Taking Your Master Plan to the Next Level

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CH2M HILL

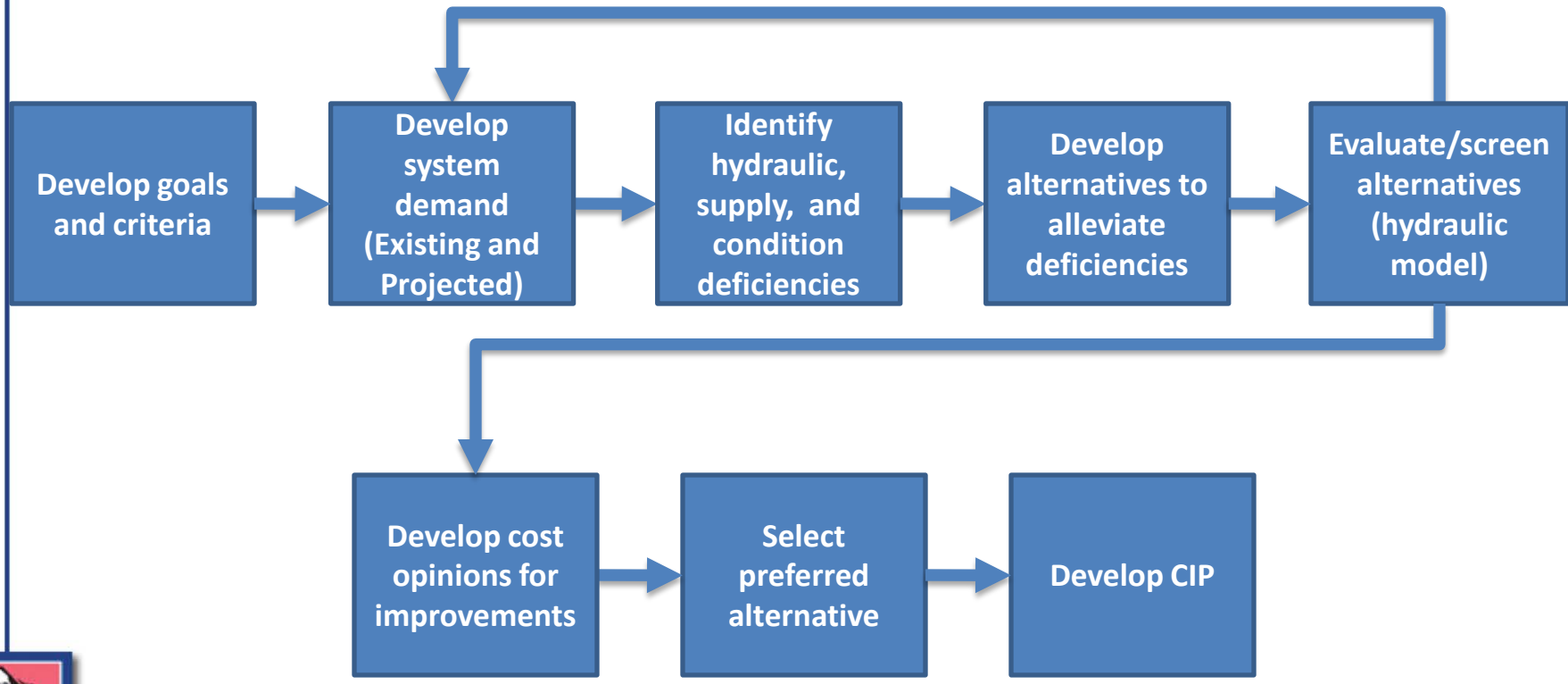
Taking Your Master Plan to the Next Level: What Does that Mean?

- Enhancement of the master planning process
  - Condition assessment/Asset management
  - Energy Management
  - Multi-variable evaluation of improvements:
    - Includes non-cost and other aspects of improvements
  - Consideration of utility management and succession planning
- Does not replace existing efforts
- Expands the analysis by looking at the data with a different perspective
- **Allows you to get more return on your planning investment**

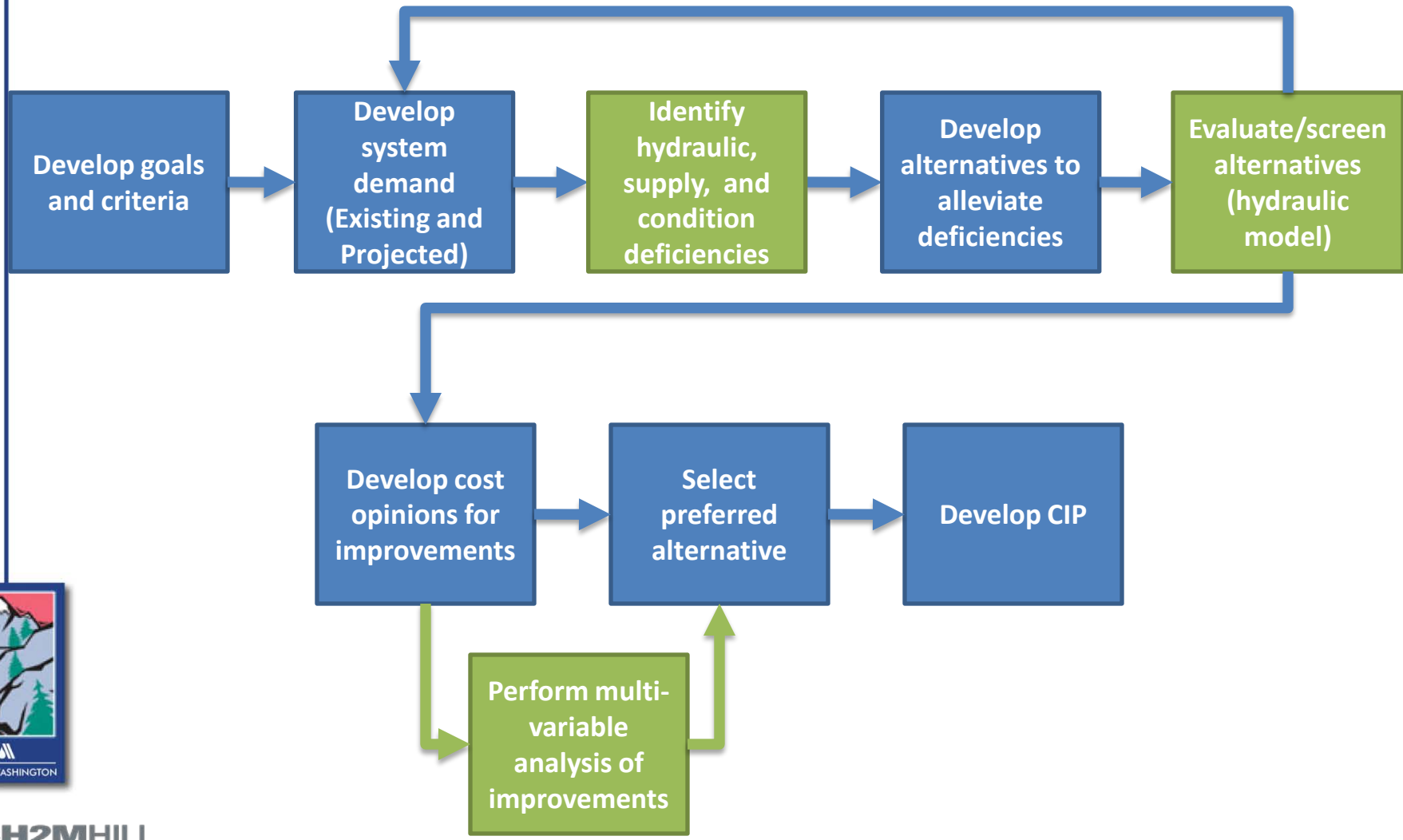
Agenda/Outline

- Review traditional Plan requirements
- Present tools for expansion of analysis
  - Condition Assessment: Consequence/Likelihood of Failure
  - Energy Management
  - Multi-variable Evaluation of Improvements
- Demonstrate application of tools

Traditional Plan Process



The Next Generation Master Plan



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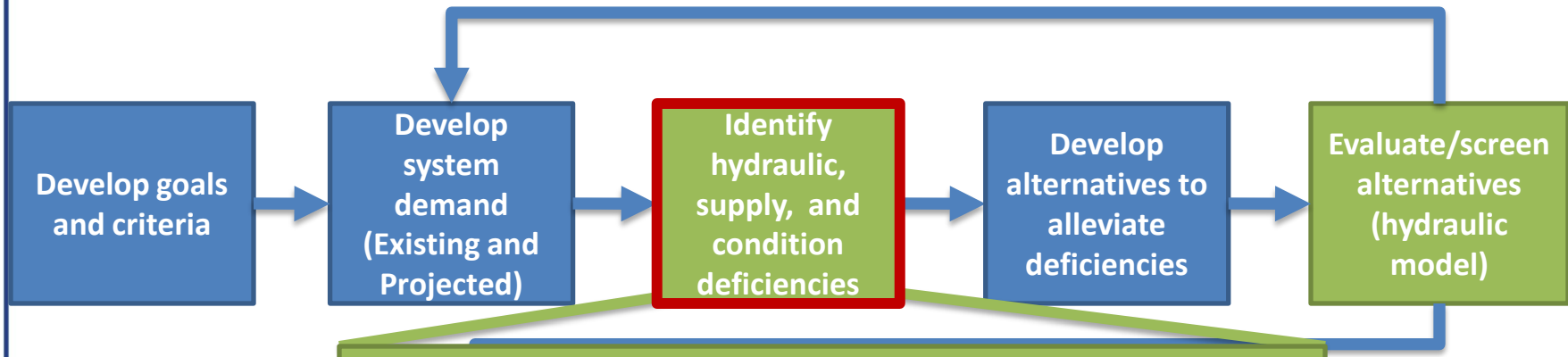
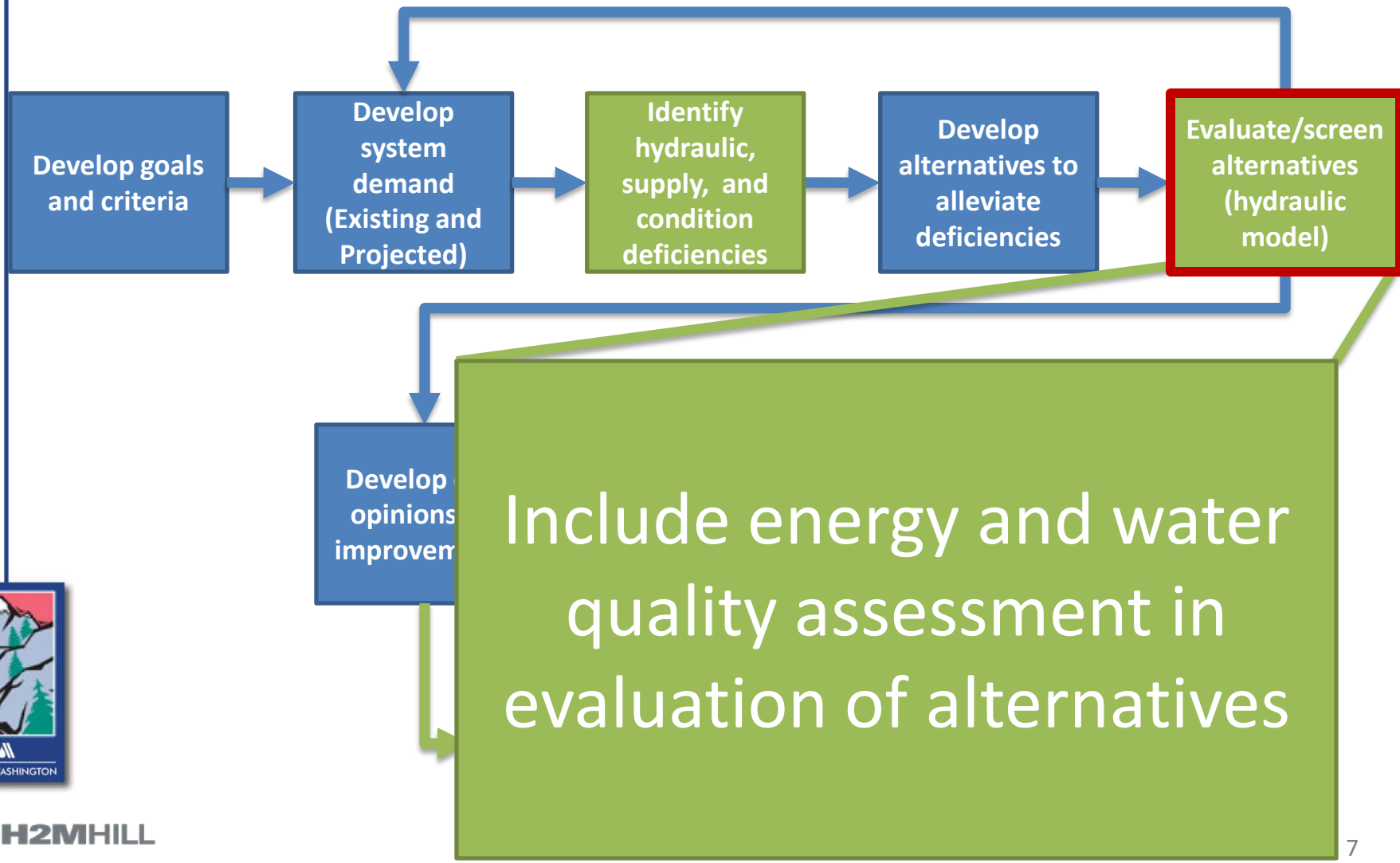
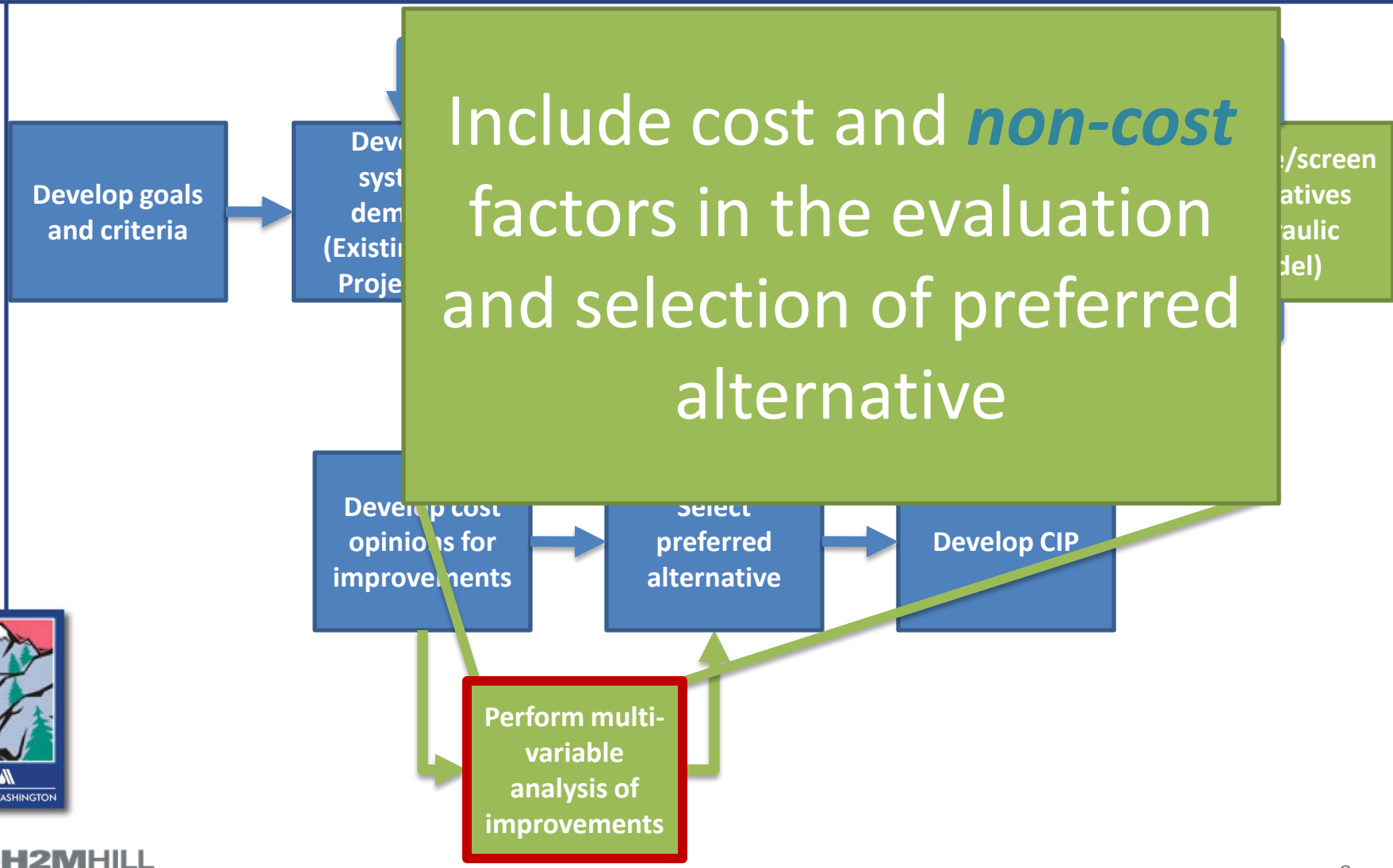


