

High Speed Rail in the Chilterns

Part 4: REPA Proposal for Extended Chilterns Tunnel

July 2015

Explanatory note

In response to proposals by petitioners in the Chilterns, and in response to petitions against the High Speed Rail (London – West Midlands) Bill, a number of options for a tunnel or tunnel extension in the Chilterns have been evaluated by HS2 Ltd.

General requirements for long tunnels are set out in Part 1, and the assessment of various options proposed by petitioners are set out in Part 2-4.

This document was prepared by HS2 Ltd in May 2015. Version Po4 was originally published in June 2015 but has now been updated and revised to the current Po5 version. It has been published to allow petitioners to better understand the Promoter's assessment of various tunnel options.



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Revision	Date	Issued for/Revision details	Revised by
P01	15/05/15	Draft Issue	E Veillard
P02	03/06/2015	Incorporates HS2 Comments	A Evans
P03	05/06/2015	Incorporates HS2 Comments	S Seddigh
P04	08/06/2015	Incorporates HS2 Comments	S Seddigh
P05	02/07/2015	Revised REPA proposals	M Sleath

Name	Data
FOI / EIR	None
Document type	Report
Directorate	London West Midland
MDL & Deliverable Ref	-
Keywords	Chiltern Tunnel
Authors	A Evans
Checker	R Weber
Approver	A Robson
Owner	C222 Atkins
Review Directorate	LWM TD
Employer's Lead Reviewer	Neil Cowie
Authorised for use	-

London West Midlands

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Part 4: REPA Proposal for Extended Chiltern Tunnel

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List of acronyms

REPA Residents Environmental Protection Association

AONB Area of Outstanding Natural Beauty

TBM Tunnel Boring Machine

References

Title	Reference
HS2 Project dictionary	HS2-HS2-PM-GDE-000-000002
Style guide	HS2-HS2-CO-GDE-000-000001

1 Executive summary

- 1.1.1 This report summarises the REPA proposal (Residents Environmental Protection Association) to extend the Chiltern tunnel. The aim of the REPA proposal is to reduce the temporary and permanent environmental impact of the Proposed Scheme, involving a significantly reduced effect on the AONB, agricultural land, ancient woodland, a listed structure and amenity to the residents of South Heath.
- 1.1.2 The original REPA proposal extended the Chiltern tunnel by approximately 3.7km from the portal at Mantle’s Wood to create a portal north of South Heath near Liberty Lane, at chainage 48+300. The revised and current REPA proposal, submitted with their petition extends the Chiltern tunnel by approximately 4.1km from the portal at Mantle’s Wood to create a portal north of South Heath near Leather Lane, at chainage 48+740.
- 1.1.3 The REPA proposal follows the Proposed Scheme horizontal alignment but the vertical alignment would need to be revised to provide the required depths needed for tunnel construction. To maintain the maximum desirable 3km spacing between ventilation shafts, a new shaft would need to be provided at approximately chainage 46+200.
- 1.1.4 Four construction methods were reviewed by HS2 Ltd for the original REPA proposal which differ based on construction methodology, programme and cost. The different construction options are:
- Option C1: as originally proposed by REPA, two TBMs would be launched from the south portal and would be extracted and removed at the revised north portal location at chainage 48+300 (Liberty Lane). Additional excavated material resulting from the additional lengths of tunnel would arise from the south portal. This option would cost approximately £67.95 million more than the Proposed Scheme but would increase the civils construction programme by approximately 12 months;
- 1.1.5 Options C2 and C3 were developed to try to mitigate the programme extension but without introducing significant new construction impacts through the use of “Simple TBMs” from the north portal:

- Option C2: two TBMs would be launched from the south portal running north to the new shaft at chainage 46+200, in parallel, two simple TBMs would be launched from the northern portal running south to chainage 46+200. Both TBMs and simple TBMs would be removed from the north portal at chainage 48+300. Additional tunnel spoil would arise from both the north and south portal. As this option would still extend the overall programme by approximately 6 months and add considerable cost to the project, it was not considered a viable option and has not been considered further.
- Option C3: two TBMs would be launched from the south portal running north, up to the location of the Proposed Scheme Chiltern tunnel north portal at chainage 44+635. In parallel, two simple TBMs would be launched from the north portal at chainage 48+300, running south to chainage 44+635. Both TBMs and simple TBMs would be removed from the north portal. For this option, additional tunnel spoil would arise from the north portal only. This option would cost approximately £273.76 million more but would have a similar programme as the Proposed Scheme;

1.1.6 Given the high cost of C3, a further option on the original REPA proposal was developed. This would utilise similar TBMs from the north portal as used from the south portal:

- Option C4: two TBMs would be launched from the south portal running north up to Amersham Vent Shaft at chainage 40+100, in parallel two TBMs would be launched from the north portal at chainage 48+300 running south to the Amersham Vent Shaft where the TBMs would be removed. This option would reduce the amount of excavated material arising at the south portal that is used for environmental mitigation, but would result in tunnel spoil arising from the north portal, which would need treatment / storage before transport for use in mitigation earthworks. The cost of this option would be approximately £162.62 million more than the Proposed Scheme. It could reduce the tunnel construction works programme by approximately 8 months;

1.1.7 Further to receipt of REPA's revised proposal in their petition, the following option is now included for comparison:

- Option C5: as presented in REPA's petition, two TBMs would be launched from the south portal and would be extracted and removed at a north portal location at chainage 48+780 (Leather Lane). Additional excavated material resulting from the additional lengths of tunnel would arise from the south portal. This option would cost approximately £82.74 million more than the Proposed Scheme but would increase the construction programme by approximately 12 months. However with a revised rail systems installation strategy, where installation is undertaken from both portals, this programme extension could be fully mitigated;

- 1.1.8 A further option has also been assessed by HS2 Ltd., to provide comparison with the above REPA options. This would provide a shorter extension of the bored tunnel but could provide comparable benefits:
- Option C6: two TBMs would be launched from the south portal and would be extracted and removed at a revised north portal location at chainage 47+205 (the location of the Proposed Scheme South Heath north portal). Additional excavated material resulting from the additional lengths of tunnel would arise from the south portal. This option would cost approximately £31.26 million more than the Proposed Scheme but would increase the construction programme by approximately 10 months. However with the rail systems being installed from both portals, this extension could be fully mitigated.
- 1.1.9 For all options the additional tunnel excavated material would need to be stored temporarily on site for treatment. The material would need to either be incorporated into revised engineering fill and landscape solutions locally or removed off site via the local road network.
- 1.1.10 For Option C4, the anticipated lead time for providing the additional power supply that would be required to support the additional TBMs running from the north portal and the associated north portal compounds has been advised at 3 – 5 years. This in turn could extend the tunnel construction duration given for this option by approximately 6 months to 2.5 years, significantly increasing the risk of long programme delay to the scheme.
- 1.1.11 For Option C3, the Simple TBMs would require a much smaller power requirement and it is assumed at present that this could be provided from local networks with only a short lead time.
- 1.1.12 A review of the rail systems demonstrates that the increased tunnel length would result in higher temperatures within the tunnels, therefore it is considered likely that cooling would be required to address the increased temperatures. It is expected that an increase in power and maintenance requirements would be essential to ensure the overall system remains acceptable. The REPA proposal would incur a slight increase in journey time due to increased tunnel length.

2 Abbreviations and descriptions

- 2.1.1 The abbreviations, descriptions and project terminology used within this document can be found in the project dictionary.

3 Introduction

- 3.1.1 The REPA proposal is to extend the Chiltern tunnel so that the north portal of the tunnel would be located north of South Heath. The proposal would provide a design which would move the local construction and operational impacts as far from South Heath as possible by lowering the Proposed Scheme vertical alignment and putting the alignment into a tunnel, subsuming the South Heath ‘green tunnel’. This report provides an engineering review of this proposal.
- 3.1.2 REPA’s original proposal extended the Chiltern Tunnel to a point near Liberty Lane, at chainage 48+300m. This proposal was addressed in an earlier revision of this report issued on 8 June 2015. REPA subsequently developed their alternative option further, and submitted revised proposals with their petition and again in a report dated 11 June 2015 entitled “Engineering Report on South Heath Chilterns Tunnel Extension, for REPA”.
- 3.1.3 The nature of modifications to REPA’s earlier proposal was to introduce a further extension of the South Heath Chilterns Tunnel, northwards to Leather Lane at chainage 48+740m. This HS2 report therefore has been revised to reflect both the earlier and current REPA proposals. For the purpose of this report, the latest REPA proposals are referred to as the ‘revised REPA proposal’ or Option C5.
- 3.1.4 HS2 Ltd has also considered alternative construction methods for the REPA proposed tunnel extensions, in particular to address the potential extended programme associated with the longer tunnel drives. This has included consideration of tunnel boring from the northern portal (Options C3 and C4); and considering a shorter tunnel extension (Option C6). Alternative mitigation for the programme extension is also considered by the use of a change in the rail systems fit-out proposals from a fit-out just from the southern portal (as per the Proposed Scheme) to fit-out concurrently from both south and north portals.
- 3.1.5 This review is limited to the area where the REPA proposal deviates from the Proposed Scheme.
- 3.1.6 For all construction options considered the horizontal alignment of HS2 will not divert from the Proposed Scheme but the vertical alignment will be revised. All options would require a track spacing of 21m, the current track spacing to be adopted in the Chiltern tunnel.
- 3.1.7 Six construction methods have been considered for the REPA and associated HS2 proposal which differ based on construction methodology, programme and cost and material handling. A summary of the different methods is shown in Table 3.1.

Table 3.1: REPA Proposal Construction Options

Option	North Portal Chainage*	Additional Tunnel Length (m)		
		TBM	Simple TBM	Total
Proposed Scheme	44+635m	-	-	-
C1	48+300m	3665	-	3665
C2	48+300m	1565	2100	3665
C3	48+300m	-	3665	3665
C4	48+300m	3665	-	3665
C5	48+740m	4105		4105
C6	47+205m	2570		2570

3.1.8 * Excludes the length of the portal hood structure

4 Assumptions

4.1 Key Design Criteria

4.1.1 Key design criteria are given in Table 4.1.

Table 4.1 Key design criteria

Description	Criterion
Running speed in Chiltern Tunnel	320kph
Running speed in open cut	400kph
Running speed in cut-and-cover tunnels	360kph
Free cross-sectional area in Chiltern Tunnel	68.2m ² per bore
Minimum gradient for tunnel drainage	0.5%
Geological Conditions Drawing No C222-ATK-GT-DPP-020-000034	<p>The bored tunnel is expected to be driven through the Lewes and Seaford Chalks (LESE) running in close proximity to the upper surface of the Chalk Rock.</p> <p>At the portals the sequence will be of Clay-with-flints within the majority of the cutting face overlying LESE chalk at the lower part of the slope and base of the cutting and the Chalk Rock.</p>
Particular features required in cutting, subject to detailed design.	<p>Gradients:</p> <p>1(v) to 3(h) in Clay-with-flints and 1:1 in Chalk;</p> <p>Depending on the thickness of Clay-with – flints and degree of weathering in Chalk there may be an opportunity to provide a two part slope with steepening of the slope within the Clay-with-flints to 1:2 and slope in Chalk to 1:1 with provision of berm in deeper sections.</p> <p>Drainage at crest, toe and on batter.</p>

4.2 Engineering Assumptions

4.2.1 The following assumptions are included in the appraisal for the options under consideration:

- The line speed would remain at 320kph through the longer tunnels.
- Sufficient space would be available at the defined north portal location or could be made available, for the extraction of the TBMs (where required), and the construction of the 550m² hard standing rescue area and the associated portal buildings;
- Length of the porous portal hood for the northern end of the Chiltern tunnel and the extended REPA tunnel to be the same (up to 220m based on current assessments);
- Sufficient space would be available for the construction of the additional vent shaft, the head house building, the rescue area and the associated infrastructure, with access connection to the local road system for both the construction and operational phases; and
- The ground conditions and ground water levels permit consideration of an alternative simplified TBM method for use in the lower cover additional tunnelling options.

5 The REPA Proposal

5.1 General

5.1.1 This section of the report describes the overall assessment area between approximate chainage 44+635 at Mantle’s Wood to 48+940 (including a 200m porous portal hood), under both the Proposed Scheme and the REPA proposals.

5.2 Existing Proposed Scheme Route Description

5.2.1 The Proposed Scheme north portal is located at 44+635m in an area of ancient woodland (Mantle’s Wood). The characteristics of HS2 Proposed Scheme’s route beyond this point is summarised below:

- Chiltern tunnel north cutting extends from the north portal for a length of approximately 1.3km and will be up to 23m deep, largely in chalk. This includes an area of potentially unstable ground comprising solution and / or erosion features;
- The South Heath green tunnel is located north of the Chiltern tunnel north cutting, and to the west of the village of South Heath. The length of this tunnel is approximately 1.2km;
- A Mid-Point Auto-transformer Station (MPATS), providing traction power, is located close to the South Heath green tunnel north portal;
- The highways-related design features of the Proposed Scheme solution are as follows:
 - New overbridge providing realignment of Hyde Lane over Chiltern Tunnel North Cutting;
 - New overbridge crossing at Hyde Lane and Hyde Farm (footpath GMI/27 Accommodation Overbridge);
 - Realignment of B485 Chesham Road and King’s Lane over South Heath green tunnel, and reinstatement of Frith Hill over the green tunnel; and
 - Permanent diversions to the following footpaths: LMI/17, GMI/23, GMI/27 and GMI/33. Temporary diversion and reinstatement to footpaths in Sibley’s Coppice (GMI/28, GMI/79 and GMI/80).
- Provision of access roads to track level at each of the tunnel portals (Chiltern Tunnel North Portal, South Heath green tunnel South and North Portals); and
- A sustainable placement area between Leather Lane and Bowood Lane to avoid traffic impacts of off-site removal on local roads (though the need for this area is currently under review).

5.2.2 The Proposed Scheme includes extensive areas of mitigation including landscaped screen bunding, planting and off-site mitigation including new tree planting areas.

5.3 Revised REPA proposal

5.3.1 The revised proposal by REPA is to extend the length of the Chiltern tunnel by 4.1km to chainage 48+740m, by Leather Lane. A porous portal structure approximately 200m long would be added to the length of the tunnel to chainage 48+940;

5.3.2 This option would result in an overall reduction in environmental impacts compared to the Proposed Scheme. There would be reduced effect on the AONB, agricultural land, ancient woodland and the residents of South Heath (particular during construction). A number of properties in the area would not need to be demolished and the National Grid utility diversion at South Heath would no longer be needed;

5.3.3 The option developed would include a lowering of the vertical alignment from the Proposed Scheme of up to 30m, to take the twin bored tunnels below ground to the west of the village of South Heath. There would be no change to the horizontal alignment but the track separation required for the bored tunnel section of 21m would be extended for the additional length of the tunnel;

5.3.4 The depth and width of the cutting to the north of the extended tunnel would increase due to the increased track separation of 21m required for the two bores of the tunnel. This separation would reduce continuously from the end of the tunnel and the width of the railway corridor would gradually converge to be the same as the Proposed Scheme, with a track separation of 5m which is the criteria for tracks in open areas;

5.3.5 An additional vent shaft would be required with this proposal and this could be provided at approximate chainage 46+000m, close to the position of the proposed south portal of the South Heath green tunnel in the Proposed Scheme. Vehicular access to this vent shaft would be from B485 Chesham Road;

5.3.6 The new additional ventilation / intervention shaft would be required to comply with the HS2 fire strategy;

5.3.7 A vehicular access road would be provided to the buildings located at the northern portal of the extended tunnel; and

5.3.8 It is likely that the South Heath MPAT would be relocated northwards to be on the surface section just beyond the north portal at/around 48+940.

6 Construction & Spoil Management

6.1 General

6.1.1 Six construction methods have been considered for the REPA and associated HS2 proposal which differ based on construction methodology, programme and cost. The options are:

- Option C1 – An extension of the Proposed Scheme bored tunnel to a new portal location near Liberty Lane, as originally proposed by REPA.
- Option C2 – An alternative arrangement consisting of part extension of the current bored tunnel with some tunnelling southwards from the new northern portal to limit programme extension. As this option did not address the programme delay associated with Option C1, it has not been considered further and instead Options C3 and C4 were developed.
- Option C3 – Further alternative arrangement consisting of no extension to the existing TBM tunnel drive and all new tunnelling undertaken southwards from a new portal location near Liberty Lane, aimed at removing all programme increase.
- Option C4 – An alternative arrangement consisting of part shortening of the current TBM tunnel drive, with tunnelling southwards from TBM tunnel drive, potentially reducing the tunnel construction works programme.
- Option C5 – A similar arrangement to C1 but with the bored tunnel extended to a new portal location near Leather Lane, as currently proposed by REPA in its revised scheme.
- Option C6 – A shorter version of C1 developed by HS2 with the bored tunnel extended to the location of the north portal of the Proposed Scheme South Heath green tunnel.

6.1.2 For Option C4 the anticipated lead time for providing the additional power supply that would be required to support the additional TBMs running from the north portal and the associated north portal compounds has been advised at 3–5 years. This would dictate the start of tunnel boring from the north portal which in turn could extend the tunnel construction duration for this option by approximately 6 months to 2.5 years, removing any potential programme saving and significantly increasing the risk of long programme delay to the scheme.

6.1.3 For Option C3, the “Simple TBMs” would require a much smaller power requirement and it is assumed at present that this could be provided from local networks with only a short lead time, but confirmation of this assumption would be required from National Grid.

6.2 Option C1 – TBM to north portal at Ch. 48+300

- 6.2.1 This would be the continuation of the bored Chiltern tunnel to the original REPA north portal location at Liberty Lane. Two TBMs would be launched from the southern portal and would be extracted and dismantled at the revised north portal location where they would be removed from site by road. This would require an area approximately 60m by 80m adjacent to the tunnel portal position, from which the TBMs can be disassembled, lifted and then removed from the construction worksite via a new access road to the A413.
- 6.2.2 Due to the nature of the construction operation and the transportation requirement to remove the dismantled TBMs from the north portal, a new link road to track level at the north portal would be required direct from the A413. This would be used both for the construction of HS2 as well as serving as a maintenance and emergency access to the tunnel portal building for the operation of HS2.
- 6.2.3 All tunnel construction operations will be serviced from the Chiltern Tunnel Main Compound, located within CFA 7 Colne Valley near the M25. Additional provision would be required for the management and treatment of the additional bored tunnelling arisings over and above that which would be handled, treated and used as landscaping fill for the Proposed Scheme.
- 6.2.4 Currently the Proposed Scheme produces approximately 2,000,000m³ of excavated material from the construction of the Chiltern tunnel. The additional spoil generated by the extended bored tunnel would equate to approximately 545,000m³ (excluding the additional shaft excavation volume which would need to be disposed of locally). Additional land in the vicinity of the south portal would be required to retain this material on site temporarily for treatment. This excess material would then need to be removed from site by the public highway network for disposal or potential landscape use elsewhere on the scheme. Moving this quantity of material would equate to approximately 127,000 two-way lorry trips which would need to be removed from site via the M25 temporary slip roads.

6.3 Option C2 – Simple TBM from north portal to new shaft at 46+200

- 6.3.1 This option looked to reduce the programme extension incurred by Option C1 but as it would still extend the overall programme and add significant additional cost, it has not been considered further.

6.4 Option C3 – Simple TBM from north portal at Ch. 48+300 to Mantle’s Wood

- 6.4.1 The proposal for this option is for the whole of the additional length of the tunnel to be constructed from the north portal at chainage 48+300, running south using a “simple TBM” method, up to the location of the northern portal of the Proposed Scheme Chiltern tunnel at chainage 44+635. The two TBMs launched for the construction of the Chiltern tunnel would run as they do for the Proposed Scheme with the difference that both TBMs and simple TBMs would be extracted through the new north portal.
- 6.4.2 Simple TBM tunnels, as proposed here, are constructed using an open-face Tunnel Boring Machine which means there is no active support to the ground and groundwater at the front of the TBM. This method is more of risk of unstable ground and high water pressures than the closed-face TBMs proposed for the Chiltern tunnel. The open-face TBM is normally mounted with a cutting tool such as a roadheader and a means of extracting spoil, such as a conveyor belt. The TBM has a segment erector which constructs the precast concrete segmental lining
- 6.4.3 There would need to be a compound for the simple TBM tunnel construction at the north portal. This compound size would be approximately 15,000m², which is a sufficient size to enable a complete office, welfare and working compound to be established, and support numerous deliveries of construction materials, including, for example, tunnel lining units and consumables. This compound would need to be serviced by a dedicated access road linked directly to the A413.
- 6.4.4 This new access road would have an increased level of construction traffic to that assumed for Option C1. The access road would also be used for transporting the dismantled Simple TBMs from site on completion of the tunnelling operation. On completion of construction, it is anticipated that the access road will remain in place during the operation of HS2 as emergency and maintenance access to the tunnel portal buildings, subject to agreement with the local highway authority.
- 6.4.5 The excavated tunnel material from the TBM construction at the southern portal would remain the same as the Proposed Scheme. No additional spoil would be arising from the southern portal.

- 6.4.6 The material arising from the simple TBM bored tunnel would arise from the tunnel at the north portal at chainage 48+300. This material amounts to approximately 545,000m³ (excluding the additional shaft excavation volume which would need to be disposed of locally). Additional land in the vicinity of the north portal would be required to temporarily retain this material on site for treatment. This material would have to be either incorporated within the revised landscaping proposals or would need to be removed from site by the public highway network. Moving this quantity of material would equate to approximately 127,000 two-way lorry trips.

6.5 Option C4 – TBM from north portal at Ch. 48+300 to Amersham Vent Shaft

- 6.5.1 The proposal for this option, which would reduce the tunnel construction works programme, would be to launch two TBMs from the southern portal, running north to the Amersham Vent Shaft at chainage 40+100. The remaining section of the tunnel would be constructed from the north, running south, using two TBMs up to the location of Amersham Vent Shaft, where all TBMs would be extracted.
- 6.5.2 The requirement to remove the TBMs' components from the Amersham Vent Shaft would require additional space and equipment near the shaft work site, along with additional anticipated HGV traffic.
- 6.5.3 There would need to be a compound for the TBM tunnel construction at the north portal, which would need to have more space to support to the additional slurry TBMs as compared to Options C1 – C3. This compound size would be approximately 60,000 m² which is a sufficient size to enable TBM assembly area, construction area, slurry treatment plant, storage for delivered tunnel linings, office and welfare areas. No allowance has been made for a segment factory or staff accommodation. This compound would need to be serviced by a dedicated access road linked directly to the A413.
- 6.5.4 This access road would have an increased level of construction traffic to that assumed for the other options. The access road would be used for transporting TBM components including precast concrete segment linings. Upon completion of construction, it is anticipated that the access road would remain in place during the operation of HS2 as emergency and maintenance access to the tunnel portal buildings, subject to agreement with the local highway authority.

- 6.5.5 The bored tunnel construction (from chainage 31+363 to 40+100) would be serviced from the Chiltern Tunnel Main Compound located within CFA 7 Colne Valley. As these TBMs would only construct the tunnel up to Amersham Vent Shaft at chainage 40+100, this option would result in a reduction of excavated material arising from the southern portal. This reduced quantity amounts to approximately 670,000m³ which would impact the Hybrid Bill landscaping proposals in areas adjacent to the southern portal. Importation of additional material could be required to rectify the shortage of material, resulting in approximately 158,000 two-way lorry trips.
- 6.5.6 The bored tunnel construction (from chainage 48+300 to 40+100) would be serviced from a new compound located at the north portal. The material arising from the north portal (as a result of TBM bores from chainage 48+300 to 40+100) would amount to approximately 1,200,000m³ (excluding the additional shaft excavation volume which would need to be disposed of locally). This material would need to be stored temporarily in the vicinity of the north portal for treatment. It is proposed that the majority of the material could be stored within the Proposed Scheme Hybrid Bill limits at Hunts Green Farm. An approximately 60,000 m² of additional storage would be required at the north portal, as shown on drawings provided in Appendix C. After treatment, this material would have to be either incorporated within revised landscaping proposal along the route towards Wendover, or would need to be removed from site by the public highway network. Moving this quantity of material from site would equate to approximately 285,000 two-way lorry trips.

