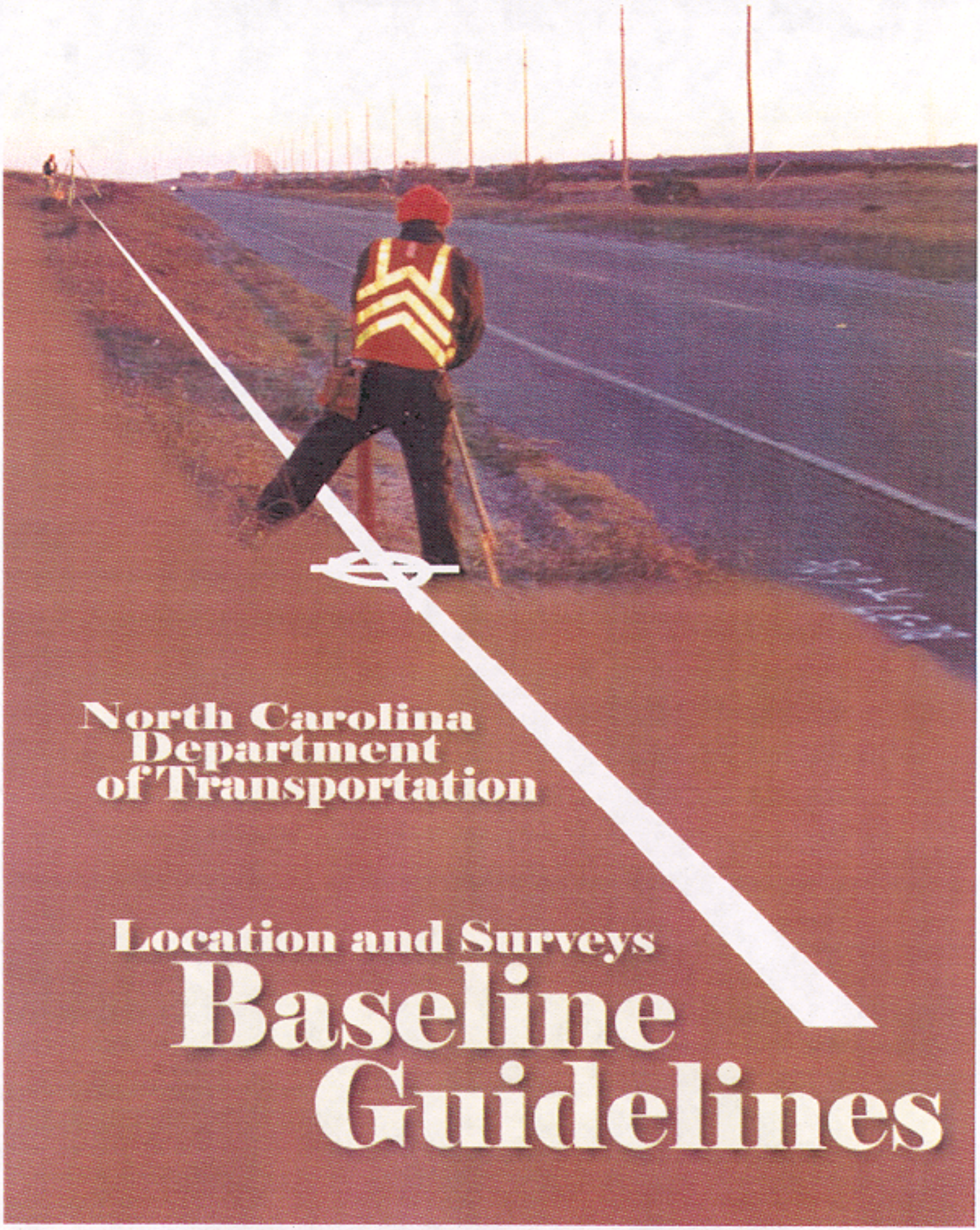

North Carolina
Department
of Transportation

Location and Surveys

Baseline Guidelines

STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

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August 21, 2000

Memorandum to: Highway Design Branch Unit Heads

From: Deborah M. Barbour, PE

State Highway Design Engineer

Subject: Coordinate Reference Systems and Baseline Survey Guidelines

After an extensive assessment period, and several modifications to adapt to the ever-changing technical advancements, the Baseline concept and Coordinate Reference System have proven to be cost effective, time efficient, and a safety enhancement. The Draft Baseline Guidelines, which were issued in June 1996, are now at a point to be finalized. The Coordinate Reference Systems and Baseline Guidelines will now be implemented as policy throughout the Highway Design Branch.

Please find attached a copy of the Coordinate Reference Systems and Baseline Survey Guidelines for your use and implementation within your Unit. This version of the Guidelines dated 8/07/00 will be considered the policy in which all plans shall be developed through the Highway Design Branch.

DMB:jdb

Attachment

CC: R. Len Hill, PE w/attachment

Coordinate Reference Systems and Baseline Survey Guidelines

Introduction:

The purpose of baseline surveys, as opposed to traditional alignment surveys, is to reduce the amount of time spent hubbing, staking, flagging, and profiling a proposed alignment, which may be revised. By providing a baseline rather than a specific alignment, the route location engineer can gather and evaluate data needed for design, while at the same time leaving the roadway design engineer free to alter or revise the proposed alignment (the final design alignment). The Route Location Engineer and the field crew are free to concentrate on the important aspects of the survey – what data is collected, accuracies, thoroughness of data – rather than concerning themselves with setting points at specific location, or staying out of traffic on a busy roadway. Also, baseline surveys enhance the increased usage of Digital Terrain Model (DTM's) in the collection of data and in the design of highways.

Survey Baselines have been in existence on route location projects and highway designs since the first engineer established the first line for the first road. The only difference between then and now is that the initial baselines included curves, spirals, and tangents. Now, due to the technological advancements in surveying equipment, computer aided drafting and design (CADD), and removing the restriction of alignment related data for mapping, several alignments may be evaluated once the designer has an opportunity to evaluate the more detailed digital data. More information is needed at a much higher level of accuracy to utilize the skills and technology now available in designing the best facilities. Having the capability to merge data collected by field teams with data gathered photogrammetrically allows the designer access to a broader and more detailed corridor for evaluation.

In times past, surveyors collected data based upon station and offset. This same method of data identification was used in the design process. Now, with CADD and software such as GEOPAK, engineers and surveyors can utilize coordinates in a digital environment. The surveyor can collect coordinate-based information rather than station and offset to a preliminary alignment. Because those coordinates are relative to the project control network (North and East, or X and Y), the information collected has a more accurate relationship to any proposed alignment. This gives the designer the ability to place the design alignment in the most functional location.

