Appendix A

A.4.4 Karst Study Report

A1

Galway County Council

N6 Galway City Transport Project

Karst Study

Karst Study Report

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Executive Summary

The eastern part of the N6 Galway City Transport Project (GCTP) study area is underlain by limestone bedrock that is classified by the Geological Survey of Ireland as a karst aquifer. Within this limestone terrain there are Annex I habitats which are water dependent. This report documents the findings from a desk study and walk over survey undertaken across the scheme study area but with specific focus on the water dependant Annex 1 habitats.

In total, 126 No. karst features were identified within the limestone terrains of the scheme study area. These were identified by the combination of a desk study and a follow-up field survey. The features identified include enclosed depressions, springs, turloughs, stream sinks and superficial solution features, as well as one cave and one small scale estavelle. All karst landforms recorded are presented in the karst database (presented as **Appendix A** of this report).

Ecological surveys have identified water dependant Annex I and non-Annex I habitats within this eastern part of the scheme study area which may be dependent on groundwater flow, level and/or quality. These assessments were made using available data only and no investigative works were undertaken as part of this stage.

1 Introduction

A study of karst landforms was carried out as part of the constraints study for the N6 Galway City Transport Project (GCTP). The purpose of the study was to document the location of karst landforms by identifying features in the scheme study area, particularly where groundwater dependant ecosystems had been identified.

Significant ecological survey work has been undertaken in the scheme study area for the N6 GCTP by Scott Cawley. A key finding of the ecological survey work was the identification of water dependent ecological Annex 1 habitats. Such habitats are potentially dependent upon groundwater levels, flows and quality. The ecological surveys have not determined the source or supply of the water that supports these habitats. Therefore, the objective of this karst survey is to document the karst landforms, study their distribution and assess their potential relationship with annex 1 habitats. An impact on water quality, levels or flows may impact on the ecological feature in question that is dependent on that water.

Detailed hydrogeological study is typically undertaken after route selection. However, it was considered that it would benefit route selection decisions and assist in constraints if this was conducted at an early stage.

2 Background

The eastern side of the scheme study area is underlain by Visean Limestone, which is classified by the Geological Survey of Ireland (GSI) as a regionally important karst aquifer. The topography has numerous karst landforms and includes features that are often associated with groundwater dependant terrestrial ecosystems (GWDTEs) such as springs and turloughs. On the basis of the karst landforms observed in the scheme study area it is considered that the subsurface is likely to include extensive conduit networks. However, to the best of the author's knowledge

there are no previous studies (for example of tracer testing) published in the scheme study area.

Impacts from route construction on water dependant habitats can be direct or indirect. Direct impacts can occur when the route extends through/within the habitat. Indirect impacts can occur when a route intersects an important conduit which provides flow into or discharge out of a water dependant habitat. Disruption of the flow in the conduit may cause changes in water levels and quality which could have the potential to damage the water dependent habitat. Due to the unpredictable nature of the conduit network, zones of contribution for water dependant habitats may not reflect the topography. However, significant contributing conduits and zones of contribution may be identified through patterns in karst features.

Water dependant habitats identified during ecological surveys within the eastern part of the scheme study area (**Section 4.3 of the Route Selection Report**) are shown in **Figure 1**. The water dependant habitats of most significance include:

- Ballindooley Lough – Annex I wetland habitat ecological sites;
- Coolagh Lakes – Annex I and non-Annex I wetland habitat Lough Corrib cSAC;
- Terryland River - Annex I wetland habitat ecological sites;
- Kentfield/NUIG and Coolanillaun Wetlands - Annex I wetland habitat ecological sites and Annex I and non-Annex I wetland habitat Lough Corrib cSAC; and
- Four turloughs, Annex I wetland habitat.

Turloughs are seasonal lakes which fill and empty in relation to rise and fall of groundwater levels. Drainage installed over the years has impacted on many turloughs so that they no longer seasonally flood. Turloughs that still seasonally flood are documented by the Geological Survey of Ireland (GSI) and are included in the GSI karst database. Each of these features have been assessed as part of these studies.

Of particular importance is the difference between a turlough and a seasonal lake. Where a turlough floods due to rise in the groundwater level, seasonal lakes can form due to ponding of rainfall in a depression and are not groundwater related.

Figure 1 Water dependant habitats identified in the eastern section of the scheme study area

3 Methodology

The karst study involved a desk based study which was carried out in October 2014 and a field survey carried out in October and November 2014.

3.1 Desk Based Study

Karst features were identified from the following sources:

- Geological Survey of Ireland karst database (www.dcenr.gov.ie);
- OSI Historic 6" Map (maps.osi.ie);
- Scott Cawley ecological surveys (**Ecological Constraints Study Appendix A.4.2**);
- Lidar Map (Office of Public Works);
- Bing Maps (www.bing.com/maps/);
- Google Maps (maps.google.ie);
- Ordnance Survey of Ireland Waterline Map (courtesy of Geological Survey of Ireland);
- EIS N6 Galway City Outer Bypass Volume 2 2006; and
- Ryan Hanley (2010) Study to Identify Practical Measures to Address Flooding on the Clare River Volume 1 – Report.

Features were identified within the scheme study area and in the surrounding area. Only features identified within the scheme study area are included in this report, with the exception of seven springs located within 300 m of the scheme study area boundary.

3.2 Field survey

Karst features identified during the desk based study were visited during the field survey. Additional karst features identified while onsite were also included in this study. The following features were noted for each karst feature during the field survey:

- Feature type;
- GPS coordinates;
- Status of feature – identified initially in desk study or field and if there were problems with the identification, e.g. heavily vegetated areas can hinder identification of features;
- Feature dimensions;
- Presence of water;
- Elevation of ground surface/water surface where applicable;
- Water quality parameters where water was present (temperature, electrical conductivity and pH);
- Local knowledge; and
- Photos.

During the initial stage of the survey, in October 2015, groundwater levels were relatively low. As a result of the low water levels it was not possible to detect the presence of some features, i.e. seasonal springs, losing streams, seasonal stream sinks. These features were revisited and assessed following wetter weather in November 2015 when groundwater levels were higher.

During October a number of turloughs and seasonal lakes remained dry, likely a consequence of a very dry September. These locations were revisited in November when the water levels were considerably higher. Visiting these karst features such as turloughs, seasonal lakes and springs during low water levels allows the dimensions and potential plug holes to be identified. Higher water level conditions allowed water quality measurements to be recorded and the confirmation of groundwater contribution to the feature.

3.3 Limitations

A number of limitations are associated with the method employed:

- The highly urbanised environment of Galway City was a hindrance to the identification of karst features. Much of the urbanised area is covered in hard-standing and buildings and may not reflect the natural topography. Furthermore manmade landscaping can be mistaken for being karst landforms;
- The identification of naturally occurring karst features in highly landscaped areas such as Glenlo Abbey Golf Course was difficult due to the presence of potential manmade landscaping;
- Larger turloughs with very shallow bases were difficult to identify from lidar where the difference in elevation compared to the surrounding area is only slight; and
- The variability in the groundwater level can change rapidly in karst aquifers. Springs, stream sinks and turloughs characteristically have variable flows and levels and as such seasons can have a significant influence on their characteristics.

4 Results

The desk study identified 171 (No.) potential karst landforms within the scheme study area. A further 29 No. features were identified during the field study which were not initially identified during the desk based study. **Table 1** below summarises the findings of the desk and field studies. Following the desk study and field survey a total of 128 potential karst features were identified.

Field results for each karst feature identified are included in **Appendix A**. The numbering system for the karst features includes all potential karst and non karst features identified from the desk study and field survey within and outside the study area (K1-K327). Therefore the numbering of features in **Appendix A** is not completely sequential as only potential karst features visited during the field study and within the scheme study area are included.

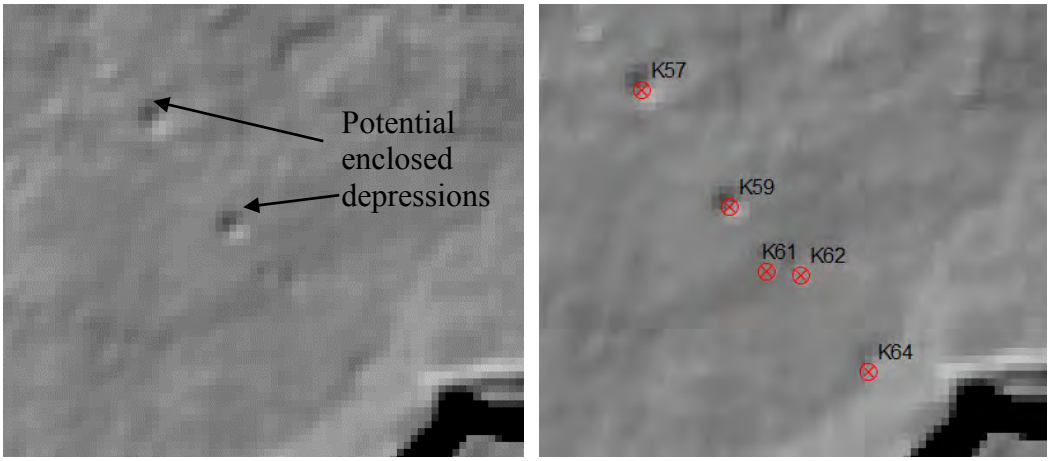
Table 1 Summary of desk and field survey results

Initial Identification	Number of Features	Results during Field Survey	Number of Features
Identified in desk study	170	Confirmed	50
		Confirmation/identification problem	35
		Not found	12
		Not karst	73
Potential features identified through desk study followed by field studies			97
Karst features identified for the first time in the field survey			29
Total number potential and confirmed features			126

Confirmed Features

Potential features were identified during the desk study and then investigated in the field. **Figure 2** presents the lidar image showing two clear circular shapes interpreted to be karst landforms. However, this image also shows multiple potential surrounding features that are less clear. The potential features (K57 and K59) were visited and confirmed as enclosed depressions during the field survey. Field observations of the surrounding features also confirmed three further enclosed depressions (K61, K62 and K64) as shown in **Figure 3**.

Figure 2 (left) lidar image showing two potential enclosed depressions (K57 & K59) identified from the desk study, Figure 3 (right) karst features confirmed during field survey



Confirmation/identification problem features

Features were classified as confirmation/identification problem where the following situations were encountered:

- Dense vegetation prevented access to the area or covered the potential feature to an extent that it could not be confirmed or discounted;
- The feature was in a highly landscaped area and may be a manmade feature;
- Access was prevented due to high walls and locked gates;
- Features were located beneath existing buildings; and
- Access was deemed unsafe due to unpredictable livestock in field.

Not found features

12 No. Springs were classified as not found. The springs were initially identified from the GSI database. Consultation on site with locals indicate that the springs are likely to be dug wells installed for domestic or farm use. These wells have since been covered with the introduction of mains water supply.

The Doughiska feature (K177) was also classified as not found because the area onsite did not reflect features of a turlough. No depression was evident which may collect water and the area was very dry at the time of the survey.

Not karst

Figure 4 and **Figure 5** shows the lidar image of three potential enclosed depression identified from the desk study. During the site visit K75 was confirmed to be an enclosed depression, however K80 and K84 were mounds and therefore classified as not karst.

Figure 4 (left) lidar image showing three potential enclosed depressions identified from the desk study, Figure 5 (right) confirmed enclosed depression K75 (red circle) and two non karst features K80 and K84 (green crosses) from the field survey findings

Not visited features

One feature within the scheme study area was not accessible and this was located on Jordan's Island.

4.1 Type of karst features identified

Karst features identified during the desk study and the field study included a cave, enclosed depressions, an estavelle, springs, turloughs, swallow holes and superficial solution features. Other features noted included wells, streams and drains. **Table 2** summarises the 126 No. potential karst features in terms of feature type and identification classification during the field study. **Figure 6** in **Appendix B** shows the karst features identified and the status assigned and the water dependant habitats within the scheme study area.

Table 2 Type of karst features identified within the scheme study area

Feature Type	No. Confirmed	No. Confirmation / identification problem	No. not found	No. not visited	Total No. Features
Cave	1	-	-	-	1
Enclosed depression	48	32	-	-	80
Estavelle	1	-	-	-	1
Spring	17	3	12	-	32
Spring/ Swallow hole	2	-	-	-	2
Superficial solution features	3	-	-	-	3
Swallow hole	1	-	-	-	1
Turlough	4	-	-	-	4
Well	2	-	-	-	2

The identified karst features are reasonably spread across the northern and eastern part of the scheme study area underlain by limestone. As expected fewer karst landforms were identified across the Galway City area but as the limestone extends into Galway Bay this is a measure of the urbanisation rather than the lack of karst landforms.

Enclosed depressions are the most abundant karst feature type identified and in general these are the most common type of karst landform. Enclosed depressions not highlighted by lidar were often very shallow and therefore the change in elevation was too subtle to be obvious in the lidar data (e.g. K37).

4.2 Water level elevation

Elevations were surveyed using a Trimble GEOXR6000. **Table 3** summarises the selected water level elevations recorded. Additional elevations are included in the karst feature field survey results in **Appendix A**.

Table 3 Water level elevations

Location	Easting	Northing	Elevation (mAOD)
Ballindooley Lough	531543	729052	9.08
River Corrib at Menlo Pier	528205	728421	6.00
Lackagh Quarry pond 1	530505	728556	13.40
Lackagh Quarry pond 2	530624	728579	13.30

5 Interpretation

Alignment, morphology and spatial distribution of karst features can provide information on underground pathways and assist in the characterisation of groundwater flows. Being able to characterise the groundwater regime is an important stage in assessing the sensitivity of water dependant habitats and can provide insight into the support that groundwater plays. Five key water dependant habitats have been identified within the scheme study area as part of ecological surveys. Karst features and zones on contribution shall be discussed for each key water dependent habitat.

5.1 Ballindooley Lough

Ballindooley Lough is a large shallow topographic depression (approx. 400m by 150m), which has a peaty/clayey base in the centre that also hosts permanent standing water. Refer to **Figure 7** below. The water level fluctuates seasonally throughout the year and floods most of the depression. There is no surface water input to the lough although there may be some runoff into the depression during intense rainfall. The fluctuation in water level is seasonal and likely to be a representation of the local groundwater level. It is likely that there is also diffuse flow to the lough via the fracture flow network.

There are a number of karst landforms in the area of Ballindooley Lough, particularly to the northeast and northwest of the depression. To the northeast the landforms include an estavelle[1] (K86) and two enclosed depressions (K82 and K85) (**Figure 7**). These landforms are aligned linearly and are indicative of fracture control of a karst flow path, most likely a conduit.

To the northwest there is an enclosed depression (K94) and a well (K92) and these again indicate a karstic flow path, most likely a conduit. Considering the rising topography both of these linear clusters of karst landforms suggest that two main fractures may provide conduit flow that feeds in to towards Ballindooley Lough.

A turlough (K72) lies approximately 0.5km to the west of Ballindooley Lough. Water levels recorded in the turlough were 5m higher than in Ballindooley Lough. The relative water elevations indicate that the turlough also could drain to Ballindooley Lough.

Another turlough (K74) and an enclosed depression (K97) are located to the south of Ballindooley Lough between it and the Terryland River. Water level elevations in turlough K74 (9.70 mAOD) is slightly higher than Ballindooley Lough but the water level in a dug well in the enclosed depression K97 (12.17 mAOD) is significantly higher (refer to **Table 3**). During the field survey the water level recorded in the dug well in K97 was similar to the ground level (12.17 mAOD) and it is possible that the water level is perched in superficial deposits and not reflect the bedrock water level.

[1] An estavelle is an orifice into which water may sink or be discharged depending on groundwater conditions.

These findings indicate that the zone of contribution for Ballindooley Lough is predominantly to the north and that flow paths have been identified towards the lough. The natural gradient from Ballindooley is southwards towards the Terryland River.

Figure 7 Ballindooley Lough karst features and water dependant habitats

5.2 Terryland River

The Terryland River extends from the River Corrib north-eastwards for approximately 2.5km where the river has two branches both of which end in karst depressions (K87 and K96) (**Figure 8**). The Terryland River is unusual in that its flow is reversible and either:

- flows from the River Corrib to the two karst depressions (K87 and K96) where all the water sinks or; and
- receives groundwater rising from the two karst depressions (K87 and K96) and discharges into the River Corrib .

The relative difference in level between the River Corrib and groundwater level is expected to be the main control on flow direction.

During the field survey the water level elevations at K87 and K96 were 1.79 and 1.77 mAOD respectively. These elevations are considerably lower than Ballindooley Lough and indicates that the groundwater flow direction is southwards towards the Terryland River. During the field survey the flow in the Terryland River was from the River Corrib towards the karst depression where it sank. The estimated flow rate was greater in K96 (764 l/s) compared to K87 (399 l/s). It is likely that the sinks are connected to a significant conduit system which discharges into Galway Bay. There is a lack of suitably large springs between the Terryland River and Galway Bay to indicate the route of this conduit system or its discharge location. Therefore, it is possible that the discharge location/locations could be within Lough Atalia or Galway Bay.

Further to the discussion from **Section 5.1**, these findings indicate that there is a southerly flow direction from north of Ballindooley Lough into a likely significant conduit system that includes the sink holes at the Terryland River. Ultimately all groundwater discharges south into Galway Bay.

Figure 8 Terryland River karst features and water dependant habitats

5.3 Coolagh Lakes

A spring, K25, was identified to the east of Coolagh Lakes (**Figure 9**). Spring K25 provides flow to the Coolagh Lakes, however, flow was not possible to measure during the field survey due to extensive vegetation in the channel flowing from the spring. The elevation of Spring K25 is 6.06 mOD.

Another spring, K45, to the north east of the Coolagh Lakes is also discharging into the Coolagh Lakes. Enclosed depressions to the east of the springs suggest the presence of the water bearing conduit system feeding K45.

The turlough K31 is likely to be hydraulically connected to the Coolagh Lakes and form part of the zone of contribution for the lake system.

It is likely that a significant proportion of discharge into the Coolagh Lakes is from groundwater. However, it is also possible that the River Corrib may be contributing water flow to the lake system. Further analysis of the water balance in the Coolagh lakes would be required to gain a better understanding of the proportion of groundwater contribution to the lake system.

Figure 9 Coolagh Lakes karst features and water dependant habitats

5.4 Kentfield/NUIG and Coolanillaun Wetlands

The Kentfield/NUIG wetland area to the west of the River Corrib is fed by four springs, K2, K7, K9 and K14 (**Figure 10**). The spring K2 is directly on the contact between the limestone and the granite bedrock. The OSI water line map was used to identify potential springs during the desk study. **Figure 10** shows the flow channels from the springs towards the Kentfield/NUIG wetland and River Corrib.

Enclosed depressions (K1, K3-6 and K10-12) are also evident between the limestone/granite contact and the River Corrib. These features indicate that the springs may not be the only water bearing conduit pathways contributing flow to the wetland.

Spring K17 was identified on the eastern side of the River Corrib in the Coolanillaun wetland, however, it is possible that there are other springs which discharge close to the boundary of the designated wetland habitat. During the field survey additional springs were searched for in the area, however none were found. It is possible that the Spring K17 is connected to the turlough K20. During the field survey the water level elevation in the turlough was 10.42 mAOD. Water elevation in the spring was lower, at 6.12 mAOD, suggesting that the groundwater flow direction is toward the spring from the turlough.

Although springs and groundwater flow are likely to be contributing to the water level, it is also likely that the River Corrib may also be contributing flow to the wetlands.

Figure 9 Kentfield/NUIG and Coolanillaun Wetlands karst features and water dependant habitats

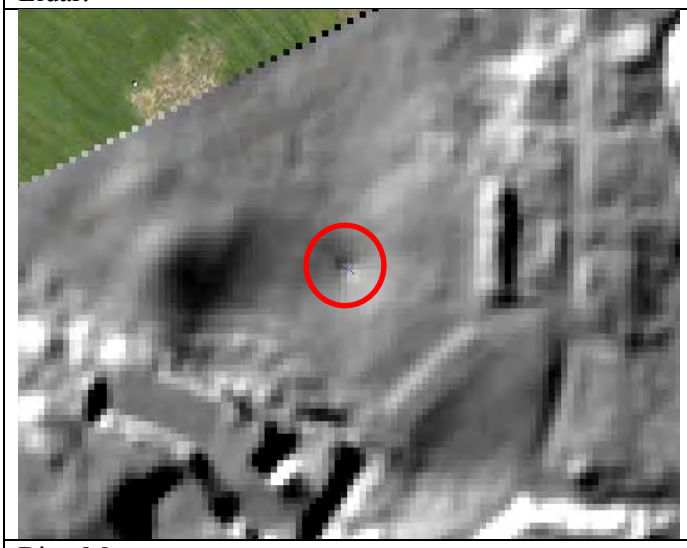
6 Conclusions

The karst survey identified 126 No. potential karst features within the scheme study area. The features identified include enclosed depressions, springs, turloughs, seasonal lakes, stream sinks and superficial solution features, as well as one cave and one small scale estavelle.

Appendix A

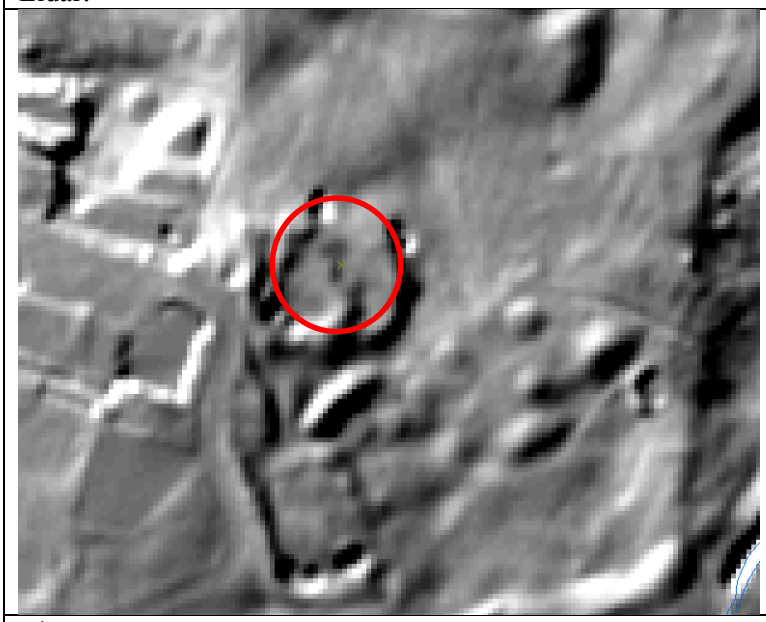
Karst Database

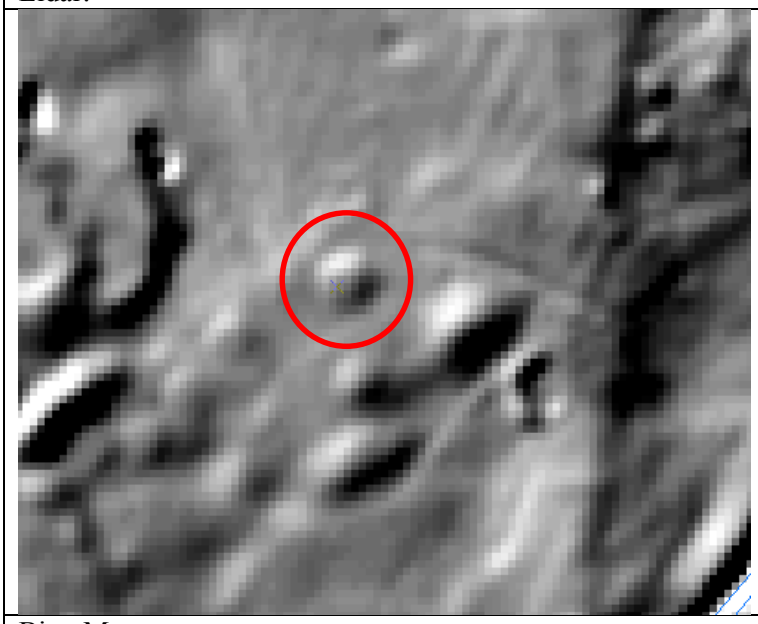
A1

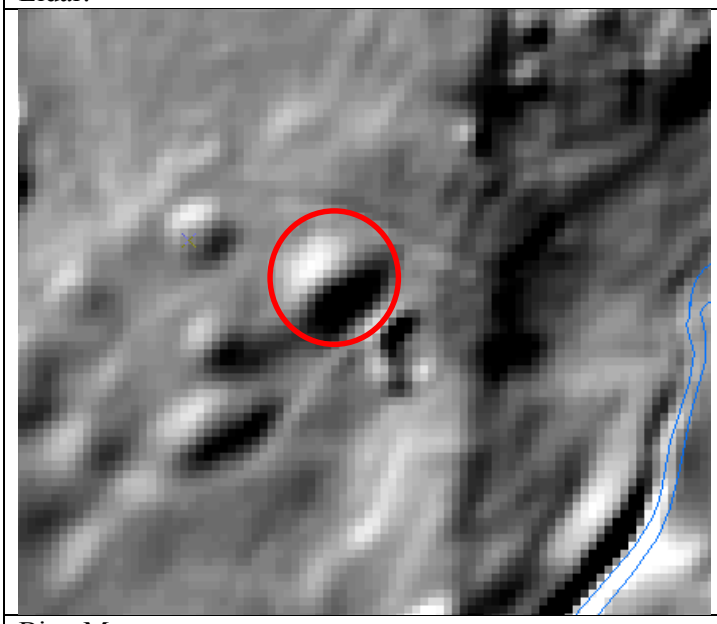
Feature ID	**K1**
Feature type	Enclosed depression
Coordinates	526676, 728520
Source	Lidar:
	
	Bing Maps:
	
Field survey date	21/10/2014
Field survey status	Confirmation/identification problem
Water present	No
Additional Information	Within golf course. Area too landscaped to confirm presence of karst feature
Site photo	Not available

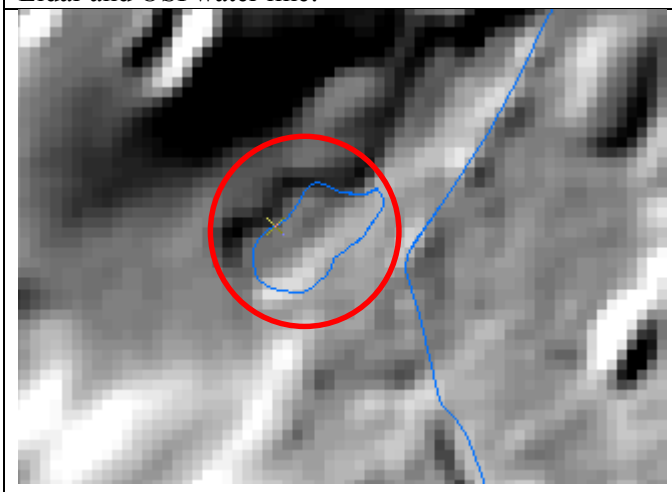
Feature ID	**K2**
Feature Type	Spring
Coordinates	526837, 728183
Source	Lidar and OSI water line:
	
	Bing Maps:
	
	Other sources: aerial photography
Field survey date	21/10/2014
Field survey status	Confirmed
Water present	Yes
Additional Information	Spring discharging into drain which discharges into a pond. The drain may be modified and contained little water on day of visit.