6.6 Option C5 – TBM to north portal at Ch. 48+740 (Leather Lane)

- 6.6.1 Option C5 assesses the current REPA proposal which would comprise the continuation of the bored Chiltern tunnel to a new north portal location near Leather Lane at chainage 48+740. Two TBMs would be launched from the southern portal and would be extracted and dismantled at this revised north portal location where they would be removed from site by road. As with Option C1, this would require an area approximately 60m by 80m adjacent to the tunnel portal position, from which the TBMs can be disassembled, lifted and then removed from the construction worksite via a new access road to the A413. This access road would be used for the construction of HS2 and, if retained thereafter, could serve as a maintenance and emergency access to the tunnel portal building for the operation of HS2.
- 6.6.2 All tunnel construction operations would be serviced from the Chiltern Tunnel Main Compound, located within CFA 7 Colne Valley near the M25. Additional provision would be required for the management and treatment of the additional bored tunnelling arisings over and above that which would be handled, treated and used as landscaping fill for the Proposed Scheme.

- 6.6.3 As noted above, the Proposed Scheme produces approximately 2,000,000m³ of excavated material from the construction of the Chiltern tunnel. The additional spoil generated by the extended bored tunnel would equate to approximately 610,000m³ (excluding the additional shaft excavation volume). Additional land in the vicinity of the south portal might be required to retain this material on site temporarily for treatment. It is expected that excess material would then need to be removed from site by the public highway network for disposal or potential landscape use elsewhere on the scheme. Moving this quantity of material would equate to approximately 143,530 two-way lorry trips which would need to be removed from site, via the M25 temporary slip roads.
- 6.6.4 This option would result in a shortfall of material required as engineering fill and in the mitigation earthworks for the section of the open route from Leather Lane to the A413, where HS2 passes over the Chiltern Line and the A413 on Small Dean Viaduct. This shortfall equates to approximately 430,000 m³ and could be mitigated by importation via the A413 or re-adjustment of the vertical alignment of the route to reduce the deficit. The latter option has not been examined at the time of publishing this report.

6.7 Option C6 – TBM drive to north portal at Ch. 47+205

- 6.7.1 Option C6 has been developed to assess a continuation of the bored Chiltern tunnel to a new north portal location near the current north portal of the South heath green tunnel in the Proposed Scheme, at chainage 47+205. Two TBMs would be launched from the southern portal and would be extracted and dismantled at this revised north portal location where they would be removed from site by road. As with Options C1 and C5, this would require an area approximately 60m by 80m adjacent to the tunnel portal position, from which the TBMs can be disassembled, lifted and then removed from the construction worksite via a new access road to the A413. This access road would be used for the construction of HS2 and could be retained as a maintenance and emergency access to the tunnel portal building for the operation of HS2.
- 6.7.2 Despite this option resulting in a shorter tunnel than Option C1, an additional ventilation shaft would still be required at approximate chainage 46+200.
- 6.7.3 As with options C1 and C5, tunnel construction operations would be serviced from the Chiltern Tunnel Main Compound, located within CFA 7 Colne Valley near the M25. Additional provision would be required for the management and treatment of the additional bored tunnelling arisings over and above that which would be handled, treated and used as landscaping fill for the Proposed Scheme.

- 6.7.4 As noted above, the Proposed Scheme produces approximately 2,000,000m³ of excavated material from the construction of the Chiltern tunnel. The additional spoil generated by the extended bored tunnel would equate to approximately 380,000m³ (excluding the additional shaft excavation volume). Additional land in the vicinity of the south portal might be required to retain this material on site temporarily for treatment. It is expected that excess material would then need to be removed from site by the public highway network for disposal or potential landscape use elsewhere on the scheme. Moving this quantity of material would equate to approximately 90,000 two-way lorry trips which would need to be removed from site via the M25 temporary slip roads.

7 Rail Systems

7.1 General

7.1.1 General issues regarding Rail System for longer tunnel options has been described in Part 1 section of the High Speed Rail in the Chilterns report C222-ATK-TN-REP-020-000013. Specific issues relating to the REPA proposal is described below.

7.2 Tunnel Ventilation and Smoke Control

7.2.1 The REPA proposal would extend the tunnel to a length of approximately 17.4km. With a ventilation shaft at chainage 46+000 and the portal at chainage 48+740, the resulting length of the ventilation zones would be 3km and 2.74km. A smoke control analysis was not conducted, but it is considered likely that smoke control could be achieved with similar sized and capacity ventilation fans and shafts as per the currently proposed 13.3 km long Chilterns tunnel. The increase in tunnel length would potentially increase the barometric pressure change across the portals. This could make smoke control more difficult in a fire emergency, and more shafts could be required to operate. This would increase the probability of not being able to deliver adequate airflow in a fire and also would increase the power demands on the auxiliary power supply system. There may therefore be an increase in maintenance requirements to ensure that the overall system availability remains acceptable.

7.2.2 The increase in tunnel length would both increase the train drag and increase the amount of warming of the air that entered from the portal. It is estimated that approximately 7km of each 17km bore would be over the 35°C criterion and that temperatures at the exit portal would be 40 to 41°C. This extent of criterion exceedance is considered likely to require addressing by the use of cooling.

7.3 Operations

7.3.1 As assessment has been undertaken to determine the implications of journey time, which indicates that the REPA proposal would result in minimal increase in journey times of approximately 4 seconds compared to the Proposed Scheme.

7.3.2 The assessment is carried out based upon 400m (22-car) AGV Reference Captive Stock, including revised tunnel resistance coefficients to reflect the different tunnel extension options. Further work would be required to confirm if these small changes to journey time and headway would impact sectional running times and route capacity respectively, which means there remains a risk that the timetable could be affected.

7.4 Non Traction Power Supply

- 7.4.1 Additional power would be required based on initial analysis of the performance of tunnel cooling requirements.

7.5 Maintenance

- 7.5.1 From a maintenance perspective, the main changes of this proposal would be a slightly increased length of slab-track (using current agreed assumption that ballast is used outside tunnels), an additional ventilation shaft and a reduction in lineside management (vegetation etc.). Overall, there would not seem to be a significant change in maintenance activity, although the mix changes. However, exchanging 4.1km of ballasted track maintenance for an extra ventilation shaft would probably mean that there is a slight reduction in possession maintenance work. The proposed additional tunnel length would not seem to have any implications on the proposed maintenance approach.

8 Programme

8.1 Civil Engineering

8.1.1 As described in Section 5, the different options assessed for the construction of the REPA proposal impact on the construction programme. The civil engineering programming has been based on an assumed average slurry TBM advance rate of 80m/week, and average Simple TBM advance rate of 40m/week:

- Option C1 (TBM through to the north portal at chainage 48+300): The construction programme for this option would increase by approximately 12 months.
- Option C2 (TBM from south-north to 46+200 and simple TBM from north-south to 46+200): The construction programme for this option would still increase by approximately 6 months; as a result this was not considered a viable option.
- Option C3 (TBM from south-north to 44+635 and simple TBM from north-south to 44+635): The construction programme for this option would be similar to the Proposed Scheme. The simple TBM constructed tunnel would be constructed in parallel with the bored tunnel.
- Option C4 (TBM from south-north to 40+100 and a slurry TBM north-south to 40+100m): The tunnel construction works programme for this option would be decreased by approximately 8 months.
- Option C5 (TBM through to the north portal at chainage 48+740): The construction programme for this option would increase by approximately 12 months.
- Option C6 (TBM through to the north portal at chainage 47+205): The construction programme for this option would increase by approximately 9 months.

8.1.2 For Option C4, the anticipated lead time for providing the additional power supply that would be required to support the additional TBMs running north-south and the associated north portal compounds has been advised at 3 – 5 years. This in turn could extend the tunnel construction duration given for this option by approximately 6 months to 2.5 years, significantly increasing the risk of long programme delay to the scheme.

8.1.3 For Option C3, the Simple TBMs would require a much smaller power requirement and it is assumed at present that this could be provided from local networks with only a short lead time.

8.1.4 As the existing Chiltern bored tunnel is on the overall project programme critical path, any increase in the tunnel construction period would represent a delay to the opening of the railway.

8.2 Rail systems

- 8.2.1 The rail system installation for the Proposed Scheme Chiltern tunnel will be carried out in a northerly direction away from West Ruislip railhead compound, located west of Breakspear Road South, in CFA 6 South Ruislip to Ickenham. This railhead is connected directly with the existing rail network, the Chiltern Line, which allows delivery of much of the tunnel rail systems equipment by rail.
-
- 8.2.2 Adopting the strategy of fitting out the rail systems from the south portal, extending the Chiltern tunnel by approximately 4.1km would take approximately 30 months, which gives a programme extension for rail systems of approximately 3 months. However, this could be mitigated against with an additional rail system worksite to allow fit out from both portal ends.
- 8.2.3 It would be possible to mitigate the programme effects of constructing an additional length of tunnel by amending the rail systems installation strategy as described in paragraph 8.2.1 and install all of the rail systems simultaneously from both the south and north portals of an extended tunnel. However, this revised strategy would require the provision of an additional rail system worksite at the north portal, similar to that being provided at the Chiltern tunnel south portal
- 8.2.4 Before the railway systems installation can commence, adequate civil engineering work will need to be completed to allow continuous track laying sequence.
- 8.2.5 With this revised strategy for rail systems installation, the increase in the programme for constructing the longer tunnels of Option C5 and C6 could be fully mitigated, so there would be no overall increase in the programme when compared with the Proposed Scheme.
- 8.2.6 To deliver this mitigated strategy, rail systems equipment being installed from the north portal site would need to be delivered by the public highway, until such time that the rail systems installation which starts at Calvert reached this location. It is not possible to directly connect this worksite location to the rail network and so form a temporary railhead in this case, therefore this traffic will need to access the site from the A413.
- 8.2.7 The rail systems worksites required at the north portal of Options C5 and C6 would need to be approximately 4,200m² and would be located as close as possible to the portal. These worksites would need to be established prior to the decommissioning of the work sites required for the receipt of the TBMs and the construction of the portal structure and therefore additional land would be required. It is envisaged that the materials for the rail systems installation could be stored within the area of land associated with Hunts Green Farm.

- 8.2.8 With Option C5, the only direct access from the A413 to the proposed worksite is via Leather Lane, which is unsuitable for the vehicles required for both the removal of the two TBMs, once the tunnel drive has been completed or for the delivery of rail systems equipment, therefore it is proposed to construct a haul road from the A413 to service the northern portal worksite. Due to the constraints in this location, the junction for this new road would need to be located in close proximity to the existing Leather Lane. Although it has not been discussed with the local Highway Authority, it is doubtful that they would approve the construction of a new access road from the A413 which has a junction in close proximity to Leather Lane and which has a 2 way traffic flow of 451 vehicles per day. Therefore, should this option be adopted, it is feasible that Leather Lane would need to be closed at its junction with the A413 and a junction created off the new haul road to join up with the realigned Leather Lane in a location close to the property half way up Leather Lane. It may be necessary to carry out local widening of the A413 to ensure that there are no safety issues with this junction.
- 8.2.9 With Option C6, there are similar access problems to the north portal as described with option C5 above, but in this case Frith Hill is the nearest public highway from the A413. Therefore, it is again proposed that new haul road is constructed, this being taken from the existing roundabout on the A413 to the west of the roundabout at the Frith Hill junction. For this option, this would be a dedicated construction haul road and if retained could subsequently serve as the access road to the portal buildings during operation of HS2.

9 Cost

- 9.1.1 The additional construction costs associated with the different construction methods described in Section 5 are listed below. Costs are inclusive of tunnel, civil and rail systems costs, land/property cost savings, allowance for time related preliminaries and indirect costs, and include efficiency and VE savings:
- Option C1: This option would cost approximately £67.95 million more than the current HS2 Proposed Scheme.
 - Option C3: would cost approximately £273.76 million more than the current HS2 Proposed Scheme.
 - Option C4: would cost approximately £162.62 million more than the current HS2 Proposed Scheme.
 - Option C5: This option would cost approximately £82.74 million more than the current HS2 Proposed Scheme.
 - Option C6: This option would cost approximately £31.26 million more than the current HS2 Proposed Scheme.

- 9.1.2 Details of costs estimates are provided in Appendix A. The high construction cost for Option C3 is due principally to the time-related costs associated with the tunnelling works using the simple TBM method.
- 9.1.3 The extended tunnel results in an increased construction cost estimate for railway systems due principally to additional requirements for tunnel systems, new ventilation shafts, fans, power equipment and tunnel cooling requirements.

10 Conclusions

- 10.1.1 REPA Options C1 and C5 would reduce the temporary and permanent environmental impact of the scheme in this section of the route, involving reduced effect on the AONB, agricultural land, ancient woodland, listed structure and amenity to the residents of South Heath.
- 10.1.2 The current REPA proposal (Option C6) positions the north portal of the extended tunnel near Leather Lane at chainage 48+740. A new ventilation shaft would be required for the extended tunnel.
- 10.1.3 Six different construction methods have been assessed for the construction of an extended tunnel in this area. While an extended tunnel is feasible in engineering terms and would have environmental benefits, there could be programme and cost implications in extending the bored tunnel.
- 10.1.4 REPA Option C1, a straight extension of the Proposed Scheme bored tunnel to Liberty Lane, at chainage 48+300, would increase the construction programme by approximately 12 months and, given that this would delay the scheme opening and increase costs, is not considered acceptable. The alternative construction method considered under Option C2 would extend the overall programme by approximately 6 months and add considerable cost to the project. It is therefore not considered a viable option.
- 10.1.5 The alternative construction method considered under Option C3, a development of the REPA proposal to avoid the programme extensions but retain the increased environmental benefits of a longer tunnel is shown to incur a very large increase in construction cost; on balance, this increased cost is not considered to provide value for money in terms of the environmental gain achieved, although the programme delay would be mitigated.
- 10.1.6 The alternative construction method considered under Option C4 could decrease the tunnel construction work period by up to 8 months, due to the TBM tunnelling from both north and south portals. However, as noted in para. 10.1.7 below, any potential programme savings would be compromised by the available timing of power supply works to supply necessary power to the northern TBMs. Although the option would give an overall reduction in operational environmental impact, there would be significantly increased local impact during construction at the northern portal. Overall, given the associated significant increase in construction cost, this option is also not considered a desirable alternative.

- 10.1.7 The anticipated lead time for providing the additional power supply that would be required to support the additional TBMs running from the north portal and the associated north portal compounds has been advised at 3 – 5 years. This in turn could extend the tunnel construction works duration given for Option C4 by approximately 6 months to 2.5 years.
- 10.1.8 For Option C3, the Simple TBMs would require a much smaller power requirement and it is assumed at present that this could be provided from local networks with only a short lead time, but confirmation of this would be required from National Grid.
- 10.1.9 REPA Option C5, which reflects the current and preferred REPA proposal extending the Chiltern tunnel to chainage 48+740, would increase the construction programme by approximately 12 months which would delay the scheme opening and increase costs. Additional land would be required to facilitate construction of the access road to the A413. Given these concerns, this is not considered an acceptable option. The alternative HS2 assessed Option C6, which would extend the Chiltern tunnel just to the current north portal of the South Heath green tunnel at chainage 47+205, would increase the construction programme by approximately 9 months and increase scheme costs, though to a lesser extent. However, given that this would delay the scheme opening, this option would also not be considered acceptable.
- 10.1.10 It has been shown that the programme impacts of options C5 and C6 could be fully mitigated by the installation of the rail systems from both portals. This would require a rail systems work site to be introduced at the north portal locations, with associated construction activities through the portal and in the adjacent rail systems compound that would be required for an approximate 18 month period. Though it would have the benefit of reducing the programme impact, HS2 consider that the Proposed Scheme with its associated mitigations on balance continues to provide the more appropriate solution.
- 10.1.11 Additional material generated by the lengthened bored tunnel under Options C1, C5 and C6 would also need to be processed at the South Portal area which might have an effect in the temporary land-take for the area. The removal of the additional material off site would result in a corresponding increase in the construction traffic on the highway network adjacent to the Chiltern Tunnel Main Compound in CFA 7. Material generated by the northern TBM bored tunnels under Options C3 and C4 would also need to be taken off site at the north portal area or where possible re-used locally in mitigation earthworks. Option C4, in particular, would generate significant amounts of material that would require treatment and storing before re-use or removal off site. Temporary land-take in the vicinity of north portal would increase to allow for construction and material handling. Option C4 could also result in shortage of material required for environmental mitigation at the south portal, which would result in requirement for importation of material to rectify the shortage.

- 10.1.12 If REPA Option C5 was adopted, further work would be required to establish if the vertical alignment could be adjusted to mitigate the shortfall of fill material required for the open section of HS2 from the tunnel north portal to the A413 at the Small Dean viaduct.
- 10.1.13 A review of the rail systems concludes that the increased tunnel length would result in higher temperatures within the tunnels, therefore it is considered likely that cooling would be required to address the increased temperatures. It is expected that an increase in power and maintenance requirements would be essential to ensure the overall system remains acceptable.

Appendix A

A.1 Cost Estimate

REPA tunnel options - cost comparison vs HS2 Proposed Scheme

	REPA OPTION C1 (to Liberty Lane)	REPA OPTION C3 (to Liberty Lane)	REPA OPTION C4 (to Liberty Lane)	REPA OPTION C5 (to Leather Lane)	HS2 OPTION C6 (to Green tunnel north portal)	COMMENTARY	
1.00	LAND AND PROPERTY	-32.70	-31.90	-31.90	-32.70	-19.60	Excludes any allowance for re-sale of returned or unused
2.00	TUNNELS	115.47	316.82	205.92	134.54	67.78	
	Bored Tunnels	163.34	370.69	252.81	181.76	116.70	
	Fire Fighting Cavern						
	Green Tunnels	-57.14	-57.14	-57.14	-57.14	-57.14	Removal of S Heath green tunnel
	Portals	-10.38	-10.57	-5.89	-10.38	-10.34	
	Portals at "Gap"	0.00	0.00	0.00	0.00	0.00	
	Shafts	14.19	13.84	16.13	14.19	14.74	One additional shaft required
	Additional disposal costs	5.45	0.00	0.00	6.11	3.82	Options 1, 5 and 6 require additional disposal at southern
3.00	CIVIL ENGINEERING	-45.51	-54.86	-53.54	-50.74	-40.15	
	CUTTINGS	-25.95	-26.03	-25.99	-27.06	-18.99	
	Cuttings	-25.95	-26.03	-25.99	-27.06	-18.99	
	EMBANKMENTS	0.00	0.00	0.00	0.00	0.00	
	EARTHWORKS	-2.96	-2.99	-1.86	-3.03	-2.48	
	Landscaping	-2.96	-2.99	-1.86	-3.03	-2.48	
	ENVIRONMENTAL MITIGATION WORKS	-3.89	-3.91	-3.19	-4.26	-3.16	
	Planting	-3.38	-3.41	-2.90	-3.72	-2.88	
	Noise Barriers	-0.50	-0.50	-0.29	-0.54	-0.28	
	RETAINING WALLS						
	BRIDGES	-7.06	-7.11	-7.16	-10.47	-6.61	
	Overbridge	-4.47	-4.52	-4.57	-7.88	-4.02	
	Underbridge	-2.59	-2.59	-2.59	-2.59	-2.59	
	VIADUCTS						
	HIGHWAYS	-7.18	-7.28	-8.01	-7.18	-7.20	
	OTHER	-6.78	-7.54	-7.33	-7.27	-7.60	
	Culverts	-0.51	-0.51	-0.51	-0.51	-0.51	
	Utilities Diversions	-6.37	-7.13	-6.70	-6.86	-7.03	
	Utilities Connections	0.10	0.10	-0.12	0.10	-0.06	
	EXTENDED PRELIMINARIES	8.31	0.00	0.00	8.53	5.89	Options 1 & 5 assume 12month longer tunnel programme; Option 6 assumes 9month longer tunnel programme; Options 3 & 4 assume no programme delay
5.00	DEPOT AND SIDINGS	0.00	0.00	0.00	0.00	0.00	
6.00	RAILWAY SYSTEMS	21.70	21.70	21.70	21.70	18.40	
8.00	INDIRECT COSTS	15.52	50.40	30.49	18.04	7.83	
		74.49	302.16	172.67	90.85	34.26	
	Less ECP/VE	-6.55	-28.40	-17.05	-8.12	-3.01	
	Net total	67.95	273.76	155.62	82.74	31.26	
	E/o for north portal TBM power supply connection	0.00	0.00	7.00	0.00	0.00	
	Adjusted Net total	67.95	273.76	162.62	82.74	31.26	

OPTION NOTES

- Option C1 would extend the existing bored tunnel from Mantles Wood to a new north portal near Liberty Lane
- Option C3 assumes two simple TBMs to construct the bored tunnel from new north portal southwards to Mantles Wood
- Option C4 assumes two TBMs to construct the bored tunnel from new north portal southwards to the Little Missenden shaft
- Option C5 would extend the existing bored tunnel from Mantles Wood to a new north portal near Leather Lane
- Option C6 would extend the existing bored tunnel from Mantles Wood to the Proposed Scheme green tunnel north portal location

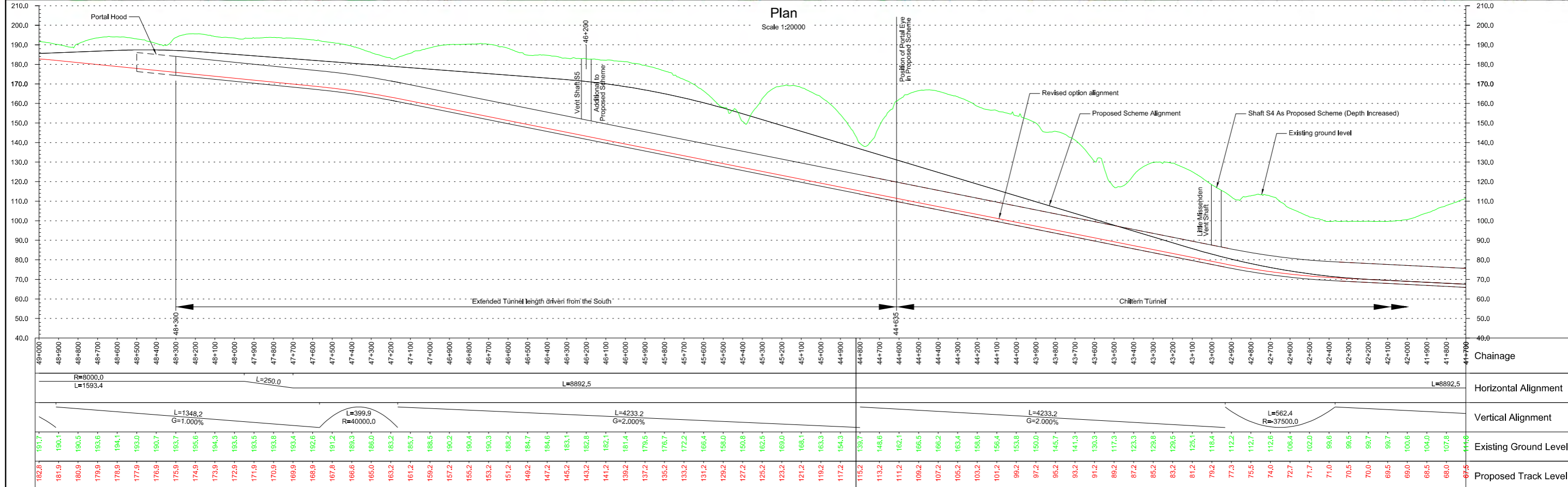
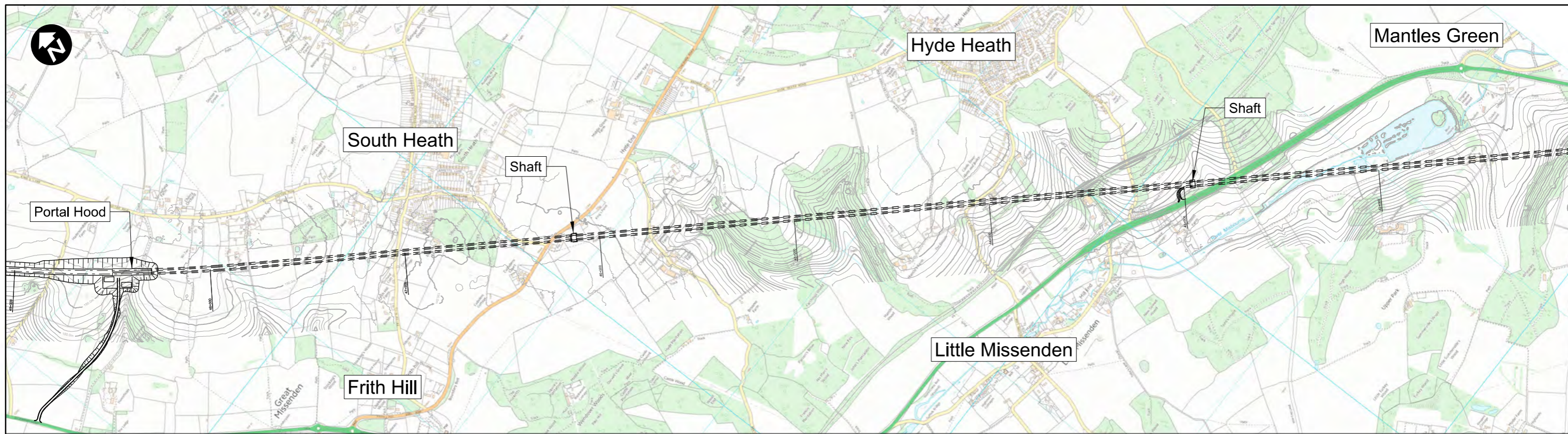
COST NOTES

- Costs are point estimates, based at second quarter 2011 levels and therefore exclude contingency and escalation
- Land and property costs are figures provided by CBRE. Property costs exclude costs associated with compensation schemes.
- Construction costs are based on PSC figures as reviewed by the HS2 costs team
- Railway systems costs are figures provided by Parsons Brinkerhoff and include allowance for tunnel cooling
- Indirect costs figures have been provided by the HS2 costs team
- Savings from the Efficiency Challenge Programme and Value Engineering have been provided by the HS2 costs team

Appendix B

B.1 Plan & Profile maps

- B.1.1 C222-ATK-TN-DPL-020-000320-PET0000000
- B.1.2 C222-ATK-TN-DPL-020-000321-PET0000000
- B.1.3 C222-ATK-TN-DPL-020-000322-PET0000000
- B.1.4 C222-ATK-TN-DPL-020-000323-PET0000000
- B.1.5 C222-ATK-TN-DPL-020-000324-PET0000000



Profile
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Scale with caution as distortion can occur.

