### Establishing a Control Point Database

Kristin Brown Grand Canyon Monitoring and Research Center

> Cory Lochridge Center for Data Insight

# Topographic Data Collection





Control Points are used to geo-reference a variety of data collected in the canyon.

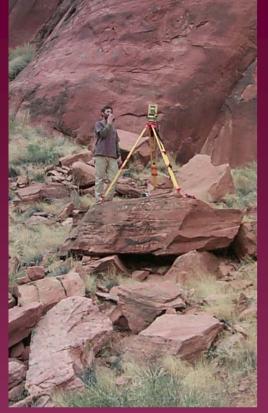
Hydrographic Data Collection

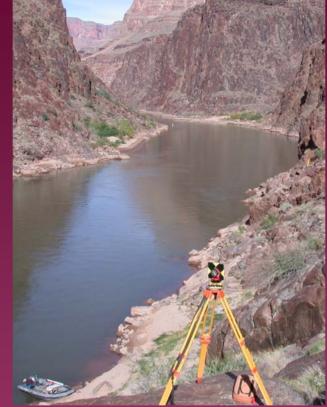
### **Remote Sensing Applications**



Control Points are used to geo-reference aerial photography and/or verify accuracy of georeferenced aerial photography





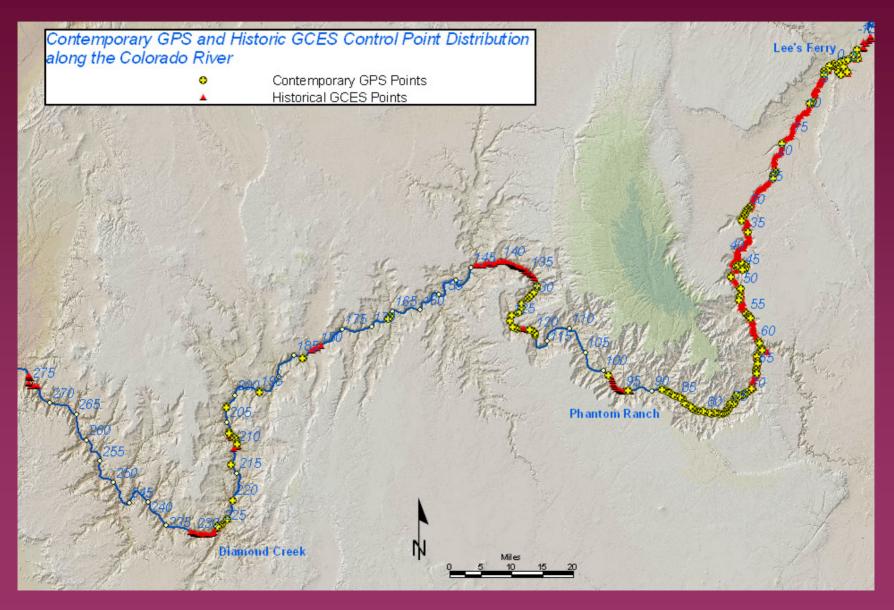


GPS Technology or Conventional Survey methods are used to georeference Control Points





### **Control Point Distribution**



### Motive for Establishing a Control Point Database

- Assign each control point a unique point identifier.
- Provide a reference to historical geographic coordinates.
- Update historical geodetic coordinates to modern, universal datum.
- Provide control point precision and accuracy statistics to researchers.
- Provide researchers and contractors a resource to independently geo-reference collected field data.

