PILOTING A NEW APPROACH TO ASSET MANAGEMENT: THE STORMWATER STORY

Carron Blom[1] and Andy Irwin[2]

1 Anguillid Consulting Engineers and Scientists Ltd, PO Box 34408 Auckland 0746.

2 Auckland Transport, Private Bag 92250, Auckland 1142.

ABSTRACT (200 WORDS MAXIMUM)

In 2009, North Shore City Council opened the Albany Lakes and Civic Crescent projects (Albany Lakes Precinct (ALP)). The projects both adopted an integrated approach to their design. This is evident in a number of areas and more particularly in the area of stormwater management where the approach adopted is consistent with the principles of water sensitive urban design (WSUD). The ALP development therefore blurs the boundaries between public art and infrastructure, stormwater management and amenity, transportation assets and parks.

Whilst an integrated solution has been delivered, industry experience of WSUD based developments has frequently found that the subsequent maintenance does not adapt to situations where assets may have multiple functions, non-standard solutions, or green engineering. A project was therefore instigated to establish a new, integrated approach to asset management that progressed beyond 'three waters' or other current 'integrated asset management' approaches. The project aimed to enable the sustainable concepts behind the WSUD, to address implementation barriers, and to identify and optimise interface efficiencies.

This paper explores this development in infrastructure management by considering the approach from the perspective of stormwater asset management. It considers the functional drivers and outcomes sought within the context of a new operational approach.

KEYWORDS

'Asset management', environment, sustainability, 'low impact design' / LID, 'water sensitive urban design' / WSUD, stormwater, integration, 'urban design', 'community outcomes', infrastructure, 'non-financial performance indicators', 'Local Government Act', 'Resource Management Act'., 'co-ordinated operational responsibilities', 'community orientated results'.

PRESENTER PROFILE

Carron Blom BSc (Chem / Zoo), MSc (Hons) Env Sci / Zoo, TIPENZ, MRSNZ, MRMLA: Carron Blom is the Managing Director of Anguillid Consulting Engineers and Scientists Ltd a specialist consultancy in environmental management strategies. She has 20 years of postgraduate experience from New Zealand and overseas, which includes a wide range of stormwater and other infrastructure related experience.

Andy Irwin CEng, MICE, BSc (Eng): Andy Irwin is the Stormwater Specialist for Auckland Transport, providing specialist advice and co-ordinating stormwater business between Auckland Transport and Auckland Council. Prior to this he had over 20 years of wide

experience in local government in traffic and road safety engineering, road design and maintenance and network management in the UK.

1 INTRODUCTION

In 2009 a project was initiated to develop a new operating framework for the Albany Lakes Precinct (ALP). The long term vision was to establish a robust, adaptable step change in asset management that could be iterated and evolve to better deliver the desired outcomes in a more sustainable and efficient manner.

A new framework has been established that accommodates the complexity of integrated design and high amenity assets, without itself being complex. It draws upon and uses existing asset management tools, but crafts a new framework against which asset managers might operate; providing a holistic integrated approach aimed at maintaining environmental integrity, community aspirations, and design intent over the longer term.

This paper explores the stormwater aspects of a holistic approach developed to assist the effective operation of complex, multipurpose assets. Stormwater is but one of the elements within the overarching project, but serves to illustrate the need for, and benefit of integrated approaches to the long term operation and maintenance of infrastructure and indeed public assets in general. The overarching concept and model is described in a parallel paper under development.

To date, information on LID / WSUD (hereafter collectively referred to LID for simplicity) has largely focused on the drivers, design approach, and examples where the approach has been adopted (e.g. Blom, 1998; Blom et al., 2002; Irwin, 2010, amongst others). The aim of this paper is to round out the information and approach to LID by providing a focus on the long term operational aspects. In so doing, the intention is that this will encourage practitioners to take a broader look at the present approach to asset management.

2 PROJECT BACKGROUND

2.1 SPATIAL SCOPE AND LOCATION

The subject area, Albany Lakes Precinct (ALP), is located within the recently established Albany town centre on Auckland's North Shore (refer to Figure 1). The project is surrounded by shopping and business precincts, schools, a University, and Stadium. Additional development has occurred to the north of the ALP and further development is planned.

The ALP encapsulates two Council capital works projects:

- Albany Lakes Park:
  This included development of the park, landscaping, and community amenity areas. Initially a separate project, the Albany Lakes – Stormwater Improvements project was incorporated into the wider Parks development, and undertook to change the shape of the lakes and to improve their function. One of the key overlapping features of the project was "*the establishment of a feature bridge based on an eel weir*" (Irwin, 2010).

- Civic Crescent:
  This part of the development included the upgrading of Civic Crescent, the installation of stormwater pre-treatment, and the delivery of the Albany Civic Crescent Bus Station.