Include condition assessment to evaluate the consequence and likelihood of failure of system components

The Next Generation Master Plan



The Next Generation Master Plan



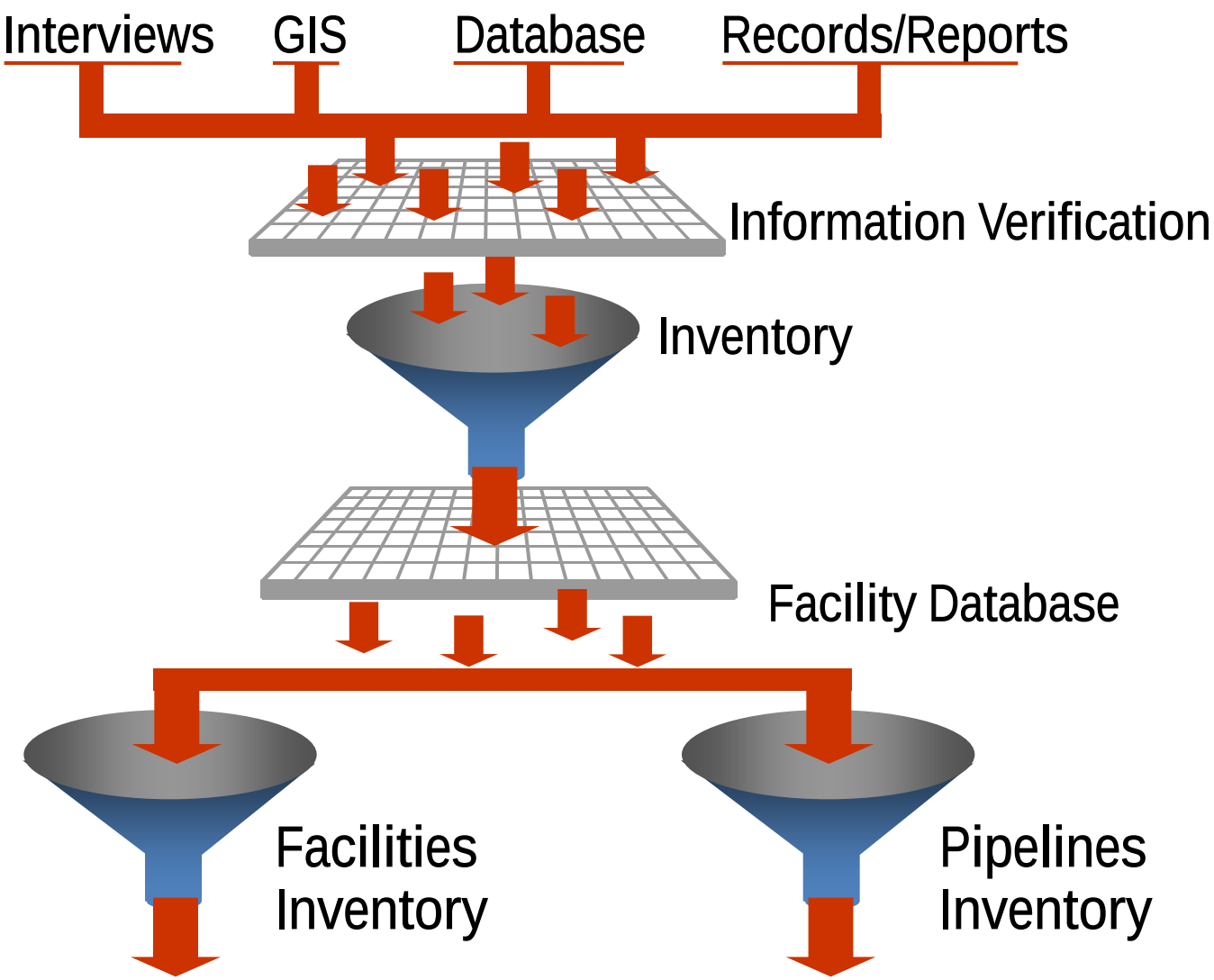
Include cost and ***non-cost*** factors in the evaluation and selection of preferred alternative

Condition Assessment/ Asset Management

Condition Assessment Implementation

- Asset identification
- Risk assessment
- Condition monitoring
- Mode of failure analysis
- Data collection
- Data interfacing
- Maintenance analysis and management

Building the Asset Inventory



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Condition Assessment: Consequence and Likelihood of Failure

- What are the risks of ***not*** maintaining your assets
  - Above ground assets
    - Pump stations, storage tanks, treatment facilities, hydrants
  - Buried assets
    - Pipes, valves
- To manage your assets
  - You must know consequence of each asset's failure to your organization
  - How likely is that asset to fail over time
- Approach described here empowers staff to ***proactively*** manage your utility's assets

Classic Risk Equation

Risk = *f* (consequence x likelihood)

How severe are the consequences of asset failure?

- Loss of service
- Environmental
- H & S implications
- Community disruption
- Damage to property
- Loss of revenue
- Regulatory compliance
- Service agreements
- Public image

How likely is it for the asset to fail?

- Condition of asset
- Performance of asset
- Effectiveness of O&M protocols
- Available inventory
- Capacity & utilization
- Functionality

Facilities Evaluation: Consequence Matrix

Consequence of Failure Determination					Water
Consequence Category	Weigh	Negligible = 1	Low = 4	Moderate = 7	Critical = 10
Service reliability	0.17	Pressure >45 psi. No unplanned service interruptions. No impact on reserve.	Pressure <45psi >30psi. <250 services effected. Possible impact on reserve.	Pressure <30 psi. Service interruption affecting 250-500 services. Definite impact on reserve.	Zero pressure. Service interruption >500 services. Fire volume reserve not met.
Financial impact on utility	0.15				
Ability to return to service	0.13				
Compliance with regs and permits	0.20				
Health & Safety of employee and public	0.20				
Disruption to the community Public Image	0.15				

Facilities Evaluation: Likelihood Matrix

Likelihood of Failure Determination						Water
Likelihood Category	Weight	Negligible = 1	Minor = 2	Moderate = 4	Major = 7	Critical = 10
Condition Assessment Overall	0.40	Very good. Only normal maintenance required. (Condition Grade 1)	Good. Minor defects only. ~5% needs maintenance. (Condition Grade 2)	Fair. Significant maintenance required. ~10 to 20% needs maintenance. (Condition Grade 3)	Poor. Significant renewal required. ~20 to 40% needs renewal. (Condition Grade 4)	Very poor. >50% requires replacement. Asset unserviceable. Condition Grade 5)
Capacity and Utilization	0.28					
Effective Operating Protocols	0.12					
Reliability	0.16					
Inventory Redundancy	0.04					

Assign consequence and likelihood scores to assets

ASSET	CONSEQUENCE							LIKELIHOOD						RISK	
Pump Station	Safety of public and employees	Financial impact on Utility	Public confidence	Regulatory compliance	Service Delivery	Consequence Score	Consequence Rank	Physical Condition	Performance (i.e., capacity, utilization and functionality of asset)	O&M Protocols (i.e., SOPs)	Planned maintenance as a % of total maintenance	Likelihood Score	Likelihood Rank	Risk Score	Risk Rank
Weight	0.15	0.15	0.20	0.25	0.25			0.45	0.30	0.05	0.20				
BELMONT	1	7	10	4	10	6.7	1	1	1	7	2	1.5	86	10.1	13
RANDOLPH	1	1	4	1	1	1.6	65	2	4	7	4	3.3	6	5.2	58
BELLS	1	7	7	1	10	5.4	4	1	1	7	2	1.5	86	8.0	30
ASTOR	4	1	4	1	7	3.6	28	2	1	7	4	2.4	21	8.3	28
RAVENSVIEW	4	1	4	1	4	2.8	41	2	1	7	4	2.4	21	6.6	48
LONGWOOD	7	7	1	1	1	2.8	39	2	1	7	4	2.4	21	6.6	46
GLENBROOK	4	7	7	1	7	5.1	7	2	1	7	4	2.4	21	11.9	6
MAGNOLIA	4	7	7	4	4	5.1	7	1	4	7	4	2.8	9	14.1	4
FRANKLIN	7	4	4	1	7	4.5	14	1	1	7	4	1.9	42	8.5	27
TEMPLE	4	7	4	1	4	3.7	19	2	1	7	4	2.4	21	8.7	25
EAST PASS	1	1	1	1	1	1.0	68	1	1	7	4	1.9	42	1.9	88
SPRINGS	4	1	1	1	1	1.5	66	1	1	7	4	1.9	42	2.8	86
FORREST RIDGE	1	1	1	1	1	1.0	68	1	4	7	4	2.8	9	2.8	84
MANTON	10	7	7	1	4	5.2	5	2	10	7	4	5.1	1	26.3	1
CASTLEWOOD	1	1	1	1	1	1.0	68	1	4	7	4	2.8	9	2.8	84
CANTERCLUB	4	7	4	1	4	3.7	19	1	1	7	4	1.9	42	7.0	36
OAKLAND	4	7	1	1	4	3.1	34	1	4	7	4	2.8	9	8.7	26
BYERS	1	1	1	1	1	1.0	68	1	1	7	4	1.9	42	1.9	88
COOPER	1	1	4	1	4	2.4	48	1	1	7	4	1.9	42	4.5	62
BRINK FALLS	1	1	1	1	4	1.8	58	1	1	7	4	1.9	42	3.3	76
MONTROSE	1	1	7	1	4	3.0	36	2	1	7	4	2.4	21	6.9	43

Example

Calculate relative risks of assets and prioritize

Risk = (consequence x likelihood)

How severe are the consequences of asset failure?

How likely is it for the asset to fail?

ASSET	CONSEQUENCE	LIKELIHOOD	RISK SCORE
MANTON	5.2	5.1	26.3
SINGLETON	5.2	4.0	20.8
UNION	3.5	5.1	17.7
MAGNOLIA	5.1	3.4	17.2
RIVERSIDE	5.1	3.2	16.2
GLENBROOK	5.1	2.6	13.1
BLUEBELL	3.9	3.1	12.1
HUNT CLUB	4.8	2.4	11.2
OAK CHASE	4.2	2.7	11.0
PLUM	4.5	2.4	10.5
REEVES	4.5	2.4	10.5
BELK	3.7	2.7	9.8
PLAINVIEW	5.1	1.9	9.6
EAGLE NEST	6.3	1.5	9.4
BELLINGS	3.9	2.4	9.0
ASTOR	3.6	2.4	8.3
DERBY PLACE	3.7	2.2	8.1

Example

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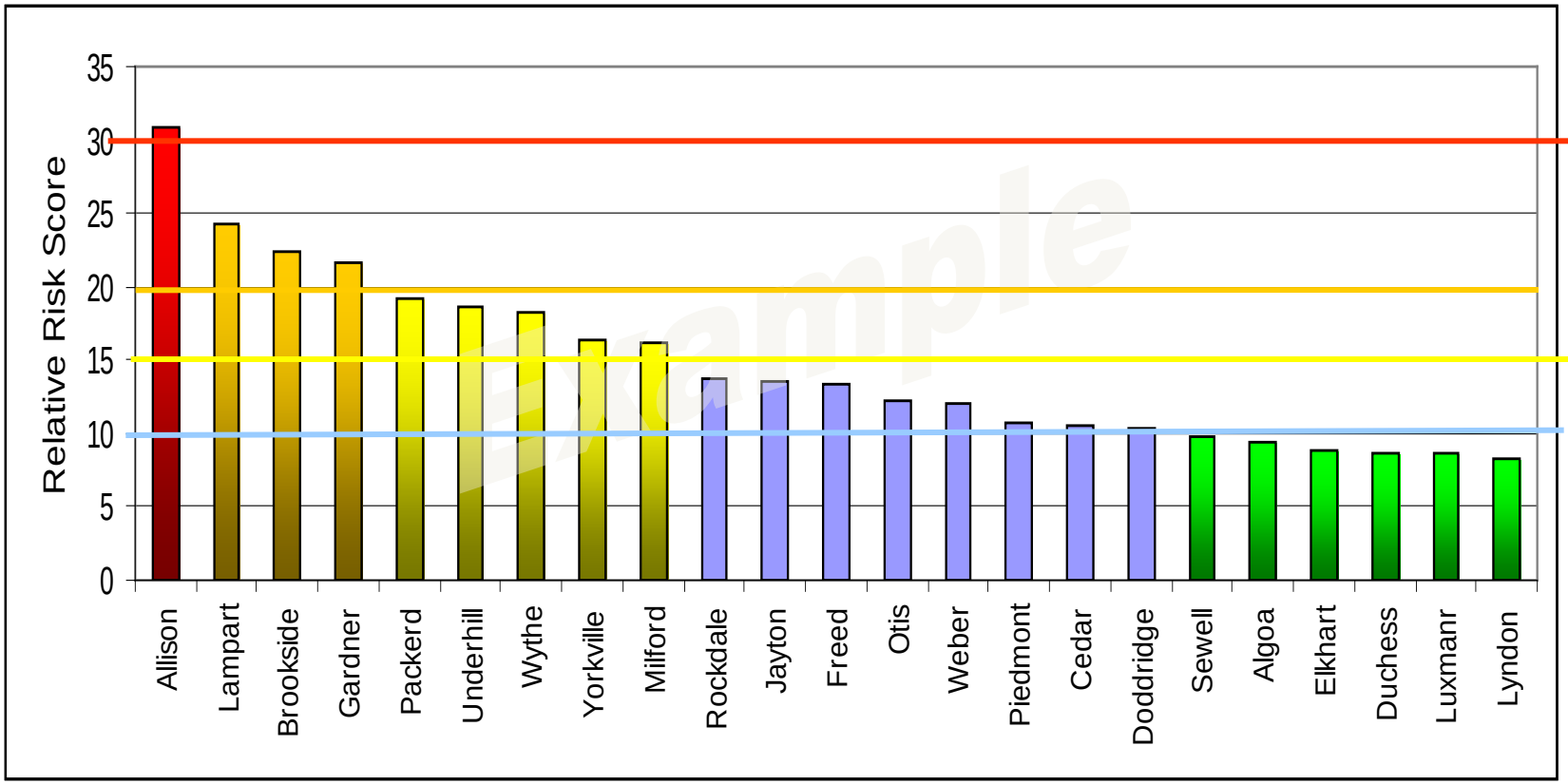
Example of risk ranking at component level of hierarchy



