Geospatial Application for Drainage Improvement in Oil Palm Cultivation: Case Study in Berau, Indonesia

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Presentation Outline

- Introduction
- General Drainage Improvement
- Technique 1: Basic drain network
- Technique 2: Embankment
- Technique 3: Compartment
- Technique 4: Channeling
- Technique 5: Diversion
- Discussion and Conclusion

Introduction

- Rapid expansion of oil palm industry planting into marginal areas
- One typical problem in marginal areas is related with water such as:
  1. **poor drainage**
  2. **flood**
  3. **high water table**
- In most cases, area having drainage problem from only part of a given concession that has to be managed
- The impact of poor drainage depends on the severity such as the extent, frequency, duration and depth of floods

Introduction (cont'd)

- inhibit palm growth

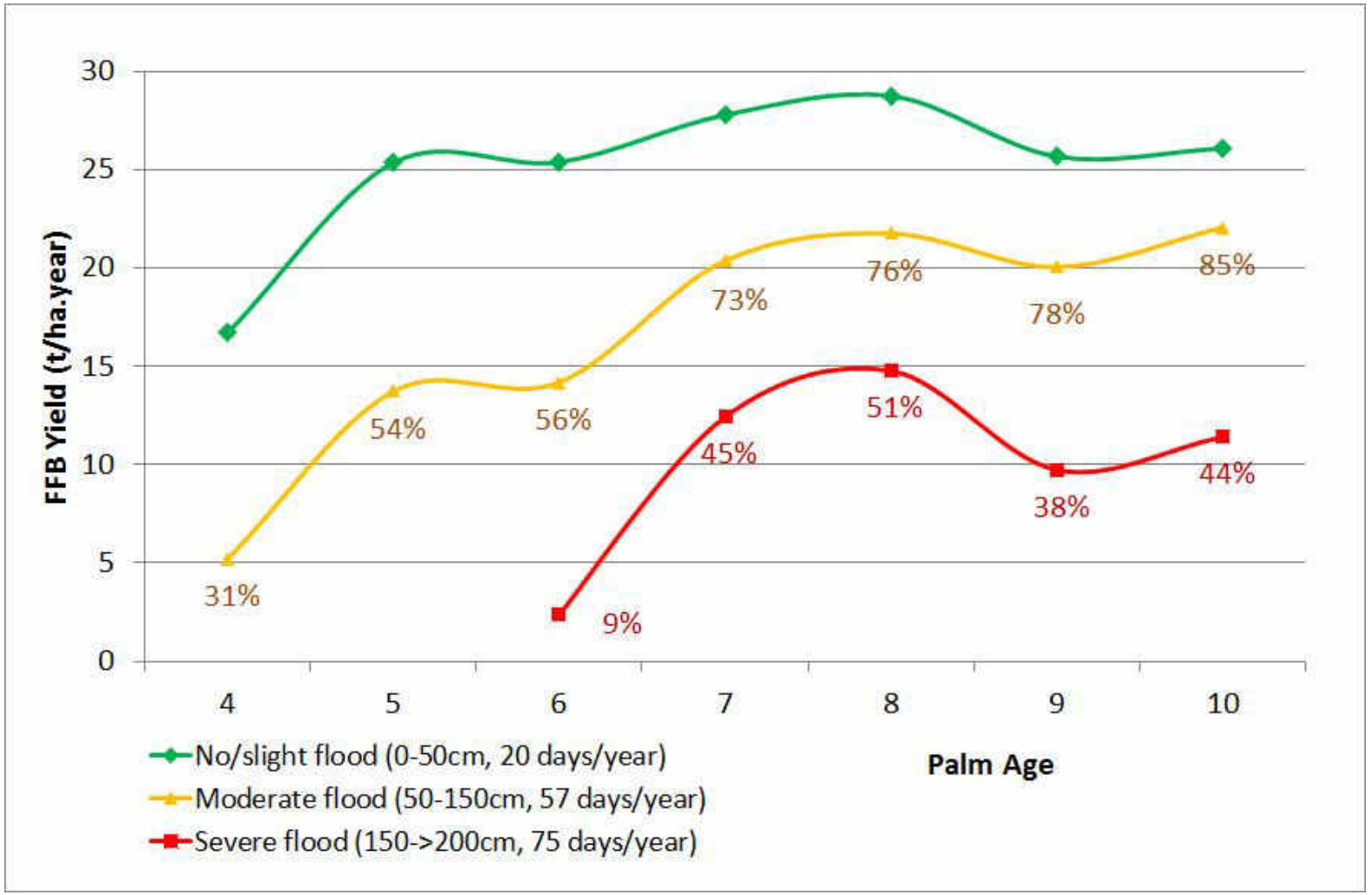
Introduction (cont'd)

- hinder crop recovery and reduce yield

Introduction (cont'd)

- areas with severe and prolonged flooding are often not worth developing and should just be left in their natural stage

Introduction (cont'd)



- Impacts of flood and poor drainage problem on oil palm yield
- Severe floods caused the field to be replanted twice and delayed harvesting

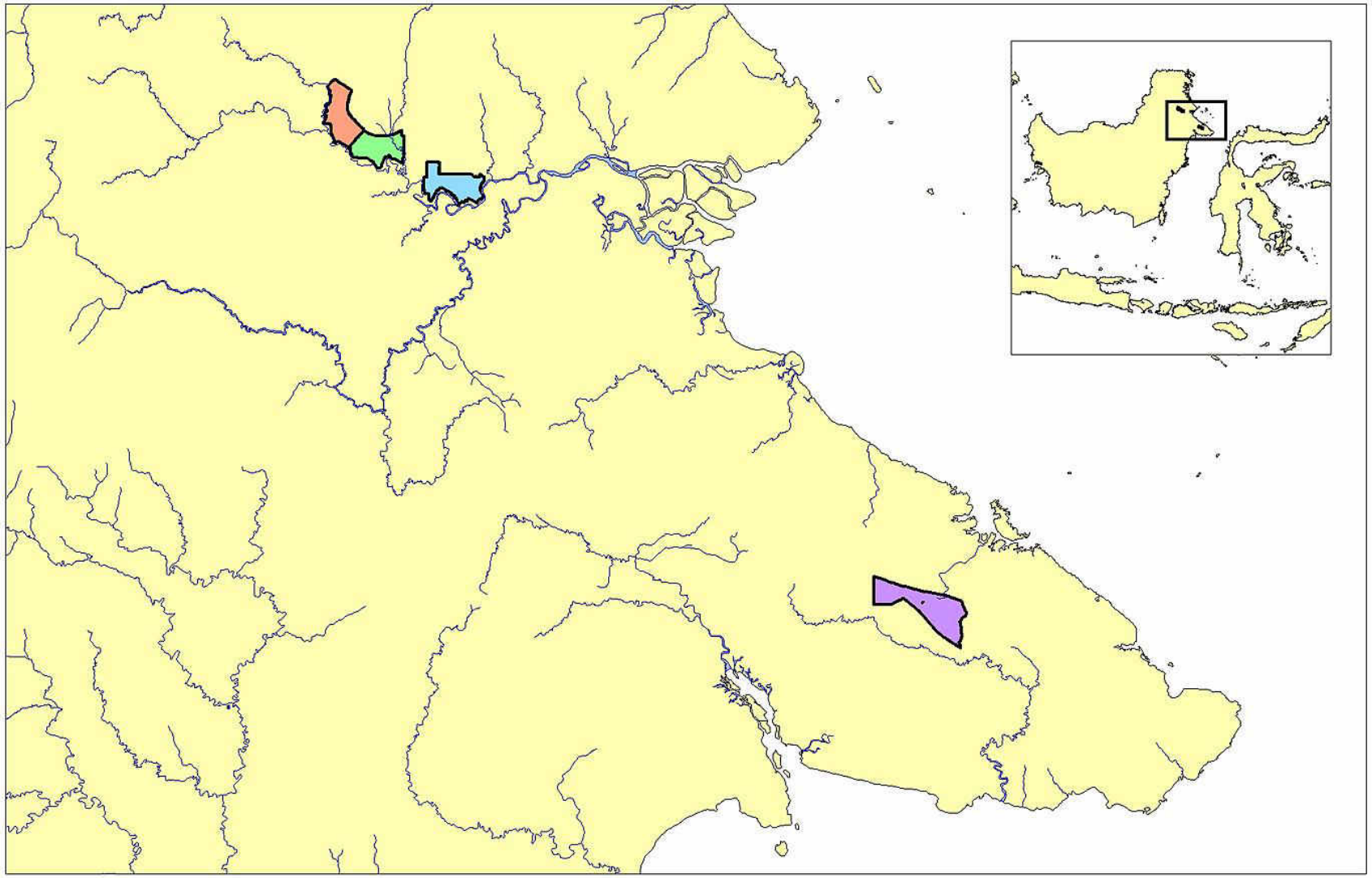
Commercial data – PT. SR

Drainage Improvement

- **A practice to improve the prevailing natural drainage condition** (Lambert *et al.*, 2004)
- Specific cases for oil palm, drainage improvement aims to:
  - **Provide a minimum 60 cm effective soil depth.** Oil palm can grow with only 50 cm of effective soil depth (Corley and Tinker, 2003), but to maximize yield, it has to be brought down to 100 cm and well supplied with nutrients.
  - **Flood mitigation**. Ensure flood free environment throughout the years for optimum palm growth and to facilitate field operations.
- A common and cost effective drainage system for oil palm cultivation is the **surface/open ditch drainage system**

