USNG: Getting it Right the First Time

>> By J. Anthony Cavell, LS

Like the proverbial mustard seed that grows large, every once in while a small, supposedly insignificant detail in a project grows, almost on its own, into a time-consuming conundrum. Such was the case for me recently. We were contracted to perform a survey for Texas Department of Transportation (TxDOT) that included setting a few control monuments, something we've done hundreds of times before. The conundrum grew out of naming the control points.

The TxDOT district had decided to begin assigning names to new control points by using the United States National Grid (USNG) 10m geoaddressing convention. The USNG is a method of designating a position with one string of numbers and letters that has its origin in the Military Grid Reference System (MGRS). It is very simple to use and growing in popularity, especially by public agencies and many GIS users. It is based on the UTM projection with its inherent map scale issues and so its advantages are not immediately evident to the land surveying professional.

The USNG joins a header and the last few digits of a point's UTM x and y coordinates to designate a 1m, 10m or other precision of the location in a single string. I studied the method briefly and created a script in MS Excel to do the work. Being a surveyor I understood that for the point to be located within 10m, I needed to use the value in the ones' column to **round** the proper value for the tens' column, drop the ones' column, and keep the previous four columns for each coordinate. By joining the two new four-digit numbers I'd have the name for my point in the USNG. All was well ... or so I thought.

Our project manager attended a seminar on the subject and returned describing how to **truncate** the ones' column. I caught the meaning of the word immediately and hoped it had been used casually and carelessly in the seminar, but he assured me it was used repeatedly. I needed to find the correct method with certainty or face the possibility that some of the points may ambiguously be named two ways! This would frustrate the whole purpose of adopting the convention, so I needed to do some homework.

Darryl Zercher, an RPLS with TxDOT referred me to FDGC's website for their USNG specifications. The site was down for a couple of days and I looked around and found some information on the NGS website. NGS also had an online script and a downloadable program to convert coordinates to USNG. I tried some of my test data felt very pleased with myself because both NGS options gave the same answers as my own script ... they **rounded**. I found an article by Tom Terry, USMC retired, in which he gave an example of rounding USNG values to achieve best accuracy in certain situations. He said that the coordinate format allows a full coordinate value to be truncated and abbreviated. I shared all this by e-mail with Mr. Zercher. He almost simultaneously had sent me by e-mail the document I couldn't get from the FGDC website. It definitely said to **truncate**. All my best references had resolved nothing!

I did some more research including some instructions on using the USNG. These documents were written at a very elementary, layman's level. They didn't mention rounding or truncating but I could tell that it was important for the system to be understood by someone who may be nearly math illiterate. It describes "moving right, then up" to lines that form the grid. It was now obvious to me that the system's origins called for locating the lower left corner of the quadrant in question, or in other words, **truncating**.

I needed to find out why NGS **rounded**, so I made a phone call to Charles Charllstrom, Director of NGS. He shared my curiosity for the differences between his agency's and FGDC's procedures. Indicating that he enjoyed running down a mystery, he said he'd investigate and get back to me. Later he confirmed that the correct method was indeed to **truncate** and that the agency's scripts would be corrected and an article like this would be beneficial to get word out to users about the corrections. That conversation was followed by another with Mr. Terry who referenced the USNG standard that describes truncation in *Annex B Truncation of USNG Coordinate Values*. He joined the now unanimous chorus of **truncation**.

The FGDC standards may be found by using links on the website: *www.fgdc.gov/standards/documents/standards/xy_proj/*. The documents one should read are: *TFIGURES_7.pdf and fgdc_std_011_2001_usng.pdf*. All surveyors should at least be familiar with the requirements. Those who may be called upon to use the system should read them carefully.

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A Guide to Using the USNG

>> By J. Anthony Cavell, LS

The United States National Grid (USNG) is the Federal Geographic Data Committee's (FGDC) standard that was developed with the hope of establishing a nationally consistent grid reference system as the preferred grid for National Spatial Data Infrastructure (NSDI) applications. To a surveyor, the benefits of such a universal grid reference system based on the Universal Transverse Mercator (UTM) System may not be obvious because of the inherent distortions and large scale factors. For casual users of positional data (most users of GIS), its simplicity and large zones of similar shape may be seductively perceived as beneficial. With it, any identifiable point on a map may be described with a single string of characters to a desired precision.

