ENVIRONMENTAL MANAGEMENT PLAN

ENVIRONMENTAL MANGEMENT TEAM

FERGUS HAMILTON

JOSH MAGOR

MOHAMMED BOKHAMSEEN

SARAH HARTLAND

MENGLIU FENG

VASILIOS HOIMES

Version Number	Purpose/Change	Name	Date
0.1	First Draft for Review	Fergus Hamilton	3/4/15
0.2	Review	David Argent	4/4/15
0.3	Review	Hugh Burger	5/4/15
0.4	Review	Joshua Magor	8/4/15
0.5	Final Edit	F.H & J.M	8/4/15

Executive Summary

The following Environment Impact Statement has being conducted for the North Terrace, Kent Town drainage system upgrade. The document highlights the key environmental issues in relation to the project, the appropriate environmental policies and environmental legalisations. The environmental impacts in relation to issues such as water quality, air quality, soil contamination, fauna, flora, existing infrastructure, noise etc. have been taken into account and analysed. Strategies to mitigate the environmental impacts have been provided as well as a recommendation on the best design solution for the drainage system upgrade.

The five design solutions being accessed in the feasibility stage include:

1. Existing stormwater upgrade
2. Swale Design
3. Water Sensitive Urban Design with infiltration
4. Water harvesting
5. Combined Water Sensitive Urban Design

This management plan takes into account all the environmental impacts and the best possible outcome for the social and economic elements of the project. The Environmental Management Team at Hydro-Future recommends that a bio retention system is the most environmentally friendly. Section 22 of the Environmental Management Plan breakdowns how this decision was made and explains the scoring system used.

Contents

Table of Figures

List of Tables

1. Introduction

The Oxford Dictionary (2015) defines the word “Environment” as the surroundings or conditions in which a person, animal, or plant lives or operates. Furthermore, the Environment can be divided into three key areas. These include the physical environment, the biological environment and the human/cultural environment.

This section of the feasibility study will involve the production of an Environmental Management Plan (EMP), also known as an Environmental Impact Assessment (EIA), which is designed to reveal any potential effects that may occur in the physical, biological and human environment as a result of the project. EMP’s or EIA’s are a staged process that takes place before a decision is made and attempts to assess the potential impacts of a proposed project. The central role of these environmental assessments are to be used as a tool to achieve sustainable development.

Hydro-Future is committed to using these environmental impact assessment tools to make sure that an effective and sustainable project solution is achieved for the North Terrace, Kent Town drainage system upgrade. The environmental plan will be used as the guideline to the environmental management of the work site to ensure that any impacts on the environment will be neutralised, or minimised to an acceptable level, whilst at the same time meeting the client’s needs.

The Environmental Management Plan will focus on potential impacts in the three key areas of the physical, biological and human environments and will look into the development of a sustainable solution that has an optimal balance between economic, social and environmental outcomes.

1.1. Background of the project

The City of Norwood Payneham and St. Peters is a metropolitan council, covering an area of 15.1km^2, east of Adelaide's CBD. One of the primary services that the council provides for the 34,000 residents is the stormwater drainage network. The drainage network allows for the effective collection of surface water in the area and provides flood protection throughout the city. The majority of the system comprises stormwater pipes, pits, junction boxes and culverts, the stormwater makes its way to First Creek, the River Torrens and ultimately Gulf St Vincent.

Over the years it has become apparent that as a result of heavy rainfall events, North Terrace Kent Town has suffered significant flooding from College Road through to the Royal Hotel. The council would like to develop a stormwater solution to resolve these flooding events and future proof the existing system against any heavy rain events that may occur. The new solution aims to include water sensitive urban design (WSUD) technologies, be cost effective and to improve the quality of the water before it exits the system into First Creek.

1.2. Project Task

In order to find the most suitable solution for the flooding problem at North Terrace, Kent Town the feasibility study will look at four main solutions that have been suggested to the client. The current suggested solutions involve a mix of upgrades to the existing system, the addition of retention basins, storage systems and using WSUD technologies to increase the capacity of the stormwater system. The feasibility study aims to find the most suitable solution after taking into account many factors such as cost, available land, site disruption, environmental friendliness, etc. The site location, as well as existing site conditions, are defined in Section 5.

2. Environmental Policy

Hydro-Future's vision is 'reducing our environmental footprint'. All environmental issues and risks are taken seriously to ensure that we preserve the environment we interact with. The company has its own Environmental Management Systems to ensure that the all environmental matters are managed with zero tolerance to any impacts that can damage the environment. Our Environmental Management Systems ensure that the business is compliant with ISO 14000 standards and Environmental Protection Act (EPA)-1993

Environmental Policy Key Points:

- All activities undertaken by Hydro-Future complies with the relevant environmental legislations and policies.
- Any environmental impacts must be identified, assessed and mitigated in all phases of the project (initiation, design, management, construction, operation and maintenance)
- Hydro-Future's Environmental Advisers are to be consulted regarding all the environmental matters, including any changes to the agreed Environmental Management Plans (EMPs).
- All staff is to be inducted to EMP, as well as the relevant legislations before commencing any work on site.
- Regular auditing by environmental advisers is to be undertaken, to ensure conformance to the agreed EMP and to identify any possible risk and manage them as soon as reasonably practicable.
- Hydro-Future's Environmental scorecards are to be evaluated annually to asses our environmental footprint and identify all opportunities for improvement.
- Adopt and promote energy and resource efficiency in all activities undertaken.
- All environmentally innovative ideas to be encourage though an annual internal Environmental award.

3. Environmental Legislation

Hydro-Future ensures that all environmental legislations and the appropriate policies will be strictly adhered to through the duration of the project. The following list of legalisations and policies will be used as the guidelines for all work that is being undertaken:

- Environment Protection Act 1993 (SA)
- Development Act 1993 (SA)
- Environment Protection (Air Quality) Policy 1994
- Environment Protection (Water Quality) Policy 2003
- Environment Protection (Noise) Policy 2007
- Environment Protection Regulations 2009
- Native Title Act 1993
- Heritage Places Act 1993 (SA)
- National Trust of South Australia Act 1955 (SA)
- Local Government Act 1999 (SA)
- Environmental Protection (Site Contamination) Amendment Act 2007 (SA)
- National Parks and Wildlife Act 1972 (SA)
- Native Vegetation Act 1991
- Environment Protection (Air Quality) Policy 1994 (SA)
- National Environment Protection Measure for Ambient Air (Ambient Air NEPM)
- National Environment Protection Measure for Air Toxics (Air Toxics NEPM)
- National Greenhouse and Energy Reporting Act 2007
- National Greenhouse Strategy (NGS)
- Environment Protection and Biodiversity Conservation Act 1999
- Water Resources Act 1997 (SA)
- Aboriginal Heritage Act 1988 (SA)
- EPA information sheet *Construction Noise 2014*
- Fire and Emergency Services Act 2005
- Management of Noise and Vibration: Construction and Maintenance Activities DPTI
- EPA information sheet *Bunding and spill management 2012*
- Real Property Act, 1886 (SA)
- Land Acquisition Information Guide (Roads and Maritime, 2012c)
- Land Acquisition (Just Terms Compensation) Act 1991.
- Environment Protection (Waste Management) Policy 1994

4. Environmental Issues

The environmental team at Hydro-Future has recognised the potential environmental impacts that may occur during the construction phase of the project. The key areas and impacts have been listed below.

4.1. Environmental Impacts

- Water Quality
- Air quality
- Noise
- Vibration
- Flora and Fauna
- Waste
- Fuels and chemicals
- Aesthetics

4.2. Social Impacts

- Interruptions to traffic flow
- Property access issues for local businesses
- Property access issues for local residents
- Property access issues for St. Peters school

4.3. Cultural and Historic Impacts

- Non – Aboriginal Heritage
- Aboriginal Heritage
- Impact on existing arch culvert

The environmental team at Hydro-Future is committed to performing the necessary research to find all potential impacts and to devise innovative mitigation strategies to combat them. The following sections outline potential impacts that may be present, provide a mitigation method and preferred design option.

5. Existing Conditions

During investigation of the project area, various factors were noted which included the existing condition of the infrastructure, vegetation, stormwater system, traffic volumes and road conditions. All design options are compared against the current condition of the project site to determine which option will be the most beneficial for the environment. The conditions of the existing features have been investigated and are detailed below.

5.1 Infrastructure/Land Use

Figure 1 below is an extract from the SA GOV Atlas site that identifies the land use in the project area. The majority of the area appears to be retail commercial businesses with a school located on the north eastern side of North Terrace. The botanic gardens and the road gardens are also located close to the project area and could potentially be affected by the construction process.

