Project Risk Management Basics: Cost and Schedule Impacts

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Risk Management Background

What is Risk?

- A risk is something that may happen, and if it does, will have either a positive or negative impact on the project
- Risk is an uncertain event that, if it occurs, has an effect on at least one project objective (e.g., time, cost, scope, quality – PMI 2004)

Consideration: There are one or more active conditions that influence the risk's probability of occurrence and one or more response conditions that influence the risk's impact

What is Risk Management?

- An intuitive process
- A “good management practice” tool to enhance the chances for an endeavor’s success
- A systematic, disciplined process that satisfies strategic objectives through management of life cycle risks

Experienced Project Manager

- Risk Management?
- I’ve Always Done That!
- What do they want me to do differently?

Benefits of Risk Management

- Prioritizes risks for Senior Managers to focus
- Provides managers with the means to decide where best to invests the program's time and money
- Complies with owner's and funding agency's requirements, (e.g.: validating funding requirements)
- A rational method for calculating realistic and defendable contingency budgets (cost and schedule)
- Forces the team to think collectively and collaboratively in mitigating risks, proactively
- Ensures that procurement and contract terms and conditions reflect the client's risk appetite and project objectives

Core to AECOM Program Management

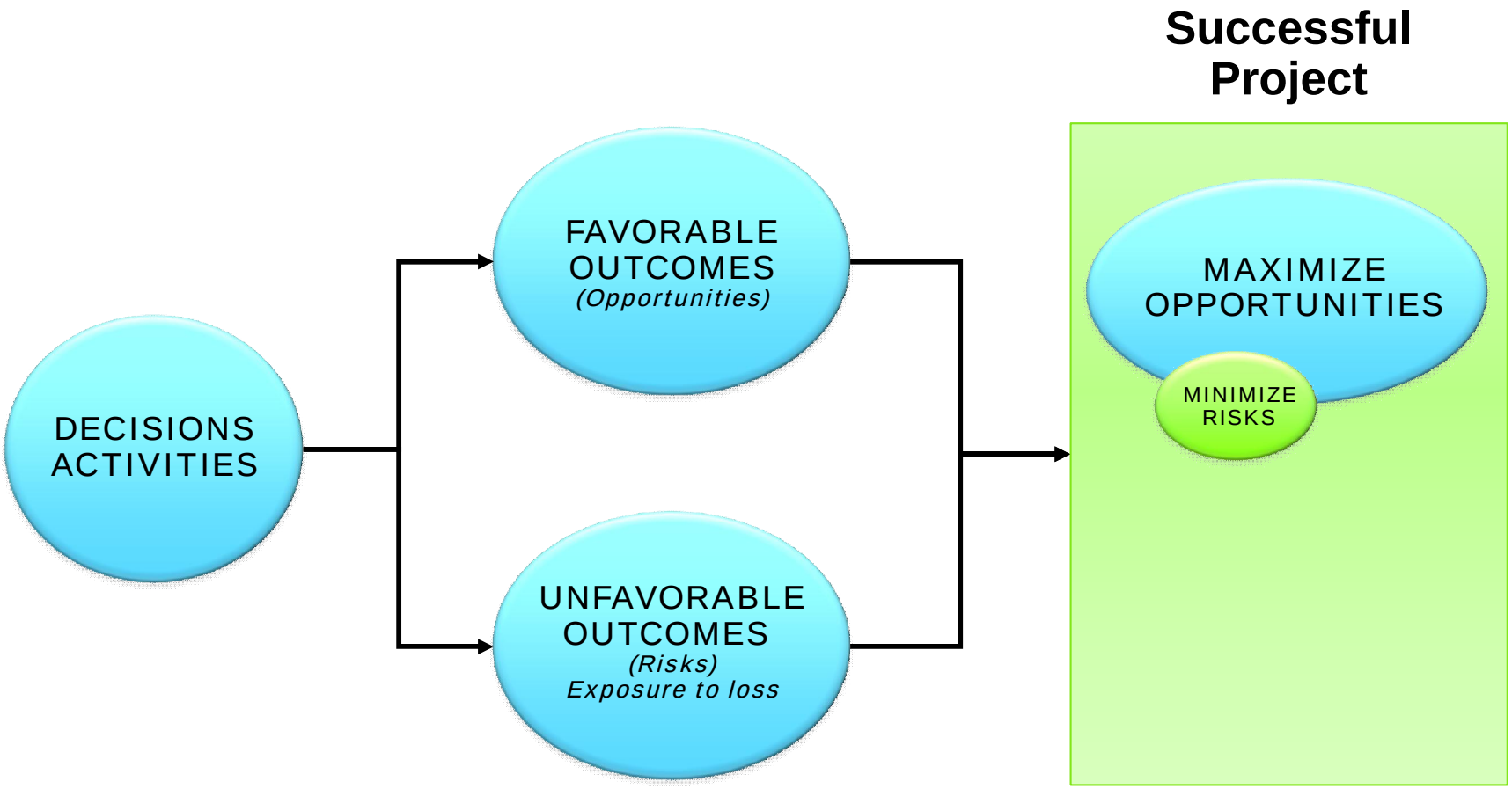
- AECOM's Risk Management practice is guided by:
  - "Practice Standard for Project Risk Management" Project Management Institute (PMI)
  - ISO 31000:2009 "Risk Management - Principles and Guidelines"
  - Practical experience managing over 200 capital programs with total Capex of over US$340 billion
- AECOM has applied Risk Management to capital programs with Capex values of approximately US$100 billion.

Risk Management Experience in Capital Programs

Program	Value (US $ millions)
Second Avenue Subway, New York, USA	$16,000
PATH Permanent World Trade Center Terminal, New York, USA	$2,000
Dallas Area Rapid Transit Airport Extension, Dallas, USA	$300
Dallas Area Rapid Transit Extension-Rowlett, Dallas, USA	$300
Lincoln Center Redevelopment, New York, USA	$750
San Diego International Airport Terminal Expansion, San Diego, USA	$1,000
Amtrak Vent Structures, New York, USA	$100
Central Corridor Light Rail Transit, Minneapolis, USA	$1,000
Route 9A West Reconstruction, New York, USA	$100
Tappan Zee Bridge Environmental Review, New York, USA	$5,000
Central Subway, Phase 2, San Francisco, USA	$1,500
Water Improvement Program, PUC, San Francisco, USA	$4,500
National Network of Highways Program, Trinidad and Tobago	$4,000
Afghanistan Infrastructure and Rehabilitation Program, Afghanistan	$150
Doha Port Qatar, Qatar	$7,000
Capital District Infrastructure Project, Abu Dhabi, UAE	$20,000
Saadiyat Island Cultural District, Abu Dhabi, UAE	$20,000
Abu Dhabi Metro, Abu Dhabi, UAE	$5,000

