PLANNING FOR WATER SENSITIVE DESIGN IN A GROWING CITY

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ABSTRACT

The nature and effects of stormwater runoff are integrally linked to land use and development practices. Past development has resulted in significant reduction in water quality, and health of freshwater and coastal water bodies from increased stormwater runoff and contaminants, as well as increasing flood risks. Addressing effects in existing urban areas retrospectively, if possible, is often prohibitively expensive. Water sensitive design and on-site management of stormwater quality and quantity are increasingly applied to new development to achieve improved outcomes.

Development of Auckland Council's Proposed Auckland Unitary Plan (the Plan) provided an opportunity to extend water sensitive design approaches across the region and all stages of development to improve integrated land and water management, and sustain and enhance freshwater and coastal water environments, while also enabling significant growth provided for in the Plan.

The approach focuses on reducing the generation of stormwater runoff and contaminants, and then managing them at source, using land use controls in conjunction with discharge provisions. It also seeks to minimise adverse effects of new development and progressively reduce existing effects at the time of redevelopment. There were significant challenges associated with integrating this approach across the Plan which are explored in this paper.

KEYWORDS

Green infrastructure

Stormwater management

Unitary Plan

Water Sensitive Design

NOMENCLATURE

AEP	Annual Exceedence Probability
LID	Low Impact Design
PAUP	Proposed Auckland Unitary Plan
RMA	Resource Management Act 1991
WSD	Water Sensitive Design

PRESENTER PROFILE

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1 INTRODUCTION

Auckland is expected to grow significantly in the next 40 years, with a potential population increase of 1 million people. To assist in managing that challenge, the legislation which established the new Auckland Council included a requirement for a high-level spatial plan to provide strategic direction over a 30 year time period. The Auckland Plan (Auckland Council, 2012) sets out that plan and includes a vision for Auckland to become *the world's most liveable city* over that time period. It establishes aspirational outcomes, transformational shifts and strategic directions for Auckland's people, economy, built and natural environment, arts, culture, heritage and social and physical infrastructure. The Auckland Plan envisages managing urban growth pressures through a mixture of urban expansion and urban infill and redevelopment. In the next decade, up to 40% of Auckland's growth may be greenfields expansion. Over time, the percentage of growth expected to be accommodated through infill and redevelopment of existing urban areas is anticipated to increase.

A "green Auckland" is a key outcome sought by the Auckland Plan and, in order to achieve this, it recognises the need for a transformational shift to "strongly commit to environmental action and green growth". Integrated management of land and water is central to achieving this, as supported by key strategic directives including the following:

> "Establish freshwater values and aspirations with communities and make freshwater an identifying feature of Auckland" (p.187);
>
> "Manage land to support the values of waterbodies by protecting them where they are high and reviving them where they are degraded" (p.188); and
>
> "Protect coastal areas, particularly those with high values … from the impacts of use and development, and enhancing degraded areas" (p.192).

The key challenge for Auckland Council lies in progressing the many aspirations of the Auckland Plan when at times they appear to be conflicting. From a stormwater management perspective, the challenge is to provide for and service the on-going physical and economic growth and development of the region, while at the same time managing effects of development to:

- minimise the risk of flood hazards on communities and property;
- maintain a natural environment that supports freshwater and marine ecosystems, and meets the expectations of the community and objectives established by legislation and national policy instruments; and
- enhance the natural environment where it has been degraded below these expectations and objectives.

Fresh and coastal water environments are particularly susceptible to the effects of stormwater runoff from new growth and, importantly, from existing developed areas. Auckland's small streams, sheltered estuaries, urban aquifers and city beaches are particularly at risk from intensive and extensive urban development. The Auckland Plan (Auckland Council, 2012, p.188) recognises the need to address effects of land use and development on freshwater and coastal receiving environments and also the importance of applying "Water Sensitive Design approaches to new development areas, to avoid the creation of new flooding and environmental problems which are costly to fix retrospectively". The Auckland Plan Addendum includes an action to "apply low impact and water sensitive design principles to new development and redevelopment".

Water Sensitive Design (WSD) offers significant potential to progress Auckland's aspirations for urban stormwater and freshwater management, alongside aspirations for better designed urban growth, development and green infrastructure. WSD is increasingly applied internationally in new and redevelopment areas to address stormwater, wastewater, water supply issues and fresh and coastal receiving environment issues in a way that also enhances the amenity of urban areas. In Auckland to date, WSD approaches have primarily been driven from a stormwater management perspective.