### Database Input Page

Point Name (Designation) (2F132266F.         Point Alae (513003.         Side State         Station Mide [12:266         Station Mide [12:266         Station Mide [12:276         Norman Station Mide [12:276         Norman Station Mide [12:276         Norman Mide [12:276         Mapping Plane Scale Factor [19:2864/51         Mapping Plane Scale Factor [19:2864/51 <td< th=""><th></th><th>printable</th></td<>		printable
Northing Meters       552842.818       N Laitude (dd mm ss.st)       26       20       39.33         Eating Meters       165122.114       W Longitude (dd mm ss.st)       112       27       14.64         Ellipsoid Ht. (m)*       566.579       N Laitude (dd dddd)       36.34425833333       Wetnal       Vertical         Orthometric Ht. (m)*       566.579       N Laitude (dd dddd)       36.34425833333       Wetnod Conventionel Survey       Conventionel Survey         Orthometric Ht. Datum       80       Hydro Azimuth       12.45406666666       GCES       GCES       GCES       GCES       GCES       7.7/1994         Mapping Plane Scale Factor       9993287       Combined Grid Factor       9998404       Network Relationship/Nework       Network Relationship/Nework       Method       Value         Ellipsoid EH: Fror (m)       Eating Error       Longitude Error       19998404       Vertical       Vertical         Orthometric Ht Error (m)       Eating Error       Longitude Error       GEOID 1990/GEOID90 exe       -22.934         Monument Type "Chiselled "X""       Collected By Brown       Survey Project       National Geodetic         Monument Ste by UNKNOWN       Site Dest       Collected Date 9/10/2003       Images 7 add/sidiview       National Geodetic         Drine to Dest	Point Alias 8513003. Side Shot Yes Station Mile 132.266 Station River Offset 77.155 River Side Right Accuracy Convention:	First Prev Next Last Add New K   New Record Number 1 of 1 Designation Name Select One   GPS Cross Reference Select One   Select One   Select One
Description       Prj ID       Field Book       Page         Monument Type "Chiselled ""X""         Collected By Brown         Survey Project       National Geodetic         Monument Condition       Existing or Recovered         Collected Date 9/10/2003       Images 7 add/edit/view       National Geodetic         Monument Set by UNKNOWN         Collected Date 9/10/2003       Images 7 add/edit/view       National Geodetic         Set Date               GPS Cross           Point Desc        3CH X 3CH CHISELLED "X" ON LEDGE OF BLOCKY                  Point Desc        3CH X 3CH CHISELLED "X" ON LEDGE OF BLOCKY                  Point Desc        3CH X 3CH CHISELLED "X" ON LEDGE OF BLOCKY                  Discord Desc	Northing Meters:         592842.818         N Latitude (dd mm ss.ss):         36         20         39.33           Easting Meters:         165122.114         W Longitude (dd mm ss.ss):         112         27         14.64           Ellipsoid Ht. (m).**         586.579         N Latitude (dd dddd):         36.344258333333         333           Orthometric Ht. (m).**         608.18591         W Longitude (dd dddd):         112.454066666666           Orthometric Ht. Datum:         90         Hydro Azimuth:         112           Mapping Plane Scale Factor:         9999287         Combined Grid Factor:         9998404           Ellipsoid (Elv.) Scale Factor:         99991171         Convergence:         0-19-06.56           Accuracy         Ellipsoid Ht. Error (m):         Northing Error;         Latitude Error;	Horizontal Vertical Datum NAD 83 (1983)  Method Conventional Survey Conventional Survey Calc By GCES  GCES  Calc Date 7/1/1994 7/1/1994 Network Relationship Network  Method Value GEOID2002 GEOID1999 WINTG.exe -22.934 GEOID1996
	Monument Type "Chiselled ""X"" Collected By Brown Surv Monument Condition Existing or Recovered Collected Date 9/10/2003 Monument Set by UNKNOWN Collected Date 9/10/2003 Monument Set by UNKNOWN Collected Date 9/10/2003 Point Desc Set Date Doc Point Desc Set X 3CM CHISELLED "X" ON LEDGE OF BLOCKY BASALT OUTCROP AT GROUND LEVEL. CON Site Desc ON DEBRI FAN OF DUBINDORF AT BASE OF BASALT ON DEBRI FAN OF DUBINDORF AT BASE OF BASALT Drive to Desc Collected Date 9/10/2003 CRed Flag Desc Collected Date 9/10/2003 Save to History Show Historical Info Save/Upda Input Tracking Checked	ey Project Survey Point ID: Images 7 add/edit/view National Geodetic urment Ref Survey US National Grid Designator: IPS Cross Reference: Field Ties Y Comments Vertcon 2.0 used to adjust NGVD29 Orthometric Datum to NAVD88 Ellipsoid Datum ate Record Cancel Save/Update

