Hydrogeological Study (Urban)

PURPOSE:

This document provides guidance for the completion of a Hydrogeological Study (Urban), which may be required for the submission of an application under the *Planning Act*. All Hydrogeological Studies shall follow the requirements referenced in this document.

A Hydrogeological Study provides information required for various development or infill Planning applications to assess dewatering needs. The Study will characterize the subsurface hydrologic and geologic conditions in an urban area and determine the quality and quantity of groundwater that may be required to be discharged to the City sewage works or managed on-site as a result of a proposed development. Hamilton's Sewer Use By-law 14-090 only permits dewatering of construction water with advanced approval from the City of Hamilton and does not permit any long-term / post construction permanent drainage (or dewatering) and discharge from a property into a Hamilton sewer.

The Hydrogeological Study is required for the following types of applications:

- Official Plan Amendment;
- Zoning By-law Amendment;
- Plans of Subdivision;
- Consent to Sever with an immediate associated development or Building permit application;
- Site Plan Control;
- Building Permits; and,

- Dewatering applications for construction dewatering (e.g., transit projects, utility projects, etc. not subject to Planning Applications or Building Permit Applications).

The applicant is responsible for the timely submission of the Hydrogeological Study.

PREPARED BY:

The Hydrogeological Study must be prepared by a consultant registered as a Professional Engineer (P. Eng.) or Professional Geoscientist in the province of Ontario. The consultant must affix their stamp and seal and specifically identify the engineer who prepared the work. The consultant is expected to be a qualified consultant experienced in hydrogeology.

CONTENTS:

A Hydrogeological Study shall contain the following:

Executive Summary

- Number of monitoring wells installed;
- Groundwater flow direction;
- Highest groundwater static water level reading measured from the monitoring wells in metres above sea level (masl) and metres below ground surface (mbgs) and estimated highest static water level with seasonal variations included;
- Number of underground levels proposed for the project and the finished floor elevation (FFE) of the lowest level in mbgs and masl; and,
- A cross-section (A-A) drawing illustrating the following:
  - Lowest anticipated excavation depth in mbgs and masl;
  - FFE of lowest level of the proposed building in mbgs and masl;
  - Seasonal highest groundwater elevations in mbgs and masl (as well as aquifers and aquitards);

        - Confined and unconfined aquifers and aquitards; and,
        - Other important groundwater features found (e.g., sand lenses, karst features etc.);
    - Construction dewatering total daily volumes in Litres per day and peak flow rate in Litres per minute with applied safety factor documented and precipitation amount applied in the total volume;
    - Summary of groundwater quality sample compliance with storm and sanitary/ combined sewer By-Law limits in Hamilton Sewer Use By-law 14-090;
    - Identification of non-compliant sample parameters and for which sewer system;
    - For long-term drainage (dewatering) and discharge, confirmation of site hydrogeological conditions to either maintain 1m separation between seasonally high groundwater table or constructing a bath-tubbed structure; **Note:** The City of Hamilton does not permit the discharge of permanent drainage of groundwater from the foundation drainage system into the municipal sewer infrastructure;
    - A summary of any impacts identified due to the construction dewatering activities and any requirements for monitoring and mitigation; and
    - Identification if the regulatory requirement of an Environmental Activity and Sector Registry (EASR) or Permit to Take Water (PTTW) is applicable for the project;

Introduction/Background

- Description of the subject site and the proposed development including a context map;
- Outline the scope of work;
- Proposed sub-grade depth of the development and sub-surface structure area (square meters);
- Land use classification of proposed building(s) (commercial, residential etc.);

- Characterization of the hydrogeological setting (i.e., a brief description of the local and regional physiographic features, nearby water bodies and the groundwater flow direction); and,
- Consulting firm and qualified person responsible for completion of the Hydrogeological Report and when it was performed;

Desktop Overview

- Study Area Map;
  - A map showing locations of all identified on-site and off-site wells, boreholes, buildings, property boundaries, watercourses, and drainage features within the study area (typically obtained via MECP well records)
  - Hydrogeological cross-sections with geology, monitoring well locations (and screened intervals) and static water level measurements range observed.
- Subsurface (Geological and Hydrogeological) and Physiographic Characterization;
- Report of Existing Monitoring Wells and Data;
- Historical use of the Subject Lands/Property; and
- Summary of Ontario Regulation 153/04 Phase 1 and 2 Environmental Site Assessment of the Subject Lands/Property Findings and remediation work resulting from a Phase 2 Environmental Site Assessment (ESA) or Regulatory Agency's requirement to remediate;

