

**Municipal District of  
Greenview**

# **Water availability assessment for the Greenview Industrial Gateway – V2**

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## 1.0 Introduction

The Municipal District of Greenview (Greenview) is developing a large-scale Eco-Industrial zone, known as the Greenview Industrial Gateway (GIG), to promote value-added industrial growth in the natural gas supply chain which will leverage the GIG's co-location with the Montney formation. It is understood that multiple project phases are envisioned within the GIG boundary, with the first such project planned for an approximately 2,000 acre boundary which will host up to five individual petrochemical facilities (e.g. methanol, amine, urea fertilizer, etc.). The possible future development within the GIG, but outside of the approximately 2,000 acre boundary, is outside the scope of this analysis.

Developing the approximately 2,000 acre boundary (i.e. the Project) requires access to a secure and reliable water supply which can support long-term operations and growth. The first step in securing a water supply is developing an understanding of the regional water context, including water availability in surface water bodies close to the GIG, existing water allocations on these water bodies, and applicable water management plans, policies, and regulations.

This report provides an assessment of the regional water context, with a focus on the water available for new allocations from the Smoky River and the implications of this availability on Greenview's potential development plan for the Project, such as water storage and staged build-out. The body of the report includes a brief summary of the data analysis approach (Section 2.0), presentation and interpretation of the results (Section 3.0), associated recommendations (Section 0), and next steps (Section 5.0) for Greenview to secure a long-term water supply for the Project. Appended to this report is a detailed analysis methodology and presentation of water availability results.

Note that this report does not include analysis of groundwater availability in the area, which is not anticipated to be a suitable alternative to the Smoky River for the Project due to expected limited available volume, withdrawal rates, reliability, and quality. In addition, the report does not contemplate climate change, which may have future impacts on the hydrology, and associated water availability, of the Smoky River. Climate change modelling and groundwater analysis can be integrated into future phases of work, as required by the regulator and/or to help further refine Greenview's water supply plan for the GIG.

## 2.0 Approach

Assessing the water availability of a source water body, informed by its hydrology, is a critical step in analyzing a proposed project's anticipated water security and the potential environmental impacts of the project. Other analyses, such as fish and fish habitat impact assessments and wildlife and terrestrial habitat impact assessments, are important, subsequent steps in securing long-term water supply access, which will be considered in future work.

The water availability assessment for the GIG was completed using an approach consistent with current regulations and best practices, using the best data currently available through public sources. To provide

an understanding of how the Project's water supply may change over time, the assessment considered a range of possible river flow scenarios, representing typical (or median), dry, and very dry years.

To determine the water availability for the Project, the first step was to determine which surface water body would be the most feasible and reliable. Based on proximity to the Project, the Smoky and Cutbank Rivers were initially considered as potential water sources. However, historical flow data indicate that the Smoky River is an order of magnitude larger than the Cutbank River and flows more consistently throughout the winter. This significant disparity in flow, coupled with the Smoky River's adjacency to the Project, resulted in the elimination of the Cutbank River from consideration.

The next step was to determine the water available for new allocations under the *Water Act* from the Smoky River at the Project location. For the Smoky River, the volume available for new allocations is dictated by the Surface Water Allocation Directive (SWAD), which requires that a specific volume of water remain in the river to sustain the environment and a healthy aquatic ecosystem. To predict water availability using the SWAD, the naturalized flow on the Smoky River was estimated at the Project location and the rules of the SWAD were applied.

The water available for new allocations informs the number of petrochemical facilities the Project may be able to support, as well as potential water storage requirements to compensate for low flow periods (year over year and/or seasonally). The analysis below includes an estimate of the storage requirements for Greenview's full build-out of the Project within the approximately 2,000 acre boundary.

To complete the analysis, several datasets for the Smoky River watershed were utilized, including historical river flow data sets from the Water Survey of Canada (WSC), and water allocation data from the Alberta Water Tool, which summarizes data directly from the Alberta Environment and Parks (AEP) licence viewer database. In addition, the water demands of the Project were estimated based on the water use profile of typical petrochemical facilities in Alberta and data provided by Greenview.

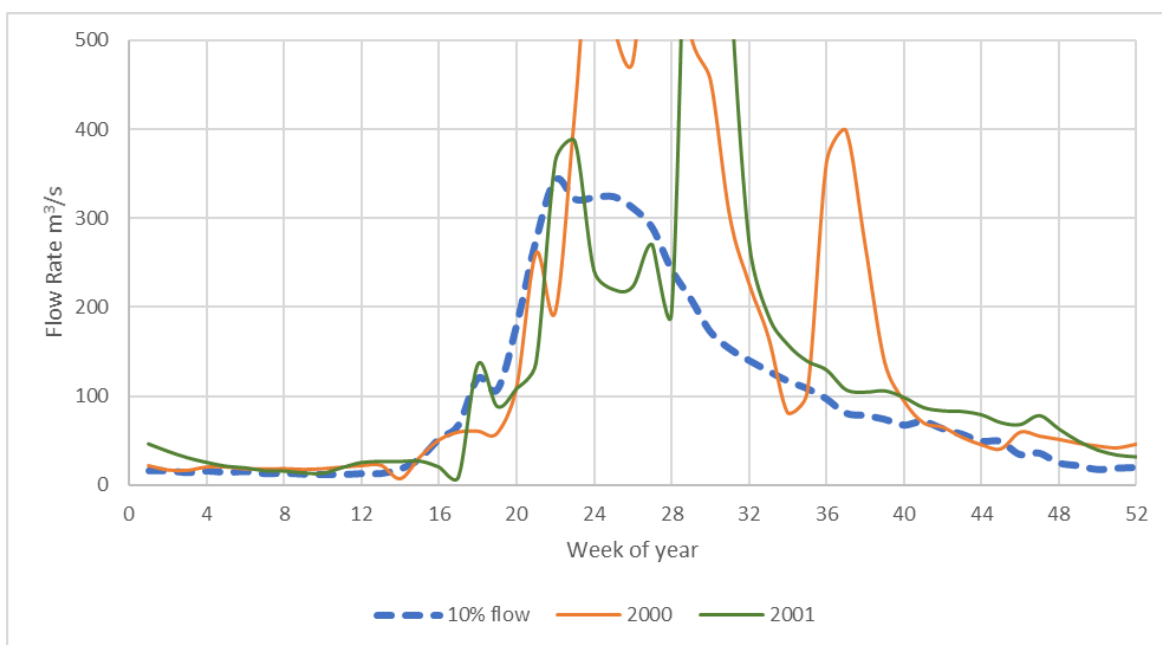
## 3.0 Results

The approach outlined above and detailed in the appendix was utilized to assess water availability on the Smoky River. The results are presented in three sub-sections below, focusing on water available for new allocations over the course of a year, implications of this availability on potential storage requirements, and existing large licence holders on the Smoky River.