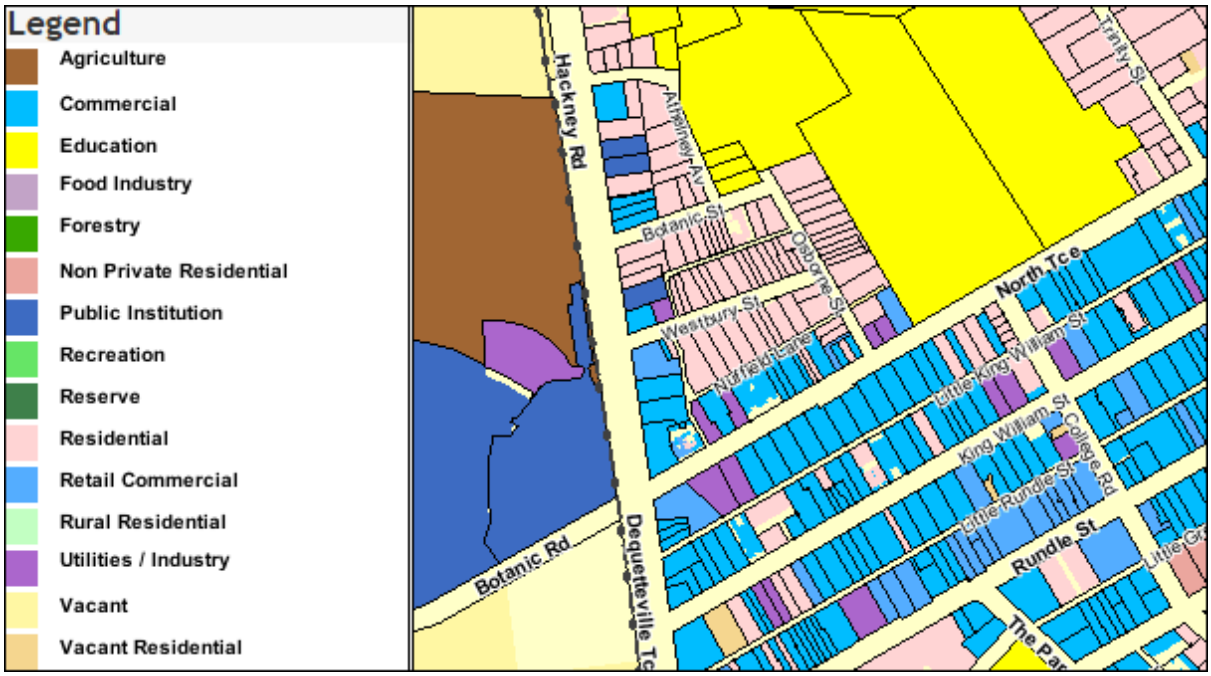

Figure 1- Project Location Land Use Diagram (SA GOV, 2015)

The infrastructure currently in this location comprises of footpaths, retail commercial buildings, driveways and services including street lighting and drainage. There is a sandstone arch culvert located over First Creek that is approximately 150 years old. It has been noted that a number of sandstone bricks from the culvert are missing and may need replacing to ensure that the culvert can be used for the proposed design. There is a diverse selection of building stones used throughout the subject section which is consistent with the building materials of the surrounding streets in the City of Norwood, Payneham and St. Peters which creates a visually appealing street with historic appeal.

5.2 Stormwater

The current stormwater system collects water from both sides of North Terrace as well as the surrounding catchment area. The system then transports the water to First Creek; it is understood that at present there is a gross pollutant trap that filters water as First Creek enters the River Torrens, currently there is no system in place to improve water quality from the project area to First Creek. Therefore, the current water quality is based purely on the litter, rubbish and other pollutants that may be deposited on the road.

5.3 Vegetation

The existing vegetation in the project area is minimal, there is no solid median in the centre of the road and there are multiple driveways which prevent a significant amount of vegetation along the footpath. A number of juvenile trees are placed at regular intervals along the southern side of North Terrace whereas the north side has fewer trees planted, these trees are of reasonable size and health.

5.4 Traffic/Road

The road is an undivided dual carriageway that provides adequate walkways on either side. This section of North Terrace has an Annual Average Daily Traffic (AADT) of approximately 34,200 vehicles and is usually busy from 5am until 3am as it is one of Adelaide's key arterial roads providing access both in and out of the city centre to the North-Eastern Suburbs. This is a significantly busy road during peak hour periods, therefore a traffic management plan will be created by the Transport Engineering team to ensure that traffic flow has minimal interruptions.

5.5 Native Fauna

The project location is a relatively small area that is almost entirely paved and does not cater for native wildlife. First Creek runs through this section underground, emerging at the Adelaide Botanic Gardens. The only vegetation along this section of road is trees, these are primarily aesthetic as the large volumes of traffic would discourage fauna. However, these trees will still need to be inspected for any bird's nests so that construction for the project can be done as far away as possible to ensure the breeding cycles are not disturbed.

5.6 Soil

The geotechnical data indicates that the soil in the study area is predominantly made up of red-brown clay soils with granular structure over clay with variable lime. Table 1 below breaks down the soil types in the area.

Table 1: Project Area Soil Description

Red-brown clay soils	
Soil Type	Soil Description
Red Brown Earth (RB3)	Heavy red-brown clay soils with prismatic or blocky structure over clay with variable lime.
Red Brown Earth (RB2)	Red-Brown Sandy clay soils with granular structure.
Red Brown Earth RB5a	Brown clay or sandy clay soils with granular structure over sandy clay with some lime.
Red Brown Earth RB9	Mottled silty clay over brown silty clay with granular structure, slight lime, becoming sandy with depth.
Alluvial Soils (AL)	Layered stream alluvium – silts, sands and gravel.

Clay layers exhibit high undrained cohesion strength. This potentially causes the soil to soften after loss of moisture from groundwater, thus causing ground settlement. However, when excavations extend to the groundwater table, caution must be taken so that the construction work does not cause any damage.

5.7 Waste and resources

Figure 1 shows that North Terrace is the main access point for a number of businesses in Kent Town for the general public, including residents and everyday commuters. A site investigation determined that there is currently two rubbish bins along the footpaths in this location with one bin located next to a bus stop. Regular services including side entry pit cleaning, street sweeping and 'Autumn Leaf' pick up services are currently operating in the area.

5.8 Noise and Vibration

According to the NSW Environment Protection Agency Road Noise Policy, the desired road noise during the daytime is to be less than 50-65dB (DECCW 2011). Without further data it will be assumed that this is the approximate level of noise experienced at the project location. As most of the works will be conducted at night any noise that exceeds this will require a noise exceedance permit to ensure the works are closely monitored. By implementing the mitigation

strategies discussed later, it will be possible to limit the effect of construction noise and vibration on the local residence and business owners.

5.9 Air Quality

Given the project location, large volumes of traffic, and limited air movement it can be assumed that the air quality will be below average. By implementing the mitigation strategies discussed later, it will be possible to limit any negative effect due to the construction phase, on air quality.

6. Water Quality Management

Stormwater quality will be an important consideration for each of the design options. There is particular concern during the construction phase that stormwater may be polluted. The Environmental Protection Agency (EPA) stormwater pollution prevention code of practice states: "*it is more cost effective and far more preferable to reduce, and where possible eliminate the causes and sources of stormwater pollution than to treat it downstream*" (EPA 1999). This can be managed in the construction phase by implementing the recommended mitigation strategies listed below.

