

MORETON BAY 'FLOOD EXPLORER' - MORE THAN A MAP

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Introduction

Much of the community surprise and exclaim reported during and after recent floods, particularly the January 2011 floods in south-east Queensland, suggests the public may not fully understand the likelihood and impact of these events. This is perhaps understandable given the inherent complexities of flood behaviour, and the generally low quality of flood mapping made available to the Australian public.

This paper describes an internet based flood mapping tool called 'Flood Explorer' currently being developed for Moreton Bay Regional Council. The tool is being developed to improve the availability of quality flood mapping for the Moreton Bay community.

Quality Flood Maps for the Community

Features of quality flood mapping

Access to quality flood mapping is fundamental to good decision making within the floodplain. In order to provide quality flood mapping to the community, the maps should have the following general features:

Currency

The flood information shown on the maps, including input data used to generate the flood estimates, must closely reflect the conditions that currently exist within the catchment and its floodplain. Importantly any major recent changes such as new infrastructure or new urban development should be reflected within the mapping. Furthermore, the ongoing flood mapping program should provide for regular maintenance and update to reflect any changes as quickly as possible after they have occurred.

Accuracy

There are numerous methods and tools available to derive estimates of flood behaviour. All of these result in a degree of uncertainty and error in the estimates. When scoping the flood mapping investigation it is important to ensure that uncertainty and error is minimised. This gives the user as much confidence as possible that the mapping can be relied upon for floodplain decision making.

Accessibility

The flood mapping provided should be intuitive and easy to understand. Maps should adhere to a high cartographic standard, make appropriate use of lines and colour, have sufficient resolution to clearly show the relationship between flood extents and property boundaries and allow for simple map navigation.

Comprehensive Coverage

The program of flood mapping preparation should provide complete coverage of the floodplain within the area of potential interest to the public. In Moreton Bay Regional Council's experience, even traditionally unmapped rural floodplains are becoming more closely settled and are therefore in need of more reliable flood mapping to support planning decisions. In urbanising areas, overland flowpath mapping for smaller tributaries and headwaters is also increasingly important as more marginal land is sought for housing.

Explanatory Notes

Given the inherent complexity of flood behaviour, any flood mapping should be accompanied by simple easy to read explanatory notes and fact sheets. These provide the user an opportunity to further their understanding of the subject matter.

Range of Flood Likelihoods

Historically flood mapping has been often limited to display of the flood extent associated with a single flood likelihood, often the 1% annual chance flood (i.e. 'Q100' or 100 year Average Recurrence Interval flood event).

It is important that the public understand that there is not a single flood extent that can fully describe flood behaviour and that in fact a wide range of flood events of different likelihood can be observed at a location. Without this understanding some of the problems that typically arise are:

- general misconception that there is only one sized flood and therefore public surprise when flood estimates change or when an actual flood behaves differently to the mapped event.
- poor appreciation of the nuisance and risks that small but frequent floods may present for some people and properties (i.e. smaller than the 1% annual chance flood)
- poor appreciation of the risks that very large and uncommon floods may present for some people and properties (i.e. larger than the 1% annual chance flood).

It is important when providing information for very large flood events that the public is given material to assist them gain an appreciation of the low likelihood of these events and suppress undue concern.

Benefits of quality flood mapping

The primary benefit of making available quality public flood mapping is a greater awareness of the potential for flooding amongst existing floodplain occupants and urban developers seeking new project sites.

This in turn promotes more appropriate decision making within the floodplain, including for example enhanced vigilance and preparation for a flood emergency (for existing floodplain occupants) and the sensible siting and design of new dwellings (for future floodplain occupants).

In the case of home and contents insurance, quality flood information can assist with more accurate determination of flood risk for a property and thereby encourage insurance customers to seek appropriate insurance cover. Insurance providers are also able to set appropriate premiums.

