Emerging Presenter Paper

Are your models dynamic?

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What is a dynamic model?

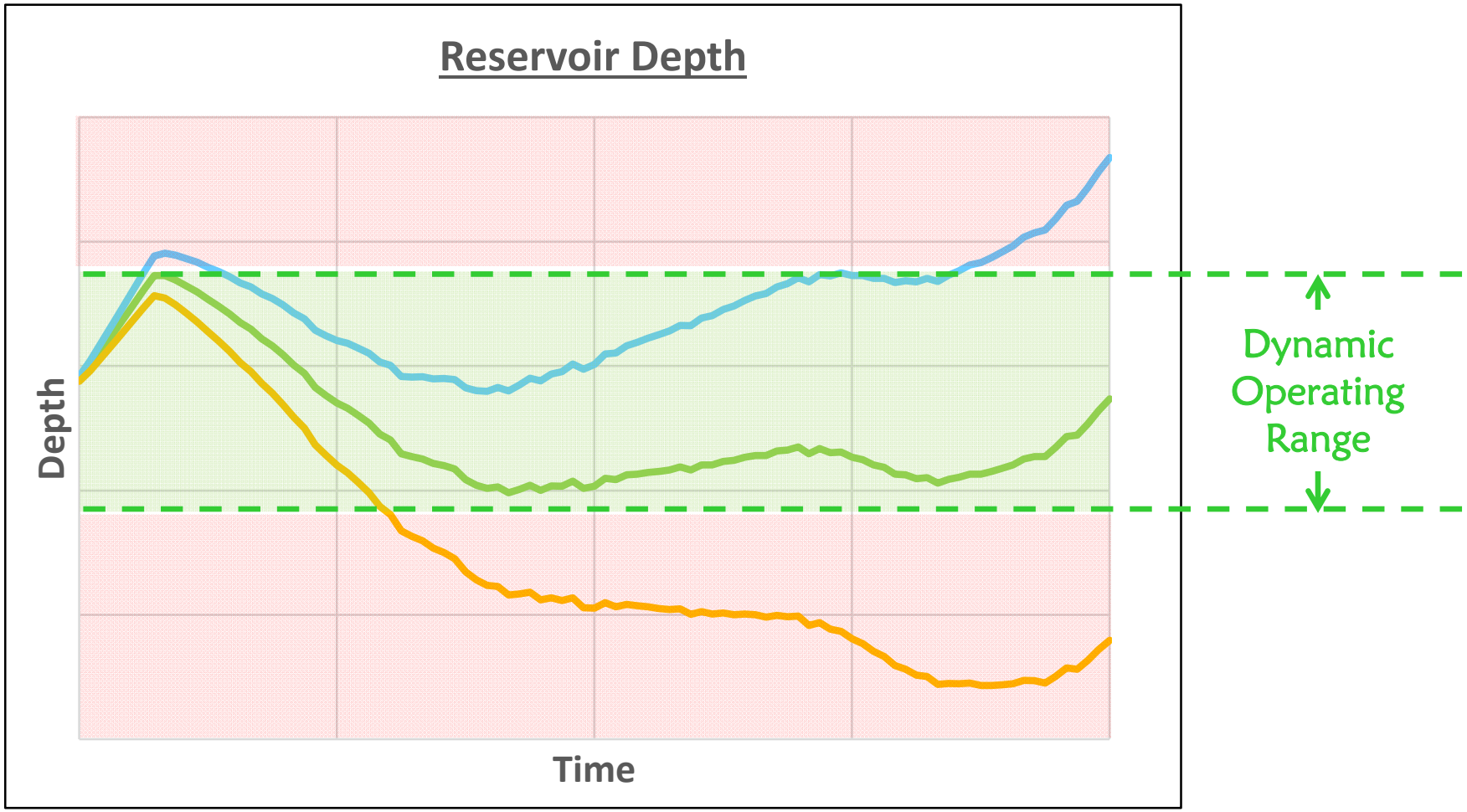
- Controls that react to changing conditions
- Always maintaining storage and levels of service
- Is fit for purpose / future proof