The stormwater quality will also need to be considered post construction as well. The project area resides in the middle of a large catchment area, therefore any runoff from North Terrace will add pollutants to the system, such as heavy metals, oils and sediments. Through proper management and careful design the stormwater run-off can be utilised as a valuable resource rather than a waste product. The objectives of the stormwater design are listed below:

- Design for a 100 year ARI
- Maintain water quality by preventing contamination during construction
- Ensure that the natural ecosystem benefits from the chosen design

6.1 Relevant Legislation and Codes of Practice

- Environment Protection Act 1993
- Water Resources Act 1997
- EPA stormwater pollution prevention code of practice 1999

6.2 Polluted storm water runoff

With the upgrade and redesign of the stormwater drainage system, the risk of new and unwanted pollutants entering the surrounding waterways need to be minimised or eliminated. Water runoff can be and often is the primary cause of pollution in rivers, lakes and oceans. As the North Terrace redesign is within the Adelaide CBD area, the pedestrian activity areas, car traffic volumes and litter levels are expected to be higher than the South Australian average. Pollutants that can enter the waterways are listed below:

- Motor oil, petrol, diesel, fertilisers, pet waste and other toxic materials
- Sediment from construction sites and from nearby soil erosion
- Litter including bottles, cans, paper, plastic and cigarette butts

6.3 Mitigation Strategies

Construction

In order to minimise any polluted stormwater run-off, the following mitigation measures will need to be adhered to during the construction phase of this project:

- Ensure vehicles entering the construction site, are mechanically sound to minimise faults causing spills of potentially hazardous substances (e.g. oils and hydraulic fluids) to the ground
- No chemicals or products are allowed to enter the immediate environment or waterways
- Appropriate erosion and sediment control to be implemented on site
- Appropriate stormwater diversion controls will be installed and maintained to divert runoff waters around/away from potential sources of contamination
- Provision and use of spill kits, drip trays, bunding trays and lined areas to minimise pollution to the ground and/or waterways
- Provision and monitoring of temporary washout basins for concrete pumps and trucks
- Provision of sediment control structures to prevent sediment entering drainage systems particularly where surfaces are exposed or soil is stockpiled for extended periods on site

Post Construction

It will be important for each of the design options to improve water quality and protect the environment by stopping litter before it enters the water system. This can be achieved through several measures, firstly by engaging street sweepers to remove vegetation and litter that is caught in the gutters prior to it making it into the stormwater system. Further to this, if the upgrade to the existing stormwater system is selected, the installation of a gross pollutant trap prior to the wetland to remove solid waste before the stormwater enters any water ways, will be required. The use of a gross pollutant trap will ensure any downstream treatment of the water can happen more easily. The gross pollutant trap will need be cleaned out periodically. For further details regarding the recommended gross pollutant traps refer to Appendix A.

In order to remove pollutants such as toxins and heavy metals, the use of either a wetland or bio retention system is recommended. These detention basins naturally and environmentally filter the water to remove pollutants. The water can then be reinjected into the waterways via two options: by following through to a final drain at the end of the basin or through natural infiltration entering the water table.

6.4 Impact on designs

Water quality management is very important for each of the designs. Regardless of the design option chosen, the main environmental issues occur within the construction phase, as there may be potential for water ways to be exposed to pollutants. This can be managed through the mitigation strategies listed above.

Design option 1 – upgrade existing stormwater system, post construction is the preferred option as it will produce a higher quality of stormwater through the use of the wetlands. It also moves future maintenance work from North Terrace; this will have positive social repercussions for the local residents and business owners. The wetlands will remove pollutants from the stormwater runoff prior to entering the water ways. This is desirable as the quality of water entering the waterways will be improved from the existing condition.

Design option 2 – Swale design, this design option will remove some contaminants through the swale and will improve the quality of the stormwater run-off. This design will increase maintenance in the project area in the future.

Design option 3 - WSUD with infiltration achieves the required result by increasing retention along the roadways and surrounding properties, reducing the quantity of stormwater runoff. This option has the least risk of contamination in the construction phase. Diverting stormwater from its original route using the surrounding businesses and public areas, will lower the strain that is on the system currently. The water will be diverted to newly built soakaways, leaky wells, retention basins and storage tanks. This method has little impact on the water quality.

Design Option 4 - Water harvesting achieves the required result by having the roadways lined with vegetation systems, buried infiltration pipes and an updated stormwater system with detention basin. Like option 1 this system will improve the quality of the storm water runoff into waterways but any future maintenance is likely to affect local residence and businesses.

Design Option 5 - Combined WSUD is a combination of WSUD with infiltration and water harvesting. This system will improve the quality and reduce the quantity of stormwater runoff in in the future. Future maintenance is still likely to affect local residence and businesses.

7. Heritage

Before any construction can begin it will be important to consider any existing heritage listed areas within the project site. Any alterations that are needed to be made on aboriginal land will first need the approval from the Minister for Aboriginal Affairs and Reconciliation. Any works conducted that can effect a heritage area will need to be in accordance with the Heritage Places Act 1993.

An issue that was outlined within the tender report is the existing 150 year old heritage arch culvert that has an existing stormwater pipe running through it. Before the construction can commence an overview of the current condition of the culvert is needed, in order to determine if it will be safe to increase flows through the structure. Further consideration will be needed for design options 1 – existing stormwater upgrade and design option 3 – WSUD with infiltration that call for the construction of a bio retention system or wetland. These design options may impact upon existing heritage trees through processes such as soil degradation and the flooding of roots caused by pooled stormwater.

7.1 Relevant legislation

- Development Act 1993 (SA)
- Native Title Act 1993
- Heritage Places Act 1993 (SA)
- Aboriginal Heritage Act 1988 (SA)
- Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)
- National Trust of South Australia Act 1955 (SA)

7.2 Mitigation Strategies

The mitigation strategies for dealing with Heritage sites and Aboriginal Heritage sites are listed below:

Heritage

- Check the quality of the arch culvert in its current state and with the help of the SA Heritage Register make a decision on whether to reuse/upgrade the stormwater drains running through the bridge.
- Investigate alternatives i.e. divert the stormwater around the bridge. Heritage listed trees will need to be surveyed to allow enough room to ensure there is no damage.

Aboriginal heritage

- Hydro-Future will not disturb or remove any material of potential archaeological or historic significance from any work site.
- Hydro-Future will take every precaution to prevent the loss, damage or removal of any item of anthropological or archaeological interest. Strategies include:
- Under the *Aboriginal Heritage Act 1988* Hydro-Future has an obligation not to damage or disturb sites or objects of Aboriginal Significance. If at any time during the works, a suspected Aboriginal site or a site containing items associated with Aboriginal occupation is uncovered, work must stop immediately and the appropriate authority will be notified immediately. Work must not recommence in the affected area until direction is provided by the Minister for Aboriginal Affairs and Reconciliation as per the *Aboriginal Heritage Act 1988*.

7.3 Impact on designs

The capacity to affect any aboriginal heritage in the area is highly unlikely, this is due to the project area already having an established infrastructure and dense population. The works that are proposed for any of the designs should have no adverse effect on aboriginal heritage.

8. Air Quality and Greenhouse Gas Emissions

The Environment Protection (Air Quality) Policy 1994 states that "*air pollution means the emission into the air of any pollutant*". All aspects of this project that have the potential to have a negative impact on air quality need to be investigated by Hydro-Future. As this project will require earth works, a large consideration will be the control of dust from the work site and the mechanical condition of the earth moving equipment.

8.1 Relevant Legislation and Policy

- Environment Protection Act 1993
- Environment Protection (Air Quality) Policy 1994

8.2 Construction Impacts

Activities which may produce unacceptable or harmful levels of dust or fumes during the construction phase of this project may include:

- Transport of waste materials from site
- Excavation
- Use of solvents
- Welding, cutting, grinding
- Plant vehicles
- Wind affecting disturbed soils

8.3 Recommended Mitigation Strategies

The recommended mitigation strategies for the control of air quality during the construction phase are listed below:

- Construction areas, in particular exposed areas and stockpiles, should be wetted down frequently during the project
- Stockpiled soils will be excavated and placed in order to minimise dust generation
- Disturbed areas will be stabilised as soon as practical
- Rehabilitation/remediation of construction areas to be undertaken as soon as practical
- Waste materials, excess soil being carted from site, soils being carted to site, and any other dust-generating materials are to be sufficiently covered during transport
- Equipment and machinery will be maintained to ensure optimal operation

- The use of solvents will be in accordance with manufacturers' recommendations with due consideration given to environmental impacts

8.4 Impact on Designs

There have been five options proposed for this feasibility study; existing stormwater system upgrade, swale design, water sensitive urban design with infiltration, water harvesting and a combined water sensitive urban design. The main concern with regard to air quality will be the production of dust during the construction phase. The largest contributing factor to greenhouse gas emissions will be the use of plant and equipment during construction. In terms of air quality and greenhouse gas emissions the most desirable design is option 1 – existing stormwater upgrade. This design option places a reduced demand on construction activity, as all of the options will require some level of stormwater system to direct flows and capture overflows. However this design option will still require construction works and the mitigation strategies listed above will need to be adhered to, this will reduce the effects on local residence/businesses and the environment.

9. Noise and Vibration

The Environment Protection Act 1993 requires that all reasonable and practicable measures are taken, in relation to construction activities to minimise noise and vibration at all times. Noise and vibration pollution can have adverse health effects on humans; including stress related illnesses, high blood pressure, speech interference, hearing loss, sleep disruption, and lost productivity (EPA 2012). Due to this, it is of the utmost importance that any construction activities undertaken in relation to this project, need to be managed with care, to minimise any impacts on local residence and businesses.