Barriers to quality flood mapping

The preparation of quality flood mapping is made more difficult by the inherent technical complexity and cost associated with the initial collection of flood data and its ongoing maintenance. This includes the cost to collect input data suitable for numerical flood modelling, the flood modelling process itself, and then the post-processing of flood model output to derive suitable spatial data for inclusion on public flood maps.

Even where suitable flood investigations have already been completed, the spatial data obtained often does not make its way onto quality flood maps. This is possibly due to:

- technical challenges associated with public delivery of quality spatial flood information
- perceptions of political and legal risk associated with presentation of flood mapping showing inundation of private property

Queensland Floods Commission of Inquiry

The Queensland Flood Commission of Inquiry investigated the need for public flood mapping. Relevant recommendations of the Inquiry include:

- *As far as practicable, councils should maintain up-to-date flood information. Rec 2.7 (Page 58)*
- *For urban areas where development is expected to occur, councils with the requisite resources should develop a flood map which shows 'zones of risk' (at least three)*

derived from information about the likelihood and behaviour of flooding. Rec 2.13 (Page 68)

- *Councils and the Queensland Government should display on their websites all flood mapping they have commissioned or adopted. Rec 2.16 (Page 70)*
- *Flood maps, and property specific flooding information intended for use by the general public, should be readily interpretable and should, where necessary, be accompanied by a comprehensible explanatory note. Rec 2.17 (Page 70)*
- *All councils should, resources allowing, map the overland flow paths of their urban areas. Rec10.9 (Page 234)*

These recommendations are consistent with the vision Moreton Bay Regional Council has for its own flood mapping program.

An Overview of the Moreton Bay ‘Flood Explorer’ Interactive Mapping Tool

The Moreton Bay local government area covers a total area of 2070 km² extending between the northern suburbs of Brisbane to the southern edge of the Glass House Mountains. The region contains a diverse mix of landuses (e.g. rural, semi-rural, urban and forest) and provides a key urban growth corridor for South-East Queensland, expected to accommodate another 150,000 people over the next 20 years. Floodplains represent one of the most common landforms in the region. The floodplain is becoming the subject of increasing land speculation as marginal land is sought for housing.

Four years ago, Moreton Bay Regional Council commenced the preparation of a region wide flood investigation referred to as the Regional Floodplain Database (RFD). The RFD has involved accurately mapping all the floodplains within the region as part of a single large mapping project. The RFD is possibly the single largest flood investigation project so far undertaken in Australia.

From its inception a major focus of the RFD project has been the objective of delivering high quality flood information for the community, including interactive display of the flood data via an internet-based mapping tool. This mapping product came to be known during the course of the project as ‘Flood Explorer’.

The key features of Flood Explorer are described in more detail within the following subsections.

General Layout and Functionality

The Flood Explorer interactive mapping tool uses ESRI ArcGIS Server map service architecture, combined with a Microsoft Silverlight client to deliver dynamic mapping of flood related spatial data via the internet.

Flood Explorer is accessed by web browser navigation to Council's main public flood information website www.moretonbay.qld.gov.au/floodcheck and then to the Flood Explorer sub-page.

The user is asked to accept a disclaimer upon entering the Flood Explorer sub-page. Once the disclaimer is accepted Flood Explorer first presents to the user a map view of the region.

Mouse based user controls, including intuitive and familiar button clicks, scrolling and hand motions allow the user to pan and zoom the map view interactively across the region. These controls allow the user to view the map at a scale best suited to the level of enquiry.

At regional scales the user is able to view the overall footprint of the floodplain, understand its general scale and location and understand how floodwaters connect across the landscape, including where floodwaters will come from and where they go to.

The base mapping layer that accompanies the flood mapping can be toggled between a vector base map and an aerial photo image option. This choice is dependent on which base map option is considered by the user to best assist their interpretation of the data.



