

Where we are now, has a long back-story stretching over three decades. It is complex with lots of detail. To fully appreciate that what we are confronted with is a **chronic, systemic problem** rather than a momentary hiccup, the detail is important.

The riverine floodplains have high groundwater primarily due to duplex soils – thin sand over clay. This sand fills with water over winter. Historically these areas held vast amounts of water that was filtered through vegetation and slowly moved down gradient to the river. The water being held was spread across a wide expanse of country and a network of creeks and wetlands. Once soils are saturated no more water can be absorbed. Excess water is expressed as ponding across the landscape.

In 1994 the Environmental Protection Authority provided advice when the North East Corridor was first proposed. It recognised this would be difficult land to develop with numerous constraints. The EPA would also have been aware that the Water Authority, (now DWER), universally used infiltration to manage drainage across the metro area. Infiltration as a means of dispersal works well in deep sands but is useless in duplex soils. Infiltration is impossible when the ground becomes saturated.

Around that period the Water Authority was transitioning out of old management strategies and technologies - drain everything to the lowest point, usually the river, using drainage sumps, compensating basins and open or piped drains.

At the same time it was acknowledged that WA was experiencing a drying climate. Indications were that water in the landscape would become scarcer and all environments would be challenged.

New thinking was to keep water in the local water cycle. This meant using new technologies like Water Sensitive Design. Through a series of swales, bioretention basins, flood storage areas and other technologies, drainage water could be cleansed and dispersed in a more environmentally responsible way. These areas also looked, or were proposed to be, more aesthetically pleasing than the old drainage sumps that were usually fenced off for public safety reasons. By using Water Sensitive Design mechanisms, drainage areas could double as public open space or at least coexist and it would be a win-win.

Because WSD technologies use infiltration as the primary mechanism to disperse water, they struggle to be effective in this area. The EPA may have been aware that infiltration would be difficult in duplex soils but it definitely was aware that these technologies were new in WA. Little was known about their effectiveness and they were completely untested in areas of high groundwater. Impacts on environmental values were unknown and there was no mechanism to effectively predict outcomes.

The EPA was aware of regional environmental values and the adverse impacts that stem from urban development. It recommended that studies already underway should include greater detail, more studies be undertaken and they be integrated to ensure the environment was protected for the long term, ie fifty plus years. Management strategies needed to be **developed and demonstrated to work**. A regional approach to drainage and planning was advised.

An ongoing performance evaluation of development as it reached completion was recommended to assess the effectiveness of decision making and technologies. As staged development was proposed, ongoing assessment would provide opportunities for thinking and technologies to evolve and improve.

The final recommendation was for an analysis comparing the cost to the community to manage associated environmental issues in relation to the benefits provided by development to the state. The Authority would

have been aware that the local government was, and still is, responsible for management of drainage works following developer handover. This includes fixing the flaws.

The EPA had some warnings. Studies needed to be completed and proven effective management strategies developed **before rezoning** to avoid expectation that land was suitable for urbanisation even if it was found to be environmentally unacceptable. It recognised this would take time but where technologies failed, alternatives were expensive and some situations may prove to be unfixable. Costs for management and remediation would be borne by the community and lastly, once constructed, urban development couldn't be undone.

Regardless of the EPA's advice, the government and the state planning department pushed on. Investigations and studies called for were not done and long-term understanding of the impacts on the environment were not determined. Cost analysis didn't happen or wasn't made public, and the land was rezoned without any real idea of outcomes and costs to the community or the environment.

In 1995 the Water Authority produced the Drainage Management Strategy for the North East Corridor. This recognised Perth had a drying climate and water levels in the Gnangara Mound were declining. There was concern that groundwater levels in the North East Corridor were also declining and there was a risk of over extraction, or drawdown, due to subsoil drains and surface drainage associated with urban development. As a corollary, it was considered important to infiltrate rainwater as much as possible and, to assist this, not set subsoil drains too low to ensure groundwater was still available for environmental needs. New technologies like those promoted by WSD were seen as a way to compliment this.