EPA Information sheet *Construction Noise 2014,* states that noise includes vibration, and defines construction noise that will have an adverse impact on amenities as; the source noise level is continuous and exceeds 45 dB, or the source noise level at its maximum exceeds 60dB.Any construction activity that will exceed these noise limits needs to be conducted using the mitigation strategies below.

9.1 Relevant Legislation and Policy

- Management of Noise and Vibration: Construction and Maintenance Activities DPTI
- Environment Protection Act 1993
- EPA information sheet *Construction Noise 2014*
- Environment Protection (Noise) Policy 2007

9.2 Construction Impacts

Due to the existing traffic condition in the project area the majority of the work will take place between the hours of 9pm and 5am. Activities, which may produce unacceptable noise levels during the construction phase of this project are:

- Engine driven equipment
- Rock breaking
- Jackhammers
- Hammering
- Friction sawing and grinding
- Vehicles entering and exiting site
- Excavations
- Compaction
- Cranes and their operations

- Warning alarms/sirens

9.3 Recommended Mitigation Strategies

Hydro-Future's recommended mitigation strategies for construction activities are:

- Engine driven equipment is to be fitted with noise suppression enclosures/devices
- Jackhammers are to be silenced and jack hammering operations are to be undertaken during less sensitive times of the day and kept to a minimum
- Hammering should not be continuous over long periods of time
- The use of friction sawing and grinding equipment is to be undertaken during less sensitive times of the day and kept to a minimum
- Vehicles entering and exiting the site will use pre-planned traffic routes
- All tasks that create noise exceeding 45dB (continuous) and 60dB (maximum) will require a noise exceedance permit that must be signed by the Project Manager and reviewed daily
- The use of acoustic barriers when any works are within close proximity to residential or commercial dwellings
- Regular monitoring of noise and vibration levels
- Advanced notice of the works to be conducted
- Conduct dilapidation reports on properties that have been identified as having a potential to be damaged by vibration during construction

9.4 Impact on Designs

There have been five options proposed for this feasibility study; existing stormwater system upgrade, swale design, water sensitive urban design with infiltration, water harvesting and a combined water sensitive urban design. The main concern with regard to noise and vibration will be the use of plant and equipment during the construction phase. All of the five options will require the use of heavy machinery to complete the works. In each of the designs there will be considerable disturbance to the residence/businesses and road users. It will be critical that whichever design is selected, the above mentioned mitigation measures are adhered to. The most desirable design option will be the one that reduces the amount of time that residence/businesses and road users will be disrupted. Option 1 – existing stormwater system upgrade is the preferred option for reducing the length of time, that noise and vibration will be an issue.

10. Fire

Hydro-Future considers the possibility of fire, a serious risk. Taking this into consideration any activities that may result in a fire, will be carefully considered and planned. There are several construction activities that pose a risk of fire, especially when performed in conjunction with high risk weather.

10.1 Relevant Legislation and Policy

- Fire and Emergency Services Act 2005

10.2 Construction Impacts

Activities which may pose a risk of fire during the construction phase of this project include:

- Welding
- Grinding
- Friction and flame cutting

10.3 Mitigation Strategies

The recommended mitigation strategies for the control of the risk of fire during the construction phase are listed below:

- Compliance with the South Australian Fire and Emergency Services Act 2005
- Monitoring of fire risk reporting and where days of acute fire risk are possible, Hydro-Future will abide by the State Fire Authority ruling
- All possible measures will be implemented for the avoidance of ignition sources on site and for the accidental lighting of fires
- Requirement of a hot work permit issued by the Project Manager for all tasks that have the potential to cause a fire, reviewed on a minimum daily basis
- Fire extinguishers to be located on site at all time
- Enforce no smoking policies on site

10.4 Impact on Designs

There have been five options proposed for this feasibility study; existing stormwater system upgrade, swale design, water sensitive urban design with infiltration, water harvesting and a combined water sensitive urban design. The main concern with regard to fire, will be the need to perform any; welding, grinding or friction and flame cutting. All of the proposed options may

require these tasks to be performed and there is no preferred option. Each design will need to consider the mitigation strategies listed above.

11. Dangerous Goods

The Environment Protection Act 1993 states that "all persons undertaking an activity that may pollute, need to take all reasonable and practicable measures to prevent or minimise any resulting environmental harm". Hydro-Future recognises that when it is necessary to use a dangerous good on site there is potential to cause harm, and whenever a dangerous good is used steps will be taken to minimise this risk.

11.1 Relevant Legislation and Policy

- Environment Protection Act 1993
- Environment Protection (Water Quality) Policy 2003
- EPA information sheet *Bunding and spill management 2012*

11.2 Construction Impacts

Dangerous goods forecast for use on site which may cause harm include:

- Paints
- Cleaning solvents
- Oils
- Excavated soils

11.3 Mitigation Strategies

The recommended mitigation strategies for the handling of dangerous goods forecast for use on site during the construction phase are listed below:

- Storage and use of all chemicals including dangerous goods will be in compliance with EPA Guideline: *Bunding and spill management 2012,* and the manufacturer's recommendations
- MSDS's will be available for all chemicals that are used and stored on site
- Maintain a MSDS register
- Appropriate storage and signage to be provided for all dangerous goods (and potentially hazardous materials)
- Management of hazardous wastes to be in accordance with EPA's requirements
- Vessels/containers containing potentially hazardous substances or dangerous goods will not be left unsealed for extended periods of time
- Spill kits and procedures will be in place for activities that may cause a spill

11.4 Impact on Designs

There have been five options proposed for this feasibility study; existing stormwater system upgrade, swale design, water sensitive urban design with infiltration, water harvesting and a combined water sensitive urban design. There are several instances during the construction of this project where it may be necessary to use dangerous goods. It is predicted that any of the designs may require the use of dangerous goods such as paints, oils or solvents. All of the proposed options may require use of these dangerous goods so there is no preferred option. Each design will need to consider the mitigation strategies listed above.

12. Earthworks

This project involves a large amount of excavation and earthworks to the drainage system. Drainage excavations are carried out primarily to allow fitting or repair of public utilities and services, drains and sewers to serve populated areas. Damage to underground utilities and services can cause fatal or severe injuries as well as significant service disruption and environmental damage. This can also postpone the project and incur considerable costs. Hence, these services need to have their exact location confirmed prior to excavation, via potholing. The detailed design will need to take into consideration minimum distances from the particular utilities.

The surrounding environment of the site should also be examined. This includes traffic volume, stability and condition of nearby buildings, groundwater table, and flooding conditions in the vicinity of the site.

12.1 Recommended Mitigation Strategies

The location of the site has been observed to have a high risk of flooding, an emergency plan is essential; this will consist of emergency contact numbers and other emergency measures such as, fencing off possibly risky zones and provision for pumping out water from trenches. Awareness programmes should be conducted for all site personnel regarding the emergency plan. In the event of an emergency it is everybody's responsibility to take action.

13.Utilities & Services

Most of the underground utilities & services are live systems including; electricity, gas, sewer storm water and water supply. These can be hazardous to personnel when damaged or ruptured. Predominantly for water mains and sewage rising mains, ground movement resulting from excavation may be sufficient to cause a failure.

By identifying and managing the dangers that are associated with the disruption of services, the construction teams are able to avoid the negative impacts associated with earthworks. Utility companies should be consulted to determine the locations of their existing services in the vicinity of the planned upgrade, prior to commencement of excavation.

The utilities & services mentioned are:

- ***Electricity cables***
    - If disrupted, could cause the area to black out.
- ***Gas pipes***
    - Damage to gas pipes and connections can cause leaks that may lead to fire or explosion.
- ***Water pipes and sewers***
    - Leaks of water from underground pipes can affect adjacent services and reduce support for other structures.
    - Damage to mains pipes can result in flooding, leading to subsequent risks from drowning or the rapid collapse of support to the sides of an excavation; water can enter gas pipes if they are also damaged.
- ***Telecommunication cables***
    - Damage to telecommunication and TV cables may require expensive repairs and can cause considerable disruption to those relying on the system.

Figure 2 below demonstrates the process to start work near underground services.