The Fundamentals

The Fundamentals

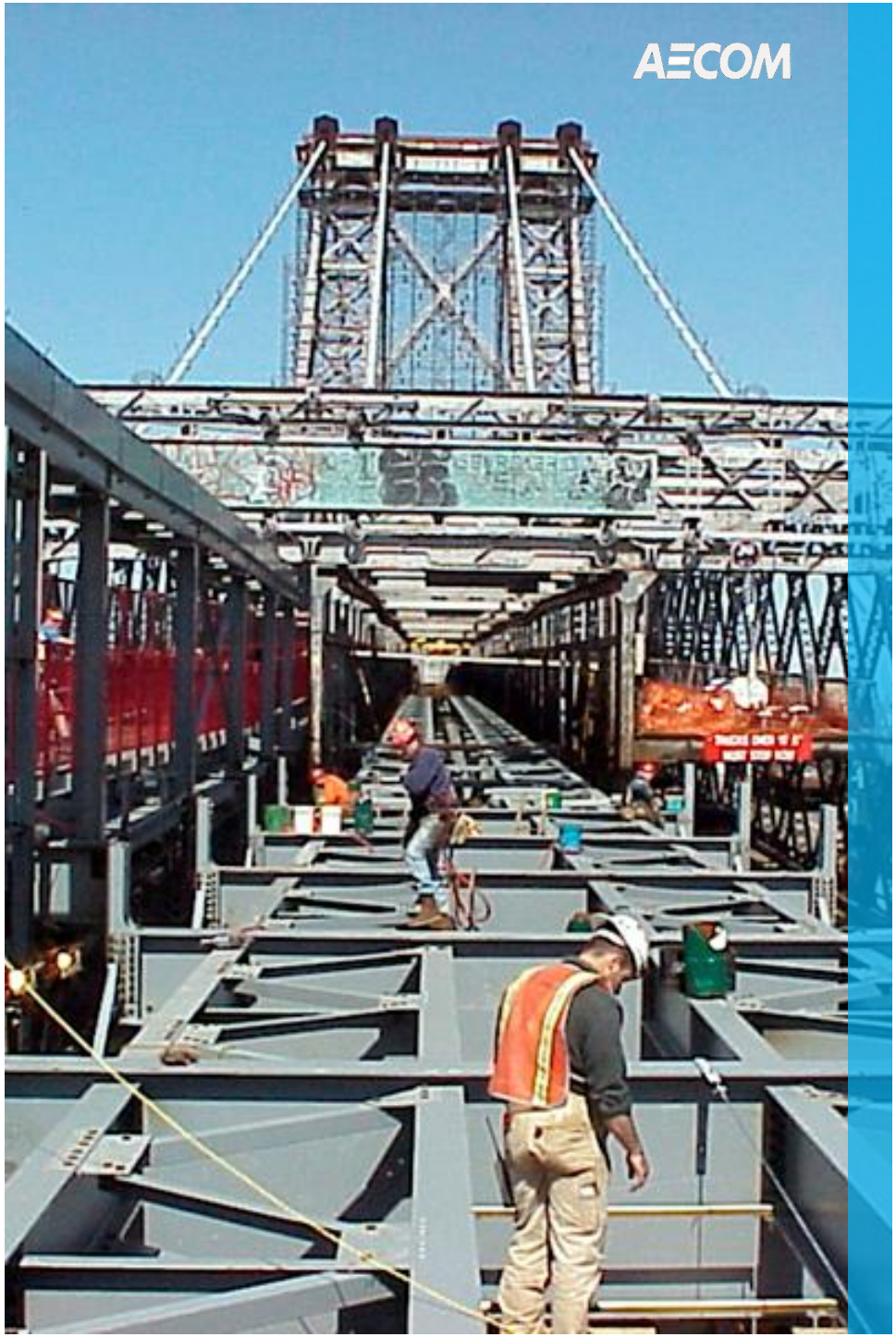


The Fundamentals

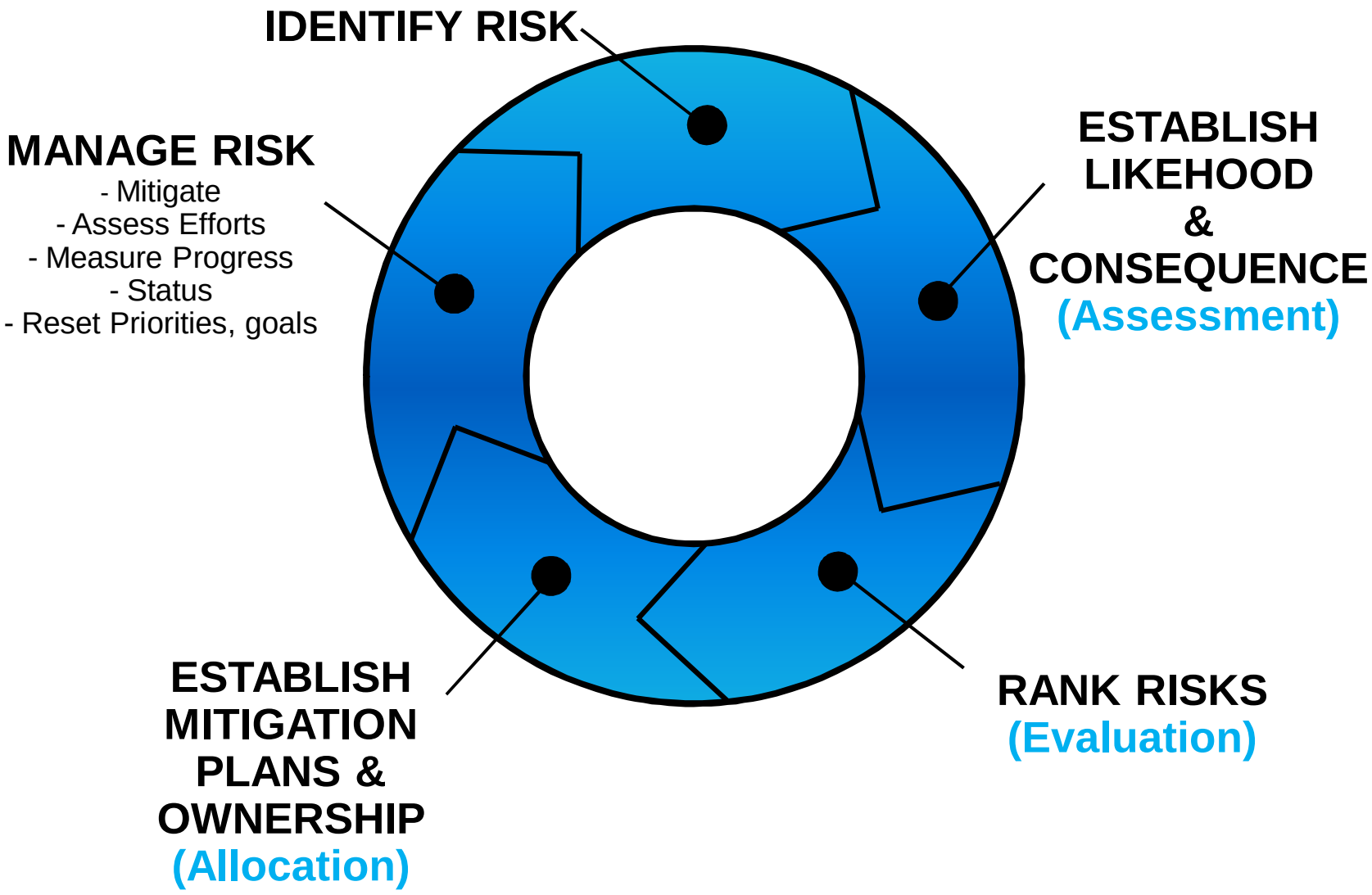
- Meet Political Objectives
- Contribute to Economic Growth
- Meet Transportation Needs
- Satisfy Environmental Objectives

- Within Budget
- Within Schedule
- Meets Quality Objectives
- No Significant Adverse Reaction

The Process



Risk Management Process



Two Approaches to Risk Assessment

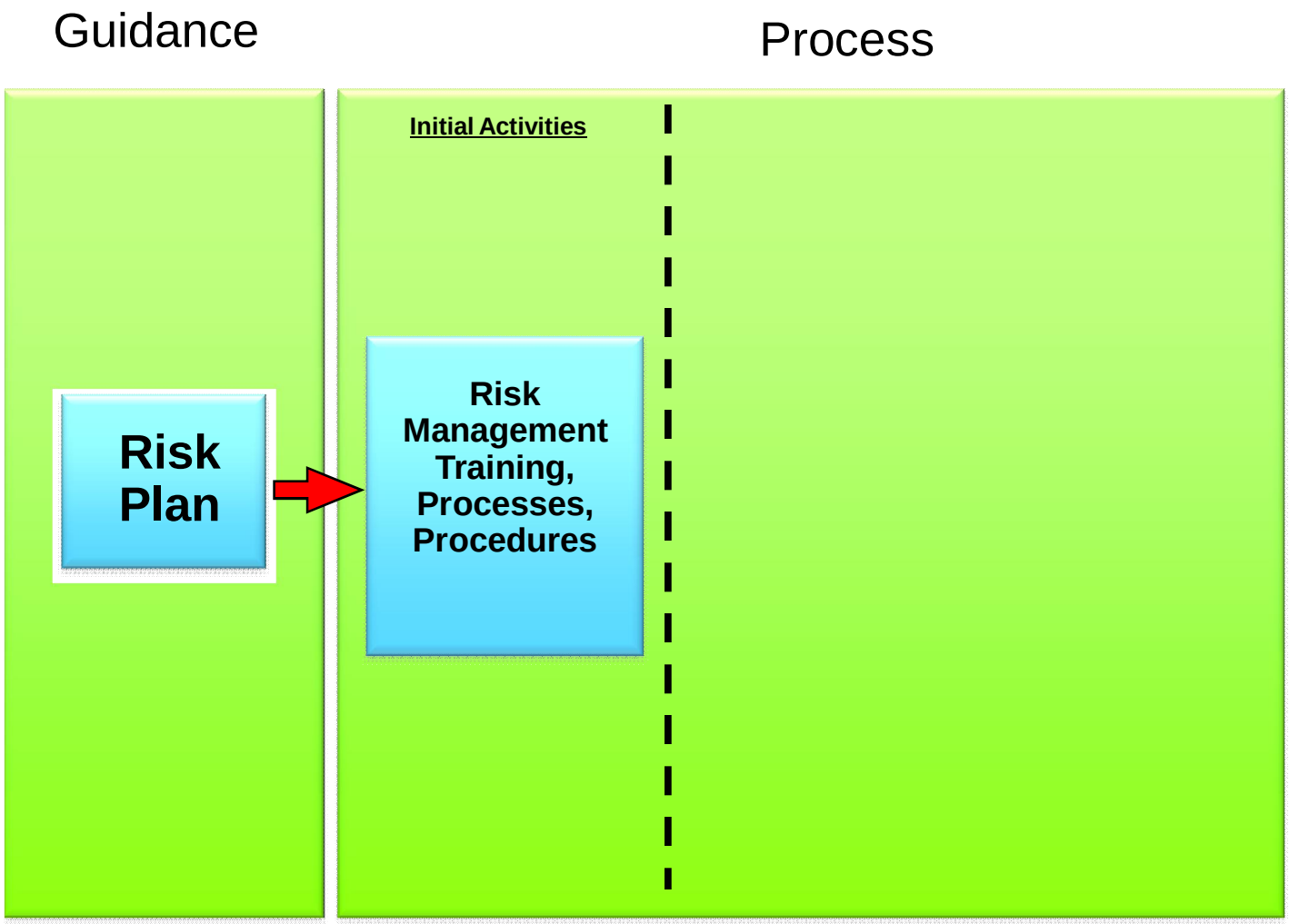
- Qualitative
  - May be used initially to set up a Project Risk Program

- Quantitative
  - Necessary to provide contingency requirements (cost and schedule) and isolate individual risk contributions

