Kindred Hydro

Technical Memorandum

Project: Carrik Court Infiltration Testing
Location: Mukilteo Speedway and 88th Street, SW, Mukilteo, WA
Job#: WES-20-1
Date: September 22, 2020

Westcott Holding, Inc.
1010 Market Street
Kirkland, Washington 98033
Attn: Ryan Appleby

Dear Mr. Appleby:

I am pleased to submit this technical memorandum providing the results of infiltration testing for stormwater infiltration design.

Background

An aerial photograph of the site is shown on Figure 1. The proposed project is located at the corner of Mukilteo Speedway and 88th Street SW in Mukilteo, Washington and covers the following parcels: 00611600013402, 00611600013500, and 00611600013600, with a total area of approximately 10 acres. There are two houses and several small out-buildings on the project site. The northern and southern portions of the site are forested and the central portion of the site is pasture and a gravel parking pad.

Based on the preliminary site plan, the project is expected to include approximately 125 townhomes with 16 live/work units along Mukilteo Speedway.

The purpose of this work was to evaluate the potential for stormwater infiltration and provide preliminary infiltration rates for feasibility assessment.

Topography, Mapped Geology, Slope Hazards, Wetlands

The site is generally sloping to the west with an elevation of approximately 445-450 feet above sea level along the east side and an elevation of approximately 415-420 feet above sea level along the west side.

The geologic map for Mukilteo[1] indicates that the site is mapped as glacial till, a dense mixture of silt sand and gravel that is generally poor for infiltration.

Based on a steep slope assessment conducted for a previous project (not publicly available) there are no slopes steeper than 40 percent on the property and in the immediate vicinity of the property. There are slopes steeper than 40 percent approximately 400 feet west of the site.

A wetland has been identified in the southern portion of the site.

[1] Minard, J.P., 1982, Distribution and Description of Geologic Units in the Mukilteo Quadrangle, Washington, USGS, Miscellaneous Field Studies, MAP MF-1438.

Borings and Testpit Explorations

Earth Solutions NW, LLC conducted borings and test pit explorations on the site. Final results of this work are not yet available but preliminary results were reviewed for this infiltration assessment.

Three borings, ranging in depth from 90 to 135 feet, were completed at the site. All three borings encountered glacial till or other low-permeability soils to the full depth of the explorations. There were no significant permeable soil horizons that were suitable for deep infiltration.

Following the deep explorations, nine test pits were excavated across the site to observe shallow soil and groundwater conditions. Most of these test pits encountered weathered glacial till to a depth of 3-4 feet and unweathered glacial till below the shallow weathered zone. Two test pits excavated just west of the gravel parking area encountered fill soils over glacial till. Some of the test pits were left open for infiltration testing.

Infiltration Testing

Shallow infiltration testing was conducted in six test pits left open during the test pit exploration program. These tests were conducted at locations shown in Figure 1 using the small-scale pilot infiltration test (PIT) method provided in the 2014 Stormwater Management Manual for Western Washington (SMMWW).

Before each infiltration test a soil sample was collected from the bottom of each PIT excavation and delivered to Amtest Laboratory in Redmond, Washington for grainsize analysis. The results are provided in Attachment A and summarized in Table 1. All six samples were well sorted silty sands with 1 to 14 percent gravel and a United States Classification System (USCS) designation of SM.

Table 1: Summary of Grainsize Analyses and Infiltration Testing Results

Location	Depth (ft)	% Gravel	% Sand	% Silt	USCS Class	Coefficient of Uniformity	Moisture Content	Design Infiltration Rate (in./hr)
IT-2	4.0	9	70	21	SM	9.8	12%	0.25
IT-3	4.5	6	69	26	SM	16	10%	0.18
IT-4	4.0	14	61	25	SM	13	10%	0.04
IT-5	4.0	6	63	31	SM	11	11%	0.03
IT-7	4.0	1	73	27	SM	7.0	11%	0.24
IT-9	4.0	5	66	30	SM	11	9%	0.12

The details of the infiltration test procedures and the test data are provided in Attachment B. For very low infiltration tests such as these, it can be difficult to obtain an accurate steady state infiltration rate. Therefore, the falling head infiltration rate is considered more reliable and were used to estimate the design infiltration rates. Note that the falling head infiltration rate declines as the depth of water decreases in the test pit and is always less than the steady state infiltration rate, so using the falling head rate provides an extra factor of safety.

