Introduction

- Highways England is a government company charged with operating, maintaining and improving England’s motorways and major A roads
  - Formerly the Highways Agency, Highways England became a government company in April 2015
- The strategic road network is vital for the UK economy and is relied on by communities and businesses nationwide
- Our primary aim is to ensure our strategic road network is more reliable, resilient and safe

The Strategic Road Network

- Accounts for 2% of England’s roads
- Carries 1/3 of all traffic and 2/3 of all freight
- The value of this asset is around £120 billion of which 18% of this is drainage

Design Manual for Roads and Bridges

- Provides information about current standards, advice notes and other published documents relating to the design, assessment and operation of trunk roads, including motorways
- Introduced in 1992 in England and Wales, and following that in Scotland and Northern Ireland
- Highways England are lead authors working with administrations in Scotland, Wales and Northern Ireland
  - Some standards and specifications have annexes specific to each devolved administration
- Have a technical board who review revisions to DMRB
Design Principles

Highway drainage objectives;
- Remove surface water from carriageway in a timely manner to reduce travel disruptions
- Effective sub-surface drainage to maximise longevity of pavement and earthworks
- Minimising impacts of runoff on receiving environment with regards to flood risk and water quality

Design Principles

- Important that drainage systems do not increase flood risk downstream
- Peak discharge rates must be controlled and appropriate attenuation storage provided for a 1 in 100 year return period

Climate Change

- The UK's climate is changing and these changes are expected to become more pronounced with continued global emissions of Green House Gases.
- Headline changes for the UK are said to be generally warmer, wetter winters, and hotter, drier summers.
- These climate change risks need to be factored into our everyday considerations for maintenance, construction and operation of England's strategic road network

Vegetated Systems for Stormwater

- When a potential flooding risk and need for control is identified, the use of stormwater ponds becomes inevitable. HE approach is to maximise the use of these ponds for environmental benefits and therefore the use of vegetated systems is considered in the first instance
- Where there is limited space, conventional systems are used both with and without the combination of vegetated systems
- The HA have been using SUDS for many years but now there is increased recognition of their role in;
  - Pollution control and treatment (WFD)
  - Flow attenuation and tackling effects of climate change (Making space for Water)
Selection of Vegetated Drainage Systems

- Must consider efficiency of water removal, effect on local hydrology and threat of pollution when designing
- Maintaining or enhancing landscape or nature conservation value is an added benefit but not considered essential
- Opportunities for environmental benefits should be carefully considered at the start of designing

Benefits of Vegetated Systems

- Increase biodiversity
- Complement landscape amenity value

All of these benefits can be achieved without diminishing the primary purpose as a component of the drainage system

Selection of Vegetated Drainage Systems (2)

- Consider local, national or international designations adjacent to or in vicinity of proposed site
- Ease of access and maintenance of systems also considered in design
- Detailed landscape assessment, hydrological study and ecological survey undertaken to influence nature, scale and location of vegetated drainage system to help secure a well integrated system within site context protecting exiting landscape features where desirable and reflecting landscape character

Benefits of Vegetated Systems – Landscape
Benefits of Vegetated Systems – Landscape

Benefits of Vegetated Systems – Pollution

- Quality of runoff in urban areas different in quality to rural areas due to debris on urban roads
- Runoff from the first 10mm of rainfall is often the most polluted. Sometimes called the first flush effect of a storm
- Discharge from short intense storms with long antecedent dry periods pose higher pollution threat that longer rainfall events which provide more dilution

How do we Ensure Additional Benefits are Incorporated?