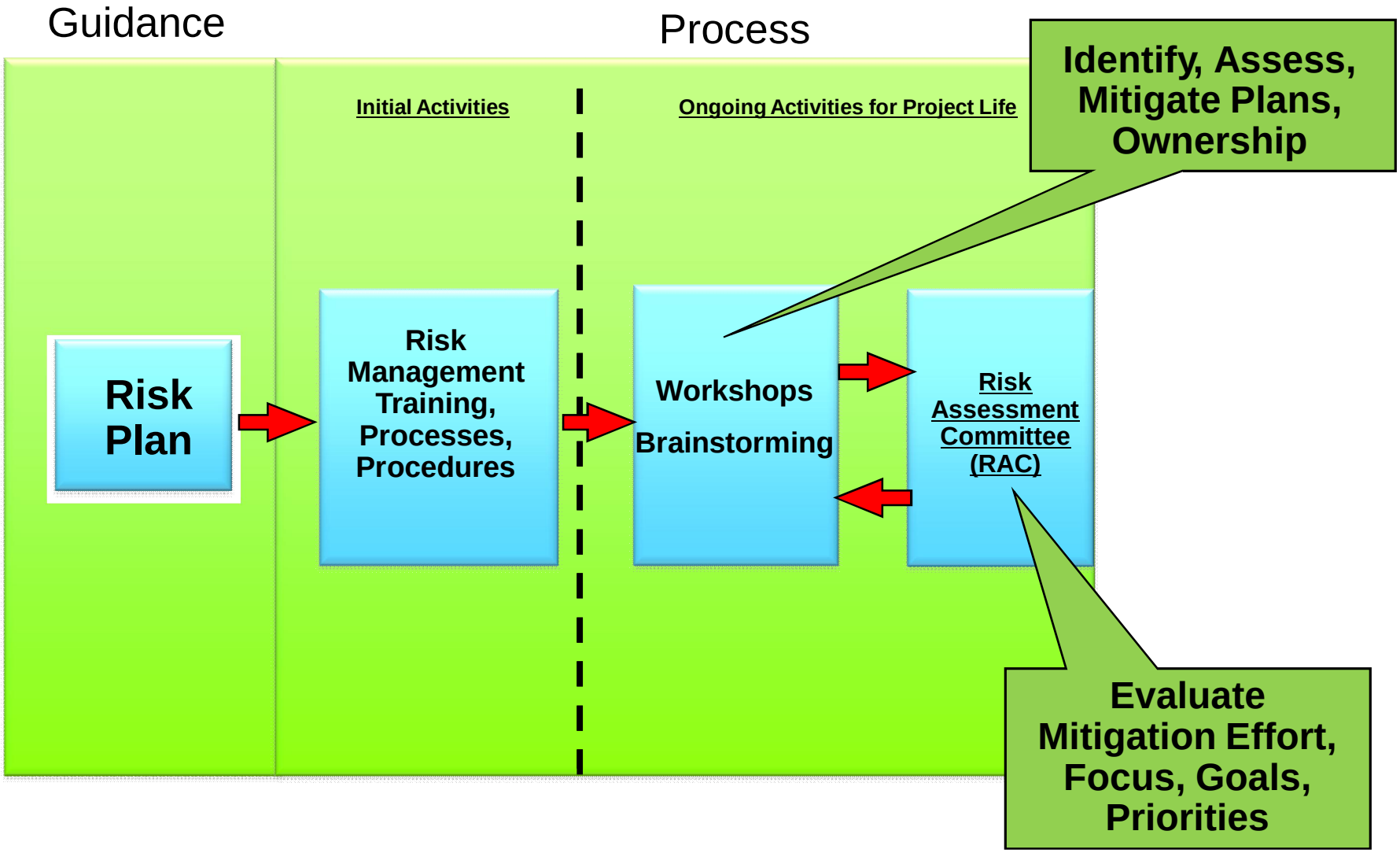
Supporting Elements of RM Process

Guidance

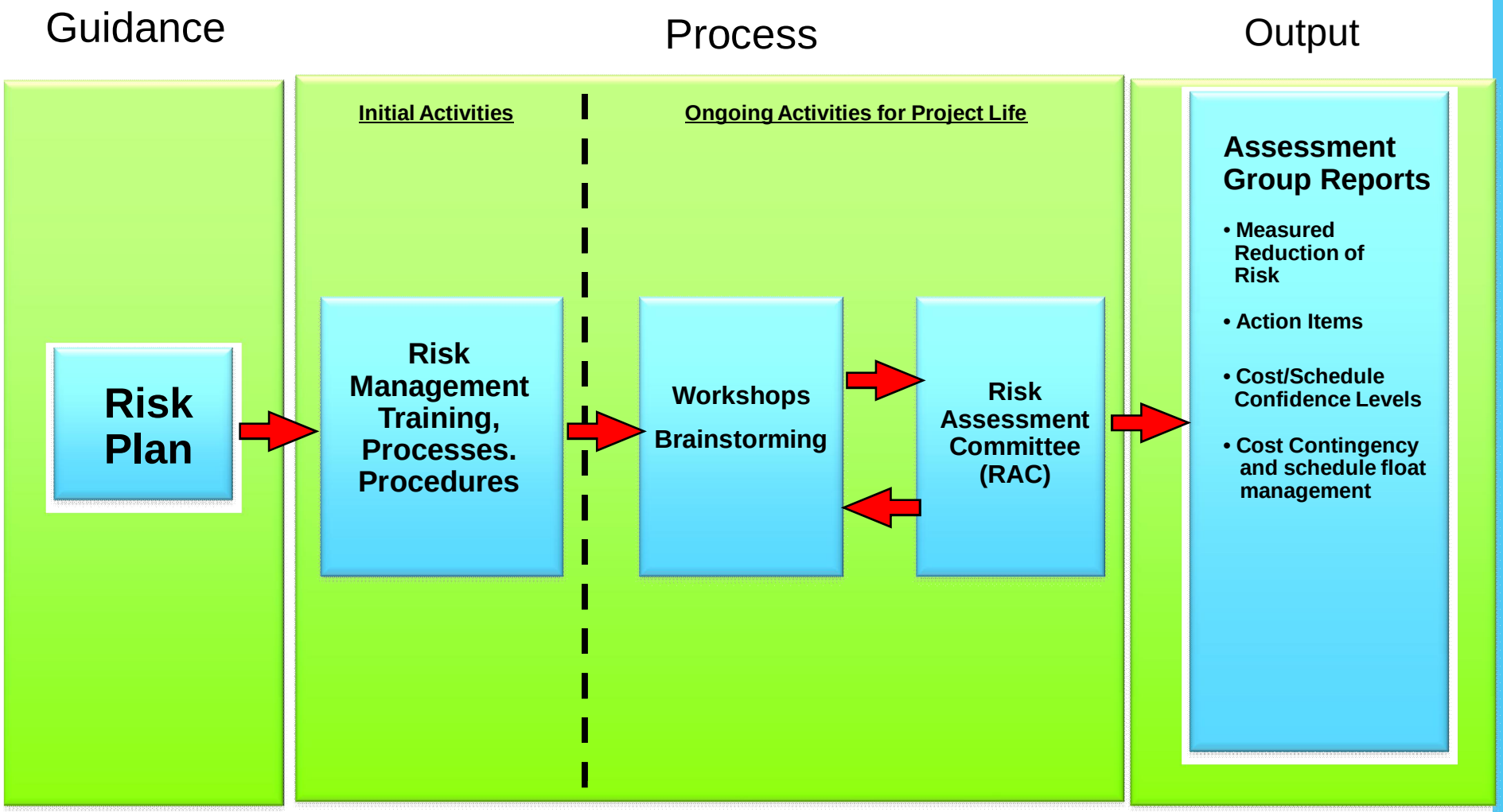
Supporting Elements of RM Process



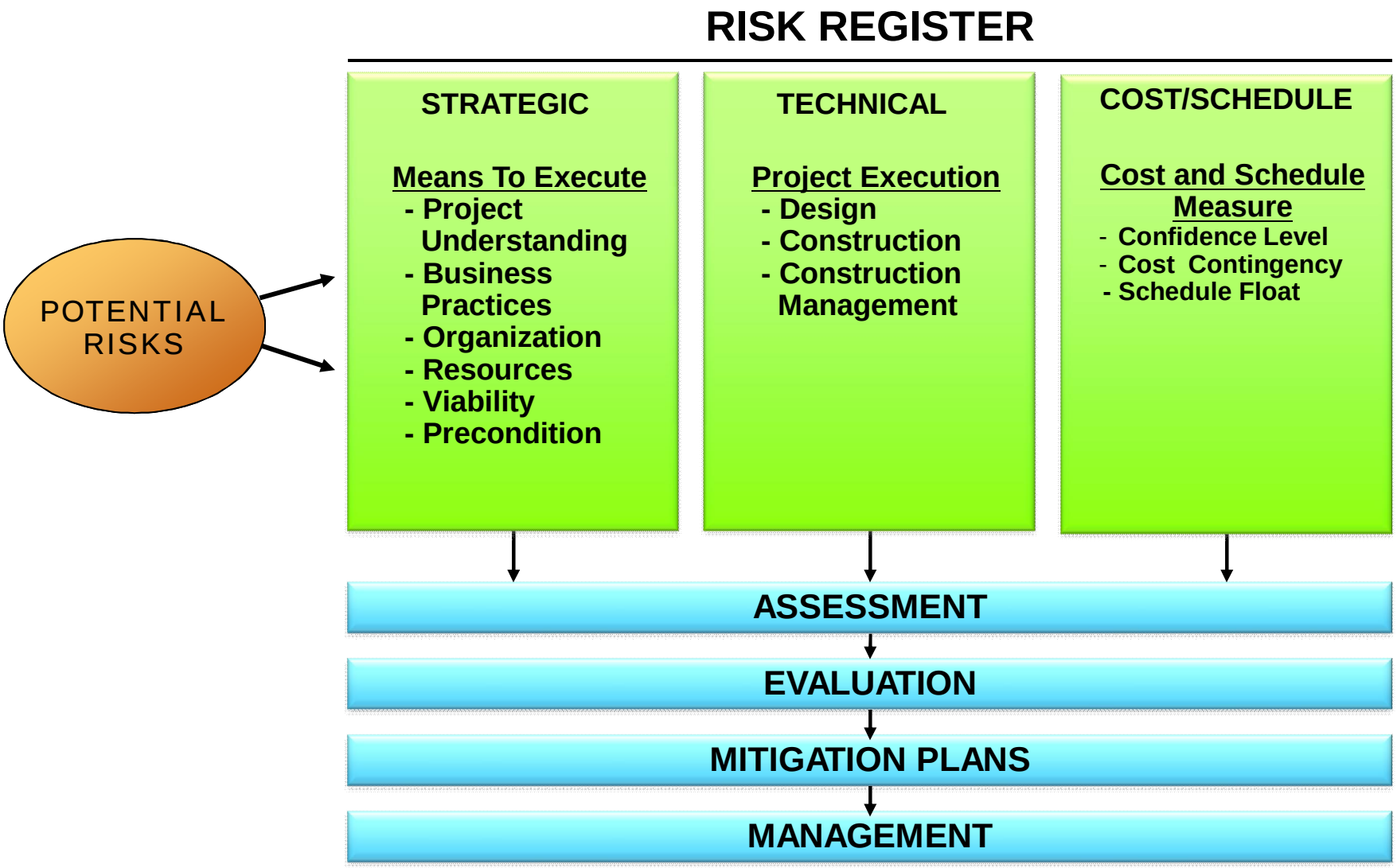
Supporting Elements of RM Process



Supporting Elements of RM Process



Risk Identification



Tools for Risk Identification

- Interviews
- Project Team workshops
- Brainstorming
- Project documents review
- Risk Breakdown Structure
- Check lists
- Cause and effect diagrams
- Questionnaire
- SWOT analysis
- Industry knowledge base
- Influence diagrams
- Post-project review / lessons learned / historical information
- Root-cause analysis
- Force field analysis
- List of assumptions and constrains
- Delphi technique (anonymous polling)

Risk Assessment

- The objective here is to communicate the “expected impact” that will happen if no proactive mitigation plan is implemented in the program/project. And the steps are as follows:
  - Select impacted variable per risk factor (e.g.: cost, schedule, quality, etc.)
  - Calculate expected consequences per risk factor

Expected Value (EV) = Likelihood x Consequence

Risk Assessment

LIKELIHOOD	DESCRIPTION OF FREQUENCY OF EVENT	PROBABILITY	SCALE VALUE
Almost Certain	Event occurs many times during period of project or single event has high likelihood of occurrence	>70%	5
Often	Event occurs several times during period of project or single event has moderate likelihood of occurrence	40 – 70%	4
Likely	Event could occur during period of project	20 – 40%	3
Possible	Event is unlikely to occur, but it is possible during period of project	10 – 20%	2
Rare	Event is so unlikely that it can be assumed not to occur during period of project.	0 – 10%	1

Risk Assessment

CONSEQUENCE	DESCRIPTION OF EFFECT OF EVENT				
	COST (IN MILLIONS)	SCHEDULE	SAFETY	PROJECT PERCEPTION/ POLITICAL REACTION	SCALE VALUE
Catastrophic	Adds up to $250	Adds 12 months	Multiple public accidents	Public perception very poor. Project seriously jeopardized. Serious political consequence to -- Owner	5
Major	Adds up to $100	Adds 6 months	Single public accident and multiple workforce accidents	Project jeopardized. Requires considerable effort to regroup public/political support	4