The primary concern of the Route Location Engineer and the survey party is the collection and evaluation of data for the design and construction of the transportation facility. Independent baselines enable the surveyor to establish a controlled survey line on the ground and collect necessary information, without spending time and effort setting pre-calculated points. The proposed alignment serves as a guide in establishing the baseline. The surveyor has the flexibility to set control points as necessary based upon terrain or critical features while avoiding environmentally sensitive areas and lessening impacts to private property. Those who follow after

the initial surveyors also have the assurance that, no matter what proposed alignment may be used, any designed information generated from field data will be applicable, because that data was measured from the one constant - the baseline. The location, documentation, and preservation of the baseline from which survey information is gathered is of vital importance, both to those working on the project during the Design phase and those working on the project during the Right of Way and Construction phases. For this reason, certain procedures and guidelines have been established which should be used for all highway Design Branch projects.

Coordinate Reference Systems

All TIP projects surveyed and designed for the North Carolina Department of Transportation should be referenced to the NC State Plane Coordinate System (NCSPC). Reference control stations or azimuth marks should be adjusted to the High Accuracy Reference Network (HARN) with coordinate values that are current and meet reference network accuracy standards (See GPS Survey Guidelines). If there are insufficient number of HARN reference monuments in a specified area, NCDOT will coordinate with NCGS to establish additional HARN monumentation in the area. The Horizontal Datum for the HARN network is NAD 1983/95. NAVD88 will be the vertical datum. Any deviation from this should be discussed with representatives from Photogrammetry and representatives of the Roadway Design Unit or Design Services Unit if the project is contracted to a consultant. Also, any deviation in vertical datum should be discussed with representatives of the Hydraulics Unit, to ensure no problems or conflicts with FEMA mapping or other hydraulic data will be created. Although these will be the preferred datums, it may be necessary to use existing monumentation with NAD83 and/or NGVD29 in order to keep consistency with previously controlled projects or with standalone projects such as bridge projects. It will be the responsibility of the Location and Surveys Unit in consultation with those Units listed above to determine the datum(s) to be utilized on a case by case basis.

NCSPC coordinates can be referenced to a project either through traversing from available geodetic monumentation (USGS, NCGS, or other monumentation providing a HARN NCSPC reference) or by using GPS technology. However the method, State Plane Coordinates, HARN NAD83/95, should be established on the project. For preliminary mapping projects, all photo control will be provided in NCSPC coordinates referenced to the HARN network. The preliminary mapping will be generated in NCSPC coordinates. For plan sheet mapping projects, one HARN NCSPC reference point will be held, using this coordinate to establish a localized coordinate system that will be relative to that project. Photo control and the plan sheet mapping will be generated in the localized coordinate system. For planning purposes, for extensions or additions, or for additional projects tying together, sufficient forethought should go into the decision of what reference coordinate and combined grid factor will be used to establish the localized coordinate system on a project.

Datum Description:

Grid monumentation, with combined grid factor (ground to grid) used to localize this coordinate system, horizontal and vertical datum, stamped station name, and published coordinates of the monument or geodetic station about which the project is localized, should be provided in a text alignment file (See Attachment #4 for naming convention). The same information will be supplied in the graphical baseline file. NCDOT supplies a Datum cell for this through NCMAP. This datum description should be displayed on all NCDOT plans for the Highway Design Branch on the initial plan sheet (Page 4 of the highway plans) (See Attachment #2) and remain on the plans throughout the life of the project and shown on the final right-of-way plans which are recorded in each county's Register of Deeds office. The datum description and tie (based upon local ground coordinates) from the monument to the "Begin Construction" or "Begin Project" station will be computed and placed in the datum description by the Roadway Design Unit's Project Design Engineer or by the private engineering firm's Roadway Design Engineer for contracted projects through the Design Services Unit.

Types of Baselines

Project Control Baseline (BL & BY):

The Project Control Baseline will be the control alignment placed on the ground for the project. This alignment will be generated in both text and graphics format. The minimum ratio of precision for baselines, including secondary baseline alignments, is 1:20,000 closure. Baselines are to begin with station 5+00.00 and should be placed such that the baseline covers the limits of the project. On North/South projects, the baseline stationing should begin with the Southernmost point with 5+00.00 and progress northward with increasing stationing. Conversely, on East/West projects, the baseline stationing should begin with the Westernmost point with 5+00.00 and progress eastward with increasing stationing. All baselines for –Y- lines should begin at the furthermost left point with station 5+00.00, if looking up station of the baseline (BL), and continue with increasing stationing to the right till the end of the project limits or intersection with –BL-. Obviously, sequential numbering of baseline points is the goal; however, due to additional requested work, required intersection points, etc. these types of acceptable exceptions may inhibit sequential numbering to be achieved in all cases.

Baseline Field Location:

Baseline traverse points should be inter-visible on the ground and spaced at approximately 300 to 1000 feet intervals where possible. Also, baseline traverse points should be set when possible in the vicinity of all –Y- line intersections and –T- lines where there is the potential for major structure construction (i.e. bridges or box culverts). Baseline control points should be labeled by alignment, (i.e.-BL-point number, -BY1-point number, etc) and numbered such that there is no repetition of point number (i.e., If there are BL points 7-19, the first BY point would be BY-20. If BY had points 20-22, the first point on BY1 would be BY1-23.) It is assumed that the initial point numbers

will be used in the azimuth pairs set for the project. In general, on North/South projects, the BL baseline point numbering should begin with the Southernmost point with BL-# (first available number following azimuth pairs) and progress northward. Conversely, on East/West projects, the BL baseline point numbering should begin with the Westernmost point with BL-# (first available number following azimuth pairs) and progress eastward. All baselines for -Y- lines should begin at the furthermost left point with BY#-#, if looking up stationing of the baseline (BL), and continue until the end of the project limits or intersection with –BL-. Any -BY- lines should have at minimum two set points (one may or may not be an intersection with the -BL-). If the intersection point with the –BL- and the –BY- is not set, then a computed intersection point should be computed and shown in the text and graphics file and labeled "not set".

Baselines denote a level of accuracy not available in secondary traverses. On non-paved surfaces, baseline points should be a 24"-36" capped rebar with witness post (exceptions may be due to utility locations or soil characteristics). Caps (provided by NCDOT) should be stamped with appropriate baseline name (i.e., BL-6, BY1-12, etc.). In instances with intersection points, a cap does not need to be stamped with two names. The cap should be stamped with the most controlling alignment (i.e., BL and BY3, BL would control, B3282-1 and BL, B3282-1 would control). On paved surfaces, baseline points should be PK nails or equivalent. Witness posts should be red carsonite markers (provided by NCDOT) labeled "NCDOT Traverse Station". In developed areas, red topped wooden stakes should be used near roadways where station and point name are painted on the road. All witness posts or painted pavement should show station and point name. Points set for secondary traverses on non-paved surfaces should be bridge spikes or nails.

In staking the alignment, stations are to be staked at 50 or 100 feet intervals depending on visibility, accurate to +/- 2 feet, when circumstances allow. Exceptions would include cultivated fields, multi-lane transportation facilities, rivers, lakes, ponds, etc. Additional stakes with full station values should be set at edges of woods, edges of pavement (paint) when a baseline crosses a road, and at tops of stream and river and banks to assist other personnel when trying to locate the baseline alignment in the field. Stakes should be 18" orange plastic, with full station values in permanent black ink. Station intervals for baselines along existing roads can be painted on the EOP. Full station values should be placed on all stakes or painted on pavement.

