THE COMMERCIAL BENEFITS OF WATER SENSITIVE DESIGN

Katja Huls MNZPI
Andrew Chin MCIWEM, MIPENZ, IPWEA Ceng Cenv.

ABSTRACT (300 WORDS MAXIMUM)

Water Sensitive Design is being implemented via the Housing Accords and Special Housing Areas Act which implements the Proposed Auckland Unitary Plan (PAUP). Special Housing Areas have allowed Auckland Council to test planning provisions to encourage Water Sensitive Design (WSD) in greenfields and brownfields scenarios. Our recent experience with implementing WSD is that it leads to a decentralised approach which provides strong commercial benefits which have been well received by the private development sector.

While WSD is intended to lead to good ecological, urban design and amenity outcomes, it also has less obvious benefits. Good WSD can do away with the need for large scale communal stormwater devices. The retention and protection of streams avoids engineered flood management approaches because stream corridors can be designed to allow flood flows to be conveyed safely. Hydrology mitigation leads to stormwater management at a sub-catchment level with multiple devices higher in the catchment - a more decentralised approach.

This decentralised approach means that the implementation of stormwater infrastructure is not tied to negotiated agreements between private landowners or cumbersome public land acquisition processes. It also leads to a shift in asset types, the use of smaller pipes and smaller devices which are significantly cheaper to build. Valuable land can be used more efficiently as smaller devices can be located within the road corridor, stream corridors and private lots. Consequently there has been a shift in asset funding sources; from straight ratepayer investment to a mix of private, ratepayer and transport corridor investment. Decentralisation and the use of a treatment train approach is also less likely to result in significant device failure, providing a more resilient network.

KEYWORDS

Water Sensitive Design, Unitary Plan, Special Housing, commercial benefits, infrastructure implementation

PRESENTER PROFILE

Andrew Chin is chartered engineer and qualified planner, with experience in three water infrastructure approaching 18 years. He has worked professionally in the public and private sector both in New Zealand and the United Kingdom. He is currently the Stormwater Asset Management team manager for Auckland Council.

Katja Huls is a qualified planner with 13 years experience in the planning profession, she has specialised in water for the majority of this time. She works for Auckland Council as a senior stormwater specialist providing stormwater input to structure and area planning processes for greenfields developments, and large scale brownfields developments.

1 INTRODUCTION

This paper considers the introduction of Housing Accords and Special Housing Areas Act (HASHAA) and Water Sensitive Design in the Proposed Auckland Unitary Plan; and how these have come together to drive solutions-focussed stormwater designs. We are meeting environmental objectives with infrastructure that is practical to implement.

Special Housing Areas have enabled implementation of the new water sensitive design approach prior to the Auckland Unitary Plan becoming operative and prior to the inevitable amendments negotiated in the Unitary Plan mediation and hearings process. This has assisted with demonstrating the benefits of water sensitive design and provided useful case studies for consideration at the Unitary Plan hearings.

Having worked through a number of greenfields developments using water sensitive design principles we've found that, as well as environmental benefits, water sensitive design has commercial benefits. It enables use of smaller scale infrastructure that is cheaper and easier to implement in the context of fragmented land ownership. The use of on-site and smaller multi-use communal stormwater devices can more readily fit into land along road and stream corridors, rather than developable land. Finally, greater reliance of on-site devices has placed less reliance on ratepayer funded maintenance and provides a more resilient network.

We also discuss some remaining points of tension that require further consideration. Have we fully captured the concept of water sensitive design in our planning framework? Where do we draw the line between innovative and responsive design processes and efficient design and build processes?

2 WHAT IS SPECIAL HOUSING

2.1 HASHAA

The Housing Areas and Special Housing Areas Act was introduced to address rising housing unaffordability driven by a shortage of housing. The Act (HASHAA) enables the establishment of Special Housing Areas which are subject to the HASHAA. The HASHAA provisions override the RMA. While incorporating many RMA processes, HASHAA also amends the assessment and weighting of planning matters, timeframes and consultation processes including appeal rights.

Sites can only be established as an SHA if they are "infrastructure ready" (s16 of HASHAA[i]). From a stormwater perspective water sensitive design enables "infrastructure readiness" by placing less reliance on large communal devices and utilising at source management. However the first steps of a water sensitive design analysis requires consideration of the suitability of a site for the land use proposed, therefore sites that are subject to significant flood hazards that cannot be readily mitigated are considered not infrastructure ready. This extends to sites where flood hazards could not be readily mitigated on up and downstream land because infrastructure is unlikely to be provided to adequately service the land.

HASHAA introduces cut down timeframes for Plan Variations and Plan Changes, allowing 130 working days (around 6.5 months) before a decision is required from the time of notification. While pre-application processes and notification decisions enable amendments to insufficient proposals, there is a possibility that proposals are heard by commissioners without council officer support or full consideration of the issues. While the decision making process is relatively robust and officer reporting can highlight matters that require further consideration, the cut down timeframes require an emphasis on strong pre-application processes and collaborative effort to reduce risk at the hearing/decision making stage.

HASHAA alters the consideration of applications and places greater weight on the purpose of HASHAA (s34) than the matters in Part 2 of the RMA. Environmental considerations may need to take a back seat to the provision of housing; however, the Act contains many balancing factors that enable appropriate consideration of environmental and urban design matters.

There is a presumption of non-notification in HASHAA. Plan variations are generally notified only to adjacent landowners and affected infrastructure providers (s29). Unlike an RMA process, full public notification of a plan variation initiated under HASHAA is not allowed. Further, there are no appeal rights (s79). This has implications for establishment. Certainty of the appropriateness of the site for houses needs to be established before a site becomes an SHA; because consultation processes can be relied upon less than a typical RMA process to flush out matters of relevance to consideration of the application.

HASHAA drives consenting and plan change processes to a 'houses on the ground' outcome with more certainty and speed than the RMA. Planning practice within Auckland Council has had to respond to this. A strong emphasis has been placed on collaborative pre-application processes. Solutions focused multi-disciplinary workshops between the applicant and council have enabled faster resolution of planning issues. While the typical RMA practice of resolving issues via requests for information (e.g. s92 requests) is still an element of HASHAA processes, there is less reliance on it. In the context of an imminent hearing, workshop style assessment processes to resolve technical issues are more common than review and comment processes. This approach is very complementary to Water Sensitive Design (WSD) which demands integrated land and water planning, drawing in other disciplines. WSD fosters a cohesive approach, typically involving collaboration between transport, urban design, ecology, parks and stormwater professionals.

