Legislative Water Commission- 2019 Legislative Recommendations:
Keeping Water on the Land
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DRAFT, for Discussion only, JRS

Throughout our state's history, people have worked to change how water flows--building dams and dikes, straightening and dredging channels, armoring streambanks, digging ditches, installing subsurface tile, and constructing complex storm sewer systems. The most extreme hydrologic alterations are the construction of impervious surfaces such as roads and buildings. However, the most widespread alteration of Minnesota hydrology has been the conversion of native prairie to farmland and the construction of the network of drainage ditches and subsurface tile that was essential for intensive crop production and transportation infrastructure. Altered hydrology has occurred in both urban and agricultural portions of the state and hydrologic alterations are locally more extreme in our cities and towns. However, the total area of affected lands are greater in agricultural portions of the state than in our cities and towns. In both areas we need to increase our efforts to retain water on the land in order to improve natural streamflow and to improve water quality and aquatic ecology. The question is this—what best management practices are appropriate in specific landscapes and how can they be financed?

Recommendations: Some critical knowledge gaps exist in our understanding of water management at landscape scales:

1. *The overall extend of drainage is unknown and needs to be better quantified. Direct estimates of the extent of subsurface drainage do not exist in Minnesota. However, several indirect methods could be utilized to estimate the extent of surface drainage*
2. *Effect of drainage on underlying aquifers is unknown. A basic understanding of unconfined and confined aquifers is necessary to quantify the effects of agricultural drainage on groundwater. We need to better understand the overall effect on groundwater.*
3. *An improved understanding of historical water-balance shifts from pre- to post-drainage periods is needed to understand long-term implications on net groundwater recharge. More direct field-scale studies and modeling studies are needed to characterize water budgets for fields with subsurface drainage.*
4. *Existing tools and systems need to be applied and used to identify the appropriate best management practices at landscape and watershed scales*
5. *Utilize the one-watershed/ one-plan process to implement best-management practices within watersheds.*
6. *Continue to evaluate the costs and effectiveness of individual best management practices.*
7. *Evaluate the effects of drainage on un-drained nearby wetland systems*
8. *Evaluate the effects of urban storm-water retention systems on the quantity and quality of groundwater recharge.*
9. *Design programs to quantify potential problems of emerging contaminants in urban storm water retention basins*
10. *Establish the role and importance of the relationship between healthy soil and healthy water*
11. *Support the recommendation of the Drainage Working Group*
12. *Identify a process that prioritizes the appropriate best-management practices on differing landscapes.*

In order to enable and enhance agricultural production, transportation, and economic development, construction of drainage ditches began before Minnesota became a state. The ditches connected the natural stream network to previously unconnected depressions and wetlands and lowered the water table near the ditches. Precipitation previously stored in the depressions and soil around them was rapidly conveyed to streams and rivers. Many natural streams were straightened and enlarged to increase transport capacity. Each county has records of the public ditch systems, however no statewide record and map of historical ditch development has been compiled. The most active ditch construction occurred in the period from 1900 to 1929, with the decade of greatest drainage being 1910 to 1919. There was little new drainage installed during the dry years and economic depression of the 1930s. Drainage activity reemerged after World War II, driven by economic factors and periods of above-average precipitation.

The network of ditches for surface drainage has been augmented by installation of subsurface drainage tiles originally fabricated from clay or concrete. More recently, perforated plastic pipe is used instead of clay or concrete. Initially, tile lines were installed to drain individual wet areas that were not intersected by the ditches. With the development of the less expensive plastic drainage pipe and efficient installation equipment, the systems have expanded by pattern installation of pipe to systematically remove water from entire fields. As with the ditch system, there is no statewide record of subsurface field-tile installation over time. Unlike the public ditch systems however, there has not been a county-maintained record of subsurface field drainage because those systems are installed by individual landowners and permits are not needed. Subsurface tile has been mapped in a few small watersheds, for example Seven Mile Creek Watershed. Subsurface field tile installation in southern Minnesota advanced throughout the 1900s and continues today. Systematic field drainage in the Red River valley was largely limited to surface drainage by ditches until about 2005, when subsurface system installation began at a rapid rate.

Estimates of the extent of subsurface drainage do not exist in Minnesota. However, several indirect methods have been utilized to estimate subsurface drainage, from the field-scale to county-level by using geographic information system (GIS) analysis and aerial photography. Based on a 2012 U.S. Geological Survey estimate of subsurface drainage extent, about 21% of the land area in Minnesota has some subsurface drainage.