Figure 1: Flood Explorer Mapping Tool at Regional Scale Zoom
(Base Map Selection Tool Highlighted Using Red Circle)

At local and property scales the user is able to clearly see the extent of the floodplain relative to property boundaries and features of interest such as roadways, public facilities, places of work and places of residence. The user is also able to search for a property or location using a typical suburb, street and street number search.

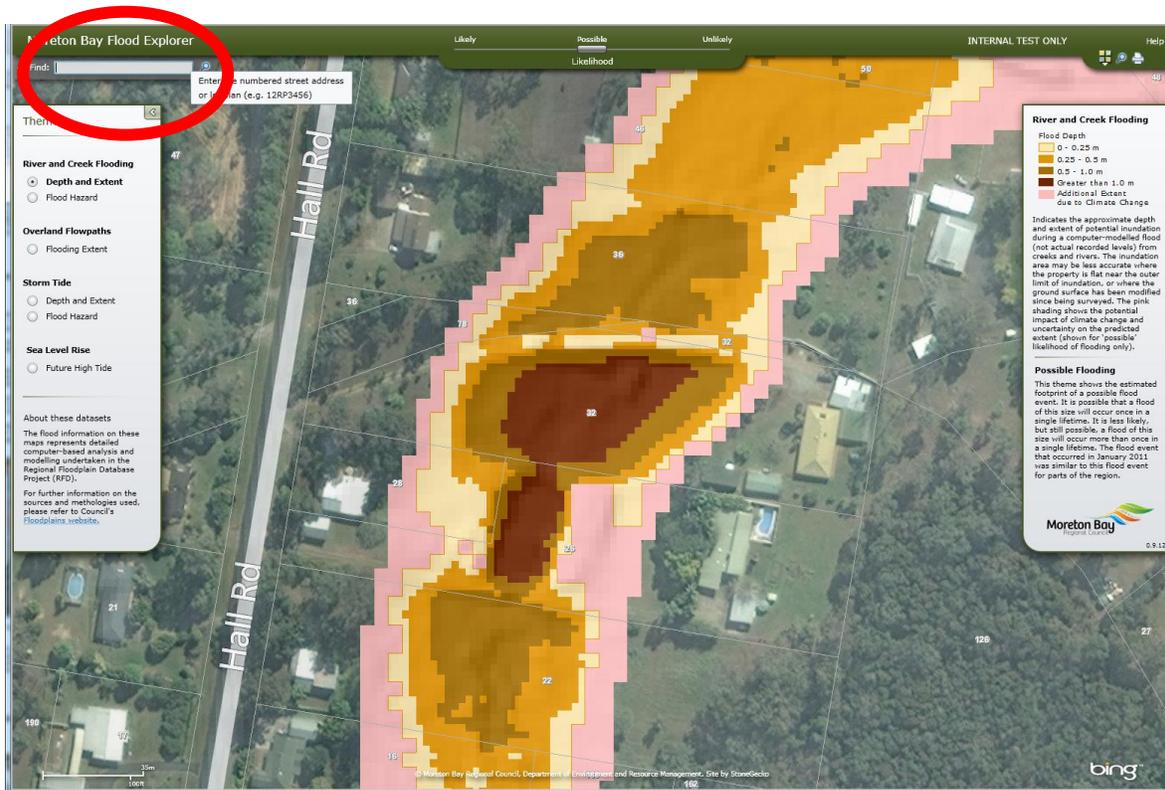


Figure 2: Flood Explorer Mapping Tool at Local Scale Zoom
(Property Search Tool Highlighted Using Red Circle)

Due to the sensitivity and complexity of the subject matter, the manner in which the mapping is able to be displayed within Flood Explorer is heavily controlled. The user is able to select from a pre-defined range of 'themes' and 'likelihoods' as described in the following sub-sections.