Time control variation

Increases or decreases in demand

Control or setpoint changes

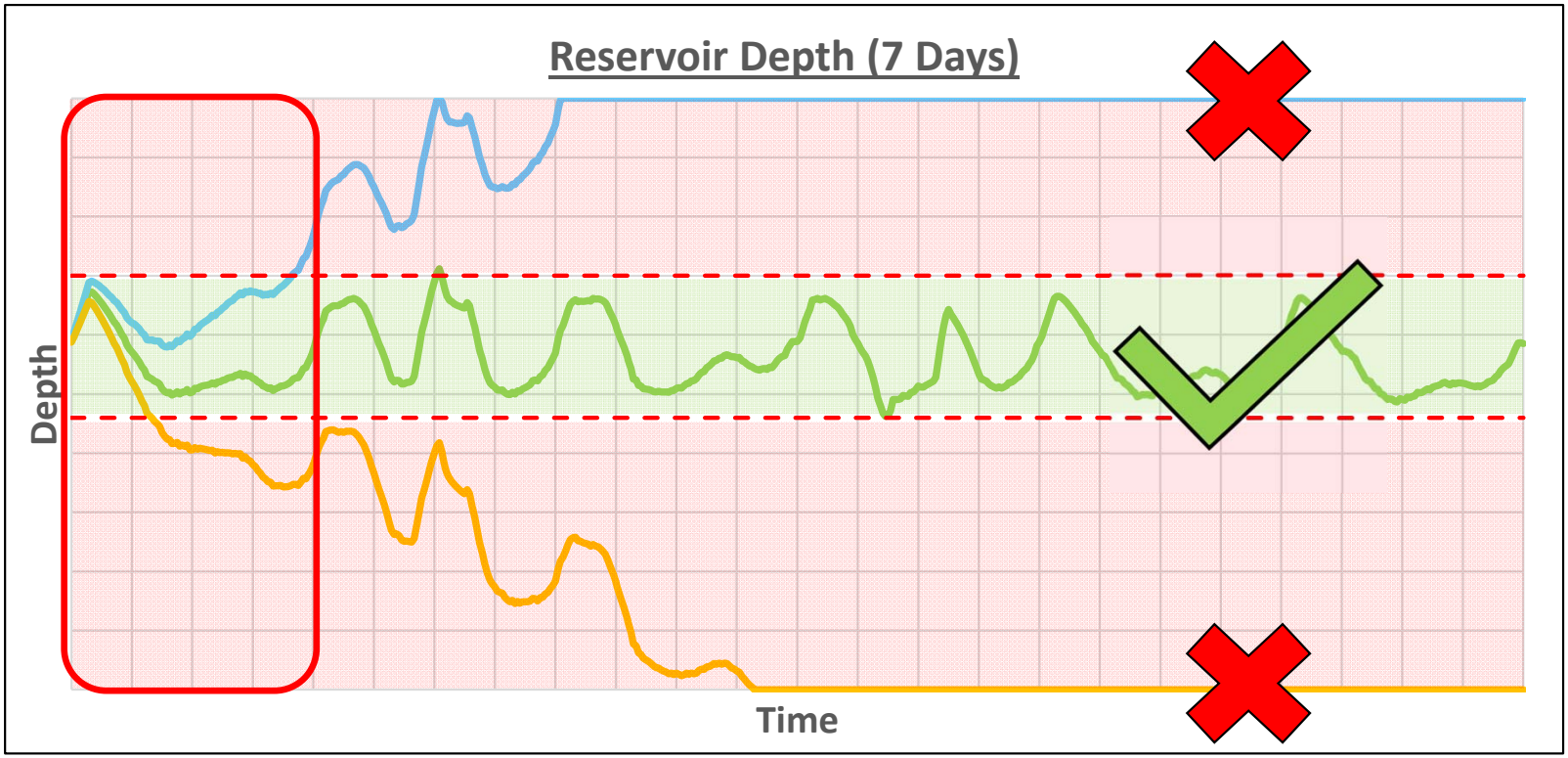
What does a dynamic model look like?



