



**SDL3222
OCTOBER 2017**

**SPECIFICATION FOR THE DRILLING AND GROUTING OF SHALLOW
MINEWORKINGS**

**beneath land off
BARNSELY ROAD, FLOCKTON**

**prepared for
PERSIMMON HOMES (WEST YORKSHIRE)**

SPECIFICATION FOR THE DRILLING AND GROUTING

OF SHALLOW MINeworkINGS

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APPENDICES

APPENDIX A FIGURES AND DRAWINGS

Drawing No.	Title	Scale
SDL3222/SP/01	Site Location Plan	1:50,000
SDL3222/SP/02	Development Layout & Constraints Plan	1:500
SDL3222/SP/03	Proposed Drill and Grout Layout Plan	1:500

1. INTRODUCTION

Sirius Drilling Ltd (Sirius) have been commissioned by Persimmon Homes (West Yorkshire) (Persimmon) to prepare a Specification for the stabilisation of shallow mineworkings at their Flockton development.

It is understood that Persimmon intend to develop the site with residential properties and associated carriageways and landscaped areas.

A geoenvironmental investigation prepared for the site, by Haigh Huddleston Associates Limited (HHA), states that...

“In BH03, a 1.3m thick layer of broken ground was encountered at a depth of 10.8-12.1m below existing ground levels. In the remaining boreholes, a 1.2-1.4m thick seam of coal was encountered at depths of 8.8-12.3m below existing ground levels. The ratio of solid rock cover to coal seam thickness varies from 5.7x to 10.1x across the site”

Sirius have been contracted to undertake the probe drilling and subsequent stabilisation of shallow mineworkings within the identified seam beneath plots and adoptable highways by means of drilling and grouting. This work will be carried out under the supervision of Sirius.

Treatment of the adoptable highway will be undertaken utilising a nominal 3m x 3m grid across the highway footprint.

Treatment of plots will be undertaken utilising a primary nominal 6m x 6m grid with a central borehole (nominally a 4.25m diamond grid), reducing to a 3m x 3m grid locally to boreholes which encounter workings. Treatment will extend up to 3m out with the building footprint.

The stabilisation works will be undertaken by injecting a PFA / cement grout into the workings via the boreholes with the aim of substantially filling any mining related voiding .

A plan showing the proposed locations of the boreholes, together with the development proposals, is enclosed as in Appendix A.

Persimmon will supply the contractor with details of all known underground and above ground services, equipment, property etc. prior to commencing operations.

All works shall be carried out in accordance with the Construction Design Management (CDM) Regulations and the Construction Phase Health and Safety Plan.

This specification is divided into two sections; the general site details including information on the site, previous investigations and their findings; the second part of this report is a general specification for the works to be undertaken.

Based upon the current available information, it appears that all plots and adoptable highways will require stabilisation however probe drilling will be undertaken to confirm this. Notwithstanding this, as works progress, seam thickness, seam depth and the nature and form of the seam will be reviewed in order to assess the effect on the anticipated zones of consolidation.

On completion of the drill and grout programme, a validation report containing copies of borehole records, a borehole location plan, procedures followed during the works, the results of validation boreholes and pressure tests, and a record of any deviation from this specification will be produced and issued to the client and all other relevant parties.

This specification has been prepared for the sole use of Persimmon and their appointed agents. No other third party may rely upon or reproduce the contents of this report without the written approval of Sirius. If any unauthorised third party comes into possession of this report, they rely on it entirely at their own risk and the authors do not owe them any Duty of Care or Skill.

2. SITE DETAILS AND DESCRIPTION

Table 2.1 Site Location

Location	The site is located to the north of Barnsley Road on the western edge of Flockton Village, 11 km south-west of Wakefield town centre (and occupies an area of approximately 1.75 hectares).
National Grid Reference	NGR SE 234149
Current Site Description	The site comprises an approximately rectangular parcel of land with the south west portion occupied by a number of warehouse/farm buildings used for processing of logs for firewood and storage of machinery. The north western and eastern site area are used as arable farmland.
Site Boundaries	West – Predominantly open farmland with farm buildings and residential properties in the south west. East – Predominantly open farmland with residential properties in the south east. A public footpath runs along the eastern site boundary. South – Barnsley Road with residential properties and commercial buildings beyond. North – Open grassland/arable farmland

3. GEOLOGICAL SETTING

A summary of available published geological information is provided in Table 3.1 below.

