NEW WATER

GREEN BAY FACILITY & DE PERE FACILITY

50-Year Vision – Session 1

May 21, 2020

NEW Water
The brand of the Green Bay Metropolitan Sewerage District

BLACK & VEATCH

DONOHUE

VIRTUAL SUGGESTIONS

Moderator

Presenters

Virtual Backups

- Slide Deck
- Call In

Contact with Problems

WORKSHOPS PREVIEW

Session 1: NEW Water Infrastructure Drivers

Session 2: Future of Nutrient Removal

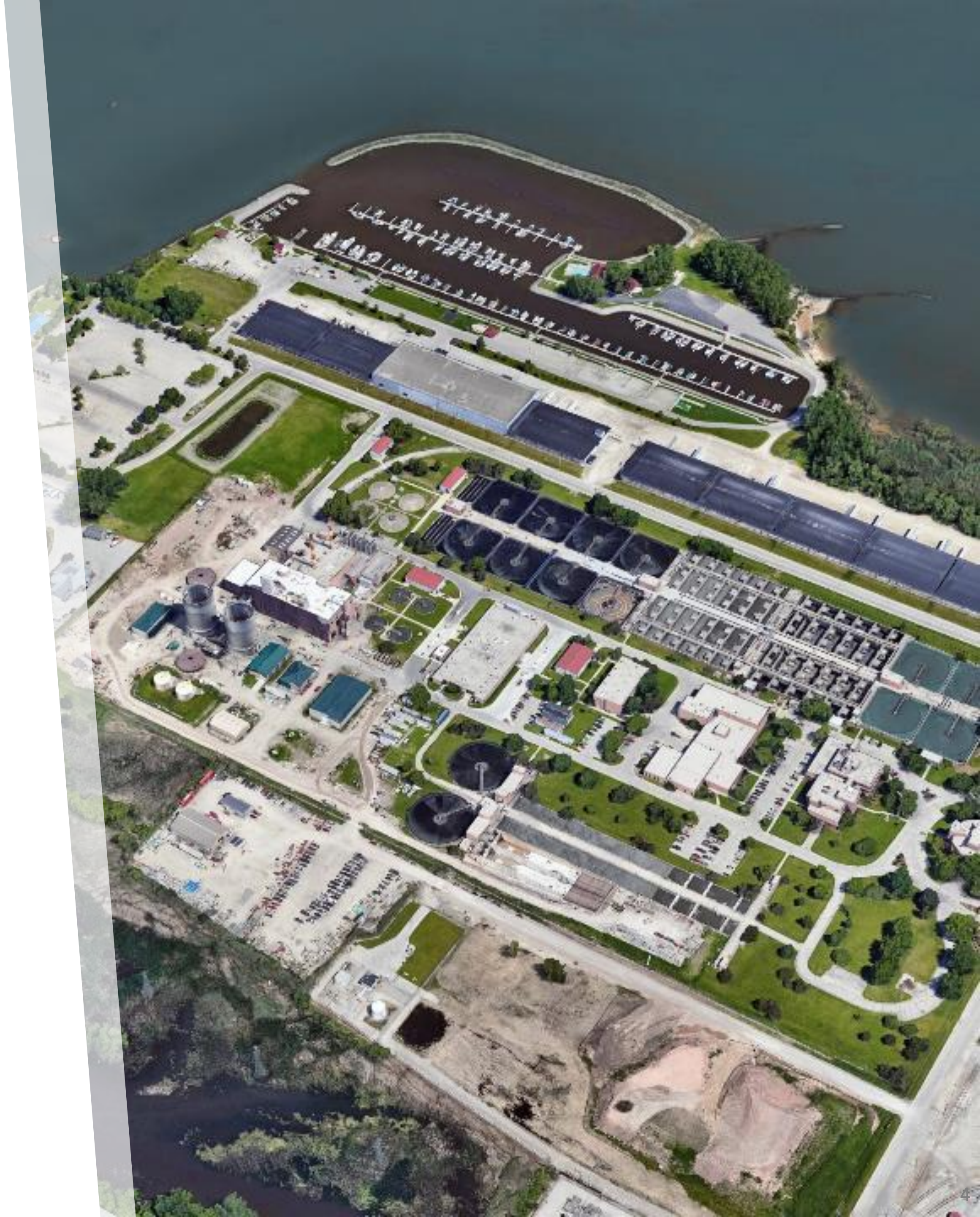
Session 3: Water Reuse, Energy Management and Resource Recovery

Session 4: Emerging Concerns and Areas

Session 5: Consolidation of long-term drivers

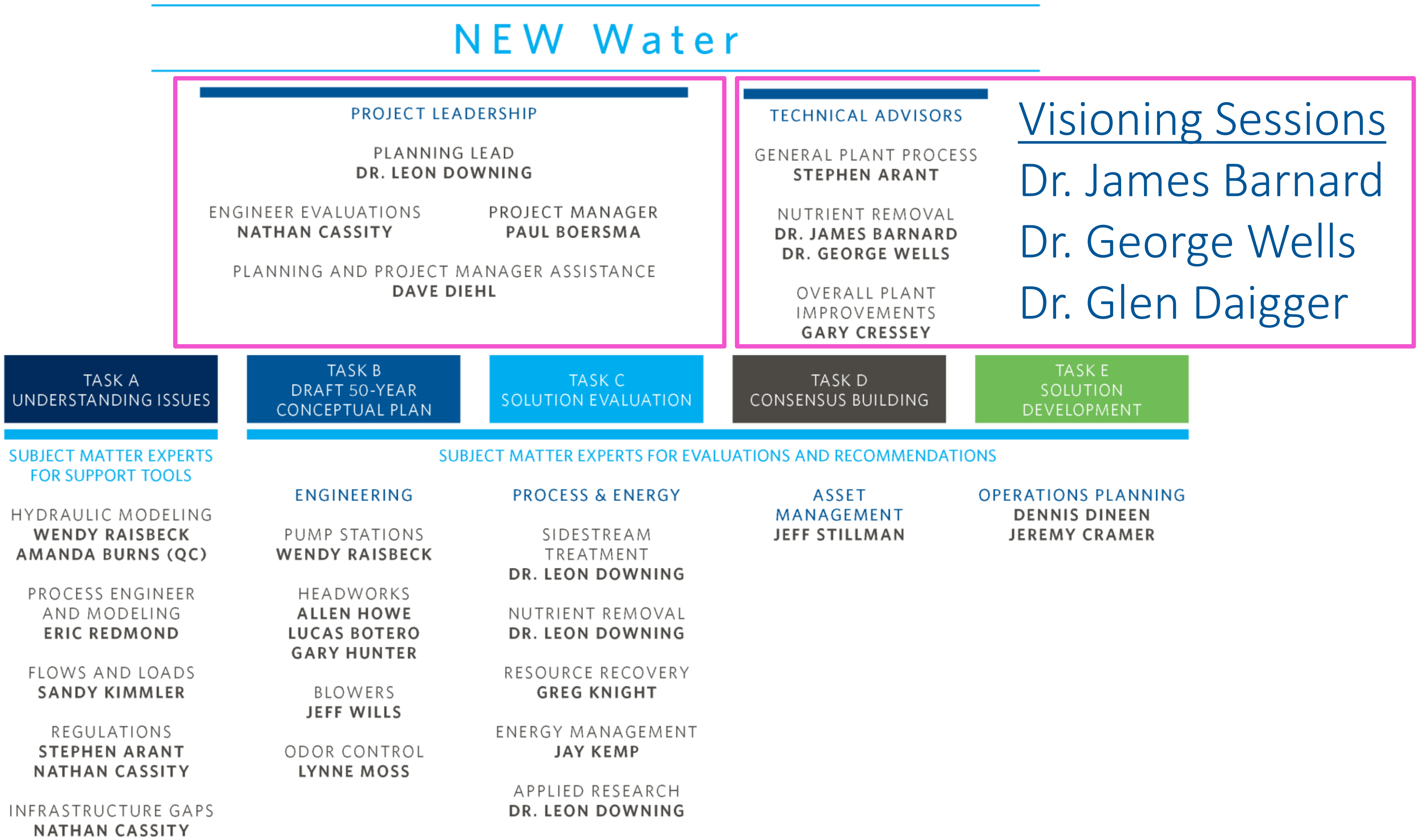
AGENDA

- Overview and Objectives
- Infrastructure Update
- Risks and Opportunities
- Discussion



Overview & Objectives

Who from the consultant team is participating in these sessions?



NEW Water

PROJECT LEADERSHIP

PLANNING LEAD
DR. LEON DOWNING

ENGINEER EVALUATIONS
NATHAN CASSITY

PROJECT MANAGER
PAUL BOERSMA

PLANNING AND PROJECT MANAGER ASSISTANCE
DAVE DIEHL

TECHNICAL ADVISORS

GENERAL PLANT PROCESS
STEPHEN ARANT

NUTRIENT REMOVAL
DR. JAMES BARNARD
DR. GEORGE WELLS

OVERALL PLANT IMPROVEMENTS
GARY CRESSEY

Visioning Sessions
Dr. James Barnard
Dr. George Wells
Dr. Glen Daigger

TASK A
UNDERSTANDING ISSUES

TASK B
DRAFT 50-YEAR CONCEPTUAL PLAN

TASK C
SOLUTION EVALUATION

TASK D
CONSENSUS BUILDING

TASK E
SOLUTION DEVELOPMENT

SUBJECT MATTER EXPERTS FOR SUPPORT TOOLS

HYDRAULIC MODELING
WENDY RAISBECK
AMANDA BURNS (QC)

PROCESS ENGINEER AND MODELING
ERIC REDMOND

FLOWS AND LOADS
SANDY KIMMLER

REGULATIONS
STEPHEN ARANT
NATHAN CASSITY

INFRASTRUCTURE GAPS
NATHAN CASSITY

SUBJECT MATTER EXPERTS FOR EVALUATIONS AND RECOMMENDATIONS

ENGINEERING

PUMP STATIONS
WENDY RAISBECK

HEADWORKS
ALLEN HOWE
LUCAS BOTERO
GARY HUNTER

BLOWERS
JEFF WILLS

ODOR CONTROL
LYNNE MOSS

PROCESS & ENERGY

SIDESTREAM TREATMENT
DR. LEON DOWNING

NUTRIENT REMOVAL
DR. LEON DOWNING

RESOURCE RECOVERY
GREG KNIGHT

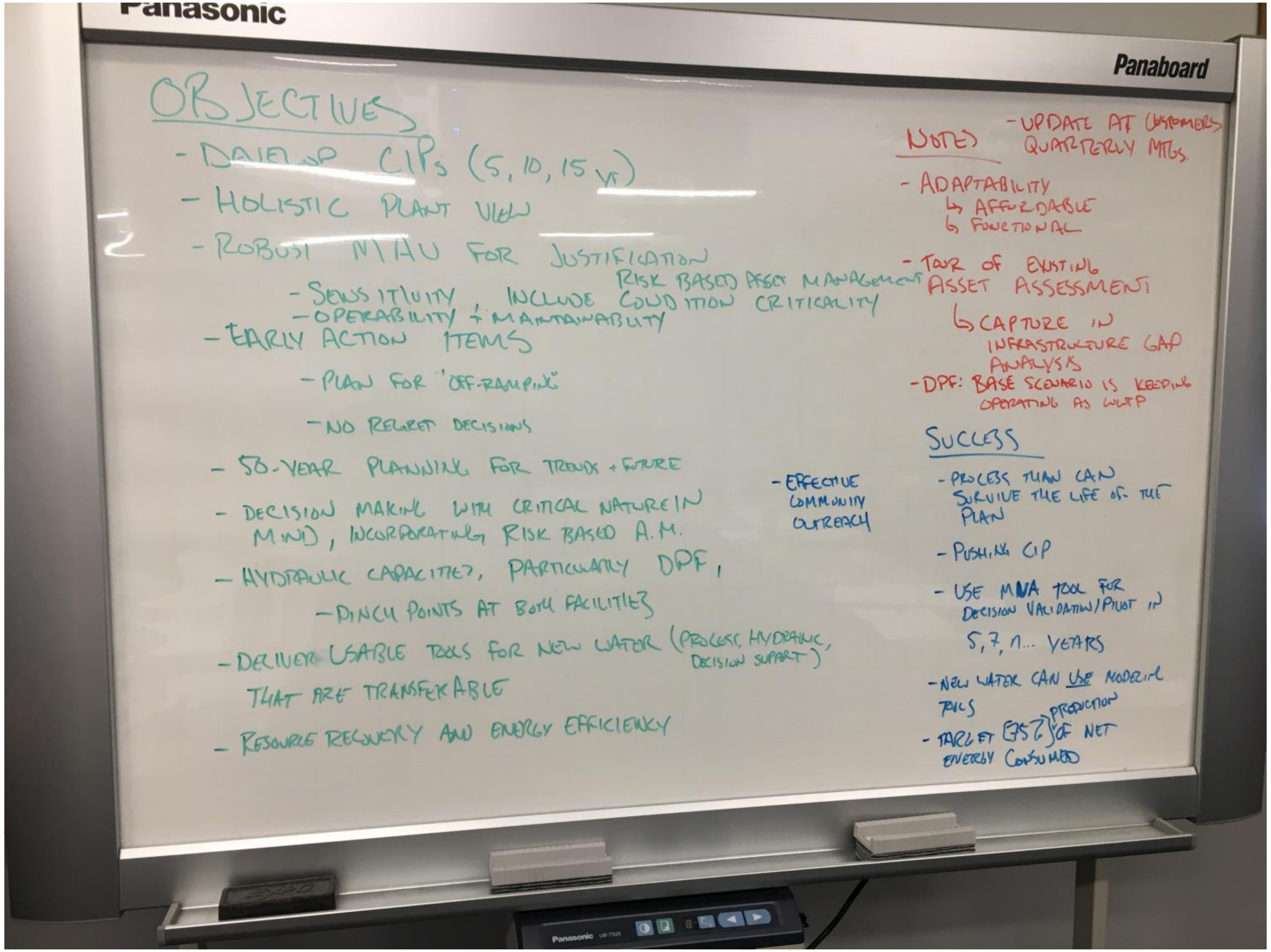
ENERGY MANAGEMENT
JAY KEMP

APPLIED RESEARCH
DR. LEON DOWNING

ASSET MANAGEMENT
JEFF STILLMAN

OPERATIONS PLANNING
DENNIS DINEEN
JEREMY CRAMER

What did we talk about back at the kickoff?



OBJECTIVES

- DEVELOP CIPs (5, 10, 15 YR)
- HOLISTIC PLANT VIEW
- ROBUST MAU FOR JUSTIFICATION
  - SENSITIVITY, INCLUDE CONDITION CRITICALITY RISK BASED ASSET MANAGEMENT
  - OPERABILITY + MAINTAINABILITY
- EARLY ACTION ITEMS
  - PLAN FOR "OFF-RAMPING"
  - NO REGRET DECISIONS
- 50-YEAR PLANNING FOR TRENDS + FUTURE
- DECISION MAKING WITH CRITICAL NATURE IN MIND, INCORPORATING RISK BASED A.M.
- HYDRAULIC CAPACITIES, PARTICULARLY DPF,
  - PINCH POINTS AT BOTH FACILITIES
- DELIVER USABLE TOOLS FOR NEW WATER (PROCESS, HYDRAULIC, DECISION SUPPORT) THAT ARE TRANSFERABLE
- RESOURCE RECOVERY AND ENERGY EFFICIENCY

- EFFECTIVE COMMUNITY OUTREACH

NOTES

- UPDATE AT CUSTOMERS QUARTERLY MTGS.
- ADAPTABILITY
  - ↳ AFFORDABLE
  - ↳ FUNCTIONAL
- TOUR OF EXISTING ASSET ASSESSMENT
  - ↳ CAPTURE IN INFRASTRUCTURE GAP ANALYSIS
- DPF: BASE SCENARIO IS KEEPING OPERATING AS WWTP

SUCCESS

- PROCESS THAN CAN SURVIVE THE LIFE OF THE PLAN
- PUSHING CIP
- USE MAU TOOL FOR DECISION VALIDATION/PIVOT IN 5, 7, n... YEARS
- NEW WATER CAN USE MODELING TOOLS
- TARGET [75%] PRODUCTION OF NET ENERGY CONSUMED

How do we take this list up a level for a Facility Plan?

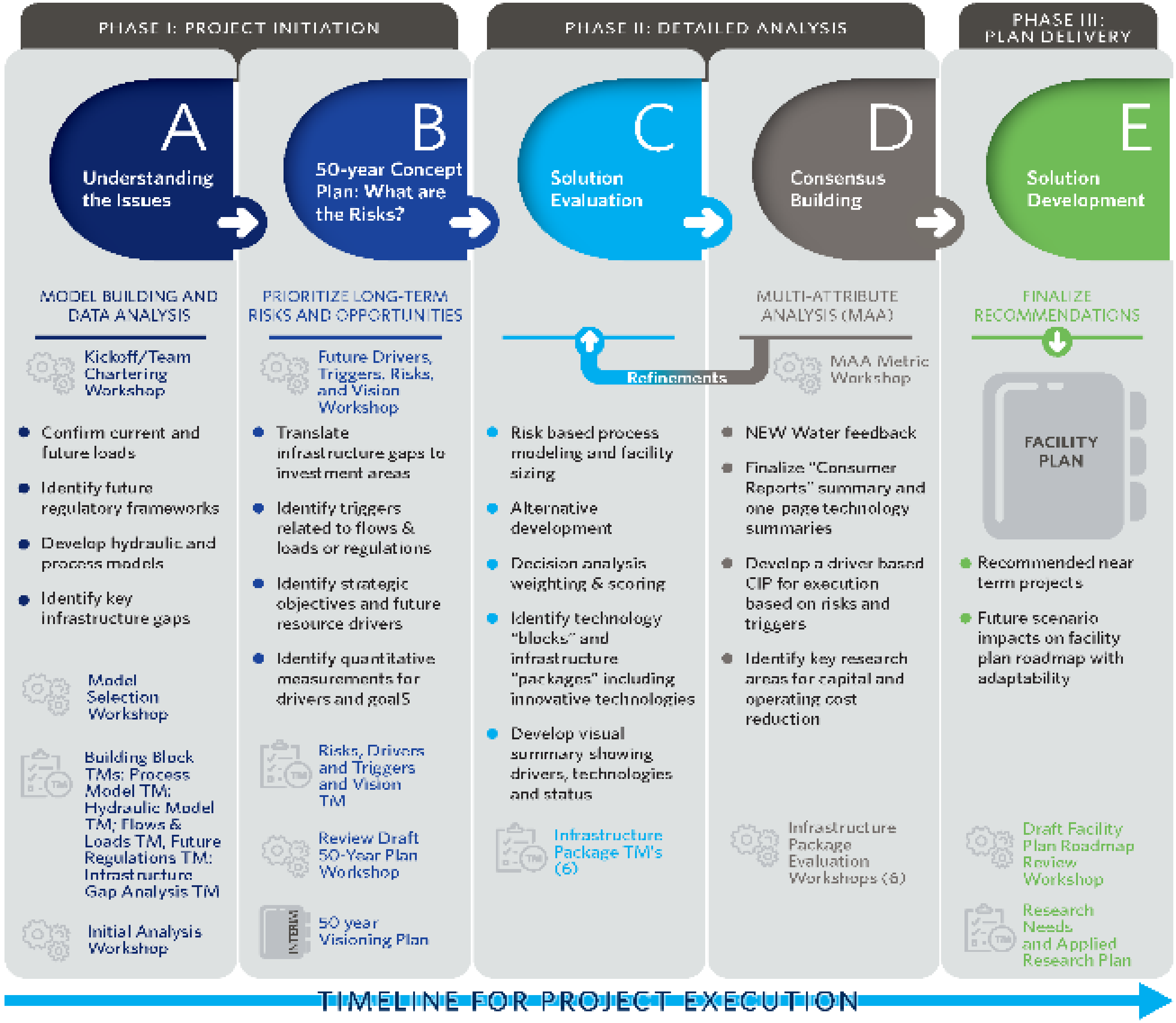
Objectives

1. Develop a vision for development of the GBF and DPF over the coming 50 years that delivers extraordinary value to the Green Bay community.
2. Understand new-term issues and develop plans to address them while retaining future flexibility.
3. Identify actions to be taken now to mitigate future risks and to create future opportunities.
4. Assist New Water to building increased internal capacity, broadly viewed (e.g. staff, capabilities, financial, stakeholder support).

Key Success Factors

1. Clearly understand the current situation.
2. Understand the broad goals and objectives of New Water internal and external stakeholders.
3. Understand the range of future issues and possibilities, including uncertainties.
4. Understand constraints and how they can be relaxed

The facility plan approach consists of five key tasks



PHASE I: PROJECT INITIATION

PHASE II: DETAILED ANALYSIS

PHASE III: PLAN DELIVERY

A Understanding the Issues

MODEL BUILDING AND DATA ANALYSIS

Kickoff/Team Chartering Workshop

- Confirm current and future loads
- Identify future regulatory frameworks
- Develop hydraulic and process models
- Identify key infrastructure gaps

Model Selection Workshop

Building Block TMs: Process Model TM; Hydraulic Model TM; Flows & Loads TM, Future Regulations TM: Infrastructure Gap Analysis TM

Initial Analysis Workshop

B 50-year Concept Plan: What are the Risks?

PRIORITIZE LONG-TERM RISKS AND OPPORTUNITIES

Future Drivers, Triggers, Risks, and Vision Workshop

- Translate infrastructure gaps to investment areas
- Identify triggers related to flows & loads or regulations
- Identify strategic objectives and future resource drivers
- Identify quantitative measurements for drivers and goalS

Risks, Drivers and Triggers and Vision TM

Review Draft 50-Year Plan Workshop

INTERIM

50 year Visioning Plan

C Solution Evaluation

Refinements

- Risk based process modeling and facility sizing
- Alternative development
- Decision analysis weighting & scoring
- Identify technology "blocks" and infrastructure "packages" including innovative technologies
- Develop visual summary showing drivers, technologies and status

Infrastructure Package TM's (6)

D Consensus Building

MULTI-ATTRIBUTE ANALYSIS (MAA)

MAA Metric Workshop

- NEW Water feedback
- Finalize "Consumer Reports" summary and one page technology summaries
- Develop a driver based CIP for execution based on risks and triggers
- Identify key research areas for capital and operating cost reduction

Infrastructure Package Evaluation Workshops (6)

E Solution Development

FINALIZE RECOMMENDATIONS

FACILITY PLAN

- Recommended near term projects
- Future scenario impacts on facility plan roadmap with adaptability

Draft Facility Plan Roadmap Review Workshop

Research Needs and Applied Research Plan

TIMELINE FOR PROJECT EXECUTION

✓ TM 2.1
✓ TM 2.2
✓ TM 2.3
✓ TM 2.4

- TM 2.5 and 2.6

- Visioning sessions
- MUA Criteria
- TM 3.1

✓ TM 4.1
✓ TM 4.2

- TM 4.3, 4.4, 4.5, 4.6

In today’s world, the water industry is facing a range of drivers for facility improvements and expansion

The NEW Water Facility Plan is a combination of facility planning and master planning

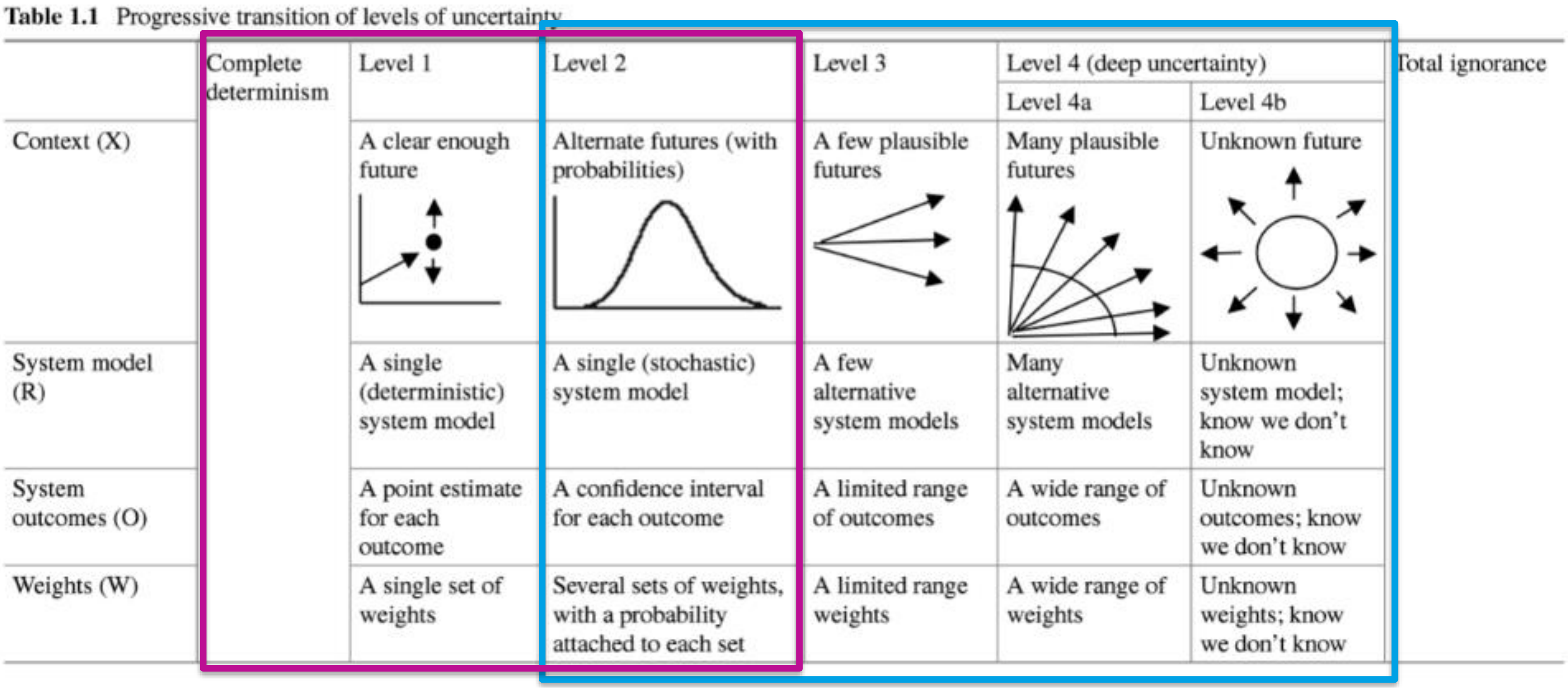


Table 1.1 Progressive transition of levels of uncertainty

	Complete determinism	Level 1	Level 2	Level 3	Level 4 (deep uncertainty)		Total ignorance
					Level 4a	Level 4b	
Context (X)		A clear enough future	Alternate futures (with probabilities)	A few plausible futures	Many plausible futures	Unknown future	
System model (R)		A single (deterministic) system model	A single (stochastic) system model	A few alternative system models	Many alternative system models	Unknown system model; know we don't know	
System outcomes (O)		A point estimate for each outcome	A confidence interval for each outcome	A limited range of outcomes	A wide range of outcomes	Unknown outcomes; know we don't know	
Weights (W)		A single set of weights	Several sets of weights, with a probability attached to each set	A limited range weights	A wide range of weights	Unknown weights; know we don't know	

Facility Planning

Master Planning

Marchau et al (2019) *Decision Making Under Deep Uncertainty*. Switzerland; Springer.

A potential goal is to keep your options flexible as long as possible

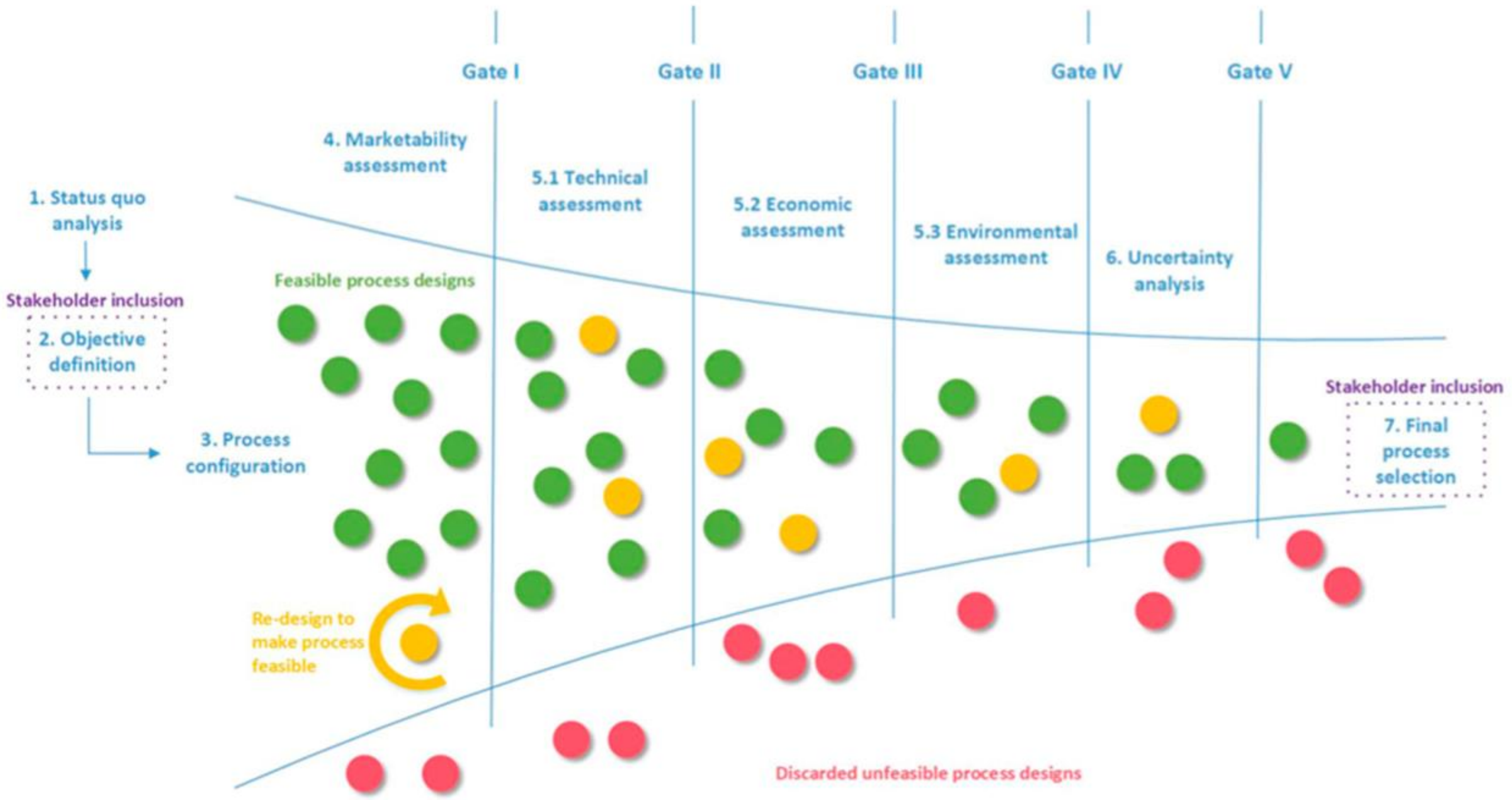


Figure 1. Funnel development and stage gating model adapted from [26] to make it specially applicable for water resource factory (WRF) process design purposes.

Kehrein et al (2020) Sustainability 12, 4168; doi:10.3390/su12104168

Quaglia, A. An Integrated Business and Engineering Framework for Synthesis and Design of Processing Networks. Ph.D.Thesis,DTUChemicalEngineering,DepartmentofChemicalandBiochemicalEngineering, Kgs. Lyngby, Denmark, 2013.

Identifying cost uncertainty during planning is a key consideration

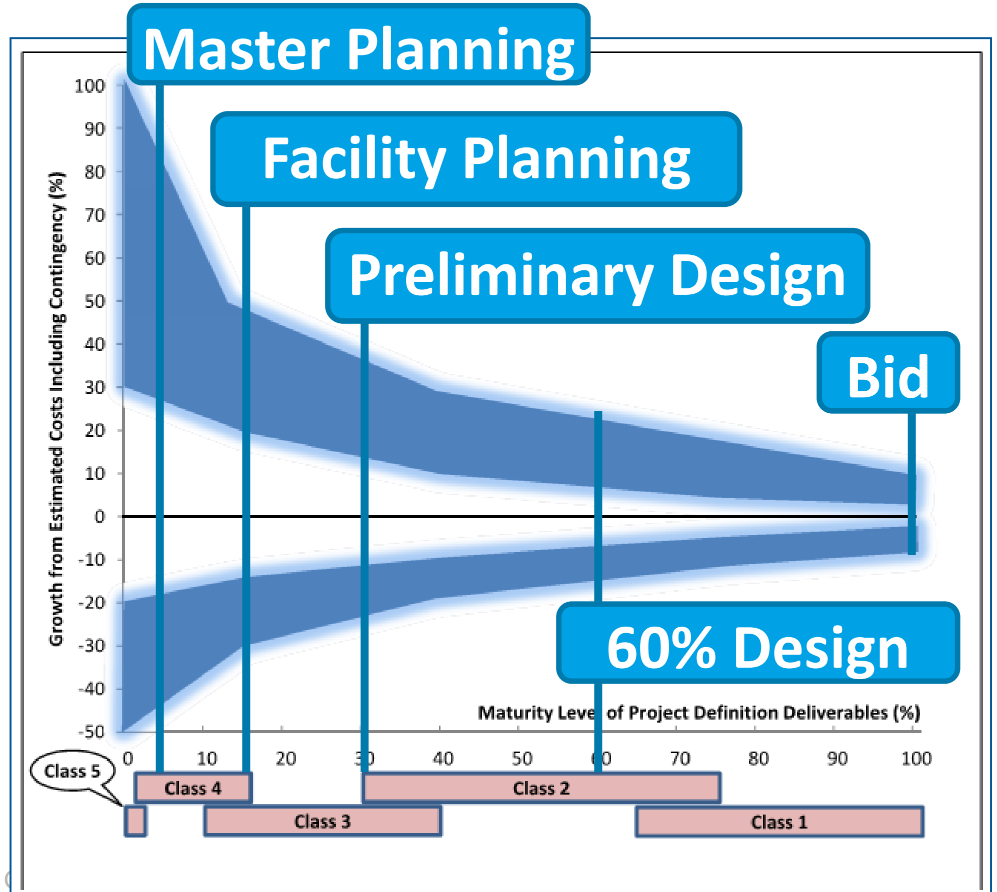


Figure 1 – Example of the Variability in Accuracy Ranges for a Process Industry Estimate

Total Probable Construction Cost

x   Accuracy Range (+/-%)

= Range of Likely Construction Costs

Total Probable Construction Cost Range

High Range ***Mid Range x 125%***

Mid Range ---

Low Range ***Mid Range x 85%***

(from AACE International Recommended Practice No. 18R-97)

How should we be thinking about the next five sessions?