Text file:

This will be an ASCII generated file. (See Attachment #4 for naming convention). All text alignments will include all control points (traverse points) with point numbers, North and East Coordinates with Elevations, station of points, and type of point set (i.e., iron pin and cap, PK nail etc.). Bearing and distance should be provided between adjacent points. Location & Surveys has developed a standard format for text alignments (See

Attachment #1). If an existing roadway is used as a baseline or in some other case where curves are built into the baseline, standard curve data should be included in the text. Intersection points should be established with other baselines, such as -BY- or any -T- line. Intersection points with existing centerlines (best-fit alignments) are not necessary unless the –EL- line is the baseline. The text file should include Hydraulic –T- Line alignments with intersection points to the -BL- or –BY- and a separate section for Bench Marks should be included at the end of the baseline alignment text file. (See Bench Marks, Page 12 and –T- Lines, Page 6 & 7)

Graphics Format:

This will be a Microstation CADD file generated by utilizing Geopak software (See Attachment #4 for naming convention). Stations, bearings, and tics need to be generated, as this is the alignment in existence on the ground. In the graphics file, Route Location & Survey Engineer will provide a station and point number at each control point. Intersection points with other baselines should be displayed in the graphical baseline file. Baseline control points will appear with the standard symbol, baseline station value, point number, and the offset distance and station to the designed alignment (this information to be placed in the graphics file by roadway design engineer). (See Attachment #2). The graphical baseline with stations should remain on the plans through the right-of-way plan submittal to the Right of Way Branch. After this phase, the roadway design engineer can remove the connecting lines from the file. The actual baseline point with standard symbol, point number, and the offset distance and station to the designed alignment should remain on the plans throughout the life of the project. However, baselines may be provided on construction plans at the request of the Division Construction Engineer on a project specific basis. This should be decided at the combined or final field inspection, unless the Division has agreed on a policy for placing baselines on plans.

The roadway designer will provide an alignment relationship between the baselines and the designed alignments in a text format to other units as requested (i.e. Geotechnical, Hydraulics, etc.). This relationship will show the station and offset from the baseline to the designed alignment at 50 feet intervals on all alignments. This relationship between 50 feet station interval points on the baseline will be computed perpendicular from the baseline to the designed alignment. The relationship between the baseline control points (i.e. BL-1, BL-2, etc.) and the designed alignment will be computed perpendicular to the designed alignment and shown on the plan sheets. The information shown will include the baseline station, control point number, designed alignment station, and the offset distance.

Baseline for Hydraulics (-T- Line)

The purpose of the Hydraulic –T- line is only to provide a baseline on the ground from which preliminary hydraulic data can be collected by the route location & survey engineer and additional information can be obtained as needed by the Hydraulics Unit or the

contracted Hydraulic Engineer. –T- lines should be established in the field at all waterways (i.e. rivers, creeks, streams, branches, ditches, etc.) that have a consistent 3 feet base width through the project survey limits. If the waterway is generally parallel with the baseline (-BL-) and in close proximity, a separate –T- line is not required. The -BL- will serve as the hydraulic control baseline to obtain hydraulic data in these instances.

-T- line Field Location:

–T- lines should be set generally parallel with the waterway and in the vicinity of the top of bank of the waterway. Nails or spikes should be used to indicate a secondary traverse. If iron pins and caps are used, the traverse should meet controlled baseline standards. At the request of the State Hydraulics Engineer, for proposed bridges, the length of the –T- line should extend at a minimum from the proposed –L- line crossing of the waterway the greater of 200 feet or 2 bridge lengths (greater of the existing bridge length or the proposed bridge length) downstream and upstream or to the requested DTM limits, whichever is greater (See Figure 6 of Hydraulic Survey Guidelines). Any -T- lines should have at minimum two set points, one of which should be an intersection point with the (–BL-). The intersection point should be an actual -BL- point with an iron pin and cap if there is the potential for major structure construction. If there is only a minor drainage system planned and no potential for any major structure construction, an intersection point set in line between two -BL- points will suffice. If the intersection point is set in line between two -BL- points, it will be considered a part of the -T- line only and not a control point on the -BL-. A 12" spike nail, rebar with no cap, or equivalent will suffice as durable construction for later use by the hydraulics engineer. A red topped wooden survey stake or red carsonite marker should be placed next to the set point with the point number and station labeled on the stake. –T- Line control points should be numbered and labeled by alignment, (i.e.-T1-101, -T1-102, T2-101, etc, where T# is the –T- line number and -### is the point number). All baselines for –T- lines should begin at the furthermost left point with T#-###, if looking up stationing of the baseline (BL), and continue until the end of the project limits. All –T- lines should be stationed and begin at the furthermost left point of the –T- line limits with station 5+00.00, if looking up stationing of the baseline (BL), and continue with increasing stationing to the right till the end of the –T- line limits. Stationing of the –T- line control points and inter-visibility between –T- line points is required; however, intermediate staking is not necessary. (See Hydraulic Survey Guidelines, Page 6 & 7).

Text File and Graphics Format:

–T- lines will be documented in the baseline alignment text file and the Microstation graphics file. All –T- line text alignments will include all traverse points with point numbers, North and East Coordinates with Elevations, station of points, and type of point

set (i.e., nail set, PK nail etc.). Bearing and distance should be provided between adjacent points in the text file. The following statement should be included in the text file:

Caution: This –T- Line is a secondary traverse only and should not be used for construction of complex structures. For more information please contact Locating Engineer in charge of surveys.

In the graphics format, -T- lines should appear in the Microstation CADD file generated for the –BL- and –BY- alignments on Level 45. –T- line traverse points will appear with the default point standard symbol, -T- line station value, point number, elevation, and bearing labeled on connecting lines. (See Attachment #2 and Hydraulic Survey Guidelines, Page 6 & 7).

Please Note: Upon acceptance, this guideline supercedes contradictory statements in prior dated versions of the Hydo Manual.

Types of Alignments

Proposed Project Alignments (ALN):

The roadway design engineer will supply the proposed project alignment to the route location engineer in Geopak format as part of the original request. The proposed project alignments are to be used as a guide for establishing the project control baseline on the ground. Efforts should be made to place the baseline as near as possible to the proposed alignment, typically within 10 feet. Exceptions would be detouring around such objects as buildings, large trees, topographic features, etc.

This proposed design alignment will generally be computed using actual NC State Plane grid coordinates based on preliminary mapping and should begin with station 10+00.00. The roadway design engineer will also begin the final design alignment with station 10+00.00. This proposed project alignment should be localized and shown in a graphics CADD file. This will be a Microstation CADD file generated by utilizing Geopak software (See Attachment #4 for naming convention). No text file is required on the proposed alignment. Stationing will be required due to property references for appraisal data.