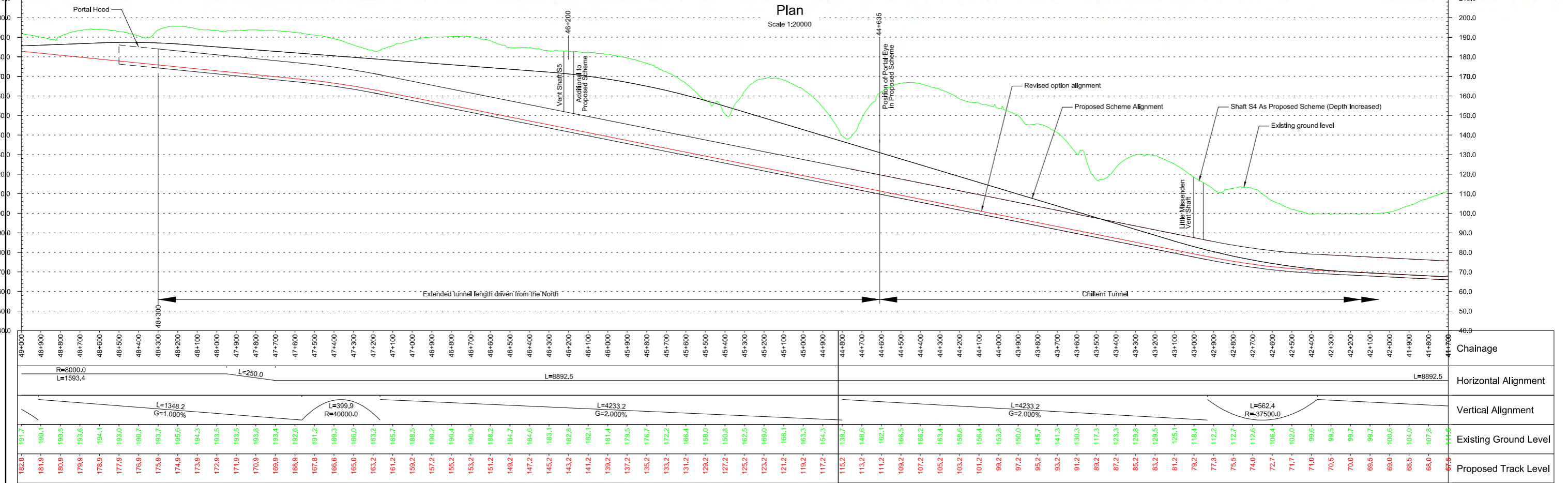
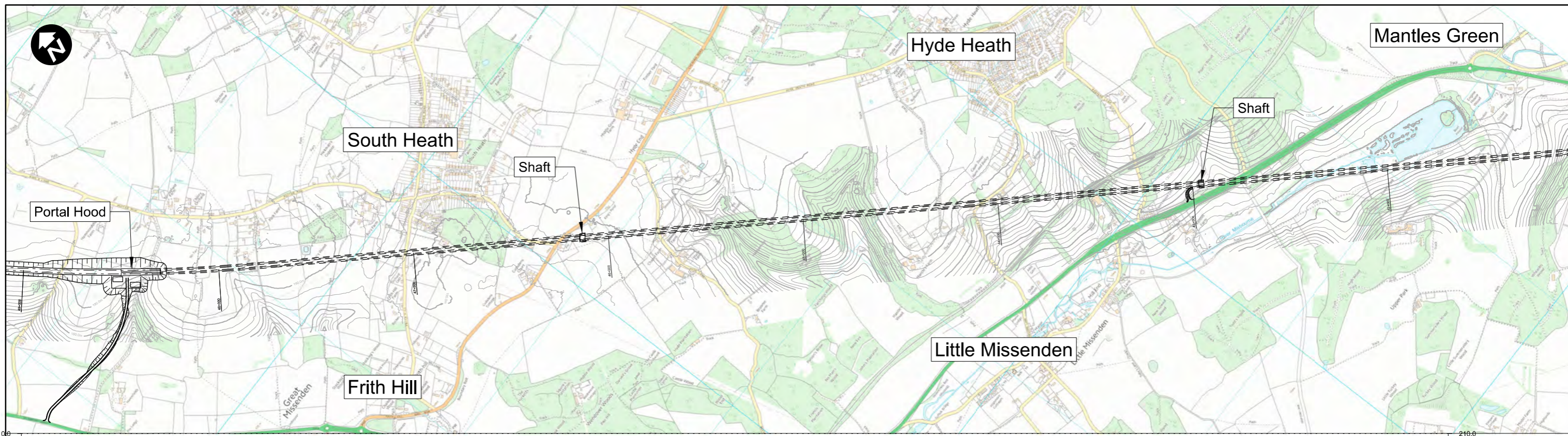
- Legends/Notes:
- The Chiltern Tunnel will consist of a twin bored tunnel constructed from the South end.
 - The maximum line speed within the tunnel shall be 320km/h.
 - A 550m² safe area for emergency vehicles is required at the tunnel portals.
 - In the event of an emergency, passengers will be evacuated via a rescue train from a place of relative safety (in the adjacent cell or portal area).
 - A 200m long portal hood structure has been allowed for at each end of the tunnel to mitigate micro-pressure wave burst.
 - Internal tunnel diameter of 8.8m.
 - External tunnel diameter of 9.6m.

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Creator/Originator
Atkins

Zone	Country South	
Design Stage	DESIGN-FOR-PETITION	
Drawing Title	Community Forum Request Chiltern Tunnel Extension to 48+300 Option C1	

Project/Contract	Country South Design		
Discipline/Function	Tunnels		
Drawn	Checked	Approved	
Date	Scale	Size	
01/07/2015	AS SHOWN	A3	
Drawing No.	Rev.		
C222-ATK-TN-DPL-020-000320-PET000000	P00.1		



48+000	48+900	48+800	48+700	48+600	48+500	48+400	48+300	48+200	48+100	48+000	47+900	47+800	47+700	47+600	47+500	47+400	47+300	47+200	47+100	47+000	46+900	46+800	46+700	46+600	46+500	46+400	46+300	46+200	46+100	46+000	45+900	45+800	45+700	45+600	45+500	45+400	45+300	45+200	45+100	45+000	44+900	44+800	44+700	44+600	44+500	44+400	44+300	44+200	44+100	44+000	43+900	43+800	43+700	43+600	43+500	43+400	43+300	43+200	43+100	43+000	42+900	42+800	42+700	42+600	42+500	42+400	42+300	42+200	42+100	42+000	41+900	41+800	41+700																																																																																																																																																																																																																																																																																																																																																												
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Rev	Description	Drawn	Checked	Con App	HS2 App

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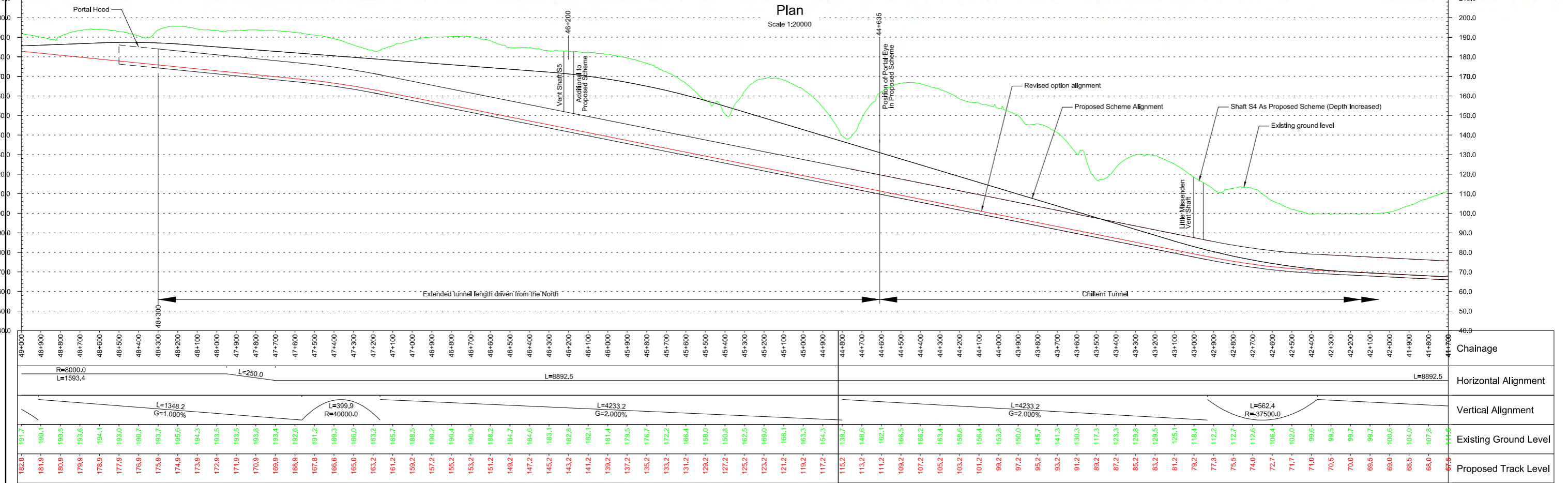
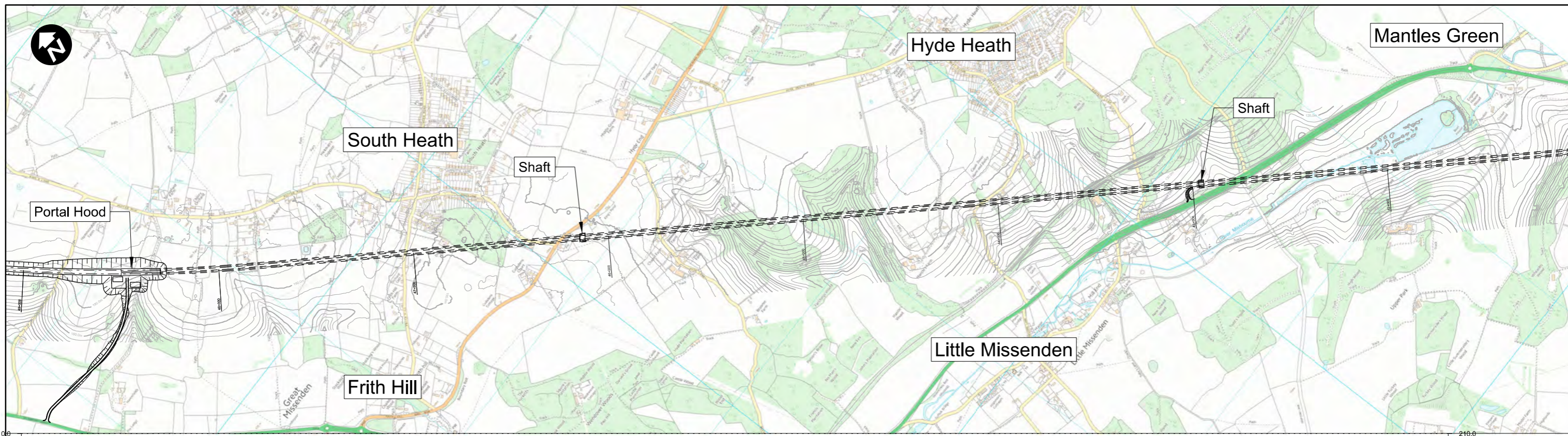
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 - Internal bored tunnel diameter of 8.8m.
 - External bored tunnel diameter of 9.6m.

Registered in England
Registration No. 06791686
Registered office:
One Canada Square,
London, E14 5AB

Creator/Originator
Atkins

Zone	Country South		Project/Contract	Country South Design	
Design Stage	DESIGN-FOR-PETITION		Discipline/Function	Tunnels	
Drawing Title	Community Forum Request Chiltern Tunnel Extension to 48+300		Drawn	Checked	Approved
	Option C3		TB		
	Date	Scale	Size		
	01/07/2015	AS SHOWN	A3		
	Drawing No.	Rev.			
	C222-ATK-TN-DPL-020-000321-PET000000	P00.1			



48+000	48+900	48+800	48+700	48+600	48+500	48+400	48+300	48+200	48+100	48+000	47+900	47+800	47+700	47+600	47+500	47+400	47+300	47+200	47+100	47+000	46+900	46+800	46+700	46+600	46+500	46+400	46+300	46+200	46+100	46+000	45+900	45+800	45+700	45+600	45+500	45+400	45+300	45+200	45+100	45+000	44+900	44+800	44+700	44+600	44+500	44+400	44+300	44+200	44+100	44+000	43+900	43+800	43+700	43+600	43+500	43+400	43+300	43+200	43+100	43+000	42+900	42+800	42+700	42+600	42+500	42+400	42+300	42+200	42+100	42+000	41+900	41+800	41+700																																																																																																																																																																																																																																																																																																																																																												
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191.7	182.8	191.1	181.9	190.5	180.9	193.6	179.9	194.1	178.9	193.0	177.9	190.7	176.9	193.7	174.9	195.6	173.9	194.3	172.9	193.5	171.9	193.5	170.9	193.8	169.9	193.4	168.9	192.6	167.8	191.2	166.6	189.3	165.0	186.0	163.2	183.2	161.2	185.7	158.5	188.5	157.2	190.2	155.2	190.4	153.2	190.3	151.2	188.2	149.2	184.7	147.2	184.6	145.2	183.1	143.2	182.8	141.2	182.1	139.2	181.4	137.2	179.5	135.2	176.7	133.2	172.2	131.2	166.4	129.2	158.0	127.2	150.8	125.2	162.5	123.2	168.0	121.2	168.1	119.2	163.3	117.2	154.3	115.2	139.7	113.2	148.6	111.2	162.1	109.2	166.5	107.2	166.2	105.2	163.4	103.2	158.6	101.2	156.4	99.2	153.8	97.2	150.0	95.2	145.7	93.2	141.3	91.2	130.3	89.2	117.3	87.2	123.3	85.2	129.8	83.2	129.5	81.2	125.1	79.2	118.4	77.3	112.2	75.5	112.7	74.0	112.6	72.7	106.4	71.7	102.0	71.0	99.6	70.5	99.5	70.0	99.7	69.5	99.7	68.5	100.6	68.0	107.8	67.5	111.6																																																																																																																																																																																																																																																																																					
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Profile
Scale H 1:20000 V 1:2000

P00.1	FIRST DRAWN				
Rev	Description	Drawn	Checked	Con App	HS2 App

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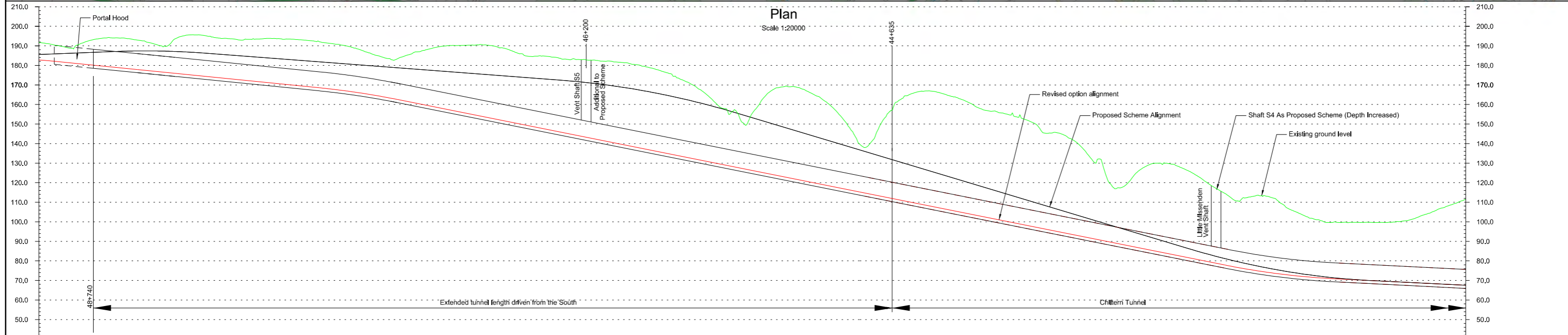
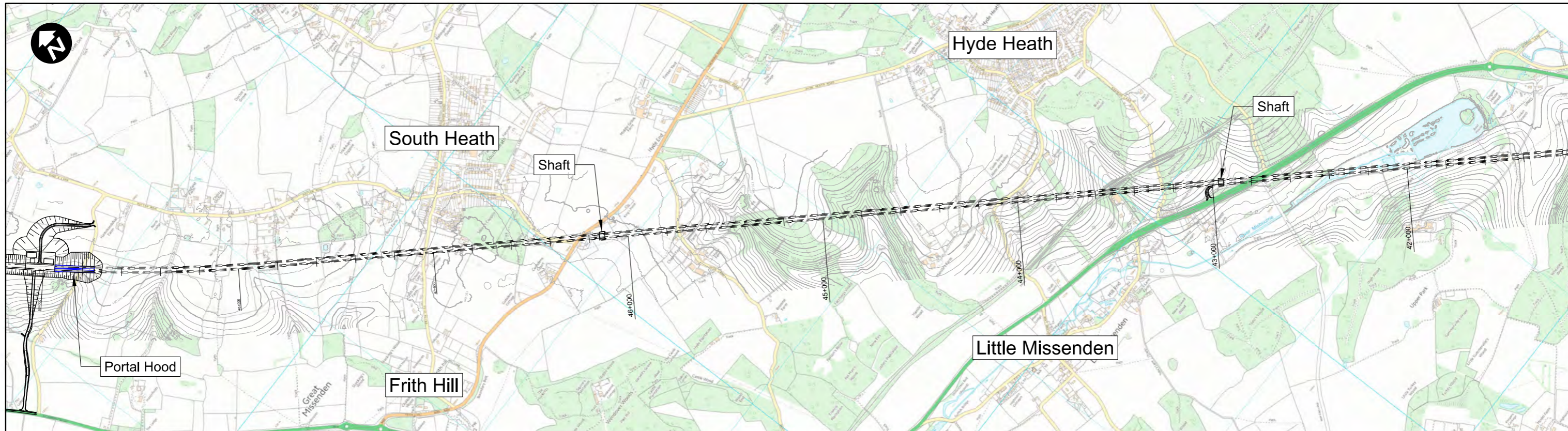
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Creator/Originator
Atkins

Zone	Country South
Design Stage	DESIGN-FOR-PETITION
Drawing Title	Community Forum Request Chiltern Tunnel Extension to 48+300 Option C3

Project/Contract	Country South Design		
Discipline/Function	Tunnels		
Drawn	Checked	Approved	
Date	Scale	Size	
01/07/2015	AS SHOWN	A3	
Drawing No.	Rev.		
C222-ATK-TN-DPL-020-000321-PET000000	P00.1		



48+740	48+900	48+800	48+700	48+600	48+500	48+400	48+300	48+200	48+100	48+000	47+900	47+800	47+700	47+600	47+500	47+400	47+300	47+200	47+100	47+000	46+900	46+800	46+700	46+600	46+500	46+400	46+300	46+200	46+100	46+000	45+900	45+800	45+700	45+600	45+500	45+400	45+300	45+200	45+100	45+000	44+900	44+800	44+700	44+600	44+500	44+400	44+300	44+200	44+100	44+000	43+900	43+800	43+700	43+600	43+500	43+400	43+300	43+200	43+100	43+000	42+900	42+800	42+700	42+600	42+500	42+400	42+300	42+200	42+100	42+000	41+900	41+800	41+700																																																
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Profile
Scale H 1:20000 V 1:2000