3 NEW RULE FRAMEWORK

HASHAA requires consideration of the notified Proposed Auckland Unitary Plan (PAUP) and places no weight in legacy plans (from the councils that formerly governed the Auckland Region). Auckland Council has introduced the concept of Water Sensitive Design into the PAUP, and it is part of the assessment of greenfields and new development, redevelopment and subdivision. The policy framework sets a higher expectation for water quality outcomes from greenfields developments.

3.1 WHAT WASN'T WORKING

Urban development has the potential to compromise, stream and marine ecosystem health. It affects both water quality and the presence and quality of habitat. The PAUP notes: *The loss of freshwater systems and degradation of their values, particularly small streams, is a significant issue facing Auckland. The piping and infilling of streams, including headwater reaches, has been prevalent in our past urban development and* *resulted in the permanent loss of important community and ecological resources and their values.*

Headwater streams, or intermittent streams, play an important role in flood management, maintaining flow to downstream freshwater ecosystems, sediment settlement, nutrient absorption and the recycling of organic carbon[ii]. In addition, they provide habitat for a diverse range of species, particularly macroinvertebrates and many species also use headwaters for spawning sites, nursery areas, feeding areas and travel corridors, as well as refuge from higher flows, extreme temperatures, predators, competitors and exotic species[iii]. Intermittent wetlands are equally important and contribute to freshwater values in the same way.

3.2 NEW RULES

The new PAUP rule framework seeks to address stream loss and changes in catchment hydrology as a consequence of urbanisation. The reclamation of permanent and intermittent streams has become a non-complying activity in the notified PAUP. Streams are further protected via the introduction of hydrology mitigation – a requirement to mitigate the effects of new impervious surfaces in greenfields areas or areas that have been assessed as being sensitive to changes in imperviousness. In practice, this entails a requirement to:

- Provide retention (volume reduction) of at least 5mm runoff depth for the impervious area for which hydrology mitigation is required; and
- Provide detention (temporary storage) and a drain down period of 24 hours for the difference between the pre-development and post development runoff volumes from the 95th percentile, 24 hour rainfall event minus the 5 mm retention volume or any greater retention volume that is achieved, over the impervious area for which hydrology mitigation is required.

The combination of a requirement to retain intermittent streams and mitigate hydrology effects has made traditional bottom of catchment stormwater devices impractical. Retention cannot be achieved in ponds and wetlands, and devices such as rain tanks, rain gardens and tree pits are typically used to achieve retention. Further, the retention of intermittent streams has meant that devices need to be designed to serve smaller catchments to avoid bypassing stream headwaters with piped networks which would defeat the purpose of retaining the streams. For this reason, on-site devices are more practical to achieve stream protection outcomes.

The distribution of on-site and smaller communal devices throughout the catchment more effectively mimics natural catchment hydrology. In practice hydrology mitigation for homes has resulted in the use of re-use tanks; a solution that also meets PAUP requirements for a 5 "green star" rating. Rain gardens, tree pits and bio-retention swales are typically implemented for roads. The combination of the two styles of solution reasonably mimics the ratio of infiltration to evapotranspiration found in pre-development conditions.

The PAUP introduces a strong policy framework requiring water sensitive design to be utilized as a core development approach for greenfields developments. It is also a strong consideration for brownfields redevelopment and subdivision; albeit with more weight placed on balancing factors for brownfields scenarios where, for example, receiving environments may already be compromised or older style catchment devices are in use.

Water sensitive design is a design process and so difficult to embody in a set of rules, but the PAUP seeks to drive an appropriate integrated land and water planning process for new development while setting some baseline standards for redevelopment.

The Water Sensitive Design approach in the PAUP is supported by Guidance Document 04 (GD04) which sets out a design process to establish the most suitable land on which to develop and considers stormwater management in parallel with the ecology of a site, best practice urban design, and community values. GD04 is embedded within the Auckland Design Manual and supported by the Auckland Council Code of Practice for Land Development and Subdivision.

The sensitivity of the marine and freshwater receiving environments is a key consideration of Water Sensitive Design. Therefore design responses may change over time as new information becomes available on the state of the receiving environment and the effects of urban development. This has been evident during the PAUP hearings process and reconsideration of appropriate design is likely to occur after work begins in earnest on the National Policy Statement for Freshwater; and water quality targets set to respond to it.

3.3 MEDIATED CHANGES TO THE PAUP

The notified PAUP has undergone amendment as a consequence of submissions, mediation and hearings. The concept of water sensitive design underpinning the provisions of the PAUP remain in place including the expectation that greenfields developments will achieve a higher standard than brownfields. Retention targets have been altered somewhat due to concerns over infiltration into Auckland's extensive clay soils; but remains conceptually unchanged. There is a new "out" for sites with very low permeability and some altered design requirements – particularly a change from retaining 10mm of rainfall to 5mm of runoff.

Design Effluent Quality Requirements have been removed and replaced with Approved Stormwater Quality Devices which provides an automatic approval for compliant designs (TP10) while leaving room for innovation. However TP10 compliant devices do not consider temperature to be a contaminant and therefore there has been some compromise of outcomes here.

The implementation of SHAs using the notified PAUP in parallel with the PAUP hearings process has been both challenging and beneficial. While there is some inconsistency between precinct rules for plan variations developed under the notified policy framework and rules developed under the mediated policy framework, the practicality of water sensitive design and its expression in the rules of the PAUP could readily be demonstrated in hearing evidence. In particular challenges to the practicality of retaining intermittent streams and using on-site stormwater devices for retention could be readily combated by presenting successful SHA examples.

3.4 THE IMPLEMENTATION OF WATER SENSITIVE DESIGN

Water sensitive design calls for tailored responses to produce good stormwater outcomes that respond to the site and receiving environment. A number of plan variations have been implemented in Auckland under HASHAA to rezone land from "Future Urban" to residentially zoned land. These plan variations have been underpinned by stormwater management plans and planning processes that implement water sensitive design. In essence, our experience has been that these stormwater management plans have resulted in fairly similar outcomes. As noted above, the use of rainwater re-use tanks has been popular, as has permeable pavement for private lots. There has been little enthusiasm for green roofs.

