

Introduction

“Low Impact Design” is a design approach for site development that protects and incorporates natural site features into erosion and sediment control and stormwater management plans.

Purpose

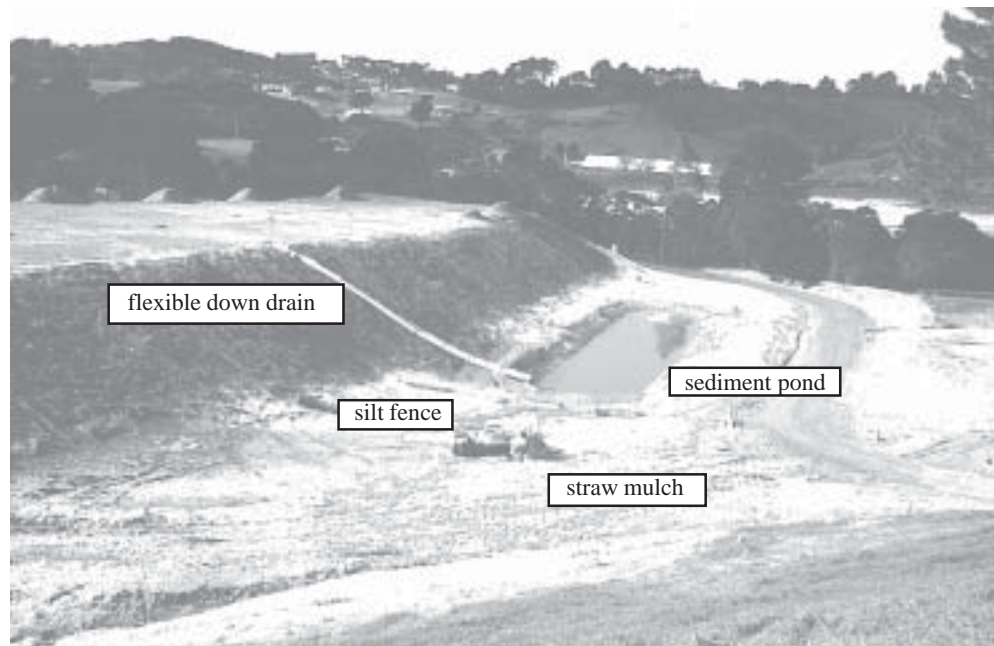
The primary purpose of this document is to present an alternative approach to site design and development from a stormwater management context, primarily applicable for residential land development. Its basis is founded in the recognition that the volume of stormwater discharged from a site may be of equal importance to limiting contaminant discharge, especially for residential development. The low impact design approach is another stormwater management tool for reducing the adverse impacts of stormwater runoff.

It is not intended that the approach will become mandated by the ARC. There may be development situations where it will be difficult for other approaches to provide the same level of protection for downstream receiving waters, but the decision as to the stormwater management approach rests with the site developer as long as there is an approach to stormwater management which can provide similar benefits and protection to receiving waters.

There are two primary areas of interest addressed in developing this design approach.

- erosion and sediment control
- stormwater management

The primary purpose of this document is to present an alternative approach to site design and development from a stormwater management context, primarily applicable for residential land development.



Multiple Erosion and Sediment Control Practices being Used On One Site. They are Necessary to Provide Significant Reduction in Downstream Impacts

Introduction

Erosion and Sediment Control

Erosion and sediment control issues relate primarily to providing guidance on ways and methods to reduce the amount of land disturbed, fitting land development to land sensitivity, the length of time of that disturbance, and the proximity of the disturbance on a site and catchment basis to sensitive receiving environments. One intention of this manual is to provide incentives for developers to retain natural ground cover during the site development process, thereby reducing:

- sediment generation,
- sediment transport, and
- delivery downstream, either off-site or to a perimeter control.

Developer benefits can include:

- Reducing earthwork areas and volumes,
- Reducing costs associated with development or associated with erosion and sediment control practices relative to total site disturbance,
- Benefits can include reduction in site erosion in terms of rate and volume of yield and
- Protection of receiving systems from sediment deposition.