P00.1	FIRST DRAWN	-			
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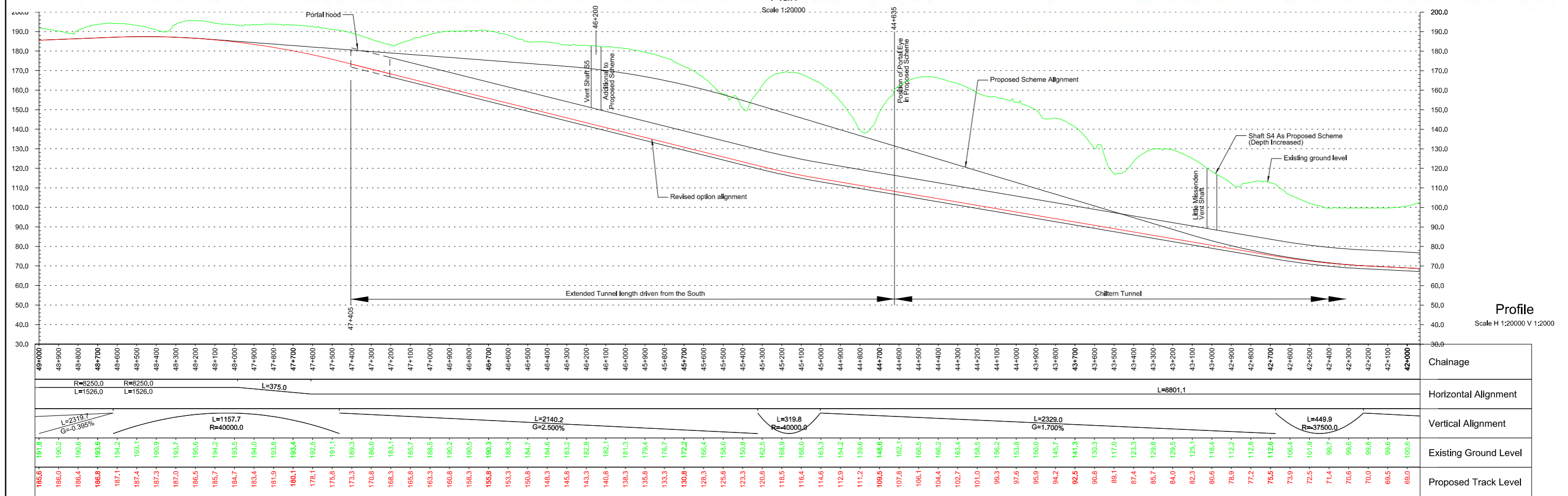
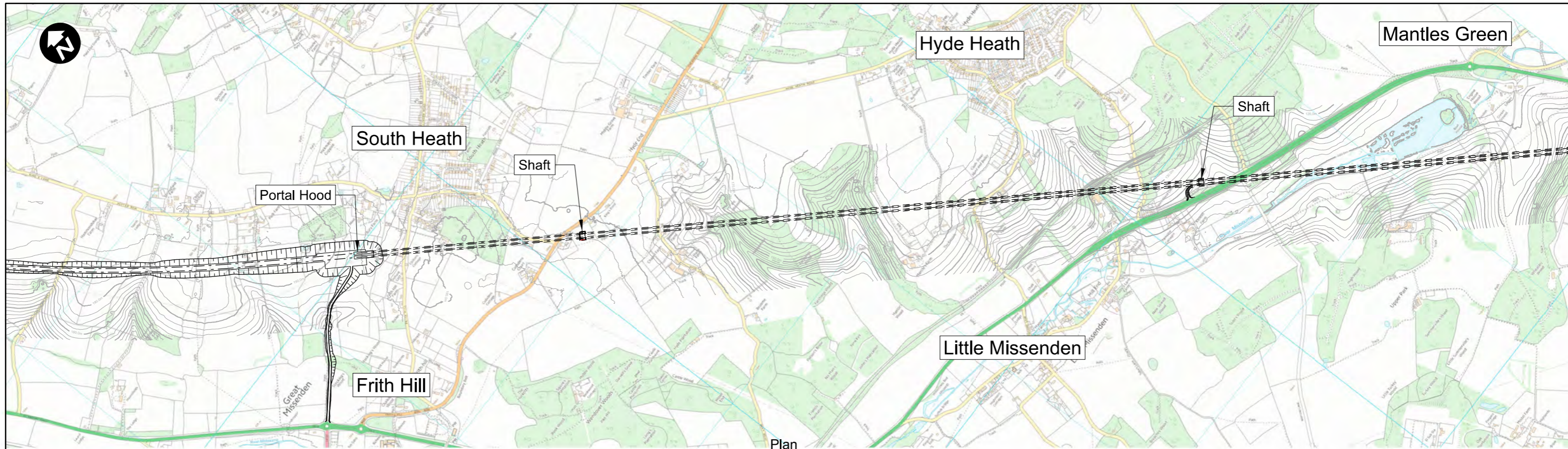
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Creator/Originator
Atkins

Zone	Country South
Design Stage	DESIGN-FOR-PETITION
Drawing Title	Community Forum Request Chiltern Tunnel Extension to 48+740 Option C5

Project/Contract	Country South Design		
Discipline/Function	Tunnels		
Drawn	Checked	Approved	
Date	Scale	Size	
01/07/2015	AS SHOWN	A3	
Drawing No.	Rev.		
C222-ATK-TN-DPL-020-000323-PET000000	P00.1		



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Appendix C

C.1 CT-05 & CT-06 Plans

- C.1.1 C222-ATK-EV-DPL-020-150902-RST00002352
CT-05-031 Construction Phase Extended Chiltern Tunnel Options C1, C2 & C3
- C.1.2 C222-ATK-EV-DPL-020-150903-RST00002352
CT-05-032 Construction Phase Extended Chiltern Tunnel Options C1, C2 & C3
- C.1.3 C222-ATK-EV-DPL-020-150906-RST00002352
CT-05-033 Construction Phase Extended Chiltern Tunnel Options C1, C2 & C3
- C.1.4 C222-ATK-EV-DPL-020-150907-RST00002352
CT-05-034a Construction Phase Extended Chiltern Tunnel Options C1
- C.1.5 C222-ATK-EV-DPL-020-150909-RST00002352
CT-05-034a Construction Phase Extended Chiltern Tunnel Options C3
- C.1.6 C222-ATK-EV-DPL-020-150910-RST00002352
CT-05-035 Construction Phase Extended Chiltern Tunnel Options C1
- C.1.7 C222-ATK-EV-DPL-020-150912-RST00002352
CT-05-035 Construction Phase Extended Chiltern Tunnel Options C3
- C.1.8 C222-ATK-EV-DPL-020-150913-RST00002352
CT-05-034a-L1 Construction Phase Extended Chiltern Tunnel Options C1, C2 & C3
- C.1.9 C222-ATK-EV-DPL-020-160902-RST00002352
CT-06-031 Proposed Scheme Extended Chiltern Tunnel Options C1, C2 & C3
- C.1.10 C222-ATK-EV-DPL-020-160903-RST00002352
CT-06-032 Proposed Scheme Extended Chiltern Tunnel Options C1, C2 & C3
- C.1.11 C222-ATK-EV-DPL-020-160906-RST00002352
CT-06-033 Proposed Scheme Extended Chiltern Tunnel Options C1, C2 & C3
- C.1.12 C222-ATK-EV-DPL-020-160907-RST00002352
CT-06-034a Proposed Scheme Extended Chiltern Tunnel Options C1, C2 & C3
- C.1.13 C222-ATK-EV-DPL-020-160908-RST00002352
CT-06-035 Proposed Scheme Extended Chiltern Tunnel Options C1, C2 & C3
- C.1.14 C222-ATK-EV-DPL-020-160909-RST00002352
CT-06-034a-L1 Proposed Scheme Extended Chiltern Tunnel Options C1, C2 & C3

- C.1.15 C222-ATK-EV-DPL-020-466807–RST00002352
CT-06-028 Proposed Scheme Option C4
- C.1.16 C222-ATK-EV-DPL-020-466808–RST00002352
CT-06-029 Proposed Scheme Option C4
- C.1.17 C222-ATK-EV-DPL-020-466809–RST00002352
CT-06-030a Proposed Scheme Option C4
- C.1.18 C222-ATK-EV-DPL-020-466902–RST00002352
CT-06-031 Proposed Scheme Extended Chiltern Tunnel Option C4
- C.1.19 C222-ATK-EV-DPL-020-466903–RST00002352
CT-06-032 Proposed Scheme Extended Chiltern Tunnel Option C4
- C.1.20 C222-ATK-EV-DPL-020-466906–RST00002352
CT-06-033 Proposed Scheme Extended Chiltern Tunnel Option C4
- C.1.21 C222-ATK-EV-DPL-020-466907–RST00002352
CT-06-034a Proposed Scheme Extended Chiltern Tunnel Option C4
- C.1.22 C222-ATK-EV-DPL-020-466908–RST00002352
CT-06-035 Proposed Scheme Extended Chiltern Tunnel Option C4
- C.1.23 C222-ATK-EV-DPL-020-466909–RST00002352
CT-06-034a-L1 Proposed Scheme Extended Chiltern Tunnel Option C4
- C.1.24 C222-ATK-EV-DPL-020-456807–RST00002352
CT-05-028 Construction Phase Option C4
- C.1.25 C222-ATK-EV-DPL-020-456808–RST00002352
CT-05-029 Construction Phase Option C4
- C.1.26 C222-ATK-EV-DPL-020-456809–RST00002352
CT-05-030a Construction Phase Option C4
- C.1.27 C222-ATK-EV-DPL-020-456902–RST00002352
CT-05-031 Construction Phase Extended Chiltern Tunnel Option C4
- C.1.28 C222-ATK-EV-DPL-020-456903–RST00002352
CT-05-032 Construction Phase Extended Chiltern Tunnel Option C4

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CT-05-033 Construction Phase Extended Chiltern Tunnel Option C4
- C.1.30 C222-ATK-EV-DPL-020-456609–RST00002352
CT-05-034a Construction Phase Extended Chiltern Tunnel Option C4
- C.1.31 C222-ATK-EV-DPL-020-456910–RST00002352
CT-05-035 Construction Phase Extended Chiltern Tunnel Option C4
- C.1.32 C222-ATK-EV-DPL-020-456913–RST00002352
CT-05-034a-L1 Construction Phase Extended Chiltern Tunnel Option C4
- C.1.33 C222-ATK-EV-DPL-020-550902-PET000000
Construction Phase Extended Chiltern Tunnel Option C5
- C.1.34 C222-ATK-EV-DPL-020-550903-PET000000
Construction Phase Extended Chiltern Tunnel Option C5
- C.1.35 C222-ATK-EV-DPL-020-550906-PET000000
Construction Phase Extended Chiltern Tunnel Option C5
- C.1.36 C222-ATK-EV-DPL-020-550907-PET000000
Construction Phase Extended Chiltern Tunnel Option C5
- C.1.37 C222-ATK-EV-DPL-020-550910-PET000000
Construction Phase Extended Chiltern Tunnel Option C5
- C.1.38 C222-ATK-EV-DPL-020-550913-PET000000
Construction Phase Extended Chiltern Tunnel Option C5
- C.1.39 C222-ATK-EV-DPL-020-560902-PET000000
Proposed Scheme Extended Chiltern Tunnel Option C5
- C.1.40 C222-ATK-EV-DPL-020-560903-PET000000
Proposed Scheme Extended Chiltern Tunnel Option C5
- C.1.41 C222-ATK-EV-DPL-020-560906-PET000000

Proposed Scheme Extended Chiltern Tunnel Option C5

C.1.42 C222-ATK-EV-DPL-020-560907-PET000000

Proposed Scheme Extended Chiltern Tunnel Option C5

C.1.43 C222-ATK-EV-DPL-020-560908-PET000000

Proposed Scheme Extended Chiltern Tunnel Option C5

C.1.44 C222-ATK-EV-DPL-020-560909-PET000000

Proposed Scheme Extended Chiltern Tunnel Option C5

C.1.45 C222-ATK-EV-DPL-020-650902-PET000000

Construction Phase Extended Chiltern Tunnel Option C6

C.1.46 C222-ATK-EV-DPL-020-650903-PET000000

Construction Phase Extended Chiltern Tunnel Option C6

C.1.47 C222-ATK-EV-DPL-020-650906-PET000000

Construction Phase Extended Chiltern Tunnel Option C6

C.1.48 C222-ATK-EV-DPL-020-650907-PET000000

Construction Phase Extended Chiltern Tunnel Option C6

C.1.49 C222-ATK-EV-DPL-020-660902-PET000000

Proposed Scheme Extended Chiltern Tunnel Option C6

C.1.50 C222-ATK-EV-DPL-020-660903-PET000000

Proposed Scheme Extended Chiltern Tunnel Option C6

C.1.51 C222-ATK-EV-DPL-020-660906-PET000000

Proposed Scheme Extended Chiltern Tunnel Option C6

C.1.52 C222-ATK-EV-DPL-020-660907-PET000000

Proposed Scheme Extended Chiltern Tunnel Option C6



CONSTRUCTION (OPTION C1)

Buckinghamshire
Chiltern District

Hyde Heath

BULLBAINERS LANE

CHALK LANE

Chiltern Tunnel

CHALK LANE

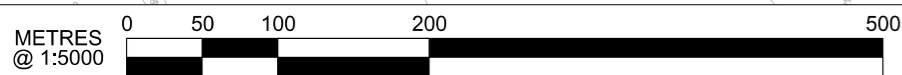
MARYLEBONE TO AYLESBURY LINE

A413

RIVER MISBOURNE

Little Missenden

For Continuation Refer to Drawing C222-ATK-EV-DPL-020-150903-PET000000



P00.1	FIRST DRAWN				
Rev	Description	Drawn	Checked	Con App	HS2 App

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Scale with caution as distortion can occur.

Legends/Notes:

Satellite construction compound	Temporary site access route / haul route
Main construction compound	Construction traffic route
Tunnel portal	Existing public right of way (PRoW)
Rail alignment formation	New, diverted or realigned PRoW
Tunnels external extent	Stopped-up PRoW
Rail alignment	Temporary PRoW
Engineering earthworks	Temporary material stockpile
Landscape earthworks	
Land potentially required during construction	



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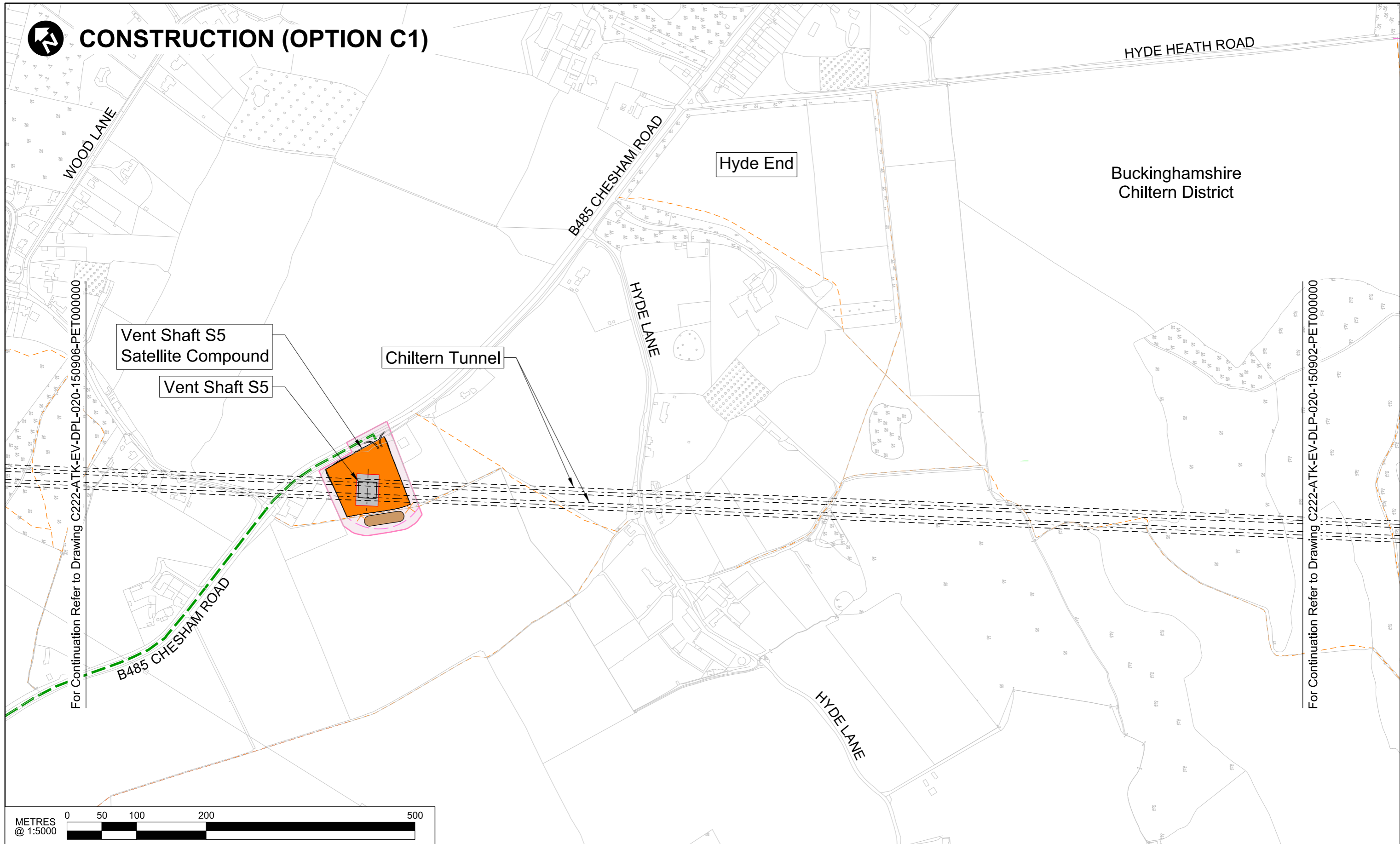
Creator/Originator
Atkins

Zone	Country South
Design Stage	DESIGN-FOR-PETITION
Drawing Title	Construction Phase Extended Chiltern Tunnel Option C1

Project/Contract	Country South Design		
Discipline/Function	Environmental		
Drawn	Checked	Approved	
Date	Scale	Size	
22/10/2013	AS SHOWN	A3	
Drawing No.	Rev.		
C222-ATK-EV-DPL-020-150902-PET000000	P00.1		

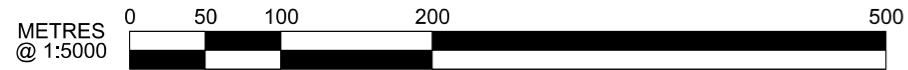


CONSTRUCTION (OPTION C1)



For Continuation Refer to Drawing C222-ATK-EV-DLP-020-150906-PET000000

For Continuation Refer to Drawing C222-ATK-EV-DLP-020-150902-PET000000



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Legends/Notes:	
	Satellite construction compound
	Main construction compound
	Tunnel portal
	Rail alignment formation
	Tunnels external extent
	Rail alignment
	Engineering earthworks
	Landscape earthworks
	Land potentially required during construction
	Temporary site access route / haul route
	Construction traffic route
	Existing public right of way (PRoW)
	New, diverted or realigned PRoW
	Stopped-up PRoW
	Temporary PRoW
	Temporary material stockpile



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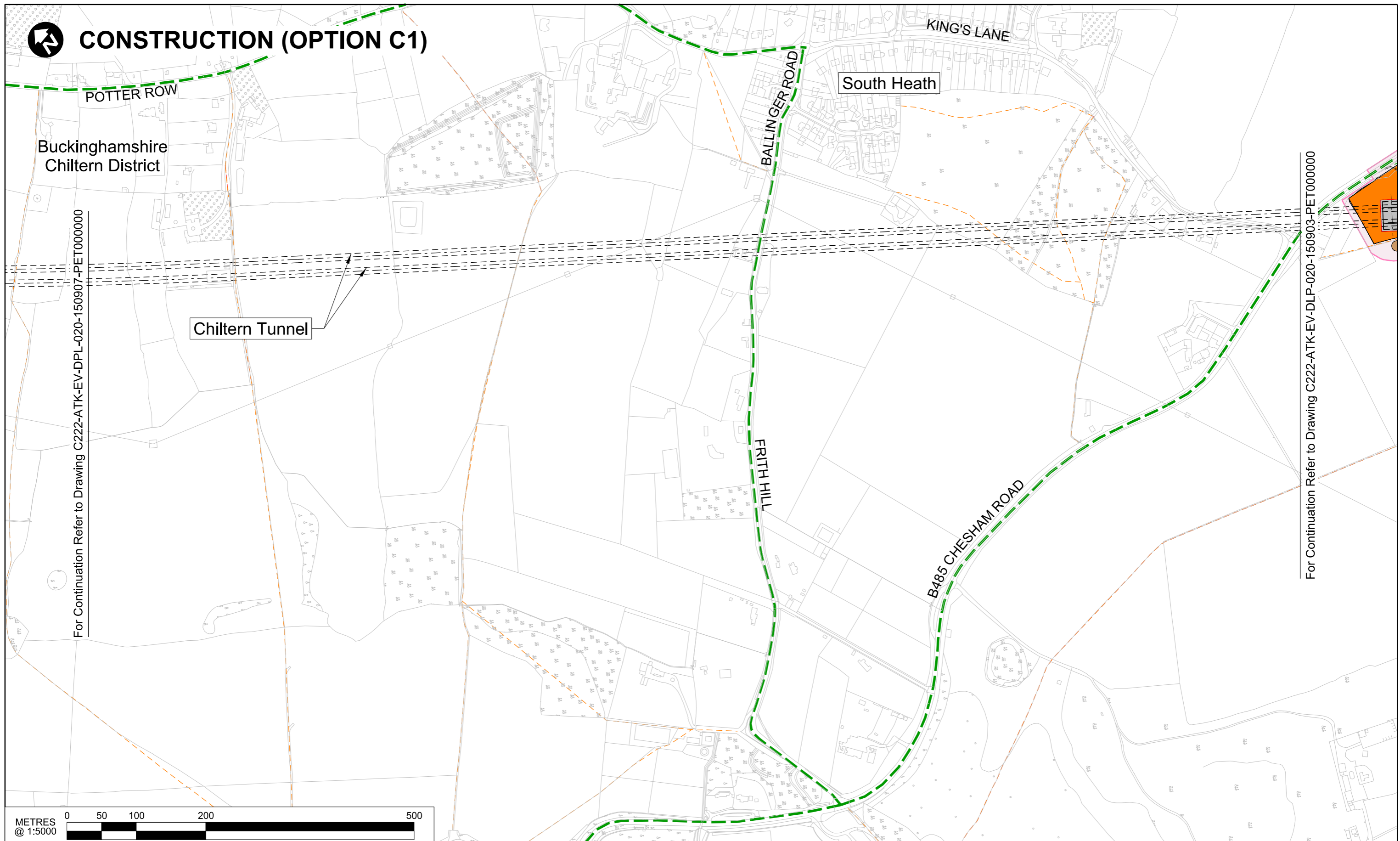
Creator/Originator
Atkins

Zone	Country South
Design Stage	DESIGN-FOR-PETITION
Drawing Title	Construction Phase Extended Chiltern Tunnel Option C1

Project/Contract	Country South Design		
Discipline/Function	Environmental		
Drawn	Checked	Approved	
Date	Scale	Size	
22/10/2013	AS SHOWN	A3	
Drawing No.	Rev.		
C222-ATK-EV-DLP-020-150903-PET000000	P00.1		



CONSTRUCTION (OPTION C1)



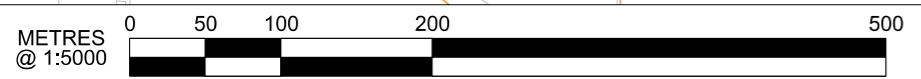
Buckinghamshire
Chiltern District

South Heath

Chiltern Tunnel

For Continuation Refer to Drawing C222-ATK-EV-DPL-020-150907-PET000000

For Continuation Refer to Drawing C222-ATK-EV-DLP-020-150903-PET000000



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A413


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- Legends/Notes:
- Satellite construction compound
 - Main construction compound
 - Tunnel portal
 - Rail alignment formation
 - Tunnels external extent
 - Rail alignment
 - Engineering earthworks
 - Landscape earthworks
 - Land potentially required during construction
 - Main utility works
 - Temporary site access route / haul route
 - Construction traffic route
 - Existing public right of way (PRoW)
 - New, diverted or realigned PRoW
 - Stopped-up PRoW
 - Temporary PRoW
 - Temporary material stockpile



