	A, O	I, A		A, I, O	A, E, S, O	A, I, O	A, L, I	A, I	A, I, O	A, I, L	A, O	A, O
Diagnosed with a health condition? *Y/N*	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y
Identified substances cause problems? *F–food, M–mold, Nm–new materials, C–chemical, D–dust, N–none given, O–other*	F, M, C	F, M, Nm, O		F, M, Nm	F, M, Nm, C, O		D, M, O-*trees*	M, C, Nm, D, O	F, C, M, Nm,	F, M, C, D, O	F, M, C, Nm, O	F, M, Nm, C,	F, M, Nm	F, M, Nm, firewood	F, M, Nm, D
Are problems seasonal? *Y/N* Feel worse in: *Sp–spring, Su–summer, F–fall, W–winter*	Y Sp	Y Sp, F, W		N	Y Sp, Su		Y W	Y Sp, Su, F	Y W	Y F	Y Sp, **Su**, F	Y Su	Y W, Sp	Y W	Y W, Su
Feel worse inside house *Y/N/? (unsure)*	Y	?		Y	?		Y	Y	Y	?	Y	Y?	Y	Y	Y
Think house contributes to health problems *Y/N/?*	?	?		?	Y		Y	Y	Y	?	Y	Y	Y	Y	Y
Detect odour when enter house *Y/N*				N	Y			Y	Y	Y	N				
Rooms where problems worse: *A–all, N-none, K–kitchen, L–living, D–dining, F–family, Ba–bath, Br–bedroom, Bs–basement, Ly–laundry, G–garage, W–workshop, O–other*	G, W	Bs		F, Ba, W oil furn backd't	**Br**, D, Br, O		F, Bs	**Ba**, K	**Br 2**, 1, L, O	N	Ba, Bs,	**Ba**, K, Brs	Bs	Br, Bs	F
Activities make problem worse: *N–none, Wc–wash clothes, V–vacuum, D–dry clothes, Wf–wash floors, H–hobbies, Wx–waxing, C–cooking, Wd–wash dishes, O–other*		Wd		H, V, Wf, C	V, Wf, C		–	Wc, V, D, Wf, Wx, C	C	Wf, V, Wf, O	Wc, V, D, Wf, H, C, O	V	V	C	strong chemical smells
Age of house: *A–new, B–1 to 15 years, C–+15 years*	C	C		B	C *very old*		C	B	C	B	C	B??	C	C	C
Type of house: *B–bungalow, S–semidetached, 2–2-storey, 3–3-storey, R–rowhouse, A–apartment \ W–wood frame, M–masonry, L–log, O–other*	B	2-W		2-W	2-W		B?	2R-W	3-M *rents main floor*	2–F	split level-F	1.5-F	S	2-W	
Area: *U–urban, R–rural, S–small town*	S	S		U	R		U	U near R	U	U	U	R	U	R	U
Outdoor Environment/Situated Near: *F–factory, L–landfill, P–paper/wood mill, I–incinerator, A–agriculture, H–highway/busy road, G–garage, RR–railroad, D–drycleaner, W–water, R–radon, E–electrical*	H, W,	H		W	H, W		–	A, H, W, high tech area	W	A	H	Spring-stream	H	A, H, E	A-nearby, W
Indoor Environment: *P–pets, S–smoker, O–home office, H–hobbies, C–cold spots, B–Heated basement*	O, H, C, B	C		P, H, B	leaky house		P, H	H	O	P, O	O, H	H	H, S-*left 3 yrs ago*	P,	P, O, H
Occupancy: *A–less than 1 year, B–1 to 10 years, C–+10 years*	C	B		B	C		C	A	A	B	C	A	C	C	C
Previous occupants: *P–pets, S–smoker, C–complaints, H–health problems, O–home office, Ho–hobbies*	P, S,	P, S,		S	P, S,		root cellar	P-*indoor pets*	P, H		S	no problems	O	P, H	P
Home improvements with ***negative*** impact: *C–carpets, W–windows, P–painting, R–renovation, I–insulation, F–flooring, L–wallpaper, H–HVAC*	R			–	fire '85, R, P,		*none indicated*		F		C, R				
Home improvements with ***positive or no*** impact: *C–carpets, W–windows, P–painting, R–renovation, I–insulation, F–flooring, L–wallpaper, H–HVAC, D–duct cleaning*	C, P, R, F, H, W	L, F, R		–	–		C, F, H, R, I, P	F, P, D, H		R, P	W, H	R	F, C-removed	W, P, I, H-*removed woodstove*	R, W
Lighting: *B–bright, M–medium, D–dark*	B	D		B	D		B	B	M	B	B	M	D	D	M
Windows: *N–newer than 5 years, O–older, C–combination* Panes: *S–single, D–double, T–triple* Frame: *W–wood, V–vinyl, M–metal, F–fibreglass, ?–unsure* Glazing: *C–clear, L–low-E, ?–unsure* Coverings *Cn–closed or On–open* at night Coverings *Cd–closed or Od–open* during day	1/2 N D W C Cn Od	O S W C Cn Od		O D W C On Od	C D W C On Od		N *(8 yrs)* T/D M C Cn Od	N D W C Cn Od	? D M C Cn Cd-some	O On Od	C S W, V C On Cd	N Cn	C D, *storm* M C On Od	O S W C On Od	N D, 2-T V C & L Cn Od
OBSERVATIONS continued	NS01	NS02	NS03	NS04	NS05	ON00	ON01	ON02	ON03	ON04	ON05	ON06	ON07	ON08	ON09

