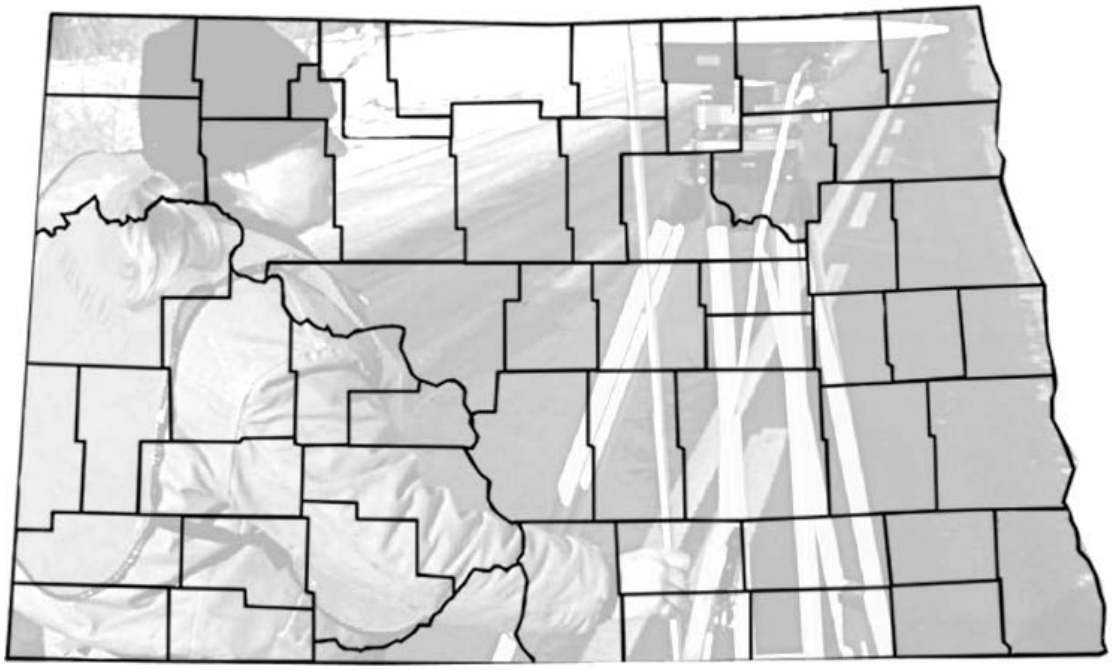
SCOPE OF WORK



FOR
CONSULTANTS PERFORMING
PRELIMINARY HIGHWAY SURVEYS

NOTE: This manual provides a written account of how certain activities are performed and is designed to guide and assist staff members in performing their functions.

When appropriate, there may be deviations from these written procedures due to changes in personnel, policies, interpretation, law, experimentation with different systems, or simply evolution of the process itself.

This manual may be changed at any time. Staff members are encouraged to review this manual periodically and suggest changes in the manual to keep the manual current and to minimize differences between the manual and actual practices.

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19

CONSULTANT SERVICES

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The content of this manual assumes that the project requirements are for an NDDOT "Full Survey." This type of survey is typically a highway corridor that is being considered for reconstruction of some kind. If such a project is just an intersection improvement or a very small study area, it will probably be selected for data collection by field survey personnel. However if the corridor is of substantial length and larger overall coverage area, it will probably utilize aerial photography and photogrammetry techniques. On some projects, the consultant may have the choice of utilizing either discipline but in either scenario, the requirements listed below would pertain to the data collection content and methodology.

No two surveys are ever alike and some may require data that is unique to them alone. Examples of unique types of data could be bridge structures, man-made drainage systems or complex underground utilities. This manual should serve as the "backbone" of what is needed for each preliminary survey project.

The 90-1 (Safety surveys) requirements are defined in Chapter 18.

SERVICES TO BE PROVIDED BY CONSULTANT

19-1 SET PROJECT GROUND CONTROL

19-1.1 Primary Project Control

The horizontal control shall be tied to the North Dakota coordinate system of 1983, north or south zone (be sure to use the correct zone), based on the most current version of the North American Datum of 1983 at the start of the project, e.g. NAD83(2011). This ***Metadata*** of the NAD83 reference frame used shall be shown on the "081CD_###.dgn" data sheet(s).

The CONSULTANT shall set the PRIMARY CONTROL for the project by using a GPS survey to occupy pairs of monumented stations at both ends of the project and at intervals of every 2 to 3 miles throughout the project.

The Continuously Operating Reference Stations (CORS) will be used as the Master Control Network for all highway projects. It is preferred that the CORS stations used surround (not all stations in a straight line or to one side) the project limits to prevent tilting of the coordinates and elevations.

The consultant shall use only geodetic grade Trimble GPS receivers (dual frequency, carrier-phase L1/L2) to collect all GPS data. A GPS receiver must occupy each PRIMARY CONTROL point for a MINIMUM of four (4) hours. The NDDOT recommends using GNSS planning to optimize satellite configuration for best results.

The coordinates of the project control must be determined by using the NGS OPUS solutions.

The National Geodetic Survey operates the On-line Positioning User Service (OPUS) as a means to provide GPS user's easier access to the National Spatial Reference System (NSRS). OPUS allows users to submit their GPS data files to NGS, where the data will be processed to determine a position using NGS computers and software. Each data file that is submitted will be processed with respect to three (3) CORS sites.

It is important to have the correct antenna type and correct antenna height to the Antenna Reference Point (ARP). If this information is not correct, the elevations will be in error. The NDDOT recommends using a fixed height tripod for all OPUS observations on control points. The project control network point coordinates are acceptable when the OPUS solution statistics are as follows:

NOTE: the coordinates must be based on the **International Foot** definition NOT the US Survey Foot definition. **NDCC_47-20.2-03**

There are three ephemeris levels

1. Ultra-rapid (predicted) orbits (near real time)
2. Rapid orbits (one day delay)
3. Precise orbits (typical delay 10-14 days) highest accuracy.

Do not use the "ultra-rapid" ephemeris. Use only the "rapid" or "precise" ephemeris.

Initially the OPUS program picks the CORS stations for its solution. The data files can be submitted again with other sites chosen to see if the solution can be improved.

Review the OPUS printouts for each point observed. If any of the following conditions are NOT met, the point(s) must be resubmitted or observed again.

1. Use 90% or more of your observations.
2. Fixed at least 80% of the fixed ambiguities.
3. Overall RMS should not exceed a Maximum 0.030 (m).
4. The peak-to-peak errors should not exceed a Maximum 0.040 (m), in LAT: LONG: EL HGT: or the ORTHO HGT:

NOTE: the peak-to-peak error is the difference between the maximum and minimum value of each coordinate obtained from the three baseline solutions.

The OPUS results must be forwarded to the NDDOT, Survey Section for approval, before any subsequent data is collected.

19-1.2 Secondary Project Control

Secondary project control shall be observed from primary control for no less than 3 minutes and 180 measurements.

19-1.3 Vertical Control

The vertical component of the survey shall be tied to the North American Vertical Datum of 1988 (NAVD 88) and computed using the most current version of the Geoid available at the commencement of the project, e.g. GEOID12A. The OPUS solution will be used to determine the elevation component of each PRIMARY CONTROL point. No levels will be run from existing Bench Marks to determine PRIMARY CONTROL elevations. The ***Metadata*** of the GEOID used shall be shown on the "081CD_###.dgn" data sheet(s).

19-1.4 Monumentation

Primary and secondary control shall be monumented with a durable ferromagnetic monument not less than 5/8" in diameter. Primary control will be not less than 30" long and secondary control will be not less than 18" long and All PRIMARY CONTROL stations must have affixed an aluminum cap stamped "GPS CONTROL" and be referenced to a highway reference point including distance left or right from centerline. The state form *Survey Control – GPS/OPUS* (SFN 9995) should be completed for all primary control.

These reference ties shall be documented by a sketch, on the SFN9995 form, for each monument.

North Dakota One Call should be notified before placement of monument.

19-1.5 NGS Monument Perpetuation

The NDDOT in partnership with the National Geodetic Survey (NGS) believes in the importance of preserving the existing NGS Horizontal Control Marks and Bench Marks.

In addition to the required primary control points for your project, all NGS marks along the survey corridor or within a one mile of the Highway, should be observed and recorded using the normal OPUS observation requirements, along with some additional information required by NGS so the observation can be shared, by selecting the option "Share my solution". The option to "share my solution" is now offered, in place of "publish my results". By "Sharing" your solution, you will not be submitting it to NGS to become part of the NSRS.

Instructions can be obtained from the OPUS website when submitting data. Select "why share?"

"View shared solutions" for examples.

By publishing these observations on the marks, your efforts will

1. Help maintain local ties to the National Spatial Reference System (NSRS).
2. Users can share their observation's OPUS solutions with the public via "View Shared Solution".
3. Provides coordinates, descriptions, photos, and map for each observation.
4. Local agencies, surveyors and scientists, can get datasheets for their own project marks tied to the NSRS.
5. Observations on benchmarks provide NGS with ellipsoid heights, which are useful for:
    - development of future hybrid geoid models
    - development of future vertical transformations
6. Preserve the mark itself for future users and preserve the vital link between legacy and future geodetic surveys, in much the same way as the US Public Land Survey Corners.