Private Well Survey

- If the subject property is located within a 500m radius of the urban-rural boundary or properties that rely on local groundwater resources for on-site water supply (i.e., domestic drinking water, irrigation etc.), then a door-to-door private well survey is required to be completed. A summary of the survey results shall be included;

Geology and Physical Hydrology

- Borehole and Monitoring Well logs with accurate geological description: GPS coordinates (X and Y axis per Hamilton's georeferencing approach). If satellite access for GPS survey is restricted, survey can be completed with total station equipment;
- Table of hydro stratigraphic units and their properties;
- Karst information;
- Description of overburden materials, including thicknesses, and composition.
- Synthesis of hydro stratigraphic units and their properties; units should be classified into aquifers and aquitards and, if possible, named according to the accepted regional model (e.g. Newmarket Till, Thorncliffe Fm., etc.);
- Bedrock type and relative rock quality index (if encountered);
- Characterization of groundwater conditions (e.g. flow directions, flow rates, perched or artesian conditions, etc.); and
- A data model is not necessary; however, a hydrogeological profile is required.

Investigation Methods

Groundwater Monitoring Well Installation

A. Multi-residential, Mid & High-Rise and Industrial, Commercial, and Institutional (ICI) with below grade structures
    - A minimum of five (5) groundwater wells shall be installed at locations that represent the entire proximity of the site. If the site is larger than 30m x 30m additional groundwater wells shall be installed and the qualified professional will use professional judgment to determine the number of additional wells required to adequately characterize the hydrogeological conditions of the entire property;
    - It is required that the wells be installed with a minimum of 3.8 cm diameter and 2 meters below the lowest elevation in the proposed building

structure(s). Additionally, one screened well drilled to a minimum depth of 8m below the lowest elevation in the proposed building structure(s), or to bedrock, whichever is shallower;

- For sites with physical restrictions or smaller and site-specific sites, pre-consultation with City Staff may be required to determine the number of monitoring wells required (however not to be less than 3 monitoring wells in unique circumstances, with prior City Staff approval);

B. Single Family Residential Infill Redevelopment and ICI Slab on Grade

- A minimum of three (3) groundwater wells shall be drilled for single family infill redevelopment (not including subdivision) and slab-on-grade ICI developments.
- The depth of monitoring well installations for single family residential infill or slab-on-grade ICI development shall be as follows:
  - Two wells installed and screened to a depth of 2m below the lowest founding elevation;
  - For the third well, one of the scenarios may apply:
    - If bedrock is not encountered to a depth of 2m below the underside of the founding elevation, then the third well shall be installed to a depth of 4m below the foundation or bedrock, whichever is shallower
    - If bedrock is encountered to a depth of 2m below the underside of the founding elevation, then the third well shall be installed to a depth of 2m below the foundation.
    - The wells shall be installed in a way that would allow determining the groundwater flow direction, and to adequately establish the site hydrogeological conditions relative to the plans for development.

Groundwater Level Monitoring

Groundwater monitoring will be required for a period of time to establish fluctuations and the seasonal high groundwater table. The minimum requirements are as follows:

- Mid and High-Rise Developments – Biweekly measurements of static manual groundwater level taken from all monitoring wells located on the property for a minimum period of 3-months. Note: If site-specific hydrogeological conditions identify highly porous deposits to be encountered as part of the development, then additional monitoring may be required, including for a period of minimum of 1-year or longer.
- Plan of Subdivision (Low-Rise Development) – Static groundwater level monitoring using continuous digital readings (via dataloggers / pressure transducers) and monthly manual readings to be collected for a minimum period of 2-years prior to submission of a detailed design application.
- Based on the groundwater level measurements observed during the monitoring period, the qualified professional will need to demonstrate that there will not be any permanent drainage or dewatering of groundwater and in-turn its discharge to the municipal sewer infrastructure. This can be achieved by either:
  - The mid-rise or high-rise developments are constructed as bath-tubbed (watertight) structures; or
  - Demonstrating that there will be a minimum of 1m separation between the seasonally high groundwater table on-site, and the lowest point of the building foundation.

