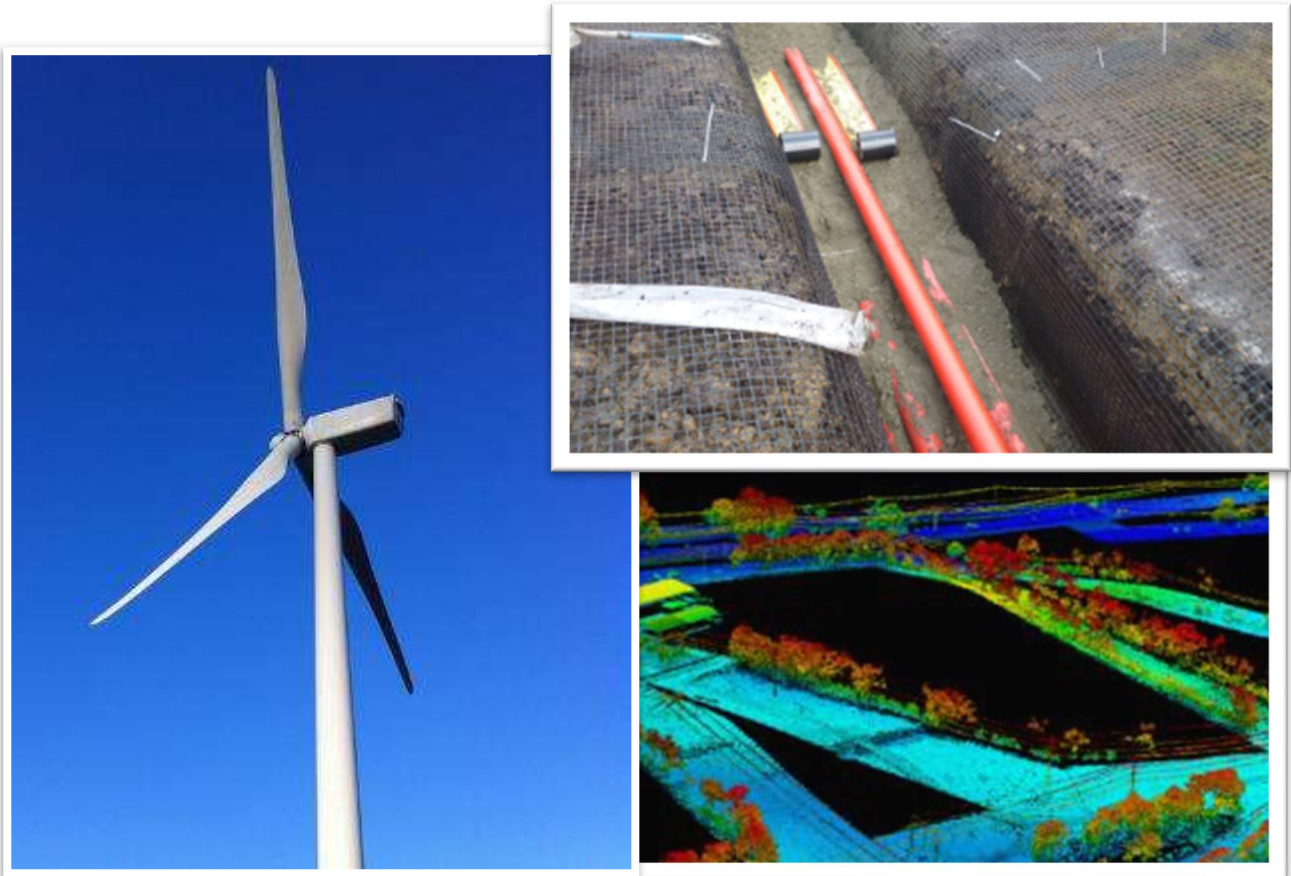


Construction Methodology – 110kV Underground Cable Connection



Gortrahilly Wind Farm Grid Connection



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Client: FEI C/o Jennings O' Donovan



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1.0 Introduction

The purpose of this document is to outline and explain the construction techniques and methodologies which will be implemented during construction of the Gortrahilly Wind Farm 110kV grid connection to the existing Ballyvouskil 220kV substation. The grid connection will consist entirely of underground cabling (UGC) with the majority of the UGC to be installed within internal forestry road networks.

The UGC works will consist of the installation of 6 No. ducts in an excavated trench to accommodate 3 No. power cables, 2 No. fibre communications cable to allow communications between the Gortrahilly Wind Farm Substation and Ballyvouskil 220kV substation and 1 No. earth continuity conductor.

This document is intended to be used as an aid to understand the methodologies to be employed during construction and should be read in conjunction with all other specialist reports which accompany the planning application. In addition, this document is in outline form only and will be revised and updated prior to the commencement of any construction activities, detailed Method Statements will be prepared in respect of each aspect of the development.

2.0 110kV Underground Cable Route

The UGC route is approximately 27.1km in length and traverse in an east to south easterly direction from the existing Ballyvouskil 220kV substation to the Gortrahilly Wind Farm substation location utilising public local road networks, existing access tracks and private forestry access tracks.

The exact location of the UGC within the curtilage of the existing access tracks, public local road network and private forestry access tracks may be subject minor modification following confirmatory site investigations to be undertaken prior to construction. The cable location will take into consideration Cork County Council, Kerry County Council and all other relevant stakeholders' requirements. Installation of the cable will consider all environmental protection measures forming part of the planning application for the development at Gortrahilly wind farm and accompanying technical reports.

Figure 1 outlines the UGC route, with the total length of each road type detailed in Table 1.

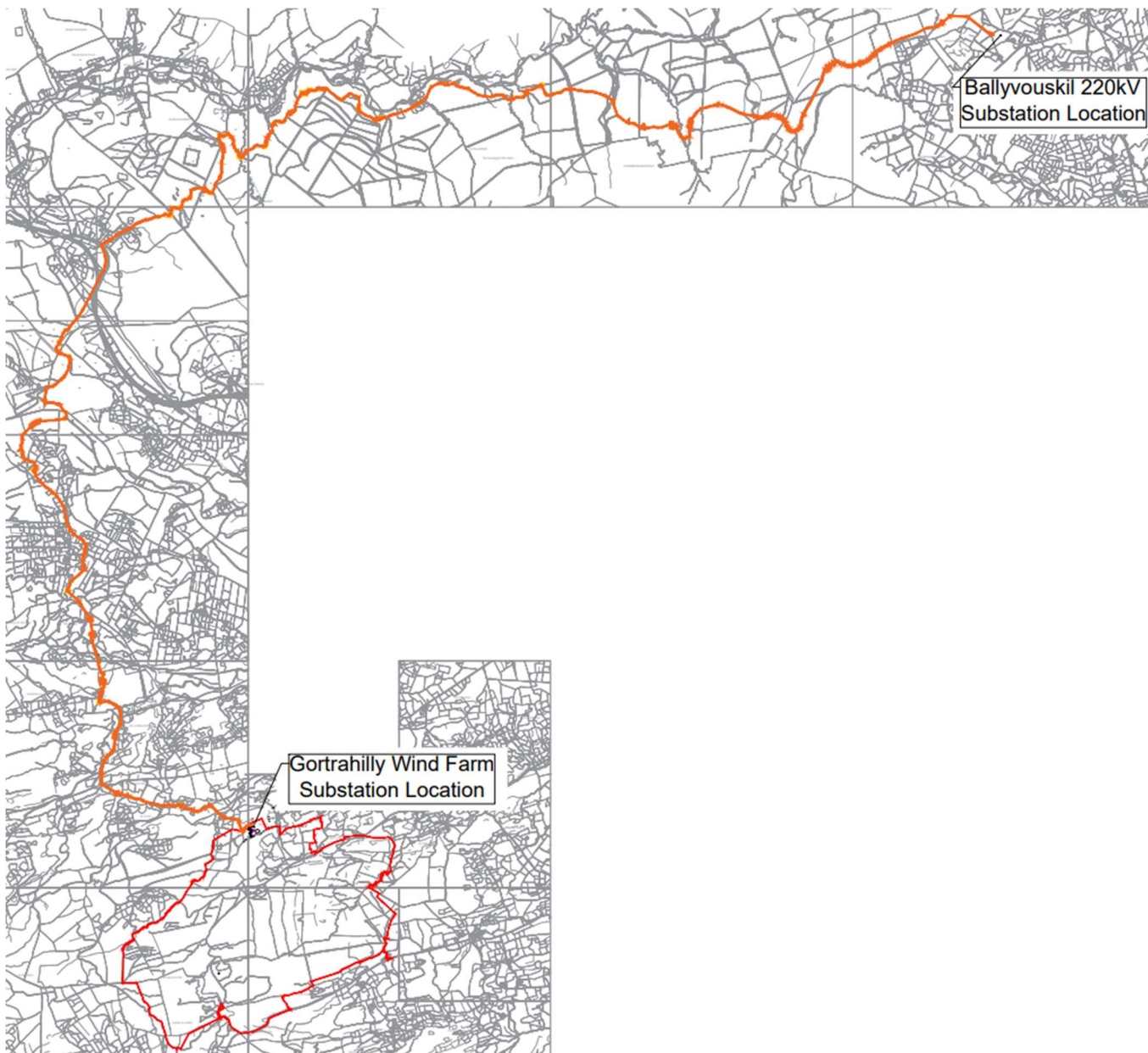


Figure 1 - Grid Connection Route Layout Plan

Table 1 – Approximate UGC Route Location of Preliminary Design:		
Wind Farm Site/Forestry Roads	Public Roads	ESB Access Track
19.6km	6.5km	1km

Table 1: Gortrahilly Wind Farm to Ballyvouskil 220kV Substation – UGC Route Location Summary

Table 2 separates the UGC route into a number of sections and describes the specific construction requirements of each individual section along with assessment of access routes to the work areas.

Table 2 - Summary of Grid Connection Design Route

Section	Description
<p>Section 1</p> <p>UGC</p>	<p>UGC from Ballyvouskil 220kV substation to N22 Road HDD Crossing (Chainage 17150m)</p> <p>The underground cable route initially begins within the townland of Caherdowney, Co. Cork where from Ballyvouskil 220kV substation compound, the UGC departs the substation on the north western boundary, converging onto a permanent access track to be constructed as part of this development within agricultural lands and traverses on an upward trajectory for approximately 950m prior to entering into forested plantations propertied by Coillte.</p> <p>The UGC will establish a route for the majority within existing forestry access tracks and will traverse adjacent to existing ESB utility infrastructure that reside within these forestry tracks. The UGC remains within these tracks for the majority of the grid connection route, carrying for an approximate length of 20km whilst sporadically crossing between Cork county and Kerry county boundaries through denoted townlands Cummeenabuddogue, Clydaroe, Knocknagowen, Glashacormick across this plantation coverage. Subsequent to crossing through the forestry properties, the UGC will leave the forestry access track on the south westerly side within the townland of Cummeenavrick, Co. Kerry and converges onto first, a section of redundant regional roadway, adjacent to the N22 National carriageway prior to accessing consented third-party property (KY30186F). The UGC will traverse this parcel within a permanent access road to be constructed as part of this development. This access road entails a 4m wide track with load bearing capacity of 10 tonne to allow for Horizontal Directional Drilling (HDD) activities commence to drill beneath approximately 70m of the N22 carriageway with the remainder of the drill shot equating to approximately 580m.</p> <p><u>Features</u></p> <p><u>Section 1 contains 21 No. joint bays.</u> Joint bays will be located below ground and finished/reinstated as per Forestry Road Manual (Guidelines for the design, construction and management of forest road) and as per private landowner reinstatement requirements.</p> <p>Joint bays will have associated communication chambers and link boxes which will have a surface access hatch which will match existing ground levels.</p> <ul style="list-style-type: none"> • Joint Bay 01 (JB-01) will be located within a permanent access track at <u>Chainage – 600m</u> • Joint Bay 02 (JB-02) will be located west of JB-01 within a permanent access track before converging onto existing forestry tracks. The joint bay will be installed at <u>Chainage – 1450m</u> • Joint Bay 03 (JB-03) will be located south west of JB-02 positioning the joint bay within a widened verge to the existing forestry track. [<u>Chainage – 2250m</u>] • Joint Bay 04 (JB-04) will be located south west of JB-03 positioning the joint bay within a widened verge to the existing forestry track [<u>Chainage – 3050m</u>] • Joint Bay 05 (JB-05) will be located south west of JB-04 positioning the joint bay within a widened verge to the existing forestry track [<u>Chainage – 3800m</u>]

- Joint Bay 06 (JB-06) will be located north west of JB-05 positioning the joint bay within a widened verge to the existing forestry track. [*Chainage – 4500m*]
- Joint Bay 07 (JB-07) will be located south west of JB-06 positioning the joint bay at receptor location for the HDD activities required to cross stream 1. [*Chainage – 5250m*]
- Joint Bay 08 (JB-08) will be located north west of JB-07 positioning the joint bay within a widened verge to the existing forestry track. [*Chainage – 6100m*]
- Joint Bay 09 (JB-09) will be located north west of JB-08 positioning the joint bay within a widened verge to the existing forestry track. [*Chainage – 6850m*]
- Joint Bay 10 (JB-10) will be located west of JB-09 positioning the joint bay within a widened verge to the existing forestry track. [*Chainage – 7650m*]
- Joint Bay 11 (JB-11) will be located west of JB-10 positioning the joint bay within a widened verge to the existing forestry track. [*Chainage – 8400m*]
- Joint Bay 12 (JB-12) will be located west of JB-11 positioning the joint bay within a widened verge to the existing forestry track. [*Chainage – 9150m*]
- Joint Bay 13 (JB-13) will be located south west of JB-12 positioning the joint bay within a widened verge to the existing forestry track. [*Chainage – 9900m*]
- Joint Bay 14 (JB-14) will be located north west of JB-13 positioning the joint bay within a widened verge to the existing forestry track. [*Chainage – 10650m*]
- Joint Bay 15 (JB-15) will be located west of JB-14 positioning the joint bay within a widened verge to the existing forestry track. [*Chainage – 11400m*]
- Joint Bay 16 (JB-16) will be located south west of JB-15 positioning the joint bay within a widened verge to the existing forestry track. [*Chainage – 12150m*]
- Joint Bay 17 (JB-17) will be located south west of JB-16 positioning the joint bay within a widened verge to the existing forestry track. [*Chainage – 12900m*]
- Joint Bay 18 (JB-18) will be located south west of JB-17 positioning the joint bay within a widened verge to the existing forestry track. [*Chainage – 13650m*]
- Joint Bay 19 (JB-19) will be located south west of JB-18 positioning the joint bay within a widened verge to the existing forestry track. [*Chainage – 14450m*]
- Joint Bay 20 (JB-20) will be located south west of JB-19 positioning the joint bay within a widened verge to the existing forestry track. [*Chainage – 15200m*]
- Joint Bay 21 (JB-21) will be located south west of JB-20, within a new permanent access road to be constructed to allow HDD activities on the eastern side of the N22 [*Chainage – 16050m*]

Section 1 has 3 No. watercourse crossings:

- Stream 1 has been surveyed with the result of insufficient clearance existing within this structure. To cross this stream, it will be required to utilise a Horizontal Directional Drill within the existing forestry track to cross beneath with a satisfactory clearance to the waterway. [*Chainage 5200m*]
- Stream 2 has been surveyed with the result of insufficient clearance existing within this structure. To cross this culvert, it will be required to utilise a Horizontal Directional Drill within the existing forestry track to cross beneath with a satisfactory clearance to the waterway. [*Chainage 9200m*]
- Stream 3 has been surveyed with the result of insufficient clearance existing within this structure. To cross this culvert, it will be required to utilise a Horizontal Directional Drill within the existing forestry track to cross beneath with a satisfactory clearance to the waterway. [*Chainage 9750m*]

	<p><u>Section 1 will require 6 No. service crossings:</u> Existing ESNB infrastructure will be encountered and the crossing schedules will be prepared at detailed design to identify under or over methods to cross these existing buried services.</p> <p><u>Section 1 has 107 No. culvert crossings:</u> A culvert schedule has been prepared to identify under or over methods to cross these existing minor watercourses.</p>
<p>Section 2 UGC</p>	<p>N22 Road HDD Crossing to Gortrahilly Windfarm site location (Chainage 27150m)</p> <p>The receptor pit from the drill shot will be located, again within Folio KY30186F on the opposite side of the N22 carriageway within the townland of Derryreag and the UGC route heads southwards towards another a subsequent block of Coillte propertied lands. In these Coillte lands, the UGC will establish within the remainder of Cork county designation from the townland of Derreenaling and continues southwards within the tertiary road L-74001-1 for circa. 900m before encountering the first bridge structure within the local road network at chainage 21300m. This bridge crossing will require the implementation of Horizontal Directional Drilling (HDD) due to insufficient deck cover within the bridge. Subsequent to crossing this obstacle, the UGC will continue southwards on a predominantly downward trajectory, navigating a route through use of sections of consented private land within Folio No CK10237. Re-converging onto the local road network at chainage 21925m, the UGC continues south along the L-7400 for an approximately 1.15km. There will be another HDD crossing at Chainage 22600m to cross beneath an existing watercourse/culvert whilst heading in a southerly direction, additionally to the preceding watercourse crossing, the UGC will encounter a second bridge structure at chainage 23150m (Droichead Barr Duínse) across the Bardinch river. To navigate a route around this obstacle, the mobilisation of a HDD will again be deployed within consented private lands, propertied within Folio CK10271. The UGC carries for an additional 830m within the local road L-3400-32.</p> <p>A third bridge crossing will be encountered at chainage 24050m (Droichead Uí Mhathúna), Sullane river. Field investigation works have identified that insufficient deck cover to accommodate 160mm ducting exists and it is intended to deploy HDD to cross beneath the structure and river network. Once navigated, the UGC carries into consenting third party property (CK10183) to traverse within a permanent access road and converges onto the L-7404-0 at chainage 24350m. Whilst in this roadway, the UGC will be installed in parallel to an existing underground cable (Grousemount 110kV cable) between chainage 24350m and 25050m. Once approaching the latter and carrying for additional 150m southwards, the UGC will converge onto the L-7405-0 to continue eastwards. The UGC will carry within this carriageway for approximately 1.55km until approaching chainage 26750m. At this point, the UGC will depart the public road network to carry southwards to head towards the location of Gortrahilly windfarm and subsequently reaches the windfarm site boundary at 27250m with the UGC terminating at chainage 27825m.</p> <p>The denoted townlands the UGC will traverse within section 2 will consist of Inchamore, Bardinch, Milleeny, Lumnagh More, Lumnagh Beg, Derreenaculling and Derree.</p> <p><u>Features</u></p> <p><u>Section 2 contains 15 No. joint bays.</u> Joint bays will be located below ground and finished/reinstated as per Forestry Road Manual (Guidelines for the design, construction and management of forest road),</p>

finished/reinstated to the required roads specification and reinstated to landowner preference where applicable.

Joint bays will have associated communication chambers and link boxes which will have a surface access hatch which will match existing ground levels.

- Joint Bay 22 (JB-22) will be located south west of JB-21, within an existing forestry access road [Chainage – 16800m]
- Joint Bay 23 (JB-23) will be located south of JB-22, within an existing forestry access road [Chainage – 17600m]
- Joint Bay 24 (JB-24) will be located south of JB-23, within an existing forestry access road [Chainage – 18350m]
- Joint Bay 25 (JB-25) will be located south west of JB-24, within a newly constructed access road [Chainage – 19150m]
- Joint Bay 26 (JB-26) will be located south of JB-25, within a newly constructed access road [Chainage – 19800m]
- Joint Bay 27 (JB-27) will be located south east of JB-26, within the tertiary roadway L-74001-1 [Chainage – 20550m]
- Joint Bay 28 (JB-28) will be located south of JB-27, within consented third party lands [Chainage – 21300m]
- Joint Bay 29 (JB-29) will be located south of JB-28, within the local roadway L-7400 at the receptor location for the HDD activities required to cross *Culvert 115* [Chainage – 22100m]
- Joint Bay 30 (JB-30) will be located south of JB-29, within consented third party lands at the receptor location for the HDD activities required to cross the Droichead Barr Duínse bridge across the Bardinch river. [Chainage – 22900m]
- Joint Bay 31 (JB-31) will be located south of JB-30, within the local roadway L-7400 at the receptor location for the HDD activities required to cross the Droichead Ui Mhathuna bridge across the Sulán river. [Chainage – 23650m]
- Joint Bay 32 (JB-32) will be located south of JB-31, within the local roadway L-3400-32 [Chainage – 24400m]
- Joint Bay 33 (JB-33) will be located south west of JB-32, within the local roadway L-7404-0 [Chainage – 25200m]
- Joint Bay 34 (JB-34) will be located east of JB-33, within the local roadway L-7405-0 [Chainage – 25950m]
- Joint Bay 35 (JB-35) will be located south east of JB-34, within consented third party lands on approach to the wind farm site boundary [Chainage – 26750m]

Section 2 has 4 No. watercourse/bridge crossings:

- Bridge 1 has been surveyed with the result of insufficient clearance existing within this structure. To cross this bridge, it will be required to utilise a Horizontal Directional Drill within the L-74001-1 to cross to a satisfactory clearance to the waterway. [Chainage 20800m]
- Bridge 2 (Droichead Barr Duínse) has been surveyed with the result of insufficient clearance existing within this structure and it is required to cross this bridge utilising the Horizontal Directional Drill method within the L-7400 roadway. [Chainage 22850m]

- Bridge 3 (Droichead Uí Mhathúna) has been surveyed with the result of insufficient clearance existing within this structure and it is required to cross this bridge utilising the Horizontal Directional Drill method within the L-3400-32 roadway. [*Chainage 23750m*]
- Culvert 115 has been surveyed with the rest of insufficient clearance existing within this structure and it is required to cross this culvert utilising the Horizontal Directional Drill method within the L-7400 roadway. [*Chainage 22250m*]

Section 2 will require 1 No. service crossings:

Existing ESNB infrastructure will be encountered and a crossing schedule will be prepared at detailed design to identify under or over method to cross this existing buried service.

Section 2 has 23 No. culvert crossings:

A culvert schedule has been prepared to identify under or over methods to cross these existing minor watercourses.

3.0 Access Routes to Work Area

The majority of the underground cable route will be installed within existing forestry access track networks and therefore will be accessed via the existing road network. Where the cable route is located on private lands, contractor(s) will be required to utilise the local public road network in the vicinity of the work area and from there utilise private access tracks, where appropriate.

A detailed Traffic Management Plan has been prepared as part of the EIAR (Environmental Impact Assessment Report). Some work areas will require a road closure where it is not possible to safely implement a Stop/Go system. Where road closures are necessary, a suitable diversion will be implemented using appropriate signage, following consultation with Cork County Council

Careful and considered local consultation will be carried out, to minimise the amount of disturbance caused during works. Prior to the commencement of construction, the contractor will assess all access routes and determine any additional access requirements which will be incorporated as part of the method statement. All plant and equipment employed during the works (e.g. diggers, tracked machines, footwear etc.) will be inspected prior to arrival on site and on leaving site and cleaned where necessary to prevent the spread of invasive aquatic / riparian species.

4.0 Traffic Management

Traffic management and road signage will be in accordance with the Department of Transport: Traffic Signs Manual - Chapter 8: Temporary Traffic Measures and Signs for Road Works and in agreement with both Cork County Council and Kerry County Council. All work on public roads will be subject to the approval of a road opening license application by both Cork County Council and Kerry County Council. The contractor will submit the traffic management plan for inclusion as part of the road opening applications. Where road widths allow, the UGC installation works will allow for one side of the road to be open to traffic at all times by means of a 'Stop/Go' type traffic management system, where a minimum 2.5m roadway will be maintained at all times.

Where it is not possible to implement a 'Stop/Go' system a full road closure will be required. Temporary traffic signals will be implemented to allow road users safely pass through the works area by channelling them onto the open side of the road. Typically, the UGC will be installed in 150m sections, and no more than 100m will be

excavated without the majority of the previous section being reinstated. Where the construction requires the crossing of a road, works on one carriageway will be completed before the second carriageway is opened, to maintain traffic flows.

All construction vehicles will be parked within the works area so as not to cause additional obstruction or inconvenience to road users or residents. The traffic signals will be in place prior to the works commencing and will remain in place until after the works are completed. The public road will be checked regularly and maintained free of mud and debris. Road sweeping will be carried out as appropriate to ensure construction traffic does not adversely affect the local road condition.

In the event of emergency; steel plates, which will be available on site, can be put in place across the excavation to allow traffic to flow on both sides of the road.

All traffic management measures will comply with those outlined within the accompanying EIAR (Environmental Impact Assessment Report) and will be incorporated into a detailed Traffic Management Plan to be prepared, in consultation with both Cork County Council and Kerry County Council, prior to the commencement of UGC construction.

5.0 Road Opening Licence

The UG grid connection works will require a road opening licence under Section 254 of the Planning and Development Act 2000-2015 from both Cork County Council and Kerry County Council. A Traffic Management Plan (TMP) will be agreed with both Cork County Council and Kerry County Council prior to the commencement of the development. The TMP will outline the location of traffic management signage, together with the location of any necessary road closures and the routing of appropriate diversions. Where diversions are required, these will be agreed with both Cork County Council and Kerry County Council in advance of the preparation of the TMP.

6.0 UGC Construction Methodology

The UGC will consist of 3 No. 160mm diameter HDPE power cable ducts, 2 No. 125mm diameter HDPE communications duct and 1 no. 63mm diameter earth continuity duct to be installed in an excavated trench, typically 825mm wide by 1,315mm deep, with variations on this design to adapt to bridge crossings, service crossings and watercourse crossings, etc. The power cable ducts will accommodate 1 No. power cables per duct. The communications duct will accommodate a fibre cable to allow communications between the Gortrahilly Wind Farm substation and Ballyvouskil 220kV substation. The inclusion 1 No. earth continuity conductor duct will also be required. The ducts will be installed, the trench reinstated in accordance with the Forestry Road Manual (Guidelines for the design, construction and management of forest road), private third-party landowners and both Cork, Kerry County Council specifications. Once all are satisfied, then the electrical cabling/fibre cable is pulled through the installed ducts in approximately 650/850m sections. Construction method statements and templates will be implemented to ensure that the UGC is installed in accordance with the correct requirements, materials, and specifications of ESBN and EirGrid.

6.1 Trenching Methodology

The following section outlines the methodology to be followed during trenching works:-

- The Contractor, and their appointed Site Manager, will prepare a targeted Method Statement concisely outlining the construction methodology and incorporating all mitigation and control measures included within the EIAR and as required by planning conditions where relevant;
- All existing underground services along the UGC route shall be confirmed prior to the commencement of construction works;
- At watercourse crossings, the contractor will be required to adhere to the environmental control measures outlined within the EIAR, the detailed Construction Environmental Management Plan (CEMP) and best practice construction methodologies;
- Where the cable route intersects with culverts, the culvert will remain in place (where possible) and the ducting will be installed either above or below the culvert to provide minimum separation distances in accordance with ESB and Irish Water specifications;
- Traffic management measures will be implemented in accordance with those included in Section 14.1 of the EIAR, and a detailed Traffic Management Plan will be prepared and agreed with both Cork, Kerry County Councils;
- Excavated material will be temporarily stockpiled onsite for re-use during reinstatement. Stockpiles will be restricted to less than 2m in height. Stockpiles will be located a minimum of 50m from surface water features and all stockpiling locations will be subject to approval by the Site Manager and Project Ecological Clerk of Works (ECOW);
- Excavated material shall be employed to backfill the trench where appropriate and any surplus material will be transported to the on-site borrow pit;
- Any earthen (sod) banks to be excavated will be carefully opened with the surface sods being stored separately and maintained for use during reinstatement;
- The excavated trench will be dewatered if required, from a sump installed within the low section of the opened trench. Where dewatering is required, dirty water will be fully and appropriately attenuated, through silt bags, before being appropriately discharged to vegetation or surface water drainage feature (please refer to Chapter 9 of the EIAR);
- Where required, grass will be reinstated by either seeding or by replacing with grass turves;
- No more than a 100m section of trench will be opened at any one time. The second 100m will only be excavated once the majority of reinstatement has been completed on the first;
- The excavation, installation and reinstatement process will take on average of 1 no. day to complete a 100m section;
- Where the cable is being installed in a roadway, temporary reinstatement may be provided to allow larger sections of road to be permanently reinstated together;
- Following the installation of ducting, pulling the cable will take approximately 1 no. day between each joint bay, with the jointing of cables taking approximately 1 week per joint bay location.



Figure 2 - Typical 110kV Underground Duct Installation

6.2 Ducting Installation Methodology

For the trenching and ducting works the following step by step methodology will apply:

1. Grade, smooth and trim trench floor when the required 1315mm depth and 825mm width have been obtained.
2. Place bedding layer of Cement Bound Granular Mixture B (CBGM B) material in accordance with the specification and compact it so that the compacted thickness is as per the drawings.
3. Lay the bottom row of ducts in trefoil formation as detailed on the design drawings. Use spacers as appropriate to establish horizontal duct spacing. Fit a secure cap / bung to the end of each duct run to prevent the ingress of dirt or water.
4. Carefully surround and cover ducts with CBGM B in accordance with the design drawings and specifications and thoroughly compact without damaging ducts.
5. Place cable protection strips on compacted CBGM B directly over the ducts.
6. Lay the top row of ducts onto the freshly compacted CBGM B including the cable protection strips above the bottom row of ducts. Place a secure cap at the end of each duct to prevent the ingress of dirt or water.
7. Carefully surround and cover ducts with CBGM B material in accordance with the drawings and thoroughly compact without damaging ducts.
8. Place red cable protection strip on top of compacted CBGM B over each set of ducts as shown on the drawings.
9. Place and thoroughly compact CBGM B material or Clause 804 backfill or soil backfill as specified and place warning tape at the depth shown on the drawings.
10. For concrete and asphalt/bitmac road sections, carry out immediate permanent reinstatement in accordance with the specification and to the approval of the local authority and/or private landowners, unless otherwise agreed with local authorities (Figure 3).

11. For unsurfaced/grass sections, backfill with suitable excavated material to ground level leaving at least 100 mm topsoil or match existing level at the top to allow for seeding or replace turves as per the specification of the local authority or landowner (Figure 4).
12. Clean and test the ducts in accordance with the specification by pulling through a brush and mandrel. Install 12 mm polypropylene draw rope in each duct and seal all ducts using robust duct end seals fitted with rope attachment eyes in preparation for cable installation at a later date. All the works should be witnessed by ESNB Clerk of Works (CoW) as required.

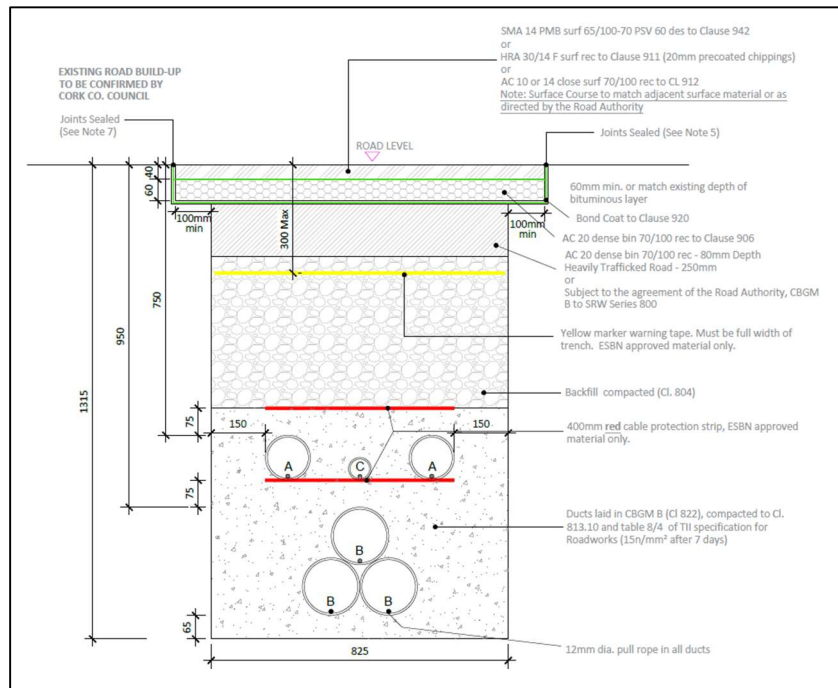


Figure 3 - Typical Trench in Roadway

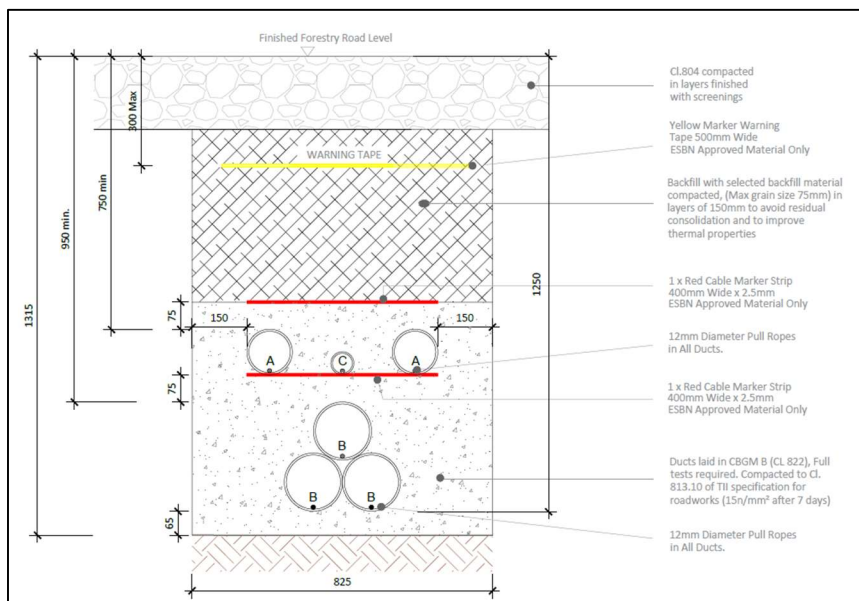


Figure 4 - Typical Trench in Forestry Road Section

6.2.1 UGC Installation on Public Road

Where the ducting is installed within public road carriages and where applicable the trench will be installed in the non-trafficked strip between the wheel marks on the road. The cable will be micro-sited based on the presence of exiting utilities and the nature of the road and the adjoining terrain. It is preferable to excavate a trench within the middle of the lane, or the middle of the roadway to reduce load on the cable.

6.2.2 UGC Installation on Tracks

The majority of the 110kV route is located within existing forestry access tracks. The location where the cable is laid will depend on several factors such as; width of track, bends along the track and crossings. Where the track needs to be widened, stone will be brought in to build up the area to the same level of the track. The excess material from the track will be used elsewhere on reinstatement works.

6.3 Marker posts

Surface cable markers will be placed along the route where cable depth is unavoidably shallow, due to constraints such as existing services, to indicate the precise location of the UGC. These markers will be metallic plates in accordance with ESNB and EirGrid standards.

Marker posts will be used on non-roadway routes to delineate the cable route and joint bay positions. Corrosion proof aluminium triangular danger sign, with 700mm base, and with centred lightning symbol, on engineering grade fluorescent yellow background shall be installed in adequately sized concrete foundations. Marker post shall also be placed in the event that burial depth is not to standard. Siting of marker posts to be dictated by ESNB as part of the detailed design process (Figure 5).

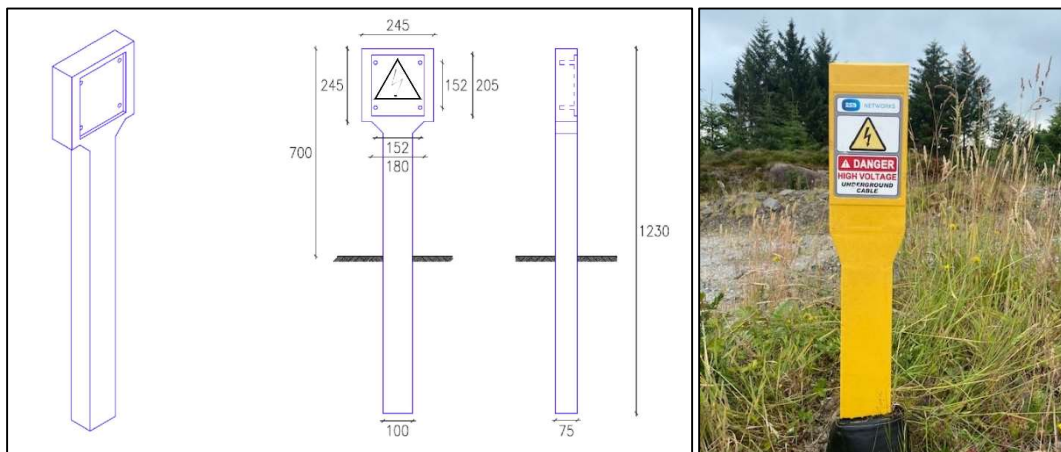


Figure 5 - Typical ESB Marker Posts Example

6.4 Managing Excess Material from Trench

All excavated material will be temporarily stored adjacent to the trench prior to re-use in the trench reinstatement (where applicable). Stockpiles will be restricted to less than 2m in height. Where excess material exists, it may be used in the reinstatement of the borrow pit as part of the Gortrahilly Wind Farm. Excavated tar from the public road network will be transported off site by an appropriately authorised waste collector and disposed of at an appropriately licenced waste facility.

6.5 Storage of Plant and Machinery

All plant, machinery and equipment will be stored on site within the UGC works area or within the temporary construction compounds to be located within the Gortrahilly Wind Farm. Oils and fuels will be stored in an appropriately bunded area within the temporary construction compounds.

6.6 Joint Bays and Associated Chambers

Joints Bays are to be installed approximately every 650m - 850m along the UGC route to facilitate the jointing of 2 No. lengths of UGC. Joint Bays are typically 6m x 2.5m x 2.05m pre-cast concrete structures installed below finished ground level. Joint Bays will be located in the non-wheel bearing strip of roadways, however given the narrow profile of local roads this may not always be possible.

In association with Joint Bays, Communication Chambers are required at every joint bay location to facilitate communication links between Gortrahilly Wind Farm substation and the existing 220kV node at Ballyvouskil. Earth Sheath Link Chambers are also required at every joint bay along the cable route. Earth Sheath Links are used for earthing and bonding cable sheaths of underground power cables, so that the circulating currents and induced voltages are eliminated or reduced. Earth Sheath Link Chambers and Communication Chambers are located in close proximity to Joint Bays. Earth Sheath Link Chambers and Communication Chambers will typically be pre-cast concrete structures with an access cover at finished surface level.

The precise siting of all Joint Bays, Earth Sheath Link Chambers and Communication Chambers is subject to approval by ESNB. Marker posts will be used on non-roadway routes to delineate the duct route and joint bay positions.

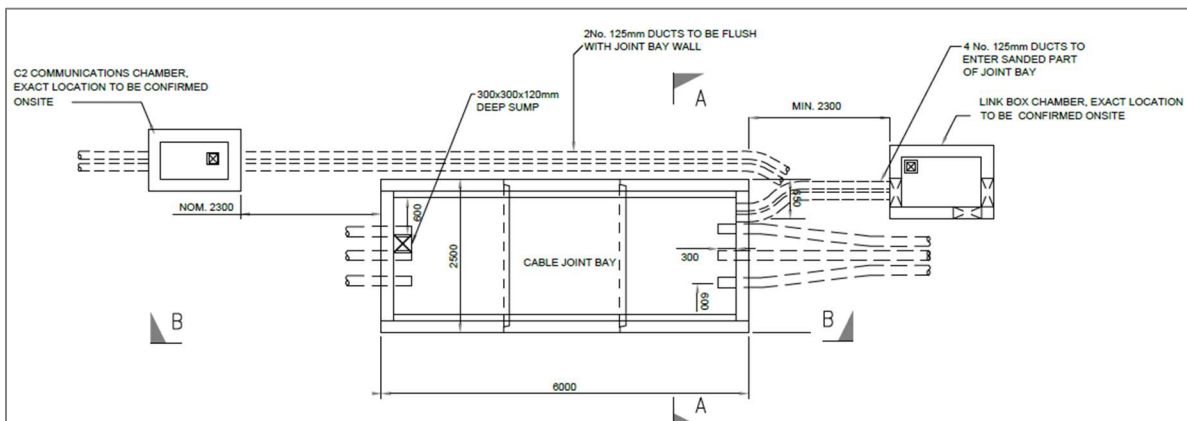


Figure 6 - 110kV Joint Bay Plan Layout

6.7 Joint Bay Construction and Cable Installation

Before starting construction, the area around the edge of the joint bay which will be used by heavy vehicles will be surfaced with a terram cover (if required) and stone aggregate to minimise ground damage. Any roadside drains within the temporary works area will be culverted and check dams made from stone or sandbags covered with terram will be inserted upstream and downstream of these culverts to intercept any solids generated during the insertion or which wash out during the works. If the ground slopes from the working area toward a watercourse or if there is evidence of solids washing off the works area toward nearby watercourses or drains, a silt fence with straw bales, will be interposed between the works area and the watercourse.

All excavated material will be stored near the excavations and reused for reinstatement works. Any soil required for reinstatement that will be temporarily stockpiled on site will be placed at least 15m back from the nearest

watercourse on level ground and will be ringed at the base by silt fencing and be regularly monitored by a designated competent person for signs of solids escape. In which case an additional line of silt fencing with straw bales will be added in line with the relevant environmental control measures.

If the joint bay needs to be dewatered, this will be pumped to a percolation area if the soil is not saturated, otherwise a settlement tank will be used to remove any solids from the dewatering process to comply with the environmental control measures.

The risk of concrete reaching surface waters is considered very low given that all concrete will be poured into the pit excavated for the joint bay so that spills will be contained. The basic requirement therefore is that all pouring operations be constantly supervised to prevent accidental spillages occurring outside the pit.

Temporary storage of cement bound sand (if required) will be on hardstand areas only where there is no direct drainage to surface waters and where the area has been bunded e.g. using sand-bags and geotextile sheeting or silt fencing to contain any solids in run-off.

The following steps outline the methodology for joint bay construction and reinstatement:

1. The contractor will excavate a pit for joint bay construction, including for a sump in one corner.
2. Grade and smooth floor; then lay a 75 mm depth of blinding concrete (for in situ construction) or 50 mm thick sand (for pre-cast concrete construction) on 200 mm thick Clause 804 granular material.
3. In situ construction. Construct 200 mm thick reinforced concrete floor slab with sump and starter bars placed for walls as detailed on the drawings.
4. In situ construction. Construct 200 mm thick reinforced concrete sidewalls as detailed on the drawings. (*Figure 7*)



Figure 7- Typical joint bay under construction (in-situ)

5. In situ construction. Remove formwork and backfill with suitable backfill material in grassed areas or Clause 804 material once ducting has been placed in the bay. Backfill externally with granular material to Co. Council/TII Specification for Roadworks. (*Figure 8*)



Figure 8 - Completed joint bay prior to cable installation (in-situ)

6. Pre-cast concrete construction. Place pre-cast concrete sections on sand bedding. (Figure 9)



Figure 9 - Typical joint bay under construction (pre-cast)

7. Where joint bays are located under the road surface the joint bay will be backfilled with compacted layers of Clause 804 and the road surface temporarily reinstated as specified by the local authority.
8. Precast concrete covers may be used as temporary reinstatement of joint bays at off road locations. These covers are placed over the constructed joint bay and are then removed at the cable installation stage of the project.
9. At a later date to facilitate cable installation and jointing, reinstate traffic management signage, secure individual sites, re-excavate three consecutive joint bays and store excavated material for reuse.
10. The cable is supplied in pre-ordered lengths on large cable drums (Figure 10). Installing “one section” of cable normally involves pulling three individual conductors into three separate ducts. The cable pulling winch must be set at a predetermined cut off pulling tension as specified by the designer. The cable will be connected to the winch rope using approved suitably sized and rated cable pulling stocking and swivel or the pulling head fitted by the cable manufacturer. A sponge may also be secured to the winch rope to disperse lubricant through the duct. Lubrication is also applied to the cable in the joint bay before it enters the duct.



Figure 10 - HV cable pulling procedure (Typical drum set-up)

11. Once the “two sections” of cable (total of 6 conductors) are pulled into the joint bay, a jointing container is positioned over the joint bay and the cable jointing procedure is carried out in this controlled environment. (Figure 11)



Figure 11 - HV cable jointing container

Following the completion of jointing and duct sealing works in the joint bay, place and thoroughly compact cement-bound sand in approximately 200 mm layers to the level of the cable joint base to provide vertical support. Install additional layers of cement-bound sand and compact each layer until the cement-bound sand is level with the top of the joint. Install an additional 100 mm cement-bound sand layer. Install cable protection strip. Backfill with cement-bound sand to a depth of 250 mm below surface and carry out permanent reinstatement including placement of warning tape at 400 mm depth below finished surface.

Equipment:

- 2-3 General Operatives
- 1 Excavator Operator
- 360° tracked excavator (13 ton normally, 22 ton for rock breaker)
- 1 no. tracked dumper or tractor and trailer

Materials:

- Sand for pipe bedding
- Blinding Concrete where necessary
- Clause 804 Material
- 160mm diameter HDPE ducting

- 125mm diameter HDPE ducting
- 63mm diameter HDPE ducting
- Precast Chamber Units / Relevant construction materials for chambers
- Earth Sheath Link Box

7.0 Relocation of Existing Services

In order to facilitate the installation of the underground cable, it may be necessary to relocate existing underground services within the curtilage of the road such as water mains, telecom networks or existing cables. In advance of any construction activity, the contractor will undertake detailed surveys and scans of the UGC route to confirm the presence or otherwise of any services. If found to be present, the relevant service provider will be consulted with in order to determine the requirement for specific excavation or relocation methods and to schedule a suitable time to carry out works.

8.0 Major Watercourse Crossings

The cable route will involve 3 No. bridge crossings. Where the cable route intersects with existing watercourses, a detailed construction method statement will be prepared by the Contractor prior to the commencement of construction and is to be approved by the Local Authority and relevant environmental agencies. The cable will be located within the bridge deck where there is sufficient depth and width available on the bridge, where there is insufficient depth and width available horizontal directional drilling (HDD) may be employed as an alternative.

Crossing existing culverts will be implemented using open trenching with either an undercrossing or an overcrossing, depending on the depth of the culvert. The cable route will involve 3 No. culvert crossings locations which will require the mobilisation of HDD. A schedule of the culverts has been identified at this stage where the crossing method to be implemented has been detailed. (Ref 05-836 Gortrahilly Culvert Schedule). The culvert crossing methods are detailed in *Figures 12 and 13* below.

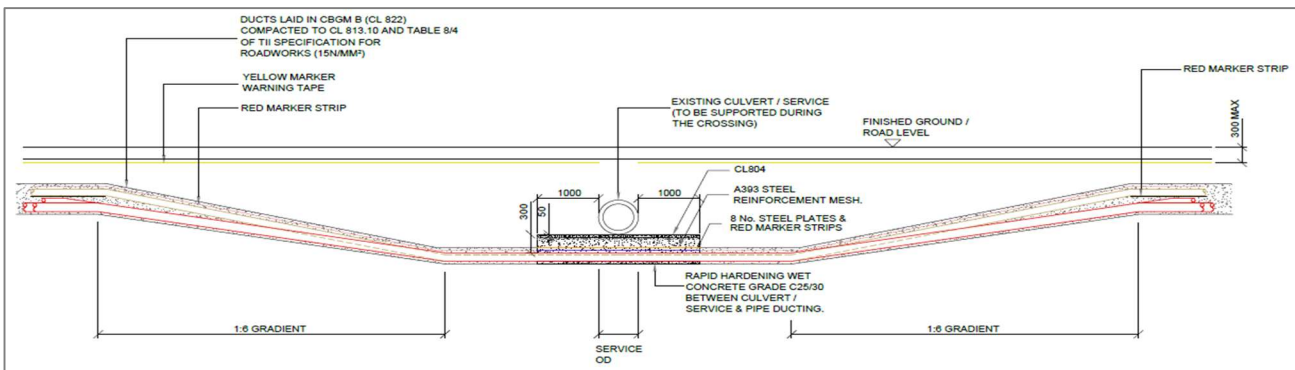


Figure 12 – 110kV UGC Culvert Undercrossing

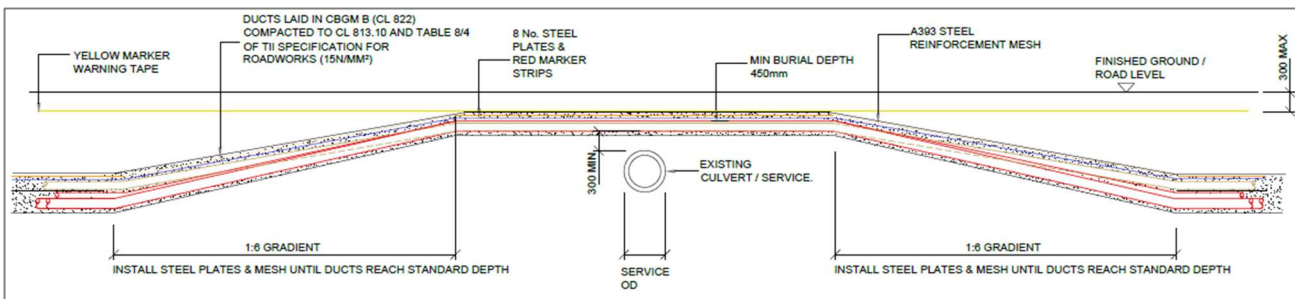


Figure 13 - 110kV UGC Culvert Overcrossing

Inland Fisheries Ireland have published guidelines relating to construction works along water bodies entitled ‘Requirements for the Protection of Fisheries Habitats during Construction and Development Works at River Sites’, and these guidelines will be adhered to during the construction of the development.

8.1 Bridge 1 - Horizontal Directional Drilling

ITM Coordinates: 513613.57, 577816.03

Bridge 1 has insufficient room to install the cable to ESB and EirGrid specifications (450mm cover to top of ducts) and the suitability of the bridge is inadequate to accommodate the works. Executing a horizontal directional drill (HDD) approximately 1500mm beneath the waterway and bridge foundations will be required. This depth is based on locating a suitable clay/silt formation for HDD and the required depth may increase subject to geotechnical investigations. Drilling will take place from the road carriageway. Ref drawing 05836-DR-250. [Chainage 20800m]



Figure 14 - Bridge 1 within L-74001-1

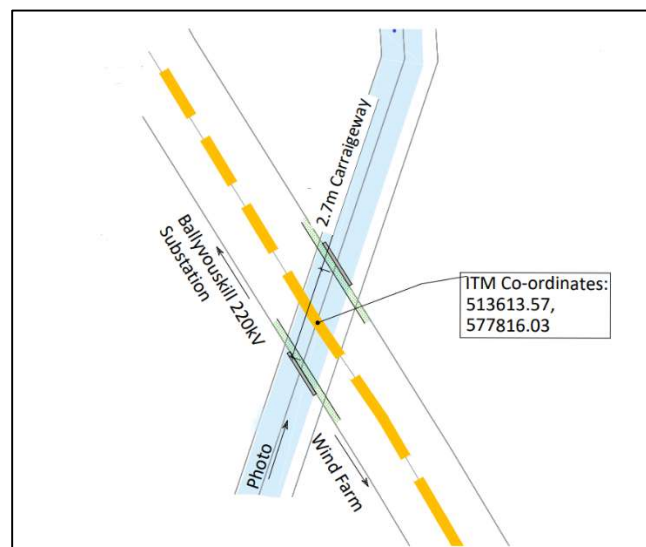


Figure 15 - Bridge 1 within L-74001-1 on OSI Background

8.2 Bridge 2 (Droichead Barr Duínse) - Horizontal Directional Drilling

ITM Coordinates: 513973.03, 576129.89

Bridge 2 is located on the L-7400 approx. 60m northwest of JB31 crossing over the Barr Duínse river, which is a tributary to the Sullane River. The Bridge has insufficient room to install the cable to ESBN and EirGrid specifications (450mm cover to top of ducts) and the suitability of the bridge is inadequate to accommodate the scope of works. Horizontal directional drilling (HDD) will be implemented to bore approximately 1500mm beneath the waterway and bridge foundations. This depth is based on locating a suitable clay/silt formation for HDD and the required depth may increase subject to geotechnical investigations. Drilling will take place from the road carriageway. The methodology for HDD is outlined in Section 9 below. Ref drawing 05836-DR-251. [Chainage 22850m]



Figure 16 - Droichead Barr Duínse across the Bardinch river within L-7400

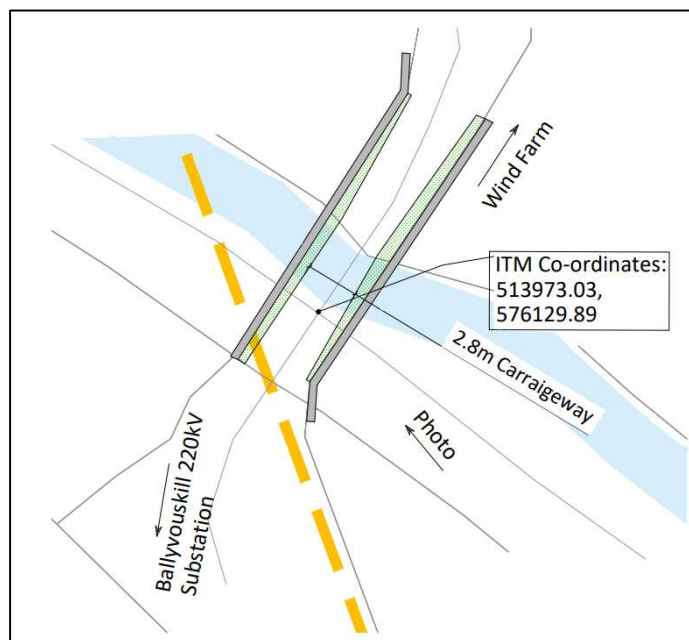


Figure 17 - Droichead Barr Duínse across the Bardinch river within L-7400 on OSI Background

8.3 Bridge 3 (Droichead Uí Mhathúna) - Horizontal Directional Drilling

ITM Coordinates: 514236.58, 575454.51

Bridge 3 is located on the L-3400-32 approx. 74m southeast of JB32 crossing over the Sullane River. The Bridge has insufficient room to install the cable to ESNB and EirGrid specifications (450mm cover to top of ducts) and the suitability of the bridge is inadequate to accommodate the scope of works. Horizontal directional drilling (HDD) will be implemented to bore approximately 1500mm beneath the waterway and bridge foundations. This depth is based on locating a suitable clay/silt formation for HDD and the required depth may increase subject to geotechnical investigations. Drilling will take place from the road carriageway. The methodology for HDD is outlined in Section 9 below. Ref drawing 05836-DR-252. [*Chainage 23750m*]



Figure 18 - Droichead Uí Mhathúna crossing the Sullane River along the L-3400-32 roadway

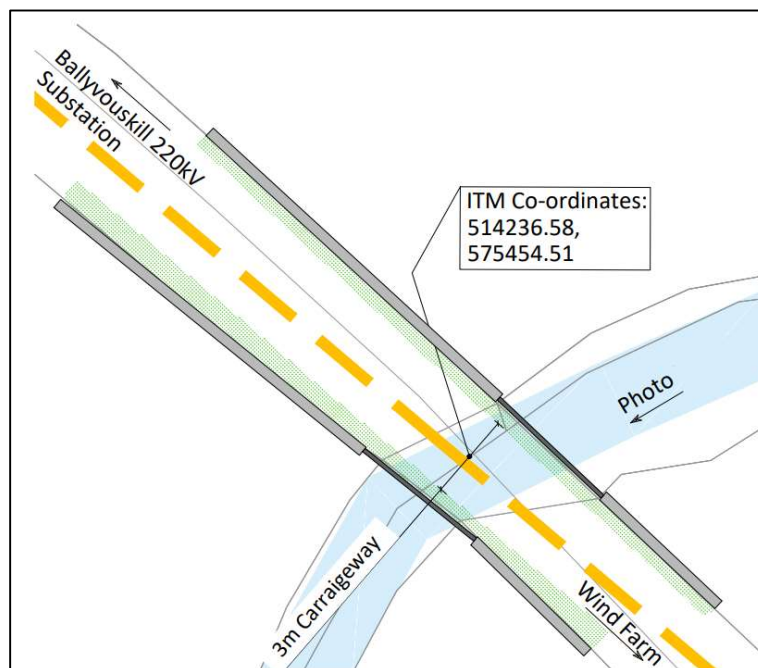


Figure 19 - Droichead Uí Mhathúna on OSI Background

8.4 Stream 1 - Horizontal Directional Drilling

ITM Co-ordinates: 521705.58, 583151.14

Stream 1 is located approx. 50m east of JB07 crossing over a large stream with in a vally. This steam flows in a northern direction. Horizontal directional drilling (HDD) will be implemented to bore approximately 1500mm beneath the waterway. This depth is based on locating a suitable clay/silt formation for HDD and the required depth may increase subject to geotechnical investigations. Drilling will take place from the forestry access track carriageway. The methodology for HDD is outlined in Section 9 below. Ref drawing 05836-DR-253. [Chainage 22250m]



Figure 20 – Stream 1 Valley Crossing

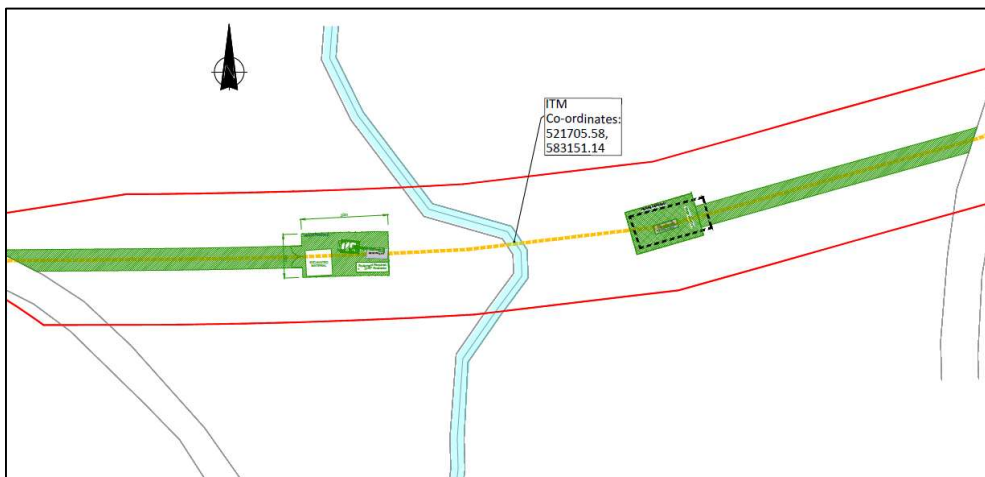


Figure 21 – Stream 1 Valley Crossing on OSI Background

8.5 Stream 2 (Culvert 56 & Culvert 57) - Horizontal Directional Drilling

ITM Coordinates: 518283.67, 583469.44

Stream 2 is located on a forestry access track approx. 75m south of JB12 crossing over a large Stream. This stream flows in a north direction and into the River Clydagh. This stream also flows into Killarney National Park, Macgillycuddy's Reeks and Caragh River Catchment SAC (Special Area of Conservation).

