



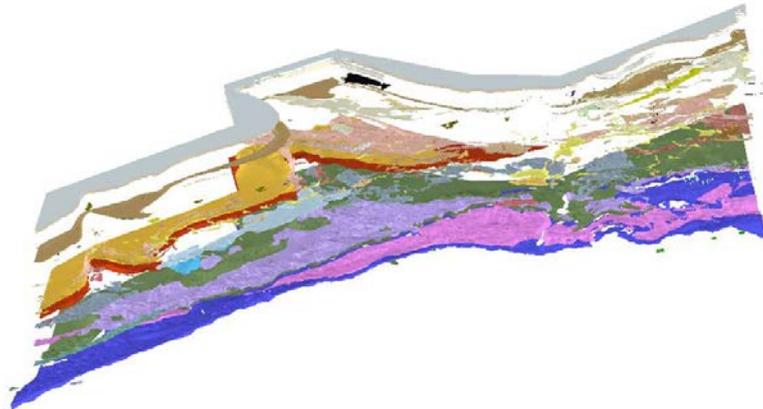
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Model metadata report for the Culloden-Nairn GSI3D Superficial Deposits Model

Geology and Regional Geophysics Scotland

Open Report OR/14/066



BRITISH GEOLOGICAL SURVEY

Geology and Regional Geophysics Scotland

OPEN REPORT OR/14/066

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Centre point 280545 853631
NE corner 295950 863957

Front cover

Geological units exploded as shown in 3D window of GSI3D, vertical exaggeration x10, looking north.

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3D images BGS©NERC 2014 using GSI3D methodology and software

Maps and diagrams in this book use topography based on Ordnance Survey mapping.

Arkley, S L B and Callaghan, E A

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Summary

This report describes the Culloden-Nairn GSI3D model which was built as part of the Geology and Landscape Scotland programme on Quaternary mapping and modelling in the north of Scotland. The Culloden-Nairn model is one of four, three superficial and one bedrock models, which have been constructed or are being constructed in this area of Scotland to provide 3D model coverage from Beauly in the west to Buckie in the east

1 Modelled volume, purpose and scale

The Culloden-Nairn GSI3D model was constructed to represent the superficial deposits geology of the area highlighted in Figure 1. The modelled area is outlined in red and the area is approximately 35 km from the north-east corner to the south-west corner. This model has been constructed for use at 1:50 000 scale and extends to a maximum depth of approximately -1000 m OD.

The eastern edge of the model shares a boundary with the Forres superficial deposits model, (Arkley, Finlayson and Callaghan, 2014) and attempts to join both models into one have been made, Appendix 2, but the Forres model requires updates to be made to the files used in GSI3D. The western edge will join the Beauly-Inverness superficial deposits model once it has been completed.



Figure 1: Location of modelled area, outlined in red

2 Modelled surfaces/volumes

The Generalise Vertical Section (GVS) for the Culloden-Nairn model, Table 1, identifies 75 superficial units in the model area, with a further 16 lenses identified within the modelled units. The GVS from the Forres 3D Model (Arkley, Finlayson and Callaghan, 2014) to the east of this model was used and new units were added which occurred in this area.

NAME	lithostrat_code	geological_unit
subtd	SUBTD	Subtidal_Holocene
soil	SOIL	Soil
mgr	MGR	Made ground
wmgr	WMGR	Infilled ground
wgr	WGR	Worked ground
lsgr	LSGR	Landscaped ground
bsa	BSA	Blown sand
slip	SLIP	Landslip
tcon	TCON	Talus cone
itdu	ITDU	Intertidal deposits
bldu	BLDU	Brackish Lagoon Deposits Undifferentiated
trd	TRD	Tidal creek or river deposits
bchd	BCHD	Present day beach deposits
stdu	STDU	Supratidal deposits
samd	SAMD	Salt marsh deposits
alv	ALV	Aluvium
peat1	PEAT1	Peat1
lde	LDE	Lacustrine Deposits
sbdg	SBDG	Storm beach deposits
head1	HEAD1	Head1
alv1	ALV1	Alluvium1
alv2	ALV2	Alluvium2
alf	ALF	Alluvial Fan Deposits
head2	HEAD2	Head2 Capping Flandrian desposits and older
rtd1	RTD1	River Terrace Deposits_1_Flandrian
rtd2	RTD2	River Terrace Deposits_2_Flandrian
rtd3	RTD3	River Terrace Deposits_3_Flandrian
rtd4	RTD4	River Terrace Deposits_4_Flandrian
rtd5	RTD5	River Terrace Deposits_5_Flandrian
rtfdf1	RTFDF1	Raised Intertidal Deposits_Flandrian_Beauly_Silt
peat2	PEAT2	Moniack_Peat
rtfdf2	RTFDF2	Raised_Intertidal Deposits_Flandrian_Barnyards_Silt
rmdf1	RMDF1	First raised marine beach deposits

rmdf2	RMDF2	Second raised marine beach deposits
rmdf3	RMDF3	Third raised marine beach deposits
rmdf4	RMDF4	Fourth raised marine beach deposits
rmbdf	RMBDF	Raised marine beach deposits_Flandrian
rbldu	RBLDU	Raised_brackish_lagoon_deposits_Undifferentiated
lngr1	LNGR1	Longman_Gravel_1
lngr2	LNGR2	Longman_Gravel_2
kebr	KEBR	Kessock_Bridge_Silt
rtfdd	RTFDD	Raised tidal flat deposits_late Devensian
rmbdd	RMBDD	Raised marine deposits_late Devensian
gftd	GFTD	Glaciofluvial_terrace deposits_1
gftd2	GFTD2	Glaciofluvial_terrace deposits_2
gfdd1	GFDD1	Glaciofluvial fan and fan delta deposits_1
gfdd2	GFDD2	Glaciofluvial fan and fan delta deposits_2
till1	TILL1	Till1
gsg1	GSG1	Glaciofluvial_sand_gravel_1
glld1	GLLD1	Glaciolacustrine_deposits_1
till2	TILL2	Till2
gsg2	GSG2	Glaciofluvial_sand_gravel_2
glld2	GLLD2	Glaciolacustrine_deposits_2
till3	TILL3	Till3
gsg3	GSG3	Glaciofluvial_sand_gravel_3
glld3	GLLD3	Glaciolacustrine_deposits_3
till4	TILL4	Till4
gsg4	GSG4	Glaciofluvial_sand_gravel_4
glld4	GLLD4	Glaciolacustrine_deposits_4
till5	TILL5	Till5
gsg5	GSG5	Glaciofluvial_sand_gravel_5
glld5	GLLD5	Glaciolacustrine_deposits_5
bti	BTI	Baddock Till
hmgd	HMGD	Hummock glacial deposits gravelly and sandy
mord1	MORD1	Morainic_Deposits_1
mord2	MORD2	Morainic_Deposits_2
mord3	MORD3	Morainic_Deposits_3
algr	ALGR	Alturlie Gravels Formation
ards	ARDS	Ardersier Silts Formation

grhs	GRHS	Grange Hill Sand Formation
mhsi	MHSI	Milton Hill Silt Member
hrgs	HRGS	Hempriggs Sand Member
egti	EGTI	East Grange Till Member
till6	TILL6	Till6
gsg6	GSG6	Glaciofluvial_sand_gravel_6
glld6	GLLD6	Glaciolacustrine_deposits_6
fint	FINT	Finglack Till Formation
till_top	TILLTOP	Till_lens_in_glaciofluvial gravel
till_base	TILLBASE	Till_lens_in_glaciofluvial gravel
peat1_top	PEAT1TOP1	Peat_lens_1
peat1_base	PEAT1BASE1	Peat_lens_1
peat2_top	PEAT2TOP	Peat_lens_2
peat2_base	PEAT2BASE2	Peat_lens_2
peat3_top	PEAT3TOP	Peat_lens_3
peat3_base	PEAT3BASE2	Peat_lens_3
gsg_top	GSGTOP	Glaciofluvial_lens
gsg_base	GSGBASE	Glaciofluvial_lens
gfsu_top	GFSUTOP	Glaciofluvial_subglacial_lens
gfsu_base	GFSUBASE	Glaciofluvial_subglacial_lens
glld_top	GLLDTOP	Glaciolacustrine_lens
glld_base	GLLDBASE	Glaciolacustrine_lens
bti_top	BTITOP	Baddock_Till_lens
bti_base	BTIBASE	Baddock_Till_lens
balt_top	BALTTOP	Balmakeith_Till_lens
balt_base	BALTBASE	Balmakeith_Till_lens
algr_top	ALGRTOP	Alturlie_Gravels_Formation_lens
algr_base	ALGRBASE	Alturlie_Gravels_Formation_lens
rmbdf_top	RMBDFTOP	Raised marine beach deposits_Flandrian_lens
rmbdf_base	RMBDFBASE	Raised marine beach deposits_Flandrian_lens
rmbdf2_top	RMBDF2TOP	Raised marine beach deposits_Flandrian_lens_2
rmbdf2_base	RMBDF2BASE	Raised marine beach deposits_Flandrian_lens_2
rmbdd_top	RMBDDTOP	Raised marine deposits_late Devensian_lens
rmbdd_base	RMBDDBASE	Raised marine deposits_late Devensian_lens
egti_top	EGTITOP	East Grange Till Member_lens
egti_base	EGTIBASE	East Grange Till Member_lens

mhsi1_top	MHSI1TOP	Milton Hill Silt Member_lens
mhsi1_base	MHSI1BASE	Milton Hill Silt Member_lens
ards_top	ARDSTOP	Ardersier Silts Formation_lens
ards_base	ARDSBASE	Ardersier Silts Formation_lens

Table 1: GVS showing the modelled units for the Culloden-Nairn model.

3 Modelled faults

No faults were included in the model.

4 Model datasets

The data used to develop the Forres model is described below. Some general caveats regarding BGS datasets and interpretations are:

- Geological observations and interpretations are made according to the prevailing understanding of the subject at the time. The quality of such observations and interpretations may be affected by the availability of new data, by subsequent advances in knowledge, improved methods of interpretation, improved databases and modelling software, and better access to sampling locations.
- Raw data may have been transcribed from analogue to digital format, or may have been acquired by means of automated measuring techniques. Although such processes are subjected to quality control to ensure reliability where possible, some raw data may have been processed without human intervention and may in consequence contain undetected errors.

4.1 RAW DATA

Raw data used to develop the Culloden-Nairn model include digital terrain models, borehole data, digital geological shapefiles, additional field observations and bathymetric data. All the data are located at:

W:\Teams\QES\QMMP\Data\MorayNessBasin_Data\GSI3D_Great_Glen_to_Moray_Firth\CULLODEN-NAIRN Model\Data

Digital Terrain Models (DTM's)

Two DTM's were extracted for use with this model, NextMap and Bald Earth both at 50m resolution. The Bald Earth DTM was chosen as the NextMap DTM had a tendency to show artefacts such as trees, which would distort the true ground surface. The Bald Earth DTM was stored as a TIN within the GSI3D workspace.

Borehole Data

Borehole data were entered into the BGS corporate database, BGS Borehole Geology according to the project GVS. The borehole information was extracted via the Data Portal for the model area using interpreter 'ECAL' and in total there were 473 boreholes and trial pits within the model boundary. Figure 2. In order to capture some deep boreholes out with the project area a buffer zone was introduced to capture these boreholes, e.g. Dalroy boreholes 1, 2 and 3, drilled up to 50.43 metres in depth. Boreholes were generally hung according to the DTM used, however where the DTM was affected by artefacts, e.g. pylons, the boreholes were aligned with the contour values.

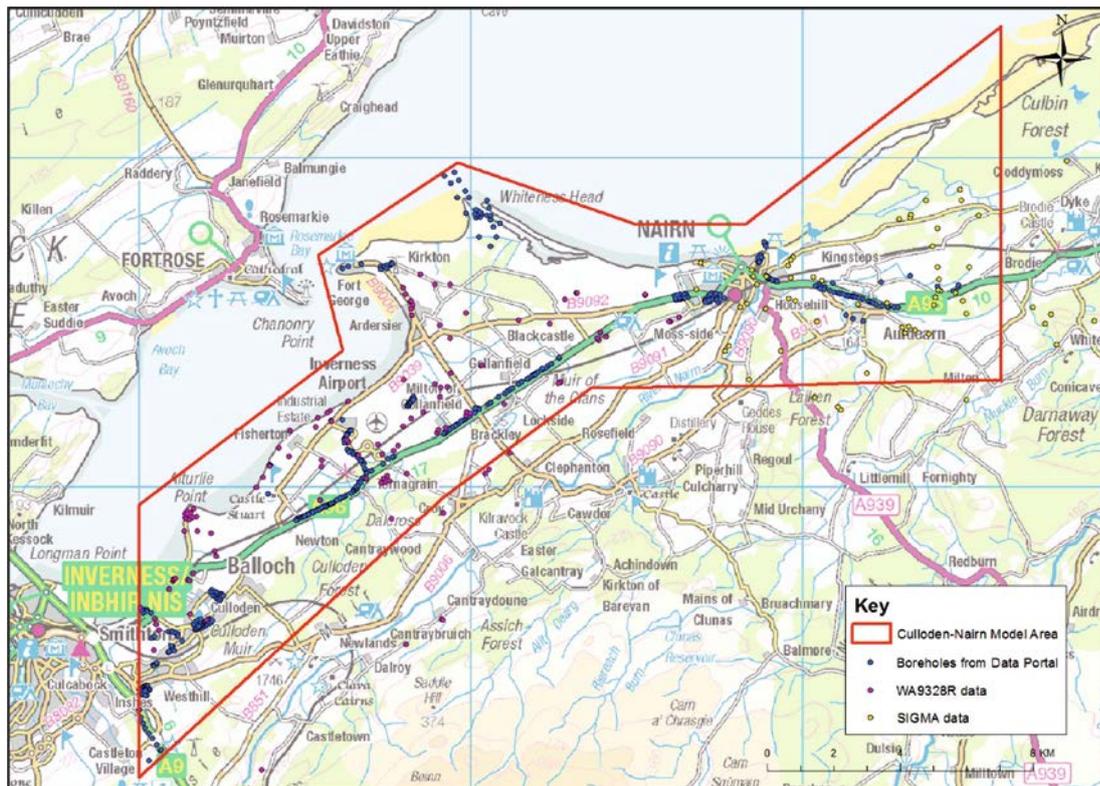


Figure 2: Location of boreholes (including field information data)

Field Information Data

Field data points providing information on the deposits and their thickness were compiled into Excel tables and converted into '.bid' and '.blg' files for use in the modelling. Two different sources of field data were used.