### Point Name and Location

- GCMRC Name
- Point Alias (GCES Name) · USGS 15" Map
- Station Mile
- Field Area

- River Side and Offset
- Accuracy Convention

Point Name (Designation	ı) GR132266R	
Point Alia	18 851 3003,	
		Side Shot: Yes
Station Mile 132.266	Field Area Grand Canyon	Traverse: No
Station River Offset 77.155	State	Hydro: No
River Side Right		GPS:No
Accura	acy Convention:	•
USGS 15 Quad: POWELL PLATE	AU NW	

# GCES Naming Convention Problematic

- Name is not clearly defined
- Numbering is not sequentially ordered upstream or downstream
- Single Point assigned multiple names Example:

GCMRC Name	GCES Name 1	GCES Name 2
MC043442L	3012357	3253057
MC043436L	3012358	3253058
MC044957R	3103026	3073026

### GCMRC Control Point Naming Convention

- Describes point location based on:
  - general location,
  - point mile up or down river, and
  - side of river

Example:

GCMRC Name	General Location	River Mile	River Side
GL-01045L	Glen Canyon	-1.045	Left
MC055802L	Marble Canyon	55.805	Left
GR225565R	Grand Canyon	225.565	Right

### Point Name and Location

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- Point Alias (GCES Name) · USGS 15" Map
- Station Mile
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Point Name (Designation	ı) GR132266R	
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Station River Offset 77.155	State	Hydro: No
River Side Right		GPS:No
Accura	acy Convention:	•
USGS 15 Quad: POWELL PLATE	AU NW	

# Accuracy Convention

Point Name (Designation) GR132266R			
Point Alia	s 851 3003,		
		Side Shot: Yes	
Station Mile 132.266	Field Area Grand Canyon	Traverse: No	
Station River Offset 77.155	State	Hydro: No	
River Side Right		GPS:No	
Accura USGS 15 Quad:POWELL PLATEA	Convention:	▼ k - Rim Control	
ordinate Northing Meters: 592842.818 Easting Meters: 165122.114			

- Primary Network Rim Control
- Secondary Network River GPS with Rim Control
- Tertiary Network River GPS with River Control
- Primary Traverse Point Control for Traverse
- Secondary Traverse Point Traverse Point
- Primary Sideshot Sideshot from two locations
- Secondary Sideshot Sideshot from one location

# Coordinate

- Northing and Easting
- Latitude and Longitude
- Elevation
- Scale Factors

Coordinate	
Northing Meters: 592842.818	N Latitude (dd mm ss.ss): 36 20 39.33
Easting Meters: 165122.114	W Longitude (dd mm ss.ss): 112 27 14.64
Ellipsoid Ht. (m):* 586.579	N Latitude (dd.ddddd): 36.344258333333
Orthometric Ht. (m):* 608.18591	W Longitude (dd.ddddd): 112.45406666666
Orthometric Ht. Datum: 90	
	Hydro Azimuth:
Mapping Plane Scale Factor: .9999287	Combined Grid Factor: .9998404
Ellipsoid (Elv.) Scale Factor: .99991171	Convergence: -0-19-06.56

\*Orthometric Height was collected, Ellipsoid Height was calculated.