Benefits and Impacts of drainage: Historically, poorly drained soils across much of the state were saturated or flooded after spring snowmelt, preventing timely farm operations such as tilling and planting crops. Installation of agricultural drainage, both surface ditches and sub-surface drainage accelerated transport of water from farm fields and resulted in greater crop yields. Agricultural drainage has provided other benefits such as preventing crop drown-out, aerating the soil profile for improved plant growth, limiting surface runoff and soil erosion, and allowing farmers better access to croplands. Without agricultural drainage on much of Minnesota's croplands, it would have been difficult to realize high-enough crop yields needed for farmers to have economically viable returns on their investments.

While drainage of Minnesota’s croplands provide benefits, several environmental concerns are associated with agricultural drainage. These include wetland loss, habitat loss, and degradation of downstream water quality and reduced potential for groundwater recharge. Early agricultural drainage efforts (pre-20th century) led to the disappearance of much of

Minnesota's natural wetlands. The increased focus on preventing or mitigating wetland loss over the last 50 years has helped curtail further losses, even as agricultural drainage proceeds. Prior to establishment of Minnesota statehood, wetlands accounted for more than 10 million acres in Minnesota, including prairie wetlands, peat-lands, and forest wetlands that comprised approximately 19 percent of the total land area. In 2018, only half of Minnesota's pre-settlement wetlands remain, mostly in parts of the State that have not experienced widespread drainage, such as northern Minnesota.

Other consequences of agricultural drainage:

Reductions of the time water is being stored in the soil: Only drainable water is removed by tile and ditches. The amount of plant available water (i.e., water held by soil particles against the pull of gravity) is not affected by artificial drainage systems.

Changing pathway of water over land: Some ditches and tile link streams to depressions (potholes) that were previously not connected.

Reducing overland flow: This occurs if water moves through soil and subsurface tile. Over flow still occurs on tiled land if surface soil structure is poor, blocking infiltration, or if the soil is saturated.

Decreasing evaporation-- by removing areas of standing water.

Increasing annual transpiration—when rooting depth and productivity are increased.

Increasing the total amount of water that reaches streams (annual yield). Models show that tiling increases the annual amount of water leaving the field.

Reducing, delaying and extending the peak flow in a stream after a precipitation or snowmelt event (if water is moving through tile systems instead of overland). Water takes longer to travel through soil to a tile system than to move overland or through ditches. This means rainfall will reach a stream later than if it only flowed overland. Soil continues to drain long after an event, so elevated stream flow lasts longer than if the rain all reached the stream overland.

Water-Quality Degradation: Water-quality monitoring has shown that agricultural drainage, in particular the practice of subsurface drainage, provides a direct flow path for moving water to nearby ditches and streams the negative consequences of agricultural drainage on surface water quality are well documented. These impacts include: excess nutrients, high sediment levels, flooding, property loss, and habitat loss. The last half century has seen substantial increases in the volumes of water delivered to streams. This has resulted in increased stream widths due to bank erosion, increased amounts of sediment transported in streams from field, and streambank, bluff and ravine erosion. Sources of sediment primarily are the result of greater stream and river flows. To protect streams, the land, wildlife, and water quality, more water needs to be retained on the land and more water needs to be transpired by plants or infiltrated to groundwater, in cities and on farms by using new and existing land and water management practices.

Groundwater recharge: The connection of hydrological effects of agricultural subsurface drainage on groundwater recharge and aquifers s not well-established. Agricultural subsurface drainage intercepts infiltrating water below croplands and directly discharges the water to nearby surface waters. However, the size of the water balance shift, comparing drained water, evaporated water, run off and drainage has not been well characterized.

Other effects of drainage, on underlying aquifers also is not well known. A basic understanding of aquifers and their recharge is necessary to connect any hydrological effects from agricultural drainage to groundwater. The basic goal of sub-surface drainage, to efficiently drain saturated soils, clearly alters the water balance in croplands. However, its overall effect on groundwater resources has been poorly characterized, and is in large part determined by the geology below drained areas and the arrangement of underlying aquifers.

Reducing the Impacts of Drainage and Water Management Strategies:

Urban Storm water Retention: Water storage can reduce peak flows in cites and in towns. Peak flows drive streambank erosion. Storage is especially effective in small watersheds that have a high sediment yield per amount of stream flow. Ravines and large gullies often supply large volumes of sediment eroded per unit of stream flow. Bypassing these areas or reducing and slowing the water flow can be effective in terms of cost per unit sediment reduced. However, the impact of stored waters in urban areas is not well established. We do not fully understand if groundwater recharge is increasing or decreasing. We also do not understand time impacts we are having on groundwater quality.