Moderate	Adds up to $50	Adds 4 months	Single public accident or multiple workforce accidents	Some concern for project viability. Some political consequence experienced by Owner. Moderate effort required to re-establish viability.	3
Minor	Adds up to $25	Adds 2 months	Single workforce accident	Minor concern for project viability and effect on Owner politically	2
Insignificant	Adds up to $10	Adds 1 month	Little possibility of accident	Little or no concern for project viability and effect on Owner politically	1

Traditional Practice of Risk Ranking

CONSEQUENCE PROBABILITY	INSIGNIFICANT (1)	MINOR (2)	MODERATE (3)	MAJOR (4)	CATASTROPHIC (5)
RARE (1)	1	2	3	4	5
POSSIBLE (2)	2	4	6	8	10
LIKELY (3)	3	6	9	12	15
OFTEN (4)	4	8	12	16	20
ALMOST CERTAIN (5)	5	10	15	20	25

Risk Allocation

- Mitigate
- Transfer (e.g.: Share, Insurance)
- Accept
- Avoid

Identify party best able to implement the allocation

Manage Risk

- Primary Risk Mitigation

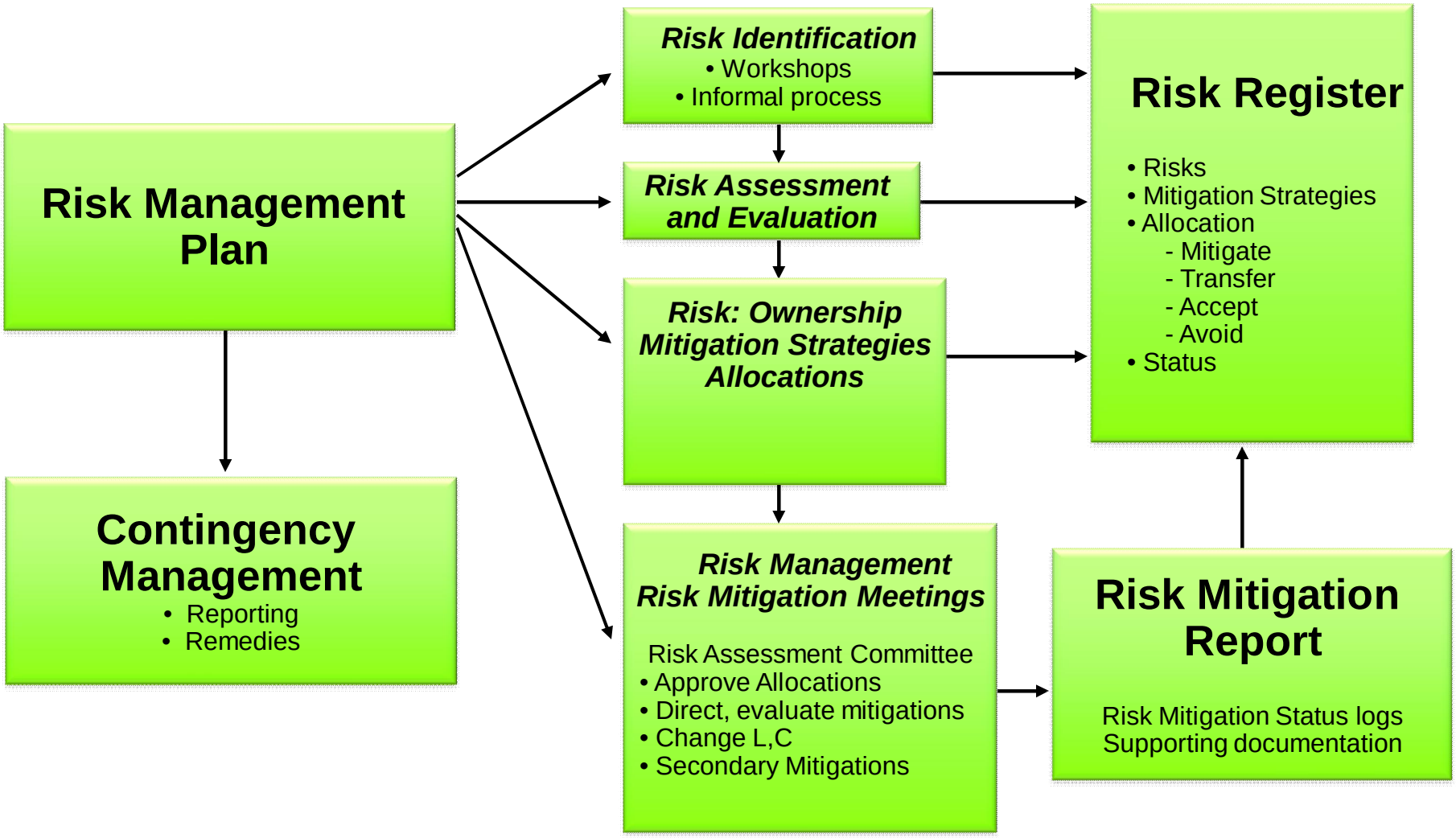
  This is the risk mitigation accomplished by implementing the risk mitigations placed in the Risk Register.

- Secondary Mitigation

  These are the items identified in advance by the project as possible areas in which to reduce scope in an effort to save money or time to replenish contingency (cost and/or schedule) that is being used more rapidly than planned.

Tools/Supporting Documentation

Risk Program Documents



Risk Mitigation Meetings

- Risk Mitigation Meetings
  - Regular interval (monthly)
  - Includes key project personnel
  - Establish priority risks and place on the agenda
  - Minutes capture essential risk / mitigation discussions

Sample Risk Mitigation Meeting Minutes

DATE: September 23, 2010
MEETING DATE: September 16, 2010
LOCATION: ----------
TIME: 2:00 pm
ATTENDEES: ----------
COPIES TO: ----------
SUBJECT: **Risk Management – Risk Mitigation Meeting**
Risk Mitigation Report No. 14

RECORD OF MEETING

Risk Mitigation Issues

Attendees discussed the following risks. A synopsis of the discussion is provided here and in the attached "Risk Mitigation Status Logs."

