

GROUND CONDITIONS, PROBLEMS AND SOLUTIONS ALONG THE A55 NORTH WALES COAST ROAD

NOTES ON VIEWING THE A55 ON THE GROUND by Frank Nicholson

Engineering notes mainly abbreviated from D. Nichols 2001, *Geo-engineering along the A55 North Wales Coast Road* Quarterly Journal of Engineering Geology & Hydrology, Vol. 34 p51-64.

The numbered sections below are those used by Nichols. For each section the approximate grid reference location is given, and the year when the section was completed. The underlying materials are usually described and any special engineering problems are discussed. Where possible junction numbers are given, (or OS map references).

START where the M53 becomes the A55 East of Chester

1 East of Chester. 432686 to 424643 (Grid Refs on Ordnance Survey Maps). 1991 (Year when upgrading of this section of the A55 was finished). The main substrate is red brown lodgement till ("Irish Sea Till") deposited by an ice sheet coming to Cheshire from the Irish Sea) with occasional softer patches, glacial sands & gravels. Various bridges but no special problems. **Ends at Shropshire Union Canal between Junction 37 & Jct 36a**

2 Chester Bypass (south of Chester). 424643 to 347633. 1976 Mixed alluvium on the Dee floodplain and till with kettle holes elsewhere. **Look at the kettle holes seen occasionally as hollows/ponds in the glacial deposits.** (Kettle holes = hollows where there was a buried ice mass during deposition of glacial deposits, which later melted out leaving a hollow). Kettle holes had peat and soft laminated clay with high moisture content, too unstable for a road foundation. The kettle holes were usually excavated and backfilled with free draining rock fill. In some infilled kettle holes there has been some settlement needing remedial work. Deep till cutting West of the River Dee with red sandstone at the base. There have been minor slips associated with silt beds. **Ends at Junction 36a Broughton (A5104)**

3 Hawarden Bypass 347633 to 283663. 1984 16m deep rock cutting in Carboniferous (Namurian) sandstone in Bilberry Wood. **As the road rises West of the Cheshire Plain (about 5 miles west of the River Dee) you move onto the Carboniferous Coal Measures Bedrock.** The Carboniferous (Westphalian) Coal Measures were extensively mined before detailed records of the mining were kept. Because they were mined before modern records were kept intense investigation was needed to locate the mined areas (where road settlement might occur). This needed drilling of 3000 holes (totalling 60,000m long) in which 12,000 tonnes of cement grout was injected to stabilise old workings. The new road would sterilise useful coal deposits for opencast mining, so these were opencast mined before road construction near the Ewloe interchange. The 30m void produced by the opencast coal extraction was carefully backfilled with compaction of the fill before the road was constructed. **Ends Junction 34 (Ewloe Interchange, where A494 to Queensferry branches off)**

4 & 5 Near Northop Hall 283663 to 254680 1975 Good ground conditions on glacio fluvial sands and gravels. **Ends at Junction 33a**

6 Northop Bypass 254680 to 231698. 1989 Carboniferous (Namurian) mudstones, siltstones and sandstones with undulating rockhead overlain by variable till and glaciofluvial deposits. A deep valley was spanned by a rockfill embankment and 6 marshy hollows were excavated and backfilled with free draining material. At the west end of this section artesian water pressure in permeable bedrock overlain by till needed 260 pressure relief wells to prevent water pressure causing heaving in the cutting.