Site photo	

Feature ID	**K3**
Feature type	Enclosed depression
Coordinates	526879, 72836
Source	Lidar:
	
	Bing Maps:
	
	Other sources: aerial photography
Field survey date	21/10/2014
Field survey status	Confirmation/identification problem
Water present	No
Additional Information	Within golf course. Area too landscaped to confirm presence of karst feature
Site photo	Not available

Feature ID	**K4**
Feature type	Enclosed depression
Coordinates	526952, 728343
Source	Lidar:
	
	Bing Maps:
	
	Other sources: aerial photography
Field survey date	21/10/2014
Field survey status	Confirmation/identification problem
Water present	No
Additional Information	Within golf course. Area too landscaped to confirm presence of karst feature
Site photo	Not available

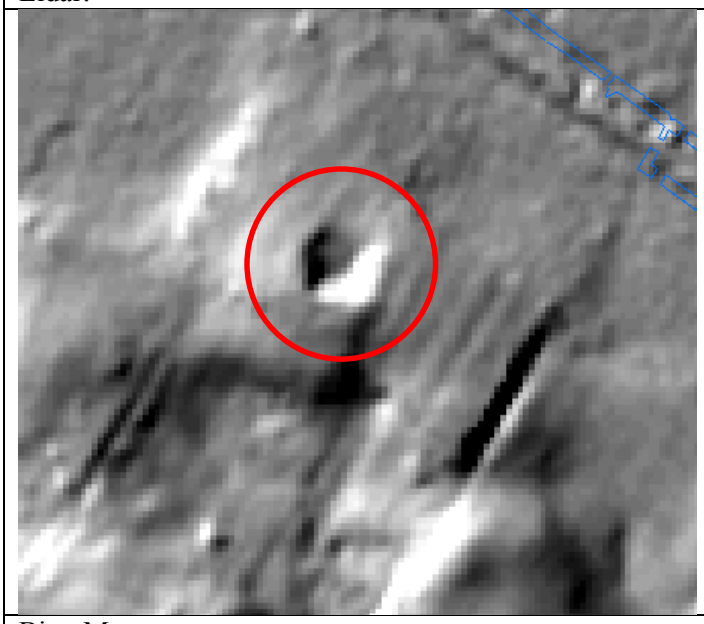
Feature ID	**K5**
Feature type	Enclosed depression
Coordinates	526985, 728332
Source	Lidar:
	
	Bing Maps:
	
	Other sources: aerial photography
Field survey date	21/10/2014
Field survey status	Confirmation/identification problem
Water present	No
Additional Information	Within golf course. Area too landscaped to confirm presence of karst feature
Site photo	Not available

Feature ID	**K6**
Feature type	Enclosed depression
Coordinates	527186, 728282
Source	Lidar and OSI water line: 
	Bing Maps: 
	Other sources: aerial photography
Field survey date	21/10/2014
Field survey status	Confirmation/identification problem
Water present	No
Additional Information	Within golf course. Area too landscaped to confirm presence of karst feature
Site photo	Not available

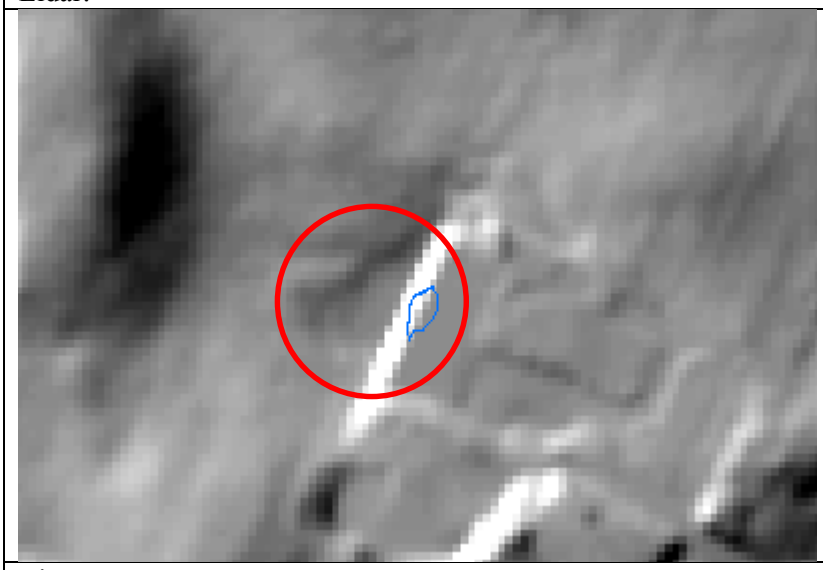
Feature ID	**K7**
Feature type	Spring
Coordinates	527195, 728079
Source	Field Survey
Field survey date	20/10/2014
Field survey status	Confirmed
Water present	Yes
Additional Information	
Site photo	

Feature ID	**K9**
Feature type	Spring
Coordinates	527285, 728284
Source	Field Survey
Field survey date	20/10/2014
Field survey status	Confirmed
Water present	Yes
Additional Information	
Site photo	

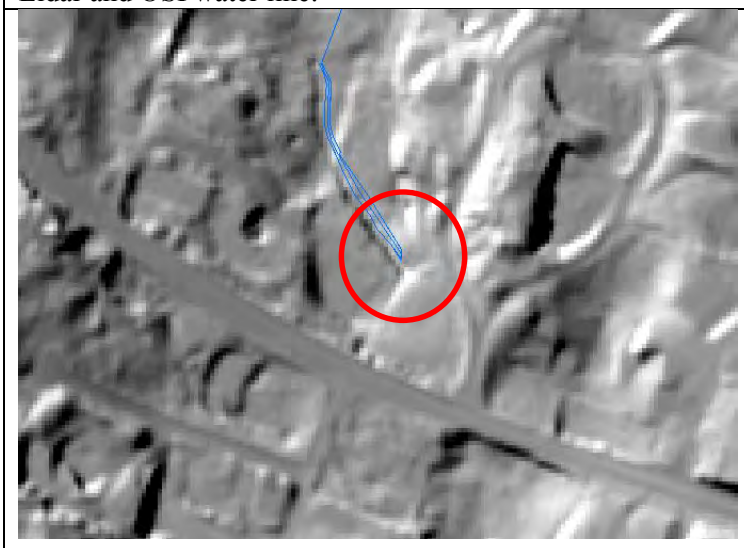
Feature ID	**K10**
Feature type	Enclosed depression
Coordinates	527301, 728143
Source	Field Survey
Field survey date	20/10/2014
Field survey status	Confirmed
Water present	No
Additional Information	1 m diameter small enclosed depression, base contains loose rocks
Site photos	 

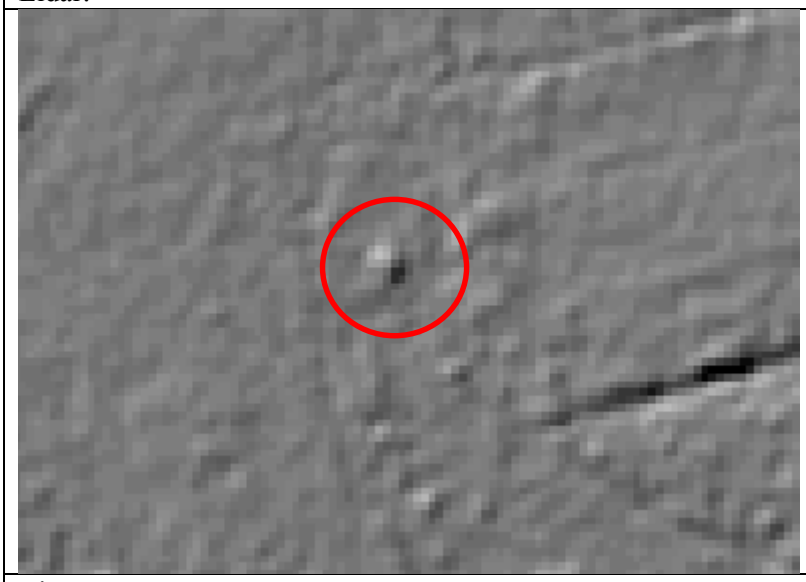
Feature ID	**K11**
Feature type	Enclosed depression
Coordinates	527396, 728307
Source	Lidar:
	
	Bing Maps:
	
	Other sources: aerial photography
Field survey date	20/10/2014
Field survey status	Confirmed
Water present	No
Additional Information	15m diameter enclosed depression.

Site photo	 

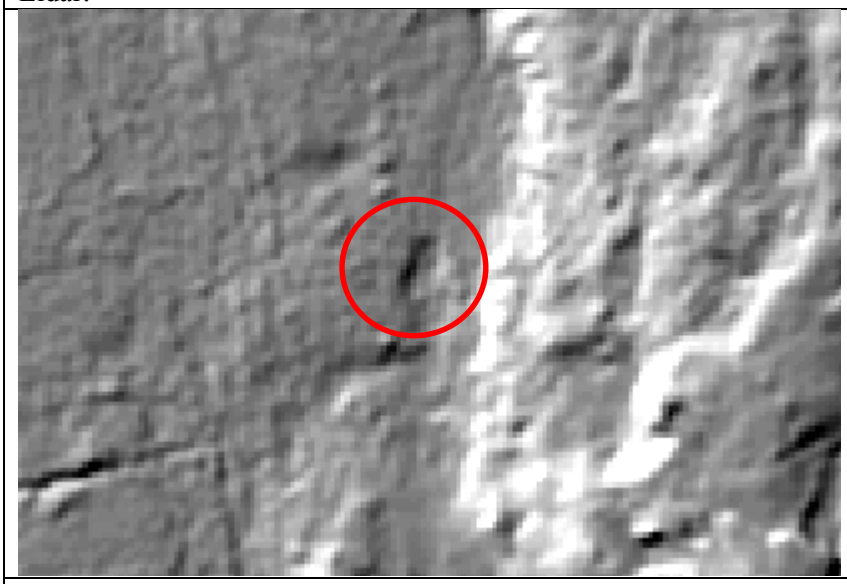
Feature ID	**K12**
Feature type	Enclosed depression
Coordinates	527555, 728068
Source	Lidar:
	
	Bing Maps:
	
	Other sources: aerial photography
Field survey date	21/10/2014
Field survey status	Confirmed
Water present	No
Additional Information	20m diameter enclosed depression with gently slopped sides.

Site photo	

Feature ID	**K14**
Feature type	Spring
Coordinates	527744, 727394
Source	Lidar and OSI water line: 
Field survey date	17/10/2014
Field survey status	Confirmed
Water present	Yes Electrical conductivity: 330 uS/cm Temperature: 12.8 °C pH: 8.34
Additional Information	Stream coming from drain under road. Exact source location of spring not found.
Site photo	

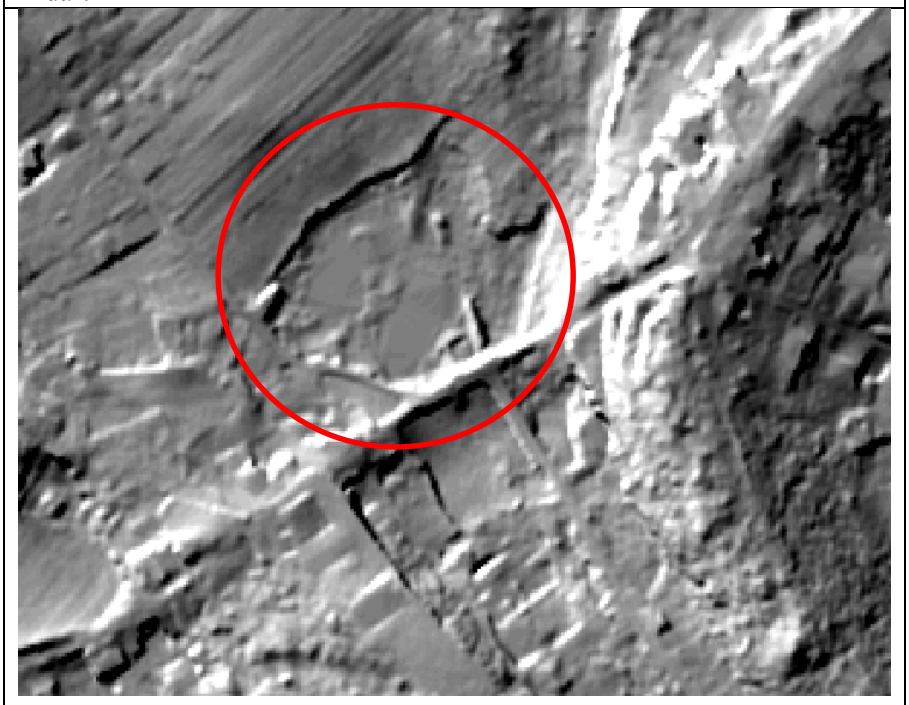
Feature ID	**K15**
Feature type	Enclosed depression
Coordinates	527954, 728876
Source	Lidar:
	
	Bing Maps:
	
	Other sources: aerial photography
Field survey date	17/10/2014
Field survey status	Confirmation/identification problem
Water present	No
Additional Information	Cannot locate. Dense vegetation
Site photo	Not available

Feature ID	**K17**	
Feature type	Spring	
Coordinates	528345, 728630	
Source	Field Survey	
Field survey date	17/10/2014	11/11/2014
Field survey status	Confirmed	Confirmed
Water present	Yes Electrical conductivity: 520 uS/cm Temperature: 13.8 °C pH: 7.83	Yes Electrical conductivity: 622 uS/cm Temperature: 12 °C pH: 6.87
Water elevation	n/a	6.12 mAOD
Additional Information	Constructed pond (2 m diameter) covered in algae surrounded by constructed stone wall beside path.	
Site photos	 	

Feature ID	**K18**
Feature type	Enclosed depression
Coordinates	528356, 728948
Source	Lidar:
	
	Bing Maps:
	
	Other sources: aerial photography
Field survey date	17/10/2014
Field survey status	Confirmed
Water present	Yes Electrical conductivity: 350 uS/cm Temperature: 14.2 °C pH: 8.72
Additional Information	Water logged depression in field.

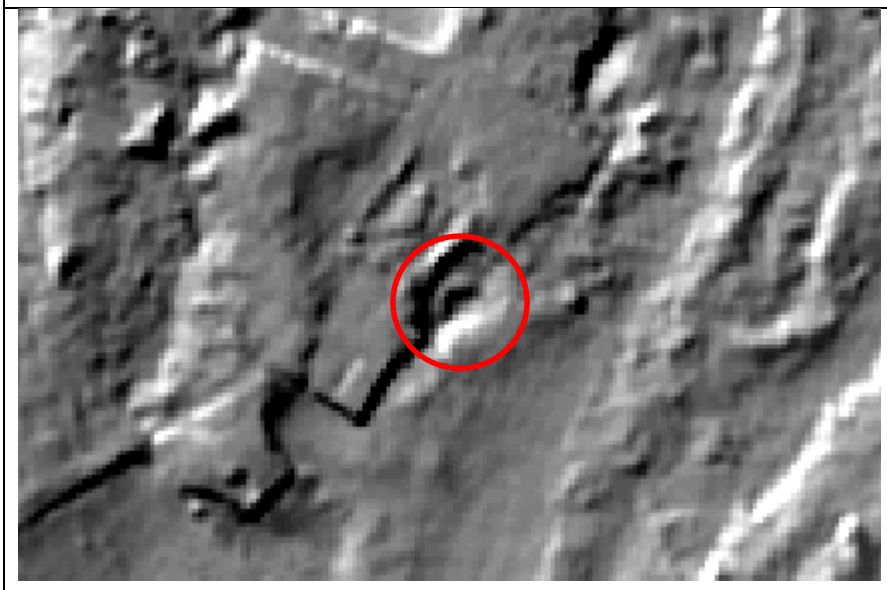
Site photo	 

Feature ID	**K19**
Feature type	Spring
Coordinates	528432, 727120
Source	Lidar and OSI water line: 
Field survey date	20/10/2014
Field survey status	Confirmed
Water present	Yes Electrical conductivity: 510 uS/cm Temperature: 14.3 °C pH: 7.62
Additional Information	The spring is discharging from a concrete culvert. The natural spring location may be upgradient of the surveyed location, however no evidence of a channel or spring upgradient was found.
Site photo	

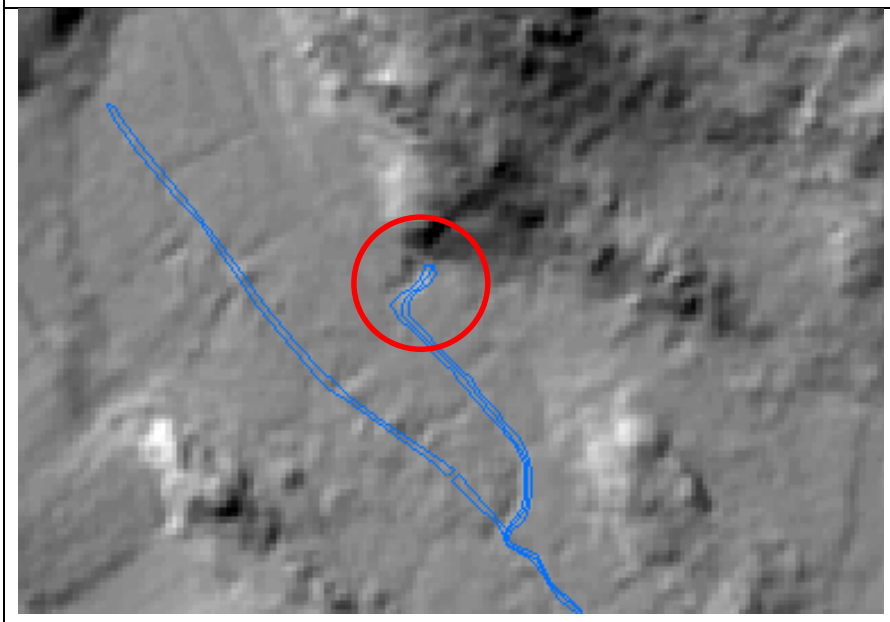
Feature ID	**K20**	
Feature type	Turlough	
Coordinates	528764, 728605	
Source	Scott Cawley ecology survey	
	Lidar: 	
	Bing Maps: 	
	Other sources: aerial photography	
Field survey date	17/10/2014	11/11/2014
Field survey status	Confirmed	Confirmed
Water present	No	Yes Electrical conductivity: 481 uS/cm Temperature: 9.8 °C pH: 7.64

Water elevation		10.42 mAOD
Additional Information	The turlough was visited when empty (17/10/14) and full (11/11/2014). There are no surface water streams contributing flow to the turlough. The topography is relatively flat, although the turlough is at a lower elevation than the surrounding ground level. Therefore it is likely that this feature is a groundwater fed turlough.	
Site photos 17/10/2014	 	

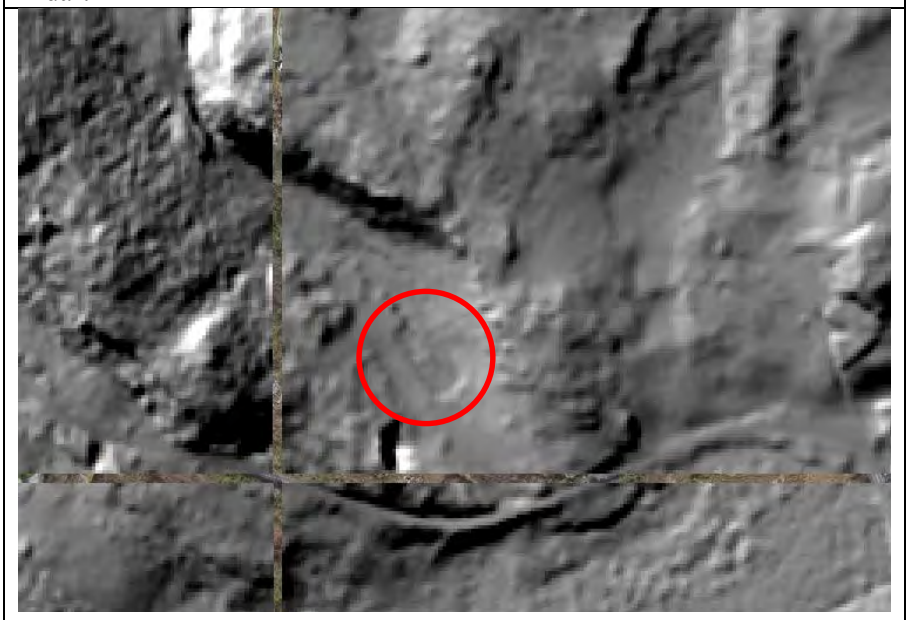
Site Photos
11/11/2014

Feature ID	**K21**
Feature type	Enclosed depression
Coordinates	528803, 729053
Source	Lidar: 
	Bing Maps: 
	Other sources: aerial photography
Field survey date	17/10/2014
Field survey status	Confirmation/identification problem
Water present	No
Additional Information	Area covered in briars and vegetation preventing access.

Site photo	

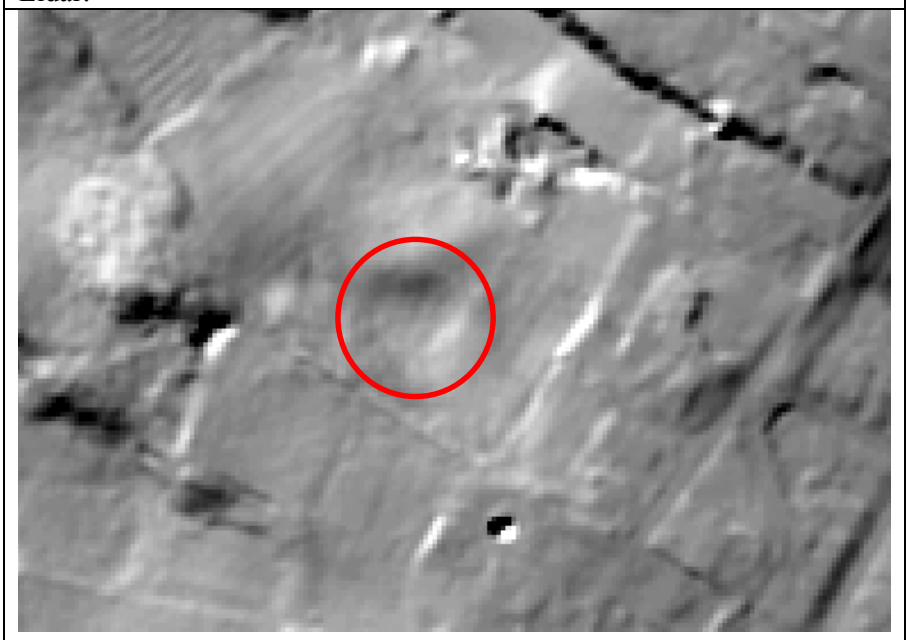
Feature ID	**K25**	
Feature type	Spring	
Coordinates	529045, 727934	
Source	Lidar and OSI water line: 	
	Bing Maps: 	
Field survey date	17/10/2014	12/11/2014
Field survey status	Confirmed	Confirmed
Water present	Yes Electrical conductivity: 490 uS/cm Temperature: 10.4 °C pH: 7.74	Yes Electrical conductivity: 480 uS/cm Temperature: 10.7 °C pH: 7.31
Water elevation		Water level elevation: 6.06 mAOD Elevation was recorded where the water is discharging beneath briars.

Additional Information	Stream channel from spring location contains considerable vegetation. Flow not measurable due to thick vegetation within channel Flow from spring discharge point was audible on the 12/11/2014.
Site photo	Spring discharge location  Spring discharge channel containing thick vegetation 

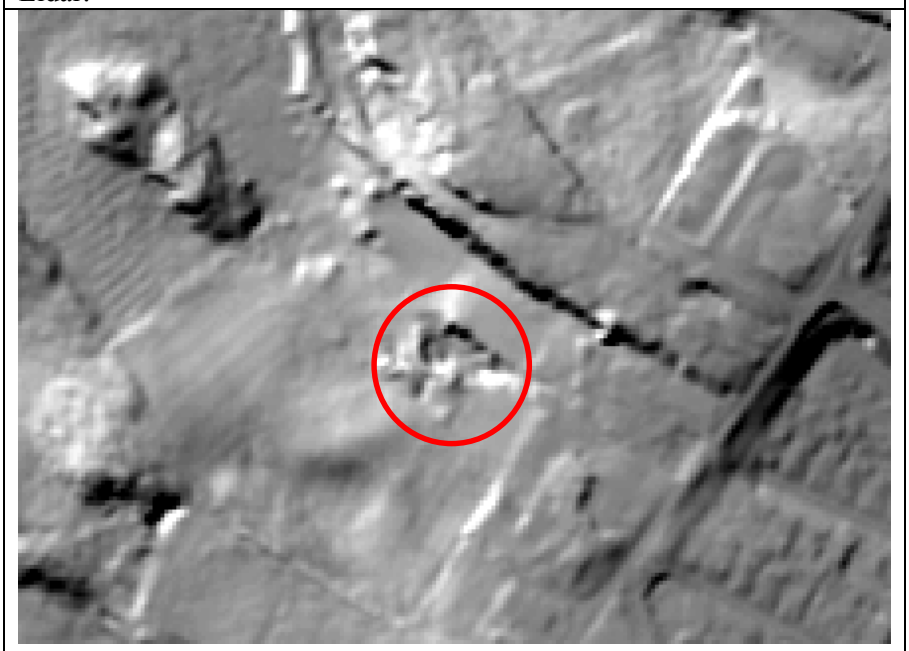
Feature ID	**K31**
Feature type	Turlough
Coordinates	529332, 728227
Source	Scott Cawley Ecologists Surveys
	Lidar:
	
	Bing Maps:
	
Field survey date	17/10/2014
Field survey status	Confirmed
Water present	No
Additional Information	The feature is a linear shaped depression, the base of which is damp and soft.

Site photo	 

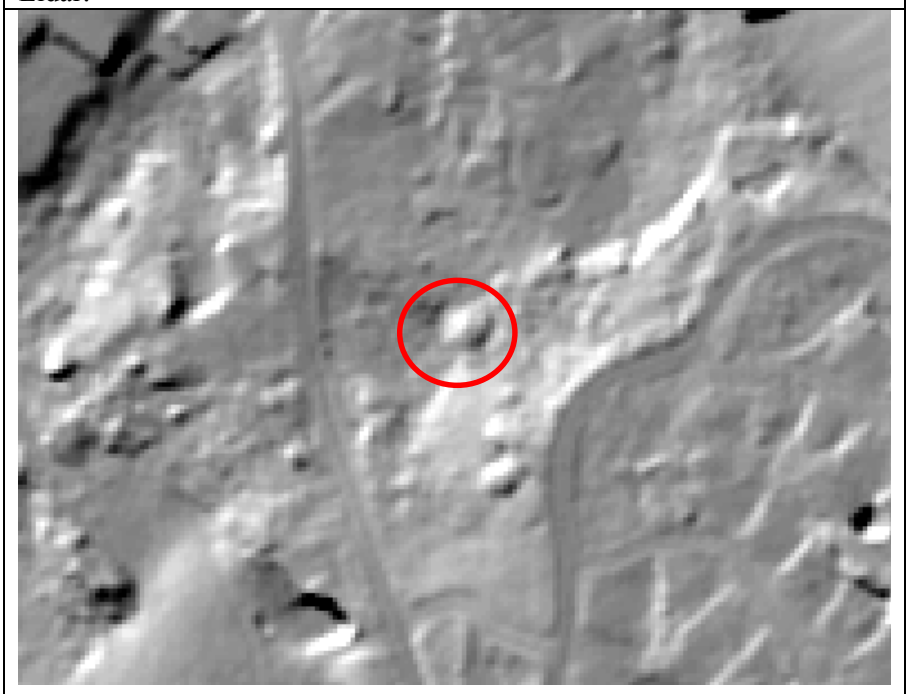
Feature ID	**K37**
Feature type	Enclosed depression
Coordinates	529562, 729011
Source	Field Survey
Field survey date	23/10/2014
Field survey status	Confirmed
Water present	No
Additional Information	Very shallow depression Approx. 20m x 19 m
Site photo	Not available
Bing map	

Feature ID	**K39**
Feature type	Enclosed depression
Coordinates	529566, 726981
Source	Lidar:  Bing Maps: 
Field survey date	20/10/2014
Field survey status	Confirmed
Water present	No
Additional Information	30 m diameter enclosed depression. However this feature is questionable as there may be disposal of material to the east of the depression.