Rain gardens, tree pits and swales have generally been implemented for roads, and a number have implemented communal vegetated (native vegetation as opposed to grass) basins to achieve detention; both for hydrology mitigation and detention of large storm events. The former have often been placed within the 1:100 year flood plain, but outside of the 1:10 year flood plain to use land efficiently. There have been some key differences in response to topography, and to receiving environment.

Use has been made of natural overland flowpaths (ephemeral streams) to provide a stormwater conveyance and treatment area without large scale earthworking and the installation of pipes as shown in the layout below.

Figure 1 Huapai Triangle Structure Plan[iv]

> *The Huapai Triangle stormwater management plan and structure plan was required to manage downstream flooding. It also retained a large overland flow path that ran diagonally across the site and incorporated a swale with check-dams in it to provide retention for the roads.*

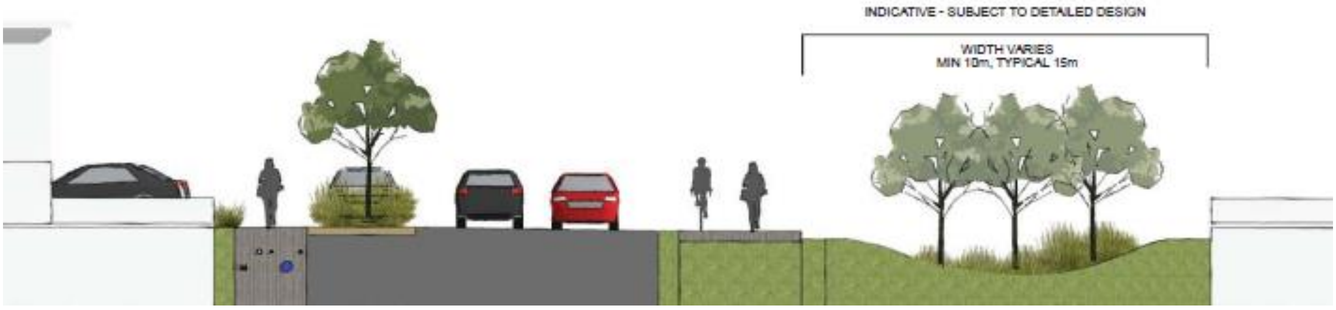

Figure 2 Huapai Triangle road cross section showing the large overland flow path/swale[v]*.*

Detention basins were co-located with parks areas and designed to be practical to implement for landholdings. Nevertheless there was some discussion at the plan variation hearing over the basin at the northern boundary which was proposed on land owned by a group not initially party to the plan change. This was partly driven by the location of the flood plain and the need to minimize the number of stormwater devices vested in council to reduce operational costs

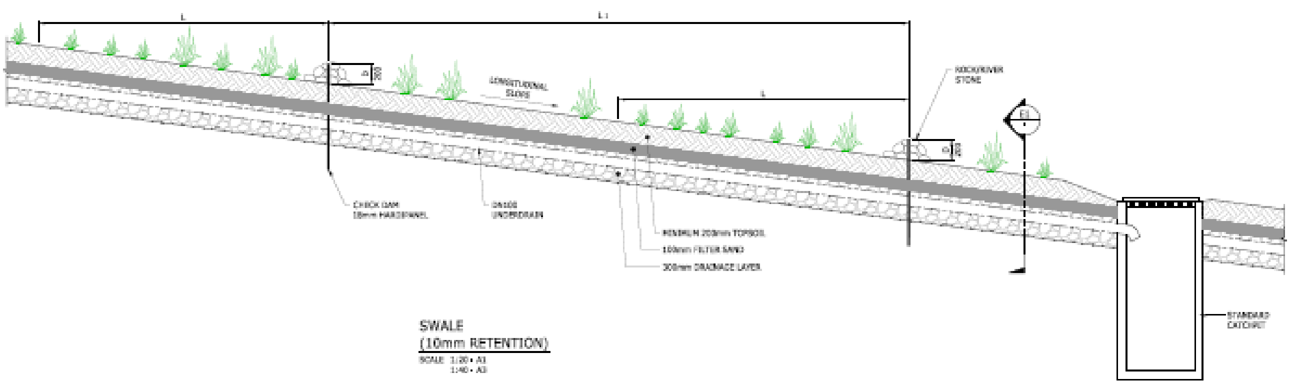

Figure 3 Huapai Triangle swale with check dams[vi]

Swales on steeper gradients become difficult to as the water will flow too quickly to allow effective infiltration and treatment, in Huapai this was overcome by utilising a series of check dams, thus the original ephemeral stream was repurposed into an effective part of the stormwater system sympathetic to the existing topography.

The Huapai example is also interesting because the large bottom of catchment flood attenuation device was the most problematic element of the stormwater management approach, while the on-site hydrology mitigation measures were straight forward.

Figure 4 Oruarangi showing the swale street[vii]

> *Oruarangi also utilised a large natural overland flow path as a swale adjacent to the road, shown in green above. The two lots at the boundary adjacent to the overland flow paths have appropriate consent notices to allow flows through and therefore provide for future development on the adjacent site.*

In Auckland greenfield development areas almost all discharge to low energy estuarine receiving environments; presumably as a consequence of earlier development favouring higher energy swimming beaches and proximity to the CBD and port area. Development in these areas poses higher environmental risk to marine receiving environments because contaminants (typically sediment, trace metals, hydrocarbons and trace organics) rapidly accumulate in these zones with minimal mixing and dispersal from coastal processes, subsequently affecting marine health. For areas discharging only to the coast (and not streams) the application of retention has still been used for lots and roads but as a mechanism to manage contaminants, as opposed to hydrology mitigation. This is because retention has a dual treatment and hydrology mitigation benefit by diverting first flush stormwater to wastewater (via re-use tanks and toilet flushing) or to ground for infiltration, where contaminants can bind to the soil and/or be broken down using bio-filtration. This enables a relatively consistent approach across a development, and prevents contamination of marine environments as a consequence of cumulative effects from large areas of housing being developed in a catchment.

