Project Risk Management Basics: Cost and Schedule Impacts

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Robert E. Rocco
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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
AECOM’s Risk Management practice is guided by:

- “Practice Standard for Project Risk Management” Project Management Institute (PMI)
- 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

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

DECISIONS ACTIVITIES

FAVORABLE OUTCOMES (Opportunities)

UNFAVORABLE OUTCOMES (Risks) Exposure to loss

Successful Project

MAXIMIZE OPPORTUNITIES

MINIMIZE RISKS
The Fundamentals

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

MAXIMIZE OPPORTUNITIES

MINIMIZE RISKS
- Within Budget
- Within Schedule
- Meets Quality Objectives
- No Significant Adverse Reaction
The Process
Risk Management Process

IDENTIFY RISK

ESTABLISH LIKELIHOOD & CONSEQUENCE (Assessment)

MANAGE RISK
- Mitigate
- Assess Efforts
- Measure Progress
- Status
- Reset Priorities, goals

ESTABLISH MITIGATION PLANS & OWNERSHIP (Allocation)

RANK RISKS (Evaluation)
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

Risk Plan
Supporting Elements of RM Process

Guidance

Process

Initial Activities

Risk Plan

Risk Management Training, Processes, Procedures
Supporting Elements of RM Process

Guidance

Process

Initial Activities

Ongoing Activities for Project Life

Risk Plan

Risk Management Training, Processes, Procedures

Workshops Brainstorming

Risk Assessment Committee (RAC)

Identify, Assess, Mitigate Plans, Ownership

Evaluate Mitigation Effort, Focus, Goals, Priorities
Supporting Elements of RM Process

Guidance

Risk Plan

Risk Management Training, Processes, Procedures

Process

Initial Activities

Risk Assessment Committee (RAC)

Ongoing Activities for Project Life

Workshops

Brainstorming

Output

Assessment Group Reports

- Measured Reduction of Risk
- Action Items
- Cost/Schedule Confidence Levels
- Cost Contingency and schedule float management
## Risk Identification

### Potential Risks

#### Strategic
- Project Understanding
- Business Practices
- Organization
- Resources
- Viability
- Precondition

#### Technical
- Project Execution
  - Design
  - Construction
  - Construction Management

#### Cost/Schedule
- Cost and Schedule Measure
  - Confidence Level
  - Cost Contingency
  - Schedule Float

### Risk Register

<table>
<thead>
<tr>
<th>Category</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Assessment</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Evaluation</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Mitigation Plans</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Management</strong></td>
<td></td>
</tr>
</tbody>
</table>
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

\[
\text{Expected Value (EV)} = \text{Likelihood} \times \text{Consequence}
\]
## Risk Assessment

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

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

<table>
<thead>
<tr>
<th>CONSEQUENCE PROBABILITY</th>
<th>INSIGNIFICANT (1)</th>
<th>MINOR (2)</th>
<th>MODERATE (3)</th>
<th>MAJOR (4)</th>
<th>CATASTROPHIC (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RARE (1)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>POSSIBLE (2)</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>LIKELY (3)</td>
<td>3</td>
<td>6</td>
<td>9</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>OFTEN (4)</td>
<td>4</td>
<td>8</td>
<td>12</td>
<td>16</td>
<td>20</td>
</tr>
<tr>
<td>ALMOST CERTAIN (5)</td>
<td>5</td>
<td>10</td>
<td>15</td>
<td>20</td>
<td>25</td>
</tr>
</tbody>
</table>
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 Management Plan

Risk Identification
- Workshops
- Informal process

Risk Assessment and Evaluation

Risk: Ownership Mitigation Strategies Allocations

Risk Register
- Risks
- Mitigation Strategies
  - Mitigate
  - Transfer
  - Accept
  - Avoid
- Status

Risk Mitigation Meetings
Risk Assessment Committee
- Approve allocations
- Direct, evaluate mitigations
- Change L,C
- Secondary Mitigations

Risk Mitigation Report
Risk Mitigation Status logs
Supporting documentation

Contingency Management
- Reporting
- Remedies
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: 2:00 pm
TIME: 
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

<table>
<thead>
<tr>
<th>Risk No. 47</th>
<th>Mitigation Strategy</th>
</tr>
</thead>
</table>
| 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 strategy 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.
## Risk Management

### Risk Assessment Committee-Mitigation Evaluation

<table>
<thead>
<tr>
<th>Date:</th>
<th>June 2, 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk Assessment Committee Meeting No.:</td>
<td>001</td>
</tr>
<tr>
<td>Risk No.:</td>
<td>49</td>
</tr>
<tr>
<td>Risk Statement:</td>
<td>Market risk - few bidders (less than 3 bonafide bids) for contracts resulting in higher costs than planned.</td>
</tr>
</tbody>
</table>

### 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: | —— —— —— |
| Risk Owner’s Statement Regarding Mitigation Status: | 
- Completed the following for the above strategy items:
  1) Developed an extensive list of potential bidders with this effort at the following conferences/events: ...
  2) Distributed information flyers at the following conferences/events: ...
  3) Met face to face with the following potential bidders: ...
  4) Developed a dispute resolution strategy for implementing conditions to be more attractive to potential bidders.
  5) Set up a project website.
  6) In process of reviewing and updating contract str...
  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 happening 2 because of the significant work done on the other same.