Table 3.1 Geological Summary

Sources of Information	BGS 1:10,000 scale geological maps (Sheets SE21SW & SE21NW).
Made Ground	None recorded on the BGS map.
Drift Geology	No superficial soils recorded on the BGS map.
Solid Geology	The Birstall Rock formation, comprising sandstone directly underlies the site and is part of the Lower Coal Measures strata comprising undifferentiated sandstones, siltstones, mudstones and coal which underlies the broader area. A fault is indicated to cross the northwest corner of the site from north east to south west and is downthrown to the northwest.
Mining and Quarrying	None recorded on site however, two coal mine entries are recorded within 20 metres of the site boundary, to the west and south west. The Coal Authority report states that <i>“the property is in the likely zone of influence of five seams of coal at from shallow to 160m depth, last worked in 1973.”</i>

4. PREVIOUS INVESTIGATIONS

The site has been the subject of a ground investigation prepared previously for Persimmon by HHA, reported as 'Geo-environmental Ground Investigation Report (ref. E14/6164/R002) dated April 2015.

Summary of Relevant Findings

Within their report, HHA state that....

"The online Coal Authority resources indicate a coal outcrop located to the south of the site. The site itself is shown to be in an area of probable shallow mine workings."

"There are two known coal mine entries within 20 metres of the boundary of the property. The first is located to the south west of the site and has been filled to an unknown specification. In July 2010 it was excavated and capped with 3x3x0.3m thick reinforced concrete slab at a depth of 1.2m below ground level. There are no records of what treatment, if any, has been undertaken to the second shaft located to the west of the site."

The report continues....

"BH03 in the south of the site recorded 1.3m of broken ground at a depth of 10.80-12.10m. In the remaining boreholes, a 1.2-1.4m intact seam of coal was encountered at depths of 8.8-12.3m below existing ground levels, indicating the coal was shallower in the south west of the site. The presence of broken ground indicates that the coal seam has been worked in the south of the site by the site entrance."

"In BH01, two further coal seams were encountered. A 0.2m thick seam was encountered at a depth of 3.90m and a 0.4m thick seam was encountered at 19.70m. These seams are too thin for any workings to be considered to have an influence at ground level and the seam to solid rock cover ratio in both instances is in excess of 1 to 10."

"The ratio of solid rock cover to coal seam thickness varies from 5.7x to 10.1x across the site...."

“The NHBC regulations state there should be in excess of 10 times the seam thickness of suitable rock cover which will not be satisfied in this instance in the south of the site.”

“In the event that workings and insufficient rock cover is proved, the house type footprint should be drilled and grouted based on a maximum 3m grid line system.”

5. GENERAL SPECIFICATION

5.1. Constituent Materials for Grouting

Water shall be from the mains supply or other source approved by the Resident Engineer (RE) and supplied by the Client.

Cement shall be CEM II 32.5 conforming to BS EN 197-1:2011

Pulverised Fuel Ash (PFA) complying with BS EN 12715: 2000 shall be conditioned hopper ash, or dry powder ash, or a type suitable as a constituent for grout and obtained from an approved supplier.

Sand shall generally comply with BS882 and be of a grading suitable for use in the Contractor's plant and approved by the RE.

Pea gravel shall comply with BS882, and be of grading approved by the RE.

Thixotropic admixtures shall be bentonite or another admixture approved by the RE.

5.2. Storage and Use of Materials

Storage of materials shall be such as to prevent contamination and deterioration. Cement shall be kept in a dry location, and the sequence of deliveries recorded so that cement can be used in rotation.

PFA shall be stored within a pre-defined area and will be kept dampened to mitigate against fugitive dust.

