



Understanding Data Alignment through BC's Datums and Transformations

Organized by:

ParcelMap BC Adoption Working Group

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Part of the ICI Society's
Virtual Café series

Welcome & Opening Remarks

Workshop

A [ParcelMap BC Adoption Working Group](#) resource, presented as part of the ICI Society Virtual Café series

Understanding Data Alignment through BC's Datums and Transformations

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Understanding Data Alignment Through BC's Datums and Transformations

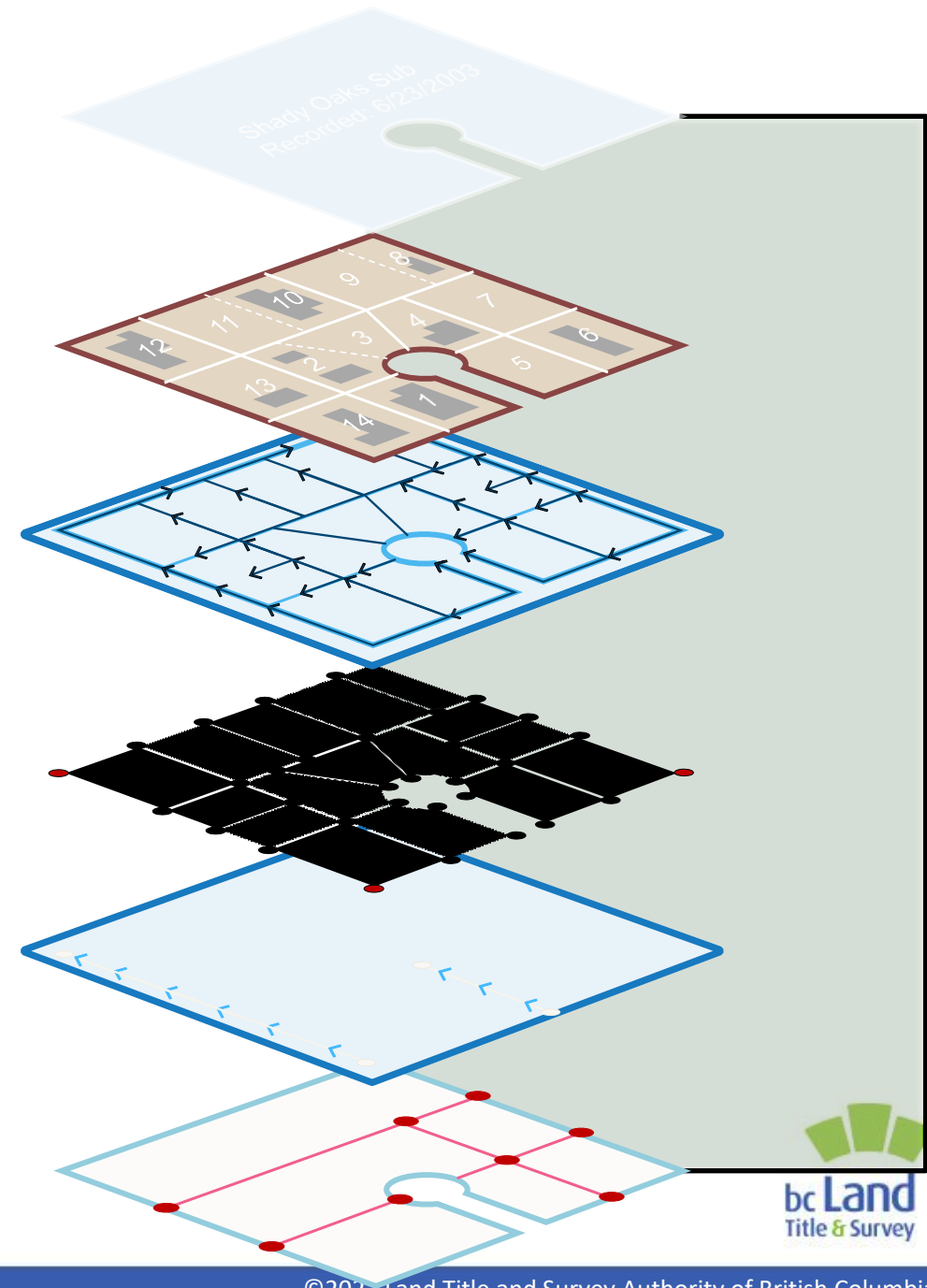
Virtual Cafe Presentation

February 22, 2023



Agenda

- Overview of Datums and Transformations in BC
 - Drawing on a “common canvas”
- Understanding Datums and Datum Transformations
 - Datums
 - Datum transformations
 - Impact of incorrect datum
- Grid Shift Files
- Common Issues and Pitfalls
- Q&A/Open Discussion



Overview of Datums and Transformations in BC

Overview of Datums and Transformations in BC

Historical Datums of British Columbia

North American Datum (NAD) 1927 (NAD27)

NAD 1983 (NAD83)

World Geodetic System (WGS) 1984 (WGS84)

Network Maintenance Integration Project (NMIP) 1993 (NMIP93 – NAD83 Adopted / Original)

International Terrestrial Reference Frame (ITRF)
1994-

NAD83 Canadian Spatial Reference System (CSRS)
1998-

Canadian Geodetic Vertical Datum (CGVD) 1928

Canadian CGVD 2013

North American Terrestrial Reference Frame (NATRF) 2022 (NATRF 2022)