The USNG is based on universally defined coordinate and grid systems and can be extended for use world-wide. When referenced to NAD 83 or WGS 84, USNG values are equivalent to Military Grid Reference System (MGRS) values. The difference in these two systems is that USNG referenced to NAD27 uses the MGRS WGS 84 scheme of 100,000-m Square Identifications (described below). Even many older consumer GPS receivers may use MGRS as a surrogate for USNG/NAD83, which should also present significant benefits for homeland security agencies.

The USNG is not designed to replace the State Plane Coordinate Systems (SPCS) established by the National Geodetic Survey (NGS). (The SPCS was designed with insignificant distortions and scale factors to describe locations of property boundaries, etc.) The USNG may, however, serve well as a unique identifier for utilities, surveyors and others with a need to catalogue inventory items that possess specific locative attributes such as power poles or control monuments. The Federal Geodetic Data Committee (FGDC) document on the USNG describes the referencing scheme.

Based on WGS 84 or NAD 83, the U.S. geographic area shall be divided into 6-degree longitudinal zones designated by a number and 8-degree latitudinal bands designated by a letter giving each area a

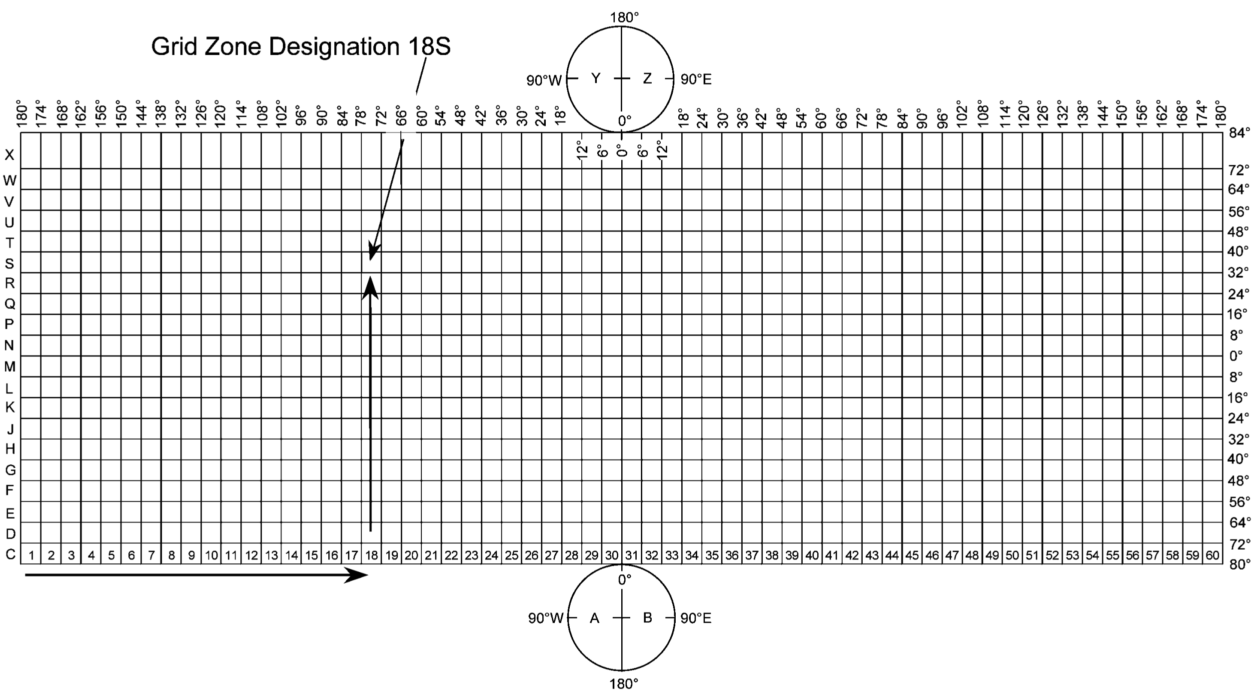

Figure 1 Grid Zone Designations of the U.S, National Grid

unique alphanumeric Grid Zone Designator (GZD). (**See Figure 1**). Each GZD area is covered by a scheme of 100,000-meter squares where a two-letter pair identifies each square. (**See Figures 2 & 3**)

A point position within the 100,000-meter square is given by the UTM grid coordinates by its Easting (E, x) and Northing (N, y). The number of digits will depend on the precision desired. Using pairs of numbers consisting of 2, 4, 6, 8 or 10 digits will designate grids of, respectively, 10km, 1km, 100m, 10m, or 1m extents. The convention can conceivably extend to any desired precision.