5.3. Grouting Plant

The Contractor shall submit to the RE, for approval, details of the proposed method of mixing, and pumping of grout to the injection points, together with the means of monitoring grouting pressures and the quantities injected. The materials shall be introduced into the mixer via approved volumetric methods.

The grout mixer shall be capable of producing a homogenous mix, all particles being thoroughly wetted without segregation.

5.4. Grout Mixes

With consideration to the future use of the area, the filling material shall generally consist of a PFA: cement grout which should be generally mixed in the proportions of to 12:1.

The mixes shall produce cubes with crushing strengths of not less than 0.75MN/m^2 at 28 days (Note: the 7 day test is performed to indicate that the 28 day strength is achievable i.e. a 7 day value of about 0.4MN/m^2 would probably be considered on target).

Where excessive lateral flow of grout is anticipated or when voids greater than 500mm are encountered, sand or pea gravel may introduced in to the workings in accordance with CIRIA SP32. The specified grout mix shall have the minimum water content consistent with effective pumping.

The actual proportions to be used initially for the various grouts shall be agreed with the RE paying due regard of the conditions met in drilling and the results of any trial grouting carried out before work commences.

5.5. Grout Properties and Testing

With water / (cement and PFA) ratios generally in the range of 0.4 to 0.45, (including the moisture in the aggregates), the mixes proposed should produce pumpable grout with flowability readings of between 300 to 600mm, when measured in a meter of the “Colcrete” type.

The sample for the flowability test shall be obtained by the grouting Contractor at the point of injection i.e. from the end of the tremie pipe.

A minimum of two flowability tests per week shall be performed by the Contractor as directed by the RE.

High-bleed grouts shall be avoided. Bleed capacity should be limited to 5% maximum unless agreed otherwise with the RE.

A minimum of two bleed capacity tests shall be performed by the Contractor per shift or as directed the RE. The sample of grout for the test shall be taken from the point of injection i.e. the end of the tremie pipe.

Bleed capacity shall be measured in a clear plastic or glass graduated cylinder which has an internal diameter not less than 50mm and with a volume of approximately 1000ml. After placing the grout, a cover shall be placed over the cylinder to avoid evaporation. Bleed capacity shall be read at hourly intervals for neat cement grout, and readings should continue for not less than 3 hours. For PFA: cement grouts, readings should continue for not less than 6 hours.

The Contractor shall prepare two sets of test cubes of grout per week, or as directed by the RE. Each cube shall be of 100mm side, or as agreed with the RE, and shall be taken from the grout at the point of injection i.e. the end of the tremie pipe.

At the instruction of the RE, the Contractor shall arrange for them to be tested by crushing at 7 and 28 days in accordance with BS1881.

The testing shall be carried out by an independent laboratory or as agreed with the RE.

As stated previously mixes shall produce cubes with crushing strengths of not less than 0.75 MN/m² at 28 days

If the RE considers the results of the test indicate that a change of mix proportions is required, the Contractor shall make such modifications as the RE may direct.

5.6. Drilling Procedures for Treatment of Shallow Mineworkings

All boreholes to be used for the injection of grout, including those which strike coal pillars, shall be drilled by rotary or rotary percussive techniques down to a minimum of 0.5m beyond the base of the old workings in the seam or the floor of the seam itself whichever is greater.

The drilling system and flushing medium to be used shall be as instructed on the Coal Authority licence, and approved by the RE. The Contractor shall allow for the provision of appropriate dust suppression for those holes that are to be drilled near sensitive receptors (e.g. nearby houses, highways, active commercial properties, car parks and public footpaths).

Treatment of the adoptable highway will be undertaken utilising a nominal 3m x 3m grid across the highway footprint.

Treatment of plots will be undertaken utilising a primary nominal 6m x 6m grid with a central borehole (nominally a 4.25m diamond grid), reducing to a 3m x 3m grid locally to boreholes which encounter workings.

Boreholes drilled for the treatment of the plots will ensure the zone of consolidation extends beyond the building footprint, based upon anticipated grout flows.

