Stormwater Design Report for Washdyke Industrial Rezoning

Opus has been commissioned by Timaru District Council (TDC) to develop a concept design for the stormwater management of an area of land located in Washdyke, Timaru.

The study area is currently zoned as both industrial and rural; however it is proposed that the entire area be re-zoned to industrial in order to open the area up for development.

The area is currently drained via soakage to ground as per the natural drainage regime and by a network of drainage ditches. There is no formal Council owned stormwater system within the area being considered and there are a number of limitations affecting any future system.

This report is a description of the stormwater concept design for the Washdyke Industrial Park and the effects of the proposed development on the stormwater runoff and measures proposed to mitigate the effects.

Design Philosophy

The design philosophy for stormwater run-off generated by the developed site covers all aspects of stormwater, from short term erosion and sediment management during the construction phase to the treatment and control of flows once the area is fully developed.

The short term stormwater management is generally termed "erosion and sediment control" and the permanent stormwater management system is comprised of four parts;

- **surface collection –** provision of an adequately sized system to collect run-off from the developed site and convey it to treatment devices;
- **treatment and flow attenuation** – through source control techniques such as swales and bottom of catchment treatment devices such as wetland ponds;
- **waterway crossings and culverts** that run perpendicular to the road alignment for conveyance of existing water courses, or connectivity of flood storage areas and existing wetland areas; and
- the **discharge** of stormwater into the ground, the stormwater system or to surface water.

The general philosophy for determining best practice for stormwater management is as follows:

- Legislative and Environmental Compliance, including the Resource Management Act 1991 requirements (provide a best practicable option to avoid, remedy or mitigate adverse environmental effects);
- Achieve hydrologic neutrality (post development runoff to mimic pre-development levels) up to a 10% AEP (Annual Exceedance Probability) rainfall event;

- provide stormwater infrastructure to the study area, sized to convey a 10 minute 10% AEP event (78mm/hr intensity) without flooding;
- Control sediment and erosion during construction phases;
- Protect and enhance ecological values;
- Provide treatment to meet or exceed regional standards;
- Achieve hydrologic connectivity and maintain natural flow regimes where possible;
- Develop site specific management practices rather than attempting to use a single solution everywhere;
- Provide centralised treatment systems for easier management and maintenance.
- Use the "Treatment Train" approach for high quality stormwater treatment

The philosophy and objectives for stormwater management can be broken down into short-term and long-term objectives as follows:

Short Term Stormwater Management

The principal short term impact of the project will be on water quality, arising from stormwater runoff during earthworks and construction. This can be best managed through appropriate erosion and sediment control (E&SC) practices. Four fundamental principals apply:

- control water running on to the site;
- separate clean from dirty water;
- protect land surface from erosion;
- minimise sediment leaving the site.

To best mitigate the effects of earthworks activities, current practice is for erosion and sediment control (E&SC) measures to be in accordance with the Environment Canterbury Erosion and Sediment Control Guidelines.

As 'industry' understanding of best practice for E&SC increases, improved practices are being developed to best manage the effects of erosion and sedimentation. Accordingly, within the project life it is possible that the objectives and best practice guidelines for E&SC will become more robust, and more onerous.

Long Term Stormwater Management

Effective site drainage is essential for levels of service, traffic safety, and pavement and building durability. However, management of stormwater must also address quantity effects to control erosion and flooding, and quality effects, as stormwater runoff is one of the principal mechanisms for transfer of site and traffic-generated contaminants to the environment.

The proposed system will consist of two catchment areas which will discharge to the existing No.1 Seadown Drain. The catchment areas are governed by the sites natural topography, the existing drainage network and land constraints. The catchment areas are detailed below:

- Catchment 1 – Area 36.2 ha
- Catchment 2 – Area 42.5 ha

Refer to Appendix A, Figure 1 for the location of the catchment areas.

Water Quantity Control

It is important to achieve hydrologic neutrality (i.e. post development discharge to best practicably mimic predevelopment flows) up to the 10% Annual Exceedance Probability (AEP) event to best practicably avoid, remedy or mitigate the effects of erosion and flooding downstream. Extended detention and flow attenuation will be provided to satisfy these conditions. Stormwater management solutions suitable for quantity control for the Washdyke industrial subdivision include swales and stormwater wetlands as proposed.

Attenuating the stormwater run-off generated by the site will ensure that the flow rate into the receiving waterway better mimics a more natural flow rate such as it would currently receive.

