memo

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Regarding |	Objective 1, Task A: Sediment Source Apportionment – Mustinka/Bois de Sioux Watersheds		

In an effort to determine sediment sources for the Bois de Sioux and Mustinka HSPF modeling, EOR conducted a review of available literature (summarized below). No field/monitoring data were available in this watershed to make this determination. The two sources available in the Red River Basin (Lauer et al. 2006 and Brigham et al. 2001) show that field erosion accounts for 65%-90% of the total suspended sediment. Additional literature sources from outside the Basin were also reviewed to bolster the assessment. Based on this literature and correspondence with Chris Lenhart, we expect that the sediment loading in the Bois de Sioux and Mustinka River watersheds would approximately be **80% field sources and 20% non-field sources**. This relative contribution will be incorporated into the model during sediment calibration.

Apportionment Considerations

According to a study by Lauer et al. (2006) that was cited in the Red River Biotic Impairment Assessment field erosion is the dominant (90%) source of sediments in the South Branch Buffalo River in the Red River Valley. This estimation was based on AnnAGNPS modeling. Additionally, Brigham et al. (2001) suggest that surface (field) erosion contributes 65-80% of the suspended sediment to the Wild Rice River.

The Sediment Fingerprinting Final Report provides estimations of the amount of sediment loading from field and non-field sources. This report was completed to determine the Lake Pepin watershed field and non-field contribution of sediments to MN River. However, geological features of the Minnesota River Basin are very different from the Red River of the North Basin. In the Minnesota River Basin, bluffs (non-field sources) are the main contributor to sediment loading, accounting for approximately 70% of sediments, whereas field sources account for approximately 30%. The Red River Basin is comprised of highly modified watersheds where the hydrology has been significantly altered from drainage and extensive ditching. As a result of land use and landform, we would expect the field source of sedimentation to be significantly higher in the Red River of the North Basin than in the Minnesota River Basin.

Additionally, according to Chris Lenhart at the University of Minnesota, who has been doing work in the Red River Basin, bank erosion is generally a lower percentage of the total sediment loading than field erosion. He mentioned that there is a lot of gully erosion in fields, as well.

Summary of all Literature Sources Reviewed

The following provides a brief description of each of the sediment source documents reviewed in preparation of this memo.

Identifying sediment sources in MN River Basin (MPCA)

Due to the glacial history of the MN River Valley, the watershed is naturally predisposed to erosion. Specifically, the Blue Earth and Le Sueur watersheds occur on erodible glacial deposits on steep slopes and incising river channels. The Blue Earth and Le Sueur watersheds contribute half of the sediment to the MN River. The major sources of sediment include:

- Fields – erosion from sheet and rill flow, gully development, enlargement of drainage ditches, drainage tiles intakes
- Bluffs – eroding bluffs, need to assign erosion rates
- Ravines – volume and rate of discharge to ravine ; can be increased by discharge from upland drainage systems
- Streambanks – net contribution determined by rates of channel migration, channel enlargement, and flooding deposition

An Integrated Sediment Budget for the Le Sueur River Basin (Gran et al. 2011)

The Le Sueur River is one of the most prolific sources of sediment to the Minnesota River Basin. The largest sediment sources are near-channel sources (e.g. erosion of bluffs and channel widening and incision). Current erosion from bluffs is producing the majority of the fine-grained sediment.
Net contributions from the channel and floodplain add an additional 8%, with most of that sediment coming from channel widening. The other main sources of sediment (ravines and uplands) contribute approximately 9% and 27%, respectively, of the annual sediment load on average between 2000 and 2010.

The current average TSS at the mouth of the Le Sueur River was 225,000 Mg/yr. Bluff and channel erosion contribute approximately 152,000 MG/yr, ravines contribute approximately 20,000 Mg/yr. Agricultural uplands account for approximately 25% of the suspended sediment currently exported from the Le Sueur watershed; however, upland sediment represents the source which has experienced the largest percentage increase in erosion rates and is the dominant source above the incised reach.

Sediment Fingerprinting Final Report (Schottler et al. 2010)

In the Lake Pepin watershed field and non-field contribution of sediments to MN River was assessed from 15 tributaries. Non-field sources contribute the majority of sediments (approximately 60-85% of sediment entering Lake Pepin). Non-field loads are greatest in steeply incised watersheds (Blue Earth-Le Sueur). Fields contributed less than 50% of sediment on average. In steeply incised watersheds (Le Sueur, Blue Earth, Maple, High Island) field erosion contributes less than 25% of sediment.

In the Le Sueur River watershed 80% of sediment loads are from non-field sources, in the Watonwan River watershed 60% are from non-field sources, and the Redwood River 79% of load is from non-field sources. Tributaries in upper portion of MN River Basin receive 30-40% of sediment from field sources and tributaries in the middle and lower portions receive less than 30% from fields. There is more variation in non-field sediment yields than in field sediment yields; additionally there is a lot of variation based on watershed. For example, steeply incised reaches have unstable slopes and increased non-field sediments.

Analysis of Suspended-Sediment Concentrations and Radioisotope Levels in the Wild Rice River Basin, Northwestern Minnesota, 1973–98 (Brigham et al. 2001)

Radioisotopes were used to assess suspended sediment sources in the Wild Rice River Basin. Upland soil erosion from cultivated fields contributes the majority of the suspended sediments load in the Wild Rice River. It was determined that sediment originated from eroded soils and from eroded streambanks, with bank material being a somewhat more important source upstream of Twin Valley, Minnesota, and approximately equal fractions of bank material and surficial soils contributing to the suspended sediment load downstream at Hendrum, Minnesota.

Mustinka Turbidity TMDL (MPCA 2010)

The primary contributing sources of the turbidity impairment for the impaired reaches of the Mustinka River are agricultural land soil erosion and stream-bank erosion caused, in part, by the extensive hydrologic modifications that have occurred across the watershed. Much of the Red River of the North basin, particularly in the portion known as the Red River Valley, is cultivated cropland. Sediment sources in streams in such settings are comprised of non-point sources of sediment that originates both from eroded soil and from erosion of stream-bank sediments. These can include background sources, such as natural soil erosion from stream channels and upland areas. Non-point sources can also include runoff from agricultural lands and non-NPDES/SDS permitted stormwater runoff.

Rabbit River Turbidity TMDL (MPCA 2010)

Much of the watershed's hydrology has been highly altered as a result of ditching and drainage. Many portions of the rivers have been channelized. Soil erosion from channelization and cropping has contributed to the turbidity and sediment loading of streams. Non-point sources are the dominant sources of sediment loading in the watershed, and are largely the result of soil erosion and stream-bank erosion.

Red River Biotic Impairment Assessment (EOR 2009)

According to Lauer et al. 2006, the majority of sediment supply to streams in the Red River Valley is believed to be from field erosion and gully erosion, caused by sheet erosion in agricultural fields. Lauer et al. (2006) estimated that the majority of sediment (90%) loading in the South Branch Buffalo River, exceeding both stream channel and bluff erosion.

References

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