19-2 ESTABLISH EXISTING HIGHWAY ALIGNMENT

19-2.1 Determination of Reference Point (RP) Stationing

The beginning point of a survey is normally at or near the intersection of two highways. This point has a known Reference Point (**RP**) station. Locate or establish this intersection. If there are any other highway intersections on the PROJECT, locate or establish them. Each of these highway intersections have known **RP** stationing AHEAD of the intersection. Therefore, there will be an equation at each highway intersection. This equation is determined by measuring the distance from the last highway intersection. Contact the NDDOT, Survey Section for the correct RP stationing of highway intersections on or near the project.

Refer to Chapter 18 section 18-1 of the survey manual for additional information regarding reference point station requirements. *https://www.dot.nd.gov/manuals/design/surveymanual/18_90_1surveys/CHAPTER_18_PT1.pdf*

19-2.2 Establish Survey Centerline Alignments

The survey centerline alignment is established by locating existing PI's, POT's, curve points, and Public Land Survey system (PLSS) corners, using existing highway plans, right of way plats, city plats, and GLO plats.

Curve definitions on older highway plans and Right of Way plats were mostly defined by the chord definition. When creating alignments for your project, the curves are now defined by the arc definition. To best match the majority of curve parameters between the chord and arc definitions utilize the radius of the chord curve.

The alignment must be shown on the MicroStation/Geopak CADD drawings and the associated GPK file needs to be included in the project submittal. The naming convention for these alignments will include the SCL prefix. Once the alignment has been established, the data will be forwarded to the NDDOT, Survey Section for approval, before any other work is completed on the corridor.

19-2.3 Monumentation of Existing Alignment

Alignment point monuments will not be set during preliminary survey unless it is a PLSS corner. PLSS corners will be addressed in the preliminary survey as defined in Section **19-6.5**.

Refer to the NDDOT standard drawing "D720-1" for instructions on monumentation.
https://www.dot.nd.gov/divisions/design/docs/standards/D720-01.pdf

19-2.4 Additional alignments

Aside from the primary survey centerline alignment(s) there are various other alignments that may be required. Some of these alignments may include but are not limited to minor roadways, side street alignments (in urban settings) and off/on ramps.

19-2.4.1 Existing Alignments

Existing alignments have a prefix of EX on the MicroStation/Geopak CADD drawings and the associated GPK file. Existing alignments represent alignments previously defined in a set of plans. These alignments will represent the previously established geometry but may not have supporting boundary data.

19-2.4.2 Office Location Alignment

Office location alignments will have a prefix of OCL on the MicroStation/Geopak CADD drawings and the associated GPK file. Office location alignments represent an alignment with a "best fit" to the road and may or may not include geometry from previously established alignments. These alignments have no supporting boundary information and **will not be used for Right of Way purposes.** OCL alignment stationing should be significantly different than RP stationing.

19-2.5 Survey Book Requirements

In the project survey book, describe the method or methods used to establish the survey centerline alignment and PLSS corners.

19-2.6 Coordinate System

Record all alignment points in the "DOT county coordinate system" as defined in Section **19-7**.

19-3 PHOTOGRAMMETRIC DATA SUPPLIED TO CONSULTANT

19-3.1 Meteorological Conditions

NDDOT's Photogrammetry Section obtains imagery when the sun angle is over 30 degrees above the horizon whenever possible. For their "controlled" project work, the highway corridor is ideally free from heavy building or tree shadows. Weather conditions that produce heavy haze are typically avoided. Cloud shadows across the image area are avoided whenever possible and any imagery displaying clouds between the aircraft and the surface is typically not utilized for controlled work.

19-3.2 Photogrammetric Sensor

19-3.2.1 Aerial Sensor

NDDOT currently utilizes a Zeiss DMC01-101 camera system with a 120mm nominal focal length lens system. The camera is mounted on a Z/I Gyro-stabilized mount and navigationally controlled via AeroOffice controller and in-camera IGI Inertial Measurement Unit (IMU).

19-3.2.2 Resolution

For high accuracy, controlled urban corridors, the platform collects data at 1200' Height Above Ground (HAG). This results in a pixel resolution or Ground Sample Distance (GSD) of 0.12'.

For controlled rural corridors, the platform typically collects data at 1500' HAG (GSD 0.15'). If extended corridor width is required, the DOT may fly corridors up to 1800' HAG (GSD 0.18').

19-3.3 Overlap

Forward lap of sixty five percent (65%) ±05% is maintained on all flight lines. For extended width, parallel flights may be flown at a side-lap of 40% to form "Blocks".

19-3.4 Exposure Properties

Optimum conditions are always striven for but under certain time constraints, imagery may be collected with overcast skies. During image analysis, histograms are manipulated to achieve optimum clarity of image details, relative to the project type. Levels of color saturation and hue are controlled together with overall brightness, contrast and gamma.

19-3.5 Ownership of Image Data

Imagery dispersed to consultants for specific projects, shall not be resold or dispersed to other entities without the written permission of NDDOT.

19-3.6 Image Data Format and Associated Resources

Imagery is processed in JPEG compressed (Q5) RGB format with final images being 8 bit Tiff with associated Tiff World Files.

Also delivered to consultants would be the results of the airborne GPS calculations with PPP refinement, together with the ISPM files "Project," "Camera," "Photo," "Model," and Coordinate System File (CSF).

Due to the large file sizes; imagery and its associated data are typically copied to a portable memory device, supplied by the consultant, for dissemination.

19-4 PHOTOGRAMMETRIC OPERATIONS

19-4.1 Analytical Aerotriangulation

19-4.1.1 Determination of Coverage Required

The consultant shall work with the NDDOT Technical Support person, to determine the required area of interest for the project and compose the necessary flight lines and aerial panel coverage, to produce an efficient flight by flight layout.

Upon observation of the imagery, the consultant may be required to remove certain aerial panels from the solution or have field crews verify horizontal and vertical data for a particular panel.

Additional ground control data may be required under certain circumstances. If so, additional "Picture points" may be collected by field crews for use in the analytical solution.

19-4.1.2 Aerotriangulation Standards

All photogrammetric products shall be completed using current grid coordinates for the project. This will be either North Dakota State Plane South Zone or North Dakota State Plane North Zone coordinates. This will include aerotriangulation, stereo compilation and orthorectified aerial mosaics. The stereo compilation graphics will be converted to County ground coordinates during CADD editing.

The expected RMSE horizontal accuracy of the analytical aerotriangulation adjustment for imagery captured from a DMC01-101 (focal length 0.12m) shall be equal to or less than the HAG/10000. The expected RMSE vertical accuracy of the analytical aerotriangulation adjustment shall be equal to or less than the HAG/9000. HAG or Height Above Ground is equal to the Altitude (AMSL) minus the average ground elevation beneath the flight.

Once the final results are tabulated, a full analytical report should be forwarded to the NDDOT, Photogrammetry Section for approval, prior to stereo-compilation taking place.

19-4.1.3 Aerotriangulation Deliverables

On completion of the project requirements, the consultant will be required to deliver to the NDDOT, Photogrammetry Section, the principal ImageStation Project files, often referred to as "The Big 5." (Project, Model, Camera, Control and Photo).

19-4.2 Stereocompilation of Surface Features and Elevation Data

19-4.2.1 Project Corridor Coverage

The area of concern for each project should have been ascertained at a "Pre-Survey Meeting" prior to any involvement by specific consultants. Each project will have its boundaries defined based on the type of activity that is taking place within the corridor.

If the consultant performing the stereo-compilation is also involved in the design phase of the project, they should be able to determine ahead of time, what the most efficient coverage area will be. However that is not always the case. A rule of thumb for data collection would be to collect surface features and elevation data out to the right of way lines on either side of the survey centerline. Then at intersections, to extend coverage 500' down the side road, collecting data at least 100' either side of that side road.

In particularly hilly or rugged terrain, it may be necessary to increase the corridor width significantly to show the rapid changes in elevation or the formation of drainage channels and creeks.

The "Pre-Survey Meeting" is also a perfect opportunity to discuss any specific features that may be encountered during the survey, such as tall towers, bodies of water, railway line crossings, underground tanks, airport glide-paths etc.

19-4.2.2 MicroStation Files

There are 3 main MicroStation drawings that can be involved in the stereo-compilation process. It is unusual to actively enter data into the 2D "Control.dgn" drawing during stereo-compilation, as it should contain only PLSS data and alignment associated features (which typically are not visible during stereo-compilation) however it can be useful to refer to this drawing prior to stereo-compilation, to avoid double digitizing features like reference markers and right of way markers.
All visible surface features that are pertinent to the survey should be digitized in the 3-D file named "Topog.dgn"
All elevation data such as DTM break lines, DTM spots, Voids and Obscured Areas, should be digitized in a 3-D file named "DTM.dgn".
Each of these MicroStation drawings should be derived from the NDDOT CADD standards "Seed Files". See Section **19-7.8** for Web site location.

A fourth drawing: 081CD_###.dgn contains the coordinate XYZ data for all the alignment points and PLSS data contained within the project corridor. It is a 2-D drawing that looks like a spreadsheet.

19-4.2.3 Feature Attributes

All feature attributes shall follow NDDOT specifications as documented in the NDDOT CADD Drafting Standards

Manual. See Section **19-7.8** for Web site location.

