Schnabel ENGINEERING

Risk Management on Infrastructure Tunnel Projects

Matt Koziol, PE

Photo courtesy of DC Water

Learning Objectives

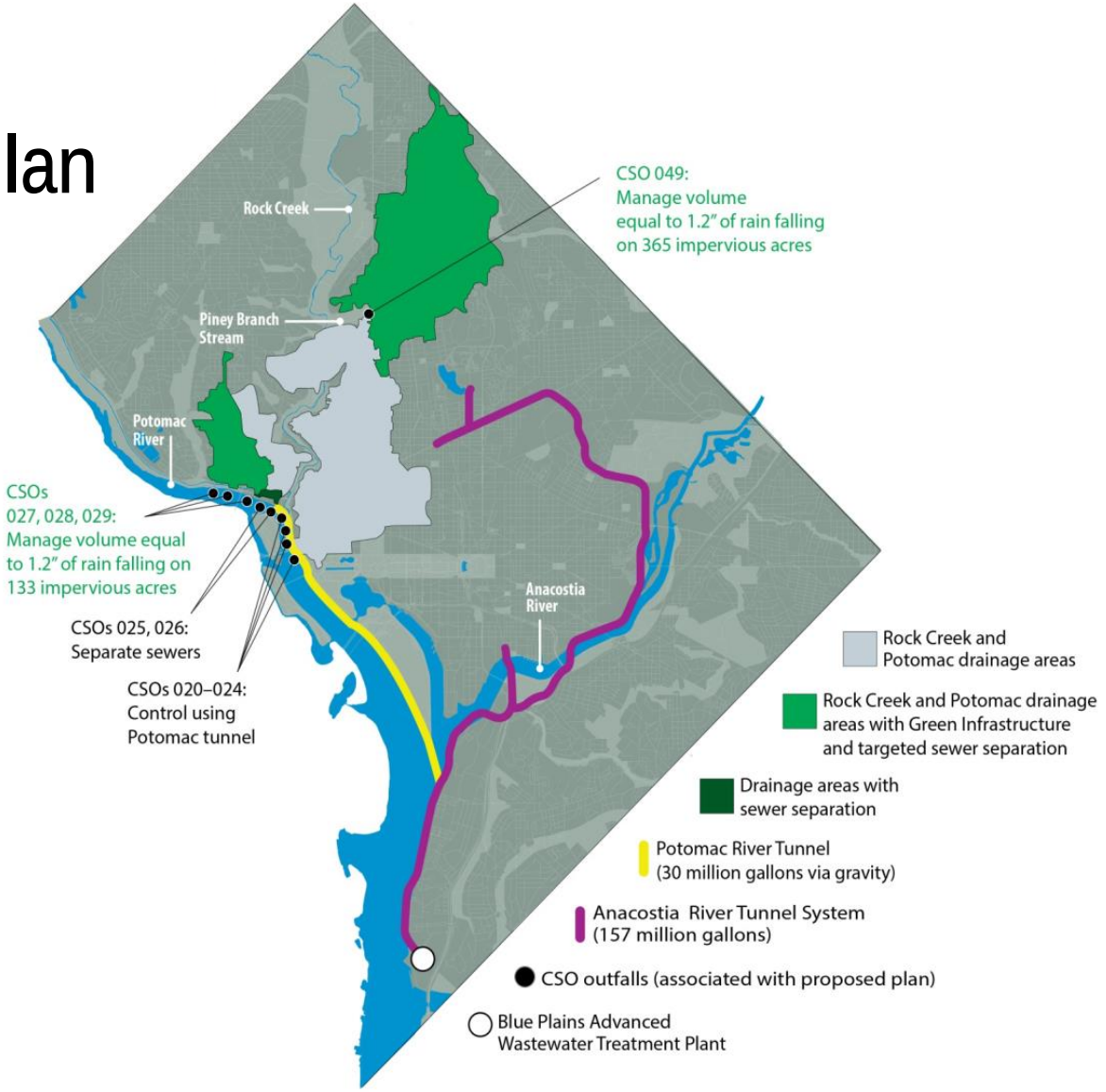
1. An appreciation for the size and complexity of the **DC Clean Rivers Project**
2. A cursory understanding of **risk management theory and processes**
3. **Results** of the Risk Management process for DCCRP

dc water is life

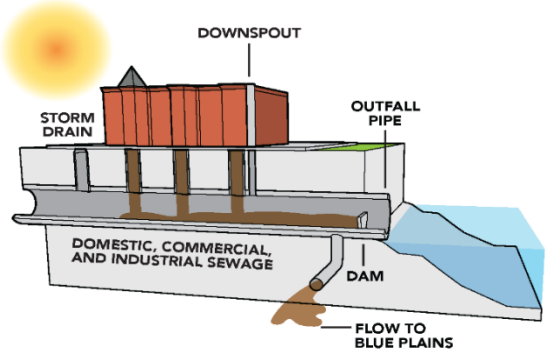
DC Clean Rivers Project (DCCRP)

In 2005, DC Water entered into a consent decree with the **Department of Justice**, the **EPA**, and the **District of Columbia** and embarked on what is currently a 25-year (2005-2030), $2.77 billion program christened the **DC Clean Rivers Project** to reduce CSOs into the Anacostia River, the Potomac River, and Rock Creek by 96% during an average year.