Horizontal directional drilling (HDD) will be implemented to bore approximately 1500mm beneath the waterway. This depth is based on locating a suitable clay/silt formation for HDD and the required depth may increase subject to geotechnical investigations. Drilling will take place from the forestry access track carriageway. The methodology for HDD is outlined in Section 9 below. Ref drawing 05836-DR-254. [Chainage 5200m]



Figure 22 - Stream 2

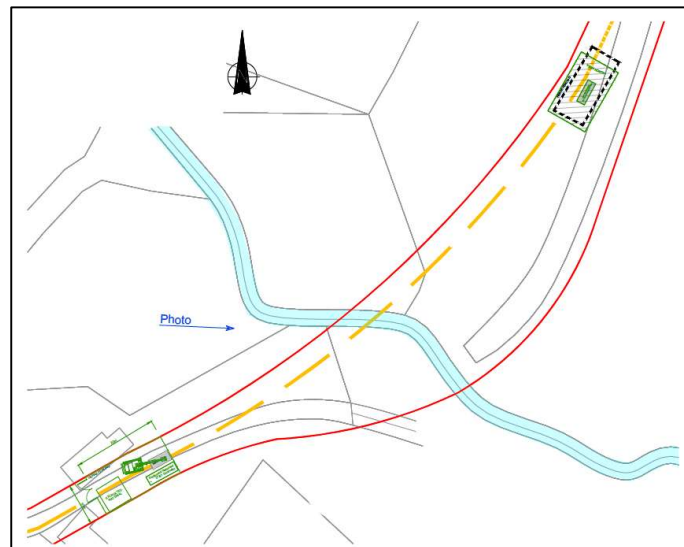


Figure 23 - Stream 2 within Forestry Road on OSI Background

8.6 Stream 3 (Culvert 59 to 63) - Horizontal Directional Drilling

ITM Coordinates: 517802.26, 583246.3

Stream 3 is located on a forestry access track approx. 145m east of JB13 crossing over a large Stream. This stream flows in a north direction and into the River Clydagh. This stream also flows into Killarney National Park, Macgillycuddy's Reeks and Caragh River Catchment SAC (Special Area of Conservation).

Horizontal directional drilling (HDD) will be implemented to bore approximately 1500mm beneath the waterway. This depth is based on locating a suitable clay/silt formation for HDD and the required depth may increase subject to geotechnical investigations. Drilling will take place from the forestry access track carriageway. The methodology for HDD is outlined in Section 9 below. Ref drawing 05836-DR-255. [*Chainage 9200m*]



Figure 24 - Stream 3

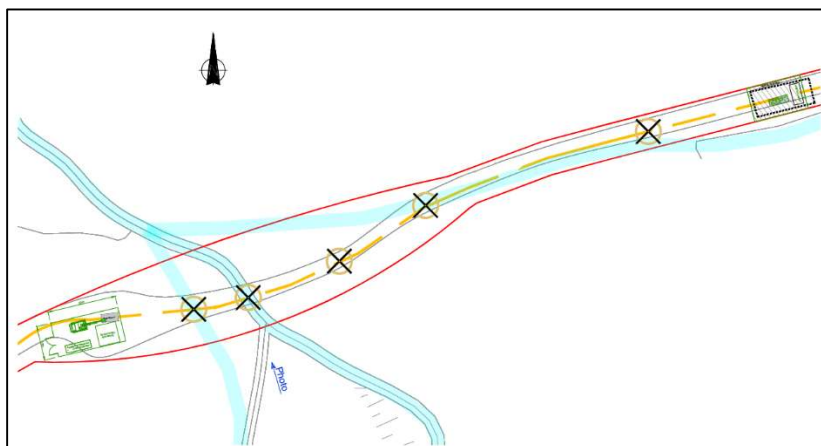


Figure 25 - Stream 3 within Forestry Road on OSI Background

8.7 Culvert 115 - Horizontal Directional Drilling

ITM Coordinates: 513832.37, 5766690.31

Culvert 115 is located within the L-7400 approx. 140m south of JB29 crossing over a large Stream. This stream flows in a eastern direction and into the Barr Duinse River. Horizontal directional drilling (HDD) will be implemented to bore approximately 1500mm beneath the waterway. This depth is based on locating a suitable clay/silt formation for HDD and the required depth may increase subject to geotechnical investigations. Drilling will take place from the forestry access track carriageway. The methodology for HDD is outlined in Section 9 below. Ref drawing 05836-DR-257. [Chainage 22250m]



Figure 26 - Culvert 115

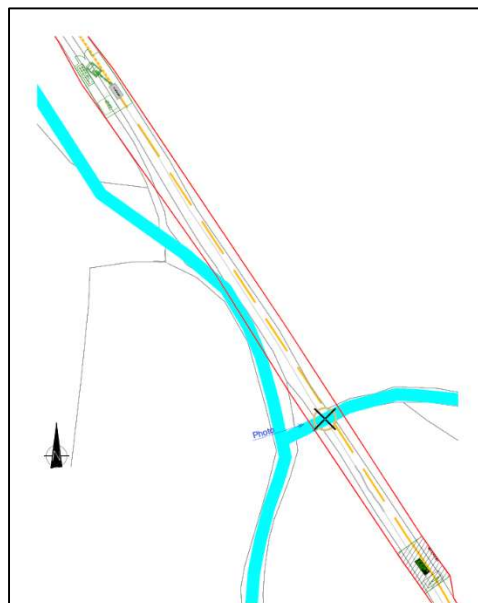


Figure 27 - Culvert 115 within L7400 on OSI Background

9.0 Horizontal Direction Drilling (HDD)

Horizontal Direction Drilling (HDD) is a method of drilling under obstacles such as bridges, railways, water courses, etc. in order to install cable ducts under the obstacle. This method is employed where installing the ducts using standard installation methods is not possible. There are a number of bridges on this UGC route which will require HDD due to there being insufficient cover and depth in the bridge to cross within the bridge deck. The drilling methodology is as follows: -

1. A works area of circa. 40m² will be fenced on both sides of the river crossing,
2. The drilling rig and fluid handling units will be located on one side of the bridge and will be stored on double bundled 0.5mm PVC bunds which will contain any fluid spills and storm water run-off.
3. Entry and exit pits (1m x 1m x 2m) will be excavated using an excavator, the excavated material will be temporarily stored within the works area and used for reinstatement or disposed of to a licensed facility.
4. A 1m x 1m x 2m steel box will be placed in each pit. This box will contain any drilling fluid returns from the borehole.
5. The drill bit will be set up by a surveyor, and the driller will push the drill string into the ground and will steer the bore path under the watercourse.
6. A surveyor will monitor drilling works to ensure that the modelled stresses and collapse pressures are not exceeded.
7. The drilled cuttings will be flushed back by drilling fluid to the steel box in the entry pit.
8. Once the first pilot hole has been completed a hole-opener or back reamer will be fitted in the exit pit and will pull a drill pipe back through the bore to the entry side.
9. Once all bore holes have been completed, a towing assembly will be set up on the drill and this will pull the ducting into the bore.
10. The steel boxes will be removed, with the drilling fluid disposed of to a licensed facility.
11. The ducts will be cleaned and proven and their installed location surveyed.
12. The entry and exit pits will be reinstated to the specification of ESBN, EirGrid and Cork County Council.
13. A transition coupler will be installed at either side of the bridge/ following the horizontal directional drilling as per ESB and EirGrid requirements, this will join the HDD ducts to the standard ducts.

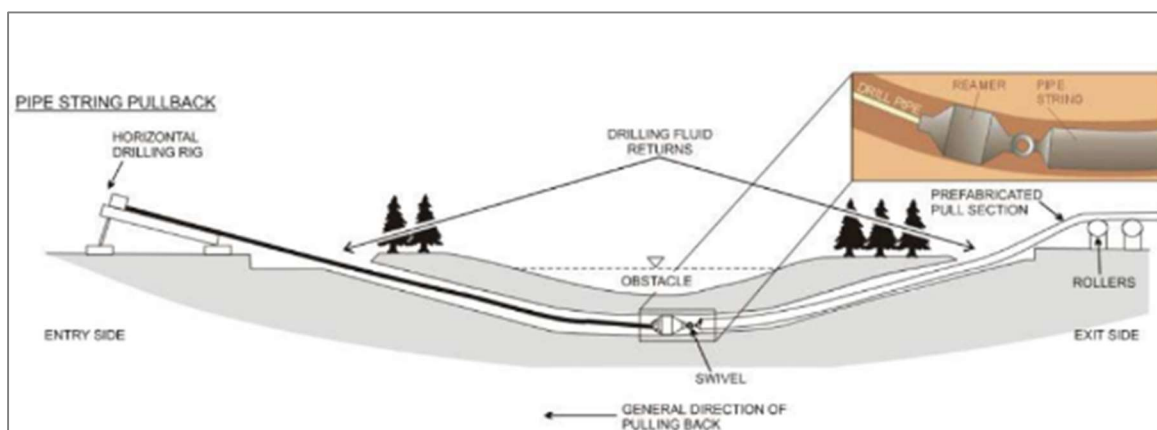


Figure 28 - Typical HDD Installation

10.0 Reinstatement of Private Land

Once all construction works are complete, the work areas will be reinstated with excavated soil and either seeded out with native species, allowed to vegetate naturally or reinstated with excavated grass turves and will be restored to their original condition. This work will be carried out in consultation with the landowner and in line with any relevant measures outlined in the planning application, CEMP and planning conditions.

11.0 Best Practice Design and Construction & Environmental Management Methodology

Prior to commencement of construction works the contractor will draw up detailed Method Statements which will be informed by this Outline Construction Methodology, environmental protection measures included within the EIAR, measures within the CEMP, and the guidance documents and best practice measures listed below. This method statement will be adhered to by the contractors and will be overseen by the Project Manager, Environmental Manager and ECoW where relevant.

The following documents will contribute to the preparation of the method statements in addition to those measures below: -

- Inland Fisheries Ireland (2016) *Guidelines on Protection of Fisheries during Construction Works in and Adjacent to Waters*. Inland Fisheries Ireland, Dublin;
- *National Roads Authority (2008) Guidelines for the Crossing of Watercourses during the Construction of National Road Schemes*. National Roads Authority, Dublin;
- E. Murnane, A. Heap and A. Swain. (2006) *Control of water pollution from linear construction projects*. Technical guidance (C648). CIRIA;
- E. Murnane et al., (2006) *Control of water pollution from linear construction projects*. Site guide (C649). CIRIA.
- Murphy, D. (2004) *Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites*. Eastern Regional Fisheries Board, Dublin;
- H. Masters-Williams et al (2001) *Control of water pollution from construction sites. Guidance for consultants and contractors (C532)*;
- Enterprise Ireland (unknown). *Best Practice Guide (BPGCS005) Oil storage guidelines*;
- Law, C. and D'Aleo, S. (2016) *Environmental good practice on site pocket book*. (C762) 4th edition. CIRIA;
- CIRIA *Environmental Good Practice on Site (fourth edition) (C741) 2015*.

The works will be carried out by employing accepted good work practices during construction, and environmental management measures such as those discussed below. Please note that the following measures will be supplemented by further specific environmental protection measures that will be included in method statements prepared for specific tasks during the works and will form part of the detailed CEMP.

- All materials shall be stored at the temporary compound within the Gortrahilly Wind Farm site and transported to the works zone immediately prior to construction;
- Where drains and watercourses are crossed with underground cables, the release of sediment will be prevented through the implementation of best practice construction methodologies.
- Weather conditions will be considered when planning construction activities to minimise risk of run off from site;
- Provision of 50m exclusion zones and barriers (silt fences) between any excavated material and any surface water features to prevent sediment washing into the receiving water environment;

- If dewatering is required as part of the works e.g. in trenches for underground cabling or in wet areas, water must be treated prior to discharge;
- The contractor shall ensure that silt fences are regularly inspected and maintained during the construction phase;
- If very wet ground must be accessed during the construction process bog mats/aluminium panel tracks will be used to enable access to these areas by machinery. However, works will be scheduled to minimise access requirements during winter months;
- The contractor shall ensure that all personnel working on site are trained in pollution incident control response. A regular review of weather forecasts of heavy rainfall is required, with the Contractor required to prepare a contingency plan for before and after such events;
- The contractor will carry out visual examinations of local watercourses from the works during the construction phase to ensure that sediment is not above baseline conditions. In the unlikely event of water quality concerns, the Environmental Manager and ECoW will be consulted;
- Excavations will be left open for minimal periods to avoid acting as a conduit for surface water flows.
- Only emergency breakdown maintenance will be carried out on site. Emergency procedures and spillage kits will be available and construction staff will be familiar with emergency procedures.
- Appropriate containment facilities will be provided to ensure that any spills from vehicles are contained and removed off site. Adequate stocks of absorbent materials, such as sand or commercially available spill kits shall be available;
- Concrete or potential concrete contaminated water run-off will not be allowed to enter any watercourses. Any pouring of concrete (delivered to site ready mixed) will only be carried out in dry weather. Washout of concrete trucks shall be strictly confined to a designated and controlled wash-out area within the Gortrahilly Wind Farm site; remote from watercourses, drainage channels and other surface water features;
- Entry by plant equipment, machinery, vehicles and construction personnel into watercourses or wet drainage ditches shall not be permitted. All routes used for construction traffic shall be protected against migration of soil or waste water into watercourses;
- Cabins, containers, workshops, plant, materials storage and storage tanks shall not be located near any surface water channels and will be located beyond the 50m hydrological buffer at all times.

12.0 Implementation of Environmental Protection Measures

All environmental protection measures contained with the EIAR and NIS (Natura Impact Statement) which accompanies the planning application will be incorporated into the final CEMP and construction method statements prior to the commencement of development and will be implemented in full during the construction phase. The Project Manager and Site Manager will be responsible for the implementation of measures following consultation with the Environmental Manager and ECoW where necessary.

13.0 Invasive Species Best Practice Measures

Invasive species can be introduced into a location by contaminated plant, machinery, and equipment which were previously used in locations that contained invasive species. Good site organisation and hygiene management shall be maintained always on-site, and best practice measures will be implemented, as follows:

- The contractor will prepare an Invasive Species Action Plan to be implemented during construction, and all personnel will be made aware of the requirements contained within;
- Plant and machinery will be inspected upon arrival and departure from the site and cleaned/washed as necessary to prevent the spread of invasive aquatic/ riparian species such as Japanese knotweed *Fallopia japonica* and Himalayan Balsam *Impatiens glandulifera*. A sign off sheet will be maintained by the contractor to confirm the implementation of measures;
- Site hygiene signage will be erected in relation to the management of non-native invasive material.

14.0 Waste Management

All waste products (general waste, plastic, timber, etc.) arising during the construction phase will be managed and disposed of in accordance with the provisions of the Waste Management Act 1996 and associated amendments and regulations, and a Waste Management Plan will be prepared by the contractor before the commencement of construction. All waste material will be disposed of at a fully licensed facility.

15.0 Archaeology

The following are the mitigation measures which will be carried out during construction where required;

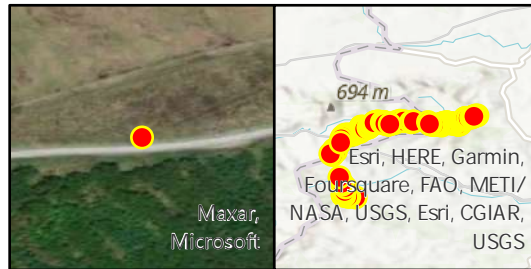
- Any specific mitigation measures outlined in the Cultural Heritage Report will be adopted.
- If required a project archaeologist will be appointed to oversee the project.
- Demarcation of protective buffer zones around cultural heritage sites where there is a potential for disturbance during the construction phase and inclusion of the same in site induction.

16.0 Programme

Estimates for the duration of the construction works are included in the table below. Please note that some of the elements are likely to happen concurrently, therefore the overall start-to-finish duration is estimated to be twelve months.

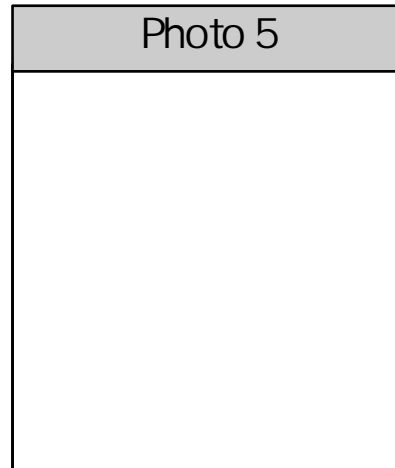
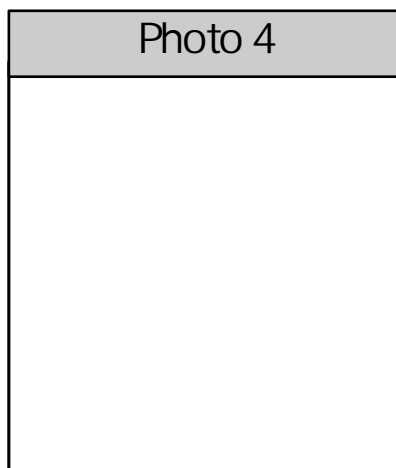
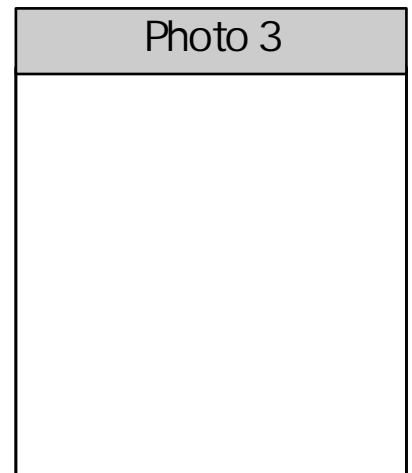
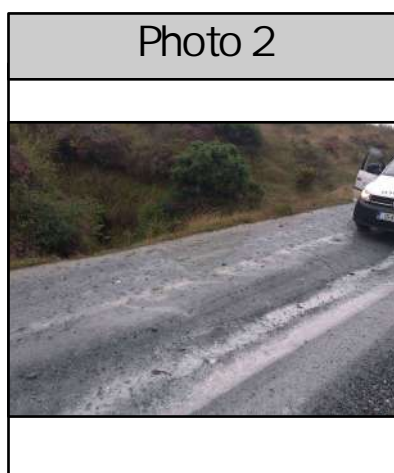
Table 3: Estimated Construction Duration	
Development Element	Estimated Construction Duration
Gortrahilly Wind Farm & Substation	12 months
Cable route (not including HDD)	12 months
HDD	6 weeks

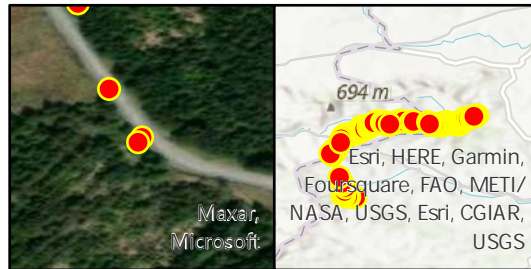
Table 3 - Estimated Construction Duration



Survey Feature	Culvert
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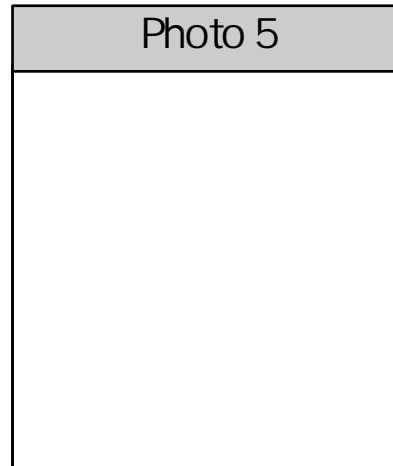
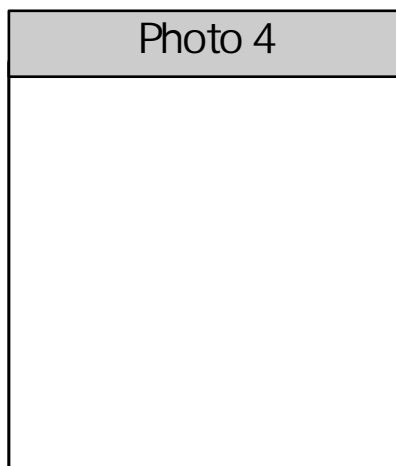
Survey Notes	
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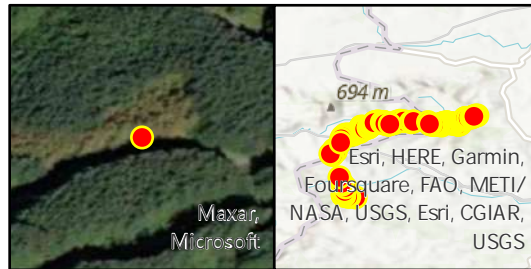




Survey Feature	Culvert
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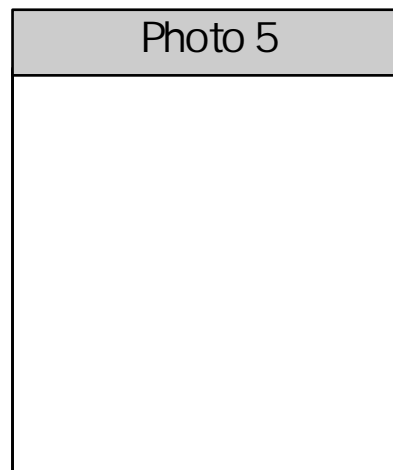
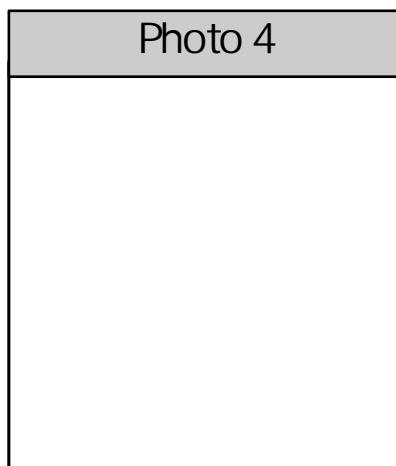
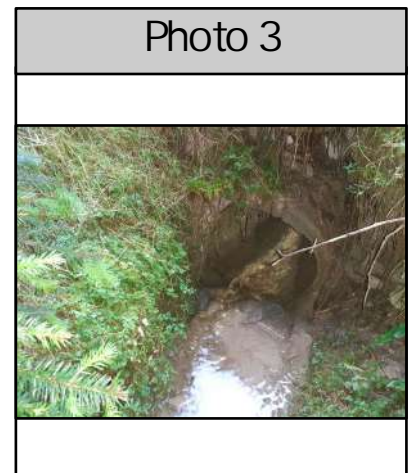
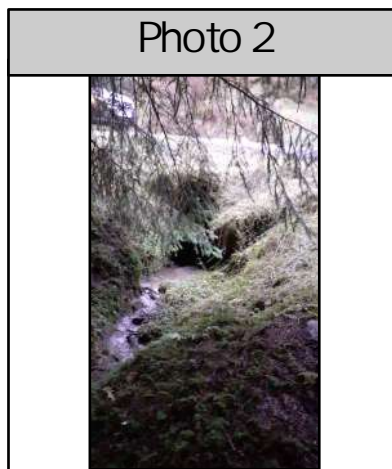
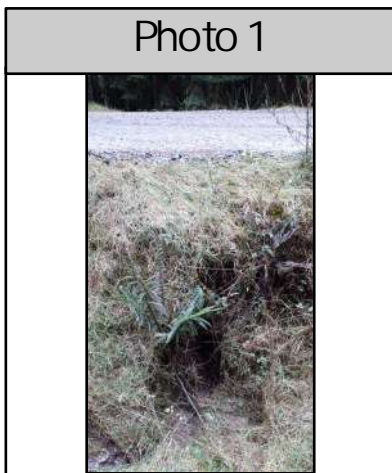
Survey Notes	
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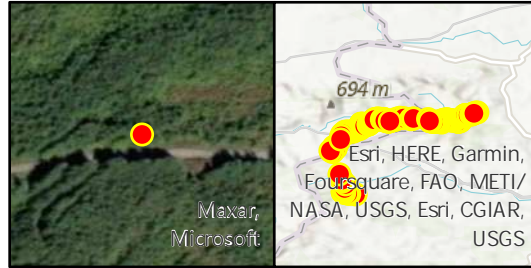




Survey Feature	Culvert - Undercrossing
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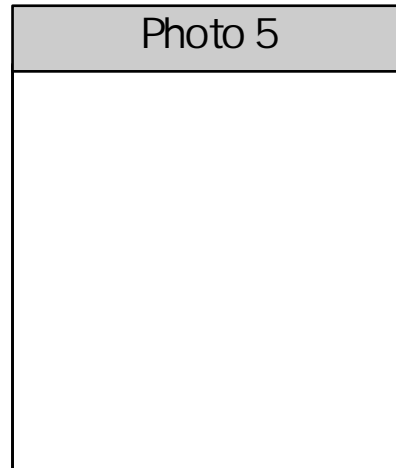
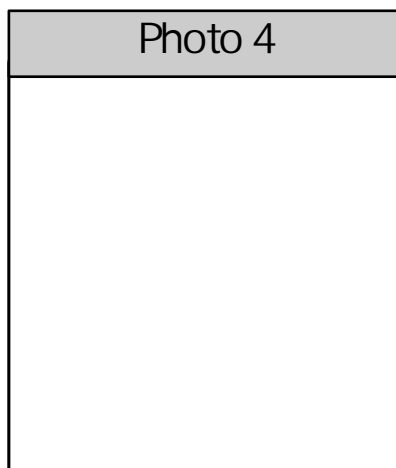
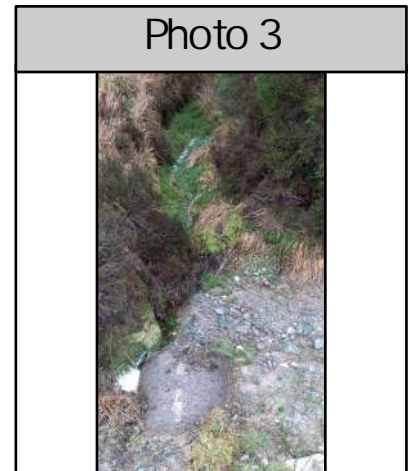
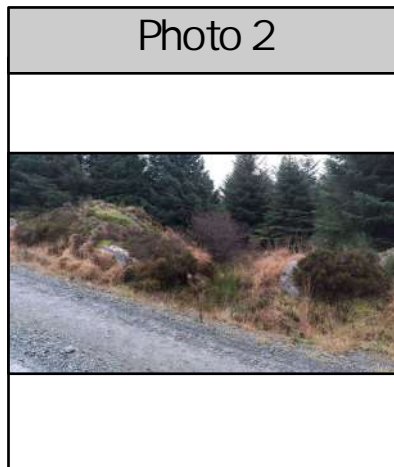
Survey Notes	400 mm concrete pipe 900mm cover flow away from SAC
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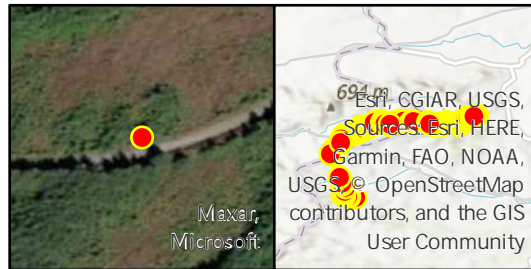




Survey Feature	Culvert - Undercrossing
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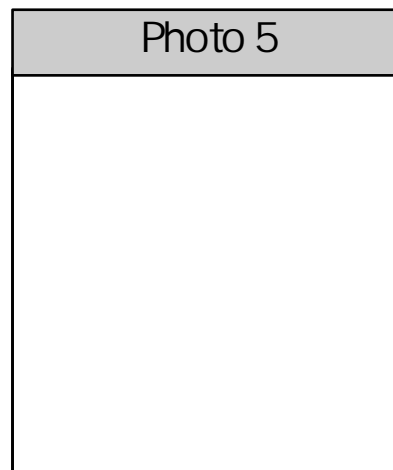
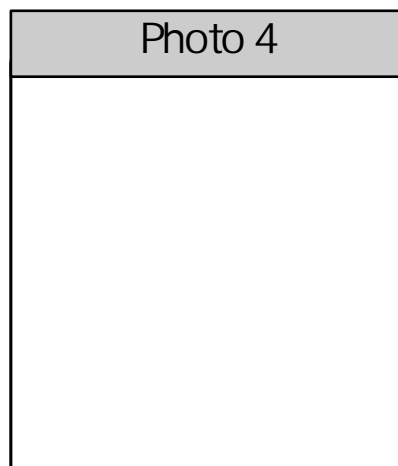
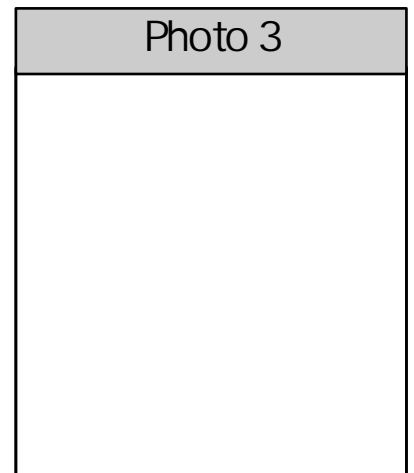
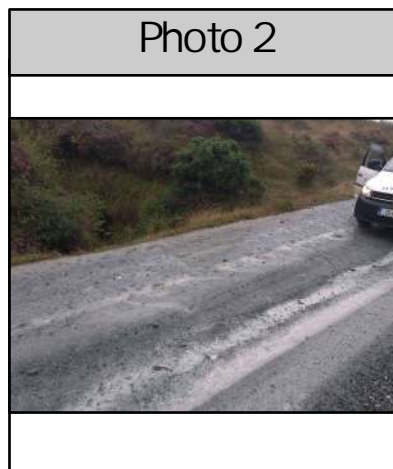
Survey Notes	600mm conc pipe 600 cover f ow away from SAC
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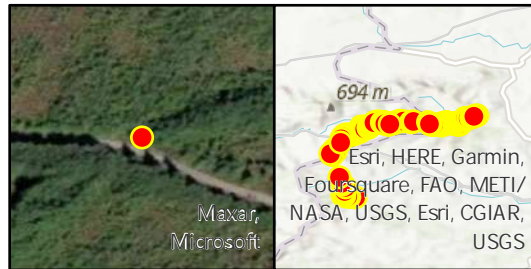




Survey Feature	Culvert - Undercrossing
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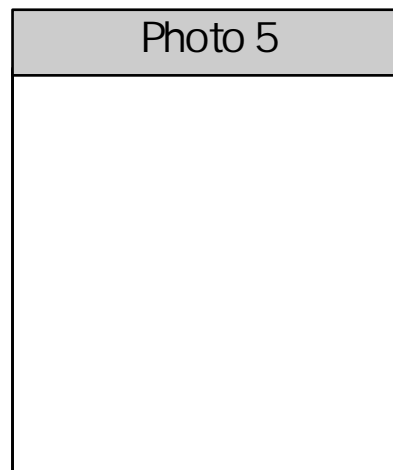
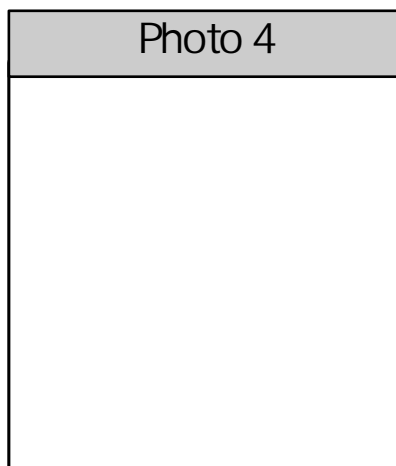
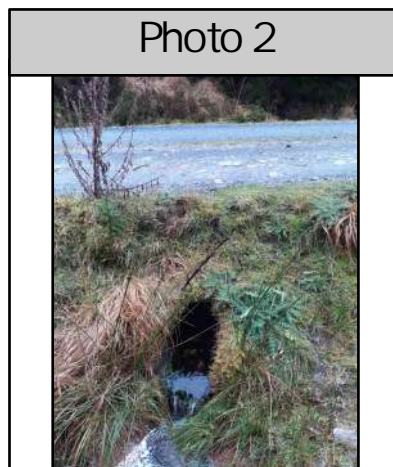
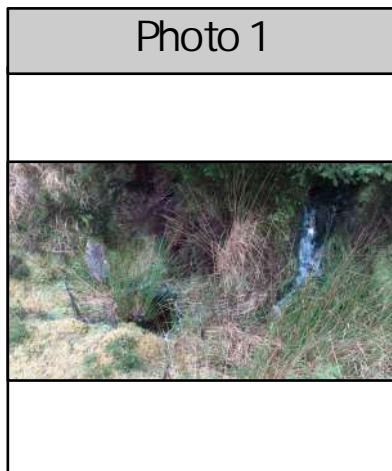
Survey Notes	600mm concrete pipe 900mm cover flowing away from SAC
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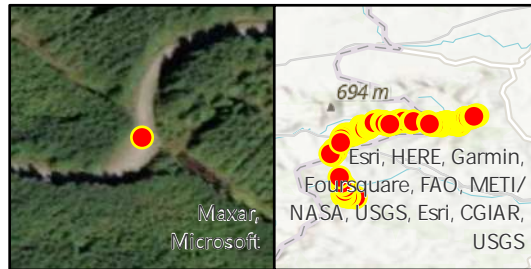




Survey Feature	Culvert - Undercrossing
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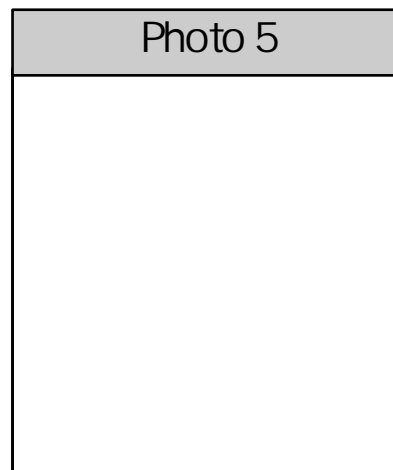
Survey Notes	600mm concrete pipe 400mm cover fast flow large volume flowing away
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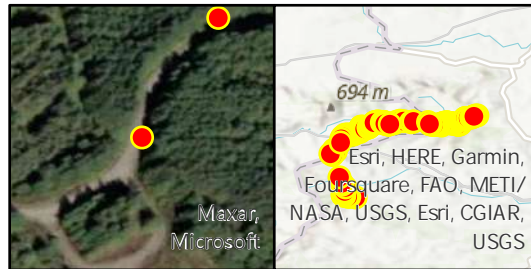




Survey Feature	Culvert - Undercrossing
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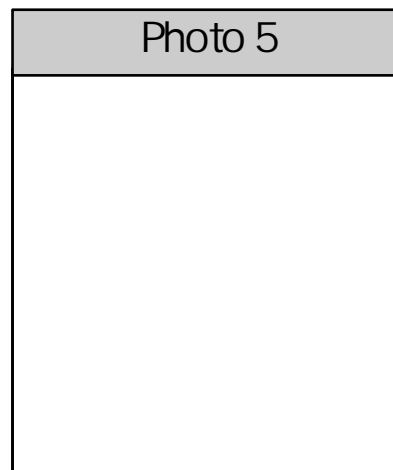
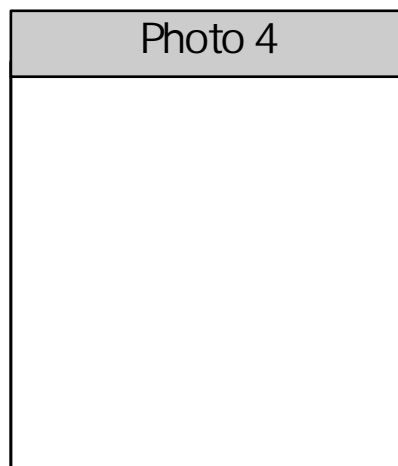
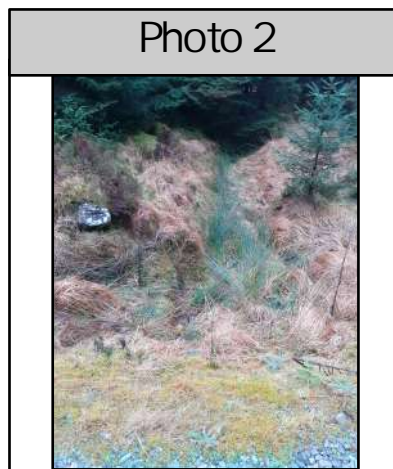
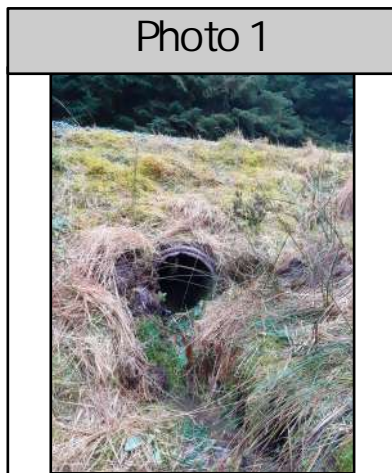
Survey Notes	600mm concrete pipe 1000mm cover flowing towards SAC
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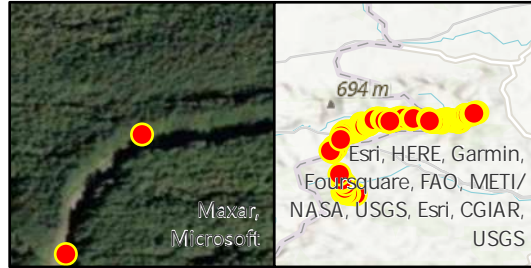




Survey Feature	Culvert - Undercrossing
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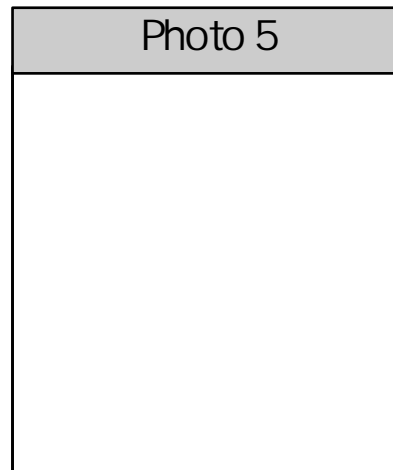
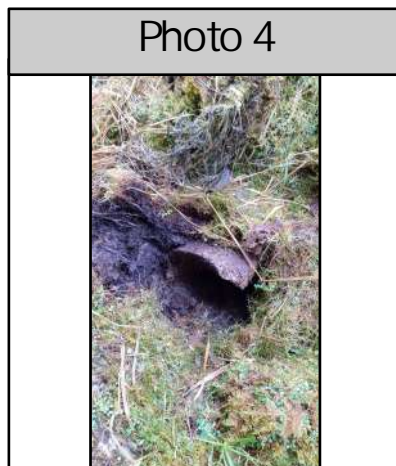
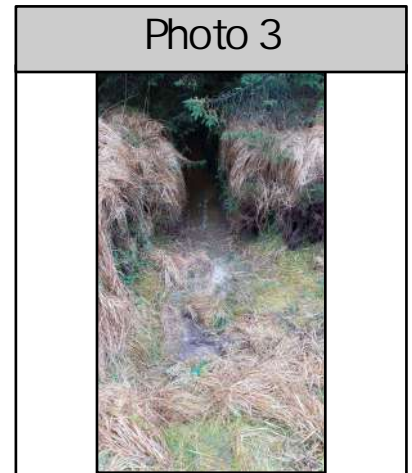
Survey Notes	600mm concrete pipe 700mm cover flowing towards SAC
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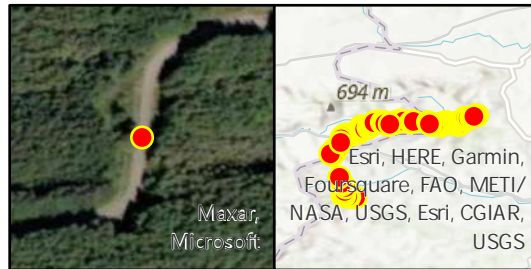




Survey Feature	Culvert - Undercrossing
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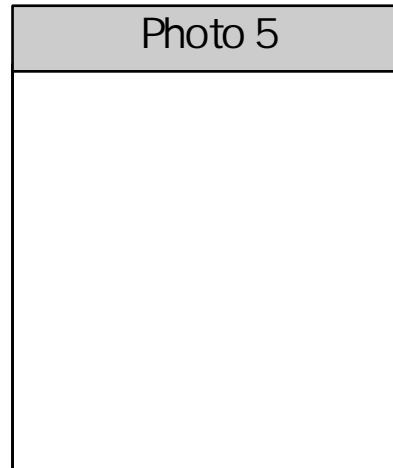
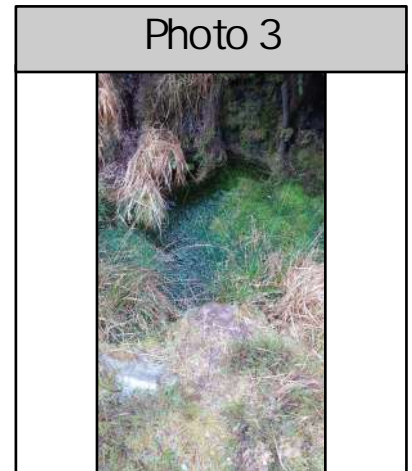
Survey Notes	400mm concrete pipe, 600mm cover, flowing to SAC
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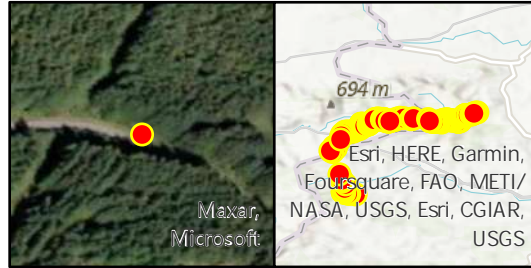




Survey Feature	Culvert - Undercrossing
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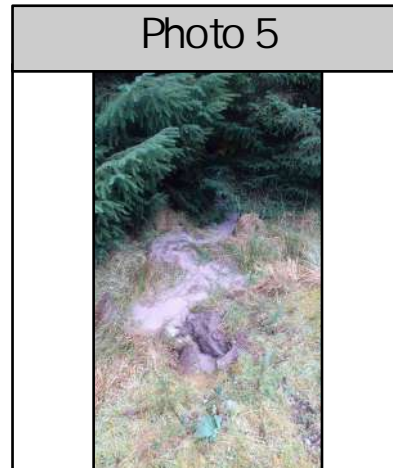
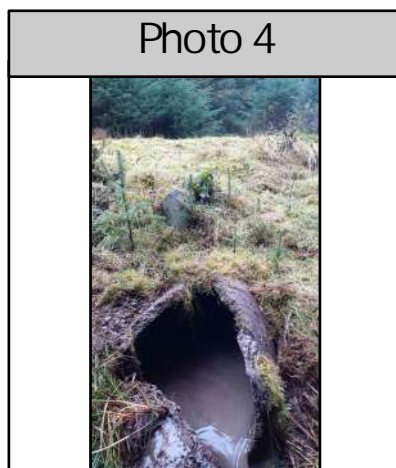
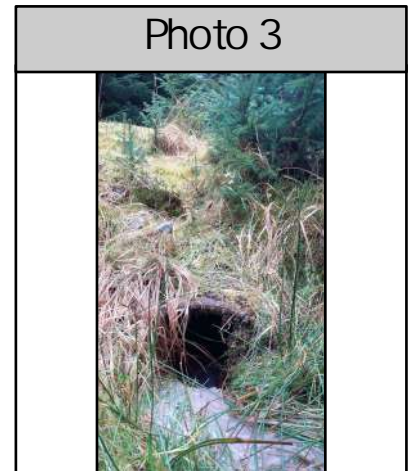
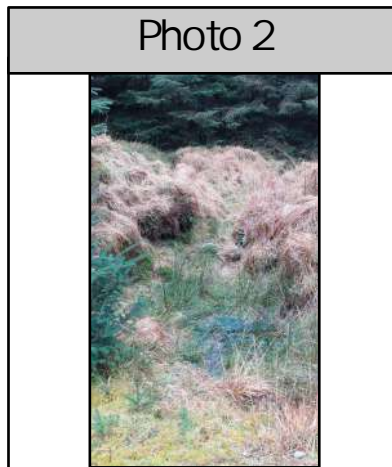
Survey Notes	600mm concrete pipe 600mm cover
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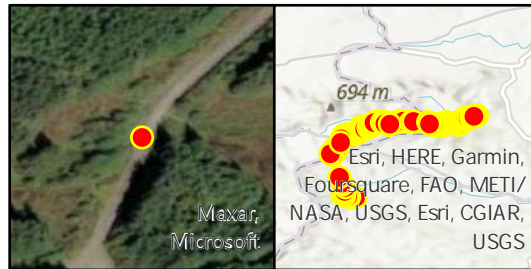




Survey Feature	Culvert - Undercrossing
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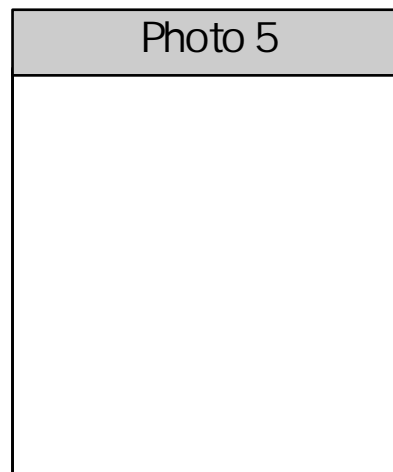
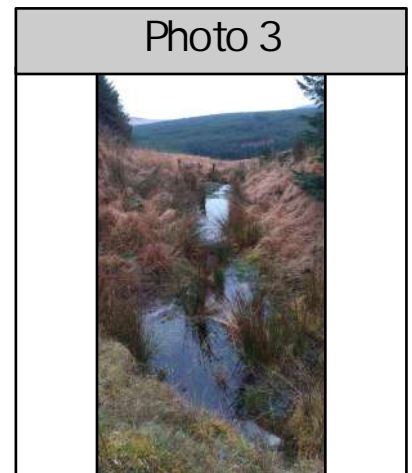
Survey Notes	600mm concrete pipe 600mm cover 45 degrees road crossing high flow towards speed
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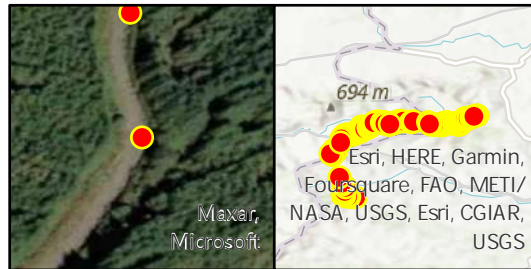




Survey Feature	Culvert - Undercrossing
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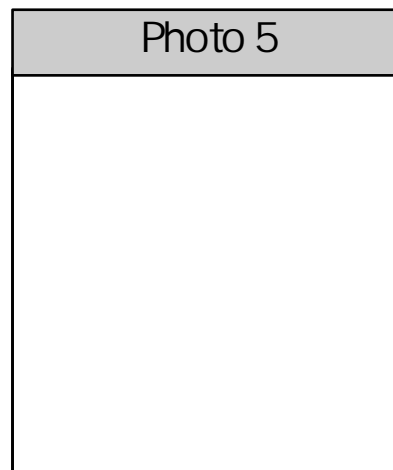
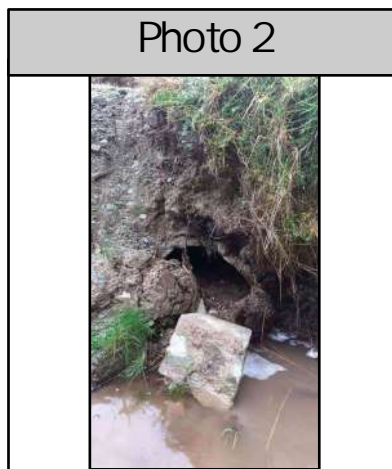
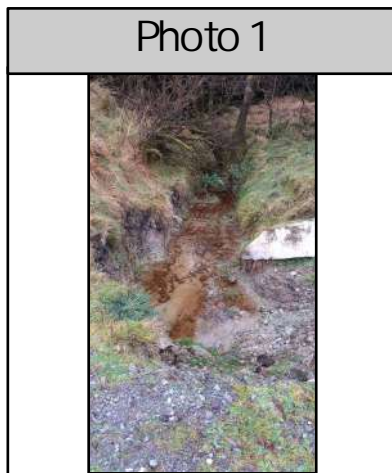
Survey Notes	800mm concrete pipe 1000mm cover culvert at 45 degree culvert crossing flowing towards SAC
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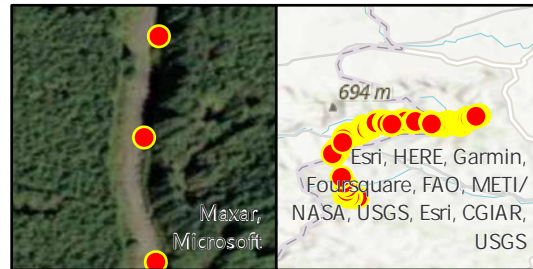




Survey Feature	Culvert - Undercrossing
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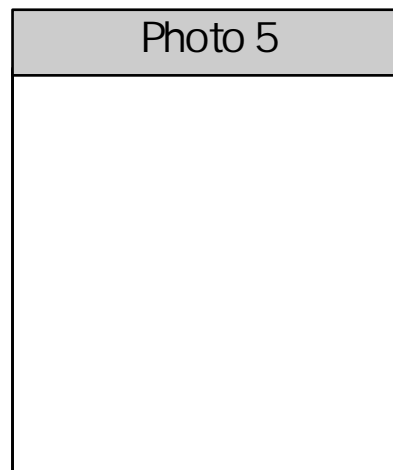
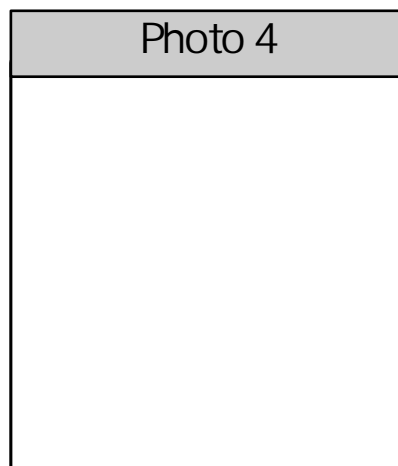
Survey Notes	600mm concrete pipe 500mm cover
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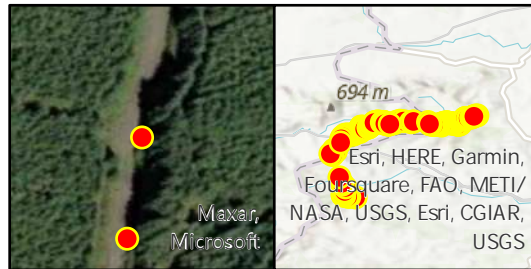




Survey Feature	Culvert - Undercrossing
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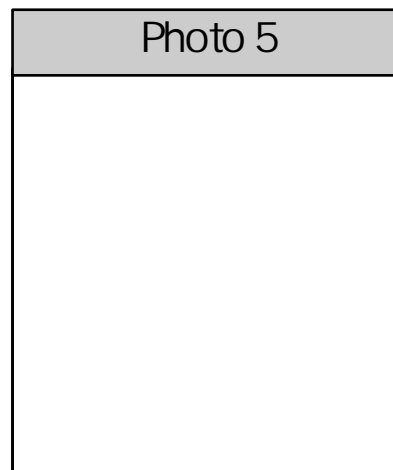
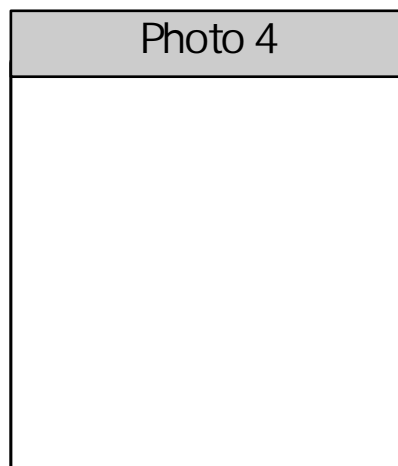
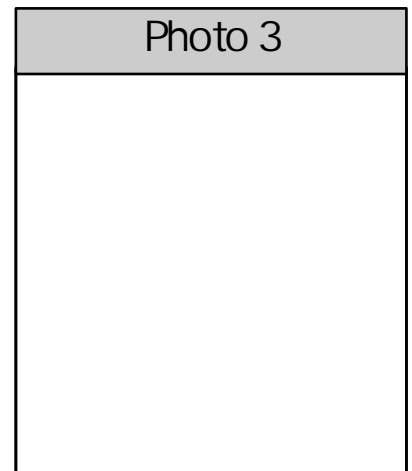
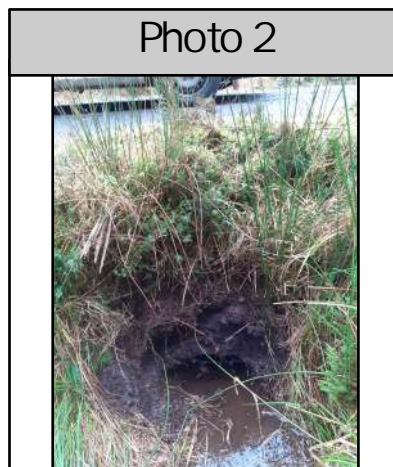
Survey Notes	600mm concrete pipe 550mm cover flowing towards SAC
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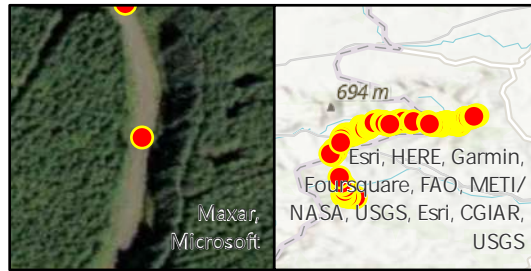




Survey Feature	Culvert - Undercrossing
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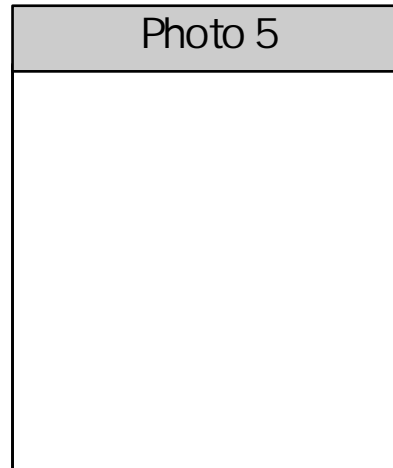
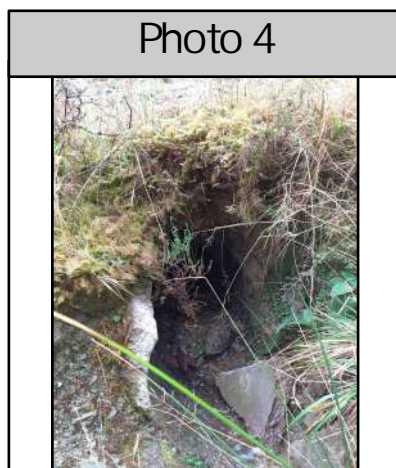
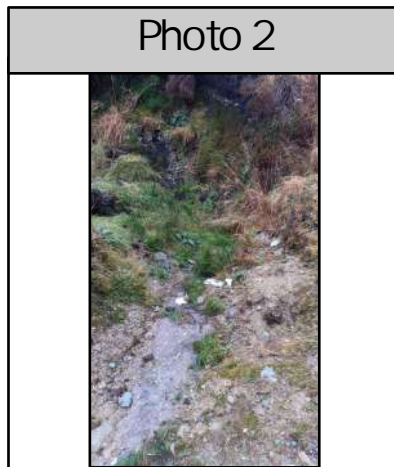
Survey Notes	600mm concrete pipe 550mm cover flowing towards SAC
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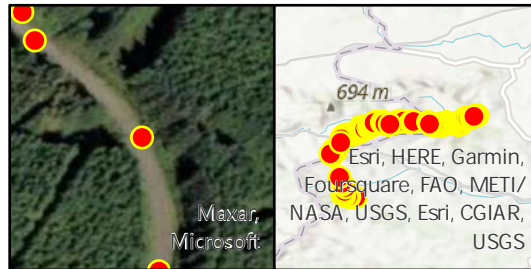




Survey Feature	Culvert - Undercrossing
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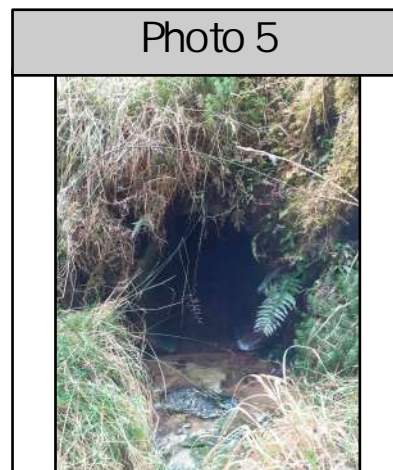
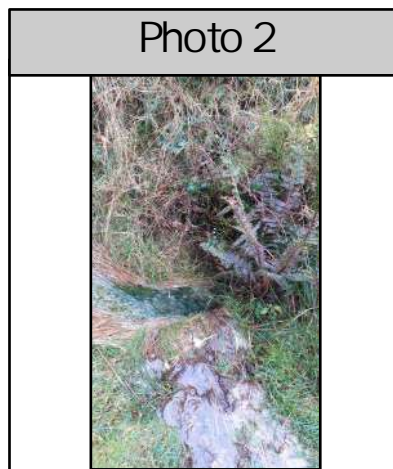
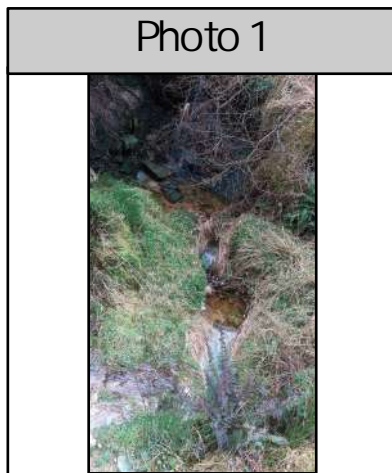
Survey Notes	600mm concrete pipe 500mm cover flowing towards SAC
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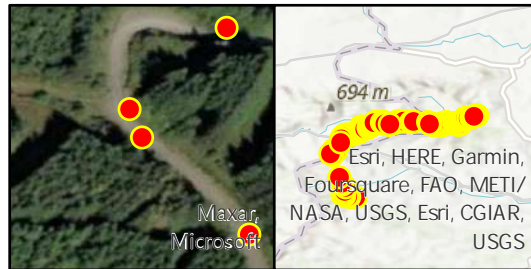