### 3.1 Water availability

In this analysis, three potential scenarios for water supply were considered, representing a median, dry, and very dry year on a weekly timestep. As detailed in the appendix, these flow scenarios were prepared using statistical percentiles from the available historical flow dataset. For a median year, the 50<sup>th</sup> percentile flow was used, while a dry year used the 25<sup>th</sup> percentile, and a very dry year used the 10<sup>th</sup> percentile. The 10<sup>th</sup> percentile flow from the WSC period of record was compared to recorded flows in the

years 2000 and 2001, which are known to have been low flow periods. As Figure 1 illustrates, the recorded flows from 2000 and 2001 are higher than the 10<sup>th</sup> percentile flow from the entire WSC dataset. This includes both the average and total flows over the course of the year. Therefore, the 10<sup>th</sup> percentile flow is more conservative than the 2000 and 2001 recorded flow. Hence, if the Project plan can account for the very dry year, 10<sup>th</sup> percentile flow, it would also accommodate the recent low flow periods in 2000 – 2001.

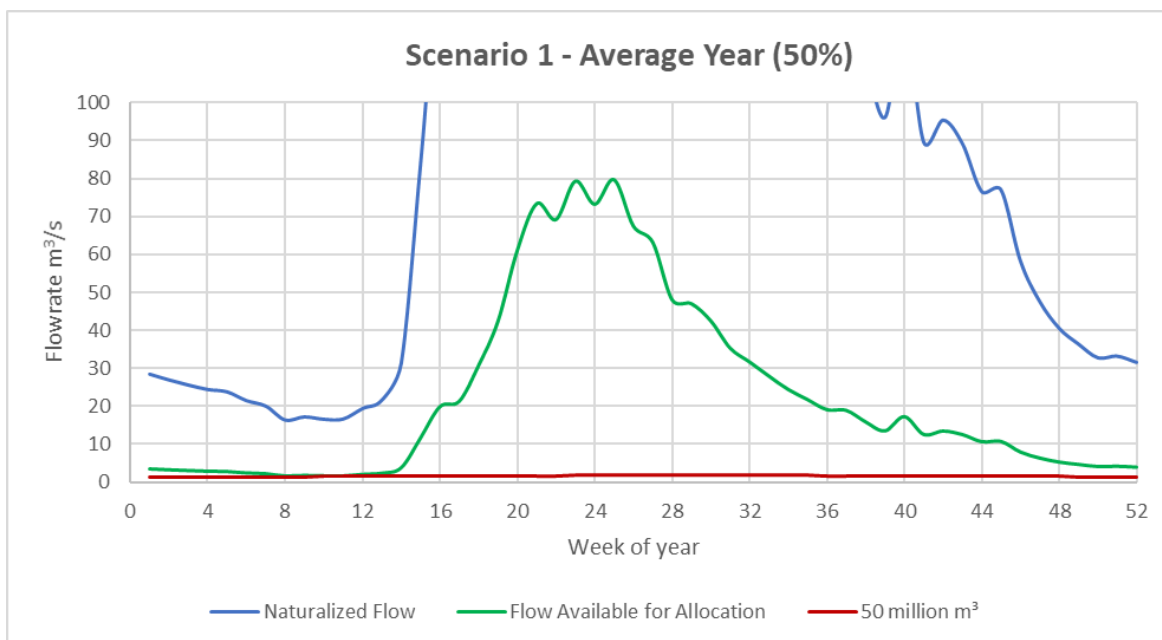


**Figure 1** Comparison of the 10<sup>th</sup> percentile flow from the WSC period of record to recorded flows in 2000 and 2001

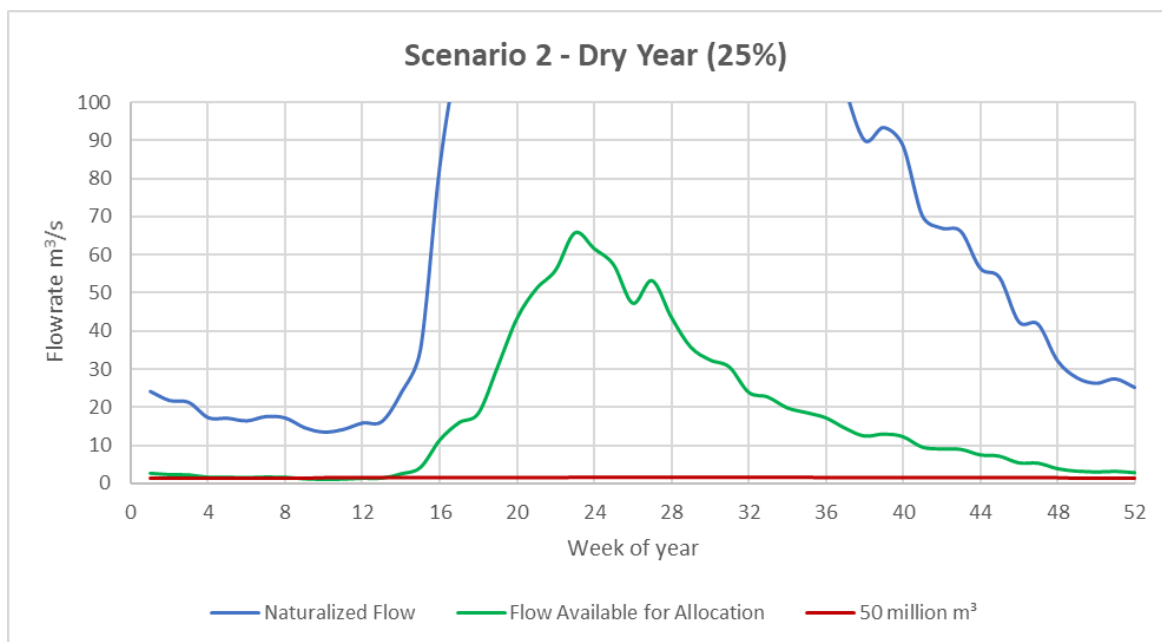
Figures 2, 3, and 4 below demonstrate how the flowrate in the Smoky River varies over the course of the year for the median, dry, and very dry flow scenarios, respectively. Each figure also includes the total volume available for new allocations under each scenario, according to the SWAD rules and accounting for water which is already allocated to existing users. For the sake of comparison, the figures below include an anticipated upper limit water demand for the Project of 50 million m<sup>3</sup> per year (representing maximum development of the approximately 2,000 acre boundary), which was distributed over the year according to the water use profile of a typical petrochemical facility in Alberta (i.e. higher in the summer to meet increased cooling needs). Note that the actual water needs of the Project may be much lower than 50 million m<sup>3</sup> per year, with estimates being refined over time as planning progresses.