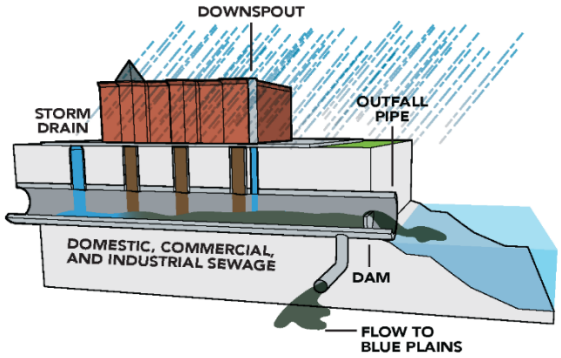
DC Clean Rivers Overview Current Plan



What is a CSO?



COMBINED SEWER DURING DRY CONDITIONS

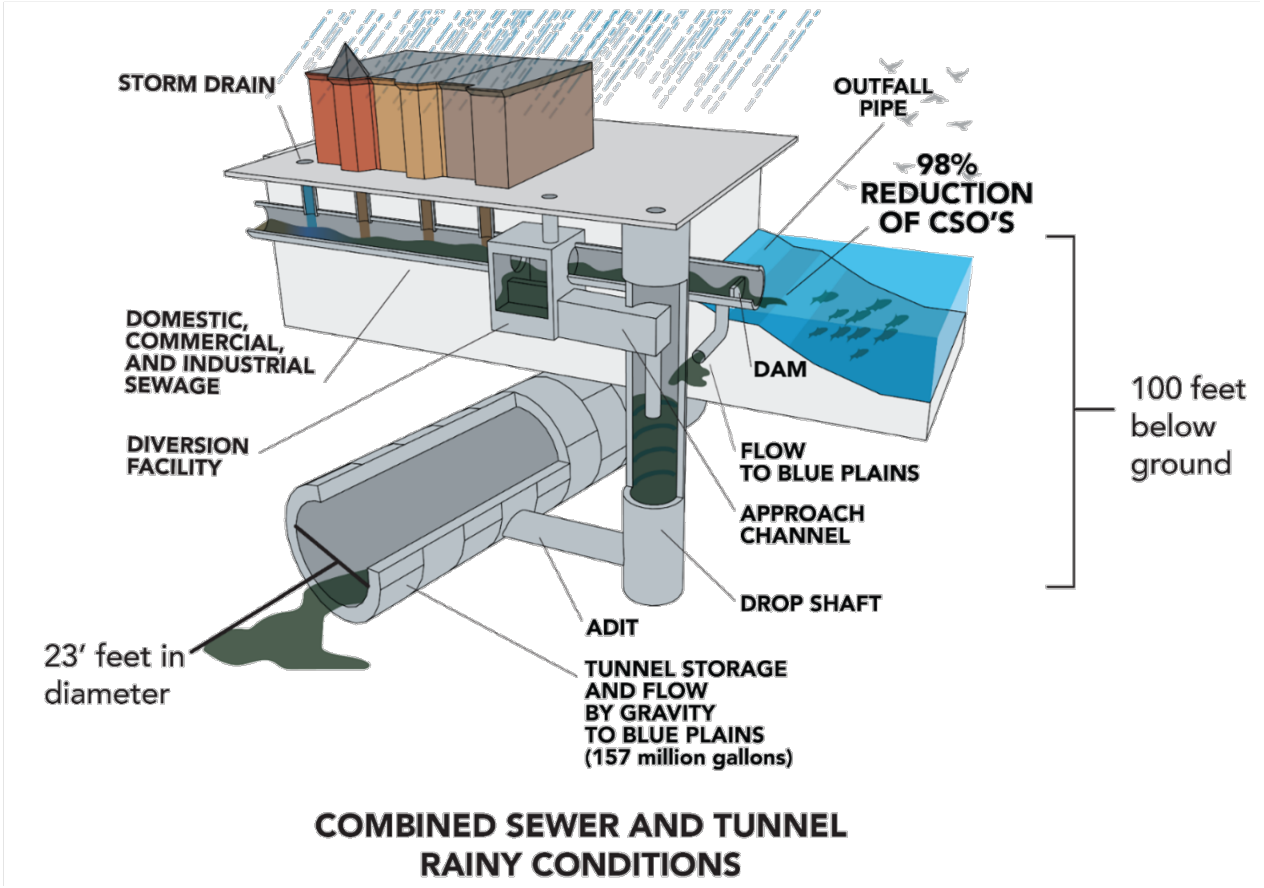


COMBINED SEWER DURING RAINY CONDITIONS

CSO Discharge to Anacostia River

On average, 2.1 billion gallons of untreated sewage and stormwater runoff (combined sewage) are discharged to the Anacostia River per year

