



# SOURCE TO STREAM

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# QUANTIFYING ASSET CRITICALITY FOR PRIORITIZATION OF GREEN RAINWATER INFRASTRUCTURE ASSETS FOR STRATEGIC ASSET MANAGEMENT

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# AGENDA



## *WHY*

Do we need to quantify the criticality of an asset in delivering our service objectives?



## *WHAT*

Is asset criticality / consequence of failure?

## *HOW*



Did we quantify the criticality of our GSI assets?

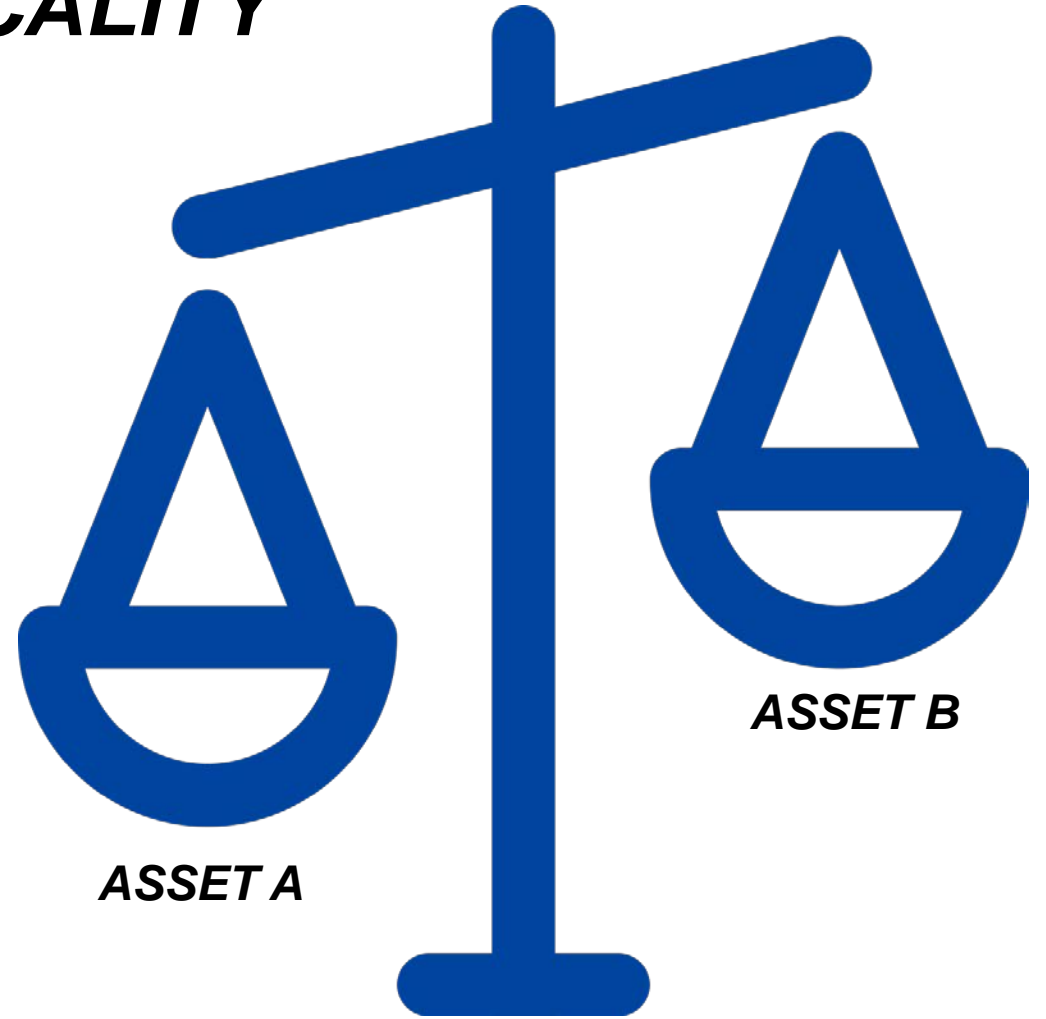
# 1 WHY

# WHY QUANTIFY ASSET CRITICALITY

LIMITED



SERVICE  
OBJECTIVE  
& GOALS



ASSET A

ASSET B

PRIORITIZE & STRATEGIZE

# WHY QUANTIFY ASSET CRITICALITY



HIGH COF  
SCORE



ASSET A



ASSET B



LOW COF  
SCORE



***WHICH ONE DO I REHAB / REPAIR /  
MAINTAIN FIRST?***



# WHY QUANTIFY ASSET CRITICALITY



**40% OF CITY'S IMPERVIOUS  
AREA BY 2050**

**10,000 +  
ASSETS**

**315  
ASSETS**



# 2 WHAT



# WHAT IS ASSET CRITICALITY

1. How likely is the asset to fail? And,
2. What are the consequences if it does?

**RISK =**

**PROBABILITY OF  
FAILURE**



**CONSEQUENCE  
OF FAILURE  
(CRITICALITY)**

- Condition
- Age

?