1. BGS report WA/93/28R (Merritt and Auton, 1993) contained natural sections which were recorded during field mapping in the 1990's. The information from these sites was recorded into an Excel table with additional information added, that is lithology, lithostrat and a GVS code for use with the GSI3D model.
2. Information on outcrops collected during SIGMA (System for Integrated Geoscience Mapping) mapping in 2010/2011 was extracted as field observation points, Table 2 and Table 3. This information was populated into an Excel table.

The two Excel tables were then merged with the '.bid' and '.blg' files from the Data Portal to create one '.bid' file and one '.blg' file for importing into GSI3D.

LocNo	X	Y	Start_Height	Source	10K_sheet
CA 1283	293730	858720	19.86	SIGMA	NH95NW(n)
CA 1284	293730	858720	19.86	SIGMA	NH95NW(n)
CA 1285	294080	857860	26.17	SIGMA	NH95NW(n)
CA 1290	293940	857320	33.94	SIGMA	NH95NW(s)
CA 1303	294090	856690	36.59	SIGMA	NH95NW(s)
CA 1304	294030	855780	35.72	SIGMA	NH95NW(s)
CA 1305	294170	855960	32.43	SIGMA	NH95NW(s)
CA 1306	294100	855980	31.59	SIGMA	NH95NW(s)
CA 1360	290440	855030	26.61	SIGMA	NH95NW(s)
CA 1369	294950	855270	46.51	SIGMA	NH95NW(s)
CA 1370	293980	855540	39.60	SIGMA	NH95NW(s)
CA1134	286810	856000	21.61	SIGMA	NH85NE(s)
CA1142	287680	854140	15.35	SIGMA	NH85SE(n)
CA1144	287790	854280	13.45	SIGMA	NH85SE(n)
CA1149	288650	856170	9.29	SIGMA	NH85NE(s)
CA1150	288540	856400	3.23	SIGMA	NH85NE(s)
CA1151	288150	855460	14.26	SIGMA	NH85NE(s)
CA1152	288330	855580	10.01	SIGMA	NH85NE(s)
CA1153	288400	853270	25.88	SIGMA	NH85SE(n)
CA1169	289740	856980	16.00	SIGMA	NH85NE(s)
CA1170	289670	856910	15.05	SIGMA	NH85NE(s)
CA1171	289570	856730	16.78	SIGMA	NH85NE(s)
CA1173	288910	855420	11.50	SIGMA	NH85NE(s)
CA1191	289670	856350	17.45	SIGMA	NH85NE(s)
CA1281	293260	858180	23.67	SIGMA	NH95NW(n)
CA1282	293280	858280	21.22	SIGMA	NH95NW(n)
CA1287	292940	858140	13.16	SIGMA	NH95NW(n)
CA1363	291700	855550	22.44	SIGMA	NH95NW(s)
CA1364	292570	855600	37.71	SIGMA	NH95NW(s)
CA1365	293110	854690	40.69	SIGMA	NH95SW(n)
CA1366	293220	854870	37.10	SIGMA	NH95SW(n)
CA1367	293010	854860	34.47	SIGMA	NH95SW(n)
CA1368	293400	854770	39.37	SIGMA	NH95SW(n)
CA1371	293830	854660	46.82	SIGMA	NH95SW(n)
CAA_105	291955	853472	44.13	SIGMA	NH95SW(n)
CAA_109	291161	852352	58.70	SIGMA	NH95SW(n)
CAA_110	291086	852432	52.19	SIGMA	NH95SW(n)
CAA_122	294953	852654	85.32	SIGMA	NH95SW(n)
CAA19981	286940	856820	9.92	SIGMA	NH85NE(s)
CAA19982	288480	856600	20.87	SIGMA	NH85NE(s)

CAA19983	289600	855720	18.60	SIGMA	NH85NE(s)
CAA19984	288920	856410	12.17	SIGMA	NH85NE(s)
CAA19985	289790	855670	17.36	SIGMA	NH85NE(s)
CAA19986	289350	854130	35.62	SIGMA	NH85SE(n)
CAA19987	294800	858710	12.69	SIGMA	NH95NW(n)
CAA19988	294750	859040	12.99	SIGMA	NH95NW(n)
CAA19989	294630	855900	44.01	SIGMA	NH95NW(s)
CAA19990	294120	856320	30.15	SIGMA	NH95NW(s)
CAA19991	294840	855670	49.03	SIGMA	NH95NW(s)
CAA19992	290600	856260	9.69	SIGMA	NH95NW(s)
CAA19993	290330	856370	16.31	SIGMA	NH95NW(s)
CAA19994	295050	856690	30.77	SIGMA	NH95NE(s)
JDEV11	296967	855456	46.68	SIGMA	NH95NE(s)
JDEV16	299515	852944	100.99	SIGMA	NH95NE(s)
JDEV20	297323	854968	65.95	SIGMA	NH95NE(s)
JDEV21	297674	854334	77.22	SIGMA	NH95NE(s)
JDEV5	298810	855060	78.08	SIGMA	NH95NE(n)
JDEV7	295330	858260	45.78	SIGMA	NH95NE(n)
JDEV8	297990	859910	23.92	SIGMA	NH95NE(n)
MFN1	290381	852721	81.85	SIGMA	NH95SW(n)
MFN2	297500	855250	80.37	SIGMA	NH95NE(s)
MFN3	299380	850030	196.34	SIGMA	NH95SE(s)

Table 2: Field points gathered from SIGMA mapping shown as a .bid file for import into GSI3D.

Loc. No.	Depth to base of unit	Lithology Code	GVS	Lithostrat
CA 1283	0.30	Soil	RMBDD	Raised marine deposits Late D.
CA 1283	0.70	Sand with tabular cobbles	RMBDD	Raised marine deposits Late D.
CA 1283	1.10	gravel	RMBDD	Raised marine deposits Late D.
CA 1283	1.50	gravel	GSG4	glaciofluvial sheet deposit
CA 1283	2.00	iron/manganeese pan	KISA	ferruginous weathered sst?
CA 1283	2.20	clay	KISA	weathered mudstone?
CA 1284	1.00	no lithology	BSA	Blown sand
CA 1284	2.20	sand with clay wisps	RMDf4	Flandrian Raised beach 4?
CA 1285	2.00	No lithology	ALV1	Alluvium
CA 1285	2.50	Diamicton	TILL	Till (?4)
CA 1290	2.10	sandy diamicton	MORD	morainic deposits
CA 1303	2.00	sandy diamicton	MORD	morainic deposits

CA 1304	0.50	sandstone	HSA	HSA (fault slightly on wrong side!)
CA 1305	3.00	sandy gravel	GSG4	glaciofluvial sheet deposit
CA 1306	2.00	pebbly diamicton	TILL6	Till
CA 1306	2.10	siltstone	HSA	HSA
CA 1360	0.60	humic silt & clay	ALV1	Alluvium
CA 1360	1.20	sandy silty	ARDS	Ardersier Silts
CA 1369	1.50	contorted gravel & sand	GSG4	subglacial esker gravel
CA 1370	0.20	Soil	TILL6	Till
CA 1370	1.70	diamicton	TILL6	Till
CA1134	0.30	MGR	MGR	MGR
CA1134	1.00	gravel	RTFDD	raised tidal flat deposits
CA1134	1.30	sand	RTFDD	raised tidal flat deposits
CA1134	2.10	sand	ARDS	Ardersier Silts
CA1134	2.90	sand	ARDS	Ardersier Silts
CA1134	3.20	silt	ARDS	Ardersier Silts
CA1142	3.50	Sst + Mudstone	INS	INS
CA1144	2.00	Cong. + Sst	RCCN	RCCN
CA1149	1.00	Sandstone	NSTN	NSTN
CA1150	3.00	Sandstone	NSTN	NSTN
CA1151	0.30	soil	RTFDD	raised tidal flat deposits
CA1151	2.20	sand	ARDS	Ardersier Silts
CA1151	2.60	gravel	ARDS	Ardersier Silts
CA1151	3.30	sand & silt	ARDS	Ardersier Silts
CA1152	2.00	Sandstone	NSTN	NSTN
CA1153	5.00	sand & gravel	GSG4	Ice contact sand & gravel
CA1169	5.00	Sandstone	KISA	KISA
CA1170	2.50	Sandstone	KISA	KISA
CA1171	1.30	MGR	MGR	MGR
CA1171	1.40	Soil	ARDS	Ardersier Silts
CA1171	2.20	sand	ARDS	Ardersier Silts
CA1173	2.90	Sand	RTFDD	raised tidal flat deposits
CA1173	3.60	sand & clayey silt	ARDS	Ardersier Silts
CA1191	0.20	MGR	MGR	MGR
CA1191	0.50	Sand	RTFDD	raised tidal flat deposits
CA1191	0.60	silt	ARDS	Ardersier Silts
CA1191	0.90	Sand	ARDS	Ardersier Silts
CA1191	1.00	silt	ARDS	Ardersier Silts
CA1191	2.00	Sand	ARDS	Ardersier Silts
CA1191	2.80	diamicton	BALT	Balmakeith Till Member (lens)

CA1281	0.60	sand	RMBDD	Raised marine deposits Late D.
CA1281	0.80	sand, silty	RMBDD	Raised marine deposits Late D.
CA1282	2.30	sandstone & congl.	KISA	KISA
CA1287	0.80	Sand with tabular cobbles	RMBDD	Raised marine deposits Late D.
CA1287	2.40	openwork gravel	RMBDD	Raised marine deposits Late D.
CA1363	0.30	soil	ALGR	Alturlie gravels
CA1363	0.70	gravel	ALGR	Alturlie gravels
CA1363	1.50	sand gravel and silt	ALGR	Alturlie gravels
CA1364	0.50	Soil	TILL6	Till
CA1364	1.80	diamicton	TILL6	Till
CA1364	2.50	decomposed sandstone	HSA	Hillhead Sandstone (lens)
CA1365	0.20	soil	GSG4	Ice contact sand & gravel
CA1365	1.90	gravel	GSG4	Ice contact sand & gravel
CA1366	2.00	sandstone	INS	INS
CA1367	0.40	soil	GSG4	glaciofluvial sheet deposit
CA1367	0.90	gravel	GSG4	glaciofluvial sheet deposit
CA1367	1.70	diamicton	TILL6	Till
CA1368	4.50	gravel	GSG4	subglacial esker gravel
CA1368	4.80	sand	GSG4	subglacial esker sand
CA1368	5.10	silt	GSG4	subglacial esker silt
CA1368	5.50	sand	GSG4	subglacial esker sand
CA1368	7.00	gravel	GSG4	subglacial esker gravel
CA1371	0.40	soil	GSG4	Ice contact sand & gravel
CA1371	0.90	gravel	GSG4	Ice contact sand & gravel
CA1371	1.50	clayey silt	GSG4	Ice contact sand & gravel
CA1371	4.00	gravel	GSG4	Ice contact sand & gravel
CAA_105	1.20	cobble gravel	GSG4	glaciofluvial sheet deposit
CAA_109	1.00	cobble gravel	RTD1	River Terrace deposits
CAA_110	1.30	Peat	PEAT1	Peat
CAA_110	2.30	sand	ALV1	Alluvium
CAA_122	7.00	Conglomerate	MBCN	MBCN
CAA19981	5.00	Sandstone	KISA	KISA
CAA19982	0.30	MGR	MGR	MGR
CAA19982	0.80	diamicton	TILL	Till (?till2)
CAA19983	0.30	peat	LDE	lacustrine deposits
CAA19983	0.70	silt	LDE	lacustrine deposits
CAA19984	3.00	MGR	MGR	MGR
CAA19985	2.00	sand	RTFDD	raised tidal flat deposits