- 24 hour model simulation

What does a dynamic model look like?

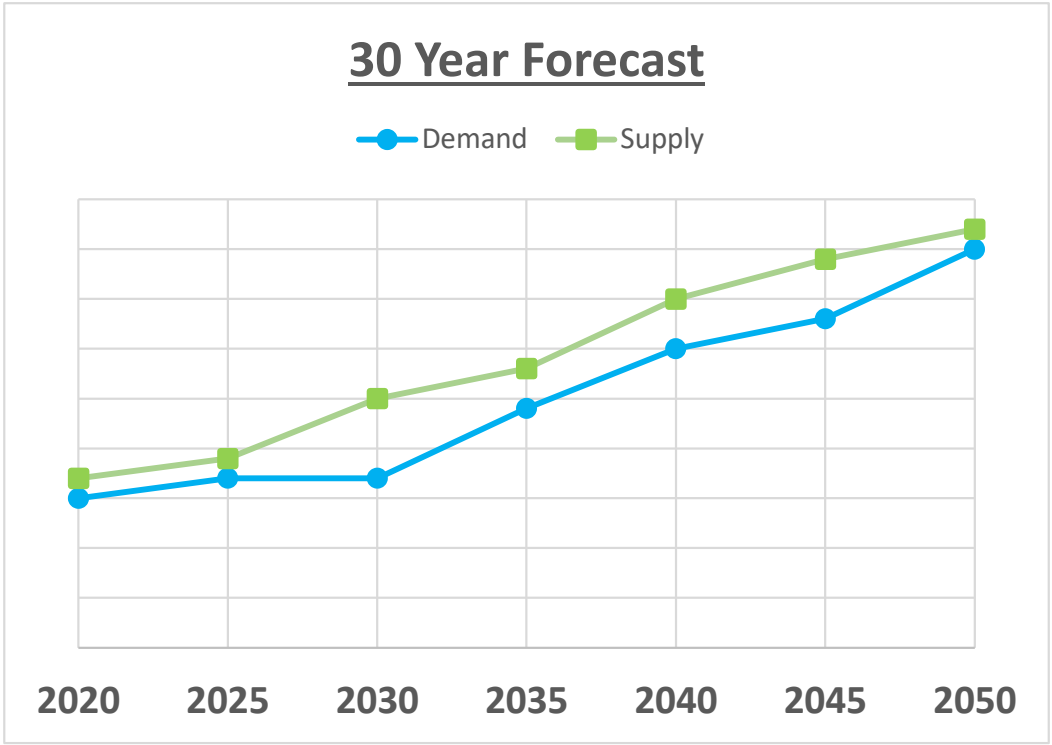
- Without dynamic control the reservoir overflows by day 3 and empties by day 4



- 7 day model simulation

Applications of a dynamic model?

- Demand increases caused by growth
- Resource / demand forecasting
- Water Quality (WQ) analysis