As the figures demonstrate, the flowrate in the Smoky River is significant, but variable over the course of the year. Similar to other Alberta rivers with headwaters in the Rocky Mountains, the Smoky River's flowrate is high during the spring and summer months, then drops in the winter (i.e. October – March). In addition, a significant volume is reserved for the environment by the SWAD. The ability of the Smoky River to meet the Project's water needs varies over the course of the year and depends on the flow and demand scenarios utilized. As will be explored further in Section 3.2, water storage may be required to address

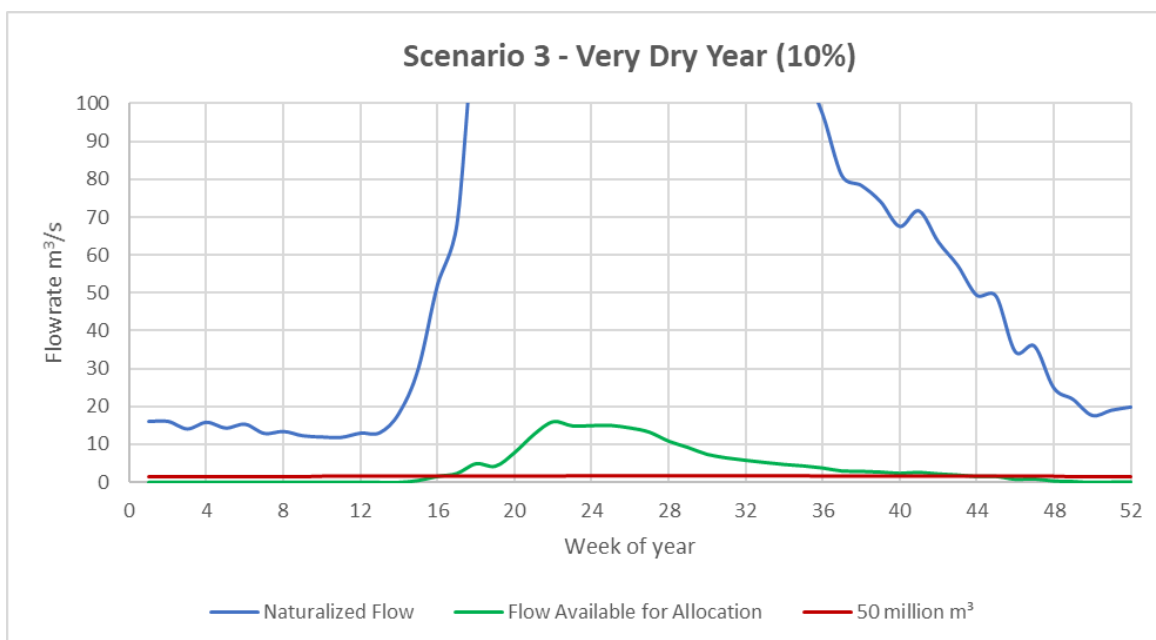
water supply risk, particularly in the winter months.



**Figure 2** Scenario 1 – median (50<sup>th</sup> percentile) flow scenario, indicating Smoky River flowrate and volume available for new allocations, compared to the anticipated upper limit water demand from the Project



**Figure 3** Scenario 2 – dry (25<sup>th</sup> percentile) flow scenario, indicating Smoky River flowrate and volume available for new allocations, compared to the anticipated upper limit water demand from the Project



**Figure 4** Scenario 3 – very dry (10<sup>th</sup> percentile) flow scenario, indicating Smoky River flowrate and volume available for new allocations, compared to the anticipated upper limit water demand from the Project

### 3.2 Storage requirements

As noted in Section 3.1, there may be periods during the year when flow in the Smoky River is reduced to the point that the water required for the Project exceeds the volume available for allocation. In such cases, Greenview would not be able to withdraw water from the river. To ensure continued operation of the Project's petrochemical facilities during low flow periods when withdrawals from the river are not permitted, on-site water storage may be required. Storage may also be considered due to its potential operational benefits; however, these considerations are not factored into the analysis in this Section.

The estimated water storage requirements are a function of water demand and water availability. Stored water is utilized more during low flow and drought conditions, so the calculation to estimate storage must assume reduced river flow. In this case, two river flow scenarios were selected, representing a dry year (25<sup>th</sup> percentile flow) and a very dry year (10<sup>th</sup> percentile flow).

In recognition that the Project's water demand will increase as more facilities become operational, five progressively increasing water demand scenarios were selected to estimate storage requirements throughout staged development of the Project. The scenarios increase in steps of 10 million m<sup>3</sup> per year, approximating the development of petrochemical facilities over time, up to the hypothetical maximum use of 50 million m<sup>3</sup>. Seasonal variability in facility water demand was accounted for, based on experience with petrochemical facilities in Alberta (i.e. lower in the winter due to lower cooling requirements).

Table 1 shows the estimated water storage volume required for each demand and flow scenario. The methodology for estimating the storage requirements for each scenario is detailed in Appendix –

Methodology. The table also indicates the number of weeks for which storage would be necessary in each scenario. This refers to the weeks when the Project's water demand exceeds the water available for allocation in the Smoky River, such that some or all of the Project's water needs would need to be met by water which is already stored.