In time this proved to be a flawed premise although it was accepted at the time, probably due to insufficient information to the contrary as recommended studies and reliable modeling had not been pursued. Significant numbers of trees in the region helped to control groundwater levels by keeping water in the water cycle. An estimated 100,000 have been removed to date and a total of 160,000 are predicted to go on completion. Replacement of trees with around 90% of impervious surfaces now keeps water in the soil.

Wetlands and creeks that once held vast amounts of water and carried it to the river have been filled. This has left a few strategic waterways, St Leonards Creek in Henley Brook, for example, to carry the load. These few that remain are now used as drainage channels and storage areas to control the release of discharge from new urban into local creeks and the Swan River. This increases volumes being held in localised areas.

Today's planning response to retain remnant bushland, wetlands and waterways includes them in Public Open Space. But a conflict happens when drainage facilities like bioretention basins, swales and flood storage areas, are also included. The policy is to infiltrate water, but once the sand layer is saturated the water can only move sideways and downhill over the impermeable clays. When large volumes of water are introduced over extended periods, as happens with urbanisation, this has significant repercussions.

Filling an area to lift buildings above flood levels compounds issues as there is more sand to fill with water. Millions of tonnes of imported sand have been used in the Swan Urban Growth Corridor. Fifteen million are predicted to be needed for North Ellenbrook East.

Large volumes are held for long periods, slowly discharging into surrounding areas and drainage channels. Waterways remain inundated, some permanently, so when it rains flooding is more likely to occur. Trees and vegetation that were retained in waterways, wetlands and swales also become inundated. Long periods of water logging robs plants of oxygen and they die. Many indigenous plants have evolved to survive in inundated areas but generally on a seasonal basis, not all year round.

The imported sand takes some time to fill but then eventually saturates so when it rains, stormwater just runs off. It also results in water tables along the urban fringe and creeklines rising and staying higher.

An example is the northern arm of the St Leonards Creek, which is continuously inundated. This is contrary to the objectives of water management strategies that aim to maintain hydrological regimes. It is highly detrimental to creek ecology which has evolved to a pattern of winter wet, summer dry.

Concentrating drainage infrastructure close to the edges of development such as NE Dayton is having devastating impacts on neighbouring rural properties down gradient. Buildings, livelihoods, animals, vegetation and landscapes are all being affected.

It was expected that rises in groundwater would be contained within the development footprint but much greater volumes of water are being generated than predicted. This is probably due to clearing, reduction in evapotranspiration and inadequate modeling. This has resulted in land surrounding new urban like Cheryl and Harry's to become inundated. This is not isolated, it is occurring all along the urban rural interface. It will also occur in the North Ellenbrook areas and the Bennett Springs East Improvement Plan area where built up areas abut remnant bush and conservation areas.

The combination of importing massive amounts of sand fill, filling creeks and wetlands and the decision to infiltrate rainwater into the soil as close to source as possible and rely on subsoil drains to control groundwater levels has had disastrous repercussions. Including drainage infrastructure within and next to wetlands and bushland has committed them to inevitable destruction.

Decision makers failed to recognise that groundwater would rise significantly in and around new urban areas on duplex, sand over clay soils. At the time they believed that in a drying climate, retaining water was essential. Instead we are facing a groundwater flood.

Engineering is not always precise. The 1995 drainage strategy was basic and struggled with methods of calculating surface runoff and groundwater extracted via subsoil drains. Modeling seemed to be generally undeveloped and tricky, as it didn't always deliver what was expected. But this didn't seem to trigger further research to understand why. A number of scenarios were modeled in the strategy but no testing was undertaken to confirm accuracy or likely compliance with objectives.

Some water related factors are extremely hard to measure so creating models to predict how things will behave is even more difficult. **Modeling is still not accurate enough to ensure that environmental damage can be avoided.**

Studies that have occurred in the interim have failed to change current government policies. The same mistakes are happening in other areas. Cullacubardee, Bennett Springs East, Brabham Stages 2 and 3, Dayton LSP2A & B and North Ellenbrook East and West will all experience the same outcomes because local conditions are essentially the same. Pushing ahead without any demonstration that development can occur without loss of biodiversity and hydrological damage is irresponsible. Decisions of this nature are extremely risky for governments and government agencies.

