

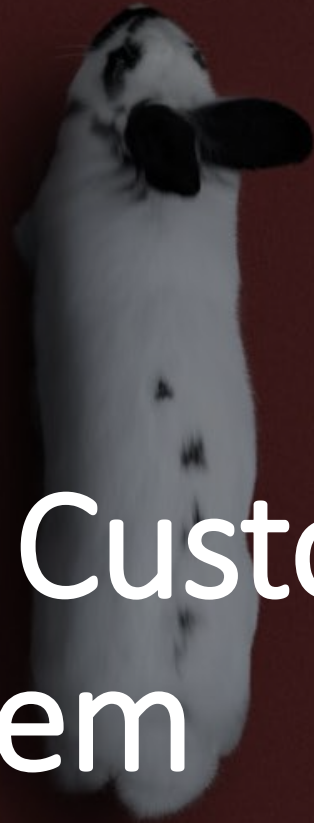
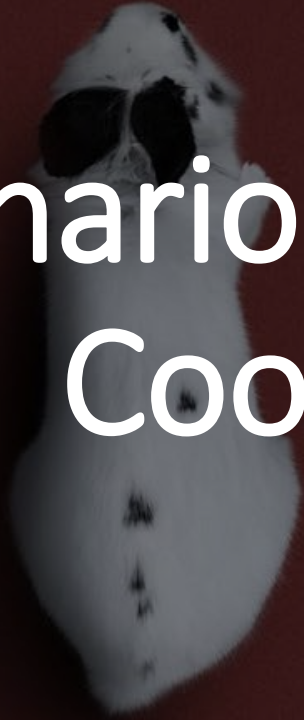
- Best Practice -

Custom Coordinate System in Kingdom 2021/2017

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Scenarios to Apply a Custom Coordinate System



Business/Operation Scenarios and Proposal

1. You are going to work on a dataset (seismic, well, or culture), which does not fall into any natively built-in Coordinate Reference Systems (“CRS”). Then you may position your datapoints **wrongly**.
2. You **failed** to import some well/seismic/culture data into your working project, due to the to-be-imported data bearing a different CRS against your working project.

Proposed Solution: Build a **Custom CRS**



2



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A Primer of Coordinate Systems

What's a Coordinate System?

Coordinate Reference System (CRS):

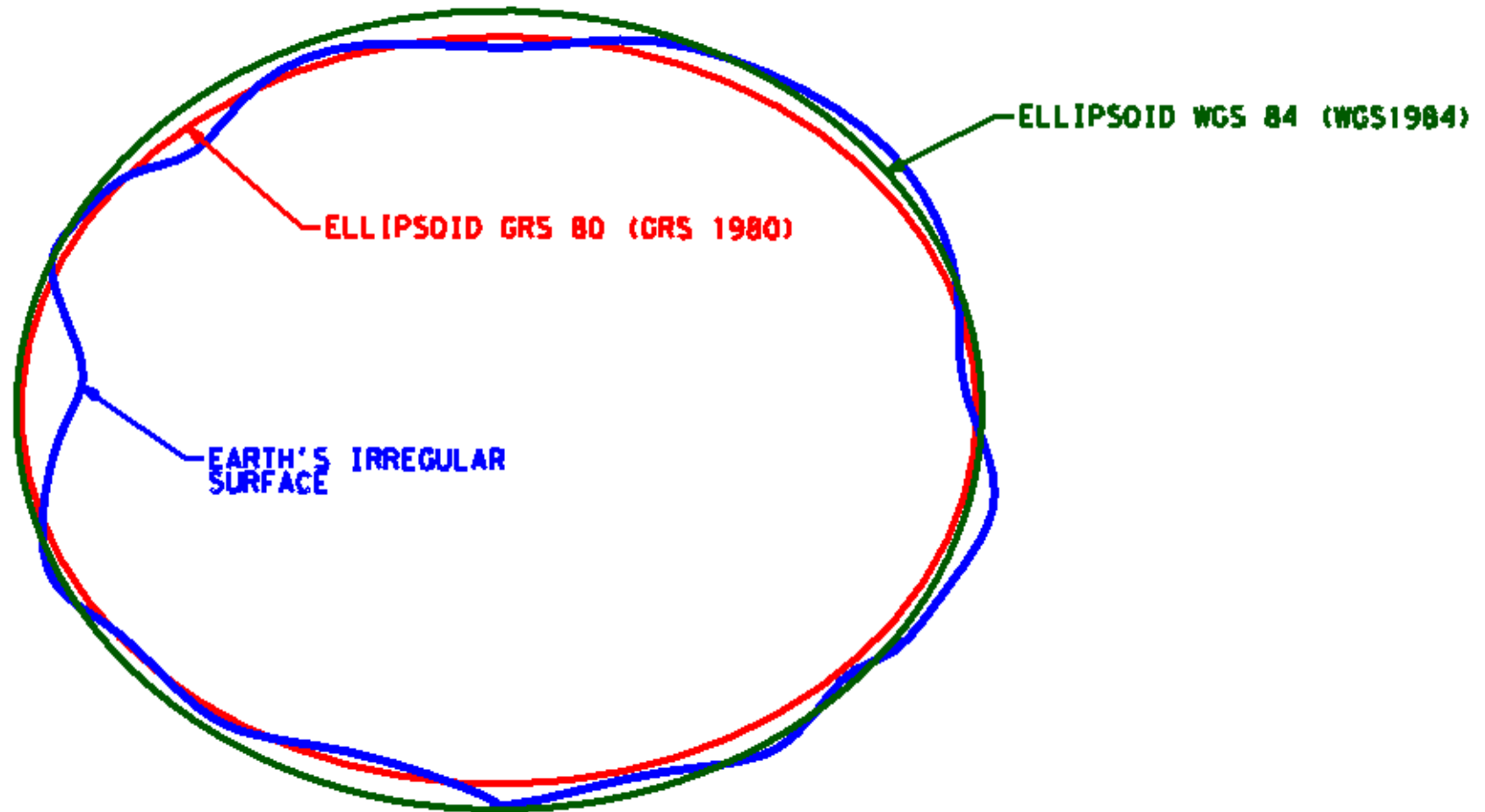
- **The mechanism to define, how the two-dimensional, projected map is related to real locations on the earth, with the help of coordinates.**

Two Types of CRS:

- **Geographic** Coordinate System: Latitude / Longitude
- **Projected** Coordinate System: X/Y values

Ellipsoid:-

a flattened three-dimensional ellipse with smooth surface to approximate the earth



Ellipsoid:-

a flattened three-dimensional ellipse with smooth surface to approximate the earth

Typically, an ellipsoid has its own specific parameters, such as, **semi-major axis** (a in meters), **semi-minor axis** (b in meters), and **inverse flattening** ($1/f = a/(a-b)$).

