

TECHNICAL MEMORANDUM

DATE: **October 5, 2020**

TO: **AC** Aaron Carranza, P.E., Director, Regulatory Division

FROM: **ML** Matt Lindsay, P.E., Manager, Engineering and Permitting Section

SUBJECT: **STREAM CROSSING DETERMINATION HYDROLOGIC METHODS**

DESCRIPTION OF PROBLEM

There is little guidance in N.D. Administrative Code § 89-14-01-03 regarding the hydrology methods to be used to calculate discharge (i.e., flow) values for the “minimum design standard recurrence interval” for a “stream crossing.” Generally, the three options, as the case may be, to use are the “rational method,” “United States Geological Survey’s” regression report, or “other recognized hydrologic methods.” However, staff have questioned the applicability of the “USGS regression approach” over all situations and how and when that method is best implemented or served given there is not existing guidance, standard, or agency policy when to use “other hydrologic methods.” This memo will serve as a guide to Office of State Engineer staff regarding what hydrologic methods to implement where and when, depending on the circumstances.

FURTHER STEPS OR ACTION NEEDED TO IMPLEMENT

None. This document could suffice as a policy or internal standard operating procedure.

RECOMMENDATION

At minimum, I recommend adopting this as an internal policy in writing, otherwise known as an standard operating procedure.

STREAM CROSSING DETERMINATION HYDROLOGIC METHODS

N.D. Administrative Code ch. 89-02 stipulates requirements for compliance with North Dakota Stream Crossing Standards, as codified in N.D. Century Code § 24-03-08. There is little guidance in ch. 89-02 regarding the “recognized” or “other recognized hydrologic methods” to use and when to use them. The following will be a general guidance for Office of State Engineer staff as to when to implement the appropriate hydrologic methods to compute discharge values. This guidance has been discussed with N.D. Department of Transportation (NDDOT) staff.

REGRESSION EQUATIONS

The U.S. Geological Survey (USGS) regression equations from USGS Scientific Investigations Report 2015-5096 (USGS Report) is the default hydrology method to utilize for **ALL** stream crossings. The following are some important considerations.

The regression equations should be calculated separately, preferably with a spreadsheet. USGS Stream Stats (<https://water.usgs.gov/osw/streamstats/>) should be checked initially to aid in review, but Stream Stats results cannot be used for formal determinations.

DATA SOURCES

Regression equation variables, such as drainage area, maximum elevation, minimum elevation, mapped stream length, longest flow path, etc., should be calculated in GIS capable software and using best available data, such as:

- 1) LiDAR from ND State Water Commission website
 - a. Preferably, 1-meter resolution DEM, based upon most recent LiDAR, should be used.
 - b. If 1-meter is too fine a resolution to analyse efficiently, DEM may be resampled to a higher resolution, preferably 3-meter resolution.
- 2) National Hydrology Dataset (NHD) from USGS website
- 3) High resolution aerial photograph from the ND State Water Commission website and Google Earth for identifying culvert locations.
- 4) ND Risk Assessment MapService for recurrence interval inundation data

EQUATION VARIABLES

In order to further refine the intent of some of the USGS Report’s equation variables, the following expands upon the definitions provided in the USGS Report.

“Stream_length” is defined as the “the summed length of all mapped streams.” The OSE interprets this to be the NHD layer 24K streams.

“LFP_length” is defined as the “length of longest flow path.” The OSE interprets this to be the length of the longest flow path in the drainage area from the downstream most point to the upstream most point in the drainage area.

EQUATION LIMITATIONS AND BASIN REPRESENTATION

If the USGS regression equations do not meet the limitations of the equations, or the parameter information does not accurately represent the basin, the data may be altered in the following ways:

- 1) “Drainage_Area” (All Hydrologic Zones)
 - a. The equation results for drainage areas less than the minimum requirements may be considered for final determinations
- 2) “Ruggedness_number” (Hydrologic Zones B and C)
 - a. The “stream_length” variable utilizes the NHD layer. This data may be altered to more closely match streams as identified on high resolution aerial photography to develop a more accurate basin representation.
 - b. For small drainage areas without sufficient “stream_length,” the longest flow path for the drainage area may be delineated with GIS software to mimic stream_length per NDDOT guidance in NDDOT’s Chapter V Hydraulic Studies and Drainage Design.

EXISTING CULVERTS OR BRIDGES

Every effort should be made to identify all existing culverts and bridges that may affect drainage area boundaries and flow paths. High resolution aerial photography will be utilized in most cases. If the existence of a culvert(s) is not known and its existence would make a substantial difference in the final determination, a site visit may be warranted and will be decided on a case by case basis.