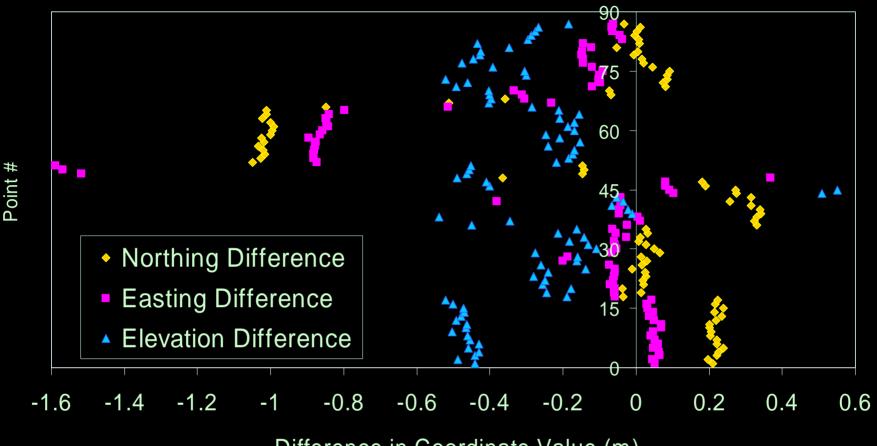
### Control Point Coordinate Datums

GCES Historical Control Point Datum

- State Plane Coordinate System
- NAD 27 Horizontal Reference Datum
- NGVD 29 Vertical Reference Datum
- Orthometric Height

GCMRC Contemporary Control Point Datum

- State Plane Coordinate System
- NAD 83 Horizontal Reference Datum
- NAVD 88 Vertical Reference Datum
- Ellipsoid Height



Difference in Coordinate Value (m)

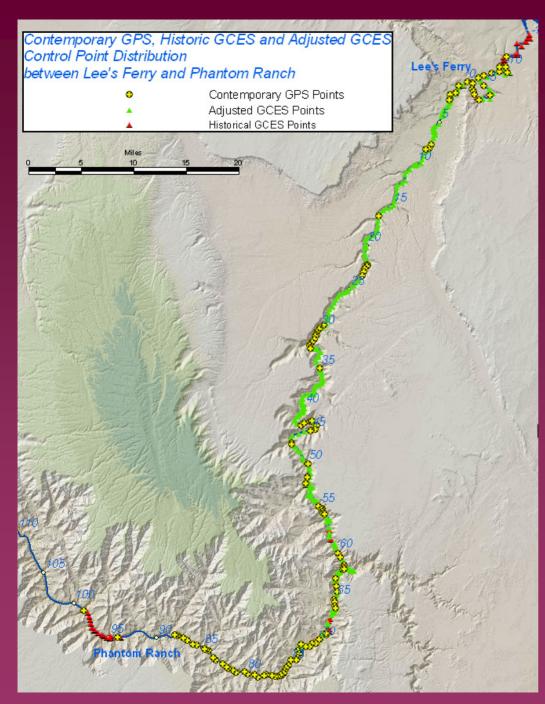
Difference between GPS and GCES Coordinate Values for 87 Control Points