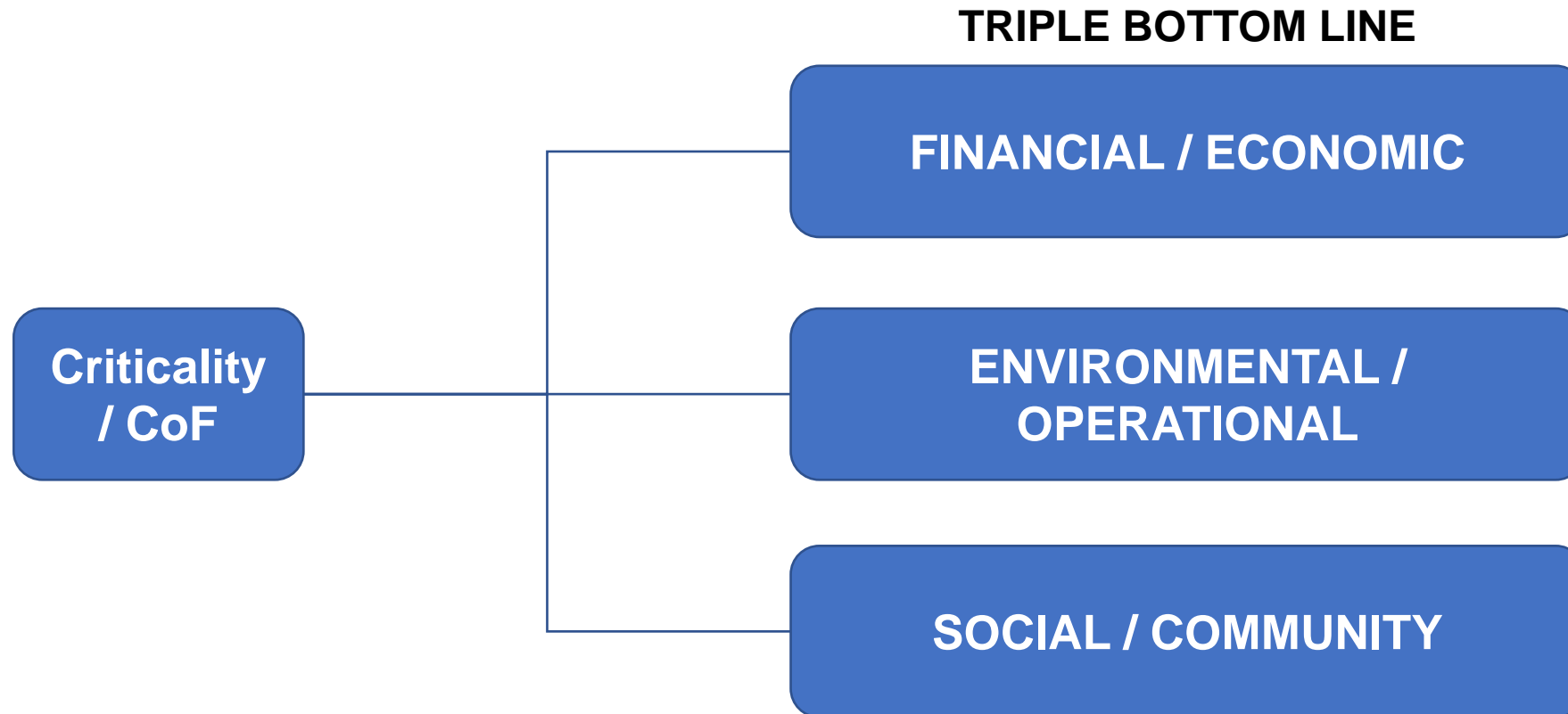
# WHAT IS ASSET CRITICALITY

How critical an asset is in meeting the organization's service objectives

Service	Service Outcomes	Supporting Assets
Improve and Protect Vancouver's Water Quality	<ul style="list-style-type: none"><li>Remove pollutants from water and air</li></ul>	<ul style="list-style-type: none"><li>Bioretention</li><li>Rainwater Tree Trench</li><li>Infiltration Trench</li><li>Permeable Pavement</li></ul>
Increase Vancouver's Resilience Through Sustainable Water Management	<ul style="list-style-type: none"><li>Increase managed impermeable area</li><li>Harvest and reuse water <b>Note 1</b></li><li>Reduce volume of rainwater entering the pipe system</li></ul>	
Enhance Vancouver's Livability by Improving Natural & Urban Ecosystems	<ul style="list-style-type: none"><li>Increase total green area</li><li>Mitigate urban heat island effect</li></ul>	

# WHAT IS ASSET CRITICALITY

- Failure consequences / impact can be categorized according to how they impact the organization's objectives



# 3 HOW

# HOW TO QUANTIFY ASSET CRITICALITY

Rating	Description
1	No identifiable consequences. Less than \$10,000 in repair costs. (use the appropriate monetary amount for your system. A smaller system will want to set a lower monetary threshold).
2	\$10,000 to \$49,999 in repair costs. Short term disruption to traffic or business or operations (less than 4 hours). Bypassing (without violating permit) for less than 3 days.
3	\$50,000 to \$99,999 in repair costs. Disruption to businesses. Disruption to traffic. Disruption to septic haulers. Disruption to staff or regular operations. Bypassing (without violating permit) for more than 3 days.