NON-CONTRIBUTING AREAS

Non-contributing areas should be removed from the drainage area, where appropriate. Identification of non-contributing areas within a drainage area should be based on the design event of the crossing. ND Risk Assessment MapService data should be utilized to aid in identifying non-contributing areas. If there is a high level of uncertainty whether an area is a non-contributing area for the crossing in question, a conservative and consistent approach is to include those areas as contributing to the crossing.

OTHER GUIDANCE AND EXCEPTIONS

Unless otherwise specified in this memorandum, the USGS Report or NDDOT guidance from NDDOT's Chapter V Hydraulic Studies and Drainage Design should be referenced in the absence of any further guidance or details in this memorandum.

The following are general exceptions to use of the regression equations. These exceptions are consistent with NDDOT guidance in NDDOT's Chapter V Hydraulic Studies and Drainage Design.

- **IF the crossing is located in an urban setting**, utilizing the rational method may be more appropriate than the regression equations or other hydrologic methods.
- **IF the stream crossing is adjacent to another major "hydrologic zone" boundary in Figure 1 of the Report**, check the equations results of the adjacent hydrologic zone. The results from the zone with the most conservative results will be used for the final determination.
- **IF the crossing is located on a gaged stream**, a statistical analysis of the stream gage data may be more appropriate. Utilizing USGS's 17B or 17C flood flow frequency methodologies in HEC-SSP program to implement is recommended. Only use a statistical analysis when there are NO tributaries entering the stream in question between the stream crossing requested and the available stream gage data.
- **IF the crossing is an equalization culvert for a large waterbody, such as a pond, slough, or lake**, utilizing the methodology in the NDDOT's Chapter V Hydraulic Studies and Drainage Design may be more appropriate than other methods.
- **Other hydrology methods** may be pursued on a case by case basis, however, every effort to utilize the USGS regression equations must be exhausted before utilizing other hydrologic methods. Use of other hydrologic methods must be approved by the OSE's Regulatory Division Director.



STREAM CROSSING DETERMINATION REQUEST
NORTH DAKOTA STATE ENGINEER
REGULATORY DIVISION
SFN 61885 (8/2020)

Crossing Type					
<input type="checkbox"/> City / Municipal Road / Urban		<input type="checkbox"/> County Road / Off System		<input type="checkbox"/> County Road / Major Collector	
<input type="checkbox"/> Township Road		<input type="checkbox"/> State Highway			
Road Authority of Jurisdiction (e.g., Barnes County Highway Department, Dwight Township, etc.)					
Have you contacted the Road Authority regarding this request? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not Applicable					
Road Description (e.g., County Hwy No. 1, 110th Ave NE, etc.)					
Request Location					
Upstream	¼	¼	Section	Township	Range
Downstream	¼	¼	Section	Township	Range
MUST ATTACH MAP TO HELP INDICATE LOCATION(S) REQUESTED. <i>If multiple stream crossings are requested, please provide location details on a separate sheet(s).</i>					
Anticipated construction start date of stream crossing, if known?					
Requestor's Certification					
<i>I am requesting a stream crossing determination from the State Engineer. I understand the requirements of North Dakota Century Code sections 24-03-06 and 24-03-08 and that upon receipt of the State Engineer's stream crossing determination, the stream crossing must be designed and installed, at minimum, according to the State Engineer's discharge (i.e., flow rate) provided the requirements in sections 24-03-06 and 24-03-08 and the requirements in North Dakota Administrative Code article 89-14. Additionally, I acknowledge that my request is accurately described and depicted as I intended. My signature below acknowledges that I have read and agree to these statements.</i>					
Requestor Affiliation					
<input type="checkbox"/> Petition by Majority of Landowners of the Area Affected		<input type="checkbox"/> Township Supervisors			
<input type="checkbox"/> Board of County Commissioners		<input type="checkbox"/> Water Resource District			
Requestor Name (Please list organization name; if petition, please provide separate sheets)					
Address			City	State	ZIP Code
Telephone Number			Email Address		
Requestor Signature					Date

Additional Sheets May Be Attached If Necessary

If you need any assistance, please contact the Regulatory Division at (701) 328-2752.

This request must be submitted to
North Dakota Office of the State Engineer

Mail | 900 East Boulevard Ave, Bismarck ND 58505

Email | swcregpermits@nd.gov

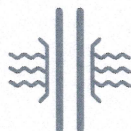
Fax | (701) 328-3696

STREAM CROSSINGS

FACTS & FAQs

WHAT IS A...