19-4.2.4 Topographic Details

All topographic detail such as roads, driveways, sidewalks, trails, railroads, power poles, telephone poles, buildings, fences, wooded areas, and other identifiable features on the photography, shall be shown in the Topog.dgn files in their correct positions and orientation. Particular attention should be paid to the elevation accuracy of features that will be used in the extraction of elevation surfaces e.g. asphalt edges, concrete, dirt, gravel and edge of water shots. Hydrographic features such as lakes, streams and rivers, should be digitized at the precise elevation of the water's edge.

Any features that are not clearly identifiable in the stereo-compilation process should be digitized with a "Whatiz" cell and a questioning label should accompany the cell e.g. "Utility marker?".

19-4.2.5 Digitizing Elevation Surface Data

The precise definition of the elevation surface is derived from a combination of field collected data and stereo-compilation data. If the field collected data has been processed prior to stereo-compilation, it should be referenced into the DTM.dgn drawing, so the operator can view the field data during the DTM data compilation.

The digital terrain model (DTM) is created using a combination of feature types, including "Break lines," "Spots," "Islands," "Voids" and "Obscured Areas."

19-4.2.5.1 Break lines

Break lines are digitized from existing surface features like asphalt edges, concrete pads, field perimeters, dirt trails, berms, retaining walls, and curb and gutter. They are also digitized from observed changes in surface elevation that form distinct "edges". The drop off edge of a roadway ditch would be an example, or the bottom of the same ditch.

Other examples of when a break line would be digitized are:

- Flow line at the intersection of curb and gutter.
- Crown of asphalt road.
- Bottom of a curved concrete drainage channel.
- Following the bottom of a natural drainage channel.
- Perimeter of a slide area.

It is critical to ensure that no break lines are allowed to cross one another during the digitization process, as this will result in inaccurate surface elevation data.

Remember WHY you are creating the 3-D model. Does the designer need to have an accurate representation of the bridge deck and wing wall layout? If they do, you have to digitize not only the top of the wing walls but the ground at the base of the wing wall. It will also be necessary to bear in mind whether the terrain modeling will end at the structure, or be processed "under" the structure; should there be two versions created, to depict both situations?

Digitizing contour lines instead of break lines is not an acceptable practice for defining the elevation surface. Attempting to follow a fixed elevation across varying terrain will always induce errors into the data collection that will compromise the accuracy of the data.

19-4.2.5.2 Spots

Spot shots are normally shot in large areas of "similar" elevations. Example: pasture land or arable fields. They are shot to describe any slight undulations in rolling terrain. Spot shots are also taken to "fill in" areas between break

lines where the break line data has the potential to heavily influence the triangulation of adjacent features.

As a rule of thumb, spot shots are rarely taken more than 30 feet apart unless the area is a large paved surface. It is also recommended that spot shots are collected in a well-spaced, non-stringed formation. If spots are collected like cross sections (in line strings), the resultant Triangulated Irregular Network (TIN) will be compromised.

19-4.2.5.3 Islands

Islands are areas of break lines and spot shots that get extracted as separate entities. The triangulated file data is not physically connected to the other triangles within the DTM model. Obviously islands within a lake, river, or pond would be extracted using this method. Another example would be multiple areas within a project where DTM data had been collected separately and the designer did not need any connection between the corresponding areas.

19-4.2.5.4 Voids

Void lines are utilized to digitize void areas (normally shot as closed shapes) around bodies of water, dense vegetation, buildings or other structures. The void areas create zones where the designer does not wish to have triangulation occur through the building or body of water. Without the creation of voids, earth volume calculations can be dramatically compromised.

19-4.2.5.5 Obscured Areas

Obscured areas are digitized around those areas on the ground, where the operator has difficulty obtaining accurate elevation values for bare ground. This situation can be caused by overhanging trees, heavy shadows from buildings, traffic on the highway or tall grasses and brush. Field survey crews will visit these areas and collect DTM data within the boundaries and identify and shoot any pertinent surface features that can be added to the stereo-compiled data.

19-4.2.5.6 Creating the final DTM surface

Using a combination of the above extraction features allows the operator to supply designers with very accurate ground representation and flexibility in future earth related applications. From accurate TIN file data, designers can cut cross sections, visualize survey centerline profiles, place proposed grade lines, compare post construction TIN's to preliminary survey TIN's, visualize perspective views, and much more.

In order to fulfill these multiple adaptations, the surface extraction procedures need to be performed with high precision. This can only be done if the compilation process has been executed with the correct levels and an acute awareness of the forthcoming DTM extraction process.

Using the techniques described above, the operator should obtain a vertical accuracy of plus or minus 0.15' over 95% of the stereo-model, when the imagery is obtained from the Department's DMC1-101 flown at 1500' HAG and the majority of the project corridor is viewable as "bare ground." (See accuracy formula in section 19-4.1.2) Data accuracy should be evaluated against elevation data obtained by field survey techniques (Ground Truthing data).

The final delivered DTM.dgn should contain all the features required to extract the necessary elevation surfaces. If there are bridges on the highway, there should be sufficient data in the drawing to extract both "Bridge_In" and "Bridge_Out" versions of the .tin.

Note: A complete description of the CAD techniques required for successful DTM generation can be found in Chapter 21 "CADD Editing Manual" sec. 21-5

19-5 CADD EDITING

Please refer to Chapter 21 "CADD Editing Manual" to establish the methods required to present the survey data in its final standardized form.

19-6 FIELD SURVEY OPERATIONS

19-6.1 Notification of Survey

Prior to any field surveys or aerial panel installations by the CONSULTANT, the CONSULTANT shall notify affected landowners on survey projects with activities occurring outside of the highway right of way. Notification may be done verbally on phone, in person, or by sending a Notification of Survey Letter. Not all projects will require landowner notification and should be discussed at the pre-survey meeting. If determined landowner notification is warranted, the method used will be discussed at the pre-survey meeting. Notification of Survey Letters may be best suited for survey projects with numerous private landowners, and generally sent out approximately 30 days prior to survey activities taking place. (See letter template in section 19-15.)

19-6.2 Data Collection Methods

19-6.2.1 Primary GPS Control

The occupied time for "GPS" points is a minimum of a four (4) hour observation. Every primary GPS control point shall be documented using the state form Survey Control – GPS/OPUS (SFN 9995). Network adjustment of OPUS solution results are acceptable. Submit network adjustment reports to the NDDOT, Survey Section prior to use.

19-6.2.2 Secondary GPS Control

The occupied time for RTK, BM and CP points is a minimum of a three (3) minute and 180 measurements RTK observation to obtain an accuracy of 0.049’ horizontally and 0.066’vertically.

19-6.2.3 Photogrammetric Aerial Panels

For projects that will be flown for photogrammetric purposes (“controlled” projects,) each aerial panel should be recorded with a minimum occupation time of ten seconds (seven measurements).

Once all the panel coordinates have been recorded and the subsequent aerial imagery has been approved through visual quality control; the aerial panels that were placed using materials other than paint, will need to be removed from the project corridor.

19-6.2.4 Photogrammetric Ground Truthing data

Separate “Field Verification” (Ground truthing) data shall be collected, preferably on the highway surface, throughout the entire length of the project corridor. On large projects, sampling areas may be selected instead. These xyz coordinates are to be used to check the elevation accuracy of the stereo-compilation data. Additional “cross sections” should be collected to check the lateral accuracies of the project corridor. Typically these cross sections can be taken every mile but they are most valuable when shot on hard surfaces or bare ground. These shots should be observed to achieve an accuracy of 0.049’ horizontally and 0.066’ vertically.

19-6.2.5 Boundary and Alignment Points

This includes all PLSS corners, property corners, alignment and R/W monuments shall be observed to achieve an accuracy of 0.049’ horizontally and 0.066’ vertically.

19-6.2.6 Hard Surface Features

This includes all concrete, asphalt road surfaces, culverts and drainage structures, manholes curb inlets, water valve covers, and any other features that would require accurate elevations. These should be observed for a minimum of 10 seconds, with 7 measurements.

19-6.2.7 DTM Collection

Great care needs to be taken in selecting the correct coding for data collectors, so that voids and figures are closed, and surface features get extracted correctly. There is also a much greater opportunity to accidentally cross break lines when data is collected in the field. The field personal cannot "see" break lines that were previously collected like the stereo plotter operator can. Multiple operators in the field may accidentally cross over one-another's work.

19-6.2.8 Other Topographic Features

Ground DTM spot shots and break lines on gravel, and dirt road surfaces, soft dirt surfaces, ELM located underground utilities, signs, poles, posts, R/W markers, trees, fences, etc. that do not require precise elevations shall be observed to achieve an accuracy of 0.10' horizontally and 0.13' vertically.

At this time, "Continuous Topo, or Rapid Point" options CANNOT be used for any data collection.

19-6.2.9 GLONASS

GLONASS satellites may be used for all data collection.

19-6.2.10 PDOP

No data point should be collected when the PDOP exceeds 6. The NDDOT prefers the limit to be set at 5.

19-6.2.11 Datum

The most current NAD83 reference frame and Geoid that is available upon project commencement shall be used when utilizing the GPS system. No site calibration or inclined planes will be accepted.

19-6.2.12 Point Numbers

To alleviate duplicate point numbers, the DOT suggests assigning each individual data collector a point range of numbers. Each point shall have a **unique** number. Each point will also include the Northing, Easting, Elevation, EFB code, and an optional description.