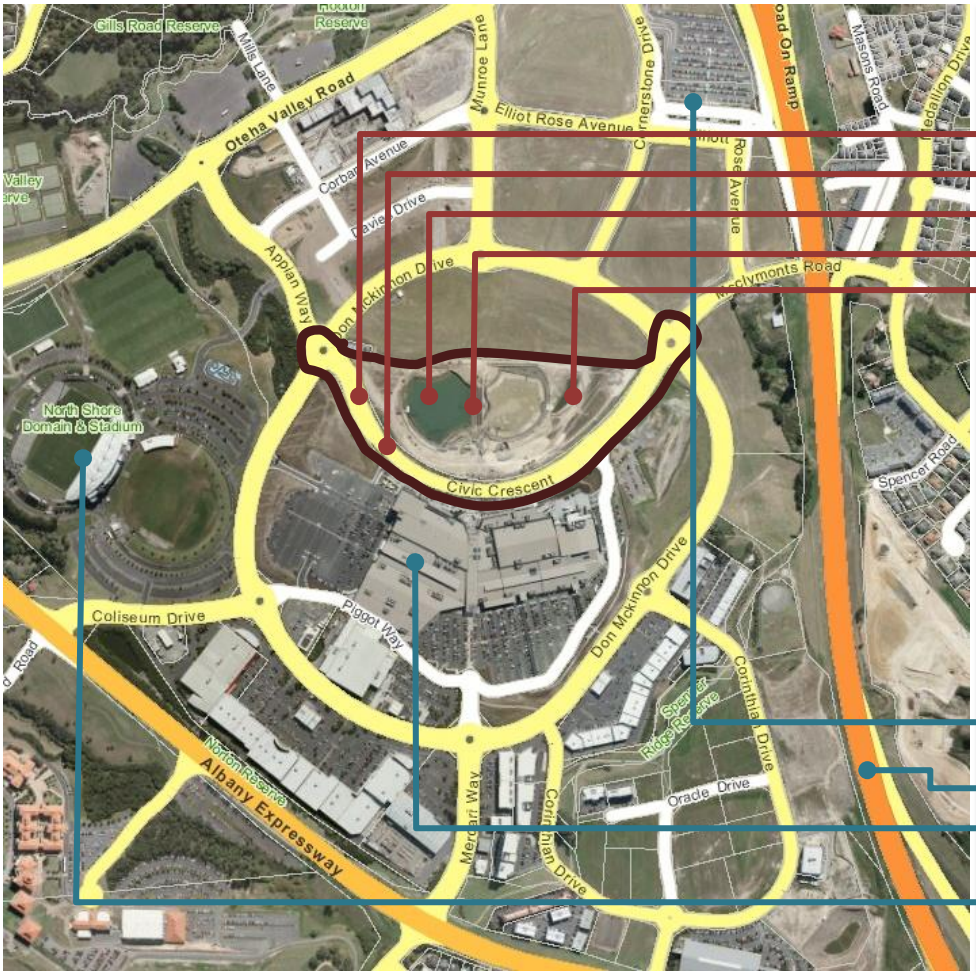


Figure 1: Project Location

Source: Auckland Council (Note that the 2008 aerial was taken prior to project completion).

The Lakes Park and Civic Crescent projects were headed by different Council divisions (Parks and Transportation respectively), and involved a wide range of departmental stakeholders (streetscapes, utilities, parks, stormwater, and transport) as well as third party and community groups. The projects were closely aligned, and were part of an overarching strategy to deliver a new civic space within the Albany Regional Centre. Figure 2 shows the relationship of the two projects comprising the spatial scope of the ALP.

2.2 PHYSICAL WORKS OBJECTIVES AND FEATURES

The vision for the overall Albany Regional Centre (of which the Albany Lakes Precinct forms the core) was to establish "*a dynamic city centre of which we can all be proud*" (NSCC, 2004). A range of key outcomes and attributes were established and embedded in City planning documents; many of which were of relevance to the long term outcomes of the ALP, for example (NSCC, 2004):

- *"Use of land and infrastructure in an environmentally sustainable way."*
- *"Efficient use of land to minimise stormwater runoff and better support public transport."*
- *"Generous public spaces that are a pleasure to be in and to walk around."*

Figure 2: Project Overview
Source: NSCC.

- *"Street trees, street furnishings and lighting enhance the public realm."*
- *"Safe and effective transport links by car, bus, cycle and foot."*
- *"The centre has a main street linking some of the major activity nodes and is accessible by all modes of transport."*
- *"Careful street design and traffic calming provides a pedestrian friendly environment."*
- *"A strong sense of place and an international reputation."*
- *"Design elements reflecting our cultural context."*
- *"Art in public places."*
- *"A vibrant main street with a unique character and a range of activities along it."*
- *"Public spaces and community facilities encourage community participation and shared experience."*
- *"X factor – at least a little bit of magic."*

Consequently performance and maintenance of the design intent is an important consideration.

The integrated approach taken during design is evident in a number of areas and more particularly in the area of stormwater management where the approach adopted is consistent with the principles of LID. Because of its functional complexity, the integrated stormwater design approach is perhaps the most critical component of the on-going maintenance and management of the area as it:

- Must meet statutory requirements (catchment / development level treatment as well as conditions such as a requirement to pre-treat runoff from car park areas before discharging to the Albany Lakes);

- Provides a soft edge and seamless transition between the roadway and the adjacent park area. In so doing it acts to remove visual or physical barriers or simple delineations and improve pedestrian interaction and encourage access from the adjacent commercial zone; and

- Provides a multipurpose means of segregating traffic flow and parking areas. The rain gardens act to not only treat stormwater, but to sustain landscaping (passive watering), and soften the urbanscape (see Figures 3 and 4).

Figure 3: Civic Crescent LID Concept

Figure 4: Civic Crescent LID Detail

Table 1 summarises some of the stormwater features within the ALP and their interface with the objectives and functions of the various parallel projects.

Table 1: Overview of Stormwater Features

Feature	Main Stormwater Function	Other Function
Grassed berms	Carriageway treatment Footpath treatment	Urban design feature. Link to wider Park. Traffic management. Services corridor.
Median Gardens / Rain Gardens	Carriageway treatment (statutory requirement at project level).	Aesthetics, feature planting, urban design. Traffic management.
Footpath gratings	Conveyance from roadway to Swale.	Urban design / architectural feature.
Grassed Swales	Carriageway treatment (statutory requirement at project level).	Park contours and interface with adjacent urban edge. Specimen / feature tree, aesthetics. Trees statutory requirement.
Tree Pits	Carriageway treatment / pavement shading.	
Vegetated slopes	Carriageway treatment.	Park contours and interface with adjacent urban edge. Includes different grass types for aesthetic finish.
Stormwater Pond	Catchment treatment. Statutory requirement (catchment level).	Water feature. Recreation focus (walking paths, passive interaction etc.).
Weir	Pond function.	Art bridge. North south axis, link to escarpment and Lucas Creek. Pedestrian link to future development. Community focal point.
Wetland planting	Pond function.	Aesthetics, cultural (flax harvesting).
Feature stream	Limited pond recirculation	Aesthetic, cultural.

Irwin (2010) provides additional background to the Civic Crescent Project, and discusses the stormwater design approach adopted, together with the innovations and lessons learned from the project development perspective.

3 DISCUSSION

In late 2009, NSCC formally opened the ALP. It was recognised at the time that the conventional means of managing and maintaining the assets were unlikely to deliver the intended outcomes, but that there was an opportunity to establish a more appropriate approach to multipurpose, high amenity assets.

A project was therefore established to collate and review the combined project information, existing maintenance specifications, contract requirements, and other relevant information to establish an integrated strategy and asset management plan for the Precinct as a whole. Because the project included all aspects of a development across all the disciplines involved, the novel nature of the project was recognised from the outset and a number of challenges identified.

3.1 DRIVERS AND CONTEXT

3.1.1 STATUTORY REQUIREMENTS

A number of statutory drivers exist in relation to the implementation of LID. These include various provisions of legislation such as the Resource Management Act (RMA), 1991, and the Local Government Act (LGA), 2002. It is not proposed to consider LID implementation drivers within this paper as such provisions have been overviewed by commentators such as Feeney et al. (2009), albeit amendments to both Acts have been made since that overview. That said, in general terms many of the clauses that argue the case for LID implementation are also applicable to its subsequent upkeep, for example:

- Under s3 of the LGA, a territorial authority (TA) must provide for the well-being of its community and take a "*sustainable development approach*";
- s11A requires a TA to have regard to the contribution its core services make to its community (network infrastructure and public transport being two such core services).