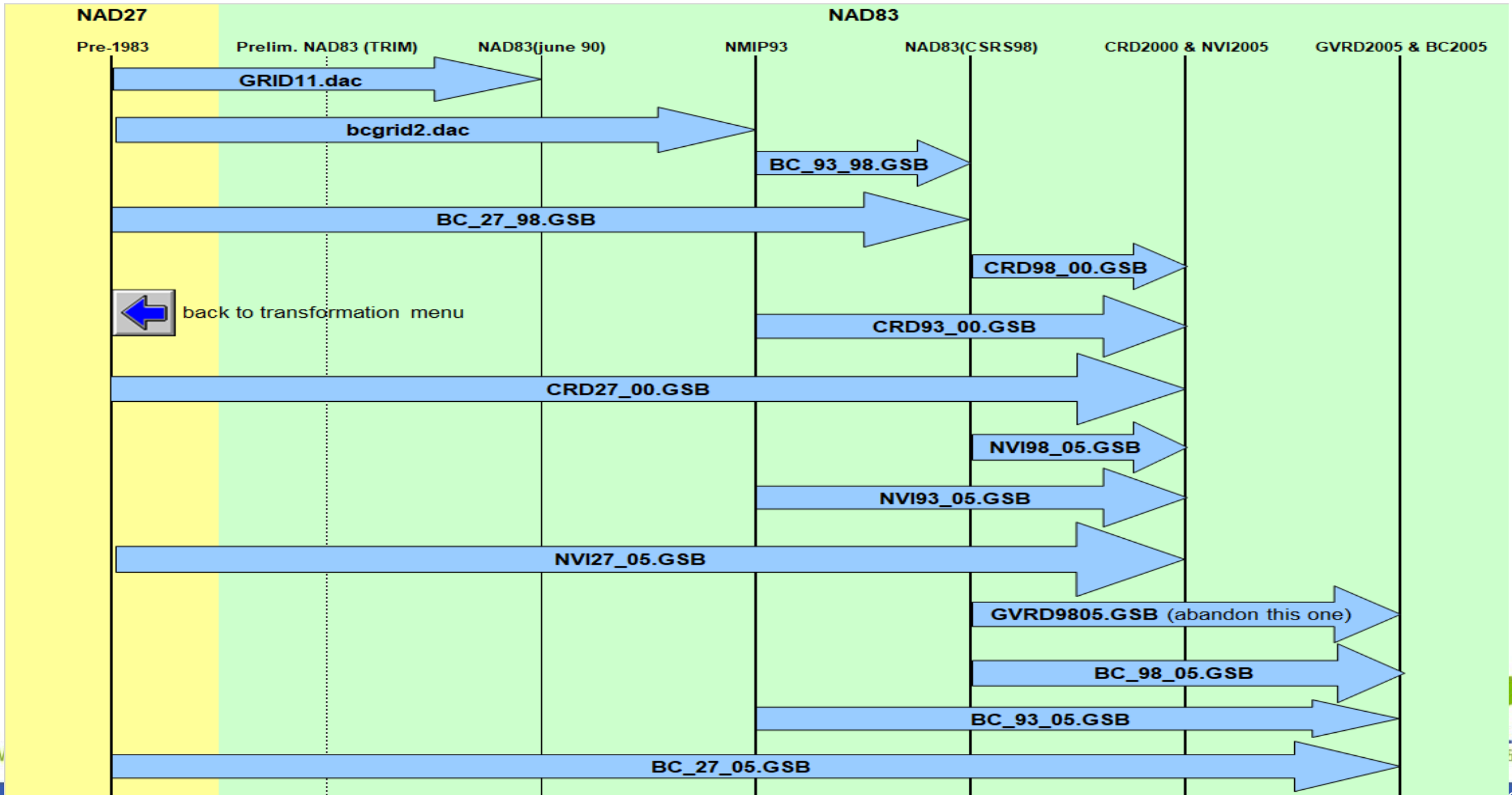


CSRS Versions

<u>Version(epoch)</u>	<u>Frame</u>	<u>Adopted</u>	<u>Based on</u>
V0 Original		1986-1993	Horizontal adjustments
v1 (1997.0)	CSRS96	1996	Transformation from ITRF94
v2 (1997.0)	CSRS98/CSRS	1998	Transformation from ITRF96 *
v3 (1997.0)		2000	Transformation from ITRF97 (first complete CBN)
v4 (2002.0)		2002	Transformation from ITRF2000
v5 (2006.0)		2009	Transformation from ITRF2005
v6 (2010.0)		2012	Transformation from ITRF2008
v7 (2010.0)		2019	Transformation from ITRF2014

* definition of NAD83(CSRS=CSRS98)

BC Transformations



Drawing on a “common canvas”

Which datum to select?

- Depends on use

What are other government agencies/partners using?

- 3 datums due to high amount of tectonic shift for Victoria/Vancouver Island
- Borders with Alberta, US, Yukon, Indigenous & First Nations
- US also plan to develop new datum

For what purpose is the data going to be used?

- Accuracy, alignment

Minimize transformations on the fly where possible

- Projections easier than transformations
- Parametric easier than grid shift
- Avoid invoking the “wrong” transformation accidentally (or no transformation at all)

Understanding Datums and Datum Transformations

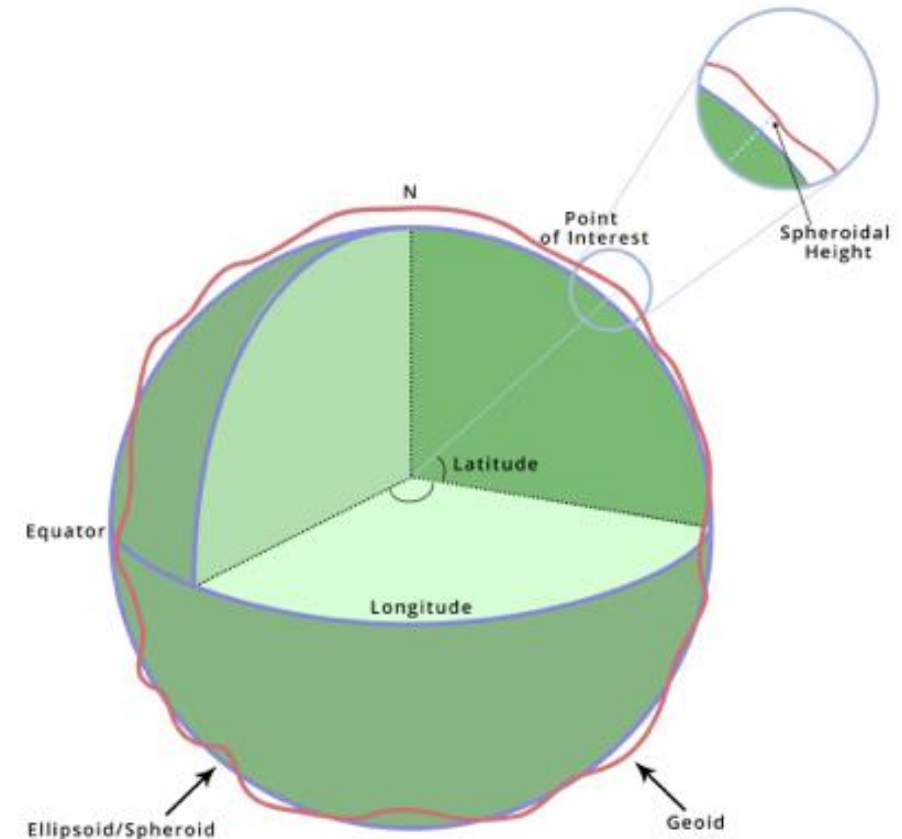
Datums

A model of a geographic area used for approximating the earth's surface on a mapping surface