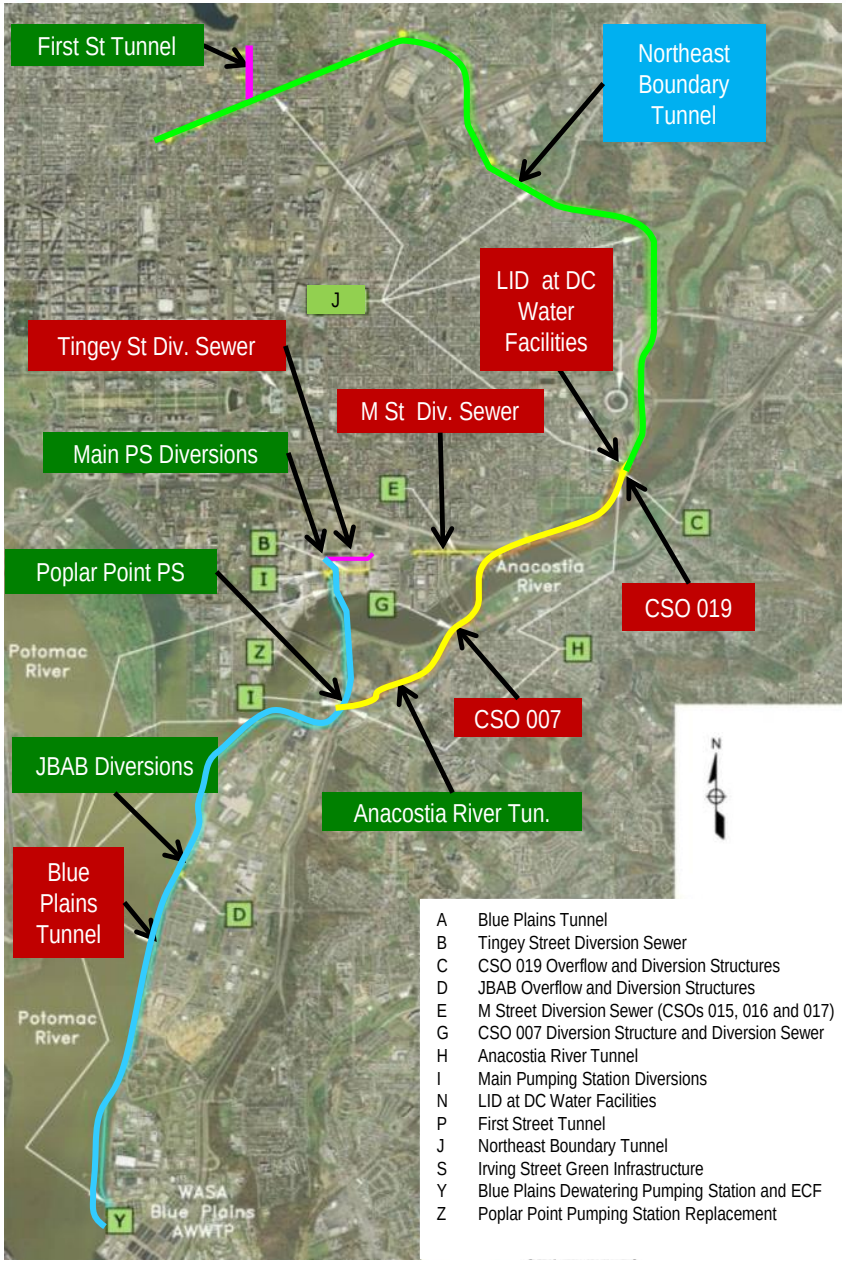
DCCRP Project Solution for the Anacostia River



Anacostia River Tunnel System Snapshot

- Procurement
- Construction
- Completed

More than $1.3 B in Contracts have been let for the Anacostia River Projects



Anacostia River Tunnel System Snapshot

