# Draft Specification - Separation distances for groundwater controlled urban development

NWW Water Sensitive Cities Speaker Series

29 July 2016

# Welcome

Mr Tim Sparks

on behalf of the Land Development in Groundwater Constrained Environments Steering Group

# Developing in areas of high groundwater

- It is hard
- Has led to inadequate fill (too much/not enough)
- Caused poor amenity – loss of vegetation & boggy parks, even areas of inundation
- High construction & maintenance costs
- Caused more conservative requirements and increased costs of development
- Trapped in a bad circle of response

# What are the key issues ?

- **Lack of technical rigour and understanding leading to a lack of confidence**
  - Lack of agreed approach
- **The development process – design, construct, maintain – transfers the risk from developer to local government and the community**
  - Are the risks real or perceived?

# Project background

- Acknowledgement of issues associated with development in areas of high groundwater – 2011 to 2013
- Workshop held in June 2014
  - Agreement of broad identified issues
    - Process
    - Technical – baselines, methodology, criteria
  - Key risks identified
  - Some discussion of desired outcomes
  - Recommendation to establish Steering Group

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# June 2015 SC meeting outcomes

- Identified a number of actions to **reduce the risks** to an appropriate level. These include
  - No development
  - Use alternative design which responds to site
  - Use alternative construction (accommodates being wet and/or raises up with construction techniques)
  - Lower groundwater locally (how do we measure and approve?)
  - Separate development and/or infrastructure from groundwater (what separation?)
- Separations are able to be addressed by LG

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# What can Local Government do?

**Complete one small part of the bigger puzzle**

- Provide greater clarity regarding separation distances
  - What separation?
  - How should it be estimated and assessed?

# Project objectives

- Develop agreed criteria for groundwater separations appropriate to acceptable levels of risk and amenity for various critical elements of built form and infrastructure
- Develop methodology for assessment and approval of groundwater levels and separations
- Support with IPWEA/WALGA policy as appropriate

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# Scope of works

1. Establish technical working groups (i) separations (ii) methodology
2. Literature review
3. Risk assessment with local government
4. Develop draft criteria
5. Develop draft methodology
6. Consult industry
7. Determine method of release
8. Finalise criteria

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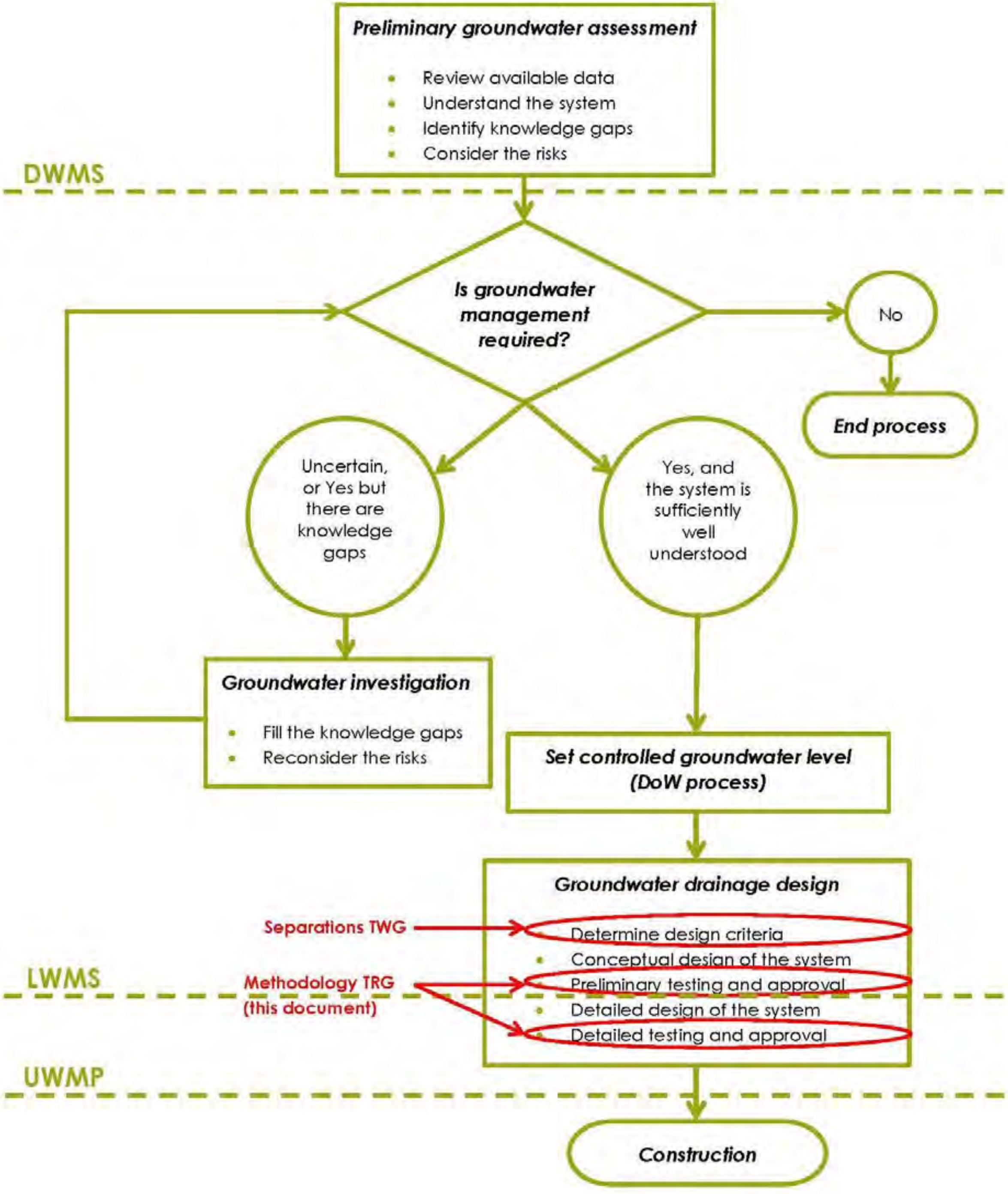
- Process for groundwater assessment



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# Key assumptions and guiding statements

- Based on scientifically accepted information including predictions of future climate
- Concerned with controlled or engineered groundwater systems
- Will not prevent poor design or guard against poor decision making
- Consistent and standardised terminology
- Regional influences are not considered
- A specified separation is not required in all cases - demonstrate that the defined objectives (outcomes) are going to be met
- ‘Deemed to comply’ criteria as well as performance measures
- Levels of service can be expressed as probabilities
- Recognises existing regulatory requirements