The stormwater designed will be constructed so that during rainfall events up to the 10% AEP event, including the high probability events (i.e. 50% AEP), the flow rate out of the pond will be equal to the pre-development flow. Thus the remainder of the stormwater volume (the difference between the post and pre development flow) will be “attenuated” onsite and released slowly following the cessation of rainfall

Water Quality Control

Operation of the industrial development and its associated roads could impact on the water quality and aquatic life in the downstream lagoon through the discharge of stormwater contaminants. There are however techniques available to significantly mitigate any potential and actual adverse effects.

Currently there is no specific local guidance on best practice stormwater treatment, but TDC endorse that the stormwater management approach be consistent with the ARC (2003) Technical Publication No 10 (TP10) Stormwater Management Devices Design Guideline Manual. The water quality management objectives for the Auckland Region will be applied to target removal of 75% of the total suspended sediment (TSS) from the runoff created by the developed site.

For design purposes the water quality event will be defined as 15mm of rainfall applied over the catchment, this depth should be sufficient to treat at lest 90% of all rainfall events to the required standard.

Stormwater management solutions suitable for quality control for Washdyke Industrial Park include swales, wetland pond and infiltration systems as proposed below.

Proposed Stormwater System

It is envisioned that each catchment (2no.) will utilise a network of swales / grassed ditches draining to wetland ponds, which then in turn discharge to the existing drainage ditch at a restricted rate. Refer to Appendix A, Figure 1 for the location of the catchment areas, swales and associated wetland systems.

The swales north of Seadown Road will be designed to attenuate flows from the upper sub-catchments during intense rainfall due to the restriction caused by the road crossing; this will slightly reduces peak flows entering the eastern wetland pond area, reducing the wetland pond volume required and increasing retention times during short duration events.

It is envisioned that the wetland ponds areas will have a permanent water area, with a dry attenuation volume above (live storage). The permanent water area will have a central deep water area with a maximum depth of 1.2m surrounded by a shallow bench (200 – 300mm deep), to form a wetland area for enhanced water treatment.

The wetland pond areas will be lined with an impermeable membrane to ensure a permanent volume of water is maintained. The permanent wetland pond volume is to be equivalent to at least 15mm of rainfall applied over the catchment area with the total wetland pond volume providing attenuation and treatment for events up to 10%.

The proposed system has been modelled using a hydraulic modelling software package to assess the catchment as a whole, ensuring a more accurate representation of how the system functions during historic and design rainfall events in order to confirm the proposed system is feasible.

The developed area will discharge a greater volume of run-off at a faster rate than the existing area. To mitigate against this, the proposed system will be designed to limit the peak discharge to less than the equivalent pre-developed rate by attenuating the additional flows. The attenuated volume of water will be released over an extended period of time potentially increasing the period in which flows occur in No.1 Seadown Drain. However, this is not expected to adversely impact on the existing ditch or Washdyke Lagoon downstream given the low velocities expected to occur.

The system will discharge primarily to surface water, but an element of infiltration will also occur throughout the proposed system due to the use of “green” techniques such as swales.

Stormwater Treatment

The proposed system has been designed to provide a high standard of treatment by combining a range of pollutant removal techniques. The various techniques utilised within the scheme are detailed below:

- Source Control Techniques
- Riparian buffer strips
- Catchpit sumps with siphon outlets or oil interceptors.
- Swales
- Wetland Areas

The various techniques utilised form a “treatment train” to ensure a robust system capable of provide a high standard of treatment for a wide range of stormwater contaminants.

The various treatment techniques to be utilised are explained in brief below:

Source Control

Source control techniques seek to reduce the build up and mobilisation of potential contaminants in order to reduce contaminant loadings entering stormwater flows. This can be achieved through public education, landscape management and industry control.

Riparian Buffer Strips

Riparian buffer strips are to be provided alongside the No.1 Seadown Drain to provide treatment to any overland flows entering the ditches. Riparian buffer strips also provide ecological and amenity value.

Catch-pits Sumps/ Oil Interceptors

Catch-pits sumps with siphon outlets and oil interceptors capture coarse suspended solids, hydrocarbons and floating debris at source preventing them from entering the system. These are to be utilised in place of traditional sumps that offer little treatment.

Swales

Swales use vegetation and slow shallow-depth flow for treatment of stormwater. Treatment is achieved through settlement of particles, filtration, infiltration, absorption and biological uptake of contaminants.