Stormwater Management

Stormwater management issues relate primarily to providing guidance for site and catchment design which incorporates natural site features into land development. The intention is to advise land developers on the benefits of retaining and incorporating these natural features into the site development process and thereby reducing or, in very limited situations, eliminating the need for structural stormwater management controls. Other benefits are certainly realized through natural site feature utilisation, such as more closely approximating the predevelopment water budget, protection of habitat, and reduced overall impact to the receiving system.

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Stormwater Wetland Fringe Pond Used for Water Quality Treatment

Site features which will be discussed include:

- Wetlands
- Watercourses
- Floodplains
- Forested areas with emphasis on native vegetation
- Riparian buffers
- Soils
- Steep slopes
- Other natural features

Design procedures are provided which allow site designers to incorporate practices, inherently known to be good, but which have not had a sound rational basis to ensure plan approval. That rational basis will be provided in this manual for a variety of situations. The design approach will be flexible enough to allow for various low impact practices to be combined on one site and quantify the benefits of that combination.

It must be emphasized that structural controls will still be essential on many sites.

It must be emphasized that structural controls will still be essential on many sites. A heavily vegetated site having a significant portion of the tree canopy removed will still have a significant increase in sediment yield and stormwater runoff, even with aggressive planning efforts related to erosion and sediment control and stormwater management. The practices detailed in this manual are provided as additional tools in the erosion and sediment control and stormwater management toolbox. They may supplement structural control practices and may, in some situations, replace or reduce the need for structural practices while providing attractive site amenities.

Audience

The manual is primarily directed toward residential land developers and users. Commercial and industrial land uses generally have a much higher level of site disturbance and imperviousness, which limits the degree that low impact urban design can be utilized. Low impact urban design practices are still recommended on commercial and industrial sites, but their ability to eliminate or significantly reduce the need for erosion and sediment control or stormwater structural practices on commercial or industrial sites may be limited.

Background

When discussing the background of this manual, it is beneficial to recognise the evolution of efforts related to erosion and sediment control and stormwater management and their relationship to the Resource Management Act. These programmes are continually evolving as we learn and this evolutionary process will have to continue as long as water quantity and quality problems exist. As can be seen, the legislation follows the increasing awareness of the interrelated nature of land developed and on soil and water resources. The greater the level of development, the greater the recognition that problems result.

History of erosion and sediment control in the Auckland Region

The earliest legislative efforts to address soil erosion rested in the Soil Conservation and Rivers Control Act of 1941 which had as an object the prevention and mitigation of soil erosion. The context at that time was related to rural land erosion and the Act provided for grants or loans to assist in erosion reduction.



Sediment Choking a Stream Channel from an Uncontrolled Earthworks Activity

Historically in the Auckland Region, from an urban context, earthworks controls were based on voluntary controls, initiated in the 1970's in response to the Soil Conservation and River Control Amendment Act 1959 by the former Auckland Regional Water Board (ARWB). As an aside, the Ministry for Works had responsibility for water and soil issues from the late 1960's until 1973 when the Auckland Regional Water Board was created. The Auckland Regional Authority (ARA) was gazetted as the Auckland Regional Water Board at that time and it implemented guidelines and a complaints response role. The 1980's saw the introduction of section 34 (offences against the Act and powers of enforcement available) notices under the Soil Conservation and River Control Amendment Act 1959 which required that consents be obtained from the Regional Water Board prior to undertaking earthworks. This approach to erosion and sediment control remained in effect until 30 September, 1993 as part of Auckland Regional Council's Transitional Regional Plan. A Soil Conservation Consent for earthworks was then required under the Auckland Regional Council's "Erosion and Sediment Control Proposed Regional Plan" (October, 1993). As a result of further submissions and subsequent hearings this has now become the current Proposed Regional Plan: Sediment Control (September, 1995) which continues to require consent for earthworks which exceed the limits set out in the Plan.

Historically in the Auckland Region, from an urban context, earthworks controls were based on voluntary controls.