Ellipsoid	Semi-Major Axis a (m)	Semi-Minor Axis b (m)	Inverse Flattening 1/f
GRS80	6378137.000	6356752.314140356	298.257222101
WGS84	6378137.000	6356752.314245179	298.257223563
International 1924	6378388.000	6356911.946	297.000
Clarke 1880 (RGS)	6378249.145	6356514.870	293.465

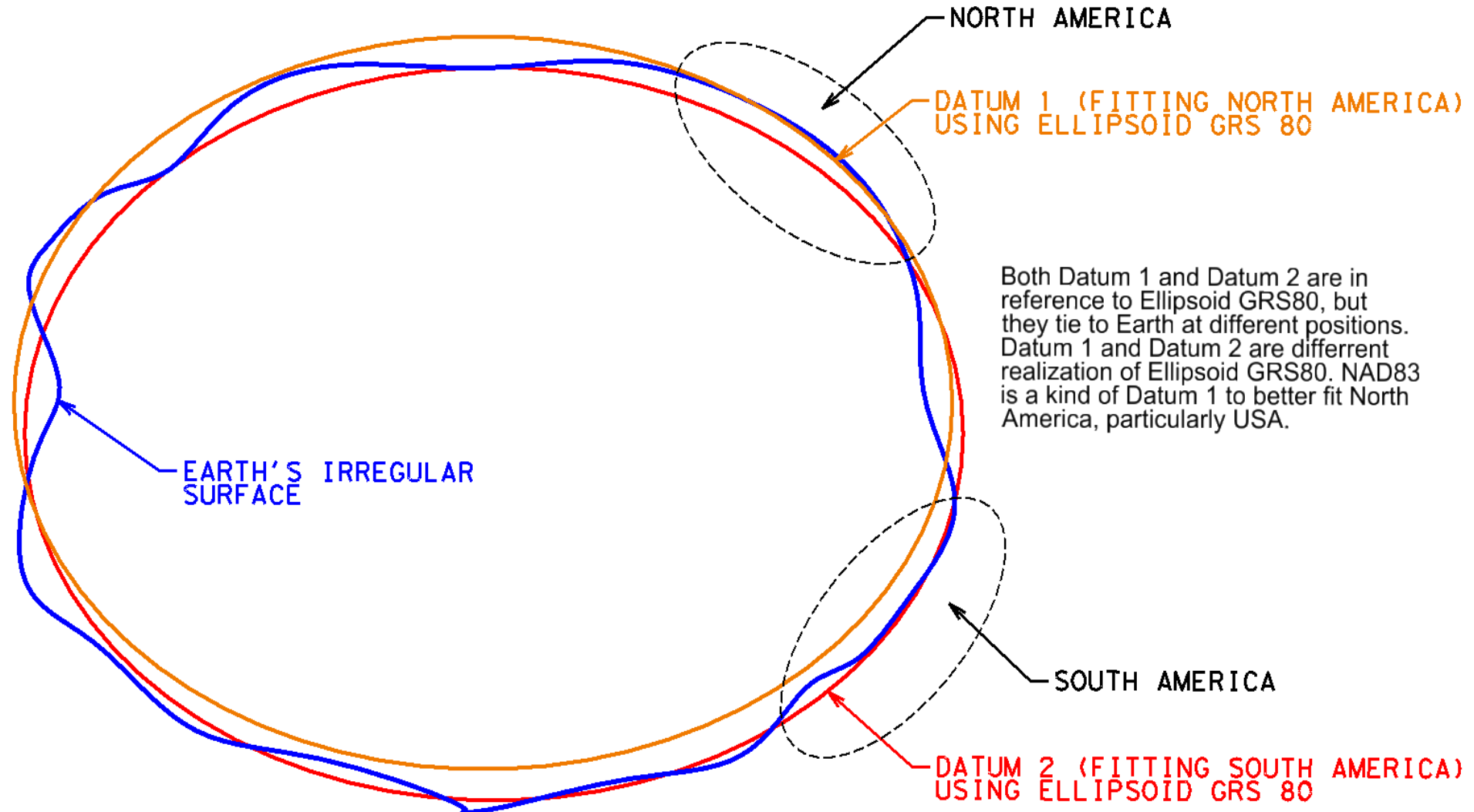
Datum:-

a model of the shape of the earth

- An ellipsoid has different realizations, which are different **ways to position itself relative to Earth depending on where its center is located**.
- **Each realization is called a datum** and therefore an ellipsoid may have different datums.
- Simply, a Datum is **a model of the shape of the earth** per se.
- Typical datum: **WGS84** (the name is same as its ellipsoid); **ED50** (its ellipsoid: International 1924/Hayford); **Nord Sahara** (its ellipsoid: Clarke 1880 RGS).

Datum:-

a model of the shape of the earth



Fun Fact -

Lat/Long values of a physical location differ from Datum to Datum.


Since longitude and latitude values are tied with datums, a location's longitude and latitude values in reference to Datum WGS84 are not same as in reference to Datum NAD83, nor Datum ED50.

City	WGS84		NAD83	
	Latitude	Longitude	Latitude	Longitude
Calgary, AB	51°02'55.0140"	-114°04'15.0456"	51°02'55.0045"	-114°04'15.0608"
St Louis, MO	38°37'37.211"	-90°11'57.847"	38°37'37.185"	-90°11'57.825"
Houston, TX	29°44'59.665"	-95°21'30.316"	29°44'59.646"	-95°21'30.290"
Pasadena, CA	34°09'22.007"	-118°07'54.995"	34°09'22.007"	-118°07'54.951"


Projection:-

the means by which you display the coordinate system and your data on a flat surface.

Mathematical calculations are used to convert the coordinate system used on the curved surface of earth to one for a flat surface.



A 3D element will **lose at least one of its three characteristics** – **angle**, **area**, and **distance** when being projected onto 2D surface, NO MATTER which projection method is used.



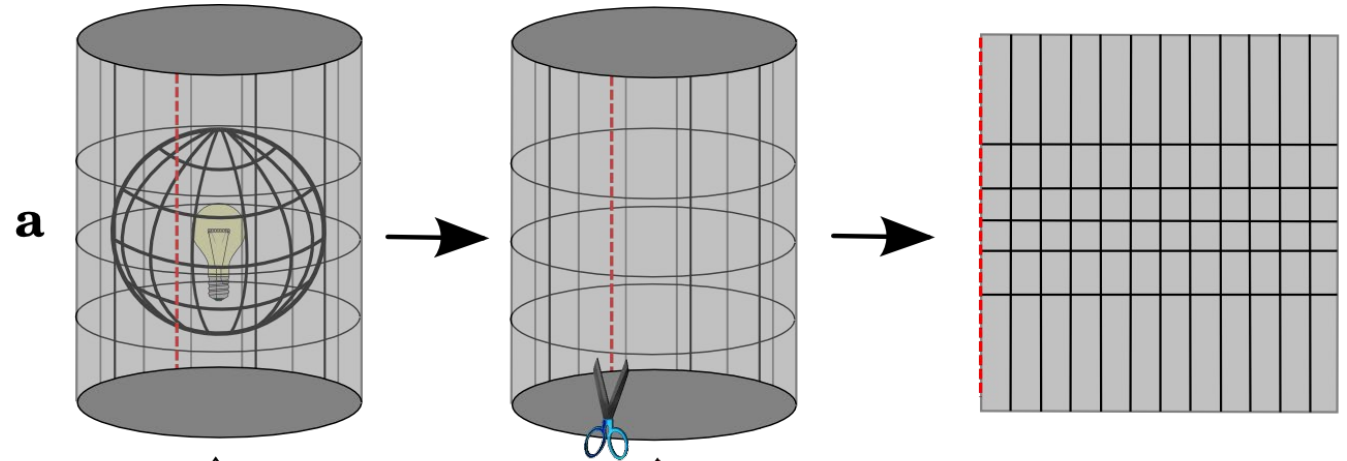
The coordinate system on 2D surface is called a Projected Coordinate System (“PCS”) with coordinate unit of foot, US foot, or meter.

