I-15 Flamingo Road to Sahara Avenue

Cost Risk Assessment

Prepared for:

Nevada Department of Transportation

June 2021

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I. EXECUTIVE SUMMARY

The Cost Risk Assessment (CRA) report for the Nevada Department of Transportation's (NDOT) proposed improvements to the Interstate 15 (I-15) corridor from Flamingo Road to Sahara Avenue identifies project threats and opportunities that could affect project cost and/or budget. The feasibility study is evaluating four potential alternatives, which are all included in this CRA. This CRA is an update to the September 2020 CRA (Appendix E) based on concept revisions, Alternative 1 Shift and Alternative 2 Shift, requested by the City of Las Vegas.

In preparing the CRA, a risk-based estimate was prepared to model project risks assuming all risks would be accepted (pre-response) and preparing the post-response estimate assuming a proactive risk management plan was implemented. The CRA evaluated two different alternatives to identify if the risks may cause significantly different potential outcomes.

Table E-1 presents the September 2020 CRA results for Alternative 1 and Alternative 2 and the April 2021 updated CRA results for Alternative 1 Shift and Alternative 2 Shift, and are intended as a quick summary for NDOT Management and Executive Leadership Team (ELT).

Risk-Adjusted Cost Results (in Millions – YOE $'s)				
Scenario	**Base Cost**	**Cost Range**		
		10th Percentile	**70th Percentile**	**90th Percentile**
Alternative 1				
Pre-Response	$227.7	$322.2	$364.1	$380.5
Post-Response		$315.1	$356.8	$371.2
Alternative 1 Shift				
Pre-Response	$254.3	$406.6	$439.8	$453.8
Post-Response		$401.3	$430.9	$442.4
Alternative 2				
Pre-Response	$364.5	$414.5	$470.7	$505.8
Post-Response		$409.6	$461.1	$483.7
Alternative 2 Shift				
Pre-Response	$357.1	$482.9	$540.6	$567.6
Post-Response		$478.8	$533.9	$557.7

Table E-1 – Risk Adjusted Cost Results (in Millions – YOE $'s)

Table E-2 summarizes the risk adjusted project completion dates for all alternatives.

Risk-Adjusted Project Completion Date				
Scenario	**Base Completion Date**	**Project Completion Date Range**		
		10th Percentile	**70th Percentile**	**90th Percentile**
Pre-Response	Dec 2028	November 2031	April 2036	April 2037
Post-Response		February 2031	August 2035	June 2036

Table E-2 – Risk Adjusted Project Completion Date

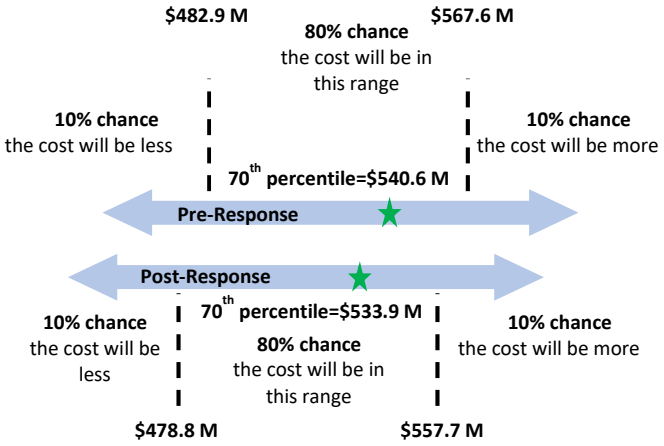
Figure E-1 presents a one-page snapshot of I-15 Flamingo Road to Sahara Avenue project with respect to overall benefits, costs, and schedule based on the outcomes of the two Shift Alternatives.

Project Summary	I-15 Flamingo Road to Sahara Avenue May 2021	

Project Description

- Widen I-15
- Improve Flamingo Road Interchange
- Improve Spring Mountain Interchange
- Improve I-15 Operations
- Accommodate City of Las Vegas Rancho Drive extension

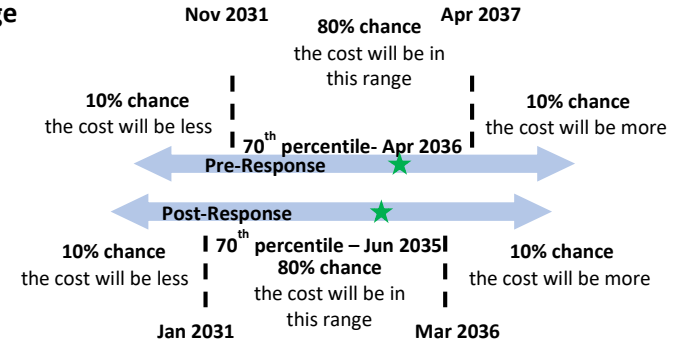
CRA Cost Range



Project Benefits

- Increase capacity
- Reduce overall interchange delay
- Enhance safety

CRA Schedule Range



Key Project Schedule Risks

Threats

- Funding Availability
- UPRR Coordination
- Utility Relocations
- Scope Changes
- NEPA

Opportunities

- Design-Build Procurement
- Use of Incentive/Disincentive Clauses

Key Project Cost Risks

Threats

- Acquisition allocation of shared right-of-way with Project NEON
- Expansion of bridge spans due to UPRR
- Phasing due to funding availability
- Unknown utilities
- Additional sidewalk and bicycle connectivity
- Right-of-way
- UPRR coordination

Level of Project Completion:	Low Medium High	May 2021

Figure E-1 - I-15 Flamingo Road to Sahara Avenue Project Summary

1. INTRODUCTION

The report summarizes an updated risk-based cost and schedule analysis completed by CA Group for the Nevada Department of Transportation's (NDOT) proposed improvements to the Interstate 15 (I-15) corridor from Flamingo Road to Sahara Avenue. Four alternatives have been identified that would provide improvements to the interstate and interchanges to enhance interchange and freeway operations, capacity, and safety. The following study documents the updated Risk Assessment Workshop for Alternative 1 Shift and Alternative 2 Shift that was conducted by CA Group on April 22, 2021. Due to restrictions related to the on-going COVID-19 pandemic and the fact the current concepts were revisions to concepts discussed in the August 2020 workshop, the workshop was held virtually utilizing Microsoft Teams with a smaller group of staff to identify any modifications to risks based on the concept refinements.

The purpose of the workshop was to:

- Update and document the potential range of uncertainty in both project cost and schedule due to risks (threats and/or opportunities) to assist in selecting a locally preferred alternative;
- Identify any changes or new significant risks or opportunities unique to the different alternatives which would be considered in the selection of the preferred alternative; and
- Identify any changes and prioritize key cost and schedule risks and opportunities for the proposed alternatives.

The workshop and subsequent statistical analysis followed an approach very similar to the Washington State Department of Transportation's Cost Estimate Validation process (CEVP®) and in accordance with NDOT Risk Management and Risk-Based Cost Estimation Guidelines.

The Risk Assessment Workshop consisted of several subject matter experts that are familiar with the project and potential risks and opportunities. Workshop attendees included the following individuals:

- Facilitator – Chad Anson, CA Group
- Jack Sjostrom – CA Group
- Jim Mischler – CA Group
- Jim Caviola – CA Group
- Bardia Nezhati – Parametrix
- Mohan Garakhalli – Atkins

The outcomes of the workshop and Risk Assessment Report are intended to assist in providing NDOT Project Management and Executive Leadership Team (ELT) an estimated overall project cost as well as recommend a schedule and risk management strategies.

2. PROJECT DESCRIPTION AND ASSUMPTIONS

2.1. Project Scope and Phasing

Interstate 15 (I-15) is the primary transportation corridor in southern Nevada, connecting to California and Arizona. Over the past three decades, NDOT has been making significant investments in improvements to I-15 to keep up with the growth in the Las Vegas area. The section of I-15 between Flamingo Road and Sahara Avenue is the last section to be upgraded adjacent to the resort corridor (Las Vegas Strip). Recently completed projects include NDOT's I-15 South Design-Build Project (Silverado Ranch Boulevard to Tropicana Avenue) to the south and NDOT's Project NEON (Sahara Avenue to I-15/US95/I-515 Interchange) to the north.

The existing corridor I-15 from Flamingo Road to Sahara Avenue can only accommodate five through lanes in each direction, while future traffic demands are expected to further breakdown I-15 in this segment. The I-15 from Flamingo to Sahara Feasibility Study (Feasibility Study) was initiated by NDOT to develop and evaluate alternatives primarily focusing on improving I-15 safety and traffic operations and identifying right-of-way needs to accommodate future traffic demands. The on-going Feasibility Study is being prepared based on the Federal Highway Administration's (FHWA) guidance for Planning and Environmental Linkages (PEL) so that the study can be used as the basis for subsequent project development under the National Environmental Policy Act of 1969 (NEPA), and its implementing regulations, as contained in 23 Code of Federal Regulations (CFR) 771.

This project study area covers approximately 4.5 miles on I-15, as shown in Figure 1. The northern limit is Sahara Avenue (the southern end of NDOT's Project NEON), and the southern limit is the I-15/I-215/CC-215 system interchange. These endpoints form the logical termini of this study, allow for the development of a project that can be constructed alone, serve a significant purpose, and address environmental impacts on a sufficient scale. The area also includes six interchanges with I-15: Sahara Avenue, Spring Mountain Road, Flamingo Road, Tropicana Avenue, Russell Road, and I-15/I-215/CC-215 system interchange. Additionally, seven grade separations exist within the corridor; Desert Inn Road (over I-15), Union Pacific Railroad (UPRR) (under I-15), Dean Martin Drive (under I-15), Twain Avenue (under I-15), Harmon Avenue (over I-15), Hacienda Avenue (over I-15), and Sunset Road (over I-15).

Currently four alternatives are under consideration. Alternative 1 consists of widening I-15 in each direction, reconfiguring of the Flamingo Road interchange (southbound ramps and cross street widening over I-15) and reconstructing the Spring Mountain Road flyover from southbound I-15 to eastbound Spring Mountain Road. Ramp braids would also be constructed between the southbound Spring Mountain Road on-ramp and Flamingo Road off-ramp and Flamingo Road on-ramp and Tropicana Avenue off-ramp.

Alternative 2 entails constructing the improvements identified in Alternative 1 and also includes the northbound Russell Road on-ramp and the Tropicana off-ramp and northbound Tropicana on-ramp and Flamingo off-ramp.

Figure 1 – Feasibility Study Limits

Since the September 2020 CRA, Alternative 1 and Alterative 2 under evaluation in the I-15 Flamingo to Sahara Feasibility Study have been revised to incorporate alignment changes that would accommodate the MLK Extension Project as requested by the City of Las Vegas. The modifications to Alternative 1 and Alternative 2, resulting in Alternative 1Shift and Alternative 2 Shift, require shifting I-15 to the east between Flamingo Road and Desert Inn Road. These modifications are identical for both Alternative 1 Shift and Alternative 2 Shift.

Major improvements for Alternative 1 Shift and Alternative 2 Shift that would be required to accommodate the MLK Extension Project include:

- Reconstruct the I-15 median between Flamingo Road and Desert Inn Road and reconstruct portions of I-15 to adjust the I-15 cross slope (superelevation) between Flamingo Road and Desert Inn Road.
- Reconstruct the northbound (NB) off-ramp to Spring Mountain Road and reconstruct the NB on-ramp/loop ramp from eastbound (EB) Spring Mountain Road to NB I-15.
- Reconstruct the NB and southbound (SB) I-15 bridge over Twain Avenue.
- Reconstruct the NB and SB I-15 bridges over Spring Mountain Road.
- Demolish the I-15 bridge over Sammy Davis Jr. Drive/Industrial Road and reconstruct I-15 with mechanically stabilized earth (MSE) and retaining walls.

Retaining wall locations and heights would be determined during detailed design. In addition to cast-in-place or MSE walls for new or widened bridges, MSE retaining walls are anticipated to accommodate grade differentials where there is insufficient space to allow for sloping embankments.

There are no new additional right-of-way impacts. The I-15 shift occurs within existing NDOT rights-of-way. In addition, a key risk identified in the September 2020 CRA was if the final phase of Project Neon would acquire right-of-way prior to the construction of the I-15 Flamingo Road to Sahara improvements. During the April 2021 update, it this risk was retired as there is high confidence that the NEON right-of-way will be acquired prior to this project.

Additional details on the alternative layouts can be found in the *I-15 Flamingo Road to Sahara Avenue Interchange Feasibility Study*.

2.2 Strategy, Key Conditions and Assumptions:

The following is a compilation of assumptions, existing conditions, analyzed forecasts and project strategies at the time of the workshop.

- Funding
  - Funding has not fully been identified or incorporated into a short-range funding plan.
- Design
  - Design Level
    - Design for the project is currently at 15-20%

        - There are a handful of possible options that will need to be evaluated further during NEPA and final design to address public and stakeholder concerns.
    - Landscaping
        - Maximum budget of 3% of construction. Minimal design completed at time of workshop.
    - Structural
        - Standard bridge types (cast-in-place post tensioned and steel girders) and construction techniques are assumed.
    - Geotechnical
        - No project specific borings have been performed.
    - Pavement
        - NDOT Wizard was utilized for roadway costs, including pavement section costs.
    - Design Deviations or Exceptions
        - No design deviations for NDOT policies or FHWA design exceptions are anticipated at this time.
- Environmental Documentation
    - Project will require a NEPA process.
- Permitting
    - No significant environmental permits are anticipated (excluding USACOE 404).
    - Contractor will obtain necessary construction permits.
- Right-of-Way
    - Right-of-way acquisitions are anticipated.
- Utilities
    - Several utility impacts anticipated.
    - NVEnergy substation located near T-Mobile Arena will not be impacted.
- Other Stakeholders
    - NDOT
    - City of Las Vegas
    - Clark County
    - RTC
    - Adjacent business and property owners
- Procurement
    - Delivery Method
        - One phase of design-bid-build delivery.
        - The Project Delivery Selection Approach (PDSA) process will used to determine the delivery method. The PDSA is not yet scheduled.
    - Market
        - A very competitive bidding environment is assumed.
- Construction

- Maintenance of Traffic
  - A detailed maintenance of traffic plan has not yet been developed.
- Construction Phasing
  - Constructed as one project.

- Priority
  - Project will be prioritized per the NDOT's statewide prioritization process.

3. INPUTS

3.1 Base Project Schedule/Flow Chart

A cost-based schedule model was utilized to provide an inclusive cost and schedule quantitative risk assessment that allows for costs to be developed on a year of expenditure basis. A duration "flow chart" was developed for the project to graphically depict key project milestones at a level of detail appropriate for the workshop. The flow chart identified key activities and predecessor relationships that exist between key milestones and is the basis for modeling the project schedule (including delays and opportunities due to risk events) and to calculate inflated, year-of-expenditure costs for each activity identified. Appendix B provides the risk assessment workshop flow chart for the project, as evaluated in this report.

3.2 Scenarios

A scenario was run for pre-response and post-response mitigation in current year costs for each option. It was assumed that the project phasing would be similar for either scenario. The pre-response scenario assumes no mitigation strategies are developed or implemented. The post-response strategy assumes NDOT is proactive in mitigating or monitoring risks. The difference in costs of the two strategies helps NDOT develop a cost/benefit of the level effort that should be applied to mitigating and monitoring risks for the project. A significant difference between scenario costs indicates a considerable effort should be made. In contrast, a minor difference in costs between the scenarios may warrant less effort in risk mitigation and monitoring.

3.3 Exclusions from the Risk Assessment

This Risk Assessment Workshop was conducted to provide the best information available for NDOT ELT and Project Management to make educated decisions on the project and alternatives during this phase. When reviewing the results, it is crucial to consider that this is a snapshot of the project and that the project is still in the early phases of development, requiring some items to be excluded. For this analysis, significant exclusions include:

- The potential for substantial changes to the current design (including additional lanes, ramps, project limits) were not considered. It is recognized that such changes might occur as a result of funding delays, shift in prioritization, and/or changes in regional development and economics.
- Significant changes to the phasing of the project were not considered.
- Other significant changes to the scope of this project were not considered.

3.4 Base Project Cost

A base cost estimate was developed for the project through NDOT's Wizard cost estimation program. The base estimate was developed by calculating the length and laneage of the new roadway and bridge work area. Other items such as traffic control, signing, ITS, and incidentals (based on NDOT WIZARD Guidance) were assigned a percentage of construction cost. Once this percentage was assigned, the overall cost was checked for reasonableness and the percentage modified, as necessary. Tables 1 and 2 provide a summary

of the base cost estimate for each alternative. It should be noted, that since this is a base estimate, no contingencies were added.

Description	Baseline Cost
Roadway and Removals	$35,925,442
Structures	$61,692,165
Traffic Signals	$814,000
Drainage	$9,504,783
Additional Items (Miscellaneous Items)	$25,789,170
Bid Item Subtotal	**$133,725,560**
Landscaping and Aesthetics (3%)	$3,726,623
Traffic Control (10%)	$12,422,078
Roadside Safety (3%)	$3,726,623
Erosion Control (1%)	$1,242,208
Subtotal	$154,843,092
Mobilization (7%)	$10,173,682
Contract Total	**$165,016,774**
NEPA (1%)	$1,650,168
Preliminary Engineering & Design (4%)	$6,600,671
Final Engineering & Design (4.0%)	$6,600,671
Construction Engineering (15%)	$24,752,516
Administration (1%)	$1,650,168
Legal (1%)	$1,650,168
Subtotal	$207,921,136
Right-of-Way Acquisition	$40,162,500
Environmental Considerations (3%)	$6,237,634
Project Total (Base Cost)	**$254,321,270**

Table 1 – Alternative 1 Shift Overall Base Cost Estimate Summary (2021 Dollars)

Description	Baseline Cost
Roadway and Removals	$41,599,705
Structures	$82,201,742
Traffic	$1,122,000
Drainage	$11,227,238
Additional Items (Miscellaneous Items)	$23,813,828
Change in Cost due to Alignment Modification	$37,392,514
Bid Item Subtotal	**$197,357,027**
Landscaping and Aesthetics (3%)	$5,583,894
Traffic Control (10%)	$18,612,979
Roadside Safety (3%)	$5,583,894
Erosion Control (1%)	$1,861,298
Subtotal	$228,999,092
Mobilization (7%)	$13,029,085
Contract Total	**$242,028,177**
NEPA (1%)	$2,420,282
Preliminary Engineering & Design (4%)	$9,681,127
Final Engineering & Design (4.0%)	$9,681,127
Construction Engineering (15%)	$36,304,226
Administration (1%)	$2,420,282
Legal (1%)	$2,420,282
Subtotal	$304,955,503
Right-of-Way Acquisition	$42,974,700
Environmental Considerations (3%)	$9,148,665
Project Total (Base Cost)	**$357,078,868**

Table 2 – Alternative 2 Shift Overall Base Cost Estimate Summary (2021 Dollars)

All project costs are currently anticipated to be borne by NDOT through various funding sources, including Federal funding. A more detailed summary of the base cost estimates prepared for each alternative is presented in Appendix A.

Uncertainty

A cost estimate is a "snapshot" of the anticipated project costs based on the preparer's perception of construction costs at that given time. Many factors will dictate the estimate, including the detail available, current construction market, and size of the project and/or quantities. Nevertheless, there will always be uncertainty in a base cost estimate due to these factors. Uncertainty can be applied to a project cost estimate by giving range of costs and quantities.

The estimator may establish this uncertainty range by analyzing unit costs and quantities based on project location, the scale of quantities, the construction market, and material availability. Depending on the level of design, other factors may play into uncertainty such as available geotechnical information, NEPA constraints, right-of-way, and type of project delivery. Tables 3 and 4 shows the Base Project Cost Uncertainty by crucial project components.

In establishing the uncertainty ranges for each item, consideration was given to factors that might affect quantities or bid prices, such as project location (rural vs. urban), quantities (large or small), items that are difficult to construct or site constraints, methods of payments, timing of advertisement, specialty work, geotechnical, and project delivery methods. Uncertainty is typically expressed in terms of a percentage (of the quantity and/or unit cost) lower or higher than the base.

Activity	Project Cost		
	Low	Base	High
NEPA	$1,482,438	$1,650,168	$1,847,296
Preliminary Engineering & Design	$5,929,753	$6,600,671	$7,389,185
Final Engineering & Design	$5,929,753	$6,600,671	$7,389,185
Construction Engineering	$22,236,575	$24,752,516	$27,709,445
Administration	$1,482,438	$1,650,168	$1,847,296
Legal	$1,482,438	$1,650,168	$1,847,296
Right of Way Acquisition	$38,154,375	$40,162,500	$50,203,125
Environmental Considerations	$5,603,617	$6,237,634	$6,982,780
Construction	$148,243,831	$165,016,774	$184,729,633
Total	**$230,545,218**	**$254,321,270**	**$289,945,241**

Table 3 – Alternative 1 Shift Base Cost Uncertainty by Activity (2021 Dollars)

Activity	Project Cost		
	Low	Base	High
NEPA	$2,247,750	$2,420,282	$2,731,651
Preliminary Engineering & Design	$8,990,998	$9,681,127	$10,926,606
Final Engineering & Design	$8,990,998	$9,681,127	$10,926,606
Construction Engineering	$33,716,243	$36,304,226	$40,974,772
Administration	$2,247,750	$2,420,282	$2,731,651
Legal	$2,247,750	$2,420,282	$2,731,651
Right of Way Acquisition	$40,825,965	$42,974,700	$53,718,375
Environmental Considerations	$8,496,493	$9,148,665	$10,325,643
Construction	$224,774,952	$242,028,177	$273,165,146
Total	**$332,538,899**	**$357,078,868**	**$408,232,101**

Table 4 – Alternative 2 Shift Base Cost Uncertainty by Activity (2021 Dollars)

Escalation Rates

Escalation rates are a measurement of change (usually increase) in project costs due to inflation, market costs, and the regional and national economy over a project's lifetime. In this analysis, escalation is applied to key project activities outlined in the project schedule, including NEPA, final design, utilities, and construction costs. With escalation, not only do project delays extend the duration of the project, they will typically increase final project costs. This project's escalation is per NDOT's Escalation Rates Forecast Technical Memorandum dated June 18, 2020. Those rates are shown in Table 5.

