Best Management Practices for Development on or Near Former Dumps

1. Introduction

Developing on or near former dumps can pose many challenges, from both a technical and regulatory perspective. This best management practices (BMP) document describes the potential hazards associated with development projects on or near former dumps and the necessary steps for investigation, waste characterization, and possible response actions.

Sites that contain solid wastes can be successfully developed, however careful consideration must be taken to ensure that human and environmental health and safety are protected as part of the development process. As such, it is important that any prospective developer or planning agency interested in developing these properties reach out to the Minnesota Pollution Control Agency (MPCA) early in the planning process to help determine the feasibility of developing the property, and to ensure all parties involved have a clear understanding of the scope of the project. Early communication during the planning process can help avoid costly mistakes and set the stage for successfully moving a project through development.

The Brownfield Program will not approve a Response Action Plan (RAP) or provide assurance letters for development on or near a dump if the development would impede or interfere with response actions to be taken by others that are needed to address releases from the dump or that may be needed to protect off-site receptors. A voluntary party enrolled in the Brownfield Program must, at a minimum, mitigate on-site risk related to their specific proposed actions; however, releases from the dump may also pose a current or future risk to off-site receptors. The Brownfield Program recommends that the environmental due diligence conducted by a voluntary party evaluate this important consideration.

The releases associated with former dumps are commonly addressed by voluntary parties through enrollment in the MPCA Brownfield Program or by responsible parties under the oversight of the MPCA Superfund Program.

This guidance is meant to provide a decision framework for a scientist, professional engineer, or professional geologist who will conduct the dump waste characterization, remediation, and/or mitigation for a proposed development project. Several case studies are provided in Appendix A of this document for reference.

2. Background

Prior to the 1970s, it was common practice to dispose of household waste, demolition debris, and industrial waste by dumping the waste into gravel pits, ravines, or wetlands. In the late 1990s, the MPCA completed an inventory of known open dumps and determined that many dumps presented little or no risk in their then-current setting, which was often an isolated rural area (MPCA 2001, Dump Assessment Study). However, today there is increasing interest to develop land on or near dumps in some areas. New development or redevelopment on or near dumps has the potential to expose people to unacceptable risk associated with contamination and/or physical hazards. Development on former dumps can become a public perception issue, especially when the proposed building(s) is for a specific land use such as residential housing, a school, or day care. Wastes allowed to remain in place can also pose a public communication challenge. It is important to approach a development on or near a dump with caution and to be fully aware of the potential problems that may be encountered.

3. Potential hazards

Some dumps are benign and don't pose significant issues for development, while other dumps, particularly those that produce landfill gas (LFG), may be unsuitable for development unless extensive response actions are taken. Some potential hazards associated with development on or near a dump include:

- LFG resulting from waste decomposition, including explosive concentrations of methane (ATSDR 2001)
- Contaminated soil vapor resulting from volatile organic compounds (VOCs) in the waste mass
- Contaminated soil in the accessible, shallow subsurface
- Physical hazards from protruding dump materials and shallow debris (e.g., broken glass, scrap metal, asbestos-containing materials), which may be an ongoing concern due to freeze/thaw cycles pushing debris toward the ground surface
- Groundwater contamination resulting from the leaching of waste material
- Contaminated stormwater runoff due to contact with near-surface dump material
- Differential settlement of waste and/or fill that could affect the integrity of structures and utilities
- New utility lines potentially acting as conduits for the migration of LFG or contaminated soil vapor/groundwater

4. Waste characterization

Prior to purchasing a property with or near a dump, it is important to conduct environmental due diligence to understand the associated hazards, development costs, and planning necessary for successful development. In some cases, environmental due diligence might reveal that the actions needed to meet MPCA requirements are too expensive to allow for cost-effective development of the dump property.

The specific characteristics of each dump must be determined to evaluate the potential risks it might present to human health and the environment, to plan for proper disposal of excavated waste, and to identify geotechnical issues that would complicate development.