7 & 8 (Near Halkyn) 231698 to 206725 1980 Mainly sand and gravel with few problems. **Ends Junction 32a**

NOT FOR JUNE 8 VISIT – you could visit this if coming to the area independently. Leave A55 soon after the access to the Burger King on left – LEAVE VIA JUNCTION 32b - signed to Halkyn, Rhosesmor etc. REFER TO LOCAL MAP 1 – follow signs to Rhosesmor. Follow the major road until reaching the Britannia Inn, where you should turn left. Turn left again at the T junction (with Church on right). Continue about 800m till reaching the Bluebell Inn – stop about 200m or so after the Blue Bell Inn. There is a boulder lined road to the TARMAC QUARRY on the right and a boulder marked PARKING AREA about 30m beyond on the right. THIS IS STOP ONE (Grid Ref 208701). A sample of the area of metalliferous mining described in section 9 can be viewed on foot from here. From the parking spot walk NNW past the radio towers, then down west and finally SE back to the start point. You can see capped shafts, linear vein workings, and a wide range of disturbed ground, buildings, water channels etc all related to mining. **Return to the A55 by the same route – past Bluebell Inn, turn right after cattle grid, then continue to the Britannia Inn, turn right and follow road down to A55 – turn left onto A55. NOT BEING VISITED 8 June 2018**

9 Holywell Bypass 206725 to 130759 1986 At the Dolphin Interchange the 16m cutting goes through till overlying glaciofluvial deposits (sand & gravel) overlying till, which are all on top of Carboniferous strata with high (artesian) groundwater pressures. This needed relief wells and other drainage measures, and the cutting was made in 3 stages whilst careful observation of water pressures was made with piezometers. Westward, on Halkyn Mountain, the Lower

Carboniferous Limestone contains many mineral veins (17 in the 1st 3 km the road crosses). These mineral veins have been intensively mined for lead, zinc and silver, especially in the 19th and early 20th centuries. Mineshafts and other subsurface workings give a high risk of collapse. Investigation of the problem included detailed desk study, geological mapping, drilling and inspections of mine workings, showing 36% of the route was affected by old mine workings. 34 mineshafts were capped and 10 reinforced concrete rafts were needed over the mineral veins. Annual monitoring is carried out but has shown no failures. **Ends at Junction 31 (A5151 to Prestatyn), but most of the mine workings were in the eastern half.**

10 Travellers Inn section 130759 to 093760 1990 On the Lower Carboniferous Limestone overlain by glacial materials, 51 natural sinkholes were found in an area of 35 hectares, suggesting the possibility of deeper cave systems and large voids, with a risk of collapse. Boreholes, geophysics, probe drill holes, trial holes and “down the hole” borehole photography were all used. “No single method provided a comprehensive understanding of the subsurface conditions”. Only solution enlarged joints were found, not cavernous openings. Precautions taken were to excavate and backfill sinkholes, use geotextiles, and regular post construction monitoring of this section. At two sites early signs of subsidence have been detected since completion and remedial measures taken. **Ends at Junction 29, just before the Rualt Hill descent.**

IMPORTANT - STOP TWO (The first for our visit on 8 June). Soon after Junction 29 – IN THE LAYBY going downhill with LARGE ROCK CUTTINGS (Rualt Hill). STOP IN THE LAYBY. We shall look at the cuttings from the layby pavement. Grid Ref 082754 See notes in following section.

11 Rualt Hill 1992 093760 to 071746 Two major cuttings were made in Silurian siltstones and mudstones where the road descends into the downfaulted Vale of Clwyd. Pre-split blasting was used to produce a less fractured face. The rocks are locally faulted and have other discontinuities, some of which slope unfavourably and could promote large and small scale failures. During construction a 7000m³ wedge failure occurred. The rock faces were stabilised with rock bolts and rock anchors. To reduce the risk from rocks falling onto the road there is benching, catch fences, catch ditch, rock bolts and shotcrete (spray on concrete).