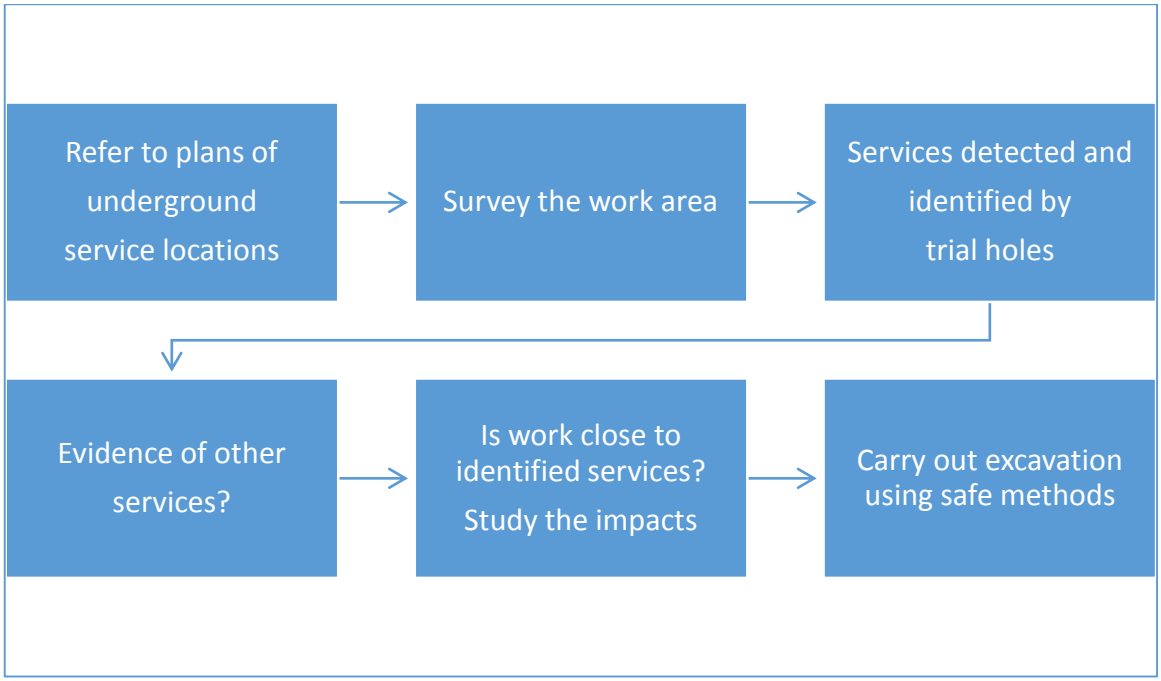

Figure 2 - Utilities & Services Safe Work Practices

13.1 Recommended Mitigation Strategies

The following are the recommended mitigation strategies that should be followed:

- Installation of fences and barriers to prevent public access to construction areas
- Safety signs and warnings to be installed around the site
- Appropriate erosion and sediment control methods to be in place
- Minimise the exposure of humans and environment to polluted soils
- Manage pollutants and waste reasonably without discharging into the environment
- Ensure all hazardous and potentially contaminated material are documented and disposed of through appropriate means
- Minimise surface runoff through drainage control
- Excavation work should be carried out carefully and follow recognised safe digging practices
- Detect underground services
- Excavation to be done alongside the service rather than directly above it, where possible
- Length of excavations kept to a minimum to reduce resulting load on services
- The routing of the utilities and services should be kept as far away from the site as possible
- Develop plans to minimise the risk of damage to services in the project area
- Ensure the teams involved in detecting and identifying services are competent in the proper use of survey tools and detecting devices as well as reading/interpreting plans
- Backfilling of excavations must properly support and protect the underground services
- All Hydro-Future employees and subcontractors to comply with WHS requirements
- All personnel to wear personal protective equipment and follow a safe system of work

13.2 Impacts on Chosen Design

There have been five options proposed for this feasibility study; existing stormwater system upgrade, swale design, water sensitive urban design with infiltration, water harvesting and a combined water sensitive urban design. For any of the design solutions, the impact will be the same in terms of earthworks and utilities & services. The project will involve large amounts of excavation and backfilling, these activities will interfere with sidewalks and roads. In addition, the utilities and services will be rerouted to another station temporarily until the project is finalised. This will affect the occupants in the area for a period of time.

14.Soil Contamination and Pollution

Soil contamination can be defined as “either solid or liquid hazardous substances mixed with the naturally occurring soil” (UEPA 2011). It is typically caused by industrial activities, construction activities, agricultural chemicals, or improper disposal of waste. Humans introduce hazardous objects, chemicals or substances, directly or indirectly into the soil environment in a way that causes harm to themselves and other living things, and destroys soil or water ecosystems.

Contaminants in the soil can impact the health of humans when they ingest, inhale, or touch contaminated soil, or when they eat plants or animals that have themselves been affected by soil contamination. Plants can be damaged when they attempt to grow in contaminated soil as they can absorb the contamination through their roots. Humans ingest and come into contact with contaminants when they come in contact with contaminated soil through a number of activities including digging in the soil as part of a construction process. When contaminants are attached to small surface soil particles they can become airborne as dust and can be inhaled.

14.1 Potential Impacts

14.1.1 Seepage and leakage

There are risks associated with any project undergoing construction. The aim is to minimise these risks and provide a safe environment. However, during construction there could be leakage of a hazardous substance. This causes the soil to become contaminated and is a threat to the surrounding environment. Chemicals present in the soil can infiltrate and pass through the soil layers, eventually coming in contact with the groundwater table. This enables the contamination to spread quickly and causes the formation of sewage sludge. Thus, it is imperative to avoid contamination of the soil layers as much as possible, as it poses a threat to the general environment.

14.1.2 Erosion

The loss of topsoil, either by removal with heavy equipment or erosion by wind and water, is the worst type of on-site damage in urban areas. This layer of soil has the highest biological activity, organic matter, and plant nutrients—all key components of healthy soil. The onsite loss of this upper layer of soil nearly eliminates the soil’s natural ability to provide nutrients, regulate water flow, and combat pests and disease (USDA 2000).

Erosion control practices are implemented to hold soil in place and reduce soil removal by stormwater. The most effective way to control erosion is to preserve existing vegetation and replant cleared or bare areas as soon as possible. Planning before construction is vital to conserve the topsoil, prevent costly flooding problems, conserve natural areas and native species, reduce paved areas, prevent property damage and minimise stormwater runoff. As the project area is mostly paved the risk of erosion is minimal, but careful consideration should be made in areas where any vegetation is present and when construction/excavations are ongoing.

14.1.3 Existing Slope Features

The stability condition of the slope features in the site area should be examined and taken into consideration in the design stage. These slope features consist of cut slopes, fill slopes or retaining walls. For each of the design options the slope of excavated areas needs to be considered. When the slope features are assumed to be slightly instable, or are prone to ground movement, preventative procedures will be put into place to support the slope features.

14.1.4 Groundwater control

Groundwater control is a significant issue in the majority of excavation sites to avoid migration of contaminants, control erosion, or to keep groundwater from escaping into the excavation site. If a high groundwater table is present, the cut-off wall method or the techniques of dewatering will need to be put into action to prevent groundwater from entering the project site. In reality however, the application of dewatering techniques may cause a reduction of the groundwater around the excavation area, resulting in an increase in the effective stress of the soil layers, resulting in soil and ground settlement (HBGC 2014).

Since the project area and its surroundings are rich in heritage with old sensitive buildings, an evaluation of the potentially negative effects associated with the groundwater control techniques will be mandatory, through careful management.

15.Social Impact

Under heavy rainfall conditions, North Terrace currently undergoes substantial flooding near the Royal Hotel. It is imperative to develop a solution to this problem. However, during the construction phase, this project will significantly impact the society and surrounding environment including; residents, business owners and public areas. Despite the fact that the project aims to minimise the flooding, the social impact linked with the project design should be considered thoroughly. Since the project area consists of residential and commercial dwellings, the occupants will be directly affected during the construction phase of the project.

15.1 Construction Impacts

It is typical for the surrounding area and occupants to have a sense of discomfort during the construction phase of the project. Air pollution, noise pollution, peak traffic flows, untidiness and many other drawbacks will cause social impacts. Air pollution could be a significant source of this discomfort and has the potential to cause adverse health effects. This could affect the surrounding area including residents, business owners, and the workers on site. Thus, the implementation of the recommended mitigation strategies to minimise, or eliminate this problem is critical.

North Terrace is the main arterial routes into the city centre from the North-Eastern suburbs. The road is busy from 5am until 3am most days. This project will radically affect the traffic in the area, thus increasing the build-up of vehicles and pollution concentrated in the surrounding area. This project will require extensive traffic management measures, to ensure safe travel and smooth traffic conditions. The business owners along the road including the Heart Centre, The Royal Hotel, and Clark Rubber will be provided access to their respected areas at all times.