Best-Fit Alignments for Existing Roads (EL & EY):

The surveyor will compute best-fit alignments for existing roads and label as -EL-, -EY- etc., as needed by designer. These are for existing road alignments that have not been staked on the ground. A text file on these alignments is not necessary, but a graphics file is. This will be a Microstation CADD file generated by utilizing Geopak software named (See Attachment #4 for naming convention). Best-fit alignments should begin with 10+00.00. Stationing may be optional, depending upon the needs of the designer. However, if appraisal data is to be referenced to this alignment, stations will be required on best-fit alignment files (See Attachment #3).

Care should be taken to place best-fit alignments within 0.5 foot of the mean centerline between the existing edges of pavement. These best-fit alignments will be used by the roadway design engineers to compute detours and realignments that require ties to the existing roadways. If only segments of the best-fit alignment are used, the roadway design engineer should make sure the beginning and end of the each proposed alignment ties to the best-fit alignment. The design engineer should be consulted if there are questions as to the need for existing best-fit alignments. If best-fit alignments are not computed, please include documentation as to why.

Normally, these best-fit alignments of the existing roadway are used to locate the existing right-of-way of roads that do not have a monumented right-of-way and to tie the proposed pavement generated by the final design alignment to the existing roadway pavement. This is especially true for secondary roads in which NCDOT can claim right-of-way for maintenance purposes and roads that are abstracted such that NCDOT has a pre-defined right-of-way symmetrical to the existing centerline of the road. Occasionally, the best-fit alignment generated by the route location survey engineer may not accommodate the best suitable transition to tie the proposed pavement to the existing pavement. In these situations, the roadway design engineer should consult with the route location survey engineer and supply the final design alignment that will best tie the proposed pavement to the existing pavement. The route location survey engineer will then re-define the existing right-of way symmetrical to the final design alignment supplied by the roadway design engineer.

Occasionally the existing Right of Way line within the project limits will be retained. This will often occur when the proposed road is shifted slightly away from the existing road. Frequently the existing R/W limits along one or both sides are sufficient and new or proposed R/W is not required. This existing R/W must be referenced and described from either the design alignment or the best fit alignment; meaning the best-fit alignment must remain on the plans. The preferred method is to use R/W monuments to reference and describe this R/W line off the design alignment and remove the best-fit alignment. At a minimum, this R/W line should also be described with the bearing and distance or chord bearing and arc distance in either table format or labeled on the lines themselves.

Final Design Alignments (-L- & -Y-)

The Highway Design Branch has committed to meeting the needs of the Division Construction personnel in utilizing baselines for project construction. Generally, this requires staking the designed alignment control points along the project providing intervisible points for construction stakeout. However, this may not be required depending on the capability of construction personnel in each division to work from the existing baseline on the ground and safety concerns depending on where the alignment control points are located on the ground (i.e. middle of travel lanes, swamps, etc.). Therefore, for in-house projects, the Location & Surveys Group Leader or Location & Surveys PEF Coordinator (if the project is a Design Services turn-key project) should consult with the Division Construction Engineer to discuss the need to set the designed alignment control points and the associated intermediate stations along the alignment.

If it is determined that designed alignment control points need to be set, then the control points (TS, SC, CS, ST, PC, PT, POTs or POCs if needed, etc.) should be set from the nearest Baseline control point. The designed alignment should be controlled from the baseline and not from an independent traverse. NCDOT's minimum ration of precision for any staked design alignment is 1:10,000. The control points that are set in the field should be documented in an ASCII text file with station values and type of point set (i.e. PK nail, iron pin, etc.). These control points can be listed in a separate ASCII file that is EXCEL or Windows Notebook compatible and made a part of the project data or the points could also be added to the original text files, if available.

Survey stakes (wooden stakes or orange plastakes) are to be placed at 50 or 100 feet intervals depending upon visibility with a positional accuracy of +/- 2 feet in wooded or uncultivated areas. Stakes should not be placed in cultivated or mowed areas unless specifically requested by the R/W agent. Placement of these stakes in questionable areas will be left to the discretion of the route location & survey engineer with close consultation with the R/W agent. These stakes may be radially set from the nearest baseline control point or from the nearest designed alignment control point. Also, these stakes can be staked by chaining along the proposed alignment. For paved surfaces, painted "+" marks for station intervals will suffice. For gravel surfaces, offset stakes will suffice with the offset distance to the centerline marked on the stake. Construction surveyors may use the designed alignment control points to stake the project; however, the stakes placed along the alignment are primarily for orienting right-of-way agents, contractors estimating construction cost, and property owners in project evaluation.

Ramps:

Ramps typically begin near a baseline control point and move away from the primary baseline (BL) and continue towards a secondary baseline (BY). Ramp control points (i.e., PC, PT, TS, SC, CS ST, etc.) will need to be set before the R/W monuments can be set. The main control points of the ramp alignment (substructure curve points, i.e. PC, PT, TS, ST) should be set and checked before occupying these main substructure curve points and setting curve points and corresponding R/W monuments. This also may require PI points to be set from the BL or connecting BY baseline with delta angles and distances between PIs confirmed before setting curve points and R/W monuments. Positional relationships are very important when staking ramps and care should be taken to establish these lines properly.

Another alternative is that ramp control points and related R/W may also be staked from a control traverse. The control traverse should originate from the (BL) baseline and tie into the connecting (BY) baseline. Field placement should be within +/-10' of the ramps design alignment. The control traverse must meet a ratio of precision of 1:20,000 and be adjusted before staking any ramp control points and associated R/W points. The main control points of the ramps should be staked from the ramp control traverse and checked before curve points and R/W monuments are set. Again, positional relationships are very important when staking ramps and care should be taken to establish these lines properly.

Designed Alignment Control Points for –L-, -Y-, and Ramps:

Control points on the ground may be #5 rebar or 12-inch spikes as determined by the route survey field engineer. Points that fall in cultivated areas should be placed just below the plow line and points falling in wooded or non-cultivated areas should be placed 0.1 to 0.3 ft. below the surface. Control points on existing pavement should always be a standard PK nail or equivalent.

48 inch red top stakes should be placed at all control points located in the ground and red top stakes should be placed on line -L- at all road crossings, entries and exits into woods. This will provide direction for those attempting to locate the designed alignments.

Painting on existing roads:

Painting to label stations and identify control points on existing roadways should be placed parallel to the existing paint stripping. Information placed across existing stripping may be painted over when stripping is repainted. Painting parallel to the existing strips is less noticeable to the traveling public and will generally allow the painter to stay nearer the centerline or EOT. Care should be taken to insure that no painting to identify stations or control points be placed over existing lane markings.

Quality Control for (-L- & -Y-) Staking:

The Location & Surveys Unit requires recording in a data collector the angle and distance from the control point occupied to the final design alignment point set. Also, during the staking phase of the designed alignment, any opportunity that arises to tie previously set designed alignment centerline control points from other occupied points, angles and distances should be recorded in a data collector. This will create redundant information from which to compare misclosures and positional accuracies of the points set. As a final check, the Stations, North, & East coordinates should be computed using the collected data and compared to the design Stations and computed coordinates shown on the design plans to insure no errors have been created.

