2023-09-29

Brian Kinzie, P.Eng., Municipal Engineer
Town of Canmore
via email: brian.kinzie@canmore.ca

Subject: Palliser Area Structure Plan – Stormwater Feasibility Review

Dear Sir:

LAND ACKNOWLEDGMENT

In the spirit of reconciliation, we acknowledge that the Town of Canmore is located within Treaty 7 region of Southern Alberta. In the spirit of respect, reciprocity and truth, we honour and acknowledge the Canmore area, known as "Chuwapchipchiyan Kudi Bi" (translated in Stoney Nakoda as "shooting at the willows") and the traditional Treaty 7 territory and oral practices of the Îyârhe Nakoda (Stoney Nakoda) – comprised of the Bearspaw First Nation, Chiniki First Nation, and Goodstoney First Nation – as well as the Tsuut'ina First Nation and the Blackfoot Confederacy comprised of the Siksika, Piikani, Kainai. We acknowledge that this territory is home to the Métis Nation of Alberta, Region 3, within the historical Northwest Métis homeland. We acknowledge all Nations who live, work, and play and help us steward this land and honour and celebrate this territory. WSP is committed to working collaboratively with Indigenous communities, groups, and businesses in the areas in which we operate. WSP continuously enhances our business practices, policies, and procedures to provide the structure, resources, and skills necessary to maintain our relationships.

1. INTRODUCTION

The Palliser Area Structure Plan was developed by the Town of Canmore and first adopted in 2000. It outlines all future development within the Palliser area (**Figure 1**), which is located on the Northeast side of Canmore adjacent to the Trans Canada Highway. It is understood that an update to the Palliser ASP is currently underway, with the goal of updating the plan to reflect changes in the local context and to align it with the town's broader planning goals and polices. The updated ASP has a planned completion target of summer 2023. Similar to other regions in Canmore, stormwater servicing for the area is reliant upon infiltration basins due to the lack of a piped storm system or an above ground outfall.

The purpose of this technical letter is to review existing studies involving the hydrologic conditions of the Palliser area with a goal of commenting on the validity of proposed designs, storm volumes, infiltration parameters, and overall stormwater management. The upslope drainage basins and the adjacent Stoneworks Creek are shown on **Figure 2** and were used as general check on catchment routing in this review. This work has been done by reviewing the provided studies and evaluating the technical information as it pertains to the Palliser area. This information has been used to evaluate the infiltration capacity and groundwater flow mechanics. The provided information along with the evaluated hydrogeological conditions, were used to evaluate the proposed designs.

The recommendations contained here-in are solely with regards to the hydrological factors provided within the existing reports as it relates to the Palliser area. WSP has not conducted any independent modelling or assessment of system capacity.

N

LEGEND

LOCATION AREA BOUNDARY

PROPERTY LINE

WSP Canada Inc.
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PROJECT NO: CA0001322.3369

