This part is optional unless the Engineer obliges either part or all of it.

10 SUSTAINABLE INFRASTRUCTURE

10.1 INTRODUCTION

10.1.1 The importance of Sustainable infrastructure

1 The Sustainable Infrastructure that is designed constructed and operated to optimize environmental, social and economic outcomes of the long term. The World Bank has stated that the Infrastructure Projects consume about 50% of raw materials & 80% of mineral raw materials used by construction sector (World Bank).

2 According to Martland (Martland, 2012) the drive to consider sustainability in infrastructure systems may originate from the following:

(a) Excessive reliance upon fossil fuels including coal, peat, petroleum, and natural gas;

(b) The increase in the world's temperature and associated climate change;

(c) Concerns in relation to equality and social justice;

(d) Unrest in different societies due to economic crisis, internal conflicts, and absence of prospects;

(e) Concerns of overcrowding and pollution within the largest cities;

(f) Breakthrough in automobile culture which resulted in devotion of huge amount of resource to vehicles and roads, excessive use of fossil fuel, escalated vehicle accidents, urban vehicle overcrowding which causes waste of time and resources; and

(g) Intensified ecological imbalance including rapid extinction of species, grave threat to the habitat, contamination of water supply with toxic chemicals and erosion.

(i) QNV 2030, Considered Environmental Development as the fourth Pillar.

(ii) UN summit on the sustainable development in 2015, has considered Building resilient and sustainable infrastructure as a one of 17 initiatives could transform the world by 2030 into better from sustainable point of view.

10.1.2 Key factors and indicators for sustainable infrastructure design

1 Preliminary and detailed designs are vital in achieving cost efficiency, in improving performance of infrastructure systems, in reducing negative social and environmental impacts of infrastructure facilities. Design of infrastructure facilities needs to consider not only construction stage aspects but also post-construction impacts.

2 A little more effort during design stage would potentially have significant influence in improving construction and operation stage performance and impacts on infrastructures. As shown in (Figure 1), design phase of infrastructure projects presents paramount opportunity to influence their lifetime performance.

Fig 1 Opportunities for Reducing Cost are Greatest at the Outset, (Martland, 2012)

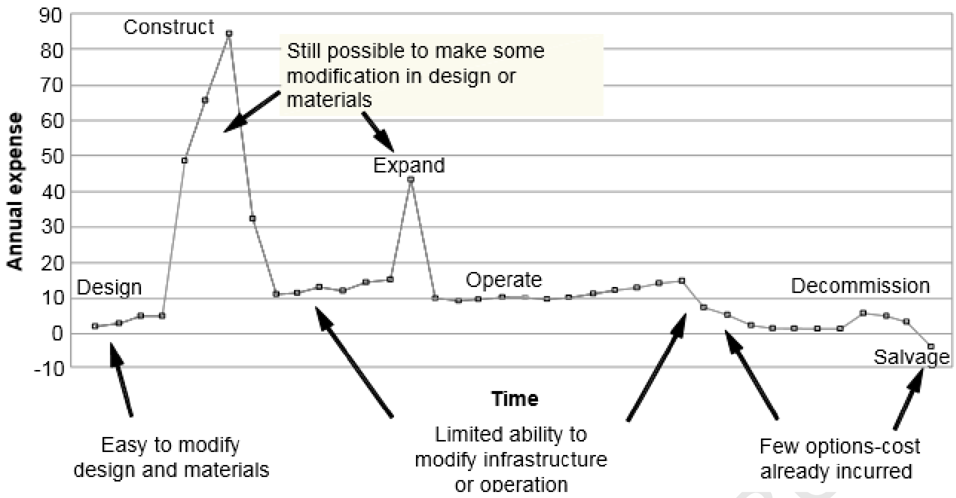

Table (1) illustrates 50 key elements and corresponding factors for sustainable infrastructure design (according to Adler & Ziglio-1996):

<table>
<tr><th>Factor 1: Material Selection</th><th rowspan="6">Factor 4: Social Considerations</th></tr>
<tr><td>1. Prescribing low energy materials
2. Use of locally available materials
3. Use of durable/high-performance materials
4. Use of materials with low health risk and pollution
5. Material reuse</td></tr>
<tr><th>Factor 2: Economic Considerations</th></tr>
<tr><td>1. Cost/benefit analysis
2. Life cycle analysis
3. Cost efficiency
4. Bankability</td></tr>
<tr><th>Factor 3: Policy and Regulations</th></tr>
<tr><td>1. Presence of design sustainability regulatory requirements
2. Presence of sustainability rating systems
3. Inclusion of sustainability requirements in public project briefs</td></tr>
</table>

Factor 4: Social Considerations

1. Public/beneficiaries participation
2. Client participation
3. Accessibility of the infrastructure to the public including people with specific needs
4. Health and safety consideration for construction workers and the public during construction and operation stages
5. Security consideration during construction and use
6. Satisfaction of the public
7. Protection of cultural heritage
8. Protection of landscape, historical areas and archaeological sites
9. Risk analysis and disaster mitigation

Factor 5: Design and Project Management	**Factor 7: Environmental Considerations**
1. Early contractors involvement at design stage 2. Early suppliers involvement at design stage 3. Selection of appropriate contract / project delivery type 4. Inclusion of sustainability related clauses in contract documents 5. Proper construction quality control procedure	1. Mitigating effects of natural disasters and climate change 2. Climate resiliency (resistant to climate change) 3. Ensuring efficient energy utilization both during construction and operation phases 4. Optimizing uses of natural resources 5. Optimizing site potentials (land use) 6. Uses of less energy during construction and operation 7. Waste minimization/ design optimization
Factor 6: Technical Considerations	**Factor 8: Design Professionals and the Design Process**
1. Exhaustive site survey and ground investigation 2. Considering alternatives prior to proposing a solution 3. Multi-disciplinary integrated design team beginning from feasibility study stage 4. Meeting functional requirements and users comfort 5. Robustness and less maintenance products 6. Completeness and clarity of design documents 7. Value engineering 8. Harmony with the surrounding environment	1. Awareness of clients about sustainability 2. Awareness of designers about sustainability 3. Knowledge and experience of designers 4. Skill of designers 5. Appropriating adequate time for design 6. Reasonable financial compensation for design work 7. Presence of design guidelines /procedures for sustainable infrastructure 8. Proper coordination among designers from different disciplines 9. Willingness of designers to implement sustainability design concept and practices in their designs

10.1.3 Scope

1 This section serves all civil engineering works such as, Roads, Water Treatment Works, Power Plants, and Public Realms and Bridges…etc.

2 This section covers all the project lifecycle from Planning, designing, construction as well as operation stages.

10.1.4 Related QCS Sections

(a) Section 1 General

(b) Section 2 Quality Assurance and Quality Control.

(c) Section 3 Ground investigation

(d) Section 6 Roadwork

(e) Section 7 Green Construction

(f) Section 8 Drainage Works

(g) Section 11 Health and Safety

(h) Section 27 External Works

(i) Section 28 Landscaping

(j) Section 29 Railways

(k) Section 32 Environmental Management

10.1.5 Responsibilities

1 The contract may identify the responsibilities of all project stakeholders, if not; it will be as stated in this section.

10.1.6 Methodology

1 The Engineer may apply this section to deliver improved project specification, design and construction of all civil engineering works.