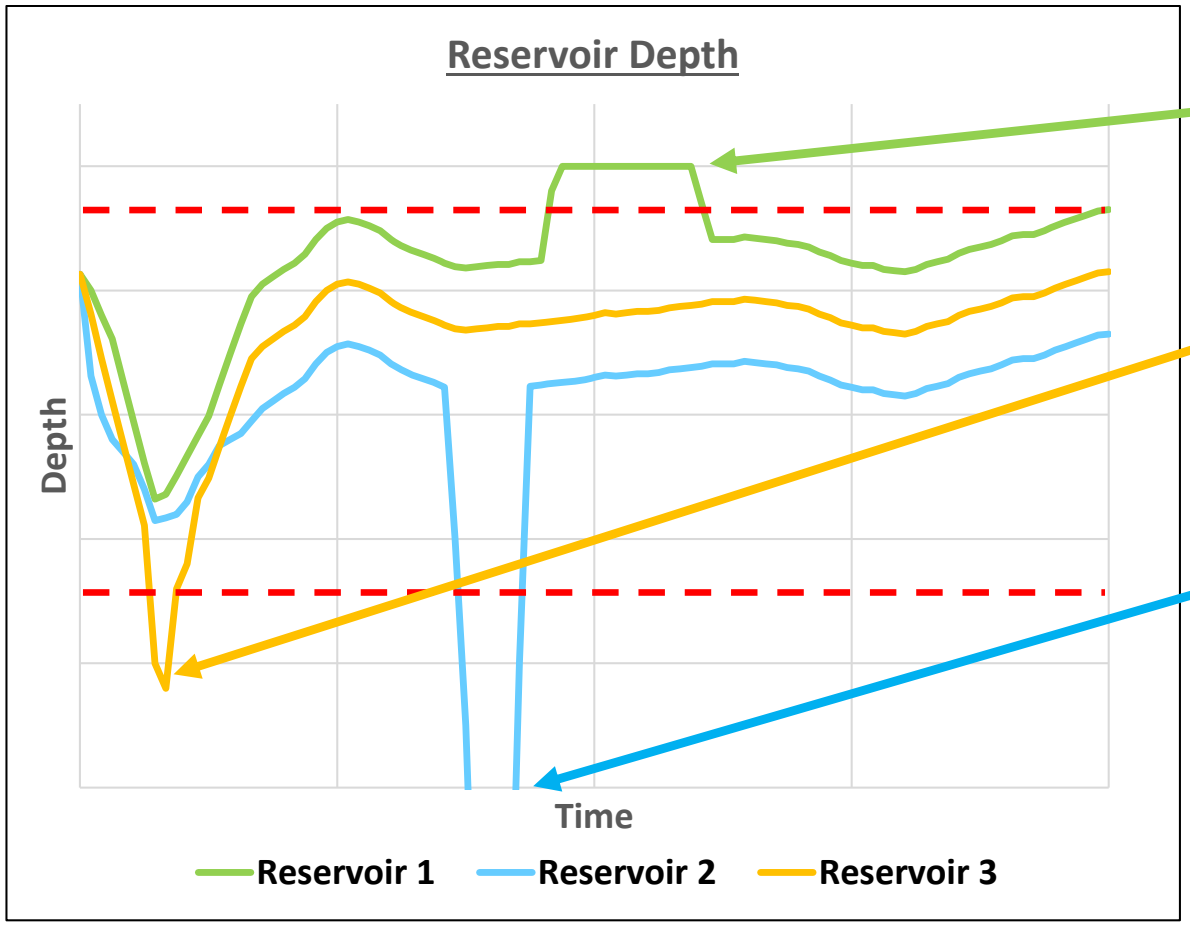
How do we check if our models are dynamic?

- Dynamic model audit SQL tool

node_id	asset_id	Operational Volume (ML)	Overflow (ML)	Minimum Depth (m)	Surplus / Deficit (ML)	Verdict
25648615	RESERVOIR 1	0.51	0	2.68	0.03	Fail - Outside Working Volume
24861153	RESERVOIR 2	12.58	0	2.91	-2.76	Pass
24073691	RESERVOIR 3	1.59	0	2.46	-0.06	Pass
23286229	RESERVOIR 4	5.46	0.65	1.55	0.21	Fail - Overflow
22498767	RESERVOIR 5	9.33	0	0	0.48	Fail - Empty
21711305	RESERVOIR 6	13.2	0	2.57	2.56	Fail - Outside Working Volume