Buffers: Buffers along streams, rivers and ditches has potential to slow water, sediment and nutrient delivery as well as increasing biological habitat. The 2017 Legislature directed the Board of Water and Soil Resources (BWSR) to coordinate the Drainage Work Group to evaluate and develop recommendations to help Minnesota drainage authorities *accelerate* the acquisition and establishment of buffer strips and alternative practices adjacent to public drainage ditches and associated compensation of landowners. The impetus for this action was the is the 2015 Buffer Law (Minnesota Statutes Section 103F.48), which required landowners to establish buffer strips, or alternative practices, along all public drainage ditches. Recommendations were developed by a 16-member Project Advisory Committee organized under the auspices of the Drainage Work Group with BWSR staff support. The Advisory Committee evaluated the impediments to drainage system acquisition and establishment of buffer strips and then formulated actions for statutory, funding, and administrative policy changes, and outreach... This report was approved by the Drainage Work Group, accepted by the BWSR Board, and is transmitted to the Legislative Policy Committees, as required by 2017 Minnesota Session Laws, Chapter 93, Article 1, Sec. 4 (h). The Recommendations are categorized according to the type of action required (e.g., statutory change, funding, administrative policy change) and grouped according to the potential for the recommended actions to *accelerate* the acquisition and establishment of drainage system buffer strips, alternative practices and landowner compensation in 2018, or for their potential long-term benefits in 2019 and beyond.

Soil Management: Enhancing the ability of the soil to infiltrate and store precipitation. Soil and crop management in agricultural fields affects infiltration rates and water holding capacity through effects on soil structure and soil organic matter.

Increased Transpiration: Managing the amount and distribution of crop transpiration throughout the year. Transpiration is the largest user of precipitation water, and its timing relative to rainfall distribution has a great influence on how much surplus water will move off the land.

Managing Overland Flow: Managing overland flow with crop residue, contour farming, and vegetated flow pathways like waterways and filter strips that slow, filter, and partially infiltrate surface runoff.

Subsurface Drainage: Managing subsurface drainage flow by sizing, depth, and spacing of drainage pipe to control rates of drainage water leaving the field. Control structures can also be installed in the drainage system to allow temporary water storage for later crop use or timed release.

Water Storage: Increasing water storage, including natural storage in wetlands and other depressions, and artificial storage with constructed wetlands, terraces, ponds, water and sediment control basins (WASCOBs), down-sized culvert retention, weirs, and large detention basins.

Streambank Protection and Riparian Area Restoration: Although not the focus of this publication, a few measures to protect channels and restore riparian areas are briefly described, along with reference information for further information.

Green cover crops and Agricultural Alternatives to corn and soybean rotations have great potential to slow the delivery of water, sediment and nutrients to our ground and surface water. The challenge is in finding crops that can compete with corn and soybeans economically.

These land and water management's practices have great potential to protect and to improve water quality by modifying water use and flows. The practices are most effective when then are combined is sequences in a watershed. Individually or when combined, these practices have multiple impacts that include: improved soil structure and water holding capacity, reduced channel erosion, improved water quality and in-stream habitat, and reduced flooding. Ponds and wetland restoration for water storage in agricultural drainage systems also improves drainage system efficiency. They dampen peak flow, and reduce the size requirement for ponds and ditches downstream Practices that add perennial vegetation or that diversify channel structure also reduce channel erosion and create habitat. These practices can be characterized according to where they are located in the various landscapes and according to the effects that they have on the hydr0logy of a watershed. In-field crop and soil management is most are most appropriate in areas of intense agriculture. They improve watersheds by increasing transpiration, water infiltration, soil-water holding capacity as well as the resistance to soil erosion. Treatments in drained landscapes include increased drainage management practices coupled with water treatment and retention/detention structures, constructed wetland, ponds, irrigation reservoirs, or modified ditch channels. Treatments that are move applicable to more slopping landscapes could include grassed waterway, fitter strips buffer strips, terraces and water and sediment control basins. Riparian are a modification and orientation, coupled with stream channel protection are most applicable near the outflow area of watersheds. Because treatment methods need to be designed for local landscapes, climate and cropping systems, systems deed to be developed that fit individual watersheds. The costs for the practices differ considerably with size, location and other factors.