Where catchments discharge to streams, the application of hydrology mitigation effectively manages contaminants for low contaminant generating activities. As noted above, retention removes contaminants by directing first flush stormwater to wastewater or to ground. Therefore, with the presumption of hydrology mitigation and management of high contaminant sources; the primary consideration for catchments that discharge to streams is avoidance of the post-development flood plain.

4 BENEFITS OF WATER SENSITIVE DESIGN

4.1 FRAGMENTED LAND

One of the most significant issues for Auckland Council when facilitating greenfield developments is coordinating the delivery of shared infrastructure between different developers and landowners. During the Plan Change and structure plan phase there is usually agreement amongst applicants for the location of a wetland, flow path or pipeline in the obvious low lying areas. However, once the plan variation is approved the agreements around the location of shared infrastructure often collapse, typically for the following reasons:

- Land is sold to new owners not party to the original agreements or unfamiliar with New Zealand planning processes.

  New owners are often dismayed when the potential yields quoted by their real estate agent are reduced by a large wetland or overland flow path. If their investment is based on over optimistic yield assumptions there is no incentive to invest more into risky land development, the option to simply land bank and wait until the value of the land increases to recover their investment becomes more attractive.

  This issue is overcome by clearly demarcating stormwater management areas as in the examples in Section 4 above.

- Land Developers are in direct competition with their neighbours.

  If a developer can bring sections to the market before their neighbors, there is less supply available in a construction season and the lots will be more valuable. When shared infrastructure is required to pass through one developers land to service another, the dominant developer can deliberately phase the delivery of the infrastructure to slow down their competition.

- The staging of development does not coincide with the logical staging of the infrastructure.

  It is common that developers wanting to proceed first are located at the top of a catchment, furthest away from the outfalls or existing network infrastructure. These developers require all of the downstream works to be completed by the downstream developers before they can proceed.

- The costs and complexity of the shared infrastructure is greater than was assumed at the Plan Change.

  In a structure plan the designs are often done at a conceptual level. Once designs are developed further for a resource consent the true costs become apparent. For example a wetland may need a large dam structure triggering additional building and resource consent requirements. More typically, the assumptions around land value are grossly underestimated.

  Expectations regarding land value usually cause the most fractious disputes between developers. Ofen, the developer with a wetland on their land that provides mitigation for others wants to be reimbursed for the land at a rate equivalent to a fully developed site and the other land owners only want to pay the original rural land value. The difference in land value can be a great as a \$25 per m^2 (rural) to \$300 per m^2 (fully developed land).

Inevitably once the private developers reach an impasse they turn to the Council to either acquire land and/or build the infrastructure under the Public Works Act/Local Government Act. Importantly, the costs are no less when the council undertakes the works and the limitations of the Development Contributions process means it is very difficult to add new projects to the funded programs in a timely enough manner to resolve these situations and meet the developers timeframes.

An example of these issues is the Beachlands development shown below:

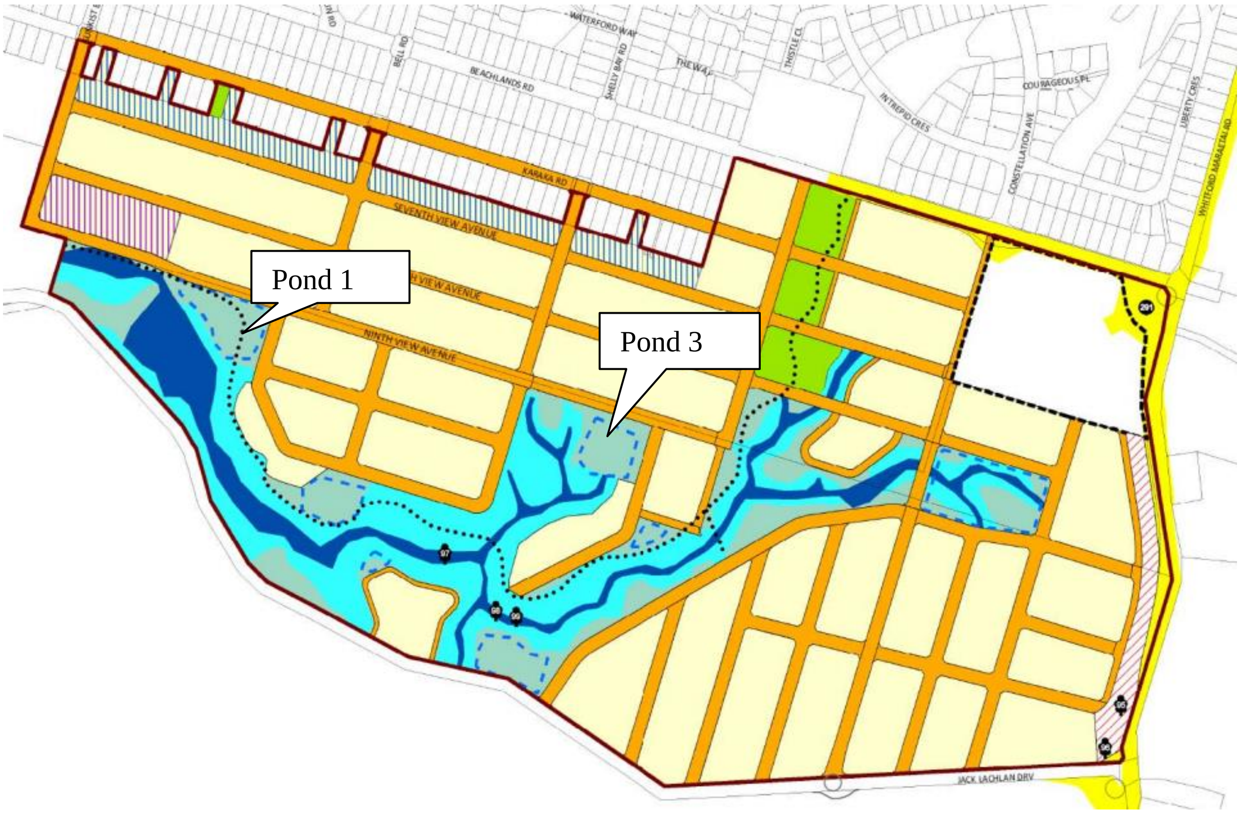

Figure 5 The Beachlands structure plan

This is a typical example of developers being unable to reach agreement to build the shared infrastructure. Pond 3 has been deliberately phased by one developer to disadvantage another and agreement is yet to be reached on Pond 1 regarding cost sharing, the value of the underlying land being the main source of contention. Temporary work arounds are being negotiated but the process is both acrimonious and difficult. The result is sub-optimal yields and infrastructure layouts, with additional delays and cost to the developers.

