Environmental and Civil Engineering Report: 112 Emma Oakley Mills Way, Mashpee, MA

0. Risk Summary and Analysis

The proposed development area presents a complex array of environmental, geological, and regulatory challenges that collectively contribute to a high-risk profile for conventional development projects.

This analysis breaks down the key risk factors and their potential impacts on development feasibility.

1. Ecological Sensitivity
    a. Risk Level: High
    b. Analysis: The presence of five vernal pools within a 1.31 km radius, with the closest just 0.21 km from the property, creates significant ecological sensitivity. Vernal pools are critical habitats for various species, including potentially rare or endangered ones. Any development risks disrupting these delicate ecosystems, potentially violating local and state regulations.
2. Hydrological Complexity
    a. Risk Level: High
    b. Analysis: The site features a complex hydrological environment with both surface (vernal pools) and groundwater (wells) resources. The high water table (as shallow as 6 feet in some areas) and permeable subsurface materials increase the risk of groundwater contamination from surface activities. This complexity necessitates sophisticated water management strategies for any development.
3. Geological Variability
    a. Risk Level: Moderate to High
    b. Analysis: The subsurface conditions vary significantly over short distances, from fine sand to boulders, with bedrock depth ranging from 6 feet to over 900 feet. This variability complicates foundation design, increases the potential for differential settlement, and may require specialized (and costly) construction techniques.
4. Regulatory Constraints
    a. Risk Level: Very High

    b. Analysis: The Mashpee Wetlands Bylaw imposes strict regulations, including a 100-foot buffer zone around water bodies and wetlands. These regulations significantly limit the developable area and require extensive permitting processes. The potential for vernal pool certification could further restrict development options.
5. Water Resource Management
    a. Risk Level: High
    b. Analysis: The presence of both high-yield and slow-recovery wells indicates complex aquifer dynamics. Ensuring sustainable water supply without impacting existing users or ecosystems will be challenging. Moreover, wastewater management is complicated by the high water table and regulatory restrictions on septic systems near wetlands.
6. Stormwater Management
    a. Risk Level: High
    b. Analysis: The combination of a high water table, permeable soils, and ecologically sensitive areas demands advanced stormwater management solutions. Conventional approaches may be insufficient to protect water quality and prevent hydrological disturbances to vernal pools.
7. Climate Change Vulnerability
    a. Risk Level: Moderate to High
    b. Analysis: The shallow water table and presence of vernal pools make the area particularly susceptible to climate change impacts, such as altered precipitation patterns or increased temperatures. Long-term development viability may be affected by these changing conditions.
8. Engineering Challenges
    a. Risk Level: High
    b. Analysis: The site presents numerous engineering challenges, including potential soil liquefaction, frost heave risks, and the need for specialized foundation designs. These factors will likely increase construction costs and complexity significantly.
9. Environmental Compliance
    a. Risk Level: Very High
    b. Analysis: The sensitive nature of the site will require extensive environmental impact assessments, ongoing monitoring, and strict compliance with local, state, and potentially federal regulations. This increases project costs and timelines and introduces the risk of regulatory violations.
10. Community and Stakeholder Opposition
    a. Risk Level: Moderate to High
    b. Analysis: Given the ecological significance of the area, any development proposals may face opposition from local environmental groups, residents, and possibly regulatory bodies. This could lead to project delays, additional costs, or even project cancellation.

Overall Development Risk Score: 8/10 (Very High Risk)

1. Executive Summary

This report provides a comprehensive analysis of the environmental and civil engineering aspects of the area surrounding 112 Emma Oakley Mills Way, Mashpee, MA. The analysis is based on data from nearby vernal pools and wells, revealing a complex hydrological environment with significant implications for development, conservation, and water resource management.

Key findings include:

- Presence of five vernal pools within a 1.31 km radius
- Five wells within a 0.31 km radius, indicating high groundwater usage
- Complex subsurface geology with variable overburden composition and depth to bedrock
- Stringent local wetland regulations that significantly impact land use and development

This report outlines the environmental considerations, civil engineering implications, regulatory landscape, and provides recommendations for sustainable development and environmental stewardship in the area.

2. Site Overview

The study area is centered around 112 Emma Oakley Mills Way, Mashpee, MA, which appears to be in a suburban or rural setting with a mix of residential and potentially commercial properties. The presence of vernal pools and various well types suggests a complex hydrological environment that requires careful consideration for any development or environmental management plans.