CAA19986	3.00	bolder & cob. Grav.	GSG4	subglacial esker gravel
CAA19987	0.20	sand	BSA	Blown sand
CAA19987	0.50	sand ferruginous	RMDF4	Flandrian Raised beach 4
CAA19988	0.50	peat	LDE	Lacustrine deposits
CAA19988	0.70	clayey silt	LDE	Lacustrine deposits
CAA19989	10.00	cobbly gravel	GSG4	subglacial esker gravel
CAA19989	10.10	sandstone	INS	INS
CAA19990	2.00	sand	ALV1	alluvium
CAA19991	2.50	cobbly gravel	GSG4	subglacial esker gravel
CAA19991	2.60	silt	GSG4	subglacial esker silt
CAA19992	0.70	clayey silt	ALV1	alluvium
CAA19992	0.80	gravel	ALV1	alluvium
CAA19993	1.50	sand	RTFDD	raised tidal flat deposits
CAA19994	1.50	sand	ALV1	alluvium
JDEV11	8.00	sandstone	NSTN	NSTN
JDEV16	10.00	sand and gravel	GSG4	Ice contact sand & gravel
JDEV20	2.00	sandstone	KISA	KISA
JDEV21	2.00	sandstone	KISA	KISA
JDEV5	6.00	sand and gravel	GSG4	Ice contact sand & gravel
JDEV7	2.00	sand and gravel	MORD	Moraine
JDEV8	1.00	diamicton	TILL4	Till
JDEV8	2.00	silt and clay	ARDS	Ardersier silts
MFN1	1.00	diamicton	TILL6	Till
MFN2	2.50	sand and gravel	GSG4	Ice contact sand & gravel
MFN3	3.00	sand and gravel	GSG4	Ice contact sand & gravel

Table 3: Field points gathered from SIGMA mapping shown as a .blg file for import into GSI3D

Raster and Shapefile Data

- Topographic maps at 1: 25 000 scale were extracted for the project area.
- Two figures (22 and 28) from the Fortrose memoir (Fletcher et al., 1996) were scanned and georeferenced for use within the GSI3D project.
- Two sections from the Fortrose 1:50 000 84W sheet (1997) were scanned and their raster files were used to create two sections within the project.

Contour Data

Onshore contours were provided from Ordnance Survey data at 5 m intervals.

Offshore bathymetry was provided as a shapefile from Arc. The files were clipped to the project area and converted into British National Grid from Latitude and Longitude.

Geological Linework Data

The modelled area encompasses three 1:50 000 sheet areas, Fortrose (84W), Nairn (84E) and Cromarty (94E). The Fortrose sheet was published in 1997 and linework which was available digitally from DigMap was clipped to the model area. The Nairn sheet was under revision at the time of modelling this area but 1:10 000 scale maps were available due to recent mapping and stored within the CartoGIS department. The digitally stored linework at this scale was imported into GSI3D as shapefiles. The geological linework for NH96SW part of Cromarty (94E) was also clipped and imported into GSI3D as a shapefile.

The offshore 1:250 000 Seabed Sediment map for Moray-Buchan (BGS) was clipped in Arc and converted into British National Grid from Latitude and Longitude. The offshore map was imported into GSI3D.

Offshore Seismic Data

In 2012 BGS undertook survey work in the Inner Moray Firth to acquire seismic and multibeam data. In an area of approximately 15 km by 5 km 33 lines were shot, Figure 3.

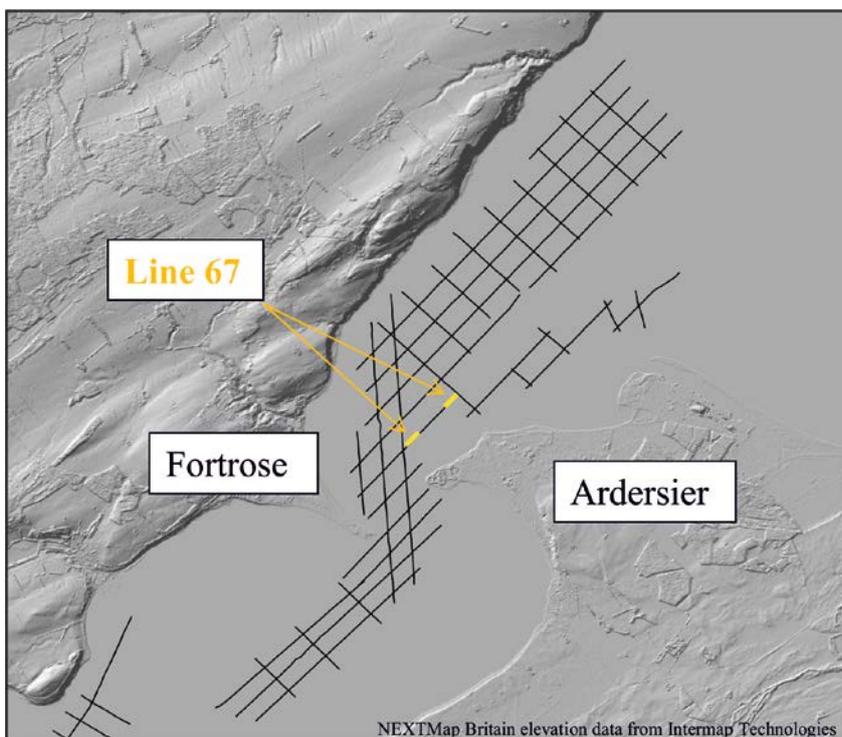


Figure 3: NextMap© image showing the seismic tracks for the Inner Moray Survey.

12 seismic lines (45,46,47,48,54,59,60,64,66,67,69 and 78) were interpreted and converted into jpeg format files, Figure 4. Before they could be imported into GSI3D the linework had to be converted to British National Grid which was undertaken in Arc. Due to the size of the files the images were cropped and resampled in order to be imported into GSI3D.

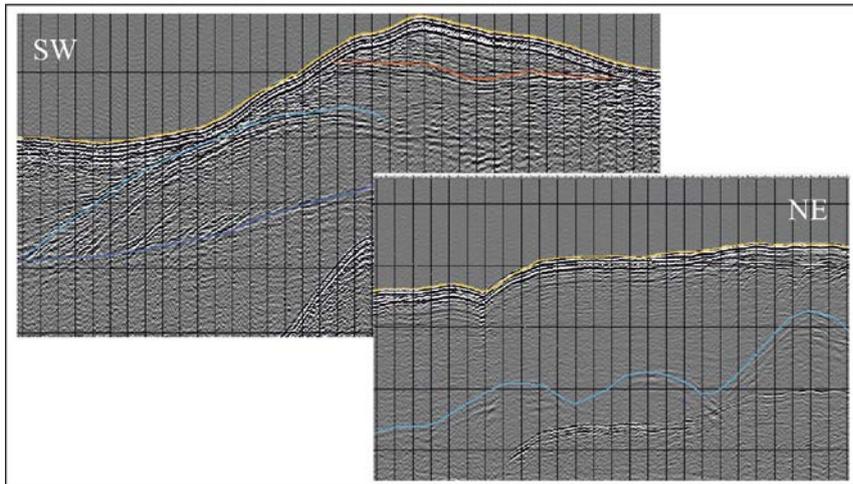


Figure 4: Seismic line 67, note also the high point of the seabed that forms the north-eastern margin of the present day channel. The angular discontinuity (orange surface) indicates that there have been several phases of deposition in the firth before erosion of the present day channel.

The depth of the cross-sections had to be converted for entry into GSI3D due to the acquisition of the offshore seismic profiles in two-way travel time. The vertical scale is measured in milliseconds and therefore has to be converted into metres.

e.g. 1500 m/s in water (so 10ms of water on seismic line approx = 7.5 m in reality) & 1700-1800 m/s in soft sediment. N.B. seafloor depth varies across seismic lines, so average value calculated.

An example of calculating depths:-

Section 45: av. depth from sea-level to seabed: $0.020/2 \times 1500 = 15$ m
: depth from seabed to base of image: $0.200 - 0.020 = 0.180$, $0.180/2 \times 1750 = 157.5$ m
: total depth (top to base of image): 15 m + 157.5 m = 172.5 m

Figures for importing section 45 as a raster backdrop into GSI3D:

Top left corner: $W=0$, $Z=0$ Bottom right corner: $W=2366.6$, $Z=-172.5$

N.B. where section crosses -10m bathymetry contour, seabed pick lies at -22.5 m

Offshore Multibeam Data

Multibeam data were collected along seismic tracks, extending approx. 25 m either side of the seismic line, so had a network of data. Attribute table indicates there are 1,585,964 data points, a data point every 2 m over the areas scanned. The deepest value recorded was -45.96 m (between Forth George and Charonry Point) and shallowest was -4.53 m as this was the shallowest that the boat could survey.

The multibeam data gathered were not used in the construction of this model due to problems encountered in trying to import the data into GSI3D.

The file size was too large for GSI3D and even by reducing this; the data were projected in the wrong location. The data were then exported as a simple .xyz file and an .asc file at 5 m resolution (38MB). The attribute table indicated there were 305,622 data points. The files were

imported into an empty GSI3D project but the Culloden-Nairn project couldn't be loaded. The multibeam dtm was visible along the seismic sections where it existed along the entire length of the section, but if a section cut in and out of the dtm data, the section was not constrained and shot upwards to 96,814 m or downwards to -143,117 m (on a test section). These extreme values made the dtm (as it existed) impossible to view in 3D.

The data are still stored within the project area and can be used for future offshore modelling.

Additional Information

Cross-sections from other projects were brought into GSI3D as they cut through the Culloden-Nairn project area.

- 10 sections from the Great Glen-Moray Firth GSI3D Faulted Bedrock Model (Arkley, 2014).
- 5 sections from the GB-3D bedrock model.
- 9 sections from the Moray Ness Regional Model (Finlayson and Arkley, 2014).

A series of surfaces to replicate the sea-level at different heights were created in GOCAD™ and clipped to the project area. These tin files represented sea level at 0 m, +7 m, +28 m and +42 m.

5 Dataset integration

All data were brought together in the GSI3D modelling software where it can be viewed and interrogated in 2D and 3D.

6 Model development log

In total, 65 cross-sections were constructed within the Culloden-Nairn GSI3D model (Figure 5): sections trended south-west – north-east and north-west – south-east. 156 helper sections were constructed to address particular issues, such as a lack of data or to constrain a geological unit. 12 seismic sections from offshore data were also constructed.

Modelling was carried out using the 2011 version of GSI3D and the 2009 version of GOCAD™.

A detailed model development log is included in Appendix 1

7 Model workflow

The methodology for construction of models in GSI3D is described in detail by Kessler et al. (2008; <http://nora.nerc.ac.uk/3737/1/OR08001.pdf>). It principally involves construction of cross-

sections between the best quality borehole data, followed by envelope construction around the limits of the geological units.

8 Model assumptions and limitations

- As with all geological models that use borehole information, the model assumes that the interpretation in the original logs is correct, and that the depths and start elevations were accurately recorded.
- Best endeavours (quality checking procedures) were employed to minimise data entry errors but given the diversity and volume of data used, it is anticipated that occasional erroneous entries will still be present (e.g. borehole location).
- The model does not reflect the full complexity of the superficial deposits geology. In reality, surfaces have been subjected to more glaciotectonic deformation than is represented in the model.
- The Bald Earth Digital Elevation Model may contain artefacts such as trees or artificial structures such as pylons. If any of these artefacts were found during the modelling then the effects of these were minimised in the model as much as possible.
- The start heights of boreholes used might differ significantly from the Bald Earth Digital Elevation Model. When modelling, these differences were taken account of by assessing the year the borehole was drilled and assessing the location of the borehole against other data such as historical maps. Therefore the modeller used their own judgment in some areas if the stratigraphy in the borehole did not match the modern day topography and changes in the subsurface (quarrying, landfill etc.).
- The thin nature of some superficial deposits means that these units are poorly shown in visualisations of the 3D model (e.g. in the Lithoframe Viewer 3D window). A substantial number of additional cross-sections ('helper sections') are needed to improve the calculation of thin deposits.
- Intertidal deposits were modelled no higher than about 3.25m above present day sea level.
- Where there was a lack of borehole information, this part of the model is heavily reliant on mapping.

