DETERMINATION REVIEW AND IMPLEMENTATION OF THE RESERVE IN THE OLIFANTS/LETABA SYSTEM

WETLAND TRAINING WORKSHOP – SESSION 1

Presented by:

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water & sanitation
Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

Wetland
Consulting Services (Pty.) Ltd.
Specialist wetland and riparian consultants

Golder Associates

What are YOUR expectations?

- What would you like us to cover regarding wetlands?

OUR expectations:

- Participate;
- Discuss; and
- Ask Questions

CONTENT – WETLAND BASICS

What are wetlands?

- *A working definition (NWA and practical)*
- *Examples*
- *Wetting regimes in wetlands*

How to identify and delineate wetlands

- *Mapping signature*
- *Landscape characteristics*
- *Soils*
- *Vegetation*

Wetland types

- *Hydrogeomorphic (HGM) classification*
- *More detailed classification (SANBI,2009, Ollis et al., 2013)*
- *Topographic setting simplified*
- *Various wetland types*

CONTENTS …

Why do we need to protect wetlands

- *Ecosystem services provided by wetlands:*
  - *Flood attenuation*
  - *Water quality improvement*
  - *Stream flow augmentation*
  - *Erosion control*
  - *Biodiversity support*
  - *Water provision*
  - *Grazing*

Hydrological drivers

- *Understanding wetlands in the context of the hydrology of the surrounding landscape:*
  - *Water in the landscape – the water cycle and wetlands; and*
  - *Conceptual water balance models for wetlands*

WHAT ARE WETLANDS?

A WORKING DEFINITION

National Water Act (Act 36 of 1998):

A wetland is land which is transitional between terrestrial and aquatic systems where the water table is at or near the surface, or the land is periodically covered with shallow water, and which in normal circumstances supports or would support vegetation typically adapted to life in saturated soil.

- *Wetlands reflect the **surface** or **near surface** expression of water that is either **static or moving** through the landscape.*
- *Water may be **rain water**, **groundwater** including perched groundwater, **surface water** or a **combination** of all the above.*
- *The water may be **temporary**, **seasonal** or **permanent** but must be present for long enough to:*
  - *Create **reducing conditions** in the **soil** profile; and*
  - ***Influence** the **plant communities** associated with these conditions.*
- *For an area to be "technically" defined as a wetland, the "edge/boundary" of the wetland is where these reducing conditions in the soil are detected within 500mm of the surface, a depth considered necessary to affect plants.*

EXAMPLES






EXAMPLES …

WETTING REGIME

- *Wetting regime refers to the wetness of the wetland and how this changes over time. It is also used to describe the wetness of the different zones within a wetland how this changes over time;*

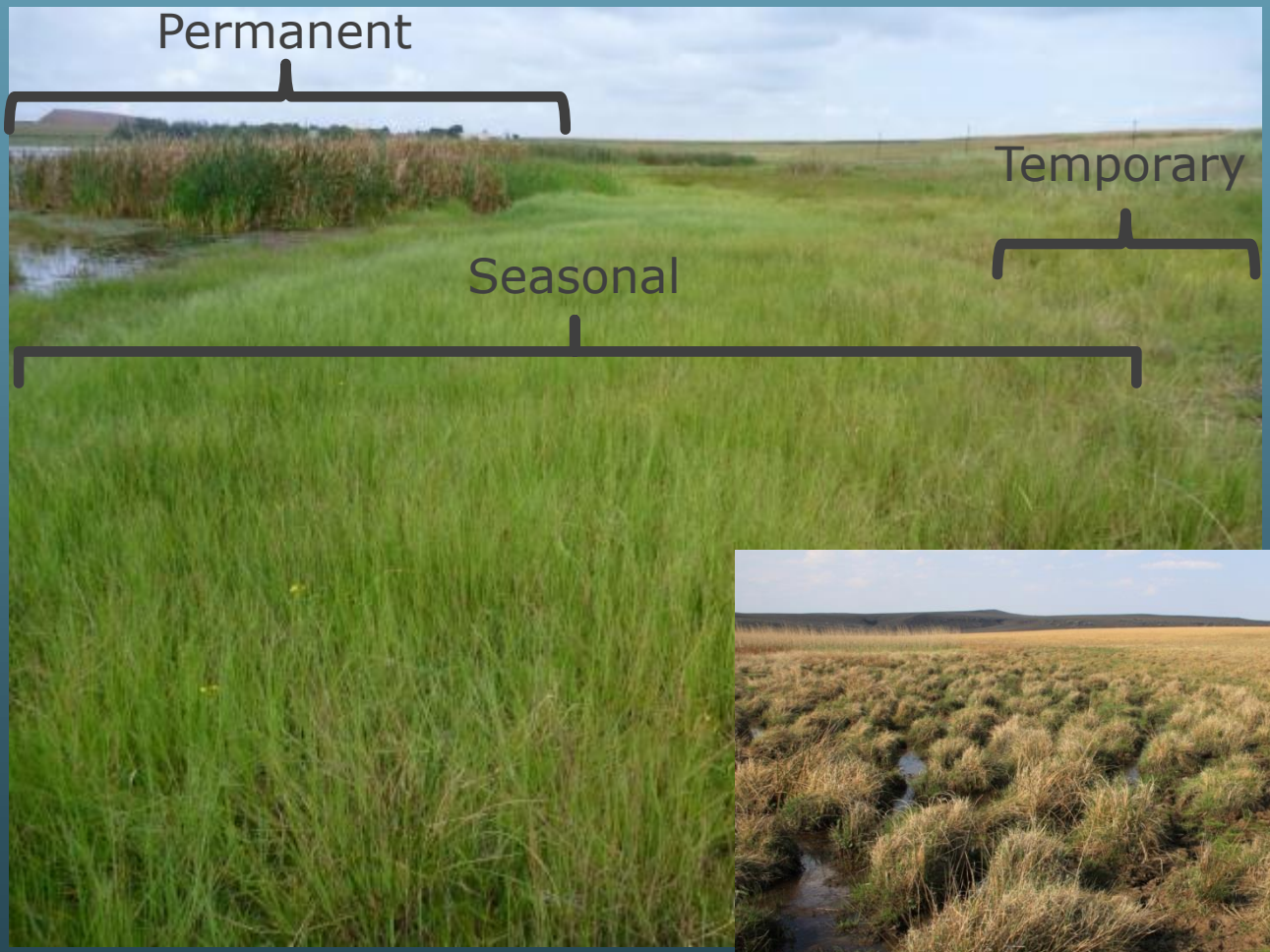
- *Generally three main wetting regimes are considered, namely:*
  - ***Permanent*** *(wet throughout the year all years)*
    - *Peatlands, for example, are always permanently wet*
  - ***Seasonal*** *(wet throughout most months of the rainy season during most years but generally dry during the dry season); and*
  - ***Temporary*** *(wet for short periods during the rainy season during most years but mostly dry for the remainder of the year). This includes wetlands that are inundated or saturated (intermittently saturated) for only a few weeks per year.*

- *Wetting regime refers to both inundation (surface water) and saturation (sub-surface water).*

WETTING REGIME …

Hydrology, soils and vegetation are used as indicators

Vegetation zonation resulting from the wetting regime



WETTING REGIME …

Not always as simple as above. In the **semi-arid regions** of SA for example, wetlands may only receive water every few years. Confining the wetting regime to certain categories **may not be as easy in such cases** where wetting may only happen say once or twice every few years due to the **variable hydrological regime** in these areas. Vegetation zonation may still develop in response to the wetting regime but describing the regime may require some more thought.

WETTING REGIME …

Seasonal and annual variability

Fixed point photographs of a section of the Nyl River floodplain showing visible changes in vegetation response to variability in flow

HOW TO IDENTIFY AND DELINEATE WETLANDS

Need to consider the following:

- ***Mapping signature****;*
- ***Landscape characteristics;***
- ***Soils*** *- wetness and form; and*
- ***Vegetation*** *- characteristics and indicator species*

- *Delineating wetlands*

  Guideline for wetland delineation – DWAF, 2005

MAPPING SIGNATURE

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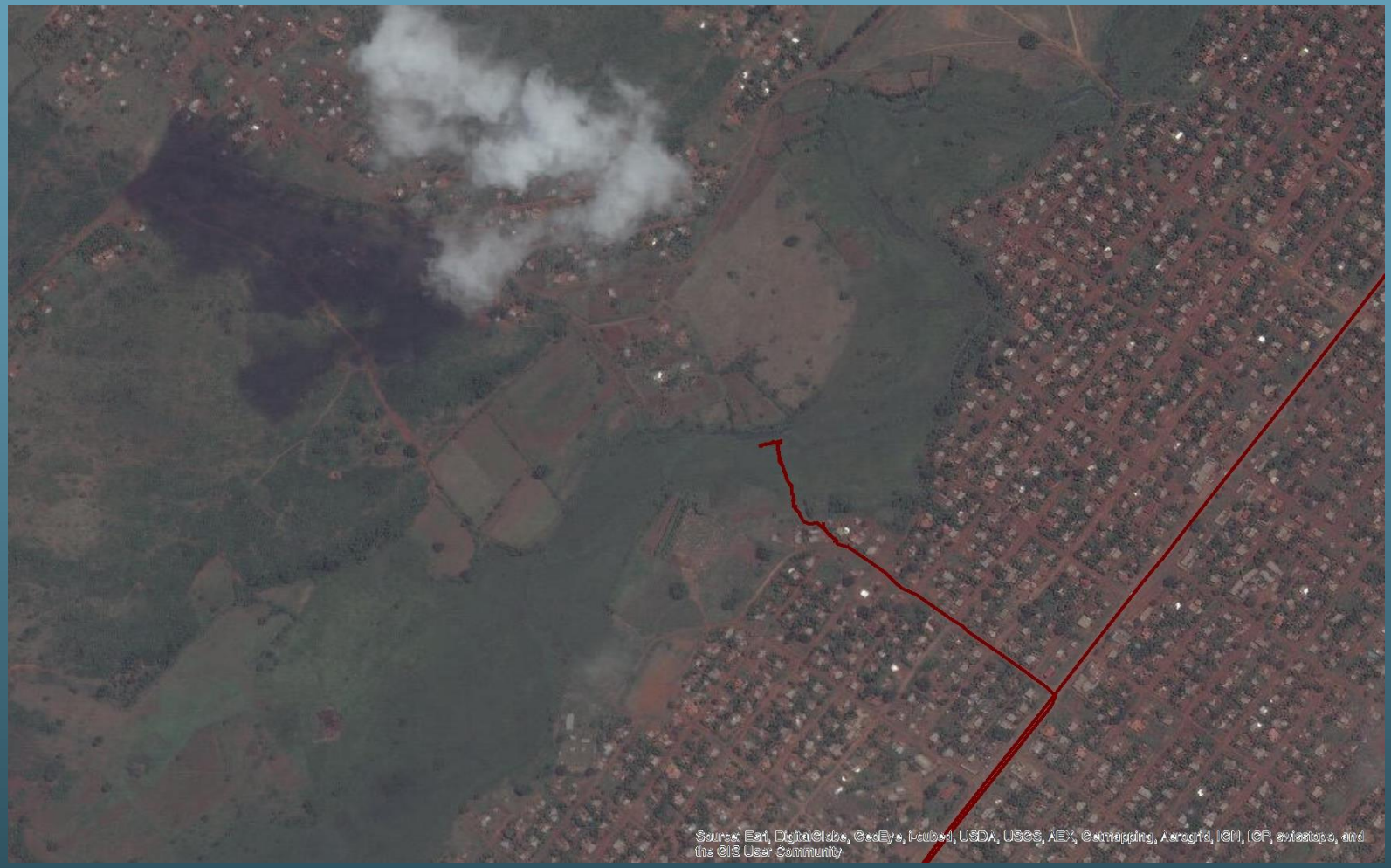
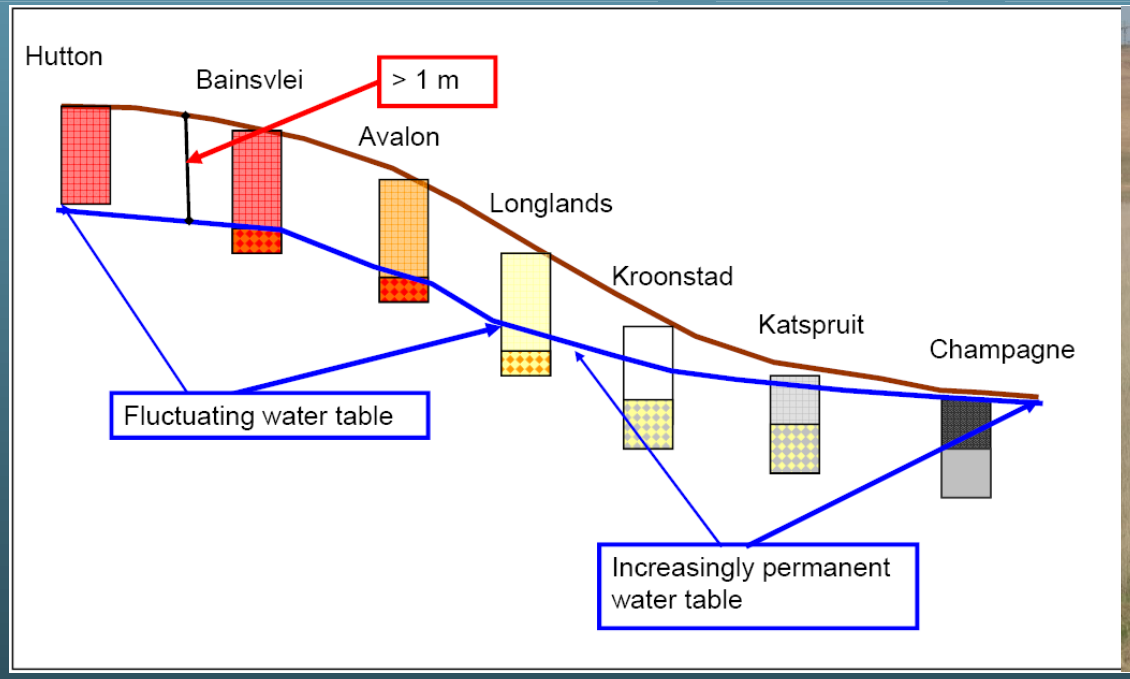


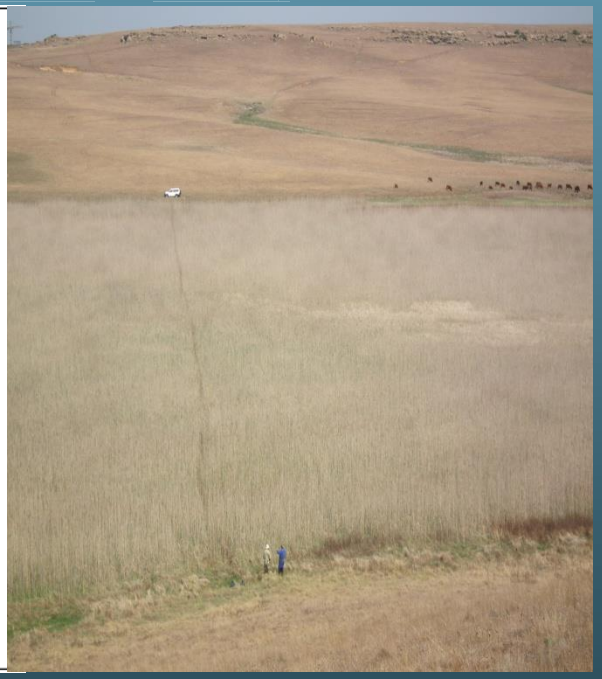
MAPPING SIGNATURE

MAPPING SIGNATURE

LANDSCAPE CHARACTERISTICS

Besides visible signatures on imagery, general landscape characteristics such as **slope**, **topographic setting**, **landform**, and **aspect** should all be considered when identifying wetlands. **Drainage patterns** and the **extent and distribution of local catchment areas** should also be used. The **landscape catena** together with the **soils** and **underlying geology** is also important in assisting with wetland delineation and an **understanding of the processes** resulting in the **formation of wetlands.**





SOILS

Image courtesy of Johan van der Waals (2010)

SOILS …

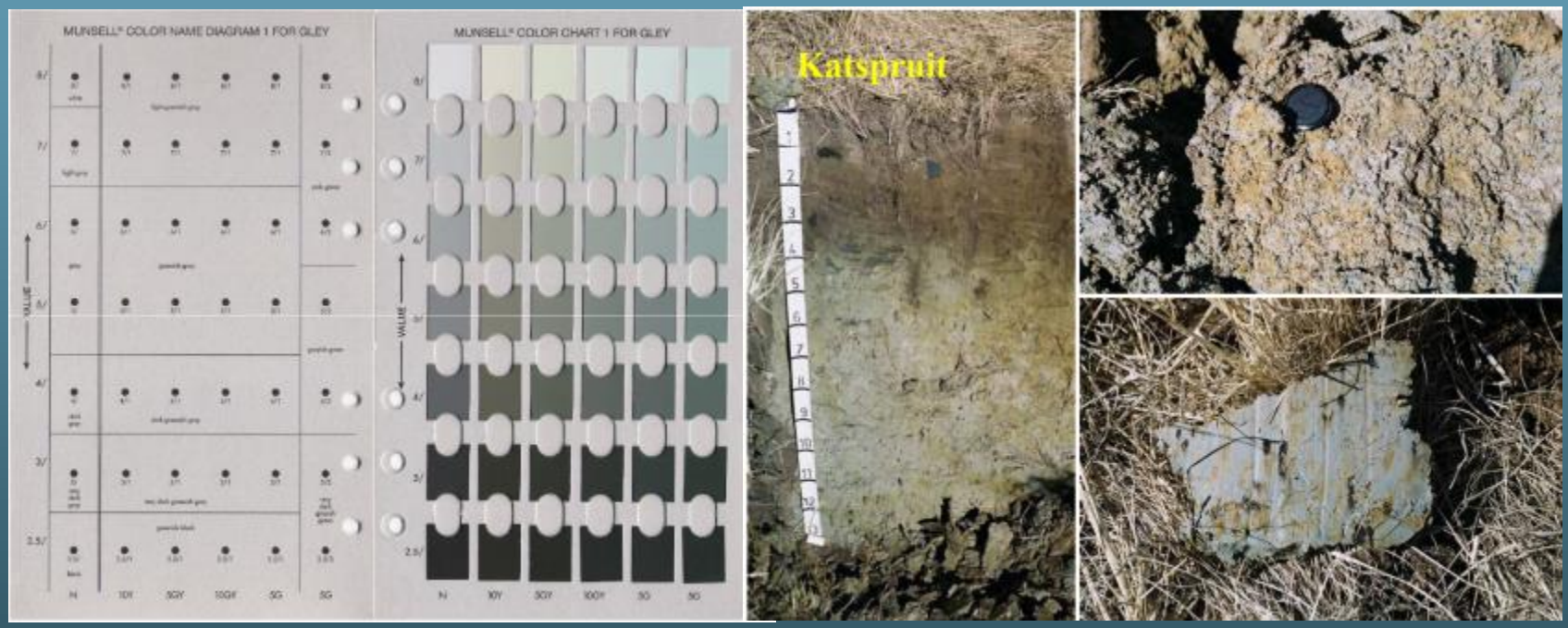


Image courtesy of Johan van der Waals (2010)

SOILS …

Use soil augering and in some cases specialised techniques.

SOILS …

VEGETATION

Plants that occur in wetlands require the ability to cope with the **adverse conditions** associated with **wetting and drying** and have **specialized life histories** that enable them to do this

Most true hydrophytes:

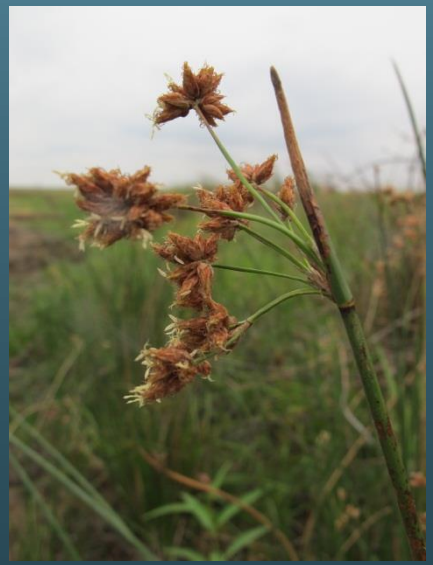
- **Grow rapidly**
- Can produce **specialized growth forms** (stolons, bladders, floating leaves, photosynthetic stems);
- Are able to maintain an adequate **oxygen supply to the roots** via specialised vascular structures;
- Develop and maintain **structural rigidity;**
- Are **competitively superior;**
- Can **store carbohydrates** and some have developed **alternative metabolic pathways;**
- Are generally able to rapidly **consolidate the occupation of available space and colonise new space; and**
- Many grow **vegetatively** and can produce **desiccation resistant propagules.**

VEGETATION …

Indicator plant species





WETLAND TYPES

TYPING – GENERALLY REFERRED TO AS CLASSIFICATION

A number of classification systems have been developed to describe the different types of wetlands

A particularly useful classification system is the **H**ydro**G**eo**M**orphic Classification (**HGM**) system originally proposed by Brinson, 1993, modified by Marneweck and Batchelor, 2002 primarily for use in the Upper Olifants River Catchment, and again by Kotze *et al*., 2007 for use nationally in South Africa.