Identify Risks

Define Opportunities

Develop Solution Pathways

Risks and opportunities will feed into the structure of the MUA

Infrastructure Update

Adaptive Management

- Alternative compliance approach selected to address TSS and Phosphorus compliance
- Focused on achieving water quality in Fox River
- 20-year plan (four permit terms)
- Approval to continue at each permit renewal
- Silver Creek Pilot
- Ashwaubenon Creek and Dutchman Creek Full-Scale Implementation
- Submitted plan is currently under review by Wisconsin DNR

Adaptive Management

- Achieving mass based TSS and Phosphorus limits required if no longer following Adaptive Management or Fox River does not achieve water quality after four permit terms
- Hopeful that Adaptive Management is successful in helping to achieve water quality goals
- Hopeful that Adaptive Management or other watershed approaches have life beyond 20-years

Resource Recovery & Electrical Energy (R2E2)

- Digesters running well
  - Bio-gas cleaning performing well
- FBI running well
  - Concern with one part of the incineration train shutting down the complete system (redundancy)
- Air pollution control running well
  - Mercury removal system (granulated activated carbon) performing well, but concerns with potential future issues (thermal excursion)
  - Potential for future more stringent limits
- Concern with continued landfill acceptance of sludge during FBI outages
- Additional digested sludge storage desired

Resource Recovery & Electrical Energy (R2E2)

- Energy Recovery
  - Currently generating approximately 40% of electrical usage
  - Bio-gas engine reliability has been an issue
    - Have not made it one complete month with both engines running
  - High strength waste (HSW) program has done well
    - Currently getting enough HSW to run one engine almost exclusively on bio-gas
    - More HSW sources are available
      - Have limited additional HSW accepted due to lack of reliable engines
  - Additional gas storage would be a benefit

Resource Recovery & Electrical Energy (R2E2)

R2E2 ENERGY - CURRENT YEAR 2020

NEW Water (GBMSD) - GREEN BAY FACILITY

	Bio-gas Generated					Electricity Used					Natural Gas Used									
		Generators		Flare			Purchased		Generated			Incineration		Heating Boiler		Thermal Oil Boiler		Co-Generation Units	
	Total (CCF)	Total (CCF)	% of Total	Total (CCF)	% of Total	Total (MWH)	Total (MWH)	% of Total	Total (MWH)	% of Total	Total (CCF)	Total (CCF)	% of Total	Total (CCF)	% of Total	Total (CCF)	% of Total	Total (CCF)	% of Total
January	240,152	222,724	92.7	17,428	7.3	3,657	2,123	58.1	1,533	41.9	125,740	6,357	5.1	109,385	87.0	0	0.0	9,998	8.0
February	202,546	198,889	98.2	3,657	1.8	3,078	1,765	57.4	1,312	42.6	132,965	13,235	10.0	108,484	81.6	0	0.0	11,246	8.5
March	220,334	203,695	92.4	16,639	7.6	3,572	2,191	61.3	1,381	38.7	101,861	17,038	16.7	77,163	75.8	0	0.0	7,660	7.5
April	247,422	10,817	4.4	236,605	95.6	3,271	3,116	95.3	154	4.7	111,252	17,341	15.6	85,014	76.4	47	0.0	8,850	8.0
May																			
June																			
July																			
August																			
September																			
October																			
November																			
December																			

	Co-Generation Unit #3 (P-21)							Co-Generation Unit #4 (P-22)							High Strength Waste Received	Struvite Harvested
	Monthly Run Time (hours)	Total Energy Generated (MWH)	Gas Consumption					Monthly Run Time (hours)	Total Energy Generated (MWH)	Gas Consumption						
				Bio-gas		Natural Gas					Bio-gas		Natural Gas			
			Total (CCF)	Total (CCF)	% of Total	Total (CCF)	% of Total			Total (CCF)	Total (CCF)	% of Total	Total (CCF)	% of Total	Total (gals)	Total (lbs)
January	212	412	43,660	41,815	95.8	1,845	4.2	580	1,121	189,062	180,909	95.7	8,153	4.3	1,588,734	0
February	672	1,308	209,577	198,544	94.7	11,033	5.3	2	4	558	345	61.8	213	38.2	1,490,460	0
March	600	1,168	174,736	167,743	96.0	6,993	4.0	110	213	36,619	35,952	98.2	667	1.8	1,869,090	0
April	90	154	19,667	10,817	55.0	8,850	45.0	0	0	0	0	0.0	0	0.0	2,140,426	0
May																
June																
July																
August																
September																
October																
November																
December																

Resource Recovery & Electrical Energy (R2E2)

R2E2 ENERGY - CURRENT YEAR 2019

NEW Water (GBMSD) - GREEN BAY FACILITY

	Bio-gas Generated					Electricity Used					Natural Gas Used								
		Generators		Flare			Purchased		Generated			Incineration		Heating Boiler		Thermal Oil Boiler		Co-Generation Units	
	Total (CCF)	Total (CCF)	% of Total	Total (CCF)	% of Total	Total (MWH)	Total (MWH)	% of Total	Total (MWH)	% of Total	Total (CCF)	Total (CCF)	% of Total	Total (CCF)	% of Total	Total (CCF)	% of Total	Total (CCF)	% of Total
January	203,137	198,046	97.5	5,091	2.5	3,906	2,338	59.8	1,569	40.2	180,443	16,665	9.2	135,240	74.9	3,534	2.0	25,004	13.9
February	140,071	140,070	100.0	1	0.0	2,993	1,927	64.4	1,066	35.6	153,521	11,724	7.6	126,258	82.2	25	0.0	15,514	10.1
March	170,110	169,817	99.8	293	0.2	3,452	2,151	62.3	1,301	37.7	146,606	13,596	9.3	110,713	75.5	54	0.0	22,243	15.2
April	185,616	182,596	98.4	3,020	1.6	3,337	2,065	61.9	1,272	38.1	88,598	12,110	13.7	63,544	71.7	0	0.0	12,944	14.6
May	222,958	210,895	94.6	12,063	5.4	3,692	2,153	58.3	1,539	41.7	49,808	13,135	26.4	29,111	58.4	0	0.0	7,562	15.2
June	232,606	215,927	92.8	16,679	7.2	3,304	2,067	62.6	1,237	37.4	22,818	13,109	57.5	1,410	6.2	0	0.0	8,299	36.4
July	226,037	202,902	89.8	23,135	10.2	3,460	2,001	57.8	1,459	42.2	34,821	11,362	32.6	623	1.8	0	0.0	22,836	65.6
August	137,092	135,800	99.1	1,292	0.9	3,343	1,330	39.8	2,014	60.2	138,090	8,754	6.3	194	0.1	0	0.0	129,142	93.5
September	199,774	198,043	99.1	1,731	0.9	3,752	2,215	59.0	1,537	41.0	60,686	18,999	31.3	2,884	4.8	0	0.0	38,803	63.9
October	200,561	176,548	88.0	24,013	12.0	3,390	2,078	61.3	1,312	38.7	75,054	12,974	17.3	36,595	48.8	0	0.0	25,485	34.0
November	176,439	168,239	95.4	8,200	4.6	3,334	1,882	56.4	1,452	43.6	154,405	14,476	9.4	89,089	57.7	1	0.0	50,839	32.9
December	183,492	183,096	99.8	396	0.2	3,464	2,105	60.8	1,359	39.2	124,909	6,671	5.3	86,835	69.5	136	0.1	31,267	25.0

	Co-Generation Unit #3 (P-21)							Co-Generation Unit #4 (P-22)							High Strength Waste Received	Struvite Harvested
			Gas Consumption							Gas Consumption						
	Monthly Run Time (hours)	Total Energy Generated (MWH)		Bio-gas		Natural Gas		Monthly Run Time (hours)	Total Energy Generated (MWH)		Bio-gas		Natural Gas			
			Total (CCF)	Total (CCF)	% of Total	Total (CCF)	% of Total			Total (CCF)	Total (CCF)	% of Total	Total (CCF)	% of Total	Total (gals)	Total (lbs)
January	250	656	83,947	72,237	86.1	11,710	13.9	501	913	139,103	125,809	90.4	13,294	9.6	0	0
February	551	742	110,786	104,397	94.2	6,389	5.8	214	324	44,798	35,673	79.6	9,125	20.4	48,000	0
March	411	654	95,247	84,680	88.9	10,567	11.1	415	646	96,813	85,137	87.9	11,676	12.1	144,000	0
April	385	635	93,937	87,409	93.1	6,528	6.9	371	636	101,603	95,186	93.7	6,416	6.3	395,610	0
May	426	794	113,876	108,873	95.6	5,003	4.4	403	746	104,581	102,022	97.6	2,559	2.4	1,437,226	3,000
June	465	875	138,847	132,933	95.7	5,914	4.3	191	362	85,379	82,994	97.2	2,385	2.8	1,452,782	5,000
July	454	813	122,492	110,930	90.6	11,562	9.4	363	646	103,246	91,972	89.1	11,274	10.9	1,594,174	0
August	369	714	85,683	15,125	17.7	70,558	82.3	669	1,300	179,259	120,675	67.3	58,584	32.7	1,772,246	20
September	281	545	78,763	64,101	81.4	14,662	18.6	510	992	158,083	133,942	84.7	24,141	15.3	1,547,606	0
October	6	11	1,617	1,386	85.7	231	14.3	681	1,301	200,416	175,162	87.4	25,254	12.6	1,844,167	0
November	585	1,138	163,260	121,996	74.7	41,264	25.3	174	314	55,818	46,243	82.8	9,575	17.2	1,647,279	0
December	114	222	31,836	23,936	75.2	7,900	24.8	584	1,137	182,527	159,160	87.2	23,367	12.8	1,600,430	0

TM 2.1. Flows & Loads

Communities Served

GBF

- Allouez
- Ashwaubenon
- Bellevue
- Green Bay
- Hobart
- Howard
- Pittsfield
- Pulaski
- Scott
- Suamico
- Dyckesville
- Luxemburg

DPF

- Ashwaubenon
- De Pere
- Hobart
- Lawrence
- Ledgeview
- Rockland (annexed)

Top 10 Significant Industrial Users

NO.	COMPANY	PLANT	AVERAGE FLOW FROM 2014-2016 (GPD)	PEAK FLOW (MGD)
1	Procter & Gamble Paper Products Company	GBF	3.43	5.71
2	Fox River Fiber	DPF & GBF	1.11	1.23
3	JBS Green Bay	GBF	1.03	1.27
4	Ahlstrom-Munksjo (formerly Expera)	DPF	0.88	1.11
5	Bay Valley Foods, LLC	GBF	0.58	0.70
6	Green Bay Dressed Beef - Acme	GBF	0.54	0.73
7	Pioneer Metal Finishing	DPF	0.43	0.50
8	Georgia Pacific Consumer Operations, LLC	GBF	0.28	0.33
9	Sanimax USA, LLC.	GBF	0.24	2.03
10	Green Bay Nonwovens, Plant 1	DPF	0.23	0.25

Design Flows and Loads for Existing Facilities

GBF

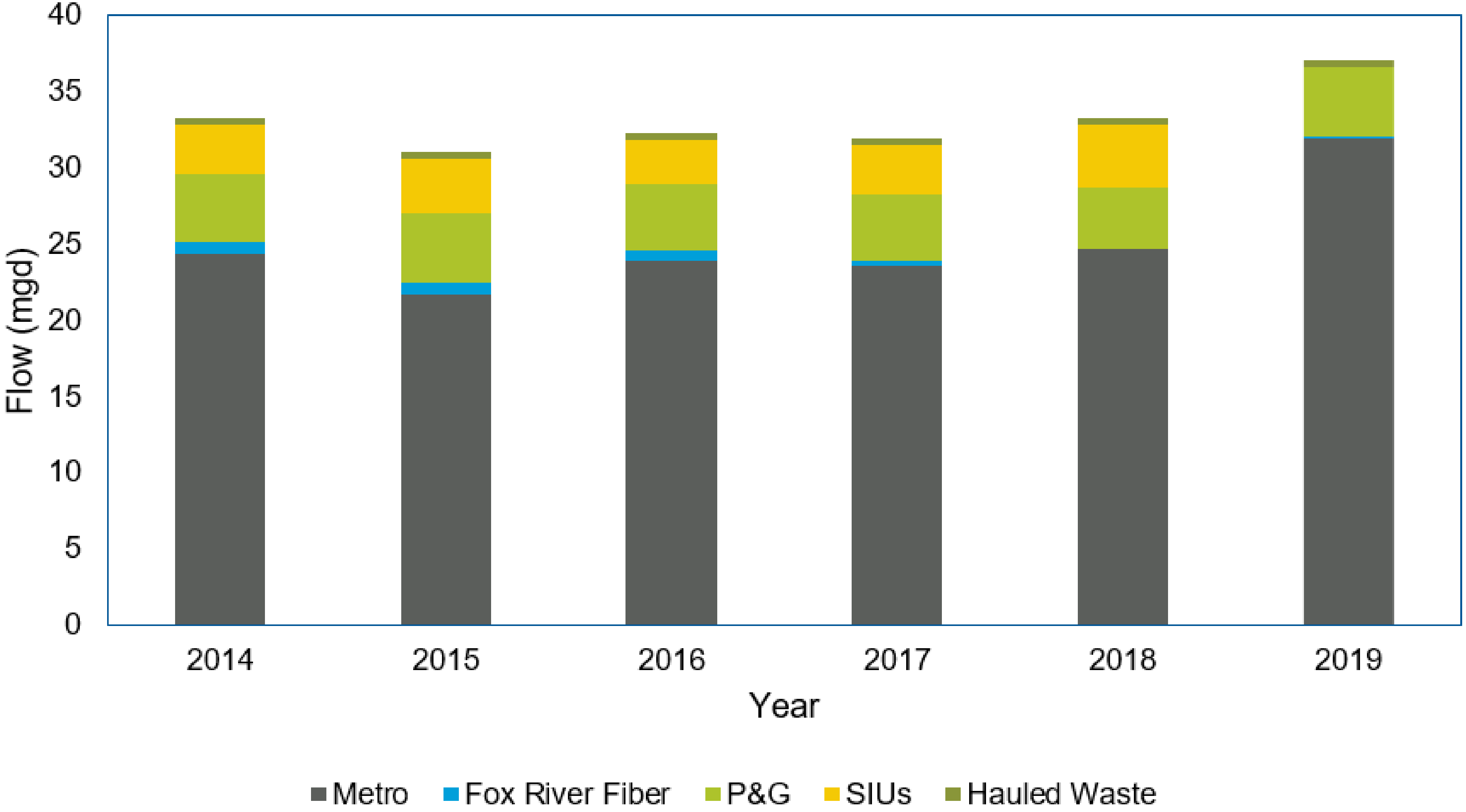
INFLUENT PARAMETER	AVERAGE	MAXIMUM MONTHLY	MAXIMUM WEEKLY	MAXIMUM DAILY
Flow (mgd)	32.4	49.2	65.5	96.6
BOD_5 (ppd)	74,660	103,110	126,630	201,390
TSS (ppd)	84,580	89,460	110,360	200,240
NH_3-N (ppd)	5,610	6,555	6,990	12,500

DPF

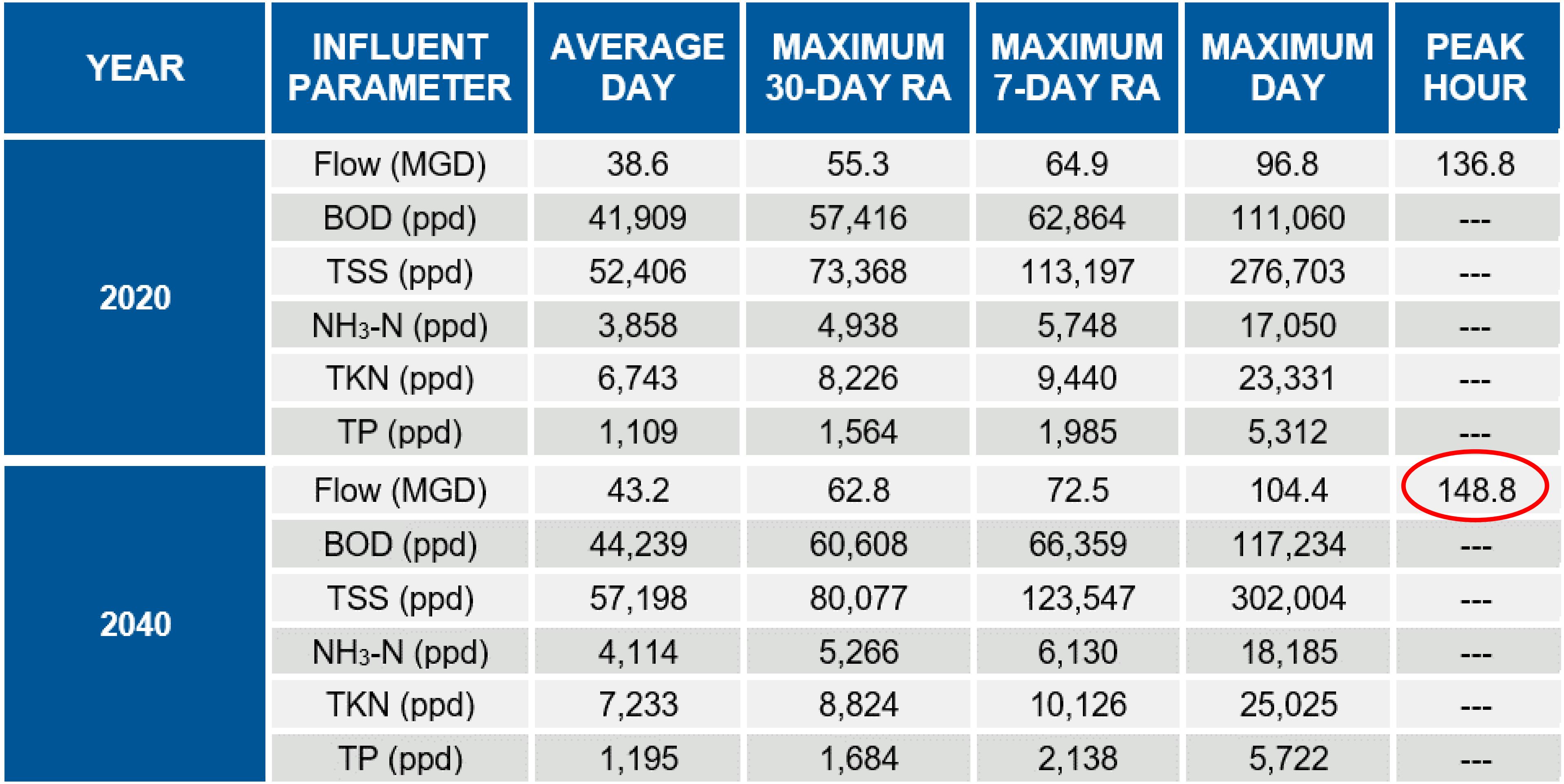
INFLUENT PARAMETER	AVERAGE	DESIGN	PEAK HOUR
Flow (mgd)	9.5	14.2	30
BOD_5 (ppd)	23,500	41,000	41,000
TSS (ppd)	18,400	23,700	28,900

Sized for significant industrial loading

GBF Historical Flows

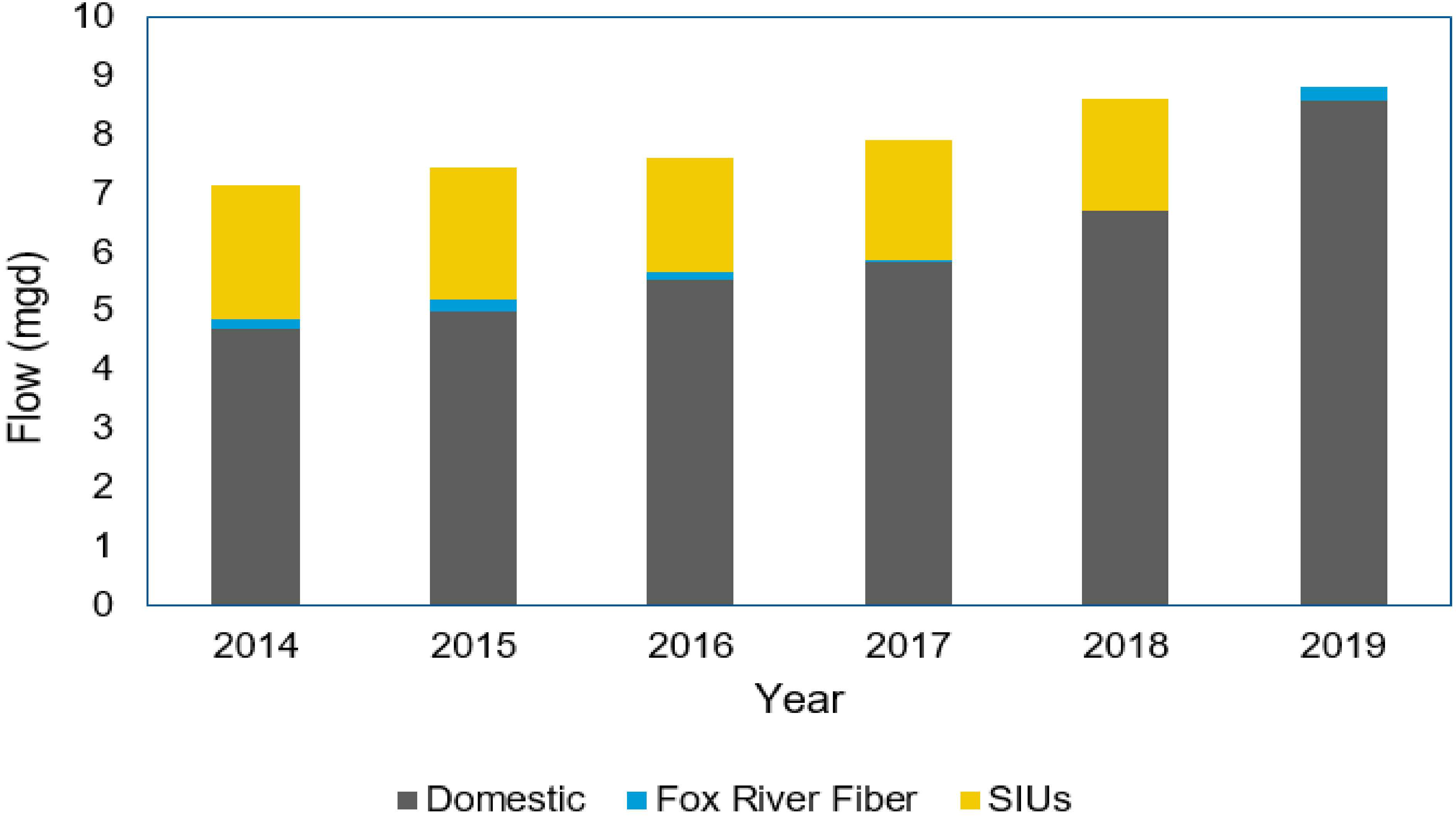


GBF Projected Flows and Loads

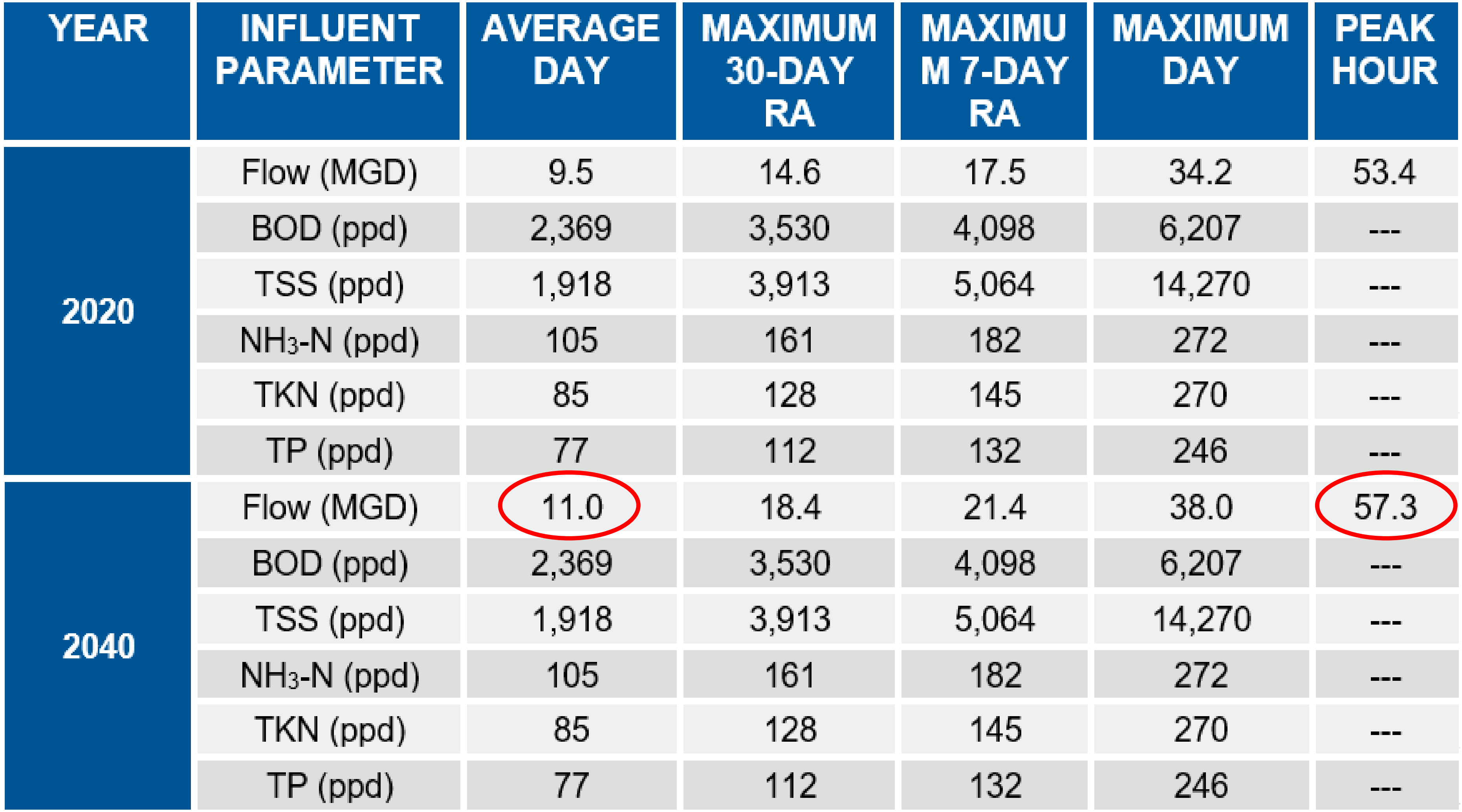


YEAR	INFLUENT PARAMETER	AVERAGE DAY	MAXIMUM 30-DAY RA	MAXIMUM 7-DAY RA	MAXIMUM DAY	PEAK HOUR
2020	Flow (MGD)	38.6	55.3	64.9	96.8	136.8
	BOD (ppd)	41,909	57,416	62,864	111,060	---
	TSS (ppd)	52,406	73,368	113,197	276,703	---
	NH$_3$-N (ppd)	3,858	4,938	5,748	17,050	---
	TKN (ppd)	6,743	8,226	9,440	23,331	---
	TP (ppd)	1,109	1,564	1,985	5,312	---
2040	Flow (MGD)	43.2	62.8	72.5	104.4	148.8
	BOD (ppd)	44,239	60,608	66,359	117,234	---
	TSS (ppd)	57,198	80,077	123,547	302,004	---
	NH$_3$-N (ppd)	4,114	5,266	6,130	18,185	---
	TKN (ppd)	7,233	8,824	10,126	25,025	---
	TP (ppd)	1,195	1,684	2,138	5,722	---

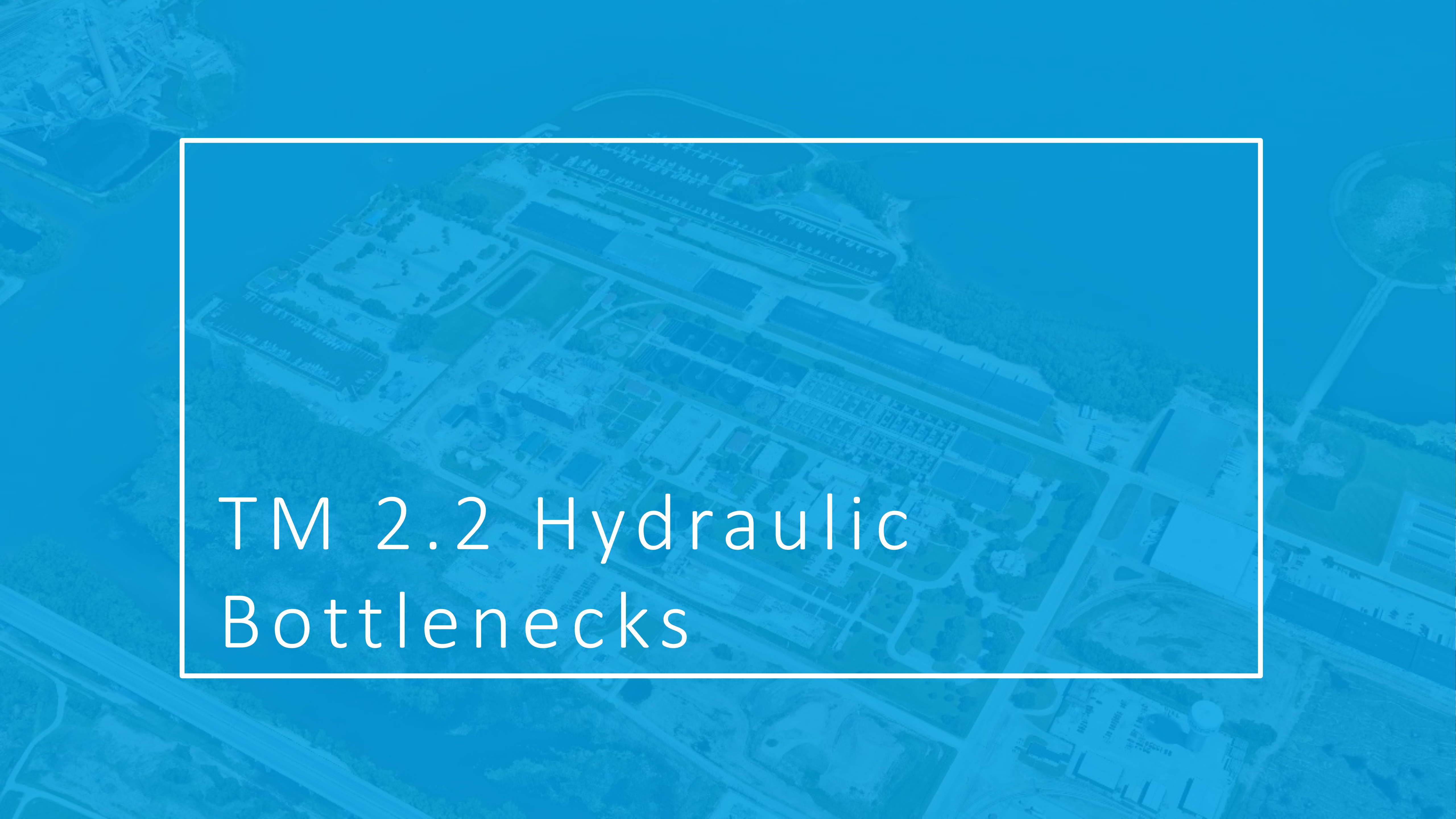
DPF Historical Flows



DPF Projected Flows and Loads



YEAR	INFLUENT PARAMETER	AVERAGE DAY	MAXIMUM 30-DAY RA	MAXIMUM 7-DAY RA	MAXIMUM DAY	PEAK HOUR
2020	Flow (MGD)	9.5	14.6	17.5	34.2	53.4
	BOD (ppd)	2,369	3,530	4,098	6,207	---
	TSS (ppd)	1,918	3,913	5,064	14,270	---
	NH_3-N (ppd)	105	161	182	272	---
	TKN (ppd)	85	128	145	270	---
	TP (ppd)	77	112	132	246	---
2040	Flow (MGD)	11.0	18.4	21.4	38.0	57.3
	BOD (ppd)	2,369	3,530	4,098	6,207	---
	TSS (ppd)	1,918	3,913	5,064	14,270	---
	NH_3-N (ppd)	105	161	182	272	---
	TKN (ppd)	85	128	145	270	---
	TP (ppd)	77	112	132	246	---



TM 2.2 Hydraulic Bottlenecks

GBF – Influent Pump Station Hydraulics

- 2040 peak hour flow of 149 MGD identified in Flows and Loads TM
- Pump station has 4 – 40 MGD pumps (firm capacity of 120 MGD)
- Recommended pumps upgrade: 4 – 50 MGD units
- Size of existing twin 48" forcemains is acceptable
- Interceptor system is currently being evaluated to look at equalization alternatives to limit flow to GBF

GBF – Gravity Hydraulics Evaluation

- Hydraulic model indicates significant upgrades and modifications required to convey the 149 MGD peak flow
- 20-year future condition, 10-year recurrence scenario (140 MGD) from Interceptor Master Plan identified as recommended maximum hydraulic capacity
  - Scenario meets critical criteria without significant upgrades
- To gain more hydraulic capacity, high priority major improvements include:
  - Primary clarifier inlet distribution channels and piping
  - Inlet channels to aeration basins

GBF - Critical Element Identification

- Critical elements evaluated to determine maximum capacity
- Critical elements include elements in violation of:
  - Freeboard
  - Velocity

Condition	Current Conditions	20-Year Future	50-Year Future	Current Conditions	20-Year Future	50-Year Future
Recurrence Interval (years)	10	10	10	25	25	25
Flow (MGD)	128	135	148	151	159	175
Channel/ Pipe Velocity						
1 Primary Basin Influent Piping	5.27	5.55	6.07	6.19	6.51	7.16
Freeboard Limitations						
2 Bar Screen Bypass Channel	NO	NO	NO	NO	FLOOD	FLOOD
3 Bar Screen Channel	NO	NO	NO	NO	FLOOD	FLOOD
4 Channel Upstream of Influent Parshall Flume	NO	NO	NO	NO	NO	FLOOD
5 Channel Downstream of Influent Parshall Flume	NO	NO	FLOOD	FLOOD	FLOOD	FLOOD
6 Channel just Upstream of Dropbox into Primary Basin	NO	NO	NO	NO	NO	FLOOD
7 Dropbox into Primary Basin	NO	NO	NO	NO	NO	FLOOD
8 Channel Downstream of Primary Effluent Channel Gate	NO	NO	NO	NO	NO	FLOOD
9 Channel from Final Basin Discharge to Effluent Channel	NO	NO	NO	NO	NO	FLOOD
10 Final Effluent Channel Downstream of Final Basin	NO	NO	NO	NO	NO	FLOOD

GBF - Non-Critical Element Identification

- Non-critical elements evaluated to confirm results
- Non-critical elements include elements in violation of:
  - Submerged flumes
  - Submerged weirs
  - Submerged gates

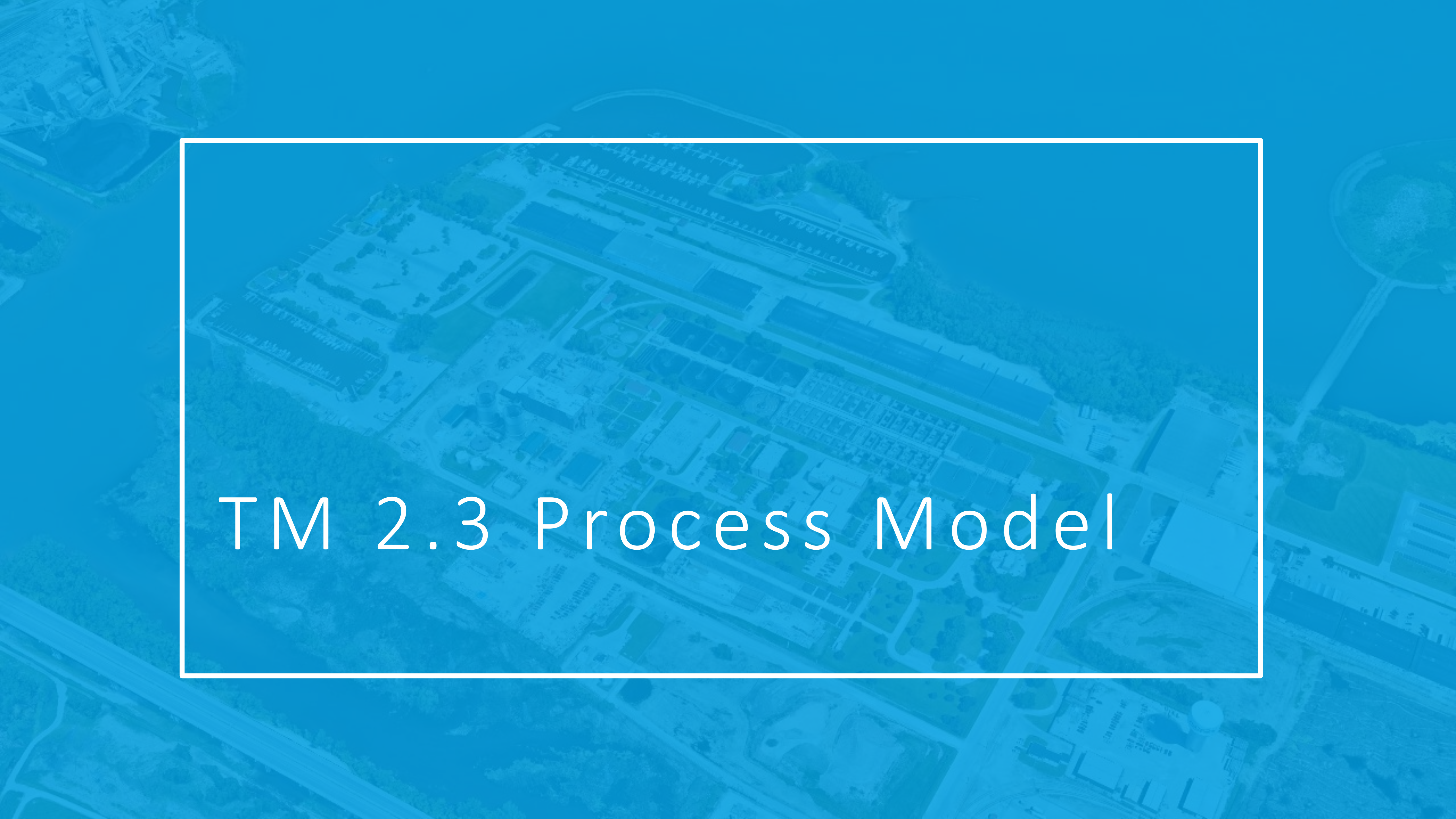
Condition	Current Conditions	20-Year Future	50-Year Future	Current Conditions	20-Year Future	50-Year Future
Recurrence Interval (years)	10	10	10	25	25	25
Flow (MGD)	128	135	148	151	159	175
Submerged Flumes						
Influent Parshall Flume	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED
Aeration Splitter Parshall Flume	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED
Effluent Parshall Flume	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED
Submerged Weirs						
Control Weir into Headworks (CW-B2)	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED
Bypass Weir (into Screen Bypass Channel)	NO	NO	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED
Control Weir Upstream of Influent Parshall Flume (CW-B5)	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED
Primary Basin V-notch Weir	NO	NO	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED
Weir Upstream of Aeration Splitter Parshall Flume (CW-B9)	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED
Weir Upstream of Contact Basin (CW-B21)	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED
Weir Upstream of Final Basin Dropbox (SG-B94)	NO	NO	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED
Final Basin V-notch Weir	NO	NO	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED
Submerged Gates						
Gate Upstream of Primary Basin Influent Dropbox (SG-B8)	NO	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED
Stop Gate at Discharge of Primary Basin (SG-B13)	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED
Gate Downstream of Primary Effluent Channel (SG-B17)	NO	NO	NO	NO	NO	SUBMERGED
Final Basin Effluent Gate (SG-101)	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED
Stop Gate Upstream of Chlorine Contact Basin (SG-B108)	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED	SUBMERGED