History of stormwater management

The earliest legislation related to stormwater may be the Land Drainage Act of 1908. Section 26 of that Act notes that every person who without the consent of the Land Drainage Board (established on a particular catchment boundary) makes any branch drain into any watercourse or drain vested in the Board or under its management commits an offence, as does any person who stops or obstructs any such watercourse or drain. The definition of "drain" in the Act includes every passage, natural watercourse, or channel on or under the ground through which water flows continuously or otherwise except a navigable river or water race.

The major piece of environmental legislation prior to the Resource Management Act, was the Water and Soil Conservation Act 1967. That Act equally addressed water quantity and water quality issues and was responsible for water classifications and

issues related to the quality of discharges from industrial activities. The Auckland Regional Authority approach at this time, from a stormwater perspective was primarily devoted to addressing water quantity issues. It formed the foundation for strategies directed towards water quantity related issues which formed the basis for the stormwater programme up to the late 1980's.

A major water quality initiative in the Auckland area was initiated in the Upper Waitemata Harbour Catchment Study whose results were published in 1983. That end product was a series of excellent guidelines and reviews, many of which are still applicable today. Topics included in that effort include discussions of stream ecology, energy patterns, fresh water resources, land resources, legal aspects, riparian zone management, earthworks, and numerous other topics. In the late 1980's greater research was done to detail the water quality impacts of urban activities. ARC Technical Publication No. 10 entitled "Stormwater Treatment Devices" was completed in 1992 which provided design guidance for stormwater management ponds and other treatment systems to fulfil applicant consent obligations.

The Resource Management Act (RMA)

The Auckland Regional Council has its duties, powers and functions specified in the RMA, which was enacted in 1991. The purpose of the Act is defined in Section 5 of the Act.

"Section 5. Purpose:

1. The purpose of the Act is to promote the sustainable management of natural and physical resources.
2. In this Act, sustainable management means managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural well-being and for their health and safety while.
 - (a) Sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and
 - (b) Safeguarding the life supporting capacity of air, water, soil, and ecosystems; and
 - (c) Avoiding, remedying, or mitigating any adverse effects of activities on the environment."

The RMA is enabling, rather than a prescriptive act. The ARC can implement management of natural and physical resources through the adoption of policies and rules.

Under the RMA Regional Councils and Territorial Authorities (TA's) have different duties, powers and functions. The ARC has the function of "the establishment, implementation, and review of policies and methods to achieve integrated management of the natural and physical resources of the region" and "the control of discharges of contaminants into or onto land, air, water, and discharges of water into water". The RMA is enabling, rather than a prescriptive act. The ARC can implement management of natural and physical resources through the adoption of policies and rules.

Under Section 32 of the RMA, the ARC has a duty to consider alternatives and assess the benefits and costs before adopting policies and rules. An urban runoff quality control programme must therefore consider all the tools available for reducing environmental degradation from urban runoff and establish a strategy which passes the tests provided for in Section 32 of the Act.

Introduction

Problem Statement

When considering problems related to erosion and sediment control or stormwater management, there are a number of contexts that can be considered. One approach is to consider problems from a temporary (erosion and sediment control) and permanent (stormwater management) perspective. From a temporary context, as will be discussed in greater detail in Chapter 1, there is the importance of site disturbance on sediment yields during construction. There are some basic statements that can be made.

- The greater the area of site disturbance, the greater the sediment yield
- The longer the area remains disturbed, the greater the sediment yield
- The greater the slope, the greater the sediment yield
- Disturbed land has a greater runoff potential than vegetated surfaces
- The closer the site disturbance is to a receiving environment (watercourse, estuary, marine area), the greater the potential impact.

When considering the permanent impacts of urbanisation, there is the historic recognition that flooding can be a problem. There is also increased recognition that other water-related problems are associated with land development. The most obvious, is stream channel erosion with subsequent impacts on the stream biota. The development of land increases the total volume of water running off the land during a rainfall event. This increased volume results during all storm runoff events and increases the potential for stream channels to erode. The channel capacity is increased (wider, deeper, or both) and results in the loss of private and public property and significant habitat degradation. There is documentation indicating that channel erosion in a catchment that is completely developed is the single largest source of sediment delivered downstream. Channel instability results in public expenditures to reduce property loss and necessitates channel works such as stone armouring or channel lining as seen on the Wairau Creek.