There are many methods available to Council to encourage WSD. The preparation of the Auckland Unitary Plan provided the key opportunity to establish the regulatory and planning framework that supports WSD. This paper outlines the approach taken to progressing a WSD approach to stormwater management through the Proposed Auckland Unitary Plan (PAUP), and also some of the constraints associated with achieving a comprehensive approach.

The paper begins with an explanation of the key stormwater management issues Auckland faces now and in the future as the city grows (Section 2). It then briefly explains WSD and how it can address these issues (Section 3). Section 4 then outlines the potential opportunities available through a unitary plan, and the approach applied in the PAUP, as well as identifying some of the constraints and difficulties experienced in drafting the PAUP. Final conclusions are included in Section 5.

2 STORMWATER MANAGEMENT ISSUES IN AUCKLAND

The summary of issues below is derived primarily from Auckland Council's Section 32 Evaluation for the Proposed Auckland Unitary Plan, chapters 2.24 Urban Stormwater and 2.25 Flooding (Auckland Council, 2013c and d). The same issues are faced in many urban environments through-out New Zealand, albeit typically at a lesser scale than Auckland.

2.1 DEGRADED FRESHWATER AND COASTAL WATER AND SEDIMENT QUALITY

Stormwater runoff from land use and development has, and will continue to have, a major impact on freshwater and sediment quality and on the health of Auckland's freshwater resources and coastal ecosystems. Urban development introduces contaminants that may become entrained in stormwater runoff and transported to streams, the coastal environment or groundwater aquifers. Past land development practices have exacerbated these effects through the modification of natural hydrological systems resulting in large areas of impervious areas and the introduction of a range of stormwater contaminants.

The effects from stormwater contaminants vary significantly and depend on the type, nature and concentration of the contaminants and the type, sensitivity and values of the receiving environment. In urban areas, contaminants can occur in stormwater at levels that affect aquatic habitat and life, pose a public health risk, and can accumulate in stream and estuarine sediments at a level that does not support diverse or healthy ecosystems.

State of the Environment Monitoring and scientific studies on the quality of streams and estuaries in Auckland that receive urban runoff show that:

- Stream water quality indicates that common stormwater contaminants are elevated when compared to guideline levels;
- Stream sediment contaminants (particularly zinc and lead) are elevated when compared to guideline values;
- Upper estuarine sediment contaminant levels are generally above threshold effect levels (levels at which adverse effects may start to occur) and in some instances are near or above probable effects levels (levels at which effects are likely to occur) for degraded ecosystem diversity and health; and
- Contaminant levels continue to increase in receiving environments close to urban areas (Auckland Council, 2013a).

Contaminants typically found in urban stormwater include sediment, metals, organic compounds, plant nutrients, and pesticides and microorganisms. The contaminants of most concern in Auckland are sediment, zinc, copper, PAH (poly-aromatic hydrocarbons), and micro-organisms. Water temperature increases can also be considered as a contaminant, and run off from hard surfaces, as well as discharges from ponds are often above recommended levels for protecting freshwater ecosystems.

Sediment is primarily derived from the erosion of land and streams, and exposed soil and clay (which occurs primarily during the development process) lead to the greatest sediment yields. Metals are present in urban stormwater in both particulate and dissolved forms with the primary metals of concern being zinc (from roofing and tyres), copper (from brake pads, roofing and horticultural products) and lead (from old petrol and paint and roofing products). PAHs come from a range of combustion processes and other sources, while micro-organisms occur as a result of sewer overflows, domestic (and non-domestic) animal and natural sources.

The coastal marine area is the ultimate receiving environment for most stormwater discharges and low energy estuarine environments (which Auckland has many of) are particularly susceptible to the accumulation of stormwater contaminants. The cost of significantly reducing existing contaminant loads in the freshwater and coastal environment is very large – estimates vary between $1.8 to $4 billion depending on the method and extent of contaminant removal (Hill Young Cooper et al., 2007). Large decreases in contaminant loads are required to bring about tangible change in receiving environment quality over time. Prevention/reduction at source is a more efficient way of consistently achieving significant load reductions across the region than seeking to remove contaminants lower in a stormwater catchment, although there are some situations where targeted larger scale treatment is appropriate. By contrast, the primary management approach to past development has been to manage contaminants at the "end of the pipe" rather than seeking to prevent/reduce them at source.