A datum provides a consistent reference frame for location

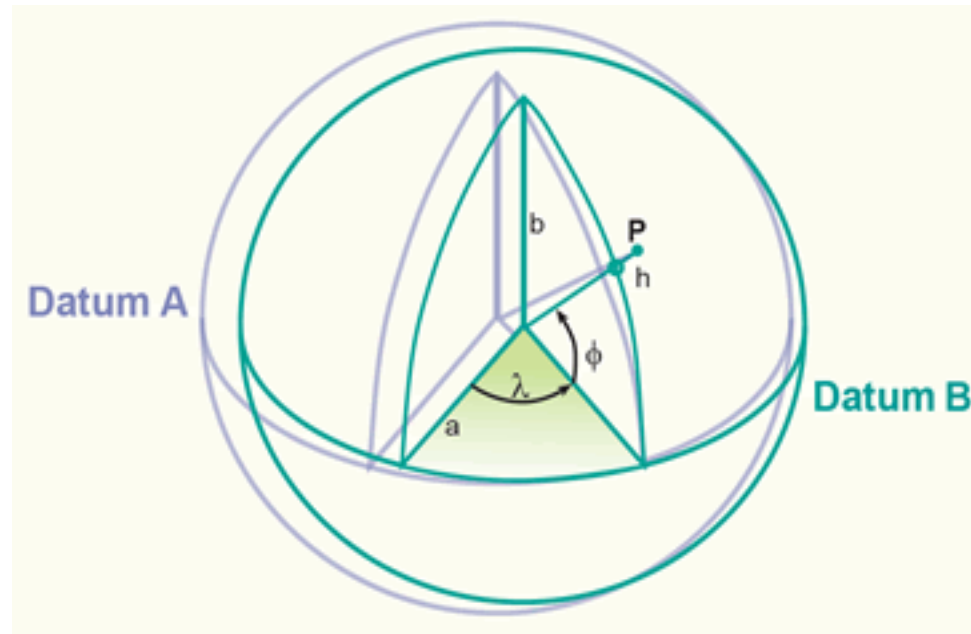
Includes reference geoid/ellipsoid, origin, and control

Different than projection, many projections can still use the same datum



Datums (cont.)

- Spatial point of reference that provides consistency and accuracy for all users



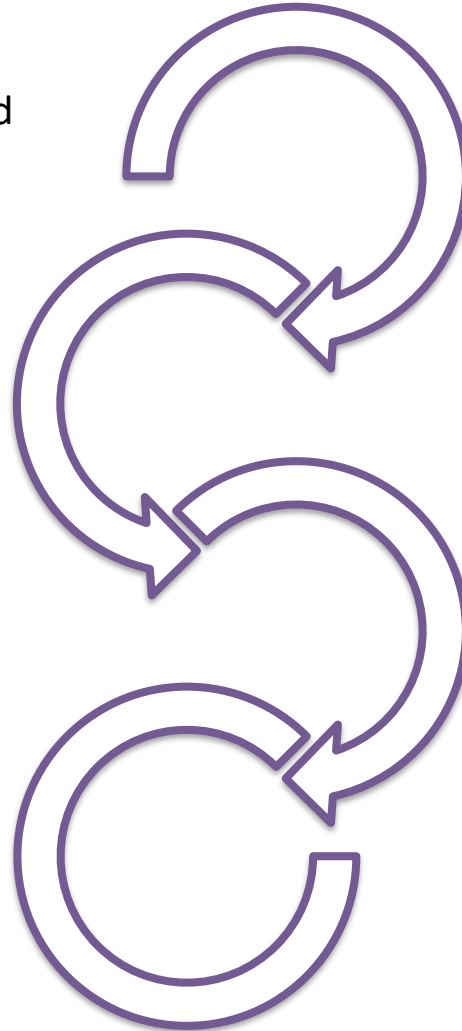
Datum transformations

Converts coordinates to X,Y,Z earth-centered coordinates

Applies change for size/shape of reference ellipsoid

Applies 3D change on origin

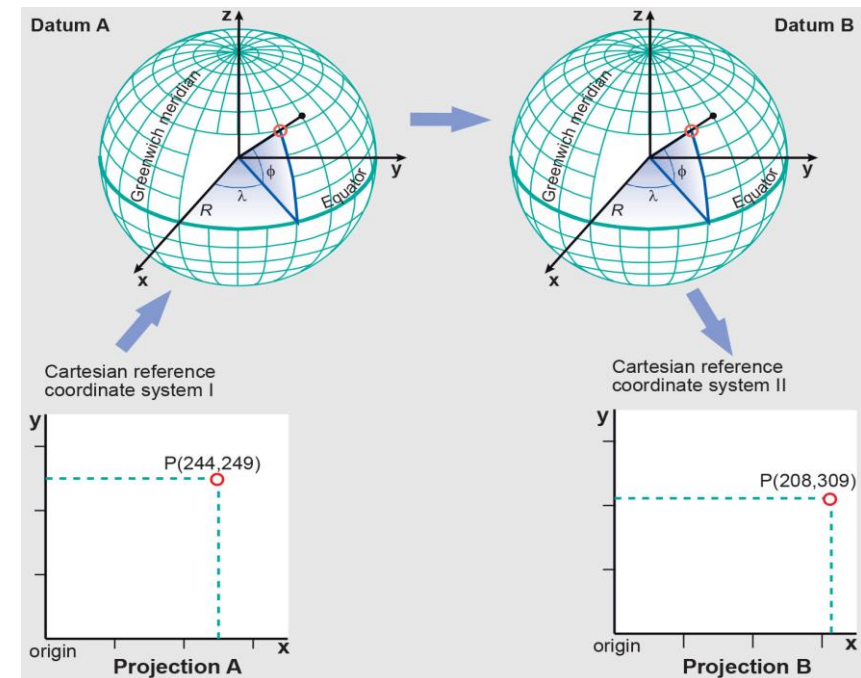
Generates new X,Y,Z coordinates for new datum