## Ranking System

- *Very subjective scale*
- *Cumbersome to apply*
- *Not easily scalable*

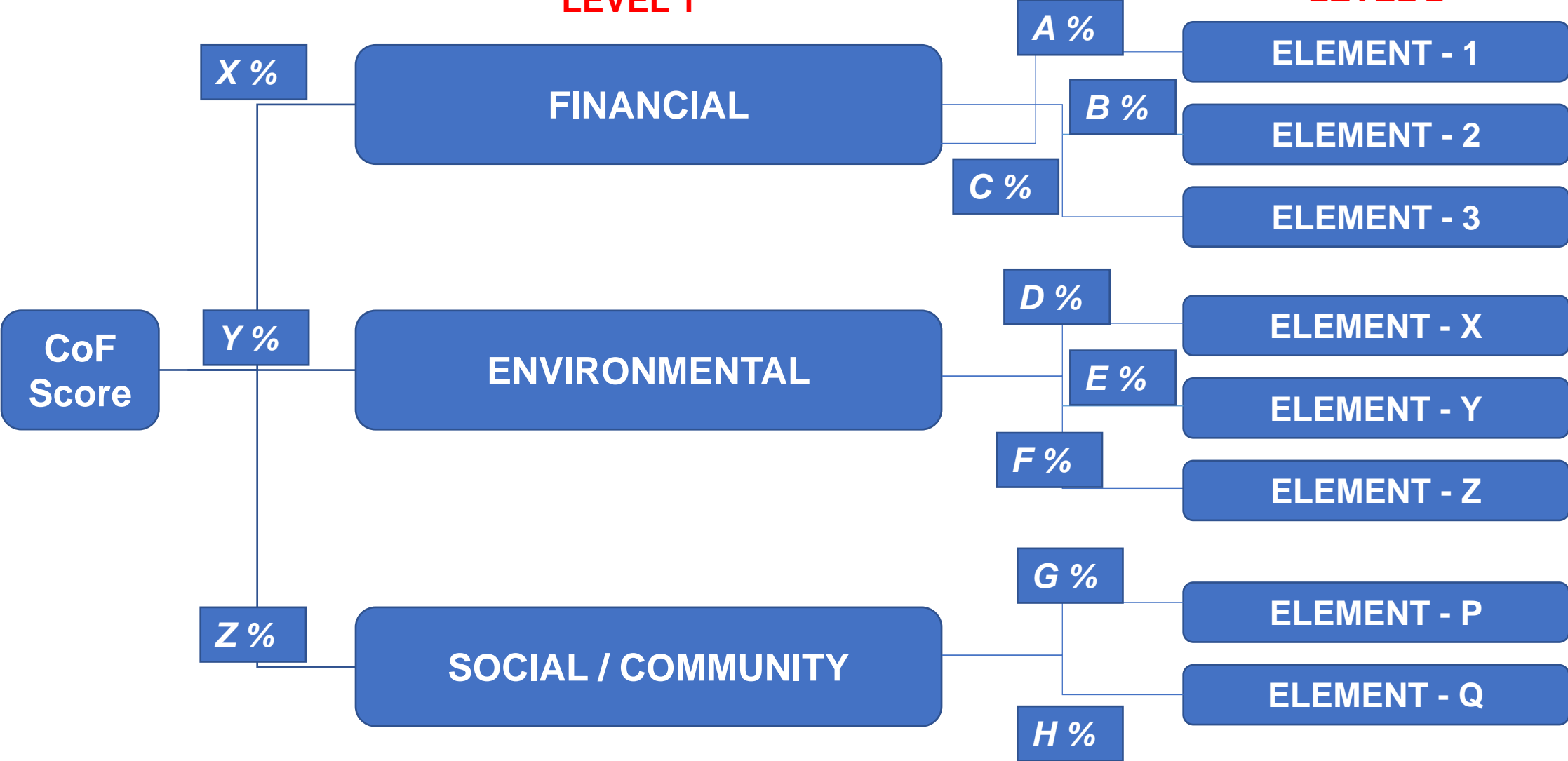


Rating	Description
4	\$100,000 or more in costs related to repair. Damage to other assets and/or private property. Potential to negatively harm the environment; potential to cause impacts to endangered species. May make some minor news report.
5	Health and safety of employees and/or public at risk. Exceedance of permit limits. Politically problematic/becomes a major news story.

# HOW TO QUANTIFY ASSET CRITICALITY

NEED TO ASSIGN WEIGHTS  
LEVEL 1

NEED TO SELECT THESE CRITERIAS  
LEVEL 2





# MULTI-CRITERIA DECISION ANALYSIS

*Data driven decision making needs DATA*

Asset Register Attributes			
Asset Typology	Longitude	First Rehab Due?	Practice Size (m2)
Asset Sub-typology	Drawing Location	Part of 2021 Rehab Program?	Drainage Area Managed (m2)
Street Name	GII Era?	Part of 2022 - 2026 Rehab List?	Watershed
Address Description	Built Year	Maintenance Performed in 2021?	Watershed Inlet
Latitude	Asset Age	Condition Assessment Performed?	Street Classification / Street Use
Remaining Useful Life	Estimated Service Life	Last Inspection Date?	Land Use Type
Replacement Cost	Remaining Useful Life	Asset Condition Grade or PoF?	Neighbourhood

# MULTI-CRITERIA DECISION ANALYSIS

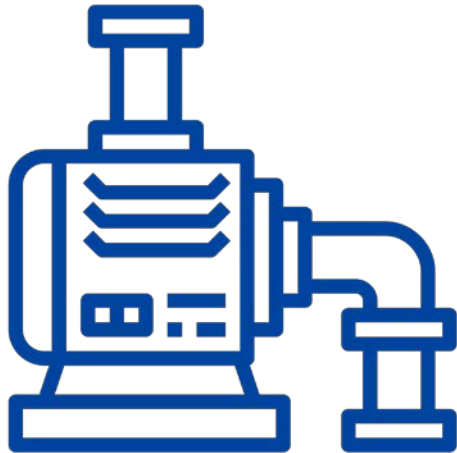


# MULTI-CRITERIA DECISION ANALYSIS

## FINANCIAL

Impact of Asset Failure

### Pump #1



**Cost of Equipment = \$50,000**

If this pump fails, I need \$50K to replace a like-for-like asset

## REPLACEMENT COST



GRI Assets are Immortal (So **NO** traditional Replacement)

GRI Assets Construction and Project Costs Do Not Accurately Represent REPLACEMENT COST

**REHAB / REPAIR COST ESTIMATES** Would Be Representative. But DATA is Currently Not Available

# MULTI-CRITERIA DECISION ANALYSIS

FINANCIAL

Impact of Asset Failure

PRACTICE SIZE (M<sup>2</sup>)



\$

Cost to Replace

\$\$

Material, Labor, Time

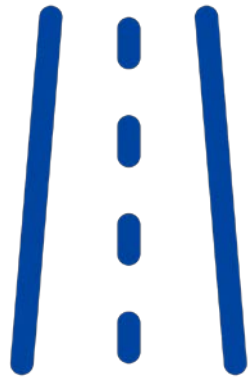
Cost to Replace is Directly Proportional to Practice Size