Year	Engineering			Right-of-Way			Construction		
	10%	50% (Median)	90%	10%	50% (Median)	90%	10%	50% (Median)	90%
2019	1.15%	1.15%	1.15%	4.75%	4.75%	4.75%	-0.47%	-0.47%	-0.47%
2020	-0.05%	1.23%	2.52%	-3.11%	1.81%	6.72%	-4.85%	0.03%	4.91%
2021	-0.06%	1.73%	4.00%	-3.69%	2.64%	9.81%	-3.11%	1.95%	8.46%
2022	0.19%	2.46%	4.72%	-4.80%	3.19%	11.59%	-1.40%	4.00%	10.16%
2023	0.61%	2.70%	4.76%	-4.33%	4.12%	12.62%	-1.30%	3.82%	9.51%
2024	0.66%	2.68%	4.76%	-4.16%	4.23%	12.57%	-1.50%	3.31%	8.74%
2025	0.40%	2.44%	4.46%	-4.28%	4.31%	12.90%	-1.78%	3.07%	8.45%
2026	0.11%	2.23%	4.29%	-4.42%	4.52%	13.70%	-2.38%	2.87%	8.84%
2027	-0.02%	2.16%	4.35%	-3.26%	5.37%	13.99%	-2.38%	2.82%	8.83%
2028+	-0.08%	2.21%	4.50%	-4.28%	4.31%	12.90%	-3.06%	2.81%	9.50%
Average	---	**2.21%**	---	---	**3.83%**	---	---	**2.74%**	---

Table 5 – Escalation Rates per NDOT's Escalation Rates Forecast Technical Memorandum

3.5 Risks

During the Risk Assessment Workshop, uncertainty in the base project costs and schedule were identified and characterized. This uncertainty included both threats and opportunities that could impact the project scope, schedule, or budget. These threats and opportunities have been compiled into a risk register, which is presented in Appendix C. Minor items have still been noted in the Risk Register for monitoring throughout the project in the event they become significant risk/opportunity factors. The Risk Register provides the Department more than a summary of potential events that have been considered in the risk-based estimate and schedule; it provides the Project Manager a list of items that need to be monitored and potential strategies that should be implemented to reduce the risk and hopefully avoid significant events impacts to the project.

4. ANALYSIS

4.1 Model

The inputs developed in the workshop (including base cost, schedule, risk, opportunities and uncertainties) were entered into @RISK software. @RISK is a probabilistic, integrated model which utilizes Monte Carlo simulation techniques to generate probability distributions of cost and schedule while also prioritizing risk rankings. The simulation generates 5,000 independent potential outcomes and provides a statistical compilation of selected results. In order to accommodate inflation and true year-of-expenditure dollars; the cost of each flowchart activity was escalated from the estimate reference date to the activity mid-point (including consideration of delays or accelerations due to events) according to the specified escalation rate.

4.2 Pre-Response Results

The following section summarizes various significant cost results from the workshop and risk-based analysis based on the pre-response scenario. The pre-response scenario assumes no risk management strategies are implemented.

It should be noted that the following is a "snapshot" of the project based on information available at the workshop. As the project evolves and more information is developed, identified risks should be mitigated, therefore reducing or "retiring" those risks that could impact the project. However, it is likely as the project progresses, new uncertainties may present themselves and will need to be recognized as part of the risk-based estimate and schedule. There is an adherent opportunity in implementing risk management strategies that, as the project progresses and risks are retired, the risk-based estimate standard deviation will decrease, thereby reducing the seventy-percentile cost and increasing confidence level.

Probability distributions for Alternative 1 Shift total overall project cost pre-response (current year dollars) are shown in Figure 2 in probability mass functions (PMFs) and cumulative distribution functions (CDFs)

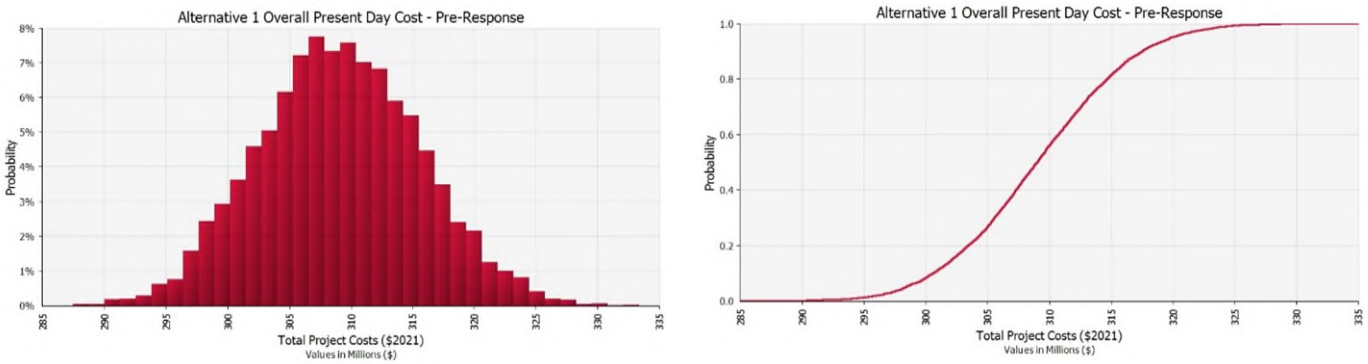


Figure 2 – Alternative 1 Shift - Probability Distribution for Overall Total Present Day Cost ($2021) – Pre-Response, presented in two ways: a) probability mass function (PMF); b) cumulative distribution function (CDF)

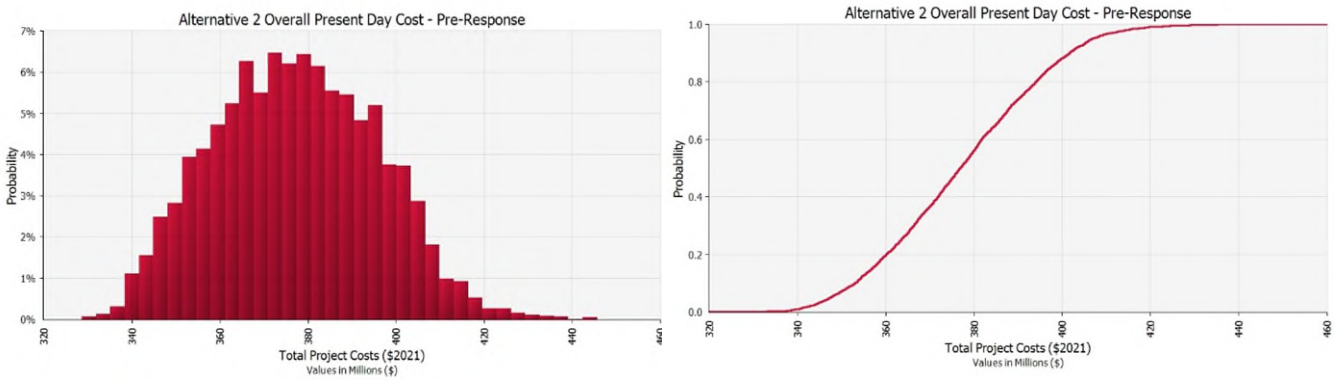


Figure 3 – Alternative 2 Shift - Probability Distribution for Overall Total Present Day Cost ($2021) – Pre-Response, presented in two ways: a) probability mass function (PMF); b) cumulative distribution function (CDF)

format. These probability distributions reflect the base cost combined with identified project risks and opportunities with no mitigation or on-going risk or opportunity management activities.

The PMF portrays a graphical measure of the range of values, including the most likely value, as represented by the tallest bar on the graph. A key risk identified in the September 2020 CRA was if the Project NEON right-of-way would be acquired prior to this project occurring. It was identified in the April 2021 CRA that the right-of-way would most likely be acquired prior and that significant risk was retired. Based on the update alternative and risk register the most likely Alternative 1 Shift project cost in 2021 dollars would be approximately $308.7 million. In comparison the most likely Alternative 2 Shift project cost in 2021 dollars is estimated at $380.7 million.

A CDF represents the cumulative probability of not exceeding a particular value (also known as a percentile or confidence level). For example, from the CDFs shown for Alternative 1 Shift in Figure 2(b), the 70th percentile means that there is a 70 percent likelihood that the total cost for the entire project will be less than or equal to approximately $312.6 million in 2021 dollars. Likewise, the CDF shown in Figure 3(b) indicates a 70th percentile likelihood that the total cost for Alternative 2 Shift would be less than or equal to $387.6 million in 2021 dollars.

Year of expenditure costs for each alternative are calculated based on an anticipated pre-response risk-based schedules are shown in Figures 4 and 5. Figure 6 identifies the project's overall pre-response risk-based schedule with the most likely completion to be on or before December 2035 based on pre-response activities.

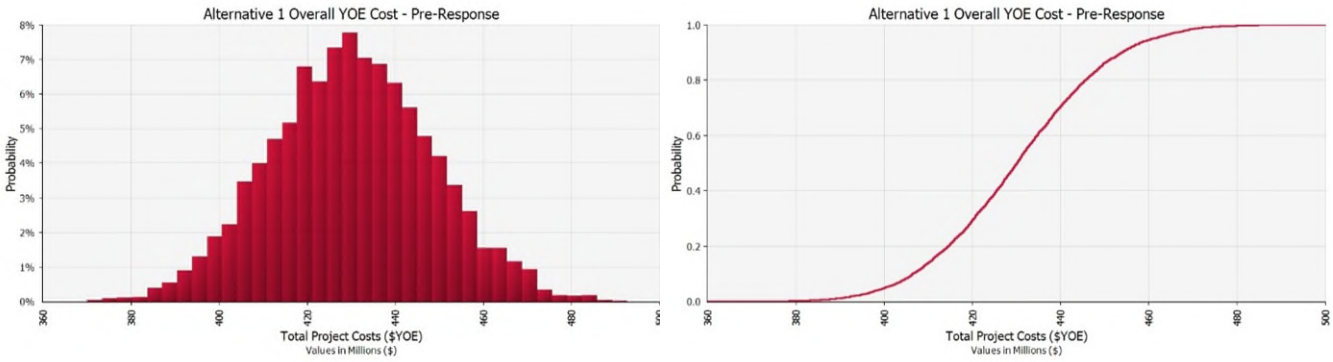


Figure 4 – Alternative 1 Shift - Probability Distribution for Overall Total Year of Expenditure Cost – Pre-Response, presented in two ways: a) probability mass function (PMF); b) cumulative distribution function (CDF)

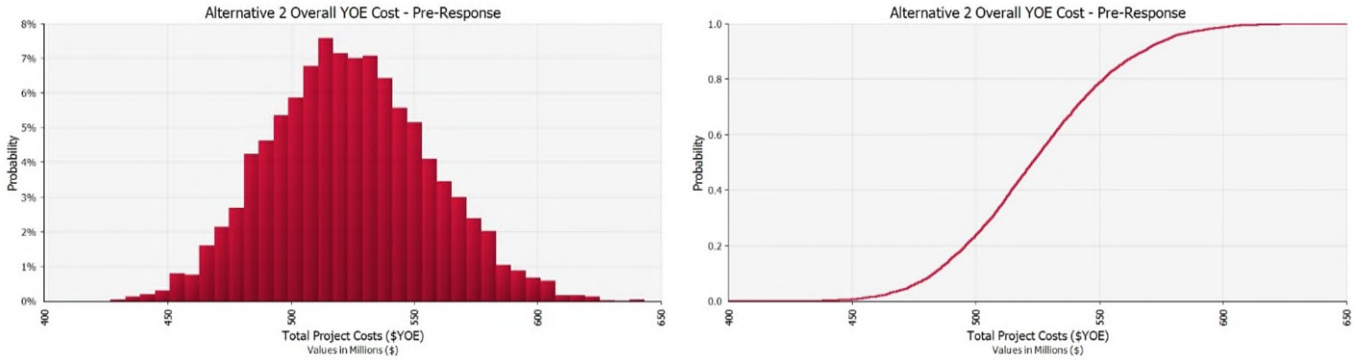


Figure 5 – Alternative 2 Shift - Probability Distribution for Overall Total Year of Expenditure Cost – Pre-Response, presented in two ways: a) probability mass function (PMF); b) cumulative distribution function (CDF)

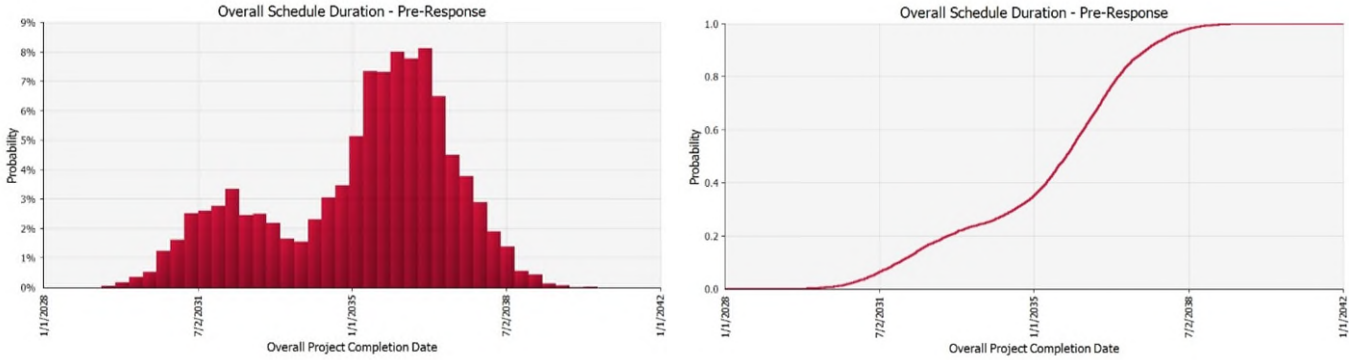


Figure 6 – Probability Distribution for Overall Schedule Duration – Pre-Response, presented in two ways: a) probability mass function (PMF); b) cumulative distribution function (CDF)

4.3 Post-Response Results

Sound project management execution consists of the agencies and those involved to proactively manage risk and opportunities; thereby, reducing potential increases and costs and schedule duration. As part of the workshop, the group identified the potential reduction in risks based on proactive management (Post-Response) and is shown in Figures 7 through 11.

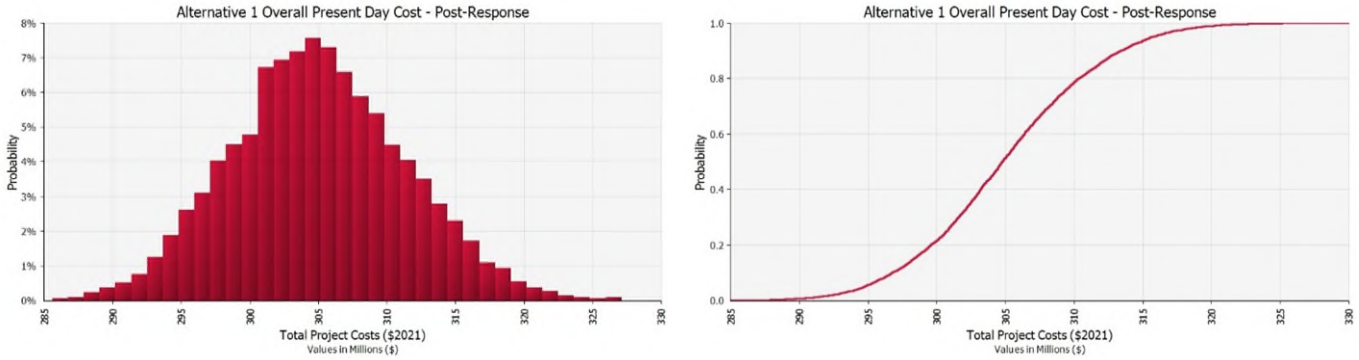


Figure 7 – Alternative 1 Shift - Probability Distribution for Overall Total Present Day Cost ($2021) – Post-Response, presented in two ways: a) probability mass function (PMF); b) cumulative distribution function (CDF)

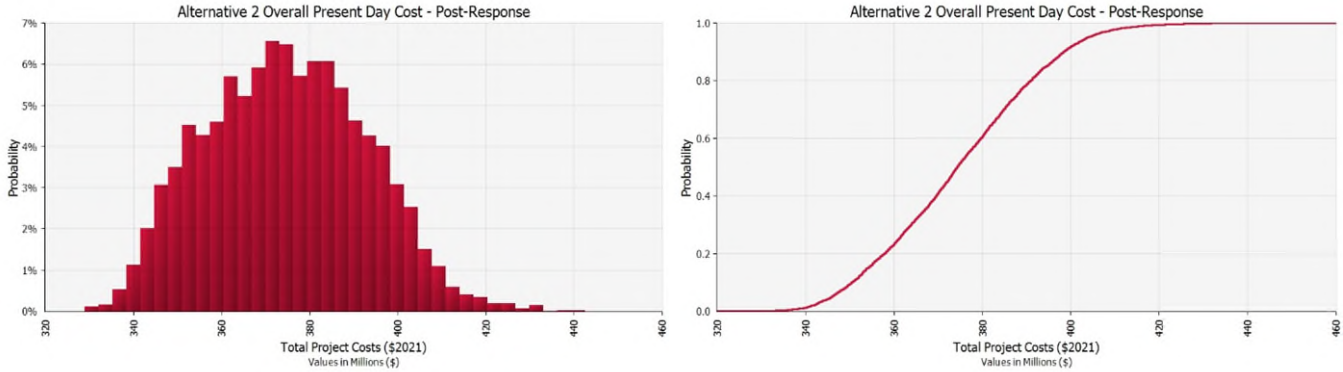


Figure 8 – Alternative 2 Shift- Probability Distribution for Overall Total Present Day Cost ($2021) – Post-Response, presented in two ways: a) probability mass function (PMF); b) cumulative distribution function (CDF)

Similar to the pre-response graphs in Section 4.2, Alternatives 1 Shift and 2 Shift develop bell shape curves and with proactively managing risks, the most likely Alternative 1 Shift project cost in 2021 dollars would be approximately $303.1 million. Alternative 2 Shift would most likely have an overall project cost of $372.8 million in 2021 dollars by utilizing post-response activities and mitigation management.

Figures 9 and 10 show the project would most likely cost $430.4 million for Alternative 1 Shift and $523.4 million for Alternative 2 in year of expenditure (YOE) dollars. Anticipated completion through the use of pro-active risk management would most likely be in July 2035 as shown in Figure 11 on page 17.

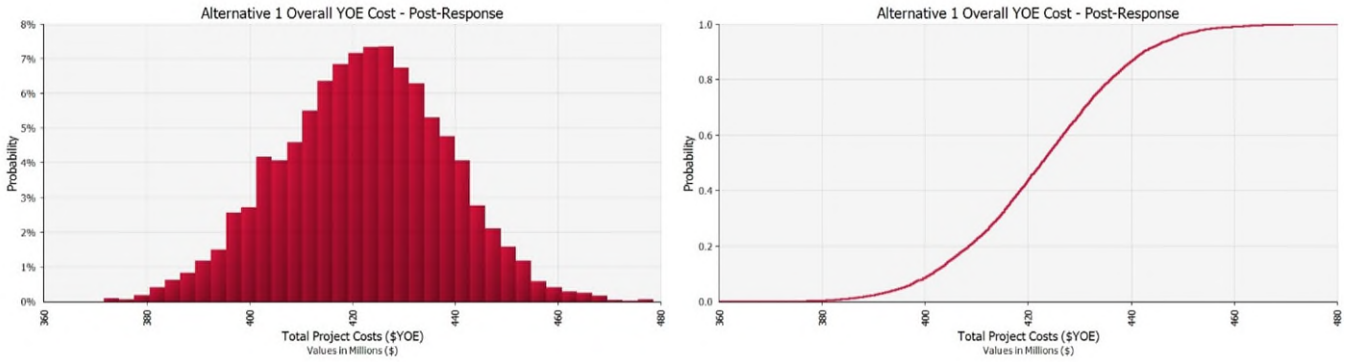


Figure 9 – Alternative 1 - Probability Distribution for Overall Total Year of Expenditure Cost – Post-Response, presented in two ways: a) probability mass function (PMF); b) cumulative distribution function (CDF)

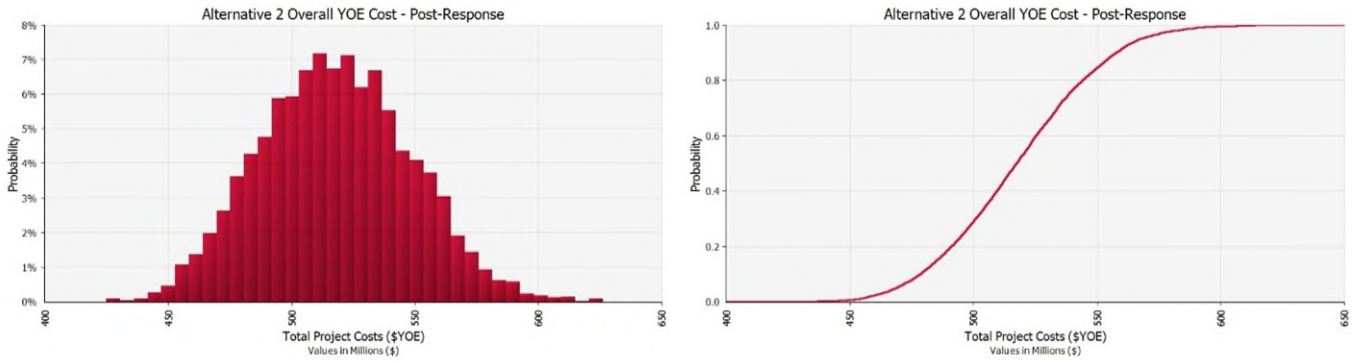


Figure 10 – Alternative 2 - Probability Distribution for Overall Total Year of Expenditure Cost – Post-Response, presented in two ways: a) probability mass function (PMF); b) cumulative distribution function (CDF)

Another method of presenting the project budget and schedule expectations to the general public and outside project stakeholders is by using the mid-80 percent confidence level. This range of cost and duration is bounded by the 10th percentile on the lower end and the 90th percentile on the higher end. This will provide an 80 percent likelihood that the project costs and schedule will be completed within this range, and only a 20 percent likelihood that it will not. Table 6 provides a summary of the mid-80 percent confidence level range post-response.