### Contemporary GPS and Historic GCES Coordinate Value Comparison

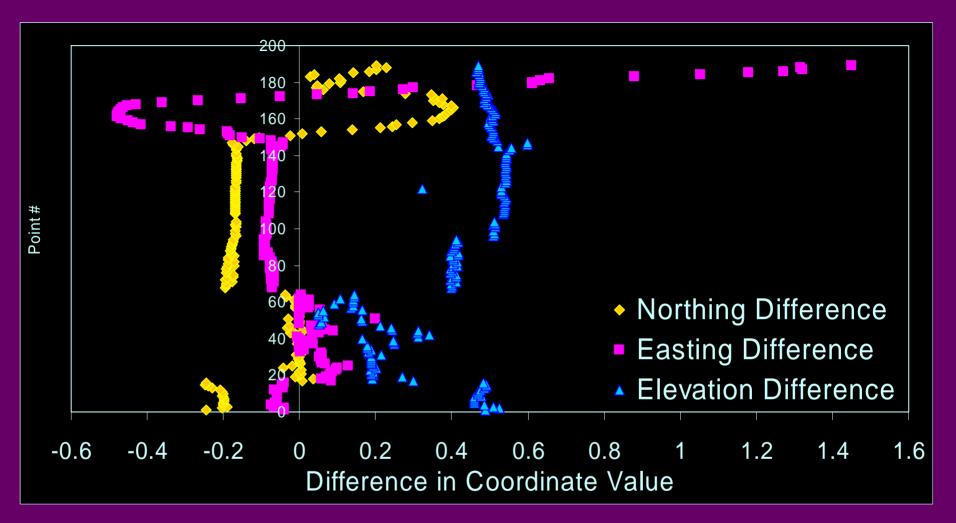
	Northing	Easting	Elevation
Range of Difference Values	1.390 m	1.956 m	1.091 m
Averaged Absolute Value of Difference	0.569 m	0.536 m	0.625 m
Std. Dev. Of Difference	0.441 m	0.406 m	0.191 m

Method for Converting GCES Control Point Coordinates to Contemporary Datum

- Adjusts conventional survey angle and distance measurements to specified control coordinates.
- Uses modern GPS derived coordinates.
- Uses historic GCES conventionally surveyed angle and distance measurements.
- Must have conventional survey measurements to control points with GPS derived coordinates.
- Can combine modern measurements with historic measurements to strengthen network.



Distribution of Historic GCES Control Points Adjusted to current GPS coordinate values.



Difference between Historical and Adjusted GCES Coordinate Values for 176 Control Points

### Adjusted and Historic GCES Coordinate Value Comparison

	Northing	Easting	Elevation
Range of Difference	0.642 m	1.926 m	0.548 m
Values	1.390 m	1.956 m	1.091 m
Averaged Absolute	0.143 m	0.163 m	0.404 m
Value of Difference	0.569 m	0.536 m	0.625 m
Std. Dev. Of Difference	0.174 m	0.304 m	0.148 m
	0.441 m	0.406 m	0.191 m

GPS Comparison Information

### Coordinate Metadata and Datum Information

- State Plane Coordinate Zone
- Method of deriving coordinate value
- Organization deriving coordinate value

•	Network Relationship	State Plane 202	
•	<ul> <li>Network</li> <li>Local</li> <li>Unknown</li> <li>Datum</li> </ul>	Horizontal Datum NAD 83 (1983) Method Conventional Survey Calc By GCES Calc Date 7/1/1994 Network Relationship Netw	Vertical Conventional Survey GCES 7/1/1994 vork
		Method GEOID2002 GEOID1999WINTG.exe GEOID1996 GEOID1990GEOID90.exe	Value -22.934 -22.443

### Accuracy

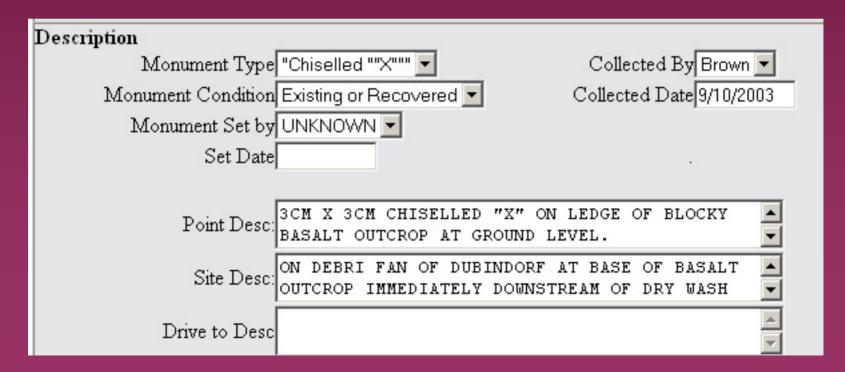
Accuracy		
Ellipsoid Ht. Error (m):	Northing Error:	Latitude Error:
Orthometric Ht.Error (m):	Easting Error:	Longitude Error:

This section will change significantly

- Network Error for Northing, Easting, and Elevation
  - Error in relation to the entire network
  - Useful for remote sensing applications
- Local Error for Northing, Easting, and Elevation
  - Error in relation to survey work of nearest neighbors
  - Useful for error associated with site specific survey data collection (beach or hydro surveys)

### Description

- Monument Type
- Monument Condition
- Monument Set by
- Set Date
- Point Description
- Site Description



Sample GCES (	Control Point Descriptions
GCMRC Name	GCES Description
MC002131R	GS-F22bolt
MC043701L	Jeff's DS crack in rock
MC055671R	IVO ID PT
MC044914L	#356 US Willie's
Descriptions associatii point.	ng a project or a person to a control

GR064949R BS1 Carbon x RL US end Carbon
GR123472L Screw in lead 50m+\- DS Forster
Description of point rock or location.

# Updated GCMRC Descriptions

- Point Description
  - 3CM X 3CM CHISELLED "X" ON LEDGE OF BLOCKY BASALT OUTCROP AT GROUND LEVEL. APPROXIMATELY .75 METER EAST OF EDGE. VERY VISIBLE X. Fd X IN BASALT LEDGE DS GALLOWAY
- Site Description
  - ON DEBRI FAN OF DUBINDORF AT BASE OF BASALT OUTCROP IMMEDIATELY DOWNSTREAM OF DRY WASH THAT OUTPUTS AT TOP OF RAPID. ON RIVER SIDE OF PRONOUNCED TRAIL 25 METERS NORTH OF WASH AND 44 METERS EAST OF RIVER.

Written directions on how to find the point using distances and bearings to obvious landmarks.

# Description cont.

- Survey Project Point is associated with
- GPS Cross Reference
- Field Ties
- Comments
- Images

Prj ID Field Survey Project	Book Page National Geodetic
	Survey Point ID:
Images 7 add/edit/view	National Geodetic
Document Ref	Survey US National
	Grid Designator:
GPS Cross Reference:	
Field Ties	
	ed to adjust NGVD29 📃 tum to NAVD88 Ellipsoid Datum 🚽

### Database Images

- Nadir images
- Oblique images

### add new photo



### Point

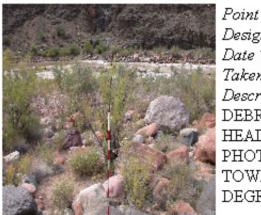
Designation: GR132266R Date Taken: 9/10/2003 Taken By: K. BROWN Description: NADIR



Point Designation: GR132266R Date Taken: 9/10/2003 Taken By: K BROWN Description: TOWARD MOUTH OF DRY WASH PHOTO TAKEN TOWARD 135 DEGREES

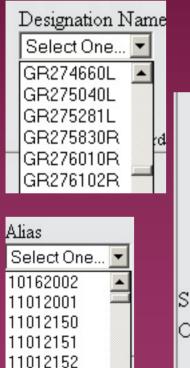


Point Designation: GR132266R Date Taken: 9/10/2003 Taken By: K. BROWN Description: FROM DRY WASH TOWARD CONTROL POINT PHOTO TAKEN TOWARD 40 DEGREES



Designation: GR132266R Date Taken: 9/10/2003 Taken By: K BROWN Description: ACROSS DEBRI FAN TOWARD HEAD OF RAPID PHOTO TAKEN TOWARD 255 DEGREES