2 The Project can go beyond the legal and environmental minimum requirements to achieve distinctive environmental and social performance

3 The Project assessment can be carried out by a sustainability professional from within any part of a project team, or contracted in, who must have been certified.

4 The recommended minimum requirements of achieved percentage scored against the scoped-out question set may be (≥ 25 %)

10.1.7 Submittals.

1 The Engineer/Contractor can submit the evidences that indicate achieving of sustainable key elements in design, construction as well as operation.

2 The Engineer/Contractor can submit the approved spread sheet / checklist with final achieved Score.

10.1.8 References

1 The following are the references used to create this Part:

(a) CEEQUAL Assessment Manual for Projects V5.2 Qatar, 23 December 2015.

(b) Martland, C.D., 2012. Toward More Sustainable Infrastructure: Project Evaluation for Planners and Engineers. Cambridge, Massachusetts: John Wiley & Sons.

(c) Sustainable Infrastructure Systems, 2016. [Online] Available at: (http://www.sustainableinfrastructure.org)

(d) Bennett, F.L., 2003. *The Management of Construction: A Project Life Cycle Approach*. 1st ed. Oxford: Butterworth-Heinemann.

(e) Akadiri, P.O. & Olomolaiye, P.O., 2012. Development of sustainable assessment criteria for Building materials selection. *Engineering, Construction and Architectural Management*.

10.2 RESOURCES MANAGEMENT

10.2.1 General

1 Resources Use

(a) The construction industry is often the largest consumer of resources in any country. Millions of tons of material are used each year derived from natural resources, such as timber, aggregates, concrete and steel. The industry also consumes substantial quantities of water.

(b) More-efficient use of physical resources makes a major contribution to reducing the environmental impacts of construction including reduced demand for landfill and natural resources. It also contributes to the economic efficiency of the sector and of the country in which it takes place.

(c) A significant proportion of the environmental impact of construction arises from the use of physical resources – principally through the energy, water and materials consumed in the manufacture, supply and use of construction products and materials. It is important that proper consideration be given to the responsible sourcing and use of construction materials and how they will be dealt with at the end of their lifetime. Similarly, consideration must be given to maximising resource efficiency and minimising material consumption. Any waste that arises should be managed responsibly and in accordance with prevailing legislation.

(d) There are many opportunities during the various stages of a civil engineering, infrastructure or landscaping project or works in public spaces to influence the supply and use of materials. There are also opportunities to conserve physical resources through the reduction, re-use and recycling of waste materials. Identifying and implementing opportunities to use physical resources more efficiently and reduce waste must be adopted at the earliest possible stage in the project cycle to ensure the maximum potential benefits are achieved.

(e) This requires all those involved in the project to adopt policies and procedures that encourage the more-efficient use of physical resources and waste reduction. For example, this includes the Client mandating requirements through the procurement process, Designers adopting approaches that promote resource efficient designs and waste reduction at design stage and Contractors actively managing their supply chains and by adopting technical solutions at the construction stage.

(f) Planned actions, metrics and targeted outcomes should be communicated between the Client and Contractor and passed down through the supply chain (including design and consultancy teams, sub-contractors, waste management Contractors and material suppliers) and across all project stages – from option identification and preliminary or outline design through to project completion.

2 ENERGY USE AND CARBON EMISSIONS

(a) There is now a widespread conviction and ever-mounting evidence that pollutants arising from human activities are largely responsible for global warming and consequent climate change. The burning of fossil fuels and the consequential release of carbon dioxide through the generation of energy is seen to be particularly important in this respect. At the 1997 Kyoto Conference, most of the developed nations made a commitment to reduce emissions of greenhouse gases over the period 2008 to 2012 and this has subsequently been re-confirmed at later meetings on climate change.

(b) A number of countries have set their own targets in addition to the Kyoto protocol commitments. In order to achieve these very challenging targets, all industries and individuals will need to reduce dramatically their overall energy consumption especially that generated by the burning of fossil fuels, and thus dramatically reduce their carbon emissions. The quantity of carbon emitted through an organisation's annual use of energy in all its forms is commonly referred to as their 'carbon footprint'.

(c) The Climate change will fundamentally affect the oil and gas producing GCC countries. Climate change, arguably the most pressing environmental issue, is a result of fossil fuel use and CO2 release. This threatens not only biodiversity and ecosystem services, locally and globally, but the lives and livelihood of hundreds of millions of people.

(d) The Designers can do minimization in energy consumption in buildings, based on new standards and regulations for energy efficiency in buildings. Energy-efficient solutions in design include passive systems using natural light, air movement and thermal mass, as well as solutions involving energy produced from renewable sources.

(e) The challenge is for civil engineering project teams to consider energy and carbon emissions issues at all stages of their project. This includes:

(i) The energy consumed in the operation of the completed works;

(ii) The energy consumed and carbon emitted (both directly and indirectly) in the production and transport to site of construction materials and components (embodied energy); and

(iii) The energy used during design and construction phases.

(iv) In civil engineering, infrastructure or landscaping projects and works in public spaces, examples of energy and carbon emission reductions include:

(v) energy plant in water or wastewater treatment plants;

(vi) optimisation of all processes including dosing of chemicals used in treatments, and thus minimising the embodied energy in those chemicals;

(vii) timing of processes to use energy off-peak;

(viii) inclusion of wind-power generation and/or combined heat & power generation in a major development

(ix) The embedment and use of solar energy for street lighting, parking meters or any small scale or remote installations.

(f) The adoption of renewable sources of energy, including electrical energy, is not an excuse to become wasteful with one's energy use. Every unit of renewably-generated electricity that is wasted is a unit that could have been used for something else by someone else, and reduced their consumption of fossil-fuel-derived electricity.

(i) The Project may demonstrate alignment with ISO 14001 to ensure efficient use of Energy resources and mitigate the carbon footprint

(ii) The Project may demonstrate alignment with ISO 50001 Energy Management Systems, which requires parties to demonstrate measurement of energy use and continual improvement towards reducing energy needs.

3 POLICIES & TARGETS FOR RESOURCE EFFICIENCY

(a) The Engineer may have formal corporate-level policies and targets for ensuring the most efficient way of physical resources use in the operation of the works.

(b) The Engineer may consider; efficient use of materials, water, and energy as well as reducing of wastes and carbon emissions, in the policy.

(c) The Engineer may consider the corporate-level policies and targets in the design stage.

(d) The Engineer may implement and monitor the corporate-level policies and targets.

10.2.2 Embodied Impacts

1 The embodied impacts associated with the production and transportation of materials used to construct infrastructure projects can be significant and often offer the greatest chance in reducing a projects overall impact. Embodied impacts can be considered as the sum of inputs required to get the material, component or product to a particular project.

2 Life-Cycle Assessment

(a) The Engineer may have a life-cycle assessment (LCA) that engages a carbon footprint analysis, for key construction materials and covering all life-cycle stages as defined in ISO 14040.

(b) The Designer may calculate the percentage of the reductions identified in the LCA in all stages of the project.

10.2.3 design for resource efficiency

1 Optimizing the use of materials minimizes the amount of new materials required on a project and maximizes the use of materials already available on site. This minimizes waste production and reduces collection and disposal costs. Applying the principles of 'materials resource efficiency' will generally lead to the most cost-effective and environmentally sustainable method of construction.