All elements of a grid reference need not be used. Their use depends upon the size of the area of activities, the type of use, and the scale of map to which the reference is keyed. For large geographical areas, such as the conterminous United States, the GZD is usually given (such as 18S in 18SUJ23480647). The designation alleviates ambiguity between identical references that may occur when reporting to a station outside the area. For areas less than a grid zone wide, but exceeding 100,000 meters, only the 100,000-meter Square Identification is needed (such as UJ in UJ23480647). For an area falling within a single 100,000-meter square, only the numerical part of the grid reference is required (such as 23480647).

A uniform system of truncation is adopted for the USNG. Truncated coordinates begin with the 10,000-meter digit. Truncated coordinate values, when combined, always consist of an even number of digits. Table 1 demonstrates how to truncate USNG grid coordinate values and UTM grid coordinates.

Do not make the natural assumption of a surveyor and round the numbers. While this would reduce the doubt in the position to 1/2 the size of a grid, and the truncated version simply identifies the lower left corner of the grid, truncation is the standard! To do otherwise would be creating a different system and lead to little good and much confusion.

What follows are the FGDC instructions for applying the USNG. Notice the simplicity implied by reading right and up. The emphasis is on reading a map, not relational accuracy.

"The first half of the total number of digits represents the Easting, and the second half the Northing. The standard convention of reading "right (Easting) and up (Northing)" is employed.

"To read the Easting coordinate, locate the first Easting (vertical grid line to the left of the point of reference and read the large digits, the principal digits labeling the line either in the top or bottom margin or on the line itself. Smaller digits shown as part of a grid number are ignored. Estimate, or scale the distance between the Easting line to the left of the point and the point itself.

"The reading of the Northing coordinate is made in a similar manner. Locate the first Northing (horizontal) grid line below the point of reference and read the principal digits labeling the line located in the left or right margin or on the line itself. Then estimate, or scale the distance between the Northing grid line below the point and the point itself."

Figure 4 demonstrates how to read the USNG grid coordinates.

Definitions and examples in this article have been excerpted from the FGDC document FGDC-STD-011-2001. It is available on the Web at www.fgdc.gov/ standards/documents/ standards/xy_proj/fgdc-std-011-2001-usng.pdf

(See p. 38 for Figures 3 & 4)