SCALE: 1:7500

DATE: 2023-04-06

DESIGNED BY: TM

DRAWN BY: AI

PROJECT: PALLISER ASP

TITLE: PALLISER ASP BOUNDARY LOCATION PLAN

DRAWING: FIG#1

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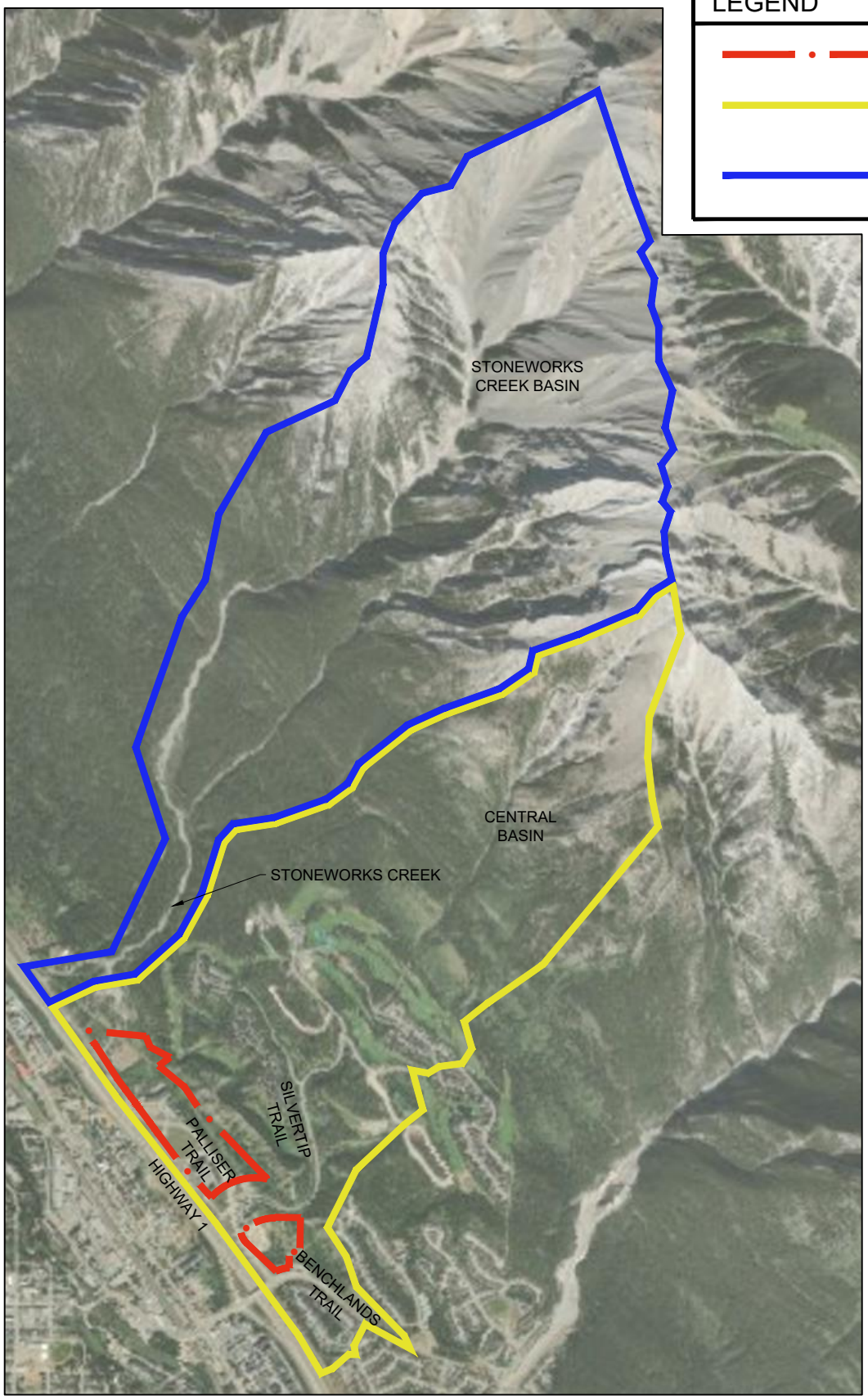

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PROJECT NO: CA0001322.3369

SCALE: 1:30000

DATE: 2023-04-06

DESIGNED BY: TM

DRAWN BY: AI

PROJECT: PALLISER ASP

TITLE: CATCHMENT AREA

DRAWING: FIG#2

2. PAST STUDIES

The Town of Canmore provided our team with several studies conducted near the Palliser ASP boundaries. Reports 2.1 through 2.7 are specifically looking at hydrological properties and stormwater management. Reports 2.8 and 2.9 are geotechnical reports that were used as additional information on the soil properties in the areas adjacent to the Palliser ASP.

2.1 Western and Central Basins Drainage and Hydrogeological Study

This study was prepared by Southwell Trapp and Associates in 2000. It reviews the runoff from two large drainage basins within the original Palliser ASP. It defines these two basins as the Western Basin and the Central Basin. The areas are given as 582 ha and 356 ha, respectively. It's stated within this report that all the runoff from the Western Basin in a 1:100-year event can be infiltrated within the Silvertip stormwater management system. This report provides infiltration rates of $8.0x10^{-4}$ m/s within the Silvertip area soils and $6.0x10^{-5}$ m/s for the Palliser area soils.