2 The biggest opportunities to influence material use, waste reduction and resource efficiency occur through decisions made at the design stage as these determine the approach that will be adopted at the construction stage. The overall concept of how best to address resource efficiency is still being developed.

3 There are five basic principles that can be applied:

(a) Design for reuse and recovery.

(b) Design for waste efficient procurement.

(c) Design for off-site construction.

(d) Design for deconstruction and flexibility.

(e) Design for materials optimization.

4 Material Resource Efficiency- Planning

(a) The Designer may draw up a plan that identifies opportunities for improving material resource efficiency and reducing waste using the five key principles.

5 Material Resource Efficiency- Implementation

(a) The Contractor may implement and monitor the plan that prepared by the designer and approved by Engineer/related authority, where applicable, that identifies opportunities for improving material resources efficiency and reducing waste.

6 Cut and Fill Optimization.

(a) The Designer may assess the opportunity of cut and fill optimization at design stage to reduce the quantity of surplus excavated materials to be taken off site.

7 Durability and Low Maintenance

(a) The Designer may consider durability and low maintenance of structures and components, in design and specifications.

8 Long Term Planned Maintenance

(a) The Designer may consider properly the long-term planned maintenance of structures and components, in design and specifications.

9 Soil Management

(a) The Designer may prepare a soil management plan.

(b) The Contractor will implement the soil management plan.

10 Beneficial Reuse of Topsoil

(a) The contractor may re-use the topsoil on the site or on a site within a reasonable distance.

11 Future Disassembly/ De-construction

(a) The Designer may optimize the percentage of components or pre-fabricated units used that can be easily separated on disassembly/de-construction into material types suitable for recycling.

12 Materials Register

(a) The Contractor may provide the Engineer with a materials register at hand- over that identifies main material types to facilitate recycling during disassembly or de-construction.

10.2.4 Design for reduced energy consumption and carbon emissions in use

1 Considering energy consumption in use and carbon emissions reduction at design stage can bring significant long-term environmental (and economic) benefits.

2 **Energy & Carbon Emissions Reduction**

(a) The Designer may recommend options for reducing both the energy consumption and carbon emissions of the project during operations, including the option of designing-out the need for energy-consuming equipment and the energy requirements in maintenance.

3 Implementation of Reductions

(a) The contractor may implement the options for reducing both energy consumption and carbon emissions.

4 Opportunities for renewable/ Low-carbon/Zero-carbon energy.

(a) The Designer may explore opportunities for the incorporation of energy from renewable and/or low-or zero-carbon sources to reduce carbon emissions.

5 Incorporating renewable/ Low-carbon/Zero-carbon energy.

(a) The Designer may incorporate in the scheme, where appropriate, and implement the identified potential energy from renewable and/or low-or zero-carbon sources to reduce carbon emissions.

10.2.5 Energy and carbon performance during construction.

1 On many projects, for example wastewater treatment plants, the energy consumption during operation is very much more significant than the consumption on site during construction. However, controlling energy consumption during construction is still important and, for many other kinds of civil engineering project – for example unlit rural roads, flood defense schemes and canals – there is little or no in-use consumption, so energy consumption during construction becomes the significant energy issue on that project.

2 A main contributor to greenhouse gas emissions during the construction process is the use of construction plant, together with the transport impacts of delivering materials to site and staff travel.

3 This section focuses on the energy and carbon impacts of construction plant and machinery.

4 The use of the correct plant for the job, only running the plant when needed, selecting more-efficient plant where available, and even designing out the need for energy-consuming construction plant will all assist in improving the energy performance of the construction works. Good programming of the introduction and use of certain types of plant, and where to position them on site, can avoid waste of energy through plant transport, excessive start-up and shut-down, premature arrival on site and unnecessary running.

5 Energy Consumption – Consideration during Design

(a) The Designer may identify opportunities to reduce the energy consumption of the project during construction.

(b) The Designer may incorporate appropriate measures to reduce energy consumption during construction where feasible.

6 Energy Consumption – consideration by contractor.

(a) The contractor may consider energy consumption and associated carbon emissions reduction measures, and incorporate through an energy management plan or equivalent.

(b) The contractor may monitor the incorporated measures throughout construction stage.

7 Construction Plant- selection and maintenance

(a) The contractor may consider the energy efficiency, energy type or carbon emissions when selection and procurement/hiring of construction plant.

8 Renewable / Low-carbon/Zero-carbon energy during construction.

(a) The Contractor may consider renewable energy and/or low- or Zero-carbon resources during construction.

10.2.6 Water use

1 Minimizing water usage is a widely accepted way of reducing human impact on water resources. Even in areas where water supply is abundant, reducing water consumption reduces many other related impacts, such as the energy and chemicals used in treatment, storage and distribution. At design stage, designs can be adapted for minimizing water usage during operation and ought to take account of long-term water requirements. Designs for utilization of grey-water and rainwater should be encouraged if appropriate.

2 “Grey water” is defined as water collected after use in washing machines, sinks etc that is not suitable for drinking but can be used for irrigation, toilet flushing etc. This always excludes sewage. Water associated with the construction stage can be attributed to direct water use (i.e. water used by construction teams for site activities) or indirect or embodied water use typically associated with construction products and materials.

3 The embodied water, or water footprint of a product, is the total volume of freshwater used to produce the product, summed over the various steps of the production chain. The water footprint of a product refers not only to the total volume of water used; it also refers to where and when the water is used. Training on these issues should be encouraged to ensure knowledge of new designs and benefits of conservation; on site, toolbox talks on water conservation have been found to be invaluable.

4 **Embodied Water**

(a) The designer may assess the embodied water in the materials required during construction.

(b) The contractor may implement the outcomes of the assessment.

5 Water consumption during operation.

(a) The Engineer may consider the potential impacts on water resources of the operation / maintenance of the completed project.

(b) The designer may include measures to conserve water and reduce water consumption during operation and maintenance of the completed project.

(c) The contractor may incorporate the measures (10.2.6, 2.b) in the works.

6 Water consumption during construction.

(a) The contractor may identify specific and measurable requirements to measure, monitor and minimize the consumption of mains or abstracted water during construction and include in the project brief and the procurement documentation.

(b) The contractor may adopt formal project-level policies and identify measurable targets for reducing water usage during construction, as well as preparing a plan to measure , monitor and minimize the consumption of mains, tinkered or abstracted water used during the construction process.

(c) The contractor may implement the policies, targets and plans mentioned in (10.2.6,3.b)

10.2.7 Responsible sourcing, re-use and recycling of material

1 The sourcing, manufacture, use and disposal of construction materials can have a significant impact on local and global environments from which they are obtained or in which they are produced.

2 The concept of responsible sourcing is developing at a rapid pace in many countries and standards have been developed in a few. It covers issues such as the standards of care for quality, employees and the environment in the supply chain, the avoidance of undue waste, of financial impropriety, and the avoidance of exploitation of the workforce.

3 Note also that, whilst an EMS certified as compliant with ISO14001 may provide a very good tool for assessing and improving an organisation’s environmental performance, using suppliers with an ISO14001 certificate or equivalent does not guarantee that their products are less environmentally damaging than materials from suppliers without one.

4 The following common construction materials can already be actively considered in this section – concrete, aggregates, asphalt, steel, concrete products and timber. More products are being certified regularly. There are many opportunities during the various stages of a civil engineering, infrastructure or landscaping project or works in public spaces to influence the supply and use of materials – through design, specification, selection, supply chain management, storage and use.