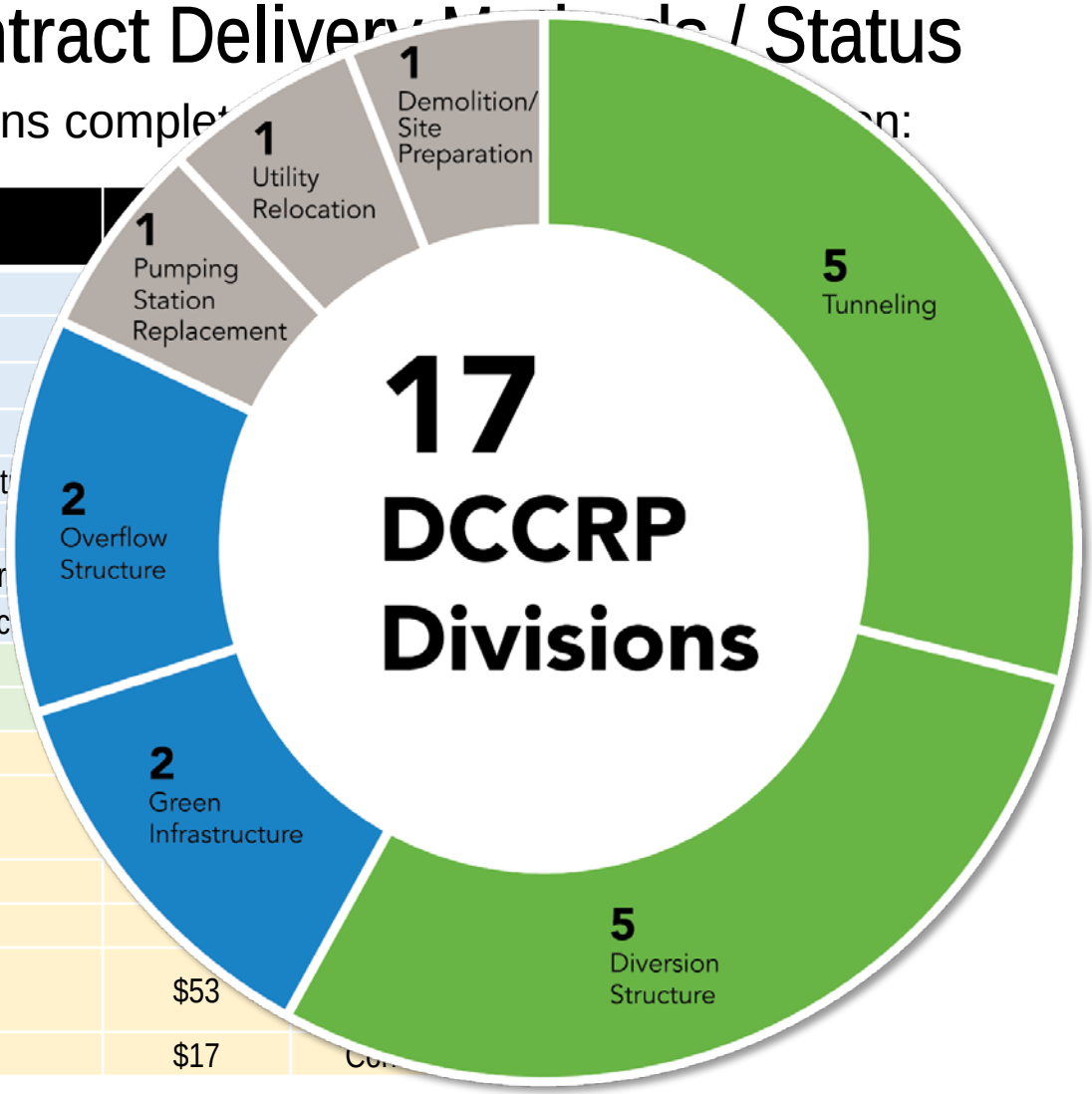
Project	Diameter	Length	Start	Finish
Blue Plains Tunnel	23	24,207	5/2011	12/2015
Anacostia River Tunnel	23	12,484	6/2013	12/2017
Northeast Boundary Tunnel	23	27,000	9/2017	5/2023
First Street Tunnel	20	2,700	10/2013	10/2016