As specified in the SMMWW, the design infiltration rate is determined by multiplying the measured infiltration rate by the total correction factor. The total correction factor was calculated using the

following correction factors:

- Site variability and number of locations tested (Cf_v) = 0.9 (Ecology recommends 0.33-1.0)
- Test Method (Cf_t) = 0.5 (Small-Scale PIT)
- Degree of influent control to prevent siltation and bio-buildup (Cf_m) = 0.9

The total correction factor (CF_t) = CF_v x CF_t x CF_m = 0.4. The design infiltration rates for each test are summarized in Table 1.

Recommendations

Two of the three infiltration tests in the southern portion of the site (IT-4 and IT-5) provided significantly lower design infiltration rates (0.03 to 0.04 inches/hour) than the remaining test locations, which provided design infiltration rates ranging from 0.12 to 0.25 inches/hour. These lower test results may be associated with the wetland located in the southern portion of the site. Excluding IT-4 and IT-5, the average design infiltration rate is 0.2 inches/hour. For evaluation of dispersed infiltration facilities outside of the southern portion of the site, I recommend using a design rate of 0.2 inches/hour. For the southern portion of the site, I recommend using a design rate of 0.04 inches/hour.

A design rate of 0.2 inches per hour is sufficient for permeable pavement as long as the permeable pavement section is flat or designed with internal check dams to create storage during large storms. This infiltration design rate may be sufficient for infiltration trenches and bioretention swales underlain by a sufficient reservoir of clean crushed drain rock. These facilities should be equipped with overflow pipes to ensure excess water can be conveyed downstream.

Dispersed infiltration in small facilities has been effective at sites underlain by glacial till. During wet periods, when the ground is most saturated, infiltrating stormwater has an opportunity to spread horizontally before infiltrating. Large infiltration facilities provide less opportunity for horizontal spreading and can be less effective in till soils during wet periods. For this reason, we recommend reliance on small dispersed infiltration facilities rather than large centralized infiltration facilities.

Once locations of infiltration facilities have been identified, additional infiltration testing will be necessary to confirm the design infiltration rate. In addition, groundwater mounding analysis may be necessary to evaluate the combined affect of multiple infiltration facilities across the site.

We recommend having Kindred Hydro, Inc. on site during construction to observe the following:

- The base of any excavation for infiltration BMP's: This inspection allows us to confirm that the soils and groundwater conditions are consistent with our expectations and that the bottom of the excavation is free of silt or other contamination that might clog the facility.
- Samples of any aggregate materials used in the construction of the BMPs to confirm that they meet specifications on the plans.
- Placement of materials during construction of the BMP's to ensure that they conform with the design drawings and specifications.

Limitations and Closure

Work for this project was performed and this report prepared in accordance with generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed. It is intended for the exclusive use of Westcott Holding, Inc. for specific application to the referenced matter. No other warranty, expressed or implied, is made.

If you have any questions or concerns, please contact the undersigned.

