

Robelle Domain

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1. INTRODUCTION

Greater Springfield is a development like no other in Australia or perhaps the world; nestled 27 km southwest of Brisbane and 15 km east of Ipswich. Original plans for the 2,860 ha green field site carried a proposal to subdivide the land into 100 separate acreage blocks. However, following the purchase of the land in the early 1990's, the area has been redefined as Australia's fastest growing emerging city. Currently home to over 36,000 residents, the area is planned for an ultimate population of 138,000 residents and 52,000 workers within a bustling town centre core.

The bold city vision projects the area to be a substantial regional city and services hub by 2030, with a complete offering of development forms allowing residents to work, play, study, shop, receive first-class medical care and be entertained - all within minutes of their home.

The region has a strong focus on public amenity and open space with one-third of the greater Springfield area dedicated to open space. The heart of the open-space network is Robelle Domain, a \$45 million, 35-hectare parkland in the centre of the Greater Springfield CBD. The parkland provides a hub around which the development is centred, and is the nucleus of the extensive network of pedestrian pathways and inter-connected open-space areas throughout the development.

The vision for the parklands took inspiration from other highly awarded inner-city open spaces, including South Bank and Roma Street Parklands. The initial concept included highly embellished urban parklands, significant water features, recreation lagoons and water play areas to provide a major attraction for the region.

The stormwater solution developed by Cardno for the parklands achieves both outcomes of outstanding amenity within the site, and providing a key asset to the surrounding community by delivering stormwater detention, flood immunity and additional open-space areas. The design of this infrastructure was completed in conjunction with stormwater master planning in order to provide an integrated stormwater solution for the region.

2. OBJECTIVES

The masterplan for Robelle Domain envisaged a highly-embellished urban parkland incorporating significant water features, recreation lagoons and water play areas to reflect the subtropical theme and provide a major attraction for the region.

The challenge in achieving this ambition was that the selected site, located on a significant tributary to Mountain Creek, was subject to substantial overland and groundwater flows. The vision for a walkable, urbanised open space featuring crystal blue water play zones was a stark contrast to the native site conditions. The existing site profile was frequently inundated and subjected to a considerable sediment load owing to the disturbed upstream catchment and sandy bed streams through which the overland flows were conveyed.

In order to reclaim usable land for the proposed parkland and water features, Cardno proposed the introduction of a bypass pipeline system to provide flood immunity and capacity for all local drainage systems. The scope of the bypass pipeline was proposed to provide drainage relief to the existing embankment of Sinnathamby Boulevard, capture local stormwater flows from within the parkland and also receive flows discharging from surrounding development lands in order to secure the storm immunity of the parkland space. The centre of the parklands was earmarked in original concepts for a central lake feature. This provided an ideal opportunity to discharge the stormwater system with the significant lake volume and series of surrounding boardwalks acting to conceal the outlet location.

To ensure this major stormwater infrastructure project serviced the needs of the sizeable catchment, a holistic review of the stormwater system was completed including detention, stormwater quality, flood immunity and integration of assets within the proposed landscape design. The review was required to consider the existing stormwater network which discharged into the parklands, overland flows from surrounding catchments in Q100 events, provision for future land uses and ensuring the design outcome was both flexible for future development and safe for the community.

Given the high level of public access and amenity to the precinct, the design of the stormwater drainage system was required to be integrated into the final form of the parkland space and consider public safety. The public safety focus required the Cardno team to consider how access to the pipeline system could be controlled through both passive and active means, but also through analysis of extreme weather events to ensure the safe egress and protection of surrounding development lands.

Throughout the course of design development, the complexity of the engineering design continued to increase in order to accommodate the site geotechnical conditions. Investigations into the existing site conditions revealed that large portions of the site contained unstable alluvial material and significant groundwater flows that would need to be addressed through the final form of the design to ensure the pipeline and surrounding built form would remain structurally stable. A series of site investigations were required to provide a detailed map of in-situ conditions and inform the design of sub-surface drainage relief and subgrade improvement works.

The existing upstream embankment beneath Sinnathamby Boulevard was initially constructed to retain stormwater in order to provide pre-development stormwater attenuation and storage for sediment in order to reduce impacts upon downstream town centre lands. However, with the surrounding lands becoming increasingly activated to public use; Cardno led an investigation as to whether this concept would be appropriate for a long-term solution. Investigation into the long-term stability of this embankment as well as the potential hazard the significant quantity of retained water presented, suggested that an alternative solution to this area would be required.