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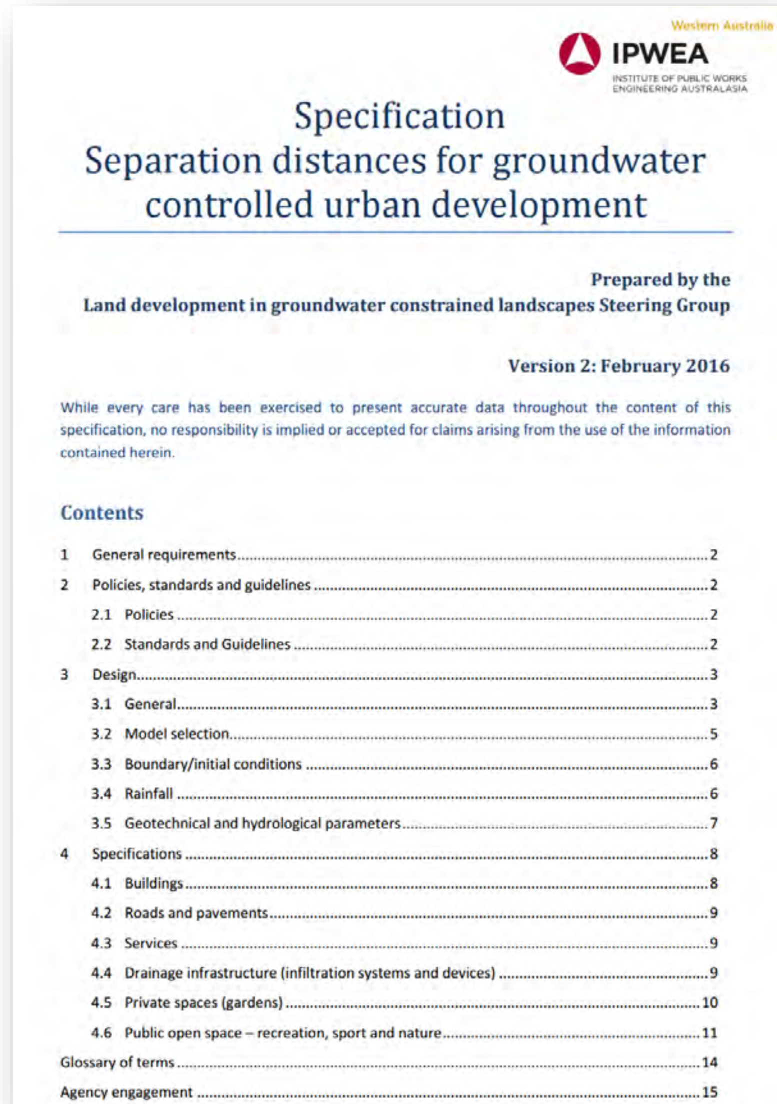
# Specification outline

- General requirements
- Policies, standards and guidelines
- Design – including planning requirements, model selection, boundary/initial conditions, rainfall and geotechnical and hydrological parameters
- Specifications – for buildings, roads and pavements, services, drainage infrastructure (infiltration systems and devices), private spaces (gardens), public open space – recreation, sport and nature
- Glossary of terms
- Agency engagement



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Specification
Separation distances for groundwater controlled urban development

Prepared by the
Land development in groundwater constrained landscapes Steering Group

Version 2: February 2016

While every care has been exercised to present accurate data throughout the content of this specification, no responsibility is implied or accepted for claims arising from the use of the information contained herein.

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# Existing policies, standards & guidelines

- State Water Plan
- State Water Strategy
- SPP 1 – State Planning Framework Policy
- SPP 2 – Environment and Natural Resources
- SPP 2.9 – Water Resources Policy
- SPP 2.10 – Swan Canning River System

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# Existing policies, standards & guidelines

- Australian groundwater modelling guidelines
- Better urban water management
- Classification Framework for Public Open Space,
- Decision process for stormwater management in Western Australia
- Guidelines for district water management strategies: Interim: Developing a local water management strategy
- Liveable Neighbourhoods: A Western Australian government sustainable cities initiative
- Model Subdivision Conditions Schedule
- National Construction Code Series 2015 Volume 1; Building Code of Australia Class 2-9 Buildings
- National Construction Code Series 2015 Volume 2; Building Code of Australia Class 1 and 10 Building
- Planning and Development (Local Planning Schemes) Regulations 2015, Structure Plan Framework
- Selection of future climate projections for Western Australia
- Urban water management plan: Guidelines for preparing plans and complying with subdivision
- conditions
- Water resource considerations when controlling groundwater levels in urban development

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# Requirements for planning stages

Table 1

# Link with BUWM process

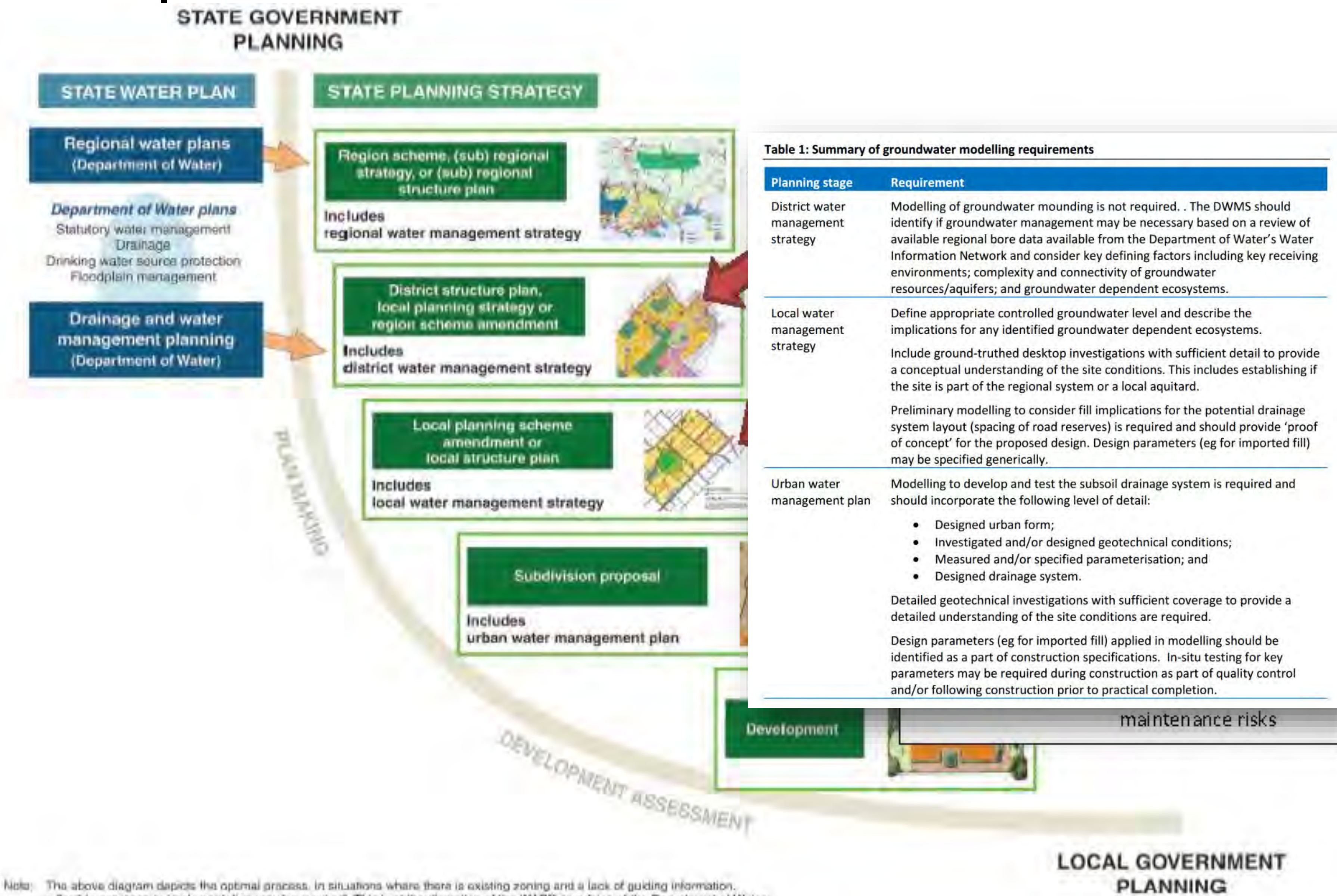
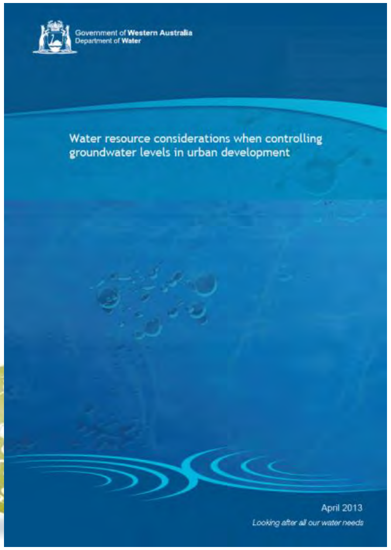