The swales will be assessed against Auckland Regional Councils Technical Publication 10 to ensure (where possible) the retention times achieved during the Water Quality event are in excess of 9 minutes, in order to ensure a high standard of treatment is achieved.

The swales are to be lined with a minimum 150mm deep layer of mixed topsoil / sand layer to provide treatment of flows filtrating through the invert.

Wetland Areas

Wetland ponds have a permanent pool of water and are generally able to achieve a higher level of treatment than dry ponds or wet ponds. Treatment is achieved by the settling out of solids and through biological.

The permanent water volume in the wetland ponds has been designed to attenuate 15mm of rainfall over the entire catchment indefinitely to provide a high standard of treatment (Water Quality volume). The water volume is retained until the next rainfall event pushes the treated water out into the existing ditch network. Events greater in volume will cause flows to rise up and fill the attenuation volume above the permanent pool and flow out via the flow control outlets. The restriction of the outflow ensures water is detained and released over a long duration so that good retention times are achieved.

Various studies suggest that retention times typically in the range of 24 hours will ensure a high standard of treatment. The retention times achieved by the proposed wetland ponds will be designed to be in the range of 24 hours during the critical duration 10% AEP rainfall event.

The eastern and northern edges of the wetlands will be lined with small trees or large shrubs to provide shade in order to prevent heating of the water and reduce evaporation losses.

The wetland outlets will be fed by a reverse slope pipe to ensure any floating hydrocarbons or litter are retained within the wetland area.

The proposed eastern wetland pond will discharge into an existing wetland area which is believed to have once been a flood attenuation area. Though this area was not designed as a treatment system, this area may provide additional treatment to flows before they enter No.1 Seadown Drain.

Stormwater System Design

Rainfall for Design

Historical rainfall for Gleniti will be used for stormwater design, this is believed to better represent rainfall for the Timaru area then HIRDS rainfall (Timaru High Intensity Rainfalls, 1999) and provides more conservative values for design.

The 10 minute duration 10% AEP rainfall event using historic Gleniti rainfall has a peak intensity equivalent to 78mm/hr, Timaru District Councils design rate and required level of service for stormwater conveyance.

Swale Design

The swale system proposed will perform two functions, the first being to treat flows, and the second to provide conveyance to stormwater through the catchment.

In the upper reaches of the system the swales will carry shallow, low velocity flows providing a good standard of treatment. The lower reaches of the system will carry greater depths of flow and will primarily function as a conveyance system, though treatment will still be achieved during times of low velocities/ shallow flow. The lower reaches are therefore considered more grassed ditches, rather than stormwater treatment swales.

The base of the swale is to be lined with a 150mm thick treatment layer of topsoil and medium sand, to provide treatment to any flows infiltrating through the invert.

The swales will typically have a 1-2m wide base with 1:4 side slopes to enable mowing and prevent slips or falls.

Wetland Design

The proposed wetland pond areas will consist of a permanent shallow pool with a combined volume of water equivalent to 15mm of rainfall applied over the catchment. The permanent pool area will have a deep central area (maximum 1.2m deep), with shallow margins, to form a wetland area.

Above the permanent pool will be an attenuation area with a restricted outlet to limit the peak discharge during extreme rainfall events.

The wetland pond will have a sediment fore-bay to capture any coarse suspended solids prior to flows entering the main basin. Flows from the sediment fore-bay will flow through or over a rip-rap weir into the main basin area to ensure laminar flow. The proposed sediment fore-bay will enhance treatment, ease maintenance and increase the wetlands lifespan.

Around the wetland pool there will be a safety bench and maintenance area for access to the permanent pool area.

The wetlands outlet structure will be located within the safety bench for ease of access. A drain will be provided within the outlet structure to enable the pond to be drained or lowered for maintenance.

The wetland outlet structure on the western wetland pond will discharge to a new ditch lined with scour protection that confluences with No.1.Seadown Drain a short distance downstream. This ensures outflows mix with the existing system in a more natural manner.

The eastern wetland pond area will discharge via a pipe under the existing railway embankment to an existing wetland area on the opposite side. The outlet will be suitably designed to minimise discharge velocities and cause minimal disturbance to the existing wetland area.

The outfall from to the western wetland pond will be fitted with a flap valve to prevent reverse flow from the ditch into the wetland.