Classifies wetlands according to their form (geomorphological characteristics) and the way in which water moves **in**, **through** and **out** of the wetland system (hydrological characteristics).

This approach has been further modified and developed for South Africa by SANBI, 2009 and then again by Ollis *et a*l., 2013.

HGM TYPES FROM WET- ECOSERVICES (Kotze, Marneweck, Batchelor, Lindley and Collins, 2007)

Uses a modified HGM classification system

Hydro-geomorphic types	Description
Floodplain 	Valley bottom, Stream channel, Gently sloped Alluvial, floodplain features (e.g. oxbow)
Valley bottom with a channel 	Valley bottom, stream channel, Alluvial, Water inputs from main channel (when channel banks overspill) and from adjacent slopes.
Valley bottom without a channel 	Valley bottom, usu gently sloped, No clearly defined channel, Alluvial
Hillslope seepage feeding a watercourse 	Hillslope, colluvial Inputs mainly subsurface Outflow is via a channel
Hillslope seepage not feeding a watercourse 	Hillslope, colluvial Inputs mainly subsurface Outflow is limited
Depression (includes Pans) 	Basin shaped, An outlet is usually absent.

CLASSIFICATION BASED ON THE NATIONAL WETLAND CLASSIFICATION SYSTEM (NWCS), (SANBI, 2009)

Includes **Marine**, **Estuarine** and **Inland** wetland systems

Comprehensive classification using levels as follows:

- Connectivity to the open ocean (Level 1)
  - Marine, Estuarine or Inland
- Regional setting (Level 2)
  - Bioregion, Biogeographic zone, Eco-region
- Sub-system (Level 3)
  - Periodicity of connection, landscape unit
- Classification (Level 4)
  - HGM units 4A, 4B and 4C
- Wetting regime (Level 5)
  - Tidal regime, Surface water hydrological regime, Sub-surface water hydrological regime, Depth class category
- Characteristics (Level 6)
  - Geology, Natural vs artificial, Vegetation cover type, Vegetation form, Vegetation status, Plant species list, Substratum category, Substratum type, Salinity, Acidity/Alkalinity

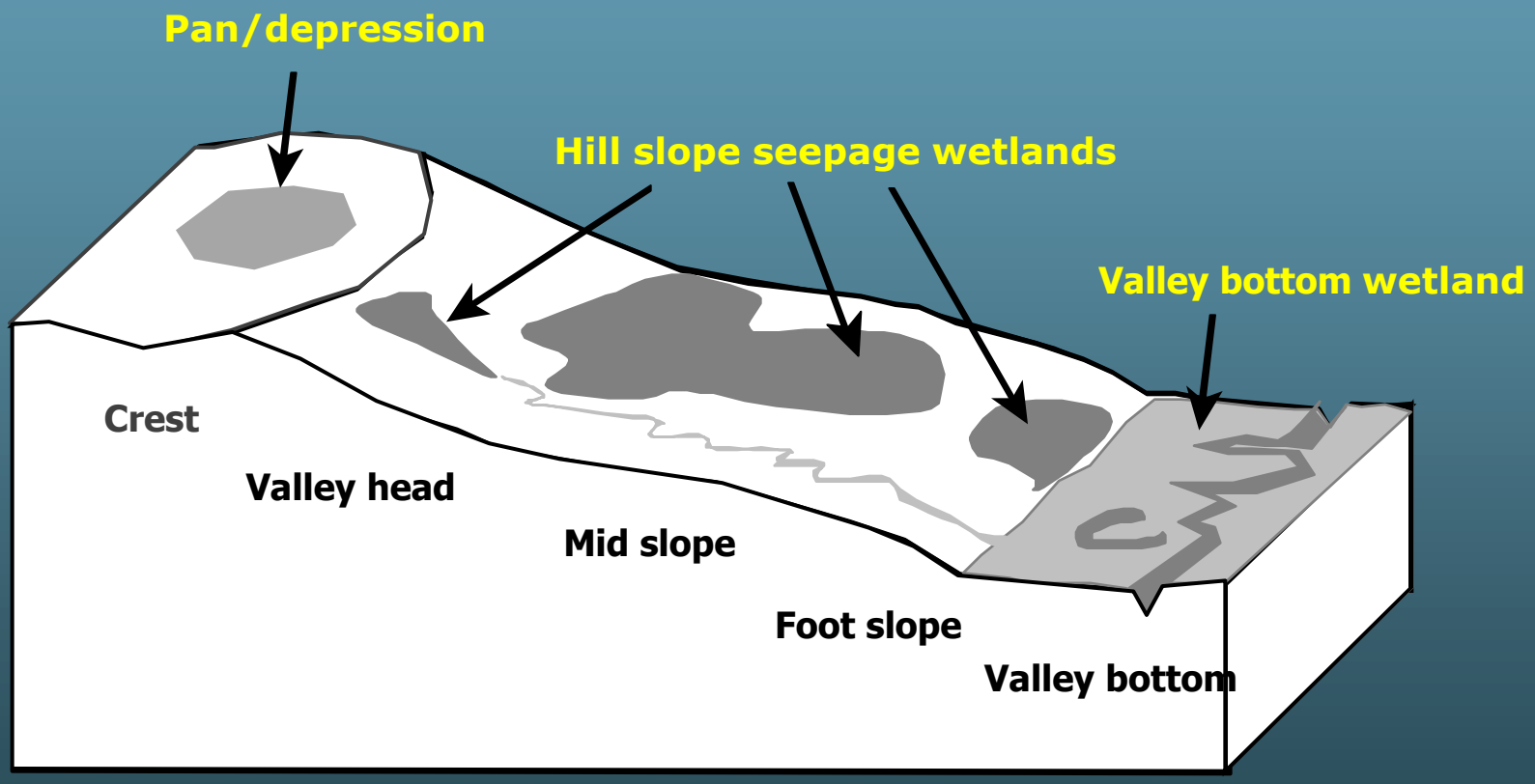
‘THE CLASSIFICATION SYSTEM’ (Ollis, Snaddon, Job and Mbona, 2013)

Focuses on **Inland** wetland systems and other aquatic ecosystems in SA. Essentially starts at Level 2 and then has different levels compared to the NWCS:

- Regional setting (Level 2)
  - DWS Ecoregions, NFEPA WetVeg Groups, Other spatial frameworks
- Landscape Setting (Level 3)
  - Valley floor, Slope, Plain, Benc (hilltop, saddle, shelf)
- Hydrogeomorphic Unit (Level 4)
  - Floodplain wetlands, Valley-bottom wetlands (Channelled valley-bottom wetlands, Unchannelled valley-bottom wetlands) Depressions (Outflow and inflow drainage characteristics), Seeps (Outflow drainage characteristics), Wetland flats
- Hydrological Regime (Level 5)
  - Hydroperiod categories (Period of inundation, Period of saturation, Inundation depth class, Rating of the hydroperiod),
- Descriptors (Level 6)
  - Natural vs artificial, Salinity, pH, Substratum type (rocky substrata, mineral soils, organic soil, salt crust, other substratum types) Vegetation cover, (vegetation form, vegetation status), Geology, Rating of Inland System descriptors

TOPOGRAPHIC SETTING SIMPLIFIED

Typical topographic setting



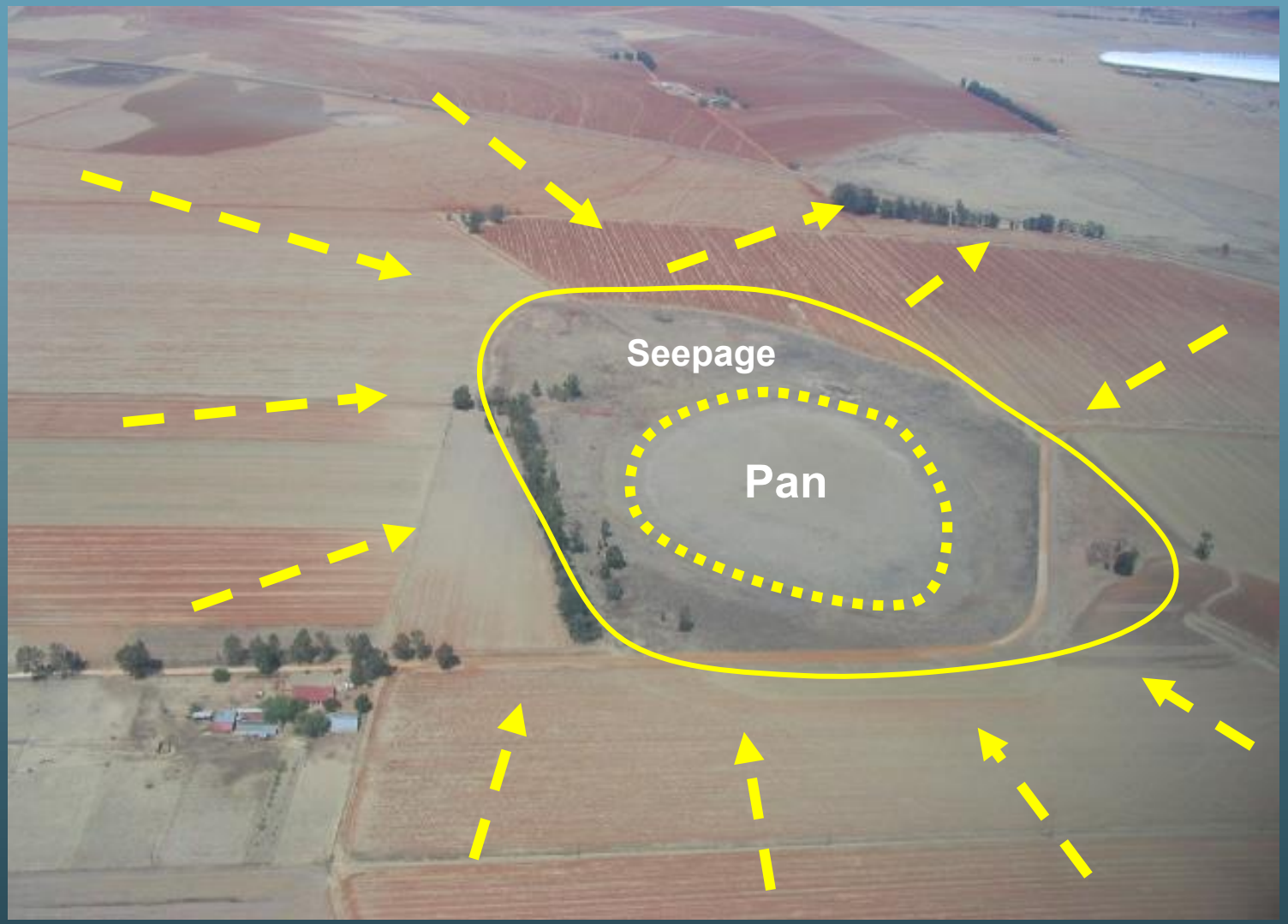
DEPRESSIONS / PANS

*Depressions are generally linked to **deflational processes** and **wind erosion***

- *Pans may be **fresh**, **saline**, **temporary** or **permanent***
- *In cases where they are **permanent** they are generally linked to **groundwater***

TYPICAL PAN

TYPICAL PAN …



DIFFERENT TYPES OF PANS

DIFFERENT TYPES OF PANS

DIFFERENT TYPES OF PANS / DEPRESSIONS …

DIFFERENT TYPES OF PANS / DEPRESSIONS …

HILLSLOPE SEEPAGE WETLANDS

HILLSLOPE SEEPAGE WETLANDS …

HILLSLOPE SEEPAGE WETLANDS …

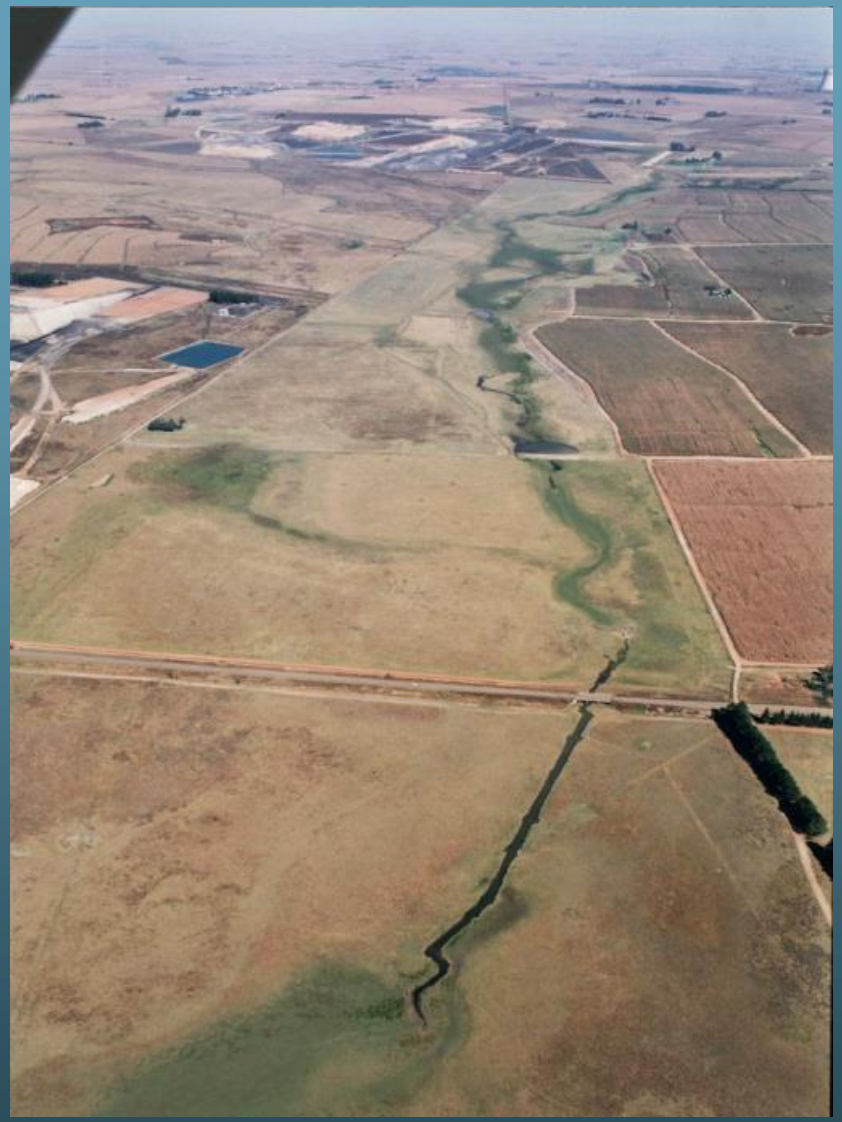
HILLSLOPE SEEPAGE WETLANDS …

UNCHANNELLED VALLEY-BOTTOM WETLANDS

UNCHANNELLED VALLEY-BOTTOM WETLANDS

CHANNELLED VALLEY-BOTTOM WETLANDS

VALLEY-BOTTOM WETLANDS …



FLOODPLAIN WETLANDS

FLOODPLAIN WETLANDS …

WETLAND TYPES …

Floodplain

Chanelled valley bottom

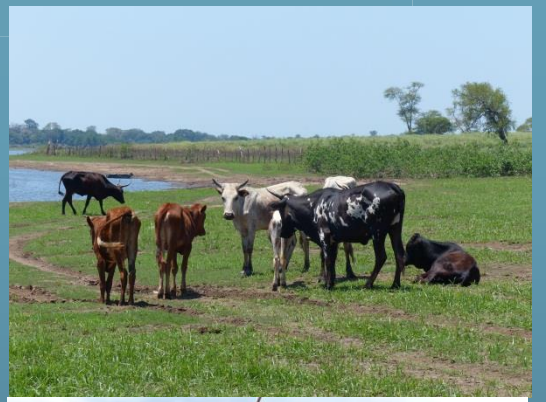
Unchanelled valley bottom

Hillslope seepage

WHY DO WE NEED TO PROTECT WETLANDS?

Ecosystem services provided by wetlands:

- Flood attenuation;
- Water quality improvement;
- Stream flow augmentation;
- Erosion control;
- Biodiversity support;
- Water provision;
- Provision of materials and direct resources;
- Groundwater recharge; and
- Grazing.



HYDROLOGICAL FUNCTIONS LIKELY TO BE PERFORMED BY A WETLAND ACCORDING TO HGM TYPE

WETLAND HYDRO-GEOMORPHIC TYPE	Source of water maintaining the wetland[1]		HYDROLOGICAL FUNCTIONS POTENTIALLY PERFORMED BY THE WETLAND								
			Flood attenuation		Stream flow augmentation		Erosion control	Potential for water quality enhancement			
	Surface	Sub-surface	Early wet season	Late wet season	Early wet season	Late wet season		Sediment trapping	Phosphate removal	Nitrates	Toxicants
1. Floodplain	*	o	++	+	o	o	++	++	++	+	+
2. Valley bottom - channelled	*	*	+	o	o	o	++	+	+	+	+
3. Valley bottom - unchannelled	*	*	+	+	+?	+?	++	+	+	+	++
4. Hill slope seepage with a stream channel	o	*	+	o	+	+	++	o	o	++	++
5. Hill slope seepage without a stream channel	o	*	+	o	o	o	++	o	o	++	++
6. Pan/ Depression	*	*	+	+	o	o	o	o	o	+	+

Water source:

o	Contribution usually small
*	Important contribution

Rating:

o	Function unlikely to be performed to any significant extent
+	Function likely to be present at least to some degree
++	Function very likely to be present (and often performed to a high level)

WETLANDS AND WATER QUALITY IMPROVEMENT

The **main water quality improvement functions** wetlands are likely to support are **nutrient and sediment removal**

HOWEVER IT IS NOT STRAIGHT FORWARD, FOR EXAMPLE

- NH_4-N removal is more likely to be transformed in a sparsely vegetated wetland, whereas
- NO_3-N is more likely to be transformed in a seepage or organically rich wetland
- Soluble reactive phosphorous is unlikely to be significantly removed in a wetland, but
- Phosphorous associated with soils is likely to be retained in a wetland provided the redox is high.

WETLANDS AND WATER QUALITY IMPROVEMENT …

Element	Oxidized form	Reduced form	Redox potential for transformation (mv)
Nitrogen	NO_3^- (Nitrate)	N_2O, N_2, NH_4^+	220
Manganese	Mn^{+4} (Manganic)	Mn^{++} (Manganous)	200
Iron	Fe^{+++} (Ferric)	Fe^{++} (Ferrous)	120
Sulphur	SO_4^- (Sulphate)	S^- (Sulphide)	-75 to -150
Carbon	CO_2 (Carbon dioxide)	CH_4 (Methane)	-250 to -350



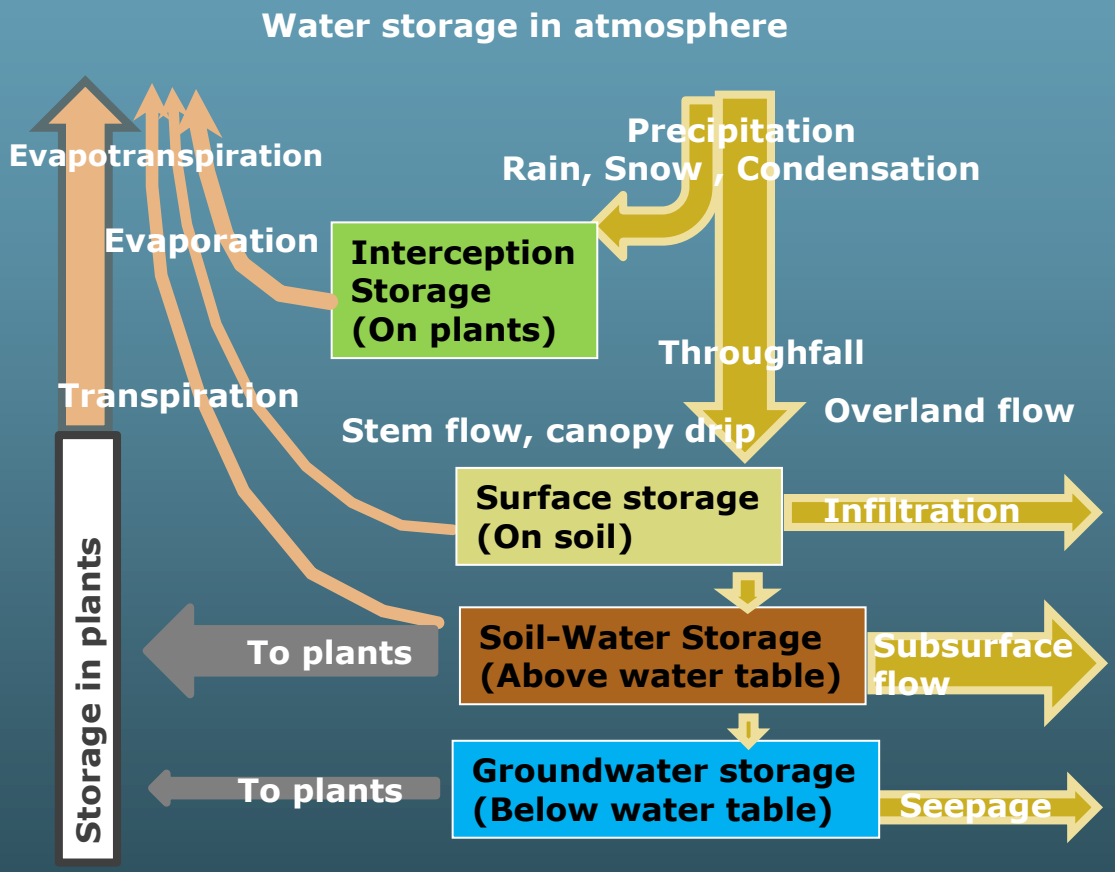
HYDROLOGICAL DRIVERS

What are the main hydrological driving processes responsible for maintaining wetlands?