**Table 1: Summary of groundwater modelling requirements**

| Planning stage | Requirement |
|---|---|
| District water management strategy | Modelling of groundwater mounding is not required. . The DWMS should identify if groundwater management may be necessary based on a review of available regional bore data available from the Department of Water's Water Information Network and consider key defining factors including key receiving environments; complexity and connectivity of groundwater resources/aquifers; and groundwater dependent ecosystems. |
| Local water management strategy | Define appropriate controlled groundwater level and describe the implications for any identified groundwater dependent ecosystems.<br>Include ground-truthed desktop investigations with sufficient detail to provide a conceptual understanding of the site conditions. This includes establishing if the site is part of the regional system or a local aquitard.<br>Preliminary modelling to consider fill implications for the potential drainage system layout (spacing of road reserves) is required and should provide 'proof of concept' for the proposed design. Design parameters (eg for imported fill) may be specified generically. |
| Urban water management plan | Modelling to develop and test the subsoil drainage system is required and should incorporate the following level of detail:<br>• Designed urban form;<br>• Investigated and/or designed geotechnical conditions;<br>• Measured and/or specified parameterisation; and<br>• Designed drainage system.<br>Detailed geotechnical investigations with sufficient coverage to provide a detailed understanding of the site conditions are required.<br>Design parameters (eg for imported fill) applied in modelling should be identified as a part of construction specifications. In-situ testing for key parameters may be required during construction as part of quality control and/or following construction prior to practical completion. |

# District WMS

- Modelling of groundwater mounding is not required
- Identify if groundwater management may be necessary based on review of available regional bore and consider
  - key receiving environments
  - groundwater dependent ecosystems

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# Local WMS

- Ground-truthed desktop investigation – understand local/regional system characteristics
- 'Proof of concept' for:
  - urban form (earthworks and finished floor levels)
  - hydrological conditions (eg: relationship to regional groundwater and/or seasonal or 'true' perching)
  - geotechnical conditions (eg: presence of and depth to confining layer)
  - parameterisation
  - proposed stormwater and groundwater drainage system.
- Design parameters (eg for imported fill) may be generically specified at this stage

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# Urban water management plan

- Detailed geotechnical investigations
- Modelling to develop and test subsoil drainage system including justification for measured and/or specified parameterisation
- Identify requirements as part of construction specifications
- In-situ testing may be required

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# Design methodology

For calculation of the height of the mound between subsoils

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# Methodology reference group

- Local Government - Gosnells
- Local Government - Armadale
- Department of Water
- SIA WA
- Consulting industry – Calibre
- Consulting industry – JDA
- Consulting industry – Emerge
- Consulting industry – Coterra

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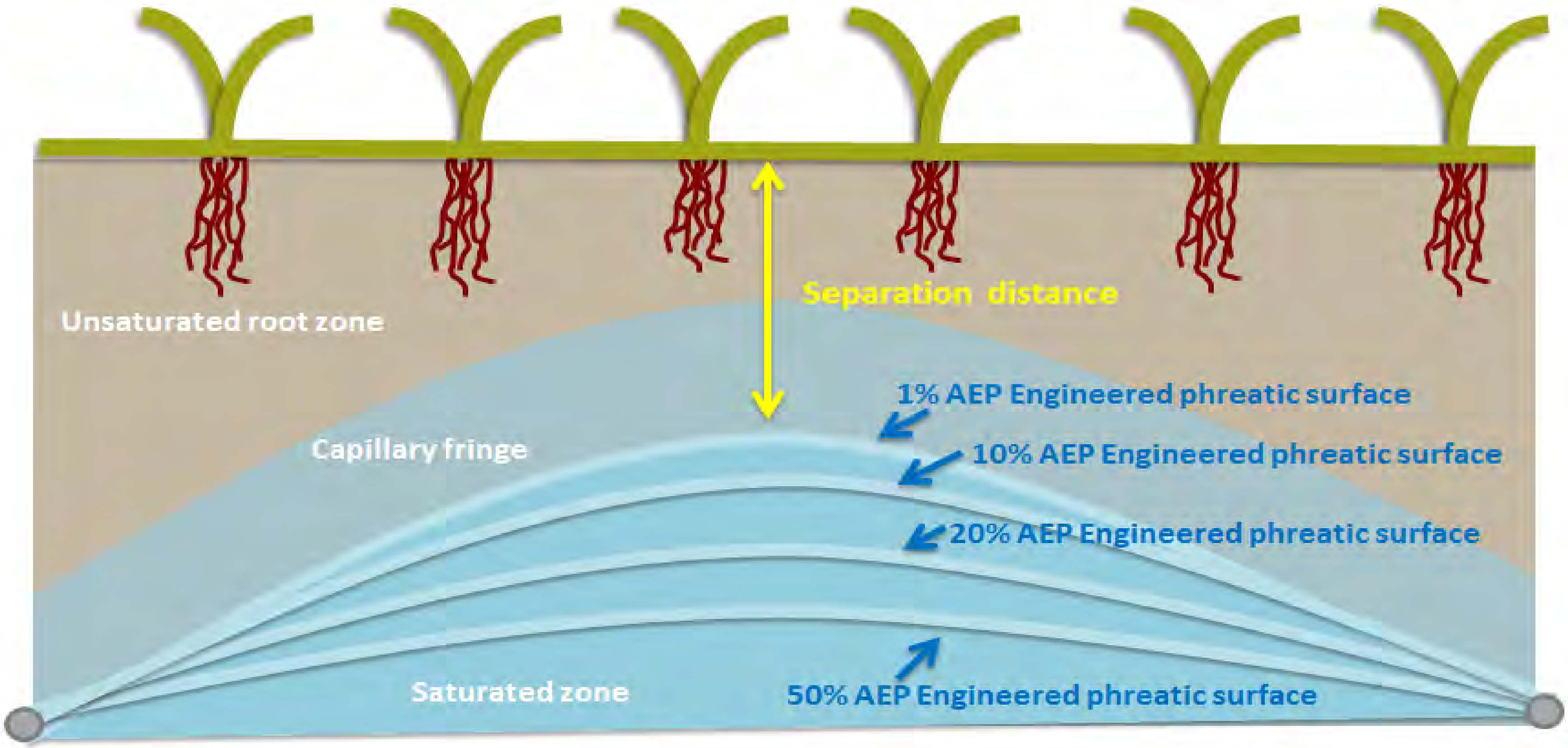
# Some terms