# MULTI-CRITERIA DECISION ANALYSIS

**FINANCIAL**

Impact of Asset Failure

## STREET CLASSIFICATION



**Laneway**



**Residential**



**Arterial**

**\$** Cost to Replace

**\$\$**

**Traffic Management Costs**

# MULTI-CRITERIA DECISION ANALYSIS

**FINANCIAL**

Impact of Asset Failure

## TYOLOGY

**BIORETENTION**

**PERMEABLE  
PAVEMENT**

**RAINWATER  
TREE TRENCH**

**INFILTRATION  
TRENCH**

**\$**

Cost to Replace

**\$\$**

**Above Ground vs Sub-surface  
Asset Components**



# MULTI-CRITERIA DECISION ANALYSIS

## FINANCIAL

Impact of Asset Failure

### PRACTICE SIZE (M<sup>2</sup>)

DATA ATTRIBUTE	RANKED SCORE
0 – 25	20
26 – 50	40
51 – 75	60
76 – 100	80
101 +	100

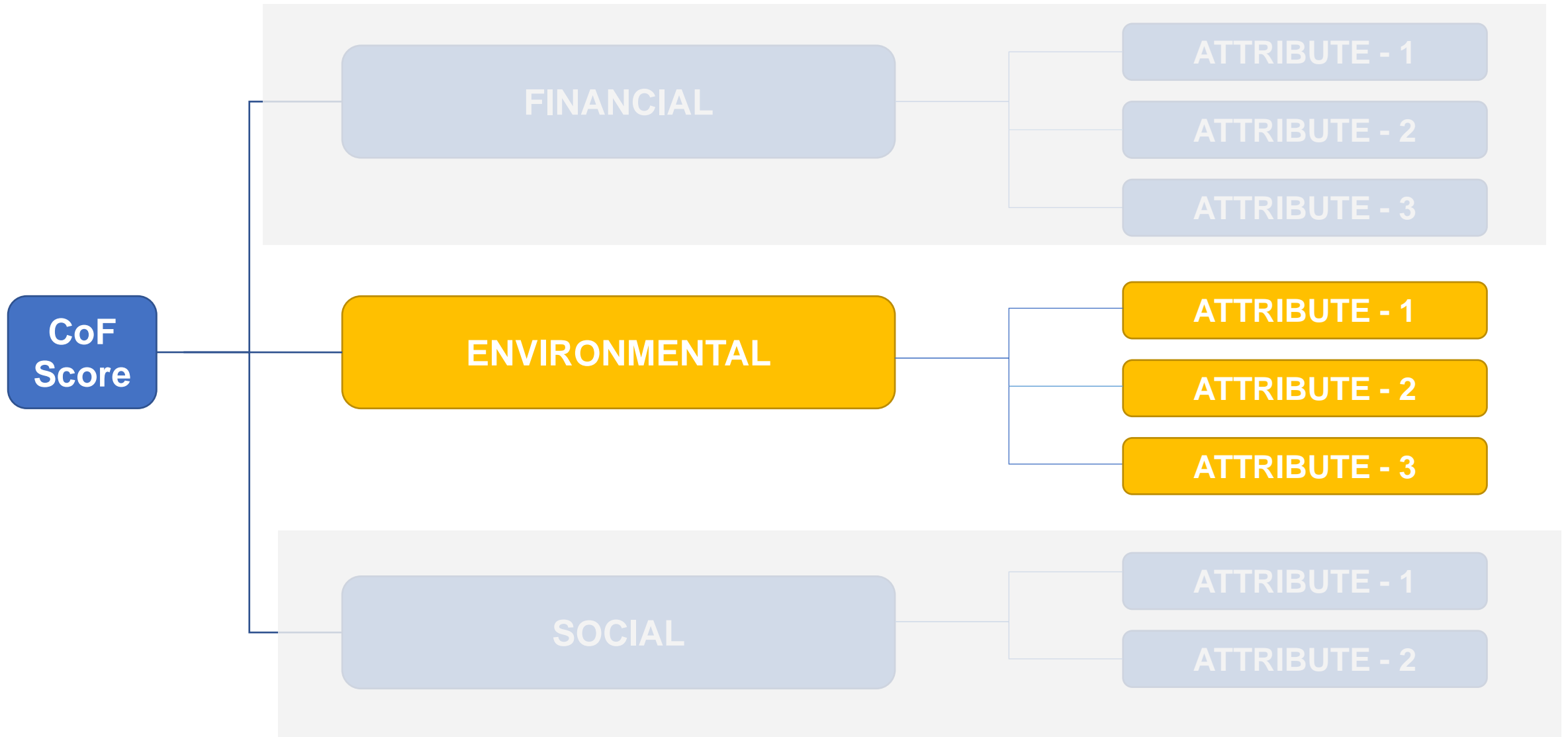
### STREET CLASSIFICATION

DATA ATTRIBUTE	RANKED SCORE
Laneway	20
Residential	60
Arterial	80

### TYOPOLOGY

DATA ATTRIBUTE	RANKED SCORE
Bioretention	40
Permeable Pavement	40
Infiltration Trench	80
Rainwater Tree Trench	80