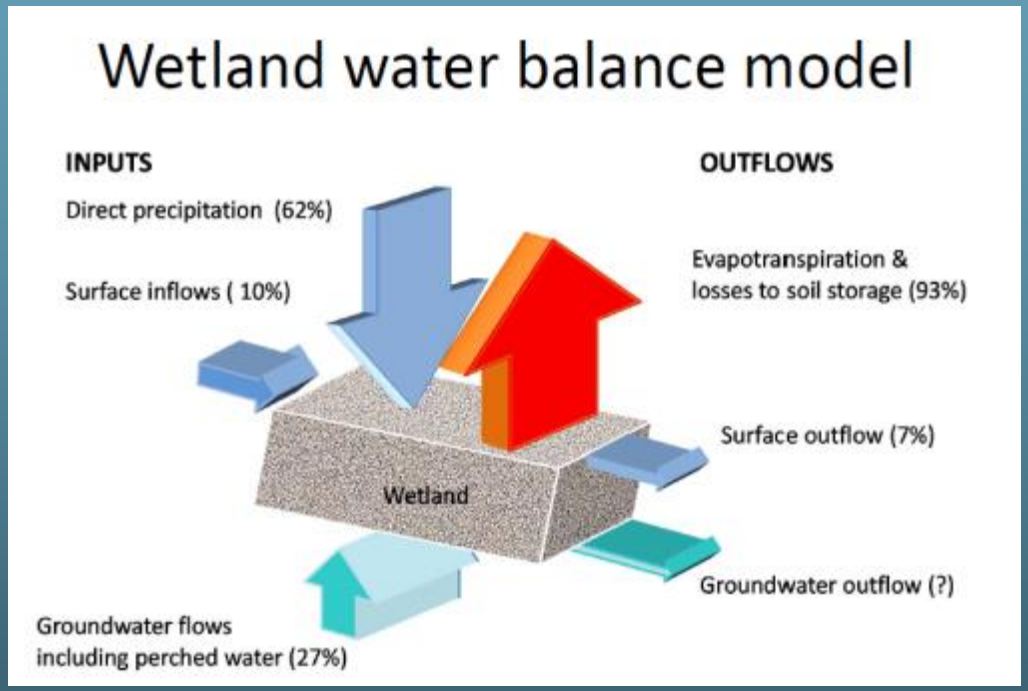
- *Fundamental to the understanding of wetlands is the understanding of the supporting hydrology which in turn is influenced by:*
  - ***Precipitation pattern***
  - ***Geology***
  - ***Surrounding and wetland soils***
  - ***Landform***
  - ***Vegetation***

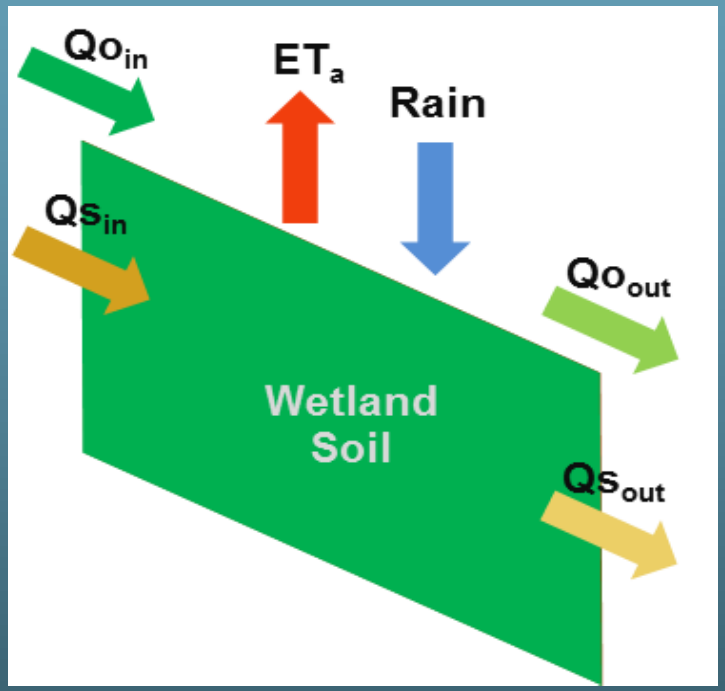
- ***Non wetland areas****, including the associated catchments,* ***are as important*** *to consider as the wetlands themselves, as for the most part they determine the* ***pattern of movement of water through the landscape*** *which directly effects the development and expression of wetlands within the landscape*

WATER IN THE LANDSCAPE - WATER CYCLE AND WETLANDS

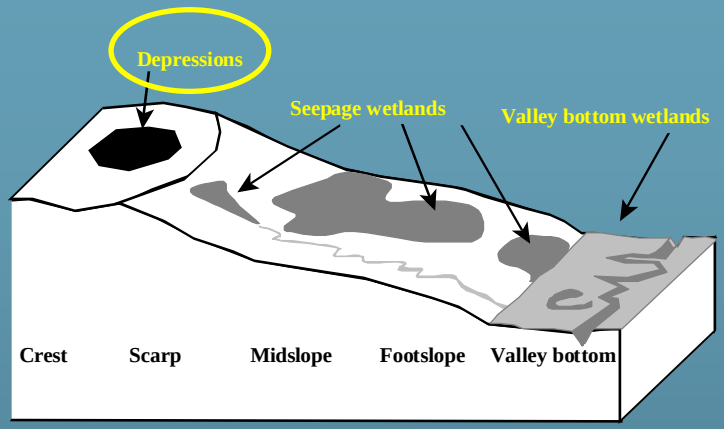


CONCEPTUAL WATER BALANCE MODELS FOR WETLANDS



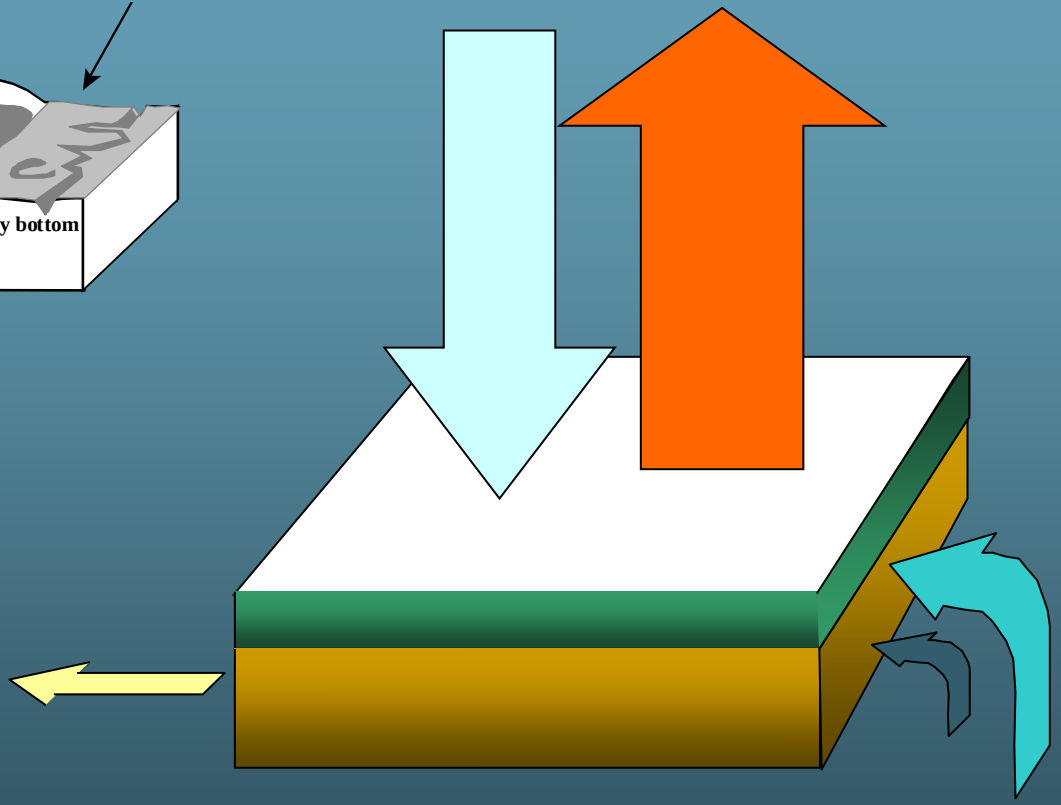


DEPRESSIONS / PANS



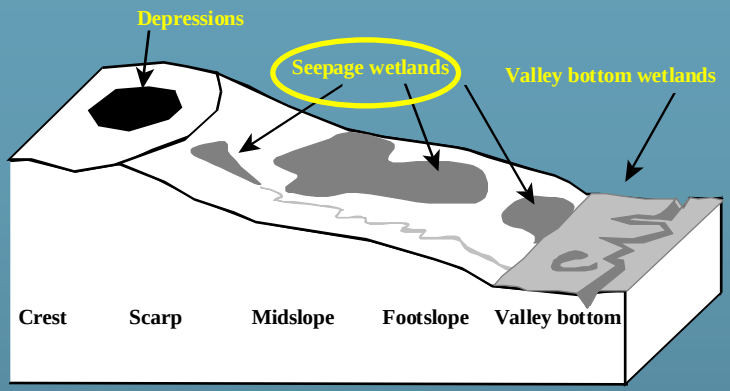
LEGEND

- Through flow
- Loss to groundwater
- Evaporation
- Surface outflow
- Surface in flow
- Perched/groundwater
- Rainfall
- Groundwater



Water balance

SEEPAGE WETLANDS



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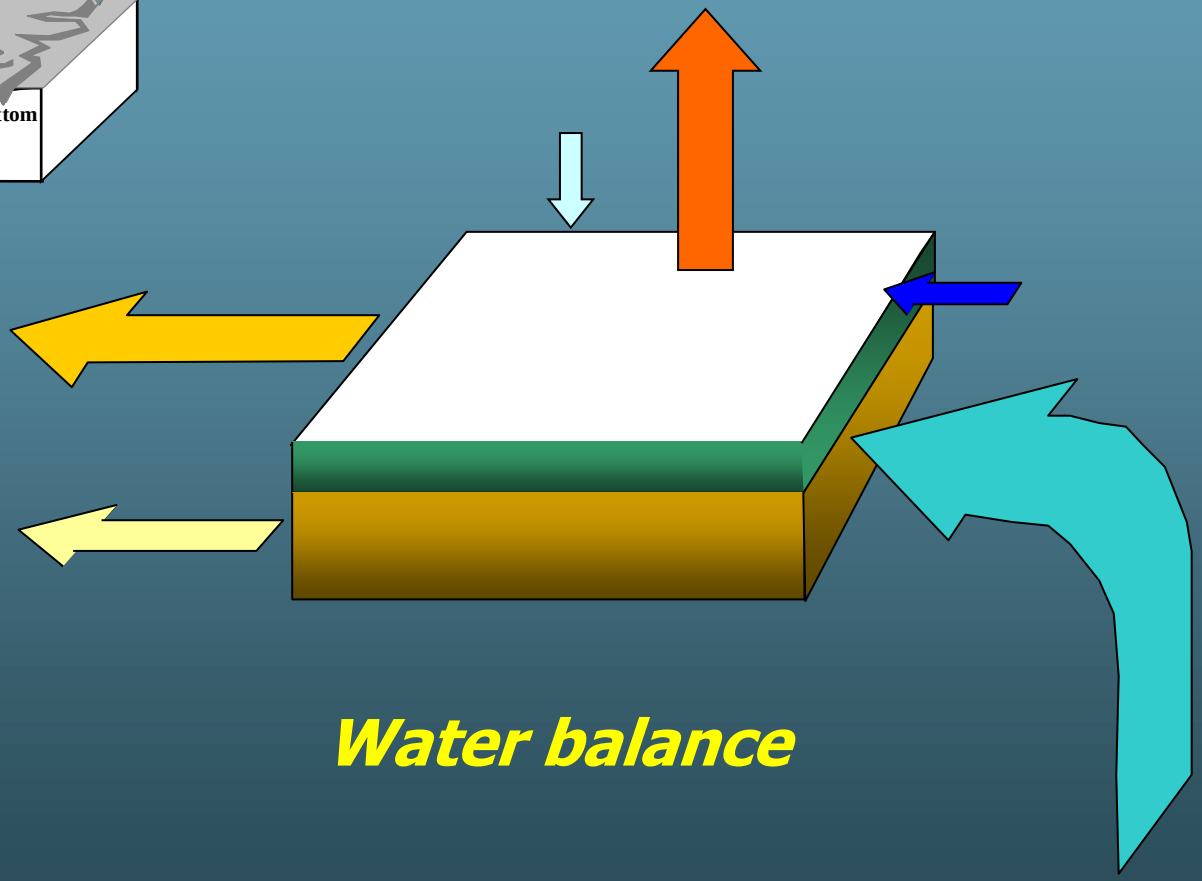
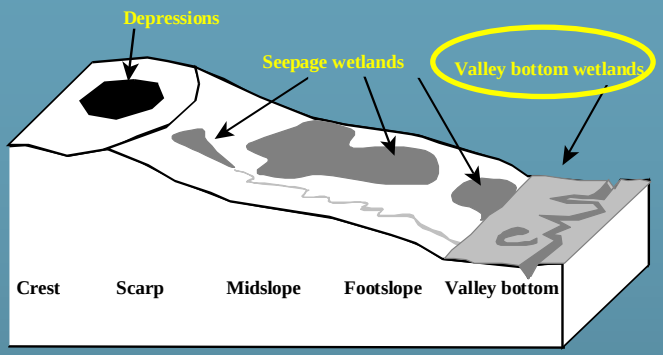


Water balance

VALLEY-BOTTOM WETLANDS



LEGEND

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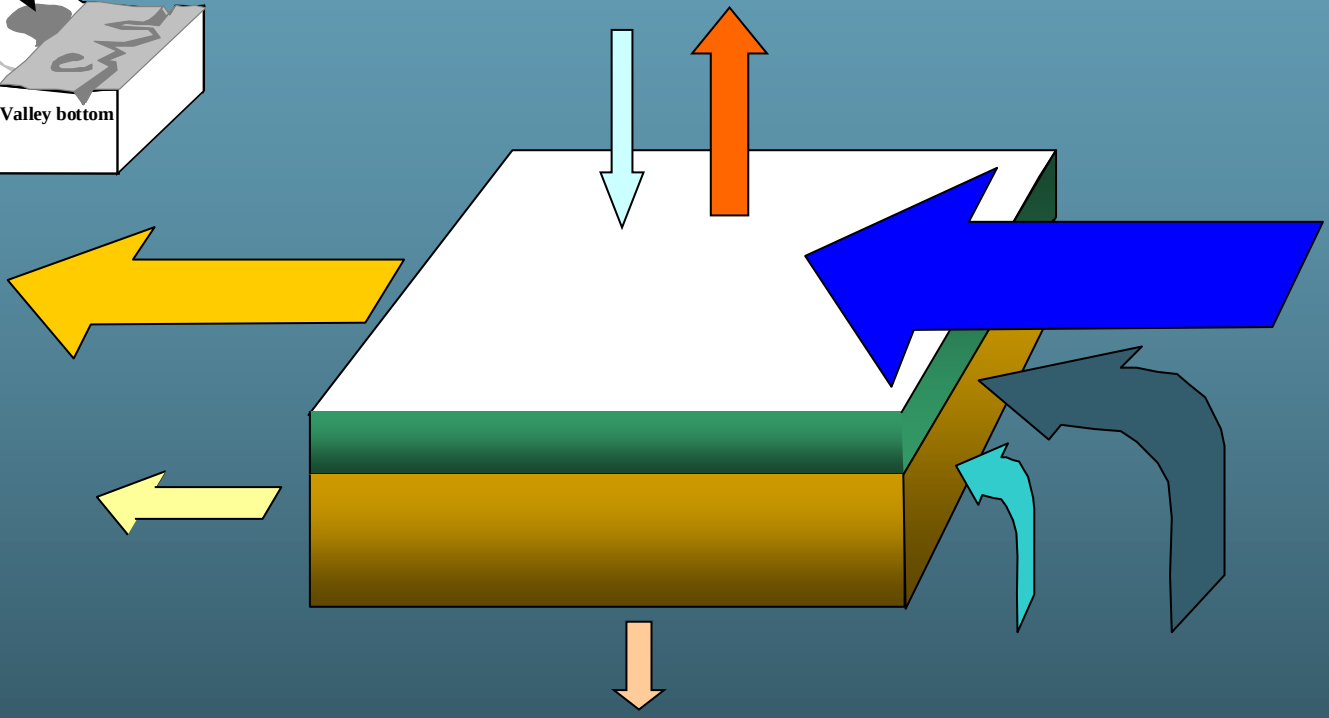


Water balance

CONTENT – AERIAL IMAGERY

Aerial Imagery Interpretation

- *Importance of aerial imagery interpretation*
- *Considerations and limitations*
- *Source of aerial imagery*
- *Historical imagery*

Desktop delineation

- *Wetland identification*
- *Wetland delineation*
- *Wetland typing*

IMPORTANCE OF AERIAL IMAGERY

Aerial imagery forms the basis of virtually all wetland assessment projects

Provides a window into areas that might be inaccessible

Allows for rapid and remote wetland assessment

Use of aerial imagery in wetland assessments

- *Wetland identification*
- *Wetland delineation*
- *Wetland typing/classification*
- *Identification of impacts*
- *Mapping of disturbance units*
- *Seasonal variations*
- *Changes over time*
- *Catchment landuse*

CONSIDERATIONS AND LIMITATIONS

Different types of aerial imagery

- *Black and white*
- *True colour*
- *Colour infrared*
- *Satellite imagery and derivatives*

Year of imagery

Season of imagery

Preceding climate patterns – drought?

Resolution

Scale

Geo-referencing

CONSIDERATIONS AND LIMITATIONS

CONSIDERATIONS AND LIMITATIONS

SOURCE OF AERIAL IMAGERY

GOOGLE EARTH

- *Probably single most important source*
- *True colour*
- *Historical imagery*
- *Imagery from various seasons*
- *Accuracy of geo-referencing can be a concern*
- *Resolution in rural areas can be problematic*

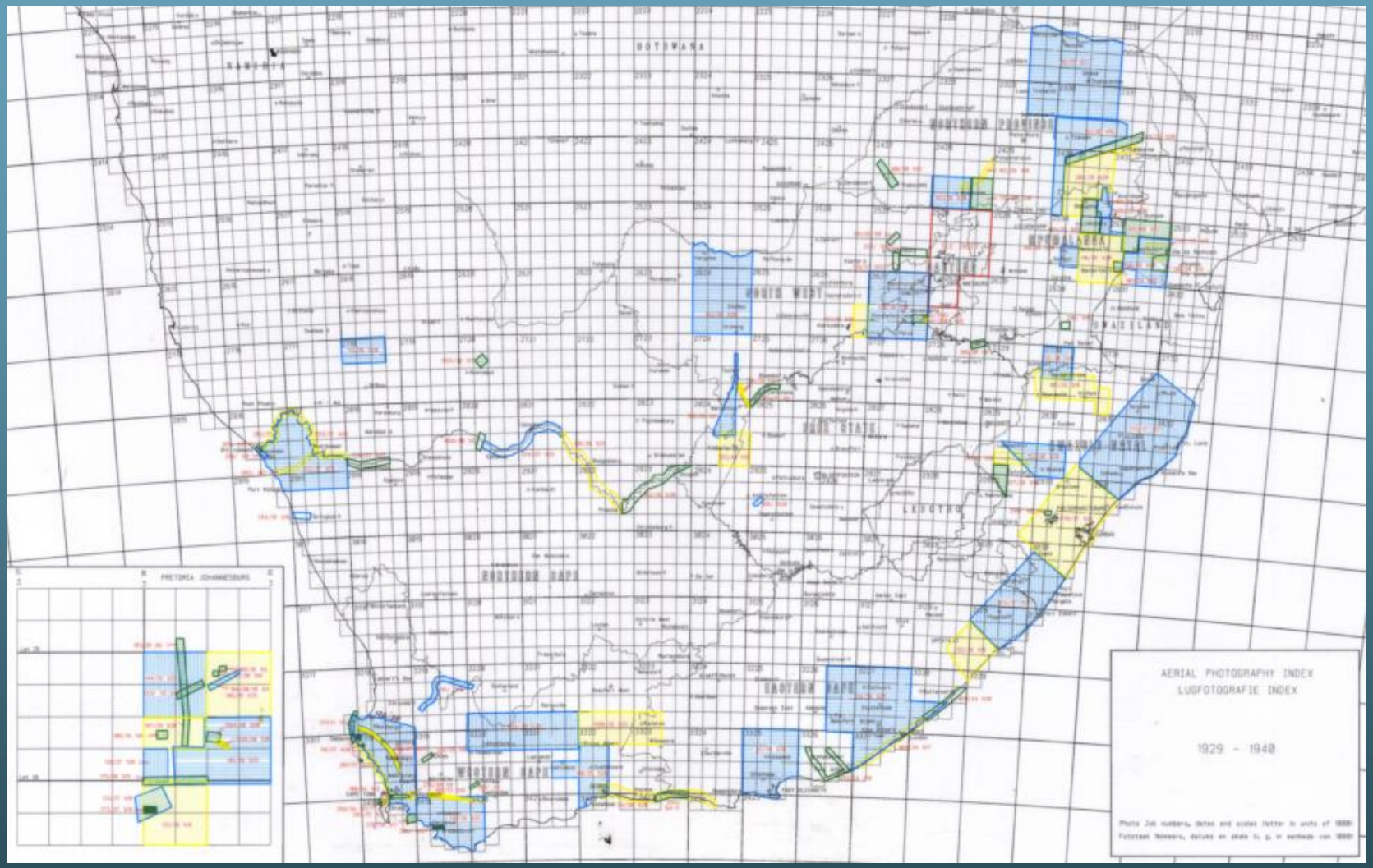
National Geospatial Institute (NGI)