7.0 Commentary

The Data: Observations, Trends, Patterns, Explanations

1. No clear common patterns emerged except in the prevalence of mold and/or moisture in the homes. As well, very few trends were observed when comparing the various houses. Some of the more consistently made observations included:
   - moldy, musty damp smell when enter house
   - some fragrant cleaning products or perfumes used in house
   - recent completion of painting or renovation in house, such as new carpeting or flooring, and new furnishings
   - composite wood in cabinets, furnishings used in house
   - pets live in house
   - dehumidifiers and/or humidifiers used in house
   - exposed insulating products in house
   - lack of adequate ventilation observed in many homes

2. All the occupants had health problems. Most of the occupants were quite knowledgeable about their conditions and the possible causes.

3. The investigative process was designed to identify probable indoor air quality causes in the houses and was not intended to establish a link to the occupant health problems. The inspectors had expertise related to building science and issues related to environmental health and were not health experts.

4. The investigators with sensitivities identified the problems of the occupant; however, they also identified items related to their own sensitivities which may not necessarily be those of the occupant. In suggesting remedial measures, the investigators own sensitivities became apparent. The use of investigators with sensitivities is discussed further at the end of the section.

5. There is a need for the investigators in the field to undergo training to ensure consistent and comprehensive inspections of the problem homes. As was observed with the Nova Scotian house inspected by two investigators, different concerns and problems were identified for the same house. In the two houses in Ontario inspected by two investigators, each investigator came to similar conclusions about the house.

6. The investigators used in this review process had a knowledge of building science and environmental health. With this resource of information at their finger tips, they seemed to rely more on their own "expertise" than the survey tools as a guide to identifying problems.

7. Regionality does not appear to have an impact on the results; however, the damp Nova Scotian climate seemed to be a contributing factor to moisture problems in the houses surveyed.

The Inspection Checklist

1. The Survey of Problem Homes House Inspection Checklist is very comprehensive and could serve as a valuable prompting and recording tool for a person with building science knowledge. The format and ease of recording, however, must be improved.

   Both the investigators and the occupants of the surveyed houses were knowledgeable about environmental health issues. For this reason, the Inspection Checklist proved to be less valuable than originally anticipated. In situations where the knowledge base of the investigator and the occupant was less developed, however, the checklist should prove to be a much more valuable tool.

2. In general, the Inspection Checklist was found to be too lengthy and difficult to fill out in its existing layout. Because the Inspection Checklist was so time consuming to complete and confusing to fill out, some of the investigators missed sections. The layout lent itself to compilation, but not data gathering. Some of their comments included:

   "The form is very complete and comprehensive, but perhaps too much so—it seems to be inordinately long. I found it difficult to wade through and pick out the important facts"

   "Very comprehensive and completely unwieldy to use"

   The layout of the Inspection Checklist was a function of the evolutionary nature of the protocol development and review process. The aim was to create a comprehensive survey tool that could be used by different investigators with varying levels of knowledge and experience. It was felt that detailed and complete worksheets for each area of a house was necessary to ensure the sufficient investigation of the house. As well the format permitted a comparison of the findings of each investigation and the identification of any common patterns.