3. Vernal Pools Analysis

3.1 Distribution and Characteristics

Five vernal pools have been identified within a 1.31 km radius of the property:

1. Closest Vernal Pool
   - Distance: 0.21 km
   - Coordinates: (42.564814, -71.428951)
   - ID: Unknown
2. Second Closest Vernal Pool
   - Distance: 0.41 km
   - Coordinates: (42.566759, -71.428118)

    - ID: Unknown
3. Third Vernal Pool
    - Distance: 0.69 km
    - Coordinates: (42.561933, -71.437467)
    - ID: Unknown
4. Fourth Vernal Pool
    - Distance: 0.73 km
    - Coordinates: (42.570546, -71.428439)
    - ID: Unknown
5. Farthest Vernal Pool
    - Distance: 1.31 km
    - Coordinates: (42.550814, -71.428145)
    - ID: Unknown

3.2 Significance and Ecological Importance

Vernal pools are temporary bodies of water that typically form in the spring from melting snow and rain, then dry up in summer or fall. These unique habitats are critical for several reasons:

1. Breeding grounds: They provide essential breeding habitat for amphibians like wood frogs and salamanders, as well as certain invertebrates.
2. Species diversity: Vernal pools support a diverse array of plant and animal species, some of which are rare or endangered.
3. Food web support: They contribute to local and regional biodiversity by supporting complex food webs.
4. Water quality: Vernal pools can help in flood control and improve water quality by filtering runoff.

3.3 Environmental Implications

- Development restrictions: The proximity of vernal pools, especially the closest one at just 0.21 km from the property, may significantly limit the types and extent of development allowed on nearby properties.
- Water quality considerations: Activities within the watershed of these pools could potentially affect their water quality. This is particularly important for the three pools within 0.73 km of the property, which form a cluster of habitats.
- Habitat connectivity: The spatial distribution of the pools, ranging from 0.21 km to 1.31 km from the property, suggests the need for maintaining corridors between them to support wildlife movement, especially for amphibian species that migrate between pools and upland habitats.

3.4 Regulatory Considerations

- Lack of identification: The absence of ID numbers for these pools may indicate that they are not officially certified or protected under state regulations. This presents both a challenge and an opportunity for local conservation efforts.
- Potential for certification: Given their proximity to developed areas, these pools may be candidates for official certification, which could provide additional legal protections.
- Buffer zones: Even without official certification, best practices often recommend maintaining undeveloped buffer zones around vernal pools. The extent of these buffers can vary but often range from 100 to 300 feet.

3.5 Monitoring and Conservation Recommendations

1. Conduct detailed biological surveys of each pool to document species presence, particularly focusing on indicator species that would qualify the pools for official certification.
2. Implement a regular monitoring program to track the hydroperiod (duration of flooding) of each pool, as this is crucial for their ecological function and may be impacted by climate change or local development.
3. Establish volunteer-based citizen science programs to engage the local community in vernal pool conservation and monitoring efforts.
4. Develop educational materials and programs to inform local residents about the importance of these vernal pools and how to protect them.
5. Work with local conservation commissions and state agencies to explore the possibility of officially certifying these vernal pools for added protection.

4. Well Analysis

4.1 Well Distribution and Characteristics

Five wells have been identified within a 0.31 km radius of the property:

1. 112 Emma Oakley Mills Way (0.08 km): Irrigation well, 900 feet deep
2. 112 Emma Oakley Mills Way (0.14 km): Monitoring well, 20 feet deep
3. 200 Emma Oakley Mills Way Road (0.27 km): Monitoring well, 21 feet deep
4. 228 Emma Oakley Mills Way Road (0.27 km): Monitoring well, 12 feet deep
5. 210 Emma Oakley Mills Way Road (0.31 km): Irrigation well, 40 feet deep

4.2 Hydrogeological Insights

- The wells serve various purposes, including irrigation and environmental monitoring.
- Well depths range from 12 to 900 feet, suggesting a complex subsurface geology with water-bearing zones at different depths.
- The well completion dates span from 1989 to 2024, indicating ongoing development and water needs in the area.

4.3 Specific Well Characteristics

a. 112 Emma Oakley Mills Way (0.08 km):

- Deepest well at 900 feet, indicating potential access to a deep aquifer
- High yield (15 GPM) but very slow recovery time (24 hours), suggesting limited aquifer recharge
- Lack of lithology data is a concern for understanding subsurface conditions

b. 112 Emma Oakley Mills Way (0.14 km):

- Shallow monitoring well (20 feet) likely used for environmental monitoring
- Detailed construction information provides insight into local shallow geology (sand and gravel)

c. 200 Emma Oakley Mills Way Road (0.27 km):

- Another shallow monitoring well (21 feet) with similar construction to the previous one
- Consistent shallow geology (fine to coarse sand) across the area

d. 228 Emma Oakley Mills Way Road (0.27 km):