Projection:-

3 Types of Projection Methods: Cylindrical, Conical, and Planar

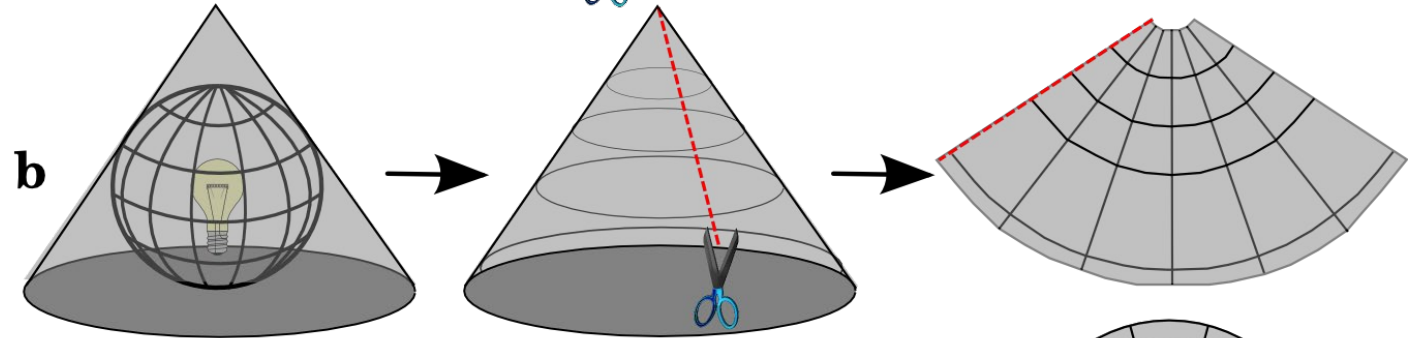
Universal Transverse Mercator →

Cylindrical
Mercator

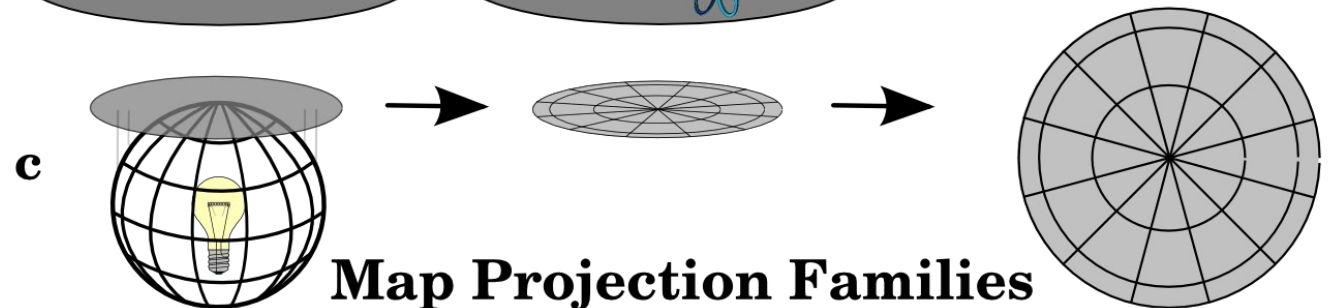


Lambert Conformal Conic →

Conical
Perspective



Planar
Orthographic



Map Projection Families

How to Create
Custom CRS in

IHS-Markit
Kingdom
2021/2017



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2



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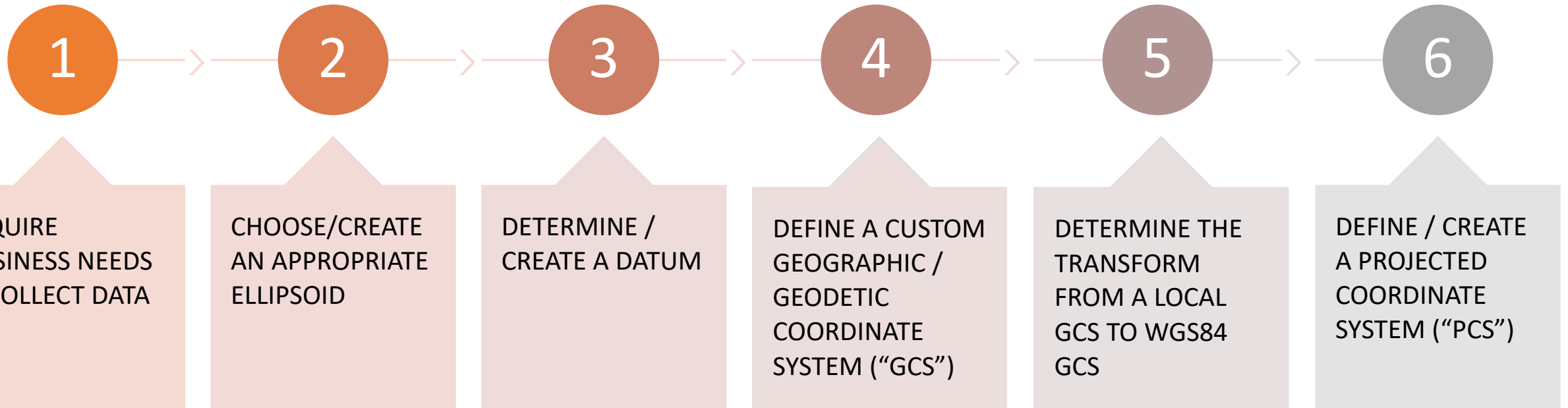


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Procedures to Create a Custom CRS in Any Application



(1) Inquire Business Needs & Collect Data

AGOCO Lambert Datum Using 2 Parallels

Ellipsoid	Clarke 1880
Projection	Lambert Conical Orthomorphic
Latitude of Origin	31° N
Longitude of Origin	18° E
Scale Factor @ the Origin	0.99938949
First Parallel	33° 00' 00"
Second Parallel	28° 59' 08.3"
False Northing	550,000m
False Easting	1,000,000m
Semi Major Axis	6,378,249.145m
Reciprocal Flattening (1/f)	296.465
Central Meridian	18° E
Zone	Libya North

1. A 3D Seismic cube of Concession NC-100 of west Libya has a projection of Lambert Conformal Conic ("LCC"), instead of the commonly used UTM Projection, and AGOCO-cooked Datum based on Clarke 1880 Ellipsoid.
2. Failed to load the seismic cube into Kingdom or Petrel due to lack of pre-defined Projected CRS related to that specific cube.
3. Plan to create a Custom Projected CRS ("PCRS") and Transform for converting or loading up such seismic cube into Kingdom 2021/2017.

(2) Choose/Create an Appropriate Ellipsoid

Launch Kingdom 2021 → "Project" → "Projections" → "Create" button

Open "Folder", then "Ellipsoids"; Comparing the ellipsoid params from AGOCO ("Clarke 1880") and the ellipsoid params in the table, then we shall choose "Clarke 1880 (RGS)" as our ellipsoid (EPSG:7012).

Create Custom Coordinate Systems

Folder

- Coordinate Systems
 - *All*
 - *Recent*
 - *Search History*
 - Geodetic
 - Projected
 - Ellipsoids**
 - *All*
 - *Recent*
 - *Search History*
 - Outdated (Deprecated)
- Horizontal Datums
 - *All*
 - *Recent*
 - *Search History*
 - HTDP
 - Outdated (Deprecated)
- Single Transformations