Dumps can contain a wide variety and mixture of materials. The type of dump materials may vary greatly from unwanted soil, mine tailings, wood debris (tree or dimensional lumber), construction and demolition materials, asbestos-containing material (ACM), household refuse, industrial wastes, and medical wastes. Mining dumps are common in northern Minnesota and were filled largely with mine tailings. Other dumps were common receptors of wastes from large industrial operations and may contain hazardous waste. Former dumps that received wastes from a hospital or laboratory may contain materials that require special handling, such as biohazards or radioactive waste. Many old city and township dumps contain significant ash deposits from routine burning of combustible materials. Former farmsteads often contain old farm dumps, which were used for disposal of household waste, old equipment and appliances, and chemical containers. Many dumps contain organic material which can degrade and produce LFG.

Experience has shown that a dump can include many different scenarios, all of which present different amounts of risk and engineering challenges. Many of the concerns discussed in this guidance document relate to development where occupied buildings are planned. Certain types of development, such as parks, open spaces, or solar arrays, may present fewer development issues and be a more appropriate use of the property, particularly for LFG-producing dumps.

The environmental risks present, the remedial measures required, and the site restrictions will vary widely depending on the type of proposed development, the hydrogeologic setting, the specific makeup of the dump, and the distance between the planned building and the waste footprint. Given the variation in the types of dumps, it becomes difficult to develop "one size fits all" best management practices for dumps. New development will require an investigation of the dump to collect key data so appropriate recommendations for controls or construction can be made.

If development is planned directly on a dump, the geotechnical properties of the dump material should also be evaluated to determine the extent of engineering measures that would be necessary. In many cases, the presence of dump materials is typically viewed by geotechnical experts as unsuitable to support new structures and pavements, subject to more detailed evaluations. In most cases, this will lead to further evaluations and include the need to consider significant geotechnical efforts (e.g., soil corrections that remove waste from beneath structures, deeper pile-supported foundations, surcharging, etc.). Testing should be performed on in-place waste to determine its stability and the need for specialized foundations or extensive soil correction. Specialized foundations such as a slab (floating) foundation or the use of pilings are useful to prevent differential settling but can create conduits for gas and leachate migration. Geotechnical considerations are outside the scope of Brownfield Program review but are mentioned here due to the need to closely coordinate geotechnical and environmental investigations and remedial measures.

5. Site investigation

A Phase I Environmental Site Assessment and a Phase II site investigation are necessary to identify the presence and composition of dumps on or near a proposed development.

During the typical environmental due diligence required for enrollment in the MPCA Brownfield Program, much of the necessary historical information will be collected during preparation of a Phase I Environmental Site Assessment (ESA) report. The Phase I ESA report should collect as much historical information about the dump area as possible. Historical aerial photos, maps, site photos, and interviews with local officials and residents are a good place to start. The topography and geology of the dump area are also important and may provide clues as to the thickness and extent of waste material and avenues of LFG and leachate migration. See the MPCA Brownfield Program's Phase I ESA Report for Brownfield Program enrollment for additional information.

Efforts should be made to obtain high resolution aerial photographs for multiple years covering the time that dumping occurred to define the aerial extent of dumping. Although old topographic maps from the early 1900s are commonly less accurate, comparison of old topographic contours with recent topographic maps can indicate past filling operations and can also identify past wetlands, ravines, and gravel pits that were commonly used for waste disposal. Historical Sanborn fire insurance maps commonly show the location of stream channels and embankments that can be observed to be filled or moved when comparing different years, indicating historical filling activities. For some dumps, records can be found that identify years of operation, extent, waste materials/volume, and parties that disposed of waste as well as the type of waste; however, such records are sparse for the majority of old unpermitted dumps.

During the Phase II ESA, the proposed development plan should help guide the investigation and determine the potential risk to human health and the environment based on exposure pathways. If the proposed development is located on or near a former dump, the geological conditions in and around the dump footprint should be thoroughly investigated. Geologic conditions can dictate the movement of impacted groundwater and the migration of LFG near the dump. The footprint, thickness, and environmental and engineering properties of the waste material should be evaluated.

Soil vapor samples should be collected at former dumps to assess the risk to existing or proposed structures related to LFG and VOCs. At least one round of soil vapor sampling for laboratory analysis, not just field screening, is necessary in each MPCA defined season (November 1 through March 31, and April 1 through October 31) to characterize vapors at the site. See the MPCA's Vapor investigation and mitigation decision best management practices guidance document for additional information. Soil vapor samples should be collected for laboratory analysis and analyzed for VOCs on the Minnesota Soil Gas List using U.S. Environmental Protection Agency (EPA) Method TO-15 and for fixed gases (includes methane) using one of the methods mentioned below.

