#	Question	Answer	Answer Name
1	I'm worried about what happens if and when the digital twin is not synchronised with the physical asset - once it's out of sync (i.e. physical changes not reflected in model) then the cross-referencing exercise to get "back on track" would be extremely onerous - thoughts? (For context, I've visited wastewater treatment plants where they can't even find work as executed drawings for major upgrades ...)	That is a very relevant question, which we address in CitytFlow Live through a variety of tools: (i) automated model calibration to keep the digital twin synced with the plant; (ii) an easy workflow to update the underlying model in the digital twin, to reflect structural changes in the plant.	Fabio Polesel
		We should use AI! :) in short time, this will be a valid approach. As utilities build databases of unstructured data for use by other AI engines, one output could certainly be a cross-reference. IMO the critical step to assess the model calibration automatically. If it no longer matches, it is obvious if something changed in the physically asset vs. minor drift and kinetics or dynamic misfit.	Ryan Sanford
2	With the CityFlow model, can you please explain how it can potentially save energy and reduce cost?	Many examples! a basic one At the treatment plant, operators test scenarios and build enough confidence to try things, like reducing SRT and airflow to run a bit closer to the edge of the permit, safely reducing power requirements. More interesting is the bigger picture though. Provide utilities a tool to potentially argue against new discharge permit requirements because they can run a scenario showcasing the cost of taking out more nutrients and then see that the impact on the river is minimal compared to some major upstream agriculture runoff and bank collapse. Extend that further upstream and maybe there is some capacity in the catchment or sewershed that can be optimized for storage and timing and ultimately support sea grass and dungong population in the bay around the corner!	Ryan Sanford
3	CAn you give examples of typical outputs from the model to the operator to make decision?	I believe this is covered on the other thread, outputs can be broad or abstract, but should focus on the actual handles that exist.	Ryan Sanford
		live answered	Fabio Polesel

4	A typical problem I have encountered at domestic WWTPs is unreliable instruments (e.g. lack of calibration, lack of validated data and control actions). This will impact the predictable performance from the digital twins. How do you guys collaborate with the WWTP asset owners to address this problem?	It's a massive consideration and an important prerequisite. We script data preprocessors into data management systems, usually outside of SCADA, but with alerts for operators. but first, we need to identify which instruments are important. if they aren't part of some workflow, control loop, or reporting strategy, they don't get the attention needed to keep them relevant. then, simple option is to perform range checks, look for flatlines with running variance, or instantaneous rate of change limits and long term drift checks. Now, python is ubiquitous in these tools so we can also use ML-based anomoly detection when it makes sense to add the payload.	Ryan Sanford
		I guess it goes without saying that you need good data for this to work - there would be an initial investment to ensure "everything" is being (accurately!) measured and reported.	Dana Ippolito
5	You mentioned that the outputs from the model go to the operator. Can this go further, replicating operator's capability to make decisions?	Simple example, if we assume the plant has a NH4-based aeration controller, the tool may suggest a new NH4 setpoint for a certain period. OPerator can use that, or if preferred close the loop and automatically accept that setpoint but that's where the client usually keeps a human in the loop. Better might be to test the actually controller PID parameters and suggest new Kp, Ti, and Td!	Ryan Sanford
6	1-Do you remove heavy metal from the influent and how? 2- Do you use any chemical to remove P or only biological process?	Heavy metal removal is very important for some of our clients. They are not explicitly simulated and tracked in the base model but can be added and assessed individually where relevant. 2- yes, both. If you have any specific questions, fire away!	Ryan Sanford
7	Are you the system gives real-time simulation for operator to try out new set points?	yes!	Ryan Sanford
		live answered	Fabio Polesel
8	The optimisation framework looks compelling, but I'm interested in the real-world validation. Have you compared the optimiser's predicted benefits against actual plant performance after implementation? Can you quantify this?	Great question- and I'd like to push for a better quantification for sure. However, I believe it's somewhat inherent in the outcome. If the operator takes a setpoint from the tool and implements it, and the model remains well calibrated for, e.g., total aeration energy use, that's essentially a check that the model was "correct".	Ryan Sanford
9	If we reduce the set points then we are exposed to higher risk of exceeding the permitted limits of parameter in the efflunet.	Indeed. But can you quantify it?? With a model, you can assess and often accept that risk.	Ryan Sanford

10	Looking at the City model as a boundary with lots of weather data and process input going in and lots of processed data going out as outputs, what is the solution for cybersecurity?	If I told you, my clients would no longer be secure. It's an ongoing discussion for sure. One-way data push from client's OT or IT network to the modeling platform helps reduce the risk of anything coming back in.	Ryan Sanford
11	Have you inbuilt a separate hydraulic model into the digital twin model, how do you account for mixing impacts on chemical consumption and decay if relevant?	I didn't follow what "mixing impacts on chemical consumption and decay" you are referencing. Elaborate if possible. Not positive for water quality, but I loosely assume that this can be applied: These are mechanistic models, which inherently has the ability to extrapolate with some level of relevance outside of the historical range. It may need recalibration though!	Ryan Sanford
		If the model learns from historical correlations, how does it handle situations where the underlying hydraulic behaviour is driving water quality outcomes, but that hydraulic behaviour is not directly measured or represented?	Zara Zbrog
12	Is weather forecasting used in the predictions for catchment behaviour?	Yes! And we're at the mercy of it's accuracy, frankly.	Ryan Sanford
		For the hydraulic system (the collection system hydraulics) we use real-time data assimilation which improves the forecast quality a lot. It handles some of the uncertainties in the rainfal forecast and also create an error model used to correct data within the	Henrik Sorensen
13	Can you use AI to fill in the gaps where there is no existing data- what sort of success have you had here?	For flow predictions it works very well. For nutrients, naiive models seems sufficient. Soft-sensors or cross referencing other indicators is the important thing for me. Double checking mass balances, etc.	Ryan Sanford
		what about for specific water quality parameters, weather forecasting can be inaccurate if it's days ahead we've found which means the water quality predictions inherit this inaccuracy	Zara Zbrog
14	Conceptually please explain how the twinning gets into the big picture definition. I can see how digital forms part of the solution	For me, it's about the ability to look at the boundary conditions. If I'm a WWTP modeler, I now have the tools to assess upstream impacts on what comes into my plant. Or how my discharge actually impacts the river. Less silo'd thinking, more "one water"	Ryan Sanford