The original construction of Robelle Domain Stage 1 initially intended to construct the entire pipework system within the project budget. However, as works progressed contingency associated with the development of park spaces resulted in the need to augment the engineering design concept in order to allow for a staged delivery. Likewise, Robelle Domain Stage 2 provided a substantial extension to the stormwater network to a second-staged scope.

With each sub-staged upgrade to the stormwater network the engineering design has been required to adapt to integrate with the landscape design, preserve future opportunities for extension with minimal redundant works. As the Springfield Drainage Master Plan Strategy has continued to mature, the function of the stormwater diversion pipeline has continued to grow in significance forming a key element in providing flood security to the Springfield CBD area, all-weather amenity to the parklands, and controlling stormwater outflows from upstream development lands.

2.1. Alignment Selection for Stormwater Pipework within Robelle Domain

Working with the project architect and client at project inception, Cardno proposed that a bypass pipeline would be required in order to achieve the ambitious urbanized design for the lagoon area of the parkland. However, the lagoon zones and surrounding permanent structures presented a number of constraints to the location of underground assets.

In order to determine the general configuration of the pipeline system, Cardno completed an opportunities and constraints review over the parkland masterplan to identify immunity zones and areas in which stormwater assets could be accommodated. To provide the desired high quality urban outcome, Cardno proposed the overland flows through this area be bypassed by means of an underground pipeline system. This design concept was to provide Q100 immunity to the parkland area as well as provide a means of integrating the several stormwater systems from surrounding development lands which discharged into the parkland space.

The alignment study sought to locate the pipework outside of zones proposed for permanent structures where possible, with access chambers located beneath major pedestrian pathways to allow maintenance access. The pipework layout generally was intended to capture cross-drainage flows discharging from the upstream Sinnathamby Boulevard roadway embankment with the system discharging into the central lake feature. Custom chambers and junctions were provided in the system in order to extend the existing stormwater outlets from adjacent development precincts and align the drainage network with major pedestrian walkway zones.

The alignment and general layout of the stormwater network was adopted as a constraint for the design of embellishment works and landscape architecture design.

Following establishment of the pipeline concept, Cardno, in conjunction with WRM Water and Environment, facilitated the development of a regional stormwater model to analyse the flows and performance of the pipeline system. The flows of adjacent and upstream precincts were modelled including the impacts of proposed attenuation measures based upon existing site conditions. At this time the contributing catchment was primarily undeveloped with existing stormwater flows being detained by the Sinnathamby Boulevard embankment.

Resultant from this study, it was revealed that the pipeline system would be required to convey a total flow of 21.2m³/s during a Q100 event. However, the existing cross-drainage beneath Sinnathamby Boulevard was not sufficient to capture this flow with a significant volume overtopping the embankment and flowing overland through the parkland site. This shortfall in existing conveyance capacity triggered a holistic review on how a 'best for project and community' outcome could be delivered.

2.2. Safety Elements

In order to determine the optimal solution to the upstream embankment drainage and capture of Q100 flows, a review was completed of the existing engineering design for the embankment. While the initial intention of the embankment area to provide interim phase protection to downstream lands served its purpose, it was unlikely this would result in a long-term solution which would provide an outstanding design outcome to the community. The requirement to provide additional stormwater capture/capacity at the upstream embankment to the roadway also represented an opportunity to improve the safety and amenity of this area.

At this time, Cardno commenced an assessment of the existing standing water and embankment zone in order to determine the existing geotechnical factor of safety and if it represented a referable dam structure, particularly given the consideration of proposed and future CBD and public parkland amenity areas. A geotechnical investigation into the construction of the existing embankment was commenced and Cardno referred the structure to the State Government Director of Dam Safety concurrent with our own independent review against State legislation.

The global stability analysis of the Sinnathamby Boulevard embankment suggested that additional stabilising works were appropriate in order to ensure the embankment would remain stable under flood conditions. The combined result of the embankment conditions, requirement for additional conveyance capacity as well as redundancy of storage for extreme flood events, suggested the best course of action for this zone would be to provide low-level drainage relief which would de-water the upstream embankment.

The resulting system was initially designed to convey a Q100 event with all inlets at 50% blockage, however, in order to consider extreme storm scenarios, the upstream inlet and pipeline arrangement

was tested for an event equal in size to double that of the Q100 storm – approximately a Q500 storm event. This resulted in an ultimate design in which the existing 2 x 1350mm diameter stormwater headwalls through the Sinnathamby Boulevard road embankment were supplemented with an additional 900mm diameter stormwater line located at the invert of the upstream natural gully. Under this configuration, with minor embankment adjustments, the downstream parklands would be protected from all of the storm events within this criteria.