3. Use of the 'sniff' test portion of the protocol produced variable results. In some cases it provided the investigator with an indication of the direction for the investigation. In other cases it tended to divert the investigation and to cause disorientation. As well, the health and safety issue was raised with regard to the repeated use of the sniff test in potentially dangerous environments (see discussion below).

4. The outside review of the collected data by the healthy housing experts appears to be feasible. The experts were able to identify the problems in the houses and suggest remediation.

Comments from John Bower (External Reviewer) on the Protocol and its Components

"I seemed to get more information out of the Occupant Surveys than the Inspection Checklists. That may be due to the fact that the occupants of both houses seemed to have a good knowledge of their sensitivities. Someone less aware of specific problems may not have been able to place as much useful information on the form. While the inspector of the one house noted some odours that were helpful in my evaluation, there were few odours noted in the other house that were helpful. Overall, I found actual descriptions of the houses, maintenance and hobby products, and furnishings more useful than descriptions of odours.

The photos were helpful, but I would have appreciated interior photos since materials inside the house contribute to indoor pollution far more than products used outdoors.

I would expect an inspector to take more care in preparing site, proximity, and floor plans—perhaps use a ruler, rather than making rough sketches—if the evaluation is to be reviewed by another party. I would also suggest that notes be printed carefully—they would be much easier to read (especially by another party) than quick scrawls. This should be spelled out in the instructions.

I think several indoor humidity measurements in different rooms and in different parts of a room (near a cool floor or wall, for example) would be useful. A gauge for determining the moisture content of wood or drywall might also be useful when a moisture problem is suspected.

I found the Occupant Survey Form easy to follow, but thought the Inspector Survey Form was more difficult to understand. For example, in some places, it says to "use your sense of smell," but other places are after more descriptive information. I still don't understand how to fill it out correctly (with numbers or check marks), and I think it would be difficult to interpret the difference between some of the descriptions of odour—"musty" and "moldy," for example. The form is very complete and comprehensive, but perhaps too much so—it seems to be inordinately long. I found it difficult to wade through and pick out the important facts. It asks for a great deal of information, some of which doesn't seem very relevant, such as the type of grate on incandescent lights, metal or glass light fixtures, type of windows (casement, slider, etc.). The form also asks for information that is difficult (or impossible) to determine in most houses: is the concrete treated?, what type of wall insulation?, is there a vapour barrier in the wall?, etc. I would think that an inspection form should be organized by pollutant type. For example, have sections devoted to moisture problems, formaldehyde sources, VOC sources, combustion by-products, maintenance and personal care products, furnishings, outdoor pollution sources, etc. This would seem to me to be an easier way to organize the data. Overall, I liked the organization of the Occupant Form better than the Inspector Form and felt it was easier to use.

I have a very serious objection to having an inspector use their sense of smell to evaluate a house. These are described as problem houses, and you are asking someone to deliberately expose themselves to a potentially dangerous situation. The ethical, moral, and legal implications of this are frightening. Though not common, some molds can be deadly. One inspector reported breathing problems, dizziness, and disorientation. Personally, I have gotten a splitting headache that incapacitated me for a full day after being exposed to a moldy situation. I think it is unconscionable to have inspectors deliberately keep exposing themselves to something that could negatively affect their own health. While it may be overkill to have an inspector wear a respirator at all times, it would seem to be better to err on the side of safety. From a practical standpoint, each of us has a nose with a different degree of sensitivity. The fragrance industry employs people with very accurate senses of smell, but I doubt that the average person is capable of determining a problem based on odor. In fact, the sense of smell often becomes less acute after a while. You may be able to detect something immediately upon entering a house, then after becoming accustomed to it, you no longer notice it, so you can't locate the source.

I hope my comments are useful. I think evaluation forms for determining health problems are sorely needed, and I feel that you are on the right track. However, I

would recommend using a person's sense of smell supplementary to their observational skills—your eyes can tell you a great deal."

Sensitivities and the Investigator

In the Protocol, the investigators are asked to use their sense of smell when they first enter the house and to note any identifiable odours. Again, as they move through the house into new areas, they are asked to note any identifiable odours.

Sensitivities to detecting molds and chemicals can be an asset to an investigator; however, they can be a liability as well. Throughout the course of this research project, the issue was discussed many times, and a number of concerns and advantages were expressed.