Themes

The Moreton Bay Region is influenced by four main types of flooding referred to as 'themes':

- River and Creek flooding caused by heavy rain and escape of floodwaters from the main channel of a large waterway
- Overland Flow caused by heavy rain and accumulation of excess stormwater in depressions, small gullies and roadways
- Storm Tide caused by cyclone and extreme offshore weather systems
- Tide rising onto the land surface inundating low-lying coastal areas (often called 'King Tide')

Through the Flood Explorer mapping tool, each of these themes is available for selection from a selection menu on the left side of the viewing area. Clicking on any of the available theme selections will make that theme available for viewing within the main window. Only one theme can be displayed at a single time to limit mapping complexity and confusion for the user.



Figure 3: Flood Explorer with Storm Tide Theme Selected
(Theme Selection Highlighted Using Red Circle)



Figure 4: Flood Explorer with River & Creek Theme Selected
(Theme Selection Highlighted Using Red Circle)

Each theme uses a different colour palette to clearly differentiate between the themes. These same theme dependant colour palettes are used across all Council's flood mapping products.

Likelihoods

The Queensland Floods Commission of Inquiry recommended that Councils develop flood maps displaying a minimum of 'three zones of risk'. This recommendation was otherwise non-prescriptive regarding the manner by which these zones should be delineated. This is appropriate as such decisions are best resolved at a local level.

The spatial distribution of flood risk is a complex spatial relationship as it depends on the nature of the specific risk being examined. For example the risk to a road user is different to the risk of property damage at a particular location.

Because of this complexity it was determined that in the first instance Council's mapping products would focus on simpler aspects of flood behaviour by only displaying the depth and extent of floodwaters for floods of different likelihood.

At the top of the Flood Explorer viewing pane a likelihood selection tool enables the user to interactively select from one of the following three flood event likelihoods:

- a small flood event referred to as having a 'high' likelihood (i.e. 5% 'annual chance')
- a large flood event referred to as having a 'medium' likelihood (i.e. 1% 'annual chance')
- a very large flood event referred to as having a 'low' likelihood (i.e. 0.1% 'annual chance')

In addition, the maximum extent of the floodplain is displayed. This maximum extent is displayed without depth information and using an alternate colour (pink). This extent is not able to be selected or de-selected using the likelihood selection tool and is instead shown on the map view as a permanent 'halo'.



Figure 5: Flood Explorer with River & Creek Theme and High Likelihood Selected (Likelihood Selection Highlighted Using Red Circle)



Figure 6: Flood Explorer with River & Creek Theme and Medium Likelihood Selected (Likelihood Selection Highlighted Using Red Circle)



Figure 7: Flood Explorer with River & Creek Theme and Low Likelihood Selected
 (Likelihood Selection Highlighted Using Red Circle)

The different display behaviour for the maximum floodplain extent is consistent with its primary purpose which is to simply identify the overall floodplain footprint. It is intended that by withholding depth information for this extreme event the public will be discouraged from active consideration of consequence for this event. This is appropriate given the very remote likelihood of such an event occurring.

Explanatory Notes

Easy to understand explanatory notes that describe the selected flood theme and flood likelihood are displayed in the panel on the right hand side of the main Flood Explorer map viewing area. These notes are context sensitive and automatically adjust depending on the specific theme and likelihood selections that have been made by the user.

These explanatory notes provide the user access to more detail about the flood information displayed on the map. The notes have been carefully worded to promote an appreciation of the flood mapping displayed that is as accurate as possible. Making sure these notes are coupled to the selected theme and likelihood is an important strategy for minimising potential misinterpretation of the mapping.