**Table 1** Estimated water storage during dry and very dry years for five water demand scenarios

|            | Annual GIG demand volume (m <sup>3</sup> /year) |            | Storage Volume required (m <sup>3</sup> /year) | Number of weeks storage is required |
|------------|-------------------------------------------------|------------|------------------------------------------------|-------------------------------------|
| Scenario 1 | Very dry year (10% flow)                        | 10,000,000 | 2,930,000                                      | 18                                  |
|            | Dry year (25% flow)                             |            | 0                                              | 0                                   |
| Scenario 2 | Very dry year (10% flow)                        | 20,000,000 | 6,370,000                                      | 20                                  |
|            | Dry year (25% flow)                             |            | 0                                              | 0                                   |
| Scenario 3 | Very dry year (10% flow)                        | 30,000,000 | 10,030,000                                     | 22                                  |
|            | Dry year (25% flow)                             |            | 0                                              | 0                                   |
| Scenario 4 | Very dry year (10% flow)                        | 40,000,000 | 14,000,000                                     | 22                                  |
|            | Dry year (25% flow)                             |            | 150,000                                        | 2                                   |
| Scenario 5 | Very dry year (10% flow)                        | 50,000,000 | 17,990,000                                     | 24                                  |
|            | Dry year (25% flow)                             |            | 780,000                                        | 5                                   |

Table 3 indicates that, purely from a water availability perspective, there is no need for water storage in the early stages of development during dry years (25<sup>th</sup> percentile flow), although it would be required during very dry years (10<sup>th</sup> percentile flow). However, as more facilities are built (Scenarios 3 and higher), storage will be required in both dry and very dry years to support the additional facilities, up to 24 weeks of the year for Scenario 5 in a very dry year scenario.

### 3.3 Major licence holders

Table 2 lists all existing surface water term licences greater than 500,000 m<sup>3</sup> on the Smoky River. These existing term licence holders, known as senior licence holders, will have priority over Greenview's future water licence for the Project, meaning they will have the right to divert all their licensed water volumes before Greenview can withdraw any water during low flow periods, regardless of whether the licence holder is located upstream or downstream of the Project. Communications can be established with senior licence holders to explore water sharing opportunities and management strategies for low flow periods. The table does not include temporary diversion licences (TDLs), because TDLs have no priority under Alberta's priority-based allocation system and will therefore not impact the Project's water access.

Notably, there are few existing licence holders, with low allocated volumes, relative to the size of the Smoky River.

**Table 2** List of all surface water licences greater than 500,000 m<sup>3</sup> on the Smoky River

| Licence Holder               | Licence Number | Priority number | Licence Volume (m <sup>3</sup> ) | Diversion Rate (m <sup>3</sup> /s) | GPS Coordinates       |
|------------------------------|----------------|-----------------|----------------------------------|------------------------------------|-----------------------|
| Milner Power <sup>1</sup>    | 00037203       | 1969-06-26      | 12,345,675                       | 0.379                              | 53.993967,-119.093858 |
| CST Canada Coal <sup>2</sup> | 00250879       | 2011-09-22      | 2,482,283                        | 0.119                              | 53.993967,-119.093858 |
| Strathcona Resources         | 00432650       | 2019-08-21      | 1,800,000                        | 0.200                              | 54.357881,-118.478222 |
| Hammerhead Resources         | 00391747       | 2018-05-23      | 1,600,000                        | 0.200                              | 54.663417,-118.532170 |
| Paramount Resources Ltd.     | 00401586       | 2018-03-23      | 1,000,000                        | 0.125                              | 54.823454,-118.588401 |
| Paramount Resources Ltd.     | 00389305       | 2018-03-15      | 800,000                          | N/A                                | 54.721587,-118.481827 |
| Hammerhead Resources         | 00458802       | 2020-02-11      | 750,000                          | 0.375                              | 54.561701,-118.330796 |
| Hammerhead Resources         | 00422836       | 2018-04-13      | 600,000                          | 0.125                              | 54.808786,-118.537548 |
| Hammerhead Resources         | 00422327       | 2018-11-22      | 500,000                          | 0.125                              | 54.808786,-118.537548 |

**Note 1:** Milner Power's consumptive use may be lower than the volume noted in Table 2, thanks to the nature of the facility and conversions from thermal coal to natural gas. However, the full licensed volume is assumed to be consumptive and is included in the water availability analysis, which is conservative.

**Note 2:** It is understood that operations at this facility are currently suspended. However, the full licensed volume is included in the water availability analysis, which adds another layer of conservatism.

## 4.0 Recommendations

Based on the preceding analysis and in recognition of the rapidly evolving nature of Greenview's planning for the Project, several recommendations have been prepared on the best water supply option for the Project and potential pathways for Greenview to secure long-term water access. These recommendations feed into the suggested next steps (Section 5.0), enabling Greenview to make progress towards long term water security for the Project without restricting the development process and future opportunities.

As documented in Section 3.0, the Smoky River is an ideal water source for the Project, thanks to its adjacency to the Project, large flowrates, and relatively modest existing allocations. It is anticipated that the Smoky River can more than accommodate the full development of the Project, with a total water demand as high as 50 million m<sup>3</sup> per year (although actual water needs may be lower). Depending on the anticipated build-out schedule and Greenview's approach to water supply risk management, water storage will likely be required to manage operational requirements and compensate for lower-flow

periods (i.e. October – March). There appear to be locations within the Project area which would be suitable for water storage reservoirs, although further analysis will be required to optimize water storage design and siting. Similarly, it may be possible for Greenview to leverage existing rights of way to transport water to the anticipated facilities and/or storage sites, although further analysis will be required to confirm this and identify the optimal location for water intake infrastructure.

Therefore, it is recommended that Greenview secure a licence under the *Water Act* for the diversion of water from the Smoky River and then secure the necessary permits to construct suitable intake, transportation, and treatment infrastructure to deliver this water to the Project customers' facilities. It is recommended that storage be incorporated as part of Greenview's water management infrastructure for the water supply risk management benefits demonstrated in Section 3.2. Future work will be required to prepare the ideal storage infrastructure plan, which will incorporate risk appetite, physical constraints, economics, and operational considerations.