Since the project requires deep excavation, significant underground obstructions and services could be removed or refurbished. These services include TV cables, electricity cables, telecommunication and Ethernet connections, potable water pipes, high pressure gas pipes and others. During the excavation phase of the project, these services may be temporary cut-off from the surrounding area to ensure safe excavation without damaging the existing utilities and services pipes.

15.2 Post-Construction Impacts

Post construction the flooding issue will be resolved in the project area regardless of the design option selected. This will have positive social impacts for the surrounding residence and business owners, they will no longer have to deal with the concerns associated with flooding.

15.3 Recommended Mitigation Strategies

- Informing the public about the project and how it may affect the surrounding area
- Taking precautionary measure to avoid any unnecessary disturbance to the public and the community
- Redirecting the utilities and services as soon as possible to reduce impact to the community
- Install appropriate signage

15.4 Impact on Chosen Design

Table 2 below shows the five different design options and the social impact each choice will have.

Table 2: Impact on chosen design

Design Option	Impact
Existing Stormwater upgrade	As the existing stormwater upgrade option would require the least amount of construction on North Terrace, it will have a reduced negative social impact during the construction phase. Post construction the flooding problem will have been solved this will have positive social impacts for residents and businesses.
WSUD with infiltration	The WSUD with infiltration option would require significant construction along North Terrace having a negative social impact, as it will disrupt traffic, residents and businesses. In addition, air and noise pollution would cause the area to be unfavourable until the work is complete. Post construction the flooding problem will have been solved this will have positive social impacts for residents and businesses.
Swale Design	All three of these options would enhance the landscape zone by integrating green ecological systems within the drainage systems. These options require large amounts of disturbance to the project area during the construction phase which will have negative social impacts for traffic, residents and businesses.
Water Harvesting	
Combined WSUD	

16 Aesthetics

Architectural impacts are expected with the North Terrace drainage system upgrade project from the pre-construction to operation stages. The impacts involve urban design, landscape character and views. In this project, there are businesses on the North side of North Terrace, as well as residential areas and St Peter College Junior School along the northern side of the road. Hence, environmental strategies will need to be used to minimise the negative influence on the surrounding environment and to improve the aesthetic aspect of the environment.

16.1 Potential impacts

16.1.1 Operation

Once the drainage system is upgraded, it would contribute to the aesthetic values of surroundings. Through the successful completion of the project, the flooding problem will be resolved, it may also enhance the landscape by incorporating Water Sensitive Urban Design features into the landscape design. The urban design and landscape areas along the road could be maintained and made consistent with other ~~recently completed~~ sections of North Terrace and the street views of Norwood city.

16.1.2 Construction

During the construction stage, the most negative visual impact would be the destruction of existing plants around the site. The construction site, earth work, waste (liquid, solid and dust) and lighting from construction will affect the adjacent businesses and residents. The project may also cause an increased traffic delays changes in lighting and added signage with the potential blocking of doorways, entrances, and paths.

16.2 Recommended Mitigation measures

A detailed aesthetics management plan would be developed referring to the selected design option. Measures need to be taken to contribute to the overall designs appearance, and to reduce the overall impact on the environment.

Investigation is needed to keep the urban design and landscaping consistent along North Terrace in Kent Town. Measures to improve visual amenities would be undertaken as follows:

- Retain existing vegetation around the perimeter of the construction sites
- Undertake revegetation or landscaping progressively
- Implement landscape wall, artwork or project information to provide visual screening

- Implement signage displaying basic information and locations of elements within the construction site
- Organise site hoardings and maintain them within the site area
- Develop a signage strategy during detailed design
- Manage lighting locations to minimise annoyance to adjoining residential and business areas
- Carry out regular clean-up and maintenance during and after construction
- Visual evaluation to control and guarantee the impact is at an minimised level

16.3 Impact on chosen design

All of the five design options of North Terrace drainage design project would bring visual changes to the current project area. They will improve the aesthetics of the project area by resolving the flood problem.

Options 1 – Existing stormwater upgrade will require the least amount of construction, meaning during this phase of the project it will have the least negative effect on the project site aesthetics. Post construction the wetlands will provide an improvement to the existing landscape, however North Terrace will remain looking the same.

Option 2 – Swale design, involves the most construction work and will have the worst effect on aesthetics during this stage of the project. Post construction this design will greatly improve the aesthetic appearance of North Terrace.

Option 3 - WSUD with infiltration will involve large excavation works to be conducted in the construction stage, aesthetically this will be unpleasant. Post construction this will add greenery to the project site increase the areas aesthetic appeal.

Option 4 – Water harvesting, will involve a large amount of earthworks to prepare the site for underground tanks having a visual displeasing appearance. Post construction the installation of underground rainwater tanks will have little impact on the aesthetics of the area.

Option 5 – Combined WUSD, involves similar amounts of earthworks to options 3 and 4 listed above as it is a combination of the two. Post construction the addition of greenery will improve the aesthetics of the area.

Options 3, 4 and 5 listed above are the preferred design options for post construction aesthetic appeal.

17 Property Access

The study area involves the city of Norwood Payneham and St Peters' Kent Town, where a high density of business and residential areas are located. Since North Terrace is one of the main arterial roads to the city centre, there is always heavy traffic and pedestrian flow during peak hours, as well as three bus stops located within the project area. The project would further increase the traffic volume and restrict access to properties along North Terrace. The traffic capacity, intersection capacity and safety index will need to be investigated. An assessment of these impacts on the road network due to the proposed works will need to be developed and presented during different stages.

17.1 Potential impacts

171.1 Operation

The impacts of the project on the operation of the area are positive: it contributes to safer traffic flow for North Terrace, Kent Town as there will be no more flooding in project area.

17.1.2 Construction

Significant access issues will occur during the construction stage. The project constructions may temporarily block the entrances to the properties along the road project area, including the Royal Hotel and St Peters' College Junior School. The project will influence the traffic heading through The City of Norwood Payneham and St. Peters and the surrounding residential and business areas during the construction stage.

17.2 Recommended Mitigation Measures

Affected property owners in the project will be consulted on where temporary property access should be located, and notified of relevant project schedules, construction works and changes to access arrangements. Those affected landowners along the road sides who need to be relocated would be appropriately compensated according to Real Property Act, 1886 (SA) and Land & Business (Sale & Conveyancing) Act 1994. Community updates would be provided on changes to the local road network within the project area during construction.

Appropriate signage would be provided to ensure an understanding of how to access local businesses, how local residents can access their homes and to indicate parking areas for people stopping in the area.

17.3 Impact on chosen design

All design options will temporarily block access to properties at various stages of the construction phase. Option 2 – Swale design, would require the most road side construction, meaning the largest amount of disruption to property access. Option 1 – Existing stormwater upgrade and Option 4 – Water harvesting are the preferred options regarding property access, these options involve the least construction along North Terrace.

18. Land Acquisition

In the project, the acquisition of land would be required for areas adjacent to North Terrace, for Water Sensitive Urban Design options, including swale and water harvesting options. A plan for land acquisition is needed to minimise the impacts on the surrounding environment, economy and community. It should be designed specifically for the chosen design option.

18.1 Recommended mitigation measures

Land acquisition for the project would be undertaken in accordance with the Land Acquisition Information Guide (Roads and Maritime, 2012) and the Land Acquisition (Just Terms Compensation) Act 1991.

It is necessary to review urban planning and contact Adelaide Land Division Services to find out if there is any reserved land available that can be used for the project temporarily within the subject area. All businesses and residents affected by land acquisition for the project will be appropriately compensated.

18.2 Impact on chosen design

Option 2 - Swale design, requires the acquisition of a large area of land adjacent to the road, for this reason this would not be a suitable design option. Option 1 - Existing stormwater upgrade, will implement a detention basins and will require the acquisition of some nearby land. Option 3 – WSUD with infiltration, Option 4 –Water Harvesting and Option 5 – Combined WSUD will require the least amount of land acquisition and are the preferred design options.

19. Waste Management

Appropriate strategies should be applied to reduce resources as well as the waste produced by the project. Resource recovery includes re-using, recycling and reprocessing. A waste management plan will be developed to provide a basis for all. Generally, construction waste and waste from earthworks or demolition of existing drainage systems would consist of the following:

- Excavation materials of site i.e. soil
- Redundant materials or green waste i.e. existing pipes, pits and vegetation
- Miscellaneous building materials
- Wastewater from construction activities
- Packaging materials
- Office and domestic waste generated by project administration activities

Through effective waste management, negative impacts on the surrounding environment can be minimised.

19.1 Potential impacts

19.1.1 Operation

The flooded stormwater in the project area is a source of waste itself. It may become contaminated be prolonged contact with the roadway and can be a breeding area for mosquitoes as well as bacteria and other microbes.