Combined total length of 12.6 miles

DCCR Projects Contract Delivery Methods / Status

A total of 17 separate Divisions comple n:

	Div	Description		
Design-Build	A	Blue Plains Tunnel		
	H	Anacostia River Tunnel		
	P	First Street Tunnel		
	I	Main Pumping Station Diversions		
	D	JBAB Outfall and Diversion Struct		
	J	Northeast Boundary Tunnel		
	PR-A	Potomac Area Green Infrastructur		
	RC-A	Rock Creek Area Green Infrastruc		
CMAR	B	Tingey Street Diversion Sewer		
	PR-B	CSO 021 Diversion Facilities		
Design-Bid-Build	W	Blue Plains Demolition		
	C	CSO 019 Outfall and Diversion Structures		
	G	CSO 007 Diversion Sewer		
	E	M Street Diversion Sewer		
	Z	Poplar Point Pumping Station Replacement	$53	
	U	NEBT Utility Relocations	$17	



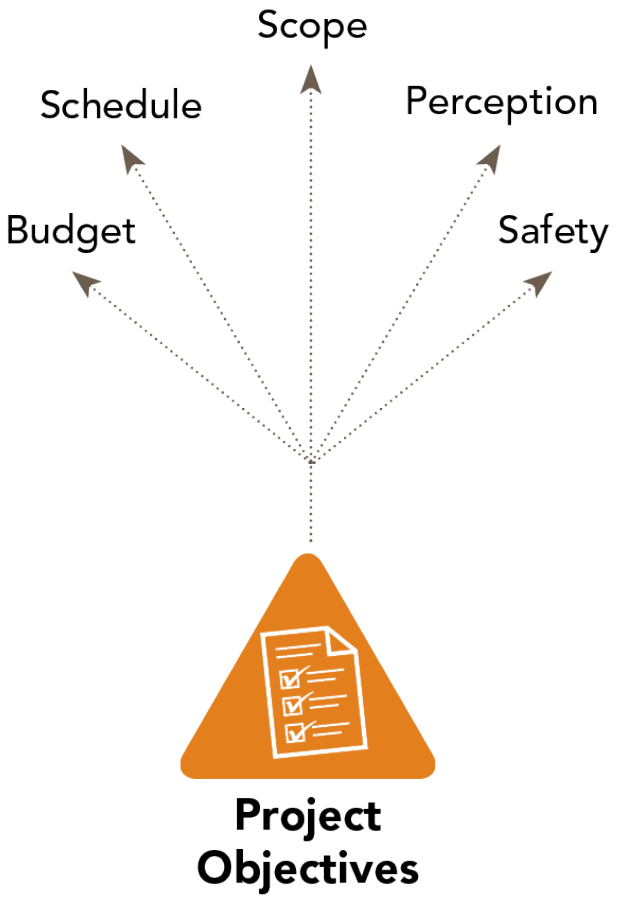
Introduction to Risk Management

Our Risk Management Approach

Risk Management = Identification + Evaluation + Mitigation

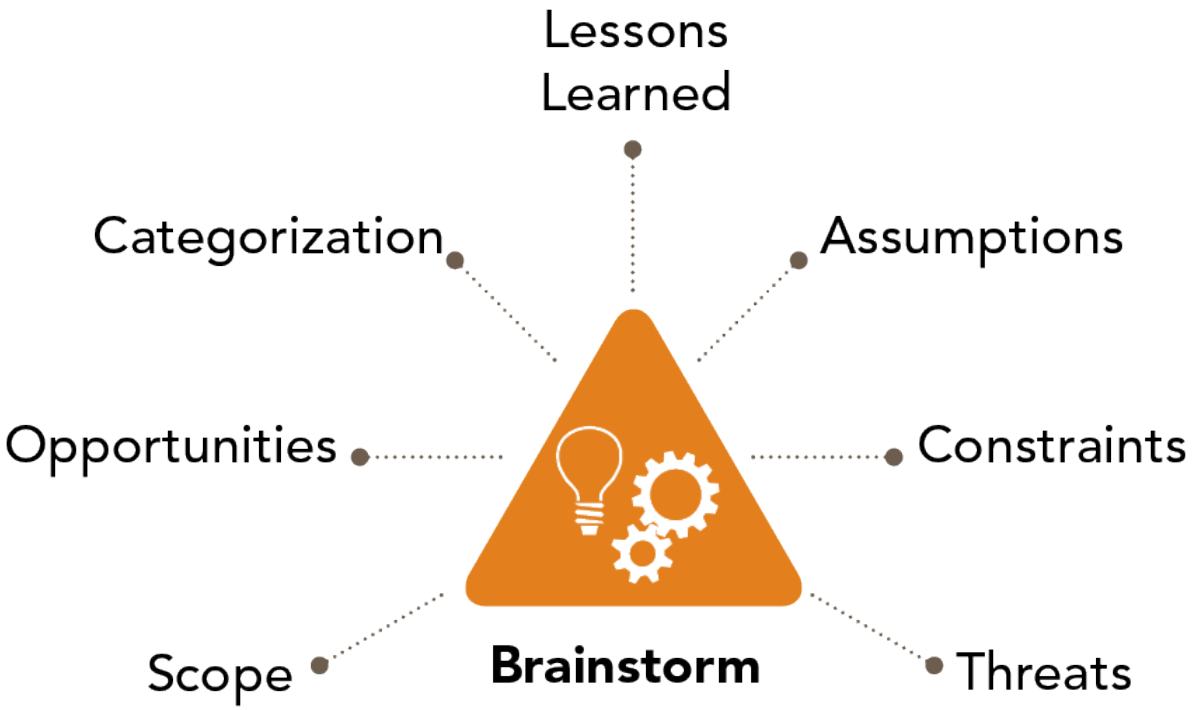
Identification

A risk is an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives[1].



[1] Project Management Institute (PMI) - *A Guide to the Project Management Body of Knowledge* (PMBOK Guide)

Identification



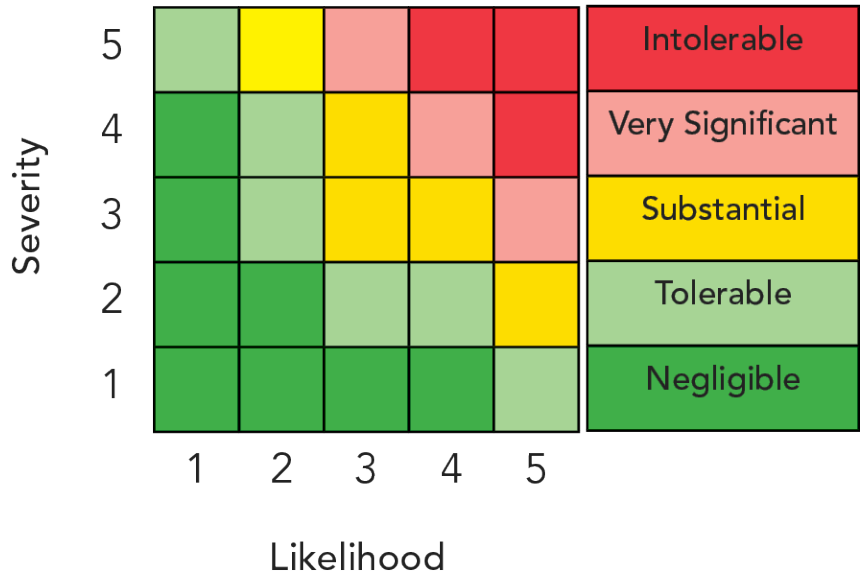
Identification Risk Breakdown Structure

Planning	100	General Planning
	200	ROW & Easements
	300	Permits
	400	Public Relations/Acceptance
	500	Legal Funding
Design	600	Engineering
Procurement	700	Contracting Issues
Construction	800	Material, Equipment & Labor Supply
	900	Environment/Public Impacts
	1000	General Site Conditions
	1100	Construction
	1200	Material Installation
	1300	Safety & Security
Operations	1400	System Operations