Drainage Improvement (cont'd)

- Study area: 4 companies covering almost 34,000 ha
- Various types of **techniques** were adopted to solve different types of problem



Technique 1:

Basic drain network

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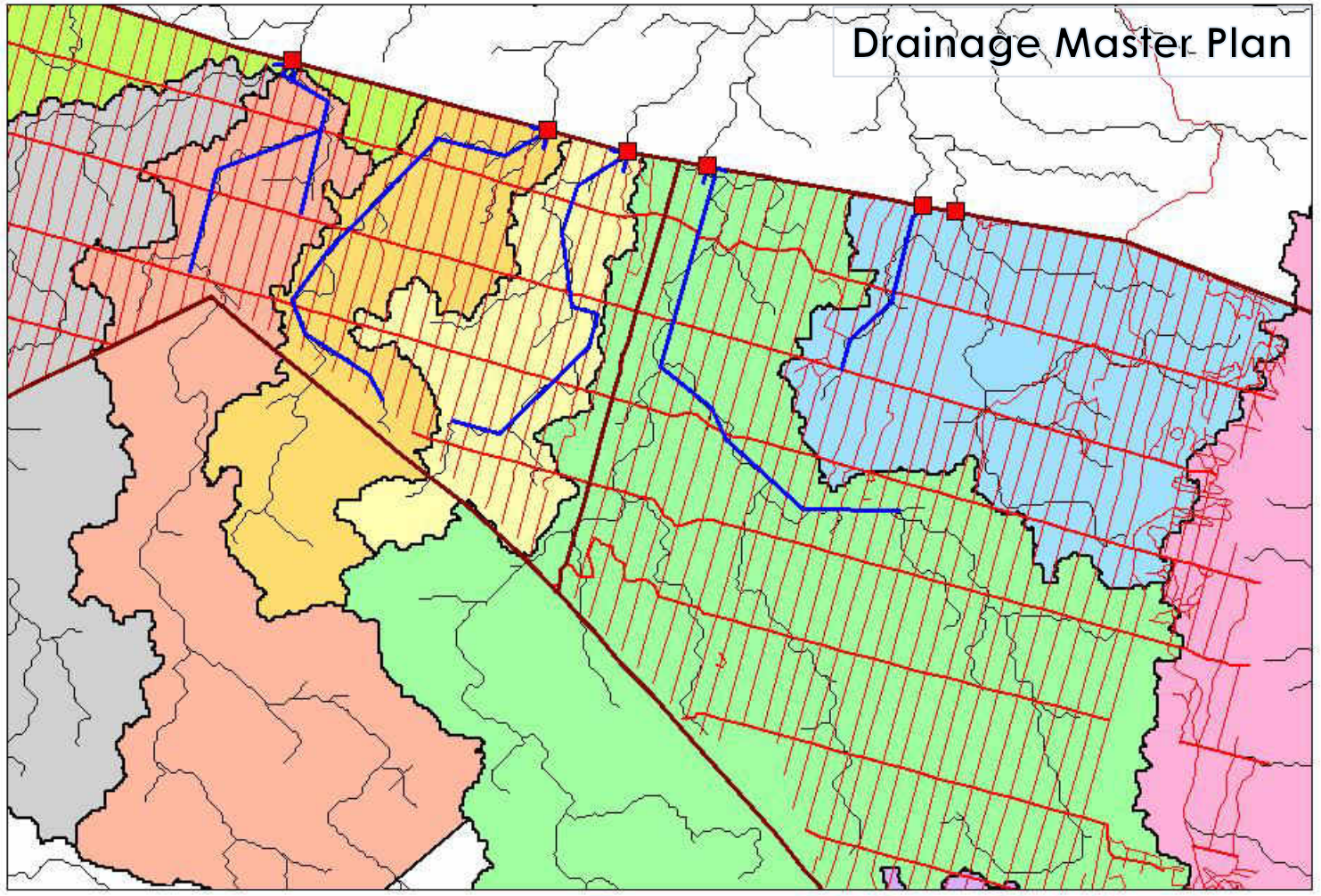
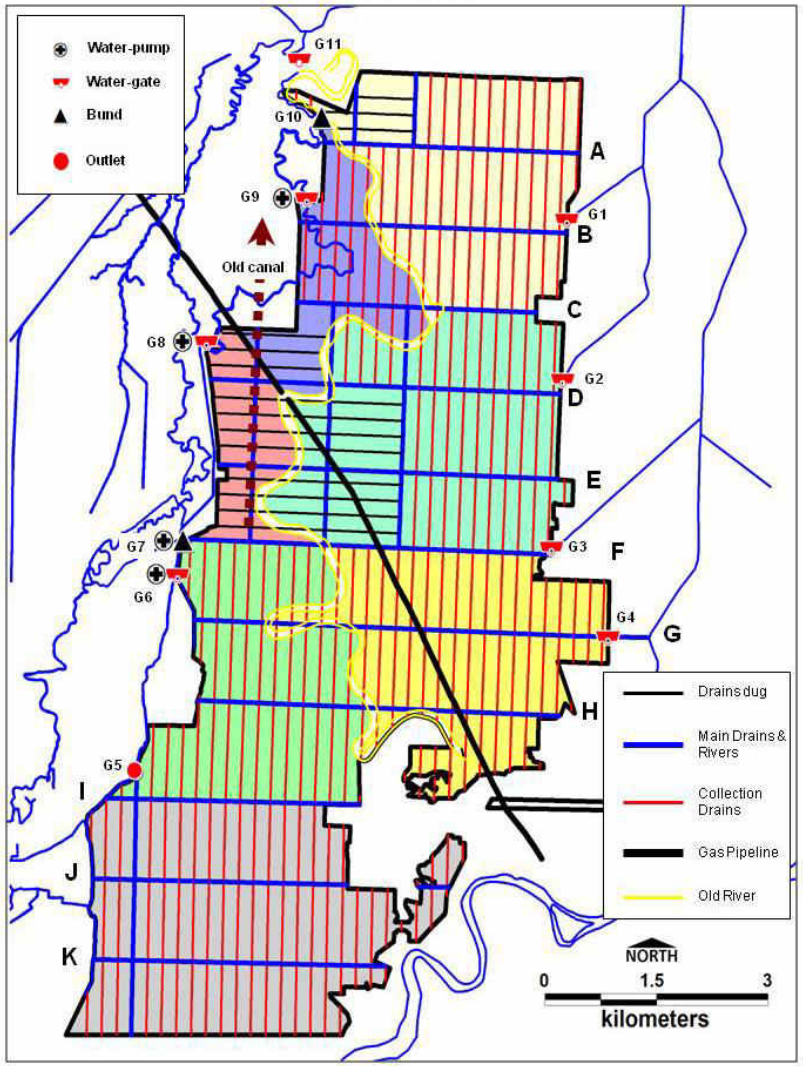
Basic drain network