9 Model images

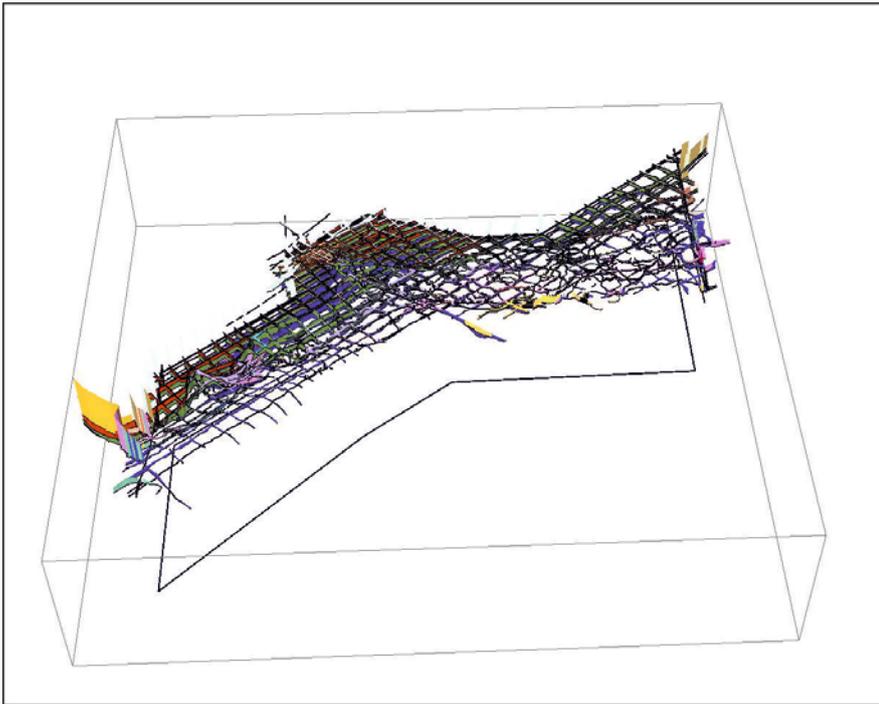


Figure 5: Cross-sections shown in 3D window of GSI3D, looking to the north. Sections have an x10 vertical exaggeration

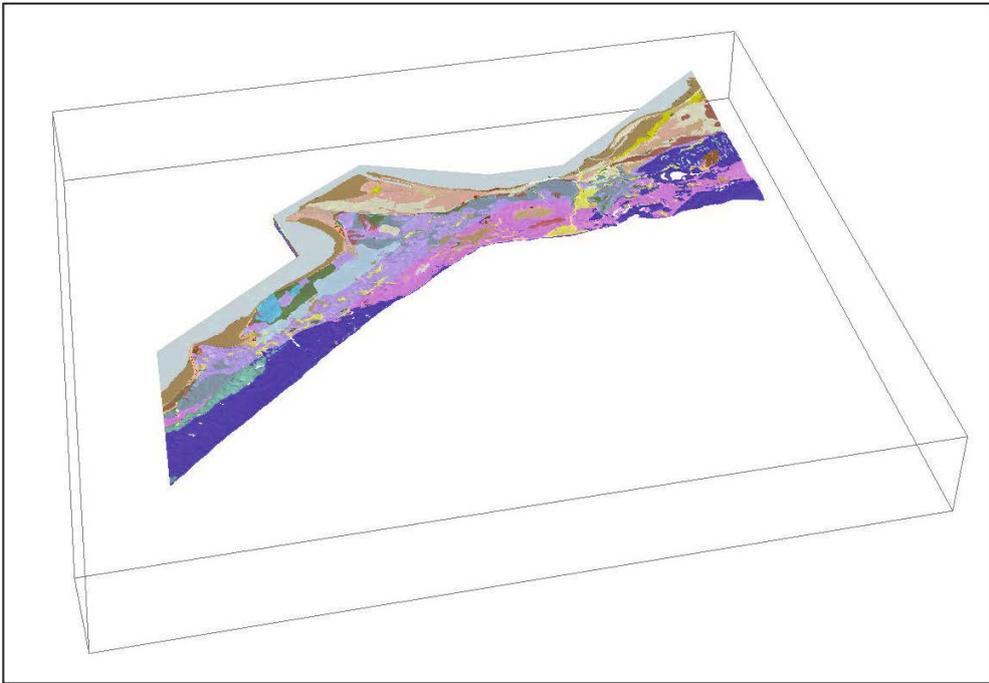


Figure 6: Geological units as seen in 3D window of GSI3D, looking north and vertical exaggeration x5

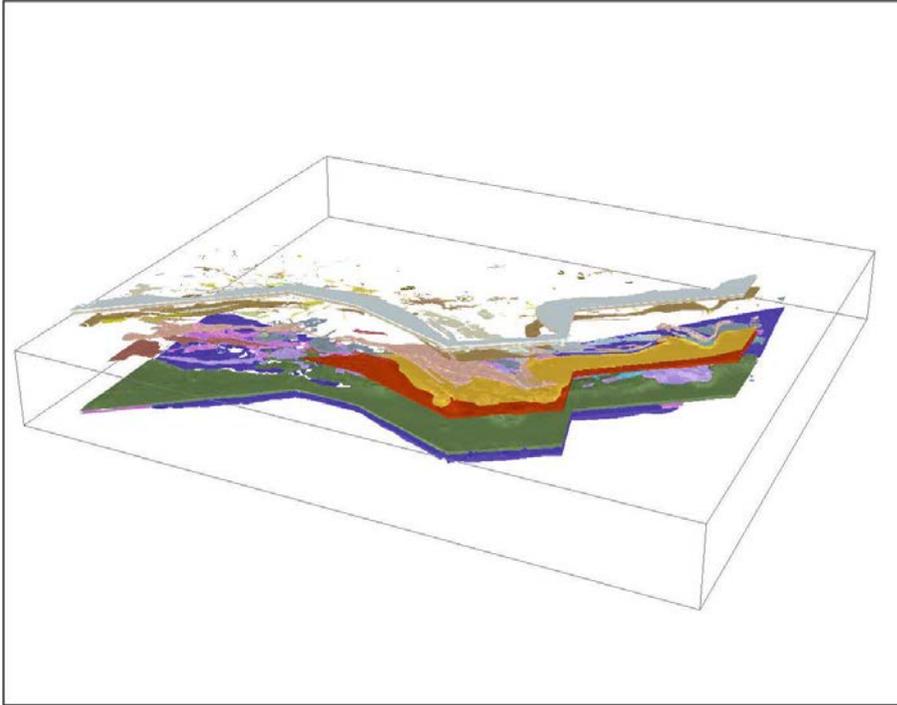


Figure 7: Exploded geological units as seen in 3D window of GSI3D, looking south and vertical exaggeration x5

References

British Geological Survey holds most of the references listed below, and copies may be obtained via the library service subject to copyright legislation (contact libuser@bgs.ac.uk for details). The library catalogue is available at: <http://geolib.bgs.ac.uk>.

ARKLEY, S L B. 2014. Model metadata report for the Great Glen-Moray Firth GSI3D Faulted Bedrock Model. *British Geological Survey, Open Report, OR/14/058*.

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BRITISH GEOLOGICAL SURVEY. 1997. 1:50 000, Fortrose, Scotland Sheet 84W Solid and Drift Geology. (Keyworth, Nottingham: British Geological Survey.)

FINLAYSON, A G and ARKLEY, S L B. 2014. Model metadata report for the Moray Ness Regional GSI3D model, *British Geological Survey, Open Report, OR/14/065*.

FLETCHER, T P, AUTON, C A, HIGHTON, A J, MERRITT, J W, ROBERTSON, S, and ROLLIN, K E. 1996. Geology of Fortrose and eastern Inverness district: *Memoir of the British Geological Survey, Sheet 84W (Scotland)*. London. H.M.S.O.

KESSLER, H, MATHERS, S J, SOBISCH, H-G, and NEBER, A. 2008. GSI3D – The software and methodology to build systematic near-surface 3-D geological models. (Version 2) *British Geological Survey Open Report, OR/08/001*.

Appendix 1

Model Development Log

Version Name	Brief Description	Modeller	Date
Culloden_Nairn_SA_1.gsipr	Initial GSi3D Project created: extracted from GSi3D BaldEarth and NextMap dtm at 50m resolution, extracted bh data from SOBI through the data portal and merged with downhole data from WA93/28R and Clive/Jez Sigma data to produce a merged .bid and .blg file, clipped 25k topo map imported, 2 maps (fig 22 and 28) from fortrose memoir imported, shapefiles of project area (aoi_2011) and data area inc. offshore (aoi_2100_data) imported, clipped superficial geology (Nairn+Fortrose sheets) added, clipped artificial geology (Nairn+Fortrose sheets) added, clipped onshore contours imported and .ts of offshore bathymetry imported.	Sarah Arkley	01/02/2012
Culloden_Nairn_SA_2.gsipr	Sketched out where to put sections on paper. Started with Auldearn bypass boreholes, decided to hang boreholes on the dtm???	Sarah Arkley	02/02/2012
Culloden_Nairn_SA_3.gsipr	Drew section along western edge of the Forres model to use as a tie with this model and brought all Forres sections into the C-N model. Looked at which GSG units were used in the Forres model to extend into this model, bought in all gsg envelopes. Decided to ignore gsg numbers recorded in bh's over C-N area and will try making map polygons of GFSD as gsg2, GFIC as gsg3, GFSU as gsg4 and any gsg deposits under till6 (particularly under raised beach deposits and offshore) as gsg6.	Sarah Arkley	03/02/2012

Culloden_Nairn_SA_4.gsipr	Imported all other envelopes form the Forres model. Looked at which till units used in the Forres model to extend into this model. Decided to use till1, till4, and till6 (main one resting on bedrock on higher ground). Completed first pass on Auldearn bypass section.	Sarah Arkley	03/02/2012
Culloden_Nairn_SA_5.gsipr	Went through Auldearn Bypass section with mapping geologist (Clive), made alterations. Decided to call till above rockhead ('fint'), although inland of 'ard' presence may be younger till ('till6'). This will cause a mismatch with the Forres model which may have to be addressed at a later date (eg. change 'till6' in forres to 'fint'). Using 'fint' required due to findings in bh NH95NW5542_7. Also decided to name all gsg deposits above bedrock or 'fint' as 'gsg6'.	Sarah Arkley	08/02/2012
Culloden_Nairn_SA_6.gsipr	Completed CN_NW-SE_1 (clipped then extended section from the Forres model). Drew section for Clive through Ardersier point.	Sarah Arkley	08/02/2012
Culloden_Nairn_SA_7.gsipr	Added 'sea' into the GVS and GLEG files (placed SEA between DTM and SOIL, with an id of 2). Moved BSA up the GVS (placed BSA at top of superficial deposits, directly beneath artificial deposits, now has an id of 21 instead of 36). Edited CN_NW-SE_2/3/4 (clipped then extended section from the Forres model). Problems extracting topo maps from Arc of the project and problems with coastal deposits – not resolved, GIS people helping.	Sarah Arkley	09/02/2012
Culloden_Nairn_SA_8.gsipr Culloden_Nairn_SA_9.gsipr	Created blank sections trending perpendicular to the coast (NW-SE_5/6/7/8/9/10)	Sarah Arkley	10/02/2012
Culloden_Nairn_SA_10.gsipr	Created blank sections trending perpendicular to the coast (NW-SE_11/12/13/14/15/16). Tried to extract extra Ardersier boreholes from the Data Portal – failed.	Sarah Arkley	10/02/2012
Culloden_Nairn_SA_11.gsipr	Created blank sections trending parallel to the coast across Ardersier point (NE-SW_1/2/3/4/5/6/7/8/9).	Sarah Arkley	10/02/2012

Culloden_Nairn_SA_12.gsipr Culloden_Nairn_SA_13.gsipr Culloden_Nairn_SA_14.gsipr	Created blank sections trending parallel to the coast across entire model (NE-SW_10/11/12).	Sarah Arkley	15/02/2012
Culloden_Nairn_SA_15.gsipr	Created blank sections bounding the model (edge_NW/W/E/SW). Still trying to get 10k topo maps into the project, Diego finally managed to extract then as .jpg's and attach a world file but v.large files which ground GSI3D to a halt. Tried reducing the image but the geographical area also reduced, eventually found a solution using ER Mapper.	Sarah Arkley	16/02/2012
Culloden_Nairn_SA_16.gsipr	Imported missing superficial geology for NH96SW (from Niall Spencer). Created blank coast parallel section (NE-SW_13).	Sarah Arkley	16/02/2012
Culloden_Nairn_SA_17.gsipr	Created blank coast parallel sections (NE-SW_14/15/16/17/18/19/20/21).	Sarah Arkley	16/02/2012
Culloden_Nairn_SA_18.gsipr	Created blank sections perpendicular to the coast (NW-SE_17/18/19/20/21/22/23/24/25/26/27/28).	Sarah Arkley	16/02/2012
Culloden_Nairn_SA_19.gsipr	Created blank sections perpendicular to the coast (NW-SE_29/30/31/32/33/34/35/36). Imported section Clive had been working on last week (from Forres_model_3rdFeb2012_CA1.gsipr) and renamed from Clive_1 to NW-SE_19). Imported sections Eileen had been working on earlier in the week (CN_NW-SE_6/7/8/9/10) from Culloden_Nairn_EC_2.gsipr.	Sarah Arkley Eileen Callaghan Clive Auton	17/02/2012
Culloden_Nairn_SA_20.gsipr	Completed CN_50kmap_section_1, adapting to match geological linework. Completed western half of CN_NE-SW_14	Sarah Arkley	17/02/2012