Survey Feature	Culvert - Undercrossing
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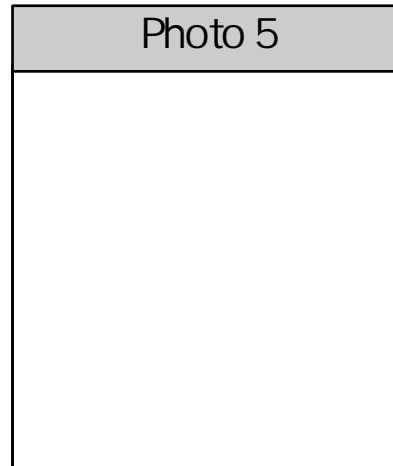
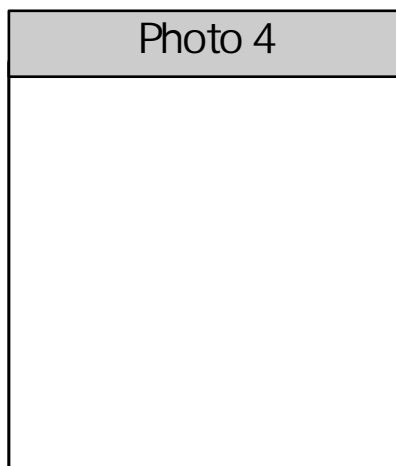
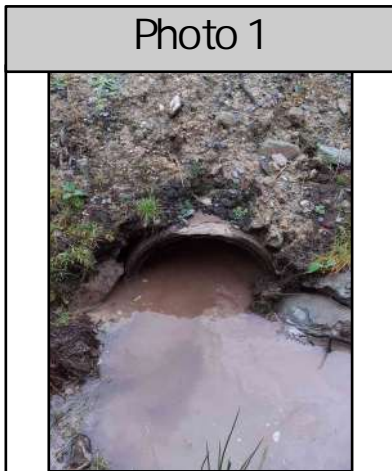
Survey Notes	700mm concrete pipe 800mm cover flowing towards SAC
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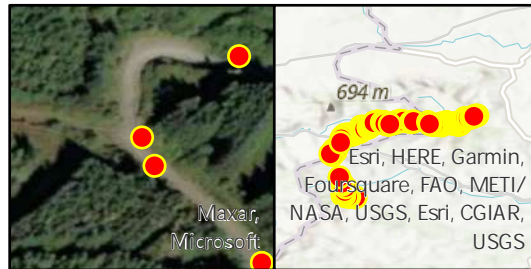




Survey Feature	Culvert - Undercrossing
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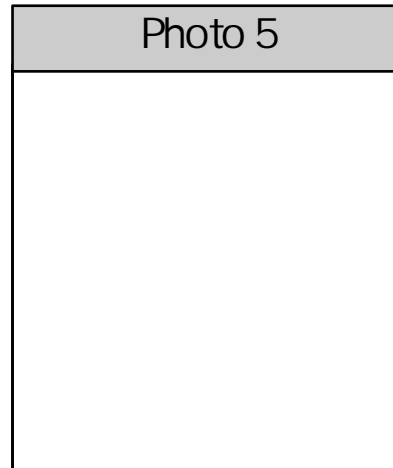
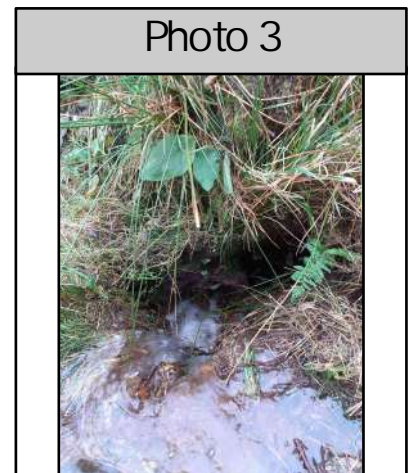
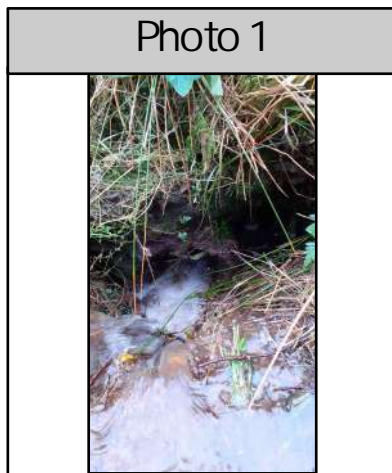
Survey Notes	700mm concrete pipe 400mm cover flowing towards SAC
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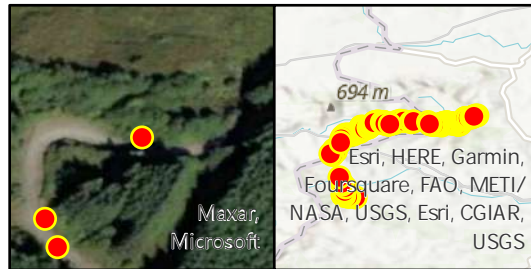




Survey Feature	Culvert - Undercrossing
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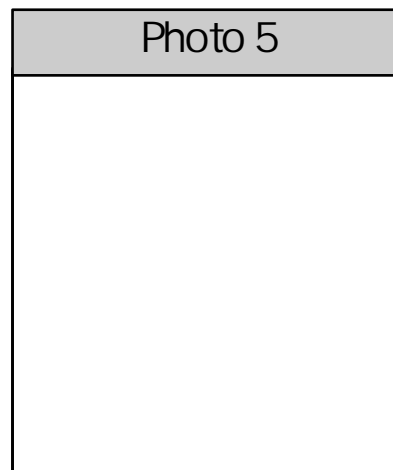
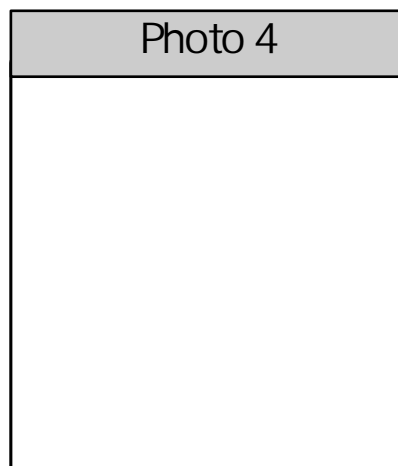
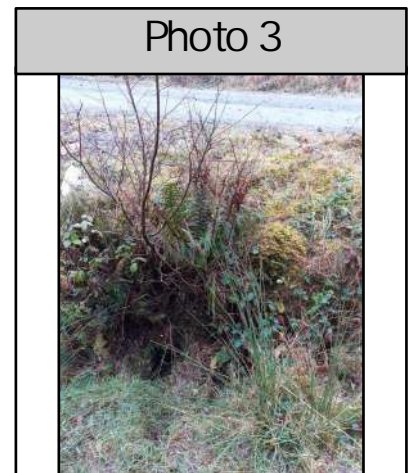
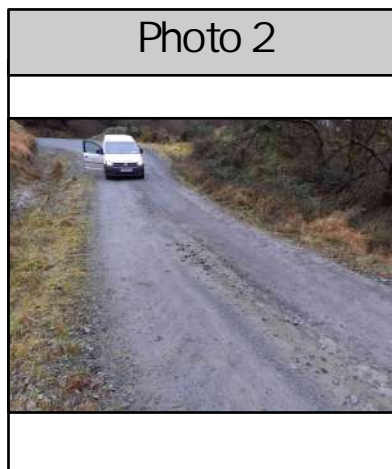
Survey Notes	400mm concrete pipe 450mm cover high volume
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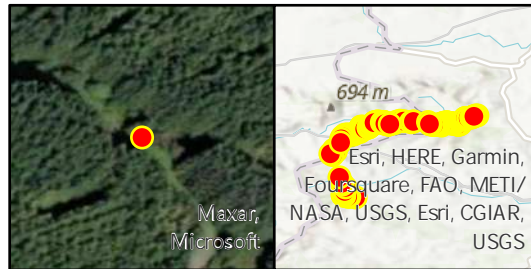




Survey Feature	Culvert - Undercrossing
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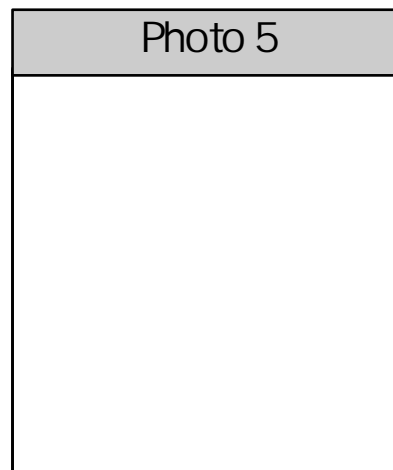
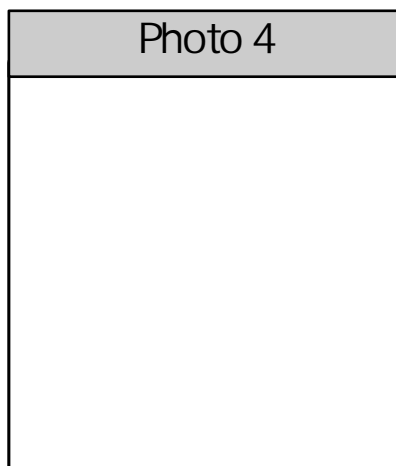
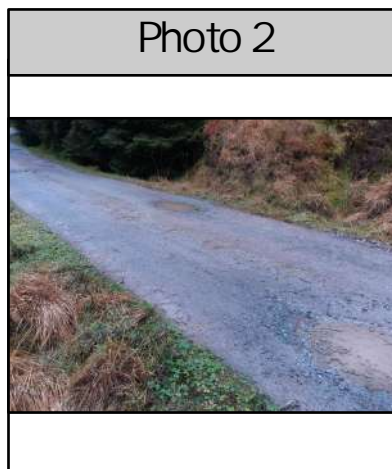
Survey Notes	600mm concrete pipe 1200mm cover high flow towards SAC
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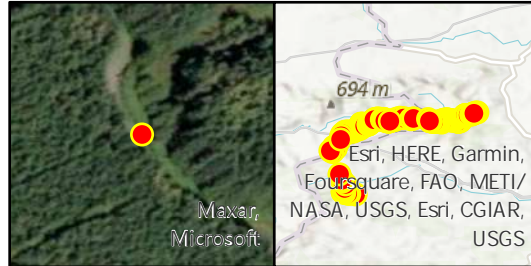




Survey Feature	Culvert - Undercrossing
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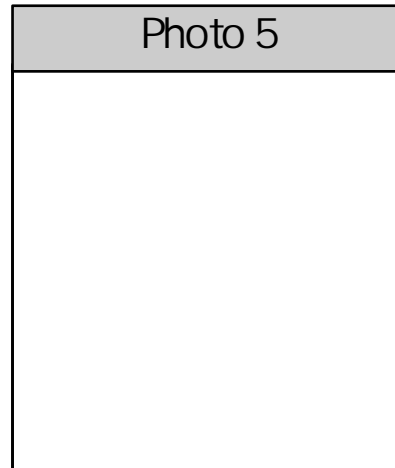
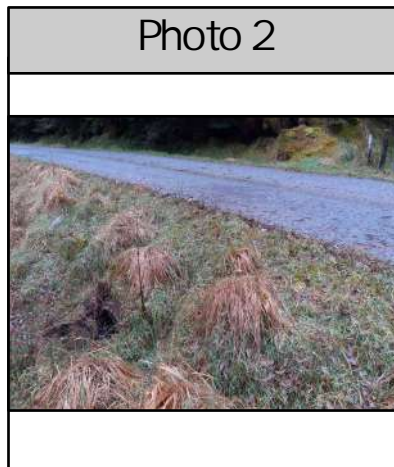
Survey Notes	300mm concrete pipe 700mm cover
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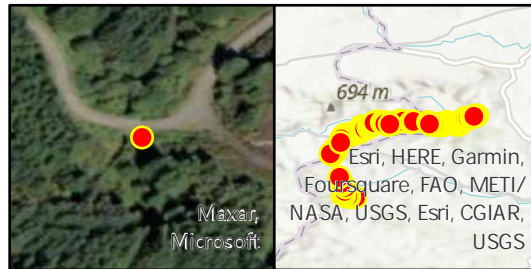




Survey Feature	Culvert - Undercrossing
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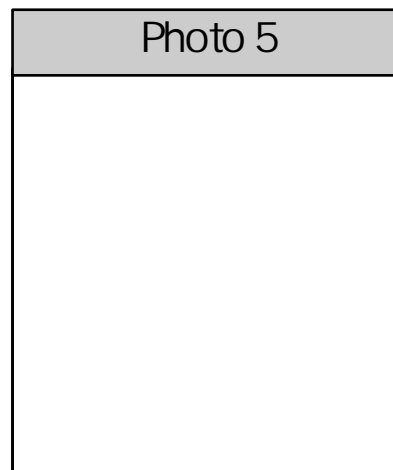
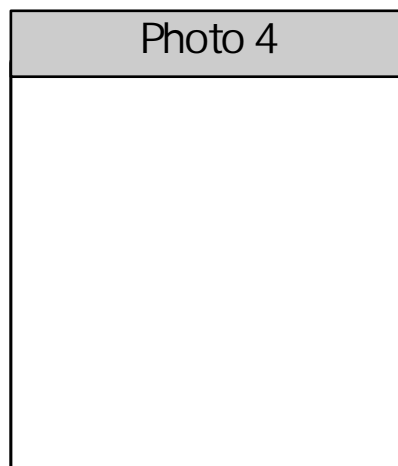
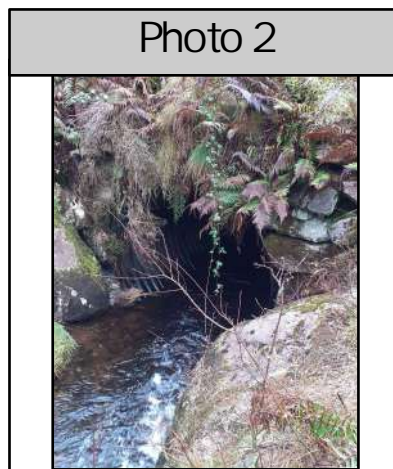
Survey Notes	600 conc pipe 700 cover high flow away from SAC
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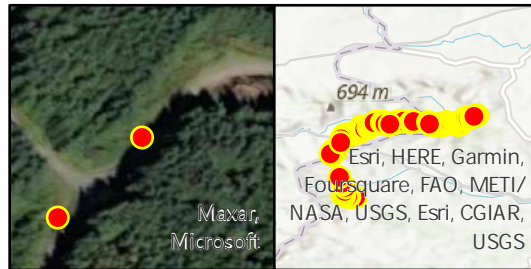




Survey Feature	Culvert - Overcrossing
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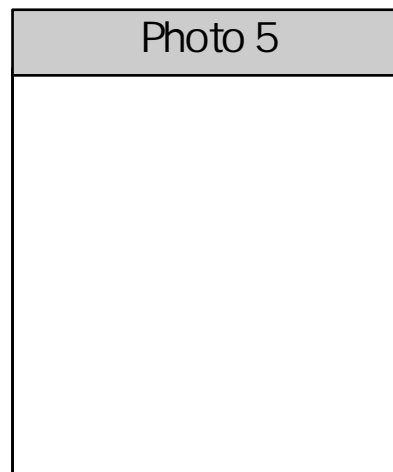
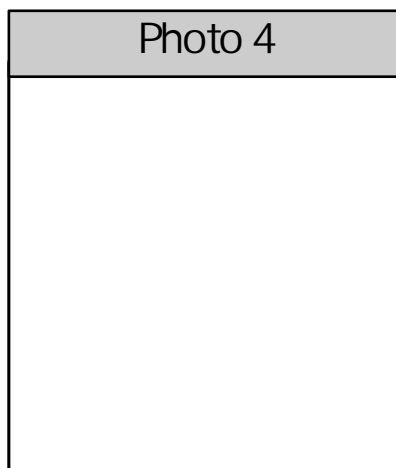
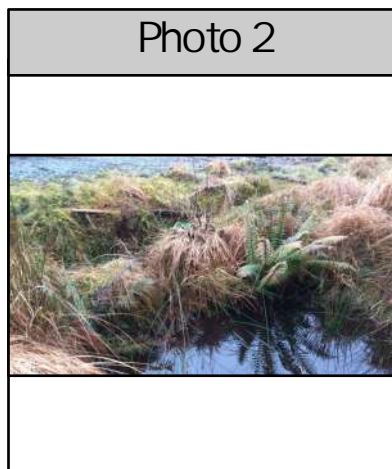
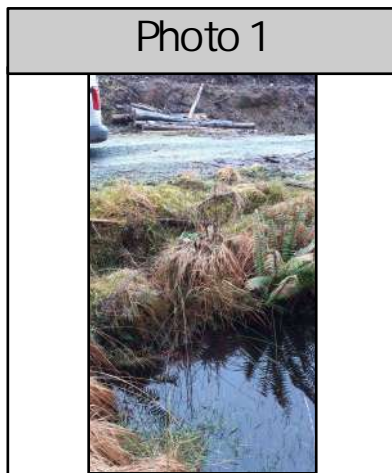
Survey Notes	1500mm twin wall 1500mm cover big flow
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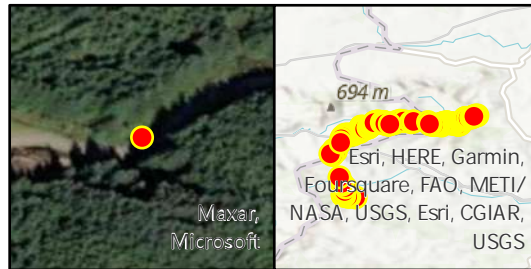




Survey Feature	Culvert - Undercrossing
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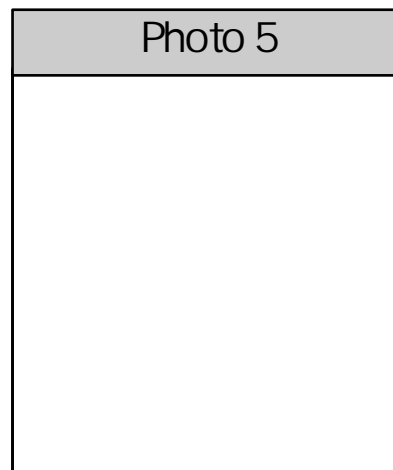
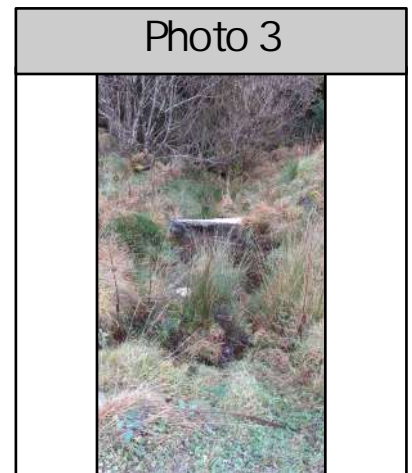
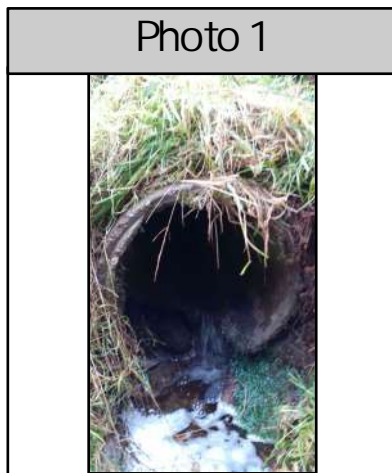
Survey Notes	Stone Drain, 700mm cover [Pump and Dam]
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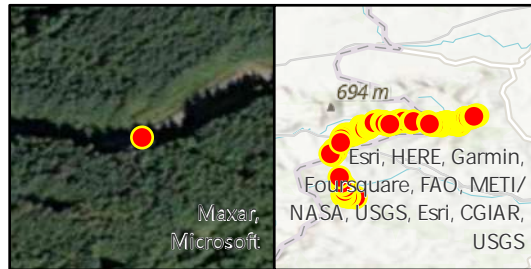




Survey Feature	Culvert - Undercrossing
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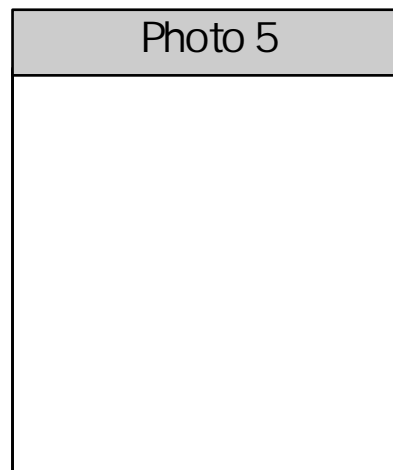
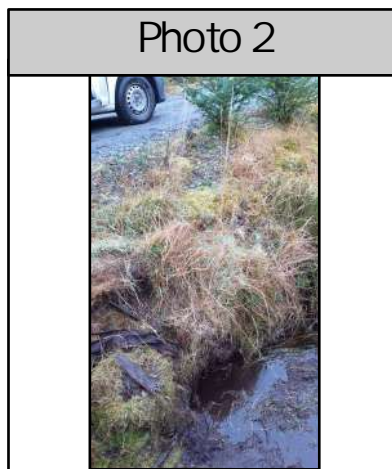
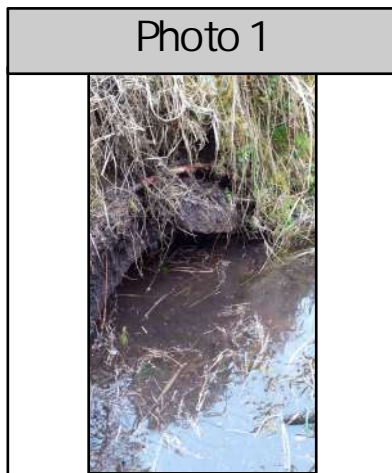
Survey Notes	500mm concrete pipe 800mm cover
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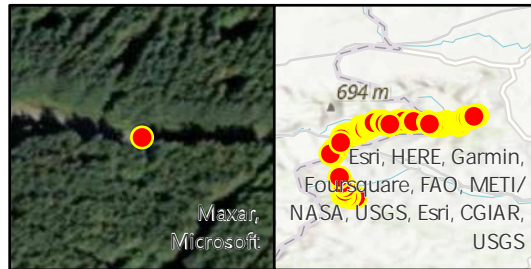




Survey Feature	Culvert - Undercrossing
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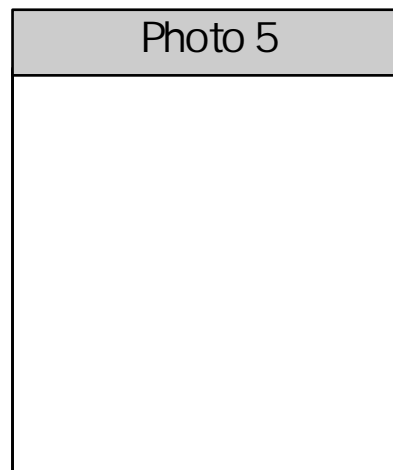
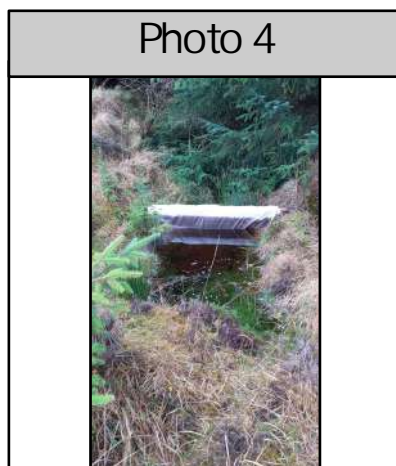
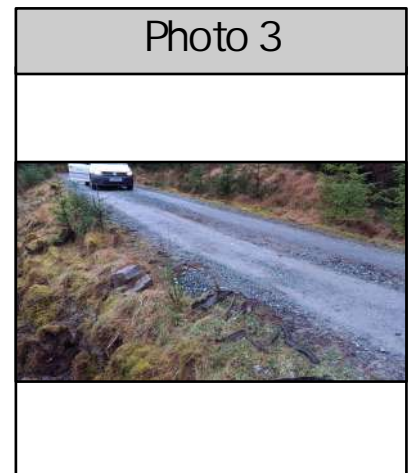
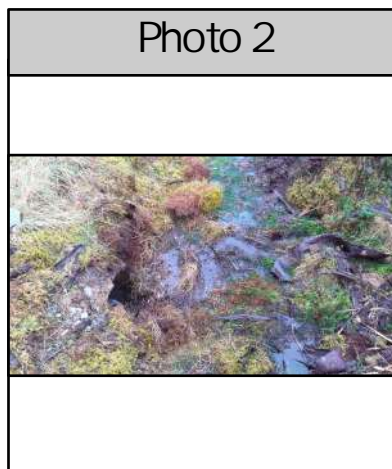
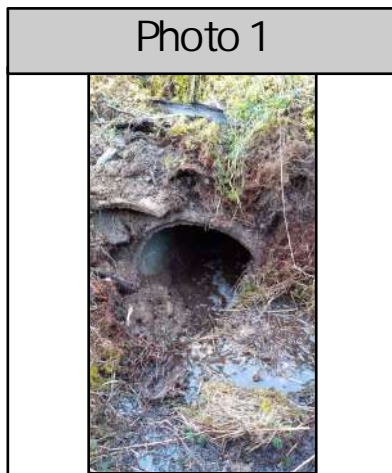
Survey Notes	500mm concrete pipe 700mm cover
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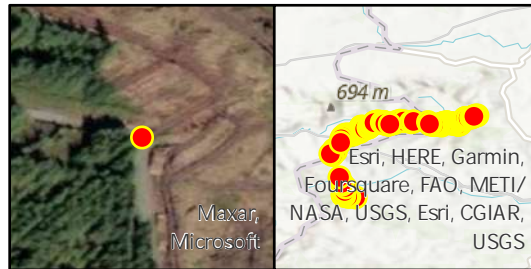




Survey Feature	Culvert - Undercrossing
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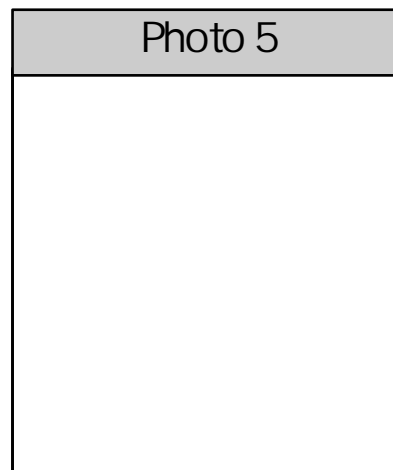
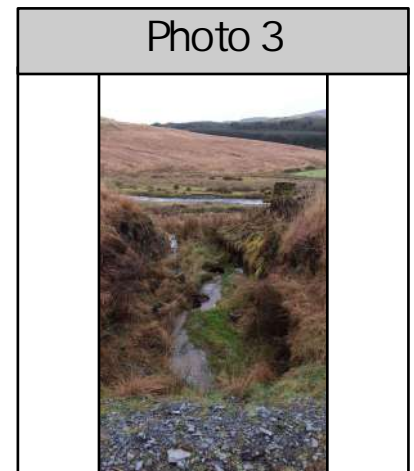
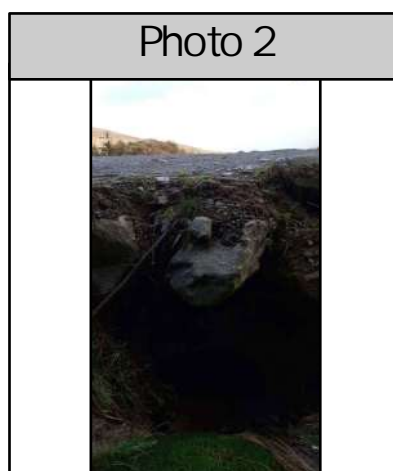
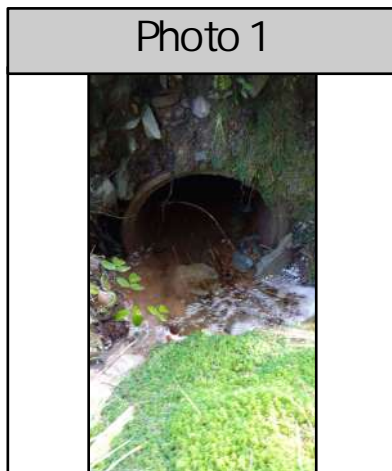
Survey Notes	500mm concrete pipe 600mm cover
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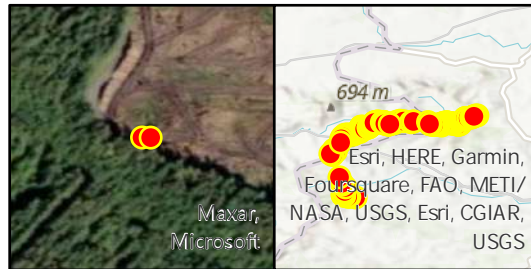




Survey Feature	Culvert - Undercrossing
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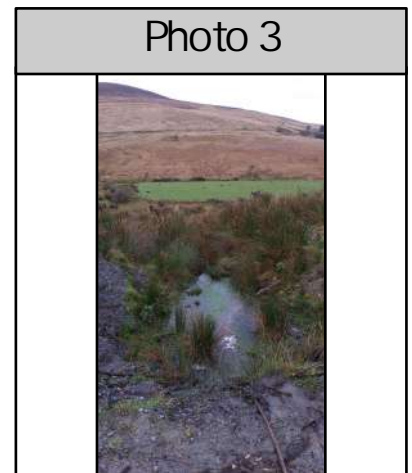
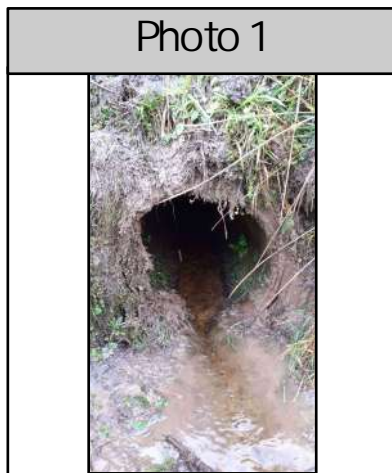
Survey Notes	700mm concrete pipe, 1100mm cover high flow
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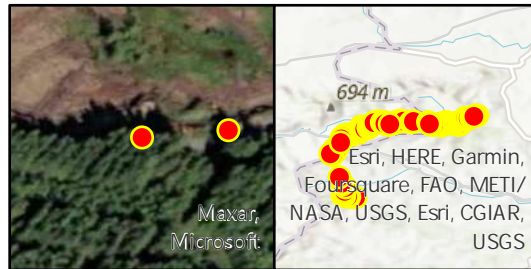




Survey Feature	Culvert - Undercrossing
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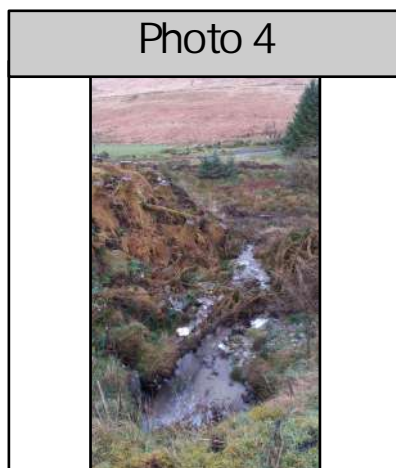
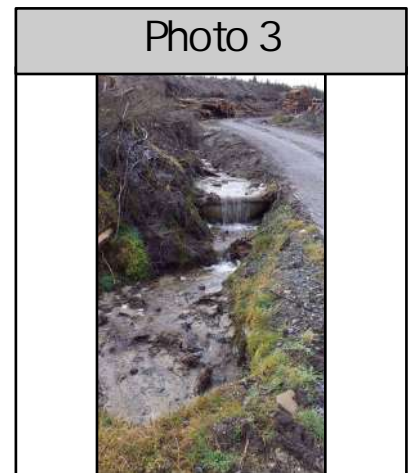
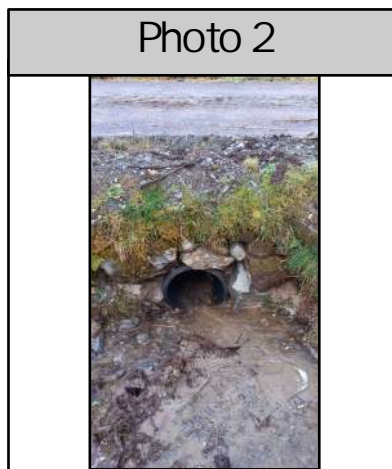
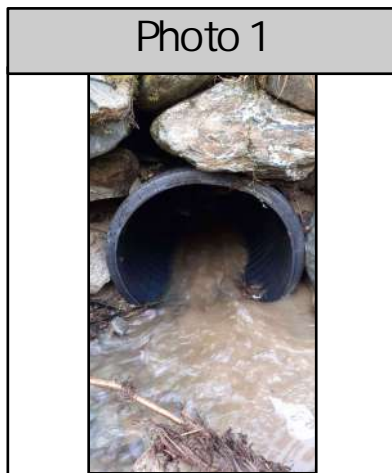
Survey Notes	400mn concrete pipe 1100mm cover,
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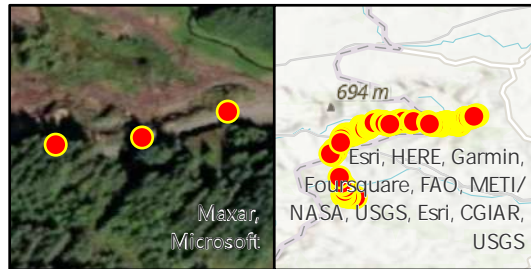




Survey Feature	Culvert - Undercrossing
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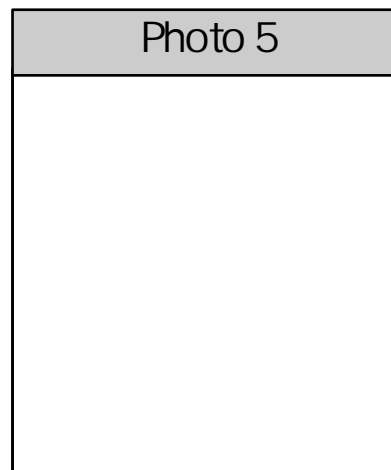
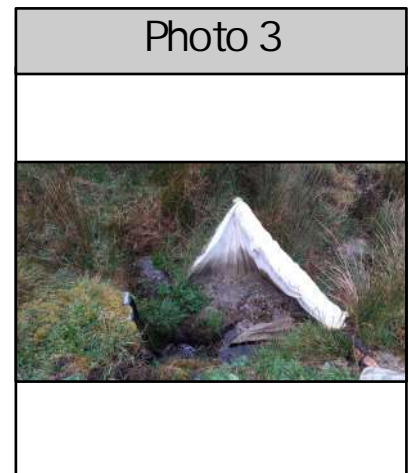
Survey Notes	600mm twinwall pipe, 700mm cover... lots of water
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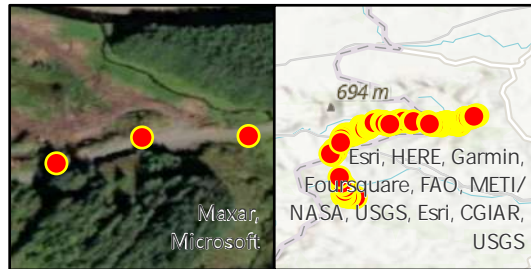




Survey Feature	Culvert - Undercrossing
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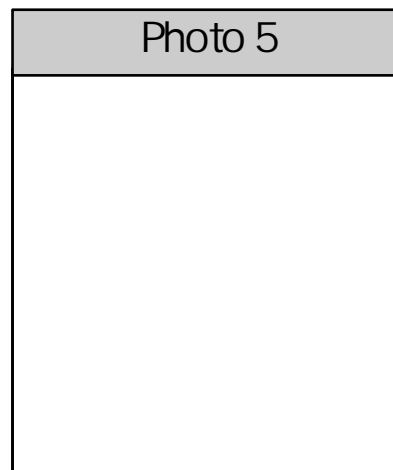
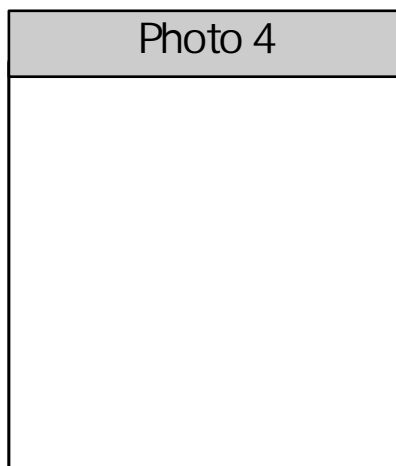
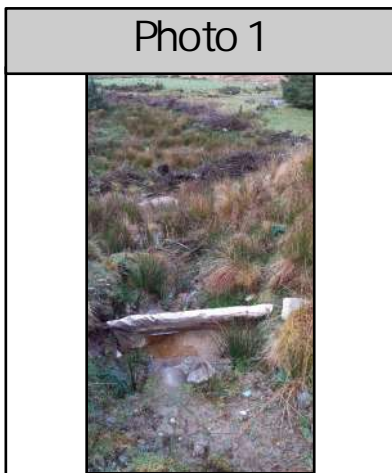
Survey Notes	600mm Twinwall, 800mm cover
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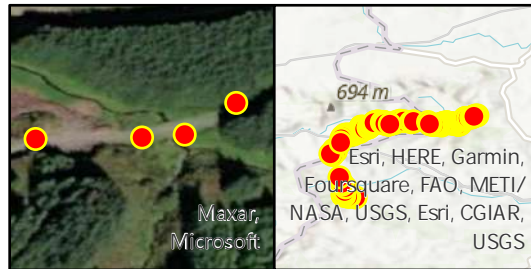




Survey Feature	Culvert - Undercrossing
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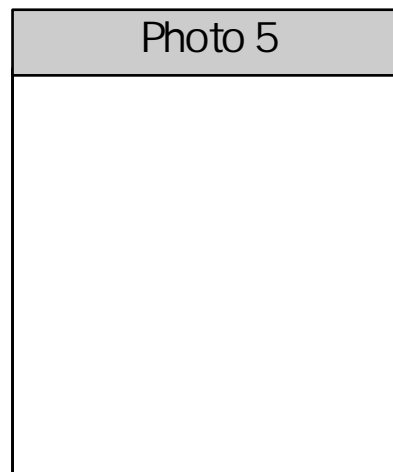
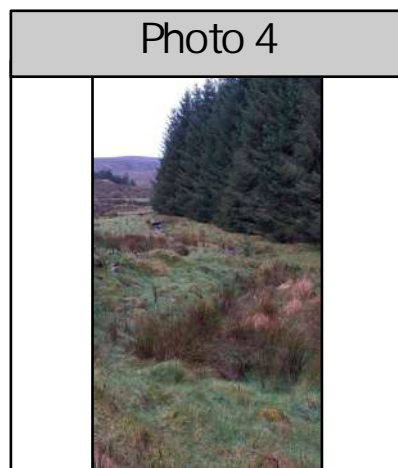
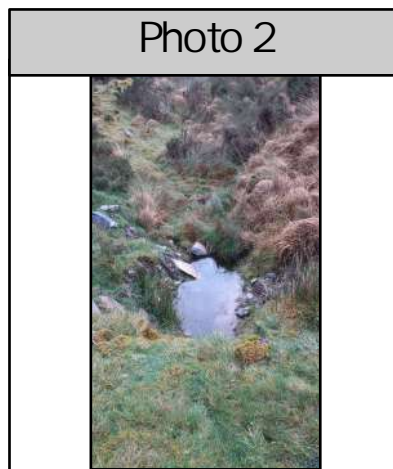
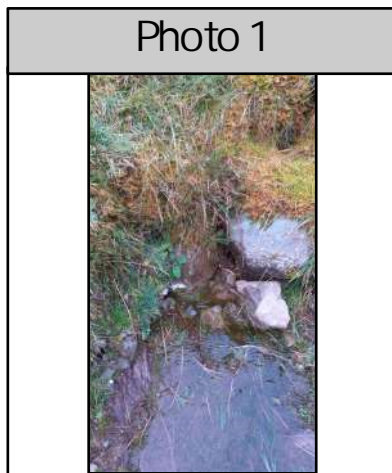
Survey Notes	400mm conc pipe 1000mm cover
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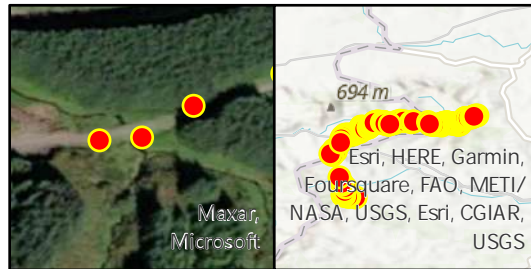




Survey Feature	Culvert - Undercrossing
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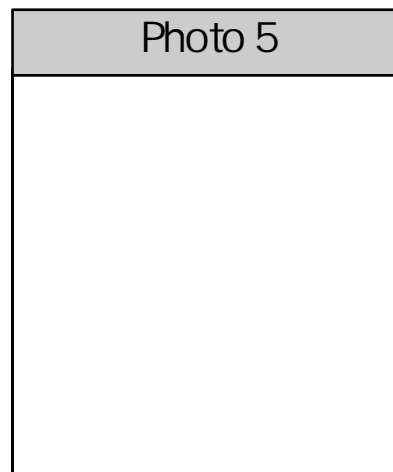
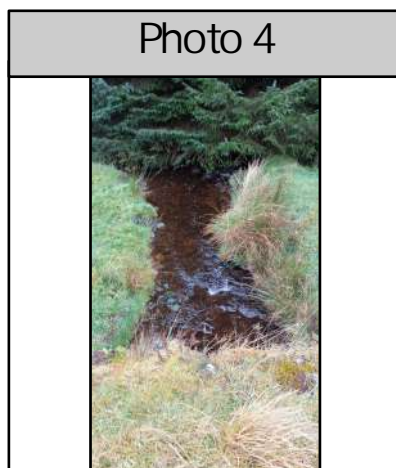
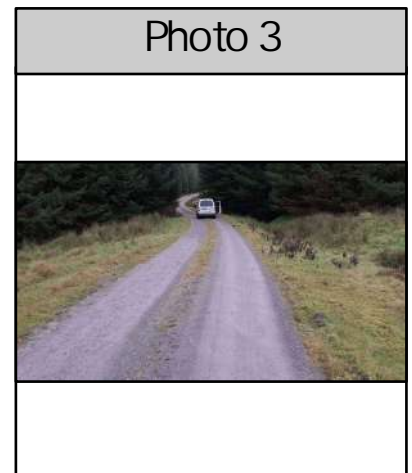
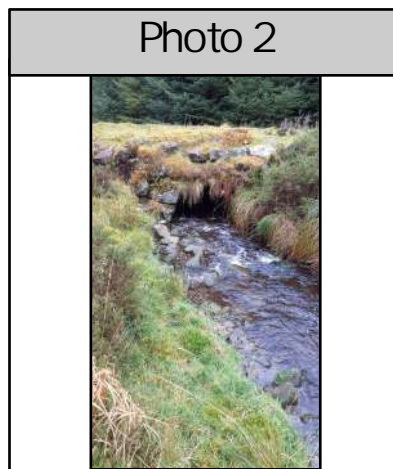
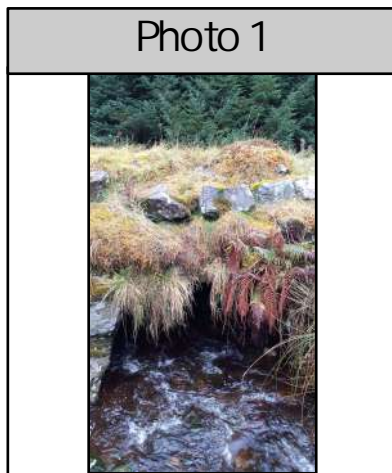
Survey Notes	Stone Drain 1000mm cover [Pump and Dam]
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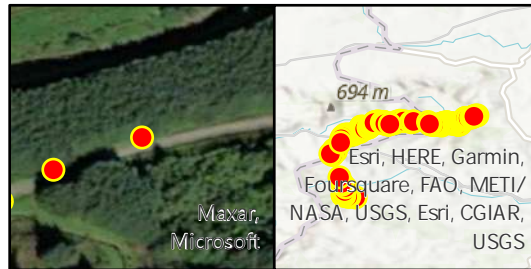




Survey Feature	Culvert - Overcrossing
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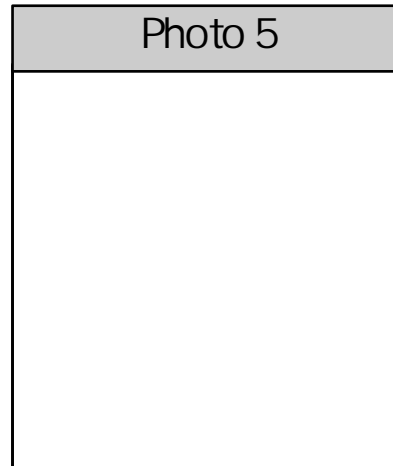
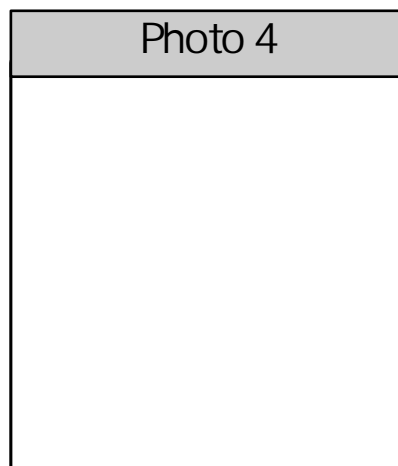
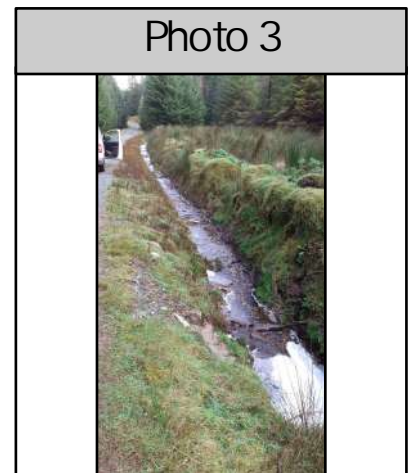
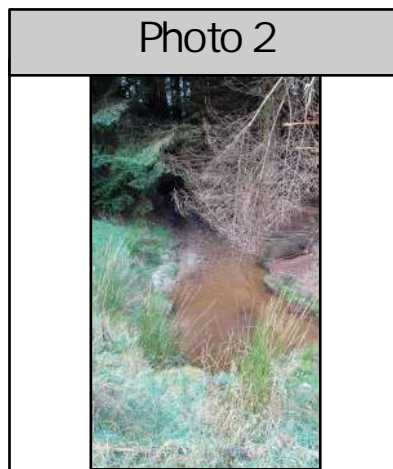
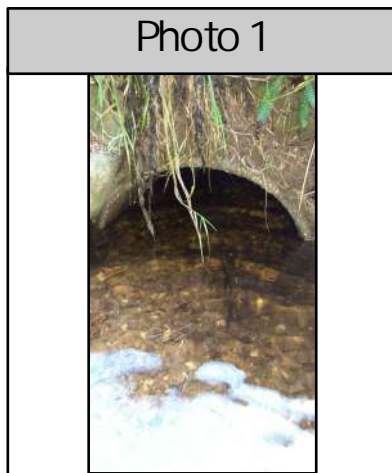
Survey Notes	1200 twin wall 1500mm cover, considerable flow
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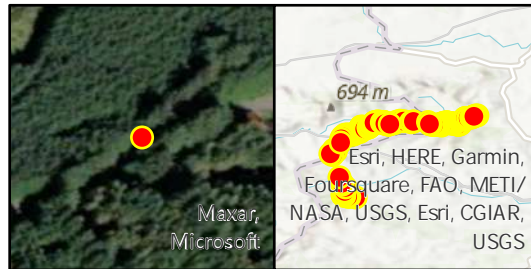




Survey Feature	Culvert - Undercrossing
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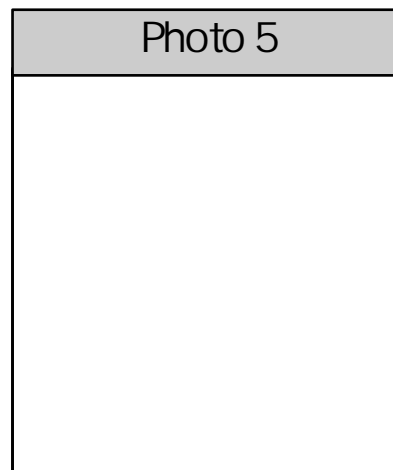
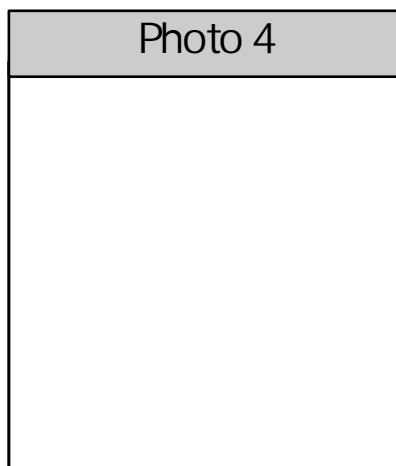
Survey Notes	500mm concrete pipe, 600mm cover
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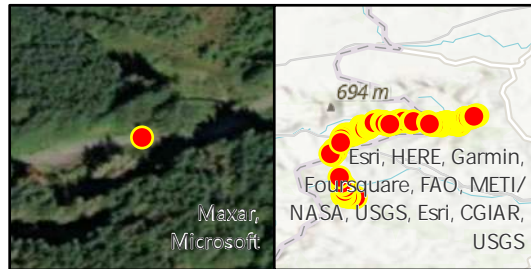




Survey Feature	Culvert - Undercrossing
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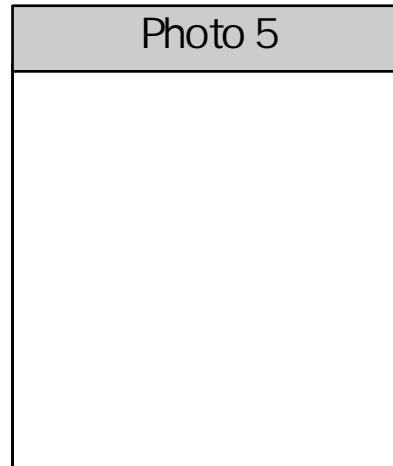
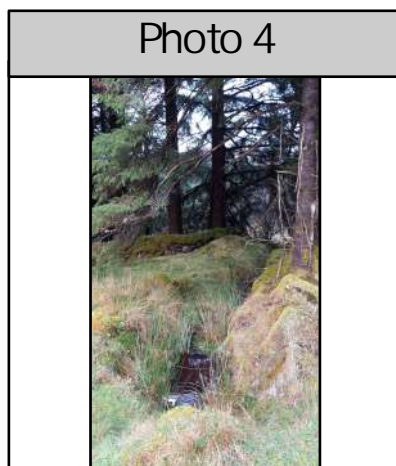
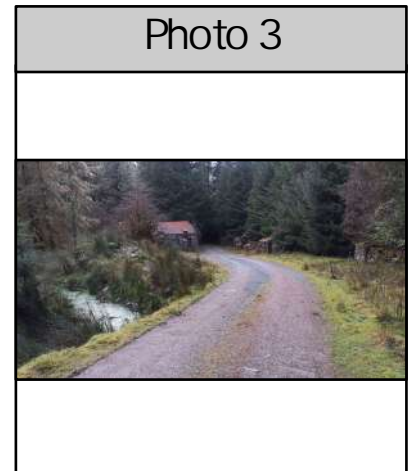
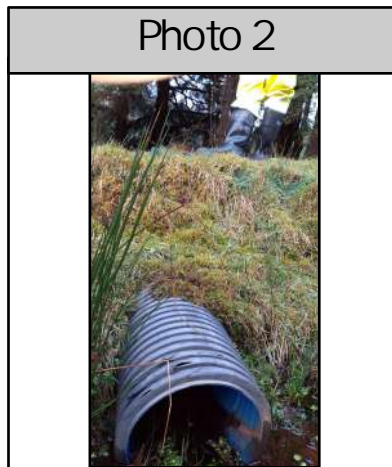
Survey Notes	300mm concrete pipe, 700mm cover 45 degrees across road
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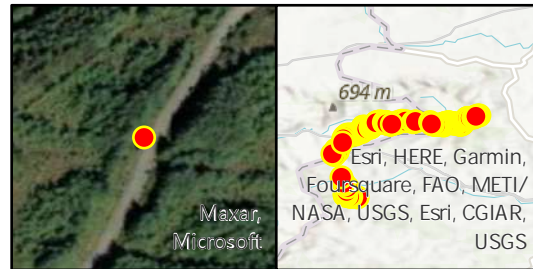




Survey Feature	Culvert - Undercrossing
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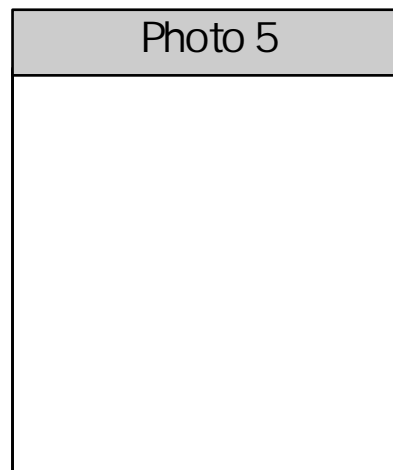
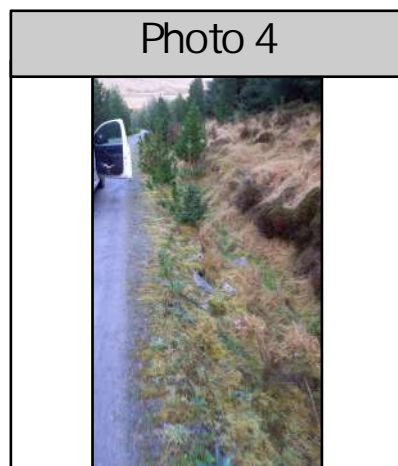
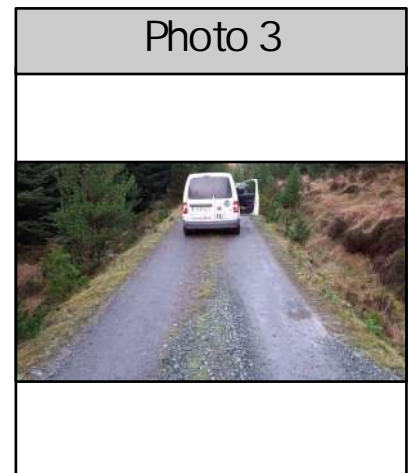
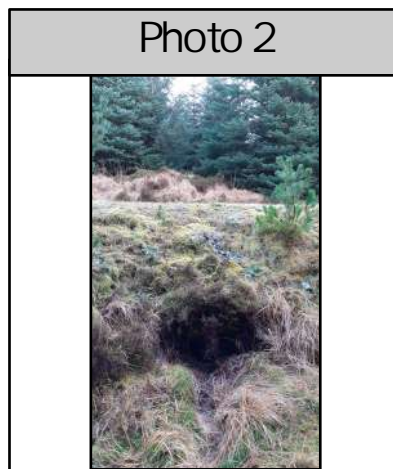
Survey Notes	300mm twinwall, 400mm cover, flowing towards River Clydaroe
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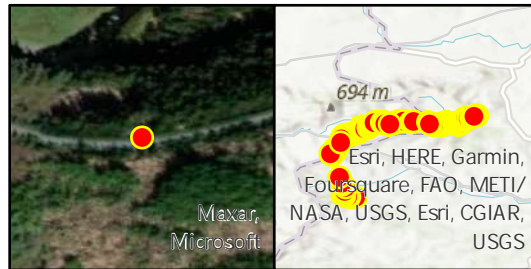




Survey Feature	Culvert - Undercrossing
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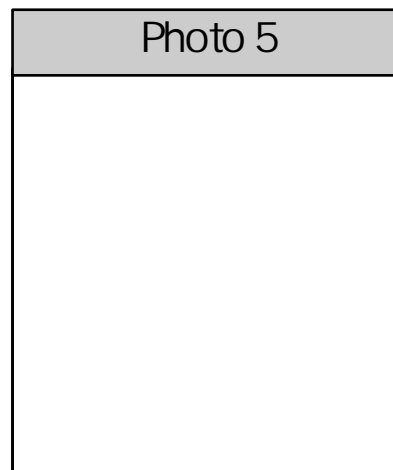
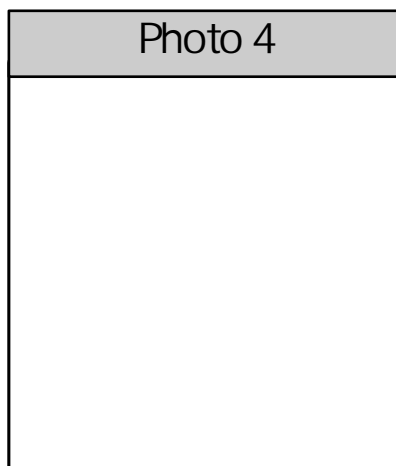
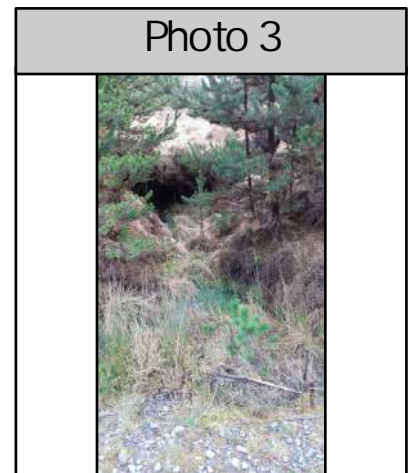
Survey Notes	300mm concrete pipe, 1100mm cover
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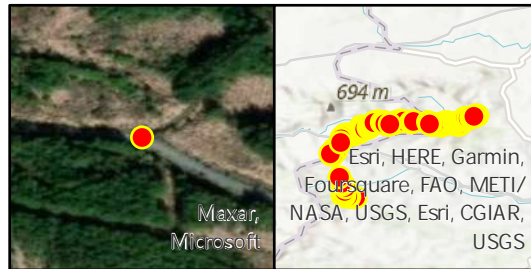




Survey Feature	Culvert - Undercrossing
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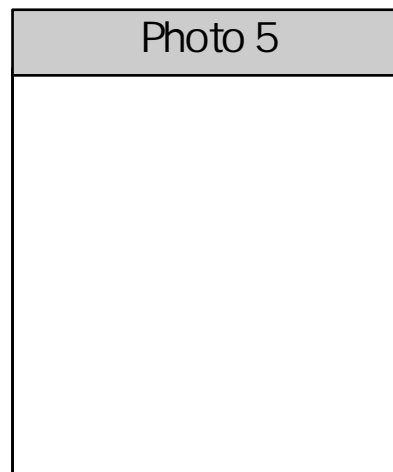
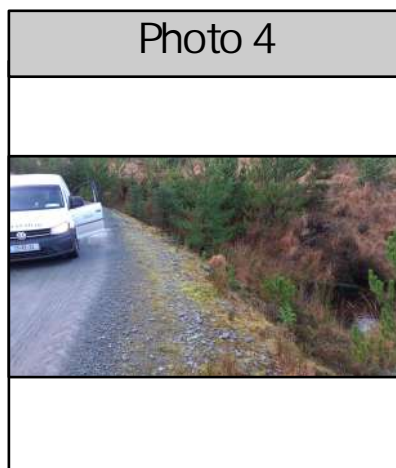
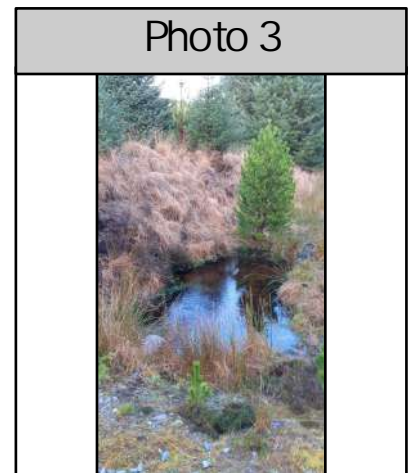
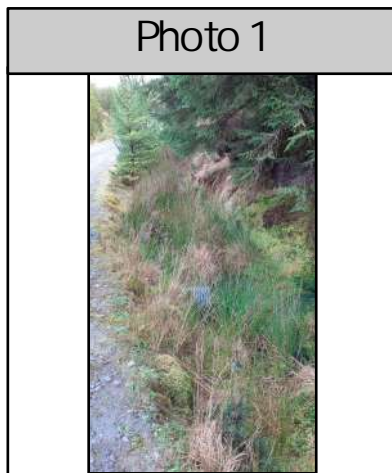
Survey Notes	300mm twinwall, 450mm cover
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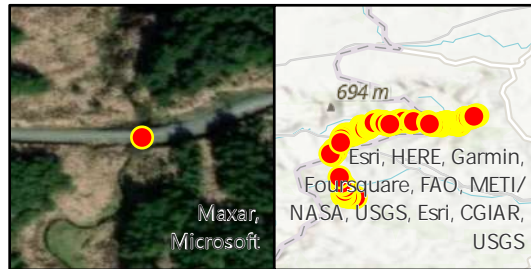