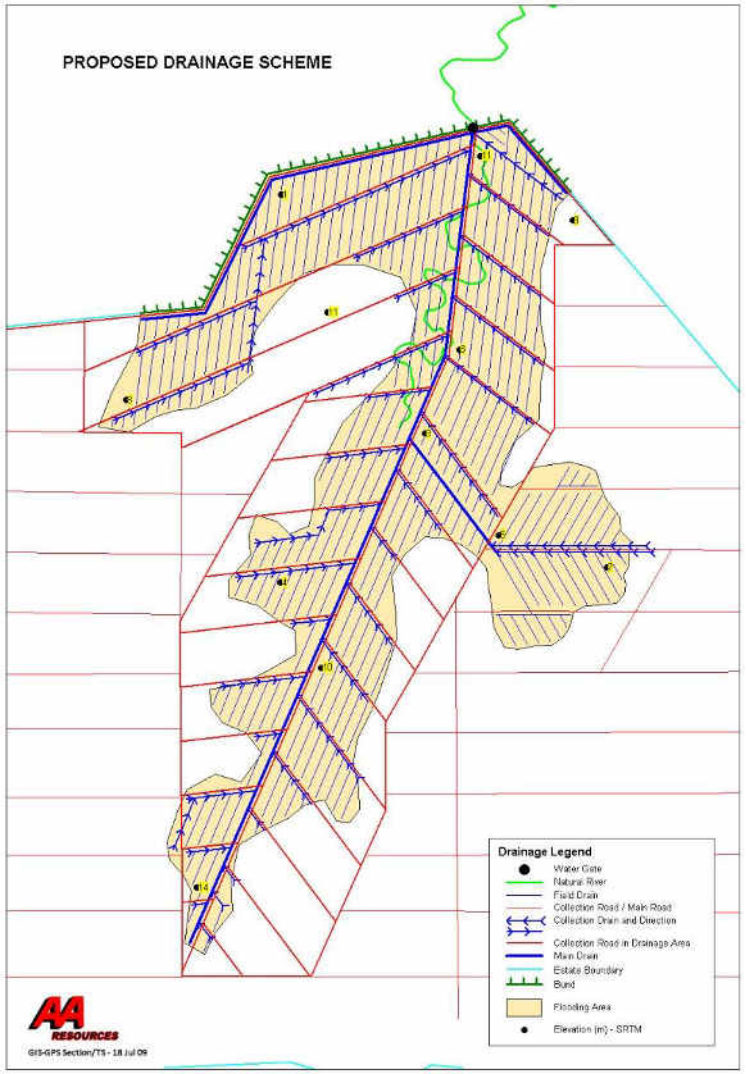
- For areas with sufficient slope gradient and no flood problem
- Digital elevation data (SRTM) is used as a guide to draw master plan
- Ground check and elevation survey may be required to confirm the design before implementation

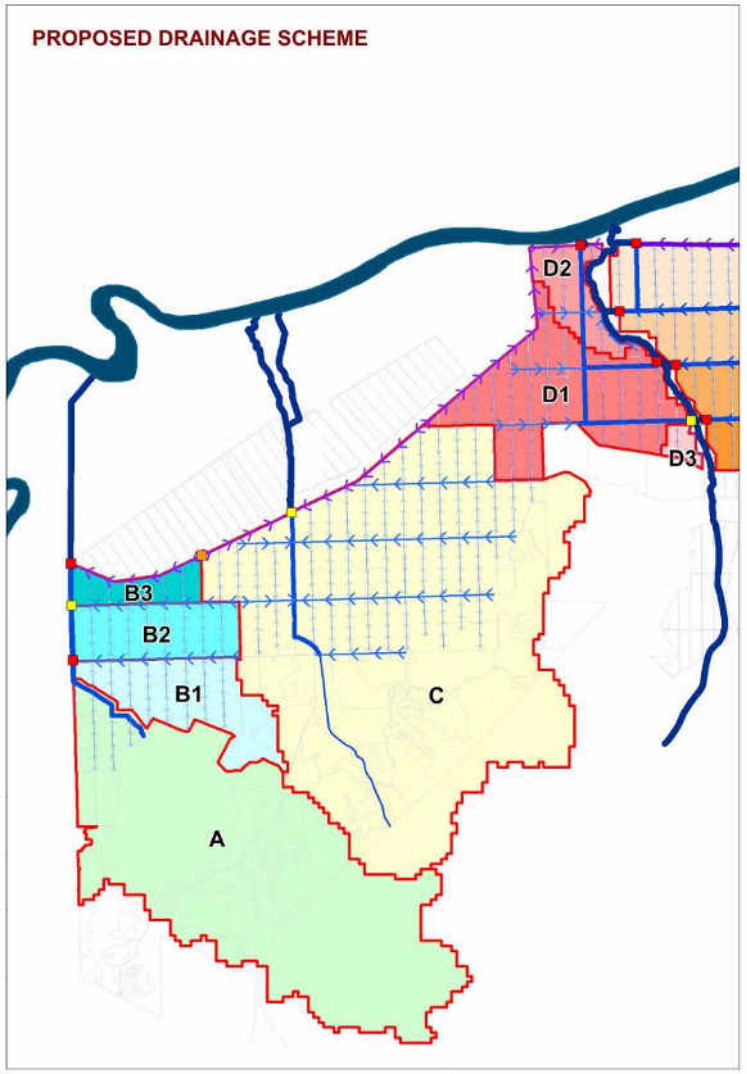


Technique 1:

Basic drain network (cont'd)



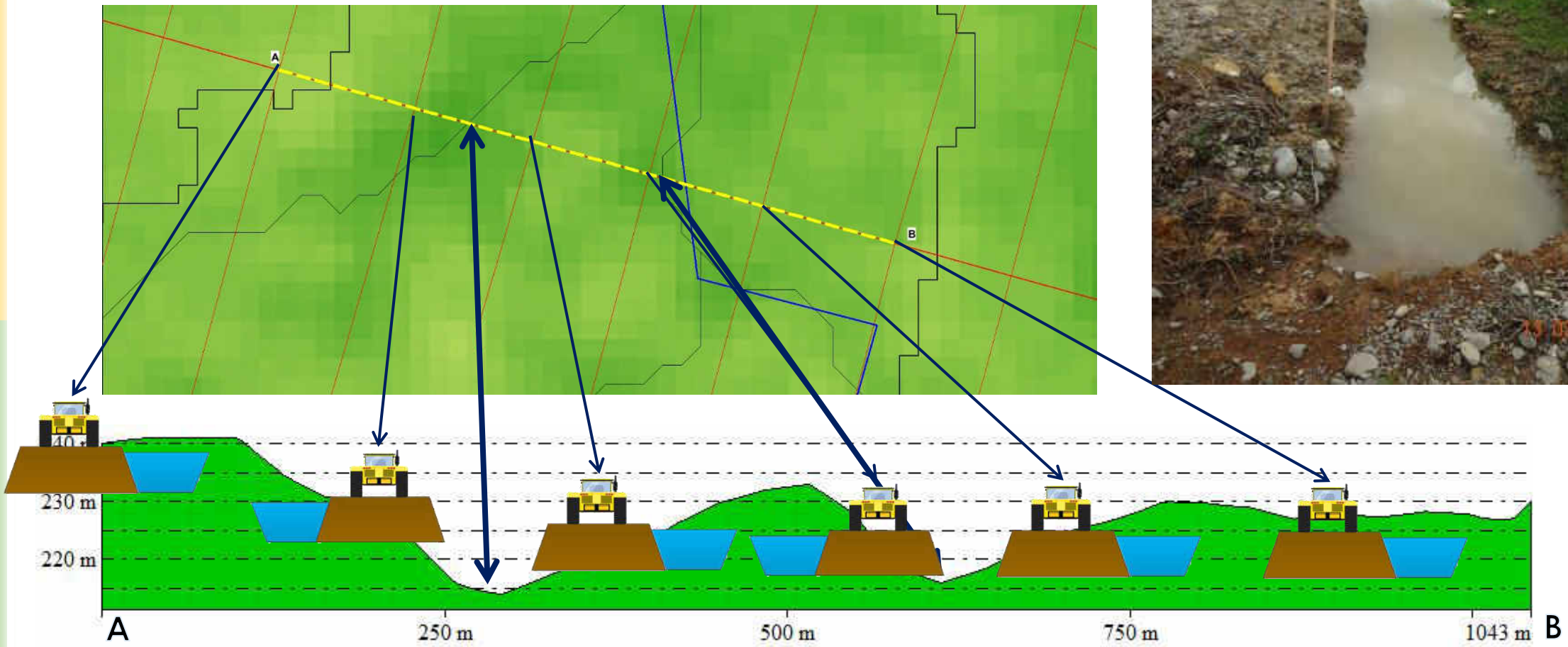




Technique 1:

Basic drain network (cont'd)