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# Methodology for modelling of groundwater drainage systems

Stages

- Model selection
- Definition of model inputs
- Required model outputs

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# Model selection

- Steady state calculations – typically spreadsheet based
- Dynamic 1-dimensional models – can also be spreadsheet based but a number of Graphic User Interface based models are commercially available
- Detailed 2- dimensional or 3-dimensional models

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# Steady state calculation

Assumes the magnitude and direction of flow is constant with time throughout the entire domain

$$Q L^2 = 8 Kb\ d\ (Di - Dd)\ (Dd - Dw) + 4\ Ka\ (Dd - Dw)^2$$

where:

Q = steady state drainage discharge rate (m/day)

Ka = hydraulic conductivity of the soil above drain level (m/day)

Kb = hydraulic conductivity of the soil below drain level (m/day)

Di = depth of the impermeable layer below drain level (m)

Dd = depth of the drains (m)

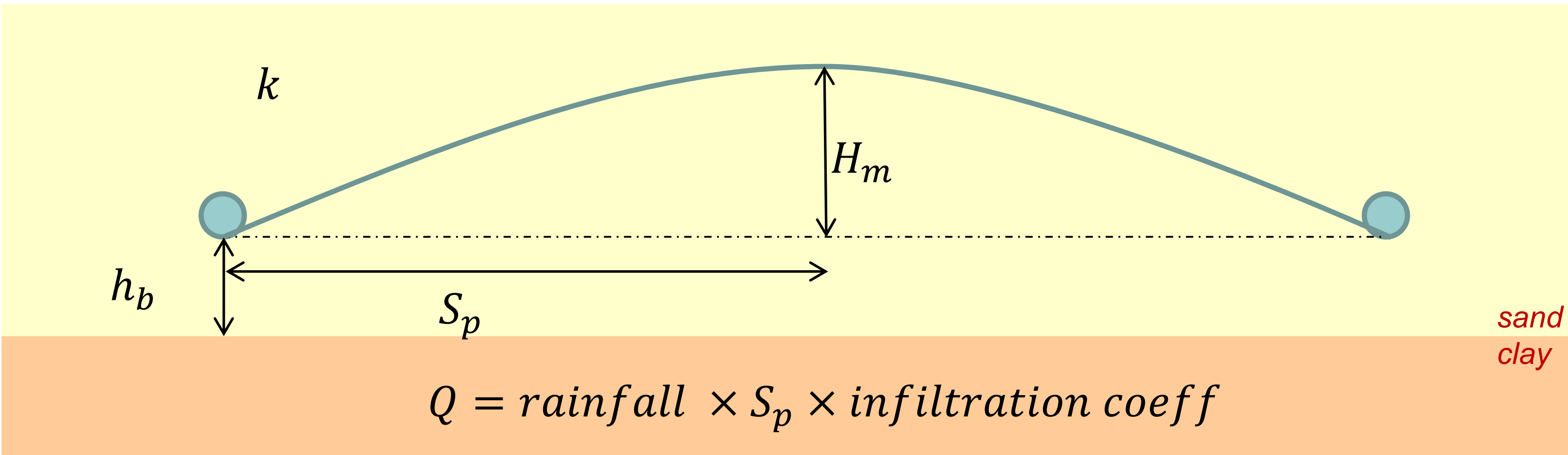
Dw = steady state depth of the watertable midway between the drains (m)

L = spacing between the drains (m)

d = equivalent depth, a function of L, (Di-Dd), and r

r = drain radius (m)

# Steady state calculation




- Apply a 50% AEP 72 hour rainfall event averaged over 24 hours to provide mm/day
- Significantly more conservative result than the 50% AEP result from a time series analysis
- $h_b$ provides greatest perturbation of results

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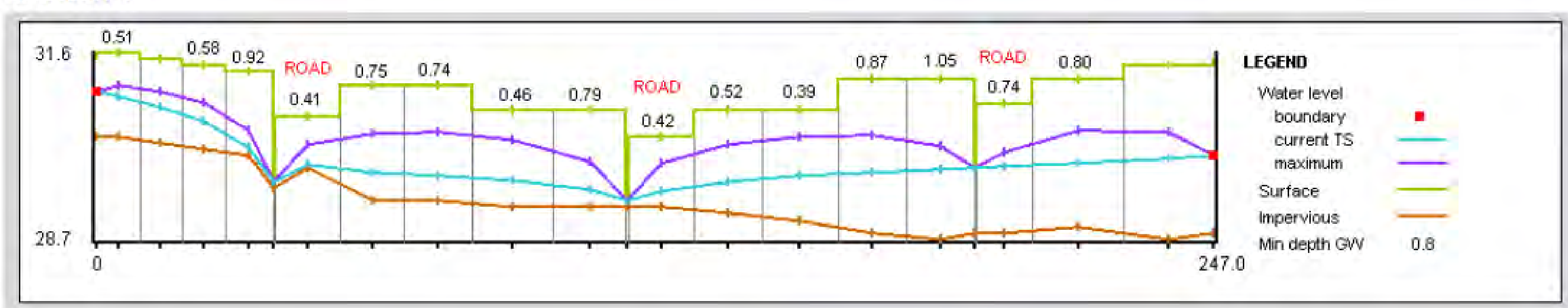
# Steady state calculation

- Gross over simplification of a dynamic system which should not be used in high risk areas
- Applied where the depth of fill proposed is driven by other factors such as sewerage, or geotechnical considerations

# Dynamic (1D) modelling

- Introduces spatial variability and a timestep - both the magnitude and direction of flow can change over time
- Allows for one or more 'typical' cross sections to be modelled to develop and test specific designs for different parts of a development
- Does not allow consideration of more complex groundwater interactions
- But appropriate for modelling of subsoils

**Section 1**




maximum subsoil discharge 41 L/hr (~4.0 L/m²/day)

# Detailed 2D/3D modelling

- Enables an assessment of an entire development area in a single model domain
- Can include consideration of complex horizontal and vertical boundary conditions (regional aquifers and ecological systems)
- Requires greater time and budget

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# Model inputs

- Boundary/initial conditions – defined by monitoring and/or larger scale modelling
- Rainfall – definition and selection of (current and future) climate scenarios
- Geotechnical and hydrological parameters – including relationship to other elements of design such as surface water management strategy