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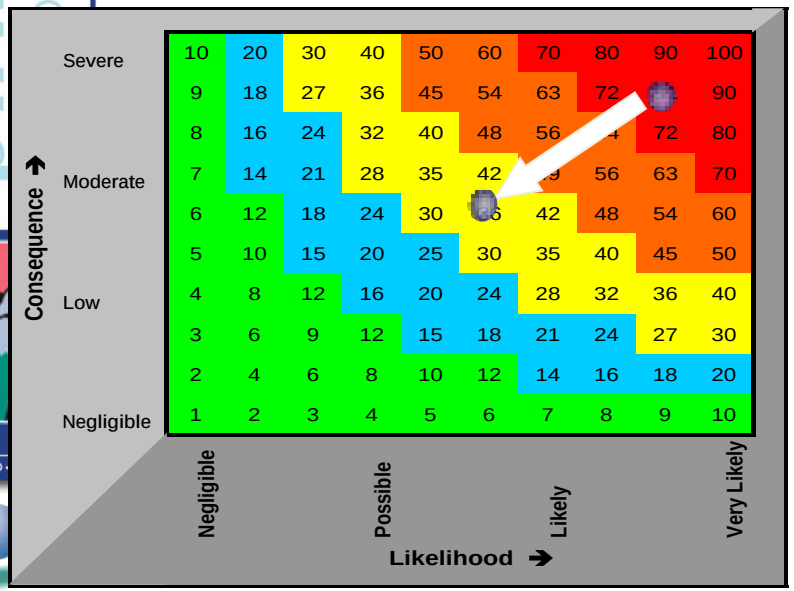
Overcoming Risk: Develop and Rank Improvement Options

Rehabilitation
Replacement

Operating procedures
Maintenance procedures

Demand management
Reduce LOS & educate
Improve response & recovery

Assess risk reduction for identified options



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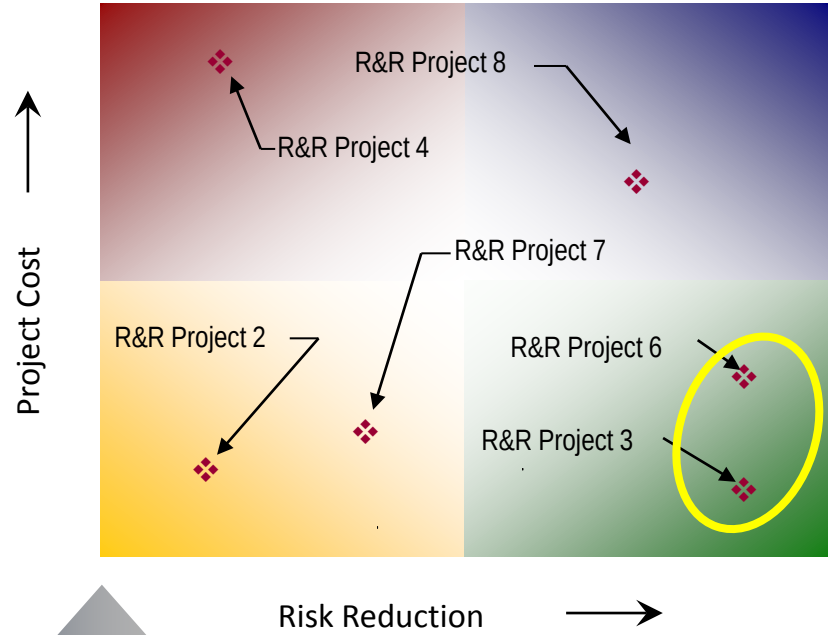


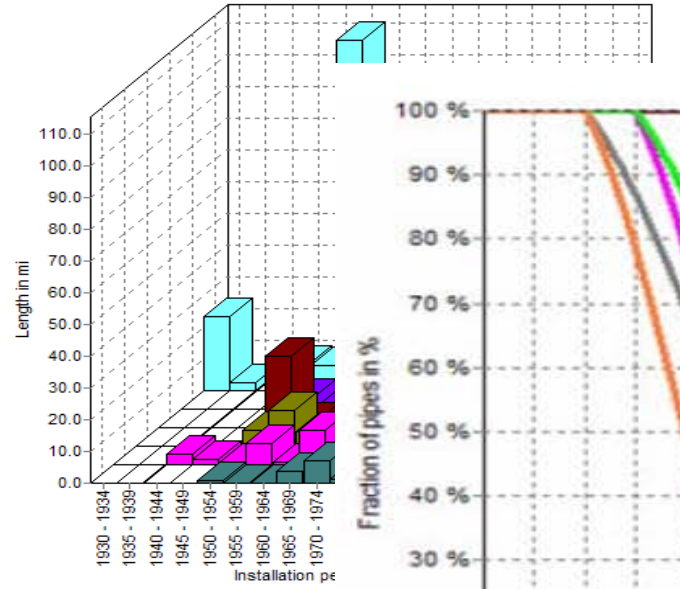
Rank options by:

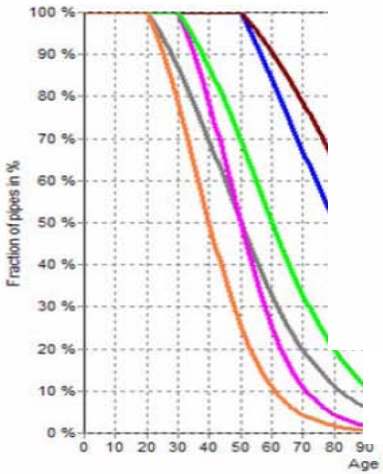
$$\frac{\text{Risk Reduction}}{\text{Cost}}$$

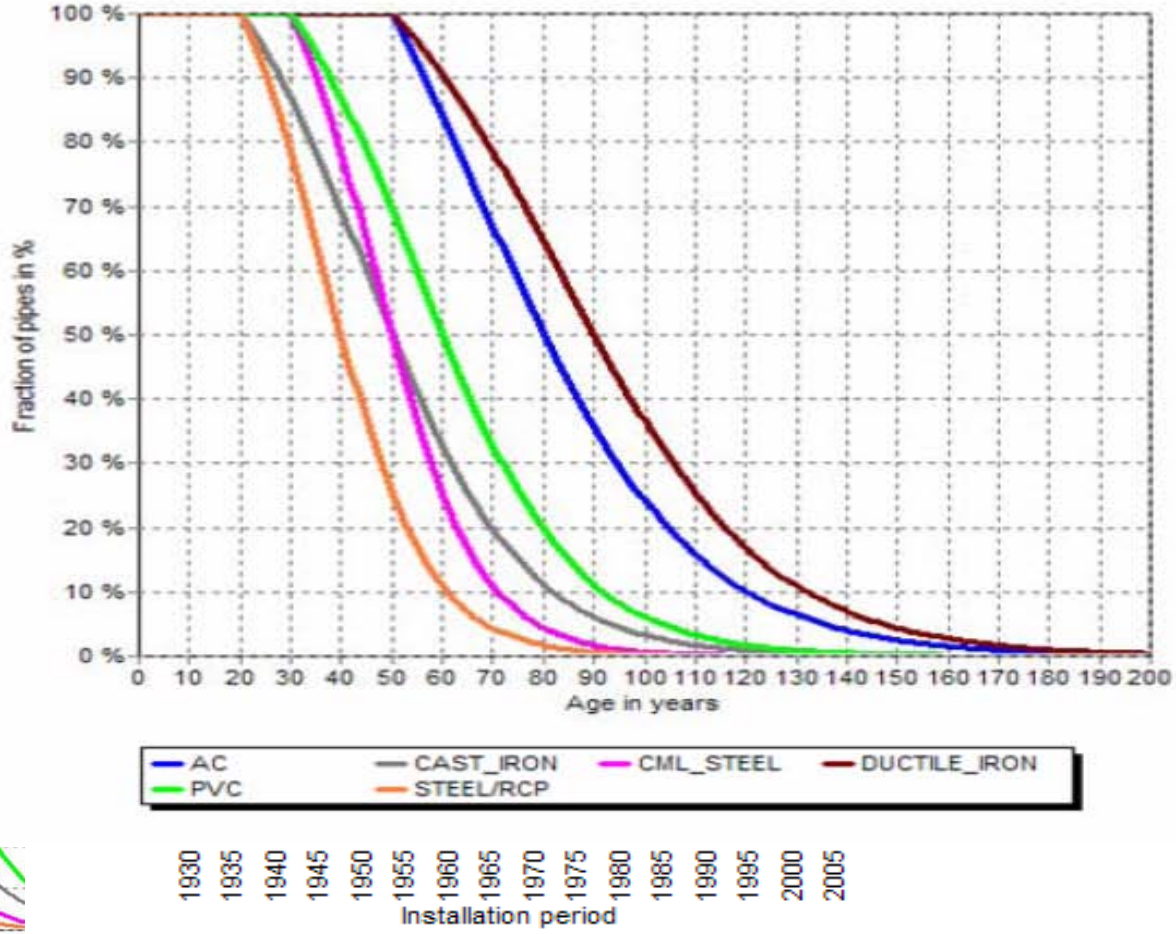
Pipeline Inventory

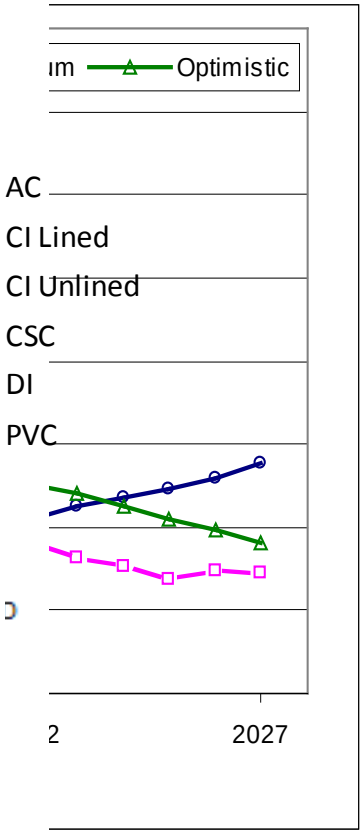
- Pipelines are assets, too and previous approach for risk and consequence of failure can be applied to pipelines as well
- Another approach is to develop a renewal program based on performance and other factors such as pipe age and pipe material
- Can use GIS based tools or apply tools available as an extension to hydraulic modeling software

Condition Assessment: Pipelines Inventory, Renewal Program



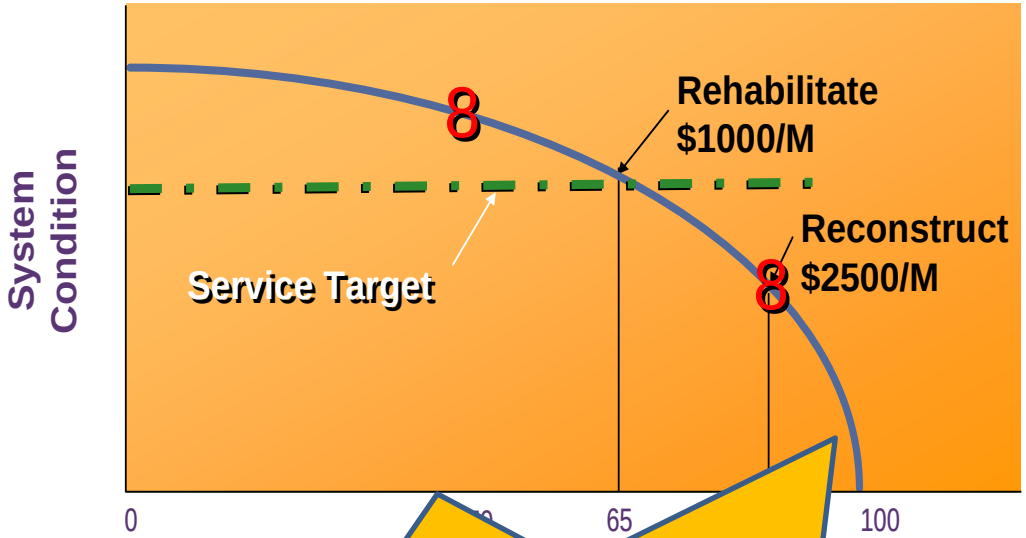






Condition Assessment: Pipelines Inventory, Renewal Program

- Infrastructure and population age in a similar way.
- Elements that fail and no longer meet the requirements constitute an annual demand for renewal.
- For renewed elements, the aging process begins an over again.