Risk 47: Revisions to the SEM sequence during construction, which differ from the plan, could lead to significant delays if not sufficiently pre-planned.

Discussion: Since commencing to address this risk, attendees have recognized that resolution is based on assuring that the Project has a skilled and committed work force for the CTS SEM. Because the crew that will perform the CTS SEM work is historically transitory and will seek the best remuneration available to them, contract arrangements that can get money to the crew are essential to attract and maintain the most skilled labor. Attendees commented that planned incentives for the work force almost always get squelched. An example of this is incentives employing early completion bonuses.

It was suggested that the Project might be able to pay for SEM work on a piece rate. European contractors work on a piece rate for SEM work. The possibility of using bonuses for meeting or exceeding scheduled milestones was also discussed. These incentives, however, create problems when delays hinder bonuses or meeting piece work targets. This is especially true with SEM which needs to continuously assess work and adjust for changing conditions.

It was agreed that the most direct method of getting incentives to the crew would be through overtime pay. Two 10 hour shifts would accomplish this and fit with a 24 hour operation. Paying the overtime might be enough to incentivize the SEM crew.

--------- agreed to be responsible for developing a matrix of the various incentive options for SEM crew. This matrix will be presented at the next risk mitigation meeting with the intent of selecting a viable option(s) to go forward.

Risk Mitigation Status Log

Risk No. 47	Mitigation Strategy
Revisions to the SEM sequence during construction, which differ from the plan, could lead to significant delays if not sufficiently pre-planned.	1. Revisit sequence strategy during FD. 2. Address change through flexible bid schedule 3. Utilize contractor pre-qualification: Require experienced SEM Contractor, approved SEM procedures, and continuous SEM inspection. 4. Provide attractive T + C's (e.g. differing site conditions) 5. Conduct peer review for FD 6. Provide performance incentives including crew incentives for production. 7. Require shotcrete, as needed. Include shotcrete & inspection costs in estimate.

Initial Assessment: 3,4,12 **Risk Owner:** --------

Status Log:

May 28, 2009 Meeting:

1. Revised the Risk and Mitigation statements.
2. Items 1 and 2: Must wait for Final Designer to develop these items
3. Item 3: Check with VTA on pre-quals used there; conduct a survey to generate a list of qualified, available SEM contractors (check with ----). Conduct some outreach at the upcoming RETC.
4. Item 4: Confer with -------
5. Item 5: Must wait for Final Designer to develop this item
6. Item 6: Confer with -------

June 23, 2009 Meeting:

1. -------- identified recent SEM work and found only four locations in the USA where it is being used. The biggest concern is getting qualified personnel to do the work. This calls for an outreach program that will increase chances of obtaining these qualified personnel and contract terms that increase the Project's chances of keeping these personnel on the Project.
2. The SEM process is viable, but project needs to refrain from stipulating Means and Methods.
3. In order to achieve acceptable SEM results, Project needs a good GBR and all instrumentation in place.
4. A means of mitigating possible uncertainties with the SEM work is to perform gradation analysis on EPBM spoils.

August 27, 2009 Meeting:

1. ------- indicated that in his discussions with ------, relative to SEM, they recommended flexibility in any contract with a SEM firm.
2. -------- provided ------ with T&C's as examples of possible incentives that could be used to improve SEM productivity.
3. The objective in improving SEM productivity is to get meaningful money down to the working crew. ----- will also look into using safety incentives as well as training programs through the unions.
4. It is expected that there will be several SEM contracts in the -------- at the time ----- is planning to do the CTS. ------ will prepare a time-phase schedule of these projects to determine the degree to which there will be a SEM laborer shortage.
5. It was agreed that the TBM will provide good geotechnical information as it bores through the CTS ahead of the SEM mining operation. It will be necessary to assure that the TBM operation obtains this information.

Assessment Committee Meeting

Risk Management

Risk Assessment Committee-Mitigation Evaluation

Date: June 2, 2010

Risk Assessment Committee Meeting No.: 001

Risk No.: 49

Risk Statement: Market risk - few bidders (less than 3 bonefide bids) for contracts resulting in higher costs than planned.

Risk Mitigation Strategy: Develop a Contractor Outreach Plan: 1) Engage in extensive contractor outreach and promote assurances of being a reasonable contract partner; 2) Invite contractor Industry Review comments; 3) Use Contract Terms and Conditions that are fair and reasonable to attract contractors to bid. Use the SFPUC T&C's as a guide; 4) Provide quick alternative dispute resolution process, including obstruction clause and allowance for differing site conditions in contract documents; 5) Website.

Risk Owner: ----------

Original Risk L and C: 3, 4, 12

Risk Owner's Statement Regarding Mitigation Status:

Completed the following for the above strategy items:

1) Developed an extensive list of potential bidders with

work.

2) Distributed information flyers at the following confer

this effort at the following conferences/events: ……..

3) Met face to face with the following potential bidder

4) Developed a dispute resolution strategy for implen

5) Set up a project website.

6) In process of reviewing and updating contract stru

conditions to be more attractive to potential bidders.

7) Held peer review of preliminary design with input

Risk Owner's requested re-assessment values:

L and C: 2, 4, 8

It is believed that the likelihood of this risk happeni

2 because of the significant work done on the outr

same.

Date: June 2, 2010

Risk Assessment Committee Meeting No.: 001

Risk No.: 49

Risk Assessment Committee Evaluation:

Re-assessed L and C: 2, 4, 8

Approved: Risk Assessment Committee Chairman

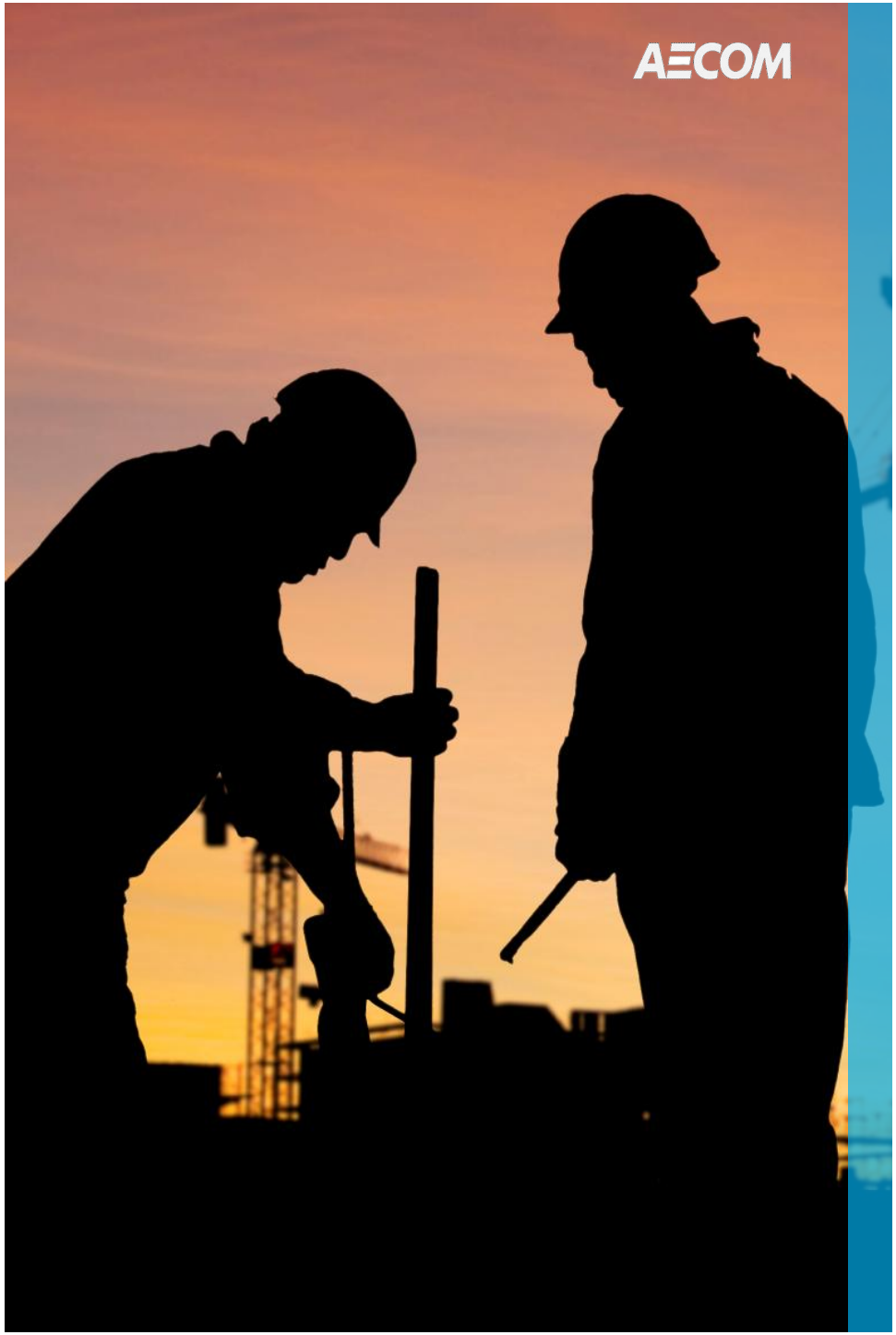
_____ **Date:**_____

Risk Register

Sample Risk Register

Risk No.	Risk	Owner	Allocation	Mitigation Strategy	Unmitigated				Due Date	Status	Mitigated			
					L	C	S	EV			L	C	S	EV
1	Permits are not obtained in time to support the project schedule	-	Mitigate	1. Develop schedule of permit requirements and due dates 2.Expedite input activities to permits, e.g., design. 3. Meet with permit issuing agencies early to arrange a schedule and assure good working relationship.	4	2	3	12	2/15/2011	At Risk Mitigation Meeting 1/19/11 Strategy Items 1 and 2 were considered complete by the RAC	3	2	3	9
2														
3														
.														
.														
.														
Total								100						85