# Boundary/initial conditions

- Understand local conditions in context of regional
- Reasonable to assume a ‘free-discharge’ from a 1-dimensional modelled system, provided the invert level was suitably elevated in relation to the ultimate discharge point to provide a reasonable grade
- For detailed models - establish fixed or variable boundary conditions using regional or district scale modelling and/or monitoring

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# Rainfall

- Use 30 years of location-specific future climate rainfall data (from DoW) and develop a probability density function from which the required level of service can be selected
- Due to equal likelihood of these events occurring, use the “future median” scenario (as rainfall is not a sensitive parameter)

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# Geotechnical and hydrological parameters

- Hydraulic conductivity or permeability for each modelled layer
  - At LWMS - Imported fill ('yellow sand') – assume 5 m/day
- Specific yield or porosity for each modelled layer
  - At LWMS - imported fill ('yellow sand') – assume 0.2
- Net recharge
  - Includes consideration of relationship to runoff and evapotranspiration
  - Limited available research or measurement of recharge rates from urban development in WA
  - Consider scale of development and modelling

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# Recharge rates

- Propose a range – for **initial guidance** only
- Chosen recharge rate should be substantiated by modeller and supported by discussion and justification
- Consider rainfall runoff relationships of different events and implications for infiltration

| Land use | Net recharge range |
|---|---|
| **Lot scale 1D modelling:** | |
| Roof/hardstand (with soakage) | 80-90% |
| Roof/hardstand (with pipe connections) | 0-10% |
| Vegetation | 10-20% |
| Turf | 40-50% |
| **Street scale 1D or small scale 2D/3D modelling:** | |
| Lots (R10-30 with soakage) | 50-60% |
| Lots (R10-30 without soakage) | 10-20% |
| Lots (30 and above with soakage) | 70-90% |
| Lots (R30 and above without soakage) | 10-15% |
| Road reserves (with soakage) | 80-90% |
| Road reserves (without soakage) | 0-20% |
| Public open space | 10-50% |
| **District/regional scale 2D/3D modelling:** | |
| Urban residential (soakage areas) | 60-90% |
| Urban residential (non-soakage areas) | 10-20% |

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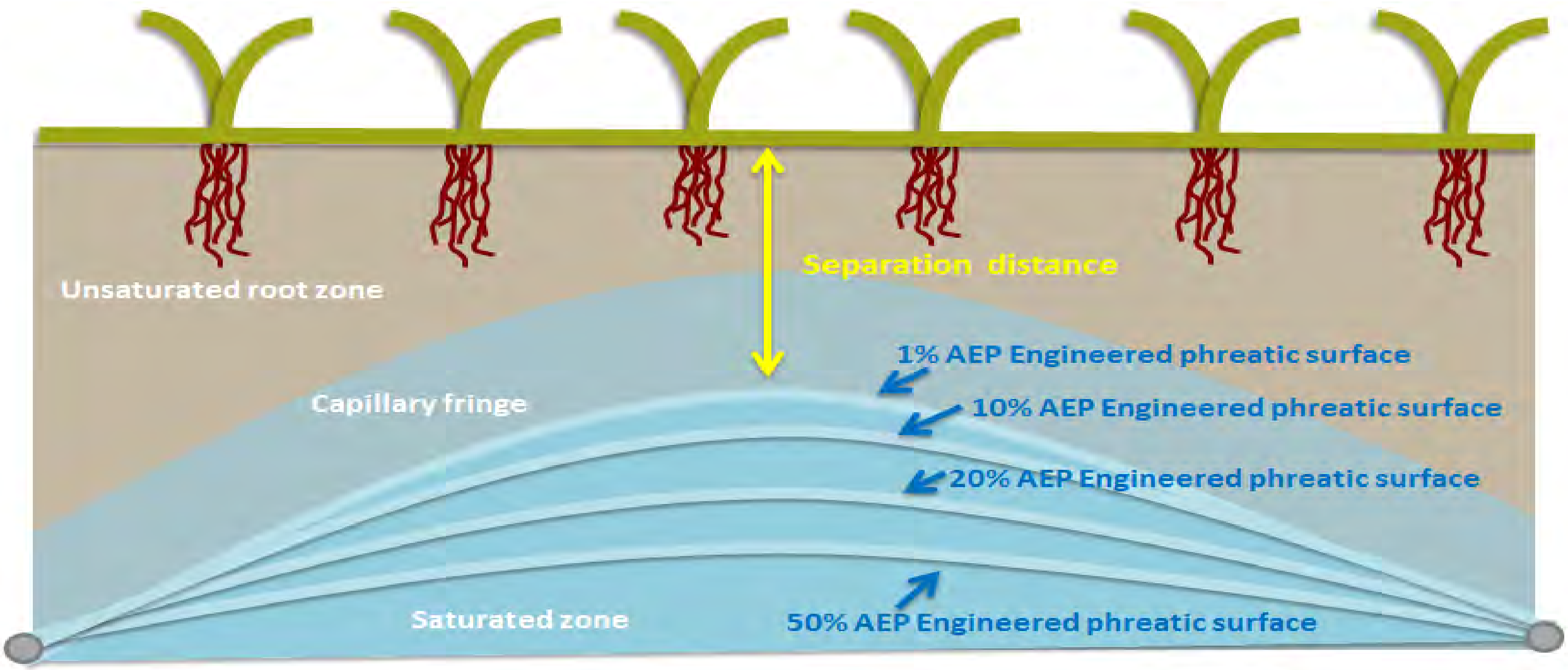
# Required model outputs

- 50% AEP phreatic crest level
- 20% AEP phreatic crest level
- 10% AEP phreatic crest level



# Criteria for separation distances

Draft Specification

# Separations technical working group

- Engineering - City of Gosnells
- Landscape - City of Armadale
- Planning - Department of Planning
- Planning - Office of Land and Housing Supply
- Sustainability - LandCorp
- Geotech - CMW Geosciences
- Hydrology - Essential Environmental

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# Separation criteria elements

- Buildings
- Roads
- Services
- Drainage infrastructure (infiltration systems and devices)
- Private spaces (gardens)
- Public open space – recreation, sport and nature

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# Buildings

Key findings and discussion

- Buildings can be affected by seepage of shallow groundwater into basements and/or rising damp through floor slabs and wall materials
- Commonly addressed through the use of vapour proof membranes and damp-proof coursing
- BCA specifies that *A building is to be constructed to provide resistance to moisture from the outside and moisture rising from the ground*

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# Buildings

**Deemed to comply criteria**

- Meet the requirements of Building Code of Australia Volume 2

**Performance measures**

- None required as this is addressed through the BCA

**Other recommended actions**

- industry and community education program
- additional damp-proofing and structural guidance
- WA specific requirements within BCA

# Roads and pavements

Key findings and discussion

- Austroads *Guide to road design* provides comprehensive guidance on the design and construction of roads under a range of conditions. It provides techniques for controlling moisture including subsurface drainage systems
- Main Roads WA *Supplement to Austroads* notes that: *“Before a subsurface drainage system is designed, investigations should be carried out to provide an understanding of the range of groundwater conditions present at the site, with the results included in the geotechnical investigation report.”*
- MRWA do not specify a standardised depth to groundwater or depth of subsurface drainage.
- IPWEA 2011 refers to both Austroads and MRWA for pavement design specifications and states that: *“The consulting engineer shall provide for pavement drainage where necessary to maintain a moisture free sub-grade and base course as determined by the site investigation.”*

# Roads and pavements

**Deemed to comply criteria**

- Meet the requirements of Module 8 of the IPWEA Local Government Guidelines for Subdivisional Development for materials selection and testing, design and construction, and Module 4 of the IPWEA Guidelines, relating to drainage design and construction, in accordance with the WAPC's model subdivision conditions schedule.