- Very shallow monitoring well (12 feet) with a high water table (6 feet below surface)
- Lack of lithology data limits geological interpretation

e. 210 Emma Oakley Mills Way Road (0.31 km):

- Irrigation well (40 feet deep) with good yield (28 GPM)
- Lithology shows boulders and gravel, indicating a potentially productive shallow aquifer

4.4 Hydrogeological Implications

- Water table fluctuations: The shallow depth to water in some wells suggests potential for seasonal fluctuations and surface water interactions.
- Aquifer vulnerability: The predominantly sandy and gravelly subsurface materials indicate high permeability, which can lead to rapid contaminant transport.
- Well interference: The high density of wells could lead to interference effects, particularly for the irrigation and deeper wells.
- Monitoring needs: The presence of multiple monitoring wells suggests ongoing environmental concerns or regulatory requirements in the area.

5. Detailed Lithology Analysis

5.1 Overburden Composition

a. 112 Emma Oakley Mills Way (0.08 km well):

- Lacks lithology data, which is a significant gap in understanding the deeper subsurface
- Reaches bedrock at 6 feet, indicating a very thin overburden layer in this location

b. 112 Emma Oakley Mills Way (0.14 km well):

- 0-20 feet: Sand and Gravel (Brown)
- Suggests a glacial outwash or alluvial deposit environment

c. 200 Emma Oakley Mills Way Road (0.27 km well):

- 0-10 feet: Fine to Coarse Sand (Brown)
- 10-21 feet: Fine to Coarse Sand (Brown)
- Indicates a relatively homogeneous depositional environment, possibly a glacial outwash plain or ancient river system

d. 228 Emma Oakley Mills Way Road (0.27 km well):

- No lithology data provided, limiting understanding of this specific location

e. 210 Emma Oakley Mills Way Road (0.31 km well):

- 0-1 foot: Top Soil
- 1-21 feet: Boulders & Gravel
- 21-40 feet: Boulders & Gravel
- Suggests a glacial till deposit, with a thin soil layer overlying poorly sorted glacial material

5.2 Bedrock Characteristics

- Only the 112 Emma Oakley Mills Way (0.08 km) well provides information about bedrock, encountered at 6 feet depth
- The well extends 894 feet into bedrock, but without lithology data, rock type or variations with depth cannot be determined
- Significant depth into bedrock suggests it may be tapping into deep fracture systems for water supply

5.3 Hydrogeological Implications

- Predominantly sandy and gravelly overburden suggests high permeability and potential for rapid groundwater movement
- Presence of boulders indicates potential for preferential flow paths and variable aquifer characteristics

- Shallow depth to bedrock in one location (6 feet) contrasted with deeper overburden elsewhere suggests a variable bedrock surface, which could influence groundwater flow patterns

5.4 Spatial Variability

- Significant variability in overburden thickness and composition over relatively short distances, indicating a complex depositional history
- This variability could result in localized differences in aquifer properties, contaminant transport potential, and geotechnical characteristics

5.5 Geotechnical Considerations

- Sandy and gravelly materials are generally favorable for foundation support but may require compaction or other treatment to prevent settlement
- Presence of boulders could pose challenges for excavation and underground construction
- Variable depth to bedrock could necessitate different foundation designs even for closely spaced structures

5.6 Environmental Implications

- High permeability of overburden materials increases the vulnerability of the aquifer to surface contamination
- Thin overburden in some areas provides little natural filtration for percolating water, potentially allowing rapid transport of contaminants to bedrock aquifers

5.7 Data Gaps

- Lack of lithology data for the deep well and one of the shallow wells represents a significant data gap
- Additional geotechnical borings or geophysical surveys would be beneficial to better characterize the spatial variability of the subsurface
- Groundwater sampling and analysis from different depths could help understand the vertical variability in water quality and aquifer characteristics

6. Environmental Considerations

6.1 Water Resources

- The area has both surface water (vernal pools) and groundwater resources that are closely interconnected
- Shallow water table and permeable subsurface materials suggest a high potential for surface activities to impact groundwater quality

- Management of stormwater runoff and potential contaminants is crucial to protect both vernal pools and groundwater

6.2 Ecosystem Management

- Vernal pools likely support a unique ecosystem that requires protection
- Maintaining buffer zones around the vernal pools and ensuring habitat connectivity should be prioritized in any land use planning
- Varying depths of wells indicate multiple aquifer systems that may support different ecological niches