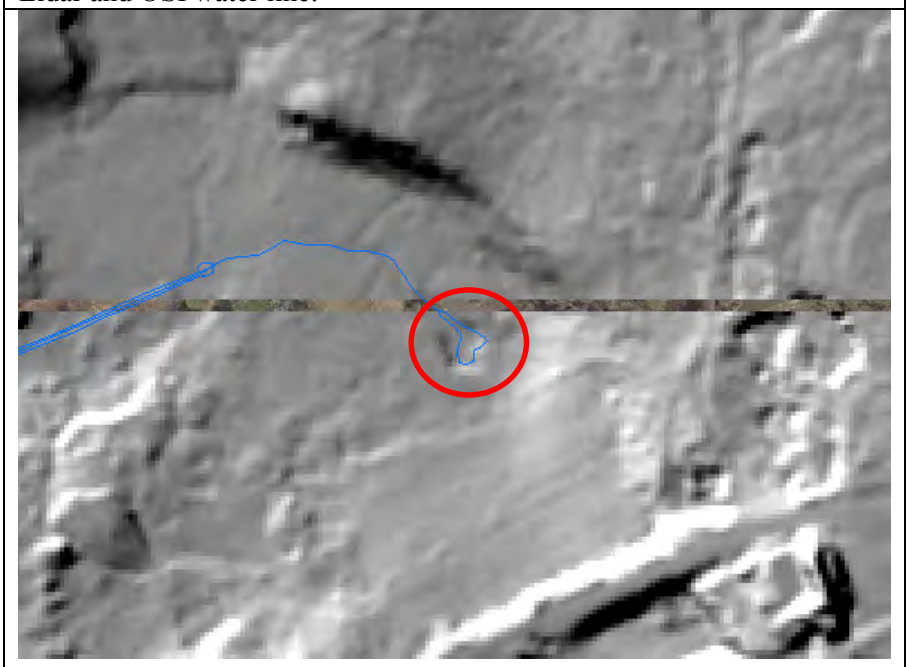
Site photos	 

Feature ID	**K40**
Feature type	Enclosed depression
Coordinates	529607, 727062
Source	Lidar:  Bing Maps: 
Field survey date	20/10/2014
Field survey status	Confirmation/identification problem
Water present	Unknown
Additional Information	May be enclosed depression but access inhibited by dense vegetation

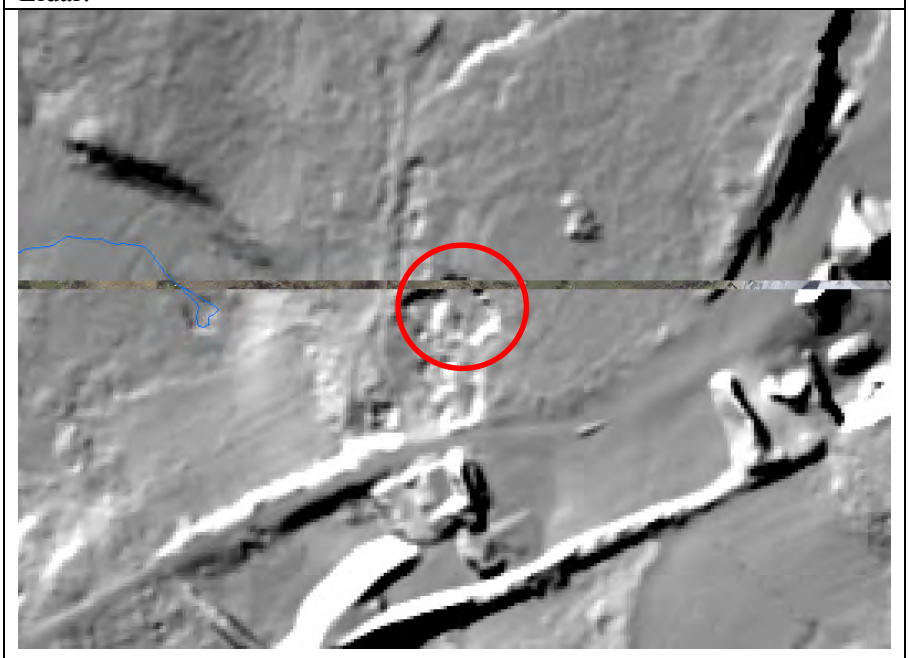
Site photos	

Feature ID	**K44**
Feature type	Enclosed depression
Coordinates	529836, 727798
Source	Lidar: 
	Bing Maps: 
Field survey date	16/10/2014
Field survey status	Confirmed
Water present	No
Additional Information	Small depression with rock exposed Approx. 2 m diameter and 1 m depth

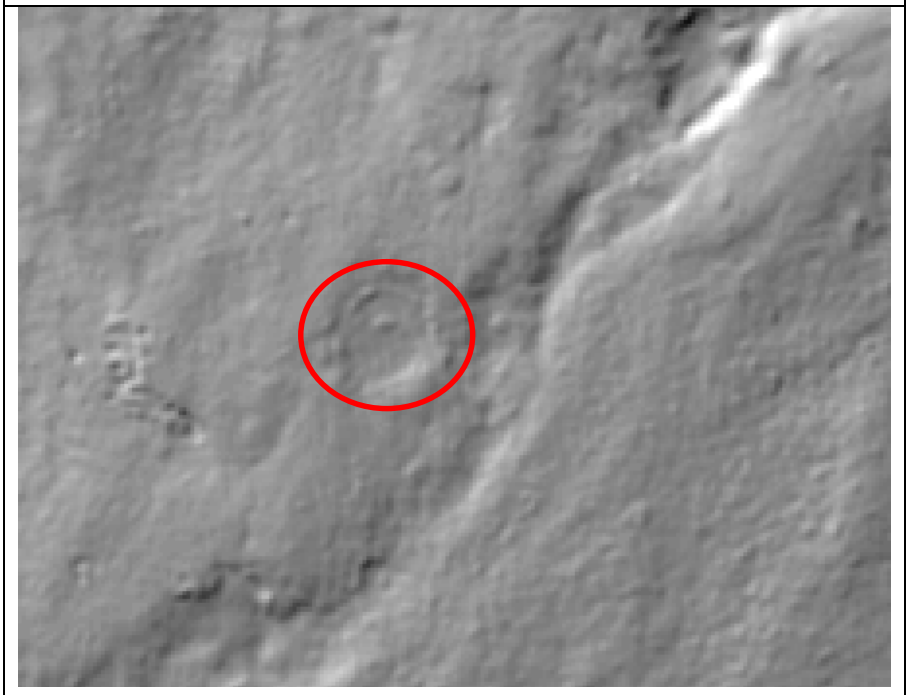
Site photo	

Feature ID	**K45**
Feature type	Spring
Coordinates	529900, 728162
Source	Lidar and OSI water line:  Bing Maps: 
Field survey date	16/10/2014
Field survey status	Confirmed
Water present	Yes Electrical conductivity: 680 uS/cm Temperature: 15.1 °C pH: 7.28
Additional Information	

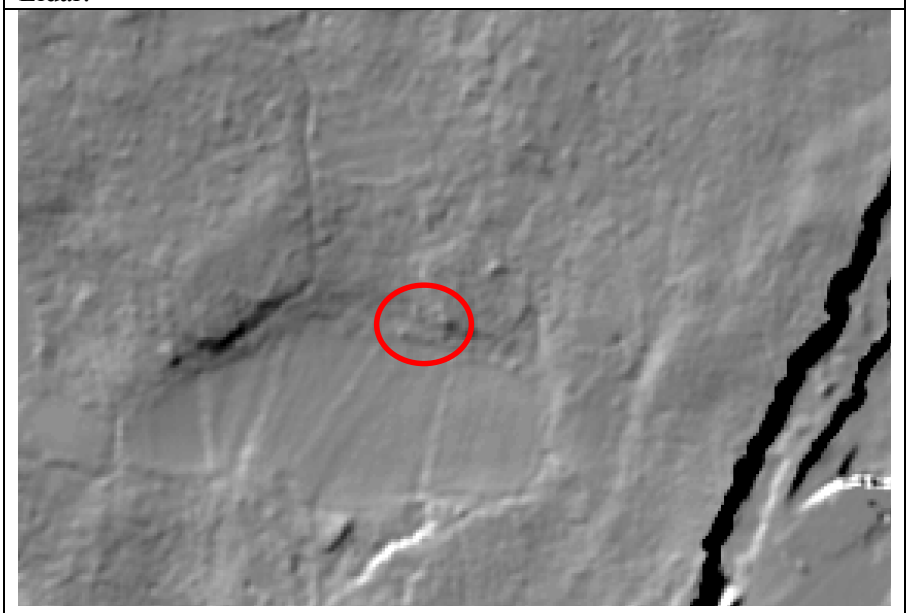
Site photo	 

Feature ID	**K49**
Feature type	Enclosed depression
Coordinates	530028, 728162
Source	Lidar:  Bing Maps: 
Field survey date	16/10/2014
Field survey status	Confirmed
Water present	No
Additional Information	Exposed rock at northern side and gentle slope on Southern side Approx. 20 m diameter 2 m depth

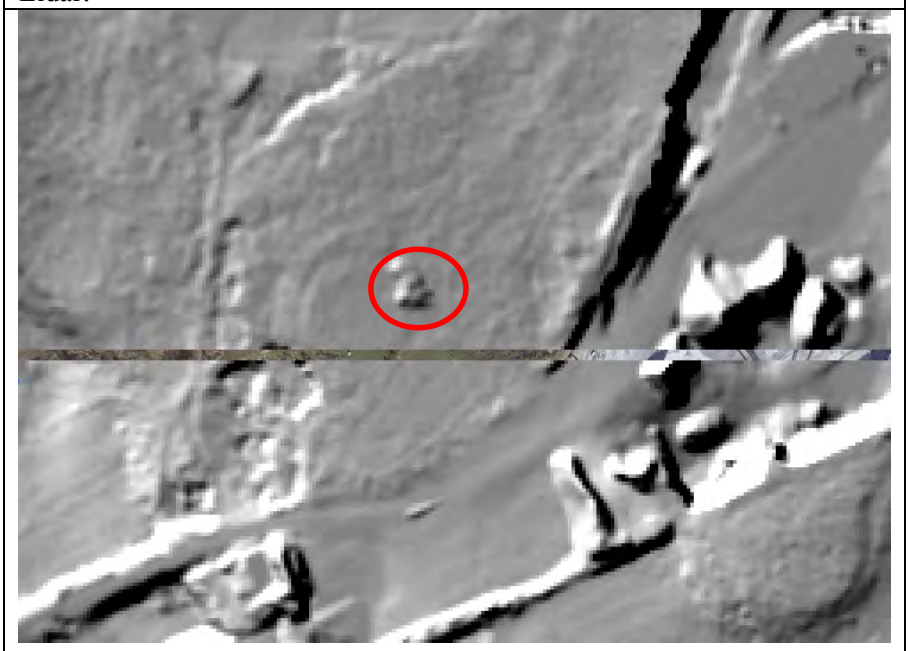
Site photos	 

Feature ID	**K50**
Feature type	Enclosed depression
Coordinates	530041, 729241
Source	Lidar:  Bing Maps: 
Field survey date	16/10/2014
Field survey status	Confirmed
Water present	No
Additional Information	Slight enclosed depression which may be filled in

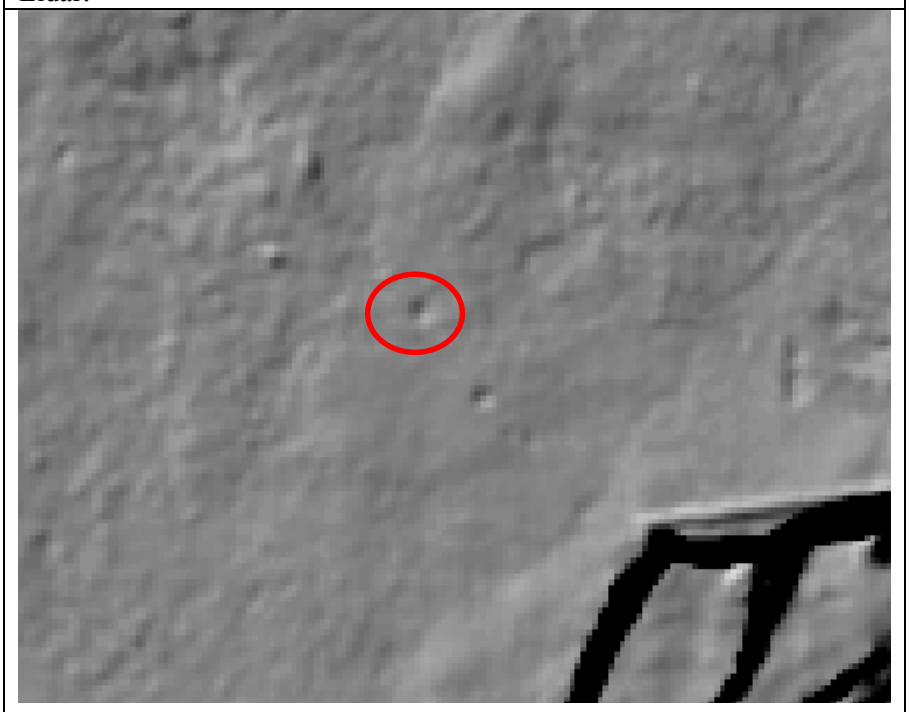
Site photos	 

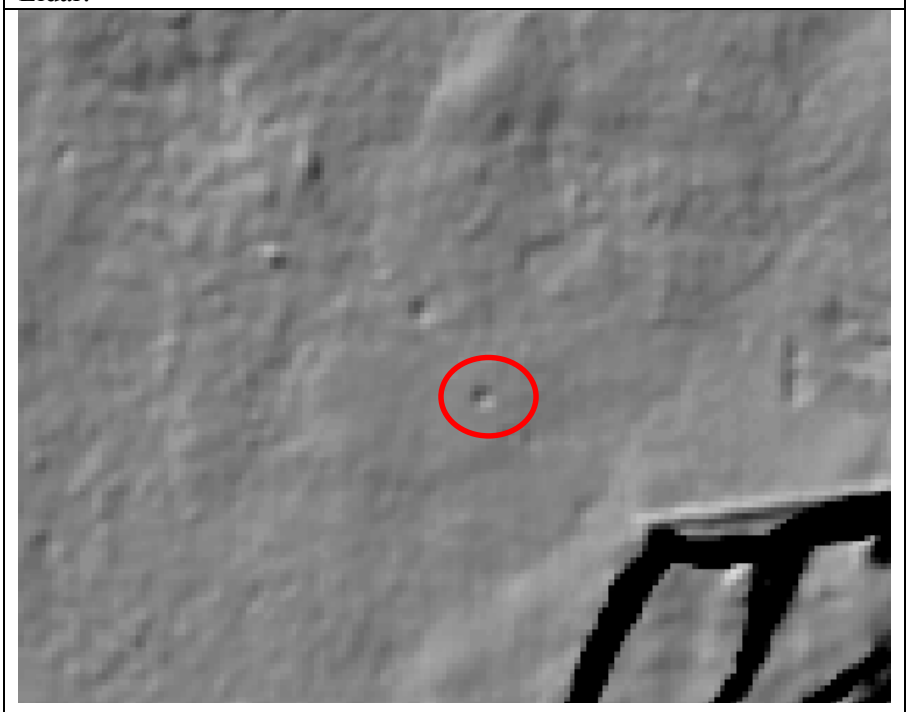
Feature ID	**K51**
Feature type	Enclosed depression
Coordinates	530084, 728466
Source	Lidar: 
	Bing Maps: 
Field survey date	16/10/2014
Field survey status	Confirmed
Water present	No
Additional Information	Very small enclosed depression plug hole not obvious but probably due to covering of moss

Site photos	

Feature ID	**K54**
Feature type	Enclosed depression
Coordinates	530120, 728208
Source	Lidar:  Bing Maps: 
Field survey date	16/10/2014
Field survey status	Confirmation/identification problem
Water present	No
Additional Information	Could not locate. Unpredictable Livestock in field and appears very overgrown where the feature is located.

Site photos	

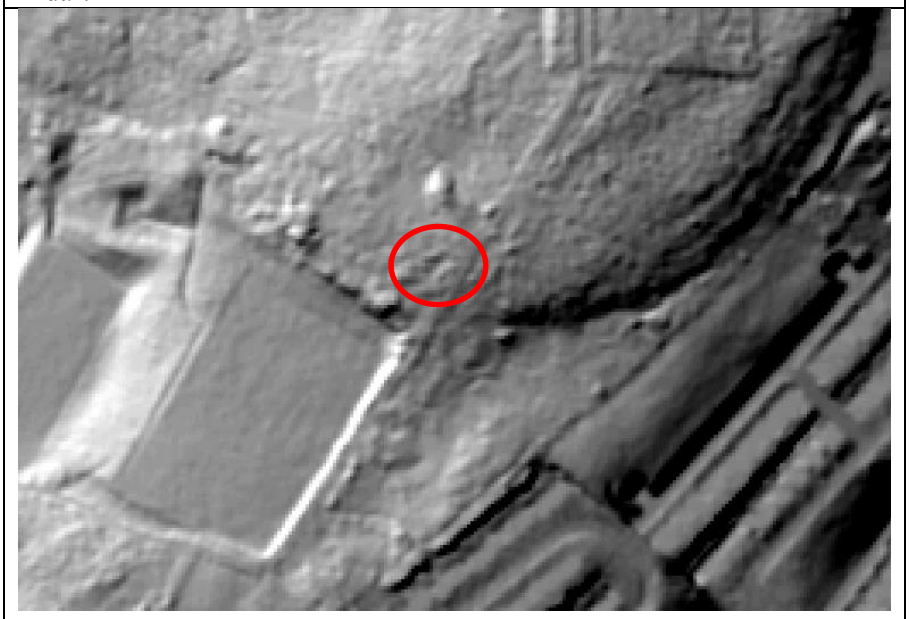
Feature ID	**K57**
Feature type	Enclosed Depression
Coordinates	530327, 728691
Source	Lidar:  Bing Maps: 
Field survey date	16/10/2014
Field survey status	Confirmed
Water present	No
Additional Information	Approx. 5m diameter 0.5 m depth
Site photo	Not available

Feature ID	**K59**
Feature type	Enclosed Depression
Coordinates	530352, 728656
Source	Lidar:  Bing Maps: 
Field survey date	16/10/2014
Field survey status	Confirmed
Water present	No
Additional Information	Enclosed depression is in line of depressions running east-west
Site photo	Not available

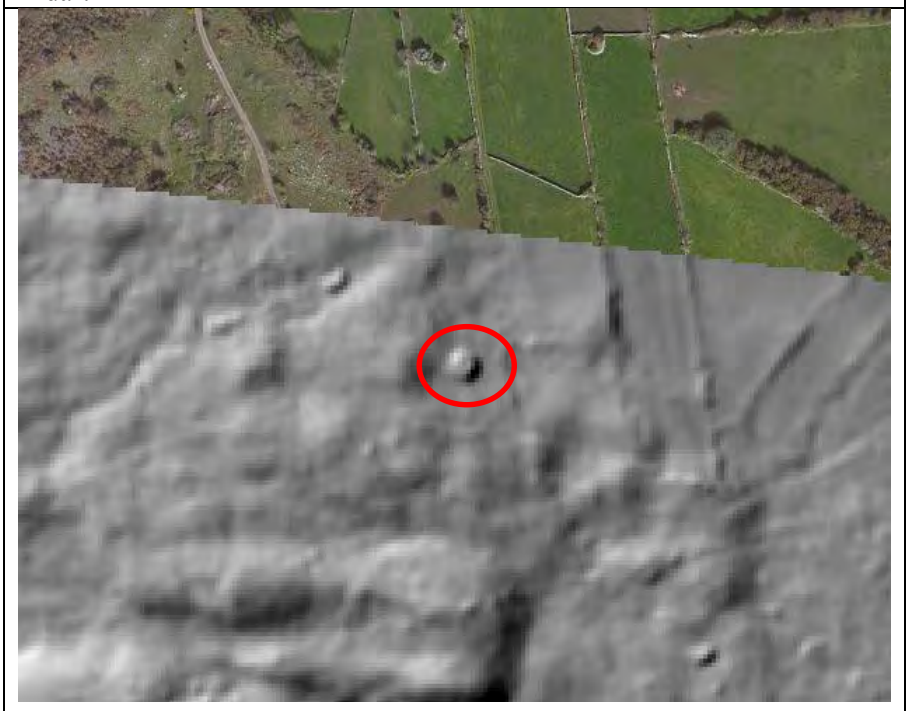
Feature ID	**K61**
Feature type	Enclosed Depression
Coordinates	530360, 728644
Source	Field Survey
Field survey date	16/10/2014
Field survey status	Confirmed
Water present	No
Additional Information	Approx. 1m diameter Enclosed depression is in line of depressions running east-west
Site photo	

Feature ID	**K62**
Feature type	Enclosed Depression
Coordinates	530369, 728642
Source	Field Survey
Field survey date	16/10/2014
Field survey status	Confirmed
Water present	No
Additional Information	Approx. 2m diameter and less than 0.5 m in depth. Enclosed depression is in line of depressions running east-west
Site photo	

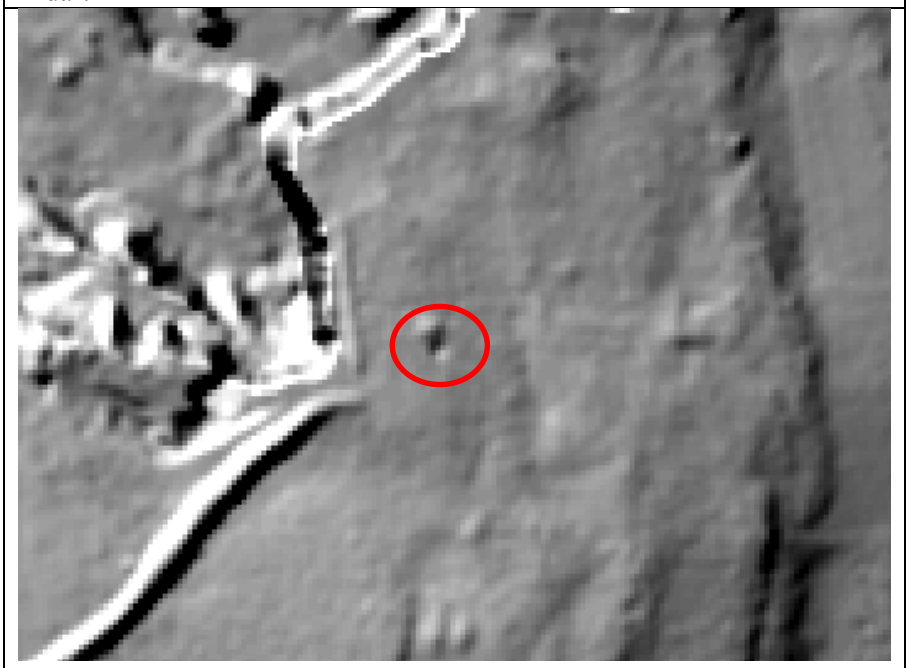
Feature ID	**K64**
Feature type	Enclosed Depression
Coordinates	530386, 728617
Source	Field Survey
Field survey date	16/10/2014
Field survey status	Confirmed
Water present	No
Additional Information	Approx. 2m diameter and less than 0.5 m in depth. Enclosed depression is in line of depressions running east-west
Site photo	

Feature ID	**K65**
Feature type	Enclosed Depression
Coordinates	530452, 727738
Source	Lidar:  Bing Maps: 
Field survey date	16/10/2014
Field survey status	Confirmed
Water present	No
Additional Information	2 depressions 3 m diameter and 1 m diameter less than 0.5 m depth. Larger depression is filled with a fire pit

Site photo	 

Feature ID	**K66**
Feature type	Enclosed Depression
Coordinates	530474, 729558
Source	Lidar:  Bing Maps: 
Field survey date	17/10/2014
Field survey status	Confirmation/identification problem
Water present	Unknown
Additional Information	Circle of brambles. Looks like a dip in the middle but covered in brambles preventing access.

Site photo	

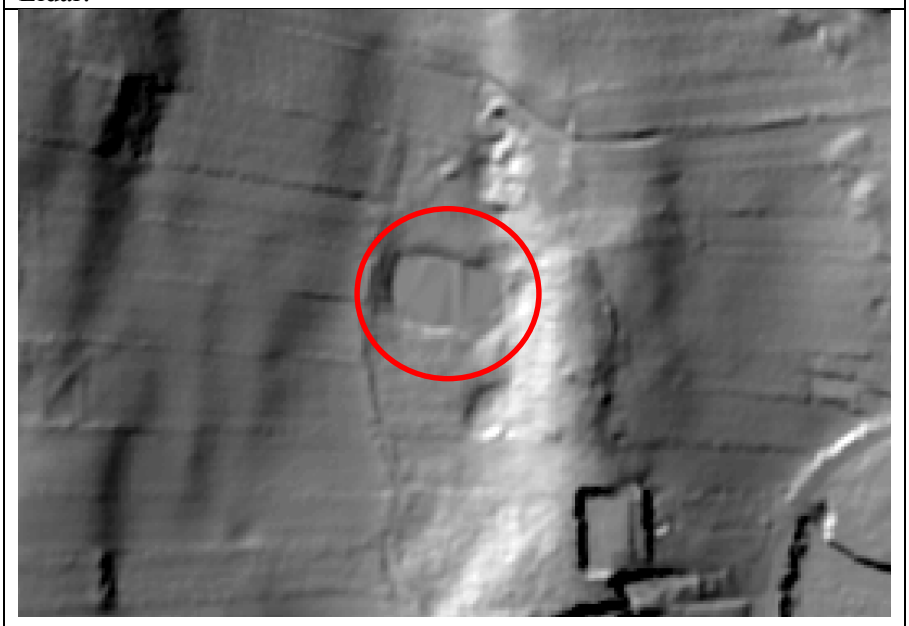
Feature ID	**K67**
Feature type	Enclosed Depression
Coordinates	530629, 728329
Source	Lidar:  Bing Maps: 
Field survey date	21/10/2014
Field survey status	Confirmed
Water present	No
Additional Information	Numerous boulders in depression Approx. 20 x 10m diameter and depth of 2m

Site photo	

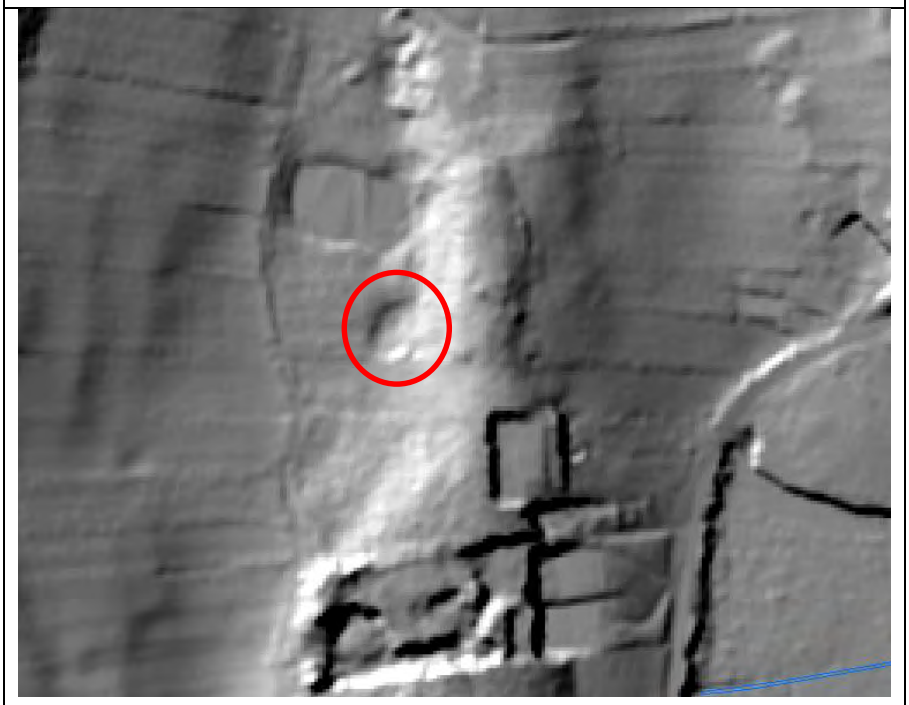
Feature ID	**K69**
Feature type	Enclosed depression
Coordinates	530669, 729123
Source	Field Survey
Field survey date	16/10/2014
Field survey status	Confirmed
Water present	No
Additional Information	Two adjacent enclosed depressions; 10 x 30m diameter and 5m diameter
Site photo	 

Feature ID	**K70**
Feature type	Enclosed depression
Coordinates	530671, 728317
Source	Field Survey
Field survey date	21/10/2014
Field survey status	Confirmed
Water present	No
Additional Information	15 x 3 m diameter enclosed depression Possibly filled in depression
Site photo	 

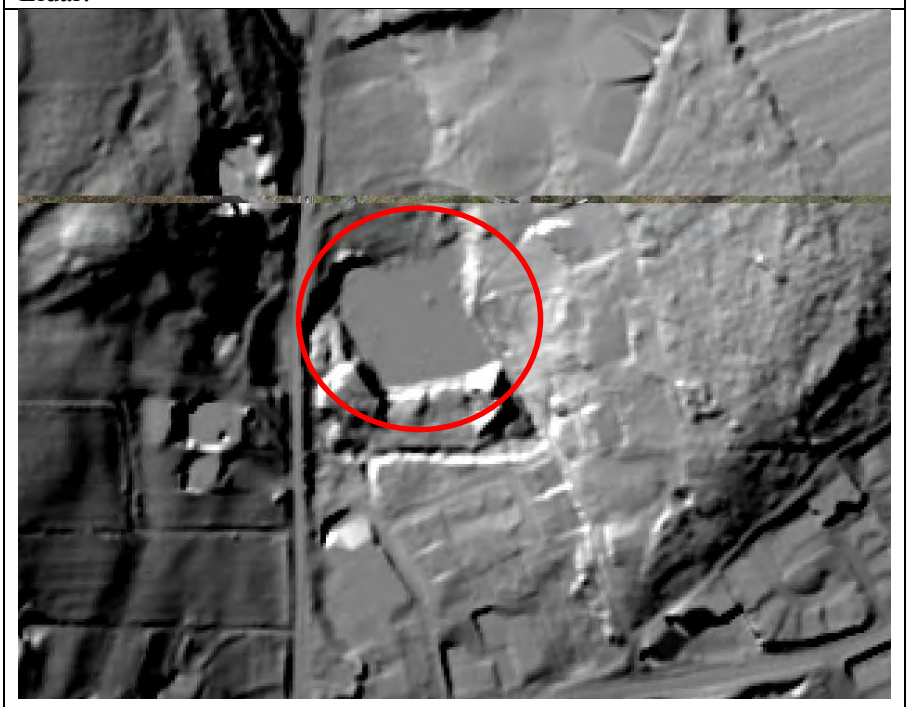
Feature ID	**K71**
Feature type	Enclosed depression
Coordinates	530694, 728662
Source	Field Survey
Field survey date	16/10/2014
Field survey status	Confirmed
Water present	No
Additional Information	2m by 4m along slope line Small depression near top of slope contains exposed rock
Site photo	