- *1:10 000 aerial photographs*
- *True colour*
- *Black and white*
- *Geo-referencing very accurate*
- *Single season*
- *Large timespan between images*

Satellite imagery

Commissioned aerial imagery

HISTORICAL AERIAL IMAGERY



DESKTOP DELINEATION

Identification of wetlands

- *Topography*
- *Presence of water*
- *Presence of channels*
- *Presence of dams*
- *Differences in vegetation*

Delineation of wetlands

- *Differences in vegetation colour*
- *Differences in shading – wetlands generally darker*
- *Differences in texture*
- *Differences in elevation*

Classification of wetlands

- *Position of wetland in the landscape*
- *Movement of water through the wetland*

CONTENT – PRACTICAL WORK SESSIONS

Session 1

- *Desktop identification of wetlands*
- *Desktop delineation of wetlands*
- *Wetland typing*
- *Additional examples*

Session 2

- *Conceptual considerations*
- *Pan wetlands*
- *Hillslope seepage wetlands*
- *Unchannelled valley bottom wetlands*
- *Channelled valley bottom wetlands*
- *Floodplain wetlands*
- *Additional examples*

Consideration of catchment land use

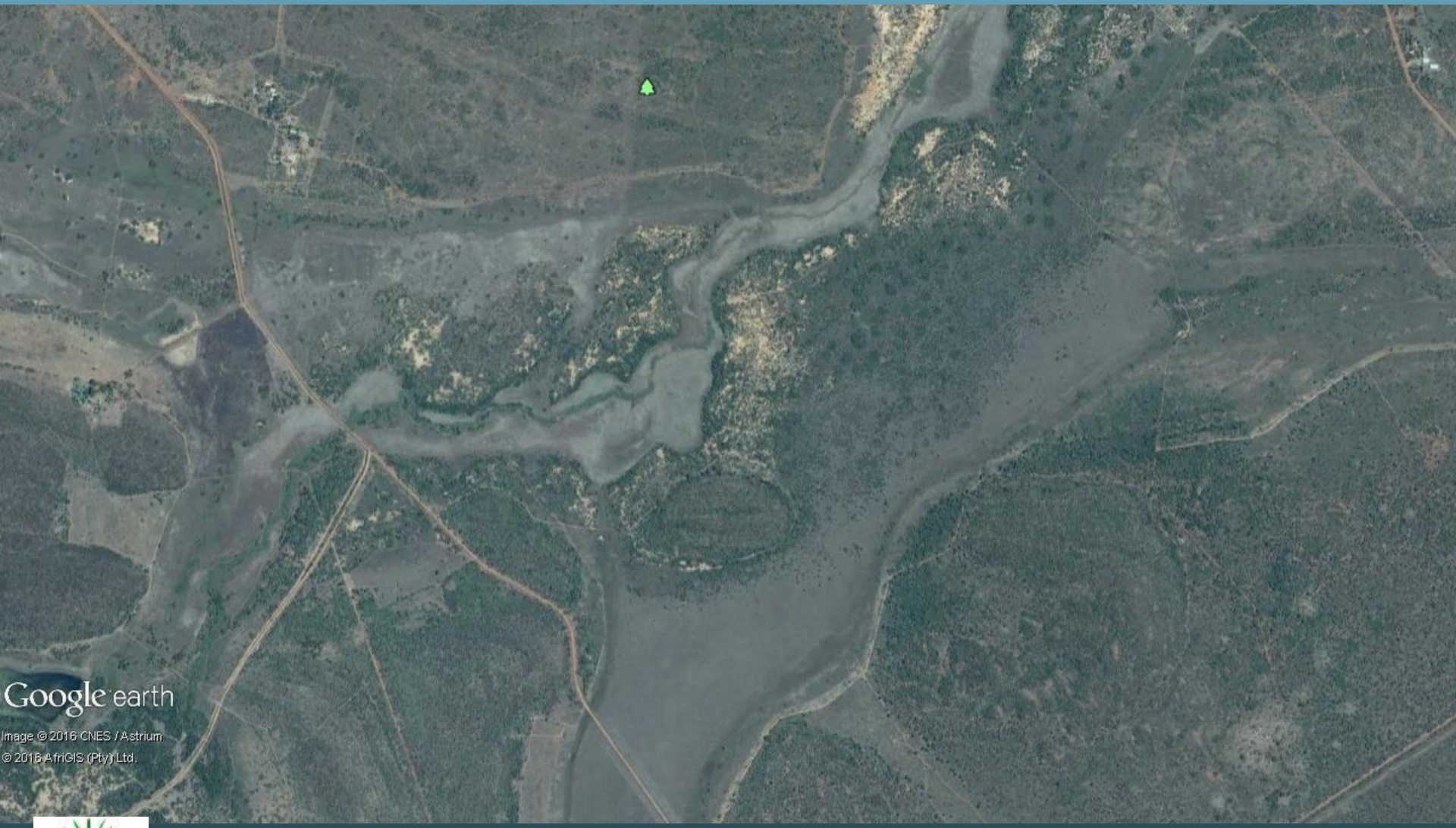
PRACTICAL WORK SESSION 1

Identify wetland habitat

Delineate wetland habitat

Type/classify wetlands using HGM

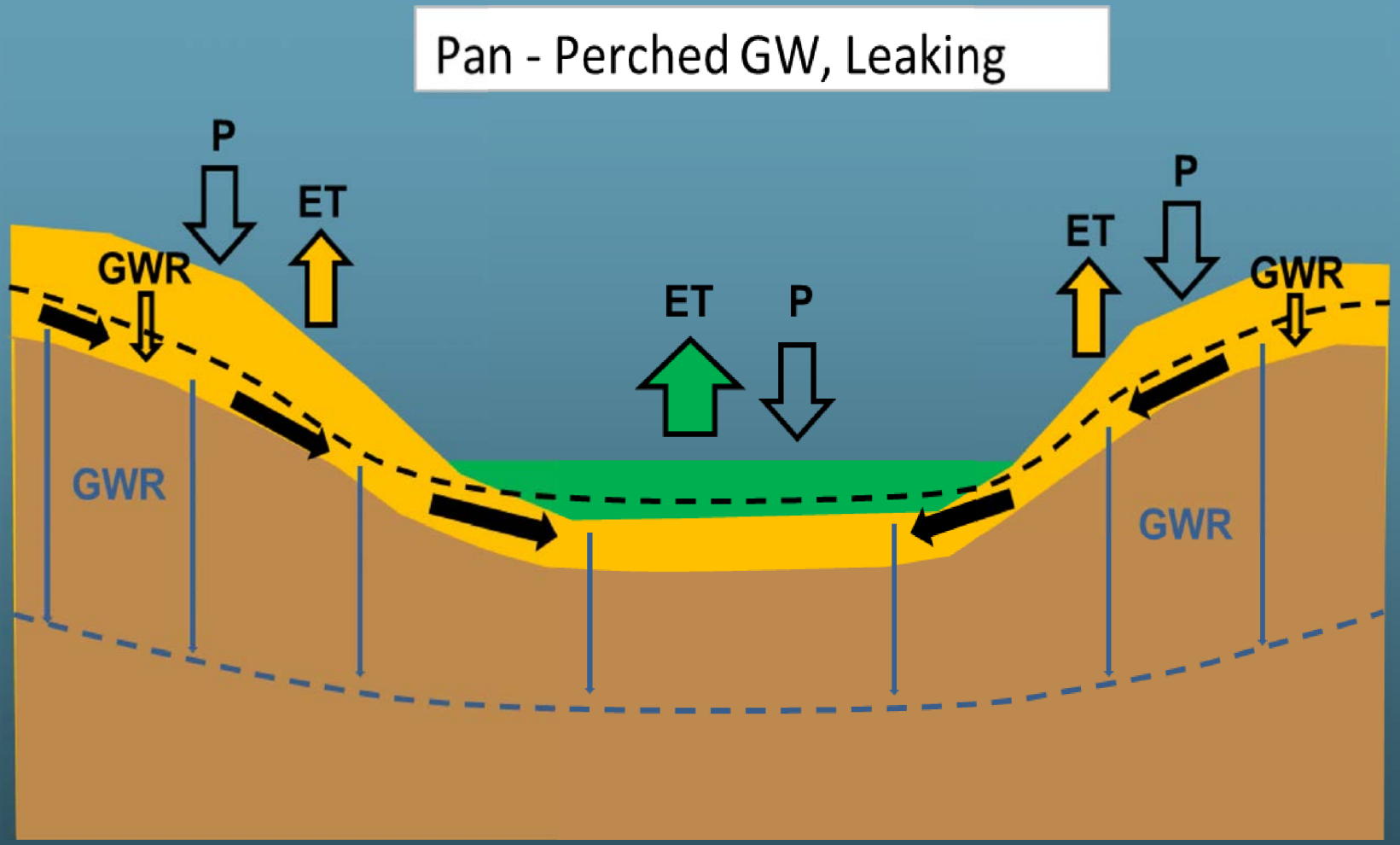

N
0
100
200
400
600
800
1 000
1 200
1 400
1 600
1 800
2 000
2 200
2 400
2 600
2 800
3 000
3 200
3 400
3 600
3 800
4 000
Meters



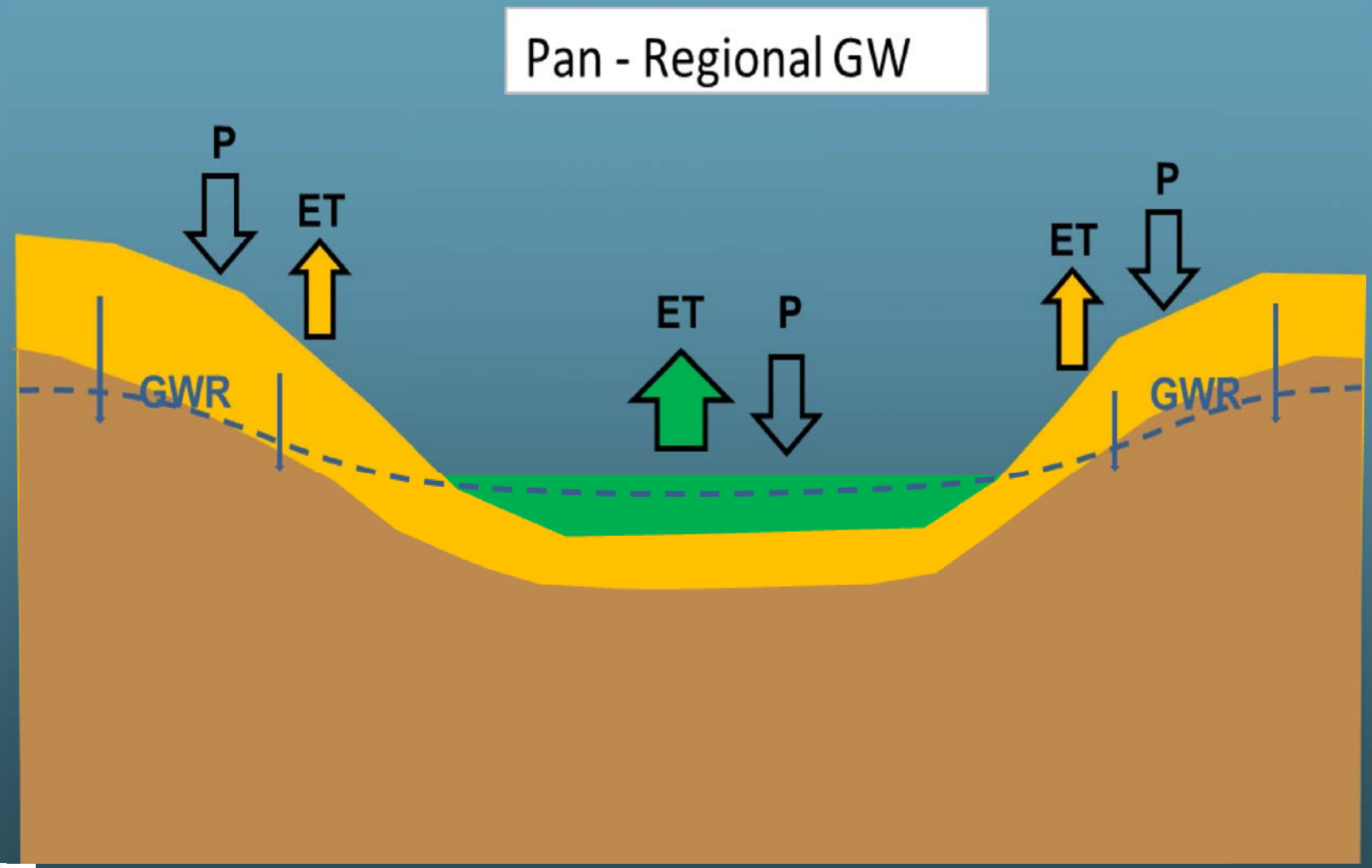
CONCEPTUAL CONSIDERATIONS

PAN

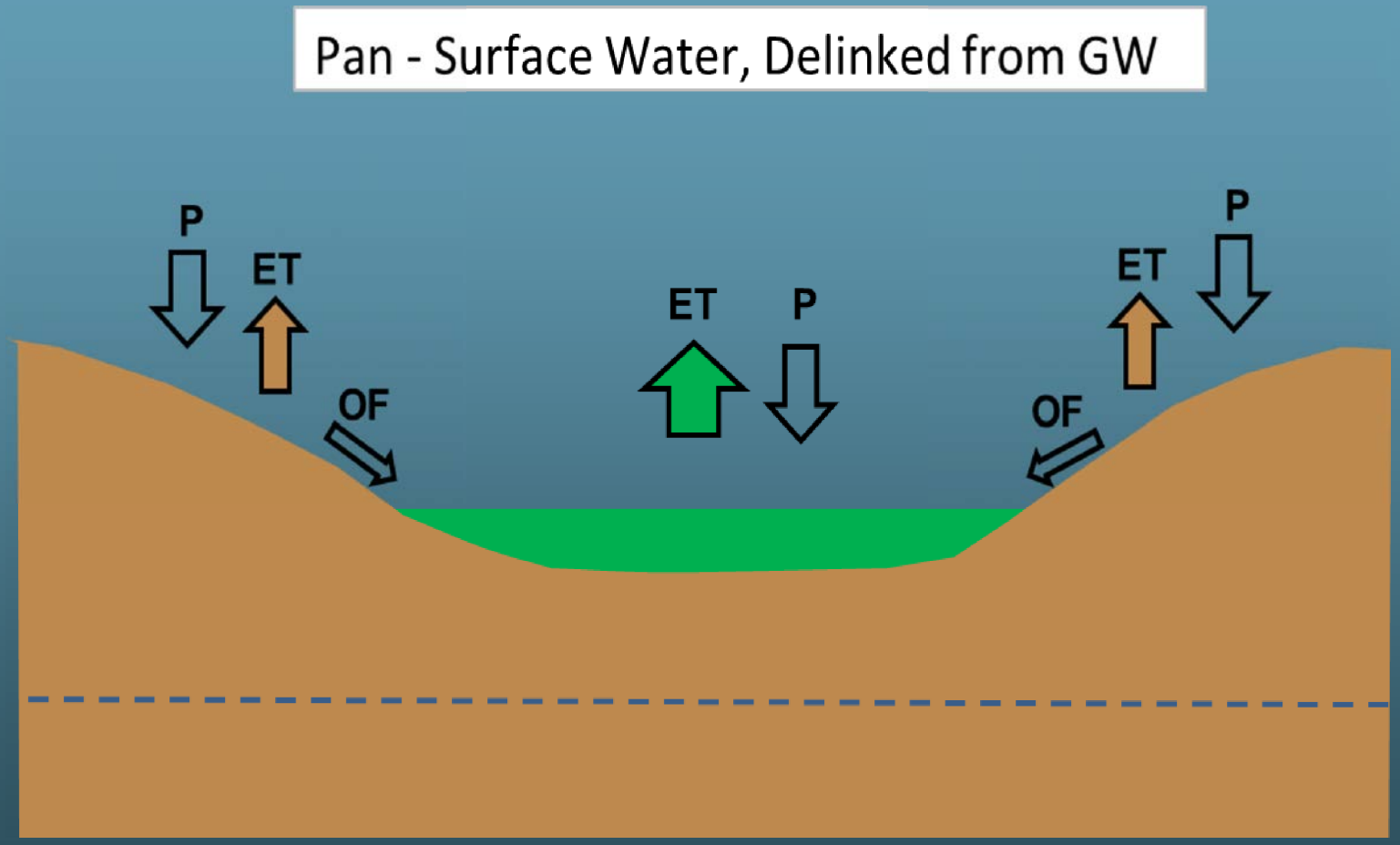
PAN



PANS



PANS



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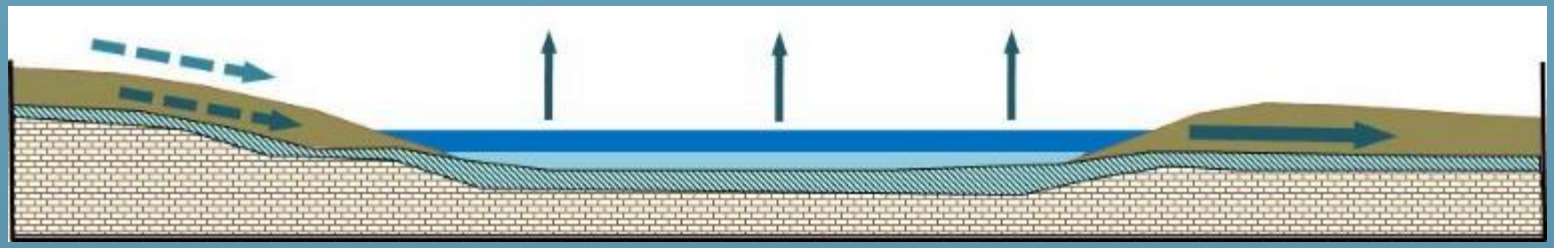
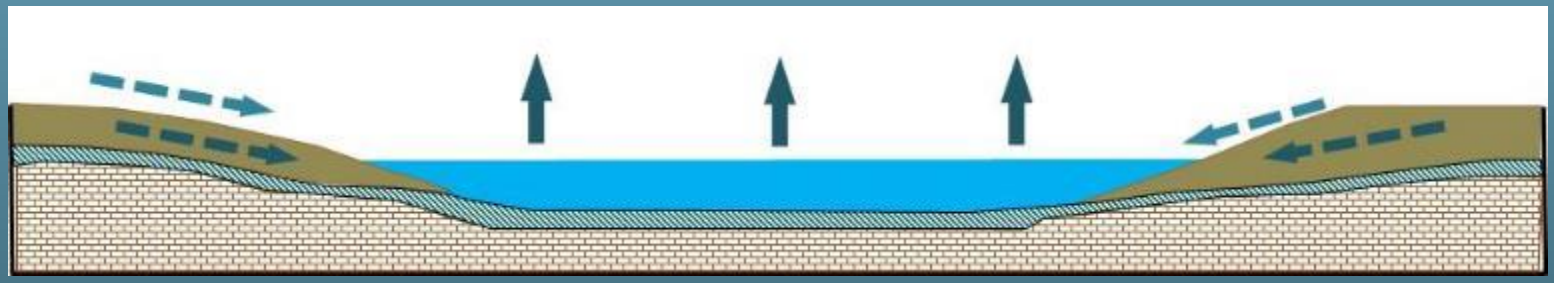
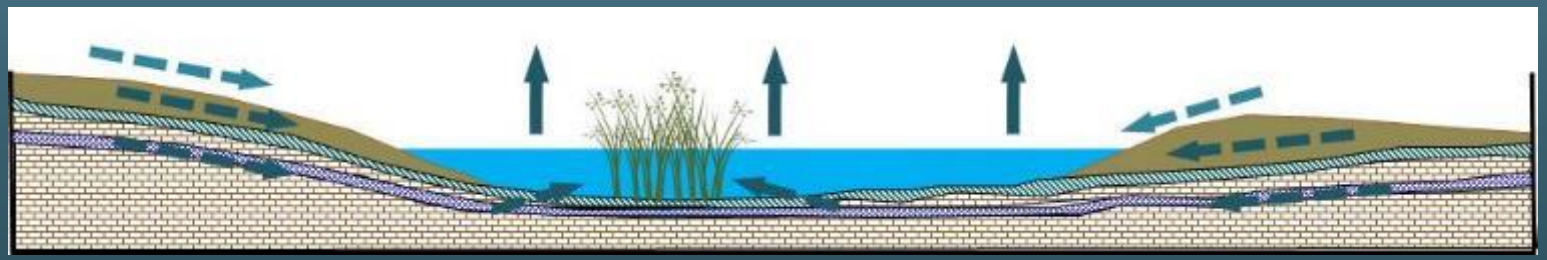