Survey Feature	Culvert - Undercrossing
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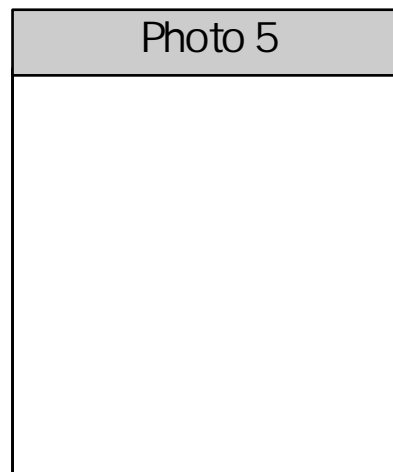
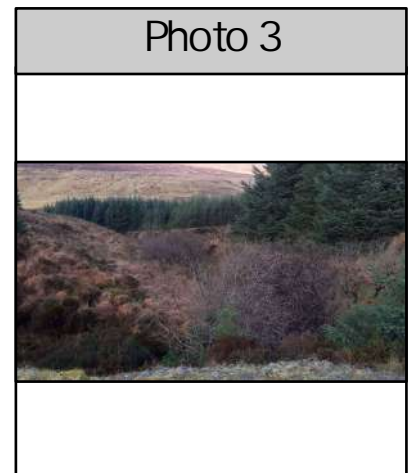
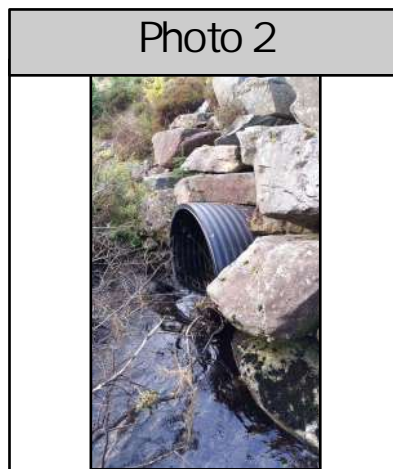
Survey Notes	400mm twinwall, 600mm cover
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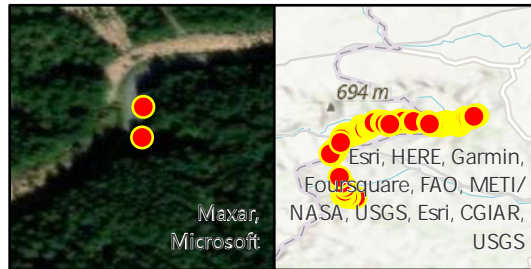




Survey Feature	Culvert - Overcrossing
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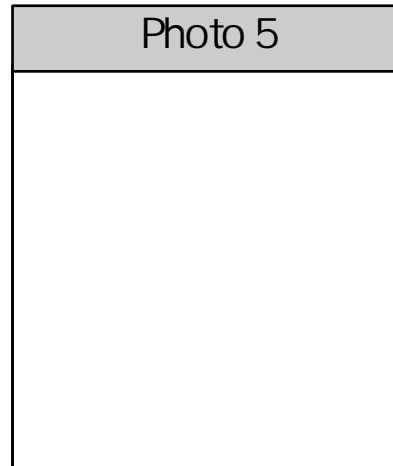
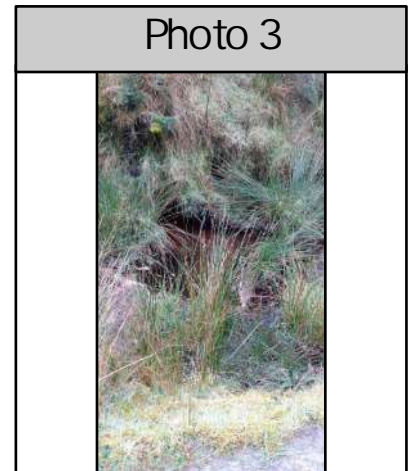
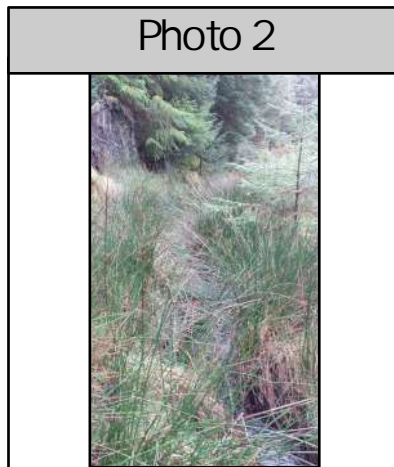
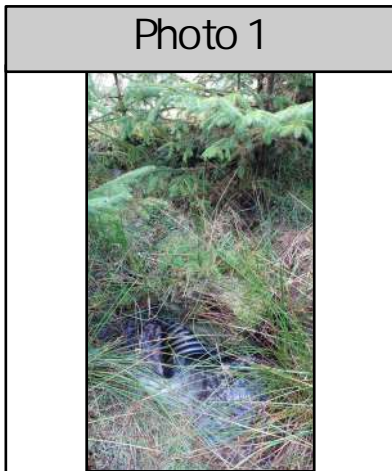
Survey Notes	1500 twin wall 1500 cover big f ow down
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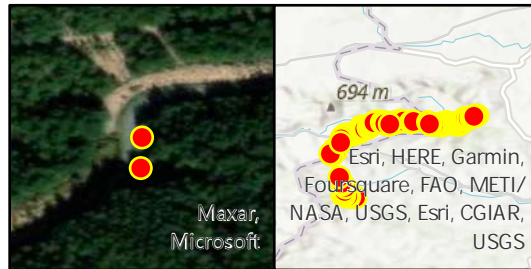




Survey Feature	Culvert - Undercrossing
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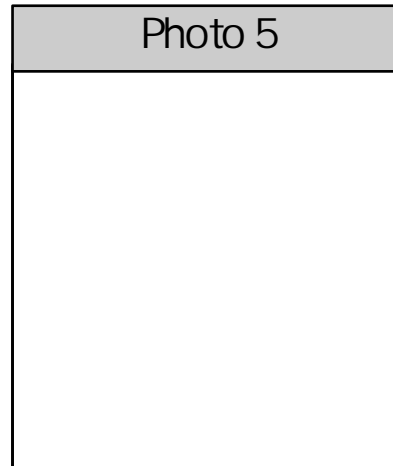
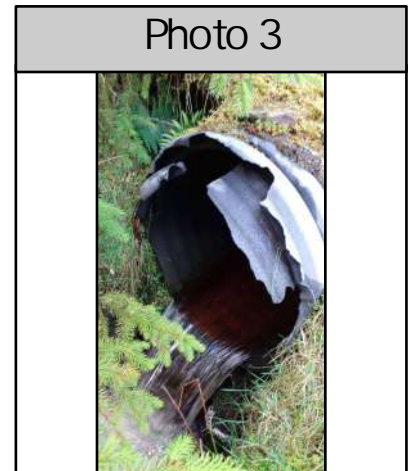
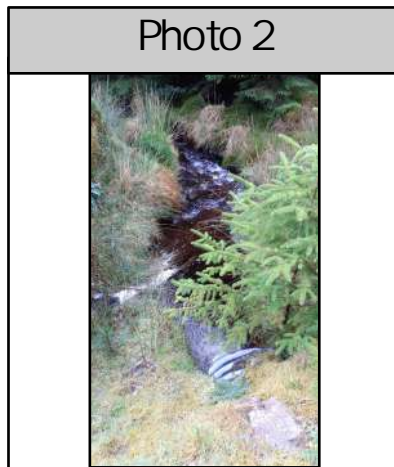
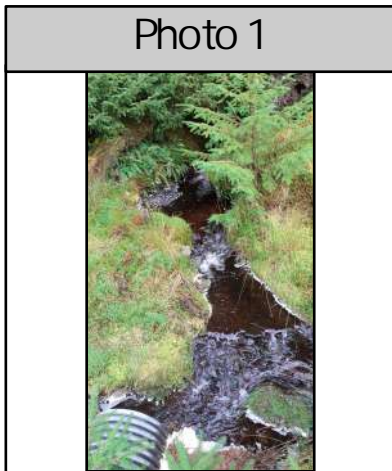
Survey Notes	300mm twinwall, 700mm cover wet
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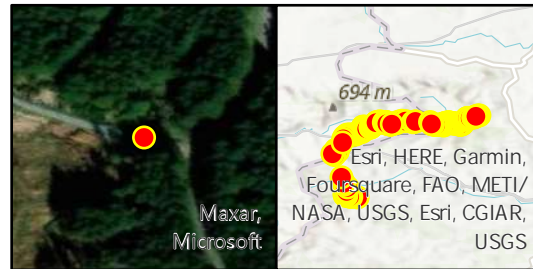




Survey Feature	Culvert - Undercrossing
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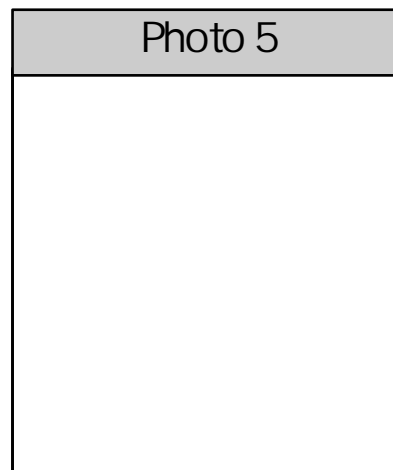
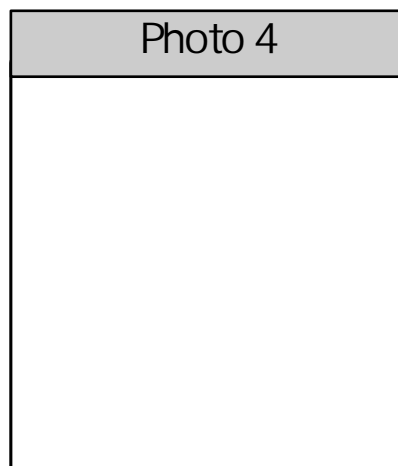
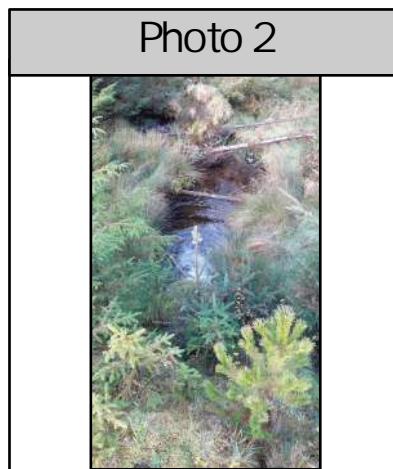
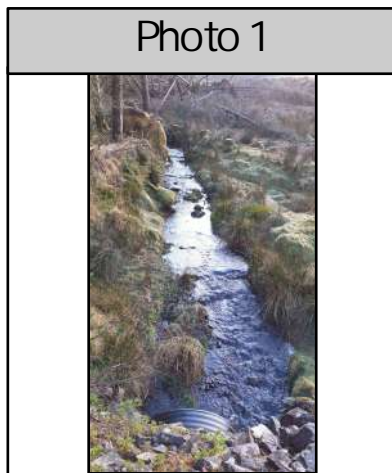
Survey Notes	700mm twinwall, 500mm cover wet
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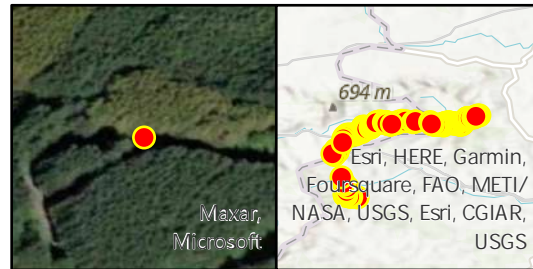




Survey Feature	Culvert - Undercrossing
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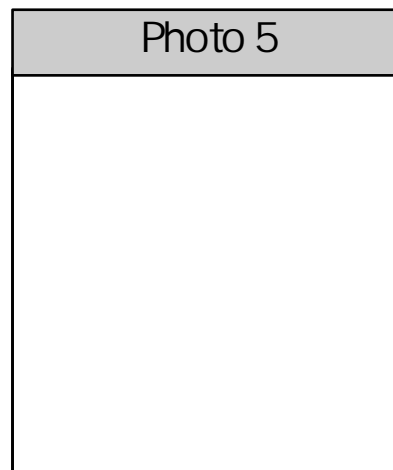
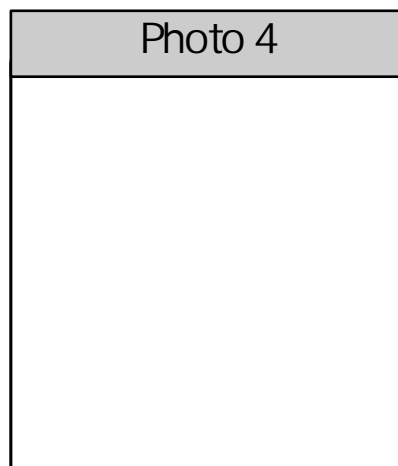
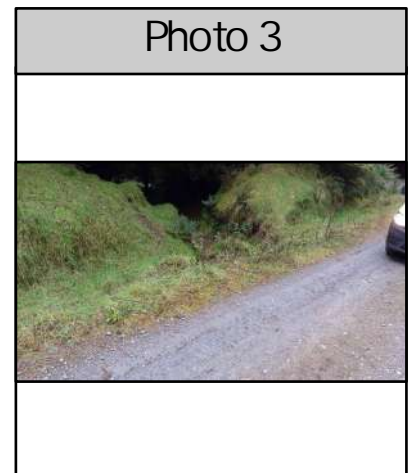
Survey Notes	1500 twin wall 1850 cover
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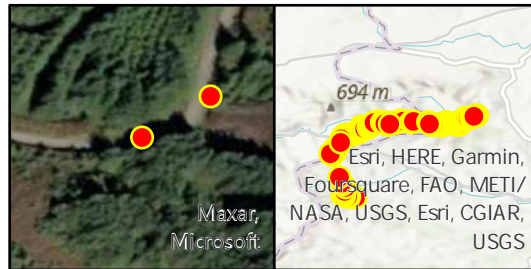




Survey Feature	Culvert - Undercrossing
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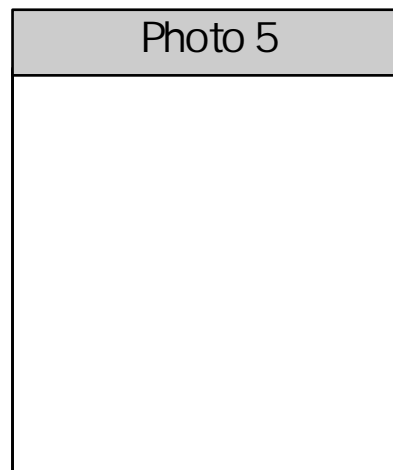
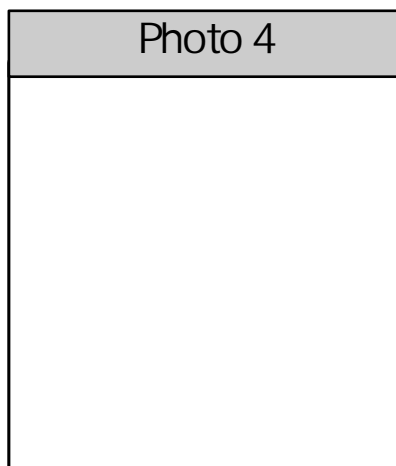
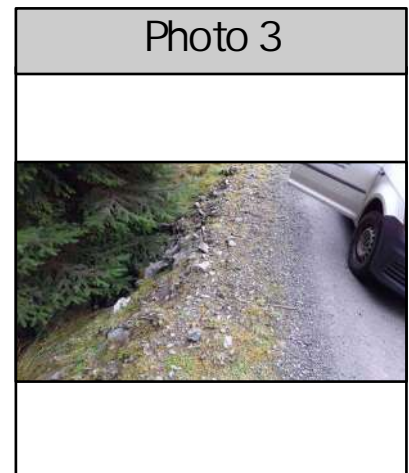
Survey Notes	Stone Drain, 600mm cover, Flow away from sensitive receptor
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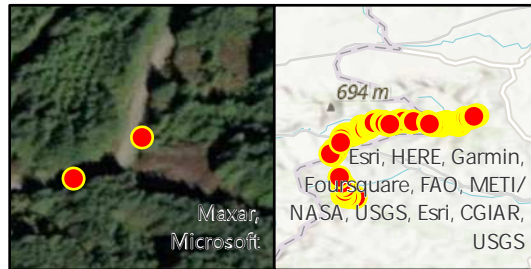




Survey Feature	Culvert - Undercrossing
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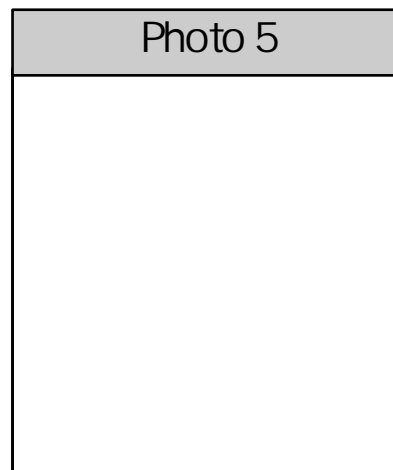
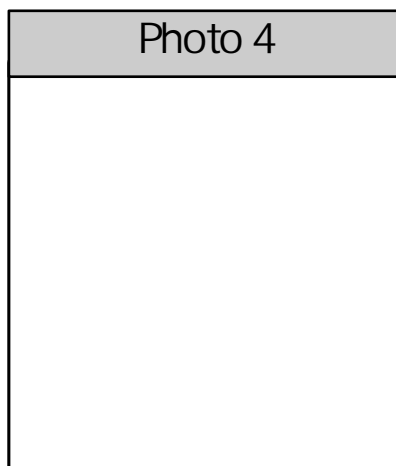
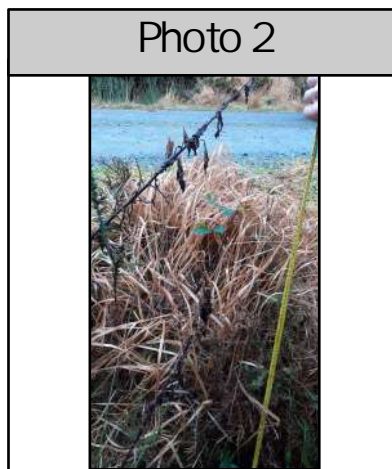
Survey Notes	600mm culvert 900mm cover
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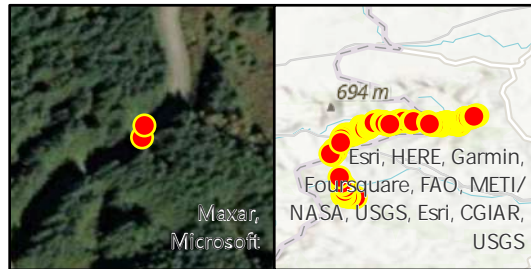




Survey Feature	Culvert - Undercrossing
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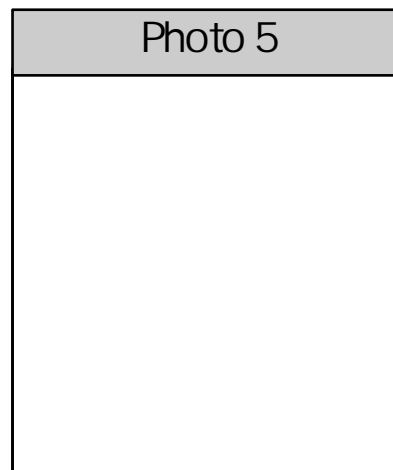
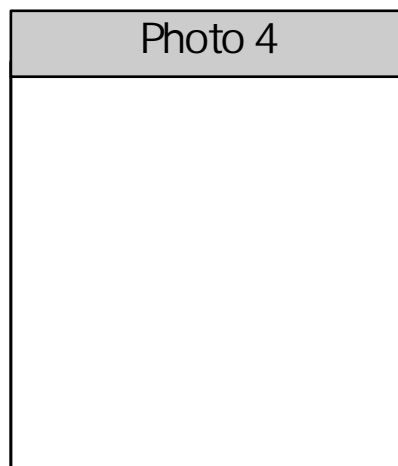
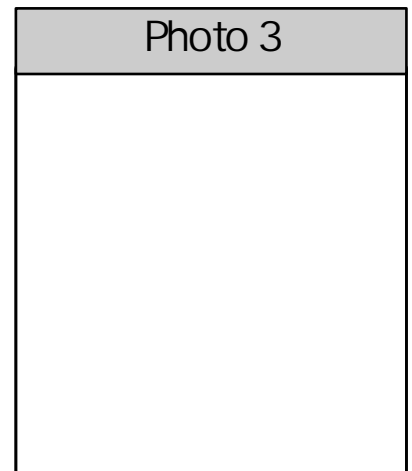
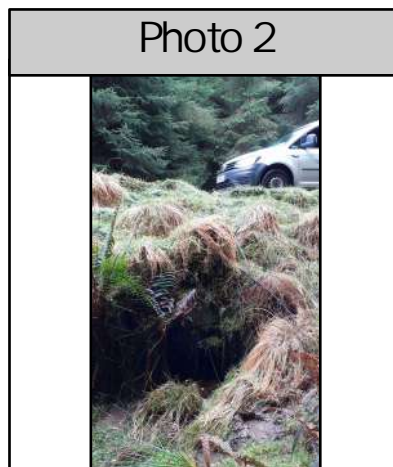
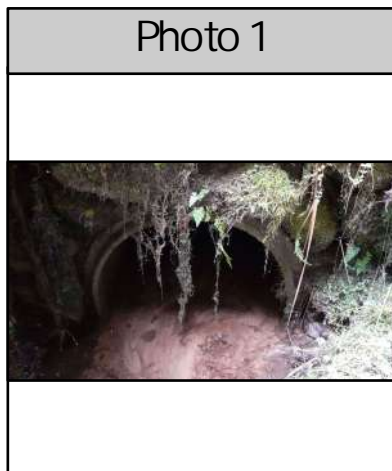
Survey Notes	600mm culvert 600mm cover
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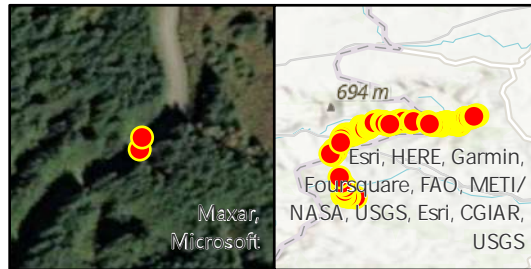




Survey Feature	Culvert - Undercrossing
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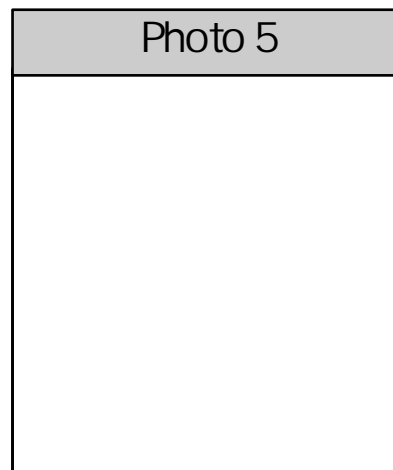
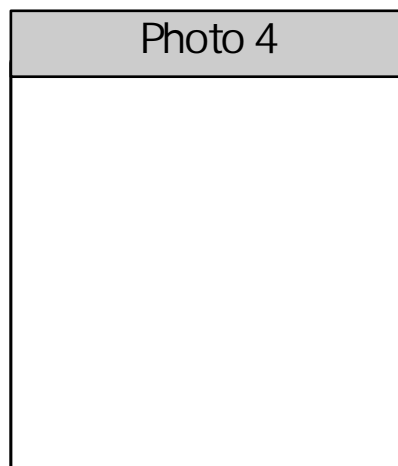
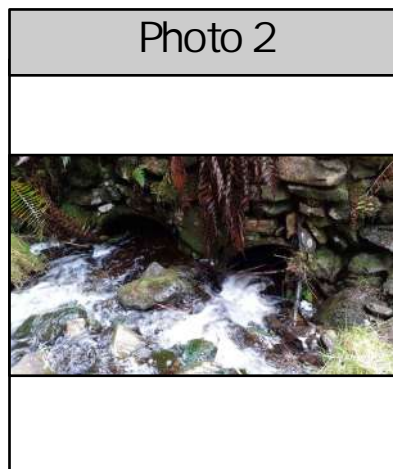
Survey Notes	600mm pipe 1500mm cover
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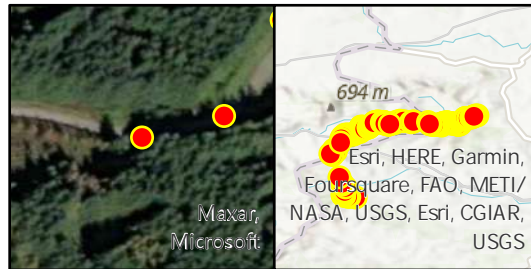




Survey Feature	Culvert - Undercrossing
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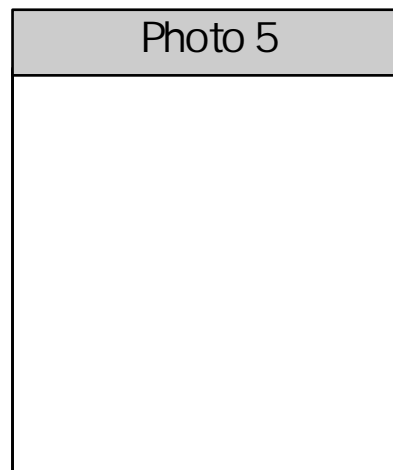
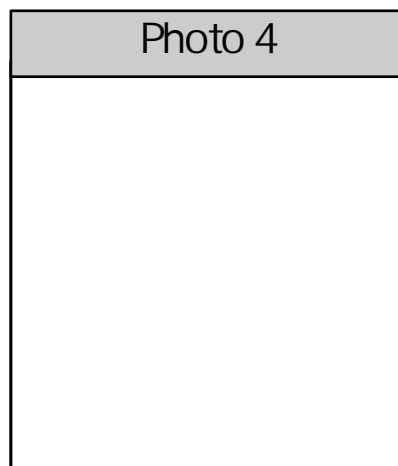
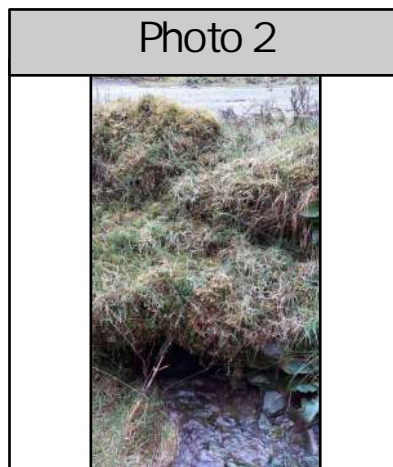
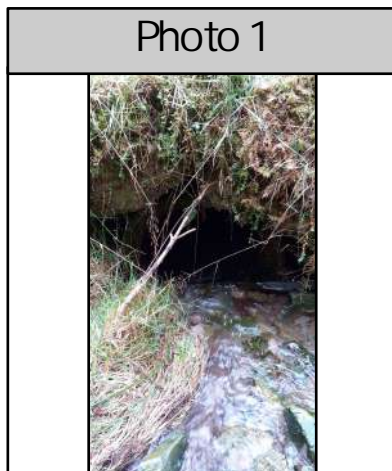
Survey Notes	Double Culvert , x2 600mm concrete culverts 1500mm cover
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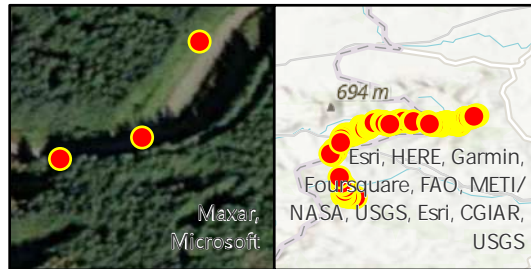




Survey Feature	Culvert - Undercrossing
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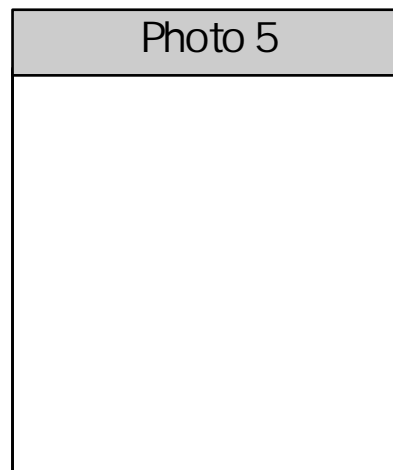
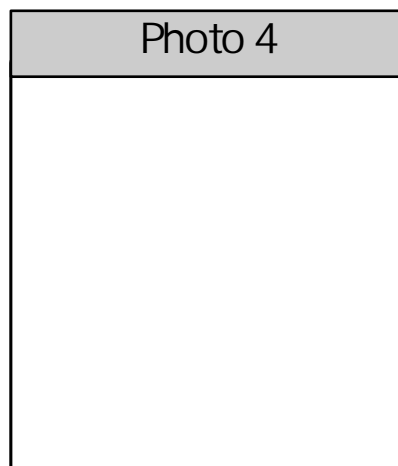
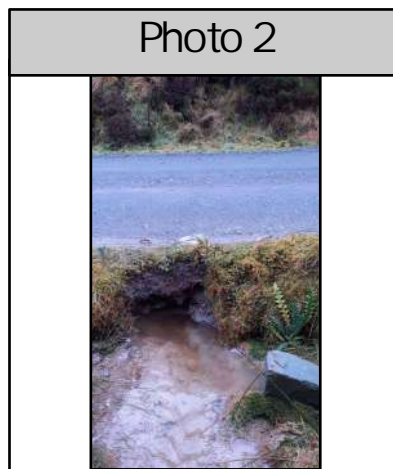
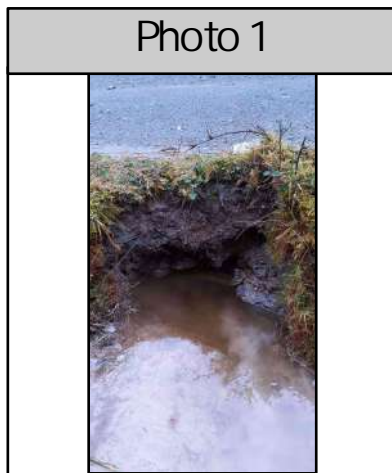
Survey Notes	600mm pipe 700mm cover
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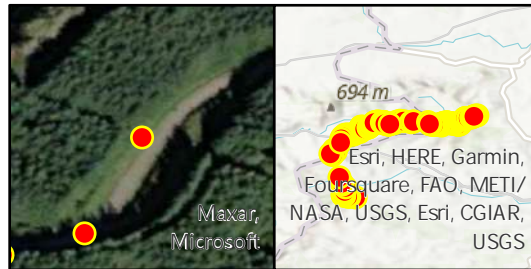




Survey Feature	Culvert - Undercrossing
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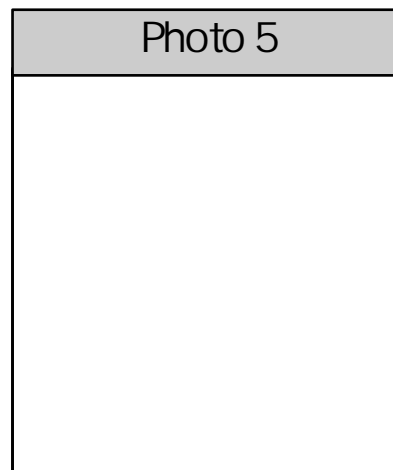
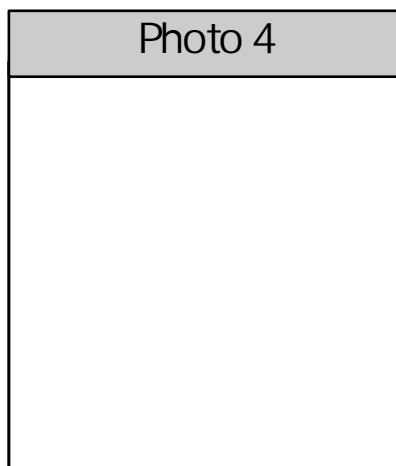
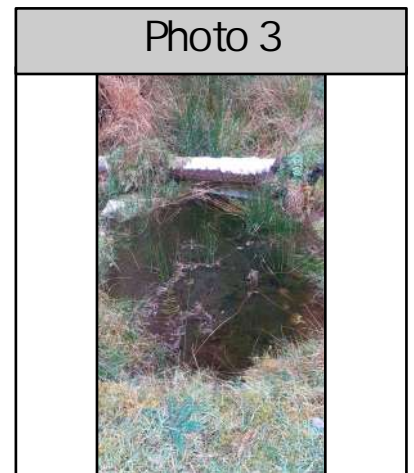
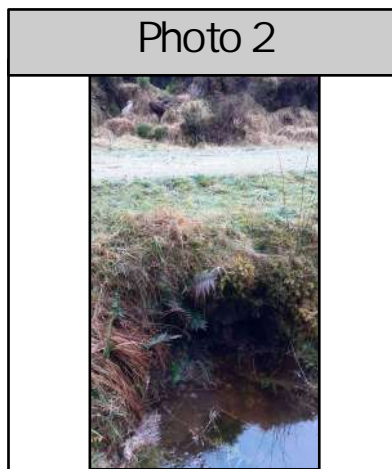
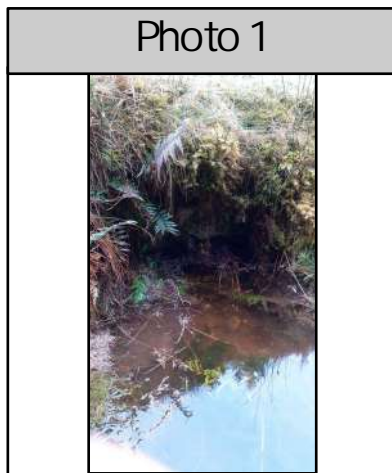
Survey Notes	600mm submerged 550mm cover f ow towards SAC
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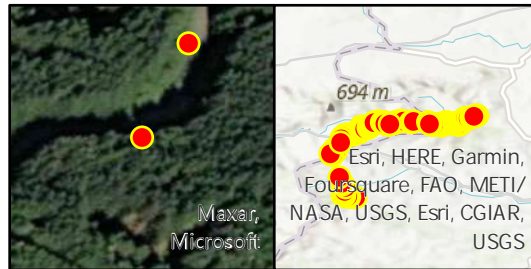




Survey Feature	Culvert - Undercrossing
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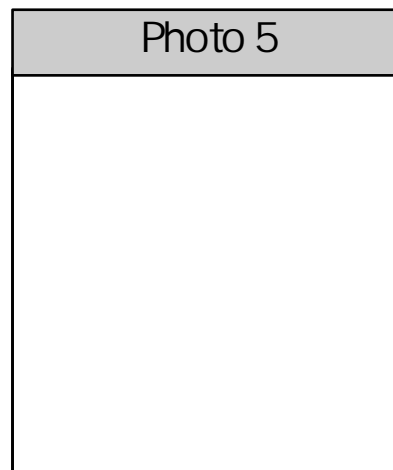
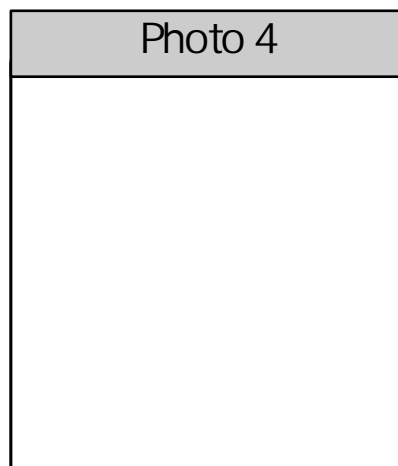
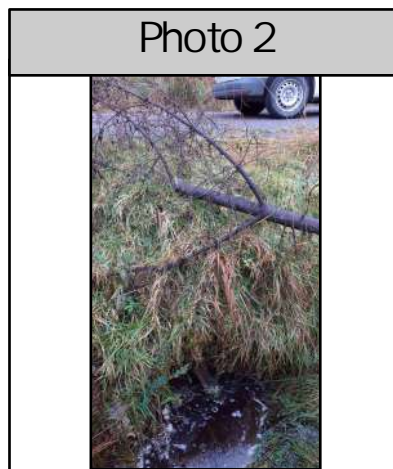
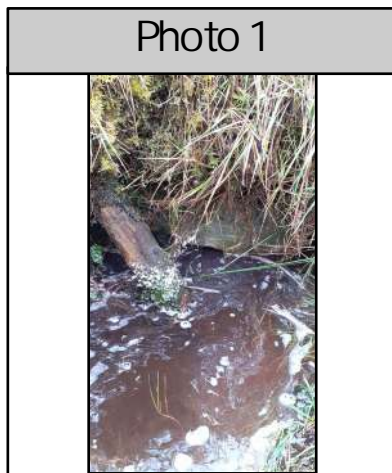
Survey Notes	Stone culvert 800mm cover, exist ng silt fence
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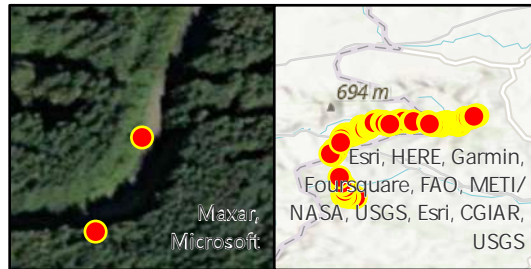




Survey Feature	Culvert - Undercrossing
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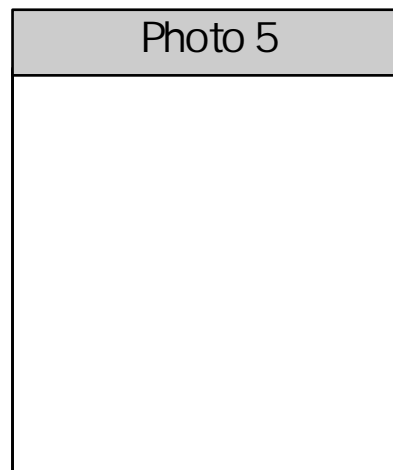
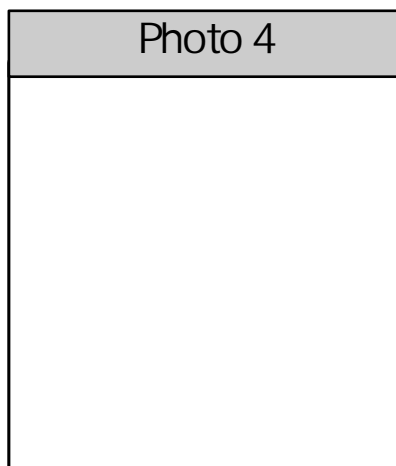
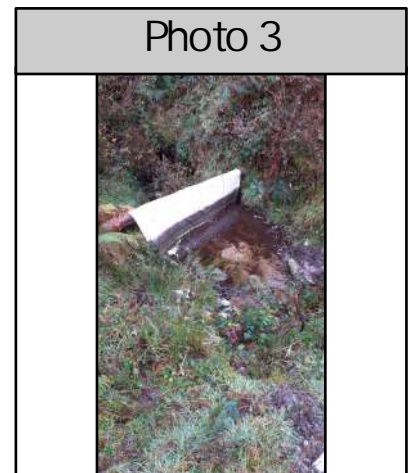
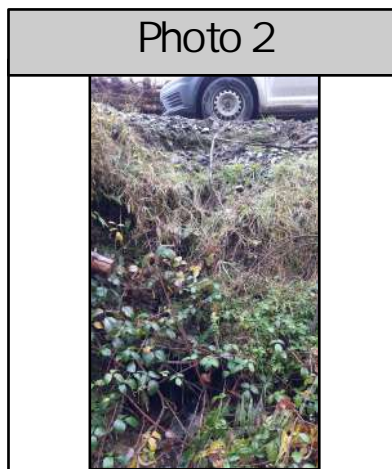
Survey Notes	Stone culvert submerged 750mm cover
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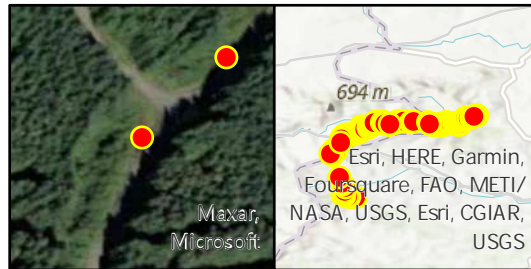




Survey Feature	Culvert - Undercrossing
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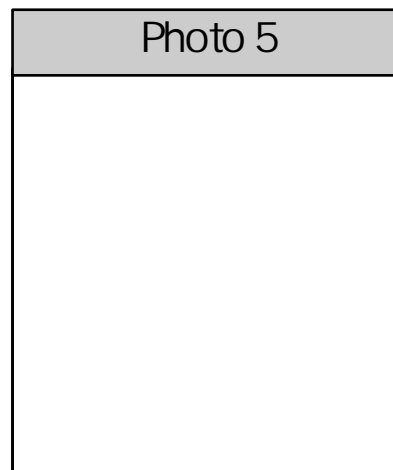
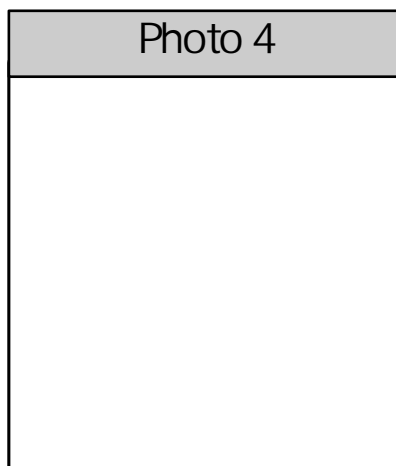
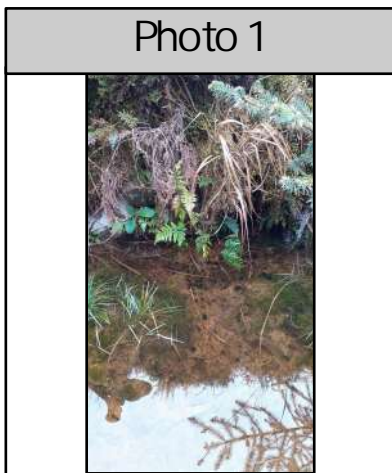
Survey Notes	Stone drain 1200mm cover [Pump and Dam]
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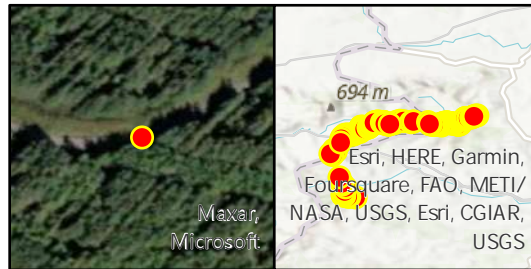




Survey Feature	Culvert - Undercrossing
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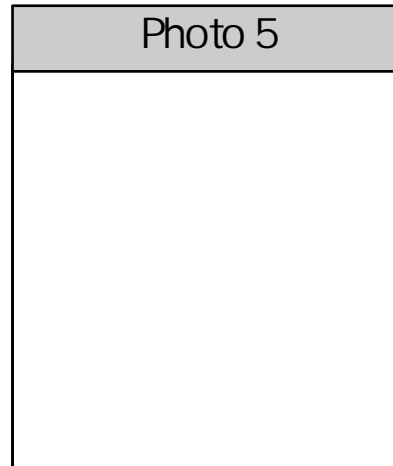
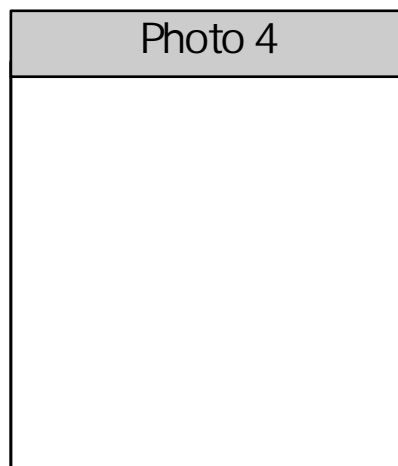
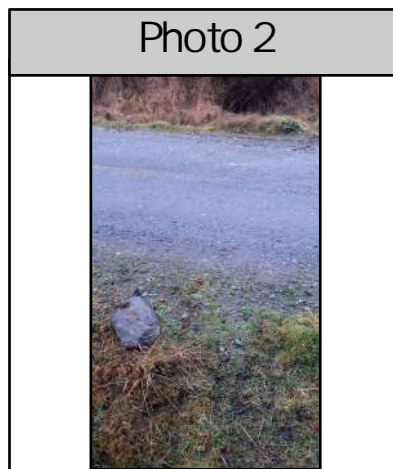
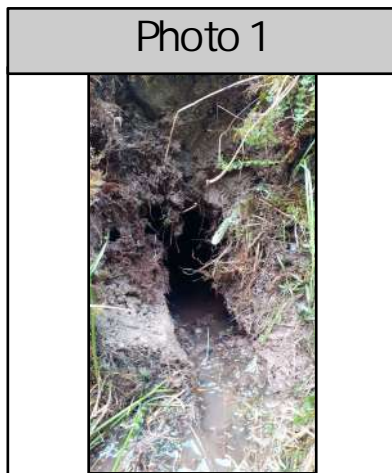
Survey Notes	Stone culvert 1200mm cover Silt fence
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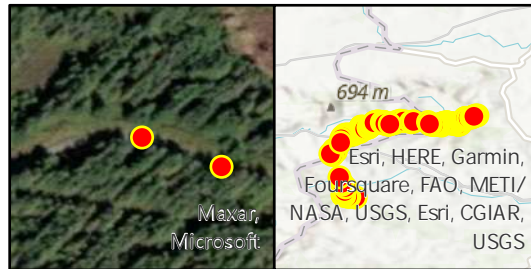




Survey Feature	Culvert - Undercrossing
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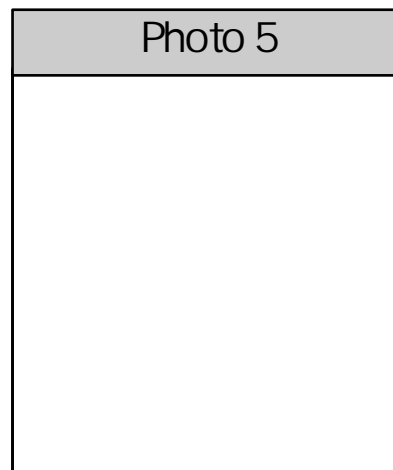
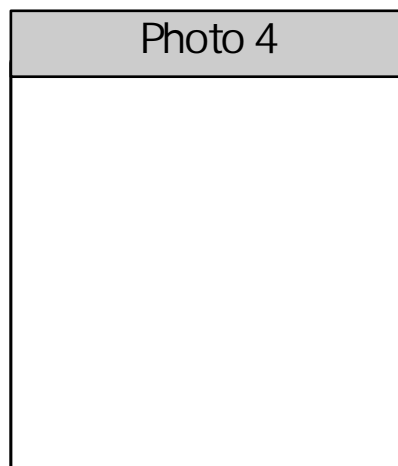
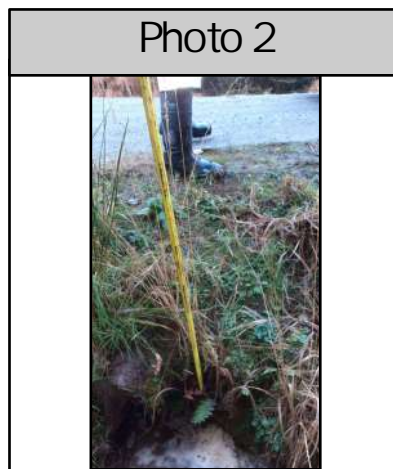
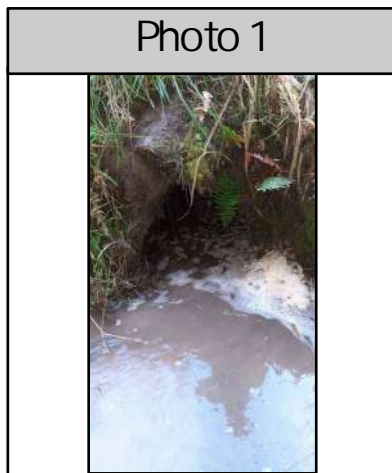
Survey Notes	Culvert pipe 600mm concrete 700mm cover
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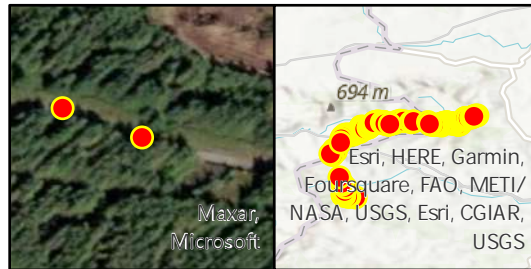




Survey Feature	Culvert - Undercrossing
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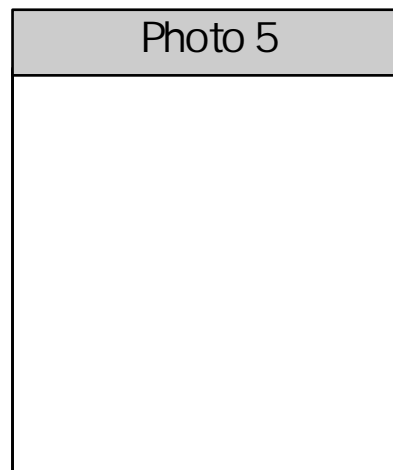
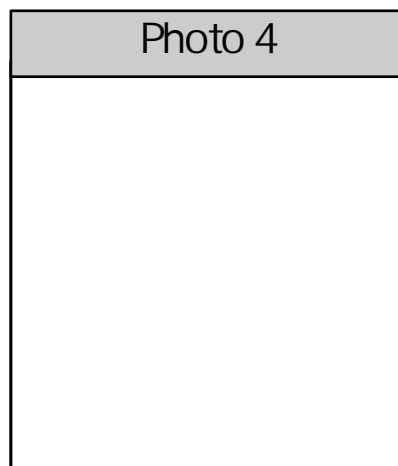
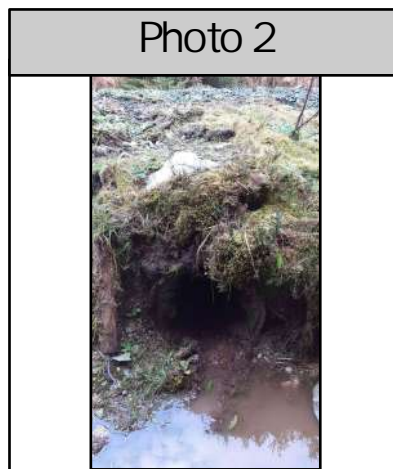
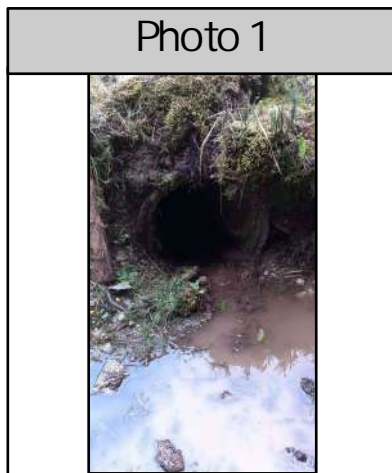
Survey Notes	600mm concrete 650mm cover
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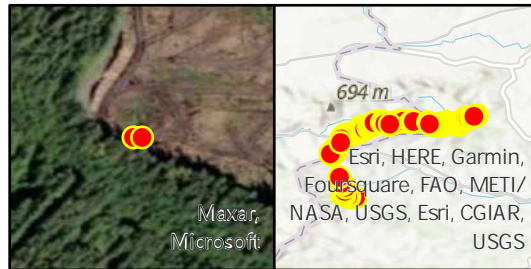




Survey Feature	Culvert - Undercrossing
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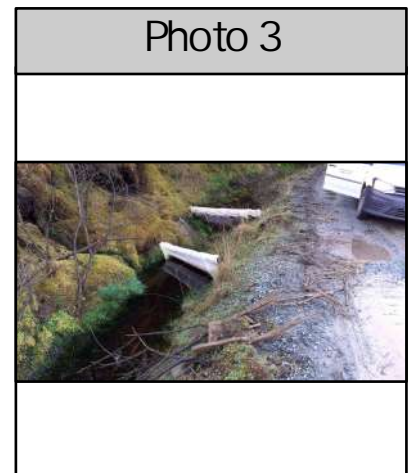
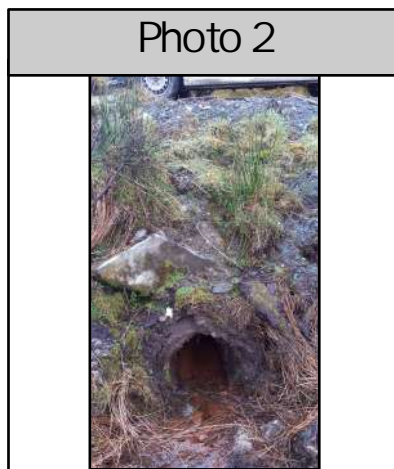
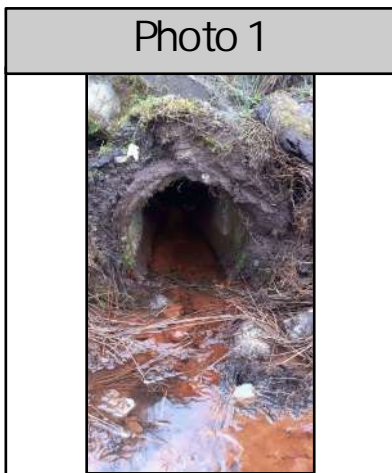
Survey Notes	Concrete culvert 600mm pipe 600mm cover
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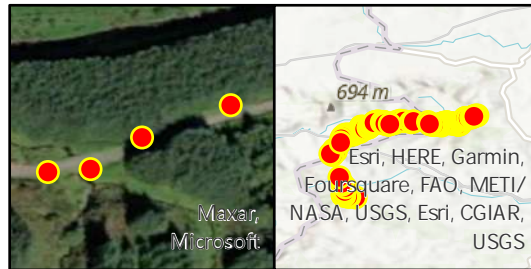




Survey Feature	Culvert - Undercrossing
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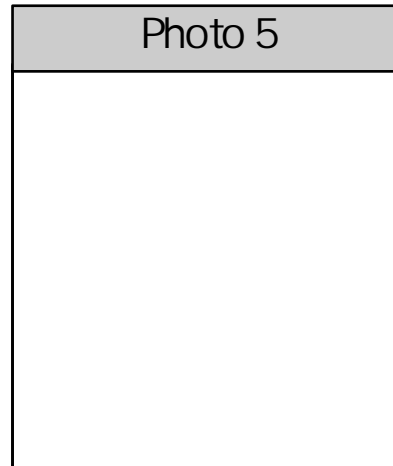
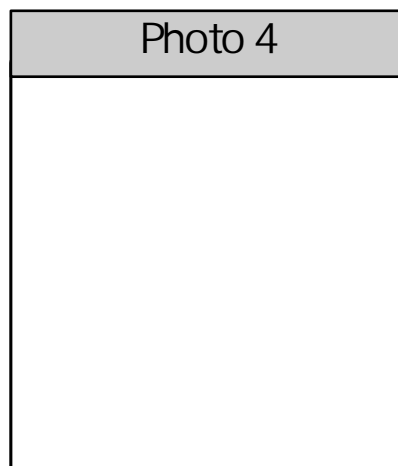
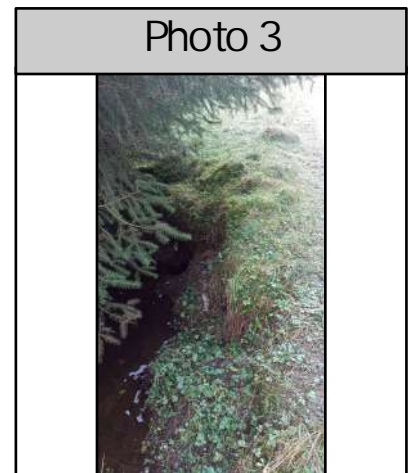
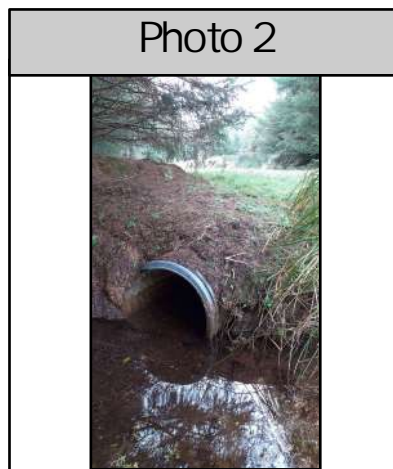
Survey Notes	600mm pipe 1100mm cover, poor containment
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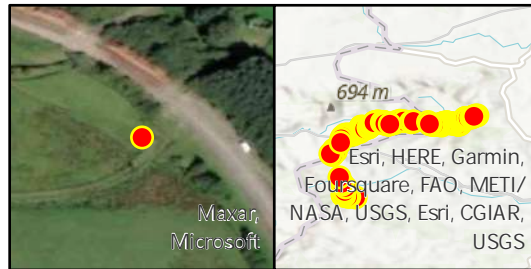




