K-01

April 8, 2005

TO: John Szerlag, City Manager

FROM: Brian Murphy, Assistant City Manager/Services
Steven Vandette, City Engineer

SUBJECT: **Agenda Item** – Premature Concrete Pavement Deterioration from Alkali-Silica Reactivity (ASR)

During the spring freeze-thaw cycles perhaps no road in Troy sustained more damage than southbound Livernois south of Long Lake and eastbound Long Lake, east and west of Livernois. Despite both roads being County roads, the City received numerous complaints about their poor condition and several claims for vehicle damage that were referred to the County.

The Engineering Department assisted the Road Commission for Oakland County (RCOC) in gathering information about the construction of these roads and subsequently received a copy of the testing report and engineer's report concerning their findings. Their conclusion was that the freeze-thaw damage was accelerated by the presence of Alkali-Silica Reactivity (ASR) in the concrete.

Alkali-Silica Reactivity is a pervasive concrete durability problem responsible for premature deterioration of pavement and structures in the United States and around the world. ASR is a chemical reaction that occurs between silica in the aggregates used to make concrete and alkalis (sodium or potassium) present in the cement. The reaction causes the formation of a gel that absorbs water and swells, exerting internal pressure that leads to cracking. The cracking weakens the concrete and facilitates further damage by traffic and environmental stresses, particularly freeze-thaw cycles. As ASR progresses, the cracks in the surface of the concrete join to create a map-cracking pattern which ultimately can lead to spalling and popouts (see attachment).

Although ASR was identified in other states in the early 1980s, Michigan did not begin to see the condition until the early to mid 1990s. ASR is often not apparent for five (5) to fifteen (15) years after placement and in the early years was often misdiagnosed. As the condition became more apparent, research increasingly focused on native aggregates that were found to be more reactive than aggregates that came from now depleted areas of Michigan gravel pits. Much research has been done to develop strategies to combat ASR, which continues today.

The most widely used strategy to reduce ASR is the use of a mineral filler to replace some of the cement in the concrete, thereby reducing the alkali in the mix. This is done through the use of ground-granulated blast-furnace slag (GGBFS); an iron making byproduct formed when molten iron blast furnace slag is rapidly chilled (quenched) by immersion in water. It is material that is readily available in this area,

highly cementitious in nature and, when ground to the fineness of cement, hydrates like portland cement. This strategy has been used in Troy since the mid 1990s on numerous projects including Big Beaver, Rochester Road, Long Lake, Livernois, Coolidge and Maplelawn among others. Studies have shown GGBFS to be effective but no guarantee that concrete will be free of ASR.

There are also new lithium-based products added to fresh concrete and lithium treatments of hardened concrete that are showing some promise in retarding the effects of ASR. Currently these products are extremely expensive, adding approximately $30 per cubic yard to concrete. Lithium compounds are on the short list of recommended preventatives and remedies but high cost and general availability of lower cost GGBFS and other materials naturally inhibit the use of these new chemicals in this area.

Lithium-based products are currently the only effective treatment for hardened concrete. These products are expensive and most effective in the early stages of ASR. Pavements in Troy currently exhibiting ASR, such as southbound Livernois south of Long Lake and eastbound Long Lake east and west of Livernois, are too far-gone to benefit from this treatment. The testing company for the Road Commission for Oakland County reported the presence of ASR throughout the thickness of the pavement. The County's engineer recommends complete replacement of this roadway, built in 1989 and only 16 years old, but the high cost and shortage of road repair funds will certainly delay this for many years. In the meantime, the engineering department is discussing with the RCOC the possibility of overlaying the pavement with asphalt to hold it together. This is not a long-term fix but a temporary one since the ASR will continue to cause premature breakup of the concrete pavement beneath the asphalt.

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Alkali-Silica Reactivity (ASR) Crack Pattern