2.2 STORMWATER RUNOFF EFFECTS ON STREAMS

Past urban development practice has usually been to re-contour land for new development through large scale earthworks, and infilling or piping of streams, overland flow paths and natural flood plains, and removal of riparian vegetation to maximise developable land area. The loss of these natural features, followed by the introduction of extensive compacted and impervious areas, results in loss of natural stream functions and health. Impervious areas cause significantly increased stormwater runoff volumes and rates, and reduced infiltration. Loss of infiltration into the soil reduces stream base flows which are essential for supporting aquatic life during drier months in Auckland's small streams. Increased runoff has significant implications for stormwater management and can lead to the following effects:

- Accelerated erosion of stream channels and banks leads to increased sediment discharges and loss of usable property;
- Increases in stream flow velocities and changes in stream channel and bed shape to a more homogenous form, which has a negative impact on aquatic habitat and life, even in small rainfall events;
- Significant structural modification including culverts, constructed channels, bank reinforcement and other structures, which also has an impact on aquatic life; and
- Loss of riparian margins that would help maintain channel and bank integrity and provide wider amenity and flood mitigation (Auckland Council, 2013a).

In general, stream quality and health declines as impervious surfaces within their catchments increase until the point where, at approximately 50 to 60% catchment imperviousness, streams have poor natural values (Auckland Council, 2013a). International research indicates that catchment impervious areas need to be maintained at low levels of less than 10% impervious for high quality stream health and structure and less than 20 to 25% for streams to sustain moderate in-stream ecosystem health, and this appears to also apply for Auckland. Such low levels of impervious coverage are unrealistic in high density urban development, where impervious areas within a catchment could be as high as 80% and even medium density development (where impervious surfaces typically comprise between 40 and 60% of the catchment area) (ibid). However, the negative effect of impervious surfaces can be reduced through the use of proven stormwater management techniques to reduce runoff volumes and manage peak flows.

Through the use of flow mitigation, large areas of impervious surface can be managed to produce a hydraulic response (i.e. infiltration, runoff volumes and flows) that is equivalent to a much lower impervious area. This is one of the most critical factors in retaining (and enhancing) stable, healthy urban streams.

The effects of stormwater discharges highlight the integrated nature of the environment and the connections between land, freshwater systems and the coastal environment. Freshwater not only maintains life in catchments, but feeds marine life in river mouths and estuaries and streams provide access for fish spawning. Water quality, aquatic life, amenity and access can be improved.

While change in development practices and their impact on streams will inevitably be slow in developed areas, intensification and redevelopment can be an opportunity to achieve some improvements in stream quality and values through management of flows from existing (and future) development.

2.3 FLOOD HAZARDS AND FLOOD RISK

In addition to the effects on water quality and stream health, the volume and rate of stormwater runoff in higher rainfall events creates flood hazards. Flood hazards are the most common natural hazard facing Auckland. Flooding is a natural process and flood plains are part of a natural freshwater system. However, risks increase significantly when people, property and development are located within flood plains, overland flow paths, and areas that are susceptible to flooding when drainage networks are blocked.

Historically, flood plains have been used for urban development as they were often the only flat land available in Auckland's otherwise hilly topography, and as a result, commonly accommodated industrial and commercial development. Residential development intruded into flood plains as the urban area intensified, and people sought to make use of what was perceived to be "spare land". Risks from flood events are usually underestimated by communities, while over time, as urban areas develop and impervious areas increase, the effects of flood events increase in severity. These risks are not always resolvable through engineered solutions.

Combined, these pressures have seen the number of properties at risk of flooding in Auckland steadily increase. Currently, more than 7,000 houses with floor levels below the flood level are estimated to lie within 1% AEP flood plains. A similar number of houses are estimated to lie in significant overland flow paths, where the consequences of flood flows may be even more severe.

People and property, where located in flood plains and overland flow paths, cannot be fully protected from some degree of flood risk. It is not possible to capture the large volumes of water that runoff from urban areas in large rainfall events and to divert or channel these floodwaters away from all housing and businesses.