- Provides us an overall verdict and reason for failure

Types of model failure



Overflow

Outside Operating Range

Empty

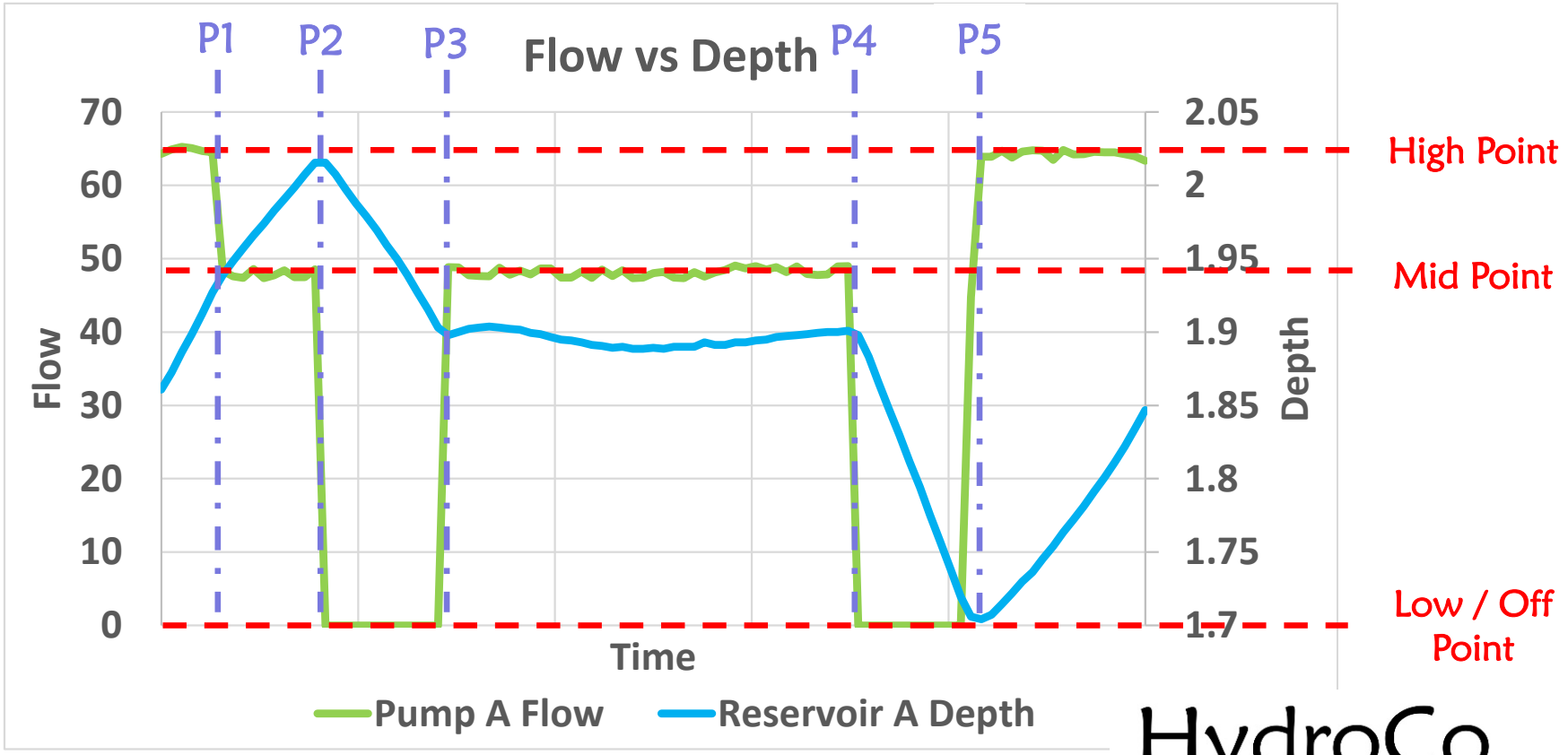
asset_id	Verdict
RESERVOIR 1	Fail - Overflow
RESERVOIR 2	Fail - Outside Working Volume
RESERVOIR 3	Fail - Empty

- Failed reservoir = Control investigation

How do we model dynamic controls?