6.3 Land Use Planning

- Development in the area should consider the locations of vernal pools and wells to minimize environmental impact
- Low-impact development techniques should be employed to maintain natural hydrology and protect water resources
- Zoning and land use regulations should reflect the sensitive nature of the local ecosystem

6.4 Water Quality Monitoring

- Presence of monitoring wells suggests ongoing or past environmental concerns
- A comprehensive water quality monitoring program should be implemented or maintained to track potential impacts on both surface and groundwater resources

6.5 Climate Change Considerations

- Shallow water table and vernal pools may be particularly susceptible to climate change impacts, such as altered precipitation patterns or increased temperatures
- Long-term planning should account for potential changes in hydrology and ecosystem dynamics

7. Civil Engineering Implications

7.1 Foundation Design

- High water table and variable subsurface conditions (from sand to boulders) present challenges for foundation design
- Structures may require special foundations, such as pile foundations or water-resistant designs for basements

7.2 Drainage Systems

- Area likely requires careful stormwater management to protect both vernal pools and groundwater
- Low Impact Development (LID) techniques, such as bioswales and permeable pavements, should be considered to maintain natural hydrology

7.3 Water Supply

- Presence of high-yield wells suggests that groundwater could be a viable water source for development
- Slow recovery time of some wells indicates the need for careful water resource management and potentially water conservation measures

7.4 Wastewater Management

- High water table and permeable soils may limit the use of conventional septic systems
- Advanced onsite wastewater treatment systems or connection to a municipal sewer system (if available) may be necessary to protect water quality

7.5 Geotechnical Considerations

- Variable subsurface conditions, from fine sand to boulders, require detailed site-specific geotechnical investigations for any significant structures
- Soil liquefaction potential should be assessed due to the saturated sandy soils

7.6 Infrastructure Planning

- Underground utilities must be designed with consideration for the high water table and potential for corrosion in saturated conditions
- Road design should account for potential frost heave in areas with shallow groundwater

7.7 Environmental Compliance

- Any development plans will likely require extensive environmental impact assessments and permitting due to the sensitive ecological features (vernal pools) and complex hydrogeology
- Erosion and sediment control plans will be crucial during any construction activities to protect water resources

8. Mashpee Wetlands Bylaw Analysis

This section provides an analysis of the Mashpee Wetlands Bylaw and its implications for the area around 112 Emma Oakley Mills Way, Mashpee, MA.

8.1 Purpose and Scope

The Mashpee Wetlands Bylaw aims to protect wetlands, related water resources, and adjoining land areas through prior review and control of potentially impactful activities [1, § 171.1]. The bylaw's scope is comprehensive, including a 100-foot buffer zone around various water bodies and wetland types [1, § 171.2.A].

8.2 Prohibited Activities and Buffer Zones

The bylaw prohibits removing, filling, dredging, altering, or building upon wetlands and within 100 feet of various water bodies and wetland types without a permit from the Conservation Commission [1, § 171.2.A]. It also specifically prohibits septic systems (with some exceptions), dumping, and storage of potentially harmful substances within the buffer zone [1, § 171.2.B].

8.3 Permit Process and Requirements

The permit process involves submitting a written application to the Conservation Commission, followed by a public hearing [1, § 171.4, § 171.6]. The Commission must issue a decision within 21 days of the hearing's closure [1, § 171.6.E].

8.4 Vernal Pool Protection

The bylaw defines a vernal pool as one certified by the Massachusetts Natural Heritage and Endangered Species Program [1, § 171.9]. It protects vernal pools by including them in the list of resource areas subject to the 100-foot buffer zone [1, § 171.2.A].

8.5 Enforcement and Penalties

The bylaw grants the Conservation Commission authority to enter private land for inspections, issue enforcement orders, and initiate civil and criminal court actions [1, § 171.11]. Violations can result in fines of up to $300 per day per violation [1, § 171.11.E].

8.6 Implications for 112 Emma Oakley Mills Way

Given the analysis of the Mashpee Wetlands Bylaw and the known presence of vernal pools near 112 Emma Oakley Mills Way, the following implications should be considered:

1. Development Restrictions: Any proposed development on the property will likely require careful planning to avoid or minimize impacts to the 100-foot buffer zones around the vernal pools [1, § 171.2.A]. This could significantly limit the developable area of the property.
2. Permit Requirements: Any work within the buffer zones will require a permit from the Conservation Commission, involving a public hearing process and potentially detailed environmental impact assessments [1, § 171.4, § 171.6]. This process could extend project timelines and increase development costs.
3. Vernal Pool Certification: While the identified vernal pools are not currently certified, it would be prudent to treat them as protected resources. The Conservation Commission

may still consider these areas during the permit review process, especially if they meet the ecological criteria for vernal pools. Seeking official certification could provide clarity but might also increase restrictions on the property.

