Navajo Engineering &
Construction Authority

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Surveying And Drafting Policy
for the
Indian Health Service

January 22, 2002
(Supercedes the surveying and drafting policy dated April 24, 1998)

COORDINATION

1. The District Engineer forwards surveying and drafting requests to the NECA Surveying and Drafting (S&D) Manager. Requests include project number, scope, assigned IHS Project Manager (PM), and the anticipated date ROW maps are to be completed or the anticipated date of construction for construction staking. Requests will also be made for addendums to existing or past work items.
2. The NECA S&D Manager distributes a monthly progress schedule of current and future work items to the IHS Deputy Director, NECA Engineer Consultant, and IHS District Engineers. The schedule shows priority, expected start dates, and completion times.
3. The NECA S&D Manager maintains a tracking log documenting essential milestones in the completion of work items.
4. The NECA S&D Manager develops and maintains a data management system and master map that may be posted to the IHS DSFC web site in the future.
5. The IHS PM and the NECA S&D Manager establish accounting data as necessary, conferring with the NECA Engineer Consultant or IHS Deputy Director.
6. If the IHS PM and IHS Technician can not resolve a conflict with the NECA Survey Crew Chief or Draftsman, the problem will be brought to the IHS District Engineer and NECA S&D Manager. And further brought to the NECA Consultant, IHS Deputy Director, and NECA Engineer Manager if necessary.

7. Procedures and timelines established by the 638 contract in completing work items take precedence.

SURVEYING

General Requirements

1. The IHS PM is the final authority for water line and sewer line alignment orientation.
2. All Points of Intersection (PIs) and their line of sight and topographic perimeters for tanks, lagoons, and other non-linear areas are staked by the IHS PM prior to survey.
3. Archaeological and environmental surveys are completed prior to land surveying.
4. The use of permanent monuments and/or control Points are required and field located or established by the IHS PM.
5. Control points should be accessible with wide vistas that will remain undisturbed. A two- to three-foot posthole filled with concrete with the top at or slightly above ground is suggested. A six-inch PVC pipe can be used as a form and left in place. Before the concrete cures, a brass cap is placed on top of the concrete column. Reinforcement of the concrete is recommended for strength and magnetic locating as well as transverse rods to prevent frost jacking.
6. Point numbering or naming follows the convention listed later in this document, and subject to the limitations of the surveying software. Numbering is discrete; only one number can be assigned to one point and vice versa.
7. For simplicity, number the PIs in the alignment starting at the Beginning of Line (BOL) and progress sequentially to the End of Line (EOL). Number PIs in laterals using the same method. Don't skip whole numbers without explanation. Drafting will question the possibility of dropped points as missing data, causing delays.
8. Once established, avoid changing the numbering scheme for risk of later confusion.
9. The IHS PM provides the NECA S&D Manager with two copies of a map documenting the alignment or topographic area with a numbering scheme prior to the pre-survey meeting. The map should also identify the selected coordinate system and it's elevation. It is recommended that as many as four elevation monuments and/or control points be identified or set for reasons stated below in "Radial Survey Requirements," item 8. The Survey Crew Chief gets one copy and the other will be placed in the NECA drafting office survey file.
10. Hold a pre-survey meeting.
11. House numbers and service line ties to the mainline associated with the point numbers are documented during the survey.
12. Environmental conditions (date, time, temperature, cloud cover, wind speed/direction, precipitation, and part per million (PPM) when necessary, etc…) as well as instrumentation and crewmembers are recorded and updated throughout the survey as required.
13. The WGS84 datum is used.
14. The most time efficient surveying techniques are used, at times requiring simultaneous procedures, i.e. ROW surveys and profile surveys.
15. Alignment profiles include shots at 200-foot intervals or at terrain elevation breaks whichever occur first.
16. Structures affecting alignment or within the topographic area or ROW are surveyed such as houses, trailers, hogans, outbuildings, sheds, corrals, fences, etc….

17. Crossings such as road, rail, utility, fence, property, wash, ditch, river, lake, pond, other watercourses, escarpment, dike, berm, etc… are surveyed. Topographic surveys for crossings should be obtained within 100 feet of the alignment centerline.
18. Survey data is backed-up to assure against loss.
19. Post processed data mapped on a USGS map is sent to the IHS PM for alignment checks and completeness as soon as data is available. Discrepancies should be brought immediately to the attention of the NECA S&D Manager for timely resolution.