- Common mistake: Generalized collection drain position



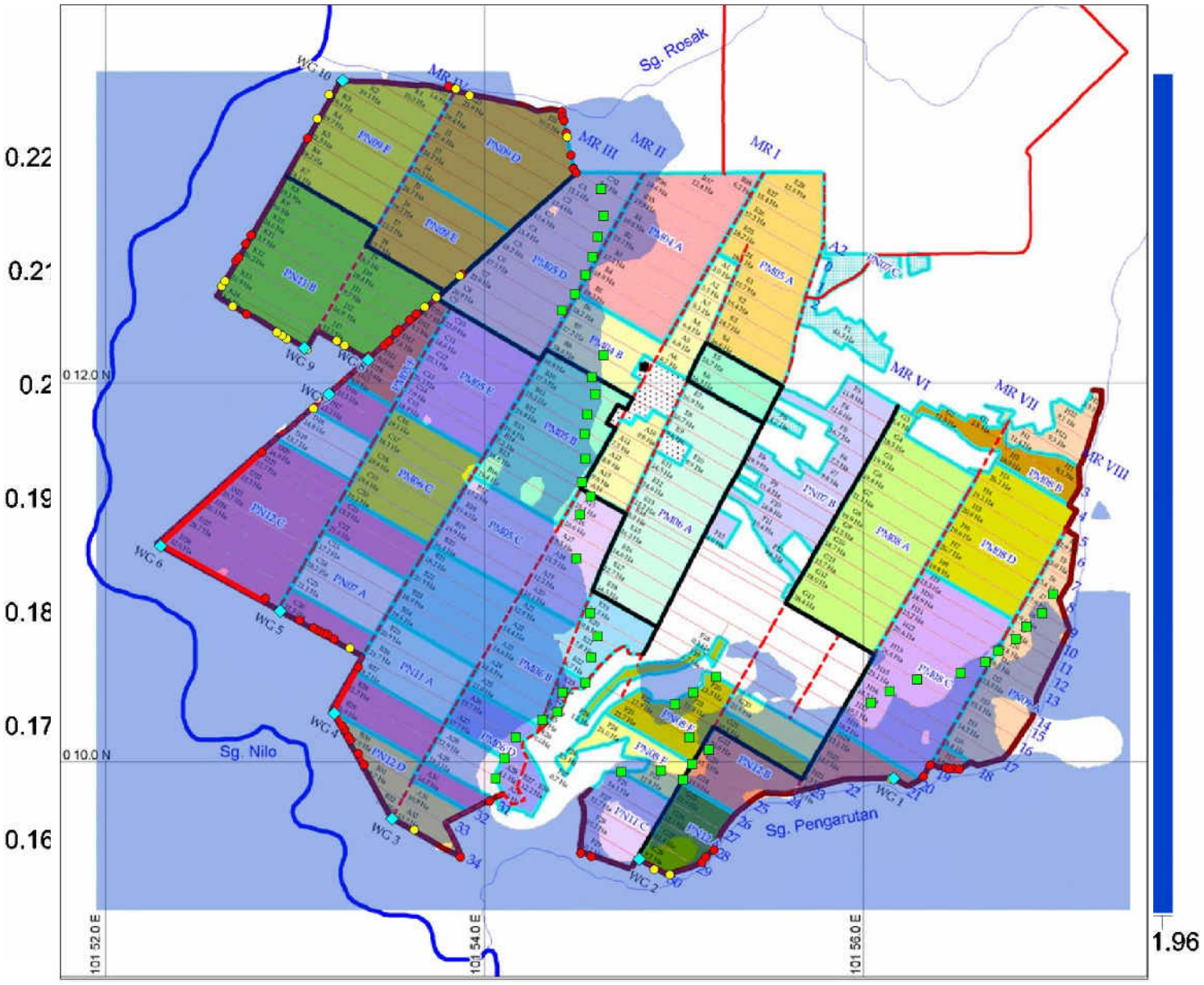
Technique 2:

Embankment

Technique 2:

Embankment

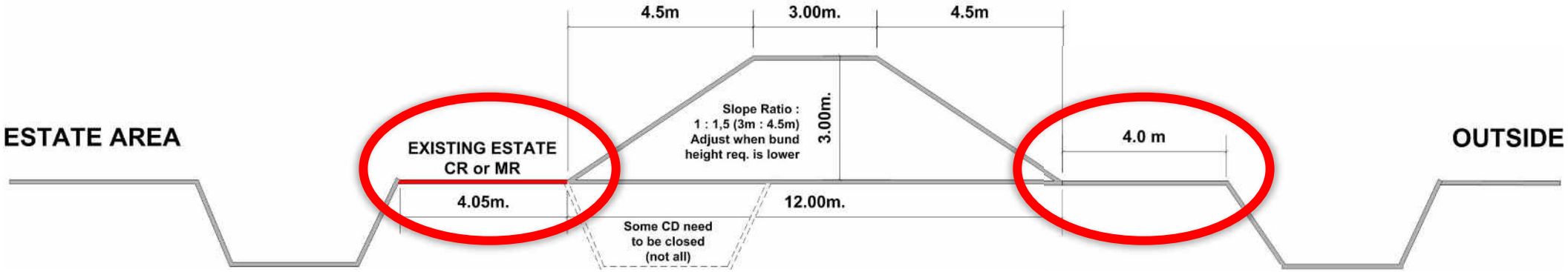
- For areas where water from rivers overflow/ backflow into the field
- Geospatial model for estimating flood:
  - extent
  - depth



Technique 2:

Embankment (cont'd)

- The design: embankment base is essential



Technique 2:

Embankment (cont'd)

- Precision levelling

Technique 2:

Embankment (cont'd)

- Water gate

Sluice gates – Manually operated or by motor

<u>Problem:</u>

- *Require manpower*
- *Poor supervision – e.g. backflow during high tides at night*

Flap gates – Will close automatically if the water level outside the embankment is higher

<u>Problem:</u>

- *Leaking caused by debris*

Technique 2:

Embankment (cont'd)

- Pump
  - To remove excess water that cannot be drained naturally (via gravity flow)
  - Costly to install and operate but usually not efficient
  - Should be the last option

Technique 2:

Embankment (cont'd)

- To utilize the embankment as road, aiming for:
  - Operational access – the embankment doesn't cut any road
  - Compaction – the more compact the better for its strength
  - Inspection - if damage, depression, land slide etc.

Technique 3:

Compartment

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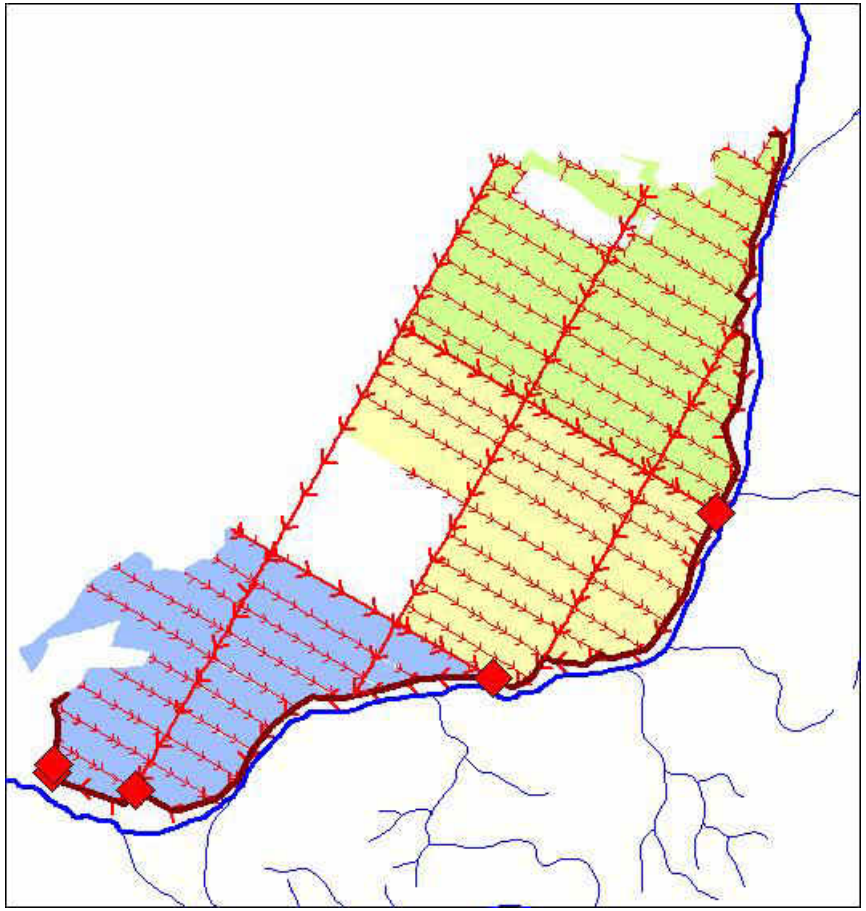
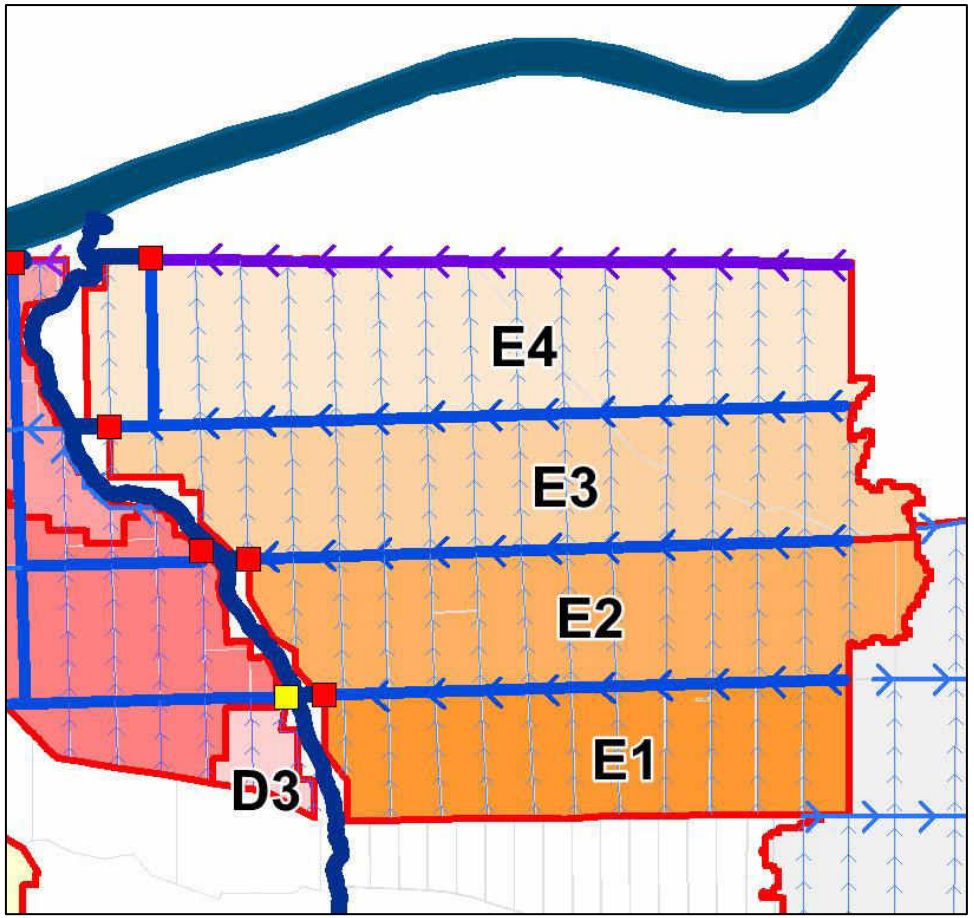
Compartment