Quantitative Analysis



Risk Analysis

- Provides confidence level for cost estimate and schedule
- Rational approach to establish cost contingency and schedule float
- Means to manage contingency and float
- Addresses oversight agency requirements

Risk Analysis Input

1. **Cost Estimate**

a. **Contractor Costs (pre-Award Contingency)**
   - Labor
   - Material
   - Equipment
   - Indirects
   - Profit
   - Risk

b. **Owner Costs**

2. **Risk Events (post-Award Contingency)**

3. **Schedule**

Cost Estimate Uncertainties Matrix

Cost Item		Base Cost ($2008)	Low	High
SCC 10 Guideways	Labor	$21,134,775	$19.0	$25.0
	Materials	$42,062,280	$36.0	$52.0
	Equipment	$6,281,032	$3.5	$7.0
	Indirects	$12,375,023	$9.0	$14.0
	Profit	$3,093,756	$1.0	$5.0
	Risk	$3,093,756	$1.0	$5.0
SCC 20 Stations	Labor	$16,960,670	$14.0	$19.0
	Materials	$21,228,464	$19.0	$24.0
	Equipment	$5,103,000	$3.0	$6.0
	Indirects	$7,494,553	$5.0	$9.0
	Profit	$1,873,638	$0.5	$3.0
	Risk	$1,873,638	$0.5	$3.0
SCC 30 OMF	Labor	$13,378,294	$10.0	$20.0
	Materials	$17,200,664	$15.0	$24.0
	Equipment	$5,733,555	$3.0	$8.0
	Indirects	$1,274,123	$1.2	$2.0
	Profit	$318,531	$0.3	$1.0
	Risk	$318,531	$0.3	$1.0
SCC 40 Sitework	Labor	$30,535,214	$23.0	$35.0
	Materials	$55,918,362	$47.0	$62.0
	Equipment	$17,157,466	$11.0	$21.0
	Indirects	$13,129,982	$10.5	$14.5
	Profit	$3,282,495	$1.5	$5.0
	Risk	$3,282,495	$1.5	$5.0
SCC 50 Systems	Labor	$27,784,249	$25.0	$29.0
	Materials	$62,512,317	$57.0	$68.0
	Equipment	$5,597,619	$3.0	$7.0
	Indirects	$13,998,723	$11.0	$17.0
	Profit	$3,499,681	$3.0	$6.0
	Risk	$3,499,681	$3.0	$6.0
SCC 60 -- Right of Way		$20,203,156	$15.0	$32.0
SCC 70 -- Light Rail Vehicle Costs		$116,762,000	$117.0[1]	$134.0
SCC 80 -- Owner Costs		$143,260,065	$140.0	$150.0
SCC 100 -- Finance Charges		$5,191,000	$5.0	$10.0
	Total	$706,412,787	$614.8	$829.5

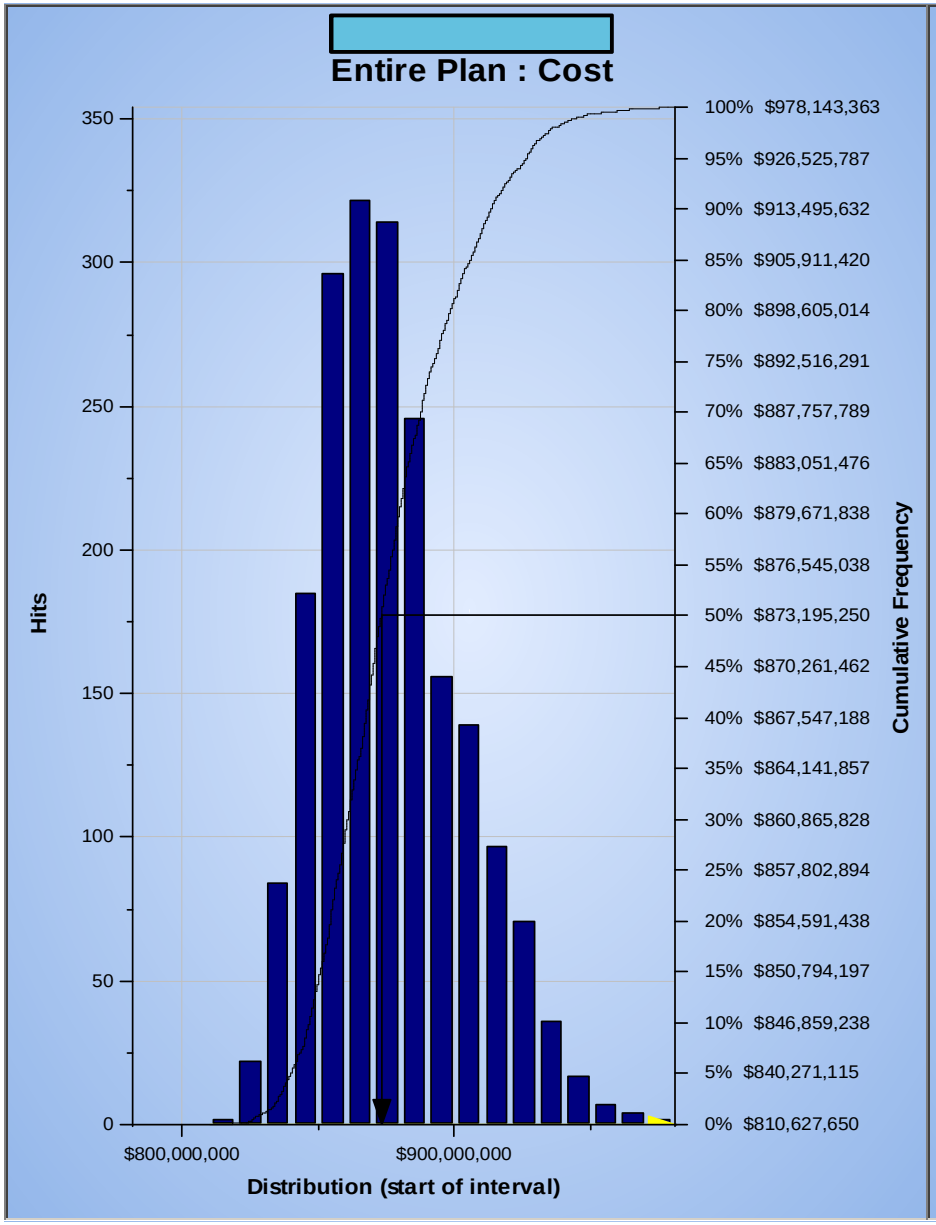
Risk Events

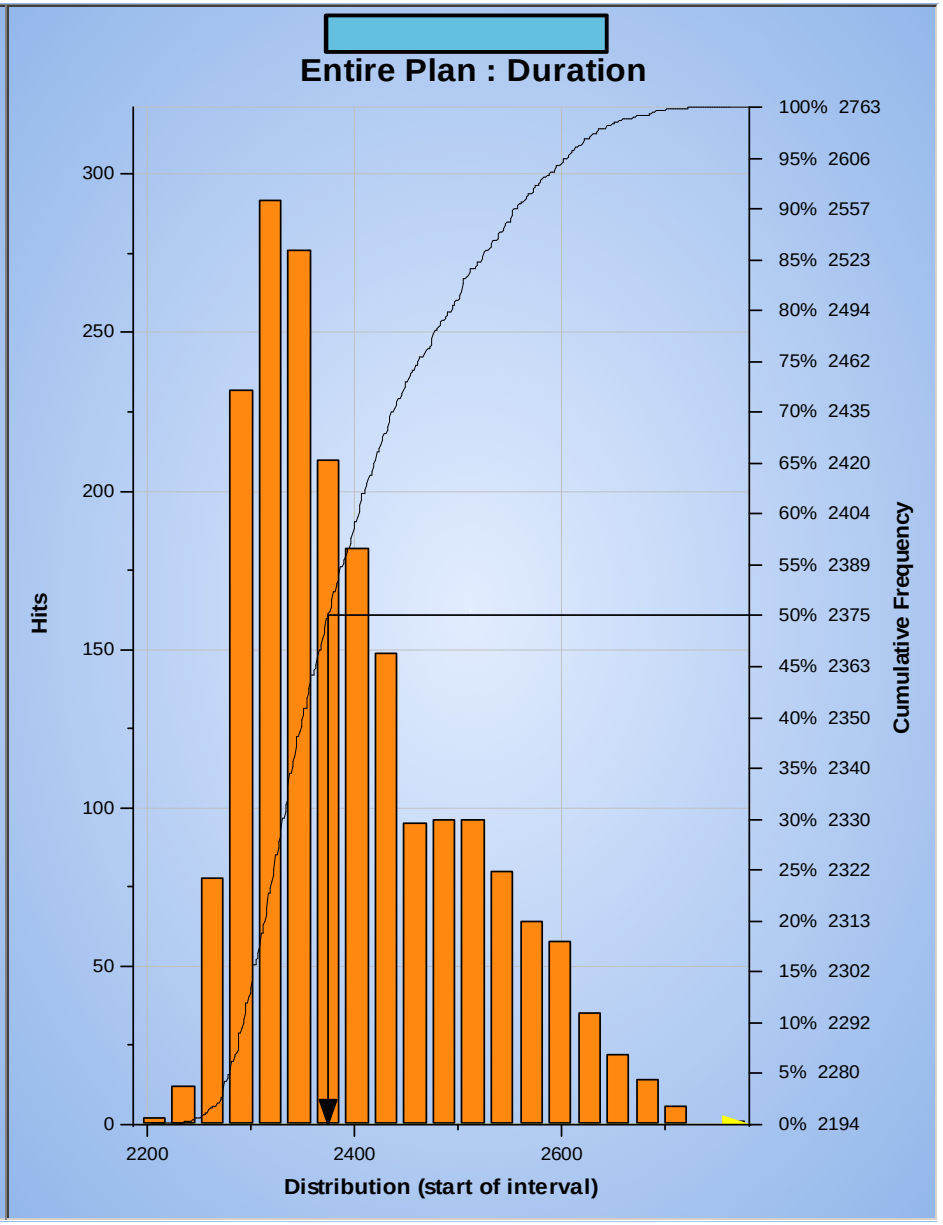
No.	Risk Event	Probability	Activity Affected	Schedule Low	Schedule High	Cost Low	Cost High
	Stimulus plan may introduce billions of dollars into the construction industry, thereby reducing pool of available contractors and producing higher than expected bids or costs	This will be addressed in the SCC Items, Profit category					
1	Property has been pledged to be donated by various public entities. Risk of property not being donated, increasing cost and delay to the Project:						
	Diagonal Property	60%				$6M	$10M
2	[redacted] Avenue property may become a larger taking than the current partial taking	90%				$5M	$8M
3	[redacted] property may become a larger parcel taking than planned	20%				$2M	$10M
4	Access impacts (Greyhound, downtown [redacted] parking ramps, etc.)	50%				$1M	$5M