John Bower, in the previous subsection, presented his objections to the use of the sense of smell to evaluate a house.

In the following paragraphs, Dr. V. Salares, Project Manager for the project, presents the advantages of including the sense of smell in the investigation procedure:

"Through the use of the sense of smell, the investigator has, at his/her disposal, one of the most sensitive tools for identifying pollutants. When we walk into a shopping center, a garage, shop or elsewhere, whether we like it or not, we breathe in whatever is airborne. Some people are very astute observers and use their sense of smell to dictate if they should stay or leave or the length of time they should spend in the place. The majority, however, either do not notice odours or ignore whatever they smell.

The protocol, as it was designed, encourages the investigator to use the sense of smell to identify the predominant class of pollutants—whether it be biological or chemical in origin. How the house smells is noted upon first entering the house. If the house has an odour, someone with an acute sense of smell coming from the outside would discern the odour as he/she enters. This perception disappears because, as one continues to be exposed to the odour, one becomes conditioned to it. The investigators are not expected to be sniffing every corner of the house. Using the checklists and observation skills, they can identify the sources of pollutants in the house. Thus pressed wood products, for example, can be identified without sniffing them. It would help if the investigator could identify each odour, but usually the odours are mixed. Some parts of the house may carry some unusual odours, and these should be noted. It is the investigator's initial sensory perception, rather than individual odours, that is considered valuable for the investigation process. This initial perception should indicate which remedial measures would likely make an improvement to the quality of the air.

The health issue raised is valid, especially if the investigators are going to be visiting many houses of varying levels of contamination. The people who are suited for this kind of work should have an acute sense of smell, excellent investigative skills, a solid building science background and should not become sick easily. Furthermore, if the house appears to pose a health risk from the severity of the contamination, the investigator will have to make a decision as to whether or not to proceed inside the building. A judicious use of the sense of smell will help in the analysis and will protect the investigator. If he/she decides to proceed inside the house, the contaminant exposure could be reduced by fully opening the windows and doors and walking through very quickly or by wearing protective equipment. These issues will be addressed in a training program that is being developed."

8.0 Post-Survey Analysis by V. Salares

The survey of fifteen houses demonstrated the feasibility of conducting indoor air quality investigations using the inspection protocol that was developed for this purpose. A detailed analysis of the summaries and the individual case studies lead to the following observations:

Indoor Air Quality Problems of the Houses

Nine houses were found to have predominantly moisture and mold problems. In these houses, chemical contaminants were also identified, but these were found to be less significant than molds. Five houses had predominantly chemical contamination, while one house had both mold and chemical contaminants of about equal importance. The nine moldy houses were older, ranging from 15 years to 154 years old. Three of the five houses with predominantly chemical contaminants were new (under ten years old), while two were older (over forty years old). The house that had mold and chemical contaminants was new (two years old).

All the houses, except one of the new ones, had a basement and/or crawl space. All had large areas of carpeting with some vinyl flooring. Pets were present in nine households. Exposed fibrous insulation material was found in more than half the houses. Poor drainage and poor air movement outside the house were also observed in half the houses.

Contamination levels in some of these houses were high enough to cause severe discomfort to the investigators. The symptoms reported after a short period of exposure during the course of the inspection included: breathing difficulties, dizziness, disorientation, headaches and itchy skin. In one case, the investigation had to be discontinued owing to the severity of the adverse reactions.

Sources of contaminants in all the test houses were identified. Earthen basements or crawl spaces were the primary source of molds in four houses. An open well in two houses was also identified as a point source of moisture. Previous history of water leakage in the house envelope, capillary rise of moisture through the concrete floor, high moisture levels generated by the occupants or by previous use of humidifiers, lack of dehumidification in the warm months and poor construction quality leading to localized condensation were among the factors found to be contributing to moisture problems. An indoor pool in the two-year old house led to elevated humidity levels in the house, causing mold growth and enhanced chemical emissions from building materials. Furthermore, chlorine gas from the pool was detected in the living areas.

Building materials and furnishings were the primary sources of chemical contaminants. Carpets and underpads and medium density fibre board subfloor, paneling, cabinets and furniture were found in all the houses. Household chemicals, scented personal products and hobby materials used by the occupants were additional sources of chemical contamination.

