REROUTING DRAINAGE SYSTEMS

TECHNICAL GUIDANCE DOCUMENT

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INTRODUCTION

In Minnesota, wetlands planned for restoration are commonly drained by surface drainage ditches and subsurface drainage tile. These drainage systems often extend upstream from planned restoration sites and provide drainage to neighboring lands not part of a restoration project.

The restoration of wetlands in these types of drainage scenarios provides a number of design and construction challenges and may not always be possible. However, options for restoration can exist and should be considered, when feasible. Restoration strategies include outletting incoming drainage systems directly into planned wetlands or other suitable areas within the restoration site. When that is not feasible or desired, a reroute of the upstream drainage system should be considered as part of the restoration design.

Figure 1. Rerouting Drain Tile Around a Planned Wetland Restoration

APPLICATION

The design strategy for modifying an approaching drainage system will primarily be dependent on the type, location, elevation and grade of the drainage system as it enters the restoration site. Recommended strategies include, when possible, outletting the incoming drainage system directly into a planned wetland restoration or other suitable vegetated area within the restoration site. This can either be done by directly daylighting the incoming drainage system or through the use of a drainage lift station. Additional information on these and other wetland restoration strategies can be found in Technical Guidance Documents as part of Appendix 4-A.

When elevations or other factors do not allow for existing upstream drainage system to be outletted into the restoration site, a reroute of the upstream drainage system should be considered. Reroutes will usually involve realigning or relocating a drainage system so it no longer affects or is affected by existing or planned wetland areas. Drainage system reroutes are usually located to traverse around and avoid these wetland areas. When feasible, reroutes could also include diverting the drainage system in another direction to a different outlet.

Rerouting is most applicable to tile drainage systems, however, there are situations where rerouting of surface ditches as part of a restoration plan will be possible and desired. Regardless of drainage system type, the design needs to consider construction costs and considerations for long term maintenance. Rerouting should be considered only if feasible and no other more practical alternatives exist, such as additional land acquisition or daylighting the drainage system into the restoration site.

DESIGN CONSIDERATIONS

The primary design objective will be to ensure that a functional and cost effective reroute will result that will not adversely affect the restoration site or compromise drainage benefits of upstream properties. This requires certain information be known about the drainage system including its size, location, elevation and grade. It also requires some understanding of site topography, soils and wetland locations along with elevation information of planned restoration areas. If rerouting in close proximity to planned wetland restoration areas, elevations of normal or design water levels and of anticipated flood events for the wetlands are also needed.

It will also be important to ensure planned wetlands will be not be "starved" of hydrology due to the resulting diversion of a portion of the wetland's contributing watershed. To determine this, an analysis should be conducted of all hydrologic inputs, wetland storage capacities, and potential capacities of the wetland's outlets. In certain situations, a comprehensive study of the wetland's water budget may be needed to help determine if expected outcomes will be in-line with established project goals.

Drainage system reroutes can potentially remove important hydrology from a planned wetland restoration

Design strategies for rerouting a drainage system are generally straightforward but will vary somewhat depending on whether the system to be rerouted is a surface ditch or a subsurface tile.

REROUTING SURFACE DRAINAGE DITCHES

The design of a surface ditch reroute needs to consider potential alignments, cut depths, soils, construction methods, cross sections, elevations, and grades for the new ditch. The design should ensure that drainage capacities of the upstream drainage ditch will not be limited or adversely affected by the reroute. A hydraulic analysis of the existing drainage system may be necessary to determine this.

The location or alignment of the planned ditch reroute will also be an important design consideration. Diverting the ditch another direction or locating it entirely outside of the restoration project should be considered, where possible. Regardless, the new ditch should be kept as far as possible from existing and planned wetlands to prevent unintended, lateral drainage effects. When reroutes are planned in close proximity to and as part of restoring drained depressional wetlands, a tradeoff often occurs because as the ditch is moved further away from a wetland's edge, ground elevations may rise and cut depths, lengths, and costs for the new rerouted ditch can increase. In some situations, finding a balance between practical excavation depths vs acceptable hydrologic losses via lateral effect may be necessary. In locations where the rerouted ditch will be immediately adjacent to the wetland, excavated ditch spoils could function as a barrier (embankment) between the planned wetland and the newly constructed ditch. Additional discussion on this restoration strategy occurs in Section 4-5, Earthen Embankments.

Rerouted ditches that are moved out of highly organic, unstable wetland soils and into adjacent upland soils may provide a more stable location for the ditch possibly resulting in reduced future ditch maintenance.