Arguably LID has a holistic focus across all four well-beings (economic, environment, social, and cultural). Furthermore the ability to deliver against long term non-financial performance measures, *if maintained and operated appropriately over the long term*, should be of particular note given the recent amendments to the LGA and the associated revisions to AG4 (Office of the Auditor General, 2010).

On-going maintenance is often a condition for approvals granted under the RMA, and at this most basic level, consents and authorisations were attached to some parts of the ALP. For stormwater related aspects, these included:

- Separate stormwater consents relating to the:
  - Treatment and management of discharges from civic crescent;
  - Form, function, and discharges from the Albany Lakes; and
  - Overall catchment.
- Designation conditions relating to the choice of street tree species and planting choices. These conditions were proposed prior to the development of an integrated design approach. The specimen street trees were subsequently incorporated into the stormwater design; changes affecting either the stormwater treatment device or the trees themselves are therefore subject to two different authorisations.

Again, the on-going maintenance of consented devices and works plays an important part in retaining the envisaged environmental integrity or designed outcomes assessed and consented as part of RMA processes. Frequently however, assumptions, design intent, and even the conditions of consent are not available to asset managers, who consequently "*do not know what they do not know*". Delays in as-builting, or a lack of a

requirement for the production of an Owner's Manual, exacerbated this gap and the associated risks.

3.1.2 INDUSTRY DRIVERS

Over the last decade the relative merits of LID have been roundly explored, challenged and debated. Whilst extensive work has been undertaken to quantify or simply expound the environmental and community benefits of LID based design and development (e.g. Bracey, 2008; Feeney et al., 2009; van Roon, 2009), less extensive information is available on quantifying or exploring operational impediments. Despite the lack of specific operational data, experience and discussions with asset managers pointed to industry issues with the life cycle robustness of the approach, and examples of degrading LID or 'green design' outcomes are starting to appear which underlines operational issues. It would be easy to point simply to a lack of performance by contractors, however this project confirmed the more systemic issues that have been suspected for some time. Consequently it highlighted the need for a rethink of conventional asset management approaches and the need to adapt to LID, which despite its design simplicity, has complex functionality and outcomes.

A range of possible operational risks were consequently identified at project commencement, and indeed assisted in establishing the project drivers and terms of reference; some were broader than LID initiatives. The issues were derived from experience and our collective understanding of issues raised by industry, and included:

- LID, and indeed many assets which provide multiple benefits, create administrative challenges:
  - Ownership of assets is not clearly established;
  - Developer contributions do not always account for whole of life costs;
  - Green assets are not always adequately maintained during the defects liability period resulting in additional / unplanned costs;
  - Inadequate budgets are often established to maintain assets as intended;
  - Who has 'ascendancy' when operating requirements or aspirations overlap or conflict?
  - LID frequently creates 'complex systems' which do not readily lend themselves to conventional linear asset management approaches.

  These may well be antecedent challenges; nonetheless the LID based approach served to accentuate the highlighted issues.

- On-going asset management requirements arising from design are frequently poorly communicated to, and understood by, asset managers:
  - Owner's manuals are still a relative novelty;
  - As-builts tend to reflect the project owner's 'interests'. For example a transport led project is typically tailored to the transportation asset management requirements rather than the asset as a whole.

- As-builts and hand over processes do not capture all the necessary information:
  - Design intent;
  - Consents and related design assumptions;
  - Non-standard specifications (grass mixes, planting media, colour batching etc.);
  - Green infrastructure (e.g. engineered outcomes using natural materials or systems, or natural features and assets).
- Maintenance contracts tend to be focussed on tangible assets, and in the case of transportation, are vehicle centric. Consequently they may not adequately address 'beyond the pavement' maintenance requirements or broader objectives and outcomes.

- LID costs more to maintain:
  - Designs or fittings can be non-standard, particularly in high amenity areas;
  - Designs do not always provide for maintenance needs, particularly across all 'disciplines';
  - LID often requires a variation to standard maintenance contracts;
  - Contractors charge extra for non-standard requirements (e.g. plant care in pavement dominant maintenance contract).
- LID proponents (designers, stakeholders, communities), can be disappointed by long term outcomes:
  - Maintenance can degrade design integrity;
  - Asset quality degrades over time and maintenance practices seen as leading to accelerated degradation;
  - Original requirements or design intent becomes lost over time and other considerations (e.g. traffic safety led requirements) prevail.

3.1.3 PROJECT CONTEXT

Traditionally NSCC managed its assets within developments such as the ALP in different maintenance and operating contracts (refer to Figure 5). These include separate contracts (and specifications) for:

- Transportation assets;
- Stormwater assets
- Parks;
- Public art;
- Street cleaning;
- CCTV / security;

- Street lighting; and
- Civic and commercial areas.

Additional contracts may have also arisen for significant renewals and capital works.

Some variations to this did occur, most notably Parks was contracted to Transportation to undertake vegetation maintenance in the road reserve. Notwithstanding this, the standard specifications were still found to be insular.