19-6.3 Locate Property Corners

When the highway project goes through or near a city or town, research and obtain plats of subdivisions and/or lots. Locate and tie in all private property (subdivision and lot corners) monuments within one block left and right of the survey centerline.

19-6.4 Airports

A notice of proposed construction must be filed with the Federal Aviation Administration on airports where the proposed construction meets the following criteria:

1. Any construction of more than 200 feet in height above ground.
2. Any proposed construction that intercepts an imaginary line that extends from a point 200 feet from the end of the nearest airport runway, upward and outward at one of the following slopes:
    a. Slope 100:1 for a horizontal distance of 20,000 feet (3.8 miles) with the length of runway more than 3,200 feet.
    b. Slope 50:1 for a horizontal distance of 10,000 feet (1.9 miles) with a length of runway not more than 3,200 feet.

c. Slope 25:1 for a horizontal distance of 5,000 feet from the nearest point of a heliport.

3. Complete FAA Form 7460-1 if any of the above conditions are encountered on the project.

Attachments to the form are required. One attachment is the source of the coordinate information and reference datum.

Any airport (Public or Private) within two miles of the project must be tied in to the survey centerline as follows:

19-6.4.1 Runway Centerline Alignment

Extend the centerline of the airport until it intersects the survey centerline. Monument and record the coordinates (in state plane X, Y, & Z, and Latitude & Longitude) of this point on the centerline. This information will be shown in the Topog.dgn.

If the airport is PARALLEL to the highway, the above intersection point determination requirement does not apply, but the items listed below are needed.

NOTE: A Registered Land Surveyor must complete a certification document.

See Section **19-14** for sample surveyor's airport certification document.

19-6.5 Locate Public Land Survey System (PLSS) Corners

Locate or establish the PLSS corners (Section, quarter, etc.), on the survey centerline and at a minimum the nearest corners left and right of the survey centerline. These PLSS corners must be shown in the Control.dgn and the 081CD_###.dgn.

19-6.5.1 Corner Search

Search for physical evidence at each site, including making excavations as appropriate, to look for monuments, or the features with which to substantiate the location of each corner.

19-6.5.1.1 Set monument and cap

Set monument and LS CAP at corners during the preliminary survey. Follow the guidance of Century Code NDCC 47-20.1 for PLSS corners outside of the NDDOT right of way. Follow the guidance of the NDDOT standard drawing D-720-1 for PLSS corners within the right of way.

19-6.5.1.2 Corner recordation

Prepare and file a "***North Dakota Land Survey Monument Record"*** form on each PLSS Corner with the appropriate County Recorder. Provide the NDDOT, Survey Section with a copy of each ***filed*** Monument Record form (in .PDF format). Each form is to be submitted as a single PDF and named to correctly identify the corner. For example, the North quarter corner of Section 22 (Index Ref. No. 8-G), Township 159 North, Range 102 West filed at the County Recorder's office in the year 2012, shall be named ***"159_102_8-G_2012.pdf"***. The underscores and hyphens must be included in the name as shown. Also, do not transpose the 8-G index reference number. We will not accept monument records that do not have the County recorders information stamped on the document.

19-6.5.2 Section and Quarter Line Crossings

Determine each section and quarter line crossing the survey centerline. This point must be in line with the PLSS corners right and left of centerline. These are alignment related points, and should be included in the survey centerline's chain definition and shown in the Control.dgn.

19-6.5.3 Section and Quarter Line Crossing Monumentation

These monuments are to be set during construction. *Refer to the NDDOT standard drawing "D-720-1" for instructions on monumentation.* https://www.dot.nd.gov/divisions/design/docs/standards/D720-01.pdf

NOTE: All of Section **19-6.5** must be completed by, or under the guidance of, a ND registered Professional Land Surveyor.

19-6.6 Reference Markers

Record the coordinate location of all Reference Marker posts (formerly called mile markers) on the project and supply the coordinate (Northing & Easting) data on the 080CD_###.dgn sheet as shown in Section **19-13**. These points must also be shown in the Control.dgn.

19-6.7 Right of Way Markers/Monuments

Locate and record the coordinate location of any right of way markers and right of way monuments found on the project. These will be shown in the Control.dgn file.

19-6.8 Sign Survey

Complete sign inventory forms for all business and State signs within the survey corridor.

- Measure and record the location of all the above signs.
- Take at least one original digital photograph of each sign. The photograph should show the entire sign structure from ground level to the top of the sign.
- It can be very useful to include the number assigned to each sign as part of the photograph, or use the photo ID number (eg. IMG_0304.jpg) as the sign number on the form.
- Use SFN 50455 (3-00) ***"Traffic control sign inventory"*** form for State signs.
- Submit Sign Inventory forms and photographs under the "Signs" folder (see **19-9**). Sign cells should also appear in the Topog.dgn file.

19-6.9 Locate Underground Utilities

Locate and record all underground utilities (water, sewer, gas, electric, fiber optic cables, telephone, petroleum lines, etc.). These lines must be shown in the Topog.dgn.

See Section **19-9** **"MICROSTATION AND GEOPAK FILE NAMING CONVENTIONS"** for file naming convention.

1. Record name, size, and type of utility, if possible, in the project survey book.
2. Measure and record elevation of all water main and gate valves within the survey corridor.
3. Record the invert elevation, size, type, and condition of each pipe in all sanitary and storm sewer manholes. Also the rim, ring elevations, and number of rings in all manholes.
4. Sketch the direction of each pipe, entering a manhole, in the project survey book.
5. Measure and record the location, invert elevation, size and type of all culverts within the existing highway right of way or survey corridor. All measurements should be made at the outlet of the pipe. Also note if the culvert has flared ends.
6. Measure and record the location, invert elevation, size and type of any hydraulic feature that is located

outside of the survey corridor but potentially flows into, or drains out of, the survey corridor

7. Record notes on utility contacts in the field project book. These should include name, telephone number, and date of contact.
8. Record the shortest distance between the overhead utility line and the highest point of the roadway(s) that may be affected by construction activities. In the case of a divide highway, this measurement shall be recorded for each roadway.

   All overhead heights shall be recorded and labeled in the Topog.dgn for grade raise projects and within 200' of intersections where signal or lighting improvements will be done. In rural areas that do not meet the previous criteria it is only necessary to record the heights of lines 25' or lower. Lines that are higher than 25' will still be labeled in the Topog.dgn stating that there is more than 25' of clearance.

19-6.10 Railroad Crossings

19-6.10.1 Railroad Features

Railroad features will need to be collected for railroads adjacent to or crossing the project corridor. This includes the centerline of the tracks, signs, cantilevers, signals, gates, switches, loop detectors and related cabinets, pedestrian mazes, fences, bungalows, related appurtenances, etc.

19-6.10.2 Railroad Crossings

Railroads tracks that cross the highway will require the following additional data.

19-6.10.2.1 Track profile

Record elevation profiles (top of each rail) where the rails cross the right of way line, edge of road base, edge of road surface and road centerline.

19-6.10.2.2 Crossing Type

The crossing type (wood plank, asphalt, concrete plank, etc.) and corners thereof shall be located and recorded.

19-6.10.2.3 Track status

The railroad tracks need to be identified as main lines, spurs or sidings.

19-6.11 Bridge (Hydraulic) Survey Data

For any structures located on the project, the NDDOT Bridge Division needs the following minimum survey data to assist in their hydraulic analysis: (Additional profile lengths and cross sections may be required)

1. Complete the Bridge Survey Report form (SFN 3853).

   A sample copy of the Bridge Survey Report form is located in Section **19-12**.

2. Typical channel profile

   The typical channel profile should begin 1000' upstream and continue through the structure 1000' downstream. Record profile shots along the thread of the stream every 100' or less, including shots taken through the structure opening.

3. Typical upstream cross section

   Take a minimum of two typical cross sections, one at approximately 500 feet and one at approximately 1000 feet upstream, to adequately cover the flood plain. These may require a cross section of 1000 feet or more in length. Cross sections should include all breaks and benches up to the water's edge and then collect a **sufficient amount of points to adequately represent the entire stream bed**.

   A typical cross section should also be recorded at the toe of the in slope on the upstream side of the road embankment.

4. Typical downstream cross section

   Take a minimum of two typical cross sections, one at approximately 500 feet and one at approximately 1000 feet downstream, to adequately cover the flood plain. These may require a cross section of 1000 feet or more in length. Cross sections should include all breaks and benches up to the water's edge and then collect a **sufficient amount of points to adequately represent the entire stream bed**.

   A typical cross section should also be recorded at the toe of the in slope on the downstream side of the road embankment.

5. A typical stream cross section at the structure site.

   Take a cross section near both sides of the existing structure to show any scour. The cross section should extend 50' past the ends of the bridge.

6. Highway centerline profile

   Take a profile of the highway centerline through the flood plain.

   Elevation data from the stream profiles may be incorporated into the DTM.dgn to enhance the final surface. At the request of the NDDOT Bridge Division, the same data can be assembled into its own unique MicroStation drawing (e.g. "StreamProfile.dgn")

Note: The distances described are dependent on the conditions of each site. Further direction with respect to the channel profile and cross section locations will typically be provided by the requestor of the survey.

19-6.12 Digital Hand Held Camera

When a digital camera is used to take project related hand held pictures (such as: signs, drainage structures, and bridges etc.), the camera must have the following specifications:

The picture should be good quality and have a minimum picture resolution of 2 megapixels. The pictures should have a file format of JPEG with 24-bit color.