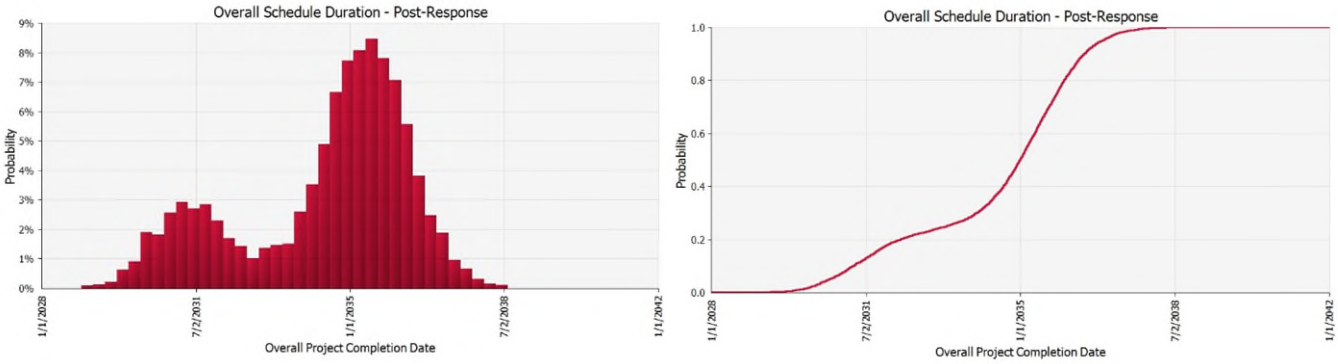


Figure 11 – Probability Distribution for Overall Schedule Duration – Pre-Response, presented in two ways: a) probability mass function (PMF); b) cumulative distribution function (CDF)

Description	10th Percentile (Lower Limit)	90th Percentile (Upper Limit)
Alternative 1 Shift		
Total Project Cost (2021 Dollars)	$296.8 million	$313.4 million
Total Project Cost (YOE Dollars)	$401.3 million	$442.4 million
Alternative 2 Shift		
Total Project Cost (2021 Dollars)	$350.6 million	$398.4 million
Total Project Cost (YOE Dollars)	$478.8 million	$557.7 million
Project Completion Date	February 2031	June 2036

Table 6 – Mid-80 Percent Confidence Level Range for the Overall Project Post-Response

Table 7 provides a summary of various post-response probability distributions (i.e. confidence levels) for the overall project including current year cost, year of expenditure and project duration.

	Alternative 1 Shift		Alternative 2 Shift		Overall Completion Date
	Total Project Cost (2021 $ Mil)	Total Project Cost (YOE $ Mil)	Total Project Cost (2021 $ Mil)	Total Project Cost (YOE $ Mil)	
Base	$254.3	$311.5	$357.1	$437.3	Dec 2028
Mean	$305.0	$422.6	$374.7	$517.9	May 2034
Standard Dev.	$6.4	$16.0	$18.1	$30.5	722 Days
5%	$294.8	$395.6	$346.0	$468.9	Aug 2030
10%	$296.8	$401.3	$350.6	$478.8	Feb 2031
15%	$298.3	$404.9	$354.2	$485.1	Aug 2031
20%	$299.6	$408.5	$357.9	$491.1	Feb 2032
25%	$300.7	$411.6	$361.2	$496.3	Mar 2033
30%	$301.6	$414.1	$363.9	$500.9	Dec 2033
35%	$302.4	$416.3	$366.9	$505.2	Apr 2034
40%	$303.2	$418.4	$369.6	$509.5	Jul 2034
45%	$304.0	$420.4	$372.1	$513.3	Oct 2034
50%	$304.8	$422.6	$374.3	$517.4	Jan 2035
55%	$305.6	$424.6	$376.8	$521.6	Mar 2035
60%	$306.4	$426.7	$379.7	$525.3	May 2035
65%	$307.2	$428.9	$382.3	$529.8	Jul 2035
70%	$308.2	$430.9	$384.9	$533.9	Aug 2035
75%	$309.2	$433.2	$387.9	$538.5	Oct 2035
80%	$310.3	$436.0	$391.0	$544.1	Dec 2035
85%	$311.8	$438.9	$394.5	$550.7	Mar 2036
90%	$313.4	$442.4	$398.4	$557.7	Jun 2036
95%	$315.7	$448.3	$403.8	$567.6	Nov 2036

Table 7 – Summary of Probability Distributions for Overall Cost and Schedule – Post Response

As Table 7 indicates, completion of the project could extend out to November 2036, if not longer. Based on the above information, there is 70th percentile confidence level that the project could be delivered by August 2035 with a maximum cost of $533.9 million (Alternative 2).

4.4 Significant Risks, Uncertainties and Strategies

Cost Risks

The tornado tables in Figures 12 and 13 show the potential impacts of the top ten post-response cost risks for Alternatives 1 Shift and 2 Shift respectively. Additional information about the risks is provided in Appendix C – Risk Register. The risk names are listed on the vertical axis with expected cost impact identified. Risks in the tornado diagram are ranked in descending order showing the greatest risk to cost on top.

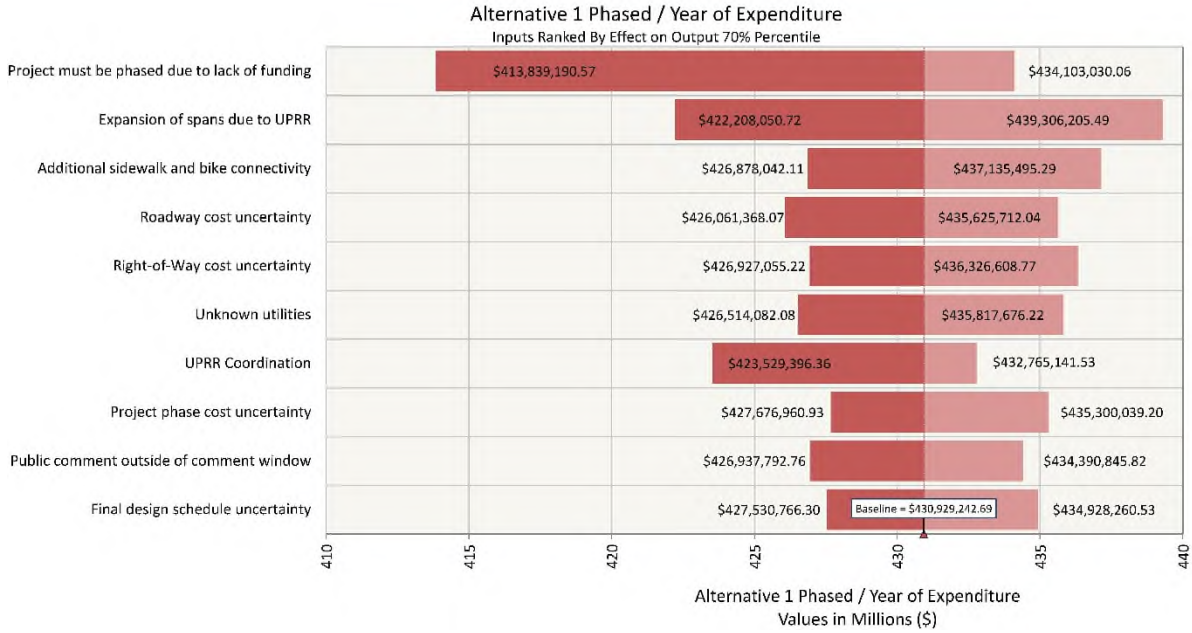


Figure 12 – Alternative 1 Shift Post Response Cost Tornado Diagram

For Alternative 1 Shift costs, the largest risk and opportunity is phasing of the project due to lack of funding which extends project cost escalation impacts.

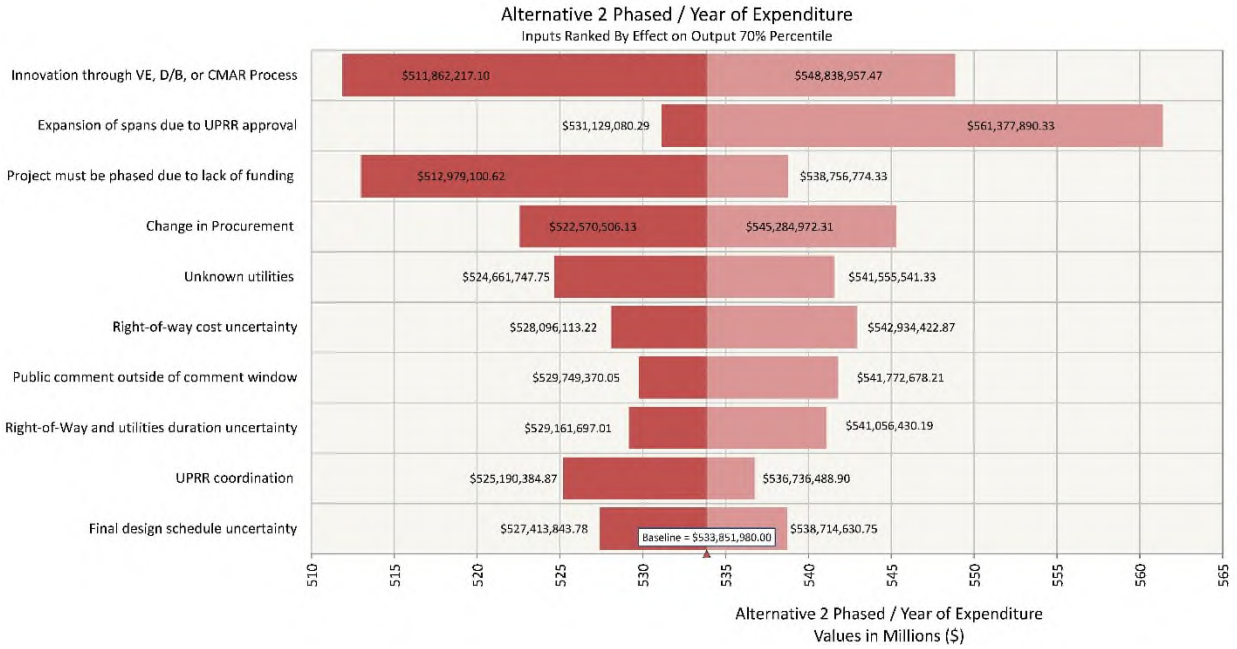


Figure 13 – Alternative 2 Shift Post Response Cost Tornado Diagram

For Alternative 2 Shift costs, the largest risk/opportunity item affecting the 70th percentile cost will be innovation developed through the value engineering, design-build, or CMAR process. UPRR guidance of mainline I-15 bridge structures can have a significant impact to both Alternatives 1 Shift and 2 Shift. Coordination with UPRR will be a high priority as the project moves into preliminary design. Funding and right-of-way cost allocation may also have a significant impact to Alternative 2 Shift.

Schedule Risks

The tornado table in Figure 14 shows the most significant potential impacts of the schedule risks for the project. Currently, the most significant item driving the project schedule is if the project must be phased over a substantial time frame due to lack of funding. Once the timing of funding has been solidified, other risks may play a more significant role in the 70th percentile project completion date. Additional information about the risks is provided in Appendix C – Risk Register. The risk names are listed on the vertical axis with expected schedule impact identified. Risks in the tornado diagram are ranked in descending order showing the greatest risk to schedule on top.

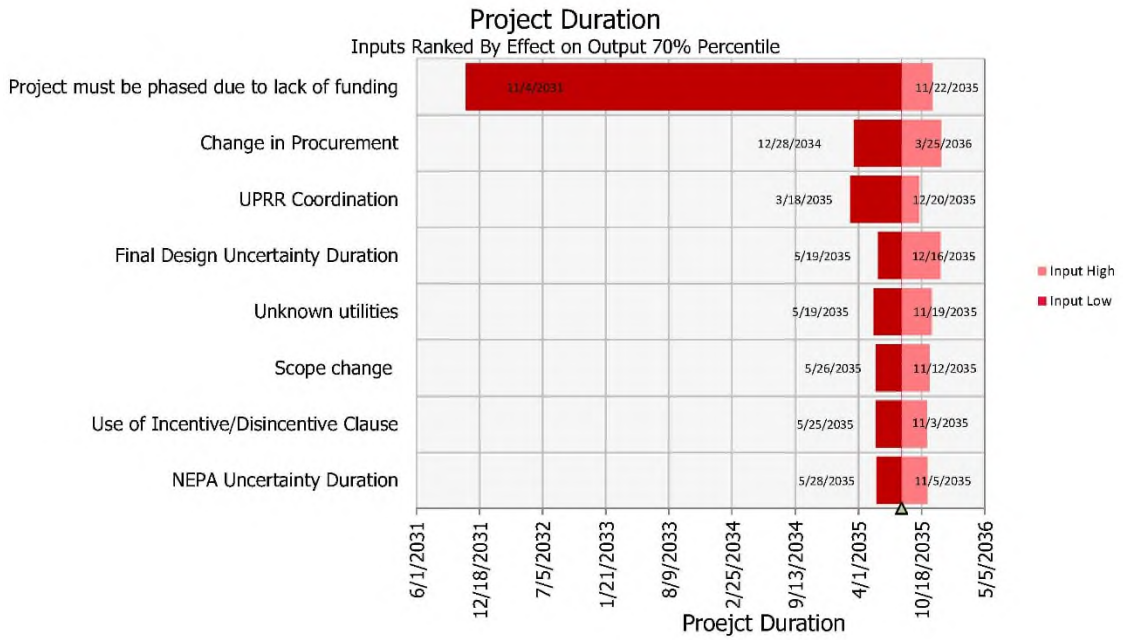


Figure 14 – Post Response Schedule Tornado Diagram

5.0 CLOSING

Based on the results of discussions during the Risk Assessment Workshop and this report, the following recommendations are made:

1. When possible, based on the above described uncertainties, it is best to provide project costs and durations in a range based on the mid-80 percentile confidence level as shown in Table 2 to help manage stakeholder expectations.
2. Recognize and communicate that this report is a snapshot into the project at the time of the Risk Assessment Workshop. As the project progresses various uncertainties will be retired, while new uncertainties may surface. In general, as time moves on the range between various confidence levels should diminish. NDOT should consider updates to the risk-based estimate at various milestones including preliminary and intermediate design submittals.
3. Utilize the 70th percentile confidence level estimates to help establish reasonable budgets and schedules, and then strive through risk management strategies identified in the risk register to bring the project in under budget and schedule.
4. Implement the strategies discussed in Section 4.3 to reduce the uncertainties in the top threats and opportunities. As the risks are retired or mitigated, update the risk-based estimate to identify the next 5-10 risks that the project team should focus on. By focusing resources on the most significant risks the project team will be able to efficiently retire those risks and reduce the mid-80th percentile confidence range.
5. By implementing a proactive risk management plan, it is safe to assume that NDOT will be able to reduce the 70th percentile project cost by approximately $3 million and reduced the project duration by approximately 5 months. However, there are several major risks and opportunities that once retired and an overall outcome is known, significant impacts to the 70th percentile cost and schedule will most likely occur.

These results are intended to provide NDOT and the Project Team with the information needed to aid in making educated decisions about the project scope, schedule, and budget. In addition, this report should aid in developing risk management strategies to ensure a successful project is developed and implemented within publicized schedules and budgets.

APPENDIX A
Base Cost Estimate

I-15 Flamingo to Sahara - Alternative 1

Item	Quantity or Percentage (Low) Under (%)		Base	(%) Over (High)		Unit	Current Year Unit Cost (Low) Under (%)		Base	(%) Over (High)		Current Year Base Total Cost
ROADWAY												
Roadway												
	1	0%	1	0%	1	LS	$27,062,848	-10.00%	$30,069,831	15.00%	$34,580,306	$30,069,831
Demolition												
	1	0%	1	0%	1		$5,270,050	-10.00%	$5,855,611	15.00%	$6,733,953	$5,855,611
											0	$35,925,442
STRUCTURES												
Bridges												
TROPICANA OFF-RAMP OVER FLAMINGO ON-RAMP	1	0%	1	0%	1	LS	$4,854,011	-10.00%	$5,393,345	10.00%	$5,932,680	$5,393,345
SB I-15 OFF-RAMP TO EB SPRING MOUNTAIN	1	0%	1	0%	1	LS	$2,304,450	-10.00%	$2,560,500	15.00%	$2,944,575	$2,560,500
WIDEN FLAMINGO OVER I-15	1	0%	1	0%	1	LS	$2,971,147	-10.00%	$3,301,274	10.00%	$3,631,401	$3,301,274
WIDEN FLAMINGO OVER FRANK SINATRA	1	0%	1	0%	1	LS	$2,016,086	-10.00%	$2,240,096	10.00%	$2,464,106	$2,240,096
WIDEN I-15 NB OVER UPRR	1	0%	1	0%	1	LS	$1,291,186	-10.00%	$1,434,651	20.00%	$1,721,581	$1,434,651
WIDEN I-15 SB OVER SPRING MOUNTAIN	1	0%	1	0%	1	LS	$1,239,832	-10.00%	$1,377,591	10.00%	$1,515,350	$1,377,591
I-15 SB (SBCD) BRIDGE OVER DEAN MARTIN	1	0%	1	0%	1	LS	$4,718,739	-10.00%	$5,243,043	10.00%	$5,767,347	$5,243,043
I-15 SB (SBCD) BRIDGE OVER TWAIN	1	0%	1	0%	1	LS	$4,189,415	-10.00%	$4,654,906	10.00%	$5,120,397	$4,654,906
I-15 SB (SBCD) BRIDGE OVER SPRING MOUNTAIN	1	0%	1	0%	1	LS	$1,728,103	-10.00%	$1,920,114	10.00%	$2,112,125	$1,920,114
I-15 (SBCD) BRIDGE OVER SPRING MOUNTAIN ON-RAMP	1	0%	1	0%	1	LS	$3,561,331	-10.00%	$3,957,034	10.00%	$4,352,737	$3,957,034
WIDEN FLAMINGO OVER DEAN MARTIN	1	0%	1	0%	1	LS	$1,891,959	-10.00%	$2,102,177	10.00%	$2,312,395	$2,102,177
SPRING MOUNTAIN OVER LOOP RAMP	1	0%	1	0%	1	LS	$2,096,390	-10.00%	$2,329,322	10.00%	$2,562,254	$2,329,322
I-15 OVER TWAIN	1	0%	1	0%	1	LS	$4,416,120	-10.00%	$4,906,800	10.00%	$5,397,480	$4,906,800
SPRING MOUNTAIN NB OFF-RAMP OVER TWAIN	1	0%	1	0%	1	LS	$723,330	-10.00%	$803,700	10.00%	$884,070	$803,700
NB I-15 AND NB SPRING MOUNTAIN OVER UPRR	1	0%	1	0%	1	LS	$4,186,080	-10.00%	$4,651,200	10.00%	$5,116,320	$4,651,200
NB/SB I-15 OVER SPRING MOUNTAIN	1	0%	1	0%	1	LS	$7,435,800	-10.00%	$8,262,000	10.00%	$9,088,200	$8,262,000
Walls												
RETAINING WALLS AT FLAMINGO	1	0%	1	0%	1	LS	$655,309	-10.00%	$728,121	25.00%	$910,151	$728,121
RETAINING WALLS AT SPRING MOUNTAIN	1	0%	1	0%	1	LS	$2,906,472	-10.00%	$3,229,413	25.00%	$4,036,766	$3,229,413
RETAINING WALLS AT SM NB OFF-RAMP @ TWAIN	1	0%	1	0%	1	LS	$1,519,679	-10.00%	$1,688,532	25.00%	$2,110,665	$1,688,532
RETAINING WALL AT SM NB OFF-RAMP TO WB SM	1	0%	1	0%	1	LS	$458,951	-10.00%	$509,946	25.00%	$637,433	$509,946
SOUNDWALL ALONG I-15 SB BETWEEN SPRING MOUNTAIN AND SAHARA	1	0%	1	0%	1	LS	$358,560	-10.00%	$398,400	10.00%	$438,240	$398,400
											Structures Subtotal	$61,692,165
TRAFFIC												
Traffic Signals												
FLAMINGO RD WB WITH I-15 NB ON-RAMP	1	0%	1	0%	1	LS	$146,300	-5.00%	$154,000	20.00%	$184,800	$154,000
FLAMINGO RD WB WITH I-15 SB ON RAMP	1	0%	1	0%	1	LS	$167,200	-5.00%	$176,000	20.00%	$211,200	$176,000
FLAMINGO RD WB WITH I-15 SB OFF-RAMP	1	0%	1	0%	1	LS	$167,200	-5.00%	$176,000	20.00%	$211,200	$176,000
SPRING MOUNTAIN W/ I-15 SB RAMPS	1	0%	1	0%	1	LS	$292,600	-5.00%	$308,000	20.00%	$369,600	$308,000
											Traffic Subtotal	$814,000
ADDITIONAL ITEMS												
Additional Items	1	0%	1	0%	1	LS	$23,210,253	-10.00%	$25,789,170	15.00%	$29,657,546	$25,789,170
											Additional Items Subtotal	$25,789,170
DRAINAGE												
Drainage												
	1	0%	1	0%	1	LS	$8,554,305	-10.00%	$9,504,783	50.00%	$14,257,175	$9,504,783
											Drainage Subtotal	$9,504,783

Table A-1 – Alternative 1 Shift Baseline Cost Estimate

I-15 Flamingo to Sahara - Alternative 1

Item	Quantity or Pecentage (Low) Under (%)	Base	(%) Over (High)	Unit	Current Year Unit Cost (Low) Under (%)	Base	(%) Over (High)	Current Year Base Total Cost
Sub-Total Present Day Construction Cost								**$133,725,560**
Landscaping and Aesthetics		3.0%				$3,726,623		$3,726,623
Erosion Control		1.0%				$1,242,208		$1,242,208
Traffic Control		10.0%				$12,422,078		$12,422,078
Roadside Safety		3.0%				$3,726,623		$3,726,623
Additional Items		0.0%				$0		$0
						Sub-Total		$154,843,092
Mobilization		7.0%				$10,173,682		$10,173,682
Total Present Day Construction Cost								**$165,016,774**
Construction Engineering/Inspection		15.0%				$24,752,516		$24,752,516
NEPA		1.0%				$1,650,168		$1,650,168
Preliminary Engineering & Design		4.0%				$6,600,671		$6,600,671
Final Engineeering		4.0%				$6,600,671		$6,600,671
Administration		1.0%				$1,650,168		$1,650,168
Legal		1.0%				$1,650,168		$1,650,168
Total Present Day Construction and Engineering Cost								**$207,921,135**
RIGHT-OF-WAY								
Right-of-Way		1		LS	$38,154,375	-5.00% $40,162,500	25.00% $50,203,125	$40,162,500
							Right-of-Way Subtotal	$40,162,500
Environmental Consideration		3.0%				$6,237,634		$6,237,634
Overall Total Present Day Cost - Alternative 1								**$254,321,269**

Note: No contingency is within the estimate since it is a baseline estimate.