The costs of resolving existing flooding risks are often prohibitive. Auckland City Council estimated the cost of resolving existing flood-related problems to be between $2.9 and $5 billion, although even then there are limitations to what can be achieved in practice. Another issue is that in the long term, flood mitigation works may increase risks and create significant ongoing asset management costs. These flood mitigation works have been shown to lead to a false sense of security as development intensifies in areas that are perceived to be safer as a result of mitigation works. However, there always remains a residual risk of failure of structures or extreme, unanticipated weather events that see the capacity of flood mitigation measures exceeded.

Planning can protect significant flood plains and overland flow paths from development, and this will become more critical as the city intensifies. Planning can also reduce the rate at which more people and properties are placed in locations where they are exposed to flood hazards, thereby avoiding current problems growing in scope and severity.

There are inevitable tensions and compromises associated with managing flood risk. In greenfields areas, it is standard practice for flood plains to be identified and set aside from urban development. They can provide open space corridors, which can have significant amenity value and some recreational attributes but can consume a considerable area of land. There is pressure for flood plains to be modified through earthworks to create more developable land area, reducing storage capacity of the flood plain in some areas and making compensatory changes elsewhere (e.g., through provision of built flood attenuation devices). A further issue is the cost and responsibility for flood plain maintenance, and whether they should be vested in Council.

In existing urban areas, where many existing properties are covered by flood plains, there is continual pressure for further development and infilling. There is a general expectation that landowners are able to make reasonable use of their property. Where there are no options but to build in the flood plain then the issue becomes one of appropriate mitigation (e.g., through flood resilient design), while still allowing for reasonable use. It is important that areas set aside due to flood hazard are maintained so as not to contribute to social and economic decline and degraded amenity. In some cases in the past councils have bought properties at severe risk of flooding (e.g. at Henderson in Waitakere) and either removed the affected houses or renovated them so floor levels are above flood levels. Generally such action is not considered as a solution to resolve current problems, while planning (RMA) processes are relied upon to avoid future growth adding to existing problems.

A risk-based approach needs to be taken to flood hazard management. This means that the likelihood (frequency of an event) and the consequences of that event need to be considered together. Consequences are not just the physical consequences of flooding, such as damage to buildings; they also need to take into account the vulnerability of people and communities to flood events, such as people's ability to safely evacuate during a storm event (even if habitable floor levels are above flood levels) and the design of buildings to allow for easy replacement of damaged materials (such as wall linings, flooring, and services).

While the RMA provides a platform for risk-based approaches to be incorporated into RMA plans, it does not set out what types of risk need to be taken into account and what level of risk is acceptable.

2.4 INTEGRATING LAND USE AND STORMWATER MANAGEMENT IN NEW AND REDEVELOPMENT

Integrated land use and stormwater management is essential to achieve a green, more sustainable Auckland, as envisaged by the Auckland Plan, that better manages and enhances the multiple community and environmental values associated with the natural environment.

The ability to manage adverse stormwater effects becomes more limited once land has been developed in a way that does not incorporate effective stormwater management. Managing the existing effects of poorly thought-out and implemented development is significantly more expensive and less effective than preventing them through land use planning and design that is integrated as far as possible with retention and enhancement of natural freshwater systems. It has been estimated that approximately $6.1 billion is required to mitigate the existing adverse effects of stormwater on the environment from current development in Auckland (Hill Young Cooper et al 2007). While this cost estimate is based on some very broad assumptions, there is no doubt that it is significant.

Current international best practice stormwater management indicates that the retention and use of natural freshwater systems is a more effective, resilient and cost-effective approach to stormwater management than past approaches that have focused on the provision of built infrastructure. Engineered stormwater networks are designed to take stormwater runoff away from development as quickly as possible, but in doing so they increase and concentrate stormwater runoff and eliminate natural processes that help retain flows and sustain the water cycle and aquatic ecosystems.

The adverse effects of stormwater can be mitigated to an extent but addressing these generally leads to an on-going cycle of expensive engineering solutions that can in turn,

lead to more modification and impacts on natural systems, i.e., the more you pipe, the more you need to pipe. As identified above, creating adverse effects through poor development design and implementation, and then mitigating them retrospectively, is significantly more expensive and less effective than preventing them through land use planning and design that is integrated as far as possible with retention and enhancement of natural water systems.