Baseline Effects of Other Data Provided by Location & Surveys

DTMs

Pavement breaklines should be provided on the crown where needed and on all edges of travel ways (EOT's) and edges of pavement (EOP's), as needed and requested by the roadway design engineer. All pavement breakline profiles and crown breaklines should be checked in accordance with the current DTM guidelines utilizing the current available tools in Geopak. (See L&S DTM Guidelines)

Property

Property Ties

For all projects, property will be located and displayed in Microstation CADD design files. Property ties to existing or proposed alignments will not be computed at the time of surveys. Once the roadway design engineer has computed and finalized an alignment, the property ties will be computed to the designed alignment. This should be completed prior to the preliminary field plan inspection.

For projects completed in-house, computation of property ties to the final designed alignment (-L- & -Y-) should take place at the same time that the design is sent to the Hydraulics Unit. The Roadway Design Unit will submit a request to the Location & Surveys Unit for property line ties (pole data and benchmark ties should be included in this request also). The proposed final design alignment (*.GPK file) will be transmitted to the Location & Surveys Unit, where the Property Surveys Section will compute the property ties and transmit the data back to the Roadway Design Unit.

For projects in which both the roadway design and the location & survey work is contracted to consultants, the task of computing property ties to the final design alignment will be scoped as part of the consultant's contract. This task can be scoped as a task for

the prime consultant or the subcontracted survey consultant. This will be determined at the initial scoping meeting.

For projects in which the location surveys portion was completed by the Location & Surveys Unit and the roadway design is contracted to consultants, the task of computing property ties to the final design alignment can be handled either by requesting the Location & Surveys Unit to complete this task or the task can be included in the consultant's contract. Whenever possible, preference should be to include this into the consultant's contract to minimize the coordination time involved in completing this task. If the preference is to request the Location & Surveys Unit to complete this task, the Design Services project engineer will send a formal request to the Location & Surveys Unit and will transmit to the Location & Surveys Unit the proposed final design alignment (*.GPK file). The Location & Surveys Unit, Property Survey Section will compute the property ties and transmit the data back to the Design Services project engineer. Again, property files and Geopak files containing alignment chains need to be part of the transmittal.

Appraisal Data

Stationing from the proposed project alignment (ALN) or the existing (best-fit ELN) road alignments will be used as a reference for property orientation. Areas left and right will be referenced from the proposed project alignment (ALN) on cross-country projects and from the existing (best-fit ELN) alignment for property along existing roadways. The roadway design engineer will make any adjustments to areas left and right during the design phase if any revisions or adjustments are made to the proposed project alignments or best-fit alignments.

Property Strip Maps

These maps are to be generated and utilized to aid the Right-of-Way Branch during the appraisal process. Property Strip maps should be generated on photographic mylars produced by the Photogrammetry Unit or some other reproducible median. The proposed localized alignment will be shown on the Property Strip Maps along with the best-fit alignments. Cardinal Stations should be placed along these alignments. Road names and Route numbers are to be shown along with all city, county, and state boundaries. All major rivers and streams should be labeled on the maps. Property is to be closed out from field ties, deeds, plats, tax maps, and any other source available. If there are exceptions to the tracts, they are to be shown as well. Property owners' name and recordation data is to be shown on the Property Strip Maps. The maps should include a north arrow and a title block. The TIP number is to be placed on the outside of the map in the upper right hand corner. No areas are to be shown on these maps.

In urban areas where property tracts are small, the actual plans can be used for property strip maps if all the parcels and topographic features are shown and the properties are closed out. Also, if county orthogonal mapping is available, this can be used for property strips maps by adding the proposed localized alignment and best-fit alignments.

The roadway design engineer will place the proposed alignment and R/W with monuments on the strip maps. A reasonably accurate representation of the alignment and R/W is the purpose. Labels for the alignment (PC, PT etc.) and for the R/W monuments (station and distance) are not needed nor desired. This map will be transmitted to the Right of Way Branch along with the deed books and pole data. The strip maps are not revised due to R/W revisions.

Utilities

Pole Data:

Pole data should be generated on all utility poles in the project area. This data should be collected and shown in ASCII format by utilizing the Pole Data program developed by NCDOT. The following information should be collected in this file:

> Station and offset from center of the pole to nearest design alignment; distance from center of existing road; all utilities carried on pole; pole ownership and owner's pole ID# (if this can be determined).

For in-house projects, normally field collection of pole data information (Counter number, Owner, distance from center of existing road, utilities carried, etc.) will occur during photo classification or plan sheet field survey (for bridge jobs). The "counter" number will be placed on the photograph. The Photogrammetry Unit will key-in the pole counter number as classified on the photographs to map the location of the poles by utilizing stereo compilation to obtain coordinately correct locations for the poles. NCMAP currently has a routine that will accomplish this. The Photogrammetry Unit will run the Check Poles program (checkpoles.ma - an MDL application developed by NCDOT that runs inside of Microstation) to determine if the CADD file generated by Photogrammetry and ASCII pole file generated by Location & Surveys contains the same number of poles. At the same time a project is transmitted to Location & Surveys to compute property ties, pole data station and offset can be computed. The project data should be transmitted to the Location & Surveys Unit, where the Property Surveys section will compute the final pole data sheets. Microstation plan sheet files, Geopak files containing alignment chains, and the original ASCII pole data file need to be part of the transmittal. An MDL application developed by NCDOT (poles.ma) that runs inside of Microstation will allow this procedure to be done through CADD.

For Design Services turn-key projects, the above described process can occur if the route surveys and photogrammetry work are contracted as part of the scope of work along with the roadway design. The contracted route location survey engineer and photogrammetric consultant will be responsible for their respective roles as described for the in-house process. However, for projects in which the location surveys are completed by in-house NCDOT forces, the project data should be transmitted to the Location & Surveys Unit, where the Property Surveys section will compute the final pole data sheets. Microstation plan sheet files, Geopak files containing alignment chains, and the original ASCII pole data file need to be part of the transmittal. Occasionally, NCDOT in-house forces complete the photogrammetric work and the location and survey work, and roadway design work is contracted to consultants. In these instances, the contracted route location survey engineer, will be responsible for the entire process; including keying in the pole number in the Microstation CADD file, generating the ASCII pole file, running the Checkpoles.ma program and generating the final pole data sheet. This will be scoped with the route location survey engineer at the initial scoping meeting.

Underground Utilities:

All underground utility data located in the field should be located relative to the baseline (BL). Test hole information (Level Service A) should be tied accurately to the localized network. Station references on the test holes should be made to the final designed alignment (-L- or –Y-) rather than the baseline (BL).