  Note: For infill residential or low-rise subdivision development, approvals will only be permitted by demonstrating a minimum of 1m separation between the seasonal high groundwater table and the underside of the basement foundation for the entire development area.
- All water levels shall be presented as geodetic elevations referenced to a City of Hamilton, or Canadian Geologic Survey benchmark.
- The static water level readings be provided within the report, in the text and also by way of an excel spreadsheet (Data Management) with the following column headings: Property Address; MW name; Location of MW; X coordinate; Y coordinate; Method used for X, Y Coordinate collection; Highest

Static Water Level Measured; Date of Highest Static Water level Measured; Company Performing Water Level Measurements.

Hydraulic Testing

- Hydraulic Conductivity / Slug Testing - At a minimum, rising head and/or falling head tests (slug testing) should be undertaken on 3 monitoring wells. Hazen method calculations are not accepted due limitations on pore size.
- Pump Test/ Drawdown Analysis – Pumping test may be required where slug tests reveal the hydraulic conductivity of soils to be high (i.e., 10^{-4} m/sec or greater). Pumping tests may require an EASR or PTTW from the MECP and discharge approval from Hamilton Water if extracted groundwater is proposed to be discharged into the City's sewage works.
- At minimum, the following are to be considered:
  - The pumping rate should be established by the qualified professional and shall be at a rate sufficient to reflect the anticipated construction dewatering rates;
  - The testing shall be carried out for a minimum of 6 hours if applicable;
  - Ensure the discharge from the pumping test(s) will not have a negative impact on the site's neighbouring environment or City sewage work;
  - All observation well(s) shall be monitored using digital devices;
  - The discharge flow rate(s) shall be monitored using digital devices;
  - Static groundwater level shall be monitored at all pumping, and observation wells several times prior to, during and after the pumping test to measure the recovery
  - If a surface water body is located within 30 m of the site boundary, the testing shall be carried out for a minimum of 24-hours;
  - If a surface water body is expected to be interfered with by a pumping test, surface water flows and/or levels should also be carried out prior to, during and after the completion of the pumping test;

- Pumping test data, graphs, and a summary of the pumping test data and analysis.
- If any other method other than pump test is used or should a shorter time period be proposed, a detailed explanation of the rationale for the change is to be provided and agreed by City staff; and,
- If discharge from pumping tests results in development activities proposed in a Conservation Authority regulated area, a Conservation Authority Permit may be required.

Groundwater Sampling and Water Quality Analyses

- The report needs to include a baseline water quality review. The water quality must be analysed for all the parameters listed in Sewer Use By-Law;
- Non-filtered sample(s) must be collected from the proposed groundwater source(s);
- Grab or discrete sampling methods for groundwater are permitted to represent groundwater conditions expected to be discharged into the sewer system and require immediate compliance with Sewer Use Bylaw limits. Composite sampling is not allowed;
- Water quality data must be analysed by a Canadian laboratory accredited and licensed by Standards Council of Canada and or Canadian Association for Laboratory Accreditation. A true copy of the analysis report, Certificate of Analysis, and a chain of custody record for the sample must be included with report. The water quality data must be collected within nine (9) months prior to the date of submission. *Groundwater sampling data over 9-months old would deem the report incomplete, and a new sample would need to be collected and analysed to update the report;* and
- If there are any sample parameter exceedances, the groundwater cannot be discharged as it is. The report must include available options and recommendations for pre-treatment.