Free draining, seasonal to temporary, fresh, Sodium <5mg/l



No flushing, seasonal to temporary, saline, sodium >900mg/l



Groundwater linked, permanent, sodium variable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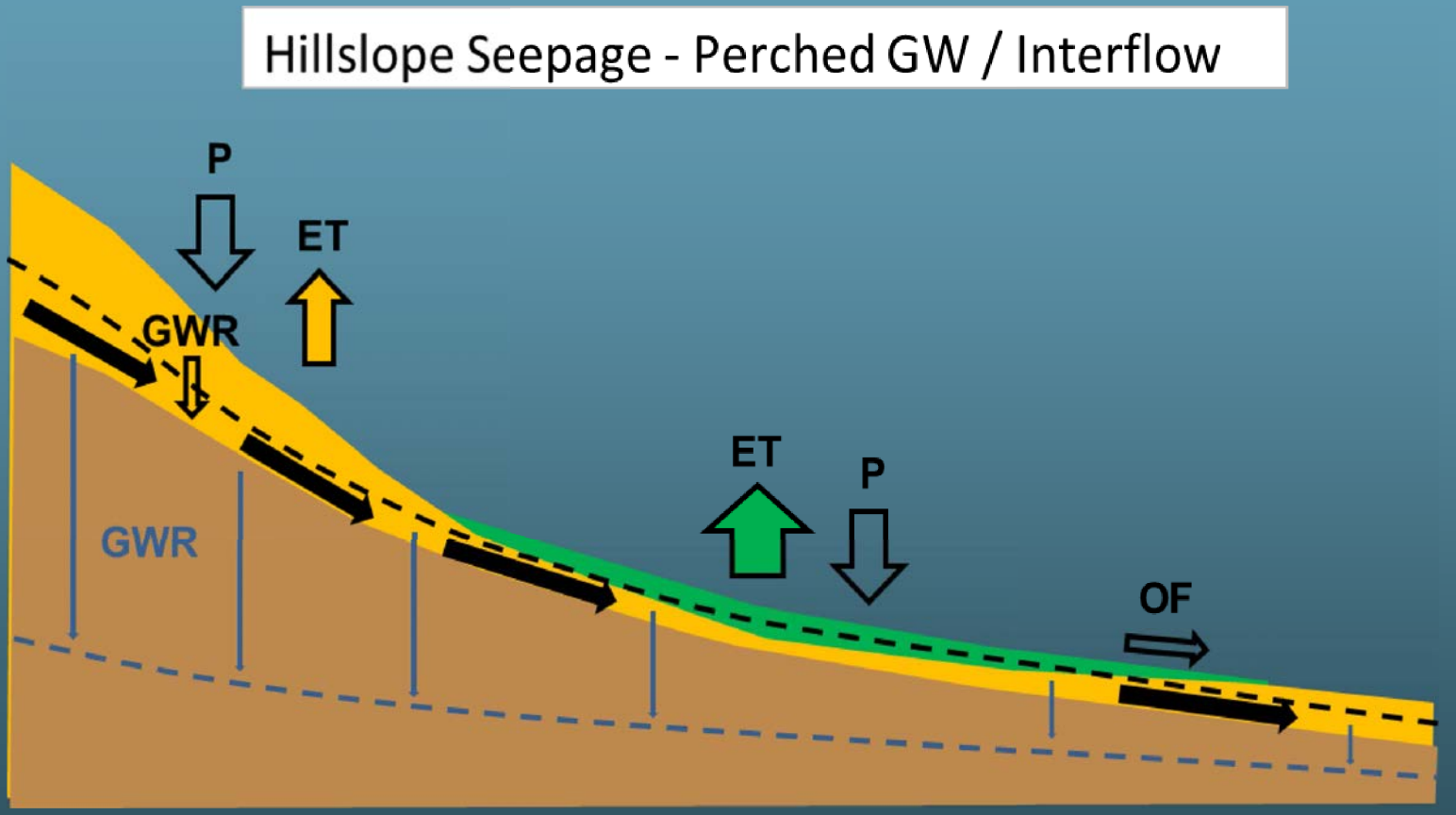
HILLSLOPE SEEPAGE

HILLSLOPE SEEPAGE



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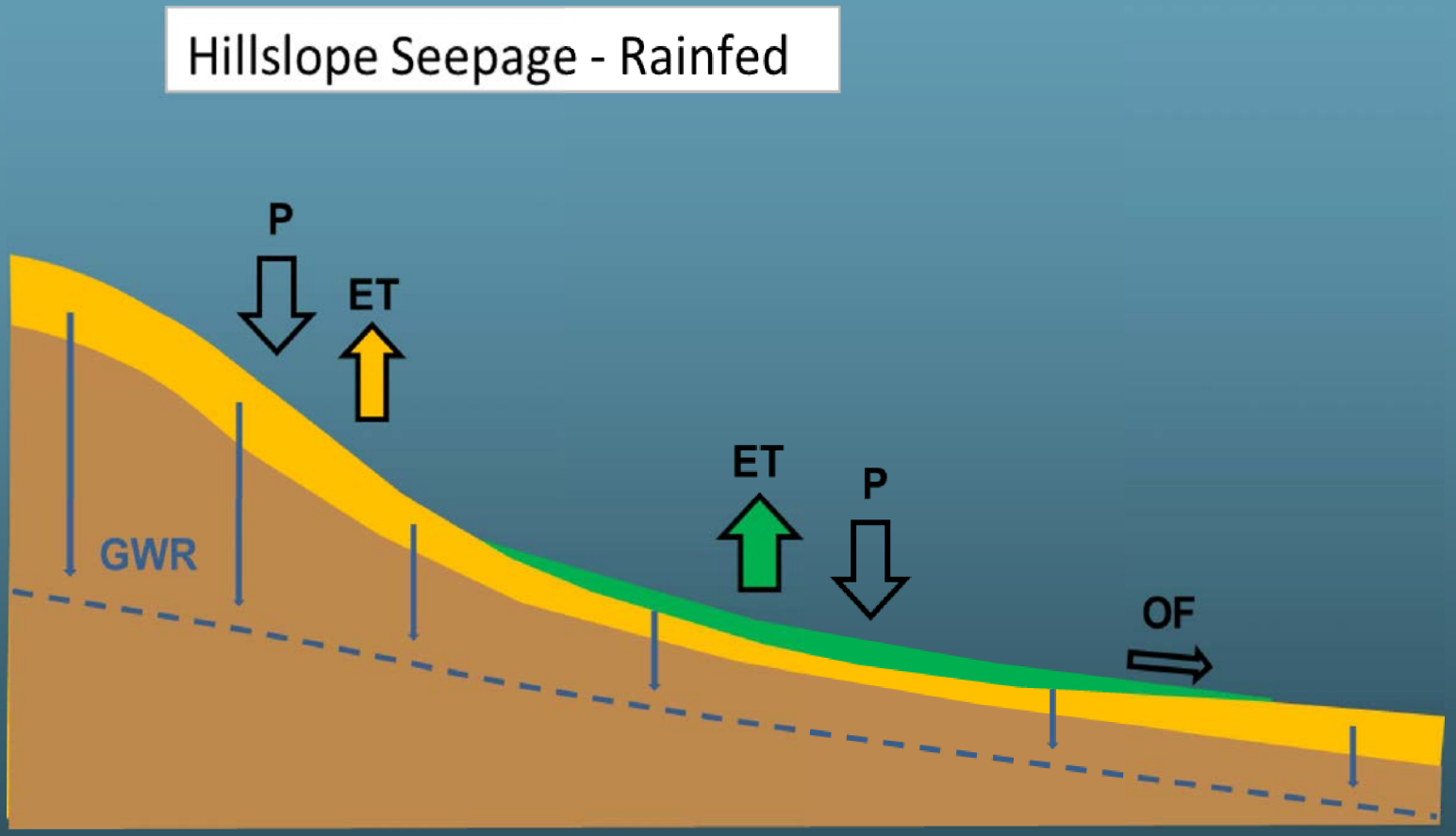

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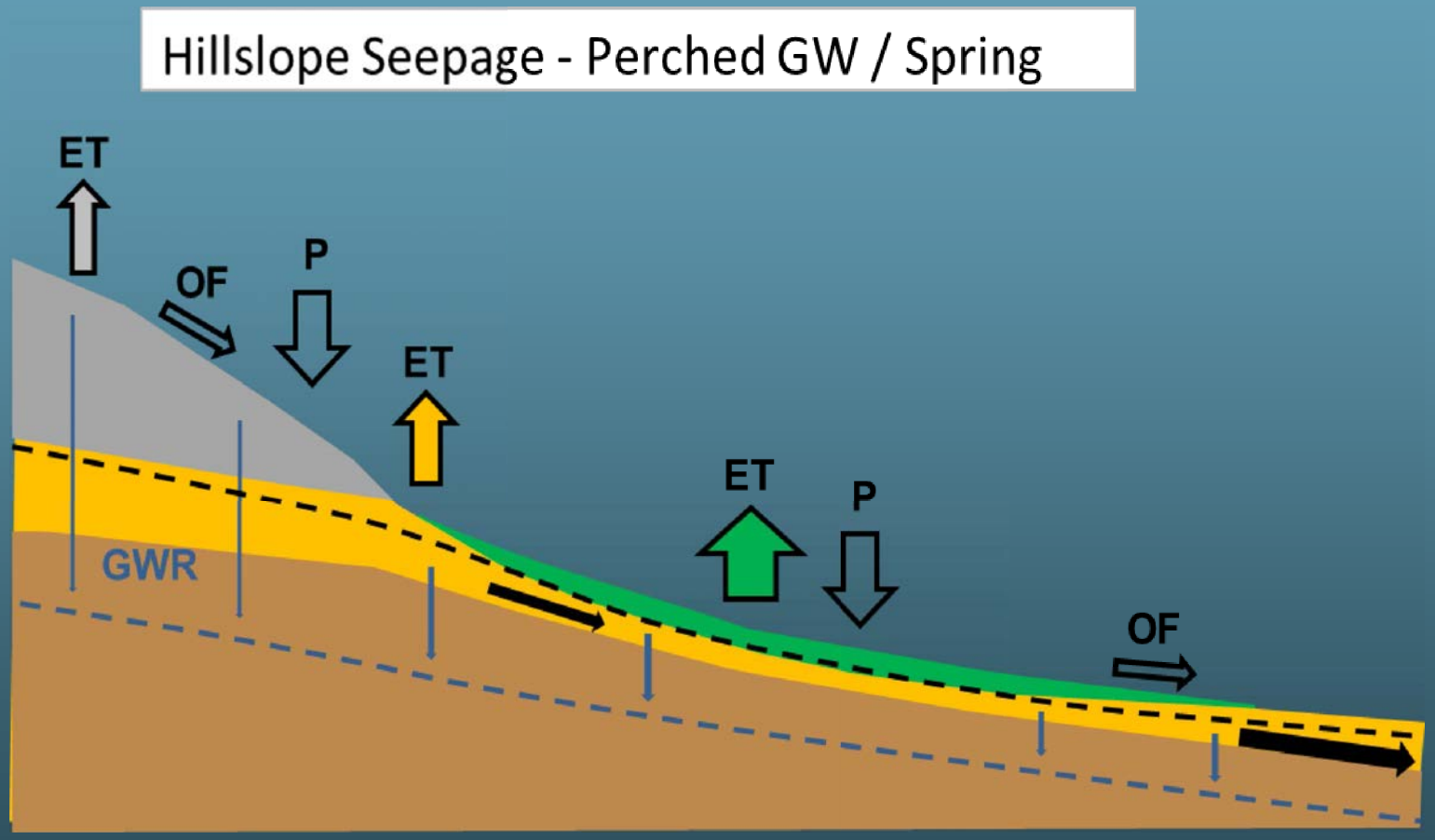

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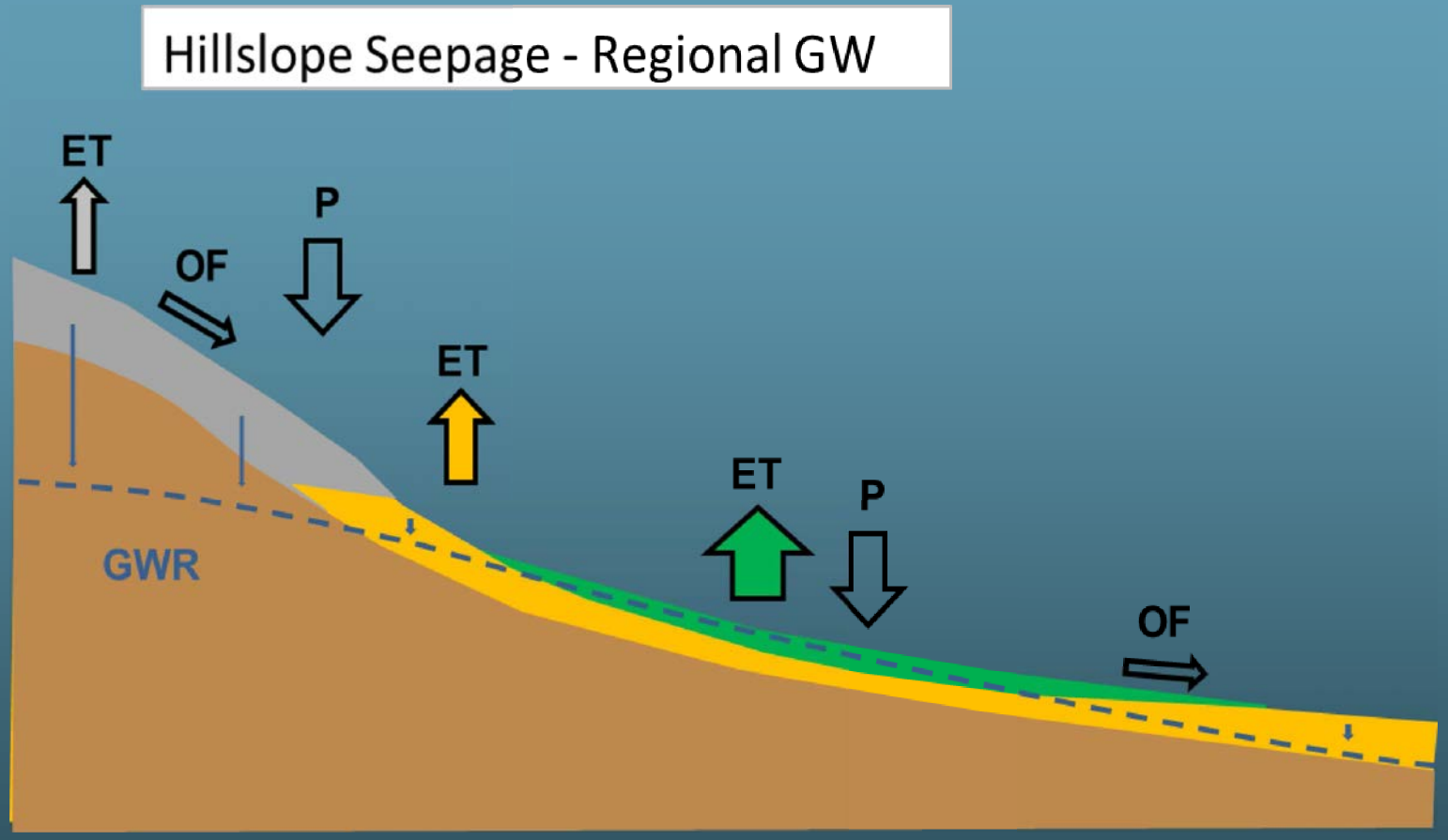
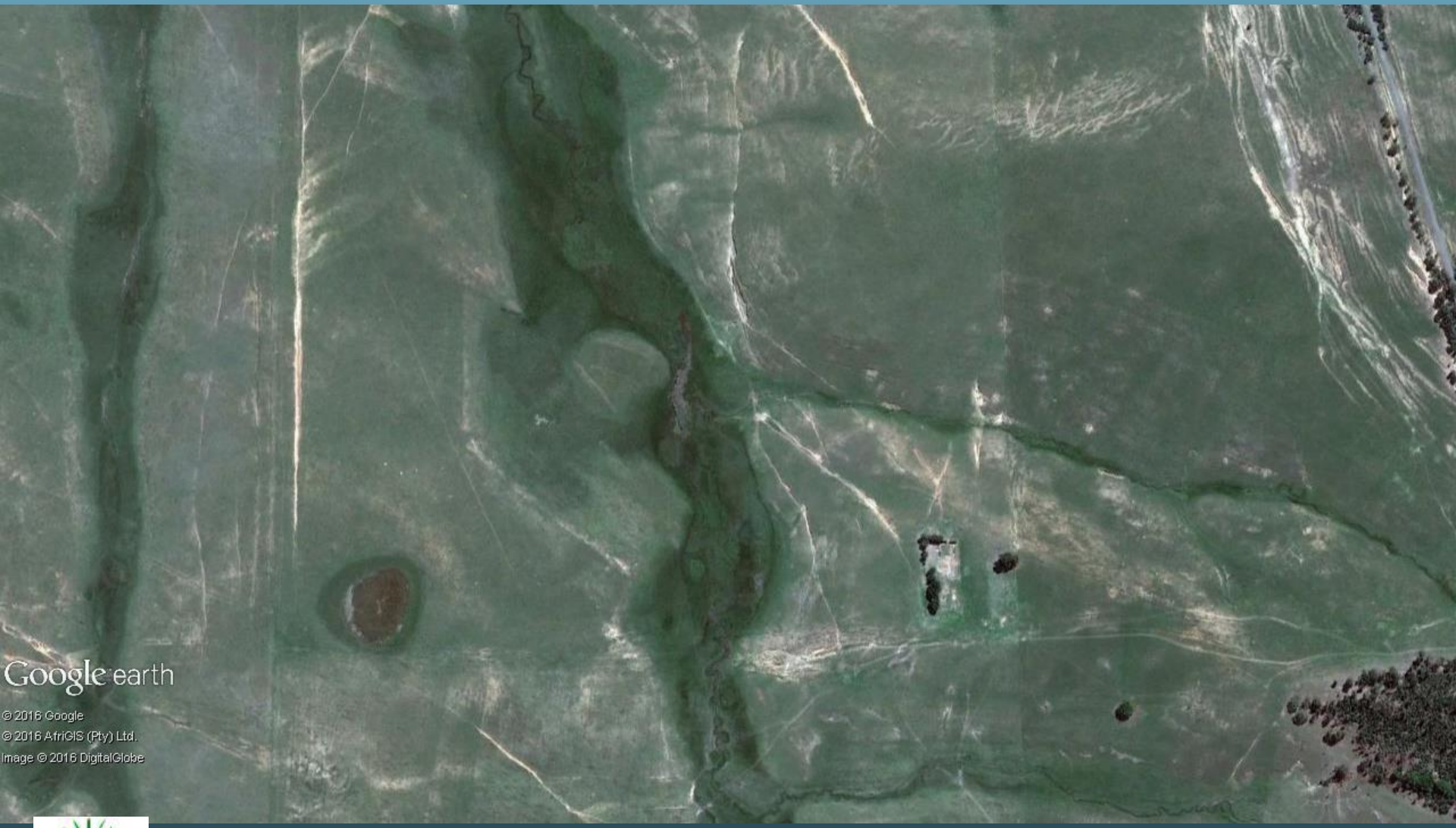