Table A-1 – Alternative 1 Shift Baseline Cost Estimate (Cont.)

I-15 Flamingo to Sahara - Alternative 2

Item	Quantity or Percentage (Low) Under (%)		Base	(%) Over (High)		Unit	Current Year Unit Cost (Low) Under (%)		Base	(%) Over (High)		Current Year Base Total Cost
ROADWAY												
Roadway												
	1	0%	1	0%	1	LS	$35,629,552	-10.00%	$39,588,391	15.00%	$45,526,650	$39,588,391
Demolition												
	1	0%	1	0%	1	LS	$1,810,183	-10.00%	$2,011,314	15.00%	$2,313,011	$2,011,314
											0	$41,599,705
STRUCTURES												
Bridges												
RUSSELL RD OVER NBCD	1	0%	1	0%	1	LS	$4,914,188	-10.00%	$5,460,209	10.00%	$6,006,230	$5,460,209
TROPICANA ON RAMP OVER FLAMINGO OFF RAMP	1	0%	1	0%	1	LS	$7,249,442	-10.00%	$8,054,935	20.00%	$9,665,922	$8,054,935
TROPICANA OFF RAMP OVER FLAMINGO ON RAMP	1	0%	1	0%	1	LS	$4,264,025	-10.00%	$4,737,805	10.00%	$5,211,586	$4,737,805
SPRING MOUNTAIN BRIDGE OVER THE LOOP RAMP	1	0%	1	0%	1	LS	$3,103,475	-10.00%	$3,448,306	10.00%	$3,793,137	$3,448,306
WIDEN FLAMINGO OVER I-15	1	0%	1	0%	1	LS	$2,971,147	-10.00%	$3,301,274	10.00%	$3,631,401	$3,301,274
WIDEN FLAMINGO OVER FRANK SINATRA	1	0%	1	0%	1	LS	$2,016,086	-10.00%	$2,240,096	10.00%	$2,464,106	$2,240,096
WIDEN I-15 NB OVER UPRR	1	0%	1	0%	1	LS	$1,291,186	-10.00%	$1,434,651	20.00%	$1,721,581	$1,434,651
WIDEN I-15 SB OVER SPRING MOUNTAIN	1	0%	1	0%	1	LS	$1,239,833	-10.00%	$1,377,592	10.00%	$1,515,351	$1,377,592
SPRING MOUNTAIN OFF RAMP OVER FLAMINGO ON-RAMP	1	0%	1	0%	1	LS	$3,965,774	-10.00%	$4,406,416	10.00%	$4,847,058	$4,406,416
I-15 SB (SBCD) OVER SPRING MOUNTAIN ON-RAMP	1	0%	1	0%	1	LS	$3,561,331	-10.00%	$3,957,034	10.00%	$4,352,737	$3,957,034
I-15 SB (SBCD) BRIDGE OVER DEAN MARTIN	1	0%	1	0%	1	LS	$4,718,739	-10.00%	$5,243,043	10.00%	$5,767,347	$5,243,043
I-15 SB (SBCD) BRIDGE OVER TWAIN	1	0%	1	0%	1	LS	$4,189,415	-10.00%	$4,654,906	10.00%	$5,120,397	$4,654,906
I-15 SB (SBCD) BRDIGE OVER SPRING MOUNTAIN	1	0%	1	0%	1	LS	$1,728,103	-10.00%	$1,920,114	10.00%	$2,112,125	$1,920,114
SPRING MOUNTAIN FLYOVER BRIDGE	1	0%	1	0%	1	LS	$4,546,640	-10.00%	$5,051,822	10.00%	$5,557,004	$5,051,822
HACIENDA BRDIGE OVER I-15 NB/SB	1	0%	1	0%	1	LS	$6,638,703	-10.00%	$7,376,337	10.00%	$8,113,971	$7,376,337
WIDEN FLAMINGO OVER DEAN MARTIN	1	0%	1	0%	1	LS	$1,891,959	-10.00%	$2,102,177	10.00%	$2,312,395	$2,102,177
HARMON BRIDGE OVER I-15 NB/SB	1	0%	1	0%	1	LS	$10,978,788	-10.00%	$12,198,653	10.00%	$13,418,518	$12,198,653
Walls												
RETAINING WALLS AT RUSSELL	1	0%	1	0%	1	LS	$689,119	-10.00%	$765,688	25.00%	$957,110	$765,688
RETAINING WALLS AT TROPICANA	1	0%	1	0%	1	LS	$277,861	-10.00%	$308,734	25.00%	$385,918	$308,734
RETAINING WALLS AT FLAMINGO	1	0%	1	0%	1	LS	$480,723	-10.00%	$534,137	25.00%	$667,671	$534,137
RETAINING WALLS AT SPRING MOUNTAIN	1	0%	1	0%	1	LS	$2,906,472	-10.00%	$3,229,413	25.00%	$4,036,766	$3,229,413
SOUNDWALL ALONG I-15 SB BETWEEN SPRING MOUNTAIN AND SAHARA	1	0%	1	0%	1	LS	$358,560	-10.00%	$398,400	10.00%	$438,240	$398,400
											Structures Subtotal	$82,201,742
TRAFFIC												
Traffic Signals												
RUSSELL RD EB WITH I-15 NB ON-RAMP	1	0%	1	0%	1	LS	$167,200	-5.00%	$176,000	20.00%	$211,200	$176,000
TROPICANA RD EB WITH I-15 NB ON RAMP	1	0%	1	0%	1	LS	$167,200	-5.00%	$176,000	20.00%	$211,200	$176,000
FLAMINGO RD W/I15 OFF/ON RAMPS	1	0%	1	0%	1	LS	$334,400	-5.00%	$352,000	20.00%	$422,400	$352,000
FLAMINGO RD EB W/ I-15 NB ON RAMP	1	0%	1	0%	1	LS	$146,300	-5.00%	$154,000	20.00%	$184,800	$154,000
SPRING MOUNTAIN W/ I-15 SB ON RAMP	1	0%	1	0%	1	LS	$250,800	-5.00%	$264,000	20.00%	$316,800	$264,000
											Traffic Subtotal	$1,122,000
ADDITIONAL ITEMS												
Additional Items	1	0%	1	0%	1	LS	$21,432,445	-10.00%	$23,813,828	15.00%	$27,385,902	$23,813,828
Alternative 1 Delta	1	0%	1	0%	1	LS	$35,522,886	-5.00%	$37,392,514	5.00%	$39,262,140	$37,392,514
											Additional Items Subtotal	$61,206,342
DRAINAGE												

Table A-2 – Alternative 2 Shift Baseline Cost Estimate

I-15 Flamingo to Sahara - Alternative 2

Item	Quantity or Pecentage (Low) Under (%)		Base	(%) Over (High)		Unit	Current Year Unit Cost (Low) Under (%)		Base	(%) Over (High)		Current Year Base Total Cost
Drainage												
	1	0%	1	0%	1	LS	$10,104,514	-10.00%	$11,227,238	50.00%	$16,840,857	$11,227,238
											Drainage Subtotal	$11,227,238
Sub-Total Present Day Construction Cost												**$197,357,027**
Landscaping and Aesthetics			3.0%						$5,583,894			$5,583,894
Erosion Control			1.0%						$1,861,298			$1,861,298
Traffic Control			10.0%						$18,612,979			$18,612,979
Roadside Safety			3.0%						$5,583,894			$5,583,894
Additional Items			0.0%						$0			$0
									Sub-Total			$228,999,091
Mobilization			7.0%						$13,029,085			$13,029,085
Total Present Day Construction Cost												**$242,028,176**
Construction Engineering/Inspection			15.0%						$36,304,226			$36,304,226
NEPA			1.0%						$2,420,282			$2,420,282
Preliminary Engineering & Design			4.0%						$9,681,127			$9,681,127
Final Engineeering			4.0%						$9,681,127			$9,681,127
Administration			1.0%						$2,420,282			$2,420,282
Legal			1.0%						$2,420,282			$2,420,282
Total Present Day Construction and Engineering Cost												**$304,955,502**
RIGHT-OF-WAY												
Right-of-Way			1			LS	$40,825,965	-5.00%	$42,974,700	25.00%	$53,718,375	$42,974,700
											Right-of-Way Subtotal	$42,974,700
Environmental Consideration			3.0%						$9,148,665			$9,148,665
Overall Total Present Day Cost - Alternative 2												**$357,078,867**

Note: No contingency is within the estimate since it is a baseline estimate.

Table A-2 – Alternative 2 Shift Baseline Cost Estimate (Cont.)

APPENDIX B

Workshop Baseline Flow Chart

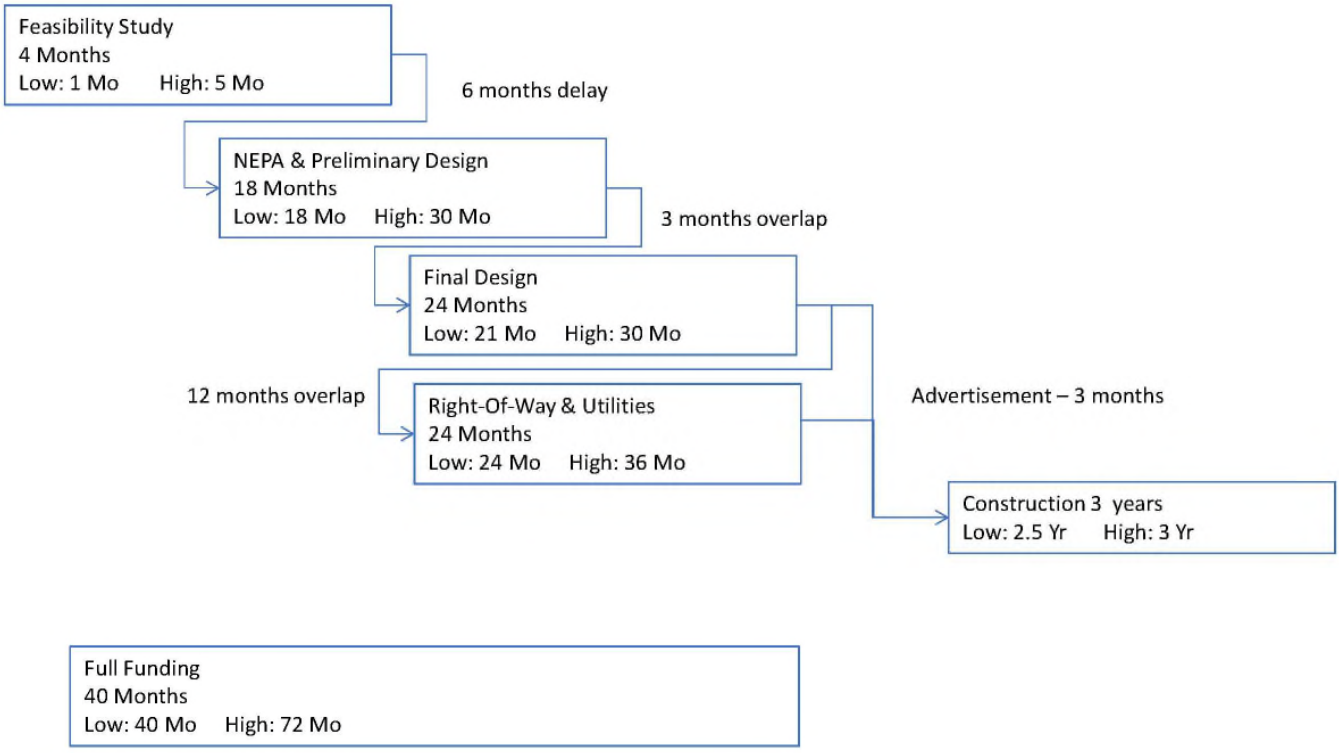


Figure B -1 – Baseline Flow Chart

APPENDIX C

Post Response Risk Register

Threat/Opportunity	Description	Status	Strategy	Alternative 1							Alternative 2							Notes
				Likelihood	Cost Impact			Schedule Impact			Likelihood	Cost Impact			Schedule Impact			
					Low	Most Likely	High	Low	Most Likely	High		Low	Most Likely	High	Low	Most Likely	High	
CONSTRUCTION																		
Displaced persons residing in corridor (Construction)		Active	Accept															Utilize NDOT's Displaced Persons Policy to prepare design details to address displaced persons. Maintenance will clean the corridor prior to construction. *(Contact Mike Yates on how this could impact schedule.)*
Minor Change Orders	NDOT averages approximately 3% of construction cost	Active	Accept	Medium	1%	2%	3%						Same					NDOT has an excellent partnering program that needs to continue.
Drilled Shafts	D/B is more challenging due to expedited schedule. Related to D-B delivery method.	Active	Mitigate	Low				-1 MO*	-2 MO*	-3 MO*						Same		Lot of unknown site conditions for drilled shafts. Mitigated through partnering.
Inclement weather	Average 5% of working days	Active	Accept	High					5%							Same		
Contractor resources/quality		Active	Accept	Low (D-B-B)(CMAR) Very Low (D-B)	$100K	$250K	$500K	1 MO	2 MO	3 MO			Same			Same		Poor performance or lack of resources from Contractor or Subcontractors. More likely under Design-Bid-Build scenario or CMAR.
CONTRACTING AND PROCUREMENT																		
Major reconstruction efforts require closure of I-15																		Develop phasing plan to limit or incrementally upgrade the project based on the alternative(s).
Change in Procurement (CMAR/D-B)		Active	Accept	Medium	5%	7.50%	10%	-6 MO	-9 MO	-1 YR			Same			Same		Combining design with early construction activites.
Innovation through VE, D/B - CMAR process		Active	Accept	Medium	-10%	-12.5%	-15%						Same					
Reciept of Federal Grant		Active	Monitor	Very Low				-1 YR	-2 YR	-3 YR						Same		Difficult to assess right now. Once an alternative, cost, and fuding sources, grants such as INFRA and BUILD could be applied for and potentially won.
Use of Incentive/Disincentive clauses		Active	Accept	Medium	$1 MIL	$2 MIL	$4 MIL	-3 MO	-4.5 MO	-6 MO			Same			Same		
DESIGN/PS&E																		
Traffic projections require facilities that are not feasible within the existing footprint		***Retired***																Traffic modeling process must conform to regional projections/volumes/OD matrices. Evaluate facilities using additional MOE besides traffic to determine feasible alternatives. *Mitigated and retired as part of the Feasibility Study.*
Schedule of Project NEON's future phase is unknown.		***Retired***																Need to work with NDOT to determine schedule of improvements and potential alternative tie-ins. Provide concept tie ins to match current NEON phase and account for throw away work for future connectivity. *NEON should be done before this project is constructed - Retired.*
Landscape plan creates areas for displaced persons to occupy project R/W.						Minor							Same					Work with NDOT L&A to develop L&A concepts that discourage occupancy of the R/W.
Coordination with adjacent City of Las Vegas MLK Extension		Active	Mitigate	Medium	$500K	$1.5 MIL	$3 MIL	2 MO	4 MO	6 MO			Same			Same		Could have an impact to alternative development during the NEPA/Preliminary Design phase.
CLV MLK Extension project concurrent construction.		Active	Monitor	Low				1 MO	2 MO	4 MO						Same		This would be during Construction.
Sidewalks do not exist on both sides of all roadways through the NDOT R/W, but do on adjacent streets. Bike connectivity will also need to be evaluated.	Primary movements have been incorporated into alternatives. Connectivity to CLV MLK Extension will need to be evaluated.	Active	Accept	Low	$500K	$1.5 MIL	$15 MIL						Same					Develop ideas and alternatives that provide better pedestrian connectivity through the corridor's crossing roadways.
HOV System	Is HOV 1 lane/2 lane, still be operated? 24/7?	Active	Accept	Low				3 MO	6 MO	9 MO						Same		If HOV system is modified during the design process, could impact schedule based on modifications/evaluations.
High Speed Rail		Active	Monitor	Low														Could change traffic patterns. Will not know true impacts till implemented which could be in 2024. Could be additional funding source.

Figure C-1 – Risk Register – Post Response

ENVIRONMENTAL & HYDRAULICS																		
Displaced persons residing in corridor (NEPA)		Active	Monitor	Low														Just an item that needs to be addressed as part of the documentation unless they already have actual residency.
Hazardous material is encountered	UPRR rail within corridor. Existing bridge structures	Active	Mitigate	Very Low	$250K	$375K	$500K	0 MO	1 MO	2 MO			Same			Same		Conduct Phase 1 ESA. Perform cleanup aligned with EPA requirements. Include in plan and specs for proper contractor notification. Not a critical path item. ***Mitigation: Do early evaluation of existing bridges for potential asbestos and lead containment. Coordinate with Environmental .***
Project/phases of the project not included in the Regional TIP/AQ conformity model delaying completion of NEPA compliance.	Have time to get initial alternative into TIP/AQ, however, any mistake could have schedule impacts	Active	Mitigate	Low				0 YR	0 YR	1 YR						Same		Develop schedule of improvements as early as possible to include in regional TIP/AQ modeling updates when they occur. ***Mitigation: Meet multiple with NDOT Planning and Project Management to conduct thorough review of the TIP/AQ documents prior to submittign to RTC.***
Public commenter complains outside of comment window.	Very high profile property owners adjacent to coorridor with fluctuating decision makers/owners	Active	Mitigate	Medium				3 MO	7.5 MO	1 YR						Same		Provide clear information and transparent process to public to reduce poor public perception. Several active lawsuits on NEON and I-15 South had a post construction lawsuit. Need to develop a dedicated, thorough, and continuous stakeholder engagement plan to be part of each project/phase to development/environmental process.
Public commenter sues NDOT based on perceived impacts.	More of a cost risk than schedule risk. Would occur post project completions.	Active	Mitigate	Very Low	$250K	$500K	$1 MIL						Same					Provide clear information and transparent process to public to reduce poor public perception. Several active lawsuits on NEON and I-15 South had a post construction lawsuit. ***Mitigation: Design team look for ways to minimize right-of-way and access impacts.***
Other agency coordination and permitting	Clark County permits	Active	Mitigate	Low				0 MO	1 MO	2 MO						Same		***Mitigation: Final stabilization and dust control plan. Pull in County early for feedback on mitigation efforts and include in plan sets.***
MANAGEMENT & FUNDING																		
Scope change		Active	Mitigate	Medium	$500K	$3 MIL	$6 MIL	3 MO	6 MO	9 MO			Same			Same		Would occur during NEPA or Design Phase. ***Mitigation: Early coordination with stakeholders and internal Divisions on adjacent projects/enhancements and early commitments that to minimize last minute scope additions.***
Project must be phased due to limited funding		Active	Accept	High	$2.5 MIL	$5 MIL	$10 Mil	3 YR	4 YR	5 YR			Same			Same		Project must be phased due to limited funding and additional funding must be identified. Would include impacts to funding related to COVID. *Cost impacts modified in April 2021 CRA updates.*
Change in NDOT Leadership/personnel		Active	Accept	High				1 MO	2 MO	3 MO						Same		May be able to mitigate by "shadowing" of personnel.
Change in NDOT priorities		Active	Accept	Medium				1 YR	2.5 YR	5 YR						Same		
Change in NDOT Standards/Specifications/Policies		Active	Accept	High				1 MO	1.5 MO	2 MO						Same		
Inefficiencies and resource impacts COVID		Active	Accept	Medium				3 MO	4.5 MO	6 MO						Same		Already experiencing this on this project and other projects.
RIGHT-OF-WAY																		
Duration of acquisition could exceed the schedule duration - uncooperative property owner		Active	Accept	Medium				1 MO	2 MO	3 MO						Same		Consider alternatives that limit the number/magnitude of acquisitions/easements. Covers timeframe for condemnations.
Property transfers from previous project have not been executed and are in limbo		***Retired***																Work with NDOT R/W to identify all parcels not currently owned or property transferred and begin final process to secure final R/W rights and ownership. *Very close to finalizing and should not have an impact to overall project critical path.*

Figure C-1 – Risk Register – Post Response (Cont.)

RAILROAD																		
UPRR Coordination		Active	Accept	High				6 MO	9 MO	1 YR						Same		NDOT has been having issues with UPRR not being responsive. Multiple bridges crossing UPRR
STRUCTURES AND GEOTECH																		
Expansion of spans due to UPRR approval		Active	Accept	Very Low	$10 MIL	$20 MIL	$30 MIL											UPRR may require r/w to r/w spans for existing bridges
Replacement of existing MSE Walls		Active	Accept	Low	$1 MIL	$2.5 MIL	$5 MIL											Need to investigate existing MSE walls and the potential of strap corrosion
UTILITIES																		
Unknown utilities		Active	Mitigate	Medium	$5 Mil	$10 Mil	$15 Mil	3 MO	6 MO	9 MO			Same			Same		Allow for additional costs in project budget. ***Mitigation: During NEPA process conduct more extensive utility coordination/research. At this point no data to justify reduced cost or delay risk.***
Potential for NVE relocations/coordination		Active	Mitigate	High	$300K	$1.2 MIL	$3 MIL	3 MO	6 MO	9 MO			Same			Same		Will identify prior rights during the prior rights research.
NVE Substation infrastructure impacts		Active	Avoid	Low														
Utility relocations needed do not happen on schedule impacting construction schedule.	Gas line along UPRR. Kern River or Kinder Morgan.	Active	Accept	Medium				3 MO	6 MO	9 MO						Same		Up-front and continued coordination with utility companies to explain the impacts. Put responsibility on CMAR/Design Builder to avoid or coordinate early with utilities.
Utility underground is damaged	Utility hit during construction	Active	Mitigate	Low		Minor		3 MO	6 MO	9 MO			Same			Same		Work with utilities in advance to identify potential damaged locations. Document these in project specifications. Follow up with utility companies RE: repair work.
Temporary NVE planned connection	There was a planned temporary line that had to be in conflict with proposed improvements due to construction of the monorail.	Active	Monitor	Very Low					N/A						0 MO	3 MO	6 MO	Monorail schedule in limbo. Need to continue monitoring and coordination with Monorail Company. ***Mitigation: NDOT will have temporary permit approval authority. Work with permits to make sure Project Management is notified if the permit is submitted to avoid project conflict.***

Figure C-1 – Risk Register – Post Response (Cont.)