DPF – Influent Pump Station Hydraulics

- 2040 peak hour flow of 57 MGD identified in Flows and Loads TM
- Pump station has 5 – 10 MGD pumps and 1 – 5 MGD pump (firm capacity of 45 MGD)
  - Can transfer 5 MGD to GBF interceptor
- Recommended pumps upgrade: 5 – 13 MGD units
- Size of existing twin 36” forcemains is acceptable

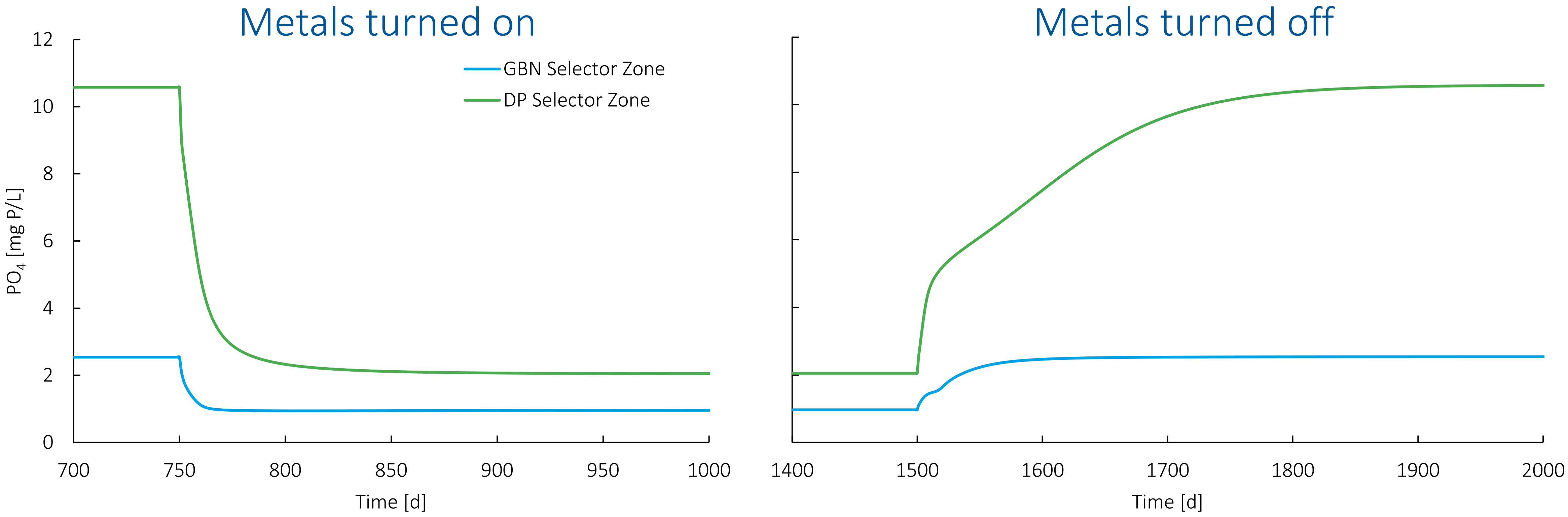
DPF – Gravity Hydraulics Evaluation

- Hydraulic model indicates significant upgrades and modifications required to convey the 57 MGD peak flow
- To gain more hydraulic capacity, high priority major improvements include:
  - New forcemain headbox, elevated grit removal tanks, and channels to aeration tanks
  - Clarifier expansion
    - Intermediates currently sized for 16 MGD, finals sized for 38 MGD
  - Filtration expansion – already in design phase
  - UV disinfection expansion – currently sized for 31 MGD

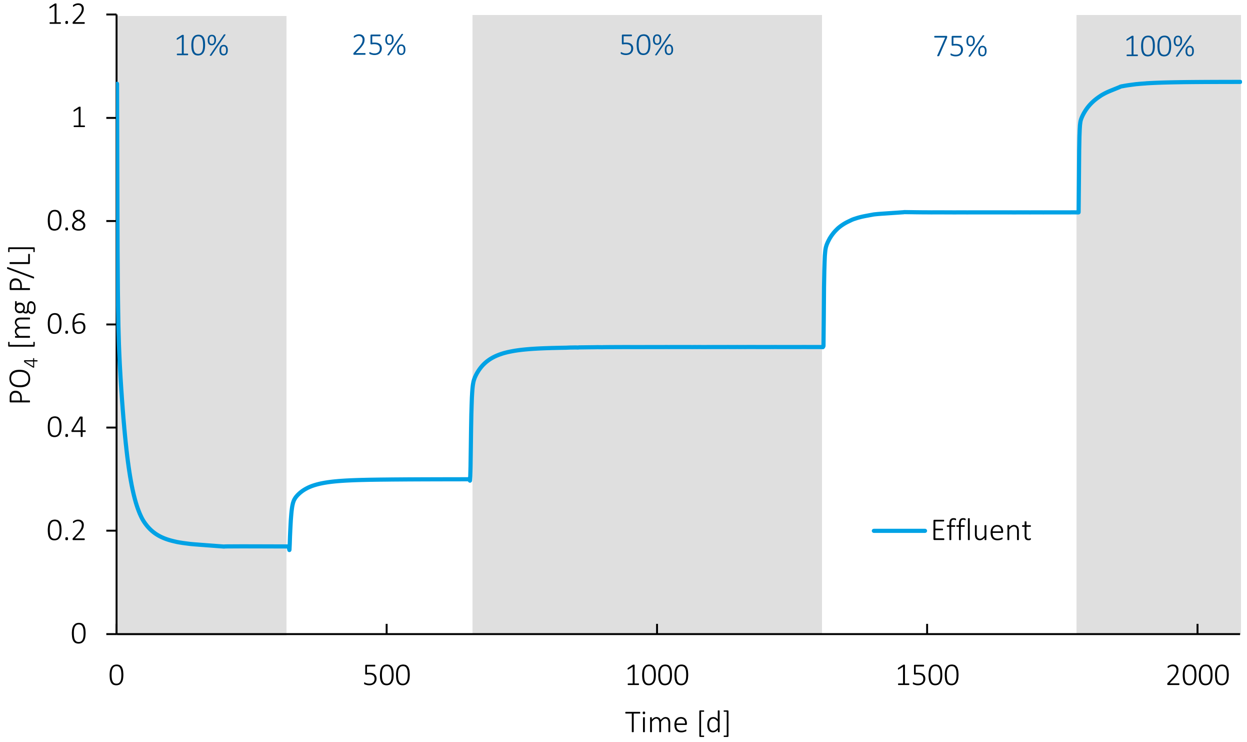


TM 2.3 Process Model

Insight into ChemP dynamics

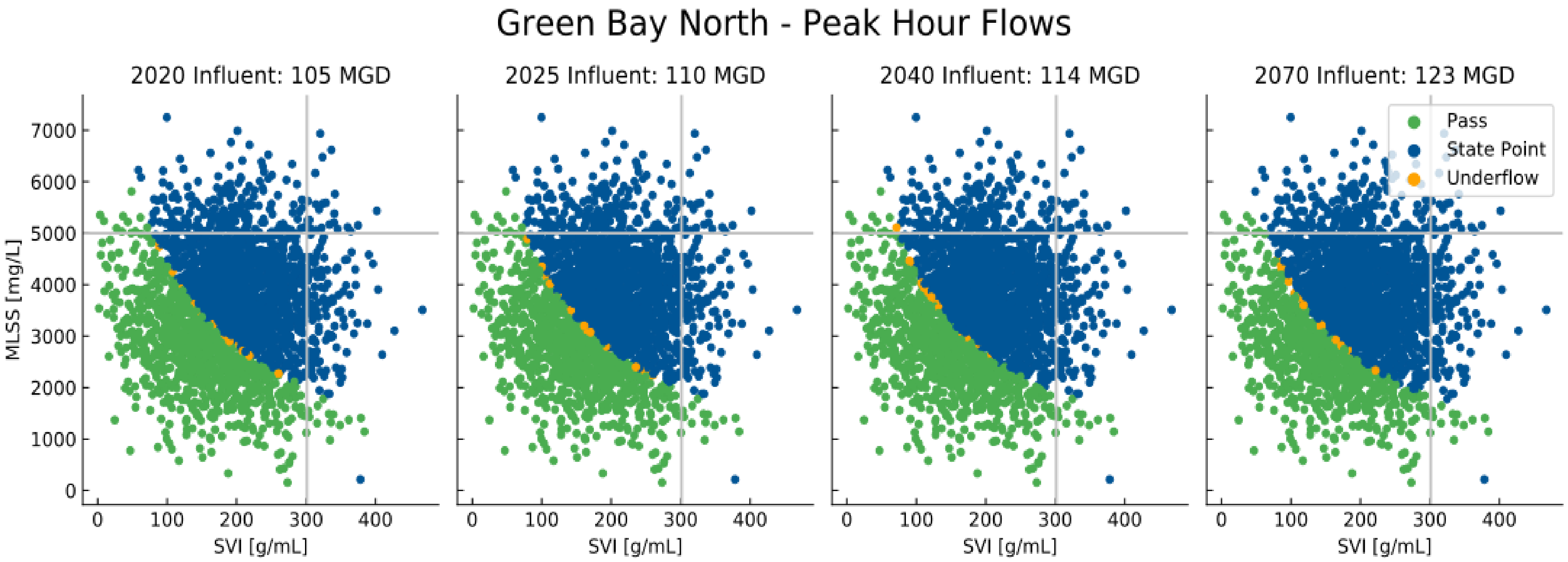


Insight into ammonium and BioP



Note: Percentages listed are % recycle stream NH_4 load

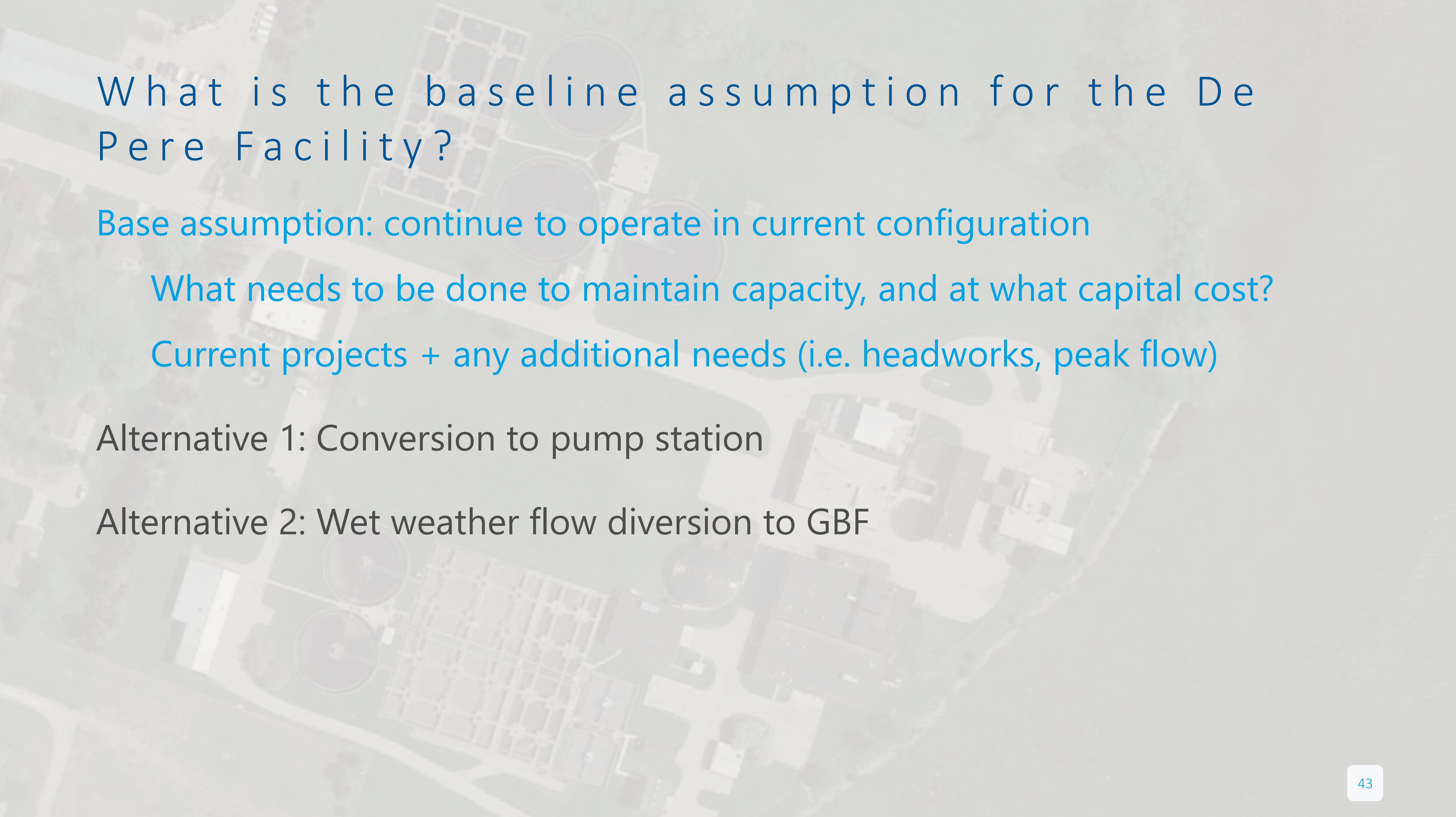
Solids balance a key to capacity



TM 2.4 Regulatory Drivers

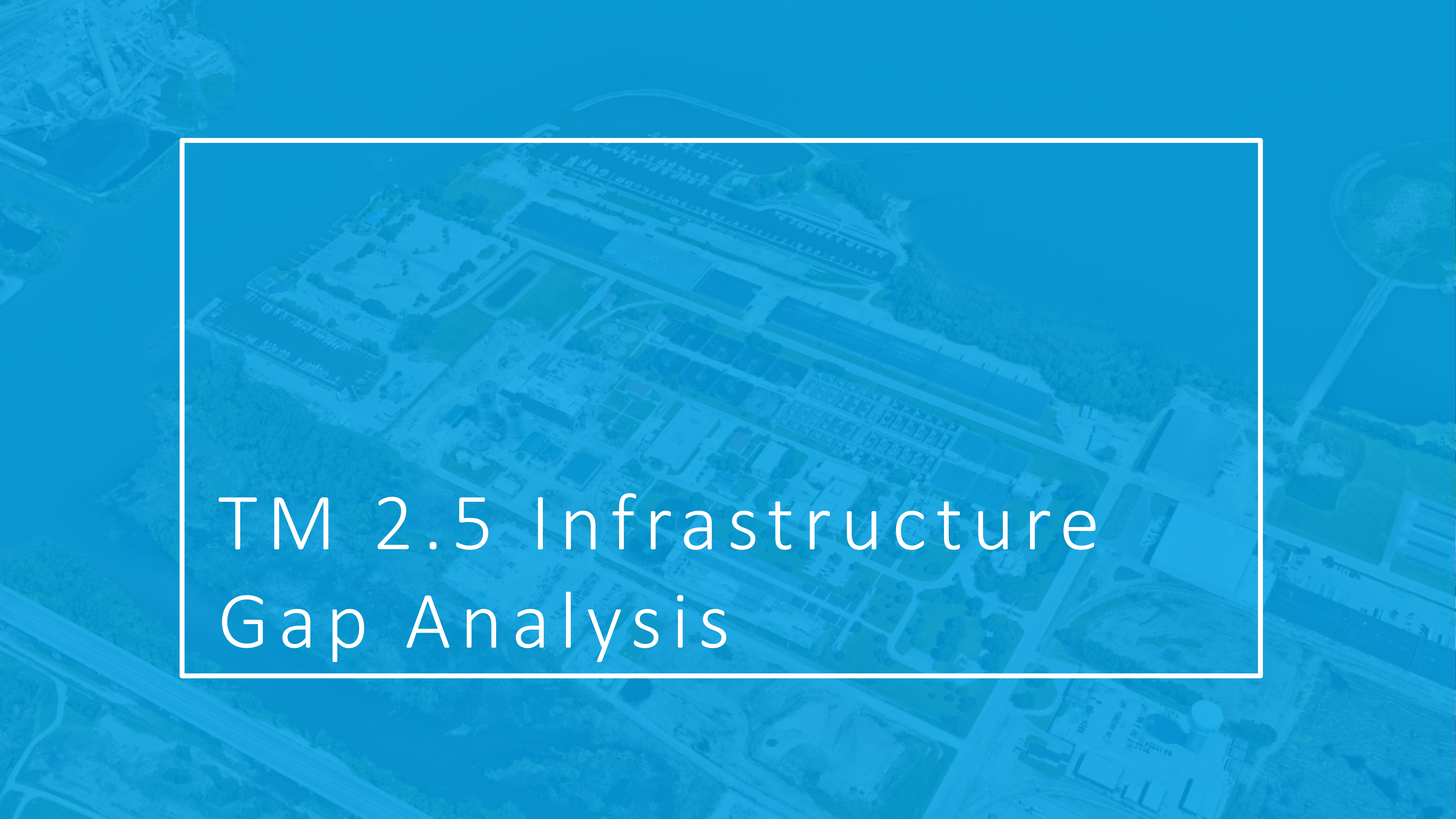
Potential drivers were categorized as near-term or long-term considerations

REGULATORY DRIVER	5 YEAR CONSIDERATION	10 YEAR CONSIDERATION	LONG-TERM CONSIDERATION
Phosphorus	X		
Suspended Solids	X		
Total Nitrogen		X	
Microconstituents			X
Microplastics			X
Water Reuse		X	
Radium			X
E. coli	X		
Ash/Biosolids Metal Content			X
PFAS/PFOA/PFOS	X		
Peak Flows	X		
Thermal Rules	X		
Chlorides/TDS		X	



What is the baseline assumption for the De Pere Facility?

- Base assumption: continue to operate in current configuration
    - What needs to be done to maintain capacity, and at what capital cost?
    - Current projects + any additional needs (i.e. headworks, peak flow)
- Alternative 1: Conversion to pump station
- Alternative 2: Wet weather flow diversion to GBF



TM 2.5 Infrastructure Gap Analysis

Infrastructure Gap Analysis

- Objective: Review existing facilities at GBF and DPF related to age, operation, maintenance, performance, reliability, and efficiency
- Approach:
  1. Evaluated existing equipment and original design approach
  2. Developed design basis for future flows and loads
  3. Incorporate asset management evaluations
  4. Document identified issues to be addressed from above analysis

Infrastructure Gap Analysis

- **GBF Priority issues to address in facility plan**
    - Peak flow management
    - Age and reliability
    - Screening and grit removal performance and operation
    - Scum management
    - Thickening operation and performance for primary sludge and WAS
    - Sludge pumping and thickened sludge pumping maintenance

GBF Unit Process Review

Unit Process	Identified Issues
Influent Pumping	Age, peak flow capacity
Screening	Capture performance, peak flow capacity
Grit Removal	Operation, capture performance
Primary Clarifiers	Age, peak flow capacity
Primary sludge pumping	Age, operation
Primary sludge thickening	Age, operation, maintenance, performance
Activated Sludge Aeration	Age, operation, energy
Secondary Clarifiers	Age, flow split, peak flow capacity
RAS and WAS pumping	(South Plant) Age, peak flow capacity
WAS Thickening	Age, operation, maintenance, performance

GBF Unit Process Review

(continued)

Unit Process	Identified Issues
Scum Handling (plant wide)	Operation, maintenance, capacity
Chlorine Disinfection	Peak flow capacity
Digestion	
Dewatering	Performance (solids content)
Drying	Performance (solids content)
Incineration	

Infrastructure Gap Analysis

- DPF Priority issues to address in facility plan
  - Peak flow management
  - Age and reliability
  - Screening and grit removal performance and operation
  - Scum management
  - Intermediate clarifier and final clarifier operation

DRF Unit Process Review

Unit Process	Identified Issues
Influent Pumping	Age, peak flow capacity
Screening	Capture performance, peak flow capacity
Grit Removal	Age, operation, capture performance, peak flow capacity
Activated Sludge Aeration	
Intermediate Clarifiers	Age, peak flow capacity
RAS and WAS pumping	Age (both systems)
Second Stage Aeration	Not used
Final Clarifiers	Age, peak flow capacity
Tertiary Filters	Age, peak flow capacity
UV Disinfection	Peak flow capacity
Scum Handling (plant wide)	Operation, maintenance, capacity

Risks & Opportunities

How should we be thinking about the next five sessions?

Identify Risks

Define Opportunities

Develop Solution Pathways

How do we facilitate this discussion?

Example 1: Thickening

Risk: thickening capacity and operation limits R2E2 efficiency

Opportunity: new thickening equipment could address capacity, age, and operational issues

Solution pathway:

Step 1: replace existing thickening equipment to provide increased capacity and reliability

Step 2: upgrade screening and grit removal facilities to provide stable thickening operation

Example 2: Emerging Contaminant Removal

Risk: future regulations will require removal of an emerging contaminant, such as PFAS, from wastewater effluent

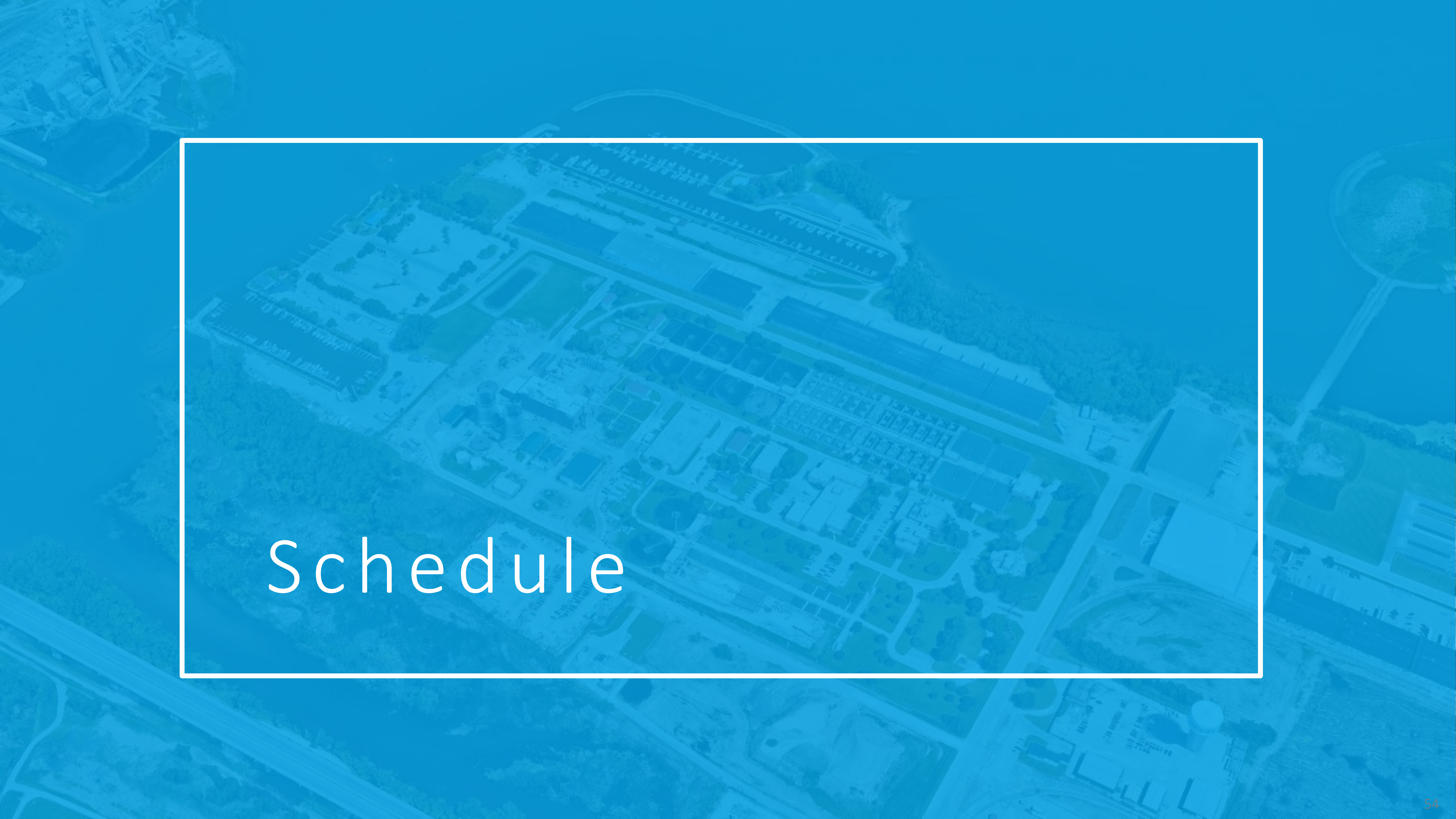
Opportunity: proactively monitor and evaluate treatment alternatives and environmental impacts

Solution pathway:

Step 1: continue to monitor progress in NACWA, WEF, CSWEA

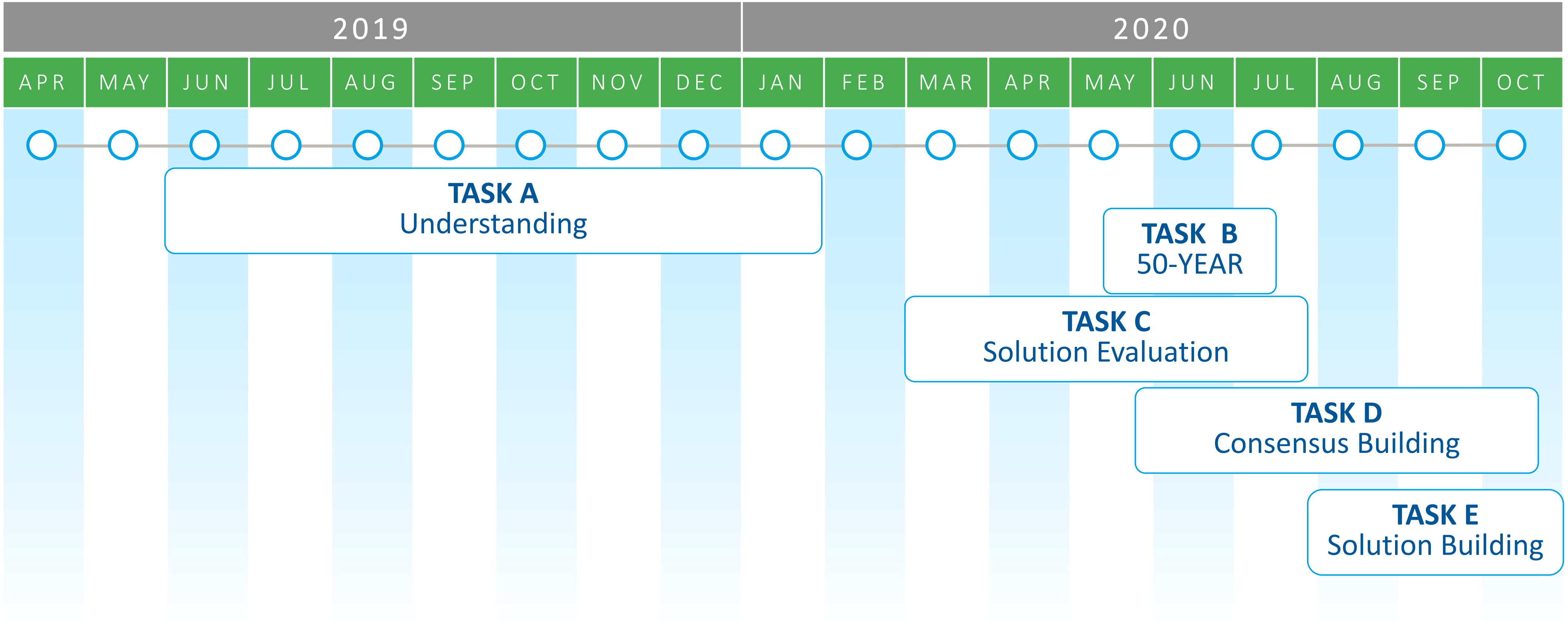
Step 2: incorporate emerging contaminant testing into any tertiary technology treatment piloting

Step 3: if tertiary treatment is required for other compounds (TSS, TP), incorporate advanced oxidation into the plan for the technology



Schedule

Project Schedule



TASK A
Understanding

TASK B
50-YEAR

TASK C
Solution Evaluation

TASK D
Consensus Building

TASK E
Solution Building

NEW WATER

GREEN BAY FACILITY & DE PERE FACILITY

50-Year Vision – Session 2

June 2, 2020

NEW Water
The brand of the Green Bay Metropolitan Sewerage District

BLACK & VEATCH

DONOHUE

WORKSHOP NO. 1 REVIEW

Objectives

1. Develop a vision for development of the GBF and DPF over the coming 50 years that delivers extraordinary value to the Green Bay community.
2. Understand new-term issues and develop plans to address them while retaining future flexibility.
3. Identify actions to be taken now to mitigate future risks and to create future opportunities.
4. Assist New Water to building increased internal capacity, broadly viewed (e.g. staff, capabilities, financial, stakeholder support).

Key Success Factors

1. Clearly understand the current situation. (Workshop No. 1.)
2. Understand the broad goals and objectives of NEW Water internal and external stakeholders. (Workshop No. 2 and following)
3. Understand the range of future issues and possibilities, including uncertainties (Workshop No. 2 and following)
4. Understand constraints and how they can be relaxed (Workshop No. 2 and following)

WORKSHOP NO. 1 REVIEW

Workshop No. 1 - Where is NEW Water at:

- Adaptive Management - uncertainty for future
- R2E2 - Need "debottlenecking" and reliability of solids process, engine reliability
- Flows and Loads - lack of peak flow both plants in 2040, lack of loading capacity at DPF in 2040
- Hydraulic Limitations - peak flows exceed hydraulic capacity
- Future Regulatory Scenarios – separated into near- and long-term considerations

WORKSHOP NO. 1 FEEDBACK

- Clear Articulation of Overall Workshop Goals
- Potential Need for Addition Small Group Discussions
- Re-Prioritize Workshops to Focus on DPF Because its Risks and Opportunties Drive Solution Pathways

Identify Risks

Define Opportunities

Develop Solution Pathways

A MINOR PIVOT

Session 1: NEW Water Infrastructure Drivers

Session 2: ~~Future of Nutrient Removal~~ De Pere Vision

Session 3: ~~Water Reuse~~, Nutrients, Energy Management and Resource Recovery

Session 4: Water Re-Use, Emerging Concerns and Areas

Session 5: Consolidation of long-term drivers

MEETING OBJECTIVES

1) Complete Infrastructure Gap Summary- Provde a Summary of Key NEW Water Infrastructure Challenges

2) DPF Evauation – Obtain Feedback on:

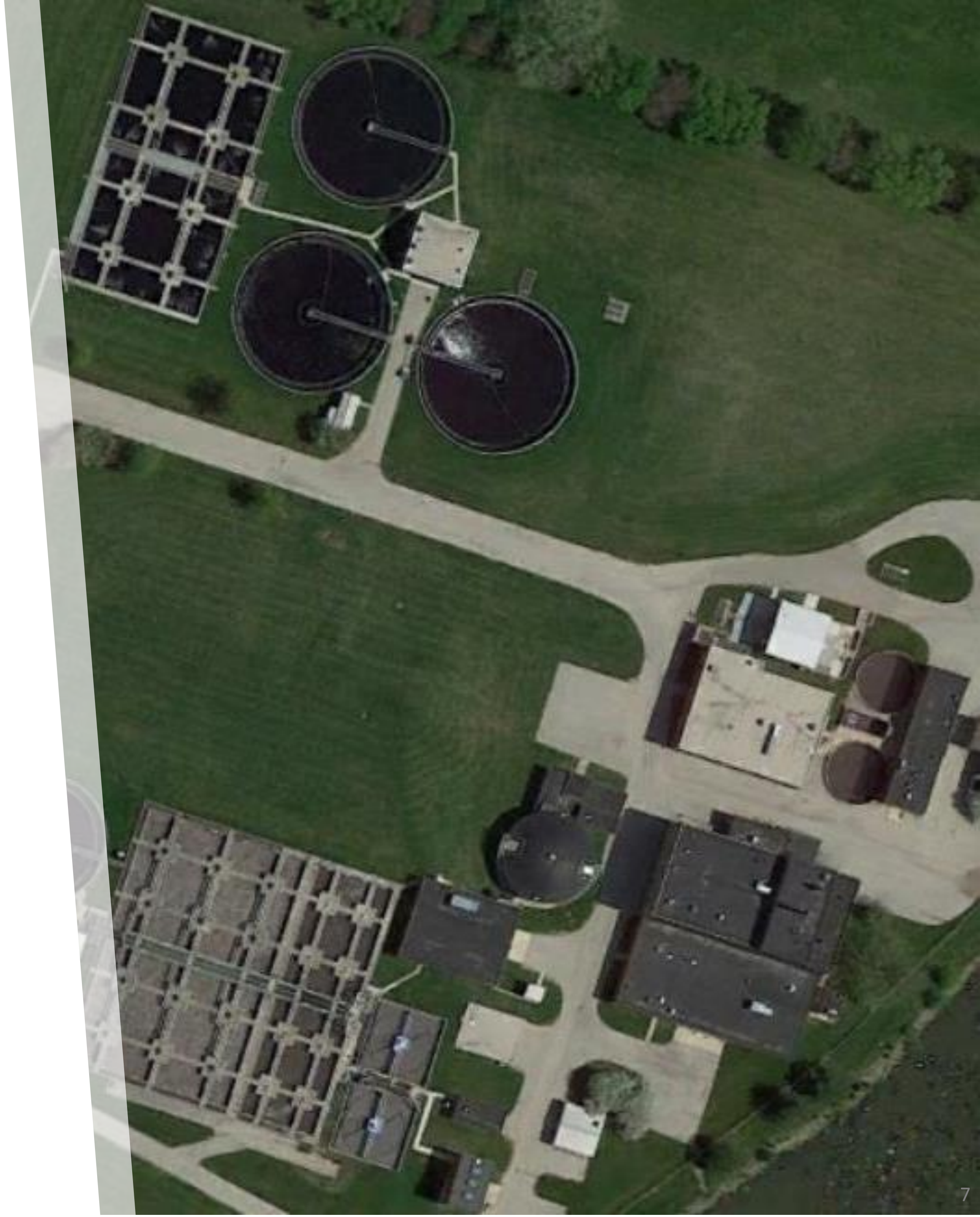
   a) Three Alternative Futures for DPF

   b) Criteria By Which DPF will be Evaluated

   c) Wet weather regulatory possibilities

AGENDA

- Infrastructure Gaps
- De Pere Facility Futures
- Risks and Opportunities
- Schedule



Infrastructure Gaps

GBF Unit Process Review

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Primary Clarifiers	Age, peak flow capacity
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WAS Thickening	Age, operation, maintenance, performance

GBF Unit Process Review (continued)

Unit Process	Identified Issues
Scum Handling (plant wide)	Operation, maintenance, capacity
Chlorine Disinfection	Peak flow capacity
Digestion	
Dewatering	Performance (solids content)
Drying	Performance (solids content)
Incineration	

DPF Unit Process Review

Unit Process	Identified Issues
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Screening	Capture performance, peak flow capacity
Grit Removal	Age, operation, capture performance, peak flow capacity
Activated Sludge Aeration	
Intermediate Clarifiers	Age, peak flow capacity
RAS and WAS pumping	Age (both systems)
Second Stage Aeration	Not used
Final Clarifiers	Age, peak flow capacity
Tertiary Filters	Age, peak flow capacity
UV Disinfection	Peak flow capacity
Scum Handling (plant wide)	Operation, maintenance, capacity

GBF AND DPF INFRASTRUCTURE SUMMARY

Both Plants

1) Peak Flow
2) Aging Assets
3) Screening and Grit Removal
4) Thickening
5) Scum Management