Evaluation

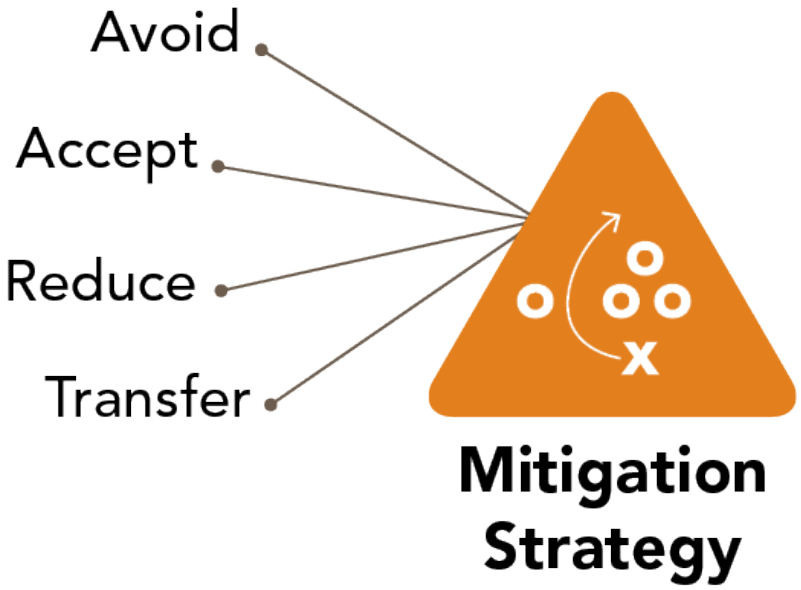
In a collaborative workshop the risks are qualitatively rated by evaluating or assessing and combining each risk's relative likelihood of occurrence and severity of consequence on a scale of 1-5 to determine a risk rating for each risk.

Risk Rating = L x S



Mitigation

Utilizing the risk ratings as a prioritization tool, mitigation actions are developed and assigned to a responsible party or person.



Mitigation: Risk Register

Risk ID	Risk							
					8	1. Submit MOT plans to DOT early. 2. 3.	1. Designer 2. 3.	
100	**PROJECT PLAN**							
101	Failure to adequ... sufficient size sta... construction.				12	1. Research State requirements. 2. Determine theoretical drawn-down levels. 3.	1. Designer 2. Designer 3.	
200	**PROJECT PLAN**							
201	Unable to obtain				8	1. Research power needs and availability. 2. Develop list of permits. 3. Conduct a permit preapplication meeting.	1. Owner/Designer 2. Designer 3. Designer	
300	**PROJECT PLAN**							
301	Difficulty in obtaining or maintaining permit for dewatering.	S - Schedule	4	3	12	1. Research State requirements. 2. Determine theoretical drawn-down levels. 3.	1. Designer 2. Designer 3.	1. Ongoing 2. Ongoing 3.
302	An unknown permit is required (e.g. air quality).	S - Schedule	4	2	8	1. Research power needs and availability. 2. Develop list of permits. 3. Conduct a permit preapplication meeting.	1. Owner/Designer 2. Designer 3. Designer	1. Ongoing 2. Ongoing 3. Complete
400	**PROJECT PLANNING & DEVELOPMENT - Public Relations/Acceptance**							
401	Local public opposition to road closures/traffic issues associated with construction.	C - Cost O - Other	5	3	15	1. Educate community about project. 2. Identify construction haul and access routes. 3. Identify alternate routes and detours.	1. Owner 2. Owner/Designer 3. Designer	1. Ongoing 2. Ongoing 3. Future