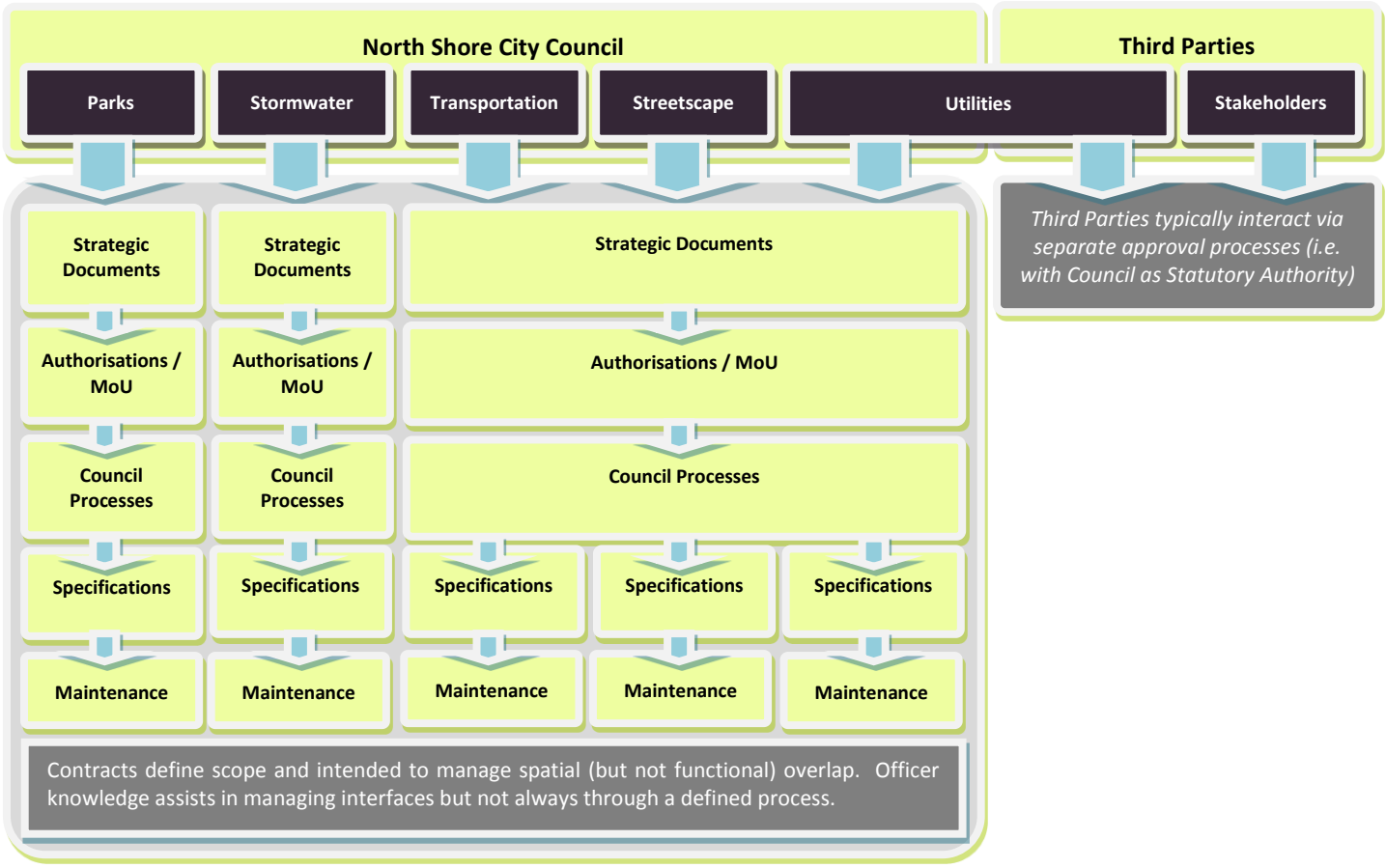


Figure 5: Existing Operational Processes

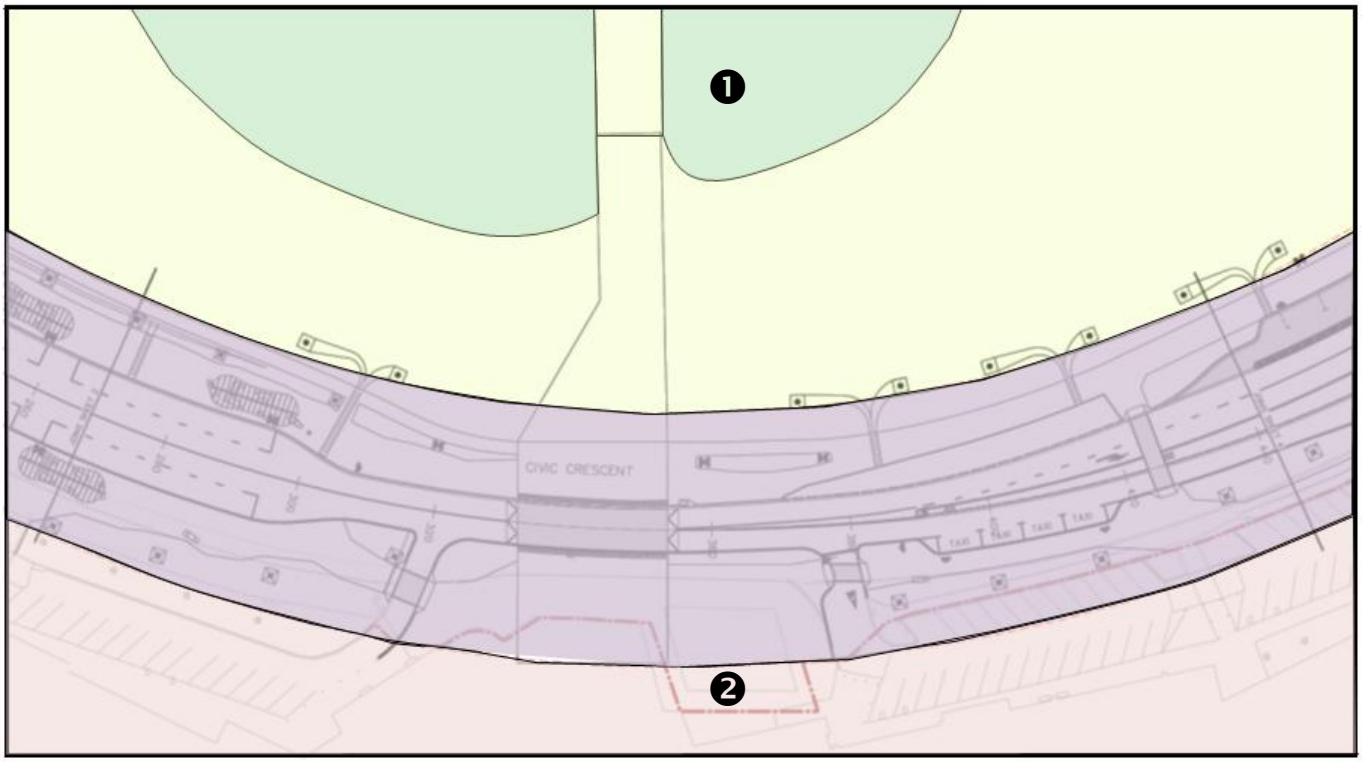
It is understood that this is not an unusual practice for territorial authorities in New Zealand. Indeed, interface issues between contracts and functional divisions almost always exist, and can relate to the shared / competing functions of the assets, specifications, levels of service, and the physical overlap of both the assets and the spatial extent of the varying contracts. Whilst the management of interfaces is par for the course, the LID based approach magnified these issues within the ALP; particularly when the functional and management interfaces with third parties such as utility operators, adjacent landowners / developments, and the Auckland Regional Transport Authority (ARTA) / MAXX (public transport branding) were considered.

This complexity is shown in Figures 6 and 7, which considers just a portion of the ALP area. Of particular note are the swale maintenance boundaries, which were found to be defined as follows:

- Stormwater: Whole of swale (but only swale);
- Parks: Footpath edge (i.e. included all of swale); and

- Transport: Invert of watertable only.

