



Memo

Date: Monday, January 05, 2015

Project: South Rochford Road

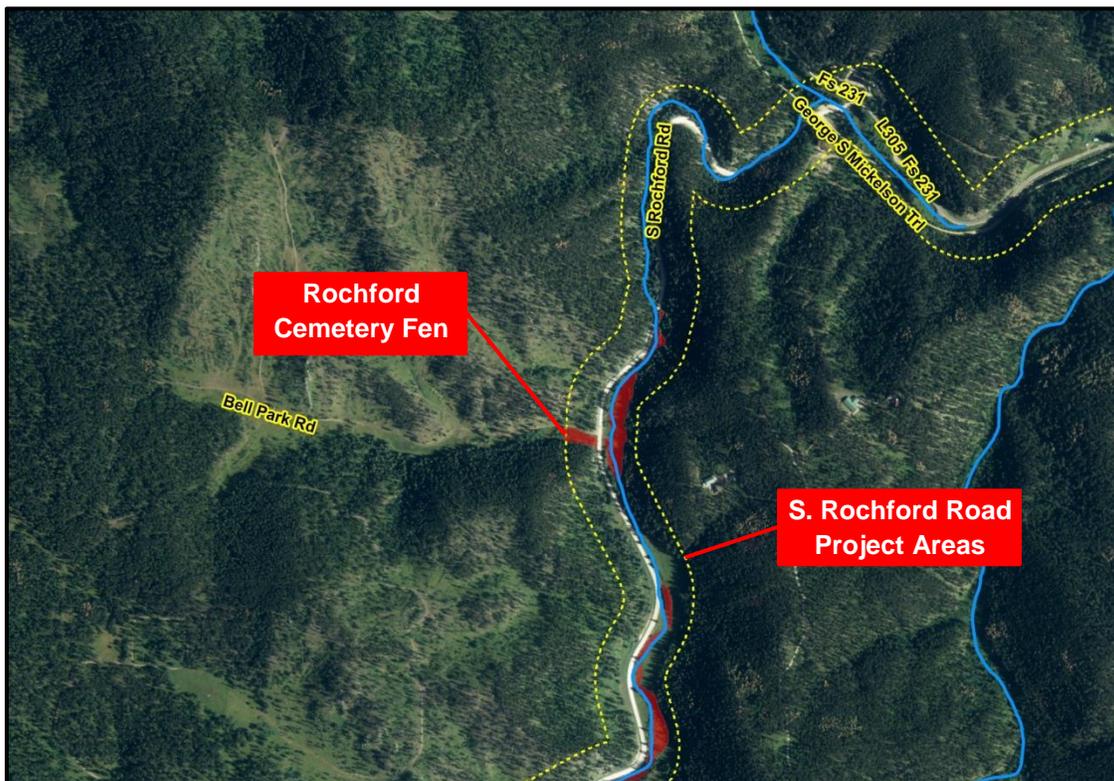
To: Type recipient(s) here

From: HDR, Inc.

Subject: Roadway Options for Protection of Iron Fen Wetlands

Background

Sphagnum angustifolium a U.S. Forest Service (Forest Service) Region 2 sensitive species is likely present within the Project Areas, specifically within the Rochford Cemetery Fen location. The habitat for this species of moss would include any fen within the Project Areas, but the Rochford Cemetery Fen has a significant value due to its classification as an acidic iron fen. When South Rochford Road was originally constructed, it crossed through the Rochford Cemetery Fen which resulted in fill and likely damaged portions of the fen and altered groundwater movement. There are also long term effects resulting from ground water leaching through fill materials and erosion from the gravel surface. These long term effects caused alterations in the overall fen chemistry, changing the habitat for fen species.



A national fen expert, Dr. David Cooper, visited the project area to evaluate the status of the fens and provide potential recommendations for protecting the existing fen and improving the



hydrologic and geochemical conditions. Dr. Cooper's site visit memo is attached as Appendix A. In the memo, Dr. Cooper identified three factors that should be considered for promoting healthy fens of this nature:

- Perennial flow of groundwater
- Low mineral sediment input
- Highly acidic water inflow

He stated that when the existing roadway was constructed; it changed the hydrology and chemistry of the existing fens. The changes had immediate impacts, but the roadway is also gradually degrading the nature of the fens over time. Carbonate rich limestone and dolomite materials were used for fill which has added mineral sediment. The groundwater flow was cut off by the road embankment and the water supply was channelized through a culvert. Dr. Cooper indicated that a new roadway project should attempt to replace the existing fill with material that is more compatible with the fens such as crushed granite. Another recommendation was the use of a permeable base layer in the roadway. The permeable base would improve shallow groundwater movement across the embankment.