Already some large developers have changed their approach from conventional storm water management in favour of the water sensitive design approach in the PAUP at late stages of their resource consent applications; primarily because at source management allows much more flexibility to develop independent of their neighbours.

While issues relating to shared infrastructure are not completely eliminated, there are significantly less instances of the large bottom of catchment wetlands being proposed. Devices tend to be smaller such as dry vegetated detention basins which are low maintenance, affording more flexibility in the location and number of these due to the relatively lower impact on operational expenditure. This is demonstrated in the Belmont structure plan shown below, which is currently being developed without any significant implementation issues.

Figure 5 Belmont Stormwater Management

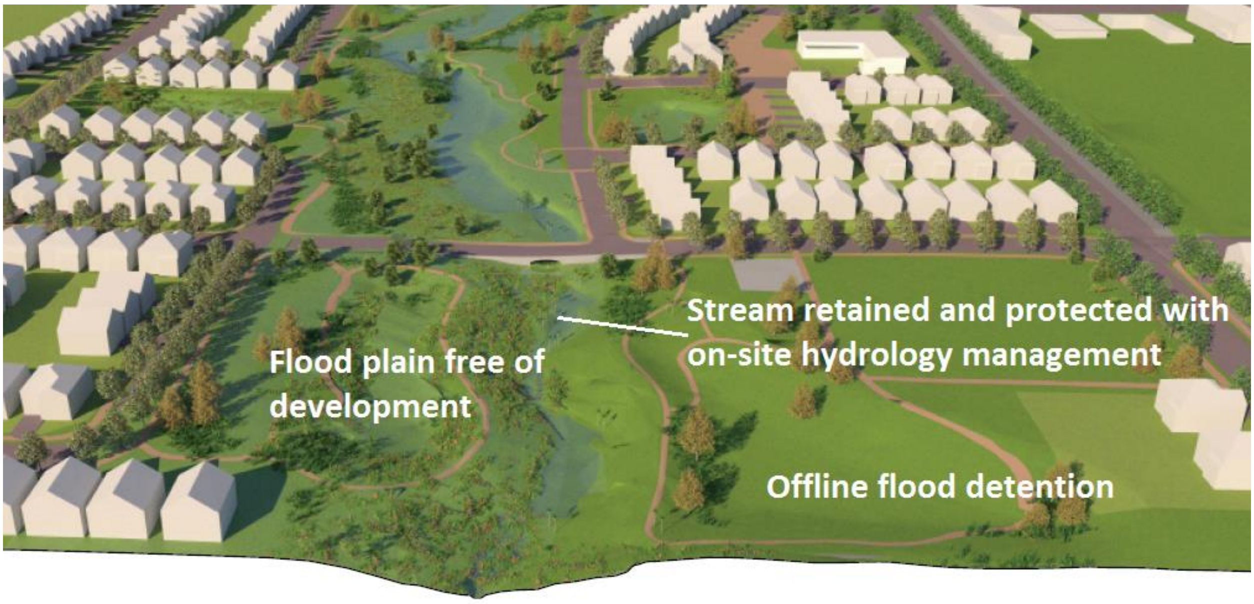

Figure 6 Belmont Stormwater Management

The Belmont structure plan and Stormwater Management Plan is a good example where stormwater management and underlying land ownership were considered together in addition to contaminant and hydrology mitigation they were also required to manage flooding effects on existing downstream development. Stormwater retention is implemented onsite and detention for hydrology mitigation and for flood mitigation is implemented in communal basins adjacent to the stream corridor. The attenuation basins were strategically located to allow individual landholdings to develop independently of each other, they are dry attenuation areas so serve a dual purpose as passive recreation spaces and land scape amenity.

4.2 EFFICIENT ALLOCATION OF COSTS

One of the most common criticisms of on-site storm water management systems is operational and maintenance costs. Ponds and wetlands are viewed as cheaper to maintain compared to raingarden renewal. This is partly because, as the operational accounting has consolidated after the formation of Auckland Council, the significant costs of pond and wetland de-silting are only becoming apparent now. Auckland Council spends over $8 million per annum removing silt from ponds and wetlands built under the previous storm water management rules; and this represents approximately 5% of the over 500 ponds and wetlands in the region. Compare this to the catchpit cleaning programme where all of the 95,000 street catchpits are cleaned twice annually for approximately $4 million.

There are a few factors that contribute to the inefficiency of renewing our ponds and wetlands. The most significant are access, consenting and dewatering. For example, resource consent to de-silt the Wattle Downs wetland (an online pond in South Auckland) has taken over two years to obtain. Because this is an online wetland the de-silting is considered works within a watercourse and triggers non-complying activity rules, and a very long consenting process. The accumulated sediments are contaminated and it is too expensive to truck them to the Waikato for disposal, where the nearest hazardous waste landfill is located. The solution in this case was to stabilise the sediments in-situ and using them to re-engineer the wetland to be more efficient with an easily accessible forebay.

In newer style subdivisions with more at source stormwater management, approximately 75% of the total impervious area will be on private lots. With rules limiting the use of contaminant generating roofing and cladding runoff from houses relatively clean. The use of rain tanks and private on-site rain gardens to mitigate the hydrology effects of dwellings means that the operational expenditure burden for the maintenance of stormwater systems on the ratepayer is reduced. Instead the costs fall to the homeowner. The remaining 25% of the impervious area is predominantly roads. Here, contaminant loads are much higher. At source treatment devices for roads become road assets. This is important because the ongoing operation and maintenance can be funded from a mixture of rates and fuel taxes. The resulting operational funding represents an economically efficient demonstration of the Polluter Pays Principle through water sensitive urban design.

While it remains to be seen, there is also an expectation that more visible stormwater management devices will foster a sense of ownership and responsibility for stormwater management in the community. This helps to reduce operational expense and environmental damage caused by carelessness, such as use of the stormwater network to dispose of harmful chemicals.