Timely capital renewal can reduce total capital costs

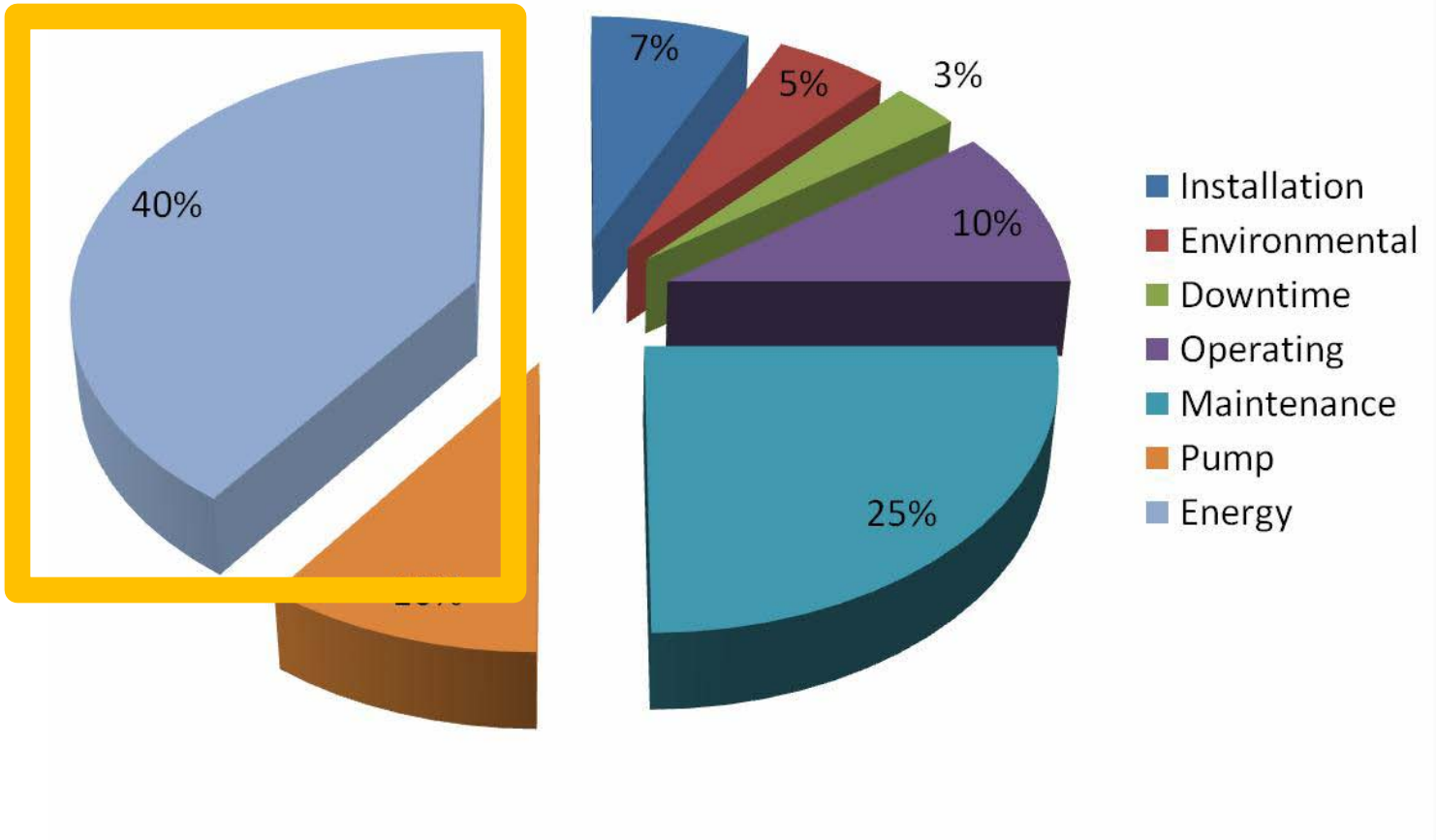
Asset Management Shouldn't Scare You

Contrary to what you may have heard:

- Asset management doesn't require an upheaval of a utility's organization
- Asset management is a practical, knowledge-based approach for improving what utilities have always done
- Each utility can proceed at its own pace, with whatever methods and tools are appropriate for its needs and resources
- Each utility can begin asset management with any part of its infrastructure, anywhere in the system

Advanced Modeling: Energy Management/ Water Quality

Total Cost of a Pump



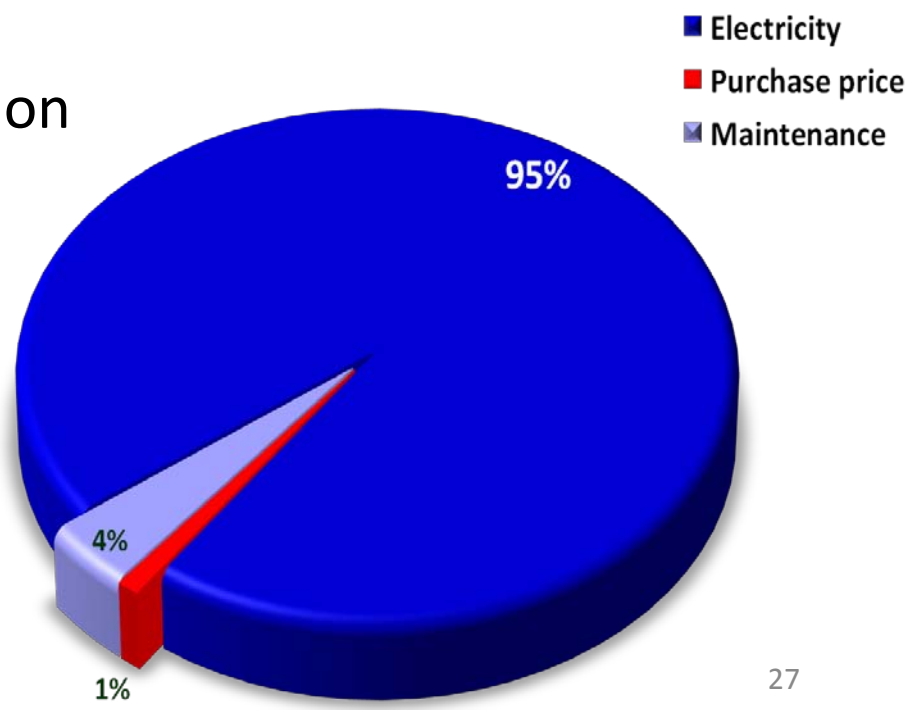
Energy Management Project Drivers

- Need to reduce energy use (and GHG emissions)
- Rising Energy Costs
- Must manage energy cost in real-time rate environment
- Must maintain and improve Water Quality
  - Improve management of tank turnover
- Need to operate more consistently to best utilize & protect assets
  - Utilize holistic optimizer that will not breach system constraints
- Need to minimize water waste
- Utilize tool that adapts and to changing conditions in real-time allowing more efficient management production and distribution

Key Cost Reduction Techniques

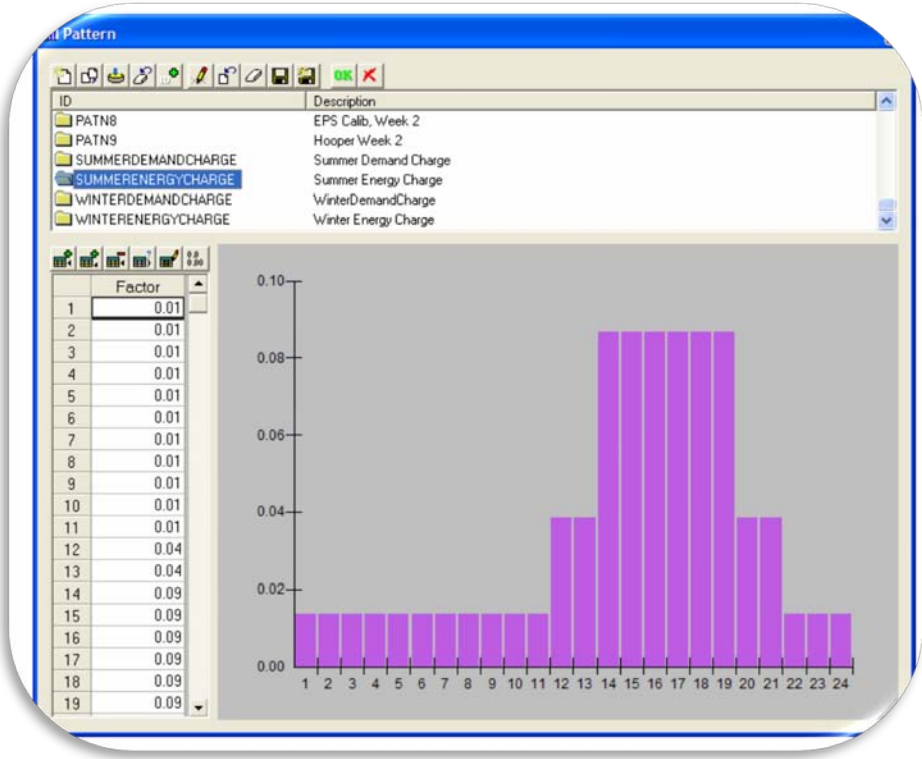
- Moving Energy (kWh) in Time
- Reducing Demand Charges (kW)
- Generating Efficiency Gains
  - Using most efficient combination of pumps and running them
- Selection of lowest production cost sources of water
- Selection of lowest cost transport path for water

Pump lifecycle costs



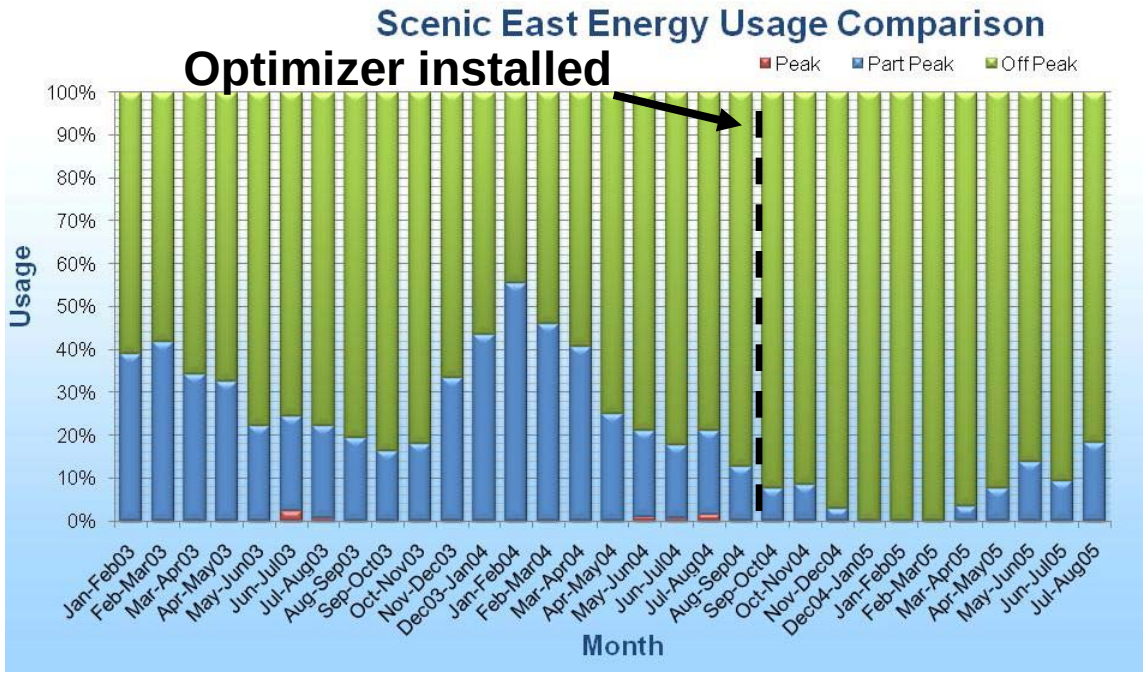
Incorporating Energy Management into Capital Planning: Hydraulic Model

- Apply off the shelf modeling software with an EPS model, pump efficiency curves, demand and energy charge curves between various seasons
- Use advanced optimization with application of software from Optimatics



Incorporating Energy Management into Capital Planning: Real Time Operation

- Development and application of an energy management software tool to use



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- Several utilities have utilized this software and benefited significantly from peak demand reduction and lowest cost source selection

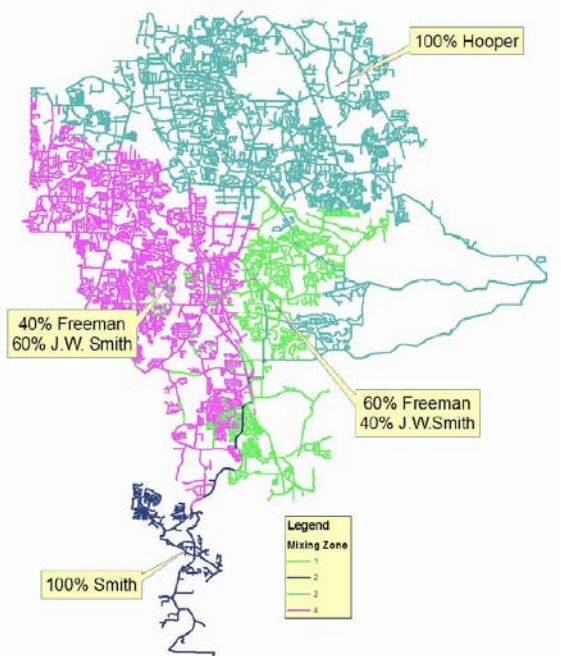
What would an Optimization Application do?

- Deliver water to customers as first priority
- Interface to your SCADA
- Schedule pumps and valves for next 48 hours to achieve lowest overall cost
- Run in real time – Like an Autopilot
- Minimize energy costs
- Maximize energy efficiency of pumps
- Improve water quality through turn-over and flow smoothing
- Recalculate new solution every 1/2-hour adapting to demand and other system changes

Hydraulic Analysis: Water Quality

Challenges

- Distribution system expansion can increase water age
- Disinfection residual maintenance
- Blending of water sources

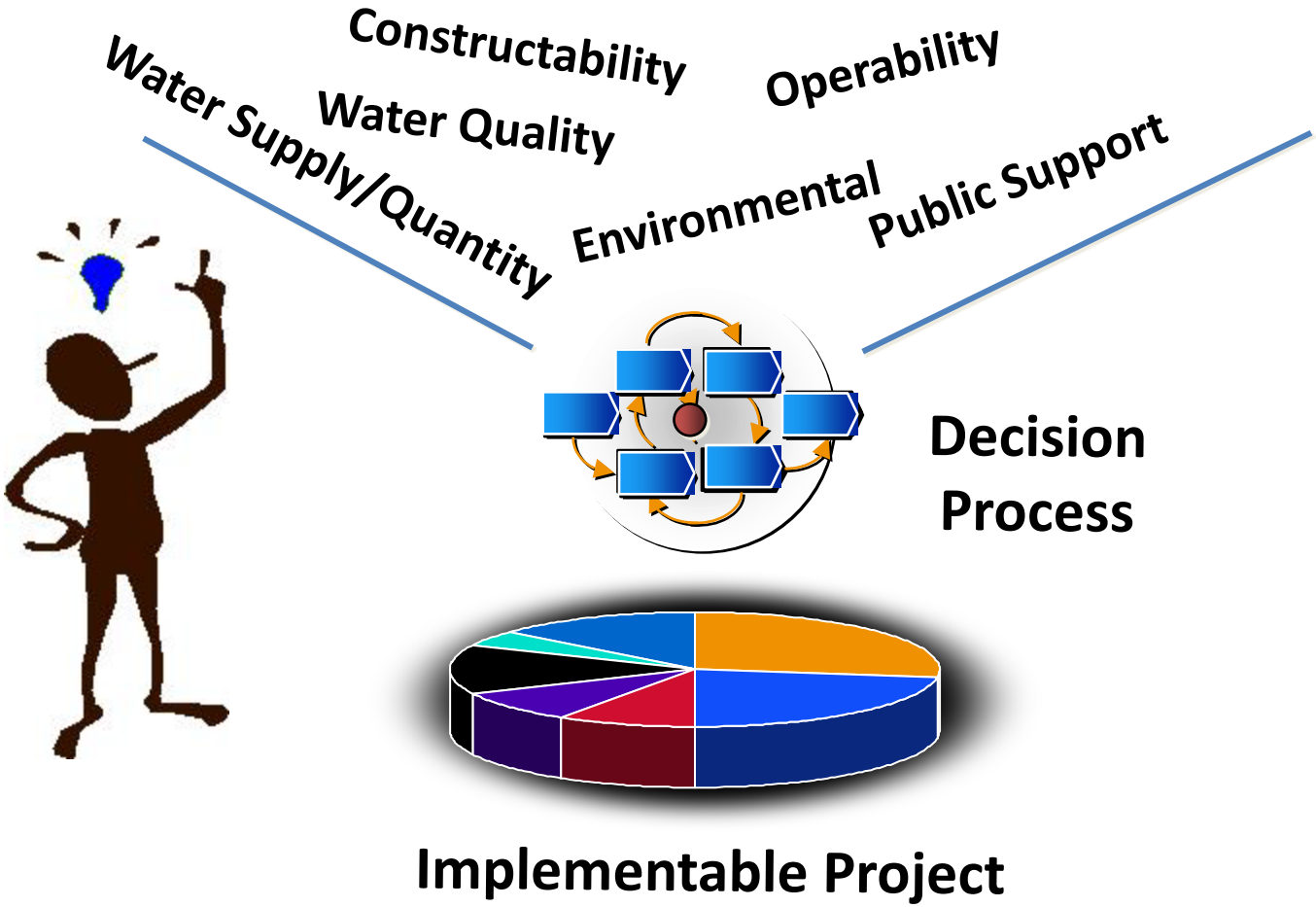


Opportunities

- WQ modeling will identify potential problem areas, booster chlorine sites and many other applications
- WQ modeling of various alternatives or operating schemes can help select improvement project
- Real time monitoring leverages staff and offers additional water quality model applications

Project Selection and Project Prioritization: Multi-Variable Assessment

Decision Process Needed to Consider Multiple Criteria



Multi-Variable Assessment

- Provides a mechanism to gain stakeholder involvement in evaluating options and focuses on what is important to the stakeholder group
- Multi-variable assessment can be applied to the evaluation of any feature being evaluated for system improvement/ enhancement
  - Development, Annexation, Facility Improvements

Multi-Variable Assessment

STEP 1 - Please rate the importance of each criterion. This will be used to weight the criteria.