- Assess telemetry data to understand controls

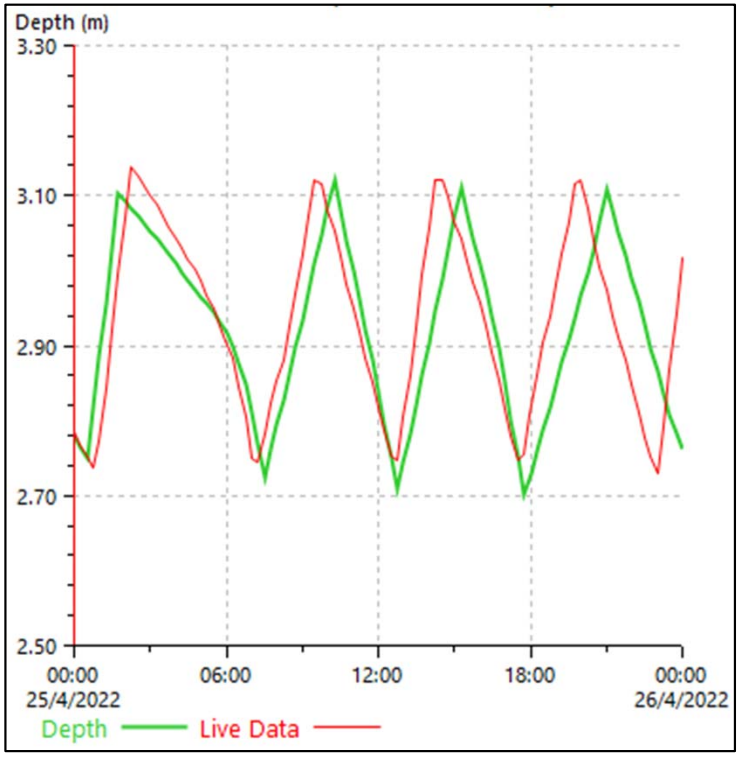
Flow Rates, Switching Points (Levels, Times, Abstraction Limits, etc)

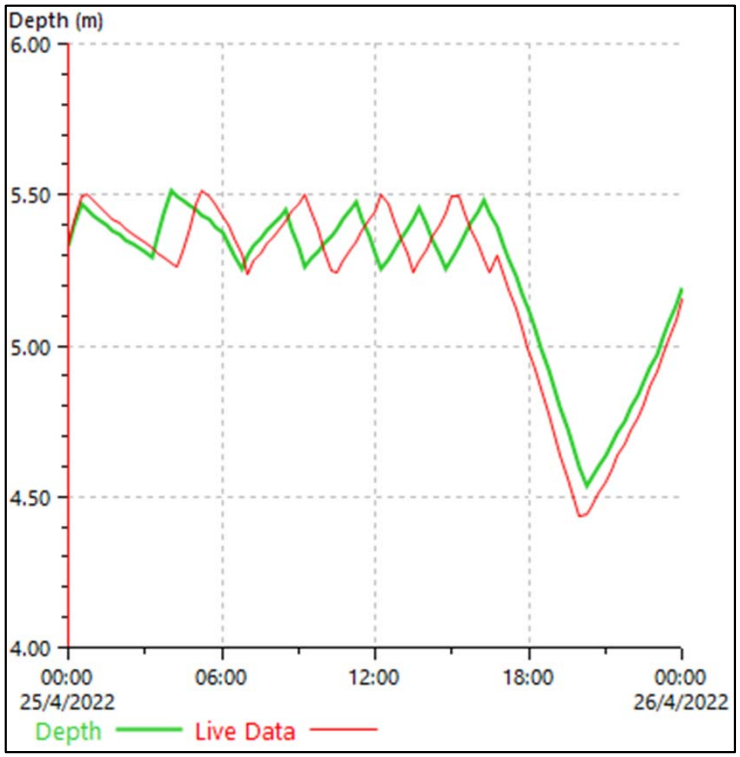


How do we model dynamic controls?