APPENDIX D

Additional Risk Output

NDOT Risk Breakdown Structure Category	I-15 – Flamingo Road to Sahara Avenue Risk Count			
	Active	Inactive	Retired	Total
Environmental & Hydraulics	6	0	0	6
Right-of-Way	1	0	1	2
Utilities	6	0	0	6
Railroad	1	0	0	1
Design/PS&E	7	0	2	9
Structure & Geotech	2	0	0	2
Management/Funding	6	0	0	6
Contracting & Procurement	5	0	0	5
Construction	5	0	0	5
Total	**39**	**0**	**3**	**42**

Table D-1 – I-15 – Flamingo Road to Sahara Avenue Risk Count Detail

APPENDIX E

September 2020 Cost Risk Assessment

I-15 Flamingo Road to Sahara Avenue

Risk Assessment Workshop Report

Prepared for:

Nevada Department of Transportation

September 2020

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I. EXECUTIVE SUMMARY

The attached Cost Risk Assessment report for the Nevada Department of Transportation's (NDOT) proposed improvements to the Interstate 15 (I-15) corridor from Flamingo Road to Sahara Avenue identifies project threats and opportunities that could affect project cost and/or budget. The feasibility study is currently evaluating two potential locally preferred alternatives, which are both included in this Cost Risk Assessment (CRA).

In preparing the CRA, a risk-based estimate was prepared to model project risks assuming all risks would be accepted (pre-response) and preparing the post-response estimate assuming a proactive risk management plan was implemented. The CRA evaluated two different alternatives to identify if the risks may cause significantly different potential outcomes.

The following tables present the August 2020 CRA results and are intended as a quick summary for NDOT Management and Executive Leadership Team (ELT).

Risk-Adjusted Cost Results (in Millions – YOE $'s)				
Scenario	**Base Cost**	**Cost Range**		
		10th Percentile	**70th Percentile**	**90th Percentile**
Alternative 1				
Pre-Response	$227.7	$322.2	$364.1	$380.5
Post-Response		$315.1	$356.8	$371.2
Alternative 2				
Pre-Response	$364.5	$414.5	$470.7	$505.8
Post-Response		$409.6	$461.1	$483.7

Table E-1 – Risk Adjusted Cost Results (in Millions – YOE $'s)

Risk-Adjusted Project Completion Date				
Scenario	**Base Completion Date**	**Project Completion Date Range**		
		10th Percentile	**70th Percentile**	**90th Percentile**
Pre-Response	Dec 2028	June 2031	December 2035	December 2036
Post-Response		February 2031	August 2035	June 2036

Table E-2 – Risk Adjusted Project Completion Date

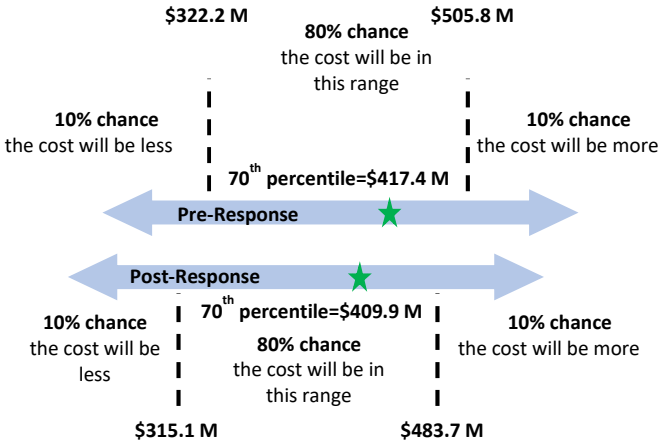
Figure E-1 on the attached page presents a one-page snapshot of I-15 Flamingo Road to Sahara Avenue project with respect to overall benefits, costs, and schedule based on the outcomes of the two alternatives.

Project Summary	I-15 Flamingo Road to Sahara Avenue September 2020	

Project Description

- Widen I-15
- Improve Flamingo Road Interchange
- Improve Spring Mountain Interchange
- Improve I-15 Operations

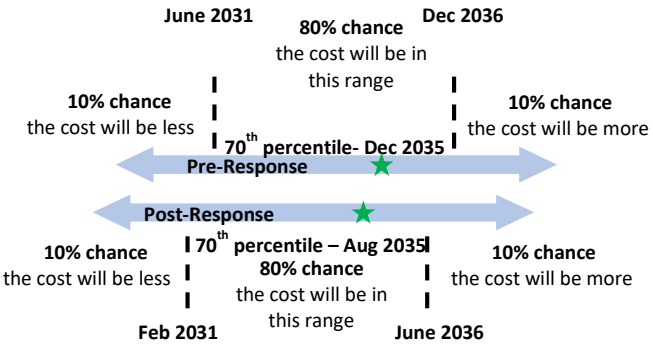
CRA Cost Range



Project Benefits

- Increase capacity
- Reduce overall interchange delay
- Enhance safety

CRA Schedule Range



Key Project Schedule Risks

Threats

- Funding Availability
- UPRR Coordination
- Utility Relocations
- Scope Changes
- NEPA

Opportunities

- Design-Build Procurement
- Use of Incentive/Disincentive Clauses

Key Project Cost Risks

Threats

- Acquisition allocation of shared right-of-way with Project NEON
- Expansion of bridge spans due to UPRR
- Phasing due to funding availability
- Unknown utilities
- Additional sidewalk and bicycle connectivity
- Right-of-way
- UPRR coordination

Level of Project Completion:	Low Medium High	September 2020

Figure E-1 - I-15 Flamingo Road to Sahara Avenue Project Summary

1. INTRODUCTION

The report summarizes a risk-based cost and schedule analysis completed by CA Group for the NDOT's proposed improvements to the I-15 corridor from Flamingo Road to Sahara Avenue. Two potential options have been identified that will provide improvements to the interstate and interchanges to enhance interchange and freeway operations, capacity, and safety. The following study documents the Risk Assessment Workshop that was conducted by CA Group on August 24-25, 2020. Due to restrictions related to the on-going COVID-19 pandemic, the workshop was held virtually utilizing Microsoft Teams.

The purpose of the workshop was to:

- Analyze and document the potential range of uncertainty in both project cost and schedule due to risks (threats and/or opportunities) to assist in selecting a locally preferred alternative;
- Identify any significant risks or opportunities unique to the different alternatives which would be considered in the selection of the preferred alternative; and
- Identify and prioritize key cost and schedule risks and opportunities for the proposed alternatives.

The workshop and subsequent statistical analysis followed an approach very similar to the Washington State Department of Transportation's Cost Estimate Validation process (CEVP®) and in accordance with the Nevada Department of Transportation's (NDOT) Risk Management and Risk-Based Cost Estimation Guidelines.

The Risk Assessment Workshop consisted of several subject matter experts that are familiar with the project and potential risks and opportunities. Workshop attendees included the following individuals:

- Facilitator – Chad Anson, CA Group
- Jeff Lerud – NDOT Project Management
- Lynette Russell – NDOT Project Management
- Mike West – NDOT Construction
- Mike Mayberry – NDOT Structures
- Bill Grennan – NDOT Right-of-Way
- Casey Sylvester – NDOT Traffic Operations
- Jason Love – NDOT Planning
- Joselio Ramirez – NDOT Hydraulics
- Laura Wiggins – NDOT Roadway
- Sonja Long – NDOT Utilities/Right-of-Way
- Tom Perez – NDOT Right-of-Way
- Jacob Waclaw – FHWA
- Iyad Alattar – FHWA
- Greg McDermott – City of Las Vegas

- Humberto Rivas – Clark County Public Works
- Jack Sjostrom – CA Group
- Jim Mischler – CA Group
- Anita Busch – CA Group
- Ghirmai Eman – CA Group
- Jim Caviola – CA Group
- Tammy Michels – CA Group

The outcomes of the workshop and Risk Assessment Report are intended to assist in providing NDOT Project Management and ELT an estimated overall project cost as well as recommend a schedule and risk management strategies.

2. PROJECT DESCRIPTION AND ASSUMPTIONS

2.1. Project Scope and Phasing

Interstate 15 (I-15) is the primary transportation corridor in southern Nevada, connecting to California and Arizona. Over the past three decades, the Nevada Department of Transportation (NDOT) has been making significant investments in improvements to I-15 to keep up with the growth in the Las Vegas area. The section of I-15 between Flamingo Road and Sahara Avenue is the last section to be upgraded adjacent to the resort corridor (Las Vegas Strip). Recently completed projects include NDOT's I-15 South Design-Build Project (Silverado Ranch Boulevard to Tropicana Avenue) to the south and NDOT's Project NEON (Sahara Avenue to I-15/US95/I-515 Interchange) to the north.

The existing corridor I-15 from Flamingo Road to Sahara Avenue can only accommodate five through lanes in each direction, while future traffic demands are expected to further breakdown I-15 in this segment. The I-15 from Flamingo to Sahara Feasibility Study (Feasibility Study) was initiated by NDOT to develop and evaluate alternatives primarily focusing on improving I-15 safety and traffic operations and identifying right-of-way needs to accommodate future traffic demands. The on-going Feasibility Study is being prepared based on the Federal Highway Administration's (FHWA) guidance for Planning and Environmental Linkages (PEL) so that the study can be used as the basis for subsequent project development under the National Environmental Policy Act of 1969 (NEPA), and its implementing regulations, as contained in 23 Code of Federal Regulations (CFR) 771.

This project study area covers approximately 4.5 miles on I-15, as shown in Figure 1. The northern limit is Sahara Avenue (the southern end of NDOT's Project NEON), and the southern limit is the I-15/I-215/CC-215 system interchange. These endpoints form the logical termini of this study, allow for the development of a project that can be constructed alone, serve a significant purpose, and address environmental impacts on a sufficient scale. The area also includes six interchanges with I-15: Sahara Avenue, Spring Mountain Road, Flamingo Road, Tropicana Avenue, Russell Road, and I-15/I-215/CC-215 system interchange. Additionally, seven grade separations exist within the corridor; Desert Inn Road (over I-15), Union Pacific Railroad (UPRR) (under I-15), Dean Martin Drive (under I-15), Twain Avenue (under I-15), Harmon Avenue (over I-15), Hacienda Avenue (over I-15), and Sunset Road (over I-15).

Currently two different options are being proposed by NDOT and the project team. Alternative 1 consists of widening I-15 in each direction, reconfiguring of the Flamingo Road interchange (southbound ramps and cross street widening over I-15) and reconstructing the Spring Mountain Road flyover from southbound I-15 to eastbound Spring Mountain Road. Ramp braids would also be constructed between the southbound Spring Mountain Road on-ramp and Flamingo Road off-ramp and Flamingo Road on-ramp and Tropicana Avenue off-ramp.

Alternative 2 entails constructing the improvements identified in Alternative 1 and also includes the northbound Russell Road on-ramp and the Tropicana off-ramp and northbound Tropicana on-ramp and Flamingo off-ramp.

Figure 1 – Feasibility Study Limits

Additional details on the alternative layouts can be found in the *I-15 Flamingo Road to Sahara Avenue Interchange Feasibility Study*.

2.2 Strategy, Key Conditions and Assumptions:

The following is a compilation of assumptions, existing conditions, analyzed forecasts and project strategies at the time of the workshop.

- Funding
  - Funding has not fully been identified or incorporated into a short-range funding plan.
- Design
  - Design Level
    - Design for the project is currently at 15-20%
    - There are a handful of possible options that will need to be evaluated further during NEPA and final design to address public and stakeholder concerns.
  - Landscaping
    - Maximum budget of 3% of construction. Minimal design completed at time of workshop.
  - Structural
    - Standard bridge types (cast-in-place post tensioned and steel girders) and construction techniques are assumed.
  - Geotechnical
    - No project specific borings have been performed.
  - Pavement
    - NDOT Wizard was utilized for roadway costs, including pavement section costs.
  - Design Deviations or Exceptions
    - No design deviations for NDOT policies or FHWA design exceptions are anticipated at this time.
- Environmental Documentation
  - Project will require a NEPA process.
- Permitting
  - No significant environmental permits are anticipated (excluding USACOE 404).
  - Contractor will obtain necessary construction permits.
- Right-of-Way
  - Right-of-way acquisitions are anticipated.
- Utilities
  - Several utility impacts anticipated.
  - NVEnergy substation located near T-Mobile Arena will not be impacted.
- Other Stakeholders

- NDOT
- City of Las Vegas
- Clark County
- RTC
- Adjacent business and property owners

- Procurement
  - Delivery Method
    - One phase of design-bid-build delivery.
    - The Project Delivery Selection Approach (PDSA) process will used to determine the delivery method. The PDSA is not yet scheduled.
  - Market
    - A very competitive bidding environment is assumed.
- Construction
  - Maintenance of Traffic
    - A detailed maintenance of traffic plan has not yet been developed.
  - Construction Phasing
    - Constructed as one project.
- Priority
  - Project will be prioritized per the NDOT's statewide prioritization process.

3. INPUTS

3.1 Base Project Schedule/Flow Chart

A cost-based schedule model was utilized to provide an inclusive cost and schedule quantitative risk assessment that allows for costs to be developed on a year of expenditure basis. A duration "flow chart" was developed for the project to graphically depict key project milestones at a level of detail appropriate for the workshop. The flow chart identified key activities and predecessor relationships that exist between key milestones and is the basis for modeling the project schedule (including delays and opportunities due to risk events) and to calculate inflated, year-of-expenditure costs for each activity identified. Appendix B provides the risk assessment workshop flow chart for the project, as evaluated in this report.

3.2 Scenarios

A scenario was run for pre-response and post-response mitigation in current year costs for each option. It was assumed that the project phasing would be similar for either scenario. The pre-response scenario assumes no mitigation strategies are developed or implemented. The post-response strategy assumes NDOT is proactive in mitigating or monitoring risks. The difference in costs of the two strategies helps NDOT develop a cost/benefit of the level effort that should be applied to mitigating and monitoring risks for the project. A significant difference between scenario costs indicates a considerable effort should be made. In contrast, a minor difference in costs between the scenarios may warrant less effort in risk mitigation and monitoring.

3.3 Exclusions from the Risk Assessment

This Risk Assessment Workshop was conducted to provide the best information available for NDOT ELT and Project Management to make educated decisions on the project and alternatives during this phase. When reviewing the results, it is crucial to consider that this is a snapshot of the project and that the project is still in the early phases of development, requiring some items to be excluded. For this analysis, significant exclusions include:

- The potential for substantial changes to the current design (including additional lanes, ramps, project limits) were not considered. It is recognized that such changes might occur as a result of funding delays, shift in prioritization, and/or changes in regional development and economics.
- Significant changes to the phasing of the project were not considered.
- Other significant changes to the scope of this project were not considered.

3.4 Base Project Cost

A base cost estimate was developed for the project through NDOT's Wizard cost estimation program. The base estimate was developed by calculating the length and laneage of the new roadway and bridge work area. Other items such as traffic control, signing, ITS, and incidentals (based on NDOT WIZARD Guidance) were assigned a percentage of construction cost. Once this percentage was assigned, the overall cost was checked for reasonableness and the percentage modified, as necessary. Tables 1 and 2 provide a summary

of the base cost estimate for each alternative. It should be noted, that since this is a base estimate, no contingencies were added.

Description	Baseline Cost
Roadway	$27,301,288
Structures	$42,758,918
Traffic	$2,000,000
Drainage	$7,087,193
Additional Items (Miscellaneous Items)	$17,185,647
Bid Item Subtotal	**$96,333,046**
Landscaping and Aesthetics (3%)	$2,889,991
Traffic Control (10%)	$9,633,305
Roadside Safety (3%)	$2,889,991
Erosion Control (1%)	$892,459
Subtotal	$112,638,792
Mobilization (7%)	$7,884,715
Contract Total	**$120,523,507**
NEPA (1%)	$1,205,235
Preliminary Engineering & Design (4%)	$4,820,940
Final Engineering & Design (4.0%)	$4,820,940
Construction Engineering (15%)	$18,076,526
Administration (1%)	$1,205,235
Legal (1%)	$1,205,235
Subtotal	$151,859,619
Right-of-Way Acquisition	$29,500,000
Environmental Considerations (3%)	$4,555,789
Project Total (Base Cost)	**$185,915,408**

Table 1 – Alternative 1 Overall Base Cost Estimate Summary (2020 Dollars)

Description	Baseline Cost
Roadway	$41,599,705
Structures	$82,201,742
Traffic	$2,000,000
Drainage	$11,227,238
Additional Items (Miscellaneous Items)	$23,813,828
Bid Item Subtotal	**$160,842,513**
Landscaping and Aesthetics (3%)	$4,825,275
Traffic Control (10%)	$16,084,251
Roadside Safety (3%)	$4,825,275
Erosion Control (1%)	$1,496,153
Subtotal	$188.073,468
Mobilization (7%)	$13,165,143
Contract Total	**$201,238,611**
NEPA (1%)	$2,012,386
Preliminary Engineering & Design (4%)	$8,049,544
Final Engineering & Design (4.0%)	$8,049,544
Construction Engineering (15%)	$30,185,792
Administration (1%)	$2,012,386
Legal (1%)	$2,012,386
Subtotal	$253,560,649
Right-of-Way Acquisition	$36,450,000
Environmental Considerations (3%)	$7,606,819
Project Total (Base Cost)	**$297,617,469**

Table 2 – Alternative 2 Overall Base Cost Estimate Summary (2020 Dollars)

All project costs are currently anticipated to be borne by NDOT through various funding sources, including Federal funding. A more detailed summary of the base cost estimates prepared for each alternative is presented in Appendix A.

Uncertainty

A cost estimate is a "snapshot" of the anticipated project costs based on the preparer's perception of construction costs at that given time. Many factors will dictate the estimate, including the detail available, current construction market, and size of the project and/or quantities. Nevertheless, there will always be uncertainty in a base cost estimate due to these factors. Uncertainty can be applied to a project cost estimate by giving range of costs and quantities.

The estimator may establish this uncertainty range by analyzing unit costs and quantities based on project location, the scale of quantities, the construction market, and material availability. Depending on the level of design, other factors may play into uncertainty such as available geotechnical information, NEPA constraints, right-of-way, and type of project delivery. Tables 3 and 4 shows the Base Project Cost Uncertainty by crucial project components.

In establishing the uncertainty ranges for each item, consideration was given to factors that might affect quantities or bid prices, such as project location (rural vs. urban), quantities (large or small), items that are difficult to construct or site constraints, methods of payments, timing of advertisement, specialty work, geotechnical, and project delivery methods. Uncertainty is typically expressed in terms of a percentage (of the quantity and/or unit cost) lower or higher than the base.

Activity	Project Cost		
	Low	Base	High
NEPA	$1,086,646	$1,205,235	$1,358,270
Preliminary Engineering & Design	$4,346,584	$4,820,940	$5,433,079
Final Engineering & Design	$4,346,584	$4,820,940	$5,433,079
Construction Engineering	$16,299,689	$18,078,526	$20,374,046
Administration	$1,086,646	$1,205,235	$1,358,270
Legal	$1,086,646	$1,205,235	$1,358,270
Right of Way Acquisition	$28,025,000	$29,500,000	$36,875,000
Environmental Considerations	$4,107,522	$4,555,789	$5,134,260
Construction	$108,664,596	$120,523,508	$135,826,974
Total	**$169,049,913**	**$185,915,408**	**$213,151,248**

Table 3 – Alternative 1 Base Cost Uncertainty by Activity (2020 Dollars)

Activity	Project Cost		
	Low	Base	High
NEPA	$1,813,481	$2,012,386	$2,259,721
Preliminary Engineering & Design	$7,253,922	$8,049,544	$9,038,885
Final Engineering & Design	$7,253,922	$8,049,544	$9,038,885
Construction Engineering	$27,202,209	$30,185,792	$33,895,818
Administration	$1,813,481	$2,012,386	$2,259,721
Legal	$1,813,481	$2,012,386	$2,259,721
Right of Way Acquisition	$34,627,500	$36,450,000	$45,562,500
Environmental Considerations	$6,854,957	$7,606,819	$8,541,746
Construction	$181,348,058	$201,238,612	$225,972,118
Total	**$269,981,011**	**$297,617,468**	**$338,829,115**

Table 4 – Alternative 2 Base Cost Uncertainty by Activity (2020 Dollars)

Escalation Rates

Escalation rates are a measurement of change (usually increase) in project costs due to inflation, market costs, and the regional and national economy over a project's lifetime. In this analysis, escalation is applied to key project activities outlined in the project schedule, including NEPA, final design, utilities, and construction costs. With escalation, not only do project delays extend the duration of the project, they will typically increase final project costs. This project's escalation is per NDOT's Escalation Rates Forecast Technical Memorandum dated June 18, 2020. Those rates are shown in Table 5.

