



U.S. Department of Housing and Urban Development

Office of Lead Hazard Control and Healthy Homes

Healthy Homes Study Plan

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Introduction

This Healthy Homes Study Plan (“Study Plan”) was prepared by HUD’s Office of Lead Hazard Control and Healthy Homes (OLHCHH) to support HUD’s Fiscal Years (FY) 2022-2026 Strategic Plan.^[1] The Strategic Plan provides the Administration’s strategy for ensuring everyone has an affordable, healthy place to live. Strategic Goal 4 of the Plan, Advance Sustainable Communities, includes a commitment to advance sustainable communities through achieving three strategic objectives, on strengthening extreme-weather resilience and energy efficiency, promoting environmental justice, and recognizing housing’s role as essential to health. Strategic Objective 4B, Strengthen Environmental Justice, includes a commitment to reduce exposure to health risks, environmental hazards, and substandard housing, especially for low-income households and communities of color. A key strategy to achieve this objective is to:

“advance the Federal research agenda on the effects, evaluations, and control of lead and other health and safety hazards in housing and the impacts on resident health.”

The purpose of the OLHCHH Healthy Homes Study Plan is to guide the Office’s technical studies^[2] that enhance our understanding of how to identify and control housing-related health and safety hazards, particularly focusing on lead. The Study Plan includes several research questions aligned with HUD’s Program Evaluation Policy Statement:^[3]

- What can next-generation surveys on lead hazards and healthy homes tell us?
- What are the most significant problems with indoor air quality in HUD-assisted housing?
- What are cost-effective ways to influence positive changes in indoor air quality?

HUD’s Learning Agenda: 2022-2026,^[4] and its Learning Agenda: Fiscal Years 2022-2026 Supplement,^[4a] both prepared by the Office of Policy Development and Research (PD&R), include key Priority Research Questions related to OLHCHH’s work, but constitute a high-level, HUD-wide plan. While the Study Plan shares some of the HUD Learning Agenda’s strategic purposes, it is a narrowly focused research agenda outlining specific priorities for OLHCHH and its partners. However, OLHCHH expects the Study Plan to help inform the development of HUD’s FY 2026-2030 Strategic Plan, future supplements to the Learning Agenda, and activities to implement Annual Performance Plans^[5] under the Strategic Plans.

This Study Plan includes research priorities identified by OLHCHH technical staff and senior staff based on research conducted to date within and outside the OLHCHH. It will inform priorities for OLHCHH’s technical studies projects. Sections are organized to reflect the major OLHCHH study areas. The Study Plan is considered a “living document” subject to Departmental priority changes, scientific, engineering, and policy advances, and other factors. Its implementation will be subject to the scoping and funding levels in the OLHCHH’s appropriations. Work will align with HUD’s Program Evaluation Policy Statement, as OLHCHH will continue to comply with its principles of research and evaluation.

The Healthy Homes Study Plan includes research categories for residential lead-based paint, indoor residential space (regarding, e.g., indoor air quality, mold growth, and pest infestations, etc.), weatherization, and extreme weather.

Healthy Homes Study Plan Focus Areas

The Healthy Homes program’s purpose includes advancing the recognition and control of priority residential health and safety hazards and more closely examining the link between housing and health. In addition to deficiencies in basic housing conditions that may affect health in well-recognized ways (e.g., structural problems, lack of adequate heating and cooling, pest infestation, excess moisture, etc.), other subtler health hazards may exist in the home (e.g., asthma triggers, volatile and semi-volatile organic compounds including pesticide residues, injury hazards, etc.). While some hazards will be found disproportionately in housing that is substandard, housing-related health and safety hazards may also exist in housing that is otherwise of acceptable quality.