The minimum diameter of the holes shall be 75mm unless otherwise specified by the RE. When it is impracticable to drill at the minimum diameter for the full depth, the diameter of the boreholes shall be increased in the upper lengths.

Boreholes shall be temporarily cased through superficial deposits down to the rockhead and if directed by the RE, down through the rock strata. The boreholes shall be kept open until grout injection into the workings and rock is complete.

Where a borehole proves abortive because it becomes obstructed, it shall be re-drilled in a suitable location as directed by the RE, at a large diameter and re-cased.

Boreholes shall be formed in general accordance with the locations shown on the plan in Appendix A. Any deviation from this proposed layout including the drilling of test holes shall be recorded by the contractor and a revised borehole location plan provided to the RE.

During the course of the works, the RE will review the borehole records generated, and will review the potential for the presence of workings at shallow depth below rockhead elsewhere on the site. If so required, the RE shall instruct the Contractor to undertake supplemental investigation boreholes in areas outwith the proposed drill and grout programme, to confirm the presence or otherwise of workings at shallow depth. If such

workings are suspected or identified, the drill and grout programme shall be extended to treat such areas.

5.7. Grouting Procedures for Shallow Mineworkings

The aim of the stabilisation work is to substantially fill any old workings within the identified seam as well as any voids or broken ground found within the overlying strata in order to prevent the development of crown holes at the surface \ foundation level.

Perimeter grout walls, if required, shall be formed by filling boreholes with a viscous grout composed of appropriate proportions of cement, PFA, sand or pea gravel and water. The mix, proportions and method must be agreed with the RE.

Pressure need not be applied to the grout in affected boreholes unless required by the RE.

Unless specified otherwise, the section of the perimeter wall at the deepest part of the seam shall be constructed first.

Immediately prior to grouting each borehole, the Contractor shall check that it is unobstructed to the required depth to receive the tubing or tremie pipes for grout injection. Obstructions shall be dealt with as described in 'drilling procedures' above.

Grout shall be injected into each hole via an approved flexible tube with grout placed to the base of the hole.

Grouting shall proceed upwards from the base of each borehole to the base of the surface deposits. It is not intended that, as a general rule, significant quantities of grout shall be injected into the surface deposits unless specified otherwise. This requirement will be subject to RE review.

The grout shall be injected at the approved rates until grout appears near the point of injection, when the borehole shall be deemed complete. If the criteria is reached quickly, the grout tubes shall be lifted to check that a local obstruction is not preventing flow of the grout into the strata.

Hydrostatic pressure shall be applied to the grout in every borehole. If grout has not appeared at the point of injection after 5 tonnes of grouting materials have been introduced

then sand and/or pea gravel (gravel which passes through a 6.33mm sieve and is retained on a 2.36mm sieve) may be added to the mix or placed down the borehole.

Treatment of adoptable highways will generally be undertaken as per the plots although should a borehole within the highway accept more than 6 tonnes of grout, treatment within the hole will be suspended for 12 hours. Thereafter further grout will be injected in 2 tonne batches. If pressure has not been achieved or grout appeared after a total of 10 tonnes of grout has been placed then a review of the borehole grid spacing, grout mix and materials used will be undertaken.

5.8. Stabilisation Procedures for the Treatment of Mine Shafts

Any former mine shafts encountered on site shall be stabilised in accordance with the recommendations given in the NCB handbook 'The Treatment of Disused Mine Shafts and Adits.' and CIRIA SP32.

All work on or about old mine shafts must be carried out from a safety platform of adequate dimensions that will span the potential collapse zone and support the crew and equipment should a catastrophic failure of the shaft occur.

Prior to work commencing the area will be inspected to ensure that the safe movement of heavy equipment can proceed. This will be carried out by a competent, experienced person who will be securely fastened to the surface by means of a full body harness anchored at an appropriate safe distance away from the potential shaft collapse zone.

If any shaft is found to be open from the surface, then it shall be backfilled with graded material. Any such material will be introduced directly into the shaft from the surface utilising equipment such as a 360 excavator or conveyor.