This memorandum evaluates roadway options that could be constructed in the build alternatives to help minimize the impacts of the roadway through fen areas and improve the hydrology and geochemical conditions of the fen systems. These options include the permeable base layer for the roadway as per Dr. Cooper's recommendation, a bridge over the fen crossing, and additional conveyance to spread the flow as it crosses from west to east.

Permeable Base / Subbase Layer

In Dr. Cooper's memo, he described a permeable base layer that included a coarse material overlaid with a geotextile separator fabric, topped with a finer material, which would be topped with pavement. Although this type of pavement section has been used on several projects, it is not well documented at this time. Roads constructed with permeable base layers have been used in the upper Midwest primarily as Best Management Practices (BMPs) for temporary access roads through sensitive wetland areas. Other regions have used permeable base layers as more of a standard practice when confronted with grade limitations that make underdrain systems infeasible. The Federal Highway Administration (FHWA) has issued a Technical Brief through the Concrete Pavement Technology Program (CPTP) titled "Daylighted Permeable Bases" (2009) (the Brief). The Brief provides information on design, construction, maintenance, cost, etc. of permeable base layers that daylight to adjacent grade. The permeable layer is partially or fully exposed on both sides of the roadway, allowing free cross drainage. Below are a few notes and practices that were described in the Brief:

- Several states were listed which have developed specifications for permeable bases.
- A base layer thickness of 18" to 24" is typically constructed when there are concerns with frost / freezing.
- The base layer can be constructed entirely with coarser materials, but it is common to use a layer of coarse material topped with finer material (maximum particle size of 2").

- A geotextile separator fabric should be used if there is fine material present that could penetrate and plug the permeable layer.
- The exposed edges of a daylighted permeable layer should be visually inspected once per year with maintenance conducted as necessary.
- Maintenance includes removing debris, weeding, and flushing the edges with water.
- The cost to construct a roadway with the permeable base layer ranges from 100% to 120% of traditional construction costs.

Figures 1 and 2 show examples of the daylighted permeable base layers. The permeable layer used for the South Rochford Road crossing would be designed to convey both surface water and shallow groundwater. A culvert could also be incorporated to handle some of the baseflow and to provide a secondary route for snowmelt runoff if the base layer were to freeze. The permeable base would still serve its purpose in connecting the groundwater flow across the roadway and providing a media for spreading out some of the flow at the crossing.

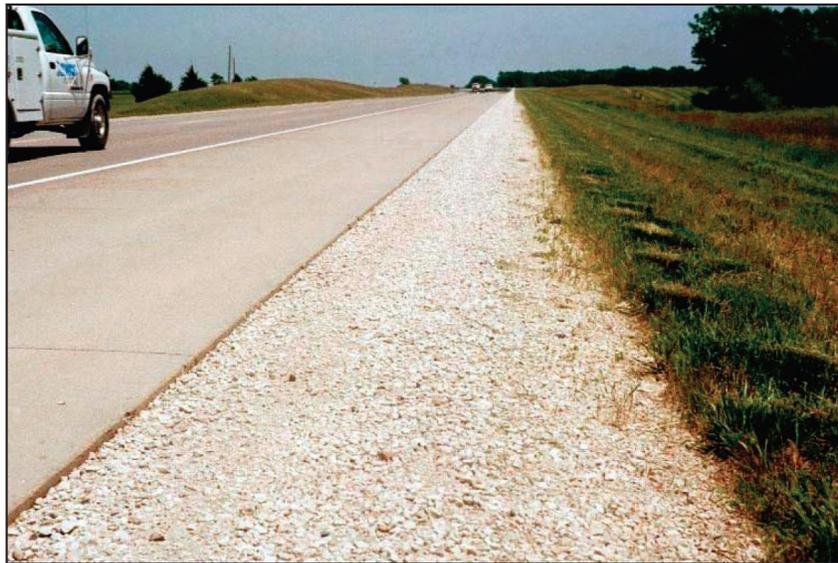


Figure 1. Daylighted permeable base on US 50 in Kansas (Gisi, Brennan, and Luedders 2004).

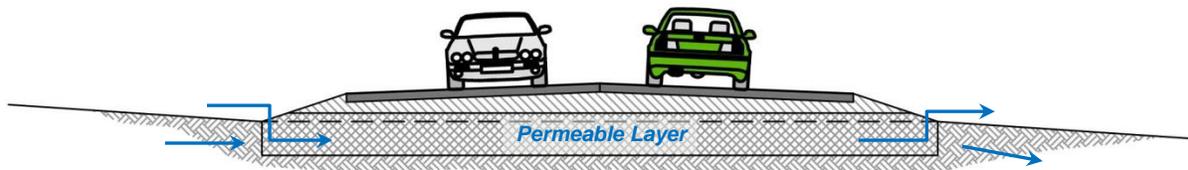


Figure 2. Partially Daylighted Permeable Layer



Bridge Over Fen Crossing

Another option for avoiding impacts and improving fen hydrology would be to span the fen crossing with a bridge. Based on the identified fen area for the environmental study, the bridge would need to be approximately 150 feet in length. Depending on the amount of desired clearance for the bridge, the roadway profile would need to be elevated up to a length of approximately 500 feet in each direction leading up to the bridge. The resulting earth embankment would create additional conflicts with the fen on the east side of the roadway, so a retaining wall would likely need to be constructed in order to avoid further impacts.