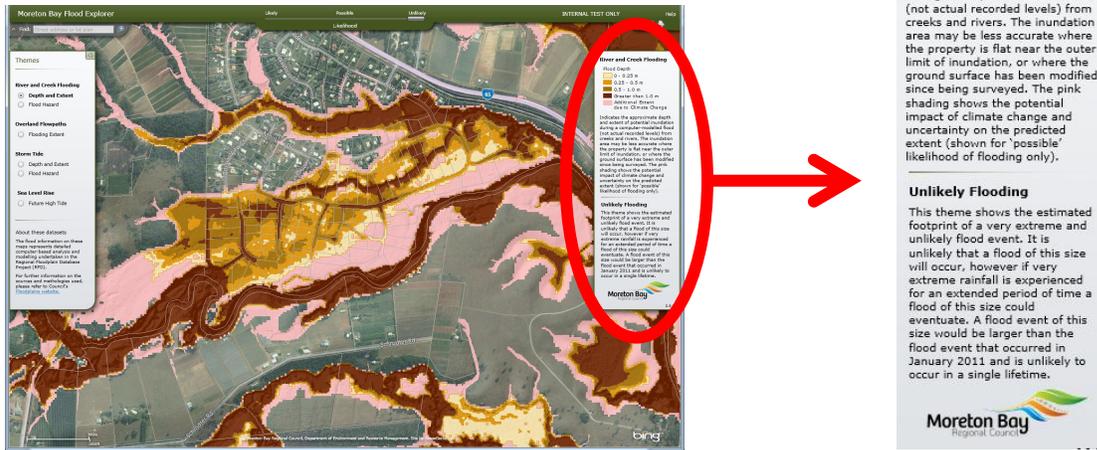


Figure 8: Explanatory Notes for River & Creek Theme and Low Likelihood

Supporting Maps and Information

Flood Check Property Reports

Council has historically provided property-based flood reports on request. These reports include detailed advice regarding the 1% annual chance flood behaviour for a specific property. These reports are typically sought by home owners, urban developers and prospective purchasers when researching a property's flood status.

In parallel to the development of Flood Explorer, Council has also developed a comprehensive flood report product branded as the 'Flood Check Property Report'. These reports provide summary and detailed flood information for each type of flooding (i.e. 'theme') experienced at a property.

For both River and Creek and Storm Tide flooding, Council is able to provide flood depth, level, and percentage parcel coverage information. This detail is provided for each of the three levels of flood likelihood mapped using Flood Explorer.

Whilst Council has also developed a stand-alone internet tool for public delivery of these Flood Check Property Reports, the same report is able to be accessed via the Flood Explorer tool by simply clicking on a property of interest and then following the web link that is presented on the pop-up screen.