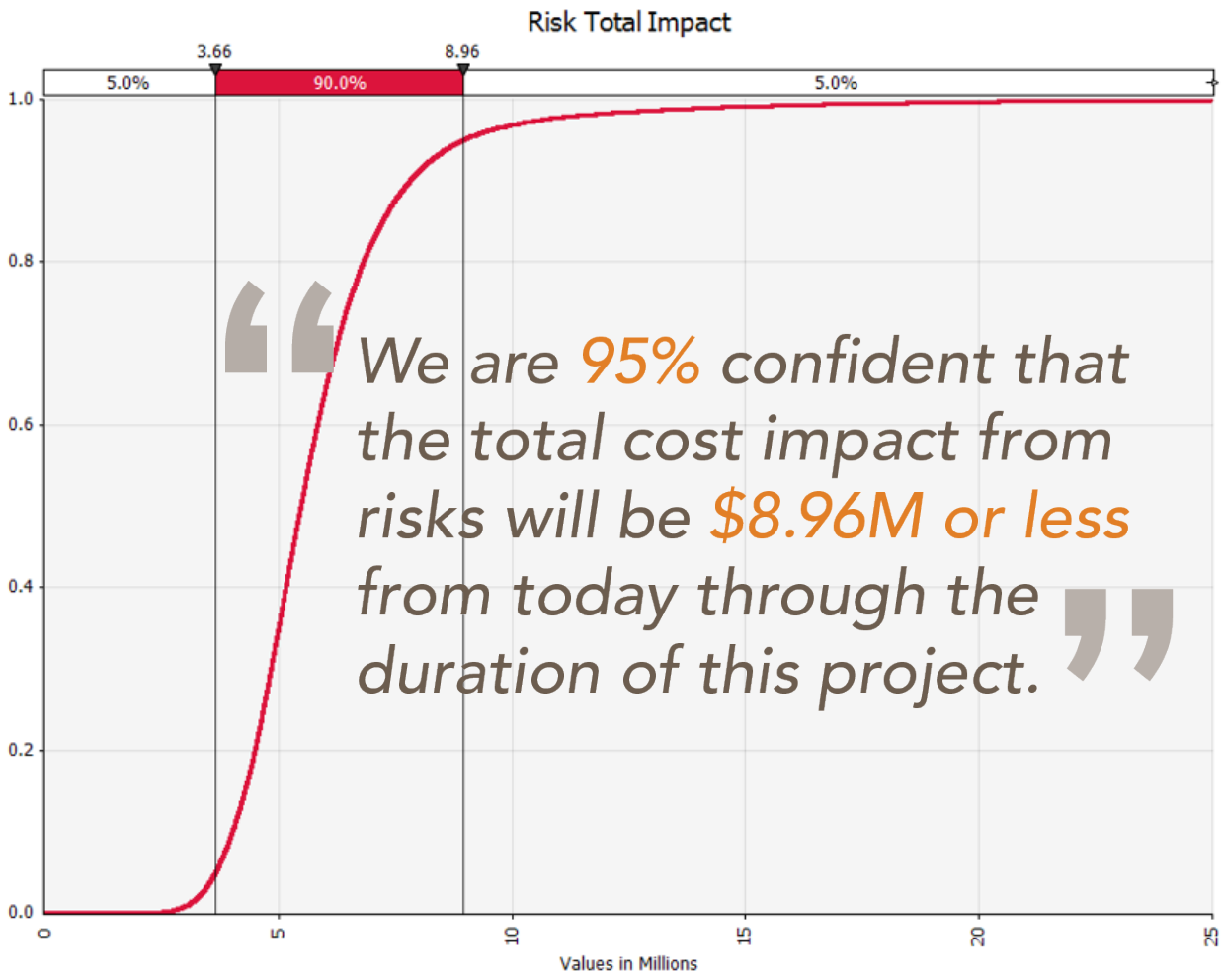
Quantitative Cost Analysis

In a collaborative workshop we quantify each cost impact risk by assigning a probability of occurrence and a range of cost consequences in dollars.

Risk ID	Risk Description	Probability of Occurrence %	Owners Share of Risk %	Multiple Occurrence Possible?	Consequence in $ C				
		P	O	Y/N	Min	10%	50%	90%	Max
900	**CONSTRUCTION - Environmental/Public Impacts (permit non-compliance)**								
903	Contaminated groundwater drawn into excavations resulting in extra cost, time and 3rd party claims	**5%**	**100%**	**Y**	$250k	$300k	$500k	$700k	$750k
904	Contractor encounters cultural or archaeological resources (or potentially cultural or archaeological resources) during construction	**90%**	**100%**	**Y**	$25K	$100K	$250K	$300K	$750K
908	Contractor unable to cut off water from excavations due to multiple SOE systems is used	**50%**	**100%**	**Y**	$0k	$50k	$500k	$700k	$2500k
1000	**CONSTRUCTION - General Site Conditions**								
1001b	Construction fails to complete TBM removal in their 90-day window	**50%**	**100%**	**N**	$100k	$200k	$400k	$750k	$1000k

Cost Impacts = P x C x O

Quantitative Cost Analysis



"We are 95% confident that the total cost impact from risks will be $8.96M or less from today through the duration of this project."

Statistics	
	Risk Total Impact
Cell	Model Input!N40
Minimum	2,068,530.85
Maximum	44,731,537.01
Mean	5,847,790.91
Mode	5,363,318.61
Median	5,480,507.84
Std Dev	2,047,429.24
Skewness	3.2810
Kurtosis	23.3622
Values	100000
Errors	0
Filtered	0
Left X	3,655,268.23
Left P	5.0%
Right X	8,958,395.72
Right P	95.0%
Dif. X	5,303,127.49
Dif. P	90.0%
1%	3,067,545.79
5%	3,655,268.23
10%	4,016,503.33
15%	4,281,177.80
20%	4,495,389.03
25%	4,674,587.00
30%	4,837,914.75
35%	4,999,721.91
40%	5,156,557.49
45%	5,316,837.94
50%	5,480,507.84
55%	5,648,957.04
60%	5,833,421.40
65%	6,034,870.88
70%	6,253,002.06
75%	6,506,258.14
80%	6,817,282.03
85%	7,222,740.59
90%	7,813,850.38
95%	8,958,395.72
99%	14,243,416.86