12 Vale of Clwyd 071746 to 044748. 1998 Mainly good foundations on till (stiff to very stiff clay), with some alluvium near the river. **Section ends at Junction 27a.**

13 St Asaph Bypass 044748 to 025747. 1970. Between the 2 rivers crossed (immediately west of the River Clwyd) there is a 12m deep cutting with slopes that are too steep (27°), and only marginally stable. Bulging and 3 circular slip failures are visible on the south side of the cutting. [Though Frank can't see these – because they are now hidden by vegetation - brambles]. **Ends Junction 26**

14 Bodelwyddan Bypass 025747 to 983761. 1986 No problems on this till plain over limestone. Note the stone walls instead of normal highway fences, to be more in keeping with the impressive church and the extensive false medieval defensive buildings, all built in Carboniferous Limestone, including Bodelwyddan Castle and the farm buildings with castellation to look like medieval defensive buildings. **Ends Junction 24a**

15 East of Abergele 983761 to 954776. 1981 The road descends from the till plain to the coastal plain. Some minor problems with variable soil conditions. **Ends Junction 24**

16 Abergele Bypass 954776 to 912785. 1969 Peat is interbedded with marine and estuarine alluvium. The peats and clays were soft to supersoft and needed excavation and backfilling with free draining rockfill. Some long term settlement has occurred in places, probably because some of the soft material has not been fully removed. **Ends just East of Junction 23**

IMPORTANT STOP THREE Leave the A55 at Junction 22, go left to the small roundabout in town where you should turn left. See Local map 2 (1). Follow the main road along the main street and up the hill, turning left onto Queens Road (Turn just before Queens Court – see photo on next page). Go down the hill, turn right onto Sefton Road, then right onto Voryn Avenue and park near the East end. THIS IS STOP THREE The extensive coast defence works and an exceptional view of the A55 can be seen at the eastern headland of Colwyn Bay (Section 17). Access is by a footpath starting at the east end of Glan-y-Mor Road. On the way you pass the lower part of an old limestone quarry, but it is not safe to attempt to approach the face. The path leads over the Rainbow Bridge. From the bridge you get a good view east along the A55 and the limestone cliffs with some glacial till that show old rotary slips that might re-activate. To prevent this the new A55 has been made as a toe weight to keep the old slips stable even when there is exceptional rain to lubricate these old slip planes. This is a major reason why there has been extensive use of tetrapod blocks (trade name “Dolos Blocks”) to protect the A55 embankment east of the headland. There is more detail in section 17. The 22,000 dolos blocks (5 tonne concrete “twisted anchor” shapes) protecting the road embankment east

the headland are very impressive. Very close to the headland on the east side there is a limestone cutting down to the sea, with a small slipway, where post 1984 weathering has opened cracks and long term cliff instability is obvious (use appropriate caution, especially in frosty conditions or heavy rain). West of the headland armourstone on crushed rock on geotextile have been used to protect against erosion. South of the road the old limestone quarry has been infilled in its lowest part with excess poor quality spoil from the A55 excavations.

Return to the A55 by reversing the route to STOP THREE (on Local Map 2) back to Exit 22 – go right on the roundabout near the town centre at the bottom of the hill (next to Plumb Centre), Then left onto the A55 towards Llandudno.



QUEENS COURT Sheltered Accommodation. Turn left here to enter Queens Road.

17 Colwyn Bay Bypass. 912785 to 817780. 1984 Starts just East of Junction 23. In the eastern section there were ancient coastal cliffs in till over limestone with extensive, deep-seated landslips. A rockfill embankment was designed to toe load the landslips and stabilise them. To protect the embankment from marine erosion there are major coast defence works with tetrapod blocks (Dolos Blocks) laid on armour stone on geotextiles. (Already seen if you have made Stop Three). Normal high tide is +4m ASL, the embankment is armoured to 10m asl. This is designed for the 100 year storm and 5m waves. In the central section there are high retaining walls where the A55 passes the main town in a deep cutting in mixed glacial deposits. In the Colwyn Bay Bypass section 170 houses were demolished and 3km of railway moved! Further west, when the road begins to descend, gabions are used on some cutting slopes and can be seen from the road.. Approaching the River Conway there is soft alluvium and peat where construction measures included use of a lightweight PFA (pulverised fuel ash – waste from coal fired power station) embankment on a piled concrete slab foundation. **Section ends Junction 19**