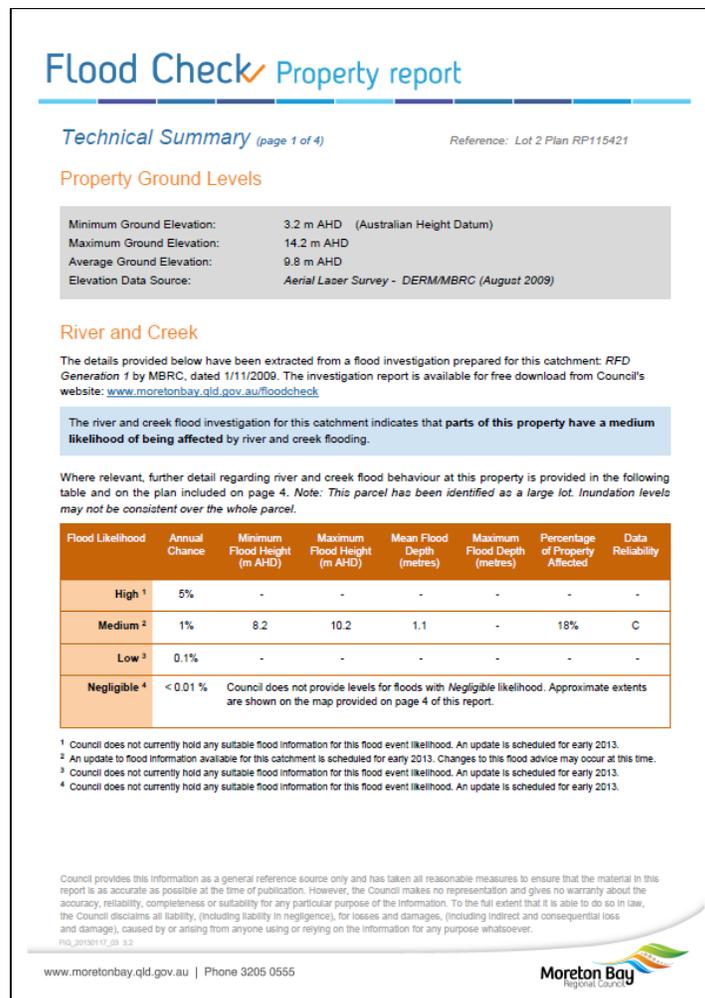


Figure 9: Flood Check Property Report Extract

Suburb Flood Maps

The current version of Flood Explorer relies on the user having access to a computer with the software package installed known as Microsoft Silverlight. Most modern computers that have the Microsoft Windows operating system include a Silverlight installation by default. However some computers do not have Silverlight installed such as Apple computer products. These computers therefore currently require an alternate way of accessing Council's flood information.

Council has therefore prepared a series of fixed-scale 'Suburb Flood Maps' that are available for download from Council's website in PDF format. Each PDF map displays the flood extent and depth for a specific flood likelihood and a specific suburb. A total of 630 individual suburb flood maps are required in order to best emulate the information able to be displayed using the Flood Explorer interactive mapping tool.

It is Council's future intent to translate the Flood Explorer tool to a more universal software platform to limit computer compatibility issues.

Fact Sheets

A series of Fact Sheets have been developed and are available on Council's website to accompany the Flood Explorer tool and the other flood information products provided by Council. These fact sheets provide the user further guidance about how to interpret the flood information provided and are an important part of the overall strategy of minimising potential for public misinterpretation of Council's flood maps.

The following is the list of current fact sheets. Additional fact sheets giving more advanced guidance are planned in the future.

- Fact sheet 1 - Things to know about flood maps
- Fact sheet 2 - How to interpret a suburb flood map
- Fact sheet 3 - How to interpret the Flood Explorer interactive mapping tool
- Fact sheet 4 - How to interpret a Flood Check Property Report
- Fact sheet 5 - Understanding the likelihood of floods

Flood Information Management Framework

Large volumes of flood information have been prepared as part of Council's Regional Floodplain Database project including over 200,000 files representing approximately 11 Terabytes of digital data. This information is challenging to store and maintain over the long term.

At the same time Council is increasing the importance of flood information to its business by providing high profile, widely used public information services such as Flood Explorer and the Flood Check Property Report system.

Accordingly, Council is implementing an Information Management Framework that supports the business processes required to ensure that these valuable flood data holdings and systems are maintained into the future.

The core components of this framework include:

- A flood information identification standard that includes a file naming convention with embedded logic to support identification, search and administration of spatial flood data.
- Managed content description to ensure quality metadata is available for users of Council's flood related spatial data holdings.
- Lifecycle and version control to manage the processes required to retire superseded flood datasets and replace them with ones that are more up to date.

- A structured data storage system to carefully control the way in which flood data is stored and optimise the type of storage technologies that are used for each class of data so that storage investment reflects the business value of each class.
- Formal staging of the process used to integrate data into the database including:
 - Level 0 (as supplied)
 - Level 1 (import, development and test)
 - Level 2 (local production version)
 - Level 3 (corporate production version)