Year	Engineering			Right-of-Way			Construction		
	10%	50% (Median)	90%	10%	50% (Median)	90%	10%	50% (Median)	90%
2019	1.15%	1.15%	1.15%	4.75%	4.75%	4.75%	-0.47%	-0.47%	-0.47%
2020	-0.05%	1.23%	2.52%	-3.11%	1.81%	6.72%	-4.85%	0.03%	4.91%
2021	-0.06%	1.73%	4.00%	-3.69%	2.64%	9.81%	-3.11%	1.95%	8.46%
2022	0.19%	2.46%	4.72%	-4.80%	3.19%	11.59%	-1.40%	4.00%	10.16%
2023	0.61%	2.70%	4.76%	-4.33%	4.12%	12.62%	-1.30%	3.82%	9.51%
2024	0.66%	2.68%	4.76%	-4.16%	4.23%	12.57%	-1.50%	3.31%	8.74%
2025	0.40%	2.44%	4.46%	-4.28%	4.31%	12.90%	-1.78%	3.07%	8.45%
2026	0.11%	2.23%	4.29%	-4.42%	4.52%	13.70%	-2.38%	2.87%	8.84%
2027	-0.02%	2.16%	4.35%	-3.26%	5.37%	13.99%	-2.38%	2.82%	8.83%
2028+	-0.08%	2.21%	4.50%	-4.28%	4.31%	12.90%	-3.06%	2.81%	9.50%
Average	---	**2.21%**	---	---	**3.83%**	---	---	**2.74%**	---

Table 5 – Escalation Rates per NDOT's Escalation Rates Forecast Technical Memorandum

3.5 Risks

During the Risk Assessment Workshop, uncertainty in the base project costs and schedule were identified and characterized. This uncertainty included both threats and opportunities that could impact the project scope, schedule, or budget. These threats and opportunities have been compiled into a risk register, which is presented in Appendix C. Minor items have still been noted in the Risk Register for monitoring throughout the project in the event they become significant risk/opportunity factors. The Risk Register provides the Department more than a summary of potential events that have been considered in the risk-based estimate and schedule; it provides the Project Manager a list of items that need to be monitored and potential strategies that should be implemented to reduce the risk and hopefully avoid significant events impacts to the project.

4. ANALYSIS

4.1 Model

The inputs developed in the workshop (including base cost, schedule, risk, opportunities and uncertainties) were entered into @RISK software. @RISK is a probabilistic, integrated model which utilizes Monte Carlo simulation techniques to generate probability distributions of cost and schedule while also prioritizing risk rankings. The simulation generates 5,000 independent potential outcomes and provides a statistical compilation of selected results. In order to accommodate inflation and true year-of-expenditure dollars; the cost of each flowchart activity was escalated from the estimate reference date to the activity mid-point (including consideration of delays or accelerations due to events) according to the specified escalation rate.

4.2 Pre-Response Results

The following section summarizes various significant cost results from the workshop and risk-based analysis based on the pre-response scenario. The pre-response scenario assumes no risk management strategies are implemented.

It should be noted that the following is a "snapshot" of the project based on information available at the workshop. As the project evolves and more information is developed, identified risks should be mitigated, therefore reducing or "retiring" those risks that could impact the project. However, it is likely as the project progresses, new uncertainties may present themselves and will need to be recognized as part of the risk-based estimate and schedule. There is an adherent opportunity in implementing risk management strategies that, as the project progresses and risks are retired, the risk-based estimate standard deviation will decrease, thereby reducing the seventy-percentile cost and increasing confidence level.

Probability distributions for Alternative 1 total overall project cost pre-response (current year dollars) are shown in Figure 2 in probability mass functions (PMFs) and cumulative distribution functions (CDFs)

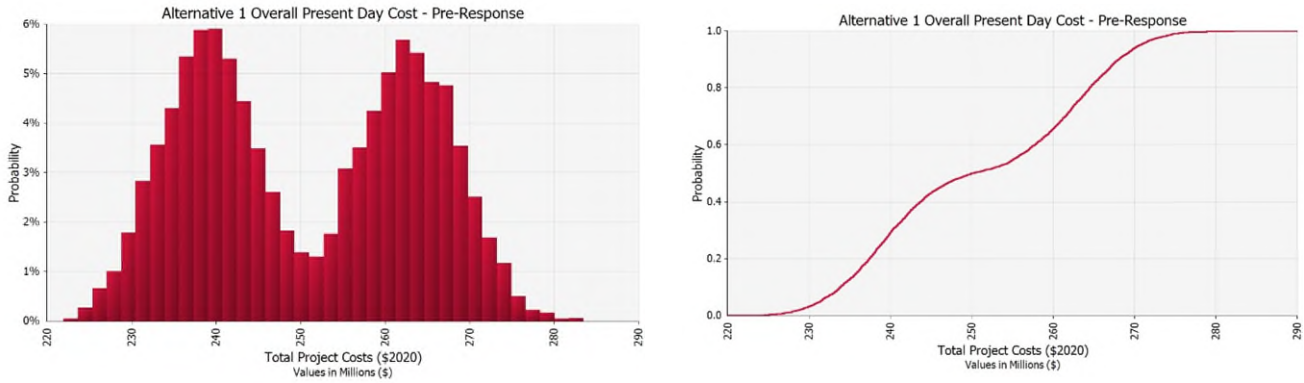


Figure 2 – Alternative 1 - Probability Distribution for Overall Total Present Day Cost ($2020) – Pre-Response, presented in two ways: a) probability mass function (PMF); b) cumulative distribution function (CDF)

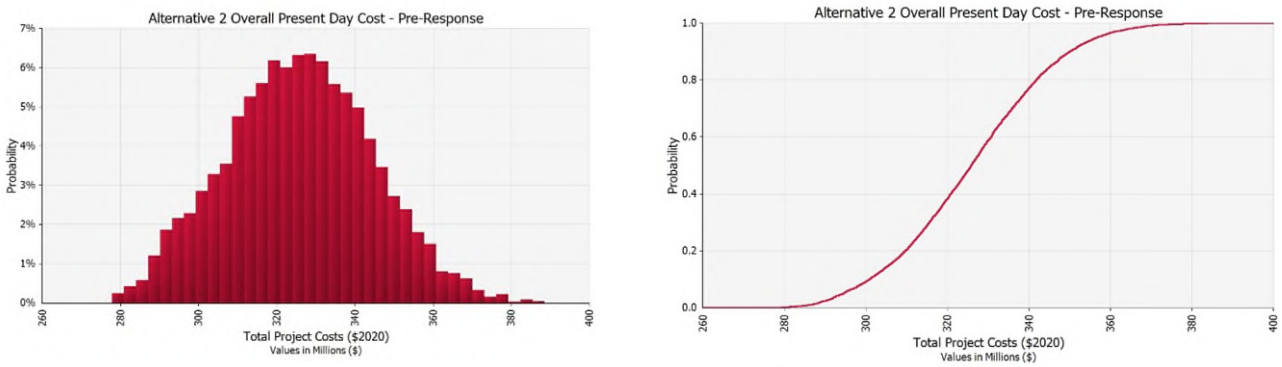


Figure 3 – Alternative 2 - Probability Distribution for Overall Total Present Day Cost ($2020) – Pre-Response, presented in two ways: a) probability mass function (PMF); b) cumulative distribution function (CDF)

format. These probability distributions reflect the base cost combined with identified project risks and opportunities with no mitigation or on-going risk or opportunity management activities.

The PMF portrays a graphical measure of the range of values, including the most likely value, as represented by the tallest bar on the graph. Alternative 1 suggests a unique circumstance in which one risk can substantially influence the outcome of the most likely project cost. The risk of a significant portion of right-of-way not being purchased by NDOT's Project NEON prior to this project is resulting in two most likely project costs. Should Project NEON acquire shared right-of-way between NEON and this project, the most likely project in 2020 dollars would be approximately $238 million. However, if the shared right-of-way is not acquired by Project NEON, the most likely project cost in 2020 dollars would be approximately $264 million.

Alternative 2 demonstrates a more typical bell curve since the overall project cost is more. The risk of shared right-of-way not being purchased by Project NEON has a less significant overall impact to the project costs. Figure 3 shows the most likely project cost for proposed Alternative 2 in 2020 dollars to be approximately $328 million.

A CDF represents the cumulative probability of not exceeding a particular value (also known as a percentile or confidence level). For example, from the CDFs shown for Alternative 1 in Figure 2(b), the 70th percentile means that there is a 70 percent likelihood that the total cost for the entire project will be less than or equal to approximately $261.6 million in 2020 dollars. Likewise, the CDF shown in Figure 3(b) indicates a 70th percentile likelihood that the total cost for Alternative 2 would be less than or equal to $335.9 million in 2020 dollars.

Year of expenditure costs for each alternative are calculated based on an anticipated pre-response risk-based schedules are shown in Figures 4 and 5. Figure 6 identifies the project's overall pre-response risk-based schedule with the most likely completion to be on or before December 2035 based on pre-response activities.

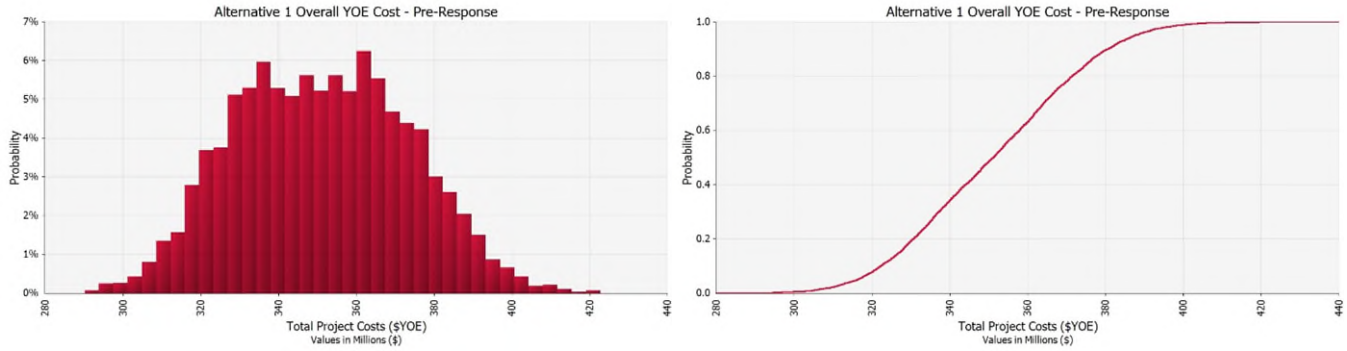


Figure 4 – Alternative 1 - Probability Distribution for Overall Total Year of Expenditure Cost – Pre-Response, presented in two ways: a) probability mass function (PMF); b) cumulative distribution function (CDF)

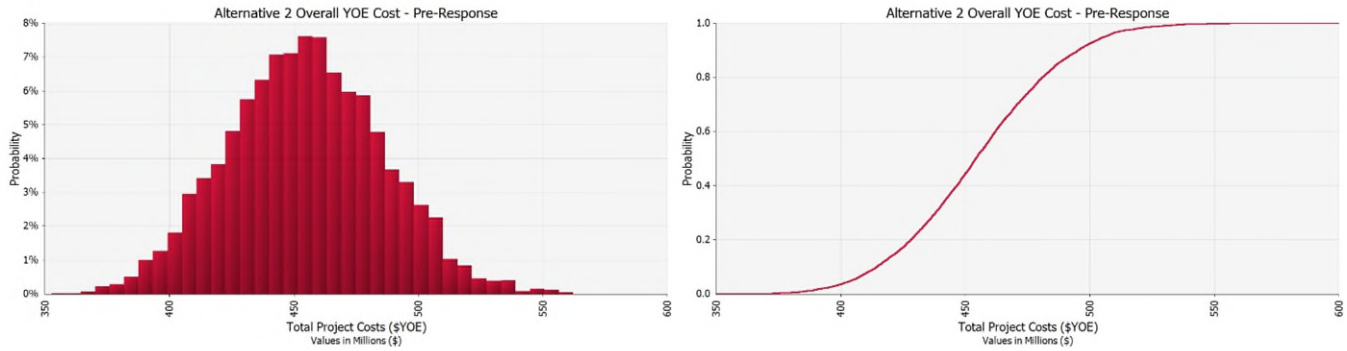


Figure 5 – Alternative 2 - Probability Distribution for Overall Total Year of Expenditure Cost – Pre-Response, presented in two ways: a) probability mass function (PMF); b) cumulative distribution function (CDF)

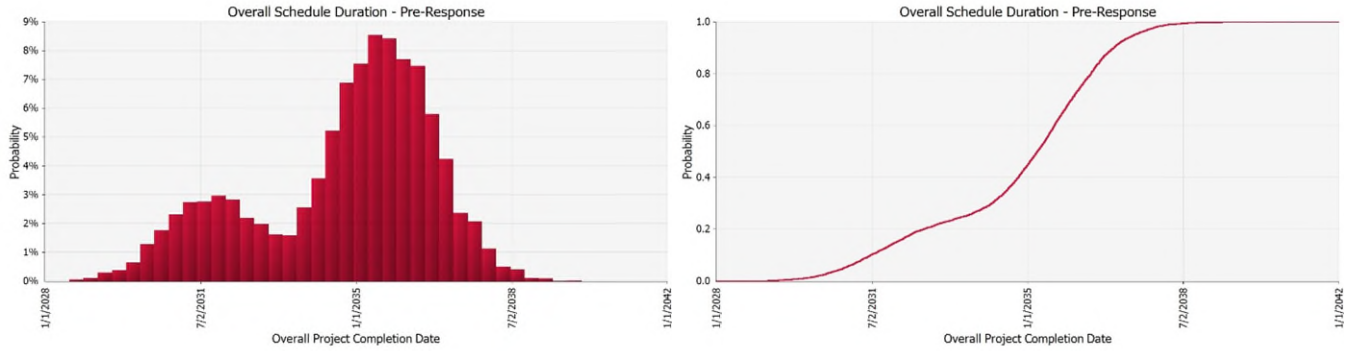


Figure 6 – Probability Distribution for Overall Schedule Duration – Pre-Response, presented in two ways: a) probability mass function (PMF); b) cumulative distribution function (CDF)

4.3 Post-Response Results

Sound project management execution consists of the agencies and those involved to proactively manage risk and opportunities; thereby, reducing potential increases and costs and schedule duration. As part of the workshop, the group identified the potential reduction in risks based on proactive management (Post-Response) and is shown in Figures 7 through 11.

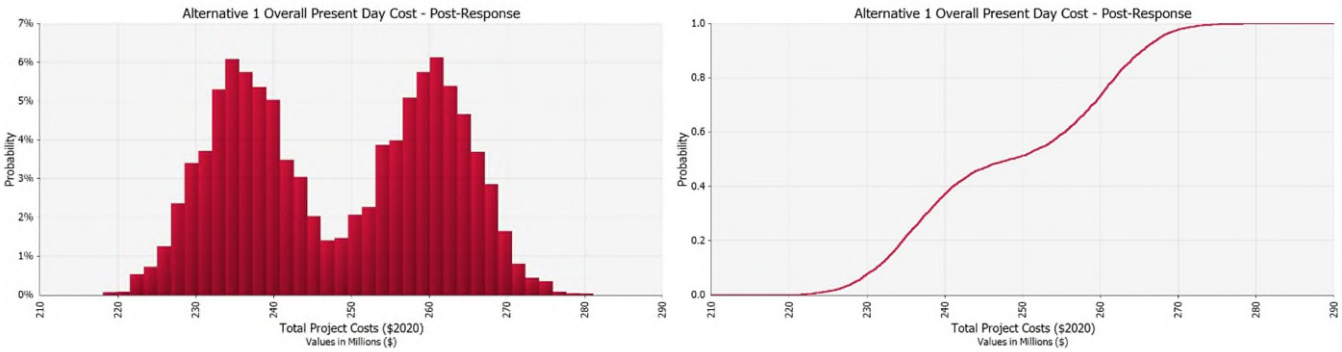


Figure 7 – Alternative 1 - Probability Distribution for Overall Total Present Day Cost ($2020) – Post-Response, presented in two ways: a) probability mass function (PMF); b) cumulative distribution function (CDF)

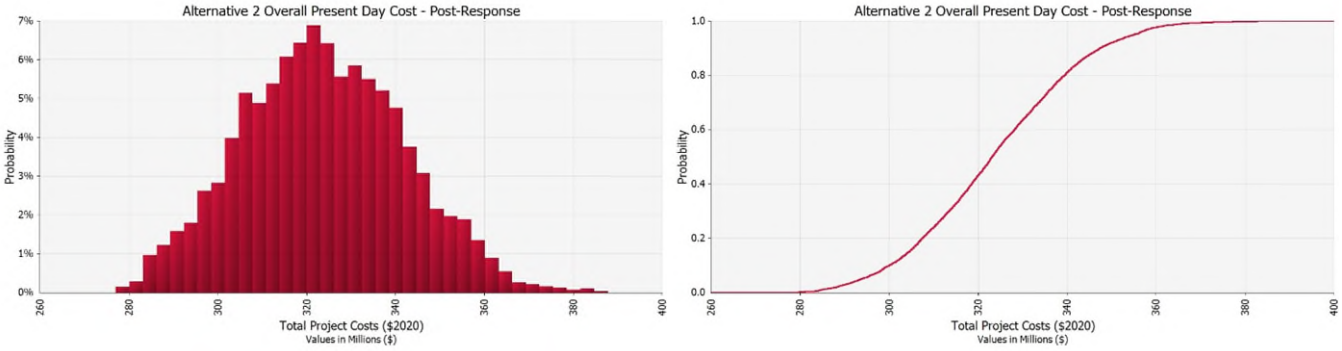


Figure 8 – Alternative 2 - Probability Distribution for Overall Total Present Day Cost ($2020) – Post-Response, presented in two ways: a) probability mass function (PMF); b) cumulative distribution function (CDF)

Similar to the pre-response graphs in Section 4.2, Alternative 1 develops two likely scenarios depending on whether the right-of-way is purchased as part of Project NEON. Should Project NEON acquire shared right-of-way between NEON and this project combined with proactively managing risks, the most likely project in 2020 dollars would be approximately $236 million. However, if Project NEON does not acquire the shared right-of-way, the most likely project cost in 2020 dollars would be approximately $262 million. Alternative 2 will most likely have an overall project cost of $317.9 million in 2020 dollars by utilizing post-response activities and mitigation management.

Figures 9 and 10 show the project would most likely cost $356.8 million for Alternative 1 and $461.1 million for Alternative 2 in YOE dollars. Anticipated completion through the use of pro-active risk management would most likely be in May 2035 as shown in Figure 11 on page 17.

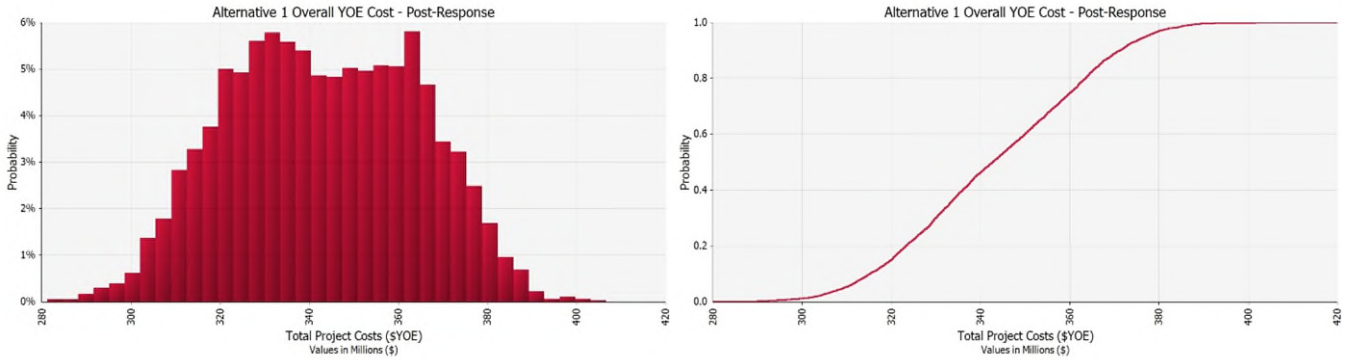


Figure 9 – Alternative 1 - Probability Distribution for Overall Total Year of Expenditure Cost – Post-Response, presented in two ways: a) probability mass function (PMF); b) cumulative distribution function (CDF)

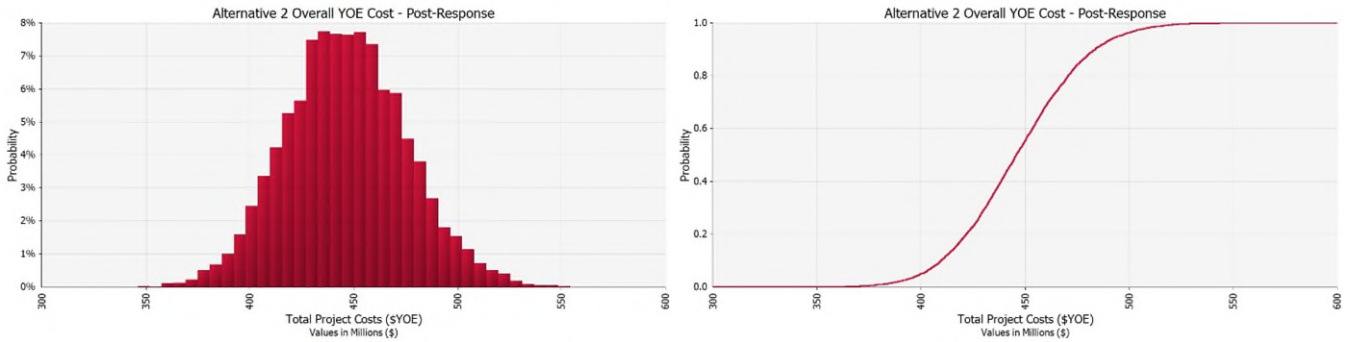


Figure 10 – Alternative 2 - Probability Distribution for Overall Total Year of Expenditure Cost – Post-Response, presented in two ways: a) probability mass function (PMF); b) cumulative distribution function (CDF)

Another method of presenting the project budget and schedule expectations to the general public and outside project stakeholders is by using the mid-80 percent confidence level. This range of cost and duration is bounded by the 10th percentile on the lower end and the 90th percentile on the higher end. This will provide an 80 percent likelihood that the project costs and schedule will be completed within this range, and only a 20 percent likelihood that it will not. Table 6 provides a summary of the mid-80 percent confidence level range post-response.