15	Can the digital twin meteorological system work in accordance with current conditions and make recommendations consistent with expected weather conditions?	not sure exactly what you're getting at, but the flow predictions certainly need a rain prediction which comes from a 3rd party (local meteo). Major storms should trigger changes to the projected performance. We would configure this to raise an alarm or, ideally, automatically re-run with new operating modes to make a recommendation.	Ryan Sanford
16	How far in advance can CSO and sewer spill events caused by heavy rainfall be predicted, allowing water authorities enough time to take preventive action? Any case study to share?If predictions are based on rainfall data, how is the model calibrated and validated against increasingly frequent record-breaking rainfall events, and what level of accuracy does it achieve?	live answered	Fabio Polesel
		For the Gothenborg case that we briefly demoed, forecasts are very reliable within a 6 hour forecast horizon. Real-time data assimilation helps a lot on the forecast quality but longer forecast-horizons are uncertain due to uncertainties in the weather forecasts. We are running a similar (though simpler) system for a danish utility. They also look at 6 hour time-horizones. But obviosuly it will also depend on they catchment hydraulics.	Henrik Sorensen
17	What are your thoughts on the digital twin architecture? I.e. generic digital twin vs. specialised digital twins for a treatment system? Would you recommend multiple specialised sub-models linked up together (e.g. N removal, dewatering, membrane polishing..) or a generic digital twin for a defined system boundary?	Never really thought about this. You have to realize that our backgrounds are in process modeling. We build models of the entire system for our clients. For WWTPs, that means using ASM2 usually for the bugs but the underlying modeling software (DHI's WEST) would be built with other models for physical separation in clarifiers, etc. I practice, it's probably feasible to break it up but it'sa problem that's already been solved by WEST. In principle, i suppose the models are actually broken up and separate as you suggest. I hope I answered it!	Ryan Sanford
18	Which two clients (catchments? plants?) have you got in Australia? Are you allowed to say?	We have a beautiful water quality model for the Brisbane River (hence my dugong comments earlier). I didn't sing any NDA but the PM might have... That's why I had the honor of coming out for this conference too! Pushing treatment plant owners to look for smarter ways of optimizing and operating rather than building new tanks.	Ryan Sanford
		Nice! I'm most interested in the treatment plant side, but my experience over here is that the water authorities here are slow on taking up new technology.	Dana Ippolito

		You can find info about the Brisbane case here: https://search.informit.org/doi/epdf/10.3316/informit.475297110071607	Fabio Polesel
19	Hello, thank you for the fruitful presentation. I have a question for the presenters. In one organization, there is an activated sludge treatment plant that is still operated manually and relies on human operators 24/7. Given this situation, I would like to ask: Would it be feasible to upgrade or retrofit such a plant to a SCADA-based control system? If so, what are the main requirements, challenges, and steps involved—for example, instrumentation, PLC/RTU installation, actuators, communication infrastructure, control logic, cybersecurity, and operator training? Thank you.	Depends on size of the facility. SCADA is pretty much a prerequisite for this next layer. Not the most detailed answer, but SCADA integrators can help more.	Ryan Sanford
		Learn to walk before you can run!	Dana Ippolito
20	How costly is the twin system for medium system?	live answered	
21	Thanks. stagewise implementation based on complexity.	Definitely! We can generate immediate value by modeling the plant offline and building in basic or advanced controllers that don't even need the live model or "twin". That gives the foundation for building the data validation methods into the plant, and then the digital version becomes more feasible and obvious as a nest step.	Ryan Sanford
22	Does the system rely on manually entered emissions guidelines or link to latest standards ie Best Available Technology or BREF?	is that what you mean by "emissions"? in the US, "emissions" referes to greenhouse gas emissions, sounds like Fabio took this as discharge (liquid) limits The N2O sensor guys (Mikkel, Unisense) came from DHI :)	Ryan Sanford
		Nitrous Oxide mainly & other potent pollutants in Flue Gas	Brian Chigondo
23	would you say that the digital twnning offers less benefit to a standalone treatment than to an integrated system?	No - not necessarily. It depends on your objectives. A digital twin of the treatment plant or collection system in isolation certainly is useful and we have dome more of those than the newer integrated digital twins. Obvisously domain specific digital twins wont address the more integrated aspects - e.g. more holistic CSO/bypass control as we also demoed yesterday	Henrik Sorensen