Feature ID	**K72**
Feature type	Turlough
Coordinates	530946, 729099
Source	Scott Cawley Ecologists Surveys
	Lidar: 
	Bing Maps: 
Field survey date	12/11/2014
Field survey status	Confirmed
Water present	Yes Electrical conductivity: 513 uS/cm Temperature: 9.2 °C pH: 7.37
Water elevation	14.13 mAOD

Additional Information	Turlough visited while in flood Estimated highest extend of water is 15.37 mAOD measured in adjacent field
Site photo	 

Feature ID	**K73**
Feature type	Enclosed depression
Coordinates	530964, 729035
Source	Lidar: 
	Bing Maps: 
Field survey date	12/11/2014
Field survey status	Confirmed
Water present	No
Ground level elevation	15.46 mAOD, Estimated elevation. Elevation not recorded within feature due to tree coverage. Elevation reading taken 20 m south and approx. 1m higher elevation (actual recorded elevation was 16.456)
Additional Information	Area mossy and covered with trees

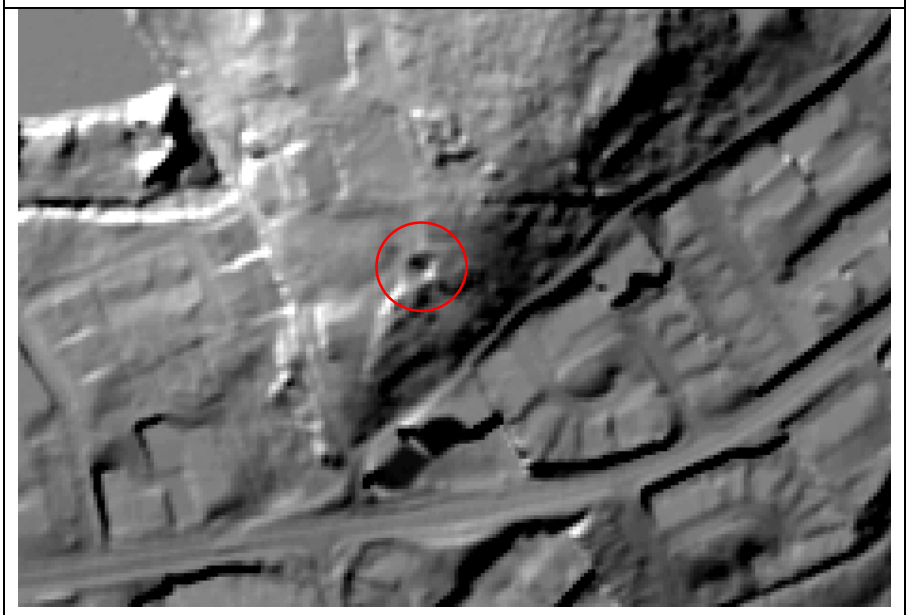
Site photo	 

Feature ID	**K74**
Feature type	Turlough
Coordinates	531066, 728080
Source	Scott Cawley Ecologists Surveys
	Lidar:
	
	Bing Maps:
	
Field survey date	12/11/2014
Field survey status	Confirmed
Water present	Yes Electrical conductivity: 551 uS/cm Temperature: 8.1 °C

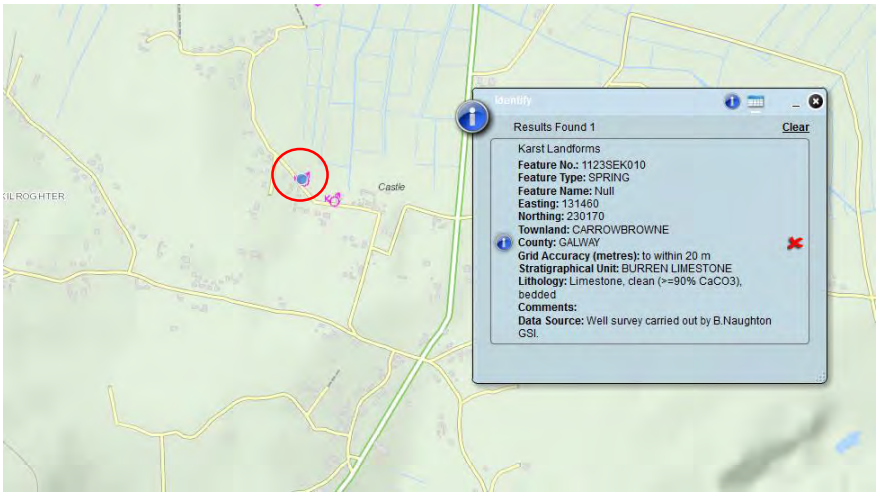
	pH: 7.42
Water level elevation	9.70 mAOD
Additional Information	Questionable turlough. May be a wetland rather than a turlough. The area contains numerous rectangular hollows filled with water. It is unlikely that the hollows are natural but are most likely manmade.
Site photo	  

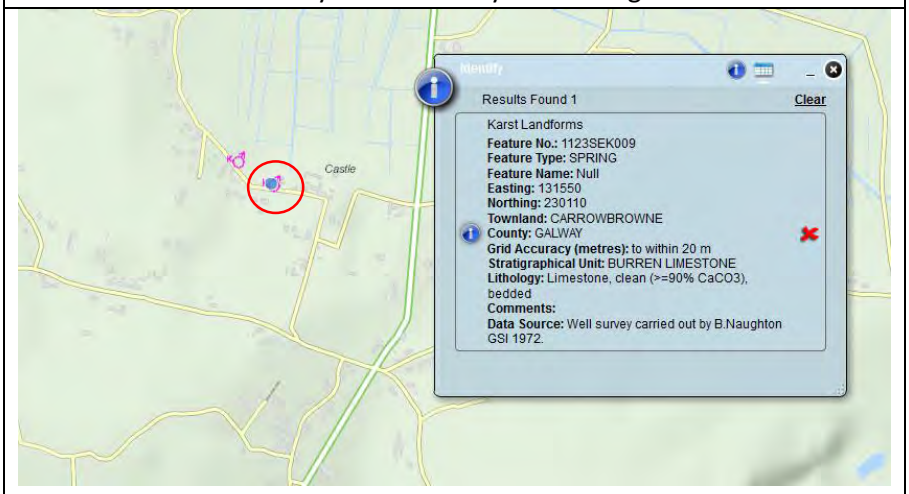
Feature ID	**K75**
Feature type	Enclosed Depression
Coordinates	531193, 727242
Source	Lidar:  Bing Maps: 
Field survey date	22/10/2014
Field survey status	Confirmation/identification problem
Water present	Unknown
Additional Information	Cannot access depression. Access hindered due to dense vegetation.

Site photo	

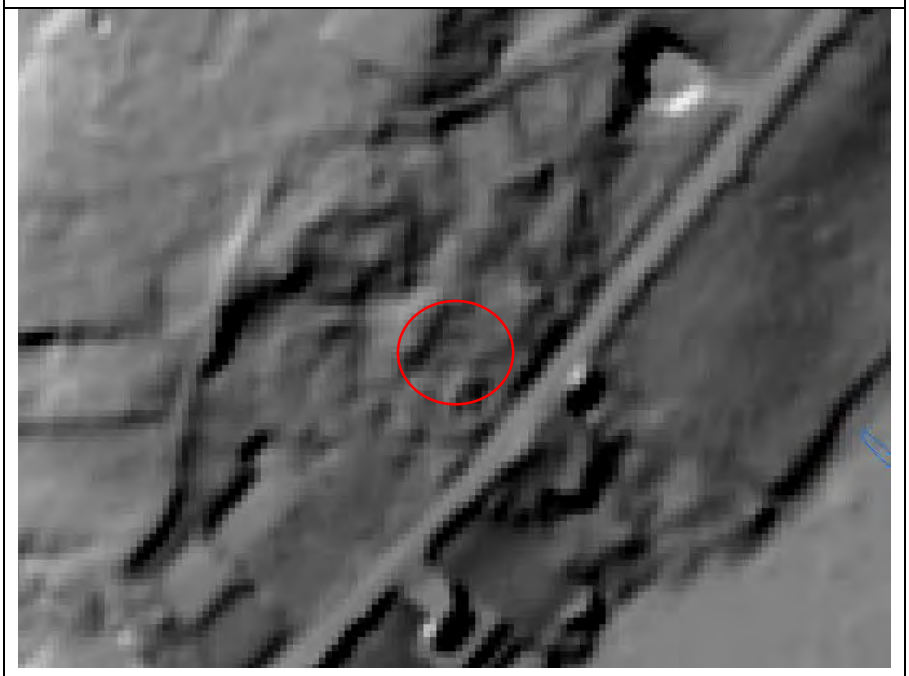
Feature ID	**K76**
Feature type	Enclosed Depression
Coordinates	531254, 727960
Source	Lidar:
	
	Bing Maps:
	
Field survey date	20/10/2014
Field survey status	Confirmed
Water present	No
Additional Information	10m diameter 4m depth. Steep sides with exposed rock May also be as result of rock excavation

Site photo	 

Feature ID	**K77**
Feature type	Spring
Coordinates	531312, 730126
Source	GSI Database: Well survey carried out by Bride Naughton GSI 1972.
	
Field survey date	12/11/2014
Field survey status	Cannot locate
Water present	n/a
Additional Information	
Site photo	n/a

Feature ID	**K81**
Feature type	Spring
Coordinates	531384, 730074
Source	GSI Database: Well survey carried out by Bride Naughton GSI 1972.
	
Field survey date	12/11/2014
Field survey status	Cannot locate
Water present	n/a
Additional Information	
Site photo	n/a

Feature ID	**K82**
Feature type	Enclosed depression
Coordinates	531437, 729244
Source	Field Survey
Field survey date	16/10/2014
Field survey status	Confirmed
Water present	No
Additional Information	10 m diameter. Possible enclosed depression slightly questionable
Site photo	

Feature ID	**K83**
Feature type	Enclosed depression
Coordinates	531449, 729223
Source	Lidar: 
	Bing Maps: 
Field survey date	12/11/2014
Field survey status	Confirmation/identification problem
Water present	Unknown
Additional Information	Could not access very overgrown

Site photo	

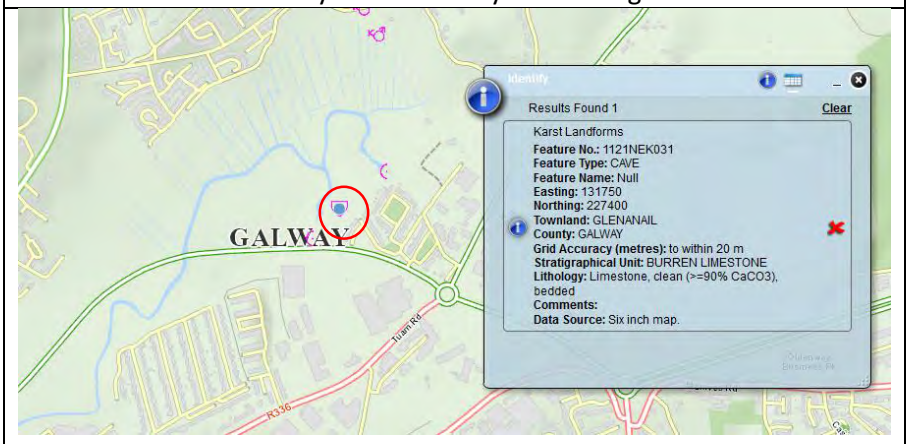
Feature ID	**K85**
Feature type	Enclosed depression
Coordinates	531456, 729194
Source	Field Survey
Field survey date	16/10/2014
Field survey status	Confirmed
Water present	No
Additional Information	10 m diameter semicircle intercepted by wall/road (N84). Possible enclosed depression slightly questionable as it could be as a result of excavation for N84 road construction
Site photo	

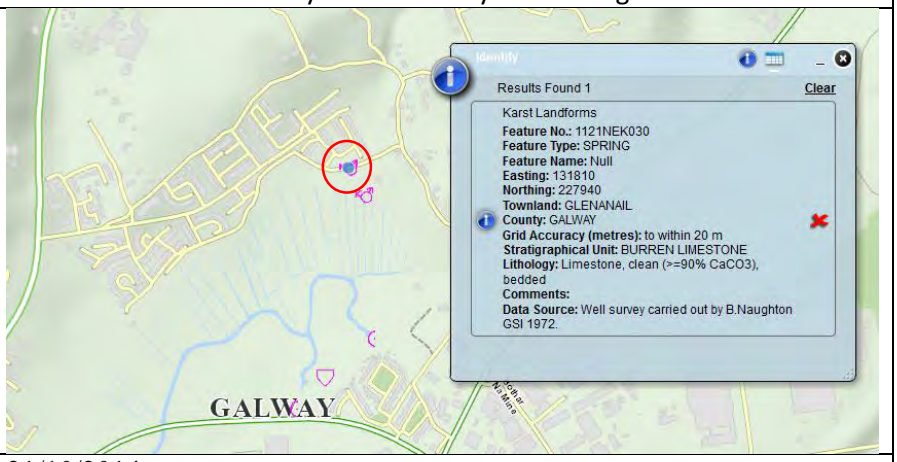
Feature ID	**K86**	
Feature type	Estavelle	
Coordinates	531476, 729108	
Source	EIS N6 Galway City Outer Bypass Vol 2 2006	
Field survey date	16/10/2014	11/11/2014
Field survey status	Confirmed	Confirmed
Water present	No	Yes Electrical conductivity: 590 uS/cm Temperature: 9 °C pH: 7.52 No flow to permit flow measurement
Water elevation	n/a	8.927
Additional Information	Drain runs from estavelle location near break in slope towards Ballindooley lough	
Site photo	Estavelle location  Shallow ditch running between the estavelle and Ballindooley Lough: 	

Feature ID	**K87**	
Feature type	Spring / Swallow hole	
Coordinates	531666, 727406	
Source	GSI Database: Well survey carried out by Bride Naughton GSI 1972.	
	Lidar: 	
	Bing Maps: 	
Field survey date	22/10/2014	12/11/2014
Field survey status	Confirmed	Confirmed

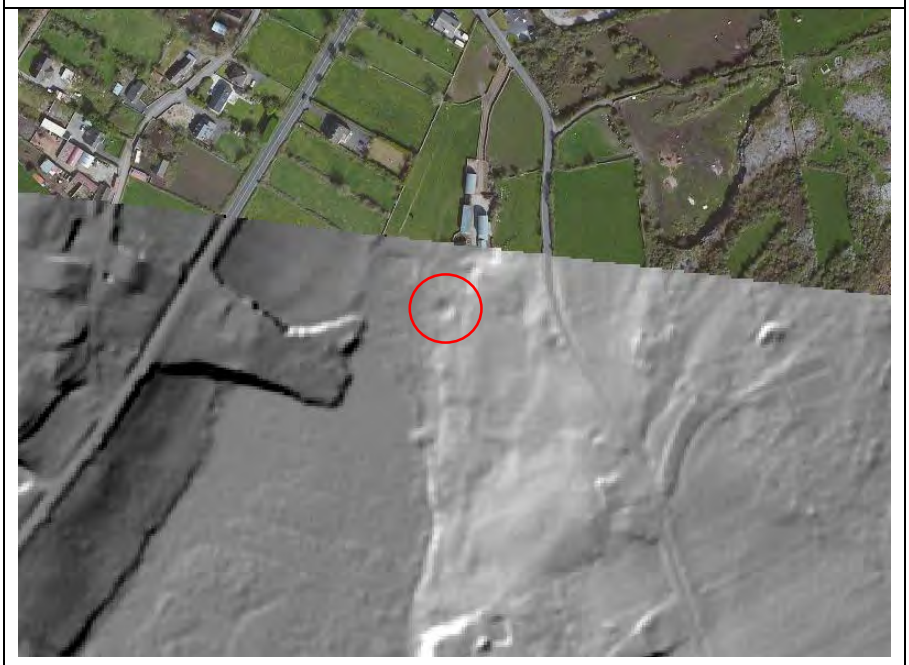
Water present	Yes Electrical conductivity: 320 uS/cm Temperature: 11.4 °C pH: 7.76 Flow direction into swallow hole No flow measurement taken	Yes Electrical conductivity: 781 uS/cm Temperature: 10.3 °C pH: 7.5 Flow direction into swallow hole Flow: 400 l/s
Water level elevation	n/a	1.79 mAOD
Additional Information	Terryland River discharges into or can be fed by this spring / swallow hole. The Feature contains three discrete discharge points to ground where flow was visible discharging to ground during both field survey visits.	
Site photo	 	

Feature ID	**K88**
Feature type	Enclosed depression
Coordinates	531671, 727351
Source	Field Survey
Field survey date	22/10/2014
Field survey status	Confirmed
Water present	No
Additional Information	Approximate dimensions: 30m x 5m Elongated depression in an east-south-east west-north-west direction. The ESE wall is approx. 4m high. The depression contains numerous trees.
Site photo	

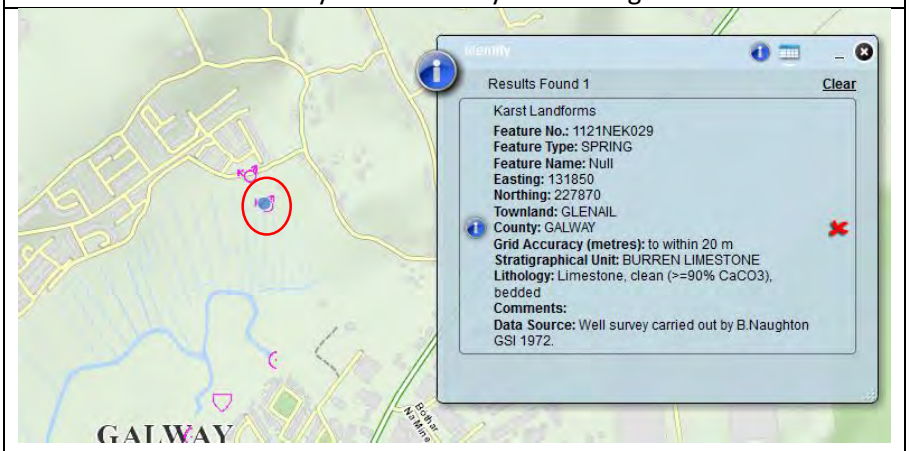
Feature ID	**K89**
Feature type	Cave
Coordinates	531725, 727427
Source	GSI Database: Well survey carried out by Bride Naughton GSI 1972. 
Field survey date	22/10/2014
Field survey status	Confirmed
Water present	No
Additional Information	Approx. 3m wide x 1 m high opening to cave
Site photo	

Feature ID	**K90**
Feature type	Spring
Coordinates	531776, 727969
Source	GSI Database: Well survey carried out by Bride Naughton GSI 1972.
	
Field survey date	21/10/2014
Field survey status	Not found
Water present	n/a
Additional Information	
Site photo	Not available

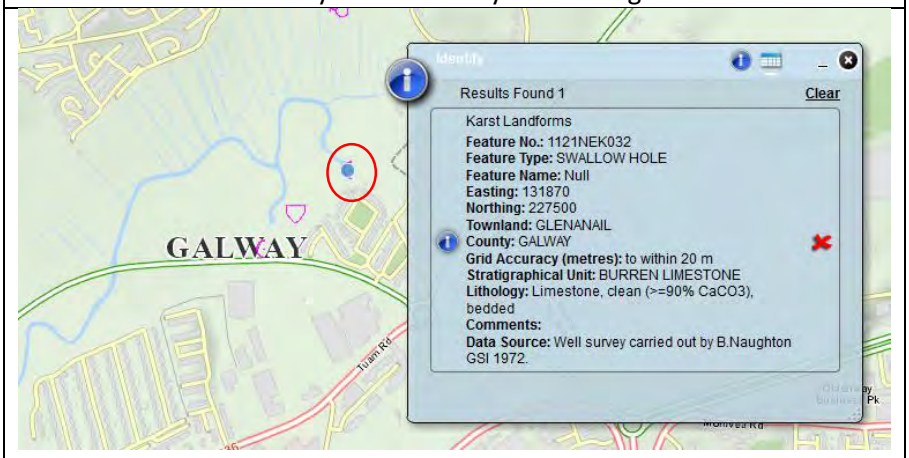
Feature ID	**K92**
Feature type	Well
Coordinates	531781, 729453
Source	Field Survey
Field survey date	21/10/2014
Field survey status	Confirmed
Water present	Yes Electrical conductivity: 370 uS/cm Temperature: 11.1 °C pH: 7.61
Additional Information	Approximate dimension: 2m diameter Old well surrounded by stone wall
Site photo	

Feature ID	**K94**
Feature type	Enclosed depression
Coordinates	531814, 729415
Source	Lidar: 
	Bing Maps: 
Field survey date	21/10/2014
Field survey status	Confirmed
Water present	No
Additional Information	Approx. 15m diameter Access inhibited due to cattle in field

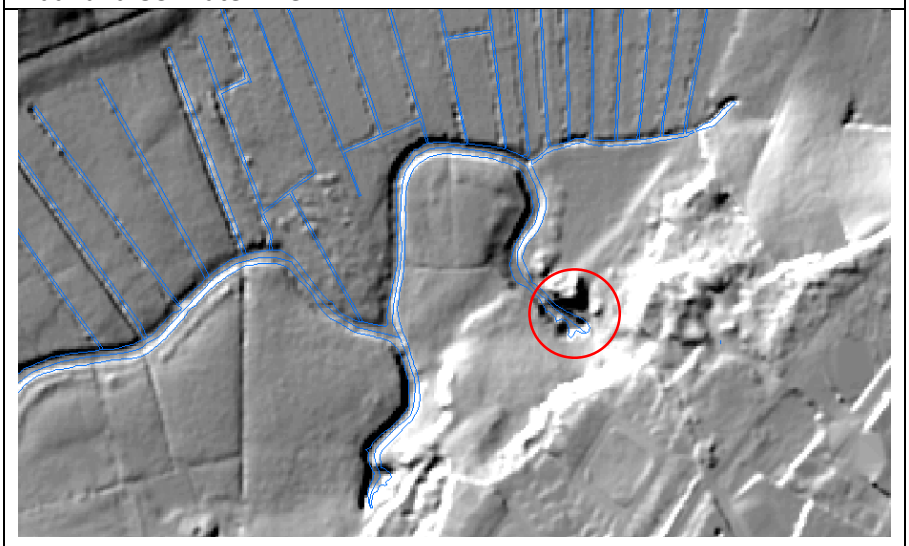
Site photo	 

Feature ID	**K95**	
Feature type	Swallow Hole	
Coordinates	531828, 727964	
Source	GSI Database: Well survey carried out by Bride Naughton GSI 1972.	
		
Field survey date	12/10/2014	12/11/2014
Field survey status	Confirmed	Confirmed
Water present	No	Yes Electrical conductivity: 728 uS/cm Temperature: 10.9 °C pH: 7.06
Water level elevation	n/a	3.73 mAOD
Additional Information	Approx. 2 m diameter Notice beside swallow hole states that the feature is known as Castlegar well. It also notes that the stream that feeds the well was capped in 2004.	
Site photo		

Feature ID	**K96**
Feature type	Spring / Swallow hole
Coordinates	531837, 727535
Source	GSI Database: Well survey carried out by Bride Naughton GSI 1972.

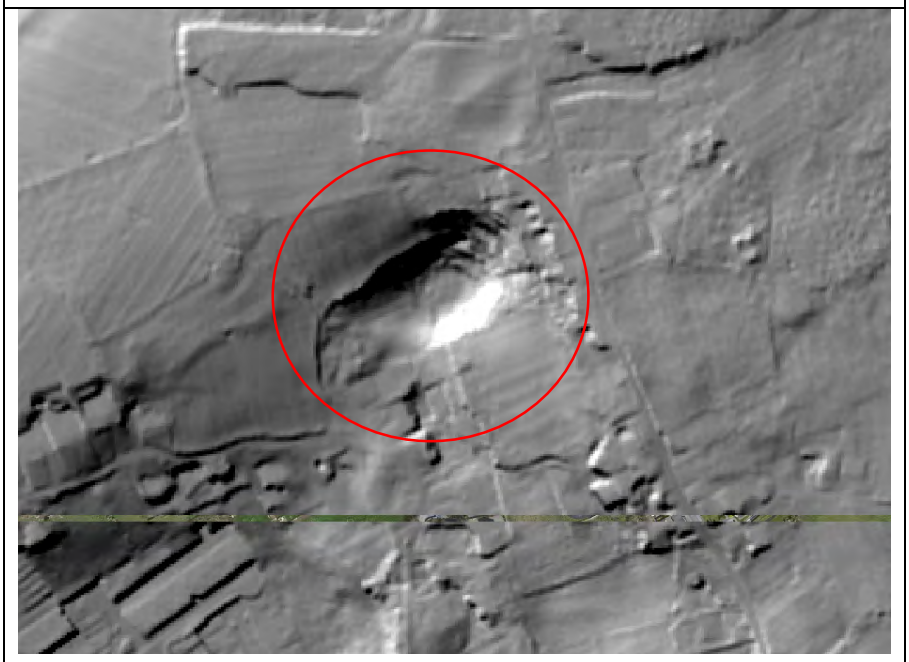


Lidar and OSI water line:

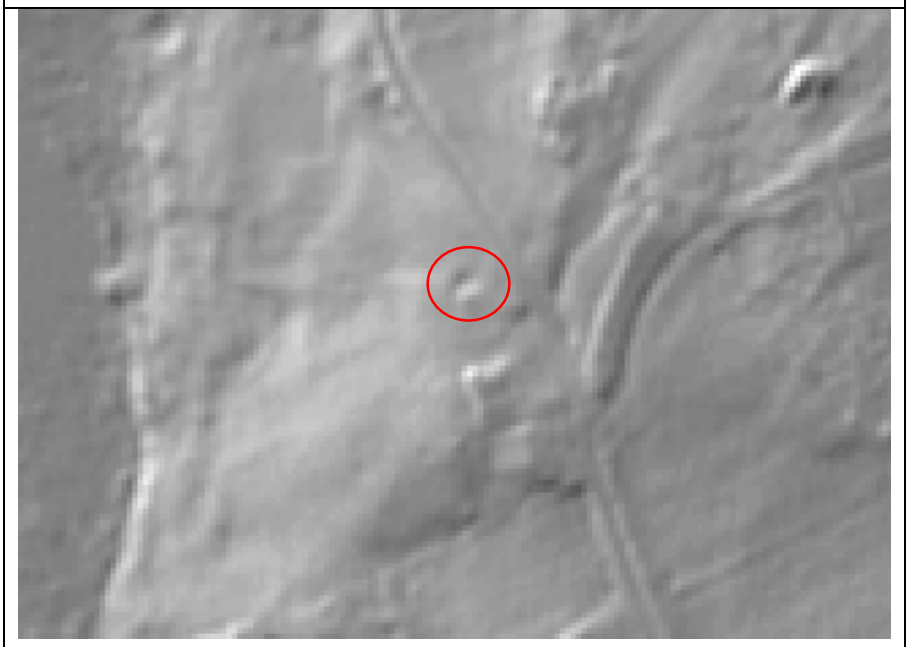


Bing Maps:

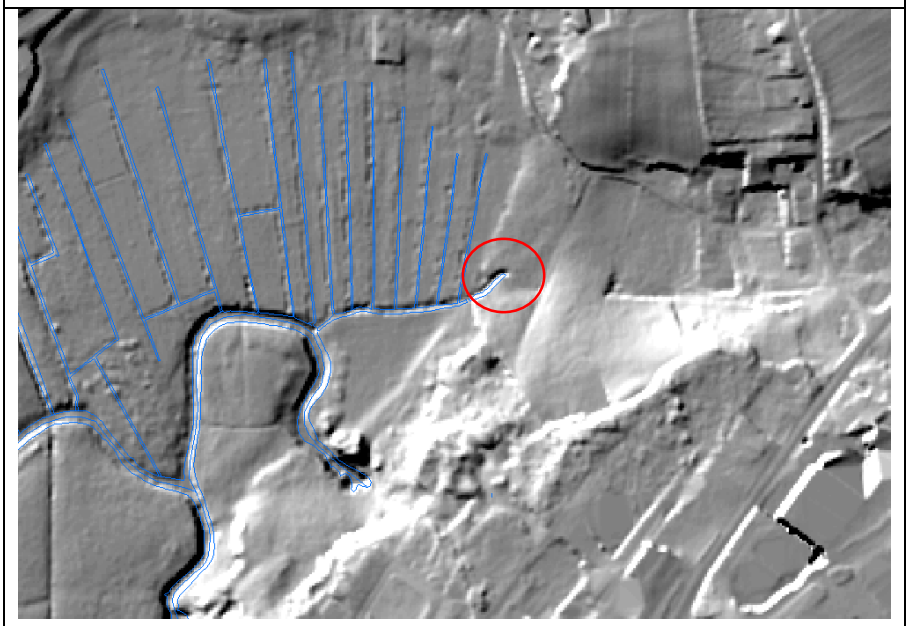
Field survey date	22/10/2014	12/11/2014
Field survey status	Confirmed	Confirmed
Water present	Yes Electrical conductivity: 370 uS/cm Temperature: 11.3 °C pH: 7.76 Flow direction into swallow hole No flow measurement taken	Yes Electrical conductivity: 576 uS/cm Temperature: 10.6 °C pH: 7.52 Flow direction into swallow hole Flow: 765 l/s
Water level elevation	n/a	1.77 mAOD
Additional Information	Terryland River discharges into or can be fed by this spring / swallow hole.	
Site photo	 	