While retention and reuse of natural systems makes sense in terms of sustainable management of natural resources, a potential downside is loss of developable land area in which to accommodate growth, and potentially more expansion of the urban foot print than might otherwise be the case. Countering this, retention of natural systems supports greater amenity and provides protection from flood hazards which supports greater urban intensity. Increasingly in Auckland as the market comes to understand these relationships a net gain can be anticipated of both higher urban densities and retained and restored natural environments.

There have been improvements to how stormwater management is considered and planned for in new urban areas in Auckland, as well as nationally and internationally. However, to date, there has been a significant gap in terms of addressing the effects of existing development. Redevelopment/intensification provides an opportunity to reduce the existing effects of development, and progress wider stormwater objectives given that a high portion of Auckland's growth is anticipated to occur via the intensification of existing urban areas.

A new approach to development throughout the region is therefore required to avoid the costs associated with past development and stormwater management practices and to achieve quality urban environments with high amenity and natural values. Focussing on compact urban form, green growth and WSD have been key planning responses in the PAUP to achieve the multiple outcomes sought.

3 A WATER SENSITIVE DESIGN APPROACH

Water Sensitive Design is defined in the PAUP and Auckland Council's draft guideline document on Water Sensitive Design (GD04) as:

> "An approach to freshwater management. It is applied to land use planning and development at complementary scales including region, catchment, development and site. Water sensitive design seeks to protect and enhance natural freshwater systems, sustainably manage water resources and mimic natural processes to achieve enhanced outcomes for ecosystems and our communities.
>
> Water sensitive design approaches:
>
> - utilise and maintain, enhance or restore natural freshwater systems
> - minimise hydrological changes to, and the adverse effects of land use development on, natural freshwater systems
> - mimic natural processes and minimise the requirement for hard constructed infrastructure to manage stormwater runoff
> - maintain, enhance or restore amenity, open space and other community and cultural values."

WSD contributes to the multiple environmental, social and economic outcomes sought for Auckland and to maintaining and, where possible, improving the overall quality of the freshwater and coastal environment consistent with national requirements and community expectations. It can be understood as a set of guiding principles and a process to be considered and implemented as early as possible in the land use planning and land development process. The high level principles for WSD in GD04 respond to the issues above and include:

"1. promote inter-disciplinary planning and design

2. protect and enhance the values and functions of natural ecosystems

3. address stormwater effects as close to source as possible

4. mimic natural systems and processes for stormwater management"

For large scale new development and comprehensive redevelopment, an interdisciplinary approach is applied to achieve a comprehensive assessment the development site, which looks at bio-physical attributes (e.g., geology and soils, topography, slope, aspect, hydrology and streams, ecology and ecosystem services), as well as socio-cultural attributes and needs (e.g. infrastructure, amenity, open space, heritage, road network, built form) and existing layout of the site and its surroundings to identify opportunities and constraints. This is followed by development design that meets freshwater and stormwater management as well as the multiple other outcomes sought as far as possible within regulatory requirements (ibid.).

A WSD approach seeks first to prevent, then to minimise, the adverse effects of stormwater runoff on communities and the natural environment (particularly in new development). It can also be applied to restore environments and values where they have been, or are likely to be, degraded below community expectations or the level necessary to sustain appropriate ecosystem health.

WSD can be applied at multiple scales (catchment wide, neighbourhood, and/or site) of development and across all phases of development from early design and layout of large developments, through to individual site development. Different elements of the approach are outlined in Table 1. The degree to which these can be applied varies depending on the scale and type of development (e.g., greenfield or brownfield, infill or comprehensive redevelopment) (Auckland Council, 2013c). These elements can be considered as a hierarchy or prioritised list of approaches and, as outlined below, they align with the various stages of development managed through the PAUP.

Low Impact Design (LID) is a term typically used in Auckland in relation to stormwater management components of Water Sensitive Design. However, there was a tendency in the development and planning industry to assume LID referred only to the use of stormwater treatment and mitigation devices, regardless of the much broader definitions of LID which are similar to WSD. The use of the term Water Sensitive Design has been specifically adopted in the PAUP and other recent documents to encourage a more holistic approach as outlined above.