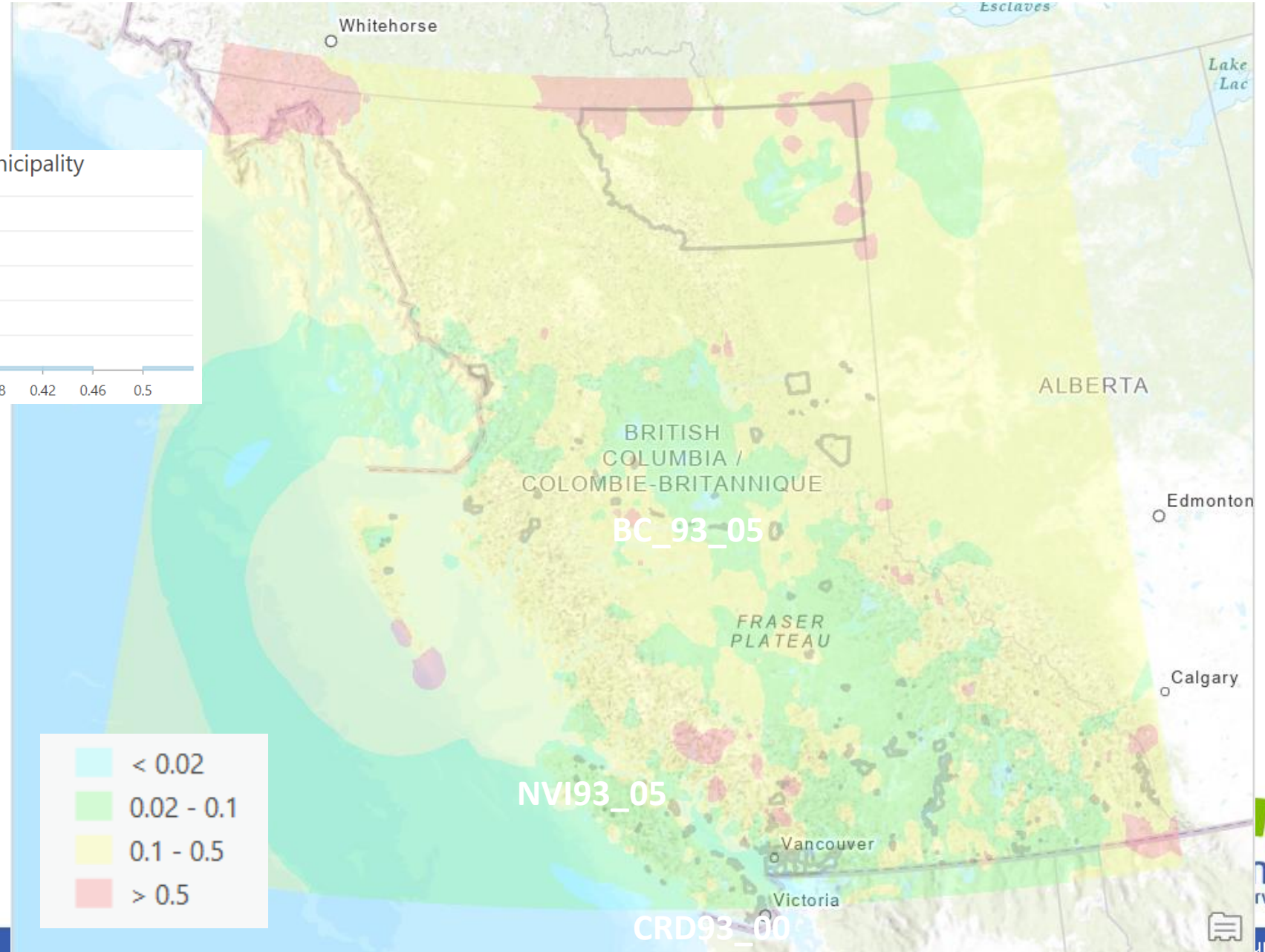
Impact of incorrect datum transformation

Datum transformations are extremely important for accuracy!

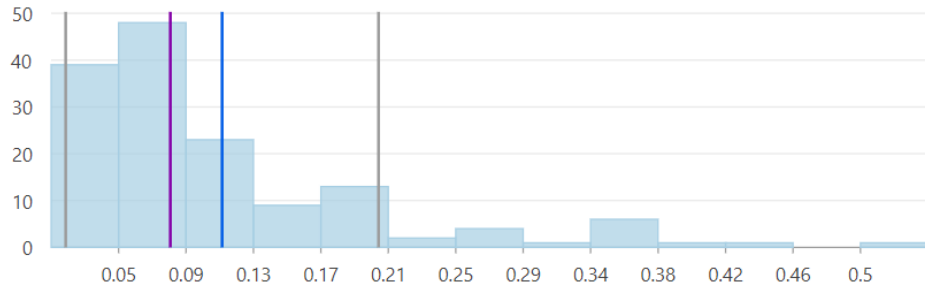
- Omit or choose the wrong datum— misalignment can be very significant horizontally and vertically
- Multiple datums exist—best practice to use the same as provincial recommendations



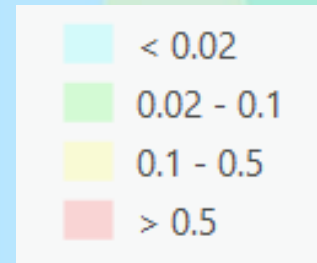
NAD 83 (Adopted / Original) to NAD 83 (CSRS) in BC