Feature ID	**K97**	
Feature type	Enclosed depression	
Coordinates	531945, 728372	
Source	Lidar: 	
	Bing Maps: 	
Field survey date	21/10/2014	12/11/2014
Field survey status	Confirmed	Confirmed
Water present	No	Yes Electrical conductivity: 219 uS/cm Temperature: 8.1 °C pH: 6.4
Elevation measurements	n/a	Ground level in centre of depression: 12.11 mAOD Water levels: Dug Well 1: 12.17 mAOD (531947, 728372) Dug Well 2: 12.22 mAOD (531934, 728379)

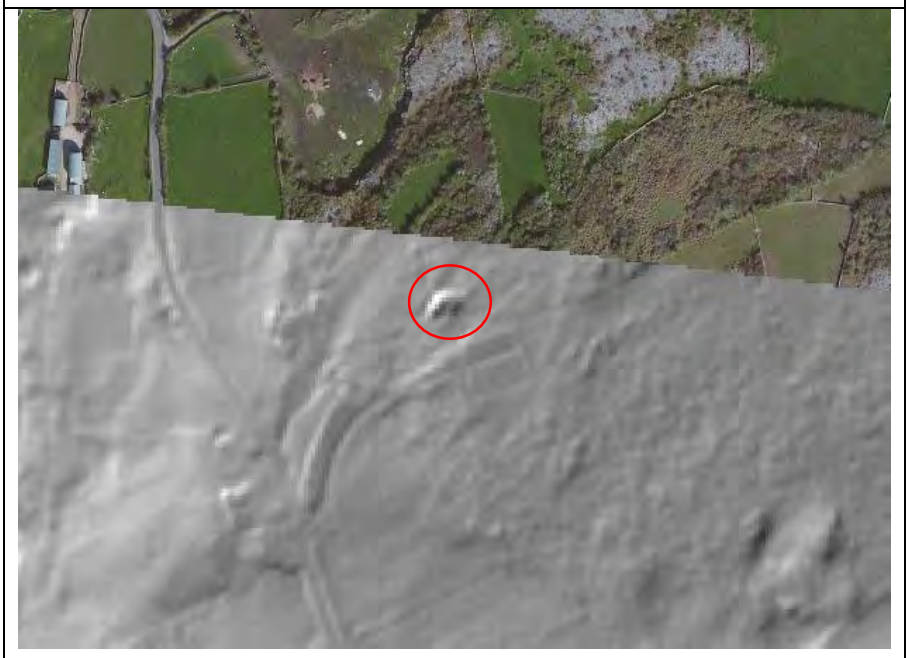
Additional Information	Approx 40 m diameter flat bottom depression. Soft muddy base. Dug well 1 identified at 531947, 728372 (See figure). Dug well 2 identified at 531934, 728379.
Site photo	 Dug well 1 

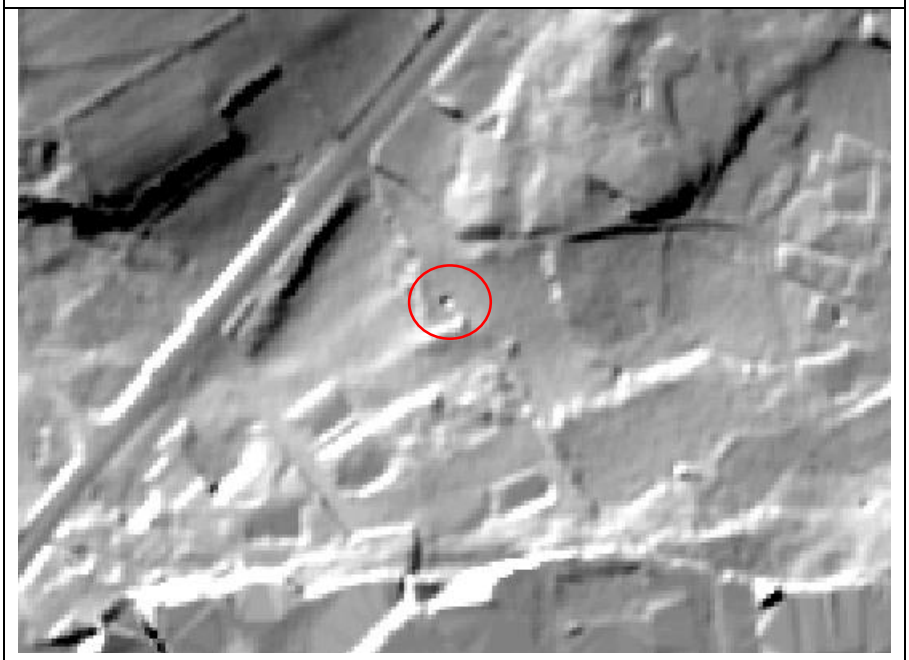
Feature ID	**K98**
Feature type	Enclosed Depression
Coordinates	531924, 729321
Source	Lidar: 
	Bing Maps: 
Field survey date	21/10/2014
Field survey status	Confirmed
Water present	No
Additional Information	Approx. 3m diameter depression

Site photos	 

Feature ID	**K99**	
Feature type	Spring	
Coordinates	531963, 727732	
Source	Lidar: 	
	Bing Maps: 	
Field survey date	21/10/2014	12/11/2014
Field survey status	Confirmed	Confirmed
Water present	No	Yes Electrical conductivity: 995 uS/cm Temperature: 12 °C pH: 7.06 Flow not great enough for flow measurement
Additional Information	Drain leading from spring towards Terryland River	

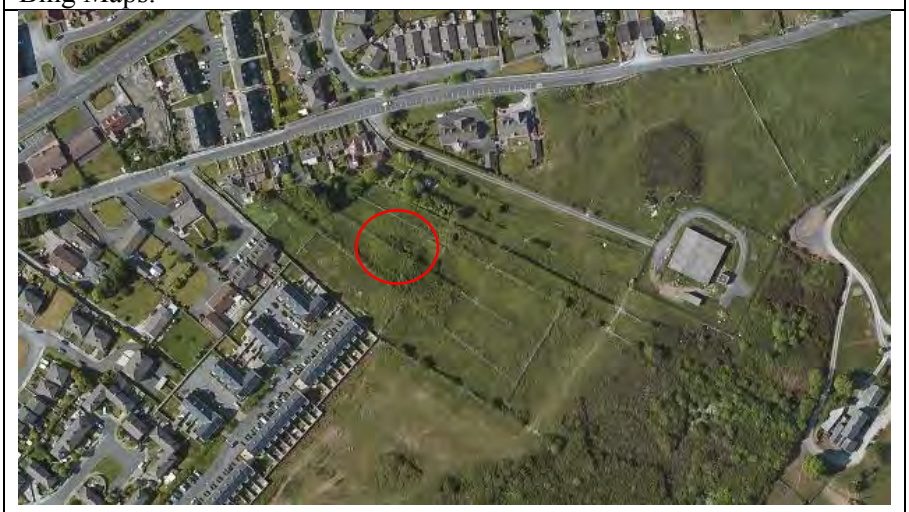
Site photos	

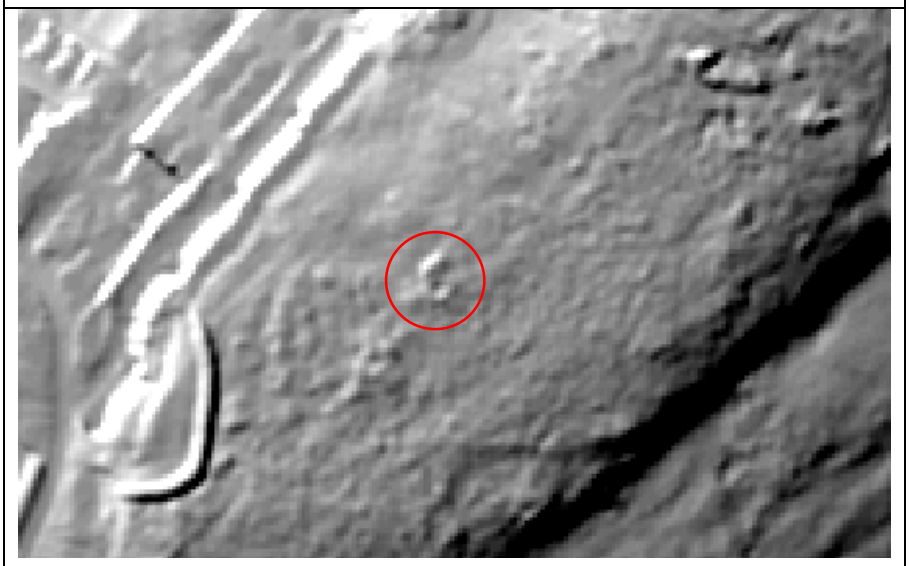
Feature ID	**K100**
Feature type	Enclosed depression
Coordinates	532049, 729396
Source	Lidar:  Bing Maps: 
Field survey date	21/10/2014
Field survey status	Confirmation/identification problem
Water present	n/a
Additional Information	Feature not found. Access hindered due to dense hazel scrub
Site photos	Not available

Feature ID	**K104**
Feature type	Enclosed depression
Coordinates	532465, 727750
Source	Lidar:  Bing Maps: 
Field survey date	12/11/2014
Field survey status	Confirmed
Water present	No
Ground level elevation	24.01 mAOD at base of depression
Additional Information	Approx. dimensions: 3m diameter, 2m depth. Very steep sides. Almost looks like an old manmade well.

Site photos	

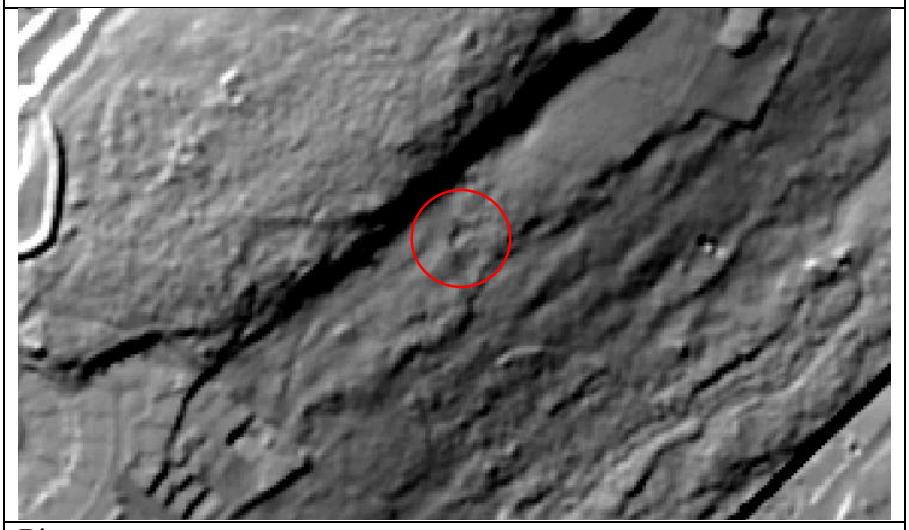
Feature ID	**K112**
Feature type	Enclosed Depression
Coordinates	533207, 725629
Source	Field Survey
Field survey date	13/11/2014
Field survey status	Confirmed
Water present	No
Additional Information	Approx. dimensions: 2 m diameter and 0.5 m depth Small depression in forest
Site photos	Not available

Feature ID	**K122**
Feature type	Enclosed depression
Coordinates	533536, 726925
Source	Lidar: 
	Bing Maps: 
Field survey date	14/11/2014
Field survey status	Confirmation/identification problem
Water present	No
Additional Information	Access issue due to dense coverage of vegetation
Site photos	Not available

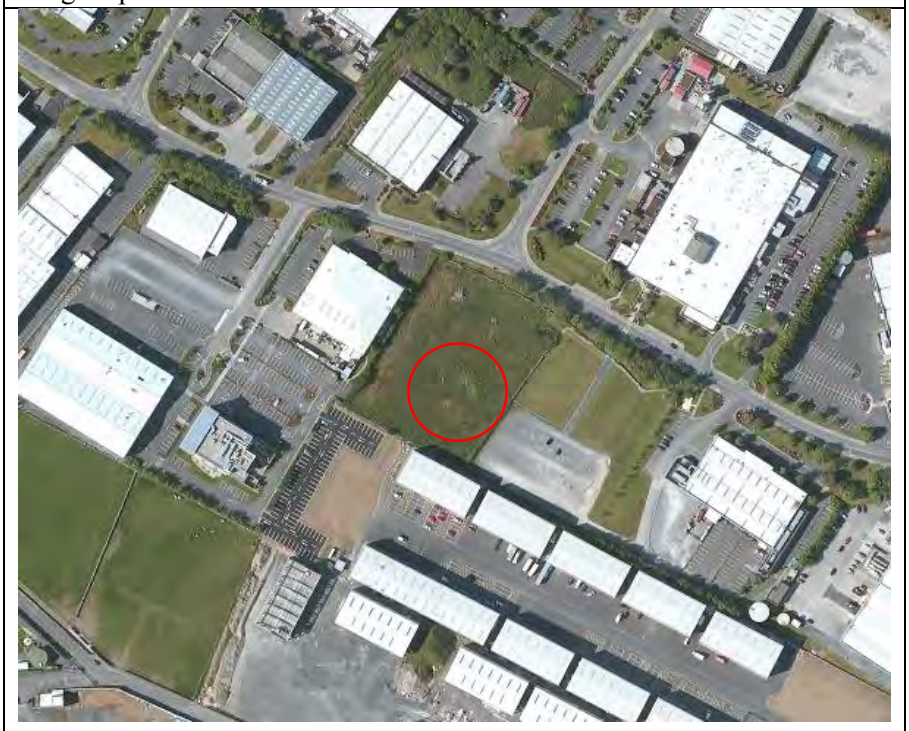
Feature ID	**K124**
Feature type	Enclosed depression
Coordinates	533566, 726759
Source	Lidar:
	
	Bing Maps:
	
Field survey date	13/11/2014
Field survey status	Confirmation/identification problem
Water present	n/a
Additional Information	Access issue due to dense vegetation cover
Site photos	Not available

Feature ID	**K126**
Feature type	Spring
Coordinates	533644, 726504
Source	Field Survey
Field survey date	13/11/2014
Field survey status	Confirmed
Water present	Yes Electrical conductivity: 474 uS/cm Temperature: 10.4 °C pH: 7.38
Water level elevation	48.56 mAOD
Additional Information	Small spring in middle of field
Site photos	Spring from down gradient:  Spring from up gradient: 

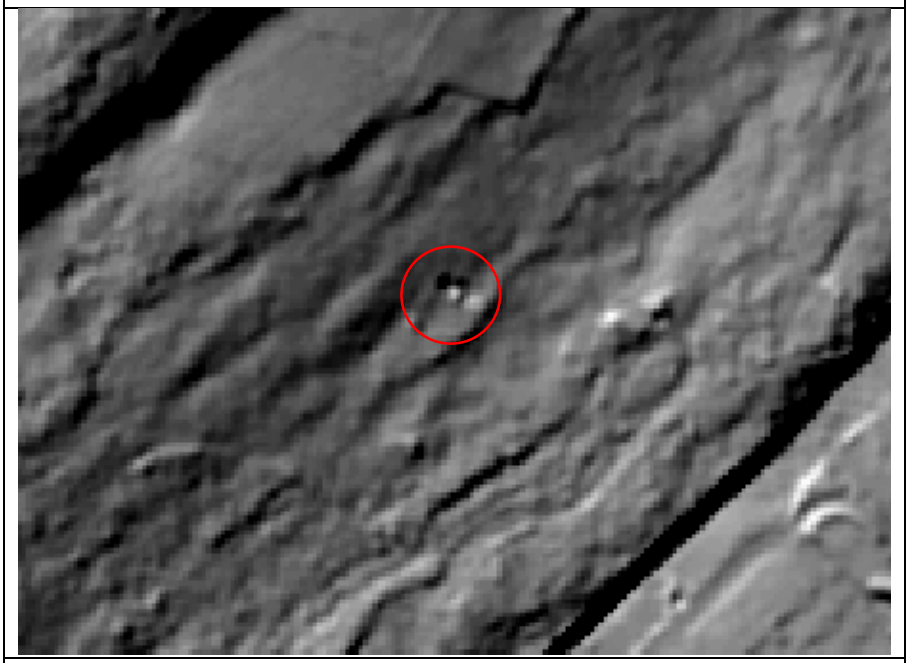
Feature ID	**K129**
Feature type	Spring
Coordinates	533701, 726678
Source	Field Survey
Field survey date	13/11/2014
Field survey status	Confirmed
Water present	Yes Electrical conductivity: 470 uS/cm Temperature: 11.2 °C pH: 7.68
Water level elevation	55.95 mAOD
Additional Information	Small stream from spring feeding K130 enclosed depression. Very low flow cannot get flow measurement
Site photos	 

Feature ID	**K130**
Feature type	Enclosed depression
Coordinates	533711, 726665
Source	Lidar:  Bing maps: 
Field survey date	13/11/2014
Field survey status	Confirmed
Water present	Yes Electrical conductivity: 199 uS/cm Temperature: 7.1 °C pH: 8.13
Elevation levels	Base of enclosed depression: 54.74 mAOD Water level elevation: 55.01 mAOD
Additional Information	Enclosed depression filled with water from stream k314.

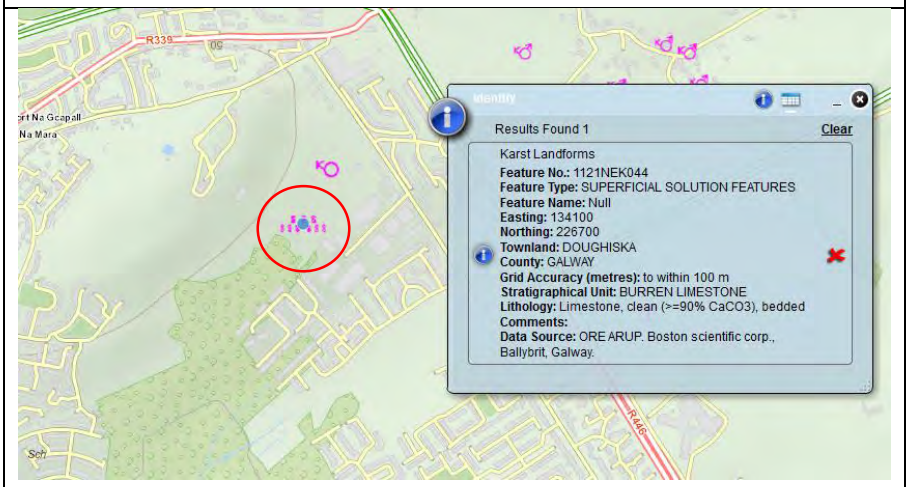
Site photos	

Feature ID	**K131**
Feature type	Enclosed depression
Coordinates	533815, 728265
Source	Lidar:  Bing maps: 
Field survey date	22/10/2014
Field survey status	Confirmed
Water present	No
Additional Information	Approx. dimensions: 10m diameter and 1.5m depth

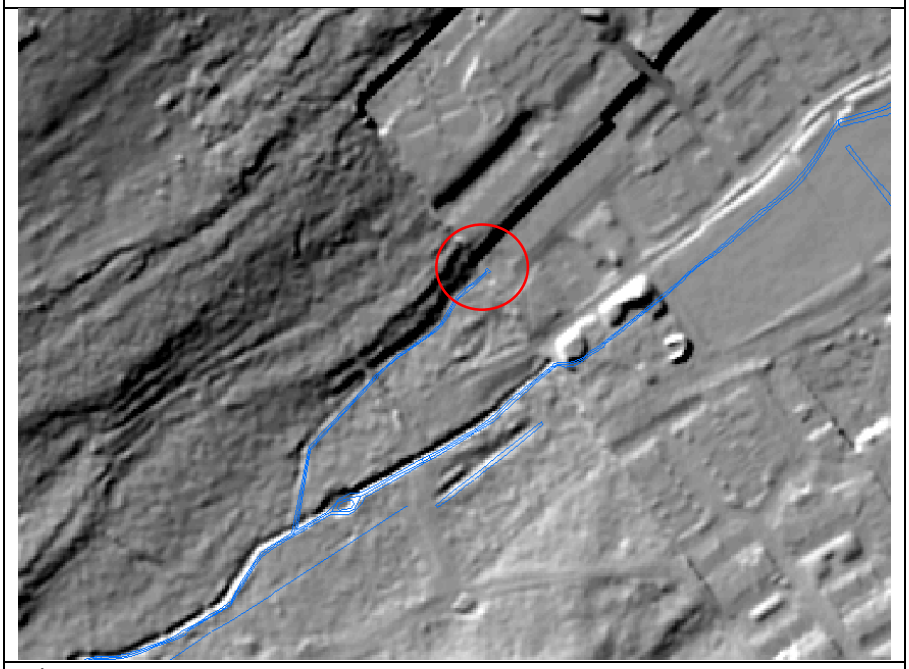
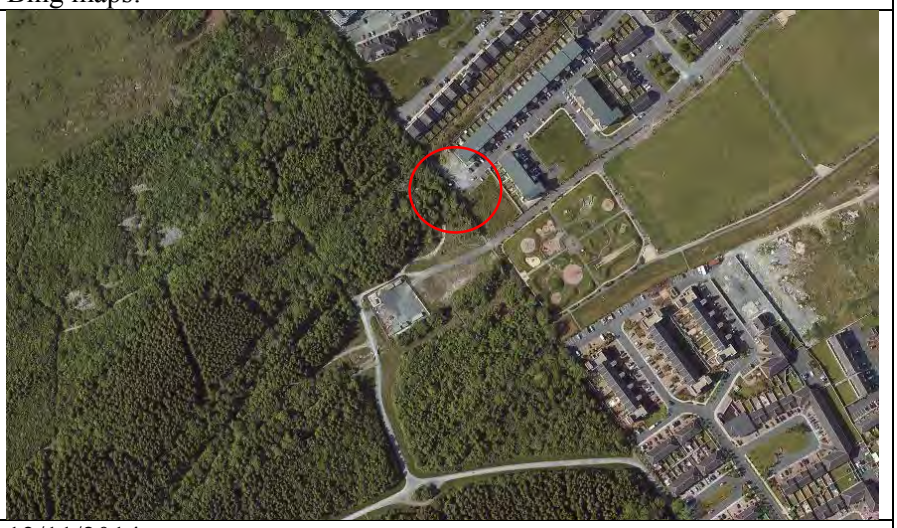
Site photos	

Feature ID	**K132**
Feature type	Spring
Coordinates	533886, 726657
Source	Lidar:  Bing maps: 
Field survey date	14/11/2014
Field survey status	Confirmed
Water present	Yes Electrical conductivity: 553 uS/cm Temperature: 11.5 °C pH: 7.27
Water elevation	46.03 mAOD
Additional Information	Initially identified in the desk study as a potential enclosed depression. Approx. 3m diameter pond

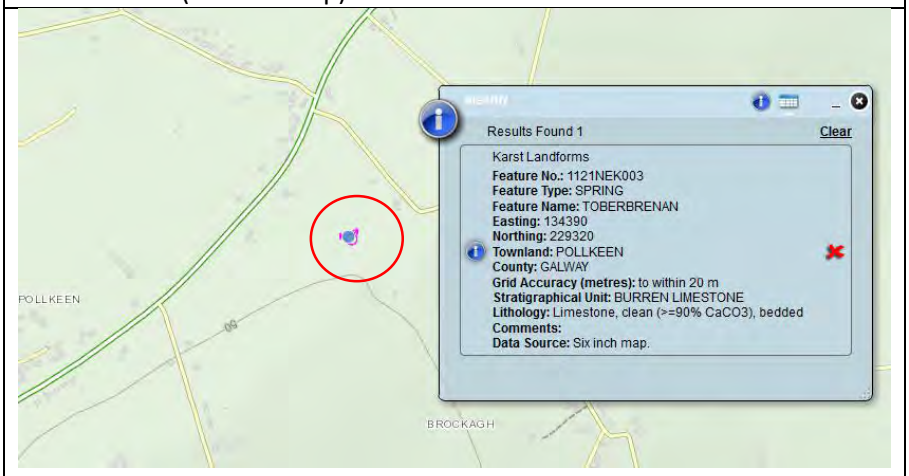
	No flow out of spring during field survey.
Site photos	 

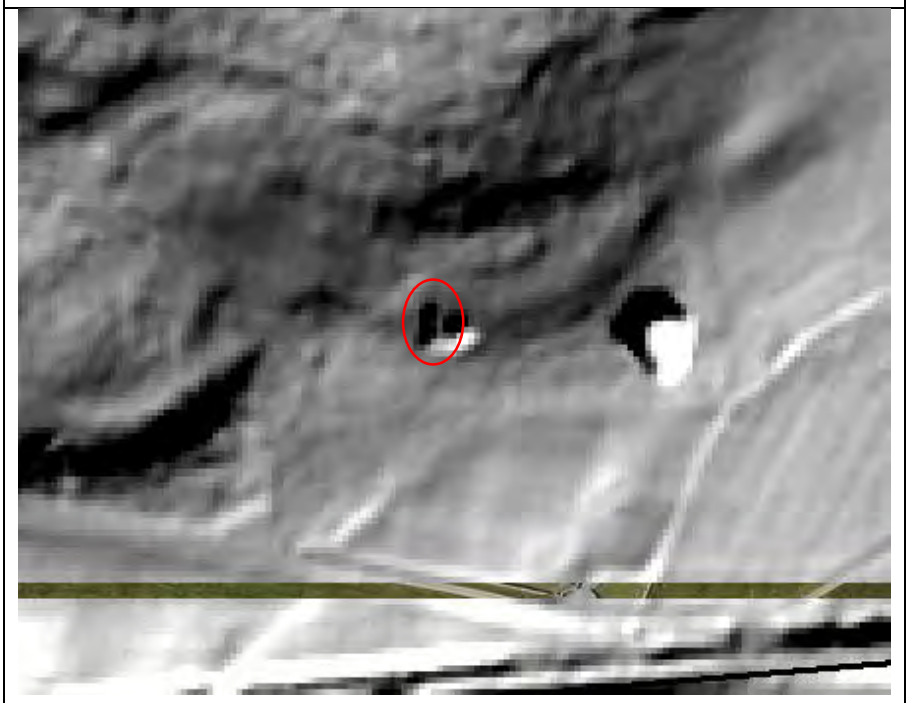
Feature ID	**K134**
Feature type	Superficial solution features
Coordinates	533959, 726686
Source	GSI Database: 
Field survey date	14/11/2014
Field survey status	Confirmed
Water present	No
Ground level elevation	44.19 mAOD
Additional Information	Area of superficial solution features noted by GSI database but not very obvious in field. Some rock visible with solution erosion, see photo.
Site photos	

Feature ID	**K135**
Feature type	Enclosed Depression
Coordinates	533959, 726688
Source	Field Survey
Field survey date	14/11/2014
Field survey status	Confirmed
Water present	Yes
Additional Information	Very shallow and wide depression.
Site photos	

Feature ID	**K136**
Feature type	Spring
Coordinates	533980, 726321
Source	Lidar and OSI water line:  Bing maps: 
Field survey date	13/11/2014
Field survey status	Confirmation/identification problem
Water present	n/a
Additional Information	Cannot locate. It is possible that this is the beginning of a manmade drain and not a spring.
Site photos	Not available

Feature ID	**K140**
Feature type	Spring
Coordinates	534085, 725198
Source	Field Survey
Field survey date	13/11/2014
Field survey status	Confirmed
Water present	Yes
Additional Information	Field with areas of flooding. A local informed that there were springs in the field.
Site photos	

Feature ID	**K147**
Feature type	Spring
Coordinates	534254, 729385
Source	GSI database (Six inch map): 
Field survey date	22/10/2014
Field survey status	Not found
Water present	n/a
Additional Information	Cannot locate spring. The landowner noted that there has been mention of a spring in the field behind his house but he did not know exactly where it is. He also mentioned that the area around his house and field to the south has flooded in the past so it is likely that the spring exists but is covered/buried.
Site photos	Not available

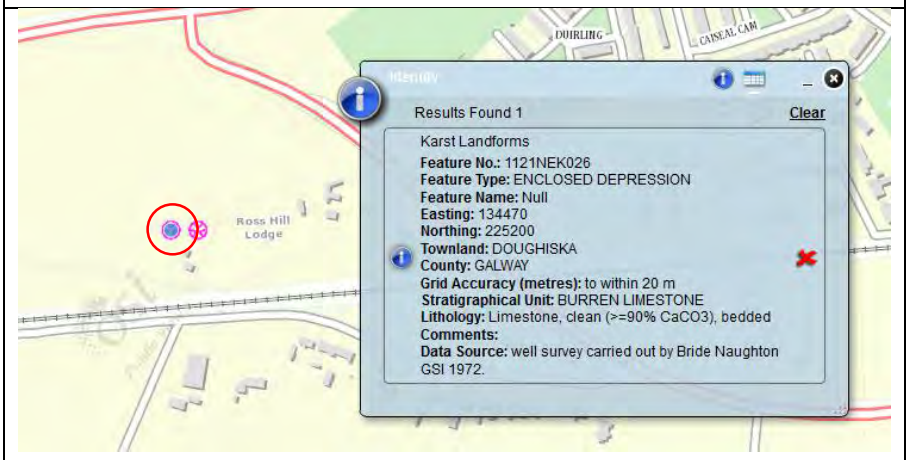
Feature ID	**K151**
Feature type	Enclosed Depression
Coordinates	534393, 725257
Source	Lidar: 
	Bing maps 
Field survey date	13/11/2014
Field survey status	Confirmed
Water present	No
Additional Information	Approx. 5m diameter, but not circular. Adjacent to K152.