[redacted]

STEP 2 - To compare the alternatives, pleas ... er
both alternatives.

STEP 3 - Scoring Alternatives

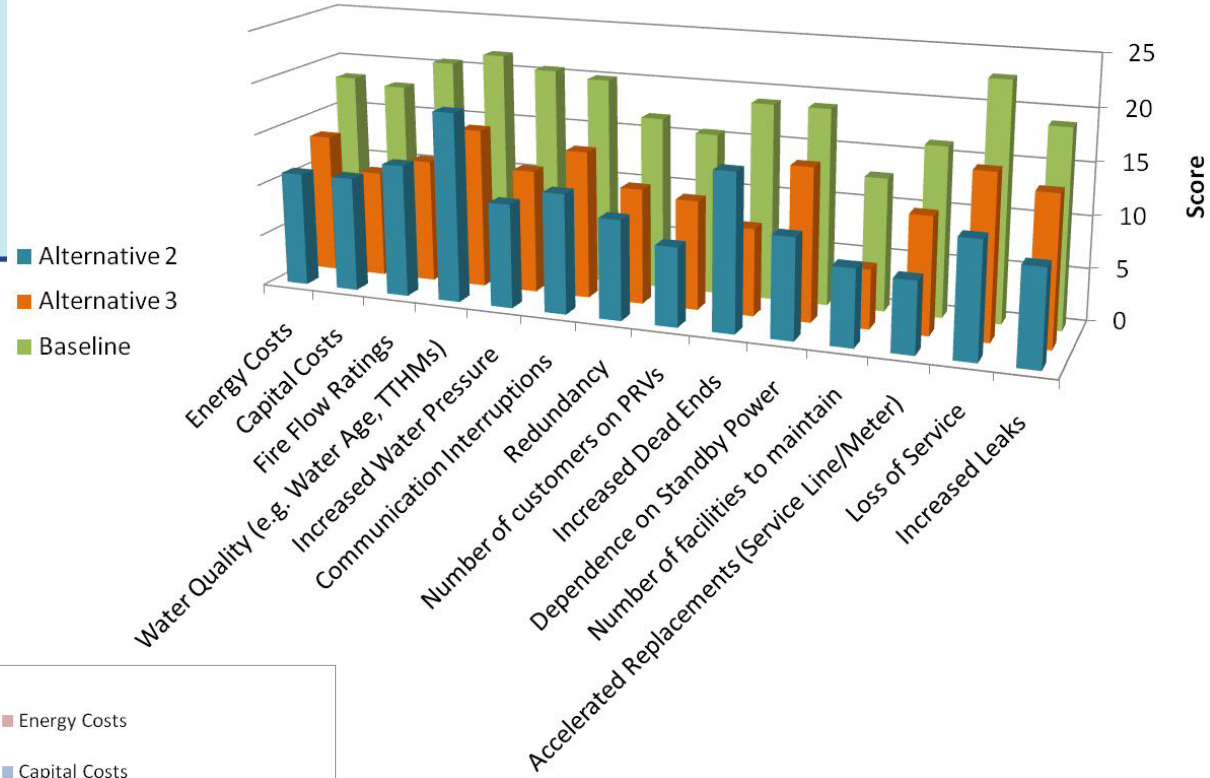
Alternative 2 (New Forest Park subzone) Score #1 Score #2

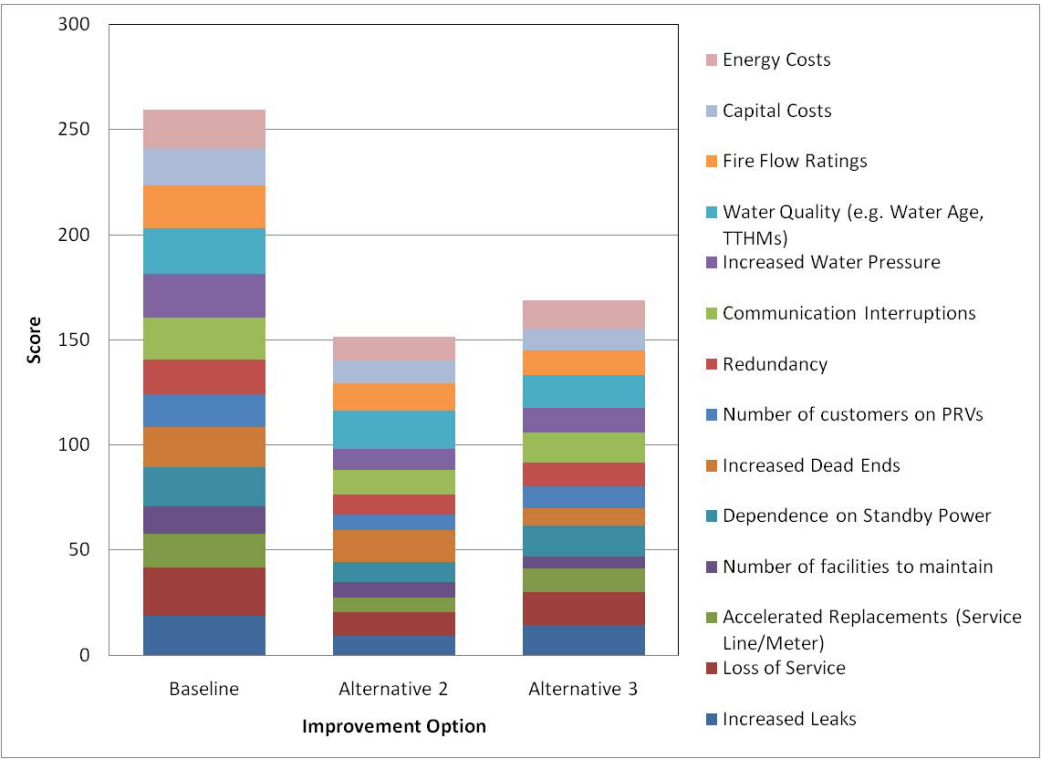
STEP 4 - Weighted Scoring

	Attribute	A Average Criteria Avg Pts	B	C = A x B Baseline	D Numerical Ranking of Concern: Alternative 2 Avg Pts	E = A x D Alternative 2	F Alternative 3 Avg Pts	G = A x F Alternative 3
1 MAINTENANCE IMPACTS								
1	Increased Leaks	3.8	5.0	18.9	2.4	9.23	3.8	14.27
2	Loss of Service	4.6	5.0	22.8	2.4	11.14	3.4	15.69
3	Accelerated Replacements (Service Line/Meter)	3.3	5.0	16.3	2.1	6.86	3.4	11.19
4	Number of facilities to maintain	2.6	5.0	12.8	2.9	7.38	2.2	5.68
5	Dependence on Standby Power	3.8	5.0	18.9	2.6	9.65	3.9	14.69
6	Increased Dead Ends	3.8	5.0	18.9	4.0	15.11	2.2	8.40
7	Number of customers on PRVs	3.1	5.0	15.6	2.4	7.60	3.4	10.50
8	Redundancy	3.3	5.0	16.7	2.9	9.63	3.3	11.11
9	Communication Interruptions	4.0	5.0	20.0	2.9	11.56	3.6	14.22
2 REGULATORY/CUSTOMER SERVICE								
10	Increased Water Pressure	4.1	5.0	20.6	2.4	10.05	2.9	11.88
11	Water Quality(e.g. Water Age, TTHMs)	4.3	5.0	21.7	4.2	18.30	3.6	15.41
12	Fire Flow Ratings	4.1	5.0	20.6	3.1	12.79	2.9	11.88
3 COST		0						
13	Capital Costs	3.6	5.0	17.8	3.1	11.06	2.9	10.27
14	Energy Costs	3.7	5.0	18.3	3.0	11.00	3.7	13.44
	TOTAL	52	70	260	41	151	45	169

13	Capital Costs	3	3	2	4	4	2	2	3	3	2.9
14	Energy Costs	3	3	4	4	4	4	4	4	3	3.7
										Avg	3.2
										Total	45.2

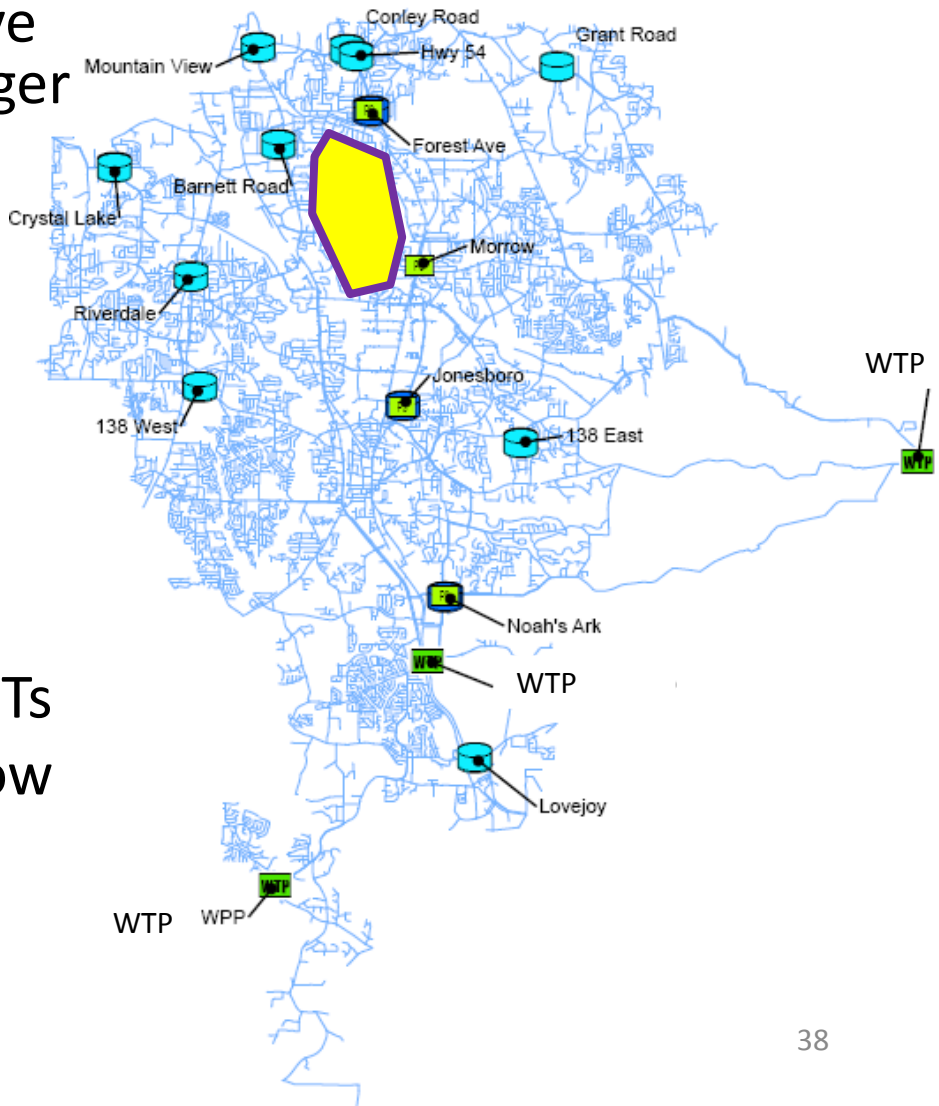
Degree of Concern for Issue	Points
No Concern	1
Small Concern	2
Moderate Concern	3
High Concern	4
Very High Concern	5


Alternative 2
Alternative 3
Baseline
Score
25
20
15
10
5
0
Energy Costs
Capital Costs
Fire Flow Ratings
Water Quality (e.g. Water Age, TTHMs)
Increased Water Pressure
Communication Interruptions
Redundancy
Number of customers on PRVs
Increased Dead Ends
Dependence on Standby Power
Number of facilities to maintain
Accelerated Replacements (Service Line/Meter)
Loss of Service
Increased Leaks

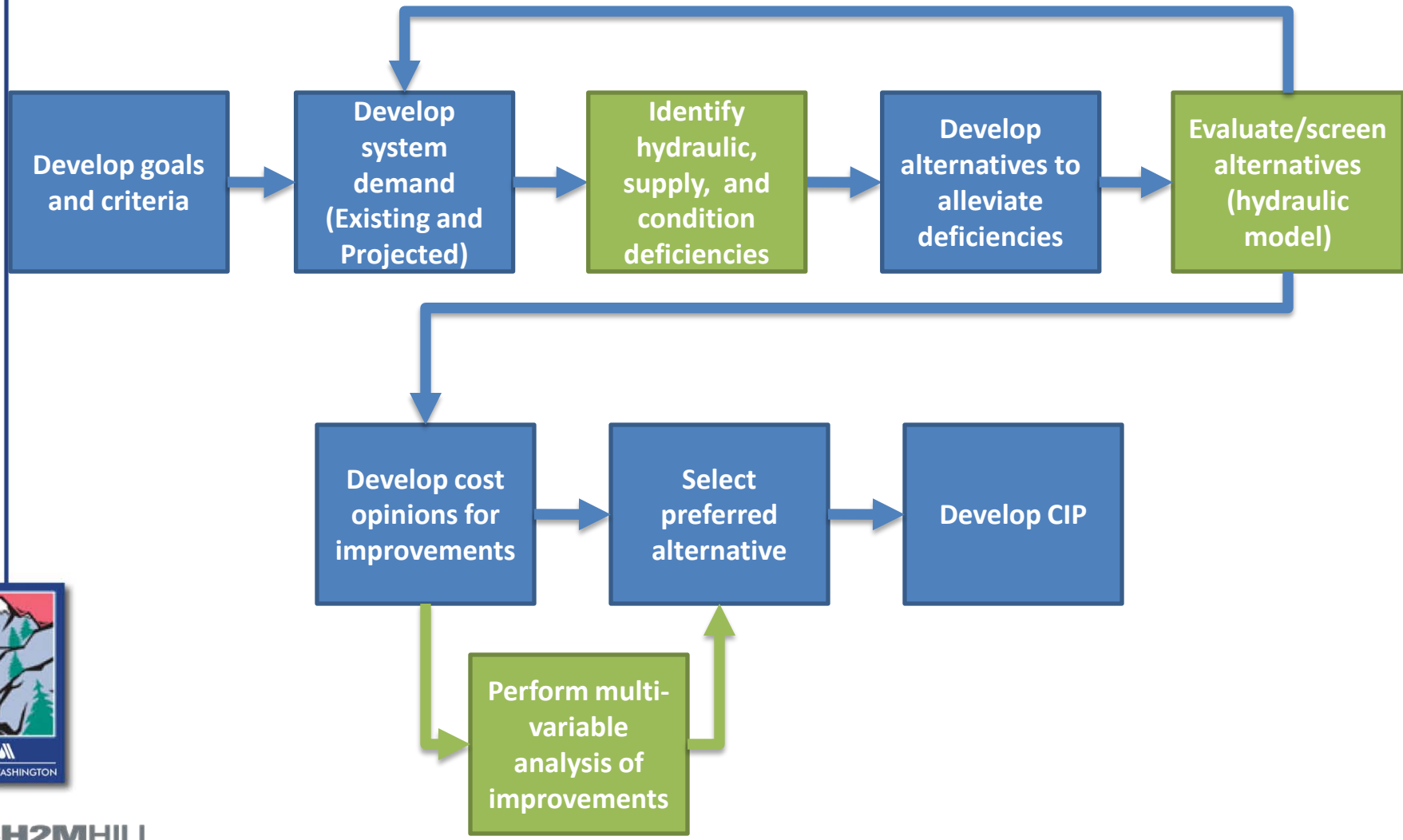

300
250
200
150
100
50
0
Score
Baseline
Alternative 2
Alternative 3
Improvement Option
Energy Costs
Capital Costs
Fire Flow Ratings
Water Quality (e.g. Water Age, TTHMs)
Increased Water Pressure
Communication Interruptions
Redundancy
Number of customers on PRVs
Increased Dead Ends
Dependence on Standby Power
Number of facilities to maintain
Accelerated Replacements (Service Line/Meter)
Loss of Service
Increased Leaks

Sample System Evaluation

- Multiple systems that have been combined into a larger system over the last 20 years
- 3 Pressure Zone system
- 3 WTPs with different source water
- WTPs pump to GSTs and then pumped to main system with ESTs
- WQ challenges around ESTs
- High elevation area has low pressure challenges



Let's follow this project through the planning process……..