18 Conway Crossing 817780 to 753783. 1991 A tunnel was chosen rather than a bridge. The substrate in which the tunnel was to be made is stratified soft alluvial deposits overlying tills. The tunnel design was the first use of an immersed tube in the UK. The main tunnel length was constructed in six 118m long sections on the west bank. A large trench was dredged and the tunnel sections floated into position, ballasted, sunk, mated together and then buried. The east and west approach sections were made by cutting a trench, making a tunnel section, and then covering. The west portal (tunnel

entrance) area needed high density extra ballast to counter buoyancy. The excess spoil excavated was used to create a wetland area for birds on the east bank. On the West tunnel approaches soft alluvium caused problems. Where it was too deep to be excavated and replaced, pre consolidation was obtained using 45,000 vertical band drains (special plastic drains with fine mesh geotextile sheath installed in vertical drill holes). These allowed water to escape rapidly from the clays when the embankment load was placed on the alluvium (typically 2m of settlement occurred in 10-15m of alluvium)! Bridges etc were given piled foundations. **Ends near Junction 17**

19 Penmaenbach Headland 753783 to 727773. 1989 This headland is a major obstacle with a new 660m long tunnel for westbound traffic, whilst the eastbound traffic uses the old road with only a very short tunnel. The rocks are various acid igneous rocks – both intrusive rhyolitic rock and rhyolitic lavas. In the west portal area 40,000m³ of scree was removed before tunnelling began. Most of the tunnel was drilled and blasted and then supported with rock bolts and shotcrete. The tunnel was given a non structural lining (i.e. mainly for aesthetic reasons) with in situ formed concrete arches. This lining has cracked, but this does not affect the integrity of the tunnel. Since the Nichols paper was published a new coloured lining has been added, covering the cracked original lining (essentially just a cosmetic lining). East of the tunnel stone columns were used to improve ground conditions, or ground was excavated and replaced with quarry waste. **Ends between Jcts 16a & 16**

IMPORTANT - STOPS FOUR AND FIVE Use Local Map 3. Leave the A55 at the roundabout, Junction 16. Go into Penmaenmawr and turn right just after the pedestrian lights (the only traffic lights in the settlement), descend the hill using Paradise Road and park in the car park on the right at the bottom (junction of Paradise Road and Station Road East – it is a free public car park, not a private park for the nearby buildings). “A” on LOCAL MAP 3. A short distance along the Station Road East there is a tunnel under both railway and A55 leading to the beach. More detailed info in section 20. The new short promenade and large scale use of armourstone (much from Ireland and Sweden) can be seen.

AFTER RETURNING FROM THE BEACH go back up the hill and turn right. Continue until the road is nearly rejoining the A55. Park at B on Local Map 3, BEFORE the last 2 blocks of row houses near the footbridge. (APPROX OPPOSITE THE LARGE BLUE SIGN ON THE RIGHT Showing “Lane Control Signals”). (grid ref 706762). Cross the road and look forward at the slope with much scree, catch fences etc. Walk to where the local road joins the A55 where there is a new footbridge for pedestrians and cyclists. More detailed info in section 21 below. The Brazilian Wall and the concrete canopy over the tunnel entrance are both seen very close up from the footbridge. The stainless steel capped covers for the cable rock anchors stand out clearly – the larger caps indicate anchors which have been instrumented to measure changing stresses through time. You can also see catch fences, catch walls and rock bolts etc. Along the cycleway other rock stabilisation and catch fences can be seen. If you have more time you can cross the eastbound carriageway (with care!) and walk along the footpath westwards alongside the road to see netting used to restrain loose rocks, rock bolts and masonry dentition (patching up weak rock with masonry, a little like dentists work on teeth), catch fences etc. After a while you also get a good view of the railway on a viaduct well below the road level. **Return to your vehicle and rejoin the A55 Westbound near the footbridge. Drive through the tunnel and reverse direction at the roundabout to return Eastwards.**

Look at the info in 20 & 21 – ideally before starting to drive.