Other impacts associated with land development include the generation of pollutants carried off the landscape by stormwater runoff. These pollutants include:

- sediment
- oxygen-demanding substances (decomposition of organic materials)
- nutrients (predominantly nitrogen and phosphorus)
- metals (many different ones but zinc, copper, lead are generally found)
- oil and grease
- microorganisms (human or animal waste)
- other pollutants (pesticides, herbicides, etc.)



Example of Contaminant Loading from a Typical Urban Street

There is documentation indicating that channel erosion in a catchment that is completely developed is the single largest source of sediment delivered downstream.

Pollutants build up in a catchment, and are delivered to a receiving system during storm runoff, and may accumulate over time. Their impacts tend to be chronic rather than acute or episodic, and increase over time. Examples of impacts associated with pollutant loadings include increased water supply treatment costs, destruction of aquatic plants and animals, beach and shellfish area closures from bacterial contamination, and bioaccumulation of chemical pollutants. More subtle impacts can include reduced harvesting or landings of fish and shellfish.

Another emerging concern is the reduction in low baseflows in streams as catchments develop. Streams which had water flowing in them all year frequently become ephemeral as groundwater recharge is reduced. As a general comment, if a stream is flowing when it is not raining, then the flow is groundwater generated. If groundwater levels drop lower than the stream invert, baseflow ceases and the stream loses its biologic values unless aquatic organisms can exist in pools until the time when the stream flows again. All of us live in catchments that have been impacted as a result of our activities on the land.

For all of these reasons, the Auckland Regional Council implements an erosion and sediment control programme and a stormwater management programme to implement temporary and permanent practices and strategies for water quantity and water quality purposes. Consent requirements for erosion and sediment control are detailed in the Proposed Regional Plan: Sediment Control, September, 1995. Existing stormwater management requirements are detailed in the Operative Transitional Regional Plan. Those requirements are under review at this time and subject to change.

The existing programmes place heavy emphasis on structural practices such as basins and ponds to minimise, to some extent, the adverse impacts of stormwater runoff both during and post-construction. Whenever site development is proposed, the land developer must consider both the quantity of water leaving the site, and the quality of that water both during and post-construction. Criteria are specified in ARC Guidelines, Technical Publication No. 90, "ARC Erosion and Sediment Control Guidelines for Land Disturbing Activities" and Technical Publication No. 10, "Stormwater Treatment Devices", that must be followed.

As outlined above, the proper implementation of erosion and sediment control and

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Sediment Pond with Floating Decant

Introduction

stormwater management in the Auckland Region has historically rested on the proper design and implementation of structural erosion and sediment control and stormwater management practices. This reliance is based upon documentation of the performance of these practices. This is especially true for sediment control and stormwater management ponds, resulting in their widespread use. However, more information is now becoming available on various innovative practices, and this manual provides guidance on a desired alternative approach to site design for erosion and sediment control and stormwater management.

Limitations of Existing Practices

Most erosion and sediment control and stormwater management programmes place a heavy reliance on implementation of structural facilities. These facilities include ponds, both wet and dry; flow diversion systems; filtering practices; and other variations of them all. The implementation of these facilities is necessary for their water quantity and water quality benefits and is expected to remain integral to programme implementation, but there should not be an overreliance on them. These facilities, in and of themselves, cannot eliminate adverse impacts that urban development has both during and post-construction. In addition, there are a number of limitations to structural facilities.

A sediment control or stormwater management programme relying solely on structural practices has a number of weaknesses. The existence of these weaknesses has been recognized for some time, but there has been little information available on alternative approaches that would justify their inclusion in programmes. In addition, clear guidance must be available on alternative design approaches or practices which can be used by plan designers and approval agencies. The guidance must also lend itself to effective field implementation. The following items and their discussion present some of the weaknesses of programmes based on structural controls.

Lack of Flexibility in Site Design

A lack of flexibility in what a site developer can do for erosion and sediment control and stormwater management will have an impact on how the site is developed. The requirement to construct ponds will necessitate that site drainage be routed to the ponds. This would mean that runoff which can travel through sheet flow across vegetated areas must be conveyed to the pond. This will normally entail conversion of the water from sheet flow into concentrated flow through a conveyance system.