Lead-based Paint Hazard Control, and Lead in Water

The US Centers for Disease Control and Prevention (CDC) has said that no safe blood lead level in children has been identified.^[6] Lead-based paint hazards in the home are among the most significant route of exposure, along with lead in water and soil, and are a major focus of OLHCHH's work. For example, while CDC-HUD research found that children aged 1 to 5 years during 2005 to 2012 who were living in HUD-assisted housing had lower blood lead levels than expected given their demographic, socioeconomic, and family characteristics,^[7] a recent OLHCHH-funded study on blood lead levels in children ages 6 to 17 found that blood lead levels are lower for children in project-based assisted housing than in unassisted housing, but not for children in tenant-based assisted housing, such as the Housing Choice Voucher program (HCV).^[8] The HUD Learning Agenda Supplement includes the following questions:^[9]

- How can HUD update its evaluation of the effectiveness and longevity of specific residential lead hazard control interventions through a new Evaluation of the HUD Lead Hazard Reduction Grant Program?^[9a]
- How can HUD contribute more to reducing the incidence of blood lead levels above CDC's blood lead reference value among children under age 6 in families in the HCV program?^[9b]

The Healthy Homes Study Plan includes two additional priority areas for study.

Evaluation of the effectiveness and longevity of specific residential lead hazard control interventions

The Office provides funding to support the evaluation of the long-term effectiveness of lead and healthy homes interventions, as well as the effect of lead hazard control projects and of engaging residents to maximize impacts of housing rehabilitation programs. Results from these grants will be published once complete. The American Healthy Homes Survey II, conducted by OLHCHH in partnership with the Environmental Protection Agency (EPA), provided corroboration of the reduction of the prevalence of lead-based paint hazards^[10] and evaluated the prevalence of carbon monoxide detectors, fire extinguishers, mold and moisture damage, airborne formaldehyde, and slip/fall hazards, among other residential contaminants and conditions.^[11] The OLHCHH has started preliminary work on an update of the National Evaluation of HUD's Lead-Based Paint Hazard Control study cited above, which was the largest study ever done on the effectiveness of lead hazard controls, and which was implemented in residential dwellings enrolled in HUD's lead hazard reduction grant programs.^[12] PD&R, EPA, CDC, and additional researchers have developed geographic lead exposure risk indices,^[13] and the agencies collaborated on a U.S. lead "hot spots" methodology analysis on identifying high lead exposure risks.^[14] The interagency lead exposure mapping collaboration effort supports the workplan for FY 2024 – 2028, priority actions^[15] of the President's Task Force on Environmental Health Risks and Safety Risks to Children, of which HUD is a member agency.^[16]

The OLHCHH will continue to collaborate with PD&R on guidance to grantees on data, databases, access, and maps, and with grantees and other interested groups to generate robust

guidelines and requirements for data collection and analysis to develop evidence for decision making.

Future study areas may include:

- How effective are lower intensity treatments (e.g., less invasive methods like cleaning and surface stabilization)?
- What is the longevity of combined lead-hazard control activities (e.g., lower intensity treatments with various types of abatement)?
- How can we evaluate the methods for mitigating lead in drinking water such as point of use filters, flushing, etc., in HUD-assisted housing?
- How can geographic information system (GIS) mapping help identify at risk areas in urban, suburban, and rural areas that may need federal support for lead hazard evaluation and control and for informing local health departments and pediatricians?
- Can the use of Artificial Intelligence (AI) and novel technology now available contribute to better prediction of households posing a higher risk of lead exposure to residents?

Use of novel methods for lead risk assessment

The Office may provide funding, if appropriated, to support studying recent technology and advanced AI machine-learning algorithms to identify homes with high lead exposure risks, and to understand the socioeconomic, policy and community interactions of lead hazard control. All support of AI work, if conducted, will align with Executive Order 14110 on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence.^[17]

Healthy Homes

Implementation research on interventions incorporating the eight principles of Healthy Homes

The Eight Principles of Healthy Homes^[18] continue to guide work by OLHCHH's grantees to improve conditions in residential settings for families. The Eight Principles include, among others, controlling moisture, improving ventilation, reducing exposure to indoor contaminants, eliminating pests, and conducting routine housing maintenance.