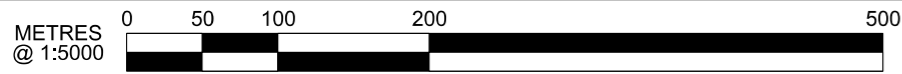
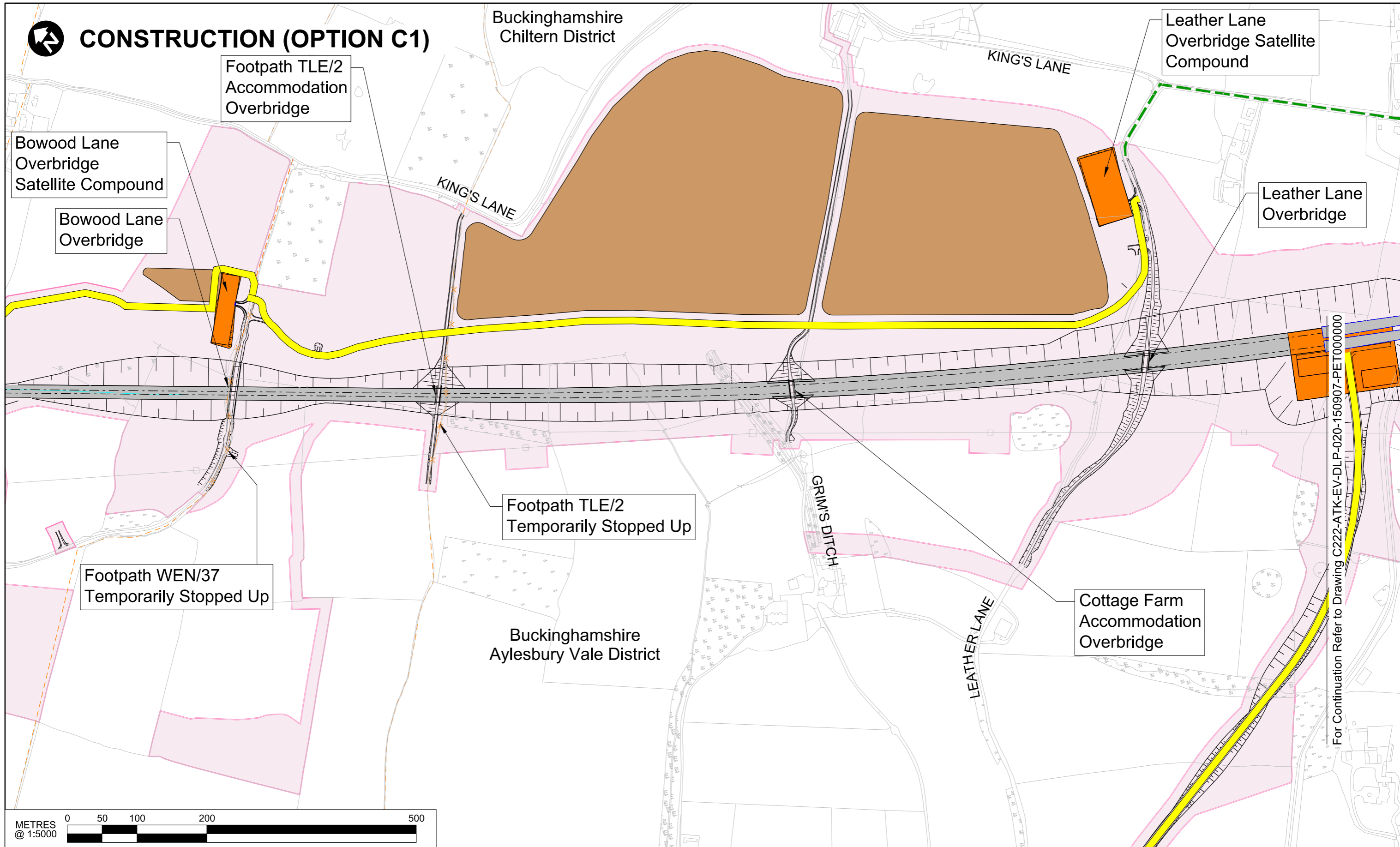
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Creator/Originator
Atkins

Zone	Country South	
Design Stage	DESIGN-FOR-PETITION	
Drawing Title	Construction Phase Extended Chiltern Tunnel Option C1	

Project/Contract	Country South Design		
Discipline/Function	Environmental		
Drawn	Checked	Approved	
Date	Scale	Size	
22/10/2013	AS SHOWN	A3	
Drawing No.	Rev.		
C222-ATK-EV-DPL-020-150906-PET000000	P00.1		

CONSTRUCTION (OPTION C1)



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Legends/Notes:	
	Satellite construction compound
	Main construction compound
	Tunnel portal
	Rail alignment formation
	Tunnels external extent
	Rail alignment
	Engineering earthworks
	Landscape earthworks
	Land potentially required during construction
	Temporary site access route / haul route
	Construction traffic route
	Existing public right of way (PRoW)
	New, diverted or realigned PRoW
	Stopped-up PRoW
	Temporary PRoW
	Temporary material stockpile

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Zone	Country South		Project/Contract	Country South Design	
Design Stage	DESIGN-FOR-PETITION		Discipline/Function	Environmental	
Drawing Title	Construction Phase		Drawn	Checked	Approved
	Extended Chiltern Tunnel		TB		
	Option C1		Date	Scale	Size
		02/09/2014	AS SHOWN	A1	
		Drawing No.	C222-ATK-EV-DPL-020-150910-PET000000		Rev.
					P00.1

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CONSTRUCTION (OPTION C1)

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Buckinghamshire
Aylesbury Vale
District

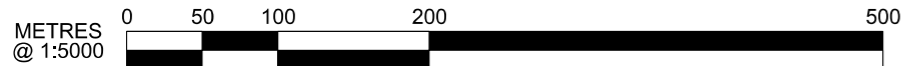
LEATHER LANE

A413

MARYLEBONE TO AYLESBURY LINE

RIVER MISBOURNE

Great Missenden



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Legends/Notes:	
Satellite construction compound	Temporary site access route / haul route
Main construction compound	Construction traffic route
Tunnel portal	Existing public right of way (PRoW)
Rail alignment formation	New, diverted or realigned PRoW
Tunnels external extent	Stopped-up PRoW
Rail alignment	Temporary PRoW
Engineering earthworks	Temporary material stockpile
Landscape earthworks	
Land potentially required during construction	



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Zone	Country South		Project/Contract	Country South Design	
Design Stage	DESIGN-FOR-PETITION		Discipline/Function	Environmental	
Drawing Title	Construction Phase		Drawn	Checked	Approved
	Extended Chiltern Tunnel		TB		
	Option C1		Date	Scale	Size
			02/09/2014	AS SHOWN	A3
	Drawing No. C222-ATK-EV-DPL-020-150913-PET000000				Rev. P00.1



OPERATION (OPTION C1)

Buckinghamshire
Chiltern District

Hyde Heath

BULLBAINERS LANE

CHALK LANE

Chiltern Tunnel

CHALK LANE

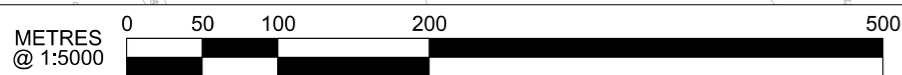
MARYLEBONE TO AYLESBURY LINE

A413

RIVER MISBOURNE

Little Missenden

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Legends/Notes:	
	Depot, station, headhouse or portal building
	Tunnel portal
	Balancing pond
	Land drainage area
	Replacement floodplain storage
	Landscape mitigation planting (scrub / woodland)
	Grassed areas
	Engineering earthworks
	Landscape earthworks
	Rail alignment formation
	Grassland habitat creation
	Tunnels external extent
	Rail alignment
	Noise fence barrier
	Ditches - new
	Hedgerow habitat creation
	HS2 Access road
	Existing public right of way (PRoW)
	New, diverted or realigned PRoW
	Stopped-up PRoW

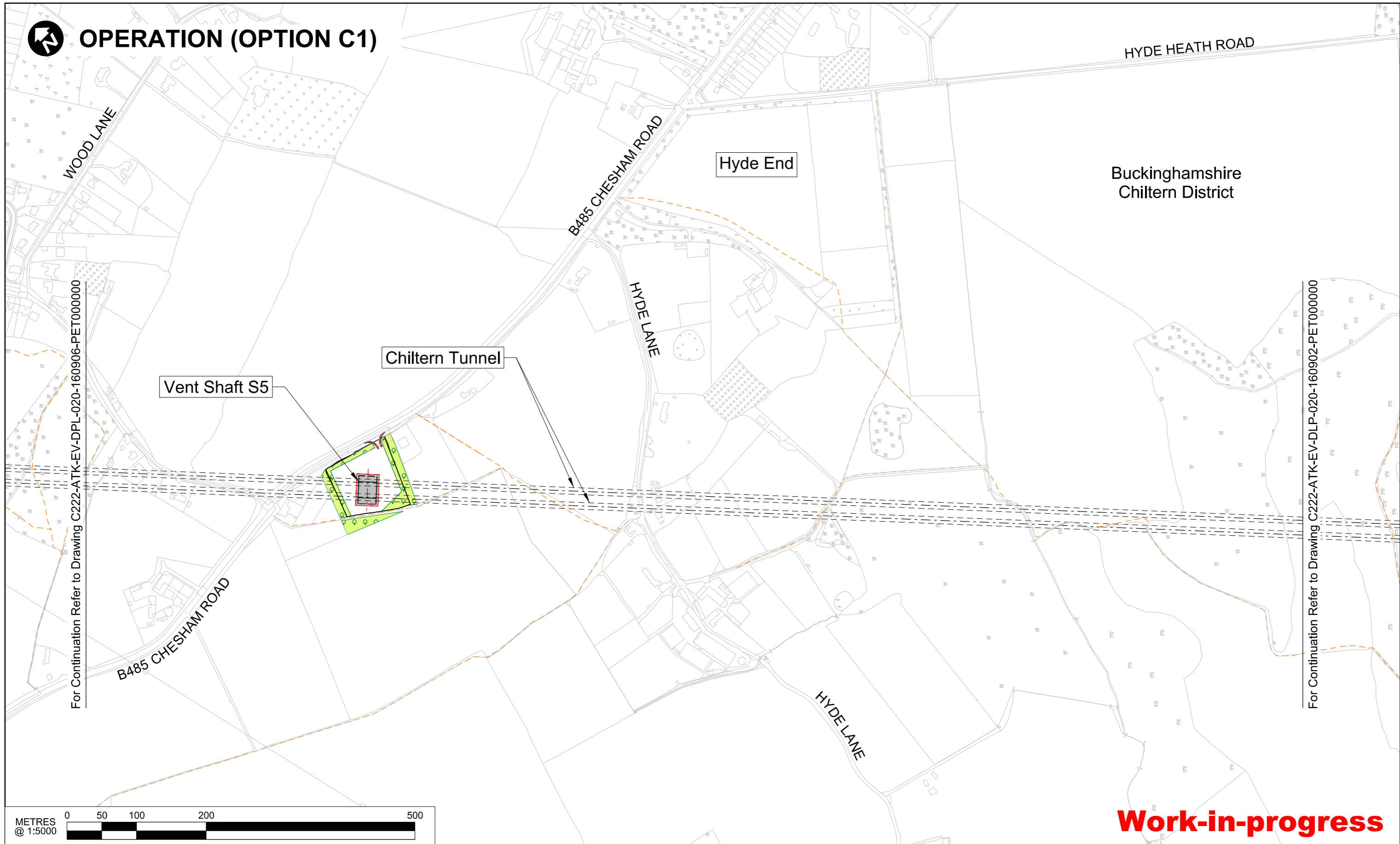


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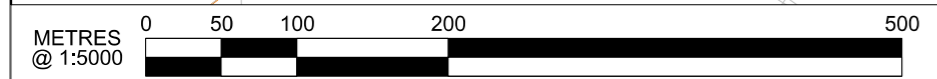
Creator/Originator
Atkins

Zone	Country South		Project/Contract	Country South Design	
Design Stage	DESIGN-FOR-PETITION		Discipline/Function	Environmental	
Drawing Title	Proposed Scheme		Drawn	Checked	Approved
	Extended Chiltern Tunnel		NM		
	Option C1		Date	Scale	Size
			22/10/2013	AS SHOWN	A3
	Drawing No. C222-ATK-EV-DPL-020-160902-PET000000				Rev. P00.1

OPERATION (OPTION C1)



Work-in-progress



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- Legends/Notes:
- Depot, station, headhouse or portal building
 - Tunnel portal
 - Balancing pond
 - Land drainage area
 - Replacement floodplain storage
 - Landscape mitigation planting (scrub / woodland)
 - Grassed areas
 - Engineering earthworks
 - Landscape earthworks
 - Rail alignment formation
 - Grassland habitat creation
 - Tunnels external extent
 - Rail alignment
 - Noise fence barrier
 - Ditches - new
 - Hedgerow habitat creation
 - HS2 Access road
 - Existing public right of way (PRoW)
 - New, diverted or realigned PRoW
 - Stopped-up PRoW

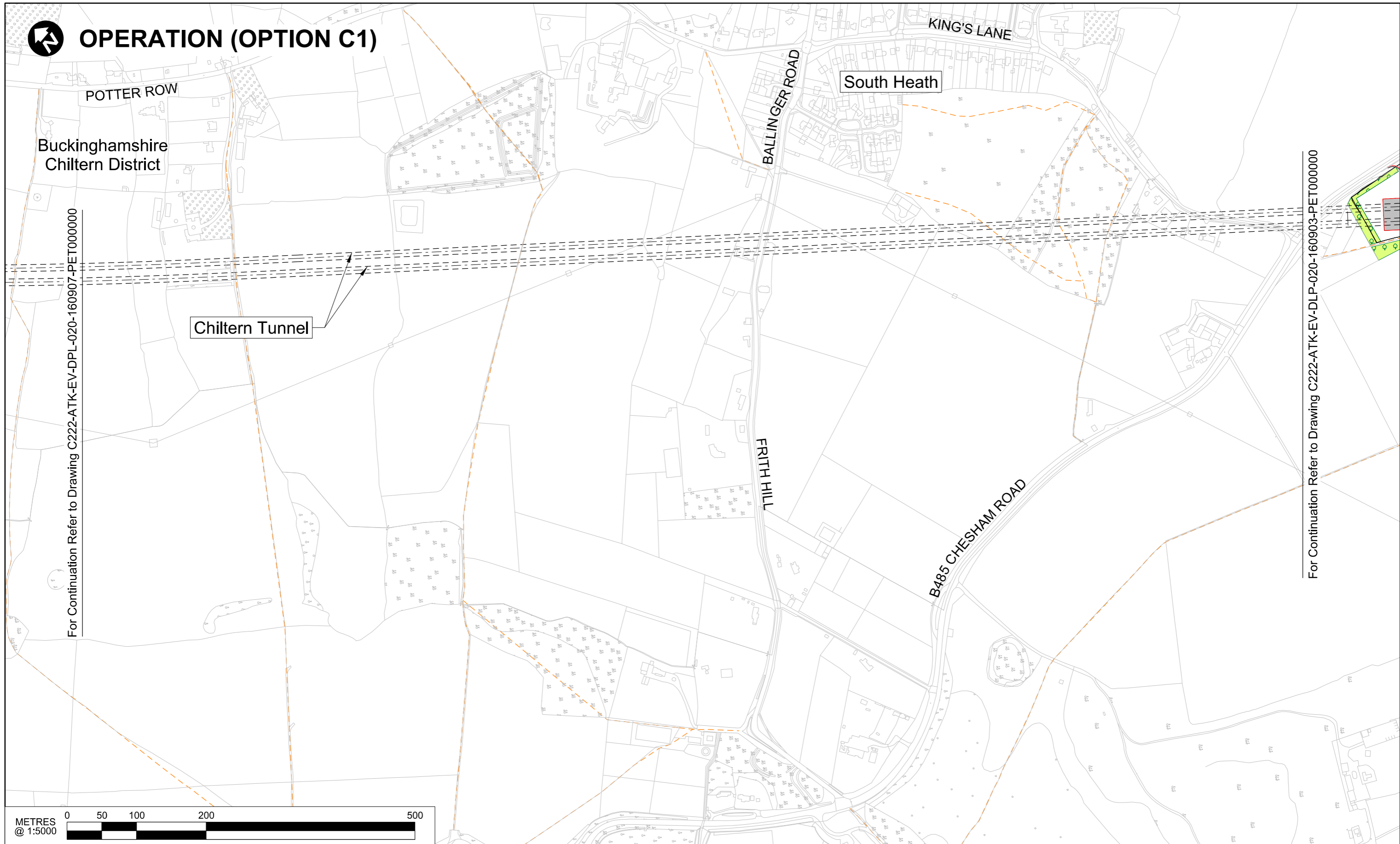
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Zone	Country South		Project/Contract	Country South Design	
Design Stage	DESIGN-FOR-PETITION		Discipline/Function	Environmental	
Drawing Title	Proposed Scheme		Drawn	Checked	Approved
	Extended Chiltern Tunnel		NM		
	Option C1		Date	Scale	Size
			22/10/2013	AS SHOWN	A3
	Drawing No.				Rev.
	C222-ATK-EV-DPL-020-160903-PET000000				P00.1



OPERATION (OPTION C1)



Buckinghamshire
Chiltern District

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Chiltern Tunnel

South Heath

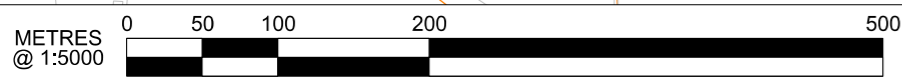
BALLINGER ROAD

KING'S LANE

FRITH HILL

B485 CHESHAM ROAD

For Continuation Refer to Drawing C222-ATK-EV-DLP-020-160903-PET000000



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Legends/Notes:

	Depot, station, headhouse or portal building		Grassland habitat creation
	Tunnel portal		Tunnels external extent
	Balancing pond		Rail alignment
	Land drainage area		Noise fence barrier
	Replacement floodplain storage		Ditches - new
	Landscape mitigation planting (scrub / woodland)		HS2 Access road
	Grassed areas		Existing public right of way (PRoW)
	Engineering earthworks		New, diverted or realigned PRoW
	Landscape earthworks		Stopped-up PRoW
	Rail alignment formation		

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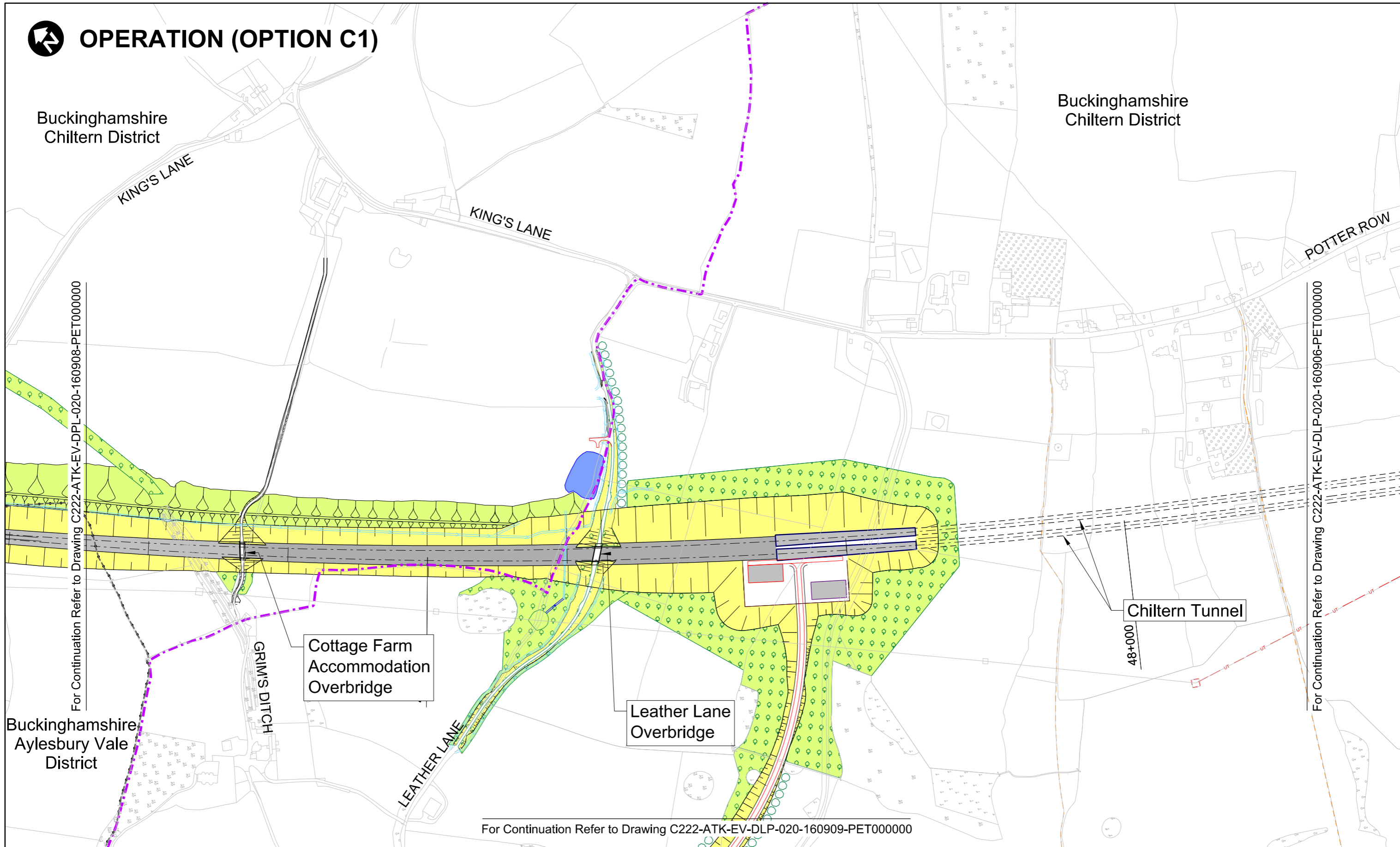
Creator/Originator
Atkins

Zone	Country South		Project/Contract	Country South Design	
Design Stage	DESIGN-FOR-PETITION		Discipline/Function	Environmental	
Drawing Title	Proposed Scheme		Drawn	Checked	Approved
	Extended Chiltern Tunnel		NM		
	Option C1		Date	Scale	Size
			22/10/2013	AS SHOWN	A3
	Drawing No. C222-ATK-EV-DPL-020-160906-PET000000				Rev. P00.1

OPERATION (OPTION C1)

Buckinghamshire
Chiltern District

Buckinghamshire
Chiltern District



For Continuation Refer to Drawing C222-ATK-EV-DLP-020-160908-PET000000

For Continuation Refer to Drawing C222-ATK-EV-DLP-020-160906-PET000000

Buckinghamshire
Aylesbury Vale
District

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Legends/Notes:	
	Depot, station, headhouse or portal building
	Tunnel portal
	Balancing pond
	Land drainage area
	Replacement floodplain storage
	Landscape mitigation planting (scrub / woodland)
	Grassed areas
	Engineering earthworks
	Landscape earthworks
	Rail alignment formation
	Grassland habitat creation
	Tunnels external extent
	Rail alignment
	Noise fence barrier
	Ditches - new
	Hedgerow habitat creation
	HS2 Access road
	Existing public right of way (PRoW)
	New, diverted or realigned PRoW
	Stopped-up PRoW
	UT - Main utility works

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Zone	Country South	
Design Stage	DESIGN-FOR-PETITION	
Drawing Title	Proposed Scheme Extended Chiltern Tunnel Options C1	

Project/Contract	Country South Design		
Discipline/Function	Environmental		
Drawn	Checked	Approved	
Date	Scale	Size	
01/07/2015	AS SHOWN	A1	
Drawing No.	Rev.		
C222-ATK-EV-DLP-020-160907-PET000000	P00.1		