UNCHANNELLED VALLEY BOTTOM



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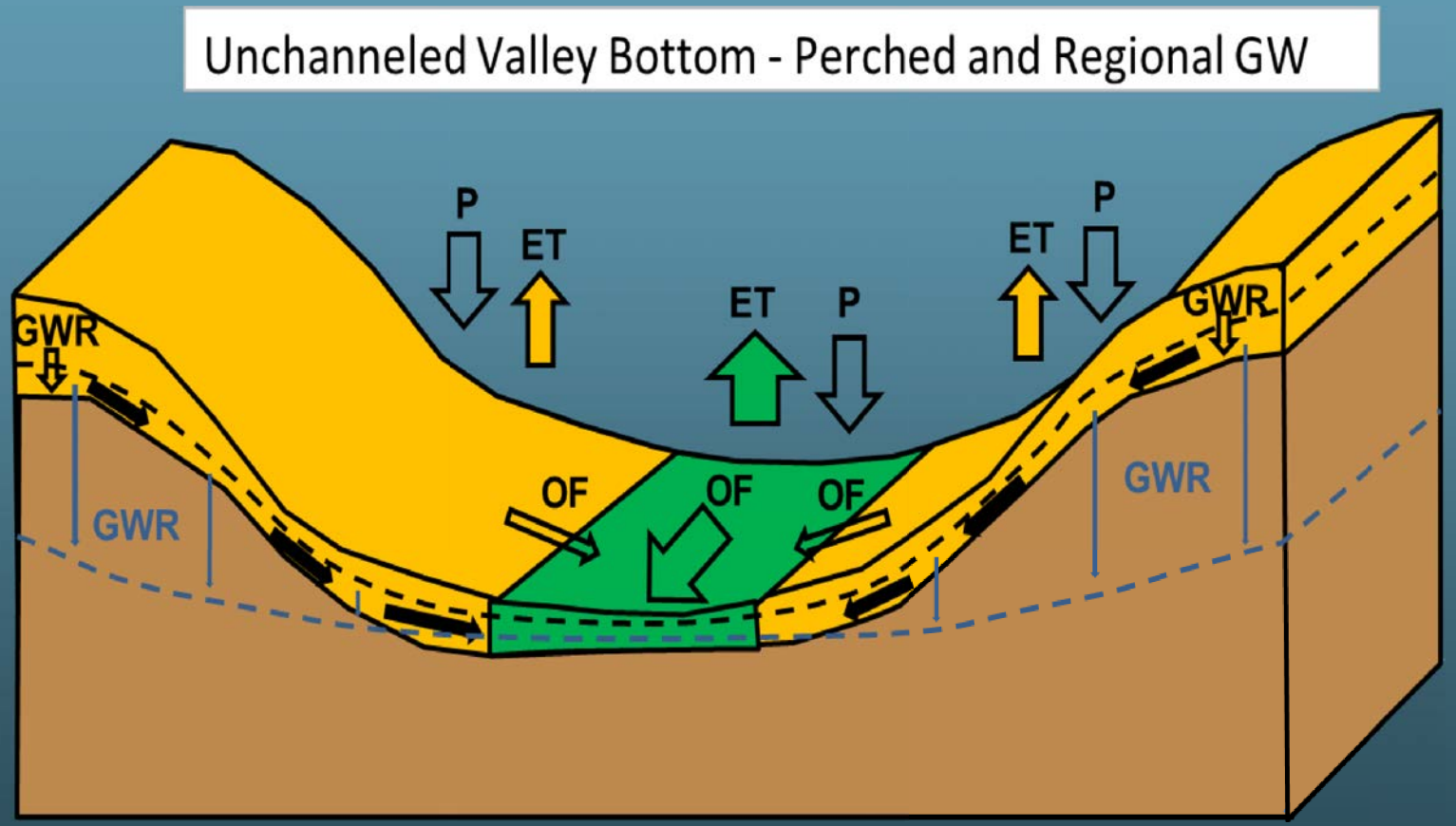

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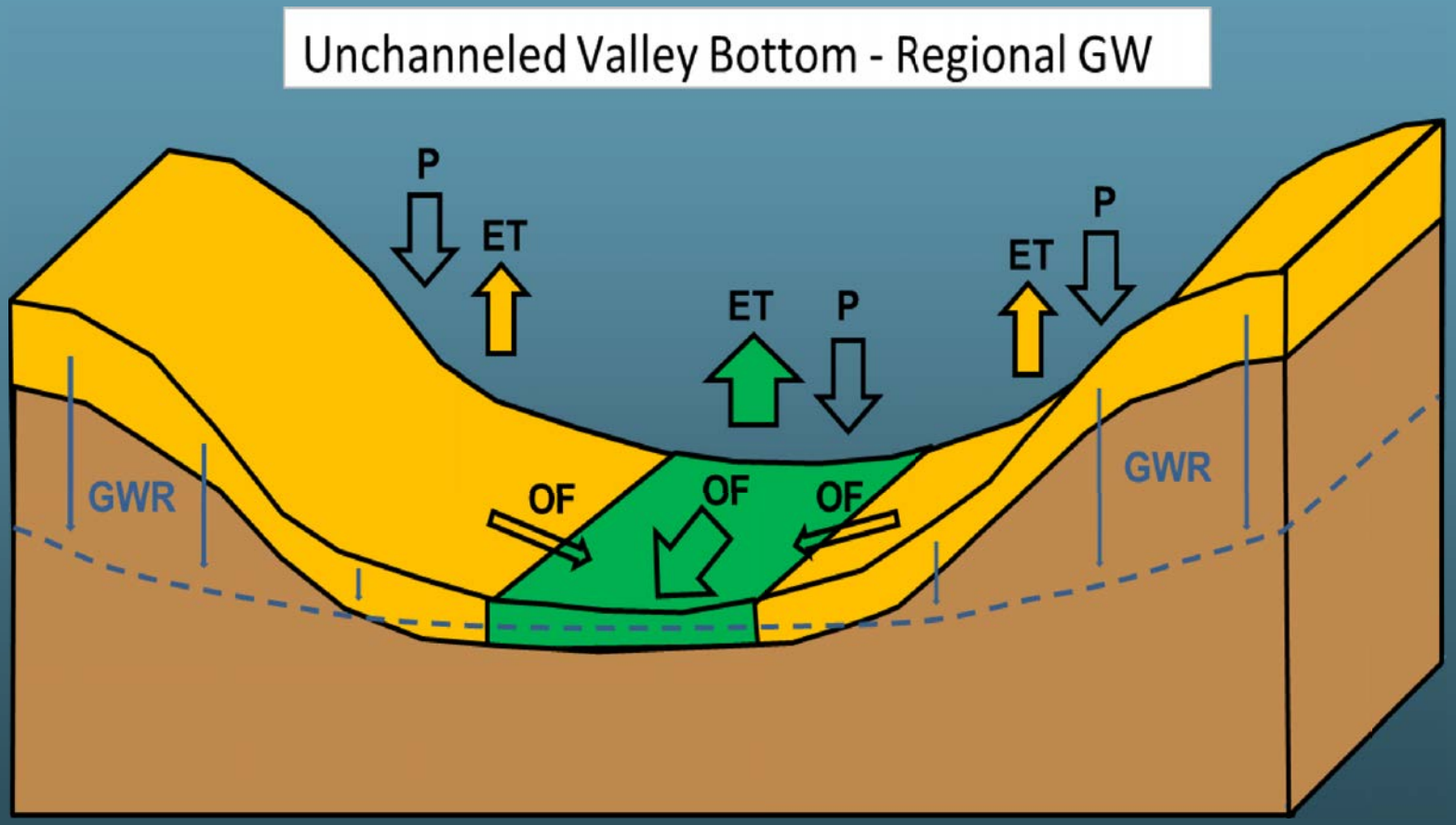


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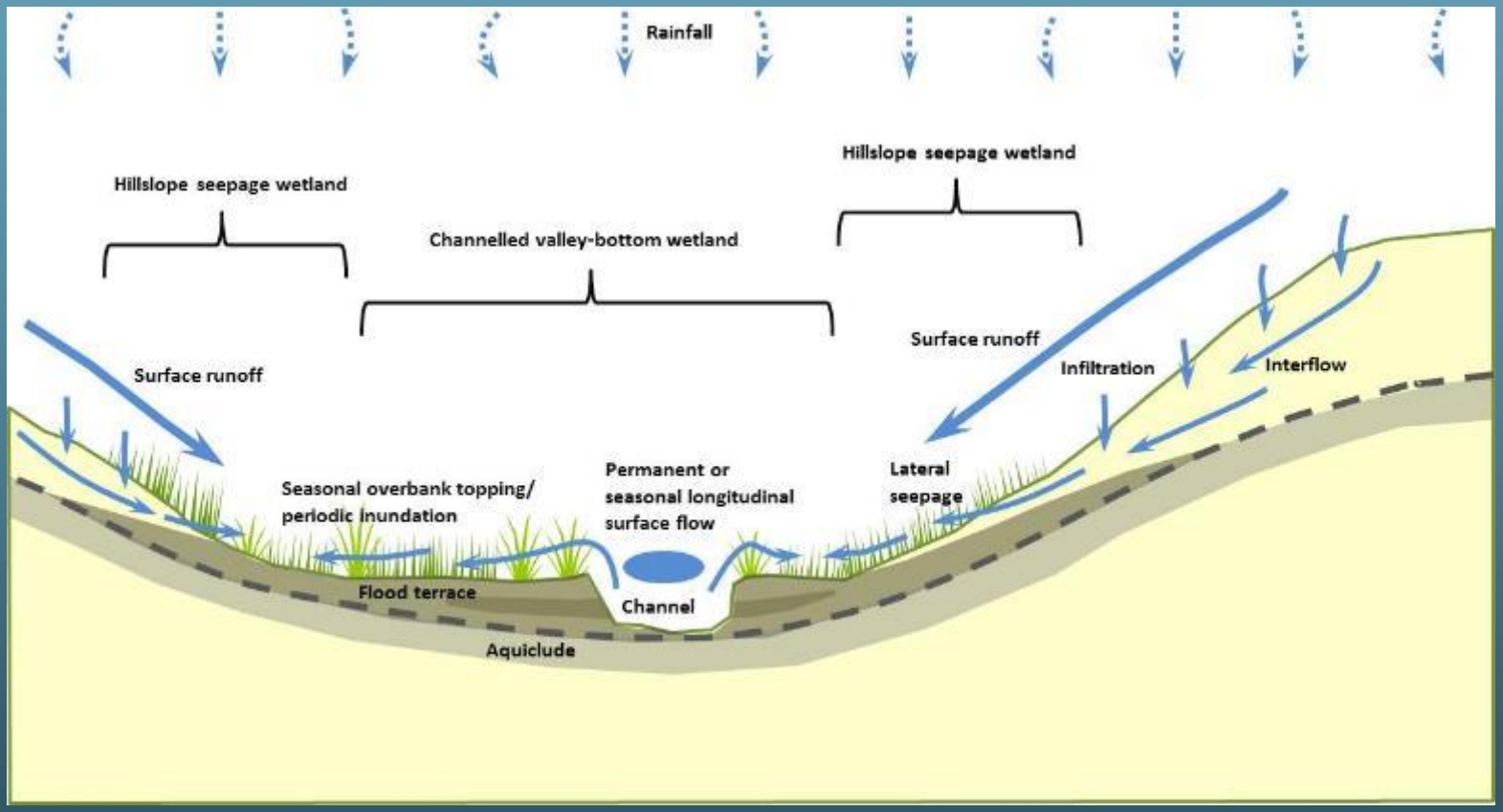
CHANNELLED VALLEY BOTTOM

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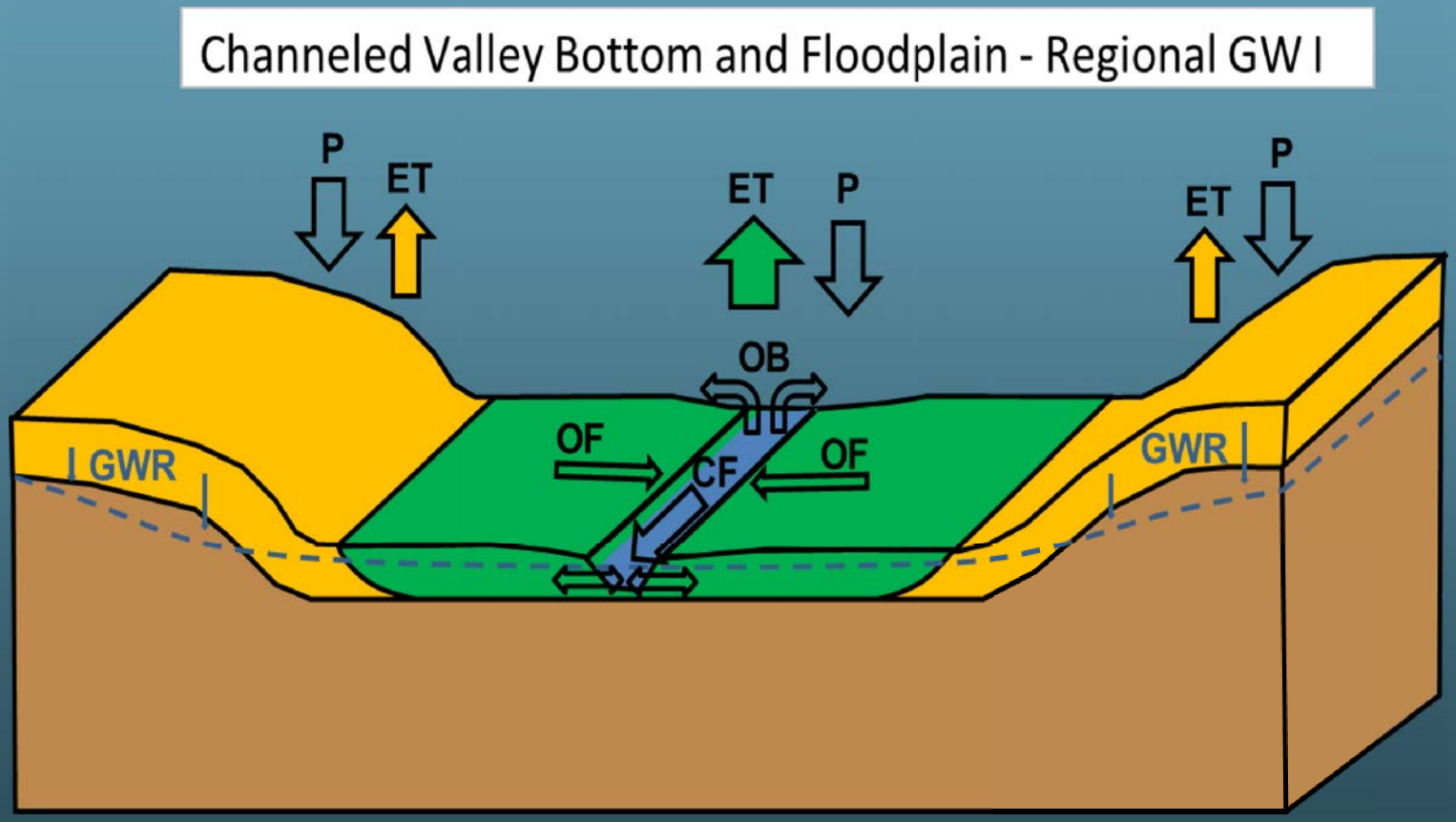
FLOODPLAIN



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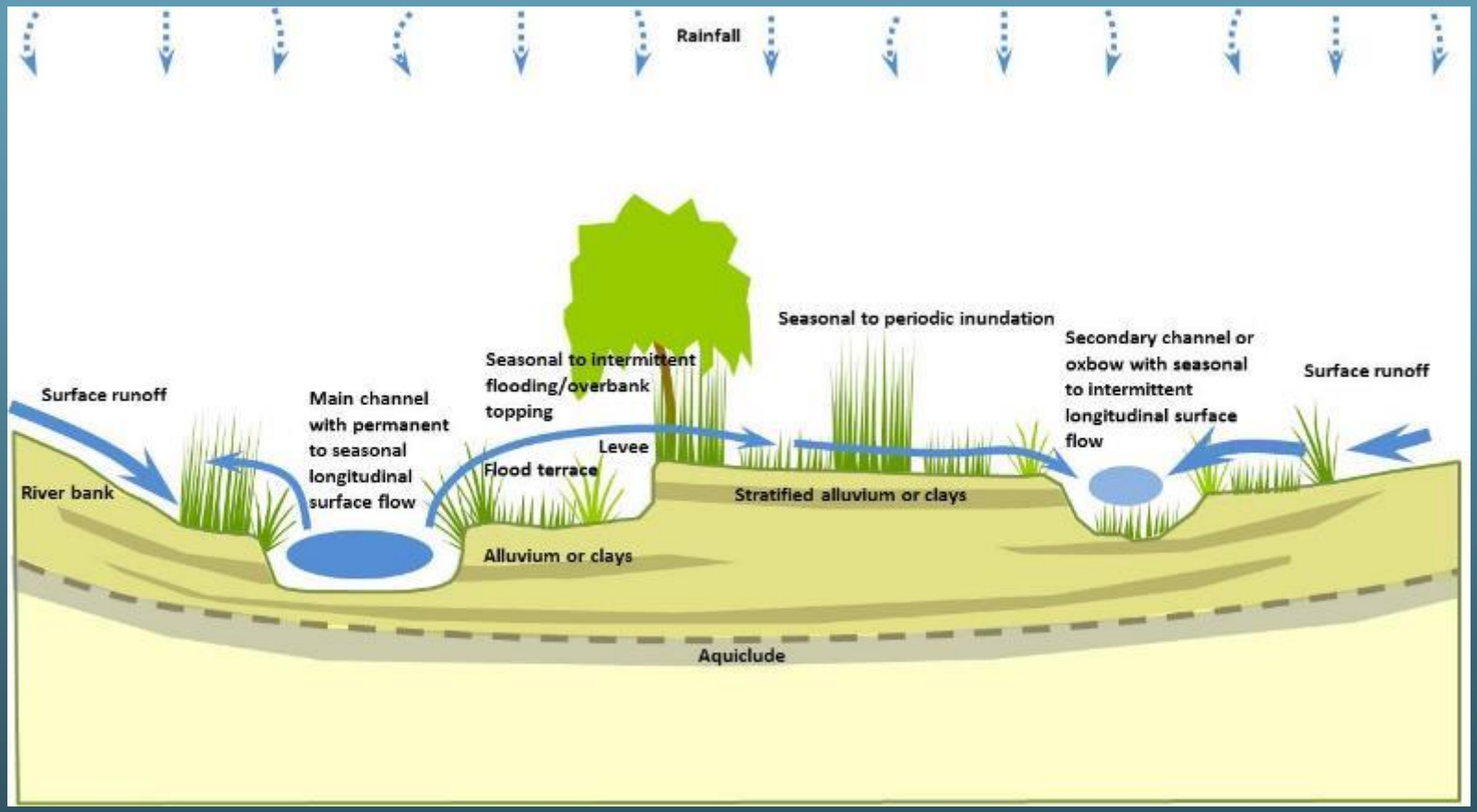


CONTENT – IMPACT ASSESSMENT AND MITIGATION CONSIDERATIONS

Mitigation Hierarchy

- *What is the mitigation hierarchy?*
- *How do we apply the mitigation hierarchy?*

Linear Infrastructure

- *Impacts associated with urban developments*
- *Mitigation considerations*

Urban & Site Specific Infrastructure

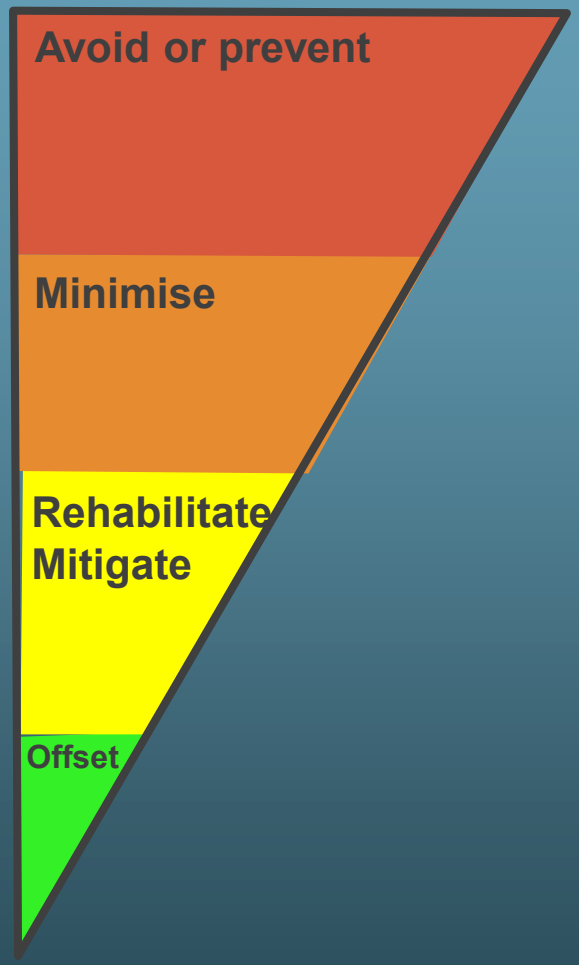
- *Impacts associated with urban developments*
- *Mitigation considerations*

Forestry

- *Impacts associated with urban developments*
- *Mitigation considerations*

MITIGATION HIERARCHY

MINING & BIODIVERSITY GUIDELINE, DEA et al., 2013



Mitigation Hierarchy

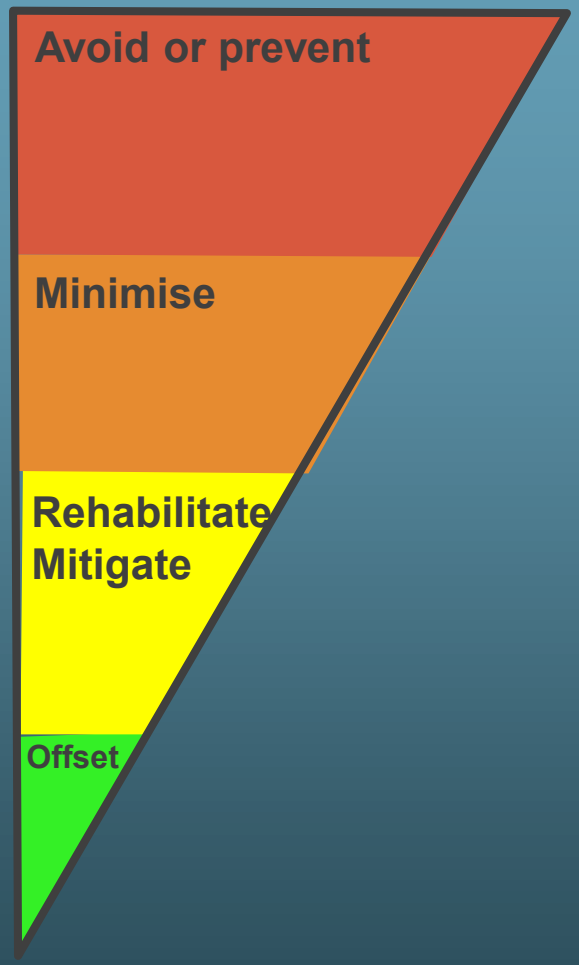
- *Fundamental tool for impact mitigation*
- *Impact mitigation is a legal requirement for authorisation*
- *Application is intended to strive to first avoid impacts and, where this is not possible, to minimise, rehabilitate or offset*
- *Inherently proactive, requiring ongoing and iterative consideration of alternatives*