STREAM CROSSING



According to North Dakota Administrative Code (N.D.A.C.) section 89-14-01-02, a "stream crossing means an opening to permit the flow of water under, adjacent to, or because of a highway."

HIGHWAY



According to North Dakota Century Code (N.D.C.C.) section 24-01-01.1(22), a "highway, street, or road" is "a general term denoting a public way for purposes of vehicular travel, including the entire area within the right of way. A highway in a rural area may be called a 'road'; while a highway in an urban area may be called a 'street'."

STREAM CROSSING DETERMINATION



A stream crossing determination is a formal determination of flow (i.e., discharge) provided by the Office of the State Engineer (OSE) upon request from an eligible party under N.D.C.C. section 24-03-08.

WHO, WHAT, WHERE'S ON STREAM CROSSINGS



WHO HAS JURISDICTION OVER STREAM CROSSINGS?

Generally, the road authority has jurisdiction over culverts, bridges, etc. in their roads, whether that be the township, county, municipal, or state road authority. Water resource districts only have authority over culverts needed to accommodate a "drain." Jurisdiction has been litigated in the North Dakota Supreme Court in several cases. A good resource for discussion on this topic is the "Roadways" section of the North Dakota Water Managers Handbook, which is available from the [North Dakota Water Resource District Association](#).

WHERE CAN I FIND THE APPLICABLE LAWS REGARDING STREAM CROSSINGS?

N.D.C.C. titles 24 and 61 include the laws directly or indirectly relating to stream crossings, depending on the specific issue. The specific laws generally governing stream crossing determinations include:

- N.D.C.C. section 24-03-06
- N.D.C.C. section 24-03-08
- N.D.C.C. section 24-06-26.1
- N.D.A.C. article 89-14

WHAT ARE "STREAM CROSSING STANDARDS?"

"Stream Crossing Standards" are minimum design standards for road crossings that were developed by the OSE and N.D. Department of Transportation (NDDOT) to further refine the requirements of N.D.C.C. section 24-03-08. In short, Stream Crossing Standards are the minimum design standards for a stream crossing to convey a standard recurrence interval (e.g., 10-year, 15-year, 25-year, and 50-year) flow rate (e.g., cubic feet per second). The "minimum design standards" for a crossing are located in N.D.A.C. chapter 89-14-01.

WHAT IS THE PURPOSE OF STREAM CROSSING STANDARDS?

Stream Crossing Standards were developed in the early 2000s through a cooperative effort between the OSE and NDDOT to ensure reasonable road design requirements for all road authorities regarding stream crossings. Stream Crossing Standards attempted to balance upstream, downstream, and road authority interests with proper roadway design. Stream Crossing Standards were also developed to provide liability protection for road authorities, their contractors, subcontractors, or agents, and any individual firm, corporation, or limited liability company that installs stream crossings that comply with Stream Crossing Standards.

WHEN SHOULD A STREAM CROSSING COMPLY WITH STREAM CROSSING STANDARDS?

Crossings installed before Stream Crossing Standards were adopted are considered "grandfathered" or "legacy" crossings if their construction pre-dated the Stream Crossing Standards design requirements. However, when a crossing is constructed or reconstructed, or when a stream crossing determination is made by the OSE, the new crossing must comply with Stream Crossing Standards. Compliance with Stream Crossing Standards affords a road authority liability protection as described in N.D.C.C. section 24-03-08 and N.D.A.C. section 89-14-01-01. However, enforcing compliance with Stream Crossing Standards is outside of the OSE's jurisdiction.

HOW DO I DETERMINE A CROSSING SIZE?

The crossing must be designed and installed under the road authority's supervision to convey the design flow rate within the allowable headwater limitations provided in the Stream Crossing Standards. The crossing design can be highly dependent on the site location and topography, the road authority's budget, availability of materials and contractors, etc.



OSE STREAM CROSSING DETERMINATIONS

WHO CAN REQUEST A "STREAM CROSSING DETERMINATION" AND HOW?

According to N.D.C.C. section 24-03-08, the following parties may request a stream crossing determination:

- Board of county commissioners
- Township supervisors
- A water resource board
- A petition of the majority of landowners of the area affected

The request can be submitted to the OSE by filling out a [Stream Crossing Determination Request form \(SFN 61885\)](#).

WHAT INFORMATION WILL I GET IF I REQUEST AN OSE STREAM CROSSING DETERMINATION?