In addition to these matters, at the time the project was instigated, NSCC was also preparing for the restructuring of local and regional government; which also necessitated clarity in the management of assets and the specific requirements of each discipline / management area.



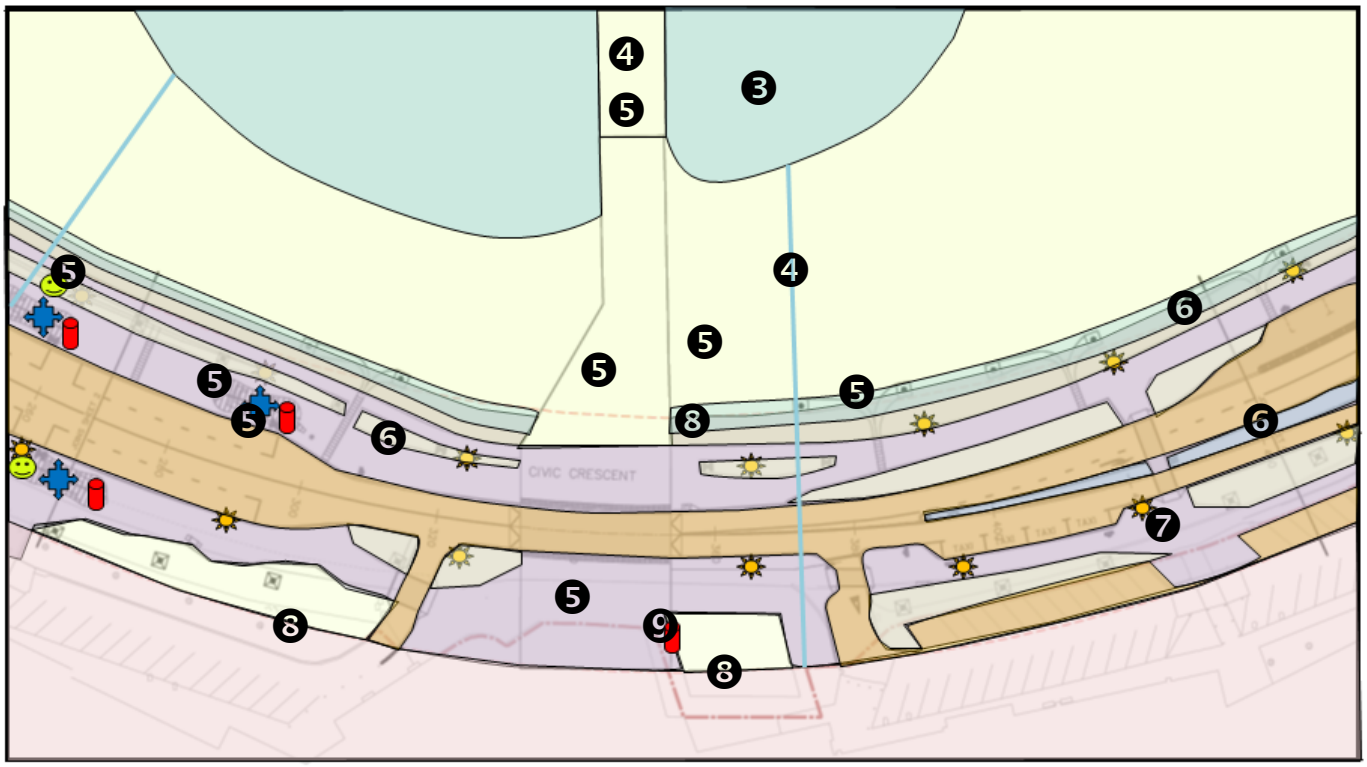
Legend	Contract	Notes
	Parks	**1.** Albany Lakes 'ownership' required clarification as the asset was subject to consent for the discharge of stormwater from the Auckland Regional Council (ARC), obtained by the developer, and modified by Parks.
	Stormwater	
	Transportation	**2.** Long term ownership boundary did not correlate with construction boundaries.
	Westfield *(3rd party)*	

Figure 6: Overview of Existing Operating Context – Asset Ownership

3.2 OUTCOMES SOUGHT AND ADOPTED APPROACH

The aims of the Integrated Asset Strategy and Plan for the ALP were to:

- Align and support the strategic vision and underlying attributes for the ALP;
- Assist Council to sustain the original integrated urban design intent and high quality outcomes over the longer term;
- Communicate design intent and statutory obligations so requirements can be met and upheld in contracts and future decision making;



Legend	Contract
	Parks
	Stormwater
	Transportation
	Westfield *(3rd party)*
	Street Cleaning and Sweeping
	Rubbish and Waste (Town Centres)
	ARTA / MAXX *(3rd party)*
	Lighting
	CCTV

Notes

3. Potential conflict of requirements between stormwater (consent requirements) versus aesthetics, amenity values, and community expectations.

4. Utilities / structures within Parks areas not covered by contract specifications.

5. No specifications (includes requirements for works by utility companies within Council assets, special finishes, and higher levels of service (non traffic related)).

6. Swales and rain gardens span contract boundaries. Transportation specification maintains to invert of swale from edge of pathway, Stormwater unspecified boundary but to edge of devices assumed (top of swale), Parks to edge of road reserve (variously to edge of path / swale invert). May result in:
- No maintenance;
- Duplicate maintenance;
- Differing maintenance regimes.

7. Grassed areas within road reserve span contract boundaries – issues as per other examples.

8. Assets span ownership boundaries. May result in:
- No maintenance;
- Duplicate maintenance;
- Differing maintenance regimes.

9. Overflow from bins and related interfaces not addressed.

Figure 7: Overview of Existing Operating Context – Asset Maintenance Accountabilities

- Adapt the existing asset management, operational, and maintenance processes and systems to the multifunctional and integrated design approach adopted during the development of the ALP;
- Enable Council to capture management and maintenance efficiencies;
- Deliver improved community and environmental outcomes; and
- Demonstrate the feasibility of integrated and quality design solutions to the community and stakeholders, and if supported by positive measures, to contribute to the shaping of a new industry approach.

Given the existing siloed operating framework (refer to Figure 5), a simplified approach was sought (refer to Figure 8), but one in which the existing asset management tools and systems could be retained and adapted.