# MULTI-CRITERIA DECISION ANALYSIS



# ***MULTI-CRITERIA DECISION ANALYSIS***

**ENVIRONMENTAL**

Impact of Asset Failure

**CONTRIBUTING DRAINAGE AREA (M2)**



**More Volume of Runoff Treated and Diverted**

# MULTI-CRITERIA DECISION ANALYSIS

**ENVIRONMENTAL**

Impact of Asset Failure

## TYOLOGY

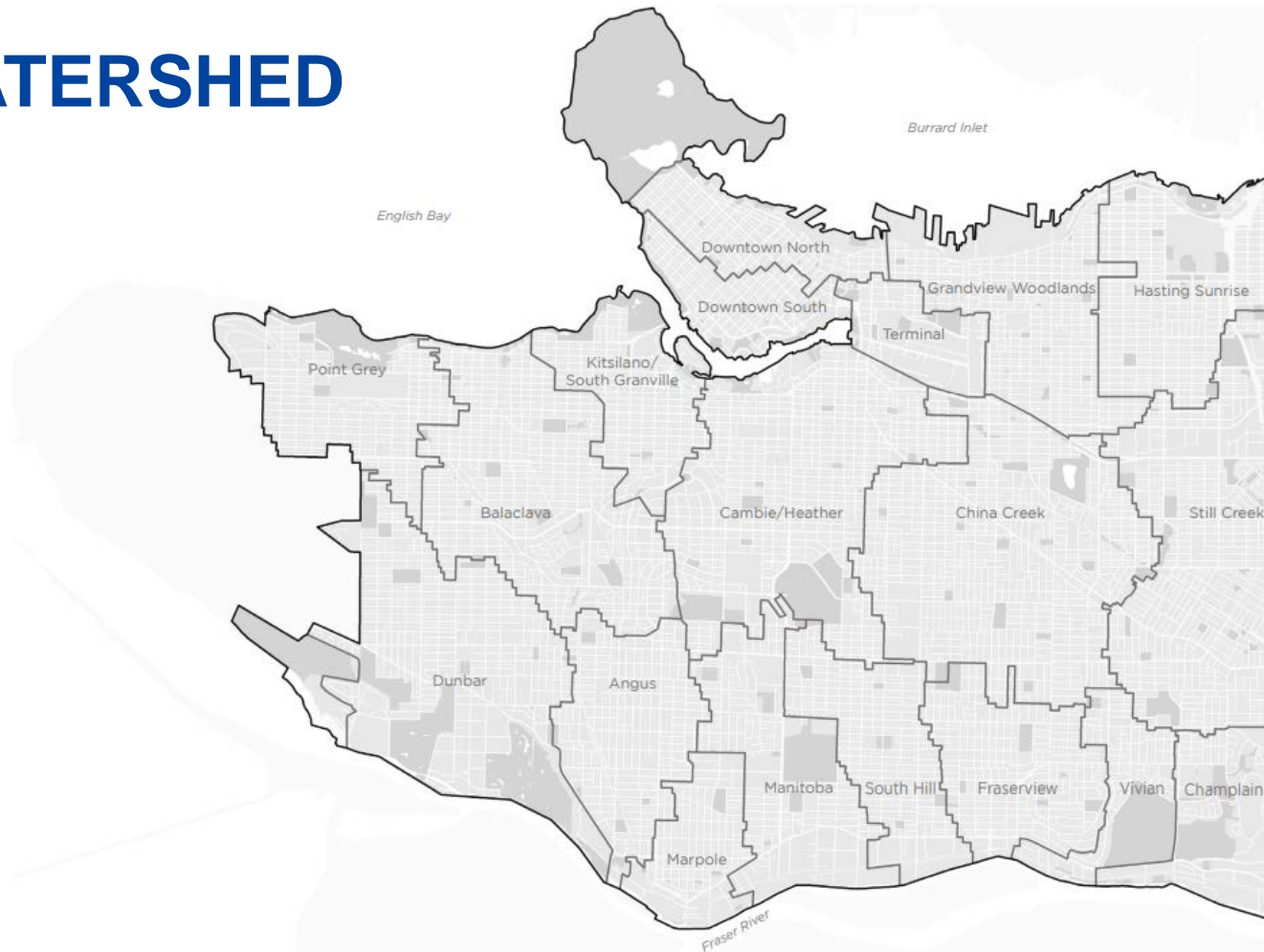
Benefits	Bioretention	Rainwater Tree Trenches	Subsurface Infiltration	Permeable Pavement
Improves Water Quality	x	x	x	x
Enhances Community Resilience	x	x		
Increases Groundwater Recharge	x	x	x	x
Enhances Wildlife Habitat	x			
Improves Air Quality	x	x		
Reduces Urban Heat Island Effect	x	x		

# MULTI-CRITERIA DECISION ANALYSIS

ENVIRONMENTAL

Impact of Asset Failure

WATERSHED



1. Pervious Area
2. Overland Flood Vulnerability
3. CSO Discharges
4. Newer Infrastructure

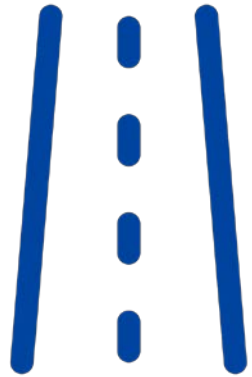
*Some Watershed's have a greater need for GRI than others*