Survey Feature	Culvert - Undercrossing
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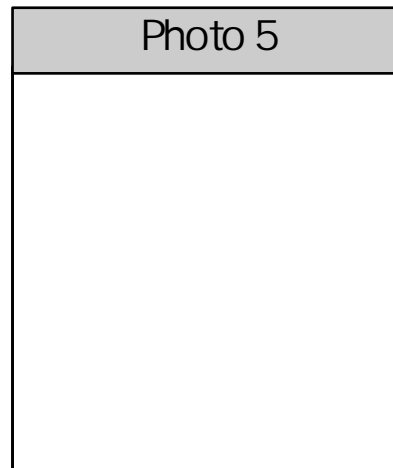
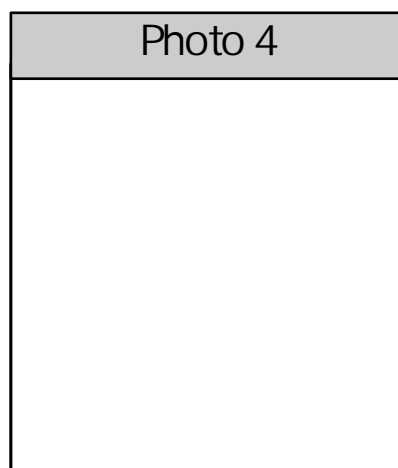
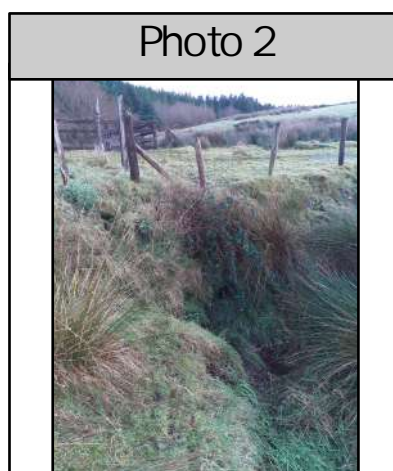
Survey Notes	Culvert twinwall 45 degree across road 600mm twin wall with 250mm cover
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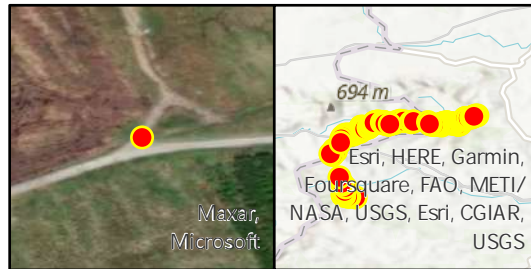




Survey Feature	Culvert - Overcrossing
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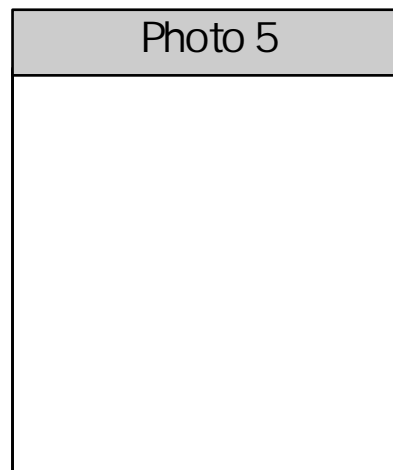
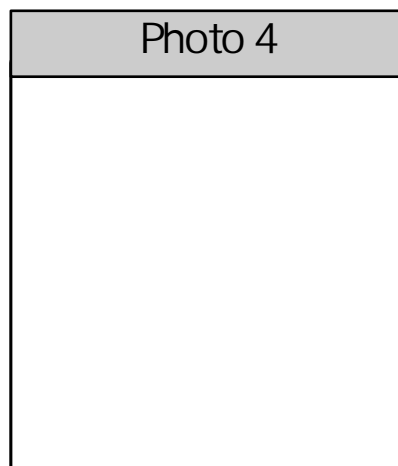
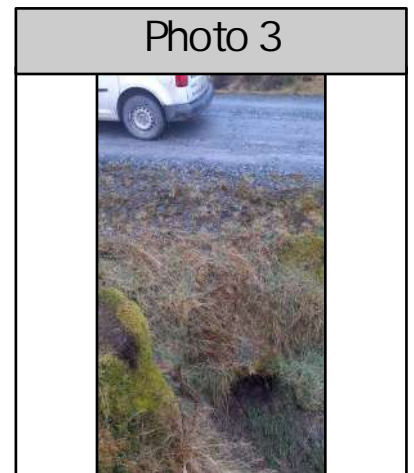
Survey Notes	Stone culvert 1200mm cover permanent access road
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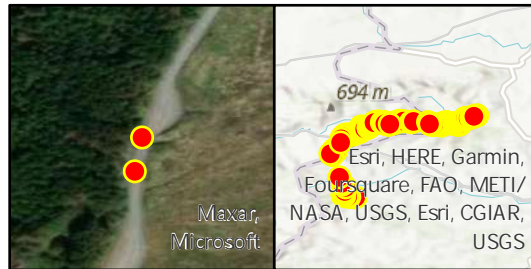




Survey Feature	Culvert - Undercrossing
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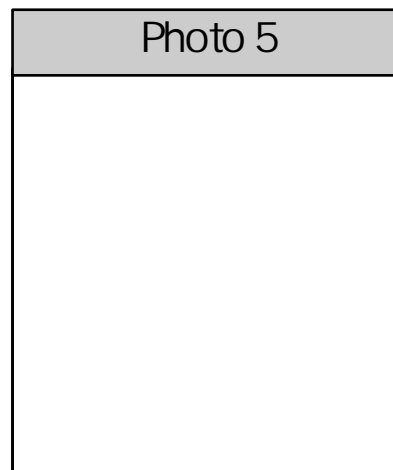
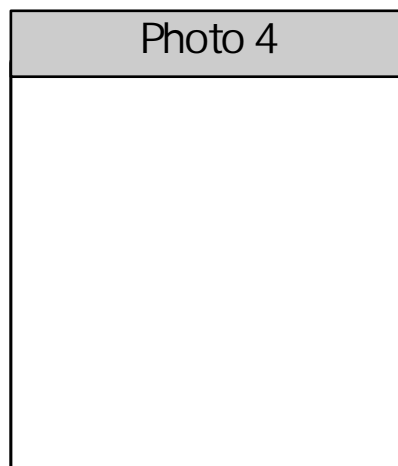
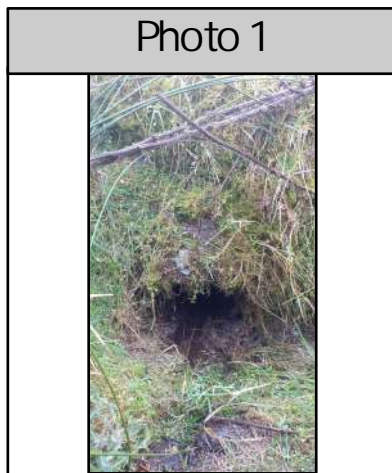
Survey Notes	Culvert 700mm pipe 1000mm cover
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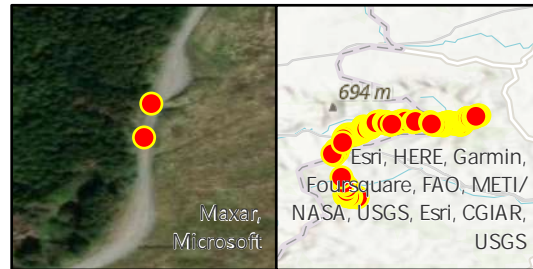




Survey Feature	Culvert - Undercrossing
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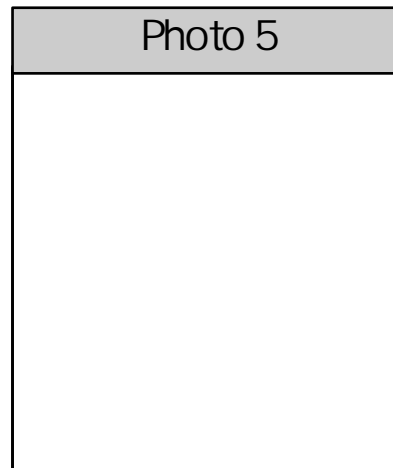
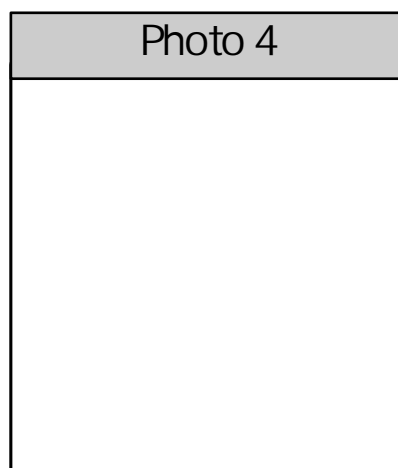
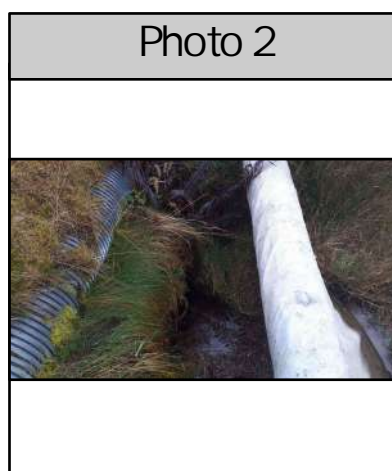
Survey Notes	600mm concrete 800mm cover
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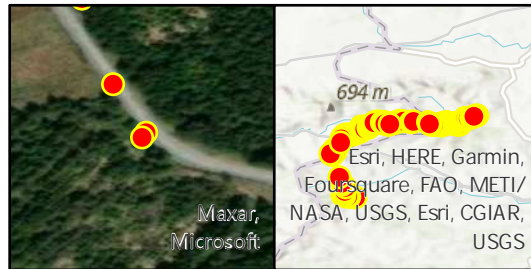




Survey Feature	Culvert - Undercrossing
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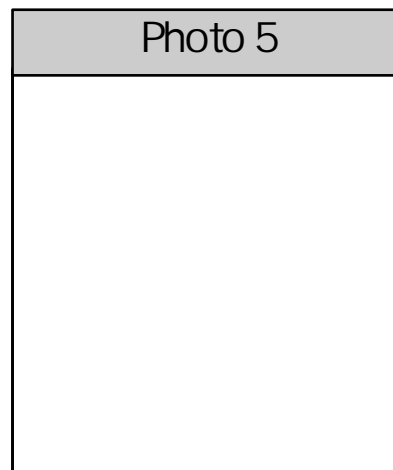
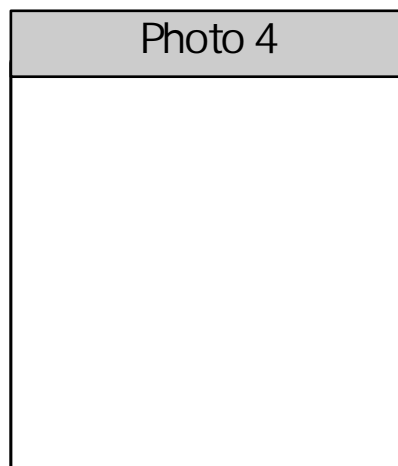
Survey Notes	Culvert with silt fence 600mm pipe, 1350mm cover, twin wall cross above 500mm perpendicular
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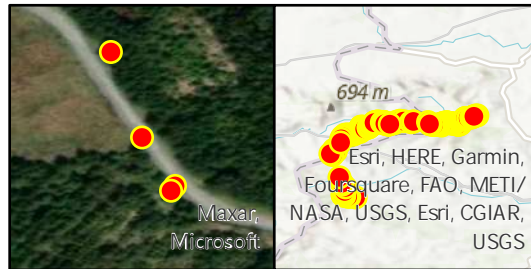




Survey Feature	Culvert - Undercrossing
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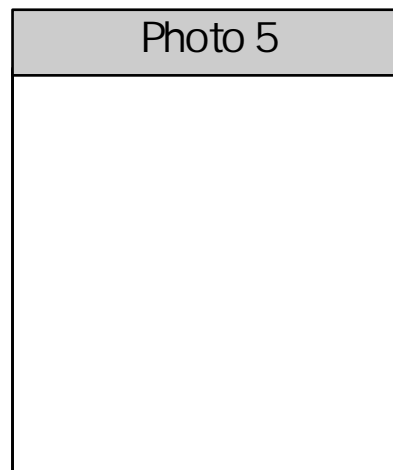
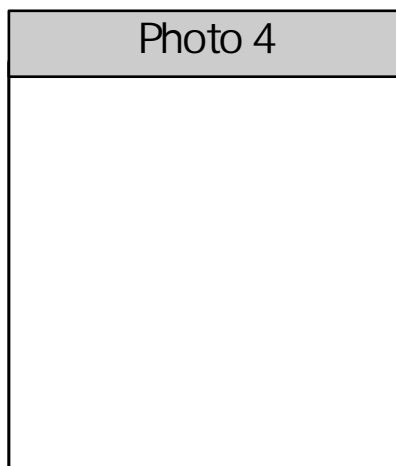
Survey Notes	600mm concrete 800mm Road cover
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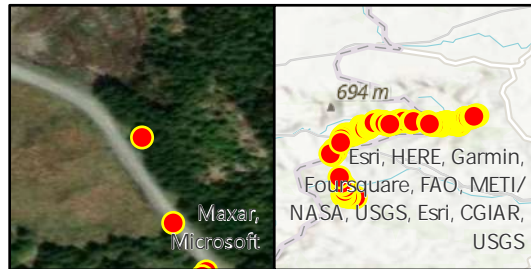




Survey Feature	Culvert - Undercrossing
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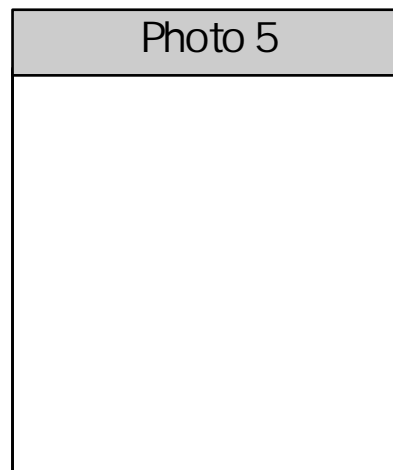
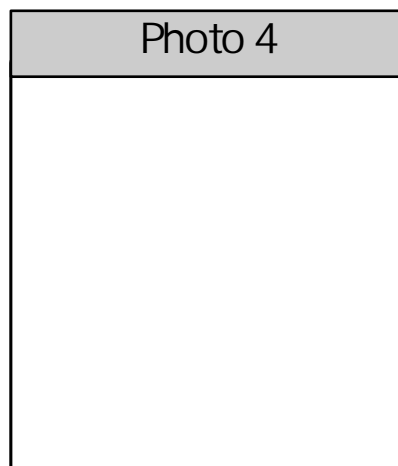
Survey Notes	600mm pipe, 700mm above cover
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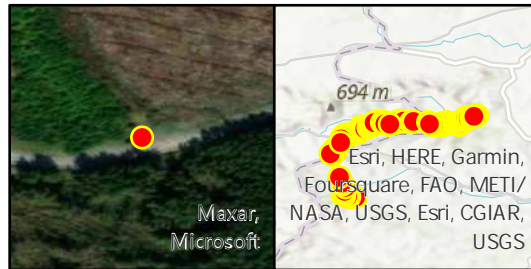




Survey Feature	Culvert - Undercrossing
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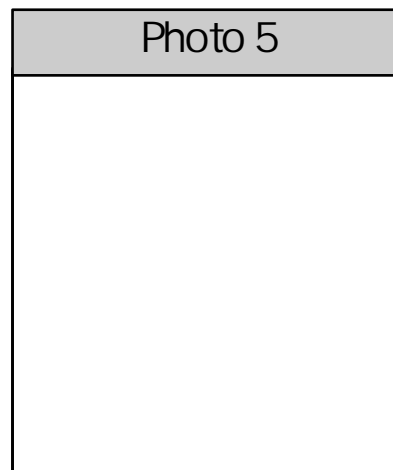
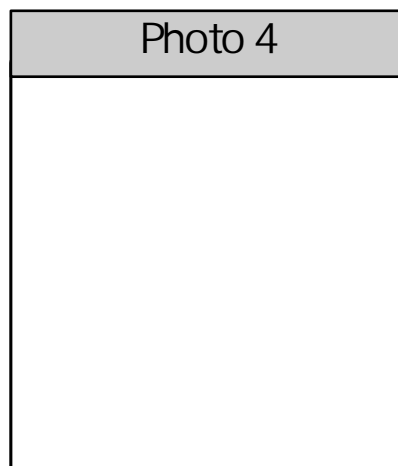
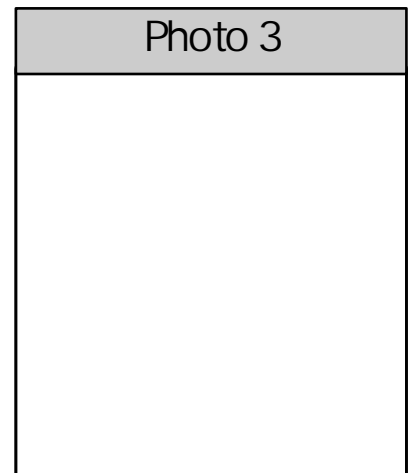
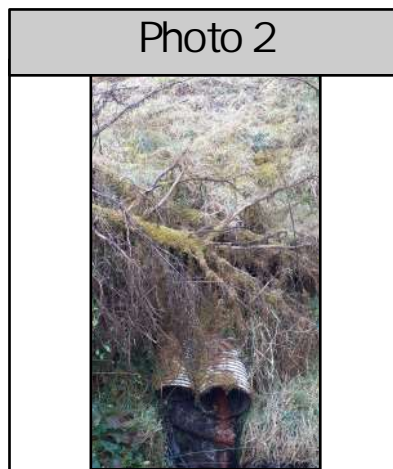
Survey Notes	600mm concrete 900mm cover
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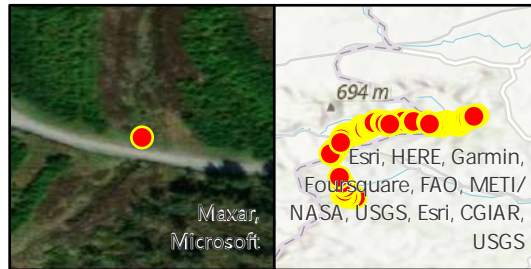




Survey Feature	Culvert - Undercrossing
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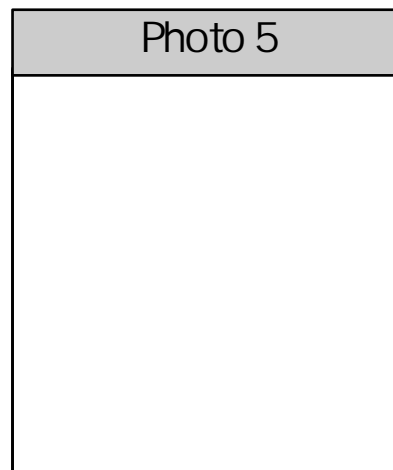
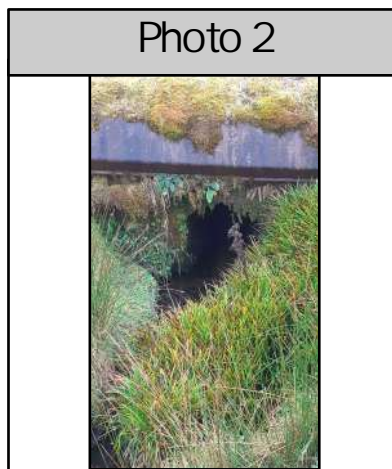
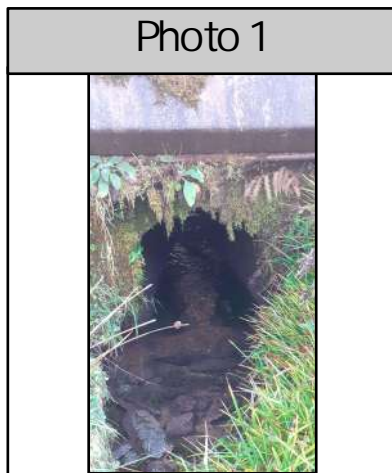
Survey Notes	x2 400mm twin walls, 1200mm cover
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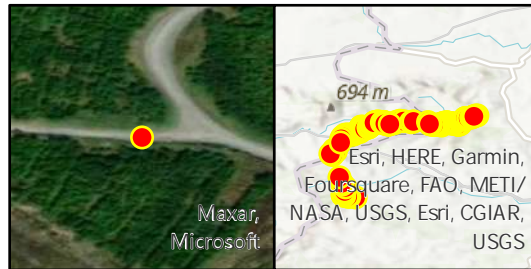




Survey Feature	Culvert - Undercrossing
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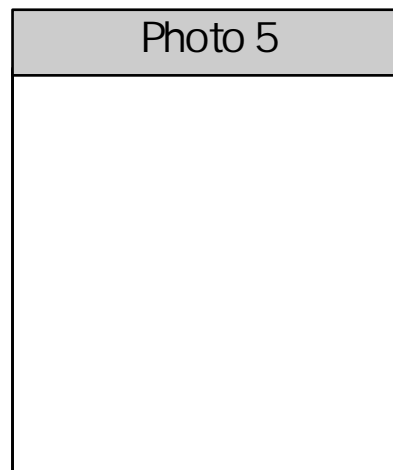
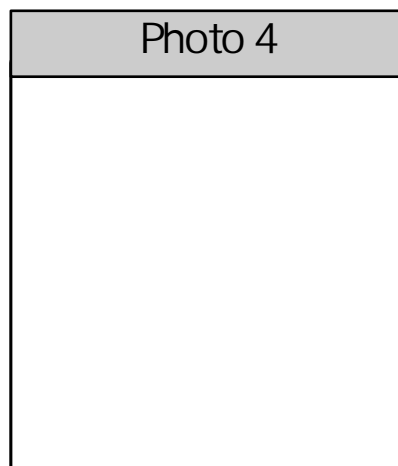
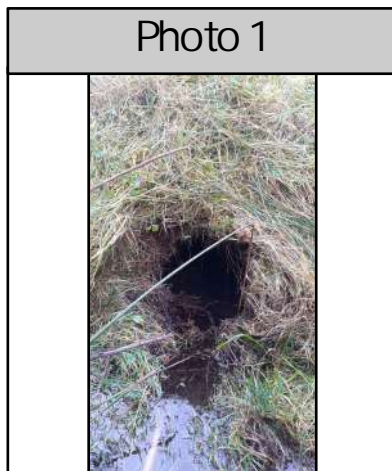
Survey Notes	800mm concrete with 1100mm cover
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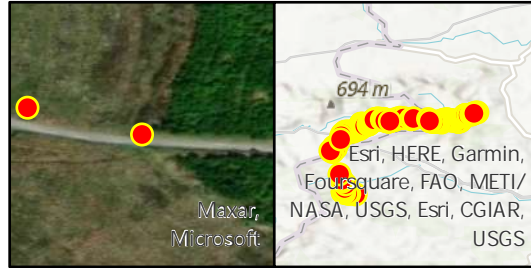




Survey Feature	Culvert - Undercrossing
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Survey Notes	600mm pipe 600mm cover
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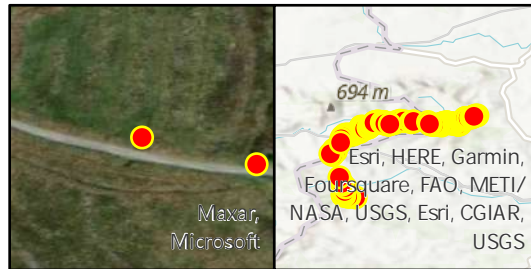




Survey Feature	Culvert - Undercrossing
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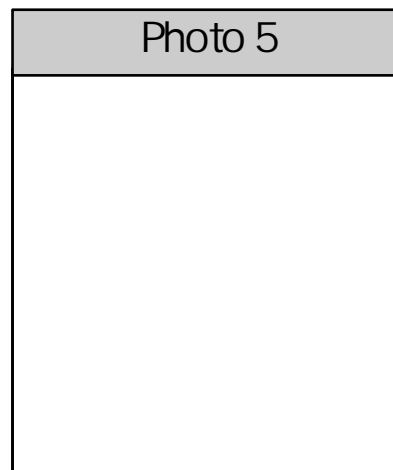
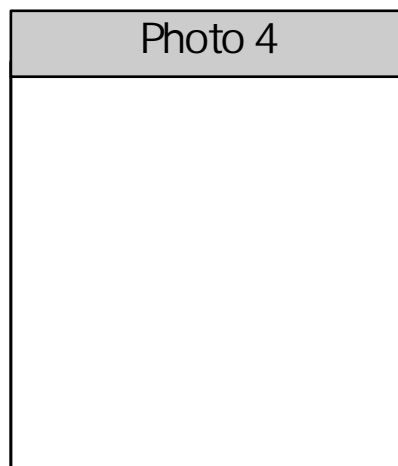
Survey Notes	HDPE culvert 600mm HDPE pipe, 800mm cover
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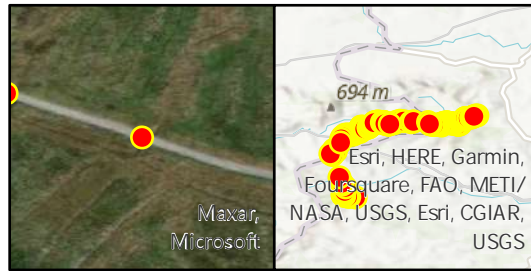




Survey Feature	Culvert - Undercrossing
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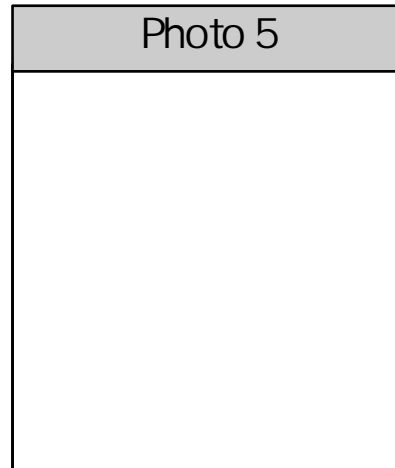
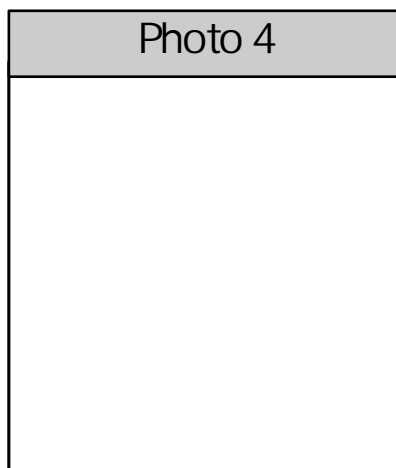
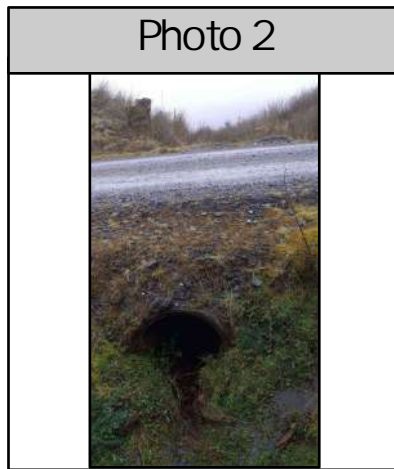
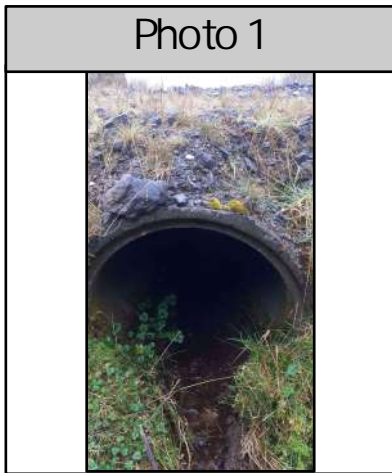
Survey Notes	600mm concrete 900mm cover
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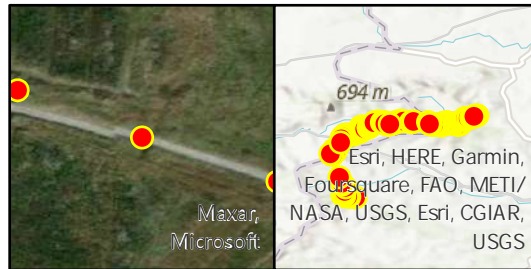




Survey Feature	Culvert - Undercrossing
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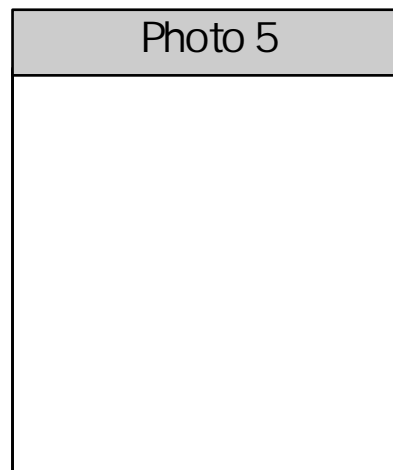
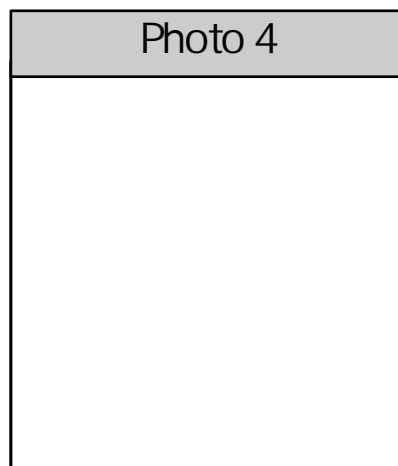
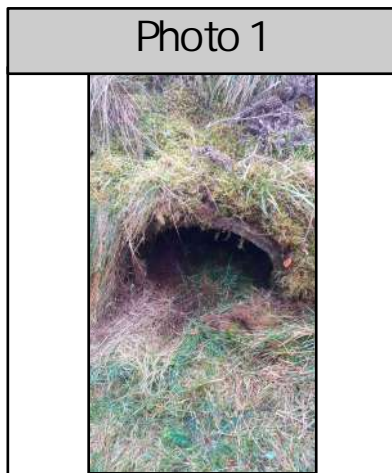
Survey Notes	700mm concrete 200mm cover
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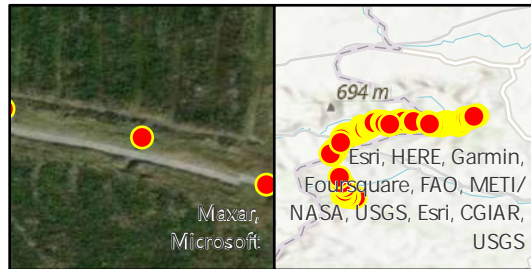




Survey Feature	Culvert - Undercrossing
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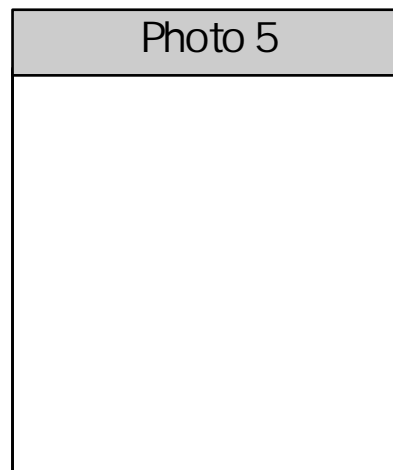
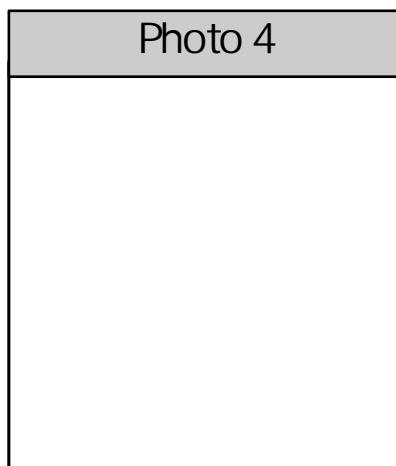
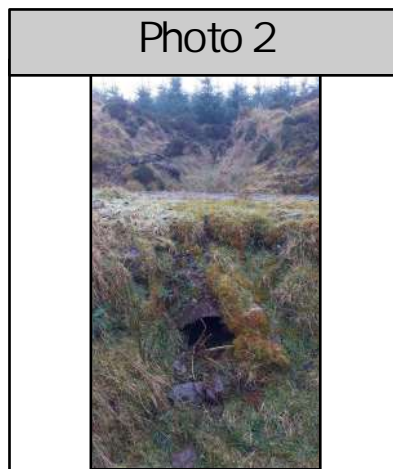
Survey Notes	Semi dry 600mm pipe 600mm cover
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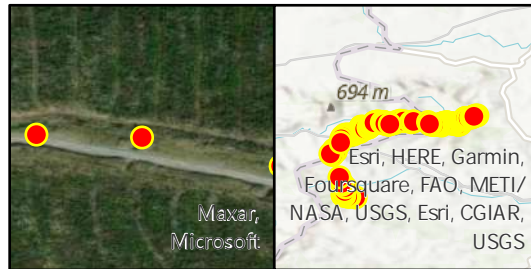




Survey Feature	Culvert - Undercrossing
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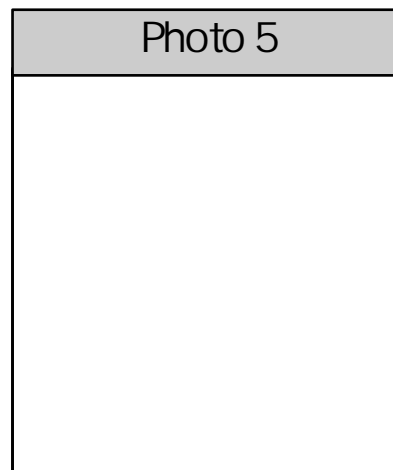
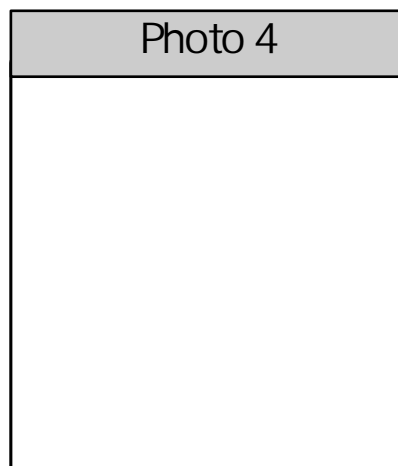
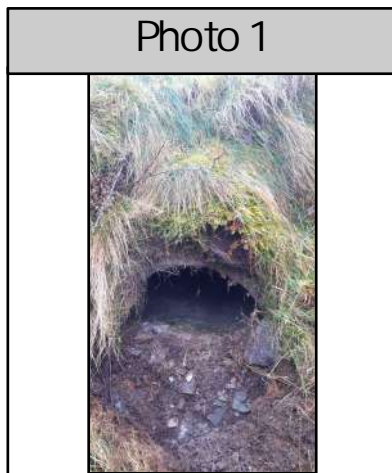
Survey Notes	600mm semi dry culvert 700mm cover
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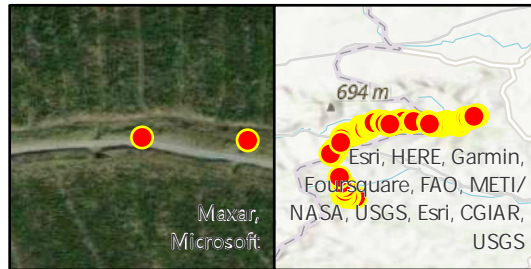




Survey Feature	Culvert - Undercrossing
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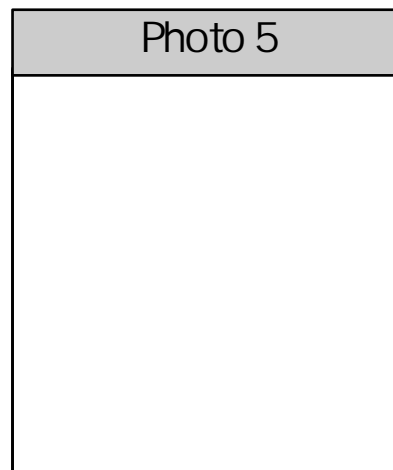
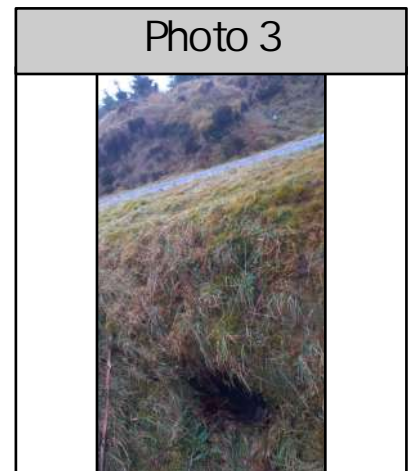
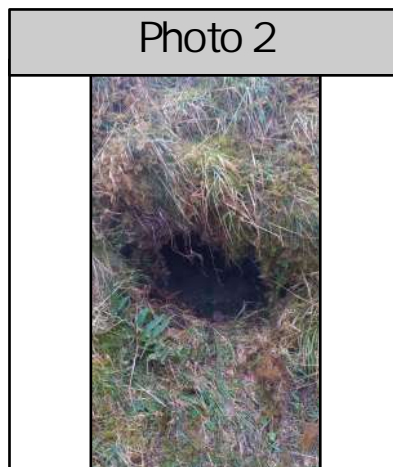
Survey Notes	600mm culvert semi dry, 700mm cover
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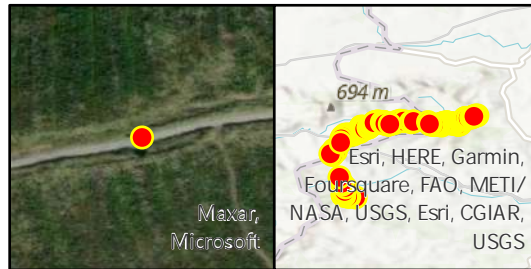




Survey Feature	Culvert - Undercrossing
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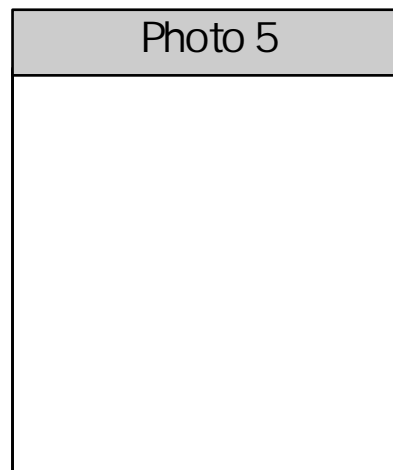
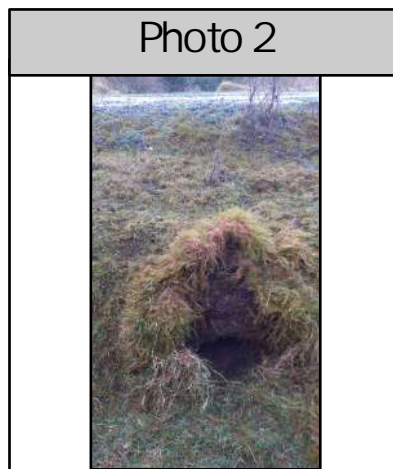
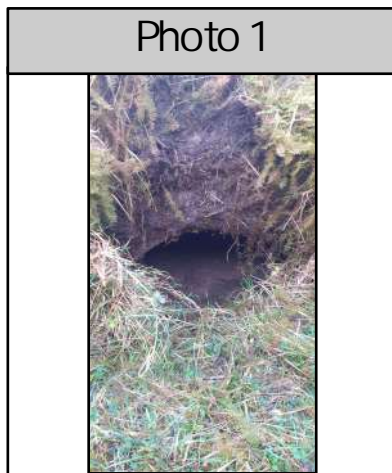
Survey Notes	At the locat on of JB06, exist ng culvert 600mm, 800mm cover above
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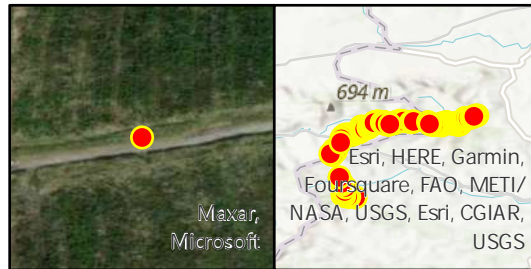




Survey Feature	Culvert - Undercrossing
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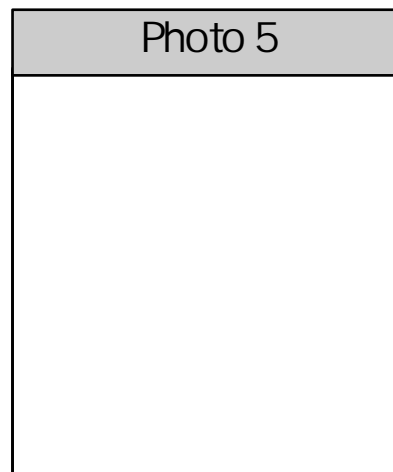
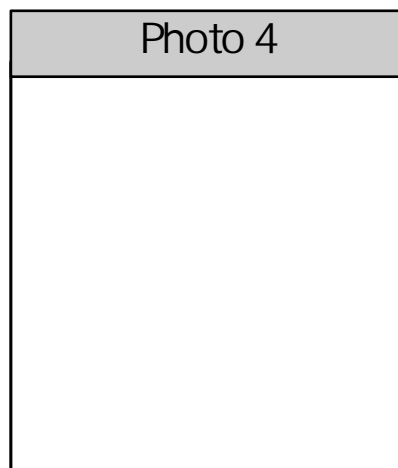
Survey Notes	600mm pipe 800mm cover
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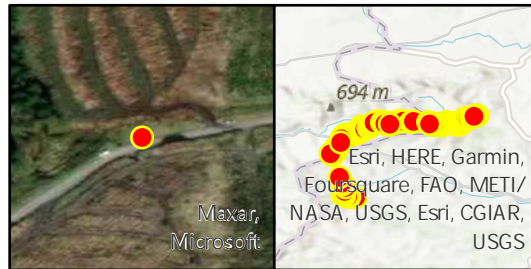




Survey Feature	Culvert - Undercrossing
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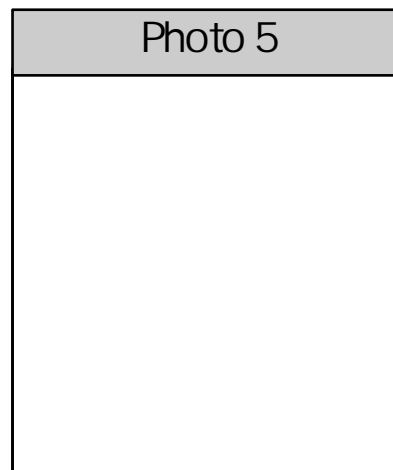
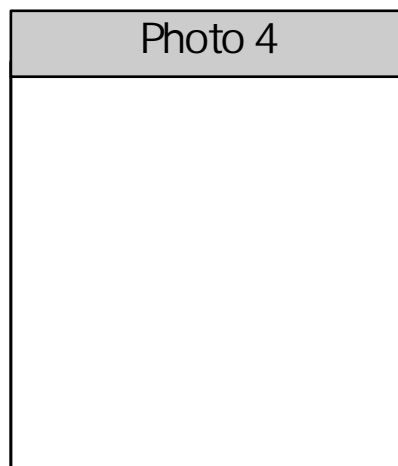
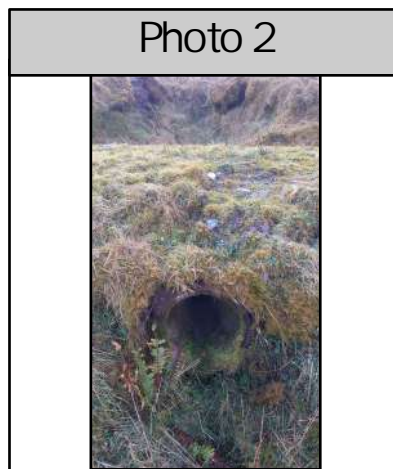
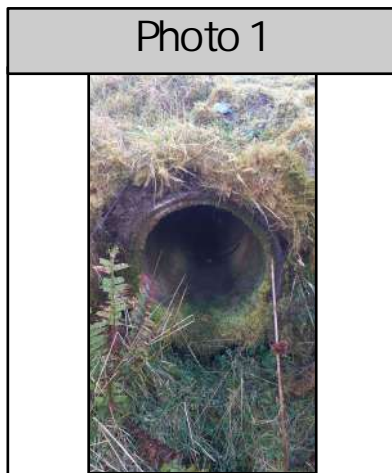
Survey Notes	600mm culvert.. Semi dry 300mm cover
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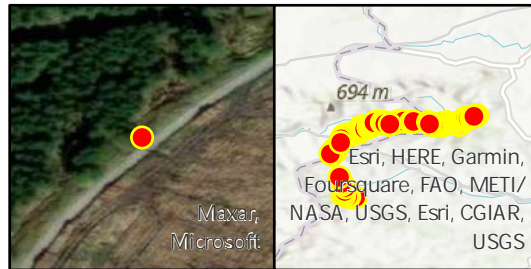




Survey Feature	Culvert - Undercrossing
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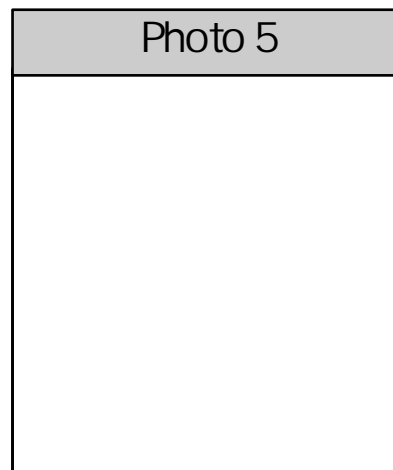
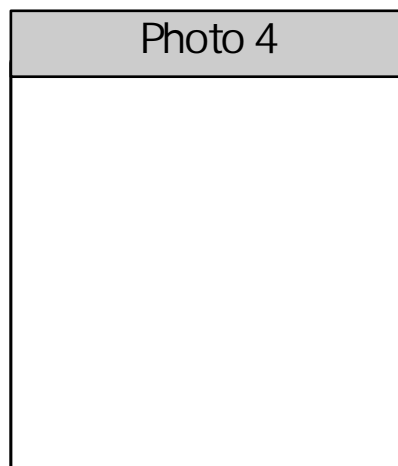
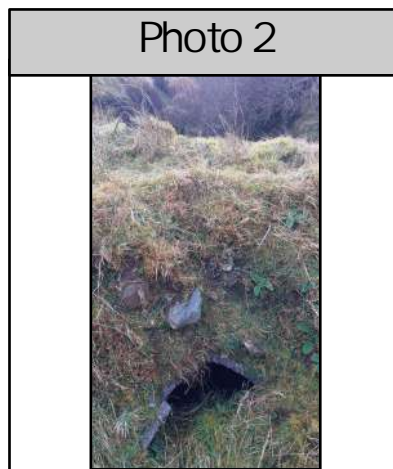
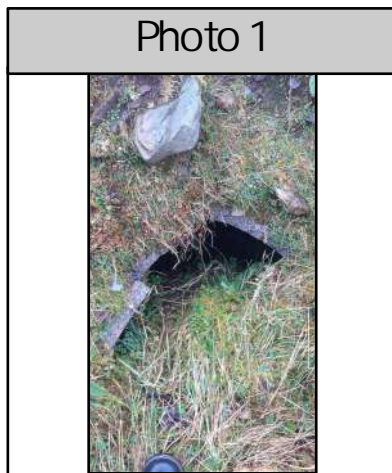
Survey Notes	600mm concrete pipe 600mm cover
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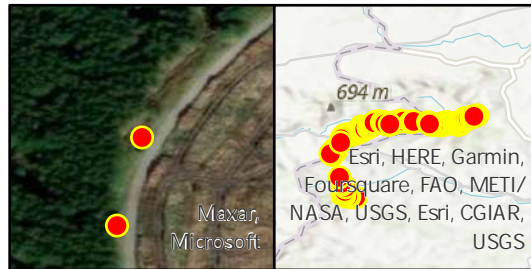




Survey Feature	Culvert - Undercrossing
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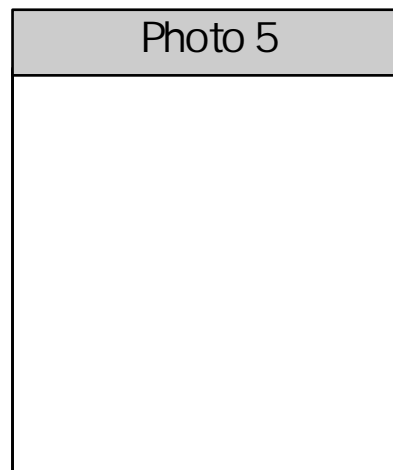
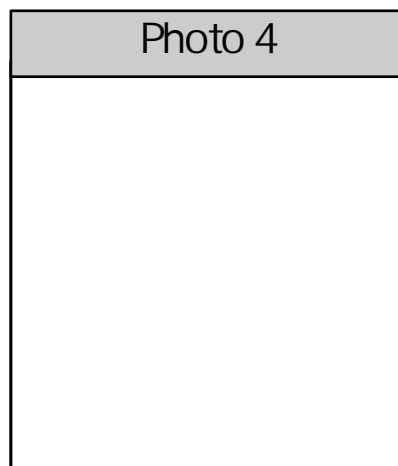
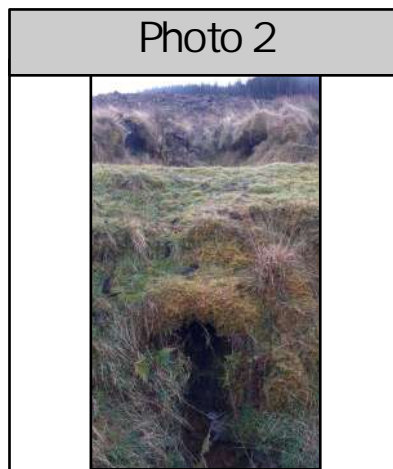
Survey Notes	600mm culvert 800mm cover
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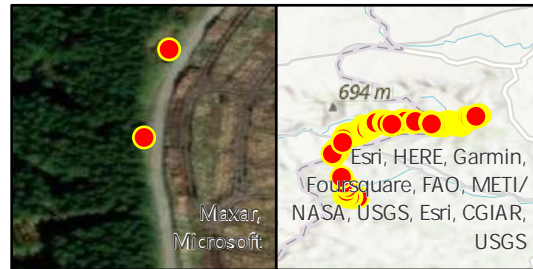




Survey Feature	Culvert - Undercrossing
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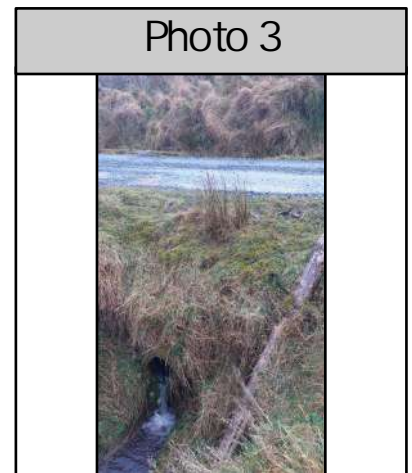
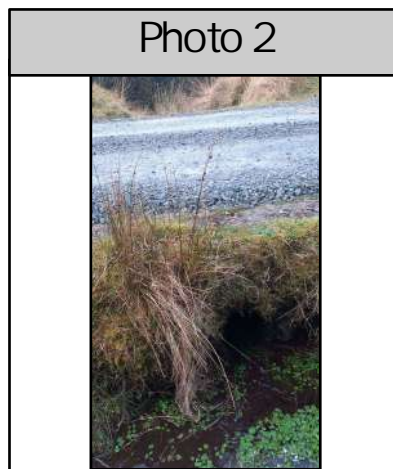
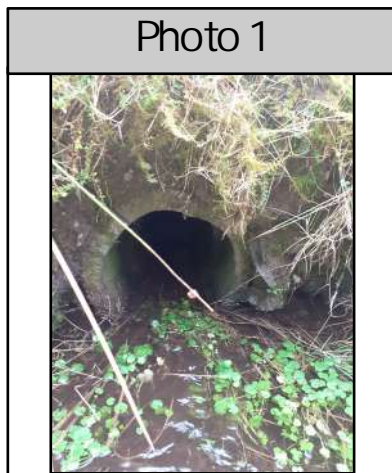
Survey Notes	600mm pipe 1000mm cover
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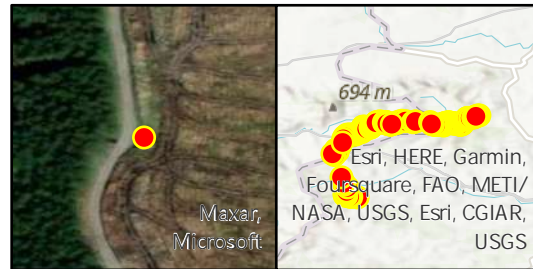




Survey Feature	Culvert - Undercrossing
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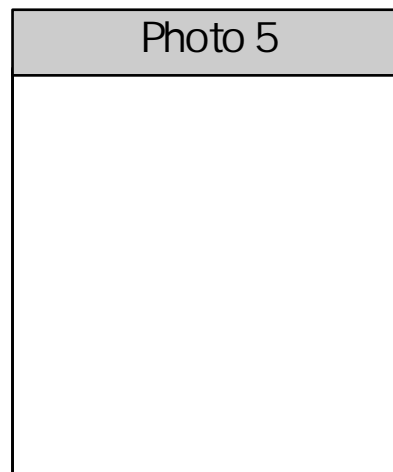
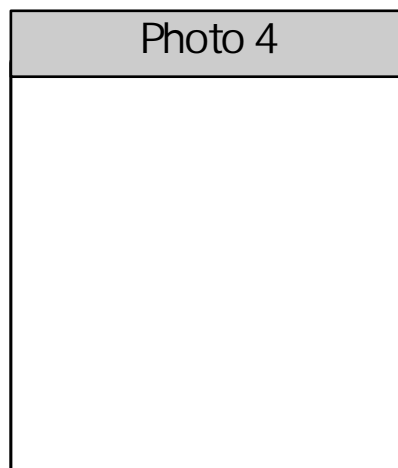
Survey Notes	Culvert 400mm concrete 400mm cover
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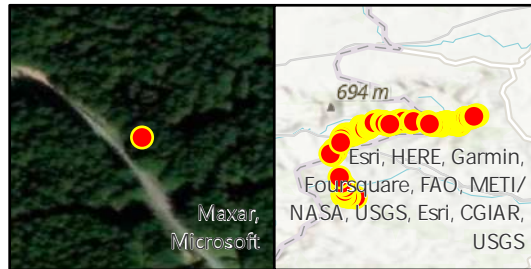




Survey Feature	Culvert - Undercrossing
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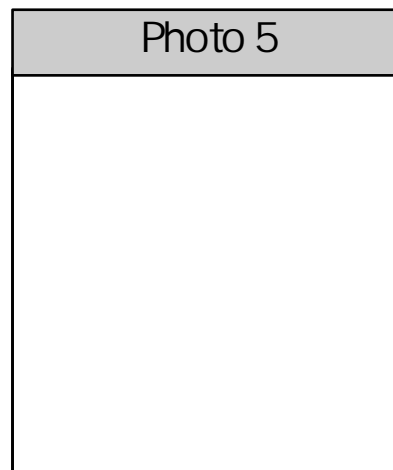
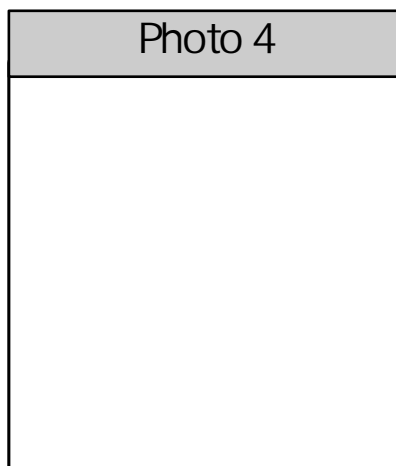
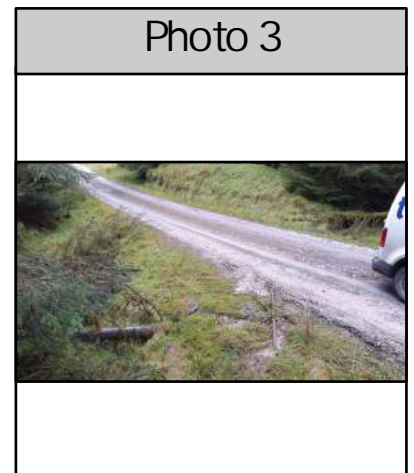
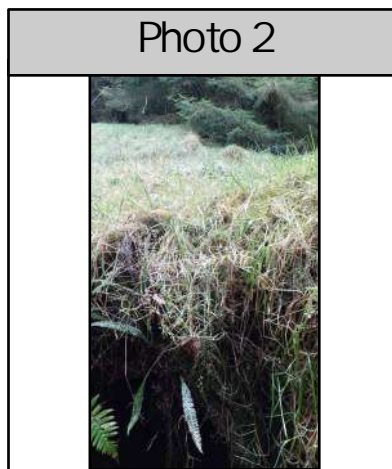
Survey Notes	700mm concrete pipe 600mm over
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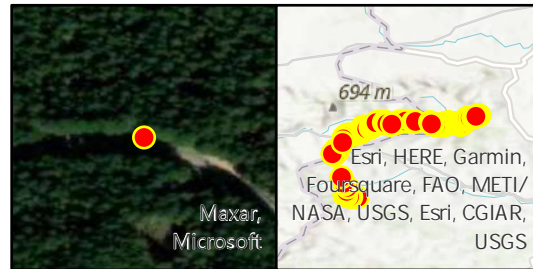




Survey Feature	Culvert - Undercrossing
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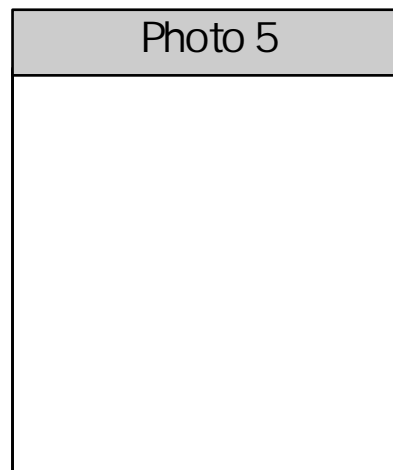
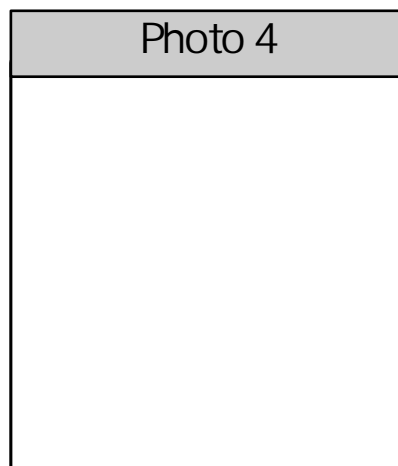
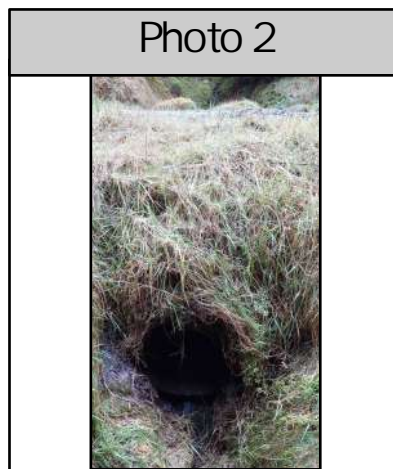
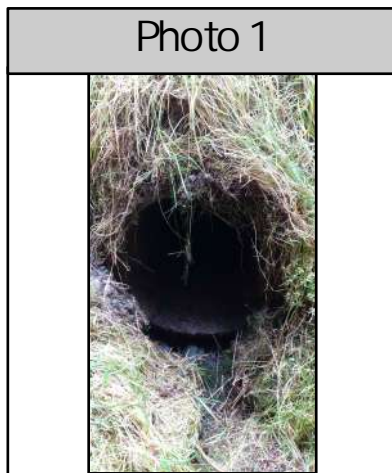
Survey Notes	600mm pipe 600mm cover
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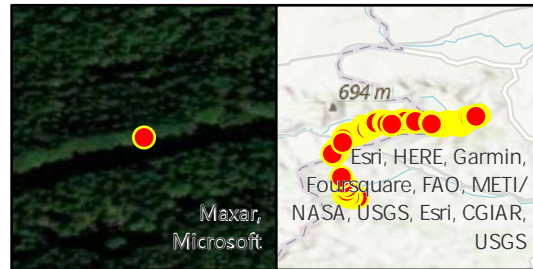