It has taken over a decade and a half but we are now seeing the outcome of that early flawed premise.

Groundwater has been rising over successive years with an increase of 1.5m being recorded since 2015. Flooding was evident in 2024 both in the developed area and along the urban fringe despite it being a dryer year.

Last year, with a return to 30 year average rainfall, flooding was extensive. Numerous rural properties down gradient of new urban experienced extreme flooding. It was also evident in new urban areas. Infrastructure resilience is pushed to extremes when year on year the ground remains full of water. When heavy rains occur, the water has nowhere to go and flooding occurs.

The data from Harry's monitoring bores show the water table is **successively rising**. This is not just seasonal, it is a rise across the year and each year. This is highly disturbing as there is no indication of an **upper limit**. The Urban Water Management Plan for a section of Dayton LSP 4 that was done in 2019 predicted a rise of 1.5m annually. **There was no sunset clause**. That is of extreme concern because it was generated by a highly respected hydrologist. **Just as concerning is that it wasn't challenged by the City of Swan's planners and engineers nor any government agencies.**

Put simply, the drainage systems provided are inadequate. Decision makers are continuing to ignore the reality that shallow, sandy soil on top of clay just can't cope with this volume of runoff entering an already saturated system.

If the outcomes can be as extensive and extreme as last year with a return to 30 year average rain, are drainage systems even capable of managing a one in 100 year flood? The prospect of extreme weather events resulting from climate change means rural and urban areas are at severe risk as there is no resilience built into plans.

As you can see, this is a growing problem. Some adverse impacts like seasonal flooding are obvious, but there is also the progressive loss of trees through prolonged inundation, wetlands collapsing, algal blooms and loss of species that become evident over time. Sometimes it takes more than a decade to become apparent. But by then it is almost too late to stop it.

The cumulative impact of disregarding the EPA's advice, the removal of thousands of trees, importation of millions of tonnes of sand fill, destructive planning decisions and poor implementation are swamping us with a tsunami of rising groundwater fuelled by storm water from urban development. All of this is being dumped right on our doorstep.

The EPA recommended ongoing performance evaluation, or adaptive planning, as a fundamental requirement for drainage plans. Although not optimal, these would have provided a means to progressively improve strategies and outcomes.

Adaptive planning, the process of 'design, trial, tweak and retrial', is specifically included in the 'Water monitoring guidelines for better urban water management strategies and plans' (DoW, 2012). These guidelines require assessment of the impacts of development to improve outcomes and refine regulatory criteria. Assessment also provides much needed information about the performance of Water Sensitive Design principles and technologies in Western Australian conditions. Inclusion of an evaluation requirement in the guidelines embedded the EPA's recommendation within the planning process.

The drainage plan that governs the southern area, the 'Swan urban growth corridor drainage and water management plan', was prepared in 2009. It is comprehensive and includes the requirement for post development monitoring and a performance review, although only for a short period of three years.

Adaptive planning is currently a requirement for all water management strategies and has been since 2012.

Adaptive planning has incrementally disappeared from drainage management plans and decision makers are letting it happen.

The requirement for ongoing monitoring is also threatened as bores are not routinely located in optimal places to monitor changes to groundwater, nor protected during construction and monitoring programs are often discontinued.

Despite being included in planning instruments, performance reviews are not being done. Not one review has occurred since development commenced fifteen years ago, not even in the Swan Urban Growth Corridor with the most comprehensive District Water Management Strategy. The lack of review and assessment at any stage has denied planners and authorities the opportunity to resource workable solutions to drainage issues in the corridor.

All of the North East Corridor drainage documents I have seen align with the approach described in the 1995 report. This would indicate that the assumptions made back in the early 90s have not been challenged by decision-makers at any time.

It explains why the WAPC, government agencies and the City of Swan have been so reluctant to acknowledge we have a problem. They either still believe the early assumptions that were made or they don't. The outcome is the same. The former results in the perpetuation of the problem. The latter requires authorities to man up, fix the problem and produce drainage strategies that are better suited to areas of high groundwater; something they have been reluctant to do.'

The City of Swan Council has recognised we have a looming problem and have resolved not to support the last four proposals to continue expansion in areas of high groundwater. Staff is not yet convinced there is a problem.