Indoor Air

OLHCHH grantees can benefit from innovative methods to reduce exposure to indoor contaminants and improve indoor air quality (IAQ) in housing. For example, regarding asthma, research has identified reduction in childhood asthma morbidity from a single intervention for cockroach control,^[19] and improved asthma control and quality of life scores among participants with poor control and impaired quality of life from high efficiency particulate adsorption treatment of indoor residential air.^[20] Regarding carbon monoxide (CO) poisoning, research suggests that considerable education is needed to inform residents of its causes and symptoms, and that CO alarm policies need to be supported with public health outreach to address their knowledge gaps.^[20a]

HUD's Learning Agenda^[21] and its Supplement^[22] have the following first two, and third questions, respectively, related to indoor air quality:

- What are the most significant problems with indoor air quality in HUD-assisted housing?

- What are cost-effective ways to influence positive changes in indoor air quality?
- What are the success and challenges related to the implementation of HUD's Smoke-Free Public Housing Rule?^[23]

Future study areas may include:

- How does indoor air chemical exposure vary by structural or behavioral factors?
- How do people respond to policies/conditions to avoid chemical exposures at home?
- What are the most cost-effective types of education about residential CO poisoning and CO alarm selection, installation, and maintenance?

Work in this area will continue to include collaboration with grantees, and HUD's Offices of PD&R, Public and Indian Housing, including its Real Estate Assessment Center (REAC), Multifamily Housing, and Energy and Environment (OEE), as well as with CDC, the Department of Energy's (DOE's) National Risk Assessment Partnership, and other Federal agencies. OLHCHH will strengthen its partnerships with the EPA's Indoor Environments Division and Office of Research and Development.

Decarbonization/Electrification Impacts on Indoor Air

OLHCHH is looking for research into how transitions to low or zero-carbon energy practices impact indoor air quality, such as in how they affect the prevalence of asthma triggers. The Office also seeks to identify the most cost-effective methods to reduce carbon emissions from homes and improve energy efficiency, and to identify machine-learning methods to optimize carbon reduction and costs.

Future study areas include:

- How can mechanical ventilation be used to improve IAQ to levels considered acceptable for an occupied home most energy- and cost-efficiently?
- What potential hazards exist for families cooking with gas stoves and ranges (whether lit or unlit), and what evidence-based practices support improved air quality in such homes, or is a switch to electric stoves more cost- and health- beneficial?
- What machine-learning methods can be used for assessing methods of gas-to-electric conversions of stoves and ranges to optimize carbon reductions and costs of interventions?

Radon

Working with its HUD, federal, and private partners, the OLHCHH continues progress implementing the National Radon Action Plan (NRAP).^[24] The NRAP framework includes radon risk reduction, approaches to promote testing, mitigation and radon-resistant construction, support for increased availability of certified radon testing and mitigation services, and increased visibility for the risk and harm of radon exposure in residential settings. Partners through NRAP include OEE, CDC, EPA, and the American Lung Association (the last two being the NRAP co-chairs), among others. OLHCHH grantees work to support innovative methods to improve the rate of radon testing and communicating results with improved technology. Additionally, they

increase the education of tenants and residential maintenance crews regarding radon testing and mitigation in public housing units and housing in general. HUD’s Learning Agenda includes the question, “What are the health benefits of HUD grants for radon testing and mitigation?”^[25] OLHCHH grantees promote and publish studies that show the effectiveness of housing management’s practices to monitor for radon and conduct mitigation.^[26]

Future study areas may include:

- How can HUD increase radon testing and mitigation in HUD-assisted housing other than public housing, in tribal housing, and in the unassisted housing market?
- How can HUD increase the number of certified individuals and companies in the radon testing and mitigation industry available to HUD-assisted and tribal housing providers and owners?^[26a]
- How is the new HUD radon policy^[27] affecting radon testing and mitigation in HUD-assisted housing?
- How can a risk-benefit analysis help find more cost-effective ways to identify and reduce residential radon risk?
- How do various residential radon testing and mitigation approaches compare in terms of their cost-effectiveness?
- Are there AI machine-learning methods that could help optimize costs of residential radon testing and mitigation?