Culvert Design

Where flows are required to pass underneath a road a culvert will be provided, in some areas multiple culverts will likely be required due to the limited fall across the study area. Culverts will be set at swale invert level or will bubble where there are depth restrictions and scour protection and energy dissipation will be provided.

Roads will be intentionally lowered where they pass over culverts to allow flows to overtop them during rainfall events greater than 10% AEP.

Outfall Locations

Two outfall locations are proposed, all of which discharge to No.1 Seadown Drain.

The eastern wetland pond will discharge under the railway embankment and into a wetland area adjacent to the railway.

The western wetland pond will discharge into a short length of new ditch which in turn will discharge into No.1 Seadown Drain. The short length of new ditch will provide a more natural discharge than a piped outfall at an angle to No.1 Seadown Drain.

Modelling Details

Initial modelling has been undertaken to confirm the feasibility of the proposed stormwater management system. The proposed system was modelled using Info-Works CS V7.5. A network of swales and wetland ponds were constructed within the model and sub-catchments created based on the areas topography and the proposed road network.

The model has been constructed to best represent the proposed system, and includes overflows, piped road crossings and filtration to the underlying soils.

Swales were sized using the Manning’s equation and an “n” value of 0.035, equivalent to dense grass.

Catchment slope was assumed to be 0.0033m/m, representative of the typical fall across the study area.

An infiltration rate of 25mm/hr was applied to the base and side slopes of all swales and to the attenuation area above the permanent water level in each wetland pond to represent the likely ex-filtration to the underlying soils that would occur.

The 15mm water quality event was routed through the hydraulic model of the stormwater system to assess likely losses, the resulting volumes of run-off predicted to reach the wetland areas are detailed below:

Wetland 1 – 1,026m^3

Wetland 2 – 1,377m^3

It should also be noted that the proposed wetland ponds provide retention and treatment to flows up to and over the 10% AEP critical duration event.

Rainfall events that generate a volume less than the permanent pool volume will be detained until the next storm displaces it for extended treatment.

Design Details

The proposed system has been sized to convey a 78mm/hr intensity rainfall event without flooding, and convey a 2% AEP event through the site with minimum risk to occupiers of the site.

The proposed wetland ponds have been sized to attenuate and dissipate the worst case duration 10% AEP rainfall event without flooding. A minimum of 200mm of freeboard will be provided within each wetland pond to allow for potential climate change and any uncertainties in the modelling.

The wetland ponds have been designed to half-drain within a 24 hour period, should a secondary rainfall event occur and prevent damage to vegetation, whilst achieving a reasonable retention time.

The proposed wetland ponds have been designed to have a permanent water volume greater than 15mm of rainfall applied over the entire catchment area, plus an additional storage volume above this. It is envisioned that water attenuated above the permanent water level will be controlled by two orifices; one set just above the permanent water level, and a second at a higher level to deal with larger rainfall events.

Design Assumptions

- Water levels in the existing ditch network have not been considered, it has been assumed that the point of discharge is not surcharged and the pond outfalls can discharge relatively freely.
- No allowance for evaporation has been made.
- The system modelled is based on the concept road layout and topographic survey of the site, therefore some elements may change during detailed design. However, the integrated stormwater management strategy will remain the same.
- An allowance has been made for rainfall falling directly onto the wetland ponds surface to ensure conservative design.

- Section 14 of Meadows Settlement and part of Lot 1 DP15376 have been assumed to discharge separately from the proposed stormwater system as these areas of land are currently under development and will have separate onsite stormwater systems designed to manage stormwater up to the 2% AEP rainfall event onsite. Refer to Appendix A, Figure 1 for details.

- A design infiltration rate of 25mm/hr has been applied to the model, which is considered representative of the infiltration rate through a 150mm topsoil and medium sand mix (sandy loam).

- The water quality volume calculated and hydraulic model assumes all roof areas discharge directly to the proposed system (which will most likely not occur). This ensures conservative design.

Design for Potential Change and Climate Change

The RMA Amendment Act (March 2004) requires Councils to “have particular regard to the effects of climate change”. Incorporating climate change predictions into stormwater design in important if infrastructure is to maintain the same level of service throughout its lifetime. Environment Canterbury has established guidelines for the consideration of climate change effects. An increase in heavy rainfall events is one of the key projected changes resulting from climate change. ECan recommend allowance for a 16% increase in rainfall severity for the Canterbury Region, this will be accounted for in the systems design.