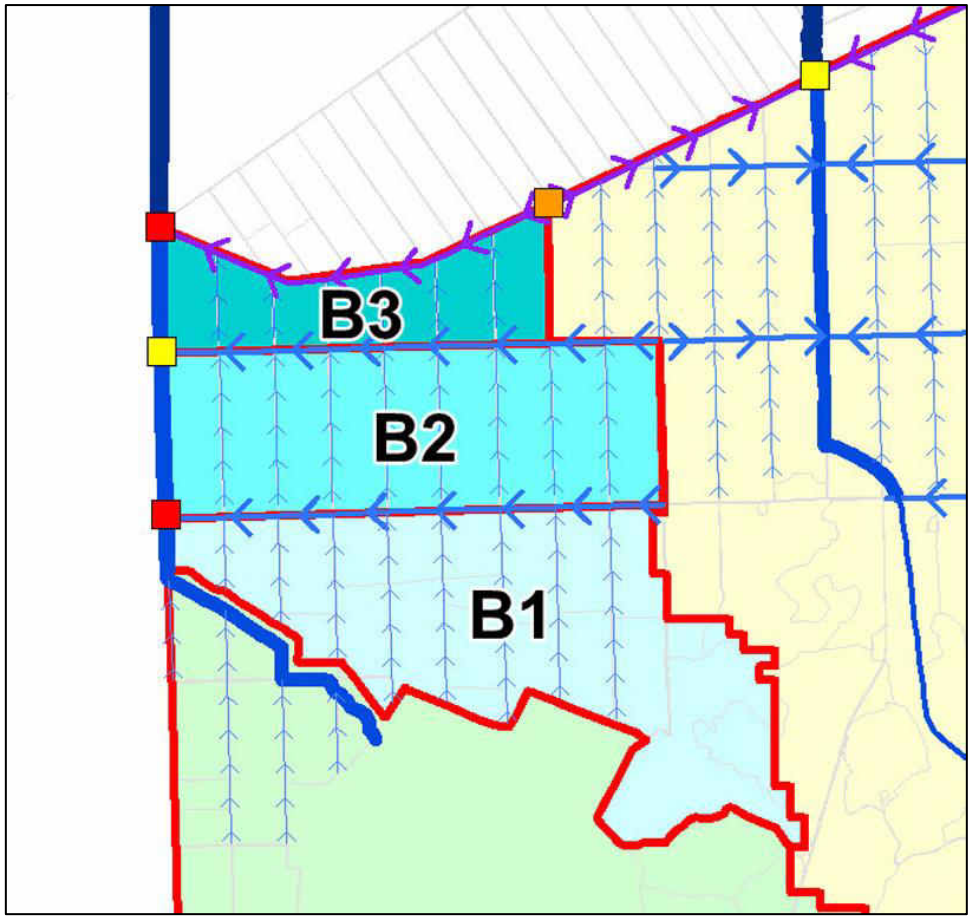
- Technique to speed up water discharge (Q)
- A single large catchment is strategically divided into smaller sub catchments with individual outlets
- It is useful for areas affected by tidal effect where the duration of outflow is limited to only during low tides



Technique 3:

Compartment (cont'd)





Technique 4:

Channeling

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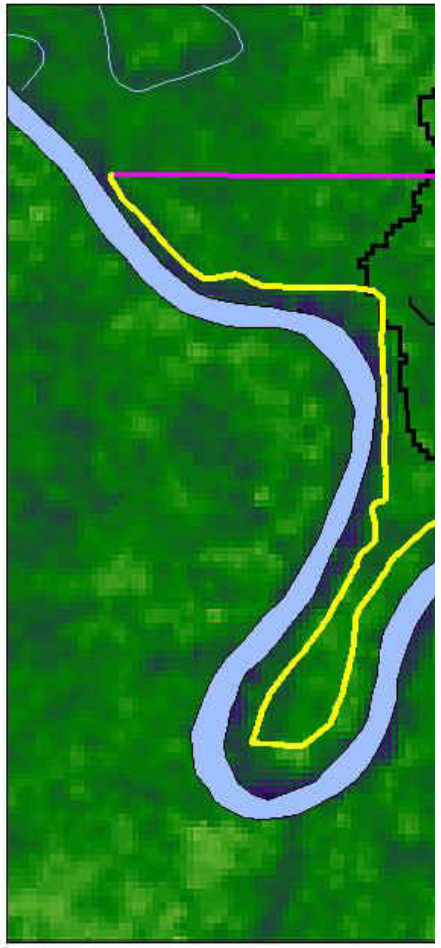
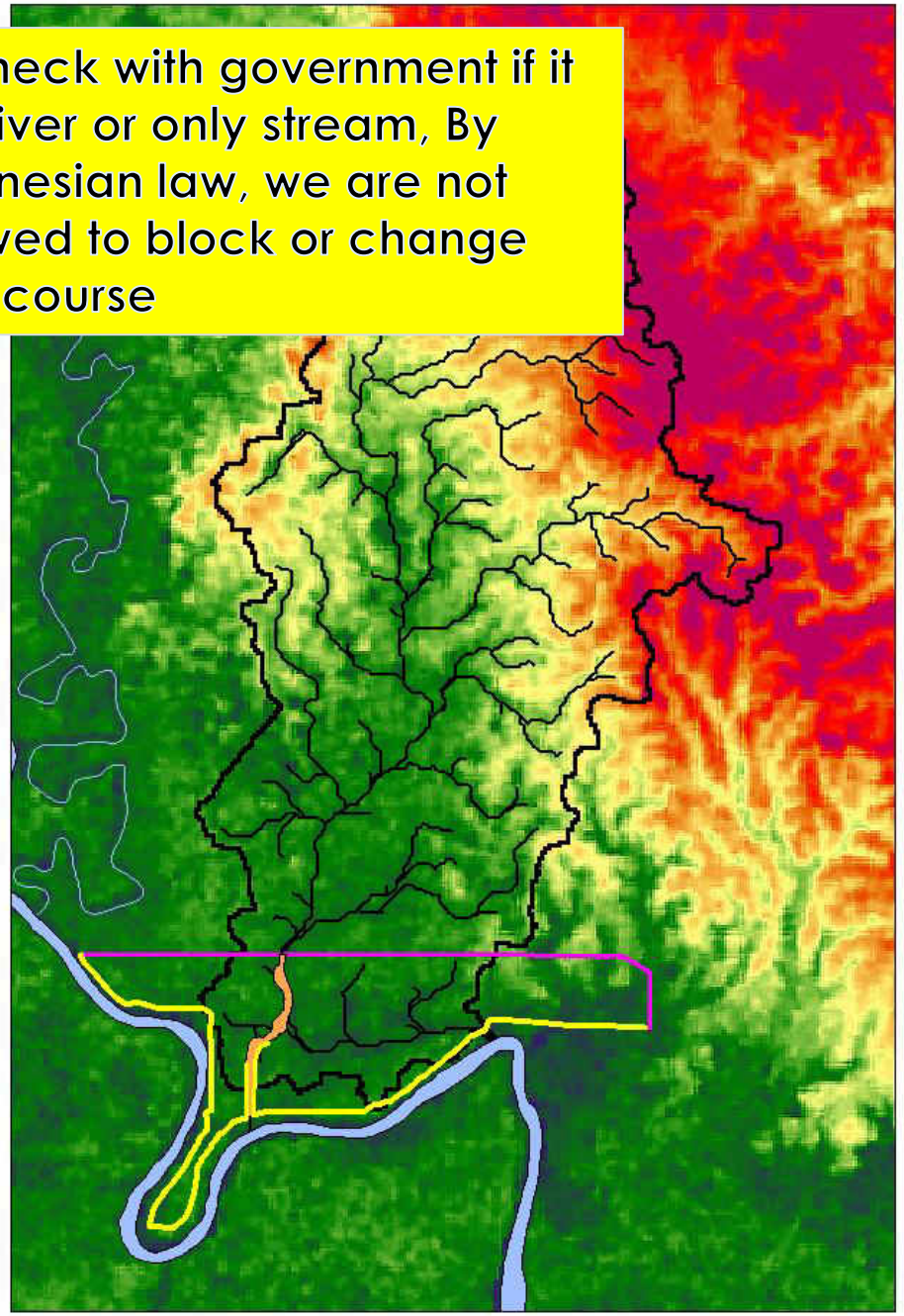
Channeling