It is recommended that Greenview take the necessary next steps (outlined below) to apply for a water diversion licence under the *Water Act* for the maximum anticipated development of the Project, with Greenview named as the licence holder. This approach will provide Greenview with both control and certainty over the Project's water supply, as well as the flexibility to contract out water delivery operations (e.g. to a utility company) as desired. Although AEP has shown deference to municipalities applying for licences with long time horizons in the past, it is anticipated engagement with AEP will be required to better understand what licensing options and time horizons may be made available for the Project.

## 5.0 Next Steps

This report has documented analysis of the Smoky River as a potential water source for the Project and associated potential water storage needs and outlined recommendations for Greenview to secure long-term water access from the Smoky River and distribute this water to the Project customers. This work can be leveraged to support several next steps to progress the Project's water access, some of which can be executed in parallel:

- **Engage in discussions with AEP:** To better understand AEP's preferences as the regulator of the Smoky (e.g. licence time horizons) and to communicate the Project's development plan and water needs, Greenview should engage in discussions with AEP, which will be led by WaterSMART.
- **Prepare documentation to support a *Water Act* application:** In pursuit of a water diversion licence for Greenview to support development of the Project, WaterSMART will prepare materials which will support a *Water Act* application. This includes documenting the most up to date version of the Project's development plan available, assessing potential regional stakeholder risks associated with the licence application, and discussing potential risk mitigation approaches (e.g. water reuse, operational strategies, communications).
- **Progress water storage planning:** Based on the updated development plan for the Project and Greenview's approach to water supply risk management, prepare updated estimates for water

storage requirements and progress design (including siting).

- **Progress water delivery infrastructure planning:** In concert with water storage planning and leveraging updated development plan information, progress the design of water intake, transportation, and treatment infrastructure. This includes design and location selection for pipelines, pumps, and water intake structures.

## Appendix – Methodology

The water availability in the Smoky River was assessed using the following steps, each of which is detailed below:

1. Estimate the naturalized flow in the Smoky River at the Project location using available recorded flow datasets in the basin<sup>1</sup>.
2. Determine water reserved for the environment in the river, based on the Surface Water Allocation Directive (SWAD).
3. Based on the water reserved for the environment (Step 2) and the estimated naturalized flow (Step 1), determine the volume of water available for allocation in the river.
4. Based on existing senior licences and accounting for their expected withdrawal profiles based on licence type, determine how much of the water available for allocation (Step 3) is left over for new allocations in the river.
5. Compare the Project's anticipated water demand to the water available for new allocations in the river (Step 4) to develop an understanding of the scenarios under which the Project's water needs will be met.
6. Based on the comparison in Step 5, estimate the volume of storage which will be required to ensure the Project has sufficient water supply when the Smoky River will not meet the Project's needs.

For each step above, various flow scenarios are used to study how flowrates can vary annually, in order to understand how water availability may change year over year (e.g. considering a wet year compared to a dry/drought year). The results will indicate the likelihood of water supply challenges over the life of the project and are fed into the risk management process.

The various flow scenarios refer to percentile flows, which are statistical values useful for assessing how the flow in rivers is expected to vary in average, dry, and very dry years.

- The 50<sup>th</sup> percentile flow, also known as median or 50% flow, represents the flow for which 50% of the recorded streamflow was higher, and 50% was lower, over the entire dataset. This gives a sense of what a typical year's flow will look like.

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<sup>1</sup> The recorded flow dataset refers to measurements of river height, taken at Water Survey of Canada stations, which are converted into river flowrate measurements using staged discharge curves, also developed by the Water Survey of Canada. Recorded flow datasets are typically developed using daily measurements over a span of several decades (ideally three or more).

- The 25<sup>th</sup> percentile flow, also known as lower quartile or 25% flow, is the flow for which 75% of the recorded streamflow was higher, and only 25% was lower. This represents a dry year.
- The 10<sup>th</sup> percentile flow, also known as lower decile or 10% flow, is the flow for which 90% of the recorded streamflow was higher, and only 10% was lower. This represents a very dry year.

Additional terms are sometimes used in the context of water availability assessments, although they are included here for completeness only and will not be utilized below. These alternative terms are applied to the same recorded flow dataset and many terms have the same statistical meaning as percentile flows. The following alternative terms can be used:

- Exceedance flow, which refers to the proportion of recorded streamflow which exceeds some value. For example, 80% exceedance flow refers to the flow for which 80% of the recorded streamflow is higher. It is an inverse way of referring to a percentile flow (e.g. 20<sup>th</sup> percentile flow = 80% exceedance flow) and either terminology can be utilized.
- Mean flow, which is the statistical average of the recorded flow dataset, is distinct from the median flow. Mean values are more sensitive to outliers, from a statistical perspective, and are not commonly used for water availability assessments.
- Mean annual discharge, which refers to the average measured flowrate for a year, over the entire recorded flow dataset.

## Data sources

The following publicly available data sources were utilized to assess water availability in the Smoky River:

1. Recorded flow datasets for the period of record from the Water Survey of Canada (WSC) gauge stations on the Smoky River and its tributaries, as summarized below:

| Station ID | River                      | Years included in data* |
|------------|----------------------------|-------------------------|
| 07GA001    | Smoky River at Hells Creek | 1968-2014, 2018         |
| 07GA002    | Muskeg River               | 1972-2015, 2018         |
| 07GB003    | Kakwa River                | 1994-2015, 2018         |
| 07GB001    | Cutbank River              | 1970-2015, 2018         |
| 07GE001    | Wapiti River               | 1961-2014, 2018         |
| 07GF001    | Simonette River            | 1969-2015, 2018         |
| 07GH002    | Little Smoky River         | 1960-2014, 2018         |
| 07GJ001    | Smoky River at Watino      | 1956-2014, 2018         |

\*Note the gap from 2014 – 2018 reflects a gap in data provided by the WSC gauge stations. Investigation into the cause(s) for this gap was outside the scope of this report.

2. The SWAD, which provides steps for determining the volume of water which is reserved for the environment. The SWAD is published by Alberta Environment and Parks (AEP) and available online [here](#).
3. Record of existing water licences for each watershed, generated by running watershed reports from the [Alberta Water Tool](#) and analyzed using the [Alberta Water Licence Viewer](#). The existing licences include diversions from the Smoky River mainstem as well as its tributaries.