- Replicating the controls:
  - Using standard modelling functionality (Flow, Level)

	Date / Time	On (m)	Off (m)
▶	25/04/2022 00:00:00	2.75	3.10



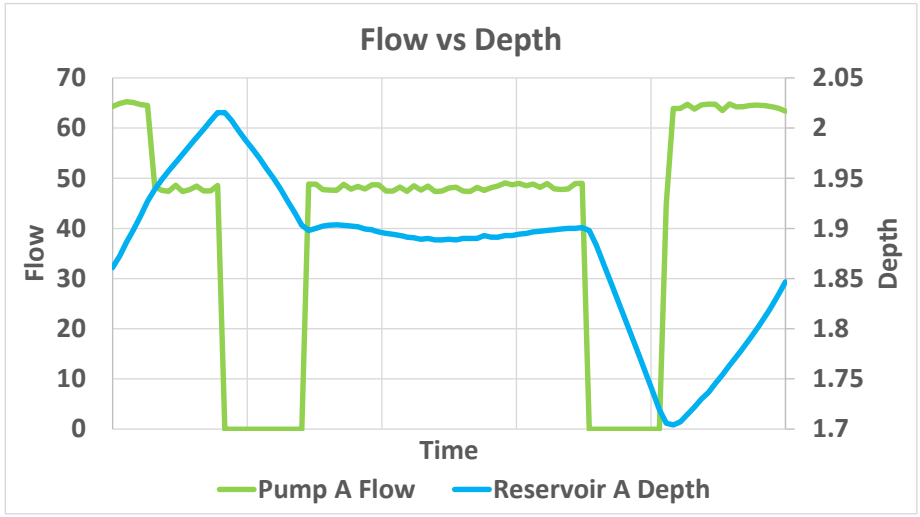


How do we model dynamic controls?

- Replicating the controls:
  - More complex controls may require UPCs or Scripts. Such as the previous example of a 'Flow and level-controlled pump'

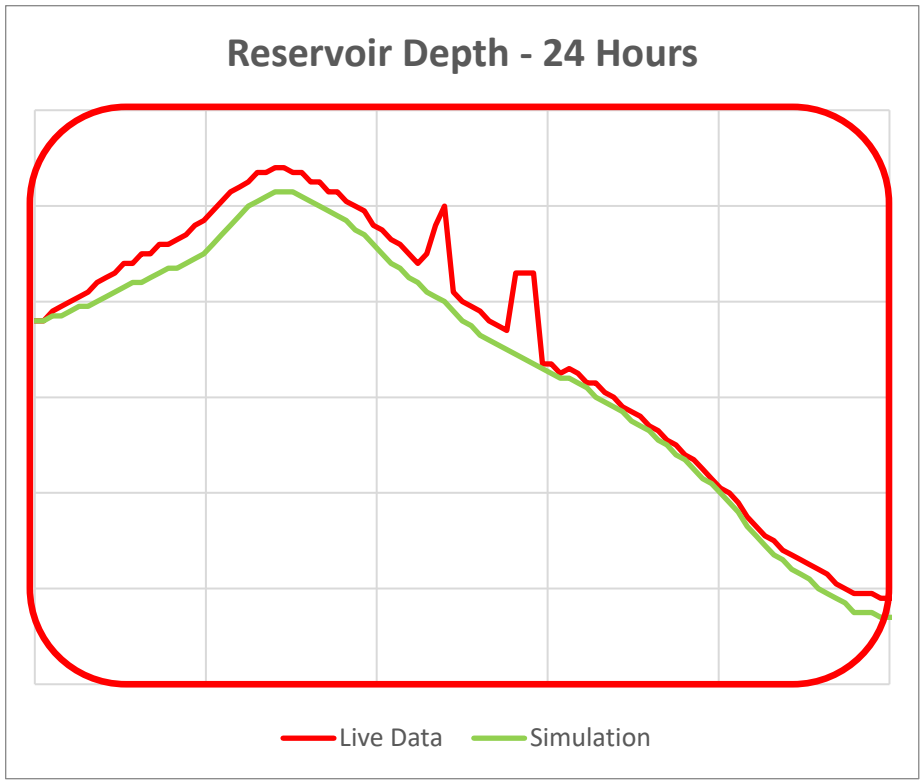
```
VAR Q_Target1 = 65
VAR Q_Target2 = 44
VAR Q_Target3 = 0
VAR Q_Link = LINK TA19063802.TA19063801.1 FLOW

VAR reslevel = RESERVOIR A127009F DEPTH
VAR depthdelta = RESERVOIR A127009F DHDT

COND Low1 = depthdelta < 0 AND reslevel < 2.45 AND reslevel > 2.3
COND Low2 = depthdelta > 0 AND reslevel > 2.3 AND reslevel > 2.4
COND High = depthdelta > 0 AND reslevel > 2.1 AND reslevel < 2.5

RULE Off
IF depthdelta < 0 AND reslevel > 2.1 THEN Q_Link = Q_Target3
USING UPSTREAM PST KON0039GRIC.KON0038GRIC.1
ENDIF

RULE Low
IF Low1 OR Low2 THEN Q_Link = Q_Target2
USING UPSTREAM PST KON0039GRIC.KON0038GRIC.1
ENDIF

RULE High
IF High THEN Q_Link = Q_Target1
USING UPSTREAM PST KON0039GRIC.KON0038GRIC.1
ENDIF
```