- Condition when:
  - Where a drain or river is draining a large amount of water from catchments outside the estate
  - backflow problem – water level in the waterway outside the bund is often high
- Channeling means to connect and guide water from the catchments directly into waterways, by-passing estate area via a large canal

!!! To check with government if it is a river or only stream, By Indonesian law, we are not allowed to block or change river course





Technique 4:

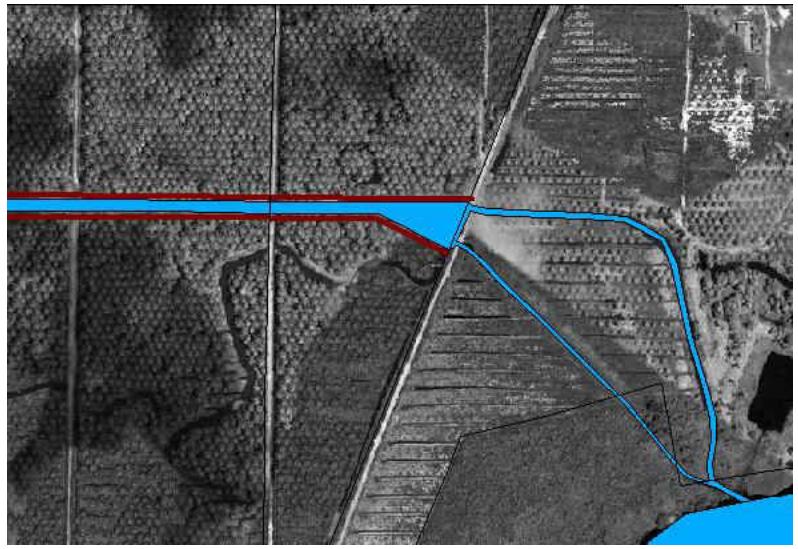
Channeling (cont'd)

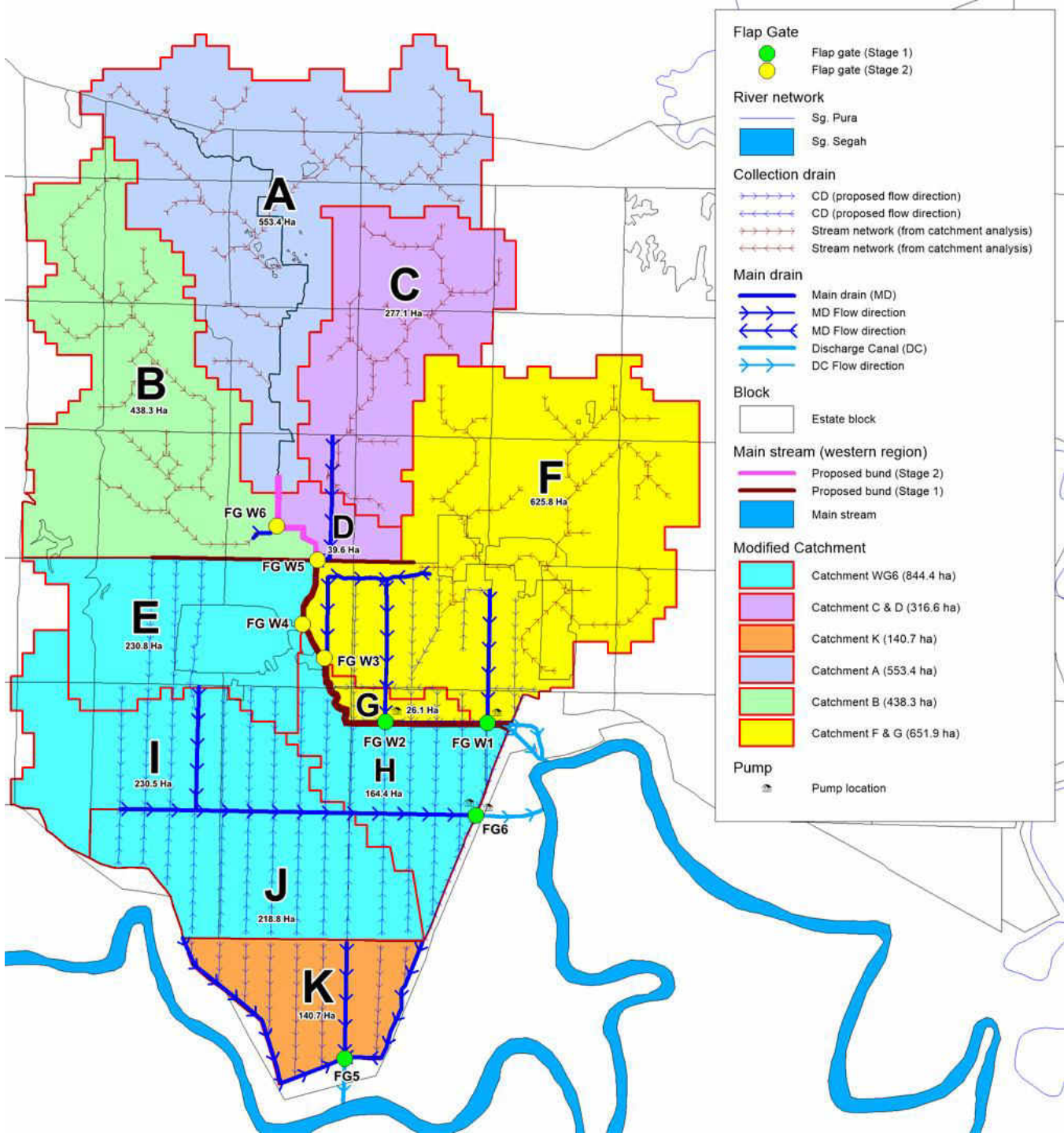
- The canal should be free flowing and flanked by high embankment on both sides – no obstacle
- Perimeter drain is required to gather rainwater from adjacent fields
- A flap-gate is not required for the canal at its outlet but necessary for the perimeter drains,
- When backflow occurs, excess water will only fill the canal but will not overflow into the fields

Technique 4:

Channeling (cont'd)

- The canal should extend to areas where water likely to overflow into the field during wet seasons
- The bund should be raised to the height (preferably not more than 6 feet) sufficient to prevent overflowing





Technique 5:

Diversion

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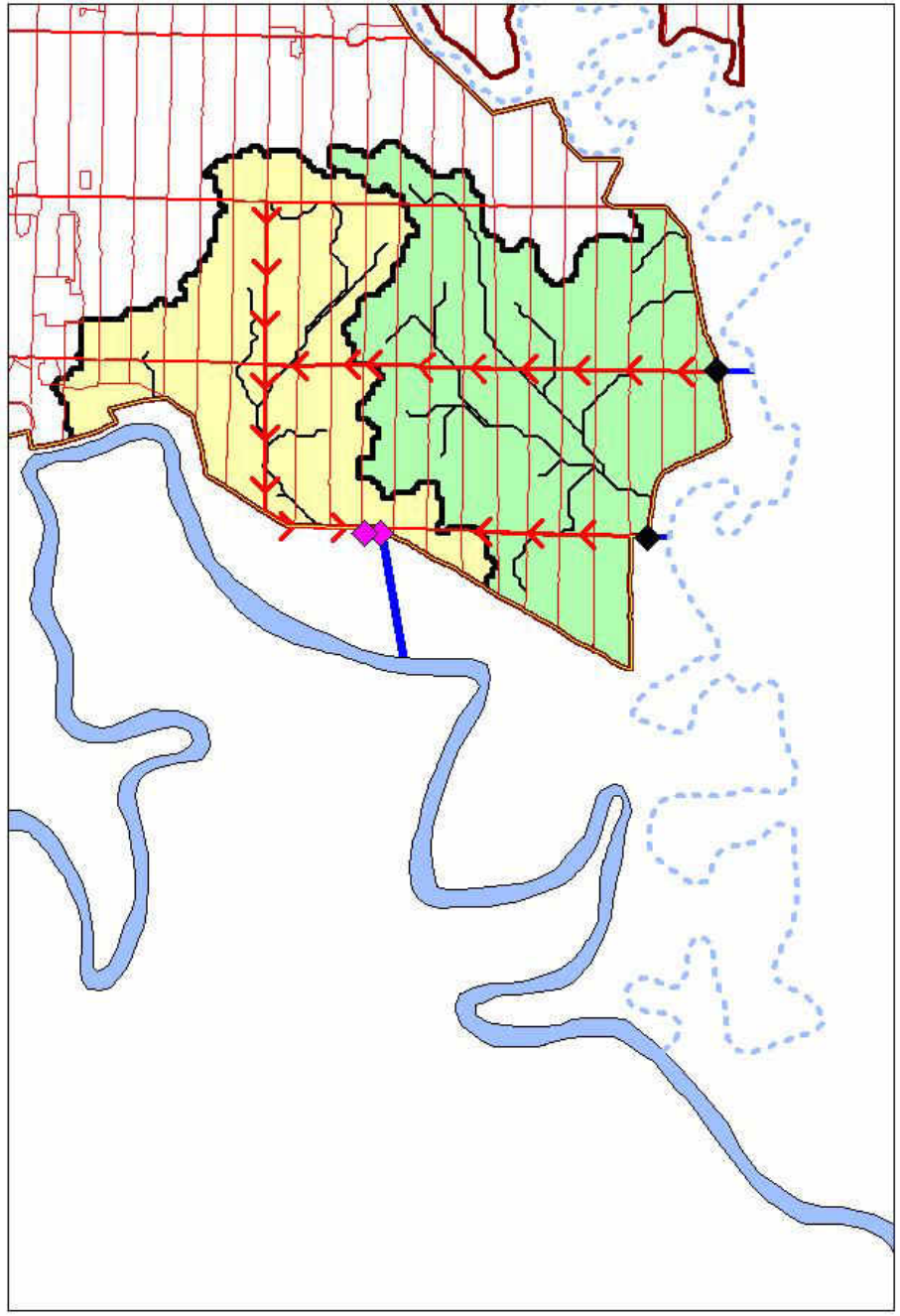
Diversion

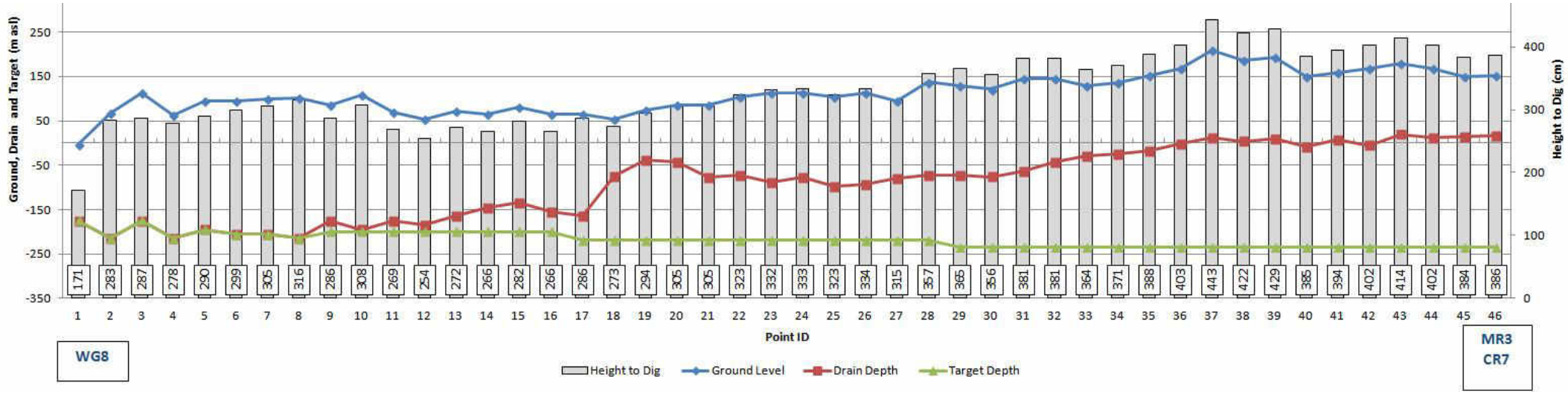
- When the waterway of an outlet is not functioning well because it is located in areas not possible for it to be routinely cleaned and desilted
- The slow flow will cause excess water to flow back through the outlet and inundate the fields
- Diversion technique is used to divert water from a failed outlet to another effective outlets nearby for discharging
- Deep cutting of drains is often required to bring excess water across sub-catchment

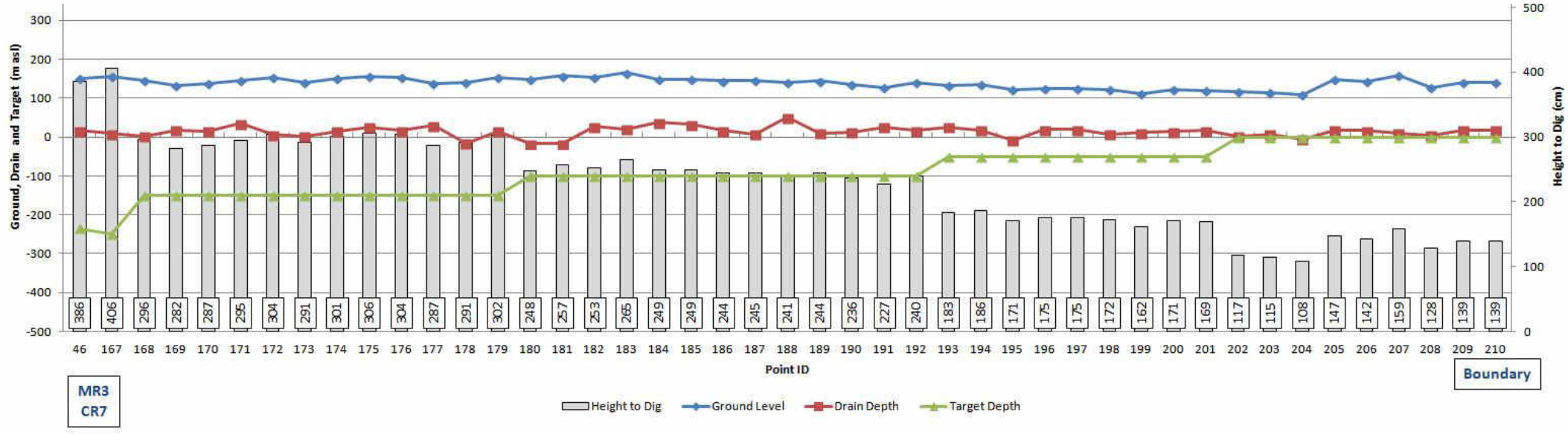


Technique 5:

Diversion (cont'd)