If the shaft is backfilled then reversed stage pressure grouting of the infill material will be undertaken. Such treatment is achieved by a combination of permeation grouting and low pressure compaction grouting of the infill material which forms an enhanced bond between the infill and the shaft lining \ country rock.

Treatment will therefore be undertaken in the following manner.

A rigid steel and wooden shaft frame will be then mounted over the shaft mouth to ensure that any slumping of the shaft infill will not jeopardise the stability of the drilling rig and the safety of the crew.

Once the safety frame is in place, the drill rig will be positioned over the shaft to allow the sinking of a centrally located borehole through fill material.

Treatment will involve the drilling of a single borehole **to the base of the shaft and at least three metres in to natural strata**, this is to ensure that no “staging” is present within the shaft and that the actual shaft base has been reached. Shaft staging would typically be encountered within the first 50m below ground within shafts although no hard or fast rules can be applied to this. Staging can be a problem if, over time, it deteriorates to such an extent that catastrophic failure of the infill material occurs

On completion of the first borehole temporary steel casing may then be inserted into the borehole. This casing forms the basis of the reversed stage pressure grouting technique.

The grouting operation will commence on completion of the borehole and will involve direct injection down the borehole under pressure through the drill rods or casing in ascending 3m stages.

The grout will possess water: solids ratio **of no more than 40 % giving an** approximate compressive strength of 0.75 MN/m² @ 28 days.

Grout will be mixed by loading hopper conditioned PFA and bagged OPC directly into the mixer via a front loading shovel and by hand. Water supplied from the approved water source will be then be added to the mix to produce grout of the correct consistency.

The grout mixer will be capable of producing a homogenous mix, with all particles being thoroughly wetted without segregation occurring.

The grout will be mixed and injected using a 50mm diaphragm pump operating at around 100 psi and will be pumped via 50mm reinforced grout hoses into borehole. This will continue until either a maximum pressure is reached or refusal of grout occurs. A length of casing will then be extracted, and the process repeated until the complete length of the shaft has been treated.

Should any significant thickness of permeable / granular fill be present on site, grouting may need to be terminated at the level of the base of such material.

If any significant voids are encountered during the operation, a grout \ pea gravel mix will be introduced into the borehole to restrict **excessive movement of grout**. However should any major mining feature such as roadways running off the shaft are suspected these will require investigation and treating separately from the shaft.

Depending on the location of the shaft, a capping solution may be required such as a reinforced concrete cap.

Any cap will be designed by a competent structural engineer with its orientation founding depth and ultimate design agreed by the Coal Authority prior to construction. As a minimum any reinforced cap will be typically twice the shaft diameter,

5.9. Services and Roads

The grouting Contractor shall take all necessary precautions, including making all reasonable liaison with the Client (Persimmon), to ascertain the positions and depths of underground services and drains passing through the site, making full allowance for working around and protecting live services and drains.

Overhead powerlines are recorded to cross the site and as such due regard to HSE Guidance Note GS6 shall be made whilst working near the powerlines.

The locations of the powerlines and a proposed 6 metre 'standoff' from the powerlines are detailed on the proposed drill and grout treatment plan.

Treatment within the identified exclusion zone shall be undertaken by means of angled drilling.

The Contractor shall be responsible for maintaining close liaison with the Local Authority and the Public Utility Authorities so as to avoid any disruption of the existing services.

When introducing grout into any borehole the Contractor shall ensure by regular inspections throughout the day that the grout is not entering adjacent drains, services, culverts and

ducts. In the event that any such leakage is detected the Contractor shall immediately suspend the grouting operations and commence to remove any accumulated grout.

5.10. *In Situ* Testing

When directed by the RE, the Contractor shall test the consolidated ground for permeability and strength.

Permeability by grout acceptance testing shall be checked by drilling test holes in positions to be selected by the RE and injecting grout at pressures appropriate to the depth, all in accordance with the requirements for infilling grouting. If the RE considers that the quantities of grout accepted are excessive, further holes shall be drilled and grouted at the rates and prices agreed.