WSD management approach	Implementation
Avoid developing in areas with the most sensitive/high value receiving environments	Location of new growth areas and clustering of development away from the most sensitive areas
Avoid/minimise generation of stormwater effects where development does occur	Design/layout of development; incorporation of natural elements including streams, riparian margins, flood plains and overland flow paths; minimising land disturbance
Target the minimisation of adverse effects to where the most benefit can be achieved	At source/on-site flow and quality management devices
Use broad scale minimisation of adverse effects as well, where appropriate	Communal/catchment scale management and comprehensive treatment approaches for sensitive receiving environments
Mitigation where WSD cannot be achieved	**Implementation**
Mitigate adverse effects directly	Local mitigation of directly affected receiving environments
Mitigate adverse effects in-directly (off set mitigation)	Contribute to mitigation/enhancement of receiving environments elsewhere or generally

Table 1: Elements of a Water Sensitive Design approach

4 WATER SENSITIVE DESIGN IN THE PROPOSED AUCKLAND UNITARY PLAN

4.1 THE OPPORTUNITY

A range of tools are available to Auckland Council to support and encourage WSD, including:

- education and information provision;
- demonstration and exemplar leadership;
- public investment in WSD;
- public-private partnerships;
- awards and recognition;
- grants and subsidies;
- regulatory incentives; and
- regulation.

Many of these have been employed by Council to some extent, but uptake of WSD approaches to date has been limited. To some degree, a WSD approach to development may also occur via market preferences in the future. However, international examples (USEPA, 2010; Boyle et al., 2012) indicate that a "step wise change" towards improved practice and successful implementation of WSD will require regulation.

The PAUP is Auckland's key regulatory tool for managing growth, development, redevelopment and effects of activities on the environment. It provides an important opportunity to apply regulatory tools to promote WSD.

In particular, the PAUP offers the following opportunities:

1. **The PAUP provides opportunity to prepare and align one current and consistent suite of provisions across the full range of planning topics under the responsibility of regional and territorial local government.** The PAUP will replace the Auckland Regional Policy Statement and all regional plans and district plans across the region (except Hauraki Gulf Islands District Plan). This should streamline and simplify the policy framework delivered by legacy plans which were prepared and amended over various times with differing policy approaches structures and requirements.

2. **Improved integration of land and water management** as district land use policy and regulation and regional environmental policy and regulation (particularly for discharges and land use effects on aquatic ecosystems) are combined into one document and delivered by one authority. District planning provisions can also be applied region-wide towards consistent outcomes, across whole freshwater catchments and coastal receiving environments more effectively than under legacy district plans.

3. **Application of regional land use rules** for the maintenance and enhancement of the quality and quantity of water and the enhancement of ecosystems in water bodies and coastal water (RMA, s.30) can be applied in these same document as district land use rules. Importantly, these are not subject to existing use rights as district land use rules are (RMA, s.10), and can therefore be used to progressively mitigate current adverse effects of existing development. The tension between application of district land use rules and regional land use rules delivered by separate district and regional authorities has typically resulted in limited uptake of regional land use functions across New Zealand (Auckland Council, 2013 c). This is no longer the case with the formation of one unitary authority and one unitary plan.

4. **The plan covers all stages of development** through a suite of provisions from structure planning (and associated plan changes) and framework planning (and associated resource consents) for major new greenfields and comprehensive redevelopment, through to subdivision requirements, zone based development controls for different land use types and special purposes, overlay controls for specific values that are spatially dispersed across the region and special precinct provisions for developments with unique development needs. This provides opportunity to thread a comprehensive suite of WSD requirements across provisions for different development scales, stages and locations.

4.2 POLICY APPROACH

The policy approach to Water Sensitive Design and stormwater management applied in the PAUP includes the following:

- Commitment to water sensitive design, green infrastructure and retaining freshwater systems in Regional Policy Statement and region-wide freshwater management policies for both greenfields (which require WSD as a core development approach) and redevelopment (which require adoption of WSD principles where possible).

- A Green Infrastructure Zone has been established for land to be set aside from development and used primarily for stormwater and flood hazard mitigation purposes. This zone will be applied at the time of structure planning and plan change to enable new growth in Future Urban Zones and will cover those parts of the 1% AEP flood plain that need an integrated management approach and/or accommodate large-scale stormwater management devices such as wetlands and treatment ponds. Generally the zone will cover land that is expected to be vested in the council for long term maintenance and protection.