Continuing on with flawed policies only produces poor outcomes. In this case it's the ratepayers of the City of Swan that are left with the problems and paying for the privilege to fix them.

Over and above the usual costs of development, the City of Swan and its ratepayers are responsible for hundreds of kilometers of drainage infrastructure. This includes subsoil pipes, nutrient stripping ponds, swales, artificial wetlands, pump machinery, drainage sumps, vegetation, trees, ancillary machinery and infrastructure associated with drainage systems. Many of the WSD technologies require cleaning and replacement. Remedial work can include replacement of amended soils and revegetation.

When any of these fail, the cost of repair can be, as the EPA warned, extremely expensive.

Liveable Neighbourhoods advises, 'the success of water-sensitive urban design is heavily dependent on the implementation of an ongoing maintenance program. The costs and skills required to manage wetlands and other water treatment devices are likely to be significant.' Further it advises that developer contributions towards these costs should be part of the approval process.

Costs for this style of drainage management are extremely high. The cost involved in managing drainage systems that don't work and/or replacement is even more expensive and in some cases can be irreparable.

This should not be placed solely on the local government and its ratepayers to manage.

Contingency actions and triggers are usually included in drainage plans in lieu of performance evaluation. But these are treating the symptoms rather than the cause. They can be effective for surface water management but, in relation to groundwater, are of questionable benefit. It's extremely difficult to alter infrastructure associated with groundwater management post development. The remedial action taken in North East Dayton is a prime example. Subsoil pipes need to be dug up and replaced. Citrus Avenue is to be raised half a metre and Basin A to be made deeper. All after houses have been built and families moved in. This has still to play out with extensive works proposed for further development adding to drainage issues. Changes to the drainage system constructed and proposed so far, do not comply with the local water management strategy. They are highly likely a public safety risk, of dubious contribution to local amenity in their present state and will probably fail because the fundamental principle that infiltration doesn't work in duplex soils has been ignored.

The current state of Lake Galup has been in the news recently due to the outcome of long term development impacts. This is a clear indication that once set in motion long term issues can be a massive and expensive problems to fix.

As the EPA cautioned, post development remedies can be extremely expensive and disruptive; success is not always guaranteed.

We have a lot to lose in the North East Corridor. The Banksia Woodlands in Bush Forever 200 are under imminent threat with extensive clearing underway upgradient of the reserve. Bennett Springs East Improvement Plan is so close to Horse Swamp it occupies part of the conservation category wetland's buffer zone. North Ellenbrook East, one of the wettest environments in the corridor, is upstream and upgradient of the Banksias in the Maralla Road Reserve, Bush Forever 13 is in the middle of the DSP and the only two remaining Western Swamp Tortoise Reserves in the world are on the eastern boundary.

The material presented today is not fringe thinking, uninformed or unsupported.

It is informed by studies undertaken by experts in the field of hydrology, like Sally, who have presented a number of papers over the last five years.

It is supported by the findings of Dr Luinstra's report on the urban impacts of North East Dayton on Harry and Cheryl's property and likely similar outcomes in similar circumstances.

It is supported by the data from Harry Gratte's monitoring bores over eleven years and data from DWER's Monitoring bore MM51A.

Finally, it is supported by the thousands of photographs taken by local residents over a number of years to record outcomes and events and **they are all undeniable.**

Three factors have had a profound influence on the outcomes in the north east corridor: the 'one size fits all' infiltration policy used to manage drainage, the flawed premise made in the 1995 that groundwater would decline under urban development and the lack of ongoing performance evaluations.

We believe there is ample legislation and planning instruments to support the protection of the environment. It takes political will and public pressure to ensure these are complied with. This is not currently happening.

We are being short changed and what you have seen today are the consequences.

- **Some of the poor planning decisions contributing to the flooding and inundation problems are historical; the outcomes are current.**
- **Current policies are not working and need to be fixed.**
- **Requests by academics for further work to be undertaken to provide better outcomes have not been acted on.**
- **There needs to be compliance with state and local planning instruments.**
- **Because continuing on the same path will deliver the same outcomes.**