Risk Events

No.	Risk Event	Probability	Activity Affected	Schedule Low	Schedule High	Cost Low	Cost High
5	Clean-up for potential contamination at acquired site is more than discount						
	OMF	20%	G1040	15 days	30 days	$0	$1M
	Railroad Properties	20%				$0	$50,000
	[redacted] property	50%				$500,000	$2M
	[redacted] Avenue property	20%				$0	$1M
	TPSS site #4	20%				$0	$50,000
6	Construction excavation along the alignment may encounter hazardous and contaminated sites (approx 10 miles).	90%	C1040 D1040	15 days 15 days	90 days 90 days	$1M	$4M
7	Under low-bid procurement, risk of unproven car designers bidding on rail car procurement if specifications are opened up to include no service proven vehicles	30%	7410	90 days	270 days		

Risk Analysis Output





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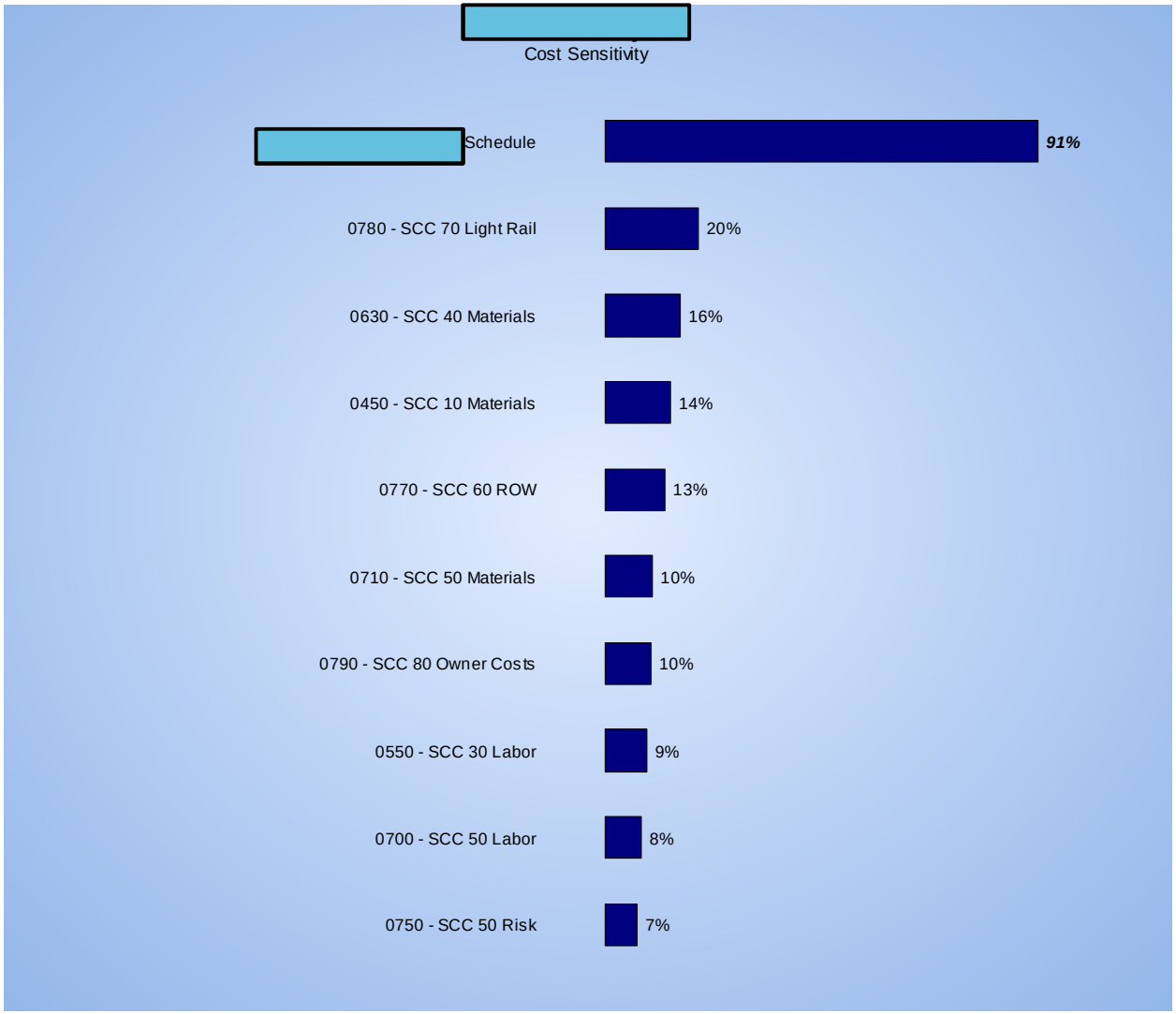
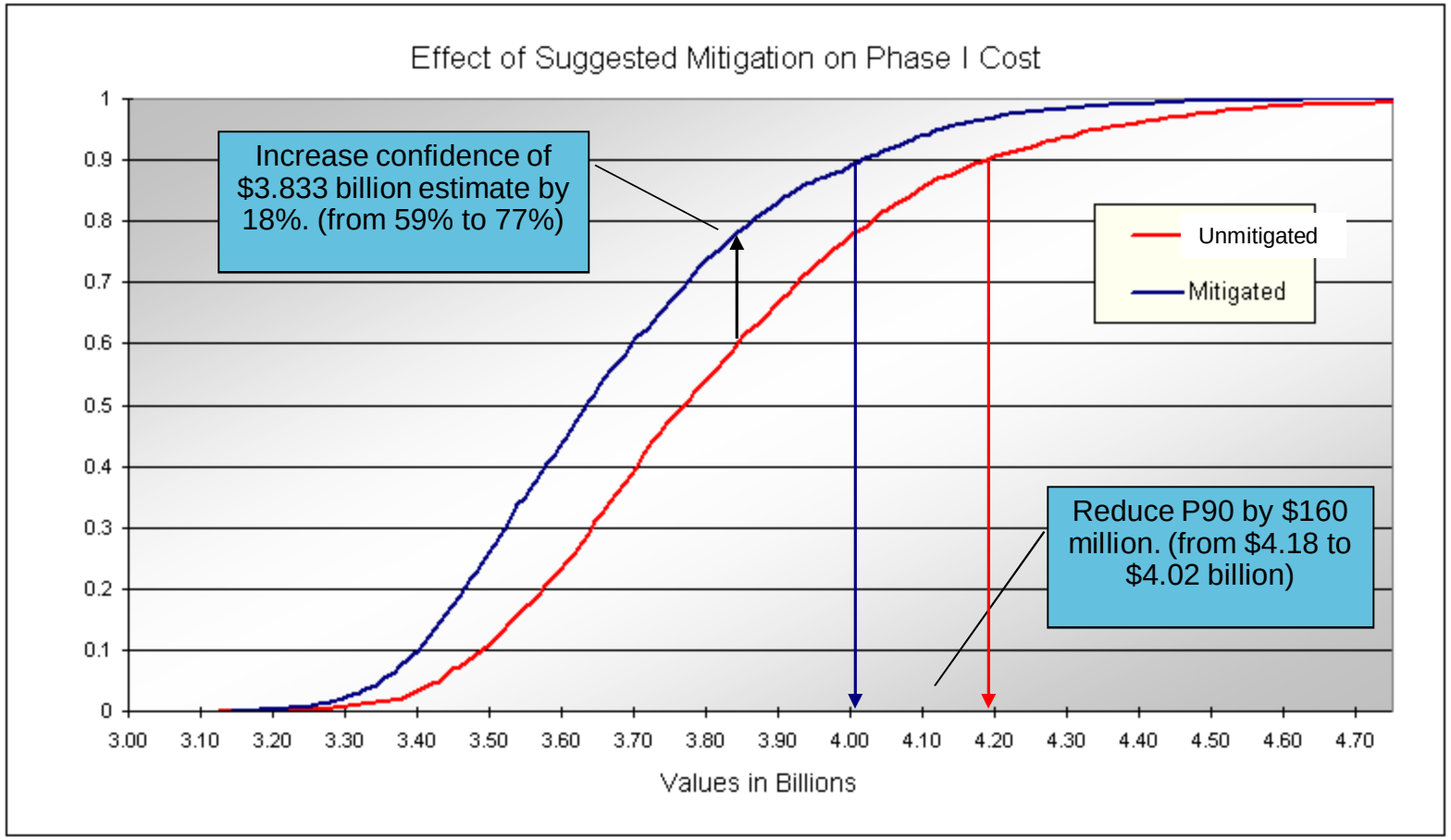


Mitigation & Effect

Suggested Mitigation:
- Finish Phase I in 9 years.
- Be 5% more confident in Labor, Material, and Equipment estimates.
- Reduce the High end of CM, Contractor Profit and Risk by 10%.