The measures adopted resulted in the embankment being declared as 'not a referable dam' under State guidelines.

Likewise, the outlet of the stormwater drainage pipeline required careful consideration in order to preserve the parkland aesthetic and public safety. Collaborating with the project architect, Cardno proposed a design solution in which the outlet headwall was submerged below the water level of the central ornamental lake with a circulation boardwalk passing over the top of the structure in order to conceal its location. The outlet level, being below that of the permanent standing water level, served to prevent access as well as reduce outlet velocities.

The outlet structure configuration was developed over the course of the final three (3) lines of pipework, with flows split from the two (2) parallel pipes of the main pipeline, into four (4) pipes and then into a series of Reinforced Concrete Box Culverts (RCBC) units in order to spread flows and reduce velocities. Custom manhole structures with flow dissipating elements were constructed in order to ensure that flows were distributed throughout the outlet pipework and velocities were reduced in the downstream reaches of the system. The outlet was designed to maintain an outlet velocity of less than 1.6m/s to ensure scour and turbulence was minimised. Underwater scour protection mattresses were provided in accordance with Queensland Urban Design Manual (QUDM) requirements in order to mitigate the impacts of jetting to the bed of the water body.

Extensive reviews of safety in construction were undertaken by the BMD, JMAC and Cardno teams to ensure appropriate construction methods were implemented during the deep trench works. Cardno undertook detailed modelling of proposed trenching solutions and extensive geotechnical investigation during construction to ensure trench access, stability and interaction with surrounding infrastructure was satisfactory. Given the poor ground conditions experienced throughout areas of the site, Cardno worked with the contractor to develop a safe method for provision of waterproofing membranes to stormwater trenches by wrapping the exterior surface of shoring boxes in the membrane prior to installation and transferring to the cut face of the trenches while suitable support was in place.

2.3. Detailed Design of Ultimate System

With the boundary conditions and alignment of the pipeline confirmed, Cardno collaborated with WRM Water and Environment to test a number of detailed design scenarios for the grading of the system in order to deliver a 'best for project' outcome. The discharge from surrounding catchments and performance of the proposed pipeline was tested for a large range of rainfall scenarios ranging from a Q3 month storm through to a Q500 extreme storm event, including provision for climate change impacts.

The client's clear objective of ensuring 'value for money' was a critical factor in the design development and materials selection process. Cardno undertook a number of first principle calculations and cost benefits analysis to ensure value for money. The final design of the main pipeline grading and material specification delivered approximately \$1M of cost reductions to the project.

Utilizing the natural grade of the site, Cardno pursued an aggressive grading of the stormwater system in order to minimise pipe size without compromising on conveyance capacity. The ensuing stormwater design contained stormwater velocities within the pipework of approximately 6m/s which was initially determined to be undesirable. A comprehensive review of the pipework selection was completed upon discovery of this information in conjunction with the consideration that the system would be subject to pressure in the event of a major storm event and the upstream detention bund being activated.

Cardno engaged with pipe manufacturer Humes (Holcim) regarding performance data of pipework varieties under high velocity and pressure scenarios. Based upon empirical research data the use of flush jointed pipework could be supported in this scenario provided that additional treatment to the pipework joints using epoxy mortar was completed in order to reinforce against scour and stormwater intrusion. The use of flush jointed pipework was critical to the project outcome as the supply costs and lead time for the pipework was significantly reduced from that of rubber ring jointed alternatives, allowing for large contract savings and timeline expediting.

Another significant area of the project in which Cardno was able to provide a value engineered solution was the construction of the central lake water body. The proposed profile of the waterbody was developed to confirm with safety bench and egress requirements of QUDM with local edge modifications to provide a free-flowing outlet from the stormwater pipework. Safety handrails were added in this location in order to mitigate fall risks.

It was decided to extensively over-excavate the underwater profile in the centre of the water body adapted from the architectural design to provide storage capacity within the area for trapped sediment originating from upstream catchments. The upstream catchment areas and existing waterways are formed from highly dispersive natural materials which resulted in the parkland being subject to high sediment loads prior to parkland development. In addition, the future proposed upstream development lands were anticipated to further impact upon the downstream waterway health. Based upon RUSLE calculations, a sediment storage capacity equivalent to approximately 12 months of anticipated pre-development deposits was allowed in order to manage the maintenance timelines of the lake area for Ipswich City Council.

Following a review of available clay materials from the local development lands, local quarries and suppliers, Cardno's design team identified the use of a bentonite-impregnated geofabric lining such as Elcoseal, as a preferred treatment to the main lake. The Elcoseal solution resulted in savings of approximately \$1.2M. Cardno prepared a range of project-specific details for the lining solution in order to detail the interface of the product with stormwater structures, surrounding sandstone edge treatments, rock scour protection and downstream weirs to ensure the integrity of the system would be maintained and an impermeable lining created.