- Precise levelling is essential





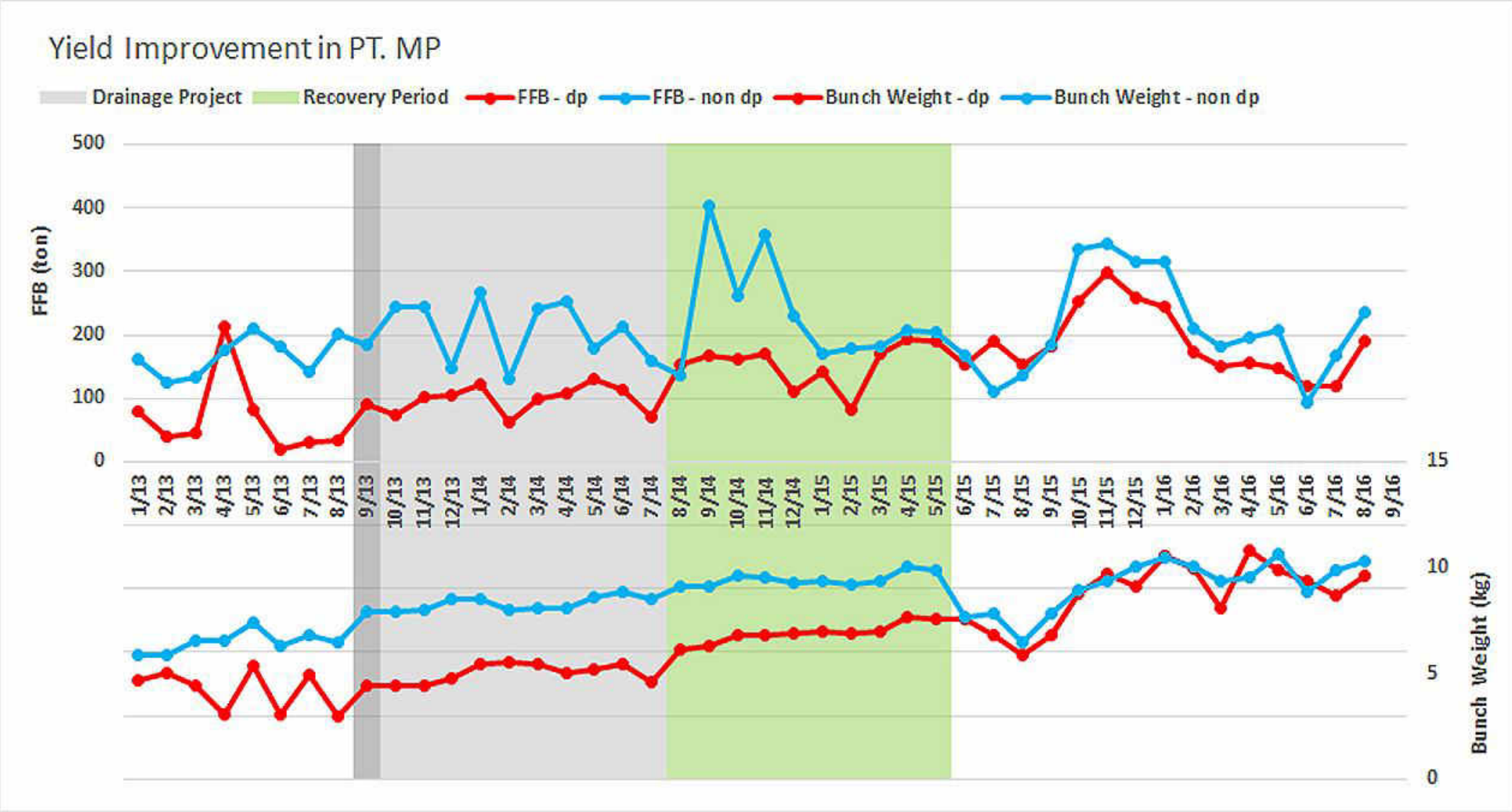
Technique 5:

Diversion (cont'd)

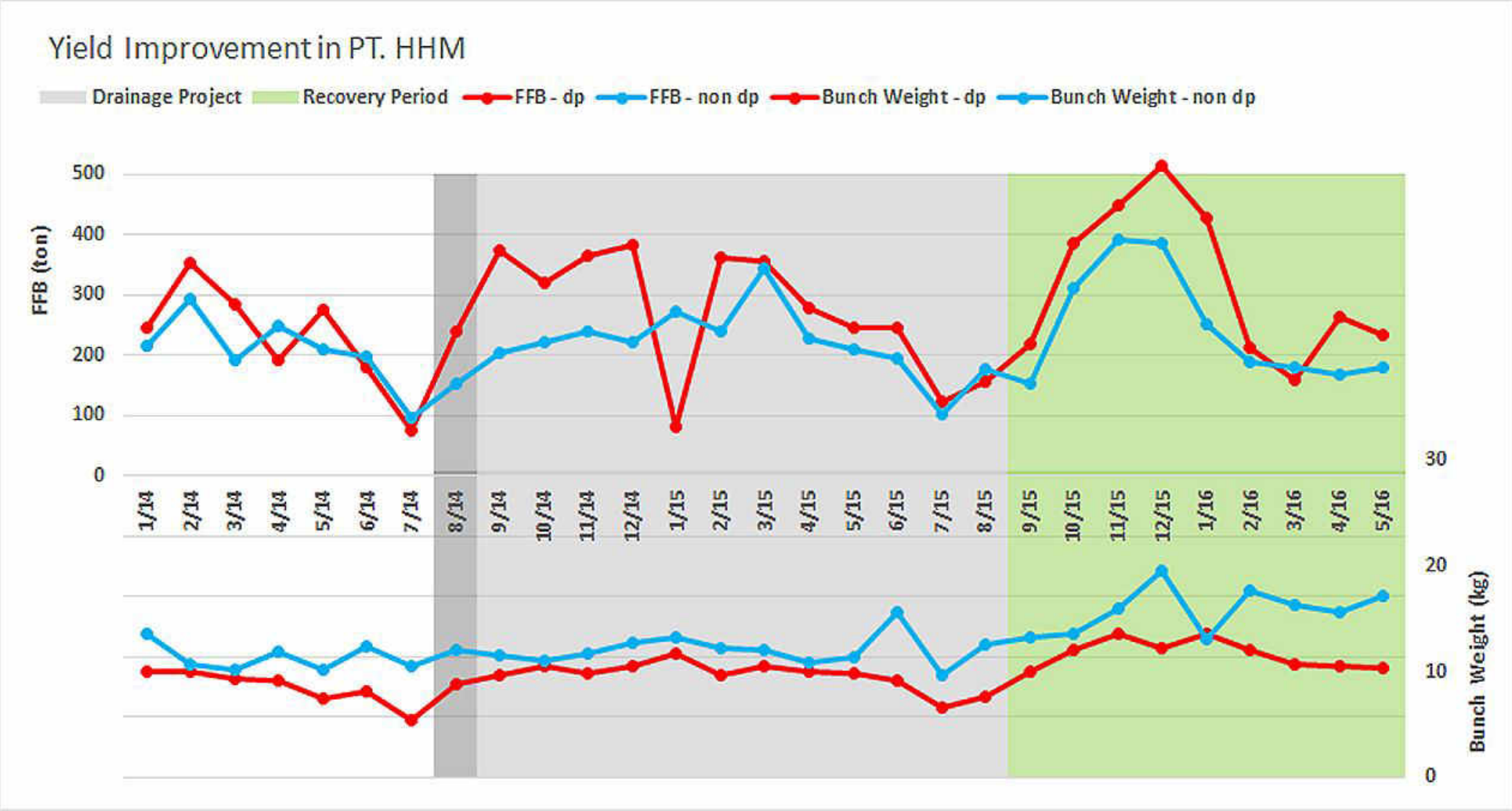
- Precise levelling is essential

Discussion

Discussion – Yield Improvement



Discussion – Yield Improvement (cont'd)



Feasibility

- Expected benefit

Block	2013/14 (t/ha)	2014/15 (t/ha)	Av, (ton/ha)	Potential (t/ha)	Yield Gap (t/ha)	Block Ha	Total Additional Ton
06N1	21.66	20.28	20.97	27.00	6.03	142	856.26
06N2	19.57	21.73	20.65	27.00	6.35	103	654.05
06N3	22.09	25.50	23.80	27.00	3.20	102	326.40
06N4	25.93	21.60	23.77	27.00	3.23	141	455.43
06N5	23.63	20.52	22.08	27.00	4.92	48	236.16
06N6	25.41	23.49	24.45	27.00	2.55	98	249.90
06O4	20.09	20.18	20.14	27.00	6.87	80	549.20
06N5	28.06	25.30	26.68	27.00	0.32	102	32.64
06N10	23.20	24.06	23.63	27.00	3.37	106	357.22
07N4	20.47	26.72	23.60	27.00	3.41	38	129.39
08P1	16.16	16.45	16.31	24.00	7.70	66	507.87
						Total	**4,354.52**

Estimated value based on CPO price (RM 2,200/ton) **~USD 527,419**

Estimated value based on CPO price (RM 1,800/ton – 20% drop) **~USD 422,361**

Feasibility (cont'd)

- Expected cost

No	Item	Cost (USD)
1	Bridge construction (3 units)	140,106
2	Canal construction (13,3 km)	181,988
3	Palm removal	13,207
4	Foot bridges	41,462
5	Flap gates and installation	76,192
6	Advisory and supervision	7,547
	Total	**460,502**

- B/C Ratio and Pay Back Period

Price condition	B/C Ratio	PBP
At CPO price (RM 2,200/ton)	1.15	3.2 year
At CPO price (RM 1,800/ton – 20% drop)	0.92	3.5 year

Conclusion

- Drainage problem is one of common limitations in oil palm plantations. The impact varies and could be damaging.
- Specific technique have to be used to solve various specific problems. Geospatial technology is prerequisite to solving problems related to drainage.
- Drainage is best planned at initial stages of estate development. Correcting poorly planned and constructed drainage network after development can be very costly and is often less effective.
- Benefit to cost analysis is essential to ascertain the feasibility of a drainage improvement project and should be done before the commencement of the project.
- Sensitivity analysis should also be included if the project is a long term project likely to be subjected to changes in commodity prices over the year.

Acknowledgement

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  - Kuala Lumpur Kepong (KLK)
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Thank you

Terima kasih