Test hole data will be provided in a Microstation graphics file (using Test Hole symbology provided by NCMAP) and a hard copy of the Test Hole Certification form. Each Test Hole Certification form should include a station/offset relative to the Baseline, a North & East Coordinate for the test hole, and a blank space designated for the Station & Offset relative to the final designed alignment (-L- & -Y-). Just below the blank space, the statement “Supplied by NCDOT” should appear on each Test Hole Certification form. The Location and Surveys PEF Section or the location and survey route engineer for Design Services turn-key projects will calculate this computation and fill in the blank on the Test Hole Certification form.

In addition, the Certification form will show a sketch of the utility, identifying type of material, diameter, depth of utility, and a special note indicating the grade type of PVC if applicable.

The graphics file should be a Microstation design file compatible with NCDOT CADD software. The Test Hole data should be added to the original SUE file (See Attachment #4 for naming convention) supplied by the SUE consultant. The proper symbology and line styles should be used on all utilities, as provided through NCMAP. Test holes should be drawn utilizing the appropriate symbol, with test hole number, station and offset relative to the final design alignment (-L- & -Y-), labeled beside each test hole. The

Location & Surveys PEF Section will calculate the station and offset relative to the final design alignment. The SUE consultant will provide an ASCII coordinate file of the North & East coordinates that can be read by Geopak to calculate the Station and Offset to the final design alignment. Location & Surveys will transmit a copy of the Test Hole Certification forms and a copy of the Microstation CADD file (See Attachment #4 for naming convention) to the requesting unit and the roadway design engineer to incorporate into the base plan sheets. The graphical Test Hole file should not be merged with the CADD planimetrics files but should be referenced and displayed on the final plans going to Construction.

Benchmarks:

Permanent Bench Marks should be established along the length of all projects, spaced at approximately 2000 feet intervals and/or near major drainage outfalls. All Bench Marks and elevated control points should be identified in the baseline text alignment file. All baseline control points should have elevations and should be included in the main text. Bench Marks offset from the baseline or proposed alignment (preferably outside of the limits of construction) should be identified in a separate section at the end of the baseline text alignment file and in the Microstation graphical baseline file. In the Microstation graphical baseline file, the NC Map menu should be utilized to correctly place all benchmark point symbols. See Attachment 1 for the text format specified by the NCDOT utilizing the NCDOT Location & Surveys' BM program. This format will provide benchmark number, elevation, and description. The station and offset from the baseline, North & East coordinates should also be provided within 5' to 10' accuracy. Baseline control points are to be elevated with the elevation shown in the main portion of the baseline alignment text file. These points should not be labeled "BM" and should not be included in the BM portion of the text file. At the same time the Location & Surveys, Property Survey section for in-house NCDOT projects or the location & survey route engineer for Design Services turn-key projects computes property ties and generates pole data forms, the stations and offsets can be computed for Bench Marks and updated in the Baseline Alignment Text file and transmitted back to the roadway design engineer.

Staking Right Of Way (R/W)

Monuments:

R/W monuments are to be staked using procedures to insure precision meets or exceeds the requirements for standard survey practices. The minimum ratio of precision for placing R/W monuments is 1:10,000. R/W monuments are to be set from the nearest baseline control points or -L- line control points that have been properly placed from the baseline. Monuments should be placed directly from the control point if at all possible; however, a traverse is acceptable to avoid cutting large trees or if meeting terrain demands (traverses of more than two legs are not recommended). If more than two traverse legs are required to place a monument, the monument should be checked by

closing the traverse or by angle and distance from another monument that has been placed from the baseline or designed alignment points that have been set from the baseline. Also, it is advised that when the opportunity arises to tie previously set R/W monuments from other occupied points, angles and distances should be recorded to create redundant information from which to compare misclosures and positional accuracies of the point set.

Witness stakes R/W and Easements:

Points set for placement of concrete R/W monuments and all easement points are to be flagged with 48 inch white top stakes. Carsonite posts are to be placed where rebar and caps are used as the monument. White tops or Carsonite stakes should be labeled with the alignment designation, station, and offset distance placed on the front of the stake (facing the designed alignment); and type of point (R/W, TDE, PDE, CE, etc.) placed on the front. If the R/W and Control of Access line is congruent, C/A should be shown on the front of the stake. Permanent black ink or paint markers should be used on Carsonite posts. R/W lines and easement lines should be delineated by placing white top stakes or flagging between points to insure an intervisible reference for locating the right-of-way and easements.

Documentation of R/W staking:

A set of plan sheets showing all calculated data relative to staking the R/W should be provided to the Division R/W agent for his/her use and for him/her to forward to the Roadway Design Unit or to the Design Services Unit on contracted turn-key projects for plan corrections. Documentation should be maintained by the Location & Surveys Group Leader or contracted Private Engineering firm as to when the points were set, type of material used, and any field notes that could be used to reestablish the points or prove their placement.

Quality Control for R/W Staking:

The Location & Surveys Unit requires recording in a data collector the angle and distance from the control point occupied to the monument set. Also, during the R/W staking phase, any opportunity that arises to tie previously set R/W monuments from other occupied points, angles and distances should be recorded in a data collector. This will create redundant information from which to compare misclosures and positional accuracies of the points set. As a final check, the Stations & Offsets should be computed using the collected North & East coordinates from this data and compared to the design Station & Offsets shown on the design plans to insure no errors have been created.

Also, at the time of plan sheet recordation and prior to let to construction, a site inspection should be made by the Location & Surveys Unit Group Leader in the project's division of all points set. This check is very critical to insure that all Right-of Way

revisions have been updated in the field. In addition, a check should be made to determine that the final recorded right-of-way plans in the local Register of Deeds office is in conformance with what is monumented on the ground.

PROJECT NUMBER : 8.2390501 B-3052 VANCE-FRANKLIN COUNTIES
BRIDGE NO. 9 ON SR. 1101 OVER TAR RIVER
DATE OF SURVEY : NOV. 1997 & OCT. 1998

SPECIAL NOTES:
A-) THIS IS AN ENGLISH PROJECT
B-) ALL BASELINE POINTS ARE 36" REBAR WITH CAP (UNLESS OTHERWISE NOTED)
C-) ALL TLINE POINTS ARE 36" REBAR WITH NO CAP (UNLESS OTHERWISE NOTED)

PERSONNEL :

RALEIGH FIELD OFFICE
309 CHAPANOKE RD.
SUITE 116
RALEIGH, NC 27603
(919) 662-4457
L.T. WILLIFORD, PE,PLS LOCATING ENGR.
R.C. CHAMBARD ASST. LOCATING ENGR. (TE I)
G.E. GREEN ASST. LOCATING ENGR. (T.T.VI)

DATUM DESCRIPTION
THE LOCALIZED COORDINATE SYSTEM DEVELOPED FOR THIS PROJECT IS BASED ON THE NAD83 STATE PLANE COORDINATES FOR THE NCDOT MONUMENT "GPS B3052-1" WITH A NORTHING OF 882504.7240, EASTING OF 2148914.3830. THE AVERAGE COMBINED FACTOR USED ON THIS PROJECT (GROUND TO GRID) IS 0.9999949 . ALL LINEAR DISTANCES ARE LOCALIZED HORIZONTAL DISTANCES. THE VERTICAL DATUM IS BASED ON NCDOT MONUMENT "GPS B3052-1" (ELEV. 254.39')(NGVD 29).