Site photos	

Feature ID	**K152**
Feature type	Enclosed Depression
Coordinates	534397, 725257
Source	Lidar: 
	Bing maps 
Field survey date	13/11/2014
Field survey status	Confirmed
Water present	No
Additional Information	Approx. 7m diameter. Adjacent to K151

Site photos	

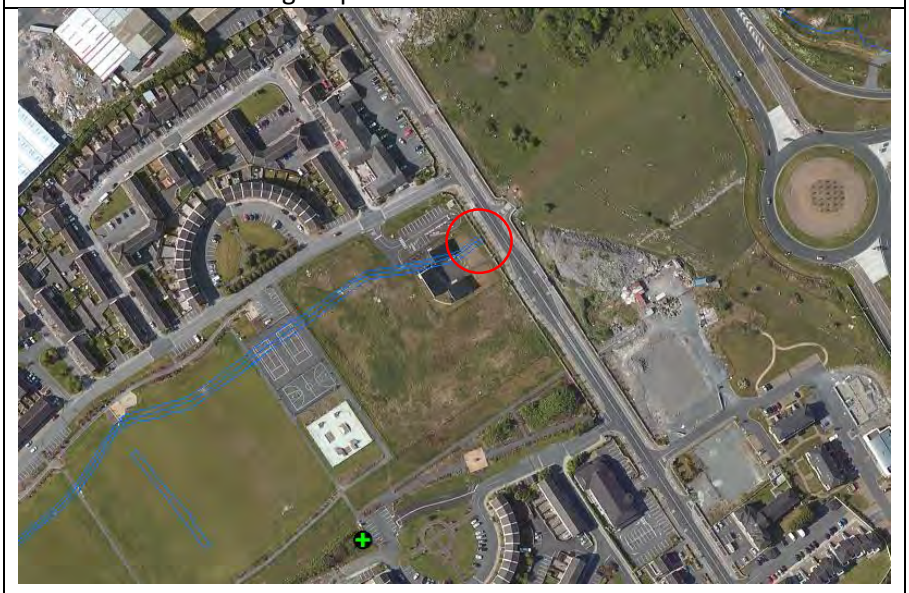
Feature ID	**K154**
Feature type	Enclosed Depression
Coordinates	534460, 725261
Source	GSI database



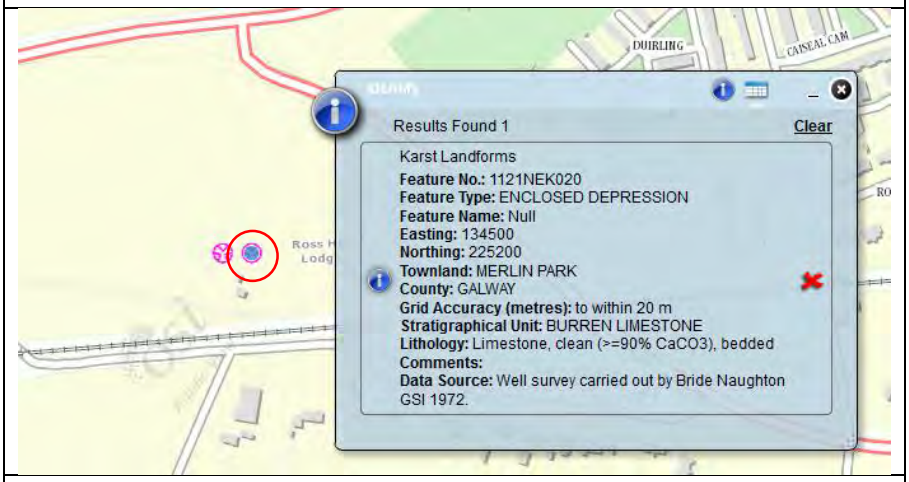
Lidar:

Bing maps

	
Field survey date	13/11/2014
Field survey status	Confirmed
Water present	No
Additional Information	Approx. dimensions: 40 m diameter 20 m deep. Potential plug hole evident The large enclosed depression is fenced off preventing access. A plug hole opening is evident at the base of the enclosed depression. This may contain water, however access is not possible due to protective fencing.
Site photos	 Plug hole / opening at base of enclosed depression

Feature ID	**K158**
Feature type	Spring
Coordinates	534481, 726554
Source	OSI water line and Bing map 
Field survey date	14/11/2014
Field survey status	Confirmation/identification problem
Water present	n/a
Additional Information	Cannot locate, possible location beneath school building. Also, it could be a manmade drain, there is no spring noted at this location on the GSI database
Site photos	Not available

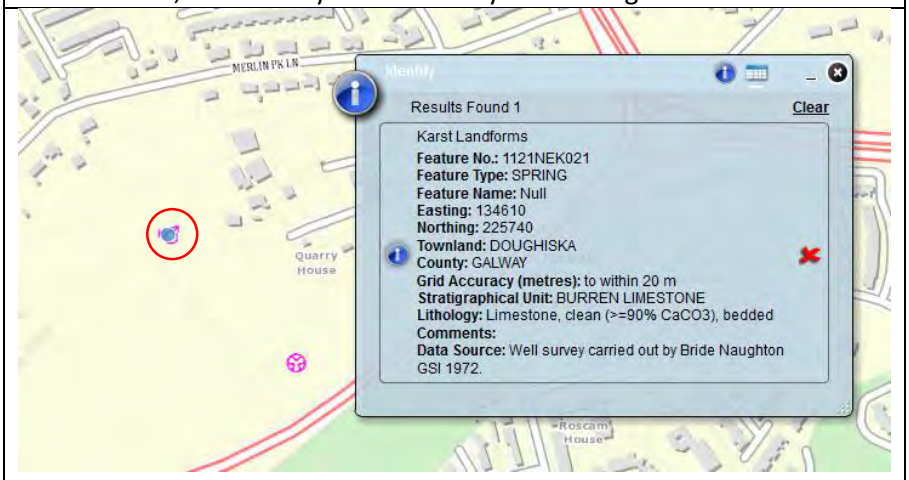
Feature ID	**K159**
Feature type	Enclosed Depression
Coordinates	534562, 725325
Source	GSI database

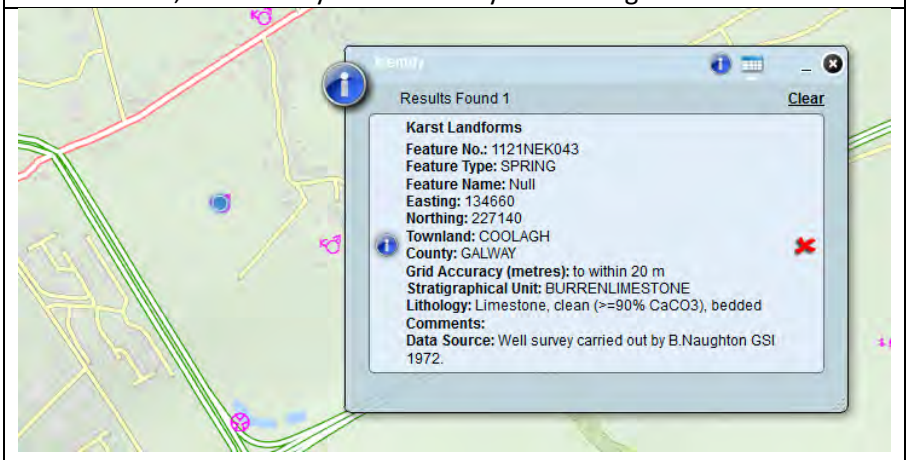


Lidar:

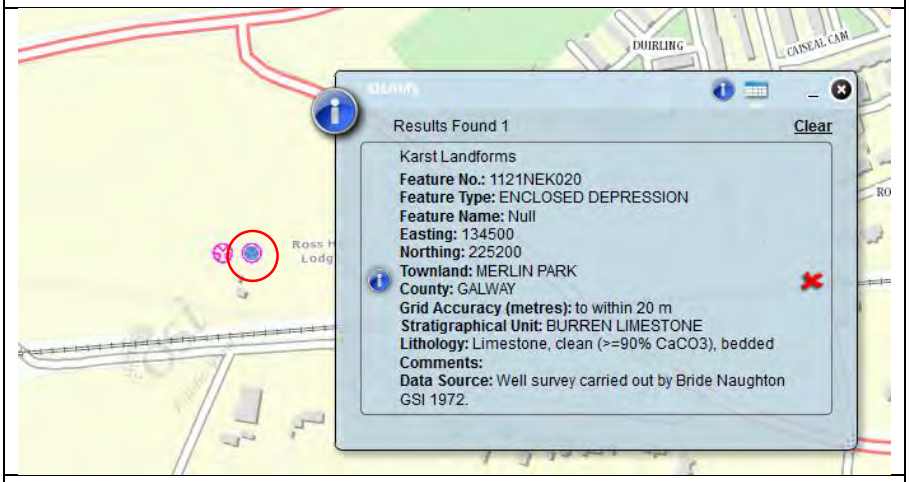
Bing maps

Field survey date	13/11/2014
Field survey status	Confirmed
Water present	No
Additional Information	Approx. dimensions: 30 m diameter 20 m deep. Contains waste Possible plug hole identified
Site photos	 

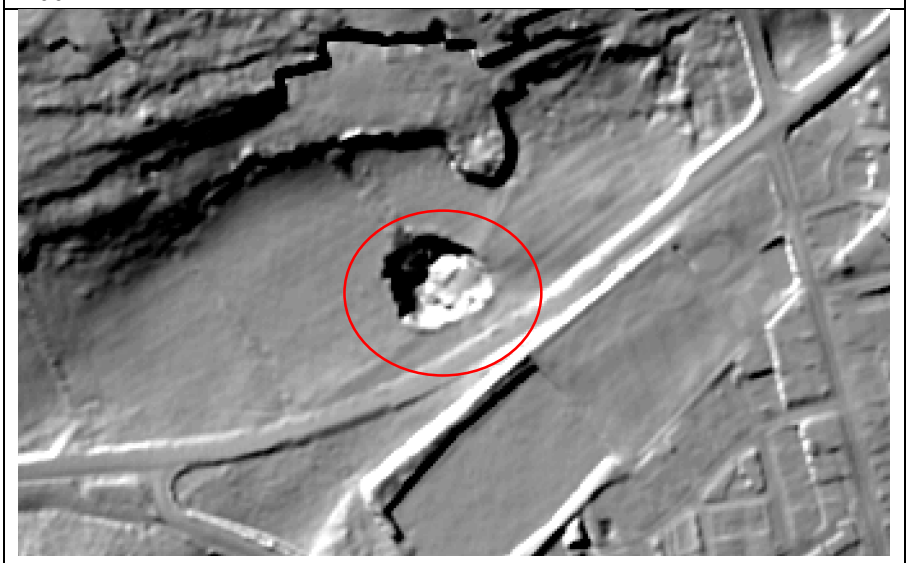
Feature ID	**K160**
Feature type	Spring
Coordinates	534588, 725786
Source	GSI database; Well survey carried out by Bride Naughton GSI 1972. 
Field survey date	14/11/2014
Field survey status	Confirmed
Water present	Yes Electrical conductivity: 490 uS/cm Temperature: 12 °C pH: 8.23
Additional Information	Feature is located in old quarry. Water is discharging from fractures approx. 5m above ground level. It is likely that the natural flow and location of the spring has been modified due to the quarry excavation.
Site photos	

Feature ID	**K161**
Feature type	Spring
Coordinates	534625, 727169
Source	GSI database; Well survey carried out by Bride Naughton GSI 1972. 
Field survey date	23/10/2014
Field survey status	Not found
Water present	n/a
Additional Information	During the field survey two local men were asked about springs in the Briarhill area. One man was not aware of any springs in the area. The other informed that there were a number of springs but that they were not in use any more and were likely covered up since the area was connected to the mains water supply.
Site photos	Not available

Feature ID	**K163**
Feature type	Enclosed depression
Coordinates	534677, 725607
Source	GSI database

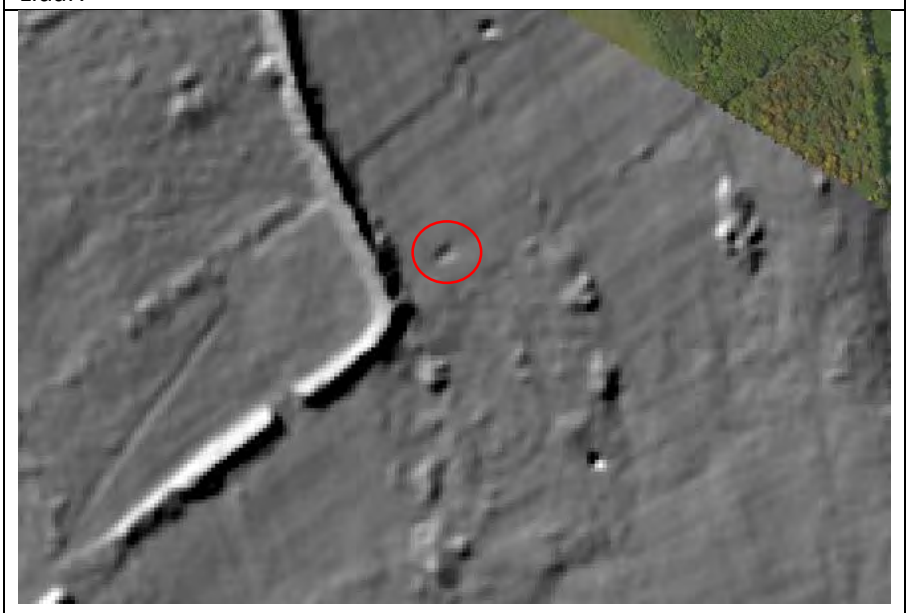


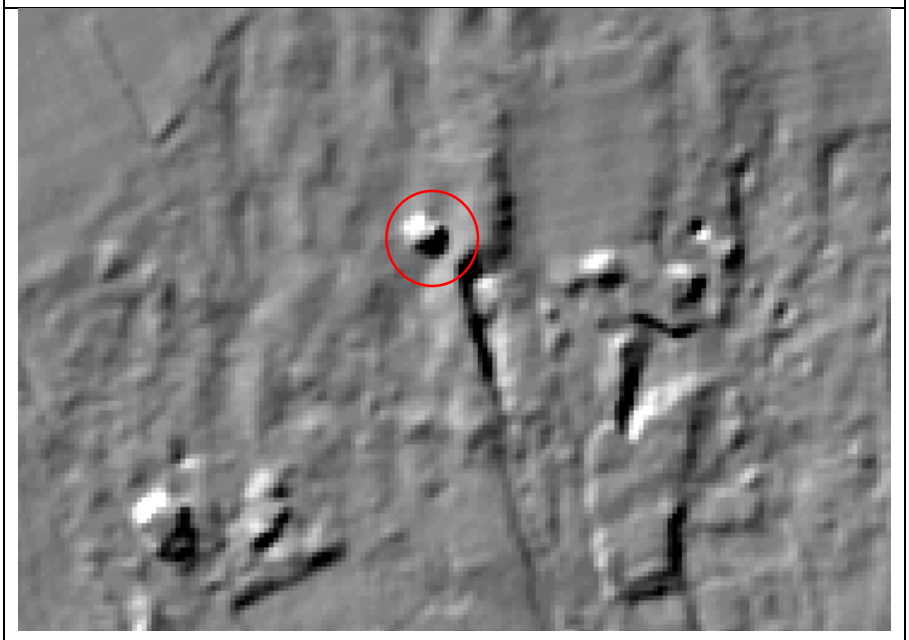
Lidar:

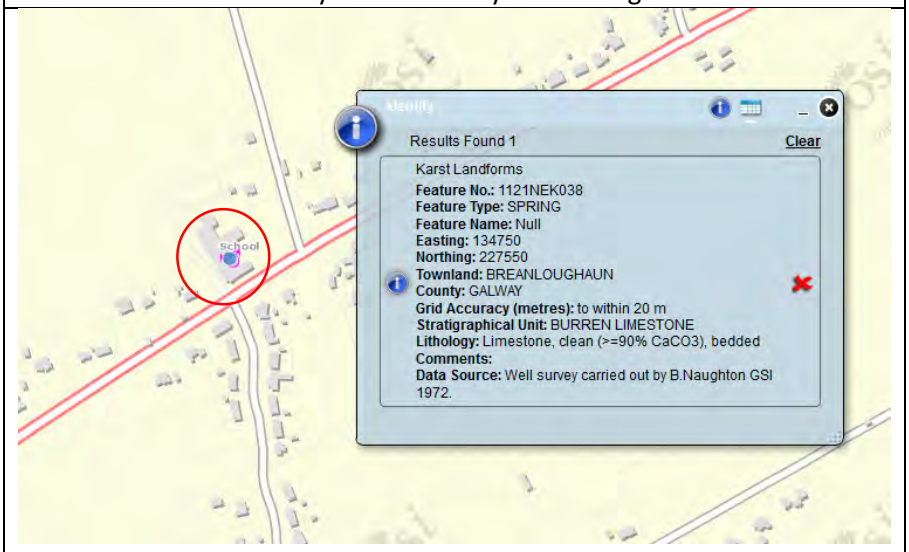


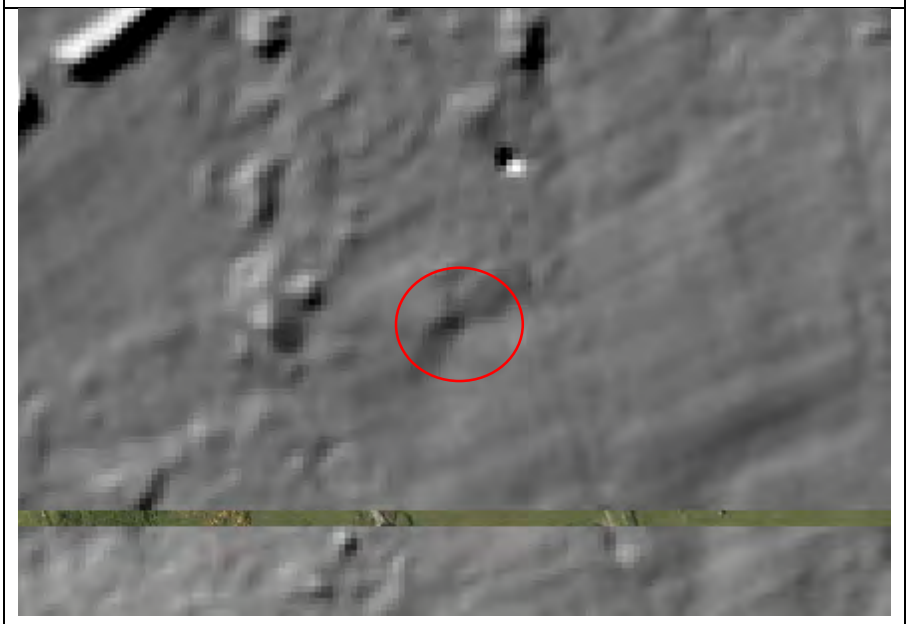
Bing maps

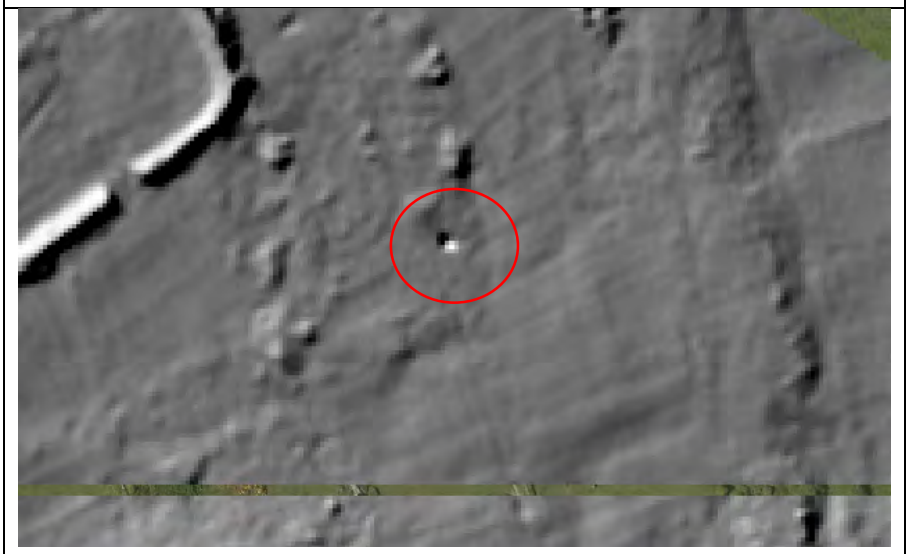
Field survey date	14/11/2014
Field survey status	Confirmed
Water present	No
Ground level elevation	Elevation within depression 13.39 mAOD. This is not the base of the depression
Additional Information	Very large depression. Large part of enclosed depression is filled in with waste and material.
Site photos	 

Feature ID	**K164**
Feature type	Enclosed depression
Coordinates	534706, 728396
Source	Lidar: 
	Bing maps 
Field survey date	22/10/2014
Field survey status	Confirmation/identification problem
Water present	n/a
Additional Information	Cannot locate. Dense vegetation
Site photos	Not available

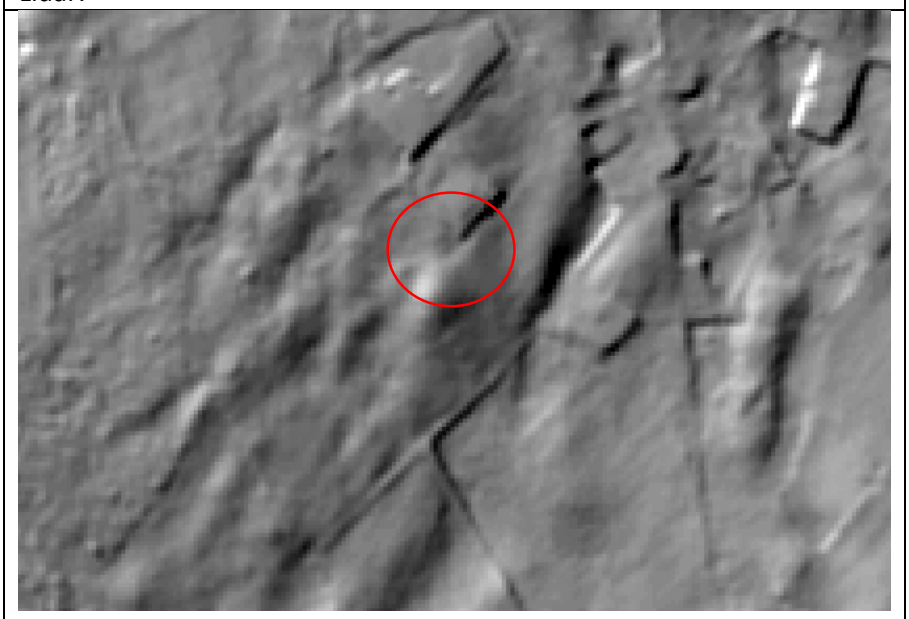
Feature ID	**K165**
Feature type	Enclosed depression
Coordinates	534715, 727838
Source	Lidar: 
	Bing maps 
Field survey date	22/10/2014
Field survey status	Confirmation/identification problem
Water present	n/a
Additional Information	Cannot locate due to dense vegetation
Site photos	Not available

Feature ID	**K166**
Feature type	Spring
Coordinates	534715, 727579
Source	GSI Database: Well survey carried out by Bride Naughton GSI 1972. 
Field survey date	22/10/2014
Field survey status	Not found
Water present	n/a
Additional Information	Could not locate spring. Location is within a school. A man working in the school informed us that there is a spring to the left of the school entrance but it could not be located.
Site photos	Not available

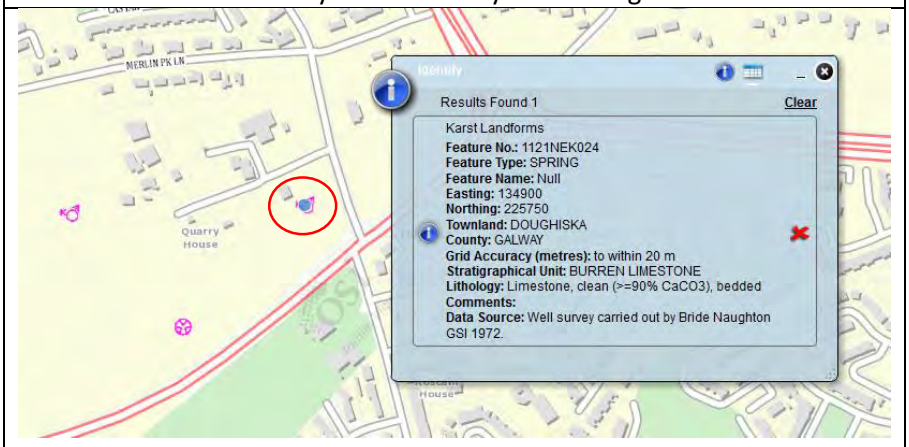
Feature ID	**K168**
Feature type	Enclosed depression
Coordinates	534764, 728234
Source	Lidar  Bing maps 
Field survey date	22/10/2014
Field survey status	Confirmation/identification problem
Water present	n/a
Additional Information	Cannot confirm as vegetation is too dense to access exact location
Site photos	Not available

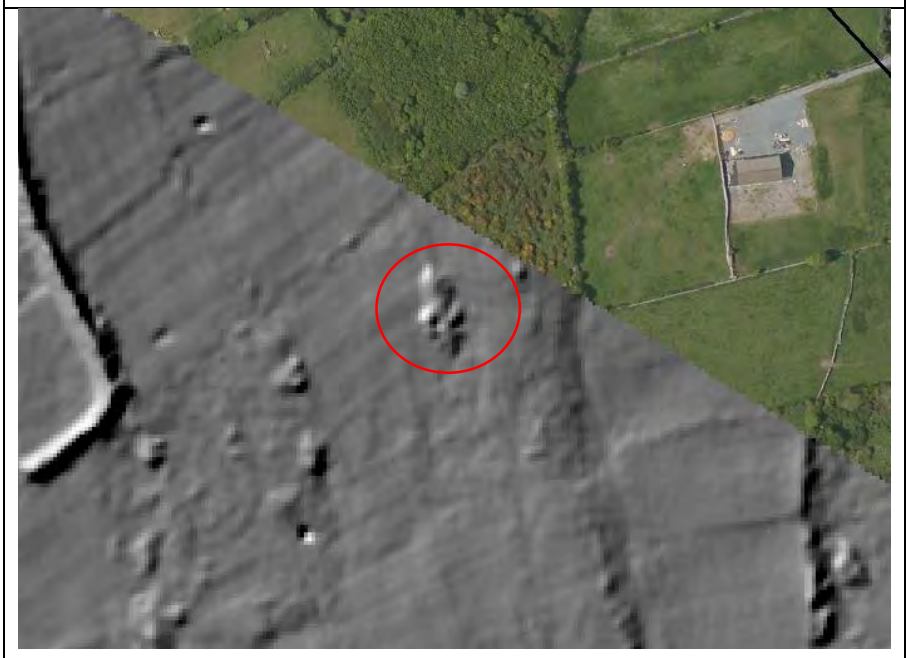
Feature ID	**K169**
Feature type	Enclosed depression
Coordinates	534784, 728290
Source	Lidar:  Bing maps 
Field survey date	22/10/2014
Field survey status	Confirmation/identification problem
Water present	n/a
Additional Information	Cannot confirm as vegetation is too dense to access exact location
Site photos	Not available