5 There are also opportunities to conserve the use of material resources through the reduction, re-use and recycling of waste materials.

6 Responsible sourcing of materials.

(a) The Engineer may consider and specify the responsible sourcing of materials prior to placing the order.

(b) The contractor may achieve, as possible, the specification for responsible sourcing.

7 Locally-sourced and recycled materials.

(a) The Engineer may give priority to the use of locally sourced and recycled materials.

(b) The contractor may do research all locally available materials sources, including recycled materials.

(c) The Engineer may adapt the designs and specifications to allow for the use of locally sourced and recycled materials, where appropriate.

8 Sourcing of Timber

(a) The contractor may use the highest possible proportion of timber and timber products in the permanent works that are sourced from legal and sustainably managed sources with recognised timber labelling (FSC/PEFC or equivalent), or from re-use.

9 Retention of existing structures and materials.

(a) The contractor may retain and use the highest possible percentage by volume of any existing structures and materials, such as roads, tanks and pipework within the project.

10 Reclaimed or recycled materials.

(a) The Engineer may specify the use of highest possible percentage by volume from recycled or reclaimed materials (excluding bulk fill and sub-base) in the permanent works.

11 Reclaimed or recycled bulk fills and sub-base.

(a) Engineer may specify the use of highest possible percentage by volume from bulk fill and sub-base, whether reclaimed from the site or elsewhere.

10.2.8 Minimizing use and impacts of hazardous materials.

1 Minimising the use and impacts of hazardous materials is closely linked to health & safety considerations. However, sometimes health & safety assessments can be extended to also cover environmental aspects of those materials being assessed.

2 An example of such an environmental issue is the pre-treatment of preserved timber: on-site treatment, which is often applied by non-specialist personnel, represents a hazard from environmental as well as health & safety considerations, compared to treatment carried out under controlled conditions by trained specialists.

3 Hazardous Materials

(a) The Engineer may assess the possibility of substitution of hazardous materials with less hazardous materials.

4 Application of coatings

(a) The contractor will apply all appropriate coatings and treatments for permanent work materials.

5 LOW-VOC and/or Biodegradable Coatings.

(a) The Engineer may specify the highest possible percentage of low-VOC and/or biodegradable coatings and other treatments.

6 Hazardous Material Assessments.

(a) The contractor will extend the health and safety assessment process for hazardous materials to cover the wider environmental impacts of those materials, the project will draw up a Construction environmental management plan (CEMP).

10.2.9 Site waste Management planning & Legal COMPLIANCE.

1 The production and management of waste from construction and civil engineering projects is governed by a large body of legislation, and at a minimum, must be adhered to. In addition, there is a professional dimension to performance in this area in that some professional institutions issue guidance to their members on wastes management alongside duties to adopt a sustainability-driven approach to their work. It is recommended that waste is treated as an important issue by the management of civil engineering companies.

2 Disposal of waste is a complex subject requiring particular attention. However, waste is often characterised into three overall types: inert, non-inert/non-hazardous or hazardous and planning based on the most appropriate action for each broad type.

3 There is a large body of legislation relating to and restricting waste management in many countries and, as a minimum, this must be adhered to. In certain circumstances it will be allowable for the re-use or recycling of certain waste materials to be allowed, for example if the waste can be put to a beneficial use elsewhere without causing any environmental risk or damage.

4 This should primarily be the responsibility of the Client and/or Designer in developing the scheme, as early consultation with the relevant regulator will enable better project design and planning. Finally, it must be recognised that very few projects – for example an on-site bioremediation contract – may generate zero construction waste for off-site disposal, but waste will still be generated from canteen facilities and plant & machinery maintenance and needs to be disposed of appropriately.

5 Site waste Management planning.

(a) The contractor will prepare a Solid Waste Management Plan (SWMP), or incorporate a solid waste management section within the construction environmental management plan (CEMP).

(b) The contractor will meet the targets or key performance indicators for waste reduction and waste recovery.

6 On site waste management

(a) The contractor will manage all waste produced on site, transport by licensed carriers and transported to an approved tip or treatment facility.

7 **Permitting for waste treated or used onsite.**

(a) The contractor will obtain the appropriate permits, licenses or exemptions prior to waste treatment on site or importing to site.

8 **Hazardous or Special Waste.**

(a) The contractor will do segregation for the hazardous/special waste in a proper way from other controlled waste, register and store in a proper way.

(b) The contractor will transport the waste into a licenced facility.

10.2.10 Wastes and management of arising.

1 Planning for waste management and the management of arising, from the design stage and through developing the SWMP (Solid waste management plan) is crucial. An essential subsequent step is using the information in the SWMP as part of the management of waste on site.

2 The forecasts in the SWMP will enable practical decisions to be taken about the materials to be segregated for recycling and/or for disposal, the methods by which segregation is implemented and the layout of site facilities, including waste storage. This is also relevant to waste materials produced during site preparation, in particular with the emphasis on limiting the amount of development on undeveloped sites.

3 Development on previously developed sites often requires extensive site preparation works giving rise to a range of wastes that require proper management. However, it can also offer the opportunity to re-use materials on site. If possible, waste should be taken to a local waste processing or disposal facility to minimize transport impacts.

4 The location relative to the project of landfill and reprocessing sites should be established at the start of the project to enable such judgments to be made. A balance needs to be struck – and recorded – between distance to a landfill site and a greater distance to a recycling facility.

5 Waste management should be part of the training for all site managers to ensure they are aware of their legal responsibilities, the actions and targets contained in the SWMP and the possibilities that exist for the prevention and reduction of waste. It is important that all of the personnel working on site, whether directly employed by the Principal Contractor or a sub-contractor, are aware of their responsibilities for reducing the amount of waste produced and for managing the waste that is produced in the correct manner.

6 Clearance and Disposal of Existing Vegetation.

(a) The contractor will apply the most environmentally beneficial ways of dealing with clearance and relocation/disposal of existing vegetation with direct coordination with relevant authorities.

7 On-site use of Demolition Arising

(a) The contractor may incorporate the highest percentage, where appropriate, of suitable/useable material from demolition or de-construction on site.

8 Beneficial Reuse of Excavated Material.

(a) The contractor may reuse the highest percentage, where appropriate, of excavated material on-site.

9 Surplus Materials

(a) The contractor may do and implement an assessment to reduce the amount of surplus materials ordered, (reduce over-ordering).

10 Materials Storage

(a) The contractor will store the materials properly to avoid wastage.

10.3 ECOLOGY AND BIODIVERSITY

10.3.1 Basic Principles

1 There is concern amongst society in general, and nature conservation organisations in particular, that wildlife habitat and the species that occupy them are continuously being damaged and destroyed.

2 New development is often cited as one of the reasons for this destruction. In order to support the conservation of biodiversity at all scales, a Convention on Biodiversity was established at the United Nations Conference on Environment and Development in Rio de Janeiro in 1992.

3 Nations around the world have translated this into action with a variety of national, local and company level schemes. However, development – and civil engineering projects in particular – need not have a negative impact on biodiversity and wildlife. There are many occasions when careful planning and implementation of civil engineering projects can not only avoid damaging important habitats and harming protected species, but can also lead to the creation of new habitats or the construction of facilities to encourage certain species.