# MULTI-CRITERIA DECISION ANALYSIS

ENVIRONMENTAL

Impact of Asset Failure

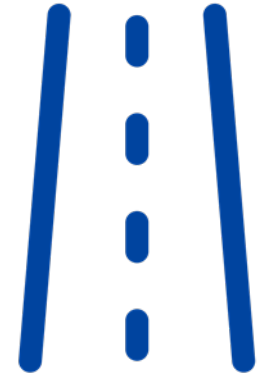
## STREET CLASSIFICATION



Laneway



Residential



Arterial

Pollutant Load

More Vehicles  
Truck and Bus Routes



# MULTI-CRITERIA DECISION ANALYSIS

ENVIRONMENTAL

Impact of Asset Failure

## URBAN HEAT ISLAND EFFECT ZONES

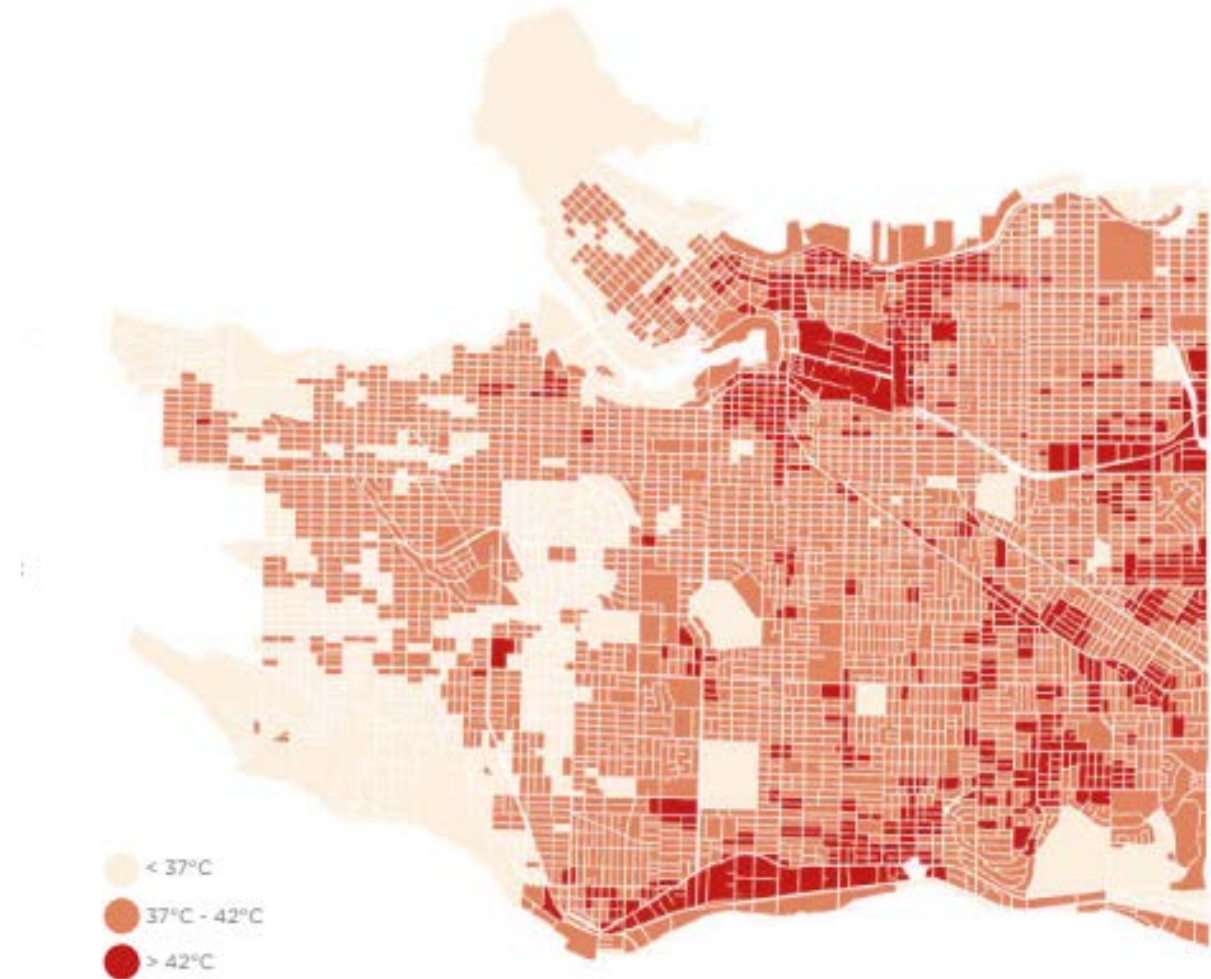
GOOD (LOWER TEMP)

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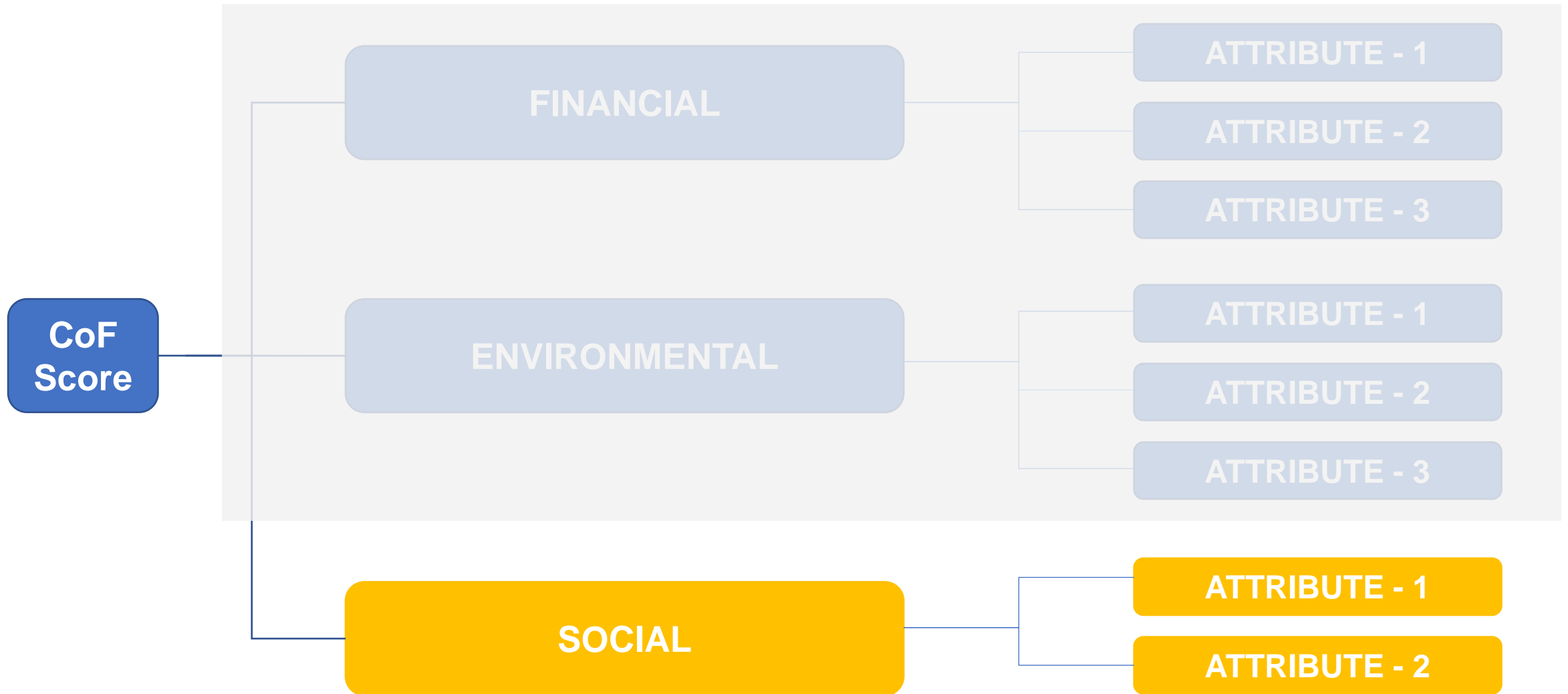
MODERATE