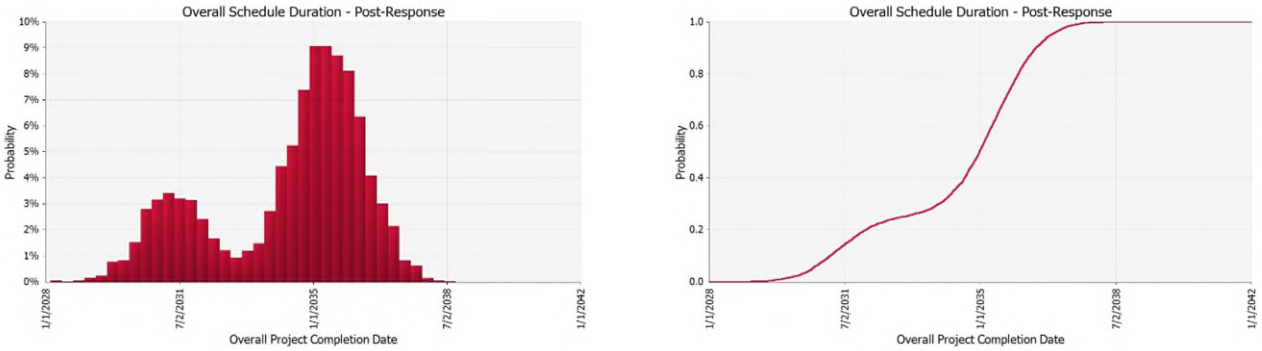


Figure 11 – Probability Distribution for Overall Schedule Duration – Pre-Response, presented in two ways: a) probability mass function (PMF); b) cumulative distribution function (CDF)

Description	10th Percentile (Lower Limit)	90th Percentile (Upper Limit)
Alternative 1		
Total Project Cost (2020 Dollars)	$231.2 million	$265.4 million
Total Project Cost (YOE Dollars)	$315.1 million	$371.2 million
Alternative 2		
Total Project Cost (2020 Dollars)	$300.0 million	$347.3 million
Total Project Cost (YOE Dollars)	$409.6 million	$483.7 million
Project Completion Date	February 2031	June 2036

Table 6 – Mid-80 Percent Confidence Level Range for the Overall Project Post-Response

Table 7 provides a summary of various post-response probability distributions (i.e. confidence levels) for the overall project including current year cost, year of expenditure and project duration.

	Alternative 1		Alternative 2		Overall Completion Date
	Total Project Cost (2020 $ Mil)	Total Project Cost (YOE $ Mil)	Total Project Cost (2020 $ Mil)	Total Project Cost (YOE $ Mil)	
Base	$185.9	$227.7	$297.6	$364.5	Dec 2028
Mean	$248.3	$343.2	$323.7	$446.4	May 2034
Standard Dev.	$13.4	$21.2	$18.2	$28.9	723 Days
5%	$228.6	$309.5	$293.8	$400.0	Aug 2030
10%	$231.2	$315.1	$300.0	$409.6	Feb 2031
15%	$233.1	$320.0	$304.4	$416.4	Jul 2031
20%	$234.6	$323.3	$307.4	$421.7	Jan 2032
25%	$236.1	$326.9	$310.6	$426.9	Dec 2032
30%	$237.7	$330.0	$313.5	$430.9	Dec 2033
35%	$239.3	$333.0	$316.1	$434.6	Apr 2034
40%	$241.1	$336.0	$318.6	$438.4	Aug 2034
45%	$243.6	$339.0	$321.0	$441.9	Oct 2034
50%	$248.3	$342.7	$323.1	$445.7	Dec 2034
55%	$253.0	$346.2	$325.5	$449.7	Feb 2035
60%	$255.4	$349.9	$328.2	$453.5	Apr 2035
65%	$257.2	$353.3	$330.8	$457.2	Jun 2035
70%	$258.9	$356.8	$333.6	$461.1	Aug 2035
75%	$260.4	$360.2	$336.4	$465.9	Oct 2035
80%	$261.9	$363.5	$339.4	$470.7	Dec 2035
85%	$263.5	$366.7	$342.8	$476.2	Mar 2036
90%	$265.4	$371.2	$347.3	$483.7	Jun 2036
95%	$267.8	$377.1	$355.1	$494.6	Nov 2036

Table 7 – Summary of Probability Distributions for Overall Cost and Schedule – Post Response

As Table 7 indicates, completion of the project could extend out to November 2036, if not longer. Based on the above information, there is 70th percentile confidence level that the project could be delivered by August 2035 with a maximum cost of $461.1 million (Alternative 2).

4.4 Significant Risks, Uncertainties and Strategies

Cost Risks

The tornado tables in Figures 12 and 13 show the potential impacts of the top ten post-response cost risks for Alternatives 1 and 2 respectively. Additional information about the risks is provided in Appendix C – Risk Register. The risk names are listed on the vertical axis with expected cost impact identified. Risks in the tornado diagram are ranked in descending order showing the greatest risk to cost on top.

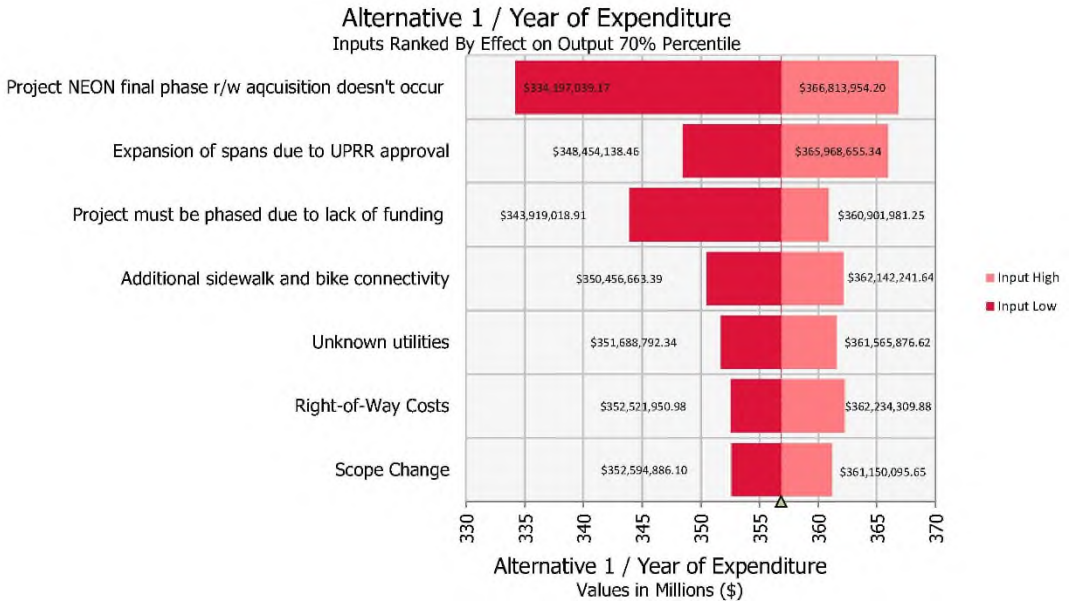


Figure 12 – Alternative 1 Post Response Cost Tornado Diagram

For Alternative 1 costs, the largest risk and opportunity is determining which project, NEON or I-15 Flamingo to Sahara, will purchase the shared right-of-way. The other primary risk which NDOT has control over is identifying the funding timing for the project and if the project will need to be phased.

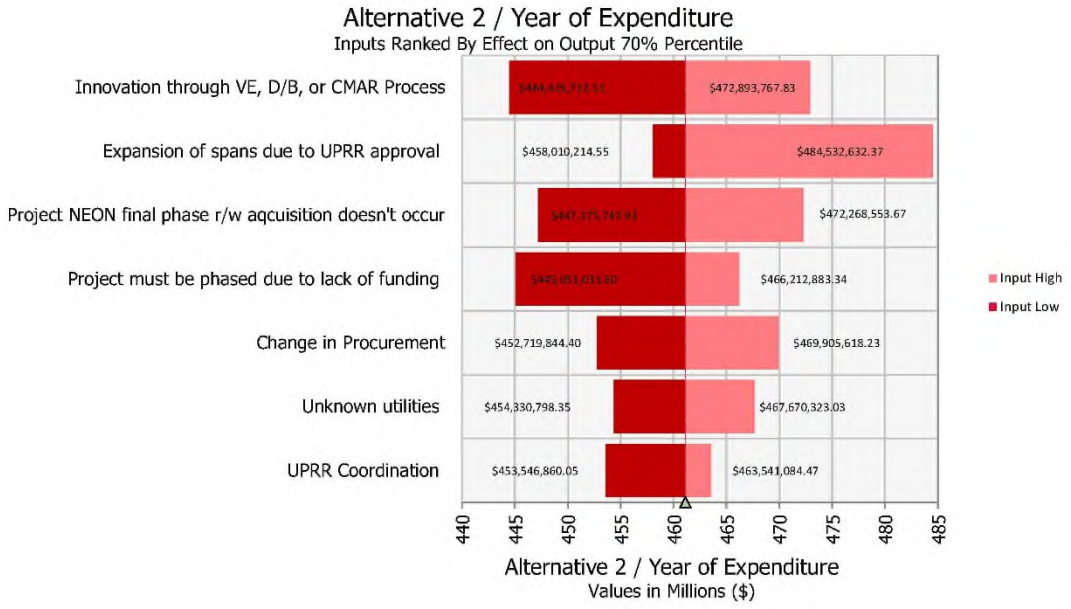


Figure 13 – Alternative 2 Post Response Cost Tornado Diagram

For Alternative 2 costs, the largest risk/opportunity item affecting the 70th percentile cost will be innovation developed through the value engineering, design-build, or CMAR process. UPRR guidance of mainline I-15 bridge structures can have a significant impact to both Alternative 1 and 2. Coordination with UPRR will be a high priority as the project moves into preliminary design. Funding and right-of-way cost allocation may also have a significant impact to Alternative 2.

Schedule Risks

The tornado table in Figure 14 shows the most significant potential impacts of the schedule risks for the project. Currently, the most significant item driving the project schedule is if the project must be phased over a substantial time frame due to lack of funding. Once the timing of funding has been solidified, other risks may play a more significant role in the 70th percentile project completion date. Additional information about the risks is provided in Appendix C – Risk Register. The risk names are listed on the vertical axis with expected schedule impact identified. Risks in the tornado diagram are ranked in descending order showing the greatest risk to schedule on top.

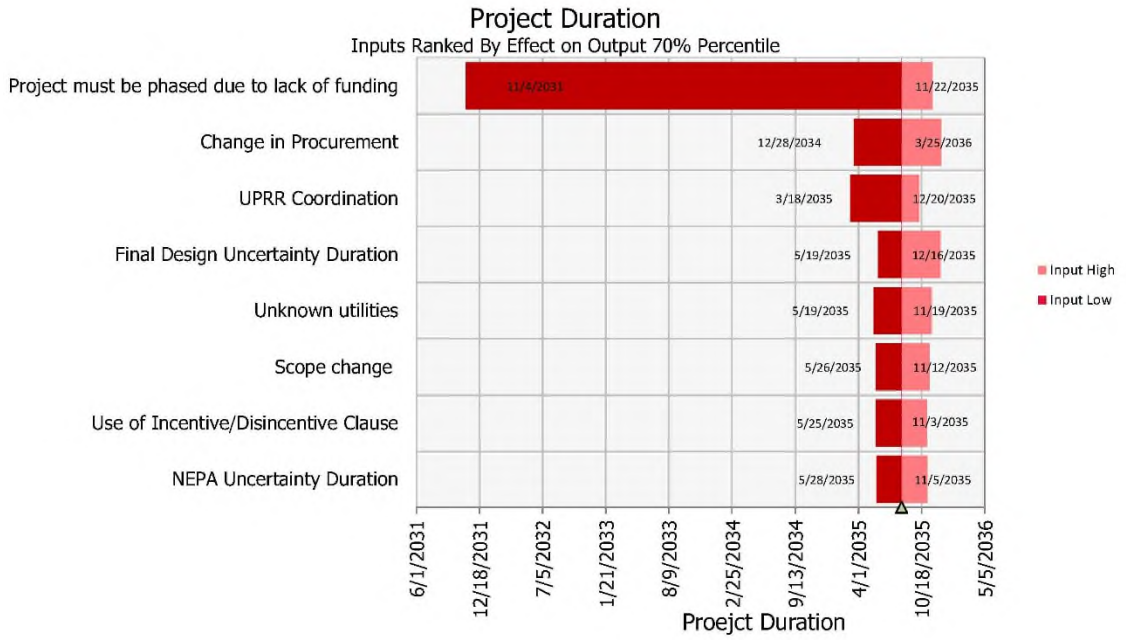


Figure 14 – Post Response Schedule Tornado Diagram

5.0 CLOSING

Based on the results of discussions during the Risk Assessment Workshop and this report, the following recommendations are made:

1. When possible, based on the above described uncertainties, it is best to provide project costs and durations in a range based on the mid-80 percentile confidence level as shown in Table 2 to help manage stakeholder expectations.
2. Recognize and communicate that this report is a snapshot into the project at the time of the Risk Assessment Workshop. As the project progresses various uncertainties will be retired, while new uncertainties may surface. In general, as time moves on the range between various confidence levels should diminish. NDOT should consider updates to the risk-based estimate at various milestones including preliminary and intermediate design submittals.
3. Utilize the 70th percentile confidence level estimates to help establish reasonable budgets and schedules, and then strive through risk management strategies identified in the risk register to bring the project in under budget and schedule.
4. Implement the strategies discussed in Section 4.3 to reduce the uncertainties in the top threats and opportunities. As the risks are retired or mitigated, update the risk-based estimate to identify the next 5-10 risks that the project team should focus on. By focusing resources on the most significant risks the project team will be able to efficiently retire those risks and reduce the mid-80th percentile confidence range.
5. By implementing a proactive risk management plan, it is safe to assume that NDOT will be able to reduce the 70th percentile project cost by approximately $3 million and reduced the project duration by approximately 5 months. However, there are several major risks and opportunities that once retired and an overall outcome is known, significant impacts to the 70th percentile cost and schedule will most likely occur.

These results are intended to provide NDOT and the Project Team with the information needed to aid in making educated decisions about the project scope, schedule, and budget. In addition, this report should aid in developing risk management strategies to ensure a successful project is developed and implemented within publicized schedules and budgets.

APPENDIX A

Base Cost Estimate

I-15 Flamingo to Sahara - Alternative 1

Item	Quantity or Pecentage (Low) Under (%)		Base	(%) Over (High)		Unit	Current Year Unit Cost (Low) Under (%)		Base	(%) Over (High)		Current Year Base Total Cost
ROADWAY												
Roadway												
	1	0%	1	0%	1	LS	$22,803,145	-10.00%	$25,336,828	15.00%	$29,137,352	$25,336,828
Demolition												
	1	0%	1	0%	1		$1,768,014	-10.00%	$1,964,460	15.00%	$2,259,129	$1,964,460
											0	$27,301,288
STRUCTURES												
Bridges												
TROPICANA OFF-RAMP OVER FLAMINGO ON-RAMP	1	0%	1	0%	1	LS	$4,854,011	-10.00%	$5,393,345	10.00%	$5,932,680	$5,393,345
SPRING MOUNTAIN FLYOVER BRIDGE OVER I-15	1	0%	1	0%	1	LS	$4,004,487	-10.00%	$4,449,430	15.00%	$5,116,845	$4,449,430
WIDEN FLAMINGO OVER I-15	1	0%	1	0%	1	LS	$2,971,147	-10.00%	$3,301,274	10.00%	$3,631,401	$3,301,274
WIDEN FLAMINGO OVER FRANK SINATRA	1	0%	1	0%	1	LS	$2,016,086	-10.00%	$2,240,096	10.00%	$2,464,106	$2,240,096
WIDEN I-15 NB OVER UPRR	1	0%	1	0%	1	LS	$1,291,156	-10.00%	$1,434,651	20.00%	$1,721,581	$1,434,651
WIDEN I-15 SB OVER SPRING MOUNTAIN	1	0%	1	0%	1	LS	$1,239,833	-10.00%	$1,377,592	10.00%	$1,515,351	$1,377,592
I-15 SB (SBCD) BRIDGE OVER DEAN MARTIN	1	0%	1	0%	1	LS	$4,718,739	-10.00%	$5,243,043	10.00%	$5,767,347	$5,243,043
I-15 SB (SBCD) BRIDGE OVER TWAIN	1	0%	1	0%	1	LS	$4,189,415	-10.00%	$4,654,906	10.00%	$5,120,397	$4,654,906
I-15 SB (SBCD) BRIDGE OVER SPRING MOUNTAIN	1	0%	1	0%	1	LS	$1,728,103	-10.00%	$1,920,114	10.00%	$2,112,125	$1,920,114
I-15 (SBCD) BRIDGE OVER SPRING MOUNTAIN ON-RAMP	1	0%	1	0%	1	LS	$3,561,331	-10.00%	$3,957,034	10.00%	$4,352,737	$3,957,034
WIDEN FLAMINGO OVER DEAN MARTIN	1	0%	1	0%	1	LS	$1,891,959	-10.00%	$2,102,177	10.00%	$2,312,395	$2,102,177
SPRING MOUNTAIN OVER LOOP RAMP	1	0%	1	0%	1	LS	$2,096,390	-10.00%	$2,329,322	10.00%	$2,562,254	$2,329,322
Walls												
RETAINING WALLS AT FLAMINGO	1	0%	1	0%	1	LS	$655,309	-10.00%	$728,121	25.00%	$910,151	$728,121
RETAINING WALLS AT SPRING MOUNTAIN	1	0%	1	0%	1	LS	$2,906,472	-10.00%	$3,229,413	25.00%	$4,036,766	$3,229,413
SOUNDWALL ALONG I-15 SB BETWEEN SPRING MOUNTAIN AND SAHARA	1	0%	1	0%	1	LS	$358,560	-10.00%	$398,400	10.00%	$438,240	$398,400
											Structures Subtotal	$42,758,918
TRAFFIC												
Traffic Signals												
FLAMINGO RD WB WITH I-15 NB ON-RAMP	1	0%	1	0%	1	LS	$380,000	-5.00%	$400,000	20.00%	$480,000	$400,000
FLAMINGO RD WB WITH I-15 SB ON RAMP	1	0%	1	0%	1	LS	$380,000	-5.00%	$400,000	20.00%	$480,000	$400,000
FLAMINGO RD WB WITH I-15 SB OFF-RAMP	1	0%	1	0%	1	LS	$380,000	-5.00%	$400,000	20.00%	$480,000	$400,000
SPRING MOUNTAIN W/ I-15 SB OFF RAMP	1	0%	1	0%	1	LS	$380,000	-5.00%	$400,000	20.00%	$480,000	$400,000
SPRING MOUNTAIN W/ I-15 SB ON RAMP	1	0%	1	0%	1	LS	$380,000	-5.00%	$400,000	20.00%	$480,000	$400,000
											Traffic Subtotal	$2,000,000
ADDITIONAL ITEMS												
Additional Items	1	0%	1	0%	1	LS	$15,467,082	-10.00%	$17,185,647	15.00%	$19,763,494	$17,185,647
											Additional Items Subtotal	$17,185,647
DRAINAGE												
Drainage												
	1	0%	1	0%	1	LS	$6,378,474	-10.00%	$7,087,193	50.00%	$10,630,790	$7,087,193
											Drainage Subtotal	$7,087,193
Sub-Total Present Day Construction Cost												**$96,333,046**

Table A-1 – Alternative 1 Baseline Cost Estimate

I-15 Flamingo to Sahara - Alternative 1

Item	Quantity or Pecentage (Low) Under (%)		Base	(%) Over (High)		Unit	Current Year Unit Cost (Low) Under (%)		Base	(%) Over (High)		Current Year Base Total Cost
Landscaping and Aesthetics			3.0%						$2,889,991			$2,889,991
Erosion Control			1.0%						$892,459			$892,459
Traffic Control			10.0%						$9,633,305			$9,633,305
Roadside Safety			3.0%						$2,889,991			$2,889,991
Additional Items			0.0%						$0			$0
									Sub-Total			$112,638,792
Mobilization			7.0%						$7,884,715			$7,884,715
Total Present Day Construction Cost												**$120,523,507**
Construction Engineering/Inspection			15.0%						$18,078,526			$18,078,526
NEPA			1.0%						$1,205,235			$1,205,235
Preliminary Engineering & Design			4.0%						$4,820,940			$4,820,940
Final Engineeering			4.0%						$4,820,940			$4,820,940
Administration			1.0%						$1,205,235			$1,205,235
Legal			1.0%						$1,205,235			$1,205,235
SOFT COST RISK SPECIFIC ITEMS												
Public commenter sues NDOT			1			LS	$500,000		$1,000,000		$2,000,000	
Project NEON final phase r/w aqcuisition doesn't occur			1			LS	$23,500,000		$23,500,000		$23,500,000	
											Soft Cost Risk Specific Subtotal	$0
Total Present Day Construction and Engineering Cost												**$151,859,619**
RIGHT-OF-WAY												
Right-of-Way			1			LS	$28,025,000	-5.00%	$29,500,000	25.00%	$36,875,000	$29,500,000
											Right-of-Way Subtotal	$29,500,000
Environmental Consideration			3.0%						$4,555,789			$4,555,789
Overall Total Present Day Cost - Alternative 1												**$185,915,408**

Note: No contingency is within the estimate since it is a baseline estimate.

Table A-1 – Alternative 1 Baseline Cost Estimate (Cont.)