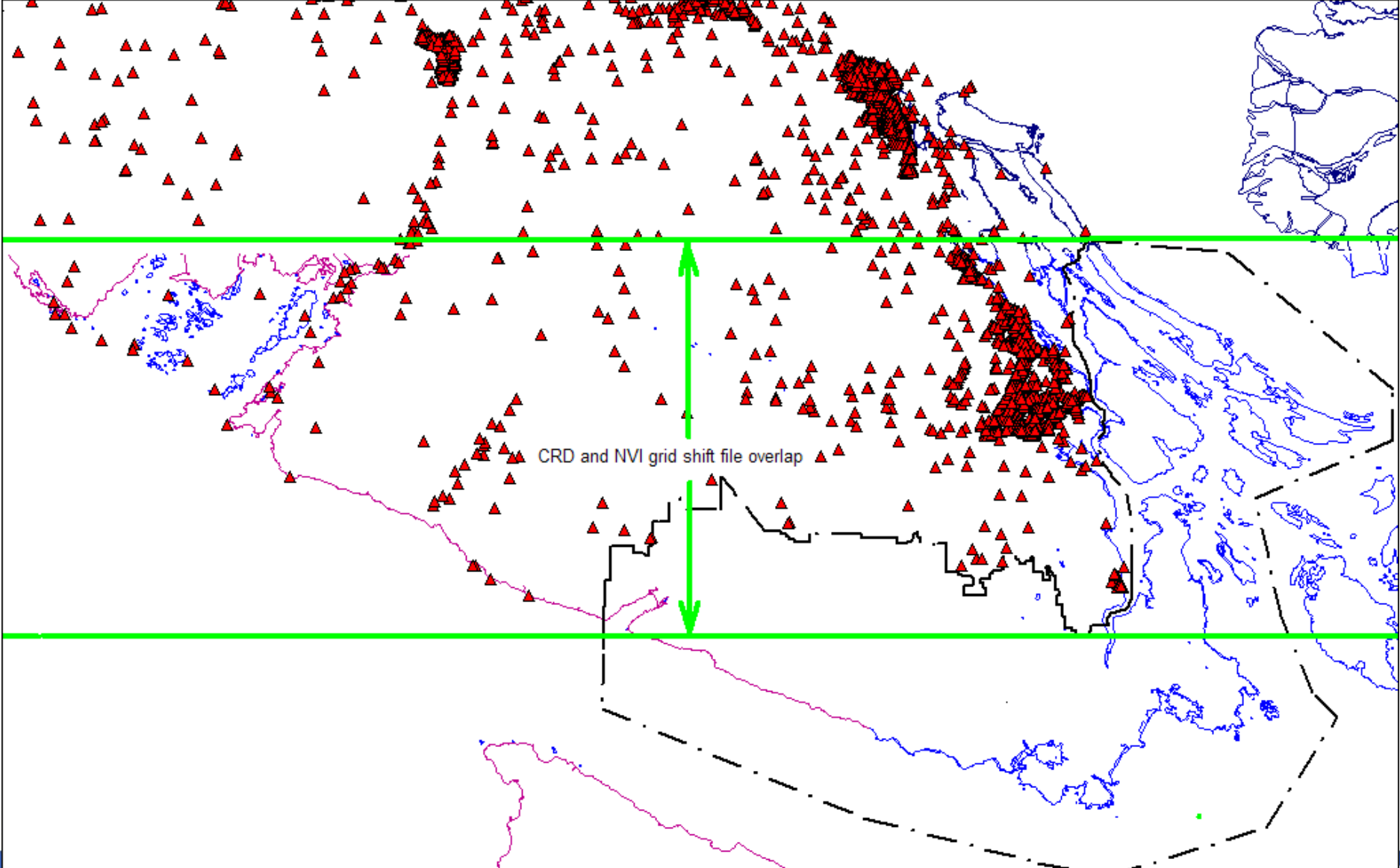
NAD83 to CSRS Shift by Municipality



Municipality	Shift
Dawson Creek	0.363
Pouce Coupe	0.362
McBride	0.409
NRRM	0.346
Squamish	0.374
Pemberton	0.541
Canal Flats	0.339
Elkford	0.425
Fernie	0.346



Overlap between CRD and NVI





Demo: misalignment with no or incorrect transformation

Other Considerations

- Epoch
 - CRD and NVI – 1997.0 (CSRS Version 3)
 - BC Mainland – 2002.0 (CSRS Version 4)
- Spatial Reference
 - NAD 1983 vs NAD 1983 (CSRS) vs NAD 1983 (CSRS) v4
 - Latter is more accurate, former are most useful
- NAD83 to WGS84 (publish to web)
 - 1 to 1.5 m shift depending on location (vertical as well)
 - $NAD83_To_WGS84_5 = NAD83_CSRS_To_WGS84_2 = ITRF96$
 - $WGS84_ITRF00_To_NAD83$ (AGP default) – within cm of ITRF96
- NATRF 2022
 - New US datum to replace NAD83, currently delayed (but coming)
 - Both horizontal and vertical, effectively WGS84

ArcGIS Transformations

NAD_1983_CSRS_To_WGS_1984	1473	Geocentric_Translation	0.0	0.0	0.0
NAD_1983_CSRS_To_WGS_1984_1	1842	Geocentric_Translation	0.0	0.0	0.0

NAD_1983_CSRS_To_WGS_1984_2	1946	Coordinate_Frame	-0.991	1.9072	0.5129	-0.02578991	-0.00965010	-0.01165994	0.0
NAD_1983_HARN_PACP00_MARP00_To_WGS_1984	108307	Coordinate_Frame	-0.9102	2.0141	0.5602	-0.029039	-0.010065	-0.010101	0.0
NAD_1983_HARN_To_WGS_1984_2	1900	Coordinate_Frame	-0.9738	1.9453	0.5486	-0.02755079	-0.01004922	-0.01135900	0.0
NAD_1983_HARN_To_WGS_1984_3	1901	Coordinate_Frame	-0.991	1.9072	0.5129	-0.02578991	-0.00965010	-0.01165994	0.0
NAD_1983_MARP00_To_WGS_1984	108018	Coordinate_Frame	-0.9102	2.0141	0.5602	-0.029039	-0.010065	-0.010101	0.0
NAD_1983_PACP00_To_WGS_1984	108017	Coordinate_Frame	-0.9102	2.0141	0.5602	-0.029039	-0.010065	-0.010101	0.0
NAD_1983_To_WGS_1984_4	1308	Coordinate_Frame	-0.9738	1.9453	0.5486	-0.02755079	-0.01004922	-0.011359	0.0
NAD_1983_To_WGS_1984_5	1515	Coordinate_Frame	-0.991	1.9072	0.5129	-0.02578991	-0.00965010	-0.01165994	0.0