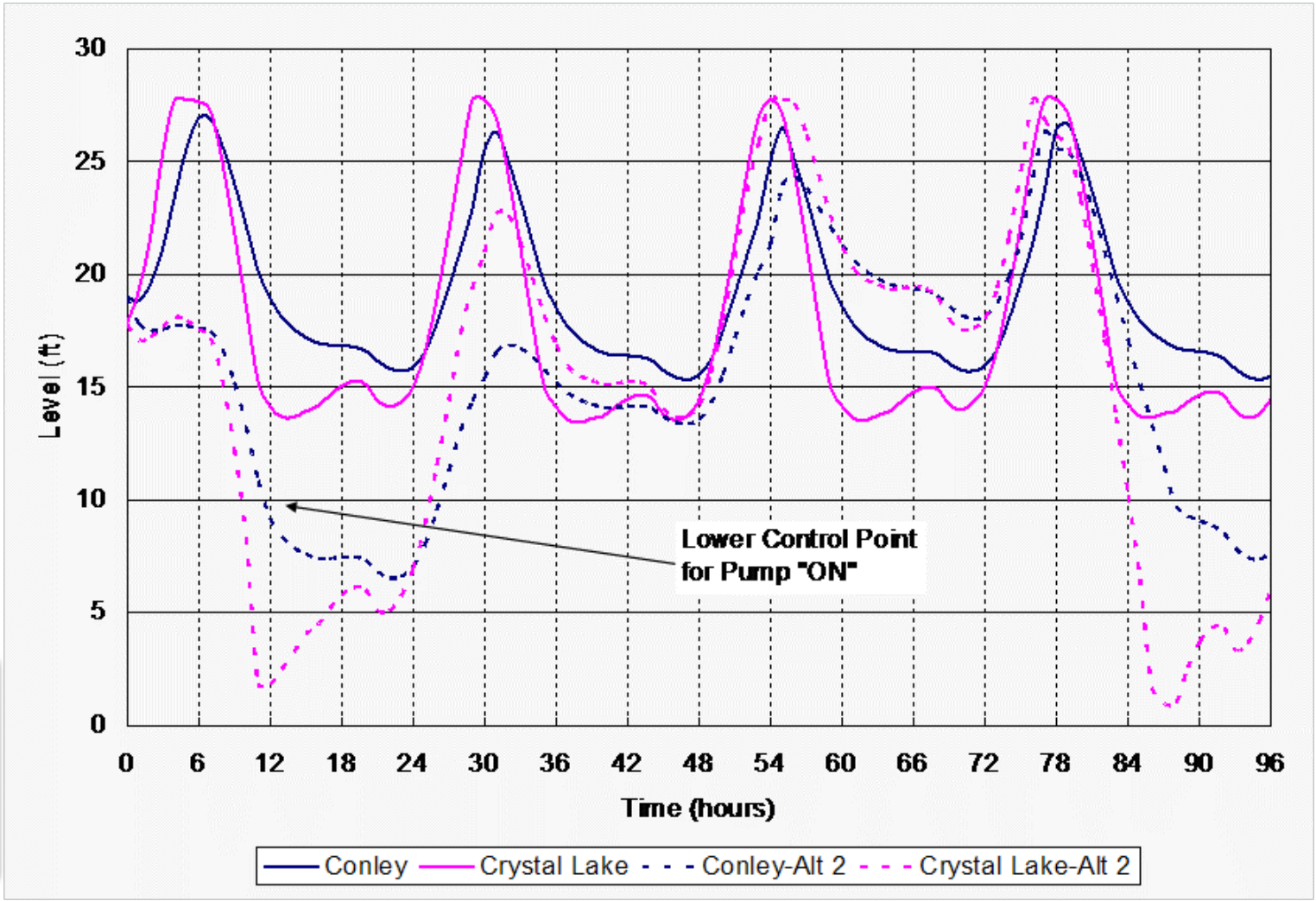
Development of Goals and Alternatives

- Goal 1: Improve System Pressures for high elevation area
- Goal 2: Improve System Water Quality as monitored with Water Age
- Goal 3: Minimize capital cost without adding excessive on going O&M costs (pumping, maintenance)

Development of Goals and Alternatives

- Developed a series of scenarios to overcome low pressure and water quality challenges
  - **Alternative 2: Create new isolated zone for high elevation area**
    - Meets pressure criteria but creates new operational challenges with more dead-ends and new pressure zone
    - Does not specifically alleviate WQ issues at ESTs: evaluate changes in operation
  - **Alternative 3: Raise HGL system wide**
    - Meets pressure criteria
    - Currently throttling pumps at one major station since pumps were oversized for future demands (have been in place for 15 years); would improve operating efficiency
    - Required to remove ESTs from operation and depend on backup power (HGL increase from 1106 to 1150)

Alternative 2 Operation



Comparison of Tank Water Age and System Water Age: Alt 2 and Alt 3

Tank	Average Tank Water Age (hr) Baseline	Alt 2	Alt 3
Conley Road	66	53	NA
Barnett	204	105	NA
Grant Road	80	67	NA
Crystal Lake	52	32	NA
Hwy 138 W	71	49	NA
Lovejoy	52	35	NA
Mountain View	152	106	NA
Jonesboro	18	18	18
Morrow	16	16	16
Noah's Ark 1	27	26	26
Noah's Ark 2	19	19	19
Riverdale	80	65	NA
Hwy 138 E	NIS	NIS	NIS

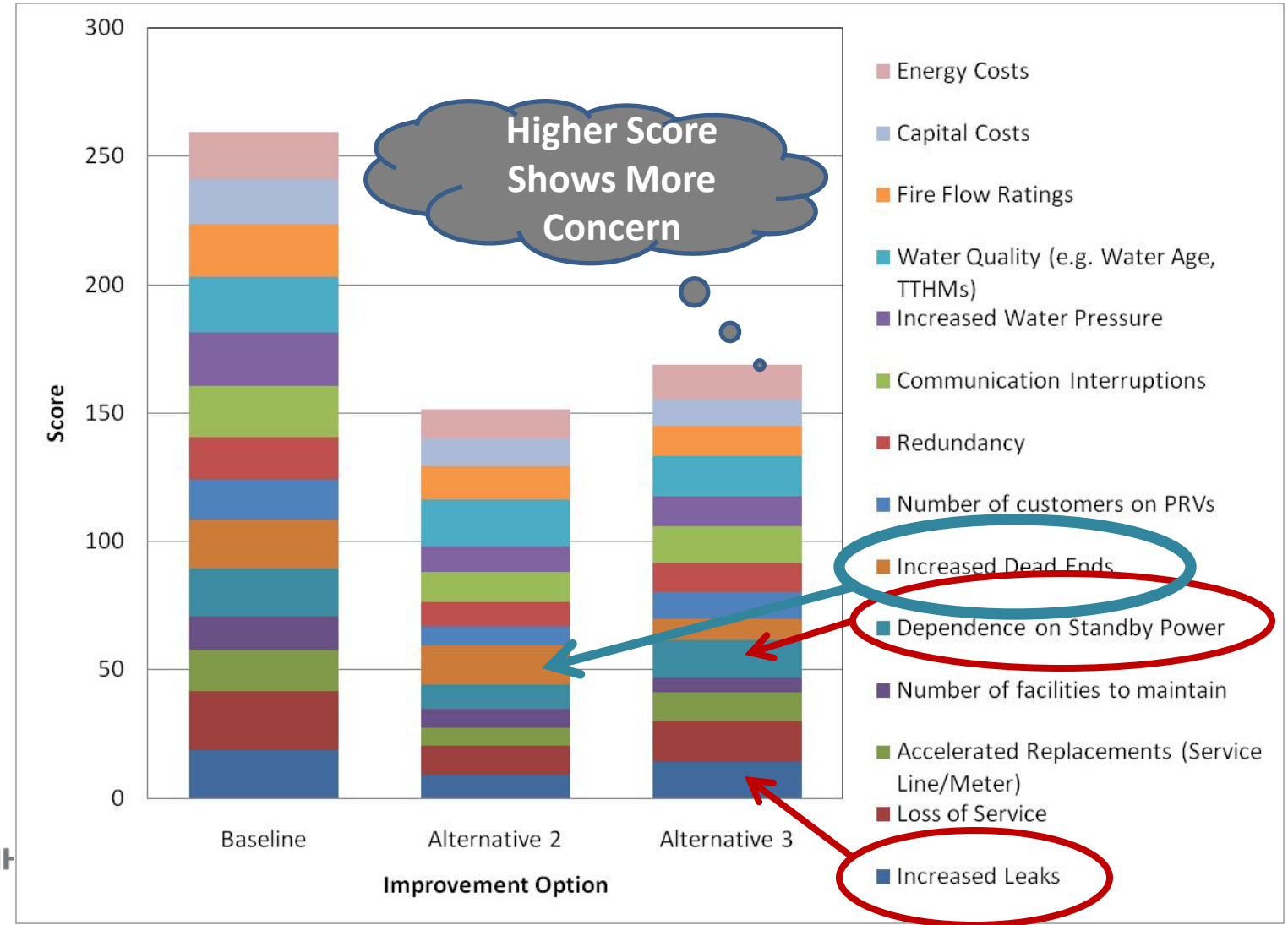
WQ-36	41	68	34	37	35	42
WQ-370	20	21	20	20	21	22
WQ-428	89	93	111	128	84	85
WQ-433	120	120	120	121	120	121
WQ-64	20	21	20	21	21	22
WQ-73	27	38	26	30	27	28
WQ-80	41	149	28	31	29	30

Cost Comparison for Alternatives

Alternative	Piping Total ($M)	Pump Station Total ($M)	Energy Total ($M)[1]	Total Cost ($M)
2A	$8.57	$4.91	$6.35	$19.83
2B	$8.57	$5.51	$6.25	$20.33
3A	$0.00	$4.47	$8.73	$13.20
3B	$0.00	$4.92	$8.53	$13.45

- Piping improvements for Alt 2 for new Zone and other headloss areas
- Alt 3 does not have new PS but has more substantial upgrades at existing stations to deliver the higher HGL
- Higher energy costs for Alt 3 are off set by reduced piping costs

Application of Decision Matrix



Alternative 2 vs Alternative 3

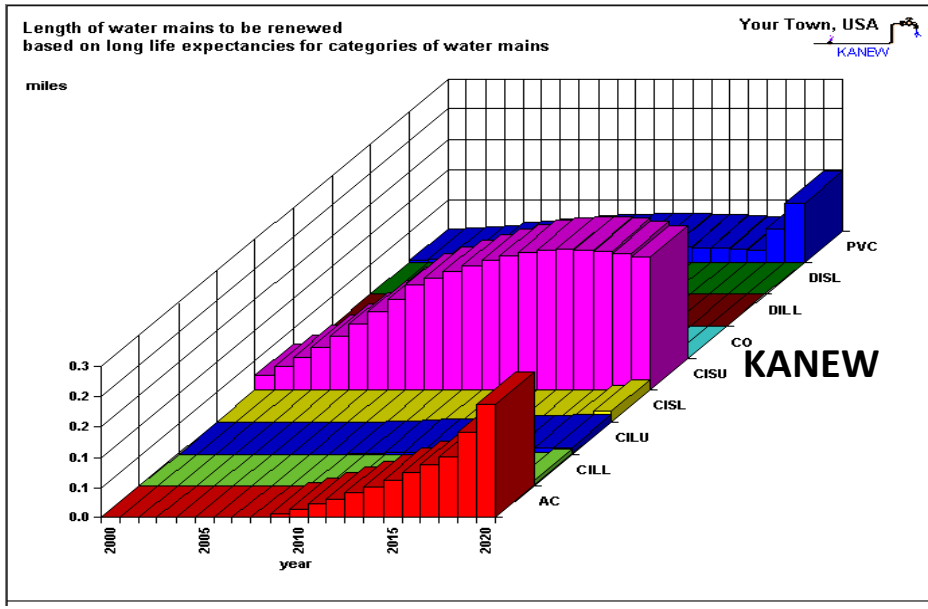
- Alternative 2
  - More extensive piping improvements
  - Creates new zone and additional dead ends
  - Minimal WQ Improvement
- Alternative 3
  - More extensive pump station improvements
  - Higher operating costs with higher pressures
  - Higher pressures produce higher concern with staff
- Let's pilot Alternative 3 and evaluation system response