19.1.2 Construction

The amount of waste generated during construction activities would be subject to the site environmental management system. Careful planning and management of the construction stage will be essential to minimise the potential waste impact on the local community and environment.

19.2 Recommended Mitigation Measures

The Contractor would be required to manage waste in accordance with the environmental performance criteria for the project. The waste must also be managed in accordance with the Environment Protection (Waste Management) Policy 1994, and South Australia's Waste Strategy 2005-2010. Relevantly, the Policy provides that a person who transports waste on or in a vehicle

must take all reasonable and practicable steps to cover, contain or secure the waste to ensure that it remains on or in the vehicle throughout the course of transportation.

19.2.1 Resource consumption

- Avoid unnecessary resource consumption
- Reuse waste materials generated by the project as much as possible
- Segregate resources for recycling i.e. paper, plastic, glass, cans
- Use appropriate recycling facilities to treat the recyclable materials
- Mulch or chip cleared vegetation and use for landscaping

19.2.2 Construction waste

- Reuse the excavation material on site for same and similar use i.e. excavated spoil
- Control the wastewater according to Section 19
- Sort and store the demolition materials for recycling
- Control packaging materials and office waste
- Classify and appropriately handle and store removed materials from site

19.3 Impact on chosen design

In the construction phase, all options will require waste and recourse management. Option 1 – existing stormwater upgrade, involves the least construction and is recommended from a waste management point of view. This option is the most economical in terms of resources as it makes full use of the existing infrastructure.

Option 4 – water harvesting, would have an additional benefit of recycling the collected stormwater post construction.

Option 2 – swale design, option 3 – WSUD with infiltration and option 5 – combined WSUD, post construction these designs will have additional maintenance requirements to manage the accumulation of waste in the newly installed infrastructure.

20. Flora and Fauna

A number of environmental issues are considered with this Environmental Impact Statement and flora and fauna is considered to be fundamental to the environmental impact that the North Terrace Drainage Design project will have. Depending on the project design chosen, the flora and fauna could be affected both during and after construction which will require a management plan to ensure no extensive damage is done that would impact the flora and fauna.

Upon conducting site evaluations and fauna surveys it has been determined that the area of construction does not contain any rare fauna species or any significant or regulated trees. Consequently, no in-depth studies of fauna have been under taken during this feasibility study. However investigations will be conducted into the current flora and the potential impacts on the existing flora surrounding the project area. The natural flora and fauna will be preserved wherever possible and re-vegetation works will be undertaken, if required, in order to sustain a healthy environment.

20.1 Potential Environmental Impacts

20.1.1 Construction impacts

After conducting a site evaluation it was noted that there are currently no trees in this location that meet criteria to be classed as a significant or regulated tree. A regulated tree in metropolitan Adelaide is a tree with a circumference of 2.0 metres or more (SA Gov 2015). Vegetation in the area was very minimal due to the pavements and buildings. This suggests that local flora and fauna will not be impacted during the construction process however there is still a potential risk that the construction may affect the surrounding environment in the following ways:

- Long term decrease in vegetation
- Disrupt breeding cycle of fauna in the area
- Potentially decrease the size and quality of the habitat of the local flora and fauna
- Construction vehicles and personnel may accidentally introduce flora species to the project area and contaminates to natural environment
- Construction materials and vehicles may contaminate the site
- Removal or disruption of native flora may reduce aesthetic value of the area and residential/commercial properties
- Dust from construction may pollute surrounding suburbs vegetation and bodies of water

- Ground compaction from heavy vehicles/materials disrupting vegetation growth
- Chemical/oil spillage may poison native flora and fauna

20.1.2 Construction Activities that Impact Flora and Fauna

Environmental impacts that may be potentially harmful to the flora and fauna of the project area and the surrounding areas caused by construction have been identified in Section 20.1.2. Multiple activities conducted during construction could be potentially harmful to the environment with a majority of these activities being unintentional. The potentially harmful construction activities are as listed below:

- Use of power tools over or near vegetation
- Parking or operating heavy machinery on or near vegetation causing ground compaction and crushing of plant roots
- Poorly maintained machinery
- Site workers walking on vegetated areas
- Storage of construction materials in vegetated areas

20.2 Recommended Mitigation Measures

Environmental preservation plans will be developed based on the requirements of the project to allow maximum functionality with minimum environmental damage to the surrounding vegetation. Any vegetation flora affected by the construction process will be replaced or relocated. The following mitigation measures are provided:

- Preventing fires which may damage local flora and fauna (refer to section 10)
- Avoid damage to flora and fauna on site when undertaking construction activities, particularly with operation of vehicles/machinery/equipment on site
- Avoid damage to flora and fauna on site through use/storage/handling of potentially hazardous materials (refer to section 11)
- Required clearing of vegetation only to be done only with prior approval and kept to a minimum
- No removal of native vegetation unless authorised in accordance with the Native Vegetation Act 1991
- Works area to be clearly defined, no disturbance beyond edge of designated works area and bunting or staking out of areas with significant vegetation
- Restrict construction traffic to roads and designated access tracks

- Stabilise disturbed areas to protect existing vegetation
- Minimise compaction in the vicinity of any trees by avoiding: parking of heavy equipment/vehicles and stockpiling within tree drip lines
- Locate stockpiles, construction materials and any potentially hazardous chemicals away from sensitive areas
- Remove excess spoil from the site in accordance with EPA and the Hydro-Future requirements
- Maintenance/watering of existing vegetation in the project area during the construction phase

20.3 Impact on Chosen Design

Design option 3: WSUD with infiltration is the most suitable design in terms of the preservation and improvement on the local flora and fauna. This option will have more construction requirements than option 1 – existing stormwater upgrade, however it is still the preferred option as it promotes biodiversity. Existing vegetation may be affected during the construction process but will be either replaced or relocated to minimise environmental impacts.

21. Environmental Impact Rating

Table 3 below shows the environmental impact rating for each of the designs post construction. Table 4 below gives the explanation of the rating system used from 1-4.

Table 3: Environmental Impact Rating Table (Post Construction)

Post Construction ***Option***	**Water Quality**	**Flora and Fauna**	**Social Impact**	**Heritage**	**Air Quality**	**Noise and Vibration**	**Soil Contamination**	**Sediment Control**	**Waste Management**	**Total/36**
Option 1: Existing Stormwater System Upgrade	3	3	4	4	4	4	4	4	3	33
Option2: Swale Design	4	4	3	4	4	4	3	3	3	32
Option 3: Water Sensitive Urban Design with infiltration	4	4	4	4	4	4	4	4	3	35
Option 4: Water harvesting	4	4	4	4	4	4	4	4	4	36
Option 5: Combined water sensitive urban design	4	4	4	4	4	4	4	4	3	35

Table 4: Environmental Impact Rating Scoring System

Scoring Table

Unsatisfactory	**Average**	**Good**	**Excellent**
1	2	3	4

Table 5 below shows the environmental impact rating for each of the designs during construction. Table 6 below gives the explanation of the rating system used from 1-4.

Table 5: Environmental Impact Rating Table (During Construction)

During Construction ***Option***	**Water Quality**	**Flora and Fauna**	**Social Impact**	**Heritage**	**Air Quality**	**Noise and Vibration**	**Soil Contamination**	**Sediment Control**	**Waste Management**	**Total/36**
Option 1: Existing Stormwater System Upgrade	1	2	1	4	1	1	2	2	1	15
Option2: Swale Design	2	1	1	4	1	1	1	1	1	13
Option 3: Water Sensitive Urban Design with infiltration	2	2	2	4	1	1	2	2	2	18
Option 4: Water harvesting	2	3	1	4	1	1	2	2	2	18
Option 5: Combined water sensitive urban design	1	2	2	4	1	1	2	1	2	16

Table 6 - Environmental Impact Rating Scoring System

Scoring Table

Unsatisfactory	**Average**	**Good**	**Excellent**
1	2	3	4

22. Design Evaluation Based on Environmental Impact Rating

The Environmental Impact Rating table is based on a 1-4 scoring system with 4 being excellent and 1 being unsatisfactory. Each heading was evaluated by the environmental engineering group to determine the score of each option out of a total of 36.

Option 1 – Existing Stormwater System Upgrade:

The option of upgrading the existing stormwater system scored the second lowest in both post construction and during construction phases for the environmental impact rating. This design could be improved environmentally by installing additional waste management control devices as well as devices to improve water quality throughout the system. Although the rating for Flora and Fauna was considered as good it is difficult to further improve the design as there is minimal area available where increased vegetation would be possible. The construction phase can be improved in the environmental rating by following the suggest mitigation processes outlined in each section.