DPF

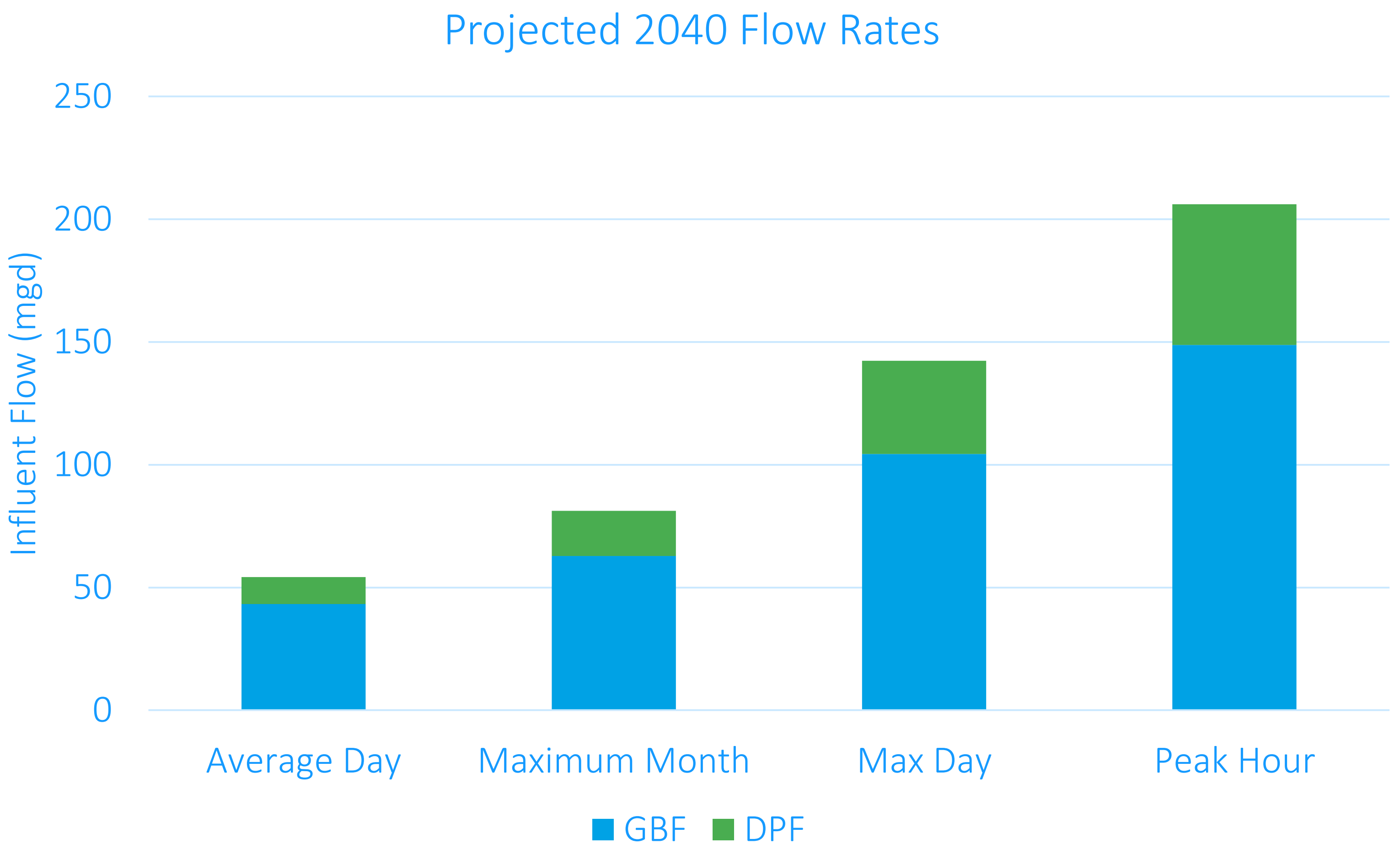
1) Not Operated as Designed and Not Designed to be Remote

De Pere Facility Futures

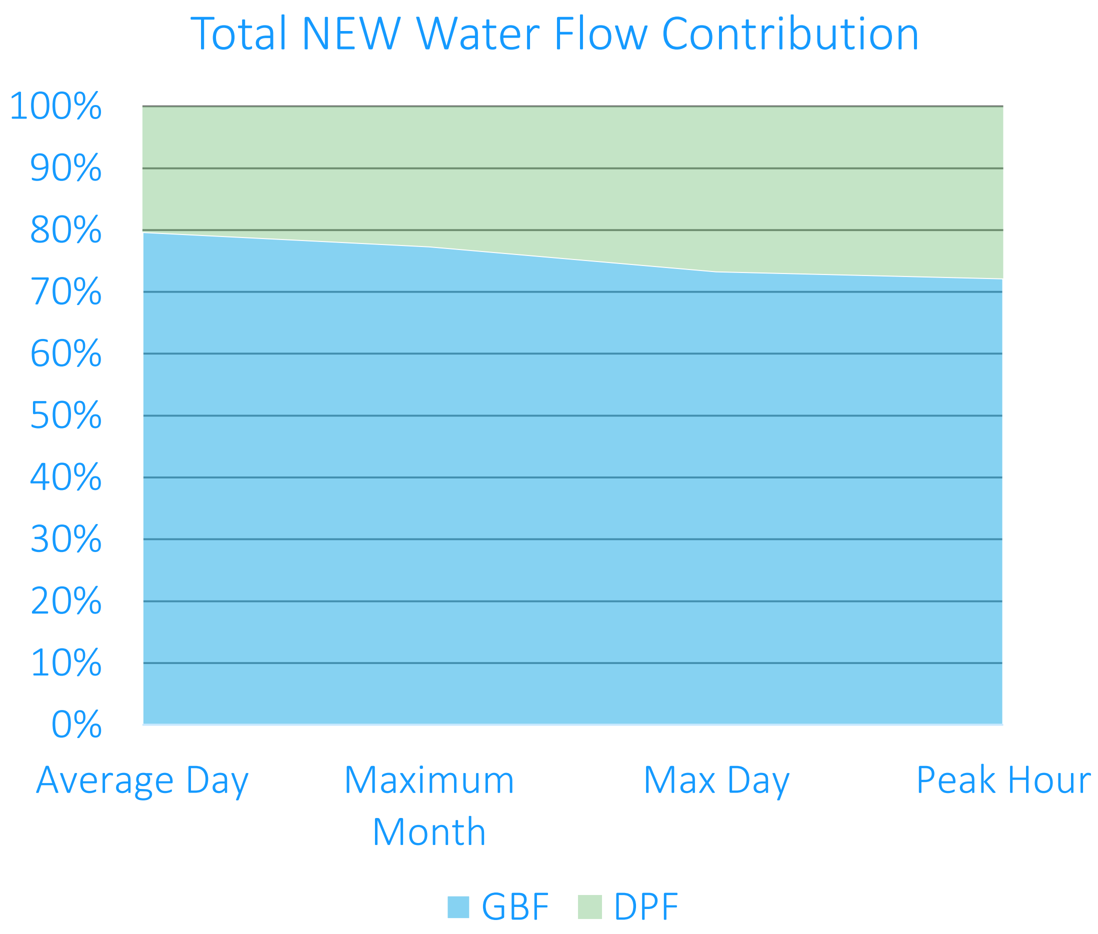
- **Option 1: Keep 'er moving**
  - Current CIP plan
  - Additional improvements for reliability
- **Option 2: Pump station**
  - Large diameter and pump station costs
  - Significant GBF expansion
- **Option 3: A new vision**
  - New treatment configuration
  - Target the initial vision for DPF

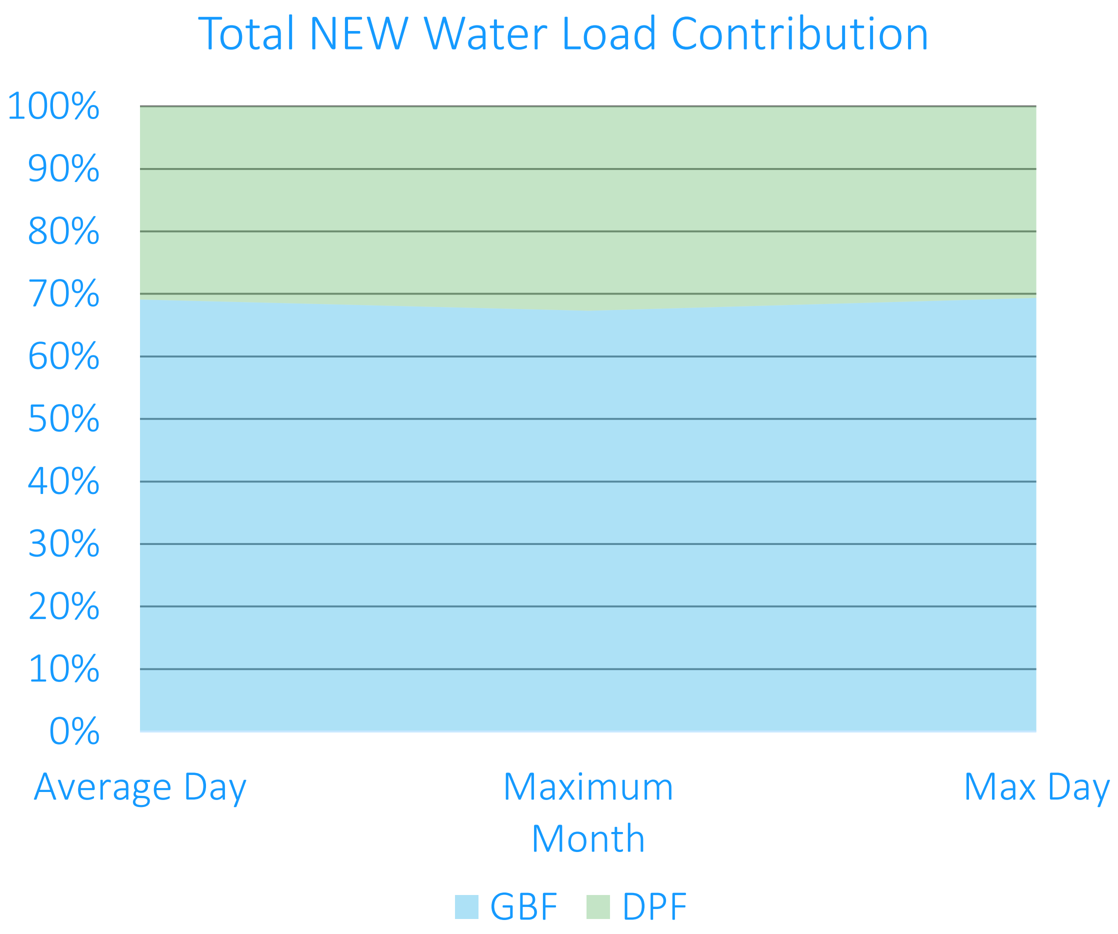
- Option 1: Likely 20-Year Investment for Headworks/AS Upgrades/Filters/UV > $50 million
- Option 2: New Pump Station/Force Main/EQ Basin > $30 million (without GBF Upgrades)
- Option 3: New wet weather plant > $50 million

We discussed numbers for GBF and DPF last time

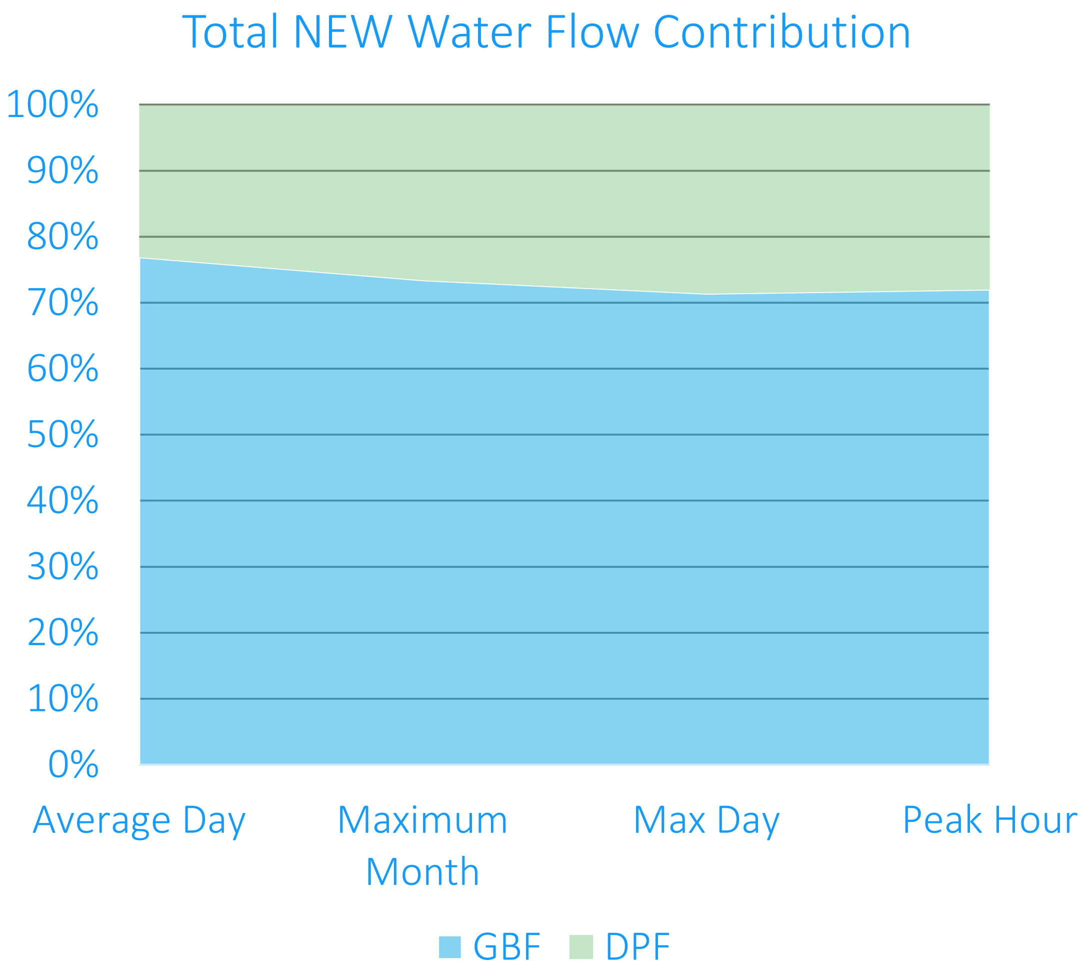


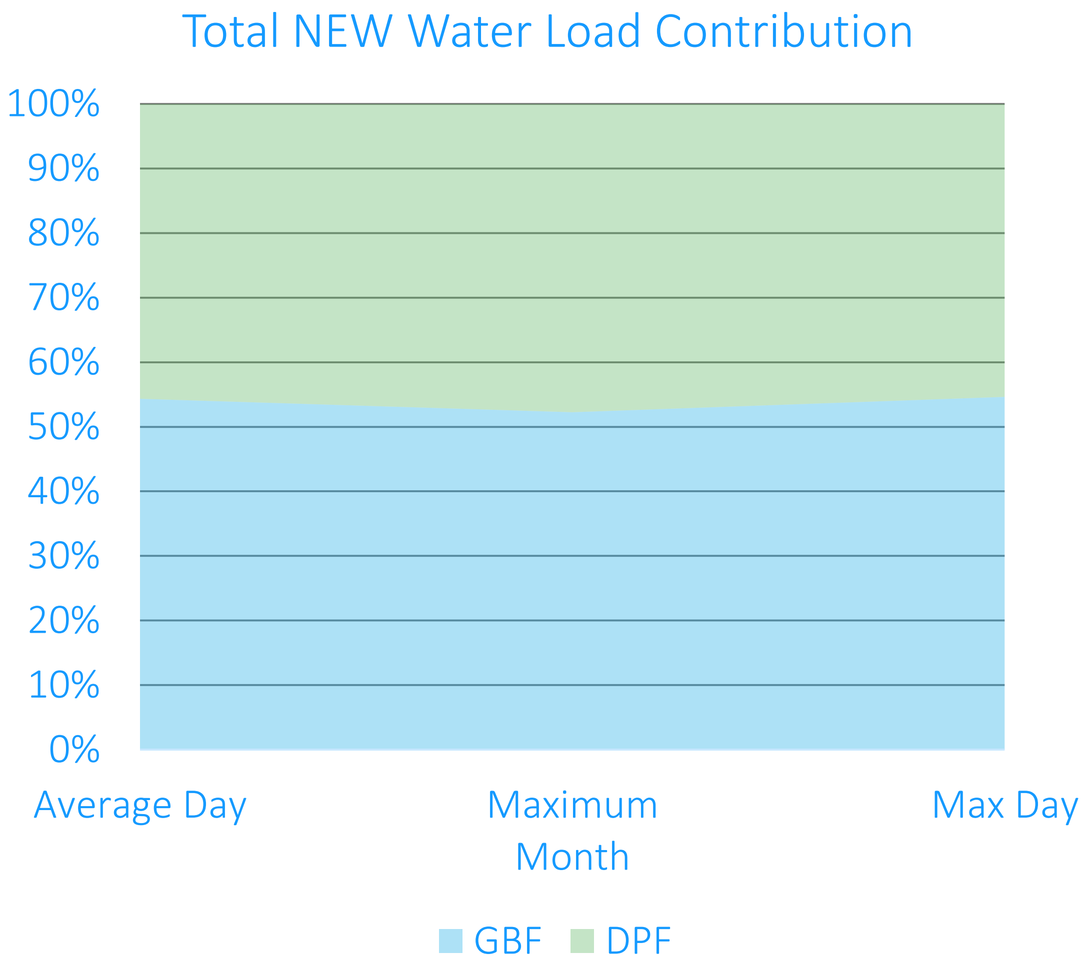
Combining DPF and GBF would require a 32% expansion by 2040…





…by 2070 (which includes the South Bridge growth), DPF would account for 50% of the load





FRAMING THE DPF EVALUATION

1) Is there a water quality benefit for two plants?

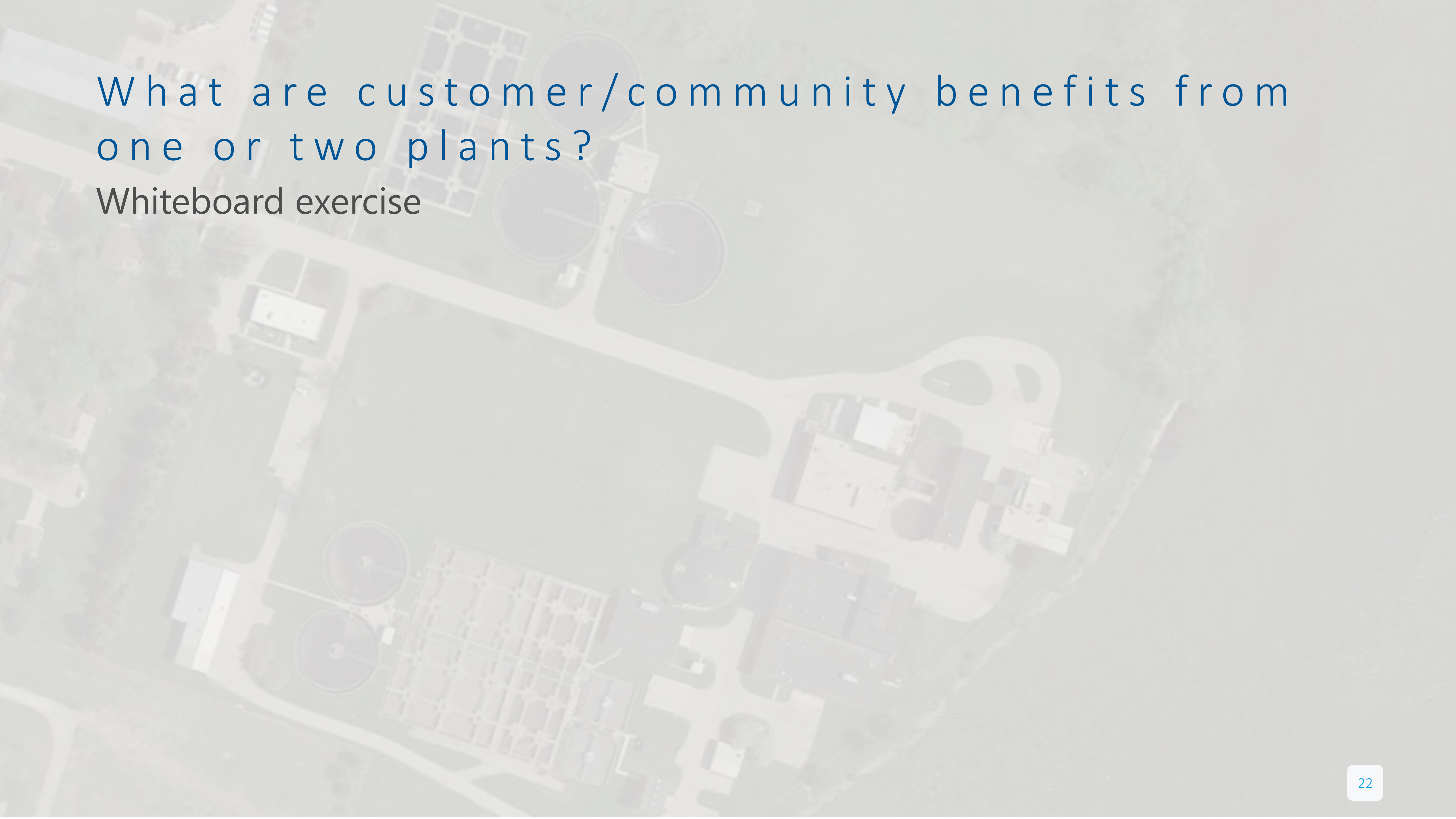
2) Is there a customer benefit for two plants? Customer benefit from one plant?

3) Does the DPF have Other Value?

4) What drives the DPF Operational Issues?

5) Understanding the Regulatory Possibilities for Wet Weather Treatment

Is there a water quality benefit to two discharges?



What are customer/community benefits from one or two plants?

Whiteboard exercise

What are the valuable assets at the De Pere Facility?

Whiteboard exercise

What drives the De Pere Facility to require more operational attention than planned?

Whiteboard exercise

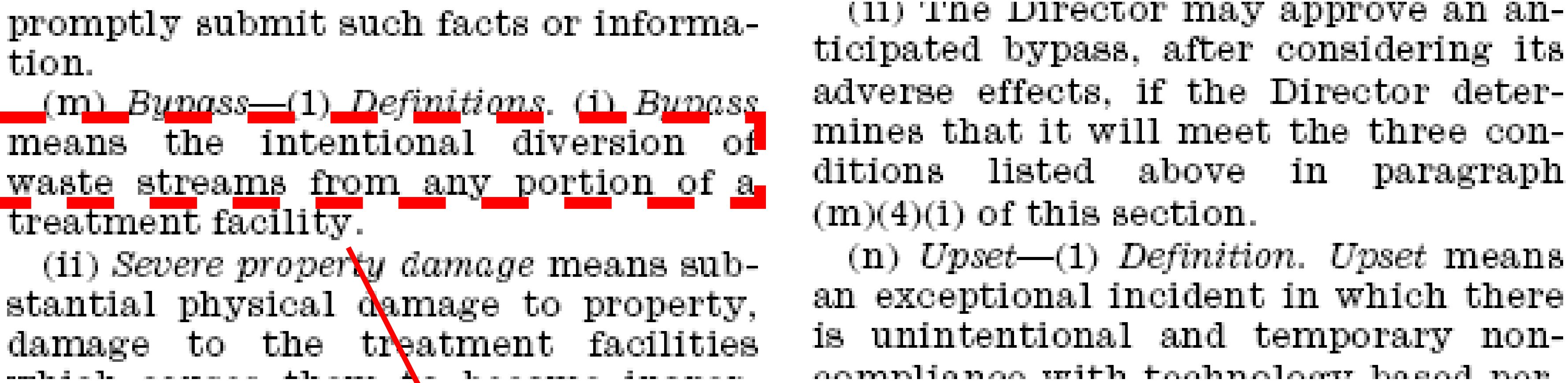
Wet Weather

Auxiliary Treatment Facilities

- Permitted use per 40 CFR 122.41(m)
- Wet-weather influent amenable to physical/chemical treatment
  - USEPA (2014), NPDES Experts Forum on Public Health Impacts of Wet Weather Blending (https://www.epa.gov/npdes/npdes-experts-forum-public-health-impacts-wet-weather-blending-documents)
  - USEPA (2007), *Wastewater Management Fact Sheet, In-Plant Wet Weather Peak Flow Management*, EPA 832-F-07-016
  - WEF (2006), *Guide to Managing Peak Wet Weather Flows in Municipal Wastewater Collection and Treatment Systems*
  - USEPA (2004), *Report to Congress, Impacts and Control of CSOs and SSOs*, EPA 833-R-04-001

Many pilot & full-scale studies by B&V and others support the use of physical/chemical auxiliary treatment facilities for wet-weather flows

40 CFR 122.41(m)(1)(i)



promptly submit such facts or information.

(m) *Bypass*—(1) *Definitions*. (i) *Bypass* means the intentional diversion of waste streams from any portion of a treatment facility.

(ii) *Severe property damage* means substantial physical damage to property, damage to the treatment facilities

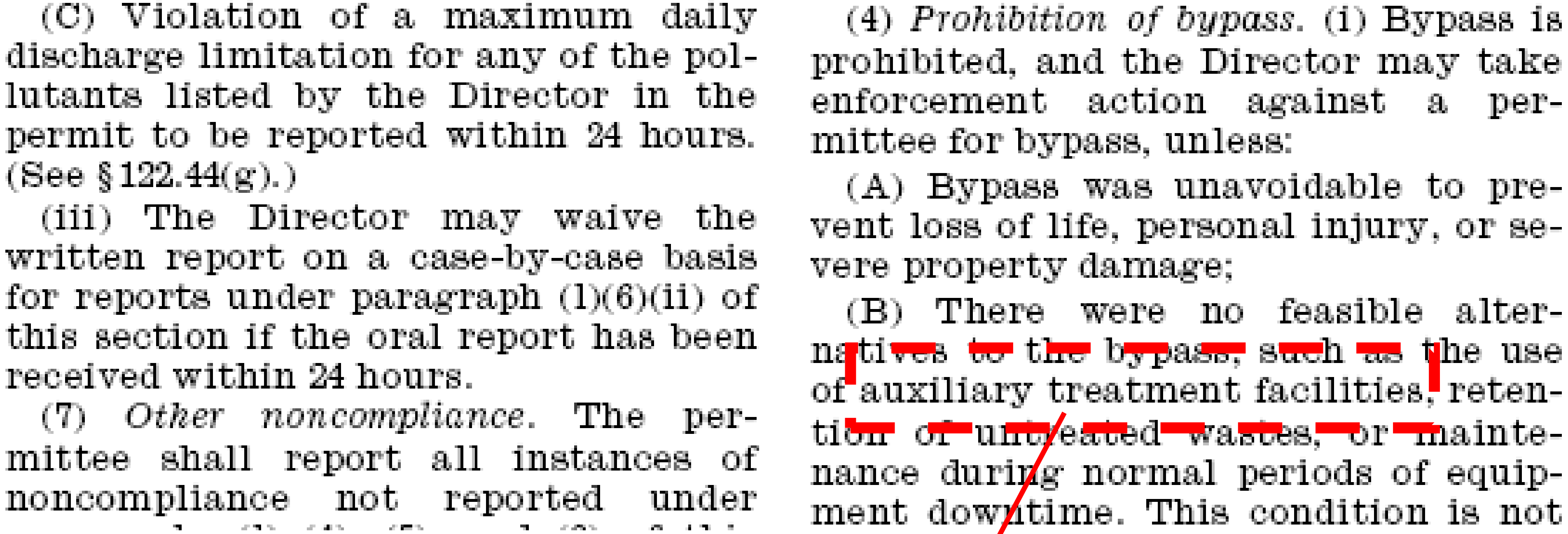
(ii) The Director may approve an anticipated bypass, after considering its adverse effects, if the Director determines that it will meet the three conditions listed above in paragraph (m)(4)(i) of this section.

(n) *Upset*—(1) *Definition*. *Upset* means an exceptional incident in which there is unintentional and temporary non-

Diversion means decreasing or cutting off flows to a process unit. Parallel treatment concept does not decrease flows to any portion of the treatment facility.

Do not use the terms *diversion or bypass* if providing auxiliary treatment

40 CFR 122.41(m)(4)(i)(B)



(C) Violation of a maximum daily discharge limitation for any of the pollutants listed by the Director in the permit to be reported within 24 hours. (See § 122.44(g).)

(iii) The Director may waive the written report on a case-by-case basis for reports under paragraph (l)(6)(ii) of this section if the oral report has been received within 24 hours.

(7) *Other noncompliance.* The permittee shall report all instances of noncompliance not reported under

(4) *Prohibition of bypass.* (i) Bypass is prohibited, and the Director may take enforcement action against a permittee for bypass, unless:

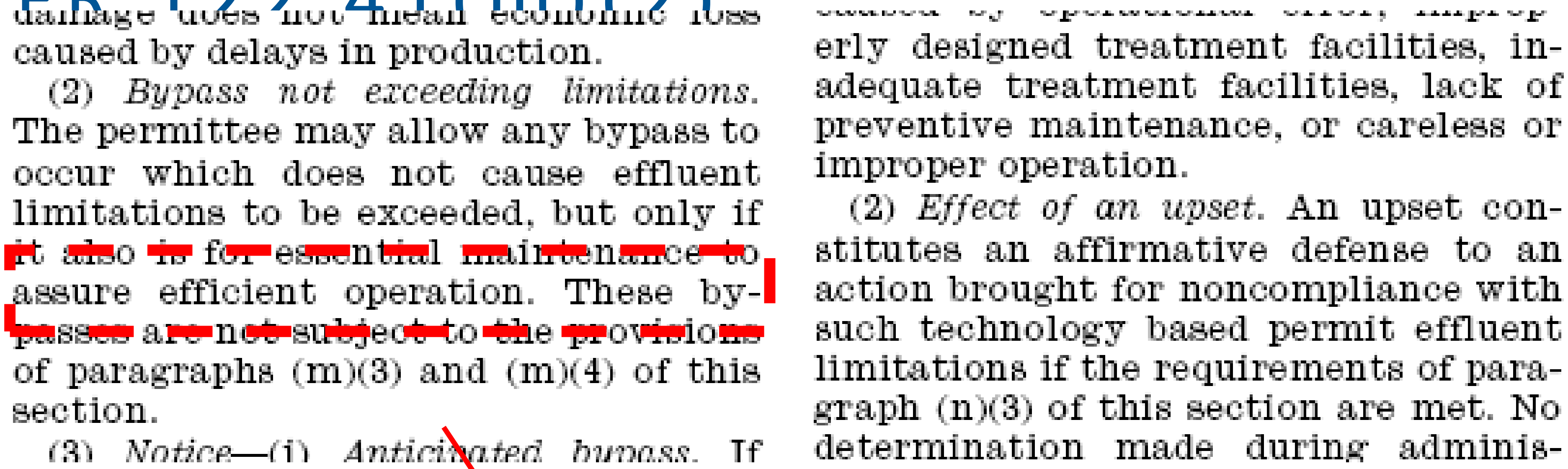
(A) Bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;

(B) There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not

Use of auxiliary treatment facilities is not a bypass

Do not use the terms *diversion or bypass* if providing auxiliary treatment

40 CFR 122.41(m)(2)



damage does not mean economic loss caused by delays in production.

(2) *Bypass not exceeding limitations.* The permittee may allow any bypass to occur which does not cause effluent limitations to be exceeded, but only if it also is for essential maintenance to assure efficient operation. These bypasses are not subject to the provisions of paragraphs (m)(3) and (m)(4) of this section.

(3) *Notice*—(i) *Anticipated bypass.* If

caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

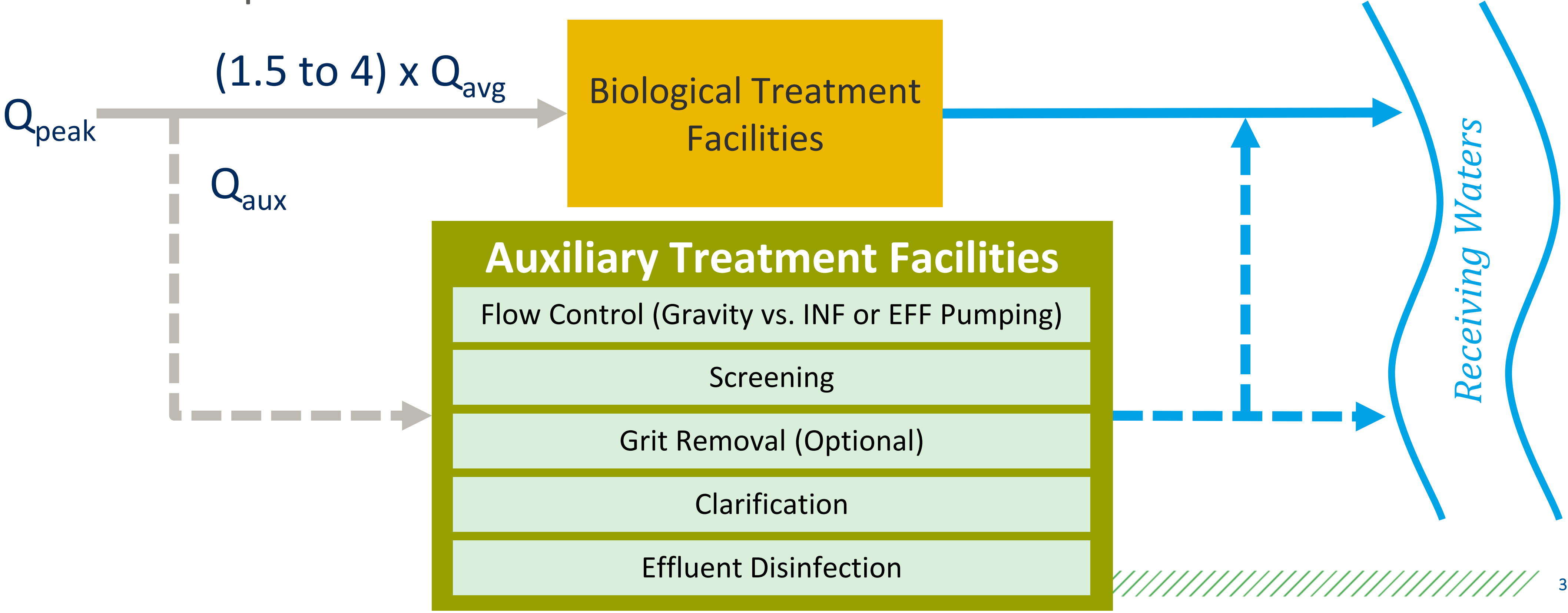
(2) *Effect of an upset.* An upset constitutes an affirmative defense to an action brought for noncompliance with such technology based permit effluent limitations if the requirements of paragraph (n)(3) of this section are met. No determination made during adminis-

Parallel auxiliary treatment provides essential maintenance of biomass to assure efficient operation

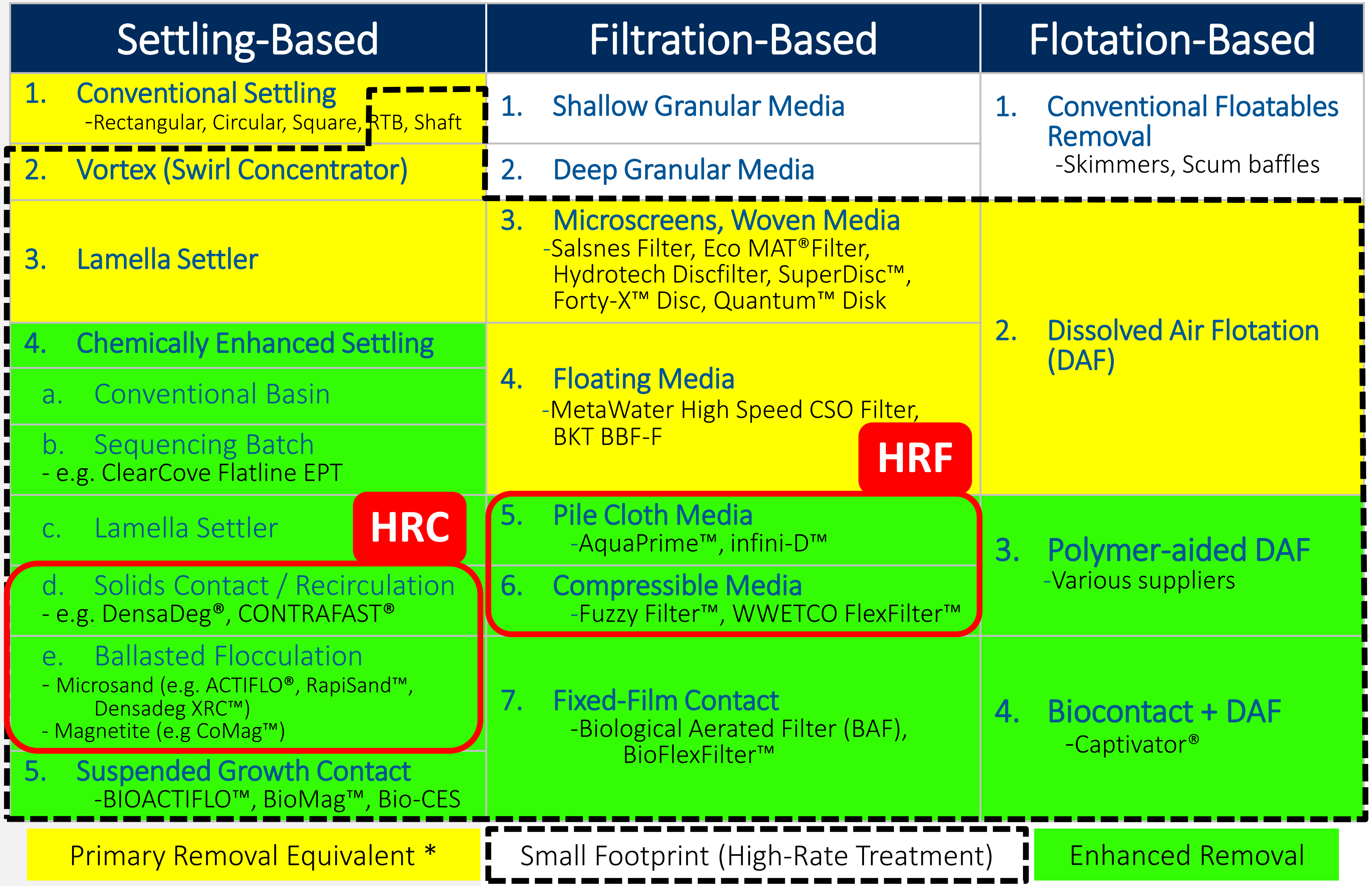
Do not use the terms *diversion or bypass* if providing auxiliary treatment

After optimizing existing storage and treatment infrastructure, consider auxiliary treatment capacity

- Optimize for **intermittent** wet-weather flows
- Complement inherent limitations of biological processes
- Long track record of success
- Small footprint alternatives. Collocated or satellite facilities.