Survey Feature	Culvert - Undercrossing
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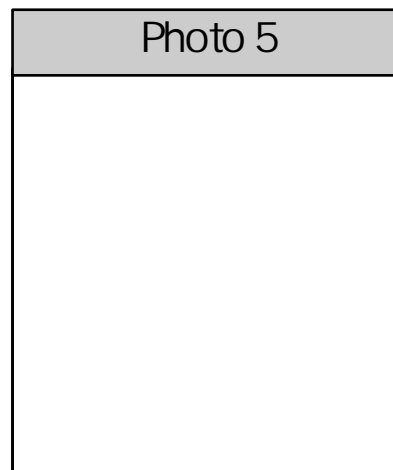
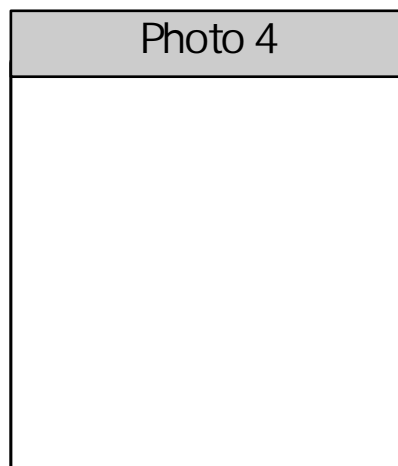
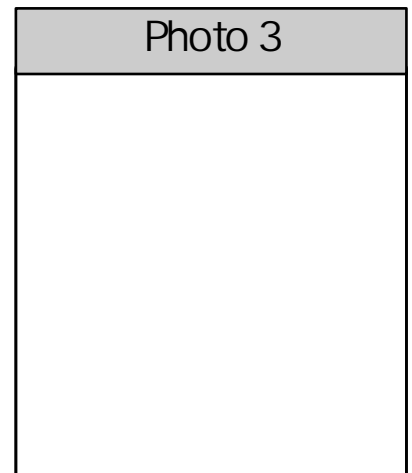
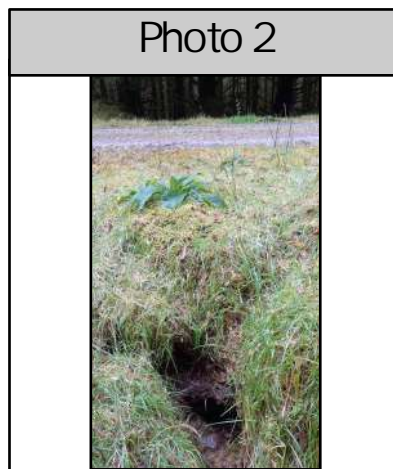
Survey Notes	400mm pipe 700mm cover
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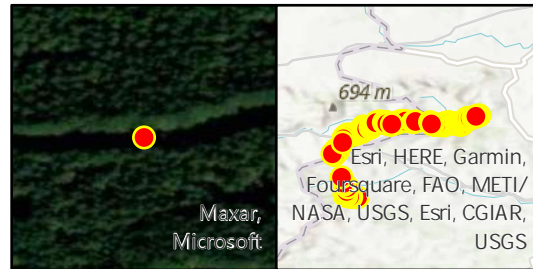




Survey Feature	Culvert - Undercrossing
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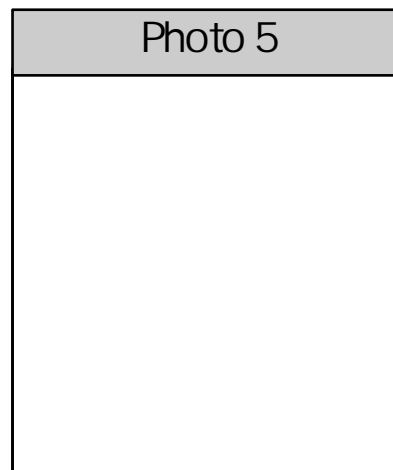
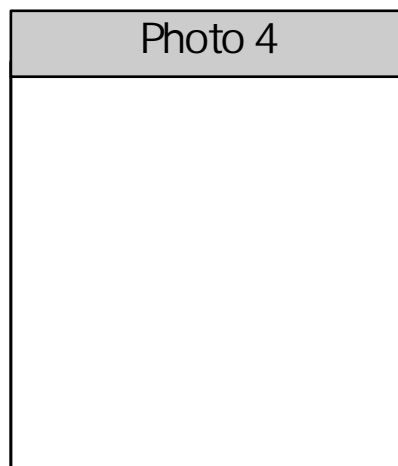
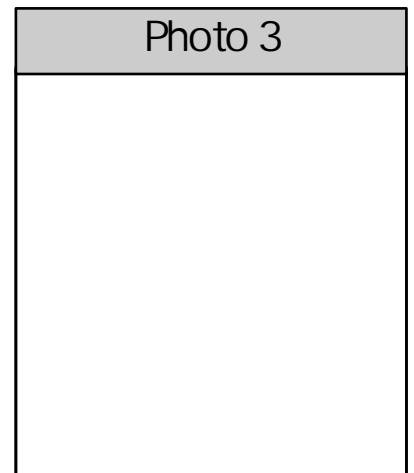
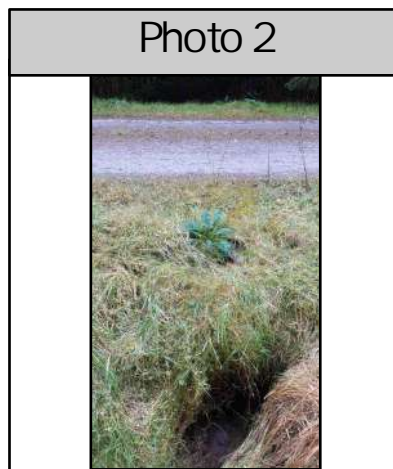
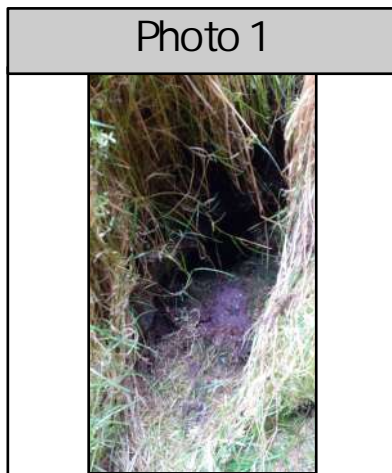
Survey Notes	600mm buried culvert 500mm cover above
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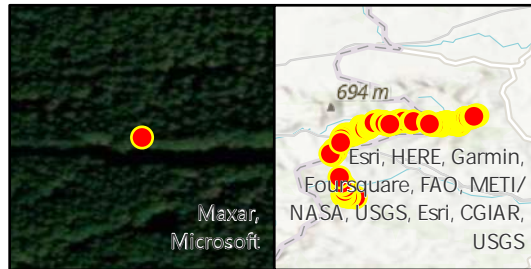




Survey Feature	Culvert - Undercrossing
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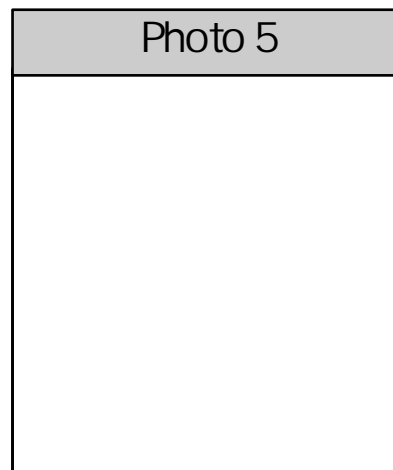
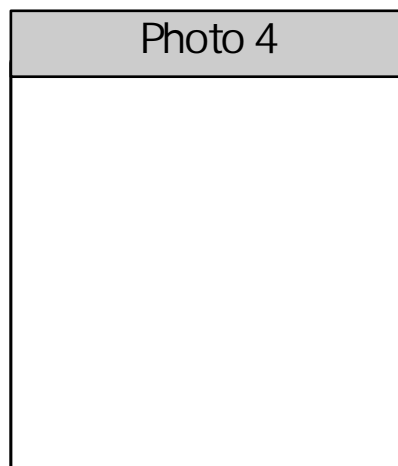
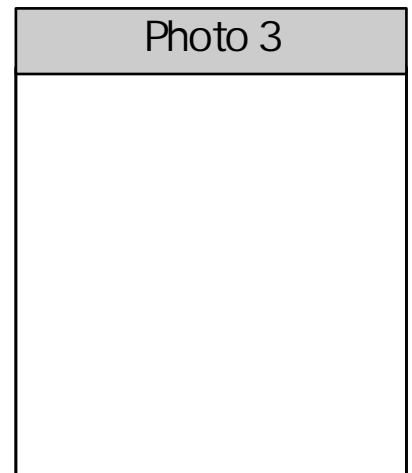
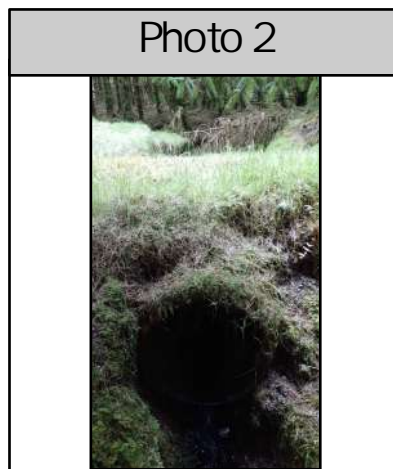
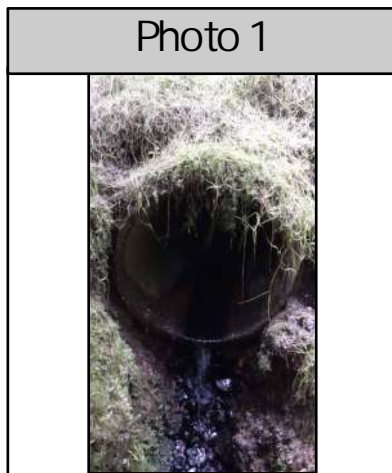
Survey Notes	600mm buried culvert 500mm cover
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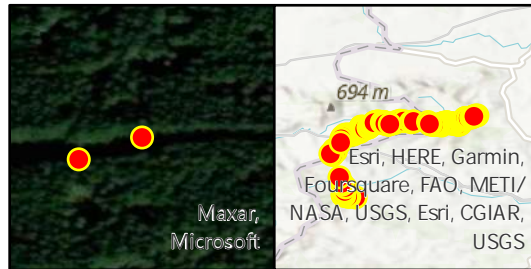




Survey Feature	Culvert - Undercrossing
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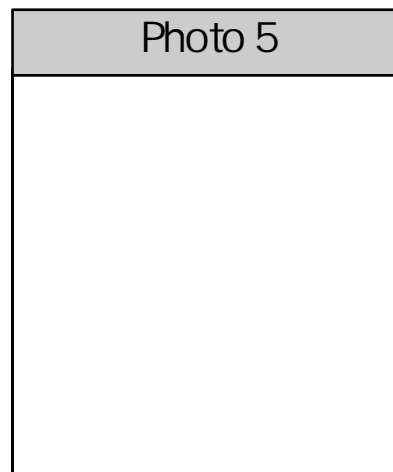
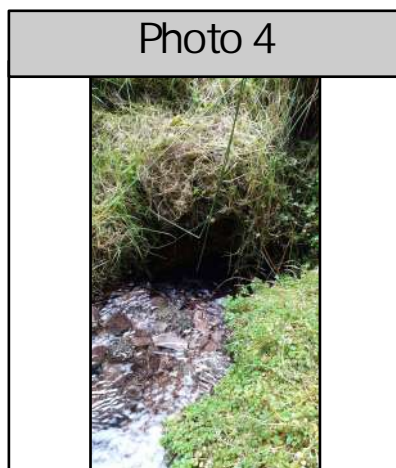
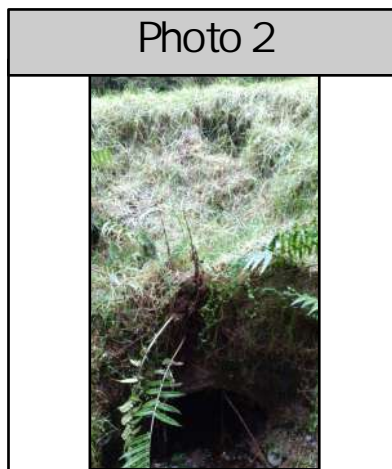
Survey Notes	600mm culvert 600mm cover
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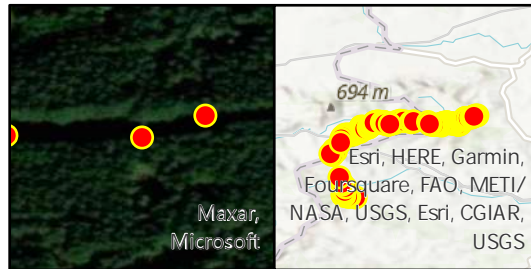




Survey Feature	Culvert - Undercrossing
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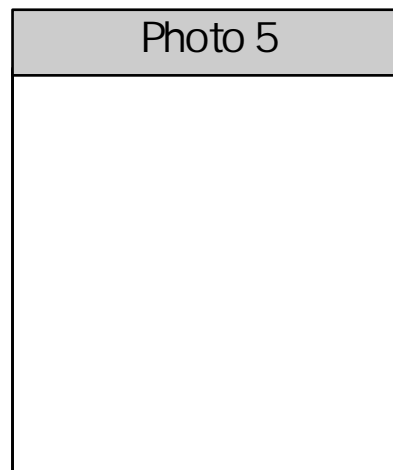
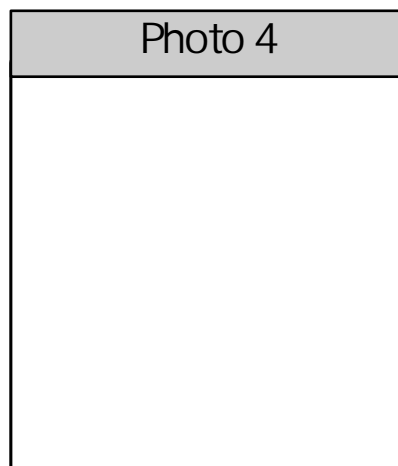
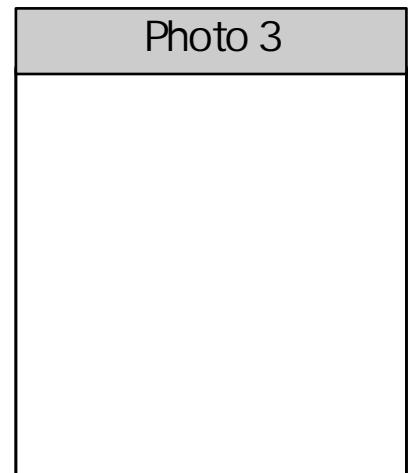
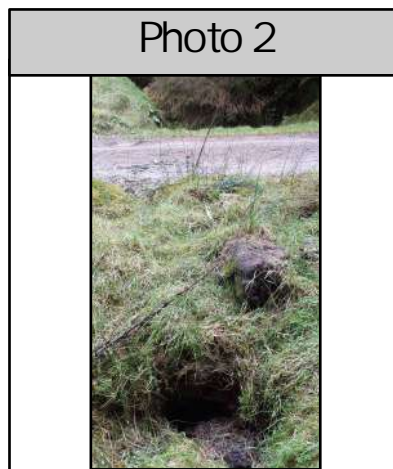
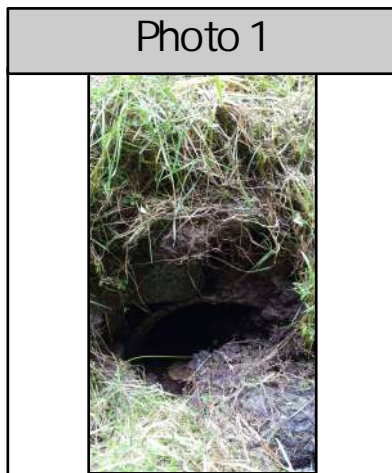
Survey Notes	600mm concrete pipe 1250mm cover
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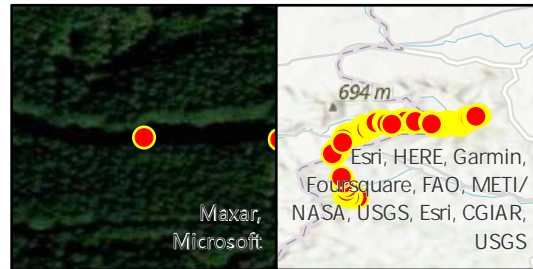




Survey Feature	Culvert - Undercrossing
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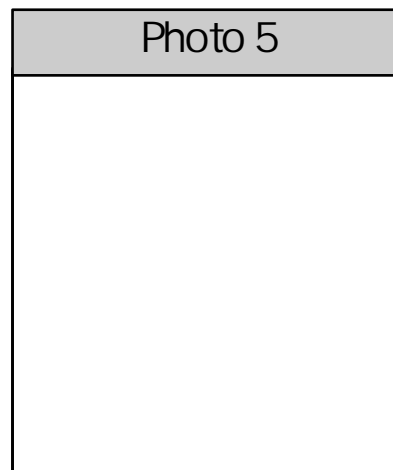
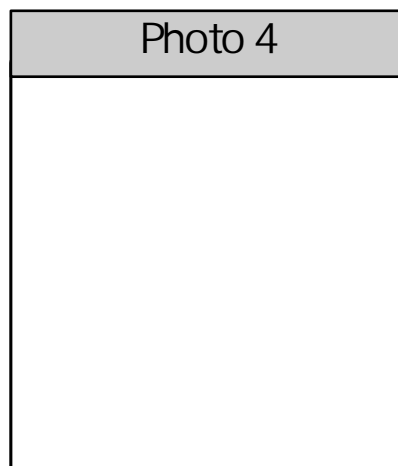
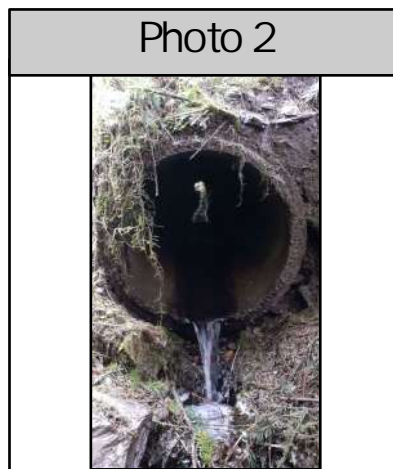
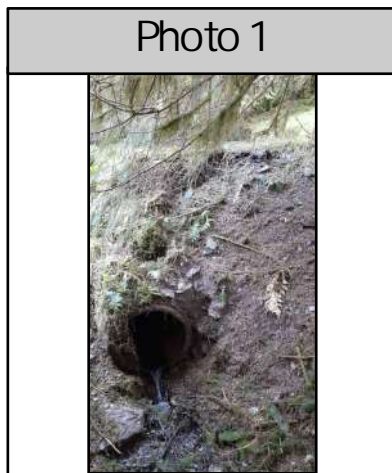
Survey Notes	600mm pipe 500mm cover
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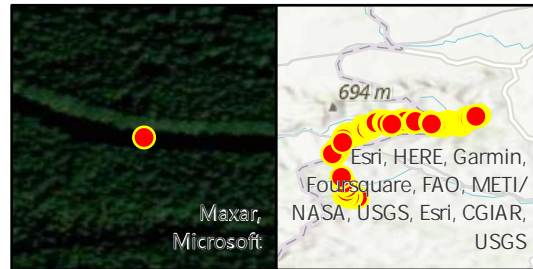




Survey Feature	Culvert - Undercrossing
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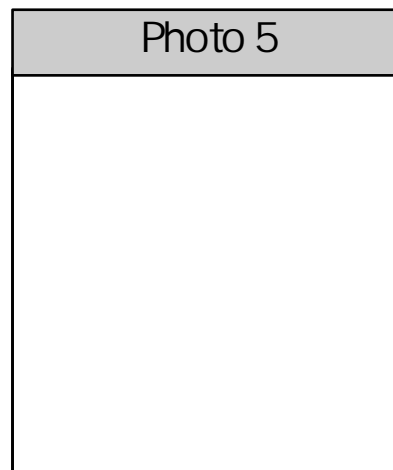
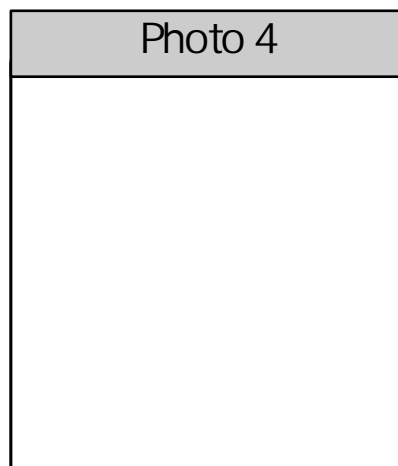
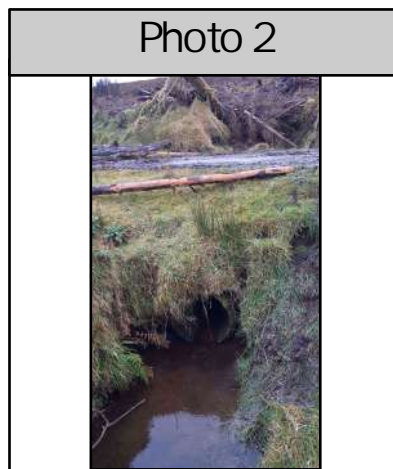
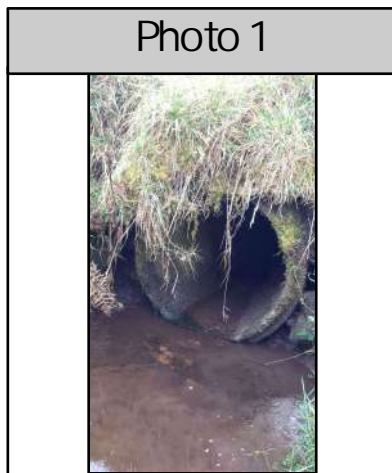
Survey Notes	600mm pipe 800mm cover
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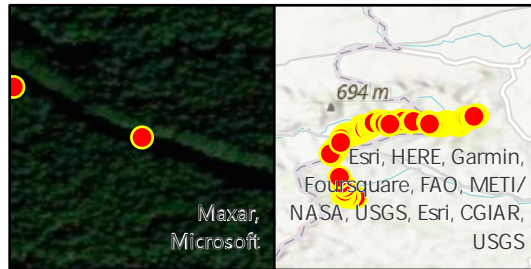




Survey Feature	Culvert - Undercrossing
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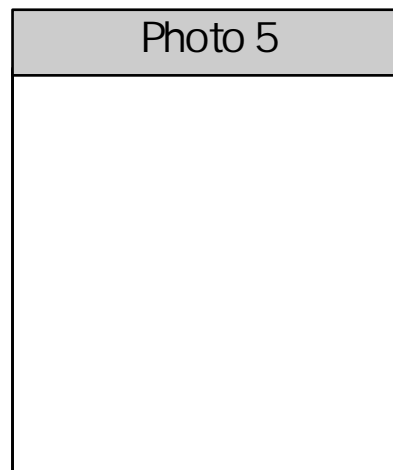
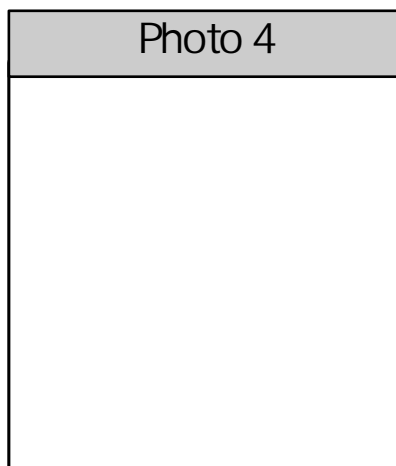
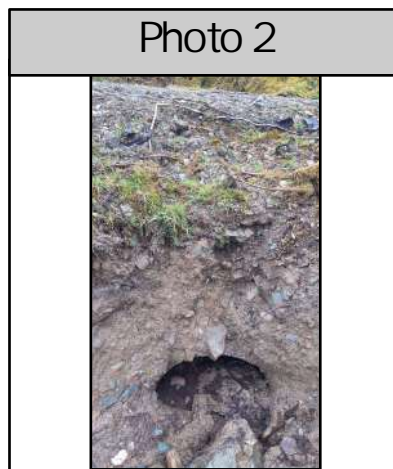
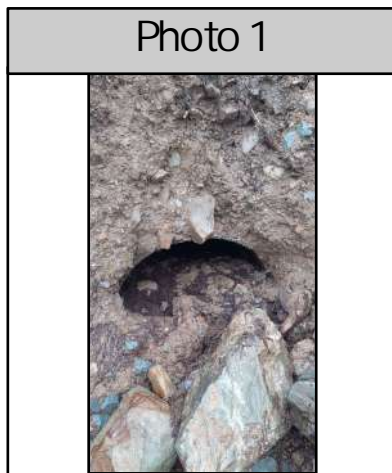
Survey Notes	600mm pipe, cover 1000mm
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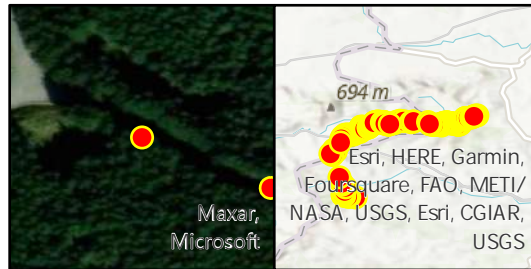




Survey Feature	Culvert - Undercrossing
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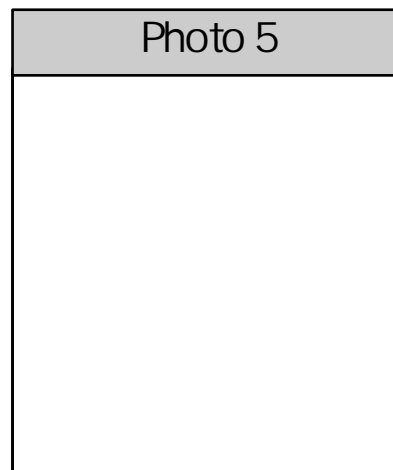
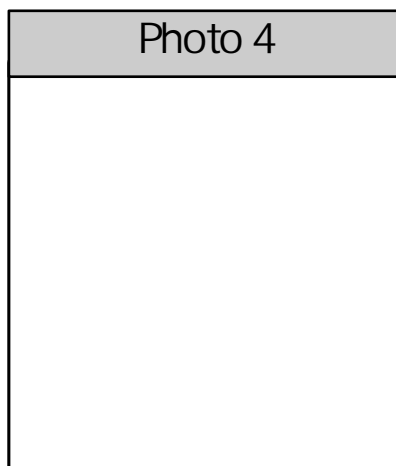
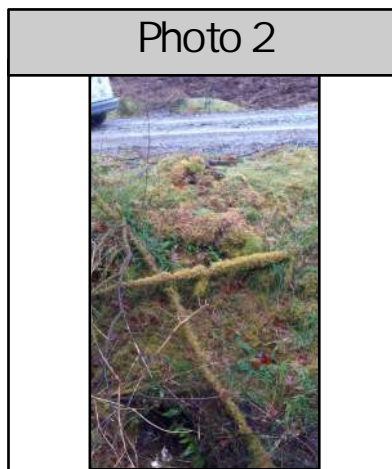
Survey Notes	Buried culvert 600mm pipe 700mm cover
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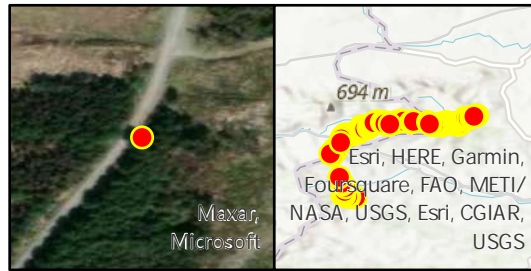




Survey Feature	Culvert - Undercrossing
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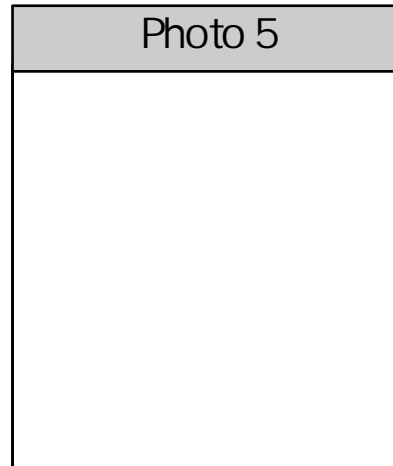
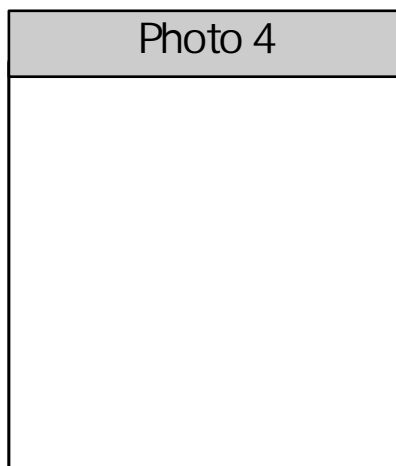
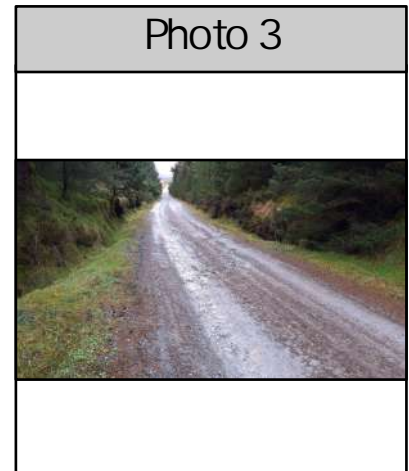
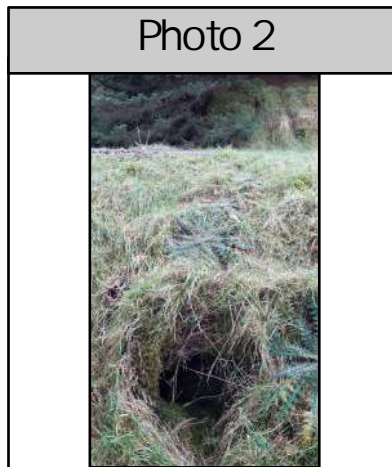
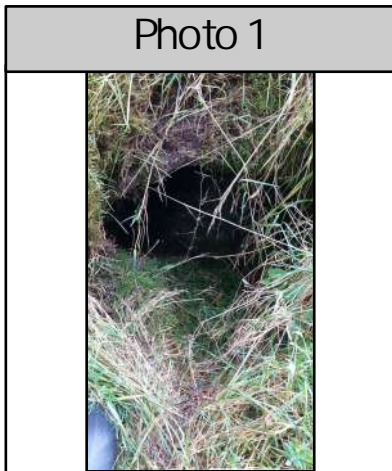
Survey Notes	Buried culvert 600mm pipe 600mm cover
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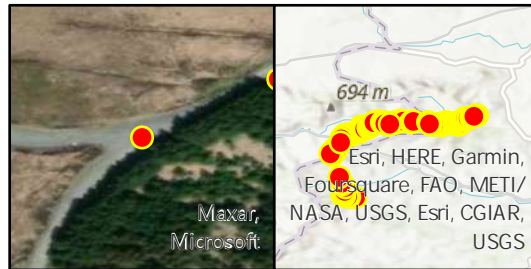




Survey Feature	Culvert - Undercrossing
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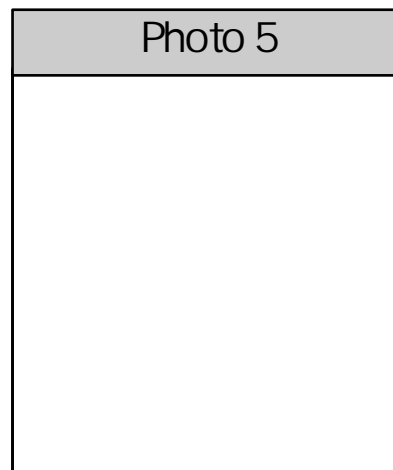
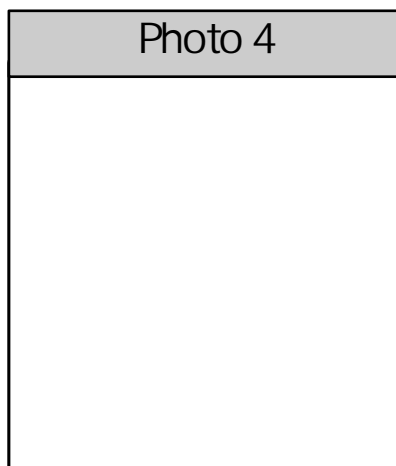
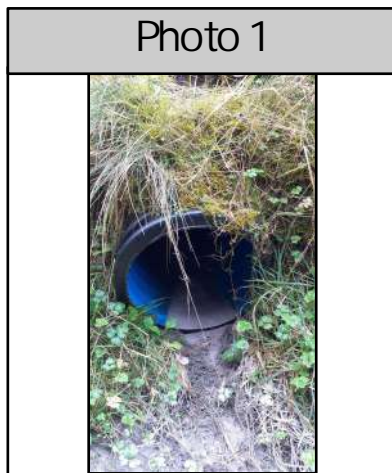
Survey Notes	600mm concrete 700mm cover
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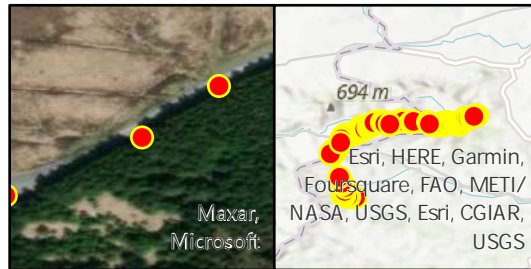




Survey Feature	Culvert - Undercrossing
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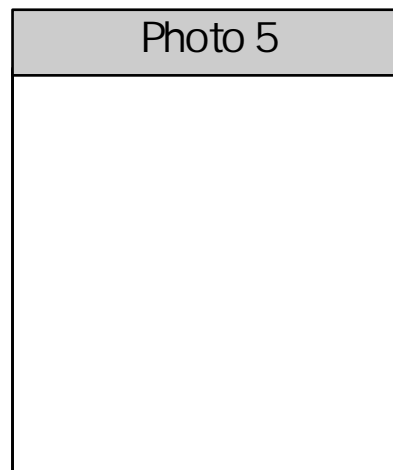
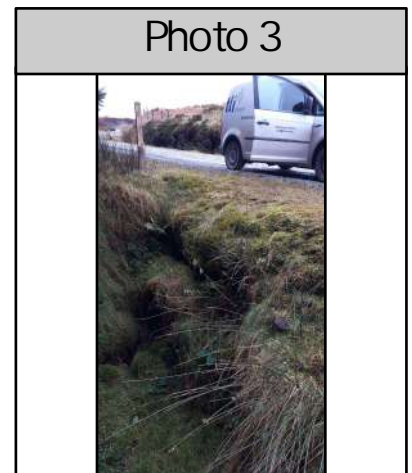
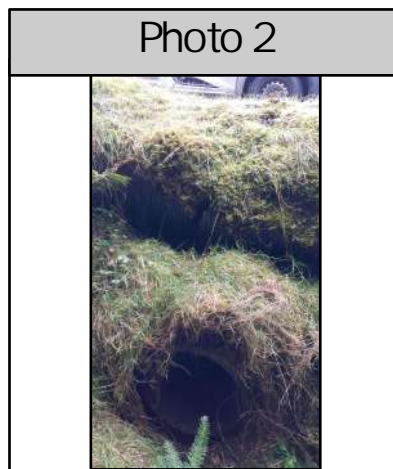
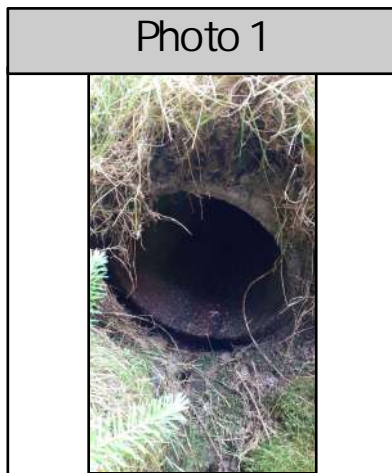
Survey Notes	Culvert 45 degree 400mm twinwall 600mm cover
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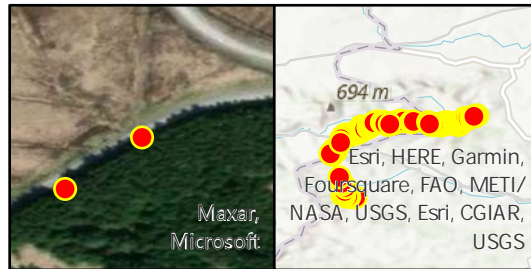




Survey Feature	Culvert - Undercrossing
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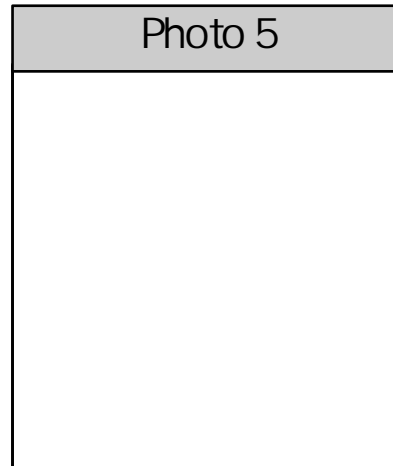
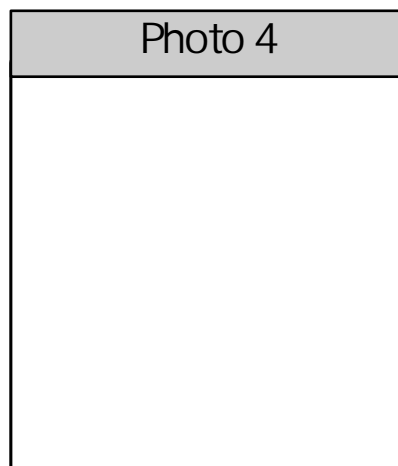
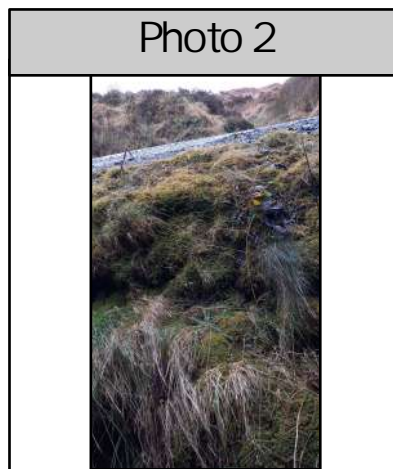
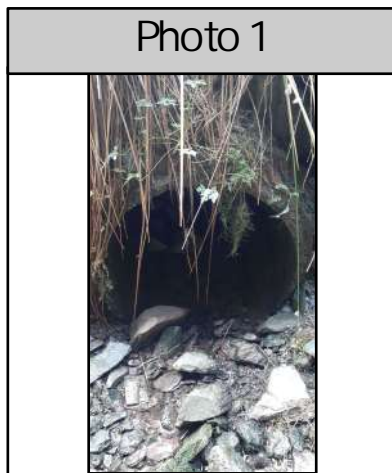
Survey Notes	600mm concrete pipe 1100mm cover
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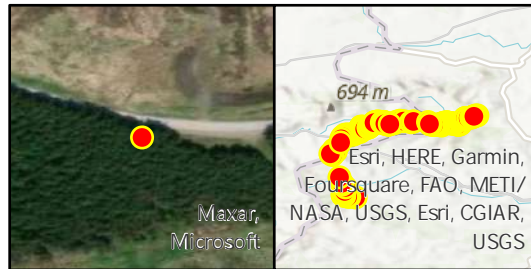




Survey Feature	Culvert - Undercrossing
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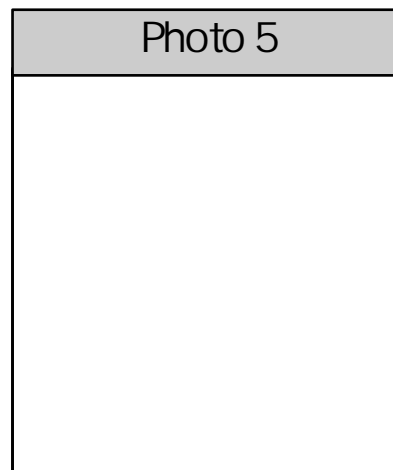
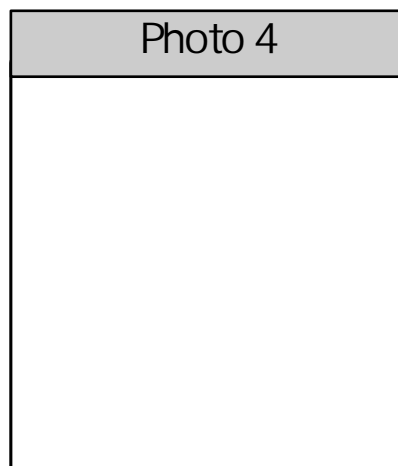
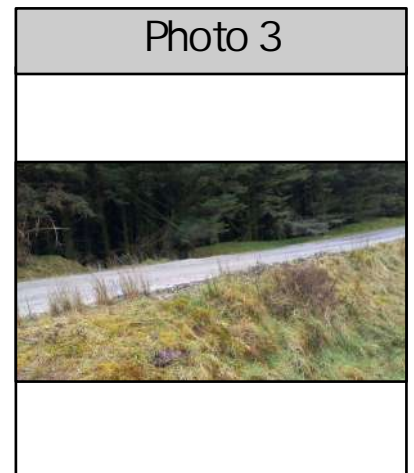
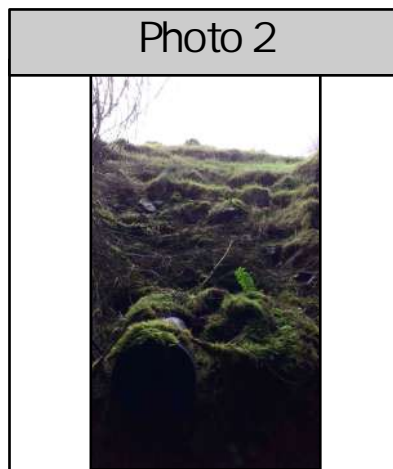
Survey Notes	600mm pipe 1350mm cover above
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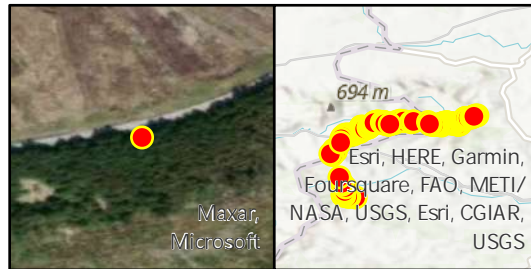




Survey Feature	Culvert - Undercrossing
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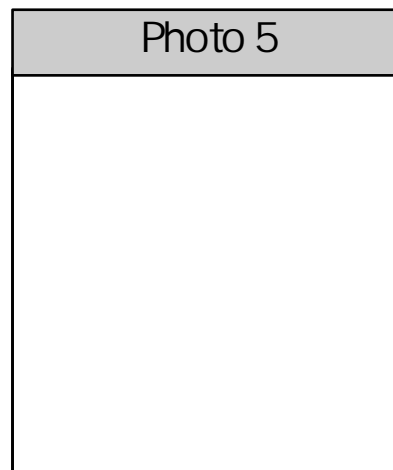
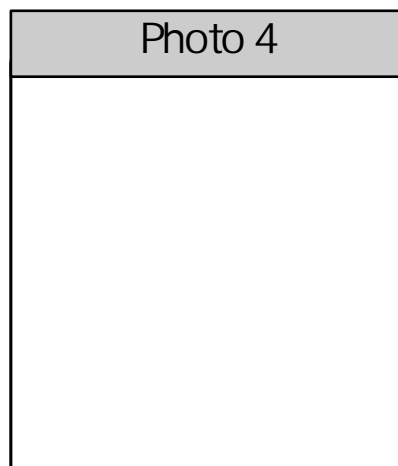
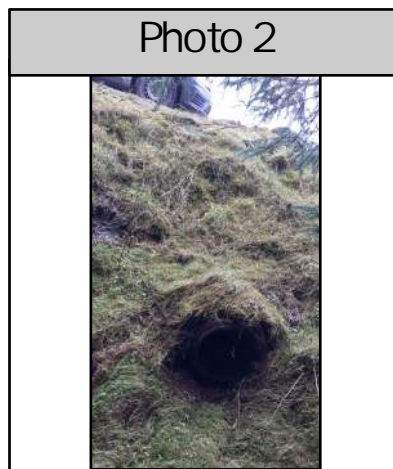
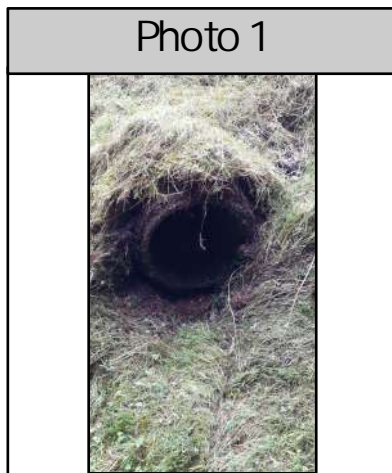
Survey Notes	400mm twinwall 1100mm cover
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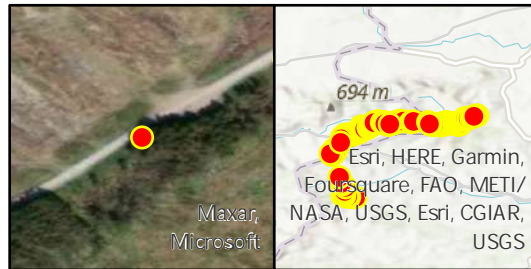




Survey Feature	Culvert - Undercrossing
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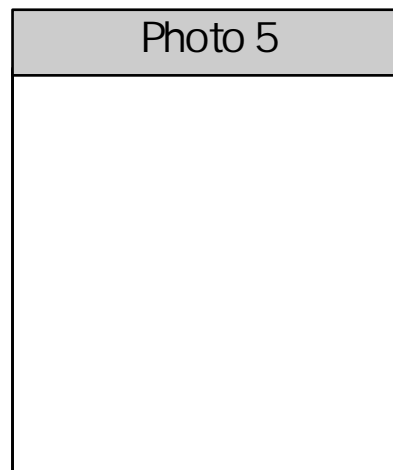
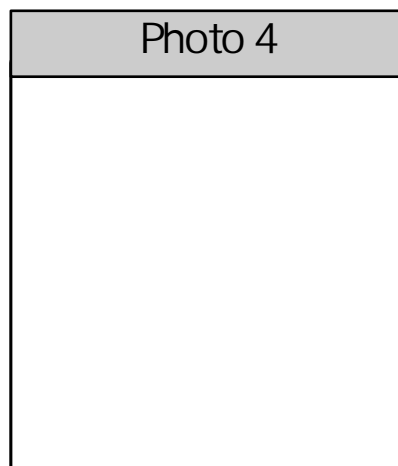
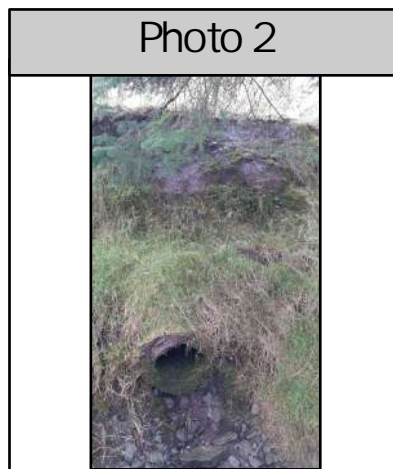
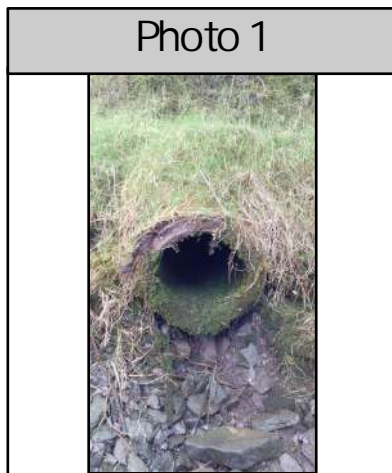
Survey Notes	600mm concrete 1 400mm cover
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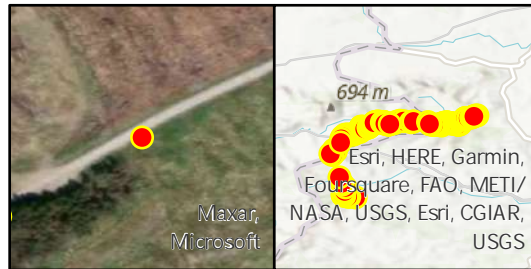




Survey Feature	Culvert - Undercrossing
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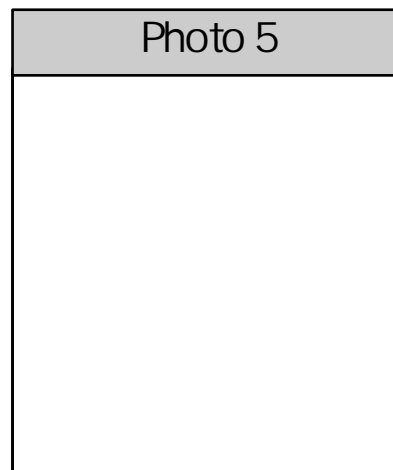
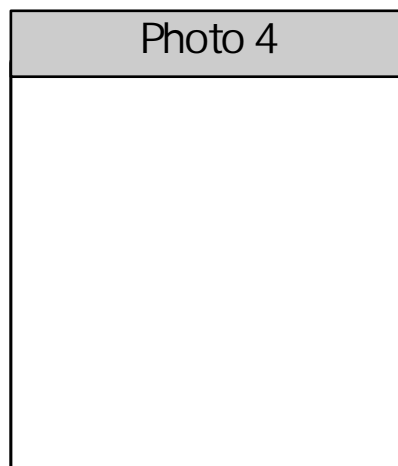
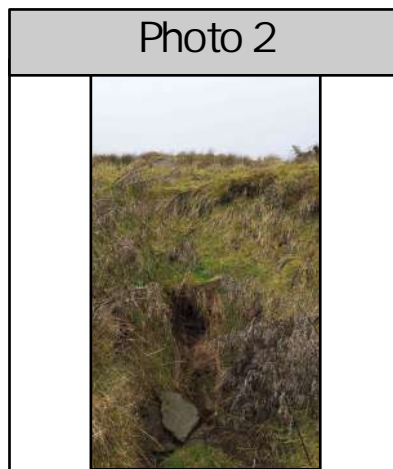
Survey Notes	400mm concrete pipe 1350mm cover
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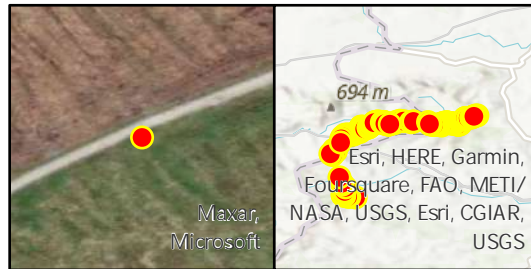




Survey Feature	Culvert - Undercrossing
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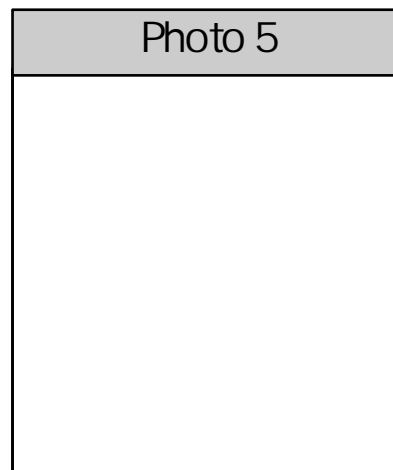
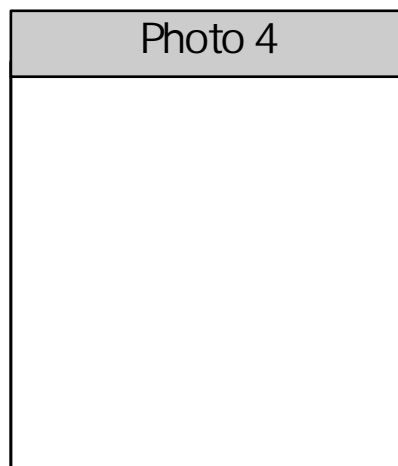
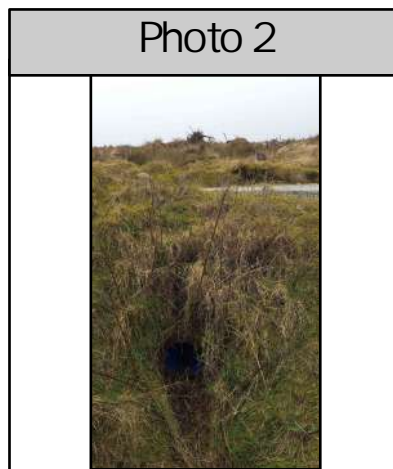
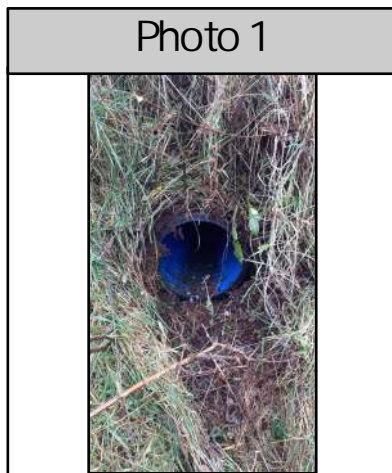
Survey Notes	400mm twinwall 1700mm cover
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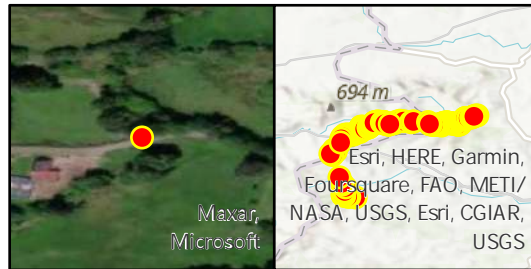




Survey Feature	Culvert - Undercrossing
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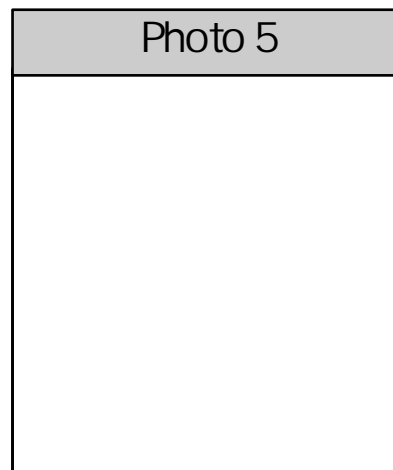
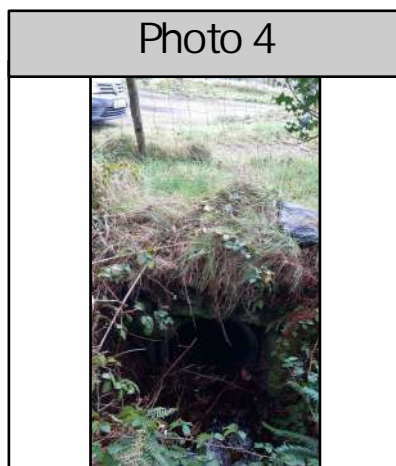
Survey Notes	400mm twinwall 1200mm cover
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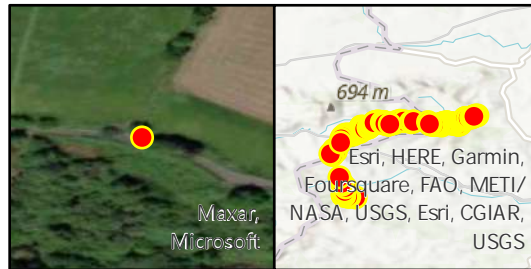




Survey Feature	Culvert - Undercrossing
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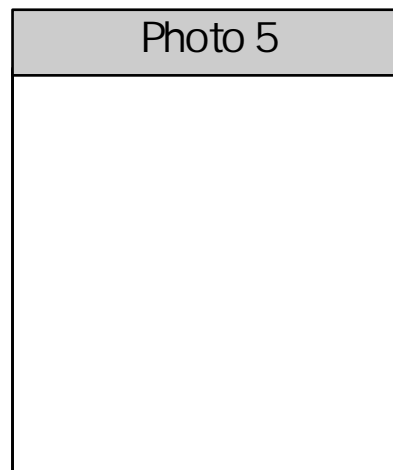
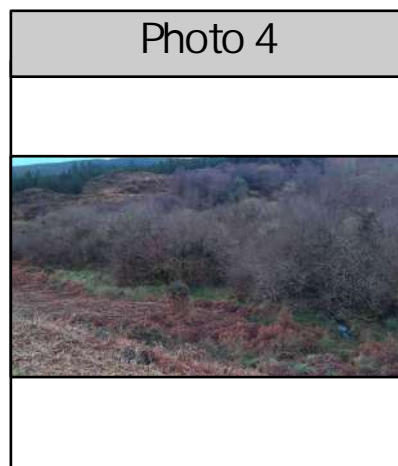
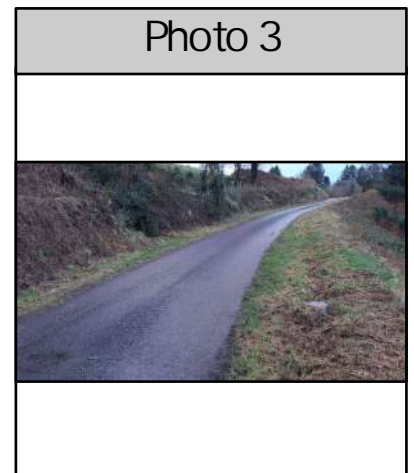
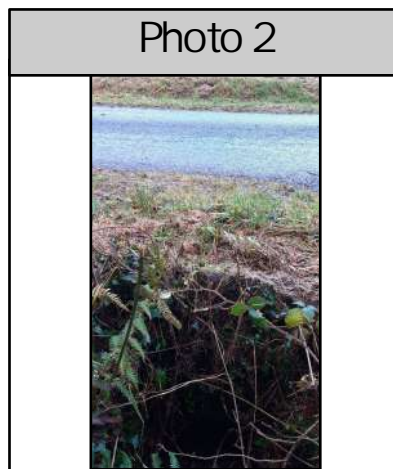
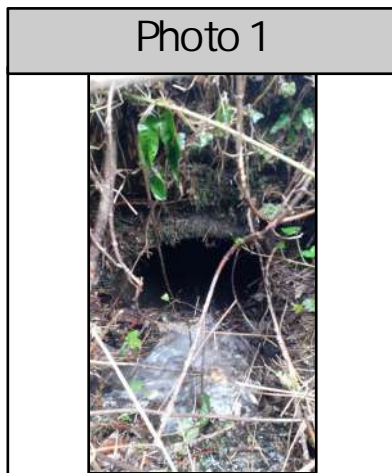
Survey Notes	600mm concrete culvert, shallow cover, undercross
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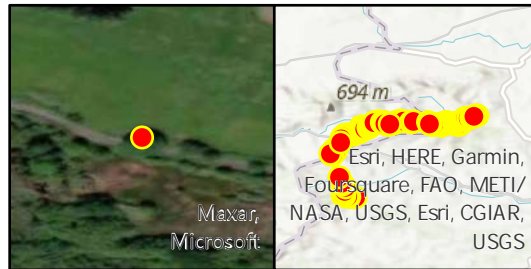