Culloden_Nairn_SA_21.gsipr	Completed CN_NE-SW_14. Hopefully will link sections perpendicular to coast completed by Eileen and myself.	Sarah Arkley	22/02/2012
Culloden_Nairn_SA_22.gsipr	Completed relevant part of CN_50kmap_section_2, adapting to match geological linework. Completed CN_NW-SE_36.	Sarah Arkley	22/02/2012
Culloden_Nairn_SA_23.gsipr	Completed CN_NW-SE_35. Could do with a Clive check, several bh/map discrepancies.	Sarah Arkley	22/02/2012
Culloden_Nairn_SA_24.gsipr	Completed CN_NW-SE_34 and 33. In section 33 ?till lens or two different moraines?	Sarah Arkley	23/02/2012
Culloden_Nairn_SA_25.gsipr	Completed CN_NW-SE_32/31/30.	Sarah Arkley	23/02/2012
Culloden_Nairn_SA_26.gsipr	Worked on CN_NW-SE_29. Deep borehole (270m) suggests >100m of Alturlie Gravels next to outcrop of Ardersier Silts !!!! Reminds me of deep borehole in Forres model which didn't fit in with surrounding geology. Worked on section CN_NW-SE_28. Generally quite similar to section 1 on 50k map but problems map/bh discrepancies of RMBDD deposits. Worked on CN_NW-SE_27, contains Baddock Till in bh but not shown on map.	Sarah Arkley	23/02/2012
Culloden_Nairn_SA_27.gsipr	Completed CN_NW-SE_27 and 26. In section 26 added in unit of 'bchd' shown in bh but not on map.	Sarah Arkley	24/02/2012

Culloden_Nairn_SA_28.gsipr	Completed CN_NW-SE_25. Base of Alturlie Gravels is seen in 2 bhs approx 170m apart, showing a vertical difference of 25m, this along with the deep borehole in section 29 suggests a very undulating base to the unit, ?redraw some NW-SE sections to represent this. Note, saw this in the Auldearn bypass section too where a higher concentration of bhs exists. Or could the undulating base be an older sand and gravel unit (?gsg6), maybe a buried channel, with 'algr' on top and seen at the surface? (see 50k map section1 with gsg under blown sands. Also drew a smear of Baddock Till in the section, shown in bh but not on the map. Added in unit of 'bchd' as unlikely that 'itdu' reaches 5.67m above sea level, stopped 'itdu' at break of slope (2.10m above sea level). Completed CN_NW-SE_24. Put in additional unit of 'bchd' as in section 25.	Sarah Arkley	24/02/2012
Culloden_Nairn_SA_29.gsipr	Completed section CN_NW-SE_23. Note on last 6-8 section have used 'gsg6' for all the glacial sand and gravels, as suggested by Clive in Auldearn bypass section, implying the sand and gravels are older/below 'ards' and 'algr', but in 50k map section 1, the glacial sand and gravel sheet deposits s are drawn above 'algr' and the glacial sand and gravel ice-contact deposits are drawn between 'algr' and 'ards'. Completed section CN_NW-SE_22.	Sarah Arkley	24/02/2012
Culloden_Nairn_SA_30.gsipr	Completed section CN_NW-SE_21. Drew 'lde' deposits under Loch Flemington, on map as superficial unknown.	Sarah Arkley	24/02/2012
Culloden_Nairn_SA_31.gsipr	Incorporated sections Eileen had been working on (saved under EC1). Copied over CN_NW-SE_ 6/7/10/ 11/ 12.	Sarah Arkley Eileen Callaghan	01/03/2012
Culloden_Nairn_SA_32.gsipr	Completed section CN_NW-SE_20. Thickness of units largely based on CN_50kmap_section_1. Added in unit of 'bchd' as unlikely that 'itdu' reaches 4.5m above sea level, stopped 'itdu' at break of slope (3.4m above sea level). Added a small capping of 'algr' where map/bh mismatch on raised cliffline. Added a small capping of 'bti' where	Sarah Arkley	01/03/2012

	map/bh mismatch just inland from raised cliffline. Brought 'ards' to the surface in the middle of the section to fit with downhole information.		
Culloden_Nairn_SA_33.gsipr	Completed section CN_NW-SE_19. Coastal end started by Clive, rest of section completed by Sarah. Thickness of units largely based on CN_50kmap_section_1. Extended outcrops of 'bti' where map/bh mismatch just inland from raised cliffline. Thick lens of 'ards' (8.5m), ?if should make it part of the actual unit and have a thin lens (1.5m) of 'algr' underneath. Outcrop of 'glld' on a pretty steep slope!	Sarah Arkley	07/03/2012
Culloden_Nairn_SA_34.gsipr	Completed section CN_NW-SE_18. Added small area of 'peat' where recorded in bh but not shown on the map.	Sarah Arkley	07/03/2012
Culloden_Nairn_SA_35.gsipr	Completed section CN_NW-SE_17. Started coast-parallel section (CN_NE-SW_10).	Sarah Arkley	07/03/2012
Culloden_Nairn_SA_36.gsipr	Loaded in updated GVS and GLEG files (v14, Subtidal Holocene Deposits added by Eileen, SUBTD). Worked on long coast-parallel section (CN_NE-SW_10).	Sarah Arkley	09/03/2012
Culloden_Nairn_SA_37.gsipr	Edits with Clive. Various sections: CN_NW-SE_10/11 (tweaked linework) + CN_50kmap_section_2 (added Kessock Bridge Silt) + CN_NW-SE_30/29/28/27/26 (dealt with huge thickness of 'algr' in Castle Stuart bh, 'ards' lens and 'bti' extent) + CN_NW-SE_19 (thick 'ards' lens and steep 'glld' lens)	Sarah Arkley Clive Auton	09/03/2012
Culloden_Nairn_SA_38.gsipr	Completed coast-parallel section (CN_NE-SW_10).	Sarah Arkley	16/03/2012

Culloden_Nairn_SA_39.gsipr	Worked on coast-parallel section (CN_NE-SW_12). Struggled to make CA1134 fit with mapping in section, fitted to downhole data.	Sarah Arkley	03/04/2012
Culloden_Nairn_SA_40.gsipr	Added Andrew's onshore-offshre RHEM and DSM. Worked on coast-parallel section (CN_NE-SW_12).	Sarah Arkley	04/04/2012
Culloden_Nairn_SA_41.gsipr	Completed coast-parallel section (CN_NE-SW_12). Removed Andrew's onshore-offshre RHEM and DSM – big files and ?because over a large area the resolution is too coarse to help with this model.	Sarah Arkley	04/04/2012
Culloden_Nairn_SA_42.gsipr	Worked on coast-parallel section (CN_NE-SW_11).	Sarah Arkley	04/04/2012
Culloden_Nairn_SA_43.gsipr	Worked on coast-parallel section (CN_NE-SW_11).	Sarah Arkley	05/04/2012
Culloden_Nairn_SA_44.gsipr	Worked on coast-parallel section (CN_NE-SW_11).	Sarah Arkley	05/04/2012
Culloden_Nairn_SA_45.gsipr	Completed coast-parallel section (CN_NE-SW_11).	Sarah Arkley	11/04/2012
Culloden_Nairn_SA_46.gsipr	Worked on section (CN_NW-SE_15), left NW'rn end, still waiting for Ardersier bh's to be entered.	Sarah Arkley	11/04/2012

Culloden_Nairn_SA_47.gsipr	Worked on section (CN_NW-SE_16), left NW'rn end, still waiting for Ardersier bh's to be entered.	Sarah Arkley	11/04/2012
Culloden_Nairn_SA_48.gsipr	Worked on section (CN_NW-SE_14), left NW'rn end, still waiting for Ardersier bh's to be entered.	Sarah Arkley	11/04/2012
Culloden_Nairn_SA_48.gsipr	Completed section CN_NW-SE_13. Tweaked other nearby sections.	Sarah Arkley	12/04/2012
Culloden_Nairn_SA_49.gsipr	Tweaked section CN_NW-SE_12. Not sure about coding of RMBDD in bh's and need to edit artificial ground in quarry at SE end.	Sarah Arkley	12/04/2012
Culloden_Nairn_SA_50.gsipr	Tweaked sections CN_NW-SE_1/2/3/4.	Sarah Arkley	12/04/2012
Culloden_Nairn_SA_51.gsipr	Completed section CN_NW-SE_5 and tweaked many other nearby sections.	Sarah Arkley	13/04/2012
Culloden_Nairn_SA_52.gsipr	Completed and tweaked sections in the NE corner of the model.	Sarah Arkley	13/04/2012
Culloden_Nairn_SA_53.gsipr	Completed a helper section in the NE corner of the model (CN_helper_NE corner). Check looks reasonable with Clive and then adapt nearby sections. Way I've drawn it suggests main post glacial cliff is further NW and RMBDD (Late Devensian) is on top of the cliff. Worked on coast-parallel section (CN_NE-SW_13).	Sarah Arkley	13/04/2012

Culloden_Nairn_SA_54.gsipr	Checked and edited helper section in the NE corner of the model (CN_helper_NE corner) with Clive. Worked on coast-parallel section (CN_NE-SW_13).	Sarah Arkley	18/04/2012
Culloden_Nairn_SA_55.gsipr	Updated sections cutting through NH96SW with new geological linework received from Clive. Worked on coast-parallel section (CN_NE-SW_13).	Sarah Arkley	18/04/2012
Culloden_Nairn_SA_56.gsipr	Loaded updated GVS (MorayNess_gvs_V14_18April2012.gvs). Completed tweaks to section CN_NW-SE_9.	Sarah Arkley	19/04/2012
Culloden_Nairn_SA_57.gsipr	Completed tweaks to section CN_NW-SE_8.	Sarah Arkley	19/04/2012
Culloden_Nairn_SA_58.gsipr	Finished tweaks to sections CN_NW-SE_4/5/6/7/8/9, to try and make raised beach levels consistent. In sections CN_NW-SE_1/2/3 RMBDD at a much lower level (fits with the Forres model but probably too low). Need to sort out gsg's, is it all to be called gsg6 or do we interfinger with Forres where most of it is gsg2 and gsg3 in the upland areas.	Sarah Arkley	19/04/2012
Culloden_Nairn_SA_59.gsipr	Wasted most of a day trying to extract an up-to-date set of bh's, without a result (Clive has coded up more bh's at western end and in Ardersier Point, entered by Eileen). Spoke to Holger et al but no solution as yet – ask Ken to extract them . Also noticed a rogue point has been added into section CN_NE-SW_11, tried deleting the point but corrupted linework in the rest of the section, so deleted the entire section from the project and re-imported the section from Culloden_Nairn_SA_45.gsipr.	Sarah Arkley	20/04/2012
Culloden_Nairn_SA_60.gsipr	Worked on section CN_edge_NW. Completed sea layer using bath contours. All layers at eastern end of section. Added new .bid/.blg file to include extra bh's on Ardersier and near Inverness.	Sarah Arkley	20/04/2012

Culloden_Nairn_SA_61.gsipr	Extended/alterd a number of section lines on Ardersier Point to incorporate new boreholes: CN_NE-SW_0/1/2/3/4/5/6 and CN_NW-SE_15/16/17.	Sarah Arkley	03/05/2012
Culloden_Nairn_SA_62.gsipr	Drawing and tweaking section lines on Ardersier Point to incorporate new borehole data: CN_NE-SW_0/1/2/3/4/5/6 and CN_NW-SE_15/16/17.	Sarah Arkley	03/05/2012
Culloden_Nairn_SA_63.gsipr	Drawing and tweaking section lines on Ardersier Point to incorporate new borehole data: CN_NE-SW_0/1/2/3/4/5/6 and CN_NW-SE_15/16/17 mainly.	Sarah Arkley	04/05/2012
Culloden_Nairn_SA_64.gsipr	Drawing and tweaking section lines on Ardersier Point to incorporate new borehole data: CN_NE-SW_0/1/2/3/4/5/6 and CN_NW-SE_15/16/17 mainly. Created 'sea' geological unit. Completed 'sea' layer in all sections, except for eastern bounding section.	Sarah Arkley	04/05/2012
Culloden_Nairn_SA_65.gsipr	Completed 'sea' layer in all sections. Completed envelop for 'sea'. Trial calculation looks reasonable after some tweaking, problems on coast at Adrisier Point where -10m bathymetry comes onshore.	Sarah Arkley	09/05/2012
Culloden_Nairn_SA_66.gsipr	Completed envelop for 'sub-tidal deposits'. Exported the 'sea' envelop as a shapefile and imported it again, copying into 'sub-tidal deposits' (see Ricky's e-mail 09/05/2012). Completed 'kebr' in sections CN_NE-SW_1/2/3/4/5 + 50 map section.	Sarah Arkley	09/05/2012
Culloden_Nairn_SA_67.gsipr	Completed 'kebr' in sections CN_NW-SE_15/16/17/18/19/20/21/22 +CN_NE-SW_6 (eastern half). Deep bhs in Ardersier Yard if hung on dtm make base of 'kebr' appear quite undulating, if you don't hang them base will appear much flatter as constructed elsewhere in the model, ?unhang bhs on areas of made ground? Currently always hung bhs for this model. At the moment have left base fitted to levels in hung bhs.	Sarah Arkley	10/05/2012