Clarification of Alternatives



Settling-Based	Filtration-Based	Flotation-Based
1. Conventional Settling -Rectangular, Circular, Square, RTB, Shaft	1. Shallow Granular Media	1. Conventional Floatables Removal -Skimmers, Scum baffles
2. Vortex (Swirl Concentrator)	2. Deep Granular Media	
3. Lamella Settler	3. Microscreens, Woven Media -Salsnes Filter, Eco MAT® Filter, Hydrotech Discfilter, SuperDisc™, Forty-X™ Disc, Quantum™ Disk	2. Dissolved Air Flotation (DAF)
4. Chemically Enhanced Settling	4. Floating Media -MetaWater High Speed CSO Filter, BKT BBF-F **HRF**	
a. Conventional Basin		
b. Sequencing Batch - e.g. ClearCove Flatline EPT		
c. Lamella Settler **HRC**	5. Pile Cloth Media -AquaPrime™, infini-D™	3. Polymer-aided DAF -Various suppliers
d. Solids Contact / Recirculation - e.g. DensaDeg®, CONTRAFAST®	6. Compressible Media -Fuzzy Filter™, WWETCO FlexFilter™	
e. Ballasted Flocculation - Microsand (e.g. ACTIFLO®, RapiSand™, Densadeg XRC™) - Magnetite (e.g CoMag™)	7. Fixed-Film Contact -Biological Aerated Filter (BAF), BioFlexFilter™	4. Biocontact + DAF -Captivator®
5. Suspended Growth Contact -BIOACTIFLO™, BioMag™, Bio-CES		

🟨 Primary Removal Equivalent *

⬚ Small Footprint (High-Rate Treatment)

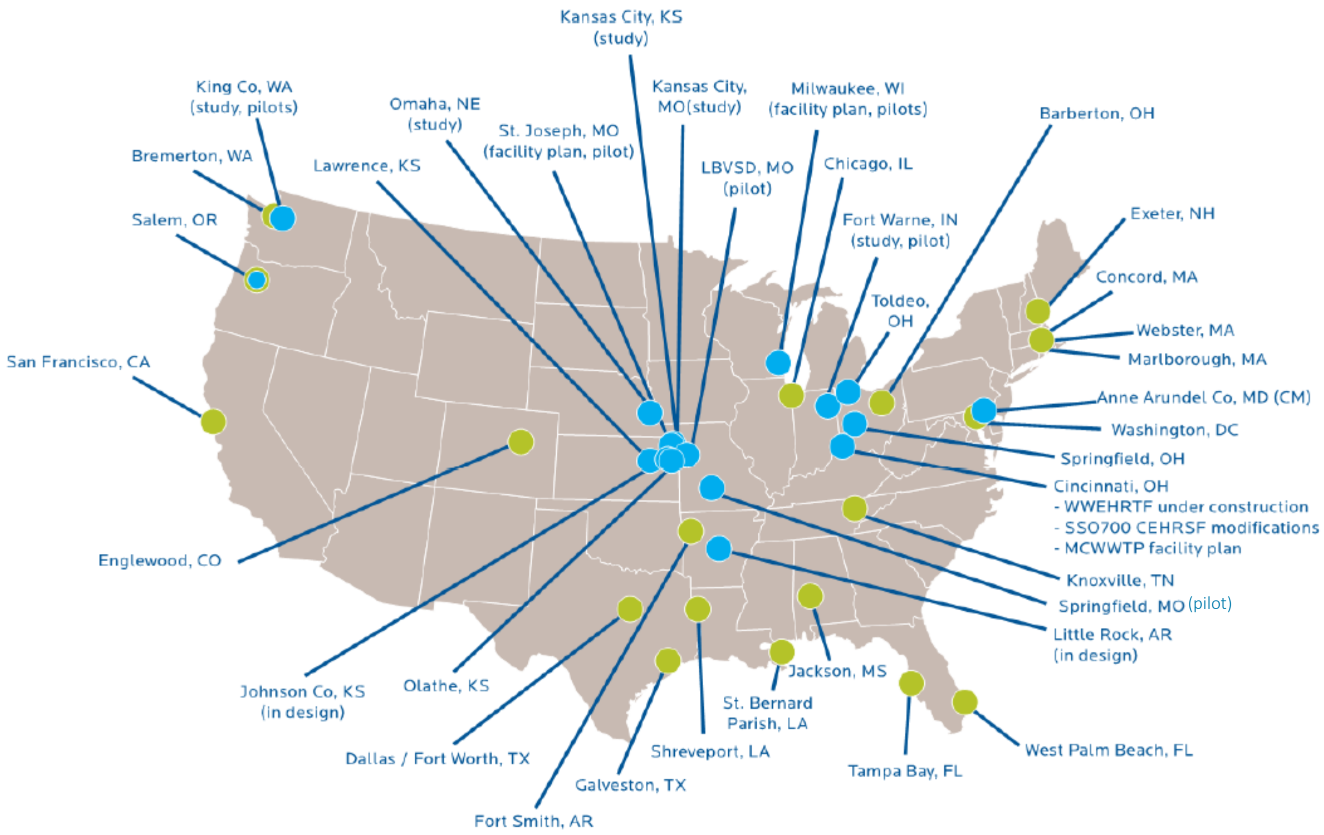
🟩 Enhanced Removal

* If coagulation/flocculation provided, HRT → EHRT (in some cases)

Pilot and Full-Scale EHRT Projects Include:

Full-Scale Auxiliary EHRT Facilities in the U.S.

EPA Region	State
1	Massachusetts, New Hampshire
2	New York
3	DC, Maryland
4	Florida, Georgia, Mississippi, Tennessee
5	Illinois, Indiana, Ohio, Wisconsin
6	Arkansas, Louisiana, Texas
7	Kansas
9	California
10	Oregon, Washington



- 30+ operating in U.S. since ~1995
- 60+ worldwide

Other Relevant Points

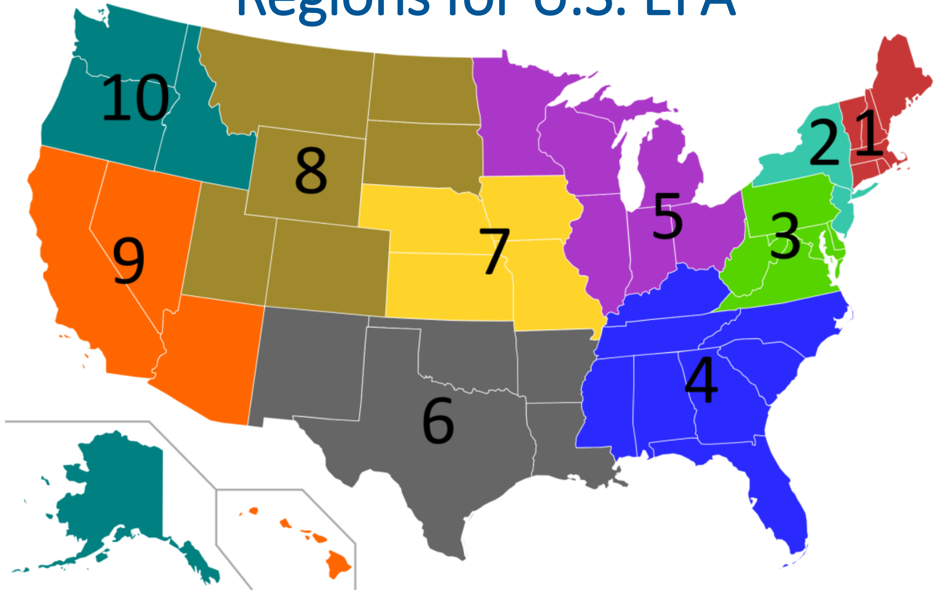
Regulatory Acceptance

- EPA CSO Control Policy - EHRT clearly allowed
- EPA SSO/blending policy - Still under development
  - EHRT allowed in 8th Circuit Court states thanks to *ILOC v. EPA*. Case-by-case elsewhere. Precedents include KS, MA, NH, NY, NJ, OH, OR, TX, WI.
  - *CRR v. EPA* trying to apply *ILOC v. EPA* nationwide

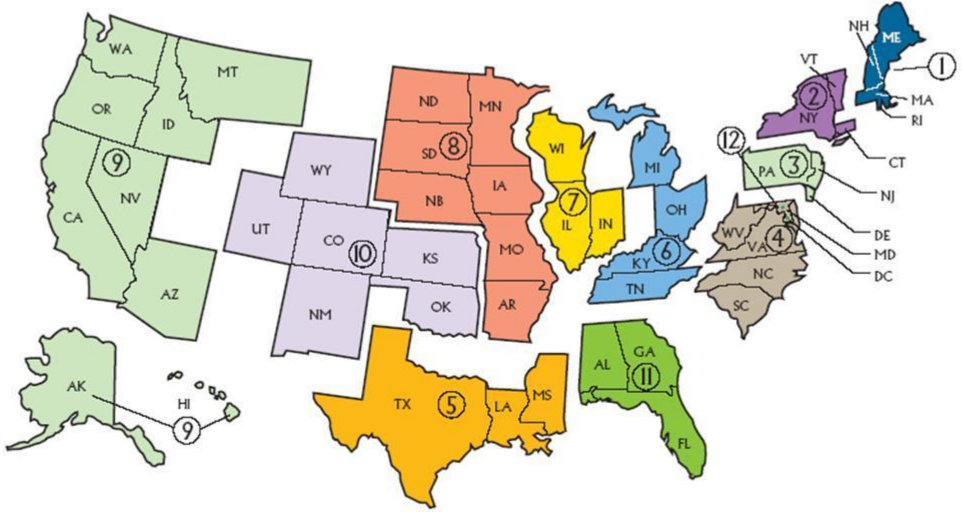
Dual-Use Potential

- Tertiary dual-use increases effluent TSS and P removal. HRF compatible with bio-P or chem-P removal without more coagulant demand.
- Primary dual-use increases raw TSS capture for carbon diversion, energy recovery and reduced secondary BOD load.

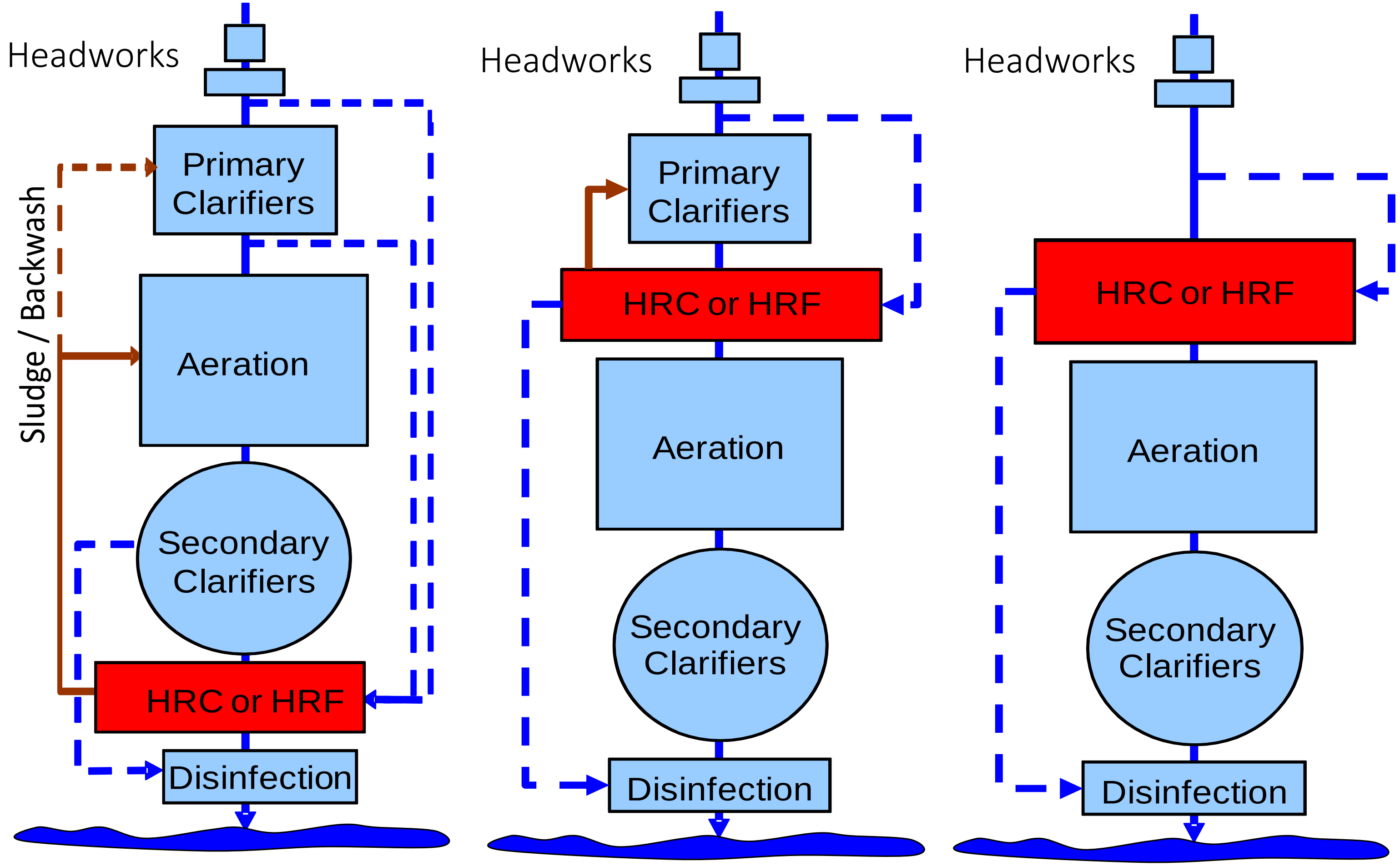
Regions for U.S. EPA



Circuits for U.S. Court of Appeals



Dual-Use Auxiliary Facilities



More WRRF benefit from capital investment than just infrequent wet weather

Risks & Opportunities

What are the keys risks and opportunities for the DPF future vision?

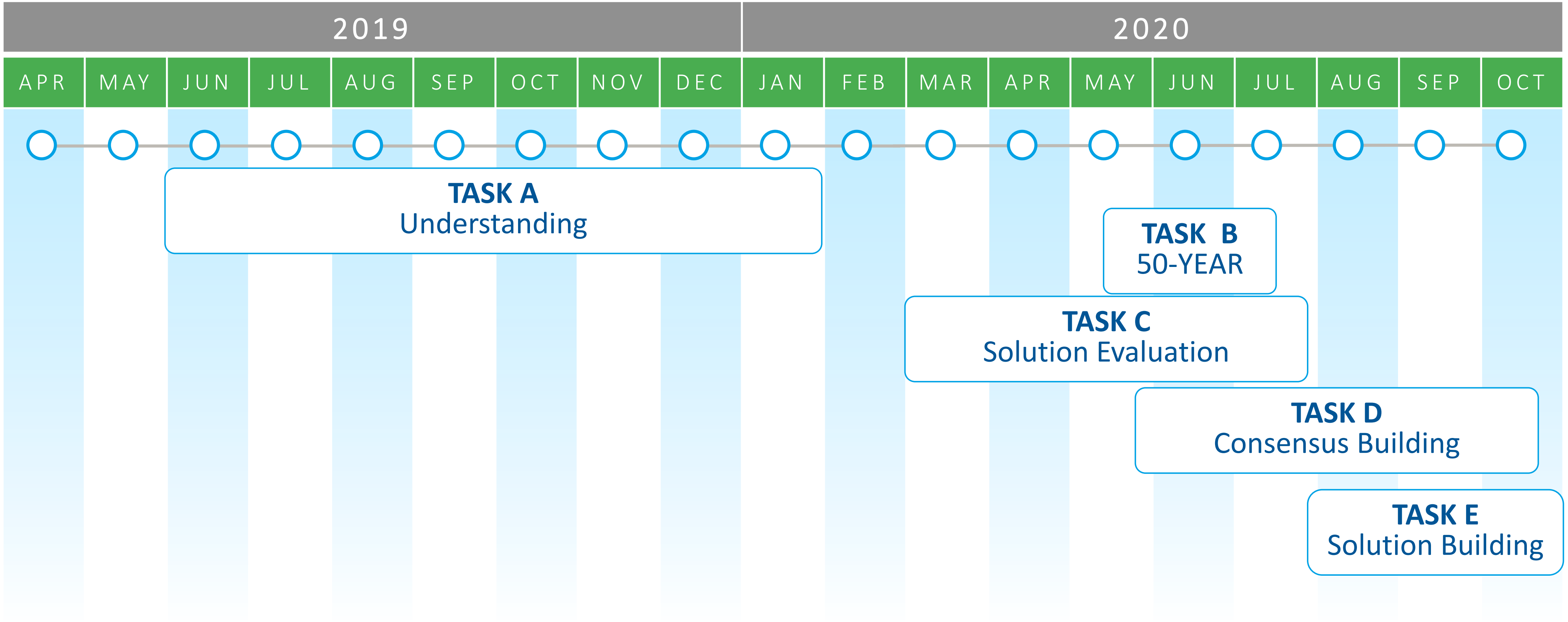
Identify Risks

Define Opportunities

Develop Solution Pathways

Schedule

Project Schedule



2019 | 2020

APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT

TASK A
Understanding

TASK B
50-YEAR

TASK C
Solution Evaluation

TASK D
Consensus Building

TASK E
Solution Building

NEW WATER

GREEN BAY FACILITY & DE PERE FACILITY

50-Year Vision – Session 3

June 17, 2020

NEW Water
The brand of the Green Bay Metropolitan Sewerage District

BLACK & VEATCH

DONOHUE

Today's Goals

1. Facility Plan schedule and decision making update
2. Concurrence on options for the DPF and GBF based on Session 2 comments
3. Set the groundwork for future MUA criteria

Facility Plan Roadmap

● ● ● ●

Task 2
Establishing existing conditions

● ●

Task 4
"Early out" analyses (screening, grit, thickening)

●

Task 3
Session 1
What are the main challenges for NEW Water?

●

Task 3
Session 2
What are the challenges at DPF?

●

Task 3
Session 3
What is the process for decision making at DPF?

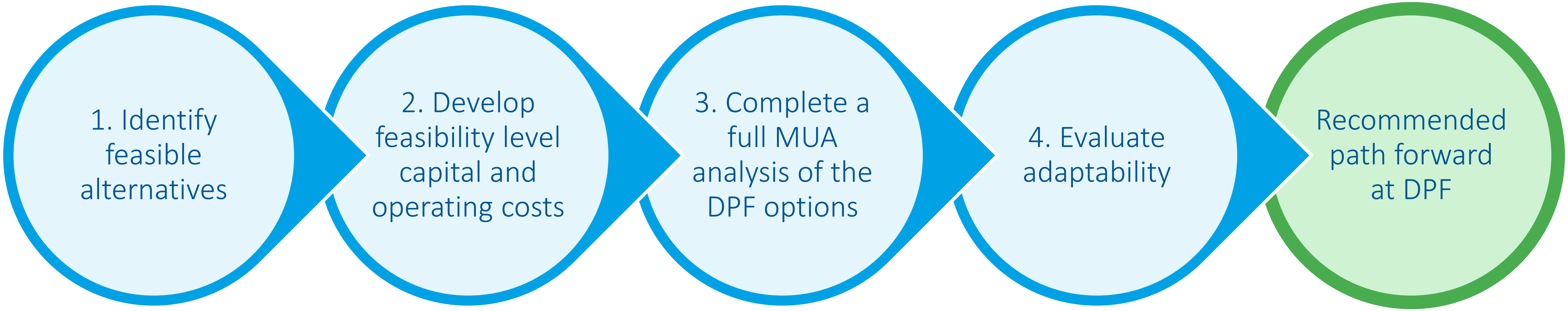
July 2019

April 2020

May 2020

June 2020

How do we make a decision on DPF?



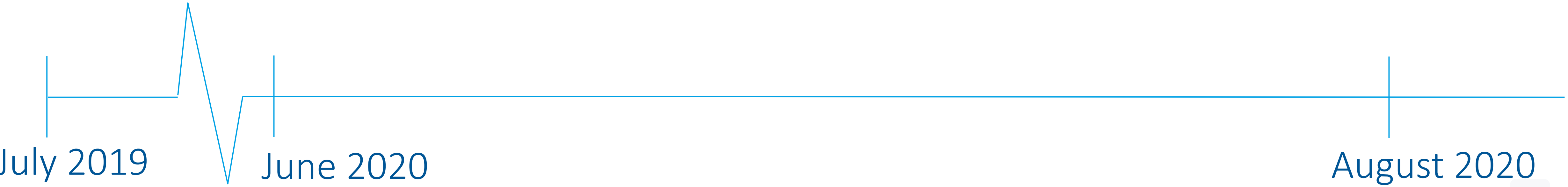
1. Identify feasible alternatives

2. Develop feasibility level capital and operating costs

3. Complete a full MUA analysis of the DPF options

4. Evaluate adaptability

Recommended path forward at DPF

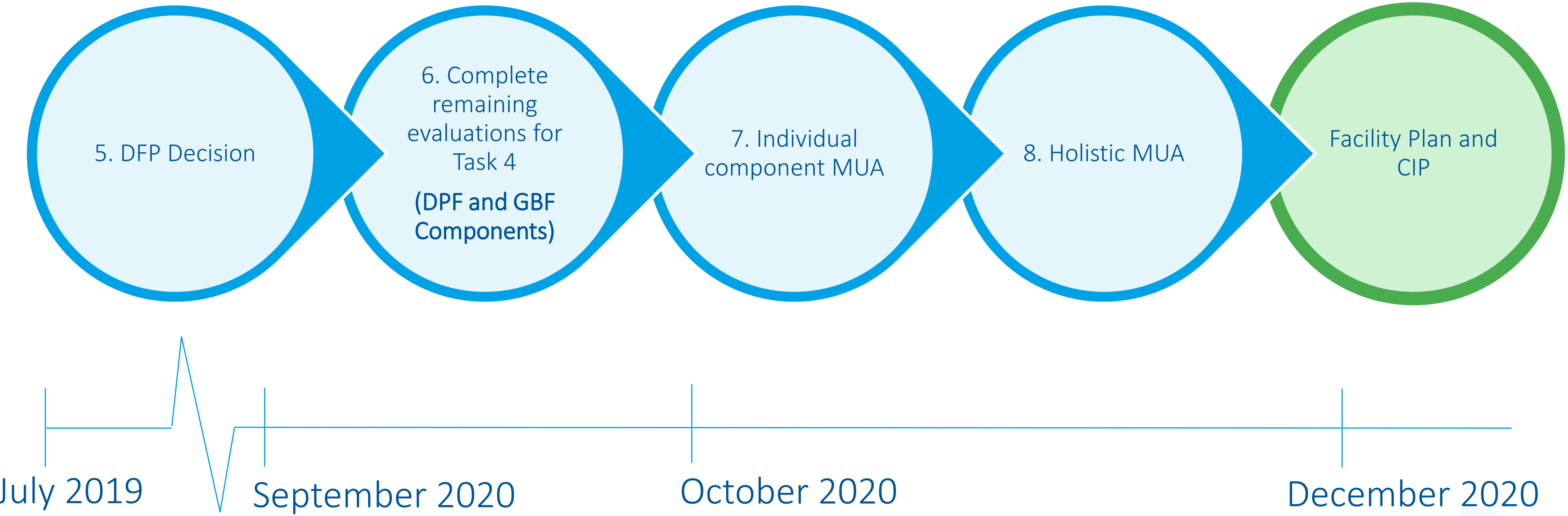


July 2019

June 2020

August 2020

What happens after the DPF decision?



5. DFP Decision

6. Complete remaining evaluations for Task 4

(DPF and GBF Components)

7. Individual component MUA

8. Holistic MUA

Facility Plan and CIP

July 2019

September 2020

October 2020

December 2020

1. Identify feasible alternative pathways

Option 1: Simplify and Expand

- Improved wet weather operation
- Simplify number of unit processes
- Energy efficiency opportunities

Option 2: Pump Station

- No DPF operation
- Significant GBF expansion
- No DFP, but more challenging GBF?

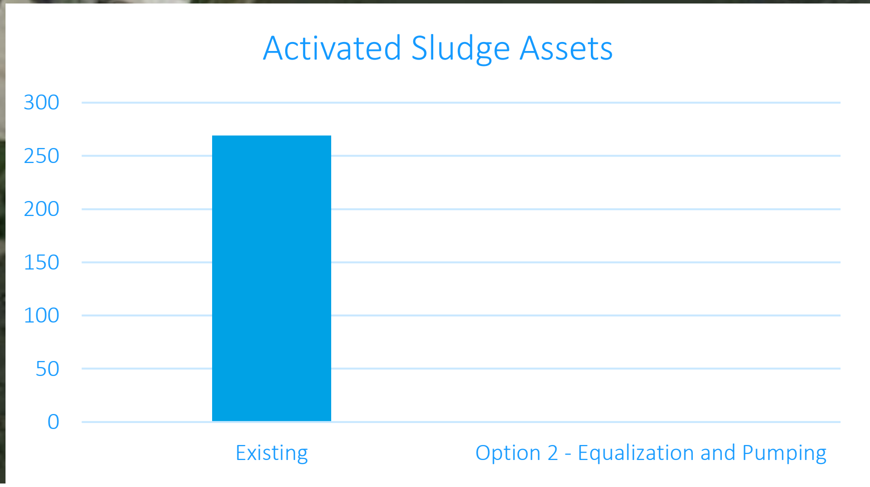
Option 3: A New Vision

- New Treatment Configuration
- Target initial vision for DPF
- Opportunities for resource recovery?

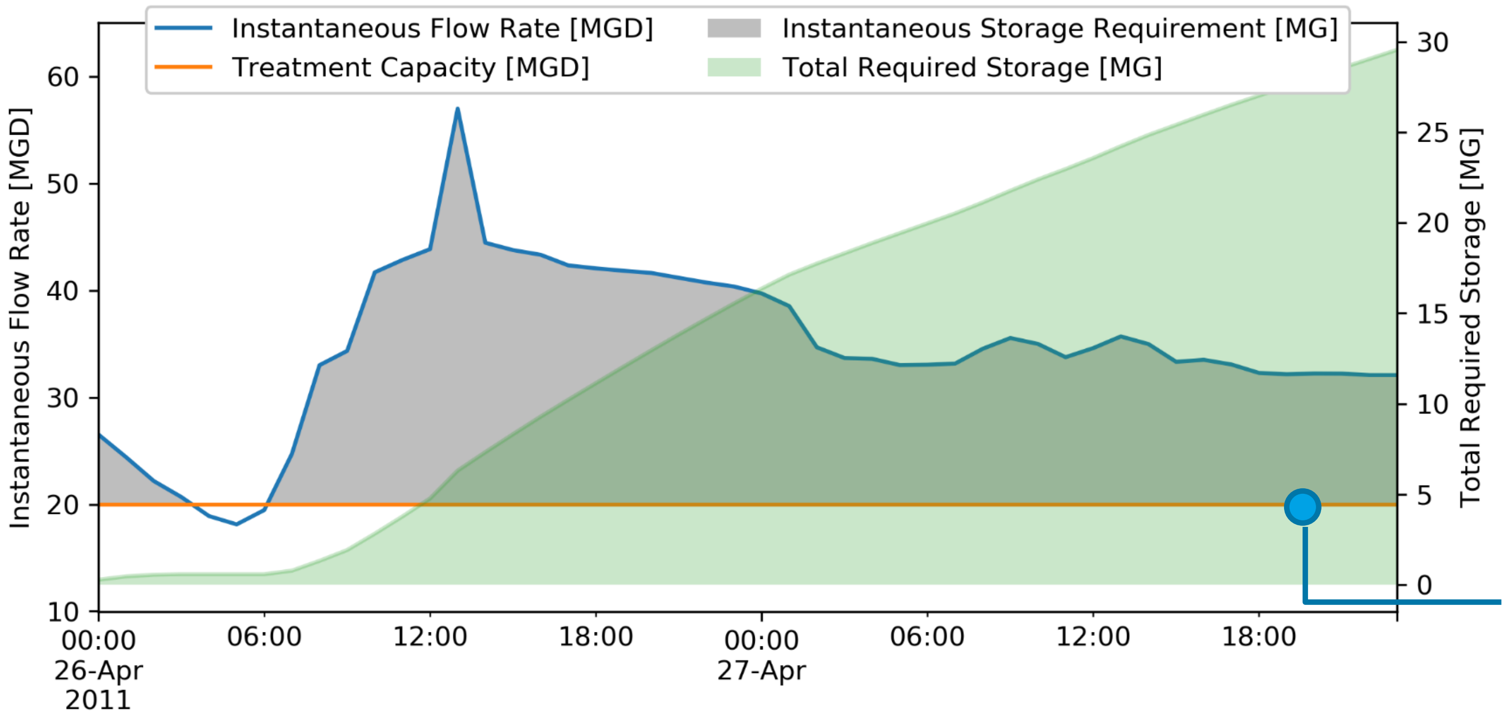
Option 2: Equalize and pump

1. Maintain a headworks facility
2. Develop equalization sizing to limit peak flow impact at GBF
3. Does this really limit rotational assets?

30 MG of Storage
(assumes 20 foot depth)



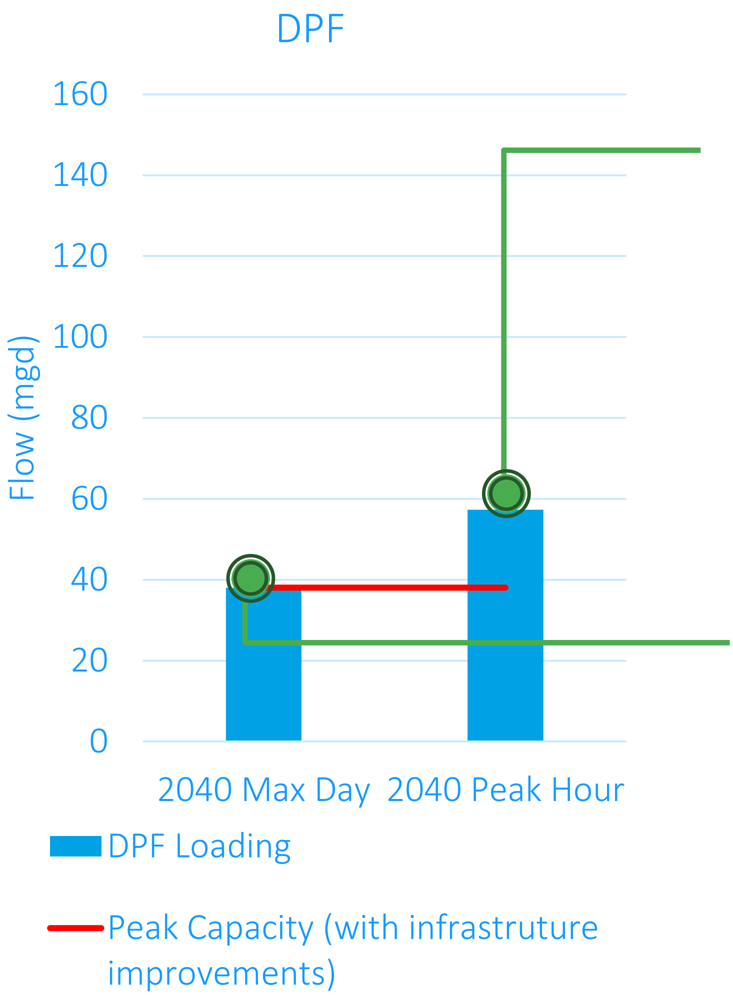
Storage at DPF could limit peak flow impact at GBF



Storage required: Likely more than 30 MG, but how much more?