**Performance measures**

- None

**Other recommended actions**

- Local government education program
- additional testing and handover arrangement guidance

# Services

Key findings and discussion

- Small amounts of fill might be specified to provide for connection and cover requirements
- Services may be located below groundwater level through temporary dewatering during installation and maintenance
- The *Utility Providers Code of Practice* (Utility Providers Services Committee, 2015) makes no mention of groundwater in the document

# Services

**Deemed to comply criteria**

- None. Services may be located within the groundwater

**Performance measures**

- None required

**Other recommended actions**

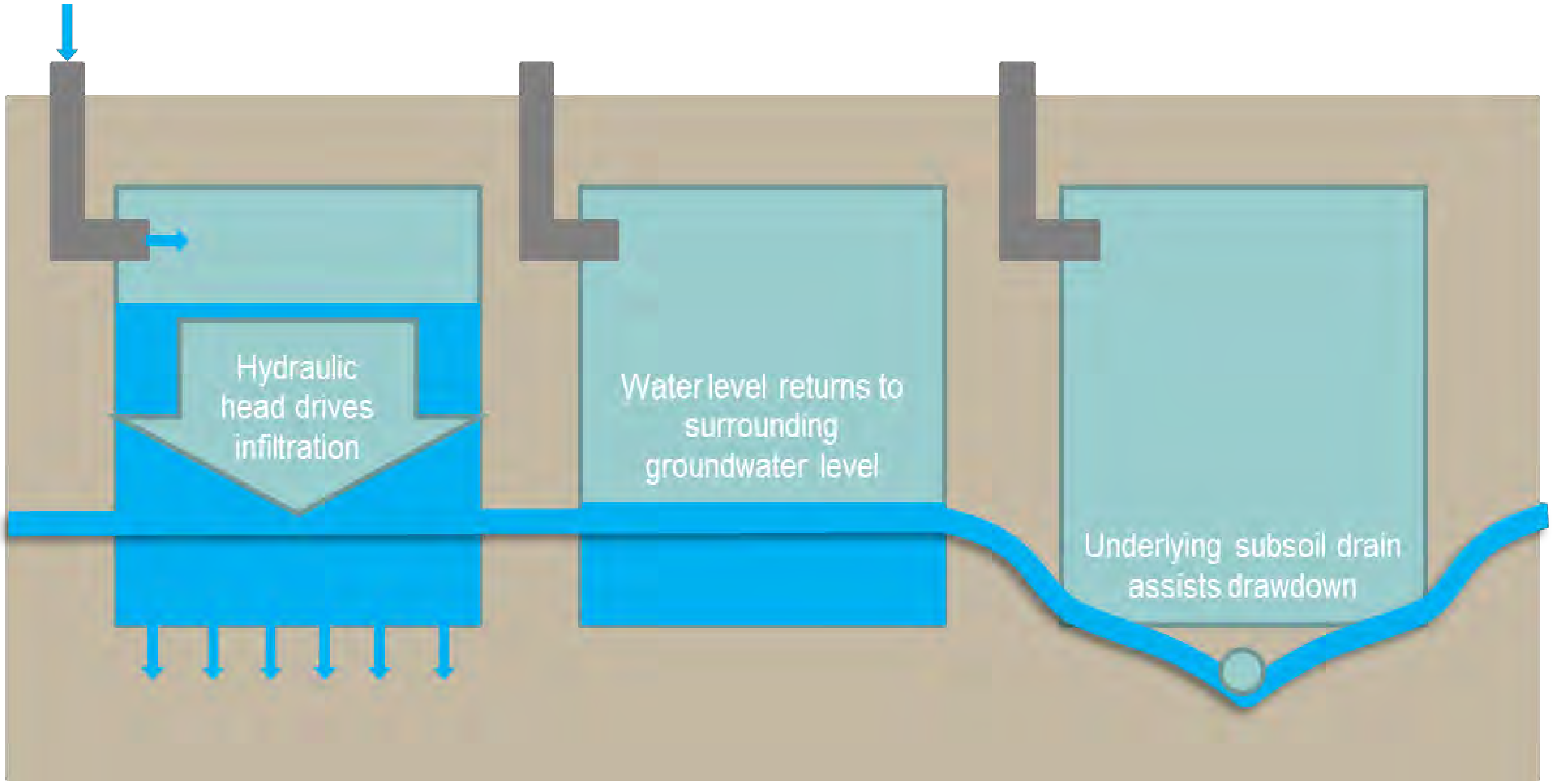
- improve understanding of dewatering protocols and alternative installation methodologies

# Drainage infrastructure (infiltration systems and devices)

Key findings and discussion

- Infiltration systems will continue to perform hydraulically with a wet or inundated base
- Surface infiltration systems and unlined biofiltration systems can be affected by lost volumetric capacity due to inundation; reduced infiltration rates; vegetation/turf death due to extended inundation and/or waterlogging periods; and mosquito breeding due to extended inundation periods.
- Vegetated infiltration systems can be designed to tolerate to the presence of shallow groundwater
- There is no specification of on-lot detention or retention requirement in either the BCA or the Plumbing Code

# Soakwell performance in shallow groundwater

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# Drainage infrastructure (infiltration systems and devices)

**Deemed to comply criteria**

- Underground infiltration systems – 0mm from the 50% AEP phreatic surface
- Surface infiltration systems (vegetated) – 300mm from the 50% AEP phreatic surface
- Surface infiltration systems (duel function turf) – default to recreational POS standards

**Performance measures**

- Underground infiltration systems – demonstration of acceptable volumetric capacity when groundwater is elevated above base of system and that the groundwater recedes below the invert of the system during mosquito breeding seasons (grated or partially open systems)
- Surface infiltration systems – None

**Other recommended actions**

- local government education program to improve understanding and implementation of lot-based drainage requirements

- Something to consider… do you really need soakwells?

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# Private spaces (gardens)

Key findings and discussion

- Commonly applied 1.2 m or 1.5 m is generally an extension of the criteria applied to ‘developments’
- City of Armadale, 0.5 m during a ‘wet’ year (approximately 10% AEP annual rainfall)
- Healthy grass needs some separation
- Should separation be specified on the assumption that a back-garden requires grass?