2.2 Stormwater Management Master Plan for Silvertip Development Area

This report was prepared, signed, and stamped by Urban Systems LTD. in 1993. This report includes a full detailed design for the stormwater management system in the Silvertip development. It breaks down the Silvertip developments and describes how each area will impact the stormwater runoff. Using computer modelling this report states the total outflow from the Silvertip development in a 1:100-year rain event to be 5.9 m^3/s. This flows directly into the infiltration area near the Benchlands overpass.

2.3 Stormwater Master Drainage Plan for Silvertip Village Phases 9, 10, and 11

This report was prepared by Westhoff Engineering Resources in 2008. The report examines the Central and Western Basins. This report states that a 1:100-year event would exceed the hydraulic capacity of the existing infrastructure above the Palliser area. It states that higher density developments in this area my require a centralized stormwater facility. In the event that the stormwater facilities in these areas fail in a 1:100-year event approximately 135,000 m^3 of runoff will flow into the Palliser area. This report explores a failure scenario in which all the stormwater management systems within the given phases of the Silvertip Village fail to mitigate any runoff. It is likely that the failure of storm ponds 13 and 14 would lead to flooding above the Trans Canada Highway. The report does not explicitly state the type of failure, it seems to explore a scenario where the stormwater flows freely, without attenuation. This report estimates that the Pallier area would have a peak flow rate of 9.26 m^3/s in a 1:100-year event with 2.3 m^3/s of that being from Silvertip.

2.4 Silvertip Stormwater Management Master plan

This report was prepared by Urban Systems in 1998. The report looks at the various retention and detention ponds within the Silvertip development and provides the peak runoff flow rate and maximum release rate for each pond. It also specifies which basin is tributary to each pond. The report indicates that these areas will flow across the Trans Canada Highway through the existing culverts near the Benchlands and Trans Canada Highway interchange. It indicates that the Western and Central Basins in a 1:100-year event would have a runoff hydrograph with a peak flow rate no greater than 5.9 m^3/s. This is sourced as the boundary condition of the original Maser plan. It is noted that the culverts under the Trans Canada Highway may not be able to convey the peak flow rate of 5.9 m^3/s.

2.5 Canmore Western Basin Stormwater Diversion – Infiltration Rate Study

This study was prepared, signed, and stamped by Stantec in 2009. The study was initiated by the Town of Canmore to determine the infiltration rates for the West Basin at high water levels. The testing was conducted in June and July. This study looks at sites to the north of the Palliser ASP boundary, and sites directly across from the Trans Canada Highway near Bow Valley Trail. Falling Head and Floating Head and Hydraulic Conductivity testing was

conducted. Groundwater monitoring wells were used to test the hydraulic conductivity. Varying infiltration rates were determined in areas of similar surficial materials. It was noted that subsurface layers of silt heavily impact the permeability of a given area.

2.6 Palliser Area Master Drainage Plan & Western Basin Diversion Feasibility Study

This feasibility study was prepared and stamped by Westhoff Engineering Resources in 2009. The study was conducted to determine the viability of diverting the Western Basin to the northwest to proposed infiltration basins so it no longer competes with the Central Basin for conveyance across the Trans Canada Highway. The study used computer modelling to compute design flows for a diversion system. The study indicated at times the high groundwater level may go above ground level within the proposed infiltration basin. It includes a drawing of the diversion and the proposed infiltration basins. The infiltration basins hold approximately 30,000 m^3. A 1:100-year 24-hour event is estimated to convey 88,000 m^3 to the infiltration basins. With the conditions present at the time of this report, the Western Basin Diversion would reduce the Palliser areas required storage volume by 26,000 m^3.

2.7 Hydrogeological Investigation for Teepee Town Stormwater Master Drainage Plan - Preliminary Findings

This memo was prepared by ISL Engineering in 2021. ISL Engineering conducted a hydrogeologic study of the Teepee Town area within Canmore. This memo describes groundwater properties such as depth, elevation, hydraulic conductivity, and silt thickness. The memo notes the concern of upwelling in the southeast corner of Teepee Town. The memo includes borehole logs, grain size analysis and hydraulic conductivity test results.