EPA Method 3C, EPA Method TO-3, and ASTM Method D1946 are common laboratory methods used for the analysis of fixed gases associated with LFG, including oxygen, nitrogen, methane, and carbon dioxide. Methane gas samples should be collected across the full extent of the dump and its perimeter during multiple sampling events. A portable gas meter can be used to monitor LFG conditions (methane, oxygen, carbon dioxide, hydrogen sulfide, etc.) during site investigations or for continued monitoring to supplement laboratory data. Refer to the MPCA's Remediation Division Methane Guidance for additional information about methane sampling and analysis.

The vertical and horizontal extent of the waste should be determined using a combination of historical data, geophysical surveys and/or soil borings and test pits. The amount of soil and waste investigation will vary depending on the dump but will typically include several soil borings and test pits. Soil borings help determine the depth of the waste, while test pits provide a more accurate characterization of dump contents/materials. More than one mobilization may be necessary to fully delineate the extent and magnitude of waste and associated contamination. Soil borings conducted at dump sites should incorporate continuous combustible gas monitoring at the ground surface during drilling to monitor for releases of explosive gasses, and the area should be immediately evacuated in the event that explosive gasses are detected, until it is safe to return.

In addition to LFG, potential contaminants of concern associated with dumps includes, but is not limited to, the contaminants listed below. The contaminants selected for analysis will depend on the results of the Phase I ESA and other information available about the waste types within a given dump.

- Volatile organic compounds (VOCs)
- Polycyclic aromatic hydrocarbons (PAHs)
- Priority Pollutant or Resource Conservation and Recovery Act (RCRA) metals
- Polychlorinated biphenyls (PCBs)
- Asbestos-containing material (ACM)
- Gasoline range organics (GRO)
- Diesel range organics (DRO)
- Polychlorinated biphenyls (PCBs)
- Per- and polyfluoroalkyl substances (PFAS)
- Dioxins/furans

Additional analytes may be necessary depending on the type of dump. If there is accurate information about the origins of the waste, contaminants that are unlikely to be present can be eliminated from testing. If elevated concentrations of hazardous substances are present, then the Toxicity Characteristic Leaching Procedure (TCLP) analysis should be performed on worst-case samples to assess the need for pre-disposal treatment of impacted media planned for removal, or the need for disposal at a hazardous waste disposal facility.

An environmental technician must be present during sampling and excavation activities. If there is suspect or known ACM at a site, then the environmental technician must also have Minnesota Department of Health (MDH) asbestos inspector credentials and be the individual collecting ACM samples. If ACM is encountered, the protocol outlined in MPCA's Asbestos Guidance on Excavation Projects must be followed, including implementation of an Emissions Control Plan.

Groundwater and surface water monitoring may be necessary depending on several factors. If the prospective developer is a Responsible Party (RP), then the magnitude and extent of contamination in all media must be fully defined. If the prospective developer is a non-RP, then the need for a groundwater or surface water investigation depends on whether the development plan will create a potential exposure pathway to groundwater or surface water. A groundwater or surface water investigation may also be required depending on the type of assurance letter being requested from the Brownfield Program.

Permanent or temporary monitoring wells should be installed to collect groundwater samples to investigate water quality upgradient and downgradient from the waste, and to define groundwater flow and other hydrogeologic conditions. A minimum of three monitoring wells must be installed, one upgradient and two downgradient of the dump. Downgradient wells should be placed on the property, but not farther than 200 feet from the edge of the waste fill area. Additional wells may be required, depending on the size of the dump and the location of human and/or environmental receptors relative to the dump. Vertical profiling of contaminants in the aquifer may be necessary, depending on the type of contaminants present. It should be noted that groundwater samples collected from temporary wells may result in detections of some contaminants, such as metals and PAHs, that are not representative of groundwater conditions. The MPCA recommends installing permanent monitoring wells for groundwater sampling at former dumps.

Former unpermitted dumps often do not follow property lines. If the prospective developer is an RP, then the full extent of the dump impacts must be evaluated. If the prospective developer is a non-RP, then the site investigation can be limited to within the brownfield site boundary. All accessible areas of the dump on the property must be fully investigated to determine risks and mitigation strategies for the proposed development. If the dump footprint and/or potential risk extends to other properties, the site will be referred to the MPCA Site Assessment or Emergency Management Program, depending on the level of contaminants and the proximity of off-site receptors. As stated in Section 1.0, the planned development project must not prevent or interfere with response actions that may be needed to protect off-site receptors.