Survey Feature	Culvert - Undercrossing
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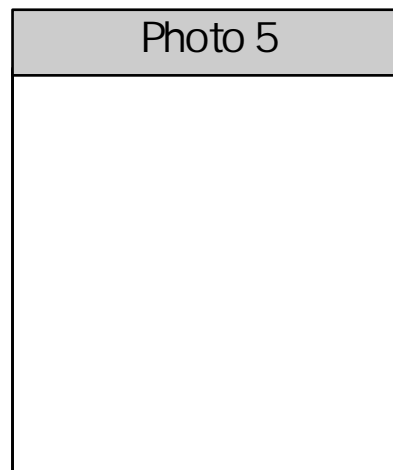
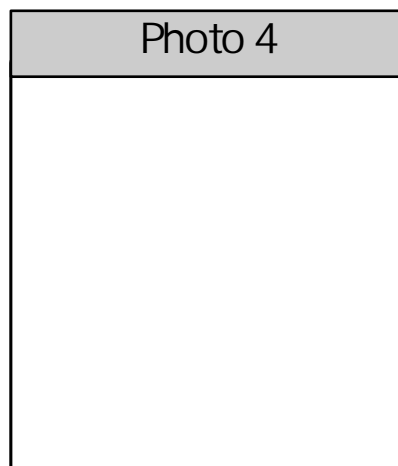
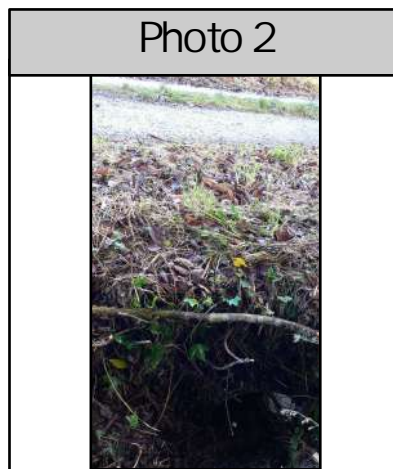
Survey Notes	Culvert road crossing. 600mm concrete 400mm cover
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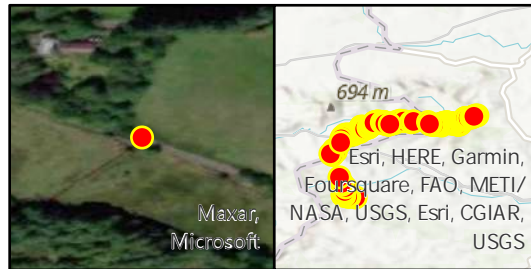




Survey Feature	Culvert - Undercrossing
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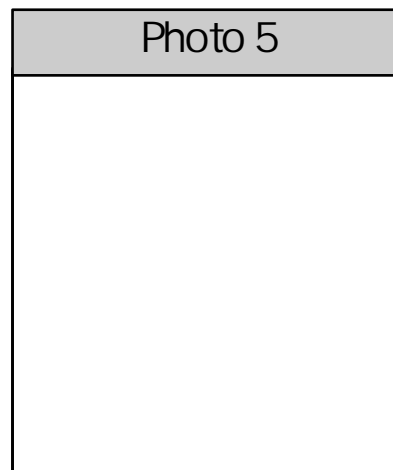
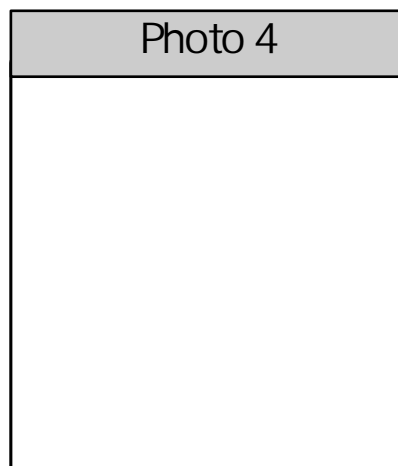
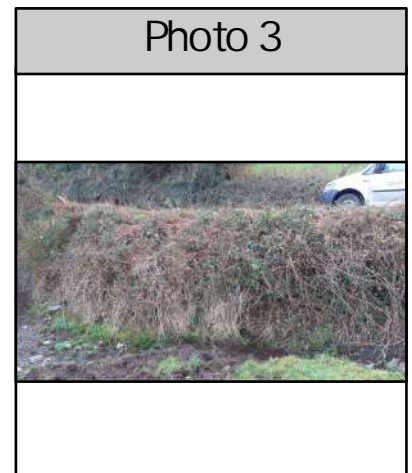
Survey Notes	400mm twinwall 300mm cover
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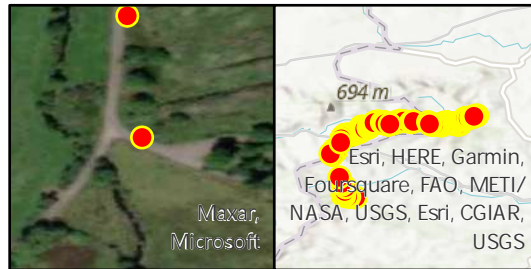




Survey Feature	Culvert - Undercrossing
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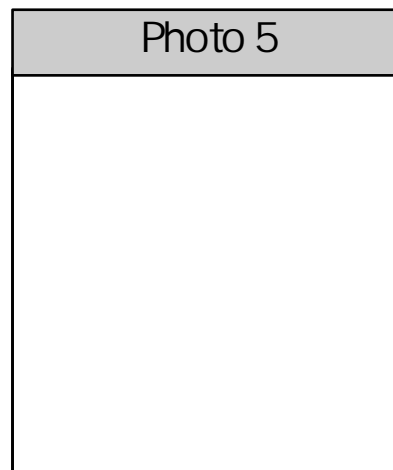
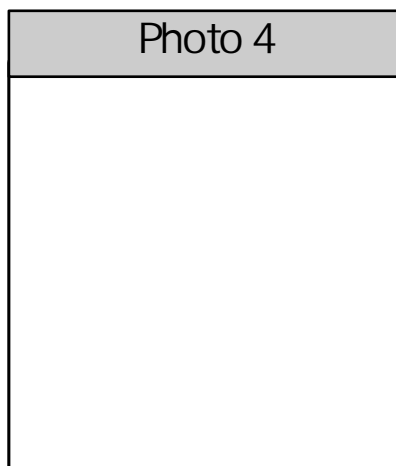
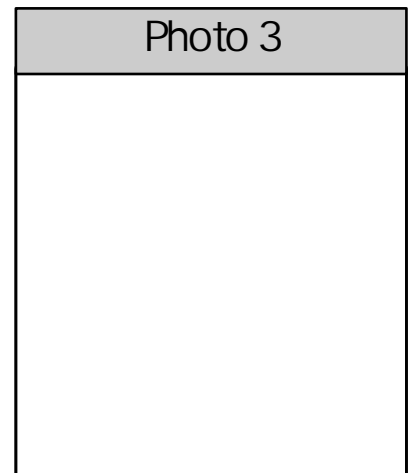
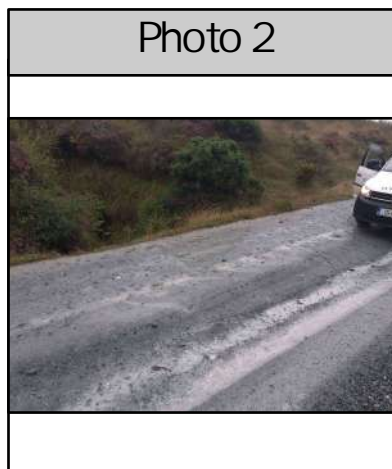
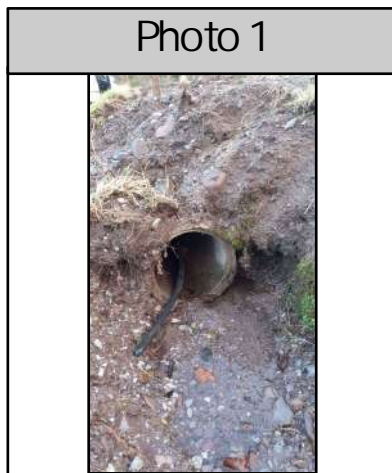
Survey Notes	Stone drain 200mm Road cover
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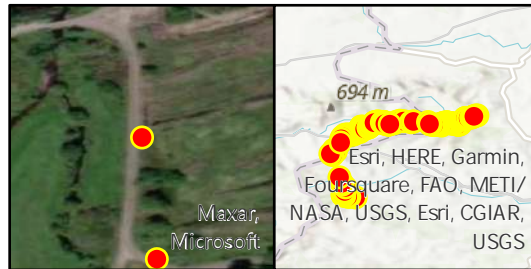




Survey Feature	Culvert - Undercrossing
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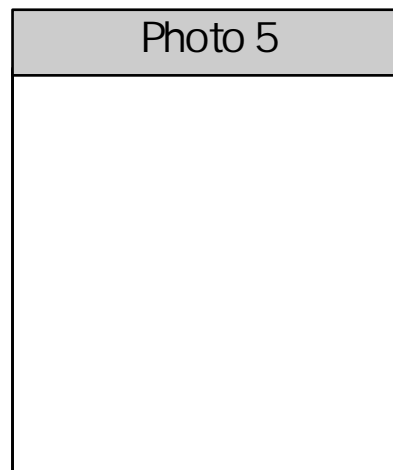
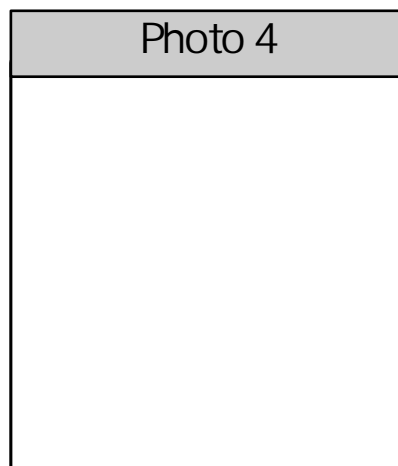
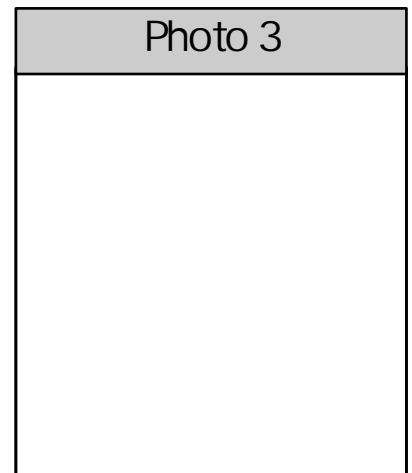
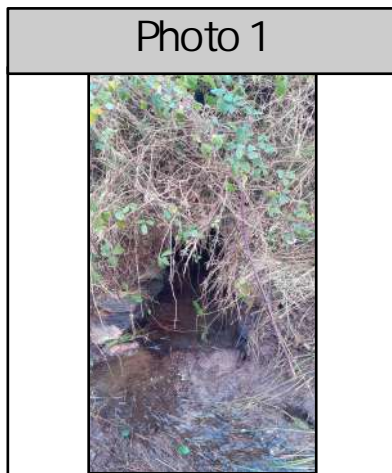
Survey Notes	400mm concrete pipe 100mm cover
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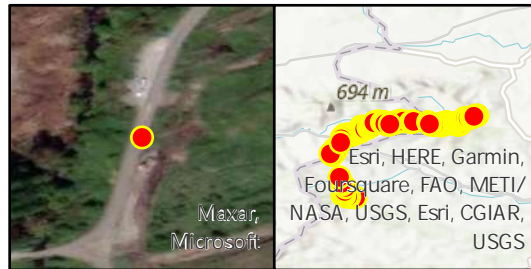




Survey Feature	Culvert - Undercrossing
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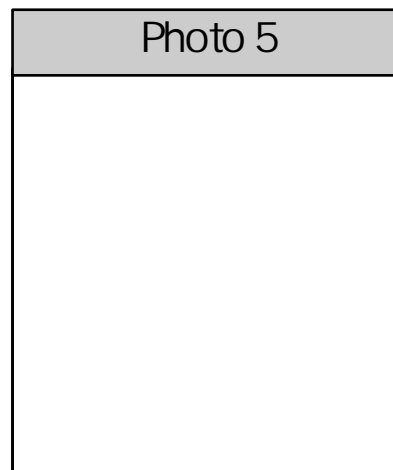
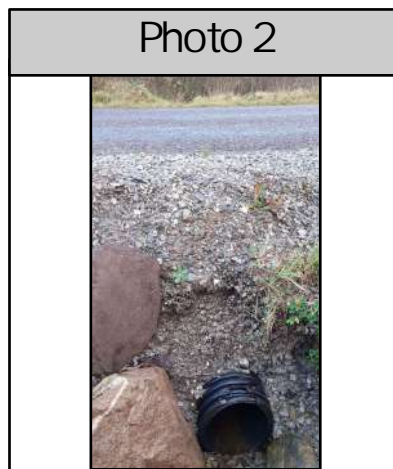
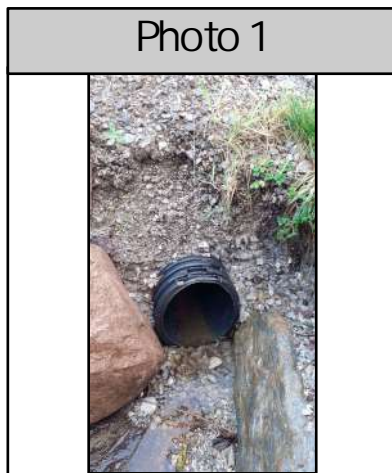
Survey Notes	Stone drain 400mm cover [Pump and Dam]
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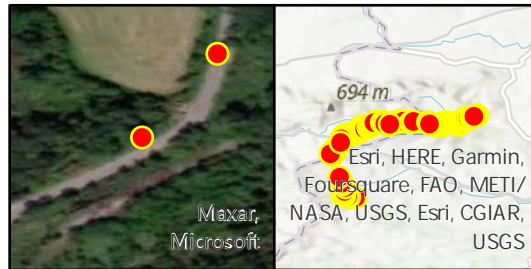




Survey Feature	Culvert - Undercrossing
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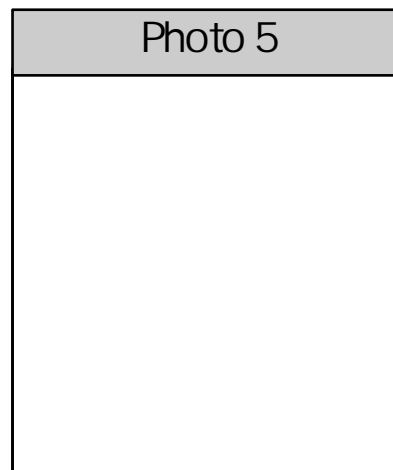
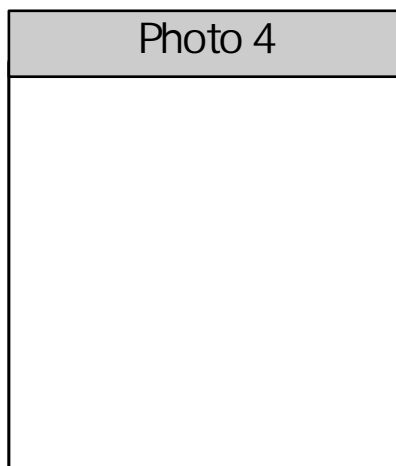
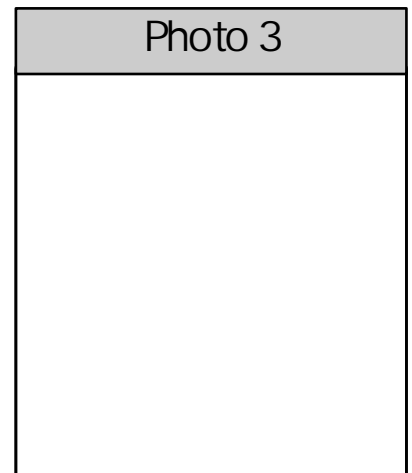
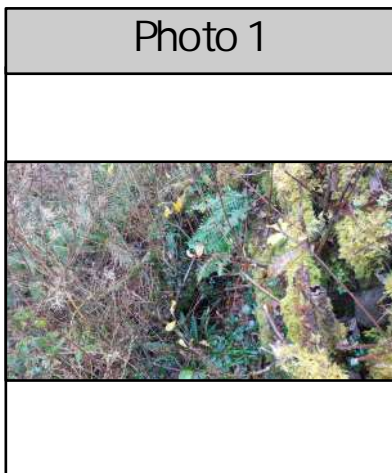
Survey Notes	250mm twinwall 500mm cover to road
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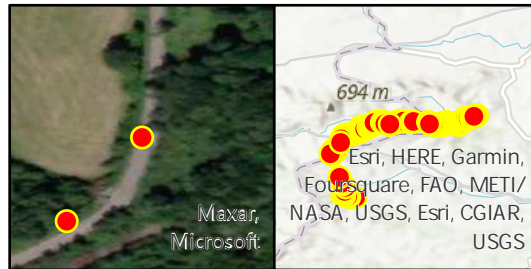




Survey Feature	Culvert - Overcrossing
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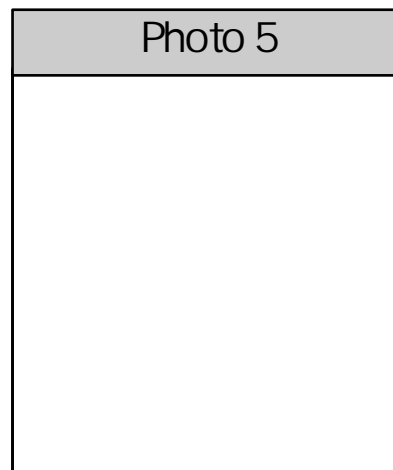
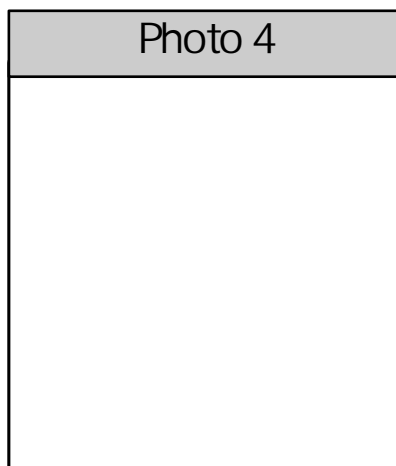
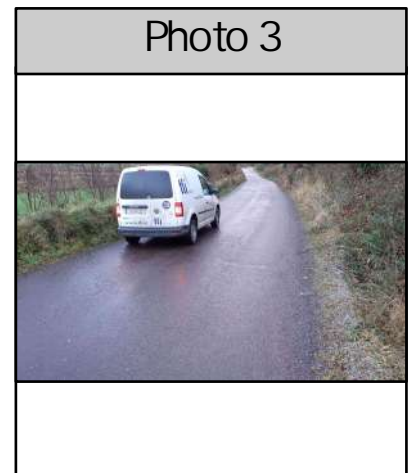
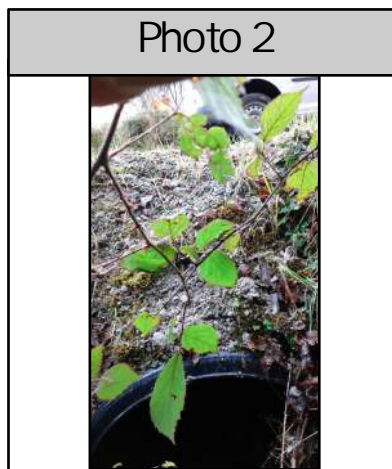
Survey Notes	Culvert / bridge. No visual 1000mm cover estimate
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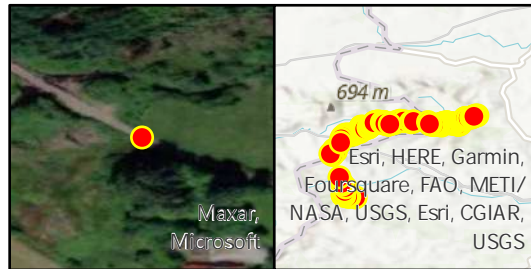




Survey Feature	Culvert - Undercrossing
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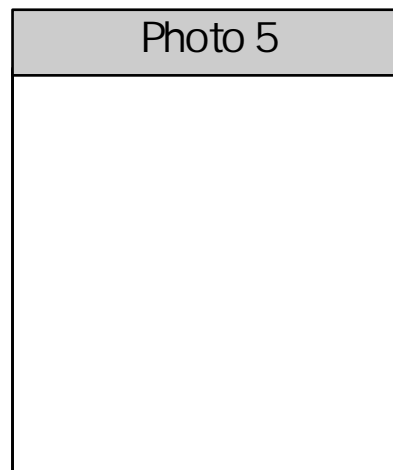
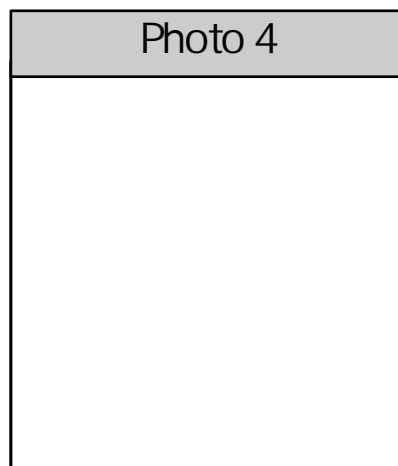
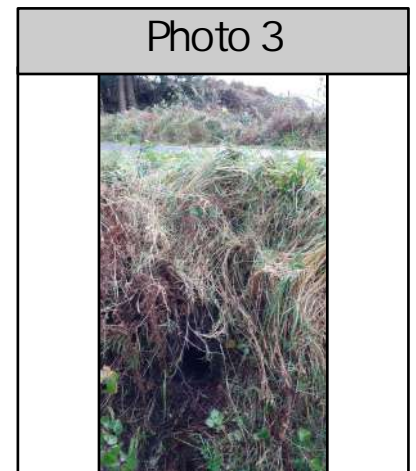
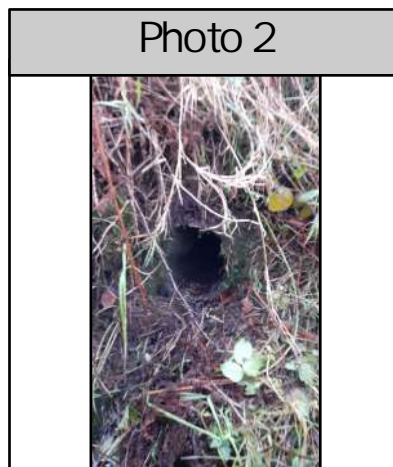
Survey Notes	600mm twinwall 400mm cover to road
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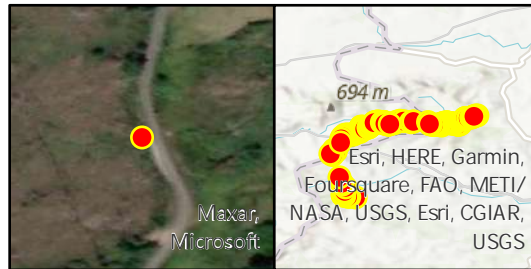




Survey Feature	Culvert - Undercrossing
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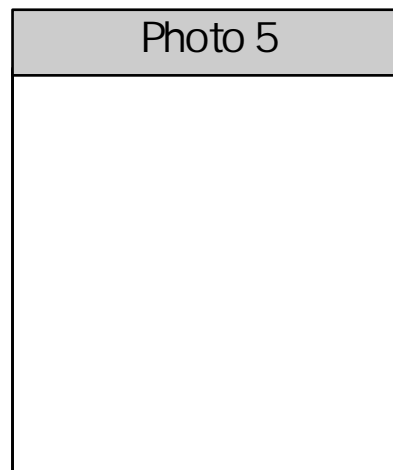
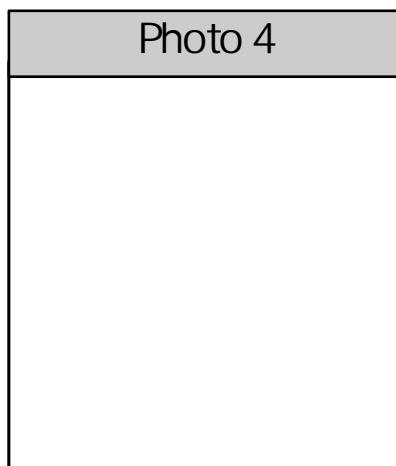
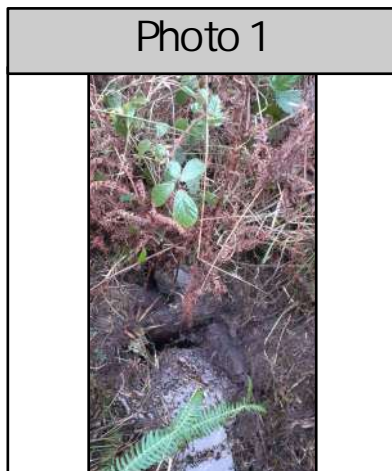
Survey Notes	Culvert & Tree removal...250mm concrete pipe recovering onto public road
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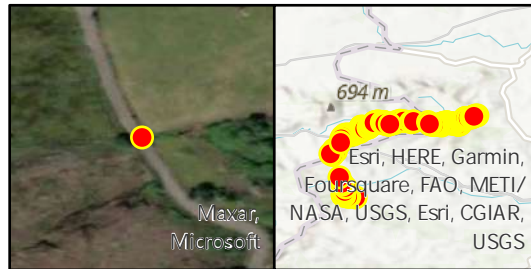




Survey Feature	Culvert - Undercrossing
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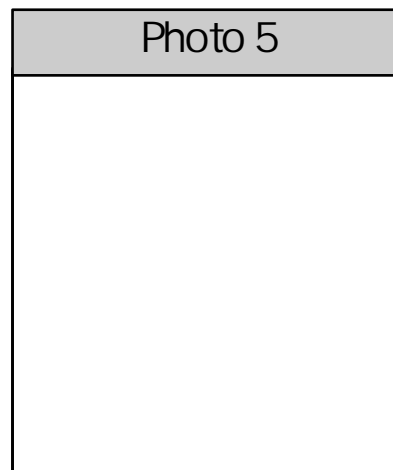
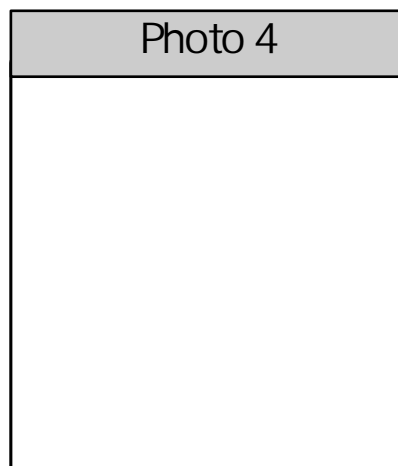
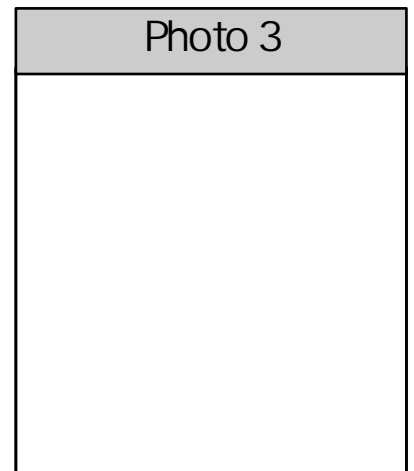
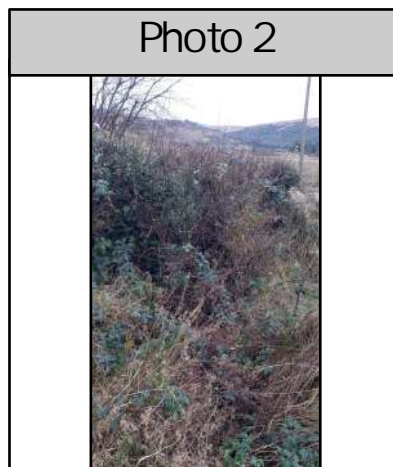
Survey Notes	Stone drain...No evidence of pipework through
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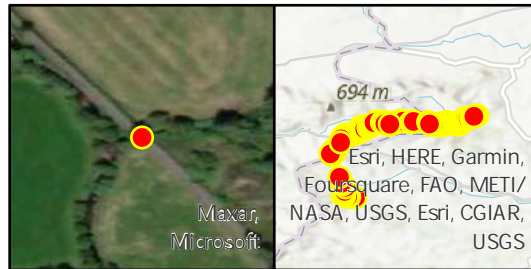




Survey Feature	Culvert - Overcrossing
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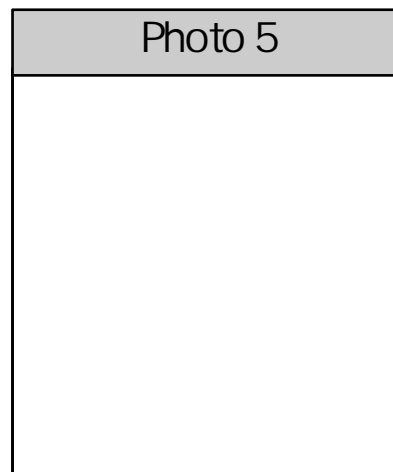
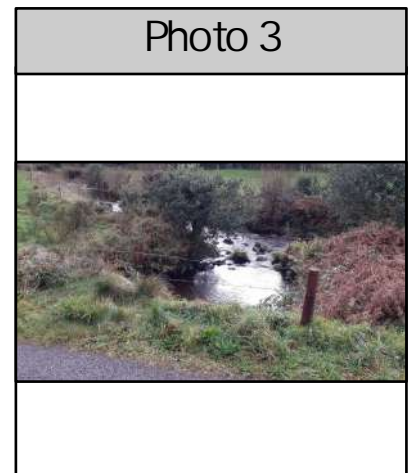
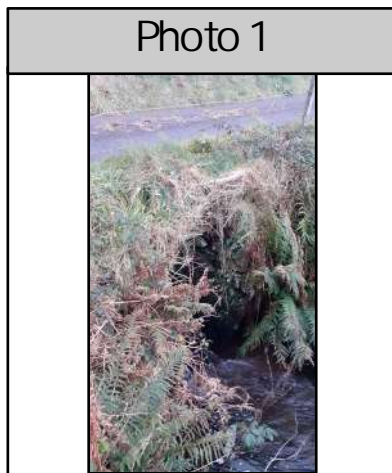
Survey Notes	No visual
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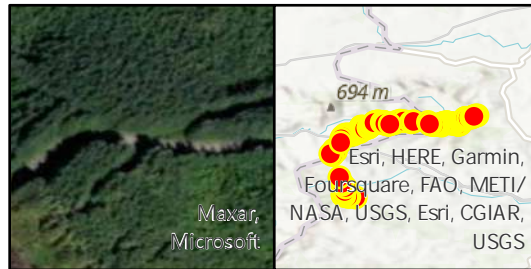




Survey Feature	Culvert - Undercrossing
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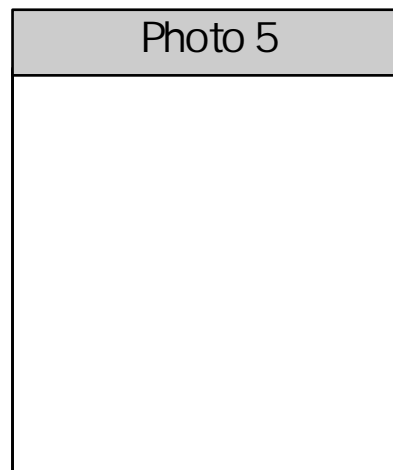
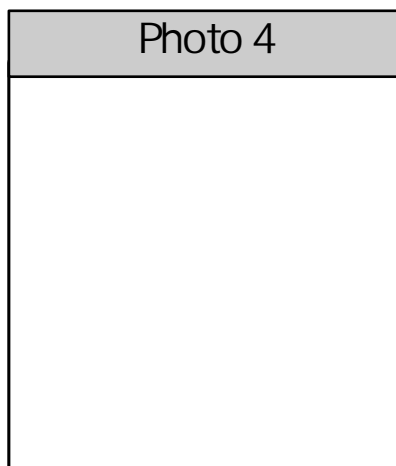
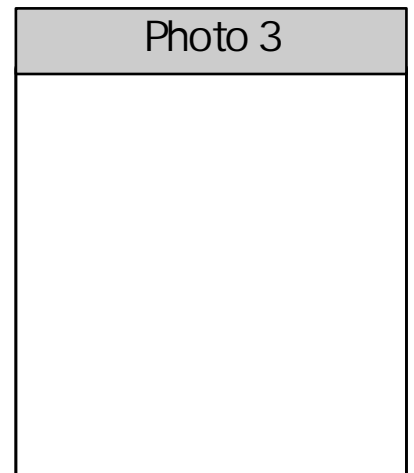
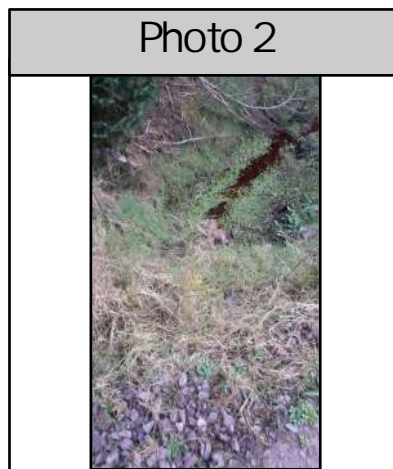
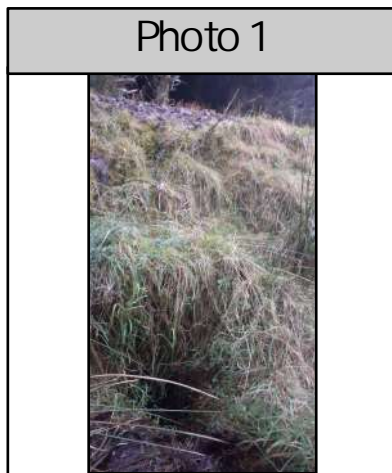
Survey Notes	New HDD beneath stone drain, considerable volume of water
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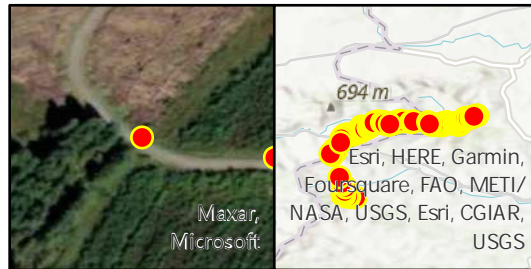




Survey Feature	Stone culvert 1000 cover
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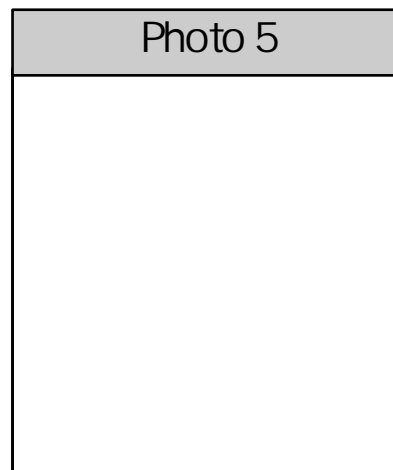
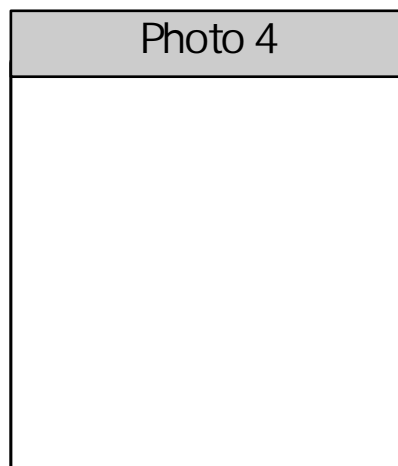
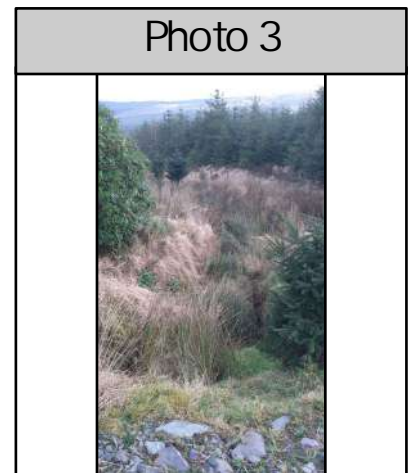
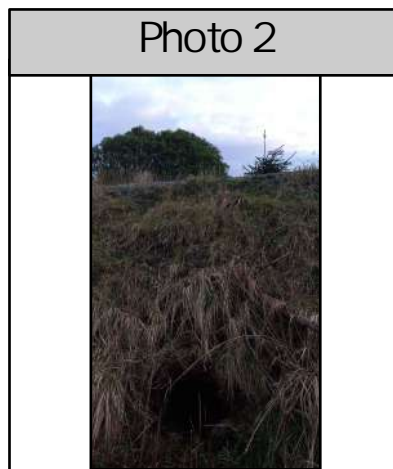
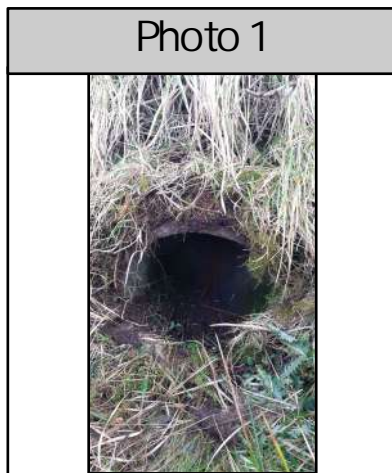
Survey Notes	
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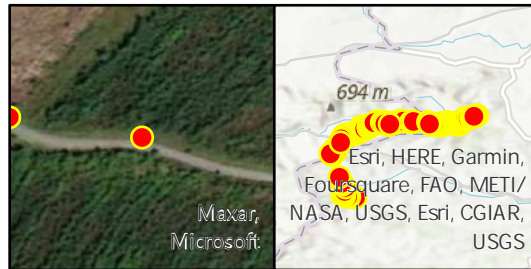




Survey Feature	Culvert
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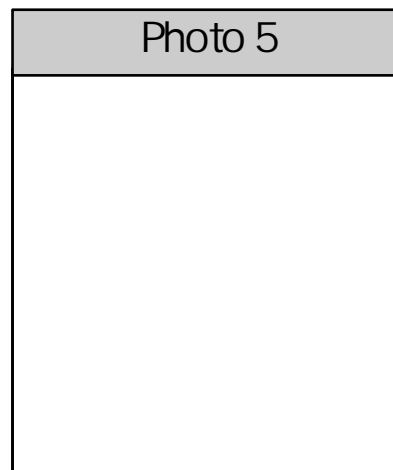
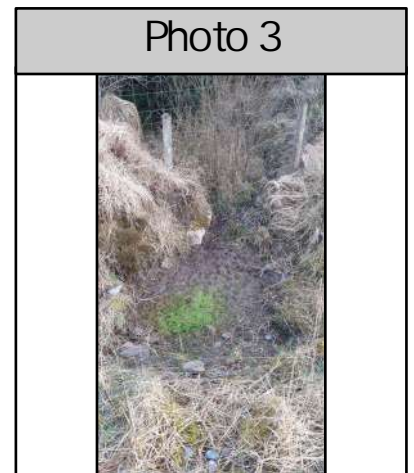
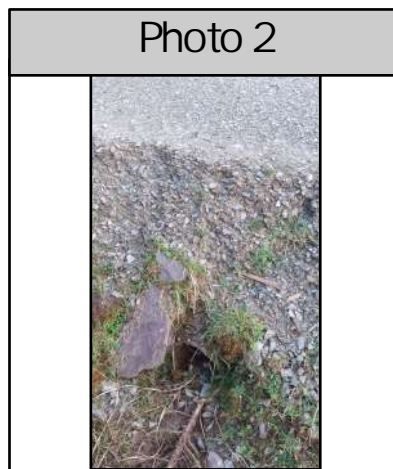
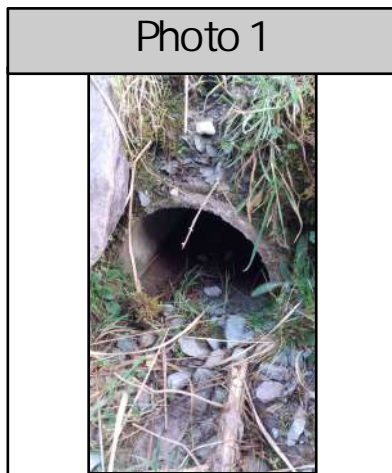
Survey Notes	700 conc pipe 950 cover
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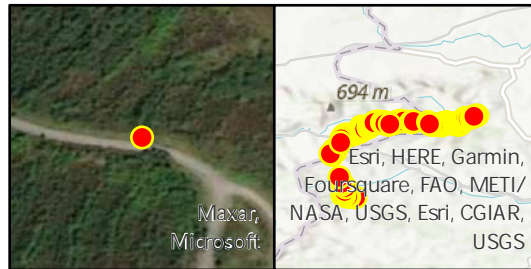




Survey Feature	Culvert
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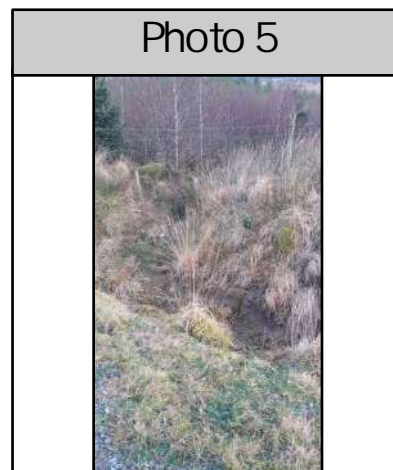
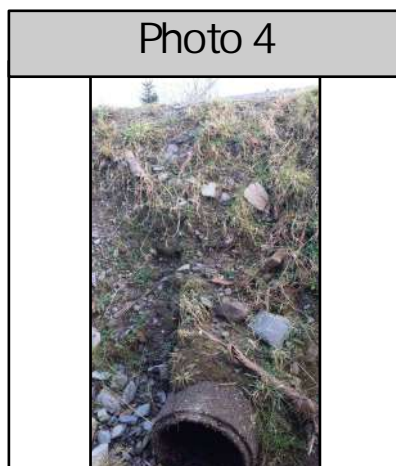
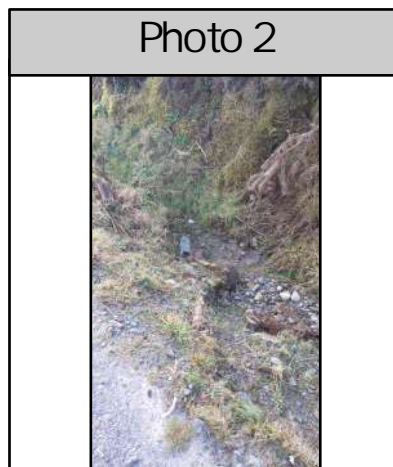
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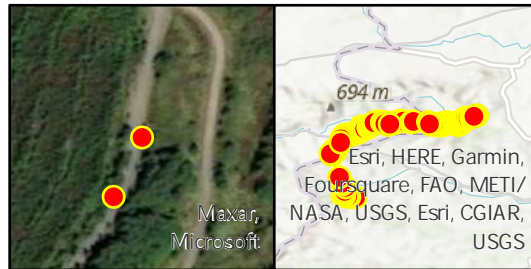




Survey Feature	Culvert
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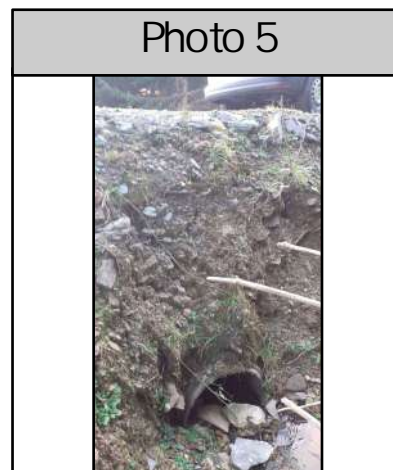
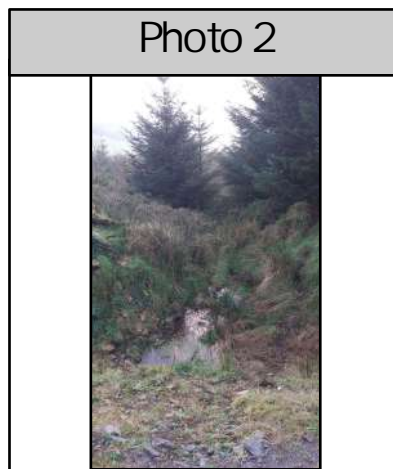
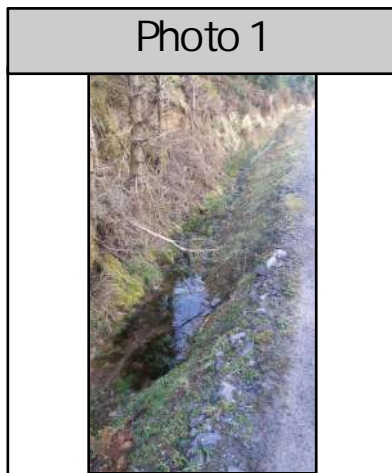
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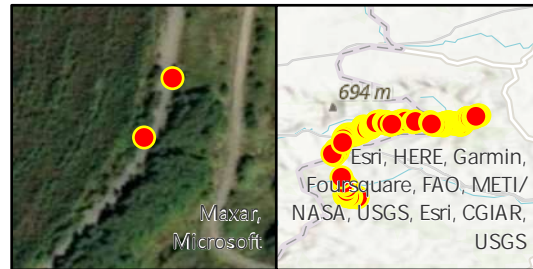




Survey Feature	Culvert
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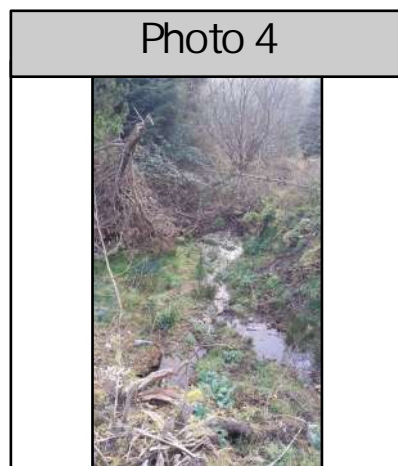
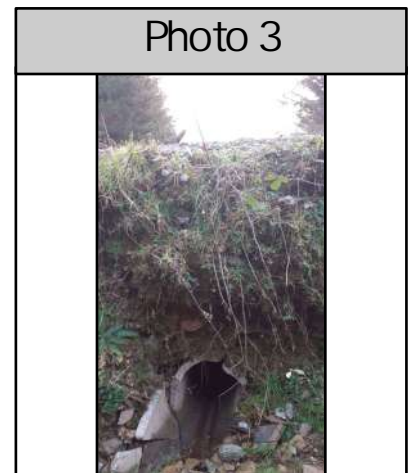
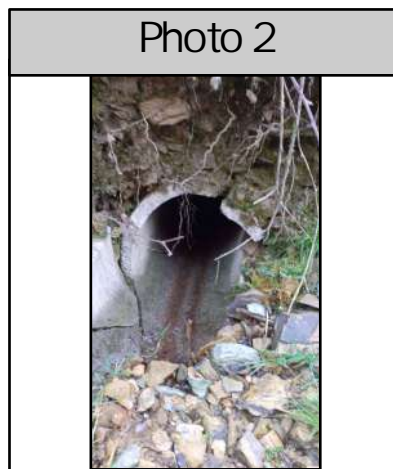
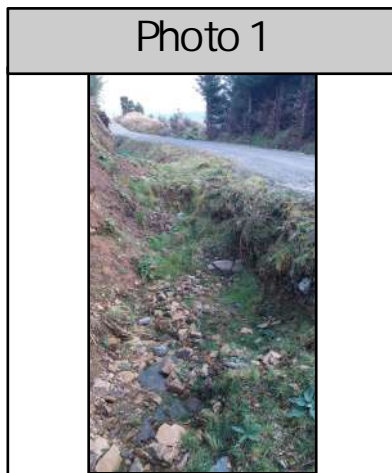
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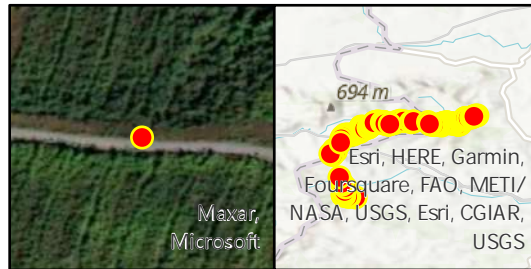




Survey Feature	Culvert
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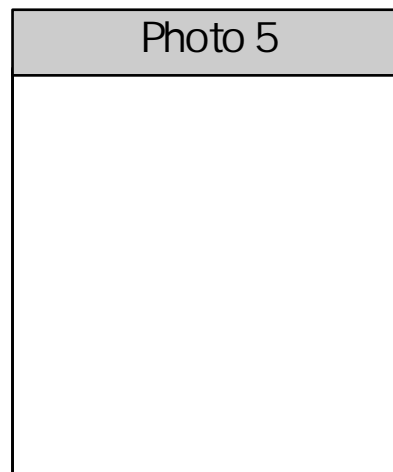
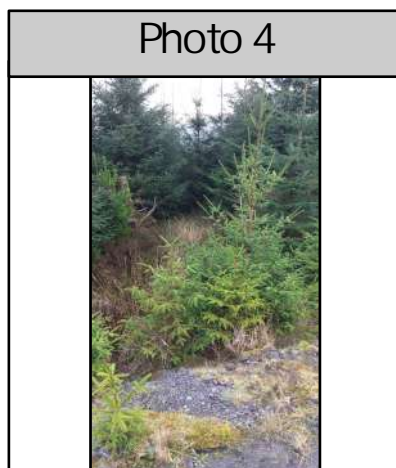
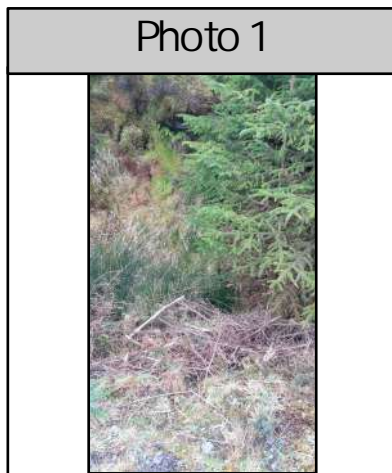
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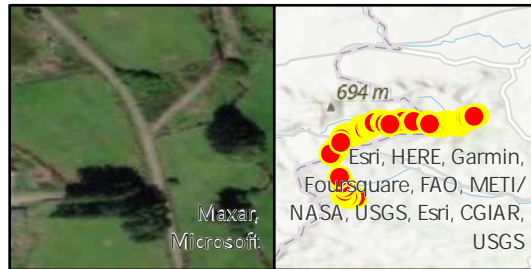




Survey Feature	Culvert
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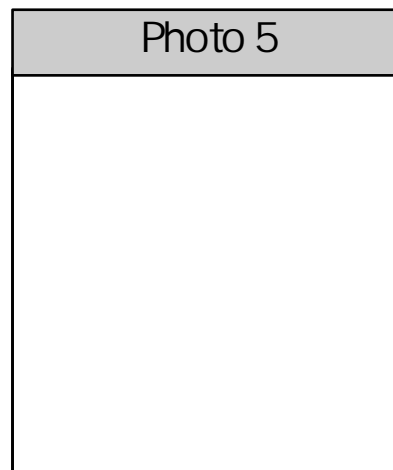
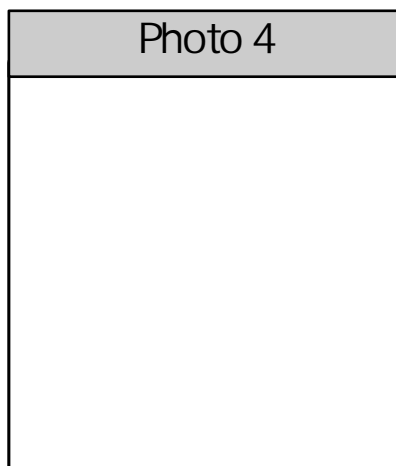
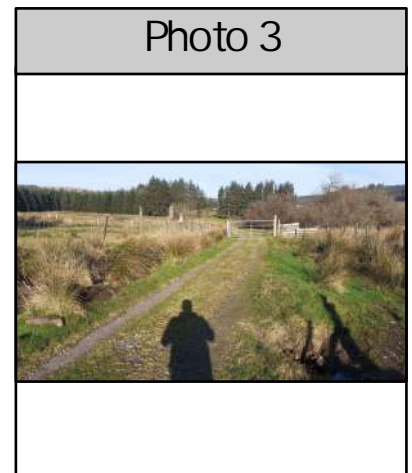
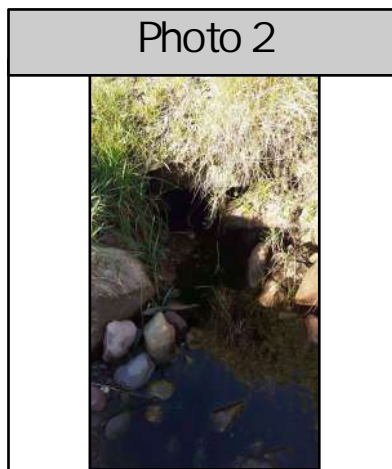
Survey Notes	600 twin wall 400 cover
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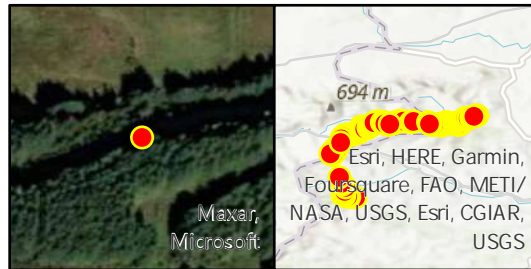




Survey Feature	Stone culvert bare cover
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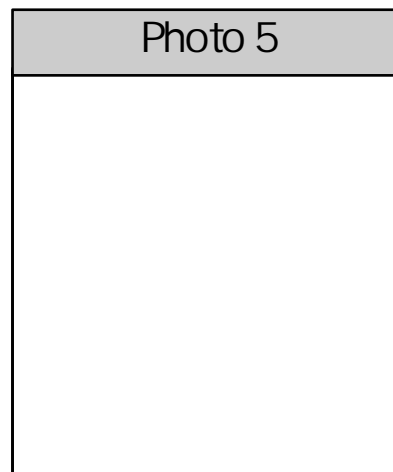
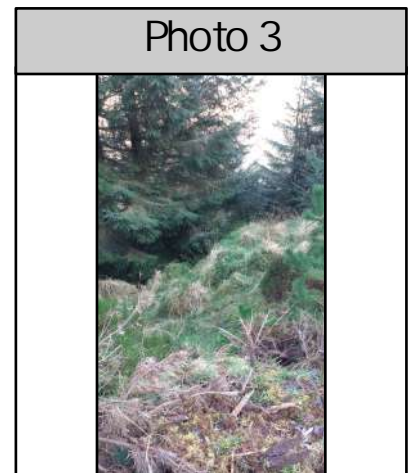
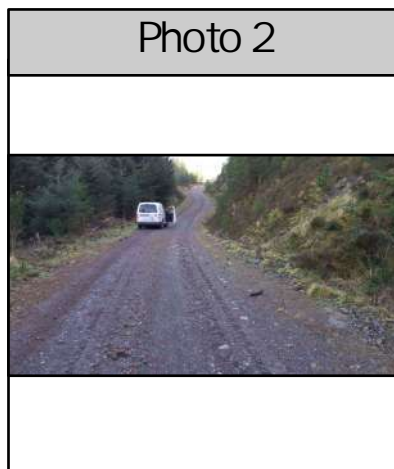
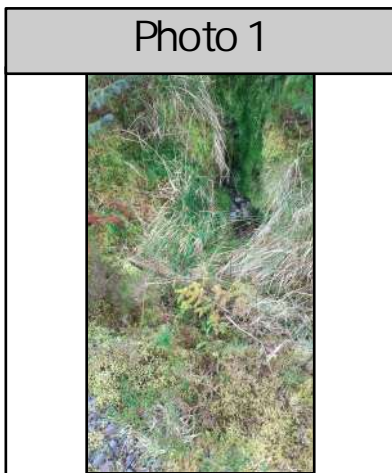
Survey Notes	
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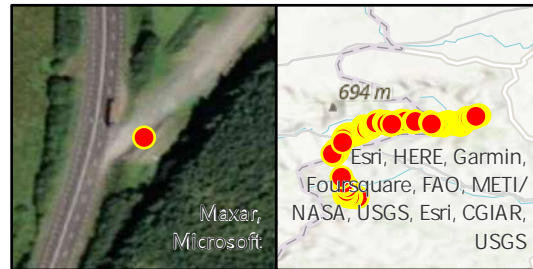




Survey Feature	Culvert
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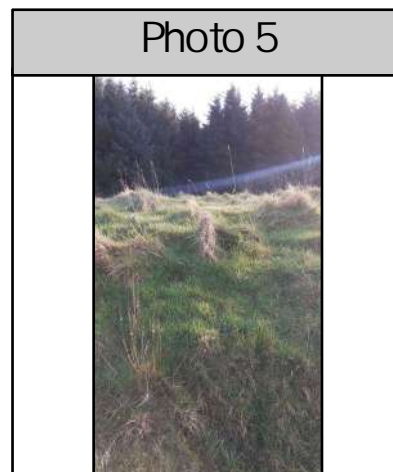
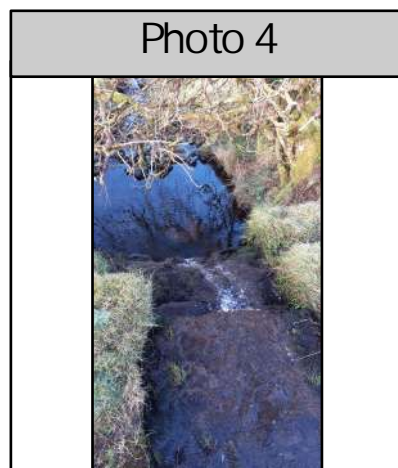
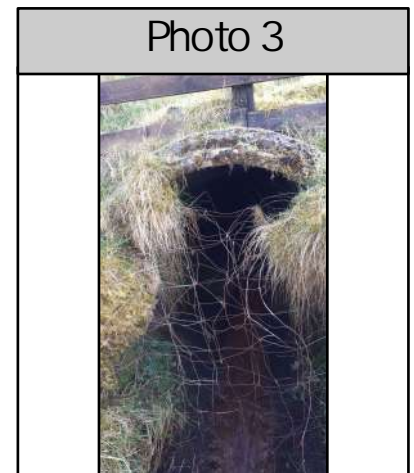
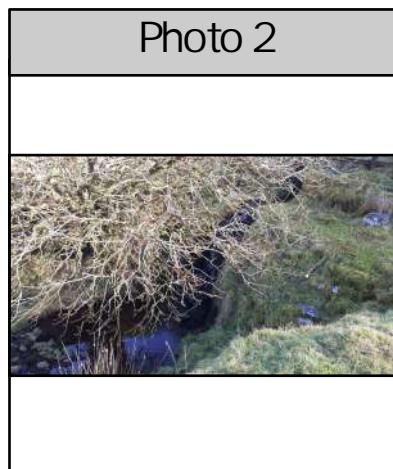
Survey Notes	
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Survey Feature	Culvert
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Survey Notes	1000 conc pipe 1500 cover
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Ballyvouskil to Gortrahilly WF - 110kV Grid Connection

Route Summary & Joint Bay Locations

(12.08.22)



Section From	Section To	Section Length	Bonding Arrangement	No. of Watercourses	Watercourses	No. of Bridges	Bridges	No. of Culverts	No. of Service Crossings	Comments
Ballyvouskil 220kV SS	JB-01	621.1	Single Point Bonded							110kV laid in parallel to Garrow UGC
JB-01	JB-02	815.5	Cross-bonded					2		110kV laid in parallel to Garrow UGC
JB-02	JB-03	812.1	Cross-bonded					8	1	110kV Cable crossing and laid in parallel to Garrow UGC
JB-03	JB-04	796.8	Cross-bonded					6		110kV laid in parallel to Garrow UGC
JB-04	JB-05	731.7	Cross-bonded					7		110kV laid in parallel to Garrow UGC
JB-05	JB-06	732.1	Cross-bonded					8		110kV laid in parallel to Garrow UGC, 110kV laid in parallel to 20kV UGC
JB-06	JB-07	732.7	Cross-bonded	1	Valley			6	2	20kV UG Cable Crossing 1x HDD Crossing
JB-07	JB-08	840.8	Single Point Bonded					10		Cable laid in parallel to 20kV Windfarm Cable
JB-08	JB-09	770.7	Cross-bonded					2	2	20kV UG Cable Crossing, 38kV UGC crossing
JB-09	JB-10	783.0	Cross-bonded					2		
JB-10	JB-11	761.9	Cross-bonded					1		
JB-11	JB-12	739.0	Cross-bonded					3		
JB-12	JB-13	757.5	Cross-bonded	2	Str.1, Str.2			10		2x HDD Stream Crossing
JB-13	JB-14	761.0	Cross-bonded					6		
JB-14	JB-15	736.0	Cross-bonded					5		
JB-15	JB-16	739.4	Cross-bonded					6		
JB-16	JB-17	754.6	Cross-bonded					6		
JB-17	JB-18	769.8	Cross-bonded					8		
JB-18	JB-19	772.5	Cross-bonded					6	1	38kV UGC crossing
JB-19	JB-20	770.7	Cross-bonded					1		
JB-20	JB-21	838.0	Single Point Bonded					2		
JB-21	JB-22	771.0	Cross-bonded					2		1x HDD N22 crossing
JB-22	JB-23	770.7	Cross-bonded					3		
JB-23	JB-24	770.5	Cross-bonded					3		
JB-24	JB-25	800.2	Single Point Bonded							
JB-25	JB-26	650.3	Single Point Bonded							
JB-26	JB-27	760.0	Cross-bonded					1		
JB-27	JB-28	771.3	Cross-bonded	1	W1 (Na Doiri)	1	B1			1x HDD Crossing
JB-28	JB-29	771.2	Cross-bonded							
JB-29	JB-30	791.0	Single Point Bonded	2	W2 (Sullane) Culvert 120	1	Droichead Uí Mhathúna	1		2x HDD Crossings
JB-30	JB-31	763.7	Cross Bonded					2		
JB-31	JB-32	762.5	Cross Bonded	1	W3 (Barr Duínse)	1	Droichead Barr Duínse	3		110kV Cable laid in parallel to Grousemount UGC
JB-32	JB-33	764.3	Cross-bonded					4	1	110kV Cable crossing and laid in parallel to Grousemount UGC
JB-33	JB-34	780.8	Single Point Bonded					4		
JB-34	JB-35	763.2	Single Point Bonded					2		
JB-35	Gortrahilly WF SS	455.4	Single Point Bonded							
Totals:		27,183		7		3		130	7	

TECHNICAL NOTE 01

Project: Gortrahilly WF – 110kV Grid Connection

Ref: rev-02

Section: Cable Rating Check

Job No: 05-836

Date: 07.07.22

Made By: POS

Checked By: DB

Sheet No: 1 of 9

Instruction

Technical Lead: Ruairi Geary - TLI Group

Date of Writing: 06.05.2022

Scope of Note: Review of the 110kV grid connection cable loading based on the proposed MEC for the project.