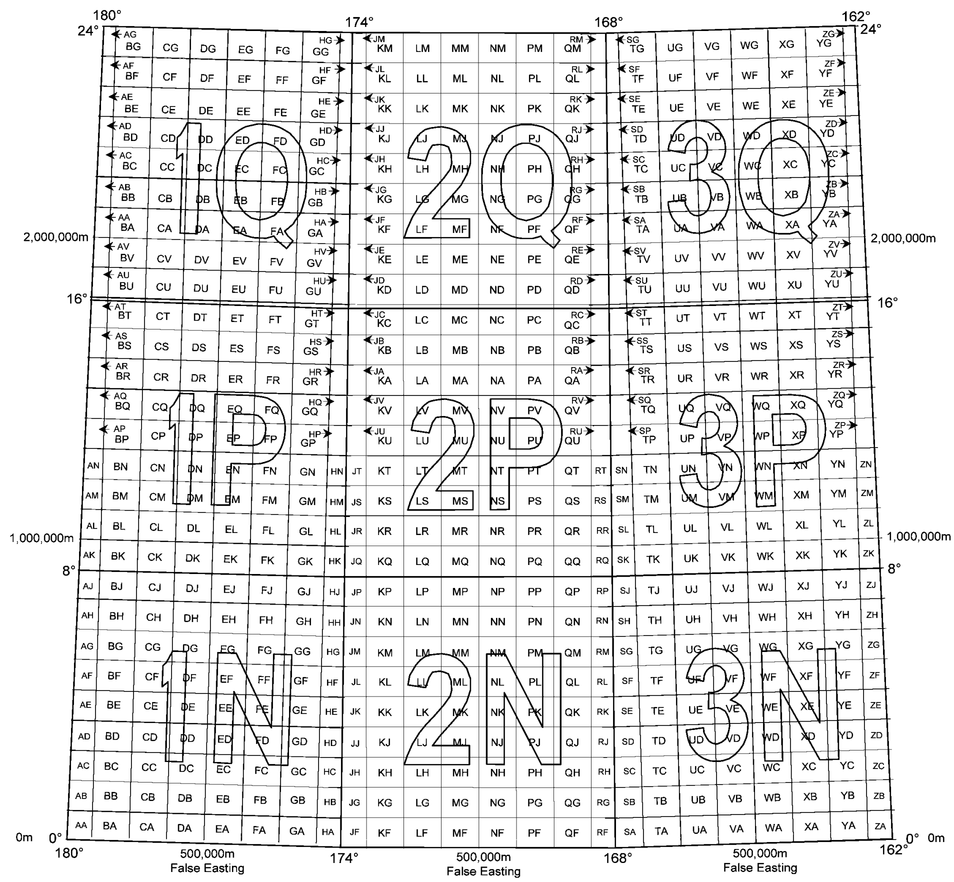

Figure 2 Basic Plan of the 100,000-meter Square Identification of the USNG

	Complete grid reference	Truncated coordinates			
		Four digit (1 km)	Six digit (100 m)	Eight digit (10 m)	Ten digit (1 m)
UTM	+18,323483.168,4306479.498	2306	234064	23480647	2348306479
USNG	18SUJ2348306479	2306	234064	23480647	2348306479

