APPENDIX 1

B4069 LYNEHAM BANKS

COMPARISON OF OPTIONS

A range of options have been considered for reinstatement of the existing B4069 at Lyneham Banks following the major landslip. Some options such as soil nailing and piled raft foundations were discounted at an early stage because of the characteristics of the site, which would make them less suitable and more expensive. Four main options have been compared in more detail.

Remove and replace with suitable fill

The stability of the slope could be improved by the excavation and removal of existing weaker and tipped material, and its replacement with engineering fill laid and compacted in controlled layers. It is a proven technique and is often used in these situations. A similar process was used for the smaller scale repairs made elsewhere on the road in the 1980s. It would require a substantial volume of fill to be removed, likely to be in the region of 10,000 to 15,000 cubic metres, requiring a significant number of lorry movements to and from the site. Drainage provision would be required to intercept groundwater. Consideration would need to be given to the disposal of excavated material because of the presence of contamination in some of the tipped material.

Soil Stabilisation

The landslide material could be excavated and mixed on site with cement or other treatment to increase its strength. It could then be re-laid in layers and keyed into the undisturbed ground. Consideration would need to be given to drainage provision as the treated material would be less permeable. The main advantage of the process would be that less material would have to be taken off site. It would require careful testing and monitoring of the operation to ensure that adequate strength is achieved, especially in view of the variability of the landslip material. Drainage of the slope above and below the road would be required, connecting into existing watercourses.

Piled Retaining Wall

A contiguous piled retaining wall could be used to stabilise the slope and support the reinstatement of the road. The bored piles of about 600mm diameter and 15 meters in length could extend into the unweathered Oxford clay. The use of micropiles would enable a more efficient and cost-effective design. Some material may need to be removed to reduce loading uphill and to allow the slope to be reprofiled downhill. The retaining wall would require drainage provision to be made for ground and surface water, which would connect to existing watercourses.

Bridge

It has been suggested that the road could be reinstated by constructing a bridge or series of bridges to span the landslip area. In view of the width of the landslip a multi-span bridge with piers on piled foundations going into the underlying clay is likely to be more efficient than a single span bridge. Some material removal would be required to facilitate construction, and access for the abutment and pier construction. Drainage provision and soil removal could be minimal if stabilising the hill side was not included.

Comparison of Options

The key factors in connection with the options are described in the table below.

It is concluded that the Piled Retaining Wall is the preferred option because of the lower cost, moderate carbon impact and lowest risks.

B4069 Lyneham Banks – Comparison of Options

Criteria	Excavate and replace	Soil Stabilisation	Piled Retaining Wall	Bridge
Construction type	Remove existing material and replace with suitable imported compacted fill.	Treatment of existing material by mixing on site to stabilise ground.	Bored pile retaining wall with micropiles to stabilise hillside.	Bridge to span slipped material without stabilisation of hillside.
Buildability	Good. Does not require specialist equipment or construction processes. Major earth moving operation and removal and import of material.	Moderate. Requires specialist treatment and testing to ensure stability. Major earth moving operation and treatment mainly on site.	Moderate. Requires specialist piling and equipment, with consideration of temporary works to facilitate construction.	Moderate. Requires substantial plant to construct abutments, piers and bridges, with consideration of temporary works.
Cost	Very High. £12.4m Costs are associated with removal of existing fill, deposition off site and import of replacement material. Includes drainage provision.	Moderate. £5.9m In-situ treatment of material avoids the high costs associated with fill removal and replacement. Includes drainage provision.	Moderate. £5.9m Retaining wall avoids high volumes of fill having to be replaced or treated. Includes drainage provision.	High. £6.8m – £8.8m Long or multi-span bridge would allow most fill material to remain in place.
Maintenance and associated whole life costs	Moderate. Periodic maintenance required to toe drainage ditch and other drainage infrastructure.	Moderate. Periodic maintenance required upper slope counterfort and other drainage infrastructure.	Moderate. Low maintenance post-construction. May require inspections to ensure drainage remains effective and checking of condition of retaining wall.	Moderate. Requires regular inspections of beams, bearings and bridge bearings and structural condition which may be difficult because of the unstable ground remaining with this option.
Health and Safety	Good. Does not require specialist equipment or labour. Straightforward construction method. Any contaminated material removed would need to be disposed of carfefully.	Moderate. Specialised construction plant and operation required for construction. Soil mixing process ‘locks in’ any contamination.	Moderate. Plant and materials pose risk to construction workers during installation. Any contaminated ground remains on site and will need consideration.	Moderate. Plant and materials pose risk to construction workers during installation. Any contaminated ground remains on site and will need consideration.

Criteria	Excavate and replace	Soil Stabilisation	Piled Retaining Wall	Bridge
Effectiveness	Moderate. Potential risk of historical slips in lower slope being re-activated in future, resulting in movement within the engineered fill slope. May require periodic patch road repair on a more frequent basis than other options.	Moderate. Potential risk of historical slips in lower slope being re-activated in future, resulting in movement within strengthened materials supporting the road.	Good. Lower risk of slip remobilisation and the need for future repairs due to certainty in intercepting failure surface. Long expected design life anticipated.	Poor. Would reinstate road but without further extensive works would not stabilise the hillside with continuing risk of landslips potentially affecting properties further up the slope requiring further interventions.
Environment/Carbon	Poor. No steel or concrete required in the construction which decreases carbon footprint, but significant carbon footprint due to material haulage.	Good. No steel or concrete required in the construction which decreases carbon footprint, and limited material removal required.	Moderate. Use of reinforced concrete piles incurs significant carbon footprint. Will require moderate amounts of fill to be disposed in landfill, with associated carbon footprint.	Moderate. Use of reinforced concrete piers and bridge beams and parapet materials incurs significant carbon footprint.
Programme	Moderate. Relatively short design programme. Moderate construction programme. Straightforward work could be procured through framework contract.	Moderate. Moderate design programme. Potentially relatively long construction programme. Procurement of specialist contractor required.	Good. Moderate design programme and relatively short construction programme. Procurement through tender for civil engineering contractor.	Good. Moderate design programme and relatively short construction programme. Procurement through tender for civil engineering contractor.
Land	Moderate. Requires earthworks and drainage over wide areas adjacent to road. Some could return to agricultural use subject to suitable arrangements.	Moderate. Requires earthworks and drainage over wide areas adjacent to road. Some could return to agricultural use subject to suitable arrangements.	Moderate. Requires earthworks and drainage over wide areas adjacent to road. Some could return to agricultural use subject to suitable arrangements.	Moderate. Requires less land but unstable ground remains which would limit future use for safety reasons.

Criteria	Excavate and replace	Soil Stabilisation	Piled Retaining Wall	Bridge
Risks	Moderate risks. Uncertainty around the extent of fill degradation and true depth of the slip surface may result in actual excavation extents being greater than anticipated, leading to programme delays and additional costs.	Moderate risks. Uncertainty of success of soil treatment which will require extensive testing. Required treatment depths may be greater than anticipated, leading to programme delays and additional costs.	Low risks. Retaining wall will stabilise hillside as well as road. Extent of works can be well defined.	High risks. Bridge would reinstate road but would not stabilise hillside. Risk remains of further landslips affecting adjoining area, potentially including residential properties, requiring further remedial work.
Summary	Expensive option with poor carbon impact and some risks associated with effectiveness.	Lower cost with less carbon impact but with some risks associated with effectiveness.	**Preferred Option**. Lower cost with moderate carbon impact and lowest risks.	Moderate cost with moderate carbon impacts but higher risks as would not improve the stability of the hillside.