4 Ecological assessment of a development project at the design stage can help to identify potential adverse impacts and can also identify ways in which these can be mitigated or compensated for, or, where existing interest can be enhanced, new habitats created or species encouraged.

5 Land that is of high or moderate value for wildlife is normally recognised in some way, such as statutory designations or other titles usually placed on sites by the local authority. Wherever possible, the development of such sites should be avoided, as the opportunities to mitigate for damage to or loss of habitats or species may be strictly limited.

6 There is now a substantial quantity of guidance available on the interaction between biodiversity and construction projects. An internet search for “biodiversity” plus “civil engineering” will yield a range of guidance resources.

7 The surveys to be undertaken early in a project in order to inform the design (often called phase 1 habitat surveys) are aimed at providing, relatively rapidly, a record of the semi-natural vegetation and wildlife habitat over large areas of land on and around a development site. There are standard methodologies and classifications available (search the internet for phase 1 habitat survey and the country or region you are in) that enable comparison between different alternative sites.

8 They normally include, at a minimum, review of available maps and aerial photography, site surveys by appropriately qualified ecologists and, if needed, other specialists, careful note-making by those specialists of the plants and animals identified, as well as the characteristics of the site and its surroundings.

9 If there has been a significant delay between initial surveys having been undertaken and works proceeding, then an updating of the initial surveys may be necessary. This is especially true if any protected species such as bats have the potential to be present or if invasive plants such as Japanese Knotweed are likely to occur.

10 Active management of civil engineering project and works in public spaces sites is needed throughout the project. Protected species not originally on the site may find conditions during the construction stage advantageous to colonise, resulting in delays.

11 Land of High Ecological Value

(a) The contractor will not being placed on or using land or seabed that has been identified as of high ecological value or as having species of high value.

12 Consultation with nature conservation dept. (MME) and other relevant authorities.

(a) The Engineer will consult with the relevant nature conservation departments on the ecological impact of the proposal and communicate the results to project team members.

(b) The Engineer will undertake and communicate the consultation with the relevant nature conservation departments on the ecological impact of the proposals to project team members at both design and construction stages of the project.

13 Ecological Works Plan

(a) The contractor will draw up an ecological works plan or an ecological section in the integrated project management plan or construction environmental management plan, and then implement during construction.

10.3.2 Legal and/or specific requirements

1 In many countries certain species of plants and animals and/or their nesting, roosting or resting habitats are protected by legislation such that is an offence to disturb them, either all or at particular times of year.

2 Failure to take adequate steps to protect such features could lead to adverse impacts and, possibly, to prosecution. Certain offences may be committed through reckless actions placing an onus on the developer of land to demonstrate that they took all reasonable steps to identify if any protected species were present on their site and that, if they were, they were adequately protected throughout the development process.

3 It is best practice for the onus to be on the developer to ensure wildlife and places used by wildlife for sheltering are not disturbed during the course of the project. Weeds may cause particular problems in wetlands. Injurious weeds, as defined by regulation in some countries, may also cause problems, particularly if there is livestock within the area.

4 If any species is causing a problem, they may require on-site control. The advice and views of a suitably qualified ecologist who is a member of the CIEEM or a Chartered Biologist or equivalent may be needed to judge whether the following actions have been achieved.

5 Surveys for Protected Species

(a) The contractor may specify and undertake appropriate surveys for protected plant and animal species effectively.

6 Injurious or invasive species.

(a) The contractor may draw up, implement and monitor an approved method statement to control and manage invasive animals, plants species or injurious weeds present on site.

10.3.3 Conservation and enhancement of biodiversity

1 Biodiversity represents richness and variety of plants, birds, animals, insects and soils that exist throughout the world. Species are becoming extinct at a rapid rate, and many more have declined in number, range or both.

2 The construction industry generally, and especially civil engineering, has a major influence on the landscape and is bound to impact on biodiversity. The industry should be seen as a contributor to achieving the targets set achieving any relevant biodiversity targets rather than simply as always harming biodiversity.

3 Steps that the industry should take include:

(a) avoiding impacts on important habitats and species, and reducing habitat fragmentation;

(b) mitigating or if this is not possible compensating for any impacts; and

(c) Always endeavouring to enhance biodiversity wherever possible.

4 Where potential damage to existing wildlife or wildlife habitat – identified in any site ecological assessment – is avoidable, then measures should be put in place at the construction stage to protect such features. Where the project being assessed will lead to the permanent loss of such wildlife features, there should be evidence that this loss will be compensated for or mitigated, preferably on the project site or as near as possible to it.

5 Existing Ecological Features- Recommendations

(a) The Engineer may identify recommendations for conserving existing ecological features, such as species and habitats or sustainable infrastructure in an ecological assessment.

(b) The Engineer may identify recommendations for mitigating or/compensating for any loss of such ecological features.

(c) The Engineer may identify recommendations for enhancing the existing ecological features of the site.

6 Existing Ecological Features- Monitoring

(a) The contractor may monitor the implementation of the recommendations set out in the design.

10.3.4 habitat creation measures.

1 Civil engineering projects often present opportunities for new habitats to be created. Land of previously low wildlife interest can be adapted to provide wildlife habitat, thus enhancing biodiversity and the overall ecological interest of the area.

2 Some projects, particularly linear ones such as roads and railways, hinder the movement of animals and create an added threat to their existence. The deliberate incorporation of features for animals can both reduce this threat and positively encourage them to get to the new habitats the project has created.

3 New Wildlife Habitats

(a) The Engineer may identify and incorporate recommendations/opportunities for creating new wildlife habitats.

4 Special Structures or facilities for wildlife.

(a) The Engineer may identify and incorporate recommendations/opportunities for installing special structures or facilities for encouraging or accommodating appropriate wildlife.

10.3.5 Monitoring and maintenance

1 Monitoring and maintaining any habitat creation or species conservation measures is crucial not only to the success of those measures, but also in helping to develop a body of knowledge about what works and what does not.

2 The monitoring programmes will focus on the main species of interest, whether plant or animal, taking into account any seasonal restriction or habits of the species in question. Monitoring programmes, such as for some mammals or birds can easily be established, as can checks for amphibians and reptiles.

3 However, more detailed investigations may be necessary for invertebrates, notably where plant habitats have been created or managed to enhance their invertebrate potential. All too often maintenance of habitats and species are neglected after completion of a project. This can result in efforts to maintain or enhance nature conservation interest being wasted, because planting and other features fail.

4 Maintenance programmes need to be coordinated with any landscape management proposals, so that vegetation management takes place at the appropriate time of year that will be beneficial for nature conservation. Five years of management and maintenance should be considered as a minimum period, although seven to ten years would be preferable.

5 On-going Ecological Management

(a) The Engineer may draw up a program for the on-going ecological management of habitats and species conservation measures, including instructions for emergencies or abnormal events, to be handed over to the owner or managing agent of the completed project.

6 Program for monitoring

(a) The Engineer may undertake on site a programme in place (for the years after project completion) for monitoring the success or otherwise of any management, habitat creation or translocation and species conservation measures

10.4 LAND USE AND LANDSCAPE

10.4.1 Basic principles on the use of land (whether above or below water)

1 Land is a valuable resource. There is increasing pressure on land globally as the world's population continues to grow. Balancing competing uses – such as food supply, development, recreation, nature conservation, water resource management, heritage and agriculture – is an important and significant challenge for all, not just all the parties to a civil engineering project or works in public spaces.