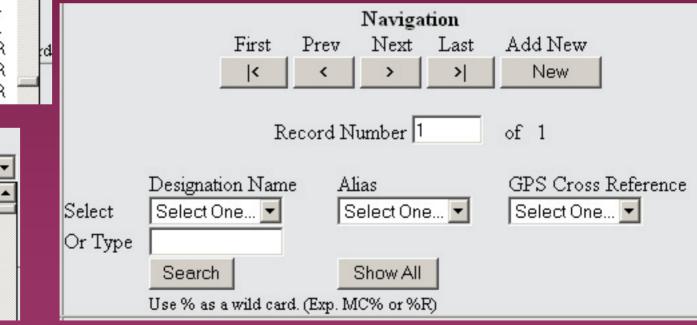
### Database Navigation and Query



11012153

11012154

- GCMRC Name
- Point Alias (GCES Name)
- GPS Cross Reference
- Using Wild Card Characters
- River mile
- Project



### Database Products

- Printed Output of Control Point Information
- Printed Output of Control Point Images
- Printed Control Point Atlas on Aerial Photographs
- Digital Control Point Atlas
- Web Interface to access Control Point Database
- Other needed products

			State Plane202	
Point Name (Designation):	GR132266R			
Point Alias: 8513003,		Horizontal	Vertical	
		Side Shot: Yes	DatumNAD 83 (1983) MethodConventional Survey	Conventional Survey
Station Mile: 132.266	Field Area: Grand Canyon	Traverse: No	Calc ByGCES	GCES
Station River Offset77.155	StateAZ	Hydro:No	Calc Date7/1/1994	7/1/1994
River SideRight		GPS:No	Network Relationship *	*****
2.22			Method	Value
POWELLE	DIATEAN	Accuracy Convention:	GEOID2002	
USGS 15 Quad: <sup>POWELL F</sup> NW	LATERO		GEOID1999WINTG.exe	-22.934
			GEOID1996 GEOID1990GEOID90.exe	-22.443
Coordinate			GEOID 1990 GEOID 90. exe	-22.443
	10010 NI23. /33			
Northing Meters: 59284		m ss.ss):36 20 39.33		
Easting Meters:16512	22.114 W Longitude (aa m	<b>m ss.ss):1</b> 12 27 14.64	Accuracy	
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Orthometric Ht. (m)*:608.13	•	ld.ddddd):112.45406666666667	Orthometric Ht.Error (m):	
Orthometric Ht. Datum:90		<b></b>	Northing Error: Latitude Error:	
	Hydro	Azimuth:	Longitude Error:	
Mapping Plane Scale Factor: 99992		d Factor: 9998404		
Ellipsoid (Elv.) Scale Factor: 9999	1171 Сонч	ergence:-0-19-06.56		
Ellipsoid (Elv.) Scale Factor: 9999	1171 Conv	егденсе:-0-19-06.56	Prj ID I	Field
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Description	X""" Coll		Book Page	National Geodetic Survey Point
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Description Monument Type"Chiselled ""2 Monument ConditionExisting or Re	X""" Coll	ected By Brown	Book Page Survey Project	National Geodetic Survey Point ID: National Geodetic Survey US
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Description Monument Type "Chiselled ""2 Monument ConditionExisting or Re Monument Set by UNKNOWN Set Date 3CM X 3CM 0	X""" Colle covered Collec CHISELLED "X" ON LEDGE OF B COXIMATELY 75 METER EAST (	ected By Brown ted Date	Book Page Survey Project Images 7 <u>edit/add/v</u> Document Ref ROUND CPS Curss	National Geodetic Survey Point ID: National Geodetic Survey US National Grid
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Printed Output Point DesignationGR132266RDate Taken9/10/2003Taken ByK. BrownDescriptionScribed XCompass Direction Nadir

oint DesignationGR132266ROcte Taken9/10/2003Taken ByK. BrownDescriptionFrom dry wash toward point - downstreamCompass Direction40



# Sample of Atlas

1:10,000 Scale for Reference

1:1,000 Scale for Locating Control Point







Future direction of the Control Point Database is to compile and include control points used by contractors, cooperators and other researchers.

- To make available the most complete control point database possible.
- To eliminate establishing multiple control points within close proximity of each other.
- To facilitate and expedite updating or establishing coordinate values for contractors, cooperators and other researchers.