- In Highways England’s operating licence we have a duty to protect and enhance the environment
- Aiming for net gain in biodiversity and have a Highways England Biodiversity Action Plan
- Using Environment Designated Funds to deliver beyond business as usual schemes
  - Promoting partnership schemes

Infiltration Basins

- Used to store water providing a reduction in flood risk downstream
- Designed to retain stormwater flow and allow water to percolate through a porous filter layer (e.g. gravel)
- Water is then directed to a surface water outfall or continue to percolate to groundwaters
- Shape is determined by land available
- For small catchments, narrow trench basins are more appropriate

<table>
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<th>Treatment System Type</th>
<th>Suspended Solids (% removal)</th>
<th>Dissolved Copper (% removal)</th>
<th>Dissolved Zinc (% removal)</th>
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<td>Wet Retention Ponds</td>
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<tr>
<td>Wetlands (Surface Flow)</td>
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</table>
Infiltration Basins - Additional Benefits

- Potential to remove suspended solids and reduce metal loads
- Effectiveness in removing pollutants depends on design for storm flows as suspended solids are prone to remobilisation resulting in high sediment and metal loads being discharged
- Typically grassed but can add vegetation to increase aesthetics

Wetlands

- Areas permanently saturated by surface water or groundwater
- Where wetland has low nature conservation value or would benefit from additional water quantity then can be used for stormwater
- Must have agreement from environment agency and water must be of adequate quality
- Constructed SSF wetlands are also rarely used due to intermittent discharge in summer

Wetlands - Additional Benefits

- Able to support aquatic and semi aquatic vegetation and natural wetlands are rare so generally of high nature conservation value

Ponds

Balancing Ponds

- Designed primarily to attenuate flow
- Also known as balancing ponds as they accept large inflows but discharge slowly
- Ability of a balancing ponds to attenuate flow depends on capacity and rate of outflow
- Designed so the natural hydrology of a catchment area is not affected by large quickly drained areas of highway
Ponds

Retention ponds
- Can be designed to retain water at all times which is useful where there is an alternative constant water supply or if they are engineered from existing ponds
- Called wet ponds or retention ponds
- Store water thus reduce flood risk downstream

Ponds – Benefits
- Can also be designed as sedimentation ponds to allow suspended solids to settle out
- In practice ponds will normally perform both functions of balancing and sedimentation to some extent
- Depending on design for storm flows, ponds have the potential to remove metal and hydrocarbon pollutants
- Dry ponds cheaper to build but have less effect in treating runoff unless they are also infiltration basins
- Highways England currently have 1005 ponds on the network

Detention Ponds
- Ponds designed to empty after a rainfall event or to be dry for an extended period are called dry ponds or detention ponds

Hybrid systems
- Vegetated system that is a hybrid being neither a pure wetland nor a balancing pond but a combination of the two
- Can be small pools of open water within a wetland or marginal wetland associated with a pond or other variations
- Hybrids are considered more effective than pond or wetland systems alone
Hybrid Systems - Additional Benefits

- Combination of benefits from the systems used

Grassed Surface Water Channels

- HE trailed this SuDS idea first on A2/M2 and monitored its performance for 5 years before publishing guidance - HA 109/06
- Development of swales for use as road edge channels
- Have gentle slopes and often combined with over the edge drainage or combined surface water and ground water drains
- Increasingly common due to potential to control storm water runoff rates

Grassed Surface Water Channels - Benefits

- Lower flow velocity reduces peak discharge rate, reduces sediment content
- Natural material
- Green appearance, perception of reduced carriageway width
- Some pollutant removal
- Allows slow controlled infiltration to recharge groundwaters

Conclusion

Why do we use vegetated systems?
- We have to transfer water from the road with to the groundwater or surface water

Why do we treat in vegetated systems?
- We have an understanding of the issues associated with copper, zinc and sediment and are now regulated

How do we ensure treatment is incorporated
- Licence requirement, biodiversity goals and Environment Designated Funds

What vegetated systems do we use?
- Ponds, infiltration basins, grasses water channels, wetlands and hybrid systems

Moving forward?
- We want to help people think and act on water quality
Moving Forward

- How can we better communicate the use of vegetated systems to engineers and designers?
- How can we account for seasonality in vegetated systems?
- How can we make assessment methods for mitigation of pollution more accurate?
- How can we utilise small and awkward parcels of lands to accommodate vegetated systems?