6. Landfill gas risk

Methane gas presents an explosion and fire hazard. There is a risk that methane can migrate laterally and vertically through unsaturated soil and collect in enclosed or confined spaces where a spark or other ignition source can trigger an explosion or fire. Methane accumulates at the source and migrates along paths of least resistance towards areas of lower pressure. Variability in weather patterns can affect LFG movement by creating pressure differentials between the atmosphere and the soil gas. The range of combustible gas concentrations within which explosion may occur for a specific combustible gas is defined by its Lower Explosive Limit (LEL) and its Upper Explosive Limit (UEL). The LEL for methane corresponds to 5% methane by volume in air, which is equivalent to a relative concentration of 50,000 parts per million (ppm) methane. The UEL for methane is 15% methane by volume in air or 150,000 ppm. Refer to the MPCA's Remediation Division Methane Guidance for instruction on converting between % methane, ppm methane, and % of the LEL.

There are both short-term and long-term exposure risks associated with LFG inhalation. The two main LFG components, methane and carbon dioxide, are colorless and odorless, and have the capability to displace oxygen, which can result in asphyxiation. The accumulation of such lethal levels is especially a concern in confined spaces, such as underground utility structures and trenches and within enclosed spaces and basements in buildings located at or adjacent to a dump. Although methane and carbon dioxide make up most of LFG, hydrogen sulfide and ammonia are responsible for most of the odors in LFG. Short-term exposures to elevated levels of hydrogen sulfide and ammonia in air can cause coughing, irritation of the eyes, nose, and throat, headache, nausea, and breathing difficulties. Long term inhalation risks from dump material may be associated with VOCs that may be present in LFG.

In addition to LFG present within the dump itself, LFG can migrate underground beyond the footprint of the dump. Landfill gas can easily move though permeable fill soils and debris like those present at many dump sites. These gases move from areas of high pressure (at depth within the landfill) to areas of low pressure, but it is often difficult to predict specific patterns of gas movement. Under certain conditions, LFG can migrate laterally for long distances from the landfill. It is difficult to predict the distance that LFG will travel because so many factors affect its ability to migrate underground. A general rule of thumb is that LFG may migrate up to 1,000 feet, but there are documented cases where LFG has traveled in the subsurface for more than 2,000 feet (EPA 2005). A study conducted by the New York State Department of Health found that of 38 landfills, gas migrated underground up to 1,000 feet at 1 landfill, 500 feet at 4 landfills, and 250 feet from the landfill boundary at 33 landfills (ATSDR 1998).

7. Land use considerations and liability assurances

Land use decisions are made by local units of government through development of comprehensive plans and zoning ordinances. In some cases, the environmental condition of a property may not align with the local land use plan, and the scope of response actions needed to make the property suitable for the desired land use and eligible for Brownfield Program assurances may not be financially feasible. The land use considerations described in this section apply to a proposed development project on or near a dump and for which a developer is seeking assurance letters and/or Brownfield Program approval of a response action plan (RAP).

The MPCA Brownfield Program will not issue liability assurance or RAP approval letters for certain proposed property uses on or near a dump that is generating elevated LFG, unless the building can achieve an appropriate setback from the waste (e.g., outside of the zone where methane is 10% LEL or greater). This includes residential use, hotels, hospitals, schools, daycare centers, and similar uses.

Often the best use of land with a former dump is to leave the property as open, green, or recreational space. The MPCA does not recommend building structures on or near LFG producing dumps; however, certain land uses are more appropriate for dump development, such as a warehouse or industrial building. It is not recommended to develop a LFG-producing former dump site for residential use, hotels, hospitals, schools, daycare centers, or similar uses. If a developer chooses to proceed with this type of development on or near a dump that is producing LFG constituents above 10% of their respective LELs, the Brownfield Program will not issue a liability assurance or RAP approval letter unless the RAP proposes significant response actions to remove LFG-producing waste from the building footprint and within an approved buffer zone. See the inset box at left for information about how to establish the buffer zone. If LFG-producing waste remains at the site after completion of response actions, then methane controls and/or long-term monitoring may be needed in the buffer zone (e.g., between the remaining waste mass and the building) to ensure that the building remains protected from LFG migration.