The restoration of wetland hydrology will require that ditch plugs be designed and constructed on the abandoned portion of the ditch just upstream and downstream of the planned wetland (**Figure 2**). Filling the abandoned ditch within the extents of the restored wetland may also be needed or desired. Additional information on these

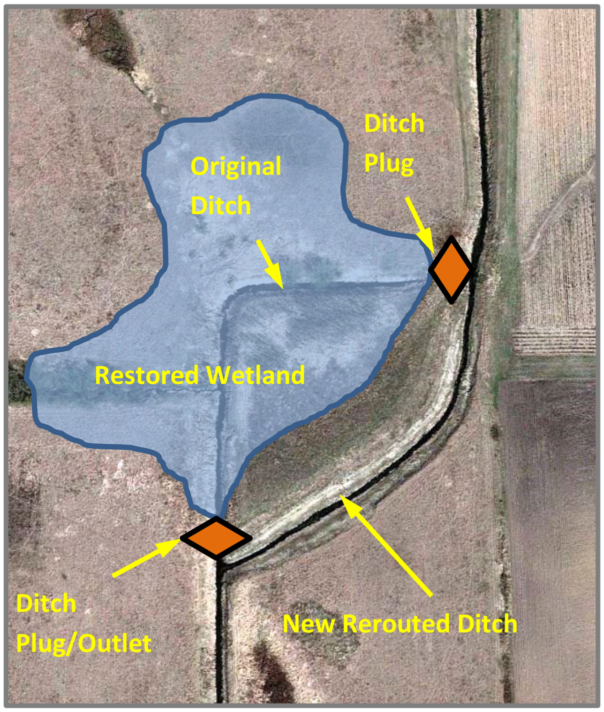

Figure 2. Rerouted Drainage Ditch Around a Planned Wetland Restoration

restoration strategies can be found in the following Technical Guidance Document 4A-1, Blocking and Filling Surface Drainage Ditches.

Rerouting Subsurface Drainage Tile

The design of a subsurface tile reroute needs to consider potential alignments, cut depths, construction methods, construction materials, size, elevations, and grades for the new tile. In addition, the design should ensure that drainage capacities of the upstream drainage system will not be limited or adversely affected by the reroute. The upstream tile drainage system can be negatively impacted if proper considerations for designing the reroute are not taken.

When planning a reroute of subsurface drainage tile, several options for tile material can be considered. In most situations, single wall corrugated polyethylene (CPE) tile will be the preferred tile material due its installation flexibility and costs. In some situations, it may be necessary or desired to use more durable plastic pipe such as dual wall corrugated polyethylene (HDPE) or polypropylene (PPE). This is especially true in situations where installation depths are greater or where deemed necessary as part of the design analysis.

The design also needs to consider whether the reroute should utilize perforated or non-perforated tile. When installed through areas that will be in permanent native vegetation or trees, non-perforated tile should be used. Otherwise, plant roots will likely end up plugging the tile. In many cases, a combination of perforated and non-perforated tile is needed.

Because this design strategy often includes changing tile grades, lengths, and possibly even tile materials, it will be important to compare flow rates of the existing tile vs. the proposed re-aligned tile to ensure that upstream drainage benefits will neither be impaired nor significantly improved by the planned changes to the tile drainage system. It is possible that larger diameter tile will be needed for the reroute than what currently exists. For example, if the existing, incoming tile to the wetland is a 6 inch concrete line, an 8 inch CPE tile installed at a similar grade will provide comparable flow or drainage capacity. As options for tile size, materials, lengths, and grades vary, an analysis of full-flow pipe capacities may be warranted to ensure the most practical and economical design. A hydraulic comparison of tile flow rates using varied sizes, materials, and grades can easily be accomplished thru the use of simple tile drainage capacity tools including manufacturer's literature, nomographs, on-line calculators, etc.

The location or alignment of the planned tile reroute will also be an important design consideration. Diverting the tile another direction or locating it entirely outside of the restoration

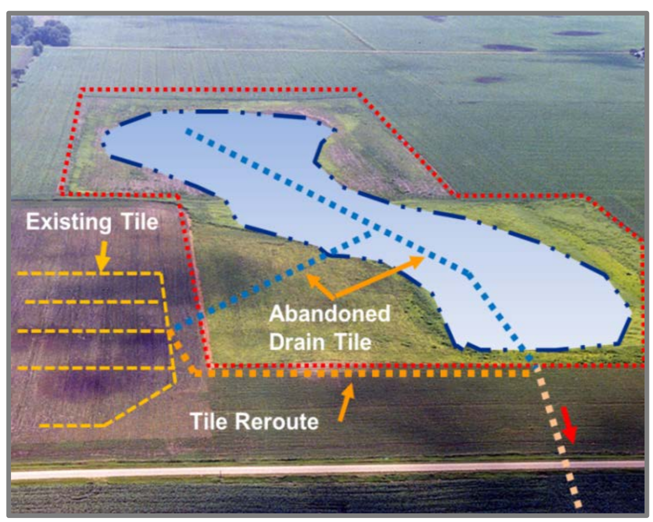

Figure 3. Drainage Tile Rerouted Around a Restored Wetland

project should be considered, where possible. It is not advisable to locate a tile re-route under or through planned or existing wetland areas on a project. Access to the tile line for future maintenance will be an issue, any cracks or joints within the tile could potentially leak adversely affecting wetland hydrology, and plastic tile located in fully saturated soil conditions could have potential problems with floatation.