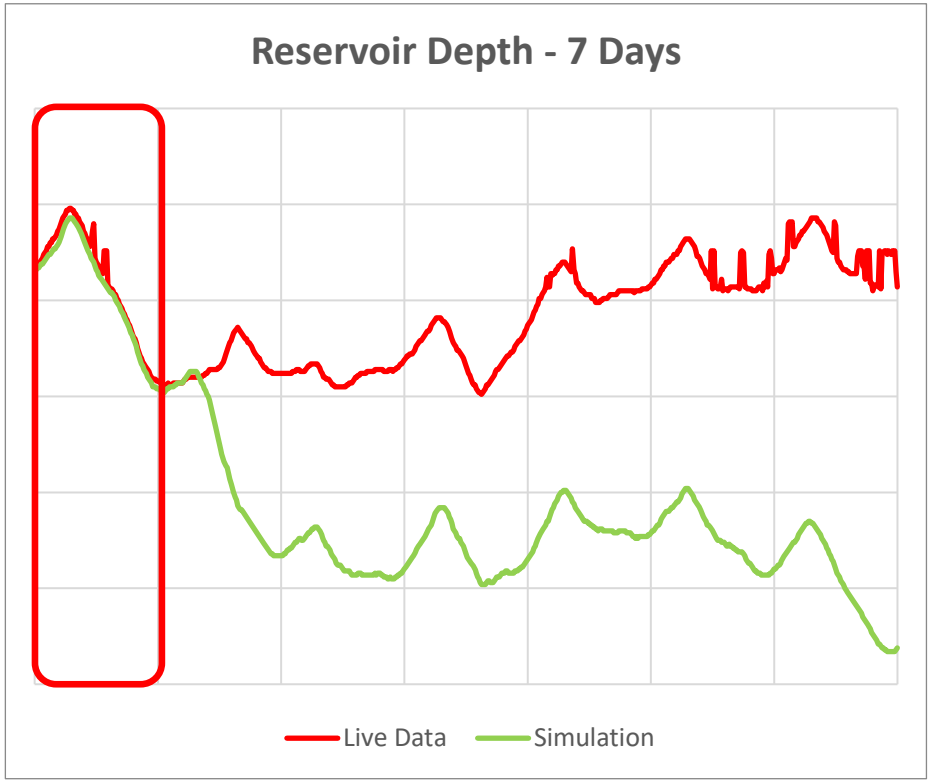
- 3 flow targets and 3 level conditions



How do we check if our models are dynamic?

- Without running for > 24 Hours you may miss non-dynamic controls





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- Repeat audit for …
  - Scenario 1 – Average day model
  - Scenario 2 – Peak day model
  - Scenario 3 – Future demand model
- Stress testing the model to check for dynamic operation

Conclusions

- Reservoir storage = good indicator for a dynamic model
- Extended simulation lengths = highlights failures
- SQL audit tool – repeatable assessment
- Tool focuses investigation into poor controls
- UPCs increasingly used to achieve dynamic operation
- Repeat audit for multiple demand scenarios (Stress test)

- Process could be included in your model build specification to promote dynamic general application models

cwmag
clean water
modelling advisory group

Thank you for listening

Are there any questions?

HydroCo
water systems engineering