Display Name	Name	Semi Major(m)	Semi Minor(m)	Inverse Flattening	EPSG Code
3.0 Unit sphere, testing only	3.0 Unit sphere, ...	3	3	1e+32	
<None>					
Airy 1830	Airy 1830	6377563.396	6356256.90923729	299.3249646	7001
Airy 1849	Airy 1849	6377340.189	6356034.44789707	299.3249640174	
Airy Modified 1849	Airy Modified 1849	6377340.189	6356034.44793853	299.3249646	7002
Australian National Spheroid	Australian Nation...	6378160	6356774.71919531	298.249999999999	7003
Average Terrestrial System 1977	Average Terrestri...	6378135	6356750.30492159	298.257	7041
Bessel - NGO 1948	Bessel - NGO 1948	6377492.018	6356173.50851611	299.1528100414	
Bessel 1841	Bessel 1841	6377397.155	6356078.96281819	299.1528128	7004
Bessel Modified	Bessel Modified	6377492.018	6356173.5087127	299.1528128	7005
Bessel Namibia (GLM)	Bessel Namibia (G...	6377483.86528043	6356165.38324582	299.15281280001	7046
CGCS2000	CGCS2000	6378137	6356752.31414036	298.257222101	1024
Clarke 1858	Clarke 1858	6378293.64520883	6356617.98767991	294.260676369251	7007
Clarke 1866	Clarke 1866	6378206.4	6356583.8	294.978698213898	7008
Clarke 1880	Clarke 1880	6378249.14480808	6356514.9662042	293.46630765564	7034
Clarke 1858 (AUSLIG)	Clarke 1858 (AUS...	6378293.645	6356617.93764936	294.26	
Clarke 1858 - 1	Clarke 1858 - 1	6378293.639	6356617.98175962	294.26068	
Clarke 1866 Authalic Sphere	Clarke 1866 Auth...	6370997	6370997	1e+32	7052
Clarke 1880 (Arc)	Clarke 1880 (Arc)	6378249.145	6356514.96639875	293.4663077	7013
Clarke 1880 (Benoit)	Clarke 1880 (Ben...	6378300.789	6356566.435	293.466315538981	7010
Clarke 1880 (Benoit)	Clarke 1880 (Ben...	6378300.79	6356566.42965924	293.4662299695	
Clarke 1880 (IGN)	Clarke 1880 (IGN)	6378249.2	6356515	293.466021293627	7011
Clarke 1880 (international foot)	Clarke 1880 (inte...	6378306.36960005	6356571.99600004	293.466307655625	7055
Clarke 1880 (RGS)	Clarke 1880 (RGS)	6378249.145	6356514.86954978	293.465	7012
Clarke 1880 (SGA 1922)	Clarke 1880 (SGA...	6378249.2	6356514.99694178	293.46598	7014

Search

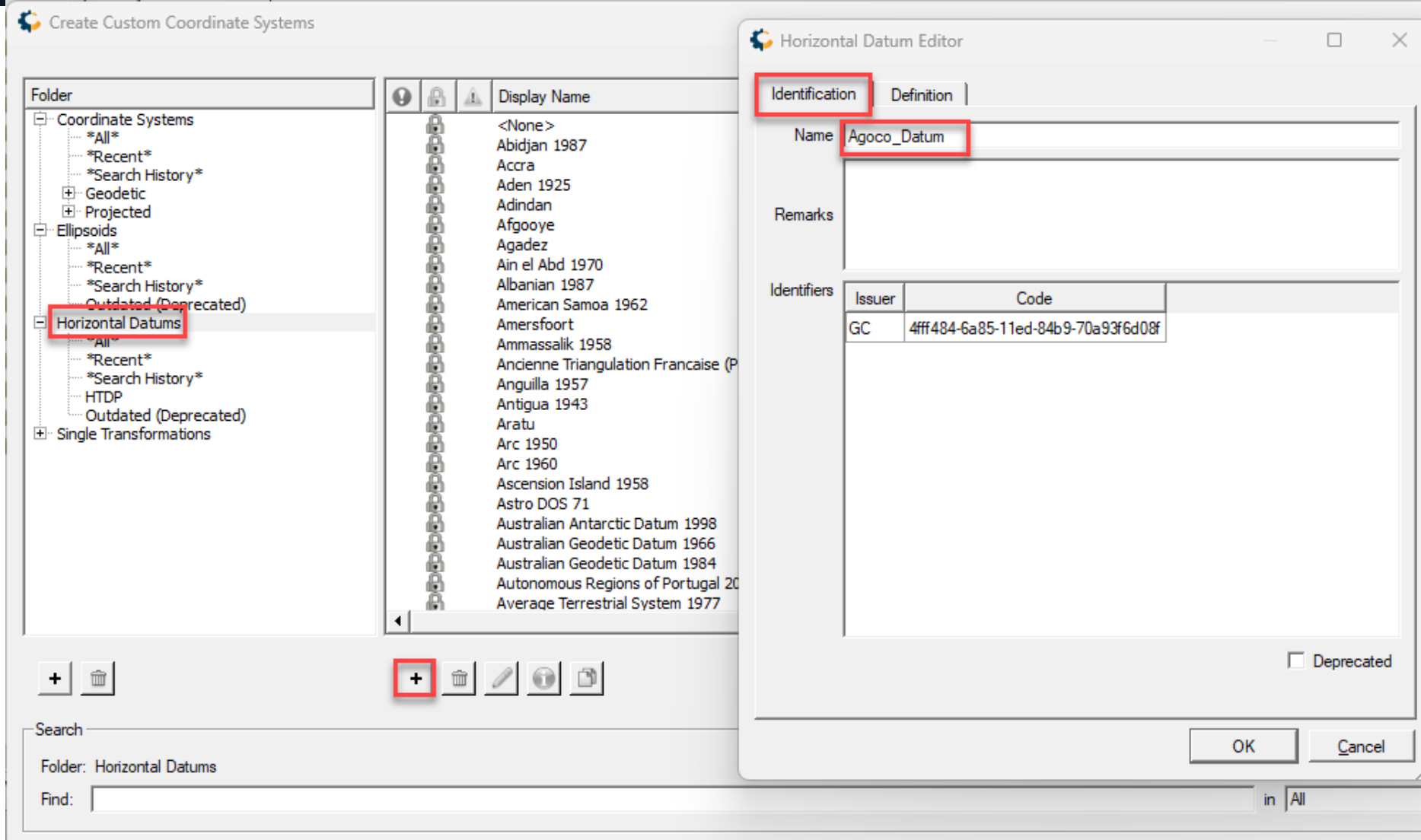
Folder: Ellipsoids

Find:

Semi Major Axis	6,378,249.145m
Reciprocal Flattening (1/f)	296.465

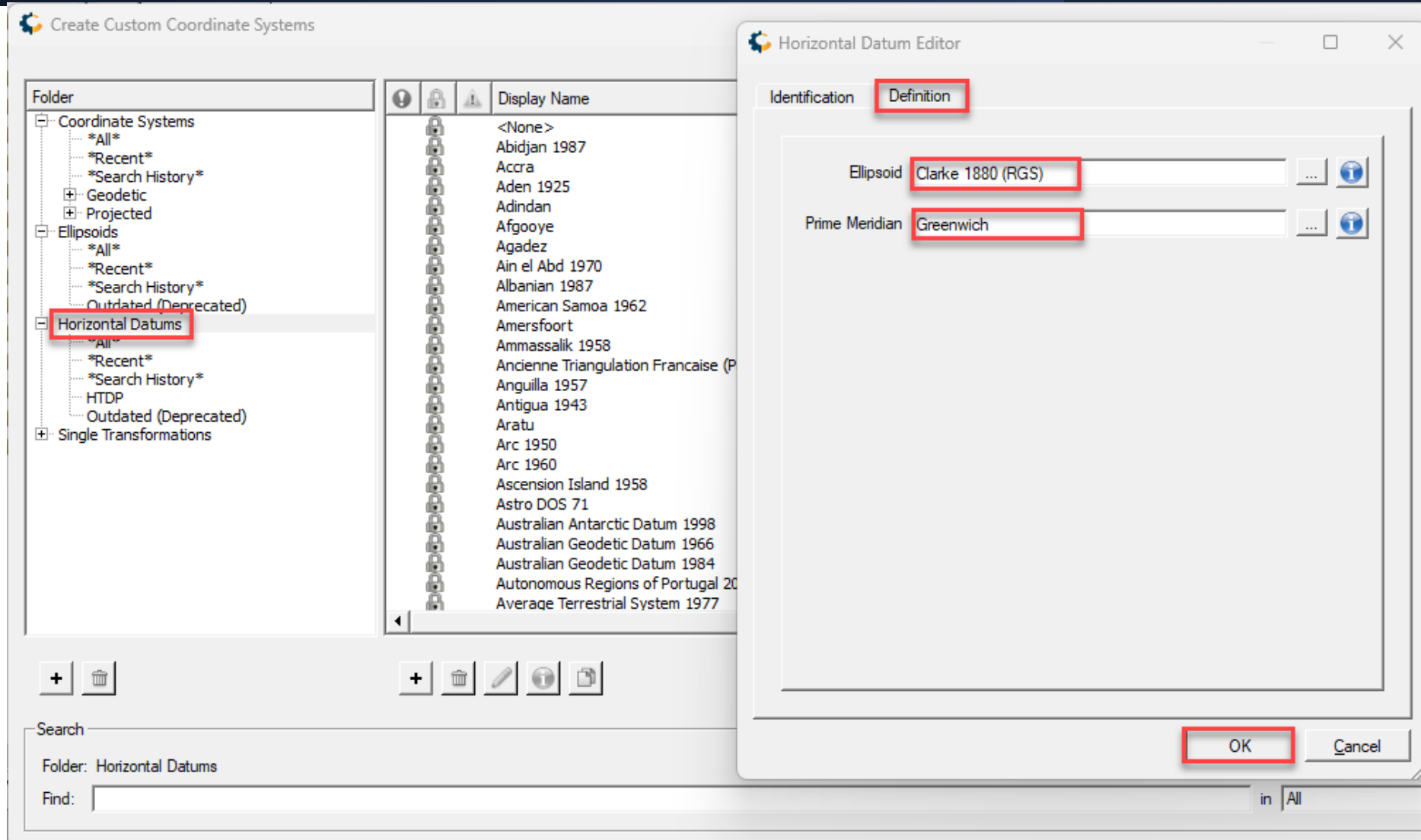
(3A) Determine/Create a Custom Datum

Horizontal Datums → Click “+” sign → Name it as “Agoco_Datum” at “Identification” tab



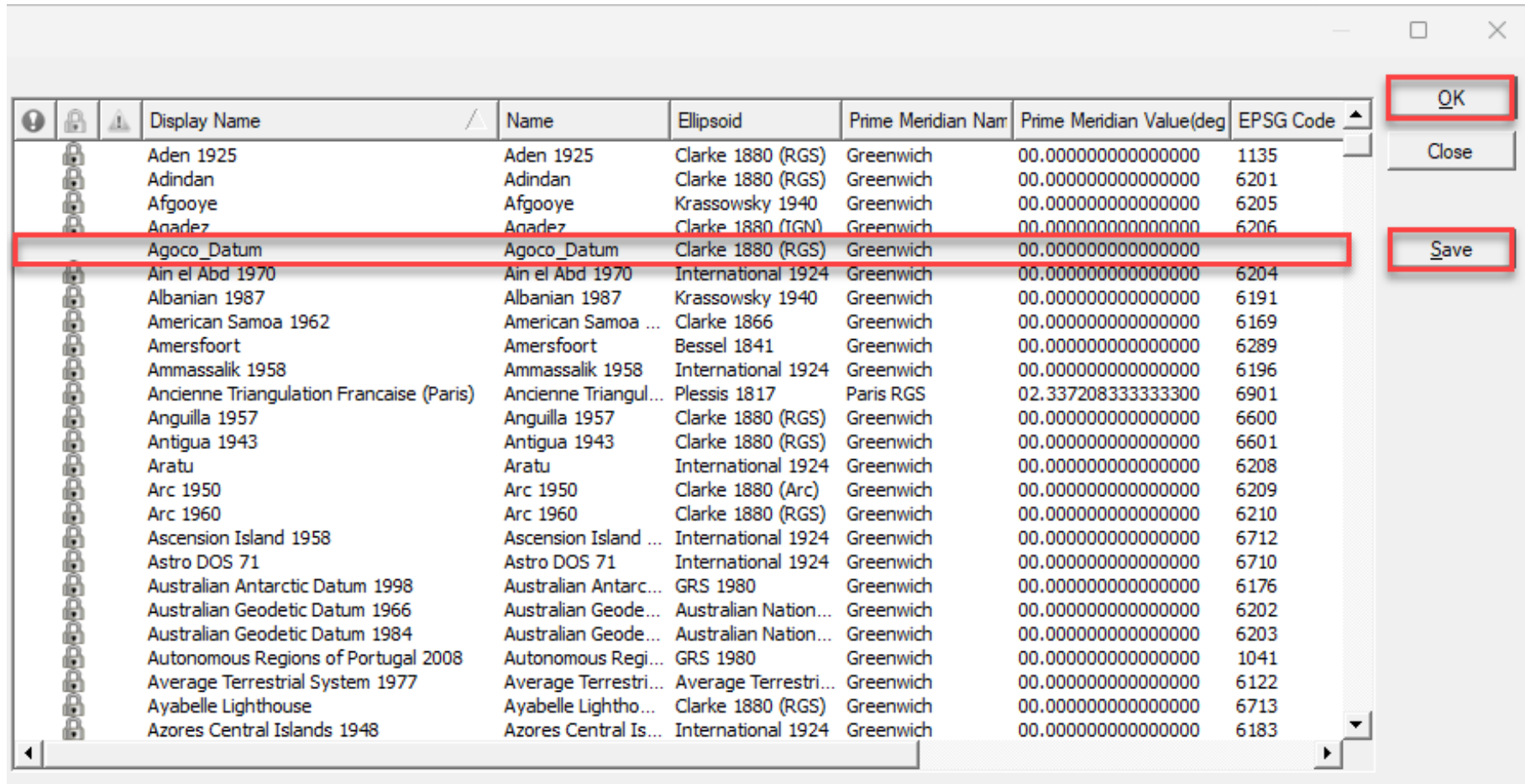
(3B) Determine/Create a Custom Datum

Switch to “Definition” tab → Pick up “Clarke 1880 (RGS)” as Ellipsoid and “Greenwich” as Prime Meridian → Click “Ok” to save the selections and return.