OPERATION (OPTION C1)

Buckinghamshire
Chiltern District

KING'S LANE

Footpath TLE/2
Accommodation
Overbridge

Leather Lane
Overbridge

Bowood Lane
Overbridge

KING'S LANE

Footpath TLE/2

Footpath WEN/37

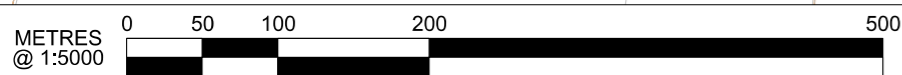
Buckinghamshire
Aylesbury Vale District

GRIM'S DITCH

Cottage Farm
Accommodation
Overbridge

LEATHER LANE

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- Legends/Notes:
- Depot, station, headhouse or portal building
 - Tunnel portal
 - Balancing pond
 - Land drainage area
 - Replacement floodplain storage
 - Landscape mitigation planting (scrub / woodland)
 - Grassed areas
 - Engineering earthworks
 - Landscape earthworks
 - Rail alignment formation
 - Grassland habitat creation
 - Tunnels external extent
 - Rail alignment
 - Noise fence barrier
 - Ditches - new
 - Hedgerow habitat creation
 - HS2 Access road
 - Existing public right of way (PRoW)
 - New, diverted or realigned PRoW
 - Stopped-up PRoW



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Zone	Country South		Project/Contract		Country South Design	
Design Stage	DESIGN-FOR-PETITION		Discipline/Function			
Drawing Title	Proposed Scheme		Drawn	Checked	Approved	
	Extended Chiltern Tunnel		NM			
Option C1	Date	22/10/2013	Scale	AS SHOWN	Size	A3
	Drawing No.	C222-ATK-EV-DLP-020-160908-PET000000			Rev.	P00.1



OPERATION (OPTION C1)

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Buckinghamshire
Aylesbury Vale
District

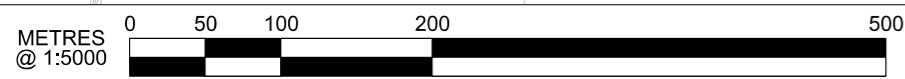
LEATHER LANE

A413

MARYLEBONE TO AYLESBURY LINE

RIVER MISBOURNE

Great Missenden



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	Tunnel portal
	Balancing pond
	Land drainage area
	Replacement floodplain storage
	Landscape mitigation planting (scrub / woodland)
	Grassed areas
	Engineering earthworks
	Landscape earthworks
	Rail alignment formation
	Grassland habitat creation
	Tunnels external extent
	Rail alignment
	Noise fence barrier
	Ditches - new
	Hedgerow habitat creation
	HS2 Access road
	Existing public right of way (PRoW)
	New, diverted or realigned PRoW
	Stopped-up PRoW



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Zone	Country South		Project/Contract	Country South Design	
Design Stage	DESIGN-FOR-PETITION		Discipline/Function	Environmental	
Drawing Title	Proposed Scheme		Drawn	Checked	Approved
	Extended Chiltern Tunnel		TB		
	Option C1		Date	Scale	Size
			18/07/2014	AS SHOWN	A3
	Drawing No. C222-ATK-EV-DPL-020-160909-PET000000				Rev. P00.1



CONSTRUCTION (OPTION C5)

Buckinghamshire
Chiltern District

Hyde Heath

BULLBAINERS LANE

CHALK LANE

Chiltern Tunnel

CHALK LANE

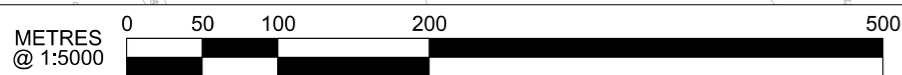
MARYLEBONE TO AYLESBURY LINE

A413

RIVER MISBOURNE

Little Missenden

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Legends/Notes:	
	Satellite construction compound
	Main construction compound
	Tunnel portal
	Rail alignment formation
	Tunnels external extent
	Rail alignment
	Engineering earthworks
	Landscape earthworks
	Land potentially required during construction
	Temporary site access route / haul route
	Construction traffic route
	Existing public right of way (PRoW)
	New, diverted or realigned PRoW
	Stopped-up PRoW
	Temporary PRoW
	Temporary material stockpile

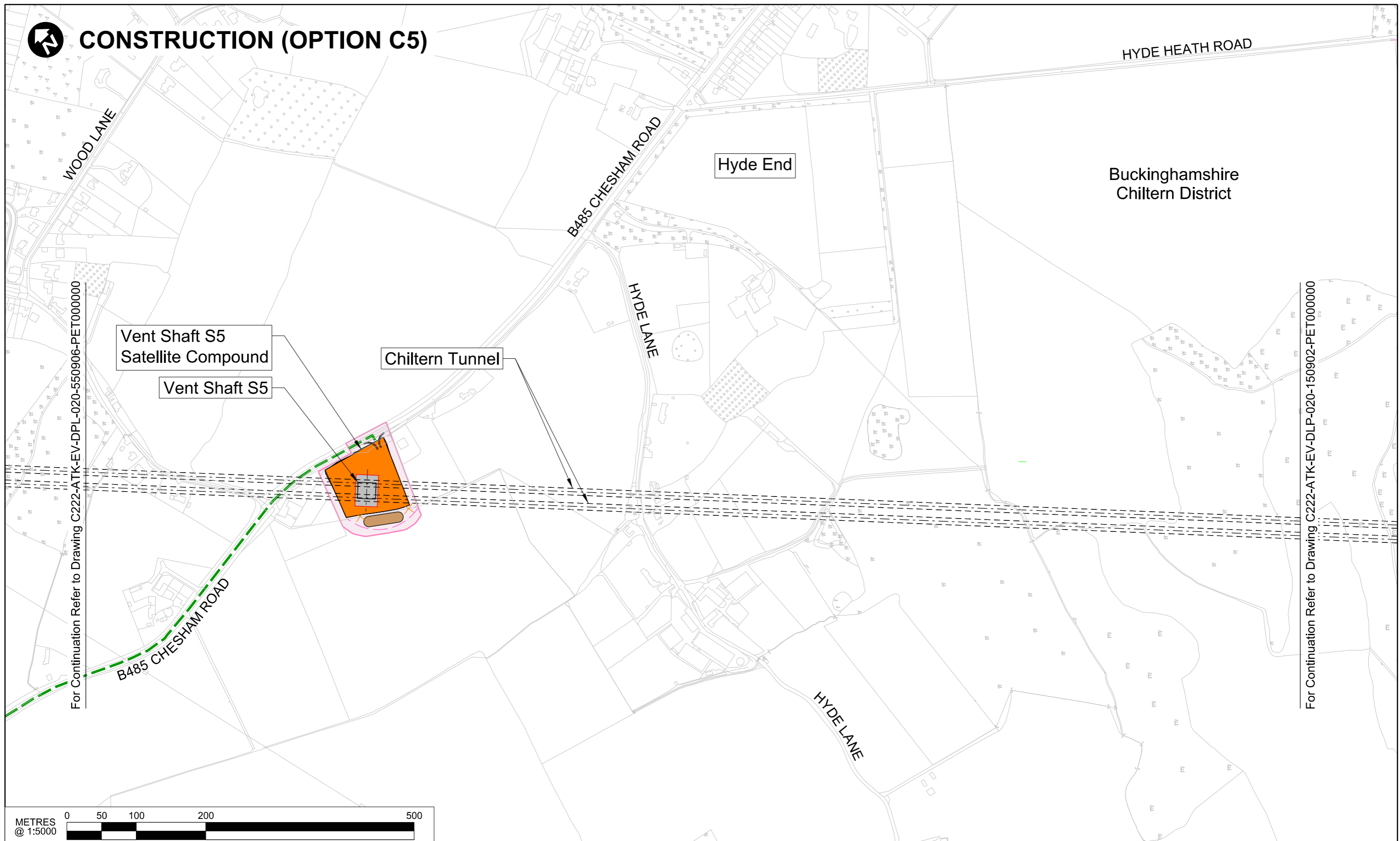


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Creator/Originator
Atkins

Zone	Country South		Project/Contract	Country South Design	
Design Stage	DESIGN-FOR-PETITION		Discipline/Function	Environmental	
Drawing Title	Construction Phase		Drawn	Checked	Approved
	Extended Chiltern Tunnel		NM		
	Option C5		Date	Scale	Size
			22/10/2013	AS SHOWN	A1
	Drawing No.				Rev.
	C222-ATK-EV-DPL-020-550902-PET000000				P00.1

CONSTRUCTION (OPTION C5)



HYDE HEATH ROAD

Hyde End

Buckinghamshire
Chiltern District

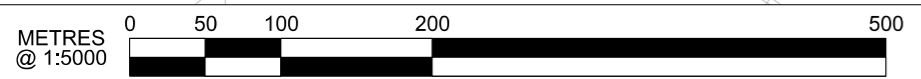
Vent Shaft S5
Satellite Compound

Vent Shaft S5

Chiltern Tunnel

For Continuation Refer to Drawing C222-ATK-EV-DLP-020-550906-PET000000

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- Legends/Notes:
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 - Main construction compound
 - Tunnel portal
 - Rail alignment formation
 - Tunnels external extent
 - Rail alignment
 - Engineering earthworks
 - Landscape earthworks
 - Land potentially required during construction
 - Temporary site access route / haul route
 - Construction traffic route
 - Existing public right of way (PRoW)
 - New, diverted or realigned PRoW
 - Stopped-up PRoW
 - Temporary PRoW
 - Temporary material stockpile



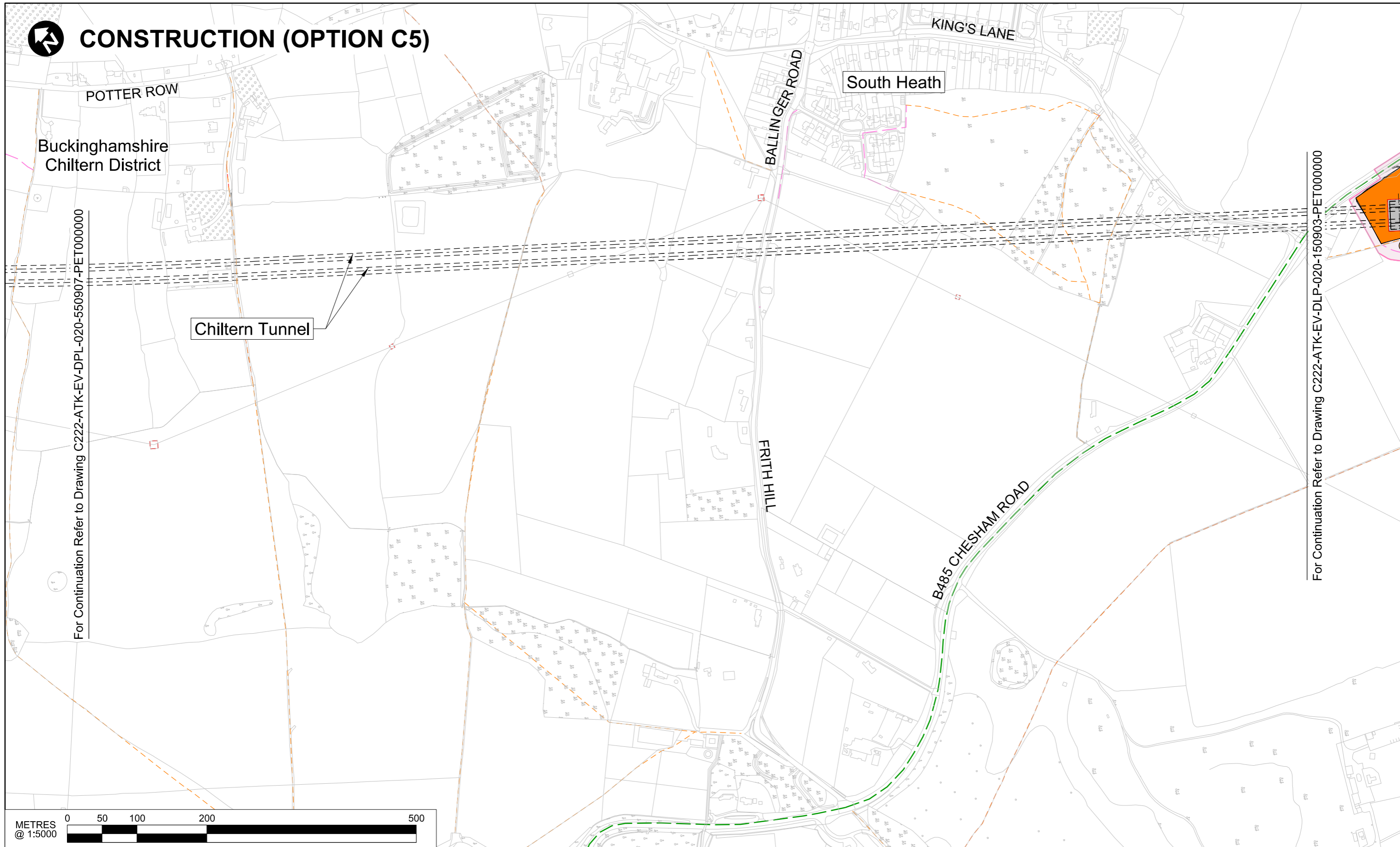
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Zone	Country South		Project/Contract	Country South Design	
Design Stage	DESIGN-FOR-PETITION		Discipline/Function	Environmental	
Drawing Title	Construction Phase		Drawn	Checked	Approved
	Extended Chiltern Tunnel		NM		
	Option C5		Date	Scale	Size
			22/10/2013	AS SHOWN	A1
			Drawing No.	Rev.	
			C222-ATK-EV-DLP-020-550903-PET000000	P00.1	

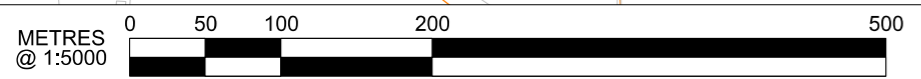


CONSTRUCTION (OPTION C5)



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Legends/Notes:

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- Main construction compound
- Tunnel portal
- Rail alignment formation
- Tunnels external extent
- Rail alignment
- Engineering earthworks
- Landscape earthworks
- Land potentially required during construction
- UT - Main utility works
- Temporary site access route / haul route
- Construction traffic route
- Existing public right of way (PRoW)
- New, diverted or realigned PRoW
- Stopped-up PRoW
- Temporary PRoW
- Temporary material stockpile

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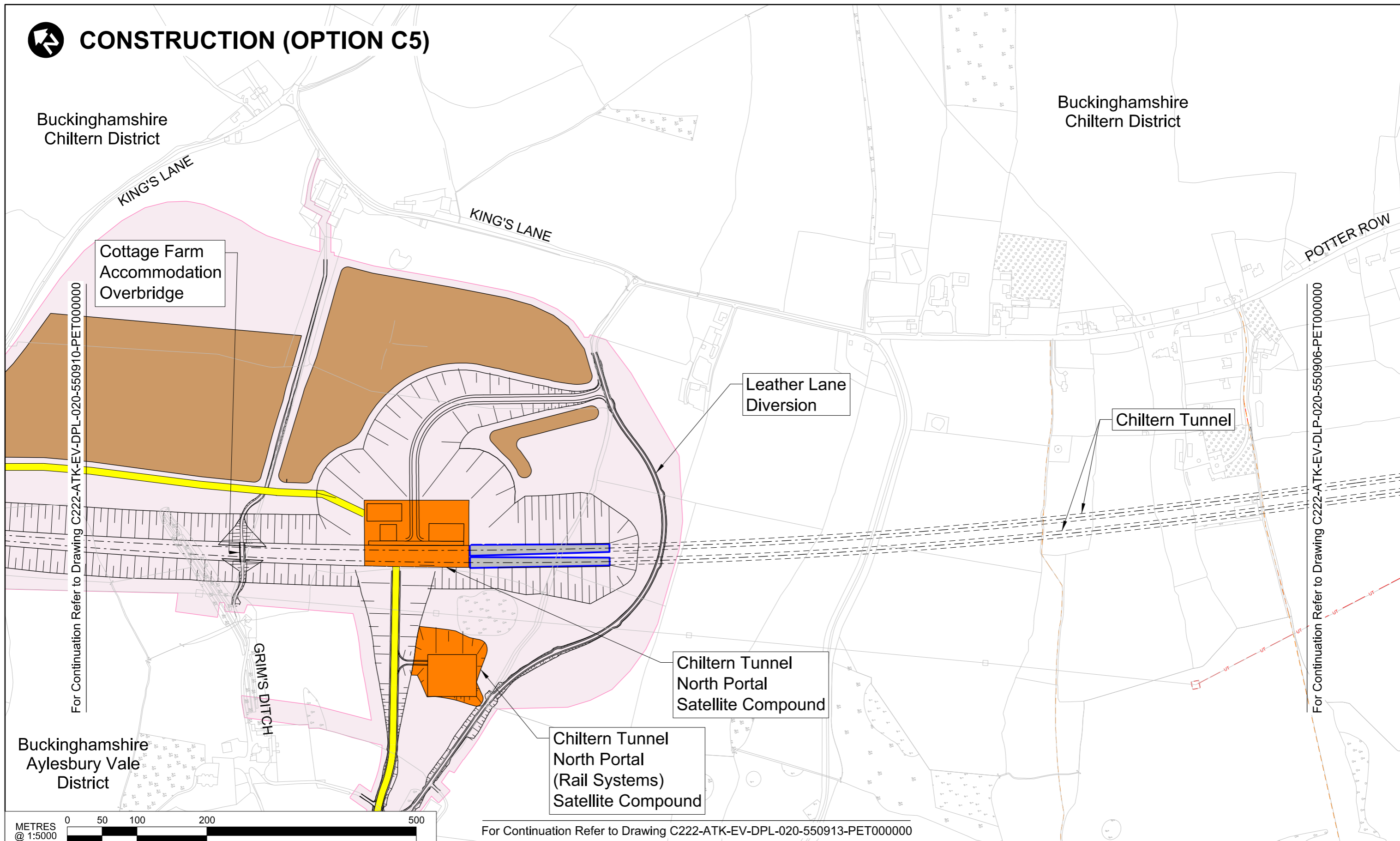
Zone	Country South	
Design Stage	DESIGN-FOR-PETITION	
Drawing Title	Construction Phase Extended Chiltern Tunnel Option C5	

Project/Contract	Country South Design		
Discipline/Function	Environmental		
Drawn	Checked	Approved	
	NM		
Date	Scale	Size	
22/10/2013	AS SHOWN	A1	
Drawing No.	Rev.		
C222-ATK-EV-DPL-020-550906-PET000000	P00.1		

CONSTRUCTION (OPTION C5)

Buckinghamshire
Chiltern District

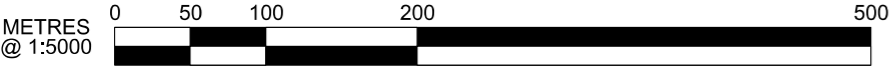
Buckinghamshire
Chiltern District



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Buckinghamshire
Aylesbury Vale
District



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- Construction traffic route
- Existing public right of way (PRoW)
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- Temporary material stockpile

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Zone	Country South		Project/Contract	Country South Design	
Design Stage	DESIGN-FOR-PETITION		Discipline/Function	Environmental	
Drawing Title	Construction Phase		Drawn	Checked	Approved
	Extended Chiltern Tunnel		Date	Scale	Size
	Option C5		24/09/2014	AS SHOWN	A1
			Drawing No.	Rev.	
			C222-ATK-EV-DPL-020-550907-PET000000	P00.1	



CONSTRUCTION (OPTION C5)

Buckinghamshire
Chiltern District

KING'S LANE

Footpath TLE/2
Accommodation
Overbridge

Bowood Lane
Overbridge
Satellite Compound

Bowood Lane
Overbridge

KING'S LANE

Leather Lane
Diversion

Footpath WEN/37
Temporarily Stopped Up

Footpath TLE/2
Temporarily Stopped Up

Cottage Farm
Accommodation
Overbridge

Buckinghamshire
Aylesbury Vale District

GRIM'S DITCH

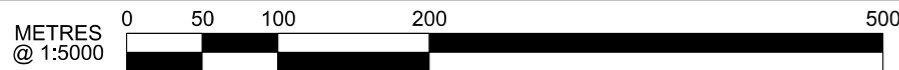
Chiltern Tunnel
North Portal
Satellite Compound

Chiltern Tunnel
North Portal
(Rail Systems)
Satellite Compound

Existing Leather Lane
Temporarily closed and diverted
on to Temporary Access Road

For Continuation Refer to Drawing C222-ATK-EV-DLP-020-550907-PET000000

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	Rail alignment
	Engineering earthworks
	Landscape earthworks
	Land potentially required during construction
	Temporary site access route / haul route
	Construction traffic route
	Existing public right of way (PRoW)
	New, diverted or realigned PRoW
	Stopped-up PRoW
	Temporary PRoW
	Temporary material stockpile



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Zone	Country South		Project/Contract	Country South Design	
Design Stage	DESIGN-FOR-PETITION		Discipline/Function	Environmental	
Drawing Title	Construction Phase		Drawn	Checked	Approved
	Extended Chiltern Tunnel		Date	Scale	Size
	Option C5		24/09/2014	AS SHOWN	A1
	Drawing No. C222-ATK-EV-DPL-020-550910-PET000000				Rev. P00.1



CONSTRUCTION (OPTION C5)

For Continuation Refer to Drawing C222-ATK-EV-DPL-020-550907-PET000000

Buckinghamshire
Aylesbury Vale
District

Existing Leather Lane
Temporarily closed and diverted
on to Temporary Access Road

LEATHER LANE

A413

MARYLEBONE TO AYLESBURY LINE

RIVER MISBOURNE

Great Missenden



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Legends/Notes:	
Satellite construction compound	Temporary site access route / haul route
Main construction compound	Construction traffic route
Tunnel portal	Existing public right of way (PRoW)
Rail alignment formation	New, diverted or realigned PRoW
Tunnels external extent	Stopped-up PRoW
Rail alignment	Temporary PRoW
Engineering earthworks	Temporary material stockpile
Landscape earthworks	
Land potentially required during construction	



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Atkins

Zone	Country South		Project/Contract	Country South Design	
Design Stage	DESIGN-FOR-PETITION		Discipline/Function	Environmental	
Drawing Title	Construction Phase		Drawn	Checked	Approved
	Extended Chiltern Tunnel		TB		
	Option C5		Date	Scale	Size
		24/09/2014	AS SHOWN	A1	
		Drawing No.	C222-ATK-EV-DPL-020-550913-PET000000		Rev.
					P00.1



OPERATION (OPTION C5)

Buckinghamshire
Chiltern District

Hyde Heath

BULLBATTERS LANE

CHALK LANE

Chiltern Tunnel

CHALK LANE

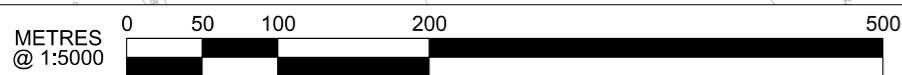
MARYLEBONE TO AYLESBURY LINE

A413

RIVER MISBOURNE

Little Missenden

For Continuation Refer to Drawing C222-ATK-EV-DPL-020-560903-PET000000



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Legends/Notes:	
	Depot, station, headhouse or portal building
	Tunnel portal
	Balancing pond
	Land drainage area
	Replacement floodplain storage
	Landscape mitigation planting (scrub / woodland)
	Grassed areas
	Engineering earthworks
	Landscape earthworks
	Rail alignment formation
	Grassland habitat creation
	Tunnels external extent
	Rail alignment
	Noise fence barrier
	Ditches - new
	Hedgerow habitat creation
	HS2 Access road
	Existing public right of way (PRoW)
	New, diverted or realigned PRoW
	Stopped-up PRoW