Pre-survey Meeting

1. Time and place of the pre-survey meeting is coordinated by the NECA S&D Manager supported by the IHS Project Manger. The meeting is held on the first day prior to commencing the survey.
2. The meeting includes the IHS PM, IHS Technician, Survey Crew Chief, and the NECA S&D Manager.
3. The NECA S&D Manager sends notice of the meeting establishing the date, time, and place to the attendees, the NECA Engineer Consultant, the NECA Manager of Engineer, NECA Draftsman, and the IHS District Engineer.
4. For lagoon, sewer, or tank foundation grade staking, design information including plan and profile sheets and data files are forwarded to the NECA S&D Manager for uploading into the surveying equipment prior to the pre-survey meeting.
5. The meeting agenda includes:
    a. scope
    b. timelines
    c. record keeping
    d. required ties to: monuments, previous surveys, new or existing control
    e. discussion of the mapped location of survey points, topographic area, control points, and monuments points
    f. point numbering and naming
    g. vertical control datum if other than WGS84
    h. horizontal datum is WGS84 (no option)
    i. selected coordinate system and it's elevation
    j. accuracy and elevation tolerances (for ROW traverses consult the certifying engineer or surveyor)
    k. crossing locations (wash, road, utility, etc…) and required profile characteristics
    l. IHS field support for the survey crew
    m. survey crew camp
    n. field tour

6. The IHS PM distributes minutes of the meeting to the above-mentioned people.

Radial Survey Requirements (GPS)

1. All GPS surveys are tied to Continuously Operating Reference Stations (CORS). Additional equipment is provided only to conduct this tie operation.
2. Base stations remain over their points for the required time to collect data for tie to the CORS (presently 1 minute per km between the base station and the CORS).
3. Fast Static surveys use at least the minimum number of satellites required by the system (presently four).
4. Setting base stations over control points or monuments is not required.
5. ROW surveys necessitate a tie from a single public survey corner or monument to provide a forward geodetic bearing to the BOL. See additional notes in Drafting, ROW Maps, item 3.
6. Base station locations maximize radio coverage.
7. The IHS PM assures an unobstructed view of the sky for points to be surveyed. A tree cutting permit and chainsaw may be necessary. the NECA Survey and Drafting Manager should be consulted, particularly for immovable objects such as canyon walls, house eves, etc…. GPS offsets or a traverse survey w/a total station may be used for hard to reach points.
8. On waterline surveys, where vertical control is not as critical, vertical control is obtained from one known benchmark (i.e. existing tank base elevation) and carried throughout the remainder of the survey. However, if the survey's plane is to be verified as level and not tilted, four monuments and/or control points of known elevation, relative to the same datum, are to be used. Three to establish the plane, and the fourth to verify the plane's angle is not tilted. A level loop may be used to resolve conflicts in data obtained from the GPS.
9. On sewer line/lagoon projects where vertical control is critical, a gravity based level loop around the project area is run using a standard differential level.
10. NECA conducts post processing to correlate the CORS data from http//www.ngs.noaa.gov/CORS/cors-data.html for the time and date of the survey.

Traverse Survey Requirements (Total Station)

1. To maintain vertical accuracy, length of shots is limited to 3,000 feet. A level loop using level and rod is recommended to check the accuracy of some points. Use of the Total Station is not recommended for level loops.
2. To maintain horizontal accuracy, length of shots is limited to a mile.
3. Additional points necessary to complete a traverse is established and staked by NECA during the survey.
4. Closure of the circle is done for the zenith angles in the control traverses. The data collector will be set to read face one and face two horizontally and vertically, and the tolerances set for 5 seconds horizontal and 15 seconds vertical. Every backsight and foresight is turned and recorded until these tolerances are met. A minimum of three circle closures is done to every traverse point.
5. For mathematical purposes, traverses are completed regarding "Strength of Figure." Minimize the number of angles of 180^{o} +/- 20^{o}. Maximize the number of angles closer to 90^{o} +/- 20^{o}.
6. The survey instrument is kept shaded.
7. The data collector's point closure routine is mandatory.
8. Side shots maintain a 10-second tolerance for a single circle closure.