Groundwater Extraction and Discharge rates and volumes

To evaluate the capacity of the City sewage works, the Report shall provide the following detailed information:

- Flow Rate (L/min) and Total Volume (L/day) for short-term (construction dewatering) with and without safety factors applied, and also the type of shoring system considered during construction;
- An estimated 15 mm rain event in 24 hours in the excavation area shall be determined and displayed separately;
- The Total Volume of groundwater that is dewatered (L/day) shall be provided together with its breakdown of raw groundwater volume (L/day), safety factor applied, and water generated from a 15 mm rain event;
- The calculations should be provided for all excavations or trenching required to support the development (i.e., below ground structures, foundation excavation, water, and sewer servicing etc.);
- Groundwater flow direction;
- For the post-construction scenario, discussion on how permanent groundwater drainage / dewatering and discharge will be mitigated;
- If on-site containment (infiltration gallery/dry well etc.) is to be incorporated as part of the proposed development additional information will be required such as demonstrating compliance with Ontario Building Code and soils are permeable to meet infiltration capabilities. Additionally, the feasibility of the on-site containment solution to manage the expected volume of water shall be demonstrated. LID may not be feasible for large volumes of water;
- Zone of Influence (ZOI) and Impact; and,
- The radius of the Zone of Influence in construction dewatering and Long Term / Perpetual dewatering as part of on-site management and identifying if any negative impact is possible on surrounding buildings; municipal infrastructure (watermains, storm, and sanitary or combined sewers); nearby well users, natural environment; and land stability.

Recommended Mitigation Measures and Monitoring Plan

Any negative impact to the natural environment, or City's sewage works, infrastructure, adjacent buildings or nearby well users or the land stability, as a result of groundwater taking and discharging, the Report shall identify the following:

- The extent of the negative impact per the Zone of Influence section above;
- Details of the existing or pre-construction state of all the infrastructure, City sewage works and natural environment within the affected zone; and,
- The proposed mitigation and monitoring plan.

- If a proposed mitigation plan is recommended, subsequently, a follow-up report is required confirming that the affected zone has been returned to its pre-development condition prior to the groundwater taking and discharging.

OTHER INFORMATION:

The applicant shall ensure that, at a minimum, the reference materials listed below are used in the preparation of the Hydrogeological Study:

- Ontario Water Resources Act
- Ontario Regulation 387/04. "Water Taking Regulation"
- Sewer Use By-law 14-090
- Comprehensive Development Guidelines and Financial Policies Manual (2019)
  Ontario Regulation 153/04 – Records of Site Condition for Phase 1 and 2.

Key Definitions

Groundwater

Groundwater refers to the water found beneath the earth's surface, stored in soil pores and rock formations. In the context of dewatering, it is the water that exists in saturated zone in sub-surface soil.

Precipitation

Precipitation includes rain, snow, sleet, or hail that falls from the atmosphere. In dewatering, precipitation contributes to surface water runoff and can increase water levels around construction sites, requiring drainage or pumping systems to control water accumulation.

Foundation Drainage (Weeping Tiles)

A perforated pipe or drainage system installed underground around the exterior perimeter of a building's foundation. Its primary purpose is to collect groundwater and stormwater and prevent it from accumulating against the foundation walls. The water is directed away from the building, often to a sump pit.

Seasonal High Groundwater Level

The seasonal high groundwater level is the highest point that groundwater reaches during a specific time of the year, typically in response to seasonal precipitation, snowmelt, or lower rates of evapotranspiration.

Temporary / Construction Dewatering

The process of removing groundwater or surface water from a construction site, excavation, or work area to create a dry and stable conditions for construction activities. This is typically accomplished done by using pumps, drainage systems or wells to prevent water accumulation in the excavation area.

Permanent Drainage (Dewatering)

The long-term or indefinite collection of groundwater through a foundation drainage system (perimeter and/or sub-floor drainage) and conveying to a sump pit(s).

Permanent Drainage Discharge

Involves the regular outflow of water collected from foundation drainage systems, typically to a municipal sewer system, water body or other designated discharge points, ensuring ongoing water management post-construction.

Note: City of Hamilton does not permit Permanent Drainage Discharge into the municipal sewer infrastructure.

General Data Report Requirements

- All flows reported shall be in Litres per minute (L/min) and L per day (L/day);
- All reported depths shall be in meters below ground surface (mbgs);
- All reported elevations shall be in meters above sea level (masl);
- Footings, foundation (if differs), and lowest point of structure and/or excavation (e.g., elevator shafts), should be defined in terms of depth in mbgs and elevation in masl; and,
- For all installed monitoring wells, borehole logs must be incorporated into the Hydrogeological Report

Urban Hydrogeological Guidelines:

City of Hamilton Guidelines for Hydrogeological Studies and Technical Standards for Private Services

REVIEWED AND APPROVED BY:

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