The existing approach detailed in the Technical Publications is presented as a “cookbook” of practices. The approach does not mandate one practice over another, but rather provides a framework by which one practice is used over or in conjunction with another one. Practices and approaches have limitations to their use and those limitations will determine, to a large extent, which ones are used. Some flexibility does exist but that flexibility is only as broad as the interpretation of the individuals designing or approving the erosion and sediment control or stormwater management plan. In reality, there is a perception, for the most part valid, that the preference for ponds is too often a mandate. In addition, design consultants must deliver an approvable plan to the site developer. The expense associated with that plan is dependent on the consultant being reasonably comfortable that their cost estimate for design will provide for their time and expense in doing the site design. An innovative site design may receive a poor reception from the approval agency and necessitate a redesign with a more traditional approach to site control. Innovation is very difficult to budget for when monetary resources are limited.

The existing approach in the Technical Publications is presented as a “cookbook” of practices.

Altered Site Hydrology

The only structural practices that attempt to mimic predevelopment site hydrology are infiltration practices. Infiltration practices reduce the total volume of stormwater runoff, provide groundwater recharge, and augment base flow in streams. Unfortunately, infiltration practices cannot be placed everywhere, and in the Auckland region, they have limited potential for use. They cannot be used where clay soils exist, where there is a high groundwater table, on steep slopes, or where bedrock is close to the surface of the ground. In addition, the long-term performance of infiltration practices has been questionable due to clogging of soils.

Other practices, such as sediment control or stormwater management ponds, only minimise, to an extent, the adverse impacts of land development. The volumes of stormwater runoff are increased immediately upon site clearance, and consequently the duration of storm flows from these ponds is considerably longer than that which would have occurred prior to site development. From a water quantity standpoint, the intention is to hold the site's stormwater long enough to allow the catchment's storm flows to pass the site, and thus reduce downstream flooding. They provide water quality treatment primarily through settling processes that are designed into the practice. However, it needs to be recognised that flows can also modify ambient water quality so as to make it unsuitable for downstream biota.

If site hydrology were not altered to the degree that is normally accomplished, downstream impacts would be reduced.

The use of ponds is a recognition and acceptance that site hydrology has drastically been modified, and an increase in the volume of stormwater runoff is inevitable. In the same regard, groundwater levels will drop and base streamflow will be reduced. The pond's purpose is to reduce, to the furthest extent possible, the adverse impacts of contaminant discharge and altered site hydrology. If the site hydrology were not altered to the degree that is normally accomplished, downstream impacts would be reduced.

Expense

In addition to design costs, there is the greater expense associated with the construction of ponds and filtering facilities. These practices can be very expensive. Too often in stormwater design the sizing of stormwater management practices is based on the generic land use draining to the practice and does not consider that portions of the site, if left undisturbed, would not generate the amount of runoff that results from the developed portion of the site.

Ponds, as generally implemented, are structural practices. They must have properly designed structural components such as a core trench, anti-seep collars, a riser assembly with a trash rack, a barrel, and structural fill. These components are expensive and require care in their proper installation and performance.

For the most part discussion in this guidance document will address ponds as the current primary means for stormwater management in site development. Ponds have been preferred historically as a result of their applicability for water quantity use in addition to their proven water quality performance values. There are a number of other practices for both sediment control and stormwater management and all of these other practices are structural practices. Other primary practices include infiltration trenches and dry wells. They also include filtration practices that rely on the movement of water through a filter media, usually sand, to provide a water quality benefit.

Introduction

Loss of site area

Ponds take up site area. When a land developer decides to develop a given piece of property, an initial consideration is how many housing units can be placed on that property, and their potential sale prices. A factor in this determination includes how much of the site must be devoted to the stormwater management pond, maintenance access to the pond, and drainage components that convey water to the pond. All of these features limit what can be done by the land developer on the remainder of the property. Low impact design practices will also utilize site area, but they can more easily be blended into the overall site development and required open space plan than can stormwater management ponds.