- Strengthened integrated land and freshwater (and stormwater) management policies for new and redevelopment, with an emphasis on avoiding the creation of new adverse effects from new and redevelopment, and reducing existing effects (or new effects that cannot be avoided) at the time of redevelopment primarily through the use of on-site/at source mitigation. Comprehensive solutions which may include communal/catchment scale management are enabled for large scale new developments.

- Structure planning and framework planning provisions which require the application of a WSD approach and delivery of an integrated land and stormwater management assessment;

- Assessment criteria relating to the application of WSD for certain scales of development, along with the requirement to comply with Council's engineering standards, within subdivision rules;

- Associated with WSD, there is a Best Practicable Option approach for network discharges (within a consent framework) and discretionary consent requirements for other stormwater discharges from significant impervious areas. These rules are similar to those in the Auckland Council's Regional Plan: Air Land and Water, with some further integration with structure planning and framework planning requirements;

- Using intensification and redevelopment as an opportunity to incrementally reduce existing adverse effects through on-site regional land use rules to manage stormwater contaminants and flows, including:

    - Region-wide stormwater quality rules targeted at High Contaminant Generating Activities (including high use roads, large car parks, and certain roofing/building materials). Treatment requirements focus on specific contaminants of concern and broad receiving environment types (freshwater and coastal);

    - stormwater retention and detention requirements for development and redevelopment in catchments of streams with moderate-high stream health which are sensitive to changes in flow from increases in catchment imperviousness;

    - mitigation requirements for any increase in imperviousness for sites whose stormwater discharges to the combined sewer network;

    - consent requirements for sites which exceed maximum impervious area for their zone and new impervious areas which are not connected to the stormwater network.

- Increased protection for intermittent streams (which are an essential component of freshwater systems), more stringent controls on reclamation, piping and culverting of streams in regional rules, and greater protection of riparian margins;

- Strengthened flood hazard and risk management provisions including:

    - avoiding new development in the 1% AEP flood plain (this is a non-complying activity) in greenfield areas;

    - requiring protection or provision for 1% AEP overland flow paths;

    - improved accommodation of risk in the approach to managing development in floodplains within existing urban areas, such as:

        - distinguishing between more vulnerable and less vulnerable activities. New vulnerable activities and extensions to existing vulnerable activities in the 1% AEP flood plain are a non-complying activity, while less vulnerable activities are a discretionary activity;

        - more stringent constraints for vulnerable activities and requirements to complete a hazard assessment and risk management plan for less vulnerable activities;

        - controls on fences, walls, car parking and the storage of materials and hazardous substances in floodplains;

        - allowing infrastructure that is functionally required to locate in the 1% AEP flood plain;

        - managing earthworks so as not to exacerbate flooding;

        - managing floor levels in Flood Prone Areas (those areas at risk of flooding due to blockage or failure of infrastructure or depressions in the landscape) and Flood Sensitive Areas (areas adjacent to the 1% AEP floodplain and within 500mm vertical elevation above 1% AEP flood level);

        - requiring significant infrastructure vulnerable to flooding is required to be resilient in the 0.5% AEP flood event.

These provisions, along with the rest of the PAUP, will be tested through public submissions, followed by hearings and decisions by a panel of independent hearing commissioners, which will determine the extent to which the proposed provisions are adopted or amended.

4.2.1 CONSTRAINTS AND HURDLES

As noted above, a large number of provisions have been included within the PAUP relating to WSD and stormwater management, but there have also been constraints on the extent to which this policy approach could be included in the PAUP. These include:

- WSD and stormwater management are cross-cutting topics and, in order to deliver a comprehensive and effective policy and rule framework, they need to be provided for across many chapters or topic areas of the plan. This required championing a consistent approach across multiple plan development workstreams and integrating provisions into a range of policy and rule frameworks.

- Inevitably, there are many competing priorities which needed to be weighed up in developing the PAUP. Some of these tensions include:

    - providing for intensification while minimising exposure to flood risk in flood plains – effort was made to avoid establishing more intensive residential zoning than in current operative plans on properties significantly constrained by the 1% AEP floodplain. However, this creates some limitations for comprehensive redevelopment in some specific localities and conflicted with intensification outcomes sought for some areas.

    - keeping development costs down to enable growth, while also ensuring an appropriate level of regulatory control to manage significant adverse effects across the life time of the development.