2 Land below water (whether fresh or marine) is also becoming crowded with various types of infrastructure, such as pipelines. By contrast, with land above water, in many areas of the world the 'land' under water (such as the seabed, estuary beds, or the beds of inland lakes) is regarded as a 'free goods' that can be exploited in ways that would be unacceptable on land.

3 Whilst marine and offshore projects could be assessed. This Methodology now expressly includes assessment of marine and offshore projects (ports and harbours, wind farms, oil & gas production, and pipelines) and therefore includes consideration of the use of seabed by such installations, and the effects of such works on the marine environment and ecosystem.

4 While many civil engineering projects intrinsically improve environmental quality and human well-being, they are still often perceived by many in society as having a damaging effect on the living environment. This perception is exacerbated where the land (whether above or below water) taken up for a project has value for any one of a wide range of uses or benefits – agricultural, environmental, nature conservation, mineral resource, recreational or amenity.

5 Careful planning and implementation of civil engineering projects, together with a good communications and consultation strategy, can help to optimise land-use or underwater bed-use decisions, enabling safe, efficient and appropriate use of land and reducing pressure on previously undeveloped or highly sought- after sites.

6 In urban areas this includes remediation of land contamination, re-use of previously developed or 'derelict' land and urban regeneration. In rural areas, it can assist with the conservation of specific land resources and ecological habitats, such as woodland or wetlands. In desert environments, developing previously undeveloped land may be the preferred option rather than choosing sites that have been developed into fertile areas.

7 Making this differentiation will be the role of the Assessor. In this section, both the appropriateness of the chosen location and the design concept are examined in relation to previously-developed and un-developed land, management and treatment of land or underwater-bed contamination, and land-use efficiency – all are assessed.

8 Location and land-use decisions in relation to flood risks, local amenity and soil or mineral resource preservation (inclusive of peat and agricultural land quality and productivity) are also covered. Detailed issues relating to water resource management, ecology, archaeology, pollution prevention, waste, materials use, transport, and other issues, although related to land use, are considered in other sections of this Manual.

9 Site selection plays an important role in determining the overall environmental effects of a project. For example, selection of sites with existing infrastructure sufficient for the new site use will minimise the need for the construction of new roads or railways. Existing local water resources may avoid the need for additional pipeline construction. On marine and offshore projects, siting of facilities on important spawning or fishing grounds can greatly disrupt the environment and economic activity.

10 Using a site with characteristics appropriate for the proposed project in terms of topography, geology and soils, ecological importance, water resources, landscape character, and historical importance will also contribute to using land or seabed to the best effect.

11 Project Location Alternatives

(a) The Engineer may make appropriate and positive decisions on the project's location based on collected sufficient and relevant information.

(b) The Engineer may demonstrate a process for considering the relative merits of the options.

12 Land Use Efficiency

(a) The Engineer may calculate the land-take of different scheme designs, process designs and layouts of the planned works, the land-use efficiency will be considered as of high importance.

13 Temporary Land Use

(a) The Engineer will employ a formal process for selecting temporary land for construction.

14 Conservation of Soils & other on-site Resources

(a) Apart from the actual land take, the Engineer may take into consideration the conservation of top soils, subsoil, seabed surface geology, and conservation or use of onsite mineral resources.

10.4.2 Contamination of land and bed of the sea

1 Land contaminated with substances that are potentially hazardous owing to their nature or quantities present and originating from previous uses may need to be treated to protect human health and the environment, and to enable redevelopment. The nature, distribution and hazards posed by contamination must be assessed on a site-specific basis.

2 Seabed contamination – for example spillage or dumping of drilling muds and sludge, and contaminants put down sea outfalls – is rarer than land contamination but can be severe in particular areas, for example harbours. Clean up of such contamination is more likely to be a project in its own right rather than an ancillary part of a marine project (such as a jetty or pipeline).

3 However, those involved in such projects need to consider relevant aspects of this section as they apply to their project –for example a pipeline passing through an area of contaminated seabed. They also need to consider whether the 'contamination' is actually natural rather than man-made and therefore needs to be worked around rather than 'treated'.

4 Hazards often include substances such as heavy metals and hydrocarbons that can pose risks to human health and the environment including water resources. Other substances can also contaminate sites including asbestos, biological contaminants, unexploded ordnance as well as hazardous gases.

5 Hazardous gases and vapours often originate from thick fill or deposits of waste either on or near to the site and may impact on developments. Gases of most concern are methane, which can be explosive or flammable, and carbon dioxide, which can be toxic and an asphyxiate through the displacement of oxygen. Both are, in addition, significant 'greenhouse gases' implicated in triggering global warming and therefore climate change.

6 Other hazardous gases and vapours, such as hydrogen sulphide, hydrogen cyanide and solvents, could arise from old industrial process sites. Hazardous gases can also derive naturally from organic deposits such as peat (for example, methane and carbon dioxide) or rocks such as granite (radon). Remediation of land for civil engineering projects involves the same processes and technologies as remediation for other types of use.

7 However, the 'suitable for use' principle indicates that, depending on the type of civil engineering project, clean-up may not be needed to the standard required for more-sensitive land uses such as housing or schools. Legislation in a number of countries controls development of land affected by contamination and may require developers to deal with any contamination as an integral part of a planning application.

8 The issue of how to deal with historical contamination that may lead to significant harm is also important from a professional standpoint irrespective of the legislative regime. A risk-based definition of what constitutes land contamination, and the management and reduction of risks posed by contamination are key drivers of current contaminated land best practice. In addition to environmental risk reduction, the sustainability of the remedial solution selected, the residual environmental risk remaining after remediation, and the durability of the solution, all need to be considered.

9 Contamination Risk Assessment

(a) The Engineer will have (if it is needed) an approved environmental impact assessment study that covers land, seabed, soil, ground water, gas, residual man-made structures and surrounding land uses.

(b) The Engineer will consult with a suitably experienced chartered contaminated land specialist regarding the land condition.

10 Land Contamination Management Procedures

(a) If contaminated land was present on site, the Engineer will make site assessment in line with appropriate local and/or international procedures for the management of land contamination.

11 Evaluation of Remediation Options.

(a) The Engineer will evaluate (if it is needed) the feasible remediation strategy determined for the site by an appropriate expert.

12 Ground-Generated Gases

(a) The Engineer will make (if it is needed) risk reduction, management and implementation for the ground-generated gases in place.

13 Implementation of Remedial Solution

(a) The Engineer will (if it is needed) assess the impacts of the implementation of the remedial solution and appropriate control measures in place.

14 Long-Term Effectiveness of Remedial Solution

(a) The Engineer will consider (if it is needed) the effectiveness and durability of the remedial solution, and maintenance and monitoring over the lifetime of the project and beyond, and operational information conveyed to the operator.

15 Prevention of Future Contamination

(a) The Engineer will ensure (if it is needed) that pollution control measures are in place to prevent any future contamination occurring in relation to the site.

10.4.3 flood risk

1 Any civil engineering project has some flood risk associated with it and may alter the flood risk for others. Flood risk can originate from a number of sources including fluvial, tidal, groundwater, overland flow and artificial sources. Consideration should be given during the planning and design of the works to current and future risks from all of these sources.