Although a bridge would open up the fen crossing area for possible restoration, the construction process would likely include some negative impacts. The existing corridor is very restrictive with the narrow roadway, rock slope on the west side, and fen areas on both sides of the road. Construction of a bridge would also require large equipment for driving piles, constructing abutments, setting retaining wall panels, hauling materials, and setting beams in place. The disturbance that is expected with construction could have a lasting impact on the fen. Installation of a permeable layer would still be necessary with this option in order to improve shallow groundwater flow across the corridor.

Along with the bridge structure and elevated roadway comes a potential for erosion. Careful detail would be required to prevent any long term erosion issues. The area under the bridge will not be able to sustain vegetation. It would likely require a rock lining, which can become mobile during a large runoff event. However, the potential for erosion would be significantly lower than the gravel road which is currently in place. The cost of a bridge structure with retaining walls would also be significantly larger than the other options. A formal construction cost estimate was not prepared for this analysis.

Additional Surface Water Conveyance

There is an existing culvert at the fen crossing due to an abandoned roadway on the west side of South Rochford Road that lies north of fen. Runoff travels from south to north until it reaches the abandoned roadbed, where it is then channeled east through a culvert under South Rochford Road and into the east fen area. There is also flow from the west coming out of the fen which passes through the same culvert. The existing culvert has constant baseflow and is linked to some erosion issues adjacent to the roadway.

A number of options were considered to replace the single pipe culvert crossing that currently exists. Additional surface water conveyance could be provided through a box culvert with a wide span or multiple pipe culverts at the crossing location. An underdrain system with multiple outfalls was also considered. The underdrain system would consist of multiple slotted drain pipes installed transverse to the roadway. The pipes would daylight on the east, downstream side of the road. Although this system could aid in spreading out the flow as it discharges on the downstream end, it would likely result in removing shallow groundwater which is vital to the fen's sustainability. Another variation of this would be to create a low point in the underdrain piping below the roadway. The slotted drain pipes would hold water and function as a siphon. This layout would reduce the amount of water that is extracted from the ground, but would not



provide enough capacity for the surface water runoff. The piping may also experience clogging over time due to the small diameter and the low point in the alignment.

A more viable conveyance option would be a wide box culvert or a series of culvert pipes. The additional capacity would likely help with the erosion issues and improve bank stability. Special grading would be required to ensure that the flow enters and discharges from the culverts in a manner that minimizes impacts to the upstream fen while improving the downstream distribution. Proper installation of the added culvert(s) and the associated grading would result in additional disturbance of the fen areas. In order to reduce erosion from the roadway, the culvert crossing should be extended further into the fen area with shaping around the ends. This option would not provide significant improvement to the shallow groundwater flow.

Evaluation

A number of factors should be considered for evaluating the proposed fen crossing. The first four factors shown in Table 1 were ranked as a positive (+) or negative (-) change over the existing conditions (o). For the last three factors (project impact, cost, and maintenance), the three options were ranked against each other.

All three of the options will provide an opportunity to remove the existing carbonate material and replace it with materials that are more compatible with the fens. The surface drainage and hydrology should also be improved by all three options. The shallow groundwater hydrology should be improved with the permeable base layer and the bridge. All three options provide an opportunity to address the erosion concerns. The permeable base layer will have the smallest footprint and should have the least overall impact to the adjacent fen areas during construction. The main drawback with the permeable base layer would be the maintenance required to keep it functioning properly over time with regard to surface flow. This could be addressed with a culvert to add redundancy to the drainage system.

The permeable base layer is the recommended option because it has the least construction impacts on the existing fen system while enhancing the hydrology downstream from the roadway. It also provides an opportunity to remove the carbonate fill materials which are degrading the fen. Implementation of the permeable base layer will result in an improved overall situation for the fen areas relative to the existing conditions.

Table 1. Evaluation Factors for the Fen Crossing.

	Carbonate Fill Material	Surface Hydrology	Groundwater Hydrology	Erosion	Project Impact	Cost	Maintenance
Permeable Base Layer	+	+	+	+	+	+	-
Bridge over Fen Crossing	+	+	+	+	-	-	+
Additional Conveyance	+	+	o	+	o	+	o