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# Private spaces (gardens)

**Deemed to comply criteria**

- Residential lots > 800 m2 – No criteria
- Residential lots 400 m2 to 800 m2 – 300mm of coarse sand applied to anticipated garden areas in the rear of lots above the 50% AEP phreatic surface
- Residential lots <400 m2 – 150mm of coarse sand applied to anticipated garden areas in the rear of lots above the 50% AEP phreatic surface

- **Performance measures**
- Residential lots > 800 m2 - 0mm from the 50% AEP groundwater level or phreatic crest level, where it has been demonstrated that lot purchasers have been provided with sufficient educational material and landscape design advice to facilitate a suitably informed decision to purchase
- Residential lots > 800 m2 – none

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# Raised lawn examples

**Other recommended actions**

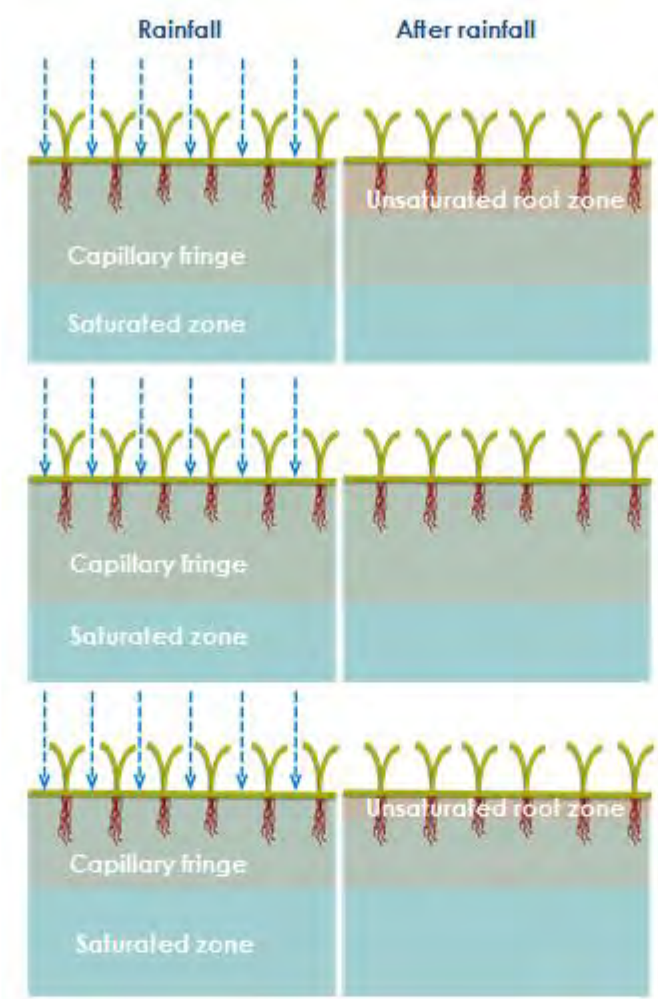
- industry and community education program to improve understanding and adoption of landscaping strategies that are appropriate to various possible site conditions

# Public open spaces

Key findings and discussion

- 1.2 or 1.5 m
- Sport, recreation & nature
- Local, neighbourhood, district, regional
- Need an unsaturated zone for roots above the capillary fringe
- Concerns about turf and vegetation health and long term viability; playing surface functionality and hardiness; and recreation space accessibility and amenity
- Manage squelchiness
- City of Armadale
  - 500 mm to passive open spaces at the furthest point from subsoil drains;
  - 750 mm to active (turfed) open spaces at the furthest point from subsoil drains; and
  - 900 mm to oval's at the furthest point from subsoil drains

# Public open space – recreation, sport and nature




Example a: Depth to groundwater > thickness of root zone + capillary fringe and soil is well-drained. ✓

Root zone is saturated during rainfall but rapidly returns to unsaturated state.

Example b: Depth to groundwater > thickness of root zone + capillary fringe but soil is poorly drained. ✗

Root zone is saturated during rainfall and for an extended duration after rainfall.

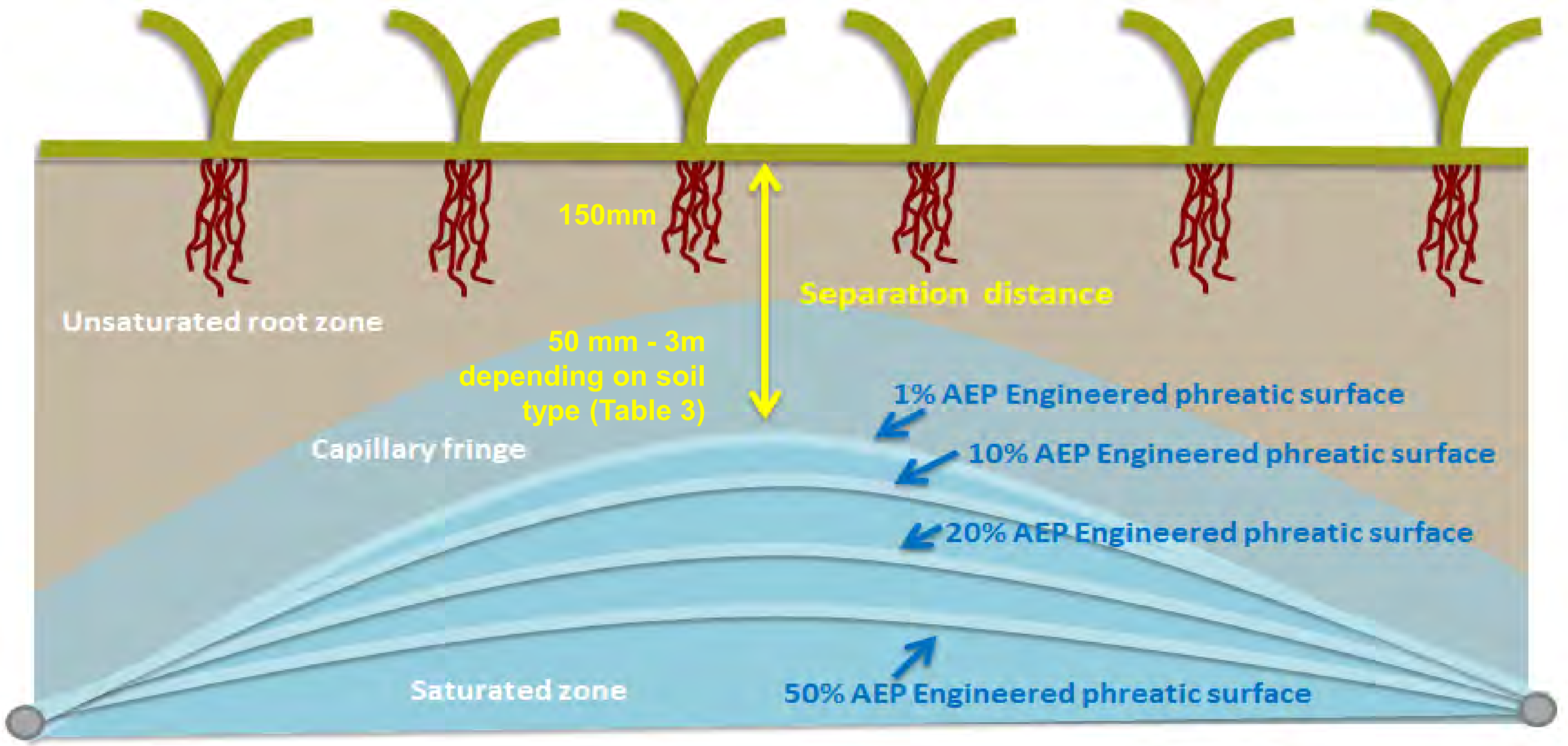
Example c: Depth to groundwater < thickness of root zone + capillary fringe and soil is well drained: ✗

Root zone is fully saturated during rainfall and partially saturated continuously.