Avoidance

- *Project location*
- *Siting*
- *Location*
- *Scale*
- *Layout*
- *Technology*
- *Phasing*
- *Early identification of no-go areas*

MITIGATION HIERARCHY

MINING & BIODIVERSITY GUIDELINE, DEA et al., 2013



Minimise

- *Consideration of alternatives*
  - *Location*
  - *Siting*
  - *Scale*
  - *Layout*
  - *Technology*

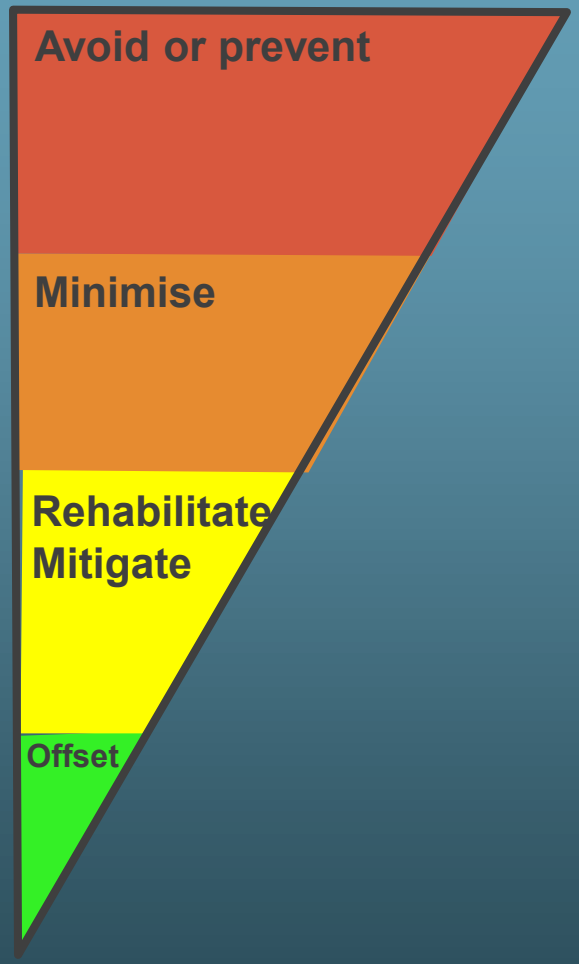
Rehabilitation/Mitigation

- *Refers to addressing impacts to areas that cannot be avoided or minimised*
  - *Re-vegetation*
  - *Re-shaping*
  - *Erosion/Sedimentation control measures*
  - *Water treatment*

- *Limitations to what can be rehabilitated and what can be achieved through rehabilitation activities*

MITIGATION HIERARCHY

MINING & BIODIVERSITY GUIDELINE, DEA et al., 2013



Offset

- *Refers to compensating for residual impacts after all other steps of the mitigation hierarchy have been exhausted*
- *Last resort*
- *Limitations to what can be offset*
- *Wetland Offset Guidelines - SANBI & DWS, 2014*

URBAN INFRASTRUCTURE
CASE STUDY

URBAN INFRASTRUCTURE

CASE STUDY

URBAN INFRASTRUCTURE
CASE STUDY

TYPICAL IMPACTS

Flow Changes

- *Increase in hardened surfaces*
- *Stormwater*
- *Interception of subsurface water*
- *Concentration of flows*

Erosion and sedimentation

- *Consequence of flow changes*

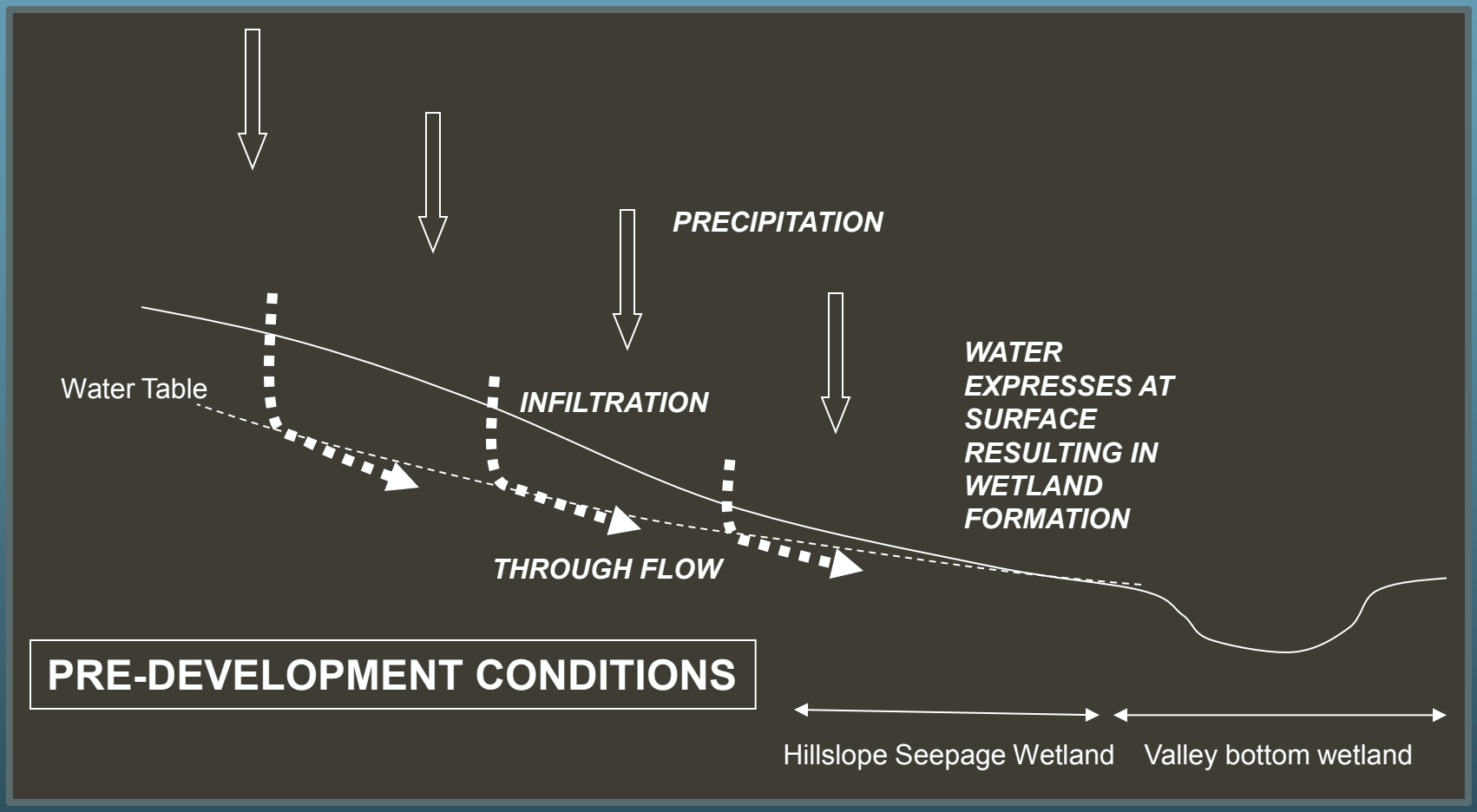
Water Quality Changes

- *Stormwater*
- *Waste water infrastructure*
- *Industrial activities*

Loss of wetland habitat & function

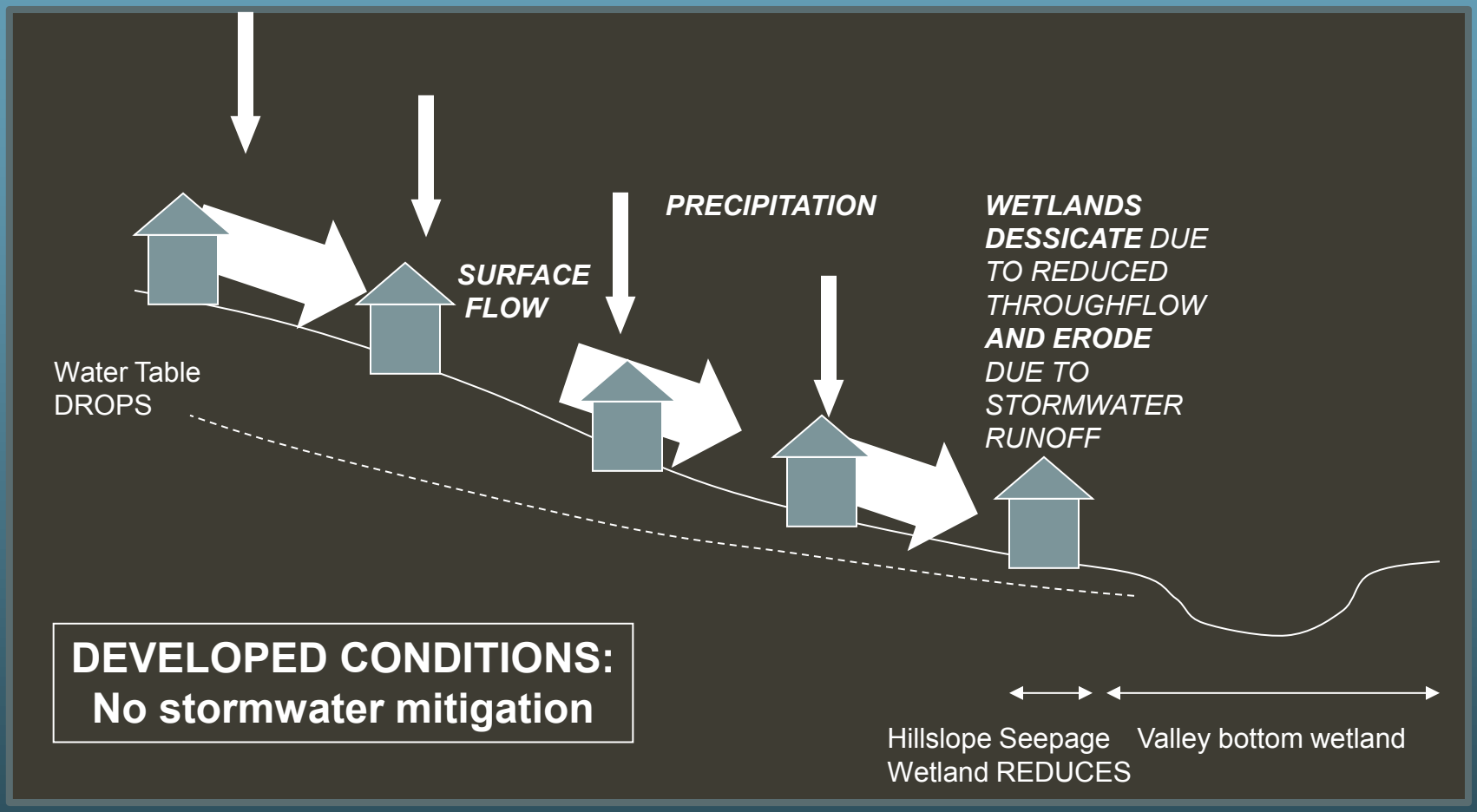
- *Wetlands located within the direct development footprint will be lost*
- *Degradation of wetland habitat*
- *Loss of species*

PRE-DEVELOPMENT CONDITIONS



DEVELOPED CONDITIONS

NO MITIGATION



TYPICAL MITIGATION MEASURES

Apply mitigation hierarchy!

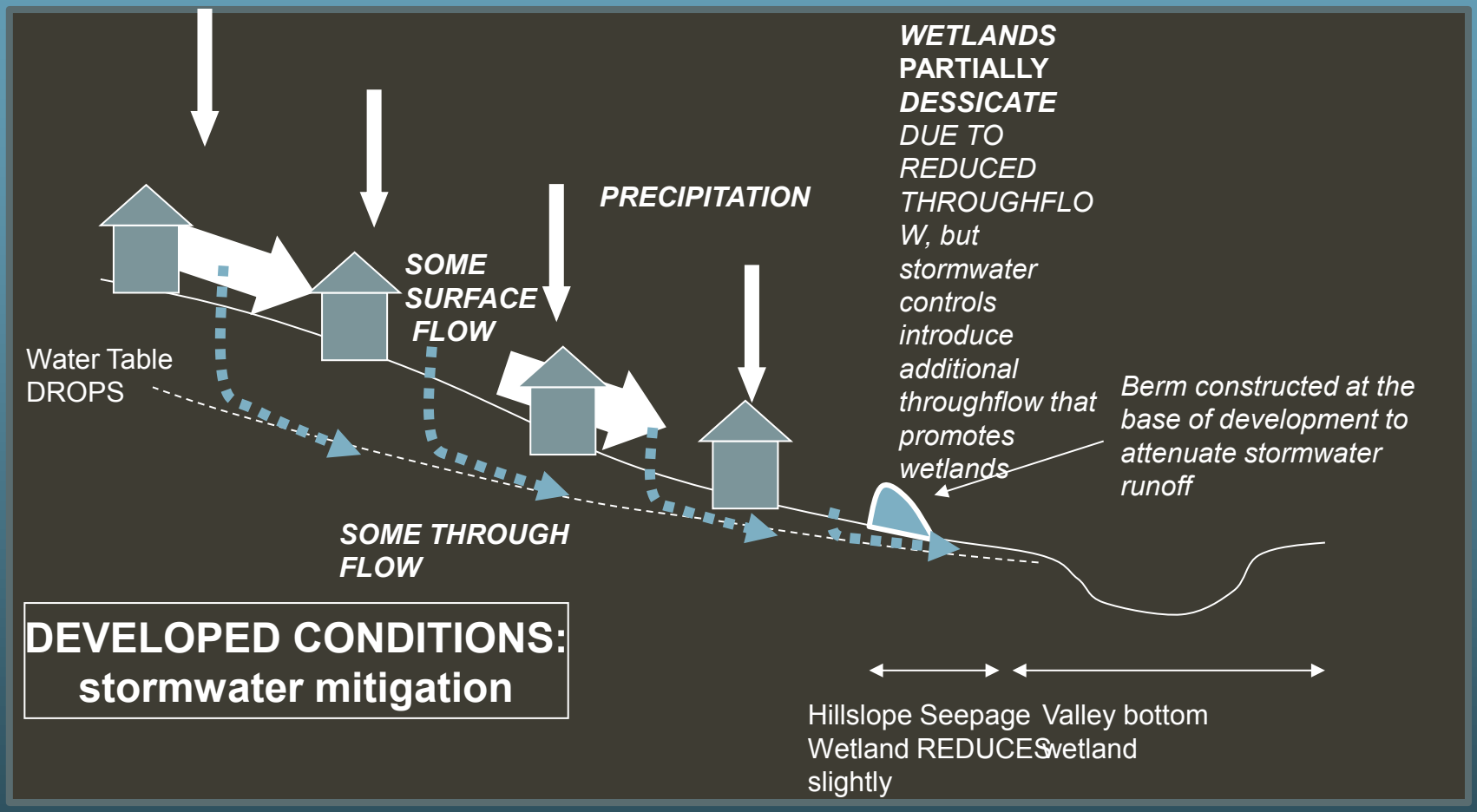
Minimise flow changes

- *Stormwater Management Plan (INCLUDE CONSTRUCTION PHASE)*
- *Attenuation Facilities*
- *Measures to reduce surface runoff*
  - *Minimise hardened surfaces*
  - *Encourage infiltration*
  - *Engineering solutions e.g. permeable paving*
  - *WSUDS – Water Sensitive Urban Design*
- *Discharge points*
  - *Energy dissipaters*
  - *Erosion protection*
  - *Sediment traps*
  - *Litter traps*

Buffer zone

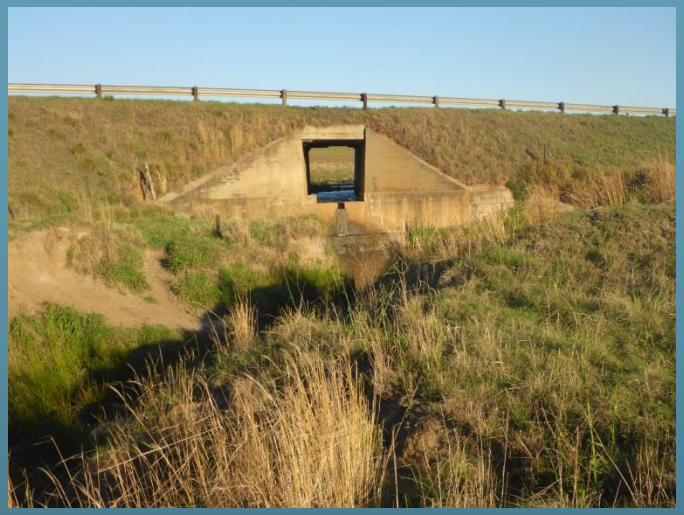
- *CANNOT ADDRESS POINT SOURCE DISCHARGES!*
- *Ecological requirements*
- *Aesthetic requirements*

DEVELOPED CONDITIONS
WITH MITIGATION



LINEAR INFRASTRUCTURE

ROADS, PIPELINES, POWER LINES, CONVEYORS



FORESTRY

CONTENT – MINING IMPACTS & MITIGATION

- *Opencast mining*
- *Underground mining*
- *AMD & decant*
- *River diversions*
- *Water management infrastructure*
- *Wetland Offsets*

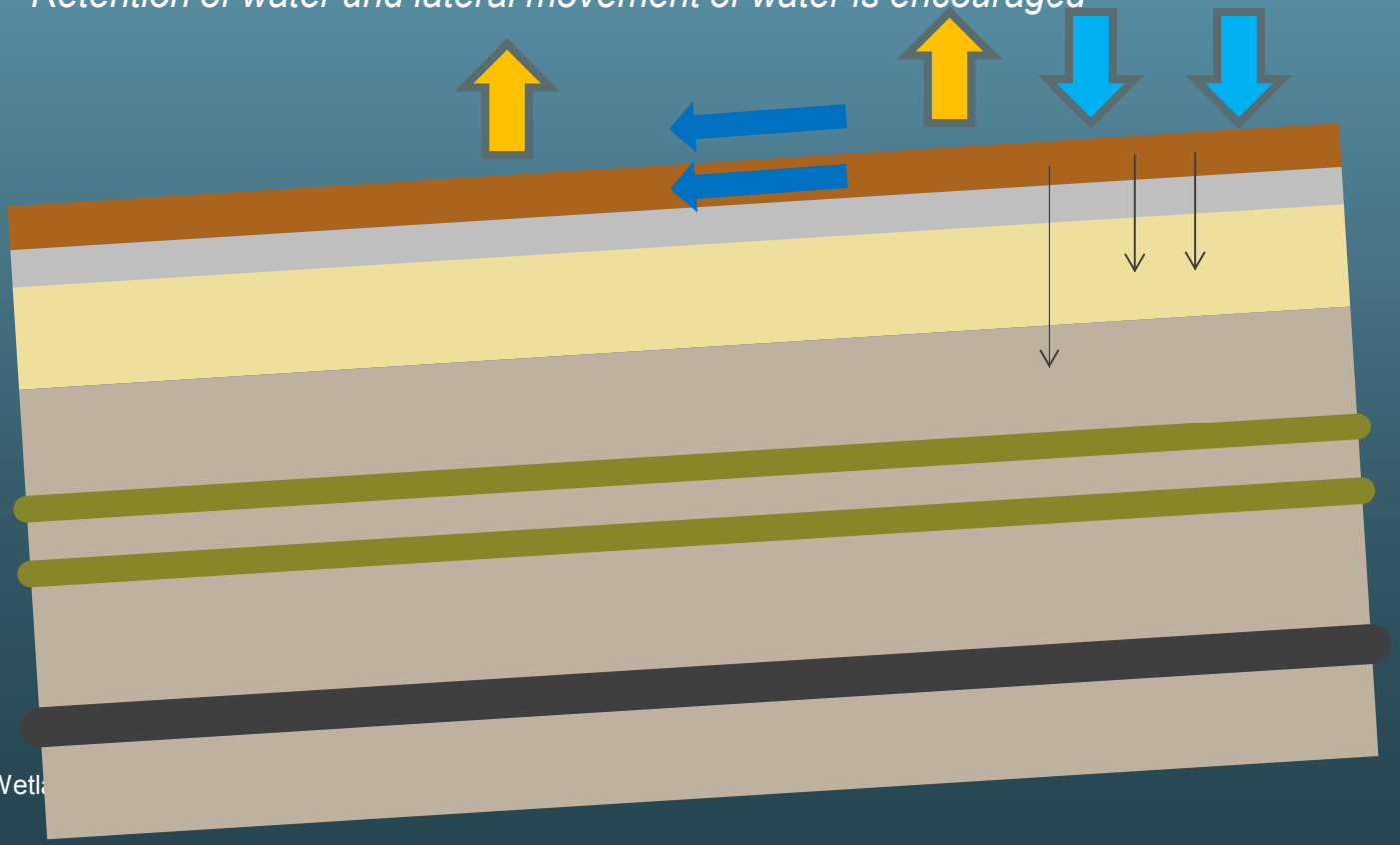
OPENCAST MINING

Opencast mining is a landscape altering process

- *Changes the way water moves through the landscape*
- *Changes the way water is retained in the landscape*