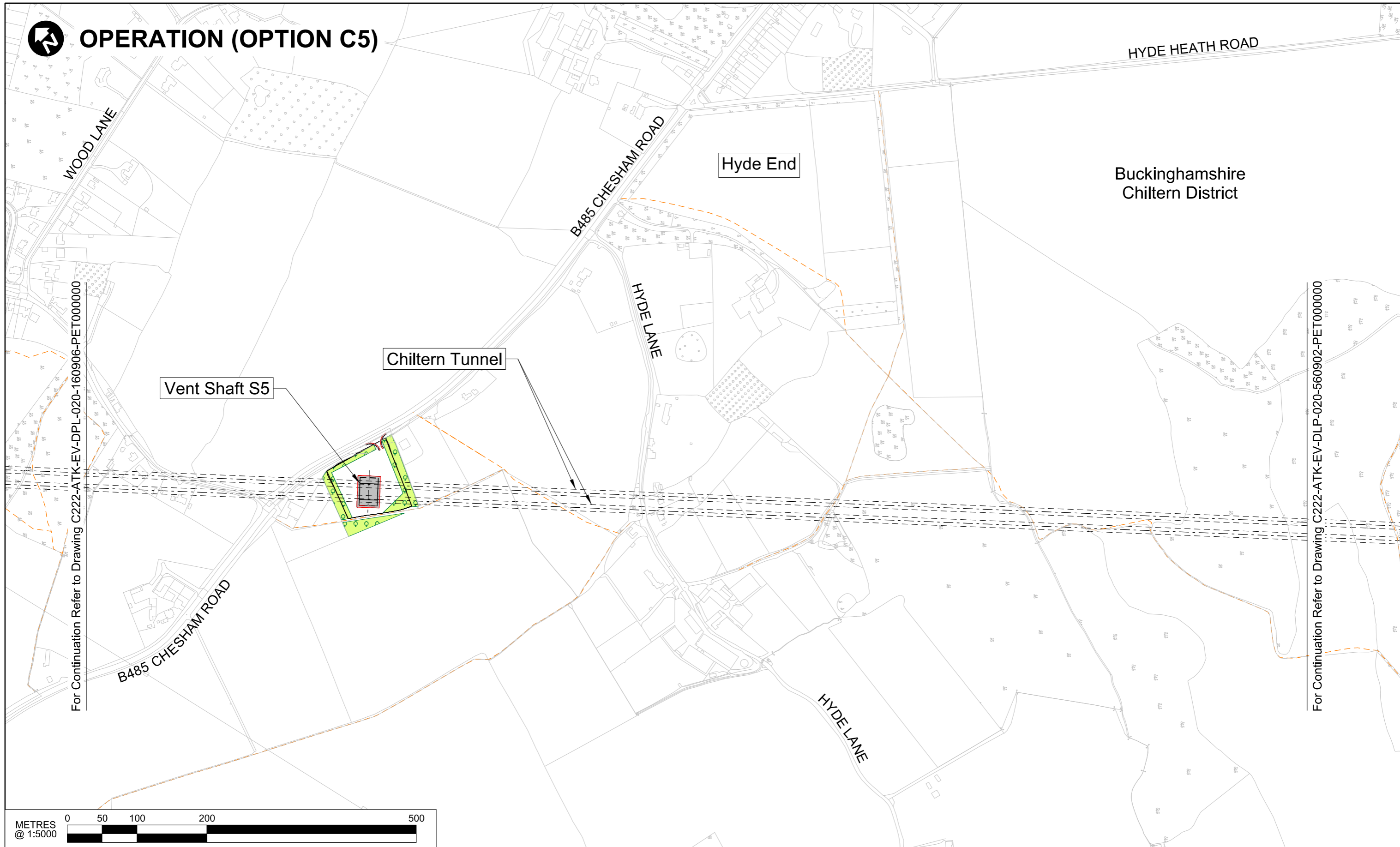
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Zone	Country South		Project/Contract	Country South Design	
Design Stage	DESIGN-FOR-PETITION		Discipline/Function	Environmental	
Drawing Title	Proposed Scheme		Drawn	Checked	Approved
	Extended Chiltern Tunnel		NM		
	Option C5		Date	Scale	Size
			22/10/2013	AS SHOWN	A1
	Drawing No.				Rev.
	C222-ATK-EV-DPL-020-560902-PET000000				P00.1



OPERATION (OPTION C5)



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 - Rail alignment formation
 - Grassland habitat creation
 - Tunnels external extent
 - Rail alignment
 - Noise fence barrier
 - Ditches - new
 - Hedgerow habitat creation
 - HS2 Access road
 - Existing public right of way (PRoW)
 - New, diverted or realigned PRoW
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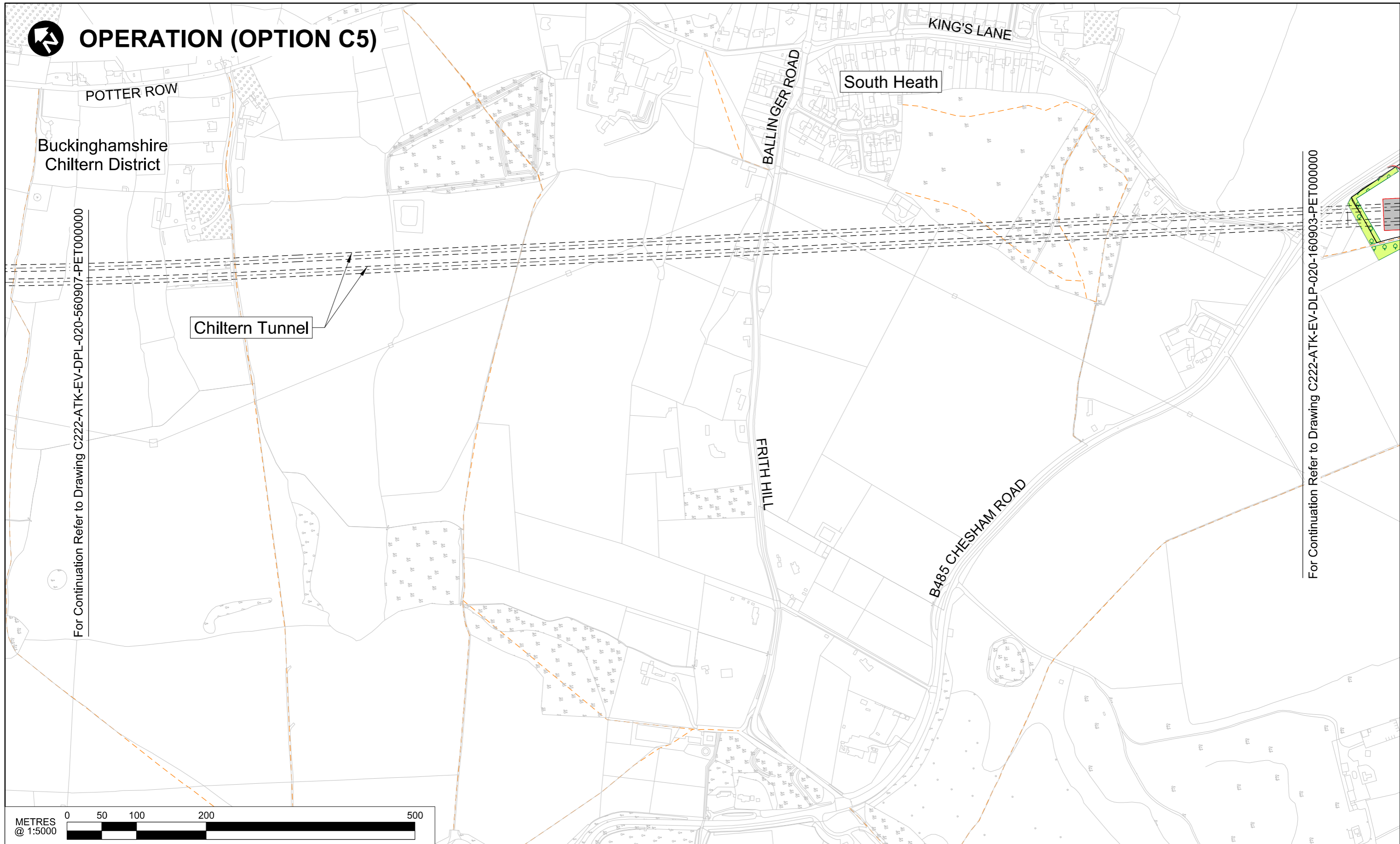
Creator/Originator
Atkins

Zone	Country South	
Design Stage	DESIGN-FOR-PETITION	
Drawing Title	Proposed Scheme Extended Chiltern Tunnel Option C5	

Project/Contract			Country South Design		
Discipline/Function			Environmental		
Drawn	Checked	Approved			
NM					
Date	Scale	Size			
22/10/2013	AS SHOWN	A1			
Drawing No.		Rev.			
C222-ATK-EV-DPL-020-560903-PET000000		P00.1			



OPERATION (OPTION C5)



Buckinghamshire
Chiltern District

South Heath

Chiltern Tunnel

For Continuation Refer to Drawing C222-ATK-EV-DPL-020-560907-PET000000

For Continuation Refer to Drawing C222-ATK-EV-DLP-020-160903-PET000000



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	Replacement floodplain storage
	Landscape mitigation planting (scrub / woodland)
	Grassed areas
	Engineering earthworks
	Landscape earthworks
	Rail alignment formation
	Grassland habitat creation
	Tunnels external extent
	Rail alignment
	Noise fence barrier
	Ditches - new
	Hedgerow habitat creation
	HS2 Access road
	Existing public right of way (PRoW)
	New, diverted or realigned PRoW
	Stopped-up PRoW



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Creator/Originator
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Zone	Country South	
Design Stage	DESIGN-FOR-PETITION	
Drawing Title	Proposed Scheme Extended Chiltern Tunnel Option C5	

Project/Contract	Country South Design		
Discipline/Function	Environmental		
Drawn	Checked	Approved	
NM			
Date	Scale	Size	
22/10/2013	AS SHOWN	A1	
Drawing No.	Rev.		
C222-ATK-EV-DPL-020-560906-PET000000	P00.1		

OPERATION (OPTION C5)

Buckinghamshire
Chiltern District

Buckinghamshire
Chiltern District

KING'S LANE

KING'S LANE

POTTER ROW

For Continuation Refer to Drawing C222-ATK-EV-DPL-020-560908-PET000000

Cottage Farm
Accommodation
Overbridge

Chiltern Tunnel

For Continuation Refer to Drawing C222-ATK-EV-DLP-020-560906-PET000000

Buckinghamshire
Aylesbury Vale
District

GRIMS DITCH

Leather Lane
Diversion

For Continuation Refer to Drawing C222-ATK-EV-DPL-020-560909-PET000000



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 - Rail alignment formation
 - Grassland habitat creation
 - Tunnels external extent
 - Rail alignment
 - Noise fence barrier
 - Ditches - new
 - Hedgerow habitat creation
 - HS2 Access road
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Zone	Country South		Project/Contract	Country South Design	
Design Stage	DESIGN-FOR-PETITION		Discipline/Function	Environmental	
Drawing Title	Proposed Scheme		Drawn	Checked	Approved
	Extended Chiltern Tunnel		NM		
	Option C5		Date	Scale	Size
			22/10/2013	AS SHOWN	A1
			Drawing No.	Rev.	
			C222-ATK-EV-DPL-020-560907-PET000000	P00.1	



OPERATION (OPTION C5)

Buckinghamshire
Chiltern District

KING'S LANE

Footpath TLE/2
Accommodation
Overbridge

Cottage Farm
Accommodation
Overbridge

Leather Lane
Diversion

Bowood Lane
Overbridge

KING'S LANE

Footpath WEN/37

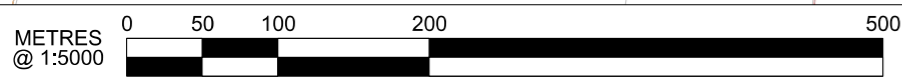
Footpath TLE/2

GRIM'S DITCH

LEATHER LANE

Buckinghamshire
Aylesbury Vale District

For Continuation Refer to Drawing C222-ATK-EV-DLP-020-560907-PET000000



P00.1					
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Zone	Country South		Project/Contract		Country South Design				
Design Stage	DESIGN-FOR-PETITION		Discipline/Function						
Drawing Title	Proposed Scheme		Environmental		Discipline/Function				
	Extended Chiltern Tunnel		Option C5		Environmental				
Drawn	NM	Checked	Approved	Date	22/10/2013	Scale	AS SHOWN	Size	A1
Drawing No.	C222-ATK-EV-DLP-020-560908-PET000000				Rev.	P00.1			



OPERATION (OPTION C5)

For Continuation Refer to Drawing C222-ATK-EV-DPL-020-560907-PET000000

Leather Lane Diversion

Buckinghamshire
Aylesbury Vale
District

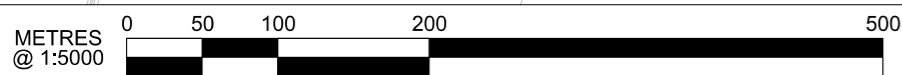
LEATHER LANE

A413

MARYLEBONE TO AYLESBURY LINE

RIVER MISBOURNE

Great Missenden



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Rev	Description	Drawn	Checked	Con App	HS2 App


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 - Hedgerow habitat creation
 - HS2 Access road
 - Existing public right of way (PRoW)
 - New, diverted or realigned PRoW
 - Stopped-up PRoW



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Creator/Originator
Atkins

Zone	Country South		Project/Contract	Country South Design	
Design Stage	DESIGN-FOR-PETITION		Discipline/Function	Environmental	
Drawing Title	Proposed Scheme		Drawn	Checked	Approved
	Extended Chiltern Tunnel		NM		
	Option C5		Date	Scale	Size
			22/10/2013	AS SHOWN	A1
	Drawing No. C222-ATK-EV-DPL-020-560909-PET000000				Rev. P00.1



CONSTRUCTION (OPTION C6)

Buckinghamshire
Chiltern District

Hyde Heath

BULLBAINERS LANE

CHALK LANE

Chiltern Tunnel

CHALK LANE

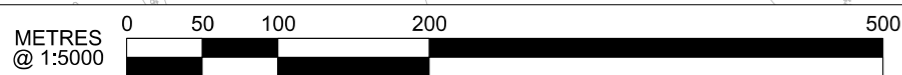
MARYLEBONE TO AYLESBURY LINE

A413

RIVER MISBOURNE

Little Missenden

For Continuation Refer to Drawing C222-ATK-EV-DPL-020-650902-PET000000



P00.1	FIRST DRAWN				
Rev	Description	Drawn	Checked	Con App	HS2 App


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Legends/Notes:	
Satellite construction compound	Temporary site access route / haul route
Main construction compound	Construction traffic route
Tunnel portal	Existing public right of way (PRoW)
Rail alignment formation	New, diverted or realigned PRoW
Tunnels external extent	Stopped-up PRoW
Rail alignment	Temporary PRoW
Engineering earthworks	Temporary material stockpile
Landscape earthworks	
Land potentially required during construction	

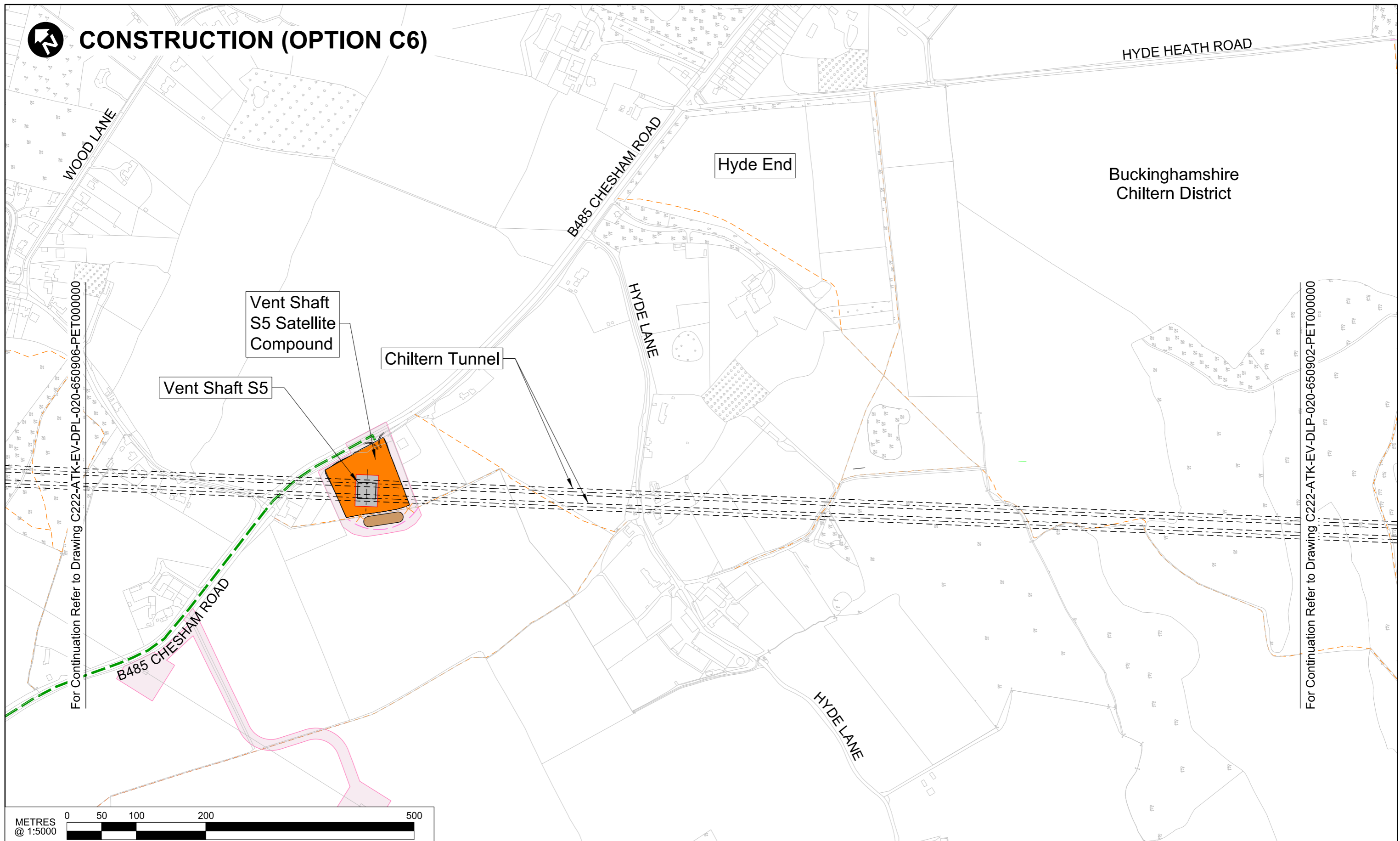


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Creator/Originator
Atkins

Zone	Country South		Project/Contract	Country South Design	
Design Stage	DESIGN-FOR-PETITION		Discipline/Function	Environmental	
Drawing Title	Construction Phase		Drawn	Checked	Approved
	Extended Chiltern Tunnel		TB		
	Option C6		Date	Scale	Size
			30/06/2015	AS SHOWN	A1
	Drawing No.				Rev.
	C222-ATK-EV-DPL-020-650902-PET000000				P00.1

CONSTRUCTION (OPTION C6)



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For Continuation Refer to Drawing C222-ATK-EV-DLP-020-650902-PET000000

HYDE HEATH ROAD

WOOD LANE

Hyde End

B485 CHESHAM ROAD

Buckinghamshire
Chiltern District

Vent Shaft
S5 Satellite
Compound

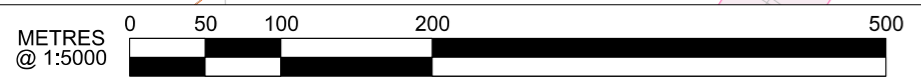
Chiltern Tunnel

Vent Shaft S5

HYDE LANE

B485 CHESHAM ROAD

HYDE LANE



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Legends/Notes:	
	Satellite construction compound
	Main construction compound
	Tunnel portal
	Rail alignment formation
	Tunnels external extent
	Rail alignment
	Engineering earthworks
	Landscape earthworks
	Land potentially required during construction
	Temporary site access route / haul route
	Construction traffic route
	Existing public right of way (PRoW)
	New, diverted or realigned PRoW
	Stopped-up PRoW
	Temporary PRoW
	Temporary material stockpile



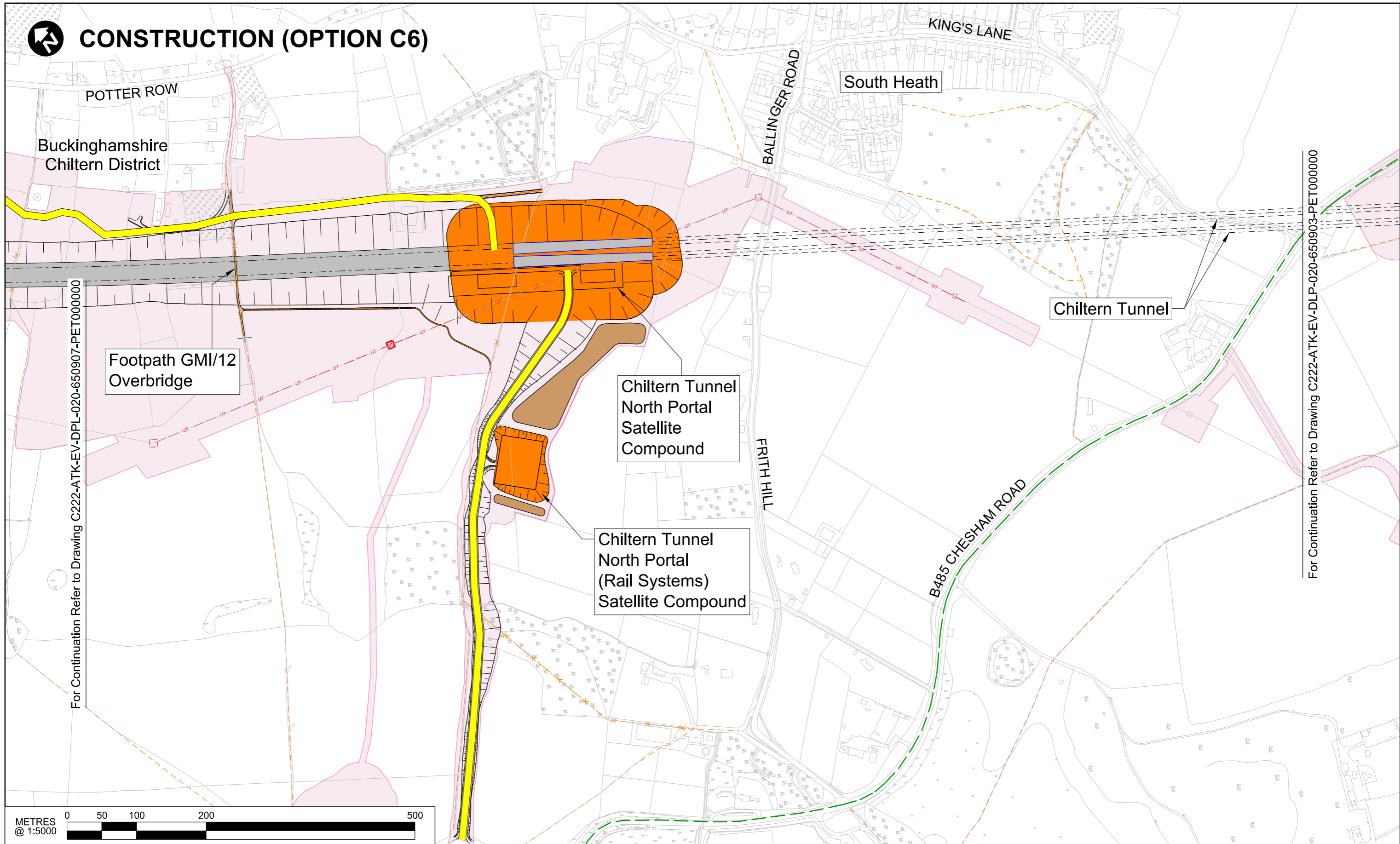
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Creator/Originator
Atkins