2.8 Pavement Design Recommendations Canmore Teepee Town Pavement

This report was prepared by Clifton Associates and submitted to ISL Engineering in 2016. Within this report the most relevant information comes from the geotechnical considerations and concerns mentioned by Clifton. Clifton Associates mention concerns that the high levels of silt at this location could lead to ice lenses. This is mentioned as a concern for asphalt degradation.

2.9 Geotechnical Investigation for the Proposed Building Our Lady of Rockies Catholic Church

This investigation was prepared, signed, and stamped by Global Engineering and Testing LTD. The study area is located between the two areas that make up the Palliser ASP boundary. The investigation included the drilling of boreholes that found a mixture of organics, sandy silts fills and sandy gravel. The groundwater elevation was measured to be between 4.9 and 5.5 m below the ground surface; the groundwater elevations were collected in the winter.

3. SURFACE WATER DISCUSSION

The most significant study with respect to infiltrating stormwater runoff within the Palliser area was carried out by Westhoff Engineering Resouces, Inc. (WER) and is documented in the report entitled “Palliser Area Master Drainage Plan & Western Basin Diversion Feasibility Study”, dated 2009. A brief summary of the report is provided above.

The report investigated options for diverting stormwater runoff from the Western Basin to the northwest because stormwater runoff from the basin was being conveyed downstream through a culvert that crosses the Trans Canada Highway with limited hydraulic capacity. The study assessed disposing of stormwater runoff from the Western

Basin using an infiltration basin located immediately northwest of the Travel Alberta Information Center as part of the Palliser stormwater management strategy.

The report referenced infiltration testing that was done for this infiltration basin by Jacques Whitford in 2006. The lithology of the site as documented in the Jacques Whitford report is sand and gravel deposits overlying gravel and clay to a depth of 68 m below the surface, with bedrock shale found at a depth of 72 m below the surface. More specifically, the soil stratigraphy is comprised of coarse gravel with a lens of fine to coarse sand at 3.7 m below ground (mbg). Silt buildup was identified beneath the cobbled surface suggesting the site was previously used as an infiltration basin. The depth to the water table was documented as 1.07 mbg on November 6 and 7, 2006. The Alberta Well Log for the observation well #760/0496372 adjacent to the proposed infiltration area reported a depth to the water table of 2.74 m on July 7, 2000.

Three infiltration test wells and a monitoring well were installed in the proposed infiltration area. Falling head and constant head tests conducted at each of the three test sites resulted in computed infiltration rates for the area ranging from 0.12 m^3/hr to 0.99 m^3/hr within a 76.2 mm radius casing. The geometric mean of the infiltration rates was computed as 0.34 m^3/hr. No fluctuation in water level was observed in the monitoring well during the infiltration testing.

WER computed a peak flow rate of 3.5 m^3/s from a catchment area of 860.45 ha for the runoff that is being diverted from the Western basin to the infiltration basin for the 1:100 year design storm event. The peak flow rate translates to a unit area flow rate of 4 L/s/ha which is within the range of flows that have been computed by others for the watersheds located within and around Canmore for the 1:100 year design storm event.

WER computed an infiltration basin area of approximately 2,100 m^2 to infiltrate a peak flow rate of 3.5m3/s based on the lowest infiltration rate of 0.12 m3/hr. This is a very elementary analysis in that it does not consider the runoff volume and the duration that the runoff volume should be infiltrated.

WER noted a major constraint to infiltrating the stormwater runoff within the infiltration basin. Based on data acquired from the Alberta Environment monitoring well #760/0496372 located adjacent to the infiltration area, groundwater levels rise to the ground surface during the months of June and July which would impede the infiltration of stormwater runoff. It is noted that the months of June and July are the highest rainfall months. WER indicated concerns pertaining to the high water table that would complicate using an infiltration basin for disposing of stormwater runoff.

Overall, we determined that the surface water modeling results presented in the previous studies, primarily the 2009 WER study, appear to fall within the expected range of results. The primary area of concern discussed in these studies is the risk of a high water table, which will be discussed in more detail within the following section.