Table 1 Examples of truncated grid coordinates

ZONES	SET 1 1, 7, 13, 19, 25, 31, 37, 43, 49, 55								SET 2 2, 8, 14, 20, 26, 32, 38, 44, 50, 56								SET 3 3, 9, 15, 21, 27, 33, 39, 45, 51, 57								SET 4 4, 10, 16, 22, 28, 34, 40, 46, 52, 58								SET 5 5, 11, 17, 23, 29, 35, 41, 47, 53, 59								SET 6 6, 12, 18, 24, 30, 36, 42, 48, 54, 60							
2,000,000 m																																																
	AV	BV	CV	DV	EV	FV	GV	HV	JE	KE	LE	ME	NE	PE	QE	RE	SV	TV	UV	VV	WV	XV	YV	ZV	AE	BE	CE	DE	EE	FE	GE	HE	JV	KV	LV	MV	NV	PV	QV	RV	SE	TE	UE	VE	WE	XE	YE	ZE
	AU	BU	CU	DU	EU	FU	GU	HU	JD	KD	LD	MD	ND	PD	QD	RD	SU	TU	UU	VU	WU	XU	YU	ZU	AD	BD	CD	DD	ED	FD	GD	HD	JU	KU	LU	MU	NU	PU	QU	RU	SD	TD	UD	VD	WD	XD	YD	ZD
	AT	BT	CT	DT	ET	FT	GT	HT	JC	KC	LC	MC	NC	PC	QC	RC	ST	TT	UT	VT	WT	XT	YT	ZT	AC	BC	CC	DC	EC	FC	GC	HC	JT	KT	LT	MT	NT	PT	QT	RT	SC	TC	UC	VC	WC	XC	YC	ZC
	AS	BS	CS	DS	ES	FS	GS	HS	JB	KB	LB	MB	NB	PB	QB	RB	SS	TS	US	VS	WS	XS	YS	ZS	AB	BB	CB	DB	EB	FB	GB	HB	JS	KS	LS	MS	NS	PS	QS	RS	SB	TB	UB	VB	WB	XB	YB	ZB
1,500,000 m	AR	BR	CR	DR	ER	FR	GR	HR	JA	KA	LA	MA	NA	PA	QA	RA	SR	TR	UR	VR	WR	XR	YR	ZR	AA	BA	CA	DA	EA	FA	GA	HA	JR	KR	LR	MR	NR	PR	QR	RR	SA	TA	UA	VA	WA	XA	YA	ZA
	AQ	BQ	CQ	DQ	EQ	FQ	GQ	HQ	JV	KV	LV	MV	NV	PV	QV	RV	SQ	TQ	UQ	VQ	WQ	XQ	YQ	ZQ	AV	BV	CV	DV	EV	FV	GV	HV	JQ	KQ	LQ	MQ	NQ	PQ	QQ	RQ	SV	TV	UV	VV	WV	XV	YV	ZV
	AP	BP	CP	DP	EP	FP	GP	HP	JU	KU	LU	MU	NU	PU	QU	RU	SP	TP	UP	VP	WP	XP	YP	ZP	AU	BU	CU	DU	EU	FU	GU	HU	JP	KP	LP	MP	NP	PP	QP	RP	SU	TU	UU	VU	WU	XU	YU	ZU
	AN	BN	CN	DN	EN	FN	GN	HN	JT	KT	LT	MT	NT	PT	QT	RT	SN	TN	UN	VN	WN	XN	YN	ZN	AT	BT	CT	DT	ET	FT	GT	HT	JN	KN	LN	MN	NN	PN	QN	RN	ST	TT	UT	VT	WT	XT	YT	ZT
	AM	BM	CM	DM	EM	FM	GM	HM	JS	KS	LS	MS	NS	PS	QS	RS	SM	TM	UM	VM	WM	XM	YM	ZM	AS	BS	CS	DS	ES	FS	GS	HS	JM	KM	LM	MM	NM	PM	QM	RM	SS	TS	US	VS	WS	XS	YS	ZS
1,000,000 m	AL	BL	CL	DL	EL	FL	GL	HL	JR	KR	LR	MR	NR	PR	QR	RR	SL	TL	UL	VL	WL	XL	YL	ZL	AR	BR	CR	DR	ER	FR	GR	HR	JL	KL	LL	ML	NL	PL	QL	RL	SR	TR	UR	VR	WR	XR	YR	ZR
	AK	BK	CK	DK	EK	FK	GK	HK	JQ	KQ	LQ	MQ	NQ	PQ	QQ	RQ	SK	TK	UK	VK	WK	XK	YK	ZK	AQ	BQ	CQ	DQ	EQ	FQ	GQ	HQ	JK	KK	LK	MK	NK	PK	QK	RK	SQ	TQ	UQ	VQ	WQ	XQ	YQ	ZQ
	AJ	BJ	CJ	DJ	EJ	FJ	GJ	HJ	JP	KP	LP	MP	NP	PP	QP	RP	SJ	TJ	UJ	VJ	WJ	XJ	YJ	ZJ	AP	BP	CP	DP	EP	FP	GP	HP	JJ	KJ	LJ	MJ	NJ	PJ	QJ	RJ	SP	TP	UP	VP	WP	XP	YP	ZP
	AH	BH	CH	DH	EH	FH	GH	HH	JN	KN	LN	MN	NN	PN	QN	RN	SH	TH	UH	VH	WH	XH	YH	ZH	AN	BN	CN	DN	EN	FN	GN	HN	JH	KH	LH	MH	NH	PH	QH	RH	SN	TN	UN	VN	WN	XN	YN	ZN
	AG	BG	CG	DG	EG	FG	GG	HG	JM	KM	LM	MM	NM	PM	QM	RM	SG	TG	UG	VG	WG	XG	YG	ZG	AM	BM	CM	DM	EM	FM	GM	HM	JG	KG	LG	MG	NG	PG	QG	RG	SM	TM	UM	VM	WM	XM	YM	ZM
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	AE	BE	CE	DE	EE	FE	GE	HE	JK	KK	LK	MK	NK	PK	QK	RK	SE	TE	UE	VE	WE	XE	YE	ZE	AK	BK	CK	DK	EK	FK	GK	HK	JE	KE	LE	ME	NE	PE	QE	RE	SK	TK	UK	VK	WK	XK	YK	ZK
	AD	BD	CD	DD	ED	FD	GD	HD	JJ	KJ	LJ	MJ	NJ	PJ	QJ	RJ	SD	TD	UD	VD	WD	XD	YD	ZD	AJ	BJ	CJ	DJ	EJ	FJ	GJ	HJ	JD	KD	LD	MD	ND	PD	QD	RD	SJ	TJ	UJ	VJ	WJ	XJ	YJ	ZJ
	AC	BC	CC	DC	EC	FC	GC	HC	JH	KH	LH	MH	NH	PH	QH	RH	SC	TC	UC	VC	WC	XC	YC	ZC	AH	BH	CH	DH	EH	FH	GH	HH	JC	KC	LC	MC	NC	PC	QC	RC	SH	TH	UH	VH	WH	XH	YH	ZH
	AB	BB	CB	DB	EB	FB	GB	HB	JG	KG	LG	MG	NG	PG	QG	RG	SB	TB	UB	VB	WB	XB	YB	ZB	AG	BG	CG	DG	EG	FG	GG	HG	JB	KB	LB	MB	NB	PB	QB	RB	SG	TG	UG	VG	WG	XG	YG	ZG
0 m	AA	BA	CA	DA	EA	FA	GA	HA	JF	KF	LF	MF	NF	PF	QF	RF	SA	TA	UA	VA	WA	XA	YA	ZA	AF	BF	CF	DF	EF	FF	GF	HF	JA	KA	LA	MA	NA	PA	QA	RA	SF	TF	UF	VF	WF	XF	YF	ZF
	200,000 m	300,000	400,000	500,000	600,000	700,000	800,000 m		200,000 m	300,000	400,000	500,000	600,000	700,000	800,000 m		200,000 m	300,000	400,000	500,000	600,000	700,000	800,000 m		200,000 m	300,000	400,000	500,000	600,000	700,000	800,000 m		200,000 m	300,000	400,000	500,000	600,000	700,000	800,000 m		200,000 m	300,000	400,000	500,000	600,000	700,000	800,000 m	