NOTE: Digital images should be geocoded whenever possible.

19-7 PROJECT COORDINATES SYSTEM AND OTHER DATA

19-7.1 Project Coordinates

Reference all project coordinate data to the NDDOT "(County name) County Coordinate System".

Table of factors is shown in Section **19-11**.

This system is based on the most current North Dakota Coordinate System available at the start of the project e.g. NAD83(2011), north or south zone.

If the project extends into another county, normally the data file stops 1000 feet ahead into the second county. A new data file is started with 1000 feet shown from the first county.

Example: A project starts in Walsh County and extends into Pembina County. In the Walsh County portion show 1000 feet of data into Pembina County using Walsh County coordinates. In the Pembina County portion show 1000 feet back into Walsh County using Pembina County coordinates. The alignment stationing at the County line crossing shall have the ***exact stationing value*** in both County drawings.

Contact the NDDOT Survey section for guidance on which state plane zone(s) and which county coordinate system(s) should be used.

19-7.2 Data Collection

Collect coordinate values for all field points in a data collector. Each point will also include the Northing, Easting, Elevation, EFB code, and an optional description.

*The "**Electronic Field Book Codes**" document shall be used for all data collection. The codes are in the CADD Standards Manual. http://www.dot.nd.gov/manuals/design/caddmanual/appendixi.pdf*

19-7.3 Length Measurements

The International Foot definition shall be used for all data point coordinates and measurements.

19-7.4 Original Survey Data

Upon **completion** of the survey, final scans of all field books shall be submitted in PDF format. The original field books shall remain in the possession of the consultant but be made available to the NDDOT if required.

19-7.5 Format Standards

All data will be submitted in the following formats and/or standards:

1.	Trimble data collector files	(*.job)
2.	GPS/OPUS observation files	(*.dat, *.T01, *.T02 or RINEX)
3.	NDDOT data collection codes and procedures.	(EFB field data)[1].
4.	NDDOT Reference point stationing procedures.	(**RP** stationing).
5.	All word processing files	Microsoft Word
6.	EFB point files	ASCII text files
7.	Plan sheet data	MicroStation V8i Select series
		Geopak V8i Select series
		NDDOT CADD Drafting Standards[1]
		CURRENT NDDOT MicroStation seed files[1]

[1] *All necessary resource files and standard files are maintained on NDDOT Web site https://www.dot.nd.gov/manuals/manuals-publications.htm.*

19-8 DELIVERY OF SURVEY DATA

Immediately upon completion of this survey, the following items must be sent to the NDDOT's Technical Support person assigned to the project:

1. Scans of original field books.

2. Electronic data collected, computed, and drawn as a result of this survey, on transferable media such as DVD, thumb drive or FTP site, along with a document of transmittal, listing the file names in the transmittal together with a description of the information they contain.
3. Electronic data shall contain a Geopak "job##.gpk" file that contains the COGO definition of the alignment, and all points collected or calculated for the project.
4. All survey data collected shall be delivered in State Plane coordinates and County Ground coordinates in their respective ASCII files. Metadata & a project header should be included. A single ASCII file in each coordinate system shall contain every point located or calculated.
5. Comprehensive Aareadme.docx files should be included under each primary folder, describing significant and unique issues encountered during the creation of all survey data submitted. Each entry shall be dated and include the author's name.
6. All GPS and conventional horizontal and vertical control survey notes shall be submitted.
7. Scans of completed sign inventory survey forms and digital photographs.
8. Ortho-rectified mosaics of the project corridor, with a full set of overviews. (If an aerial survey)
9. Scans of plats obtained as requested in Sections **19-6.3** and **19-2.2**.
10. Copy of completed surveyors' certification as required in Section **19-6.4**.
11. Copy of filed ***"North Dakota Land Survey Monument Record"*** forms for all PLSS corners as documented in Section **19-6.5.1.2**

***NOTE**: Refer to Chapter 20 of the survey manual for information and instructions regarding Right of Way.*
https://www.dot.nd.gov/manuals/design/surveymanual/chapter-20.pdf

19-8.1 Special Cases

The designated project Technical Support staff member must approve any departure from, or modification to, the minimum specifications.

19-9 MICROSTATION AND GEOPAK FILE NAMING CONVENTIONS

SURVEY Folder (Plan & volumetric information)

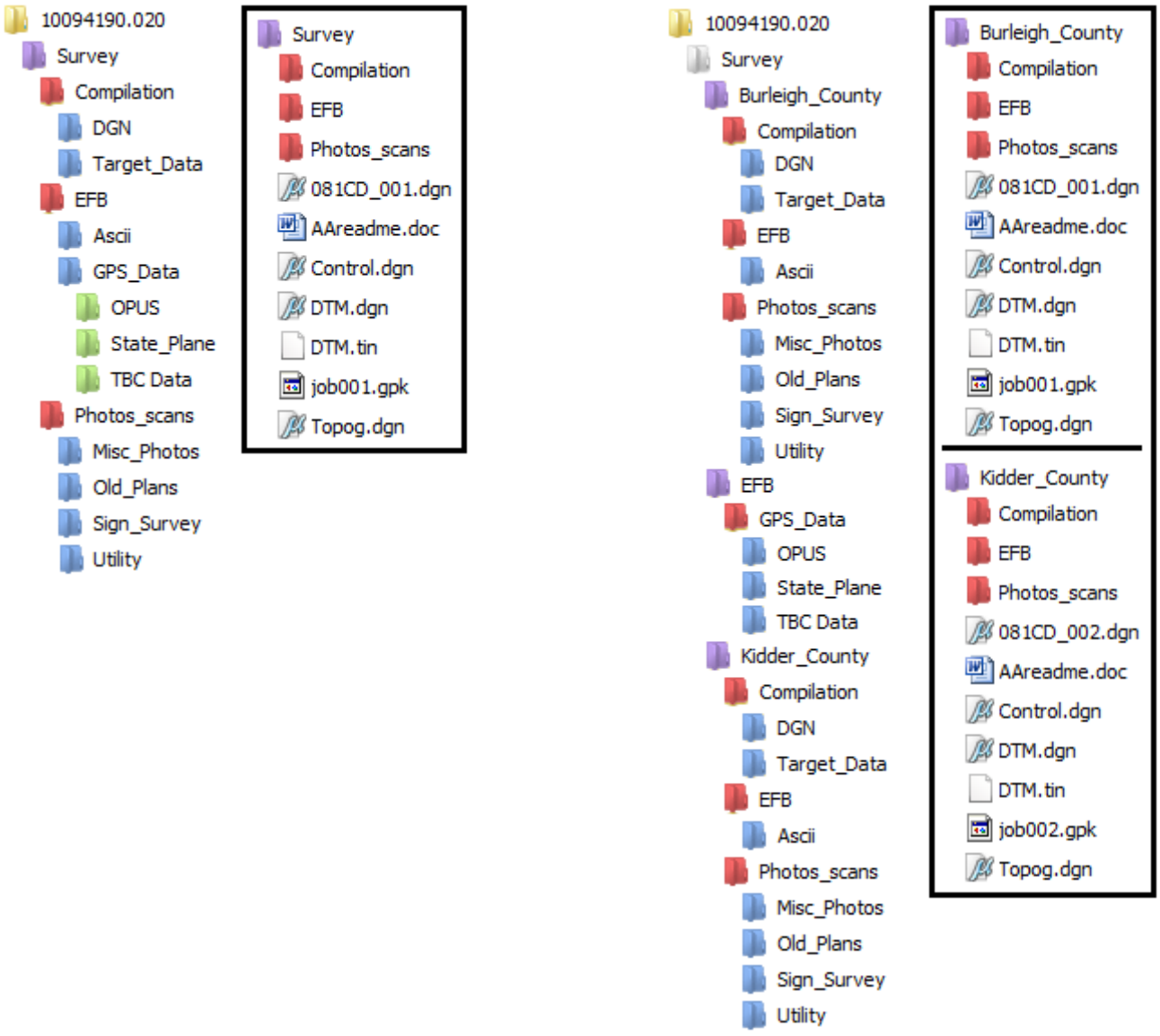
EFB (folder)	Field survey and data collection information.
AAreadme.doc	A document describing the sequence of events on the project, particularly those aspects that are uncommon or may be of use in the future.
Job###.gpk	A copy of EFB original job###.gpk file. Contains control for alignment definition plus all imported points. There should be only one *.GPK file for each project. In cases where a project is split across multiple counties, there should be only one *.GPK file for each county.
081CD_###.dgn	[2-D] Coordinate data sheet containing alignment coordinates, survey point data, section corner locations, GPS points etc.
Control.dgn	[2-D] Section corner, property lines/corners, R/W data, survey centerline, curve data, swing ties.
Topog.dgn	[3-D] Final edit of topographic features; roadways, buildings, signs, posts, utilities, drains, culverts, water, vegetation, etc.
DTM.dgn	[3-D] Extractable features, spots, break lines, voids, edges of roadways, concrete surfaces, edges of water, etc.
*****.tin	Triangulation file extracted from relevant 3D data.