4. SUB-SURFACE WATER DISCUSSION

There are numerous studies that outline the geology and hydrogeology of the area, of most interest is the “Canmore Western Basin Stormwater Diversion – Infiltration Rate Study”, dated 2009, written by Stantec Consulting Ltd., (Stantec Report) and “Geotechnical Investigation for the Proposed Building Our Lady of Rockies Catholic Church”, (Geotechnical Report) study, located directly downgradient of the Palliser area. A Hydrogeological study done by Alberta Environment in 2002 also discussed the geology and hydrogeology of the Canmore Corridor and North-West Kananaskis Country (Alberta Environmental Report) which included detailed geological information of the Canmore area. Other reports have also been used as complimentary information.

The Stantec report discusses a small section of the Palliser Trail to the northwest corner of the project area. The report details eight (8) shallow infiltration wells and one (1) monitoring well that were drilled and installed at site #4, with the purpose of obtaining groundwater and infiltration information. The observed geology at site #4 was

described as having a thin (<0.3m) topsoil layer, underlain by a sandy clay of less than 1 m with gravel inclusions. Coarse gravel and sand were observed from between 3 m and 4.5 m below the ground. The clay was classified as a lower permeability clay at most of the infiltration wells. Water level information indicated that the approximate depth to the water table was 2.1 m below the ground surface. The presence of varying thicknesses of lower permeability materials overlying the high permeability gravels was predicted to lower the overall potential for infiltration capacity in the site #4 area.

The Geotechnical Report describes the geology for the southeastern tip of the Palliser area. Borehole logs indicate the presence of silty clay fill at ground surface that ranged in thickness from 1 to 5 m. A sandy silt layer of variable thickness (between 1 to 3 m) was observed below the silty clay fill. Underlying the sandy silt was a sandy gravel layer which extended to the maximum drilled depth of 12 m below ground surface. Groundwater levels included in this report indicate depth to groundwater varied between 4.5 and 5.5 m below the surface (in February). The geotechnical report recommended that the water table levels be monitored prior to construction to assess fluctuations associated with seasonal changes.

Although the areas of investigation in both the Stantec and Geotechnical reports were limited, the observations collected regarding the geology, infiltration rate, and water table depth are relevant to the Palliser area.

As sited in Section 3, the WER Report contains a section specific to the Palliser area, which includes culvert storage information. This report focused on a drainage option to divert water, which was recommended to be implemented before further development would be feasible within the Palliser area. It was concluded that the limitation of the area is not infiltration specifically but, rather the existing culvert capacity to divert water away from the area. The information in this report specifies the storage capacity of culverts in the Palliser area based off values obtained from the Stormwater Management and Design Manual of the City of Calgary. This report did not include geological data or infiltration rates, and that information was not considered in the recommendation to divert water.

Southwell Trapp & Associates published “Western and Central Basins Drainage and Hydrogeological Study” in 2000, covering the bulk of the Palliser area in its assessment. The study outlined that the gravel soils of the Western Basin are highly porous with high infiltration rates (area equated to the northwest corner of the Central Basin in this report – Figure 2), whereas areas closer to the roadways were lower. It was recommended to consider groundwater elevations prior to constructing an infiltration basin in the area and ground elevations should be filled to a minimum of 1310 m based on the high-water level of the Bow River.

Hatfield Consultants LLP prepared the 2022 Bow River Aquifer Groundwater Model Construction and Calibration report for the Town of Canmore. This report further details the geology, drainage, aquifers, and groundwater characteristics of the Bow Valley, specifically in the Town of Canmore. The unconsolidated sediments that fill the Bow Valley are mostly composed of gravel, sand, and silt. In Canmore specifically, the sediments are composed mostly of gravel and can reach depths of 110 m below the ground surface along the thalweg of the valley. Cross-sections show that the valley bottom is constrained by bedrock which rises steeply from the center of the valley to the east and west. Unconsolidated sediment thickness beneath the Silver Tip golf course was determined to be 40 m which is slightly upgradient from the Palliser area.