ITRF_2000_To_NAD_1983_2011	108353	Coordinate_Frame	0.9956	-1.9013	-0.5215	0.025915	0.009426	0.011599	0.00062
ITRF_2000_To_NAD_1983_COR596	108150	Coordinate_Frame	0.9956	-1.9013	-0.5215	0.025915	0.009426	0.011599	0.00062
ITRF_2000_To_NAD_1983_HARN	108281	Coordinate_Frame	0.9956	-1.9013	-0.5215	0.025915	0.009426	0.011599	0.00062
ITRF_2005_To_ITRF_2008_2	108052	Position_Vector	0.002	0.0009	0.0047	0.0	0.0	0.0	-0.00094
ITRF_2008_To_IG05(2012)_Intermediate_CRS	9186	Coordinate_Frame	-23.772	-17.49	-17.859	-0.3132	-1.85274	1.67299	5.4262
ITRF_2008_To_ITRF_2014_7par	108074	Position_Vector	-0.0016	-0.0019	-0.0024	0.0	0.0	0.0	0.00002
ITRF_2008_To_NAD_1983_2011	108360	Coordinate_Frame	0.99343	-1.90331	-0.52655	0.02591467	0.00942645	0.01159935	0.00171504
ITRF_2008_To_NAD_1983_MA11	108361	Coordinate_Frame	0.908	-2.0161	-0.5653	0.028971	0.01042	0.008928	0.0011
ITRF_2008_To_NAD_1983_PA11	108362	Coordinate_Frame	0.908	-2.0161	-0.5653	0.027741	0.013469	0.002712	0.0011
ITRF_2014_To_NAD_1983_CSRS_v7_7par	108075	Position_Vector	1.0053	-1.9092	-0.5416	-0.0267814	0.0004203	-0.0109321	0.00037

Grid Shift Files

Grid shift files

Grid shift files (.gsb) are used to complete datum transformations and adjust coordinates between reference systems

In Canada, grid shift files *do not* come packaged with Esri software - the user must obtain the appropriate file and place it in the correct location

When transforming between NAD 83(Original) and NAD 83(CSRS), there is no national grid shift file that works for all of Canada

Grid shift files are maintained by regional authorities

Esri software does not always have OOTB transformations that correspond to all grid shift files in Canada or between all datums, so the user usually needs to create one

Downloading grid shift files

MASCOT Survey Utilities:

National Transformation Coordinate Conversions

The official software for conversion of coordinates from NAD27 to various versions of NAD83 or conversion between NAD83 versions (latitude/longitude or UTM) in British Columbia is called the National Transformation Version 2.0 (the Federal Geodetic Survey Division in cooperation with the provinces. For a web application visit NTv2.uscan-rncan.gc.ca, and to download a desktop application visit [Desktop Applications \(nrc\)](#).

Please refer to the [Disclaimer.txt](#) file before proceeding. By continuing you have implicitly agreed to the disclaimer.

[Read Me](#) in order to determine which transformation(s) you require. Also the files [Naming.txt](#) and [Numbering.doc](#) list equivalent naming and numbering schemes used for the various NAD83 re-adjustments.

IMPORTANT - When performing transformations on Vancouver Island please refer to the file [NVI-CRDwarning.doc](#)

The following Transformations can be performed by downloading the appropriate Binary Grid Shift file (.GSB) listed below for use / input to the NTv2 software:
Or download via the [Graphics Spread Sheet](#) by clicking on the pale blue arrows within. (Log on as: Anonymous - No Password Required)

NAD27 to NAD83(PRF1998):	BC_27_98.GSB
NAD27 to NAD83(CRD2000):	CRD27_00.GSB
NAD27 to NAD83(NVI2005):	NVI27_05.GSB
NAD27 to NAD83(PRF2005):	BC_27_05.GSB
NAD83(NMIP93) to NAD83(PRF1998):	BC_93_98.GSB
NAD83(NMIP93) to NAD83(CRD2000):	CRD93_00.GSB
NAD83(NMIP93) to NAD83(NVI2005):	NVI93_05.GSB
NAD83(NMIP93) to NAD83(PRF2005):	BC_93_05.GSB
NAD83(PRF1998) to NAD83(CRD2000):	CRD98_00.GSB
NAD83(PRF1998) to NAD83(NVI2005):	NVI98_05.GSB
NAD83(PRF1998) to NAD83(PRF2005):	BC_98_05.GSB

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Coordinate Transformations

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3D Transformations

3D coordinate transformations between NAD83(CSRs) and ITRF realizations are computed using a Helmert similarity transformation. The transformation parameters (3 translations, 3 rotations, 1 scale factor) are given for a reference epoch along with their rates of change. The Helmert transformation will transform between NAD83(CSRs) and ITRF at the same epoch as the input coordinates. The transformation does not change the epoch of the output coordinates. NAD83(CSRs) coordinates can be transformed to other epochs using the predicted velocities from the Canadian Geodetic Survey.

British Columbia

In the province of British Columbia there are a series of grid shift files for transforming between NAD27 and various versions of NAD83.

British Columbia: Download

Coverage	From	To	Grid
BC (CRD)	NAD27	NAD83(CSRs) 1997	Download CRD27_00.GSB
BC (CRD)	NAD83(Original)	NAD83(CSRs) 1997	Download CRD93_00.GSB
BC (Vancouver Island)	NAD83(Original)	NAD83(CSRs) 1997	Download NVI93_05.GSB
British Columbia	NAD27	NAD83(CSRs) 2002	Download BC_27_05.GSB
British Columbia	NAD83(Original)	NAD83(CSRs) 2002	Download BC_93_05.GSB

