8 VISIBILITY

8.1 Setting

The Project is in Sturgeon County within Alberta’s Industrial Heartland area (the Heartland). The Heartland includes a number of petroleum, petrochemical and chemical industries that are major sources of air emissions. The primary emissions in the Fort Air Partnership (FAP) airshed come from industrial combustion process emissions. One of the emissions is water vapour, which is visible as plumes from facility stacks.

8.2 Assessment Focus

Under normal operating conditions, only the process equipment and the associated stacks will be visible from a distance. Most of the process stacks tend to be 35 to 65 m tall, whereas the taller thermal oxidizer stacks can be 90 m in height. Flare stacks range from 20 to 116 m in height. The final height selection to be determined when a more detailed flare management plan is prepared. Under normal conditions, the emissions from these stacks will not be visible; however, there might be exceptions:

- Small flames might be visible at the flare stack tips because of the flare pilot or when small, unwanted volumes of waste gas are discharged to the flare system. Under these conditions, the flame lengths would typically be a few metres.
- Larger flames at the flare tips will occur when large volumes of gas are directed to the flare under upset or emergency conditions. Although these cases tend to occur infrequently and are of limited duration, the flame length can be several tens of metres.
- Under low temperature or high humidity conditions, the water vapour in the stack plumes will condense to form visible plumes. Though these plumes will be visibly at large distances, they will not result in ground-level visibility restrictions.
- Under low temperature or high humidity conditions, the water vapour in the cooling tower plumes will also condense to form visible plumes. Depending on the prevailing meteorological conditions, these plumes might result in ground-level visibility restrictions.

Table 8-1 lists the visibility issue discussed in this section. This issue is based on the Terms of Reference (TOR) prepared by Alberta Environment (AENV) (AENV 2006) through public input, and with the professional judgement of the author (Refer to Author Page).

<table>
<thead>
<tr>
<th>Project Phase</th>
<th>Key Issue</th>
<th>Source</th>
<th>Relevance to Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operations</td>
<td>Visibility changes resulting from emissions</td>
<td>AENV TOR, Section 3.6(b), Section 4.6(e)</td>
<td>Under low temperature conditions, water vapour emissions will condense to form visible plumes, and can create or add to fog on roads.</td>
</tr>
</tbody>
</table>
### 8.3 Analytical Approach

#### 8.3.1 Occurrence of Elevated and Ground-Level Plumes

Given that the largest visibility issues are associated with water vapour emissions, the occurrence and extent of these plumes was evaluated. The water vapour emissions from the Project (for stacks and cooling towers) were calculated, and the CALPUFF model (Section 5: Air) was used to predict the occurrence of elevated visible plumes, and the occurrence of visible plumes at ground level for the segment of Highway (Hwy) 643 that bisects Principal Development Area (PDA).

### 8.4 Project Design and Mitigation to Reduce Effects

High-efficiency cooling towers will be incorporated into the cooling tower design to address the visibility issues identified in this assessment.

### 8.5 Project Effects

#### 8.5.1 Plume Height

The height of a visible plume will be determined by several factors:

- the final rise of a plume
- the mixing height that can restrict plume rise
- relative humidity
- ambient temperature

Visible plumes would only be expected during low temperature conditions, which for the most part would be associated with stable conditions (Stability Classes E and F) during the night and early mornings and near neutral conditions (Stability Class D) during the day. The SCREEN3 model was used to determine typical plume heights for the cooling towers and for the stacks. For the cooling towers, enhanced plume rise because of merging plumes from individual cooling tower cells was accounted for (Briggs 1975). No merging for the stack plumes was assumed.

Figures 8-1 and 8-2 show the predicted plume heights for the Phase 2/3 cooling towers and stacks. The results reveal the following:

- For stable conditions, the cooling tower plume heights typically range from 100 to 200 m. For neutral conditions, the predicted plume heights vary from about 1000 m for low wind speeds to about 250 m for higher wind speeds.

- For stable conditions, the stack plume heights typically range from 100 to 200 m. For neutral conditions, the predicted plume heights vary from 300 to 1000 m for low wind speeds to 100 to 300 m for higher wind speeds.

Under low temperature, early morning conditions, the plume height for neutral conditions will likely be limited by the mixing height. As shown in Appendix 5C, the mixing heights under these conditions typically range from 300 to 400 m. The high predicted neutral plume heights in the figures might not necessarily be associated with visible plumes.
Figure 8-1: Phase 2/3 Cooling Tower Plume Height Dependence on Wind Speed and Atmospheric Stability

Figure 8-2: Phase 2/3 Stack Plume Height Dependence on Wind Speed and Atmospheric Stability
Figures 8-3 and 8-4 show the frequency of the plume heights predicted using the CALPUFF model for all hours of the day and for day-time hours only. The results show that:

- when all hours of the day are considered, the most frequent visible plume heights are less than 75 m or between 100 and 200 m. Visible plumes are least frequent in the summer and most frequent in the winter.

- when only day-time hours are considered, the most frequent visible plume heights are in the 150 to 200 m range. Visible plumes are least frequent in the summer and most frequent in the winter.

The SCREEN3 and CALPUFF predictions are similar, even though the CALPUFF application is more rigorous. The net effect is that visible plume heights can range from 150 to 250 m.

### 8.5.2 Roadway Visibility

The frequencies of fogging along the segment of Hwy 643 that bisects the Project Fence Line (PFL) are highest between January and March, and lowest between May and July (Figure 8-5).

![Figure 8-3: Predicted Frequencies of Visible Plume Heights for All Hours of the Day Resulting from Phase 2/3 Stack and Cooling Tower Emissions](image-url)
Figure 8-4: Predicted Frequencies of Visible Plume Heights for Day-Time Hours due to Phase 2/3 Stack and Cooling Tower Emissions

Figure 8-5: Predicted Fog Occurrences along Highway 643
8.5.2.1 Prediction Confidence

The heights of the visible plumes provided are reasonable. The predicted frequencies of the visible plume heights and the predicted frequency of fog occurring along the Hwy 643 segment are less certain because of the limited documentation provided with the CALPUFF model and the lack of confirming field study comparisons.

8.6 Follow-up and Monitoring

No follow-up and monitoring will be required for effects of the Project on visibility.

8.7 References