After testing, boreholes shall be completed in accordance with the requirements for grouting infill holes.

In general, test holes will be undertaken along the adoptable highways adjacent to boreholes exhibiting grout taken in excess of 6 tonnes.

5.11. Records

The Contractor shall prepare and keep available for inspection on site, plans showing the positions of all boreholes, daily drilling records (see below), together with the total amounts of grout injected. Levels shall be given with reference to a datum to be confirmed by the RE.

The plans shall be updated daily in conformity with the Records noted below. On completion of the works, the Contractor shall give fair copies of the plans and sections to the RE within one week of completion of the programme of grouting.

As works proceed, the Contractor shall maintain separate daily records for drilling, for grouting and for materials and plant received in a form to be approved by the RE. The daily records signed by the Contractor's agent shall be submitted each day to the RE for his agreement. The Contractor shall provide one copy of the agreed record for the RE's retention and keep a further copy available for inspection on site.

Daily drilling records shall be provided for each borehole and contain the following information:

1. Job title and location
2. Borehole reference number
3. Date
4. Contractor's name
5. Plant in use, crew members and hours worked
6. Method of boring or drilling
7. Type, diameter and depth of casing used
8. Diameter and depth of hole at the beginning and end of each working day or shift
9. Loss of any flushing medium during drilling
10. Standing time, with reason, or time lost overcoming obstructions
11. Details of underground services located
12. Details of any settlement or ground heave
13. Daily and cumulative length drilled
14. Depth to each major change of stratum
15. Description , with identification, of the stratum and whether it is intact or broken
16. Each depth at which groundwater is encountered (if apparent), the depth to which it rose and any steps taken to stop the flow
17. Depths at which any samples are taken
18. Details and results of any permeability tests instructed by the RE

19. Details of any voids or suspected workings

20. Details of any emissions of gas, water, etc.

21. Depth of completed borehole

Daily grouting records shall be provided for each borehole and contain the following information:

1. Job title and location
2. Borehole reference number
3. Date
4. Contractor's name
5. Plant in use, crew members and hours worked
6. Details of type of injection grout-line dimensions and length of standpipes inserted
7. Type of grout mix and volumetric quantity injected including total quantity by weight by each type of grouting material introduced
8. Grout pressures recorded, with the corresponding depths
9. The results of all flow and bleed tests
10. Details of casing abandoned
11. Details of grouting materials delivered to the site and a running total of each of the materials delivered
12. The nature, frequency and results of all inspections of services to check for grout penetration
13. Details of all stoppages or delays and any other relevant information

The daily records of materials and plant received shall show in particular that day's quantities by weight of each type of material and cumulative quantities. With the daily records, the

Contractor shall submit to the RE copies of receipts or invoices for all materials delivered and he shall keep them on site until the Works are complete.

Notwithstanding the information listed above, the Contractor shall provide any other information required by the RE.

On completion of the drill and grout programme, the RE shall prepare a validation report containing copies of borehole records, a borehole location plan, procedures followed during the works, the results of validation boreholes and pressure tests, and a record of any deviation from this specification.