For preliminary planning purposes, the surrounding buffer area should consist of a minimum of 200 feet between the waste footprint and the building(s). As more information regarding specific site conditions is gathered, the buffer setback may be either increased or decreased. The final extent of the buffer zone will be determined by the distance needed to achieve concentrations of LFG reliably and consistently less than 10% of the LEL within the building footprint.

The MPCA Brownfield Program may provide assurance letters and/or approve a response action plan for industrial or certain types of commercial buildings to be constructed on or near a LFG-producing dump, with robust engineering and legal/administrative controls.

The amount of sampling and/or clean up for a former dump development site will depend on the proposed land use and type of liability assurance requested from the Brownfield Program. See the Brownfield Program Services guidance document for a description of available assurance letters.

8. Response actions

Once the dump footprint, thickness, type of waste, and magnitude and extent of contamination are determined, a RAP for the proposed development can be submitted for MPCA approval. The RAP contains details of the site development plan and proposes remedial measures to achieve risk-based criteria and Brownfield Program requirements. For additional information about RAP development, see the Brownfield Program Response Action Plans guidance document. Common response actions and best management practices (BMPs) for former dump sites are discussed below.

Response Action Plans (RAPs) for dumps may include measures needed to remove waste material and contaminated soil for disposal in a permitted landfill, stabilize the dump, consolidate its footprint, install wells to monitor LFG and groundwater, install engineered systems to control LFG or treat groundwater, and construct a soil cover or low-permeability cap.

8.1 Waste management and disposal

Waste material may have to be excavated and disposed of in a permitted landfill to achieve required setbacks for development. Excavated waste material should be sorted to remove and stockpile restricted wastes for proper treatment and/or disposal (e.g., hazardous wastes, tires, appliances, electronics, etc.). To the extent possible, recyclable materials should be removed from the waste mass and recycled. The MPCA encourages reuse of some inert solid wastes as a substitution for an engineered product. Examples of reuse include uncontaminated recognizable concrete and brick when used as a substitute for conventional aggregate. Refer to the MPCA's Beneficial use of solid waste webpage for information and requirements. The amount of anticipated sorting will depend on the type of dump, known dump history, and information from geophysical surveys, field observations, and subsurface soil sampling.

Permitted solid waste landfills in Minnesota have an Industrial Solid Waste Management Plan that has been approved by the MPCA's Solid Waste division. A landfill's permit and its Industrial Solid Waste Management Plan establish its waste acceptance criteria. It is the responsibility of the property owner/remediation contractor to characterize excavated material and determine a suitable landfill for wastes generated during RAP implementation, and it is the responsibility of the chosen landfill to require and review sufficient information so it can make a waste acceptance decision that complies with its Solid Waste permit and Industrial Solid Waste Management Plan. Brownfield Program approval of a RAP does not provide approval for contaminated material to go to any particular landfill.

Hazardous waste generated during site cleanup or development:

When excavating contaminated soil, special management procedures are necessary if the contaminated soil is classified as hazardous. Contaminated soil is a hazardous waste if it is either ***characteristically hazardous***, as defined in Minn. R. 7045.0131 or if it contains a ***listed waste***, as defined by Minn. R. 7045.0135.

- Excavated material that is characteristically hazardous must be treated prior to disposal in an appropriate Subtitle D landfill, to render the material non-hazardous.
- If excavated material contains a listed hazardous waste, reach out to your MPCA project manager to discuss a *Hazardous Waste Determination* for disposal purposes.

In some cases, on-site consolidation of waste might be an option, subject to approval by the MPCA and potentially local units of government. Reducing the footprint of the dump to the extent possible may allow more flexibility for development. In addition, screening of excavated material during consolidation may allow removal of wastes that present a higher health or structural risk. Consolidation of dump materials is restricted to within the original footprint of the dump and must not create slopes that are steeper than 20 percent.