At source stormwater management enables more efficient sizing of devices. When we consolidate all the treatment at the bottom of the catchment we are mixing large relatively clean flows with the smaller dirty flows from the roads. Therefore, stormwater devices are less efficient because the concentration gradients are lower. Also, because in this scenario road runoff is less than a quarter of the catchment, their operation and maintenance is not eligible for fuel tax funding.

4.3 RESILIENCE

Forecasting of pond renewals is not a simple matter because the rate of sediment accumulation is variable for every catchment, as is the number of assets vested to council in any given year. Simply scheduling a percentage of assets to be renewed or renewing the assets once they reach a certain age is ineffective. Budget constraints mean assets cannot be renewed asset. Therefore, the use of large bottom of catchment ponds and wetlands over the last 20 years in Auckland created higher risk assets, particularly where the devices have been built online. This is because, in an extreme event, accumulated contaminants deposited from the whole catchment can be re-suspended and discharged into the receiving environment. Even normal rainfall can cause this if we are unable to de-silt the device in time.

Five years into the new Auckland Council the early stages of a systematic renewal of ponds and wetlands are showing that we will have a significant backlog of pond and wetland renewals to undertake. Physical surveys of the pond bathymetries are currently being undertaken by a team of university students to measure the actual levels of sediment accumulation to optimise our renewal programme. In new developments where at source contaminant management is utilised small volumes of contaminants are located within multiple devices with much smaller catchments associated with them. This is lower risk and more resilient the risk of asset failure is less, the devices being smaller and more numerous. Further, flood flow rates and velocities cannot reach levels that can damage all of the assets.

While many of the at-source stormwater management assets will be privately owned, contaminant loads on residential lots will not be high. Even if a moderate proportion of private landowners do maintain their assets correctly, our risk profile is still better than relying on a single asset to undertake all the mitigation. To ensure that privately owned storm water management devices are maintained a new storm water bylaw has been implemented in Auckland that allows the council to require a property owner to maintain private devices. Note that assets in the road corridors, where the contaminant load is higher, will still be publically owned and maintained.

Early concept for the example below, Scott Point in Hobsonville, had a number of bottom of catchment wetlands, which were replaced with a mix of on-site devices and end of catchment devices. The latter consist of vegetated swales that provide a treatment train. These can be implemented on each landholding and be sited to suit the topography.

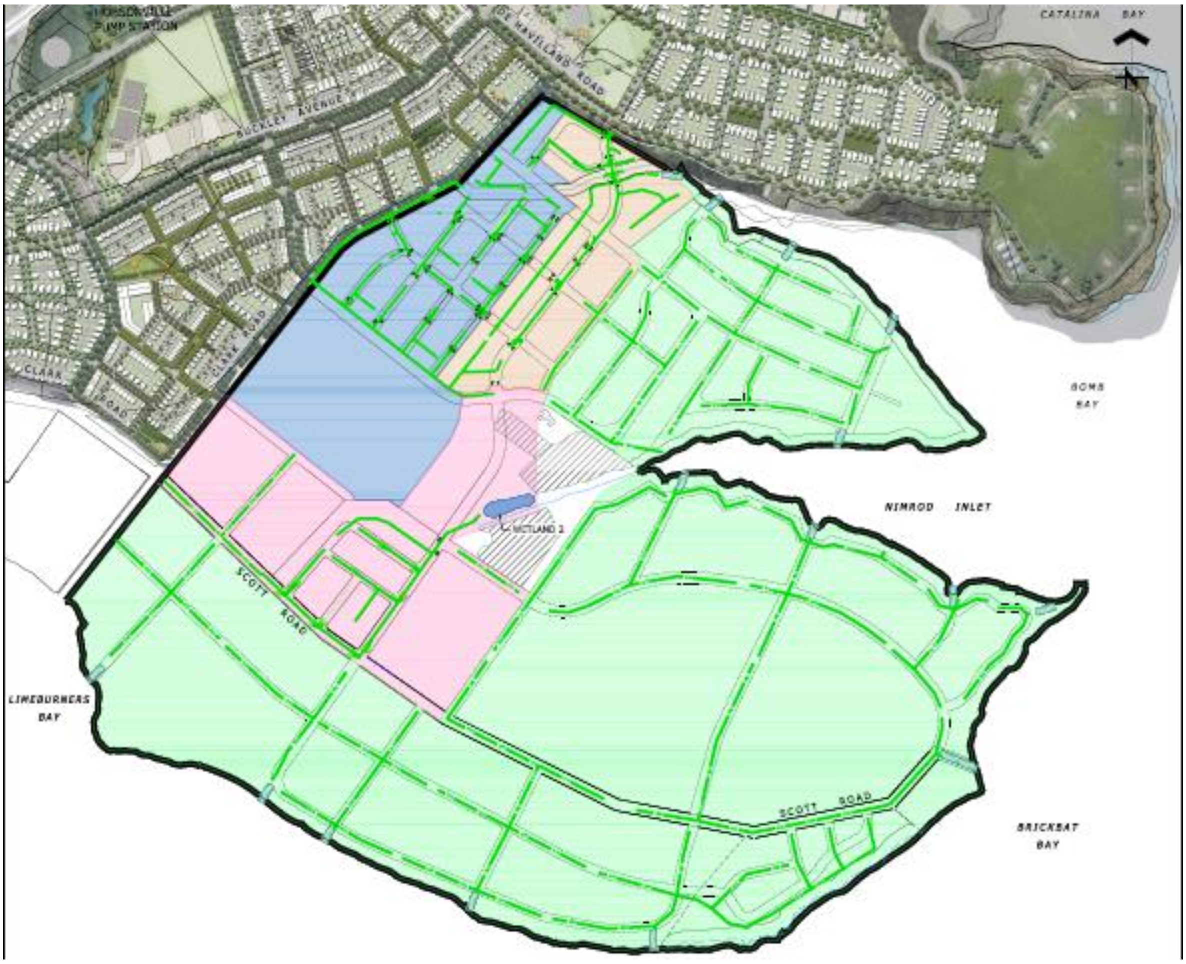

Figure 7 The Scott Point Stormwater approach – different catchments have different management options according to their receiving environment[viii].