Potential increased impacts to site and catchment natural resources

Generally, the lowest elevation of the site will be where the sediment control or stormwater management pond is to be located. This will ensure gravity flow throughout the site to the pond. If this portion of the site is vegetated or wetland, construction in this area or near this area could adversely impact on those resources.

Even if wetlands or other natural features are avoided by the sediment control or stormwater management practice, getting a reasonable return on the project may ne-



An Efficient Stormwater Conveyance System. Rapid Travel Through the System Precludes any Water Quality Treatment

cessitate disturbance in those areas for another aspect of site development. This could occur because housing lots may need to have a greater wetland area contained in their boundary or may necessitate cutting down more trees to get the minimum number of lots needed.

Increased disruption of natural site features can have impacts off-site. Downstream wetlands or estuarine areas may have greater sedimentation as a result of increased site disturbance or increased disturbance of steep slopes, or erodible soils, etc. New Zealand has lost approximately 90 percent of its nontidal wetlands. Those wetlands were not lost overnight or as the result of one activity. Adverse sediment and stormwater impacts are cumulative in nature and result from numerous activities having a marginal individual impact.

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Configuration of Development

The traditional approach to sediment control and stormwater management seems to also fit with the traditional approach to site development. The site design approach allocates a portion of the site to sediment control and stormwater management in conjunction with a “cookie cutter” logic to site layout. Site development is configured in a traditional pattern that easily goes through the territorial authority approval process. Traditional structural sediment control and stormwater management requirements are now well understood and are just incorporated in an overall site plan with little consideration of the need to protect existing site resources.

Connection of Impervious Areas

Where a site has significant impervious area, those impervious areas are usually linked by conventional storm drains. Storm drains are efficient water conveyance systems which collect and quickly pass runoff into a structural stormwater management practice. Rapid travel through an enclosed storm drain system eliminates any potential for pollutants to be removed from the stormwater conveyance system prior to its entry into the stormwater management practice. This results in the stormwater management practice being the only means of treating the runoff water quality, and providing for water quantity control.

Disregards Site Resource Conservation Benefits

There is little incentive, under the existing approach to site development, to leave trees in a given location, to establish native vegetation in open space, or to maintain low areas as wetlands. All of these practices reduce the total volume of runoff and provide water quality benefits. There is no incentive if structural sediment control and stormwater management are still required for the land development, and the volume and areal extent of the practice cannot be reduced.

Protecting and preserving site natural features requires a greater effort during the land development process. At present, there is little incentive for the land developer to take additional natural feature protection efforts, especially if public perception indicates that site buyers might prefer a more manicured site. The land developer must receive an economic benefit by leaving natural features if that individual is to “sell” eventual property owners on the rationale for leaving natural features.

Maintenance Obligations

Operation and maintenance of structural sediment control and stormwater management practices is a significant responsibility if ongoing adequate performance of the practices is to occur. Structural practices require routine and periodic inspections to ensure proper function and all system components need to be checked. Individuals conducting these inspections need to be trained to recognize when a problem exists and what steps need to be taken to rectify them. Inspection report forms need to be completed and given to those individuals responsible for maintenance of the practice.

Actual maintenance of the structural practice is generally divided into two categories: routine and non-routine. Routine maintenance needs to be ongoing, such as mowing or maintenance of terrestrial vegetation, debris removal, lubrication of any moving parts to the practice, etc. Non-routine maintenance is done on an “as-needed” basis and can include sediment removal, aquatic weed removal, replacement of worn

Rapid travel through an enclosed storm drain system eliminates any potential for pollutants to be removed from the stormwater conveyance system prior to its entry into the stormwater management practice.

Introduction

parts, needed structural repairs, and other activities associated with a particular structural practice. Maintenance activities represent a significant commitment of time and resources to ensure long term function of the sediment control and stormwater management practice.

Also, the issue of who is responsible for operation and maintenance can be a problem, especially for permanent stormwater management practices. This can exist where stormwater facilities such as ponds have been installed in new subdivisions. Territorial authorities or maintenance organizations may not have the expertise, awareness, or inclination to address operation and maintenance obligations or problems. There may also be a potential safety or liability problem in the event of stormwater facility failure.