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POOR (HIGHER TEMP)



# MULTI-CRITERIA DECISION ANALYSIS



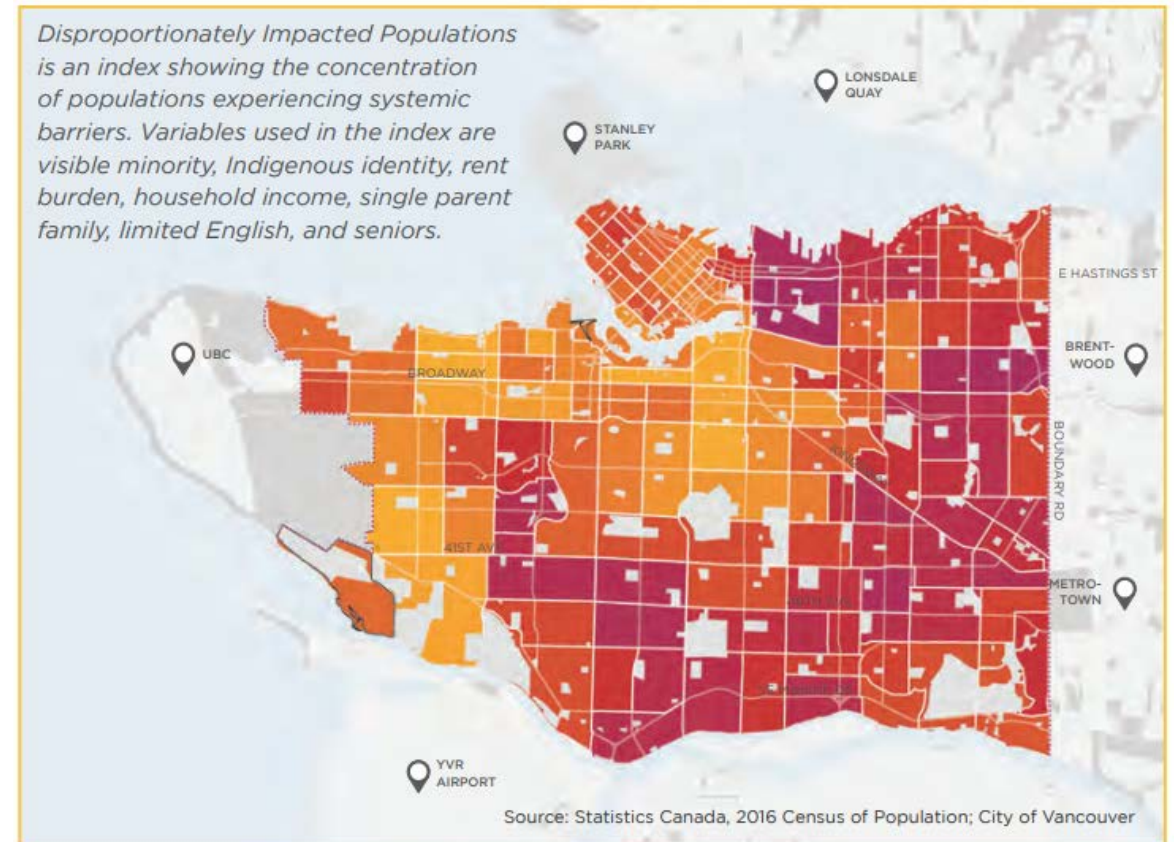
# MULTI-CRITERIA DECISION ANALYSIS

## SOCIAL

Impact of Asset Failure

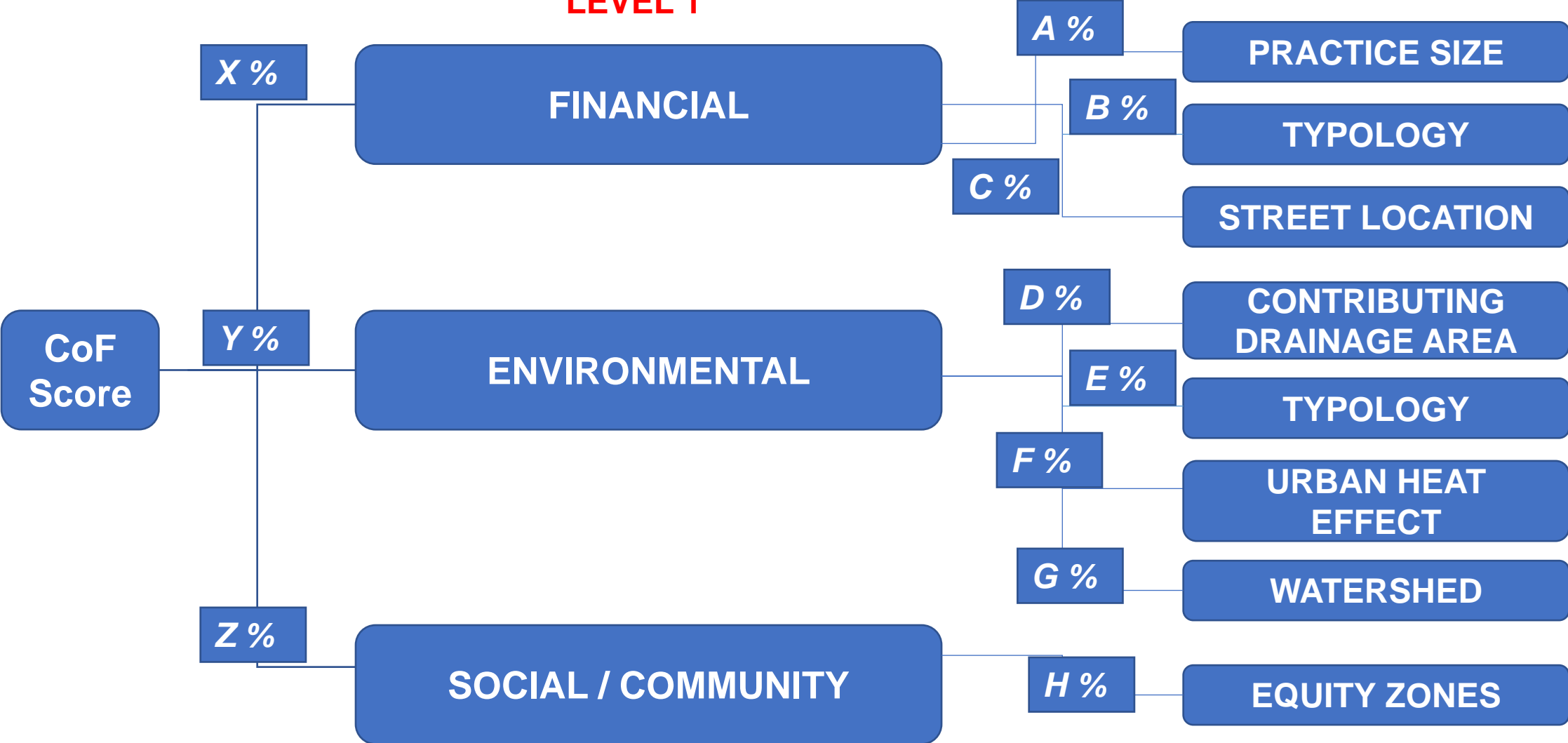
## DISPROPORTIONATELY IMPACTED COMMUNITIES / EQUITY SCORE

- Seniors (people aged 65+)
- Indigenous people
- Visible minorities
- Single-parent households
- People with limited knowledge of English
- Rent-burdened households (30%+ of income spent on rent)
- Median household income



# MULTI-CRITERIA DECISION ANALYSIS

NEED TO ASSIGN WEIGHTS  
LEVEL 1



# ***MULTI-CRITERIA DECISION ANALYSIS***

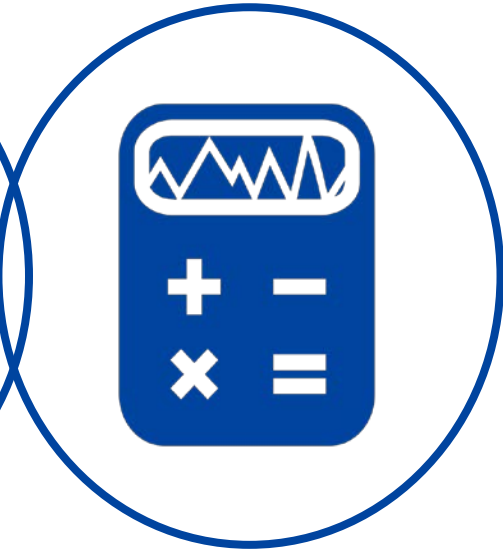
## **ANALYTICAL HIERARCHY PROCESS (AHP)**



**GROUP DECISION  
MAKING PROCESS**



**SUBJECTIVE  
HUMAN  
JUDGEMENT**



**OBJECTIVE  
EVALUATION**

# MULTI-CRITERIA DECISION ANALYSIS

## BEFORE

ASSET ID
Asset # 001
Asset # 002
Asset # 003
Asset # 004
Asset # 005
Asset # 006
Asset # 007
Asset # 008
Asset # 009
Asset # 010

**ABILITY TO  
RANK OUR  
ASSETS BASED  
ON CRITICALITY  
FOR  
OPTIMIZING  
RESOURCES**

## AFTER

ASSET ID
Asset # 009
Asset # 001
Asset # 010
Asset # 003
Asset # 002
Asset # 008
Asset # 007
Asset # 006
Asset # 005
Asset # 004

3

## KEY TAKEAWAYS

# ***KEY TAKEAWAYS***

1. Employ tools that help you shift focus from being asset-centric to being service-centric / from managing assets to asset management
2. Data, data, data – Focus on maturing your asset register and collecting crucial attribute data
3. Ensure your asset criticality framework takes into consideration the overall goals and strategies defined by your organization
4. Analytical Hierarchy and Pairwise Comparison can help you engage a large stakeholder group and scale your model



THANK YOU

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