4. Septic System Considerations: The prohibition on new septic systems within buffer zones could significantly impact development options if the property is not connected to municipal sewer systems [1, § 171.2.B(1)]. This underscores the need to verify the property's current wastewater management system and the availability of municipal sewer connections.
5. Stormwater Management: Any development plan will need to include comprehensive stormwater management to prevent impacts on the nearby vernal pools and other wetland resources [1, § 171.1]. This may require innovative Low Impact Development (LID) techniques.
6. Long-term Compliance: The strong enforcement mechanisms in the bylaw emphasize the need for ongoing compliance, even after development is complete [1, § 171.11]. This could impact long-term property management and maintenance practices.

9. Recommendations

Based on the comprehensive analysis of environmental conditions, civil engineering considerations, and local regulations, we propose the following recommendations:

1. Vernal Pool Assessment: Conduct a detailed ecological survey of the vernal pools to determine their ecological significance and potential for certification. This will help clarify their regulatory status and inform development planning.
2. Wetland Delineation: Engage a certified wetland scientist to accurately delineate the wetland boundaries and associated buffer zones on the property. This will provide a clear understanding of developable areas.
3. Geotechnical Investigation: Perform a comprehensive geotechnical study to better characterize the variable subsurface conditions, particularly the depth to bedrock and the presence of boulders. This will inform foundation design and construction planning.
4. Hydrogeological Assessment: Conduct a detailed hydrogeological study to understand groundwater flow patterns, potential impacts on nearby wells, and the property's water supply potential.
5. Stormwater Management Plan: Develop a comprehensive stormwater management plan incorporating LID techniques to minimize impacts on vernal pools and groundwater resources.
6. Wastewater Management Evaluation: Assess the feasibility of connecting to municipal sewer systems. If not possible, explore advanced on-site wastewater treatment options that comply with local regulations.
7. Environmental Impact Assessment: Prepare a thorough environmental impact assessment, considering both short-term construction impacts and long-term effects of development on local ecosystems.

8. Regulatory Consultation: Engage in early and ongoing consultation with the Mashpee Conservation Commission to understand how they interpret and apply the Wetlands Bylaw, particularly regarding uncertified vernal pools.
9. Sustainable Design Approach: Adopt a sustainable design approach that minimizes environmental impacts, preserves natural habitats, and enhances the property's ecological value. This could include creating wildlife corridors and implementing green building practices.
10. Long-term Monitoring Plan: Develop a long-term environmental monitoring plan to track water quality, vernal pool health, and overall ecosystem function before, during, and after any development activities.
11. Community Engagement: Implement a community engagement strategy to inform and involve local residents in the planning process, addressing concerns and fostering support for environmentally responsible development.
12. Climate Change Resilience: Incorporate climate change projections into the design process, considering potential changes in precipitation patterns, temperature, and extreme weather events.
13. Adaptive Management Strategy: Develop an adaptive management strategy that allows for adjustments in property management based on ongoing monitoring results and changing environmental conditions.

10. Conclusion

The area surrounding 112 Emma Oakley Mills Way, Mashpee, MA, presents a complex interplay of surface water features (vernal pools), groundwater resources, variable geological conditions, and stringent local wetland regulations. This environmental and regulatory complexity creates both challenges and opportunities for sustainable development and environmental conservation.

The presence of ecologically significant vernal pools, the high density of wells, the variable lithology, and the comprehensive Mashpee Wetlands Bylaw all contribute to a sensitive environmental and regulatory setting that requires careful management. Any future plans for this area should prioritize the protection of water resources, maintain ecological connectivity, adapt to the unique subsurface conditions, and strictly adhere to local wetland protection regulations.

By implementing the recommendations outlined in this report and working closely with local regulatory bodies, particularly the Mashpee Conservation Commission, stakeholders can work towards sustainable development that balances human needs with environmental protection. Ongoing monitoring, adaptive management, community engagement, and strict regulatory compliance will be key to preserving the unique characteristics of this area while allowing for responsible growth and development.

This report provides a foundation for informed decision-making, but site-specific investigations, ongoing environmental monitoring, and careful navigation of local regulations will be crucial for any future projects or conservation efforts in the area. The complex nature of the site demands a multidisciplinary approach, combining expertise in ecology, hydrology, geology, civil engineering, and environmental law to develop truly sustainable solutions.

References:

[1] Town of Mashpee, Massachusetts. (2019). General Bylaws of the Town of Mashpee, Massachusetts 2019, Chapter 171: Wetlands.