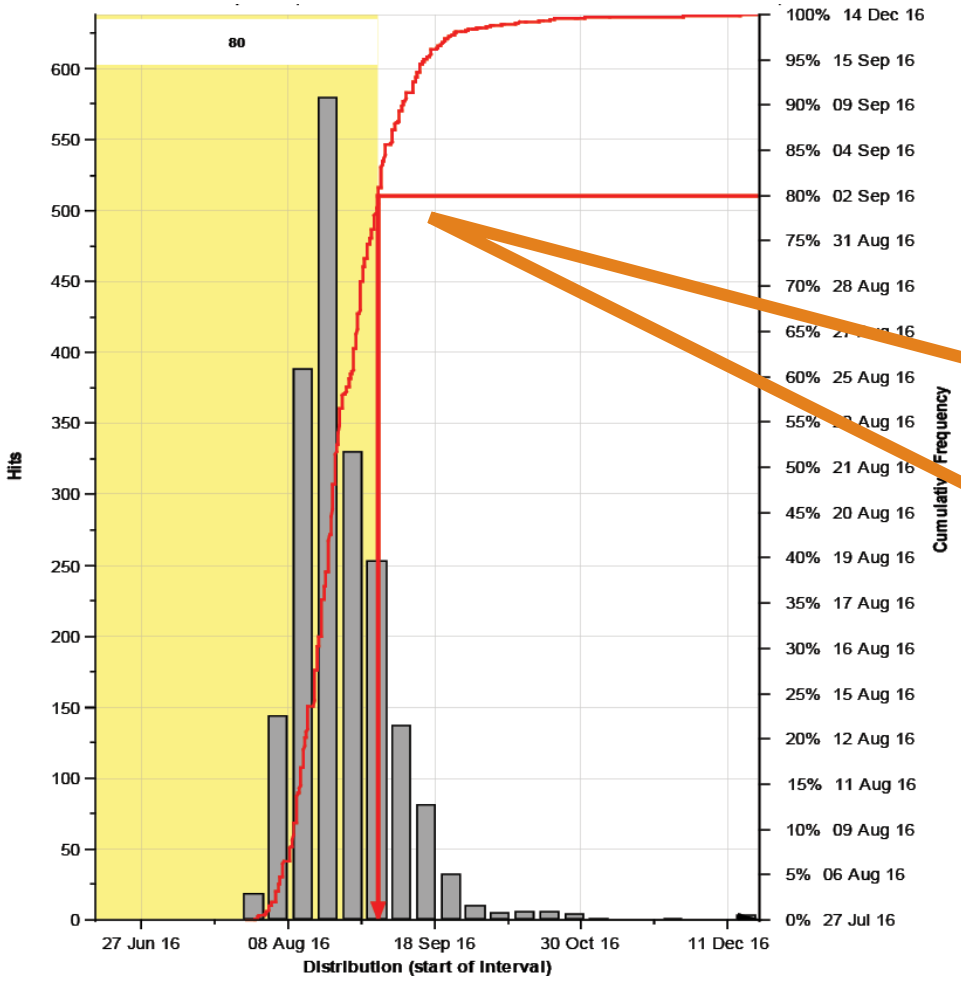
Quantitative Schedule Analysis

Risk ID	Risk Description	Schedule Activity	Probability of Occurrence %	Consequence in Days		
				Minimum	Most Likely	Maximum
1100						
1103	Tunneling induced settlement of CSX railroad, exceeds allowable limits	**TBM-CON-1120**	**2%**	5	10	20
1107	Existing sewers or utilities are damaged due to age or condition	**CON-VS-1570 CON-VS-1240**	**20%**	3	5	10

The variability of schedule activities are also assigned

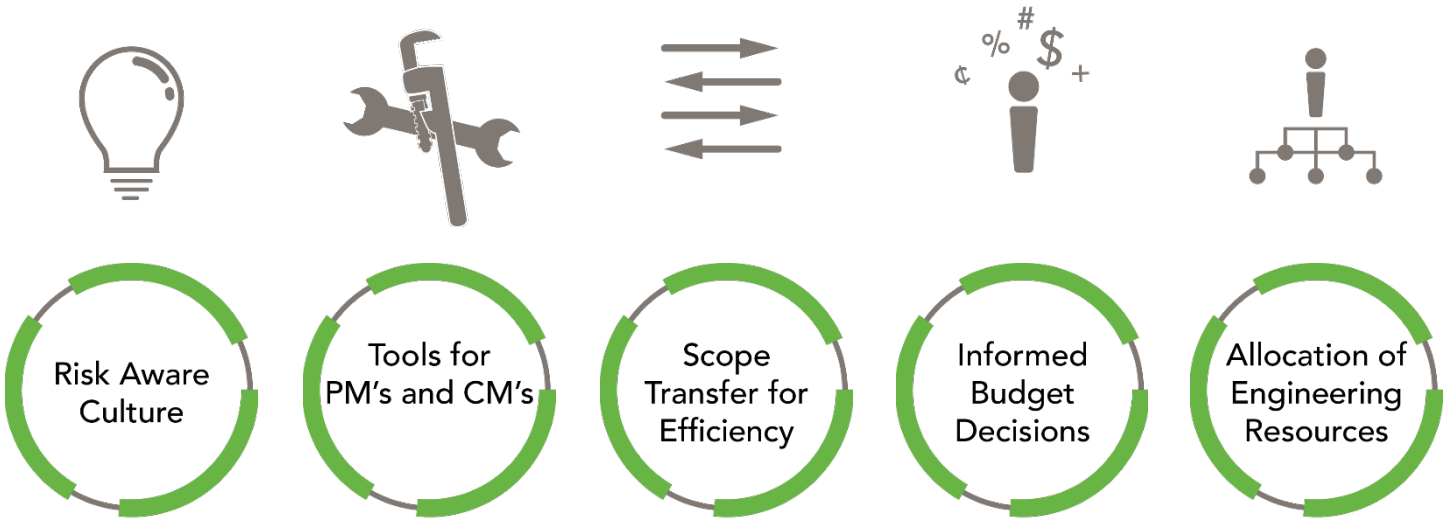
Activity ID	Activity	Activity Duration		
		Minimum	Most Likely	Maximum
TBM-CON-1120	**TBM mine from Station 0+00 to 12+43**	20	25	35
CON-VS-1570	**Tie-in to existing 36" RCCP water main**	3	5	10

Quantitative Schedule Analysis



"We are 80% confident that, considering the impacts of risks and the estimated variability in selected activity durations, the project will finish on 09-02-16 or earlier."

Results of Risk Management Process for DCCRP



Thank You

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