<ftp://ftp.gdbc.gov.bc.ca>

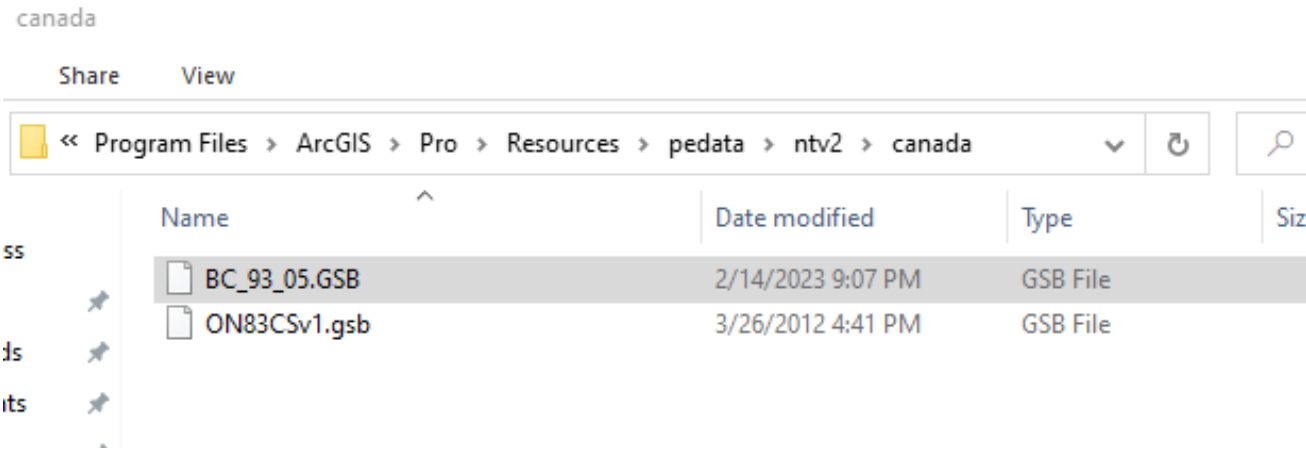
<https://a100.gov.bc.ca/pub/mascotw/protected/convert.html>

<https://webapp.csr-scrs.nrcan-rncan.gc.ca/geod/data-donnees/transformations.php>

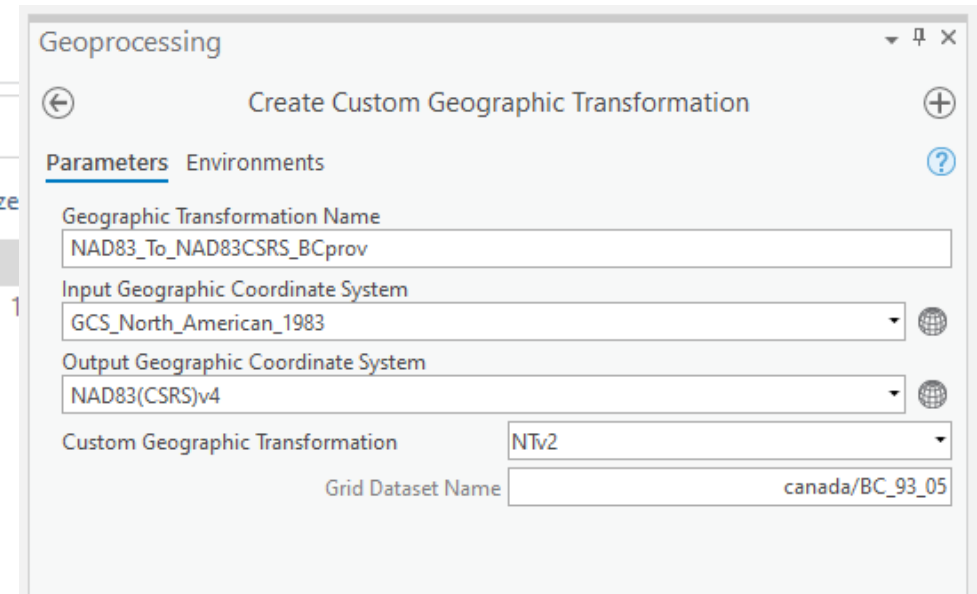
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Working with grid shift files

- To use the grid shift file to perform a transformation, several things must occur:
 - The .GSB file must be copied to the appropriate file path in the ArcGIS Pro folder
 - A custom transformation must be created that references the .GSB file
 - Make sure the transformation is tested to ensure that it is configured properly