Results of Increasing Pressure Pilot

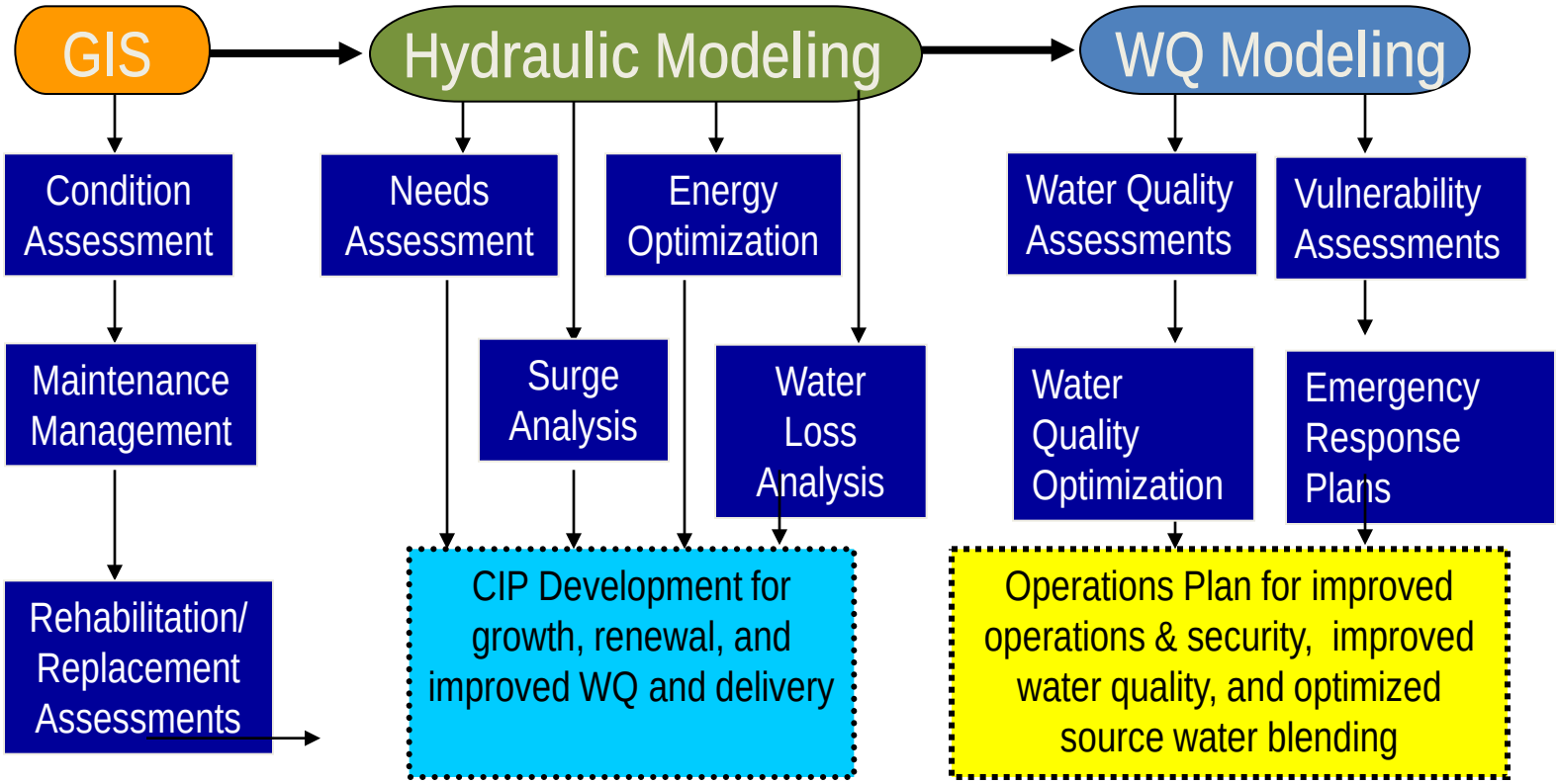
- Developed systematic program to increase pressures system-wide by removing throttling at pump stations and isolating ESTs
- Used hydraulic model results to guide system operation modifications
- Installed numerous pressure loggers at high and low points throughout the system
- 10 psi pressure increase: system performed well with minimal breaks or issues
- 20 psi pressure increase: additional breaks and challenges
- investment in the hydraulic model and performing pilot study allowed client to evaluate the performance under the two conditions without implementing full-scale improvements

Use all the tools available for optimal decision making for a Master Plan

- Pipe inventory and condition data in GIS for structural integrity decisions
- Water quality and pressure complaints, pipe breaks in GIS
- Network model for hydraulic performance decisions
- Critical customer information in GIS and Model for high consequence decisions
- Financial and statistical decision support tools



Building a Hydraulic and Water Quality Models Create Tools For Many Applications



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Thank you!

Questions

Jennifer Henke, P.E.

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Asset Management: What's Out / What's In

OUT	*IN*
➢ Asset management is a something new	➢ Utilities have always been managing their assets
➢ GASB 34 drives utilities to asset management	➢ Good management drives utilities to asset management
➢ Asset management costs too much	➢ Asset management is affordable
➢ A complete inventory is needed	➢ Start with the data and knowledge you have

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Asset Management: What's Out / What's In

OUT	*IN*
➢ CMMS is asset management	➢ Asset management is not software
➢ New systems don't need asset management	➢ Systems of all ages will benefit from asset management
➢ Making R&R decisions based on condition	➢ Making R&R decisions based on risk
➢ Asset management focuses on infrastructure	➢ Asset management must include people and processes

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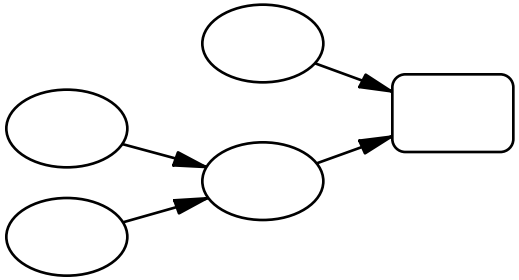
Advanced Tools Can Guide Decision Process if Data Don't Lead to Clear Decision

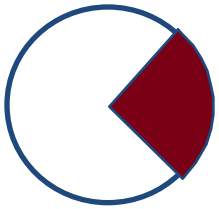
Influence diagrams identify factors and dependencies



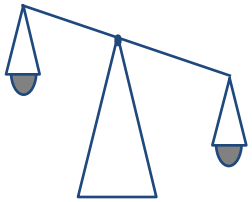
Constructed scales measure performance against objectives

Level of Impact	
1	No Impact
2	Minor Impact
3	Moderate Impact
4	Major Impact

Probability encoding quantifies scientific judgments

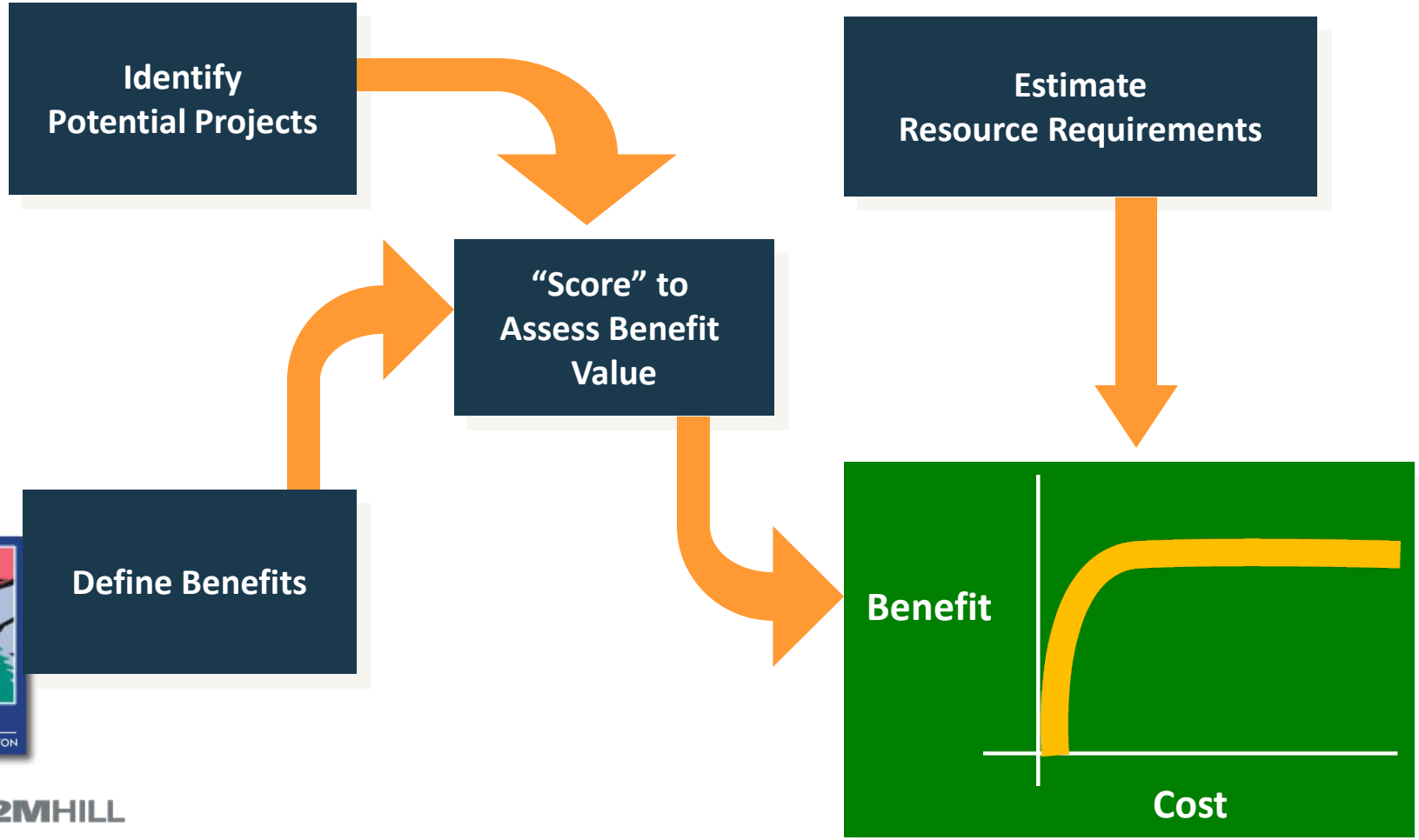


Utility assessment quantifies value judgments



CH2M HILL-Developed Scoring System uses LWC-Defined Benefits to Score Each Capital Project

Overview of Prioritization Process



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Treatment Process Selection Model

- **Treatment Alternatives Evaluation**
- ***The key tool for treatment alternatives evaluation is the Treatment Process Selection Model.***
- Evaluation of treatment alternatives is a cornerstone of any water system master planning. Most systems, as is the case at Great Falls, must consider the ability of their existing treatment facilities to meet future required capacities and increasingly stringent regulations. In cases where the existing plant infrastructure is old, it is useful to benchmark the plant against state-of-the-art treatment processes such as membrane filtration or ultraviolet light disinfection. In most cases, there are a number of combinations of existing and new processes that could also be implemented to meet project objectives. In our experience, there is a risk of making a premature judgment on whether to rely on the existing plant or make a switch to a new plant. Reliance on existing infrastructure often appears to be the lowest cost alternative, especially from a capital standpoint. **The downside of relying on existing infrastructure is the potential inability to meet future drinking water regulations or water quality goals, as well as increased maintenance, rehabilitation, and operating costs going forward and facilities continue to age.**
- We have developed a number of tools for facilitating decisionmaking where multiple project objectives must be met. A key tool for treatment alternatives evaluation is a Treatment Process Selection Model. The approach has been developed to provide a rigorous, rational, and defensible basis for screening treatment process combinations when multiple project objectives must be met. **The value of this approach is that it incorporates those criteria and issues that are identified by City staff as being important, and characterizes the degree to which the alternatives meet regulatory, implementation, and cost standards.** The process is rigorous and defensible, and incorporates various influences that drive the decision for a recommended plan. The evaluation process does the following:
- Considers all goals and objectives (quantitative or qualitative) when evaluating alternatives, for example, water quality and regulatory engineering, operating, environmental, public interests, and total costs
- Considers all alternatives (for example, new technologies like membranes or UV versus continued use of existing facilities) on an equal basis, such as, no bias towards particular approaches
- Identifies the best or most favorable alternative(s) based on benefits and the cost for achieving those benefits (Cost-Benefit Analysis)
- Uses a process that is systematic, understandable, and defensible to stakeholder groups (for example, regulators, public, special interest groups)
- Provides a process that can accept input from stakeholders at any point during the evaluation process and, if necessary, can be used by other stakeholder groups to verify or influence the process and findings
- Minimizes the cost of the data collection and evaluation process by focusing efforts on relevant criteria
- Confirms that the most cost-effective approach is selected consistent with the assessment of criteria as listed above

Capital Cost Forecasting

Challenges

- Increased Capital Needs Require Accurate Cost Forecasting
- Forecasting Needs Proper Escalation Factors
- Proper Prioritization of Projects
- Scheduling Must Address Regulatory Compliance

Opportunities

- Use of State-of-the Art Costing Tool to Better Define Actual Costs
- Develop Process which Properly Identifies Costs and Benefits of Each Project

Asset Management

Challenges

- Older Facilities at CHWTP and Zorn do not meet current building codes
- Current facilities must be Assessed for Future Use
- Improve operational efficiency
- Main replacement/ rehabilitation model needs updating

Opportunities

- Some existing facilities & buildings may be reusable for new service
- O&M Procedures and Standards can be updated to latest industry standards
- Water Main Rehabilitation Program Updated to State-of-the-Industry

Our Costing Tool (CPES) Provides Accurate Capital Cost Estimates Efficiently

- CPES is a Parametric Costing model which increases the accuracy of conceptual cost estimating by incorporating quantity take-offs and actual bid costs (not cost curves)
- Unit costs are constantly updated by using bids on CH2M HILL-designed [illegible] throughout the country
- O[illegible] cost model
- C[illegible] al[illegible]

CH2M HILL Uses CPES When Bidding Hard Dollar Bid Design-Build Projects

CPES

Real-Time Monitoring Offers Dual Benefits: (1) Early Warning & (2) Operational Guidance

Real-Time Monitoring Approach Will Establish Starting Points for System-wide Program:

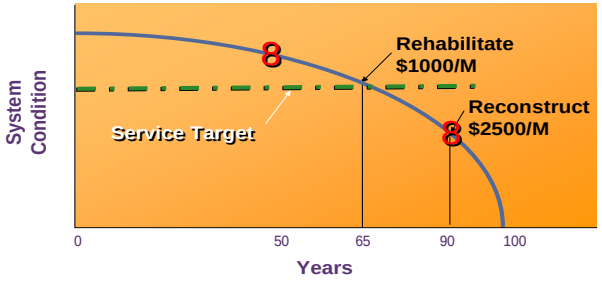
- ID parameters most important to monitor
- Site preliminary locations based on several criteria
- ID O&M characteristics and life cycle costs
- Assess SCADA system communications

Multi-Variable Assessment

Multi-Variable Assessment

Multi-Variable Assessment

Timely capital renewal will lower capital costs



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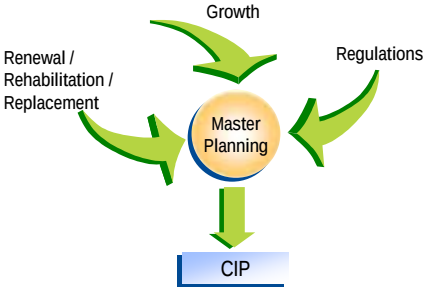
Three drivers define the need for Facilities Master Planning to develop a CIP