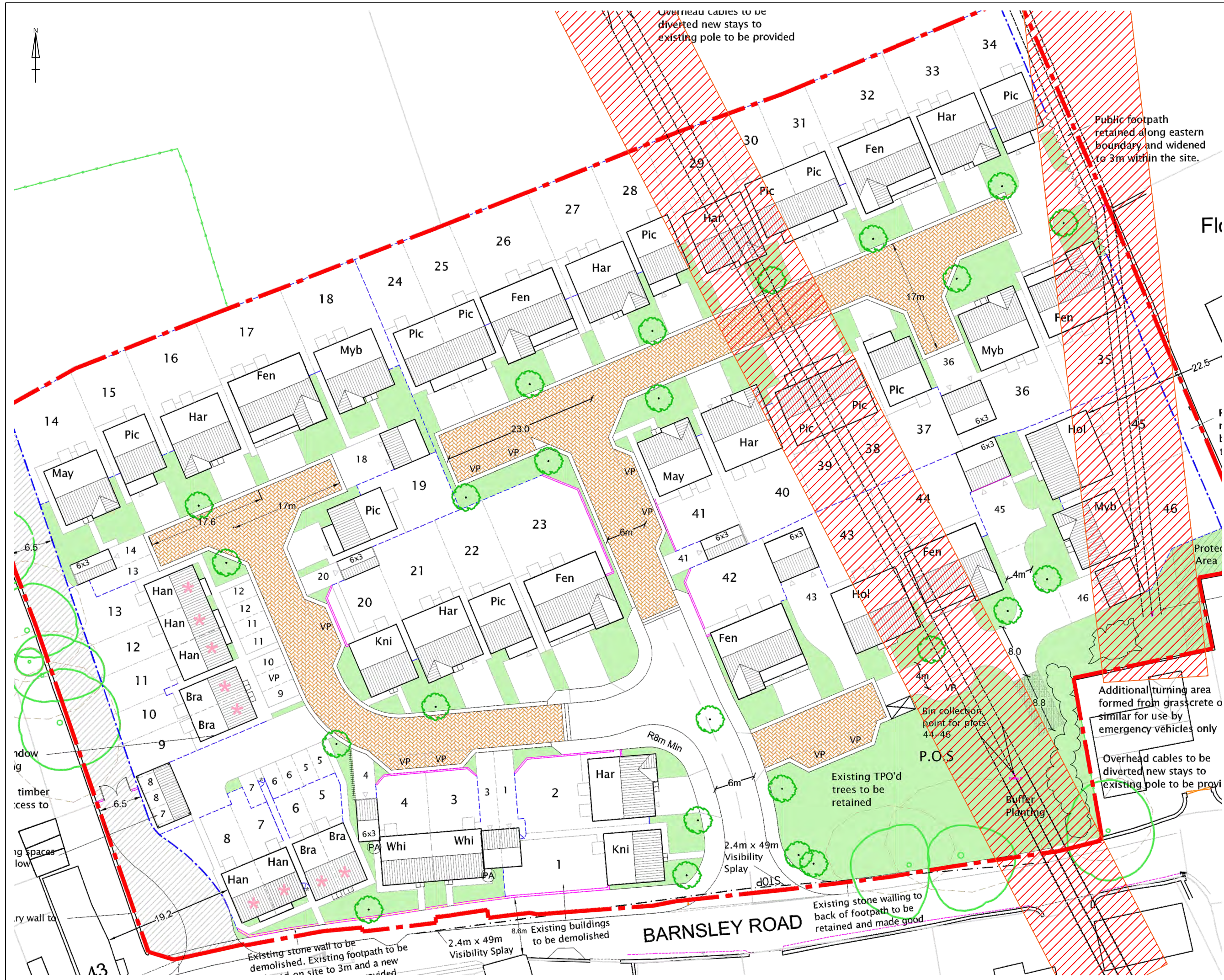
APPENDIX A

FIGURES AND DRAWINGS



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A	>>		
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PERSIMMON HOMES (WEST YORKSHIRE)			
SITE BARNSELEY ROAD, FLOCKTON			
DRAWING TITLE SITE LOCATION PLAN			
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DRAWN BY NI		APPROVED BY AGT	
DATE OCTOBER 2017	SCALE 1:25,000	PAPER SIZE A4	



NOTES

Public footpath retained along eastern boundary and widened to 3m within the site.

REVISION

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CLIENT

SITE
**BARNSELY ROAD
FLOCKTON**

DRAWING NO.
SDL3222/SP/02

~~Overhead cables to be
diverted new stays to
existing pole to be provided~~

Existing T

~~P.O.S~~

Additional turning area
formed from grasscrete
similar for use by
emergency vehicles only

Overhead cables to be diverted new stays to existing pole to be provided

2.4m x 49
Visibility
Splay

Existing buildings
to be demolished

2.4m x 49m
Visibility Splay

Existing stone wall to be demolished. Existing footpath to be widened on site to 3m and a new provided.