Culloden_Nairn_SA_68.gsipr	Added seismic lines from Alick (reprojected them to BNG in ArcCatalogue). Completed 'kebr' in sections CN_NE-SW_0/7/8/9/10(eastern half) + CN_NW-SE_14/13/12 + NW edge section around Ardersier Pt.	Sarah Arkley	10/05/2012
Culloden_Nairn_SA_69.gsipr	Completed 'rmbdf' in sections CN_NW-SE_15/16/17/18/19/20/21 + CN_NE-SW_0/1/2/3/4/5 + some of NW edge section.	Sarah Arkley	10/05/2012
Culloden_Nairn_SA_70.gsipr	Completed 'rmbdf' in sections CN_NW-SE_13/14/22/23/24/25 + CN_NE-SW_6/7/8/9 + NW edge section around Ardersier Pt.	Sarah Arkley	11/05/2012
Culloden_Nairn_SA_71.gsipr	Worked on 'ards', using the 50k map section as a control along with one of the deepest bhs at the Ardersier Yard (NH85NWB14) constructed a base of 'ards' along CN_NE-SW_5 to use as a control with the 50k map section. Completed 'ards' in sections CN_NW-SE_14/15/16/17/18/19/20/21/22 + CN_NE-SW_0/1/2/3/4/5/6 (eastern part).	Sarah Arkley	11/05/2012
Culloden_Nairn_SA_72.gsipr	Completed 'ards' in sections CN_NE-SW_7+8 + 9 + 10 (eastern parts).	Sarah Arkley	11/05/2012
Culloden_Nairn_SA_73.gsipr	Completed 'ards' in NW edge section around Ardersier Pt. and in sections CN_NE-SW_7 (western part). Completed a v.basic envelope for 'ards', fiddled with sections to try and make the base look sensible, struggled.	Sarah Arkley	16/05/2012
Culloden_Nairn_SA_74.gsipr	Completed 'ards' in all sections, although some degree of tweaking is still required, esp in section to the east of Ardersier Pt. Calculated unit, put contours on base, looks much better than before. Completed a v.basic envelope for 'rmbdf'.	Sarah Arkley	16/05/2012
Culloden_Nairn_SA_75.gsipr	Completed some tweaking of 'ards', 'rmbdf' and kebr' in necessary sections across the model, calculating and contouring basal surfaces using v.basic envelopes.	Sarah Arkley	17/05/2012

Culloden_Nairn_SA_76.gsipr	Completed some more tweaking of 'ards', 'rmbdf' and 'kebr' in necessary sections across the model, calculating and contouring basal surfaces using v.basic envelopes.	Sarah Arkley	17/05/2012
Culloden_Nairn_SA_77.gsipr	Discussions with Alick re matching up GSI3D linework with Moray Firth seismic linework, plus possibility of importing multibeam seabed surface into GSI3D and seismic (with picks if possible) into GSI3D.	Sarah Arkley	18/05/2012
Culloden_Nairn_SA_78.gsipr	Added missing units into Ardersier Point sections.	Sarah Arkley	31/05/2012
Culloden_Nairn_SA_79.gsipr	Added missing units into Ardersier Point sections.	Sarah Arkley	01/06/2012
Culloden_Nairn_SA_80.gsipr	Completed 'bsa' in sections and drew envelopes, still needs some editing at eastern edge to join with Forres model. Worked on envelope for 'itdu'.	Sarah Arkley	01/06/2012
Culloden_Nairn_KW_81.gsipr	Completed sections CN_NE-SW_15 Issue with raised tidal flat deposits at sheet boundary in area of Cran Loch (947 591). The deposits are numbered differently across the sheet edge (e.g. RMDF2 is equivalent to RMDF3 on the adjacent sheet and RMDF3 is equivalent to RMDF4).	Katie Whitbread	06/06/2012
Culloden_Nairn_KW_82.gsipr	Completed section CN_NE-SW_16. (Note that till and glaciofluvial sand and gravel units are named differently to those of Forres model.)	Katie Whitbread	06/06/2012
Culloden_Nairn_KW_83.gsipr	Completed section CN_NE-SW_17. (Note that till and glaciofluvial sand and gravel units are named differently to those of Forres model.)	Katie Whitbread	06/06/2012

Culloden_Nairn_KW_84.gsipr	Completed section CN_NE-SW_18. To fit with crossing sections, some sand and gravel modelled as gsg2, elsewhere gsg6 was used.	Katie Whitbread	06/06/2012
Culloden_Nairn_SA_85.gsipr	Drew 4 new sections along Moray Firth offshore seismic lines 45, 47, 66 & 67, located close to Ardersier Point. Imported .jpg seismic images with picks as raster backdrops. Note big discrepancy between seismic seabed and bathymetry DTM which needs sorted before trying to correlate base of geological units.	Sarah Arkley	13/06/2012
Culloden_Nairn_SA_86.gsipr	Edits to envelope for 'itdu'.	Sarah Arkley	14/06/2012
Culloden_Nairn_SA_87.gsipr	Edits to envelope for 'fint'.	Sarah Arkley	14/06/2012
Culloden_Nairn_SA_88.gsipr	Edits to envelope for 'fint'.	Sarah Arkley	14/06/2012
Culloden_Nairn_SA_89.gsipr	Drew tentative linework on seismic images, discussed matches/mismatches with Alick.	Sarah Arkley	15/06/2012
Culloden_Nairn_SA_90.gsipr	Received another 8 seismic sections from Alick to import into GSI3D. Cropped and reduced images, then created sections in GSI3D to hang them from. Only then realised that the .shp file I'd been given showing the location of the lines was the 'planned' lines not the 'actual' lines! Found the .shp file showing the actual lines from the marine GIS, copied it into Culloden-Nairn folder and reprojected the file into BNG. Imported it into GSI3D. Lines don't vary hugely but in places 40m out. Deleted the sections drawn to planning lines and redrew them using actual lines (CN_seismic_46/48/54/59/60/64/69/78).	Sarah Arkley	20/06/2012

Culloden_Nairn_SA_91.gsipr	Calculated total depths in metres for seismic images (variable depending on average water depth) and imported seismic images as raster backdrops into 8 sections (CN_seismic_46/48/54/59/60/64/69/78).	Sarah Arkley	20/06/2012
Culloden_Nairn_SA_92.gsipr	Completed 'sea' layer on sections CN_seismic_46/48/54/59/60/64/69/78.	Sarah Arkley	21/06/2012
Culloden_Nairn_SA_93.gsipr	Messed around on seismic lines. Having lots of trouble matching everything up.	Sarah Arkley	21/06/2012
Culloden_Nairn_SA_94.gsipr	Messed around on onshore lines.	Sarah Arkley	21/06/2012
Culloden_Nairn_SA_95.gsipr	Messed around on onshore lines.	Sarah Arkley	21/06/2012
Culloden_Nairn_SA_96.gsipr	Lots of editing and tweaking in onshore sections. All sections QA'd by Clive.	Sarah Arkley Clive Auton	22/06/2012
Culloden_Nairn_SA_97.gsipr	Lots of editing and tweaking in onshore sections. All sections QA'd by Clive.	Sarah Arkley Clive Auton	22/06/2012
Culloden_Nairn_SA_98.gsipr	Made edits to onshore sections following QA session with Clive. CN_NW-SE_1/2	Sarah Arkley	28/06/2012

Culloden_Nairn_SA_99.gsipr	Made edits to onshore sections following QA session with Clive. CN_NW-SE_3/4/5	Sarah Arkley	28/06/2012
Culloden_Nairn_SA_100.gsipr	Created 19 helper sections to capture all artificial ground polygons.	Sarah Arkley	29/06/2012
Culloden_Nairn_SA_101.gsipr	Created 3 helper sections to capture all morainic polygons. Made edits to onshore sections following QA session with Clive. CN_NW-SE_6/7/8.	Sarah Arkley	29/06/2012
Culloden_Nairn_SA_102.gsipr	Made edits to onshore sections following QA session with Clive. CN_NW-SE_9 and part way through 10.	Sarah Arkley	29/06/2012
Culloden_Nairn_KW_103.gsipr	Added interpretation to artificial deposit helper sections CN_helper_artificial_1 and 2	Katie Whitbread	02/07/2012
Culloden_Nairn_KW_104.gsipr	<p>Added interpretation to sections CN_helper_artificial_3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18 and 19</p> <p>Artificial ground only modelled in these sections where recorded in boreholes.</p> <p>Note: area of sand and gravel in section CN_NW-SE_10 where it crosses CN_helper_artificial_10 is classed as gsg5 whereas the same unit in adjacent sections is gsg6 (CN_NE-SW_17 and CN_NE-SW_19) or gsg2 (CN_NW-SE_9 and CN_NE-SW_18). All helper sections modelled here with gsg6.</p>	Katie Whitbread	02/07/2012

Culloden_Nairn_SA_105.gsipr	Made edits to onshore sections following QA session with Clive. CN_NW-SE_10	Sarah Arkley	04/07/2012
Culloden_Nairn_SA_106.gsipr	Made edits to onshore sections following QA session with Clive. CN_NW-SE_11/12	Sarah Arkley	05/07/2012
Culloden_Nairn_SA_107.gsipr	Made edits to onshore sections following QA session with Clive. CN_NW-SE_13/14	Sarah Arkley	05/07/2012
Culloden_Nairn_SA_108.gsipr	Made edits to onshore sections following QA session with Clive. CN_NW-SE_15/16 (not completed)	Sarah Arkley	05/07/2012
Culloden_Nairn_SA_109.gsipr	Tried to import multibeam data from Rhys. Completely failed – probably due to large file size, also projects in the wrong place in the GIS, asked Diego to look at it, but couldn't solve the problem, asked Ricky to take a look. Fixed corrupted file, back to Diego to create grids. Edited marine and raised beach deposits in sections CN_NW-SE_36/35/34/33/32/31/30/29/28.	Sarah Arkley	18/07/2012
Culloden_Nairn_SA_110.gsipr	Edited marine and raised beach deposits in sections CN_NW-SE_27/26/25/24/23. Completely finished 36, almost finished 35.	Sarah Arkley	18/07/2012
Culloden_Nairn_SA_111.gsipr	Diego decided better to make grids in software marine guys use not Arc, so back to Rhys (out of office). Completely finished CN_NW-SE_35/34/33/32.	Sarah Arkley	19/07/2012
Culloden_Nairn_SA_112.gsipr	Diego decided better to make grids in software marine guys use not Arc, so back to Rhys (out of office). Completely finished CN_NW-SE_31/30/29/28/27 (not completed).	Sarah Arkley	19/07/2012

Culloden_Nairn_SA_113.gsipr	Rhys looked at multibeam data again. Completely finished CN_NW-SE_27/26 (not completed).	Sarah Arkley	20/07/2012
Culloden_Nairn_SA_114.gsipr	Completely finished CN_NW-SE_26/25/24 + CN_edge_SW.	Sarah Arkley	25/07/2012
Culloden_Nairn_SA_115.gsipr	Worked on CN_NE-SW_12. Lost 2hrs work when GSI3D crashed – network/power-cut problems in KW. Went home.	Sarah Arkley	25/07/2012
Culloden_Nairn_SA_116.gsipr	Completely finished CN_NE-SW_12 and 13. Put in envelopes for alv1 (alv in e and w superficial geology shapefiles) and envelopes for peat (peat in e and w superficial geology shapefiles) deleted a few polygons from the w superficial geology where overlapped with the e superficial geology map. No edits made to envelopes. Put in envelopes for mgr, wgr, lsgr and wmgr for eastern and western areas.	Sarah Arkley	26/07/2012
Culloden_Nairn_SA_117.gsipr	Completely finished CN_NE-SW_14 and 15.	Sarah Arkley	26/07/2012
Culloden_Nairn_SA_118.gsipr	Completely finished CN_NE-SW_16 and 17.	Sarah Arkley	27/07/2012
Culloden_Nairn_SA_119.gsipr	Completely finished CN_NE-SW_18 and 19.	Sarah Arkley	27/07/2012
Culloden_Nairn_SA_120.gsipr	Completely finished CN_NE-SW_20 and 21.	Sarah Arkley	27/07/2012

Culloden_Nairn_SA_121.gsipr	Completely finished CN_helper_mord_1/2.	Sarah Arkley	27/07/2012
Culloden_Nairn_SA_122.gsipr	Completely finished CN_helper_mord_3 and CN_helper_artificial_1/2/3/4/5.	Sarah Arkley	29/07/2012
Culloden_Nairn_SA_123.gsipr	Completely finished CN_helper_artificial_6/7/8/9/10.	Sarah Arkley	29/07/2012
Culloden_Nairn_SA_124.gsipr	Completely finished CN_helper_artificial_11/12/13.	Sarah Arkley	29/07/2012
Culloden_Nairn_SA_125.gsipr	Completely finished CN_helper_artificial_14/15/16/17/18/19.	Sarah Arkley	01/08/2012
Culloden_Nairn_SA_126.gsipr	Completely finished CN_helper_Balt, CN_helper_NE_corner and almost finished CN_edge_E.	Sarah Arkley	01/08/2012
Culloden_Nairn_SA_127.gsipr	Completed envelopes for 'sea' and 'itdu'. Drew additional sections (CN-helper_bsa_1 and 2) on laptop at home.	Sarah Arkley	01/08/2012
Culloden_Nairn_SA_128.gsipr	Tried and failed to copy over envelopes and sections completed on the laptop, Tim also had a go but file appears corrupted. Very annoying – took hours. Redrew the 2 helper sections, still to redraw envelopes.	Sarah Arkley	02/08/2012