C:\Program Files\ArcGIS\Pro\Resources\pedata\ntv2\canada



<user profile>\AppData\Roaming\Esrri\ArcGISPro\ArcToolbox\CustomTransformations



Demo: working with grid shift files

Common Issues and Pitfalls

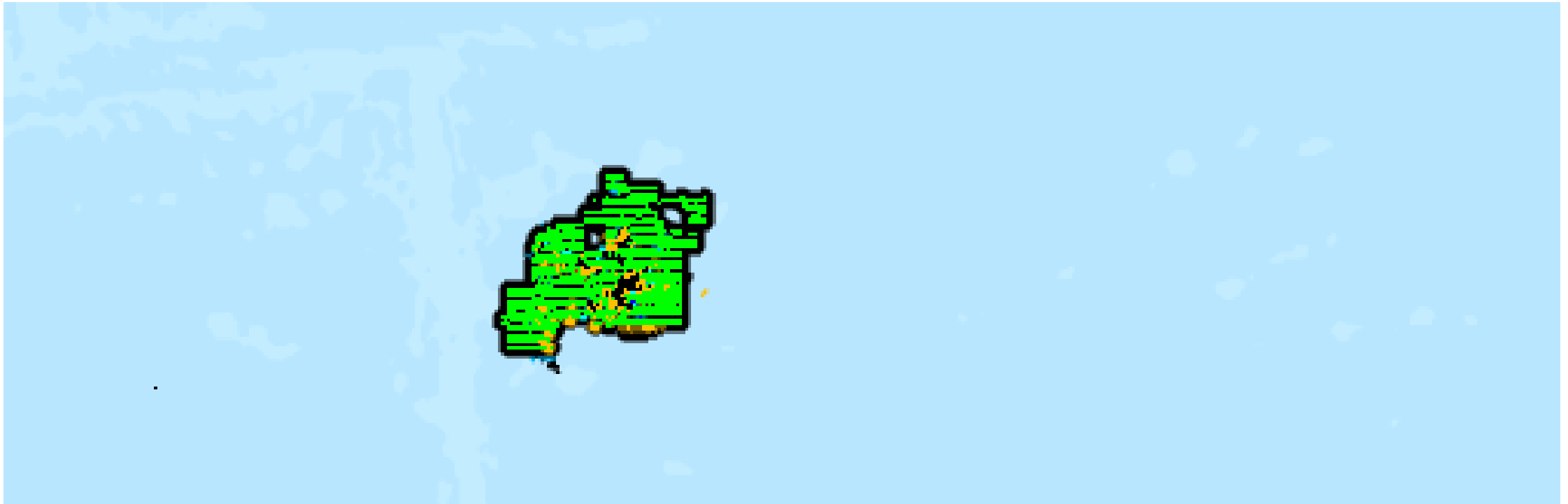
Common issues and pitfalls



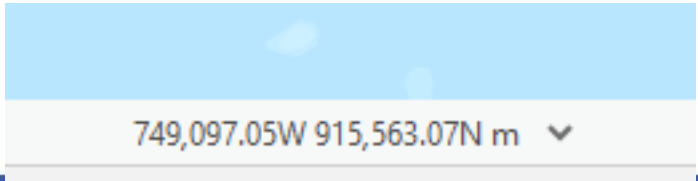
- ! Undefined or incorrect spatial reference
- ! Unknowingly double transforming data
- ! Differences in regional datums
- ! Custom transformation method is not available in pick list

Scenario: undefined or incorrect spatial reference

Picture this: you receive data> you add it to your map> it lines up smack in the middle of the ocean...



Solution: examine the coordinates of the data in an unprojected map and make an educated guess on the correct spatial reference



Scenario: unknowingly double transforming your data

Picture this: you've done your research> you've read some [blog posts](#)> you're confident you are applying the correct transformation> the data moves *further* apart than it was before...



Solution: determine if the data has incorrect metadata

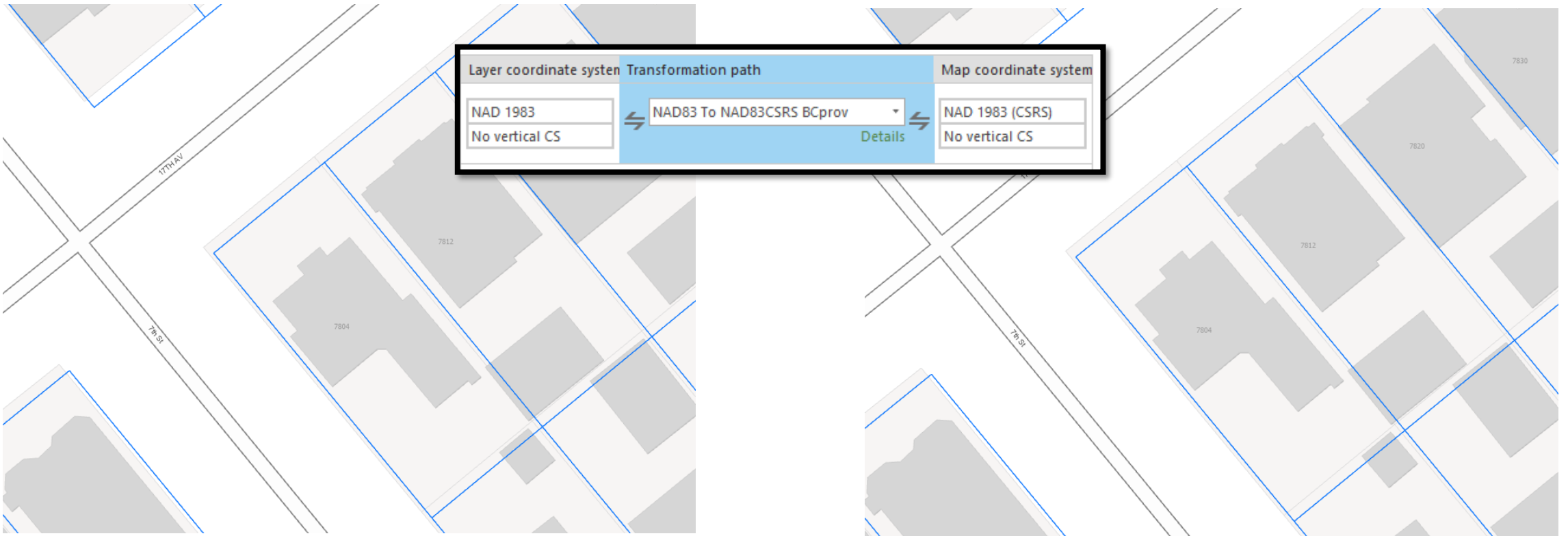
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▼ Spatial Reference

Projected Coordinate System	NAD 1983 UTM Zone 11N
Projection	Transverse Mercator

Scenario: differences in regional datums

Picture this: you've stored the GSB file correctly> you've created a custom transformation> you apply it> all appears successful, but your data hasn't actually moved...



Solution: ensure the GSB file you are using applies to your area of work

Scenario: custom transformation method is not available

Picture this: you've stored the GSB file correctly> you've created a custom transformation> but, the custom transformation you've created is not available from the pick list...

The screenshot shows the Geoprocessing tool interface. The 'Geographic Transformation' dropdown menu is open, showing a list of transformations. The first option, 'WGS_1984_(ITRF00)_To_NAD_1983 + NAD_1983_CSRS_To_WGS_1984_2', is selected and highlighted. This transformation is not present in the dropdown list. An inset window shows the 'CustomTransformations' folder in ArcGIS, containing a file named 'NAD83_To_NAD83CSRS_BCprov.gtf' with a size of 1 KB, which is the custom transformation that is missing from the tool's pick list.

Name	Date modified	Type	Size
NAD83_To_NAD83CSRS_BCprov.gtf	2/15/2023 6:34 AM	GTF File	1 KB

Solution: ensure the coordinate systems specified when you created the custom transformation are the same as the datasets you are working with



Demo: resolving common transformation issues

Q&A/Open Discussion

Feedback, Questions & Closing Remarks

ParcelMap BC Resources:

- [Adoption Resources & Tools](#)
- [Data Products & Descriptions](#)
- [Webinars & Workshops](#) (slides & videos)

Thank You For Participating!

Video recording & slide deck will posted soon!

<https://help.ltsa.ca/parcelmap-bc-workshops-and-tutorials>

Learn more at:

ltsa.ca/parcelmapbc

help.ltsa.ca/parcelmap-bc

➔ Have questions? Contact us parcelmapbc@ltsa.ca

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