9. The written field notes for side shots include all information contained in the electronic data collector.
10. The survey instrument is level checked and re-backsighted after each series of side shots to assure precision.
11. Prism rod height is minimized to reduce sway.

DRAFTING

ROW Maps

1. All information for the preparation of the Right-of-Way maps (land status, proposed and existing line designation, associated project numbers, etc…) and other preferences is supplied by the IHS PM to the NECA S&D Manager.
2. ROW map format follows the standard examples available at the IHS Area Office.
3. A forward geodetic bearing from a single public monument to the BOL is produced from a GPS survey. A note on the map refers to this as the basis of bearing. Showing a back bearing to a second public monument from the first monument for a GPS survey will likely introduce conflict with previously published reference bearings and will delay Grant of Easement as the conflict is resolved.
4. Once completed, draft ROW maps are submitted to the IHS PM for review. The IHS PM completes the review and provides redlines to the NECA S&D Manager within two weeks.
5. After correction, completed ROW mylars, red-lines, signed affidavits, Softdesk alignment station reports, all Softdesk field book files, survey instrument field book files, hard copy printouts of the original traverse records containing the original and corrected traverse information are sent to the IHS PM.
6. Changes to certified ROW mylars can be authorized only by the Engineer or Surveyor stamping the drawings and affidavits.
7. After construction, reroutes are surveyed and changes are made to the original ROW mylars.

Construction Drawings

1. In creating new construction drawings and to support composting effort, the IHS PM provides the NECA S&D Manager all copies of existing composite asbuilts redlined for updates with associated AutoCAD files. This aids the NECA S&D Manager in creating changes to the system layouts and construction drawings. A pre-drafting meeting may assist with this communication.
2. Hardcopies of changes to the existing system layouts (or new system layouts), new plan and profiles, crossing locations, surveyed structures, homes, etc… are created by NECA Drafting and sent to the IHS PM.
3. The IHS PM adds appurtenances and redlines corrections. A list of standard details is made and returned with the redlines to the NECA S&D Manager.
4. Hardcopies of corrections and standard detail sheets are returned to the IHS PM along with the redlines.

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5. If further changes are needed, redlines are regenerated and returned to the NECA S&D Manager. Corrections are returned with the redlines to the IHS PM.
6. Upon approval of the drawings by the IHS PM, mylars and the AutoCAD files are forwarded to the IHS PM.
7. After the NTUA design review, minor corrections can be done by the IHS PM.
8. A copy of the final design is forwarded to the NECA Warehouse Manager for material take-off.
9. During construction, the asbuilt information is accumulated in the field and given to the NECA S&D Manager on a weekly basis.
10. The NECA S&D Manager is notified when construction is complete, and provides a draft set of asbuilts to the IHS PM. If changes are needed, redlines are returned to the NECA S&D Manager for corrections and final drafting.
11. Upon approval of the asbuilts by the IHS PM, mylars and the AutoCAD files are forwarded to the IHS PM.
12. After the Final Inspection, minor changes may be made by the IHS PM or redlines may be given to the NECA S&D Manager.

APPROVED:

Ron Everson, Manager of Engineering
Navajo Engineering and Construction Authority

CONCURRED:

Jeffrey J. Nolte, P.E., Director
Division of Sanitation Facilities Construction
Office of Environmental Health and Engineering, NAIHS

ATTACHMENT A: POINT NUMBER SERIES LIST

(whole numbers only)