Culloden_Nairn_SA_129.gsipr	Completely finished CN_edge_E. Stripped out lots of .jpg and.shp files. Almost finished drawing 'sea' envelope, working from west end, up to River Nairn snapping envelope to sections.	Sarah Arkley	02/08/2012
Culloden_Nairn_SA_130.gsipr	Completely finished drawing/snapping 'sea' envelope, which includes a handful of inland lochs and the lower reaches of the River Nairn.	Sarah Arkley	03/08/2012
Culloden_Nairn_SA_131.gsipr	Completely finished drawing/snapping 'subtd' envelope.	Sarah Arkley	03/08/2012
Culloden_Nairn_SA_132.gsipr	Worked on 'bsa' envelope. Finished drawing envelopes but computer slowed down massively when asked to display "correlation snap-points" (to snap envelopes to extent of the unit in the sections) – to the extent that it's unusable. Snapped envelopes as best as could.	Sarah Arkley	03/08/2012
Culloden_Nairn_SA_133.gsipr	Edited list of geological units used in the model and updated an excel table of sections/envelopes completed to date.	Sarah Arkley	03/08/2012
Culloden_Nairn_CAA_133.gsipr	Construction and snapping of various envelopes.	Clive Auton	06/08/2012
Culloden_Nairn_CAA_134.gsipr	Construction and snapping of various envelopes.	Clive Auton	06/08/2012
Culloden_Nairn_CAA_135.gsipr	Construction and snapping of various envelopes.	Clive Auton	06/08/2012

Culloden_Nairn_SA_136.gsipr	Continued from envelope work Clive has completed. Incorporated all 'mord3' into 'ards'. Removed 'mord3' from list of geological units. Added a couple of 'algr' lenses into 'ards' unit. Converted 'mord1' polygons (envelopes) and linework (sections) in central and eastern part of the model to 'hmgd' to match with the Forres model. Left extensive outcrops of moraine in the western part of the model as 'mord1'.	Sarah Arkley	08/08/2012
Culloden_Nairn_SA_137.gsipr	Completed and snapped 'lsgr' and 'wgr' envelope.	Sarah Arkley	08/08/2012
Culloden_Nairn_SA_138.gsipr	Completed and snapped 'wmgr' envelope. Removed all of the Forres sections to see if it would speed up the computer a bit.	Sarah Arkley	09/08/2012
Culloden_Nairn_SA_139.gsipr	Completed and snapped 'mgr' and 'trd' envelope.	Sarah Arkley	09/08/2012
Culloden_Nairn_SA_140.gsipr	Worked on 'bchd' and 'itdu' envelopes.	Sarah Arkley	09/08/2012
Culloden_Nairn_SA_141.gsipr	Completed and snapped 'bchd' and 'itdu' envelopes.	Sarah Arkley	10/08/2012
Culloden_Nairn_KWHI_143.gsipr	(Base file was Culloden_Nairn_SA_141.gsipr) rmbdd envelope created and snapped. Issues at eastern edge where CN model joins the adjacent model. Section CN_NW-SE_2 contains no rmbdd but edge section does. ...	Katie Whitbread	13/08/2012
Culloden_Nairn_KWHI_144.gsipr	Rtfdd envelope completed and snapped. (Digmap polygons imported and edited)	Katie Whitbread	13/08/2012

Culloden_Nairn_SA_142.gsipr	Completed and snapped 'samd' and 'peat2' envelopes.	Sarah Arkley	15/08/2012
Culloden_Nairn_SA_143.gsipr	Checked/snapped CN_Auldearn_bypass_section. Completed CN_helper_peat_1 and CN_helper_peat_2.	Sarah Arkley	15/08/2012
Culloden_Nairn_SA_144.gsipr	Completed CN_helper_peat_3 /4/5/6/7/8.	Sarah Arkley	16/08/2012
Culloden_Nairn_SA_145.gsipr	Checked/snapped 'peat1' envelopes.	Sarah Arkley	16/08/2012
Culloden_Nairn_SA_146.gsipr	Added checked and snapped 'ards' and 'gfdd1' envelopes from Clive (Culloden_Nairn_CAA_145.gsipr).	Sarah Arkley Clive Auton	16/08/2012
Culloden_Nairn_SA_147.gsipr	Worked on numbering raised beach deposits in western part of the model where previously all 'rmbdf'. Clive completed and snapped 'alf' polygons.	Sarah Arkley Clive Auton	17/08/2012
Culloden_Nairn_SA_148.gsipr	Worked on numbering raised beach deposits in western part of the model where previously all 'rmbdf'.	Sarah Arkley	17/08/2012
Culloden_Nairn_SA_149.gsipr	Worked on numbering raised beach deposits in western part of the model where previously all 'rmbdf'.	Sarah Arkley	17/08/2012

Culloden_Nairn_SA_150.gsipr	Worked on numbering raised beach deposits in western part of the model where previously all 'rmbdf'.	Sarah Arkley	17/08/2012
Culloden_Nairn_SA_151.gsipr	Completely finished CN_NW-SE_23/22/21 + CN_edge_W.	Sarah Arkley	17/08/2012
Culloden_Nairn_SA_152.gsipr	Added 'rmdf1-3' envelopes worked on by Eileen (Culloden_Nairn_ECAL_144.gsipr). Added 'lde' envelope, completed and snapped by Clive (Culloden_Nairn_CAA_152.gsipr). Sarah completed some edits to the sections. Computer crashed, error messages coming up when loads the project, but still seems to work once ok'd the error message.	Sarah Arkley Eileen Callaghan Clive Auton	22/08/2012
Culloden_Nairn_SA_153.gsipr	Completely finished CN_NW-SE_20. Worked on CN_NW-SE_19.	Sarah Arkley	22/08/2012
Culloden_Nairn_SA_154.gsipr	Completely finished CN_NW-SE_19/18/17.	Sarah Arkley	23/08/2012
Culloden_Nairn_SA_155.gsipr	Completely finished CN_NW-SE_16 and CN_NE-SW_11.	Sarah Arkley	23/08/2012
Culloden_Nairn_SA_155.gsipr	Added 'rmbdd' and 'rtfdd' envelopes, completed and snapped by Katie. Made some edits to 'rtfdd' envelope.	Sarah Arkley Katie Whitbread	23/08/2012
Culloden_Nairn_SA_156.gsipr	Finished edits to 'rtfdd' envelope.	Sarah Arkley	24/08/2012

Culloden_Nairn_SA_157.gsipr	Started and completed edits to 'rmbdd'. Created new helper section (CN_helper_rtfd) and snapped envelopes already completed to it.	Sarah Arkley	24/08/2012
Culloden_Nairn_SA_158.gsipr	Started and completed 'rtd1' envelope. Completed new helper section (CN_helper_rtd1) and snapped envelopes already completed to it. Started and completed 'rtfd1' envelope.	Sarah Arkley	24/08/2012
Culloden_Nairn_SA_159.gsipr	Error messages still appearing when load the project. Tried deleting some rasters and shapefiles. No difference.	Sarah Arkley	29/08/2012
Culloden_Nairn_SA_161.gsipr	Opened 'Culloden_Nairn_SA_160.gsipr', deleted 'alv1' envelope and re-imported the envelope from Culloden_Nairn_CAA_156.gsipr (completed and snapped by Clive), still some section edits to make. Sorted list of geological units back into GVS order. Deleted 'gsg6' envelope and re-imported the envelope from Culloden_Nairn_CAA_156.gsipr (worked on by Clive), still to be completed and section edits to make. Sorted list of geological units back into GVS order. Still need to do Clive's edits (written in notebook) . Worked on envelope for gsg6.	Sarah Arkley Clive Auton	07/11/2012
Culloden_Nairn_SA_162.gsipr	Opened 'Culloden_Nairn_SA_161.gsipr', worked on envelope for gsg6.	Sarah Arkley	08/11/2012
Culloden_Nairn_SA_163.gsipr	Opened 'Culloden_Nairn_SA_162.gsipr', worked on envelope for gsg6. Made edits with Clive to 'alv1' and 'gsg6' mainly.	Sarah Arkley Clive Auton	08/11/2012
Culloden_Nairn_SA_164.gsipr	Opened 'Culloden_Nairn_SA_163.gsipr', worked on envelope for gsg6.	Sarah Arkley	08/11/2012

Culloden_Nairn_SA_165.gsipr	Opened 'Culloden_Nairn_SA_164.gsipr', completed envelope for gsg6.	Sarah Arkley	08/11/2012
Culloden_Nairn_SA_166.gsipr	Opened 'Culloden_Nairn_SA_165.gsipr', completed first pass envelope for 'kebr'. Worked on 'gsg2' envelope.	Sarah Arkley	08/11/2012
Culloden_Nairn_SA_167.gsipr	Opened 'Culloden_Nairn_SA_166.gsipr', completed 'gsg2' envelope. Edits on 'mord1' and 'hmgd' envelope	Sarah Arkley	09/11/2012
Culloden_Nairn_SA_168.gsipr	Opened 'Culloden_Nairn_SA_167.gsipr', completed all lens envelopes ('till_top', 'glld_top', 'bti_top', 'algr_top', 'balt_top', and 'ards_top'). Some edits on 'mord1' and 'hmgd' envelope.	Sarah Arkley	09/11/2012
Culloden_Nairn_SA_169.gsipr	Opened 'Culloden_Nairn_SA_168.gsipr', imported 'rbldu' enveloped from Culloden_Nairn_ECAL_152.gsipr.	Sarah Arkley Eileen Callaghan	09/11/2012
Culloden_Nairn_SA_170.gsipr	Opened 'Culloden_Nairn_SA_169.gsipr', did trial calculated and looked at the calculated polygons in section and where problems area where, which may need additional helper sections (usually where existing sections are too far apart). Added 'glld2' geological unit and did envelope for it.	Sarah Arkley	14/11/2012
Culloden_Nairn_SA_171.gsipr	Opened 'Culloden_Nairn_SA_170.gsipr', imported updated envelopes for rmdf1-4 from Culloden_Nairn_ECAL_152.gsipr and went through edits with Eileen – Eileen to make further changes to envelopes to fit with sections, Sarah to make changes to a few sections. Also imported updated envelopes for 'algr' from Culloden_Nairn_ECAL_152.gsipr and went through edits with Eileen –Sarah to make changes to envelopes and sections.	Sarah Arkley Eileen Callaghan	28/11/2012

Culloden_Nairn_SA_172.gsipr	Opened 'Culloden_Nairn_SA_171.gsipr', completed changes to 'algr' envelopes and sections.	Sarah Arkley	28/11/2012
Culloden_Nairn_SA_173.gsipr	Opened 'Culloden_Nairn_SA_172.gsipr', worked on changes to 'rmdf1-4' envelopes and sections.	Sarah Arkley	29/11/2012
Culloden_Nairn_SA_174.gsipr	Opened 'Culloden_Nairn_SA_173.gsipr', worked on changes to 'rmdf1-4' envelopes and sections. Completed envelopes for 'rmbdf1'.	Sarah Arkley	29/11/2012
Culloden_Nairn_SA_175.gsipr	Opened 'Culloden_Nairn_SA_174.gsipr', worked on changes to 'rmdf1-4' envelopes and sections. Almost completed envelopes at western end.	Sarah Arkley	29/11/2012
Culloden_Nairn_SA_176.gsipr	Opened 'Culloden_Nairn_SA_175.gsipr', worked on changes to 'rmdf1-4' envelopes and sections. Completed envelopes from CN_NW-SE_27 westwards – I think! Did trial calculation and did quick check through all NW-SE sections for any obvious errors in the synthetic/calculated base of units. Plus a bit of work on 'Ide'. Errors mainly resulting from 'fint' (envelope not drawn yet) and seismic sections (delete before final calculation if not interpreted) and some from rmdf units (envelopes not finalised). Something weird going on in a number of sections with base of 'algr' in the area between Nairn and Auldearn along grid line Y=855866. Can't work it out!!!!	Sarah Arkley	30/11/2012
Culloden_Nairn_SA_177.gsipr	Opened 'Culloden_Nairn_SA_176.gsipr', few changes to envelope for 'Ide'. From trial calculation did quick check through all helper sections for any obvious errors in the synthetic/calculated base of units. Plus a bit of work on 'alv1'.	Sarah Arkley	30/11/2012
Culloden_Nairn_SA_178.gsipr	Opened 'Culloden_Nairn_SA_177.gsipr', from trial calculation did quick check through some NE-SW sections for any obvious errors in the synthetic/calculated base of units. Starting at top of list got down to ??? (turned the computer off – bugger!)	Sarah Arkley	30/11/2012