### Risk Assessment Committee Evaluation:

<table>
<thead>
<tr>
<th>Date:</th>
<th>June 2, 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk Assessment Committee Meeting No.:</td>
<td>001</td>
</tr>
<tr>
<td>Risk No.:</td>
<td>49</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Approved:</th>
<th>Risk Assessment Committee Chairman</th>
</tr>
</thead>
<tbody>
<tr>
<td>License:</td>
<td>——</td>
</tr>
</tbody>
</table>
Risk Register
## Sample Risk Register

<table>
<thead>
<tr>
<th>Risk No.</th>
<th>Risk</th>
<th>Owner</th>
<th>Allocation</th>
<th>Mitigation Strategy</th>
<th>Unmitigated</th>
<th>Due Date</th>
<th>Status</th>
<th>Mitigated</th>
</tr>
</thead>
</table>
| 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

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

<table>
<thead>
<tr>
<th>No.</th>
<th>Risk Event</th>
<th>Probability</th>
<th>Activity Affected</th>
<th>Schedule Low</th>
<th>Schedule High</th>
<th>Cost Low</th>
<th>Cost High</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>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</td>
<td>60%</td>
<td></td>
<td></td>
<td></td>
<td>$6M</td>
<td>$10M</td>
</tr>
<tr>
<td>2</td>
<td>Property has been pledged to be donated by various public entities. Risk of property not being donated, increasing cost and delay to the Project: Avenue Property may become a larger taking than the current partial taking</td>
<td>90%</td>
<td></td>
<td></td>
<td></td>
<td>$5M</td>
<td>$8M</td>
</tr>
<tr>
<td>3</td>
<td>Property may become a larger parcel taking than planned</td>
<td>20%</td>
<td></td>
<td></td>
<td></td>
<td>$2M</td>
<td>$10M</td>
</tr>
<tr>
<td>4</td>
<td>Access impacts (Greyhound, downtown parking ramps, etc.)</td>
<td>50%</td>
<td></td>
<td></td>
<td></td>
<td>$1M</td>
<td>$5M</td>
</tr>
</tbody>
</table>

This will be addressed in the SCC Items, Profit category
## Risk Events

<table>
<thead>
<tr>
<th>No.</th>
<th>Risk Event</th>
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<th>Schedule Low</th>
<th>Schedule High</th>
<th>Cost Low</th>
<th>Cost High</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Clean-up for potential contamination at acquired site is more than discount</td>
<td>20%</td>
<td>G1040</td>
<td>15 days</td>
<td>30 days</td>
<td>$0</td>
<td>$1M</td>
</tr>
<tr>
<td></td>
<td>OMF</td>
<td>20%</td>
<td></td>
<td>$0</td>
<td>$50,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Railroad Properties</td>
<td>20%</td>
<td></td>
<td></td>
<td>$50,000</td>
<td>$2M</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Avenue property</td>
<td>50%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TPSS site #4</td>
<td>20%</td>
<td></td>
<td>$0</td>
<td>$1M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Construction excavation along the alignment may encounter hazardous and contaminated sites (approx 10 miles)</td>
<td>90%</td>
<td>C1040 D1040</td>
<td>15 days</td>
<td>90 days</td>
<td>$1M</td>
<td>$4M</td>
</tr>
<tr>
<td>7</td>
<td>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</td>
<td>30%</td>
<td>7410</td>
<td>90 days</td>
<td>270 days</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Risk Analysis Output

Entire Plan: Cost

Entire Plan: Duration
Risk Analysis Output

- Schedule: 91%
- 0780 - SCC 70 Light Rail: 20%
- 0630 - SCC 40 Materials: 16%
- 0450 - SCC 10 Materials: 14%
- 0770 - SCC 60 ROW: 13%
- 0710 - SCC 50 Materials: 10%
- 0790 - SCC 80 Owner Costs: 10%
- 0550 - SCC 30 Labor: 9%
- 0700 - SCC 50 Labor: 8%
- 0750 - SCC 50 Risk: 7%

Cost Sensitivity
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%.

Effect of Suggested Mitigation on Phase I Cost

- Increase confidence of $3.833 billion estimate by 18%. (from 59% to 77%)
- Reduce P90 by $160 million. (from $4.18 to $4.02 billion)
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

Cost Contingency Drawdown Forecast

- Planned Drawdown
- Minimum Contingency
- Buffer
- Actual Drawdown

Updated Planned Curve

-$200
-$250
-$300
-$350
-$400
-$450
-$500
-$550


472.495 515.371 492.150
Contingency Management

Cost Contingency Drawdown Forecast

- 90% Bid
- 50%
- 50%
- 50%
- 90%

Forecast

- Planned Drawdown
- Minimum Contingency
- Buffer
- Actual Drawdown

Hold Point
Q1 2012 $220M

- 2010
- 2011
- 2012
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

robert.rocco@aecom.com
Project Risk Management Basics: Questions and Answers