To allow for any potential climate change a minimum of 200mm of freeboard is proposed within each wetland pond (with 100mm of freeboard below the outlet overflow), and a minimum of 150mm of freeboard within the swales.

This also provides freeboard against any uncertainties in the modelling or further urban intensification of the catchment area beyond that allowed for (80% total impermeable surface or 72% total contributing impermeable area).

Flood Risk

The proposed system has been designed to convey a 2% AEP event through the site to the detention wetland ponds where flows can then overflow into the existing drainage system.

Intentional low spots in the roads are to be provided where swales cross underneath, in order that flows can overtop the road, should the pipe capacities be exceeded or should they become blocked.

To assess the likelihood of flooding occurring, the proposed system was considered against a 2% AEP rainfall event with varying durations.

Likely Impact of Flooding

Given the likely depth and velocity of flooding predicted, the risk to life or vehicles is minimal during the 2% AEP event. Vehicular access would be possible at all times during the 2% AEP rainfall event, should emergency access be required.

Based on initial hydraulic modelling, during the 2% AEP rainfall event, the maximum predicted swale velocity is approximately 1.2m/s. Given the predicted velocities, no significant grass damage or scouring is likely to occur.

Should any minor flooding occur within the study area, the impacts are likely to be minimal, given the proposed flood mitigation measures that are to be put in place.

Flood Mitigation Measures

- Provision for overtopping shall be provided at each road crossing. The proposed roads shall be intentionally lowered in these areas and be free of obstruction to allow flows to pass over without being impeded.
- Finished floor levels shall be a minimum level of 4m MSL and a minimum of 300mm above existing ground level to provide freeboard against sheet flow, overtopping or other unforeseen sources of flooding not considered.
- Site design levels shall be designed to convey flood flows through the site without being impeded. Flood flows should be encouraged away from buildings where possible.
- All swales are to have a minimum side slope of 1V:4H to prevent slips or falls into the swales.
- The maximum slope within the wetland pond areas will be 1V:4H with a safety bench provided around the permanently wet area of the wetland pond. The margins of the wetland pond areas will be planted to deter people from entering them.

Existing Stormwater systems within the Washdyke area

Currently there are several consented stormwater discharges within the Washdyke Industrial Area, these include:

- Thompson's Yard – Run-off is collected by treatment swales and conveyed to enhanced infiltration basins where the water quality volume is filtered through a treatment medium before passing into a granular infiltration blanket below. Events greater than the WQ event by-pass the filtration media and pass directly into infiltration blanket below.
- South Canterbury Textiles – Run-off is collected by a swale and discharged into an extended detention / infiltration basin. The water quality event is captured, treated via filtration through a treatment medium and disposed of via infiltration. Events greater than the WQ event discharge to No.1 Seadown Drain at a rate restricted to less than the permissible Greenfield rate.

Both systems are designed to a 10% AEP event with sufficient freeboard to contain a 2% AEP event on-site.