2 One of the most common sources of flood risk to the project or elsewhere is increased surface water run-off. The central tenet of this sub-section is for Designers first to assess what the flood risks associated with the project are likely to be once the project is completed, and to then undertake any measures to deal with or to reduce identified flood risk, whether for the project or elsewhere.

3 Flood Risk Assessment

(a) The Engineer may assess the run-off, flood risk, and potential increased flood risk elsewhere as a result of the completed works over their expected working life, and the appropriate flood management measures will be included in the design.

4 Flood-Risk-Based Enhancements

(a) The designer may actively propose and incorporate opportunities for providing enhancements as part of the flood risk management measures and/or the merits of designing for a larger event or for greater flood resilience than required by planning regulations or guidance.

5 Long-Term Flood Resilience & Adaptation

(a) The project may be designed for long-term flood resilience and adaptation.

10.4.4 basic principles on landscape issues

1 The visual impacts of engineering schemes on their surroundings have long been an issue of concern, especially in their setting, where the density of development and infrastructure can dominate the often-valuable landscape, townscape and seascape settings. Guidance on the evaluation of such effects covers both the visible effects on the intrinsic qualities and value of the setting and the visual effects on people within that setting.

2 The general assumption has been that engineering schemes will have an adverse effect on the appearance of a place. However, this section allows equally for the assessment of beneficial effects. Landscape Designers may be involved in such public spaces projects. In addition, considerable benefits can be gained from the inclusion of landscape planning and design skills in a civil engineering project from the earliest stage, to influence the design as well as assessment of issues.

3 Scheme concepts and options are then developed with best 'fit' into their environment as a key aspect, with concerns being addressed through the basic form of the proposal and not left for expensive mitigation measures added after decisions have been made.

4 In many countries, landscapes and townscapes of particular value are protected. The areas given protection vary from country to country and reflect the conservation and cultural values of these countries – landscape value is, after all, a human construct, and therefore significantly influenced by different cultures' views of the importance of different features of local landscapes. Landscape works for land-based civil engineering projects are often implemented by specialist Contractors and may be designed by consultants.

5 These works usually contain most of the environmental measures included with a project, such as planting, habitat creation, public space, recreation facilities, screen walls or fences, interpretation boards, and amenity lighting. They may also have had substantial community involvement in design development and in aspects of the implementation. These elements will have a significant influence on the public perception of the scheme as a whole.

6 Construction and maintenance of the landscape works may continue long after the main engineering elements have been completed and brought into use.

7 Landscape & Visual Factors

(a) The project may consider the landscape and visual factors by a suitably qualified landscape professional at each stage of the project, including the evaluation of scheme options.

8 Local Landscape Character

(a) The project design may fit the local landscape character in terms of landforms, materials, planting, style and detailing, scale, townscape pattern.

10.4.5 Landscape-related legal requirements

1 Many countries have specific areas set aside as national parks or areas recognized and valued for their natural beauty. These are often afforded statutory protection that place strict controls on the extent and types of work that can be undertaken, with a general presumption against development. Regionally important areas of landscape often have similar statutory protection, including coastal landscapes and island seascapes, are designated in structure and unitary plans, with presumption against some forms of development and controls on others.

2 Urban authorities in temperate climates often designate 'green belts' areas of undeveloped land which are protected primarily for their openness rather than any intrinsic landscape qualities but also include a presumption against development. Coastal areas are also often granted protection, either within national parks or as separate schemes.

3 Planning documents issued by national and/or local community governments may also include policies intended to foster improvement in landscape quality outside the protected areas, often in association with development and/or with the establishment of community vegetable gardens or other landscape features.

4 Most of the adverse impacts of a project on the landscape or townscape are the direct result of the choice of location or alignment and can be broadly identified from an early stage. It is therefore important that these fundamental decisions are made on the basis of appropriate design standards and evaluation of options.

5 Poor location or alignment can also lead to a cumulative impact with other adjacent facilities, which can be greater than the sum of its parts. This should lead to some reconsideration of the design, but may not be brought out by current assessment guidance. It is a particular factor in the gradual erosion of landscape quality in rural and Green belt areas.

6 Public access to the landscape, beyond established rights of way, confers its own added value, provided that this includes consideration of safety and security in design that results in adequate levels of natural surveillance. Doing so avoids the creation of places likely to attract anti-social behaviour, or publicly accessible areas that are perceived as unsafe and consequently are not used by the public.

7 Impact on Landscape Character

(a) The Engineer may assess the impact of the development on the character of the protected high amenity value for its landscape, coastal or townscape character that the project is located within or near it.

8 Landscape Development Policies

(a) The Engineer may prepare landscape proposals that will go beyond the aims of applicable landscape development or enhancement policies published by the relevant local or national authority.

9 Existing Vegetation

(a) The Engineer may assess the condition of existing vegetation and will consider the retention of vegetation (trees, hedgerows, mangroves, cacti, reed beds etc.) with high or moderate value in design proposals.

10 Non-Vegetation Features

(a) The Engineer may assess the landscape and amenity value of other features (not vegetation), as well as considering the retention of valuable distinctive or historic features in the design proposals.

10.4.6 Implementation and management

1 Inclusion of an EMS and its related detail in the Landscape Management Strategy (LMS) or Landscape Works Plan (LWP) or equivalent should both help to counter any concerns over the quality of landscaping that will be delivered.

2 If a SEMP (strategic environmental management plan) or equivalent is drawn up to manage the environmental aspects of the construction work, this should include a section on landscape, which can then be considered equivalent to an LMS or an LWP. However, this will only work if sufficient means of control are built into the contract and carried through into Implementation.

3 In addition to good environmental practice relating to landscape works, the development of the project through the design and implementation stages needs to acknowledge the importance of safeguarding existing landscape features, and maintaining suitable growing conditions in areas where future establishment of plants and habitat is proposed.

4 Landscape Design Proposals

(a) The Contractor may implement a plan during construction period to ensure that:

(i) Planning and third party commitments were implemented;

(ii) Best practice was applied for planting or habitat areas to Avoid damage to landscape features; and

(iii) Ensure that soil conditions met the requirements for successful establishment of the landscape design

5 2 Advance Landscape Works

(a) The Engineer may consider opportunities for advance landscape works, such as planting prior to construction.

6 Appropriateness of Species Selected

(a) The Engineer may take into account, when planting design, the appropriateness of species selection with regards to factors such as, climate adaptation, local provenance and soil stability.

10.4.7 completion and aftercare.

1 Aftercare of landscape schemes can be as important for their success as good design and implementation. This is particularly the case for schemes that incorporate wild flowers and/or herbaceous planting, which aim to create a diverse flora over time, or establish conditions suitable for a particular species, group of species, or generally to enhance biodiversity.

2 Public perception of amenity planting schemes is too often let down by an untidy and uncared for appearance, or by planting or habitat creation schemes not developing their full potential due to lack of appropriate management and maintenance. Soft landscape schemes are dynamic in nature and require monitoring and review of objectives in response to changing conditions over time.

3 It is important that the level of management, monitoring and review of objectives is appropriate for the type of planting or habitats involved. Maintenance of hard landscape elements should not be overlooked.