Feature ID	**K170**
Feature type	Well
Coordinates	534787, 728293
Source	Field survey
Field survey date	22/10/2014
Field survey status	Confirmed
Water present	No
Additional Information	Dug well Approx. 3m diameter and 2m to base Base of well is covered in moss covered rocks
Site photos	

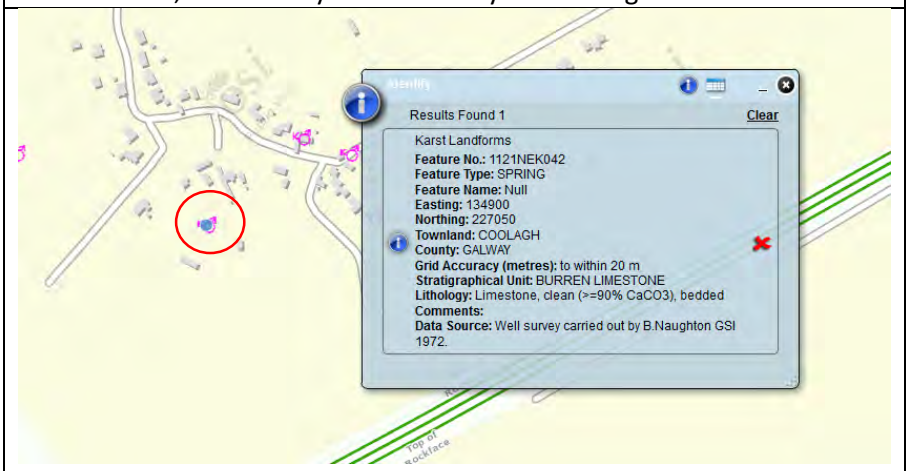
Feature ID	**K172**
Feature type	Enclosed depression
Coordinates	534791, 727078
Source	Lidar: 
	Bing maps 
Field survey date	23/10/2014
Field survey status	Confirmed
Water present	No
Additional Information	Very shallow depression

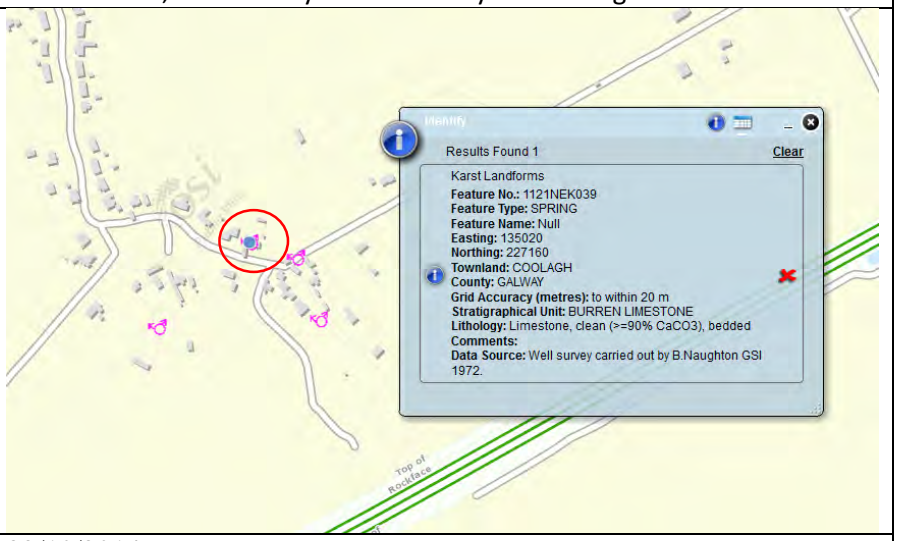
Site photos	

Feature ID	**K173**
Feature type	Spring
Coordinates	534843, 725787
Source	GSI Database: Well survey carried out by Bride Naughton GSI 1972. 
Field survey date	14/11/2014
Field survey status	Confirmed
Water present	Yes Electrical conductivity: 510 uS/cm Temperature: 9.7 °C pH: 7.88 Flow: 6.3 l/s
Water level elevation	25.22 mAOD
Additional Information	Spring discharges from under an old mill building.
Site photos	

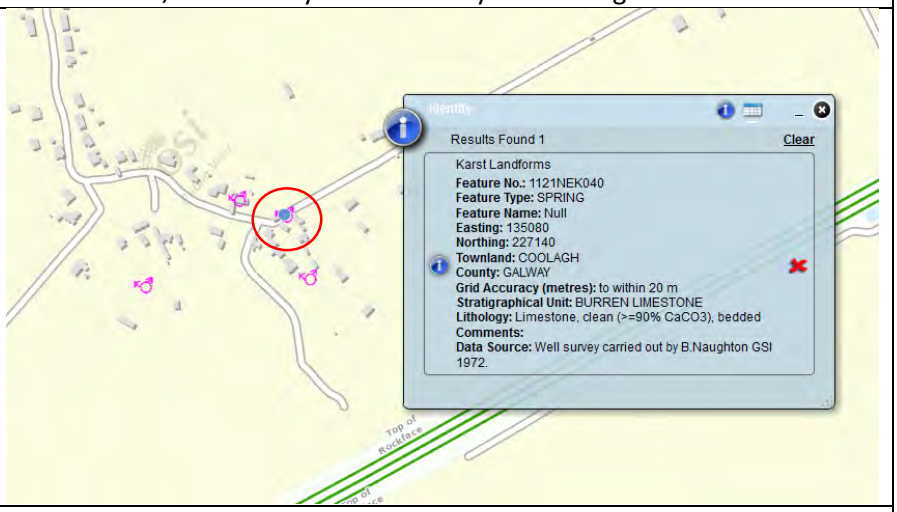
Feature ID	**K174**
Feature type	Enclosed depression
Coordinates	534854, 728406
Source	Lidar:  Bing maps 
Field survey date	22/10/2014
Field survey status	Confirmation/identification problem
Water present	No
Additional Information	Appears to be dip in topography but cannot gain access due to dense vegetation
Site photos	Not available

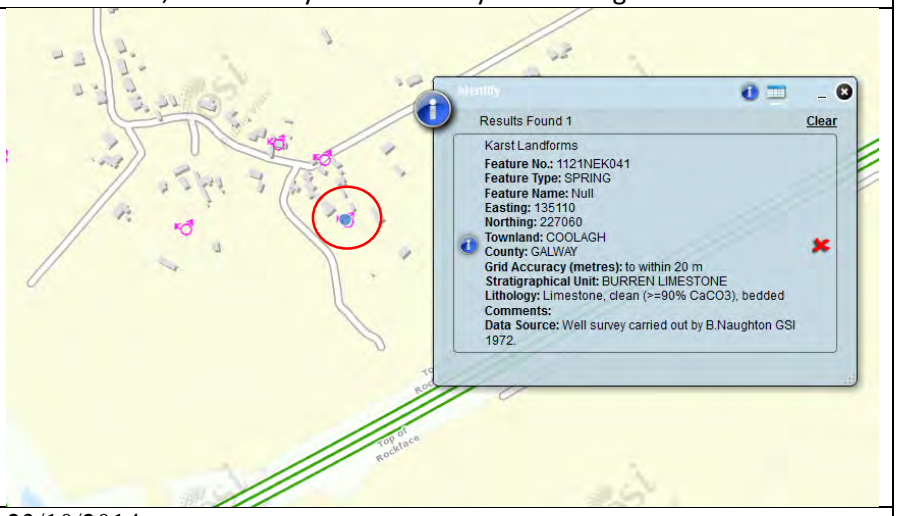
Feature ID	**K175**
Feature type	Enclosed depression
Coordinates	534857, 727168
Source	Field survey
Field survey date	23/10/2014
Field survey status	Confirmed
Water present	No
Additional Information	Approx. dimensions: 20m diameter, 2m depth
Site photos	 

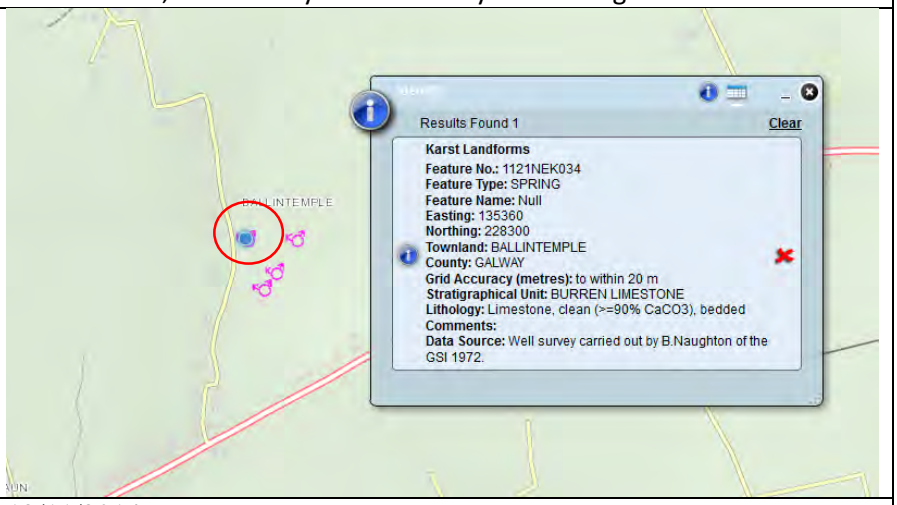
Feature ID	**K176**
Feature type	Spring
Coordinates	534865, 727079
Source	GSI database; Well survey carried out by Bride Naughton GSI 1972.
	
Field survey date	23/10/2014
Field survey status	Not found
Water present	n/a
Additional Information	During the field survey locals were asked about springs in the Briarhill area. We were informed that there were a number of springs but that they were not in use any more and were likely covered up since the area was connected to the mains water supply.
Site photos	Not available

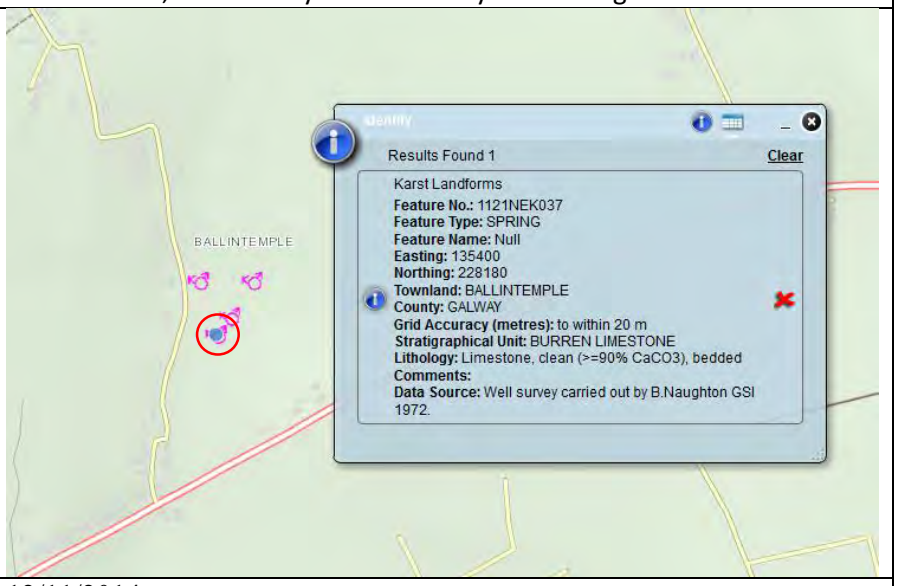
Feature ID	**K178**
Feature type	Spring
Coordinates	534985, 727189
Source	GSI database; Well survey carried out by Bride Naughton GSI 1972. 
Field survey date	23/10/2014
Field survey status	Not found
Water present	n/a
Additional Information	During the field survey locals were asked about springs in the Briarhill area. We were informed that there were a number of springs but that they were not in use any more and were likely covered up since the area was connected to the mains water supply.
Site photos	Not available

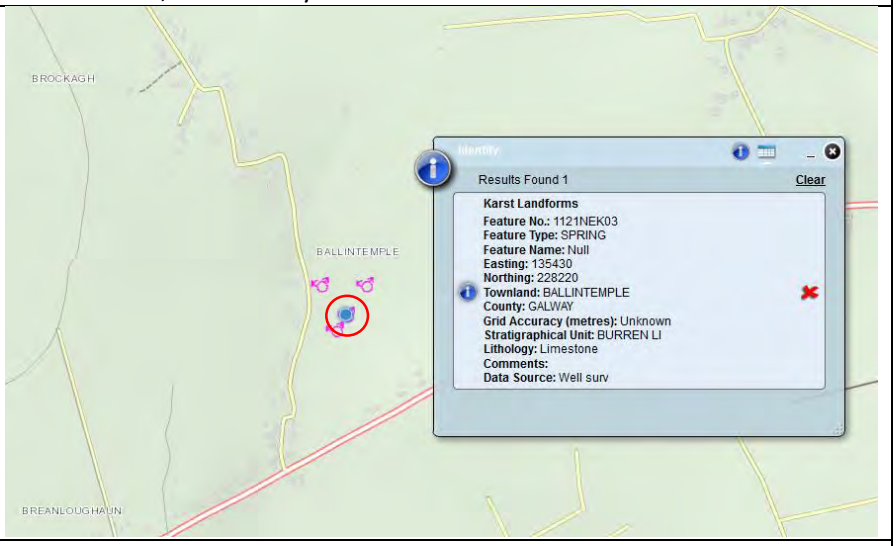
Feature ID	**K179**
Feature type	Enclosed depression
Coordinates	534990, 727121
Source	Field survey
Field survey date	23/10/2014
Field survey status	Confirmed
Water present	No
Additional Information	Approx. dimensions: 20m diameter semicircle
Site photos	 

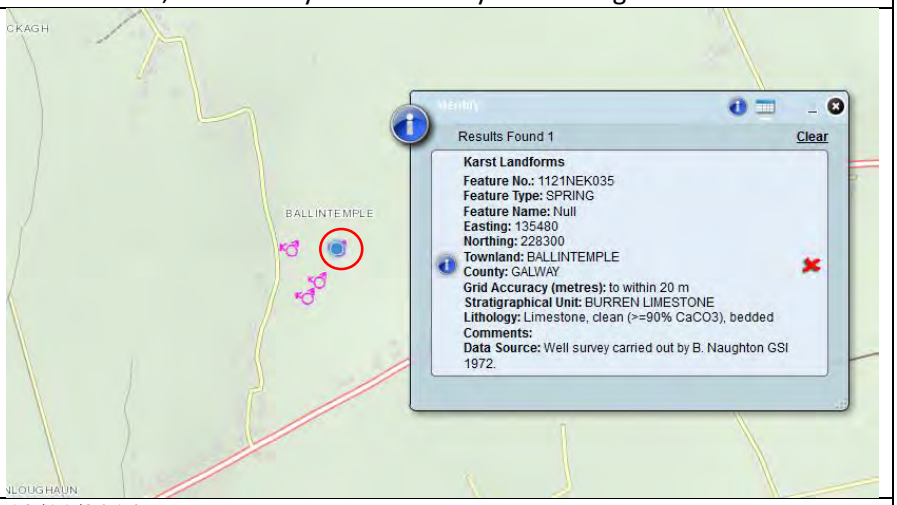
Feature ID	**K180**
Feature type	Spring
Coordinates	535045, 727169
Source	GSI database; Well survey carried out by Bride Naughton GSI 1972. 
Field survey date	23/10/2014
Field survey status	Not found
Water present	n/a
Additional Information	During the field survey locals were asked about springs in the Briarhill area. We were informed that there were a number of springs but that they were not in use any more and were likely covered up since the area was connected to the mains water supply.
Site photos	Not available

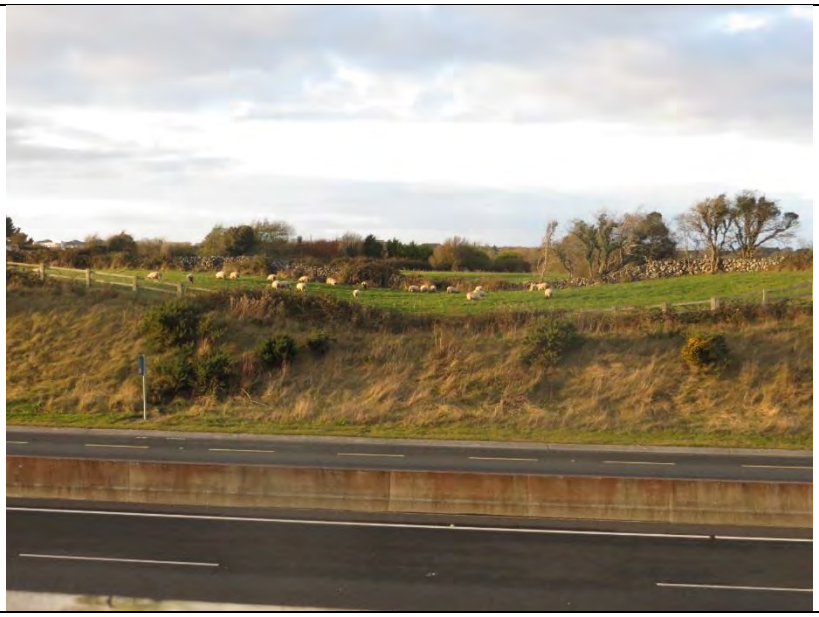
Feature ID	**K181**
Feature type	Spring
Coordinates	535074.86, 727088.79
Source	GSI database; Well survey carried out by Bride Naughton GSI 1972.
	
Field survey date	23/10/2014
Field survey status	Not found
Water present	n/a
Additional Information	During the field survey locals were asked about springs in the Briarhill area. We were informed that there were a number of springs but that they were not in use any more and were likely covered up since the area was connected to the mains water supply.
Site photos	Not available

Feature ID	**K184**
Feature type	Spring
Coordinates	535325, 728328
Source	GSI database; Well survey carried out by Bride Naughton GSI 1972. 
Field survey date	12/11/2014
Field survey status	Not found
Water present	n/a
Additional Information	Could not locate spring
Site photos	Not available

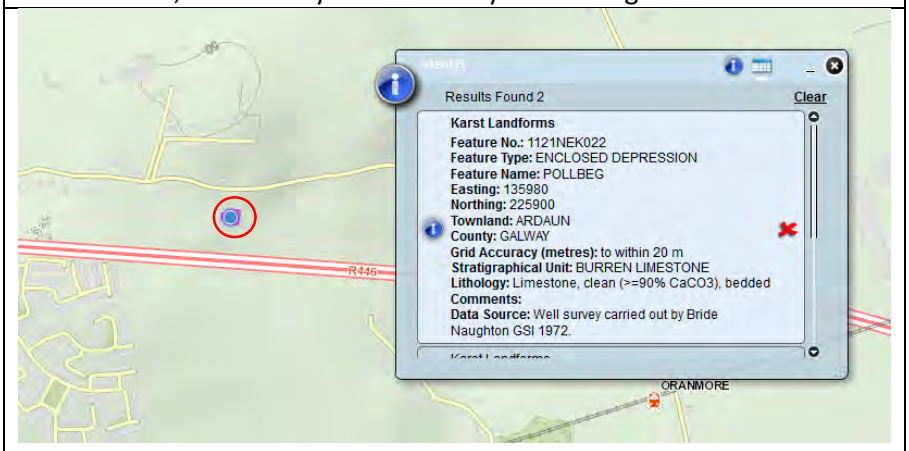
Feature ID	**K189**
Feature type	Spring
Coordinates	535443, 728233
Source	GSI database; Well survey carried out by Bride Naughton GSI 1972. 
Field survey date	12/11/2014
Field survey status	Confirmed
Water present	Yes Electrical conductivity: 662 uS/cm Temperature: 8.9 °C pH: 7.52
Water level elevation	26.84 mAOD (approx.) Elevation taken at ground level beside the spring (27.34 mAOD). Spring water level approx. 0.5 m below ground level.
Additional Information	Approx. 3m diameter Fenced area with briars and vegetation.
Site photos	Not available

Feature ID	**K190**
Feature type	Spring
Coordinates	535445, 728328
Source	GSI database; Well survey
	
Field survey date	12/11/2014
Field survey status	Confirmation/identification problem
Water present	n/a
Additional Information	Cannot access field
Site photos	Not available

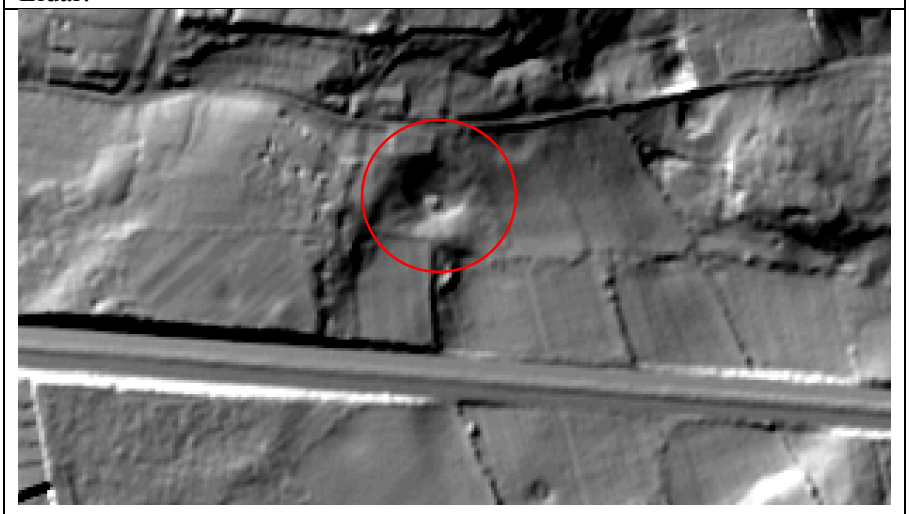
Feature ID	**K192**
Feature type	Spring
Coordinates	535471, 728311
Source	GSI database; Well survey carried out by Bride Naughton GSI 1972. 
Field survey date	12/11/2014
Field survey status	Not found
Water present	n/a
Additional Information	Cannot locate
Site photos	Not available

Feature ID	**K193**
Feature type	Enclosed depression
Coordinates	535482, 727051
Source	Field survey
Field survey date	17/11/2014
Field survey status	Confirmed
Water present	No
Additional Information	Approx. 30m diameter depression cut in half by M6 motorway
Site photos	

Feature ID	**K198**
Feature type	Enclosed depression
Coordinates	535953, 725945
Source	GSI database; Well survey carried out by Bride Naughton GSI 1972.

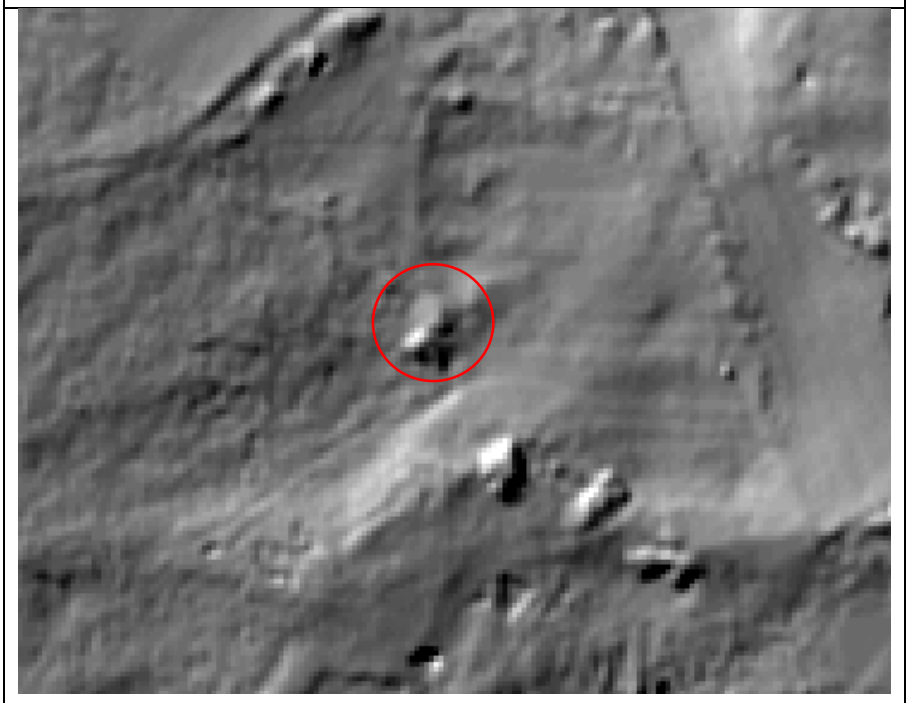


Lidar:



Bing maps:

Field survey date	18/11/2014
Field survey status	Confirmed
Water present	Yes No water quality analysis recorded
Additional Information	Farmer noted that the depression fills with water
Site photos	

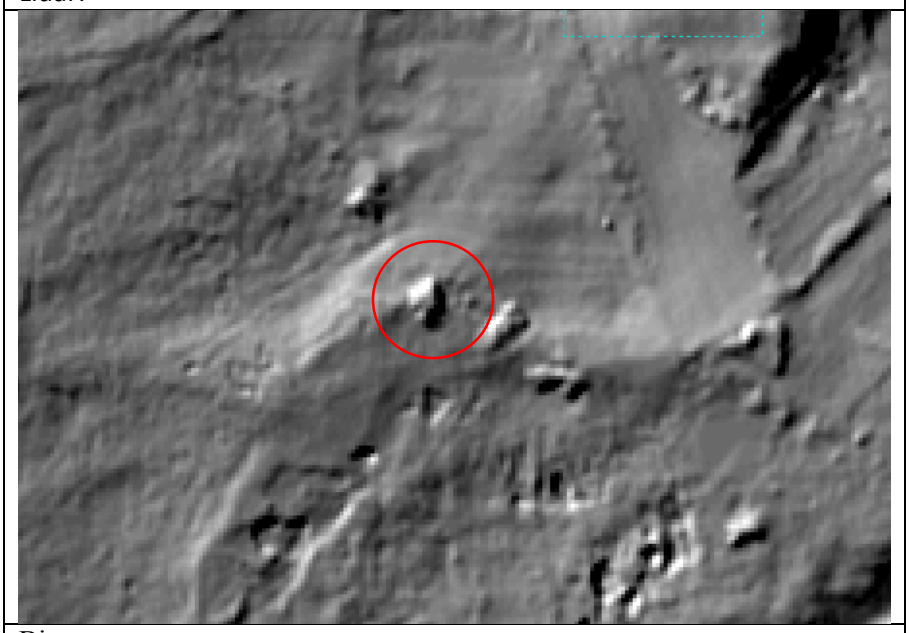
Feature ID	**K199**
Feature type	Enclosed depression
Coordinates	536026, 725583
Source	Lidar:  Bing maps: 
Field survey date	18/11/2014
Field survey status	Confirmation/identification problem
Water present	n/a
Additional Information	Access inhibited due to thick vegetation
Site photos	Not available

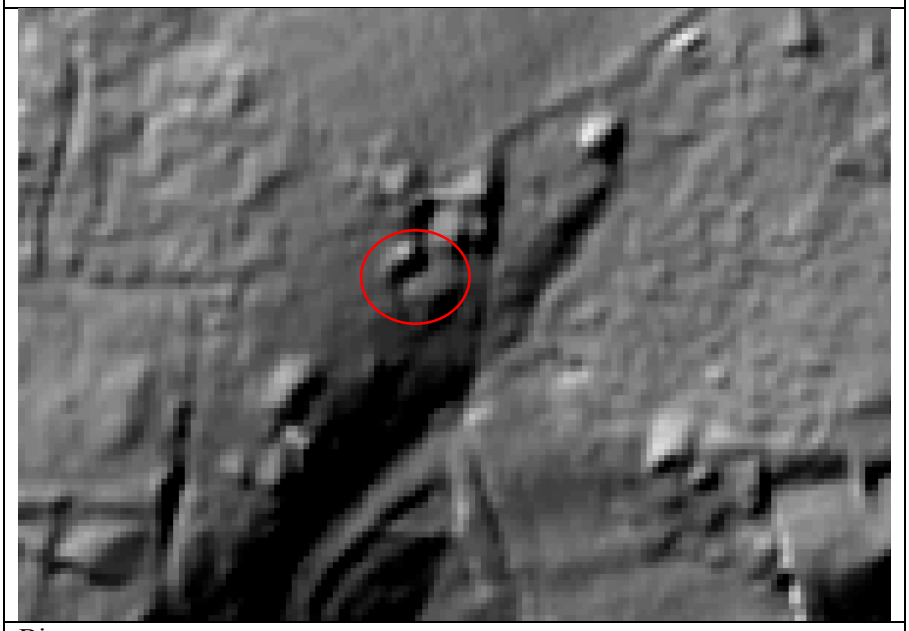
Feature ID	**K201**
Feature type	Enclosed depression
Coordinates	536027, 725739
Source	Field survey
Field survey date	18/11/2014
Field survey status	Confirmed
Water present	No
Ground level elevation	29.92 mAOD at base of enclosed depression
Additional Information	Approximate dimensions: 2 m diameter less than 1 m depth
Site photos	 