Mold

Preventing and safely addressing mold in residential units continues to be a priority for OLHCHH and HUD housing assistance programs. In 2023, HUD published the final rule for the National Standards for Physical Inspection of Real Estate (NSPIRE).^[28] These requirements are the first update to HUD’s inspection protocol in over twenty years and include an updated standard for assessing mold with hazard rating levels to compel action within established timeframes.^[29] To support this work, the OLHCHH supports developing easily replicable, cost-effective methods for identifying, preventing, and controlling mold and excess moisture with a focus on affordable housing. The OLHCHH collaborates with its grantees, PIH (including REAC), Multifamily Housing, other HUD offices, Federal stakeholders (e.g., CDC, EPA, and the National Institute of Environmental Health Sciences (NIEHS)), and academic, industry, and advocacy organizations.

Future study areas may include:

- Are there cost-effective methods for identifying, preventing, and controlling mold and excess moisture in various types of residential buildings, with a focus on affordable housing, taking into consideration risk factors (e.g., poorly controlled asthma) and building, geographic, and climatic factors?
- What better tools can be applied for the identification of hidden residential mold and moisture problems?
- How can GIS mapping help identify at risk areas in need of federal support for residential dampness and mold reduction?

- How can surveillance and maintenance protocols for existing residential buildings (e.g., training of maintenance workers and supervisors on use of structured surveillance and response protocols) be improved?
- What are the benefit/cost ratios of health improvement associated with the most common methods of mold reduction and control?
- Can using AI or new technology help predict how much residential dampness and mold are unhealthy?
- How can effective residential mold reduction strategies tailored to specific individuals be developed?
- Are there new residential building materials that are more-resistant to mold growth than widely used materials? Can HUD-assisted housing properties (whether new construction or existing buildings) better use more mold-resistant residential building materials?
- What role can residents play in mold identification and prevention, and how can they be supported in this role?

Integrated Pest Management (IPM)

With the implementation of NSPIRE, HUD also improved how it assesses pests in HUD assisted and rental housing, including hazard rating levels to compel action within established timeframes,^[30] with a renewed emphasis on integrated pest management being “strongly encouraged.”^[31] Although such methods represent a substantial improvement, much work remains for HUD programs and OLHCHH grantees. The OLHCHH will strive to help design safe, more effective strategies and management policies for pest infestations (e.g., bed bugs, mosquitos, Dengue, chikungunya, Zika, cockroaches, mice, rats, etc.) and to increase awareness on the health risks associated with them . HUD’s Learning Agenda has the following question: “Which program designs for deploying Integrated Pest Management in public and assisted housing are most cost-effective and manageable?”^[32]

Future study research areas may include:

- How can HUD better promote, or in some situations, require the adoption and integration of residential IPM policies and practices by assisted housing providers?
- What is the future risk for emerging infectious disease exposures in the home (such as Dengue fever, Zika virus) with the increase in global travel?
- Should OLHCHH include risks from mosquito-borne infectious diseases related to the home, including lack of proper disposal of water accumulated in cans, tires, etc., in its inspection and mitigation protocols?
- Are there innovative and effective residential IPM methods and education to control vectors?
- What role can residents play in IPM, and how can they be supported in this role?

Weatherization and Healthy Homes

Enhance use of data on energy efficiency and health in housing, and streamline cross-program eligibility for government assistance programs related to energy, Healthy Homes, and health in housing.