Chain BL contains:
1 10 11 12 2 14 15
-BL- CHARLIE GRISSOM ROAD (SR. 1101)

Point 1 (GPS B3052-1) N 882,504.7240 E 2,148,914.3830 ELE.254.39' Sta 5+00.00

Course from 1 to 10 N 25^ 58' 58.6" W Dist 406.49

Point 10 (BL-10) (PK) N 882,870.1260 E 2,148,736.2990 ELE.243.49' Sta 9+06.49

Course from 10 to 11 N 19^ 07' 47.1" W Dist 324.22

Point 11 (BL-11) (PK) N 883,176.4460 E 2,148,630.0480 ELE.242.75' BL-11 Sta 12+30.71
=T1 Sta 8+26.57

Course from 11 to 12 N 18^ 30' 08.8" W Dist 296.60

Point 12 (BL-12) N 883,457.7160 E 2,148,535.9230 ELE.240.10' Sta 15+27.31

Course from 12 to 2 N 17^ 52' 36.6" W Dist 331.70

Point 2 (GPS B3052-2) N 883,773.4020 E 2,148,434.1000 ELE.238.83' Sta 18+59.01

Course from 2 to 14 N 12^ 06' 13.4" W Dist 504.76

Point 14 (BL-14) N 884,266.9350 E 2,148,328.2620 ELE.240.47' BL-14 Sta 23+63.77
=BY Sta 9+03.89

Course from 14 to 15 N 11^ 11' 54.1" W Dist 522.84

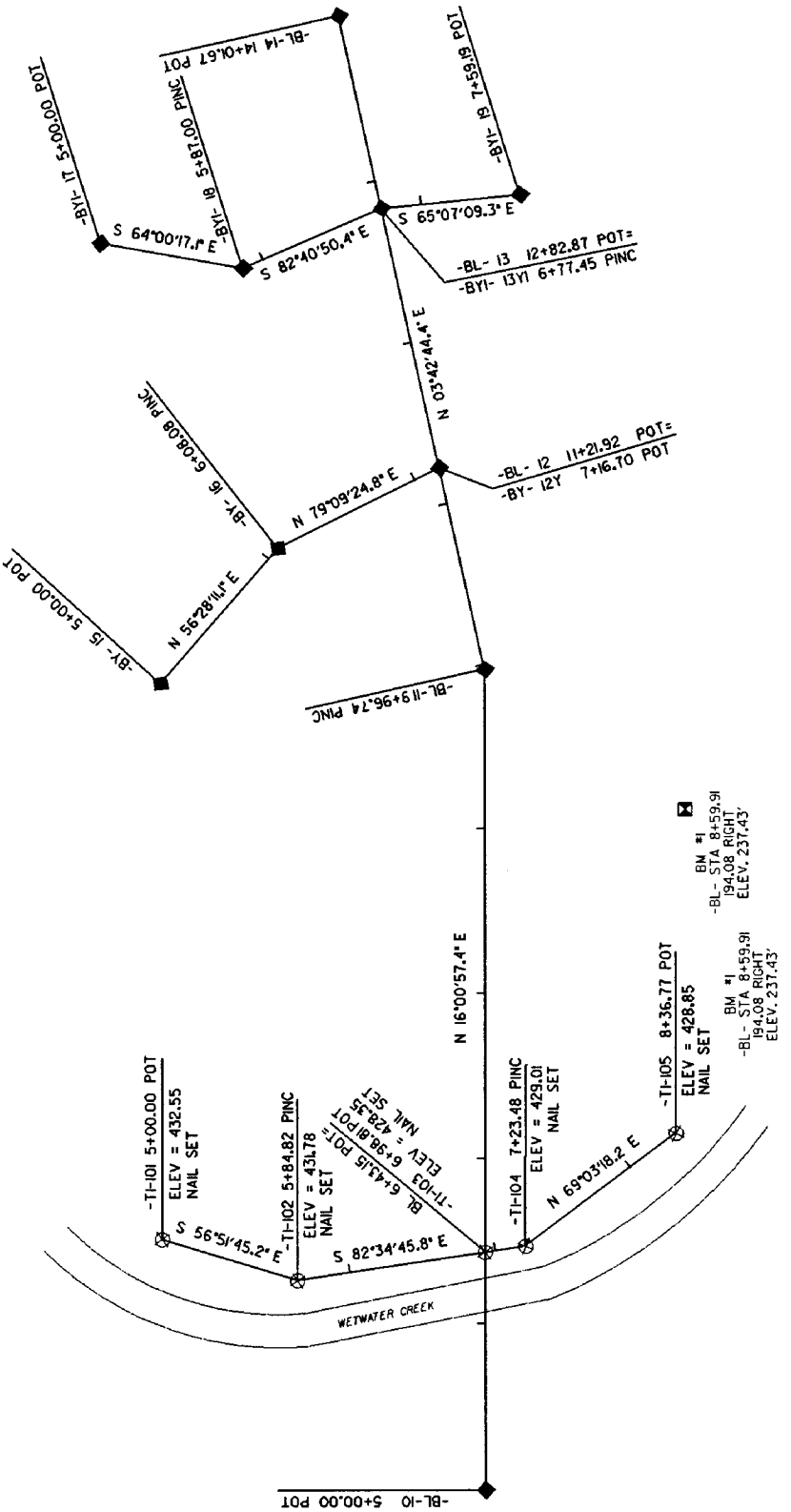
Point 15 (BL-15) N 884,779.8260 E 2,148,226.7220 ELE.255.41' Sta 28+86.61

Chain BY contains:
17 18 16 19 20
-BY- (JOHN HENRY ROAD)