Overall, we determined that the hydrogeological data presented in the previous studies fall within the expected range of results given the observed geology. The reviewed studies contain valuable information that can be used to extrapolate or interpret what might be ‘expected’ in the Palliser area for groundwater conditions; however, there is little groundwater monitoring data to confirm the depth of the water table throughout the Palliser area, and only minimal data regarding the depth of fine-grained materials at the ground surface which would inhibit infiltration.

5. PARCEL LEVEL SERVICING COMMENTARY

It is understood that Canmore envisions parcel-level servicing within the Palliser Triangle ASP area. This method of servicing is typical in this type of hydrogeological region and based upon our review of the underlying studies, is an appropriate servicing methodology. This section provides some details on how parcel-level infiltration servicing could be implemented. At the parcel level, the onsite stormwater system will consist of the following typical elements:

- Surface water collection including swales, gutters, ditches, culverts, and catch basins.
- Stormwater storage using surface or subsurface techniques including oversized piping, tanks, or open storage facilities.
- Sediment capture, either oil and grit separators, Low Impact Development features, or other systems, to reduce the probability of downstream clogging in the infiltration facility.
- Infiltration outlets typically consisting of drywell or infiltration gallery.

Infiltration rates are highly site specific, and on this basis, site level testing will be required at all locations of planned infiltration. The achievable infiltration rates from the system will dictate the necessary sizing of the storage elements. All infiltration systems require independent assessment by a qualified geotechnical engineer or hydrogeological engineer.

The storage element is a very significant variable in onsite servicing costs. In locations with constrained infiltration rates, onsite storage volumes could be significant. Onsite storage costs are further variable depending upon how the volume storage is achieved, ranging from surficial storage in depressions (essentially free) to underground concrete storage vaults.

6. CONCLUSIONS AND RECOMMENDATIONS

Based upon the review documented in this letter, WSP makes the following conclusions and recommendations:

- The technical basis of servicing documented in the referenced studies appears to be valid and falls within the range of results WSP would generally expect to encounter.
- Servicing of the Palliser ASP area via infiltration is a feasible stormwater servicing solution assuming overall aquifer capacity is monitored and managed effectively. It is important to note that local and regional groundwater table elevations are variable and subject to infiltration inputs. Current efforts to better manage drainage within Stoneworks Creeks are important and will assist with reducing the load on the aquifer.
- Parcel level infiltration system site planning must include geotechnical drilling to assess the thickness of fine-grained sediments and infiltration testing conducted by a qualified geotechnical consultant to confirm the site-specific infiltration rates and to assess the local risk of groundwater mounding.
- Design criteria should be developed for infiltrating stormwater systems, including:
    - Modelling requirements.
    - Design storms.
    - Drawdown rates.
    - Materials and specifications.
- Despite the planned 100-year return period servicing to groundwater, the Town should consider opportunities for emergency overflow routes to allow for a more resilient system.
- Available hydrogeological data is insufficient to predict seasonal water table level variations within the Palliser ASP. The Town of Canmore has two groundwater monitoring wells (#30 and #39) located in the

Palliser ASP. These monitoring wells should be located and assessed, if they are found to be functional (i.e. similar total depth to when installed, not damaged, or silted up), water level data should be collected at the same frequency as the rest of the Towns monitoring well network.

- The Stantec 2009 Western Basin Stormwater Diversion – Infiltration Rate Study indicates that a monitoring well (09-MW03) was installed on the west side of the highway. Effort should be made to locate this monitoring well and if it still exists and is functional, it too should be included in the Towns water level monitoring program.

5. CLOSING

We trust you find the information provided here-in to be sufficient for your purposes. Further details can be provided if deemed necessary.

Yours sincerely,

Surface Water

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Groundwater

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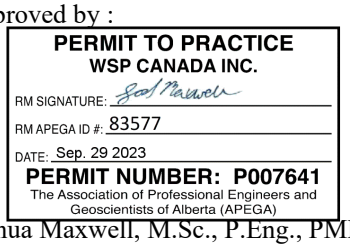
Group Manager, Hydrogeology – Water Management

Approved by :



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