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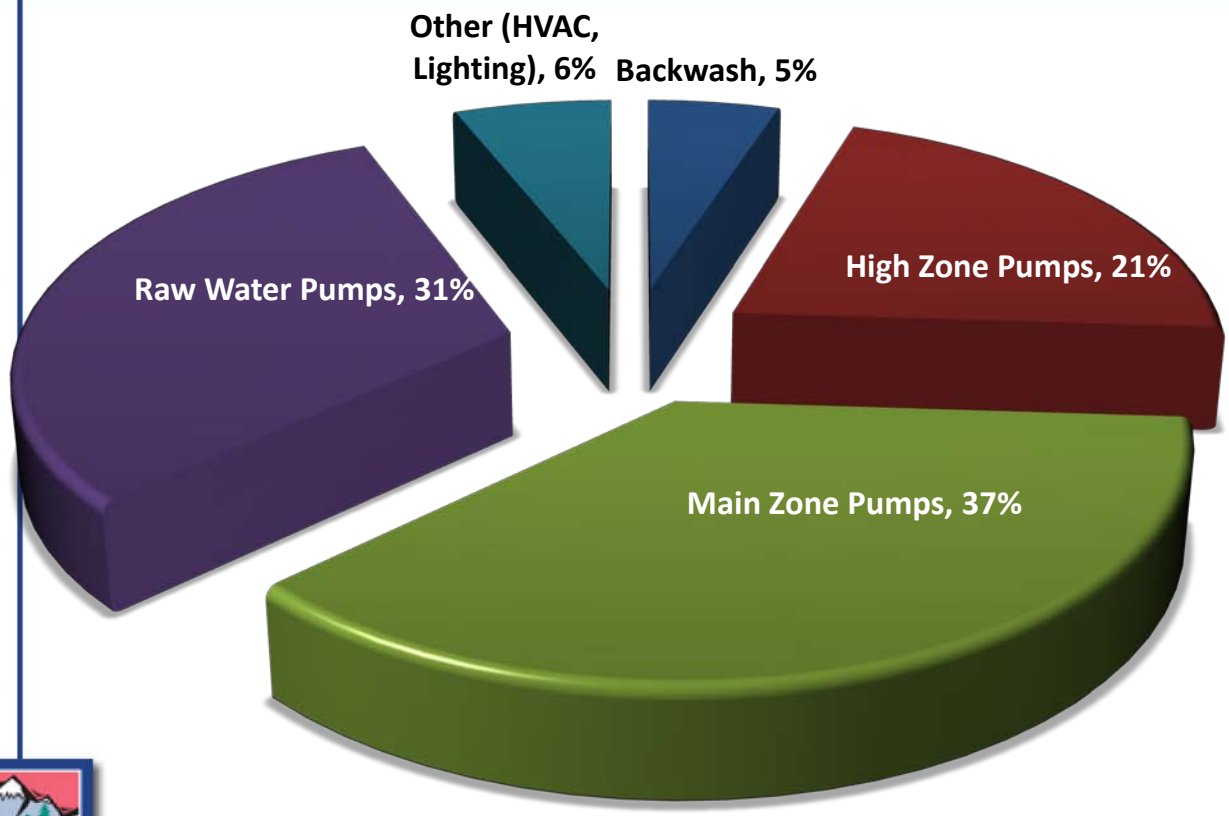
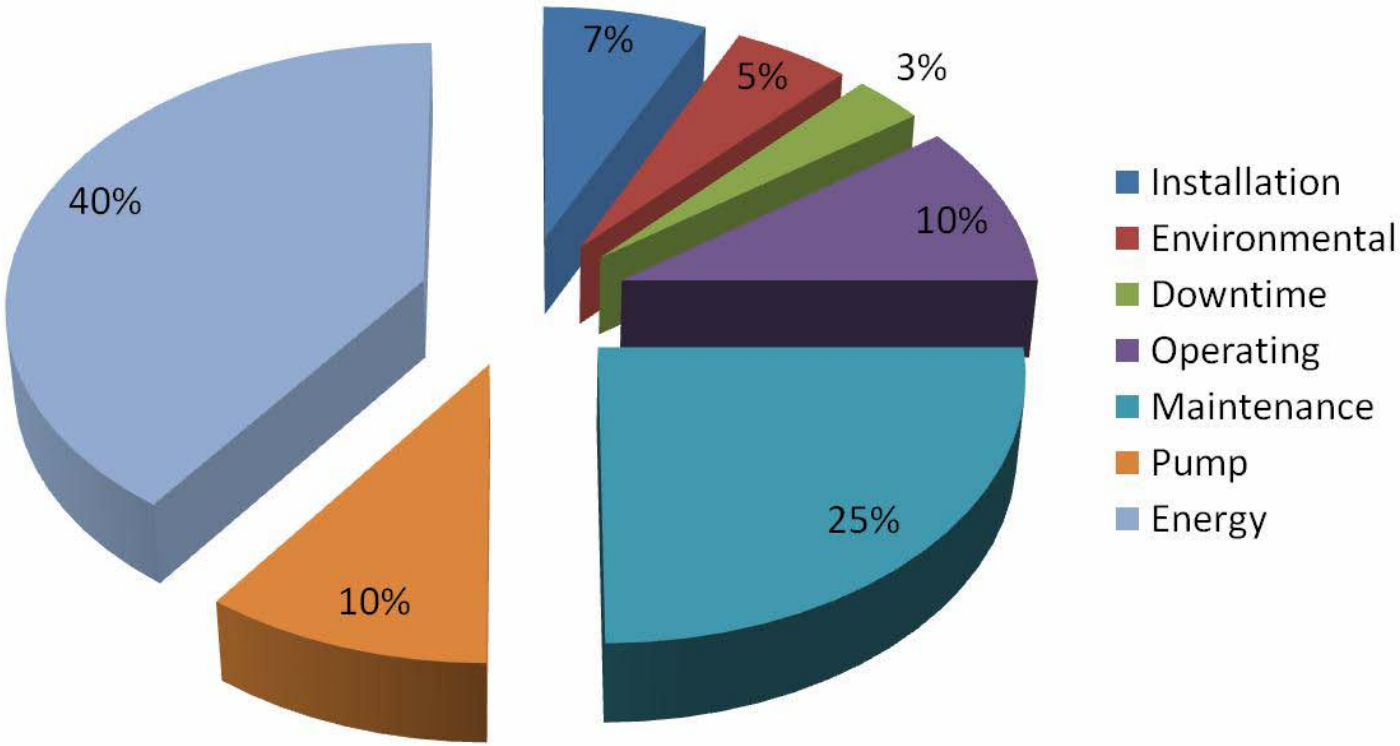
Typical Power Use in a Water System



89 %+ of Water System Energy Use is in Pumping
Energy Costs Typically 2nd Behind Labor
20 % of all energy used in California is Water Pumping
50 % of all energy use in Dallas, TX is Water Pumping

Energy Usage Comparison



Hydraulic Analysis: Energy Management and Water Quality

- Interfaces directly to existing SCADA with minimal equipment, instrumentation or hardware changes
- Operational tool to schedule pumps/valves to achieve lowest overall cost (without breaching constraints)
- Solves mass-balance first (i.e. must deliver water)
- Aims to minimize costs of energy (best use of off-peak rates)
- Aims to maximize energy efficiency of pumps (BEP)
- Has shown to improved water quality by managing turnover
- Runs in real time – Like an autopilot
- Recalculates schedule (next 24-48 hours) every 1/2-hour, <u>adapting to changing conditions of the day</u>

	Baseline		Alt 2		Alt 3	
Water Quality Site	Average Water Age (hr)	Max Water Age (hr)	Average Water Age (hr)	Max Water Age (hr)	Average Water Age (hr)	Max Water Age (hr)
WQ-10	47	65	41	44	41	44
WQ-121	22	23	24	27	24	26
WQ-137	69	95	70	94	59	62
WQ-138	20	21	21	21	22	22
WQ-154	23	25	23	34	27	29
WQ-217	5	6	5	5	5	6
WQ-22	48	67	40	46	41	45
WQ-23	29	31	30	32	31	34
WQ-230	39	54	59	83	47	67
WQ-24	46	122	30	31	32	33
WQ-254	24	26	25	27	27	28
WQ-259	33	34	35	37	36	38
WQ-275	33	34	34	36	36	37
WQ-288	47	48	48	49	51	52
WQ-3	30	45	30	42	30	30
WQ-304	54	160	36	37	37	38
WQ-321	88	90	51	53	51	53
WQ-36	41	68	34	37	35	42
WQ-370	20	21	20	20	21	22
WQ-428	89	93	111	128	84	85
WQ-433	120	120	120	121	120	121
WQ-64	20	21	20	21	21	22
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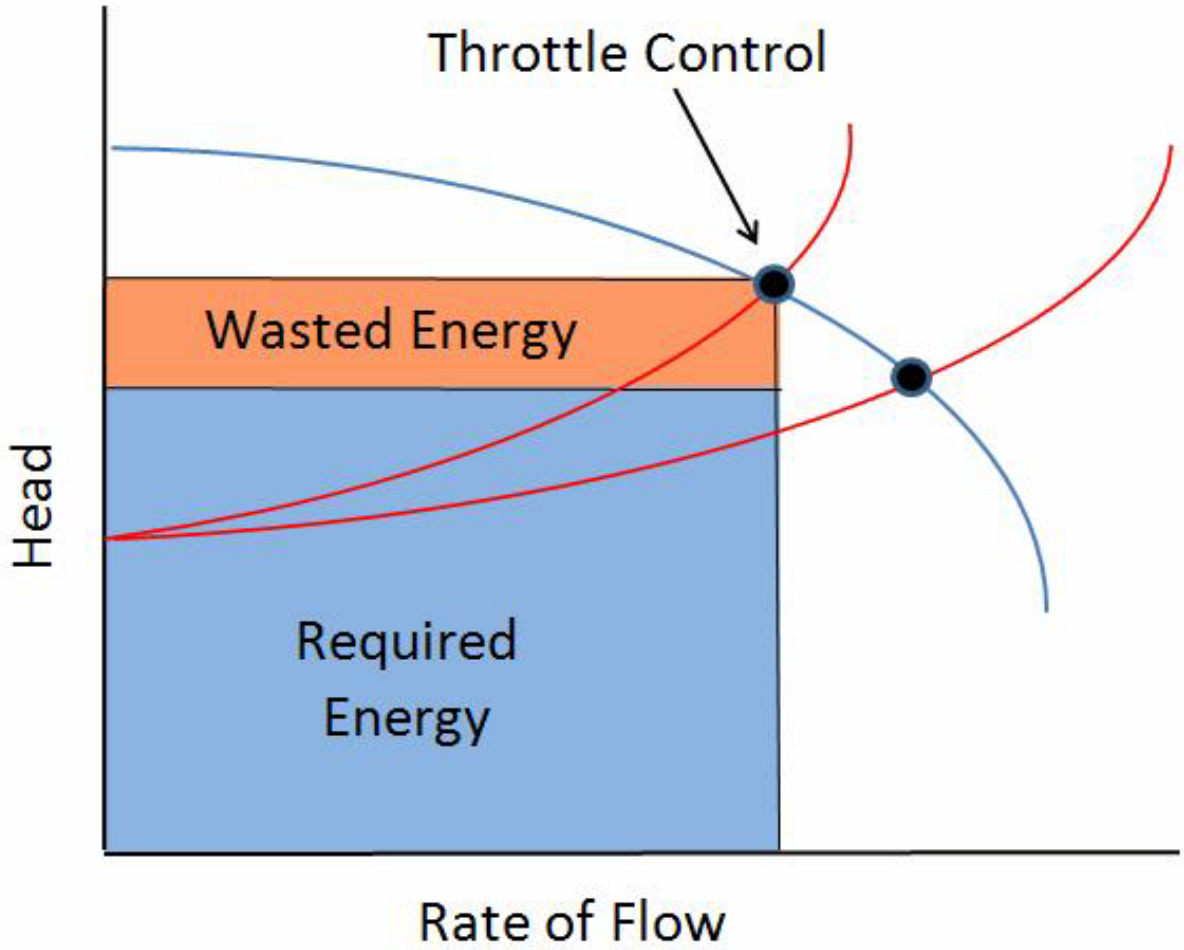
WQ-80	41	149	28	31	29	30

Energy Usage Comparison



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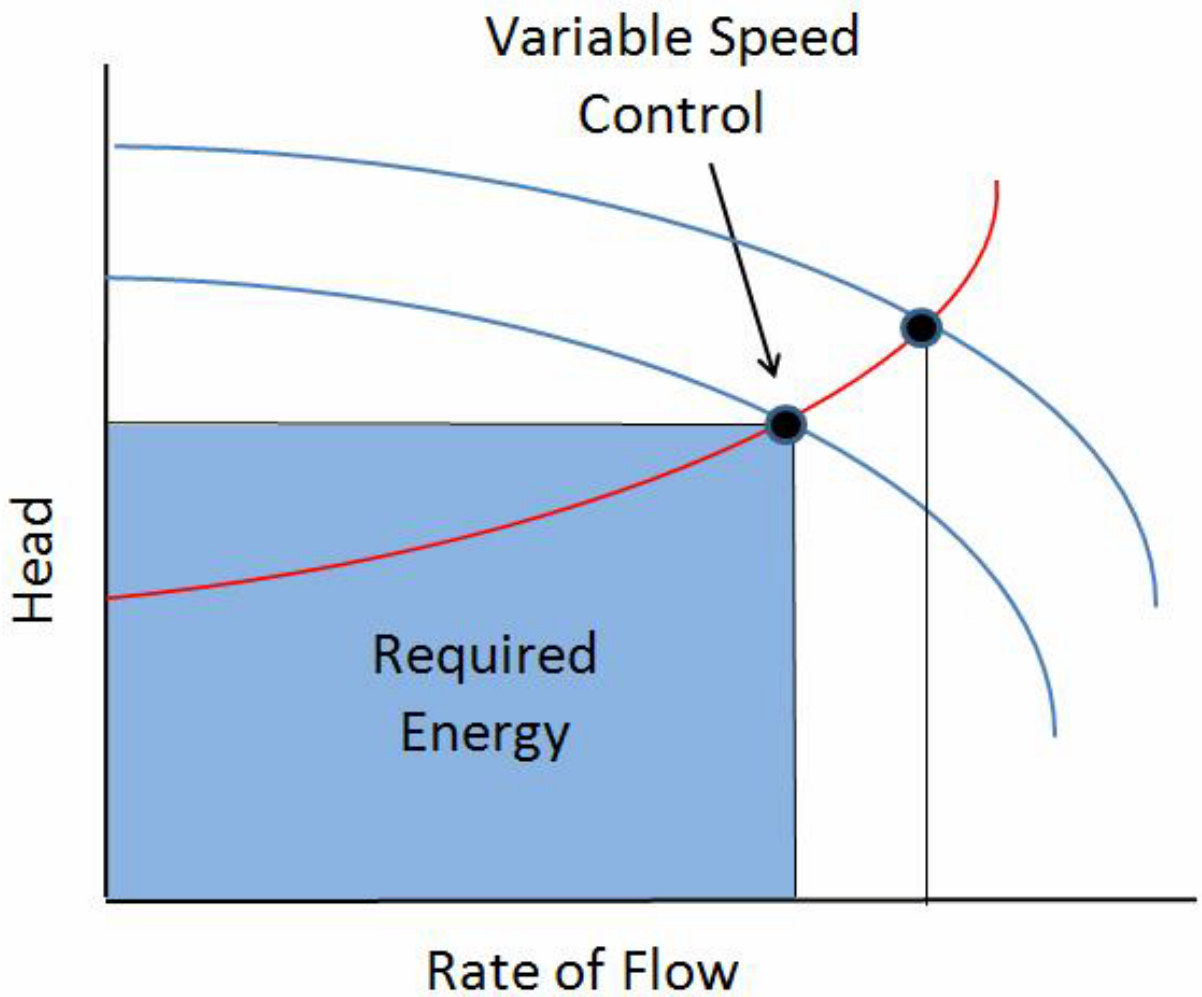
Energy Usage Comparison



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