Sincerely,

J. Scott Kindred, PE
President
Kindred Hydro, Inc.
Date: ___September 22, 2020

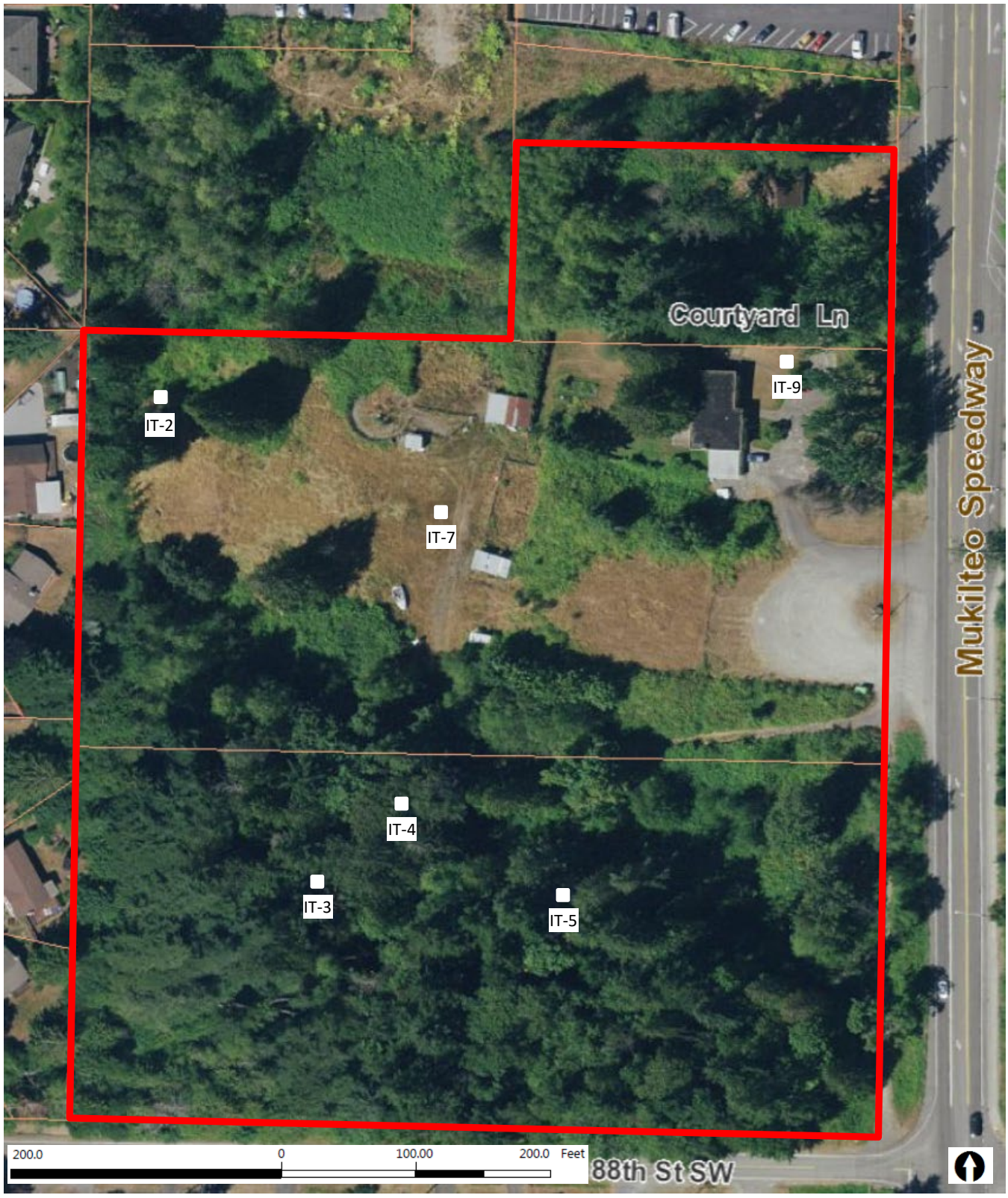

Figure 1: Aerial Photograph of the Site and Infiltration Test Locations

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Attachment A:

Grain Size Distribution Results

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Attachment B:

Infiltration Testing Procedures and Results

Small-Scale Pilot Infiltration Test Procedure

Infiltration testing was conducted in general accordance with the small-scale pilot infiltration test (PIT) method provided in the 2014 Stormwater Management Manual for Western Washington (SMMWW). Key elements of the PIT methodology, along with any significant deviations from the SWWMM procedures, are provided below:

1) The test pits were excavated to a depth of 4.0 to 4.5 feet. This depth was through the weathered glacial till zone and into the unweathered glacial till, which is expected to provide a conservative estimate of infiltration across the site.

2) The horizontal surface area of the bottom of the test pits ranged from 13.5 to 16.2 square feet.

3) The depth of water in the pit was measured using both a vertical measuring rod marked in inches and tenths of an inch and a pressure transducer. The data shown on the data sheets is based on the transducer data.

4) Water was conveyed into the pits using slotted PVC pipe to reduce erosion and disturbance of the bottom soils.

5) Due to the very low infiltration rates, it was not possible to measure the flow rate that would maintain a constant water level in the pits (usually less than 0.1 gallons/minute). Instead, the water level was maintained between a depth of approximately 12 and 14 inches by adding water periodically during the pre-soak period. The pre-soak period lasted at least 6 hours.

6) Once the pre-soak period was ended, the water level was allowed to fall below 12 inches. The steady-state infiltration rate was assumed to equal the falling head rate approximately one hour after the pre-soak period was complete. Using the falling head rate at the end of the hour was more accurate than adding water at a fixed rate to maintain a constant head for an hour.

7) The falling head rate was assumed to equal the falling head rate approximately 60 to 160 minutes after the steady state portion of the test was complete.

8) Due to the slow infiltration rates none of the pits were dry when we returned the next day. Therefore, it was not necessary to over-excavate the pits to see if the test water was mounded on a shallow restrictive layer.

The results of each test are provided on the attached datasheets.