Culloden_Nairn_SA_179.gsipr	Opened 'Culloden_Nairn_SA_178.gsipr', deleted 'fint' envelope and re-imported the envelope from Culloden_Nairn_CAA_179.gsipr (completed and snapped by Clive), completed edits in sections too.	Sarah Arkley Clive Auton	05/12/2012
Culloden_Nairn_SA_180.gsipr	Opened 'Culloden_Nairn_SA_179.gsipr', did another trial calculation and checked through the rest of the NE-SW sections (quickly) for any obvious errors in the synthetic/calculated base of units.	Sarah Arkley	05/12/2012
Culloden_Nairn_SA_181.gsipr	Opened 'Culloden_Nairn_SA_180.gsipr', deleted 'rmdf1-4' envelopes and re-imported the envelope from Culloden_Nairn_ECAL_153.gsipr (completed and snapped by Eileen). Finished editing envelopes from CN_NW-SE_23 westwards.	Sarah Arkley Eileen Callaghan	05/12/2012
Culloden_Nairn_SA_182.gsipr	Opened 'Culloden_Nairn_SA_181.gsipr', did very little to the model but calculated it and exported all as grids, then imported the sections, bh's, and geological units into Arc, along with changing the ascii grids into esri grids and importing them too. Saved as CN_v181.mxd. Created 7 new helper sections to help with water bodies, River Nairn and inlets. Only drew water lines or where under the sea drew water and subtidal deposits.	Sarah Arkley	18/01/2013
Culloden_Nairn_SA_183.gsipr	Opened 'Culloden_Nairn_SA_182.gsipr'. Created new sea helper section for sea inlet in NE of model, drawing sea and subtidal deposits only in section. Created several 'bsa' helper sections to improve areas where the base of the unit was coming up above the dtm.	Sarah Arkley	30/01/2013
Culloden_Nairn_SA_184.gsipr	Opened 'Culloden_Nairn_SA_183.gsipr'. Created several 'bsa' helper sections to improve areas where the base of the unit was coming up above the dtm.	Sarah Arkley	30/01/2013
Culloden_Nairn_SA_185.gsipr	Opened 'Culloden_Nairn_SA_184.gsipr'. Created 2 'itdu' helper sections, along the western part of the coastline to improve areas where the base of the unit was coming up above the dtm. Also did a few helper sections for 'trd'.	Sarah Arkley	30/01/2013

Culloden_Nairn_SA_186.gsipr	Opened 'Culloden_Nairn_SA_185.gsipr'. Added 'rmbdf' and 'kebr' to the 2 long 'itdu' sections, and recalculated	Sarah Arkley	30/01/2013
Culloden_Nairn_SA_187.gsipr	Opened 'Culloden_Nairn_SA_186.gsipr'. Completed some 'bchd' helper sections, completing any overlying units in the section too.	Sarah Arkley	06/02/2013
Culloden_Nairn_SA_188.gsipr	Opened 'Culloden_Nairn_SA_187.gsipr'. Completed some helper sections, completing any overlying units in the section too.	Sarah Arkley	13/02/2013
Culloden_Nairn_SA_189.gsipr	Opened 'Culloden_Nairn_SA_188.gsipr'. Completed some helper sections, completing any overlying units in the section too.	Sarah Arkley	13/02/2013
Culloden_Nairn_SA_190.gsipr	Opened 'Culloden_Nairn_SA_189.gsipr'. Completed some helper sections, completing any overlying units in the section too. Mainly working on 'rbldu'.	Sarah Arkley	13/02/2013
Culloden_Nairn_SA_191.gsipr	Opened 'Culloden_Nairn_SA_190.gsipr'. Completed some helper sections, completing any overlying units in the section too.	Sarah Arkley	14/02/2013
Culloden_Nairn_SA_192.gsipr	Opened 'Culloden_Nairn_SA_191.gsipr'. Completed some helper sections, completing any overlying units in the section too. Mainly working on 'rftdd', did approx 20 helper sections for this unit.	Sarah Arkley	14/02/2013
Culloden_Nairn_SA_193.gsipr	Opened 'Culloden_Nairn_SA_192.gsipr'. Completed some helper sections, completing any overlying units in the section too. Mainly working on 'rmbdd', did approx 8 helper sections for this unit.	Sarah Arkley	14/02/2013

Culloden_Nairn_SA_194.gsipr	Opened 'Culloden_Nairn_SA_193.gsipr'. Completed some helper sections, completing any overlying units in the section too.	Sarah Arkley	14/02/2013
Culloden_Nairn_SA_195.gsipr	Opened 'Culloden_Nairn_SA_194.gsipr'. Completed some helper sections, completing any overlying units in the section too.	Sarah Arkley	15/02/2013
Culloden_Nairn_SA_196.gsipr	Opened 'Culloden_Nairn_SA_195.gsipr'. Completed some helper sections, completing any overlying units in the section too. Mainly working on 'alv1' helper sections.	Sarah Arkley	15/02/2013
Culloden_Nairn_SA_197.gsipr	Opened 'Culloden_Nairn_SA_196.gsipr'. Completed some helper sections, completing any overlying units in the section too.	Sarah Arkley	15/02/2013
Culloden_Nairn_SA_198.gsipr	Opened 'Culloden_Nairn_SA_197.gsipr'. Did trial calculation and looked at synthetic polygons in section to see where there were problems, e.g. extra nodes needed. Problems around Fort George (itdu helper section).	Sarah Arkley	15/02/2013
Culloden_Nairn_SA_199_clipped_DTM.gsipr	Opened 'Culloden_Nairn_SA_198.gsipr'. Did calculation on all units worked fine, clipped the DTM to model area, and repeated calculation – hung on 'ards' when calculating top to 'rmdf2'. Repeated the calculation several times tried doing it one unit at a time but always hung at the same place. Ricky to look over it 07/01/2013.	Sarah Arkley	01/03/2013
GVS and GLEG changes	Opened 'MorayNess_gvs_V15_06June2012.xlsx' added a 'rockhead' and 'base_model' unit into the GVS file and saved it as 'MorayNess_gvs_V16_07March2013.gvs'. Opened 'MorayNess_legend_V15_06June2012.xlsx' added a 'rockhead' and 'base_model' unit into the GLEG file and saved it as ' Both units were as compiled as shown in the Glasgow superficial model GVS and GLEG.	Sarah Arkley	07/03/2013

Culloden_Nairn_SA_200.gsipr	Opened 'Culloden_Nairn_SA_198.gsipr'. Drew a 'base_model' section all the way round, which will represent bedrock under the superficial deposits. Updated the GVS and GLEG with recently revised ones (see above). Drew 'base_model' in the section and completed an envelope for it. Tweaked 'bti' enveloped slightly so followed contours better on the coastline.	Sarah Arkley	07/03/2013
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Appendix 2

14th March 2013 – Merging of the Culloden-Nairn and Forres models

Opened 'Culloden_Nairn_SA_202.gispr' and saved as 'Culloden_Nairn_SA_203_Forres.gispr'

Imported all sections from the most recent/complete Forres model, located at:

W:\Teams\QES\QMMP\Data\MorayNessBasin_Data\Data\MorayNess-Region\GSi3D\MorayNess 3Dmodel\Published model Feb 2012\Forres_all_Hydro_Chronostrat_Eng_19Dec2011.GSIPR, using Log file located at: W:\Teams\QES\QMMP\Data\MorayNessBasin_Data\Data\MorayNess-Region\GSi3D\MorayNess 3Dmodel\Published model Feb 2012\Forres_Eileen_bhs_and_field_notes.blg

Imported all envelopes from the same Forres model (location described above)

Imported the DTM (.grd file) used in the Forres model, located at:

W:\Teams\QES\QMMP\Data\MorayNessBasin_Data\Data\MorayNess-Region\GSi3D\ForessLocalModelBaselineData\From Data Portal (10thJuly'09)\Forres_NEXTMAP_DTM_25m.asc and converted it into a TIN, named 'DTM_NextMap_25m_Forres' and deleted the .grd file

All geological units greyed out when completing the above actions. Looked at 'file' – 'properties' and noted that the GVS and GLEG files had converted to those of the Forres model, changed them back to the CN files (most up-to-date gvs and gleg for the Inverness area, which covers units used on both Forres and CN models) and all coloured up ok again

SLBA identified a number of issues in merging the two models (units not matching across the boundary) – to discuss with CAA

Meeting between SLBA and CAA to resolve merging issues – 14th March 2013

General Issues:

- **Issue:** Large amounts of envelope overlap along the merged edge.
Fix: Open most recent versions of the individual models and clip the envelopes to just beyond the model edge before importing the envelopes into a 'merged' model, this will ensure the envelopes match with the sections of the respective models.
- **Issue:** Individual DTM's were used to construct each model. The CN model used a BaldEarth 50m resolution DTM and the F model used a NextMap 25m resolution DTM. To calculate a model, a DTM is chosen to act as a capping surface, so currently the whole 'merged' area cannot be calculated as a single model.
- **Fix:** Need to extract a new single DTM which will cover both the CN and F models. A decision will need to be made whether NextMap or BaldEarth is used and whether a 25m or 50m or lower resolution is used. Immediate thoughts are that a DTM at 25m resolution over that size of area would be too big in terms of memory required and shouldn't even be attempted.
- **Issue:** A number of geological units are in different stratigraphic positions or have different names in the most up-to-date version of the GVS (used in CN model) than in the GVS used for the F model.
- **Fix:** Go through the two GVS's, identify any problems with specific units (see 'Specific Issues' below)

- **Issue:** Geological unit names are not always official lexicon names, Glasgow superficial geological units were converted into lex-racs. Note that there aren't lexicon codes for many of the units modelled

Specific Issues:

- **Issue:** Sea has been modelled in CN but not in F.
Fix: Extend existing 'sea' envelope from CN model across F model and draw 'sea' linework in all necessary F sections. Note that the 'merged' model will start to struggle for memory when importing topo maps from F to extend the 'sea' envelope – may be better to make a copy of the most recent F model, import 'sea' envelope from CN and extend the 'sea' envelope in there and then import back into the 'merged' model.
- **Issue:** Subtidal deposits have been modelled in CN but not in F.
Fix: Extend existing 'subtd' envelope from CN model across F model and draw 'subtd' linework in all necessary F sections. Note that 'sea' envelope and 'subtd' envelope have exactly the same extent, so can probably complete the 'sea' envelope and then 'copy' (export unit as a shapefile then re-import shapefile) and paste in as a 'subtd' envelope.
- **Issue:** A number of units in the F model have a different name in the CN model, even though they are the same geological unit (e.g. hmgd=hmgd1, gfdd=gfdd1, peat=peat1, rtd6=gftd – careful with this one, I think rtd6 on F represents 'gfsu' glaciofluvial subglacial deposits which is different to 'gftd' glaciofluvial terrace deposits)
Fix: Need to rename the units, so they have the same name/code throughout, best to change the names in the F model, as the CN model GVS is the most up-to-date. Need to make sure the envelopes for these units come across into the 'merged' model. See if there is a 'find and replace' way to change the linework codes globally, I think there is, ask Ricky, otherwise will have to go through all the sections, doing each line individually.
- **Issue:** A number of units modelled in F, were not in the CN model.
Fix: Need to make sure all the envelopes come across into the 'merged' model.
- **Issue:** 'bsa' is in a different stratigraphic position in the F model to shown in the CN model.
Fix: Change the GVS so there are two 'blown sand' units, called 'bsa' and 'bsa1', keeping the stratigraphic positions of each, i.e. 21 and 36 respectively. This should avoid any alteration of linework in the sections and is geologically realistic.
- **Issue:** Regional till unit in the CN model, which is the most extensive till and rests dominantly on bedrock is coded as 'fint', the equivalent unit in the F model is coded as 'till6'. In the GVS these units are separated by 'gsg6' which is used fairly extensively in both models.
Fix: Change 'till6' in the F model to 'fint', probably is the case geologically. See if there is a 'find and replace' way to change the linework codes globally, I think there is, ask Ricky, otherwise will have to go through all the sections, doing each line individually. Changes will need to be made to the nature of the till/gsg contact in F sections where the two units are on top of each other, as previously the till was the younger unit and now gsg will be the younger unit. Will also need to merge 'till6' envelopes and 'fint' envelopes, there is a function in GSI3D to do this (right click on 'fint' geological unit – 'create, edit, merge' – merge (dissolve) another unit into his unit).
- **Issue:** Bulk of the sand and gravel deposits at surface on the F model are coded as 'gsg2' and 'gsg3' and lie on the higher ground, away from the coast. The equivalent units in the CN model are coded as 'gsg6'. In the GVS 'gsg3' and 'gsg6' are separated by many units, including 'ards' which is extensive across both models.
Fix: Merge together 'gsg2' and 'gsg3' in the F model and rename as 'gsg6'. Then any existing 'gsg6' (sand and gravels lying below 'till6'/'fint') change to a new unit 'gsg7' – will need to add this to the GVS. See if there is a 'find and replace' way to change the linework codes globally, I think there is, ask Ricky, otherwise will have to go through all the sections, doing each line individually. There is a function in GSI3D to merge the envelopes from two geological units, but I suspect linework will have to be deleted section by section.
- **Issue:** Many of the sand and gravel units appear the same colour.
Fix: Change the sand and gravel units to different shades of pink in the GVS.

Sarah Arkley
15th March 2013

N.B. Further discussions on 28th March between Clive and Sarah, at the onset of the Beaulieu-Inverness modelling, may result in some changes to those written above, see notes on setting up the BI model.