2.4. Geotechnical Considerations

The existing geotechnical profile of the site was known to contain a range of alluvial soils as a product of its history as an overland flow path for a significant tributary of Mountain Creek. In preparation for construction activities, Cardno commissioned a broad-scale geotechnical site investigation to confirm that appropriate bearing capacity would be able to be achieved along the pipeline alignment. The results returned were highly variable, suggesting both regions of sandstone rock material as well as significant deposits of saturated and highly organic unsuitable material. In addition, the saturated regions were demonstrated to be subject to significant groundwater flows which would potentially act to destabilise the stormwater trenches. Groundwater was unable to be relieved from some areas of the site as the natural rock interfaces created trapped zones of groundwater.

In order to manage the impacts of groundwater upon the parkland and the underground infrastructure, Cardno proposed a subsurface drainage system to be integrated with the trench gravels for the pipeline. Cardno collected data of existing groundwater flow rates over a 2-week investigation following wet weather events in order to quantify the flows to be conveyed. The results of this investigation were compared with data supplied by the Polaris Data Centre, which is located adjacent to the parklands, within a similar groundwater seam. The Polaris Data centre regularly pumps collected groundwater from basement areas of their premises into the parklands.

Based upon groundwater flow data, the subsurface drainage design for the pipeline system was confirmed, consisting of 50mm Rainsmart Nero Pave Drainage Cells to the affected areas of stormwater trenches in order to capture groundwater. The drainage cells discharge into each chamber of the stormwater pipeline. In order to prevent backflow, Primeflex rubber duckbill check valves were installed to all discharge locations.

To ensure the structural stability of the pipeline and significant structures, initial preliminary design works identified that significant piers were required at locations of poor soil conditions. However, taking advantage of sound material won as part of complimentary earthworks operations and following further geotechnical investigations, the Cardno team reviewed other techniques to achieve the required bearing capacities. A site-specific trench and subgrade replacement design was composed as an alternative, providing a cost-effective substitute for the site.

2.5. Sub Staging of Design within Robelle Domain

Due to budgetary constraints, the ultimate extent of stormwater drainage works was not able to be constructed in full in conjunction with the initial stage of Robelle Domain construction works. Accordingly, Cardno was required to develop an engineering design to allow for the sub-staging of the works, increasing the complexity of the design. As part of the first stage of parkland construction works Cardno modified the ultimate pipeline design to terminate at the location of the next available chamber upstream of the site boundary. The design of this chamber was substituted for a customised stormwater structure 14m x 1.8m x 3.6m, containing a custom fabricated series of inlet grates providing a conservative cross-sectional area for stormwater inflows. The structure was designed to a finished surface level below that of the ultimate park construction. The inlet was able to be removed and replaced with a converter slab as part of future works to allow for a minimal manhole riser to be provided within pedestrian pathways at the time of future parkland embellishment works.

The capacity of this inlet was designed to capture the Q100 storm event in 50% blockage conditions. However, in order to honour the extreme event considerations of the ultimate engineering design, downstream parkland areas were profiled and structures reinforced to also convey Q100 flows overland to account for a 100% blockage or Q500 storm event scenario. The extent of overland flow was modelled to demonstrate that adjacent property would be provided with a safe level of freeboard in an extreme event.

As part of Robelle Domain Stage 2 construction works the pipeline was once again sub-staged and extended to beyond the extent of the proposed works. In order to provide an efficient design solution, Cardno ensured the proposed upstream inlet structure was of equal dimensions to that of the existing structure. This was not necessary to accommodate the proposed pipework, however, allowed for the existing custom inlet lid to be recycled, delivering a substantial contract saving. Due to the inefficiency of sub-staging the works at this second location an additional custom inlet chamber was required to ensure that Q100 capture was achieved. This chamber was positioned such that it could be retained as part of future development works as a maintenance structure with minor augmentation.

Similarly to the Stage 1 contingency scenario, Cardno provided a design for all downstream infrastructure and parkland areas to ensure that Q100 capacity existed overland as well as mitigating a 100% blocked or Q500 storm scenario. The second stage of the parkland works is bisected by a local access street, Barry Alexander Drive, beneath which a series of culverts have been provided in order to achieve stormwater overland capacity.