8.2 Soil management

Old dumps often have one or more feet of soil cover that was placed over the waste when the dump was closed. The source of the cover soil is not usually known, and sampling of the cover soil is necessary to determine if it is contaminated. Similarly, soil surrounding the dump may be impacted from erosion of dump materials, leachate seeps, contaminated surface water runoff, or other activities that occurred on the property, outside of the dump footprint. If soil contaminants exceed risk-based values for the relevant land use and depths, impacted soil should be removed for proper disposal in accordance with an MPCA-approved RAP. Final development grade must include an appropriate vertical buffer or cap in greenspace areas and below buildings and pavements. Refer to the Property Use and Institutional Controls guidance document for information on vertical buffers for different scenarios.

8.3 Landfill gas monitoring

Refer to the Remediation Division's Methane Guidance document for additional information about LFG monitoring, analytical methods, data evaluation, and other related topics.

LFG monitoring in soil vapor and sub-slab soil vapor

- If the concentrations of methane or hydrogen sulfide in soil vapor within the footprint of a proposed commercial or industrial building are greater than 10% of the LEL, an active methane vapor mitigation system should be installed in the building. The fan should be intrinsically safe and equipped with an alarm system in case the power is interrupted, or the equipment shuts down. As per Section 7, above, a residential building, hotel, hospital, school, daycare center, or similar use would need to be located outside of the 10% LEL zone.
- It may be necessary to install vertical gas vents and gas monitoring probes around the perimeter of the former dump to prevent the buildup of LFG and to monitor for the migration of LFG from the dump towards the building. Monitoring should be conducted at least quarterly but will fluctuate based on LFG levels at the property.
- Care must be taken to ensure that combustible gasses and VOCs from the vapor mitigation system are safely discharged and not re-entrained into the building.

LFG monitoring inside buildings

Acceptable monitoring frequency will vary considerably depending upon gas concentrations detected, the location of gas detections, and the potential for significant seasonal temperature and barometric fluctuations. Initial LFG monitoring will be more frequent in buildings where explosive gases were detected. At sites with lower levels of LFG, initial subsurface monitoring may be conducted quarterly for at least a year to show seasonal variation. A site-specific monitoring program should be developed for MPCA review and approval. Continuous combustible gas monitoring devices equipped with alarms may be required in some cases for long-term monitoring.

Levels of combustible gas at or greater than 10% of the LEL in indoor air is cause for evacuation of a building if these levels cannot be mitigated immediately. Usually, gas accumulates to such high levels only in confined or enclosed spaces. The decision to evacuate a building should be made in consultation with the local fire department. Additionally, each local fire department may have their own protocol for building evacuation and for reentering a building following evacuation. At a minimum, a building or an enclosed space with methane concentrations at 10% of the LEL or greater should not be entered following evacuation, except by a person properly trained and authorized by the local fire department.

Construction considerations

The Brownfield Program recommends that buildings constructed on a LFG-producing dump take special precautions, including but not limited to the items listed below. It is important to enlist the services of a licensed professional who is experienced with methane mitigation design and construction of buildings in a methane zone.

- All appliances in the structure should be intrinsically safe (i.e., spark proof) and equipment requiring a pilot light should not be installed.
- The structure should be adequately ventilated to prevent accumulation of gas in "dead space" areas.
- The foundation of the building should include an appropriate vapor barrier.
- All penetrations of the foundation (for utility lines, etc.) should be carefully sealed and checked on a routine basis.
- If water supply lines are placed through waste, there are special provisions that must be followed to hydraulically isolate the lines from the surrounding waste and to provide flexible joints to prevent cracking and breakage due to waste settlement. Whenever possible, utilities such as telephone and electrical should enter the structure from above ground to prevent LFG from migrating into the

structure through the utility trench. Utility trenches should be lined to avoid becoming a conduit for methane migration. Water and sewer entrances must be carefully sealed.

- Buried utility corridors should have a clean soil backfill and setback to ensure that future repair work is unlikely to encounter waste materials.

8.4 VOCs in soil vapor

A vapor mitigation system is required for existing and proposed buildings if VOCs are detected in soil vapor within or near the planned building footprint(s) at concentrations exceeding 33-times the MPCA's intrusion screening values (ISVs) for the relevant land use. The vapor investigation and mitigation measures should be conducted in accordance with MPCA guidance documents Vapor investigation and mitigation decision best management practices and Vapor mitigation best management practices.