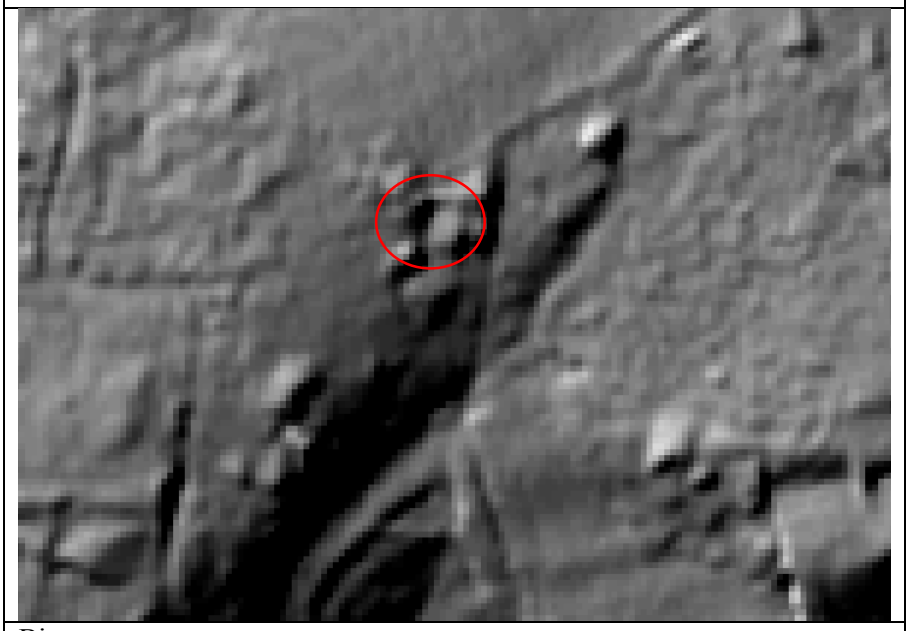
Feature ID	**K202**
Feature type	Enclosed depression
Coordinates	536033, 726313
Source	Field survey
Field survey date	23/11/2014
Field survey status	Confirmed
Water present	No
Additional Information	Very shallow enclosed depression Approx. 20m diameter
Site photos	

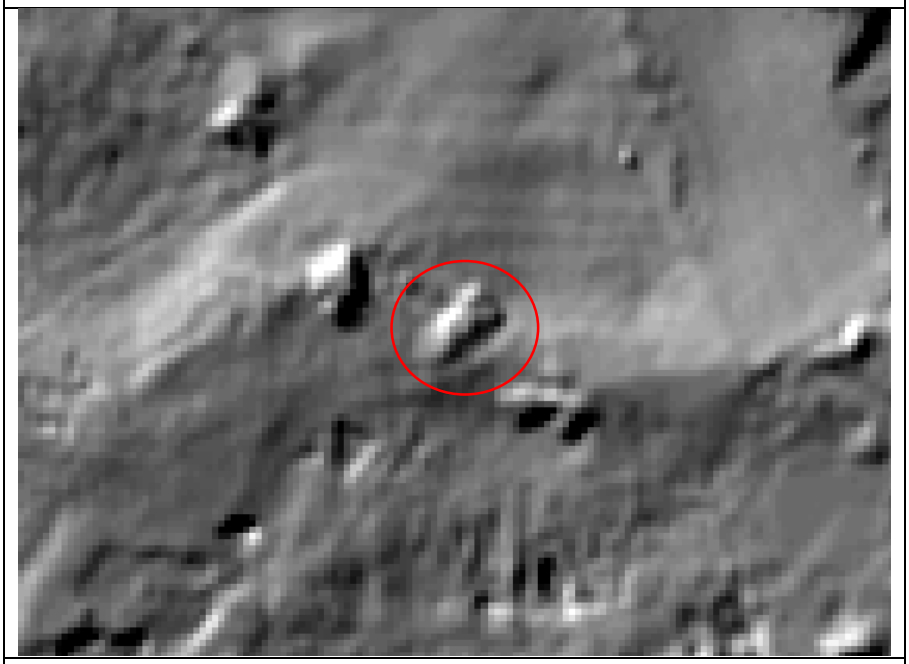
Feature ID	**K203**
Feature type	Enclosed depression
Coordinates	536033, 725740
Source	Field survey
Field survey date	18/11/2014
Field survey status	Confirmed
Water present	No
Ground level elevation	29.44 mAOD
Additional Information	Small enclosed depression Approximate dimensions: 5m x 2 m less than 1 m deep
Site photos	 

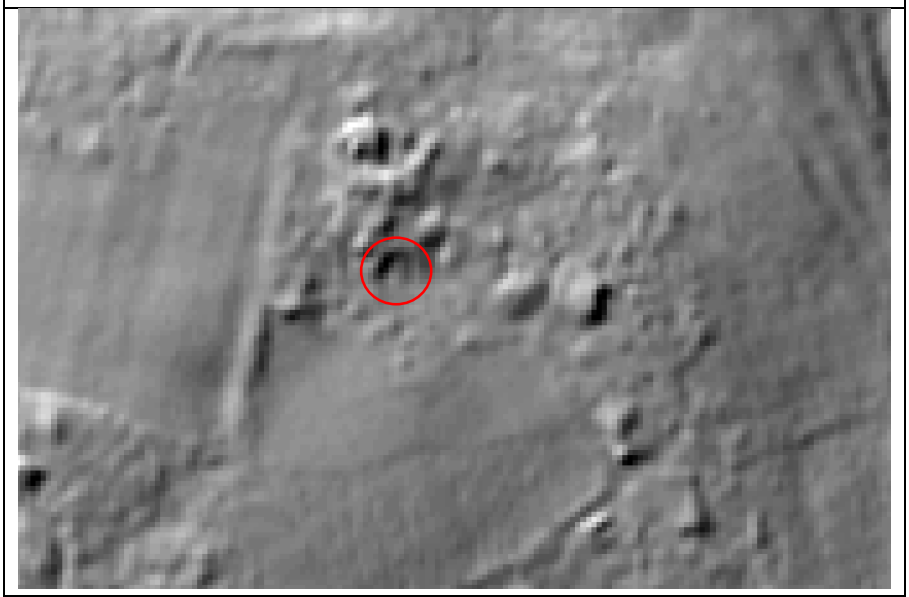
Feature ID	**K204**
Feature type	Enclosed depression
Coordinates	536046, 726864
Source	Lidar:  Bing maps: 
Field survey date	17/11/2014
Field survey status	Confirmation/identification problem
Water present	n/a
Additional Information	Covered by vegetation.
Site photos	Not available

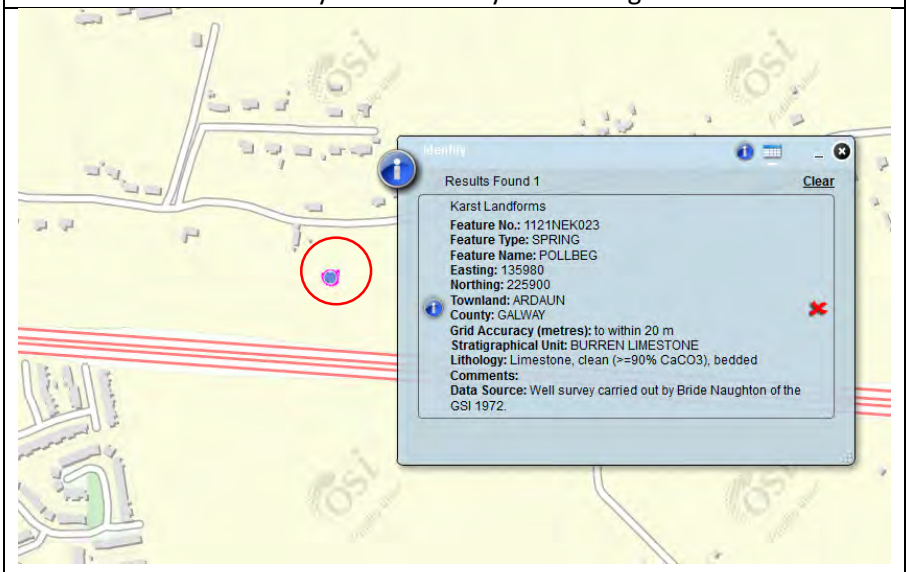
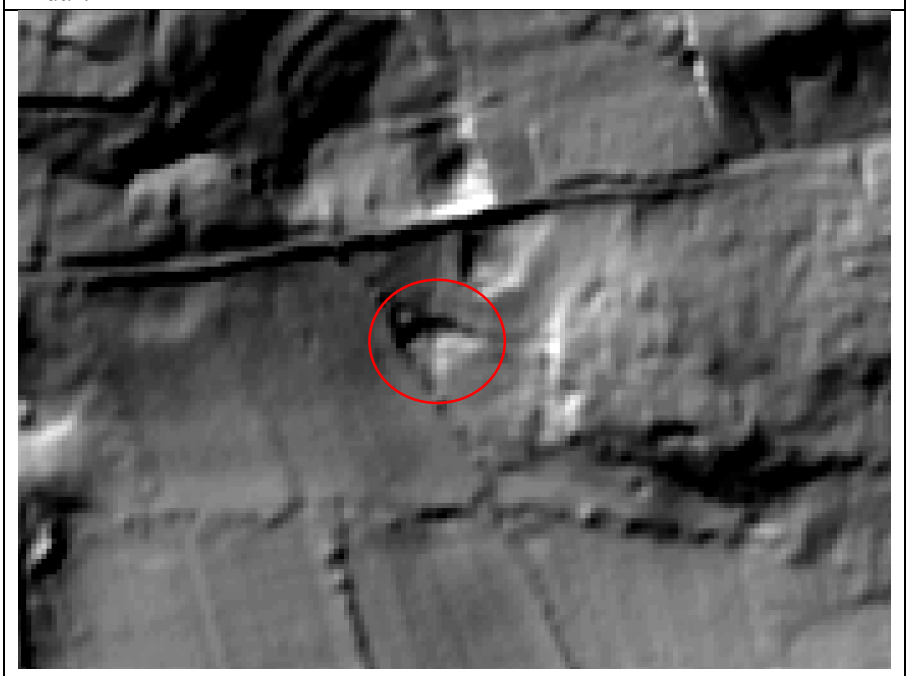
Feature ID	**K205**
Feature type	Enclosed depression
Coordinates	536055, 725532
Source	Lidar:
	
	Bing maps:
	
Field survey date	18/11/2014
Field survey status	Confirmation/identification problem
Water present	n/a
Additional Information	Access issue due to thick vegetation
Site photos	Not available

Feature ID	**K206**
Feature type	Enclosed depression
Coordinates	536087, 726186
Source	Lidar:
	
	Bing maps:
	
Field survey date	23/10/2014
Field survey status	Confirmation/identification problem
Water present	n/a
Additional Information	Access issue due to thick vegetation
Site photos	Not available

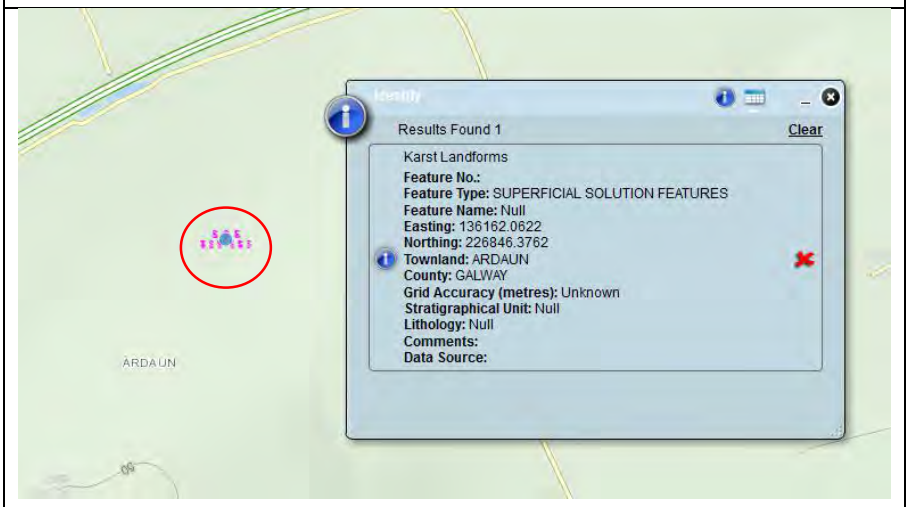
Feature ID	**K207**
Feature type	Enclosed depression
Coordinates	536095, 726205
Source	Lidar:
	
	Bing maps:
	
Field survey date	23/10/2014
Field survey status	Confirmation/identification problem
Water present	n/a
Additional Information	Access issue due to thick vegetation
Site photos	Not available

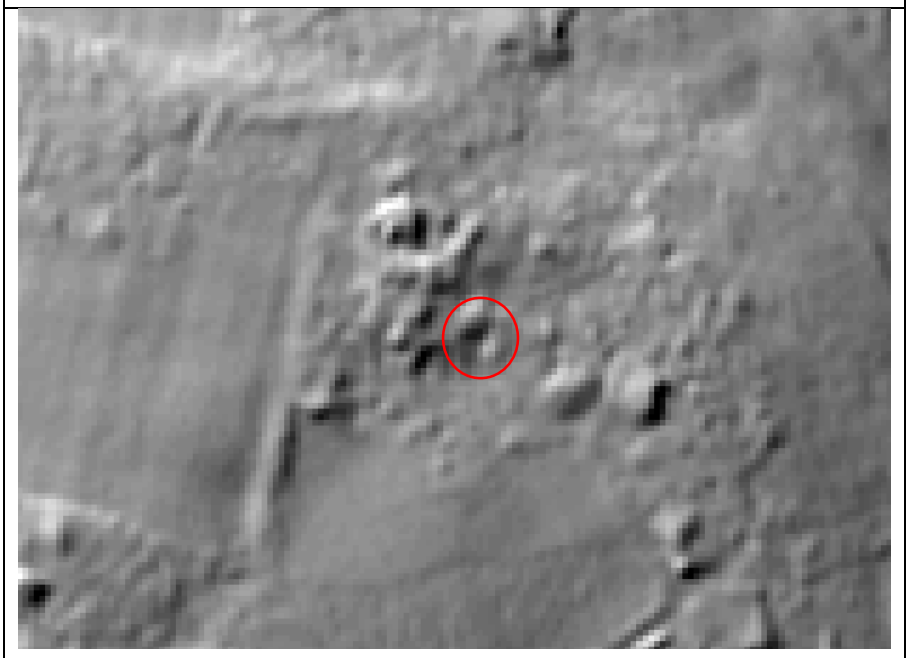
Feature ID	**K208**
Feature type	Enclosed depression
Coordinates	536099, 725516
Source	Lidar:  Bing maps: 
Field survey date	18/11/2014
Field survey status	Confirmation/identification problem
Water present	n/a
Additional Information	Access issue due to thick vegetation
Site photos	Not available

Feature ID	**K209**
Feature type	Enclosed depression
Coordinates	536101, 726363
Source	Lidar:
	
	Bing maps:
	
Field survey date	23/10/2014
Field survey status	Confirmation/identification problem
Water present	n/a
Additional Information	Access issue due to thick vegetation
Site photos	Not available

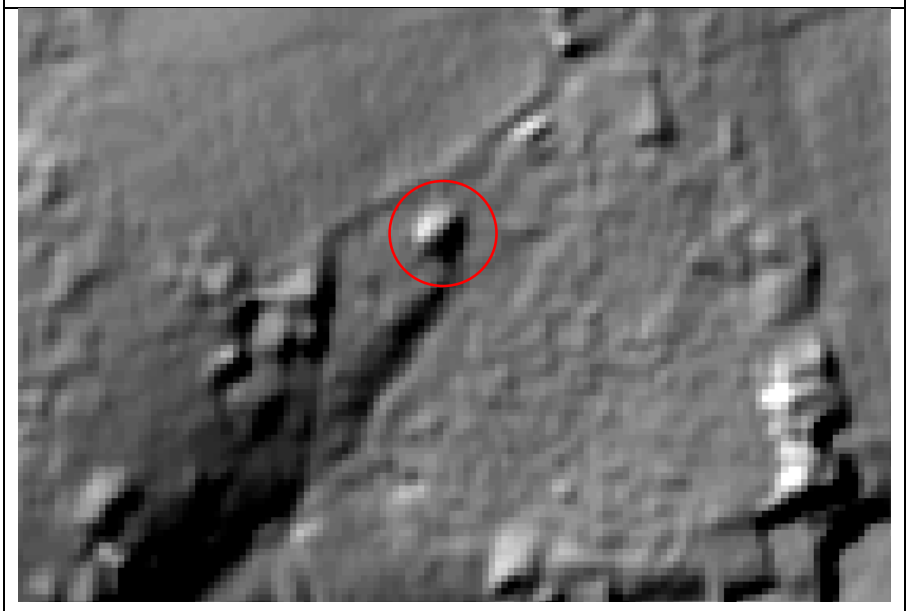
Feature ID	**K210**
Feature type	Spring
Coordinates	536114, 725968
Source	GSI Database: Well survey carried out by Bride Naughton GSI 1972.:  Lidar: 
Field survey date	18/11/2014
Field survey status	Confirmed
Water present	Yes Electrical conductivity: 704 uS/cm Temperature: 9.8 °C pH: 7.88
Water level elevation	26.37 mAOD
Additional Information	The spring is at the base of a depression. The ground is very soft and covered in vegetation. Water is present, however due to the low water

	levels and vegetation flow not measurable. The spring discharge area is approx. 20 m diameter. The landowner lives in the house across the road and informed us that the spring has been used in the past as the drinking water supply but is currently not in use.
Site photos	 

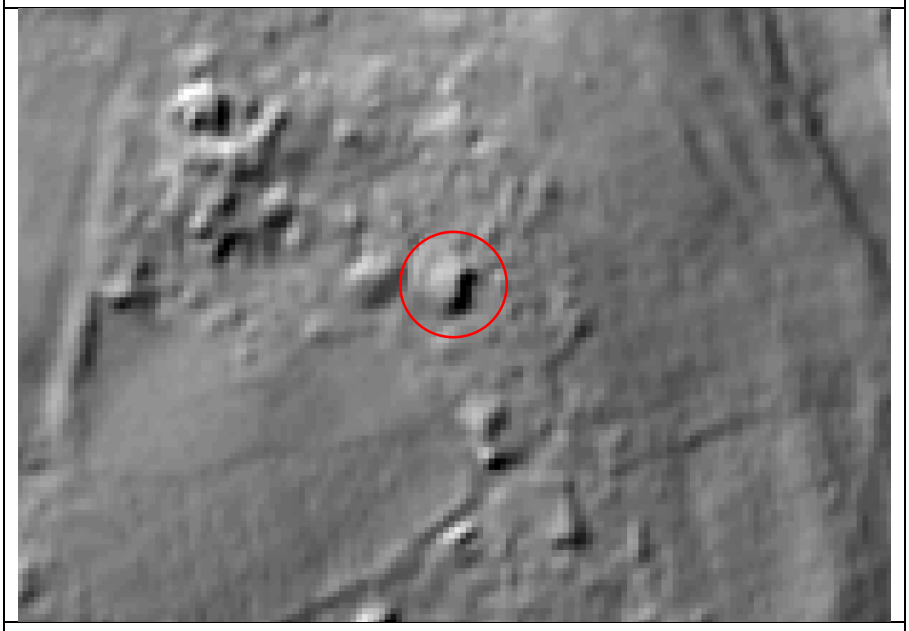
Feature ID	**K211**
Feature type	Superficial solution features
Coordinates	536119, 726817
Source	GSI Database: 
Field survey date	17/11/2014
Field survey status	Confirmed
Water present	No
Additional Information	Superficial solution features. Not very obvious. Some bumps etc in ground surface and exposed rock
Site photos	Not available

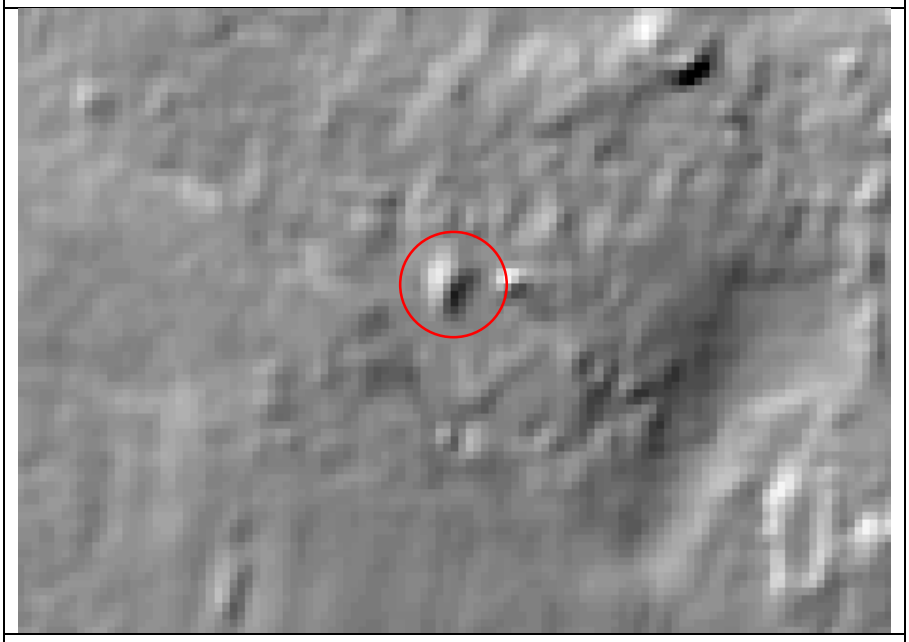
Feature ID	**K212**
Feature type	Enclosed Depression
Coordinates	536121, 726370
Source	Lidar: 
Field survey date	23/10/2014
Field survey status	Confirmation/identification problem
Water present	No
Additional Information	Could not locate due to dense vegetation cover in the area
Site photos	Not available

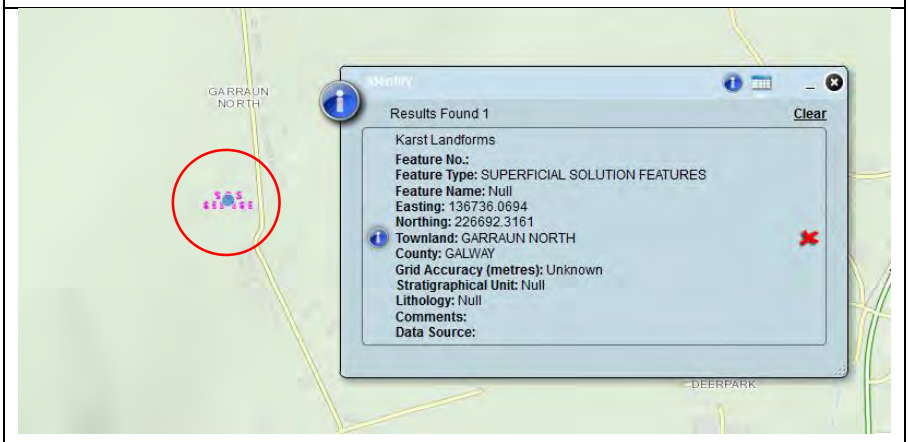
Feature ID	**K213**
Feature type	Enclosed Depression
Coordinates	536132, 726003
Source	Field survey
Field survey date	18/11/2014
Field survey status	Confirmed
Water present	No
Additional Information	Approx. dimensions: 20 m diameter. The depression may contain some fill or modification
Site photos	

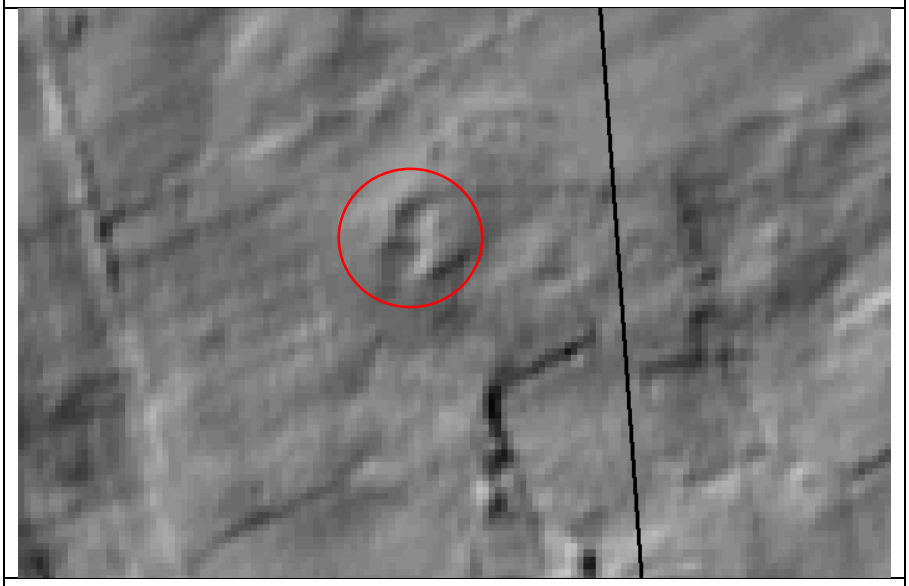
Feature ID	**K214**
Feature type	Enclosed Depression
Coordinates	536149, 726234
Source	Lidar:  Bing maps 
Field survey date	23/10/2014
Field survey status	Confirmation/identification problem
Water present	No
Additional Information	Could not locate due to dense vegetation cover in the area
Site photos	Not available

Feature ID	**K215**
Feature type	Enclosed Depression
Coordinates	536157, 725528
Source	Field survey
Field survey date	18/11/2014
Field survey status	Confirmed
Water present	No
Ground level elevation	25.14 mAOD
Additional Information	Very shallow depression Approx. dimensions: 5 m diameter and less than 0.5 m depth
Site photos	Not available

Feature ID	**K216**
Feature type	Enclosed Depression
Coordinates	536177, 726351
Source	Lidar:
	
	Bing maps
	
Field survey date	18/11/2014
Field survey status	Confirmation/identification problem
Water present	No
Additional Information	Could not locate due to heavily vegetated area
Site photos	Not available

Feature ID	**K218**
Feature type	Enclosed Depression
Coordinates	536381, 726690
Source	Lidar:
	
	Bing maps
	
Field survey date	17/11/2014
Field survey status	Confirmation/identification problem
Water present	No
Additional Information	Access issue due to dense vegetation
Site photos	Not available

Feature ID	**K222**
Feature type	Superficial solution features
Coordinates	536701, 726721
Source	Lidar: 
Field survey date	17/11/2014
Field survey status	Confirmed
Water present	No
Additional Information	Superficial solution features. Small shallow dips and small patches of outcrop.
Site photos	

Feature ID	**K223**
Feature type	Enclosed Depression
Coordinates	536722,726303
Source	Lidar:  Bing maps 
Field survey date	17/11/2014
Field survey status	Confirmation/identification problem
Water present	No
Additional Information	Access issue, bull in field.
Site photos	Not available

Appendix B

Karst Feature and Wetland Habitat Mapping

B1

A3

ROUTE SELECTION

Legend

- Scheme Study Area Boundary
- Hydroecological Sites

Karst Features

- Enclosed Depression
- Estavelle
- Spring Swallow Hole
- Spring
- Swallow Hole
- Turlough
- Well
- Cave
- Superficial solution features

Disclaimer Note:
The constraints shown are draft only and subject to change. More detailed assessments, on-going studies and the information received from the public may result in changes to these constraints.

Nóta Séanta:
Tá na srianta atá léirithe ina bhfoirm dréacht, d'fhéadfaí athraithe teacht orthu. Is mar thoradh ar mheasúnaithe níos mionchruinne, ar staidéar leanúnach agus ar eolas ón bpobal go ndéanfar athruithe ar na srianta seo.

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Job Title
N6 Galway City Transport Project

Scale: **1:30,000**

Date: **August 2015**

Issue	Date	By	Chkd	Appd
I1	27/02/2015	AO	LB	EM

Drawing Title
Kast Study - Karst Features with Wetland Habitat Mapping

Drawing Status
Route Selection

Job No	Drawing No	Issue
233985-00	Figure 6	I1