Ventilation was found to be lacking or inadequate in all the houses. Lack of ventilation was indicated by stale air, moldy or chemical odours, lingering cooking odours and pet odours. Two houses had a heat recovery ventilators (HRV); but because of improper installation, the full benefits from having one were not gained. It was also evident that the presence of an HRV did not solve the indoor air problems of these houses.

Evaluation of the Checklists and Inspection Protocol

The occupant survey forms provided invaluable information to the investigator and reduced the time spent on site. The checklists were found to be comprehensive; they were also reported to be tedious to use. A typical walk-through can take several hours, depending on the size of the house. The checklists should not unduly prolong the investigation and, therefore, should contain no more detail than is necessary. Conversely, complete information is needed for the analysis of the problems and solutions. Thorough documentation is important, as it may be necessary to review the data off-site at a later time. Feedback from the team members resulted in improvement of the format.

An odour was detected by the investigators in every house upon entry. Some houses clearly had stronger odours than others. In comparison, only four out of fifteen homeowners reported noticing an odour in their own house upon entering.

Most of the occupants believed their houses were contributing to their health problems. Some could specify the areas that bothered them most, but others did not know. Those who knew where they did not feel well could not associate these areas with the major sources.

The detailed site inspection is unquestionably an indispensable part of the investigation. Thoroughness in completing the checklists is as important as the observational skills of the investigator. The duplicate inspections showed that the two members of the team had basically the same analysis, but there were differences in their recommendations. Allergies and sensitivities of the investigator to some substances were noted to have some influence on their diagnosis. Recommendations from one investigator were sometimes incomplete and were supplemented by other members of the team.

Air testing was not indicated to be a necessity prior to remediation except in two houses, which required extensive renovation. The two team members who inspected one house found severe moisture in the basement, and both recommended gutting the finished walls and flooring. Mold testing was suggested to enable the homeowner to decide whether to proceed with the renovation or not. (Subsequent mold tests showed the presence of the toxic mold, ***Stachybotrys atra***. The owner had the basement gutted and cleaned.)

Remediation measures suggested for the houses ranged from simple to extensive. Many of the suggested procedures could be done easily, but others required a substantial amount of work. In two houses, it was questionable whether the air quality could be improved due to the extent of the problems—previous fire damage, moldy basement, poor structure overall. The suggestion for one house was that it be replaced rather than rebuilt.

Discussion

Six of the houses were so contaminated as to cause symptoms in the investigators. The fact that they felt ill from being in the houses for a short duration indicated the seriousness of the problems. It is, therefore, not surprising that the occupants report being sick in their own homes. Sensitivity may not be the issue, since the problems are real; and 'average' people, living in the same environment for the same length of time, would likely be affected. The question is raised whether their health condition might not have developed if their houses were not 'sick'. In one case, the illness and housing connection was very strong—onset of health problems occurred three months after moving into the house, and the symptoms disappeared after a month's absence—only to reappear upon the occupant's return.

The checklists by themselves, although comprehensive, are insufficient. The investigators must know what to look for and be able to deduce what they mean. Their ability depends on their familiarity with houses and how they work. Their expertise is perhaps the most valuable aspect of the investigation.

The investigation relies on the observations correlated with all the information collected about the house. The sense of smell is one of the most sensitive and valuable tools the investigators have at their disposal and can assist them in prioritizing remediation measures. Its use is limited to odour detected upon entry for two reasons. Due to adaptation, odours are lost quickly. This explains why most occupants are unable to detect the odour of their own house. Using the sense of smell more than absolutely necessary also increases the investigators' exposure to contaminants.

The field tests demonstrated that IAQ problems can be characterized qualitatively. More precise characterization, such as testing the air for chemical contaminants, involves costs, and the results neither identify the sources of the problems, nor their solutions. Homeowners are further ahead applying testing costs to remediation. In cases suspected of mold contamination, testing for molds may be useful before extensive renovation is undertaken.

An important conclusion from the field testing is that a formalized program to train investigators is necessary. The importance of selecting candidates who possess the necessary skills was supported by the field tests. In addition to background in building science, renovating or building experience and knowledge of mechanical systems, investigators must have good analytical, inter-personal and communication skills. The training program should cover all aspects of the investigative process, including issues dealing with clients' needs, client-investigator contracts, preparation of reports, as well as liability and health risks. Based on this study, a program consisting of an intensive three-day course and an apprenticeship is under way in Canada.

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