20 Penmaenmawr Bypass. 727773 to 707763. 1989 The road, and railway alongside, are very close to the sea in this section of the A55 and needed a lot of land reclamation and sea defences including a 12m embankment. 110,000 tonnes of armourstone was used in coast protection works. Some of this stone came from local quarries (limestone and microdiorite) but most came from coastal quarries in Sweden (granite and gneiss) and Ireland (dolerite and diorite). According to Nichols the construction works here included the building of the first post Victorian promenade in the UK (about 100m long). **Ends at Junction 15a**

21 Pen-y-Clip Tunnel. 707763 to 690758. 1994 This 930m tunnel was made in Silurian microdiorite and needed extensive retaining walls (Brazilian Wall, top first, construction for two of the biggest ones) at each end. The difficult ground conditions included made ground (man disturbed material, especially from old quarrying activity), scree, fossil scree and tills. The eastbound carriageway, the westbound carriageway and the railway are all at different levels so there are a lot of retaining walls and approach ramps etc needed, including many new ones. Thus the works for this section needed 2000 ground anchors. The ground anchors are basically cables grouted into the far end of long (up to 30m) gently inclined drill holes, so that load can be supported at the surface end. Extensive rockfall countermeasures were needed, using check fences, a gabion wall as a rockfall catch wall along an old high level quarry access road, rock bolts, masonry dentition, scaling (scaling = removal of all loose or potentially loose material on a bedrock slope) etc. The bedrock is Upper Ordovician microdiorite intruded into lower Ordovician mudstones. Although the rock is very strong, during the tunnelling the rock was found to have many more joints than expected, which meant much more tunnel support was needed. The construction in this section began in 1989, the tunnel opened in 1993 and all site work was completed in 1994. **This section ends just before Junction 15. Junction 15 is a roundabout and is the end of this viewing of**

the A55 – use the roundabout to reverse direction of travel to Eastbound. Returning towards Pen y Clip gives further views of the tunnel and associated slope stability works. END OF GUIDED VISIT

THE REMAINDER OF THESE NOTES ARE NOT NEEDED UNLESS GOING ON TO HOLYHEAD ANOTHER DAY.

22 Llanfairfechan Bypass. 690758 to 663736. 1989 Poor ground conditions here included soft alluvial silts and clays, sometimes with peat, overlying till, and much of the ground waterlogged. The road was constructed on an embankment with a variety of stabilisation measures. In places soft ground was excavated and replaced with free draining gravel. At two problem peat areas a concrete slab was laid supported on piles. Geotextiles were used extensively.

23 Aberwyngregwyn 663736 to 637722 1994 **& 24 Aber to Tair Meibon** 637722 to 616707
Here there are shallow glacial deposits over typical Ordovician dark grey silty mudstone rocks. Some problems were caused by limited patches of soft ground, and also surface and groundwater flows across the line of construction.

25 Bangor Bypass. 616707 to 547702 1984 The eastern part of this section is mainly cuttings in shallow till over Ordovician siltstones and mudstones. At the A5 interchange extensive rock cuttings in bedrock were needed for the 2.7km of new linking roads. Peat problems were overcome by either excavation and replacement or “punching large rocks into shallow peat”. West of the A5 junction there is a series of rock cuttings in a variety of rocks getting progressively older, from Lower Ordovician near the A5 to early Cambrian near the Britannia Bridge. The rocks include black mudstones with a dolerite sill, quartzite, and purple, green & white tuffs. Rock from the cuttings was used as aggregate. There was also extensive use of the local slate, especially for pavement construction [presumably for the non asphaltic base and sub base], and also for cladding on bridge abutments etc.