Note that only surface water is considered in this report. In some cases, groundwater sources may be connected, or contributing, to surface water bodies, but this does not constitute the majority of river flow. In most cases, groundwater availability and licensing are handled separately from surface water. In addition, the groundwater allocations for the Smoky River watershed are relatively small compared to surface water allocations.

### **Step 1: Naturalized flow estimate**

The naturalized flow, which is required by the SWAD for estimating water availability, is defined as recorded (measured) streamflow or water levels that are adjusted for upstream flow regulation by structures and impoundments, and water licences or uses, to approximate the flows that would occur in the absence of regulation, water extractions, or returns. Hence, to estimate the naturalized flow on the Smoky River at the proposed location of the Project, both recorded flows and allocations must be taken into consideration. Note that a naturalized flow dataset for the Smoky River from AEP did not exist at the time of analysis, necessitating this estimation.

The Smoky River has a WSC gauge station near its headwaters (Smoky River at Hells Creek) and near its confluence with the Peace River (Smoky River at Watino). The Project is located almost in the middle of these two locations, quite far from each. Therefore, the naturalized flow on the Smoky at the Project must be estimated using the Smoky's existing WSC gauge stations far upstream and downstream of the site, and accounting for the contribution of the Smoky's tributaries in between. The tributaries are either added to, or subtracted from, the WSC gauge stations on the Smoky to work forwards or backwards to the Project location.

Two methods were utilized to estimate the naturalized flow in the Smoky at the Project, one starting from the upstream WSC gauge station and the other starting from the downstream WSC gauge station. For each approach, the naturalized flow in the tributaries was estimated by taking the recorded flow dataset from the WSC gauge station and adding in the diversion licence volumes upstream of the station. The two approaches are illustrated in Figure 5 and can be expressed mathematically as follows:

#### **Upstream analysis**

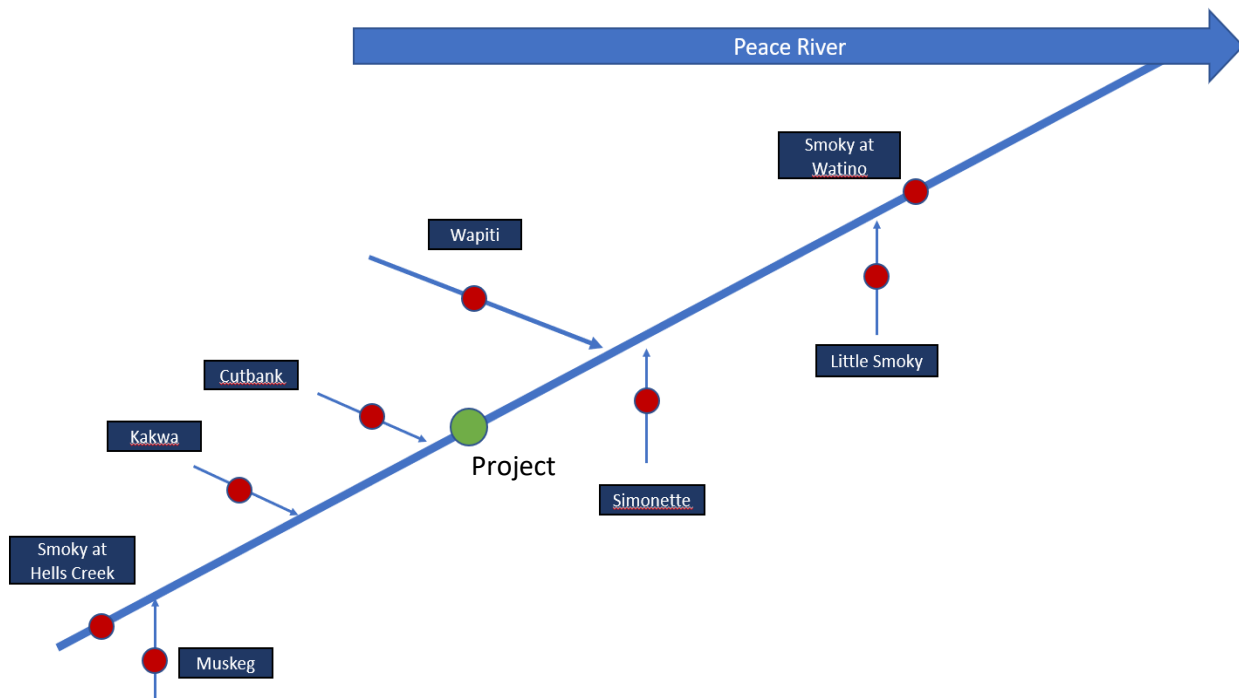
*Naturalized Smoky River at Project = Naturalized Smoky River at Hells Creek + Naturalized Muskeg River +  
Naturalized Kakwa River + Naturalized Cutbank River*

## Downstream analysis

$$\text{Naturalized Smoky River at Project} = \text{Naturalized Smoky River at Watino} - \text{Naturalized Wapiti River} - \\ \text{Naturalized Simonette River} - \text{Naturalized Little Smoky River}$$

The downstream analysis produced a higher estimate of the naturalized flow at the Project than the upstream estimate. The difference in the two estimates can be attributed to the significant distance between the two WSC gauge stations on the Smoky River and the contribution of flows between these stations which are not measured in (e.g. groundwater flows and smaller tributaries that don't have WSC gauge stations).

When comparing the flows of the upstream and downstream analysis, it was noted that the upstream analysis had non-recorded (i.e. 0 m<sup>3</sup>/s) flows for the first eight and the last eight weeks of the year. This is likely because the equipment used for flow recording could not operate under frozen river conditions, which occur in this part of the watershed during winter. In contrast, the WSC gauge stations used in downstream analysis provided recorded flow throughout the entire year, thanks to greater flowrates in the downstream rivers, which prevents freezing issues. It is expected that the Smoky River at the Project location will flow throughout the year, meaning the upstream naturalized flow estimate would significantly underestimate the naturalized flow at the Project, particularly for the low-flowing winter months where precision is most important. Furthermore, accuracy in the high-flow periods is less important because the flowrates are significant regardless of estimation approach used. Because of this limitation in the upstream naturalized flow estimate, the downstream naturalized flow analysis was used to assess water availability at the Project.