The Scott Point Structure plan and stormwater management plan is a good example where resilience has been integrated into the stormwater management approach. Scott Point discharges to a sensitive marine receiving environment and has implemented retention for contaminant management in coastal catchments and hydrology mitigation for catchments discharging to streams. The proposal in the plan variation was to also use a wetland to treat a small commercial area; however the wetland construction has proved too challenging and has been replaced with on-site mitigation.

Figure 8 Scott Point vegetated swale

> *Stormwater is discharged to the coast via vegetated swales that are sized to fit into the topography rather than achieve a particular treatment standard. These are designed to be practical for individual land holdings and be sympathetic to the terrain. Coastal erosion is a significant long term hazard in this area and vegetated swale provide a broad area to dissipate the energy of the discharges to minimise erosion effects on the coast*

5 POINT OF TENSION

5.1 STREAM LOSS

The true cost of stream loss is still not being fully captured by developers. Consented permanent stream loss through piping and land development is currently running at 1.02 kms of permanent stream loss and 5.2 km of intermittent stream loss in the first six months of the current financial year. In 2014 the total consented stream loss for the year was 4kms of permanent streams and 8.6kms of intermittent streams.

Under the PAUP works modifying intermittent streams has become a non-complying activity and it is fair to say that the industry is still adjusting to the concept of intermittent stream protection. Even though consenting requirements for stream loss are onerous, these figures are not improving yet.

The requirements for offset mitigation of stream loss are not consistently being fulfilled. Offset mitigations are meant to dis-incentivise stream loss and to compensate (balance out) the loss of ecosystem services that stream loss entails. However, finding suitable locations for offset mitigation is a constant issue and conditions that specify the type and location of offset mitigations often cannot be prescribed.

In order to improve the quality and compliance rate of delivering offset mitigation the Stormwater Department is currently setting up a programme of stream restoration programmes to which developers can contribute to satisfy their obligations. The tension remains as to what is an acceptable price of the off sets, too low and it will be seen as a pay to pollute mechanism, too high and we end up in endless litigation intended to avoid the costs.

5.2 TRANSPORT

At first glance there seems to be a conflict between at source stormwater management and road design, however this is where it is important to understand Water Sensitive Design is a process, not a prescription for low impact design devices everywhere. Water Sensitive Design calls for meaningful consideration of alternatives and integration of stormwater management at the beginning of the development design, rather than a last minute add on. When viewed this way, efficient stormwater infrastructure can be developed regardless of the development site. Competition for space in the road corridor and the compatibility of infiltration devices with road construction have been an issue but can be overcome with pragmatic approaches.

At source storm water management competes for space within the road corridor with cycle ways, lighting, footpaths and car parking it fulfils other important road functions. Tree pits, swales and raingardens can fulfil landscaping, ecological and place-making requirements. When the road is viewed in a more holistic way it is no longer appropriate to consider stormwater management as a secondary function of our roads, rather, it is an integral part of the road structure, just as the kerbs and catch pits and asphalt are. Where space is very constrained alternative approaches such as permeable paving, larger raingardens placed at intersections, or communal devices can be considered.

Infiltration devices for hydrology mitigation in the road corridor can be of concern to road engineers. Good roads require a low water table under them so the sub-base can drain effectively. If the sub base becomes saturated and water is able to enter the road pavement, failure of the seal will occur and potholes appear. Early site assessment should identify where there is a risk of sub-base saturation due to topographic constraints and poor sub-soils, and infiltration devices may not be appropriate. In these situations it is acceptable to use alternatives. However any alternatives assessment should be mindful of managing environmental effects.

Figure 9 A pothole in caused by poor sub-base drainage.

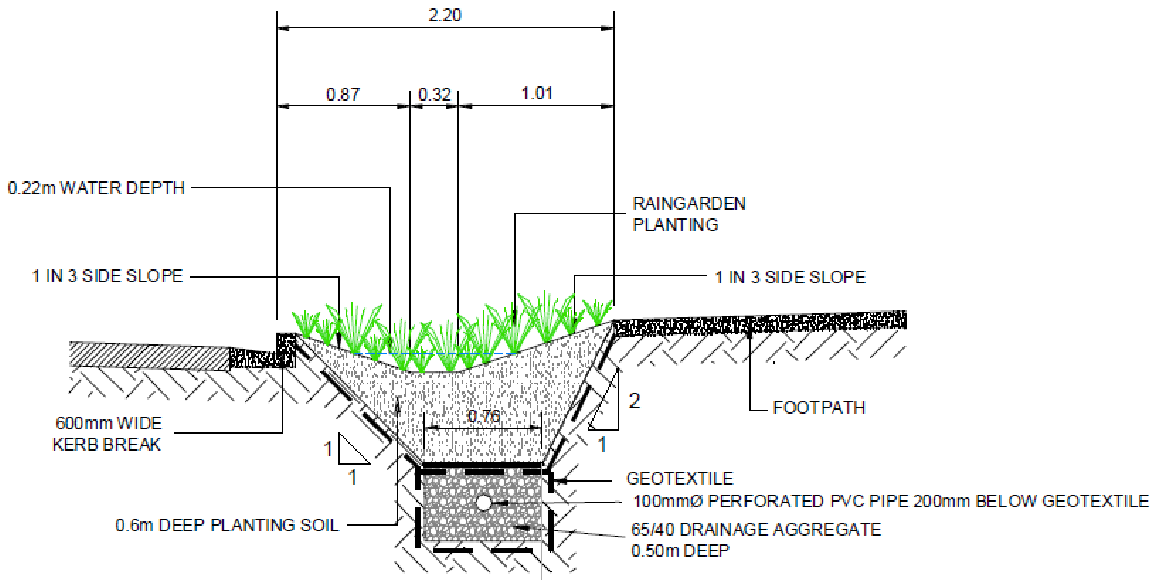

Figure 10 A recent rain garden design by Candor 3; key design features include the 1:1 batter from the kerb to maintain the structural strength of the road, the batter can be steeper on the footpath side due to the smaller loads. The water table is also kept below the invert of the PVC pipe, allowing the road subgrade to drain effectively.