26 Pont Britannia. 547702 to 539713. 1980 This bridge was built by Robert Stevenson (about 1850) as a tubular steel box beam supported on 3 masonry towers on piers, the central pier founded on a mid channel islet. Unfortunately there was a severe train fire inside the box beam in 1970 which terminally weakened the original bridge. The box beam was replaced by steel arch supported spans with a new road (now the A55) on top of the railway, but still using the original towers. These towers are constructed with Carboniferous Limestone rock from near Red Wharf Bay on Anglesey. As the A55 approaches the bridge from the east it crosses the Dinorwic Fault onto shallow glacial deposits over varied Carboniferous rocks.

27 Llanfairpwllgwyngyll Bypass. 547702 to 521718. 1983 Here there are thin glacial (till) deposits overlying Precambrian Mona Complex rocks. These are intensely folded quartz mica schists which were encountered in shallow rock cuttings.

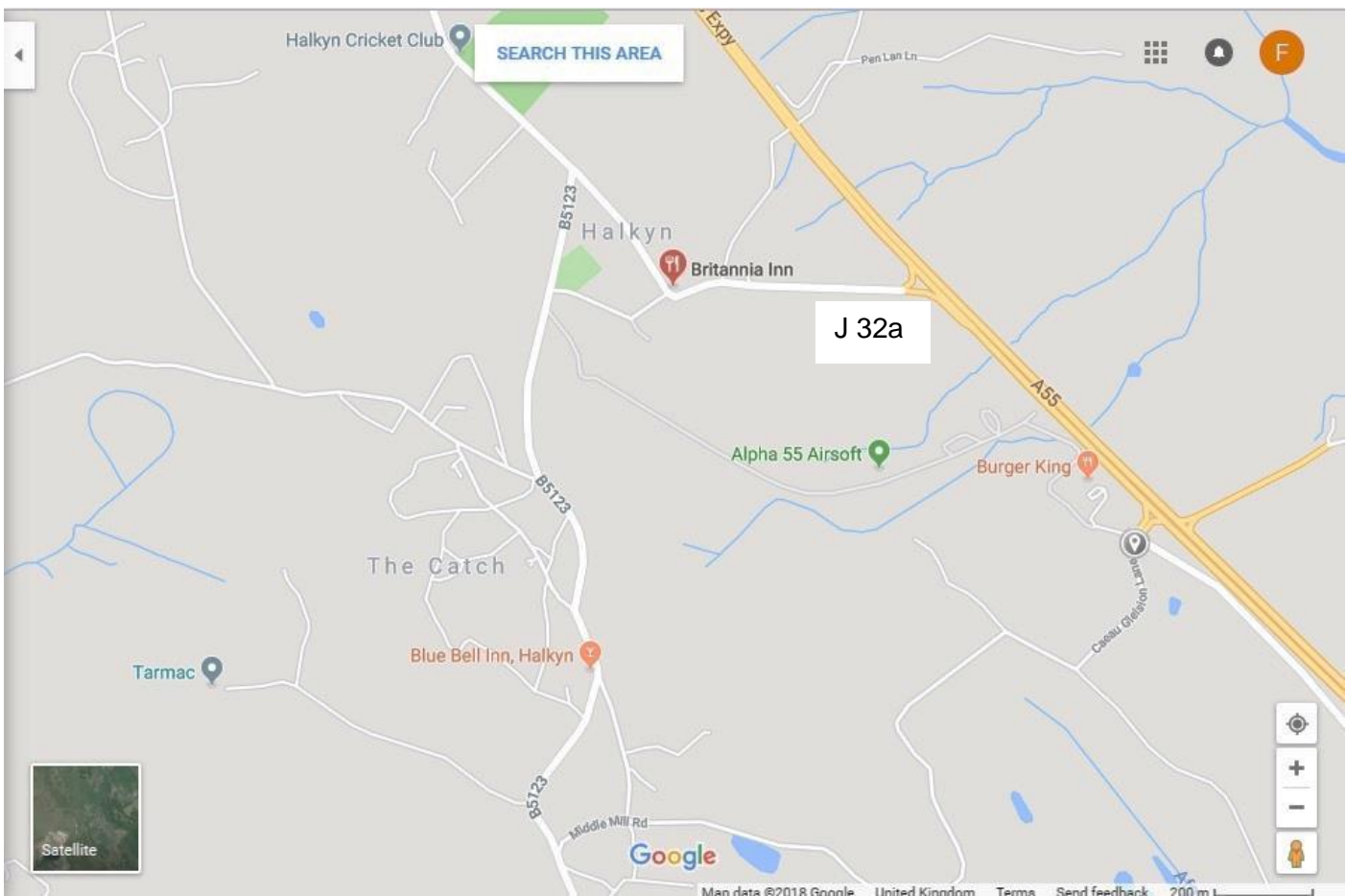
28 Llanfairpwllgwyngyll to Pentre Berw. 521718 to 470727. 2001 The route is underlain by Mona Complex schists. For most of the distance these are quartz mica schists which are sometimes highly weathered. These are overlain by thin tills and variable alluvium associated with local streams. Soft ground conditions causing problems occurred due to poor soils, poor drainage and deep weathered bedrock. At the west end of the section there are hornblende schists which stand up as a prominent ridge and a relatively deep cutting was needed near to Pentre Berw.