Documents & Data Issued for Review: n/a

Overview

TLI Group (the Consultant) were engaged by Jennings O’Donovan (the Client) who are working with Future Energy Ireland (“the Developer”) on the development of Gortrahilly Windfarm in counties Cork and Kerry. The Consultant was engaged to assist the Client in selecting and preparing a planning application for the 110kV grid connection for Gortrahilly Windfarm. The Client is currently working on the development of the windfarm.

The proposed grid connection will be a 110kV UGC from the existing Ballyvouskil 220kV Substation to a new Tail fed substation serving Gortrahilly Windfarm which will consist of an approximate grid connection length of 28km. This cable rating study was completed to assess the suitability of the proposed cable size and cable trench designs for the 110kV UGC grid connection circuit.

The cable ratings which have been completed as part of this study include:

- Standard Trefoil Trench Design
- Flat Formation Trench Design
- Existing Cable Crossings (2000mm Separation)
- HDD Crossings – Direct Buried Trefoil Formation (Depth 3000mm)
- Parallel Trench Design

Table 1 - Cable Study General Parameters

Cable Study Parameters	
Cable Size:	1600mm ² Al Cable / 1600mm ² Cu Cable (for HDDs)
Nominal Voltage:	110kV assumed (Range 105kV to 120kV)
Power:	Required 178MVA
Power Factor:	0.95 assumed (Range 0.85 lag to 0.93 lead)
Avg. Cable Section Length:	800m (trefoil), 100m (flat)
Cable Trench Design:	See Appendix A
Ambient Temp (Soil)	20°C (Summer rating)
Soil Thermal Resistivity	1.2 K·m/W (Summer rating)
Backfill Thermal Resistivity	1 K·m/W (Summer rating)
Cable Screen Bonding:	Cross bonded / Single Point Bonded
Power Duct Size:	160mm

Project: Gortrahilly WF – 110kV Grid Connection

Ref: rev-02

Section: Cable Rating Check

Job No: 05-836

Date: 07.07.22

Made By: POS

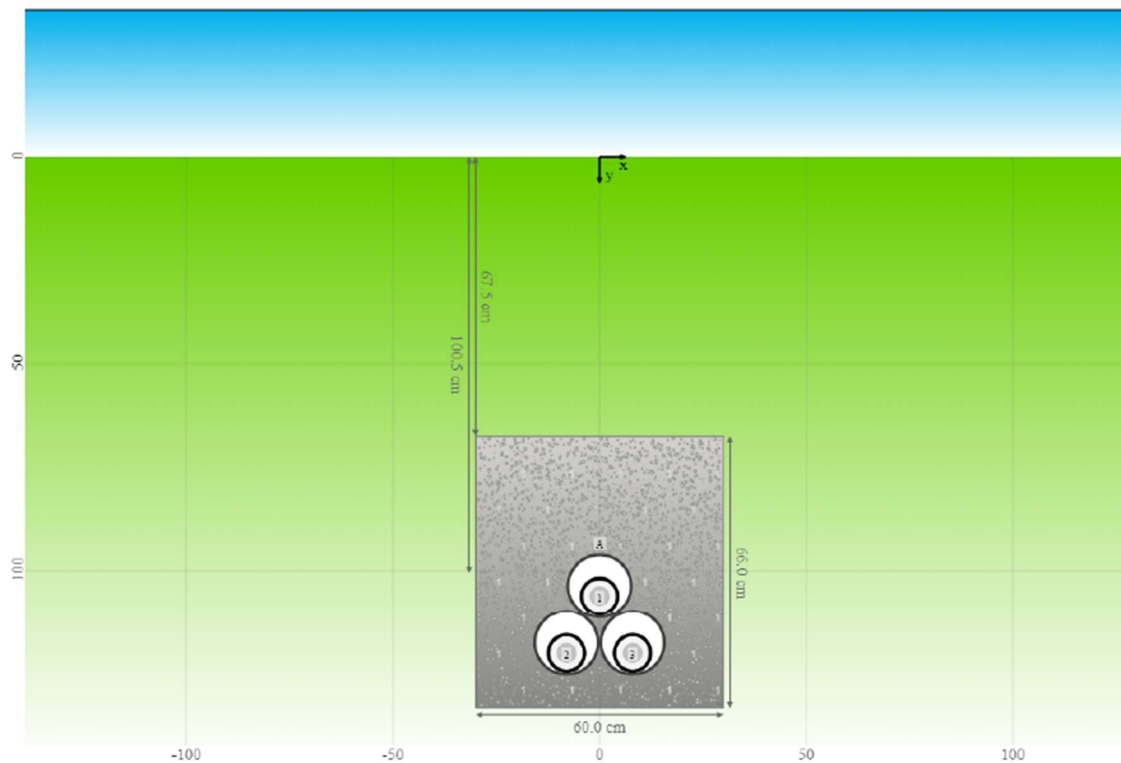
Checked By: DB

Sheet No: 2 of 9

Cable Study Analysis

1600mm² Al Cable - 110kV Standard Trefoil Trench (Depth 950mm) Design:

A cable rating study was completed for a **NKT 1600mm² AL XLPE (110kV) UGC** over a distance of 4km using the **standard trefoil trench design in 160mm ducts** as detailed in Appendix A. Using this arrangement, the circuit is capable of carrying a maximum full load current of **1021.3A** without exceeding the cables max insulative property of 90°C. Therefore, 1600mm² Al XLPE (110kV) UGC when installed using the standard trefoil trench design is capable of achieving the required maximum full load (178MVA).



Systems

Following systems are active in the arrangement:

System	Object	Current I_c [A]	max Temp. $\theta_c \theta_e (\theta_{de})$ [°C]	Losses W_{sys} [W/m]
System A	NKT 1600mm ² Al XLPE (110kV)	1021.3	90.0 79.3 (68.8)	94.3

Figure 1 - Cable Rating Model, Standard Trench Design, 1600mm.sq Al

Project: Gortrahilly WF – 110kV Grid Connection

Ref: rev-02

Section: Cable Rating Check

Job No: 05-836

Date: 07.07.22

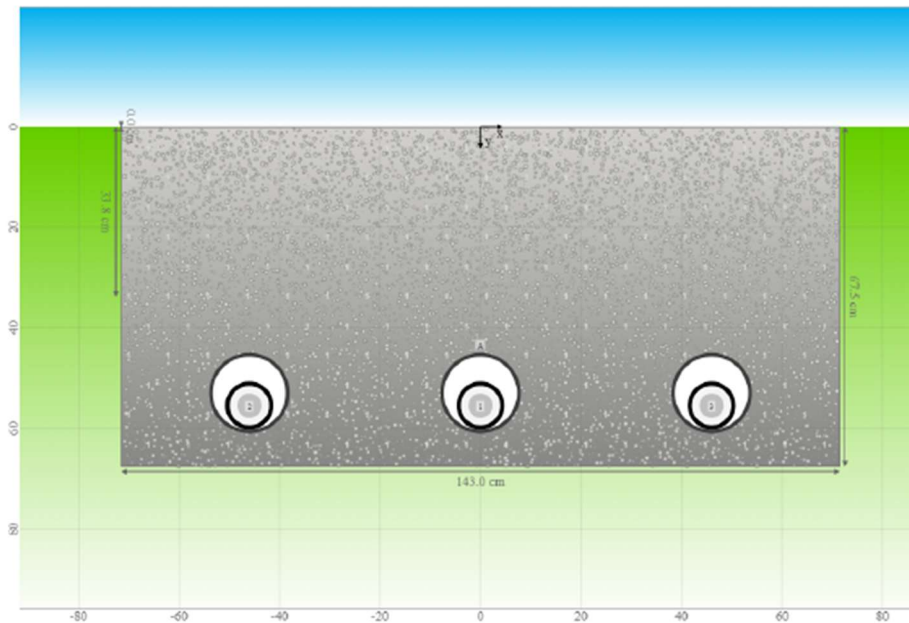
Made By: POS

Checked By: DB

Sheet No: 3 of 9

1600mm² Al Cable - 110kV Flat Formation Trench (Depth 675mm) Design:

A cable rating study was completed for a **NKT 1600mm² AL XLPE (110kV) UGC** over a distance of 100m using the **Flat Formation Trench design in 160mm ducts** as detailed in Appendix B. Using this arrangement, the circuit is capable of carrying a maximum full load current of **1332A** without exceeding the cables max insulative property of 90°C. Therefore, 1600mm² Al XLPE (110kV) UGC when installed using the standard trefoil trench design is capable of achieving the required maximum full load (178MVA).



Systems

Following systems are active in the arrangement:

System	Object	Current I_c [A]	max Temp. $\theta_c \theta_w (\theta_{da})$ [°C]	Losses W_{sys} [W/m]
System A	NKT 1600mm ² Al XLPE (110kV)	1332.0	90.0 72.4 (54.9)	146.6

Figure 2: Cable Study Results – 110kV 1600mm.sq Al Flat Formation (450mm Depth)

TECHNICAL NOTE 01



Project: Gortrahilly WF – 110kV Grid Connection

Ref: rev-01

Section: Cable Rating Check

Job No: 05-836

1600mm² Cu Cable – Garrow 110kV Flat Formation Crossing (Separation 2000mm) Design:

Two cable rating studies were completed for the crossing of an existing **1000mm² Cu XLPE (110kV) UGC** in operation to conduct flow between Garrow GIS to Ballyvouskil Node (**System A**). Crossing beneath with (**System B – Ballyvouskil to Gortrahilly WF**) over a distance of 100m whilst implementing a flat formation trench arrangement with a separation of 2000mm between above and below circuits and supplying a load without compromising the insulative properties of the selected cable.

Cable Crossing Cable Rating Study Results										
1600mm ² Al XLPE or 1600mm ² Cu XLPE Cable										
Rev0 [17.10.21]										
Cable Rating Study Results										
Rating Sheet Ref	Season	Duct Config.	Duct Spacing (mm)	Bonding Arrangement	Duct Depth (mm)	Required Amps (A)	Max Ampere Rating @ 90°C	MW Loading	Loading Capacity	Rating met
Garrow 1000 Cu_Flat_160D_Summer_[950 Depth]_SP	Summer	Trefoil 160mm	N/A	Single Point	950	934	989.0	179.0	94%	Yes
NKT 1600 Al_Flat_160D_Summer_[3190 Depth]_SP	Summer	Flat 160mm	300	Single Point	3190	934	940.9	170.3	99%	No
Rating Sheet Ref	Season	Duct Config.	Duct Spacing (mm)	Bonding Arrangement	Duct Depth (mm)	Required Amps (A)	Max Ampere Rating @ 90°C	MW Loading	Loading Capacity	Rating met
Garrow 1000 Cu_Flat_160D_Summer_[950 Depth]_SP	Summer	Trefoil 160mm	N/A	Single Point	950	934	988.2	178.9	95%	Yes
NKT 1600 Cu_Flat_160D_Summer_[3190 Depth]_SP	Summer	Flat 160mm	300	Single Point	3190	934	1172.1	212.1	80%	Yes

Figure 3: Cable Study – 110kV 1600mm² Al crossing beneath existing 110kV Garrow Circuit.

The first study showed that System B (Gortrahilly – Ballyvouskil) would use **NKT 1600mm² AL XLPE (110kV) UGC** set to operate at the maximum temperature without exceeded the insulative property of the existing cable at 90°C wouldn't achieve the 178MVA rating. To fulfil this rating when encountering an existing cable undercrossing, a second study was compiled. The consultant believes that the use of **1600mm² Cu XLPE (110kV) UGC** will need to be implemented at crossing intervals to achieve the 178MVA rating. As seen above in Figure 3, System B (Gortrahilly to Ballyvouskil) will conduct in excess of full load carrying capacity proving that the NKT 1600mm² Cu XLPE (110kV) UGC is sufficiently capable of carrying the required load with allowance for additional increased loading.

TECHNICAL NOTE 01



Project: Gortrahilly WF – 110kV Grid Connection

Ref: rev-01

Section: Cable Rating Check

Job No: 05-836

Horizontal Directional Drill - Trefoil Formation (Depth 3000mm):

A cable rating study was completed for a **1600mm² AL XLPE (110kV) UGC** over a distance of 200m utilising a HDD in a trefoil formation, at a **depth of 3000m**. It should be noted that 180mm or 225mm ducts (SDR = 11) will be utilised for HDD crossings. It can be seen from Table 4 below that the 1600mm² AL XLPE is **not capable of achieving the 178MVA rating** when installed in this formation. The use of bentonite in the power ducts was also modelled, but the 178MVA rating was still not achieved.

HDD Cable Rating Study Results 1600mm ² Al XLPE or 1600mm ² Cu XLPE Cable										
Rev0 [17.10.21]										
Cable Rating Study Results										
Rating Sheet Ref	Season	Duct Config.	Duct Spacing (mm)	Bonding Arrangement	Duct Depth (mm)	Required Amps (A)	Max Ampere Rating @ 90°C on System A	MW Loading	Loading Capacity	Rating met
NKT 1600 Al_Trefoil_225D_Summer_[3000 Depth]_SP	Summer	Trefoil 225mm	N/A	Single Point	3000	934	931.6	168.6	100%	No
NKT 1600 Cu_Trefoil_225D_Summer_[3000 Depth]_SP	Summer	Trefoil 225mm	N/A	Single Point	3000	934	1002.5	181.5	93%	Yes

Table 2 – HDD Trefoil Options, Achieved with 1600mm² Cu XLPE cable

In order to utilise a HDD in a trefoil formation at a depth of 3000mm, it will be necessary to install **1600mm² Cu XLPE cable** for the HDD crossing points. Using this arrangement, each cable circuit is capable of carrying a maximum full load current of **1002A (181.5MW)** when installed without bentonite.

The use of bentonite in the power ducts was also modelled, utilising a HDD in a trefoil formation at a depth of 3000mm, it will be necessary to install **1600mm² Cu XLPE cable** for the HDD crossing points. Using this arrangement, each cable circuit is capable of carrying a maximum full load current of **1193.1A (215.95MW)** when installed with bentonite.

TECHNICAL NOTE 01



Project: Gortrahilly WF – 110kV Grid Connection

Ref: rev-01

Section: Cable Rating Check

Job No: 05-836

1600mm² Cu Cable – Grousemount 110kV Flat Formation Crossing (Separation 2000mm) Design:

Two cable rating studies were completed for the crossing of an existing **1600mm² Al XLPE (110kV) UGC** in operation to conduct flow between Coomtaggart 110kV Substation to Ballyvouskil Node (**System A**). Crossing beneath with (**System B – Ballyvouskil to Gortrahilly WF**) over a distance of 100m whilst implementing a flat formation trench arrangement with a separation of 2000mm between above and below circuits and supplying a load without compromising the insulative properties of the selected cable.

Cable Crossing Cable Rating Study Results										
1600mm ² Al XLPE or 1600mm ² Cu XLPE Cable										
Rev0 [17.10.21]										
Cable Rating Study Results										
Rating Sheet Ref	Season	Duct Config.	Duct Spacing (mm)	Bonding Arrangement	Duct Depth (mm)	Required Amps (A)	Max Ampere Rating @ 90°C	MW Loading	Loading Capacity	Rating met
Grousemount 1600 Al_Trefoil_160D_Summer_[950 Depth]_SP	Summer	Trefoil 160mm	N/A	Single Point	950	934	965.2	174.7	97%	
NKT 1600 Al_Flat_160D_Summer_[3190 Depth]_SP	Summer	Flat 160mm	300	Single Point	3190	934	939.0	170.0	99%	No X
Rating Sheet Ref	Season	Duct Config.	Duct Spacing (mm)	Bonding Arrangement	Duct Depth (mm)	Required Amps (A)	Max Ampere Rating @ 90°C	MW Loading	Loading Capacity	Rating met
Grousemount 1600 Al_Trefoil_160D_Summer_[950 Depth]_SP	Summer	Trefoil 160mm	N/A	Single Point	950	934	964.4	174.6	97%	
NKT 1600 Cu_Flat_160D_Summer_[3190 Depth]_SP	Summer	Flat 160mm	300	Single Point	3190	934	1170.0	211.8	80%	Yes ✓

Figure 5: Cable Study – 110kV 1600mm² cable crossing beneath existing 110kV Grousemount Circuit.

The first study showed that System B (Gortrahilly – Ballyvouskil) would use **NKT 1600mm² AL XLPE (110kV) UGC** set to operate at the maximum temperature without exceeded the insulative property of the existing cable at 90°C wouldn't achieve the 178MVA rating. To fulfil this rating when encountering an existing cable undercrossing, a second study was compiled. The consultant believes that the use of **1600mm² Cu XLPE (110kV) UGC** will need to be implemented at crossing intervals to achieve the 178MVA rating. Using this arrangement, Gortrahilly – Ballyvouskil circuit is capable of achieving the power rating without compromising the insulative properties of the cable.

TECHNICAL NOTE 01



Project: Gortrahilly WF – 110kV Grid Connection

Ref: rev-01

Section: Cable Rating Check

Job No: 05-836

Gortrahilly WF 110kV Trefoil parallel run Ballyvouskill – Garrow 110kV Trefoil Formation (Separation 1000mm edge to edge) Design:

Two cable rating studies were completed for the parallel run of an existing **1000mm² Cu XLPE (110kV) UGC** in operation to conduct flow between Garrow GIS to Ballyvouskil Node (**System A**). Running parallel with (**System B – Ballyvouskil to Gortrahilly WF**) over a distance of 4000m whilst implementing a trefoil formation trench arrangement with a separation of 1000mm between edge to edge of both trenches and supplying a load without compromising the insulative properties of the selected cable.

Para Cable Rating Study Results										
Gortrahilly Para Ballyvouskill-Garrow										
Rev0 [07.07.22]										
Cable Rating Study Results										
Rating Sheet Ref	Season	Duct Config.	Duct Spacing (mm)	Bonding Arrangement	Duct Depth (mm)	Required Amps (A)	Max Ampere Rating @ 90°C	MW Loading	Loading Capacity	Rating met
Ballyvouskill-Garrow 1000 Cu_Trefoil_160D_Summer_[950 Depth]_SP	Summer	Trefoil 160mm	N/A	Single Point	950	934	981.2	177.6	95%	Yes
NKT 1600 Al_Trefoil_Summer_SP	Summer	Trefoil 160mm	N/A	Single Point	950	934	958.1	173.4	98%	Yes
Rating Sheet Ref	Season	Duct Config.	Duct Spacing (mm)	Bonding Arrangement	Duct Depth (mm)	Required Amps (A)	Max Ampere Rating @ 90°C	MW Loading	Loading Capacity	Rating met
Ballyvouskill-Garrow 1000 Cu_Trefoil_160D_Summer_[950 Depth]_SP	Summer	Trefoil 160mm	N/A	Single Point	950	934	980.0	177.4	95%	Yes
NKT 1600 Cu_Trefoil_Summer_SP	Summer	Trefoil 160mm	N/A	Single Point	950	934	1170.1	211.8	80%	Yes

Figure 4: Cable Study – Gortrahilly WF 110kV parallel existing 110kV Garrow Circuit.

The first study showed that System B (Gortrahilly – Ballyvouskil) would use **NKT 1600mm² AL XLPE (110kV) UGC** set to operate at the maximum temperature without exceeding the insulative property of the existing cable at 90°C wouldn't achieve the 178MVA rating. To fulfil this rating when traveling parallel to an existing 110kV cable, a second study was compiled. The consultant believes that the use of **1600mm² Cu XLPE (110kV) UGC** will need to be implemented at 110kV - 110kV parallel intervals to achieve the 178MVA rating. As seen above in Figure 4, System B (Gortrahilly to Ballyvouskil) will conduct in excess of full load carrying capacity proving that the NKT 1600mm² Cu XLPE (110kV) UGC is sufficiently capable of carrying the required load with allowance for additional increased loading.

TECHNICAL NOTE 01

Project: Gortrahilly WF – 110kV Grid Connection

Ref: rev-01

Section: Cable Rating Check

Job No: 05-836

Date: 07.07.22

Made By: POS

Checked By: DB

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Cable Study Results Summary

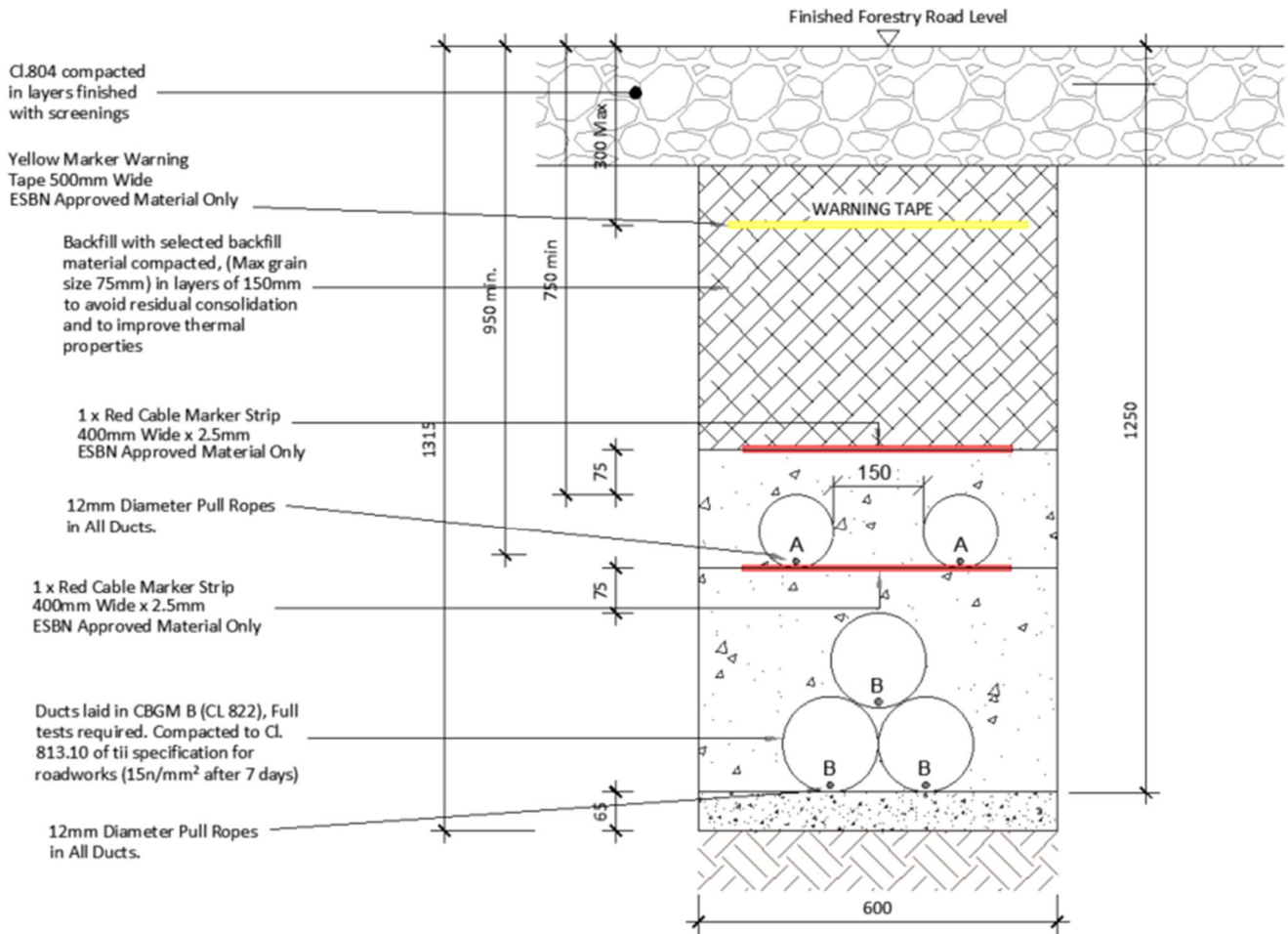
The Cable Rating Study Checks completed have indicated that it should be possible to carry the maximum export capacity of the cable at **178MVA** on a standard 110kV single circuit **1600mm² Al cable** for the majority of the grid connection without exceeding the proposed recommended maximum conductor temperature of 90°C when using the proposed trench designs with the exception of the HDDs, existing cable crossing intervals and travelling in parallel with existing 110kV cables.

It will be necessary to install **1600mm² Cu cable** for the four potential HDD crossings in order to achieve the 178MVA rating. The results from the initial cable crossing locations also indicate that the use of 1600mm² Cu cable for these crossings will be required to sufficiently carry the maximum rating of 178MVA when undercrossing the existing circuits in a flat formation with a minimum of separation of 2000mm. This separation distance will minimise the derating between the two circuits due to mutual heating. Should there be a need to reduce this separation distance at any point in the route it may result in a derating on the cables, this should be accounted in any future calculations

It should be noted that any crossings or parallel runs with other underground cable MV/HV circuits or other services may result in a derating of the Gortrahilly Grid Connection Cable. This derating effect will further decrease the available loading capacity of the cable. Two further existing service routes, both a 38kV UGC circuit and a 20kV cable route exist within forestry access tracks west of Garrow GIS substation but a derating study hasn't been concluded on these circuit owing to minimal circuit rating information.

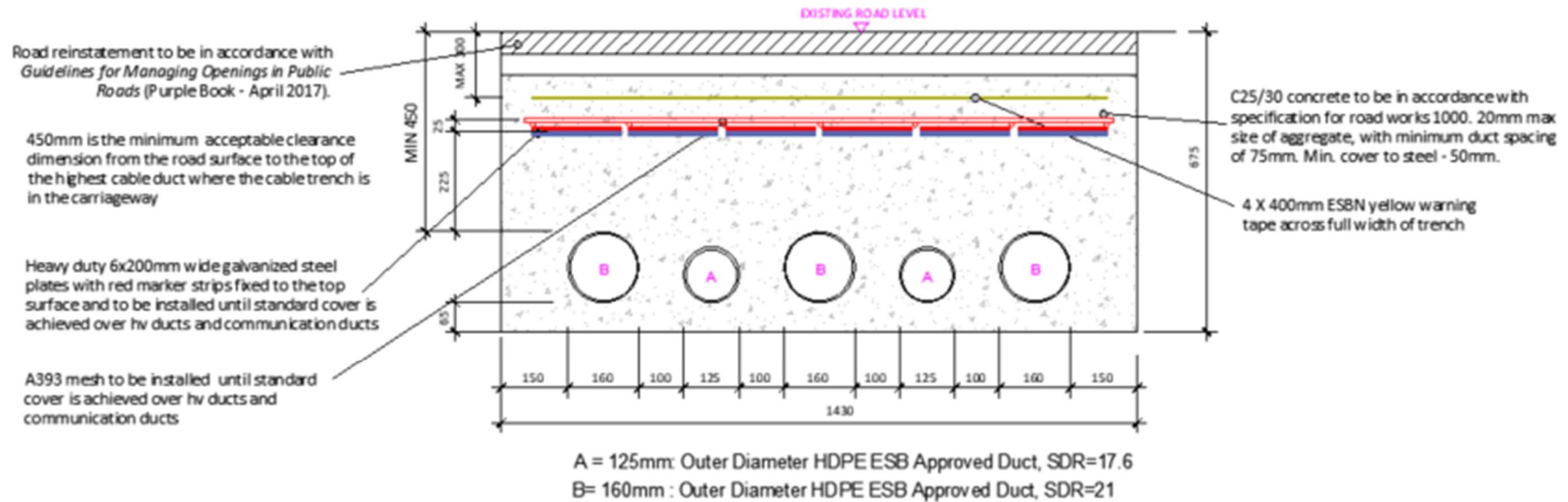
All results at this stage are indicative only, further analysis will be required at the detailed design phase in order to accurately calculate the final loading on the cables.

Appendix A – Standard 110kV Trench Trefoil Design (160mm Ducts)



A = 125mm : Outer Diameter HDPE ESB Approved Duct, SDR=17.6
 B = 160mm : Outer Diameter HDPE ESB Approved Duct, SDR=21

Appendix B – Flat Formation 110kV Trench Design (160mm Ducts – 675mm Depth)



TECHNICAL NOTE 2

Project: Gortrahilly WF – 110kV Grid Connection

Ref: rev01

Section: UG Cable Pulling Calculation Check

Job No: 05-836

06.05.22

Made By: DB

Checked By: SK

Sheet No: 1 of 7

Instruction:

Technical Lead: Ruairi Geary - TLI Group

Date of Writing: 06.05.2022

Scope of Note: Summary of cable pulling calculations check on pinch point sections within the UGC route.

Documents & Data Issued for Review: N/A

Details:

TLI Group (the Consultant) were engaged by Jennings O’Donovan (the Client) to identify and evaluate Cable Pulling Calculations from Gortrahilly Windfarm Substation to the node at Ballyvouskil 220kV Substation for the proposed 110kV grid connection as part of the planning application process. The purpose of this Technical Note is to outline the calculations completed to ensure that the maximum pulling tension and side wall bearing pressure limits of the installed cable would not be exceeded during construction. These calculations were based on the current design, elevations and profile details for the UGC route recorded as part of the topographical survey.

The study area for these calculations were carried out between joint bays where potential pinch point sections could be encountered.

Coefficient of Friction considerations for Pulling of electroconductive cables have been incorporated in respect to cable manufactures parameters. These are as follows;

<i>Material of Ducting:</i>	<i>Greasing:</i>	<i>Outer Sheath PE</i>
HDPE	Without	0.20
	With	0.15

For the cable pulling calculations check it has been assumed that 110kV NKT 1600mm² Al XLPE Cable is to be installed for this project. The following pulling tension and side wall bearing pressure limits apply to this cable and have been used as part of the calculations:

<i>Cable Type:</i>	NKT 1600mm ² AL XLPE (110kV)
<i>Max Pulling Tension:</i>	48 kN ≈ 48000 N ≈ 4855 kg (force)
<i>Max Side Wall Bearing Pressure:</i>	10 kN ≈ 10000 N ≈ 1001.97 kg (force) for Cables installed within ducts

These limits have been formulated, originating from cable manufacturers functional specifications **Appendix A, Mechanical Properties**. Max pulling tension and the max side wall bearing pressure can be derived from the unit conversion from kilo-newton meter (kN/m) to kilogram per meter units.

For calculation purposes applying the following: **1kN/m ≈ 101.97 kg/m**

TECHNICAL NOTE 2

Project: Gortrahilly WF – 110kV Grid Connection

Ref: rev01

Section: UG Cable Pulling Calculation Check

Job No: 05-836

06.05.22

Made By: DB

Checked By: SK

Sheet No: 2 of 7

Section 1: Ballyvouskil Node to JB01

On review of the pinch point section highlighted within the Ballyvouskil to Inchamore section, (Ballyvouskil Node to JB01) the cable pulling study analysis found installing **NKT 1600mm² AL XLPE (110kV) UGC** from entry pit at Ballyvouskil Node and exiting at JB01, the permissible pulling force exerted onto the cable for this prospective install resulted in approx. **25974N ≈ 25.9kN** which is within the manufactures specified limit of 48kN.

The cable pulling study finding for the maximum permissible sidewall force allowable was found to be satisfactory with approx. **497N/m ≈ 0.497kN** and therefore within the specified manufactures limit of 10kN when pulled predominantly on an upward trajectory from Ballyvouskil Node to JB01.

On review of the section from entry at JB01 and exiting at Ballyvouskil Node, the permissible pulling force exerted onto the cable was more efficient. The pulling tension value for this prospective install resulted in approx. **9154N ≈ 9.15kN**

The cable pulling study finding for the maximum permissible sidewall force allowable was found to be satisfactory with approx. **4796N/m ≈ 0.48kN** and therefore within the specified manufactures limit of 10kN when pulled from JB01 to Ballyvouskil Node.

It is therefore recommended that this section of cable is pulled from Joint Bay 01 to Ballyvouskil Node.

Section 2: JB02 to JB03

On review of the pinch point section highlighted within the Ballyvouskil to Inchamore section, (JB02 to JB03) the cable pulling study analysis found installing **NKT 1600mm² AL XLPE (110kV) UGC** from entry pit at JB02 and exiting at JB03, the permissible pulling force exerted onto the cable for this prospective install resulted in approx. **14804N ≈ 14.8kN** which is within the manufactures specified limit of 48kN.

The cable pulling study finding for the maximum permissible sidewall force allowable was found to be satisfactory with approx. **390N/m ≈ 0.39kN** and therefore within the specified manufactures limit of 10kN when pulled from JB02 to JB03.

On review of the section from entry at JB03 and exiting at JB02, the permissible pulling force exerted onto the cable was more efficient. The pulling tension value for this prospective install resulted in approx. **9548N/m ≈ 9.548kN**

The cable pulling study finding for the maximum permissible sidewall force allowable was found to be satisfactory with approx. **57.1N/m ≈ 0.015kN** and therefore within the specified manufactures limit of 10kN when pulled from JB03 to JB02.

It is therefore recommended that this section of cable is pulled from Joint Bay 03 to Joint Bay 02.

TECHNICAL NOTE 2

Project: Gortrahilly WF – 110kV Grid Connection

Ref: rev01

Section: UG Cable Pulling Calculation Check

Job No: 05-836

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Section 3: JB15 to JB16

On review of the pinch point section highlighted within the Ballyvouskil to Inchamore section (JB16 to JB15) the cable pulling study analysis found installing **NKT 1600mm² AL XLPE (110kV) UGC** from entry pit at JB15 and exiting at JB16, the permissible pulling force exerted onto the cable for this prospective install resulted in approx. **10871N** \approx **10.8kN** which is within the manufactures specified limit of 48kN.

The cable pulling study finding for the maximum permissible sidewall force allowable was found to be satisfactory with approx. **327.1 N/m** \approx **0.327kN** and therefore within the specified manufactures limit of 10kN when pulled from JB15 to JB16.

On review of the section from entry at JB16 and exiting at JB15, the permissible pulling force exerted onto the cable was more effective. The pulling tension value for this prospective install resulted in approx. **7967.6N** \approx **7.96kN**

The cable pulling study finding for the maximum permissible sidewall force allowable was found to be satisfactory with approx. **133.6 N/m** \approx **0.133kN** and therefore within the specified manufactures limit of 10kN when pulled from JB16 to JB15.

It is therefore recommended that this section of cable is pulled from Joint Bay 16 to Joint Bay 15.

Section 4: JB20 to JB21

On review of the pinch point section highlighted within the Ballyvouskil to Inchamore section (JB20 to JB21) the cable pulling study analysis found installing **NKT 1600mm² AL XLPE (110kV) UGC** from entry pit at JB20 and exiting at JB21, the permissible pulling force exerted onto the cable for this prospective install resulted in approx. **10930N** \approx **10.9kN** which is within the manufactures specified limit of 48kN.

The cable pulling study finding for the maximum permissible sidewall force allowable was found to be satisfactory with approx. **313.4 N/m** \approx **0.313kN** and therefore within the specified manufactures limit of 10kN when pulled from JB20 to JB21.

On review of the section from entry at JB21 and exiting at JB20, the permissible pulling force exerted onto the cable was less effective. The pulling tension value for this prospective install resulted in approx. **17643N** \approx **17.6kN**

The cable pulling study finding for the maximum permissible sidewall force allowable was found to be satisfactory with approx. **560.3 N/m** \approx **0.560kN** and therefore within the specified manufactures limit of 10kN when pulled from JB21 to JB20.

It is therefore recommended that this section of cable is pulled from Joint Bay 20 to Joint Bay 21.

TECHNICAL NOTE 2

Project: Gortrahilly WF – 110kV Grid Connection

Ref: rev01

Section: UG Cable Pulling Calculation Check

Job No: 05-836

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Section 5: JB01 to JB02

On review of the pinch point section highlighted within the Gortrahilly to Inchamore section (JB01 to JB02) the cable pulling study analysis found installing **NKT 1600mm² AL XLPE (110kV) UGC** from entry pit at JB01 and exiting at JB02, the permissible pulling force exerted onto the cable for this prospective install resulted in approx. **22723N** \approx **22.72kN** which is within the manufactures specified limit of 48kN.

The cable pulling study finding for the maximum permissible sidewall force allowable was found to be satisfactory with approx. **1339 N/m** \approx **1.339kN** and therefore within the specified manufactures limit of 10kN when pulled from JB01 to JB02.

On review of the section from entry at JB02 and exiting at JB01, the permissible pulling force exerted onto the cable was more effective. The pulling tension value for this prospective install resulted in approx. **15648N** \approx **15.6kN**

The cable pulling study finding for the maximum permissible sidewall force allowable was found to be satisfactory with approx. **640.2 N/m** \approx **0.640kN** and therefore within the specified manufactures limit of 10kN when pulled from JB02 to JB01.

It is therefore recommended that this section of cable is pulled from Joint Bay 02 to Joint Bay 01.

Section 6: JB07 to JB08

On review of the pinch point section highlighted within the Gortrahilly to Inchamore section (JB07 to JB08) the cable pulling study analysis found installing **NKT 1600mm² AL XLPE (110kV) UGC** from entry pit at JB07 and exiting at JB08, the permissible pulling force exerted onto the cable for this prospective install resulted in approx. **27283N** \approx **27.28kN** which is within the manufactures specified limit of 48kN.

The cable pulling study finding for the maximum permissible sidewall force allowable was found to be satisfactory with approx. **1830.1 N/m** \approx **1.83kN** and therefore within the specified manufactures limit of 10kN when pulled from JB07 to JB08.

On review of the section from entry at JB08 and exiting at JB07, the permissible pulling force exerted onto the cable was more effective. The pulling tension value for this prospective install resulted in approx. **11052N** \approx **11.05kN**

The cable pulling study finding for the maximum permissible sidewall force allowable was found to be satisfactory with approx. **170.7 N/m** \approx **0.170kN** and therefore within the specified manufactures limit of 10kN when pulled from JB08 to JB07.

It is therefore recommended that this section of cable is pulled from Joint Bay 08 to Joint Bay 07.

TECHNICAL NOTE 2

Project: Gortrahilly WF – 110kV Grid Connection

Ref: rev01

Section: UG Cable Pulling Calculation Check

Job No: 05-836

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Section 7: JB08 to JB09

On review of the pinch point section highlighted within the Gortrahilly to Inchamore section (JB08 to JB09) the cable pulling study analysis found installing **NKT 1600mm² AL XLPE (110kV) UGC** from entry pit at JB08 and exiting at JB09, the permissible pulling force exerted onto the cable for this prospective install resulted in approx. **19031N** \approx **19.03kN** which is within the manufactures specified limit of 48kN.

The cable pulling study finding for the maximum permissible sidewall force allowable was found to be satisfactory with approx. **319.3 N/m** \approx **0.319kN** and therefore within the specified manufactures limit of 10kN when pulled from JB08 to JB09.

On review of the section from entry at JB09 and exiting at JB08, the permissible pulling force exerted onto the cable was less effective. The pulling tension value for this prospective install resulted in approx. **22754N** \approx **22.75kN**

The cable pulling study finding for the maximum permissible sidewall force allowable was found to be satisfactory with approx. **1929.7 N/m** \approx **1.93kN** and therefore within the specified manufactures limit of 10kN when pulled from JB09 to JB08.

It is therefore recommended that this section of cable is pulled from Joint Bay 08 to Joint Bay 09.

Appendix A – Functional Cable Specification

Item	Query	Required	Offered
1	Conductor: (a) Material (b) Type e.g. round, etc. (c) Design e.g. stranded, etc. (d) Nominal diameter (mm) (e) Cross-sectional area (mm ²) (f) Method of water blocking	Cu/Al	Aluminium round stranded 48,3 1600 swellable yarns and tapes
2	Inner Semi-conducting Layer: (a) Material (b) Nominal thickness (mm) (c) Minimum thickness (mm)	Semiconductive compound	semicon compound 1,3 0,7
3	Insulation: (a) Material (b) Nominal thickness (mm) (c) Minimum thickness (mm) (d) Diameter over insulation = Ovality of cable Core (mm)	XLPE ≤10% < 0.7	XLPE 13,3 appr. 12 < 0.7
4	Outer Semi-conducting Layer: (a) Material (b) Nominal thickness (mm) (c) Minimum thickness (mm)	Semiconductive compound	semicon comp 0,9 0,7
5	Nominal diameter over core screen (mm)		79,7

SCHEDULE A
(continued)

Item	Query	Required	Offered
10	Nominal diameter of completed cable (mm)		96
11	Weight of finished cable (kg/m)		appr. 9,7
12	(a) Normal length per drum (m)		1000
	(b) Maximum length per drum (m)		tbd
13	(a) Normal gross weight of loaded drum (kg)		12000
	(b) Max gross weight of loaded drum (kg)		tbd
14	Drum dimensions width/height (m/m)		3,6 / 4,3
15	Minimum radius of bend around which cable can be pulled		
	(a) Laid direct (m)		2,4
	(b) In ducts (m)		2,4
	(c) Cable placed in position with former (m)		1,5
	(d) Cable placed in position without former (m)		2,4
16	Permissible pulling force allowed on conductors during installation (kN)		48
17	Maximum permissible sidewall forces (kN/m)		10

TECHNICAL NOTE 3

Project: Gortrahilly Wind Farm

Ref: rev1

Section: Drilling Methodologies

Job No: 05-836

Date: 20.07.22

Made By: POS

Checked By: DB

Sheet No: 1 of 6

Instruction

Technical Lead: Ruairi Geary (TLI Group)

Date of Writing: 20/07/22

Scope of Note: Summary of drilling methodologies with respect to associated environmental protection measures through Protected Areas.

Documents & Data Issued for Review: N/A

Overview

The purpose of this document is to outline and explain the construction techniques which will be involved on the proposed Gortrahilly Wind Farm underground cable (UGC) grid connection where crossing (Watercourses, SAC, NHA, etc) will be carried out with respect to the relevant Local Authorities Environment and planning sectors.

A detailed study area was created in order to identify any protected areas coinciding with the existing Watercourses, SAC, NHA established along the proposed Grid Connection route.

1.0 Crossing Methodology

Sections of the proposed Gortrahilly Wind Farm UGC grid connection are within the designated Natural Heritage Area (NHA) and Special Area of Conservation (SAC) of Killarney National Park.

For the proposed crossing of certain watercourses within the NHA and SAC where standard trenching methodologies cannot be applied, the preference of the Consultant would be to implement the Horizontal Directional Drilling (HDD) or Auger Bore method to facilitate underground cabling. These trenchless methods would avoid impacting the natural habitat of wildlife and bird and mitigate vegetation cutting in the designated area. Additional precautionary measures will also be put in place for all areas of natural drainage from the area of works. These measures will prevent material draining from the Horizontal Directional Drilling or Bore method from entering into any adjacent drainage ditches, river networks or streams in accordance with Irish Water specifications.

2.0 HDD Option

This Horizontal Directional Drilling option can be achieved by excavating temporary drill pits (launch pit and a receptor pit) within the designated site area and private occupied lands at a maximum span of circa. 600m. In order to accommodate the drill and associated operations, entry and exit pits within compound areas are required either side of the watercourses/ protected area.

TECHNICAL NOTE 3

Project: Gortrahilly Wind Farm

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- Setting up the Site Access to the entry and exit pits will be via a newly constructed temporary access or existing access track.
- Silt fences will be erected around the entire work area at both entry and exit pits prior to the drilling contractor preparing a laydown area of approximately 30 m x 25 m.
- The works area will be a minimum of 15 m back from the watercourse and within this zone, the natural vegetative cover will not be altered, and no construction traffic will use the area so that the natural filtering capacity of the vegetation if required will remain intact. If areas are overgrown with thick vegetation, a section of it will be removed appropriately and disposed of via a licensed waste contractor.
- The area is then levelled where required by using the 22 bucket of a 360° excavator and overlain with "Terram" geotextile and 200 mm of Clause 804 material which will be removed on completion.
- Stripped topsoil will be stored on level ground at least 15 m back from the watercourse and ringed by silt fencing to prevent solids washout.
- The boundaries of the rig up area and exit area would both be defined with security fencing positioned to ensure adequate access is maintained. Entry and exit pits (2m x 2m x 2m) are excavated using an 360° excavator and the resultant spoil banded in 0.5mm PVC liner within the designated working areas.
- A steel box (1m x 1m x 2m) is placed in the ground to control drilling fluid returns from the borehole.

These conditions will be further determined by the Drilling Contractor when undertaking the scope of works with respect to the Local Authorities Environment and planning sectors.

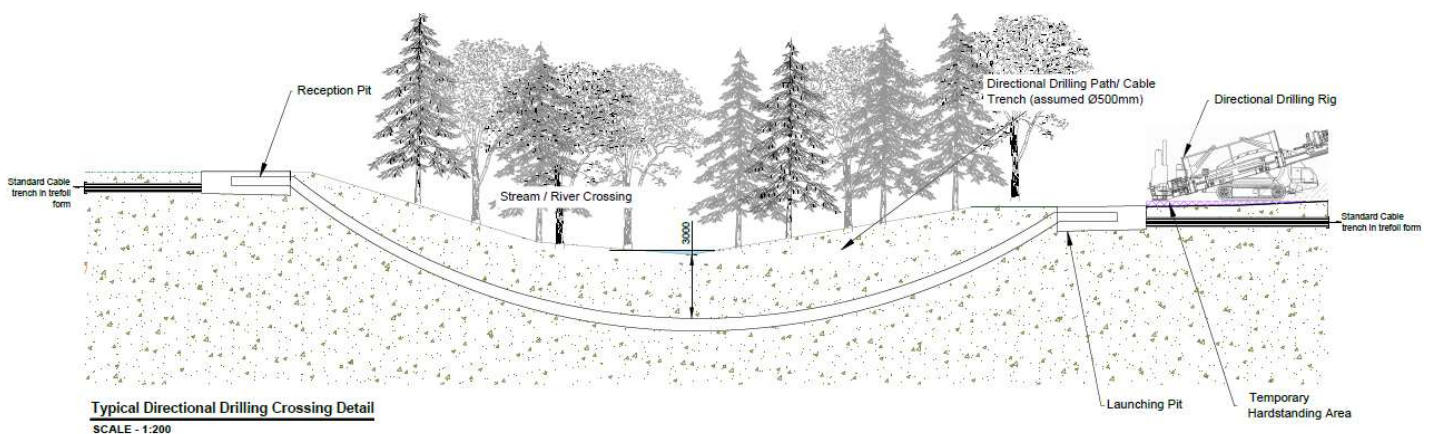


Figure 1 Typical HDD installation method

3.0 Bore Design

Following examination of the ground conditions based on geological mapping and site investigation results, a longitudinal profile of the bore will be designed. The profile will be designed so that the risk of negative impact on the watercourses and existing lands and structures will be negligible.

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3.1 Bore Construction

- A pilot hole is drilled from the entry pit at an initial angle of approximately 15 to 20 to the horizontal. The hole will pass through the overburden into the bedrock and travel underneath the riverbed before emerging through the overburden in the exit pit. The drill will pass through the bedrock layer below the riverbed. The depth of the drill below the riverbed will have been determined from site investigations.
- Drilling depths are of a magnitude that will significantly reduce the risk of water pollution as there is a thick layer of rock between the drill and the riverbed.
- Drilling fluid is pumped down the drill string and through the downhole motor, which converts the fluid's hydraulic power to mechanical power and rotates the drill bit. The drill bit is oriented by the surveyor, and the driller pushes the drill string into the ground maintaining the bore path. The drilled cuttings are flushed back by the drill fluid flowing via nozzles in the bit, up the annulus to surface, where they are separated from the fluid fraction for disposal.
- A comprehensive closed-loop drilling fluid mixing and circulation system with recycling capability will be utilised to minimise the volume of fluids required on site.
- Constant monitoring of fluid volume, pressure, pH, weight, and viscosity will be undertaken. Constant attention will also be given to amount of cuttings produced so that no overcutting takes place and that hole cleaning is maintained.
- Any excess drilling fluid which collects in the exit pit will be transported by road to the entry pit from where it will be re-circulated. A proprietary steering system, guided by tri-axial magnetometers and accelerometers that provide real time directional information to the surveyor at the driller's console, will be used to navigate the bores.

Once the pilot hole has been completed, a larger Tungsten Carbide Insert (TCI) hole-opener will be fitted to the drill string at the exit side and pulled back through the bore to the entry side. The hole will thus be reamed to the required 500 mm diameter. This reaming may be executed in one or more incremental stages. A 125 mm drill pipe will be added from the exit side to ensure that a mechanical presence is always within the bore.

4.0 Duct Installation

The ducts will be laid out on the exit side in preparation for installation. Each duct will consist of a continuous coil of maximum length 200 m. This will depend on transport and handling capabilities. Additional straight lengths of 13.5 m will be butt fusion welded on to the 200 m coils and will be externally and internally debaded prior to installation. When the ducts are ready and the drill hole diameter has been proven, a towing assembly consisting of tow heads, a swivel and a reamer will be used to pull the ducts into the bore. Close attention is paid to modelled drag forces during pullback with constant monitoring of load stress undertaken to ensure that modelled tensile stress, collapse pressures, hoop stress and buckling stress are not exceeded. 24 The ducts will be cleaned and proven and their as-laid location surveyed.

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5.0 Precautions to be taken when working with River/ Watercourse networks

The proposed works will be carried out by employing accepted good work practices during construction, and environmental management measures such as those discussed below. Please note that the following measures will be supplemented by further specific environmental protection measures that will be included in method statements prepared for specific tasks during the works and will form part of the detailed CEMP.

- Trench de-watering: Ground water and surface water accumulating in the base of trenches will not be pumped directly to roadside drains or watercourses. The outflow pipe will be positioned such that the greatest possible vegetated distance will be maintained between it and any adjacent watercourse. This will allow the water to dissipate naturally through the ground.
 - Solids contaminated water will be discharged to a geotextile membrane percolation area, this is in respect where drains and watercourses are crossed with underground cables. The release of sediment will be prevented through this designated area.
 - Heavy contamination the water will either be transported off site for disposal in a licensed facility or pumped to a portable on-site settlement tank for treatment.
 - Approved forms of scaffolding are required to support decking. It is essential that this deck will completely capture any falling debris and rebound. Any debris material captured will be removed safely and disposed.
 - Weather conditions will be considered when planning construction activities to minimise risk of run off from site into water networks
 - Installation of a barrier (silt fence) around excess spoil heaps from drilling works to prevent sediment entering adjacent watercourses.
 - Provision of 50m exclusion zones and barriers (silt fences) between any excavated material and any surface water features to prevent sediment washing into the receiving water environment;
 - The contractor shall ensure that silt fences are regularly inspected and maintained during the construction phase;
 - The contractor shall ensure that all personnel working on site are trained in pollution incident control response. A regular review of weather forecasts of heavy rainfall is required, and the Contractor is required to prepare a contingency plan for before and after such events;
 - The contractor will carry out visual examinations of local watercourses from the proposed works during the construction phase to ensure that sediment is not above baseline conditions. In the unlikely event of water quality concerns, the Environmental Manager and ECoW will be consulted;
 - Drilling fluids returning to the surface are diverted through a conductor pipe to a mud pan on the surface. The ability to clean and re-circulate drilling fluids keeps the volume of drilling fluids required to a minimum.
 - Excavations will be left open for minimal periods to avoid acting as a conduit for surface water flows.
 - Only emergency breakdown maintenance will be carried out on site. Emergency procedures and spillage kits will be available and construction staff will be familiar with emergency procedures.
 - Appropriate containment facilities will be provided to ensure that any spills from vehicles are contained and removed off site. Adequate stocks of absorbent materials, such as sand or commercially available spill kits shall be available;
-

TECHNICAL NOTE 3

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- Concrete or potential concrete contaminated water run-off will not be allowed to enter any watercourses. Any pouring of concrete (delivered to site ready mixed) will only be carried out in dry weather. Washout of concrete trucks shall be strictly confined to a designated and controlled wash-out area within the wind farm site; remote from watercourses, drainage channels and other surface water features;
- Entry by plant equipment, machinery, vehicles and construction personnel into watercourses or wet drainage ditches shall not be permitted. All routes used for construction traffic shall be protected against migration of soil or waste water into watercourses;
- No re-fuelling of equipment will be undertaken on work sites adjacent to watercourses (within 50m). All re-fuelling is to take place in designated areas using double-skinned fuel bowsers and drip trays.
- Cabins, containers, workshops, plant, materials storage, and storage tanks shall not be located near any surface water channels and will be located beyond the 50m hydrological buffer at all times.
- Auxiliary equipment such as generators, excavators, telehandlers, bowsers etc. The drilling rig and fluid handling units will be placed in a bund (bunded 0.5 mm PVC) to ensure that any spills or storm water run-off is captured and managed.

6.0 Waste Disposal

As outlined above, the selected drilling fluid will be non-toxic. Nevertheless, the system is designed and operated so as to contain the fluid and the drilled arisings and dispose of them safely. During drilling, the control and minimisation of waste fluids are the responsibility of the Fluids Technician and the Drilling Superintendent. Fluids can be minimised by the following procedures:

1. Cleaning and recirculating the drilling fluid.
2. Maintaining excellent fluid properties (pH, density, viscosity, gel strength, shear strength) while drilling to eliminate the need for additional drilling fluid.
3. Monitoring of borehole volumes, flow rates, pressures and drag characteristics to ensure that all cuttings are being circulated out of the borehole and that critical annular fluid velocities are not exceeded maintaining laminar flow to prevent eddying and sloughing of the borehole.

The fluid used is inert clay and can be classified in the European Waste Catalogue under 01-05-04 as freshwater drilling muds and wastes. The cuttings circulated from the bore can be classified under 17-05-04 as soil and stones not containing dangerous substances. The fluid and the cuttings are non-hazardous wastes and therefore suitable for disposal to landfill. MSDS (Material Safety Data Sheets) and COSHH (Control of Substances Hazardous to Health) Sheets for all materials will be kept on site. Drilled cuttings are stored on site for disposal via a licensed waste contractor. The European Waste Catalogue reference is 17-05-04. Drilling fluid volumes will be minimised. Excess fluid disposal will be via a licensed waste contractor. The European Waste Catalogue reference is 01-05-04 The Contractor will provide a site office, mess and welfare facilities. These units will be powered by a bunded and silenced generator and water will be stored in on-site tanks. The units will be serviced on a weekly basis which includes removal of all wastewater by a licensed contractor.

TECHNICAL NOTE 3

Project: Gortrahilly Wind Farm

Ref: rev1

Section: Drilling Methodologies

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7.0 Reinstatement of Site

On completion of the installation of the ducts, disposal of material and backfilling of trenches, the site will be restored as agreed with the landowners while silt fences remain in place. Geotextile and Clause 804 material used in construction of access tracks and site compound will be removed and disposed of to a licensed facility. Topsoil will be imported, where necessary and the area reseeded.