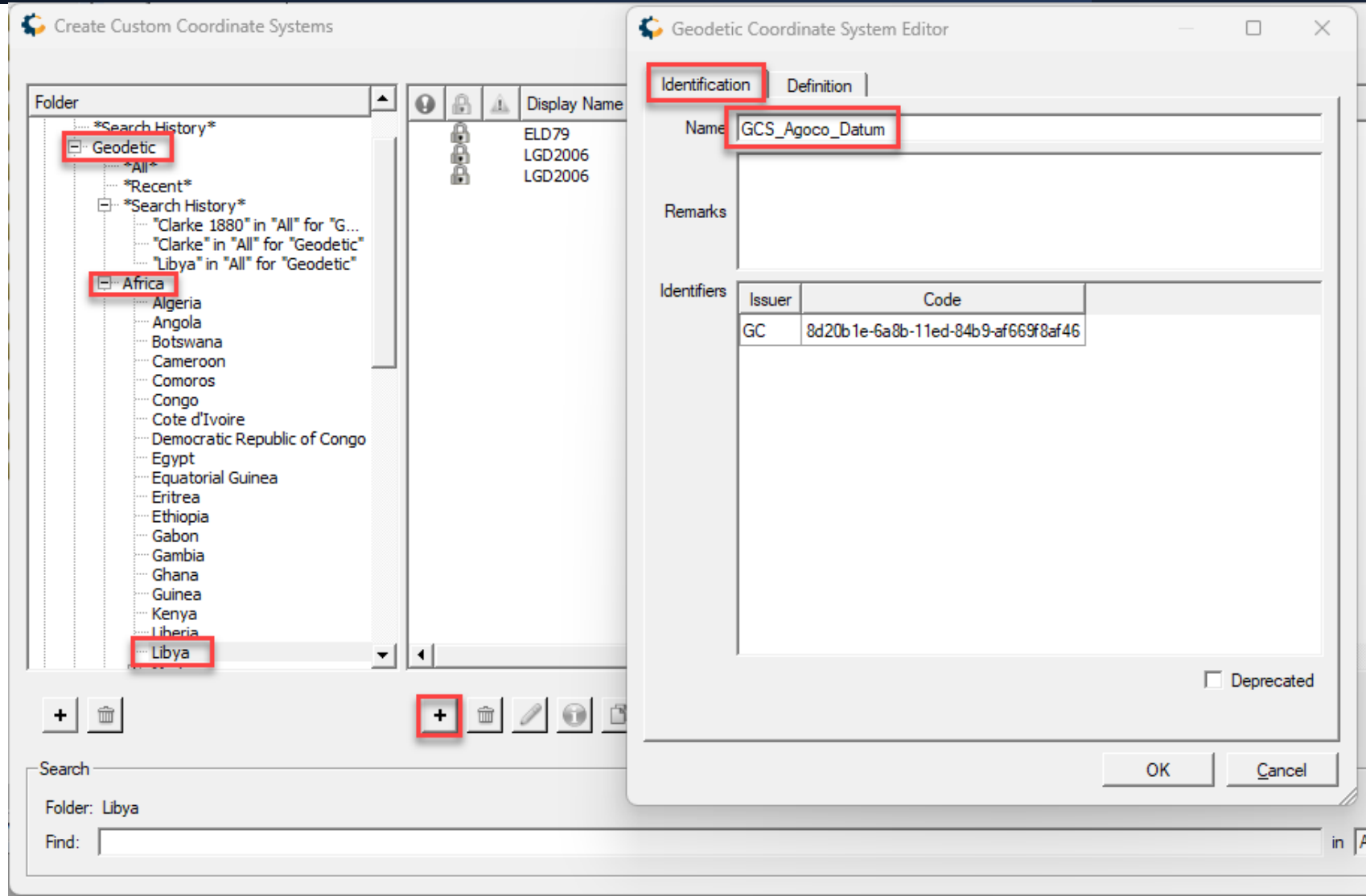
(3C) Determine/Create a Custom Datum

Check the new Datum is listed in place → Click “Save” button to save the custom Datum.



(4A) Define a Custom Geodetic Coordinate System (“GCS”)

Expand “Geodetic”, “Africa”, “Libya” → Click “+” sign → Name the Geodetic CS as “GCS_Agoco_Datum” at “Identification” tab.



(4B) Define a Custom Geodetic Coordinate System (“GCS”)

Switch to “Definition” tab → Pick up “Libya” as Area of Use, “Ellipsoidal 3D CS” as Point Style and the Custom “Agoco_Datum” as Datum. Then return to the main window to click “save” and “OK” buttons.

The screenshot shows the 'Geodetic Coordinate System Editor' window with the 'Definition' tab selected. The 'Area Of Use' is set to 'Libya', the 'Point Style' is 'Ellipsoidal 3D CS. Axes: latitude, longitude, ellipsoid', and the 'Datum' is 'Agoco_Datum'. Each of these three fields is highlighted with a red rectangular box.

Please note: the Ellipsoidal CS Point system shall bear an **EPSG code: 6422 (2D) or 6423 (3D)**.

EPSG 6422/6424 is a 2D geographic Point System and it's good for most of the cases.

EPSG 6423/6426 is a 3D geographic Point System, bearing the ability for Vertical Datum transform, which is a very rare case though;

The screenshot shows the 'Create Custom Coordinate Systems' window. On the left, a tree view shows a folder structure with 'Africa' expanded, listing countries like Algeria, Angola, Botswana, and Cameroon. The main table lists several coordinate systems. The row for 'GCS_Agoco_Datum' is highlighted with a red rectangular box. On the right side of the window, the 'OK', 'Close', and 'Save' buttons are also highlighted with red rectangular boxes.

Folder	Display Name	Name	Datum	Units	Area of Use
	FLD79	FLD79	European Libyan	Degree	Libya
	GCS_Agoco_Datum	GCS_Agoco_Datum	Agoco_Datum	Degree	Libya
	LGD2006	LGD2006	Libyan Geodetic ...	Degree	Libya
	LGD2006	LGD2006	Libyan Geodetic ...	Degree	Libya

(5) Determine the transform from a local GCS to WGS84 GCS

Every built-in or custom Geographic Coordinate System (“GCS”) can be functional ONLY through the “Hub” of all Coordinate Systems – the WGS84.

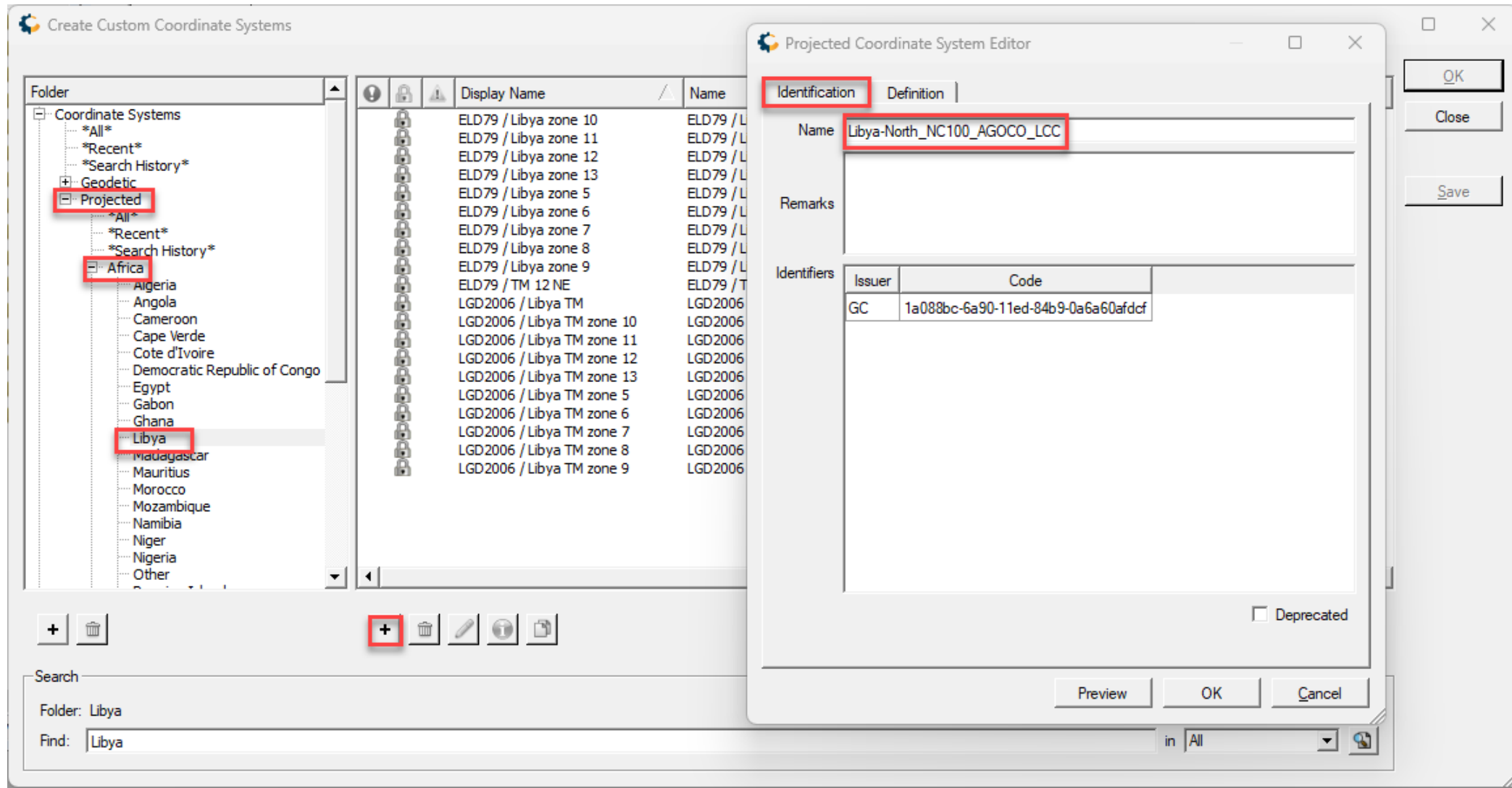
In ArcGIS, Blue Marble Geographics, Petrel and other applications, the transform parameters (3-param or 7-param method) must be specified explicitly.