The OLHCHH is making its programs more effective by streamlining cross-program eligibility for government assistance programs related to energy and health in housing, by increasing the “linkage” to collaborate with other agencies offering similar services. The Office is increasing awareness by, e.g., creating maps identifying various programs to leverage funds, and creating memoranda of understanding (MOUs) to share data and collaborate on program implementation. For this work, OLHCHH is collaborating with DOE’s Weatherization Assistance Programs (WAP), through the Healthy Homes Weatherization Cooperation Demonstration grant program, to identify novel models for eligibility, streamline communication, and improve energy efficiency and safety. OLHCHH is also supporting improved communications and data sharing, and is collaborating with DOE, HHS, EPA, the Department of Agriculture (USDA), and the Department of Veterans Affairs (VA), such as through developing MOUs, including one issued in 2024. ^[33]

Healthy Homes Study Plan questions include:

- What is the most effective way to provide a “one-stop” information shop for weatherization, healthy homes upgrades, and radon mitigation work to improve local coordination between healthy homes efforts and weatherization efforts?
- Will improved data sharing among federal agencies, state, tribal, and local governments, and institutions leverage existing data from other programs to streamline eligibility determination processes?
- What are the impediments, including administrative barriers, to further cooperation and coordination between Healthy Homes and WAP programs, and how can they be overcome?
- How could HUD cost-effectively capture data on health effects associated with reductions in residential energy consumption, particularly for assisted housing properties and use the data to inform energy policy choices?
- How effective are OLHCHH programs at incorporating energy efficiency into their implementation?

Extreme Weather and Healthy Homes

Severe storms and flooding, wildfires, drought, and extreme heat and cold are impacting communities across the United States. As the Federal agency dedicated to creating strong, sustainable, inclusive communities and quality affordable homes, HUD is on the front lines of the nation’s efforts to increase resilience of housing structures and operation to extreme weather impacts.

To support this work, OLHCHH helps develop and evaluate cost-effective methods for hazard assessment and control. This includes assessing and improving indoor air quality and

understanding the relationship between residential exposures and health outcomes. Program goals include addressing the impacts of extreme weather and ensuring resilience. To accomplish this, HUD prioritizes research and interventions that benefit underserved communities and vulnerable populations such as children, communities of color, persons with disabilities, and senior citizens, and ensures equitable access to healthy and resilient housing. HUD's Learning Agenda has the following related question: "What are the health outcomes for residents of high-heat climate zones, and what are the strategies (including housing design options) to help low-income, vulnerable residents survive heat events while remaining in their current housing?"^[34]

Future study areas may include:

- What is the impact of weather conditions and events on the prevalence lead hazards and other housing health hazards and on their recurrence after hazard reduction?
 - How do these impacts vary across different housing types and regions?
- What are effective weather adaptation and mitigation measures for OLHCHH programs?
 - What are the most effective weather adaptation strategies for reducing health hazards in homes, and how can they be implemented cost-effectively?
 - How have families and housing units enrolled in OLHCHH programs that previously provided Healthy Homes interventions been affected by extreme weather events compared to similar families and housing in their communities that did not receive such interventions?
 - How have changes in the locations of the different U.S. temperature-oriented and moisture regime climate zones^[35] affected mold prevalence in homes in different areas of the nation?
- What are effective extreme weather adaptation strategies for resilient housing?
 - What are the most effective adaptation strategies for maintaining healthy housing standards when considering constructing or rehabilitating homes to be resilient?
 - How can healthy homes assessments and interventions integrate extreme weather risk analysis to effectively prevent and anticipate housing health and safety issues and hazards?
- What policies and practices are needed to ensure healthy homes principles are upheld in extreme weather events in existing housing?

Next Steps for the Healthy Homes Study Plan

The Healthy Homes Study Plan will help guide research conducted by OLHCHH grantees and contractors, especially in grants under its Lead and Healthy Homes Technical Studies Notices of Funding Opportunity.^{[36],[37]} The Study Plan will be posted on OLHCHH's website.^[38] After publication, OLHCHH will solicit feedback for future versions through structured meetings, and sessions with grantees, academic organizations, advocacy groups, and industry representatives. The OLHCHH will use the Study Plan to help inform the HUD FY 2026-2030 Strategic Plan and future editions of the Annual Performance Plans and the Learning Agenda.

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