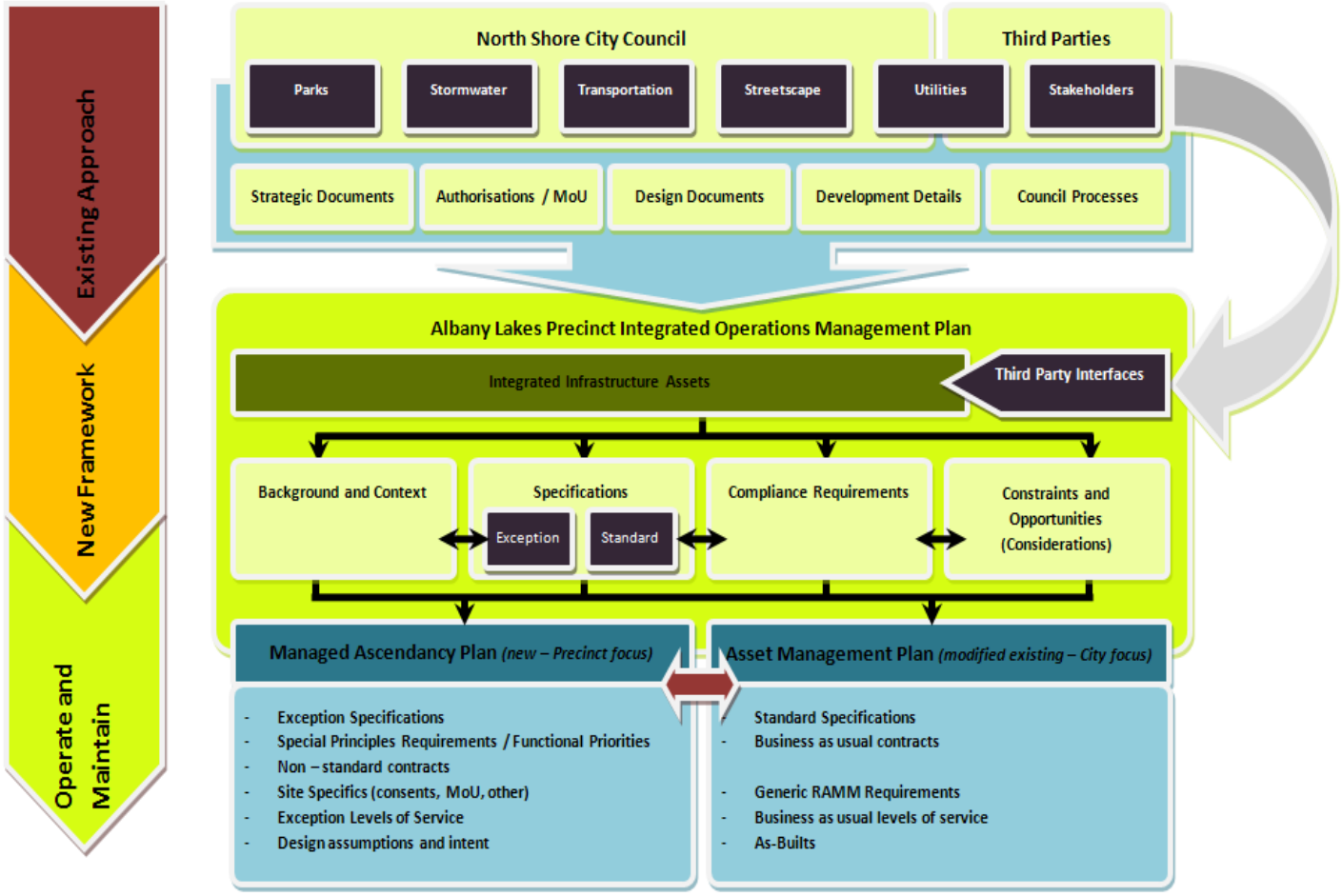


Figure 8: Project Approach

3.3 PROPOSED FRAMEWORK FOR CHANGE

The basic premise of the framework is that integrated designs require an integrated operational approach; one that is focussed on the outcomes sought rather than conventional delivery mechanisms. In this context a performance or objectives based approach was proposed as the basis for further development with Council stakeholders. The basic implementation framework is summarised within Figure 9.

Quite simply, the approach seeks to work within the existing Council structure and departments, however rather than establishing contracts based on existing departments or operating silos, it instead defines the levels of service (LOS) sought and assigns the most appropriate party to manage the contract that align with those services. The Contract Manager (which may or may not be the asset owner) then reports back to the other stakeholders that the agreed LOS have been achieved. The process is aimed at being transparent, establishing clear accountabilities, improving efficiency, and being auditable without imposing additional layers of management. It is also aimed at retaining original design intent and community outcomes, particularly for high amenity assets. Interestingly, this also foreshadowed changes arising from the Auckland Governance changes and highlighted more than ever, the need to establish a simple operating framework for infrastructure.