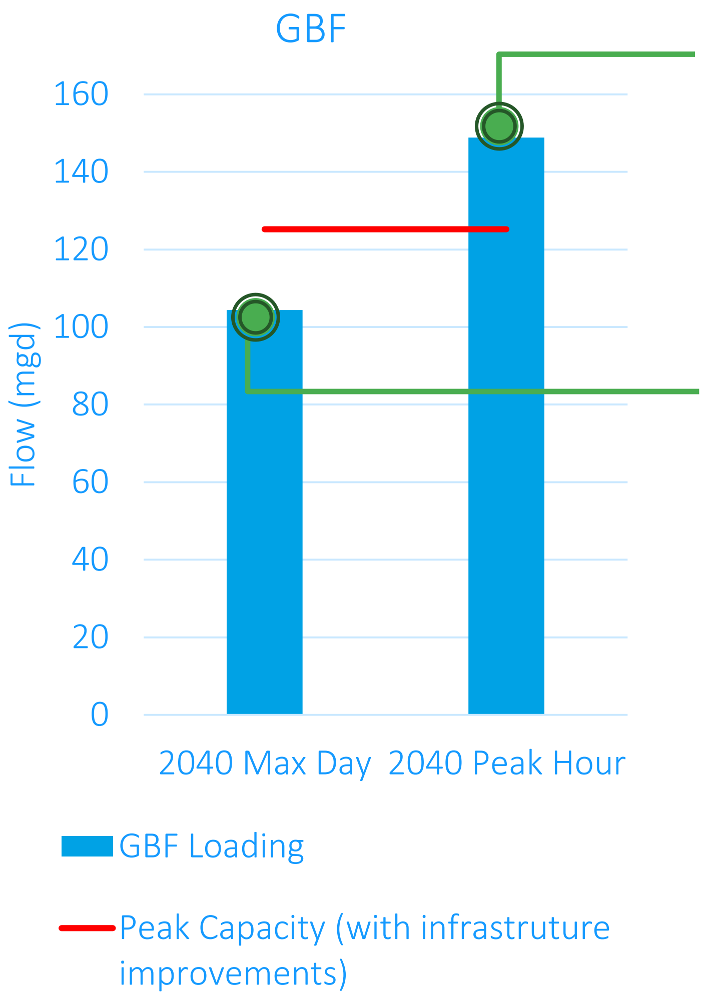
Flow rate sent to GBF becomes the critical factor

Step 1 - Understanding the context: Future Flows and Loads



Peak hour flow:
19.3 mgd gap

Peak day flow:
Matches capacity



Peak hour flow:
23.6 mgd gap

Peak day flow:
20.8 mgd surplus

Capital Cost

$140M to $240M

Option 2: Equalize and pump

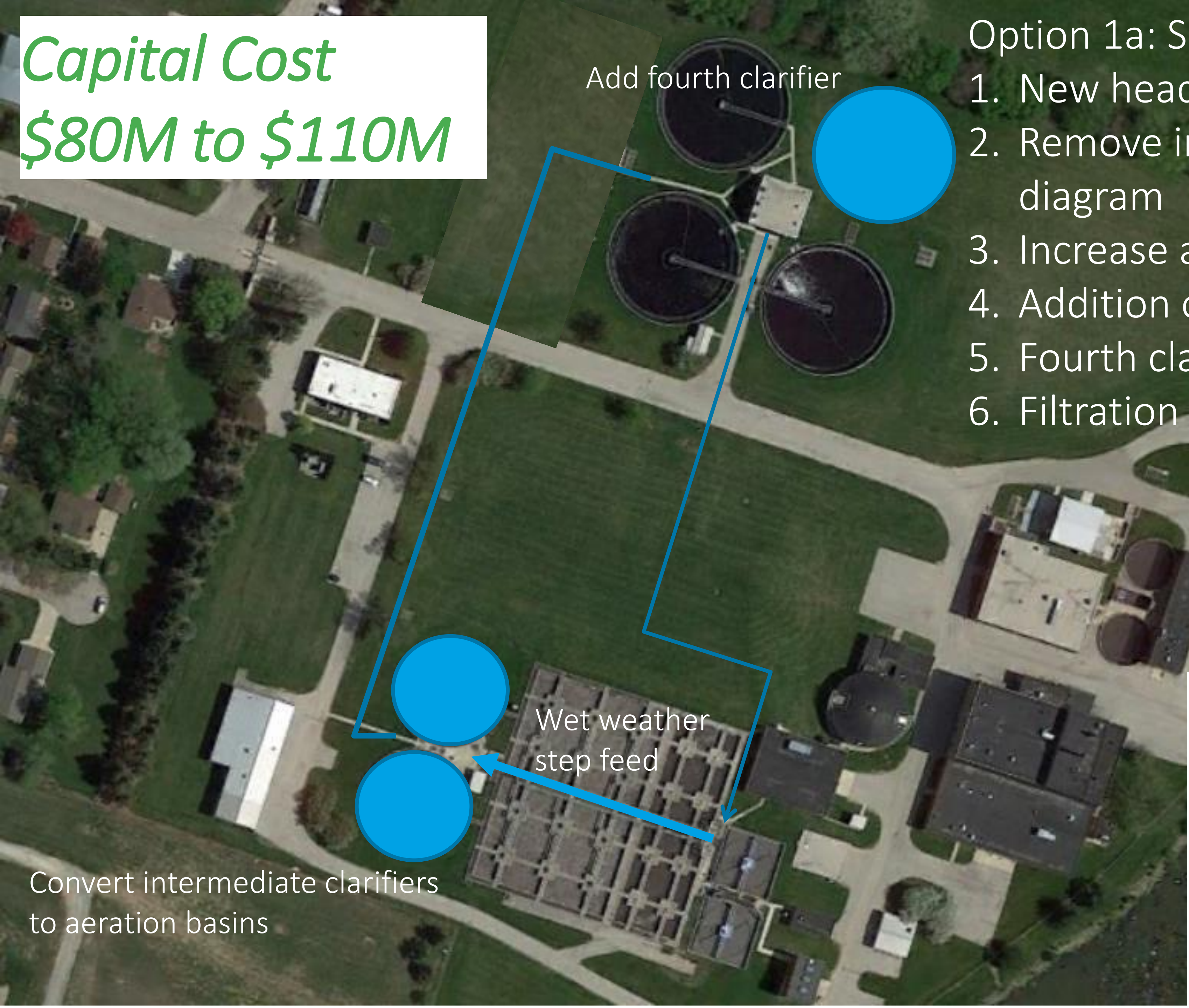
1. DP pump station and force main
2. Small equalization at DPF
3. Capacity expansion at GBF
    1. Headworks
    2. Primary clarifiers
    3. Aeration basin
    4. Final clarifiers
    5. Disinfection

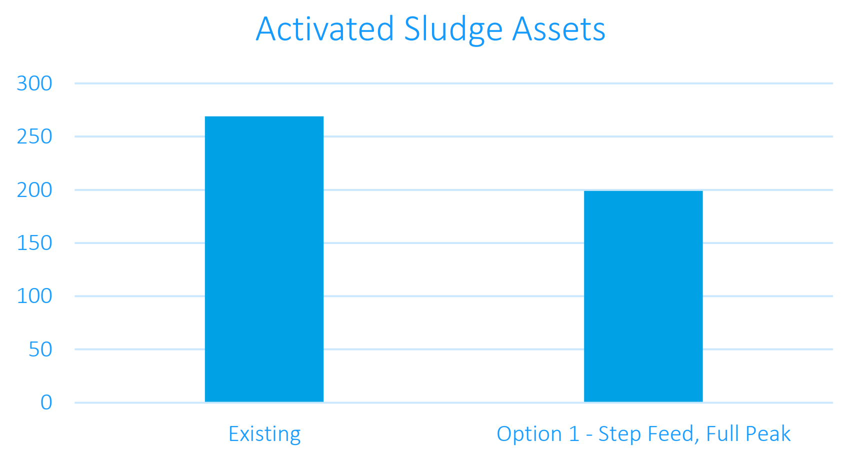
Capital Cost

$80M to $110M

Option 1a: Simplify and expand

1. New headworks
2. Remove intermediate clarifiers from flow diagram
3. Increase activated sludge volume
4. Addition of step feed
5. Fourth clarifier (or equalization)
6. Filtration and UV for tertiary treatment



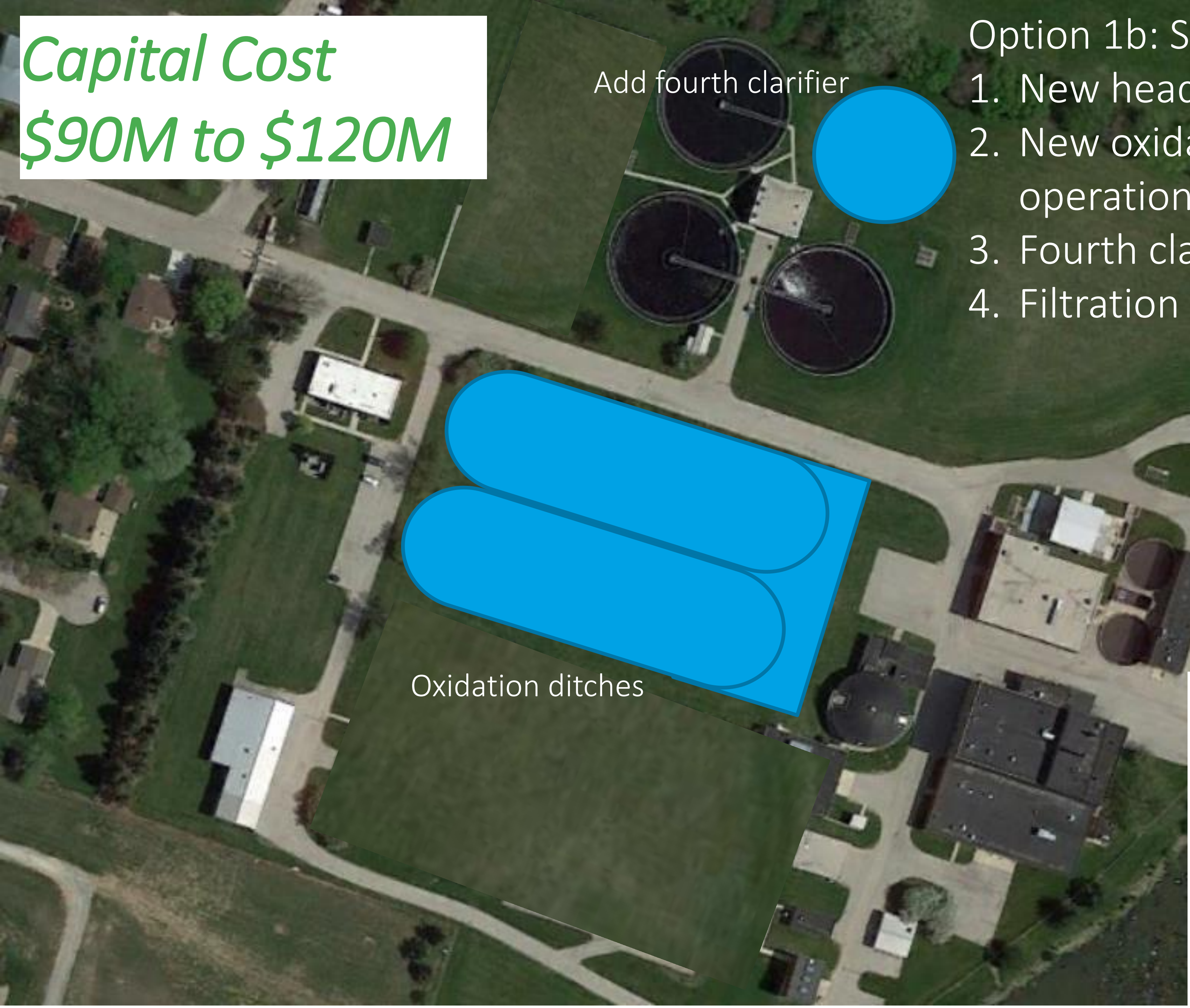


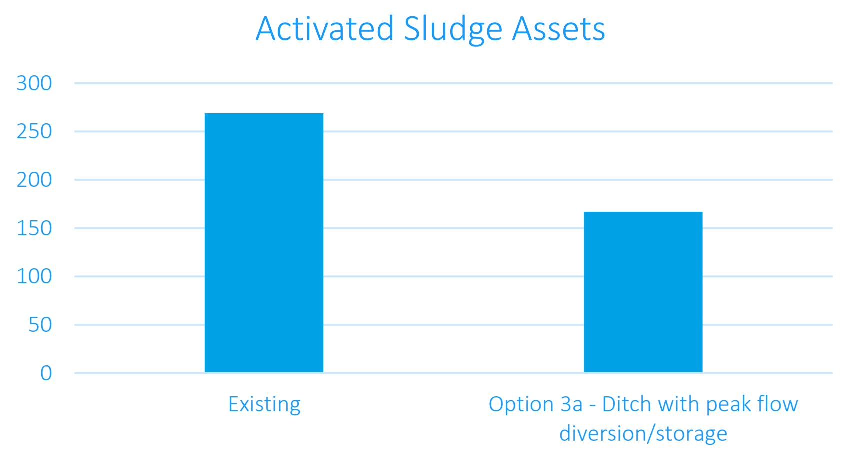
Option 1b: Simplify and expand

1. New headworks
2. New oxidation ditches for simplified operation
3. Fourth clarifier (or equalization)
4. Filtration and UV for tertiary treatment

Capital Cost

$90M to $120M



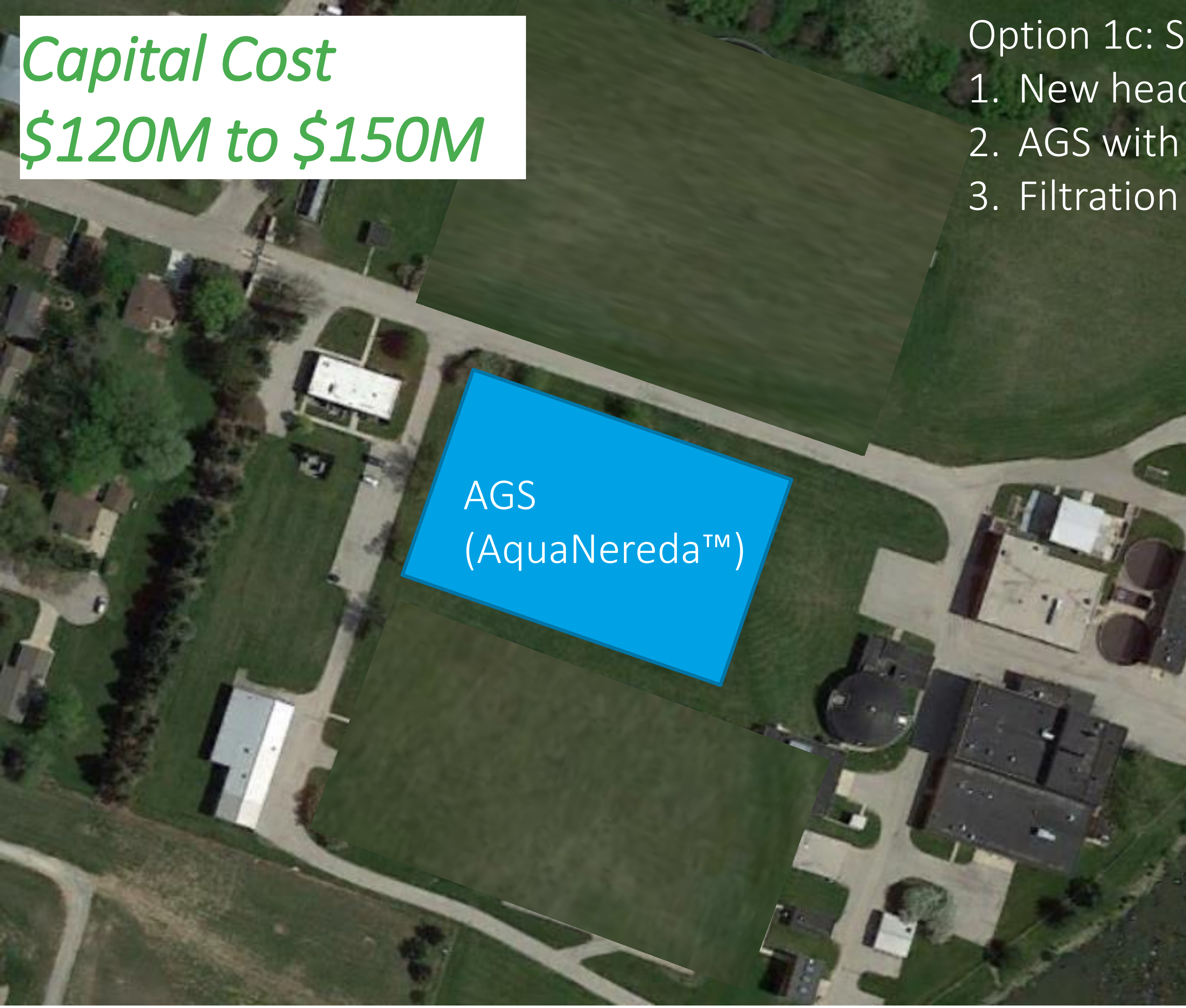


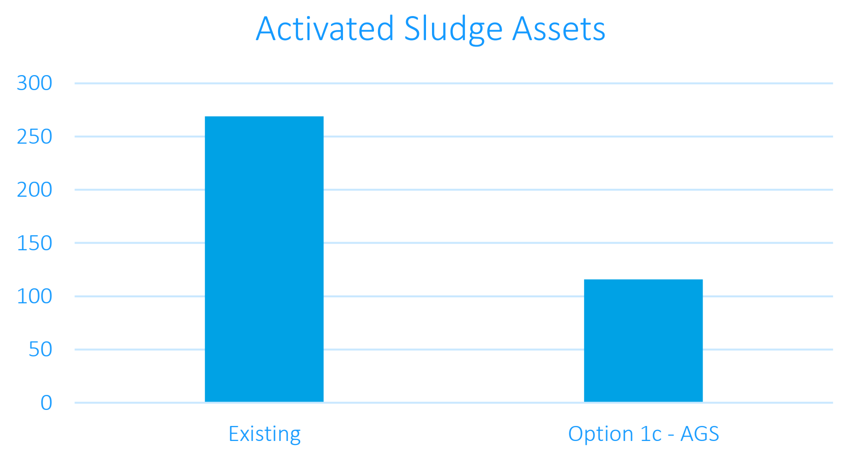
Capital Cost

$120M to $150M

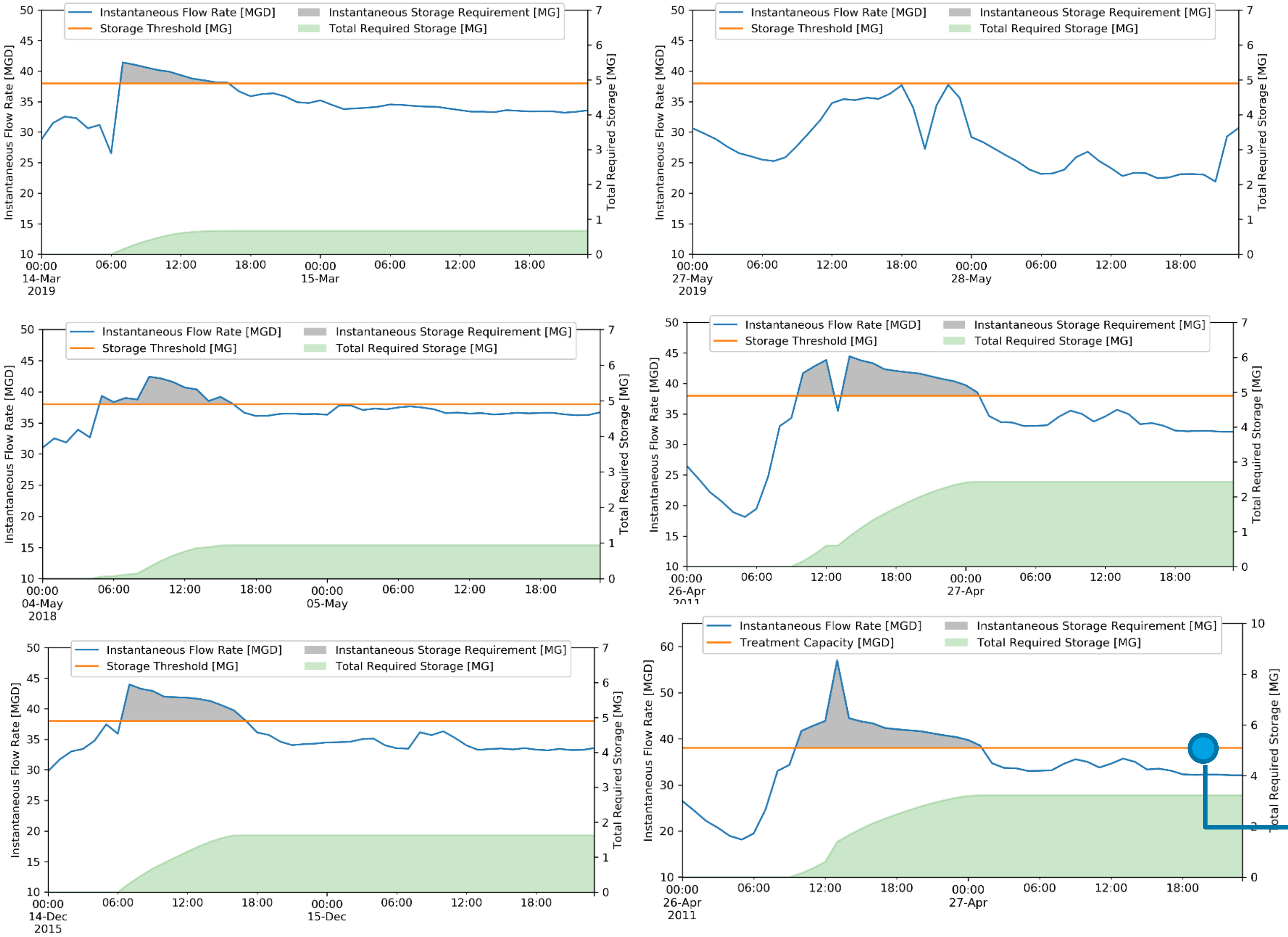
Option 1c: Simplify and expand

1. New headworks
2. AGS with equalization
3. Filtration and UV for tertiary treatment





Is it possible to equalize instead of expanding?



Storage range: 0.6 MG to 3.2 MG

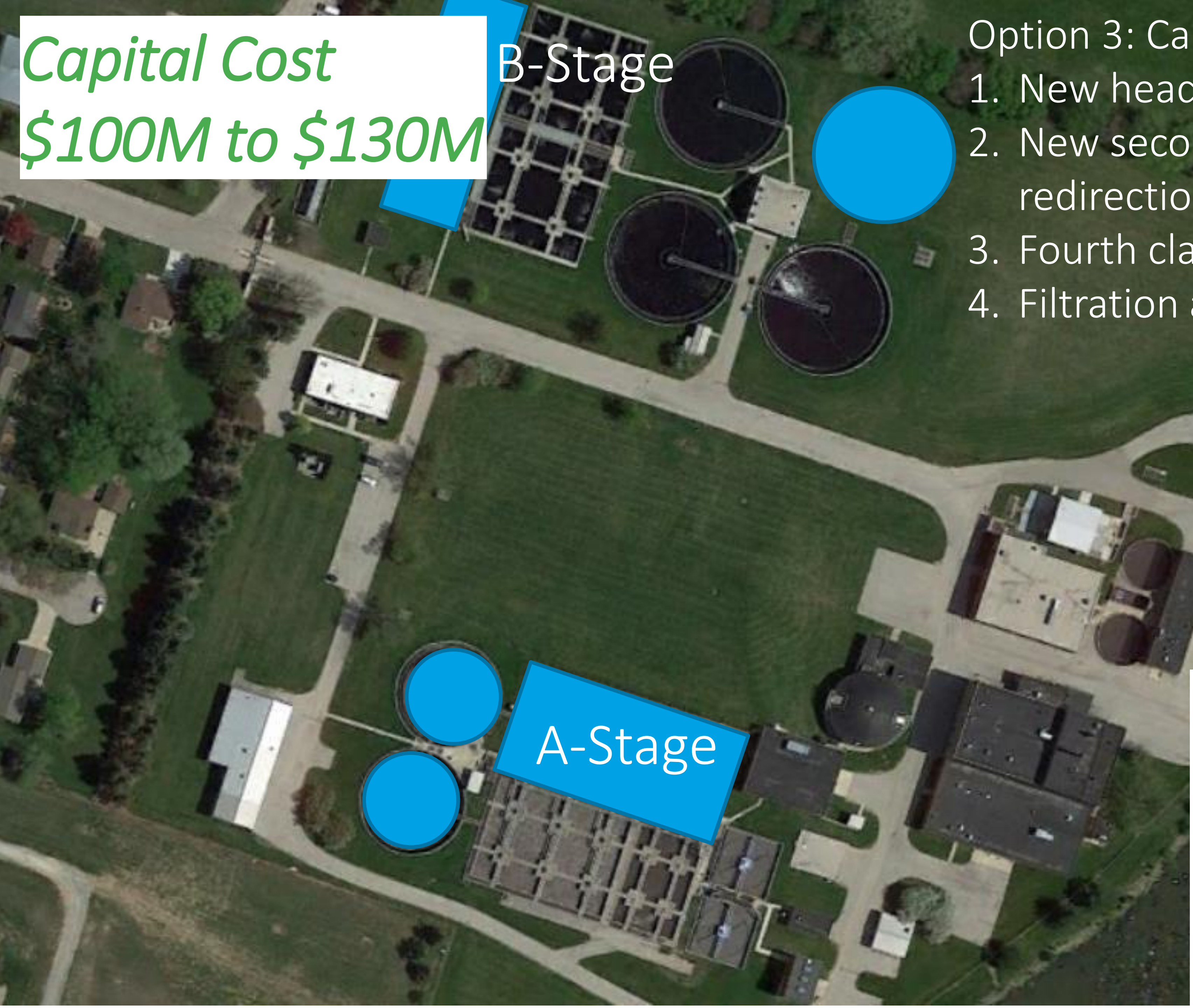
Limits DPF to 38 MGD

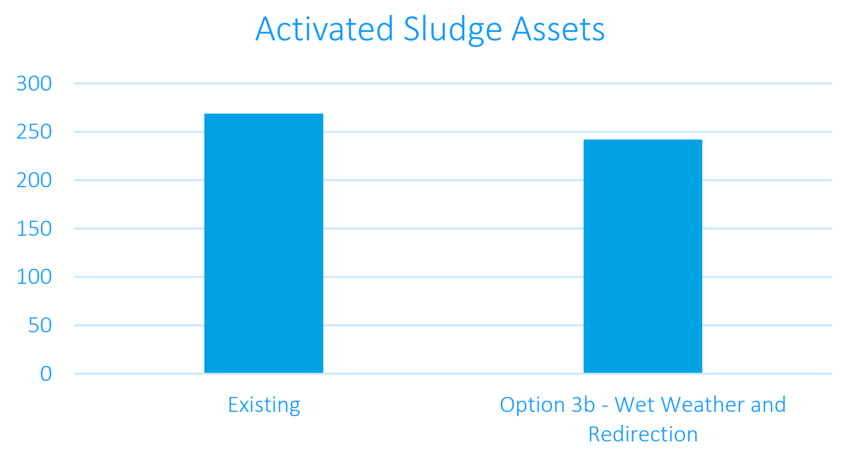
Capital Cost

$100M to $130M

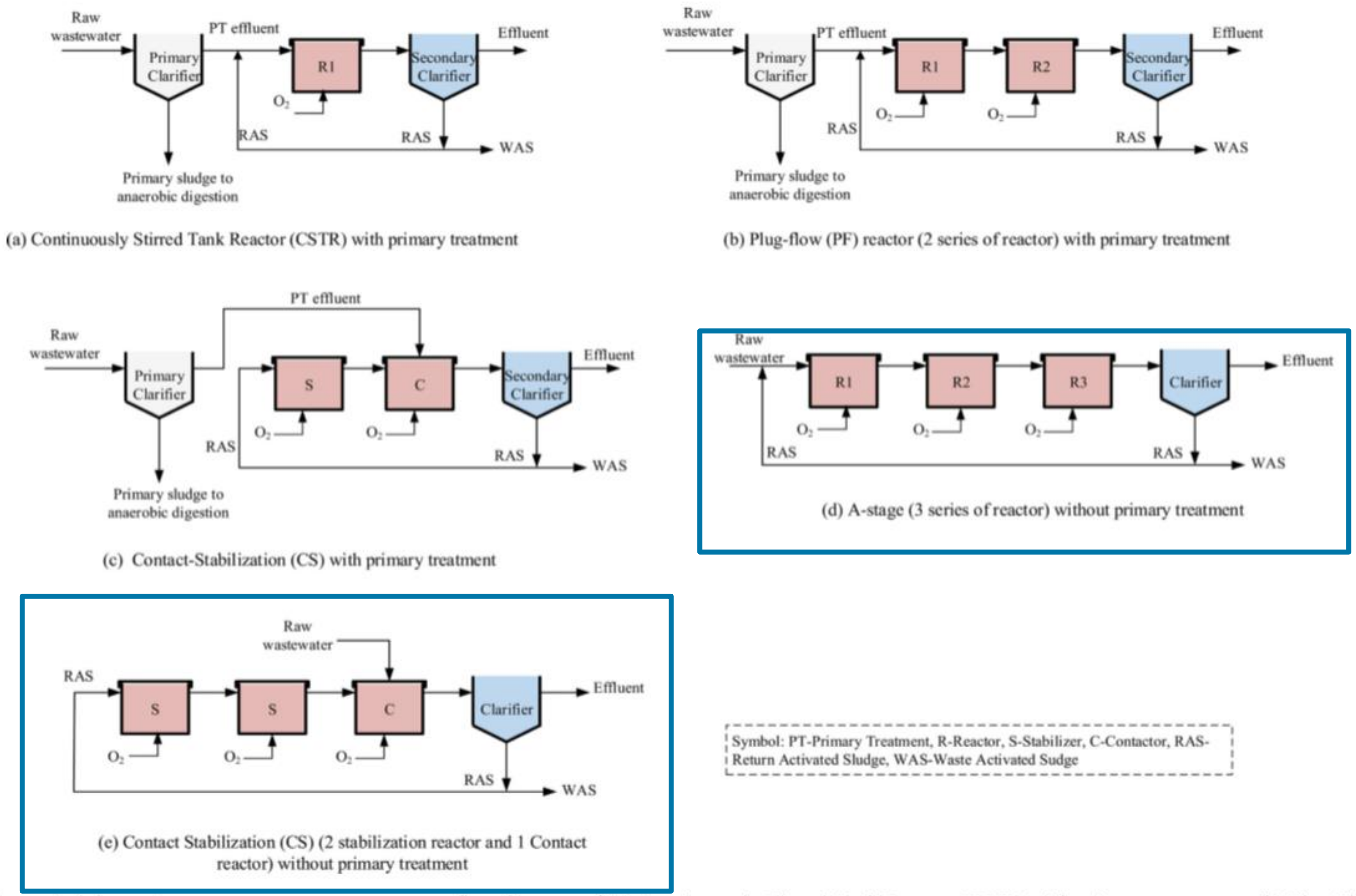
Option 3: Carbon redirection

1. New headworks
2. New secondary process with carbon redirection (maybe A/B?)
3. Fourth clarifier (or equalization)
4. Filtration and UV for tertiary treatment





What is A-stage treatment?



(a) Continuously Stirred Tank Reactor (CSTR) with primary treatment

(b) Plug-flow (PF) reactor (2 series of reactor) with primary treatment

(c) Contact-Stabilization (CS) with primary treatment

(d) A-stage (3 series of reactor) without primary treatment

(e) Contact Stabilization (CS) (2 stabilization reactor and 1 Contact reactor) without primary treatment

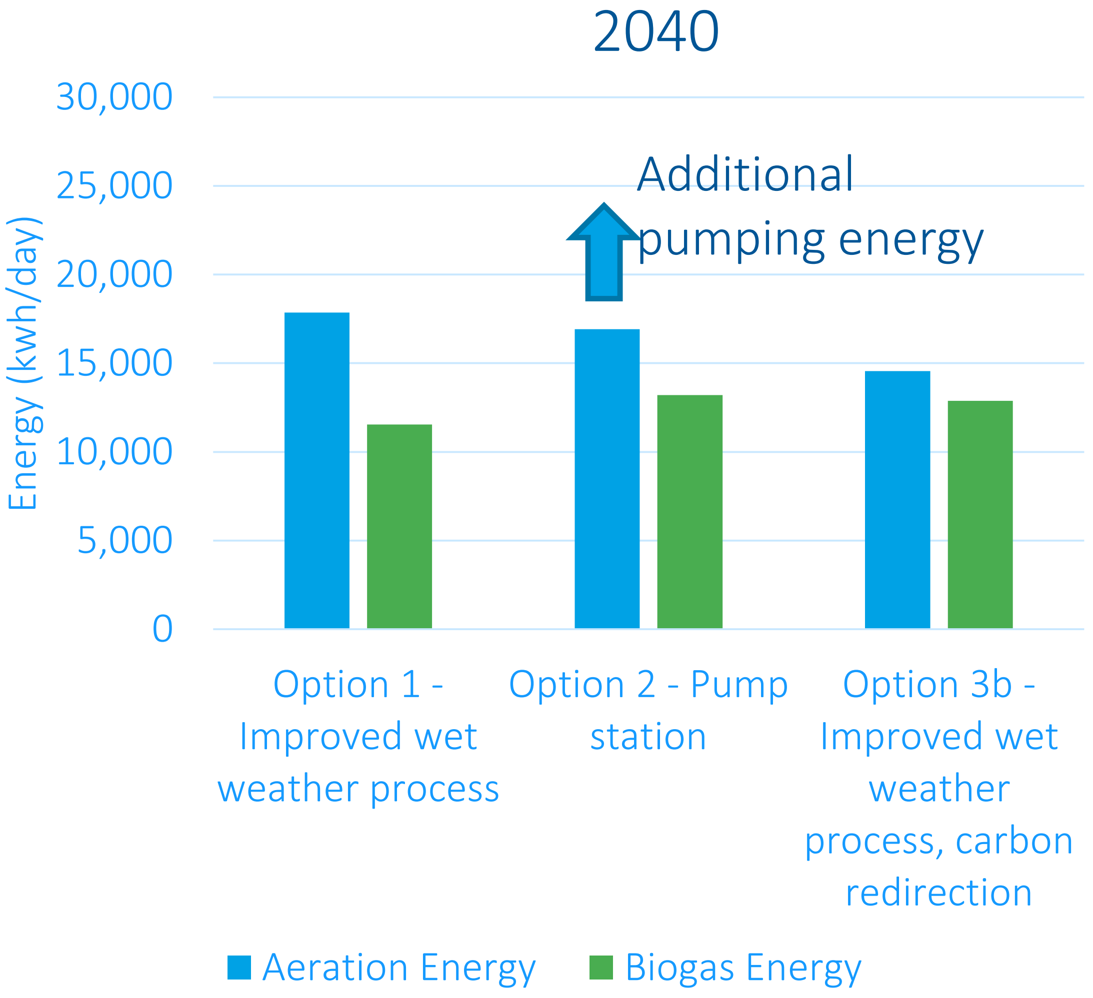
Symbol: PT-Primary Treatment, R-Reactor, S-Stabilizer, C-Contactor, RAS-Return Activated Sludge, WAS-Waste Activated Sudge

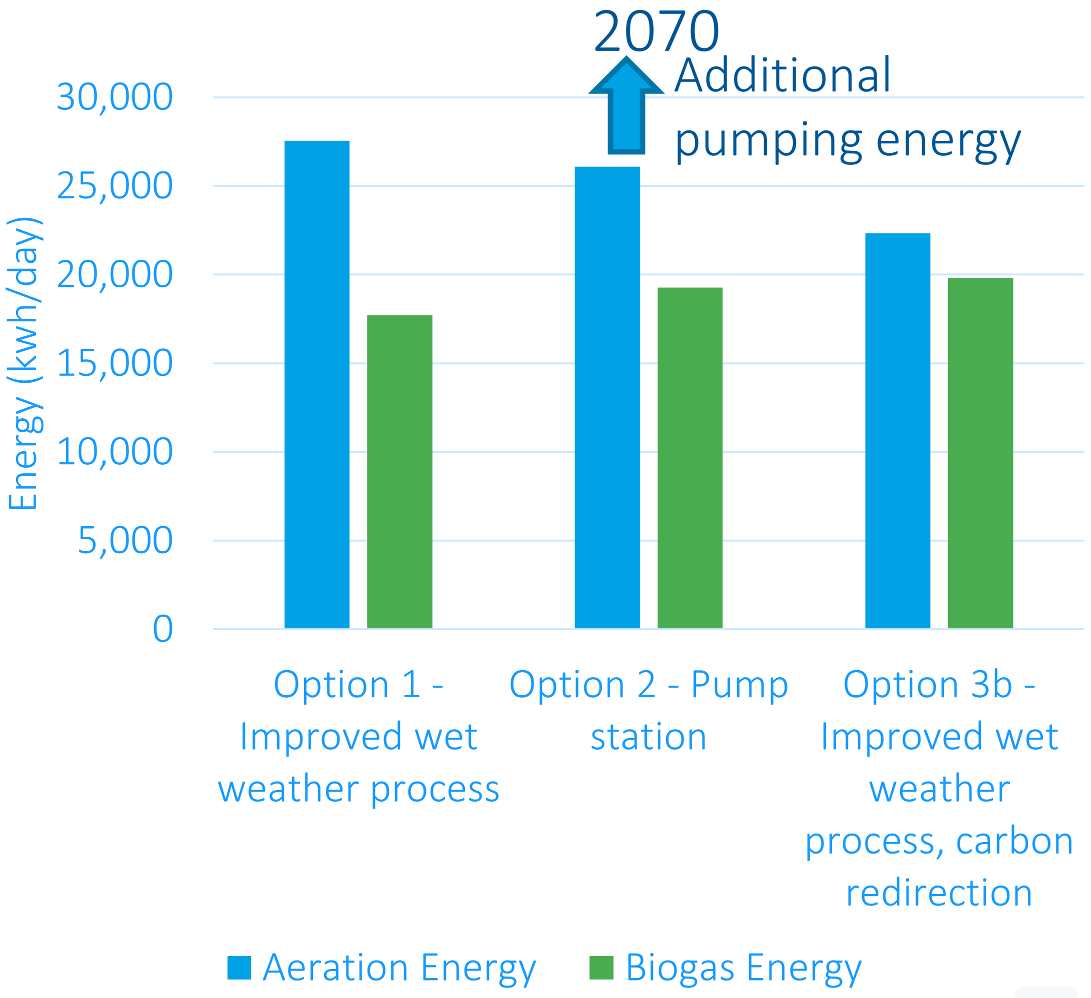
Fig. 1. The typical domestic wastewater treatment process flow diagram of (a) Continuously Stirred Tank Reactor (CSTR) with primary treatment, (b) Plug-Flow (PF) reactor system with primary treatment, (b) Contact-Stabilization with primary treatment, (c) A-stage (without primary treatment) and (d) Contact-Stabilization (CS) without primary treatment.

Rahman et al (2020) Journal of Water Process Engineering **36**

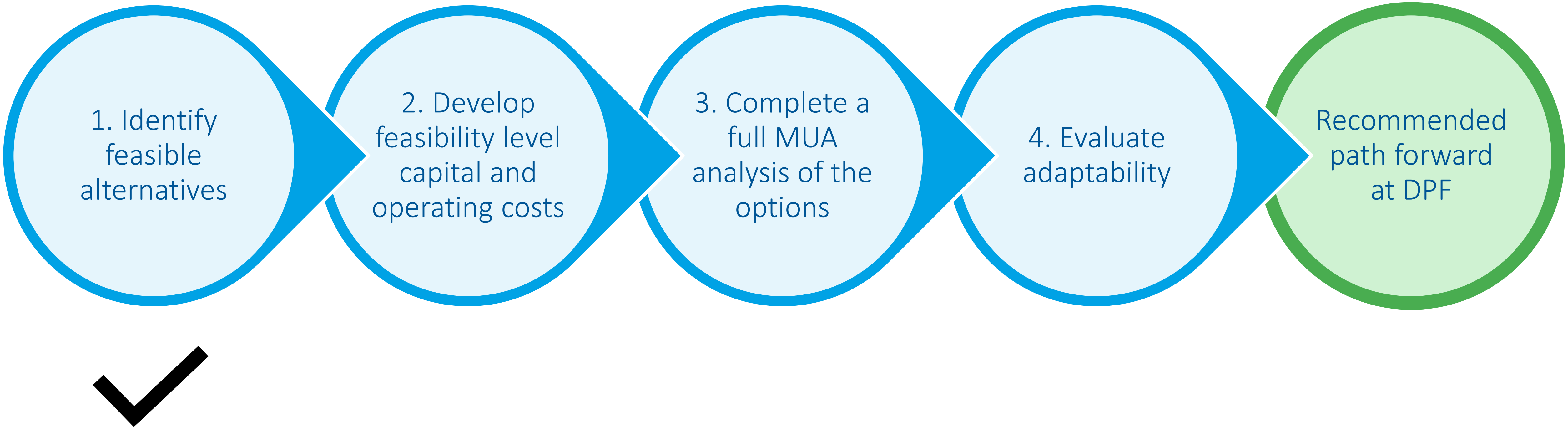
- High rate activated sludge (HRAS)
  - <1 day SRT
  - <2 hour HRT
- Sorb COD to biological floc
- Divert to anaerobic digestion

Are we focused too much on today, and not on a resource recovery future?