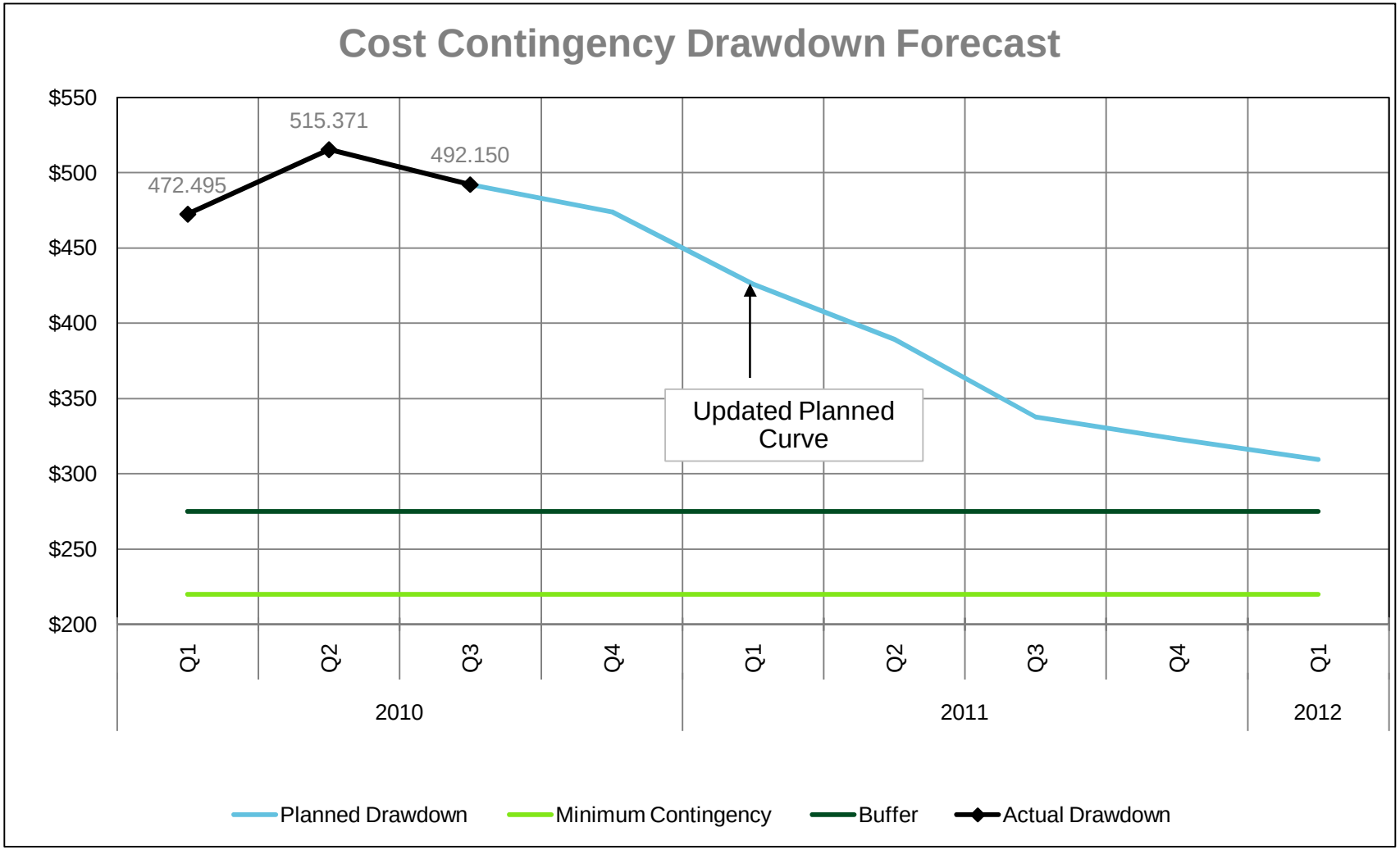


Contingency Management

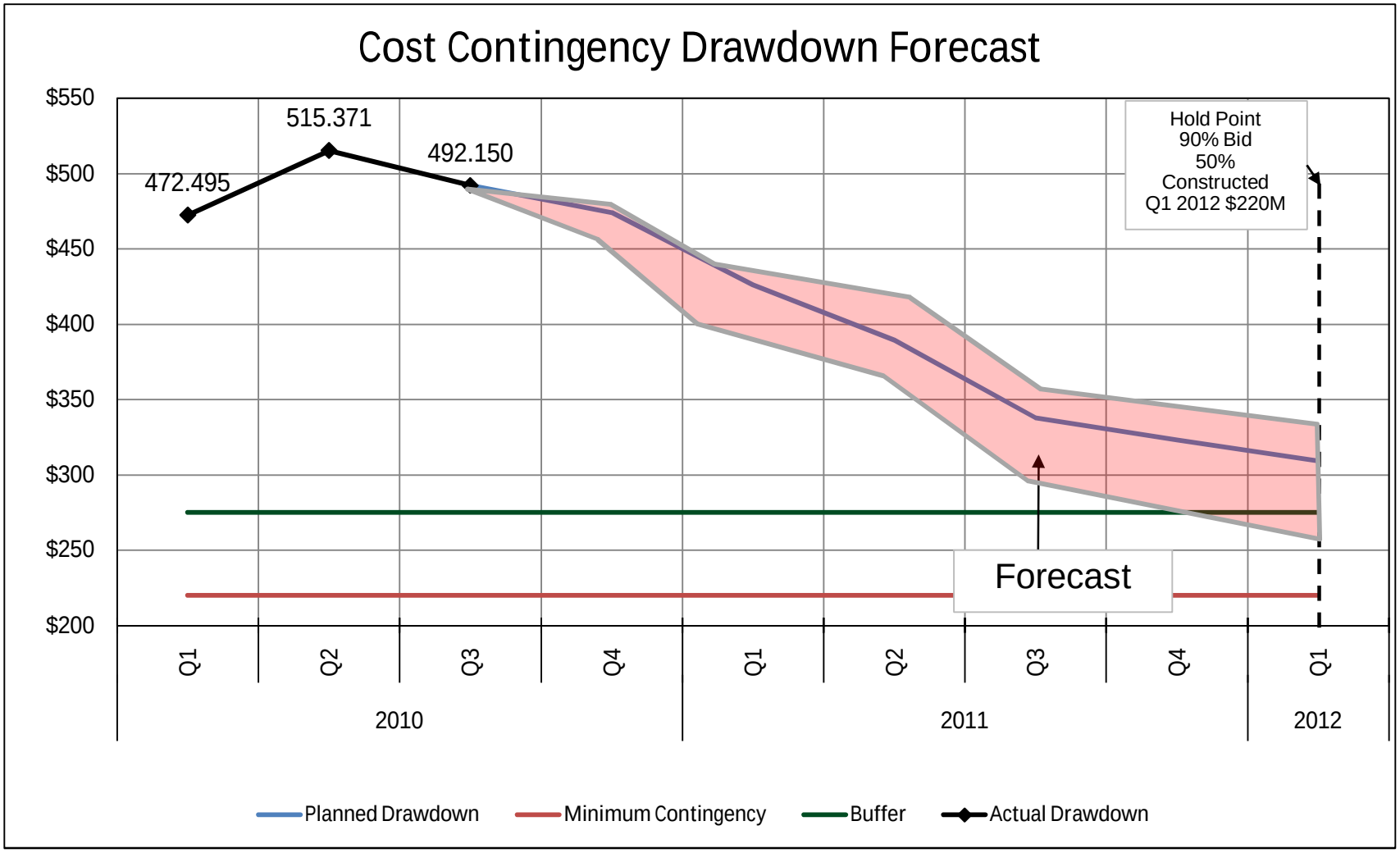
Contingency Management Includes:

- Recording actual values of remaining contingency on a month by month basis
- Forecasting contingency values into the future based on possible opportunities and risks
- Identifying options to address any significant variations in contingency usage
- Implementing the options to restore contingency usage to planned levels

Contingency Management



Contingency Management



Tools and Resources

- Software
  - @RISK
    - A Palisade Corporation Windows-based tool, which is an ‘add-on’ to Microsoft Excel
    - It is AECOM Standard software for conducting cost risk analysis and modeling
  - Oracle Primavera Risk (Formerly PERTMASTER) / @RISK for Project
    - Oracle Primavera Risk Analysis (Formerly PERTMASTER) or @RISK for Projects are both AECOM standard tools used for conducting schedule risk analysis and modeling
- References
  - (2009) “Practice Standard for Project Risk Management” published by the Project Management Institute (PMI)
  - ISO 31000:2009 “Risk Management-Principles and Guidelines”

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