Natural soil profile and underlying Karoo sediments are horizontally layered

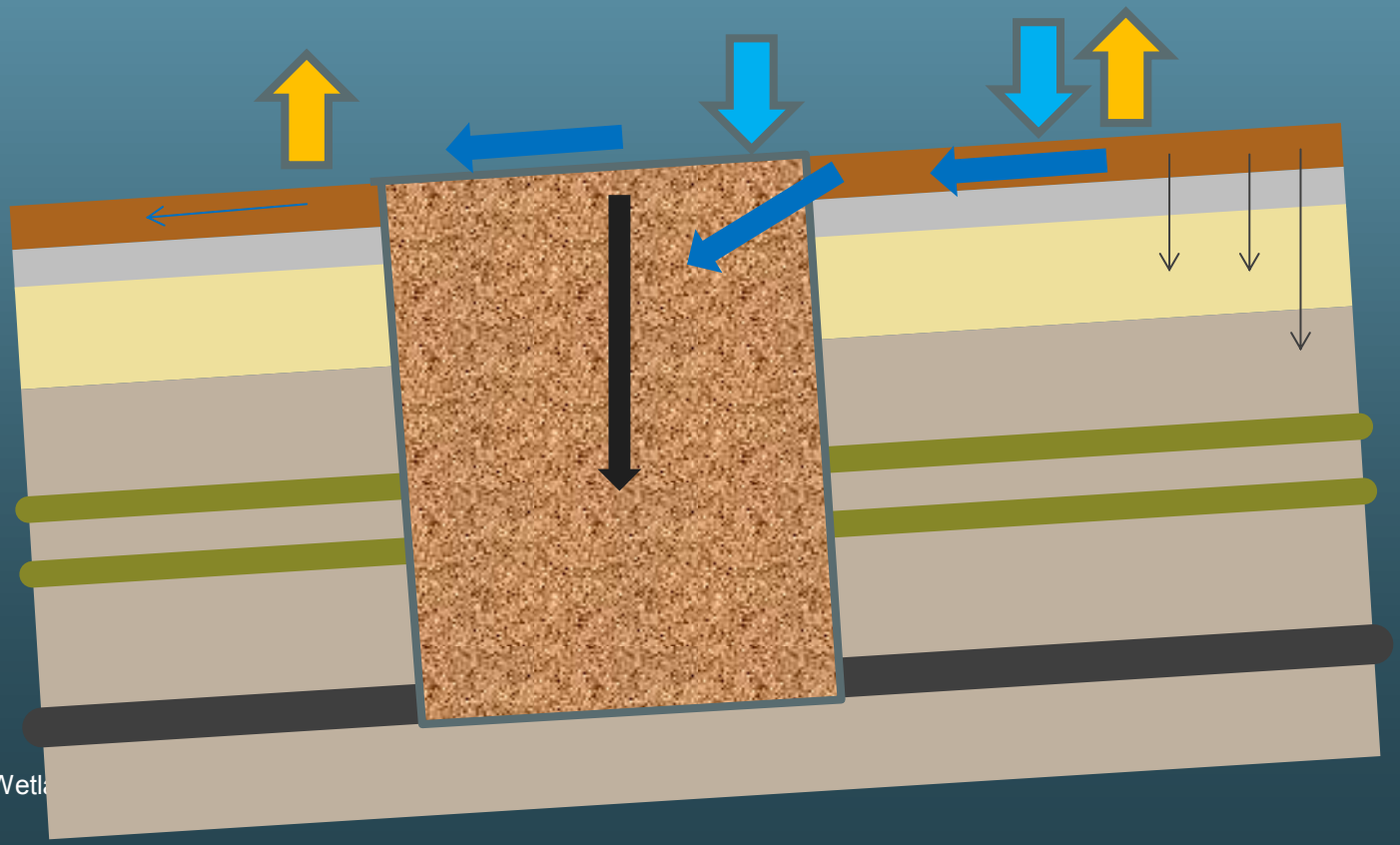
- *Vertical movement of water is limited – only 0-5% of rainfall enters groundwater*
- *Retention of water and lateral movement of water is encouraged*



OPENCAST MINING

Opencast mining

- *Increased infiltration to groundwater – 15 -20 % of rainfall*
- *Interception of interflow and groundwater*
- *Backfilled pits shaped to be free-draining – surface runoff*
- *Eventual decant*
- *Wetlands do not generally re-establish on rehabilitated landforms*



OPENCAST MINING

OPENCAST MINING

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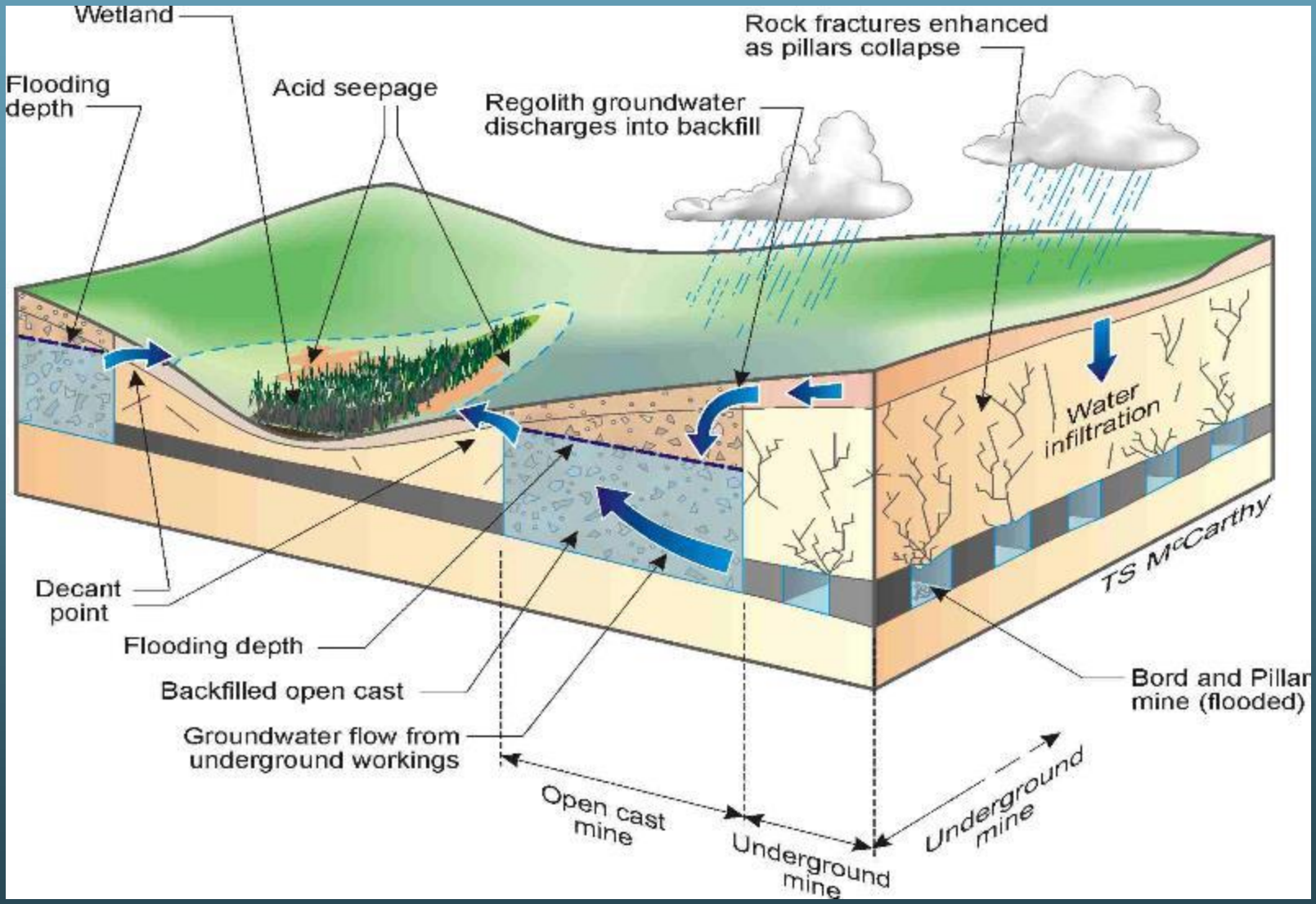


OPENCAST MINING

OPENCAST MINING

MITIGATION

Mine plan amendments

- *Avoid*
- *Minimise*
- *Rehabilitate/Mitigate*
- *Offset*

Exclude sensitive and no-go areas

- *Catchment?*
- *Buffer?*
- *Critical to consider drivers!*

Diversion of clean water

- *River diversions*
- *Clean & dirty water separation*
- *Re-introduction of water into natural systems*

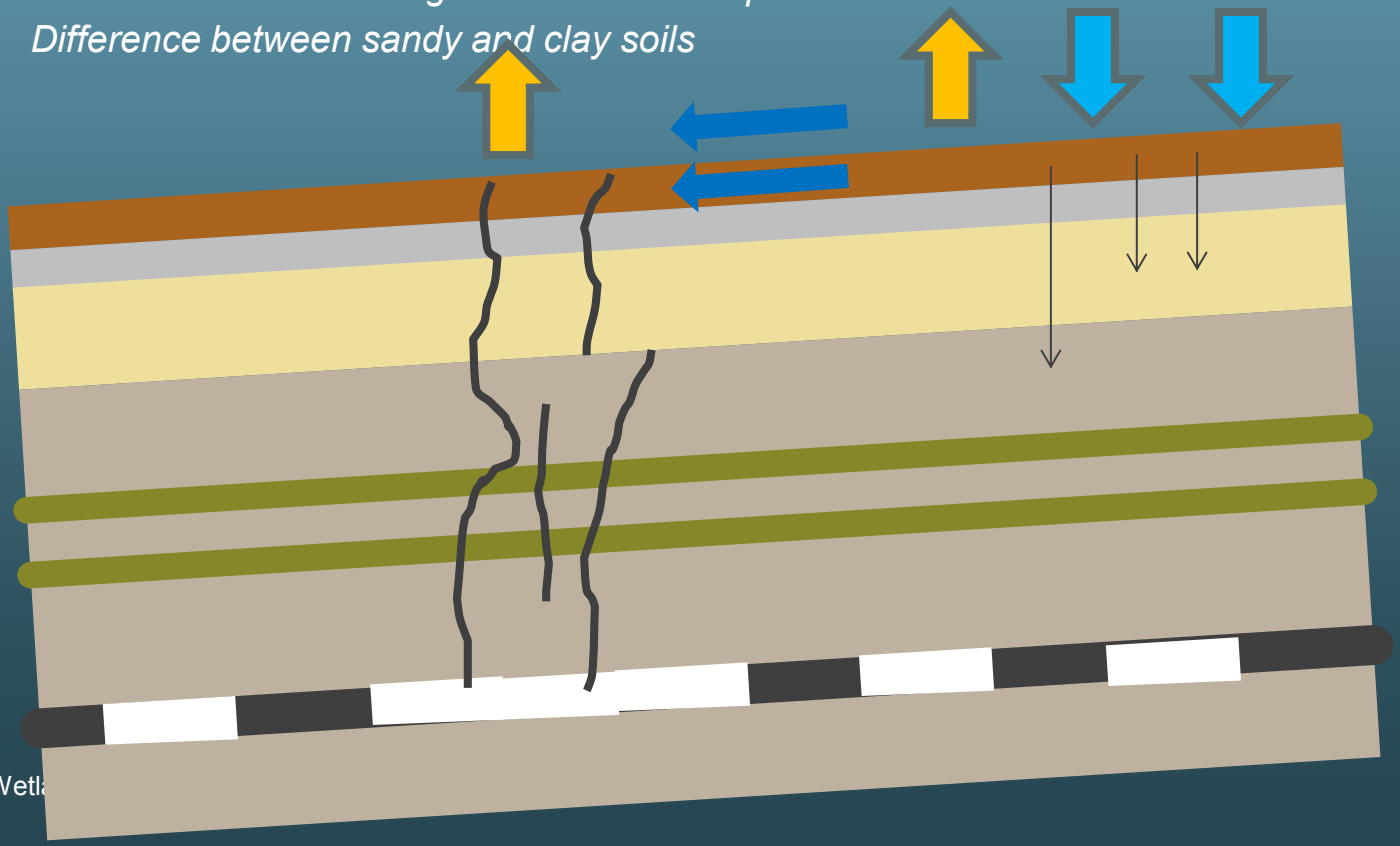
Water Quality

- *During and after mining*
- *Sedimentation*
- *Water treatment*

UNDERGROUND MINING

Underground mining

- *Various mining methods with various impacts*
  - *Bord and pillar*
  - *Longwall*
  - *Total extraction*
  - *Stooping*
- *If surface topography remains intact, impact might be minimal*
- *Subsidence and cracking could increase impact*
- *Difference between sandy and clay soils*



UNDERGROUND MINING

UNDERGROUND MINING

UNDERGROUND MINING

UNDERGROUND MINING

MITIGATION

Mine plan amendments

- *Avoid*
- *Minimise*
- *Rehabilitate/Mitigate*
- *Offset*

Restrict extraction

- *Ensure surface, interflow and weathered aquifer remain intact*
- *Increase pillar safety factor to ensure long-term stability*
- *Variable pillar safety factors based on wetland sensitivity*

Water Quality

- *Manage decant*
- *Water treatment*

ACID MINE DRAINAGE

AMD generation

- *Oxidation of pyrites in coal, discard and carbonaceous overburden can lead to generation of AMD*
- *Mining exposes pyrites trapped in rock to air and oxygen*
- *Mining increases the surface area of exposed rock*

Sources of AMD

- *Not restricted to coal mining*
- *Gold mining*
- *Dependant on chemical make-up of mined material*
- *Platinum group metals generally do not lead to AMD formation*

Water Quality

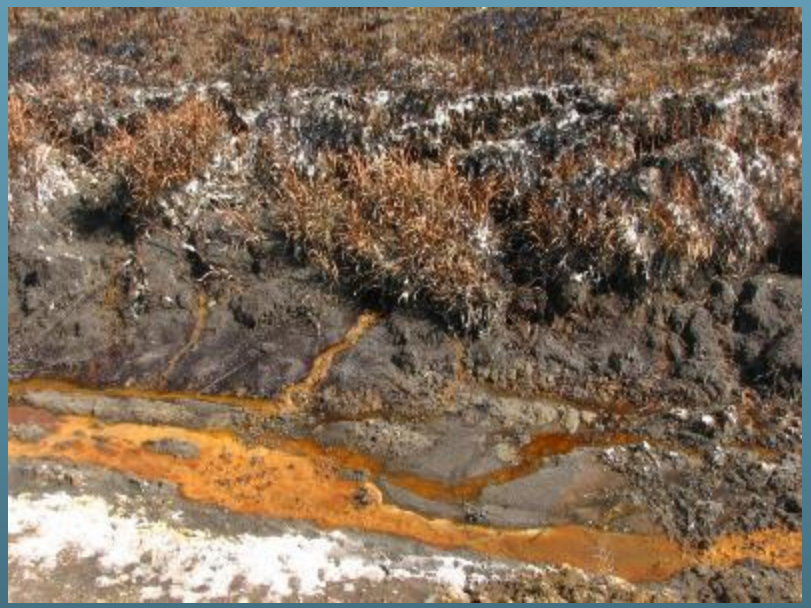
- *Manage decant*
- *Water treatment*

DECANT

DECANT

DECANT

DECANT & SEEPAGE



DECANT MITIGATION

Management of water levels

- *Flooding of mine workings – underground*
- *Underground storage of water*
- *Evaporation*
- *Controlled releases*

Water Treatment

- *Various technologies available*
- *Reverse osmosis generally used*
- *Passive treatment receiving increased attention*

Benefits of Water Treatment

- *Water can be treated to desirable quality*
- *Water becomes available for re-use*
- *Discharge of treated water - dillution*

Impact of Water Treatment

- *Generation of hazardous brine*
- *Discharge of treated water – increased flows*

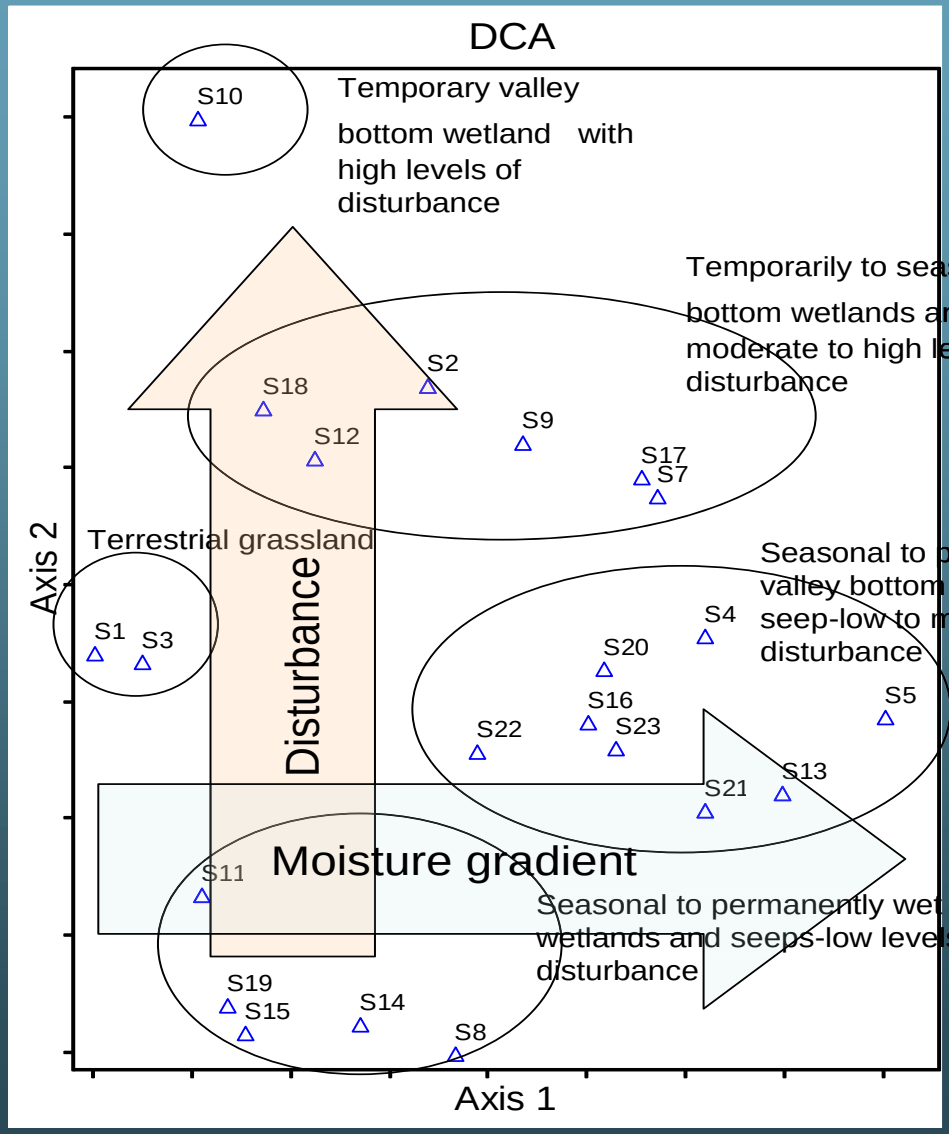
RIVER DIVERSIONS

RIVER DIVERSIONS

RIVER DIVERSIONS

CHANGES IN WATER MOVEMENT IN THE LANDSCAPE

IMPLICATIONS FOR BIODIVERSITY



WETLAND OFFSETS

Best practice guideline for wetland offsetting has been compiled by SANBI & DWA

> *SANBI and DWS, 2014. Wetland Offsets: A best practice guideline for South Africa. First Edition. Pretoria.*

Still a draft document – not yet gazetted – but widely applied

3 types of offset targets calculated

- *Functional Offset Target*
- *Ecosystem Conservation Targets*
- *Species of Conservation Concern*

Principle of NO-NET-LOSS

WETLAND OFFSETS

Last step of the mitigation hierarchy

- *Avoid*
- *Minimise*
- *Rehabilitate/Mitigate*
- *Offset/Compensate*

Wetland offsets present numerous challenges

- *Land ownership*
- *Mineral rights*
- *Surrounding activities*
- *Risk of failure*
- *Securing offsets into the future*

Not a means of gaining authorisation for impacting on wetlands, but an additional 'mitigation' measure

FEASIBILITY OF REINSTATING WETLANDS IN A POST-MINED LANDSCAPE

The reinstatement of wetlands in the post mining landscape relies on the ability to manage water flow through the landscape.

This is technically feasible for some wetland types.

Been avoided in the past in order to avoid any risk of increased water make back into the mined out, backfilled voids.

Lack of offset opportunities in certain catchments is forcing some of the mining houses to consider this option.

FEASIBILITY OF REINSTATING WETLANDS IN A POST-MINED LANDSCAPE

The expectations as to what may be achievable should be realistic

Cannot expect to recreate wetlands that once occurred at the site nor create systems that would necessarily approach the biodiversity and functionality of natural systems

Aim should rather be to improve the functionality and associated habitat and species diversity in the post-mined rehabilitated landscape

Getting authority buy-in to such an approach will be a pre-requisite

Could be undertaken as part of a passive treatment system

WETLAND REINSTATEMENT IN POST-MINING LANDSCAPES

THANK YOU