EFB Folder (Field survey & data collection)

AAreadme.doc	A document describing the sequence of events on the project, particularly those aspects that are uncommon or may be of use in the future.
job###.gpk	Geopak data file. Contains control for alignment definition plus all imported points.
EFB_Control.dgn	[2-D] Section corner, property lines/corners, R/W data, survey centerline, curve data, swing ties.
EFB_Topog.dgn	[3-D] Topographic features; roadways, buildings, signs, posts, utilities, drains, culverts, water, vegetation, etc.
EFB_DTM.dgn	[3-D] Extractable features, spots, break lines, voids, edges of roadways, concrete surfaces, edges of water, etc.
ASCII (folder)	ASCII text versions of the data collector information. Two uniquely named datasets of the ASCII files need to be submitted: State Plane and County Coordinate versions.

NOTE: See following pages for one county and two county folder flow charts.

19-9 MICROSTATION AND GEOPAK FILE NAMING CONVENTIONS (Cont.)



NOTE: AAreadme.doc files should be included in every folder.

19-11 NDDOT COUNTY COORDINATE CONVERSION FACTORS

ND LAMBERT STATE PLANE COORDINATE SYSTEM 83 "NAD83 (2011)"

The NDDOT county conversion factor is used to determine ground (horizontal not vertical) distances from grid distances. It is also used to reduce ground (horizontal **not vertical**) distances to the State Plane Grid. A county conversion factor (average) has been determined for each county in North Dakota.

These factors are listed in the **19-11.1** table and map.

The factors are used to convert a distance or a coordinate from the grid to ground or from ground to grid.

Distance example:

A project is located in Burleigh County. The Burleigh County conversion factor (cf) is 0.9998515. The 1/cf factor is 1.0001485221.

1. To determine the ground distance from the grid distance, divide the grid distance by the conversion factor.

   The distance on the grid is 5279.22 feet.
   What is the ground distance?

   5279.22 / 0.9998515 = 5280 feet
   The ground distance is 5280 feet.

2. To determine the grid distance from a ground distance, multiply the ground distance by the conversion factor.

   The distance on the ground is 5280 feet.
   What is the grid distance?

   5280 * 0.9998515 = 5279.22 feet
   The grid distance is 5279.22 feet

NOTE: One (1) divided by the conversion factor will provide a ground factor that when multiplied by the grid distances will determine the ground distances.

5279.22 * 1.0001485221 = 5280 feet

Coordinate example:

A project is located in Burleigh County. It has the same conversion factors as the example above.

1. To determine the ground coordinates (DOT Burleigh County Coordinate System) from the grid coordinates. Multiply the grid coordinates by 1.0001485221.

   Grid Coordinates * Burleigh County conversion factor (1/cf) = Ground coordinate
   421,173.7664 N * 1.0001485221 = 421,236.3200 Y
   1,889,225.8327 E * 1.0001485221 = 1,889,506.4245 X

2. To determine the grid coordinate (State Plane coordinate) from the ground coordinates. Multiply the ground coordinates by 0.9998515.

   Ground coordinate * Burleigh County conversion factor (cf) = Grid coordinate (state plane-South Zone)
   421,236.3200 Y * 0.9998515 = 421,173.7664 N
   1,889,506.4245 X * 0.9998515 = 1,889,225.8328 E

It is always a good idea to hand calculate the conversions back and forth for at least one GPS control point, then compare those values with what is given from the GPS processing software normally used. This will insure the correct local site settings are properly entered.

19-11.1 County Coordinate Conversion Factors Table

ND LAMBERT STATE PLANE COORDINATE SYSTEM "NAD83 (2011)"

State Plane Coordinate (or grid distance) = Ground Coordinate (or distance) times cf
Ground Coordinate (or distance) = State Plane Coordinate (or grid distance) times 1/cf

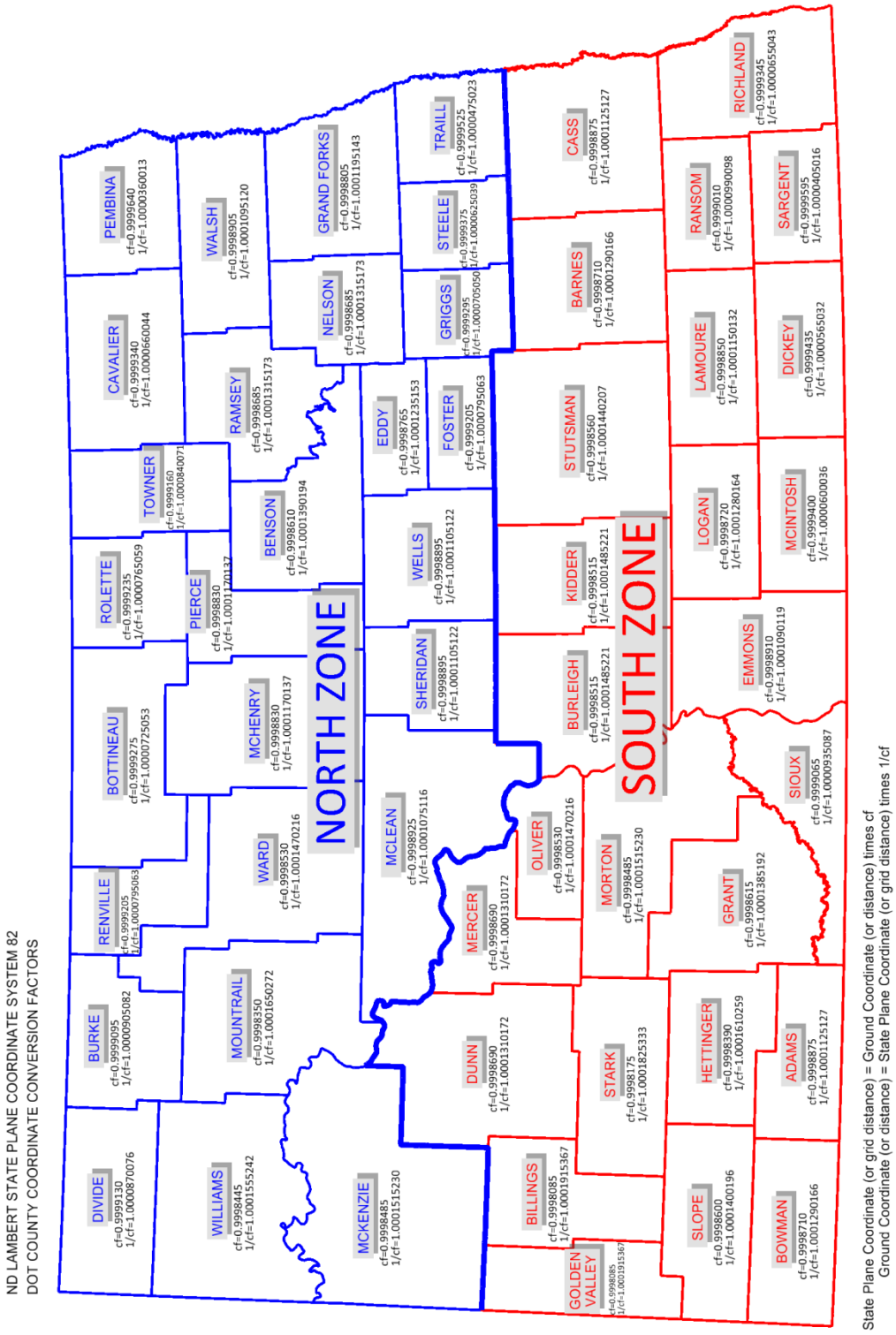
NORTH ZONE

COUNTY	COUNTY COMBINATION FACTOR (cf)	1/cf
Benson	0.9998610	1.0001390194
Bottineau	0.9999275	1.0000725053
Burke	0.9999095	1.0000905082
Cavalier	0.9999340	1.0000660044
Divide	0.9999130	1.0000870076
Eddy	0.9998765	1.0001235153
Foster	0.9999205	1.0000795063
Grand Forks	0.9998805	1.0001195143
Griggs	0.9999295	1.0000705050
McHenry	0.9998830	1.0001170137
McKenzie	0.9998485	1.0001515230
McLean	0.9998925	1.0001075116
Mountrail	0.9998350	1.0001650272
Nelson	0.9998685	1.0001315173
Pembina	0.9999640	1.0000360013
Pierce	0.9998830	1.0001170137
Ramsey	0.9998685	1.0001315173
Renville	0.9999205	1.0000795063
Rolette	0.9999235	1.0000765059
Sheridan	0.9998895	1.0001105122
Steele	0.9999375	1.0000625039
Towner	0.9999160	1.0000840071
Traill	0.9999525	1.0000475023
Walsh	0.9998905	1.0001095120
Ward	0.9998530	1.0001470216
Wells	0.9998895	1.0001105122
Williams	0.9998445	1.0001555242

SOUTH ZONE

COUNTY	COUNTY COMBINATION FACTOR (cf)	1/cf
Adams	0.9998875	1.0001125127
Barnes	0.9998710	1.0001290166
Billings	0.9998085	1.0001915367
Bowman	0.9998710	1.0001290166
Burleigh	0.9998515	1.0001485221
Cass	0.9998875	1.0001125127
Dickey	0.9999435	1.0000565032
Dunn	0.9998690	1.0001310172
Emmons	0.9998910	1.0001090119
Golden Valley	0.9998085	1.0001915367
Grant	0.9998615	1.0001385192
Hettinger	0.9998390	1.0001610259
Kidder	0.9998515	1.0001485221
LaMoure	0.9998850	1.0001150132
Logan	0.9998720	1.0001280164
McIntosh	0.9999400	1.0000600036
Mercer	0.9998690	1.0001310172
Morton	0.9998485	1.0001515230
Oliver	0.9998530	1.0001470216
Ransom	0.9999010	1.0000990098
Richland	0.9999345	1.0000655043
Sargent	0.9999595	1.0000405016
Sioux	0.9999065	1.0000935087
Slope	0.9998600	1.0001400196
Stark	0.9998175	1.0001825333
Stutsman	0.9998560	1.0001440207