0001	thru	0699	CENTERLINE OF ROW: ANGLE POINTS, TEES & Eols ON ALLWATERLINES
0700	thru	0799	ARCHAEOLOGICAL OR OTHER REROUTES ADDED TO THE ALIGNMENT
0800	thru	0899	MISC. HOMESITE, PROPERTY, BOUNDARY, HIGHWAY AND OTHER CORNERS
0900	thru	0999	NEW CONTROL POINTS ADDED TO THE TRAVERSE POINTS (9000 SERIES)
1000	thru	2999	INTERMEDIATE PROFILE SHOTS BETWEEN CENTERLINE ROW PIs
3000	thru	3999	HOUSE, TRAILER, OUT BLDGs AND OTHER RESIDENTIAL STRUCTURES
4000	thru	4999	GAS, OIL, POWER, TELEPHONE, CABLE AND OTHER SIMILAR CROSSINGS
5000	thru	5999	MONUMENTATION: SECTION CORNERS, BENCHMARKS, TRI-STATIONS
6000	thru	6999	CENTERLINE OF ROW: MHs, TIE-INs AND EOLs OF ALL SEWERLINES
7000	thru	7999	CENTERLINE OF EXISTING WATERLINES FOR LOCATION & CROSSINGS
8000	thru	8999	WORKING POINTS: POLs, TAN. PROLONGATION, OFFSETS, SUB-TRAVERSE
9000	thru	9999	TRAVERSE POINTS ON CONTROL TRAVERSE CIRCUIT

ATTACHEMENT B: NECA FEATURE CODE LIBRARY LISTING

PC = POINT CODE
CC = CONTROL CODE
CCP = CONTROL CODE WITH USER INFORMATION INPUT

CODE ID	FEATURES	SCOPE
ARC	ARCHAELOGICAL AREA	PC
ARV	AIR VALVE	PC
BDY	BOUNDARY LINE	PC
BOW	BOTTOM OF WASH	PC
BUSH	BUSH	PC
CHECK	CHECK OBS (NOT PLOTTED)	PC
CL	ROAD CENTER LINE	PC
CLOSE	JOIN LAST LINE OF LOOP	CC
CLSCV	END OF CURVE AT A TP IN LOOP	CC
CLSRECT	CLOSE THREE POINTS	CC
CS	CURB STOP	PC
D	ENTER NEW DESCRIPTION	CCP
DIST	CO-ORDINATE BY DISTANCE	CC
DR	DIRT ROAD	PC
EHWY	EDGE OF HIGHWAY	PC
ENDCV	END OF CURVE AT A TP	CC
ENDLOOP	END OF A CLOSED LOOP	CC
ENDONCV	END CURVE WITH NO MORE LINES	CC
EPAV1	EDGE OF PAVEMENT	PC
EPAV2	EDGE OF PAVEMENT	PC
EXWL	EXISTING WATER LINE	PC
FC	FENCE	PC
FDN	FOUNDATION	PC
FL	FLOWLINE	PC
FV	FLUSH VALVE	PC

GAS	GAS VALVE	PC
GATE	GATE SYMBOL (RIGHT HAND)	PC
GL	GAS LINE	PC
GV	GATE VALVE	PC
HGN	HOGAN	PC
HSE	HOUSE	PC
JPT	JOINS TO SPECIFIED POINT	CCP
LAGOON	LAKE EDGE-AREA NOT CONTOURED	PC
LEN	PATTERN LENGTH	CCP
LF	LEECH FIELD	PC
LP	LAMP POST	PC
MH	MAN HOLE	PC
NG	NATURAL GROUND	PC
OL	OIL LINE	PC
OPL	OVERHEAD POWER LINE	PC
PC	POINT OF CURVATURE	CC
PP	POWER POLE	PC
PRV	PRESSURE REDUCING VALVE	PC
PT	POINT OF TANGENT	CC
RBR	REBAR	PC
RECT	MAKE A RECTANGLE	CC
ROW	RIGHT OF WAY	PC
RR	RAILWAY LINE	PC
RR1	RAILWAY LINE	PC
SC	SECTION CORNER	PC
SIZE	MODIFIES THE SIZE OF SYMBOLS	CCP
ST	START OF A NEW LINE	CC
STCV	START OF CURVE AT A TP	CC
STLOOP	START OF A CLOSED CURVE LOOP	CC
STOPCV	STOP CURVE WITHOUT PREV OBS	CC

TEL	PHONE LINE	PC
TLR	TRAILER	PC
TOW	TOP OF WASH	PC
TP	TELEPHONE POLE	PC
TRISTA	TRIANGULATION STATION (survey mark)	PC
UC	BURIED CABLE	PC
UPL	UNGERGROUND POWER LINE	PC
WID	WIDTH OF LINE	CCP
WL	WATER LINE	PC
WM	WATER METER	PC
WT	WATER TANK	PC