I-15 Flamingo to Sahara - Alternative 2

Item	Quantity or Pecentage (Low) Under (%)		Base	(%) Over (High)		Unit	Current Year Unit Cost (Low) Under (%)		Base	(%) Over (High)		Current Year Base Total Cost
ROADWAY												
Roadway												
	1	0%	1	0%	1	LS	$35,629,552	-10.00%	$39,588,391	15.00%	$45,526,650	$39,588,391
Demolition												
	1	0%	1	0%	1	LS	$1,810,183	-10.00%	$2,011,314	15.00%	$2,313,011	$2,011,314
											0	$41,599,705
STRUCTURES												
Bridges												
RUSSELL RD OVER NBCD	1	0%	1	0%	1	LS	$4,914,188	-10.00%	$5,460,209	10.00%	$6,006,230	$5,460,209
TROPICANA ON RAMP OVER FLAMINGO OFF RAMP	1	0%	1	0%	1	LS	$7,249,442	-10.00%	$8,054,935	20.00%	$9,665,922	$8,054,935
TROPICANA OFF RAMP OVER FLAMINGO ON RAMP	1	0%	1	0%	1	LS	$4,264,025	-10.00%	$4,737,805	10.00%	$5,211,586	$4,737,805
SPRING MOUNTAIN BRIDGE OVER THE LOOP RAMP	1	0%	1	0%	1	LS	$3,103,475	-10.00%	$3,448,306	10.00%	$3,793,137	$3,448,306
WIDEN FLAMINGO OVER I-15	1	0%	1	0%	1	LS	$2,971,147	-10.00%	$3,301,274	10.00%	$3,631,401	$3,301,274
WIDEN FLAMINGO OVER FRANK SINATRA	1	0%	1	0%	1	LS	$2,016,086	-10.00%	$2,240,096	10.00%	$2,464,106	$2,240,096
WIDEN I-15 NB OVER UPRR	1	0%	1	0%	1	LS	$1,291,186	-10.00%	$1,434,651	20.00%	$1,721,581	$1,434,651
WIDEN I-15 SB OVER SPRING MOUNTAIN	1	0%	1	0%	1	LS	$1,239,833	-10.00%	$1,377,592	10.00%	$1,515,351	$1,377,592
SPRING MOUNTAIN OFF RAMP OVER FLAMINGO ON-RAMP	1	0%	1	0%	1	LS	$3,965,774	-10.00%	$4,406,416	10.00%	$4,847,058	$4,406,416
I-15 SB (SBCD) OVER SPRING MOUNTAIN ON-RAMP	1	0%	1	0%	1	LS	$3,561,331	-10.00%	$3,957,034	10.00%	$4,352,737	$3,957,034
I-15 SB (SBCD) BRIDGE OVER DEAN MARTIN	1	0%	1	0%	1	LS	$4,718,739	-10.00%	$5,243,043	10.00%	$5,767,347	$5,243,043
I-15 SB (SBCD) BRIDGE OVER TWAIN	1	0%	1	0%	1	LS	$4,189,415	-10.00%	$4,654,906	10.00%	$5,120,397	$4,654,906
I-15 SB (SBCD) BRDIGE OVER SPRING MOUNTAIN	1	0%	1	0%	1	LS	$1,728,103	-10.00%	$1,920,114	10.00%	$2,112,125	$1,920,114
SPRING MOUNTAIN FLYOVER BRIDGE	1	0%	1	0%	1	LS	$4,546,840	-10.00%	$5,051,822	10.00%	$5,557,004	$5,051,822
HACIENDA BRDIGE OVER I-15 NB/SB	1	0%	1	0%	1	LS	$6,638,703	-10.00%	$7,376,337	10.00%	$8,113,971	$7,376,337
WIDEN FLAMINGO OVER DEAN MARTIN	1	0%	1	0%	1	LS	$1,891,959	-10.00%	$2,102,177	10.00%	$2,312,395	$2,102,177
HARMON BRIDGE OVER I-15 NB/SB	1	0%	1	0%	1	LS	$10,976,788	-10.00%	$12,198,653	10.00%	$13,416,518	$12,198,653
Walls												
RETAINING WALLS AT RUSSELL	1	0%	1	0%	1	LS	$689,119	-10.00%	$765,688	25.00%	$957,110	$765,688
RETAINING WALLS AT TROPICANA	1	0%	1	0%	1	LS	$277,561	-10.00%	$308,734	25.00%	$385,918	$308,734
RETAINING WALLS AT FLAMINGO	1	0%	1	0%	1	LS	$480,723	-10.00%	$534,137	25.00%	$667,671	$534,137
RETAINING WALLS AT SPRING MOUNTAIN	1	0%	1	0%	1	LS	$2,906,472	-10.00%	$3,229,413	25.00%	$4,036,766	$3,229,413
SOUNDWALL ALONG I-15 SB BETWEEN SPRING MOUNTAIN AND SAHARA	1	0%	1	0%	1	LS	$358,560	-10.00%	$398,400	10.00%	$438,240	$398,400
											Structures Subtotal	$82,201,742
TRAFFIC												
Traffic Signals												
RUSSELL RD EB WITH I-15 NB ON-RAMP	1	0%	1	0%	1	LS	$380,000	-5.00%	$400,000	20.00%	$480,000	$400,000
TROPICANA RD EB WITH I-15 NB ON RAMP	1	0%	1	0%	1	LS	$380,000	-5.00%	$400,000	20.00%	$480,000	$400,000
FLAMINGO RD W/I15 OFF/ON RAMPS	1	0%	1	0%	1	LS	$380,000	-5.00%	$400,000	20.00%	$480,000	$400,000
FLAMINGO RD EB W/ I-15 NB ON RAMP	1	0%	1	0%	1	LS	$380,000	-5.00%	$400,000	20.00%	$480,000	$400,000
SPRING MOUNTAIN W/ I-15 SB ON RAMP	1	0%	1	0%	1	LS	$380,000	-5.00%	$400,000	20.00%	$480,000	$400,000
											Traffic Subtotal	$2,000,000
ADDITIONAL ITEMS												
Additional Items	1	0%	1	0%	1	LS	$21,432,445	-10.00%	$23,813,828	15.00%	$27,385,902	$23,813,828
											Additional Items Subtotal	$23,813,828

Table A-2 – Alternative 2 Baseline Cost Estimate

I-15 Flamingo to Sahara - Alternative 2

Item	Quantity or Pecentage (Low) Under (%)		Base	(%) Over (High)		Unit	Current Year Unit Cost (Low) Under (%)		Base	(%) Over (High)		Current Year Base Total Cost
DRAINAGE												
Drainage												
	1	0%	1	0%	1	LS	$10,104,514	-10.00%	$11,227,238	50.00%	$16,840,857	$11,227,238
											Drainage Subtotal	$11,227,238
Sub-Total Present Day Construction Cost												**$160,842,513**
Landscaping and Aesthetics			3.0%						$4,825,275			$4,825,275
Erosion Control			1.0%						$1,496,153			$1,496,153
Traffic Control			10.0%						$16,084,251			$16,084,251
Roadside Safety			3.0%						$4,825,275			$4,825,275
Additional Items			0.0%						$0			$0
									Sub-Total			$188,073,468
Mobilization			7.0%						$13,165,143			$13,165,143
Total Present Day Construction Cost												**$201,238,611**
Construction Engineering/Inspection			15.0%						$30,185,792			$30,185,792
NEPA			1.0%						$2,012,386			$2,012,386
Preliminary Engineering & Design			4.0%						$8,049,544			$8,049,544
Final Engineeering			4.0%						$8,049,544			$8,049,544
Administration			1.0%						$2,012,386			$2,012,386
Legal			1.0%						$2,012,386			$2,012,386
SOFT COST RISK SPECIFIC ITEMS												
Public commenter sues NDOT			1			LS	$500,000		$1,000,000		$2,000,000	
Project NEON final phase r/w aqcuisition doesn't occur			1			LS	$19,200,000		$19,200,000		$19,200,000	
											Soft Cost Risk Specific Subtotal	$0
Total Present Day Construction and Engineering Cost												**$253,560,649**
RIGHT-OF-WAY												
Right-of-Way			1			LS	$34,627,500	-5.00%	$36,450,000	25.00%	$45,562,500	$36,450,000
											Right-of-Way Subtotal	$36,450,000
Environmental Consideration			3.0%						$7,606,819			$7,606,819
Overall Total Present Day Cost - Alternative 2												**$297,617,469**

Note: No contingency is within the estimate since it is a baseline estimate.

Table A-2 – Alternative 2 Baseline Cost Estimate (Cont.)

APPENDIX B

Workshop Baseline Flow Chart

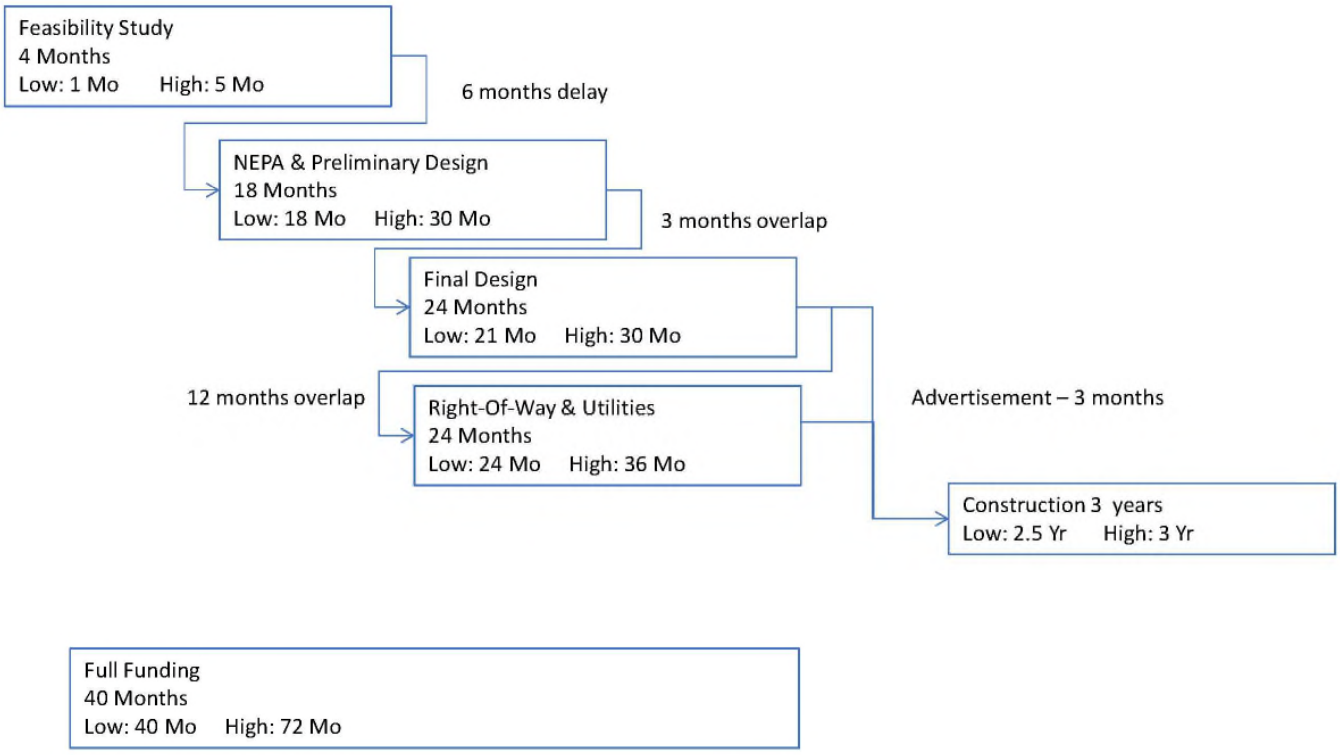


Figure B -1 – Baseline Flow Chart

APPENDIX C

Post Response Risk Register

Threat/Opportunity	Description	Status	Strategy	Alternative 1							Alternative 2							Notes
				Likelihood	Cost Impact			Schedule Impact			Likelihood	Cost Impact			Schedule Impact			
					Low	Most Likely	High	Low	Most Likely	High		Low	Most Likely	High	Low	Most Likely	High	
CONSTRUCTION																		
Displaced persons residing in corridor (Construction)		Active	Accept															Utilize NDOT's Displaced Persons Policy to prepare design details to address displaced persons. Maintenance will clean the corridor prior to construction. *(Contact Mike Yates on how this could impact schedule.)*
Minor Change Orders	NDOT averages approximately 3% of construction cost	Active	Accept	Medium	1%	2%	3%						Same					NDOT has an excellent partnering program that needs to continue.
Drilled Shafts	D/B is more challenging due to expedited schedule. Related to D-B delivery method	Active	Mitigate	Low				-1 MO*	-2 MO*	-3 MO*						Same		Lot of unknown site conditions for drilled shafts. Mitigated through partnering.
Inclement weather	Average 5% of working days	Active	Accept	High					5%							Same		
Contractor resources/quality		Active	Accept	Low (D-B-B)(CMAR) Very Low (D-B)	$100K	$250K	$500K	1 MO	2 MO	3 MO			Same			Same		Poor performance or lack of resources from Contractor or Subcontractors. More likely under Design-Bid-Build scenario or CMAR.
CONTRACTING AND PROCUREMENT																		
Major reconstruction efforts require closure of I-15																		Develop phasing plan to limit or incrementally upgrade the project based on the alternative(s).
Change in Procurement (CMAR/D-B)		Active	Accept	Medium	5%	7.50%	10%	-6 MO	-9 MO	-1 YR			Same			Same		Combining design with early construction activities.
Innovation through VE, D/B - CMAR process		Active	Accept	Medium	-10%	-12.5%	-15%						Same					
Receipt of Federal Grant		Active	Monitor	Very Low				-1 YR	-2 YR	-3 YR						Same		Difficult to assess right now. Once an alternative, cost, and fuding sources, grants such as INFRA and BUILD could be applied for and potentially won.
Use of Incentive/Disincentive clauses		Active	Accept	Medium	$1 MIL	$2 MIL	$4 MIL	-3 MO	-4.5 MO	-6 MO			Same			Same		
DESIGN/PS&E																		
Traffic projections require facilities that are not feasible within the existing footprint		***Retired***																Traffic modeling process must conform to regional projections/volumes/OD matrices. Evaluate facilities using additional MOE besides traffic to determine feasible alternatives. *Mitigated and retired as part of the Feasibility Study*
Schedule of Project NEON's future phase is unknown.		***Retired***																Need to work with NDOT to determine schedule of improvements and potential alternative tie-ins. Provide concept tie ins to match current NEON phase and account for throw away work for future connectivity. *NEON should be done before this project is constructed - Retired*
Landscape plan creates areas for displaced persons to occupy project R/W						Minor							Same					Work with NDOT L&A to develop L&A concepts that discourage occupancy of the R/W.
Coordination with adjacent City of Las Vegas MLK Extension.		Active	Mitigate	Medium	$500K	$1.5 MIL	$3 MIL	2 MO	4 MO	6 MO			Same			Same		Could have an impact to alternative development during the NEPA/Preliminary Design phase.
CLV MLK Extension project concurrent construction.		Active	Monitor	Low				1 MO	2 MO	4 MO						Same		This would be during Construction.
Sidewalks do not exist on both sides of all roadways through the NDOT R/W, but do on adjacent streets. Bike connectivity will also need to be evaluated.	Primary movements have been incorporated into alternatives. Connectivity to CLV MLK Extension will need to be evaluated.	Active	Accept	Low	$500K	$1.5 MIL	$15 MIL						Same					Develop ideas and alternatives that provide better pedestrian connectivity through the corridor's crossing roadways.
HOV System	Is HOV 1 lane/2 lane, still be operated 24/7?	Active	Accept	Low				3 MO	6 MO	9 MO						Same		If HOV system is modified during the design process, could impact schedule based on modifications/evaluations.
High Speed Rail		Active	Monitor	Low														Could change traffic patterns. Will not know true impacts till implemented which could be in 2024. Could be additional funding source.

Figure C-1 – Risk Register – Post Response

ENVIRONMENTAL & HYDRAULICS																		
Displaced persons residing in corridor (NEPA)		Active	Monitor	Low														Just an item that needs to be addressed as part of the documentation unless they already have actual residency.
Hazardous material is encountered	UPRR rail within corridor. Existing bridge structures	Active	Mitigate	Very Low	$250K	$375K	$500K	0 MO	1 MO	2 MO			Same			Same		Conduct Phase 1 ESA. Perform cleanup aligned with EPA requirements. Include in plan and specs for proper contractor notification. Not a critical path item. ***Mitigation: Do early evaluation of existing bridges for potential asbestos and lead containment. Coordinate with Environmental .***
Project/phases of the project not included in the Regional TIP/AQ conformity model delaying completion of NEPA compliance.	Have time to get initial alternative into TIP/AQ, however, any mistake could have schedule impacts	Active	Mitigate	Low				0 YR	0 YR	1 YR						Same		Develop schedule of improvements as early as possible to include in regional TIP/AQ modeling updates when they occur. ***Mitigation: Meet multiple with NDOT Planning and Project Management to conduct thorough review of the TIP/AQ documents prior to submittign to RTC.***
Public commenter complains outside of comment window.	Very high profile property owners adjacent to corridor with fluctuating decision makers/owners	Active	Mitigate	Medium				3 MO	7.5 MO	1 YR						Same		Provide clear information and transparent process to public to reduce poor public perception. Several active lawsuits on NEON and I-15 South had a post construction lawsuit. Need to develop a dedicated, thorough, and continuous stakeholder engagement plan to be part of each project/phase to development/environmental process.
Public commenter sues NDOT based on perceived impacts.	More of a cost risk than schedule risk. Would occur post project completions.	Active	Mitigate	Very Low	$250K	$500K	$1 MIL						Same					Provide clear information and transparent process to public to reduce poor public perception. Several active lawsuits on NEON and I-15 South had a post construction lawsuit. ***Mitigation: Design team look for ways to minimize right-of-way and access impacts.***
Other agency coordination and permitting	Clark County permits	Active	Mitigate	Low				0 MO	1 MO	2 MO						Same		***Mitigation: Final stabilization and dust control plan. Pull in County early for feedback on mitigation efforts and include in plan sets.***
MANAGEMENT & FUNDING																		
Scope change		Active	Mitigate	Medium	$500K	$3 MIL	$6 MIL	3 MO	6 MO	9 MO			Same			Same		Would occur during NEPA or Design Phase. ***Mitigation: Early coordination with stakeholders and internal Divisions on adjacent projects/enhancements and early commitments that to minimize last minute scope additions.***
Project must be phased due to limited funding		Active	Accept	High	$1 MIL	$2.5 MIL	$5 MIL	3 YR	4 YR	5 YR			Same			Same		Project must be phased due to limited funding and additional funding must be identified. Would include impacts to funding related to COVID.
Change in NDOT Leadership/personnel		Active	Accept	High				1 MO	2 MO	3 MO						Same		May be able to mitigate by "shadowing" of personnel.
Change in NDOT priorities		Active	Accept	Medium				1 YR	2.5 YR	5 YR						Same		
Change in NDOT Standards/Specifications/Policies		Active	Accept	High				1 MO	1.5 MO	2 MO						Same		
Ineffieciencies and resource impacts COVID		Active	Accept	Medium				3 MO	4.5 MO	6 MO						Same		Already experiencing this on this project and other projects.
RIGHT-OF-WAY																		
Duration of acquisition could exceed the schedule duration - uncooperative property owner		Active	Accept	Medium				1 MO	2 MO	3 MO						Same		Consider alternatives that limit the number/magnitude of acquisitions/easements. Covers timeframe for condemnations.
Property transfers from previous project have not been executed and are in limbo		***Retired***																Work with NDOT R/W to identify all parcels not currently owned or property transferred and begin final process to secure final R/W rights and ownership. *Very close to finalizing and should not have an impact to overall project critical path*
RAILROAD																		
UPRR Coordination		Active	Accept	High				6 MO	9 MO	1 YR						Same		NDOT has been having issues with UPRR not being responsive. Multiple bridges crossing UPRR

Figure C-1 – Risk Register – Post Response (Cont.)

STRUCTURES AND GEOTECH																		
Expansion of spans due to UPRR approval		Active	Accept	Very Low	$10 MIL	$20 MIL	$30 MIL											UPRR may require r/w to r/w spans for existing bridges.
Replacement of existing MSE Walls		Active	Accept	Low	$1 MIL	$2.5 MIL	$5 MIL											Need to investigate existing MSE walls and the potential of strap corrosion.
UTILITIES																		
Unknown utilities		Active	Mitigate	Medium	$5 Mil	$10 Mil	$15 Mil	3 MO	6 MO	9 MO			Same			Same		Allow for additional costs in project budget. ***Mitigation: During NEPA process conduct more extensive utility coordination/research. At this point no date to justify reduced cost or delay risk.***
Potential for NVE relocations/coordination		Active	Mitigate	High	$300K	$1.2 MIL	$3 MIL	3 MO	6 MO	9 MO			Same			Same		Will identify prior rights during the prior rights research.
NVE Substation Infrastructure Impacts		Active	Avoid	Low														
Utility relocations needed do not happen on schedule impacting construction schedule.	Gas line along UPRR, Kern River or Kinder Morgan	Active	Accept	Medium				3 MO	6 MO	9 MO						Same		Up-front and continued coordination with utility companies to explain the impacts. Put responsibility on CMAR/Design Builder to avoid or coordinate early with utilities.
Utility underground is damaged	Utility hit during construction	Active	Mitigate	Low		Minor		3 MO	6 MO	9 MO			Same			Same		Work with utilities in advance to identify potential damaged locations. Document these in project specifications. Follow up with utility companies RE: repair work.
Temporary NVE planned connection	There was a planned temporary line that had to be in conflict with proposed improvements due to construction of the monorail.	Active	Monitor	Very Low					N/A						0 MO	3 MO	6 MO	Monorail schedule in limbo. Need to continue monitoring and coordination with Monorail Company. ***Mitigation: NDOT will have temporary permit approval authority. Work with permits to make sure Project Management is notified if the permit is submitted to avoid project conflict.***

Figure C-1 – Risk Register – Post Response (Cont.)

APPENDIX D
Additional Risk Output

NDOT Risk Breakdown Structure Category	I-15 – Flamingo Road to Sahara Avenue Risk Count			
	Active	Inactive	Retired	Total
Environmental & Hydraulics	6	0	0	6
Right-of-Way	1	0	1	2
Utilities	6	0	0	6
Railroad	1	0	0	1
Design/PS&E	6	0	2	8
Structure & Geotech	2	0	0	2
Management/Funding	6	0	0	6
Contracting & Procurement	5	0	0	5
Construction	5	0	0	5
Total	**38**	**0**	**3**	**41**

Table D-1 – I-15 – Flamingo Road to Sahara Avenue Risk Count Detail