# Public open spaces

Deemed to comply criteria

- Separation distance for soil type plus level of service surface height



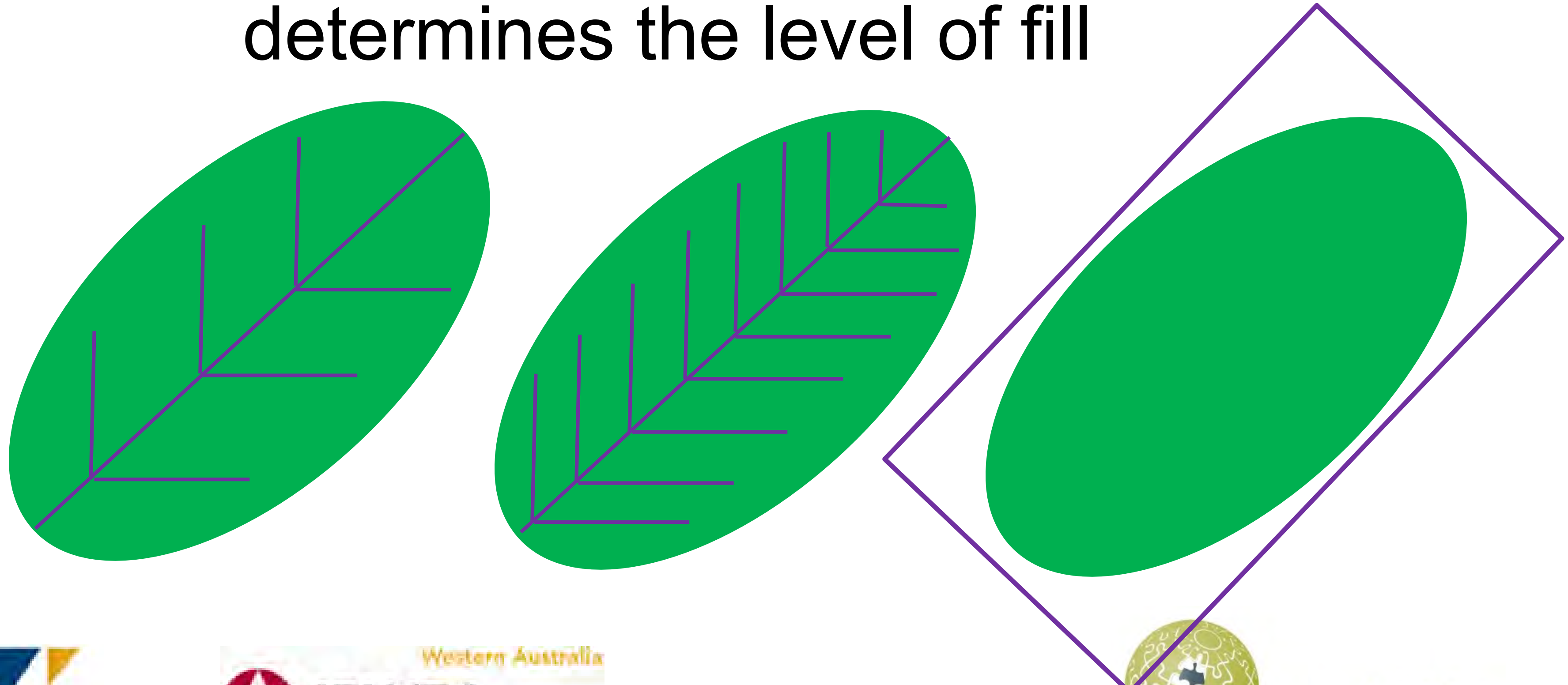
# Public open space

- Multi-function areas (drainage and recreation): Where turf is proposed as a landscape treatment, the approach appropriate to its public open space function and catchment is to be applied.
- Proposed level of service

| | Local | Neighbourhood | District | Regional |
|---|---|---|---|---|
| **Nature** | EWRs | EWRs | EWRs | EWRs |
| **Recreation** | 50% AEP | 50% AEP | 20% AEP | 20% AEP |
| **Sport** | 50% AEP | 20% AEP | 20% AEP | 10% AEP |

# Public open space

- The design process actually determines the level of fill



# Public open space

**Performance measure**

- Turf for recreation or sports use should be planted with a well-drained layer of underlying soil no less than 300 mm deep to provide ideal growing conditions and surface performance.
- The thickness of the capillary fringe will not exceed around half of the thickness of the soil layer
- Undertake site specific testing to provide a more accurate assessment of capillary fringe thickness (replace default separations)

**Other recommended action**

- local government and industry education program for landscaping design including turf management

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# Case studies

| Case study location (local government area) | Max depth of fill | | |
|---|---|---|---|
| | previous methodology (1-dimensional) & locally specified criteria | proposed methodology & criteria (1-dimensional) | proposed methodology & criteria (steady state) |
| **Bletchley Park (City of Gosnells)** | 2.0m to provide 1.2 m from winter peak groundwater to finished lot levels | 1.0 m to provide 0 m to base of 0.6 m deep soakwell<br>0.6 m to provide 0 m to the backyard | 1.7m to provide 0 m to the backyard |
| **Byford (Serpentine-Jarrahdale Shire)** | 1.6m to provide 0.8 m separation from phreatic line to finished lot level | 1.2 m to provide 0 m to base of 0.6 m deep soakwell<br>0.7 m to provide 0 m to the backyard | 2.7 m to provide 0 m to the backyard |
| **Pinjarra Shire of Murray)** | 0.9 m to provide 0.5 m from winter peak groundwater to finished lot levels | 0.9 m to provide 0 m to base of 0.6 m deep soakwell<br>0.2 m to provide 0 m to the backyard | 1.2 m to provide 0 m to the backyard |
| **Wungong (City of Armadale)** | 1.8 m to provide 0.3 m to base of 0.6 m deep soakwell<br>1.5 m to provide 0.5 m to the backyard | 1.3 m to provide 0 m to base of 0.6 m deep soakwell<br>0.9 m to provide 0 m to the backyard | 2.0 m to provide 0 m to the backyard |

# The trial

# The trial

- Project by project basis
  - agreed on commencement of the project by both parties (developer and local government)
- Used to further refine the criteria to ensure that sustainable outcomes are achieved
- trial period extend until next review of IPWEA guidelines - expected in two years' time
- On-line feedback form - hosted by Department of Planning

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# Take home messages

- ✋ Won't prevent bad design
- ✋ Risks may be higher in uncontrolled systems
- ✋ Amenity is important – in back gardens and in parks
- ☑ Standardised way of talking about groundwater
- ☑ Engage early
- ☑ Encourages Innovation in land development

# Thanks to:

# Questions?

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