9. Institutional controls

Properties where buried solid waste remains on site will be required to have an institutional control (IC). An IC may also be necessary if the solid waste is removed but contamination remains at concentrations above MPCA risk-based criteria and/or if site conditions require long-term maintenance and monitoring. The type of IC, either an *Affidavit Concerning Real Property Contaminated with Hazardous Substances* or an *Environmental Covenant and Easement* will be a site-specific decision based on the collective body of information available and whether activity restrictions or affirmative obligations are needed to manage future risk. The IC will describe the nature and extent of the dump and document any activity restrictions and affirmative obligations. The institutional control will be recorded with the property records in the appropriate county office, so any new owners will be informed of the presence of dump materials and associated use restrictions and/or affirmative obligations at the site. Such a document may require setbacks, inspection and erosion controls, operation/maintenance of engineering controls, monitoring of remedial systems, and other site-specific requirements.

The specific controls necessary to protect public health and the environment will be at the discretion of the MPCA. Failure to implement the site restrictions or affirmative obligations may impact the liability assurances that the applicant may have received from the MPCA. It is up to the applicant to work closely with the MPCA to develop remedial options and controls and restrictions early in the development process to avoid conflicts prior to implementation. See the MPCA's Property Use and Institutional Controls guidance document for additional information about institutional controls.

10. Best management practices for dump closure

Proper closure of a former dump on a brownfield site requires consideration of several factors to prevent future risk to human health and the environment. If a former dump at a brownfield site needs proper closure to address risk, the RAP should propose measures to accomplish that goal. The Brownfield Program staff will confer with MPCA engineers when reviewing proposed response actions related to dump closure. Some examples of actions that may be needed for proper dump closure are listed below.

- Dump materials allowed to remain in place must have a four-foot-thick vertical buffer of clean soil to prevent exposure to underlying waste materials and/or be capped to reduce infiltration. The type of cover material (vertical buffer versus engineered cap) will depend on the type of wastes in the dump and the extent and magnitude of contamination.
- Development and implementation of a cover management plan may be necessary to ensure ongoing protectiveness of the vertical buffer or engineered cap.
- For dumps producing high concentrations of methane, a LFG venting system or an active methane extraction system may be needed.
- Waste removal and/or grading may be necessary to achieve proper slopes on the dump, for erosion control and to reduce infiltration.
- Construction of stormwater infrastructure may be needed to properly manage surface water runoff from the dump.

11. Conclusions and recommendations

Development on or near former dumps can be challenging, however, successful development is possible with proper planning, investigation, and response actions. Early communication with the MPCA during the planning process is key to determine the feasibility of the redevelopment project and/or necessary response actions to ensure human and environmental health and safety are protected. Many of the risks associated with former dumps discussed in this guidance are in scenarios where occupied buildings are proposed, therefore the MPCA does not recommend occupied buildings on or near LFG producing dumps. In many cases, non-structural development, such as greenspace or recreational land use, is more appropriate.

If a developer, prospective landowner, or other party is interested in developing a property at or near a former dump, the MPCA encourages early enrollment in the Brownfield Program for technical assistance and guidance. Information about the Brownfield Program and an enrollment application can be found on the MPCA's Brownfield Redevelopment website.

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Appendix A - Successful Case Studies

Midway Stadium (VP27170)

The St. Paul Port Authority redeveloped the 12.9-acre site with a large office/warehouse building on top of the former State Fair dump. The extent of the dump area covers approximately 75% of the site, with waste thicknesses ranging from 10 to over 40 feet. A large volume of straw and manure from the State Fair animal barns was disposed of in the dump, which resulted in methane concentrations up to 555,000 ppm in sub-slab soil vapor by volume. Approximately 9,810 cubic yards of dump material was excavated during site redevelopment but much of the waste mass remains beneath the building and pavement. Subsurface soil vapor containing methane greater than the LEL and VOCs are present within the remaining waste materials and require on-going mitigation. Site redevelopment included installation of a methane extraction system in the waste mass and a vapor mitigation system in the building. Bentonite plugs were installed at the property boundary within identified vulnerable utility trenches to prevent vapor migration offsite. Vapor mitigation system performance monitoring was weekly for the first month of operation, with the frequency gradually reduced over time to quarterly monitoring.

New Brighton Exchange (VP18560)

In the 1960s, one million cubic yards of debris were placed in a pond and swamp known as Old Miller Dump. The dump occupied approximately half of the eastern portion of the 100-acre New Brighton Exchange redevelopment area. Clean up of the New Brighton Exchange site is complete and most of the area has been redeveloped into five corporate headquarters and a 25-acre residential development. The residential development is located outside of the footprint of the former dump and is monitored for potential methane LFG migration.