Figure 3 Organization of the USNG 100,000-meter grid squares

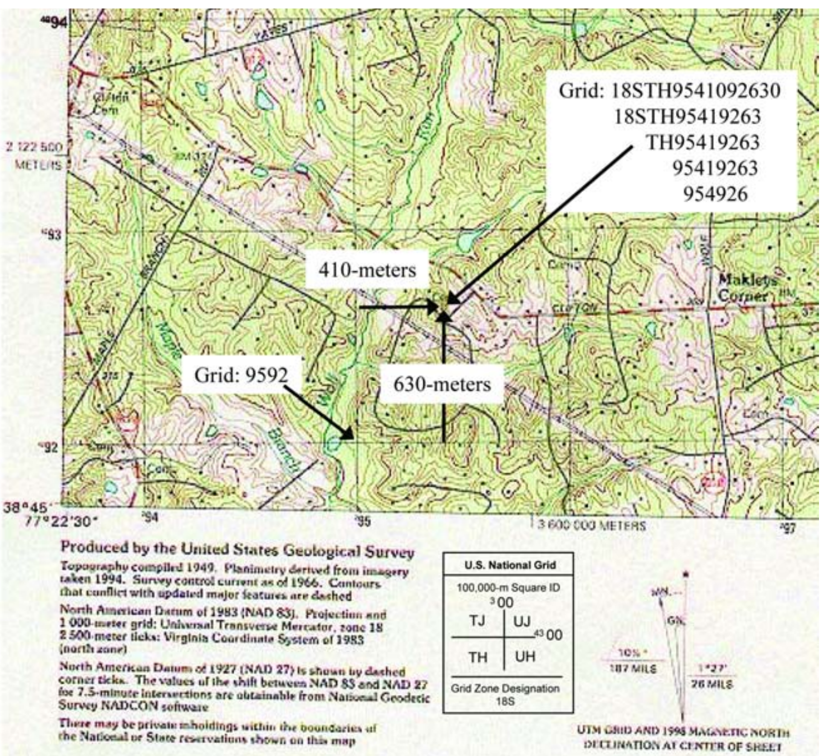

Figure 4 illustrates how to obtain the spatial address for a feature on the map, in this case a cemetery. Coordinates are depicted as full and truncated values. Values preceding grid coordinates are the Grid Zone Designation, and 100,000-meter Square Identification (In this case 18S and TH respectively). These values are found in the Grid Reference Box in the map legend and are used as appropriate to locate the feature within increasingly larger areas. A full coordinate (i.e., 18STH95419263) provides a unique value over the entire world. TH95419263 provides a value with 10-meters precision out of a large, regional size area.

Finding 95419263. Think 9541 / 9263.

- Reading right to grid line 95, measure right another 410-meters. Dropping the one-meter digit 0 produces the grid coordinate Easting value 9541.
- Read up to grid line 92. Measure up another 630-meters. The Northing coordinate value is produced from grid line 92 + 630-meters (drop the 0) to make 9263. This makes the grid coordinate 95419263 (think 9541 / 9263).

TRUNCATED EXAMPLES:	
Feature	**USNG Grid Coordinates**
Bench Mark 324	94349341
Pond	94329206
Building	95649379
Road intersection	96189260

Map extract from US Geological Survey 7.5-minute quadrangle FAIRFAX, VA, 1994 edition.

Figure 4 How to read USNG grid coordinates