The restoration of wetland hydrology will require that tile blocks be designed and constructed on the abandoned portion of the existing tile system just upstream and downstream of the planned wetland. This restoration strategy is discussed further in Technical Guidance Document 4A-2, Blocking Subsurface Drainage Tile.

CONSTRUCTION REQUIREMENTS

The success of a planned drainage system reroute will be determined by its location and construction techniques used. The construction plans that are prepared to address these items should include requirements and specifications for all related construction components including the excavation and grading of open ditches and/or installing drainage tile.

When installing new tile, the construction plans should include requirements for how the junction of the new tile and the existing tile will be made. Changes to tile material, size and grade often occur at these junctions and proper joint construction is necessary to avoid problems with joint separation. Separated joints can allow excessive soil to be pulled into the tile system and cause settling or sinkholes of the above ground soils. To address this, it is recommended that the tile junction be held securely with couplers, tape, or other means, and grouted with enough concrete to securely hold it in place. If the new tile is large enough, slide it over the existing tile by at least 6 inches before grouting.

It is also recommended when constructing tile junctions as part of reroutes that open ends of the disabled tile are sealed with a tile cap or grouted shut. If tile ends are left open, soils can be pulled into the tile and create a "sink hole" at the ground surface. If the existing tile system within the wetland is connected to and made part of the planned outlet (ex. part of drawdown system), sediment in the tile system can affect performance of the outlet.

OTHER CONSIDERATIONS

- Despite the best planning and site assessment efforts, sizes, grades, and locations of existing tile lines or even their existence altogether may be uncertain for many project sites. As such, certain assumptions may have to be made as part of the design. In such situations, the construction plan should ensure enough flexibility and funding exists as adjustments during construction are often needed. In other cases, tile investigations should be performed using a tile probe or excavation equipment to gather accurate information prior to completing the design.
- Non-perforated tile installed thru existing or planned wetland areas will be subject to floatation due to pipe buoyancy. If a rerouted non-perforated tile needs to be installed thru wet areas, a buoyancy analysis for the tile is likely needed. Factors that will affect buoyancy include type and sizes of tile, depth of tile, soil material, and installation method. In addition, special attention is needed where any tile joints may occur to ensure water-tightness. In these situations, a qualified, experienced engineer will be needed to determine specific design requirements.
- Consideration is needed to address stabilizing areas of the restoration site that are disturbed during construction. All disturbed areas should be seeded with consideration for additional stabilization on slopes and in other areas where concentrated flow may occur. This can include the use of straw mulch, erosion control blankets, hydro mulching, etc. (**Figure 4**).

Figure 4.   Seeding and Hydro-Mulching a Constructed Ditch Reroute

- It will be important to understand the legal implications of any planned actions to manipulate an existing drainage system. This includes determining whether the drainage system is part of a public drainage system or governed by a private drainage agreement. If so, certain legal and administrative functions may need to be addressed as part of the planning and design process. Additional discussion on this topic occurs in Section 4-9 Construction Related Laws, Regulations and Permits.

COST

The cost to reroute drainage systems varies significantly depending on the type, scope, and length of construction necessary. Ditch excavation, ditch plugs/fills, tile installation, tile junctions, and tile blocks along with methods to stabilize construction areas are all potential construction components that will be needed and which will affect the cost of this strategy. Due to such variability, it is not possible to provide accurate cost information for this wetland restoration strategy.

MAINTENANCE

Drainage systems need periodic inspection to identify and correct any identified problems. Various problems with ditches can include poor vegetation establishment, excessive erosion, sloughing, or scouring of constructed ditch slopes, and excessive sediment deposition within the ditch bottom. Problems with drainage tile can include joint separation, excessive settling of the backfill materials, etc. Inspections should look for depressions or "sink holes" at the soil surface in the vicinity of any tile junctions.

ADDITIONAL REFERENCES

Other Related Technical Guidance Documents can be found in Appendix 4-A of the Minnesota Wetland Restoration Guide.

Standard Engineering Drawings to aide in the design of drainage system reroutes along with other drainage manipulation strategies are provided in Appendix 4-B**.**