When maintenance is not accomplished, the results can range from increased downstream flooding and increased pollutant discharge, all the way to potential loss of life and property. Maintenance is a major expense associated with structural stormwater management practices.

Low Impact Design Approach

Low impact design approaches reflect a totally different philosophy towards site design which integrates sediment control and stormwater management into the very core of site design, as opposed to being considered an afterthought to site design. These approaches can include an almost endless universe of practices, strategies, planning, and common sense. This manual cannot include all potential components but will provide guidance and information on many that are currently recognized where data exists or can be generated to substantiate their benefits from a water budget perspective.

It is important to develop an ethic which treats stormwater runoff as a “resource” rather than a “by-product” of development. As such, there are a number of key site design components to consider:

- Reducing site disturbances
- Reducing impervious surfaces
- Constructing biofiltration practices
- Creating natural areas
- Clustering development

Low impact approaches will be discussed through the manual but some are briefly discussed here to provide an initial awareness of the range of options that will be discussed later in greater detail.

Reducing site disturbances

Many sites have existing resources which, in addition to other values, have soil retention and stormwater management benefits. These natural systems include forested areas, wetlands, and other areas of natural value and are discussed in greater detail in Chapter 3.

Forested areas provide for rainfall interception by leaf canopy. In addition, an organic forest litter develops on the forest floor which acts very much as a sponge to capture the water and prevent overland flow. Trees use and store nutrients for long periods of time. Trees also moderate temperatures during the summer and provide

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wildlife habitat, thus providing other environmental benefits.

Wetlands are valuable resources and provide numerous benefits including flood control, low streamflow augmentation, erosion control, water quality, and habitat. They are very productive ecosystems whose maintenance would have significant water quantity and quality benefits. Where they exist on a land development site, they could become an important element in site design.

From a construction standpoint, leaving areas in natural ground cover can have a significant benefit by reducing downstream sediment delivery. Sediment yield from disturbed soils can be 2000 times greater than yields from forested areas. Leaving site areas undisturbed is an important low impact approach component.

Reducing impervious surfaces

Impervious surfaces (roads, roofs, footpaths) prevent the passage of water through their surface into the ground. Water must then be transported across the surface to a point of discharge. Residential subdivisions can reduce the width of roadways, or design the roadways to limit the total length needed to service individual properties. In conjunction with imperviousness, roof downdrains may be directly connected to streets or reticulation systems when providing splash blocks and discharging the water across grass and away from impervious surfaces (footpaths, streets) will allow for a greater amount of water to infiltrate into the ground.

An important factor in limiting impervious surfaces and separating roof drains from direct connection to streets is the need for education of home owners regarding their awareness and responsibility to ensure continued function of these practices. Home-owners often change or otherwise redirect lot drainage to impervious surfaces which undoes a lot of low impact design benefits. Community education and involvement is integral if programme implementation is to be effective.

Constructing biofiltration practices

The use of vegetative swales and buffer strips can provide a significant water quality benefit in addition to reducing the total volume of stormwater runoff. The primary processes involved in their performance are filtering of pollutants contained in storm-

Community education and involvement is integral if programme implementation is to be effective.



Biofiltration Swale at the North Harbour Stadium

Introduction

water runoff and infiltration of runoff into the ground.

Even with kerbs being needed to prevent traffic movement off of paved surfaces, kerb cuts or openings can be placed in the kerb to allow water to pass off the paved surface into a biofiltration facility. This would allow for both objectives (public works and stormwater) to be attained.

Creating natural areas

In many site development situations, the predevelopment condition may be paddock or highly modified hydrological condition. Creation of a natural area as open space would have significant stormwater management benefits for both water quantity and water quality. The area, if well designed and constructed, could become an attractive amenity to a community and enhance the value of the properties.



Example of Site Revegetation in the Oratia Catchment

Clustering development

How a site is developed and to what degree the entire site must be utilized will have a significant impact on sediments and stormwater runoff from the site. Conventional land development encourages sprawl, while other approaches to land development can provide significant sediment control and stormwater benefits. Cluster development encourages smaller lots on a portion of a site, allowing the same site density, but leaving more site area in open space or disturbing less of the natural ground cover. Clustering entails designing residential neighbourhoods more compactly, with smaller lots for narrower single-family homes, as are found in traditional villages and small towns. Cluster development can provide for protection of site natural areas, while at the same time reducing total site imperviousness by reducing the areal extent of roads.