The requesting party will receive "the design discharge that the crossing is required to carry to meet the stream crossing standards" (see N.D.A.C. section 24-03-08). In other words, the requesting party will receive the minimum flow rate required at the crossing in question and for the particular recurrence interval required in Stream Crossing Standards.

The road authority shall install a culvert or bridge of sufficient capacity upon notification of the stream crossing determination made by the OSE, as described in N.D.C.C. section 24-03-08. The OSE does not recommend or suggest the size or shape opening necessary to meet "sufficient capacity" to convey the identified minimum flow. This is a task left to the road authority.

HOW DOES THE OSE MAKE A DETERMINATION?

OSE staff will assess the location and determine the best engineering method to calculate the minimum flow rate. Typically, the acceptable engineering practice is to utilize the U.S. Geological Survey's regression equations, which are summarized in [USGS's Scientific Investigations Report 2015-5096](#). OSE staff will use these equations in combination with analyzing the most recent topographic data, typically GIS software and LiDAR data, to delineate a drainage area contributing to the crossing and develop the variables needed for the equations.

The OSE will verify culvert locations via aerial photography investigation. Typically, the OSE will not make a site visit to verify culvert locations unless it would make a substantial difference in the OSE's determination. OSE staff will also identify non-contributing areas from several data sources and decide whether those areas should be included in the drainage area.

USGS STREAM STATS

OSE staff often use [USGS's Stream Stats](#) when feasible to do an initial approximation of the drainage area. This tool is publicly available online. While this tool provides an approximation of the drainage area and anticipated flow rate, the OSE does not recommend usage of this tool for formal stream crossing studies or determinations.

OTHER METHODS

There are limitations to using the regression equations to determine a flow rate, so OSE staff may use other hydrology methods to verify the regression equations' results or determine a flow rate.

IS A ROAD CROSSING EVER CONSIDERED A "DAM?"

Generally, the State Engineer does not regulate highways or stream crossings as "dams" as long as the crossing meets Stream Crossing Standards. However, road authorities should properly place culverts at grade or channel bottom to ensure the crossing acts as an "opening to permit the flow of water" and does not otherwise impound water.

WHAT ABOUT PRIVATE ROAD STREAM CROSSINGS?

Private road stream crossings are not subject to Stream Crossing Standards. However, any approach crossing within a road right of way must meet Stream Crossing Standards. Additionally, it is recommended that all private roads comply with Stream Crossing Standards so that the road does not act as a dam, as defined in N.D.A.C. section 89-08-01-01, or as an obstruction, as defined in N.D. Century Code section 61-16.1-51.

WHAT IF I DISAGREE WITH AN OSE STREAM CROSSING DETERMINATION?

OSE stream crossing determinations are considered an "action or decision" by the State Engineer as described in N.D.C.C. section 61-03-22. Any person aggrieved by a stream crossing determination has 30 days to request a State Engineer hearing on the matter.



OTHER IMPORTANT CONSIDERATIONS

- The OSE does not provide culvert or bridge sizing services.
- The OSE hydrologic review process incorporates NDDOT's approach to determinations, which takes a conservative regional approach.
- Site-specific detailed hydraulics modeling and review is beyond the scope of the OSE's determination services.
- Compliance with Stream Crossing Standards provides liability protection to the road authority and others (see N.D.C.C. sections 24-03-06, 24-03-08, and 24-06-26.1). Non-compliance may remove this liability protection.
- Nothing contained in the Stream Crossing Standards is intended to restrict a road authority from providing greater flow capacity in a crossing beyond minimum standards.
- If multiple crossings or an entire watershed is being considered, it may be more beneficial and economical to seek the assistance of a consulting engineer with experience in water resources engineering. They will be able to determine both the flow rate and crossing design necessary to comply with Stream Crossing Standards.
- If requesting a stream crossing determination for a NDDOT stream crossing, the OSE recommends contacting the applicable [NDDOT District Engineer](#) before submitting stream crossing request to the OSE.
- Road authorities may request a deviation from Stream Crossing Standards, but such a deviation must be approved by both the OSE and NDDOT. NDDOT has deviation authority over Stream Crossing Standards if it "determines it is appropriate to do so and the crossings are designed under scientific highway construction and engineering standards" (see N.D.A.C. section 89-14-01-06).

MORE INFORMATION

Contact the OSE at (701) 328-2752 or by email at swcregpermits@nd.gov.

More information is available on the OSE's "Other Regulations" webpage [website](#).