19-11.2 DOT County Coordinate Conversion Factors Map



19-12 SAMPLE COPY OF BRIDGE SURVEY REPORT FORM

BRIDGE SURVEY REPORT
North Dakota Department of Transportation, Bridge
SFN 3853 (Rev. 4-2015)

Bridge Number	155-188,222
Project Number	BRS-4-155 (023) 188

County: McHenry	Section: 10	Township: 156 N	Range: 76 W
Bridge Over: Mouse River	Route (Highway Number): ND 14		
Surveyed by: John Doe	Date: 12/21/2006		

EXISTING STRUCTURE

Type: ☐ Truss ☒ Steel girder ☐ Concrete girder ☐ Slab ☐ Box culvert ☐ Timber girder ☐ Other

Year Built: 1951	Structure Position: ☒ Normal ☐ Skew	Size (Span Arrangement And Total Length): Span = 3, Length = 205'
Bridge Deck or Roadway Elevation: Begin Br. 1463.62 End Br. 1463.82		Station: Begin Br. 441+61.00 End Br. 443+66.50
Low Point in Roadway, If Not at Structure		Elevation of bottom of girder at lowest point (Bridges only)
Culvert's Invert Elevation (box culverts only): at inlet / at outlet		
Scour Location	Depth	Length / Width

COMMENTS

New guardrail has been placed off the end of the bridge. There is spalling under the bridge on the eastern abutment.

FIELD SUGGESTIONS FOR OFFICE PLANNING OF NEW STRUCTURE

Scour is occurring upstream and downstream from the west abutment. Channel stability of west bank may be of concern. Perhaps a longer bridge, or shifting bridge to the west will rectify this problem.

Provide channel profile 1,000 feet upstream and 1,000 feet downstream or at locations as defined by the requestor of the survey. For bridges, provide channel section at upstream and/or downstream edge of bridge. Obtain stream sections preferably 100 feet to 500 feet both upstream and downstream. Select locations that represent typical stream sections.

OTHER STRUCTURES ACROSS SAME STREAM

	NUMBER 1	NUMBER 2
Location of structure		
Railroad or highway crossing		
Kind of structure		
Number and length of spans		
Extent of scour at crossing		
Distance from stream bed to clearance line		

Other Comments

HISTORICAL FLOOD DATA

Maximum Known Stage: 1457.00	Date of Maximum Stage: 1976
How Long Was this Stage at or near Maximum? Month / 6 weeks	Location of Maximum Stage: ☐ Upstream ☐ Downstream ☒ Unknown
Head Differential Between Upstream and Downstream: Ft. ☒ Unknown	Stage Affected by: ☒ Other ☐ Ice ☐ Debris ☐ Dams
Water Overtop Roadway: ☐ Yes ☒ No Comment:	If Yes, Depth and Length of Section Overtopped: Depth Length
Was the above Stage Exceptional or Have Other Stages Been near the Maximum Stage? Yes. It was reported that the river was flooding over the banks. The following years have been near the maximum stage: 1969, 1975, 1979, 1996, 1999.	
Elevation or Depth of Extreme Low Water: 1-2'	Source of Information: Jeff Johnson
Where Does Source Live? Owns land to the north of the bridge	How Long? All his life / Did Source Personally Observe Maximum Stage? ☒ Yes ☐ No
Other Comments: No debris or icing problems have been known to occur at this bridge	

HISTORICAL FLOOD DATA

Maximum Known Stage	Date of Maximum Stage
How Long Was this Stage at or near Maximum?	Location of Maximum Stage: ☐ Upstream ☐ Downstream ☐ Unknown
Head Differential Between Upstream and Downstream: Ft. ☐ Unknown	Stage Affected By: ☐ Other ☐ Ice ☐ Debris ☐ Dams
Water Overtop Roadway: ☐ Yes ☐ No Comment:	If Yes, Depth and Length of Section Overtopped: Depth Length
Was the above Stage Exceptional or Have Other Stages Been near the Maximum Stage?	
Elevation or Depth of Extreme Low Water	Source of Information
Where Does Source Live?	How Long? / Did Source Personally Observe Maximum Stage? ☐ Yes ☐ No
Other Comments	

HISTORICAL FLOOD DATA

Maximum Known Stage	Date of Maximum Stage
How Long Was this Stage at or near Maximum?	Location of Maximum Stage: ☐ Upstream ☐ Downstream ☐ Unknown
Head Differential Between Upstream and Downstream: Ft. ☐ Unknown	Stage Affected by: ☐ Other ☐ Ice ☐ Debris ☐ Dams
Water Overtop Roadway: ☐ Yes ☐ No Comment:	If Yes, Depth and Length of Section Overtopped: Depth Length
Was the above Stage Exceptional or Have Other Stages Been near the Maximum Stage?	
Elevation or Depth of Extreme Low Water	Source of Information
Where Does Source Live?	How Long? / Did Source Personally Observe Maximum Stage? ☐ Yes ☐ No
Other Comments	

19-13 SAMPLE COPY OF COORDINATE AND CURVE DATA SHEET

PRELIMINARY SURVEY COORDINATE AND CURVE DATA - ND 46, 2 miles E of ND 18 S Jct, E to the Sheyenne River

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	SS-8-046(043)103	81	1

HORIZONTAL ALIGNMENT

PNT	STATION	NORTHING	EASTING
ND 46 (Chain: SCL46)			
BEG	5478+88.24	368829.45	2803111.90
Rec amended Cor	5481+75.20	368842.51	2803398.56
Rec 1/4 SC	5505+36.39	368949.99	2805757.31
Rec Sec SC	5531+84.52	369070.55	2808402.69
Rec amended Cor	5532+26.15	369072.20	2808444.28
Rec 1/4 SC	5557+81.19	369173.79	2810997.30
Station equation ND 46(SCL46) at ND 18(SCL18S)			
ND 46 BK Rec amended corner	5581+29.68	369267.15	2813343.94
ND 46 AHD Rec amended corner	5581+22.40	369267.15	2813343.94
ND 18 Rec amended corner	2674+32.00	369267.15	2813343.94
Rec Sec SC	5583+83.73	369281.74	2813604.86
Rec 1/4 Cor	5610+61.06	369431.20	2816278.02
Rec Sec Cor	5689+87.86	369838.39	2824194.33
Rec Sec Cor	5795+51.21	370323.65	2834746.52
PC	5874+79.21	370683.07	2842666.36
PI C20005	5886+17.23	370734.19	2843803.23
PT	5897+26.01	371215.91	2844834.27
Sec line	5901+73.93	371405.51	2845240.09
TS	5906+33.53	371600.05	2845656.48
SC	5911+33.53	371784.76	2846120.38
PI SCS20004	5915+78.39	372000.00	2846512.51
CS	5919+22.20	371774.90	2846899.07
ST END	5924+22.20	371578.50	2847358.15
ND 18 (Chain: SCL18S)			
BEG	2625+72.38	364410.55	2813515.28
Rec 1/4 Cor	2652+14.62	367051.15	2813422.14
ND 46 Rec amended corner	2674+32.00	369267.15	2813343.94
Northeast Ramp (Chain: NERAMP, Office created alignment)			
PC	10+23.33	374008.70	2890122.23
PI C410	13+46.46	373686.09	2890140.36
PT	16+58.94	373402.49	2890295.21

CURVE DATA

ARC DEFINITION

C20005		
PI STA	=	5886+17.23
Delta	=	22° 28' 04" LT
D_a	=	1° 00'
R	=	5729.65'
T	=	1138.02'
L	=	2246.80'
SCS20004		
PI STA	=	5915+78.39
Delta	=	51° 32' 11" RT
D_a	=	3° 59' 57"
R	=	1432.69'
L_s	=	500.00'
S_c	=	9° 59' 53"
T_s	=	944.86'
L	=	788.67'
C410		
PI STA	=	13+46.46
Delta	=	25° 25' 09" LT
D_a	=	3° 59' 57"
R	=	1432.69'
T	=	323.12'
L	=	635.61'