**Figure 5** Simple schematic of the available WSC gauge stations in the Smoky River watershed which contributed to the estimate of the naturalized flow at the Project

## Step 2: Water reserved for the environment

In line with Alberta's Water for Life strategy and on behalf of the Government of Alberta, AEP reserves a portion of the water flowing in water bodies to protect aquatic ecosystems. There are several mechanisms through which AEP can reserve water in a given water body, such as Ministerial Orders, water management plans under the *Water Act*, Land-use Framework regional plans under the *Alberta Land Stewardship Act*, and the SWAD, which applies in the absence of other guidance. In the case of the Smoky River, the SWAD is applied because other mechanisms are not in place.

The SWAD is an update to the Alberta Desktop Method for aquatic ecosystem protection which, in some cases, provides greater flexibility for human use. It attempts to balance environmental needs with the need for safe, secure drinking water and reliable, quality water supplies for a sustainable economy by defining a cumulative allocation limit using a two-step process:

1. **Watershed scale:** Determine whether the watershed can support a new allocation, given the existing allocations. Mathematically, the sum of all yearly cumulative allocations in the watershed must be less than or equal to 12% of the mean annual natural outflow of the watershed. This is used as an initial screening to determine if new licences can be accommodated.
2. **River scale:** If the watershed can support the allocation, examine the water availability on the river specifically, on a daily or weekly timestep. The flowrate for each timestep for a given flow scenario (e.g. median or dry year) is categorized into one of three buckets:

- a. greater than the 20<sup>th</sup> percentile, or 20% flow;
- b. less than the 20<sup>th</sup> percentile flow but greater than the 5<sup>th</sup> percentile, or 5% flow; and
- c. less than the 5<sup>th</sup> percentile flow.

Within each bucket, a percentage of the flowrate for each timestep can be allocated. For higher flowrates (i.e. greater than the 20% flow), a higher percentage can be allocated, whereas for lower flowrates, a lower percentage can be allocated. In some cases where flow is sufficiently low, the amount available for allocation may be zero.

The SWAD requires the use of natural<sup>2</sup> or naturalized<sup>3</sup> datasets which are specific to the point of diversion. Per Step 1, an estimate of the naturalized flow was prepared for utilization with the SWAD rules.

### Step 3: Water available for allocation

To determine the volume of water available for all allocations (cumulative allocation limit), the water reserved for the environment (calculated in Step 2) is subtracted from the naturalized flow dataset (calculated in Step 1) at each timestep.

### Step 4: Water available for new allocations

As illustrated in Section 3.0, a portion of the water available for allocation in Step 3 has already been allocated to term licence holders. These licences are known as senior licences because they have a higher priority than any new licences under Alberta's priority-based allocation system. A portion of the water available for allocation is also allocated each year through TDLs, which do not have priority over any term licences (either existing senior licences or new term licences issued in the future).

To determine the water available for new allocations, the sum of water allocated for *consumptive* use under senior term licences is subtracted from the water available for allocation in Step 3. It is important to consider consumptive allocation volumes, rather than total volumes, since many licence holders return water to rivers, resulting in a smaller flowrate reduction and therefore more water available for other uses. As outlined in Section 3.0, most licence holders on the Smoky River and its tributaries are anticipated to be consumptive users (e.g. oil and gas). Therefore, the total allocated volumes will be used for the water availability assessment. This is also conservative, especially for Milner Power's large licence,

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<sup>2</sup> From the SWAD: **Natural flow** – Recorded (measured) streamflow or water levels that are deemed to be relatively free of anthropogenic influence and therefore reflect essentially natural hydrologic response to meteorological and climatic conditions within a watershed.

<sup>3</sup> As defined above from the SWAD: **Naturalized flow** – Recorded (measured) streamflow or water levels that are adjusted for upstream flow regulation by structures and impoundments, and water licences or uses, to approximate the flows that would occur in the absence of regulation, water extractions or returns.

because it assumes more water is allocated for consumptive use than may be the case.

When accounting for existing water allocations, it is important to understand the activity that licence holders are withdrawing water for, as this can impact the timing of their withdrawals over the course of the year. For example, commercial licence holders typically withdraw water consistently throughout the year, whereas irrigators divert only in the summer. In cases where a wide range of use types exist on the same river, assumptions regarding the timing of withdrawals, based on the licence type, can be applied to help improve the accuracy of water availability models.

The water allocated for TDLs is typically not considered in Step 4 because TDLs are non-permanent and do not have priority over term licences. Therefore, TDLs have no bearing on the water which is available for term licences.

### **Step 5: Water demand compared to water availability**

Once the preceding steps are completed and the volume of water available throughout the year for new licences is estimated, a comparison is made between what is available and what is required for the project. As outlined in Section 3.0, several potential demand scenarios were utilized to represent the anticipated build-out of the Project.

### **Step 6: Potential storage requirements**

Storage of water may be required to compensate for periods when there is a shortfall between the water available for allocation within the Smoky River and the required withdrawal to meet the Project's demand. The weekly demand shortfall is defined as the difference between the water available for new allocations (calculated in Step 4) and water required to meet demand in any given week. The annual storage volume for the given flow conditions is calculated by summation of the weekly demand shortfalls in consecutive weeks.

Storage volume is a function of demand; higher annual demand typically equates to larger required storage volumes. To account for increasing water demand resulting from the phased development of the Project noted in Section 1.0, storage needs were calculated for five demand scenarios. These scenarios assumed a gradual build-out within the Project, one facility at a time. Based on preliminary information provided by Greenview, it was estimated that a typical petrochemical facility in the Project would require approximately 10 million m<sup>3</sup> of water per year (although actual facility requirements may be lower as planning progresses). Hence, the five scenarios, which account for Project build-out, are:

- Scenario 1: 10 million m<sup>3</sup>/year;
- Scenario 2: 20 million m<sup>3</sup>/year;
- Scenario 3: 30 million m<sup>3</sup>/year;
- Scenario 4: 40 million m<sup>3</sup>/year; and
- Scenario 5: 50 million m<sup>3</sup>/year.