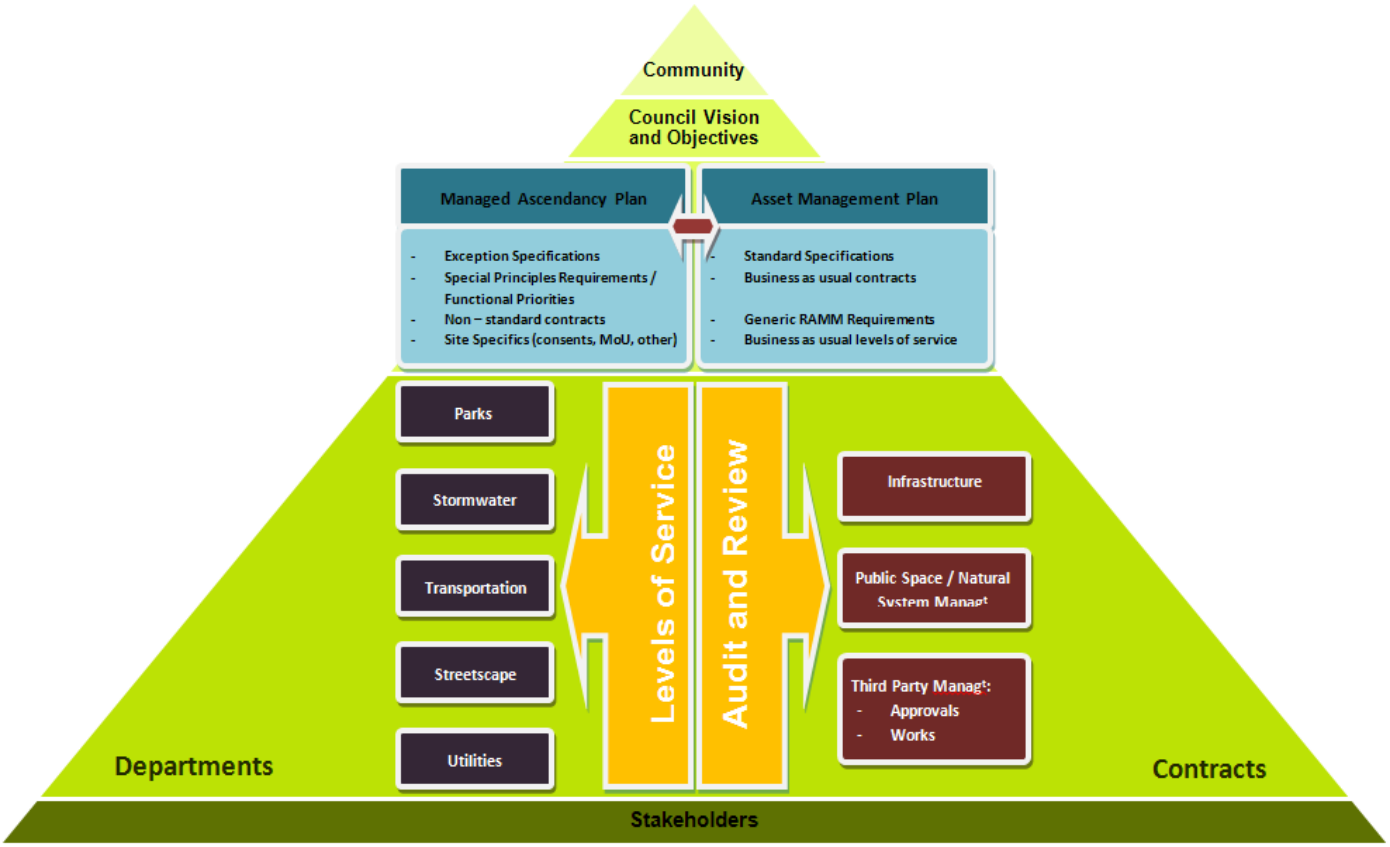


Figure 9: Precinct Implementation Framework

Eventually this approach may also provide an opportunity for cross departmental / inter organisational subcontracting where specialist services are required. For example the care of plantings within constructed stormwater wetlands may be able to be subcontracted to the department with the appropriately skilled project managers to optimise Contractor performance for that part of the overall contract. Also, contract specifications and schedules will be suited to what is being maintained, and contractors will have appropriate skills and resources. However for the purposes of bedding down this integrated approach, that option was set to one side for the time being.

The key features of the approach (which are discussed in further detail in a separate paper along with the more detailed mechanisms of the framework), include:

- Outcome centric rather than asset centric;
- Adaptive and responsive to community aspirations and environmental conditions;

- Shared, simplified systems;
- Ascendancy and priority of function and performance can be agreed up front; and
- Processes that enable accountability and transparency.

Perhaps of overriding importance is that complexity is accommodated as an opportunity rather than a risk; something that is particularly important to LID developments.

3.4 IMPLICATIONS FOR STORMWATER MANAGEMENT

Looking firstly at the basic building blocks of the framework, it is expected that the implications for stormwater assets and their management are as follows:

- Data capture and information retention:

  The design and assessment of stormwater proposals include numerous assumptions, parameters, and frequently statements of intent (often agreed with a third party). Whilst systems exist to capture consent conditions, the underlying requirements (often included within design documents or an Assessment of Environmental Effects) are often overlooked and not communicated through to asset management. This information can be captured for future reference; ideally in the form of an Owner's Manual so that as-built information can also be included and maintenance occur as intended by design.

- Statutory compliance:

  Stormwater consents frequently include maintenance conditions as treatment devices cannot function over the longer term unless they are appropriately maintained. The framework requires all statutory requirements to be identified, actioned, and reported. This approach does not preclude the use of existing databases or systems for compliance management. Where such systems are not in place, it prompts means to be established to close such gaps.

- Establishes operational context:

  In addition to information obtained from an Owner's Manual, as-builts, or consents, the framework provides for spatial and other information to also be retained for future reference. The intention is that this be integrated with existing Council GIS systems for ready reference. By documenting the operating context and not just the requirements, asset managers should be able to make more informed decisions. This should benefit stormwater assets, especially those where a LID approach has been used, as often the environmental and community context is important and has informed the final design and asset configuration.

- Managed ascendancy:

  Because the framework establishes contracts that are based upon the delivery of outcomes, it requires upfront agreement of matters such as operational conflict, priority, and functionality. Again, areas of 'ascendancy' can be mapped using existing Council tools such as GIS so that requirements can be communicated to asset managers and contractors.

  In the ALP, swales and tree pits along Civic Crescent, whilst partially within the park area, are first and foremost stormwater devices and any related requirements prevail as these are linked to a consent. The choice of tree species within the tree pits, in the event that the tree pits need re-engineering, must however be consistent with the Outline Plan of Works. This in turn has highlighted the need for a process for any re-

engineering works to manage and provide for parks and community expectations around specimen trees. This links back to the agreed LOS between Council departments / stakeholders and the establishment of integrated specifications (which should prevent the re-engineering of tree pits without reference to Parks and the appropriate plant related controls).

- Extended influence:

  Because the framework is based on outcomes, it is expected that each stakeholder / department / discipline would influence in some way the operational requirements as a whole; thereby providing an opportunity to influence a broader array of outcomes. This is not about exerting power, but rather the inclusion of a range of different factors. These might be 'considerations' or may extend to specific requirements (such as consent conditions), and is aimed at avoiding situations where contracts are established to address specific but limited requirements.

- Co-ordinated management and integrated outcomes (specifications):

  Revising and integrating Standard Technical Specifications across a range of Council departments and disciplines has the general benefit of:

  - Collating and aligning all specifications from the given departments to reduce the extent of overlap;

  - Uplifting the specifications to better reflect the requirements of environmental management and community outcomes focus (including improved urban design);

  - Ensuring that recognition of community outcomes results in appropriate accounting for multiple objectives;

  - Starting the process of breaking down the silos in 'anticipation' of integrated design solutions (which is increasingly becoming business as usual);

  - Providing for High Service Level (HSL) Assets that may have different drivers than the presently identified HSL Roads (i.e. High Amenity Assets (HAAs)).

  Non-standard specifications can also be accommodated, but also need to be integrated in the first instance, then consolidated as variations to maintenance contracts.

  The approach has some real benefits for LID and stormwater where treatment trains, or the device or system as a whole (rather than a single aspect of it) is crucial. This is essentially reflective of natural systems where linear approaches are rarely appropriate.

Whilst each of the building blocks within this framework is considered to impart a benefit in its own right, there is also an overall benefit of completing the infrastructure life cycle process. Whilst this is likely to have more relevance and significance when considering the asset as a whole, it is nonetheless considered to be of relevance and benefit to LID based development. Table 2 explores this relevance against the practice issues identified in Section 3.1.2.