29 Pentre Berw to Nant Turnpike. 470727 to 430742. 2001 At Pentre Berw the A55 crosses the Berw Fault onto Carboniferous rocks. The Carboniferous rocks are covered by thick till and alluvium, though some old coal mining features still needed (unspecified) attention. Malltraeth Marsh, which the A55 crosses north west of Pentre Berw, was a tidal marine salt marsh until drained in the 18th century. The soil is marine and estuarine silty clay and clayey silt with occasional peaty layers. The road was constructed on an embankment that was made in stages to allow settlement between stages. Band drains and stone columns were installed to speed up settlement. West of the marsh the road is in a shallow cutting in till with no special ground problems.

30 Nant Turnpike to Holyhead. 430742 to Holyhead. 2001 In the final 23 km of the A55 the route crosses a series of NE-SW trending subdued bedrock ridges mainly formed of Precambrian rocks but some Lower Palaeozoic. Between the ridges are broad valleys with glacial sands and gravels overlain by a thin layer of till. The A55 therefore has a series of alternating rock cuttings through **higher ground and shallow embankments crossing the low ground. There is a rock fill causeway to Holy Island and Holyhead.**

LOCAL MAP 1 - Halkyn

IMPORTANT – Look Out after Junction 33. Leave A55 soon after the access to the Burger King on left – LEAVE VIA JUNCTION 32b - signed to Halkyn, Rhosesmor etc. REFER TO LOCAL MAP 1 – follow signs to Rhosesmor. Follow the major road until reaching the Britannia Inn, where you should turn left. Turn left again at the T junction (with Church on right). Continue about 800m till reaching the Bluebell Inn – stop about 200m or so after the Blue Bell Inn. There is a boulder lined road to the TARMAC QUARRY on the right and a boulder marked PARKING AREA about 30m beyond on the right. THIS IS STOP ONE (Grid Ref 208701). A sample of the area of metalliferous mining described in section 9 can be viewed on foot from here. From the parking spot walk NNW past the radio towers, then down west and finally SE back to the start point. You can see capped shafts, linear vein workings, and a wide range of disturbed ground, buildings, water channels etc all related to mining. Return to the A55 by the same route – past Bluebell Inn, turn right after cattle grid, then continue to the Britannia Inn, turn right and follow road down to A55 – turn left onto A55.



LOCAL MAP 3

IMPORTANT Leave the A55 at the roundabout, Junction 16. Go into Penmaenmawr and turn right just after the pedestrian lights, descend the hill and park in the car park on the right at the bottom (junction of Paradise Road and Station Road East). "Parking A" on the Map.

After returning from the beach go back up the hill and turn right. Continue until the road is nearly rejoining the A55. Park BEFORE the last 2 blocks of row houses near the footbridge. "Parking B" on the Map. This is just BEFORE the road rejoins the A55.