WSD calls for subdivision design that responds to the site; one of the key objectives is to try and work with the natural land contours as much as possible. Placement of rain gardens based on a minimum catch pit spacing guideline is not appropriate and results in multiple small catch pits taking up large berm areas. This is inefficient for future operations and maintenance. A balance between optimal kerb flows and the number of inlets is required so the right balance between the number of assets the risk of surface flows and efficient land use is achieved. Design packages such as 12D or Mike 21 are now being used by most reputable subdivision designers. These tools are key to optimising the efficiency of a subdivision design, particularly with locating overland flows paths, inlets and treatment. Industry training may be required to ensure that designs standards and understood and appropriate.

WSD is not a case of green infrastructure at any cost. Pragmatism is part of a WSD approach. Yield requirements and good urban design are key considerations. Typical compromises will include rationalising at source treatment to areas of heavy braking and acceleration, consolidation of rain gardens, and using hard engineering structures where space and contour constraints dominate.

5.3 INDUSTRIAL LAND

There are a number of submissions to the PAUP that challenge the efficacy of water sensitive design for industrial land use. The submissions essentially argue that because industrial sites need to be large, flat and impervious, the earthworks and compaction required to develop the site will make the retention and detention requirements ineffective; and large scale reclamation of streams will be inevitable.

However, if a WSD approach is followed ground conditions and site contours can be taken into account. An area of land on the site (say 10%) can be retained to allow for infiltration. There are many example of industrial sites were low impact solutions have been utilised very successfully because they are cost effective and provide amenity, such as the Lion Breweries site in East Tamaki. Alternatives to retention and detention for hydrology can be acceptable, but proper consideration is required.

Submissions from the steel industry argue against rules in the PAUP requiring stormwater quality mitigation for the use of un-coated galvanised or zinc alum roofing and cladding. Large warehousing buildings in industrial areas are of particular concern to the steel industry. Painted or coated steel roofing and cladding is more expensive (approximately $8/m^2 more than uncoated); extrapolated over the massive surface area of a large warehouse it does become significant. Unfortunately, targeting of these large surface areas is exactly what is needed to effectively manage heavy metal contamination of the receiving environment. In our view the additional cost of coated steel products for warehouses is far less that the cost of land and assets required to try and build treatment systems to capture the contaminants at the bottom of the catchments. This is one area where the Stormwater Department will keep trying to influence change, but the decision of the commissioners in June will be the next step to seeing how this issue is resolved.

5.4 BUILDING GUARANTEE

Major building companies sell new houses with a 50yr build guarantee and there is resistance to some technologies such as pervious paving and rain gardens for private lots which require maintenance within the 50 year period. These devices are still in the early stages of widespread use and a long term track record will give the building industry more confidence. Well-designed devices made from durable high quality materials are essential. Possible options to reassure building companies could include expanding the scope of recommended proprietary devices or LID products.

We note that low impact stormwater management systems contribute to the Green Star rating for a new build. It is not uncommon for the stormwater management devices such as rain tanks to feature prominently in the marketing material of new subdivisions. There doesn’t to be a conflict between the objectives of building companies and good environmental outcomes.

5.5 EARTHWORKS PRACTICES

Building companies prefer flat 350m^2 sections. These suit a range of pre-approved flat slab building foundations and house typologies that have an entire factory production line of ready to assemble components behind them. This is one of the main market forces driving stream loss and the significant earth works undertaken in greenfield subdivisions. Sloping sites and pile foundations require bespoke engineering design for each house and are therefore less sought after by building companies. This is a particular area that is ripe for innovation across the development sector. How can we make building just as easy on sloping sites?

Figure 11 The Karapiro Drive development in Whangaporoa, note the numerous retaining walls and fleet of motor scrapers employed to create flat sections.

Just because the hill is flattened does not mean the geotechnical risks have disappeared. Each retaining wall will only have an asset life of 50 years. How will they be replaced in future? Who will be responsible if they fail? Concrete slab foundations may be subject to differential settlement and repairs to under slab utilities are an issue.

From a resilience perspective, the wholesale move away from pile foundations is disappointing for a number of reasons. "Slab on grade" is more at risk of overland flow flooding. Heavily earth worked sites become compacted and infiltration becomes less effective in the remaining pervious surfaces. This exacerbates "Urban Stream Syndrome". Finally, much of the easily developable land in Auckland is already developed so more and more of the marginal hill country will be developed in future. Even with best practice sediment and erosion control measures in place the shear volume of earthworks results in a significant slug of sediments into the receiving environments during the development phase.

This is an area of further investigation with huge potential. Everyone is aware that house prices in Auckland are an issue. If we are able to build on sloping sites with the same build efficiency as flat sites the underlying section will be less expensive to create and therefore should be a more affordable. How we are able to make development easier whilst avoiding large scale earthworks?

5.6 INNOVATION VS STANDARD SOLUTIONS

Water Sensitive Design is a design process that is intended to respond to the site and the receiving environment. It isn't intended to refer to a suite of devices. There is a danger that the term 'water sensitive design' will be considered synonymous with green infrastructure as has been the case for 'low impact design' which is now commonly understood to mean devices such as rain gardens, rather than a design process it began life as. It's a challenge to retain the idea of water sensitive design being an iterative and responsive design process while enabling practical on the ground solutions. The latter seems to call for a palette of standardised solutions which are readily accepted by the regulator and can be mass produced by manufacturers; however there is a risk that these become out of step with best practice. Once solutions are readily accepted it's this very acceptance that can make it hard to shift away from them when better solutions are found, indeed superior solutions may not be sought in the context of a known accepted solution.

6 CONCLUSIONS

Water Sensitive Design makes sense. Working with a site and mimicking natural hydrology not only produces better environmental outcomes, it produces stormwater designs that are practical. Working with smaller catchment devices and on-site devices creates a number of points within the catchment where stormwater can be captured and managed and the cost of doing so is spread between residents, ratepayers and infrastructure providers (the tax payer). In a planning environment where development is driven by developers owning relatively small landholdings within one planned development area a move away from large scale devices facilitates timely development.

A number of challenges remain to find the balance point between environmental protection and cost-effective land development. Further consideration is required of the implementation of water sensitive design, the planning process that underpins it and perhaps how it is embodied in the PAUP to ensure we're capturing the maximum benefit from this new design challenge.

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