The Case for Alberta Bitumen in Sustainable Road Building

Economic, Environmental and Societal Benefits

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There is enough crude bitumen in the Alberta oil sands to produce asphalt binder capable of paving every road on earth for the next 100-200 years. With proven reserves of 165 billion barrels, an estimated 250 billion additional barrels potentially recoverable with advancing technology and/or more favorable economic conditions, and with a binder (glue) yield in the 40-60% range, it is possible to supply the roughly 150-175 million tonnes global asphalt market annually, a market projected to grow at 4% a year, for centuries to come.

Sales of this end-use product, which produces zero direct greenhouse gas (GHG) emissions, together with fuels, lubricants and chemical feedstocks comprising the remaining 40-60% of the barrel, would generate revenues in the $10-20 trillion dollar range. In a future with declining light oil production and reduced upgrading and refining—driven by a global transitioning to net zero and the electrification of transportation—the outlook for oil sands production remains strong. Major reductions in Scope 3 emissions from oil sands bitumen under such a scenario would make achieving net zero far more feasible. Without this contribution, the 2050 target becomes much less realistic.

What distinguishes asphalt binder derived from Alberta bitumen is its exceptionally low wax and moderate asphaltene levels. Heavy crudes and oil sands bitumen from the Athabasca, Cold Lake and Peace River deposits are nearly free of crystallizable fractions, making them the ideal feedstock for producing durable, high-quality asphalt binder. Recovery processes such as Cyclic Steam Stimulation (CSS), surface mining with paraffinic or naphthenic froth treatments, Steam-Assisted Gravity Drainage (SAGD), Cold Heavy Oil Production with Sand (CHOPS), among others, enable production of a wide range of feedstocks tailored for asphalt applications.

These binders can be engineered for sustainable road construction across all climates and traffic conditions. Incorporating modifiers—such as virgin and recycled polymers and varying levels of reclaimed asphalt pavement (RAP)—provides further gains in both economy and sustainability. Asphalt made from straight Alberta bitumen and associated heavy crudes has also been shown to be re-recyclable through the addition of special rejuvenating oils, effectively extending road lifespans by decades.

With support from Alberta Transportation (AT), the Ontario Ministry of Transportation (MTO), the U.S. Federal Highway Administration (FHWA), the U.S. National Cooperative Highway Research Program (NCHRP), Alberta Innovates (AI), and numerous end users, full-scale pavement trials have consistently demonstrated the superior performance of straight Alberta binder.

Early pavement trials in Lamont, Alberta (AT, seven sections, 1992) and Hearst, Ontario (MTO, three sections, 1992), conducted under the Canadian Strategic Highway Research Program (C-SHRP), showed that straight Cold Lake binder produced smooth driving surfaces lasting 20+ years without signs of thermal or traffic induced cracking, rutting, wheel path cracking or moisture damage.

Subsequent trials on Highway 118 in Bracebridge, Ontario (MTO, seven sections, 1996) and on Trans-Canada Highway 17 Special Pavement Site Type 9 (SPS-9 site) near Petawawa, Ontario under the U.S. Long-Term Pavement Performance Program (LTPP) (MTO, six sections, 1996), demonstrated once again that straight Alberta binder, modified with a small addition of virgin styrene-butadiene type elastomer, significantly outperformed competitors under higher traffic conditions.

More recent trials on Highway 655 north of Timmins, Ontario (seven sections, 2003; eight sections, 2007), Highway 417 near Casselman, Ontario (seven sections, 2006), and on Highway 427 in Toronto, Ontario (five sections, 2008) confirmed that the best performance is consistently achieved with straight Alberta binder free of waxes and other deleterious additives. A single test section on Highway 655 has a projected lifespan of 38 years to a Pavement Condition Index (PCI) of 50%—nearly three times the regional average.

Research from these sections and subsequent contracts has led to the development of enhanced asphalt acceptance specifications that encourage the use of durable binders with stable, performance-based properties required for long-life pavement designs. These specifications have been formally accepted by MTO and the American Association of State and Highway Transportation Officials (AASHTO) and are now widely implemented across Ontario. In the Region of Durham, they have resulted in pavement lifespans doubling and even tripling compared to pre-2015 projections (Figure 1).

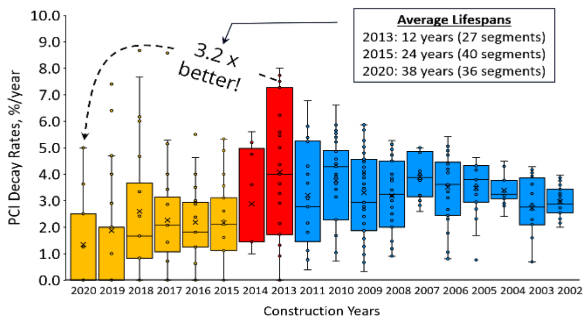

Figure 1. Changes in pavement decay rates and projected lifespans for The Regional Municipality of Durham, which implemented enhanced asphalt specifications in 2015 (Kokabi et al., 2023). Note: Pavement lifespans declined by ~66% from the 1980s to 2013. After enhanced specifications were adopted, projected lifespans double by 2015 and tripled by 2020 (baseline: 2013). The 2008 increase in decay rates is linked to inappropriate use of REOB, RAP and other unregulated additives following the global financial crisis.

With the sharp increase in crude oil prices between 2003-2008, asphalt wholesalers and road builders began substituting binder with low-cost re-refined engine oil bottoms (REOB) and high RAP contents, leading to a 66% reduction in pavement lifespans compared with the 1980s. Implementing test methods developed through this long-term collaborative research program has reversed this trend, with lifespans now restored to their historical 35-40 years in several Ontario municipalities.

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Professor Hesp earned his doctoral degree in Chemical Engineering and Applied Chemistry from the University of Toronto in 1991. He has served as a professor of Chemistry at Queen's University since then and has supervised nearly 200 students. His group's work has received numerous awards, including the Walter J. Emmons Award from the U.S. Association of Asphalt Paving Technologists (1996), the Editors Award from the Canadian Technical Asphalt Association (1996, 2004), and the Elaine Thompson Award from the same association (2015).

His research has been generously supported by user agencies, professional organizations and industry partners. He has contributed to the design, evaluation, and monitoring of more than 50 full-scale pavement test sections in Lamont, Petawawa, Timmins, Hearst, and the Ottawa and Greater Toronto areas, and is the author of several pavement materials specification standards.