4 Long Term Management Plan

(a) The Engineer may develop a management plan that:

(i) Defines long-term landscape objectives,

(ii) Establishes recommendations for work required to ensure that objectives are achieved, and

(iii) Sets a program for ongoing monitoring and review to assess the effectiveness of maintenance operations

5 The Engineer may ensure that:

(a) Responsibility for the implementation of the management plan has been allocated to an appropriate individual or organization;

(b) Appropriate skills and resources (including financial) are committed; and

(c) That a program of monitoring is in place beyond the normal planting establishment period.

10.5 THE WATER ENVIRONMENT

10.5.1 Basic principles

1 The importance of protecting the water environment – fresh and marine – has become increasingly recognized throughout the world during the last decade and many countries have developed legislation in order to minimize future impacts on this valuable resource.

2 Water use during construction and in completed works, and prevention of pollution of the water environment, are key issues for consideration by the construction industry in particular. When looking at the impacts of civil engineering projects on water, the main aspects need to be considered are:

3 Impacts on water resources;

(a) impacts on and of flood risk; Sustainable Drainage Systems is assessed in this section but flood risk overall is assessed in Section 10.4.3);

(b) protection and enhancement of the fresh and marine water environments (the feasibility, design and construction stages lead to opportunities as well as threats to the water environment);

(c) Impacts and opportunities associated with water consumption (assessed in Section 10.2.6). This section focuses on impacts on water resources and on protection and enhancement of the water environment, whether fresh or marine.

4 Impacts on the Water Environment

(a) The Engineer may prepare a plan and incorporate the necessary elements in the design stage to control the impacts of the completed project on the water environment (fresh and/or marine as appropriate).

(b) The Contractor can implement the produced plan to control the impacts of the project on the water environment (fresh and/or marine as appropriate) during construction.

10.5.2 Legal requirements

1 It is possible that in the project location numerous acts and regulations will deal with the protection of water resources and the prevention of their pollution. Details of any relevant legislation should form part of an EMS or equivalent.

2 Consultation with Regulatory Authorities

(a) The Engineer will consult with regulatory authorities about water issues related to the project, including the need for any consent, and the outcome will be communicated to the project team members at each stage of the project.

10.5.3 Protection of the water environment

1 The project will evaluate the potential impact on the groundwater and surface water environment of a civil engineering, infrastructure or landscaping project or works in public spaces must be considered. Potential impacts from the marine environment may be very similar on coastal projects, but different in character for offshore projects such as wind farms, oil and gas production facilities or pipeline and cable installations.

2 For land-based projects, the geological history and hydro-geological details of the area will be important at design stage, as these will determine the groundwater movement in the area. This will help to decide the best design and construction method to protect the environment, including the hydro-geological regime. The design should aim to control run-off paths and drainage, and the quality and turbidity of the run-off is of great concern.

3 At construction stage, prevention of pollution of water bodies of sea water and the ground water is of extreme importance. There is a variety of potential sources of site-derived contamination, including:

(a) Operational leaks and spillage from tanks, pipes and vehicles;

(b) Accidents or spillage during storage and transport of raw materials, manufactured products and waste materials;

(c) Storage of waste on or adjacent to the site;

(d) Leaks from drains from process areas;

(e) Movement of contaminated groundwater onto the site from areas that are contaminated;

(f) Demolition of works that have contained contaminating materials;

(g) Silt washed from the site.

4 Contamination of marine environments may also come from materials incorporated into the works. The potential of materials and products to leach pollutants into the environment should be assessed during the design stage.

5 Pollution Prevention

(a) The Engineer will recommend specific measures to prevent pollution of groundwater and the sea (as appropriate) during construction, operation and maintenance.

(b) The contractor will implement a plan to protect the existing sea water features from degradation or physical damage during construction works and processes.

6 Long-Term Monitoring of Impacts

(a) The Engineer may incorporate the appropriate measures (or equipment) in the project that will allow long-term monitoring of the project's impact on the marine environments as appropriate.

7 Sustainable Drainage Systems

(a) The Engineer may incorporate the sustainable drainage system into the design and project where appropriate.

(i) For example, rainwater retention, balancing ponds systems, and/or grass roofs.

(ii) The sustainable drainage system also includes measures such as reducing concrete cover to reduce runoff and facilitate faster absorption of rainwater where it falls.

(iii) Vegetation can also be used to slow down flood water on other runoff and therefore reduces its potential for damage.

(iv) The incorporation of sustainable drainage system may be actively considered.

(v) Guidance on design and implementation of the sustainable drainage system is available in four CIRIA publications:

- The sustainable drainage system Manual (C753, 2015).
- Site handbook for the construction of the sustainable drainage system (C698, 2007).
- Retrofitting to manage surface water (C713, 2013).
- Managing urban flooding from heavy rainfall – encouraging the uptake of designing for exceedance (C738, 2014).

8 Water Quality during Construction

(a) The Engineer can monitor the water quality of that water body before construction and then regularly during construction in accordance with the regime identified as appropriate in the risk assessment.(if the project could affect a body of ground or surface waters).

(b) Visual inspection of watercourses is considered to be standard industry practice on sites with ground and surface waters or features on or near them, due to the ease with which silt, in particular, can enter and be detected.

(c) Risk assessment of the water quality impacts on the environment should be undertaken to establish appropriate level of on-site monitoring and chemical analysis.

(d) The outcome of the risk assessment may require additional monitoring and analysis above the standard industry practice. Monitoring may be carried out in liaison with the appropriate environmental regulators or agencies.

(e) However, it is considered good practice for Contractors to be proactive in establishing a monitoring regime – and it is in their own interest to do so. In this section, emphasis is placed on monitoring, both short-term and long-term.

(f) Evaluation of the long-term impact of materials may be difficult if materials have been used that have not had long term research carried out on them. For example, these may have delayed pollution characteristics, which would be costly and possibly difficult to rectify.

10.5.4 Enhancement of the water environment

1 Opportunities should be taken to enhance the water environment whenever appropriate. Most of these will arise at design stage, when modifications to the design can be carried out at little or no extra cost.

2 At the construction stage, opportunities can still occur once conditions on site are better known. However, this will require good cooperation between the Owner, Designer and Contractor.

3 During assessment, it is necessary to understand reasons why an evaluation of opportunities may not have led to enhancement of the water environment, even though opportunities may have been identified.

4 It is important to take account of costs, appropriate use of project funding in the project program and safety issues. Positive impacts on the water environment may not be visible for a long time, possibly long after handing over the project to the Client. This is why there are no questions on the long-term success of the measures.

5 Improving the Water Environment

(a) The Engineer may consider, identify, include in design and implement opportunities to improve the local water environment where appropriate.

6 Incorporating Existing Water Features

(a) The Engineer may incorporate the existing water features (for example as an amenity and/or for site drainage) in the design of the project.

(b) Incorporation of water features can provide amenity benefit, but water features that are incorporated into the project must form an integral part of the design and not reduce the ecological or environmental quality of the water feature.

7 Capturing Run-off for Beneficial Use

(a) The Engineer may make provision for capturing run-off for beneficial use on the project or nearby and, if appropriate, it will be incorporated in the completed project.

8 Flood risk from new developments can be reduced by keeping the number of sealed surfaces requiring drainage to a minimum (for example by using permeable paving materials or green roofs) and by introducing capture of run-off before it reaches the main drainage system. This capture may involve systems included within the wide-ranging definition of sustainable drainage design, but it is the capture for beneficial use that is important here.

END OF PART