Point 17 (BY-17) N 884,294.8047 E 2,147,925.8660 ELE.254.41' Sta 5+00.00

```
Course from 17 to 18   S 88^ 56' 24.4" E      Dist 205.01

Point 18 (BY-18)       N  884,291.0125 E  2,148,130.8449  ELE.245.91'       Sta   7+05.01

Course from 18 to 14   S 83^ 02' 47.0" E      Dist 198.88

Point 16 (BL-14)       N  884,266.9350 E  2,148,328.2620  ELE.240.47'     BY Sta  9+03.89
Point 16 = Point 14                                                   =BL-14 Sta 23+63.77

Course from 14 to 19   S 73^ 02' 47.0" E      Dist 187.59

Point 19 (BY-19)       N  884,212.2343 E  2,148,507.6996  ELE.235.71'       Sta  10+91.48

Course from 19 to 20   S 70^ 33' 12.1" E      Dist 380.21

Point 20  (BY-20)      N  884,085.6485 E  2,148,866.2277  ELE.234.69'       Sta  14+71.70
================================================================================
Ending chain BY description
*      2   Describe Chain TLINE
Chain TLINE contains:
 100 101 102 103 104
-T1- (ALONG TAR RIVER)

Caution:  This -T- Line is a secondary traverse only and should not be used for
construction of complex structures.  For more information please contact Locating
Engineer in charge of surveys.

================================================================================
Point 100 (T1-100)    N  883,203.8930 E  2,148,331.9030 ELE.240.27'         Sta   5+00.00

Course from 100 to 101   S 71^ 18' 59.6" E

Point 101 (T1-101)    N  883,126.8380 E  2,148,559.7690 ELE.241.47'         Sta   7+40.54

Course from 101 to 11    N 54^ 46' 58.0" E

Point 102 (BL-11)     N  883,176.4460 E  2,148,630.0480 ELE.242.75'        T1 Sta 8+26.57
Point 102 = Point 11                                                  =BL-11  Sta 12+30.71

Course from 11 to 103    S 48^ 41' 06.8" E

Point 103  (T1-103)   N  883,091.0410 E  2,148,727.2120 ELE.241.54'         Sta   9+55.93

Course from 103 to 104   N 43^ 36' 00.5" E

Point 103  (T1-104)   N  883,215.8000 E  2,148,846.0190 ELE.240.37'          Sta 15+28.21
================================================================================
Ending chain TLINE description
BENCHMARKS:
--------------------------
BM # 1 ELEVATION = 237.43'
N = 883135  E = 2148557
-BL- STATION 12+35  123' LEFT
R/R SPIKE SET IN 24" BIRCH
```

EXAMPLE OF PROJECT CONTROL BASELINE (TIP#.BLN)



NOT TO SCALE

DATUM DESCRIPTION

THE LOCALIZED COORDINATE SYSTEM DEVELOPED FOR THIS PROJECT IS BASED ON THE STATE PLANE COORDINATES ESTABLISHED BY NCDOT FOR MONUMENT "B3001-2"

WITH NAD 83 STATE PLANE GRID COORDINATES OF NORTHING: 745518.9950(ft) EASTING: 1128062.7930(ft)

THE AVERAGE COMBINED GRID FACTOR USED ON THIS PROJECT (GROUND TO GRID) IS: 0.99984183

THE N.C. LAMBERT GRID BEARING LOCALIZED HORIZONTAL GROUND DISTANCE FROM "B3001-2" TO +/- STATION (supplied by roadway) IS

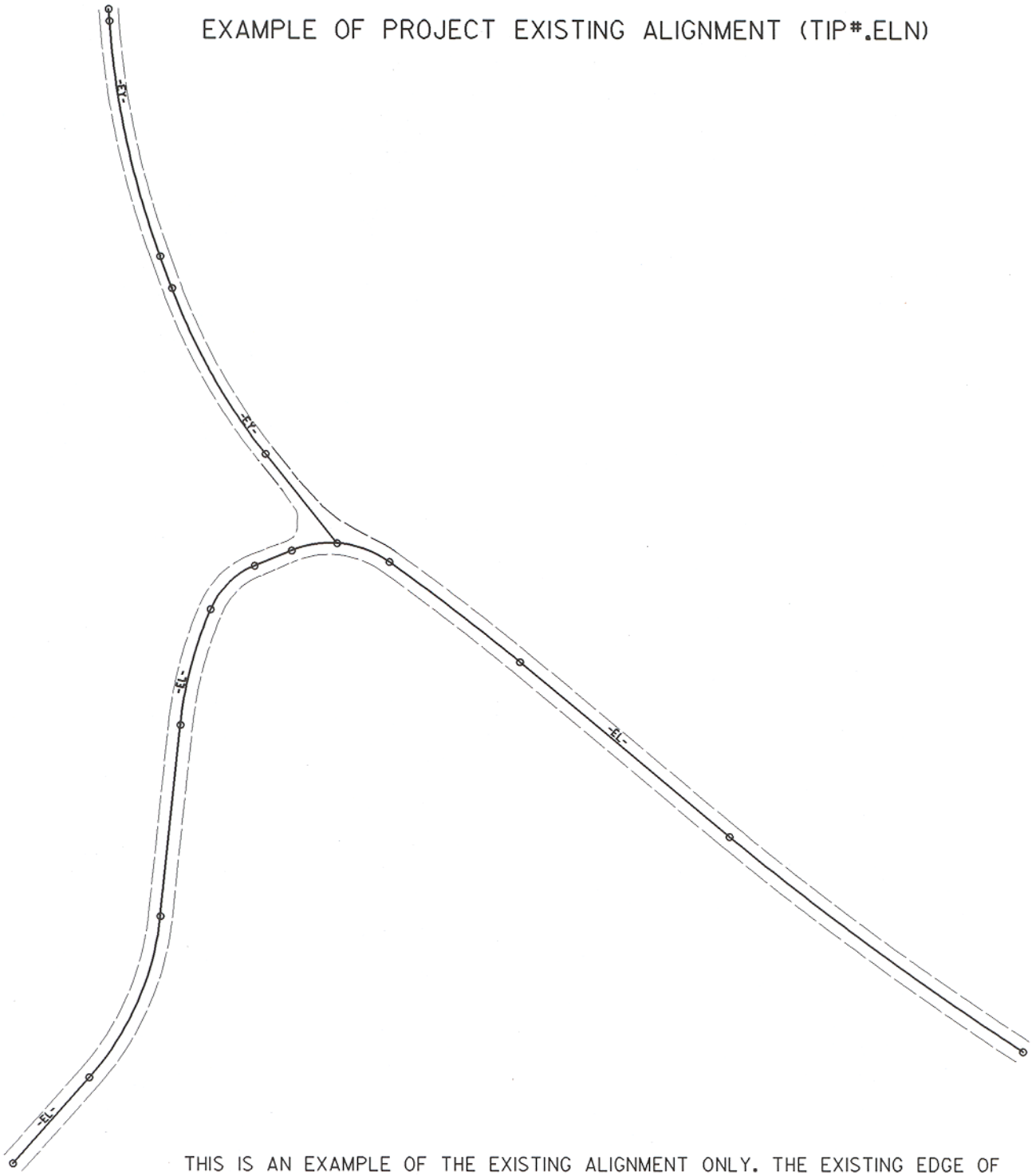
ALL LINEAR DIMENSIONS ARE LOCALIZED HORIZONTAL DISTANCES

VERTICAL DATUM USED IS NGVD 29

REVISED 6/13/02

ATTACHMENT 3

EXAMPLE OF PROJECT EXISTING ALIGNMENT (TIP#.ELN)



THIS IS AN EXAMPLE OF THE EXISTING ALIGNMENT ONLY. THE EXISTING EDGE OF PAVEMENT IS ONLY BEING SHOWN TO ILLUSTRATE THAT THE EXISTING ALIGNMENT IS FOLLOWING THE CENTER LINE OF THE ROAD.