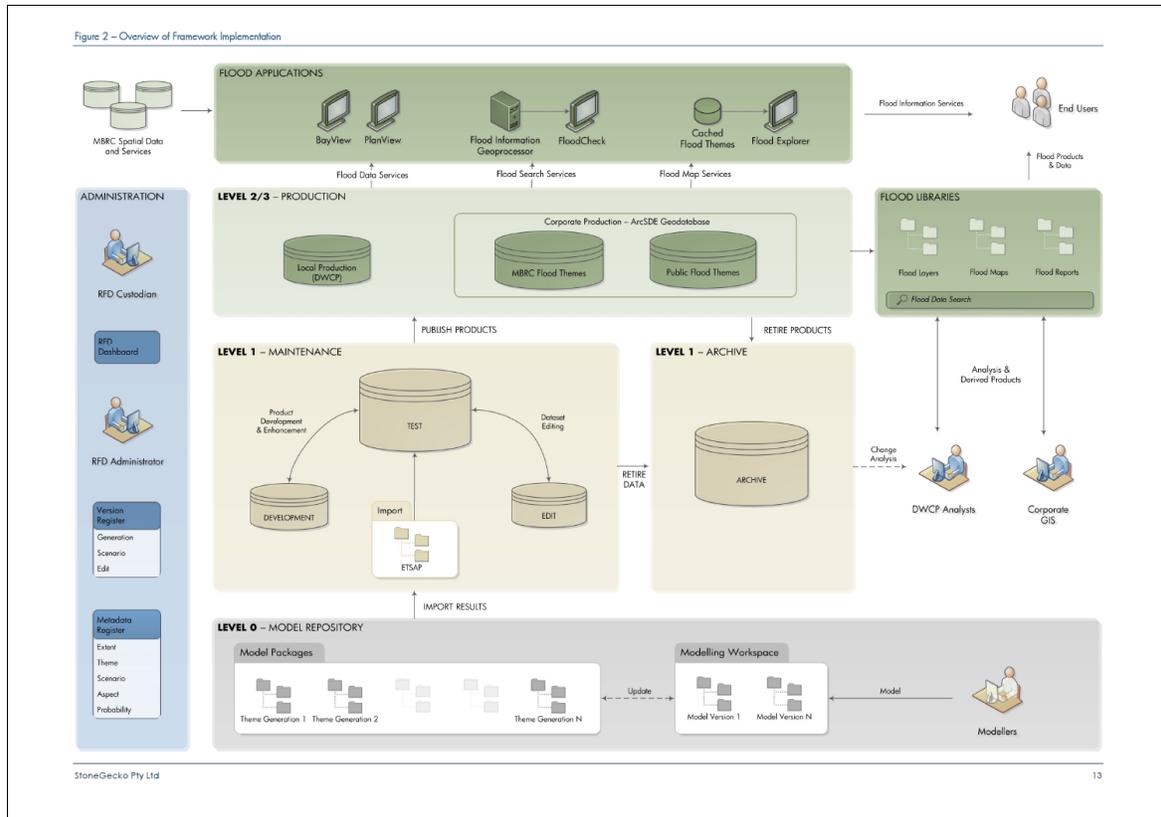


Figure 10: Flood Information Management Framework Overview Diagram

This Information Management Framework is important to the long-term success of Flood Explorer as it provides Council with guidance and tools to manage the spatial data holdings ultimately displayed to the public through Flood Explorer.

Conclusion

All floodplain management authorities in Australia are tasked with undertaking flood investigations to assess flood behaviour and risk. Only a small part of the flood information obtained from these investigations is sometimes published in the public domain. There remains great potential for these various flood information holdings to be more fully

leveraged in order to provide Australians with better awareness and understanding of flood behaviour.

Rather than treat public display of flood mapping as an afterthought, the Flood Explorer tool was an early consideration for Moreton Bay Regional Council's flood mapping program. A great deal of effort has been spent by Council and its consultants, optimising various aspects of the flood information capture and management process, to facilitate the smooth delivery of quality flood mapping for the community.

At the time of writing the Flood Explorer tool is in the process of final testing and development before release on Council's website www.moretonbay.qld.gov.au/floodcheck. The authors look forward to the tool being released and seeing long-term benefits emerge as the community gains access to more than a map.