2.6. Design of Upstream Infrastructure and Amenity Zones

As the design of upstream development and the Spring Mountain Stormwater Drainage masterplan have continued to develop and mature, so has the function of the Robelle Domain Stormwater Drainage pipeline. The de-watering of the previously inundated upstream embankment to Sinnathamby Boulevard has activated a further 2.5 hectares of open space lands which have been converted into a valuable community asset as it is now in the process of being converted into an embellished open space.

The development of the upstream catchment is anticipated to trigger the completion of the Robelle Domain stormwater drainage network, with the inlet system upstream of the Sinnathamby Boulevard embankment being utilised to provide a control for stormwater outflows from the development lands. The upstream parkland spaces have been designed to function in conjunction with the stormwater drainage system to ensure that detention storage capacity is available, with a range of spaces at different levels of stormwater immunity providing amenity to the area.

Partnering with Douglas and Partners, the Sinnathamby Boulevard embankment design has been updated to ensure long-term stability against the effects of stormwater drawing down of ponded water and integrate public through-movements while retaining clear delineation of exclusion zones.

The profile of the upstream parkland has been designed to provide storage for stormwater detention purposes whilst also achieving the following design criteria:

- The piped and overland stormwater system was then designed to achieve Q500 bypass to Robelle Domain without the overtopping of the Sinnathamby Boulevard embankment;
- Q20 immunity is provided to the upstream sporting fields;
- Pedestrian zones within the upstream parkland have been provided Q2 immunity with low flow areas preserved as non-trafficable zones;
- Upstream club houses, access roads and sporting courts have been provided with Q100 immunity; and
- All detention structures have been tested for safety based upon a cascade failure scenario to ensure that our design is robust.

2.7. Results

The implementation of the Robelle Domain stormwater diversion drainage has provided a lasting legacy of community capital for the Springfield Town Centre. Within Robelle Domain this infrastructure allows for reclaiming of over 5 hectares of urban parkland space which is now home to the Orion Lagoon, a highly urbanised and immensely popular public swimming facility. In addition, the completion of the pipeline will provide a further 2.5 hectares of open space for the surrounding community and a framework for the development of all upstream catchments within the Spring Mountain Drainage Masterplan.

The strong project collaboration and stakeholder engagement has earned Cardno the praise of the local authority, contractors and local community groups for the contribution the engineering design has made to the local landscape.

The strong integration of infrastructure within the landscape design has led to recognition of the Robelle Domain parklands with a number of industry awards including the following:

- Queensland Parks and Open Space Landscape Architecture Award, AILA 2016;
- Award for Leisure Facilities in Development Category, Parks and Leisure Australia 2016 Awards of Excellence; and
- Wildcard Award, UDIA Qld Awards for Excellence, 2011.

The high level of accessibility throughout the parkland forms a feature for Greater Springfield - a pedestrian connected community. Robelle Domain forms the nucleus of the pedestrian pathway network, providing connections to all surrounding precincts and onwards to the extents of the development boundary.

The park is visited by thousands of people each day with attendance at the opening day of the lagoon attracting over 10,000 people and receiving national media attention. The Robelle Domain project has provided widespread recognition to the region as an outstanding recreation facility. Robelle Domain continues to live up to its vision as the 'jewel in the crown' of the Greater Springfield CBD.

3. CONCLUSION

Cardno is very proud of its long-standing involvement in the stormwater trunk infrastructure which underpins the Springfield Town Centre development. Cardno has been a leader within the consultant team for this project from the early planning stages, providing an innovative trunk drainage design to bypass the major stormwater flows through this area of the parkland, reclaiming urban parkland space to create a legacy for the Springfield community.

The success of the infrastructure project is evident in the strong integration of landscape and engineering designs, passively serving its function of major stormwater conveyance whilst not detracting from the strong aesthetic of one of South-east Queensland's finest open spaces. The concealment of the infrastructure works within the landscape has also served to ensure a safe public environment by preventing unauthorised access.

The system achieves a suite of stormwater immunity and conveyance conditions in order to ensure both amenity and security to the heart of the Springfield CBD, and has evolved over time to fortify the stormwater management strategy of Spring Mountain, a major residential community located upstream of the CBD area.

As the reach of adjoining open spaces is extended, the resulting stormwater management solution will allow for increased value open space outcomes to be delivered. The completed system is a valuable asset for the Springfield Town Centre which will continue to provide value to the community for years to come.

Robelle Domain, amongst numerous other projects within Greater Springfield, has been successfully delivered by the Cardno team throughout their 18-year involvement in the project. The Greater Springfield master planned development has been recognised by receiving the FIABCI Prix D'Excellence Award for Worlds Best Master Planned Community and has been described by Prime Minister Malcolm Turnbull as a "Nation Building Project".