Zone	Country South		Project/Contract	Country South Design	
Design Stage	DESIGN-FOR-PETITION		Discipline/Function	Environmental	
Drawing Title	Construction Phase		Drawn	Checked	Approved
	Extended Chiltern Tunnel		Date	Scale	Size
	Option C6		30/06/2015	AS SHOWN	A1
	Drawing No. C222-ATK-EV-DPL-020-650903-PET000000				Rev. P00.1



CONSTRUCTION (OPTION C6)



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Legends/Notes:	
	Satellite construction compound
	Main construction compound
	Tunnel portal
	Rail alignment formation
	Tunnels external extent
	Rail alignment
	Engineering earthworks
	Landscape earthworks
	Land potentially required during construction
	Temporary site access route / haul route
	Construction traffic route
	Existing public right of way (PRoW)
	New, diverted or realigned PRoW
	Stopped-up PRoW
	Temporary PRoW
	Temporary material stockpile

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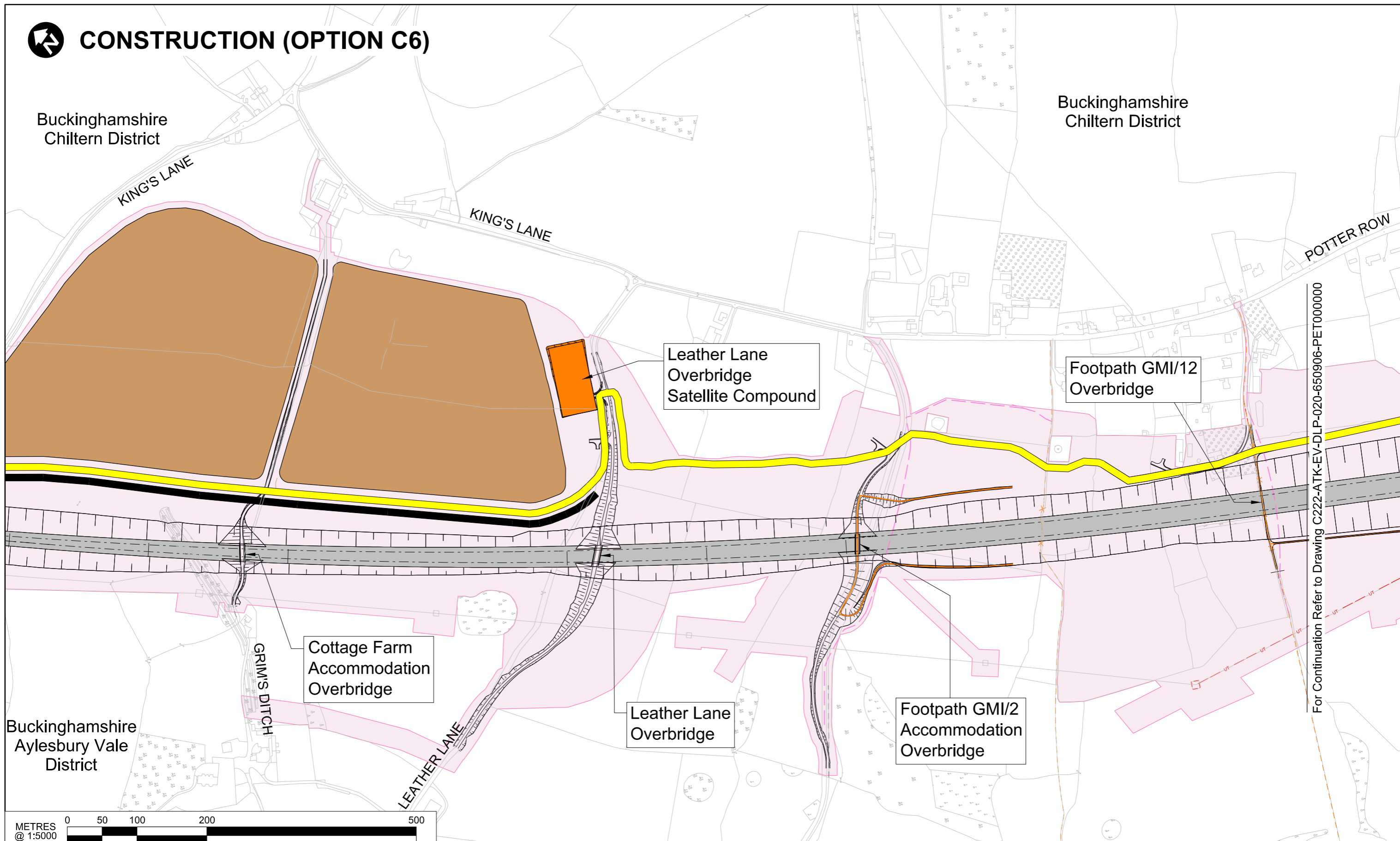
Creator/Originator
Atkins

Zone	Country South		Project/Contract	Country South Design	
Design Stage	DESIGN-FOR-PETITION		Discipline/Function	Environmental	
Drawing Title	Construction Phase		Drawn	Checked	Approved
	Extended Chiltern Tunnel		TB		
	Option C6		Date	Scale	Size
			11/07/2014	AS SHOWN	A1
			Drawing No.	Rev.	
			C222-ATK-EV-DPL-020-650906-PET000000	P00.1	

CONSTRUCTION (OPTION C6)

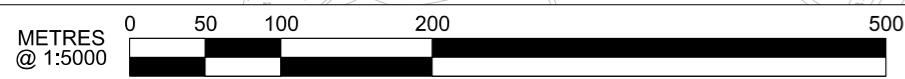
Buckinghamshire
Chiltern District

Buckinghamshire
Chiltern District



Buckinghamshire
Aylesbury Vale
District

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Legends/Notes:

	Satellite construction compound		Temporary site access route / haul route
	Main construction compound		Construction traffic route
	Tunnel portal		Existing public right of way (PRoW)
	Rail alignment formation		New, diverted or realigned PRoW
	Tunnels external extent		Stopped-up PRoW
	Rail alignment		Temporary PRoW
	Engineering earthworks		Temporary material stockpile
	Landscape earthworks		
	Land potentially required during construction		

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Zone	Country South		Project/Contract		Country South Design	
Design Stage	DESIGN-FOR-PETITION		Discipline/Function		Environmental	
Drawing Title	Construction Phase		Drawn	Checked	Approved	
	Extended Chiltern Tunnel		TB			
	Option C6		Date	Scale	Size	A1
		30/06/2015	AS SHOWN			
				Drawing No.	C222-ATK-EV-DLP-020-650907-PET000000	
				Rev.	P00.1	



OPERATION (OPTION C6)

Buckinghamshire
Chiltern District

Hyde Heath

BULLBAINERS LANE

CHALK LANE

Chiltern Tunnel

CHALK LANE

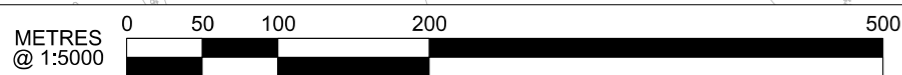
MARYLEBONE TO AYLESBURY LINE

A413

RIVER MISBOURNE

Little Missenden

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Legends/Notes:	
	Depot, station, headhouse or portal building
	Tunnel portal
	Balancing pond
	Land drainage area
	Replacement floodplain storage
	Landscape mitigation planting (scrub / woodland)
	Grassed areas
	Engineering earthworks
	Landscape earthworks
	Rail alignment formation
	Grassland habitat creation
	Tunnels external extent
	Rail alignment
	Noise fence barrier
	Ditches - new
	Hedgerow habitat creation
	HS2 Access road
	Existing public right of way (PRoW)
	New, diverted or realigned PRoW
	Stopped-up PRoW



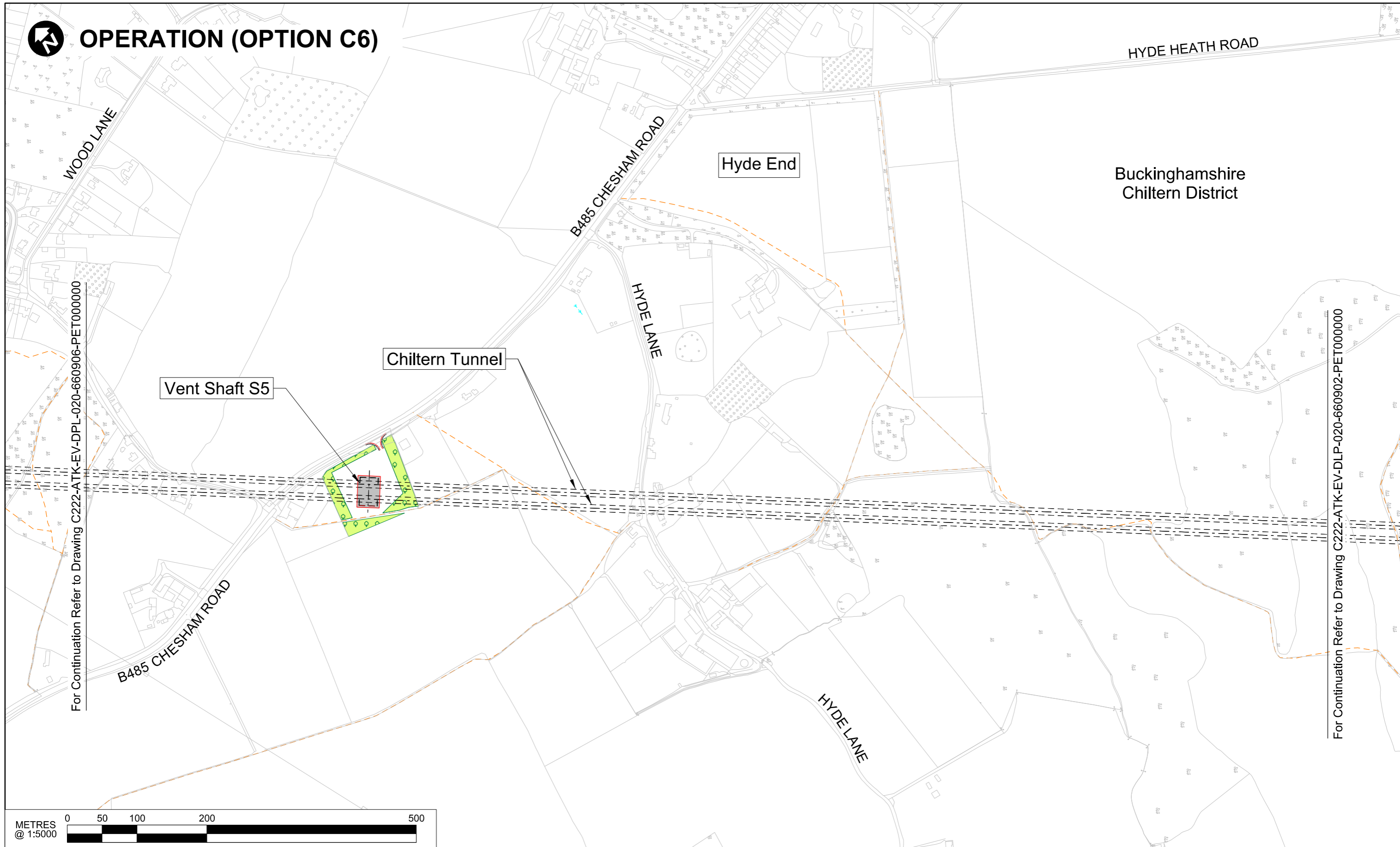
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Zone	Country South		Project/Contract	Country South Design	
Design Stage	DESIGN-FOR-PETITION		Discipline/Function	Environmental	
Drawing Title	Proposed Scheme		Drawn	Checked	Approved
	Extended Chiltern Tunnel		TB		
	Option C6		Date	Scale	Size
			30/06/2015	AS SHOWN	A1
	Drawing No.				Rev.
	C222-ATK-EV-DPL-020-660902-PET000000				P00.1



OPERATION (OPTION C6)



HYDE HEATH ROAD

WOOD LANE

Hyde End

Buckinghamshire
Chiltern District

B485 CHESHAM ROAD

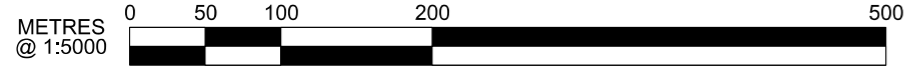
HYDE LANE

Chiltern Tunnel

Vent Shaft S5

B485 CHESHAM ROAD

HYDE LANE



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- Legends/Notes:
- Depot, station, headhouse or portal building
 - Tunnel portal
 - Balancing pond
 - Land drainage area
 - Replacement floodplain storage
 - Landscape mitigation planting (scrub / woodland)
 - Grassed areas
 - Engineering earthworks
 - Landscape earthworks
 - Rail alignment formation
 - Grassland habitat creation
 - Tunnels external extent
 - Rail alignment
 - Noise fence barrier
 - Ditches - new
 - Hedgerow habitat creation
 - HS2 Access road
 - Existing public right of way (PRoW)
 - New, diverted or realigned PRoW
 - Stopped-up PRoW



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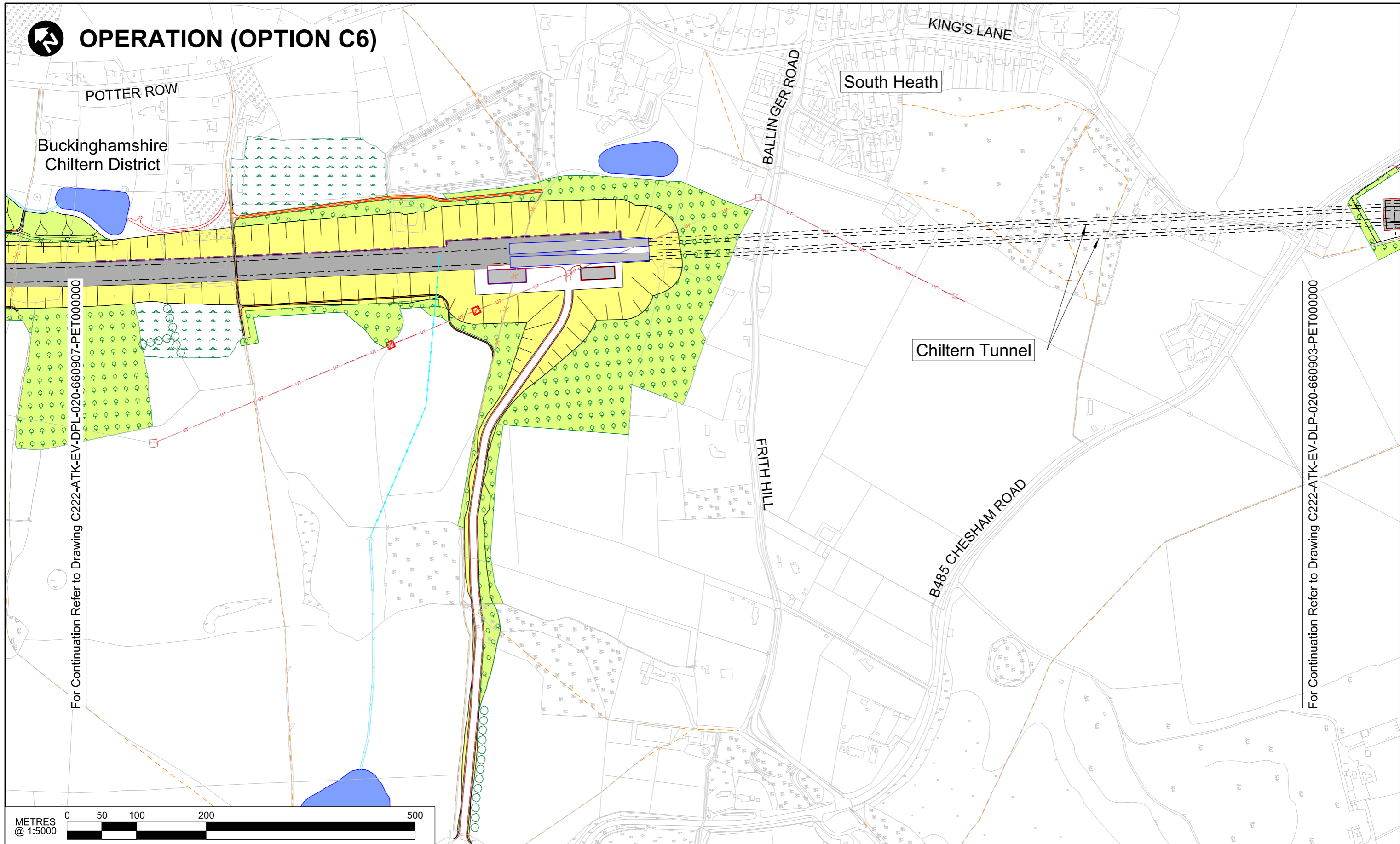
Creator/Originator
Atkins

Zone	Country South
Design Stage	DESIGN-FOR-PETITION
Drawing Title	Proposed Scheme Extended Chiltern Tunnel Option C6

Project/Contract			Country South Design		
Discipline/Function			Environmental		
Drawn	Checked	Approved			
TB					
Date	Scale	Size			
30/06/2015	AS SHOWN	A1			
Drawing No.		Rev.			
C222-ATK-EV-DLP-020-660903-PET000000		P00.1			



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Legends/Notes:	
	Depot, station, headhouse or portal building
	Tunnel portal
	Balancing pond
	Land drainage area
	Replacement floodplain storage
	Landscape mitigation planting (scrub / woodland)
	Grassed areas
	Engineering earthworks
	Landscape earthworks
	Rail alignment formation
	Grassland habitat creation
	Tunnels external extent
	Rail alignment
	Noise fence barrier
	Ditches - new
	Hedgerow habitat creation
	HS2 Access road
	Existing public right of way (PRoW)
	New, diverted or realigned PRoW
	Stopped-up PRoW
	Main utility works



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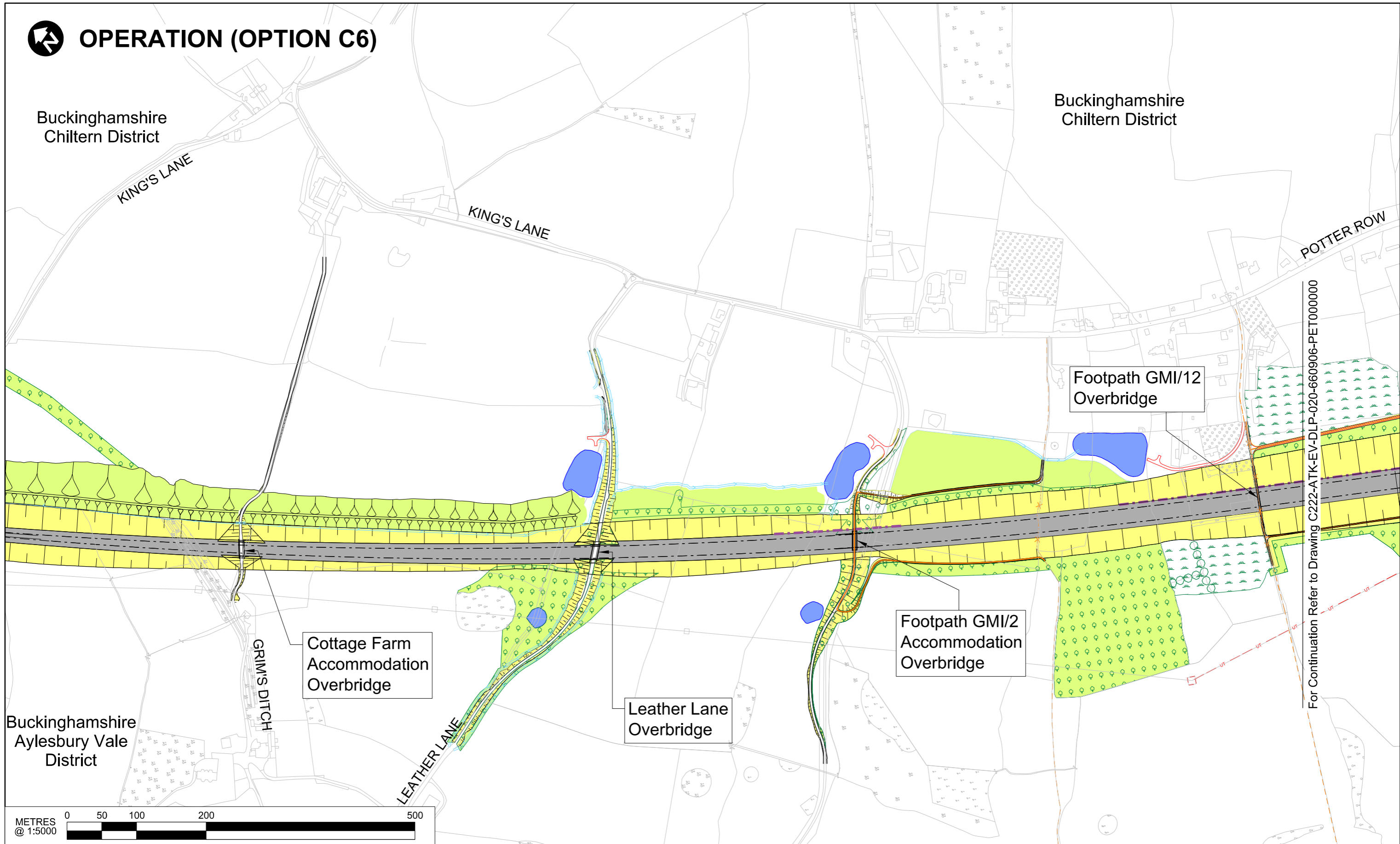
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Atkins

Zone	Country South		Project/Contract	Country South Design	
Design Stage	DESIGN-FOR-PETITION		Discipline/Function	Environmental	
Drawing Title	Proposed Scheme		Drawn	Checked	Approved
	Extended Chiltern Tunnel		TB		
	Option C6		Date	Scale	Size
			30/06/2015	AS SHOWN	A1
	Drawing No. C222-ATK-EV-DPL-020-660906-PET000000				Rev. P00.1

OPERATION (OPTION C6)

Buckinghamshire
Chiltern District

Buckinghamshire
Chiltern District



Buckinghamshire
Aylesbury Vale
District

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	Balancing pond
	Land drainage area
	Replacement floodplain storage
	Landscape mitigation planting (scrub / woodland)
	Grassed areas
	Engineering earthworks
	Landscape earthworks
	Rail alignment formation
	Grassland habitat creation
	Tunnels external extent
	Rail alignment
	Noise fence barrier
	Ditches - new
	Hedgerow habitat creation
	HS2 Access road
	Existing public right of way (PRoW)
	New, diverted or realigned PRoW
	Stopped-up PRoW

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Creator/Originator
Atkins

Zone	Country South
Design Stage	DESIGN-FOR-PETITION
Drawing Title	Proposed Scheme Extended Chiltern Tunnel Option C6

Project/Contract	Country South Design		
Discipline/Function	Environmental		
Drawn	Checked	Approved	
Date	Scale	Size	
30/06/2015	AS SHOWN	A1	
Drawing No.	Rev.		
C222-ATK-EV-DLP-020-660907-PET000000	P00.1		