Table 2: Performance of Framework against LID Practice Issues

Issue	Assessment	Comment
LID creates administrative challenges:		
Ownership of assets is not clearly established;	✓	Asset ownership becomes secondary as outcome based contract and relates to LOS, reporting, and apportioning / distribution of costs.
Developer contributions do not always account for whole of life costs;	✓	This should be addressed over time as the true cost of LID over the asset life cycle is better documented and understood. The holistic approach should see all cost centres included and reduce present inefficiencies arising from the siloed approach to LID.
Green assets are not always adequately maintained during the defects liability period resulting in additional / unplanned costs;	✗	This needs to be addressed through changes to capital works procurement. This is part of the broader framework but not necessarily a direct action.
Inadequate budgets are often established to maintain assets as intended;	✓	See above.
Who has 'ascendancy' when operating requirements or aspirations overlap or conflict?	✓	Agreed as part of the establishment of shared operating systems / captured from design documents.
LID frequently creates 'complex systems' which do not readily lend themselves to conventional linear asset management approaches.	✓	Modified approach that accommodates complexity without being complex itself.
On-going asset management requirements arising from design are frequently poorly communicated to, and understood by, asset managers:		
Owner's manuals are still a relative novelty outside of stormwater;	✓	This needs to be addressed through changes to capital works procurement. This is part of the broader framework but not necessarily a direct action. However in the absence of an Owner's Manual, the framework requires the collation of equivalent information.
As-builts are 'owner centric' and hand over processes do not capture all the necessary information.	✓	See above.
Maintenance contracts tend to be focussed on tangible assets, and in the case of transportation, are vehicle centric. 'Beyond the pavement' or broader objectives and outcomes not included.	✓	Outcome focused approach, so performance rather than 'widgets' prevail. Holistic approach so all aspects can be included (see comments regarding ascendancy and reconciliation of conflicting requirements). Natural feedback loop to design to encourage holistic design (LID).

Issue	Assessment	Comment
LID costs more to maintain:		
Designs or fittings can be non-standard especially for high amenity area;	✓	Creates new standards and provides framework to remove unnecessary variability.
Designs do not provide for integrated maintenance needs (i.e. across all disciplines);	✗	This needs to be addressed through changes to capital works procurement. This is part of the broader framework but not necessarily a direct action. A natural feedback loop does however exist.
LID requires a variation to maintenance contracts;	✓	Creates new standards and provides framework to remove variations.
Contractors charge extra for non-standard requirements (e.g. specialised plant care in pavement dominant maintenance contract).	✓	Creates new standards with scope for subcontracting specialist services. A broader range of LOS and KPIs to be aimed at protecting all multidisciplinary interests.
LID proponents (designers, stakeholders, communities), can be disappointed by long term outcomes:		
Maintenance degrades design integrity;	✓	Design intent communicated and incorporated into contracts.
Asset quality degrades over time and maintenance practices seen as leading to accelerated degradation despite design intent;	✓	See above
Original requirements or design intent becomes lost over time and other considerations (e.g. traffic safety led requirements) prevail.	✓	See above.

3.5 STATUS AND FINDINGS TO DATE

The development and roll out of this framework has established an appetite for a more holistic approach to asset management. This call has come from asset managers, design specialists from across a range of disciplines, and has led to the concept being explored on a wider basis by both Auckland Transport and Auckland Council. Its application to LID and other high amenity or multipurpose assets has especially been noted; furthermore the concept is now being explored in other applications, and in asset management planning more generally.

The project itself has resulted in some salient lessons in the development phase to date:

- There is a distinct process gap between design, asset, and operational management – asset and operational managers frequently do not know what they need to know as critical information has not been passed on;
- Seeking non-standard performance or outcomes (such as from LID, high amenity, and multipurpose assets) from conventional approaches (including contracts and specifications) is unrealistic;

- Presently, asset management is siloed with little exploration of common ground between operational departments or disciplines or reconciliation of contradictory aspirations or requirements;
- Existing process negatives can be addressed through a revised framework. The framework does not preclude the use of existing tools and systems;
- Currently large gaps in processes exist, and it will take time and iteration to bed down the approach, however over time, the efficiencies within the system should prevail;
- Providing a framework for managing multi-function and high-amenity assets enables and encourages their incorporation in Council projects and private development. Multiple objectives for assets can increase value for money;
- Whilst the approach lends itself to LID and high amenity assets, initial feedback and development is indicating that the framework has much wider application.

4 CONCLUSIONS

The Albany Lakes Precinct comprised two individually complex projects, both of which included integrated or low impact design concepts. A new asset management approach was developed for the Precinct in recognition of the need to maintain this high amenity asset to the standard intended and to reflect the inappropriateness of applying standard, linear asset management approaches to a complex system. The framework accommodates this complexity without itself being complex.

The concept is of particular relevance to stormwater management and the management of assets within LID developments in particular as it actively addresses a range of practice barriers to successful long term implementation of LID. However the project has resulted in the development of a framework with much wider application than just the ALP. It is in the process of being rolled out for the ALP and being explored by both Auckland Council and Auckland Transport for wider application.

ACKNOWLEDGEMENTS

The authors wish to thank the project team from North Shore City Council (now parts of both Auckland Council and Auckland Transport) for their assistance with this project. We also wish to thank Siri Rangamuwa (Auckland Transport), and Chris Stumbles (Auckland Council) for their peer review, and their support of the ongoing development and evolution of the concepts outlined within this paper.

REFERENCES

Blom, C. (1998). 'Revisiting the Principles of Land Development Planning Through Appropriate Stormwater Design'. 1998 NZWWA Conference Proceedings.

Blom, C. et al. (2002). 'Riparian Concepts for Urban 'Rivers''. 2002 NZWWA Stormwater Conference Proceedings.

Bracey, S. et al. 2008. 'Important Lessons Applying Low-Impact Design: Talbot Park'. 2008 Water New Zealand Conference Proceedings.

Irwin, A. (2010). 'Integrating LID Innovation in a Streetscape Project – Albany Civic Crescent'. Water New Zealand 2010 Stormwater Conference Proceedings.

Feeney, C. et al. (2009). 'Managing Natural and Physical Assets for Integrated Outcomes'. 2009 Water New Zealand Conference Proceedings.

North Shore City Council (NSCC) (2004). 'Albany Centre Vision and Development Strategy'.

Office of the Auditor General (OAG) (2010). AG-4 (Revised) The Audit of Service Performance Reports.

Van Roon, M and H. (2009). Low Impact Design and Development: The Big Picture – An Introduction to the LUIDD Principles and Methods Framework. Landcare Research Science Series Nº. 37. Manaaki Whenua Press.