US PUBLIC LAND SURVEY DATA

DESC.	SEC-TWP-RGE	NORTHING	EASTING
SW SC Sec 31 T-137-N R-51-W		368829.45	2803111.90
NW amended Cor Sec 1 T-136-N R-52-W		368842.51	2803398.56
W 1/4 Cor Sec 1 T-136-N R-52-W		366532.01	2803487.98
SW Cor Sec 1 T-136-N R-52-W		363942.87	2803588.19
N 1/4 Cor Sec 31 T-137-N R-51-W		374236.35	2805538.09
S 1/4 SC Sec 31 T-137-N R-51-W		368949.99	2805757.31
N 1/4 Cor Sec 1 T-136-N R-52-W		368957.69	2805922.32
S 1/4 Cor Sec 1 T-136-N R-52-W		364044.94	2806222.58
NW Cor Sec 32 T-137-N R-51-W		374343.73	2808177.01
SW SC Sec 32 T-137-N R-51-W		369070.55	2808402.69
NW amended Cor Sec 6 T-136-N R-51-W		369072.22	2808444.28
W 1/4 Cor Sec 6 T-136-N R-51-W		366772.34	2808636.98
SW Cor Sec 6 T-136-N R-51-W		364147.37	2808856.94
N 1/4 Cor Sec 32 T-137-N R-51-W		374454.37	2810802.72
S 1/4 Cor Sec 6 T-136-N R-51-W		364259.73	2810846.60
S 1/4 SC Sec 32 T-137-N R-51-W		369173.79	2810997.30
NW amended Cor Sec 5 T-136-N R-51-W		369267.15	2813343.94
W 1/4 Cor Sec 5 T-136-N R-51-W		367051.15	2813422.14
SW Cor Sec 5 T-136-N R-51-W		364410.55	2813515.28
W 1/4 Cor Sec 33 T-137-N R-51-W		371923.71	2813524.32
SW SC Sec 33 T-137-N R-51-W		369281.74	2813604.86
S 1/4 SC Sec 33 T-137-N R-51-W		369431.20	2816278.02
NW amended Cor Sec 4 T-136-N R-51-W		369557.81	2818561.05
NW amended Cor Sec 3 T-136-N R-51-W		369821.84	2823861.90
SW SC Sec 35 T-137-N R-51-W		369838.39	2824194.33
S ¼ SC Sec 35 T-137-N R-51-W		369962.76	2826816.30
NW amended Cor Sec 2 T-136-N R-51-W		370072.75	2829135.05
SW SC Sec 36 T-137-N R-51-W		370087.85	2829453.41
SW SC Sec 31 T-137-N R-50-W		370323.65	2834746.52

SURVEY CONTROL POINTS

PNT	NORTHING	EASTING	ELEV	STATION	OFFSET	CONTROL POINT DESCRIPTION
PRIMARY CONTROL						
GPS 8	368241.47	2787950.87	1056.00	5327+16	95' Lt	#6 Rebar w/Alum Cap stamped "ND DOT - GPS CONTROL"
GPS 7	368779.12	2803126.26	1050.11	5479+00	51' Rt	#6 Rebar w/Alum Cap stamped "ND DOT - GPS CONTROL"
GPS 6	369564.93	2817490.25	1020.81	5622+79	66' Lt	#6 Rebar w/Alum Cap stamped "ND DOT - GPS CONTROL"
SECONDARY CONTROL						
RTK 3182	369287.47	2812836.87	1031.62	5576+24	40' Lt	
RTK 3180	369222.10	2813019.71	1027.06	5578+04	32' Rt	
RTK 3181	369266.83	2813030.31	1027.06	5578+17	32' Lt	
RTK 3174	369328.61	2813758.20	1030.12	5585+39	38' Lt	
BM Z357	369253.59	2813772.82	1027.54	5585+50	37' Rt	

REFERENCE MARKERS

R Mkr #	NORTHING	EASTING	STATION	O\S	ALIGNMENT
104	368858.18	2804357.83	5491+34	28' Rt	SCL46
105	369091.55	2809639.75	5544+21	28' Rt	SCL46
106	369326.96	2814914.42	5598+94	28' Rt	SCL46
107	369609.14	2820205.89	5649+93	31' Rt	SCL46
108	369865.62	2825461.69	5702+55	33' Rt	SCL46
109	370117.57	2830744.55	5755+44	28' Rt	SCL46
110	370352.57	2836013.10	5808+18	29' Rt	SCL46
111	370593.84	2841291.33	5861+02	28' Rt	SCL46
112	371801.78	2846359.87	5913+75	26' Rt	SCL46
50	365831.99	2813462.32	2639+95	29' Rt	SCL18S

NOTES: Sheet 1 of 2
Primary control derived from NDDOT

!!! FICTIONAL PROJECT !!!

Date Survey Completed 6/29/15

☐ Assumed Coordinates

☒ All coordinates on this sheet are Cass County ground coordinates. They are derived from the NAD83(2011) reference frame; North Dakota South Zone Combination Factor (cf) = 0.9998875

All coordinates and measurements on this document derived from the International Foot definition.

INITIALIZING BENCH MARK NDGPS Stations (OPUS)

☒ NAVD-88
☐ NGVD-29
☐ GEOID 09 ☐ _____
☒ GEOID 12A

This document was originally issued and sealed by Robert D. Zahn, Registration Number LS- 3659 , on 06/29/15 and the original document is stored at the North Dakota Department of Transportation

6/29/2015 1:01:18 PM tzomjek R:\project\80046103.043\survey\061CD_001.dgn

19-14 SAMPLE COPY OF SURVEYOR'S AIRPORT CERTIFICATION DOCUMENT

North Dakota
Department of Transportation

Grant Levi, P.E.
Director

Jack Dalrymple
Governor

SURVEYOR's CERTIFICATION July 3, 2015

PROJECT **SS-5-049(014)082**
MORTON COUNTY LINE to BEULAH

A survey was made to determine the coordinate position (Latitude and Longitude) and elevation of a point on the centerline of ND Hwy 49, south of Beulah, ND. The point is where the extended centerline of the Beulah Municipal Airport (ID #95D) runway 10/28 intersects the centerline of ND Hwy 49.

CORS stations **"P052-PID: DI3425, "BSMK-PID: AJ7216"** and **"NDMB-PID: DI1073"**, with OPUS solutions, were used to control the horizontal & vertical coordinates of this point.

The calculated coordinates and Hwy station intersection for the point are as follows:

I certify that the Latitude and Longitude for the point listed below is within ±15 feet horizontally.

ND 49 Station 5302+06.5 Latitude 47°14'30.57" N Longitude 101°47'06.97" W

Elevation for the point (within 3 feet vertically) is as listed below.

ND 49 Station 5302+06.5 1909 feet

The horizontal datum (geographic coordinates) are in terms of the North American Datum of 1983 [NAD83 (2011)] and are expressed as degrees, minutes, and seconds.
The Elevation (orthometric height) is based on the North American Vertical Datum of 1988 [NAVD88 (GEOID 12A)] and is determined to the nearest foot.

SIGNED:

Robert D. Zahn : LS 3659
North Dakota Registered "Professional Land Surveyor"

ROBERT D. ZAHN
REGISTERED LAND SURVEYOR
L.S. 3659
NORTH DAKOTA

608 East Boulevard Avenue • Bismarck, North Dakota 58505-0700
Information: 1-855-NDROADS (1-855-637-6237) • FAX: (701) 328-0310 • TTY: 711 • www.dot.nd.gov

19-15 NOTIFICATION OF SURVEY LETTER

(Company Title Block)

Month dd, yyyy

«CTitle» «First» «Last»
«Address»
«City», «State» «Zip»

PROJECT NO. (Project Number), PCN (Number)
(DESCRIPTION) *-all caps*
(COUNTY) *-all caps*

The North Dakota Department of Transportation will be completing field data collection activities for a proposed roadway improvement project along (Highway Name, Vicinity, Description). The total length of the improvement area under consideration is approximately ## miles. ***Please refer to the enclosed Project Location Map.***

The purpose of this letter is to inform you that we may be entering upon your property to collect data. Data collection activities will include aerial photography panels, preliminary topographic survey, wetland delineation, cultural resource survey, and noise measurements. These surveys will generally consist of the following:

- *Aerial Photography Panels* – A survey crew will temporarily install white 12 inch wide panels (vinyl or plastic) in an L-shaped pattern at specified locations and collect Global Positioning System (GPS) data for each location. Once the aerial photography has been completed (normally within a couple weeks), a survey crew will return and remove the white panels. These aerial panels are placed approximately 800 feet off of the highway on both sides of the road, and typically spaced in one mile intervals along section lines. *–delete if not apply*

- *Preliminary Topographic Survey* – A survey crew measuring the location and elevation of various features such as utility lines, property & building corners, and drainage structures such as culverts or bridges relevant to the proposed project. *–delete if not apply*

- *Wetland Delineation* – An environmental scientist and soil scientist will be working in the area and mapping the limits of wetland areas. This will include creating small hand-dug test holes with a tile spade and/or soil probe and walking boundaries of wetlands to collect Global Positioning System (GPS) data. *–delete if not apply*

- *Cultural Resource Survey* – Archaeologists will be working in the area and identifying previously recorded cultural resource sites or identifying previously unidentified sites. This work may include shovel/auger probes in areas of limited visibility in order to fully identify previously unrecorded cultural resources. *–delete if not apply*

- *Noise Measurements* – A noise analyst will collect background noise measurements using a sound level meter at select locations, including noise sensitive areas (e.g., residences). Each location will be evaluated for approximately 20 to 60 minutes and may be evaluated multiple times. *–delete if not apply*

The field survey work for the project is scheduled to begin in approximately (Month, yyyy)

Should you have a tenant on the land either by written or verbal lease agreement, please notify those individuals of the survey work being conducted in the area.

If you have any questions or concerns, please contact the project manager (Designer) at (Phone) or (email).

TTY users may use Relay North Dakota at 711 or 1-800-366-6888. Language interpretive services are also available.

(NAME) *-all caps (Refer to Section II – 03.01.03 for signatory agent)*

#/si/wi *-for NDDOT internal projects: (div.#/signatory initials/writers initials)* or
si/wi *-for consultant projects: (signatory initials/writers initials)*

Enclosure