IHS Kingdom has a black-box mechanism to transform the Custom GCS to WGS84 GCS as far as the former is based upon any built-in ellipsoid (and it has to be that way). That’s why Kingdom works very well with the build-in ellipsoid and its derived datums.

Since our Custom Datum is based on “Clarke 1880 (RGS)”, the transform is to be taken care of by Kingdom behind the scene.

(6A) Define / Create a Projected Coordinate System (“PCS”)

Expand “Projected” > “Africa” > “Libya” → Click “+” sign → at “Identification” tab: Name the Projected CS as “Libya-North_NC100_AGOCO_LCC” or anything you like.



(6B) Define / Create a Projected Coordinate System (“PCS”)

Switch to “Definition” tab → Pick up “Libya” as Area of Use, “Projected Point in Meters (EPSG: 4461)” as Point Style, the custom “GCS_Agoco_Datum” as Geodetic, “Lambert Conformal Conic [EPSG: 9802]” as Projection, then fill in the table.

The screenshot shows the 'Projected Coordinate System Editor' dialog box with the 'Definition' tab selected. The following fields are highlighted with red boxes:

- Area of Use: Libya
- Point Style: Projected Point in Meters
- Geodetic: GCS_Agoco_Datum
- Projection: Lambert Conformal Conic [EPSG: 9802]

Below these fields is a table with the following data:

Parameter	Value	Units
Longitude of false origin	18	Degree
Easting at false origin	1000000	Meter
Northing at false origin	550000	Meter
Latitude of false origin	31	Degree
Latitude of 1st standard parallel	33	Degree
Latitude of 2nd standard parallel	28.985639	Degree

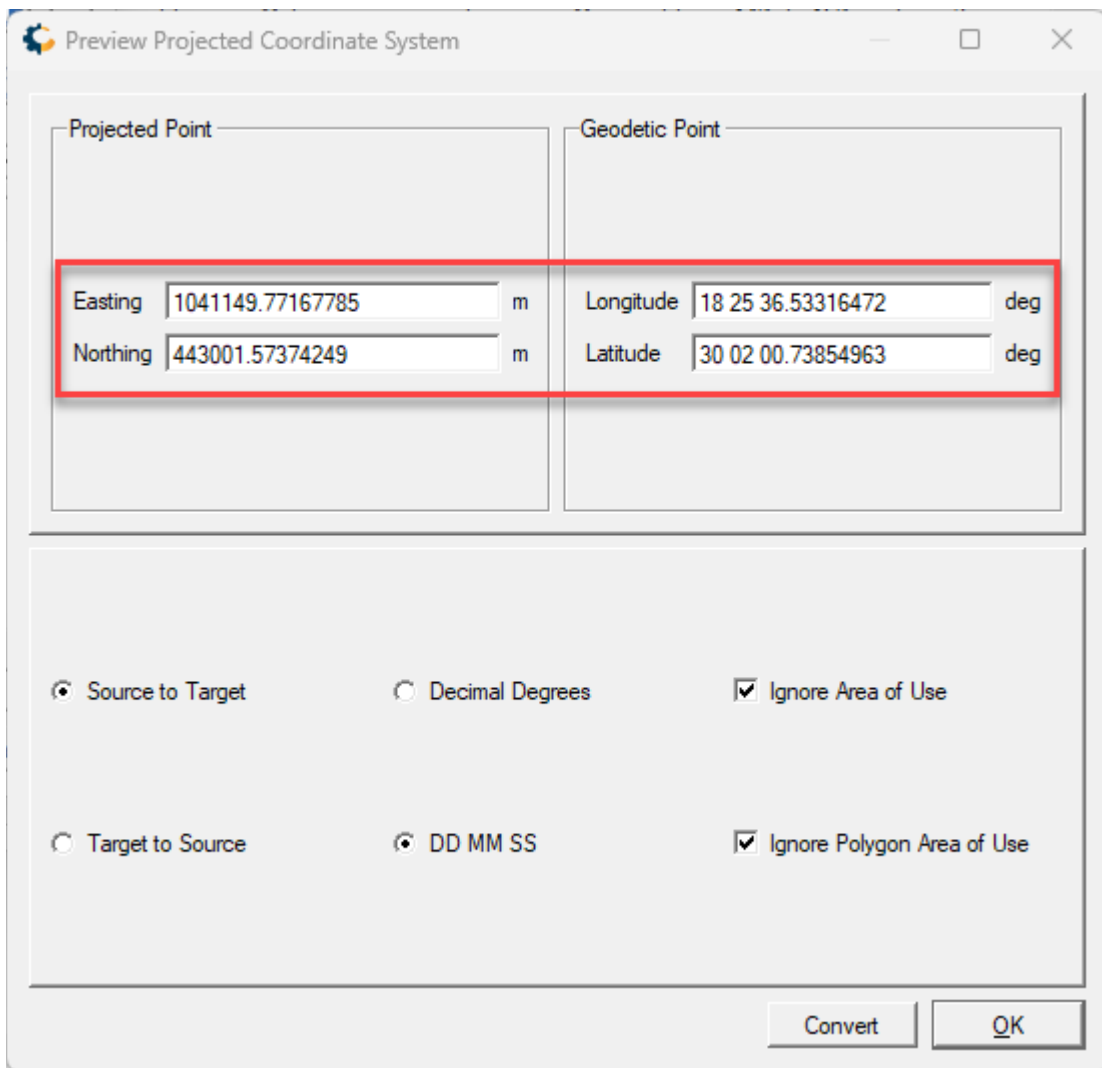
At the bottom of the dialog, the 'Preview' button is also highlighted with a red box.

For the Projection Method, you can pick up “Lambert Conformal Conic [EPSG: 9801]”, which is for the 1-standard-parallel LCC (tangent). That does not fall into our case.

Click “Preview” button to take a look into how good your custom Projected CRS is. The details are demonstrated in next slide.

(6C) Define / Create a Projected Coordinate System (“PCS”)

The results at Preview window (Left) demonstrates a very precise conversion versus the results from Petrel (Right). Then return to the main window, click “Save” and “Ok” button to save everything.