How do we make a decision on DPF?



1. Identify feasible alternatives ✓

2. Develop feasibility level capital and operating costs

3. Complete a full MUA analysis of the options

4. Evaluate adaptability

Recommended path forward at DPF

2. Develop feasibility study level capital cost and operating costs

Options	Capital Cost	Main Components
Option 1	$80M to $110M	• Existing CIP (headworks, filters, UV, clarifiers) • Aeration basin improvements • New clarifier
Option 2	$40M to $60M Pump Station and Pipeline $30M to $60M DPF Storage $70M to $120M GBF improvements $140M to $240M Total	• 30 mgd pump station and pipeline • DPF storage • GPF expansion (south primary clarifiers, south aeration basin, south final clarifiers, disinfection) • Headworks expansion
Option 3	$100M to $130M	• Existing CIP (headworks, filters, UV, clarifiers) • Aeration basin improvements (A/B stage) • New clarifier

How do we make a decision on DPF?

1. Identify reasonable alternatives

2. Develop feasibility level capital and operating costs

3. Complete a full MUA analysis of the options

4. Evaluate adaptability

Recommended path forward at DPF

✓ → ✓

How do we make a decision on DPF?

1. Identify reasonable alternatives

2. Develop feasibility level capital and operating costs

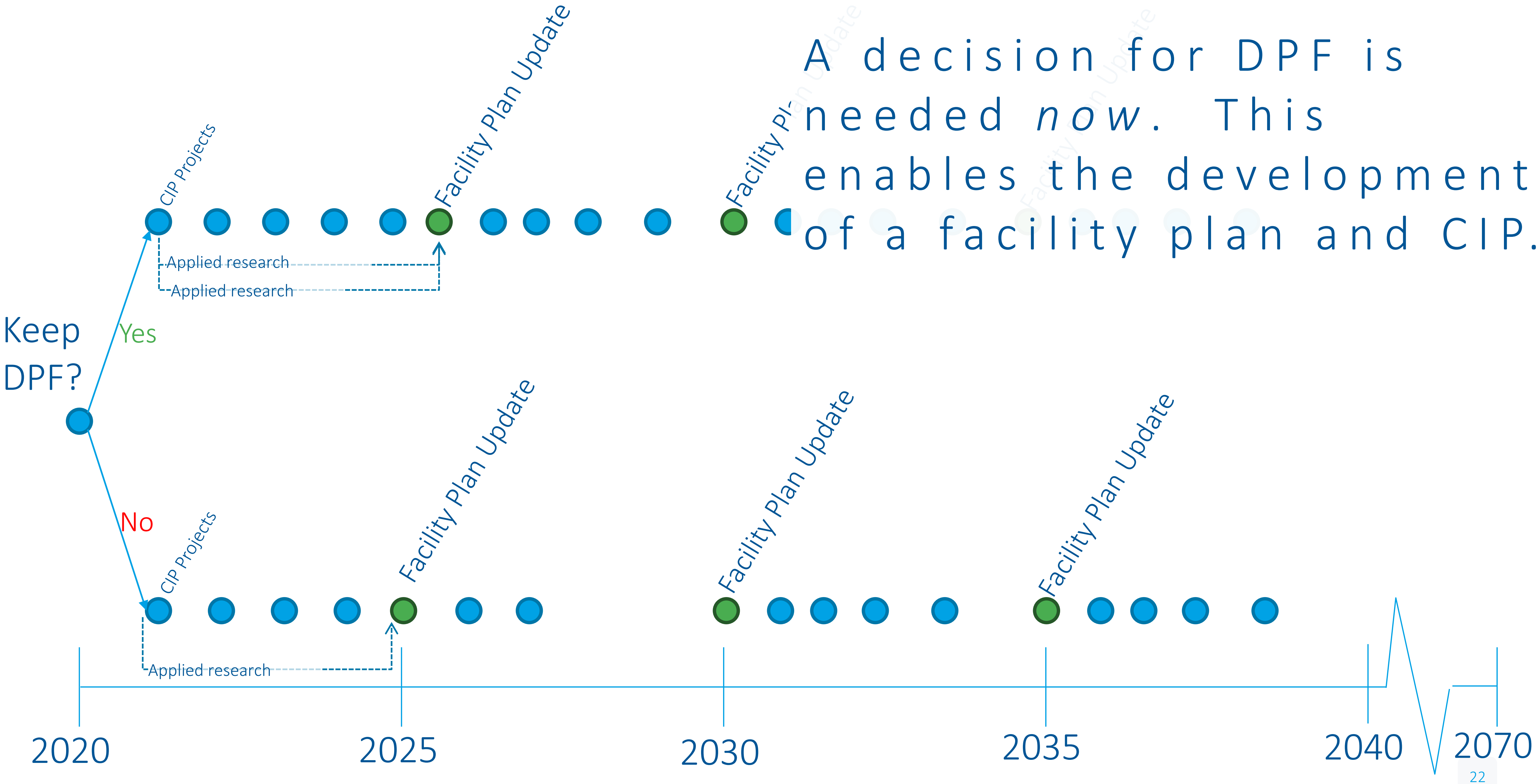
3. Complete a full MUA analysis of the options

4. Evaluate adaptability

Recommended path forward at DPF

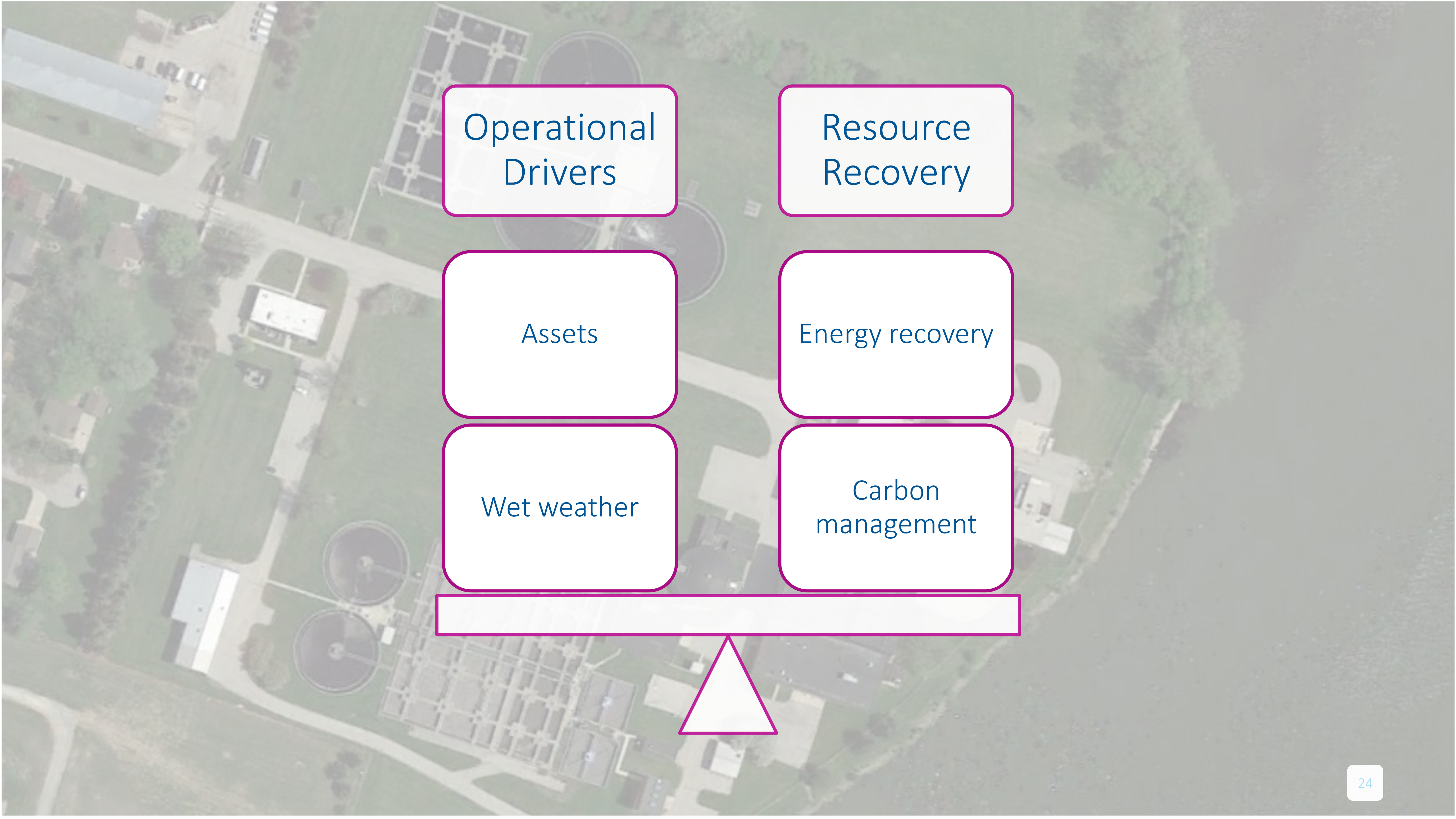
✓ → ✓ →

Need for collaborative discussions in the next two sessions



A decision for DPF is needed *now*. This enables the development of a facility plan and CIP.

Risks, Opportunities and MUA



Operational Drivers

Assets

Wet weather

Resource Recovery

Energy recovery

Carbon management

Thinking through MUA criteria will be particularly critical for the DPF vision

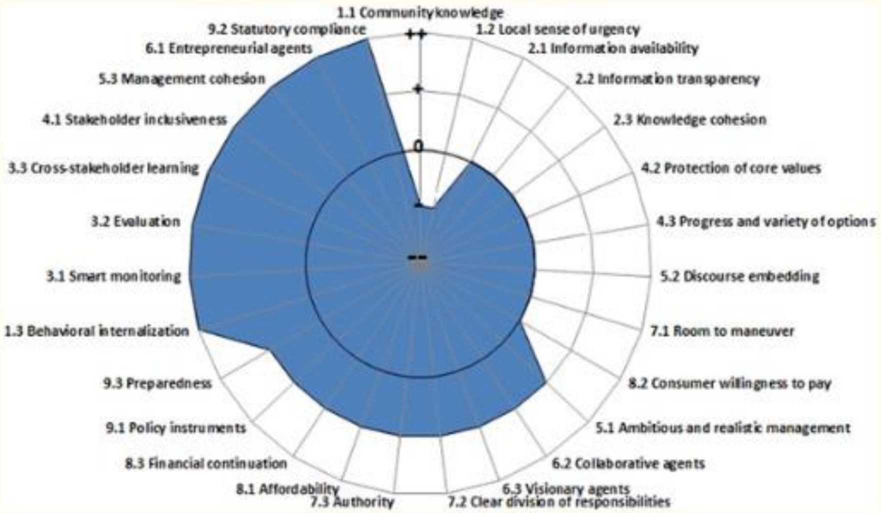
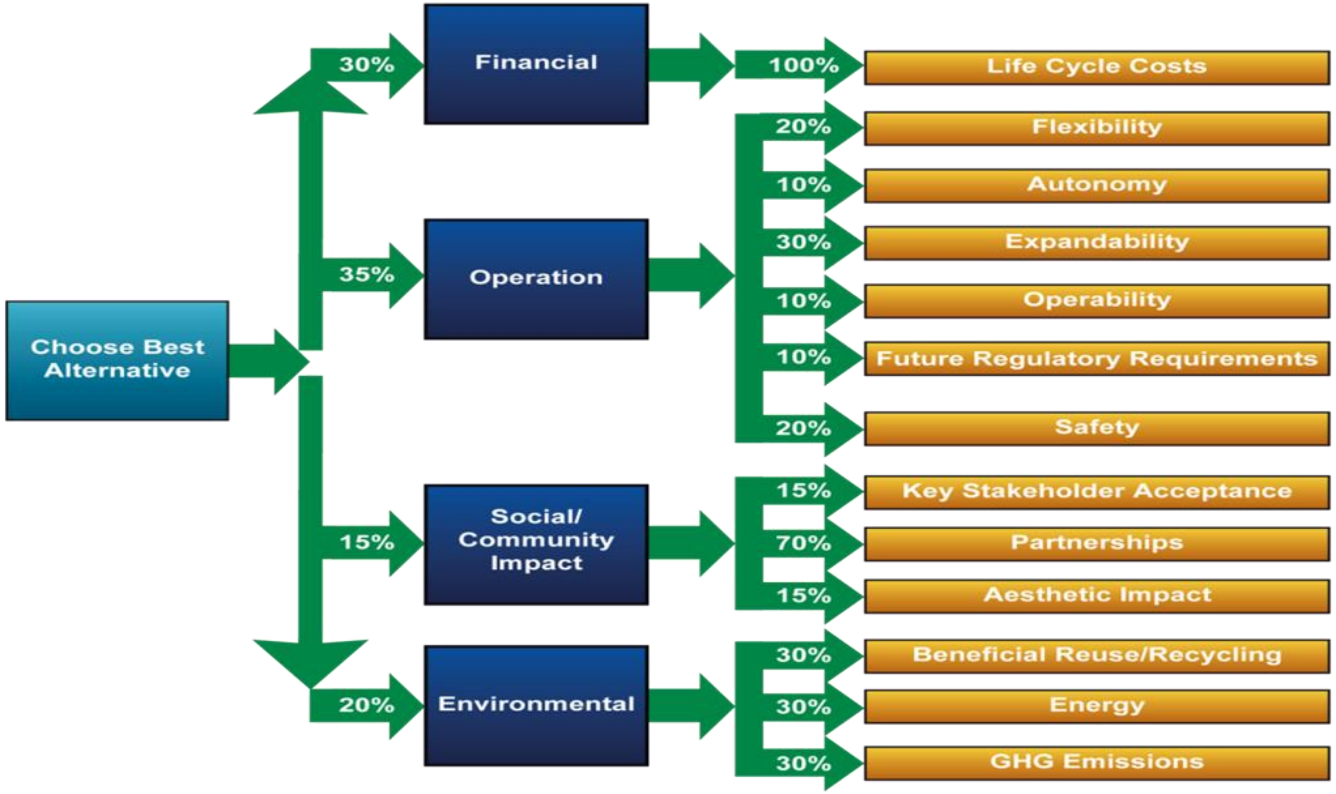


Fig. 2

Scores of the 27 indicators of the GCF water governance performance on wastewater treatment for the city of Amsterdam (Koop et al. 2017)

Example output from the Netherlands

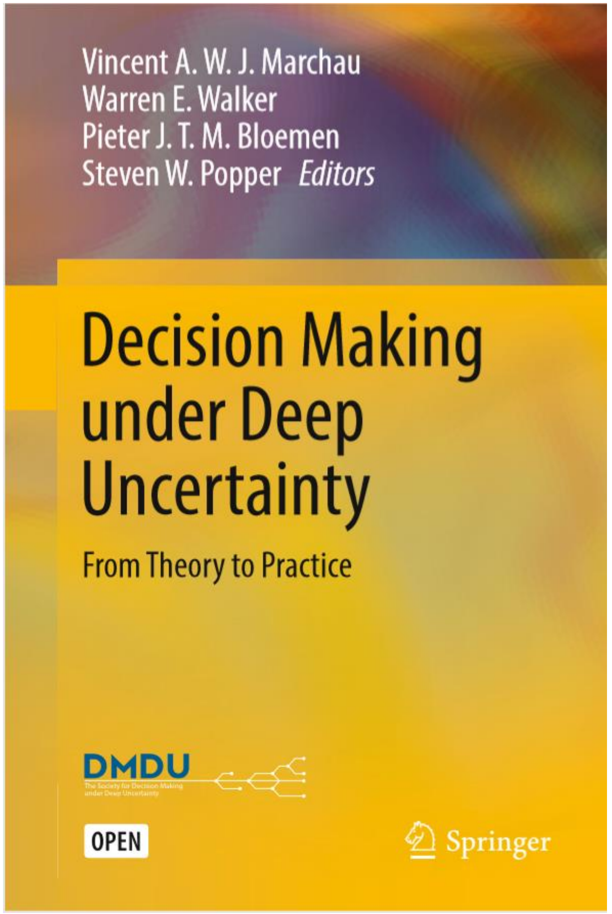


Choose Best Alternative

- 30% **Financial**
  - 100% Life Cycle Costs
- 35% **Operation**
  - 20% Flexibility
  - 10% Autonomy
  - 30% Expandability
  - 10% Operability
  - 10% Future Regulatory Requirements
  - 20% Safety
- 15% **Social/ Community Impact**
  - 15% Key Stakeholder Acceptance
  - 70% Partnerships
  - 15% Aesthetic Impact
- 20% **Environmental**
  - 30% Beneficial Reuse/Recycling
  - 30% Energy
  - 30% GHG Emissions

R2E2 MUA

Five approaches for decision making in an uncertain world



Vincent A. W. J. Marchau
Warren E. Walker
Pieter J. T. M. Bloemen
Steven W. Popper *Editors*

Decision Making under Deep Uncertainty

From Theory to Practice

DMDU

OPEN

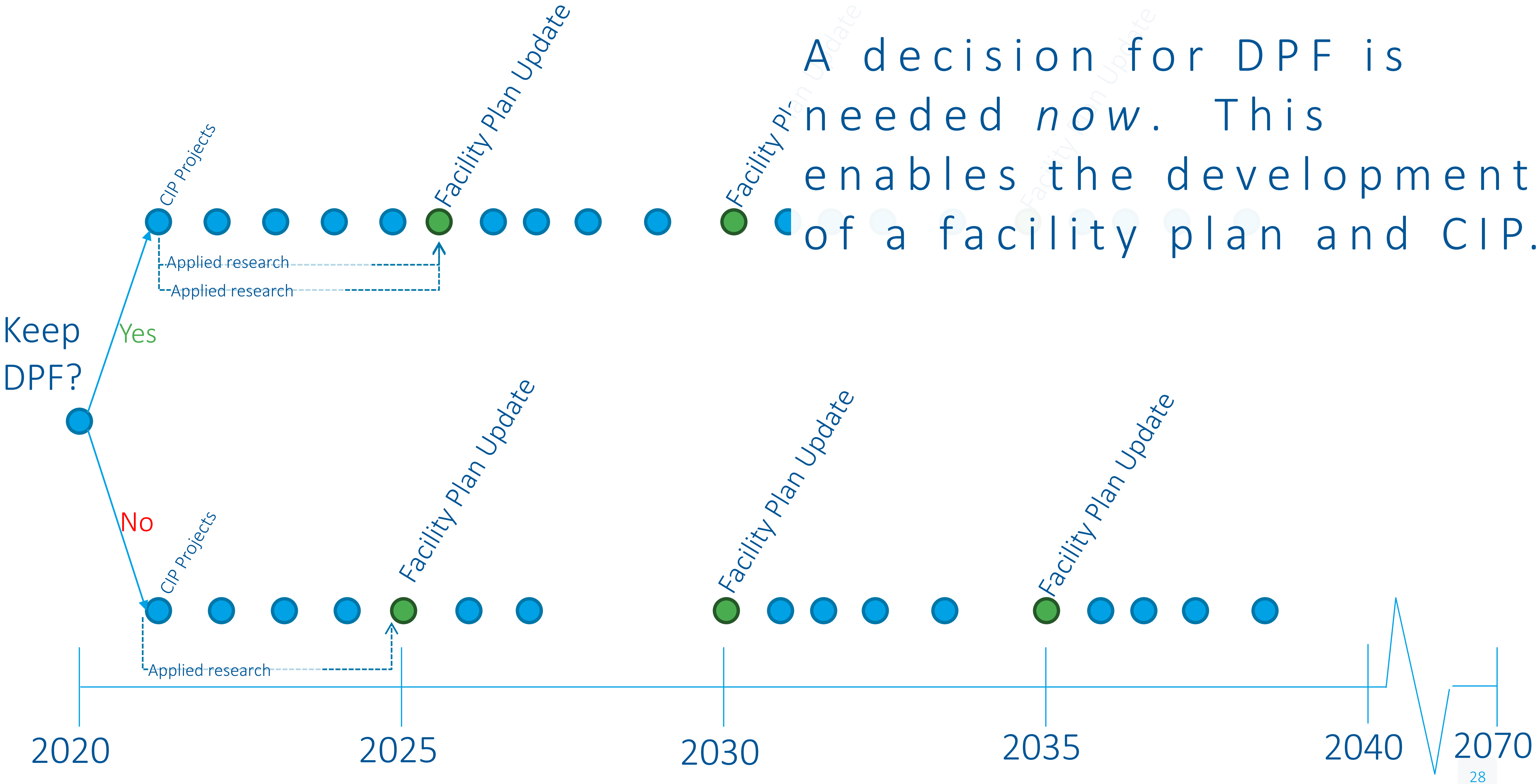
Springer

- **Robust decision making (RDM):** stress test alternatives under various scenarios for technical robustness
- **Dynamic adaptive planning (DAP):** implementation of a plan that is adapted over time based on new knowledge
- **Dynamic adaptive policy planning (DAPP):** development of alternative routes as part of DAP
- **Info-Gap Decision Theory (IG):** An info-gap is the disparity between what is know and what needs to be known to make a decision; evaluation of a large range of options computationally
- **Engineering Options Analysis (EOA):** assignment of economic value to technical flexibility

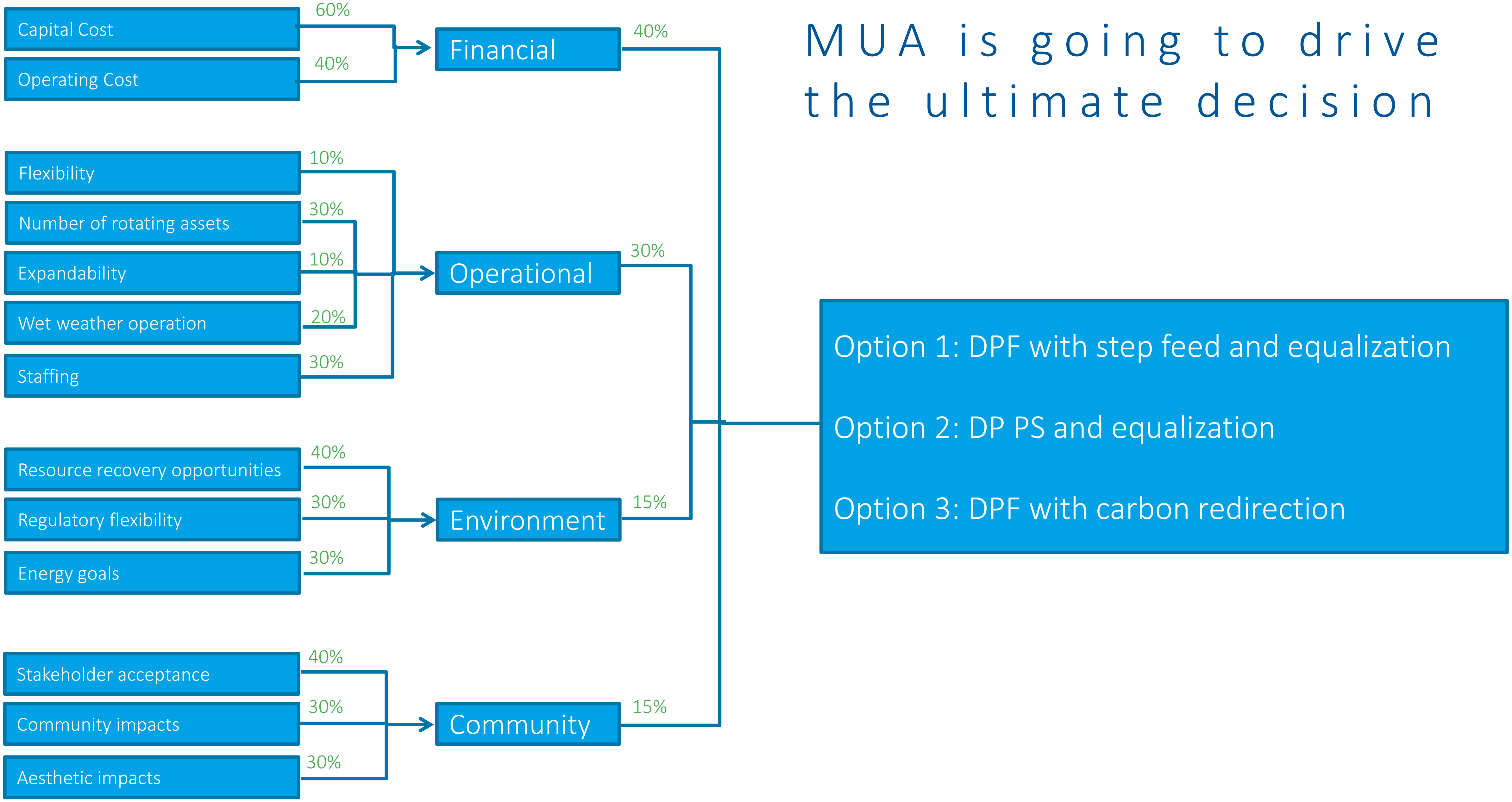
How can dynamic adaptive planning be implemented for NEW Water?

- Specify goals and objectives – Risks, opportunities, and MUA
- Develop an initial plan to meet these goals and objectives – 5-year CIP
- Identifying the vulnerabilities of the plan – Addressed by MUA
- Develop an initial plan of actions to be taken immediately upon implementation to protect it against some of these vulnerabilities – Applied Research Plan
- Establishment of signposts to monitor the remaining uncertain vulnerabilities – Future risks and opportunities
- Continued development of actions to advance the plan as the future becomes more certain – 10-year and 15-year CIP

A decision for DPF is needed *now*. This enables the development of a facility plan and CIP.



MUA is going to drive the ultimate decision



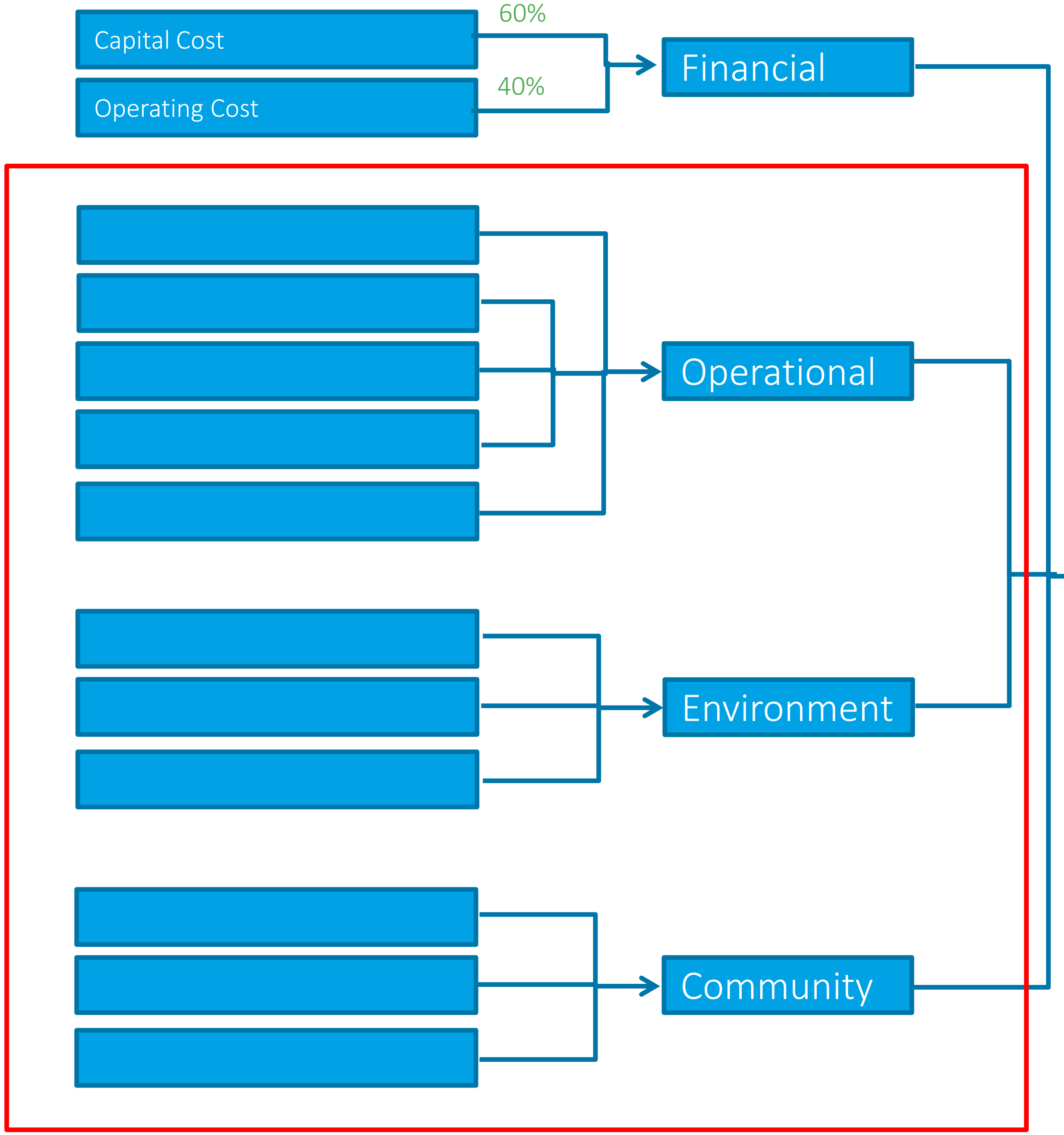
- Financial 40%
  - Capital Cost 60%
  - Operating Cost 40%
- Operational 30%
  - Flexibility 10%
  - Number of rotating assets 30%
  - Expandability 10%
  - Wet weather operation 20%
  - Staffing 30%
- Environment 15%
  - Resource recovery opportunities 40%
  - Regulatory flexibility 30%
  - Energy goals 30%
- Community 15%
  - Stakeholder acceptance 40%
  - Community impacts 30%
  - Aesthetic impacts 30%

Option 1: DPF with step feed and equalization

Option 2: DP PS and equalization

Option 3: DPF with carbon redirection

MUA is going to drive the ultimate decision

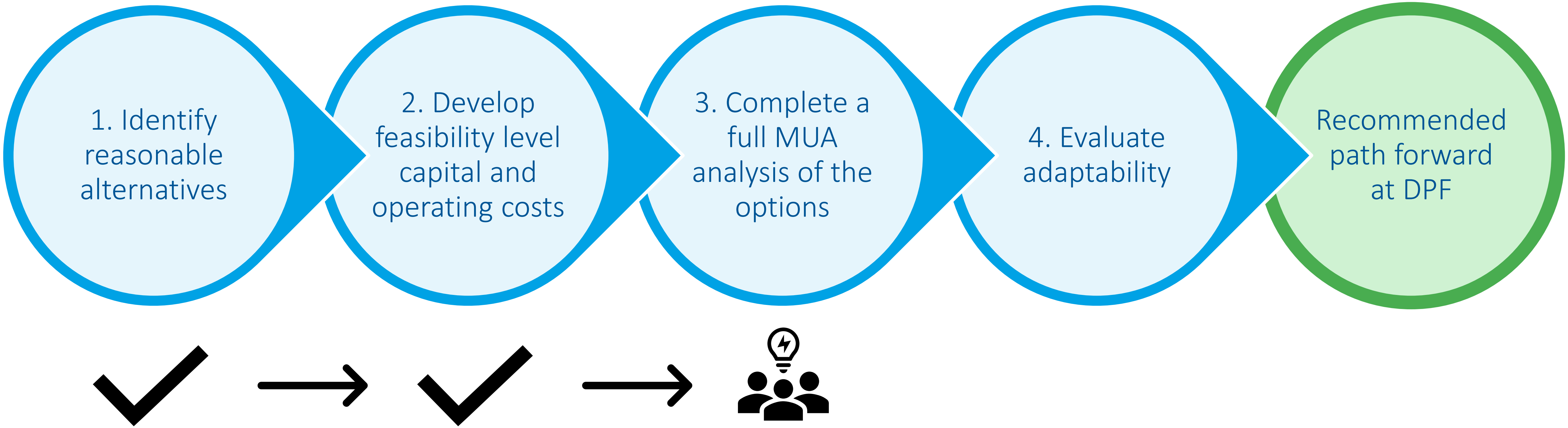


Option 1: DPF with step feed and equalization

Option 2: DP PS and equalization

Option 3: DPF with carbon redirection

How do we make a decision on DPF?



1. Identify reasonable alternatives

2. Develop feasibility level capital and operating costs

3. Complete a full MUA analysis of the options

4. Evaluate adaptability

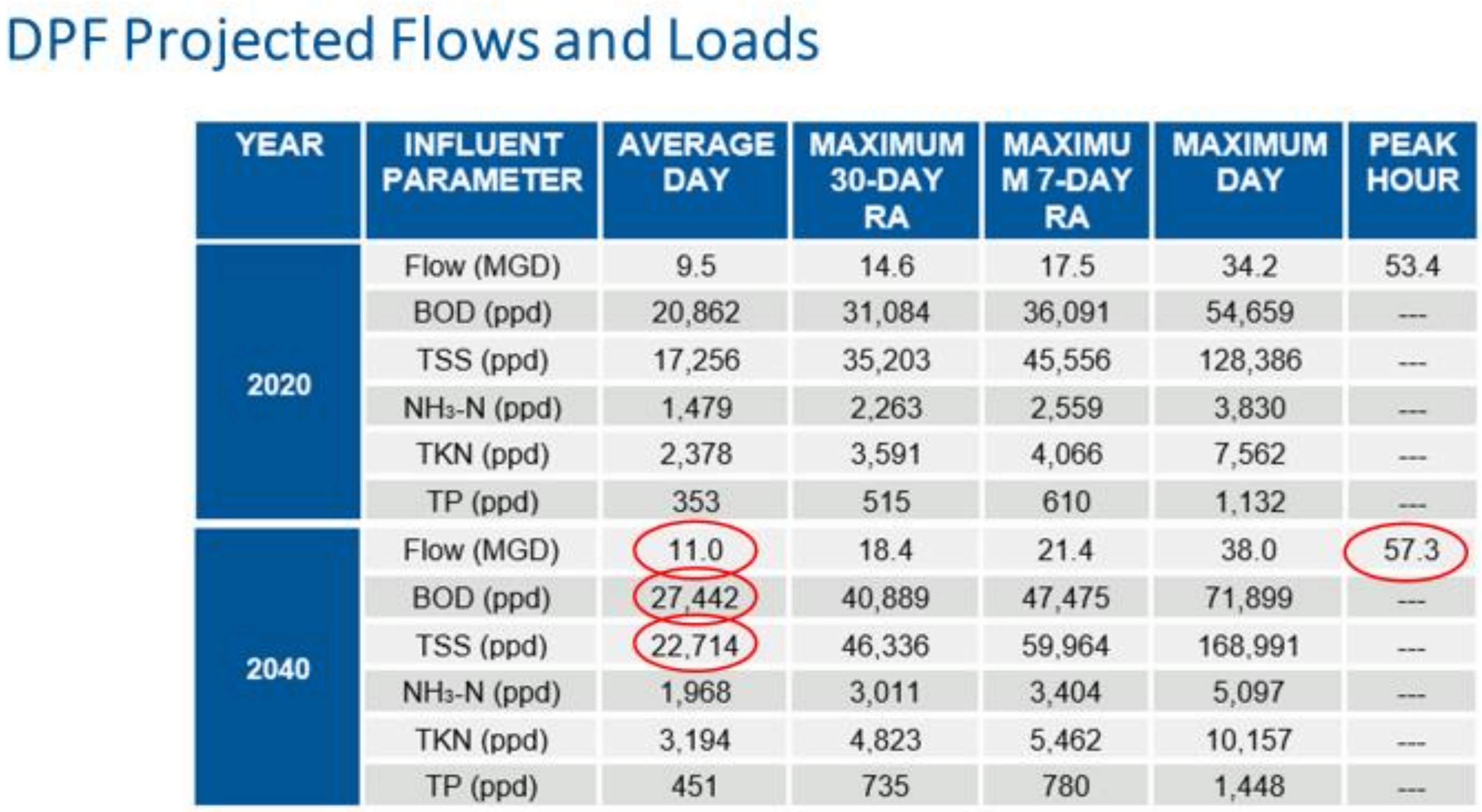
Recommended path forward at DPF

✓ → ✓ →

Finalize criteria on July 2, 2020

Session 2 notes

Step 1 - Understanding the context: Future Flows and Loads



DPF Projected Flows and Loads

YEAR	INFLUENT PARAMETER	AVERAGE DAY	MAXIMUM 30-DAY RA	MAXIMU M 7-DAY RA	MAXIMUM DAY	PEAK HOUR
2020	Flow (MGD)	9.5	14.6	17.5	34.2	53.4
	BOD (ppd)	20,862	31,084	36,091	54,659	---
	TSS (ppd)	17,256	35,203	45,556	128,386	---
	NH_3-N (ppd)	1,479	2,263	2,559	3,830	---
	TKN (ppd)	2,378	3,591	4,066	7,562	---
	TP (ppd)	353	515	610	1,132	---
2040	Flow (MGD)	11.0	18.4	21.4	38.0	57.3
	BOD (ppd)	27,442	40,889	47,475	71,899	---
	TSS (ppd)	22,714	46,336	59,964	168,991	---
	NH_3-N (ppd)	1,968	3,011	3,404	5,097	---
	TKN (ppd)	3,194	4,823	5,462	10,157	---
	TP (ppd)	451	735	780	1,448	---

Step 1:Understanding the context: Required Infrastructure Investment

Unit Process	Identified Issues
Influent Pumping	Age, peak flow capacity
Screening	Capture performance, peak flow capacity
Grit Removal	Age, operation, capture performance, peak flow capacity
Activated Sludge Aeration	
Intermediate Clarifiers	Age, peak flow capacity
RAS and WAS pumping	Age (both systems)
Second Stage Aeration	Not used
Final Clarifiers	Age, peak flow capacity
Tertiary Filters	Age, peak flow capacity
UV Disinfection	Peak flow capacity
Scum Handling (plant wide)	Operation, maintenance, capacity

Step 2: What are the risks and opportunities for Keeping DPF?