Option 2 – Swale Design:

The Swale design scored the lowest for environmental impact rating in both the post construction phase and the during construction phase. The disadvantages of constructing a swale is the amount of space that would be required as well as the high amount of construction needed in this location which is why the design scored lower compared to other options. To further improve the rating of the swale design mitigation measures would need to be followed as well as increased treatments for both sediment control and soil contamination.

Option 3 – Water Sensitive Urban Design with Infiltration:

Option 3 had the second highest score for the post construction phase and was tied equally as high as option 4 during the construction phase. This option lost points for waste management which can be improved by installing devices for further waste management treatments. The construction phase can be improved in the environmental rating by following the suggest mitigation processes outlined in each section.

Option 4 – Water Harvesting:

The Water Harvesting design scored a perfect rating for the post construction phase which was mainly due to the amount of increased vegetation that would improve various environmental issues and social impacts. It also scored equal highest during the construction phase with a total of 18/36 although improvements could be made to this score by ensuring mitigation measures and followed throughout the construction of the project. While Option 3 scores extremely highly

it will still need to be evaluated to determine if this is the option that will give the highest functionality as well as the best environmental impact.

Option 5 – Combined Water Sensitive Urban Design:

Option 5 is a combination of the Water Sensitive Urban Design with infiltration with any of the other design options listed which would enable the system to be able to completely carry all the stormwater flow rate in the occurrence of a major storm system and was tied for second highest in the post construction environmental impact rating. To improve the score for this design further waste management treatments will need to be considered as well as mitigation measures to improve air and water quality during the construction phase.

23. References

Allison, R., Chiew, F. and McMahon, T. 1997, Stormwater Gross Pollutants, Industry Report 97/11, Cooperative Research Centre for Catchment Hydrology, Monash University, Victoria

Department of Planning, Transport and Infrastructure (DPTI), 2015, *Traffic Violumes*, accessed online 01/04/2015, http://dpti.sa.gov.au/traffic_volumes#metro

Department of Planning and Local Government, 2010, Water Sensitive Urban Design Technical Manual for the Greater Adelaide Region, Government of South Australia, Adelaide

Environment Protection Agency, 2012, *Noise Pollution*, accessed online 24/03/2015 http://www.epa.gov/air/noise.html

Department of Environment, Climate Change and Water NSW (DECCW), 2011, *NSW Road Noise Policy,* accessed online 8/04/2015, http://www.epa.nsw.gov.au/resources/noise/2011236nswroadnoisepolicy.pdf

Hayward Baker Geotechnical Construction (HBGC), 2014, *Groundwater Control,* accessed online 7/04/2015, http://www.haywardbaker.com/WhatWeDo/Applications/GroundwaterControl/default.aspx

IEAust (2006). Australian Runoff Quality: A Guide to Water Sensitive Urban Design. New South Wales.

The Government of South Australia (SA Gov), 2015 *Regulated and Significant Trees*, accessed online 08/04/2015, https://www.sa.gov.au/topics/housing-property-and-land/building-and-development/building-and-development-applications/heritage-listing-and-significant-trees/regulated-and-significant-trees

The Government of South Australia (SA Gov), 2015, *Altas*, accessed online 01/04/2015, http://www.atlas.sa.gov.au/mapviewer?envelope=397936%2C1243467%2C1602318%2C2664775&appDataTopic=Landuse

Thomson, B, 2004, *Soil Association Map of the Adelaide Region,* accessed online 01/04/2015, https://sarigbasis.pir.sa.gov.au/WebtopEw/ws/plans/sarig1/image/DDD/200471-235

United States Department of Agriculture (USDA), 2000, *Errosion and Sedimentation on Construction Sites,* accessed online 01/04/2015, http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_053285.pdf

United States Environmental Protection Agency (UEPA), 2011, *Soil Contamination,* accessed online 08/04/2015, http://www.epa.gov/superfund/students/wastsite/soilspil.htm

24. Appendix A

Gross Pollutant Traps

According to the Water Sensitive Urban Design technical manual, a Gross Pollutant Trap (GPT) is a "device for the removal of solids conveyed by runoff that are typically greater than 5 millimetres." (Department of Planning and Local Government 2010) There are a number of different variations of GPT's that may be suitable for use in urban environments, these include:

- Gully baskets
- In-ground gross pollutant traps
- Trash racks
- Pipe nets
- Direct screening devices

The main function of the trap is to help improve water quality by the removal of gross pollutants. Gross pollutants are defined as "debris items larger than 5mm" (Allison 1997) and can pose a threat to the local wildlife, local water environments, aesthetics, create smell and attract vermin.

Relevant Legislation

Before any design of a GPT can begin its important to check with the appropriate legislation and regulations to see if there are any requirements that apply to GPT's in the project area. The legislations which are most applicable to the design and installation of GPT's in the Adelaide region are:

- Development Act 1993
- Development Regulations 2008
- Environmental Protection Act 1993

Advantages

The addition of a GPT to the existing stormwater system would be an effective way to improvement stormwater quality. Advantages of GPT's include:

- Effective way of removing gross pollutants
- Some traps can be hidden from view
- Take up a relative small area

Disadvantages

Limitations of GPT's include:

- Limited in the removal of fine sediments, dissolved pollutant and other material that are less than 5mm in size
- Needs to be maintained and regularly cleaned
- High initial installation cost
- Some designs are complex to install
- May be aesthetically unpleasant in public areas

Cost

The cost of the GPT is largely dependent on its size and its application. To help with the decision on the appropriate GPT design to use, the life cycle cost of the trap should be considered. The life cycle cost is the combination of both maintenance and instillation costs. This provides a true long term cost estimate of the infrastructure. This is done by taking into account an assumed life cycle of the project. Using simple hand calculation or the computer software MUSIC, a good estimate on the overall life cycle cost for a GPT can be calculated. The cost factors that should be considered when selecting the appropriate GPT are:

- Installation costs
- Maintenance costs
- Waste disposal costs

Installation prices of GPT's can vary anywhere between $300 and $12,000. Maintenance and disposal costs on the other hand are dependent on a number of different factors. Factors effecting maintenance costs include:

- GPT size, based on the total area which the GPT is receiving stormwater
- Techniques used for maintenance, based on the unknown nature of present gross pollutants
- Time required for maintenance, i.e hours, days needed

Factors effecting waste disposal costs include:

- Special disposal requirements for hazardous wastes
- Total volume of waste

- Implications of materials that are in a wet or dry condition

These factors should be taken into consideration as there is potential for them to have a significant effect on the lifecycle cost

Recommendation

The decision on the most suitable GPT will be made with consideration of the following key areas:

- Accessibility
- Maintenance
- Aesthetics
- Lifecycle cost

Of the many available GPT options available, the Environmental Team believes that a direct screening device would be best suited for the stormwater system in place at North Terrace, Kent Town. It is believed that it will be a more feasible option in comparison to other traps such as drainage entrance treatments, floating traps, sediment traps etc. If drainage entrance treatments are installed along North Terrace, any required maintenance will disturb traffic in this area. The use of a screening device at the end of the stormwater system, will relocate the required maintenance work away from North Terrace.

In comparison to other types of GPT's, a direct screening option will be much more cost effective long term. The simple design will mean there is a lower installation cost, it will be easier to maintain and will have a smaller disposal of wastes costs, when compared to the other types of GPT's available. In order to provide a cost effective solution, the Environmental Team believe that spending the extra money on a more efficient GPT wouldn't be feasible and a simple direct screening trap would be sufficient for this project.

The Environmental Management Team suggests the use of one of the following direct screening devices:

Option 1 – Litter Collection Basket at the end of the stormwater pipe

The first option is to install a littler collection basket at the end of the stormwater pipe exiting at First Creek. Any gross pollutants will be removed directly into the collection basket before they enter First Creek. For this reason, the litter collection basket would be the preferred

solutions to choose. However, due to the stormwater pipe location installation and future maintenance may be difficult. An example of litter collection basket can be seen in Figure 1 below.

Figure 1: Litter Collection Basket Collingwood, VIC Source: IEAust (2006)

Option 2 – Channel Nets in First Creek

The second option involves the screening device being submerged in First Creek, in a location that is easily accessible. Like the litter collection basket it will be an effective tool to remove gross pollutants but may be visible to the public creating aesthetic and odour problems. As the net will be in a visible position this makes it easily accessible for installation and maintenance. An example of channel net can be seen in Figure 2 below.

Figure 2 Channel Nets West Torrens, SA Source: IEAust (2006)