For each scenario, weekly water demand rates were calculated based on the likely weekly demand of a typical petrochemical facility operating in Alberta (which varies seasonally). As noted, each scenario represents the construction of an additional facility along the development path to full Project build-out.

Storage requirements vary according to flow conditions, with dry years necessitating more storage. Estimating storage requirements under dry conditions is critical to understanding the options for managing water supply risk across the Project. For this analysis, a 25<sup>th</sup> percentile flow and a 10<sup>th</sup> percentile flow were used to represent a dry year and very dry year, respectively. Both dry and very dry year calculations were applied to the five scenarios listed above to calculate storage volume requirements under low flow conditions, with the very dry year (i.e. 10<sup>th</sup> percentile) analysis considered conservative.

## Appendix – Detailed Results

Table 3 provides more details on the results of the water availability analysis, broken down for each week of the year. The data in the table are represented visually in Figures 2, 3, and 4 in Section 3.1. Weeks with relatively low volumes (i.e. less than 2 m<sup>3</sup>/s) available for new allocation are highlighted in yellow, while weeks with no water available for new allocations are highlighted in red.

**Table 3** Detailed results summary for the water availability analysis. Yellow cells indicate the weeks for which the water available for new allocations is below 2 m<sup>3</sup>/s, while red cells indicate when there is no water available for new allocations.

| Water available for allocation prior to Project allocation (m <sup>3</sup> /s) |         |                    |                |                     |
|--------------------------------------------------------------------------------|---------|--------------------|----------------|---------------------|
| Approx. Month                                                                  | Week    | Average year (50%) | Dry year (25%) | Very dry year (10%) |
| January                                                                        | Week 1  | 3.41               | 2.74           | 0.00                |
| January                                                                        | Week 2  | 3.18               | 2.38           | 0.00                |
| January                                                                        | Week 3  | 2.98               | 2.30           | 0.00                |
| January                                                                        | Week 4  | 2.80               | 1.70           | 0.00                |
| January                                                                        | Week 5  | 2.70               | 1.68           | 0.00                |
| February                                                                       | Week 6  | 2.35               | 1.58           | 0.00                |
| February                                                                       | Week 7  | 2.14               | 1.74           | 0.00                |
| February                                                                       | Week 8  | 1.58               | 1.68           | 0.00                |
| February                                                                       | Week 9  | 1.69               | 1.28           | 0.00                |
| March                                                                          | Week 10 | 1.59               | 1.11           | 0.00                |
| March                                                                          | Week 11 | 1.59               | 1.19           | 0.00                |
| March                                                                          | Week 12 | 1.99               | 1.43           | 0.00                |
| March                                                                          | Week 13 | 2.30               | 1.47           | 0.00                |
| April                                                                          | Week 14 | 3.73               | 2.58           | 0.00                |
| April                                                                          | Week 15 | 11.61              | 4.28           | 0.51                |
| April                                                                          | Week 16 | 19.85              | 11.47          | 1.60                |
| April                                                                          | Week 17 | 21.28              | 16.00          | 2.36                |
| May                                                                            | Week 18 | 30.73              | 18.49          | 4.95                |
| May                                                                            | Week 19 | 42.40              | 30.69          | 4.28                |
| May                                                                            | Week 20 | 61.12              | 43.33          | 7.90                |
| May                                                                            | Week 21 | 73.40              | 51.09          | 12.66               |
| June                                                                           | Week 22 | 69.24              | 55.98          | 16.02               |
| June                                                                           | Week 23 | 79.34              | 65.74          | 14.92               |
| June                                                                           | Week 24 | 73.27              | 61.58          | 15.00               |
| June                                                                           | Week 25 | 79.72              | 57.39          | 15.04               |
| July                                                                           | Week 26 | 67.48              | 47.29          | 14.39               |
| July                                                                           | Week 27 | 63.20              | 53.20          | 13.27               |

| Water available for allocation prior to Project allocation (m <sup>3</sup> /s) |         |                    |                |                     |
|--------------------------------------------------------------------------------|---------|--------------------|----------------|---------------------|
| Approx. Month                                                                  | Week    | Average year (50%) | Dry year (25%) | Very dry year (10%) |
| July                                                                           | Week 28 | 48.04              | 43.57          | 10.90               |
| July                                                                           | Week 29 | 47.01              | 35.79          | 9.24                |
| July                                                                           | Week 30 | 42.46              | 32.42          | 7.42                |
| August                                                                         | Week 31 | 35.29              | 30.58          | 6.48                |
| August                                                                         | Week 32 | 31.64              | 23.95          | 5.84                |
| August                                                                         | Week 33 | 27.91              | 22.71          | 5.27                |
| August                                                                         | Week 34 | 24.37              | 19.88          | 4.74                |
| September                                                                      | Week 35 | 21.71              | 18.62          | 4.35                |
| September                                                                      | Week 36 | 19.05              | 17.27          | 3.80                |
| September                                                                      | Week 37 | 18.86              | 14.53          | 3.02                |
| September                                                                      | Week 38 | 15.82              | 12.49          | 2.92                |
| October                                                                        | Week 39 | 13.44              | 13.01          | 2.72                |
| October                                                                        | Week 40 | 17.22              | 12.31          | 2.42                |
| October                                                                        | Week 41 | 12.51              | 9.58           | 2.64                |
| October                                                                        | Week 42 | 13.40              | 9.11           | 2.26                |
| October                                                                        | Week 43 | 12.48              | 9.00           | 1.96                |
| November                                                                       | Week 44 | 10.59              | 7.56           | 1.57                |
| November                                                                       | Week 45 | 10.66              | 7.20           | 1.57                |
| November                                                                       | Week 46 | 7.87               | 5.46           | 0.85                |
| November                                                                       | Week 47 | 6.26               | 5.37           | 0.92                |
| December                                                                       | Week 48 | 5.22               | 3.94           | 0.38                |
| December                                                                       | Week 49 | 4.59               | 3.28           | 0.23                |
| December                                                                       | Week 50 | 4.05               | 3.05           | 0.01                |
| December                                                                       | Week 51 | 4.11               | 3.23           | 0.08                |
| December                                                                       | Week 52 | 3.87               | 2.89           | 0.13                |