Conclusion

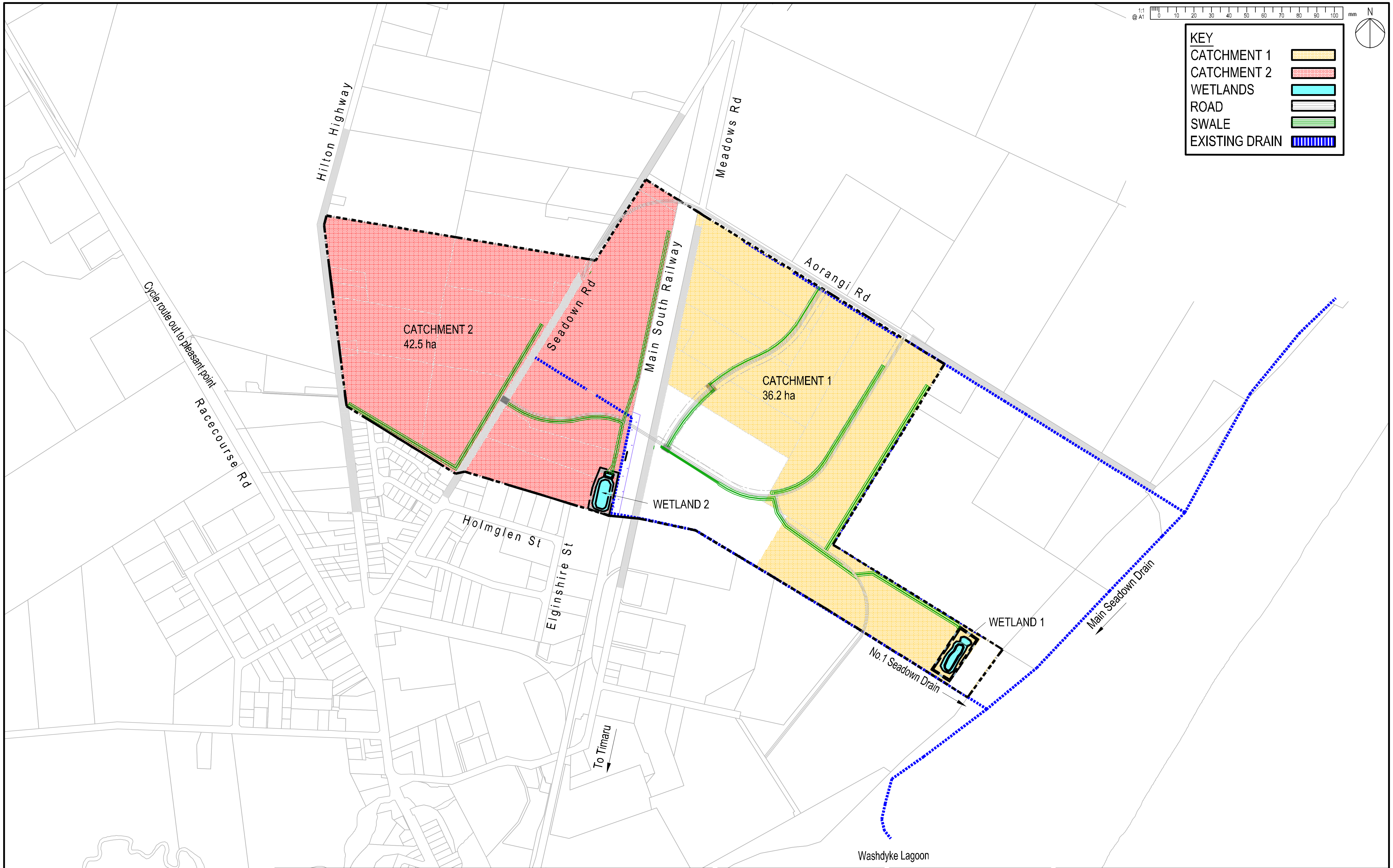
The Washdyke Industrial Park stormwater system will be designed in accordance with best practice guidance using low impact sustainable stormwater practices that will incorporate both the treatment of urban contaminants and minimise flood risk and erosion downstream. It is envisioned that treatment will be provided by grassed filter strips, swales, wetlands and infiltration systems. Particular attention will be paid to the potential impact on groundwater and surface water quality and mitigating the effects due to the treatment efficiencies of proposed solutions.

The proposed stormwater system, in conjunction with on-site stormwater systems and stormwater management techniques, will provide a high standard of stormwater treatment and will effectively convey, attenuate and treat stormwater flows through the study area up to a 10% AEP event, and provide conveyance for events up to 2% AEP through the site.

The proposed system will form an attractive amenity space and habitat for wildlife when compared to traditional drainage systems.

The proposed stormwater system will be managed by TDC, minimising the need to rely on developers to manage and maintain their own on-site systems effectively, ensuring a robust system.

The detail design will aim to create a sustainable stormwater system that will be "future-proofed" for potential environmental changes such as rainfall variation or land use change upstream. This will prevent any costly and inconvenient upgrade works in future.



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Catchment areas changed, Swales moved. New Wetlands created.	SG	20/09/09	This drawing and its contents are the property of Opus International Consultants Limited. Any unauthorised employment or reproduction, in full or in part, is forbidden.			
AMENDMENT	APP'D	DATE				

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TITLE
TIMARU DISTRICT COUNCIL
INEGRATED CATCHMENT MANAGEMENT PLAN

FIGURE 1 – PROPOSED STORMWATER SYSTEM

STATUS	PRELIMINARY	FILE	6DS202.01/FIGURE 1		
SCALE	PLOT DATE	FEATURE IDENTIFIER	CODE	SHEET	REVISION
NTS	01/10/09 @ 08:33		5605	01	1

GRAPHIC SCALES

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