Catchment Wide Approaches

While not a focus of this manual, catchment-wide considerations, from a broad perspective, are important and should be the context from which many resource-based

How a site is developed and to what degree the entire site must be utilised will have a significant impact on sediments and stormwater runoff from the site.

land development decisions are made. Catchment based approaches are further discussed in an ARC document “Investigation Strategy for Erosion and Sediment Control in the Auckland Region”. This document strongly supports catchment based approaches to land use decisions. This context is important from a number of perspectives.

- Catchment approaches allow for a recognition and consideration of where growth distribution should occur.
- Consideration of land use from a catchment perspective allows for a greater awareness of the cumulative impacts of catchment development. Impervious surfaces are important to consider if downstream areas are to be protected.
- A comprehensive approach to resource protection can be developed and implemented based on consideration of catchment specific issues such as steep slopes, erodible soils, existing bush retention, high water table, the need for aquifer recharge, etc.
- A catchment approach allows for developers and the general public to understand the basis by which land use decisions were made in a rational format which can be easily understood.
- Land use decisions based on catchment wide analyses provide the territorial authority a basis for making decisions that can be defended.



Long Bay Catchment Where a Comprehensive Catchment Plan is Being Developed

From a long term perspective, catchment approaches represent the most economical approach if resource protection is to be considered in conjunction with land development.

As desirable as catchment-wide approaches are, it must be recognized that significant “up front” resources and costs may be needed to accomplish these efforts. Depending on the goals of the effort, significant data needs may exist. From a long term perspective, catchment approaches represent the most economical approach if resource protection is to be considered in conjunction with land development.

Organisation of Manual

The manual is organised along the following chapters.

Chapter 1 - Importance of Site Disturbance on Sediment Control Issues

This chapter specifically looks at impacts related to construction activities. The rela-

Introduction

relationship of disturbed area and slope as a function of sediment yield is discussed. Conventional approaches to sediment control are also presented along with the benefits of vegetation for sediment reduction. In addition, natural mechanisms for sediment yield reduction are provided.

Chapter 2 - Importance of Water Cycle in Stormwater Management

Various aspects of the water budget are discussed. Rainfall and its relationship to site stormwater runoff are components of the water cycle. Data that relates to ecological response to urbanisation and that relationship to water quantity and quality are also presented. A final element mentioned is natural mechanisms for stormwater pollution removal.

Chapter 3 - Site Resources

Site resources will be discussed in terms of their inclusion as components of overall site design. This will include a discussion of ecology and landscape form, wetlands, floodplains, riparian buffers, forests, soils, steep slopes, and other natural features. Consideration of these site components may have a significant impact on reducing adverse stormwater related impacts.

Chapter 4 - Low Impact Design Approach

A low impact design approach will be presented that considers an array of nonstructural low impact techniques. These techniques include: reduction of site imperviousness, use of swales appropriately, reduction in use of kerbing, clustering to reduce site disturbance and imperviousness, lengthening stormwater flow paths, preservation and enhancement of native bush, and other concepts.

Chapter 5 - Detailed Design Procedures

A design procedure is provided for minimising adverse impacts related to earthworks during construction and minimising impacts on a long term basis relating to permanent stormwater management. Checklists are provided to assist in site design.

Chapter 6 - Case Studies

Case studies of conventional residential site development are presented. In each case study, highlighting adverse impacts associated with the development's structural stormwater management approach. Hydrologic calculations are presented to detail these impacts. These case studies are designed to incorporate an array of different factors such as soils and slopes, densities of development, and predevelopment land use and ground cover. Representative costs and cost benefits analyses are also provided.

Chapter 7 - Institutional Issues

Territorial authority institutional requirements in the form of consent or permit conditions have a profound impact on the nature of land development. Issues such as road widths, requirement for kerbing, and flexibility in lot sizing will facilitate or preclude low impact options. Individual territorial authority requirements will be detailed and recommendations made to facilitate low impact design, if needed.