Response actions at the site included excavation of 20% of the dump and consolidation of the remaining materials under a new landfill cap. An LFG collection system was installed and incorporated into the cap. The system, which controls horizontal migration, is monitored to verify that methane vapors are dissipated safely.

LFG is monitored using a network of vapor monitoring (VM) points located beyond the perimeter of the closed dump. The LFG venting system at Old Miller Dump includes a passive LFG recovery system with vent risers (VRs) in the dump footprint, and a passive vertical LFG venting system with vertical vent risers (VVRs) and vent cleanouts (VCOs) located in the northwest portion of the dump footprint (Barr 2014).

The current monitoring network consists of eight primary VM points and five secondary VM points. If measured methane concentrations at the primary VM point(s) exceed the primary action level, then secondary VM point(s) and/or building venting systems will be evaluated against their action level. Monitoring frequency varies at the site depending on methane levels. Due to the presence of elevated methane at one of the newly installed wells, monthly monitoring was initiated, and sub-slab monitoring was conducted quarterly in the nearby buildings for a year, which confirmed results did not exceed action levels. Quarterly monitoring is conducted in the remaining areas at the site. Dump cover integrity inspections are conducted semiannually.

Redhead Mountain Bike Park

This 225-acre mountain bike park was designed out of an abandoned mine pit near Chisholm. The former iron rangeland sat vacant for over 40 years after a decline in iron-mining production. No contaminant remediation was required, however, the 35+ miles of trails were designed to avoid stockpiles of iron ore, wetlands, and other mine features. The final trail alignment was also based on the presence of desirable views, sensitive plant species, slope stability, local drainage, ease of maintenance, and non-biking recreational sites and trails.

France Avenue Dump (VP6661 through VP6667 and BF0001348)

The France Avenue Dump in Bloomington was mined for gravel and backfilled with fill and debris. Following its use as a dump, light industrial and commercial buildings were constructed in the former dump area. These buildings were razed in the 1990s to prepare for redevelopment in the mid-2000s of the MarketPointe Office Park and other redevelopment projects. Subsequent investigations defined the location of waste and soil contamination and found elevated methane gas in the former dump area. Response actions at the MarketPointe Office Park included construction of vapor mitigation systems, methane monitoring from gas probes, and sealing utility penetrations with flexible boots, expanding foam and mastic. The methane monitoring from gas probes and groundwater monitoring were discontinued with MPCA approval in 2007. The vapor mitigation systems operate continuously and are inspected semi-annually.

Bass Lake Dump (VP22530)

The 5.5-acre property in St. Louis Park is adjacent to a wetland and Bass Lake. The property was used for disposal of burned household, commercial, and industrial wastes in the 1960s and 1970s. The ash had been covered by a thin layer of soil and vegetated and was used for sports fields prior to 2006. The mixed soil and ash were found to contain RCRA metals, PCBs, pesticides, PAHs, and DRO. The cleanup goal was to increase the soil cover over the ash to reduce the risk to human health and to reduce the potential for further erosion or runoff from the ash into the wetlands. During construction of the existing healthcare facility, the ash and contaminated soil was managed on site at a deeper depth and covered with clean soil. The ash was completely removed in the areas redeveloped as stormwater ponds. Approximately 400 cubic yards of excess contaminated soil was disposed of at an industrial solid waste landfill. As a precaution against vapor intrusion, a vapor barrier and passive venting system were installed on the building. The passive venting system is inspected annually and provided to the MPCA in an annual report, which also includes a summary of any subsurface work completed during that monitoring period in accordance with the MPCA-approved RAP for the site.

Kaposia Landing (VP5391, VP5392, and BF0001447)

This park located along the Mississippi River was once part of the large Port Crosby dump in South Saint Paul. The first phase of redevelopment included construction of baseball diamonds, a dog park, and trails. Response Actions during the first phase of redevelopment included removal of some impacted soil intermixed with debris, site regrading, vapor barrier installation in baseball dugouts, and capping the remaining debris. The second phase of redevelopment included construction of volleyball courts, a playground, picnic areas, and stormwater features. Cap inspections are conducted annually and after major floods along the river.