1) Water quality and permit benefit for two plants?

2) Does the DPF have Other Value? (Outside the fence to customers or neighbors.)

4) Asset Value and Maintenance

5) Operational considerations

6) Understanding the Regulatory Possibilities for Wet Weather Treatment

Is there a water quality benefit to two discharges?

Step 2: Water Quality & Permit Risks and Opportunities for Keeping DPF

Risks

- Possibly more legal liability with two discharges.
- Emerging contaminants discharged at two locations could be a future risk.

General

- Bubble permit between two facilities (TP and TSS) and permit limits established by TMDL
- Removing DPF discharge and moving upstream likely not a huge impact on water quality.
- Potentially worse Fox River water quality if no DPF discharge (mainly suspended solids)

Opportunities

- Two plants may have more flexibility to trade mass between the plants for a mass-based limit

Step 2: Outside the Fence Considerations
Risks and Opportunities for Keeping DPF

Risks

- Few “outside the fence” risks such as odor.
- All things equal, one plant is better than two so could possibly eliminate DPF

General

- Plant is relatively isolated with mostly park space surrounding it.
- One or two discharges isn’t a huge driver for customer decisions.
- No major complaints about facility
- No decentralization driver for combining the plants.

Opportunities

- Little opportunity or interest in land re-use or site redevelopment for alternative purposes.
- Little opportunity for reclaimed wastewater from DPF by customers.
- Potential opportunity for river trail in the future – could be with or without the plant.
- Two plants provide more resiliency.

Step 2: Asset Value And Maintenance Risks and Opportunities for Keeping DPF

Risks

- Too many individual assets at DPF that take too much operations. The GBF and DPF have the same number liquid assets.
- Much maintenance time invested at DPF relative to its size.

General

- Intermediate clarifiers are a pinch point
- Wet weather flows are challenging.
- Dry weather flow operation is stable.

Opportunities

- Final clarifiers, filters, back end of the facility are valuable,
- Blowers relatively new
- Lots of space for expansion
- Continue to use recent electrical investments and new generators
- IT systems of two plants well tied together

Step 2: Operational Considerations
Risks and Opportunities for Keeping DPF

Risks

- Wet weather is a challenge. Large loading swings cause issues.
- Final clarifiers are used for equalization, but this is operationally intensive. Formal equalization volume could alleviate operational issues during wet weather flow.
- Intermediate clarifiers are a critical bottleneck to process stability; high risk operational condition

General

Opportunities

- Flexibility is a benefit; ability to shift load to GBF from mill waste as well as 5 mgd of metro wastewater
- Stable operations at lower influent flows (fairly good resilience to swings in industrial loadings)
- Good and stable operations for normal flows

NEW WATER

GREEN BAY FACILITY & DE PERE FACILITY

50-Year Vision – Session 4

July 1, 2020

NEW Water
The brand of the Green Bay Metropolitan Sewerage District

BLACK & VEATCH

DONOHUE

Today's Goals

1. Discuss and finalize approach for incorporation of a 50-year vision
2. Finalize criteria and approach for the MUA for the Facility Plan

Looking ahead 50 years

Development of a "technological constellation" to address today and tomorrow

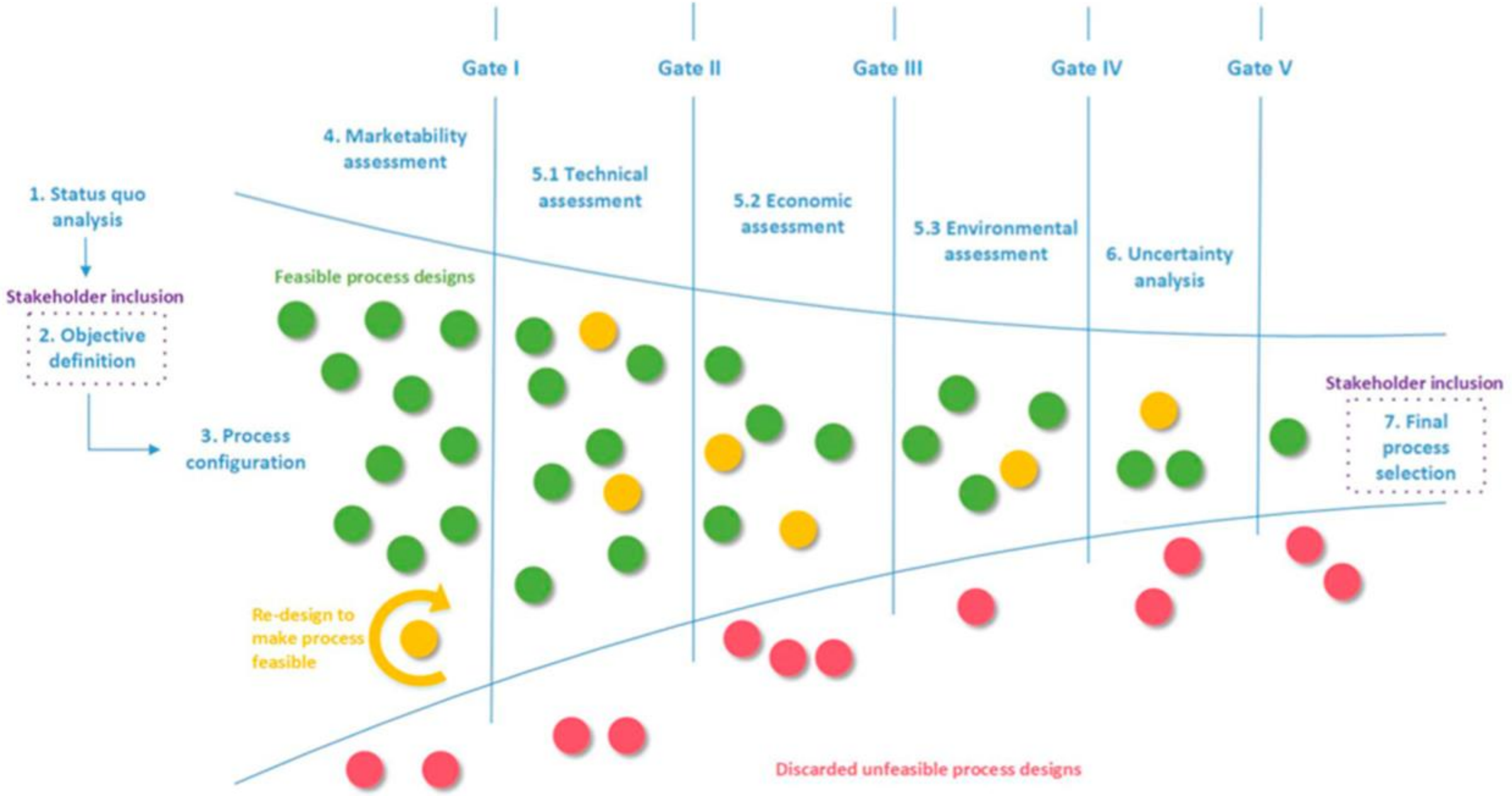
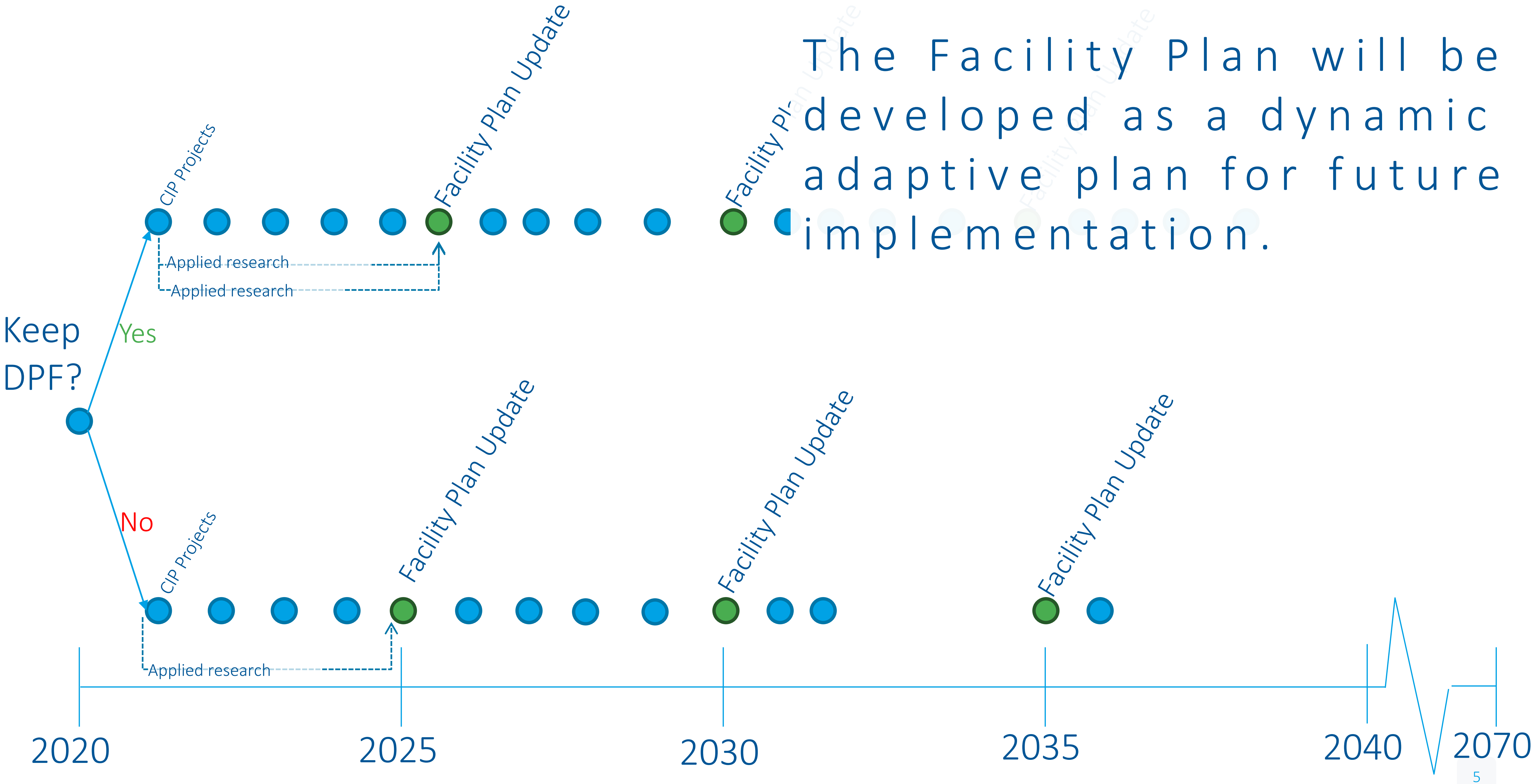


Figure 1. Funnel development and stage gating model adapted from [26] to make it specially applicable for water resource factory (WRF) process design purposes.

Kehrein et al (2020) Sustainability 12, 4168; doi:10.3390/su12104168

Quaglia, A. An Integrated Business and Engineering Framework for Synthesis and Design of Processing Networks. Ph.D.Thesis,DTUChemicalEngineering,DepartmentofChemicalandBiochemicalEngineering, Kgs. Lyngby, Denmark, 2013.

The Facility Plan will be developed as a dynamic adaptive plan for future implementation.



The NEW Water Facility Plan is a combination of facility planning and master planning

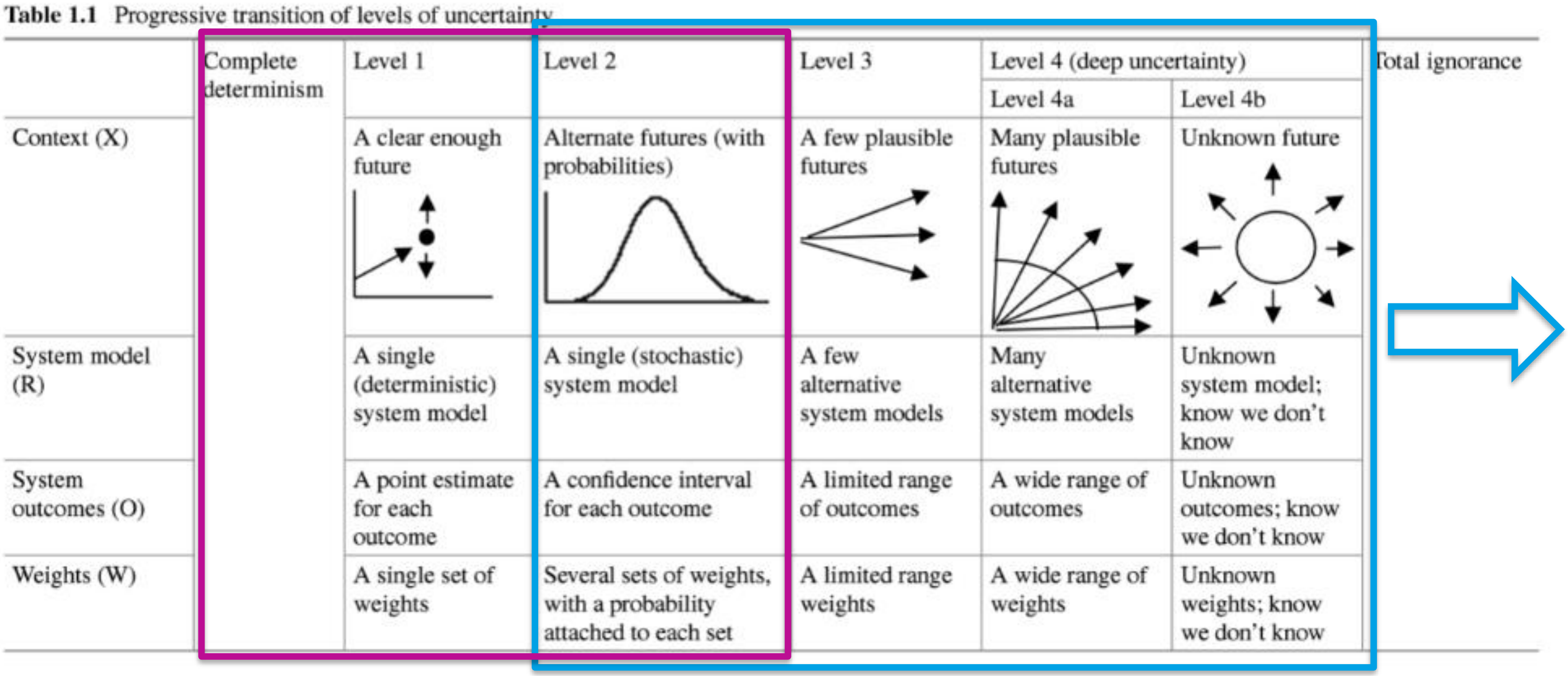


Table 1.1 Progressive transition of levels of uncertainty

	Complete determinism	Level 1	Level 2	Level 3	Level 4 (deep uncertainty)		Total ignorance
					Level 4a	Level 4b	
Context (X)		A clear enough future	Alternate futures (with probabilities)	A few plausible futures	Many plausible futures	Unknown future	
System model (R)		A single (deterministic) system model	A single (stochastic) system model	A few alternative system models	Many alternative system models	Unknown system model; know we don't know	
System outcomes (O)		A point estimate for each outcome	A confidence interval for each outcome	A limited range of outcomes	A wide range of outcomes	Unknown outcomes; know we don't know	
Weights (W)		A single set of weights	Several sets of weights, with a probability attached to each set	A limited range weights	A wide range of weights	Unknown weights; know we don't know	

Facility Planning

Master Planning

Relating this concept to a 50-year vision

1. Identify long-term risk categories and risks
2. Develop a likely response
3. Identify a facility plan opportunity

Marchau et al (2019) *Decision Making Under Deep Uncertainty*. Switzerland; Springer.

What can we identify as 50-year risks, and how does NEW Water respond (collaborative discussion)?

Risk category	Risk	Likely Response	Facility Plan Opportunity
Regulatory	New effluent compounds	Tertiary treatment/ membrane filtration	Maintain site footprint, consider as part of DPF improvements
	Effluent nitrogen limits	Aeration basin modifications	Develop plan for basin modifications
	Microplastics	Tertiary treatment/ membrane filtration	Maintain site footprint, consider as part of DPF improvements
	GHG emission regulations	Reduce use of non-renewable energy	

What can we identify as 50-year risks, and how does NEW Water respond (collaborative discussion)?

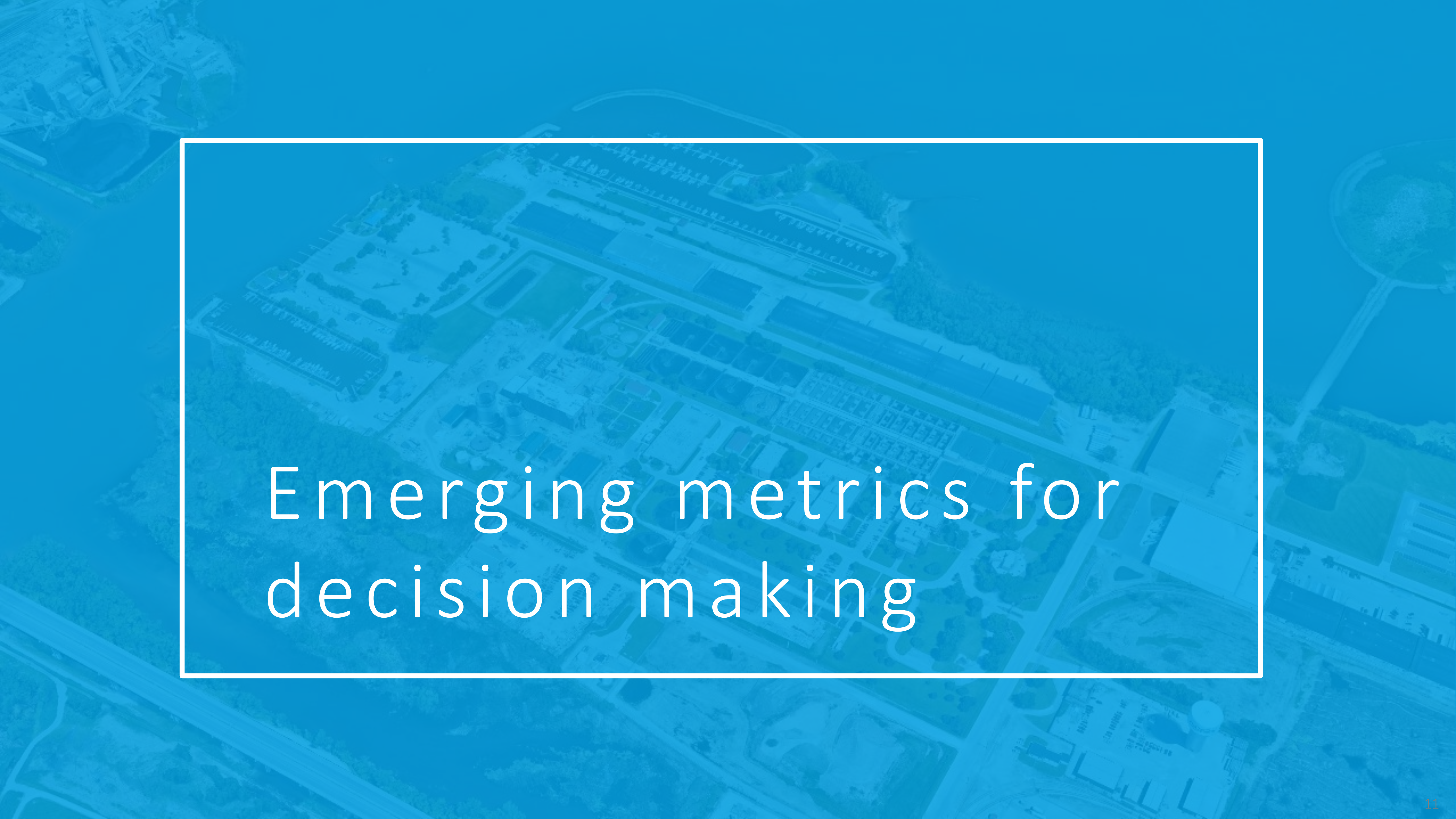
Risk category	Risk	Likely Response	Facility Plan Opportunity
Aging infrastructure	Concrete failure	Repair and maintain	Plan for concrete rehabilitation in all projects
Shift in industry / demographics	Significant reduction in organic loading	Reduction in dry weather hydraulic capacity needs	Phased implementation of organic loading projects
	Decreased water usage from conservation	Optimization of basin operation	
	Rapid population growth	Expansion of facilities	Maintain expansion flexibility

What can we identify as 50-year risks, and how does NEW Water respond (collaborative discussion)?

Risk category	Risk	Likely Response	Facility Plan Opportunity
Community changes	Increased demand for reuse water	Tertiary treatment/ membrane filtration	Maintain site footprint, consider as part of DPF improvements

What can we identify as 50-year risks, and how does NEW Water respond (collaborative discussion)?

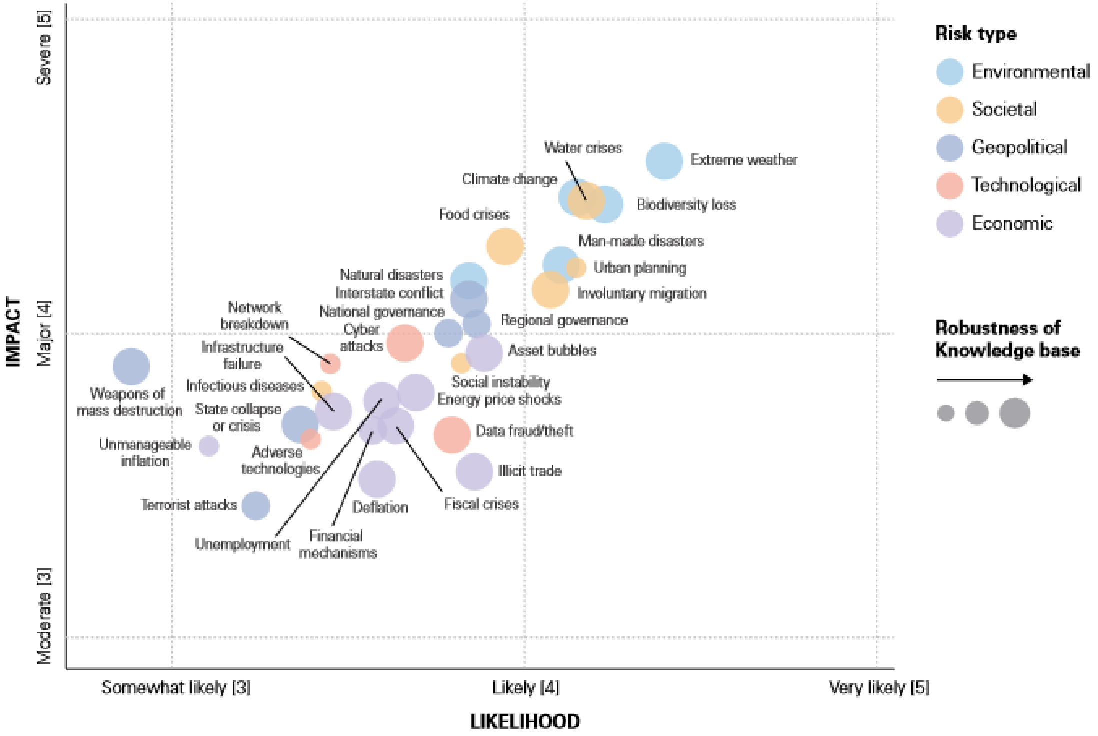
Risk category	Risk	Likely Response	Facility Plan Opportunity



Emerging metrics for decision making

UN SDGs are increasingly being considered as foundation goals

Our Future on Earth presents concepts from the Stockholm Resilience Center



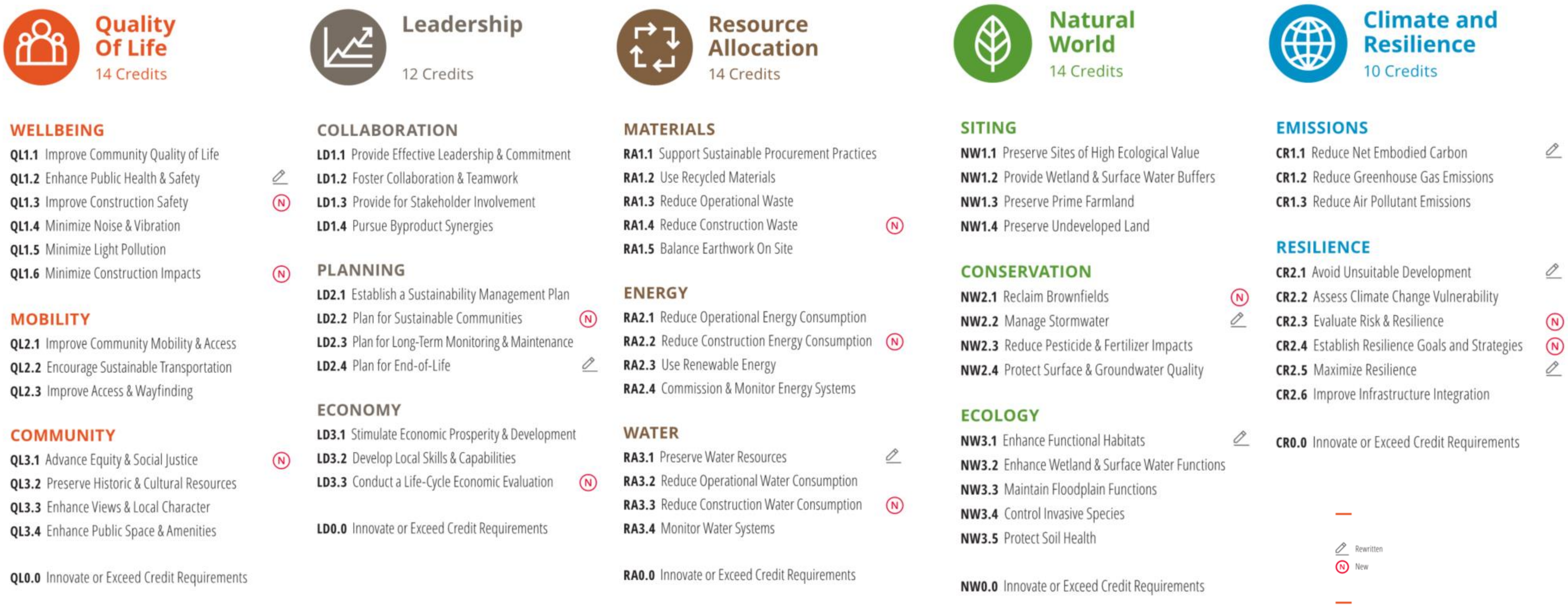
Likelihood and Impact
Mean ranked likelihood and impact of global risks and robustness of the knowledge base surrounding each risk (size of the circle) for the 30 global risks in 5 categories (colors). *Source: Future Earth Global Risks Scientists' Perception survey, 2019*

These five risks, or a subset of them, showed up repeatedly across the different questions of this survey

CLIMATE CHANGE
EXTREME WEATHER
BIODIVERSITY LOSS
FOOD CRISES
WATER CRISES

resilient approaches might be possible where the combined effects are kept in mind with every move

ISI Envision framework can provide additional metrics



Quality Of Life
14 Credits

WELLBEING
- **QL1.1** Improve Community Quality of Life
- **QL1.2** Enhance Public Health & Safety ✎
- **QL1.3** Improve Construction Safety Ⓝ
- **QL1.4** Minimize Noise & Vibration
- **QL1.5** Minimize Light Pollution
- **QL1.6** Minimize Construction Impacts Ⓝ

MOBILITY
- **QL2.1** Improve Community Mobility & Access
- **QL2.2** Encourage Sustainable Transportation
- **QL2.3** Improve Access & Wayfinding

COMMUNITY
- **QL3.1** Advance Equity & Social Justice Ⓝ
- **QL3.2** Preserve Historic & Cultural Resources
- **QL3.3** Enhance Views & Local Character
- **QL3.4** Enhance Public Space & Amenities

- **QL0.0** Innovate or Exceed Credit Requirements

Leadership
12 Credits

COLLABORATION
- **LD1.1** Provide Effective Leadership & Commitment
- **LD1.2** Foster Collaboration & Teamwork
- **LD1.3** Provide for Stakeholder Involvement
- **LD1.4** Pursue Byproduct Synergies

PLANNING
- **LD2.1** Establish a Sustainability Management Plan
- **LD2.2** Plan for Sustainable Communities Ⓝ
- **LD2.3** Plan for Long-Term Monitoring & Maintenance
- **LD2.4** Plan for End-of-Life ✎

ECONOMY
- **LD3.1** Stimulate Economic Prosperity & Development
- **LD3.2** Develop Local Skills & Capabilities
- **LD3.3** Conduct a Life-Cycle Economic Evaluation Ⓝ

- **LD0.0** Innovate or Exceed Credit Requirements

Resource Allocation
14 Credits

MATERIALS
- **RA1.1** Support Sustainable Procurement Practices
- **RA1.2** Use Recycled Materials
- **RA1.3** Reduce Operational Waste
- **RA1.4** Reduce Construction Waste Ⓝ
- **RA1.5** Balance Earthwork On Site

ENERGY
- **RA2.1** Reduce Operational Energy Consumption
- **RA2.2** Reduce Construction Energy Consumption Ⓝ
- **RA2.3** Use Renewable Energy
- **RA2.4** Commission & Monitor Energy Systems

WATER
- **RA3.1** Preserve Water Resources ✎
- **RA3.2** Reduce Operational Water Consumption
- **RA3.3** Reduce Construction Water Consumption Ⓝ
- **RA3.4** Monitor Water Systems

- **RA0.0** Innovate or Exceed Credit Requirements

Natural World
14 Credits

SITING
- **NW1.1** Preserve Sites of High Ecological Value
- **NW1.2** Provide Wetland & Surface Water Buffers
- **NW1.3** Preserve Prime Farmland
- **NW1.4** Preserve Undeveloped Land

CONSERVATION
- **NW2.1** Reclaim Brownfields Ⓝ
- **NW2.2** Manage Stormwater ✎
- **NW2.3** Reduce Pesticide & Fertilizer Impacts
- **NW2.4** Protect Surface & Groundwater Quality

ECOLOGY
- **NW3.1** Enhance Functional Habitats ✎
- **NW3.2** Enhance Wetland & Surface Water Functions
- **NW3.3** Maintain Floodplain Functions
- **NW3.4** Control Invasive Species
- **NW3.5** Protect Soil Health

- **NW0.0** Innovate or Exceed Credit Requirements

Climate and Resilience
10 Credits

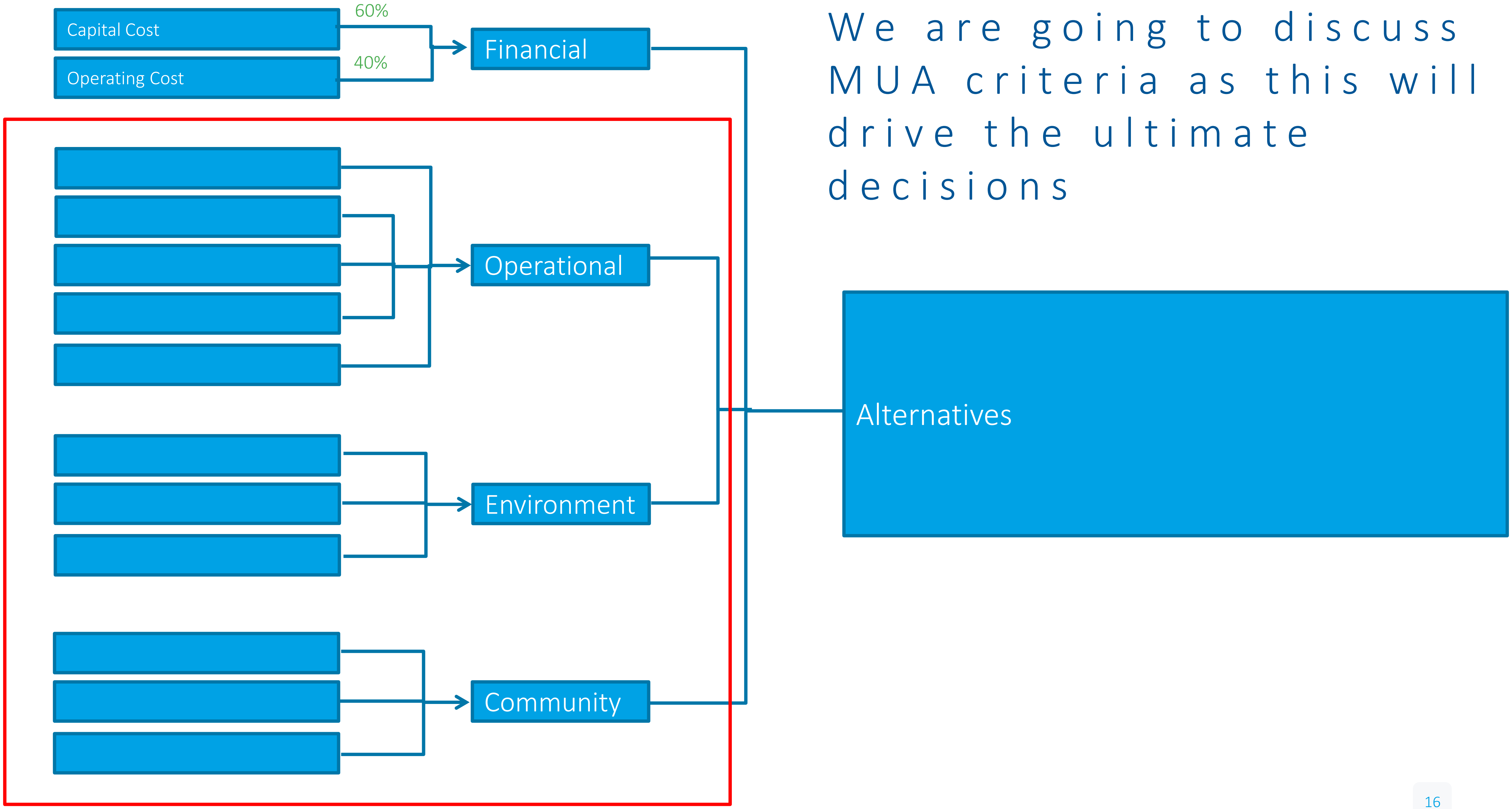
EMISSIONS
- **CR1.1** Reduce Net Embodied Carbon ✎
- **CR1.2** Reduce Greenhouse Gas Emissions
- **CR1.3** Reduce Air Pollutant Emissions

RESILIENCE
- **CR2.1** Avoid Unsuitable Development ✎
- **CR2.2** Assess Climate Change Vulnerability
- **CR2.3** Evaluate Risk & Resilience Ⓝ
- **CR2.4** Establish Resilience Goals and Strategies Ⓝ
- **CR2.5** Maximize Resilience ✎
- **CR2.6** Improve Infrastructure Integration

- **CR0.0** Innovate or Exceed Credit Requirements

✎ Rewritten
Ⓝ New

NEW Water MUA



We are going to discuss MUA criteria as this will drive the ultimate decisions

Several questions to debate today

- Is resilience and adaptability an *evaluation criteria* or a *non-negotiable, foundational goal*?
- Should a ranking be used for criteria, or a binary (yes/no) approach?
- Are there broad, global categories that will change recommended decisions?

MUA Tool review