    - managing adverse effects of stormwater, which are inherently incremental and cumulative. While an individual site or development may not result in a significant adverse effect, the scale of intensification and growth in Auckland is such that managing cumulative effects is a significant issue.

    - determining the extent to which WSD should be implemented when it is a flexible approach that needs to be developed for individual sites, developments and catchments. The PAUP does not offer substantial guidance by way of assessment criteria to planners or applicants as to "how far to go" with WSD as this will in part depend on the circumstances for each development. Preparation of guidance and practice notes may assist in this regard. The site/development specific nature of WSD means some level of expertise is required in making and reviewing assessments.

    - many of the stormwater management requirements outlined in the approach above, require a level of expert assessment and discretion which can be achieved through a regulatory approach. However, this needed to be weighed against the increased regulatory burden which may be seen to constrain growth. For example, controlled activity status has been used for on-site stormwater flow and contaminant rules with the intent of ensuring stormwater flow mitigation/treatment requirements are met, will assist in keeping consenting burden to a minimum.

- Infill housing provides less opportunity to implement WSD (e.g., reinstatement of overland flow paths and waterways through clustering of houses) and improved stormwater management than comprehensive redevelopment. While development controls within the PAUP promote redevelopment to the full intensity/density available in any zone and back yard subdivisions and infill is constrained, there will still be a significant amount of site by site or small multiple site intensification. On site requirements are therefore going to be a critical component of a WSD approach in brownfields areas. More comprehensive solutions are most likely to be limited to where there are individual large land owners (e.g., Housing NZ and iwi).

- Regulatory development incentives were considered, such as providing further development rights (e.g., gross floor area, building coverage) for developments which implement WSD. This is an emerging approach in New Zealand and internationally. However, at this stage, the main incentive applied in some circumstances is activity status, e.g., controlled activity status applies for activities affected by stormwater flow and quality rules, if specified requirements are met. Otherwise, the activity becomes a restricted discretionary activity.

- Council is currently planning and progressing the implementation of the National Policy Statement for Freshwater Management 2011 requirements, which will establish water quality and quantity objectives, targets and limits for freshwater bodies. Additionally, a marine spatial planning exercise is underway. The approach taken to stormwater contaminant and flow management in the PAUP has utilised the opportunity to provide more targeted and regionally consistent provisions, while recognising that these may need to be amended in the future to reflect specific receiving environment objectives and outcomes that are yet to be established.

5 CONCLUSIONS

In conclusion, it is clear that past approaches to development have resulted in:

- significant loss and modification of freshwater systems;
- significant increases in stormwater runoff volumes and anthropogenic contaminant loads, which have had adverse effects on freshwater and coastal receiving environments; and
- increased risk of flooding to people and property.

Auckland will grow significantly in the next 30 years. Over the same time period, climate change will result in more extreme weather events, and people and communities are likely to increasingly expect restored and enhanced natural environments that are woven into the fabric of their neighbourhoods. The Auckland Plan and PAUP provide the blueprint for this growth, seeking to accommodate it through a mix of intensification and greenfields development. A substantial change in development and redevelopment practices is needed to avoid continuing to increase new adverse effects on the environment and increases in flooding risks, and to also address existing effects through the opportunities afforded by redevelopment.

A growing body of evidence nationally and internationally shows that a WSD approach supports integrated land and water management and sustainable urban development that achieves multiple social, cultural and environmental outcomes. This approach needs to be adopted across all phases of greenfield and brownfield development and redevelopment at multiple scales from catchment to neighbourhood/development scale to single site/at source.

Regulation is a necessary approach, and the PAUP is a key tool for achieving improved stormwater management and uptake of WSD. Successful and consistent application through the PAUP has required discussion and decision making as to "how far to go" with WSD when considered against potentially competing aspirations. WSD is not an entirely new approach for Auckland, having been applied in several recent plan changes and green field developments. However, the approach in the PAUP provides significantly greater emphasis on WSD throughout the planning and development process, and importantly during redevelopment. This will be tested through the submission, hearing and decision process under the RMA. Further progress of WSD in Auckland will also depend on the provision of practice guidance and strategic application of other non-regulatory tools. Strong commitment will be needed if Auckland is to achieve a transformational shift towards green growth and the environmental and social outcomes it seeks in order to become "the world's most liveable city".

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