Preview Projected Coordinate System

Projected Point

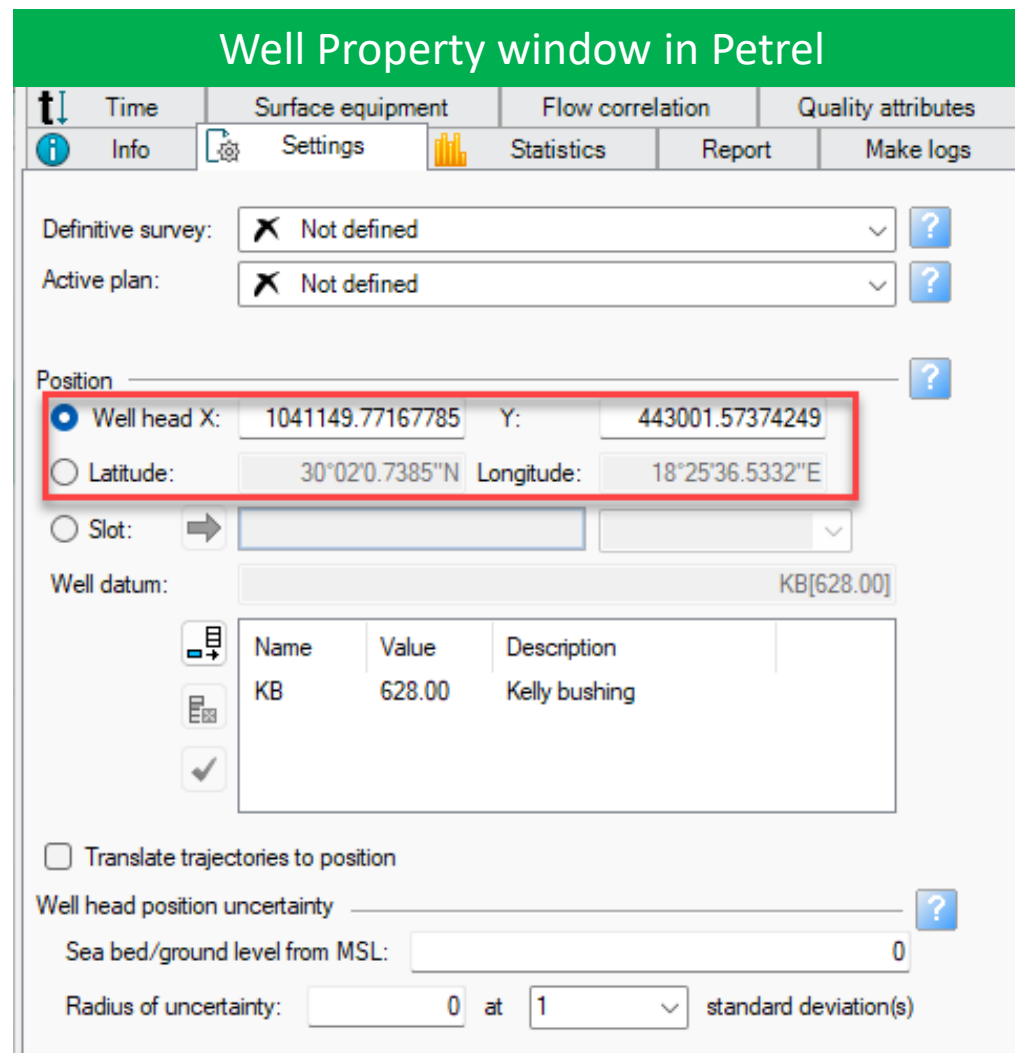
Geodetic Point

Projected Point	Geodetic Point
Easting: 1041149.77167785 m	Longitude: 18 25 36.53316472 deg
Northing: 443001.57374249 m	Latitude: 30 02 00.73854963 deg

☒ Source to Target ☐ Decimal Degrees ☒ Ignore Area of Use

☐ Target to Source ☒ DD MM SS ☒ Ignore Polygon Area of Use

Convert OK



Well Property window in Petrel

Time Surface equipment Flow correlation Quality attributes

Info Settings Statistics Report Make logs

Definitive survey: ?

Active plan: ?

Position ?

☒ Well head X: 1041149.77167785 Y: 443001.57374249

☐ Latitude: 30°02'0.7385"N Longitude: 18°25'36.5332"E

☐ Slot: →

Well datum: KB[628.00]

Name	Value	Description
KB	628.00	Kelly bushing

☐ Translate trajectories to position

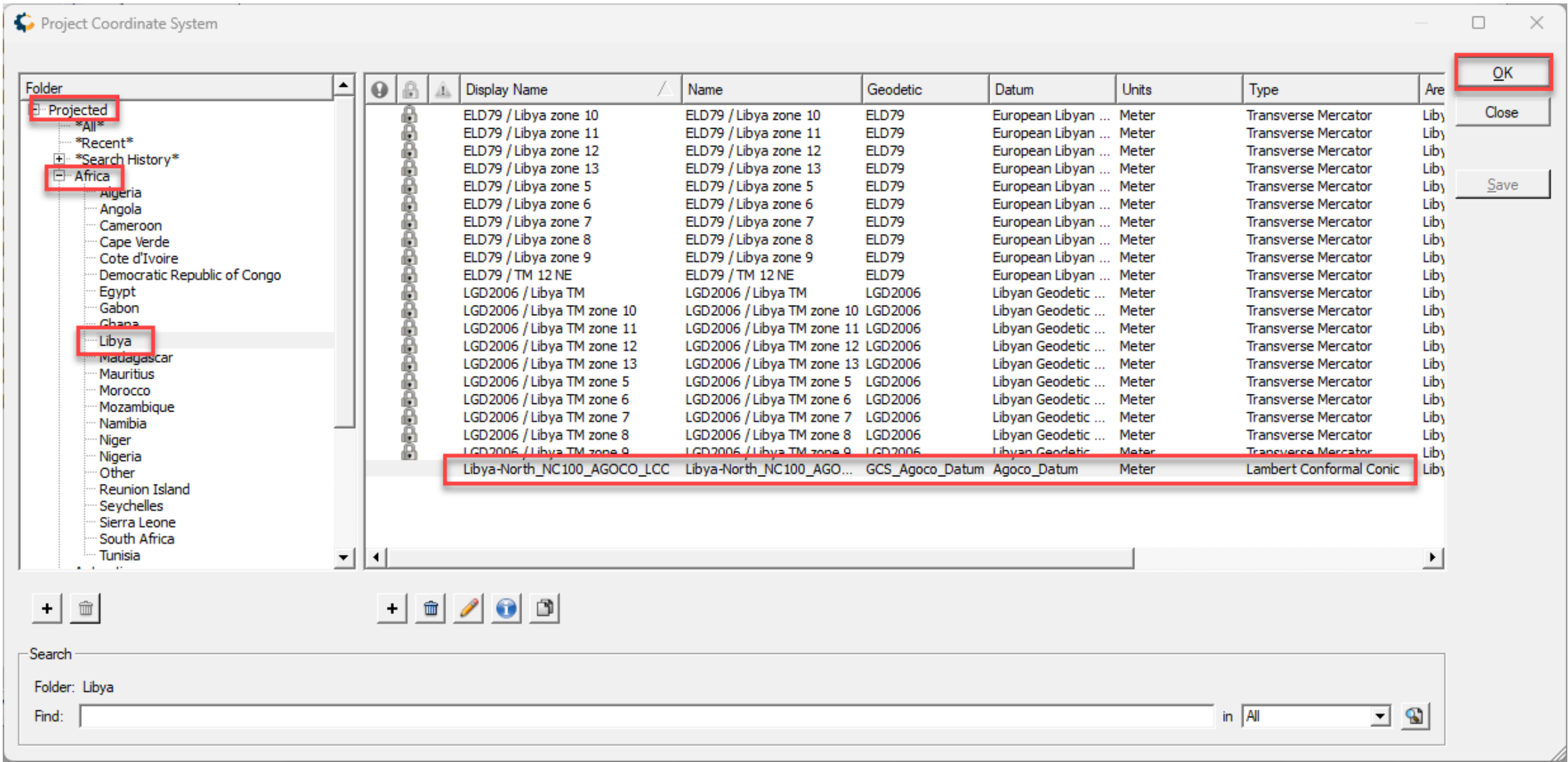
Well head position uncertainty ?

Sea bed/ground level from MSL: 0

Radius of uncertainty: 0 at 1 standard deviation(s)

Lastly set the Projected CRS for the project

Launch Kingdom 2021 → Click “Project” > “Projections” > “Set” and select “Libya-North_NC100_AGOCO_LCC”.



Conclusions: Custom CRS is Doable/Applicable in Kingdom

Application / Version	Able to Customize Coordinate System?
Kingdom 2021	Yes, tested Okay, results verified against Petrel/ArcGIS.
Kingdom 2017	Yes, tested Okay, results verified against Petrel/ArcGIS.
Kingdom 8.8	Yes, tested Okay.

Note: Coordinate Reference System (“CRS”) and Coordinate System (“CS”) are interchangeably used in line with the industry practice.

The End



References

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ArcGIS website	www.arcgis.com
Blue Marble Geographics	www.bluemarblegeo.com
Wikipedia	www.wikipedia.org
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